Department of Energy

Condition Assessment Survey (CAS) Program

Deficiency Standards & Inspections Methods Manual

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for
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INTRODUCTION

CAS PROGRAM OVERVIEW

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INTRODUCTION

GENERAL

Welcome to the DOE Condition Assessment Survey (CAS) Program. In the next few pages you will be introduced to a new way of seeing familiar things. As an introduction to CAS, this Program Overview will explain how the various parts of CAS have been developed and integrated to meet the needs of DOE sites, Field Offices, and Headquarters. Our discussion will center around three broad topics:

- WHY CAS?

  This section will discuss issues DOE has faced in previous inspection approaches and explain the CAS goals of providing creative “standardized” solutions.

- WHAT IS CAS?

  Here, key elements of the CAS Program and how they relate to each other will be examined

- HOW IS CAS IMPLEMENTED?

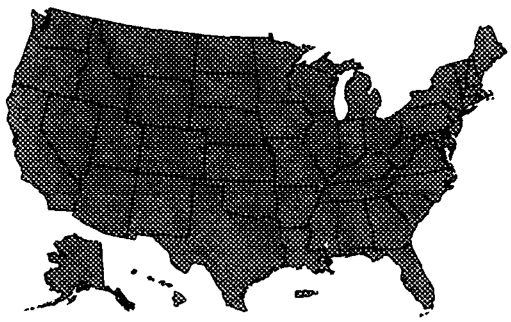
  Strategies for beginning to use CAS and the key roles facility managers and CAS inspectors play within the CAS process are detailed.

Again, welcome to the CAS Program. Your role in this program is essential to its overall success.

INTRODUCTION

WHY CAS?

DOE NATIONWIDE INVENTORY:



- 10,000 BUILDINGS AND 15,000 STRUCTURES ON 52 SITES NATIONWIDE
- LACK OF DOE STANDARDS
- VARYING DEGREES OF INSPECTION
- INCONSISTENT RESULTS **LEADING TO INEQUITIES AMONG SITES**

INTRODUCTION

WHY CAS? - The State of DOE

The use of standards, from simple weights and measures to complex computer language, has been a fundamental part of human development. Because of standards, we can be assured that a meter of length in one place is the same in another. This question of standards has become increasingly important for DOE. Over the past 50 years, DOE and predecessor agencies have been at the forefront of the nation's technical advances. This investment has left the department a vast array of facilities under its care. With 10,000 facilities and 15,000 miscellaneous structures comprising over 100,000,000 square feet at 52 sites across the country, the problem of design, construction, and maintenance of all DOE physical plants is acute. Add aging facilities, revised missions, and changing technology, and condition assessment becomes a vital tool to use to ensure facilities will continue to meet DOE's and the nation's program goals.

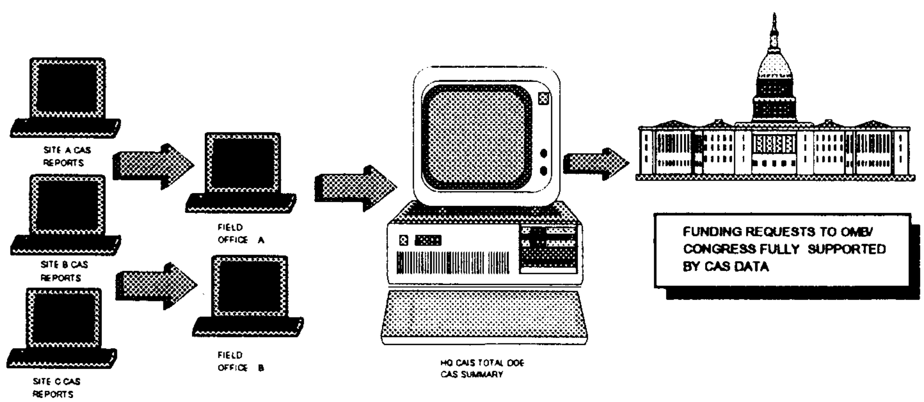
The current state of condition assessment across all DOE assets is mixed. While DOE regulations dictate facility assessments be made, no one methodology is mandated to conduct them. As a result, DOE surveys have varied from site to site, with some locations providing exhaustive in-depth analysis while others have used a more limited approach. Because of such different interpretations, it is difficult to judge the validity and comparability of data being provided. This, in turn, has led to funding requests that cannot be fully substantiated to Congress.

This lack of standards for use in the facility assessment process and the resultant inconsistencies in developing program budgets have convinced DOE that a standardized, clearly defined methodology for condition assessment is essential to support DOE's program missions.

INTRODUCTION

WHY CAS?

- ASSESS PHYSICAL CONDITION OF EXTENSIVE AND VARIED DOE FACILITY AND EQUIPMENT INVENTORY
- STANDARDIZE INSPECTION PROGRAM FOR ALL SITES
- IDENTIFY REPAIR/REPLACEMENT NEEDS TO FACILITATE KEY BUDGET DECISION MAKING
- DEVELOP SUPPORTABLE FUNDING REQUESTS BASED ON "UNIVERSAL" STANDARDS



INTRODUCTION

WHY CAS? - Four Key Requirements

In today's economic environment, it is essential that the DOE knows with confidence the condition of its vast asset inventory. To accomplish this, a method to review all DOE assets in a "standardized" approach is required. In designing guidelines for such a program, DOE established four key requirements:

Assess Physical Condition of All Assets:

To be valid, all sites eventually must be included in the program. Universal participation will ensure that all DOE sites and installations will be using the same "score card."

Standardize Inspection Programs:

To remove the problem of inconsistent and misinterpreted facility inspection data, a "standard" evaluation method used by all DOE sites is required. Results from such a program will allow DOE to determine a "base condition" for all of its assets.

Identify Repair/Replacement Funding:

Using inspection data from all sites, a general picture across all DOE assets and programs can be used to direct limited resources to crucial areas. Standardized reports form "a level playing field" to ensure that all programs and missions will receive a fair analysis.

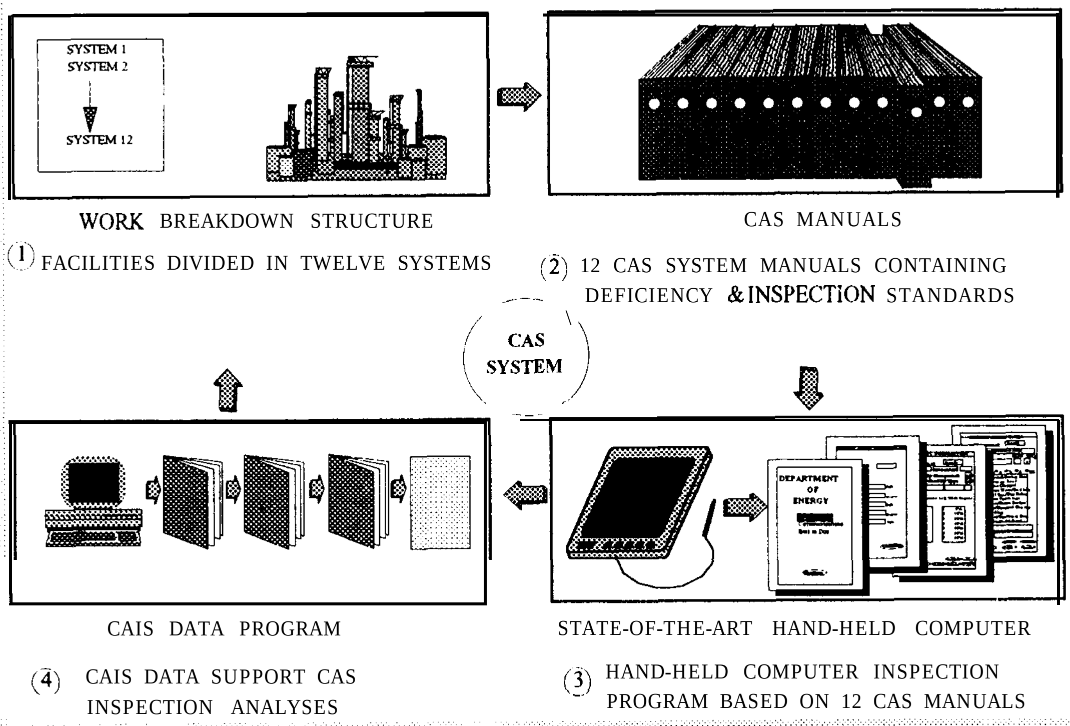
Develop Supportable Funding Requests:

In today's atmosphere of fiscal constraint, requests for funds from Congress require extensive justification, backed up by reliable, consistent field data, if such programs are to be successfully supported.

INTRODUCTION

WHAT IS CAS?

A SYSTEMATIC INSPECTION APPROACH INSTITUTED AT ALL SITES



INTRODUCTION

WHAT IS CAS? - The Work Breakdown **Structure** (WBS)

The CAS system has been developed to answer the critical questions facing DOE. Using state-of-the-art hand-held computers and system software programs, the CAS process will establish a systemized, standard approach to facility and asset evaluations. This program will help DOE provide the necessary assets as it seeks to bring our nation's premier research and development agency into the year 2000 and beyond.

The condition assessment process involves evaluating separate building "systems" that comprise the entire facility. These systems traditionally fall under three broad professional disciplines: architectural (including structural), mechanical, and electrical. Specialty assessments (e.g. industrial hygiene, chemical engineering) are usually performed as adjuncts to these primary disciplines when required. The WBS employed under CAS is based on the 12 system assemblies that R.S. Means employs in its square foot cost analysis. Using this system as a foundation to define assemblies and components in the CAS Program will create a direct link to a broadly accepted industry-wide standard.

TABLE ONE

WORK BREAKDOWN STRUCTURE

SYSTEM (R.S. MEANS CAT.)	CONTROL NO.
FOUNDATIONS & FOOTINGS..	0.01 SYSTEM
SUBSTRUCTURE	0.02 SYSTEM
SUPERSTRUCTURE..	0.03 SYSTEM
EXTERIOR CLOSURE	0.04 SYSTEM
ROOFING	0.05 SYSTEM
INTERIOR FINISHES & CONSTRUCTION	0.06 SYSTEM
CONVEYING SYSTEMS	0.07 SYSTEM
MECHANICAL SYSTEMS	0.08 SYSTEM
ELECTRICAL SYSTEMS	0.09 SYSTEM
*PROD/LAB/OTHER EQUIPMENT..	0.10 SYSTEM
SPECIALTY SYSTEMS..	0.11 SYSTEM
SITEWORK	0.12 SYSTEM

CONSTRUCTION SPECIFICATIONS

DIVISION (MASTERFORMAT)	DESCRIPTION
01000	GENERAL REQUIREMENTS
02000	SITEWORK
03000	CONCRETE
04000	MASONRY
05000	METALS
06000	WOOD & PLASTICS
07000	THERMA L & MOISTURE PROTECTION
08000	DOORS &WINDOWS
09000	FINISHES
10000	SPECIALTIES
11000	EQUIPMENT
12000	FURNISHINGS
13000	SPECIAL CONSTRUCTION
14000	CONVEYING SYSTEMS
15000	MECHANICAL
16000	ELECTRICAL

The WBS of the CAS Program will be linked to the MASTERFORMAT system developed by the Construction Specifications Institute (CSI) and used as the basis for the DOE Design Guide (DOE 6430.1A). These CSI numbers will be referenced after each system assembly and component in the CAS Manuals as follows:

EXAMPLE: Roofing (CSI 07000)

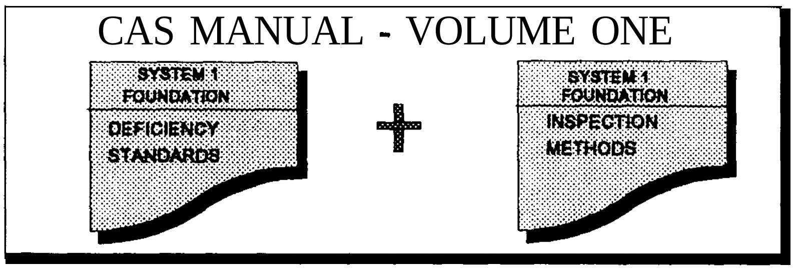
*NOTE: This section supersedes Means 0.10 category and includes FIS 700 Series Asset Codes.

INTRODUCTION

WHAT IS CAS?

DEFICIENCY STANDARDS & INSPECTION METHODS MANUAL

- DEVELOPED SEPARATELY FOR EACH SYSTEM
- DEFICIENCY STANDARDS CONTAIN NARRATIVE AND GRAPHICS FOR DESCRIBING DEFICIENCIES AFFECTING SYSTEM ASSEMBLIES
- INSPECTION METHODS CONTAIN PROCEDURES TO IDENTIFY TYPE, SEVERITY, AND PERCENT COVERAGE OF EACH COMPONENT OR SYSTEM DEFICIENCY ILLUSTRATED



INTRODUCTION

WHAT IS CAS? - DOE CAS Manual Format

Using these 12 systems as the basic organizing principal, the DOE CAS Manual will contain Deficiency Standards and Inspection Methods. It will be divided into 12 volumes corresponding to these established WBS systems The internal organization of manuals is outlined below.

SECTION 1 - SYSTEM INFORMATION

1.1 Asset Determinant **Factor/CAS** Repair **Codes/CAS** Cost Factors - Discusses the Asset Determinant Factor (ADF), a decision matrix used to provide a graded approach to inspectlons commensurate with the use and relative importance of the asset inspected. Also addresses the CAS repair codes, and a general overview of cost estimating techniques.

1.2 Guide Sheet Tools & Materials Listing - Contains tools and materials groups used in conjunction with the inspection methods process for the system outlined in each volume.

I.3 Testing Methods - Contains the specific requirements for testing methods applicable to the systems

1.4 Inspection Frequency - Schedule of CAS inspection frequencies for systems/components

1.5 Standard System Design Life Tables - Standard design life tables for the system assemblies/components.

I.6 System Work Breakdown Structure (WBS) - Complete listing of all assemblies/components

1.7 General System/Material Data - General material data relevant to system deficiency problems (Optional, not included for all systems.)

SECTION 2 - DEFICIENCY STANDARDS

Each major assembly/component is defined by a brief narrative and accompanying graphic(s) that visually illustrate the general characteristics. Major deficiencies affecting this assembly/component are described, including probable failure points. A deficiency characteristics profile and graphic illustrations are provided with each deficiency defined

SECTION 3 - INSPECTION METHODS

This section contains discussions of methods and procedures involved in inspecting each of the WBS systems Each system contains an Inspection Method, including a narrative and a System/Component Inspection Guide Sheet Listing that provides a general overview for each defined major assembly/component type. This information will be developed for Standard and Non-Standard Inspections and testing methods that would be used in conjunction with Standard or Non-Standard Inspection Methods. Also included is a simulated example, “walking” the inspector through the data collection process.

SECTION 4 - REFERENCES

All major reference standards used and/or associated with the system are described, including government, industry, and DOE references.

APPENDICES

Appendix A Abbreviations - All abbreviated terms contained in the CAS manuals

Appendix B Glossary - All technical terms directly related to the particular systems discussed will be defined in this subsection.

Appendix C Technical Bulletins/Updates/Advisories - This subsection contains technical information issued by the government and/or private industry that may affect specific data as developed in the particular volume. DOE guidelines may also be included in this subsection.

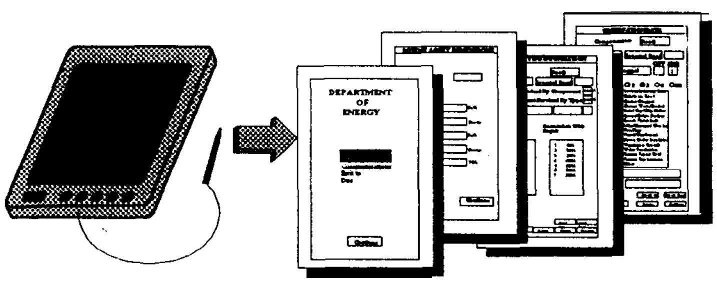
Appendix D Revisions Summary - All revisions listed in chronological sequence The last revision listed will be the most current modification.

INTRODUCTION

WHAT IS CAS?

STATE-OF-THE-ART TECHNOLOGY STREAMLINES FIELD CONDITION ASSESSMENT SURVEY PROCESS

- ❑ HAND-HELD COMPUTER "PROMPTS" INSPECTOR WITH PRELOADED SOFTWARE SYSTEM "MENUS"
- ❑ INSPECTOR SELECTS DEFICIENCIES, SEVERITY, PERCENTAGE OF COVERAGE, LOCATION, ETC. FROM "MENU" SYSTEM



INTRODUCTION

WHAT IS CAS? - State-Of-The-Art Technology

At the outset of this introduction, we talked about a "new way" of seeing familiar things. The traditional methods of facility assessment inspection, using hard copy forms then entering data either by laptop or into a PC, have given way to a new, exciting technology: The Pen-Based Computer. This hardware, and the Condition Assessment Information System (CAIS) software developed to support it, form the heart of the DOE CAS data collection process. Using the CAS manuals as the basis to develop the inspection process, CAIS software will create pre-stocked survey "menus". These will be used to record defined deficiencies in terms of severity and coverage. With this user-friendly device, inspectors will simply use a pen-like device to record their observations directly on the prompted inspection screens developed for each system.

The advantages in using this technology for the DOE CAS Program are exceptional. The efficiency gained by using the hand-held computer technology to prompt the inventory and facility inspection process will be significant. This eliminates the manhour-intensive and error-prone process of converting manually developed data into an automated database. This technology system ensures that all pertinent data is collected, guiding the inspector through each step of the process. This method will significantly enhance the effectiveness of quality assurance/quality control of the DOE CAS Program, permitting editing as data is entered, eliminating illogical or erroneous choices.

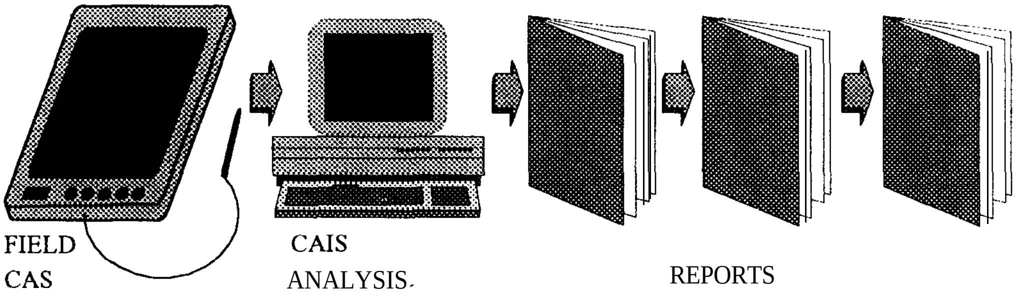
In short, the CAS process will be conducted in a carefully structured, "standardized" manner to ensure that the quality of raw inspection data is consistent throughout all DOE installations.

INTRODUCTION

WHAT IS CAS?

CAIS PROGRAM FOR HAND-HELD & PCs SUPPORT THE CAS PROGRAM

- INSPECTION DATA DOWNLOADED TO PC-BASED CAIS PROGRAM
- DATA ANALYZED, CATEGORIZED, AND SORTED
- REPORTS GENERALIZED, INCLUDING UNIVERSAL AND SUMMARY VERSIONS
- REPORTS WILL INCLUDE DEFICIENCY DESCRIPTIONS, COSTS TO REPAIR/REPLACE, AND SCHEDULE



INTRODUCTION

WHAT IS CAS? - The **CAIS** Connection

Asset condition information is uploaded directly to the PC and the CAIS program, eliminating the laborious hand input of data. If the hand-held is the “eyes and ears” of CAS, then the CAIS database is the “brain.” In the program, raw data is sorted and analyzed to create CAS reports. Several key factors are determined during the process:

Deficiencies Affecting Survey Assets:

The inspector describes each deficiency noting its severity and coverage, i.e. how much of the component or assembly reflects the deficiency. The inspector also codes each component or assembly as to condition and the urgency and purpose of proposed repair or replacement actions.

Corrective Repairs:

Based on these recorded deficiencies, corrective actions and their associated repair codes are defined and processed by the CAIS database.

Project Costs:

Costs to accomplish repairs and replacements are generated by the manipulation of field data in the CAIS program, which employs several methods including determining cost as a percentage of total replacement and/or direct entry of costs. (See Section 1, Subsection 1.1 for discussion of cost development.)

Asset Reports:

Preformatted reports and tables are generated by the CAIS System. Report types include “universal” reports listing all deficiencies and observations recorded by the Inspector, summary asset reports, and summary site reports. Data within the CAIS system can also be manipulated readily to create “custom” reports.

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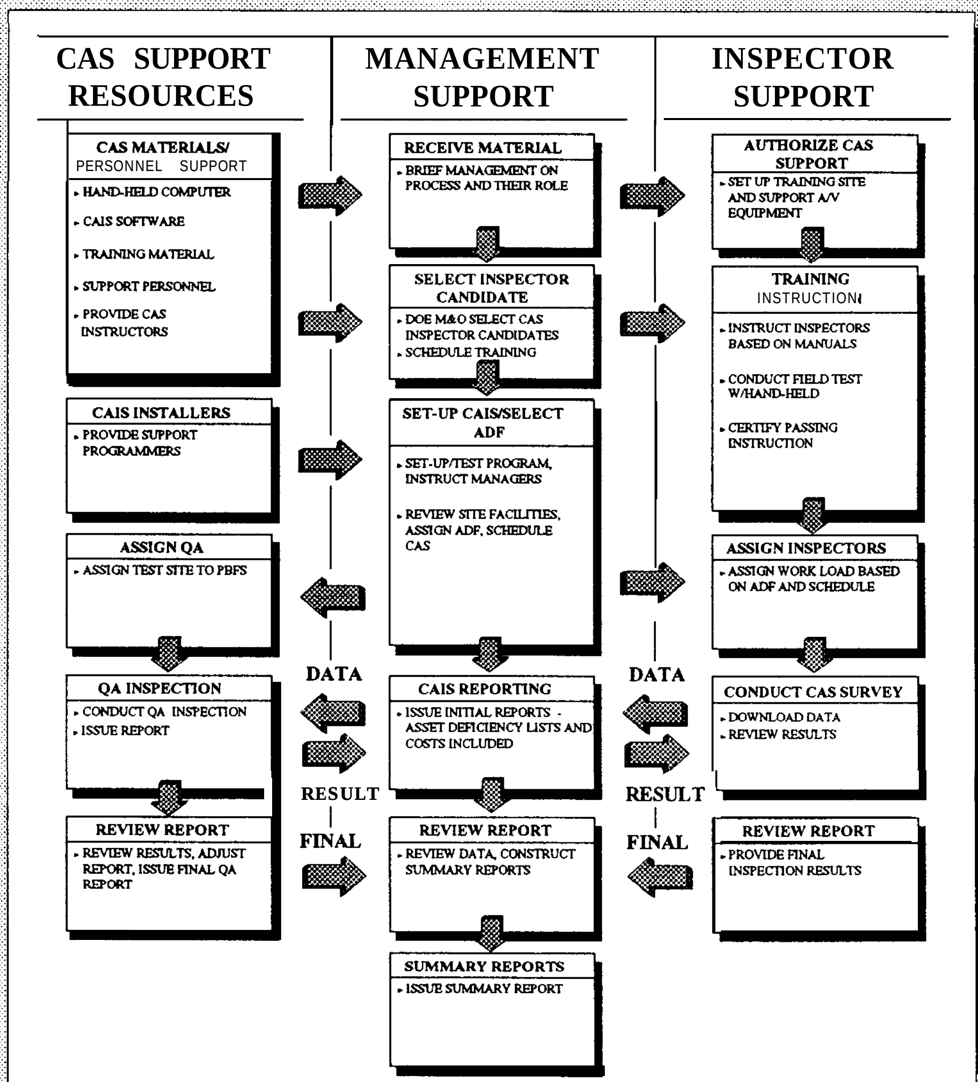
HOW IS CAS IMPLEMENTED?



INTRODUCTION

HOW IS CAS IMPLEMENTED? - Support Roles

While CAS manuals, hardware and the CAIS database are the main building blocks of the CAS Program, CAS support personnel will form the standing framework. Your role in the implementation process is crucial if the CAS system is to succeed. In reviewing this process, three key support groups are highlighted.

CAS Contractor Support Personnel:

In conjunction with DOE managers and Site Management & Operations (M&O) contractors, CAS contractor support personnel will work closely with DOE in setting up and conducting the training program, installing CAIS, and validating CAS through a Quality Assurance (QA) program. This team of CAS trainers, CAIS programmers, and QA engineers and architects will form, along with DOE M&O personnel, the strong team required to support the CAS Program as it proceeds.

Manager Support:

No group is more important in implementing CAS than the DOE managers and M&O contractors. Their in-depth knowledge of the sites and their personnel will help guide and strengthen the entire CAS system.

CAS Inspectors:

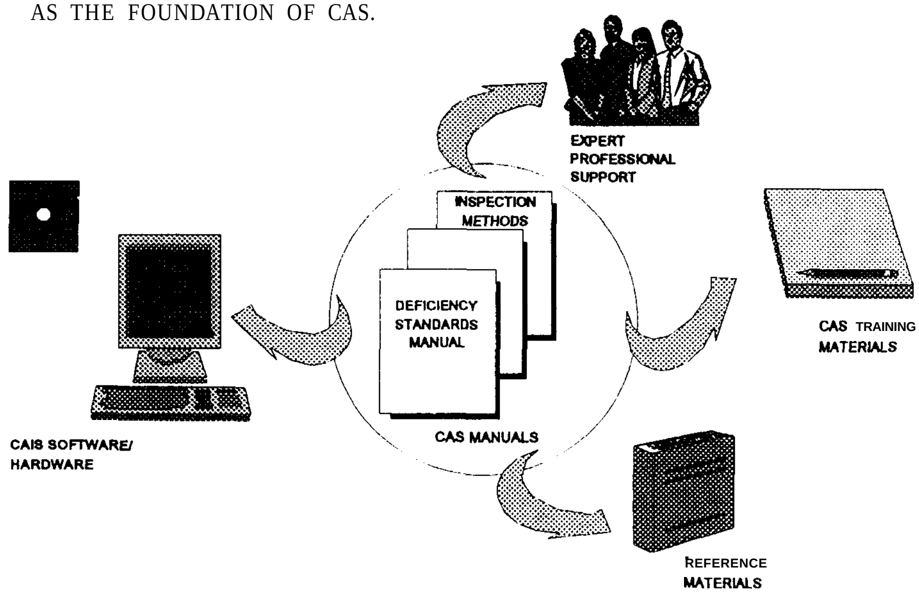
Without highly skilled, knowledgeable inspectors, the CAS Program will not succeed. The integrity of these inspectors and their expertise will ensure that the base data supporting the entire CAS process will be an accurate reflection of the condition of the DOE inventory of facilities and assets.

INTRODUCTION

HOW IS CAS IMPLEMENTED?

CAS SUPPORT RESOURCES

- DEFICIENCY STANDARDS AND INSPECTION METHODS MANUALS SERVE AS THE FOUNDATION OF CAS.



INTRODUCTION

HOW IS CAS IMPLEMENTED? - CAS Support Resources

We have spoken generally of the CAS Process and those resources (manuals, hardware, CAIS software) required to implement the system. Additionally, the CAS contractor will supply all of the technical personnel to support, implement, and guide the CAS Program. Among those key professionals are:

CAS Training Instructors:

Professionals with a technical background and well-versed in training methods, will train CAS inspector candidates. Their mission will be to instruct and guide CAS inspector candidates through the entire process, supervise field exercises, and provide final testing. Their goal is that all candidates will be successful participants in the CAS Inspection process.

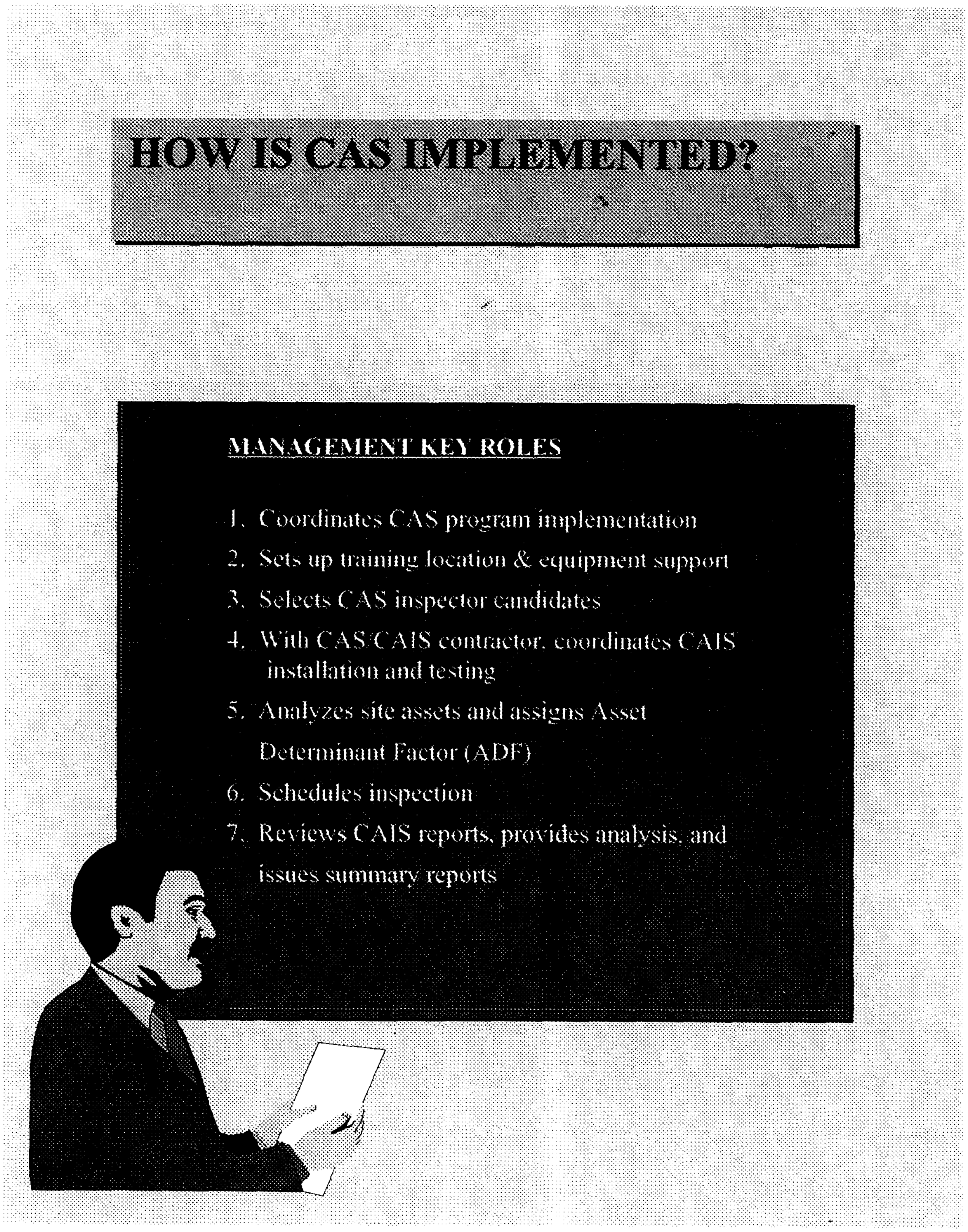
CAIS Programmers:

A key CAS Program element is the CAIS. Expert programmers will supervise the installation of the PC-based program and provide guidance and instruction for DOE M&O managers in using the system.

CAS/CAIS Hotline:

The Contractor will provide support resources in order to field questions from various site locations. Expert engineers, architects, and computer programmers will answer with written and/or verbal responses all inquiries originating from the field.

INTRODUCTION



INTRODUCTION

HOW IS CAS IMPLEMENTED? - The Management Role

The critical role DOE M&O managers will play in the CAS process cannot be overstated. Their understanding and direct input will guide the construction of the CAS Program. Their chief responsibilities are:

Initial Implementation:

CAS start-up will include a general briefing by the CAS contractor at designated sites to instruct all key managers in the process and their responsibilities. DOE M&O management actions include training site set-up (to hold maximum of 25 students), arrangements for required A/V equipment (overheads, slide projectors, etc.), and CAS inspector candidate selection (see Guidelines for Implementation of CAS Certification Training under separate cover).

Setting Up CAIS:

In conjunction with CAIS programmers, DOE M&O managers will be instructed in the function and various uses of CAIS software. Data input, system operation, report generation with predetermined report format, and how data can be manipulated to customize reports, will be examined during this training.

ADF Selection & CAS Schedule:

A vital element of the CAS Program is the development of a CAS “strategy.” DOE M&O managers will be instructed in the use of the Asset Determinant Factor (ADF) to sort site assets into varied inspection effort levels. See Section 1, Subsection 1 .1 Asset Determinant Factor (ADF), CAS Repair Codes, and CAS Cost Factors. The ADF will guide the DOE M&O managers in scheduling the survey and assigning CAS Inspectors to various assets.

Report **Analysis:**

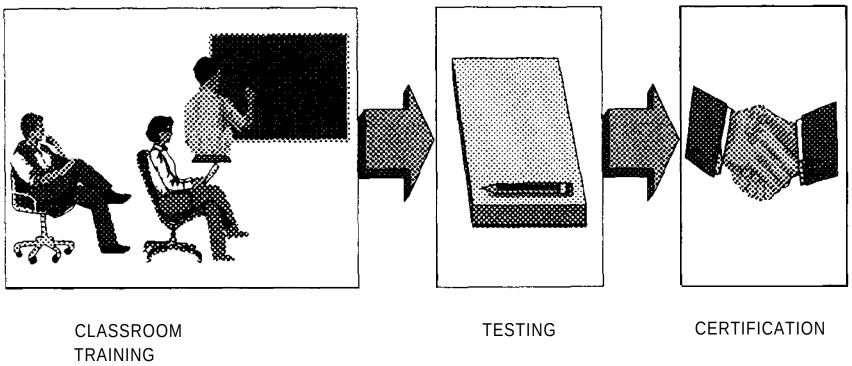
The process of up-loading CAS field data to the PC-based CAIS program will be demonstrated to the M&O CAS managers. Analysis processes will be examined using predetermined, formatted reports. Final management project “sorts” and prioritization schemes, and construction of summary reports for higher authorities, will comprise the basic CAS report development sequence.

INTRODUCTION

HOW IS CAS IMPLEMENTED?

CAS INSPECTOR CERTIFICATION

- ❑ INSPECTOR CANDIDATES ARE TRAINED, TESTED, AND CERTIFIED USING THE CAS PROGRAM



INTRODUCTION

HOW IS CAS IMPLEMENTED? CAS **Inspector** Certification

While the CAS manuals, hand-held computer, and CAIS software program are the tools of the CAS system, the CAS Inspector is the system "operator." The old adage, "The data output is only as good as the data input," truly applies to the inspectors' role in the CAS process. As part of the effort to assure accurate, consistent results, the CAS Program includes an Inspector training phase that will "certify" all candidates in the use of the CAS system. It should be noted that it is not the training course's intent to train personnel to be inspectors: it is assumed that candidates will come to the CAS Program with a strong background and past experience in the disciplines they will inspect (see Guidelines for Implementation of CAS Certification Training (GICT) under separate cover for detailed information). Key phases of the course include:

Prequalification:

Based on experience levels set by GICT, candidates are selected by the M&O contractors and sent to the CAS training program.

Classroom Training:

Classroom instruction will be conducted at the sites selected by DOE. Course materials, based on the Deficiency Standards and Inspection Methods sections in the manuals, will clearly demonstrate the nature of the CAS system and how it is to be used. Hand-held computers will be used during the course. At course conclusion, these units will be turned over to the inspectors for use in the CAS Program and become the property of the site that the inspectors represent.

Field Exercise:

During the training course, a field exercise using the hand-held will be conducted at a predetermined test asset. This survey and its results will be an integral part of the inspection education program.

Certification Test:

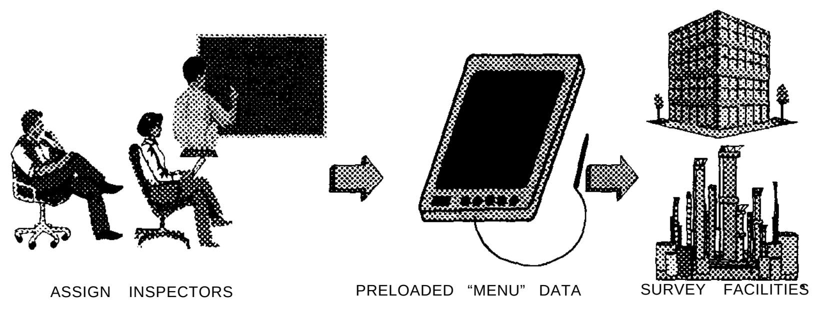
At the completion of the CAS training, each candidate is required to take and pass a written examination based on the material covered in the class. It is the goal of the training team to pass 100% of the candidates. Those having difficulty will receive additional instructor attention during the class as required. After passing this examination, candidates will be fully certified CAS Inspectors.

INTRODUCTION

HOW IS CAS IMPLEMENTED?

THE SURVEY PROCESS

- CERTIFIED CAS INSPECTORS FOR EACH MAJOR DISCIPLINE ARE ASSIGNED FACILITY ASSETS TO INSPECT
- PRE-LOADED SURVEY ROUTINES FOR EACH SYSTEM ARE PROVIDED THROUGH HAND-HELD COMPUTER CAS SOFTWARE PROGRAM



INTRODUCTION

HOW IS CAS IMPLEMENTED? - The Survev Process

At the completion of CAS training and upon the M&O managers' ADF asset selection and development of survey schedules, certified CAS inspectors will be assigned assets to inspect. This step initiates the CAS process, which will involve several major phases.

start-up:

The objective during start-up is to prepare a profile information file for the asset being surveyed and to verify preloaded information (RPIS data, name, and address, etc.). Such a review might include part and/or all of the material listed below:

- As-built and/or construction documents
- Square footage, type of construction, and age of each building
- Existing studies, surveys, and reports; and
- Existing repair, alteration, or construction projects

Conduct CAS Inspection/Evaluation:

With the benefit of the information contained in the asset file, the CAS Inspector will perform a thorough evaluation of the WBS systems required for each of the assigned assets. The Inspector will initially review the asset file to note particular problems. With this accomplished, the CAS Inspector will methodically survey each of his assets and record deficiencies (in terms of severity and coverage) and other observations on the preprogrammed hand-held computer. He accomplishes this data recording through "menu" screens contained in the CAS hand-held computer software, which will guide the CAS Inspector through the process (see Section 3 for full detailed information outlining step-by-step the CAS inspection process).

CAS Report Generated by **CAIS:**

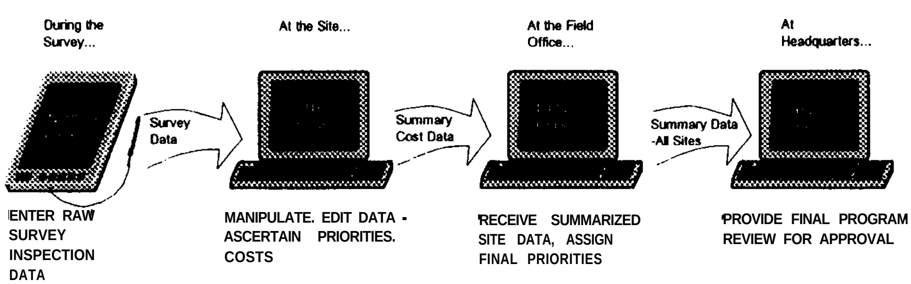
After completing the CAS Inspection, information is uploaded to the PC-based CAIS system. "Universal" reports showing all asset deficiencies, observations, associated cost, scheduling priorities, and repair purposes will be produced. As part of the QA, the Inspector will review this information with the manager to ensure that all aspects of the inspection asset information are correct.

INTRODUCTION

HOW IS CAS IMPLEMENTED?

SUMMARY REPORTS

- IMPROVE ACCURACY AND PROVIDE QA FOR ALL SITE INSPECTION DATA
- FINAL REVIEW OF PRELIMINARY REPORTS BY THE MANAGERS TO "PRIORITIZE" REPAIR/REPLACEMENT REQUIREMENTS FROM ASSET TO ASSET
- ISSUE SUMMARY RESULTS WITH FULL BACK-UP AT SITE



INTRODUCTION

HOW IS CAS IMPLEMENTED? . Report Development

With the completion of the CAS Inspector's survey, data uploaded into the PC-based CAIS program is analyzed to provide the survey reports. The primary preformatted reports include:

"Universal" Report:

This document contains all the information recorded concerning deficiencies found in the WBS systems surveyed in each asset. The report lists all deficiencies and observations system by system. The summary section provides the cost of repairing surveyed asset deficiencies and repair codes showing condition, purpose, and urgency. Costs are calculated in CAIS based on deficiencies noted. Inspectors can also directly input repair costs either as a percentage of replacement costs or as an absolute dollar value.

Asset Summary Report:

This report contains summary asset deficiency data at the WBS system level only. The report lists deficiency/corrective repair action by codes (see Subsection 1 .1 for more information). All assets surveyed by the Inspector will be listed here. Manager input to these reports includes resorting the priority list (including additions and/or deletions) and recommendations.

Site Asset Summary Report:

After all inspector surveys have been processed, analyzed, and final recommendations input by the manager, this preliminary site-wide report lists all assets included and preliminary manager sorts (Asset Summary Report). Manager input includes selecting of final projects recommended for the budget cycle, including cost and priority schedules.

Site Summary Report:

This report, issued to DOE Headquarters, contains a site project summary and synopsis of back-up data. This report will serve as the basis for establishing the site maintenance and repair backlog which in turn supports funding recommendations to OMB and Congress.

OTHER REPORTS

QA Report:

As part of the QA process, the contractor QA team will randomly select assets inspected by site CAS Inspectors. Results will be analyzed to determine both accuracy and content of the CAS Program to ensure the validity of CAS procedures.

Custom Reports:

Data within the CAS/CAIS database can be manipulated to create various reports. Examples might include a report showing all site roofs, cost magnitude, and/or by building type.

INTRODUCTION

CAS SUMMARY

- STANDARD APPROACH TO CONDITION ASSESSMENT
- EASE/ACCURACY OF DATA COLLECTION
- SITE-CONTROLLED DATABASE
- SUMMARY DATA TO FIELD OPERATIONS & HQ LEVELS
- MORE CREDIBLE DOE BUDGET SUBMISSIONS

INTRODUCTION

THE CAS SYSTEM: - A Summary

In summary, the CAS System has been designed to support the vital process of creating a facility condition baseline that is founded on recognized, fully defined Standards. This established baseline will determine the direction and cost of future assets required to define the DOE's changing mission against a background of government fiscal constraint. As you have seen, your role in this overall program is vital if the CAS framework is to be created and supported. The CAS System is your tool for constructing the essential, realistic requirements needed to obtain budgetary funding. Obtaining these funds is the final measure of whether a site program will move forward or be eliminated.

We began this introduction by promising you a "new way" of seeing familiar things. The CAS Program's combination of state-of-the-art technology and the DOE M&O's talented professionals will be the essential mix to successfully initiate and sustain the CAS process.

INTRODUCTION

END OF SUBSECTION

ASSET DETERMINANT FACTOR/CAS REPAIR CODES/CAS COST FACTORS

GENERAL

The CAS Program is built on the physical analysis of each asset through the inspection of the major systems as defined by the WBS. System-specific deficiencies (as defined for each assembly/component in the Deficiency Standards section of this Manual) and the extent of their severity "bracket" the general asset conditions as of the inspection date. Recording actual deficiencies, however, is only part of the process. The CAS process also documents the urgency and purpose of repairs or replacements as well as the overall condition of the assembly/component surveyed.

The following elements are important parts of the CAS process and will be discussed in detail in this subsection:

- ASSET DETERMINANT FACTOR (ADF): Discusses various possible levels of CAS inspections, and the manager's role in determining the type survey appropriate for each asset.
- CAS REPAIR CODES: Describes categories used by the inspector to document the urgency and purpose of repairs and replacements, and the general condition of the assembly/-component.
- CAS COST FACTORS: The general overview of CAS cost development and the factors used to build project costs are outlined in this section.

CAIS Interface:

As outlined in the Introduction "A CAS Program Overview," the Condition Assessment Information System (CAIS) is a key element. CAIS software will provide critical data analyses required to process CAS raw field data, including repair codes and costing factors for recorded facility asset conditions. The CAS Manuals, the hand-held data collection device and software, and the CAIS Program together form the foundation of the CAS process.

In DOE's vast inventory, asset conditions vary widely in terms of age and use, new or renovated facilities are mixed with assets built during the 1940s and 1950s. It is therefore recognized that not all assets at a given site require the full CAS inspection. The ADF has been developed as a tool that provides site facility managers with a means to categorize each site asset by identifying the type of survey to conduct.

CAS Survey Levels:

For the purposes of allowing flexible CAS Program implementation, three broad categories of asset inspections are defined:

- CAS - Base Level: Assessment is primarily a visual inspection (augmented in some instances by simple testing; eg., light level measured by light meter) recorded at the assembly level of the Work Breakdown Structure (WBS). Deficiencies typical to each assembly are recorded in terms of severity and coverage.
- CAS - Component Level: Provides more extensive inspection information based on conducting the assessment at a component level. Components are defined as major parts of an assembly.
- CAS - Limited: Survey not requiring assessments of all systems for a given asset.

ASSET DETERMINANT **FACTOR/CAS** REPAIR **CODES/CAS** COST FACTORS

ASSET DETERMINANT FACTOR **(ADF)**

Ten key categories to be used as ADF guidelines are illustrated below. These classifications are sensitive to key DOE criteria, including short-term and mothballed facilities.

ADF#	Guidance	Description	Systems
1	Existing asset (>3 years), program projected to last 5 years	Full CAS Inspection (base CAS - assembly level or optional component level)'	ALL
2	Existing temporary asset (>3 years) program projected to last - < 5 years	Limited CAS Inspection (base CAS assembly level only)	ALL
3	Asset decommissioned - "warm mothball" (maintained for future unidentified function)	ARCH(ext), MECH & ELEC (base CAS - assembly level or optional component level)[1]	0.04, 0.05, 0.08, 0.09
4	Asset decommissioned - "cold mothball" (to be removed, dismantled, destroyed at some future date)	Exterior envelope (base CAS - assembly level only)	0.04, 0.05
5	Asset ROOF inspection only	ROOF inspection (base CAS - assembly level or optional component level)'	0.05
6	Asset ARCHITECTURAL only	ARCH/STRUCTURAL inspection (base CAS - assembly level or optional component level)'	0.01, 0.02, 0.03, 0.04, 0.05, 0.06, and 0.11
7	Asset MECHANICAL only	MECHANICAL inspection (base CAS - assembly level or optional component level including incidental electrical)'	0.07, 0.08
8	Asset ELECTRICAL only	ELECTRICAL inspection (base CAS - assembly level or optional component level)'	0.09
9	Asset SITE inspection only	SITE inspection (base CAS - assembly or optional component level) [1]	0.12
10	As developed by each site	As constructed by site[2]	As Required

GENERAL NOTES:

1 Survey may combine levels (eg., ADF #1, Systems 0.01-0.06, 0 11, and 0.12 Assembly level survey; 0.07, 0.08, and 0.09 Component level survey.)

2 Other surveys may be structured on an as-required by sites.

3. ADF values are guidelines onlv and svstems mav be added to base ADF values as reauired.

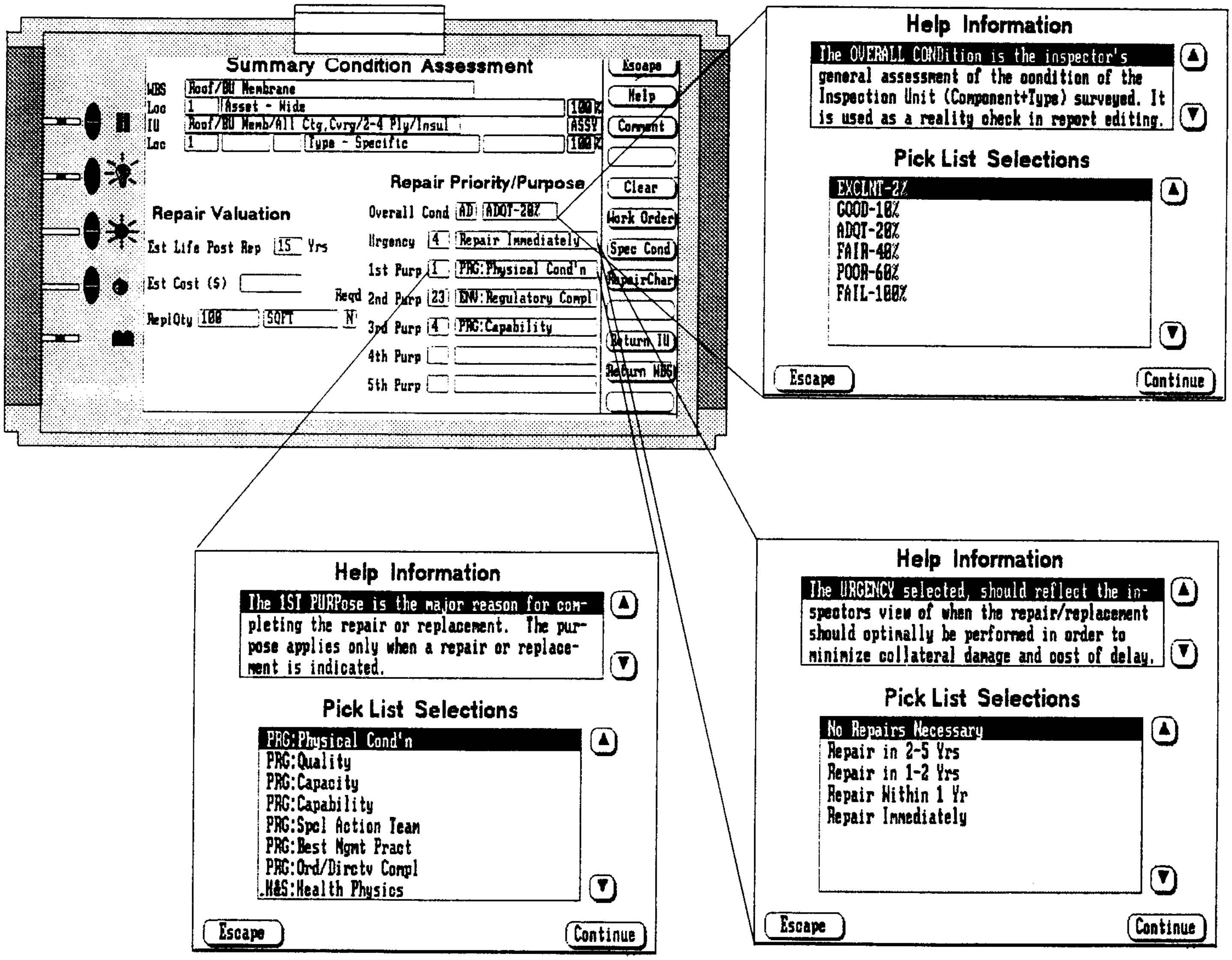
ASSET DETERMINANT **FACTOR/CAS** REPAIR **CODES/CAS** COST FACTORS

ASSET DETERMINANT FACTOR (ADF) (Continued)

ADF #	Definition
1	Assets within this factor represent "typical" DOE facility assets. These assets are over three years old and serve current programs projected to last over five years. A full CAS inspection at the assembly level is required. Component level CAS may be conducted as resources permit.
2	For temporary facilities supporting short-term programs (less than five years), a limited CAS inspection at assembly level involving all systems.
3	For currently unused assets that will be considered for future program development. In this case, only exterior envelope and interior mechanical and electrical systems are assessed at the assembly level.
4	For facilities deemed unfit for future use, a limited CAS inspection is recommended. This would involve exterior envelope only to ensure that asset will not deteriorate prior to scheduled decommission and disposal action (eg., destroy, dismantle).
5	Covers circumstances when only a roof inspection is required.
6	For assets requiring architectural survey only, including 0.01 Foundations and Footings, 0.02 Substructure, 0.03 Superstructure, 0.04 Exterior Closure, 0.05 Roofing, and 0.06 Interior Finishes and Construction, and 0.11 Specialty Systems.
7	For assets requiring mechanical survey only, including 0.07 Conveying, and 0.08 Mechanical.
8	For assets requiring electrical survey only, 0.09 Electrical.
9	General site survey system 0.12 Site Systems only.
10	This factor allows sites to build their own inspection. These will be reviewed by Headquarters for possible addition to the ADF Guidelines.

ASSET DETERMINANT FACTOR/CAS REPAIR CODES/CAS COST FACTORS

CAS REPAIR CODES



Refer to the following page for definitions of the three (3) major CAS Repair Codes.

ASSET DETERMINANT FACTOR/CAS REPAIR CODES/CAS COST FACTORS

CAS REPAIR CODES

One of the key aspects of the assessment process, once significant deficiencies are recorded, is determining the repair category. CAS defines three major repair codes: condition, purpose, and urgency. Condition is derived both by the CAIS algorithm based on raw deficiency data and by the inspector's subjective judgment. Purpose and urgency are each selected by the inspector. Definitions for each major code are listed as follows:

(CAS Repair Codes are **guidelines** only. Codes may vary as required by **sites.)**

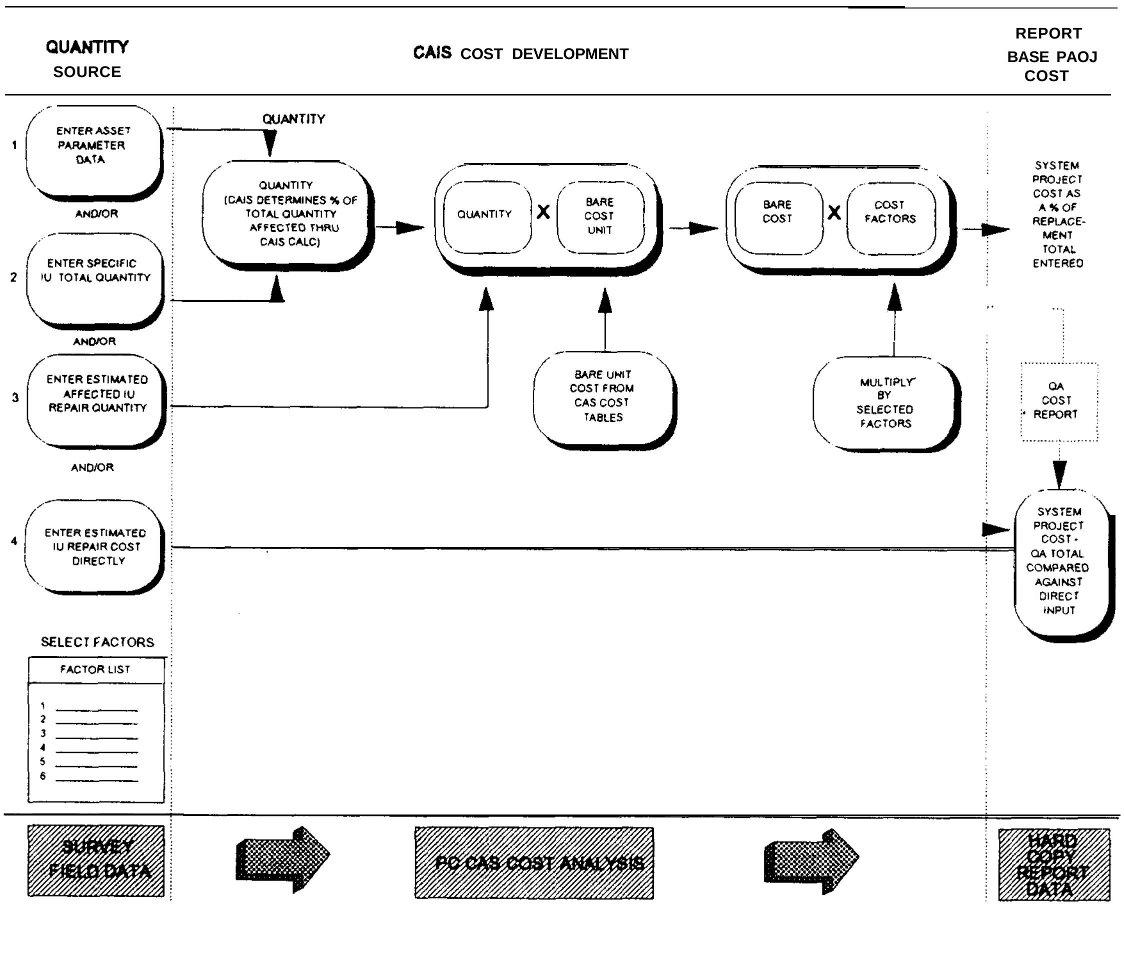
CONDITION CODE	**DEFINITION**
A	Excellent: Performs to original specifications as measured using non-standard tests; easily restorable to "like new condition; only minimal routine maintenance required at cost <2% of replacement value.
B	Good: Performs to original specifications as measured using historical data and non-standard tests; routine maintenance or minor repair required at cost <5% of replacement value.
C	Adequak: Performance meets requirements; some corrective repair and/or preventive maintenance required at cost <10% of replacement value.
D	**Fair:** Performance fails to meet code or functional requirement in some cases; failure(s) are inconvenient; extensive corrective maintenance and repair required at cost <25% of replacement value.
E	Poor: Consistent substandard performance; failures are disruptive and costly; fails most code and functional requirements; requires constant attention, renovation, or replacement. Major corrective repair or overhaul required at cost <60% of replacement value.
F	Fall: Non-operational or significantly substandard performance. Replacement required because repair cost is >60% of replacement cost.

PURPOSE CODE*	**DEFINITION**
P2	PRG: Capacity
H2	H&S: Industrial Safety
E2	ENV: Solid Waste Management
84	S&S: Security
•	Partial list based on CAMP Order DOE 4330.4A dated 10-l 7-90.

URGENCY CODE	DEFINITION
1	Repair Immediately: Asset condition critical; initiate corrective action immediately.
2	Repair within 1 Year: Asset condition serious; initiate corrective action within 1 year.
3	Repair in 1 to 2 Years: Asset condition degraded; initiate repair in 1 - 2 years.
4	Repair in 3 to 5 Years: Asset stable for period; integrate repairs into appropriate schedules.
5	No Repairs Necessary: Continue life cycle maintenance actions.

The following illustrates the cost development process for the Depaitment of Energy CAS/CAIS Project and the various processes involved.

COST DEVELOPMENT PROCESS



END OF SUBSECTION

GUIDE SHEET TOOL & MATERIAL LISTING

SAFETY REQUIREMENTS

Inspections shall comply with all Federal, State, and Local regulations and all applicable safety and health regulations or requirements (including reporting requirements) of DOE.

TOOLS

This subsection contains tool and material listings for use in standard and non-standard inspections for 0.03 Superstructure, in addition to the Basic Tool Group outlined below.

Accomplishing the activities identified in the inspection guides requires tools: basic, craft (standard), and specialized (non-standard). Specialized tools included in the non-standard tool group consist of special instruments as well as unique tools and are identified in the guides.

All crafts involved in inspecting Superstructure assemblies and components should employ a standard or basic tool set. This basic tool set may vary somewhat between equally qualified personnel; however, the following is a representative set of common basic tools.

BASIC TOOL GROUP

- Flashlight
- Measuring Tape
- Mirror
- Pocket Knife
- Rags

STANDARD TOOL GROUP

- 12 foot measuring tape
- 3/8 inch drive socket set and ratchet
- 3x5 inch card stock for indicating photograph locations
- Aerosol can of bright colored paint for marking deficiency locations
- Assorted center punches, drift punches, steel chisel
- Ball peen hammer
- Camera
- Claw hammer
- Crescent wrenches 4 and 8 inch
- Emery cloth
- Extension cords and inspection lights
- File
- Grease guns and oilers
- Hack saw and spare blades
- Level, 4 foot
- Metal square
- Open and box end wrenches I/4 and 3/8 inch
- Permanent black marker
- Pipe wrenches to 14 inch
- Pliers - vise grip (2), slip joint, needle-nose, diagonal, cutting pliers, side cutters
- Pocket knife
- Small crowbar
- Small set of Allen wrenches
- Standard and phillips head screwdrivers - various sizes
- Stiff bristle brush
- Torpedo level
- Various cleaning tools - brushes, scrapers, etc.
- Wire brush

GUIDE SHEET TOOL & MATERIAL LISTING

NON-STANDARD TOOL GROUP

- Acoustical emission analyzer
- Borescope or fiberscope
- Core driller
- Eddy current (Electrical Resistance) measuring device
- Infrared measuring device
- Magnetic scanning device
- Microwave absorption scanning device
- Moisture detection devices
- Nuclear analysis mechanism
- Ultrasonic measuring device
- Video camera
- X-Ray or radiography testing device

The basic tool set may be augmented to accomplish inspection actions on a specific assembly or component. The Guide Sheets identify this augmentation. Also, test methods for Superstructure systems are defined in subsection 1.3.

END OF SUBSECTION

NOTE: It is not the intent of this manual to have sites perform non-standard tests These guidelines may be used in the event standard inspection is not sufficient to determine system condition. Such non-standard inspections will be provided by others (eg., consultants, outside labs)

TESTING METHODS

GENERAL

During the course of the Condition Assessment Survey, various tests will be employed to better ascertain the condition of the assets. These are indicated on the Component Specific Guide Sheets included in Section 3 of this Manual. Testing will not be required on all assets. Where indicated, results will be recorded in the Data Collection Method.

The critical nature of concrete and its overall condition cannot be understated. Concrete or masonry compressive strength is vital to maintain structural integrity. Where direct foundation characteristics can be observed, surface deficiencies such as cracks, spalling, and exposed reinforcing indicate hidden problems. In these cases, underlying deterioration can be determined by further test measures. Testing concrete in-situ seeks to gauge current conditions including position and size of reinforcement, poor consolidation areas, voids, cracks, honey-combing, and moisture content to quantify current strength, durability, and elastic parameters as they exist in view of observed physical deficiencies.

Testing methods do not specify the following:

- Expertise of user (to use the instrument or interpret results).
- The advantage of one testing method versus another.
- The limitations of the testing method.
- Whether the user must be trained and licensed to operate (such as the Nuclear Moisture Meter Test, which requires licensing).

Variability

Estimating in-situ concrete strength by the following test methods may provide site readings that vary from lab test calibrations between 2 to 10%. Pulse velocity tests are the most accurate with a site and lab calibration difference of approximately 2%. Other methods will generally range from 6 to 10% between site and lab conditions.

Standard vs. Non-Standard

Inspection Methods are classified as Standard versus Non-Standard based on techniques employed.

Standard Methods are generally quick, visual, hands-off walk-throughs not requiring a component to be taken out of service. Few tests are required in the associated Guide Sheets. Where tests are indicated, they are non-invasive. An example is Stress Monitor Analysis.

Non-Standard Methods are generally those that require specialized equipment and analysis as well as destructive testing. Examples include Infrared, Nuclear Analysis, Core Sampling, Ultrasonic Pulse Velocity Testing, and Surface Hardness Testing.

Some of the tests could be conducted as part of either type inspection. For discussion purposes, they will be classified according to their specialized equipment and analysis; i.e., if a test can be conducted without specialized services, it will be listed under Standard Test Methods:

TESTING METHODS

STANDARD TEST METHODS

- Stress Monitor Analysis

STANDARD TEST DESCRIPTION

Stress Monitor Analysis

Stress analysis consists of documenting the location, pattern, depth and width, presence of foreign materials, and elevation differences between two cracked concrete or masonry masses and other horizontal or vertical surfaces. Determine if the crack is active or dormant by following these steps:

- Mark the end of the crack and check after a few days to see if it has extended past the mark. Note direction.
- Place a notched piece of tape across the crack. Wait for a period of a month of more. If tape tears or compresses (wrinkles) the crack is active, and if the tape shows no apparent change the crack is dormant.
- Apply pins and gauge points on either side of crack. Measure distance between points at regular intervals with vernier calipers to determine the extent of movement.

NON-STANDARD TEST **METHODS**

- Acoustic Emission Testing
- Borescope or Fiberscope
- Core Sampling
- Electrical Resistivity Testing
- Infrared Testing
- Magnetic Testing
- Maturity Concept Analysis
- Microwave Absorption Scanning
- Nuclear Analysis
- Pick Test
- Radiography (X-Ray Testing)
- Surface Hardness Testing
- Ultrasonic Pulse Velocity Testing

NON-STANDARD TEST DESCRIPTION

Acoustic Emission Testing

Acoustic Emission testing measures the acoustic or stress emissions from cracks or surfaces under strain. The stresses are detected as small displacements by sensors positioned on the surface. This type of testing has been used in recent years, however, its major drawback is that it can only be used during periods of high stress and deformations and does not work for static loading conditions.

Borescope or Fiberscope

This method involves instruments to view into materials, primarily masonry, to visually locate deficiencies such as cracks, spalls, or material deterioration. Using these instruments involves drilling or creating holes in the sample material, which require patching at completion.

Core Sampling

Core Sampling involves taking core samples at various controlled sections to ascertain the condition or strength of the material by laboratory mechanical/chemical analysis. Sample holes must be patched immediately.

TESTING METHODS

NON-STANDARD TEST DESCRIPTION (Continued)

Electrical Resistivity Testing

Electrical Resistivity testing involves passing electrical currents through the material to determine the resistance offered. This test is used to determine reinforcement corrosion and concrete pavement thickness. This method may also determine the moisture content or penetration of concrete surfaces and degree of decay in wood members. Although relatively simple, it is highly dependent on moisture, salt content, and the temperature of the material.

Infrared Testing

Infrared testing measures heat loss or gain. Those areas of the superstructure that absorb water will not insulate. Heat is lost more rapidly through these water absorbing areas, so higher temperatures are detected with an infrared scanner. Cracks, voids, and other discontinuities in the surface all affect heat emissions: scanners can show the difference between sound and unsound surfaces. Infrared is done by scanning the surface with a hand-held instrument. This method requires further research and development.

Magnetic Testing

Magnetic testing involves scanning concrete surfaces with a U-shaped magnetic core that has two coils; an alternating current is passed through one coil and measured in the second. This test is used to measure the depth and detect position of reinforcement in concrete. It should be noted, however, that temperatures below freezing and heavily reinforced sections adversely affect the performance and results.

Maturity Concept Analysis

The Maturity Concept used in measuring in-situ concrete is based on the fact that concrete strength varies as a function of both time and temperature. These conditions are measured by thermocouples and/or instruments.

Microwave Absorptlon Scanning

Microwaves are electromagnetic in nature and can be reflected, diffracted, and absorbed. Wave absorption by water allows moisture content of the material to be determined. This is relatively new and unproven, while the technique based on reflected electromagnetic waves has been used successfully. This method is fast and easy to perform, although planning and skill are required to interpret and evaluate the results.

Nuclear Analysis

Nuclear analysis is accomplished using a mechanism that scatters neutrons on the surface being tested. Where water is present, radiation or neutrón energy is taken back into the unit, The surface is squared off in a grid pattern and readings are taken from various points. Another method (relatively new and underdeveloped) involves bombarding the concrete surface with neutrons, which causes the surface materials to become radioactive. A comparative analysis is performed as the radioisotopes decay to a stable state,

Source: School and College - "**A** Systematic Approach to **Roofing."** October 1989, Mary E. **Skelly,** Author.

TESTING METHODS

NON-STANDARD TEST DESCRIPTION (Continued)

Pick Tort

Pick testing consists of inserting any pointed tool into the surface of wood to lift a sliver. If the wood slivers, a sharp break indicates it is sound wood, a brash break suggests decay. A similar test is striking the wood surface with a hammer. A sharp ring usually indicates sound wood, and a dull or hollow sound indicates decay or rot. This is not a very reliable test, so if decay is suspected, additional testing should be performed.

Radiography (X-Ray) Testing

Radiography testing involves passing radiation in the form of X-rays through an object to expose photographic film on the opposite side to detect cracking, voids, or position of reinforcing. This method is seldom used for these building systems due to the cost and dangerous equipment required. Testing with gamma rays however, is relatively portable and easier to use. The only limiting factors appear to be high cost and safety concerns.

Surface Hardness Testing

This test consists of impacting the concrete or masonry surface using standard instruments with a given energy pulse to measure the size of rebound. A rebound hammer is most commonly used. Problems and limitations are affected by concrete surface smoothness, carbonation, and moisture condition as well as size, age, and aggregate type.

Ultrasonic Pulse Velocity Testing

Ultrasonic testing is accomplished by passing ultra-high frequency sound waves through a material. An oscilloscope, chart recorder, or computer printout then records or displays the sound waves converted into electrical signals deflected off the rear surfaces or any defects within the material.

The basic concept used in the Ultrasonic Pulse Velocity Test consists of generating an ultrasonic wave through the concrete, masonry, or wood and measuring the travel time. This technique is excellent for establishing existing concrete, masonry, or wood uniformity and strength. It should be noted, however, that concrete conditions such as age, moisture, aggregate to cement ratio, aggregate type, and steel reinforcement placement may adversely influence test results.

Source: School and College - "A Systematic Approach to Roofing." October 1989, Mary E. Skelly, Author.

END OF SUBSECTION

INSPECTION FREQUENCY

CAS INSPECTION SCHEDULE

The following constitutes recommended inspection frequencies for the listed assemblies and components. The purpose of these inspections is to support the Condition Assessment Survey (CAS) rather than maintenance purposes. Each site has the option of varying the inspection frequencies to meet individual site requirements.

The recommended Base CAS inspection frequencies are listed below in Table One for the system described in this manual. The base CAS constitutes standard inspections only and utilizes the standard Guide Sheets as a reference. All Non-Standard inspections are optional for Superstructure system assemblies and components.

TABLE ONE

Assembly/Component	**Year One**	**Year Two**	**Year Three**	**Year Five**
Beams Cast-in-Place Concrete				S
Precast Concrete				S
Steel			S	
Wood			S	
Pre-Engineered Building Systems Metal	S			
Wood	S			
Floors Concrete Structure Cast-in-Place		S		
Concrete Precast		S		
Steel	S			
Composite		S		
Wood	S			
Roof Structure Steel		S		
Concrete			S	
Wood	S			
Stairs Cast-in-Place	S			
Precast	S			
Steel	S			
Composite (Steel Pan w/Concrete)	S			
Wood	S			
Ladders	S			
Fireproofing		S		

S - STANDARD INSPECTIONS — NS - NON-STANDARD INSPECTIONS

NOTES: 1. Severe weather or facility operational conditions may require additional inspections.
2. Non-Standard inspections will be provided on an as-required basis.

INSPECTION FREQUENCY

END OF SUBSECTION

STANDARD SYSTEM DESIGN LIFE TABLES

GENERAL

The Standard (nominal) Design Life of a given System Assembly/Component is defined as the projected service design life measured from the date of installation to the date of replacement. These time periods are based on manufacturer product specifications and tests that determine the average "outside" time parameter a given System Assembly/Component will last. The Standard Design Life Tables that follow list design life and replacement cost parameters for WBS. TABLE ONE below illustrates key column headings.

TABLE ONE

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
Note 1:	Used to document the replacement life* of significant WBS System Assembly/Components.	
Note 2:		Used to estimate percent of WBS System Assembly/Component cost replaced at the year specified (measured from installation date to end date specified by the replacement life period*).

*Note: The term Replacement Life is synonymous with Design Life.

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE TWO

ITEM DESCRIPTION	Replacement Life, Years	Percent Replaced
0.03 SUPERSTRUCTURE		
STRUCTURAL FRAME		
Steel structural frame (includes columns, beams, girders, trusses, spandrels, bracing, and fireproofing)	75	100
Reinforced concrete structural frame (includes columns, beams, and miscellaneous frame elements)	75	100
Precast concrete structural frame (includes columns, beams, and miscellaneous frame elements)	75	100
Wood structural frame (includes posts, girts, plates, studs, girders, and built-up beams)	50	100
Metal joist structural frame (includes metal joists and accessories)	75	100
INTERIOR STRUCTURAL WALLS		
Interior concrete block load-bearina walls	60	100
Interior brick load-bearing walls	75	100
Interior concrete load-bearing walls	75	100
Interior wood load-bearing walls	50	100
FLOOR SLABS & DECKS		
Reinforced concrete floor slabs (includes slab and beams)	50	100
Post-tensioned concrete floor slabs	50	100
Precast prestressed concrete floor slabs (may include planks, concrete, tees, floor channels, and structural concrete topping)	50	100
Noncellular open metal decking with structural concrete topping	50	100
Cellular metal decking with structural concrete topping	50	100

STANDARD SYSTEM DESIGN LIFE TABLES

ITEM DESCRIPTION	Replacement Life, Years	Percent Replaced
0.03 SUPERSTRUCTURE (Continued)		
FLOOR SLABS & DECKS		
Structural wood framing (includes sheathing, joists, beams, etc.)	40	100
Corrugated metal deck with light weight concrete topping	50	100
Corrugated metal deck only	30	100
Precast concrete (hollow core) roof slab	50	100
Poured-in-place gypsum concrete over formboards	40	100
STAIRS		
Metal-edged gypsum plank	40	100
Cement fiber planks	40	100
Precast concrete	50	100
Steel pan type, filled with concrete	40	100
Steel tread and riser	40	100
Prefabricated steel form filled with concrete	50	100
Steelframe, precast concrete treads, and risers	40	100

STANDARD SYSTEM DESIGN LIFE TABLES

END OF SUBSECTION

SYSTEM WORK BREAKDOWN STRUCTURE

GENERAL

Facilities are composed of various assemblies/components which, in turn, form the primary facility systems. These systems, such as foundations, roofs, heating and cooling units, and electrical distribution, have varying life spans. They require maintenance, repair, and renovation over a period of time and do not all “fail” at the same time. Systems have varying life spans. Their condition may be influenced by the deterioration of other assembly/component parts within the systems.

To consider each facility and their major systems, the CAS Program uses the Work Breakdown Structure (WBS) based on the R.S. Means square foot costing system. This industry accepted standard allows a logical “breakdown” of facilities into their major systems, assemblies, components, etc. The WBS is a heirarchical structure; this concept is illustrated in Figure 1. The development of project costs are then applied within this framework as shown in Figure 2.

The Work Breakdown Structure for this volume follows.

SYSTEM WORK BREAKDOWN STRUCTURE

0.03 SYSTEM - SUPERSTRUCTURE

0.03.01	BEAMS
0.03.01.01	Cast-in-Place Concrete
0.03.01.02	Precast Concrete
0.03.01.03	Steel
0.03.01.04	Wood
0.03.02	PRE-ENGINEERED BUILDING SYSTEMS
0.03.02.01	Metal
0.03.02.02	Wood
0.03.03	FLOORS
0.03.03.01	Cast-in-Place Concrete
0.03.03.02	Precast Concrete
0.03.03.03	Steel
0.03.03.04	Composite
0.03.03.05	Wood
0.03.04	ROOF STRUCTURE
0.03.04.01	Steel
0.03.04.02	Concrete
0.03.04.03	Wood
0.03.05	STAIRS
0.03.05.01	Cast-in-Place Concrete
0.03.05.02	Precast Concrete
0.03.05.03	Steel
0.03.05.04	Composite (Steel Pan w/Concrete)
0.03.05.05	Wood
0.03.05.06	Ladders
0.03.06	FIREPROOFING

SYSTEM WORK BREAKDOWN STRUCTURE

WBS LEVEL TABLE

0.05	*LEVEL I*	0.08
ROOHNG	SYSTEM	MECHANICAL
0.05.01	*LEVEL 2*	0.08.01
BUILT-UP	*ASSEMBLY*	PLUMBING
0.05.01.01	LEVEL 3	0.08.01.01
MEMBRANE	COMPONENT	DOM. WATER
0.05.01.01.01	LEVEL 4	0.08.01.01.01
3-PLY ASPHALT	*SUBCOMPONENT/* TYPE	PIPE
0.05.01.01.01.01	LEVELS	0.08.01.01.01.01
NOT USED	*TYPE*	3/4" DIA. COPPER

WBS *ORGANIZATION HIERARCHY*

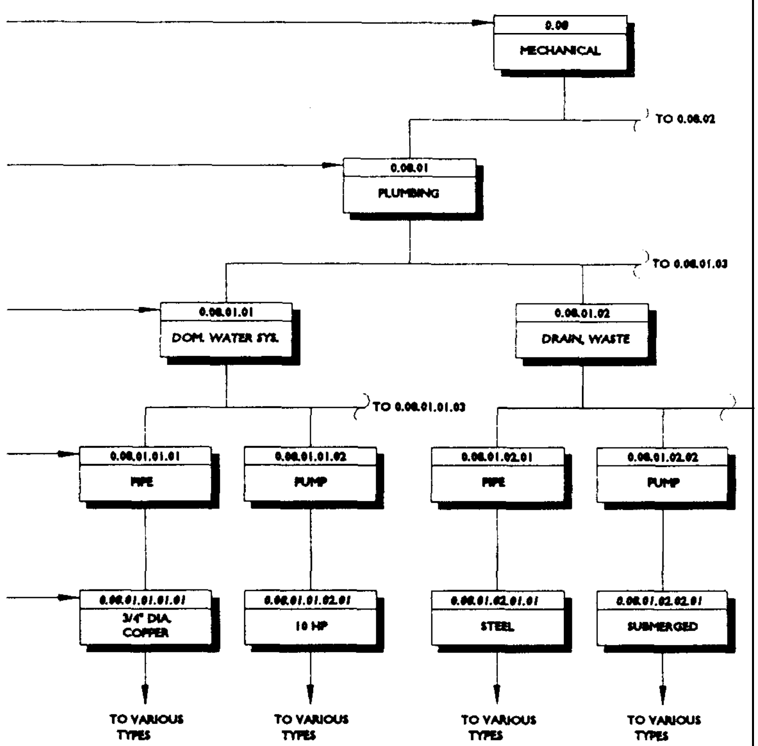


FIG. I

SYSTEM WORK BREAKDOWN STRUCTURE

WBS LEVEL TABLE

0.05	*LEVEL I*	**0.0**
ROOFING	*SYSTEM*	**MECHANICAL**
0.05.01	***LEVEL 2***	**0.08.01**
BUILT-UP	*ASSEMBLY*	**PLUMBING**
0.05.01.01	***LEVEL 3***	**0.08.01.01**
MEMBRANE	*COMPONENT*	**DOM. WATER**
0.05.01.01.01	***LEVEL 4***	**0.08.01.01.01**
3-PLY ASPHALT	***SUBCOMPONENT/ TYPE***	**PIPE**
0.05.01.01.01.01	*LEVELS*	**0.08.01.01.01.01**
NOT USED	***TYPE***	**3/4" DIA. COPPER**

WBS COST DEVELOPMENT HIERARCHY

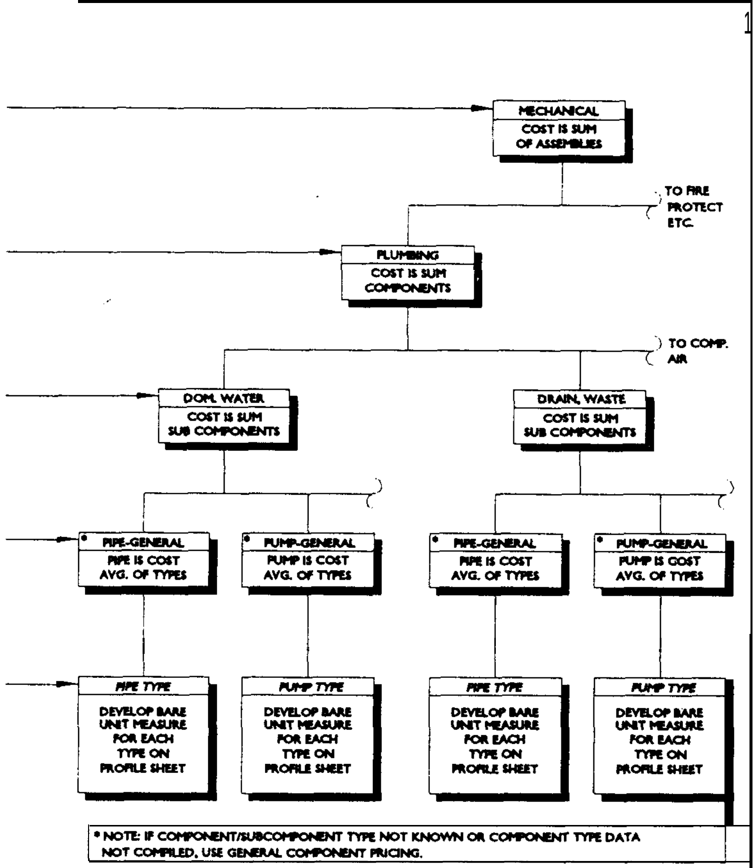


FIG. 2

END OF SUBSECTION

GENERAL SYSTEM/MATERIAL DATA

INTRODUCTION

With the increasing cost of new construction and equipment, it is becoming more of a necessity to ensure that existing buildings and systems are maintained at regular intervals an'd repairs are made to last over the long term. This section is composed of several tables consisting of Concrete Deterioration, Deterioration of Structural Steel, Imperfections in Wood, Causes of Timber Deterioration, Preservations, and Effects of Chemicals on Concrete.

The purpose of this section is to give a general description of damages, diagnosis, and causes of deterioration of building materials such as concrete, structural steel, and wood. This is oriented toward locating defects and potential material failure problems prior to major damage or complete failure of systems/components. Recognition of Superstructure defects and their effects on the building and its occupants and contents are stressed. Special attention should be given to the causes and correction or repair of common defects. Data herein should be used as a reference and in conjunction with specific System/Assembly data that follows this general section.

GENERAL SYSTEM/MATERIAL DATA

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GENERAL SYSTEM/MATERIAL DATA

COMMON CAUSES OF CONCRETE **DETERIORATION**
[Similar for Pre-Cast Concrete]

Damaae	**Diaanosis**	Cause
Alkali-Aggregate Expansion	Slight cracking to complete breakup.	Chemical reaction between aggregate and cement paste.
Cavitation	Spalling around projections. Honey-combing. Popping and cracking noises when water moves over the surface.	Rapid movement of water or other liquids across the surface.
Cracks (Active and Dormant)	Random, isolated or patterned cracks.	Construction movement, settlement, shrinkage around reinforcement. Setting shrinkage due to inadequate finishing and curing.
Before hardening of the concrete:	Patterned cracking, protruding aggregate, popouts. Chemical analysis indicates deterioration of cement paste.	Chemical reactions, such as corrosion.
After hardening of the concrete:	Surface cracking, patterned.	Physical, such as drying shrinkage.
	Extreme change in measured temperatures between inner and outer surfaces. Shallow cracking.	Thermal changes (subjected to temperature extremes, such as from freezing and thawing cycles).
	Localized cracking.	Stress concentration.
	Cracks, usually isolated.	Structural design.
	Cracks can be isolated or patterned depending on crack-producing agent.	Accidents from overload, vibration, fatigue and earthquake.
Corrosion of Reinforcing Steel	Cracks will occur at the level of the reinforcement and parallel to it. Rusting or discoloration will be evident.	Insufficient cover of steel. Quality of concrete. Over-use of calcium chloride as admixture.
Crazing	Shallow cracks forming a hexagonal pattern.	Surface shrinkage more rapid than interior of concrete to the surface and depositing salts.
Dusting	Appearance of a powdery substance on the surface of the concrete.	Too wet of a concrete mixture. Premature or excessive working of the surface. Organic materials in the aggregate. Inadequate curing.
Efflorescence	Appearance of crystalline salts on the concrete surface.	Water migrating from the interior mass of the concrete to the surface and depositing salts.
Fire	Charred and spalled surfaces.	Fire.
Form Scabbing	Difficult to remove forms. Uneven, spalled areas.	Form oil improperly applied
Holes (Small and Large)	Popouts, holes, random pattern or isolated in extreme.	Chemical reaction. Inadequate construction and desian.
Honeycombing	Surface defects-voids. Coarse aggregate broken away from the surface.	Placing concrete aggregate with insufficient type of mortar. Improper placing techniques, such as inadequate vibration.

Source: **Means Facilities** Maintenance **Standards - "R.S. Means** Co., Inc., Kingston, **Massachusetts"**

GENERAL SYSTEM/MATERIAL DATA

COMMON CAUSES OF CONCRETE DETERIORATION
(SImilar for Pre-Cast Concrete1

Damage	Diagnosis	Cause
Popouts	Breaking away of a particle near the surface. Excessive amount of moisture or temperature changes in the region.	Depressions left by material popping out. Presence of disintegrated material near the popout.
Sand Streaking	Vertical streaks of sand which appear on the surface, most noticeable when forms are immediately stripped.	Concrete mixed with a high water content or a deficiency of finer sand sizes are placed in a formwork that is not water-tight.
Scaling	Flaking or peeling away of thin layers of concrete.	Severe freeze/thaw conditions. Improper use of deicing salts. Repeated wetting and drying of concrete. Improper finishing. Chemical attack of concrete. Heat blast.
Spalling	Fragments of concrete that have been broken from the surface. Corrosion of reinforcement.	Corrosion of reinforcement. Mechanical damage. Incorrect form removal. Shock-waves.
Stain and Uneven Color	Discoloration or lacking uniformity in appearance.	Chemical action of foreign materials on the surface. Mixing of different types of cement with each other. Reaction of materials comprising the concrete mixture.

A SUMMARY OF THE TYPES & CAUSES OF DETERIORATION OF STRUCTURAL STEEL

Type of Deterioration	Cause
Abrasion	Members subjected to contact with moving parts. Members subjected to wave action. Members immersed in a moving liquid. Worn, smooth appearance, general depression of the abraded area.
Corrosion	Resulting from a chemical or eiectro-chemical reaction which converts the metal into an oxide, carbonate and sulfides. Pitted, oxidized surface showing loose flakes, reddish-brown rust colored appearance.
Fatigue	Repetitive, cyclic loading occurring at stresses at or below allowable design values. Small fractures oriented perpendicular to the line of stress.
Impact	Local distortion of the member in the form of a sharp crimp. Will occur in a tension member of flange.
Lamellar Tearing	Minute, often times unseen cracking in the weldment. May need microscopic instruments to observe. Incorrect welding process.
Loosening of Connections	Impact and fatigue loading. Vibrations and improper tightness.

Source: Means Facilities Maintenance Standards - 'U.S. Means Co., Inc., Kingston, Massachusetts'

GENERAL SYSTEM/MATERIAL DATA

COMMON IMPERFECTIONS IN WOOD

Imperfection	Description	Effects on Strength	Effect on Grading Structural Lumber
Checks and Splits	Split in the wood.	In lumber subjected to bending, checks and splits reduce the resistance to shear; they do not affect the strength for longitudinal compression,	Checks and splits are restricted in those parts of a bending member where shearing stresses are highest
Holes	Either a knothole or a hole caused by some other means.	Reduces tensile strength somewhat more than compressive and shear strength and affect stiffness.	The size, number and location of knots is restricted for structural lumber; cluster knots are prohibited.
Knots	Localized imperfections.	Same as for holes.	Same as for holes.
Pitch Pockets	Opening between growth rings containing pitch or bark.	Little or no effect.	Usually disregarded except if a large number occur; shake may be present or bond between annual growth rings may be weakened.
Shakes	A separation of the wood between the annual growth rings.	Same as for checks and splits	Same as for checks and splits.
Slope of Grain	Areas where the direction of the wood grain is not parallel to the edges of the piece of lumber.	Will twist with changes in moisture content.	Cross-grained pieces are undesirable; reduction of strength due to cross grain in structure is taken as twice the reduction observed in tests of small clear specimens.
Wane	Bark or lack of wood on the edge or corner of the piece of lumber.	Affects nailing and bearing.	Limited in structural lumber requirements for fabrication, bearing, nailing and appearance and not for effect on strenath.

SUMMARY OF CAUSES OF TIMBER DETERIORATION WITH SYMPTOMS

Cause of Deterioration	Symptoms
Carpenter Ants, Beetles & Carpenter Bees	Similar to termites.
Termites	Bore holes; lacing/cavitation of wood; connecter tunnels from grade to wood source (usually mud). Premature wood bowing and failure.
Decay (Rot) Due to Fungi	Softening and discoloration of wood, fluffy or cottony appearance, destruction of wood cells, appearance of fruity bodies in the form of mushrooms, incrustations in the advanced stage.
Excessive Splitting and Checking	Excessive relative amount of members at a joint, bowing of compression members (shown by broken paint lines or newly exposed wood), elongated bolt holes.
Fire Damage	Surface cellular damage, charred surfaces, easily probed with a knife.
Hardware	Loose connections, formation of rust on hardware surfaces, discoloration of wood adjacent to hardware.
Loosened Connections	Loose connections, excessive deflection
Marine Borers	Minute openings in the timber, hollow sound when struck with a hammer, a myriad of surface grooves, narrowing of a section giving it an hourglass appearance.

Source: Means Facilities Maintenance Standards - "R.S. Means Co.. Inc.. **Kingston, Massachusetts"**

GENERAL SYSTEM/MATERIAL DATA

PRESERVATIVES — ADVANTAGES & DISADVANTAGES

Oil-Based wood **Preservatives**

Typo of **Preservative**	**Advantages**	**Disadvantages**
Anthracene Oils	High toxicity to wood-destroying organisms; insoluble in water; low volatility; ease of application; permanence.	Dark brown color, cannot be painted; strong, unpleasant odor; easily ignited when first applied.
Coal-Tar Creosotes	See Anthracene Oils.	See Anthracene Oils.
Copper Naphthenate	High protection against decay fungi and termites; can be painted; not unpleasant odor; less easily ignited than coal-tar creosotes.	Gives wood greenish or dark color and provides less protection against marine borers than creosote.
Creosotes Derived From Wood, Oil and Water Gas	Same as Anthracene Oils and Coal-Tar Creosotes.	About the same as Anthracene Oils and Coal-Tar creosotes, but less effective.
Creosote Solutions	See Anthracene Oils and Coal-Tar Creosotes.	About the same as Anthracene Oils and Coal-Tar creosotes, but less effective.
Water-Repellent Preservatives	Retards moisture changes in wood; good protection against decay and insects.	Cannot be used in contact with ground or areas where continual dampness can occur unless preservative is thoroughly applied.

Water-Based Wood **Preservatives**

Acid Copper Chromate	Provides protection against decay and insects; can be painted; no objectionable odor; if thoroughly impregnated has some resistance to marine borers.	Wood can be used in contact with ground, but generally not recommended for contact with water.
Ammonical Copper Arsenite	Good protection against decay and insects and some protection against marine borers.	Wood can be used in contact with ground, but generally not recommended for contact with water.
Chromated Zinc Chloride	Provides protection against decay, insects and fire; can be painted; no objectionable odor.	Wood cannot be used in contact with ground or water.
Chromated Zinc Chloride (FR)	See Chromated Zinc Chloride.	See Chromated Zinc Chloride.
Copperized Chromated Zinc Chloride	See Chromated Zinc Chloride.	See Chromated Zinc Chloride.
Tanalith (Wolman Salts)	Protects against decay and insects; can be painted; no objectionable odor.	Wood cannot be used in contact with ground or water.
Zinc Meta Arsenite	Good protection against decay and insects; can be painted; no objectionable odor.	Wood can be used in contact with ground, but generally not recommended for contact with water.

Source: Means **Facilities Maintenance** Standards • "R.S. Means Co., Inc., Klngston, Massachusetts'

GENERAL SYSTEM/MATERIAL DATA

Acetic Acid, all Concentrations	Disintegrates slowly.
Acetone	Liquid loss by penetration. May contain acetic acid as impurity.
Acid Waters	(pH of 6.5 or less) (a) Disintegrates slowly. In porous or cracked concrete, attacks steel.
Aluminum Chloride	Disintegrates rapidly. In porous or cracked concrete, attacks steel.
Ammonla Vapors	May disintegrate moist concrete slowly or attack steel in porous or cracked moist concrete.
Ammonium **Bisulfate**	Disintegrates. In porous or cracked concrete, attacks steel.
Ammonlum Carbonate	Not harmful.
Ammonlum Cyanide	Disintegrates slowly.
Ammonium Fluoride	Disintegrates slowly.
Ammonlum Nitrate	Disintegrates. In porous or cracked concrete, attacks steel.
Ammonium Oxalate	Not harmful.
Ammonlum Sulfide	Disintegrates.
Ammonlum Sulfite	Disintegrates.
Ammonium Superphosphate	Disintegrates. In porous or cracked concrete, attacks steel.
Ammonium **Thiosulfate**	Disintegrates.
Ashes	Harmful if wet, when sulfides and sulfates leach out (see sodium sulfate).
Ashes, hot	Cause thermal expansion.
Automobile and **Diesel** Exhaust **Gases (d)**	May disintegrate moist concrete by action of carbonic, nitric, or sulfurous acid.
Benzol (Benzene)	Liquid loss by penetration.
Bromine	Gaseous bromine disintegrates. Liquid bromine disintegrates if it contains hydrobromic acid and moisture.
Butyl Stearate	Disintegrates slowly.
Calcium **Bisulfite**	Disintegrates rapidly.
Chlorine Gas	Slowly disintegrates moist concrete.
Chrome Plating Solutions (e)	Disintegrates slowly.
Chromic Acid, **&** Concentrations	Attacks steel in porous or cracked concrete.
Cinders	Harmful if wet, when sulfides and sulfates leach out (see, for example, sodium sulfate).
Coal	Sulfides leaching from damp coal may oxidize to sulfurous or sulfuric acid, or ferrous sulfate (see ferrous sulfate).
Coal Tar Oils	See anthracene, benzol, carbazole, chrysen, creosote, creosol, cumol, paraffin, phenanthrene, phenol, toluol, xylol.
Cobalt Sulfate	Disintegrates concrete of inadequate sulfate resistance.
Coke	Sulfides leaching from damp coke may oxidize to sulfurous or sulfuric acid.
Copper Chloride	Disintegrates slowly.
Copper Sulfate	Disintegrates concrete of inadequate sulfate resistance.
Copper Sulfide	Harmful if it contains copper sulfate.
Corrosive Sublimate	See mercuric chloride.
creosote	Phenol present disintegrates slowly.
Cresol	Phenol present disintegrates slowly.
Cumol	Liquid loss by penetration.
Deicing Salts	Scaling of non-air-entrained or insufficiently aged concrete (b).
Diesel Gases	See automobile and diesel exhaust gases.
Ferric Chloride	Disintegrates slowly.
Ferric Sulfate	Disintegrates concrete of inadequate quality.
Ferric Sulfide	Harmful if it contains ferric sulfate
Ferrous Chloride	Disintegrates slowly.
Ferrous Sulfate	Disintegrates concrete of inadequate sulfate resistance.

GENERAL SYSTEM/MATERIAL DATA

Flue Gases	Hot gases (400-I 100°F) causes thermal stresses. Cooled, condensed sulfurous, hydrochloric acids disintegrate slowly.
Gas Water (e)	Ammonium salts seldom present in sufficient quantity to disintegrate.
Gasoline	Liquid loss by penetration.
Hydrofluoric Acid, all Concentrations	Disintegrates rapidly, including steel.
Hydrogen Sulfide	Not harmful dry. In moist, oxidizing environments converts to sulfurous acid and disintegrates slowly.
Hypochlorous Acid, 10 **percent**	Disintegrates slowly.
Iodine	Disintegrates slowly.
Kerosene	Liquid loss by penetration of concrete.
Lead Nitrate	Disintegrates slowly.
Lead **Refining Solutions (f)**	Disintegrates slowly.
Lignite Oil8	If fatty oils are present, disintegrates slowly.
Locomotive Gases	May disintegrate moist concrete by action of carbonic, nitric or sulfurous acids (see also automobile and diesel exhaust gases).
Lubricating **Oil**	Fatty oils, if present, disintegrate slowly.
Machlne Oil	Fatty oils, if present, disintegrate slowly.
Magnesium Nitrate	Disintegrates slowly.
Manganese Sulfate	Disintegrates concrete of inadequate sulfate resistance.
Mercuric Chloride	Disintegrates slowly.
Mercurous Chloride	Disintegrates slowly.
Methyl Alcohol	Liquid loss by penetration.
Methyl Ethyl Ketone	Liquid loss by penetration.
Methyl **Isobutyl** Ketone	Liquid loss by penetration.
Mine Water, Waste	Sulfides, sulfates, or acids present disintegrate concrete and attack steel in porous or cracked concrete.
Mineral Spirits	Liquid loss by penetration.
Muriatic Acid	See hydrochloric acid.
Nickel plating Solution8	Nickel ammonium sulfate disintegrates slowly.
Nickel Sulfate	Disintegrates concrete of inadequate sulfate resistance.
Nitric Acid, all Concentrations	Disintegrates rapidly.
Ores	Sulfides leaching from damp ores may oxidize to sulfuric acid or ferrous sulfate.
Oxalic Acid	Not harmful. Protects tanks against acetic acid, carbon dioxide, salt water. Poisonous, Do not use with food or drinking water.
Paraffin	Shallow penetration not harmful, but should not be used on highly porous surfaces like concrete masonry (g).
Perchloric Acid, 10 percent	Disintegrates.
Perchloro- Ethylene	Liquid loss by penetration
Petroleum **Oils**	Liquid loss by penetration. Fatty oils, if present, disintegrate slowly.
Phenanthrene	Liquid loss by penetration.
phenol, 5-25 percent	Disintegrates slowly.
Potassium Cyanlde	Disintegrates slowly
Potassium Dichromate	Disintegrates.
Potassium Hydroxide, 25 percent or over	Disintegrates concrete.
Potassium Permanganate	Harmless unless potassium sulfate present.
Potassium Persulfate	Disintegrates concrete of inadequate sulfate resistance.
Potassium Sulfate	Disintegrates concrete of inadequate sulfate resistance.

GENERAL SYSTEM/MATERIAL DATA

Potassium **Sulfide**	Harmless unless potassium sulfate present.
Pyrites	See ferric sulfide, copper sulfide.
Sal Soda	See sodium carbonate.
Salt for **Deicing** Roads	Also calcium chloride, magnesium chloride, sodium chloride.
Saltpeter	See potassium nitrate.
Sea Water	Disintegrates concrete of inadequate sulfate resistance. Attacks steel in porous or cracked concrete.
Sewage	Usually not harmful (see hydrogen sulfide).
Silage	Acetic, butyric, lactic acids (and sometimes fermenting agents of hydrochloric or sulfuric acids) disintegrate slowly.
Sodium **Bisulfate**	Disintegrates.
Sodium **Bisulfite**	Disintegrates.
Sodium Bromlde	Disintegrates slowly.
Sodium Carbonate	Not harmful, except to calcium aluminate cement.
Sodium Chloride	Magnesium chloride, if present, attacks steel in porous or cracke concrete. (b) Steel corrosion ma cause concrete to spall.
Sodium Cyanide	Disintegrates slowly.
Sodium **Dichromate**	Dilute solutions disintegrate slowly.
Sodium Hypochlorite	Disintegrates slowly.
Sodium Nitrite	Disintegrates slowly.
Sodium Phosphate (Monobasic)	Disintegrates slowly.
Sodium Sulfate	Disintegrates concrete of inadequate sulfate resistance.
Sodium Sulfide	Disintegrates slowly.
Sodium **Thiosulfate**	Slowly disintegrates concrete of inadequate sulfate resistance.
Strontium Chloride	Not harmful.
Sulfite Liquor	Disintegrates.
Sulfite Solution	See calcium bisulfate.
Sulfurous Acid	Disintegrates rapidly.
Toluol (Toluene)	Liquid loss by penetration.
lung Oil	Liquid disintegrates slowly. Dried or drying films are harmless.
Turpentine	Mild attack. Liquid loss by penetration.
Urine	Attacks steel in porous or cracked concrete.
Xylol (Xyiene)	Liquid loss by penetration.
Zinc Nitrate	Not harmful.
Zinc Refining Solutions **(l)**	Hydrochloric or sulfuric acids, if present, disintegrate concrete.
Zinc Slag	Zinc sulfate sometimes formed by oxidation.
Zinc Sulfate	Disintegrates slowly.

GENERAL SYSTEM/MATERIAL DATA

SPECIAL NOTATIONS

a. Waters of pH higher than 6.5 may be aggressive, if they also contain bicarbonates. (Natural waters are usually of pH higher than 7.0 and seldom lower than 6.0 though pH values as low as 0.4 have been reported. For pH values below 3, protect as for dilute acid.)

b. Frequently used as a deicer for concrete pavements. If the concrete contains too little entrained air or has not been aged more than one month, repeated application may cause surface scaling. For protection under these conditions, see "deicing salts."

c. Water used for cleaning coal gas.

d. Composed mostly of nitrogen, oxygen, carbon dioxide, carbon monoxide, and water vapor. Also contains unburned hydrocarbons, partially burned hydrocarbons, oxides of nitrogen, and oxides of sulfur. Nitrogen dioxide and oxygen in sunlight may produce ozone, which reacts with some of the organics to produce formaldehyde, peracylnitrates, and other products.

e. These either contain chromium trioxide and a small amount of sulfate, or ammonium chromic sulfate (nearly saturated) and sodium sulfate.

f. Contains lead fluosilicates and fluosilicic acid.

g. Porous concrete which has absorbed considerable molten paraffin and then been immersed in water after the paraffin has solidified, has been known to disintegrate from sorptive forces.

h. Contains nickelous chloride, nickelous sulfate, boric acid, and ammonium ion.

i. Usually contains zinc sulfate in sulfuric acid. Sulfuric acid concentration may be low (about 6 percent in "low current density" process) or higher (about 22-28 percent in "high current density" process).

END OF SUBSECTION

0.03.01.01 BEAMS • CAST-IN-PLACE CONCRETE (CSI 03300)

DESCRIPTION

Cast-in-Place Beams are structural members transversely supporting a load, such as a girder, rafter, or purlin. A beam anchor is used for securing a beam firmly to a wall. Beam and girder construction are sometimes used in floor systems: slabs to distribute the load to spaced beams and girders, A beam bearing plate (steel) is used under the end of the beam to distribute the reaction load over a larger area. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Cast-in-Place Beams (CSI 03300)

The structural and architectural design of beams requires very careful consideration because all of the factors that produce tension in concrete may be additives over portions of the member. Depths should be kept to the minimum recommended size at the top and bottom of beams in regions of flexural tension. Cast-in-Place Beams vary in depth and thickness depending on the loads and weight of the structure they are to support.

Joints intended to allow substantial axial and/or rotational movement must be designed and detailed to prevent spalling and leakage if exposed to weather.

Cast-in-Place Concrete (CSI 03300)

Cast-in-Place Concrete is concrete placed in forms at its final location. Concrete is a composite material that consists of essentially a binding medium with embedded particles or fragments of aggregate; in Portland cement concrete, the binder is a mixture of Portland cement and water. The design mix also plays a great part in the strength of the beam. ACI publication 318 “Building Code Requirements for Reinforced Concrete” and ACI publication 303 “Specification for Structural Concrete for Buildings” have indicated a preference for proportioning and designing mixes by other than prescriptive methods.

Because concrete itself has limited resistance to tensile and shear stresses, it is necessary that a composite material is used to take advantage of maximum capabilities of the ingredients in the composite. This composite is called reinforced concrete and makes use of concrete in compression and steel in tension. When designing structural elements to be constructed of reinforced concrete, the engineer assumes that each ingredient is in exact proportion one to another. These proportions will be a factor in the loads involved and the element size. The reinforcing ingredient consists of reinforcing steel in the form of bars and mesh, and must have the concrete positioned so that each ingredient will be efficiently used to its maximum capability.

The capability of the reinforcing materials to bond with the concrete must not be destroyed in any way. Before placement, the reinforcing must be thoroughly cleaned of loose or flaky rust, mill scale, ice, oil, or any other substance that might reduce or destroy the bond. This will include cleaning any steel that may have been contaminated after placement while waiting for the concreting operation.

The cross-sectional area of the reinforcing should not be reduced in any way because the tensile capacity of the material will be affected.

0.03.01.01 BEAMS • CAST-IN-PLACE CONCRETE (CSI 03300)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS (Continued)

Formwork (CSI 03100)

Forms are a temporary structure or mold to support concrete while it is setting and gaining sufficient strength to be self-supporting. It is the, total system of support for freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as all supporting members, hardware, and necessary bracing. For cast-in-place beams, form anchors are used to secure formwork to previously placed concrete of adequate strength. The device is embedded in the concrete during placement. A form coating liquid is applied to the interior of formwork surfaces for a specific purpose, usually to promote easy release from the concrete, to preserve the form material, or retard the set of the near-surface matrix for preparation of exposed aggregate finishes.

Reinforced Concrete **(CSI 03300)**

Because concrete has limited resistance to tensile and shear stresses, steel reinforcing material is necessary. Rebars and/or wire mesh must have a capability of developing a bond with the concrete and be so positioned that each element will be used efficiently. The cross-sectional area of the reinforcing bar should not be reduced in any way, because the tensile capacity of the material will be reduced. A thorough knowledge of contract requirements, construction documents including shop drawings, and the placement of reinforcing steel are very important.

The capability of the reinforcing materials to bond with the concrete must not be destroyed in any way. Before placement, the reinforcing must be thoroughly cleaned of loose or flaky rust, mill scale, ice, oil, or any other substance that might reduce or destroy the bond. This will include the cleaning of any steel that may have been contaminated after placement.

Admixtures (CSI 03370)

An ingredient other than cement, aggregate, or water that is added to a concrete or mortar mix to affect the physical or chemical characteristics of the concrete. The most common affects the plasticity, air entrainment, and curing time.

Air-Entrainment Aaents:

- Provide a more workable material.
- Definitely used when concrete surface will be exposed to freeze/thaw cycles.

Retarder & Densifvinn Agents:

- Retard the set; suggested in warm weather to reduce cracking due to rapid set-up.
- Increase the workability of the mix.
- Allow for delayed finishing, resulting in less permeable concrete.

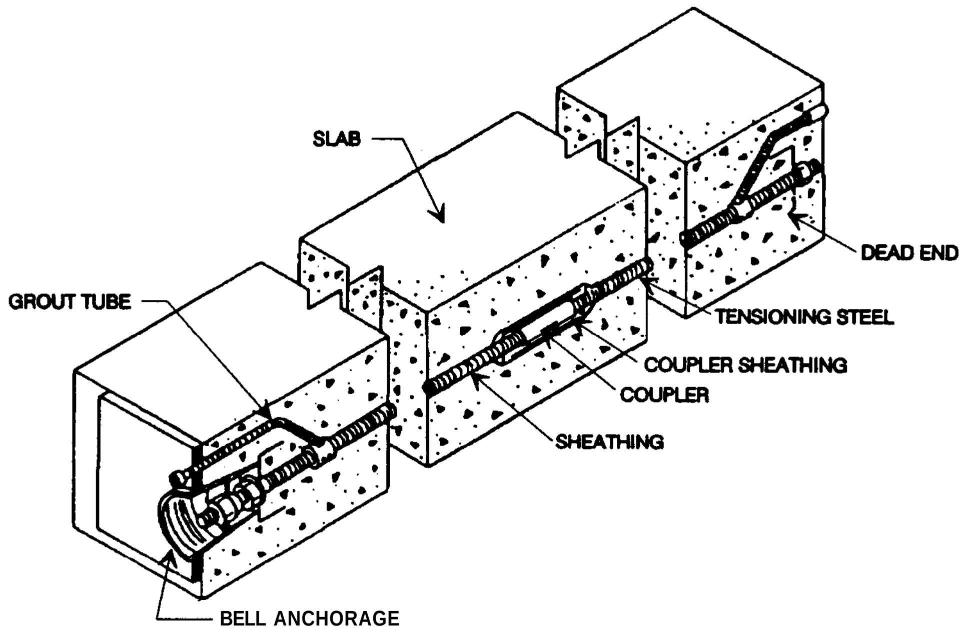
Accelerator:

- Useful in winter (cold weather concreting).
- Useful when working to seal against the water-flow.
- Should be used sparingly because the admixture tends to increase shrinkage.

OTHER RELATED COMPONENTS

See the following subsections for related components:

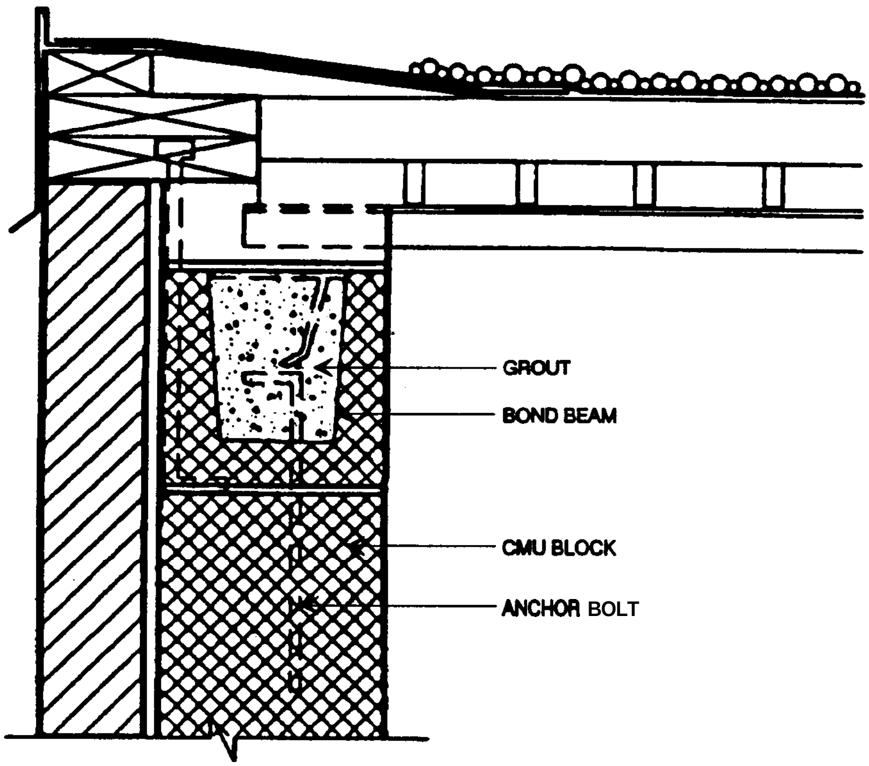
0.02.02.02 Cast-in-Place Concrete 2.2.2-l



POSTTENSIONING ASSEMBLY

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION "R.S. Means Co., Inc., Kingston, Massachusetts"

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	CONCRETE BEAMS (POST-TENSION)		
BEAMS CAST-IN-PLACE CONCRETE (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. A030101-1



SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	MASONRY BOND BEAM		
BEAMS CAST-IN-PLACE CONCRETE (CSI 04200)	Revision No.	Issue Date 5/93	Drawing No. A030101-2

DEFICIENCY FACTORS
0.03.01.01 BEAMS . CAST-IN-PLACE CONCRETE (CSI 03300)

PROBABLE FAILURE POINTS

- Lack of curing will increase the degree of cracking within a concrete structure.
- Reinforcement corrosion is an electro-chemical process that occurs in the presence of air and moisture.
- The weathering processes that can cause cracking include: (1) freezing and thawing, (2) wetting and drying, and (3) heating and cooling.
- A number of deleterious chemical reactions may result in concrete cracks. The reactions may be due to the aggregate used to make the concrete or the materials that come into contact with it after it has hardened or cured.
- A wide variety of poor construction practices can be the result of cracks in concrete structures, expecially adding water to concrete to improve workability, which reduces strength, increases deformation, and increases ultimate drying shrinkage.
- The effects of improper design and/or detailing range from poor appearance to lack of serviceability to catastrophic failure.
- Externally applied loads induce tensile stresses that result in cracks. Current ACI 318 design procedures use reinforcing steel, not only to carry the tensile forces, but also to control both an adequate crack distribution and width.

SYSTEM ASSEMBLIES/DEFICIENCIES

Concrete

Alkali-Aggregate Expansion:	Chemical reaction between aggregate and cement paste.
Cracks (Active & Dormant):	Construction movement, settlement, shrinkage around reinforcement. Inadequate finishing and curing. Chemical reactions such as corrosion. Physical reactions such as drying shrinkage. Thermal changes (subjected to temperature extremes such as freeze/thaw cycles). Stress concentration. Structural design. Accidents from overload, vibration, fatigue, and earthquake.
Surface Deterioration:	Crazing from surface shrinkage more rapid than interior of concrete mass. Too high a slump. Too rich a mix. Poor timing on finishing. Too rapid absorption of moisture. Cavitation from water or liquid action over surface. Chemical reactions.
Holes (Small & Large):	Inadequate construction and design. Impact damage.
Form Scabbing:	Form oil improperly applied.
Spalling:	Fragment flakes from the surface due to weather, pressure, or other actions.
Out-of-Alignment:	Bowing, deflection, or other movement that brings the surface out of plumb or not level in one or more directions.
Staining:	Discoloration in the surface of a material from a foreign substance or material.
Efflorescence:	A whitish powdery deposit of soluble salts brought to the surface by moisture. Leaves residue after evaporating.

DEFICIENCY FACTORS
0.03.01.01 BEAMS - CAST-IN-PLACE CONCRETE (CSI 03300)

SYSTEM ASSEMBLIES/DEFICIENCIES

Concrete (Continued)

Corrosion of Rebar:	Metal rebar oxidation by chemical or electrochemical action after prolonged exposure to moisture.

SPALLING/DETERIORATION OF CONCRETE BEAM
AT METAL BEAM CONNECTION

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUPERSTRUCTURE	DETERIORATION OF CONCRETE BEAM		
BEAMS CAST-IN-PLACE CONCRETE (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D030101-1

REVIEW PENDING

REVIEW PENDING

CIP BEAM SPALLING AND CRACKING

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUPERSTRUCTURE	BEAM DETERIORATION		
BEAMS CAST-IN-PLACE CONCRETE (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D030101-2

DEFICIENCY FACTORS
0.03.01.01 BEAMS - CAST-IN-PLACE CONCRETE **(CSI 03300)**

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DEFICIENCY FACTORS
0.03.01.01 BEAMS - CAST-IN-PLACE CONCRETE (CSI 03300)

END OF SUBSECTION

0.03.01.02 BEAMS ▪ PRECAST CONCRETE (CSI 03400)

DESCRIPTION

Precast is a concrete member that is cast and cured in other than its final position. Precast beams are either reinforced or prestressed in a manufacturer/casting plant and then shipped to the project site. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Precast Columns (CSI 03400)

The use of manufactured precast and prestressed concrete elements permit a wide variety of framing solutions. In addition to the double tee, prestressed channels, joists, and planks could be used. The feasibility of using prestressed elements will often depend on the accessibility of manufacturing plants. Prestressed concrete elements are of little advantage for short spans, but can be used to advantage for long spans with all types of construction.

Advantaaes:

Precast has the greatest advantage when there are identical members to be cast, because the same forms can be used several times. In addition to using the same forms, precast concrete has other advantages:

- Quality control
- Smoother surfaces, and plastering is not necessary
- Less storage space is needed
- Concrete member can be cast under all weather conditions
- Better protection for curing
- Weather conditions do not affect erection
- Faster erection time

Because concrete in itself has limited resistance to tensile and shear stress, a composite material is necessary to take advantage of the maximum compatibility of the ingredients in the composite.

Reinforcing steel should be placed in accordance with engineers requirements. Laps, tying, and hook positions should conform to the ACI codes. Concrete covering over steel reinforcement is critical because of the protection afforded the steel.

The cross-sectional area of the reinforcing should not be reduced in any way because the tensile capacity of the reinforcing materials is specified to conform to ACI 315.

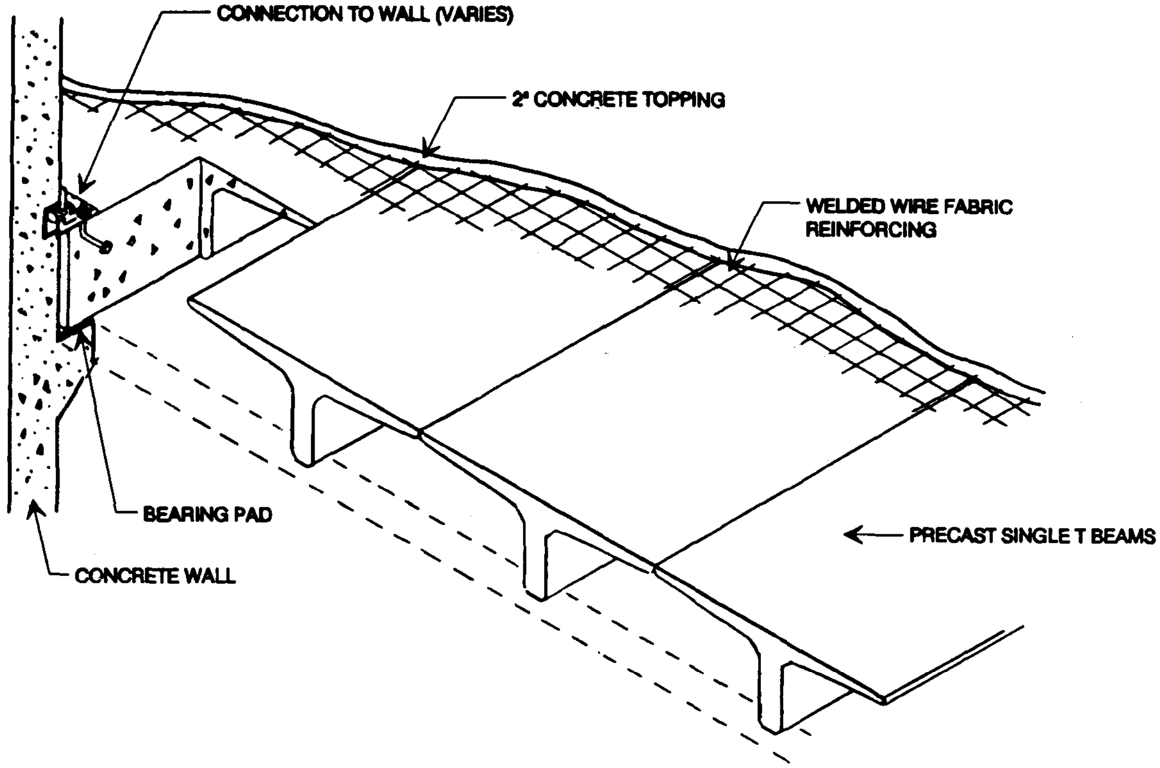
Precast Beams (CSI 03400)

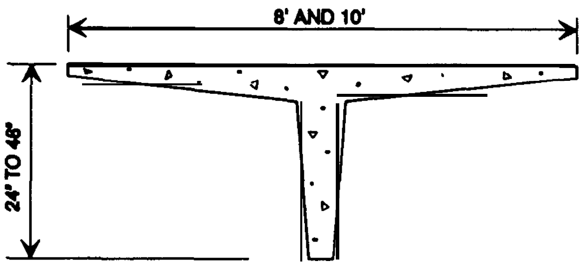
Precast, prestressed, single T-beams are plant-produced structural members that are transported to the site and erected; long-span T-beams require heavy erection equipment. Ts are available in both normal and lightweight concrete in 8 and 10 foot widths for spans of over 100 feet (roofs). They are usually supported on bearing walls, beams, or columns. Ts used for floors are normally topped with concrete. Double Ts are usually 8 to 10 feet wide with a 2 inch flange thickness, and depths range from 8 to 32 inches. Span distances are less than with single Ts: the maximum span is 60 to 80 feet. Double Ts typically have a 2 inch thick concrete topping that covers the joints, smoothes out any irregularities between adjacent panels, and strengthens the floor or roof assembly. Double Ts are used frequently because of their many advantages. They function both as structure and decking.

0.03.01.02 BEAMS - PRECAST CONCRETE (CSI 03400)

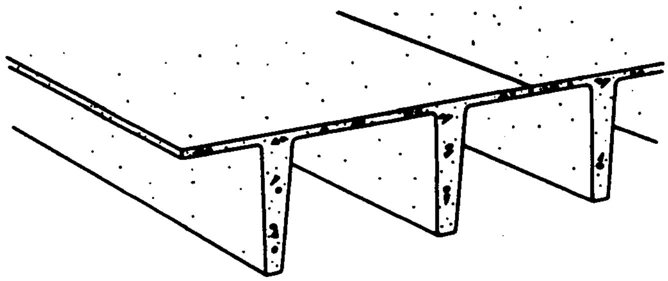
OTHER RELATED COMPONENTS

See the following subsections for related components:

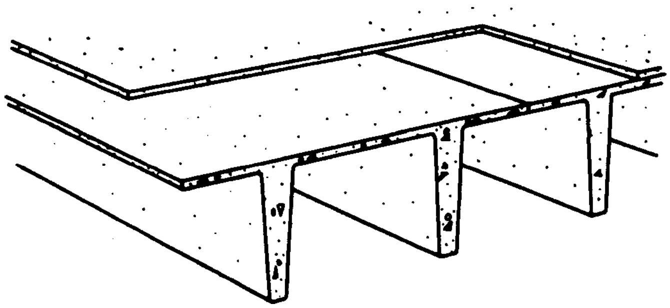




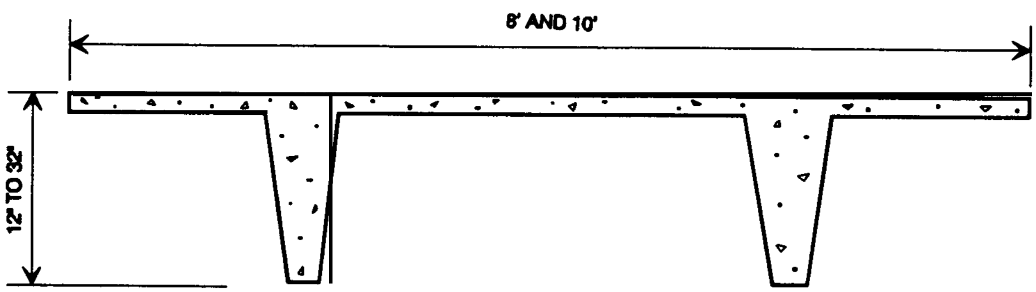
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	PRECAST SINGLE T-BEAM		
BEAMS PRECAST CONCRETE FLOORS(CSI 03400)	Revision No.	Issue Date 5/93	Drawing No. A030102-1



DOUBLE T WITH NO TOPPING



DOUBLE T WITH 2" TOPPING



DOUBLE T SIZE VARIATIONS

<table>
<tr><td>SYSTEM ASSEMBLY
DETAILS-SUPERSTRUCTURE</td><td colspan="3">PRECAST DOUBLE T-BEAM</td></tr>
<tr><td>BEAMS
PRECAST CONCRETE
FLOORS(CSI 03400)</td><td>Revision No.</td><td>Issue Date
5/93</td><td>Drawing No.
A030102-2</td></tr>
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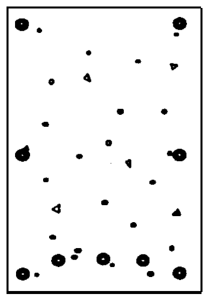
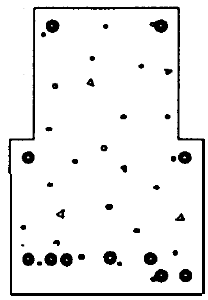
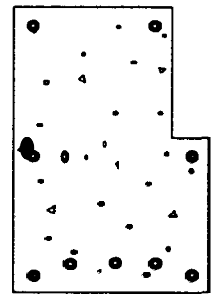
PRECAST CONCRETE PRESTRESSED OR REINFORCED BEAMS



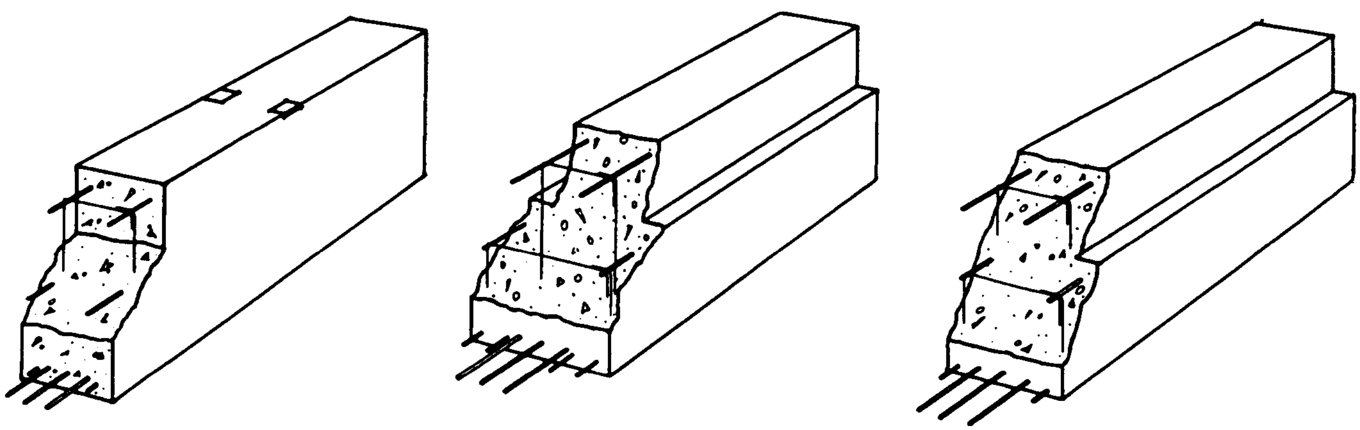
RECTANGULAR



T SHAPE

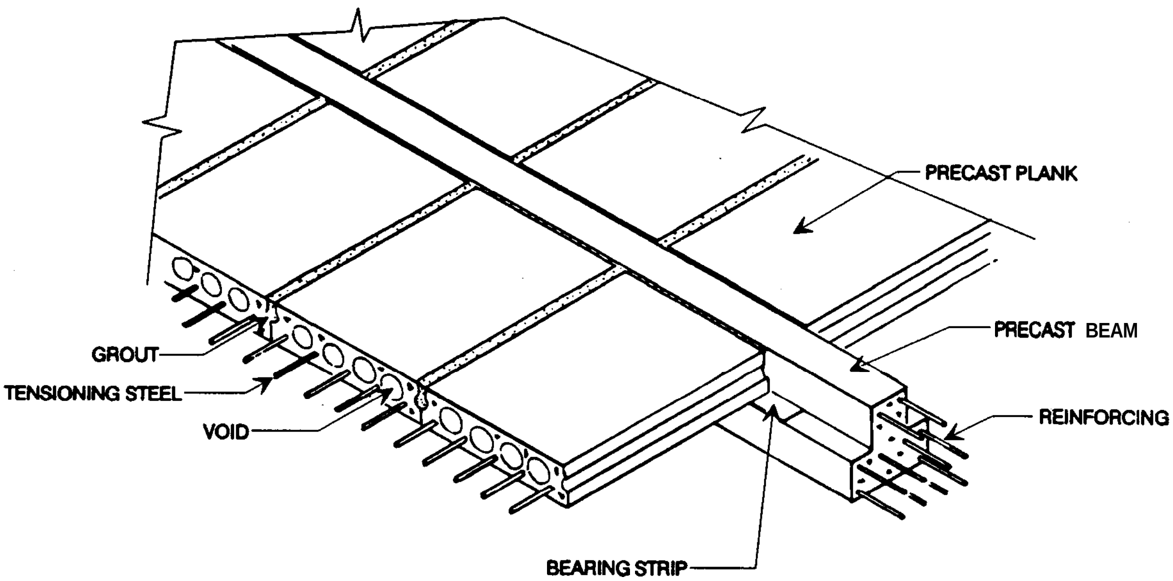


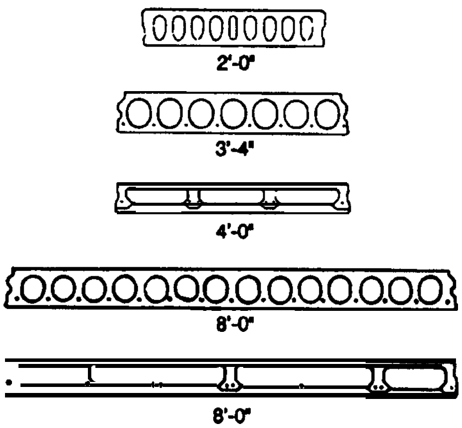
L SHAPE

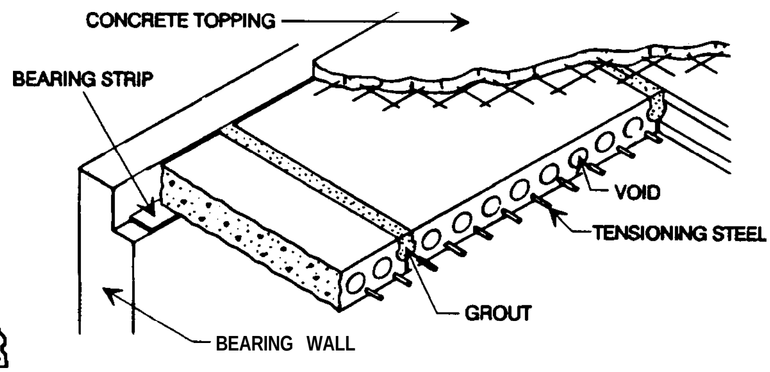


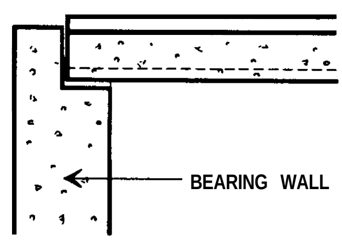
REINFORCING PLACEMENT

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	PRECAST BEAMS		
BEAMS PRECAST CONCRETE (CSI 03400)	Revision No.	Issue Date 5/93	Drawing No. A030102-3









SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	PRECAST CONCRETE PLANK SYSTEM		
BEAMS PRECAST CONCRETE FLOORS(CSI 03400)	**Revision No.**	**Issue Date** 5/93	**Drawing No.** A030102-4

DEFICIENCY FACTORS
0.03.01.02 BEAMS - PRECAST CONCRETE (CSI 03400)

PROBABLE FAILURE POINTS

- Reinforcement corrosion is an electrochemical process that occurs in the presence of air and moisture.
- Precast members should not be skidded, rolled, driven, or subjected to full design load until they have attained their 28-day strength, as indicated by cylinders made from the same concrete.
- Construction overloads induced during construction can be far more severe than those experienced in the lifetime of the structure. These conditions may occur at early ages when the concrete is most susceptible to damage, and often result in cracks.
- The effects of improper design and/or detailing range from poor appearance to lack of serviceability to catastrophic failure.
- Externally applied loads induce tensile stress which result in cracks. Current ACI 318 design procedures use reinforcing steel, not only to carry the tensile forces, but also to control adequate crack distribution and width.

SYSTEM ASSEMBLIES/DEFICIENCIES

Surface Deterioration:	Cavitation from water or liquid action over surface. Chemical reactions.
Holes (Small & Large):	Inadequate construction and design. Impact damage.
Out-of-Alignment:	Bowing, deflection, or other movement that brings the surface out of plumb or not level in one or more directions.
Spalling:	Fragment flakes from the surface due to weather, pressure, or other actions.
Staining:	Discoloration in the surface of a material from a foreign substance or material.
Eff lorescence:	A whitish powdery deposit of soluble salts brought to the surface by moisture. Leaves residue after evaporating.
Cracks (Active & Dormant):	Construction movement, settlement, shrinkage around reinforcement. Inadequate finishing and curing. Chemical reactions such as corrosion. Physical reactions such as drying shrinkage. Thermal changes (subjected to temperature extremes such as freeze/thaw cycles). Stress concentration. Structural design. Accidents from overload, vibration, fatigue, and earthquake.
Corrosion of Rebar:	Metal rebar oxidation by chemical or electrochemical action after prolonged exposure to moisture.

DEFICIENCY FACTORS
0.03.01.02 BEAMS • PRECAST CONCRETE (CSI 03400)

END OF SUBSECTION

0.03.01.03 BEAMS - STEEL (CSI 05120)

DESCRIPTION

Structural Steel Beams are one of the most important structural materials used in buildings today. Its widespread use can be attributed to its properties, availability, and competitive price. Some of its desirable qualities include great strength and stiffness, durability, workability, and reliability. Steel is non-combustible, unaffected by fungi or insects, and dimensionally stable. The disadvantages are corrosion and lack of fire resistance. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Standard **I-Beam Shape** (CSI 05120)

An I-beam is a structural member of rolled steel with a cross-section that resembles the capital letter I. In former years built-up sections were used extensively, but wide flange sections are now rolled in a large variety of sizes and are used universally because they require minimal fabrication. For excessive loads or unusual conditions, plates are welded to the flanges of wide flange sections to give added strength.

Structural **Tube Beams** (CSI 05120)

Steel beams are also fabricated from structural tubing in both square and rectangular shapes and can be used for light to moderate weight structural framing. Square tubing is available in sizes of 2 to 16 inches and rectangular sizes ranges from 3x2 to 20x12 inches. Sections are produced with various thicknesses, thus allowing a considerable range of structural capacities. Tubing is specified by its actual outside dimensions, and may be available in various steel strengths.

Connections:

Connections are commonly provided by bolting, riveting, welding, or by a combination of shop-welded and field-bolted. Bolts may be common (ASTM A307) or high strength (ASTM A325 or A490).

High-strength bolts may be specified with friction or bearing-type connections with threads included or excluded from the shear plane. Connection details vary with type and number.

Both shop and field connections may be either bolted or welded, as determined by the engineer. Connections are not provided by proprietary fastening devices. The use of such devices must be specified to suit the project. Combinations of connections and types of connections must be coordinated with structural calculation.

Welded connections are generally governed by the American Welding Society document D1.I-88, “Structural Welding Code, Steel.” Full and complete information regarding location, size, type, and extent of all welds, as well as distinguishing shop and field welds, must be clearly shown on drawing.

OTHER RELATED COMPONENTS

See the following subsections for related components:

0.03.01.03 BEAMS - STEEL (CSI 05120)

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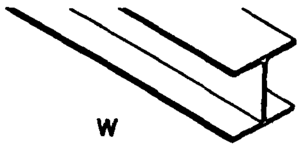
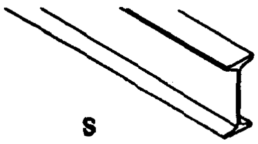
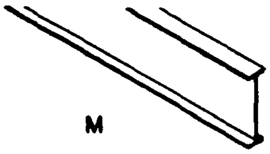
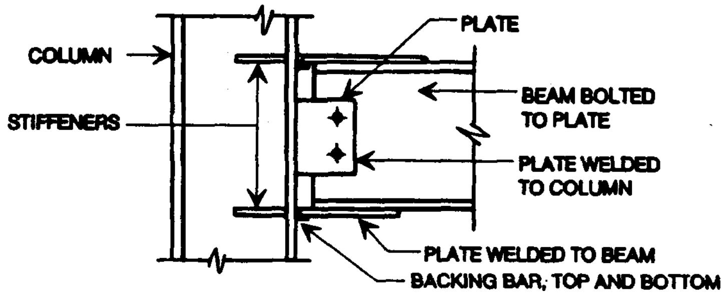
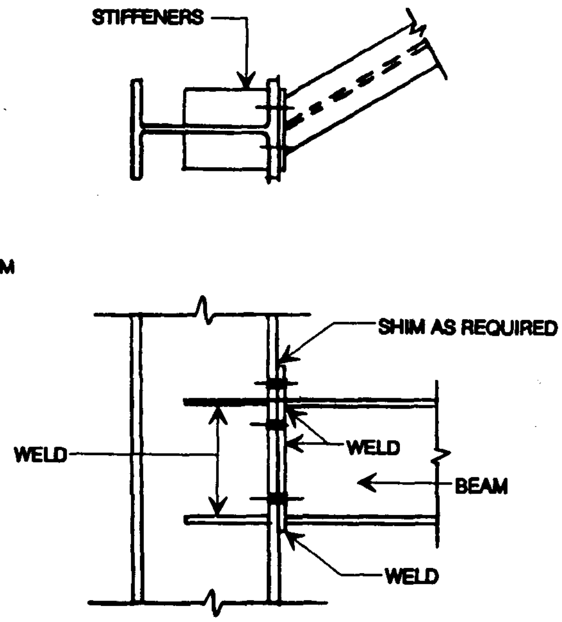
SHAPE AND DESIGNATION	NAME AND CHARACTERISTICS
 W	WIDE FLANGE PARALLEL FLANGE SURFACES
 S	AMERICAN STANDARD BEAM (I BEAM) SLOPED INNER FLANGE
 M	MISCELLANEOUS BEAMS CANNOT BE CLASSIFIED AS W, HP OR S INFREQUENTLY ROLLED BY SOME PRODUCERS

STEEL BEAM SHAPES

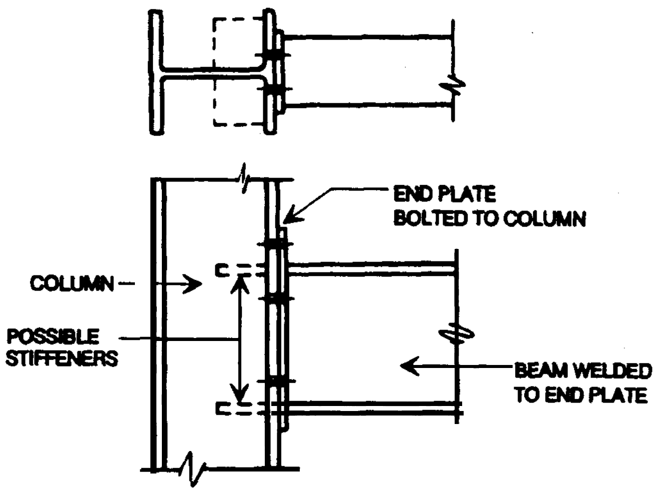
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	STEEL BEAM SHAPES		
BEAMS STEEL (CSI 05100)	Revision No.	Issue Date 5/93	Drawing No. A030103-1



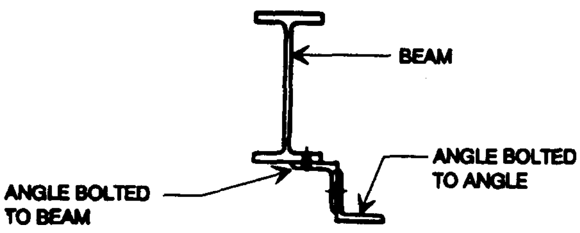
MOMENT CONNECTION-WELDED



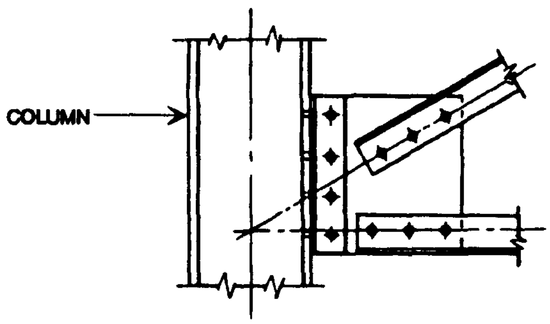
SKEWED BEAM CONNECTION



MOMENT CONNECTION-END PLATE



ZEE CONNECTION



TRUSS CONNECTION

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	BEAM TO COLUMN CONNECTIONS		
BEAMS STEEL (CSI 05050)	Revision No.	Issue Date 5/93	Drawing No. A030103-2

DEFICIENCY FACTORS
0.03.01.03 BEAMS - STEEL (CSI 05120)

PROBABLE FAILURE POINTS

- Steel corrosion is an electrochemical process that occurs in the presence of air and moisture.
- Cracked or broken welds caused by stress, settlement/movement, poor materials, or improper construction.
- Loose connections caused by vibration, temperature changes, or improper tightness.
- Impact damage caused by objects striking or impacting the surface.

SYSTEM ASSEMBLIES/DEFICIENCIES

Abrasion:	Caused by contact with moving parts, wave action, or immersion in a moving liquid.
Corrosion:	Results from a chemical or electro-chemical' reaction that converts the metal into an oxide, carbonate, and sulfides.
Out-of-Alignment:	Bowing, deflection, or other movement that brings thr surface out of plumb or not level in one or more directions.
Impact Damage:	Depressions, dents, or buckled surface from objects striking or impacting the surface.
Loss of Protective Coating/Paint:	Chalking, peeling, chipping, blistering, or deterioration.
Fatigue Cracking:	Caused by repetitive, cyclic loading occurring at stresses at or below allowable design values.
Lamellar Tearing:	Strains and separation(s) within the steel induced by hot metal weld shrinkage as it cools.
Loose Connections:	Caused by impact, vibration, fatigue loading, or incorrect tightness.
Damaged Welds:	Cracked or broken welds caused by stresses, poor materials, or improper construction.

DEFICIENCY FACTORS
0.03.01.03 BEAMS - STEEL (CSI 05120)

END OF SUBSECTION

0.03.01.04 BEAMS - WOOD (CSI 06100)

DESCRIPTION

Wood Beams are a structural member transversely supporting a load either in tension or compression or both as a girder or purlin. Beams are generally supported by metal ties to other beams, joists, or to a wall. Wood beams also rest on bearing plates that distribute the reaction load over a larger column. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Wood Beams (CSI 06100)

Wood, unlike most processed building materials, is an organic material that can be used in its natural state. Factors that influence its strength are density, natural defects (knots, grain, etc.), and moisture content. Wood can be easily shaped or cut to size on the site or prefabricated in the shop. Structurally, wood may be used for joists, posts, column, beams, and trusses. Structural lumber is stress-graded for bending, tension parallel to the grain, compression parallel to the grain, and modulus of elasticity.

General Design Information:

Investigation of the strength and stiffness requirements of a wood beam under transverse loading should take into consideration the following factors:

- Bending moment induced by the load
- Deflection or deformation caused by the load
- Horizontal shear at the supports
- Bearing on supporting members
- Lateral stability of beams

Beams that are relatively deep in comparison to width may be unstable under the application of loads. Such instability is due to the tendency of the compression edge of the beam to buckle, causing the beam to deflect laterally.

General Information:

The following general rules, based on nominal dimensions, may be applied in providing lateral restraint for sawn lumber bending members:

- If the ratio of depth to width or thickness is 2 to 1, no lateral support is needed.
- If the ratio is 3 to 1 or 4 to 1, the ends should be held in position, as when nailed or bolted to a vertical member or laterally supported by blocking.
- If the ratio is 5 to 1, one edge should be held in line for its entire length.
- If the ratio is 5 to 1 or more, the beam should be supported laterally at intervals of 8 feet by bridging or transverse beams, or both edges should be held in line, or the compression edge should be supported throughout its length to prevent lateral displacement and the ends. Points of bearing should have lateral support to prevent rotation.

0.03.01.04 BEAMS . WOOD (CSI 06100)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Wood **Beams** (CSI **06100)** (Continued)

Deflection of Wood Beams:

Beam deflection is a measure of the deformation that occurs as the beam resists bending under applied load. When the induced bending stress does not exceed the applicable design value, the deformation does not seriously affect the beam endurance. Thus, where assembly appearance or rigidity is not important, deflection may be ignored and the design' based on strength alone. However, where appearance or rigidity is important, deflection may be the controlling factor in determining the size of member required. Another reason for limiting deflection is to control vibration due to impact on residential floors.

Conditions for Deflection:

The reason for controlling deflection influences the design load selected. Deflection due to the dead load of the construction materials has occurred by the time they are installed. Where the purpose is to provide adequate rigidity to avoid damaging brittle materials or to eliminate excessive vibration in floors due to impact, design for live load only is adequate.

The deflection of a wood beam, under long-continued full design load, will increase beyond what it was immediately after the load was first applied, but without endangering the safety of the beam. Where it is necessary to limit the deflection under such long-continued loading, extra stiffness can be provided in the design stage by increasing member size. This can be done by applying an increase factor to the deflection due to long-term load. Total deflection is thus calculated as the immediate deflection due to long-time or permanent loading, times the appropriate increase factor, plus deflection due to the short-term or normal design load component.

Horizontal Shear:

A beam subjected to a vertical shearing force is also subjected to a horizontal or longitudinal shearing force. Such a vertical load results in a tendency of the upper part of the beam to slide by the lower part. To maintain equilibrium within the beam, the shear resistance of the wood must equal or exceed the horizontal shear induced by the vertical load. In a rectangular beam, the maximum intensity of horizontal shear occurs at the neutral axis of the section and is dependent on the magnitude of the vertical shear force.

Laminated Wood **Beams** (CSI **06170)**

Laminated construction is a popular method of wood construction. These structural members are made up of individual pieces of lumber 3/4 or 1 1/2 inches thick glued together under pressure in a factory. Standard widths are 3 1/8 inch, 5 1/8 inch, 6 3/4 inch, and 8 3/4 inch. Larger widths are available. Typical spans are between 15 and 60 feet.

Laminated wood beams may be used to frame floors and roofs with varied spans and loadings. The connectors are usually fabricated-designed and supplied. Because they are lightweight, these wood members may be erected without the assistance of expensive lifting equipment, thus decreasing the installed cost of the floor or roof system.

I-Shaped Joist (CSI 06170)

I-Shaped joists consist of a top and bottom chord of solid or laminated construction separated by a plywood weld. This type of joist is used in residential and light commercial construction and allows longer spans than are possible with a joist system. It has a very efficient structural shape, like a steel wide flange, and is manufactured in a factory. This type of product is stronger and stiffer than a standard wood joist.

0.03.01.04 BEAMS . WOOD (CSI 06100)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS (Continued)

Wood Truss (CSI 06170)

Wood trusses are made up of standard size wood members connected with metal plates. Typical spans range from about 24 to 40 feet and typical depths are from 12 to 36 inches. A common spacing is 24 inches on center. These trusses are used for residential and light commercial construction and allow easy passage of mechanical ductwork through the truss.

Wood **Joist** (CSI 06100)

Joists are commonly wood. They are light, closely spaced members that span between beams or bearing walls. Typical sizes are 2x6, 2x8, 2x10 , and 2x12 inches. Typical spacing is 12, 16, and 24 inches on-center. The typical maximum normal span is about 20 feet, but spans up to 25 feet are often used.

OTHER RELATED COMPONENTS

See the following subsections for related components:

0.03.01.04 BEAMS - WOOD (CSI 06100)

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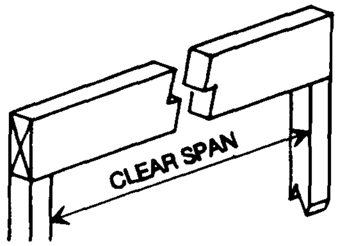
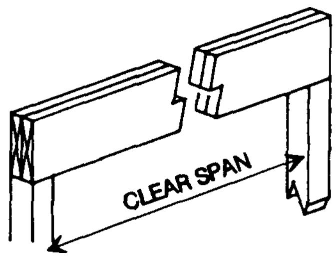
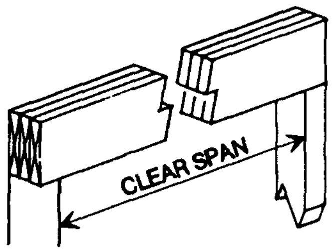


SINGLE BEAM



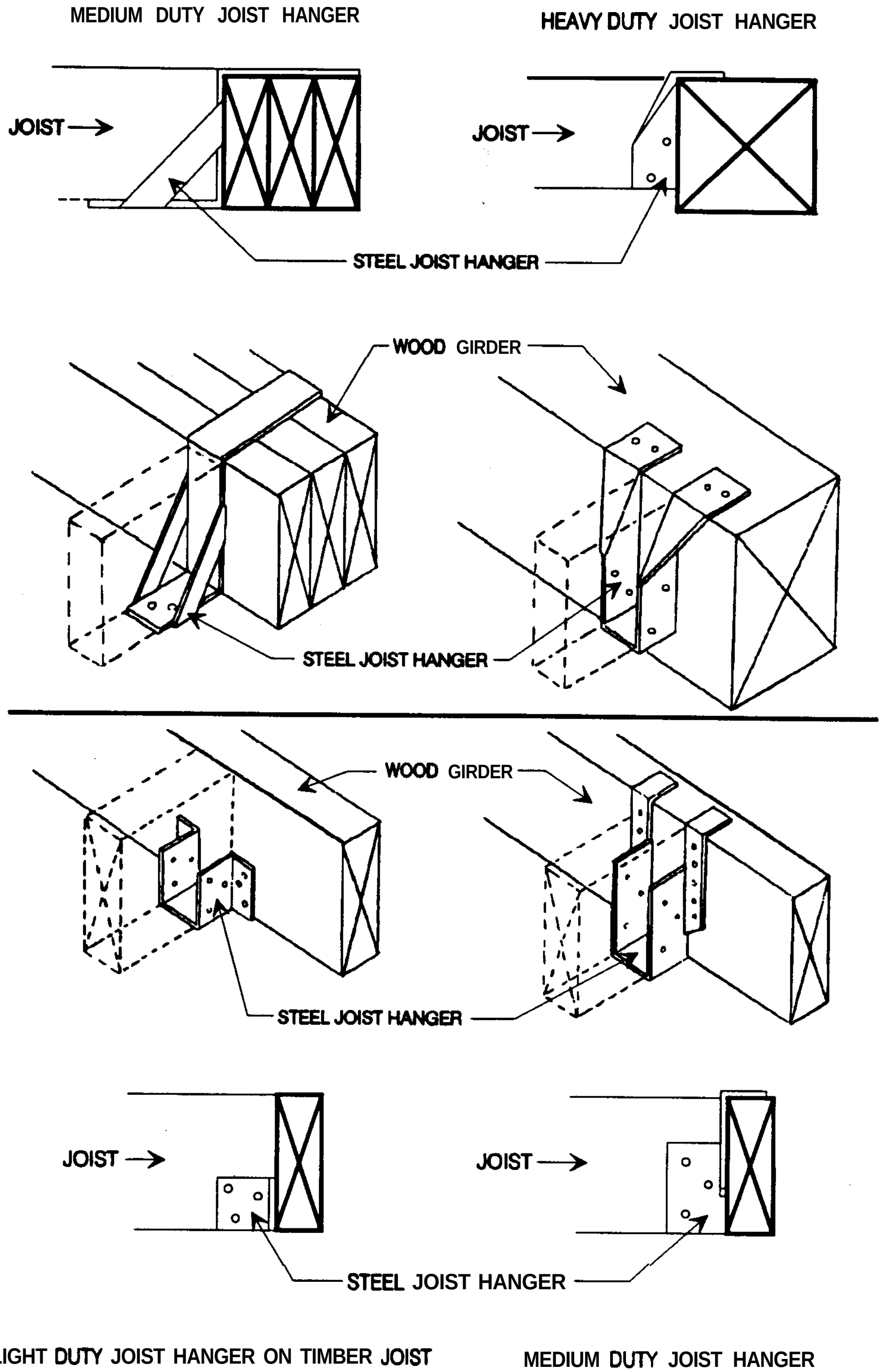
DOUBLE BEAM



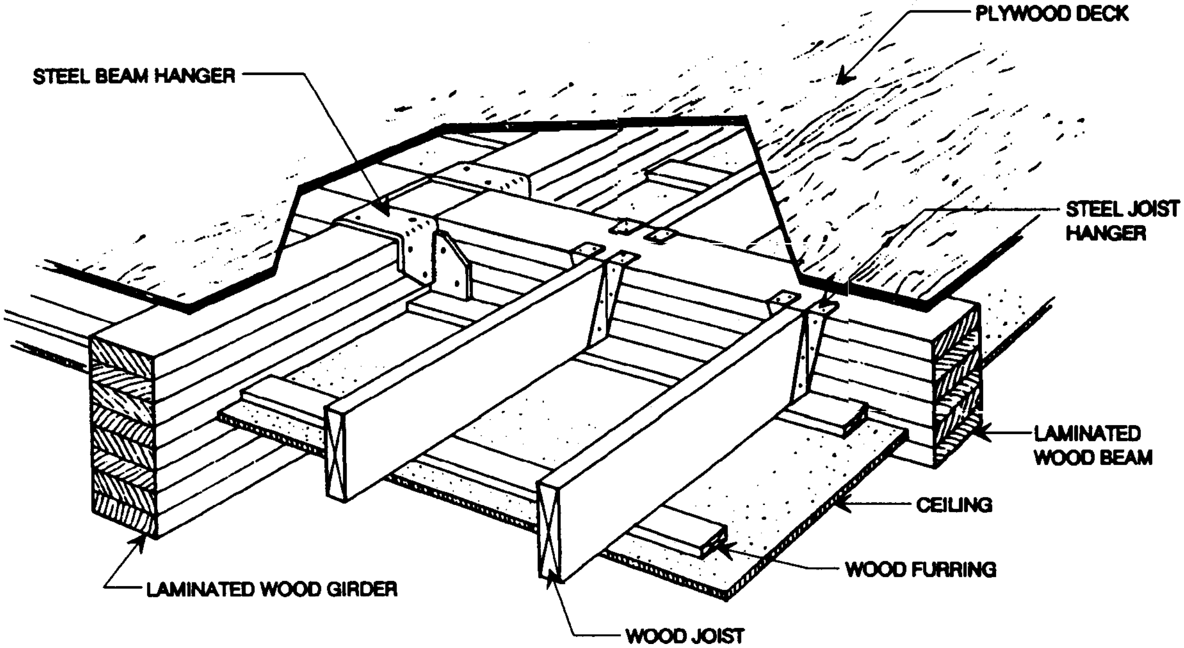
TRIPLE BEAM

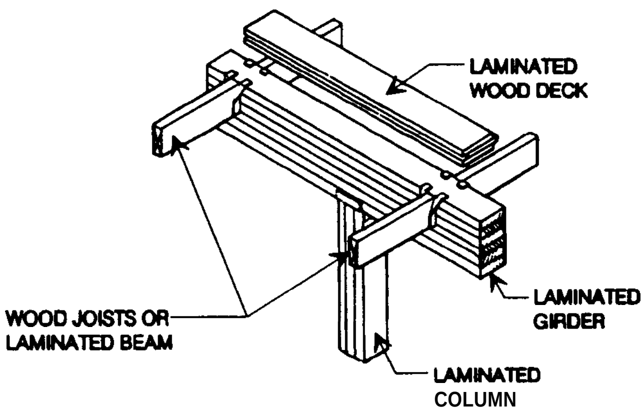
WOOD BEAMS AND COLUMNS

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	WOOD BEAMS		
BEAMS WOOD (CSI 06100)	Revision No.	Issue Date 5/93	Drawing No. A030104-1



SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	JOIST TO BEAM CONNECTIONS, VARIOUS JOIST HANGER SIZES		
BEAMS WOOD (CSI 06100)	Revision No.	Issue Date 5/93	Drawing No. A030104-2

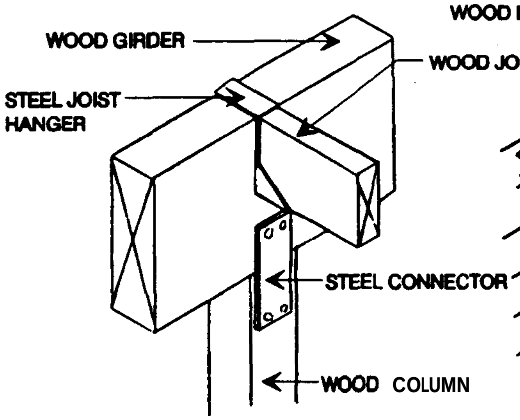




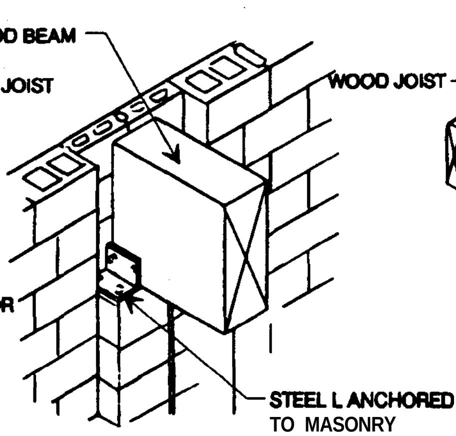
LAMINATED WOOD FLOOR SEAMS

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION "R.S. Means Co., Inc., Kingston, Massachusetts"

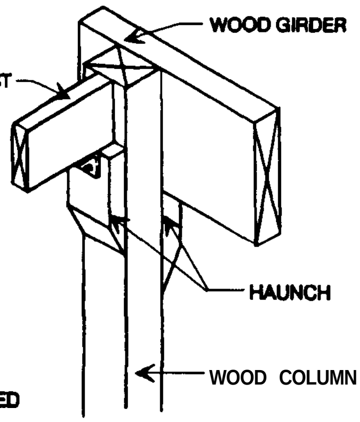
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	LAMINATED WOOD BEAM		
BEAMS WOOD (CSI 06180)	Revision No.	Issue Date 5/93	Drawing No. A030104-3



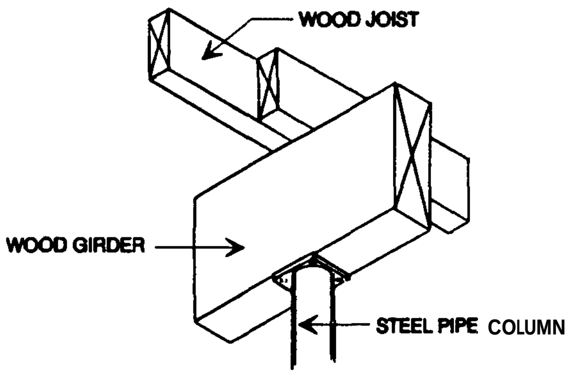
WOOD COLUMN
GIRDER AND JOIST



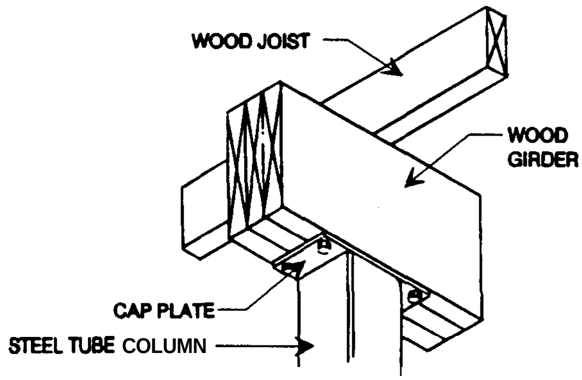
WOOD GIRDER SUPPORTED
BY MASONRY WALL



WOOD COLUMNS WITH
LAMINATED HOUNCHES

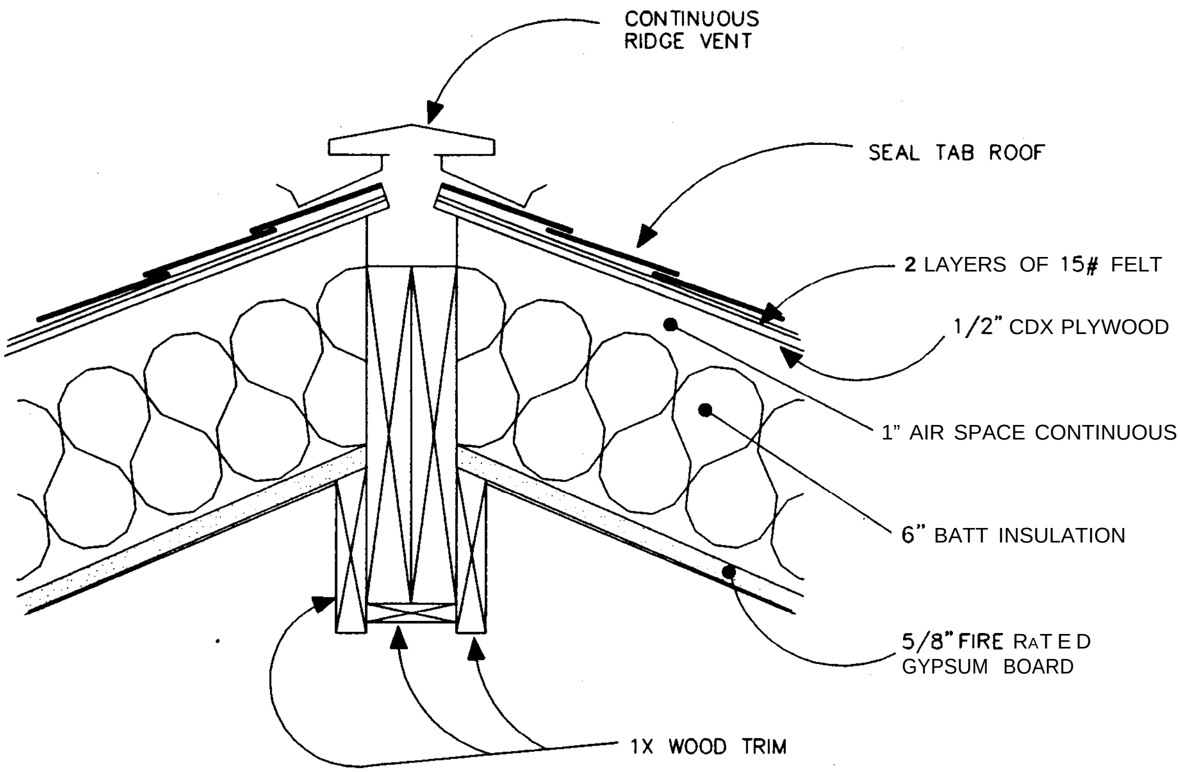


WOOD GIRDER SUPPORTED
BY PIPE COLUMN



WOOD GIRDER SUPPORTED BY
SQUARE TUBE COLUMN

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	POST AND BEAM CONNECTION		
BEAMS WOOD (CSI 06100)	Revision No.	Issue Date 5/93	Drawing No. A030104-4



TYPICAL RIDGE DETAIL

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	WOOD BEAM AND RAFTERS		
BEAMS WOOD (CSI 06100)	Revision No.	Issue Date 5/93	Drawing No. A030104-5

DEFICIENCY FACTORS
0.03.01.04 BEAMS - WOOD (**CSI** 06100)

PROBABLE FAILURE POINTS

- Termite and boring insect damage causing structural integrity breakdown.
- Prolonged exposure to moisture can lead to decay (rot) fungi, mildew, or dry rot causing surface deterioration.
- Fire damage or charred surfaces causing surface flaking or breakdown.
- Loose connections caused by vibration, temperature changes, or improper tightness.
- Splitting or checking caused by stress, bending, or twisting.
- Cracking caused by stress, settlement/movement, poor materials, or improper construction
- Impact damage caused by objects striking or impacting the surface.

SYSTEM ASSEMBLIES/DEFICIENCIES

Out-of-Alignment:	Bowing, deflection, or other movement that brings the surface out of plumb or not level in one or more directions.
Cracking:	Cracking, usually structural in nature, that results in tearing, ripping, or shearing. Cracks can be random, horizontal, vertical, or diagonal.
Surface Deterioration:	Crazing, small surface cracks, corrosion, or surface breakdown due to weather, pressure or other actions.
Staining:	Surface discoloration of a material from a foreign substance or material.
Insufficient Anchors/Connections:	Broken, damaged, loose, corroded, or missing anchorage or fasteners caused by vibration, excessive deflection, or improper tightness.
Dry Rot/Decay:	Structural integrity breakdown from mold/mildew or dry rot.
Loss of Protective Coating/Paint:	Chalking, peeling, chipping, blistering, or deterioration.
Splitting:	Surface splitting or tearing.
insect Damage:	Holes, cracks, or punctures from burrowing insects.
Burned or Charred Surface:	Damage from fire or excessive heat on surface.

DEFICIENCY FACTORS
0.03.01.04 BEAMS - WOOD **(CSI** 06100)

END OF SUBSECTION

0.03.02.01 PRE-ENGINEERED BUILDING SYSTEMS • METAL (CSI 13120)

DESCRIPTION

Pre-Engineered Steel Buildings are manufactured by many companies and normally erected by franchised dealers. They are manufactured of pre-engineered components, which allow flexibility in the choice of configuration for one- or two-story buildings. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Pre-Engineered Building System • Metal (CSI 13120)

Pre-engineered buildings are relatively low in construction cost. They are used extensively for industrial, commercial, institutional, and recreational facilities. There are four types: Rigid Frames, Truss types, Post and Beams, and Sloped Beam. Roof pitches vary, but the most popular type is a low pitch of 1 in 12 inches.

Structural Steel Framing (CSI 13120)

Bay sizing and clear span are usually the prime design determinant factors. Structural framing may be designed in unlimited combinations of columns, girders, beams, and miscellaneous shapes. It is usually shop-fabricated to conform with shop drawings, with individual pieces numbered to agree with erection drawings. Shop operations may consist of shearing or cutting to length, punching holes, coping for connection clearances, attaching connection materials, web stiffeners, etc., and painting.

The erection procedure normally includes shakeout or unloading (spreading or sequencing the pieces); lifting and connecting; plumbing and guying (accomplished with wire cables and turnbuckles); and bolting up, riveting, or welding the connections

Hoisting, lifting, or raising is accomplished using truck-mounted cables and or hydraulic cranes, track cable cranes, stiff leg derricks, guy derricks, climbing cranes, or sometimes, chainfalls or forklifts in existing buildings.

OTHER RELATED COMPONENTS

See the following subsections for related components:

0.03.06 Fireproofing 2.6-l

0.03.02.01 PRE-ENGINEERED BUILDING SYSTEMS - METAL (CSI 13120)

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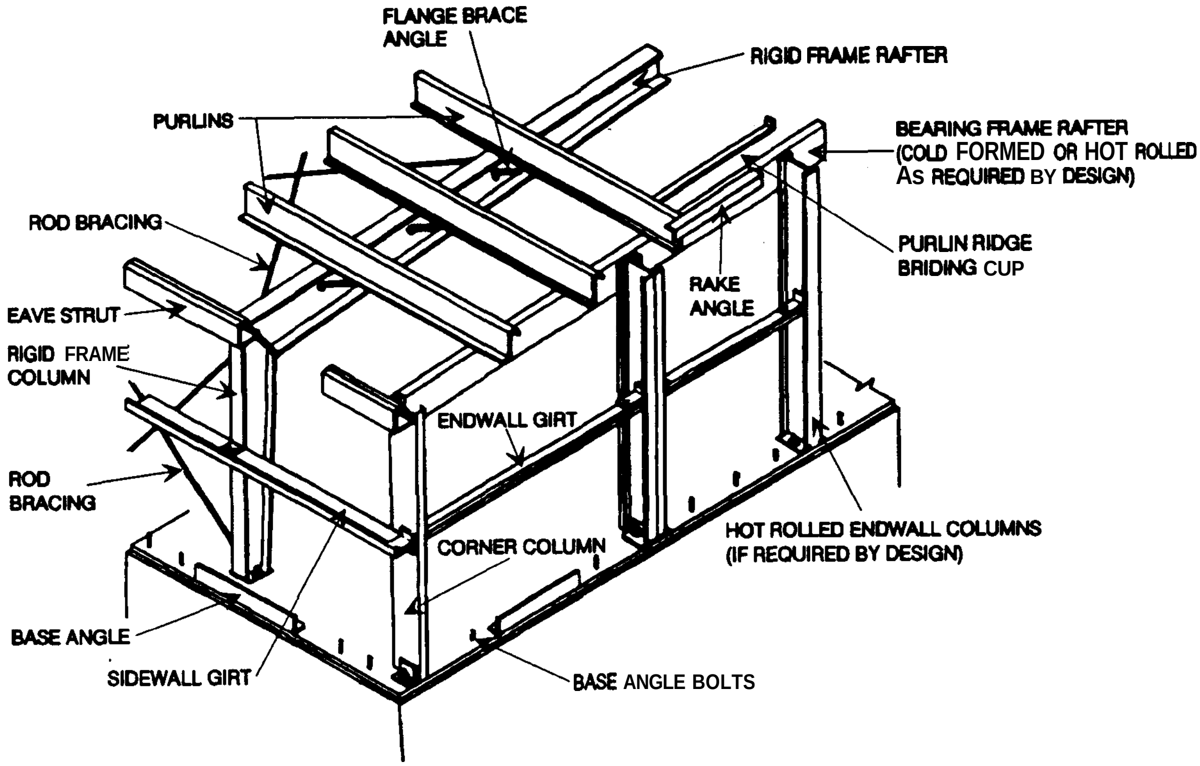
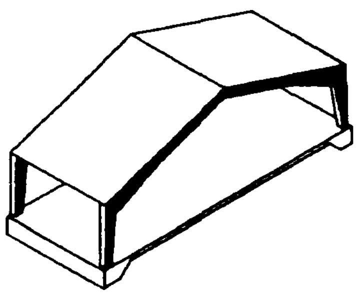
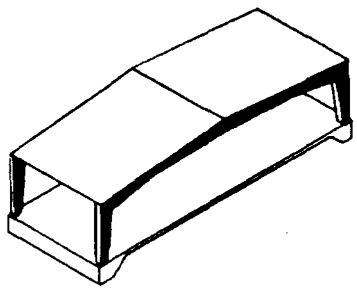


PRE-ENGINEERED BUILDING



HIGH PROFILE RIGID FRAME



LOW PROFILE RIGID FRAME

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION "R.S. Means Co., Inc., Kingston, Massachusetts"

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	FRAME CONFIGURATIONS		
PRE-ENGINEERED BUILDING SYSTEMS METAL (CSI 13120)	Revision No.	Issue Date 5/93	Drawing No. A030201-1

DEFICIENCY FACTORS
0.03.02.01 PRE-ENGINEERED BUILDING SYSTEMS - METAL (CSI 13120)

PROBABLE FAILURE POINTS

- Steel corrosion is an electro-chemical process that occurs with the presence of air and moisture.
- Cracked or broken welds caused by stress, settlement/movement, poor materials, or improper construction.
- Loose connections caused by vibration, temperature changes, or improper tightness.
- Impact damage caused by objects striking or impacting the surface.

SYSTEM ASSEMBLIES/DEFICIENCIES

Abrasion:	Caused by contact with moving parts, wave action, or immersion in a moving liquid.
Corrosion:	Resulting from a chemical or electrochemical reaction that converts the metal into an oxide, carbonate, and sulfides.
Out-of-Alignment:	Bowing, deflection, or other movement that brings the surface out of plumb or not level in one or more directions.
Impact Damage:	Depressions, dents, or buckled surface from objects striking or impacting the surface.
Loss of Protective Coating/Paint:	Chalking, peeling, chipping, blistering, or deterioration.
Fatigue Cracking:	Caused by repetitive, cyclic loading occurring at stresses at or below allowable design values.
Lamellar Tearing:	Strains and separation(s) within the steel induced by hot metal weld shrinkage as it cools.
Loose Connections:	Caused by impact, vibration, fatigue loading, or incorrect tightness.
Damaged Welds:	Cracked or broken welds caused by stresses, poor materials, or improper construction.

DEFICIENCY FACTORS
0.03.02.01 PRE-ENGINEERED BUILDING SYSTEMS . METAL (CSI 13120)

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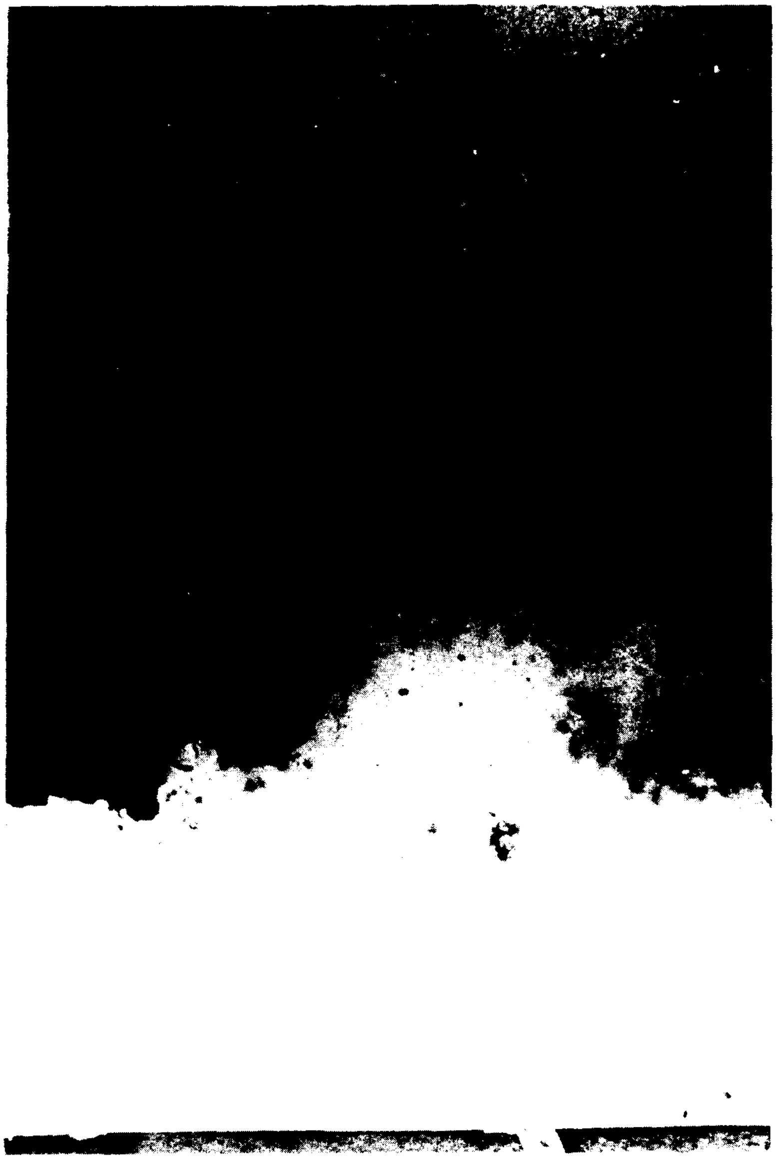


METAL PANEL CORRODED AND DETERIORATED

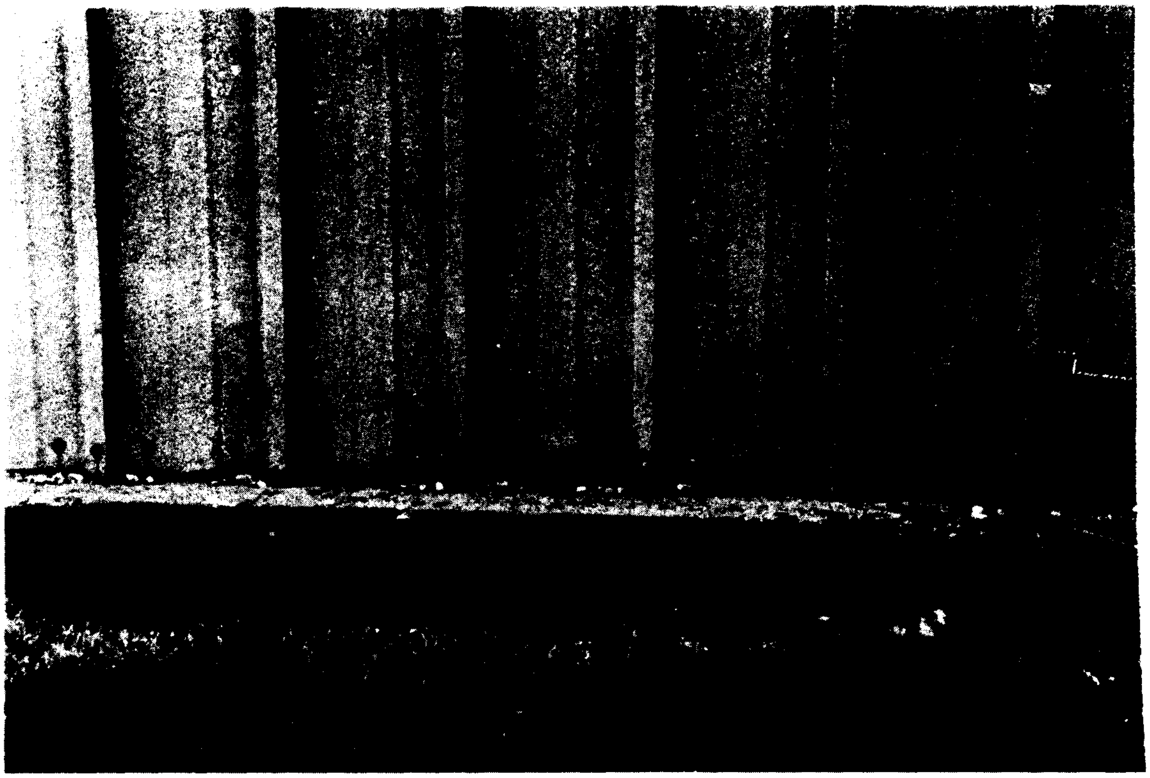
PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUPERSTRUCTURE	PANEL DETERIORATION		
PRE-ENGINEERED BUILDING SYSTEMS **METAL** **(CSI 13120)**	Revision No.	Issue Date 5/93	Drawing No. D030201-1

DENTED SIDE PANEL

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUPERSTRUCTURE	METAL SIDE PANEL		
PRE-ENGINEERED BUILDING SYSTEMS METAL (CSI 13120)	Revision No.	Issue Date 5/93	Drawing No. D030201-2



CORRODED SIDING AT BASE

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUPERSTRUCTURE	SIDING DETERIORATION		
PRE-ENGINEERED BUILDING SYSTEMS METAL (CSI 13120)	Revision No.	Issue Date 5/93	Drawing No. D030201-3

DEFICIENCY FACTORS
0.03.02.01 PRE-ENGINEERED BUILDING SYSTEMS . METAL (CSI 13120)

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DEFICIENCY FACTORS
0.03.02.01 PRE-ENGINEERED BUILDING SYSTEMS - METAL (CSI 13120)

END OF SUBSECTION

0.03.02.02 PRE-ENGINEERED BUILDING SYSTEMS - WOOD (CSI 13120)

DESCRIPTION

Wood engineered buildings are designed to be attractive, functional and economical. Wood engineered buildings are versatile, using various building materials such as fenestrations of exterior walls, examples are: wood, steel, or masonry. Roofing material choices are traditional asphalt shingles, wood shingles, steel panel, or standing seam. Pre-engineered design and controlled manufacturing processes allow for fast, efficient, on-site construction. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENT

Pro-Engineered Building System Wood (CSI 13120)

Foundation design of wood pre-engineered building consists of pour-in-place concrete sized according to the loading and soil conditions. A steel anchor set provides uplift resistance on perimeter columns.

Wall Framinn Svstem:

Consists of precision interlocking framing members.

- The wall columns are nail-laminated with interlocked joints that give added strength at stress points. Full-height nail-laminated columns are usually untreated lumber (graded lumber of #1 Southern Yellow Pine, Kiln dried at 15%) used above grade.

  Lumber used below grade is treated eg.; CCA Treated (oxide basis) and kiln-dried after treatment to 19% moisture content.

  Sidewall and endwall columns consist of 3-plies with two 2x6 inch outside plies and one 2x8 inch center ply. Columns are full height to the roof line.

- Splash planks are 2x8 inch tongue and groove treated lumber, grade #2 southern yellow pine. They are treated with CCA Treatment (oxide basis) and kiln-dried after treatment to 19% moisture content.

- Wall girts are interlocked with columns. Girts are 2x4 inch grade #2 southern yellow pine or better, spaced at 32 inches on-center.

Roof Framina Svstem:

- Clear span metal-plate connected wood trusses are normally designed in accordance with provisions of the Truss Plate Institute to meet the standard live load requirements. The top and bottom chords should be machine-stress-rated lumber. Web members should be a minimum of 2x4 inch #2 southern yellow pine.

  Metal connector plates are galvanized, and between 16 and 20 gauge thicknesses are used.

- Roof purlins span between adjacent trusses, 2x6 inch #2 southern yellow pine. The purlins are oriented such that the load is applied in the strong axis. Spacing depends on loading, with a maximum spacing of 32 inches.

0.03.02.02 PRE-ENGINEERED BUILDING SYSTEMS - WOOD (CSI 13120)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS (Continued)

Pre-Engineered Building System Wood (CSI 13120)

Bracing:

- 2x6 inch diagonal corner bracing is attached to the inside of wall rails at each corner of a building.
- 2x4 inch bottom chord lateral bracing and 2x4 inch compression lateral bracing of truss webs, or 2x4 inch T-bracing of some truss webs as required by the truss manufacturers.
- Metal connected, wood-framed wall shear frames.

Accessory Items:

- Roof gable and eave overhangs in various sizes; pre-formed vented soffits/fascia panel, low profile ridge vents available in various lengths, and roof vent assemblies.

OTHER RELATED COMPONENTS

See the following subsections for related components:

0.03.06 Fireproofing 2.6-l

DEFICIENCY FACTORS
0.03.02.02 PRE-ENGINEERED BUILDING SYSTEMS - WOOD (CSI 13120)

PROBABLE FAILURE POINTS

- Termite and boring insect damage causing breakdown of structural integrity.
- Decay (rot) due to fungi, mildew, and dry rot cause surface deterioration.
- Fire damage or charred surfaces causing surface flaking or breakdown.
- Loose connections caused by vibration, temperature changes, or improper tightness.
- Splitting or checking caused by stress, bending, or twisting.
- Cracking caused by stress, settlement/movement, poor materials, or improper construction.
- Impact damage caused by objects striking or impacting the surface.

SYSTEM ASSEMBLIES/DEFICIENCIES

Out-of-Alignment:	Bowing, deflection, or other movement that brings the surface out of plumb or not level in one or more directions.
Cracking:	Cracking, usually structural in nature, that results in tearing, ripping, or shearing. Cracks can be random, horizontal, vertical, or diagonal.
Surface Deterioration:	Crazing, small surface cracks, corrosion, or surface breakdown due to weather, pressure, or other actions.
Staining:	Discoloration in the surface of a material from a foreign substance or material.
Insufficient Anchors/Connections:	Broken, damaged, loose, corroded, or missing anchorage or fasteners caused by vibration, excessive deflection, or improper tightness.
Dry Rot/Decay:	Breakdown of structural integrity from mold/mildew or dry rot.
Loss of Protective Coating/Paint:	Chalking, peeling, chipping, blistering, or deterioration.
Splitting:	Splitting or tearing of surface.
Insect Damage:	Holes, cracks, or punctures from burrowing insects.
Burned or Charred Surface:	Damage from fire or excessive heat on surface.

DEFICIENCY FACTORS
0.03.02.02 PRE-ENGINEERED BUILDING SYSTEMS - WOOD (CSI 13120)

END OF SUBSECTION

0.03.03.01 FLOORS - CAST-IN-PLACE CONCRETE (CSI 03300)

DESCRIPTION

Concrete floors are fiat, horizontal (or nearly so), molded layers of reinforced concrete, usually uniform but sometimes of variable thickness; they are poured by pumping machines and other installing equipment. The design of concrete floor slabs is affected by the formwork, yet is directly influenced by types and brand of cement, admixtures, uniformly in mixing and placing techniques, curing methods, and other quality control factors. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

One-Way Slabs (CSI 03300)

One-Way Slabs are solid, poured-in-place concrete slabs of uniform depth. They may be single or multiple span and are usually supported by bearing walls or beams. Formwork (or centering) for slabs may be constructed of plywood and wood framing, steel deck, adjustable beams and plywood, or with patented forming systems. For flexure, one-way slabs are reinforced in the direction of the span. For temperature and shrinkage, they are reinforced perpendicular to the span. Multiple-slabs usually require top and bottom flexure reinforcement.

One-Way Concrete Girders, Beams, & Slabs:

One-Way Concrete Girders, Beams, and Slabs are solid, monolithically cast systems. They are an effective support system for heavy or concentrated loads and are most cost-effective at spans under 20 feet. The floor system is relatively deep and the formwork is complex and costly. Form materials usually consist of plywood and wood framing, with shores or scaffolding as the support system. Slabs are reinforced in the direction of the span for flexure and perpendicular to the span for temperature and shrinkage.

Two-Wav Concrete Beams & Slabs:

Two-Way Concrete Beams and Slabs are solid slabs cast monolithically with support beams on columns. They are an effective support system for heavy or concentrated loads. They are most cost-effective in square bays with spans under 30 feet. Slabs are reinforced for flexure in both directions. Beams in square bays assume equal loading for uniform superimposed loads.

Concrete Flat Slabs:

Concrete Flat Slabs are solid slabs cast monolithically with a drop panel. The drop panel is a thick area of concrete surrounding the column where it meets the slab. Flat slabs will sustain heavy loads with long spans, use less concrete and reinforcing, and usually require smaller columns. Flat slabs are most cost-efficient for square bays. Flat slabs with no spandrels can be formed with flying forms and are reinforced for flexure in both directions.

Flat-Plate Slabs:

Flat-Plate Slabs are solid, uniform two-way slabs without drops or interior beams. They are economically efficient for moderate uniform loads and spans and are of minimum floor depth, so they save on building height. Flexibility in column and opening location and the adaptability to flying forms construction make flat slabs a popular choice for multistory buildings with repetitive floors. Flat-plates slabs are reinforced for flexure in both directions. Column sizes are determined by slab thickness unless shear heads or special methods to distribute loads at the top of columns are provided. Flat-plates require larger columns than flat slabs.

0.03.03.01 FLOORS . CAST-IN-PLACE CONCRETE (CSI 03300)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

One Way Slabs (CSI 03300) (Continued)

One-Wav Concrete Joist Construction:

This construction is a monolithic combination of regularly spaced concrete joists and a thin slab. The voids between joists are created by prefabricated void forms shaped like pans. The forms may be metal, fiberglass, or paper. The joist are arranged spanning in one direction between parallel supports. The joists may be supported on integrally placed concrete beams of equal or greater depth, or they may be supported on bearing walls. Standard void forms are 20 inches and 30 inches wide and are available in 6, 8, 10, 12, 14, 16, or 20 inch depths.

Span lengths are varied using telescoping forms. The joist bottoms may be formed by installing an overall plywood forming system similar to the form used for flat-plate construction, or by using centering material to form the bottom of each joist. For spans over 20 feet, the floor system requires distribution ribs at least 4 inches wide placed perpendicular to the span.

Joists are reinforced for flexure in the direction of the span. For ease in placing reinforcing bars with the required cover, it is desirable to use a minimum joist width of 5 inches. Temperature reinforcing in the slab may be accomplished with bars or welded-wire fabric.

Maximum economy is realized in multiple joist slab construction by selecting pan forms of sufficient depth to maintain a uniform dimension between beams and joists and consistent layouts throughout the structure.

Compared to one-way slabs, one-way joist construction is lightweight and permits long spans and heavy uniform superimposed loading. Special architectural ceiling effects may be achieved by integrating the joist and rib patterns with acoustical material and lighting fixtures.

Two-Wav Waffle Slabs:

This construction consists of evenly spaced joists at right angles to each other, integrally placed with a thin slab. The joists are formed using a standard square dome, usually prefabricated from steel or fiberglass. Domes are omitted around the columns to form solid heads. Standard forms to create voids between ribs are 19 or 30 inches square and are usually available in 6, 8, 10, and 12 inch depths for 19 inch domes and 8, 10, 12, 14, 16, and 20 inch depths for 30 inch domes. Nineteen inch square domes create a 24 inch module, and 30 inch domes create a 36 inch module.

Joists are reinforced for flexure in both directions, creating a two-way slab with voids. Bay sizes should be relatively square in configuration.

Waffle slab construction is considerably lighter than solid flat-slab or flat-plate construction and allows longer spans and heavier superimposed loads. The geometrical shape is often architecturally desirable for exposed ceilings.

Forming (CSI 03100)

Suspended concrete slabs vary with job conditions, type of slab, degree of repetition, and weight. Form material may consist of wood, plywood, steel, aluminum, or a combination. Shoring may be accomplished with wood posts, adjustable aluminum or steel beams, or flying truss systems. Edge forms may be prefabricated and reused. Good practice dictates a crown or rise in the center of exposed beams and slabs to offset the appearance of deflection or sagging.

0.03.03.01 FLOORS - CAST-IN-PLACE CONCRETE (CSI 03300)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Forming (CSI 03100) (Continued)

The placing sequence for slab reinforcement usually follows this order: bottom steel, electrical conduit or horizontal pipes, and top steel. Reinforcing varies with the type of slab, but most systems require top and bottom steel supported by slab or beam bolsters and high chairs, which may be individual or continuous.

Beams and column reinforcing may be prefabricated and placed in the forms either by hand or , preferably, by crane.

Formwork (CSI 03100)

Forms are a temporary structure or mold for support of concrete while it is setting and gaining sufficient strength to be self supporting. It is the total system of support for freshly placed concrete, including the mold or sheathing which contacts the concrete, as well as all supporting members, hardware, and necessary bracing. For cast-in-place stairs form anchors are used to secure formwork to previously placed concrete of adequate strength. The device is embedded in the concrete during placement. Also a form coating, a liquid is applied to the interior of the formwork surfaces for a specific purpose, usually to promote easy release from the concrete, to preserve the form material, or retard the set of the near-surface matrix for preparation of exposed aggregate finishes.

Reinforced Concrete (CSI 03300)

Because concrete has limited resistance to tensile and shear stresses, steel reinforcing material is necessary. Rebars and/or wire mesh must have a capability of developing a bond with the concrete and be so positioned that each element will be used efficiently. The cross-sectional area of the reinforcing bar should not be reduced in any way, because the tensile capacity of the material will be reduced. A thorough knowledge of contract requirements, construction documents including shop drawings, and the placement of reinforcing steel are very important.

The capability of the reinforcing materials to bond with the concrete must not be destroyed in any way. Before placement, the reinforcing must be thoroughly cleaned of loose or flaky rust, mill scale, ice, oil, or any other substance that might reduce or destroy the bond. This will include the cleaning of any steel that may have been contaminated after placement.

OTHER RELATED COMPONENTS

See the following subsections for related components:

Refer to Foundations & Footings and Substructure Systems, Volumes 1 and 2 respectively, for additional deficiencies that may impact this system.

0.03.03.01 FLOORS . CAST-IN-PLACE CONCRETE (CSI 03300)

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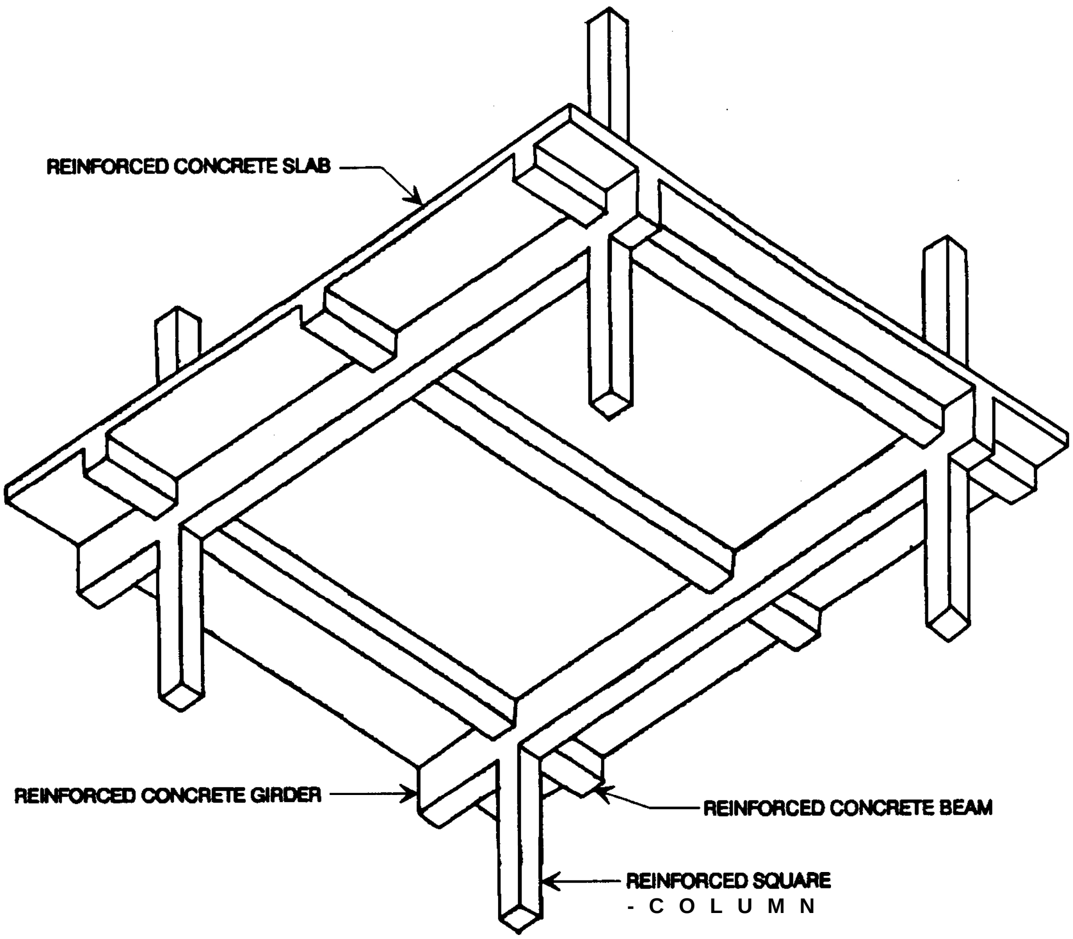
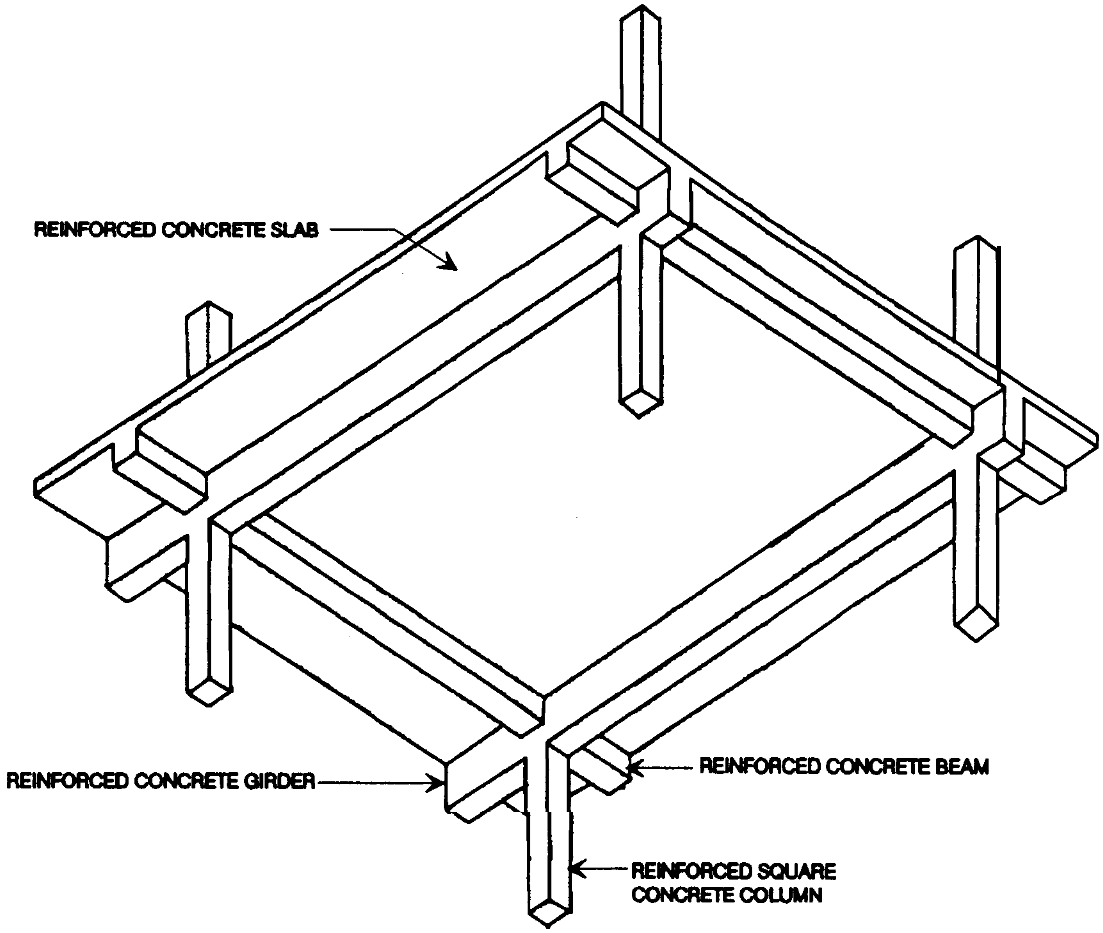
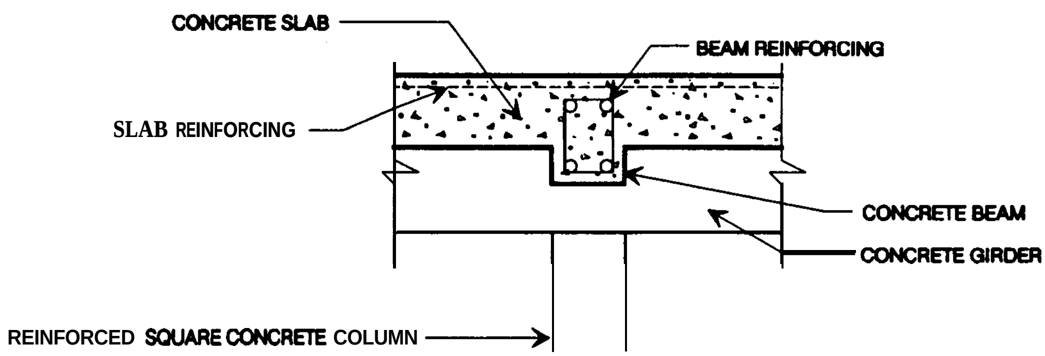


ONE-WAY CONCRETE BEAM AND SLAB SYSTEM

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	ONE-WAY CONCRETE BEAM AND SLAB SYSTEM		
FLOORS CAST-IN-PLACE CONCRETE (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. A030301-1

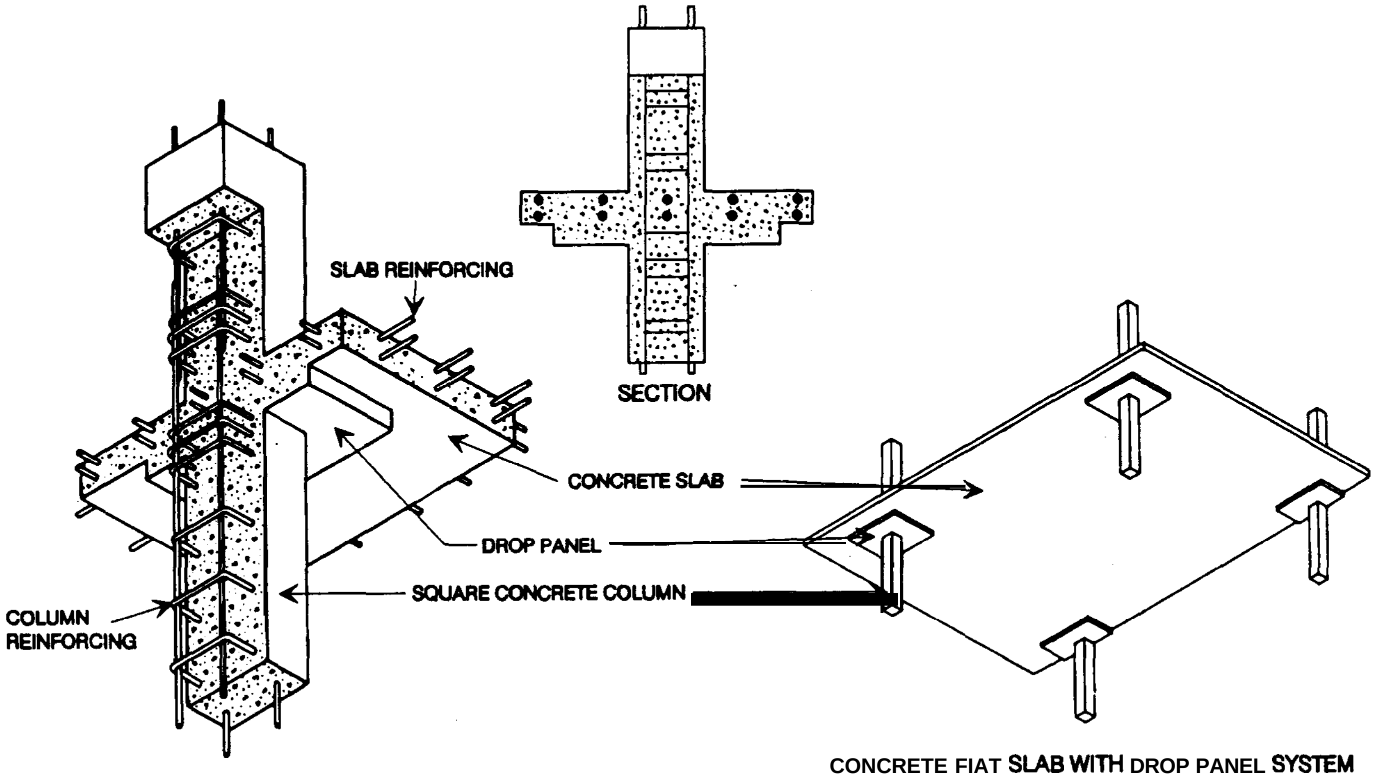


TWO-WAY CONCRETE BEAM AND SLAB

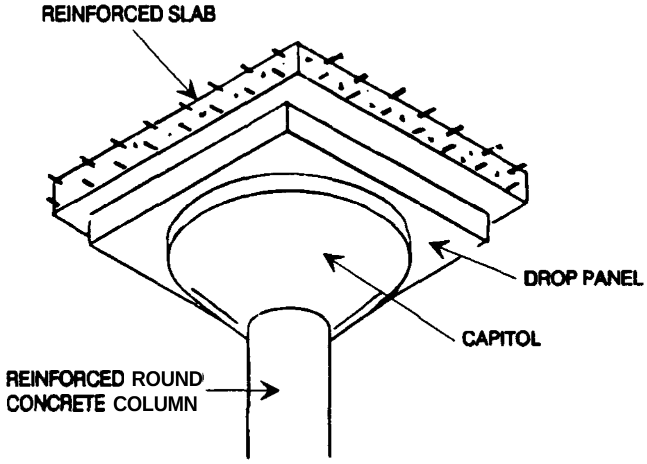


SECTION

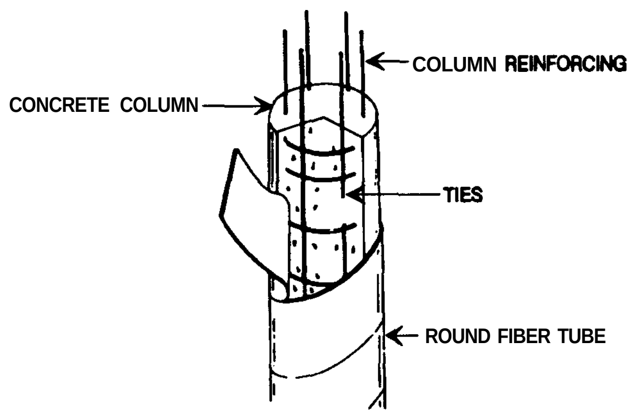
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	TWO-WAY CONCRETE BEAM AND SLAB		
FLOORS CAST-IN-PLACE CONCRETE (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. A030301-2



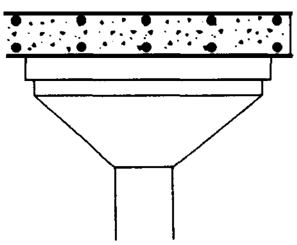
CONCRETE FIAT SLAB WITH DROP PANEL SYSTEM



DROP SLAB WITH CAPITOL



COLUMN-ROUND TIED



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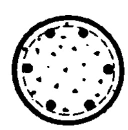
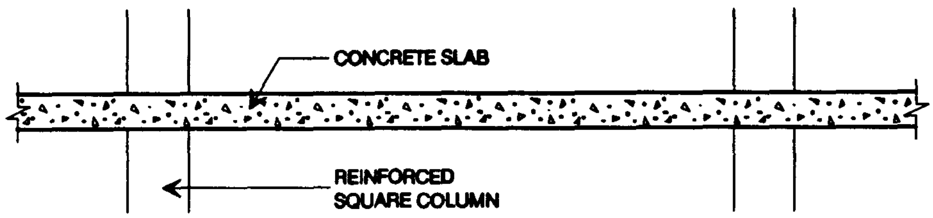


SECTION

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	CONCRETE FLAT SLAB WITH DROP PANEL SYSTEM		
FLOORS CAST-IN-PLACE CONCRETE (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. A030301-3



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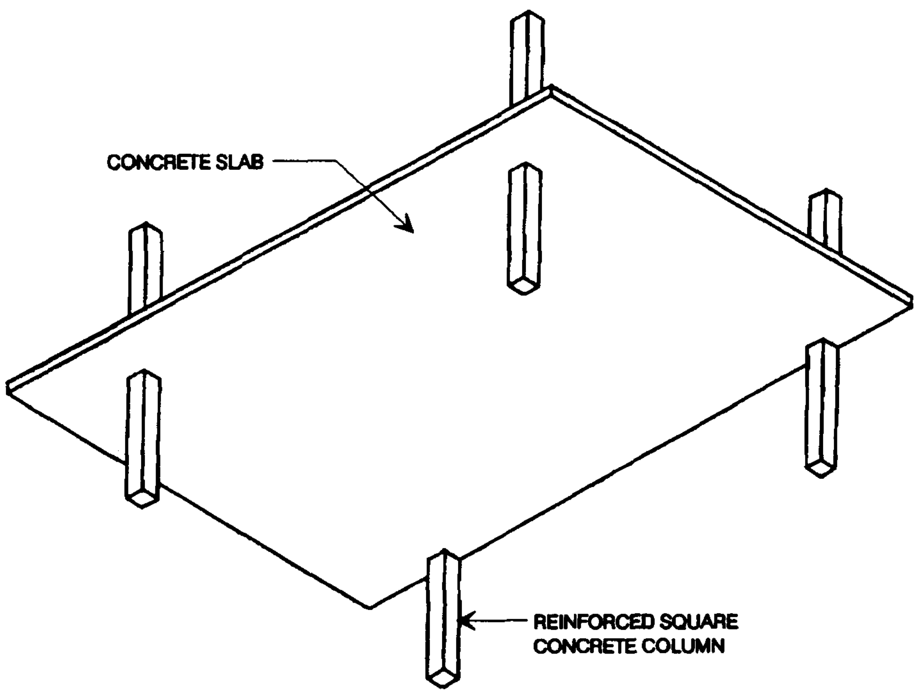
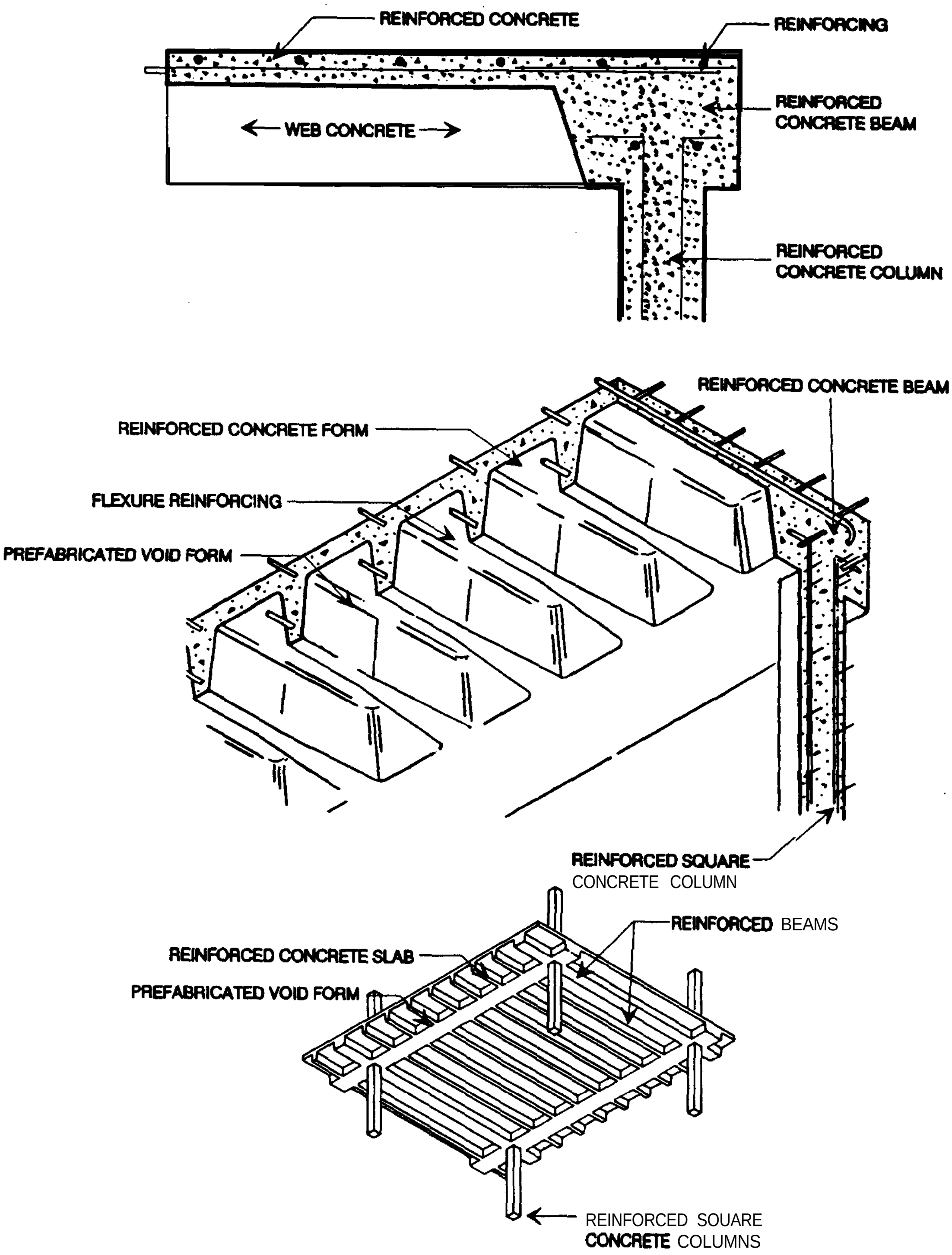


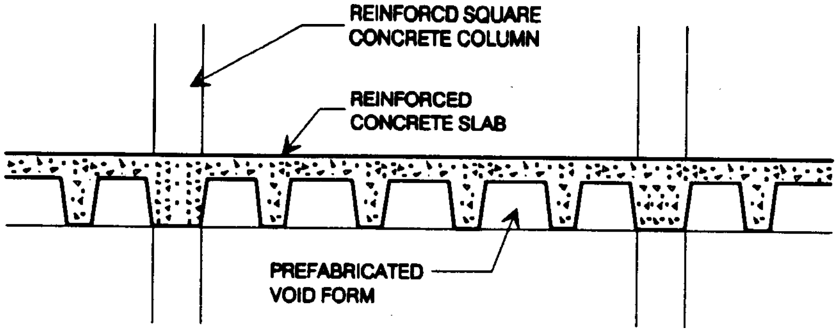
CONCRETE FIAT SLAB SYSTEM

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	CONCRETE FLAT SLAB SYSTEM		
FLOORS CAST-IN-PLACE CONCRETE (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. A030301-4

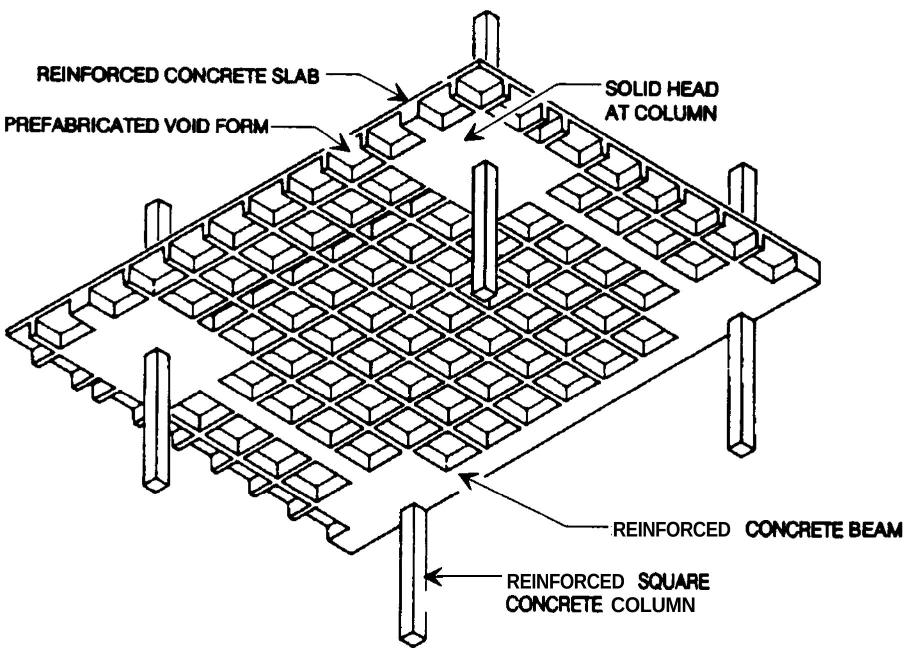


ONE-WAY CONCRETE JOIST SLAB SYSTEM

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	ONE-WAY CONCRETE JOIST SLAB SYSTEM		
FLOORS CAST-IN-PLACE CONCRETE (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. A030301-5



SECTION



CONCRETE WAFFLE SLAB SYSTEM

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	CONCRETE WAFFLE SLAB SYSTEM		
FLOORS CAST-IN-PLACE CONCRETE (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. A030301-6

DEFICIENCY FACTORS
0.03.03.01 FLOORS . CAST-IN-PLACE CONCRETE (CSI 03300)

PROBABLE FAILURE POINTS

- Lack of curing will increase the degree of cracking within a concrete structure.
- Reinforcement corrosion is an electro-chemical process that occurs in the presence of air and moisture.
- The weathering processes that can cause cracking include: (1) freezing and thawing, (2) wetting and drying, and (3) heating and cooling.
- A number of deleterious chemical reactions may result in concrete cracks. These reactions may be due to the aggregate used to make the concrete or materials that come into contact with it after it has hardened or cured.
- A wide variety of poor construction practices can result in cracking in concrete structures, especially adding water to improve workability, which reduces strength, increases settlement, and increases ultimate drying shrinkage.
- Construction overloads induced during construction can be far more severe than those experienced in the lifetime of the structure. Unfortunately, these conditions may occur at early ages when the concrete is most susceptible to damage and often result in cracks.
- The effects of improper design and/or detailing range from poor appearance to lack of serviceability to catastrophic failure.
- Externally applied loads induce tensile stress, which results in cracks. Current ACI 318 design procedures use reinforcing steel, not only to carry the tensile forces, but also to control both an adequate crack distribution and width.

SYSTEM ASSEMBLIES/DEFICIENCIES

Spalling:	Concrete fragments broken from the surface, caused by reinforcement corrosion.
Settlement:	Solid particles sink in fresh concrete after placement and before initial set.
Exposed Reinforcing:	Insufficient steel cover. Concrete quality. Calcium chloride overused as admixture.
Alkali-Aggregate Expansion:	Chemical reaction between aggregate and cement paste causing separation and bond failure.
Cavitation:	Rapid movement of water or other liquids across the surface.
Cracking (Active & Dormant):	Construction movement, settlement, shrinkage around reinforcement. Setting due to inadequate finishing and curing. Chemical reactions such as corrosion. Physical such as drying shrinkage. Thermal changes (subjected to temperature extremes such as freeze/thaw cycles). Stress concentration. Structural design. Accidents from overload, vibration, fatigue, and earthquake.
Crazing:	Surface shrinkage more rapid than concrete mass interior. Too high a slump. Too rich a mix. Poor timing on finishing. Too rapid absorption of moisture.
Holes (Small & Large):	Chemical reaction. Inadequate construction and design
Form Scabbing:	Form oil improperly applied

DEFICIENCY FACTORS
0.03.03.01 FLOORS - CAST-IN-PLACE CONCRETE (CSI 03300)

END OF SUBSECTION

0.03.03.02 FLOORS • PRECAST CONCRETE (CSI 03400)

DESCRIPTION

Concrete Precast Floors are plant-produced, tensioned structural members that are trucked to the site and erected. They may be supported on steel beams, concrete walls, or block walls. The precast concrete floor system is generally produced on long beds and cut to specified lengths. Standard widths are 2 feet, 3 feet 4 inches, 4 feet, 5 feet, and 8 feet. Cross-sections vary with patented manufacturers' systems. The shape of voids (used to lighten the weight of the plank) varies according to the methods used by the different manufacturers. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Precast Concrete Planks (CSI 03400)

This system may be used with reinforced concrete and masonry structures as well as with steel frames. The core may serve as a passage for utility lines and can also be used for warm air heating systems. The slab used in this design employs prestressing only to control deflections that would be developed by the small slab depths. The smooth undersurface of the slab may be caulked and painted directly. Other prestressed hollow-core units are available in widths up to 8 feet and are usually called slabs rather than planks.

The planks may be erected with ends bearing on masonite planks and are grouted with a cement-sand mixture. Where planks are to be used as exposed structures or where spans change direction, they should be leveled by using screw jacks or other suitable devices before grouting. Planks are used untopped and grouted or with structural concrete topping, usually 2 inches thick and reinforced with welded wire fabric for both floor and roof structures.

Precast, prestressed planks are quickly erected and produce a large workable floor area in a minimum amount of time. In relation to span, they are lightweight when compared to pour-in-place systems. Plank bottoms are often painted and used as the exposed ceiling for the area below. Voids are often used to carry utilities.

<u>Lonu-Span Units</u>:

Precast, prestressed long-span units are generally related to single-T, double-T, and channel sections used primarily as flooring and roofing members.

<u>Double-T Slabs</u>:

Double-T Slabs are used extensively for both roof and floor construction, and are made in a variety of widths and depths. When used as floor slabs, a concrete topping from 2 to 4 inches thick is placed over the top of the slabs, The topping is generally designed to work compositely with the precast section. The topping also provides a means of obtaining a flat wearing surface. It should be recognized that due to casting irregularities, variations in camber or deflection, and other construction inaccuracies, the upper surface of erected double-T slabs cannot be expected to be flat and true to line.

It is normal practice to provide weld plates in the edges of the top flanges so that slabs can develop diaphragm action and thus eliminate differential deflection between the flanges of adjacent double-T slabs.

Double-T slabs are efficient structurally. The wing slab portion is quite thin and has well-balanced negative and positive moments. The webs of the Ts are thin and are normally high stressed. The slabs are relatively light when compared to other types of framing for long spans. A significant contribution to the structural efficiency of the slabs results from the fact that a very large portion of the total dead load is acting on the slab at the time of prestressing.

0.03.03.02 FLOORS - PRECAST CONCRETE (CSI 03400)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS (Continued)

Single-l **Beams** (CSI 03400)

There are two general types of single-T beams. Roof single-T beams will be discussed in a later chapter. Floor single-T beams are made in a mold that allows the dimensions to be varied. This member can be used on roof spans up to 120 feet long and in bridge spans up to 60 feet. The web and flange thicknesses of this member are greater than normally used in the double-T slabs and can be varied within limits. The large single-T has been used extensively in many areas of the country. The section is one of high structural efficiency.

Long-Span Channels **(CSI** 03400)

Long-Span Channels are members that, like double-T slabs, incorporate a relatively thin slab with a web in such a manner that the member can be used for relatively long spans without spanning from bearing wall to bearing wall, or from beam to beam, just as the double-T slabs are.

Like a single-T, some channel forms are made from the same forms used to make double-T slabs and have the same general attributes.

End and intermediate diaphragms or flange stiffeners have been used in some types of prestressed and reinforced-concrete channels, but the provision of such secondary members greatly complicates the manufacturing procedures and techniques that must be employed.

Structural Framinq Units:

Precast or prestressed structural members are generally related to beams or girders, columns, and joist system.

Joists of the "T", "I" or keystone types are normally used as roof purlins with precast lightweight slabs running between them. "I" joists are also sometimes used with a composite cast-in-place slab to form a floor or roof system.

Girders (ledger beams) are primarily used to support single-T, double-T, channels, or hollow slab units that rest on ledges and are flush with the top stem. "L" shaped units are used where the spanning units frame into one side only.

Columns are often precast when precast prestressed beams, "Ts", etc. are used for a structure to eliminate the need for vertical forms at the job site. Reinforced concrete columns may be precast in single units several stories high and set on footings in much the same manner as steel columns. Columns may be precast using conventional reinforcing materials as well as being prestressed.

Reinforced Precast Concrete (CSI 03400)

Since concrete has limited resistance to tensile and shear stresses, it is necessary that a composite material be used in order to take advantage of the maximum capability of the composite material. The cross-sectional area of the reinforcement should not be reduced in any way since the tensile capacity of the material will be affected. Reinforcing steel should be placed in accordance with engineering requirements. Laps, ties, hook positions, and stirrups should conform to shop drawings and ACI codes.

OTHER RELATED COMPONENTS

See the following subsections for related components:

0.02.02.02 Loaded Precast Columns 2.2.2-l
0.03.01.02 Precast Concrete Beams 2.1.2-1

DEFICIENCY FACTORS
0.03.03.02 FLOORS - PRECAST CONCRETE (CSI 03400)

PROBABLE FAILURE POINTS

- Lack of curing will increase the degree of cracking within a concrete structure.
- Reinforcement corrosion is an electro-chemical process that occurs in the presence of air and moisture.
- The weathering processes that can cause cracking include: (1) freezing and thawing, (2) wetting and drying, and (3) heating and cooling.
- A number of deleterious chemical reactions may result in the cracking of concrete. These reactions may be due to the aggregate used to make the concrete or materials that come into contact with it after it has hardened or cured.
- A wide variety of poor construction practices can result in cracking in concrete structures, especially adding water to concrete to improve workability which reduces strength, increases settlement, and increases ultimate drying shrinkage.
- Construction overloads induced during construction can be far more severe than those experienced in the lifetime of the structure. These conditions may occur at early ages when the concrete is most susceptible to damage and often result in cracks.
- The effects of improper design and/or detailing range from poor appearance to lack of serviceability to catastrophic failure.
- Externally applied loads induce tensile stresses which result in cracks. Current ACI 318 design procedures use reinforcing steel, not only to carry the tensile forces, but also to control both an adequate crack distribution and width.

SYSTEM ASSEMBLIES/DEFICIENCIES

Spalling:	Concrete fragments broken from the surface, due to reinforcement corrosion.
Settlement:	Solid particles sink in fresh concrete after placement and before initial set.
Exposed/Corroded Reinforcing:	Insufficient steel cover. Concrete quality. Calcium chloride overused as admixture.
Alkali-Aggregate Expansion:	Chemical reaction between aggregate and cement paste causing separation and bond failure.
Cavitation:	Rapid movement of water or other liquids across the surface.
Cracking (Active & Dormant):	Construction movement, settlement, shrinkage around reinforcement. Inadequate finishing and curing. Chemical reactions such as corrosion. Physical reactions such as drying shrinkage. Thermal changes (subjected to temperature extremes such as freeze/thaw cycles). Stress concentration. Structural design. Accidents from overload, vibration, fatigue, and earthquake.
Crazing:	Surface shrinkage more rapid than concrete mass interior. Too high a slump. Too rich a mix. Poor timing on finishing. Too rapid absorption of moisture.
Holes (Small & Large):	Chemical reaction. Inadequate construction and design. Broken or missing sections.

DEFICIENCY FACTORS
0.03.03.02 FLOORS - PRECAST CONCRETE (CSI 03400)

SYSTEM ASSEMBLIES/DEFICIENCIES (Continued)

Form Scabbing:	Form oil improperly applied.
Damaged Anchorage:	Loose, missing, or corroded anchors and clips. Inadequate construction and design.

END OF SUBSECTION

0.03.03.03 FLOORS - STEEL (CSI 05310)

DESCRIPTION

Steel Floor deck may be composite or noncomposite; cellular or non-cellular. When suitably fastened, the steel deck acts as a working platform for the various trades, provides decking as required by OSHA code, and provides the form for the concrete deck. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Steel Floors Deck (CSI 05130)

The most commonly used steel decking consists of a single-fluted section with flat plate closure or in a double-fluted section. Some manufacturers offer variations to these types and some have proprietary designed units for air and electrical distribution. Selecting deck type units must be carefully coordinated with the structural, mechanical, and electrical requirements of the project.

Fire-Resistance Rated Floor (CSI 07250)

Constructions with steel floor decking units are described in Underwriters' Laboratories, Inc.'s "Fire Resistance Directory" and American Insurance Association's "Fire Resistance Ratings." To be fire-resistance-rated, the complete floor and ceiling construction must be composed of the materials assembled in the manner specified by the fire-rating agency for the required fire resistance. This construction limits the types and arrangement of the steel floor deck units and method of fastening the floor deck units to the supporting members, the type and spacing of the floor framing, the type of ceiling construction, the requirements for air ducts within the ceiling space and diffuser outlets in the ceiling, the requirements for recessed lighting fixtures, and floor construction.

Meta Decking Types

Open Type, Galvanized	Non-Cellular Composite Deck Galvanized
1 1/2" Deep 22 gauge 20 or 18 gauge	2" Deep 22 gauge 20 or 18 gauge 16 gauge
3" Deep 22 or 18 gauge 18 gauge 16 gauge	3" Deep 22 gauge 20 or 18 gauge 16 gauge
4 1/2" Deep Long Span 20 gauge 18 gauge 16 gauge	Steel Slab Form Uncoated or Galvanized
6" Deep Long Span 18 gauge 160r 14gauge	Sheet Metal Edge Closure Form 12" Wide with two Bends
7 1/2" Deep Long Span 18 gauge 16 gauge	

0.03.03.03 FLOORS . STEEL (CSI 05310)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS (Continued)

Joist Girders (CSI 05210)

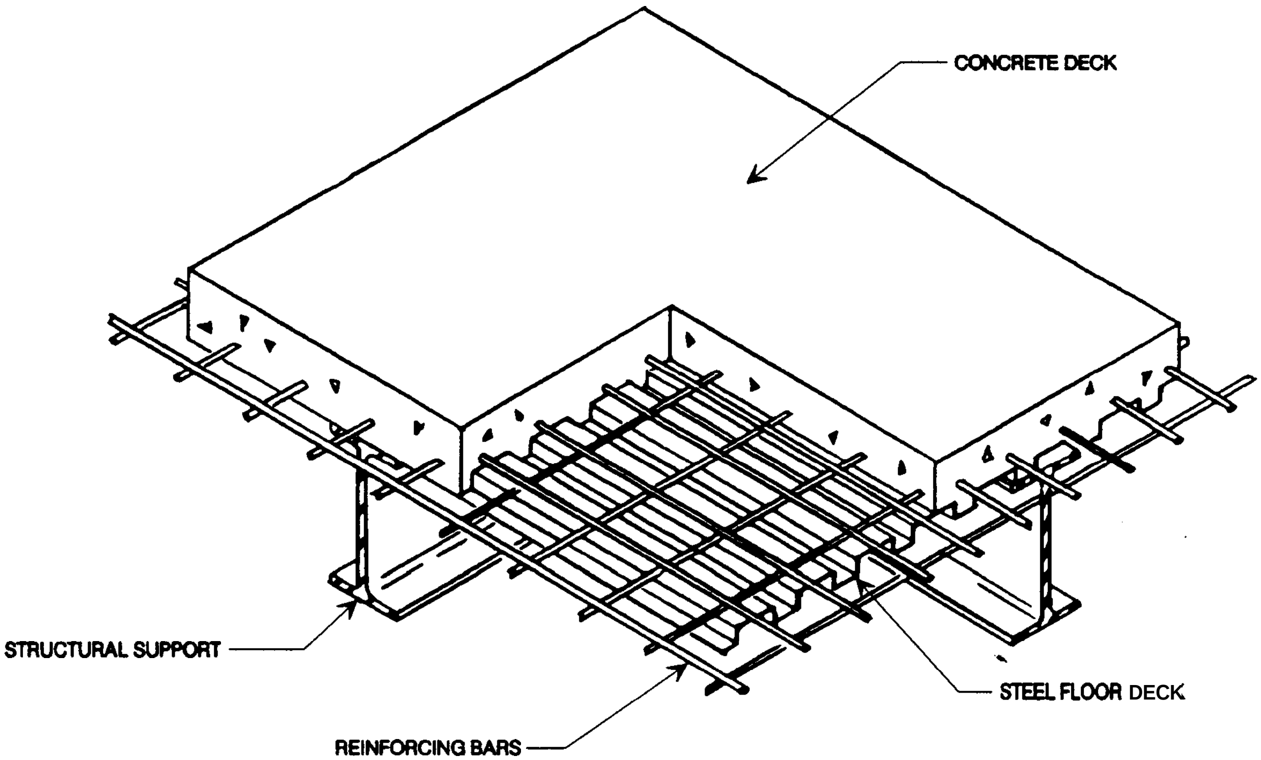
Joist Girders are framing members that span between columns and support floor or roof joists. They are often used in place of steel beams or girders. Joist girders are steel trusses that look like long-span, open-web joists. They are designed as single-span members and support equally spaced open-web joists at the panel points. Spans vary in length from 20 to 100 feet and in depth from 20 to 96 inches. Approximate standard weight per foot are shown in manufacturer catalogs.

Joist girders allow larger bay sizes, fewer columns, and more usable floor space. They are easily erected, form rigid connections at columns, and provide openings for passage of ducts and piping.

OTHER RELATED COMPONENTS

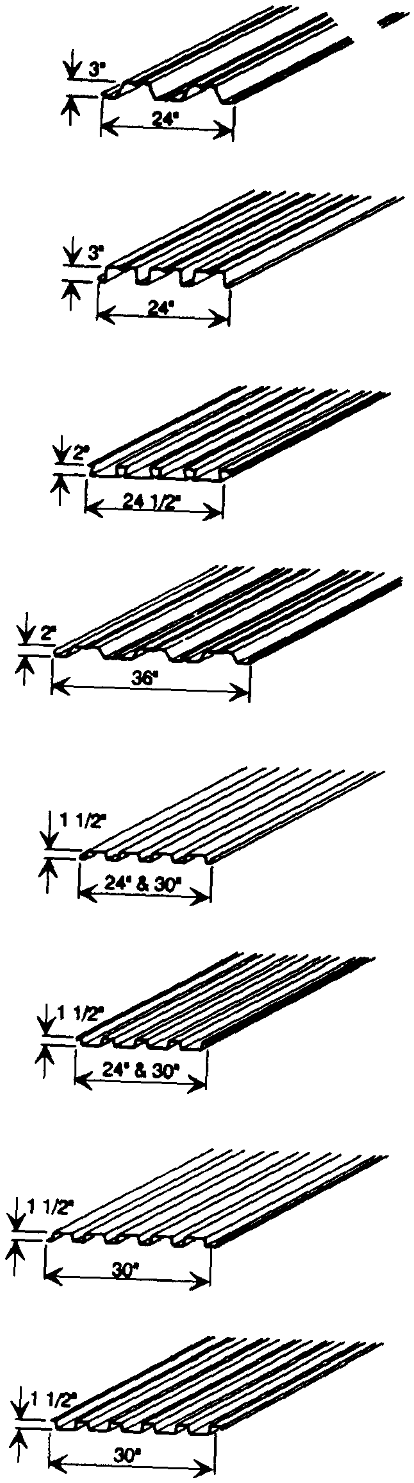
See the following subsection for related components:

0.02.02.03 Steel Columns 2.2.3-l
0.03.01.03 Steel Beams.. .... .2.2.3-1
0.03.06 Fireproofing.. .... .2.6-1

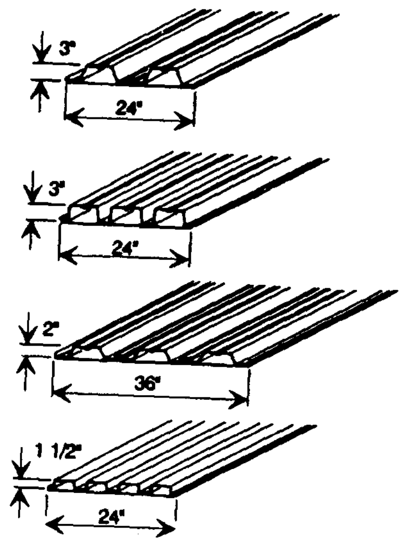


SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS. 1ST EDITION "R.S. Means Co., Inc., Kingston, Massachusetts"

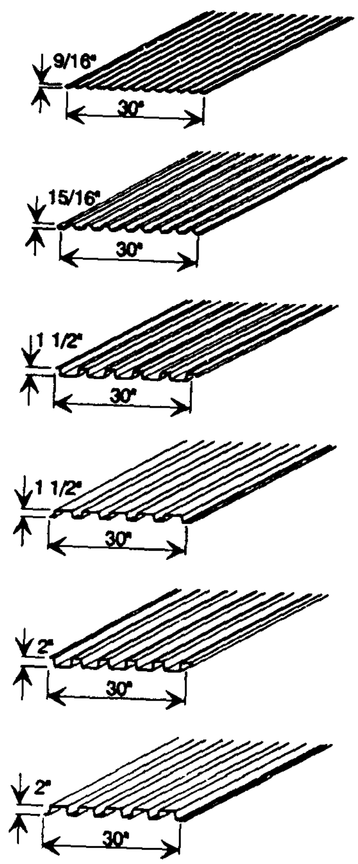
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	STEEL FLOOR DECK		
FLOORS STEEL (CSI 05310)	Revision No.	Issue Date 5/93	Drawing No. A030303-1



COMPOSITE FLOOR DECK



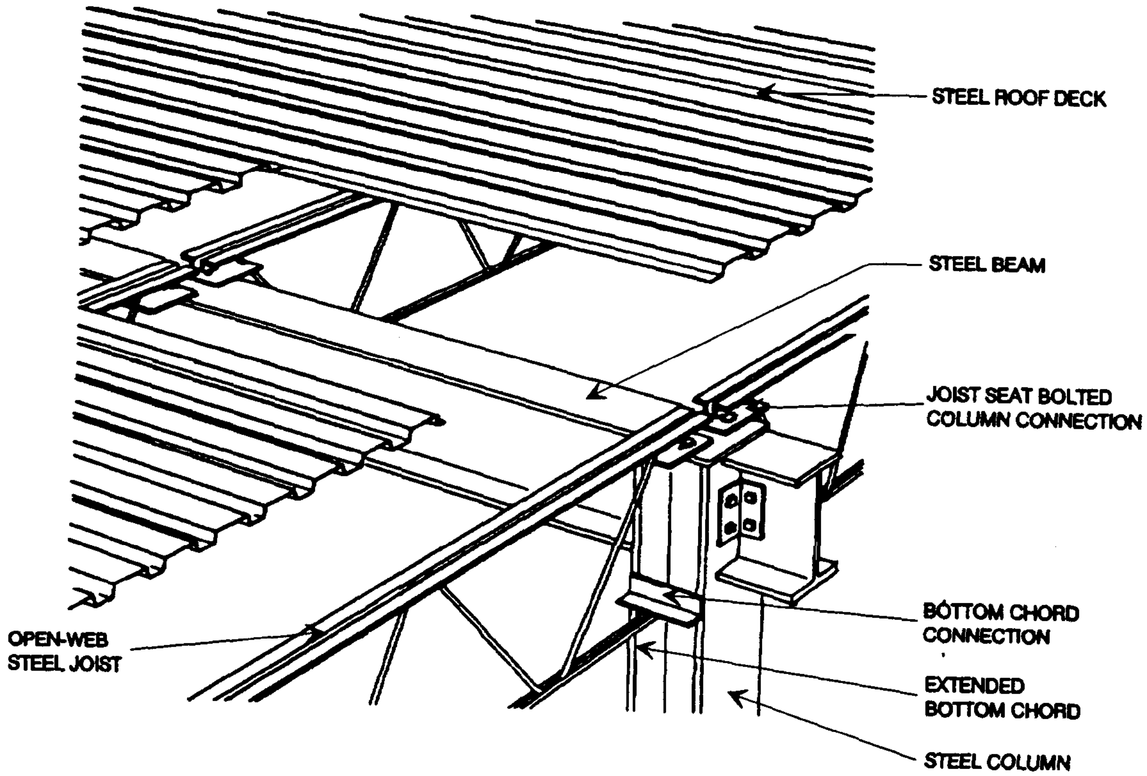
CELLULAR DECK



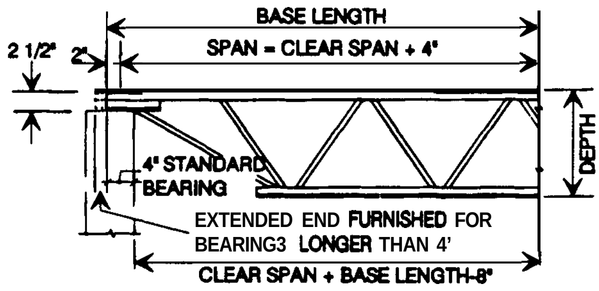
FORM DECK

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION "R.S. Means Co., Inc., Kingston, Massachusetts"

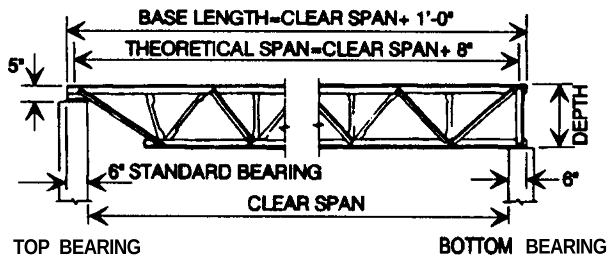
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	STEEL FLOOR DECK		
FLOORS STEEL (CSI 05310)	Revision No.	Issue Date 5/93	Drawing No. A030303-2



SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	STEEL FLOOR JOIST		
FLOORS STEEL (CSI 05310)	Revision No.	Issue Date 5/93	Drawing No. A030303-3

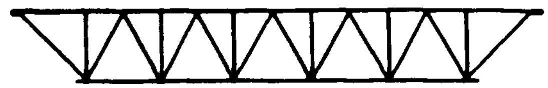


H SERIES

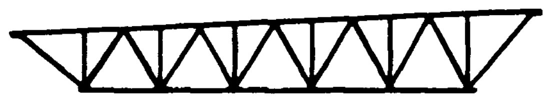


LH AND DLH SERIES

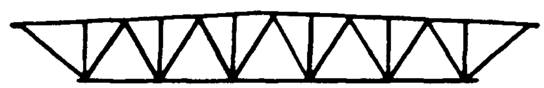
STEEL JOIST DETAILS



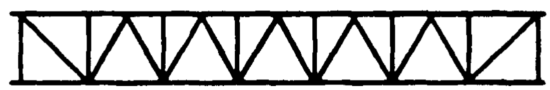
PARALLEL CHORDS, UNDERSLUNG



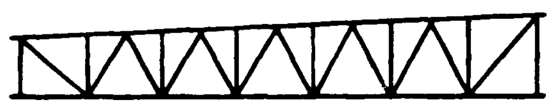
TOP CHORD SINGLE PITCHED, UNDERSLUNG



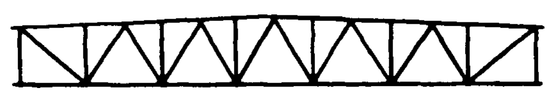
TOP CHORD DOUBLE PITCHED, UNDERSLUNG



PARALLEL CHORDS, SQUARE END3



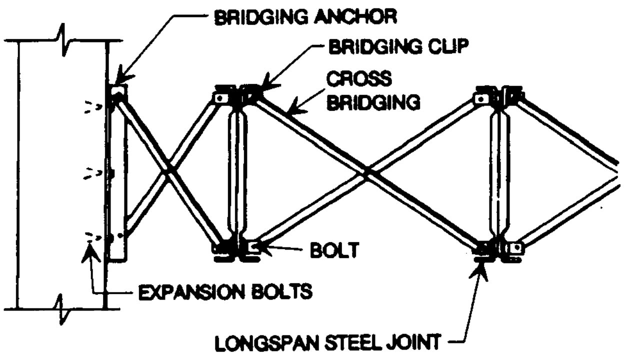
TOP CHORD SINGLE PITCHED, SQUARE ENDS



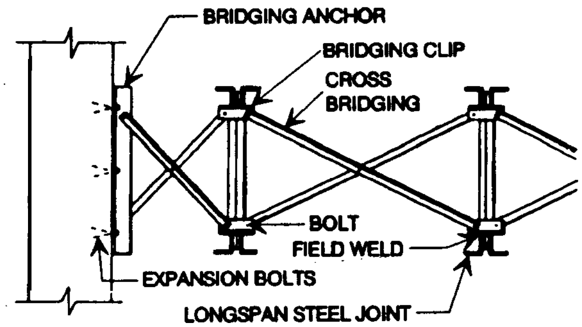
TOP CHORD DOUBLE PITCHED. SQUARE ENDS

STEEL JOIST DETAILS

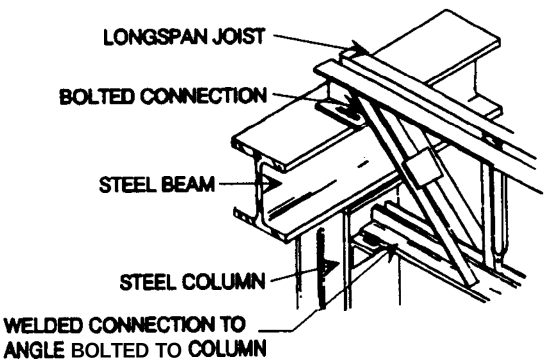
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	STEEL FLOOR JOIST		
FLOORS STEEL (CSI 05310)	Revision No.	Issue Date 5/93	Drawing No. A030303-4



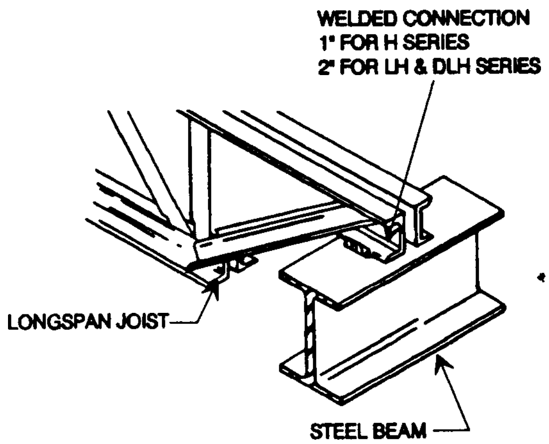
BOLTED CROSS BRIDGING - LH AND DLH SERIES



BOLTED CROSS BRIDGING - LH AND DLH SERIES (ALTERNATE)



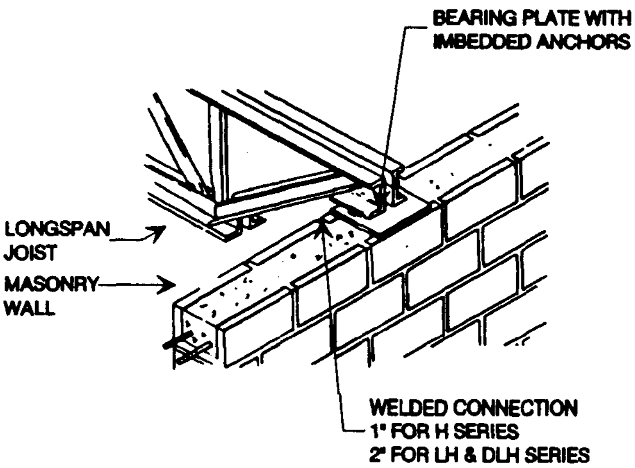
BOLTED CONNECTION TO STEEL



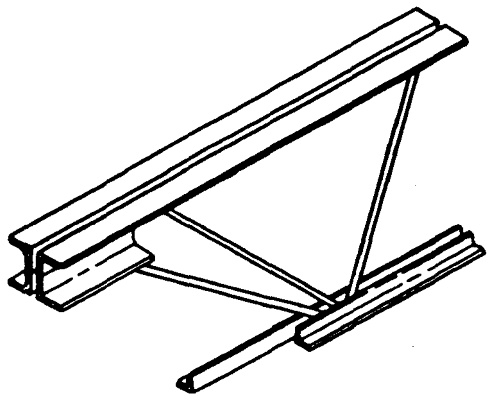
WELDED CONNECTION TO STEEL

ANCHORAGE TO MASONRY (ALTERNATES) H SERIES

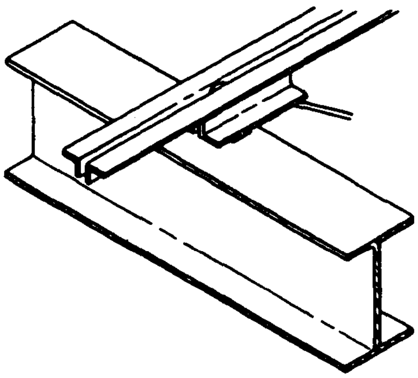
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	STEEL FLOOR JOIST		
FLOORS STEEL (CSI 05310)	Revision No.	Issue Date 5/93	Drawing No. A030303-5



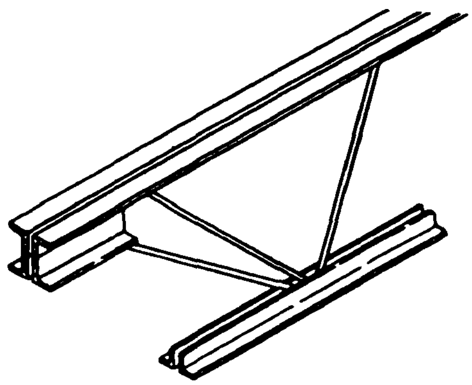
ANCHORAGE TO MASONRY



CEILING EXTENSION



TOP CHORD EXTENSION



BOTTOM CHORD EXTENSION

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	STEEL FLOOR JOIST		
FLOORS STEEL (CSI 05310)	Revision No.	Issue Dsts 5/93	Drawing No. A030303-6

DEFICIENCY FACTORS
0.03.03.03 FLOORS • STEEL **(CSI 05310)**

PROBABLE FAILURE POINTS

- Steel corrosion is an electro-chemical process that occurs in the presence of air and moisture.
- Cracked or broken welds caused by stress, settlement/movement, poor materials, or improper construction.
- Loose connections caused by vibration, temperature changes, or improper tightness.
- Impact damage caused by objects striking or impacting the surface.

SYSTEM ASSEMBLIES/DEFICIENCIES

Abrasion:	Caused by contact with moving parts, wave action, or immersion in a moving liquid.
Corrosion:	Resulting from a chemical or electro-chemical reaction that converts the metal into an oxide, carbonate and sulfides.
Impact Damage:	Depressions, dents, or buckled surface from objects striking or impacting the surface.
Loss of Protective Coating/Paint:	Chalking, peeling, chipping, blistering, or deterioration.
Fatigue Cracking:	Caused by repetitive, cyclic loading occurring at stresses at or below allowable design values.
Loose Connections:	Caused by impact, vibration, fatigue loading, or incorrect tightness.

DEFICIENCY FACTORS
0.03.03.03 FLOORS - STEEL (CSI 05310)

END OF SUBSECTION

0.03.03.04 FLOORS . COMPOSITE (CSI 03000)

DESCRIPTION

For many years Composite Floor construction was confined to highway and bridge roadways where the relationships between deck slab and supporting steel members were ideally suited to composite design criteria. In recent years, the introduction of metal deck doubling as forms, spray-on fireproofing displacing poured concrete haunches, etc., and use of composite design in building construction has become more attractive. Composite structures are constructed of various building materials or use more than one construction method, such as a structural steel frame with a precast floor or a cast-in-place floor with steel floor decking. This type of design offers no economic advantage for short-span construction; therefore, designs for spans of less than 32 feet are rare. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Steel Deck & Cast-in-Place Concrete (CSI 05310 & 03300)

Composite-steel floor deck is cold-formed steel that acts as the permanent form and as positive bending reinforcement for the cast-in-place concrete slab. It is normally available in 14, 16, 18, 20, 22 gauge and is galvanized to last through the structure life.

Composite decks vary in depth from 1 1/2 to 3 inches and have cover widths of 12, 24, 30, and 36 inches. They are available from some manufacturers in a form that allows blending cellular and non-cellular decks to provide raceways in the floor structure.

Form deck is available galvanized, uncoated, or painted with one coat of prirner in 22, 24, 26, and 28 gauge steel. Some available depths include 9/16, 19/32, 1 5/16, 1 1/2, and 2 inches. Coverage widths include 27 and 30 inches.

The deck should be erected. in accordance with an approved manufacturer's drawing and should span three or more supports, where it is more practical. The deck should be attached to all supporting members, including bearing walls, with a minimum 5/8 inch puddle weld. The minimum compressive strength of the concrete used with composite decks should be no less than 3,000 psi. Admixtures containing chloride should not be used. Wire mesh or two-way reinforcing bars should be installed in accordance with design requirements for temperature and concrete crack control.

Composite Beam, Deck, & Slab (CSI 05310 & 03300)

Composite construction, as applied to floor systems, consists of steel beams and girders with metal studs welded to the top flange of the steel beam to act as shear connections and encased by a concrete slab. The system causes the concrete slab and steel beam to act as one unit. Because the connectors are sized and spaced to resist horizontal shear between the steel beam and concrete slab, the effective depth is increased.

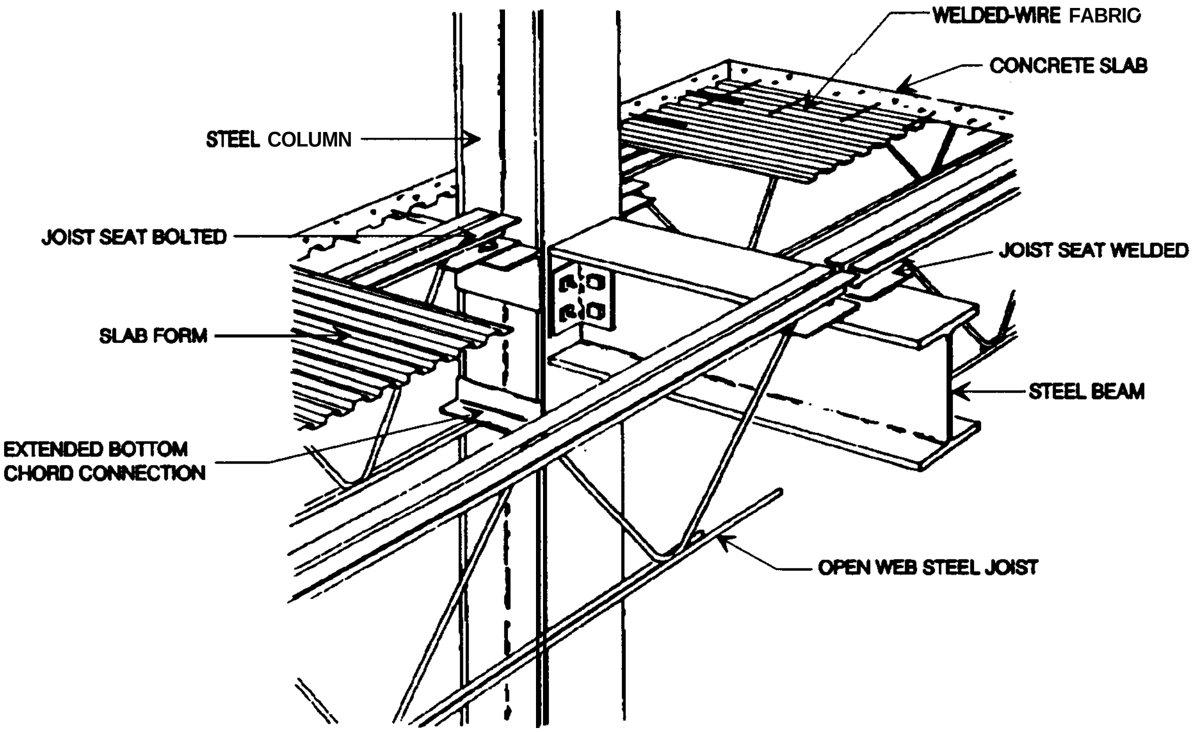
Because a composite beam has greater stiffness than a non-composite beam of equal size, it is an effective system to use for heavy loading, relatively long-span, and wide beam spacing. The concrete slab depth usually ranges from 4 to 5 1/2 inches and may be made from regular or lightweight concrete. The use of 4 inch lightweight concrete usually conforms to required fire-resistance codes for concrete decks, without using sprayed on fireproofing on the metal deck form. Metal studs are generally welded to the beams after erection. In addition, the studs are used as shear connections and are 1/4 or 7/8 of an inch.

0.03.03.04 FLOORS . COMPOSITE (CSI 03000)

OTHER RELATED COMPONENTS

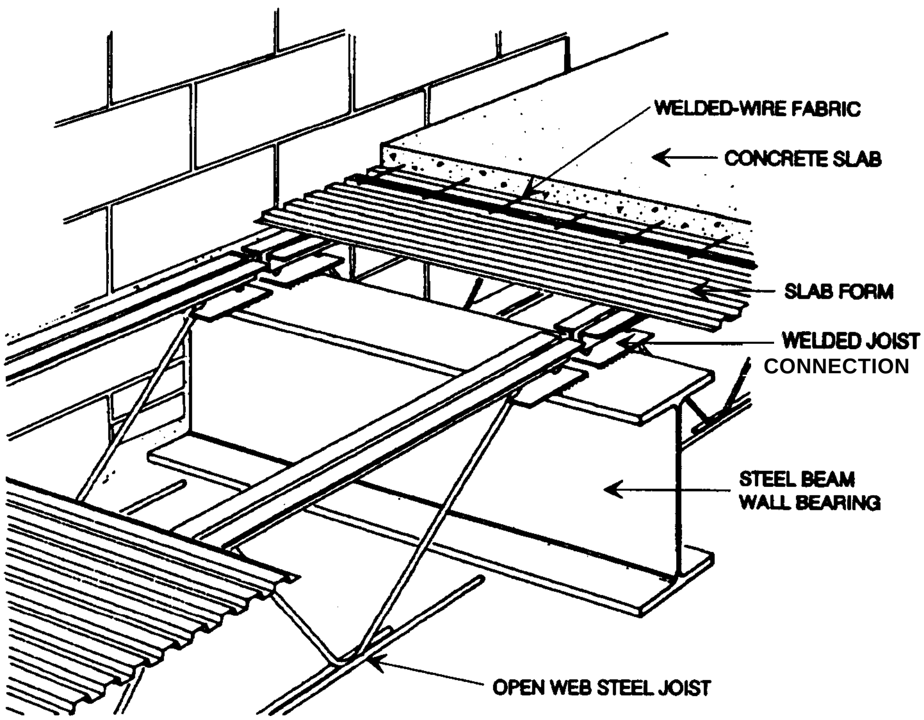
See the following subsections for related components:

Refer to Foundations & Footings and Substructure Systems, Volumes 1 and 2 respectively, for additional deficiencies that may impact this system.



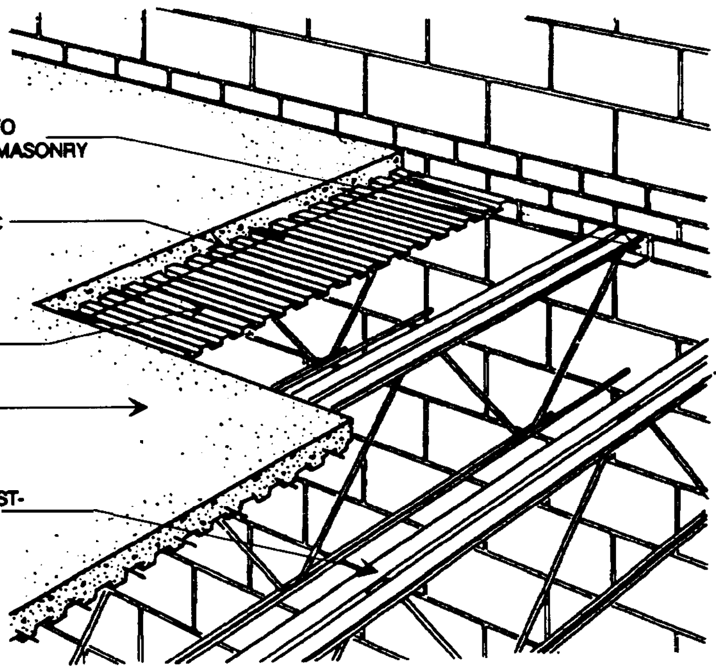
STEEL FLOOR SYSTEM

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	COMPOSITE FLOOR STRUCTURE		
FLOORS COMPOSITE (CSI MULTIPLE)	Revision No.	Issue Date 5/93	Drawing No. A030304-1



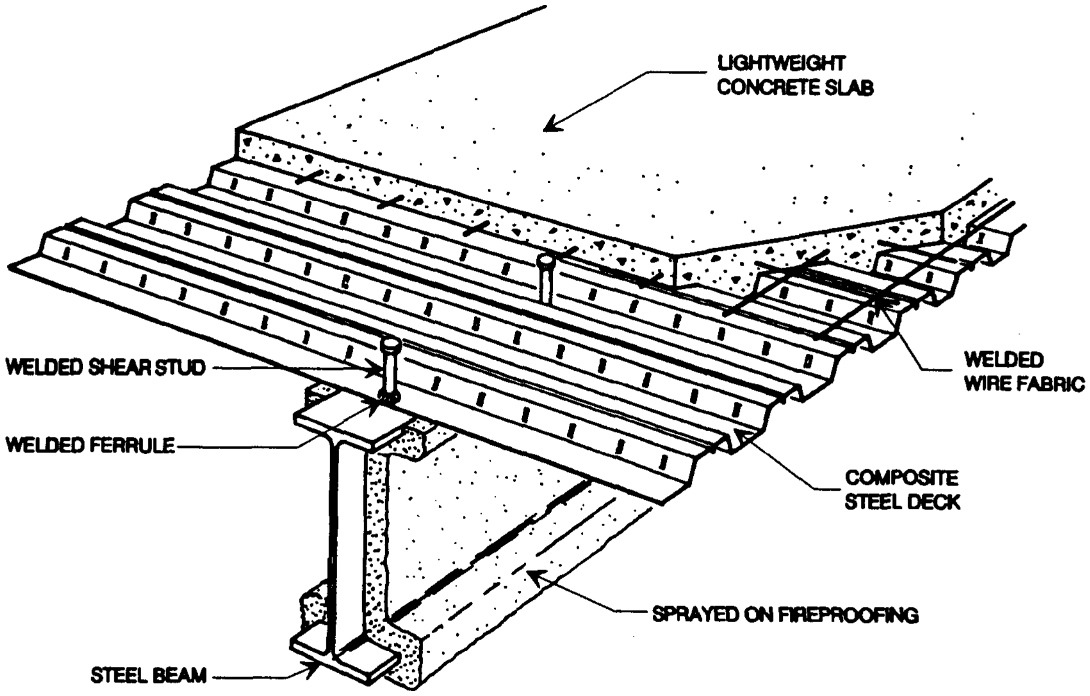
DECK AND JOIST ON STEEL BEAMS

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	COMPOSITE FLOOR STRUCTURE		
FLOORS COMPOSITE (CSI MULTIPLE)	Revision No.	Issue Date	Drawing No.
		5/93	A030304-2



DECK AND JOISTS ON BEARING WALLS

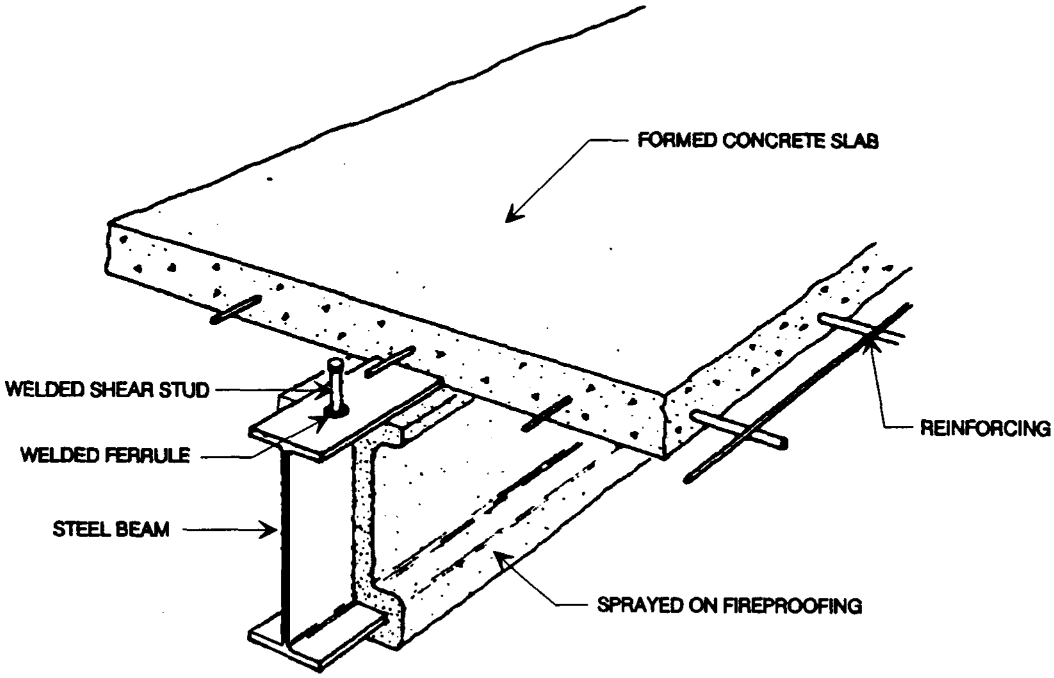
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	COMPOSITE FLOOR STRUCTURE		
FLOORS COMPOSITE (CSI MULTIPLE)	Revision No.	Issue Date 5/93	Drawing No. A030304-3



COMPOSITE BEAM, DECK AND SLAB

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION "R.S. Means Co., Inc., Kingston, Massachusetts"

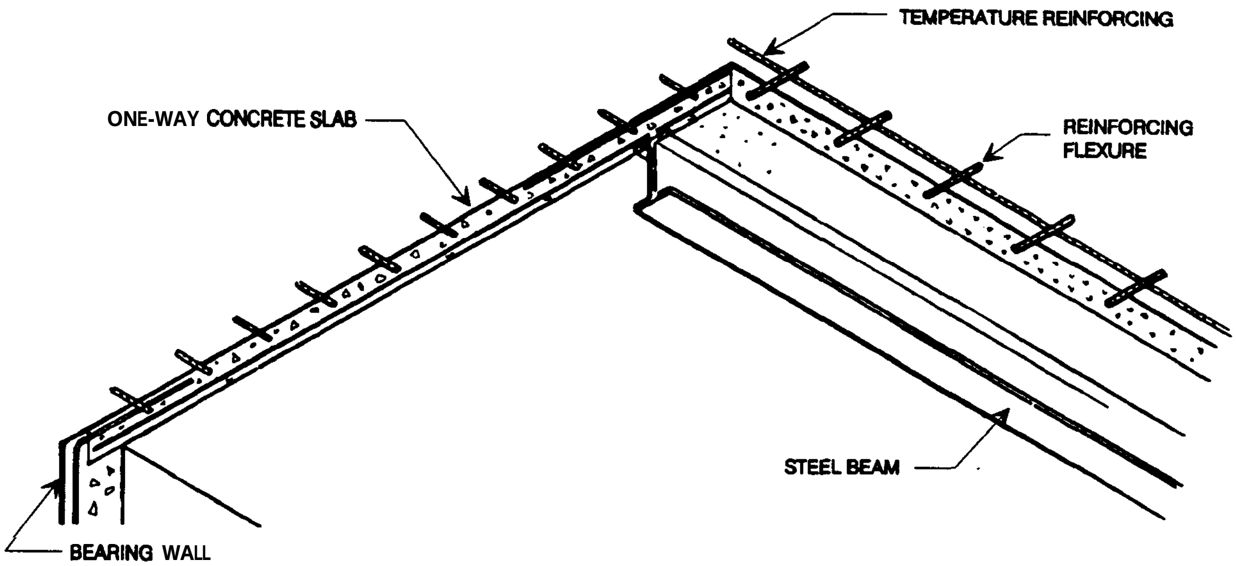
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	COMPOSITE FLOOR STRUCTURE		
FLOORS COMPOSITE (CSI MULTIPLE)	Revision No.	Issue Date 5/93	Drawing No. A030304-4



COMPOSITE BEAM, DECK, AND SLAB

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION "R.S. Means Co., Inc., Kingston, Massachusetts"

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	COMPOSITE FLOOR STRUCTURE		
FLOORS COMPOSITE (CSI MULTIPLE)	Revision No.	Issue Date 5/93	Drawing No. A030304-5



SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	COMPOSITE FLOOR STRUCTURE		
FLOORS COMPOSITE (CSI MULTIPLE)	Revision No.	Issue Date 5/93	Drawing No. A030304-6

DEFICIENCY FACTORS
0.03.03.04 FLOORS - COMPOSITE (CSI 03000)

PROBABLE FAILURE POINTS

- Steel corrosion is an electro-chemical process that occurs in the presence of air and moisture.
- Cracked or broken welds caused by stress, settlement/movement, poor materials, or improper construction.
- Loose connections caused by vibration, temperature changes, or improper tightness.
- Impact damage caused by objects striking or impacting the surface.

SYSTEM ASSEMBLIES/DEFICIENCIES

Steel

Abrasion:	Caused by contact with moving parts, wave action, or immersion in a moving liquid.
Corrosion:	Resulting from a chemical or electro-chemical reaction that converts the metal into an oxide, carbonate, and sulfides.
Out-of-Alignment:	Bowing, deflection, or other movement which brings the surface out of plumb or not level in one or more directions.
Impact Damage:	Depressions, dents, or buckled surface from objects striking or impacting the surface.
Loss of Protective Coating/Paint:	Chalking, peeling, chipping, blistering, or deterioration.
Fatigue Cracking:	Caused by repetitive, cyclic loading occurring at stresses at or below allowable design values.
Lamellar Tearing:	Strains and separation(s) within the steel induced by hot metal weld shrinkage as it cools.
Loose Connections:	Caused by impact, vibration, fatigue loading, or incorrect tightness.
Damaged Welds:	Cracked or broken welds caused by stresses, poor materials, or improper construction.
Alkali-Aggregate Expansion:	Chemical reaction between aggregate and cement paste.
Cracks (Active & Dormant):	Construction movement, settlement, shrinkage around reinforcement. Inadequate finishing and curing. Chemical reactions such as corrosion. Physical reactions such as drying shrinkage. Thermal changes (subjected to temperature extremes such as freeze/thaw cycles). Stress concentration. Structural design. Accidents from overload, vibration, fatigue, and earthquake.
Surface Deterioration:	Crazing from shrinkage more rapid than concrete mass interior. Too high a slump. Too rich a mix. Poor timing on finishing. Too rapid absorption of moisture. Cavitation from water or liquid action over surface. Chemical reactions.
Holes (Small and Large):	Inadequate construction and design. Impact damage.
Form Scabbing:	Form oil improperly applied.
Spalling:	Fragment flakes from the surface due to weather, pressure, or other actions.

DEFICIENCY FACTORS
0.03.03.04 FLOORS - COMPOSITE (CSI 03000)

SYSTEM ASSEMBLIES/DEFICIENCIES

Steel (Continued)

Leaching: Process of separating liquids from solid materials by allowing them to percolate into surrounding soil.

Out-of-Alignment: Bowing, deflection, or other movement that brings the surface out of plumb or not level in one or more directions.

Mortar/Joint Material Missing/Eroded: Deteriorated or damaged joints that have fallen out or worn down. Excessive joint movement.

Staining: Surface discoloration from a foreign substance or material.

Efflorescence: A whitish powdery deposit of soluble salts brought to the surface by moisture. Leaves residue after evaporating.

Corrosion of Rebar: Metal rebar oxidation by chemical or electrochemical action after prolonged exposure to moisture.

END OF SUBSECTION

0.03.03.05 FLOORS - WOOD (CSI 06100)

DESCRIPTION

Wood floor framing system falls under Rough Carpentry in the building industry. Careful consideration must be given to the type of material used, not only for strength, but dimensional stability, treatment against decay and fire, fastener-holding capacity, and other characteristics that affect structural integrity. Graphic assembly details that follow illustrate general assembly/ component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Construction Panels (CSI 06100)

Construction Panels have been specified for various concealed applications where panels form integral parts of the framing system. APA Performance-Rated Panels include several panel grades intended for use as combination subflooring-underlayment, subflooring, and sheathing based on satisfying performance criteria related to end use, strength, and exposure.

Span ratings are a part of the trademark on APA Rated Sheathing and APA Rated Sturdifloor. For sheathing, two numbers separated by a slash refer to the maximum span rating in inches recommended for center-to-center spacing of panel supports. The number before the slash is for span ratings of roof sheathing, and the number after the slash is for subflooring where panels are placed with their long dimension or strength axis across three or more supports. For APA Rated Sheathing, only one number is included and indicates the maximum support spacing where panels are installed as combination subflooring-underlayment under carpet.

Structural Joists & Planks (CSI 06100)

Wood joists may be used with all types of bearing wall or support systems. They may also be used in conjunction with various deck materials to provide economical floor and roof. systems with moderate spans and loadings. The spacing of the wood joists may be varied to suit deck span or loading requirements. Structural Joists and Planks classification includes four grades with same designations as structural light framing. In addition to the conventional method of specifying by selecting a particular grade and species with required stress values, it is possible under grading rules to specify lumber under this classification by referring to required design values and fastener grouping.

Prefabricated Metal-Plate-Connected Wood Trusses (CSI 06191)

These trusses are manufactured in a wide range of spans and shapes. Metal connector plates are sold by manufacturers to truss fabricators. Recommended design data are contained in TPI Design Specification for Metal Plate Connected Wood Trusses. Responsibility for engineering prefabricated wood trusses can be either be shared with the fabricator and metal connector plate manufacturer or completely assumed by the architect and structural engineer depending on types of trusses, loadings, and regulations.

OTHER RELATED COMPONENTS

Refer to Foundations and Footings and Substructure systems, Volumes 1 and 2 respectively, for additional deficiencies that may impact this system.

0.03.03.05 FLOORS - WOOD (CSI 06100)

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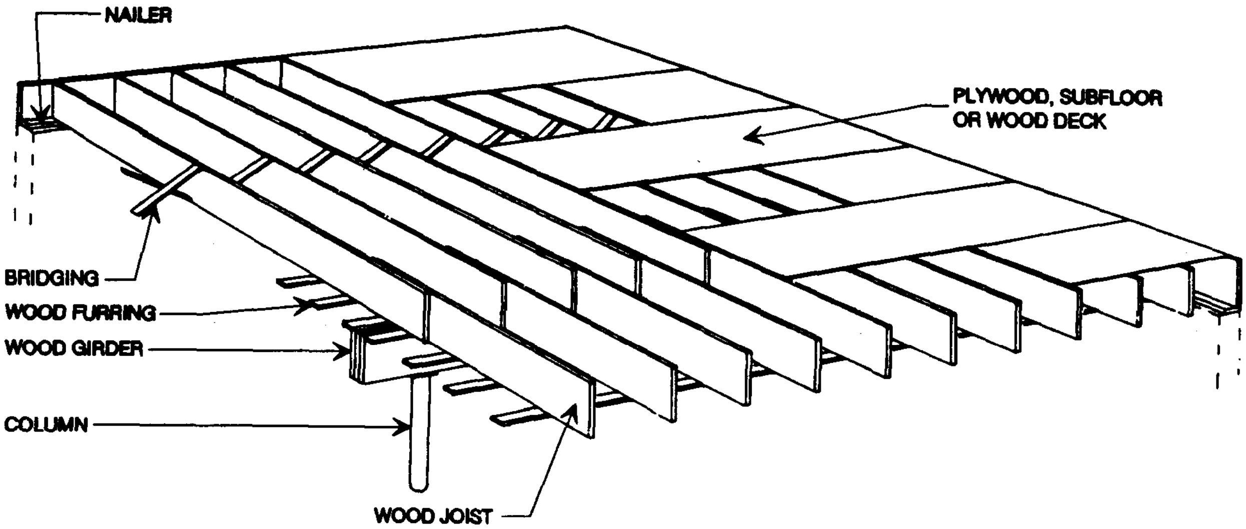
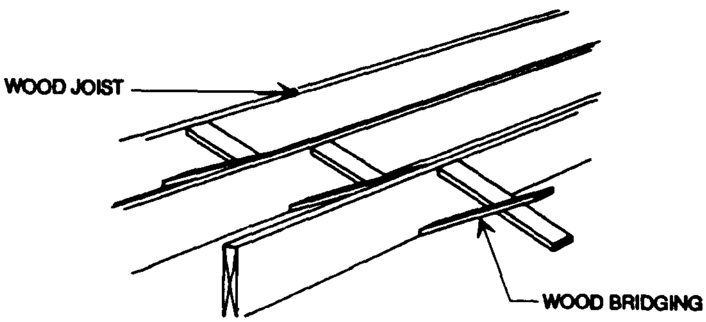
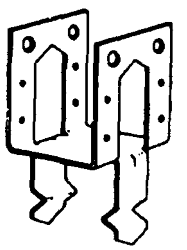
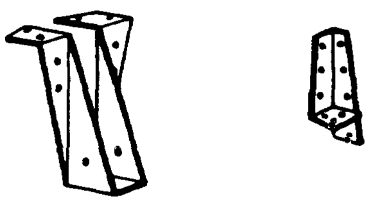




BRIDGING



POST BASE



TIMBER CONNECTORS

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	TONGUE AND GROOVE WOOD DECKING		
FLOORS WOOD (CSI 06220)	Revision No.	Issue Date 5/93	Drawing No. A030305-1

DEFICIENCY FACTORS
0.03.03.05 FLOORS . WOOD (CSI 06220)

PROBABLE FAILURE POINTS

- Termite and boring insect damage causing breakdown of structural integrity.
- Decay (rot) due to fungi, mildew, dry rot causing surface deterioration.
- Fire damage or charred surfaces causing flaking or surface breakdown.
- Loose connections caused by vibration, temperature changes, or improper tightness.
- Splitting or checking caused by stress, bending, or twisting.
- Cracking caused by stress, settlement/movement, poor materials, or improper construction.
- Impact damage caused by objects striking or impacting the surface.

SYSTEM ASSEMBLIES/DEFICIENCIES

Out-of-Alignment:	Bowing, deflection, or other movement that brings the surface out of plumb or not level in one or more directions.
Cracking:	Cracking, usually structural in nature, that results in tearing, ripping, or shearing. Cracks can be random, horizontal, vertical, or diagonal.
Surface Deterioration:	Crazing, small surface cracks, corrosion, and surface breakdown due to weather, pressure, or other actions.
Impact Damage/Denting:	Depressions, punctures, or buckled surface from objects striking or impacting the surface.
Staining:	Surface discoloration from a foreign substance or material.
Plant Growth Moss/Algae:	Moss or algae growth over the surface, usually from excessive moisture.
Insufficient Anchors/Connections:	Broken, damaged, loose, corroded, or missing anchorage or fasteners caused by vibration, excessive deflection, or improper tightness.
Dry Rot/Decay:	Structural integrity breakdown from mold/mildew or dry rot.
Loss of Protective Coating/Paint:	Chalking, peeling, chipping, blistering, or deterioration.
Splitting:	Surface splitting or tearing.
Insect Damage:	Holes, cracks, or punctures from burrowing insects.
Burned or Charred Surface:	Damage from fire or excessive heat on surface.

DEFICIENCY FACTORS
0.03.03.05 FLOORS - WOOD (CSI **06220)**

END OF SUBSECTION

0.03.04.01 ROOF STRUCTURE - STEEL (CSI 053001

DESCRIPTION

Steel roof decking has the advantages of being a lightweight material that covers a large area and can be installed in a minimum amount of time. Decking is manufactured in depths ranging from 1 1/2 to 7 1/2 inches, thicknesses from 18 to 22 gauge, and various cover widths. Economy dictates that lengths cover a minimum of two supporting members. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Steel Deck (CSI 05310)

Steel roof decks measure 1 1/2 inches thick and are rolled into three configurations: narrow rib, intermediate rib, and wide rib. The interior surface finish may be galvanized or factory painted. Deck sheets should be placed in accordance with an approved erection-layout drawing supplied by the deck manufacturer and in accordance with the deck manufacturer's standards. Roofs having a slope of 1/4 inch in 12 inches or more should be erected from the low side up to produce shingle effect. The ends of the sheet should lap a minimum of 2 inches and be located over a support.

The deck may be welded to supporting members, including bearing walls, or fastened with screws. Welds are made from the topside of the deck with puddle welds at least 1/2 inch diameter and fillet welds at least 1 inch long. Screws are as follows for all deck widths: all side laps plus a sufficient number of interior ribs to limit the spacing between adjacent points of attachment to 18 inches. For spans greater than 5 feet, side laps shall be fastened between supports, center-to-center, at a maximum spacing of 3 feet.

The deck erector normally cuts openings (including skew cuts) in the roof deck which are shown on the erection drawings and are less than 16 square feet in area. Openings for stacks, conduits, vents, etc. are usually cut (and reinforced if necessary) by the trades that require the openings.

Open-Web Steel Joist (CSI 05210)

These joists are parallel chord members suitable to support floors and roof decks. They are normally manufactured in three classifications: H series in spans of 8 to 30 feet; LH series in spans of 25 to 96 feet and depths of 18 to 48 inches; and DLH series in spans of 89 to 144 feet and depths of 52 to 72 inches. The H and LH joist are suitable for floor and roof decks; DLH series are suitable for the support of roof decks only. Joists are manufactured of high-strength steel in accordance with specifications adopted by the Steel Joist Institute.

Steel roof deck on open-web steel joists is a widely used roof support system due to light weight, fast erection time, and span flexibility. The deck is normally attached to the joist by welding or self-drilling, self-tapping screws for economy; joist spacing should be close to the maximum allowable span for the deck used. Spans may be limited by construction and maintenance loads or by insurance regulations. When the deck bearing terminates at a bearing wall, the deck specifications require a positive attachment at the wall, such as a continuous embedded plate for welding or other suitable attachment devices. A steel deck is typically covered by rigid insulation boards, but may also be insulated with vermiculite, perlite, or cellular types of roof fill which are then covered by the roofing material.

0.03.04.01 ROOF STRUCTURE - STEEL (CSI 05300)

Formwork (CSI 03100)

Forms are a temporary structure or mold for support of concrete while it is setting and gaining sufficient strength to be self supporting. It is the total system of support for freshly placed concrete, including the mold or sheathing which contacts the concrete, as well as all supporting members, hardware, and necessary bracing. For cast-in-place stairs form anchors are used to secure formwork to previously placed concrete of adequate strength. The device is embedded in the concrete during placement. Also a form coating, a liquid is applied to the interior of the formwork surfaces for a specific purpose, usually to promote easy release from the concrete, to preserve the form material, or retard the set of the near-surface matrix for preparation of exposed aggregate finishes.

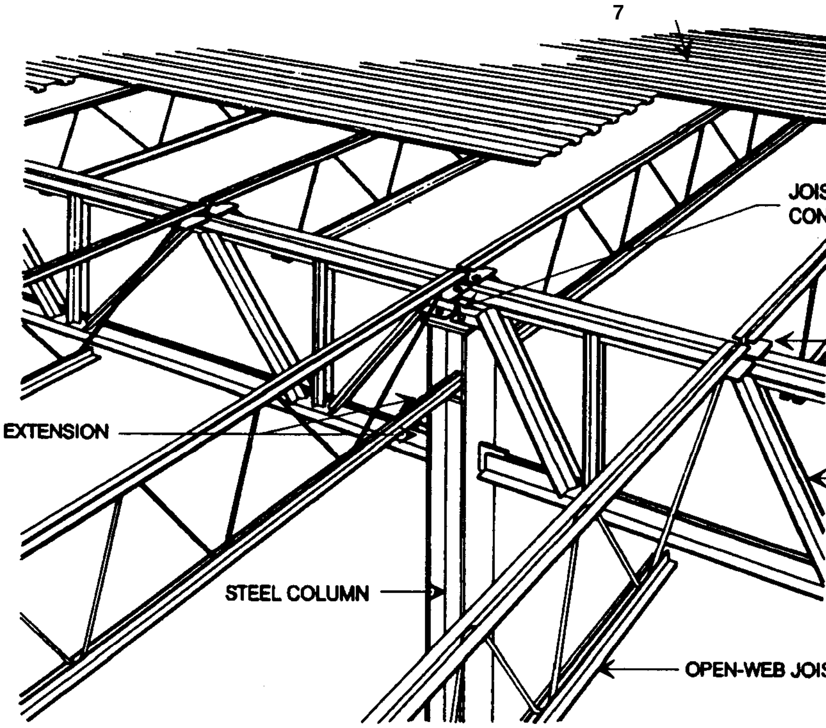
Reinforced Concrete (CSI 03300)

Because concrete has limited resistance to tensile and shear stresses, steel reinforcing material is necessary. Rebars and/or wire mesh must have a capability of developing a bond with the concrete and be so positioned that each element will be used efficiently. The cross-sectional area of the reinforcing bar should not be reduced in any way, because the tensile capacity of the material will be reduced. A thorough knowledge of contract requirements, construction documents including shop drawings, and the placement of reinforcing steel are very importa'ht.

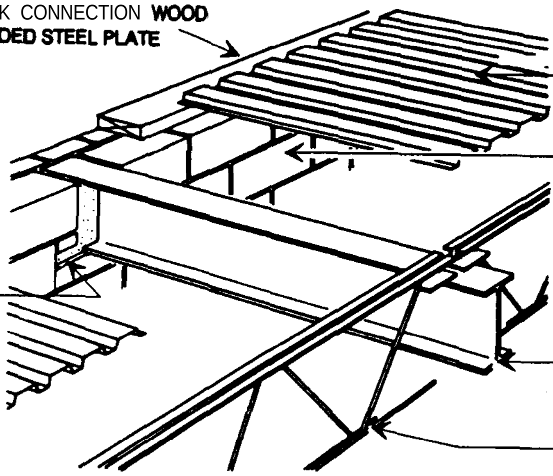
The capability of the reinforcing materials to bond with the concrete must not be destroyed in any way. Before placement, the reinforcing must be thoroughly cleaned of loose or flaky rust, mill scale, ice, oil, or any other substance that might reduce or destroy the bond. This will include the cleaning of any steel that may have been contaminated after placement.

OTHER RELATED COMPONENTS

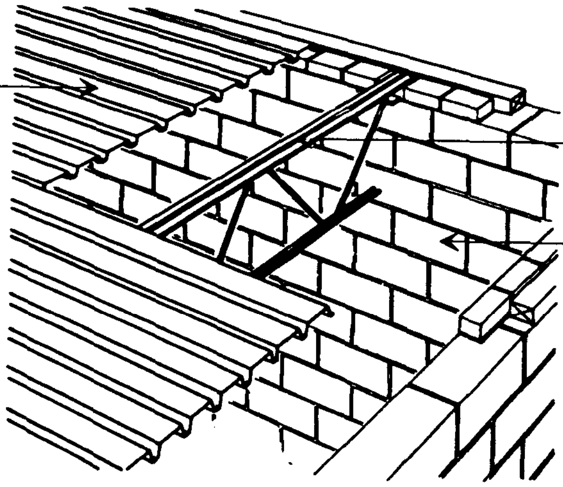
See the following subsections for related components



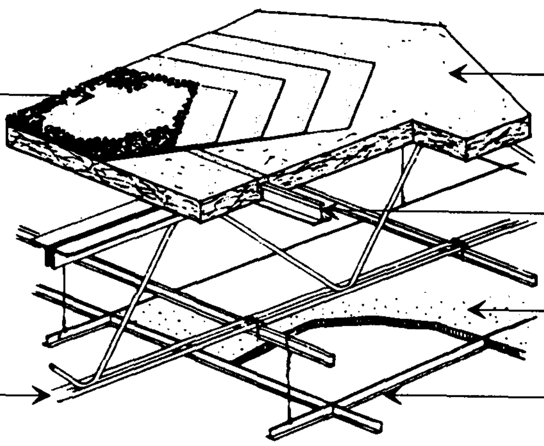
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	STEEL ROOF DECK AND COMPONENTS		
ROOF STRUCTURE STEEL (CSI 05310)	Revision No.	Issue Date 5/93	Drawing No. A030401-1



METAL DECK AND STEEL JOISTS ON BEAMS



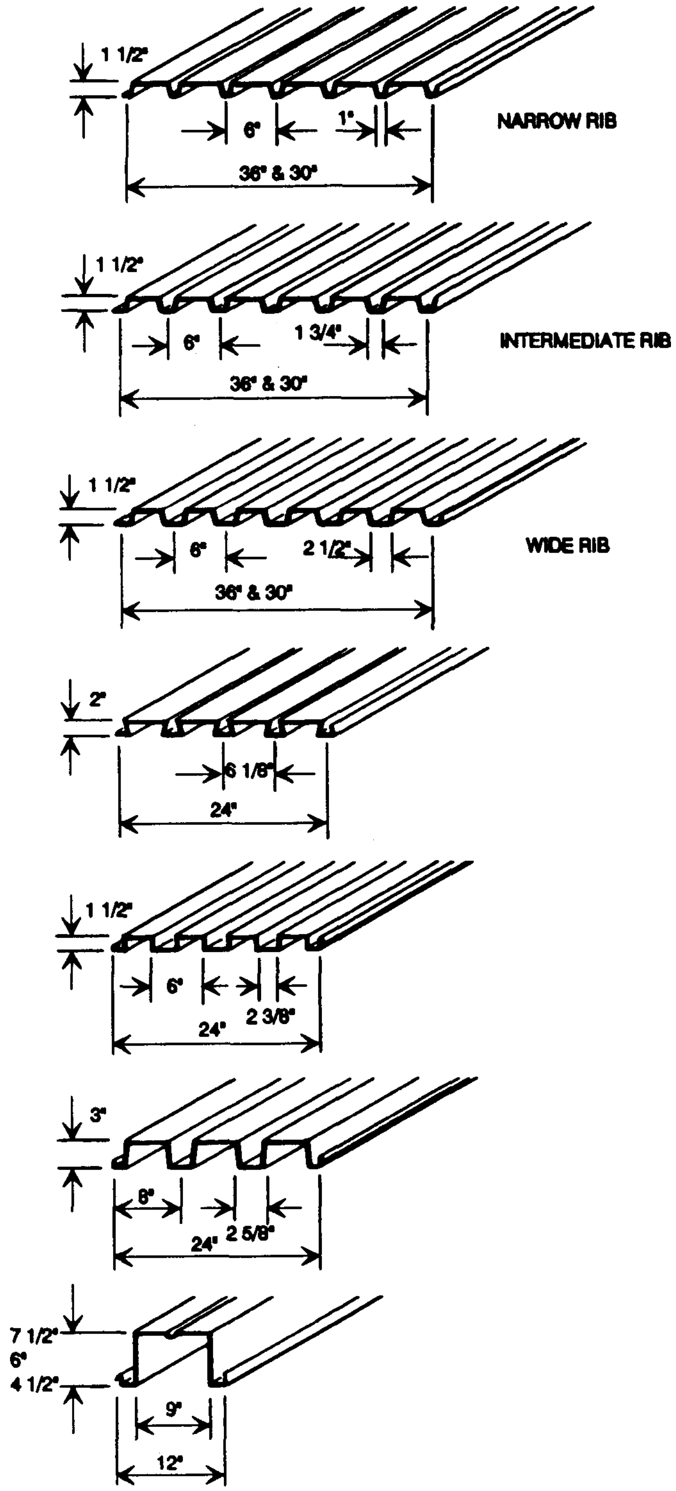
METAL DECK AND STEEL JOISTS ON WALLS



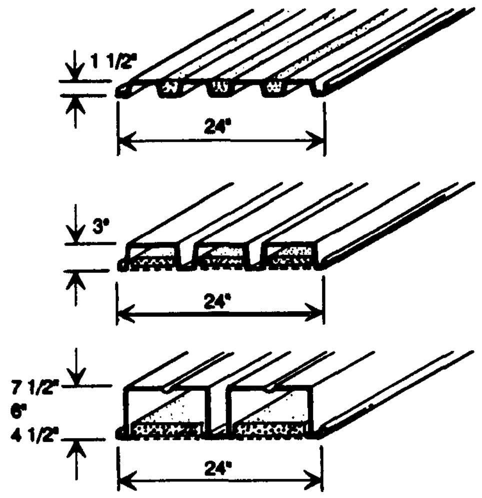
FORMBOARD DECK, BULB T'S, AND STEEL JOISTS

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION "R.S. Means Co., Inc., Kingston, Massachusetts"

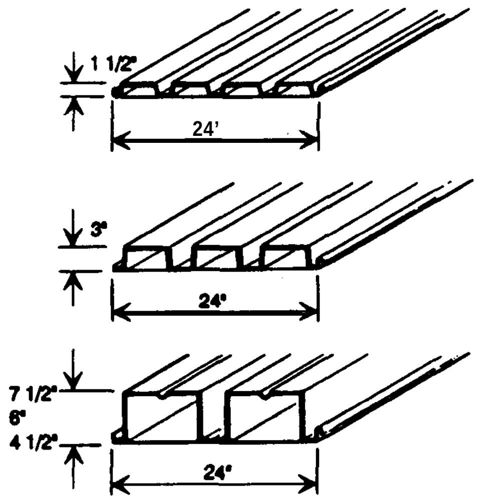
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	ROOF STRUCTURE WITH STEEL COMPONENTS		
ROOF STRUCTURE STEEL (CSI 05310)	Revision No.	Issue Date 5/93	Drawing No. A030401-2



ROOF DECK



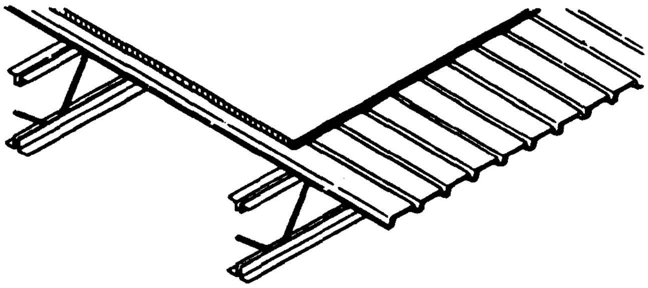
ACOUSTIC DECK



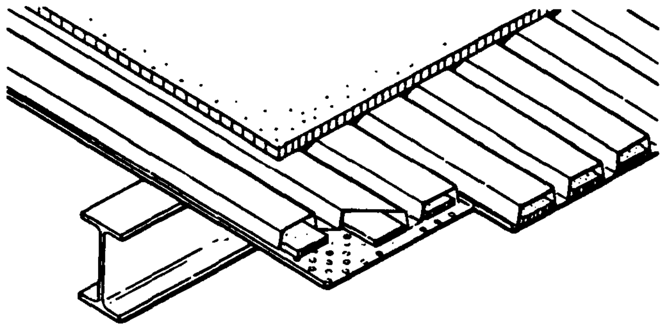
CELLULAR DECK

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION "R.S. Means Co., Inc., Kingston, Massachusetts"

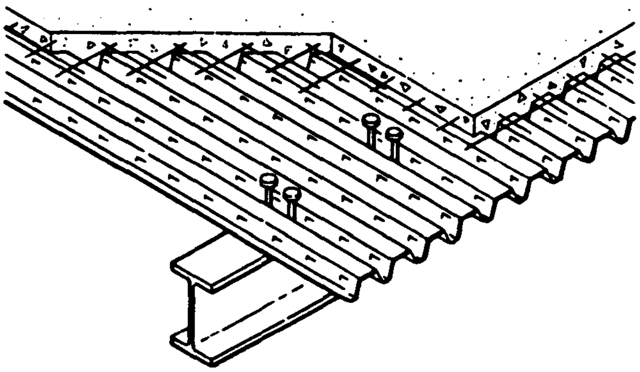
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	STEEL ROOF DECK CONFIGURATIONS		
ROOF STRUCTURE STEEL (CSI 05310)	Revision No.	Issue Date 5/93	Drawing No. A030401-3



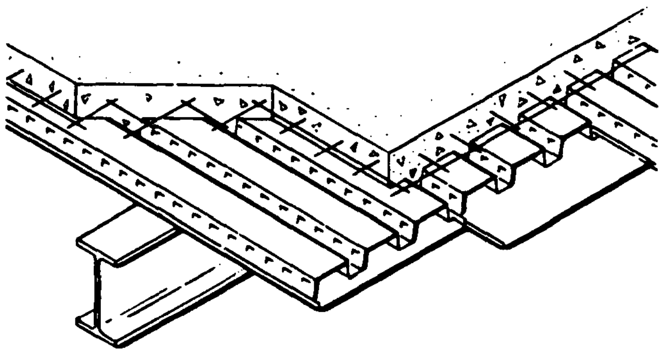
ROOF DECK SYSTEM WITH INSULATION



ACOUSTIC DECK SYSTEM



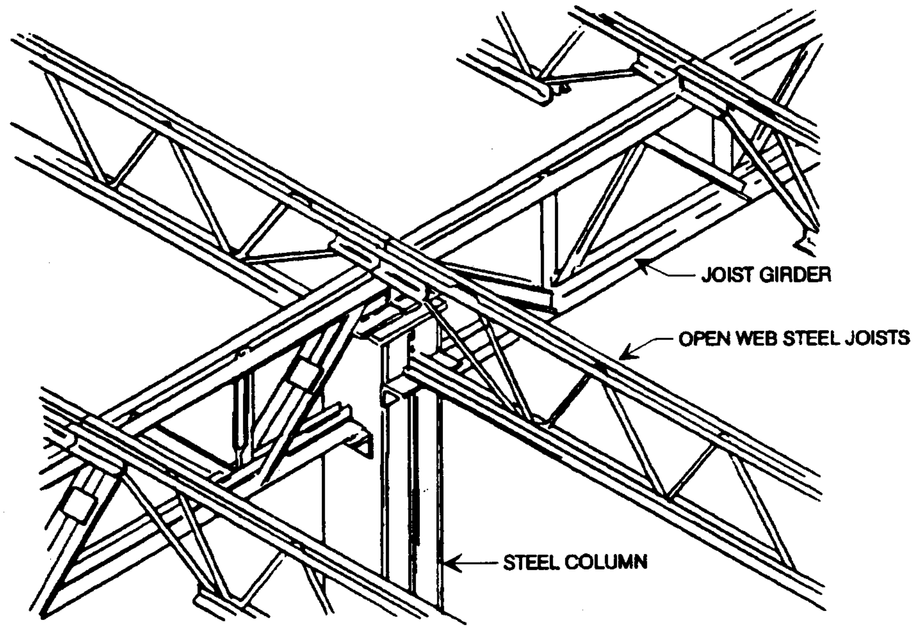
COMPOSITE BEAM, DECK AND SLAB



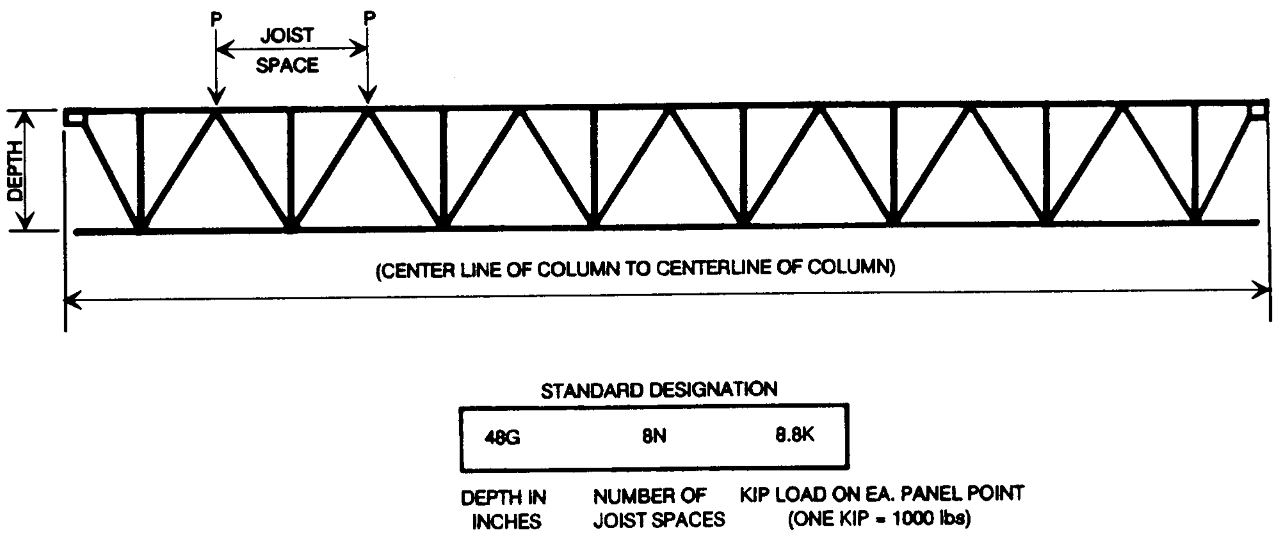
CELLULAR DECK SYSTEM

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION "R.S. Means Co., Inc., Kingston, Massachusetts"

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	TYPES OF STEEL ROOF DECK SYSTEMS		
ROOF STRUCTURE STEEL (CSI 05310)	Revision No.	Issue Date 5/93	Drawing No. A030401-4



JOIST GIRDER SYSTEM



SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION "R.S. Means Co., Inc., Kingston, Massachusetts"

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	STEEL ROOF DECK SUPPORT SYSTEM		
ROOF STRUCTURE STEEL (CSI 05310)	Revision No.	Issue Date 5/93	Drawing No. A030401-5

DEFICIENCY FACTORS
0.03.04.01 ROOF STRUCTURE - STEEL (CSI 05300)

PROBABLE FAILURE POINTS

- Steel corrosion is an electro-chemical process that occurs in the presence of air and moisture.
- Cracked or broken welds caused by stress, settlement/movement, poor materials, or improper construction.
- Loose connections caused by vibration, temperature changes, or improper tightness.
- Impact damage caused by objects striking or impacting the surface.

SYSTEM ASSEMBLIES/DEFICIENCIES

Abrasion:	Caused by contact with moving parts, wave action, or immersion in a moving liquid.
Corrosion:	Resulting from a chemical or electrochemical reaction that converts the metal into an oxide, carbonate, and sulfides.
Out-of-Alignment:	Bowing, deflection, or other movement that brings the surface out of plumb or not level in one or more directions.
Impact Damage:	Depressions, dents, or buckled surface from objects striking or impacting the surface.
Loss of Protective Coating/Paint:	Chalking, peeling, chipping, blistering, or deterioration.
Fatigue Cracking:	Caused by repetitive, cyclic loading occurring at stresses at or below allowable design values.
Lamellar Tearing:	Strains and separation(s) within the steel induced by hot metal weld shrinkage as it cools.
Loose Connections:	Caused by impact, vibration, fatigue loading; or incorrect tightness.
Damaged Welds:	Cracked or broken welds caused by stresses, poor materials, or improper construction.

DEFICIENCY FACTORS
0.03.04.01 ROOF STRUCTURE - STEEL (CSI 05300)

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CORRODING CORRUGATED ROOF DECKING

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUPERSTRUCTURE	ROOF DECK DETERIORATION		
ROOF STRUCTURE STEEL (CSI 05310)	Revision No.	Issue Date 5/93	Drawing No. 0030401-I

DEFICIENCY FACTORS
0.03.04.01 ROOF STRUCTURE - STEEL (CSI 05300)

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DEFICIENCY FACTORS
0.03.04.01 ROOF STRUCTURE - STEEL (CSI 05300)

END OF SUBSECTION

0.03.04.02 ROOF STRUCTURE . PRECAST CONCRETE (CSI 03300)

DESCRIPTION

Concrete roof slabs are flat, horizontal (or nearly so), molded layers of reinforced concrete, usually uniform but sometimes of variable thickness. Concrete slabs are poured by pumping machines and other equipment. Concrete roof slab design is affected by the formwork, yet is also directly influenced by types and brand of cement, admixtures, uniformity in mixing and placing techniques, curing methods, and other quality control factors. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Reinforced Precast Concrete (CSI 03400)

Because concrete has limited resistance to tensile and shear stresses, it is necessary that a composite material be used to take advantage of the maximum capability of the composite ingredients. The cross-sectional area of the reinforcement should not be reduced in any way since the tensile capacity of the material will be affected. Reinforcing steel should be placed in accordance with engineering requirements. Laps, ties, hook positions, and stirrups should conform to shop drawings and ACI codes.

The capability of the reinforcing materials to bond with the concrete must not be destroyed in any way. Before placement, the reinforcing must be thoroughly cleaned of loose or flaky rust, mill scale, ice, oil, or any other substance that might reduce or destroy the bond. This will include cleaning any steel that may have been contaminated after placement.

Concrete Slab Placement (CSI 03100)

In placing concrete roof slabs other considerations need to be emphasized. Some relate to finishing and curing operations, but will be covered here for special emphasis. The requirement is that the placement will be continuous for a unit of operation that will terminate at an expansion, contraction, or construction joint.

In final placement, concrete under all conditions will be placed as nearly as practicable in its final position. In placing extremely thick slabs sections, concrete must be placed in uniform lifts or layers not exceeding 12 inches thick.

Concrete Floor **&** Slab **Finishes** (CSI 03250)

The degree of level and smoothness required in the finished slab must be understood at the outset. The forms must be accurately and rigidly set to true line and grade. To keep the level uniform between forms in large areas, it will be necessary to set ends of drag-off equipment. Slabs should be pitched to drain. If this sloping surface is to have any degree of consistency and uniformity, screeds must be set from the line where the slope begins to the drain.

The deviation from a true plane surface shall not exceed 1/8 inch when tested with a lo-foot straightedge. Concrete “shall be screeded and floated with straightedges to bring the surface to the required finished level with no coarse aggregate visible.” The word “straightedges” used in this sentence is interpreted to mean drag-off and floating instruments that have straight and true edges.

Expansion, Construction, **&** Contraction Joints (CSI 03250)

Expansion joint is defined as a joint in a roof slab that does not affect the adjacent slab because both are separated. Reinforcement, corner protection angles, and other embedded metal items should not run continuously through this joint.

0.03.04.02 ROOF STRUCTURE . PRECAST CONCRETE (CSI 03300)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Expansion, Construction, & Contraction Joints (CSI 03250) (Continued)

The construction joint is defined as the joint that occurs at a placement stop form. Once the form is removed and the specified time has elapsed, new concrete will be placed directly in contact with the old concrete surface. Reinforcing and embedded items can continue through this joint. Construction joints in concrete are to be formed as adequately as other formwork and will incorporate the features shown on plans.

The contraction joint is defined as a joint formed either by embedding a separating element through the depth of the slab or sawing joints in the slab after placement. This joint is planned for uniformity of pattern and so located that shrinkage cracking can be controlled. Concrete placement is continuous through this joint. Joints of one type or a combination of types will be used to divide the slab into areas not to exceed 600 square feet.

Expansion joints and other joints to receive joint sealers should be properly placed with removable dressed and oiled wood strips attached to the pop edge. The positioning of this item will be such that when removed, a 3/4 inch deep groove shall remain.

Support for Reinforcement (Chairs, Spacers, & Bolsters) (CSI 03250)

Chairs are a small metal support for reinforcing steel to maintain the proper positioning during concrete placement. A spacer is used in the same fashion as a chair to maintain proper positioning during concrete pours. A bolster in concrete is a continuous wire bar support used to support bars in the bottom of footings. The top wire is corrugated at 1 inch centers to hold the bar in its position.

Reinforced Precast Concrete (CSI 03400)

Since concrete has limited resistance to tensile and shear stresses, it is necessary that a composite material be used in order to take advantage of the maximum capability of the composite material. The cross-sectional area of the reinforcement should not be reduced in any way since the tensile capacity of the material will be affected. Reinforcing steel should be placed in accordance with engineering requirements. Laps, ties, hook positions, and stirrups should conform to shop drawings and ACI codes.

Admixtures (CSI 03370)

An ingredient other than cement, aggregate, or water that is added to a concrete or mortar mix to affect the physical or chemical characteristics of the concrete. The most common effects of admixtures, affects the plasticity, air entrainment, and curing time.

Air-Entrainment Aaents:

- Provide a more workable material.
- Definitely used when concrete surface will be exposed to freeze/thaw cycles

Retarder & Densifying Aaents:

- Retard the set; suggested in warm weather to reduce cracking due to rapid set-up.
- Increase the workability of the mix.
- Allow for delayed finishing, resulting in less permeable concrete.

Accelerator:

- Useful in winter (cold weather concreting).
- Useful when working to seal against the water-flow.
- Should be used sparingly because the admixture tends to increase shrinkage.

0.03.04.02 ROOF STRUCTURE - PRECAST CONCRETE (CSI 03300)

OTHER RELATED COMPONENTS

See the following subsections for related components:

0.03.04.02 ROOF STRUCTURE - PRECAST CONCRETE (CSI 03300)

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DEFICIENCY FACTORS
0.03.04.02 ROOF STRUCTURE . PRECAST CONCRETE (CSI 03300)

PROBABLE FAILURE POINTS

- Lack of curing will increase the degree of cracking within a concrete structure.
- Reinforcement corrosion is an electro-chemical process that occurs in the presence of air and moisture.
- The weathering processes that can cause cracking include: (1) freezing and thawing, (2) wetting and drying, and (3) heating and cooling.
- A number of deleterious chemical reactions may result in the cracking of concrete. These reactions may be due to the aggregate used to make the concrete or materials that come into contact with it after it has hardened or cured.
- A wide variety of poor construction practices can result in cracking in concrete structures, especially adding water to concrete to improve workability, which reduces strength, increases settlement, and increases ultimate drying shrinkage.
- Construction overloads induced during construction can be far more severe than those experienced in the lifetime of the structure. Unfortunately, these conditions may occur at early ages when the concrete is most susceptible to damage and often result in cracks.
- The effects of improper design and/or detailing range from poor appearance to lack of serviceability to catastrophic failure.
- Externally applied loads induce tensile stress that result in cracks. Current ACI 318 design procedures use reinforcing steel, not only to carry the tensile forces, but also to control both an adequate crack distribution and width.

SYSTEM ASSEMBLIES/DEFICIENCIES

Concrete

Spalling:	Concrete fragments broken from the surface caused by reinforcement corrosion.
Settlement:	Solid particles sink in fresh concrete after placement and before initial set.
Exposed Reinforcing:	Insufficient cover of steel. Concrete quality. Calcium chloride overused as admixture.
Alkali-Aggregate Expansion:	Chemical reaction between aggregate and cement paste causing separation and bond failure.
Cavitation:	Rapid movement of water or other liquids across the surface.
Cracking (Active & Dormant):	Construction movement, settlement, shrinkage around reinforcement. Setting due to inadequate finishing and curing. Chemical reactions such as corrosion. Physical such as drying shrinkage. Thermal changes (subjected to temperature extremes such as freeze/thaw cycles). Stress concentration. Structural design. Accidents from overload, vibration, fatigue, and earthquake.
Crazing:	Surface shrinkage more rapid than concrete mass interior. Too high a slump. Too rich a mix. Poor timing on finishing. Too rapid absorption of moisture.

DEFICIENCY FACTORS
0.03.04.02 ROOF STRUCTURE • PRECAST CONCRETE (CSI 03300)

SYSTEM ASSEMBLIES/DEFICIENCIES

Concrete (Continued)

Holes (Small & Large):	Chemical reaction. Inadequate construction and design.
Form Scabbing:	Form oil improperly applied.

REINFORCING CORROSION IN CONCRETE SLAB

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUPERSTRUCTURE	REINFORCING CORROSION AT JOINTS		
ROOF STRUCTURE CONCRETE (CSI 03400)	Revision No.	Issue Date 5/93	Drawing No. 0030402-I

DEFICIENCY FACTORS
0.03.04.02 ROOF STRUCTURE - PRECAST CONCRETE (CSI 03300)

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DEFICIENCY FACTORS
0.03.04.02 ROOF STRUCTURE • PRECAST CONCRETE (CSI 03300)

END OF SUBSECTION

0.03.04.03 ROOF STRUCTURE • WOOD **(CSI 06100)**

DESCRIPTION

Wood roof systems generally consist of a framing system such as trusses and rafters. A roof decking such as exterior plywood sheathing, wood framing plank, and glued laminated planking is applied to the top of the framing system as lateral support and a base for applying roof coverage. The covering material is applied to the roof deck, and the type of covering used depends on the roofing system specified to weatherproof the structure properly. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Wood Roof Trusses (CSI **06190)**

Wood Roof Trusses are factory fabricated of dimensional lumber for high or low pitched roofs, mansard roofs, and flat roofs. They are available from many manufacturers in many different configurations. Members are connected with wood or metal gussets and are glued and/or power nailed in a jig to ensure uniformity.

The clear span characteristics of trusses provide flexibility for interior planning and partition layout, A considerable cost saving results from the fact that ceilings or decking can be applied directly to the truss chords. Truss spacing is dictated by maximum allowable span of the sheathing material. Normal span wood trusses can be erected by hand due to their lightweight property, but are also efficiently erected utilizing a boom truck or crane and a small erection crew.

Wood Rafters (CSI 06110)

Wood Rafters are fabricated in the field from dimensional lumber, for high or low pitched roofs, hipped roofs, mansard roofs, and flat roofs. They are typically used in conjunction with plywood decking to provide a roof structure compatible with many types of bearing wall systems. The spacing and slope of wood rafter systems may be varied to suit the loading span and aesthetic requirements of the installation.

Plywood Sheathing (CSI **06125)**

Sheathing is made of an odd number of layers or piles of thin wood (veneer) bonded together in such a way that the direction of the grain of the adjacent piles is at right angles. The outside piles are called faces (or face and back), and the center ply (or piles) is called the core. In the case of five or more ply construction, the inner piles that are bonded directly and at right angles to the faces are called crossbands are usually veneer, while the core may be of veneer, lumber, or other material.

The principle values of plywood compared to solid wood are as follows:

- Equalized strength along panel length and width.
- Equalized and reduced dimensional changes due to moisture.
- Greater resistance to checking, spitting, and warping.
- Reduced construction labor, weight, and thickness resulting from the availability of wood in wallboard form.

Preframed Roof Panels (CSI **06170)**

Spans of 8 to 12 feet are usually the most practical with preframed panel construction, although spans to 30 feet are not uncommon. Unsanded 4 x 8 foot panels with stiffeners preframed at 16 or 24 inches on-center are common, The long panel dimension typically runs parallel to supports. Stiffeners and roof purlins provide support for all panel edges. Minimum nailing requirements for preframed panels are the same as for roof sheathing.

0.03.04.03 ROOF STRUCTURE - WOOD (CSI 06100)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS (Continued)

Glued Laminated Decking (CSI 08180)

Glued Laminated Decking is used almost exclusively as roof decking where the exposed appearance of the bottom surface is important. Architectural graded lumber boards are used for the bottom surface, and only structural grade for the other lamination sections. There are only a few manufacturers of laminated decking, and it is not stockpiled by lumber yards.

Nailing laminated wood roof decking is somewhat easier than solid wood decking. The tongue and groove is formed much larger, so that the edges of units can be successfully toe nailed together between supports. Both 6 and 8 inch lumber is commonly used, and 10 and 12 inch is available in some species. By using special adhesive in the long joints of laminated decking, it is possible to qualify the wood deck construction as a structural diaphragm. Otherwise it is necessary to cover wood roof decking with a course of plywood or diagonal sheathing for structural compliance.

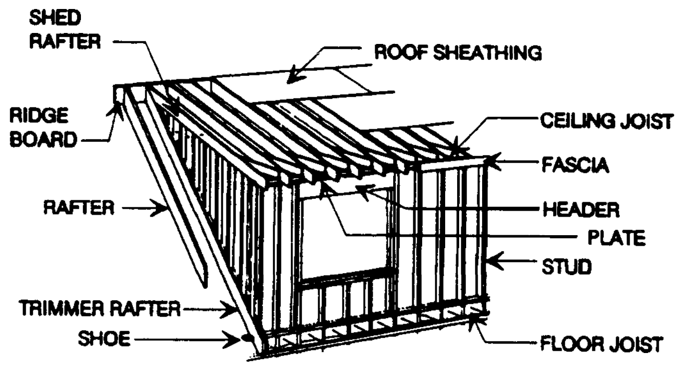
Solid Wood Decking (CSI 08125)

Solid Wood Decking is produced by a fair number of lumber manufacturers. For building codes, technically, only solid decking is qualified as heavy timber, with the associated fire resistance ratings. Solid wood decking for heavy timber construction is used almost exclusively in a 6 inch nominal width, which is then edge nailed with 8 inch spikes and sometimes metal-end-splined.

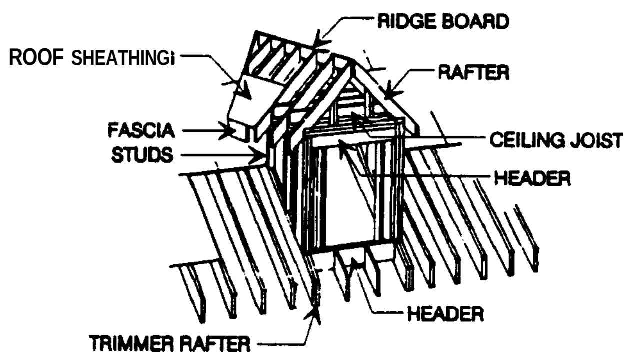
OTHER RELATED COMPONENTS

See the following subsections for related components:

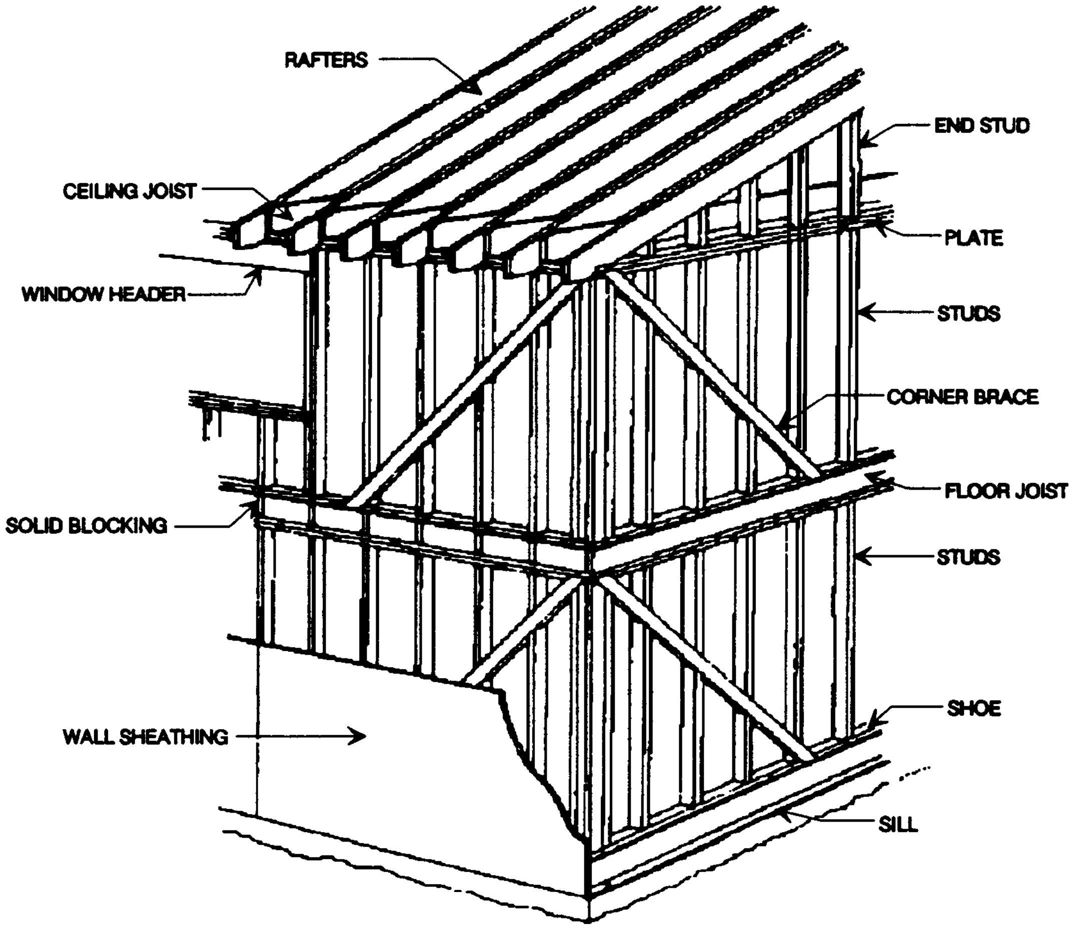
0.02.02.03 Steel (Columns) 2.2.3-l
0.02.02.04 Wood (Columns). 2.2.4-1
0.03.01.04 Wood (Beams). 2.1.4-1
0.03.06 Fireproofing.. ....2.6-1



SHED DORMER FRAMING

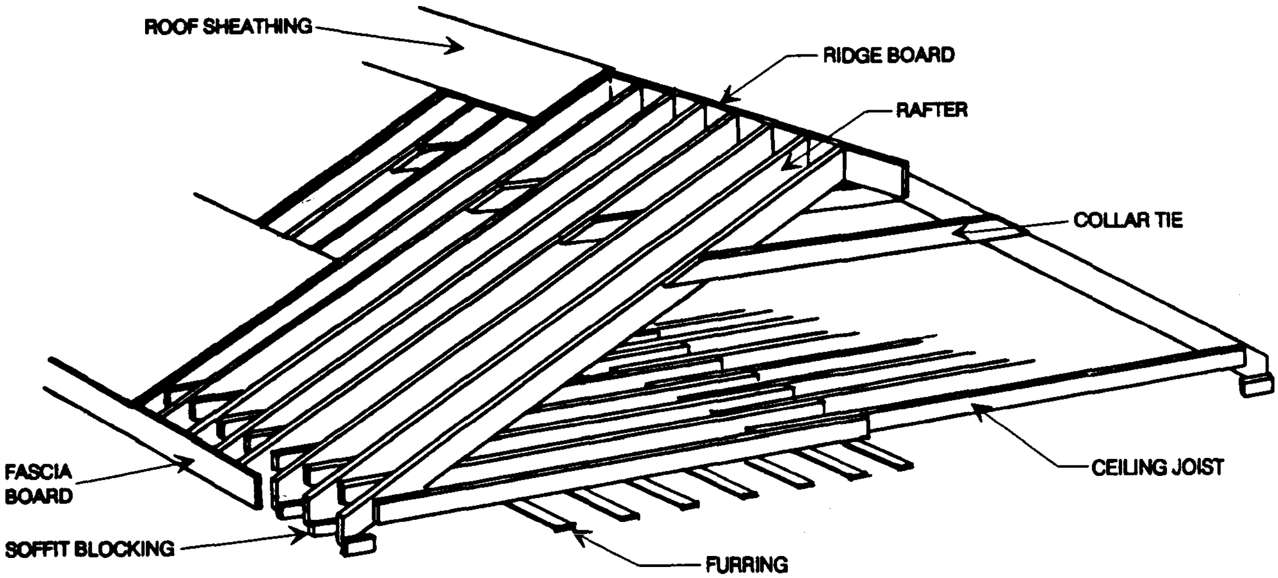


GABLE DORMER FRAMING

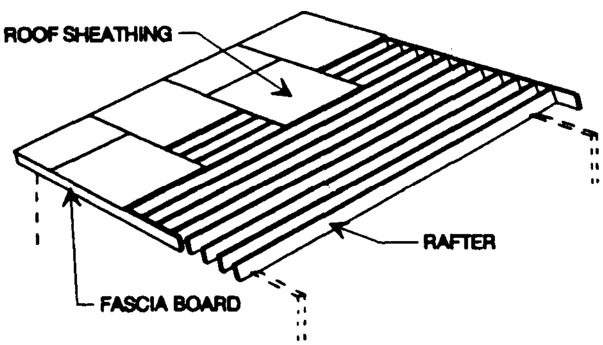


PLATFORM FRAMING

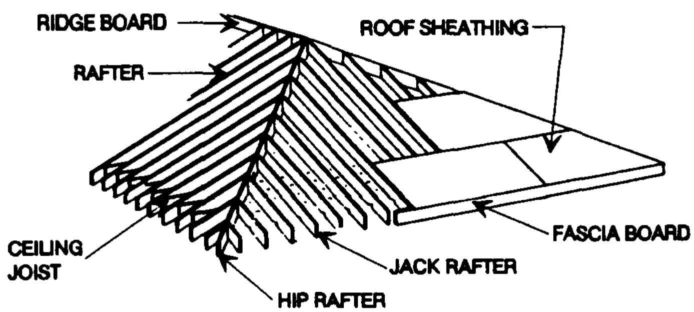
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	PLATFORM WOOD FRAMING SYSTEM		
ROOF STRUCTURE WOOD (CSI 06100)	**Revision** No.	**Issue Date** 5/93	**Drawing** No. A030403-2



GABLE END ROOF

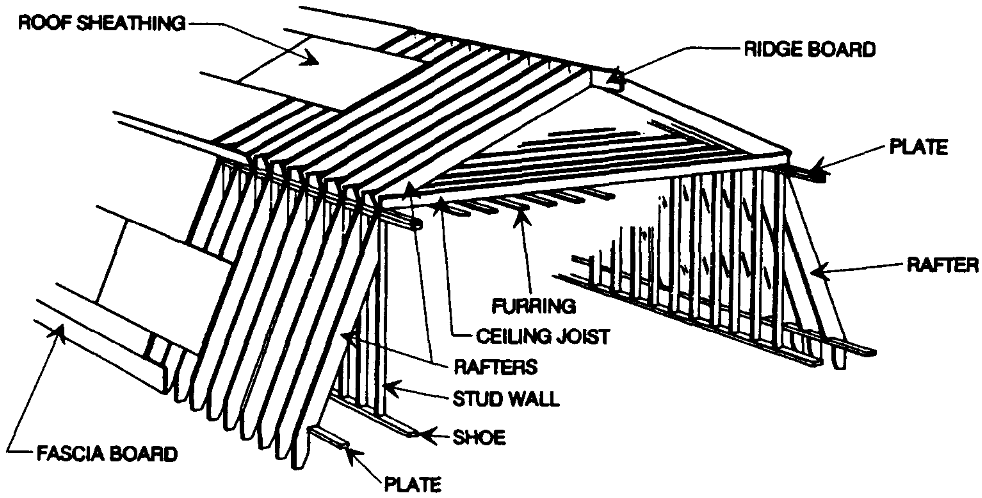


SHED ROOF

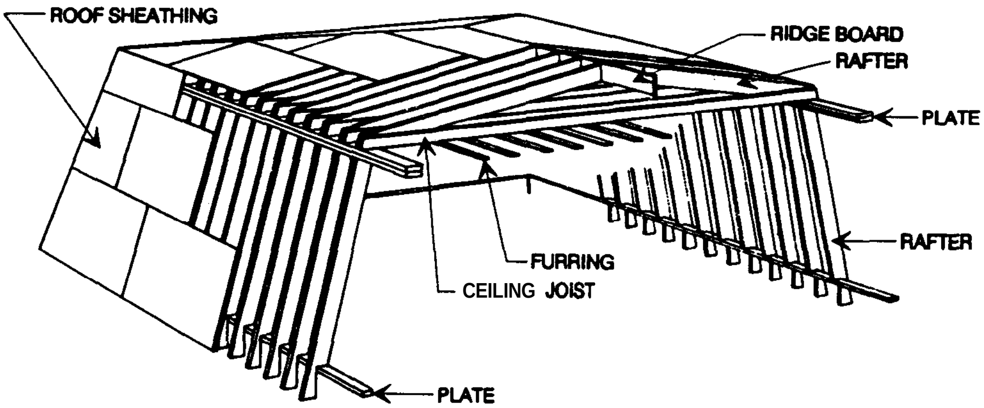


HIP ROOF

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	ROOF RAFTER FRAMING		
ROOF STRUCTURE WOOD (CSI 06100)	Revision No.	Issue Date 5/93	Drawing No. A030403-3

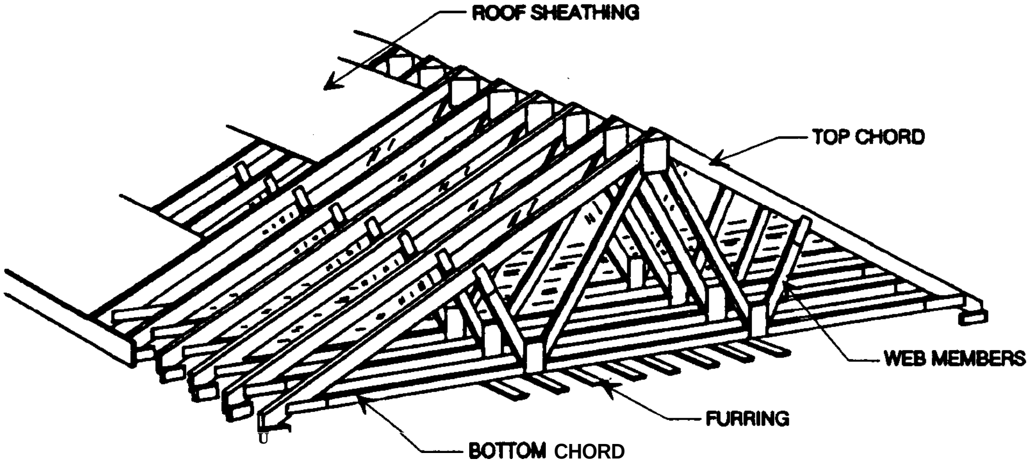


GAMBREL ROOF

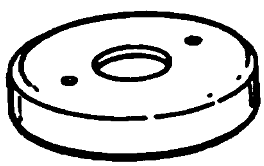


MANSARD ROOF

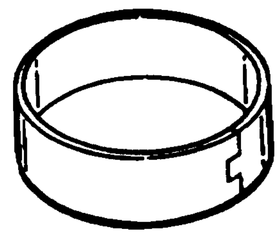
SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	ROOF RAFTER FRAMING		
ROOF STRUCTURE WOOD (CSI 06100)	Revision No.	Issue Date 5/93	Drawing No. A030403-4



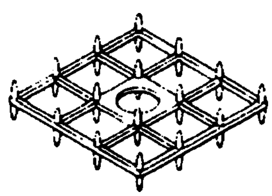
TRUSS ROOF



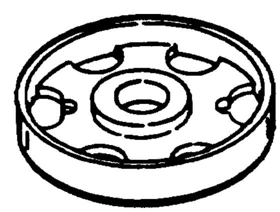
2 5/8" SHEAR PLATE CONNECTOR



SPLIT RING CONNECTOR



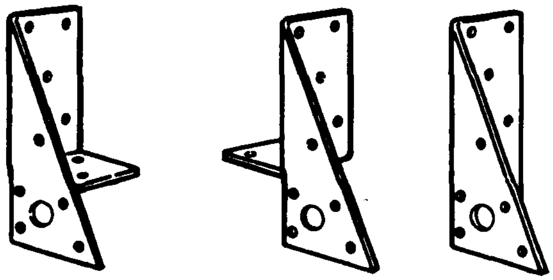
FIAT SPIKED GRID CONNECTOR'



4' SHEAR PLATE CONNECTOR

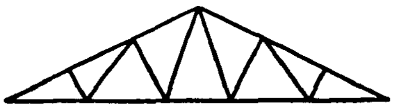
CONNECTORS, USED IN TRUSSES FABRICATED FROM TIMBERS

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	ROOF TRUSS SYSTEM AND CONNECTORS		
ROOF STRUCTURE WOOD (CSI 06100)	Revision No.	Issue Date 5/93	Drawing No. A030403-5

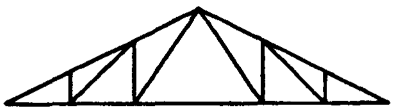


TYPE A TYPE B TYPE C

FRAMING ANCHORS USED IN TRUSS CONNECTIONS



BELGIAN



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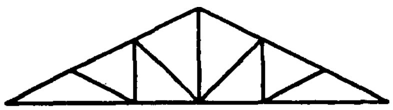

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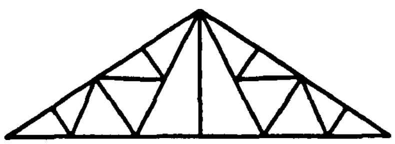

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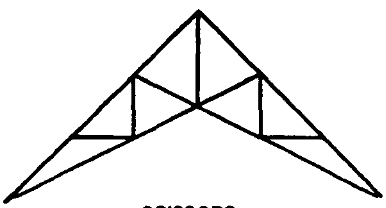
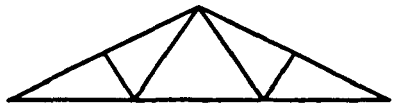
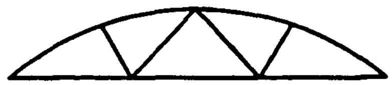


SCISSORS

PITCHED TRUSS TYPES

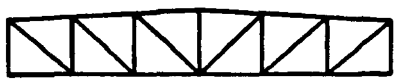


PITCHED



BOWSTRING

PITCHED TRUSS TYPES



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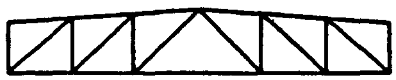

HOWE

FLAT TRUSSES

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	FRAMING ANCHORS AND ROOF TRUSS CONFIGURATIONS		
ROOF STRUCTURE WOOD (CSI 06170)	Revision No.	Issue Date 5/93	Drawing No. A030403-6

DEFICIENCY FACTORS
0.03.04.03 ROOF STRUCTURE . WOOD (CSI 06100)

PROBABLE FAILURE POINTS

- Deterioration caused by the chemical reaction of fire retardant plywood sheathing to heat.
- Termite and boring insect damage causing breakdown of structural integrity.
- Decay (rot) due to fungi, mildew, dry rot causing surface deterioration.
- Fire damage or charred surfaces causing flaking or surface breakdown.
- Loose connections caused by vibration, temperature changes, or improper tightness.
- Splitting or checking caused by stress, bending, or twisting.
- Cracking caused by stress, settlement/movement, poor materials, or improper construction.
- Impact damage caused by objects striking or impacting the surface.
- Water or moisture damage or deterioration resulting from roof system failures or condensation.

SYSTEM ASSEMBLIES/DEFICIENCIES

Cracking:	Cracking, usually structural in nature, that results in tearing, ripping, or shearing. Cracks can be random, horizontal, vertical, or diagonal.
Surface Deterioration:	Crazing, small surface cracks, corrosion, and surface breakdown due to weather, pressure, or other actions.
Insufficient Anchors/Connections:	Broken, damaged, loose, corroded, or missing anchorage or fasteners caused by vibration, excessive deflection, or improper tightness.
Dry Rot/Decay:	Breakdown of structural integrity from mold/mildew or dry rot.
Loss of Protective Coating/Paint:	Chalking, peeling, chipping, blistering, or deterioration.
Splitting:	Surface splitting or tearing.
Insect Damage:	Holes, cracks, or punctures from burrowing insects.
Burned or Charred Surface:	Damage from fire or excessive heat on surface.

DEFICIENCY FACTORS
0.03.04.03 ROOF STRUCTURE - WOOD (CSI 06100)

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DETERIORATION OF WOOD PLANKING

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUPERSTRUCTURE	PLANKING DETERIORATION		
ROOF STRUCTURE WOOD (CSI 06125)	Revision No.	Issue Date 5/93	Drawing No. 0030403-I

WATER DAMAGED WOOD RAFTERS

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUPERSTRUCTURE	RAFTER DETERIORATION		
ROOF STRUCTURE WOOD (CSI 06110)	Revision No.	Issue Date 5/93	Drawing No. 0030403-2

DEFICIENCY FACTORS
0.03.04.03 ROOF STRUCTURE . WOOD (CSI 061001

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DEFICIENCY FACTORS
0.03.04.03 ROOF STRUCTURE . WOOD (CSI **06100)**

END OF SUBSECTION

0.03.05.01 STAIRS . CAST-IN-PLACE CONCRETE (CSI 03300)

DESCRIPTION

Cast-in-Place Stairs are formed and then cast. Concrete stair systems allow design flexibility in creating aesthetic shapes and orientations. Precast treads of concrete or terrazzo in combination with cast-in-place stringers allow cantilevered open stairways. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Cast-in-Place Stairs (CSI 03300)

The structural and architectural design of stairs requires careful consideration due to factors that include life/safety, building code requirements, and proper attention to building types. Cast-in-place concrete stairs are formed by the final shape of formwork placement. The cast-in-place stairs vary in thickness, width, and depth depending on design criteria.

Joints intended to allow substantial axial and/or rotational movement must be designed and detailed to prevent spalling and leakage if exposed to weather.

Cart-in-Place Concrete (CSI 03300)

Cast-in-Place Concrete is placed in forms at its final location. Concrete is a composite material that consists of essentially a binding medium within which'are embedded particles or fragments of aggregate; in Portland cement concrete, the binder is a mixture of Portland cement and water. Cast-in-place stairs vary in depth and thickness depending on the loads and weight of the structure it is to support.

Reinforced Concrete (CSI 03300)

Because concrete has limited resistance to tensile and shear stresses, steel reinforcing material is necessary. Rebars and/or wire mesh must have a capability of developing a bond with the concrete and be so positioned that each element will be used efficiently. The cross-sectional area of the reinforcing bar should not be reduced in any way, because the tensile capacity of the material will be reduced. A thorough knowledge of contract requirements, construction documents including shop drawings, and the placement of reinforcing steel are very important.

The capability of the reinforcing materials to bond with the concrete must not be destroyed in any way. Before placement, the reinforcing must be thoroughly cleaned of loose or flaky rust, mill scale, ice, oil, or any other substance that might reduce or destroy the bond. This will include cleaning any steel that may have been contaminated after placement.

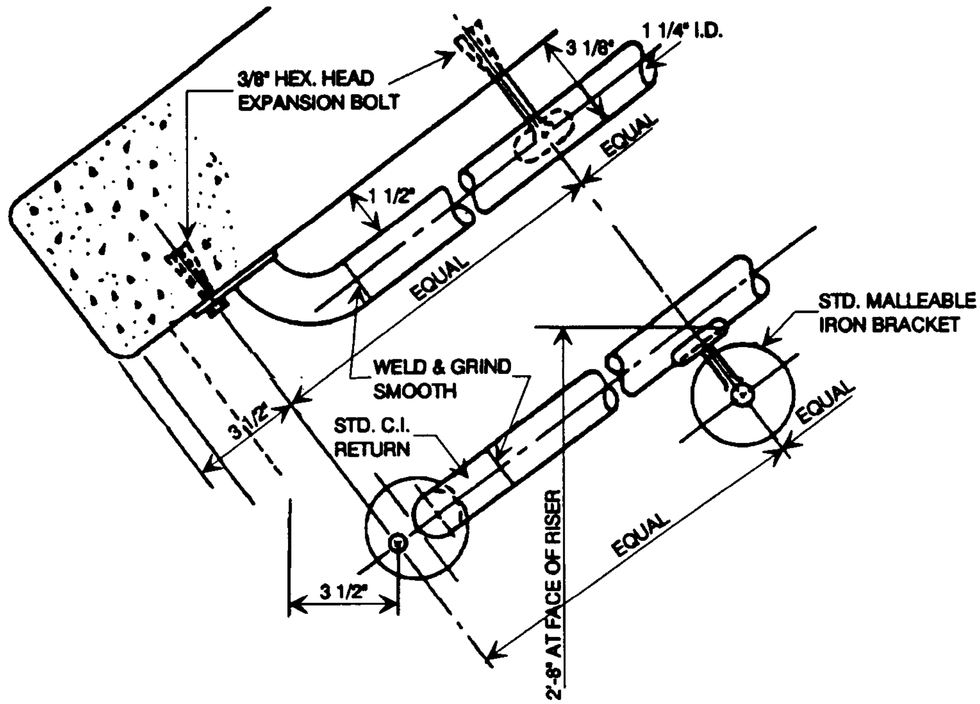
Formwork (CSI 03100)

A forms is a temporary structure or mold to support concrete while it is setting and gaining sufficient strength to be self-supporting. It is the total system of support for freshly placed concrete, including the mold or sheathing which contacts the concrete, all supporting members, hardware, and necessary bracing. For cast-in-place stairs, form anchors are used to secure formwork to previously placed concrete of adequate strength. The device is embedded in the concrete during placement. Also a form coating, a liquid is applied to the interior of the formwork surfaces for a specific purpose, usually to promote easy release from the concrete, to preserve the form material or retard the set of the near-surface matrix for preparation of exposed aggregate finishes.

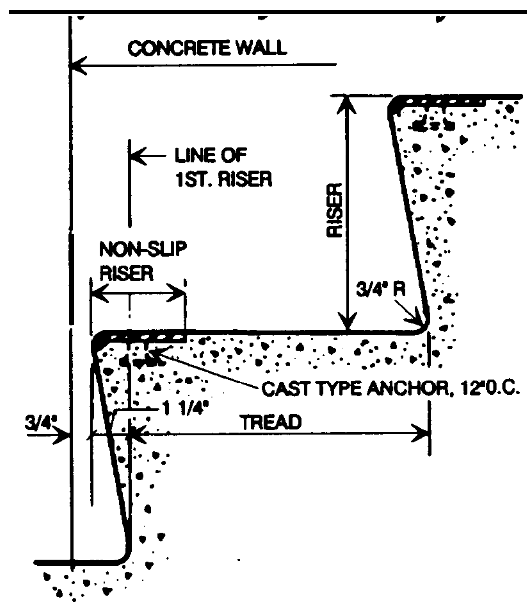
0.03.05.01 STAIRS . CAST-IN-PLACE CONCRETE (CSI 03300)

OTHER RELATED COMPONENTS

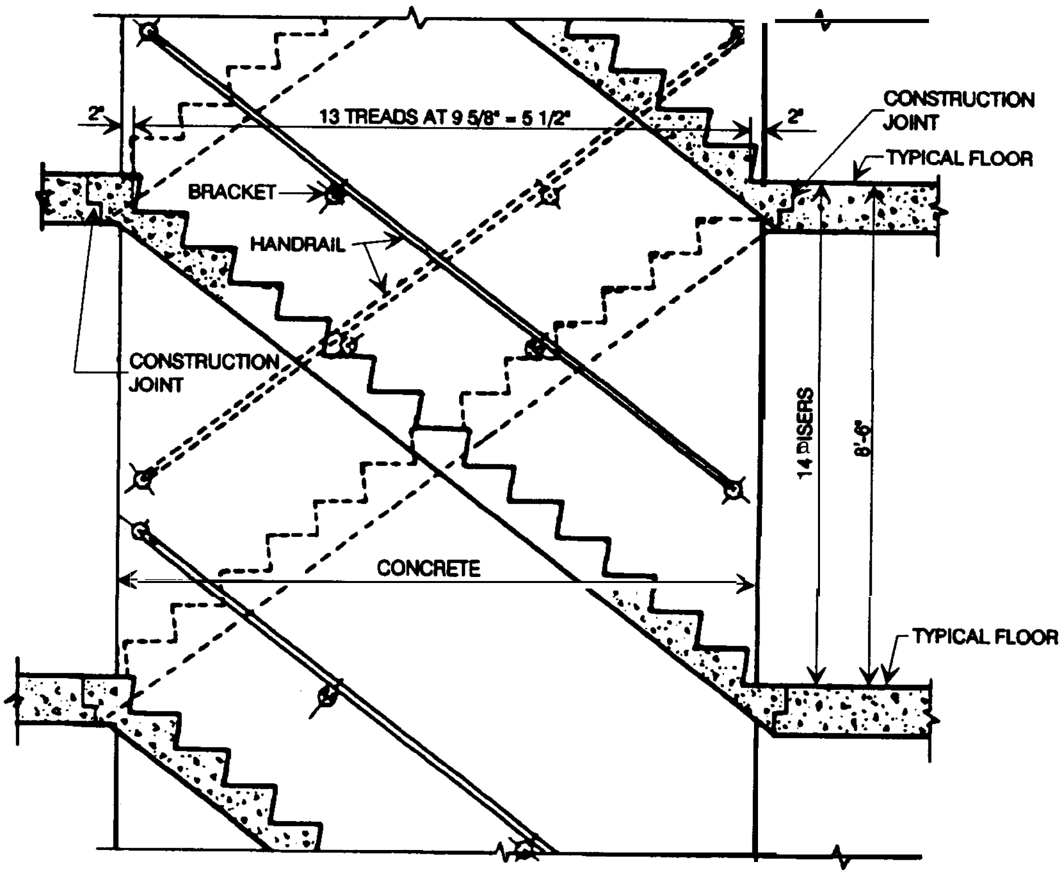
Refer to Foundations and Footings and Substructure, Volumes 1 and 2, for additional deficiencies that may impact this system.



PIPE HANDRAIL DETAILS



SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	HANDRAIL AND RISER/TREAD DETAILS		
STAIRS CAST-IN-PLACE CONCRETE (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. A030501-1



TYPICAL REINFORCED CONCRETE SCISSORS STAIR

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	REINFORCED CONCRETE STAIR		
STAIRS CAST-IN-PLACE CONCRETE (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. A030501-2

DEFICIENCY FACTORS
0.03.05.01 STAIRS • CAST-IN-PLACE CONCRETE (CSI 03300)

PROBABLE FAILURE POINTS

- Lack of curing will increase the degree of cracking within a concrete structure.
- Reinforcement corrosion is an electro-chemical process that occurs in the presence of air and moisture.
- The weathering processes that can cause cracking include: (1) freezing and thawing, (2) wetting and drying, and (3) heating and cooling.
- A number of deleterious chemical reactions may result in the cracking of concrete. These reactions may be due to the aggregate used to make the concrete or materials that come into contact with it after it has hardened or cured.
- A wide variety of poor construction practices can result in cracking in concrete structures, especially adding water to concrete to improve workability, which reduces strength, increases settlement, and increases ultimate drying shrinkage.
- Construction overloads load induced during construction can be far more severe than those experienced in the lifetime of the structure. Unfortunately, these conditions may occur at early ages when the concrete is most susceptible to damage and often result in cracks.
- The effects of improper design and/or detailing range from poor appearance to lack of serviceability to catastrophic failure.
- Externally applied loads induce tensile stresses that result in cracks. Current ACI 318 design procedures use reinforcing steel, not only to carry the tensile forces, but to obtain both an adequate crack distribution and width.

SYSTEM ASSEMBLIES/DEFICIENCIES

Spalling:	Concrete fragments broken from the surface, caused by reinforcement corrosion.
Settlement:	Solid particles sink in fresh concrete after placement and before initial set.
Exposed Reinforcing:	Insufficient steel cover. Concrete quality. Calcium chloride overused as admixture.
Alkali-Aggregate Expansion:	Chemical reaction between aggregate and cement paste causing separation and bond failure.
Cavitation:	Rapid movement of water or other liquids across the surface.
Cracking (Active & Dormant):	Construction movement, settlement, shrinkage around reinforcement. Setting due to inadequate finishing and curing. Chemical reactions such as corrosion. Physical such as drying skrinkage. Thermal changes (subjected to temperature extremes such as freeze/thaw cycles). Stress concentration. Structural design. Accidents from overload, vibration, fatigue, and earthquake.
Crazing:	Surface shrinkage more rapid than interior of concrete mass. Too high a slump. Too rich a mix. Poor timing on finishing. Too rapid absorption of moisture.
Holes (Small & Large):	Chemical reaction. Inadequate construction and design.
Form Scabbing:	Form oil improperly applied

DEFICIENCY FACTORS
0.03.05.01 STAIRS . **CAST-IN-PLACE** CONCRETE **(CSI** 03300)

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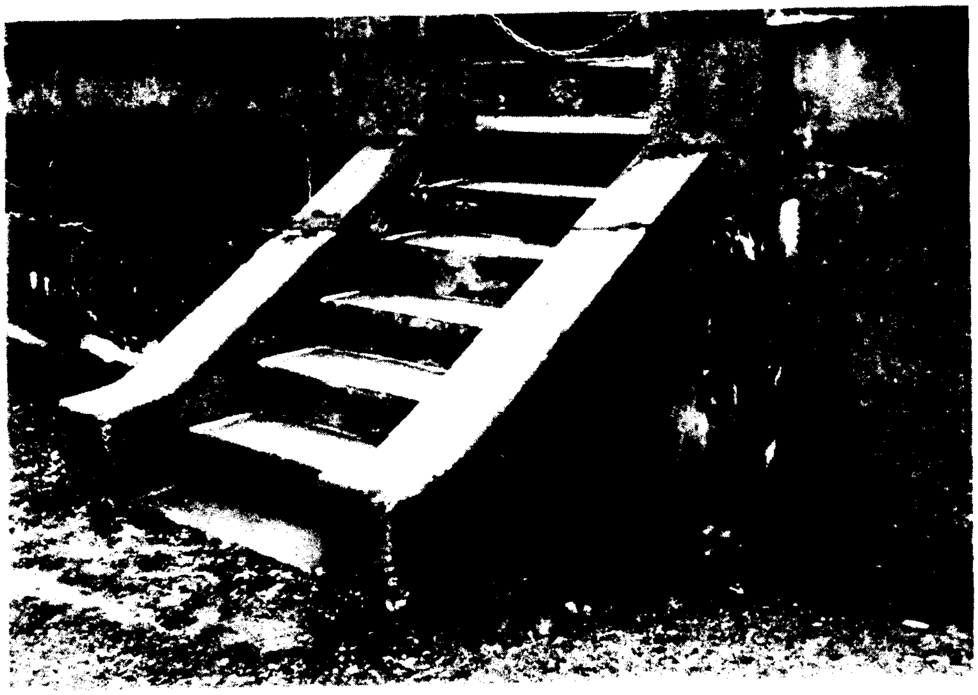
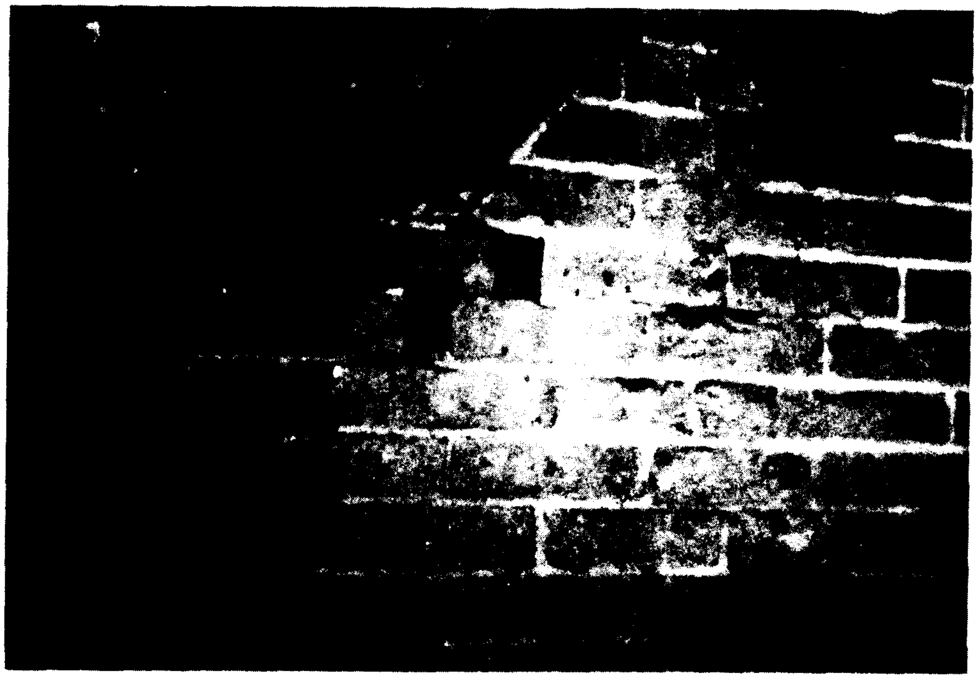


SPALLING CIP CONCRETE STAIRS

PHOTO ILLUSTRATION

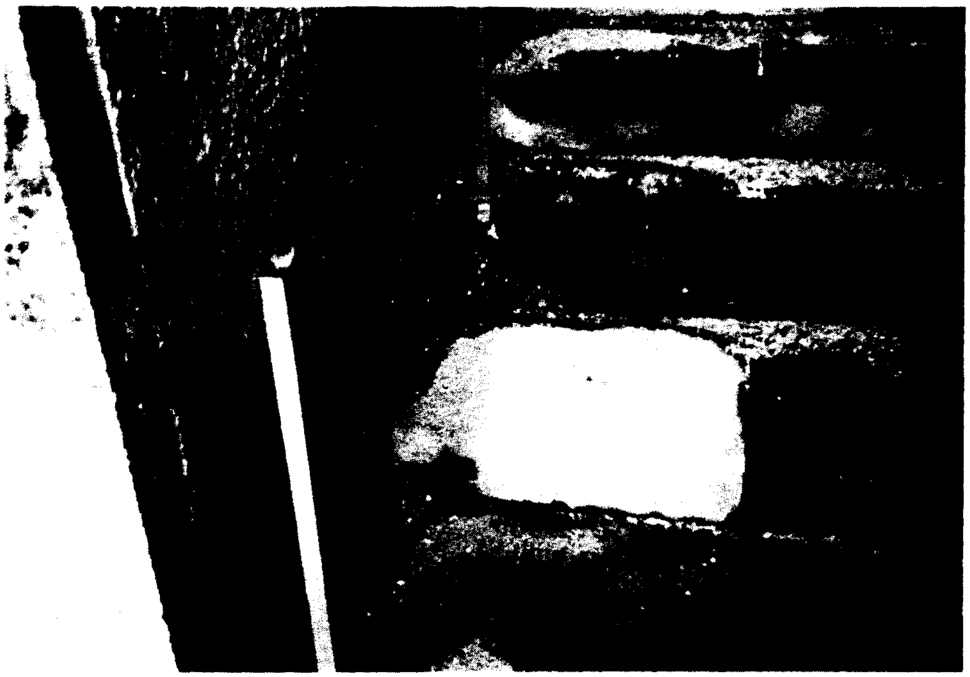
SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUPERSTRUCTURE	DETERIORATING CONCRETE STAIRS		
STAIRS CAST-IN-PLACE CONCRETE (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D030501-1



DETERIORATING MASONRY RETAINING WALL AT STAIRS

PHOTO ILLUSTRATION

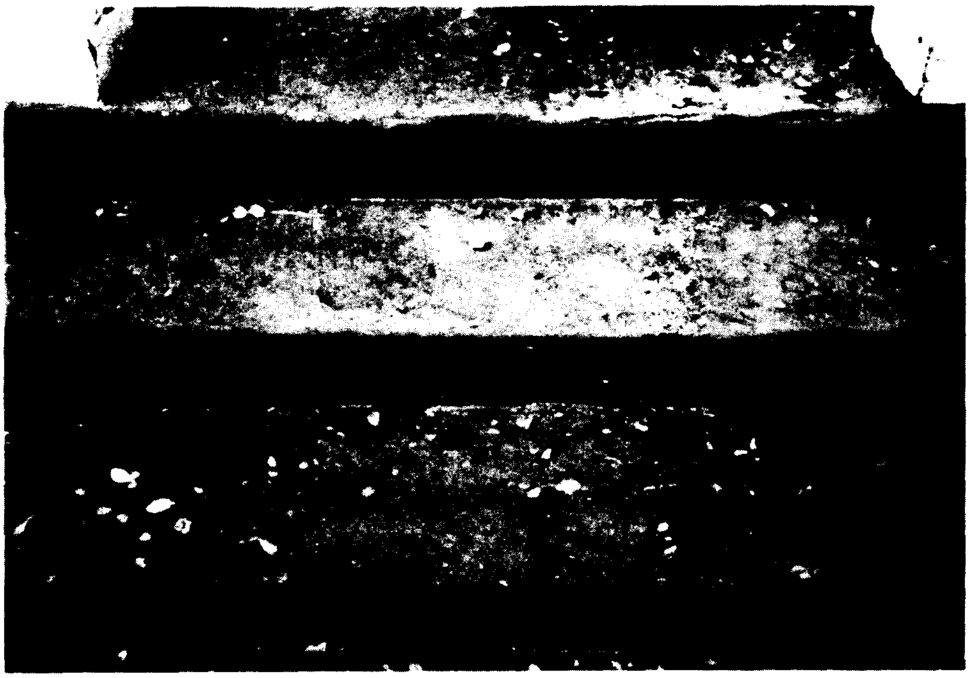
SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUPERSTRUCTURE	MASONRY DETERIORATION		
STAIRS CAST-IN-PLACE CONCRETE (CSI 04210)	Revision No.	Issue Date	Drawing No. D030501-2



EXCESSIVE WEAR AND TEAR OF STONE STAIRS

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUPERSTRUCTURE	STONE STAIR CHIPPING/DETERIORATING		
STAIRS CAST-IN-PLACE CONCRETE (CSI 04420)	Revision No.	Issue Date 5/93	Drawing No. D030501-3



WEAR AND TEAR OF STONE STAIRS

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUPERSTRUCTURE	CHIPPING, SPALLING STONE STEPS		
STAIRS CAST-IN-PLACE CONCRETE (CSI 04420)	Revision No.	Issue Date 5/93	Drawing No. D030501-4

DEFICIENCY FACTORS
0.03.05.01 STAIRS . **CAST-IN-PLACE** CONCRETE **(CSI 03300)**

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DEFICIENCY FACTORS
0.03.05.01 STAIRS . CAST-IN-PLACE CONCRETE (CSI 03300)

END OF SUBSECTION

0.03.05.02 STAIRS - PRECAST CONCRETE (CSI 03400)

DESCRIPTION

Precast Stairs are a concrete member that is cast and cured in other than its final position. They are either reinforced or prestressed in a manufacturer/casting plant and then shipped to the project site. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Precast stairs (**CSI** 03400)

The structural and architectural design of stairs requires careful consideration due to factors that include life/safety, building code requirements, and proper attention to building types. Precast concrete stairs are formed to final shape by manufacturer/casting plants. The precast stairs vary in thickness, width, and depth depending on design criteria.

Precast has the greatest advantage when there are identical members to be cast,' because the same forms can be used several times. In addition to using the same forms, precast concrete has other advantages:

- Control of the concrete quality.
- Smoother surfaces, and plastering is not necessary.
- Less storage space is needed.
- Concrete member can be cast under all weather conditions.
- Better protection for curing.
- Weather conditions do not affect erection.
- Faster erection time.

Precast members should not be skidded, rolled, driven, or subjected to full design load until they have attained their 28-day strengths as indicated by cylinders that are made from the same concrete, at the same time as the precast concrete, and cured in the same manner.

Reinforced Precast Concrete (CSI 03400)

Because concrete has limited resistance to tensile and shear stresses, it is necessary that a composite material be used to take advantage of the maximum capability of the composite material. The cross-sectional area of the reinforcement should not be reduced in any way since the tensile capacity of the material will be affected. Reinforcing steel should be placed in accordance with engineering requirements. Laps, ties, hook positions, and stirrups should conform to shop drawings and ACI codes.

OTHER RELATED COMPONENTS

See the following subsections for related components:

0.03.05.02 STAIRS - PRECAST CONCRETE (**CSI** 03400)

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DEFICIENCY FACTORS
0.03.05.02 STAIRS . PRECAST CONCRETE (CSI 03400)

PROBABLE FAILURE POINTS

- Reinforcement corrosion is an electro-chemical process that occurs in the presence of air and moisture.
- Construction overloads induced during construction can be far more severe than those experienced in the lifetime of the structure. These conditions may occur at early ages when the concrete is most susceptible to damage and often result in cracks.
- The effect of improper design and/or detailing range from poor appearance to lack of serviceability to catastrophic failure.
- Externally applied loads induce tensile. stresses which result in cracks. Current ACI 318 design procedures use reinforcing steel, not only to carry the tensile forces, but also to control both an adequate crack distribution and width.

SYSTEM ASSEMBLIES/DEFICIENCIES

Surface Deterioration:	Cavitation from water or liquid action over surface. Chemical reactions.
Holes (Small & Large):	Inadequate construction and design. Impact damage.
Out-of-Alignment:	Bowing, deflection, or other movement that brings the surface out of plumb or not level in one or more directions.
Spalling:	Fragment flakes from the surface due to weather, pressure, or other actions.
Staining:	Surface discoloration from a foreign substance or material.
Efflorescence:	A whitish powdery deposit of soluble salts brought to the surface by moisture. Leaves residue after evaporating.
Cracks (Active & Dormant):	Construction movement, settlement, shrinkage around reinforcement. Inadequate finishing and curing. Chemical reactions such as corrosion. Physical reactions such as drying shrinkage. Thermal changes (subjected to temperature extremes such as freeze/thaw cycles). Stress concentration. Structural design. Accidents from overload, vibration, fatigue, and earthquake.
Corrosion of Rebar:	Metal rebar oxidation by chemical or electrochemical action after prolonged exposure to moisture.

DEFICIENCY FACTORS
0.03.05.02 STAIRS - PRECAST CONCRETE (CSI 03400)

END OF SUBSECTION

0.03.05.03 STAIRS - STEEL (CSI 05510)

DESCRIPTION

Stair construction is considered a pre-finished item. Stairs range from simple utilitarian assemblies to elaborate, ornate, finely crafted work. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Steel stairs (CSI 05510)

Assemblies are usually prefabricated of channel stringers with treads of light gauge metal called "pans," cast iron, checkered plates, or gratings. The treads may be combined with non-slip nosings of various materials. The treads may also be treated with non-slip treatments. Pan stairs require concrete fill in the pans to provide the contact area for the treads. Landings are designed and fabricated of various structural shapes and are usually covered with the same materials used in the stair treads.

The four different classifications of stairs defined are straight, curved, circular, and spiral. The above listing is not necessarily all-inclusive, but does represent the majority. It is not uncommon however, to find two or more types represented in the same stair, and in some rare cases, the classification may not fall in any of the four categories.

Straight stairs are by far the most common type, representing the bulk of the stair market. Though the term "straight" is self-explanatory, for purposes of classification, a straight stair is defined as one in which the stringers are straight members. Straight stairs, unlike the three other types, may be arranged in several different ways.

Curved stairs are stairs that, in plan view, have two or more centers of curvature, being oval, elliptical, or some other compound curved form. They may have one or more intermediate platforms between floors.

Circular stairs are stairs that, in plan view, have an circular form with a single center of curvature. They may have intermediate platforms between floors.

Spiral stairs are stairs with a closed circular form and supporting center column.

Railings (CSI 05520)

The most economical type of rail for a stair is a steel pipe rail connected at the ends by standard terminal castings *to* a square or rectangular tube newel. This construction provides rigid support at both ends of a flight, yet permits minor installation adjustments where necessary at floors and platforms.

The use of square or rectangular tube for the railing provides an alternative. The use of continuous rails with ramps and easements at floors and platforms increases the cost of the stair. It also minimizes the possibilities of field adjustment for proper alignment, which the newel type of construction provides. Often, on relatively short flights, the need for intermediate posts on pipe rails can be eliminated by substituting a larger size pipe. This also reduces cost.

Connections & Finishing Work:

The use of hex head bolts in place of flat or oval head bolts eliminates the necessity of countersinking and speeds stair assemblies. Where appearance is not critical, welding neatly done but not ground smooth, provides maximum rigidity at minimum cost. When using flat or oval head bolts, grinding welds and completely removing all sharp edges and burrs are required only in the travel area or wherever they may be hazard to stair users.

0.03.05.03 STAIRS - STEEL (CSI 05510)

OTHER RELATED COMPONENTS

Refer to Foundations and Footings and Substructure System, Volumes 1 and 2, for additional deficiencies that may impact this system.

DEFICIENCY FACTORS
0.03.05.03 STAIRS - STEEL (CSI 05510)

PROBABLE FAILURE POINTS

- Metal corrosion electrochemical process that occurs in the presence of air and moisture.
- Settlement, movement, poor materials, or improper construction.
- Loose connections caused by vibration, temperature changes, or improper tightness.
- Impact damage caused by objects striking or impacting the surface.

SYSTEM ASSEMBLIES/DEFICIENCIES

Abrasion:	Caused by contact with moving parts, wave action, or immersion in a moving liquid.
Corrosion:	Resulting from a chemical or electro-chemical reaction that converts the metal into an oxide, carbonate, and sulfide.
Impact Damage:	Depressions, dents, or buckled surface from objects striking or impacting the surface.
Loss of Protective Coating/Paint:	Chalking, peeling, chipping, blistering, or deterioration.
Loose Connections:	Caused by impact, vibration, fatigue, loading, or incorrect tightness.

DEFICIENCY FACTORS
0.03.05.03 STAIRS . STEEL (CSI 05510)

END OF SUBSECTION

0.03.05.04 **STAIRS -** COMPOSITE (STEEL PAN W/CONCRETE) **(CSI 05500)**

DESCRIPTION

Stair construction is considered a pre-finished item. Stairs range from simple utilitarian assemblies to elaborate, ornate, finely crafted work. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Pan Stairs (CSI **05500)**

Assemblies are usually prefabricated of channel stringers with treads of light gauge metal called "pans." The treads may be combined with non-slip nosing of various materials or treated with non-slip treatments or materials. Pan stairs require concrete fill in the pans to provide the contact area for the treads, Landings are designed and fabricated of various structural shapes and usually covered with the same materials used in the stair treads.

Description of Assembly:

- Stringers: Structural steel channel
- Treads: Formed steel sheet, concrete filled
- Risers: Formed steel sheet, exposed
- Platforms: Steel sheet deck, concrete filled; flight headers and platform headers structural channels; both suspended on hanger rods
- Railing: Square steel tubing, welded
- Finish: Steel painted

Classification of Stairs:

The four type of stairs defined are: straight, curved, circular, and spiral. This listing is not necessarily all-inclusive, but does represent the majority. It is not uncommon, however, to find two or more types represented in the same stair, and in rare cases, classification does not fall into these four categories.

Straight stairs are by far the most common types, representing the bulk of the stair market. Though the term "straight" is self-explanatory, for purposes of classification, a straight stair is defined as one in which the stringers are straight members. Straight stairs, unlike the other types, may be arranged in several different ways.

Curved stairs are stairs that, in plan view, have two or more centers of curvature, being oval, elliptical, or some other compound curved form. They may have one or more intermediate platforms between floors.

Circular stairs are stairs that, in plan view, have a circular form with a single center' of curvature. They may have intermediate platforms between floors.

Spiral stairs are stairs with a closed circular form and supporting center column.

Railings (CSI **05520)**

The most economical type of rail for a stair is a steel pipe rail connected at the ends by standard terminal castings to a square or rectangular tube newel. This construction provides rigid support at both ends of a flight, yet permits minor installation adjustments where necessary at floors and platforms.

0.03.05.04 STAIRS - **COMPOSITE (STEEL** PAN W/CONCRETE) **(CSI 05500)**

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Railings (CSI 05520) (Continued)

The use of square or rectangular tube for the railing provides an alternative. The use of continuous rails with ramps and easements at floors and platforms increases the cost of the stair. It also minimizes the possibilities of field adjustment for proper alignment, which the newel type of construction provides. Often, on relatively short flights, the need for intermediate posts on pipe rails can be eliminated by substituting a larger size pipe. This also reduces cost.

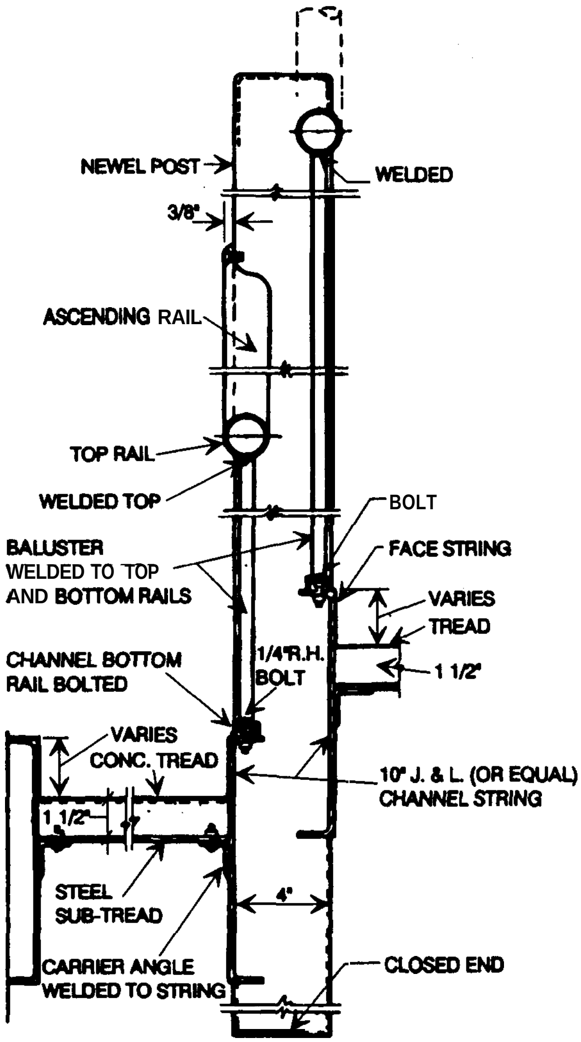
Connections & Finishina Work:

The use of hex head bolts in place of flat or oval head bolts eliminates the necessity of countersinking and speeds stair assembles. Where appearance is not critical, welding neatly done but not ground smooth provides maximum rigidity at minimum cost. When using flat or oval head bolts, grinding welds and completely removing all sharp edges and burrs are required only in the travel area or wherever they may be hazard to stair users.

OTHER RELATED COMPONENTS

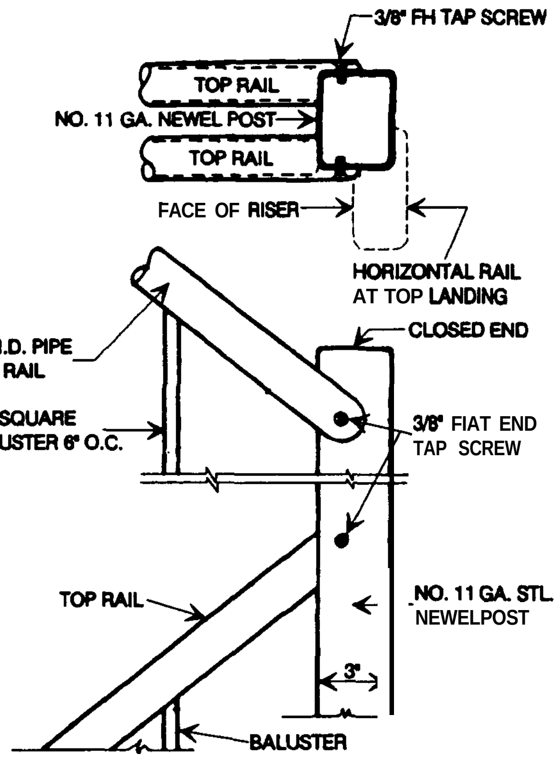
See the following subsections for related components:

0.03.05.03 Steel (Stairs) 2.5.3-1

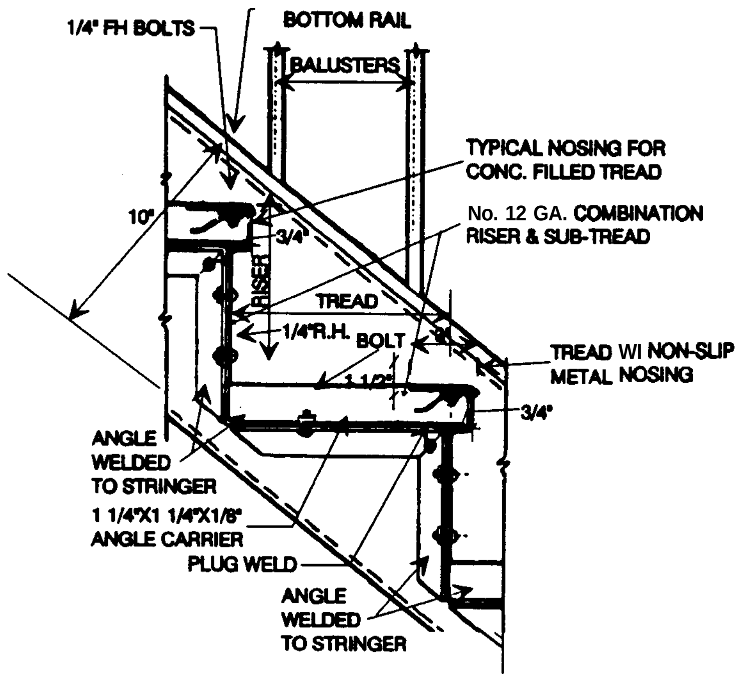


DETAIL OF RAILING AND NEWEL POST

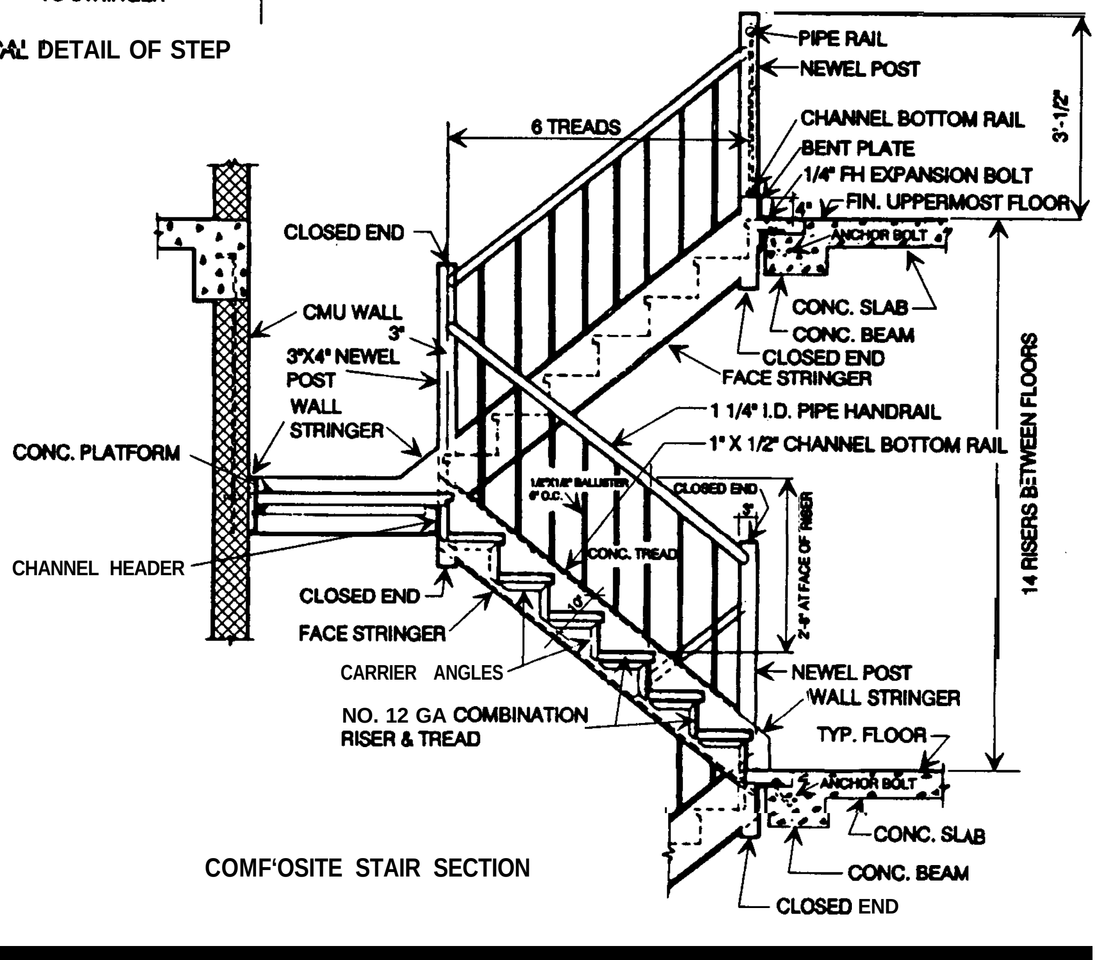
PLAN OF NEWEL POST



SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	STAIR RAILINGS		
STAIRS COMPOSITE(Steel Pan w/Concrete) (CSI 05700)	Revision No.	Issue Date 5/93	Drawing No. A030504-1



TYPICAL DETAIL OF STEP



COMPOSITE STAIR SECTION

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	COMPOSITE STAIR CONFIGURATIONS AND COMPONENTS		
STAIRS COMPOSITE(Steel Pan w/Concrete) (CSI MULTIPLE)	Revision No.	Issue Date 5/93	Drawing No. A030504-2

DEFICIENCY FACTORS .
0.03.05.04 STAIRS - COMPOSITE (STEEL PAN W/CONCRETE) (CSI 05500)

PROBABLE FAILURE POINTS

- Excessive corrosion causing weld joint failure.
- Spalling, pitting, or surface deterioration of concrete'fill.
- Excessive bending or deflection caused by overloading.

SYSTEM ASSEMBLIES/DEFICIENCIES

Composite - Steel Pan w/Concrete

Abrasion:	Caused by contact with moving parts, wave action, or immersion in a moving liquid.
Corrosion:	Resulting from a chemical or electro-chemical reaction that converts the metal into an oxide, carbonate, and sulfide.
Impact Damage:	Depressions, dents, or buckled surface from objects striking or impacting the surface.
Loss of Protective Coating/Paint:	Chalking, peeling, chipping, blistering, or deterioration
Loose Connections:	Caused by impact, vibration, fatigue, loading, or incorrect tightness.
Surface Deterioration:	Spalling, pitting, cracking, or breakdown of concrete surface.

DEFICIENCY FACTORS
0.03.05.04 STAIRS . COMPOSITE (STEEL PAN W/CONCRETE)
(CSI 05500)

END OF SUBSECTION

0.03.05.05 STAIRS - WOOD (CSI 06400)

DESCRIPTION

Wood stairs may be prefabricated box or basement types, but their application varies with the available space and the aesthetic effect desired. Unlimited shapes, orientations, and railing arrangements are available in various species of wood, both as prefabricated kits or built-in-place. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Wood Stairs (CSI 06400)

Wood, unlike most processed building materials, is an organic material that can be used in its natural state. Factors that influence its strength are density, natural defects (knots, grain, etc.) and moisture content. Wood can be easily shaped or cut to size on the site or prefabricated in the shop. Structurally, wood may be used for stairs, posts, column, and beams. Structural lumber is stress-graded for bending, tension parallel to the grain, compression parallel to the grain, and modules of elasticity.

Investigation of the strength and stiffness requirements of a wood beam under transverse loading should take into consideration the following factors:

- Bending moment induced by the load
- Deflection or deformation caused by the load
- Horizontal shear at the supports
- Bearing on supporting members
- Lateral stability of stairs

Wood stair assemblies are usually premanufactured but can be field-built. The treads have a minimum depth of 11 1/4 inches and the height of the stair riser is 6 inches. The four different types of stairs defined are straight, curved, circular, and spiral. This listing is not necessarily all-inclusive, but does represent the majority. It is not uncommon, however, to find two or more types represented in the same stair, and in rare cases, a stair falls in none of these four categories.

Straight stairs are by far the most common types, representing the bulk of the stair market. Though the term “straight” is self-explanatory, for purposes of classification, a straight stair is defined as one in which the stringers are straight members. Straight stairs, unlike the other types, may be arranged in several different ways.

Curved stairs are stairs that, in plan view, have two or more centers of curvature, being oval, elliptical, or some other compound curved form. They may have one or more intermediate platforms between floors.

Circular stairs are stairs that, in plan view, have a circular form, with a single center of curvature. They may have intermediate platforms between floors.

Spiral stairs are stairs with a closed circular form and supporting center column.

0.03.05.05 STAIRS - WOOD (CSI 00400)

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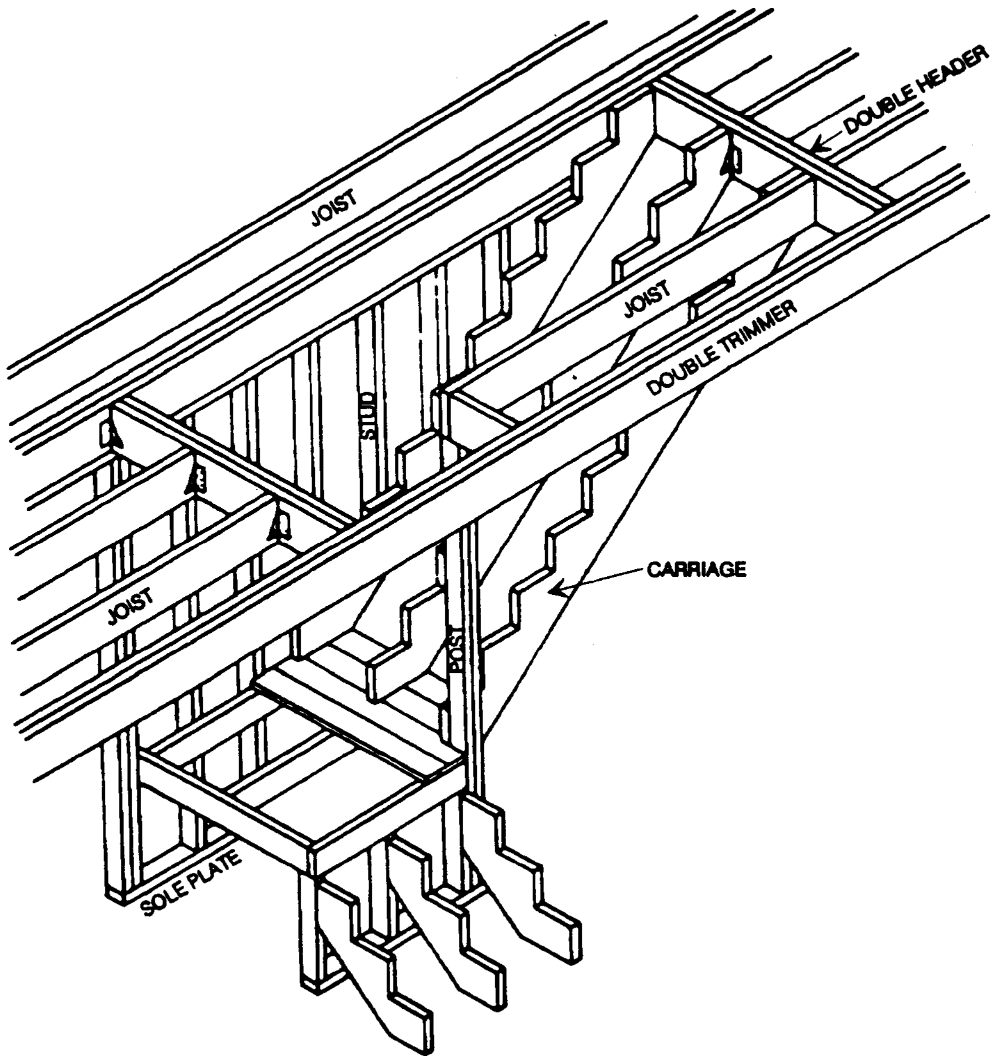

FRAMING FOR STAIRWAY WITH LANDING

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	WOOD STAIR FRAMING		
STAIRS WOOD (CSI 06200)	Revision No.	Issue Date 5/93	Drawing No. A030505-1

DEFICIENCY FACTORS
0.03.05.05 STAIRS - WOOD (**CSI** 06400)

PROBABLE FAILURE POINTS

- Material deterioration or damage caused by the presence of water or moisture.
- Loose connections caused by vibration, temperature change, or improper tightness.
- Impact damage caused by objects striking or impacting the surface.
- Cracking or sagging of material caused by overloading.

SYSTEM ASSEMBLIES/DEFICIENCIES

Loose Connection:	Brackets loose or missing. Loose or missing rungs caused by impact, vibration, fatigue, loading, or incorrect tightness.
Abrasion:	Caused by contact with moving parts.
Impact Damage:	Depressions, dents, or buckled surface from objects striking or impacting the surface.
Surface Deterioration:	Crazing, small surface cracks, corrosion, and breakdown of surface due to weather, pressure, or other actions.
Staining:	Surface discoloration from a foreign substance or material.
Dry Rot/Decay:	Structural integrity breakdown from mold/mildew or dry rot.
Loss of Protective Coating/Paint:	Chalking, chipping, blistering, or deterioration.
Splitting:	Surface splitting or tearing.
Insect Damage:	Holes, cracks, or punctures from burrowing insects.
Burned or Charred Surface:	Damage from fire or excessive heat on surface.

DEFICIENCY FACTORS
0.03.05.05 STAIRS - WOOD (CSI 06400)

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DETERIORATION OF WOOD STAIRS

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUPERSTRUCTURE	DETERIORATING WOOD STAIRS		
STAIRS WOOD (CSI 06200)	Revision No.	Issue Date 5/93	Drawing No. D030505-1

DEFICIENCY FACTORS
0.03.05.05 STAIRS - WOOD (CSI 06400)

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DEFICIENCY FACTORS
0.03.05.05 STAIRS - WOOD (CSI **06400)**

END OF SUBSECTION

0.03.05.06 STAIRS - LADDERS (CSI 05515)

DESCRIPTION

Various parts of a building are not always accessible by stairs and ladders must be used. Ladders vary from material to type, depending on locations and other requirements. Access to platforms is usually provided by steel ladders, stairs, or ship's ladders. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Ladders (CSI 05515)

Fabricated ladders must comply with the requirements of ANSI A14.3. Dimensions, spacing, details, and anchorages are to follow the manufacturer's specifications.

Siderails are continuous steel flat bars, usually 1/2 x 2 1/2 inches, with eased edges, spaced about 18 inches apart. Fabricated ladders have bar rungs that are round or square steel bars, 3/4 inch in diameter, spaced 12 inches on-center. The supports at each ladder are at the top and bottom and at the intermediate points spaced not more than 5 feet on-center by welded or bolted steel brackets.

Brackets are used to support design and live loads and to hold centerline of ladder rungs clear of the wall surface by not less than 7 inches.

A non-slip surface is sometimes applied to the top of each rung by either coating it with aluminum oxide granules set in epoxy resin adhesive, or by using a manufactured type of non-slip surface rung filled with aluminum oxide grout.

Ship Ladders (CSI 05515)

Ship Ladders are factory or shop-assembled with rails attached, and are mainly for platform access. Ship's ladders are fabricated of open type construction with structural steel channel or steel plate stringers, pipe handrails, and open steel grating treads.

Ladder Safety Caaes:

Fabricated safety cages must comply with ANSI A14.3 assembly by welding or riveting. The primary hoops are made of steel bars that are 5/16 x 4 inches for top, bottom, and cages longer than 20 feet, intermediate bars spaced no more than 20 inches on-center. The secondary intermediate hoops are also made of steel bars that are 5/16 x 2 inches. Hoops are spaced no more than 4 feet on-center between primary hoops. The vertical bars are made of steel that is 5/16 inch, secured to each hoop, and spaced approximately 9 inches on-center.

OTHER RELATED COMPONENTS

Refer to Foundations and Footings and Substructure Systems, Volumes 1 and 2 for additional deficiencies that may impact this system.

0.03.05.06 STAIRS - LADDERS (CSI 05515)

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DEFICIENCY FACTORS
0.03.05.06 STAIRS - LADDERS **(CSI 05515)**

PROBABLE FAILURE POINTS

- Metal corrosion is an electro-chemical process that occurs in the presence of air and moisture.
- Loose connections caused by vibration, temperature change, or improper tightness.
- Impact damage caused by objects striking or impacting the surface.

SYSTEM ASSEMBLIES/DEFICIENCIES

Loose Connection:	Brackets loose or missing. Loose or missing rungs caused by impact, vibration, fatigue, loading, or incorrect tightness.
Abrasion:	Caused by contact with moving parts.
Impact Damage/Denting:	Depressions, punctures, or buckled surface from objects striking or impacting the surface.

DEFICIENCY FACTORS
0.03.05.06 STAIRS - LADDERS (CSI 05515)

END OF SUBSECTION

0.03.06 FIREPROOFING (CSI 07250)

DESCRIPTION

Modern building codes specify minimum fire-resistant requirements based on studies by fire protection engineers. The degree of fire hazard in each class of occupancy and the degree of fire resistance required for any structural components are evaluated. The ASTM Standard fire test specification (E 119-58) is the universally accepted standard for classifying the duration and intensity of fire resistance provided for building materials and constructions. These tests indicate the length of time that structural members, such as columns and beams, maintain their strength and rigidity. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Fireproofing agents must provide the following characteristics or properties to qualify as safe, dependable fireproofing:

- They must not burn or support combustion.
- They must prevent the rapid and excessive flow of heat for a definite period of time.
- They must be sufficiently standardized and controlled to ensure consistent, dependable protection.
- Their effective fire resistance must be determined by the ASTM standard time-temperature fire test for each type of construction in which they are to be used.

Gypsum (CSI 09250)

Gypsum is a mineral with unusual fire-resistant qualities. Gypsum plaster, machine or manually applied to metal or gypsum lath, is an excellent fireproofing material. Gypsum wallboard, in the form of lath or finish material, and gypsum tile are used as components of fire-resistant constructions.

Vermiculite & Perlite (CSI 07250)

Vermiculite and Perlite are lightweight aggregates possessing high thermal insulation qualities. They are used both in gypsum and cement plaster and in concrete. The weight of these aggregates is one-tenth that of sand. They possess excellent fire-resistance, acoustical, and insulating properties. The plaster types may be machine-applied directly to the underside of light-gauge steel floor or roof decks, columns or beams, or to gypsum or metal lath.

Mineral Fiber (CSI 07265)

Mineral Fiber combined with a mineral binder, air, and water forms a very effictive fireproofing material. Applied with a special spray gun, the material will bond directly to steel, metal lath, and most other clean rigid surfaces such as gypsum lath and concrete. Mineral fiber has excellent fire-resistant and acoustical qualities when applied to structural members such as columns, beams, girders, and trusses.

Portland Cement (CSI 07255)

Portland Cement continues to be useful as a fireproofing material. When subjected to high temperatures, it releases water in a manner similar to gypsum, although to a lesser degree. The selection of aggregate is critical to its fire-resistance eg., the use of light aggregates instead of stone greatly improves this quality. Portland cement plaster is also used for fire protection. Mixing it with lightweight aggregates and mineral fibers greatly improves its fire resistance. It is preferred to gypsum plaster where there is exposure to the weather or high humidity.

0.03.06 FIREPROOFING (CSI 07250)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Magnesium Oxychloride (CSI 07262)

Sprayed-on Magnesium Oxychloride type fireproofing is a special type of plaster that can be applied easily. It reacts to fire exposure differently than ordinary gypsum or Portland cement plasters. It is therefore a much better protector, but at a higher cost. It can not be classified as a sound absorber or a thermal insulator. Compared to the aggregate type, it is heavier (but offers the same protection with less thickness), stronger, less affected by moisture, and bonds stronger to substrates (such as plaster bond). Spraying produces a relatively clean application, and freshly placed material can be troweled, screeded, or leveled with a smooth paint roller. It is often used with metal lath boxing and corner beads as screeds, resulting in a finished plaster appearance. Although relatively costly, it is of sastifactory durability and can be used to replace thicker cast-in-place concrete in various uses, saving space, weight, and cost. It can be effectively combined with an intumescent top coating to provide the greatest amount of protection in the least amount of space (thickness), remaining weather-resistant and durable.

Magnesium oxychloride formulations have been labeled corrosive. Thus, they must be prevented from contacting nonferrous metals such as stainless steel, aluminum, and copper alloys. It is imperative that their use be limited to substrates whose compatibility with specific formulations has been documented by testing and field use, despite manufacturers' claims that current formulations are not corrosive to listed substrates (including steel).

Intumescent Coatings (CSI 07260)

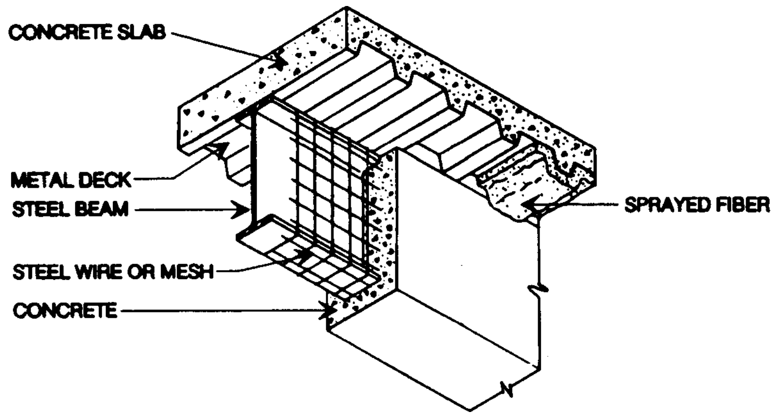
Sprayed-on intumescent coatings serve as a different type of fireproofing. They foam or expand under intense heat, forming a thick, inert insulator on substrates. Based on dollars per hour of protection, they are the most costly system. However, benefits include being thin, lightweight, durable, and moisture/weather-resistant, They bond strongly to substrates and are clean to use. These substrates, however, must not have a noncompatible primer or paint coat, presenting a coordination problem with structural steel, joists, steel deck, and other surfaces that need coating. Sprayed coats can be immediately roller-leveled to provide a smooth finish (which is recommended due to the unsightly drips and runs resulting from application). One unique feature of intumescent coatings is that they must cure or age for about 30 days before reaching their nominal protective capacity.

Firestops (CSI 07270)

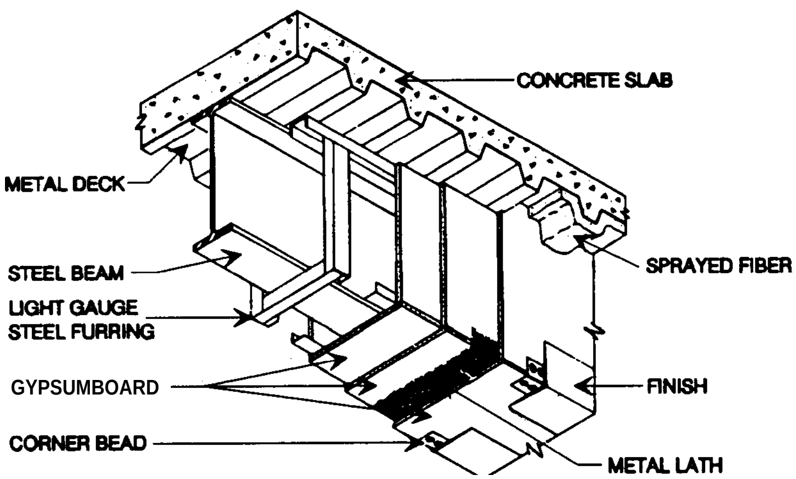
Firestops are barriers installed in concealed spaces of combustible construction to prevent the spread of fire caused by drafts. Allowable materials include nominal 2 inch thick wood members, gypsum board, or mineral wool. In most cases, wood blocking is used. The building code specifies where and when firestops must be installed, but in general, firestopping is used in concealed spaces between floors, between a floor and ceiling or attic spaces, and in vertical openings around vents, chimneys, and ducts between floors.

OTHER RELATED COMPONENTS

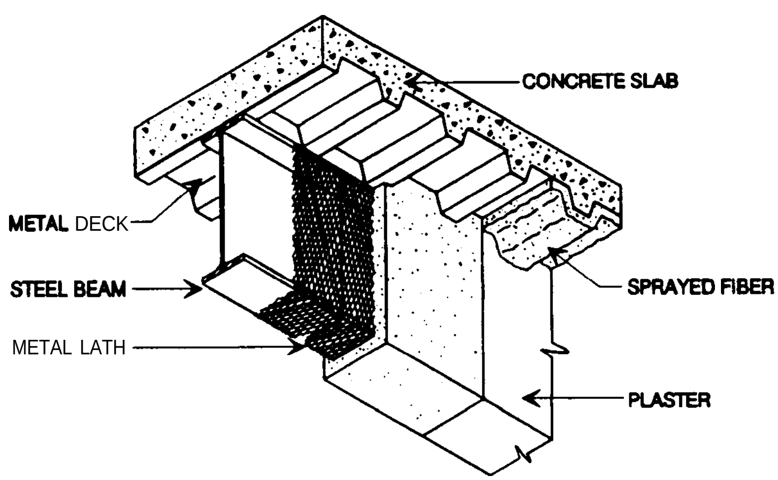
See the following subsections for related components:



CONCRETE ENCASEMENT ON BEAMS AND GIRDER



GYPSUM BOARD ON BEAMS AND GIRDERS



PLASTER ON METAL LATH - BEAMS AND GIRDERS

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION 'R.S. Means Co., Inc., Kingston, Massachusetts"

SYSTEM ASSEMBLY DETAILS-SUPERSTRUCTURE	FIREPROOFING		
FIREPROOFING (CSI 07250)	Revision No.	Issue Date 5/93	Drawing No. A0306-1

DEFICIENCY FACTORS
0.03.06 FIREPROOFING (CSI 05300)

PROBABLE FAILURE POINTS

- Unsealed or improperly sealed penetrations.
- Cracking caused by structural movement or improper joint compound application.
- Water damage caused by leaking piping or other sources.
- Impact damage from objects striking or impacting the surface.

SYSTEM ASSEMBLIES/DEFICIENCIES

Portland Cement

Cracking (Active and Dormant): Construction movement, settlement. Setting due to inadequate finishing and curing. Chemical and physical reactions such as drying shrinkage. Thermal changes (subjected to temperature extremessuch as freeze/thaw cycles). Stress concentration.

Holes (Small and Large): Chemical reaction. Inadequate construction and design.

Spalling: Concrete fragments broken from the surface, caused by reinforcement corrosion.

Staining: Surface discoloration from a foreign substance or material.

Plant Growth Moss/Algae: Moss or algae growth over the surface, usually from excessive moisture.

Gypsum

Penetration/Holes: Unsealed or improperly sealed penetration made through wall for pipes, ducts, or cable.

Impact Damage: Damage caused by objects striking or impacting the surface.

Water Damage: Bulging, sagging, discoloration, softening of material caused by leaking pipes, standing water, or other leaks.

Cracking: Caused by settlement/movement, joint compound shrinkage, sagging or warpage of supporting structure, or inferior workmanship.

Loose Fastener: Caused by improper framing or application of fasteners.

Mineral Fiber

Cracking: Cracking caused by settlement/movement, deflection of member.

Bond Failure: Poor material application, improper preparation.

Surface Deterioration: Surface breakdown from abrasive action, exposure to elements, or improper mixture and application.

Impact Damage: Damage caused by objects striking or impacting the surface.

Water Damage: Bulging, sagging, discoloration, softening of material caused by leaking pipes, standing water, or other leaks.

DEFICIENCY FACTORS
0.03.06 FIREPROOFING (CSI 05300)

END OF SUBSECTION

INSPECTION METHODS • STANDARD

GUIDE SHEETS

The following Guide Sheets provide a general overview of inspection methods and requirements used to provide a general Superstructure inspection. Sheets have been developed for each major type and associated assembly components as follows:

TABLE OWE

Assembly/Component	Control Number
BEAMS	
Cast-in-Place Concrete	GSS 0.03.01 .01
Precast Concrete	GSS 0.03.01.02
Steel	GSS 0.03.01.03
Wood..	GSS 0.03.01.04
PRE-ENGINEERED BUILDING SYSTEMS	
Metal	GSS 0.03.02.01
Wood	GSS 0.03.02.02
FLOORS	
Cast-in-Place Concrete	GSS 0.03.03.01
Precast Concrete	GSS 0.03.03.02
Steel	GSS 0.03.03.03
Composite	GSS 0.03.03.04
Wood..	GSS 0.03.03.05
ROOF STRUCTURE	
Steel	GSS 0.03.04.01
Concrete	GSS 0.03.04.02
Wood	GSS 0.03.04.03
STAIRS	
Cast-in-Place Concrete	GSS 0.03.05.01
Precast Concrete..	GSS 0.03.05.02
Steel..	GSS 0.03.05.03
Composite (Steel Pan w/Concrete)	GSS 0.03.05.04
Wood	GSS 0.03.05.05
Ladders	GSS 0.03.05.06
FIREPROOFING	GSS 0.03.06

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INSPECTION METHODS • STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: BEAMS - CAST-IN-PLACE CONCRETE
CONTROL NUMBER: GSS 0.03.01 .01

APPLICATION

This guide applies to all Cast-in-Place Concrete Beams.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Beams - other types that may be applicable. (See GSS 0.03.01 series)
2. Inspect Floors. (See GSS 0.03.03 series)
3. Inspect Roof Structure. (See GSS 0.03.04 series)
4. Inspect foundations and footings and substructure for any other signs of damage or deterioration that may be related to cast-in-place concrete beams.

INSPECTION ACTIONS

Condition Assessment Survey of Cast-in-Place Concrete Beams includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes cracking and spalling; compression. (pushing or crushing force), which causes crushing or spalling; shear (slicing action), which causes diagonal or stepped cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking with no spalling.
2. Check for uneven settlement by observing condition of floor or roof surface for high or low spots.
3. Check for improper design and construction conditions that can cause deficiencies such as cracking and surface deterioration.
4. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, efflorescence, staining and rust, dusting, surface deterioration, pitting, spalling, operation or misuse of material, and extent of each.
5. Check all previous repairs and patches for any possible cracking or deterioration.
6. Check for any exposed reinforcement and extent of rust or deterioration.
7. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analyis consists of documenting the location, pattern, depth, width, presence of foreign materials, and elevation differences between two cracked surfaces. Determine if crack is active or dormant by following these steps.
   a. Mark the end of the crack and check to see if crack has extended past mark. Note direction.
   b. Place a notched piece of tape across the crack. Wait for a period of a month or more. If tape tears or compresses (wrinkles) the crack is active, and if the tape shows no apparent change the crack is dormant.
   c. Apply pins and gauge points on either side of crack. Measure distance between points at regular intervals with vernier calipers to determine the extent of movement.

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: BEAMS - CAST-IN-PLACE CONCRETE (Continued)
CONTROL NUMBER: GSS 0.03.01 .01

TOOLS & MATERIALS

Standard Tools - Basic

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: BEAMS - PRECAST CONCRETE
CONTROL NUMBER: GSS 0.03.01.02

APPLICATION

This guide applies to all Precast Concrete Beams.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Beams - other types that may be applicable. (See GSS 0.03.01 series)
2. Inspect Floors. (See GSS 0.03.02 series)
3. Inspect Roof Structure. (See GSS 0.03.04 series)
4. Inspect foundations and footings and substructure for any other signs of damage or deterioration that may be related to precast concrete beam deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Precast Concrete Beams includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes cracking and spalling; compression. (pushing or crushing force), which causes crushing or spalling; shear (slicing action), which causes diagonal or stepped cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking with no spalling.
2. Check for uneven settlement by observing condition of floor or roof surface for high or low spots.
3. Check for improper design and construction conditions that can cause deficiencies such as cracking and surface deterioration.
4. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, efflorescence, staining and rust, dusting, surface deterioration, pitting, spalling, operation or misuse of material, and extent of each.
5. Check all previous repair and patches for any possible cracking or deterioration.
6. Check for any exposed reinforcement and extent of rust or deterioration.
7. Check for improperly designed or placed anchorage components. Verify that anchorage is intact and properly tightened.

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: BEAMS - PRECAST CONCRETE (Continued)
CONTROL NUMBER: GSS 0.03.01.02

INSPECTION ACTIONS

8. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analysis consists of documenting the location, pattern, depth, width, presence of foreign materials and elevation differences between two cracked surfaces. Determine if crack is active or dormant by following these steps.
   a. Mark the end of the crack and check to see if crack has extended past mark. Note direction.
   b. Place a notched piece of tape across the crack. Wait for a period of a month or more. If tape tears or compresses (wrinkles) the crack is active, and if the tape shows no apparent change the crack is dormant.
   c. Apply pins and gauge points on either side of crack. Measure distance between points at regular intervals with vernier calipers to determine the extent of movement.

TOOLS & MATERIALS

Standard Tools - Basic

INSPECTION METHODS • STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: BEAMS - STEEL
CONTROL NUMBER: GSS 0.03.01.03

APPLICATION

This guide applies to all Steel Beams.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-buifts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Beams - other types that may be applicable. (See GSS 0.03.01 series)
2. Inspect Floors. (GSS 0.03.03 series)
3. Inspect Roof Structure. (See GSS 0.03.04 series)
4. Inspect Fireproofing. (GSS 0.03.06 series)
5. Inspect foundations and footings and superstructure for any other signs of damage or deterioration that may be related to steel beam deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Steel Beams includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes stretching; compression (pushing or crushing force), which causes crushing; shear (slicing action), which causes diagonal or perpendicular to the member cracks or breakage from point of maximum load or shear; and bending (combination of tension and compression), which causes twisting of member.
2. Check for uneven settlement by observing condition of floor or roof surface for high or low spots.
3. Check for improper design and construction conditions that can cause deficiencies.
4. Check bearing plates for proper bearing, anchorage and deterioration.
5. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, staining and rust, corrosion, surface deterioration, operation or misuse of material, and extent of each.
6. Check all previous repairs and patches for any possible failures or deterioration.
7. Check for improper or damaged welds and "Lamellar" tearing of weld joints.
8. Check condition of anchorage to verify that anchorage is intact, in place, and properly tightened.
9. If any cracks are evident, go to non-standard inspection. Immediately provide emergency shoring until such time as non-standard procedures and/or tests determine cause of cracks.

TOOLS & MATERIALS

Standard Tools - Basic

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INSPECTION METHODS • STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: BEAMS -WOOD
CONTROL NUMBER: GSS 0.03.01.04

APPLICATION

This guide applies to all structural/non-structural Wood Beams.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Beams - other types that may be applicable. (See GSS 0.03.01 series)
2. Inspect Floors. (GSS 0.03.03 series)
3. Inspect Roof Structure. (See GSS 0.03.04 series)
4. Inspect Fireproofing. (GSS 0.03.06)
5. Inspect foundations and footings and substructure for any other signs of damage or deterioration that may be related to wood beam deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Wood Beams includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes ripping or tearing; compression (pushing or crushing force), which causes crushing; shear (slicing action), which causes diagonal or perpendicular to the member cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking or splitting.
2. Check for uneven settlement by observing condition of floor or roof surface for high or low spots.
3. Check for improper design and construction conditions that can cause deficiencies such as cracking and surface deterioration.
4. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, staining, dry rot, surface deterioration, decay, splitting, operation or misuse of material, and extent of each.
5. Check all previous repairs and patches for any possible deterioration.
6. Check for improperly designed or placed anchorage components. Verify that anchorage is intact and properly tightened or anchored.
7. Check all sealant, expansion/contraction joints, or mortar/grout joints for deterioration or cracking.

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: BEAMS -WOOD (Continued)
CONTROL NUMBER: GSS 0.03.01.04

INSPECTION ACTIONS

8. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analysis consists of documenting the location, pattern, depth, width, presence of foreign materials, and elevation differences between cracked surfaces. Determine if crack is active or dormant by following these steps:
   a. Mark the end of the crack and check after a few days to see if crack has extended past mark. Note direction.
   b. Place a notched piece of tape across the crack. Wait for a period of a month or more. If tape tears or compresses (wrinkle) the crack is active, and if the tape shows no apparent change the crack is dormant.
   c. Apply pins and gauge points on either side of crack. Measure distance between points at regular intervals with vernier calipers to determine the extent of movement.

TOOLS & MATERIALS

Standard Tools - Basic

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: PRE-ENGINEERED BUILDING SYSTEMS - METAL
CONTROL NUMBER: GSS 0.03.02.01

APPLICATION

This guide applies to all Metal Pre-Engineered Building Systems and associated work.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts'and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Floors. (see GSS 0.03.03 series)
2. Inspect Fireproofing. (GSS 0.03.06)
3. Inspect foundations and footings, substructure, exterior closure, and roofing for any other signs of damage or deterioration that may be related to metal pre-engineered building system deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Metal Pre-Engineered Building Systems includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes stretching; compression (pushing or crushing force), which causes crushing; shear (slicing action), which causes diagonal or perpendicular to the member tearing or breakage from point of maximum load or shear; and bending (combination of tension and compression), which causes twisting of member.
2. Check for uneven settlement by observing condition of existing grade on exterior or condition of foundation slab.
3. Check for improper design and construction conditions that can cause deficiencies.
4. Check bearing plates and anchor bolts for proper anchorage, bearing, and deterioration.
5. Check structural members for level or plumb and true.
6. Check for uplift or presence of hydrostatic pressure causing upward movement of existing grade or slab that can impact assembly/component.
7. Check for exposure conditions, specifically chemical attack (i.e., is 'surface material resistant to process contamination), freeze/thaw action, impact exposure, staining, rust, corrosion, surface deterioration, operation or misuse of material, and extent of each.
8. Check all previous repairs and patches for any possible failures or deterioration.
9. Check for improper or damaged welds and "Lamellar" tearing of weld joints.
10. Check condition of fasteners and bolts to verify they are are intact and properly tightened.
11. Check all bracing and tie rods for any damage and tightness.
12. Check for watertightness or extent of leaks.
13. Check closure strips and joint sealants for damage and/or deterioration.

TOOLS & MATERIALS

Standard Tools - Basic

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INSPECTION METHODS . STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: PRE-ENGINEERED BUILDING SYSTEMS -WOOD
CONTROL NUMBER: GSS 0.03.02.02

APPLICATION

This guide applies to all Wood Pre-Engineered Building Systems and associated work.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Floors. (see GSS 0.03.03 series)
2. Inspect Fireproofing. (GSS 0.03.06)
3. Inspect foundations and footings, substructure, exterior closure, and roofing for any other signs of damage or deterioration that may be related to wood pre-engineered building system deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Wood Pre-Engineered Building Systems includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes ripping or tearing; compression (pushing or crushing force), which causes crushing or splitting; shear (slicing action), which causes diagonal or perpendicular to the member cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking or splitting. Buckling is a form of bending and is most visible at the outermost fibers of the member. Buckling is usually associated with a high failure rate.
2. Check for uneven settlement by observing condition of existing grade on exterior or condition of foundation slab.
3. Check bearing plates and anchor bolts for proper anchorage, bearing, and deterioration.
4. Check structural members for level or plumb and true.
5. Check for water damage or spongy/soft areas.
6. Check for fire or heat damaged surface resulting in deteriorated areas.
7. Check for improper design and construction conditions that can cause deficiencies such as cracking and surface deterioration.
8. Check for uplift or presence of hydrostatic pressure causing upward movement of existing grade or slab, which can impact assembly/component.
9. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, staining, dry rot, surface deterioration, decay, splitting, operation or misuse of material, and extent of each.
10. Check all previous repairs and patches for any possible cracking or deterioration.
11. Check for improperly designed or placed anchorage components. Verify that anchorage is intact and properly tightened.
12. Check all sealant, expansion/contraction joints, or mortar/grout joints for deterioration or cracking.

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: PRE-ENGINEERED BUILDING SYSTEMS -WOOD (Continued)
CONTROL NUMBER: GSS 0.03.02.02

TOOLS & MATERIALS

Standard Tools - Basic

INSPECTION METHODS . STANDARD.

GUIDE SHEET

SYSTEM/COMPONENT: FLOORS - CAST-IN-PLACE CONCRETE
CONTROL NUMBER: GSS 0.03.03.01

APPLICATION

This guide applies to all Cast-in-Place Concrete Structures (Floors and Slabs).

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Beams. (See GSS 0.03.01 series)
2. Inspect foundations and footings, substructure, and exterior closure for any other signs of damage or deterioration that may be related to cast-in-place concrete structures (Floors and Slabs) deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Cast-in-Place Concrete Structures (Floors and Slabs) includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes cracking and spalling; compression (pushing or crushing force), which causes crushing or spalling; shear (slicing action), which causes diagonal or stepped cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking with no spalling.
2. Check for uneven settlement or deflection by observing condition of floor or slab for high or low spots.
3. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, efflorescence, staining and rust, dusting, surface deterioration, pitting, spalling, operation or misuse of material, and extent of each.
4. Check for improper design and construction conditions that can cause deficiencies such as cracking and surface deterioration.
5. Check all previous repairs and patches for any possible cracking or deterioration.
6. Check for any exposed reinforcement and extent of rust or deterioration.
7. Check all sealant, expansion/contraction joints, or mortar/grout joints for deterioration or cracking.
8. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analysis consists of documenting the location, pattern, depth, width, presence of foreign materials, and elevation differences between two cracked surfaces. Determine if crack is active or dormant by following these steps.
   a. Mark the end of the crack and check to see if crack has extended past mark. Note direction.
   b. Place a notched piece of tape across the crack. Wait for a period of a month or more. If tape tears or compresses (wrinkles) the crack is active, and if the tape shows no apparent change the crack is dormant.
   c. Apply pins and gauge points on either side of crack. Measure distance between points at regular intervals with vernier calipers to determine the extent of movement.

INSPECTION METHODS . STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FLOORS - CAST-IN-PLACE CONCRETE (Continued)
CONTROL NUMBER: GSS 0.03.03.01

TOOLS & MATERIALS

Standard Tools - Basic

INSPECTION METHODS . STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FLOORS - PRECAST CONCRETE
CONTROL NUMBER: GSS 0.03.03.02

APPLICATION

This guide applies to all Precast Concrete Floors and Slabs.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Beams. (See GSS 0.03.01 series)
2. Inspect foundations and footings, substructure, and exterior closure for any other signs of damage or deterioration that may be related to precast concrete floor deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Precast Concrete Floors includes visual survey, examination of building records, and analysis, Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes cracking and spalling; compression (pushing or crushing force), which causes crushing or spalling; shear (slicing action), which causes diagonal or stepped cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking with no spalling.
2. Check for uneven settlement by observing condition of floor or slab for high or low spots.
3. Check for improper design and construction conditions that can cause deficiencies such as cracking and surface deterioration.
4. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, efflorescence, staining and rust, dusting, surface deterioration, pitting, spalling, operation or misuse of material, and extent of each.
5. Check all previous repair and patches for any possible cracking or deterioration.
6. Check for any exposed reinforcement and extent of rust or deterioration.
7. Check for improperly designed or placed anchorage components. Verify that anchorage is intact and properly tightened.
8. Check all sealant, expansion/contraction joints, or mortar/grout joints for deterioration or cracking.
9. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analysis consists of documenting the location, pattern, depth, width, presence of foreign materials, and elevation differences between two cracked surfaces. Determine if crack is active or dormant by following these steps.
   a. Mark the end of the crack and check to see if crack has extended past mark. Note direction.
   b. Place a notched piece of tape across the crack. Wait for a period of a month or more. If tape tears or compresses (wrinkles) the crack is active, and if the tape shows no apparent change the crack is dormant.
   c. Apply pins and gauge points on either side of crack. Measure distance between points at regular intervals with vernier calipers to determine the extent of movement.

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FLOORS - PRECAST CONCRETE (Continued)
CONTROL NUMBER: GSS 0.03.03.02

TOOLS & MATERIALS

Standard Tools - Basic

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FLOORS - STEEL
CONTROL NUMBER: GSS 0.03.03.03

APPLICATION

This guide applies to all Steel Floors.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Beams. (See GSS 0.03.01 series)
2. Inspect Floors, other types that may be applicable. (See GSS 0.03.03 series)
3. Inspect Fireproofing. (See GSS 0.03.06)
4. Inspect foundations and footings, substructure, and exterior closure for any other signs of damage or deterioration that may be related to steel floor deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Steel Floors includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes stretching; compression (pushing or crushing force), which causes crushing; shear (slicing action), which causes diagonal or perpendicular to the member cracks or breakage from point of maximum load or shear; and bending (combination of tension and compression), which causes twisting and tearing.
2. Check for uneven settlement by observing condition of floor for high or low spots.
3. Check for improper design and construction conditions that can cause deficiencies.
4. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), impact exposure, staining and rust, corrosion, surface deterioration, operation or misuse of material, and extent of each.
5. Check all previous repairs and patches for any possible failures or deterioration.
6. Check for improper or damaged welds and "Lamellar" tearing of weld joints.
7. Check condition of anchorage to verify that it is intact, in place, and properly tightened.

TOOLS & MATERIALS

Standard Tools - Basic

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INSPECTION METHODS • STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FLOORS - COMPOSITE
CONTROL NUMBER: GSS 0.03.03.04

APPLICATION

This guide applies to all Composite Floor systems.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Beams. (See GSS 0.03.01 series)
2. Inspect Fireproofing, if applicable. (See GSS 0.03.06)
3. Inspect foundations and footings, substructure, and exterior closure for any other signs of damage or deterioration that may be related to composite floor deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Composite Floors includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes cracking and spalling or stretching; compression (pushing or crushing force), which causes crushing or spalling; shear (slicing action), which causes diagonal or stepped cracking or breakage from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking with no spalling or twisting and tearing.
2. Check for uneven settlement by observing condition of floor for high or low spots.
3. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, efflorescence, staining and rust, dusting, surface deterioration, decay, splitting, operation or misuse of material, and extent of each.
4. Check for improper design and construction conditions that can cause deficiencies.
5. Check all previous repairs and patches for any possible cracking, deterioration, or failures.
6. Check for any exposed reinforcement and extent of rust or deterioration.
7. Check all sealant, expansion/contraction joints, or mortar/grout joints for deterioration or cracking.
8. Check for improper or damaged welds and "Lamellar" tearing of weld joints.
9. Check condition of anchorage to verify that anchorage is intact and properly tightened.

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INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FLOORS -WOOD
CONTROL NUMBER: GSS 0.03.03.05

APPLICATION

This guide applies to all structural/non-structural Wood Floors.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts'and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Floors, other types that may be applicable. (See GSS 0.03.03 series)
2. Inspect Beams. (See GSS 0.03.01 series)
3. Inspect Fireproofing. (See GSS 0.03.06)
4. Inspect foundations and footings, substructure, and exterior closure for any other signs of damage or deterioration that may be related to wood floor deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Wood Floors includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes splitting, ripping, or tearing; compression (pushing or crushing force), which causes crushing; shear (slicing action), which causes diagonal or perpendicular to the member cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking or splitting.
2. Check for uneven settlement by observing condition of existing floor for high or low spots.
3. Check for improper design and construction conditions that can cause deficiencies such as cracking and surface deterioration.
4. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, staining, dry rot, surface deterioration, decay, splitting, operation or misuse of material, and extent of each.
5. Check all previous repairs and patches for any possible deterioration.
6. Check for improperly designed or placed anchorage components. Verify that anchorage is intact and properly tightened.
7. Check all sealant, expansion/contraction joints, or mortar/grout joints for deterioration or cracking.
8. Check for water damage or spongy/soft areas.
9. Check for fire or heat damaged surface resulting in deteriorated areas.

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GUIDE SHEET

SYSTEM/COMPONENT: ROOF STRUCTURE - STEEL
CONTROL NUMBER: GSS 0.03.04.01

APPLICATION

This guide applies to all Steel Roof Structures.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Beams. (See GSS 0.03.01 series)
2. Inspect Fireproofing. (GSS 0.03.06)
3. Inspect roofing systems, refer to Volume 5 for any other signs of damage or deterioration that may be related to steel roof structures.

INSPECTION ACTIONS

Condition Assessment Survey of Steel Roof Structures includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes stretching; compression (pushing or crushing force), which causes crushing; shear (slicing action), which causes diagonal or perpendicular to the member cracks or breakage from point of maximum load or shear; and bending (combination of tension and compression), which causes twisting and tearing.
2. Check for uneven settlement by observing condition of existing deck for high or low spots.
3. Check for improper design and construction conditions that can cause deficiencies.
4. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, staining and rust, corrosion, surface deterioration, operation or misuse of material, and extent of each.
5. Check all previous repairs and patches for any possible failures or deterioration.
6. Check for improper or damaged welds and "Lamellar" tearing of weld joints.
7. Check condition of anchorage to verify that it is intact and properly tightened.

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GUIDE SHEET

SYSTEM/COMPONENT: ROOF STRUCTURE - CONCRETE
CONTROL NUMBER: GSS 0.03.04.02

APPLICATION

This guide applies to all Concrete Roof Structural slabs.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Beams. (See GSS 0.03.01 series)
2. Inspect roofing system, refer to Volume 5 for any other signs of damage or deterioration that may be related to concrete roof slabs.

INSPECTION ACTIONS

Condition Assessment Survey of Concrete Roof Structural Slabs includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes cracking and spalling; compression (pushing or crushing force), which causes crushing or spalling; shear (slicing action), which causes diagonal or stepped cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking with no spalling.
2. Check for uneven settlement by observing condition of slab for any high or low spots.
3. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, efflorescence, staining and rust, dusting, surface deterioration, pitting, spalling, operation or misuse of material, and extent of each, if exposed or cam easily be exposed to view.
4. Check all previous repairs and patches for any possible cracking or deterioration.
5. Check for any exposed reinforcement and extent of rust or deterioration.
6. Check all sealant, expansion/contraction joints, or mortar/grout joints for deterioration or cracking.
7. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analysis consists of documenting the location, pattern, depth, width, presence of foreign materials, and elevation differences between two cracked surfaces. Determine if crack is active or dormant by following these steps.
   a. Mark the end of the crack and check to see if crack has extended past mark. Note direction.
   b. Place a notched piece of tape across the crack. Wait for a period of a month or more. If tape tears or compresses (wrinkles) the crack is active, and if the tape shows no apparent change the crack is dormant.
   c. Apply pins and gauge points on either side of crack. Measure distance between points at regular intervals with vernier calipers to determine the extent of movement.

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INSPECTION METHODS . STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: ROOF STRUCTURE -WOOD
CONTROL NUMBER: GSS 0.03.04.03

APPLICATION

This guide applies to all structural/non-structural Wood Roof Structures.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Beams. (See GSS 0.03.01 series)
2. Inspect Fireproofing. (See GSS 0.03.06)
3. Inspect roofing system, refer to Volume 5 for any other signs of damage or deterioration that may be related to wood roof structures.

INSPECTION ACTIONS

Condition Assessment Survey of Wood Roof Structures includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes splitting, ripping, or tearing; compression (pushing or crushing force), which causes crushing; shear (slicing action), which causes diagonal or perpendicular to the member cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking or splitting. Bending is usually associated with a high failure rate.
2. Check for uneven settlement by observing condition of existing deck for high or low spots.
3. Check for improper design and construction conditions that can cause deficiencies such as cracking and surface deterioration.
4. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, staining, dry rot, surface deterioration, decay, splitting, operation or misuse of material, and extent of each.
5. Check all previous repairs and patches for any possible deterioration.
6. Check for improperly designed or placed anchorage components. Verify that anchorage is intact and properly tightened.
7. Check all sealant, expansion/contraction joints, or mortar/grout joints for deterioration or cracking.
8. Check for water damage or spongy/soft areas.
9. Check for fire or heat damaged surface resulting in deteriorated spots.

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GUIDE SHEET

SYSTEM/COMPONENT: STAIRS - CAST-IN-PLACE CONCRETE
CONTROL NUMBER: GSS 0.03.05.01

APPLICATION

This guide applies to all Cast-in-Place Concrete Stairs and associated work.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service, call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Floors. (See GSS 0.03.03 series)
2. Inspect applicable structural framing support members for any other signs of damage or deterioration that may be related to cast-in-place concrete stair deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Cast-in-Place Concrete Stairs includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes cracking and spalling; compression (pushing or crushing force), which causes crushing or spalling; shear (slicing action), which causes diagonal or stepped cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking with no spalling. Buckling is a form of bending and is most visible at the outermost fibers of the member. Buckling is usually associated with a high failure rate.
2. Check for uneven settlement by observing condition of floors and enclosure walls.
3. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, efflorescence, staining and rust, dusting, surface deterioration, pitting, spalling, operation or misuse of material, and extent of each.
4. Check for improper design and construction conditions that can cause deficiencies such as cracking and surface deterioration.
5. Check associated railings for damage, loose anchorage, and/or surface deterioration.
6. Check all previous repairs and patches for any possible cracking or deterioration.
7. Check for any exposed reinforcement and extent of rust or deterioration.

a. Check all sealant, expansion/contraction joints, or mortar/grout joints for deterioration or cracking.

9. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analysis consists of documenting the location, pattern, depth, width, presence of foreign materials, and elevation differences between two cracked surfaces. Determine if crack is active or dormant by following these steps.
    a. Mark the end of the crack and check to see if crack has extended past mark. Note direction.
    b. Place a notched piece of tape across the crack. Wait for a period of a month or more. If tape tears or compresses (wrinkles) the crack is active, and if the tape shows no apparent change the crack is dormant.
    c. Apply pins and gauge points on either side of crack. Measure distance between points at regular intervals with vernier calipers to determine the extent of movement.

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: STAIRS - CAST-IN-PLACE CONCRETE (Continued)
CONTROL NUMBER: GSS 0.03.05.01

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INSPECTION METHODS • STANDARD.

GUIDE SHEET

SYSTEM/COMPONENT: STAIRS - PRECAST CONCRETE
CONTROL NUMBER: GSS 0.03.05.02

APPLICATION

This guide applies to all Precast Concrete Stairs and associated work.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Floors. (See GSS 0.03.03 series)
2. Inspect applicable structure framing support members for any other signs of damage or deterioration that may be related to precast concrete stair deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Precast Concrete Stairs includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes cracking and spalling; compression (pushing or crushing force), which causes crushing or spalling; shear (slicing action), which causes diagonal or stepped cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking with no spalling. Buckling is a form of bending and is most visible at the outermost fibers of the member. Buckling is usually associated with a high failure rate.
2. Check for uneven settlement by observing condition of floors and enclosure walls.
3. Check for improper design and construction conditions that can cause deficiencies such as cracking and surface deterioration.
4. Check associated railings for damage, loose anchorage, and/or surface deterioration.
5. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, efflorescence, staining and rust, dusting, surface deterioration, pitting, spalling, operation or misuse of material, and extent of each.
6. Check all previous repairs and patches for any possible cracking or deterioration.
7. Check for any exposed reinforcement and extent of rust or deterioration.
a. Check for improperly designed or placed anchorage components. Verify that anchorage is intact and properly tightened.
9. Check all sealant, expansion/contraction joints, or mortar/grout joints for deterioration or cracking.

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GUIDE SHEET

SYSTEM/COMPONENT: STAIRS - PRECAST CONCRETE (Continued)
CONTROL NUMBER: GSS 0.03.05.02

INSPECTION ACTIONS

10. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analysis consists of documenting the location, pattern, depth, width, presence of foreign materials, and elevation differences between two cracked surfaces. Determine if crack is active or dormant by following these steps.
    a. Mark the end of the crack and check to see if crack has extended past mark. Note direction.
    b. Place a notched piece of tape across the crack. Wait for a period of a month or more. If tape tears or compresses (wrinkles) the crack is active, and if the tape shows no apparent change the crack is dormant.
    c. Apply pins and gauge points on either side of crack. Measure distance between points at regular intervals with vernier calipers to determine the extent of movement.

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INSPECTION METHODS . STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: STAIRS - STEEL
CONTROL NUMBER: GSS 0.03.05.03

APPLICATION

This guide applies to all Steel Stairs and associated work.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Floors. (See GSS 0.03.03 series)
2. Inspect Fireproofing. (See GSS 0.03.06)
3. Inspect applicable structural framing, support members for any other signs of damage or deterioration that may be related to steel stair deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Steel Stairs includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes stretching and cracking; compression (pushing or crushing force), which causes crushing; shear (slicing action), which causes diagonal or perpendicular to the member stepped cracking or breakage from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking and twisting of member. Bending is usually associated with a high failure rate.
2. Check for uneven settlement by observing condition of floors and enclosure wails.
3. Check associated railings for damage, loose anchorage, and/or surface deterioration.
4. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, staining and rust, corrosion, surface deterioration, operation or misuse of material, and extent of each.
5. Check all previous repairs and patches for any possible failures or deterioration.
6. Check for improper or damaged welds and “Lameliar” tearing of weld joints.
7. Check condition of anchorage to verify that anchorage is intact and properly tightened.

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GUIDE SHEET

SYSTEM/COMPONENT: STAIRS - COMPOSITE (STEEL PAN W/CONCRETE)
CONTROL NUMBER: GSS 0.03.05.04

APPLICATION

This guide applies to all Composite (Steel Pan with Concrete) Stairs and associated work.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Floors. (See GSS 0.03.03 series)
2. Inspect Fireproofing. (See GSS 0.03.06)
3. Inspect applicable structural framing support members for any other signs of damage or deterioration that may be related to composite stair deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Composite Stairs includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes cracking, spalling, or stretching; compression (pushing or crushing force), which causes crushing or spalling; shear (slicing action), which causes diagonal or stepped cracking or breakage from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking with no spalling or twisting and tearing. Bending is usually associated with a high failure rate.
2. Check for uneven settlement by observing condition of floors and enclosure walls.
3. Check for improper design and construction conditions that can cause deficiencies such as cracking and surface deterioration.
4. Check associated railings for damage, loose anchorage, and/or surface deterioration.
5. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, efflorescence, staining and rust, dusting, surface deterioration, pitting, spalling, operation or misuse of material, and extent of each.
6. Check all previous repair and patches for any possible cracking or deterioration or possible failures.
7. Check for any exposed reinforcement and extent of rust or deterioration.
8. Check for improperly designed or placed anchorage components. Verify that anchorage is intact and properly tightened.
9. Check all sealant, expansion/contraction joints, or mortar/grout joints for deterioration or cracking.

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GUIDE SHEET

SYSTEM/COMPONENT: STAIRS -WOOD
CONTROL NUMBER: GSS 0.03.05.05

APPLICATION

This guide applies to all structural/non-structural Wood Stairs and associated work.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Floors. (See GSS 0.03.01 series)
2. Inspect Fireproofing. (See GSS 0.03.06)
3. Inspect applicable structural framing support members for any other signs of damage or deterioration that may be related to wood stair deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Wood Stairs includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes ripping or tearing; compression (pushing or crushing force), which causes crushing or splitting; shear (slicing action), which causes diagonal or perpendicular to the member cracking from point of maximum load or shear: and bending (combination of tension and compression), which causes cracking or splitting. Bending is usually associated with a high failure rate.
2. Check for uneven settlement by observing condition of floors and enclosure walls.
3. Check associated railings for damage, loose anchorage, and/or surface deterioration.
4. Check for improper design and construction conditions that can cause deficiencies such as splitting and surface deterioration.
5. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, staining, dry rot, surface deterioration, decay, splitting, operation or misuse of material, and extent of each.
6. Check all previous repairs and patches for any possible deterioration.
7. Check for improperly designed or placed anchorage components. Verify that anchorage is intact and properly tightened or anchored.
8. Check for any splitting, cracking, or deterioration of surface.

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GUIDE SHEET

SYSTEM/COMPONENT: STAIRS - LADDERS
CONTROL NUMBER: GSS 0.03.05.06

APPLICATION

This guide applies to all fixed Ladders.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Beams, structural framing. (See GSS 0.03.01 series)
2. inspect Walls, Exterior Closure. (See GSS 0.04.01)

INSPECTION ACTIONS

Condition Assessment Survey of fixed Ladders includes visual survey, examination of building records, and analysis. Points include:

1. Check for improper design and construction conditions that can cause deficiencies such as cracking or splitting and surface deterioration.
2. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, staining and rust, corrosion, dry rot, decay, splitting, surface deterioration, operation or misuse of material, and extent of each.
3. Check all previous repairs and patches for any possible failures or deterioration.
4. Check for improper or damaged welds and "Lamellar" tearing of weld joints.
5. Check condition of anchorage to verify that anchorage is intact and properly tightened.
6. Check for loose or missing components.

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GUIDE SHEET

SYSTEM/COMPONENT: FIREPROOFING
CONTROL NUMBER: GSS 0.03.06

APPLICATION

This guide applies to all Fireproofing systems and associated work.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Refer to references and glossaries as needed.

CONCURRENT ACTIONS

1. Inspect Beams. (See GSS 0.03.01 series)
2. Inspect Pre-engineered Building System. (See GSS 0.03.02 series)
3. Inspect Floors. (See GSS 0.03.03 series)
4. Inspect Roof Structure. (See GSS 0.03.04 series)
5. Inspect foundation and footings, substructure, and exterior closure systems for any other signs of damage or deterioration that may be related to fireproofing deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Fireproofing includes visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes cracking and spalling; compression (pushing or crushing force), which causes crushing or spalling; shear (slicing action), which causes diagonal or stepped cracking from point of maximum load or shear.
2. Check for uneven settlement by observing condition of existing substrate or structural members.
3. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), freeze/thaw action, impact exposure, staining, dusting, surface deterioration, splitting, operation or misuse of material, and extent of each.
4. Check for water or moisture damage causing material deterioration and breakdown.
5. Check all previous repairs and patches for any possible cracking or deterioration.
6. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Results of this test can indicate condition of substrate; i.e., structural members such as beams.
7. Check for improper use or application of material exposing substrate.

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEETS

The following Guide Sheets outline an overview of inspection methods and requirements used in providing a general non-standard superstructure inspection. For these non-standard inspections, it is assumed that all standard inspections will be completed to determine non-standard methodology. (However, non-standard methods may be implemented as a non-contingent option.) Non-standard Guide Sheets have been developed for each major assembly type and associated assembly components as follows:

TABLE TWO

Assembly/Component	Control Number
BEAMS	
Cast-in-Place Concrete	GSNS 0.03.01.01
Precast Concrete	GSNS 0.03.01.02
Steel	GSNS 0.03.01.03
Wood	GSNS 0.03.01.04
PRE-ENGINEERED BUILDING SYSTEMS	
Metal	GSNS 0.03.02.01
Wood	GSNS 0.03.02.02
FLOORS	
Cast-in-Place Concrete	GSNS 0.03.03.01
Precast Concrete	GSNS 0.03.03.02
Steel	GSNS 0.03.03.03
Composite	GSNS 0.03.03.04
Wood	GSNS 0.03.03.05
ROOF STRUCTURE	
Steel	GSNS 0.03.04.01
Concrete	GSNS 0.03.04.02
Wood	GSNS 0.03.04.03
STAIRS	
Cast-in-Place Concrete	GSNS 0.03.05.01
Precast Concrete	GSNS 0.03.05.02
Steel	GSNS 0.03.05.03
Composite (Steel Pan w/Concrete)	GSNS 0.03.05.04
Wood	GSNS 0.03.05.05
Ladders	GSNS 0.03.05.06
FIREPROOFING	GSNS 0.03.06

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GUIDE SHEET

SYSTEM/COMPONENT: BEAMS - CAST-IN-PLACE CONCRETE
CONTROL NUMBER: GSNS 0.03.01 .01

APPLICATION

This guide applies to all non-standard inspection procedures for Cast-in-Place Concrete Beams.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and. references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Beams, other types that may be applicable. (See GSNS 0.03.01 series)
2. Inspect Floors. (See GSNS 0.03.02 series)
3. Inspect Roof Structure. (See GSNS 0.03.04 series)
4. Inspect foundations and footings and substructure for any other signs of damage or deterioration that may be related to cast-in-place concrete beam deficiencies.
5. Complete inspection requirements listed in GSS 0.03.01 .01.

INSPECTION ACTIONS

Based on results of GSS 0.03.01.01 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Surface Hardness Testing or Maturity Concept Analysis to determine material condition and locate possible defects or deficiencies within the material.
3. Take core samples to determine condition or strength of the material. Patch sample holes immediately. Use great care when performing this work, and consult a licensed structural engineer before proceeding.
4. Perform Infrared or Nuclear Analysis Testing to determine if water or moisture is present, indicating general location of cracks or breaks.
5. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
6. Perform Magnetic Test to determine material thickness and reinforcement location.
7. Perform Electrical Resistivity Test to determine moisture content, material thickness, and degree of corrosion or deterioration.
8. Perform Radiography (X-Ray) Testing to detect cracking, internal defects, and deficiencies.
9. Perform Microwave Absorption Scanning to determine moisture content and material defects. This is a relatively new method and is still under development.
10. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

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2. As required for the type of test being performed.

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GUIDE SHEET

SYSTEM/COMPONENT: BEAMS - PRECAST CONCRETE
CONTROL NUMBER: GSNS 0.03.01.02

APPLICATION

This guide applies to all non-standard inspection procedures for Precast Concrete Beams.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Beams, other types that may be applicable. (See GSNS 0.03.01 series)
2. inspect Floors. (See GSNS 0.03.02 series)
3. Inspect Roof Structure. (See GSNS 0.03.04 series)
4. Inspect foundations and footings and substructure for any other signs of damage or deterioration that may be related to precast concrete beam deficiencies.
5. Complete inspection requirements listed in GSS 0.03.01.02.

INSPECTION ACTIONS

Based on results of GSS 0.03.01.02 and/or as directed, proceed to non-standard. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Surface Hardness Testing or Maturity Concept Analysis to determine material condition and locate possible defects or deficiencies within the material.
3. Take core samples to determine condition or strength of the material. Patch sample holes immediately. Use great care when performing this work, and consult a licensed structural engineer before proceeding.
4. Perform infrared or Nuclear Analysis Testing to determine if water or moisture is present, indicating general location of cracks or breaks.
5. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
6. Perform Magnetic Test to determine material thickness and reinforcement location.
7. Perform Electrical Resistivity Test to determine moisture content, material thickness, and degree of corrosion or deterioration.
8. Perform Radiography (X-Ray) Testing to detect cracking, internal defects, and deficiencies.
9. Perform Microwave Absorption Scanning to determine moisture content and material defects. This is a relatively new method and is still under development.
10. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS . NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: BEAMS - STEEL
CONTROL NUMBER: GSNS 0.03.01.03

APPLICATION

This guide applies to all non-standard inspection procedures for Steel Beams.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Beams, other types that may be applicable. (See GSNS 0.03.01 series)
2. Inspect Floors. (See GSNS 0.03.03 series)
3. Inspect Roof Structure. (See GSNS 0.03.04 series)
4. Inspect Fireproofing. (See GSNS 0.03.06)
5. Inspect foundations and footings and substructure for any other signs of damage or deterioration that may be related to steel beam deficiencies.
6. Complete inspection requirements listed in GSS 0.03.01.03.

INSPECTION ACTIONS

Based on results of GSS 0.03.01.03 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
3. Perform Magnetic Test to determine material thickness and cracks.
4. Perform Radiography (X-Ray) Testing to detect cracking, defects, or deficiencies.
5. Perform Microwave Absorption Scanning to determine material defects. This is a relatively new method and is still under development.
6. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

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INSPECTION METHODS . NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: BEAMS -WOOD
CONTROL NUMBER: GSNS 0.03.01.04

APPLICATION

This guide applies to all non-standard inspection procedures for structural/non-structural Wood Beams.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Beams, other types that may be applicable. (See GSS 0.03.01 series)
2. Inspect Floors. (See GSNS 0.03.03 series)
3. Inspect Roof Structure. (See GSNS 0.03.04 series)
4. Inspect Fireproofing. (See GSNS 0.03.06)
5. Inspect foundations and footings and substructure for any other signs of damage or deterioration that may be related to wood beam deficiencies.
6. Complete inspection requirements listed in GSS 0.03.01.04.

INSPECTION ACTIONS

Based on results of GSS 0.03.01.04 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform a Pick Test to determine degree of deterioration, decay, or rot.
3. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
4. Perform Radiography (X-Ray) Testing to detect cracking, splitting, defects, or deficiencies.
5. Perform Microwave Absorption Scanning to determine material defects. This .is a relatively new method and is still under development.
6. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS • NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: PRE-ENGINEERED BUILDING SYSTEMS - METAL
CONTROL NUMBER: GSNS 0.03.02.01

APPLICATION

This guide applies to all non-standard inspection procedures for Metal Pre-Engineered Building Systems and associated work.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Floors. (See GSNS 0.03.03 series)
2. Inspect Fireproofing. (See GSNS 0.03.06)
3. Inspect foundations and footings, substructure, exterior closure, and roofing for any other signs of damage or deterioration that may be related to metal pre-engineered building system deficiencies.
4. Complete inspection requirements listed in GSS 0.03.02.01.

INSPECTION ACTIONS

Based on results of GSS 0.03.02.01 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Use a Borescope or Fiberscope to visually locate and detect material defects or cracked surfaces.
3. Verify tension on bolts and fasteners with a calibrated wrench.
4. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
5. Perform Magnetic Test to determine material thickness and cracks.
6. Perform Radiography (X-Ray) Testing to detect cracking, defects, or deficiencies.
7. Perform Electrical Resistivity Test to determine material thickness, and degree of corrosion or deterioration.
8. Perform Infrared or Nuclear Analysis Testing to determine physical condition of material by locating breaks or cracks.
9. Perform Microwave Absorption Scanning to determine material defects. This is a relatively new method and is still under development.
10. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. Calibrated wrench
3. As required for the type of test being performed.

INSPECTION METHODS . NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: **PRE-ENGINEERED BUILDING SYSTEMS -WOOD**
CONTROL NUMBER: **GSNS 0.03.02.02**

APPLICATION

This guide applies to all non-standard inspection procedures for Wood Pre-Engineered Building Systems and associated work.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Floors. (See GSNS 0.03.03 series)
2. Inspect Fireproofing. (See GSNS 0.03.06)
3. Inspect foundations and footings, substructure, exterior closure, and roofing for any other signs of damage or deterioration that may be related to wood pre-engineered building system deficiencies.
4. Complete inspection requirements listed in GSS **0.03.02.02.**

INSPECTION ACTIONS

Based on results of GSS 0.03.02.02 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform a Pick Test to determine degree of deterioration, decay, or rot.
3. Use a Borescope or Fiberscope to visually locate and detect material defects or cracked surfaces.
4. Verify tension on bolts and fasteners with a calibrated wrench.
5. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
6. Perform Radiography (X-Ray) Testing to detect cracking, splitting, defects, or deficiencies.
7. Perform Infrared or Nuclear Analysis Testing to determine physical condition of material by locating breaks or cracks.
8. Perform Microwave Absorption Scanning to determine material defects. This is a relatively new method and is still under development.
9. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. Calibrated wrench
3. As required for the type of test being performed.

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FLOORS - CAST-IN-PLACE CONCRETE
CONTROL NUMBER: GSNS 0.03.03.01

APPLICATION

This guide applies to all non-standard inspection procedures for Cast-in-Place Concrete Structural Floors and Slabs.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Beams. (See GSNS 0.03.01 series)
2. Inspect foundations and footings, substructure, and exterior closure for any other signs of damage or deterioration that may be related to cast-in-place concrete structure floor slab deficiencies.
3. Complete inspection requirements listed in GSS 0.03.03.01.

INSPECTION ACTIONS

Based on results of GSS 0.03.03.01 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Surface Hardness Testing or Maturity Concept Analysis to determine material condition and locate possible defects or deficiencies within the material.
3. Take core samples to determine condition or strength of the material. Patch sample holes immediately, Use great care when performing this work, and consult a licensed structural engineer before proceeding.
4. Perform Infrared or Nuclear Analysis Testing to determine if water or moisture is present, indicating general location of cracks or breaks.
5. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
6. Perform Magnetic Test to determine material thickness and reinforcement location.
7. Perform Electrical Resistivity Test to determine moisture content, material thickness, and degree of corrosion or deterioration.
8. Perform Radiography (X-Ray) Testing to detect cracking, internal defects, and deficiencies.
9. Perform Microwave Absorption Scanning to determine moisture content and material defects. This is a relatively new method and is still under development.
10. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions,

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS ▪ NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FLOORS - PRECAST CONCRETE
CONTROL NUMBER: GSNS 0.03.03.02

APPLICATION

This guide applies to all non-standard inspection procedures for Precast Concrete Structural Floors and Slabs.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Beams. (See GSNS 0.03.01 series)
2. Inspect foundations and footings, substructure, and exterior closure for any other signs of damage or deterioration that may be related to precast concrete floor deficiencies.
3. Complete inspection requirements listed in GSS 0.03.03.02.

INSPECTION ACTIONS

Based on results of GSS 0.03.03.02 and/or as directed, proceed to non-standard. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Surface Hardness Testing or Maturity Concept Analysis to determine material condition and locate possible defects or deficiencies within the material.
3. Take core samples to determine condition or strength of the material. Patch sample holes immediately. Use great care when performing this work, and consult a licensed structural engineer before proceeding.
4. Perform Infrared or Nuclear Analysis Testing to determine if water or moisture is present, indicating general location of cracks or breaks.
5. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
6. Perform Magnetic Test to determine material thickness and reinforcement location.
7. Perform Electrical Resistivity Test to determine moisture content, material thickness, and degree of corrosion or deterioration.
8. Perform Radiography (X-Ray) Testing to detect cracking, internal defects, and deficiencies.
9. Perform Microwave Absorption Scanning to determine moisture content and material defects. This is a relatively new method and is still under development.
10. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS • NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FLOORS - STEEL
CONTROL NUMBER: GSNS 0.03.03.03

APPLICATION

This guide applies to all non-standard inspection procedures for Steel Floors.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Beams. (See GSNS 0.03.01 series)
2. Inspect Floors, other types that may be applicable. (See GSNS 0.03.03 series)
3. Inspect Fireproofing. (See GSNS 0.03.06)
4. Inspect foundations and footings, substructure, and exterior closure for any other signs of damage or deterioration that may be related to steel floor deficiencies.
5. Complete inspection requirements listed in GSS 0.03.03.03.

INSPECTION ACTIONS

Based on results of GSS 0.03.03.03 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
3. Perform Magnetic Test to determine material thickness and cracks,
4. Perform Radiography (X-Ray) Testing to detect cracking, defects, or deficiencies.
5. Perform Electrical Resistivity Test to determine material thickness and degree of corrosion or deterioration.
6. Perform Microwave Absorption Scanning to determine material defects. This is a relatively new method and is still under development.
7. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS - NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FLOORS - COMPOSITE
CONTROL NUMBER: GSNS 0.03.03.04

APPLICATION

This guide applies to all non-standard inspection procedures for Composite Floor Systems.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Beams. (See GSNS 0.03.01 series)
2. Inspect Fireproofing. (See GSNS 0.03.06)
3. Inspect foundations and footings, substructure, and exterior closure for any other signs of damage or deterioration that may be related to composite floor deficiencies.
4. Complete inspection requirements listed in GSS 0.03.03.04.

INSPECTION ACTIONS

Based on results of GSS 0.03.03.04 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Surface Hardness Testing or Maturity Concept Analysis to determine material condition and locate possible defects or deficiencies within the material.
3. Take core samples to determine condition or strength of the material. Patch sample holes immediately. Use great care when performing this work, and consult a licensed structural engineer before proceeding.
4. Perform Infrared or Nuclear Analysis Testing to determine if water or moisture is present, indicating general location of cracks or breaks.
5. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
6. Perform Magnetic Test to determine material thickness and reinforcement location.
7. Perform Electrical Resistivity Test to determine moisture content, material thickness, and degree of corrosion or deterioration.
a. Perform Radiography (X-Ray) Testing to detect cracking, internal defects, and deficiencies.
9. Use a Borescope or Fiberscope to inspect and detect defects within cores of decking material or weld joints. This will require destructive coring to provide access for instruments.
10. Perform Microwave Absorption Scanning to determine moisture content and material defects. This is a relatively new method and is still under development.
11. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FLOORS - COMPOSITE (Continued)
CONTROL NUMBER: GSNS 0.03.03.04

TOOLS & MATERIALS

1. **Standard Tools - Basic**
2. **As required** for the type of test being performed.

INSPECTION METHODS • NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FLOORS -WOOD
CONTROL NUMBER: GSNS 0.03.03.05

APPLICATION

This guide applies to all non-standard inspection procedures for structural/non-structural Wood Floors.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Beams. (See GSNS 0.03.01 series)
2. Inspect Floors, other types that may be applicable. (See GSNS 0.03.03 series)
3. Inspect Roof Structures. (See GSNS 0.03.04 series)
4. Inspect Fireproofing. (See GSNS 0.03.06)
5. Inspect foundations and footings and substructure for any other signs of damage or deterioration that may be related to wood floor deficiencies.
6. Complete inspection requirements listed in GSS 0.03.03.05.

INSPECTION ACTIONS

Based on results of GSS 0.03.03.05 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform a Pick Test to determine degree of deterioration, decay, or rot.
3. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
4. Perform Radiography (X-Ray) Testing to detect cracking, defects, or deficiencies.
5. Perform Microwave Absorption Scanning to determine material defects. This is a relatively new method and is still under development.
6. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS • NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: ROOF STRUCTURE - STEEL
CONTROL NUMBER: GSNS 0.03.04.01

APPLICATION

This guide applies to all non-standard inspection procedures for Steel Roof Structures.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Beams. (See GSNS 0.03.01 series)
2. Inspect Fireproofing. (See GSNS 0.03.06)
3. Inspect roofing systems, refer to Volume 5 for any other signs of damage or deterioration that may be related to steel roof structure deficiencies.
4. Complete inspection requirements listed in GSS 0.03.04.01.

INSPECTION ACTIONS

Based on results of GSS 0.03.04.01 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
3. Perform Magnetic Test to determine material thickness and cracks.
4. Perform Radiography (X-Ray) Testing to detect cracking, defects, or deficiencies.
5. Perform Electrical Resistivity Test to determine material thickness and degree of corrosion or deterioration.
6. Perform Microwave Absorption Scanning to determine material defects. This is a relatively new method and is still under development.
7. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS - NON-STANDARD

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INSPECTION METHODS • NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: ROOF STRUCTURE - CONCRETE
CONTROL NUMBER: GSNS 0.03.04.02

APPLICATION

This guide applies to all non-standard inspection procedures for Concrete Roof Structural Slabs.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Beams. (See GSNS 0.03.01 series)
2. Inspect roofing systems, refer to Volume 5 for any other signs of damage or deterioration that may be related to concrete roof slab deficiencies.
3. Complete inspection requirements listed in GSS 0.03.04.02.

INSPECTION ACTIONS

Based on results of GSS 0.03.04.01 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Surface Hardness Testing or Maturity Concept Analysis to determine material condition and locate possible defects or deficiencies within the material.
3. Take core samples to determine condition or strength of the material. Patch sample holes immediately. Use great care when performing this work, and consult a licensed structural engineer before proceeding.
4. Perform Infrared or Nuclear Analysis Testing to determine if water or moisture is present, indicating general location of cracks or breaks.
5. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
6. Perform Magnetic Test to determine material thickness and reinforcement location.
7. Perform Electrical Resistivity Test to determine moisture content, material thickness, and degree of corrosion or deterioration.
8. Perform Radiography (X-Ray) Testing to detect cracking, internal defects, and deficiencies.
9. Perform Microwave Absorption Scanning to determine moisture content and material defects. This is a relatively new method and is still under development.
10. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS ▪ NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: ROOF STRUCTURE -WOOD
CONTROL NUMBER: GSNS 0.03.04.03

APPLICATION

This guide applies to all non-standard inspection procedures for structural/non-structural Wood Roof Structures.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Beams. (See GSNS 0.03.01 series)
2. Inspect Fireproofing. (See GSNS 0.03.06)
3. Inspect roofing systems, refer to Volume 5 for any other signs of damage or deterioration that may be related to wood roof structure deficiencies.
4. Complete inspection requirements listed in GSS 0.03.04.03.

INSPECTION ACTIONS

Based on results of GSS 0.03.04.03 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform a Pick Test to determine degree of deterioration, decay, or rot.
3. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
4. Perform Radiography (X-Ray) Testing to detect cracking, defects, or deficiencies.
5. Perform Microwave Absorption Scanning to determine material defects. This is a relatively new method and is still under development.
6. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: STAIRS - CAST-IN-PLACE CONCRETE
CONTROL NUMBER: GSNS 0.03.05.01

APPLICATION

This guide applies to all non-standard inspection procedures for Cast-in-Place Concrete Stairs and associated work.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Floors. (See GSNS 0.03.03 series)
2. Inspect applicable structural framing support members for any other signs of damage or deterioration that may be related to cast-in-place concrete stair deficiencies.
3. Complete inspection requirements listed in GSS 0.03.05.01.

INSPECTION ACTIONS

Based on results of GSS 0.03.05.01 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Surface Hardness Testing or Maturity Concept Analysis to determine material condition and locate possible defects or deficiencies within the material.
3. Take core samples to determine condition or strength of the material. Patch sample holes immediately. Use great care when performing this work, and consult a licensed structural engineer before proceeding.
4. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
5. Perform Magnetic Test to determine material thickness and reinforcement location.
6. Perform Electrical Resistivity Test to determine moisture content, material thickness, and degree of corrosion or deterioration.
7. Perform Radiography (X-Ray) Testing to detect cracking, internal defects, and deficiencies.
8. Perform Microwave Absorption Scanning to determine moisture content and moisture defects. This is a relatively new method and is still under development.
9. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS - NON-STANDARD

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INSPECTION METHODS • NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: STAIRS - PRECAST CONCRETE
CONTROL NUMBER: GSNS 0.03.05.02

APPLICATION

This guide applies to all non-standard inspection procedures for Precast Concrete Stairs and associated work.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Floors. (See GSNS 0.03.03 series)
2. Inspect applicable structure framing support members for any other signs of damage or deterioration that may be related to precast concrete stair deficiencies.
3. Complete inspection requirements listed in GSS 0.03.05.02.

INSPECTION ACTIONS

Based on results of GSS 0.03.05.02 and/or as directed, proceed to non-standard. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Surface Hardness Testing or Maturity Concept Analysis to determine material condition and locate possible defects or deficiencies within the material.
3. Take core samples to determine condition or strength of the material. Patch sample holes immediately. Use great care when performing this work, and consult a licensed structural engineer before proceeding.
4. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
5. Perform Magnetic Test to determine material thickness and reinforcement location.
6. Perform Electrical Resistivity Test to determine moisture content, material thickness, and degree of corrosion or deterioration.
7. Perform Radiography (X-Ray) Testing to detect cracking, internal defects, and deficiencies.
8. Perform Microwave Absorption Scanning to determine moisture content and material defects. This is a relatively new method and is still under development.
9. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS - NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: STAIRS - STEEL
CONTROL NUMBER: GSNS 0.03.05.03

APPLICATION

This guide applies to all non-standard inspection procedures for Steel Stairs and associated work.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2 Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Floors. (See GSNS 0.03.03 series)
2. Inspect Fireproofing. (GSNS 0.03.06)
3. Inspect applicable structural framing support members for any other signs of damage or deterioration that may be related to steel stair deficiencies.
4. Complete inspection requirements listed in GSS 0.03.05.03.

INSPECTION ACTIONS

Based on results of GSS 0.03.05.03 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Use a Borescope or Fiberscope to visually locate and detect material defects or cracked surfaces and welds.
3. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
4. Perform Magnetic Test to determine material thickness and cracks.
5. Perform Radiography (X-Ray) Testing to detect cracking, defects, or deficiencies.
6. Perform Electrical Resistivity Test to determine material thickness and degree of corrosion or deterioration.
7. Perform Microwave Absorption Scanning to determine material defects. This is a relatively new method and is still under development.
a. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS ▪ NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: STAIRS - COMPOSITE (STEEL PAN W/CONCRETE)
CONTROL NUMBER: GSNS 0.03.05.04

APPLICATION

This guide applies to all non-standard inspection procedures for Composite (Steel Pan w/Concrete) Stairs and associated work.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Floors. (See GSNS 0.03.01 series)
2. Inspect Fireproofing, if applicable. (See GSNS 0.03.06)
3. Inspect foundations and footings, substructure, and exterior closure for any other signs of damage or deterioration that may be related to composite stair deficiencies.
4. Complete inspection requirements listed in GSS 0.03.05.04.

INSPECTION ACTIONS

Based on results of GSS 0.03.05.04 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Surface Hardness Testing or Maturity Concept Analysis to determine material condition and locate possible defects or deficiencies within the material.
3. Use a Borescope or Fiberscope to visually locate and detect material defects or cracked surfaces and welds.
4. Take core samples to determine condition or strength of the material. Patch sample holes immediately. Use great care when performing this work, and consult a licensed structural engineer before proceeding.
5. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
6. Perform Magnetic Test to determine material thickness and reinforcement location.
7. Perform Electrical Resistivity Test to determine moisture content, material thickness, and degree of corrosion or deterioration.
8. Perform Radiography (X-Ray) Testing to detect cracking, internal defects, and deficiencies.
9. Perform Microwave Absorption Scanning to determine moisture content and material defects. This is a relatively new method and is still under development.
10. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS • NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: STAIRS - WOOD
CONTROL NUMBER: GSNS 0.03.05.05

APPLICATION

This guide applies to all non-standard inspection procedures for structural/non-structural Wood Stairs and associated work.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Floors. (See GSNS 0.03.03 series)
2. Inspect Fireproofing. (GSNS 0.03.06)
3. Inspect applicable structural framing support members for any other signs of damage or deterioration that may be related to wood 'stair deficiencies.
4. Complete inspection requirements listed in GSS 0.03.05.05.

INSPECTION ACTIONS

Based on results of GSS 0.03.05.05 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform a Pick Test to determine degree of deterioration, decay, or rot.
3. Use Borescope or Fiberscope to visually locate and detect material defects or cracked and split surfaces.
4. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
5. Perform Radiography (X-Ray) Testing to detect cracking, defects, or deficiencies.
6. Perform Microwave Absorption Scanning to determine material defects. This is a relatively new method and is still under development.
7. Perform Acoustic Emission Test to determine stress points and deformations of the material. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS ▪ NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: STAIRS - LADDERS
CONTROL NUMBER: GSNS 0.03.05.06

APPLICATION

This guide applies to all non-standard inspection procedures for fixed Ladders.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to glossary and references as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CONCURRENT ACTIONS

1. Inspect Beams - structural framing. (See GSNS 0.03.01 series)
2. Inspect Walls - exterior closure. (See GSNS 0.04.01 series)
3. Complete inspection requirements listed in GSS 0.03.05.06.

INSPECTION ACTIONS

Based on results of GSS 0.03.05.06 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform a Pick Test to determine degree of deterioration, decay, or rot (for wood).
3. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
4. Perform Magnetic Test to determine material thickness and cracks.
5. Perform Radiography (X-Ray) Testing to detect cracking, defects, or deficiencies.
6. Perform Electrical Resistivity Test to determine material thickness and degree of corrosion or deterioration.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS . NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FIREPROOFING
CONTROL NUMBER: GSNS 0.03.06

APPLICATION

This guide applies to all non-standard inspection procedures for Fireproofing Systems and associated work.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to references and glossaries as needed.
3. It is recommended that such non-standard inspection be performed under the supervision of a licensed structural engineer. Based on the review of standard inspection results, he/she may recommend that the following tests and analyses be conducted (can include all or some of the tests listed below).

CON2URRENT ACTIONS

1. Inspect Beams. (See GSNS 0.03.01 series)
2. Inspect Pre-engineered Building Systems. (See GSNS 0.03.02 series)
3. Inspect Floors. (See GSNS 0.03.03 series)
4. Inspect Roof Structures. (See GSNS 0.03.04 series)
5. Inspect foundations and footings, substructure, and exterior closure systems for any other signs of damage or deterioration that may be related to fireproofing deficiencies.
6. Complete inspection requirements listed in GSS 0.03.06.

INSPECTION ACTIONS

Based on results of GSS 0.03.06 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Infrared or Nuclear Analysis Testing to determine if water or moisture is present, indicating general location of cracks or breaks.
3. Perform Ultrasonic Pulse Velocity Test to locate defects within the material to determine degree of deterioration and material thickness.
4. Take core samples to determine condition or strength of the material. Patch sample holes immediately to maintain Fireproofing rating.
5. Perform Electrical Resistivity Test to determine moisture content, material thickness, and degree of deterioration.
6. Perform Microwave Absorption Scanning to determine moisture content and material defects. This is a relatively new method and is still under development.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed

INSPECTION METHODS ▪ NON-STANDARD

END OF SUBSECTION

DATA COLLECTION METHODS

GENERAL

The heart of the CAS System is built around the hand-held data collection device and the CAIS software that supports it. As discussed in the Introduction, this is a "new way" of seeing and recording specific standardized information, Several phases are involved in the CAS inspection process. They include:

PHASE I **PRESURVEY**

- Facility managers review assets and assign each an Asset Determinant Factor (ADF) to define the level and type of inspection to be accomplished (see Subsection 1 .1 for definition).
- Facility managers assign specific assets to CAS inspectors.
- The CAS Inspector reviews existing asset data (including as-builts and past repair reports) and the Work Breakdown Structure (WBS) systems requiring inspection, which are then subdivided as necessary. (For example, a large roof may be subdivided into four (4) WBS items such as North, South, East and West sections.)
- The inspector establishes the Inspection Units (IU) to be surveyed based on the WBS (or multiple WBS). IUs may also be added in the field.
- Facility manager and/or staff downloads asset data into the hand-held data collection device.

PHASE 2 SURVEY

- Conduct CAS inspection.
- Upload data into PC-based CAIS.
- Review raw data "universal" reports.

PHASE 3 **POSTSURVEY**

- Correct data, as necessary, issue final "universal" report, and create other required reports for facility managers.
- Data and reports are created and issued through DOE hierarchy (see Introduction).

DATA COLLECTION METHODS

ENTERING DATA: DATA COLLECTION MENU

SURVEY STEP: **LOGIN** SCREEN 1.0

The screen contains identification data including the inspector's name, ID number, and discipline to be inspected. This data may be input or preloaded. From this screen, several information and help pop-up aids can be accessed. Help functions would provide screen-specific instructions, and information functions would list special management instructions and/or schedules specifically for the inspector.

SURVEY STEP: ASSET IDENTIFICATION SCREEN 2.0

Asset identification including class, type, ADF number (see subsection 1.1 for ADF description), and asset ID numbers are captured on this screen. Pop-up screens with preformatted picklists (for type and class) are provided for the inspector's review and selection. Additional support screens include ASSET DIMENSIONS indicating key elements required for inspection (such as asset gross square footage, perimeter, height, etc.); and ASSET DESCRIPTION for recording asset name and address. Such information would be entered (or verified) by the inspector prior to the actual asset CAS inspection.

SURVEY STEP: WBS SELECTION SCREEN 3.0

This screen displays the preselected systems and WBS listings based on the ADF selected for the particular asset. Although all WBS assemblies for a system will be listed, the inspector selects only assemblies applicable to the specific asset. For example, although all system 0.05 Roof WBS categories are listed, the inspector would eliminate all non-applicable categories by "de-selecting" non-applicable items. Once this process is complete, the inspector can re-sort the included WBS items. Columns are also provided that indicate the survey status for each WBS item.

At this point, the inspector can subdivide the WBS. For example, the inspector may elect to split a large roof into four sections, each as a separate WBS, or isolate a pump from a WBS containing several pumps. This feature will allow the inspector to logically build his survey based on the unique properties and requirements of each asset.

Finally, while most WBS structuring will be accomplished prior to the CAS inspection, WBS subdivision can also be done in the field.

DATA COLLECTION METHODS

ENTERING DATA: DATA COLLECTION MENU (Continued)

SURVEY STEP: INSPECTION **UNIT (IU)** SELECTION SCREEN 4.0

While screen 3.0 defines the WBS structure, screen 4.0 concerns selecting the IU for each WBS category. In the CAIS software, the base CAS (see subsection 1.1 for definition) is preset at the assembly level for all systems. For example, a WBS Roof System, Built-up Membrane Roofing (0.05.01), is set at the assembly level. At this point the inspector would select the type of assembly based on a preselected picklist. (Such a picklist at the assembly level might include various roof assembly groupings; eg., 3 to 5-ply asphalt with gravel coating and composite insulation.) If a more detailed inspection is required, the inspector would "de-select" the base CAS assembly level by crossing through the LVL Box "Assy." This action would bring up the next level "component." In our roof example, this would mean that the inspector would now assess the membrane, flashing, and insulation as separate components. As with the assembly level, the inspector would choose a type from a selected picklist for each component. Although IUs are usually determined prior to the survey, multiple IUs may also be developed during the inspection. For example, a WBS of the south quadrant built-up roof may be divided into two IUs (eg., SW corner and remaining roof) if the inspector chooses to highlight and isolate some abnormal conditions from the main IU.

Additional information developed on this screen would include the percentage of WBS served by the IU, the estimated quantity (this figure will also be independently generated by CAIS status (see subsection 1.1), estimated life remaining useful without repair (WOR), and estimated age.

SURVEY STEP: DEFICIENCY ASSESSMENT SCREEN 4.1

With the WBS and IU established, the inspector now conducts the CAS inspection for each WBS IU. As the inspector surveys the asset, a preformatted picklist containing all deficiencies that may affect the particular WBS IU is reviewed. The default setting shows a zero in each coverage block, indicating no deficiencies. As the survey proceeds, the inspector "de-selects" this normal setting by entering a percentage of coverage under condition categories listed (light, moderate, severe, and fail). For example, inspector entries for WBS roofing, IU built-up membrane, deficiency "splitting" of 10% light, 0% moderate, 0% severe, 0% fail, would be interpreted by CAIS software as 90% normal, and light splitting occurring over 10% of the membrane. If the inspector cannot determine the condition using standard inspection methods, he can indicate the need for a non-standard inspection (NSIP) by de-selecting the "NO" in the NSIP column. To complete the inspection, the aforementioned procedures would be carried out for each deficiency noted by the inspector.

DATA COLLECTION METHODS

ENTERING DATA: DATA COLLECTION MENU (Continued)

SURVEY **STEP:** SUMMARY CONDITION ASSESSMENT SCREEN 5.0

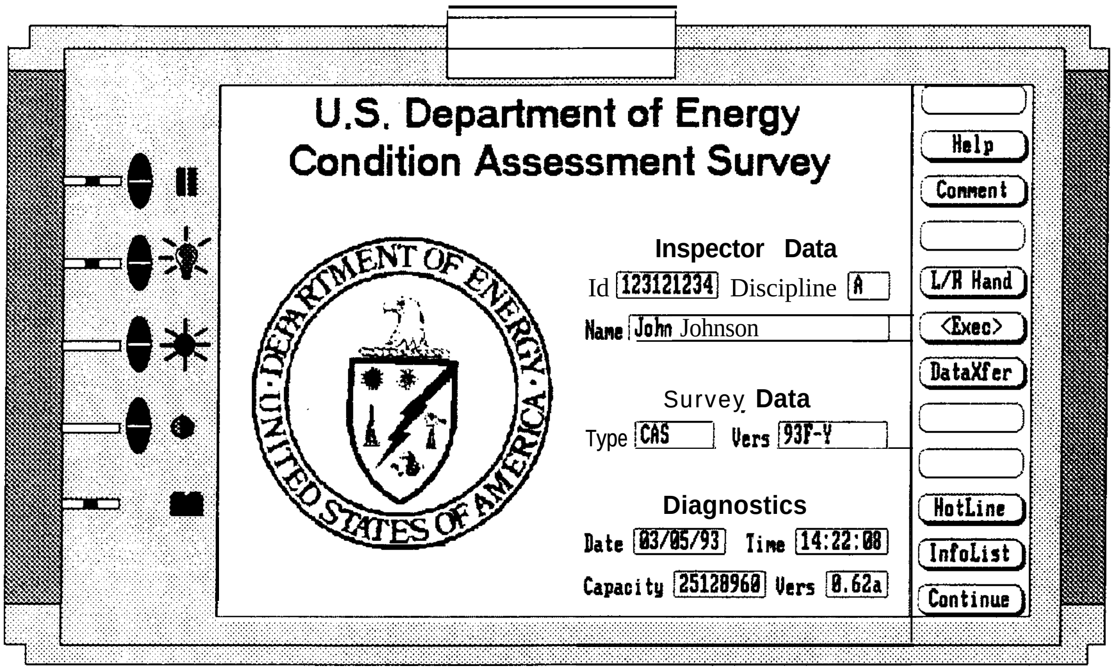
This final screen summarizes the WBS IU in three major categories: urgency, purpose, and condition. In each category, the inspector will call up a picklist and select the category he feels is most appropriate for the WBS IU surveyed. (For the purpose category, the inspector may select multiple headings.) Additionally, the inspector may elect to enter an estimated cost and/or quantity. (This is optional as CAIS will generate these data based on the inspector's survey information.) The inspector will also enter an estimated remaining life post-repair. As an option, a work order may be generated based on the CAS survey information. This option is generated by selecting the WORK ORDER function key and filling out pertinent data. Finally, the inspector may choose to describe the repair more fully by selecting the REPAIR CHARACTER key.

After completing all WBS IUs, the CAS inspection for the system is complete. This procedure is repeated for each applicable system. Once all systems for the asset are complete, the information is uploaded to the PC-based CAIS program for data analysis and report generation.

In the remainder of this subsection, actual data screens, as they will appear to the inspector, are displayed to illustrate a typical inspection. As previously noted, five main screens are used in the system supported by numerous "pop-up" lists, information, comment, and other auxiliary screens. In our examples, main screens are numbered 1.0 - 5.0; secondary screens are labeled 1.1, 1.2, etc.; and general support screens use the series 99.0. Key inspector actions on each screen are highlighted. Support function keys are listed below these main functions.

SURVEY STEP LOGIN

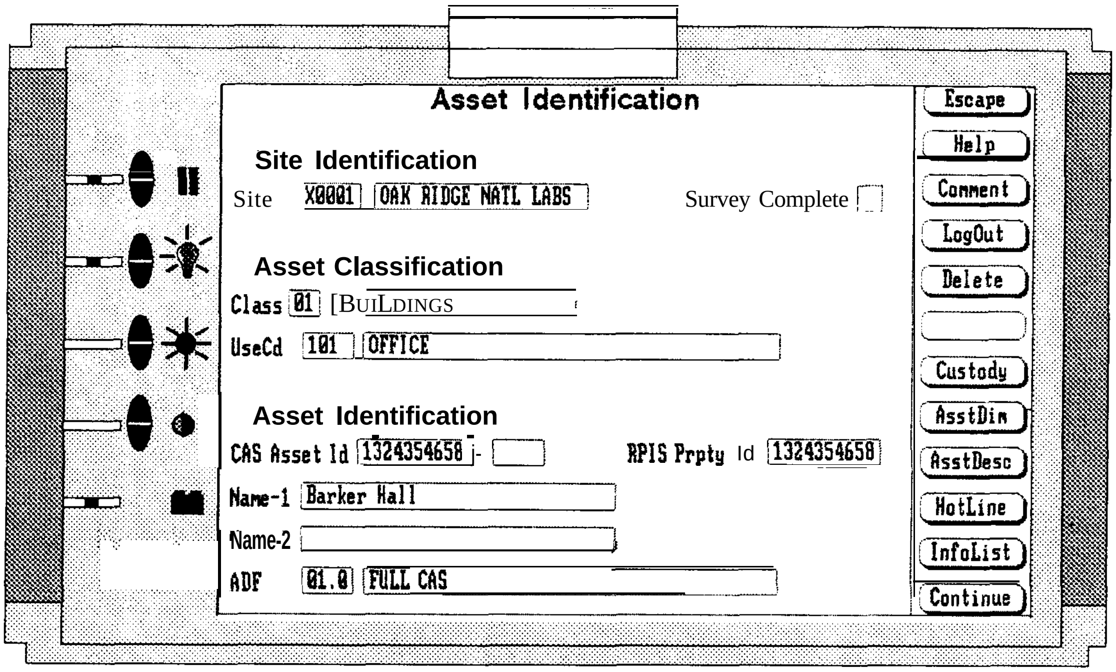
Screen 1 .0



SCREEN	ACTION	COMMENT
1.0	1. Enter Name and Employee Id #	May be preloaded for security
	2. Tap "Discipline" title for picklist, cursor select or enter by pen	Picklist preformatted A=Arch, C=Site/Civil, E=Elec, M=Mech
	3. Tap "Type" and "Vers" title under Survey Data for picklist cursor select or enter by pen	Picklist preformatted for type of survey to be performed and version date for record
	4. Diagnostics data is system generated and for information purposes only	N/A
	5. Press (Continue) to go to Screen 2.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information.
(Help)	Press to bring up screen help	Screen 99.1
(Comment)	Press to bring up screen for entering inspector comments	Screen 99.2
(LH/RH)	Press to change screen between Left or Right Hand use	N/A
(<Exec>)	Press to exit to the Grid System Menu	This option can be password protected
(DataXfer)	Press to transfer data to site computer	Used for data upload/download procedures
(Hotline)	Press for important contacts and telephone numbers	Screen 99.3
(InfoList)	Press to bring up information/directions preloaded for inspector	Screen 99.4

SURVEY STEP ASSET IDENTIFICATION

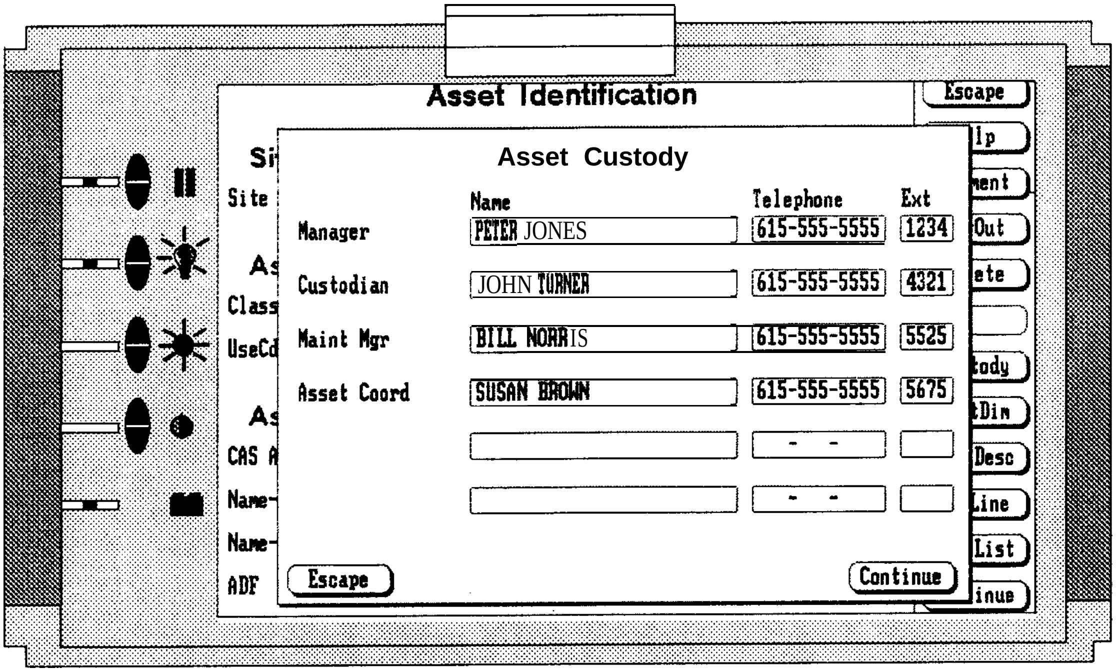
Screen 2.0



SCREEN	ACTION	COMMENT
2.0	1. Tap "Site" title for picklist Cursor select or enter by pen	Picklist can be preloaded, site code appears automatically to match name selected
	2. Tap "Class" title for picklist Cursor select or enter by pen or skip to item 4	Picklist preformatted based on RPIS categories
	3. Tap "Use Cd" title for picklist Cursor select or enter by pen or skip to item 4	Picklist preformatted based on RPIS categories
	4. Enter Asset Identification information by selecting "CAS Asset Id" corresponding "RPIS Prpty Id" and "Name-1 or Name-2" will be generated	This data can be preloaded
	5. Enter a Split Asset by creating an extension to "CAS Asset ID" and selecting a new name	This data can be preloaded or created by inspector
	6. Enter Asset Determinant Factor "ADF" provided by Site Mgr.	Determined by Site Manager prior to survey
	7. Press box next to Survey Complete upon completion of Asset Survey	N/A
	8. Press (Continue) to go to Screen 3.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information
(Escape)	Press to return to Screen 1.0	By pressing (Escape) information is not verified and any changes made are lost
(Help)	Press to bring up screen help	Screen 99.1
(Comment)	Press to bring up screen for entering inspector comments	Screen 99.2
(Logout)	Press to save all data entered and leave survey	N/A
(Custody)	Press to bring up asset contact names	Screen 2.1 This data can be preloaded
(AssetDim)	Press to bring up screen for entering or verifying key asset dimensions	Screen 2.2 This data can be preloaded
(AssetDes)	Press to bring up screen for entering or verifying asset name, address and descriptions	Screen 2.3 This data can be preloaded
(HotLine)	Press for important contacts and telephone numbers	Screen 99.3
(InfoList)	Press to bring up information/directions preloaded for inspector	Screen 99.4

SURVEY STEP ASSET CUSTODY SCREEN

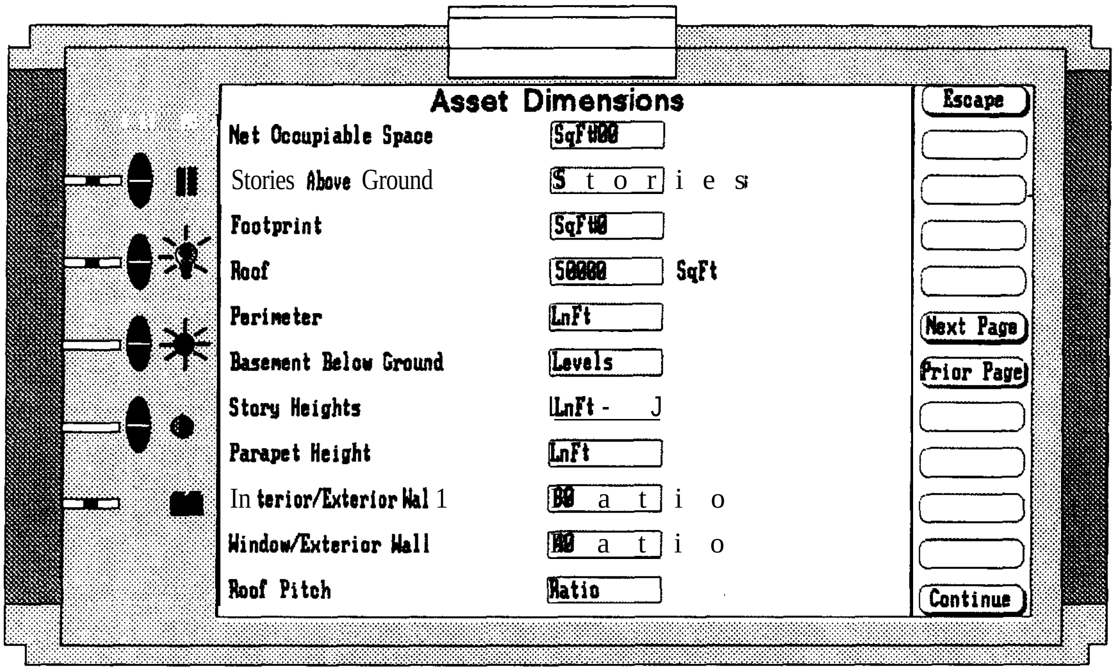
Screen 2.1



SCREEN	ACTION	COMMENT
2.1	1. Pop up window displays important names and numbers for asset. Cross through data and make any changes	Data can be either preloaded or inspector generated.
	2. Press (Continue) to return to Screen 2.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information.
(Escape)	Press to return to Screen 2.0	ℨy pressing- information is not verified and any changes made are lost.

SURVEY STEP ASSET DIMENSIONS

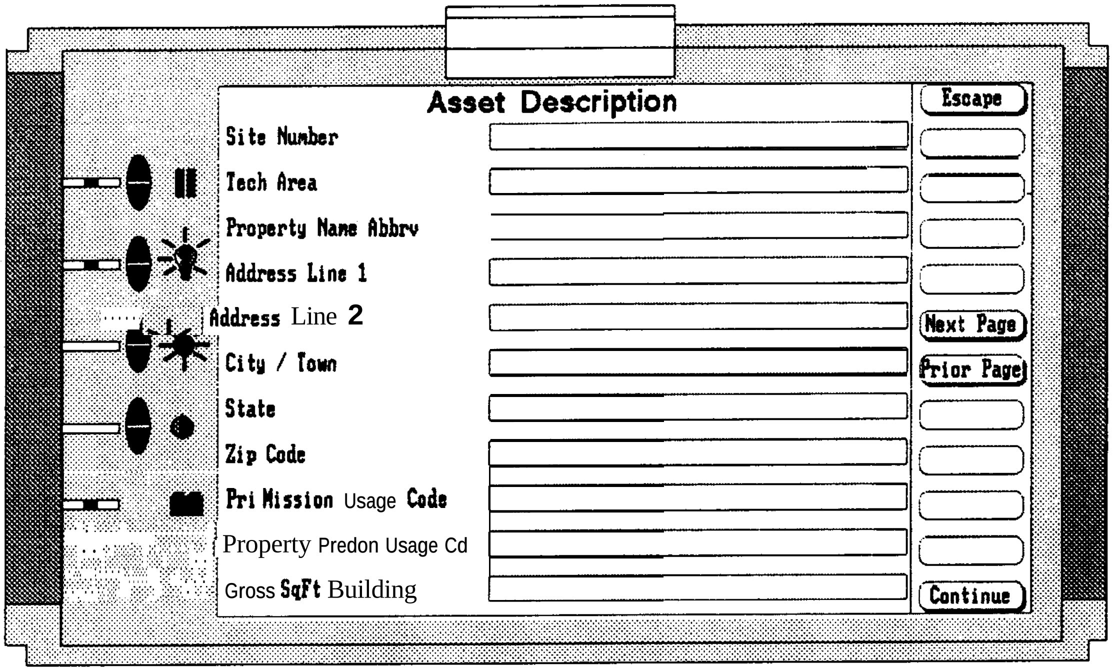
Screen 2.2



SCREEN	ACTION	COMMENT
2.2	1. Screen displays important dimension related to the asset verify data or cross through data and make any changes	Data can be either preloaded or inspector generated.
	2. Press (Continue) to return to Screen 2.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information.
(Escape)	Press to return to Screen 2.0	By pressing (Escape) information is not verified and any changes made are lost.
(NextPage)	Press to bring up next screen of important dimensions	Data can be either preloaded or inspector generated.
(PriorPage)	Press to return to previous asset dimension screen	Data can be either preloaded or inspector generated.

SURVEY STEP ASSET DESCRIPTION

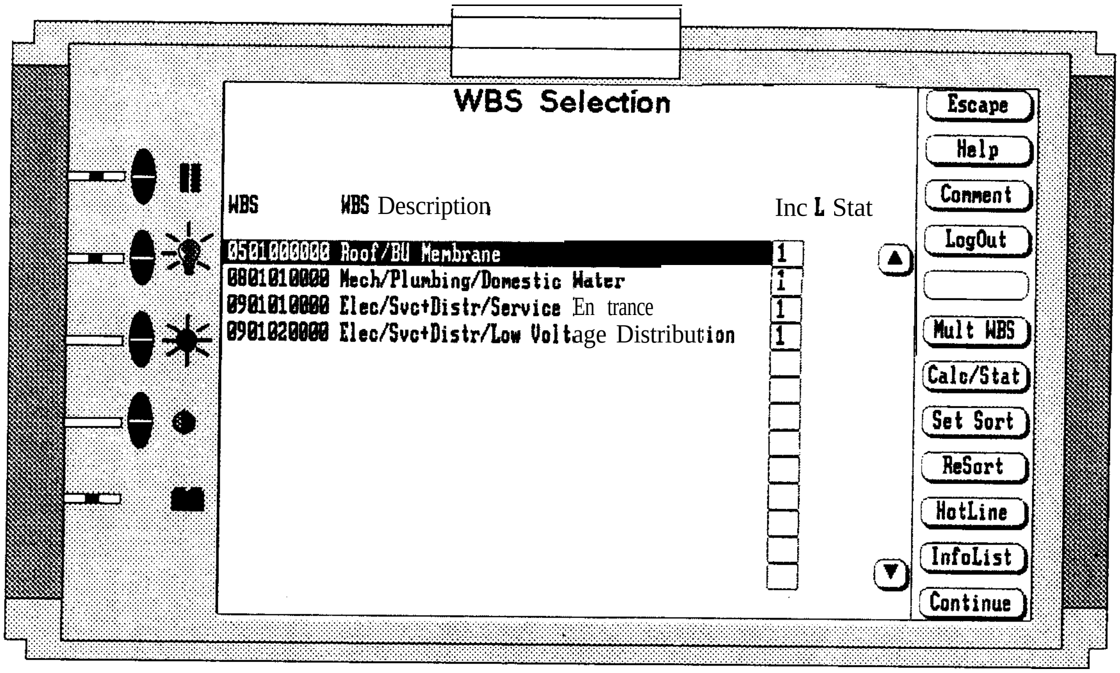
Screen 2.3



SCREEN	ACTION	COMMENT
2.3	1. Screen displays important asset description information verify data or cross through and make changes	Data can be either preloaded or inspector generated
	2. Press (Continue) to return to Screen 2.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information
(Escape)	Press to return to Screen 2.0	By pressing (Escape) information is not verified and any changes made are lost
(NextPage)	Press to bring up next screen of important descriptions	Data can be either preloaded or inspector generated
(PriorPage)	Press to return to previous asset description screen	Data can be either preloaded or inspector generated

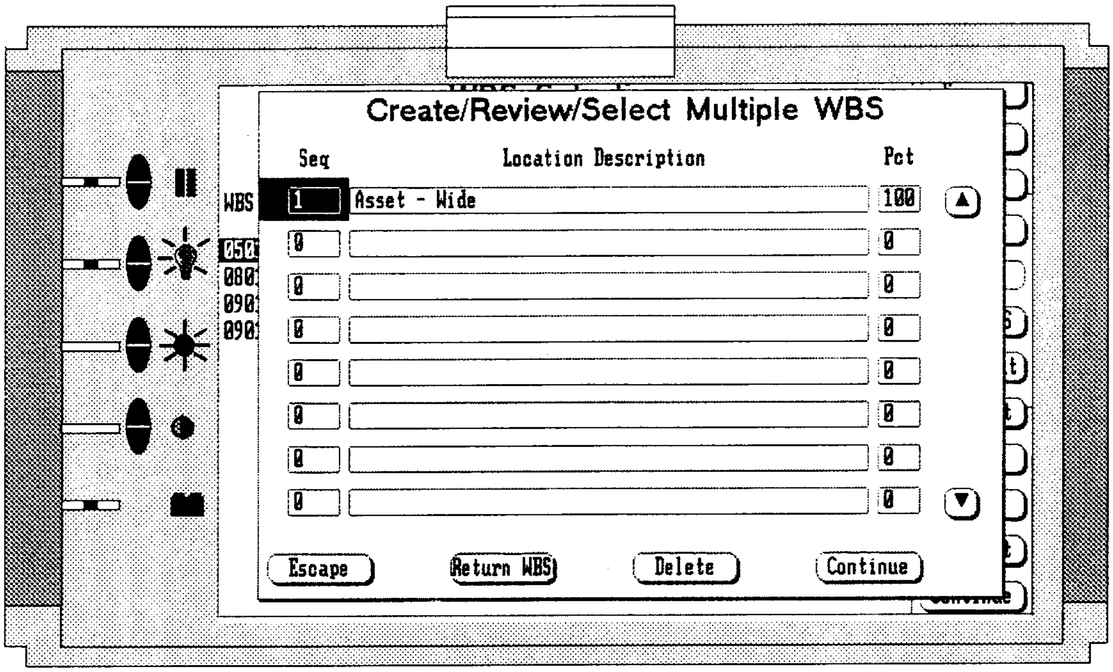
SURVEY STEP WBS SELECTION

Screen 3.0



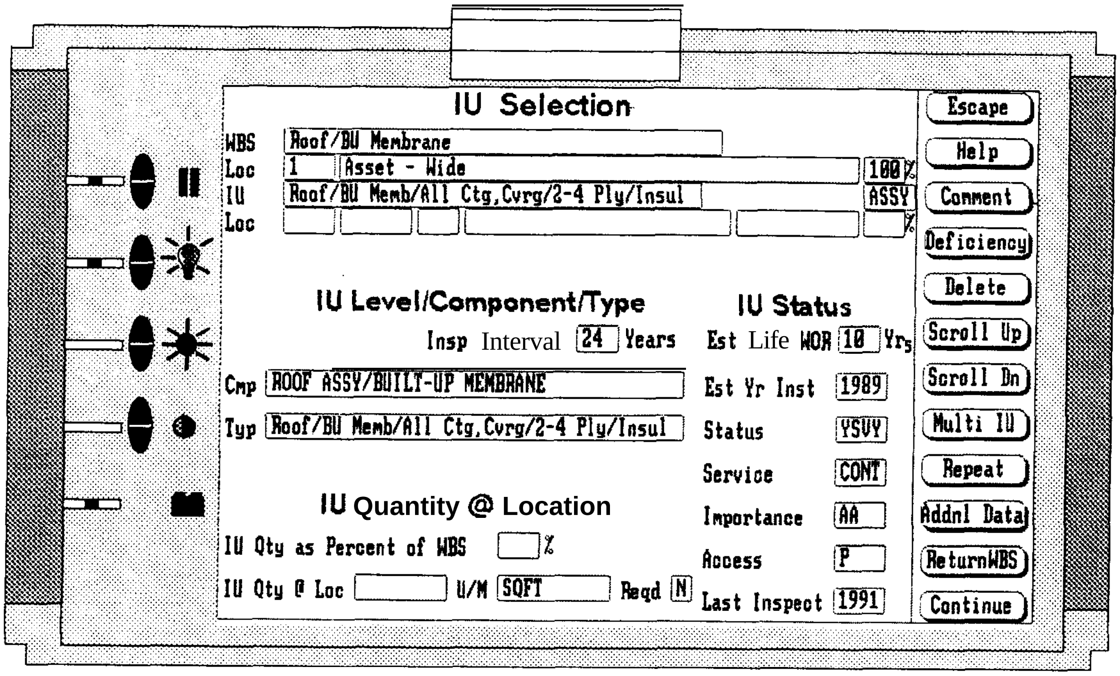
SCREEN	ACTION	COMMENT
3.0	1. Select WBS item to inspect from picklist	Picklist preformatted and is presorted by ADF numbers. Columns at end of WBS list show: "Inc" (included) by sort order 1,2,3...; "M" (multiple items); and "Stat" (Status) (In Progress, Complete, or Not Started [*])
	2. All WBS for ADF included on screen; cross through number in "Inc" column to deselect	By crossing through "inc" number, WBS item is deselected
	3. Press (Continue) to go to Screen 4.0	By pressing (Continue) information is verified and inspections units under the selected WBS are loaded
(Escape)	Press to return to Screen 2.0	By pressing (Escape) information is not verified and any changes made am lost.
(Help)	Press to bring up screen **help**	Screen 99.1
(Comment)	Press to bring up screen for entering inspector comments	Screen 99.2
(Logout)	Press to save all data entered and leave survey	N/A
(Multi WBS)	Press to create, view or select multiple WBS and locations	Screen 3.1
(CalcSort)	Press to recalculate the status of or number of multiple locations	N/A
(SetSort)	Resets the sort sequence of systems, etc. by accessing a pop-up window	N/A
(Resort,	Press to **resort** list in order of priority of WBS items selected	N/A
(HotLine)	Press for important contacts and telephone numbers	Screen 99.3
(InfoList)	Press to bring up **information/directions preloaded** for inspector	Screen 99.4
▲	Press Scroll Up button	Used to scroll up through information.
▼	Press Scroll Down button	Used to scroll down through information.

SURVEY STEP CREATE/REVIEW/SELECT MULTIPLE WBS — Screen 3.1



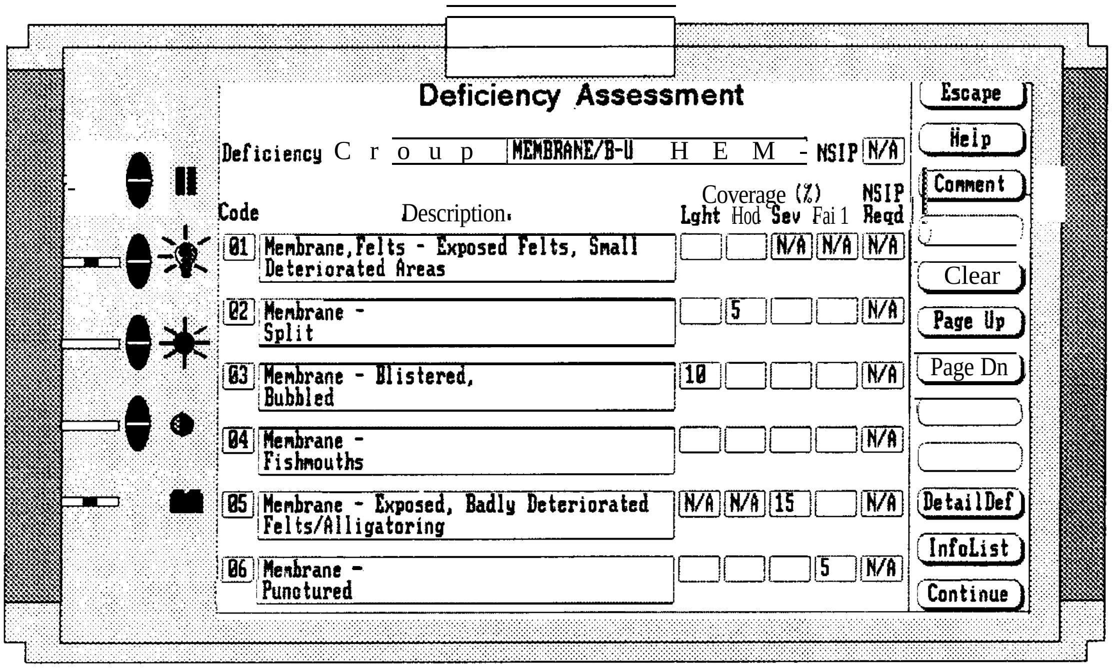
SCREEN	ACTION	COMMENT
3.1	1. Define locations of multiple WBS. Could be multiple systems or multiple parts of single system.	Inspector developed
	2. Define percentage of Asset serviced by WBS section	Inspector developed
	3. Press (Continue) after selecting multiple WBS locations from list and continue to Screen 4.0 to select Inspection Unit (IU).	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information or selecting another item
(Escape)	Press to return to Screen 3.0	By pressing (Escape) information is not verified and any changes made are lost
(RtrnWBS)	Press to return to WBS selection screen to make additional selections	N/A
(Delete)	Press to delete a highlighted entry on screen	N/A
▲	Press scroll up button	Used to scroll up through information.
▼	Press scroll down button	Used to scroll down through information.

SURVEY STEP IU SELECTION **Screen 4.0**



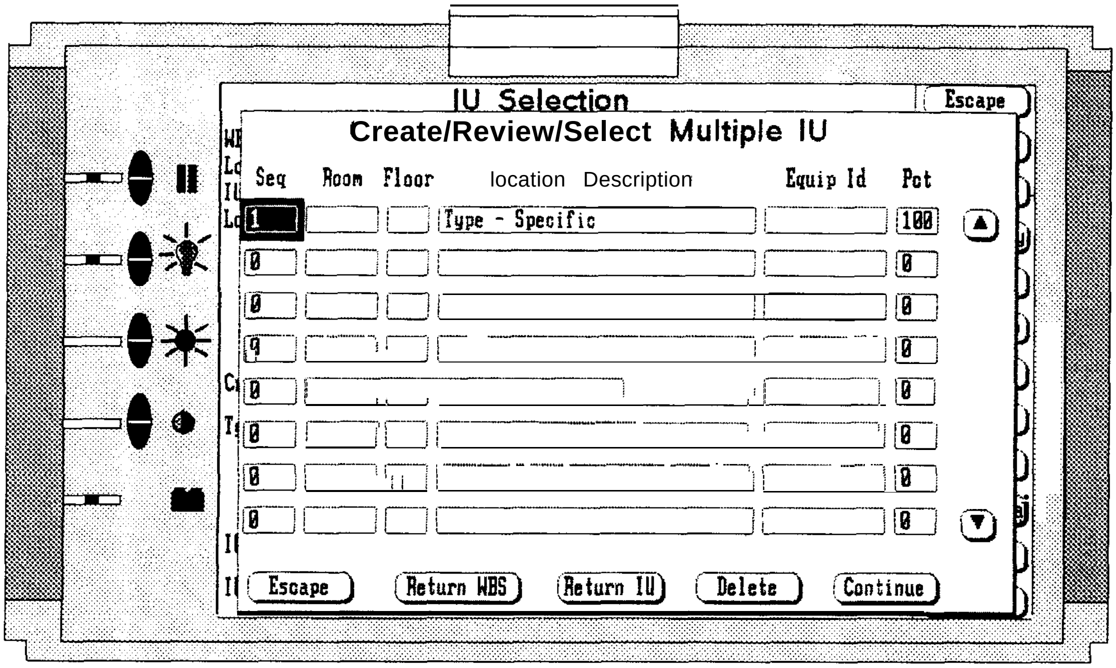
SCREEN	ACTION	COMMENT
4.0	1. Tap "Cmp" title for component picklist Cursor select or enter by pen	Picklist is preformatted
	2. Tap "Typ" title for type of component picklist Cursor select or enter by pen	Picklist is preformatted
	3. Press (Deficiency) to bring up deficiency assessment screen	Screen 4.1 brings up deficiency picklist for WBS IU
	4. Enter estimated life without repair	Inspector generated
	5. Enter estimated year "IU" installed	Inspector generated
	6. Tap "Status" title for picklist Cursor select or enter by pen	Picklist is preformatted
	7. Tap "Service" title for picklist Cursor select or enter by pen	Picklist is preformatted
	8. Tap "Importance" title for picklist	Picklist is preformatted
	9. Tap "Access" title for picklist Cursor select or enter by pen	Picklist is preformatted
	10. Enter year "IU" last inspected	Inspector generated
	11. Enter percentage of WBS served by inspection unit	Inspector generated
	12. Enter quantity of inspection unit at location as required	Inspector generated
	13. Press (Continue) to go to Screen 5.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information
(Escape)	Press to return to Screen 3.0	By pressing (Escape) information is not verified; and any changes made are lost
(Help)	Press to bring up screen help	Screen 99.1
(Comment)	Press to bring up screen for entering inspector comments	Screen 99.2
(Delete)	Press to delete an inspection unit record	N/A
(Scroll Up)	Press to scroll up thru inspection units selected	N/A
(Scroll Dn)	Press to scroll down thru inspection units selected	N/A
(Multi IU)	Press to create, view, or select multiple IU's and locations	Screen 4.2
(Repeat)	Press to repeat or copy inspection unit selection data as a new entry	N/A
(AddnlData)	Press to bring up Additional Data screen and enter boiler plate information	Screen 4.3 - Inspector generated
(RtrnWBS)	Press to save data entered and go to Screen 3.0 for next selection	By pressing (RtrnWBS) information is verified; corrections made by crossing through data and entering new information

SURVEY STEP DEFICIENCY ASSESSMENT Screen 4.1



SCREEN	ACTION	COMMENT
4.1	1. Select deficiency from list	Picklist preformatted
	2. Select degree of severity of deficiency	Inspector developed
	3. Enter percentage of coverage under selected severity	Inspector developed
	4. Indicate whether non-standard inspection/test procedures are required or recommended	Inspector choice, preset at "No": line through to deselect
	5. Press (Continue) to go to Screen 5.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information
(Escape)	Press to return to Screen 4.0	By pressing (Escape) information is not verified and any changes made are lost
(Help)	Press to bring up screen help	Screen 99.1
(Comment)	Press to bring up screen for entering inspector comments	Screen 99.2
(Clear)	Press to unselect a deficiency	N/A
(Page Up)	Press to scroll up though data by page	N/A
(Page Dn)	Press to scroll down through data by page	N/A
(Detail Def)	Press to bring up long description of selected deficiency	N/A
(InfoList)	Press to bring up information/directions preloaded for inspector	Screen 99.4

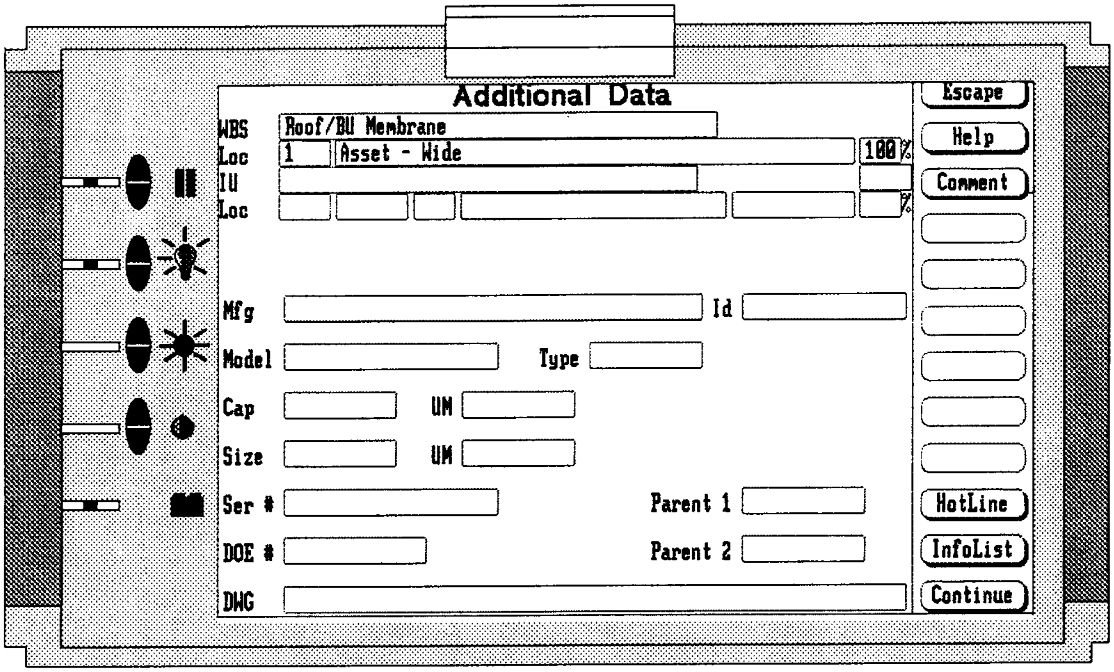
SURVEY STEP CREATE/REVIEW/SELECT MULTIPLE IU **Screen 4.2**



SCREEN	ACTION	COMMENT
4.2	1. Define locations of Multiple IU's by room, floor and/or location description - optional equipment identification number can be added	Inspector developed
	2. Define percentage of Asset or WBS serviced by IU	Inspector developed
	3. Press (Continue) after selecting Multiple IU location from list and continue to Screen 4.1 to select deficiencies	By pressing (Continue) information is verified; corrections made by crossing thru data and entering new information or selecting another item
(Escape)	Press to return to Screen 4.0	By pressing-information is not vedfied and any changes made are lost
(RtrnWBS)	Press to return to Screen 3.0	N/A
(RtrnIU)	Press to return to Screen 4.0	N/A
(Delete)	Press to delete a highlighted entry on screen	N/A
(▲)	Press scroll up button	Used to scroll up through information
(▼)	Press scroll down button	Used to scroll down through information

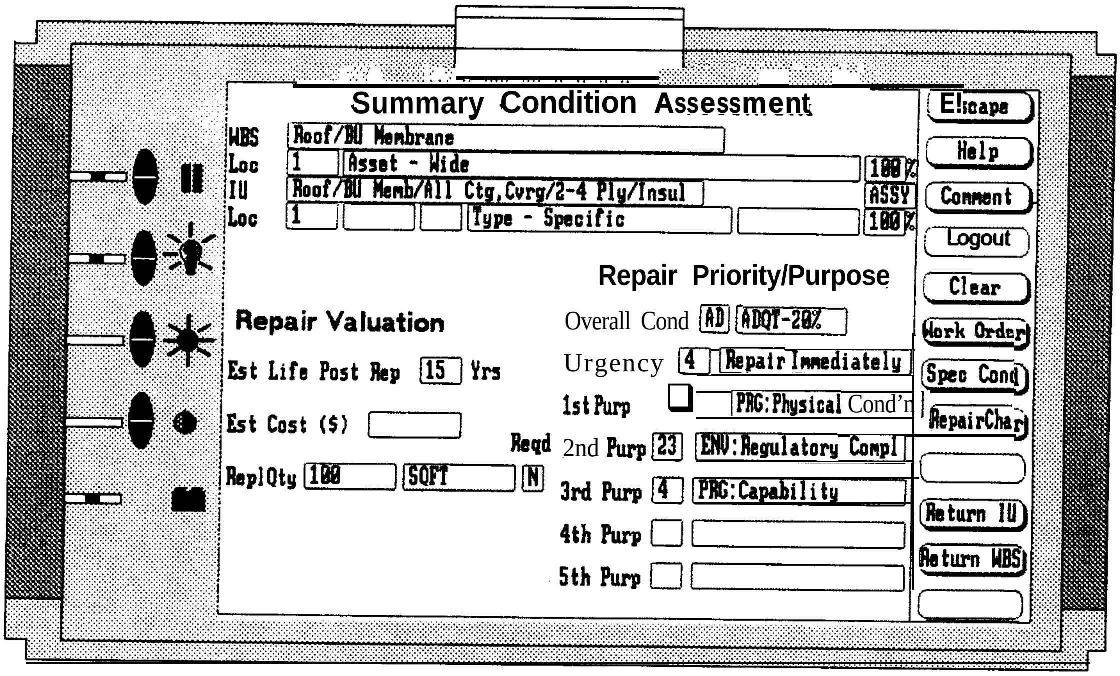
SURVEY STEP ADDITIONAL DATA

Screen 4.3



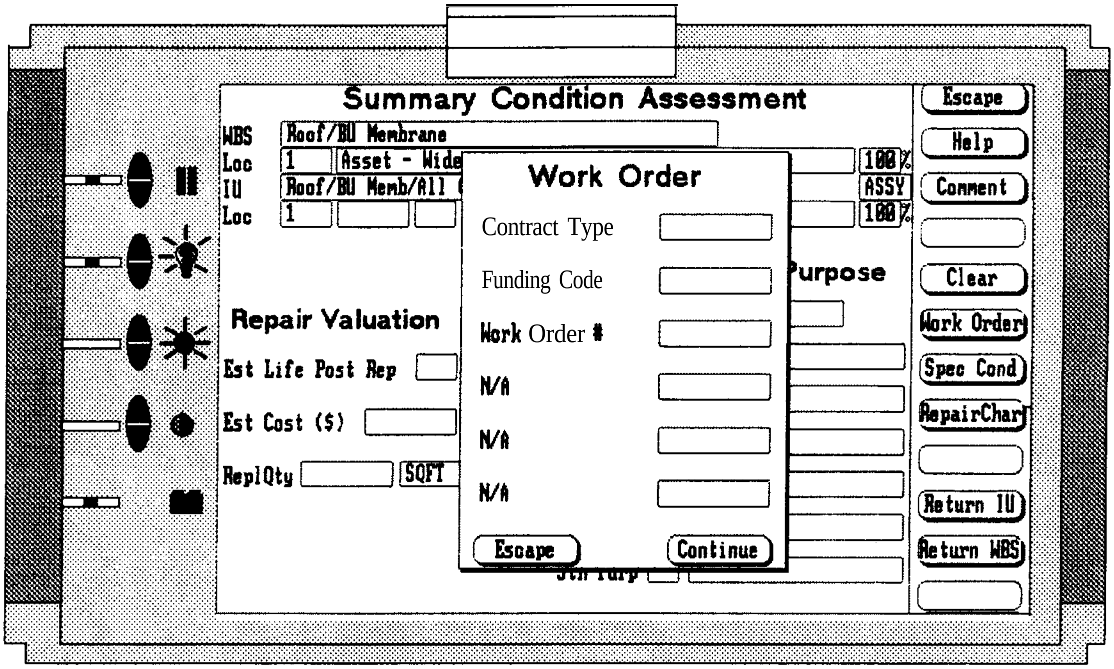
SCREEN	ACTION	COMMENT
4.3	1. Enter boiler plate data about component being inspected	Inspector generated from data on the component, drawing specifications or determined in the field. This data can be used for inventorying inspection units
	2. Press (Continue) to go to Screen 4.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information
(Escape)	Press to return to Screen 4.0	By pressing (Escape) information is not verified; and any changes made are lost
(Help)	Press to bring up screen help	Screen 99.1
(Comments)	Press to bring up screen for entering inspector comments	Screen 99.2
(Hotline)	Press for important contacts and telephone numbers	Screen 99.3
(InfoList)	Press to bring up information/directions preloaded for inspector	Screen 99.4

SURVEY STEP SUMMARY CONDITION ASSESSMENT Screen 5.0



SCREEN	ACTION	COMMENT
5.0	1. Tap "Overall Condition" title for picklist Cursor select or select by pen	Picklist preformatted, inspector determined
	2. Tap "Urgency" title for picklist Cursor select or enter by pen	Picklist preformatted, inspector determined
	3. Tap "Purp" title for picklist Cursor select or enter by pen Multiple purposes can be specified	Picklist preformatted inspector determined
	4. Enter estimated life of IU after repairs in years	Inspector determined
	5. Enter an estimated cost for repairs (optional)	Inspector determined
	6. Enter repair quantity as required	Inspector determined
	7. Press to save data entered and go to Screen 4.0 for next selection	By pressing (ReturnIU) information is verified; corrections made by crossing through data and entering new information
	8. Press to save data entered and go to Screen 3.0 for next selection	By pressing (ReturnWBS) information is verified; corrections made by crossing through data and entering new information
(Escape)	Press to return to Screen 4.0	By pressing (Escape) information is not verified and any changes made are lost
(Help)	Press to bring up screen help	screen 99.1
(Comment)	Press to bring up screen for entering inspector comments	Screen 99.2
(Logout)	Press to save all data entered and leave survey	N/A
(Clear)	Press to clear or delete an entry	N/A
(Work Order)	Press to bring up work order screen pop-up	Screen 5.1
(Spec Cond)	Press to bring up special condltiin screen pop-up	Screen 5.2
(Repair Char)	Press to bring up special repair characteristics screen pop-up	Screen 5.3

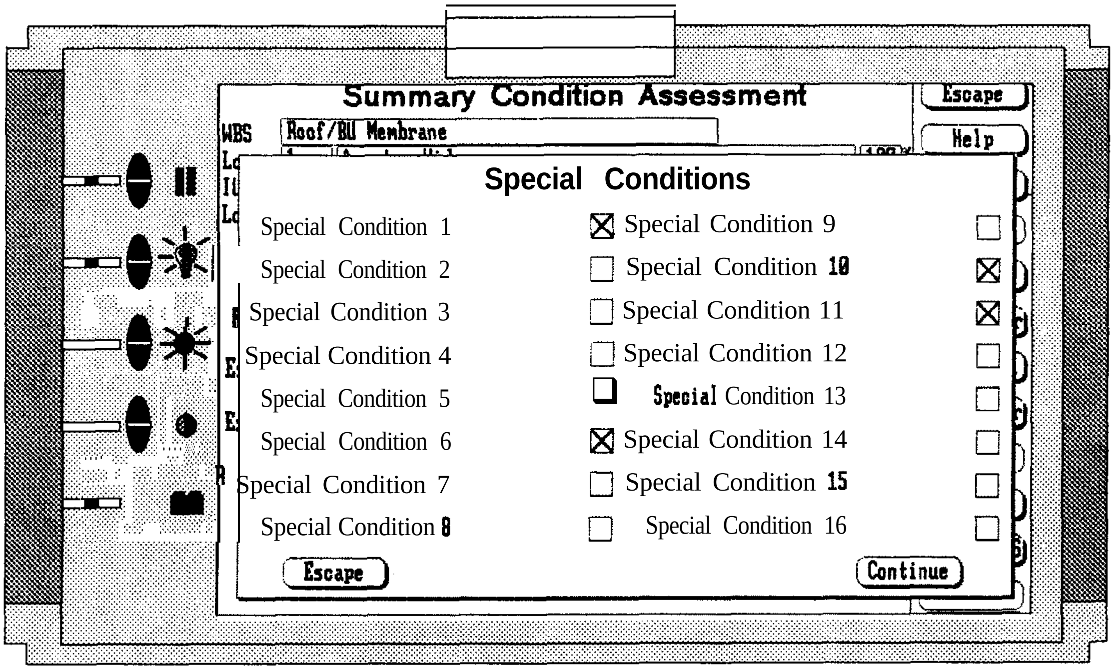
SURVEY STEP WORK ORDER GENERATION Screen 5.1



SCREEN	ACTION	COMMENT
5.1	1. Enter data to define Work Order number to tag repair to create a job estimate for repairs	Inspector generated as determined by Site Manager prior to survey
	2. Press (Continue) to go to Screen 5.0	By pressing (Continue) information is verified; corractiins made by crossing thnugh data and entering new information
	3. Press (Escape) to retwn to Screen 5.0	By pressing (Escape) information is not verified; and any changes made are lost

SURVEY STEP SPECIAL CONDITIONS SELECTION

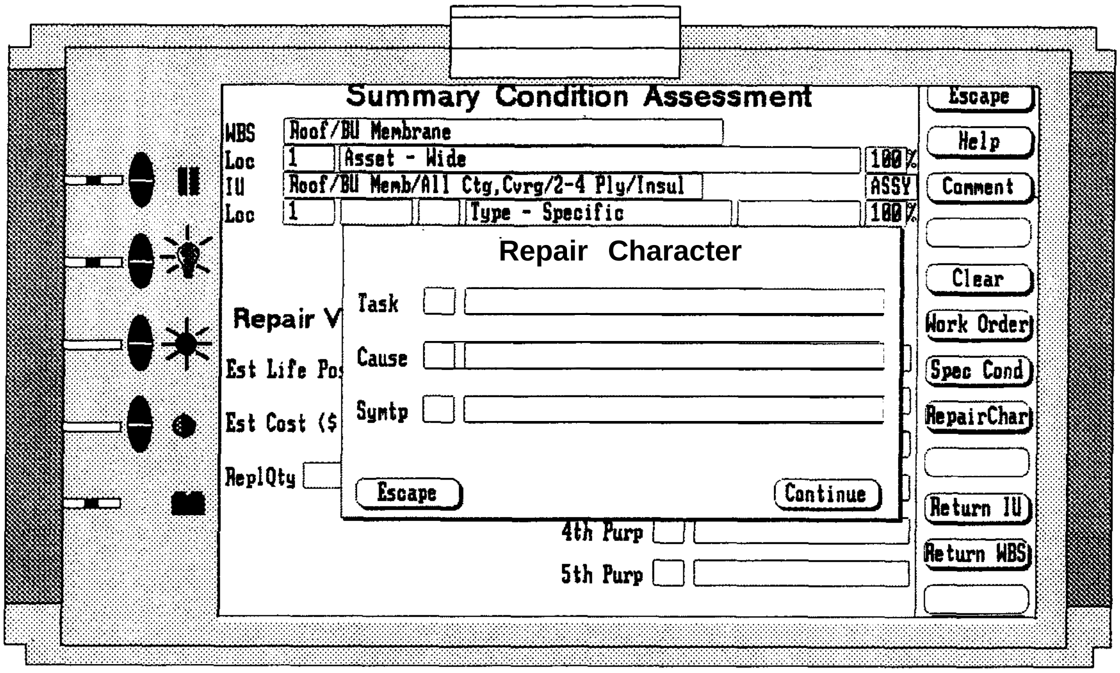
Screen 5.2



SCREEN	ACTION	COMMENT
5.2	1. Press box next to special condition to select	Picklist is preloaded by site. Selections determined by Site Manager prior to survey
	2. Press (Continue) to go to Screen 5.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information
	3. Press (Escape) to return to Screen 5.0	By pressing- information is not verified: and any changes made are lost

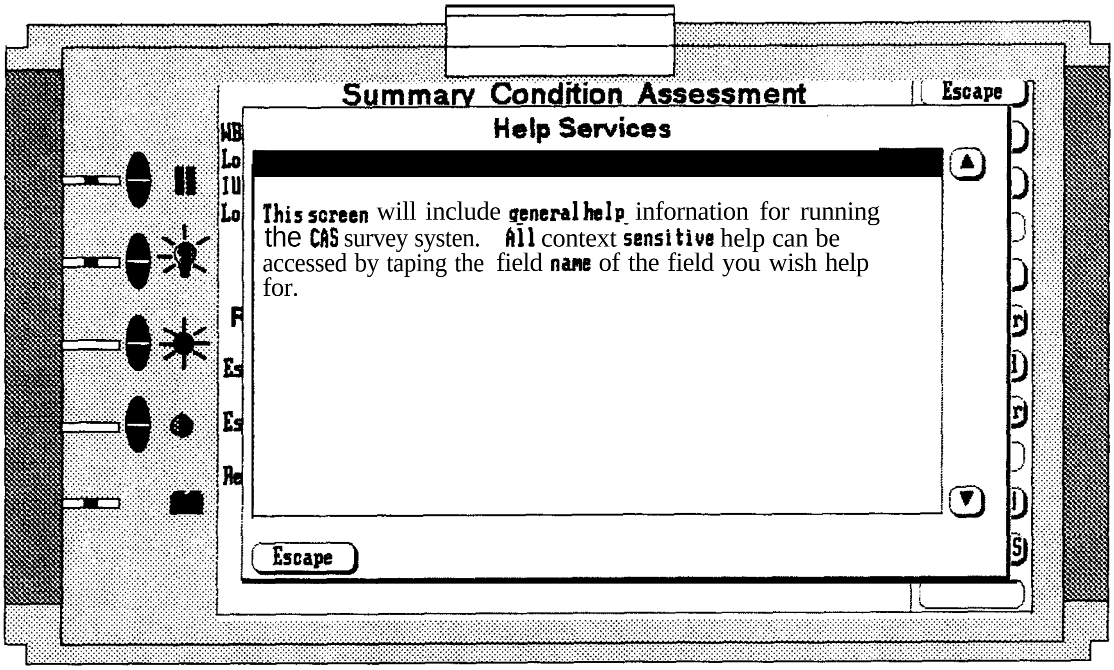
SURVEY STEP REPAIR CHARACTER DOCUMENTATION

Screen 5.3



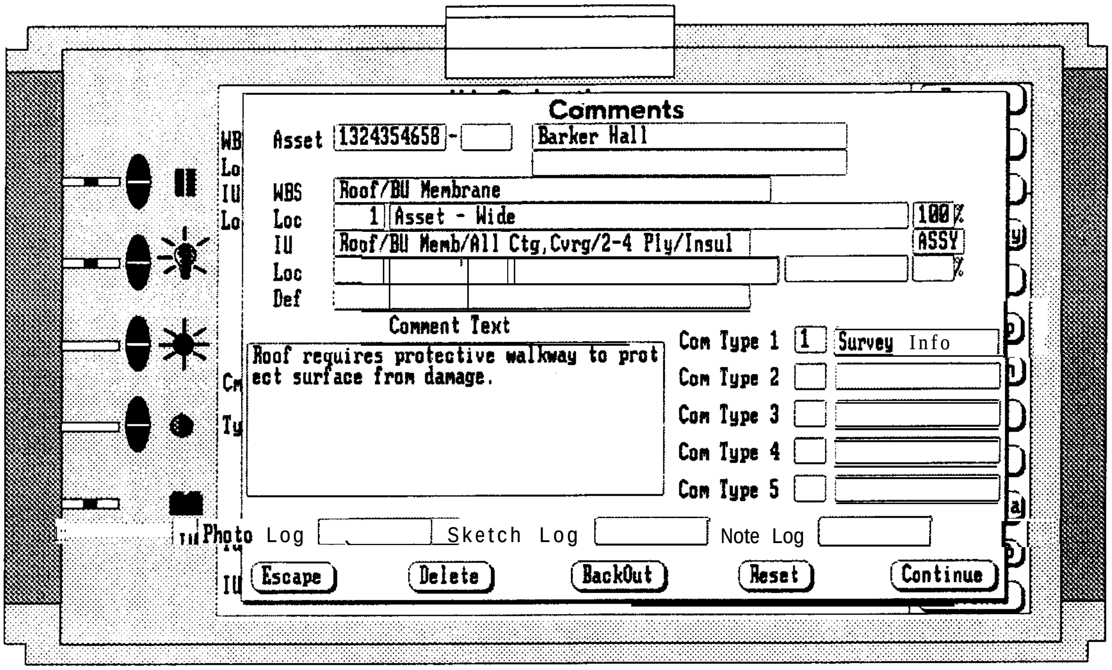
SCREEN	ACTION	COMMENT
5.3	1. Enter repair characteristics for tracking related deficiencies	Inspector generated from input of asset users to document what is deficient, what caused deficiency and any symptoms. Picklist can be preformatted
	2. Press (Continue) to go to Screen 5.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information
	3. Press (Escape) to return to Screen 5.0	By pressing (Escape) information is not verified; and any changes made are lost

SURVEY STEP HELP Screen 99.1



SCREEN	ACTION	COMMENT
99.1	N/A	Screen pop-up help information Dynamic help for locations selected Screen data cannot be changed
(Escape)	Press to exit Help Screen and return to previous screen	N/A
▲	Press scroll up button	Used to scroll up through information
▼	Press scroll down button	Used to scroll down through information

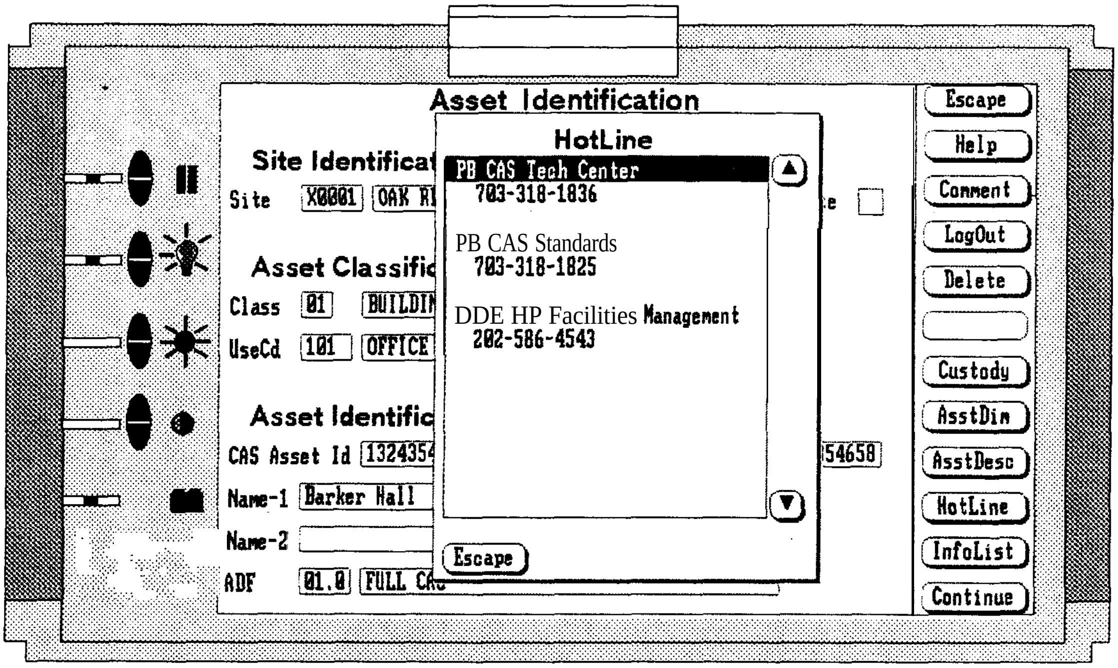
SURVEY STEP COMMENT SCREEN Screen 99.2



SCREEN	ACTION	COMMENT
99.2	1. Select a Comment Type Selection	Picklist preformatted
	2. Enter Comment inside comment text field (QWERTY keyboard can be called in to use)	Text field expands as required
	3. Enter a Photo, Sketch, or Note Log tag number	Can be standardized or inspector generated
	4. Press (Continue) to return to previous screen	By pressing (Continue) information is verified; corrections made by crossing thru data and entering new information
(Escape)	Press to exit comment screen and return to previous screen	By pressing- information is not verified and any changes made are lost
(Delete)	Press to delete a selected comment	N/A
(Backout)	Press to move backwards through the navigation screen at top	This option allows an inspector to move backwards to enter or change a comment tagged to a previous screen
(Reset)	Press to move forward through the navigation screen at top	This option allows an inspector to move forward after entering a comment on a previous screen to continue the inspection

SURVEY STEP HOTLINE SCREEN

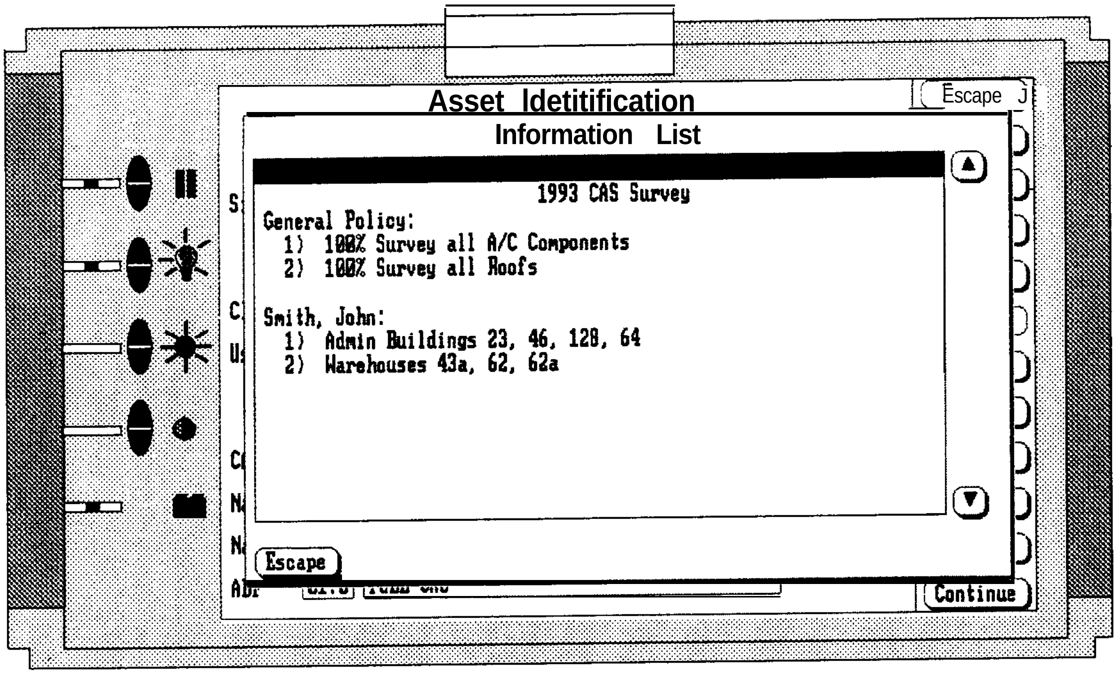
Screen 99.3



SCREEN	ACTION	COMMENT
99.3	N/A	Screen pop-up for important contacts and telephone numbers Preformatted and adjusted by Site Manager. Screen data cannot be changed by inspector
(Escape)	**Press** to exit Hotline screen and return to previous screen	N/A
▲	**Press** scroll up button	Used to scroll up through information
▼	**Press** scroll down button	Used to **scroll** down through information

SURVEY STEP INFO SCREEN

Screen 99.4



SCREEN	ACTION	COMMENT
99.4	1. CAS inspection parameters & schedules as inputted by site manager	Cannot be changed by inspector
(Escape)	Press to exit **InfoList** screen and **return** to **previous** screen	N/A
▲	**Press** scroll up button	Used to scroll up through information
▼	Press scroll **down** button	Used to scroll **down** through information

DATA COLLECTION METHODS

END OF SUBSECTION

FEDERAL SPECIFICATIONS

FEDERAL SPECIFICATION	TITLE
FS HH-M-622	Mortar, Refractory, Heat Setting, Bonding (Wet and Dry Types)
FS MM-L-738	Lumber, Hardwood
F8 MM-L-751	Lumber, Softwood
FS MM-P-371	Lumber Piles and Poles, Wood
FS MMM-A-001993	Adhesive, Epoxy, Flexible, Filled (for Binding, Sealing and Grouting)
FS QQ-S-763	Steel Bars, Wire, Shapes, and Forgings, Corrosion Resisting
FS QQ-S-775	Steel Sheets, Carbon, Zinc-Coated (Galvanized) by the Hot-Dip Process
FS QQ-W-461	Wire, Steel, Carbon (Round, Bare, and Coated)
FS RR-B-191	Bedpan, Corrosion-Resisting Steel
FED-STD 88	Steel, Chemical Composition and Hardening Ability
FS SS-C-158	Federal Specification for Cements, Hydraulic, General Specifications (methods for sampling, inspection, and testing)
FS SS-C-181	Federal Specification for Cement, Masonry
FS SS-C-192	Federal Specification for Cements, Portland (10 types)
FS SS-C-208	Federal Specification for Cement, Portland, Pouolana
USCE CRD-C13	Test for Evaluation of Air-Entraining Admixtures for Concrete
USCE CRD-C109	Field Test for Absorption by Aggregates
USCE CRD-C119	Test for Flat and Elongated Particles in Coarse Aggregates
USCE CRD-C129	Test for Particles of Low Specific Gravity in Coarse Aggregate (Sink-Float Test)
USCE CRD-C213	Test for the Presence of Sugar in Cement, Mortar, Concrete, and Aggregates
USCE CRD-C248	Corps of Engineers Specifications for Slag Cement
USCE CRD-C300	Specifications for Pigmented Membrane-Forming Compounds for Curing Concrete
USCE CRD C400	Requirements for Water for Use in Mixing or Curing Concrete

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FEDERAL SPECIFICATIONS

END OF SUBSECTION

NATIONAL STANDARDS

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	Standard Tolerances for Concrete Construction and Materials
ACI 211.89	Standard Practice of Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 211.2	Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 211.3	Standard Practice for Selecting Proportions for No-Slump Concrete
ACI 301	Specifications for Structural Concrete for Buildings
ACI 304	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 308	Standard Practice for Curing Concrete
ACI 309	Standard Practice for Consolidation of Concrete
ACI 318	Recommendations for Construction of Concrete Pavements and Concrete Bases
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 338.1	Standard Specification for the Construction fo End Bearing Drilled Piers
ACI 347	Recommended Practice for Concrete Formwork
ACI 508	Guide to Shotcrete

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC M013	Detailing for Steel Construction
AISC M014	Engineering for Steel Construction - The Source Book of Connections
AISC M015L	Load and Resistance Factor Design (LRFD) Manual of Steel Construction
AISC M016	Manual of Steel Construction ASD
AISC S302	Code of Standard Practice for Steel Buildings and Bridges
AISC S329	Allowable Stress Design Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts
AISC S335	Specification of Structural Steel Buildings - Allowable Stress Design and Plastic Design

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)

AITC 01	Timber Construction Manual
AITC 111	Recommended Practice for Protection of Structural Glued Laminated Timber During Transit, Storage, and Erection
AITC 112	Tongue-and-Groove Heavy Timber Roof Decking
AITC 117	Structural Glued Laminated Timber of Softwood Species, Design Requirements
AITC 200	Inspection Manual
AITC A190.1	Structural Glued Laminated Timber

NATIONAL STANDARDS

AMERICAN IRON & STEEL INSTITUTE (AISI)

AISI SG-671	Cold-Formed Steel Design Manual: Part I - Design of Cold-Formed Steel Structural Members
AISI SG-673	Cold-Formed Steel Design Manual

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A58.1	Minimum Design Loads for Buildings and Other Structures

AMERICAN PLYWOOD ASSOCIATION (APA)

APA AFG-01	Adhesives for Field-Gluing Plywood to Wood Framing
APA PRP-108	Performance Standards and Policies for Structural-Use Panels

AMERICAN SOCIETY FOR TESTING & MATERIALS (ASTM)

ASTM A6	Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use
ASTM A36	Structural Steel
ASTM A49	Heat-Treated Carbon Steel Joint Bars
ASTM A62	Steel Wire, Plain, for Concrete Reinforcement
ASTM AI43	Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM AI46	Steel Castings, High Strength, for Structural Purposes
ASTM AI64	Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM AI65	Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A211	Spiral-Welded Steel or Iron Pipe
ASTM A242	High-Strength Low-Alloy Structural Steel
ASTM A325	High-Strength Bolts for Structural Steel Joints
ASTM A416	Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
ASTM A421	Uncoated Stress-Relieved Wire for Prestressed Concrete
ASTM A496	Steel Wire, Deformed, for Concrete Reinforcement
ASTM A467	Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A562	Steel Structural Rivets
ASTM A529	Structural Steel with 42 ksi (290 MPa) Minimum Yield Point 1/2 in. (13 Micrometer) Maximum Thickness
ASTM A568	High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 in. (100 micrometer) Thick
ASTM A611	Steel, Sheet, Carbon, Cold-Rolled, Structural Quality
ASTM A615	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A616	Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A61 7	Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A633	Normalized High-Strength Low-Alloy Structural Steel
ASTM A706	Low-Alloy Steel Deformed Bars for Concrete Reinforcement
ASTM A722	Uncoated High-Strength Steel Bar for Prestressing Concrete
ASTM A767	Zinc-Coated (Galvanized) Bars for Concrete Reinforcement
ASTM C5	Quicklime for Structural Purposes
ASTM C6	Specification for Normal Finishing Hydrated Lime

NATIONAL STANDARDS

AMERICAN SOCIETY FOR TESTING & MATERIALS (ASTM)

ASTM C29	Unit Weight and Voids in Aggregate
ASTM C31	Making and Curing Concrete Test Specimens in the Field
ASTM C33	Concrete Aggregates
ASTM C39	Compressive Strength of Cylindrical Concrete Specimens
ASTM C40	Organic Impurities in Fine Aggregates for Concrete
ASTM C70	Surface Moisture in Fine Aggregate
ASTM C78	Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C87	Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C88	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C91	Masonry Cement
ASTM C94	Ready-Mixed Concrete
ASTM C 109	Compressive Strength of Hydraulic Cement Mortars (Using 2-in or 50-micrometer Cube Specimens)
ASTM CI 14	Chemical Analysis of Hydraulic Cement
ASTM CI 15	Fineness of Portland Cement by the Turbidimeter
ASTM CI 17	Materials Finer Than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM CI 23	Lightweight Pieces in Aggregate
ASTM CI 25	Concrete and Concrete Aggregates
ASTM CI 27	Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	Specific Gravity and Absorption of Fine Aggregate
ASTM CI31	Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM CI38	Sieve Analysis of Fine and Coarse Aggregates
ASTM CI 41	Hydraulic Hydrated Lime for Structural Purposes
ASTM CI 43	Standard Test Method for Slump of Portland Cement Concrete
ASTM CI 50	Portland Cement
ASTM CI51	Autoclave Expansion of Portland Cement
ASTM C 158	Water Retention by Concrete Curing Materials
ASTM CI 57	Length Change of Hardened Hydraulic-Cement Mortar and Concrete
ASTM CI71	Sheet Materials for Curing Concrete
ASTM C 172	Standard Method of Sampling Freshly Mixed Concrete
ASTM CI83	Sampling and the Amount of Testing of Hydraulic Cement
ASTM CI 84	Test for Fineness of Hydraulic Cement by the No. 100 and No. 200 Sieves
ASTM C 188	Heat of Hydration of Hydraulic Cement
ASTM C 187	Test for Normal Consistency fo Hydraulic Cement
ASTM CI88	Density. of Hydraulic Cement
ASTM CI90	Tensile Strength of Hydraulic Cement Mortars
ASTM CI 91	Time of Setting of Hydraulic Cement by Vicat Needle
ASTM C204	Fineness of Portland Cement by Air Permeability Apparatus
ASTM C206	Finishing Hydrated Lime
ASTM C207	Hydrated Lime for Masonry Purposes
ASTM C219	Definitions of Terms Relating to Hydraulic Cement
ASTM C226	Specification for Air-Entraining Additions for Use in the Manufacture of Air-Entraining Portland Cement

NATIONAL STANDARDS

AMERICAN SOCIETY FOR TESTING & MATERIALS (ASTM)

ASTM C227	Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar Bar Method)
ASTM C230	Specification for Flow Table for Use in Tests of Hydraulic Cement
ASTM C233	Air-Entraining Admixtures for Concrete
ASTM C243	Test for Bleeding of Cement Pastes and Mortars
ASTM C260	Air-Entraining Admixtures for Concrete
ASTM C265	Test for Calcium Sulfate in Hydrated Portland Cement Mortar
ASTM C266	Time of Setting of Hydraulic-Cement Paste by Gillmore Needles
ASTM C267	Chemical Resistance of Mortars, Grouts, and Monolithic Surfacings
ASTM C295	Petrographic Examination of Aggregates for Concrete
ASTM C309	Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311	
ASTM C330	Lightweight Aggregates for Structural Concrete
ASTM C332	Lightweight Aggregates for Insulating Concrete
ASTM C465	Specification for Processing Additions for Use in Manufacture of Hydraulic Cements
ASTM C494	Specification for Chemical Admixtures for Concrete
ASTM C535	Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C595	Blended Hydraulic Cements
ASTM C851	Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
ASTM D75	Methods of Sampling Aggregates
ASTM D96	Specification for Calcium Chloride
ASTM DII43	Method of Testing Piles Under Static Axial Compressive Load
ASTM D2166	Standard Test Methods for Unconfined Compressive Strength of Cohesive Soil
ASTM D2216	Standard Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
ASTM El 1	Specification for Wire Cloth Sieves for Testing Purposes

AMERICAN WELDING SOCIETY (AWS)

AWS 03	Welding Handbook
AWS A3.0	Standard Welding Terms and Definitions
AWS DI.I	Structural Welding Code - Steel
AWS DI.3	Structural Welding Code - Sheet Steel
AWS DI.4	Structural Welding Code - Reinforcing Steel
AWS D9.1	Sheet Metal Welding Code

AMERICAN WOOD-PRESERVERS ASSOCIATION (AWPA)

AWPA CI	All Timber Products - Preservative Treastment by Pressure Processes
AWPA C20	Structural Lumber - Fire-Retardant Treatment by Pressure Processes
AWPA M2	Inspection of Treated Timber Products
AWPA M4	Care of Preservative-Treated Wood Products

NATIONAL STANDARDS

BUILDING OFFICIALS & CODE ADMINISTRATORS INTERNATIONAL (BOCA)

BOCA SO	The BOCA National Plumbing Code

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI	Specifications for Placing Reinforcement
CRSI DA4	Manual of Standard Practice

NATIONAL FOREST PRODUCTS ASSOCIATION (NFOPA)

NFOPA 02	Manual for Wood Frame Construction

NATIONAL HARDWOOD LUMBER ASSOCIATION **(NHLA)**

NHLA 01	Rules for the Measurement & Inspection of Hardwood and Cypress

PORTLAND CEMENT ASSOCIATION (PCA)

PCA	Specifications for Plain and Reinforced Concrete
PCA	Architectural Concrete Specifications

PRECAST PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI **Mnl-116**	Manual for Quality Control for Plants and Production of precast and Prestressed Concrete Products
PCI Mnl-120	PCI Design Handbook - Precast and Prestressed Concrete

STEEL JOIST INSTITUTE (SJI)

SJI 01	Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC PA-1	Shop, Field, and Maintenance Painting

TRUSS PLATE INSTITUTE (TPI)

TPI **TPI**	Design Specification for Metal Plate Connected Wood Trusses
TPI QST	Quality Standard for Metal Plate Connected Wood Trusses Addendum to TPI-85
TPI **BWT**	Bracing Wood Trusses

NATIONAL STANDARDS

END OF SUBSECTION

INDUSTRY PUBLICATIONS

PUBLICATION	PUBLISHER
1991 ASTM Standard8 In **Building Codes**	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103
Index of **Federal Specifications, Standards** and **Commercial Item Descriptions**	General Services Administration Office of Federal Supply and Services 7th & D Streets, S.W. Washington, DC 20202
UL Building **Materials Directory**	Underwriters Laboratories, Inc. 333 Pfingsten Road Northbrook, IL 60062
FM Approval **Guide** and FM Lou **Prevention Data Sheets**	Factory Mutual Research Norwood, MA 02062
ACI **Detailing** Manual and Structural **Concrete** for **Buildings**	American Concrete Institute P.O. Box 19150 Detroit, MI 48219-0150

INDUSTRY **PUBLICATIONS**

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OTHER RELATED REFERENCES

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Minimizing Concrete Surface Abrasion. Plant Engineering. July 3, 1991.

The Performance of Portland Cement. ASTM Standardization News. January, 1992.

OTHERRELATEDREFERENCES

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APPENDIX A

ABBREVIATIONS

A, Amp	Ampere, Area
A/E	Architect-Engineer
AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
ABMA	American Boiler Manufacturers Association
ABS	Acrylonitrile-Butadiene-Styrene
AC	Alternating Current, Air Conditioning
ACFM	Actual Cubic Feet per Minute
ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
ACSM	American Congress on Surveying and Mapping
ADF	Asset Determinant Factor
ADJ	Adjustable
ADM	Action Description Memorandum
ADP	Automated Data Processing
AEC	U.S. Atomic Energy Commission
AFM	U.S. Air Force Manual
AFR	U.S. Air Force Regulation
AFWL	U.S. Air Force Weapons
AGA	American Gas Association
AHU	Air Handling Unit
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ALARA	As Low as Reasonably Achievable
Allow	Allowance
Amb	Ambient
AMC	U.S. Army Materiel Command
AMCA	Air Movement Contractors Association
AMC-R	Army Materiel Command Regulation
Amp	Ampere
ANS	American Nuclear Society
ANSI	American National Standards Institute
API	American Petroleum Institute
Approx.	Approximately
AR	U.S. Army Regulation
AREA	American Railway Engineering Association
ARI	American Refrigeration Institute
ARMA	Asphalt Roofing Manufacturers Association
ASBC	American Standard Building Code
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration & Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATM	Atmosphere
AVG	Average
AVLIS	Atomic Vapor Laser Isotope Separation
AWG	American Wire Gauge
AWS	American Welding Society

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AWWA	American Water Works Association
BAT	Best Available Technology
BATEA	Best Available Technology Economically Achievable
BCPCT	Best Conventional Pollutant Control Technology
BESEP	Base Electronic System Engineering Plan
BHP	Brake Horsepower
BI	Black Iron
BIA	Brick Institute of America
BIL	Basic Impulse Insulation Level
BKRS	Breakers
BLDG	Building
BOCA	Building Official Code Association
BOD	Biochemical Oxygen Demand
	Building Research Advisory Board (now Building Research Board)
BRB	Building Research Board
BRG	Bearing
BTU	British Thermal Unit
°C	Degrees Centigrade (Celsius)
C&GS	U.S. Coast and Geodetic Survey (now National Geodetic Survey)
C M	Clean Air Act
CAMS	Continuous Air Monitoring System
CAS	Condition Assessment Survey
C C N	Closed Circuit Television
CDR	Conceptual Design Report
CEM	Continuous Emissions Monitoring
CERC	U.S. Army Coastal Engineering Research Center
CERCLA	Comprehensive Environmental Response, Compensation, & Liability Act
CF	Cubic Feet
CFC	Chlorofluorocarbon
CFM	Cubic Feet per Minute
CFR	Code of Federal Regulations
CGA	Compressed Gas Association
CHW	Chilled Water
CI	Cast iron
CIP	Cast-in-Place, Cast Iron Pipe
CISCA	Ceiling and Interior Systems Contractors Association
CISPI	Cast Iron Soil Pipe Institute
CMP	Corrugated Metal Pipe
CO_2	Carbon Dioxide
COE	U.S. Army Corps of Engineers
COMPR	Compressor
COP	Coefficient of Performance
CP	Concrete Pipe
CPLG	Coupling
CPSC	Consumer Product Safety Commission
CPVC	Chlorinated Polyvinyl Chloride
CRI	Carpet and Rug Institute
CRT	Cathode Ray Tube
C_v	Flow coefficient
c w	Cold Water
CWA	Clean Water Act
CYL	Cylinder

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DAC	Derived Air Concentration
DARCOM	U.S. Army Development, Acquisition and Readiness Command
DB	Dry Bulb, Decibel
DBA	Design Basis Accident
DBE	Design Basis Earthquake
DBF	Design Basis Fire
DBFL	Design Basis Flood
DBG	Distance Between Guides
DBT	Design Basis Tornado
DBW	Design Basis Wind
DC	Direct Current
DCQ	Derived Concentration Guide
DCPA	Defense Civil Preparedness Agency
DL	Dead Load
DM	NAVFAC Design Manual
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOP	Dioctylphthalate
DOT	U.S. Department of Transportation
DP	Differential Pressure
DP-1	Assistant Secretary for Defense Programs
DP-34	Director of Safeguards and Security Agreement
DPDT	Double-Pole Double-Throw
DSC	Differential Scanning Calorimetry
DTA	Differential Thermal Analysis
DWT	Double Wrap Traction
DWV	Drain, Waste & Vent
DX	Direct Expansion
DYN	Dyne
EA	Each
ECC	Emergency Control Center
ECP	Entry Control Point
EMCS	Energy Monitoring and Control System
ECS	Emergency Control Station
EDE	Effective Dose Equivalent
EED	Electroexplosive Device
EIA	Electronics Industries Association
EIFS	Exterior Insulation and Finish System
EIMA	Exterior Insulation Manufacturers Association
EIS	Environmental Impact Statement
Elev	Elevator
EM	U.S. Army Engineering Manual
EMS	Energy Management System
EMT	Electrical Metallic Tubing
EO	Executive Order
EOC	Emergency Operating Center
EPA	U.S. Environmental Protection Agency
EPS	Emergency Power System
Equip	Equipment
ERDA	Energy Research and Development Administration (precursor to DOE)
ESF	Engineered Safety Feature
Est	Estimated

APPENDIX A

Ext	Exterior
°F	Degrees Fahrenheit
F M	Federal Aviation Administration
FAI	Fauske and Associates, Inc.
FAR	Federal Acquisition Regulation
FCC	Federal Construction Council
FEMA	Federal Emergency Management Agency
FGA	Flat Glass Marketing Association
FGCC	Federal Geodetic Control Committee
FGD	Flue Gas Desulphurization
FHWA	Federal Highway Administration
FHDA	Fir and Hemlock Door Association
Fig	Figure
FIPS	Federal information Processing Standards
Fixt	Fixture
Flr	Floor
FM	Factory Mutual
Fndtn	Foundation
FPM	Feet Per Minute
FPT	Female Pipe Thread
FR	Federal Register
fr	Frame
FS	Federal Specifications
FSAR	Final Safety Analysis Report
Ft	Foot, feet
Ft/lb	Foot-Pound
FWPCA	Federal Water Pollution Control Act
fy	Yield strength
G	Gauss
g	Gram
GA	Gypsum Association
ga	Gauge
Gal	Gallon
Galv	Galvanized
GDC	General Design Criteria, DOE 6430.1A
GPD	Gallon Per Day
GPH	Gallon Per Hour
GPM	Gallons Per Minute
GSA	General Services Administration
HE	High Explosives
HE-PU	High Explosives-Plutonium
HF	High Frequency, Hydrogen Fluoride
HI	Hydraulic Institute
HID	High Intensity Discharge
HLW	High-Level Waste
HOA	Hand-Off-Automatic
HP	Horsepower
HR	Hour
Htg	Heating
Htt	Heater
HTW	High Temperature Water
HVAC	Heating, Ventilating, and Air-Conditioning

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Hvy	Heavy
HW	Hot Water
Hyd	Hydraulic
HX	Heat Exchanger
Hz	Hertz, frequency
IAPMO	International Association of Plumbing and Mechanical Officials
IAS	Intrusion Alarm System
ICBO	International Conference of Building Officials
ICRP	International Commission on Radiological Protection
ID	Inside Diameter
IDA	Intrusion Detection and Assessment
IDS	Intrusion Detection System
IEEE	Institute of Electrical and Electronic Engineers
IES	Illumination Engineering Society
IFM	Irradiated Fissile Material
IFYSF	Irradiated Fissile Material Storage Facility
IHE	Insensitive High Explosives
IMC	Intermediate Metal Conduit
In	Inch
Incl	Installed, Including
Inst	Installation
Insul	Insullation
IP	Iron Pipe
IPS	Iron Pipe Size
IPT	Iron Pipe Threaded
ISDSI	Insulated Steel Door Systems Institute
IU	Inspection Unit
IUEC	International Union of Elevator Contractors
J	Joule
°K	Degrees Kelvin
K	Subgrade modulus, Thousand, heavy wall copper tubing
Kg	Kilogram
kHz	Kilohertz
Kip	1000 pounds
Km	Kilometer
kPa	kilo Pascal
Kv	Kilovolt
kVA	kiloVolt Ampere
kW	kilowatt
kWh	kilowatt hour
lb	Pound
lb/hr	Pounds Per Hour
lbf	Pounds Per Foot
LCC	Life-Cycle Cost
LCD	Liquid Crystal Display
LF	Linear Feet
LL	Live load psf - pounds per square foot
LLW	Low-Level Waste
LP	Liquid Petroleum, Low Pressure
LPG	Liquified Petroleum Gas
Lt	Light
LV	Low Voltage

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MA	Management and Administration (U.S. DOE)
mA	milliAmpre
MAA	Material Access Area
Mach	Machine
Maint	Maintenance
MAWP	Maximum Allowable Working Pressure
MBA	Material Balance Area
MBH	Thousand BTUs per Hour
MBMA	Metal Building Manufacturers' Association
MC&A	Material Control and Accountability
MCF	Thousand Cubic Feet
Mfg	Manufacturing
Mfr	Manufacturer
MCC	Motor Control Center
mg	Milligram
mg/l	Milligrams per liter
MGPH	Thousand Gallons Per Hour
Mhz	Megahertz
MI	Miles, total level route
MIL-HDBK	U.S. DOD military handbook
MIN	Minute
mln	Minimum
Mlsc	Miscellaneous
ml	Millileter
ML/SFA	Metal Lath/Steel Framing Association
mm	Millimeter
M&O	Management and Operations
MPH	Miles Per Hour
MPT	Male Pipe Thread
mr/h	milli roentgen/hour
mrad/h	milli roentgen, absorbed dose/hour
mrem	milli roentgen equivalent man
MSSA	Master Safeguards and Security Agreement
Mtng	Mounting
MVA	Million-Volt-Amps
N_2	Nitrogen
N/A	Not Applicable
NAAMM	National Association of Architectural Metal Manufacturers
NACE	National Association of Corrosion Engineers
NAD	North American Datum
NAEC	National Association of Elevator Contractors
NAESA	National Association of Elevator Safety Authorities
NAPHCC	National Association of Plumbing-Heating-Cooling Contractors
NASA	National Aeronautics and Space Administration
NAVFAC	Naval Facilities Engineering Command
NBC	National Building Code
NBS	National Bureau of Standards
NC	Noise Criteria
NCEL	Naval Civil Engineering Laboratory (references listed under NAVFAC)
NCMA	National Concrete Masonry Association
NDA	Non-Destructive Assay
NEC	National Electrical Code

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NEII	National Elevator Industry Incorporated
NEMA	National Electrical Manufacturers Association
NEMI	National Elevator Manufacturing Industry, Inc. (now NEII)
NEPA	National Environmental Policy Act
NFGS	Naval Facilities Guide Specification (references listed under NAVFAC)
NFPA	National Fire Protection Association
NGS	National Geodetic Survey (formerly U.S.Coast and Geodetic Survey)
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NIJ	National Institute of Justice
NIST	National Institute of Standards and Technology (see NBS)
N O M	National Oceanic and Atmospheric Administration
NO	Normally Open
NO_x	Oxides of Nitrogen
NPDES	National Pollutant Discharge Elimination System
NPDWS	National Primary Drinking Water Standards
NPSH	Net Positive Suction Head
NPT	National Pipe Thread
NRC	Nuclear Regulatory Commission
NRCA	National Roofing Contractors Association
NRTA	Near-Real-Time Accountancy
NRTL	Nationally Recognized Testing Laboratory
NSA	National Security Agency
NSPC	National Standard Plumbing Code
NSPS	New Source Performance Standards
NTIA	National Telecommunications and Information Administration
NTMA	National Terrazzo and Mosaic Association
NUREG	Nuclear Regulatory Commission-produced reference document
NWWDA	National Wood Window and Door Association
OA	Outside Air
OBA	Operating Basis Accident
OBE	Operating Basis Earthquake
o c	On Center
o c s	Office of Computer Services (U.S. DOE)
OD	Outside Dimension
ODH	Oxygen Deficiency Hazards
O & M	Operations and Maintenance
OMB	Office of Management and Budget
OP AMP	Operational Amplifier
Oper	Operator
OPFM	Office of Project and Facilities Management (U.S. DOE)
OS&Y	Outside Screw and Yoke
OSHA	Occupational Safety and Health Administration
OSR	Operational Safety Requirement
o s s	Office of Safeguards and Security (U.S. DOE)
OSTI	Office of Scientific and Technical Information (U.S. DOE)
OWG	Oil, Water, or Gas
Oz	Ounce
p	Minimum reinforcing ratio
PA	Protected area
PB	Polybutylene
PCB	Polychlorinated biphenyls

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PCI	Prestressed Concrete Institute
PEL	Permissible Exposure Limit
PF	Protection Factor
Ph	Phase
PI	Point of Intersection, Proportional-plus Integral
PIV	Post Indicator Valve
PLF	Pounds per Linear Foot
Pkg	Package
PMFL	Probable Maximum Flood
POL	Petroleum, Oil, and Lubricants
POTW	Publicly-Owned Treatment Works
PPHF	Plutonium Processing and Handling Facility
PPM	Parts Per Million
PRV	Pressure Regulating Valve
PSAR	Preliminary Safety Analysis Report
PSF	Plutonium Storage Facility, Pound-force per square foot
PSI	Pound-force per square inch
PSIA	Pounds per square inch absolute
PSIG	Pound-force per square inch gauge
PTI	Post Tensioning Institute
Pu	Plutonium
PUBN	Publication
PURPA	Public Utility Regulatory Policy Act
PVC	Polyvinyl Chloride
QA	Quality Assurance
Qty	Quantity
R	Resistance
R12, R22	Refigerant (12,22, etc.)
°R	Degrees Rankine
RCP	Reinforced Concrete Pipe
RCRA	Resource Conservation and Recovery Act
RDF	Refuse-Derived Fuel
REM	Roentgen Equivalent Man
Reqd	Required
RFCI	Resilient Floor Covering Institute
RG	Regulatory Guide
RLWF	Radioactive Liquid Waste Facility
RPFM	Real Property and Facilities Management (U.S. DOE)
RPIS	Real Property Inventory System (U.S. DOE)
RPM	Revolutions Per Minute
RSWF	Radioactive Solid Waste Facility
RTD	Resistance Temperature Detector
S&S	Safeguards and Security
SAR	Safety Analysis Report
SARS	Safety Analysis and Review System
SAS	Secondary Alarm Station
SC	Safety Class
SCFM	Standard Cubic Feet per Minute
SCR	Sillicon Control Rectifier
SCS	U.S. Department of Agriculture, Soil Conservation Service
SDI	Steel Deck Institute, Steel Door Institute
SDWA	Safe Drinking Water Act

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SF	Safety Factor
SGFT	Structural Glazed Facing Tile
SISL	Special Isotope Separation Laser
SJI	Steel Joist Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SNG	Supplementary Natural Gas
SNM	Special Nuclear Materials
SO_2	Sulfur dioxide
SOP	Standard Operating Procedure
SP	Special Publication (of the American Concrete Association)
SPCC	Spill Prevention Control and Countermeasure
SPDT	Single-Pole Double-Throw
SPRI	Single Ply Roofing Institute
SPST	Single-Pole Single-Throw
ssco	Single Speed Center-Opening
SQFT	Square foot
SSE	Safe Shutdown Earthquake
SSFI	Scaffolding, Shoring, and Framing Institute
SSSP	Site Safeguards and Security Plan
SSPC	Steel Structures Painting Council.
ssss	Single Speed Side-Sliding
STC	Sound Transmission Classification
Std	Standard
STP	Standard Temperature and Pressure
Sys	System
SWI	Steel Window Institute
SWP	Safe Working Pressure
SWT	Single Wrap Traction
T	Ton, Temperature
TCA	Tile Council of America, Inc.
TCDD	Tetrachlorodibenzo-p-dioxin
TDS	Total Dissolved Solids
TEC	Total Estimated Cost
TID	Tamper Indicating Device
TIMA	Thermal Insulation Manufacturers Association
TLV	Threshold Limit Value
TM	U.S. Army technical manual
tot	Total
TR	DOD technical report
Transf	Transformer
TRU	Transuranic
TSCA	Toxic Substances Control Act
TSD	Treatment, Storage and Disposal
Tstat	Thermostat
TYP	Typical
TV	Television
U value	Overall heat transfer coefficient value
UBC	Uniform Building Code
UCRF	Uranium Conversion and Recovery Facility
UEF	Uranium Enrichment Facility
UEU	Unirradiated Enriched Uranium

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UEUSF	Unirradiated Enriched Uranium Storage Facility
UF_4	Uranium tetrafluoride
UF_6	Uranium hexafluoride
UFAS	Uniform Federal Accessibility Standards
UHF	Ultra High Frequency
UL	Underwriters Laboratory
UMC	Uniform Mechanical Code
UO_2	Uranium dioxide
UO_3	Uranium trioxide
UPA	Unit Process Area
UPC	Uniform Plumbing Code
UPHF	Uranium Processing and Handling Facility
UPS	Uninterruptible Power Supply
URF	Uranium Recovery Facility
USC	U.S. Code
USCE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
USPHS	U.S. Public Health Service
USPS	U.S. Postal Service
V	Volt
VA	Volt-Ampere
Vac	Vacuum
VAV	Variable Air Volume
VCT	Vinyl Composition Floor Tile
Vel	Velocity
Vent	Ventilating
VHF	Very High Frequency
Vol	Volume
W	Watt
WB	Wet Bulb
WBT	Wet Bulb Temperature
WC	Water Column
WG	Water Gauge
WB	Wet Bulb
WBS	Work Breakdown Structure
WPCF	Water Pollution Control Federation
WRC	Water Resources Council
Yd	Yard
Yr	Year

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SYMBOLS

°R'	Degrees Rankine
°K	Degrees Kelvin
°F	Degrees Fahrenheit
°C	Degrees Centigrade (Celcius)
>	Greater Than
<	Less Than
≥	Greater Than or Equal To
≤	Less Than or Equal To
%	Percent
#	Pound, Number
α, Α	Alpha
β, Β	Beta
ϕ, Φ	Theta
λ, Λ	Lambda
μ, Μ	Mu
π, Π	Pi
σ, Σ	Sigma
ω, Ω	Omega

APPENDIX A

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APPENDIX B

GLOSSARY

Abutment: That part of a structure that takes the thrust of a beam, arch, vault, truss, girder, or foundation wall.

Accelerator: Any material added to concrete that speeds the natural setting.

Admixture: Act of mixing or the compound formed by mixing different substances together.

Aggregates: Inert minerals such as sand, gravel, and crushed stone. The aggregates are divided into two sizes - fine and coarse.

Anchor: A piece or connected pieces of metal used for tying together two or more pieces of masonry materials.

Anchor Bolts: Bolts to secure a wooden sill plate to concrete or masonry floor or wall. A threaded bolt, usually embedded in a foundation or footing to secure a column base or other structural member.

Arch: A curved structural member used to span an opening or recess; also built fiat. Structurally, an arch is a piece or assemblage of pieces so arranged over an opening that the supported load is resolved into pressures on the side supports, and practically normal to their faces.

Awls: A sharp edge forming an external corner at the junction of two surfaces.

Base: The lowest part, or the lowest main division, of a building, column, pier, or wall.

Base Plate: See Bearing Plate.

Beam: A structural member transversely supporting a load.

Bearing: That part of a lintel, beam, girder or truss, that rests upon a column, pier, or wall.

Bearing Partition: A partition that supports any vertical load in addition to its own weight.

Bearing **Plate:** A piece of steel, iron, or other material that receives the load concentration and transmits it to the masonry or concrete.

Bearing Wall: A wall that supports any vertical load in addition to its own weight.

Bevel: The angle that one surface or line makes with another, when they are not at right angles.

Bond Beam: A horizontally reinforced concrete or concrete masonry beam built to strengthen and tie a masonry wall together. A bond beam is often placed at the top of a masonry wall with continuous reinforcing around the entire perimeter.

Bolster: A short horizontal timber or steel beam on top of a column to support and decrease the span of beams or girders.

Bugged **Finish:** A smooth finish produced by grinding with power sanders.

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Buttross:	A piece of masonry, like a pier, built against and bonded into a wall to strengthen the wall against side thrust.
Buttress (Flying):	A detached buttress or pier of masonry at some distance from the wall, and connected thereto by an arch or portion of an arch, to assist in resisting side thrust.
C/B Ratio:	The ratio of the water weight absorbed by cold immersion (usually 24 hours) to the weight absorbed by immersion in boiling water (usually 5 hours). This ratio is also known as the saturation coefficient.
Calcite **Streaks:**	Description of a white or milky streak occurring in stone. It is a joint plane usually wider than a glass seam that has been recemented by deposition of calcite in the crack. It is structurally sound.
Camber:	A slight or upward curve of a structural member so that it becomes horizontal, or nearly so, when loaded.
Caulking:	The operation or method of rendering a joint tight against water by means of some plastic substances such as oakum, pitch, elastic cement, and the like.
Check Cracks:	Shrinkage cracks in concrete still bonded to its base.
Chip Cracks:	Similar to check cracks, except that the bond has been partially destroyed, causing eggshelling. Sometimes referred to as fire cracks, map cracks, crazing, fire checks, or hair cracks.
Column:	A pillar or pier of rather slender proportions that carries a load and acts as an upright support.
Concrete:	A mixture of two components, cement paste, and aggregates.
Concrete plain:	Concrete either without reinforcement, or reinforced only for shrinkage or temperature changes.
Connectors:	A device that holds two or more structural members intact.
Construction Joint:	The interface/meeting surface between two successive concrete pours.
Coping:	The material or member used to form a capping or finish on top of a wall, pier, or the like, to protect the masonry below by throwing off the water to one or more sides.
Counterfort:	A buttress or portion projecting from a wall and upward from the foundation to provide additional resistance to thrusts.
creep:	The time-dependent deformation of steel or concrete due to sustained load.
Crown:	The top or high point of a horizontal surface.

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Deformed Bars: Reinforcing bars with closely spaced shoulders, lugs, or projections formed integrally with the bar during rolling so as to firmly engage the surrounding mortar. Wire mesh with welded intersections not farther apart than 12 inches (30 cm.) in the direction of the principal reinforcement and with cross wires not smaller than No. 10 may be rated as a deformed bar.

Drip: Any projecting piece of material, member or part of a member so shaped and placed as to throw off water and prevent its running down the face of a wall or other surface of which it is a part.

Dry Seam: Unhealed fracture which is a plane of weakness.

Dusting: The development of dust on the surface of concrete. Dusting can be the result of trowelling too soon, too much water in the mix, improper mix design, or other reasons.

Effective Area of Reinforcement: The area obtained by multiplying the right cross-sectional area of the metal reinforcement by the cosine of the angle between its direction and that for which the effectiveness of the reinforcement is to be determined.

Effective Depth: The distance from the center of gravity of tensile reinforcement to the compression surface of a structural member.

Efflorescence: Mortars or cements containing an excess of soluble salts that contribute to masonry efflorescence. Efflorescence can only occur when water penetrates the masonry or concrete, dissolves the salts, and upon evaporation deposits them on the face of the wall. The surest preventative of efflorescence is to keep water out of masonry or concrete.

Eggshelling: Refers to the condition of chip-cracked concrete, mortar, or plaster. The form taken is concave to the surface and the bond is partially destroyed.

Enclosure Wall: An exterior non-bearing wall in skeleton construction, anchored to columns, piers, or floors, but not necessarily built between columns or piers nor wholly supported at each story.

Expanded Metal: Sheets of metal that are slit and drawn out to form diamond-shaped openings. This is used as a metal reinforcing for plaster and is termed metal lath.

Expansion Anchor: A metal expandable unit inserted into a drilled hole that grips stone by expansion.

Expansion Joint: A bituminous fiber strip used to separate blocks or units of concrete to prevent cracking due to expansion as a result of temperature changes. Also used in concrete slabs.

Face: The front or exposed surface of a wall.

Facing: Any material, forming a part of the wall, used on the exterior as a finishing surface.

APPENDIX B

Fire Resistance: The property of a material or assembly to withstand fire, characterized by the ability to confine a fire and/or to continue to perform a given structural function.

Fireproofing: Any material or combination of materials used to enclose structural members to make them fire resistant.

Flashing: The material used and the process of making watertight the roof intersections and other exposed places on the outside of the house structure.

Formwork: The total system of support for freshly placed concrete including the mold or sheathing which contacts the concrete, as well as all supporting members, hardware and necessary bracing.

I-Beam: A structural member of rolled steel whose cross section resembles the capital letter I.

Incombustible (Building Material): Any building materialthat does not contain matter subject to rapid oxidation within the temperature limits of a standard fire test of not less than 2.5 hours duration. NOTE: Materials that continue burning after this time period are combustible.

Joint: The space between the adjacent surfaces of two members or components joined and held together by nails, glue, cement, mortar, or other means.

Joist: One of a series of parallel beams, usually 2 inches (5 cm.) in thickness, used to support floor and ceiling loads, and supported in turn by larger beams, girders, or bearing walls.

Key: A wedge section of masonry placed at the crown of an arch, acting as a key.

Keystone: The wedge-shaped stone placed at the top center of an arch.

Lintel: A horizontal structural member that supports the load over an opening such as a door or window.

Lintel (Safety): A lintel of wood or other suitable material placed behind the main lintel or behind an arch; generally used in conjunction with a relieving arch.

Miter: The junction of two units at an angle. The junction line usually bisects on a 45 degree angle.

Non-Bearing Wall: Any wall that carries no load other than its own weight.

Panel Wall: A non-bearing wall in skeleton construction, built between columns or piers, and wholly supported at each story.

Partition: A wall that subdivides spaces within any story of a building.

Perm: A measure of water vapor movement through a material (grains per square foot per hour per inch of mercury difference in vapor pressure).

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Pier(s):	A column of masonry, usually rectangular in horizontal cross section, used to support other structural members; or supports set independently of the main foundation.
Pilaster:	A pier, built as an integral part of a wall, and projecting slightly from either vertical surface thereof.
Pipe Column:	A column made of steel pipe and often filled with concrete.
Plumb:	Exactly perpendicular; vertical.
Post:	A timber set on end to support a wall, girder, or other member of the structure.
Precast Concrete:	A concrete member that is cast and cured in other than its final position.
Reglet:	A recess to receive and secure metal flashing.
Reinforced Brick **Masonry** (R-B-M):	Brick masonry in which metal is embedded in such a manner that the two materials act together in resisting forces.
Reinforcement:	Structural steel shapes, steel bars, rods, wire mesh, or expanded metal embedded or encased in brick or other masonry or concrete to increase its strength.
Reinforcing:	Steel rods or metal fabric placed in concrete slabs, beams, or columns to increase their strength.
Retarder:	Any material added to concrete, mortar, or grout that slows up its natural set.
Scaffold or Staging:	A temporary structure or platform enabling workmen to reach high places.
Sealant:	A resilient compound used as the final weatherface in stone joints. (This term is sometimes misused to indicate clear water-repellent treatments that are sometimes sprayed or otherwise applied to masonry.)
Shrinkage:	The volume change in concrete caused by drying normally occurring during the hardening process.
Skeleton Construction:	A type of building construction in which all loads are transmitted to the foundation by a rigidly connected framework of suitable material, with the enclosing walls supported by girders or by the floor at each floor level.
Skew:	Inclination in any direction.
Smooth **Finish:**	A finish of minimum textural quality, presenting the least interruption of surface. Smooth finish may be applied to any surface, fiat, or molded. It is produced by a variety of machines.
Solid Wall:	Walls built of solid masonry units (or solid concrete), laid contiguously, with spaces between the units completely filled with mortar.

APPENDIX B

Spall: A small fragment removed from the face of stone, brick, masonry, or concrete material by impact or due to weather.

Span: The distance between structural supports such as walls, columns, piers, beams, girders, and trusses.

Splay: A beveled or slanted surface.

Springing **Line:** A line marking the level from which the curve of an arch or vault rises from the upright or impost.

Structural **Tube** Columns: Structural column shaped as a square or rectangle.

Stud: One of a series of slender wood or metal vertical structural members placed as supporting elements in walls and partitions.

support: An angle, plate, or other stone that carries a gravity load.

Swedge Anchor: An anchor bolt, threaded at one end and swedged or flattened in spots along the shank so as to produce greater holding power.

Tall Beam: A relatively short beam or joist supported in a wall on one end and by a header at the other.

Template: A pattern used in the fabrication operation.

Texture: Any finish other than a smooth finish.

Tolerance: Acceptable dimensional allowance, under or over ideal net sizes.

Wall **Plate** Anchor: A machine bolt anchor, with a head at one end and threaded at the other, and fitted with plate or punched washer so as to securely engage the brickwork or concrete and hold the wall plate or other member in place.

Walls, Bearing: A wall supporting a vertical load in addition to its own weight.

Walls, **Cavity:** A wall in which the inner and outer wyths are separated by an air space, but tied together with metal ties.

Walls, **Composite:** A wall in which the facing and backing materials are bonded together.

Water **Retentivity:** Flow and resistance to segregation are factors affecting workability, which in turn are affected by the properties of both the cementitious materials and the aggregate.

Welded **Wire** Mesh: A series of longitudinal and transverse wires arranged substantially at right angles to each other and welded together at all points of intersection.

Workability: That property of freshly mixed concrete or mortar that determines the ease and homogeneity with which it can be mixed, placed, compacted, and finished.

END OF SUBSECTION

APPENDIX C

TECHNICAL BULLETINS/UPDATES/ADVISORIES

Index of Bulletins/Advisories
followed by Bulletins/Advisories
as developed

APPENDIX C

TECHNICAL ADVISORY TO501 -1

DATE: 10/91
SYSTEM: Roofing (CSI 07000)
ASSEMBLY: Built-Up (CSI 07510)
SUBJECT: Roof Top Lighting and Insect Damage

"In March, 1988 a professional roofing magazine article described a bizarre but apparently avoidable, phenomenon. In about a dozen documented cases ranging from Washington State to Florida, beetles have bored through roof membranes, causing leaks. It was determined that the beetles are attracted to lights (especially mercury vapor) mounted on, over, or near roof surfaces, including nearby billboard lighting. Falling to the roof, they burrow into the roof substrate, seeking protection from the sun during the day. The types of roof membrane affected were asphaltic BUR, modified bitumen, and single-ply roofing. Evidently, no instance has yet been found among coal tar BUR. It is advisable to exercise care in the selection of roof membranes where billboards may exist adjacent to a planned roof installation, or when rooftop lighting is required. The roof specifier should discuss the types of luminaire to be used with project electrical engineers before mercury vapor fixtures are specified."

Source: Roofing Design Criteria Options. **R.D.** Herbert II

EXAMPLE: TECHNICAL ADVISORY BULLETIN

END OF SUBSECTION

APPENDIX D

REVISIONS SUMMARY

AT A GLANCE SUMMARY OF ALL

REVISIONS UP TO LATEST REVISION DATE

APPENDIX D

END OF SUBSECTION