I

Department of Energy

Condition Assessment Survey (CAS) Program

Deficiency Standards & Inspections Methods Manual

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for
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Washington, DC 20585

VOLUME 1: 0.01 FOUNDATIONS & FOOTINGS

Printed with soy ink on recycled paper

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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 wav of seeina familiar thinas. 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?

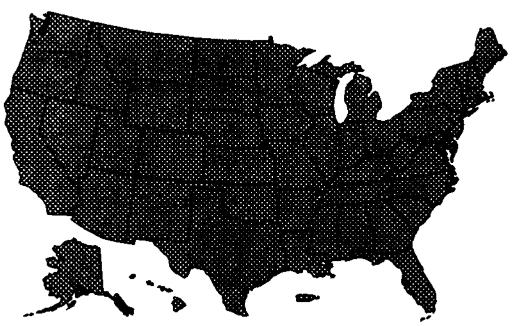
  Strategies for beginning to use CAS and the key roles facility managers and CAS inspectors play within the CAS process are detailed.

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.

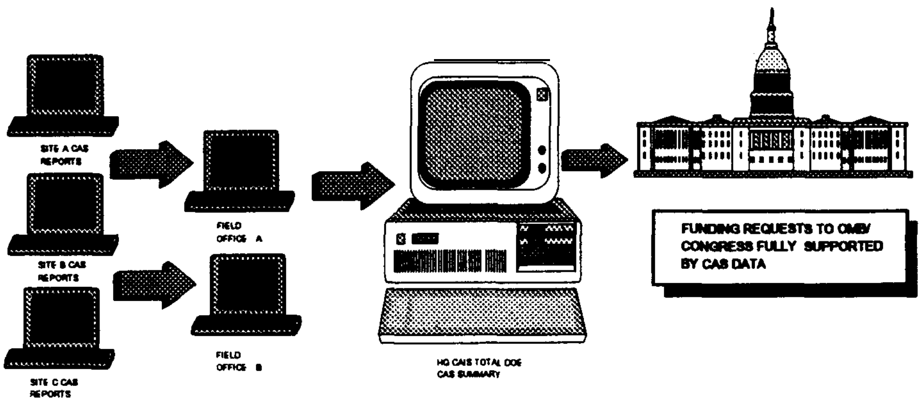
The current state of condition assessment across all DOE assets is mixed. While DOE regulations dictate facility assessments be made, no one methodology is mandated to conduct them. As a result, DOE surveys have varied from site to site, with some locations providing exhaustive in-depth analysis while 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."

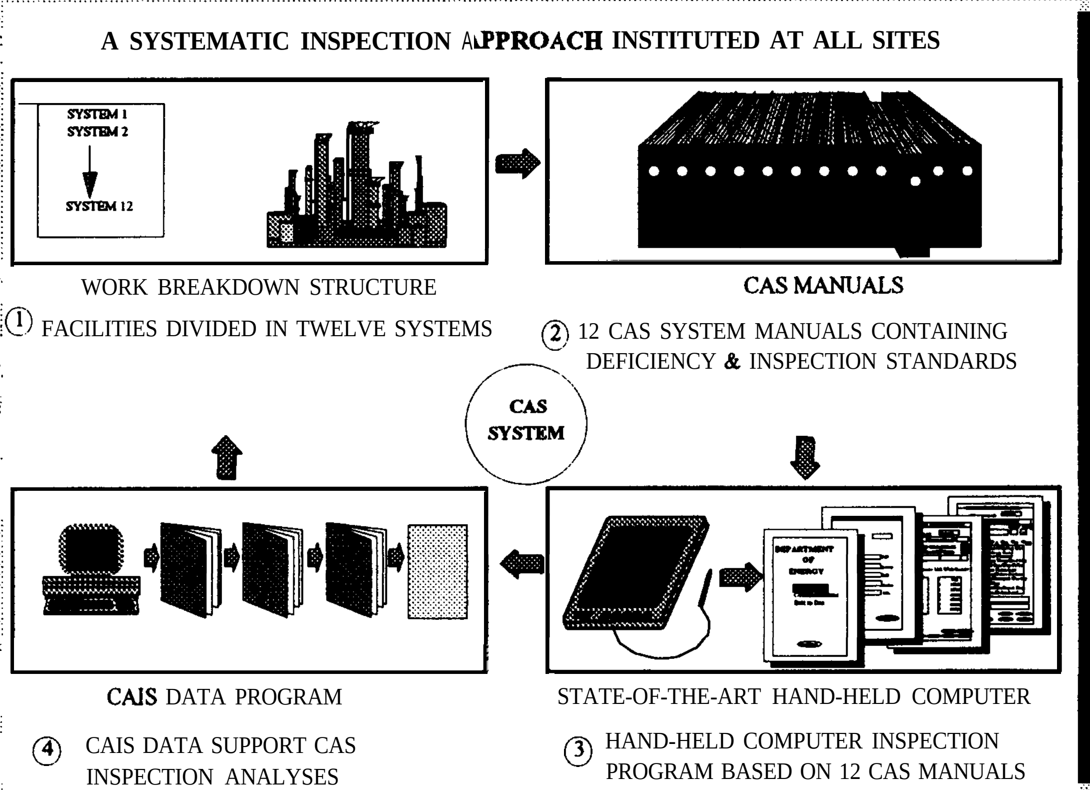
Standardize **Inspection** programs:
To remove the problem of inconsistent and misinterpreted facility inspection data, a "standard" evaluation method used by all DOE sites is required. Results from such a program will allow DOE to determine a "base condition" for all of its assets.

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?



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	THERMAL & 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)

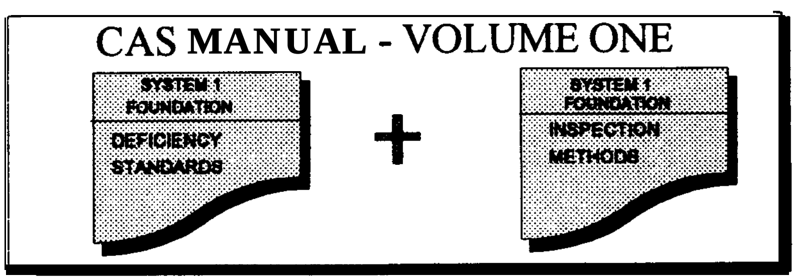
*NOTE: This section supersedes Means 0.10 category and includes FIS 700 Series Asset Codes.

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

1.3 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.

1.6 **System** Work **Breakdown** Structun **(WBS)** - Complete listing of all assemblies/components

1.7 **General System/Material** Dab - 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.

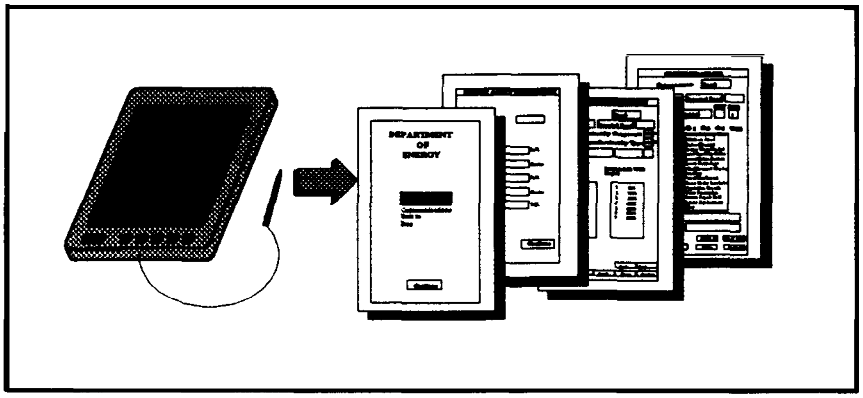
Appendix D **Revisions** Summary - All revisions listed in chronological sequence. The last revision listed will be the most current modification.

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.

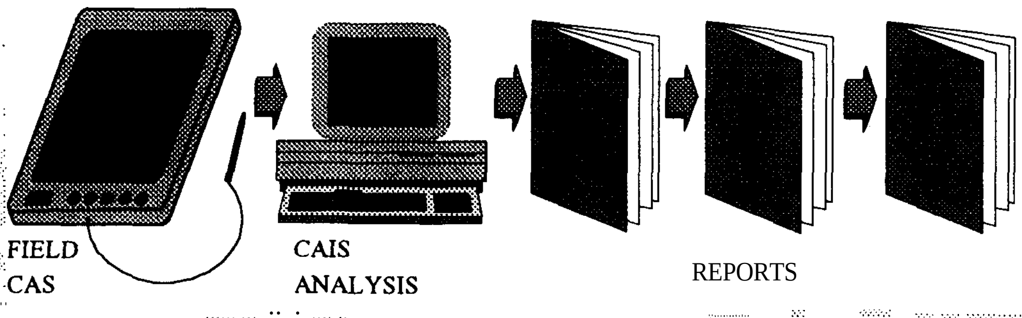
In short, the CAS process will be conducted in a carefully structured, "standardized" manner to ensure that the quality of raw inspection data is consistent throughout all DOE installations.

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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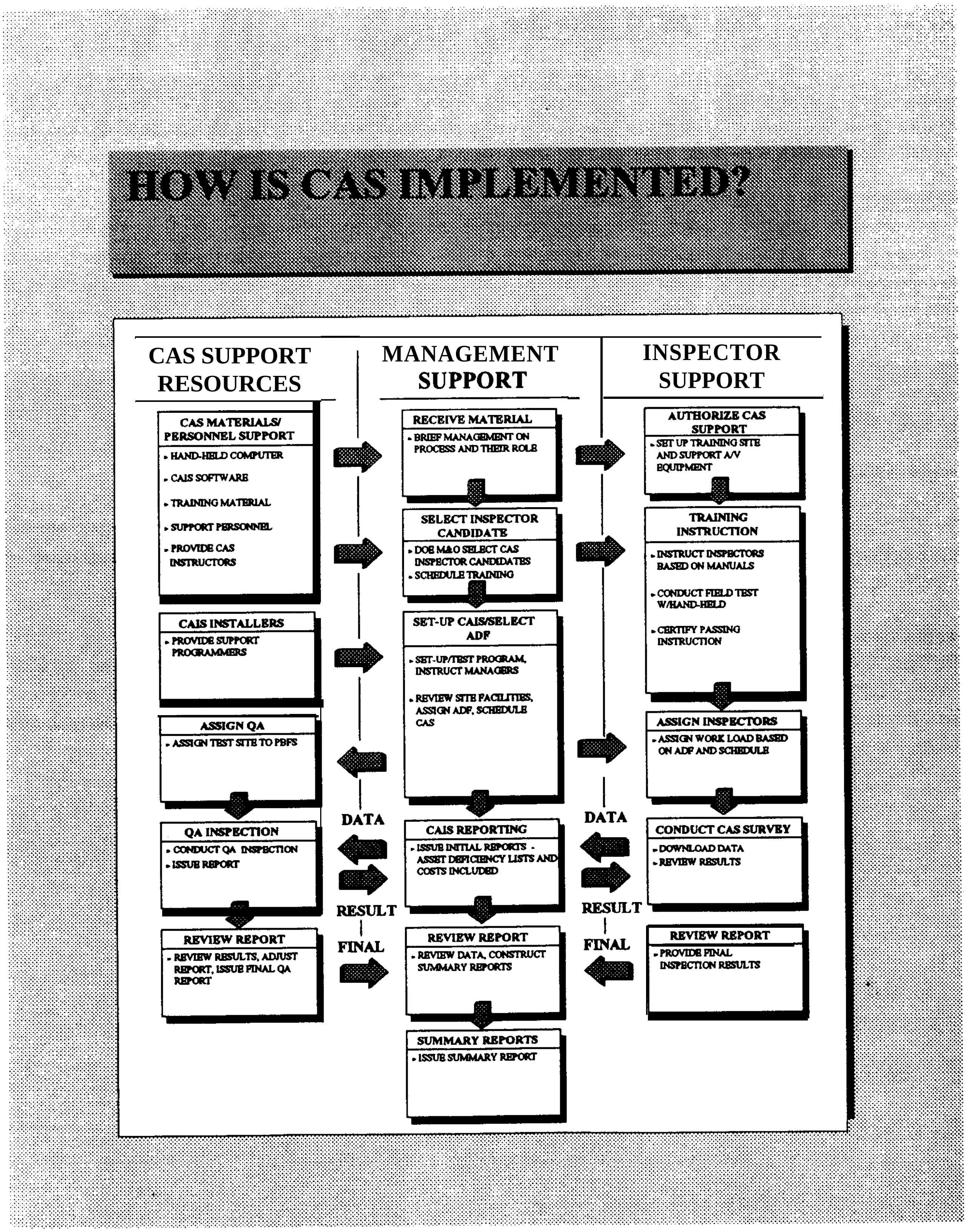


INTRODUCTION

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.

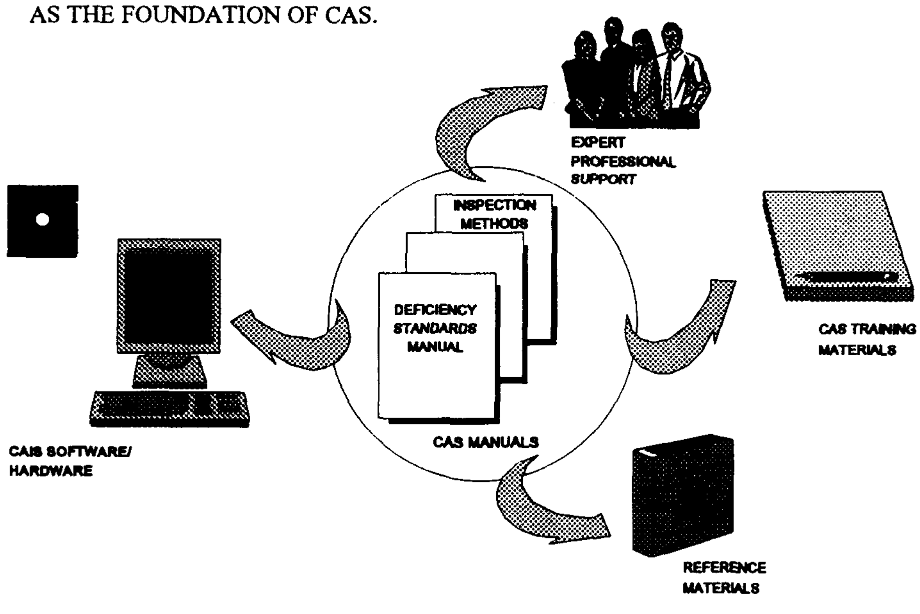
CAS Inspectors:
Without highly skilled, knowledgeable inspectors, the CAS Program will not succeed. The integrity of these inspectors and their expertise will ensure that the base data supporting the,entire CAS process will be an accurate reflection of the condition of the DOE inventory of facilities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

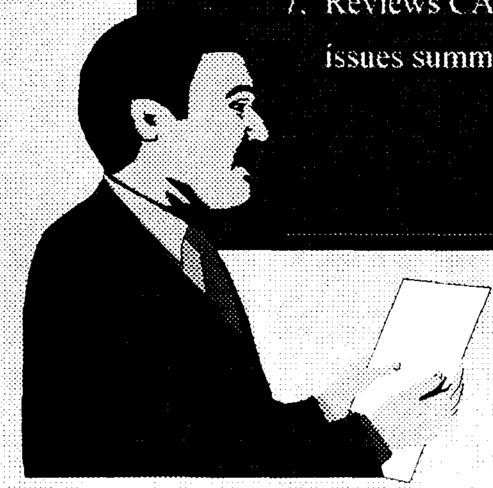
CAS/CAIS Hotline:
The Contractor will provide support resources in order to field questions from various site locations. Expert engineers, architects, and computer programmers will answer with written and/or verbal responses all inquiries originating from the field.

INTRODUCTION

HOW IS CAS IMPLEMENTED?

MANAGEMENT KEY ROLES

1. Coordinates CAS program implementation
2. Sets up training location & equipment support
3. Selects CAS inspector candidates
4. With CAS/CAIS contractor, coordinates CAIS installation and testing
5. Analyzes site assets and assigns Asset Determinant Factor (ADF)
6. Schedules inspection
7. Reviews CAIS reports, provides analysis, and issues summary reports



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.

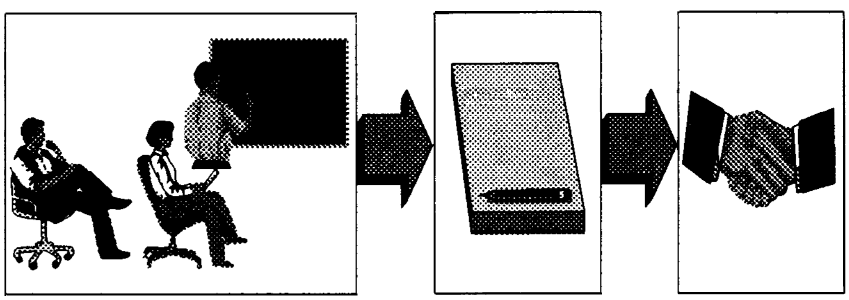
Report Analysis:
The process of up-loading CAS field data to the PC-based CAIS program will be demonstrated to the M&O CAS managers. Analysis processes will be examined using predetermined, formatted reports. Final management project "sorts" and prioritization schemes, and construction of summary reports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

INTRODUCTION

HOW IS CAS IMPLEMENTED?

CAS INSPECTOR CERTIFICATION

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



CLASSROOM TRAINING TESTING CERTIFICATION

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 Exorcise:
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.

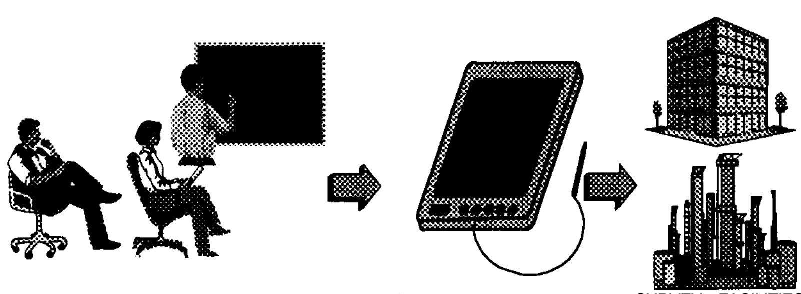
Certification Test:
At the completion of the CAS training, each candidate is required to take and pass a written examination based on the material covered in the class. It is the goal of the training team to pass 100% of the candidates. Those having difficulty will receive additional instructor attention 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



ASSIGN INSPECTORS PRELOADED "MENU" DATA SURVEY FACILITIES

INTRODUCTION

HOW IS CAS IMPLEMENTED? - The Survey 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).

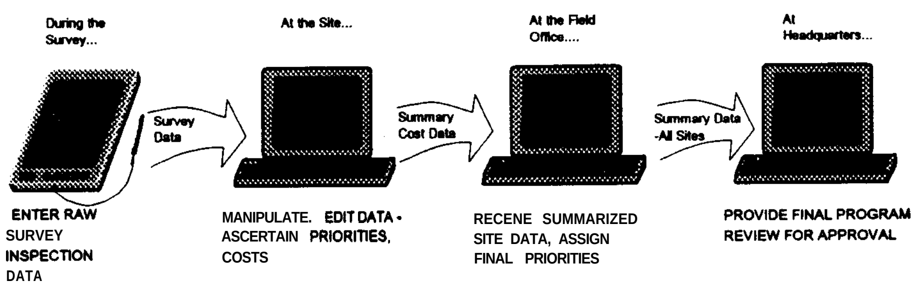
CAS **Report Generated** by **CAIS:**
After completing the CAS Inspection, information is uploaded to the PC-based CAIS system. "Universal" reports showing all asset deficiencies, observations, associated cost, scheduling priorities, and repair purposes will be produced. As part of the QA, the Inspector 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)[1]	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, 0.06, 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)[1]	0.05
6	Asset ARCHITECTURAL only	ARCH/STRUCTURAL inspection (base CAS - assembly level or optional component level)[1]	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)[1]	0.07, 0.08
8	Asset ELECTRICAL only	ELECTRICAL inspection (base CAS - assembly level or optional component level)[1]	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 only and systems may be added to base ADF values as required.

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

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:

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	**Adequate:** 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.

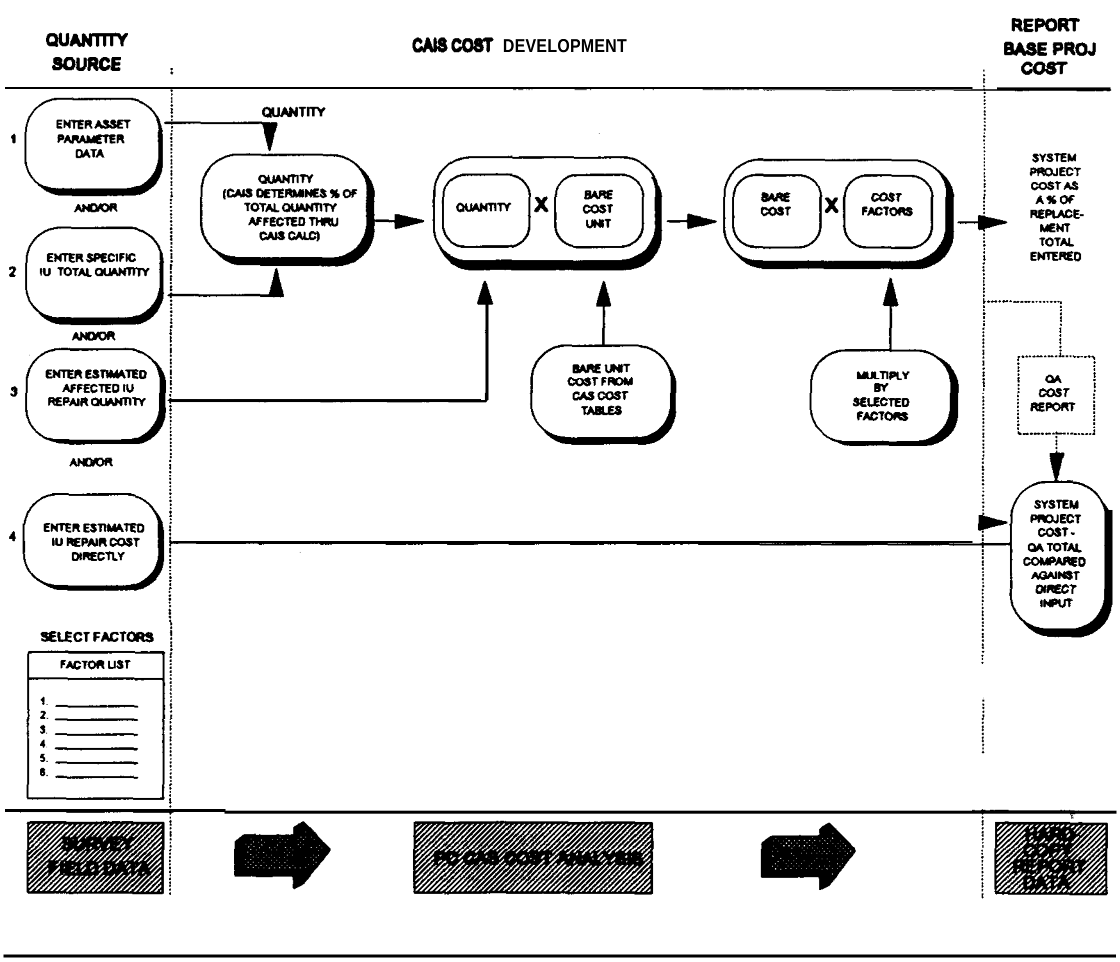
PURPOSE CODE*	DEFINITION
P2	PRG: Capacity
H2	H&S: Industrial Safety
E2	ENV: Solid Waste Management
s 4	S&S: Security
•	Partial list based on CAMP Order DOE 4330.4A dated 10-l 7-90.

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.

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

The following illustrates the cost development process for the Department 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 for inspections 0.01 Foundations & Footings 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 inspection 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

- Standard and Phillips head screw drivers - various sizes
- 50 foot measuring tape
- Pocket knife
- Flashlight
- Extension cord and inspection lights
- Rags
- Ball peen hammer
- Claw hammer
- Small crowbar

STANDARD TOOL GROUP

- Pliers; vise grip (2), slipjoint, needlenose, diagonal, cutting pliers, side cutters.
- Pipe wrenches to 14 inches
- Small and large level, and square
- Wire brush and stiff bristle brush
- Various cleaning tools: brushes, scrapers, etc.

NON-STANDARD TOOL GROUP

- Infrared Measuring Device (Optional)
- Borescope or Fiberscope
- Ultrasonic Measuring Device (Optional)
- Radiography (X-Ray) Measuring Device (Optional)
- Core Drilling Equipment (Optional)
- Nuclear (Radiation) Measuring Device (Optional)

The basic tool set must be augmented to accomplish inspection actions on a specific item of equipment or assembly/component. The Guide Sheets found in Section 3, Inspection Methods identify this augmentation. Also, test methods for Foundations & Footings are' defined in subsection 1.3.3.

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 (e.g., consultants, outside labs.)

GUIDE SHEET TOOL & MATERIAL LISTING

END OF SUBSECTION

TESTING METHODS

GENERAL

During the course of the CAS, 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 Data Collection Methods.

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, poorly consolidated areas, voids, cracks, honey-combing, and moisture content will 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).

TESTING METHODS

Variability

Estimating in-situ concrete strength using 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 the 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 standard Guide Sheets. Where tests are indicated, they are non-invasive (e.g., Stress Monitor Analysis).

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

Some 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.

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 crack is active or dormant by following the steps:

- Mark the end of the crack. Check after a few days to see if crack has extended past mark and note its direction.
- 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.
- 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.

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 (e.g., consultants, outside labs).

TESTING METHODS

WOW-STANDARD TEST **METHODS**

- Acoustic Emission Testing
- Core Sampling
- Electrical Resistivity Testing
- Infrared Testing
- Magnetic Testing
- Maturity Concept Analysis
- Microwave Absorption Scanning
- Nuclear Analysis
- 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.

Con **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.

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 thickness of concrete pavements, and may also determine the moisture content or moisture penetration of concrete surfaces. Even though this is a relatively simple test method, it is highly dependent on moisture and salt content and the temperature of the material.

Infrared Testing

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

Magnetic Testing

Magnetic testing involves scanning concrete surfaces with a U-shaped magnetic core with two coils in which an alternating current is passed through one coil and the current is 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.

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

TESTING METHODS

NON-STANDARD TEST DESCRIPTION (Continued)

Microwave Absorption Scanning

Microwaves are electromagnetic in nature, and can therefore be reflected, diffracted, and absorbed. Wave absorption by water allows for the. determination of moisture content of the material. This is relatively new and unproven, while the technique based on electromagnetic wave reflection has been used successfully. Although this method is fast and easy to perform, 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 foundation or footing. Where water is present, radiation or neutron 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.

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. Conversely, testing with gamma rays is relatively portable and easier to use. The only limiting factor appears to be high cost, safety concerns, and the requirement to have access to both sides of a surface.

Surface Hardness Testing

This test consists of impacting the concrete or masonry surface using standard devices to gauge with given energy pulse and measuring the size of rebound. A rebound hammer is the most commonly used method. 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 performed 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 or masonry and measuring the travel time. This technique is excellent for establishing existing concrete or masonry uniformity and strength. It should be noted, however, that concrete conditions such as age, moisture, aggregate to cement ratio, aggregate type, and steei reinforcement placement location may adversely influence test results; and that a good coupling is required between the transducer and the test substrate.

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 CAS and are not necessarily for 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 Footings and Foundations system assemblies and components.

TABLE ONE

Assembly/Component	Year One	Year Two	Year Three	Year Five
Footings-Spread/Strip/Grade Beams				S
Walls		S		
Dampproofing/Waterproofing		S		
Excavation/Backfill				S
Piles & Caissons				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 unless noted otherwise.

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 manufacturers' product specifications and tests that determine the average "outside" time parameter that a given System Assembly/Component will last. The Standard Design Life Table that follows lists 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
0.01 FOUNDATIONS		
Raft concrete slab foundation	Life	N/A
Concrete grade beams	Life	N/A
Cast-in-place concrete footings	Life	N/A
Cast-in-place concrete foundation walls	75	100
Precast concrete foundation walls	75	100
Masonry foundation walls	50	100
Concrete block foundation walls	50	100
Stone foundation walls	45	100
Wood pile foundations, treated	Life	N/A
Wood pile foundations, untreated	30	N/A
Precast concrete piles, square	Life	N/A
Prestressed concrete piles	Life	N/A
Cast-in-place concrete piles	Life	N/A
Steel pipe piles, concrete-filled	Life	N/A
Steel pipe piles, nonfilled	Life	N/A
Steel "H" piles	Life	N/A
Wood with cast-in-place concrete composite piles	Life	N/A
Wood with precast concrete composite piles	Life	N/A
Foundation dampproofing	50	100
Foundation waterproofing	50	100
Excavation Backfill	50	100

END OF SUBSECTION

SYSTEM WORK BREAKDOWN STRUCTURE

GENERAL

Facilities are composed of various assembly/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 and 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

0.01 SYSTEM - FOUNDATIONS & FOOTINGS

0.01.01	FOOTINGS - SPREAD/STRIP/GRADE BEAMS
0.01.02	FOUNDATION WALLS
0.01.03	FOUNDATION DAMPPROOFING/WATERPROOFING
0.01.04	EXCAVATION/BACKFILL
0.01.05	PILES & CAISSONS

SYSTEM WORK BREAKDOWN STRUCTURE

WBS LEVEL TABLE

0.05	*LEVEL 1*	0.08
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 ORGANIZATION HIERARCHY

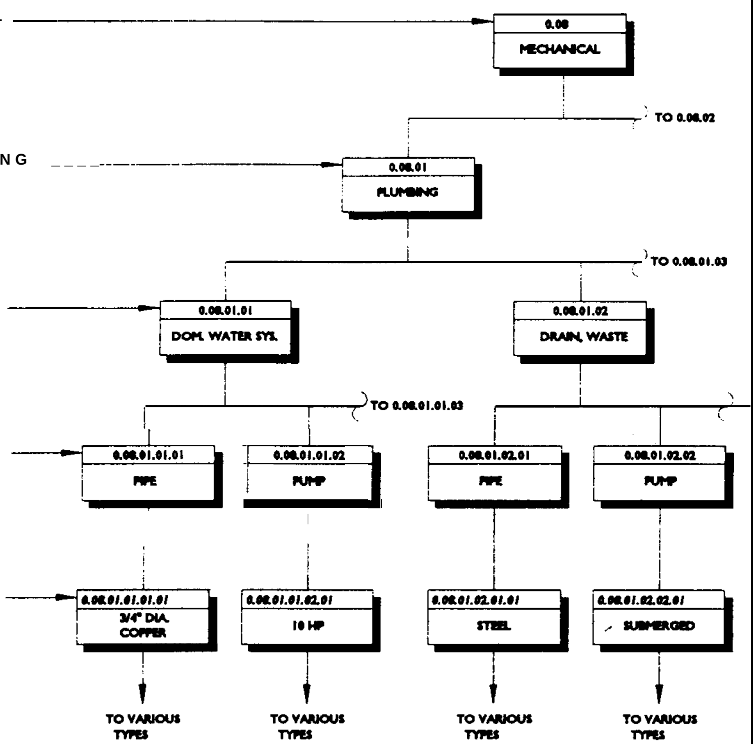


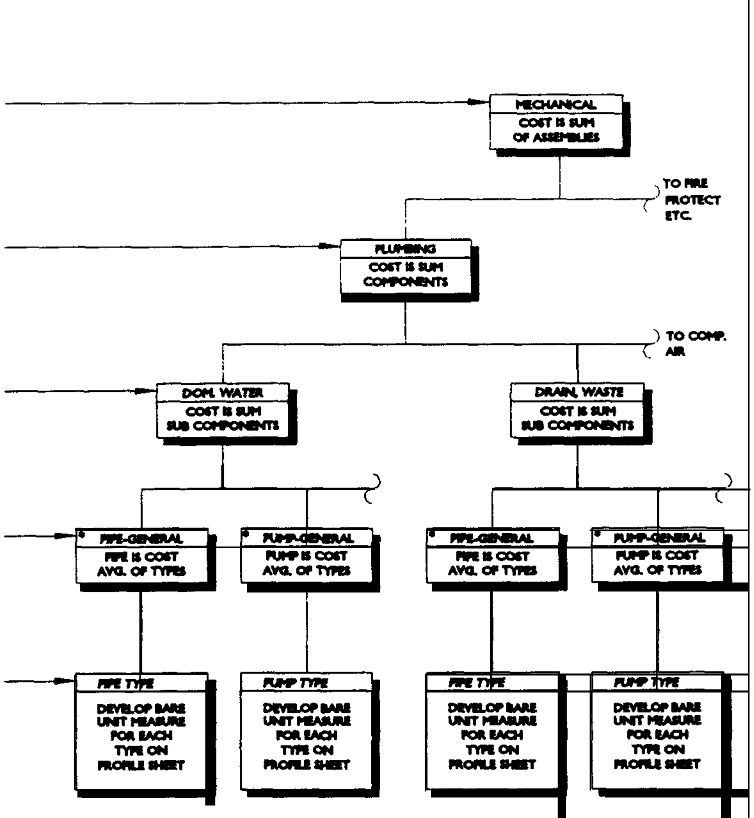
FIG. I

SYSTEM WORK BREAKDOWN STRUCTURE

WBS LEVEL TABLE

0.05	LEVEL I	0.08
ROOFING	***SYSTEM***	MECHANICAL
0.05.01	LEVEL 2	0.08.01
BUILT-U?	***ASSEMBLY***	PLUMBING
0.05.01.01	LEVEL 3	0.08.0 I .01
MEMBRANE	***COMPONENT***	Don. 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



* NOTE: IF COMPONENT/SUBCOMPONENT TYPE NOT KNOWN OR COMPONENT TYPE DATA NOT COMPILED, USE GENERAL COMPONENT PRICING.

FIG. 2

END OF SUBSECTION

GENERAL SYSTEM/MATERIAL DATA

INTRODUCTION

With the increasing cost of the new construction and equipment, it is becoming more of a necessity to ensure that existing buildings and systems are maintained at regular intervals and repairs are made to last over the long term. This section is composed of several tables, including 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 foundation and/or footing 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)

Damage	Diagnosis	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 design.
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 Concrete)**

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 electrochemical 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: Nuns **Facilities Maintenance** Standards - **"R.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 some what 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 require ments 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 ot **Preservative**	Advantagor	Disadvantages
Anthracene Oils	High toxicity to wood-destroying organisms; insoluble in water; low vola-tility; 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., **Kingston, Massachusetts**'

GENERAL SYSTEM/MATERIAL DATA

Acetic Acid, ail **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.
Ammonia 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.
Ammonium **Cyanide**	Disintegrates slowly.
Ammonium **Fluoride**	Disintegrates slowly.
Ammonium **Nitrate**	Disintegrates. In porous or cracked concrete, attacks steel.
Ammonium **Oxalate**	Not harmful.
Ammonium **Sulfide**	Disintegrates.
Ammonium **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.
Benzoi (Benzene)	Liquid loss by penetration.
Bromine	Gaseous bromine disintegrates. Liquid bromine disintegrates if it contains hydrobromic acid and moisture.
Butyi **Stearate**	Disintegrates slowly.
Calcium Bisulfite	Disintegrates rapidly.
Chlorine Gas	Slowly disintegrates moist concrete.
Chrome plating Solution8 **(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 Chiorido	Disintegrates slowly.
Ferrous Sulfate	Disintegrates concrete of inadequate sulfate resistance.

GENERAL SYSTEM/MATERIAL DATA

Flue Gases	Hot gases (400-l 1 00°F) causes thermal stresses. Cooled, condensed sulfurous, hydro-chloric 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 porcont	Disintegrates slowly.
Iodine	Disintegrates slowly.
Kerosene	liquid loss by penetration of concrete.
Lead Nitrate	Disintegrates slowly.
Lead Refining Solutions (f)	Disintegrates slowly.
Lignite Oils	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.
Machine Oil	Fatty oils, if present, disintegrate slowly.
Magnesium Nitrate	Disintegrates slowly.
Manganese Sulfate	Disintegrates concrete of inadequate sulfate resistance.
Mercuric Chlorldo	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 Wakr, **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** Solutions	Nickel ammonium sulfate disintegrates slowly.
Nickel **Sulfate**	Disintegrates concrete of inadequate sulfate resistance.
Nitric Acid, all Concontratlons	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 porcont	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 Cyanide	Disintegrates slowly.
Potassium Dlchromak	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 **Bromide**	Disintegrates slowly.
Sodium **Carbonate**	Not harmful, except to calcium aluminate cement.
Sodium Chiorido	Magnesium chloride, if present, attacks steel in porous or cracke concrete. (b) Steel corrosion ma cause concrete to spall.
Sodium **Cyanide**	Disintegrates slowly.
Sodium Dichromak	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 Chiorido	Not harmful.
Sulfite Liquor	Disintegrates.
Suifik Solution	See calcium bisulfate.
Suiturous Acid	Disintegrates rapidly.
Toiuoi **(Toluene)**	Liquid loss by penetration.
Tung **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.
Xyioi **(Xylene)**	Liquid loss by penetration.
Zinc Nitrak	Not harmful.
Zinc Refining Solutions (I)	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

0.01 .OI **FOOTINGS-SPREAD/STRIP/GRADE** BEAMS (CSI 03300)

DESCRIPTION

Footings are the structural common portion of the foundation that spread and transmit loads directly to the soil. The three most common assemblies/components are the spread footing, strip footing, and grade beams. Spread footings are generally rectangular prisms of concrete larger in lateral dimensions than the column or wall they support. Strip footings are continuous foundations where length considerably exceeds breadth. The grade beam is a horizontal end-supported (as opposed to ground-supported) load-bearing foundation member that supports an exterior wall superstructure. The concrete footing design is created not only by specific formwork, but is also based on physical properties of specified cement, admixtures, uniformity in mixing and placing technique, 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

Cast-in-Place Concrete (CSI 03300)

Cast-in-Place Concrete consists of concrete placed in forms at its final location. Concrete is a composite material that consists essentially of 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. See ACI publications 318 “Building Code Requirements for Reinforced Concrete” and 301 “Specifications for Structural Concrete for Buildings.”

Design Mixes Providina the Most Common Normal Weiaht Concrete:

- 4000-psi, 28-day compressive strength w/c ratio; 0.44 max
- 3500-psi, 28-day compressive strength w/c ratio; 0.51 max
- 3000-psi, 28-day compressive strength w/c ratio; 0.58 max
- 2500-psi, 28-day compressive strength w/c ratio; 0.67 max

Concrete Reinforcement (CSI 03200)

Concrete reinforcement consists of bars, wires, strands, and other slender members embedded in concrete in such a manner that the reinforcement and the concrete act together in resisting forces. This is done due to concrete’s limited resistance to tensile and shear stresses. Reinforcement must be accurately located to ensure proper cover and to reduce the chance of loss or corrosion of a structural section of reinforcing steel. When concrete is deposited directly against the earth for footings, at least 3 inches of concrete should exist between the steel and the earth. When concrete is deposited directly against formwork for footings there should be at least 2 inches of concrete between the steel and the formwork. Follow ACI 318 publication “Building Code Requirements for Reinforced Concrete.”

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

Chairs are small metal or plastic supports for reinforcing steel. The support is used to maintain the proper positioning during concrete placement. Spacers are used in the same fashion as chairs to maintain proper positioning during concrete pours. Concrete bolsters are a continuous wire bar support used to support bars in the bottom of footings. The top wire is usually corrugated at one-inch centers to hold the bar in position.

Admixtures (CSI 03370)

Admixtures is 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 admixtures affect plasticity, air entrainment, and curing time.

0.01 .01 FOOTINGS-SPREAD/STRIP/GRADE BEAMS (CSI 03300)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Admixtures (CSI 03370) **(Continued)**

Air-Entrainment Aoents:

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

Retarder & Densifying 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:

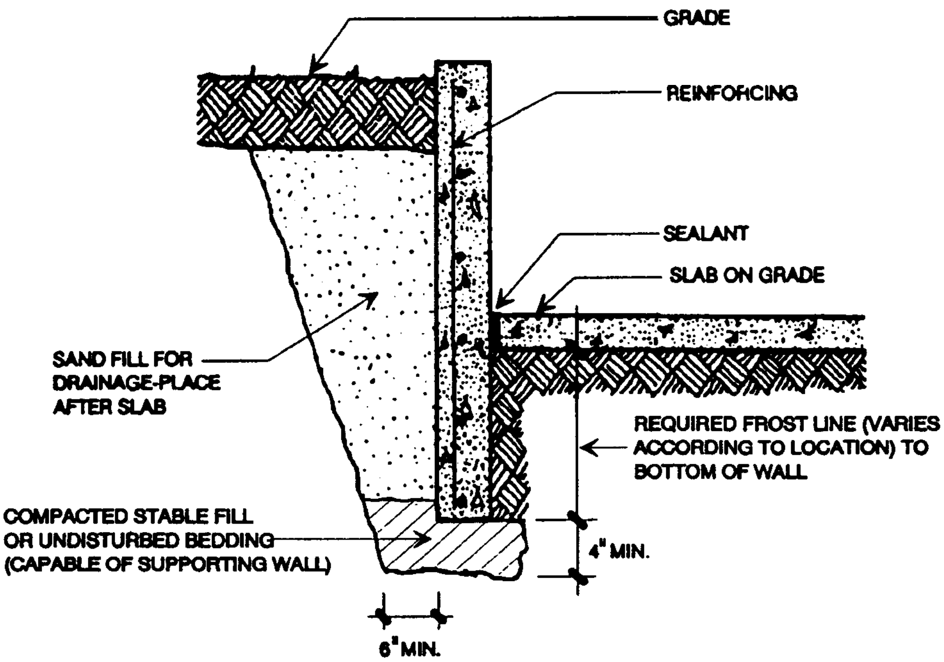
- Useful in winter (cold weather concreting).
- Useful when working to seal against the water-flow.
- Should be used sparingly because the admixture tends to increase shrinkage.

Granular **Base** (CSI 03300)

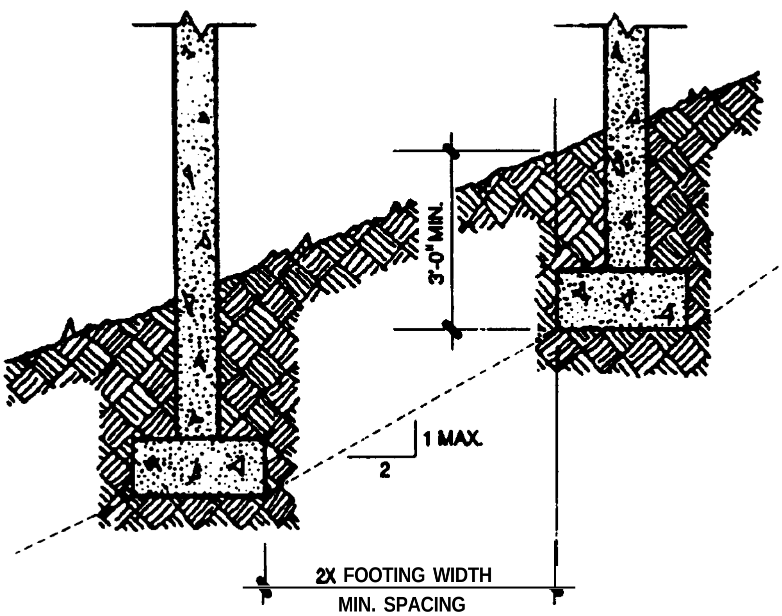
Evenly graded mixture of fine and course aggregates to provide, when compacted, a smooth and even surface below footings and allow for proper drainage.

OTHER RELATED COMPONENTS

See the following subsections for related components:

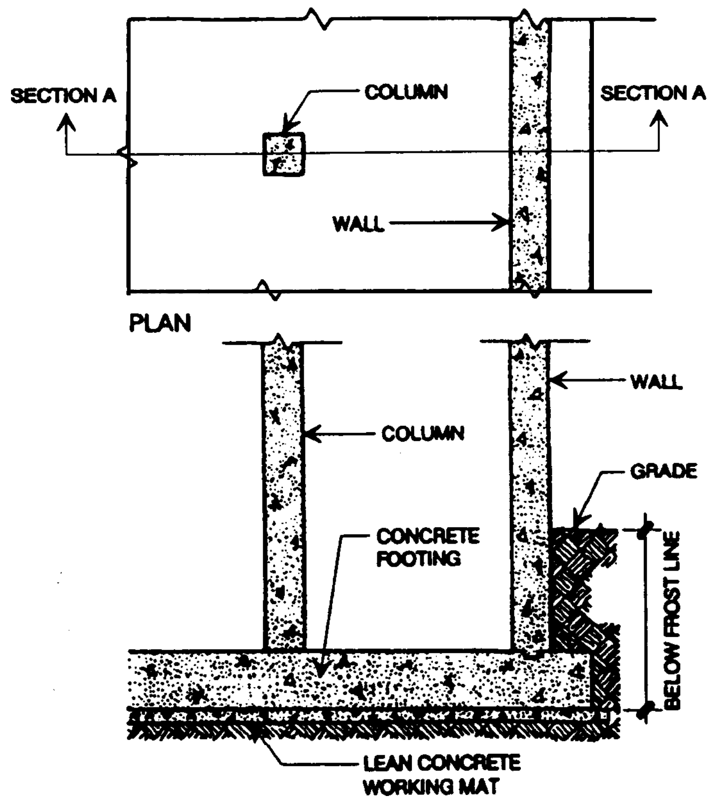


AREAWAY WALL



STEP FOOTINGS
MAX. STEEPNESS: 2 HORIZONTAL TO 1 VERTICAL

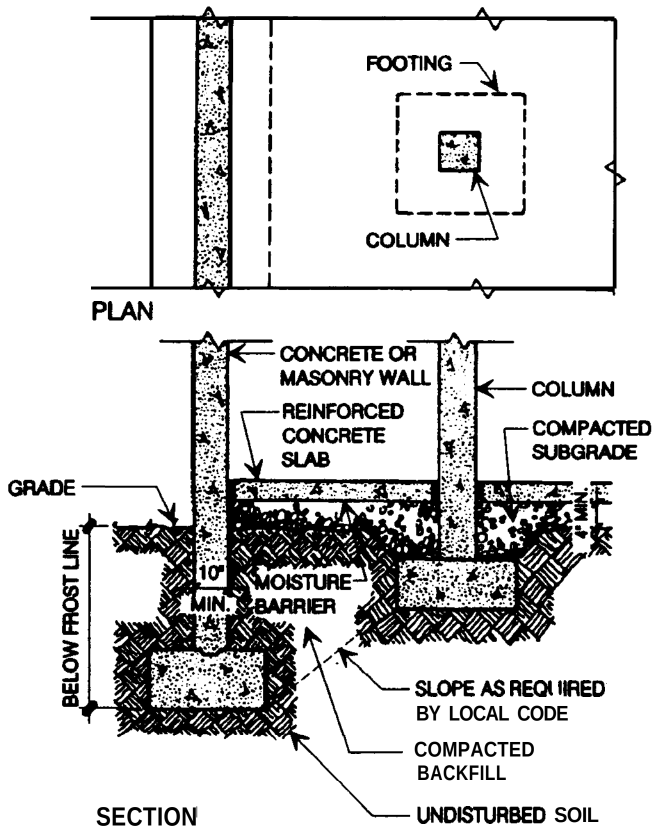
SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	SPREAD/STEP FOOTING		
FOOTINGS- SPREAD/STRIP/GRADE BEAMS (CSI 03310)	Revision No.	Issue Date 5/93	Drawing No. A0101-1



SECTION A

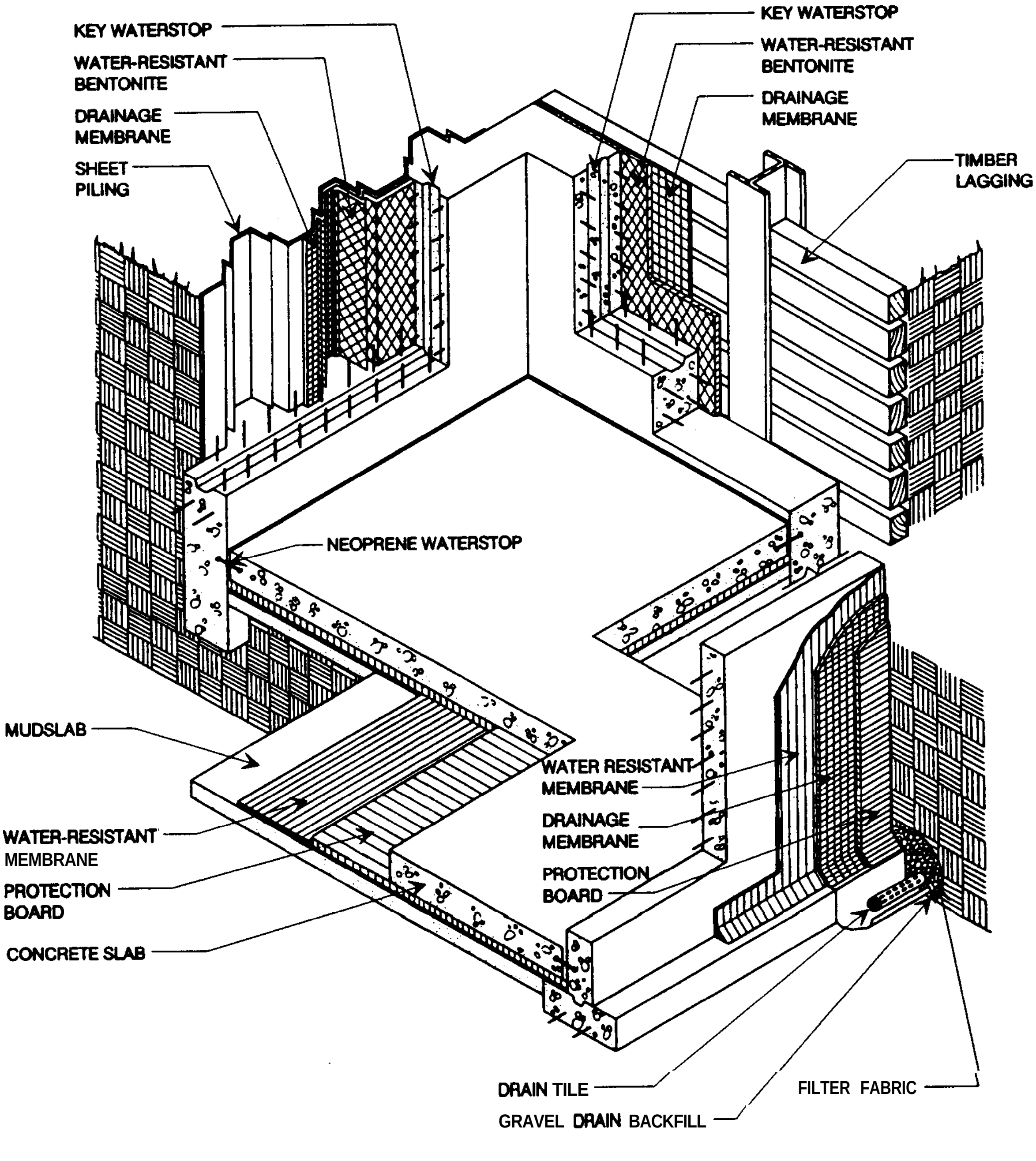
SPREAD FOOTINGS

SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	SPREAD FOOTING		
FOOTINGS- SPREAD/STRIP/GRADE BEAMS (CSI 03310)	Revision No.	Issue Date 5/93	Drawing No. A0101-2



SPREAD FOOTING

SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	SPREAD FOOTING		
FOOTINGS- SPREAD/STRIP/GRADE BEAMS (CSI 03310)	Revision No.	Issue Date 5/93	Drawing No. A0101-3

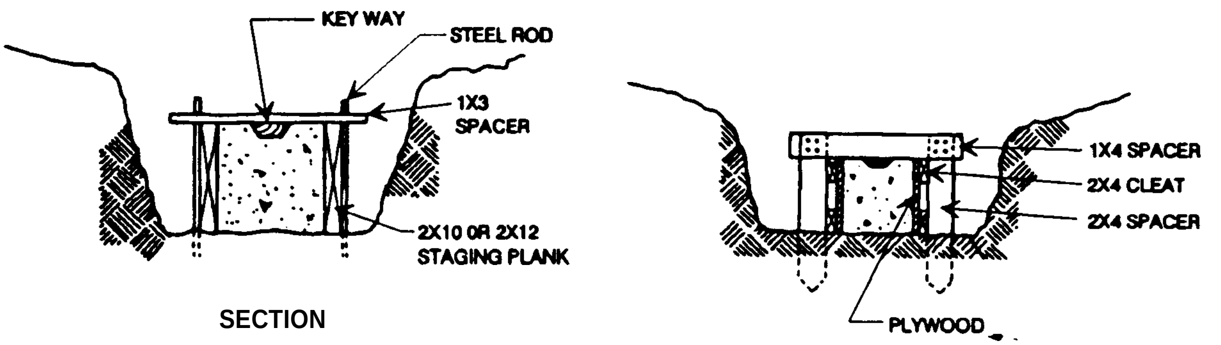


FOUNDATION CONDITIONS

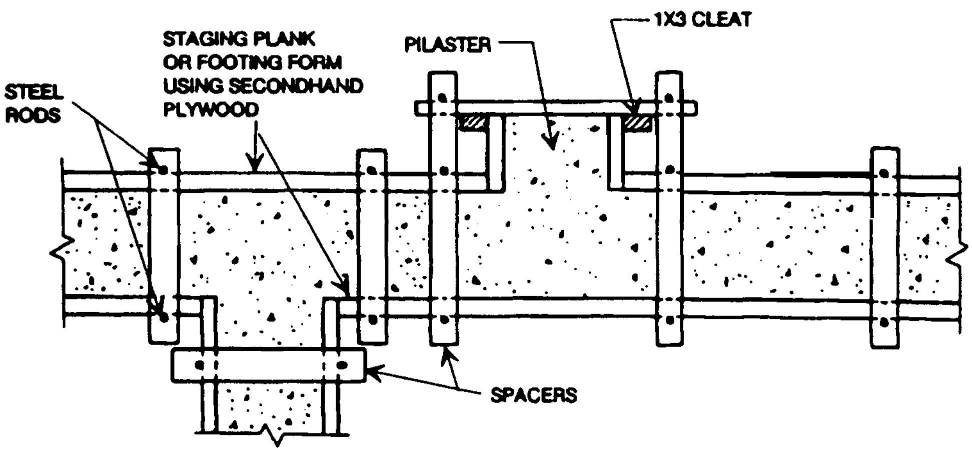
WATER RESISTANCE APPLICATIONS

SOURCE: ARCHITECTURAL GRAPHIC STANDARDS, EIGHTH EDITION ("Reprinted by permission of the American Institute of Architects")

SYSTEM ASSEMBLY DETAILS-FOUNDATIONS AND FOOTINGS	FOUNDATION GENERAL CONDITION		
FOOTINGS-SPREAD/STRIP/GRADE BEAMS GRADE BEAM (CSI 03310)	Revision No.	Issue Date 5/93	Drawing No. A0101-4

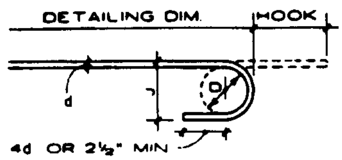


WALL FOOTING SECTIONS



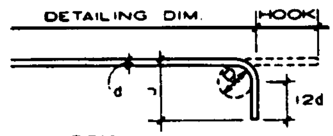
PLAN OF WALL FOOTINGS

SYSTEM ASSEMBLY **DETAILS**- FOUNDATIONS AND FOOTINGS	CONCRETE **FORMWORK**		
FOOTINGS- SPREAD/STRIP/GRADE BEAMS **FORMWORK(CSI** 03110)	**Revision** No.	Issue Date 5/93	Drawing No. A0101-5



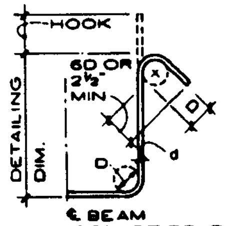
180° HOOK

d = (1) Bar Diameter
D = 6d for No. 3 to No. 8 Bars
D = 8d for No. 9 to No. 11 Bars
J = D + 2d
H = 5d + D/2 (or) 2 1/2" + d + D/2 minimum



90° HOOK

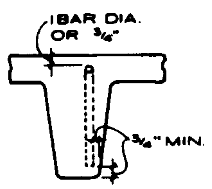
d = (1) Bar Diameter
D = 6d for No. 3 to No. 8 bars
D = 8d for No. 9 to No. 11 bars
J = 13d + D/2



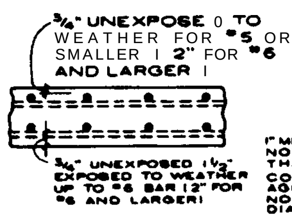
135° HOOK STIRRUP — TIES SIMILAR

d = (1) Bar Diameter
D = 1½" for No. 3
D = 2" for No. 4
D = 2½" for No. 5
D = 6d for No. 6 to No. 8

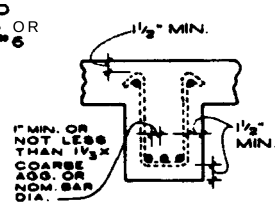
STANDARD REINFORCING BAR HOOK DETAILS



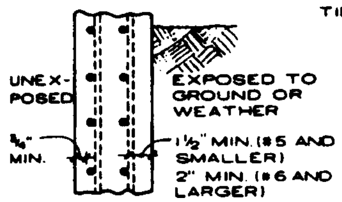
JOISTS



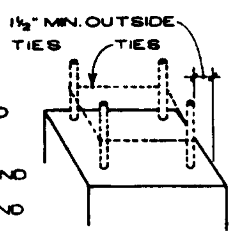
FLOOR SLABS



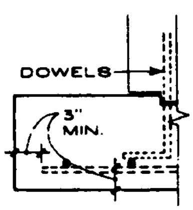
BEAM OR **GIRDER**



WALLS



COLUMNS



FOOTINGS

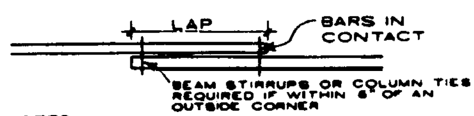
● ROTCCTION **FOR REINFORCEMENT**

TEMPERATURE REINFORCEMENT FOR STRUCTURAL FLOOR AND ROOF SLAB (ONE WAY) (IN PERCENTAGE OF **CROSS**-SECTIONAL AREA OF CONCRETE)

REINFORCEMENT		**CONCRETE SLABS**	
GRADE	**TYPE**		
40/50	Deformed bars	0.20%	Max. spacing five times slab thickness
–	Welded wire fabric	0.18%	
60	Deformed bars	0.18%	

LAP SPLICE REQUIREMENTS
1983 CODE IN BAR DIAMETERS

f_y (KSI)	SPIRAL COLUMN	TIED COLUMN	LOOSE
40	15.0	16.6	20
50	16.75	20.75	25
60	22.5	24.9	30
75	32.6	36.2	43.5
80	39.0	39.9	49.0

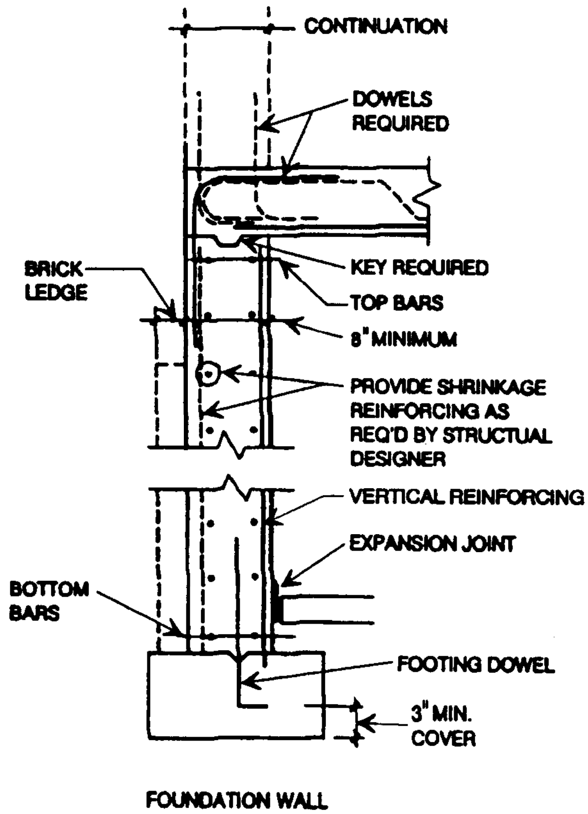


NOTES

1. These requirements are for compression lap splices only.
2. Lap splice lengths are minimum for $f'_c \geq 3000$ psi.
3. Minimum lap is 12 in.
4. Maximum reinforcing bar size permitted in lap splice is No. 11.

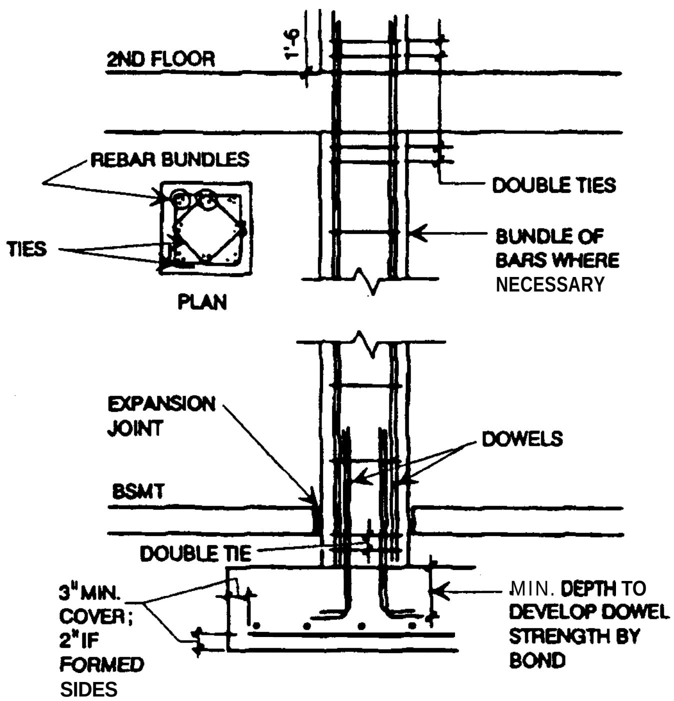
SOURCE: ARCHITECTURAL GRAPHIC STANDARDS, EIGHTH EDITION ("Reprinted by permission of the American Institute of Architects")

SYSTEM ASSEMBLY DETAILS-FOUNDATIONS AND FOOTINGS	CONCRETE REINFORCEMENT		
FOOTINGS-SPREAD/STRIP/GRADE BEAMS (CSI 03200)	Revision No.	Issue Date 5/93	Drawing No. A0101-6



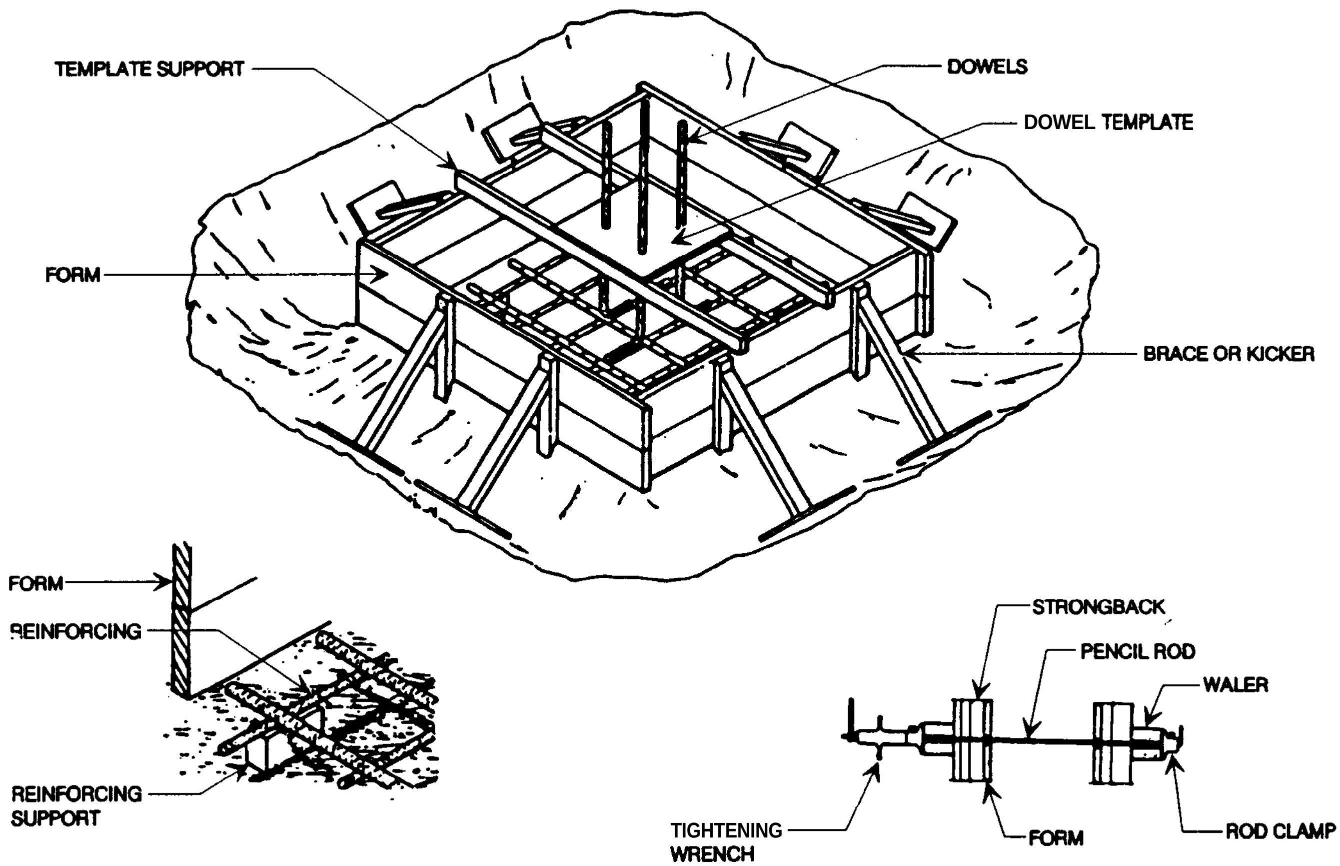
COMPOSITE OF MAJOR TYPES
OF COLUMN REINFORCING BARS

SYSTEM ASSEMBLY DETAILS-FOUNDATIONS AND FOOTINGS	CONCRETE REINFORCEMENT		
FOOTINGS-SPREAD/STRIP/GRADE BEAMS (CSI 03200)	Revision No.	Issue Date 5/93	Drawing No. A0101-7



COMPOSITE OF MAJOR TYPES
OF COLUMN REINFORCING BARS

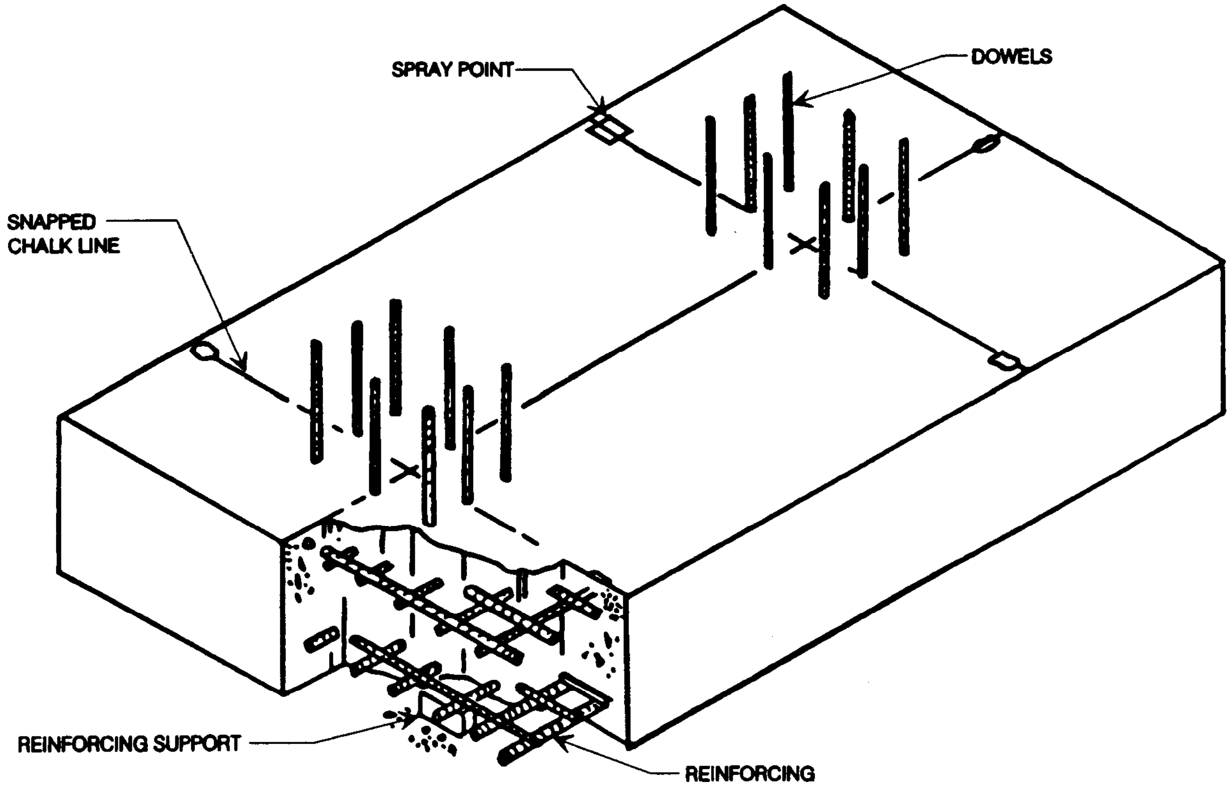
SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	CONCRETE REINFORCEMENT		
FOOTINGS- SPREAD/STRIP/GRADE BEAMS (CSI 03200)	Revision No.	Issue Date 5/93	Drawing No. A0101-8



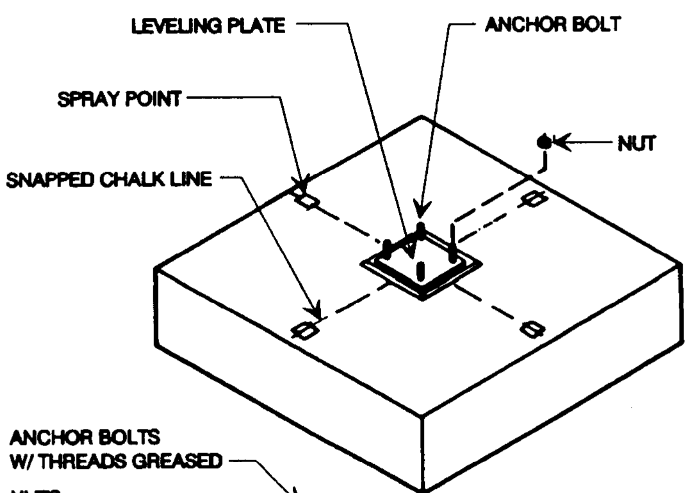
FOOTING FORMWORK

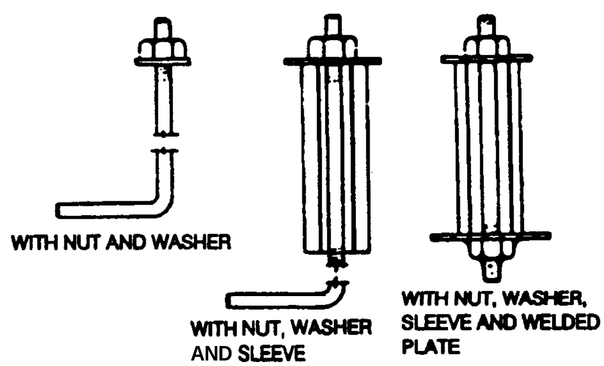
SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION., "R.S. Means Co., Inc., Kingston, Massachusetts"

SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	FOOTING FORMWORK		
FOOTINGS- SPREAD/STRIP/GRADE BEAMS (CSI 03310)	Revision No.	Issue Date 5/93	Drawing No. A0101-9

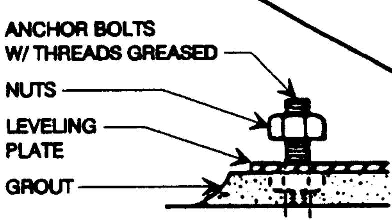


COMBINED SPREAD FOOTING





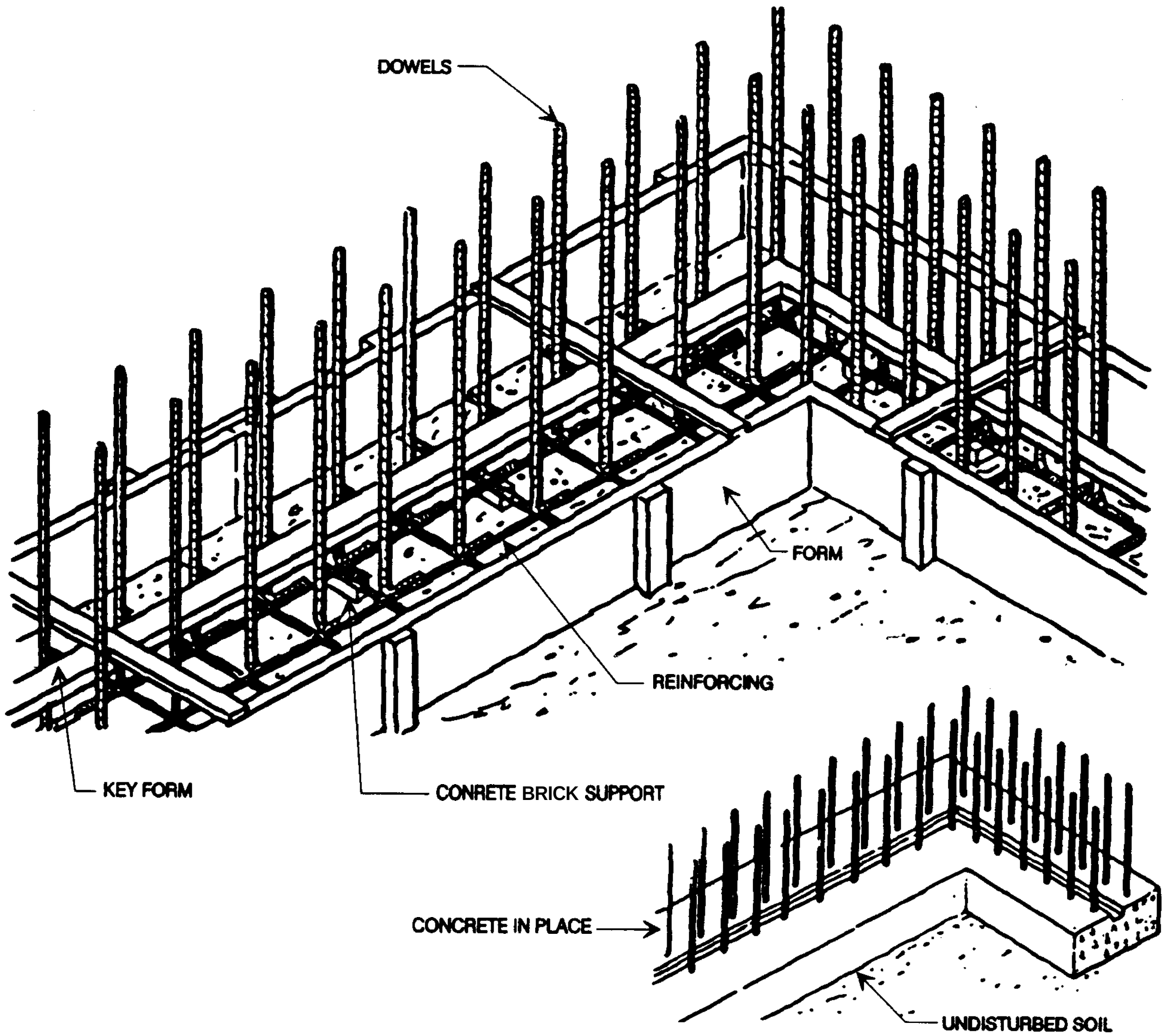
ANCHOR BOLT TYPES



BOLT AND LEVELING PLATE

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

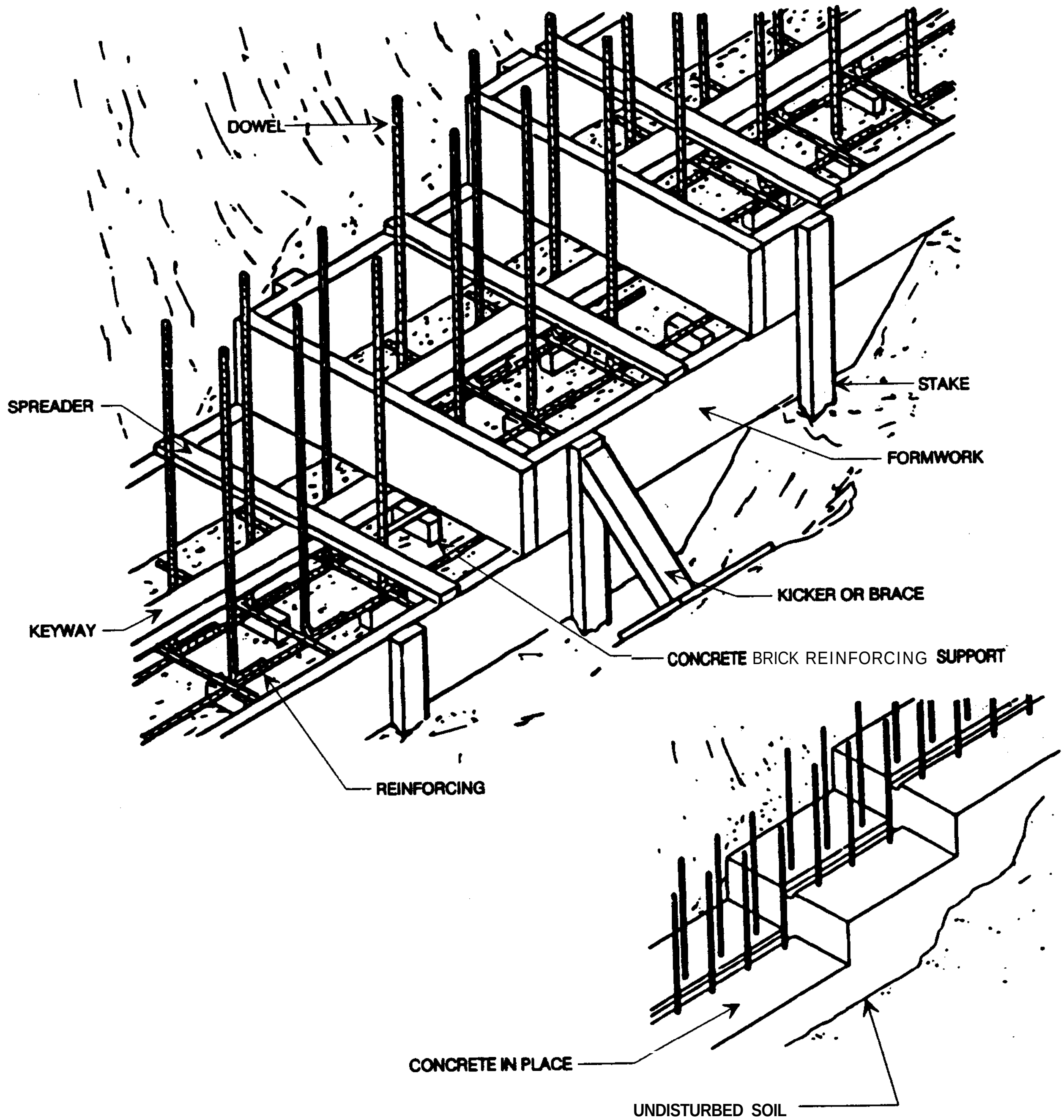
SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	COMBINED SPREAD FOOTING		
FOOTINGS- SPREAD/STRIP/GRADE BEAMS COMBINED(CSI 03310)	Revision No.	Issue Date 5/93	Drawing No. A0101-10



FOOTING FORMWORK STRIP

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

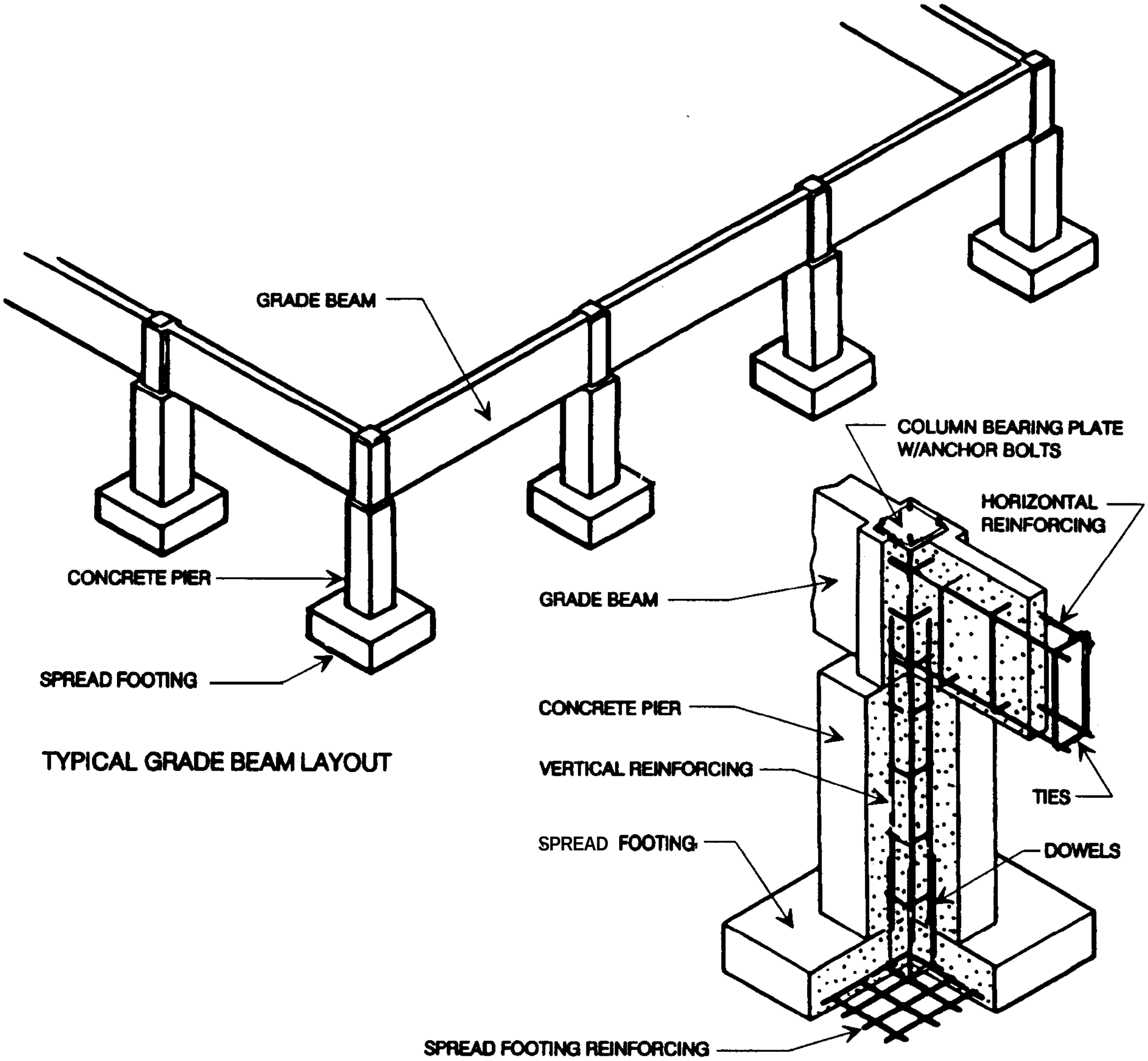
SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	STRIP FOOTING DETAIL		
FOOTINGS- SPREAD/STRIP/GRADE BEAMS (CSI 03310)	Revision No.	Issue Date 5/93	Drawing No. A0101-11



STEP FOOTING FORMWORK

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

SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	STEP FOOTING FORMWORK		
FOOTINGS- SPREAD/STRIP/GRADE BEAMS (CSI 03310)	Revision No.	Issue Date 5/93	Drawing No. A0101-12



GRADE BEAM

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

SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	GRADE BEAM DETAIL		
FOOTINGS- SPREAD/STRIP/GRADE BEAM (CSI 03310)	Revision No.	Issue Date 5/93	Drawing No. A0101-13

DEFICIENCY FACTORS
0.01 .01 FOOTINGS-SPREAD/STRIP/GRADE BEAMS (CSI 03300)

PROBABLE FAILURE POINTS

- Lack of curing will increase the degree of cracking in a concrete structure.
- Reinforcement corrosion caused by an electro-chemical process that occurs in the presence of air and moisture.
- 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 concrete cracking. These reactions may be due to the aggregate used to make the concrete, or to materials that come into contact with it after it has hardened or cured.
- A wide variety of poor construction practices can result in concrete structure cracks, especially the common practice of adding water to concrete to improve workability. Added water reduces strength, increases deformations, and increases ultimate drying shrinkage.
- 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 stresses that result in concrete cracks. Current ACI 318 design procedures use reinforcing steel, not only to carry the tensile forces, but also to, control both crack distribution-and width.
- Improper compaction or soft spots in the grade result in uneven'footing settling.
- Hydrostatic pressure from groundwater results in heaving or structure .

SYSTEM ASSEMBLIES/DEFICIENCIES

Concrete

Uneven Settlement:	Improper backfill' compaction or weak/loose spots. in grade causing sinking and flloting slippage, usually, indicated by grade change and wall or substructure movement.
Uplift/Hydrostatic Pressure:	Upward movement, of footings from external pressures. or hydrostatic pressure. Hydrostatic pressure results from water pressure on the structure. Results are usually evident by slab movement or wall cracking with water or moisture penetration.
Lateral Movement:	Position shifting caused by external forces' such as hydrostatic pressure or ground movement.
Surface Deterioration:	Surface crazing, cracking, spalling, or crumbling usually resulting in supported structure movement and ultimately failure.
Foundation Wall Cracking:	Stress or shear cracking resulting in diagonal or step cracking due to footing slippage or movement.

DEFICIENCY FACTORS
0.01 .Ol FOOTINGS-SPREAD/STRIP/GRADE BEAMS (CSI 03300)

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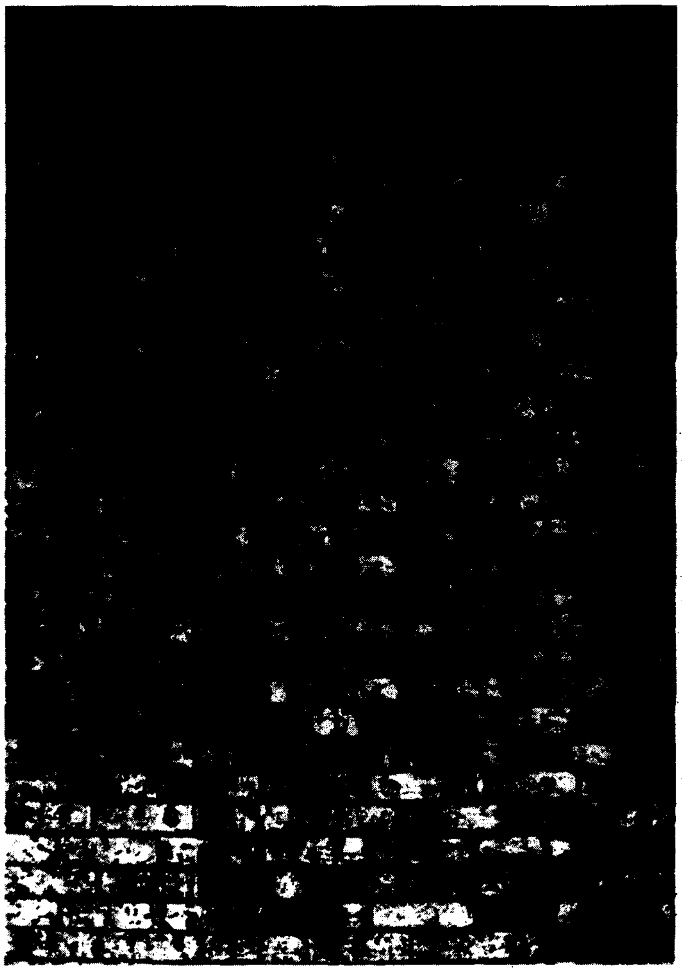
COLUMN CRACKING CAUSED BY FOOTING MOVEMENT

PHOTO ILLUSTRATION

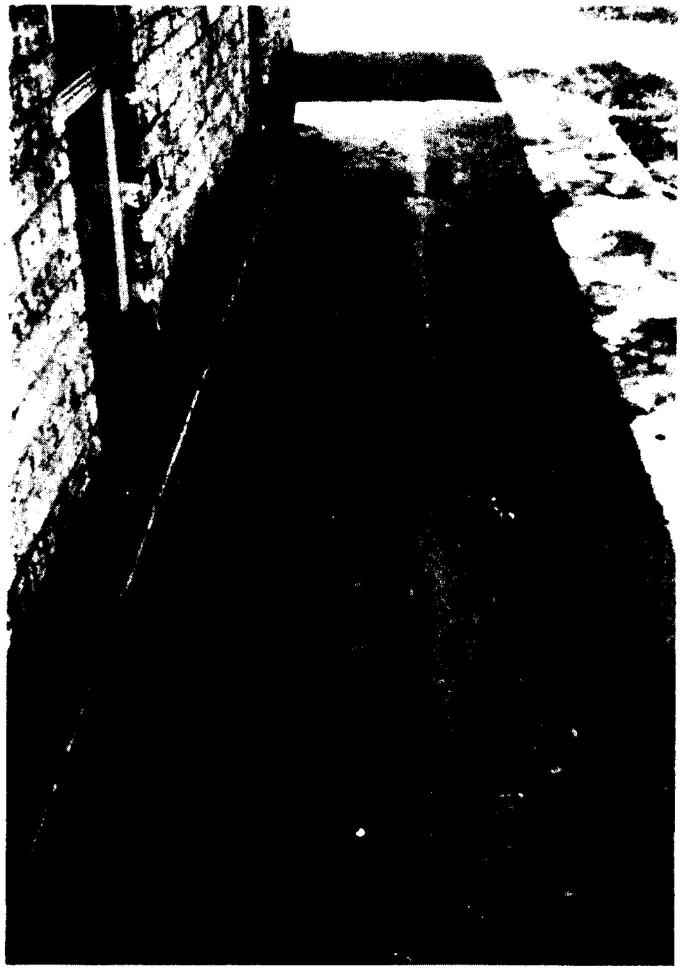
SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	FOOTING MOVEMENT		
FOOTINGS- SPREAD/STRIP/GRADE BEAMS CIP COLUMN(CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. 00101-I



BRICK WALL CRACKING CAUSED BY FOUNDATION SETTLEMENT

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	FOUNDATION SETTLEMENT		
FOOTINGS- SPREAD/STRIP/GRADE BEAMS 'BRICK WALL(CSI 04210)	Revision No.	Issue Date 5/93	Drawing No. D0101-2



CRACKS CAUSED BY LATERAL MOVEMENT

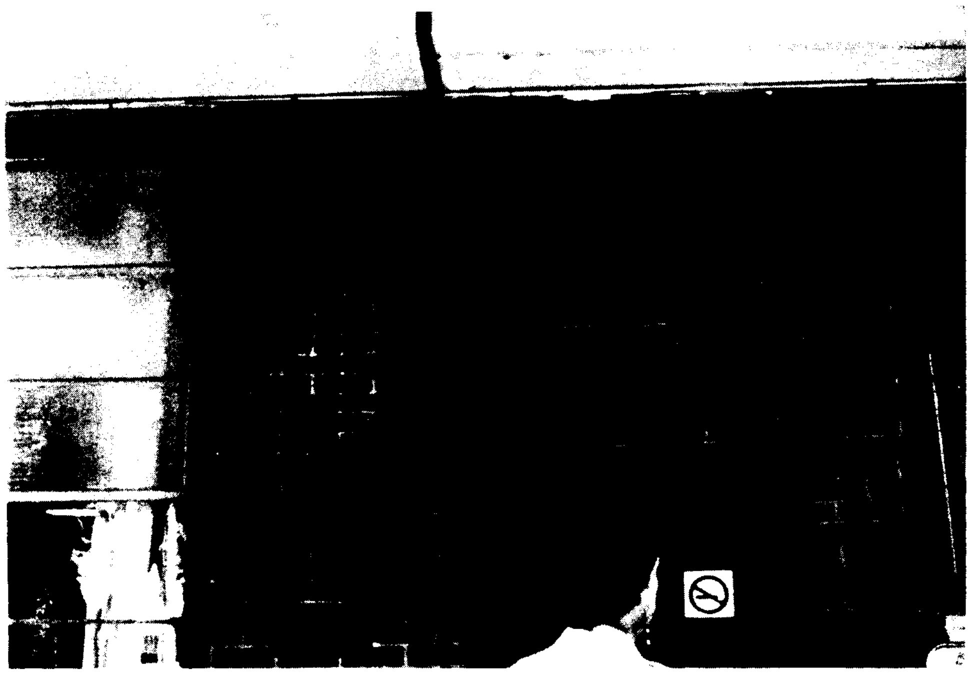
PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	WALL & SLAB MOVEMENT		
FOOTINGS- SPREAD/STRIP/GRADE BEAMS CONCRETE SLAB(CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D0101-3

CRACKS CAUSED BY SUBGRADE MOVEMENT

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	WALL & SLAB MOVEMENT		
FOOTINGS-SPREAD/STRIP/GRADE BEAMS (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D0101-4



DIAGONAL/STEP CRACKING CAUSED BY FOUNDATION MOVEMENT

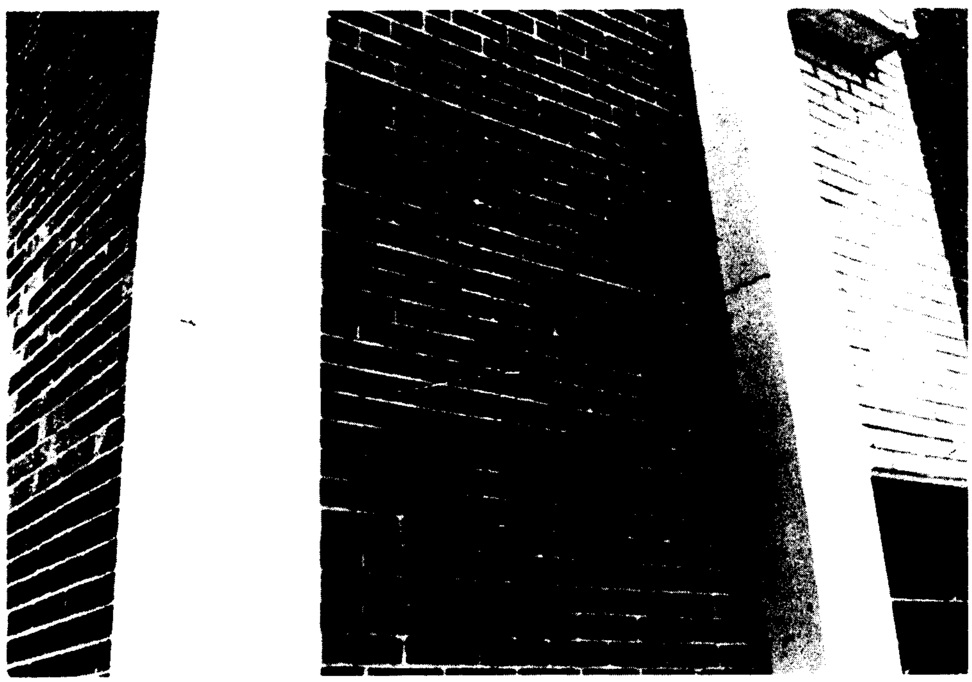
PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	FOUNDATION MOVEMENT		
FOOTINGS-SPREAD/STRIP/GRADE BEAMS BRICK WALL(CSI 04210)	Revision No.	Issue Date 5/93	Drawing No. D0101-5

COLUMN CRACKING CAUSED BY FOOTING MOVEMENT

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	FOOTING MOVEMENT		
FOOTINGS- SPREAD/STRIP/GRADE BEAMS CIP COLUMN(CSI 03300)	Revision No.	Issue oats 5/93	Drawing No. D0101-6



COLUMN CRACKING CAUSED BY FOOTING MOVEMENT

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	FOOTING MOVEMENT		
FOOTINGS- SPREAD/STRIP/GRADE BEAMS CIP COLUMN(CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D0101-7

DEFICIENCY FACTORS
0.01 .Ol FOOTINGS-SPREAD/STRIP/GRADE **BEAMS** (CSI 03300)

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DEFICIENCY FACTORS
0.01 .Ol FOOTINGS-SPREAD/STRIP/GRADE BEAMS (CSI 03300)

END OF SUBSECTION

0.01.02 FOUNDATION WALLS (CSI 03300)

DESCRIPTION

Cast-in-Place Foundation walls are part of the structural foundation that forms a retaining wall for the building portion below grade. Foundation walls transfer structural loads to the footings, which in turn transmit loads to the earth below. Foundation wall design is determined by the formwork, but is also based on the specific properties of cement and admixtures, uniformity in mixing and technique, curing methods, and otherquality 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

Cast-in-Place Concrete (CSI 03300)

Cast-in-Place Concrete consists of concrete placed in forms at its final location. Concrete is a composite material that consists essentially of a binding medium with embedded particles or fragments of aggregate. In Portland cement concrete, the binder is a mixture of Portland cement and water. Cast-in-place walls vary in thickness depending on the angle of repose and the weight of the structure they are to 'support; the design mix also largely determines the strength of the foundation wall. See ACI publications 318 "Building Code Requirements for Reinforced Concrete" and 301 "Specifications for Structural Concrete for Buildings" for-further details.

Design Mixes Providing the Most Common Normal Weiaht Concrete:

- 4000-psi, 28-day compressive strength w/c ratio; 0.44 max
- 3500-psi, 28-day compressive strength w/c ratio; 0.51 max
- 3000-psi, 28-day compressive strength w/c ratio; 0.58 max
- 2500-psi, 28-day compressive strength w/c ratio; 0.67 max

Concrete Reinforcement (CSI 03200)

Concrete reinforcement consists of bars, wires, strands, and other slender 'members embedded in concrete in such a manner that the reinforcement and the concrete act together in resisting forces. This is done due to concrete's limited resistance to tensile and shear stresses. Reinforcement must be accurately located to ensure proper cover and to reduce the chance of loss or corrosion of a structural section of reinforcing steel. When concrete is deposited directly against the earth for footings, at least 3 inches of concrete should exist between- the steel and the earth. When concrete is deposited directly against formwork for footings there should be at least 2 inches of concrete between the steel and the formwork. Follow ACI 318 publication "Building Code Requirements for Reinforced Concrete."

Admixtures (CSI 03370)

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

Air-Entrainment Agents:

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

Retarder & Densifying 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.

0.01.02 FOUNDATION WALLS (CSI 03300)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Admixtures (CSI 03370) (Continued)

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.

Concrete Masonry Walls (CSI 04200)

Concrete masonry walls may be classified as solid, hollow, cavity, composite, veneered, reinforced, or grouted. The classifications sometimes overlap, but the basic terminology and bonding directions remain the same. Modern concrete masonry wall construction is of two general types: unreinforced (plain) and reinforced. These classifications are characterized by some differences in mortar type requirements, use of reinforcing steel, and erection techniques. Both types are usually subject to the provisions of applicable building codes.

Unreinforced (plain) concrete masonry is the ordinary type that has been in use for many years. Any steel reinforcement used in this type of concrete masonry is generally a light gauge and placed in relatively small quantities in the horizontal joints.

Reinforced concrete masonry contains reinforcing steel that is placed and embedded so that the masonry and steel act together in resisting forces. This structural behavior is obtained by placing deformed reinforcing steel bars in continuous vertical and horizontal cores or cavities in the masonry, and filling these spaces with properly consolidated Portland cement grout.

Reinforced concrete masonry is used where the compressive, flexural, and shear loads are higher than can be accommodated with plain concrete masonry. It is required by code in areas of recurring hurricane winds or earthquake activity where major building damage to is highly probable.

Masonry Brick Walls (CSI 04210)

Brick Classification:

A finished brick structure contains “face brick” (brick placed on the exposed face of the structure) and “back-up” brick (brick placed behind the face brick). The face brick is often higher quality than the back-up brick, although the entire wall may be built of “common” brick. Common brick is is made from pit-run clay, with no attempt at color control and no special surface treatment like glazing or enameling. Most common brick is red.

Types of Brick:

Many types of bricks are available. Some are different in formation and composition, while others vary according to their use. Some commonly used types of bricks are as follows:

- Building: Used generally for the backing courses in solid or cavity brick walls. The harder and more durable kinds are preferred for this purpose.
- Face: Used in the exposed face of a wall and are higher quality than back-up brick (durability and appearance). The more common colors of face brick are various shades of brown, red, gray, yellow, and white.
- Glazed: One surface of each brick that is glazed in white or other color.

The ceramic glazing consists of mineral ingredients that fuse together as a glass-like coating when fired. This type of brick is generally used in or well suited for hospitals, dairies, laboratories, or other buildings where cleanness and easy cleaning are necessary.

0.01.02 FOUNDATION WALLS (CSI 03300)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Masonry Brick Walls (CSI 04210) (Continued)

Fire brick is made of a special type of fire clay that will withstand the high temperatures of boilers, etc. without cracking or decomposing. Fire brick is generally larger than regular structural brick and is often hand-molded.

Cored brick is made with two rows of five holes extending through the bed to reduce weight. There is no significant difference in strength between walls constructed with cored brick and those of solid brick are resistance to moisture penetration is about the same. The most easily available brick that will meet requirements should be used.

Sand-lime brick is made from a lean mixture of slacked lime and fine siliceous sand molded under mechanical pressure and hardened under steam pressure.

Masonry Stone Walls (CSI 04400)

Type of Stone:

Because of its durability, strength, and unique appearance. stone provides a wide range of structural and decorative applications as a building material. It can be installed in small units referred to as “building stone,” which can be assembled in many different formats. with or without mortar, to create a variety of walls and veneers.

Stone masonry units consist of natural stone. In rubble stone masonry, the stones are left in their natural state without shaping. In Ashlar masonry, the faces of stones to be placed in surface positions are squared so that the finished structure surface will be more or less continuous plane. Both rubble and Ashlar work may be either coursed or random.

Random rubble is the crudest of all stonework. Each layer must contain bonding stones that extend through the wall; bed joints may run in any direction. Coursed rubble is assembled of roughly squared stones to produce approximately continuous horizontal bed joints.

Small stone units may also be quarry split and processed to meet aesthetic needs. For example, decorative building stone can be purchased by the ton in 4-inch thick slabs, available in lengths ranging from 6 to 14 inches and in heights ranging from 2 to 16 inches. These pieces are commonly installed with mortar to create veneer walls of varying patterns, such as ledge stone, spider web, uncoursed rectangular, and squared.

Ashlar stone, also priced by the ton, is the name give to building stones that have been sewed on the edges to produce a rectangular face. This shape makes Ashlar stone another veneer material because the pieces can be arranged in either a regular or random-coursed pattern within the wall face. Stone veneer can be tied to the back-up wall with galvanized ties or 8” stone headers in a method similar to that used in brick veneer walls. The coverage of stone veneer ranges from 35 to 50 square feet per ton for 4inch wide veneer, with correspondingly reduced coverages per ton for veneers of 6 and 8inches in width.

Large stone facing panels can be installed as decorative features in many types of commercial buildings. These panels, which are usually priced by the square foot, are available in widths of up to 5 feet and in thicknesses of approximately 1 to 5 inches. Panel faces may be clear or patterned with split, sawed, or sand-rubbed surface finish. The edges of the panel are saw-cut and the back is planed.

0.01.02 FOUNDATION WALLS (CSI 03300)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS (Continued)

Continuous Metal lies (CSI 04150)

Prefabricated joint reinforcement or mesh are referred to as continuous metal ties, which consist of two or more longitudinal wires to which cross wires are welded. Joint reinforcement may be used for the following reasons:

- Horizontal reinforcement.
- Longitudinal reinforcement for crack control due to drying shrinkage and temperature changes.
- To bond the wythes without using unit metal ties.

Joint reinforcement and ties must be corrosion-resistant. Cross wires in joint reinforcement are welded diagonally or perpendicularly to the longitudinal wires, usually at 16-inch spacings. The longitudinal wire are deformed to obtain a better bond with the mortar.

Control Joints (CSI 07900)

Also called contraction or movement joints, control joints are continuous, vertically weakened sections built into the wall. If stresses or wall movements are sufficient to crack the wall, the cracks will occur at the control joints and be inconspicuous.

Expansion Joints (CSI 07900)

An expansion joint must permit ready wall movement in a longitudinal direction and be sealed against vision, sound, and weather. It may also be required to stabilize the wall laterally across the joint.

Types of Expansion Joints:

There are a number of types of expansion joints for building concrete masonry walls, but the most common types are the Michigan, the tongue and groove, and the premolded gasket.

- The Michigan type uses conventional flanged units. A strip of building paper is curled to cover the end of the block on one side of the joint laid. The core is filled with mortar. The filling bonds to one block but the paper prevents bond to the block on the other side of the expansion joint, the expansion joint then permits longitudinal movement of the wall while the mortar plug transmits transverse loads.

- The tongue and groove is manufactured in sets consisting of full- and half-length units. The tongue of one special unit fits into the groove of another special unit or into the open end of a regular flanged stretcher. The units are laid in mortar exactly the same as any other masonry unit. Also, part of the mortar is allowed to remain in the vertical joint to form a backing against which caulking can be placed.

- Premolded gaskets allow movement at joints while maintaining wall alignment perpendicular to wall movement. These anchors are also adaptable for attaching concrete masonry walls to wood, steel, or concrete.

Waterstops (CSI 03250)

A thin sheet of metal, rubber, or other material inserted across a joint to obstruct the water seepage through the joint. Usually formed from rubber in a dumb-bell shape with fins cast into the concrete when poured.

0.01.02 FOUNDATION WALLS (CSI 03300)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS (Continued)

Wood Foundation System (CSI 06105)

The all weather wood foundation system uses a plywood sheathed, wood stud assembly for foundations and basements. The system was developed by the American Wood Preservers Institute (AWPI), the Economics and Marketing Division of the U.S. Forest Service, and the National Forest Product Association (NFPA).

Treated-wood footing planks are placed directly on an aggregate bed to serve as the base support for the basement walls. Wall sections are framed from studs end-nailed to top and bottom plates. Treated plywood sheathing is then nailed to the studs to form the basement envelope.

Joints between plywood wall panels are caulked, and a polyethylene vapor barrier is installed below grade on the exterior side of the wall sheathing. Inside, a concrete slab is cast on top of the aggregate bed. This slab becomes a structural element in the plywood system because it holds the toe of the wall in place against outside earth pressures.

If the walls are insulated, the interior should be finished with a cover to protect the insulation. Constructing the building on top of the plywood basement is essentially the same as traditional wood frame construction.

All lumber used in the system must be pressure-treated with waterborne chemical compounds protect against decay and resist attack by wood-destroying organisms. Early approvals for installing of wood foundations were based on MFA Technical Report No. 7.

OTHER RELATED COMPONENTS

See the following subsections for related components:

0.01.02 FOUNDATION WALLS (CSI 03300)

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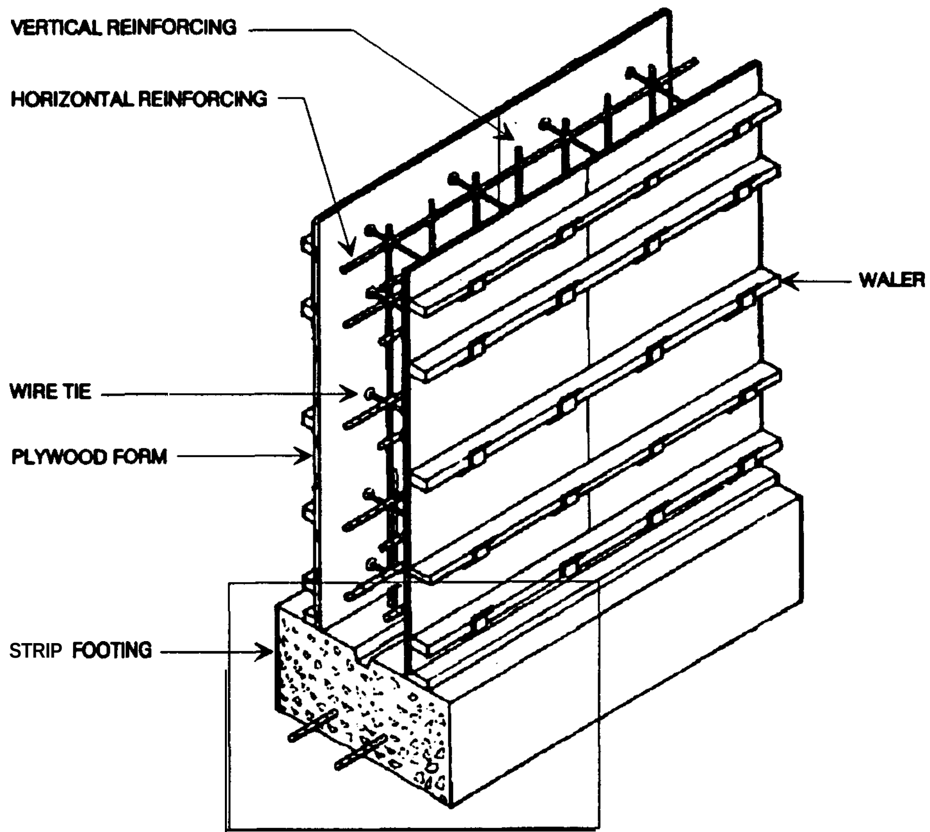
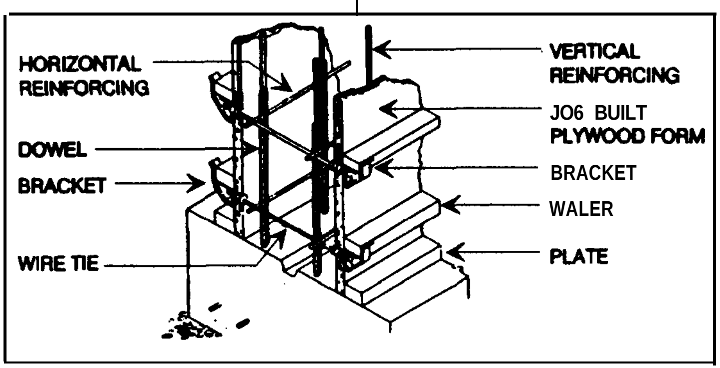
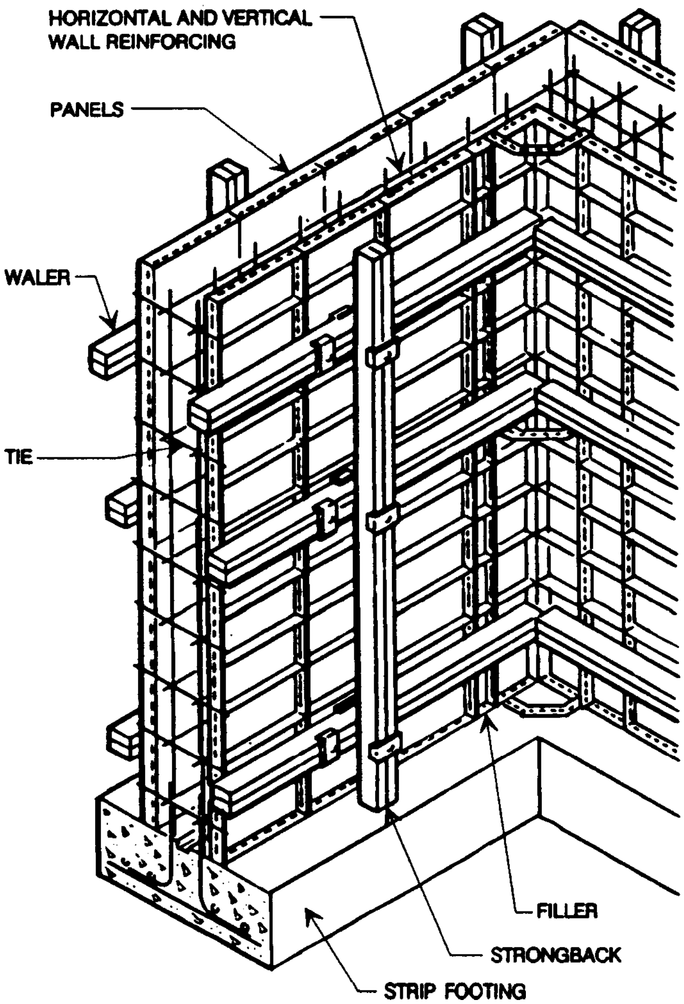
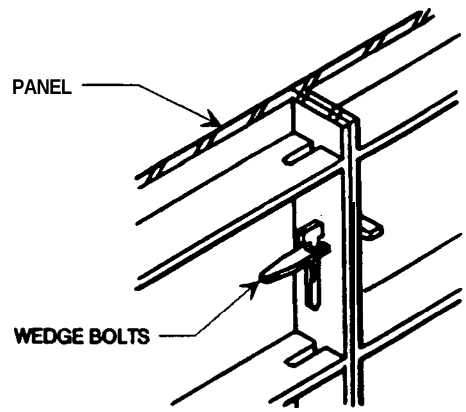




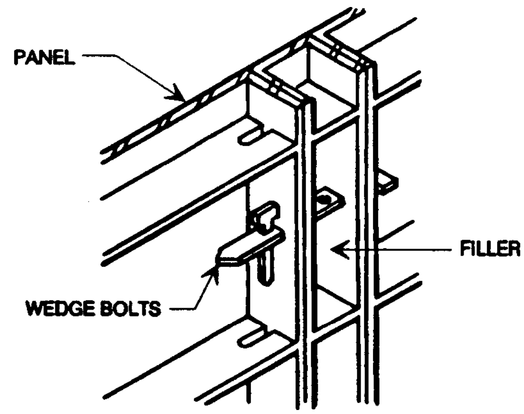
SYSTEM ASSEMBLY DETAILS-FOUNDATIONS AND FOOTINGS	FOUNDATION WALL FORMWORK		
FOUNDATION WALLS (CSI 03300, 04200)	Revision No.	Issue Date 5/93	Drawing No. A0102-1



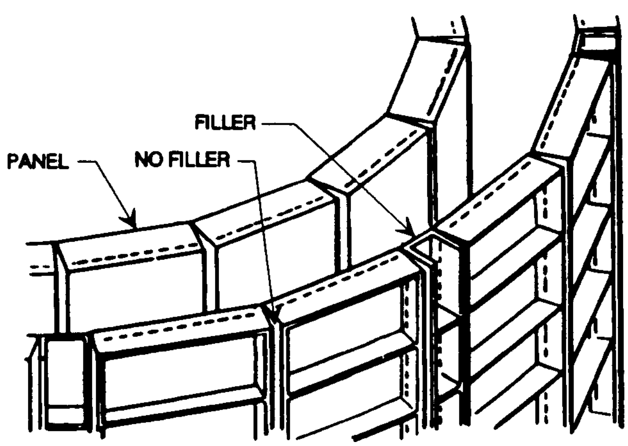
STEEL-PLY CONCRETE FORMING SYSTEM



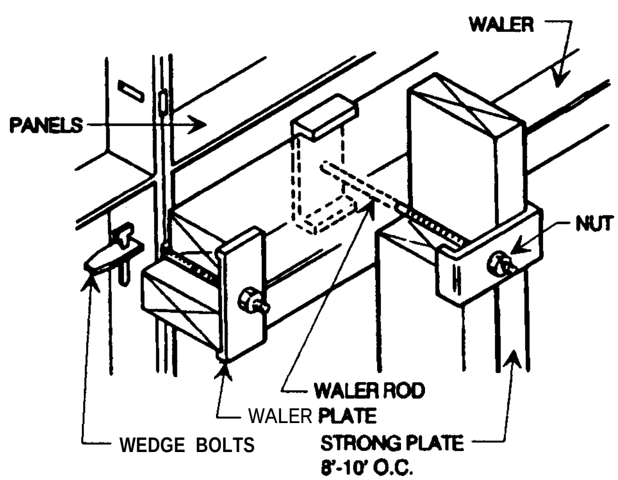
PANEL ATTACHMENT



PANEL FILLER ATTACHMENT



CURVED WALL



STRONGBACK AND WALER ATTACHMENT

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

SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	FOUNDATION WALL FORMWORK		
FOUNDATION WALLS (CSI 03300. 04200)	Revision No.	Issue bate 5/93	Drawing No. A0102-2

DEFICIENCY FACTORS
0.01.02 FOUNDATION WALLS (CSI 03300)

PROBABLE FAILURE POINTS

- Lack of curing will increase the degree of cracking in 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 freezing and thawing, wetting and drying, and heating and cooling.
- A number of deleterious chemical reactions may result in concrete crack. These reactions may be due to the aggregate used to make the concrete or materials that come into contact with after it has hardened or cured.
- A wide variety of poor construction practices can result in cracked concrete or masonry structures, especially the common practice of adding water to concrete to improve workability. Added water reduces strength, increases deformation, and increases ultimate drying shrinkage.
- 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 or masonry 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 also to control both crack distribution and width.
- Improper compaction or soft spots in the grade result in uneven settling or wall slippage.
- Hydrostatic pressure from groundwater range from cracks to total failure.
- Any likely failure points for masonry (CMU) or wood.

SYSTEM ASSEMBLIES/DEFICIENCIES

Concrete

Alkali-Aggregate Expansion:	Chemical reaction between aggregate and cement paste.
Cracks (Active and 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 interior of concrete mass. Too high a slump. Too rich a mix. Poor timing on finishing. Too rapid moisture absorption. 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:	Fragments flakes from the surface due to weather, pressure, or other actions.

DEFICIENCY FACTORS
0.01.02 FOUNDATION WALLS (CSI 03300)

SYSTEM ASSEMBLIES/DEFICIENCIES

Concrete (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 that leaves residue after evaporating.
Plant Growth Moss/Algae:	The growth of plant life such as moss or algae over the surface. Usually results from excessive moisture.
Rebar Corrosion:	The oxidation or eating away of the metal rebar by chemical or electrochemical action after prolonged exposure to moisture.

Masonry

Cracks (Active & Dormant):	Construction movement, settlement, shrinkage around reinforcement. Inadequate finishing and curing. Vertical or horizontal cracking. Chemical reactions such as corrosion. Physical reactions such as drying shrinkage. Surface cracking. Thermal changes (subjected to temperature extremes such as freeze/thaw cycles). Stress concentration from excessive loads. Step cracking. Accidents from overload, vibration, fatigue, and earthquake. Shear cracking.
Surface Deterioration:	Cavitation from water or liquid action over surface. Chemical reactions causing surface breakdown.
Holes (Small and Large):	Inadequate construction and design. Impact damage.
Spalling:	Fragments 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.
Mortar/Joint Material Missing/Eroded:	Deteriorated or damaged mortar/grout 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 that leaves residue after evaporating.
Plant Growth Moss/Algae:	The growth of plant life such as mdss or algae over the surface. Usually results from excessive moisture.

DEFICIENCY FACTORS
0.01.02 FOUNDATION WALLS (CSI 03300)

SYSTEM ASSEMBLIES/DEFICIENCIES

Masonry (Continued)

Inadequate Expansion Joint: Lack of expansion or control joints resulting in surface cracks from stresses.

Damaged/Missing Sections: Broken, damaged, cracked, or missing units or sections.

Stone

Cracks (Active and Dormant): Construction movement, settlement, shrinkage around reinforcement. Inadequate finishing and curing. Vertical or horizontal cracking. Chemical reactions such as corrosion. Physical reactions such as drying shrinkage. Surface cracking. Thermal changes (subjected to temperature extremes, such as freeze/thaw cycles). Stress concentration from excessive loads. Step cracking. Accidents from overload, vibration, fatigue, and earthquake. Shear cracking.

Surface Deterioration: Cavitation from water or liquid action over surface. Chemical reactions causing surface breakdown.

Holes (Small & Large): Inadequate construction and design. Impact damage.

Spalling: Fragments 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.

Mortar/Joint Material Missing/Eroded: Deteriorated or damaged mortar/grout 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 that leaves residue after evaporating.

Plant Growth Moss/Algae: The growth of plant life such as moss or algae over the surface usually results from excessive moisture.

Inadequate Expansion Joint: Lack of expansion or control joints resulting in surface cracks from stresses.

Damaged/Missing Sections: Broken, damaged, cracked, or missing units or sections.

Wood

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

Checking: Small splits or cracks running parallel to the wood grain. Caused by shrinkage from excessive drying.

Surface Deterioration: Crazing, small surface cracks, and/or surface breakdown due to weather, pressure, or other actions.

DEFICIENCY FACTORS
0.01.02 FOUNDATION WALLS (CSI 03300)

SYSTEM ASSEMBLIES/DEFICIENCIES

Wood (Continued)

Inadequate Expansion Joint:	Lack of expansion or control joints resulting in warping or surface split from stresses.
Damaged/Missing Sections:	Broken, damaged, cracked, or missing units or sections.
Impact Damage/Denting:	Depressions, punctures, or buckled surface from objects striking or impacting surface.
Staining:	Surface discoloration from a foreign substance or material.
Plant Growth Moss/Algae:	The growth of plant life such as moss or algae over the surface. Usually results from excessive moisture.
Insufficient Anchorage:	Broken, damaged, loose, corroded, or missing anchorage or fasteners.
Dry Rot/Decay:	Breakdown of structural integrity from mold/mildew or dry rot. Caused by excessive moisture exposure.
Loss of Protective Coating/Paint:	Chalking, peeling, erosion blistering (temperature and moisture) 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.

WALL DISPLACEMENT

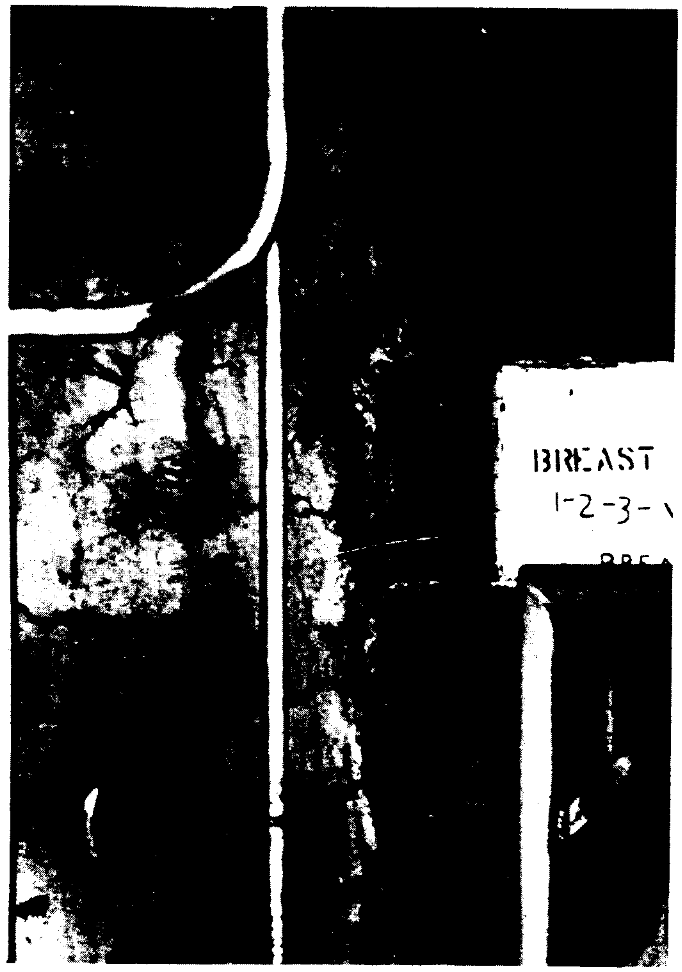
PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	CONCRETE WALL DISPLACEMENT		
FOUNDATION WALLS (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. 00102-I

WALL CRACKS

PHOTO ILLUSTRATION

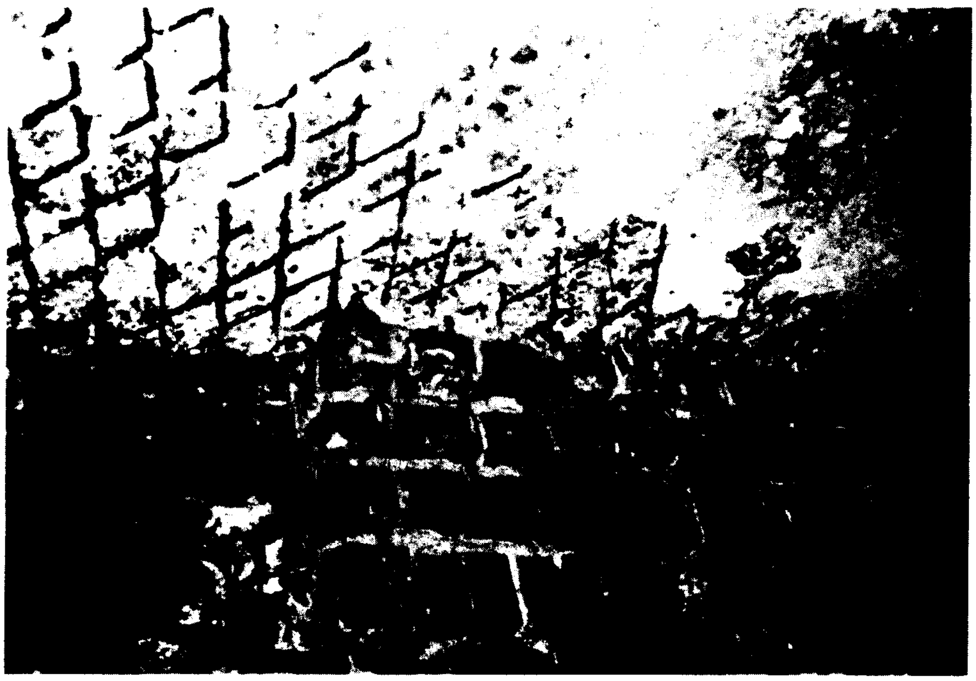
SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	CONCRETE WALL CRACKS		
FOUNDATION WALLS (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D0102-2



WALL SPALLING

PHOTO ILLUSTRATION

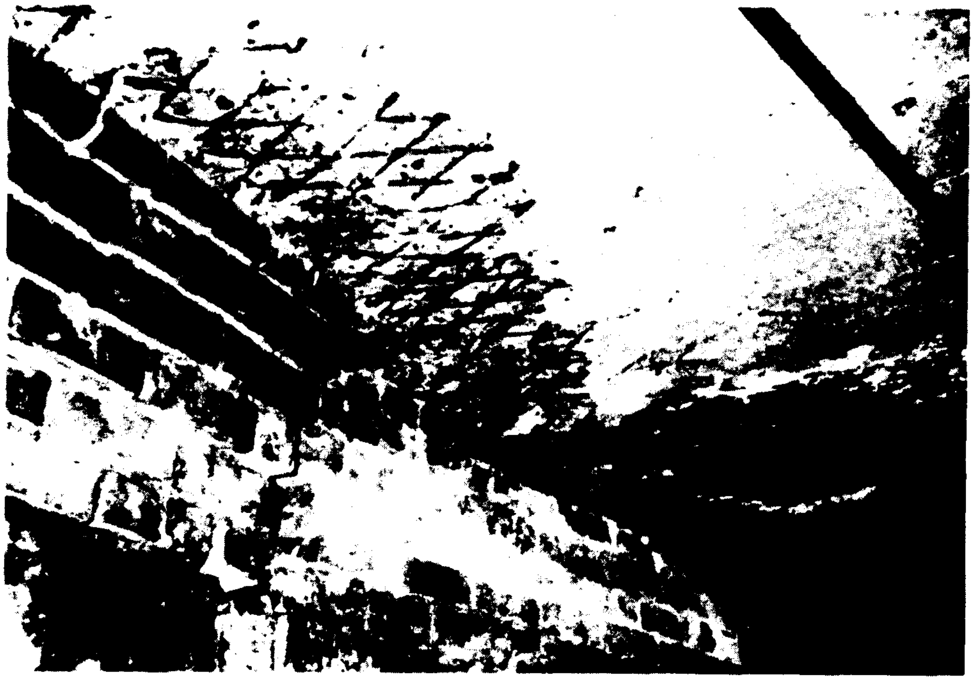
SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	CONCRETE WALL SPALLING		
FOUNDATION WALLS (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D0102-3



BRICK AND CONCRETE WALL EFFLORESCENCE

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	BRICK & CONCRETE WALL EFFLORESCENCE		
FOUNDATION WALLS (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D0102-4



MASONRY DIAGONAL CRACKS

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	MASONRY WALL DIAGONAL CRACKS		
FOUNDATION WALLS (CSI 04210)	Revision No.	Issue Date 5/93	Drawing No. D0102-5

REVIEW PENDING

APPROVAL PENDING

CONCRETE WALL DETERIORATION

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	CONCRETE WALL DETERIORATION		
FOUNDATION WALLS (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D0102-6

CONCRETE AND MASONRY WALL EFFLORESCENCE

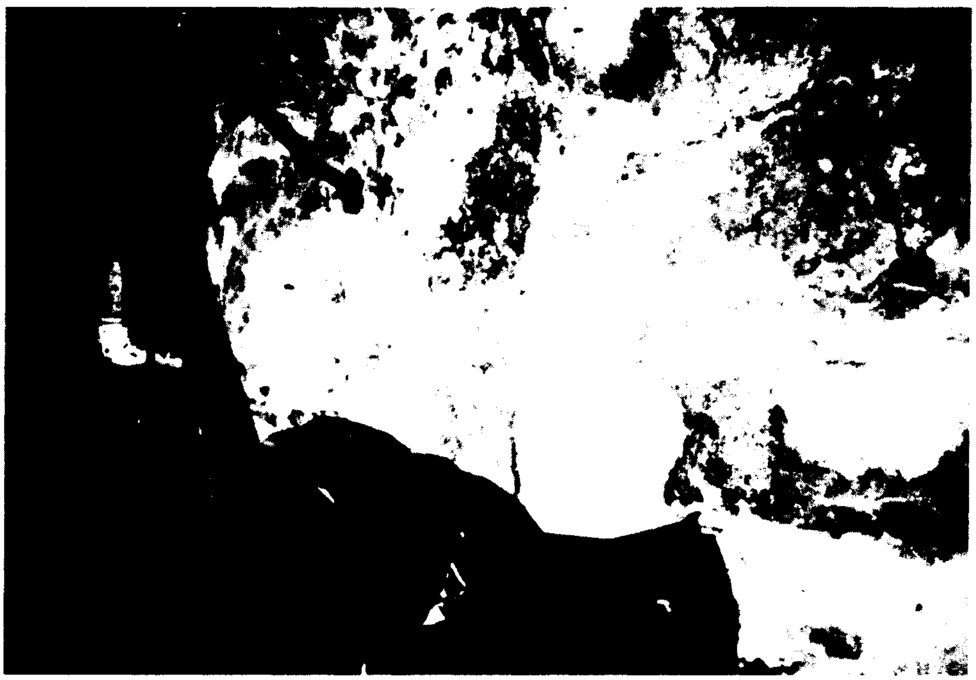
PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	CONCRETE AND MASONRY WALL EFFLORESCENCE		
FOUNDATION WALLS (CSI 03300, 04120)	Revision No.	Issue Date 5/93	Drawing No. D0102-7

CMU CRACKING AND CHIPPING

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	CMU CRACKING AND CHIPPING		
FOUNDATION WALLS (CSI 04220)	Revision No.	Issue Date 5/93	Drawing No. D0102-8



CONCRETE WALL EFFLORESCENCE

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	CONCRETE WALL EFFLORESCENCE		
FOUNDATION WALLS (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D0102-9

MASONRY WALL CRACKING

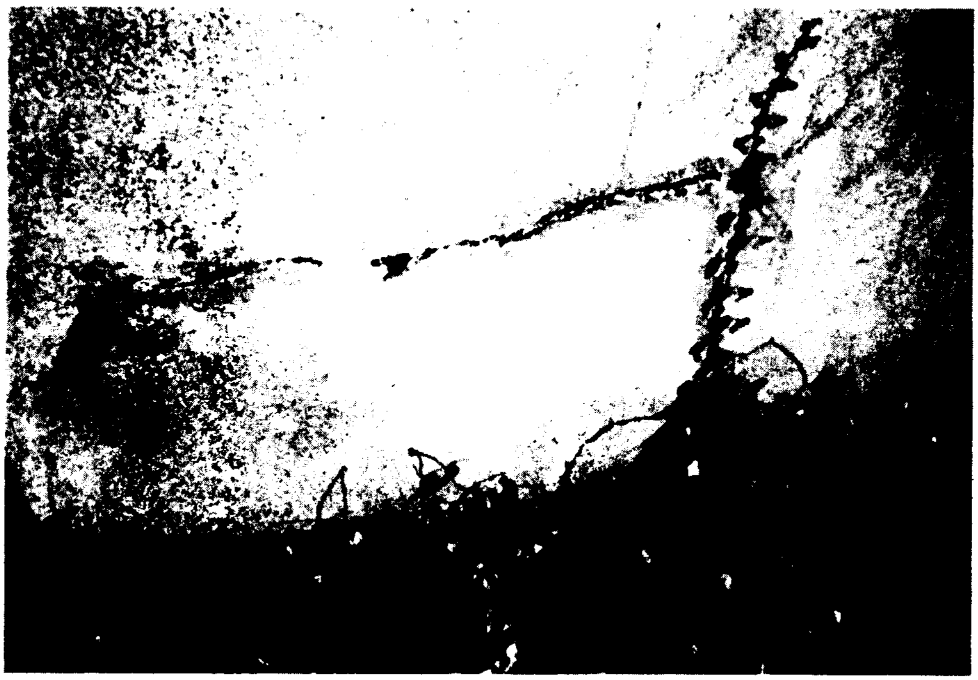
PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	MASONRY WALL CRACKING		
FOUNDATION WALLS (CSI 04210)	Revision No.	Issue Date 5/93	Drawing No. D0102-10

FOUNDATION SETTLEMENT CAUSING CRACKING IN WALL

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	FOUNDATION SETTLEMENT CAUSING CRACKING IN WALL		
FOUNDATION WALLS (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D0102-11



CONCRETE WALL CRACKING

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	CONCRETE WALL CRACKING		
FOUNDATION WALLS (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D0102-12

MORTAR JOINT DETERIORATION

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-FOUNDATIONS AND FOOTINGS	MORTAR JOINT DETERIORATION		
FOUNDATION WALLS (CSI 04220)	Revision No.	Issue Date 5/93	Drawing No. D0102-13

DEFICIENCY FACTORS
0.01.02 FOUNDATION WALLS (CSI 03300)

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DEFICIENCY FACTORS
0.01.02 FOUNDATION WALLS (CSI 03300)

END OF SUBSECTION

0.01.03 FOUNDATION **DAMPPROOFING/WATERPROOFING** (CSI 07100)

DESCRIPTION

Dampproofing/waterproofing is used to prevent moisture penetration. Waterproofing barrier systems are a treatment of surface or structural systems that prevent water passage under hydrostatic pressure. Dampproofing barrier systems are a treatment of surface or structural systems that resist water passage in the absence of hydrostatic pressure. Because concrete and masonry may develop cracks after placement, it is sometimes necessary to cover the surface with a barrier material to meet these requirements. Protective barrier systems are required to protect concrete and masonry from deterioration when exposed to chemicals. In some cases a barrier IS required to prevent chemicals from being contaminated when they contact a concrete surface. 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

Waterproofing (CSI 07100)

Waterproofing is normally used to prevent leakage of water into, through, or out of concrete or masonry under hydrostatic pressure. If freezing and thawing conditions exist, or if water carries aggressive chemicals that attack reinforcing steel or concrete, then the waterproofing barrier will be used to prevent leakage into the concrete or masonry. If a dry surface is required for applying coatings, waterproofing could be used to prevent moisture from leaving the concrete. Waterproofing is also used to minimize unsightly carbonates or efflorescence.

Positive side barrier systems are placed on the same side as the applied hydrostatic pressure. Negative side barrier systems are placed on the side opposite the applied hydrostatic pressure.

Waterstops (CSI 03250)

A thin sheet of metal, rubber, or other material inserted across a joint to obstruct water seepage through the joint. Usually formed from rubber in a dumb-bell shape with fins cast into the concrete when poured or inserted into pockets formed by specially shaped masonry units.

Water Repellents (CSI 07175)

Transparent applications for masonry, stucco, and concrete intended to reduce water penetration. They may also improve the ability of the substrate to resist soiling and staining.

Silicone is a unique water repellent, neither organic nor mineral in nature. It is colorless (in thin concentrations) and can be dispersed in several types of vehicles. Silicone is hydrophobic by nature and weathers reasonably well. It is also the most “invisible” of the water repellent coatings, upon initial application.

0.01.03 FOUNDATION **DAMPPROOFING/WATERPROOFING** (CSI 07100)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Water Repellents (CSI 07175) (Continued)

Acrylic compounds were developed as the answer to some silicone problems. They have their own limitations, however, including a tendency to alter the appearance of substrates. Acrylic tends to "darken" some surfaces. On dark surfaces this amounts only to a slightly "wet" or "oiled" appearance. Excessive use of acrylic or use on impervious surfaces may produce a gloss or sheen like that of varnish or lacquer. The acrylic is then behaving like a paint or special coating, and not like a water repellent. Unfortunately acrylics contribute to air pollution and are therefore forbidden by some building codes. Water repellent applications are mostly used on exterior walls above the finish grade.

Comparison of Positive or Negative Side Waterproofing Barriers

Negative Side Waterproofing	Positive Side Waterproofing
Advantages	Advantages
• Concrete may remain moist eliminating drying, shrinkage, and cracking • Inspection and repair possible and economical after backfill • No additional excavation costs for application or repair	• Water is prevented from entering concrete • Dried concrete is protected from freeze/thaw damage • Corrosion protection if aggressive chemicals are present
Disadvantages	Disadvantages
• No freeze/thaw protection on above grade or exposed applications • No corrosion protection if aggressive chemicals are present • May have to stop moisture flow to install the system	• Membrane inaccessible, if sandwiched or backfilled, for inspection • Repairs are difficult • Additional excavation costs for installation of membrane • Damage possible during backfill

Membrane Waterproofing (CSI 07100)

Membrane waterproofing is the most reliable barrier type that prevents liquid water under a hydrostatic head from entering an underground structure . When used in conjunction with good design, high quality concrete, admixtures, and hydrostatic pressure reduction by, designed drainage (surface tile, drainage fabric, wellpoints, etc.) they should reduce water leakage problems.

Waterproofing membranes have varying permeability coefficients (perms). Waterproofing barriers typically consist of multiple layers of bituminous-saturated felt or fabric cemented together with hot-applied coal tar pitch or asphalt for positive side applications. There are also cold-applied systems that use multiple asphaltic mastic and glass fabric applications. A number of other positive side waterproofing barriers can be selected, including cold-applied systems, (such as elastomeric membrane barriers), cementitious membranes, modified bituminous materials, and bentonite-based materials.

0.01.03 FOUNDATION **DAMPPROOFING/WATERPROOFING** (CSI 07100)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Membrane Waterproofing (CSI 07100) (Continued)

For negative side waterproofing, cementitious membranes or metallic oxide waterproofing materials can be used. The number of coats or plys, thickness, and the types of materials will vary with the job conditions.

Tvpes of Waterproofing Barrier Svstems:

- Hot-applied bituminous-reinforced
- Hot-applied bituminous-nonreinforced
- Prefabricated bituminous
- Prefabricated nonbituminous
- Cold-applied bituminous-nonreinforced
- Cold-applied nonbituminous-reinforced
- Cold-applied nonbituminous-nonreinforced
- Cementitious barriers

Hot-Applied Bituminous Barrier Materials (CSI 07100)

The materials used for hot-applied systems are bituminous substances of either coal tar pitch or asphalt derived from petroleum. The bitumens (coal tar pitch and asphalt) used in hot-applied systems have very little strength within themselves. Fabrics and felts act as reinforcement to withstand the strains of expansion, contraction, temperature changes, vibration, and building movement.

Felts (CSI 07100)

Felts used in a waterproofing system are usually the same as those used for roofing purposes. Cotton fabrics weigh a minimum of 10 ounce. per sq yard and have a long record of use. Glass fabric is the strongest fabric in use, having a minimum tensile strength of 75 pound. per inch of width. Jute (treated burlap) is sometimes used because of its coarse texture. All of the fabrics are available in a variety of widths ranging from 3 to 48 inches.

Cold-Applied Bituminous Barrier Materials (CSI 07100)

May use bituminous and/or elastomeric materials: They may be “built-up” in a manner similar to hot-applied systems; may be applied as a liquid to form a membrane; or may be factory-fabricated into sheets or rolls and then joined in the field to form the barrier system. Cold bituminous systems use asphalt emulsions or solvent cut-back asphaltic mastics and are reinforced with fabric. These mastics and emulsion have little strength within themselves. The fabric acts as a reinforcement in the same manner as in hot-applied systems.

Liquid-Applied Elastomeric Barrier Materials (CSI 07120)

Elastomeric materials are liquids that are applied by means of squeegee, roller, brush, trowel, or spray. When cured, they form a film that is resistant to water and many other chemicals. With some of these materials, the manufacturer may require reinforcement with glass fabric. An elastomer is defined in ASTM D1566 as a “macromolecular material that returns rapidly to approximately the initial dimensions and shape after substantial deformation by a weak stress and release of the stress.” Liquid-applied membranes are formulated as single- or multiple-component products such as neoprene (polychloroprene), neoprene-bituminous blends, polyurethane, polyurethane-bituminous blends, and epoxy-bituminous blends.

0.01.03 FOUNDATION DAMPPROOFING/WATERPROOFING (CSI 07100)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS (Continued)

Dampproofing (CSI 07160)

Treatment of a surface or structure to resist water passage in the absence of hydrostatic pressure. Dampproofing barrier systems are used to perform the same functions as a waterproofing system, but cannot be used to protect against water under pressure. A drainage system may be required to prevent the development of a head of water. Dampproofing is a low-cost system because the material thickness is relatively low and minimal surface preparation is required. A dampproofing barrier system will minimize water vapor transmission through concrete that is not subject to a continuous or intermittent head of water.

Flashing (CSI 07600)

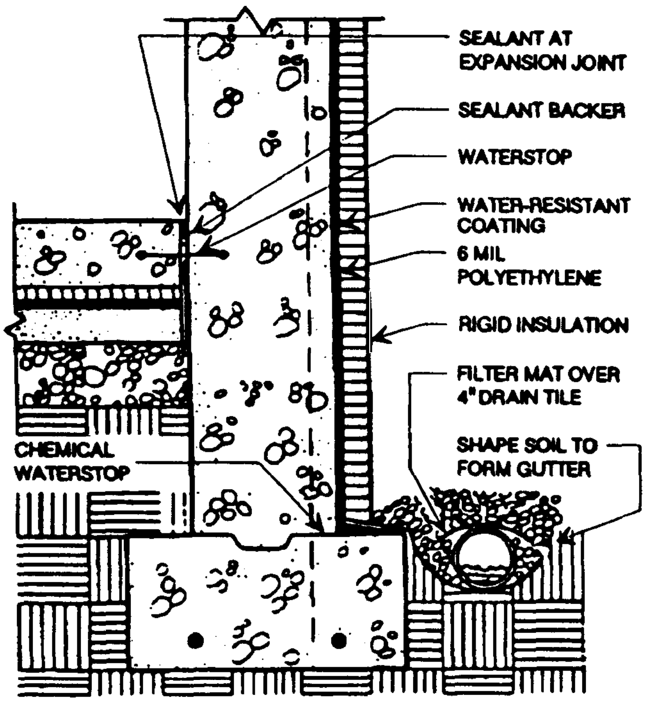
The wall or joint where the waterproofing membrane terminates at the wall, etc., can be the most vulnerable area of the whole system. Many failures or leaks can be traced back to faulty or poor construction details. Flashing's sole purpose is to prevent water penetration or direct moisture/water flow away from a structure or assembly. Flashing details are generally subject to the most extreme weathering conditions and mechanical damage (due to maintenance actions, etc.).

Nailers (CSI 05060)

When vertical surfaces are to be waterproofed and nailing is required, a horizontal nailing strip, flush with the surface, should be provided at least 4 inches above grade. The nailer should be treated with a chemical that is compatible with the bituminous weatherproofing materials to resist rot, decay, and termites.

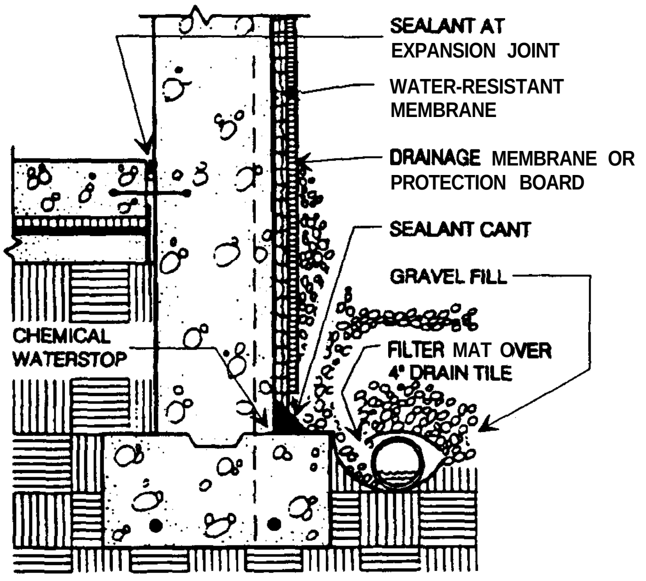
OTHER RELATED COMPONENTS

See the following subsections for related components:

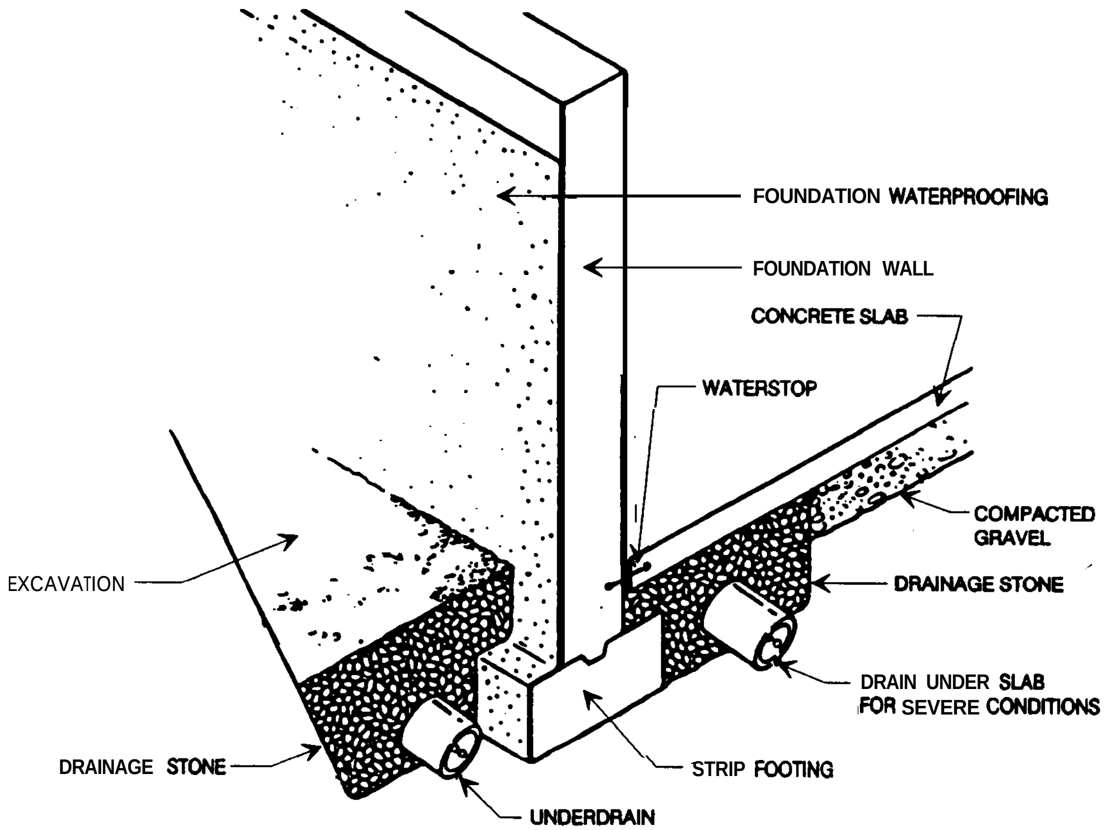


FOOTING WATER RESISTANCE-TYPE 1

SYSTEM ASSEMBLY DETAILS-FOUNDATIONS AND FOOTINGS	DAMPPROOFING/WATERPROOFING AT FOOTING		
FOUNDATION DAMPPROOFING/ WATERPROOFING (CSI 02710)	Revision No.	Issue Date 5/93	Drawing No. A0103-1



FOOTING WATER RESISTANCE-TYPE 2



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

SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	WATERPROOFING ASSEMBLY		
FOUNDATION DAMPPROOFING/ WATERPROOFING (CSI 02710)	Revision No.	Issue Date 5/93	Drawing No. A0103-3

DEFICIENCY FACTORS
0.01.03 FOUNDATION DAMPPROOFING/WATERPROOFING (CSI 07100)

PROBABLE FAILURE POINTS

- Efflorescence - A deposit of salts (usually white) formed on a surface, thatemerged in solution from within concrete or masonry and is deposited by evaporation. Soluble salts of various kinds, chiefly sulfates, may be carried by water into the concrete from the soil or other environmental source.
- Water Leakage - Water may be forced through foundation walls by hydrostatic pressure, water vapor gradient, capillary action, wind-driven rain, or any combination of these.
- Acid and Alkali Attack - Acids, some salt solutrons, and water (depending on purity and temperature) will react with the calcium hydroxide in the hydrated Portland cement binder of concrete or mortar to form water soluble reaction products resulting in disintegration of the material.
- Rebar - Chemical or salt solutions penetrate concrete or masonry causing localized corrosion of reinforcing steel. Rust formation results in expansive pressures, which cause concrete or masonry deterioration near the steel. A protective barrier may be factory applied to reinforcing steel before use and/or a waterproofing barrier may be applied to the positive side of the concrete.
- Backfilling Procedures - Backfilling of soil, if not compacted at time of placement, will settle (consolidate). This settlement of the soil backfill will scrape off or drag off the dampproofing/waterproofing material. Correct placement invovles compacting soil in lifts or using a protection board to cover and protect the waterproofing as necessary to prevent damage.

SYSTEM ASSEMBLIES/DEFICIENCIES

Membrane/Coating

Loose Adhesive and Bubbles:	Adhesive breakdown causing slippage, loose areas, or membrane pop-up.
Fishmouths and Open Seams:	Seam opening or puckering from improper installation and/or adhesive breakdown allowing water penetration.
Holes/Penetrations/Leaks:	Impact or chemical reaction causing missing membrane or barrier areas .
Surface Deterioration:	Ultraviolet light, chemical reaction, or weathering causing surface breakdown.
Blistering:	Surface dimpling or puckering usually caused by chemical reaction.
Surface Splitting:	Surface ripping or tearing from excess substrate movement.
Alligatoring/Cracking:	Random surface cracking from weathering or ultraviolet light.

DEFICIENCY FACTORS
0.01.03 FOUNDATION **DAMPPROOFING/WATERPROOFING** (CSI 07100)

END OF SUBSECTION

0.01.04 EXCAVATION/BACKFILL (CSI 02200)

DESCRIPTION

Foundations for most structures are established below finished grade level and cannot be constructed until the soil or rock above the base level of the foundation has been excavated.

Ordinarily, it is not the function of the design professional to select materials or equipment for excavating at a given site or to design the excavation support system, if any is required. This is considered the responsibility of the general contractor. All existing sites require a change in topography when subject to physical alterations. This alteration, which is usually based on cut and fill principals to minimize non-situ materials usage, is specified by the grading plan. Because of this, excavation/backfilling has a strong influence on cost, utility, and appearance of the completed project. Improperly excavated or backfilled sites can affect other assemblies and system from uneven settlement or exposure. Graphic assembly details which follow illustrate general component assembly 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 design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Excavation (CSI 02200)

The removal of earth, usually to allow the construction of a foundation or basement. The following are classifications of excavation:

Common Excavation:

Consists of removal and disposal of any materials that can be removed by hand or with one cubic yard capacity power excavator (shovel, back hoe, and similar power excavators), without drilling or blasting.

Rock Excavation :

- Solid ledge rock.
- Bedded or conglomerate deposits, cemented to present characteristics of solid rock. Cannot be removed by hand or with one cubic yard capacity power excavator (shovel, back hoe, and similar power excavators), without drilling or blasting.
- Boulders having a volume of more than one half cubic yard.

Excavation Support **Systems** (CSI 02160)

Shorina & Bracing:

When the excavation depth is significant, one method of supporting sidewalls steel H-section (soldier) piles and heavy timber lagging. Piles are driven with flanges parallel to sides of excavation below final elevation depth. As excavation proceeds, timber lagging is wedged between pile flanges. Horizontal beams, called wales, may be required for additional stability. In deep excavations, adjacent to existing structures or improvements, diagonal cross-bracing using wide-flange or tubular steel members may be required.

In addition, extensive pressures may be encountered where very deep excavations are required, Under these conditions, rock or soil anchors may also be incorporated in the excavation support system.

Sheet Piles:

In excavations ranging between 12 and 15 feet, sidewall stabilization may be accomplished using steel sheet piles: rolled shapes with interlocking edges. When interlocked, sheet piles form a continuous wall or cell to retain earth or water. They are widely used for temporary and permanent marine structures.

0.01.04 EXCAVATION/BACKFILL (CSI 02200)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS (Continued)

Site Preparation (CSI 02100)

Stripping Topsoils:

On some sites, topsoil is stripped from designated areas and replaced (either with stored, existing, or new topsoil fill) with fertile, friable, natural, loamy topsoil characteristic of locality. Characteristics include capability of growing healthy horticultural crops of grasses; absence of foreign material such as weeds, roots, stones, subsoil, frozen clods, and similar foreign materials, larger than one half cubic foot in volume; and finally, when topsoil is used in finish grading, all foreign material should be removed if larger than 2 inches in any dimension. Topsoil work, such as stripping, stockpiling, and similar topsoil work, shall not be carried out when the soil is wet so that the tilth of the soil will not be destroyed.

Excavation Drainaae:

Excavation drainage systems operate pumping equipment to keep the excavation free of water and the subgrade dry, firm, and undisturbed until the permanent work is approved. When the subgrade for foundations is disturbed by water, the material must be removed until firm, undisturbed material is reached. After the water is brought under control, trench subgrade must be replaced by mechanically tamped sand or gravel.

Placing/Compaction:

Material is placed in horizontal layers not exceeding 8 inches in loose depth and then compacted. No material is placed on surfaces that are muddy, frozen, or contain frost.

Compaction requirements are based on the optimum moisture-density relations (cohesive soils) or relative density (cohesionless soils) for satisfactory soil materials, and should be reviewed for applicability site conditions. Percentages specified are suggested minimums, which may be adjusted to suit site requirements.

Backfilling (CSI 02200)

Soil or other material is used to replace previously excavated material, as around a newly constructed basement or foundation wall:

- Backfilling begins when all foreign materials are removed from the excavation. Backfill is usually accomplished using excavated materials and/or borrow. Unsuitable excavated materials should not be used. The backfilling should not start until foundation walls are completed above and adequately braced, waterproofing or dampproofing is applied, and pipes that come into contact with backfill are installed, inspected, and approved.
- Compaction is accomplished with approved equipment well suited to the soil being compacted. Material should be moistened or aerated as necessary. Each layer should be compacted to not less than the percentage of maximum density specified in TABLE ONE below:

0.01.04 EXCAVATION/BACKFILL (CSI 02200)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Backfilling (CSI 02200) (Continued)

TABLE ONE

Fill, Embankments, & Backfill	Percent Maxlmum Density
Under proposed structures, building slabs, steps, and paved areas	95
Curbs and gutters	95
Under sidewalks	95
Landscaped areas	85 (Top 16") 90 (Below 16" of Fin. Grade)
Natural ground (cut or existing)	Percent Max. Density
Under building slabs, steps, and paved areas, top 6"	95
Curbs, curbs, and gutters, top 6"	95
Under sidewalks, top 6"	95

Grading:

Altering the ground surface to a desired grade or contour by cutting, filling, leveling, and/or smoothing.

- Rough or sloping rock is cut to level for foundations. In unfinished spaces, the low spots are filled and leveled off with coarse sand or fine gravel.
- Backfilled buildings slope away from the building walls for a distance of 6 feet.
- After rough grades are established in cut areas and fill is placed in areas under building and pavements, the exposed subgrade is proof-rolled with a fully loaded dump truck or roller to check for pockets of soft material.
- Proof-rolling consists of at least two complete passes perpendicular to each other. Areas that deflect, rut, or pump excessively during proof-rolling or fail to consolidate after successive passes are removed to suitable soils and replaced with compacted fill. Subgrade is maintained until the following operation is accomplished.
- Finished grade is a minimum 6 inches below the bottom line of windows or other building wall opening unless greater depth is shown.
- Crushed stone or gravel fill is placed under concrete slabs on grade, tamped, and leveled. Fill thickness is normally 6 inches unless soil conditions require other thickness due to bearing or drainage.
- Subgrade is finished to an acceptable condition. Finished grade maintains a smooth and compacted condition.

OTHER RELATED COMPONENTS

See the following subsection for related components:

0.01.04 EXCAVATION/BACKFILL (CSI 02200)

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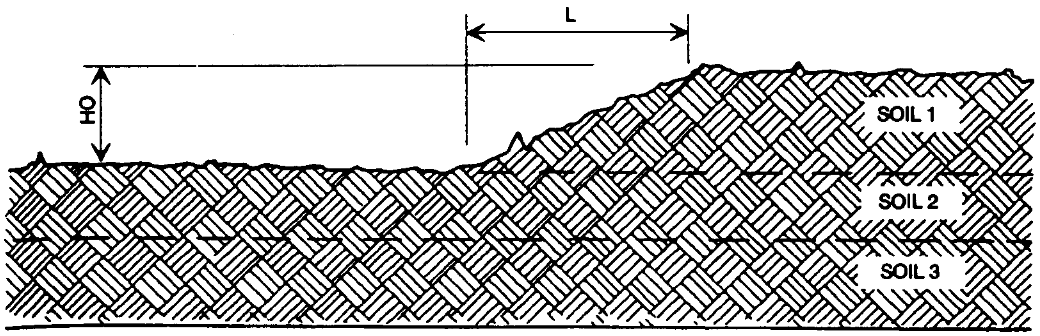
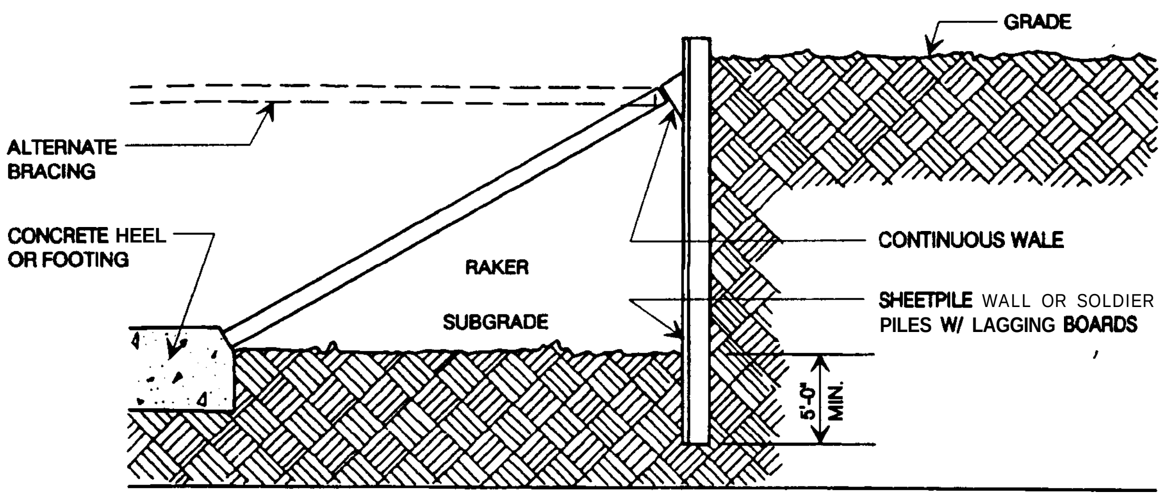
EMBANKMENT **STABILITY**
CONSULT **FOUNDATION ENGINEER**

SOIL TYPES				
S1	S2	S3	L/HO	REMARKS
Fill	Rock		> 1.5	Check sliding of S1
Soft clay	Hard clay	Rock	>1.0	Check sliding of S1
Sand	Soft clay	Hard clay	>1.5	Check lateral displacement of S2
Sand	Sand	Hard clay	>1.5	
Hard clay	Soft clay	Sand	<1.0	Check lateral displacement of S2



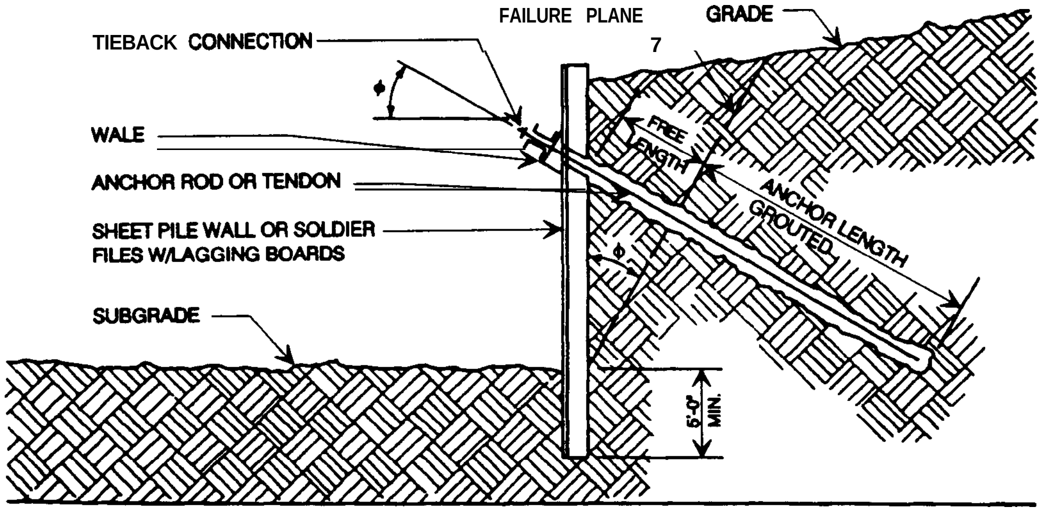
OPEN EXCAVATION



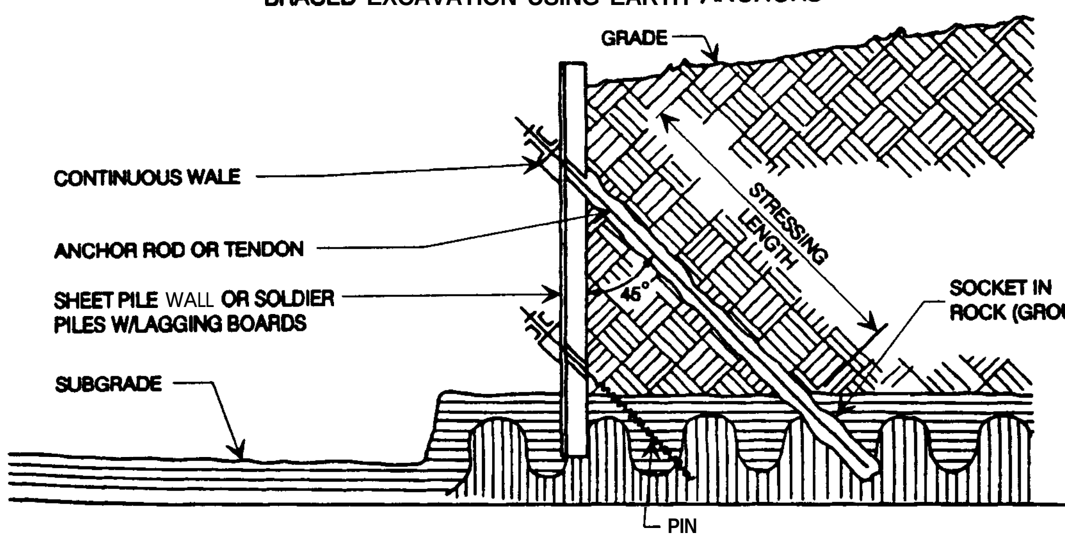
BRACED EXCAVATION USING RAKERS

SOURCE: ARCHITECTURAL GRAPHIC STANDARDS, EIGHTH EDITION ("Reprinted by permission of the American Institute of Architects")

SYSTEM ASSEMBLY DETAILS-FOUNDATIONS AND FOOTINGS	TYPES OF EXCAVATION METHODS		
EXCAVATION/BACKFILL (CSI 02220)	Revision No.	Issue Date 5/93	Drawing No. A0104-1



BRACED EXCAVATION USING EARTH ANCHORS



BRACED EXCAVATION USING ROCK ANCHORS

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SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	TYPES OF EXCAVATION METHODS		
EXCAVATION/BACKFILL (CSI 02220)	Revision No.	Issue Date 5/93	Drawing No. A0104-2

DEFICIENCY FACTORS
0.01.04 EXCAVATION/BACKFILL (CSI 02200)

PROBABLE FAILURES

- Improper soil compaction causing excessive of structure or grade settlement, exposing dampproofing/waterproofing.
- improper fill materials such as clays or construction and organic materials resulting in settlement or movement.
- Excessive earth movement from freeze/thaw or seismic action resulting in the supporting grade heaving or collapsing.
- Erosion from excessive water over or through material to expose buried surfaces.

SYSTEM ASSEMBLIES/DEFICIENCIES

Excavation/Backfill

Erosion:	Bank erosion, gullies (direct view). Sunken or heaving slabs against building indicating erosion (indirect and hidden condition).
Ponding/Standing Water:	Water against building caused by uneven backfill or settling.
Water Leaks:	Water in building through foundation wall from improper backfilling that may have damaged the dampproofing or waterproofing (exterior applied).
Excessive Grade Movement:	Evidence of structural damage caused by footings on unstable or poorly compacted soils or freeze/thaw action causing uplift, sinking, or other movement.

NOTE: The deficiencies listed above result from improperly compacted fill.

DEFICIENCY FACTORS
0.01.04 EXCAVATION/BACKFILL (CSI 02200)

END OF SUBSECTION

0.01 .05 PILES & CAISSONS (CSI 023501

DESCRIPTION

Piles are vertical or slightly slanting structural foundation members, having relatively small cross-sectional dimensions with respect to their length. They are installed in soil and transmit the loads and forces acting on the superstructure to the subsoil. The length, method of installation, and structural performance pile can vary greatly. They are easily adaptable to various conditions and requirements.

Caissons are deep foundations constructed by placing concrete in an excavated hole to transfer structural loads to bearing strata well below the unusable portion of the geographic soil conditions. Caissons and piles serve the same function; the significant difference is the method of construction. Piles are usually installed by driving or vibrating the structural member and displacing the ground. Caissons are installed by excavating or drilling a shaft, which may be cased or uncased depending on the soil conditions, and then filling the shaft with concrete. The shaft may be enlarged at the base to form what is known as a belled caisson.

Pile construction and use have developed rapidly in recent years, and it can be said today that their forms represent the most general and widespread method of deep foundation. In the last two decades, caisson foundations have increasingly replaced some types of pile foundations. Today, caissons are used mainly where their walls serve as a permanent confinement structure. 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

Piles (CSI 02350)

Commonly divided into two kinds: Point-bearing (end bearing) and friction. The point-bearing pile derives practically all of its support from the rock or soil surrounding its lower part. A friction pile derives its support principally from the surrounding soil through the development of shearing resistance between the soil and the piles.

The four basic types of driven pile systems are: Timber, Steel H-Section, Concrete-Filled Steel Shell, and Precast Concrete piles. Piles in this section are classed as either point-bearing or friction.

Timber Piles:

Timber piles have been in continuous service for many years. It has been reported that piles in bridges in London and Paris over 1000 years old have calculated design loads of over 60 tons and are still in service. Although wood piles last indefinitely when located below the permanent water table, they are subject to decay when exposed to alternately wet and dry conditions.

Specification text indicates that wood timbers for foundation piles must comply with requirements of ASTM D25-89 “Standard allows piles to be... of any species of wood for which clear wood strength values are given in (ASTM) Test Method D2555." AWPA Standard C3 “Piles Preservative-Treatment by Processes” indicates that acceptable foundation piles should be treated. Design values for compression parallel to grain may limit types of wood species allowed. In addition, AWPA C3 allows the use of creosote.

Steel H-Section Piles:

This type is used to carry both dead and live loads in foundation systems. They may also be used as soldier piles for retaining deep excavations. When driven to refusal, steel H-section piles will support high concentrated loads utilizing the full strength of the bearing stratum.

0.01.05 PILES & CAISSONS (CSI 02350)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Piles (CSI 02350)

Steel H-Section Piles (Continued):

Steel H-section piles are wide-flange structural shapes rolled from steel that complies with ASTM A572 in Grades 45, 50, 55, and 60 with minimum yield points of 45,000, 50,000, 55,000, and 60,000 psi, respectively.

Steel H-section piles in standard HP sections are available in lengths up to 85 feet. When longer sizes are required, they are usually weld-spliced at the project site. Butt welds can be made to develop 100 percent of the compressive and bending strength of the pile.

Many studies have been made that steel H-section piling is not normally affected by corrosion (National Bureau of Standard Monograph 58 “Corrosion of Steel Piling in Soils”). Pile coatings are generally not required in interior geographic locations.

Concrete-Filled Steel Shell Piles:

Two primary types of concrete-filled steel shell piling systems are currently in common use: continuous-taper type (“Monotube”) and the step-taper type (“Raymond”). Selecting which type is to be used or retaining both as contractor’s option will have to be determined for each distinct project.

Continuous-taper steel shells are available in ll-, 9-, 7-, 5-, or 3-gage metal thickness and are driven without a mandrel. Shells up to 75 feet may be continuously tapered or combinations of tapered sections and cylindrical extensions are available. Nominal tip diameter is 8 inches, and butt diameters may be 12, 14, 16, or 18 inches. Sections are self-aligning due to telescopic joint and fluted cross-section, and are welded. Three different tapers are available (determined by length).

Step-taper steel shell piles are helically corrugated and cylindrical in cross-section, consisting of several sections that increase in diameter from the pile point. Steps are made at regular intervals with the increase in diameter controlled by required pile length, loading with rather conclusive results conditions, and shell section lengths. Sections are made of various metal gages and in lengths of 8, 12, and 16 feet, Joints between sections at steps are watertight, threaded screwed connections.

Precast Concrete Piles:

This broad classification covers both conventionally reinforced concrete piles and prestressed concrete piles. Both types can be formed by casting, spinning (centrifugal casting), or extrusion methods and are made in various cross-section shapes such as square, octagonal, and round. Such piles are frequently cast with a hollow core. Piles are usually of constant cross-section, but may have a tapered tip.

Precast concrete piles must be designed and manufactured to withstand handling, perpendicular lifting, and driving stresses in addition to service loads.

Prestressed Concrete Piles:

Piles are developed by placing concrete with steel rods or strands of wires under tension to replace the longitudinal steel used to construct reinforced concrete piles. The stressing steel is enclosed in a conventional spiral. Such piles can usually be made lighter and longer than normally reinforced concrete piles for the same rigidity and bearing strength.

0.01.05 PILES & CAISSONS (CSI 02350)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Piles (CSI 02350)

Prestressed Concrete Piles (Continued):

Prestressed piles can be either pre-tensioned or post-tensioned. Pre-tensioned piles are usually cast full length in permanently established casting beds. Post-tensioned piles are usually manufactured in sections and assembled and post-tensioned on the job site to the required pile lengths.

Cast-in-Place Concrete Piles:

This type is constructed of concrete with internal reinforcement consisting of a cage made up of several longitudinal bars and lateral or tie steel in the form of individual hoops or spirals.

Pile Drivina Equipment:

A pile driving rig consists of an impact hammer with hoisting gear for handling the pile and lifting the hammer, and frame with leads to control the direction of hammer movement and for placing and holding the pile in position. The energy output of the hammer must be sufficient to ensure that the desired bearing value (by formula) can be reached before the pile reaches practical refusal.

A drop hammer is a metal ram or weight that is allowed to fall on top of the piles by gravity. The ram is raised by a hoisting line and released by a trip to fall freely.

A single-acting steam hammer is a freely falling weight with steam pressure acting only on the underside of the ram.

A double-acting or differential-acting steam hammer also employs steam pressure on the piston to raise the ram. However, at the top of the stroke steam pressure is applied to the upper side of the piston and the gravity acceleration is increased. This permits shorter strokes with increased velocity.

While steam hammers (which also may be operated by compressed air) are most commonly employed for pile driving, both diesel hammers and vibratory-type hammers are being used in increasing numbers. The impact type of driving formula to determine bearing capacities cannot be used with vibratory hammers.

Caissons (CSI 02350)

There are four (4) basic caisson designs: High-Capacity Rock, Normal Rock, Hardpan or Clay, and Friction caissons. Each has distinct requirements which can affect the selection process. Caissons may often be placed more rapidly and economically than other systems when deep foundations are required.

High-Capacity Rock Caisson:

The load-carrying capacity of the shaft uses the combined strength of a permanent steel shell, steel core, and concrete. The load is transmitted by both end-bearing and side friction in a rock socket at the bottom.

Normal Rock Caisson:

The load is transmitted through the concrete shaft to the surface bedrock (with or without sockets).

Hardpan or Clay Caisson:

These caissons can have either straight shafts to the bearing strata, or have the bottoms belled to reduce the unit load on the bearing material (usually undisturbed layer).

0.01.05 PILES & CAISSONS (CSI 02350)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Caissons (CSI 02350) (Continued)

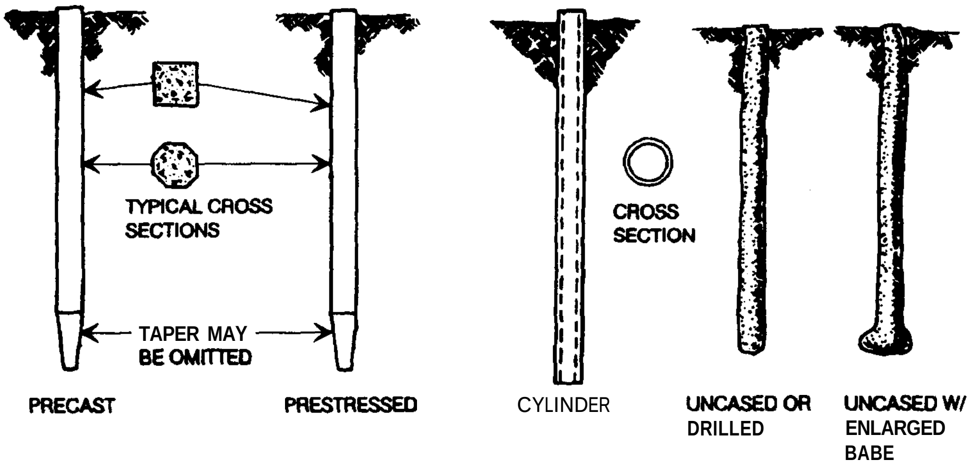
Friction Caisson:

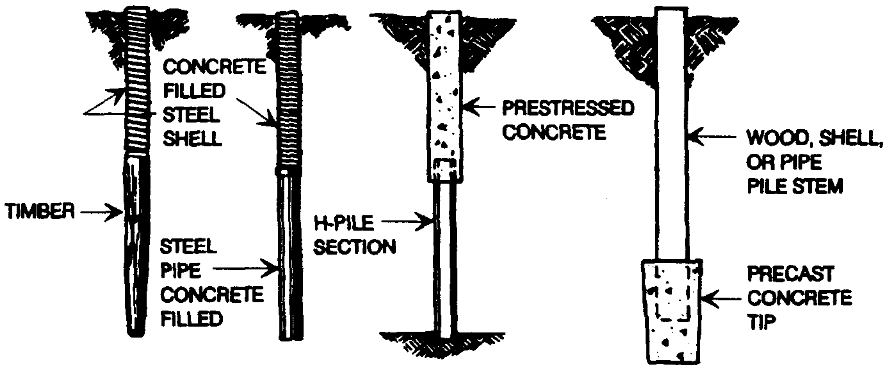
This design is based on a predetermined depth, developing a frictional carrying capacity between the sides of the concrete shaft and the undisturbed excavation walls.

The proper evaluation of a proposed design or shaft application depends on the results of a detailed and accurate subsurface investigation.

OTHER RELATED COMPONENTS

See the following subsections for related components:





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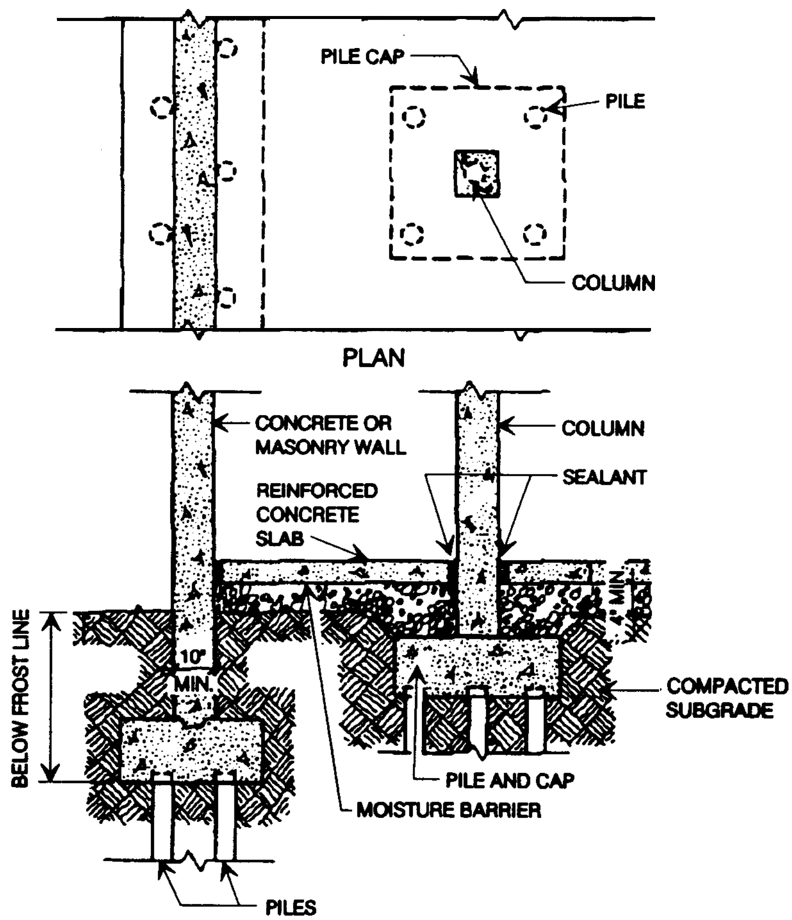
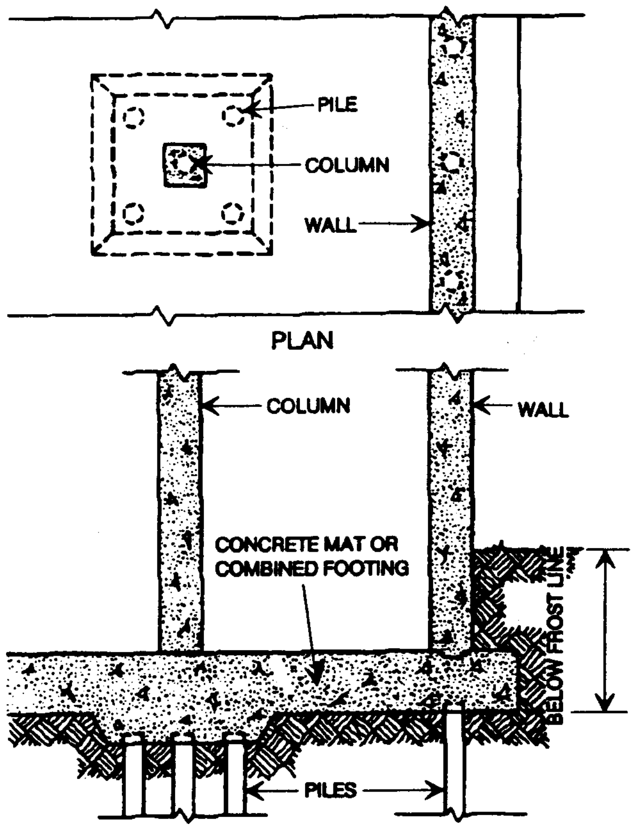
SYSTEM ASSEMBLY DETAILS-FOUNDATIONS AND FOOTINGS	PILE AND CAISSON TYPES		
PILES AND CAISSONS (CSI 02350)	Revision No.	Issue Date 5/93	Drawing No. A0105-1



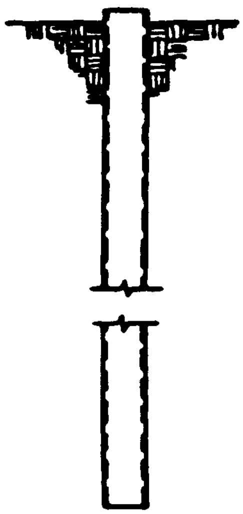
SECTION @ PILE SUPPORTED FOUNDATIONS

SYSTEM ASSEMBLY DETAILS-FOUNDATIONS AND FOOTINGS	PILE AND CAISSON TYPES		
PILES AND CAISSONS (CSI 02350)	Revision No.	Issue Date 5/93	Drawing No. A0105-3

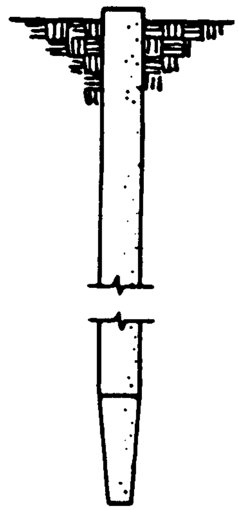


SECTION @ PILE SUPPORTED FOUNDATIONS

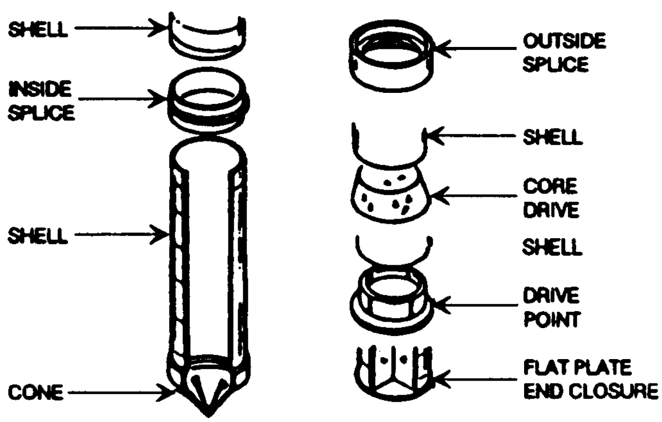
SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	PILE AND CAISSON TYPES		
PILES AND CAISSONS (CSI 02350)	Revision No.	Issue Date 5/93	Drawing No. A0105-4



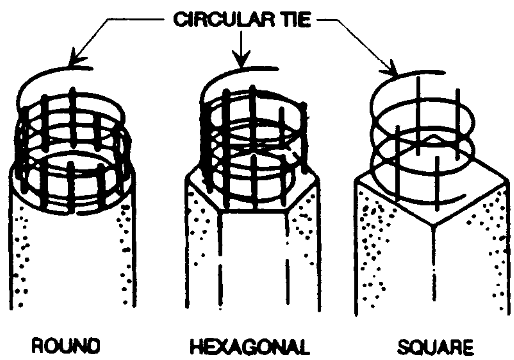
CAST-IN-PLACE CONCRETE PILE



PRECAST CONCRETE PILE



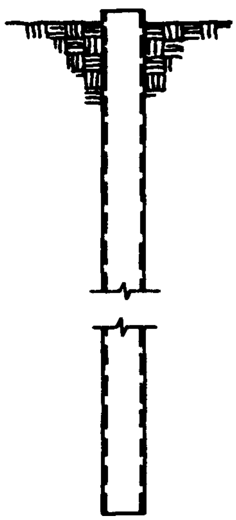
DRILL AND ACCESSORIES



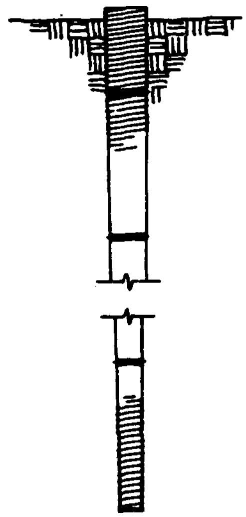
REINFORCEMENT

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

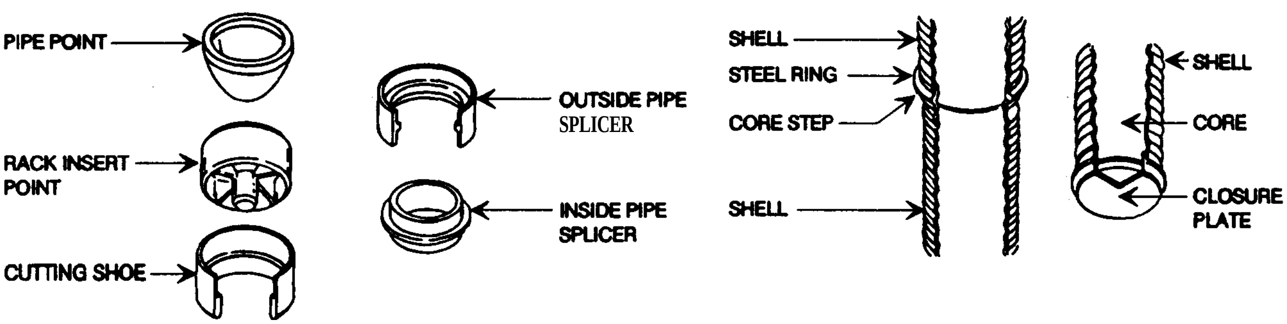
SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	PILE TYPES AND ACCESSORIES		
PILES AND CAISSONS (CSI 02350)	Revision No.	Issue Date 5/93	Drawing No. A0105-5



STEEL PIPE PILE



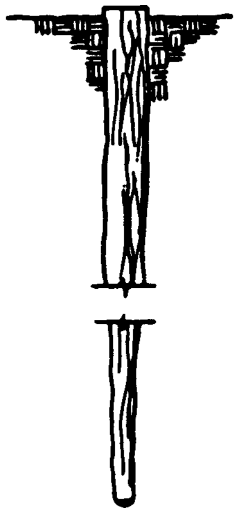
STEP-TAPERED PILE



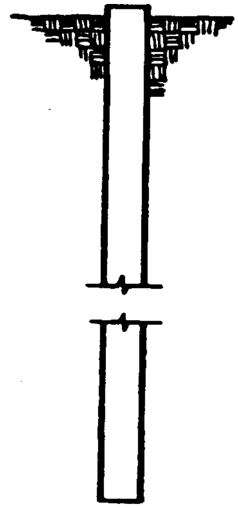
DRILL AND ACCESSORIES

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

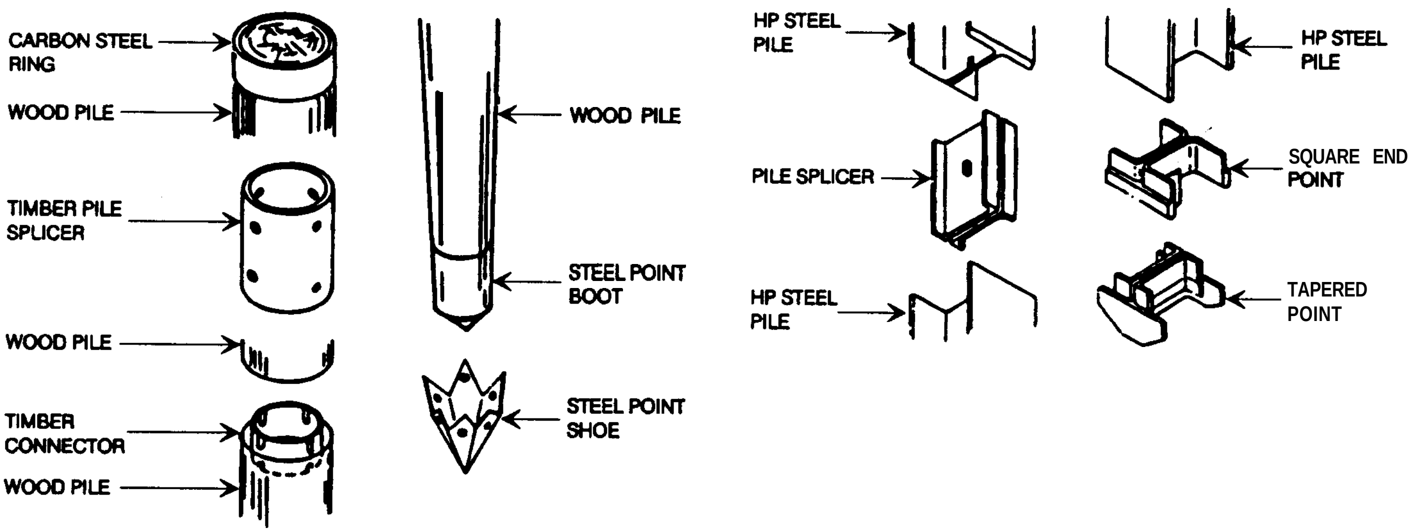
SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	PILE TYPES AND ACCESSORIES		
PILES AND CAISSONS (CSI 02350)	Revision No.	Issue Date 5/93	Drawing No. A0105-6



TREATED WOOD PILE



STEEL HP PILE



DRILL AND ACCESSORIES

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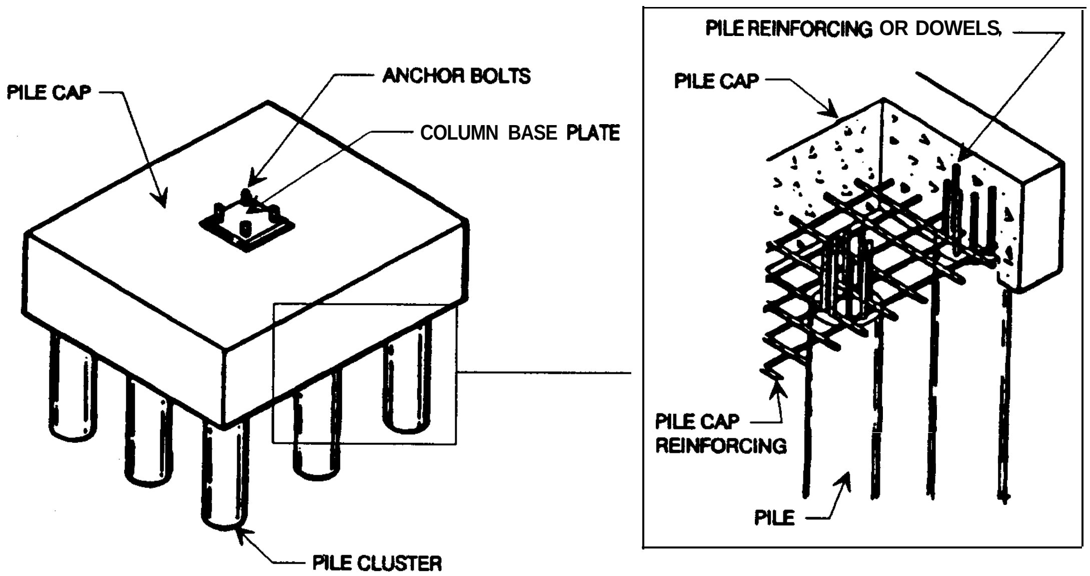
SYSTEM ASSEMBLY DETAILS- FOUNDATIONS AND FOOTINGS	PILE TYPES AND ACCESSORIES		
PILES AND CAISSONS (CSI 02350)	Revision No.	Issue Date 5/93	Drawing No. A0105-7



PILE AND PILE CAP

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

SYSTEM ASSEMBLY DETAILS-FOUNDATIONS AND FOOTINGS	PILE AND PILE CAP		
PILES AND CAISSONS (CSI 02350)	Revision No.	Issue Date 5/93	Drawing No. A0105-8

DEFICIENCY FACTORS
0.01.05 PILES & CAISSONS (CSI 02350)

PROBABLE FAILURES

- Excessive member loading or unbalanced loading causing failure or collapse.
- Improper design or construction with improperly sized member creating unbalanced loading.
- Improper or unstable supporting grade resulting in member slippage or failure.

SYSTEM ASSEMBLIES/DEFICIENCIES

Piles & Caissons

Surface Deterioration/Cracking:	Stress cracking or breakdown of surface material from weathering or chemical actions.
Thermal Stress/Excessive Movement:	Excessive material movement from temperature changes or supporting grade upheaval and settlement.
Fatigue/Overloading:	Crushing, buckling, or failure of member from excessive or improper loads.
Improper Design/Construction:	Underdesigned or improper type of pile/caisson for conditions. Poor or improper material selection or placement for type or member of material used.
Corrosion of Rebar/Steel:	Metal rebar oxidates or is eaten away by chemical or electrochemical action after prolonged exposure to moisture.

*NOTE: Failure of piles and/or caissons is almost always indicated by secondary failure of substructure and/or superstructure. Such evidence may include structural sinking or uplift, stress cracks, etc. Determination will involve non-standard testing.

DEFICIENCY FACTORS
0.01.05 PILES & CAISSONS (CSI 02350)

END OF SUBSECTION

INSPECTIONS METHODS . STANDARD

GUIDE SHEETS

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

TABLE ONE

Assembly/Component	Control Number
Footings - Spread/Strip/Grade Beams	GSS 0.01 .01
Foundation Walls	GSS 0.01.02
Foundation Dampproofing/Waterproofing	GSS 0.01.03
Excavation/Backfill	GSS 0.01.04
Piles & Caissons	GSS 0.01.05

INSPECTIONS METHODS - STANDARD

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INSPECTIONS METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FOOTINGS - SPREAD/STRIP/GRADE BEAMS
CONTROL NUMBER: GSS 0.01.01

APPLICATION

This guide applies to all footing systems including spread, strip, stepped strip, and grade beams with associated components (eg. reinforcing).

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 foundation walls. (See GSS 0.01.02)
2. Inspect dampproofing/waterproofing. (See GSS 0.01.03)
3. Inspect excavation/backfill. (See GSS 0.01.04)
4. Inspect substructure and superstructure for any other signs of damage or deterioration that may be traced to footing deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Footings to include visual survey, examination of building records, and analysis. Because footings are normally hidden from direct view, the condition of systems supported are to be carefully considered during the survey. Points include:

1. Check for overall water tightness including presence, location, and/or duration of any water leaks. Verify any historical information concerning leaks. Leaks can signify cracks or excessive hydrostatic pressures.
2. Check general appearance of foundation wall or substructure for any stress-related conditions. Determine type of stress as tension, compression, shear, bending or buckling.
3. Check for uneven settlement by observing condition of existing exterior grade, foundation slab, or wall.
4. Check for uplift or presence of hydrostatic pressure causing upward movement of existing grade, foundation wall, or floor slab.
5. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analysis consists of documenting the location, pattern, depth and width, presence of foreign materials, and elevation differences between two cracked surfaces. Determine if crack is active or dormant by the following 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 (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 the distance between points at regular intervals with vernier calipers to determine the extent of movement.
6. Check for exposure conditions, specifically chemical attack and freeze/thaw action.
7. Check all previous repairs and patches for any possible cracking or deterioration.

INSPECTIONS METHODS • STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FOOTINGS - SPREAD/STRIP/GRADE BEAMS (Continued)
CONTROL NUMBER: GSS 0.01 .01

TOOLS & MATERIALS

1. Standard Tools- Basic
2. Permanent Ink Marker
3. Tape - Masking or Duct
4. Pins or Nails
5. Vernier Calipers
6. Level
7. Optical Comparator

INSPECTIONS METHODS • STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FOUNDATION WALLS
CONTROL NUMBER: GSS 0.01.02

APPLICATION

This guide applies to all foundation wall systems including concrete, masonry, or wood.

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 footings. (GSS 0.01 .01)
2. Inspect dampproofing/waterproofing. (GSS 0.01.03)
3. Inspect excavation/backfill. (GSS 0.01.04)
4. Inspect piles and caissons. (GSS 0.01.05)
5. Inspect substructure and superstructure for any other signs of damage or deterioration that may be traced to foundation wall deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Foundation Walls to include visual survey, examination of building records, and analysis. Points include:

1. Check for overall water tightness including presence, location, and/or duration of any water leaks. Verify any historical information concerning leaks. Leaks can signify cracks or excessive hydrostatic pressures.
2. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes cracking but usually no spalling; compression (pushing or crushing force), which causes crushing and 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 andspalling. Buckling is a form of bending; this condition is most visible at the outermost fibers of the member. Bending is usually associated with a high probability of failure.
3. Check for uneven settlement by observing condition of exterior grade or foundation slab.
4. Check for uplift or presence of hydrostatic pressure causing upward movement of existing grade or slab.
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, decay, splitting, 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.
8. Check all sealant, expansion/contraction joints, or mortar joints for deterioration or cracking, which will allow for water penetration.

INSPECTIONS METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FOUNDATION WALLS (Continued)
CONTROL NUMBER: GSS 0.01.02

INSPECTION ACTIONS

9. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analysis consists of documenting the location, pattern, depth and width, presence of foreign materials, and elevation differences between cracked surfaces. Determine if crack is active or dormant by the following 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 the distance between points at regular intervals with vernier calipers to determine the extent of movement.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. Permanent Ink Marker
3. Tape - Masking or Duct
4. Pins or Nails
5. Vernier Calipers
6. Level

INSPECTIONS METHODS . STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FOUNDATION DAMPPROOFING/WATERPROOFING
CONTROL NUMBER: GSS 0.01.03

APPLICATION

This guide applies to all dampproofing and waterproofing 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 and types.
3. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect footings. (GSS 0.01.01)
2. Inspect foundation walls. (GSS 0.01.02)
3. Inspect excavation/backfill. (GSS 0.01.04)

INSPECTION ACTIONS

Condition Assessment Survey Dampproofing/Waterproofing to include visual survey, examination of building records, and analysis. Most dampproofing and waterproofing is normally hidden from direct view; the condition of adjacent systems must be surveyed. Points include:

1. Check for surface damage in the form of holes, ripped or torn areas, abrasions, impact damage, or worn areas.
2. Check for loose adhesive in the form of bubbles, membrane slippage, open seams, or fishmouths.
3. Check for overall water or moisture tightness including presence, location, and/or duration of any water leaks. Verify any historical information concerning leaks. Leaks can signify cracks, openings, or excessive hydrostatic pressures.
4. Check for exposure conditions and surface deterioration from chemical attacks or ultraviolet light in the form of blistering, alligatoring, or cracking.
5. Check all previous repairs and patches for deterioration and/or compatibility of materials.
6. Check substrate for excessive movement, cracking, or deterioration.

TOOLS & MATERIALS

Standard Tools - Basic

INSPECTIONS METHODS . STANDARD

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INSPECTIONS METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: EXCAVATION/BACKFILL
CONTROL NUMBER: GSS 0.01.04

APPLICATION

This guide applies to all excavation, backfill work, and their associated work.

SPECIAL INSTRUCTIONS

1. This is a general inspection and deficiencies should be handled on a service call or repair basis.
2. Review as-builts and soil reports for types and historical information.
3. Refer to references and glossaries as needed.

CONCURRENT ACTIONS

1. Inspect footings. (GSS 0.01 .01)
2. Inspect foundation wails. (GSS 0.01.02)
3. Inspect dampproofing/waterproofing. (GSS 0.01.03)
4. Inspect piles and caissons. (GSS 0.01.04)
5. Inspect substructure and superstructure for any signs of damage or deficiencies that may be traced to excavation or backfill deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Excavation/Backfill to include visual survey, examination of building records, and analysis. Excavation and backfill do not constitute a true building system; however, it involves an important construction process that can affect various building systems. Points include:

1. Check for excess or improper grade settlement.
2. Check for surface heaving indicating excessive internal forces such as hydrostatic pressure.
3. Check for improper fill materials, such as organic material, which can decompose.
4. Check for improper drainage and erosion.
5. Check for improper bracing or support of open trenches or cuts.

TOOLS & MATERIALS

Standard Tools - Basic

INSPECTIONS METHODS ▪ STANDARD

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INSPECTIONS METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: PILES & CAISSONS
CONTROL NUMBER: GSS 0.01.05

APPLICATION

This guide applies to all piles, caissons, and their 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 foundation walls. (GSS 0.01.02)
2. Inspect excavation/backfill. (GSS 0.01.04)
3. Inspect substructure and superstructure for any other signs of damage or deterioration that may be traced to pile and caisson deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Piles and Caissons to include visual survey, examination of building records, and analysis. Because piles and caissons are normally hidden from direct view, the condition of adjacent systems must be surveyed. Points include:

1. Check for surface deterioration in the form of cracking, spalling, pop-outs, or separations, due to exposure of pile or caisson, if applicable.
2. Check for exposure conditions, specifically chemical attack and freeze/thaw action, causing excessive movement or surface deterioration (if applicable) from surface exposure above grade or under water.
3. Check for improper, unbalanced, or overloading conditions that can cause fatigue or failure.
4. Check for uneven settlement by observing condition of existing grade, foundation wall or slab.
5. Check for uplift or presence of hydrostatic pressure that can cause upward movement of existing grade, foundation wall, or slab.
6. Check general appearance of foundation wall or substructure for any stress-related conditions. Determine type of stress as tension, compression, shear, bending, or buckling.
7. Check for corrosion of rebar or steel casing and degree of damage.
8. Check all previous repairs and patches for cracking or deterioration.
9. Perform a stress analysis and monitor cracking to determine if the cracks are active or dormant. Refer to Footings (GSS 0.01 .01) for procedures.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. Permanent Ink Marker
3. Tape - Masking or Duct
4. Pins or Nails
5. Vernier Calipers
6. Level

INSPECTIONS METHODS . STANDARD

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INSPECTIONS METHODS - NON-STANDARD

GUIDE SHEETS

The following Guide Sheets outline an overview of inspection methods and requirements used in providing a general non-standard 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 Foundations & Footings type and associated assembly components as follows:

TABLE TWO

Assembly/Component	Control Number
Footings - Spread/Strip/Grade Beams	GSNS 0.01 .01
Foundation Walls	GSNS 0.01.02
Foundation Dampproofing/Waterproofing	GSNS 0.01.03
Excavation/Backfill	GSNS 0.01.04
Piles & Caissons	GSNS 0.01.05

INSPECTIONS METHODS - NON-STANDARD

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INSPECTIONS METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FOOTINGS - SPREAD/STRIP/GRADE BEAMS
CONTROL NUMBER: GSNS 0.01 .01

APPLICATION

This guide applies to all non-standard inspection procedures for Footing systems.

SPECIAL INSTRUCTIONS

1. Review any as-buiits and other data to determine locations, types and construction.
2. Refer to references and glossaries as needed.

CONCURRENT ACTIONS

1. Inspect foundation walls. (See GSNS 0.01.02)
2. Inspect dampproofing/waterproofing. (See GSNS 0.01.03)
3. Inspect excavation/backfill. (See GSNS 0.01.04)
4. Inspect substructure and superstructure for any other signs of damage or deterioration that may be traced to footing deficiencies.
5. Complete inspection requirements. (See GSS 0.01 .01)

INSPECTION ACTIONS

Based on results of GSS 0.01.01 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis in accordance with DOE requirements to determine the effects of external environmental conditions.
2. Perform Infrared or Nuclear Analysis Testing to determine if water or moisture is present.
3. Perform Ultrasonic Pulse Velocity Test to locate defects within the material indicating cracks or breaks and general location to determine the degree of deterioration and material thickness.
4. If footings are exposed, take core samples to determine condition or strength of the material. Patch sample holes immediately.

TOOLS & MATERIALS

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

INSPECTIONS METHODS • NON-STANDARD

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INSPECTIONS METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FOUNDATION WALLS
CONTROL NUMBER: GSNS 0.01.02

APPLICATION

This guide applies to all non-standard inspection procedures for foundation wall systems including concrete, masonry, or wood.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Consult a licensed structural engineer for significant deficiencies.
3. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect footings. (See GSNS 0.01 .01)
2. Inspect dampproofing/waterproofing. (See GSNS 0.01.03)
3. inspect excavation/backfill. (See GSNS 0.01.04)
4. Inspect piles and caissons. (See GSNS 0.01.05)
5. Inspect substructure and superstructure for any other signs of damage or deterioration that may be traced to foundation wall deficiencies.
6. Complete inspection requirements. (See GSS 0.01.02)

INSPECTION ACTIONS

Based on results of GSS 0.01.02 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis in accordance with DOE requirements to determine the effects of external environmental conditions.
2. Perform Infrared or Nuclear Analysis Testing to determine if water or moisture is present
3. Perform Ultrasonic Pulse Velocity Test to locate defects within the material indicating cracks or breaks and general location to determine the degree of deterioration and material thickness.
4. Take core samples to determine condition or strength of the material. Patch sample holes immediately.
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.
7. Perform Surface Hardness Testing or Maturity Concept Analysis to determine material condition and locate possible defects or deficiencies within the material.
8. Perform Acoustic Emission Test or Microwave Absorption Scanning if conditions allow. Both methods are relatively new and results are questionable.

TOOLS & MATERIALS

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

INSPECTIONS METHODS - NON-STANDARD

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INSPECTIONS METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: FOUNDATION DAMPPROOFING/WATERPROOFING
CONTROL NUMBER: GSNS 0.01.03

APPLICATION

This guide applies to all non-standard inspection procedures for dampproofing and waterproofing systems.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations and types.
2. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect footings. (See GSNS 0.01 .01)
2. Inspect foundation walls. (See GSNS 0.01.02)
3. Inspect excavation/backfill. (See GSNS 0.01.04)
4. Complete inspection requirements. (See GSS 0.01.03)

INSPECTION ACTIONS

Based on results of GSS 0.01.03 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis in accordance with DOE requirements to determine the effects of external environmental conditions.
2. Excavate or expose surface and perform Infrared or Nuclear Analysis Testing to determine if water or moisture is present indicating general location of cracks or breaks.
3. Excavate or expose surface and perform Electrical Resistivity Test or Microwave Absorption Scanning to determine if water or moisture is present.

TOOLS & MATERIALS

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

INSPECTIONS METHODS • NON-STANDARD

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INSPECTIONS METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: EXCAVATION/BACKFILL
CONTROL NUMBER: GSNS 0.01.04

APPLICATION

This guide applies to all non-standard inspection procedures for excavation, backfill work, and their associated conditions.

SPECIAL INSTRUCTIONS

1. Review as-builts and soil reports for types and historical information.
2. Refer to references and glossaries as needed.

CONCURRENT ACTIONS

1. Inspect footings. (See GSNS 0.01 .01)
2. Inspect foundation walls, (See GSNS 0.01.02)
3. Inspect dampproofing/waterproofing. (See GSNS 0.01.03)
4. Inspect piles and caissons. (See GSNS 0.01.04)
5. Inspect immediate area to determine if adjoining excavations had an impact on the backfill under investigation.
6. Inspect substructure and superstructure for any signs of damage or deficiencies that may be traced to excavation or backfill deficiencies.
7. Complete inspection requirements. (See GSS 0.01.04)

INSPECTION ACTIONS

Based on results of GSS 0.01.04 and/or as directed, proceed to non-standard inspections. No definitive tests are available to perform on-site. Points include:

Excavate and remove test cores or material samples for laboratory analysis to determine type, bearing capacity, and composition.

TOOLS & MATERIALS

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

INSPECTIONS METHODS - NON-STANDARD

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INSPECTIONS METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: PILES & CAISSONS
CONTROL NUMBER: GSNS 0.01.05

APPLICATION

This guide applies to all non-standard inspection procedures for piles, caissons, and their 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.

CONCURRENT ACTIONS

1. Inspect foundation walls. (See GSNS 0.01.02)
2. Inspect excavation/backfill. (See GSNS 0.01.04)
3. Inspect substructure and superstructure for any other signs of damage or deterioration that may be traced to pile and caisson deficiencies.
4. Complete inspection requirements. (See GSS 0.01.05)

INSPECTION ACTIONS

Based on results of GSS 0.01.05 and/or as directed, proceed to non-standard inspections. Because piles and caissons are normally hidden from direct view, the condition of adjacent systems must be surveyed or the piles and caissons must be exposed. Points include:

1. Perform an environmental data analysis in accordance with DOE requirements to determine the effects of external environmental conditions.
2. Perform Ultrasonic Pulse Velocity Test to determine compressive strength and quality of material to locate defects, and to determine the degree of deterioration.
3. Perform Maturity Concept Analysis to determine strength and capacity of in-situ concrete.
4. If piles or caissons are exposed, take core samples to determine condition or strength of the material. Patch sample holes immediately.
5. Perform Acoustic Emission Test to determine stress points, cracks, or strained surfaces.
6. Perform Magnetic Test to determine thickness and position of reinforcement.

TOOLS & MATERIALS

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

INSPECTIONS 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. These 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; e.g., 3 to 5-ply asphalt with gravel coating and composite insulation.) If a more detailed inspection is required, the inspector would "deselect" 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 (e.g., 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 (see subsection 1.1) status, 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 "deselects" 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 deselecting 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

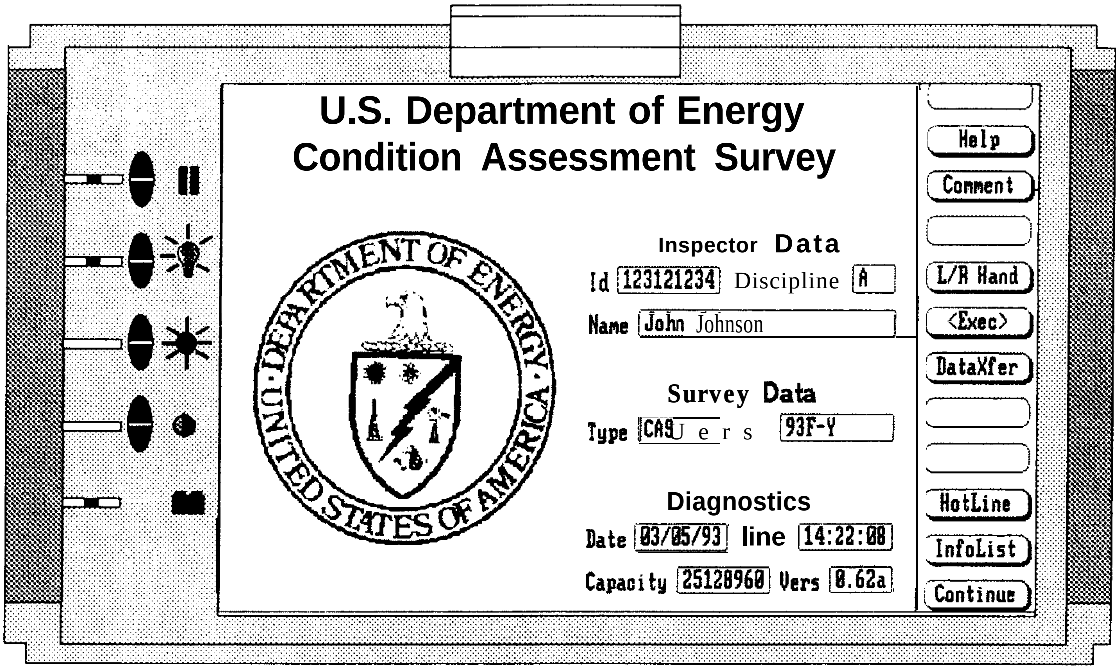
This final screen summarizes the WBS IU in three major categories: urgency, purpose, and condition. In each category, the inspector will call up a picklist and select the category he feels is most appropriate for the WBS IU surveyed. (For the purpose category, the inspector may select multiple headings.) 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 .O - 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.

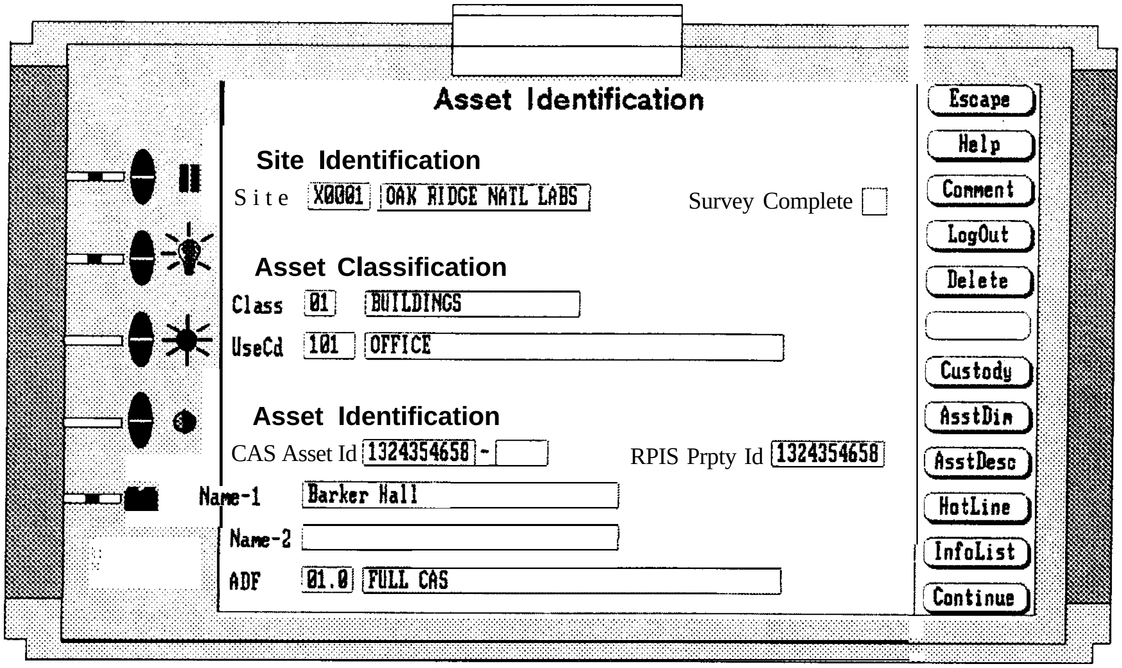
SURVEY STEP LOGIN

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/direction preloaded for inspector	Screen 99.4

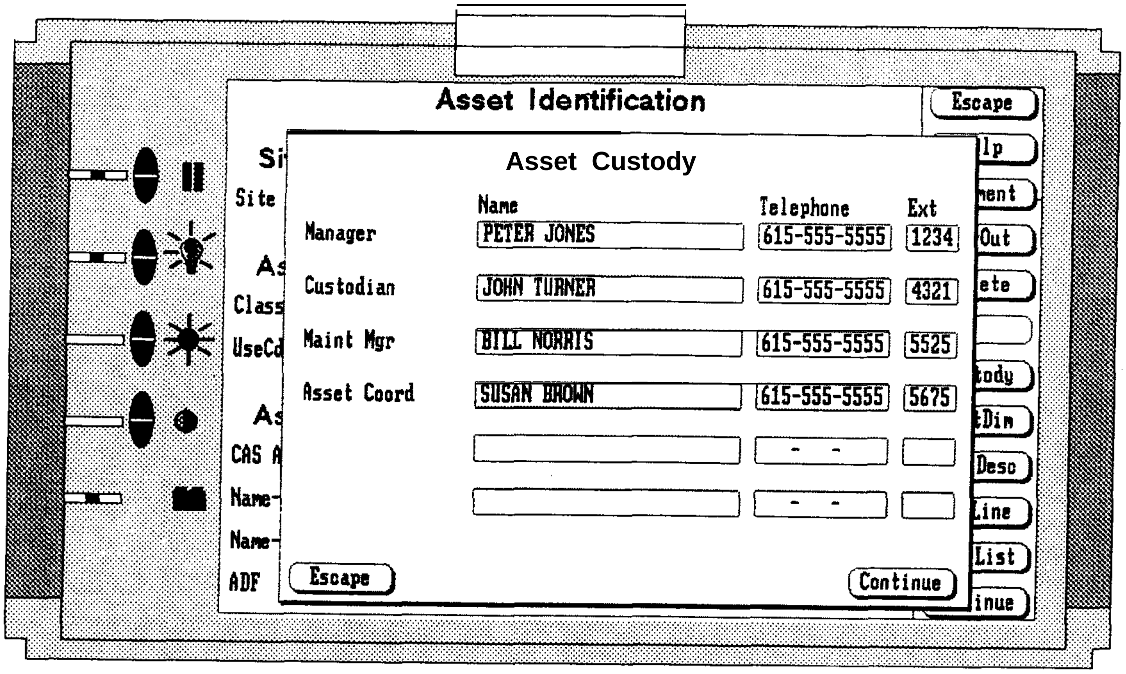
SURVEY STEP ASSET IDENTIFICATION Screen 2.0



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 prefoaded
(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 prefoaded
(HotLine)	Press for important contacts and telephone numbers	Screen 99.3
(InfoList)	Press to bring up information/directions preloaded for inspector	Screen 99.4

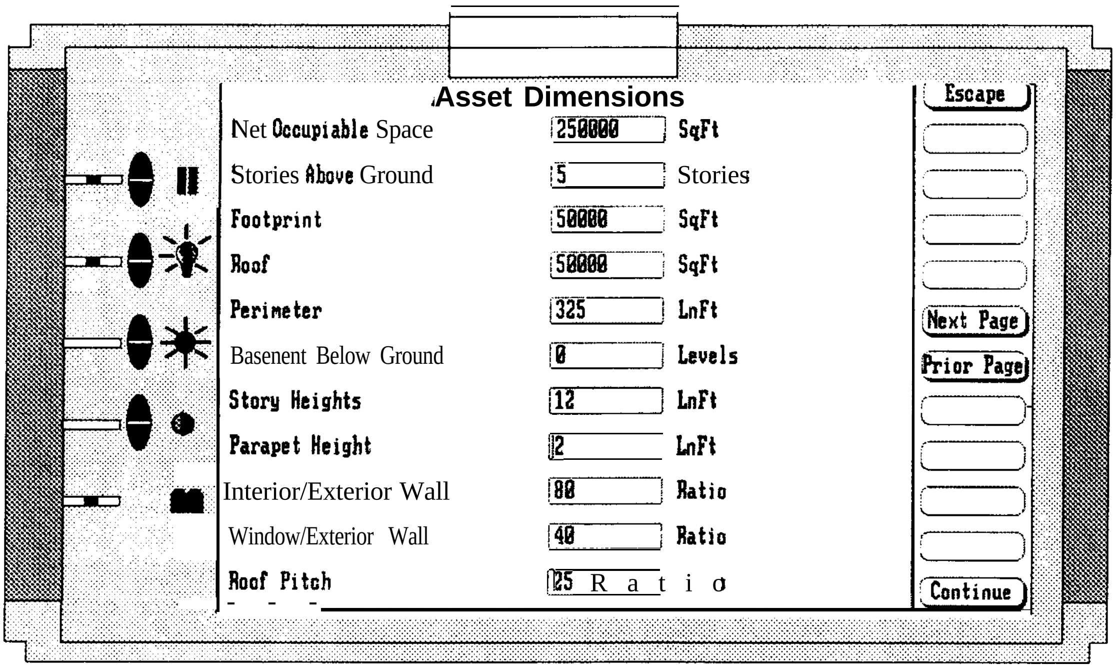
SURVEY STEP ASSET CUSTODY SCREEN

Screen 2.1



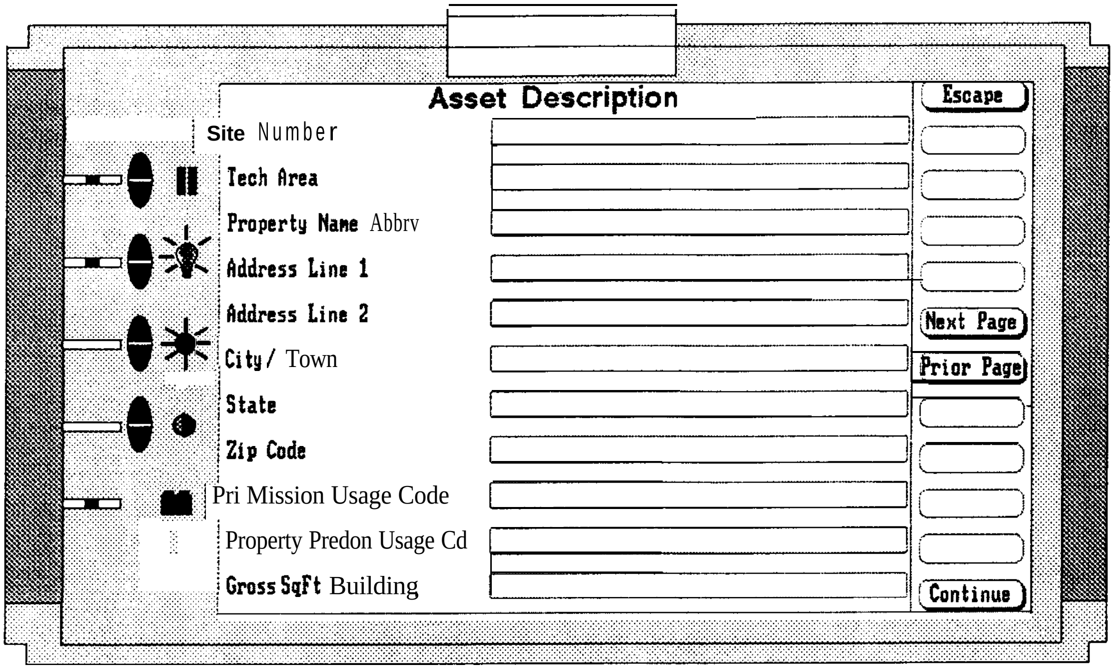
SCREEN	ACTION	COMMENT
2.1	1. Pop up window displays important names and numbers for asset. Cross through data and make any changes	Data can be either preloaded or inspector generated.
	2. Press (Continue) to return to Screen 2.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information.
(Escape)	Press to return to Screen 2.0	By pressing (Escape) information is not verified and any changes made are lost.

SURVEY STEP ASSET DIMENSIONS **Screen** 2.2



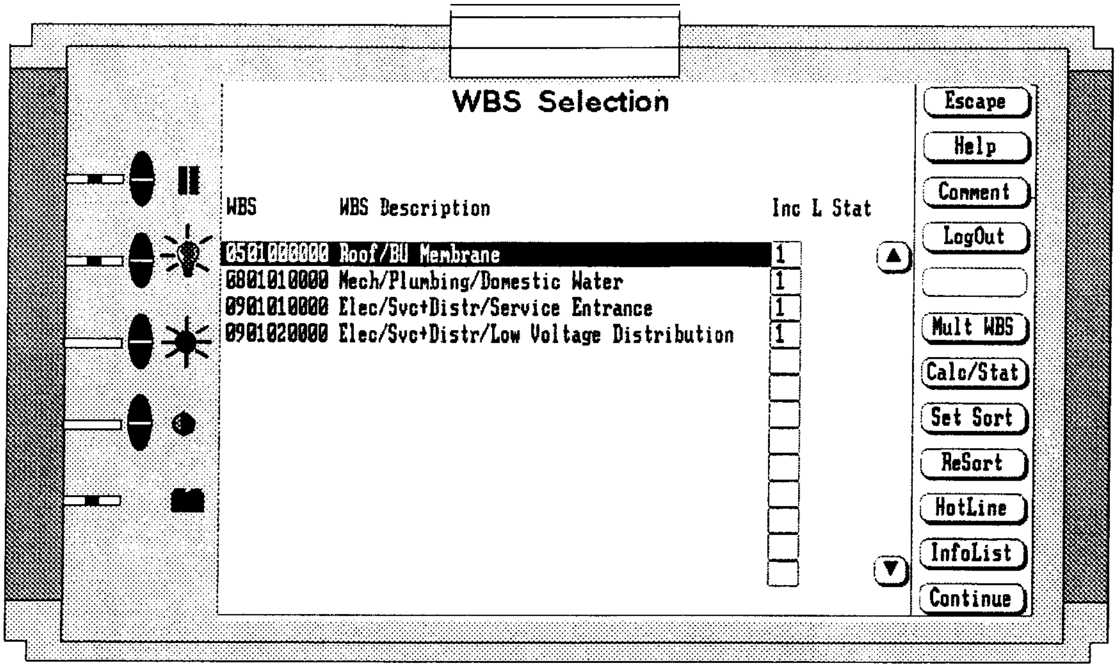
SCREEN	ACTION	COMMENT
2.2	1. Screen displays important dimension related to the asset verify data or cross through data and make any changes	Data can be either preloaded or inspector generated.
	2. Press (Continue) to return to Screen 2.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information.
(Escape)	Press (Escape) 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



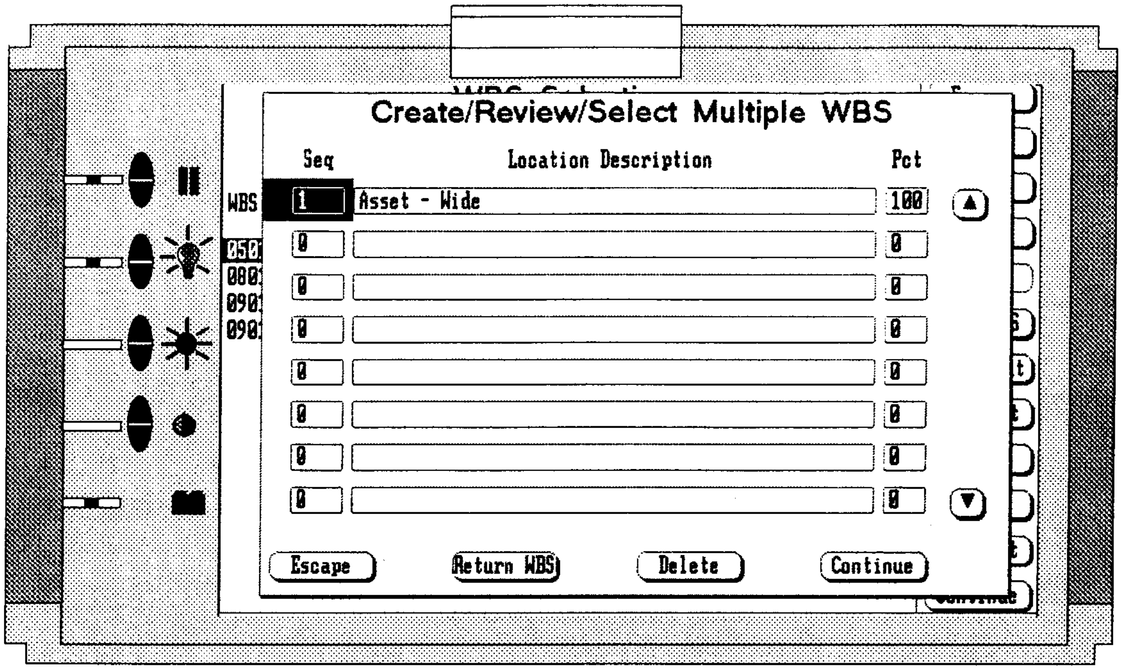
SCREEN	ACTION	COMMENT
2.3	1. Screen displays important asset description information verify data or cross through and make changes	Data can be either preloaded or inspector generated
	2. Press (Continue) to return to Screen 2.0	By pressing (Continue) information is verified; corrections made by crossing 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



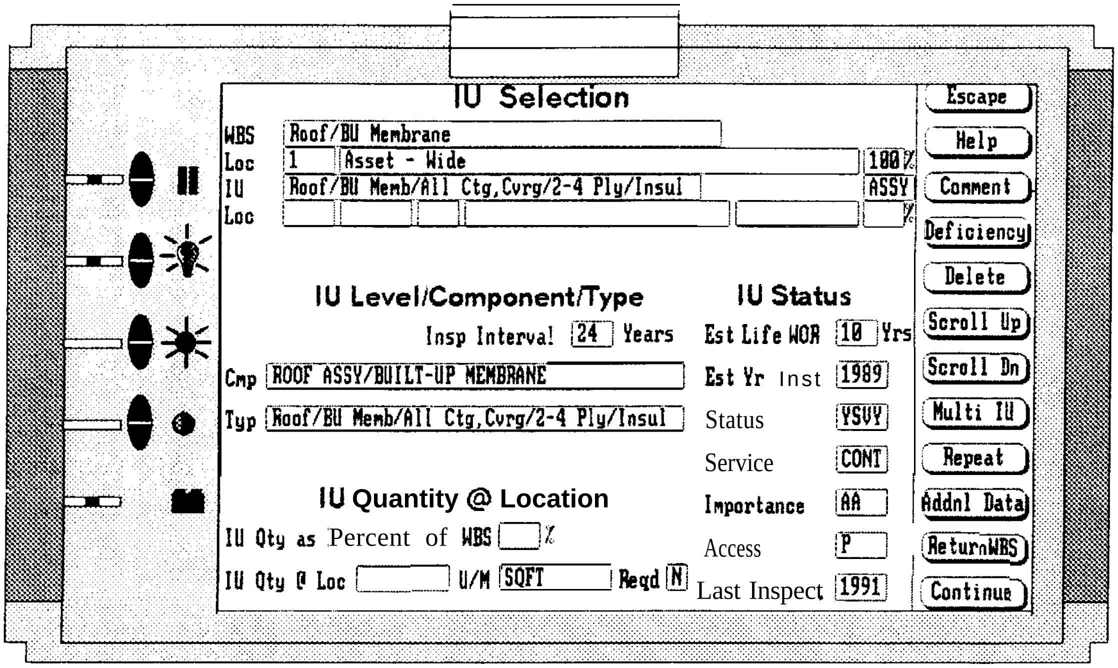
SCREEN	ACTION	COMMENT
3.0	1. Select WBS item to inspect from picklist	Picklist preformatted and is presorted by ADF numbers. Columns at end of WBS list show; "inc" (included) by sort order 1,2,3...; "M" (multiple items); and "Stat" (Status) (In Progress, Complete, or Not Started [*])
	2. All WBS for 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 mate. 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 Clown button	Used to scroll down through information.

SURVEY STEP CREATE/REVIEW/SELECT MULTIPLE WBS Screen 3.1



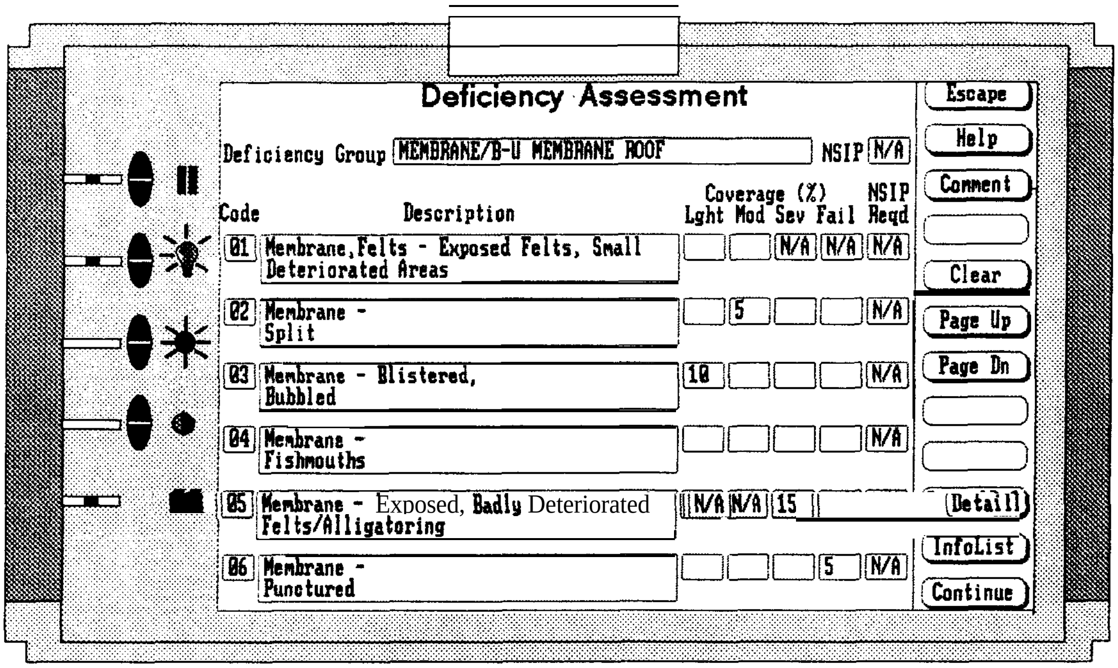
SCREEN	ACTION	COMMENT
3.1	1. Define locations of multiple WBS. Could be multiple systems or multiple parts of single system.	Inspector developed
	2. Define percentage of Asset serviced by WBS section	Inspector developed
	3. Press (Continue) after selecting multiple WBS locations from list and continue 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@@%> information is not verified and any changes made are iost
(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



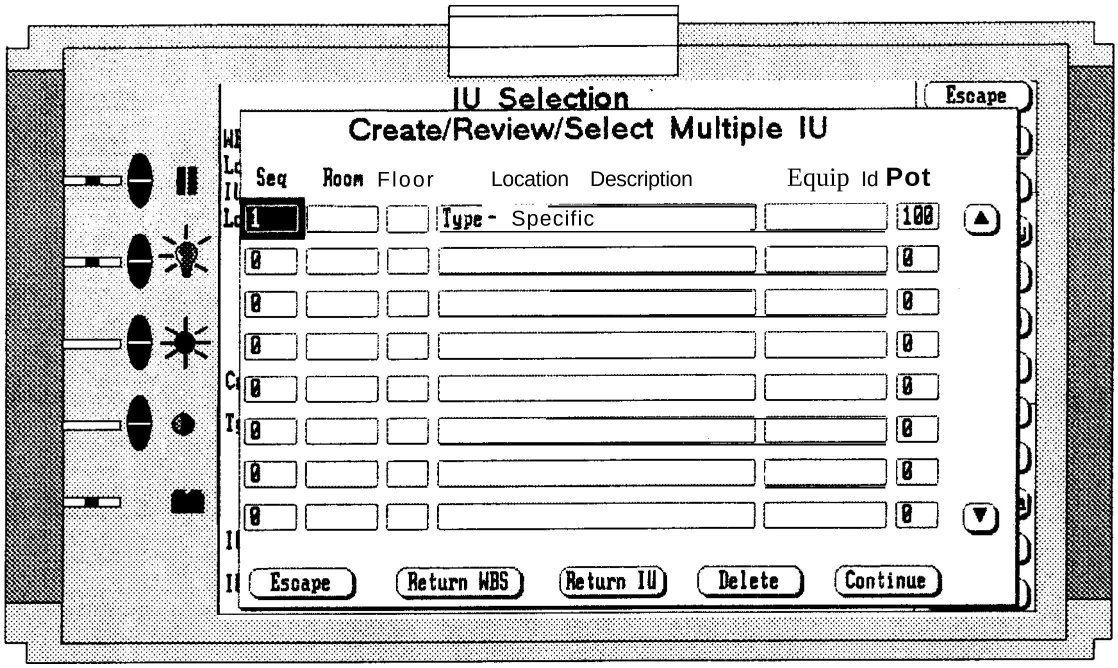
SCREEN	ACTION	COMMENT
4.0	1. Tap "Cmp" title for component picklist Cursor select or enter by pen	Picklist is preformatted
	2. Tap "Typ" title for type of component picklist Cursor select or enter by pen	Picklist is preformatted
	3. Press (Deficiency) to bring up deficiency assessment screen	Screen 4.1 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-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
(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 varifiad 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

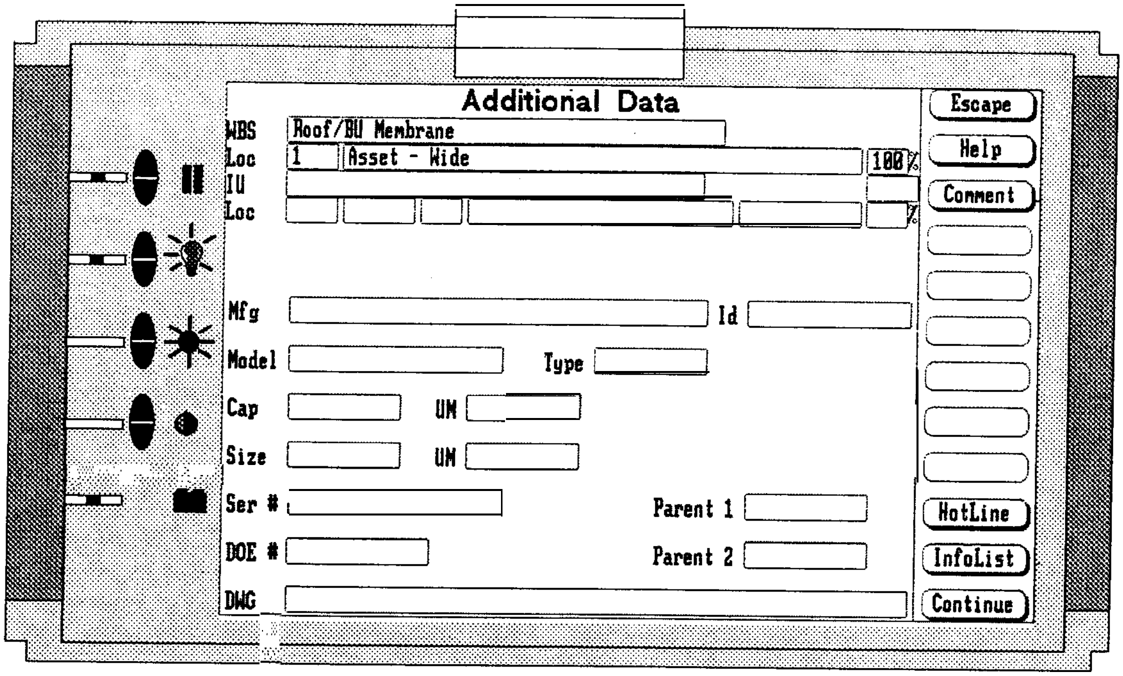
SURVEY STEP CREATE/REVIEW/SELECT MULTIPLE IU Screen 4.2



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 de[redacted]
	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 (Escape) information is not verified 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

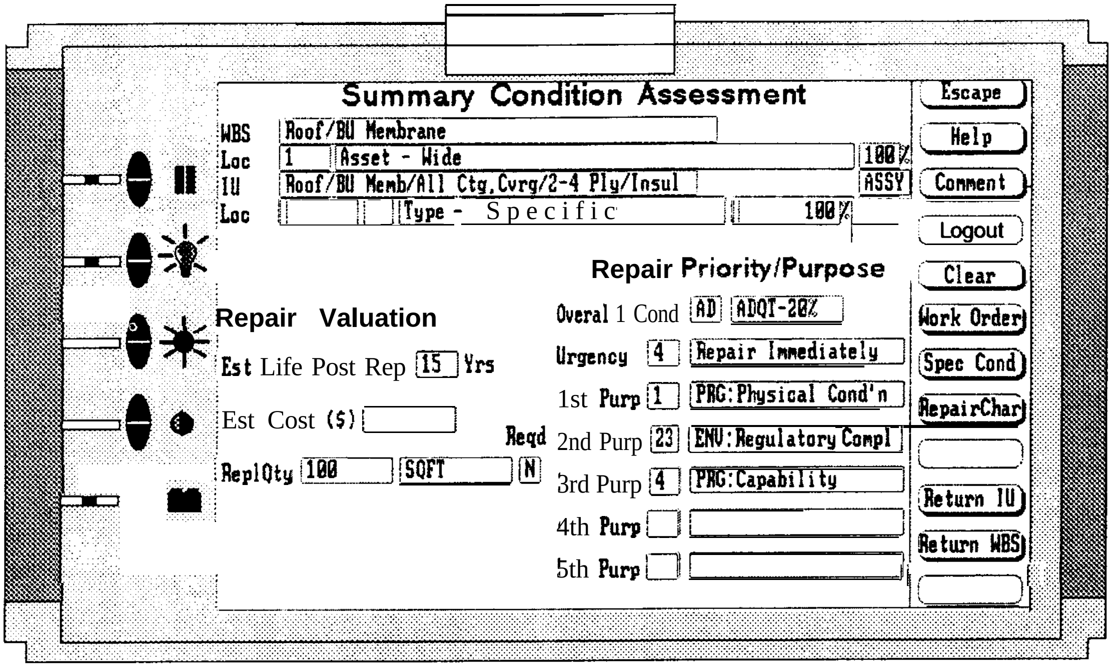
SURVEY STEP ADDITIONAL DATA

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 specificatk or determined in the field. This data can be used for ir 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

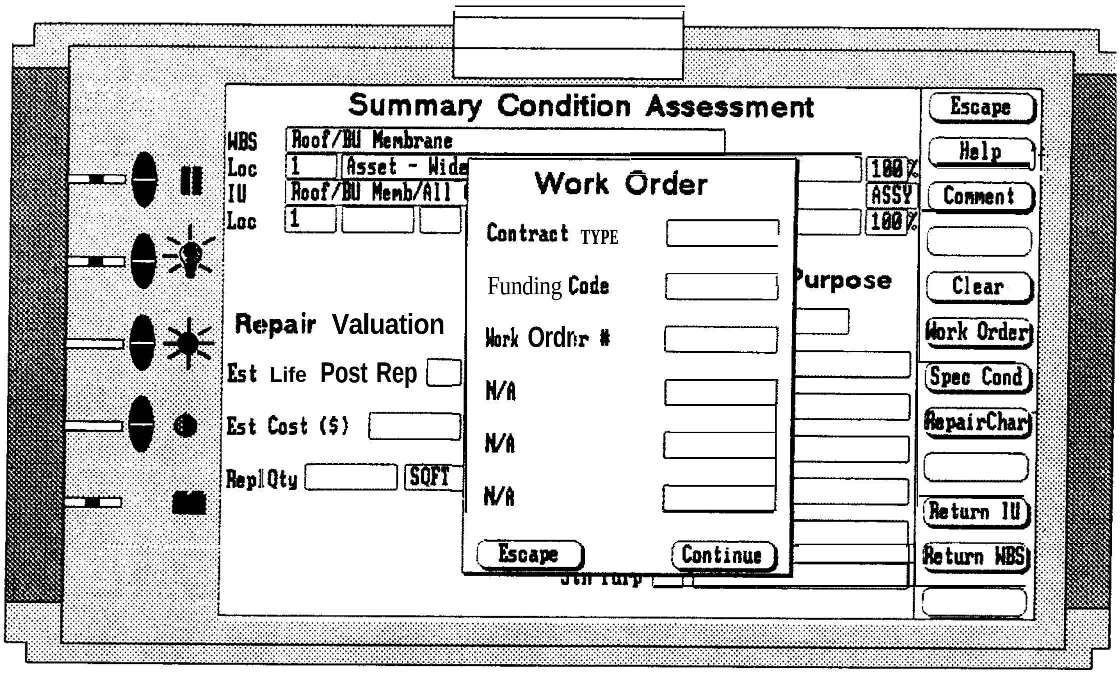
SURVEY STEP SUMMARY CONDITION ASSESSMENT Screen 5.0



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 condition 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

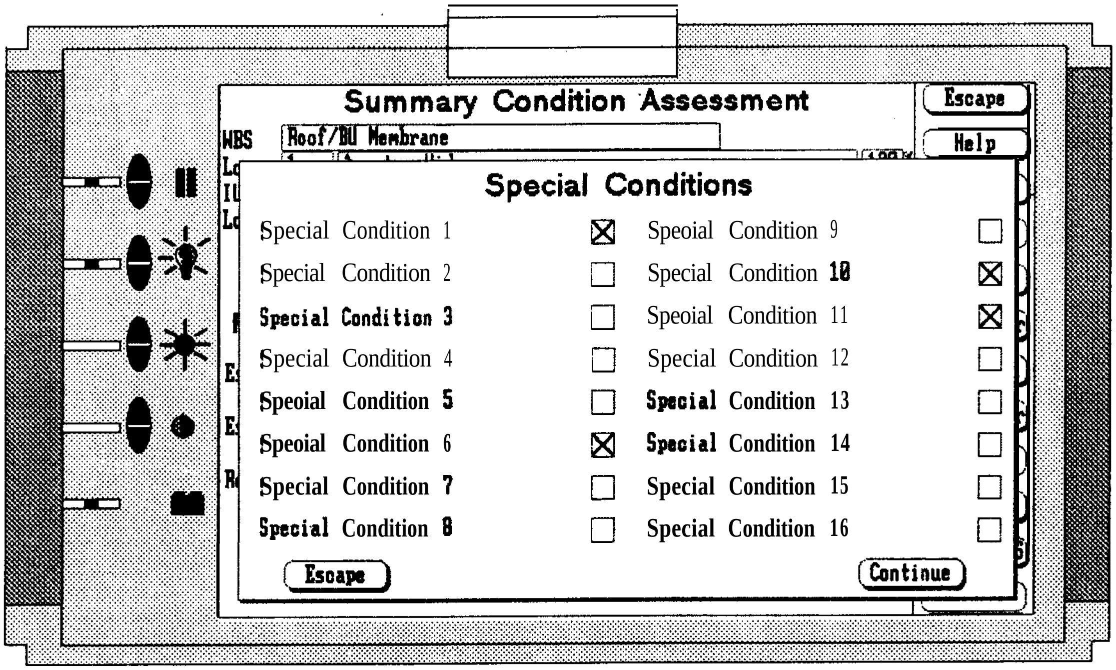
Screen **5.1**



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; corrections made by crossing through data and entering new information
	3. Press-to return to Screen 5.0	By pressing Escape information is not verified; and any changes made are lost

SURVEY STEP SPECIAL CONDITIONS SELECTION

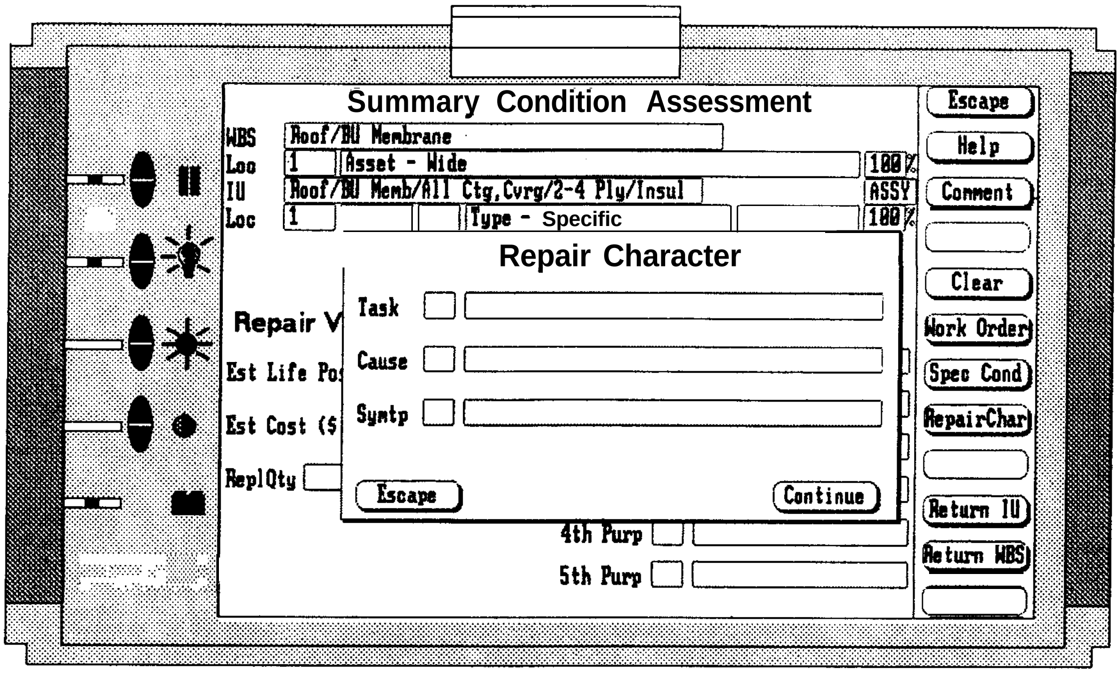
Screen 5.2



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; comctions made by crossing through data and entering new information
	3. Press-to return to Screen 5.0	By pressing (Escape) information is not verified; and any changes made are lost

SURVEY STEP REPAIR CHARACTER DOCUMENTATION

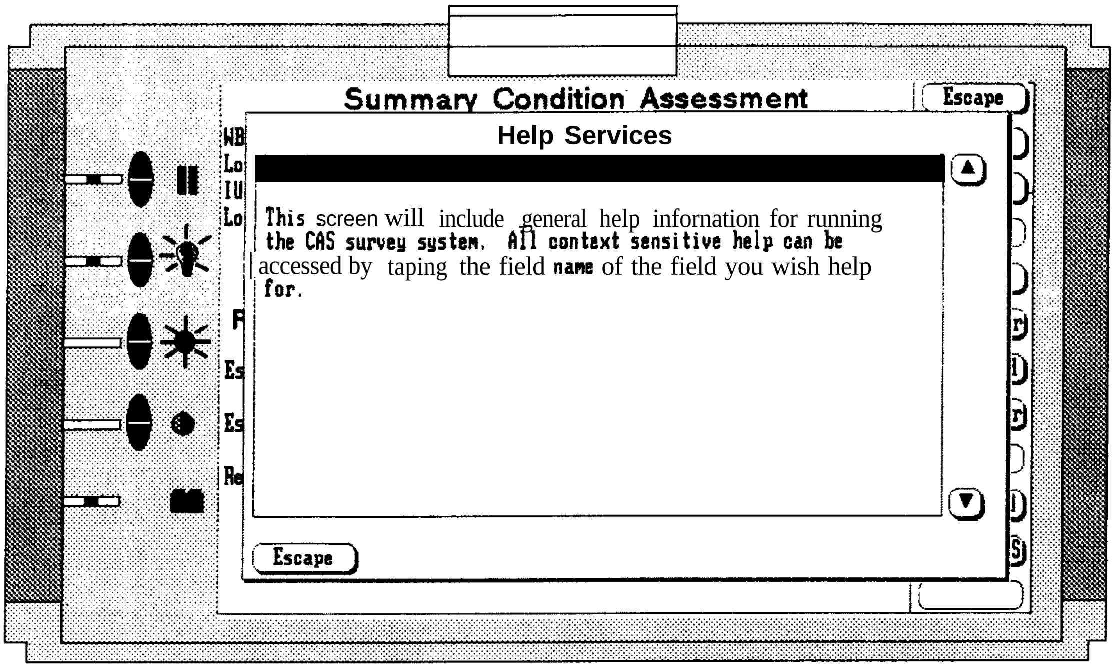
Screen 5.3



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

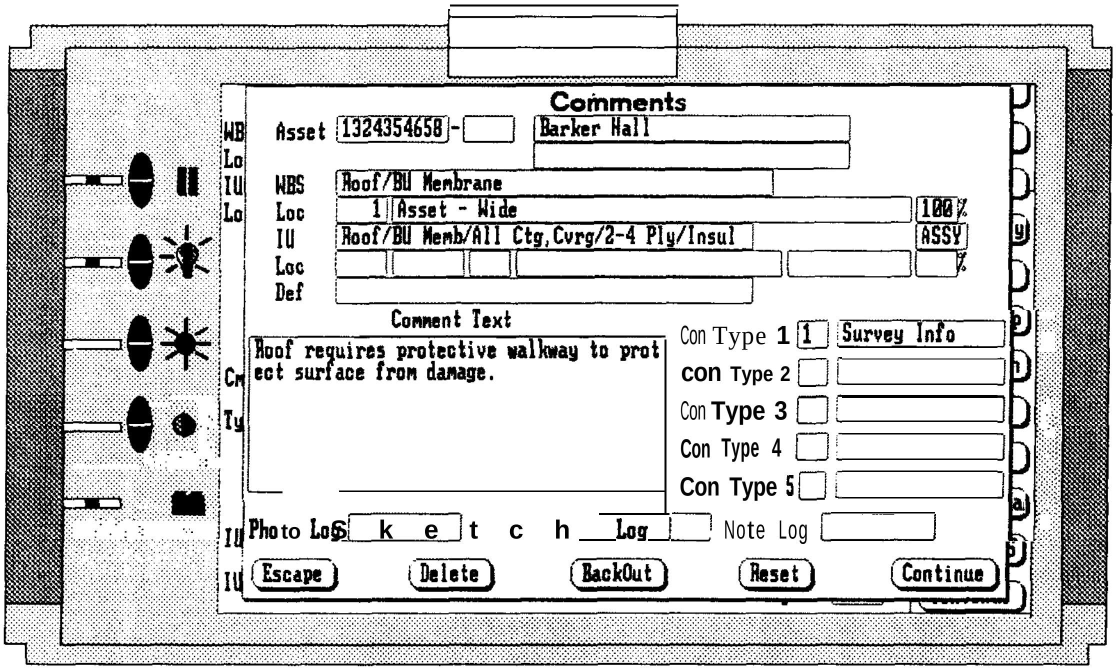
SURVEY STEP HELP

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	I/A
▲	Press scroll up button	Ised to scroll up through information
▼	Press scroll down button	Ised to scroll down through information

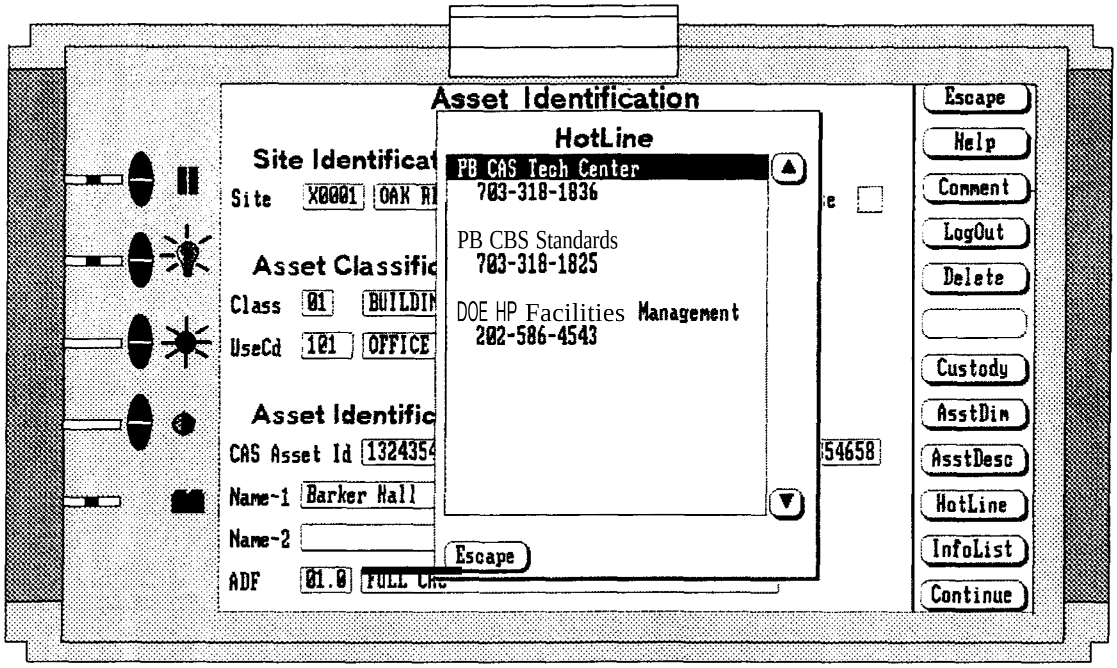
SURVEY STEP COMMENT SCREEN Screen 99.2



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 (Escape) information is not verified and any changes made are lost
(Delete)	Press to delete a selected comment	WA
(Backout)	Press to move backwards thtwgh 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

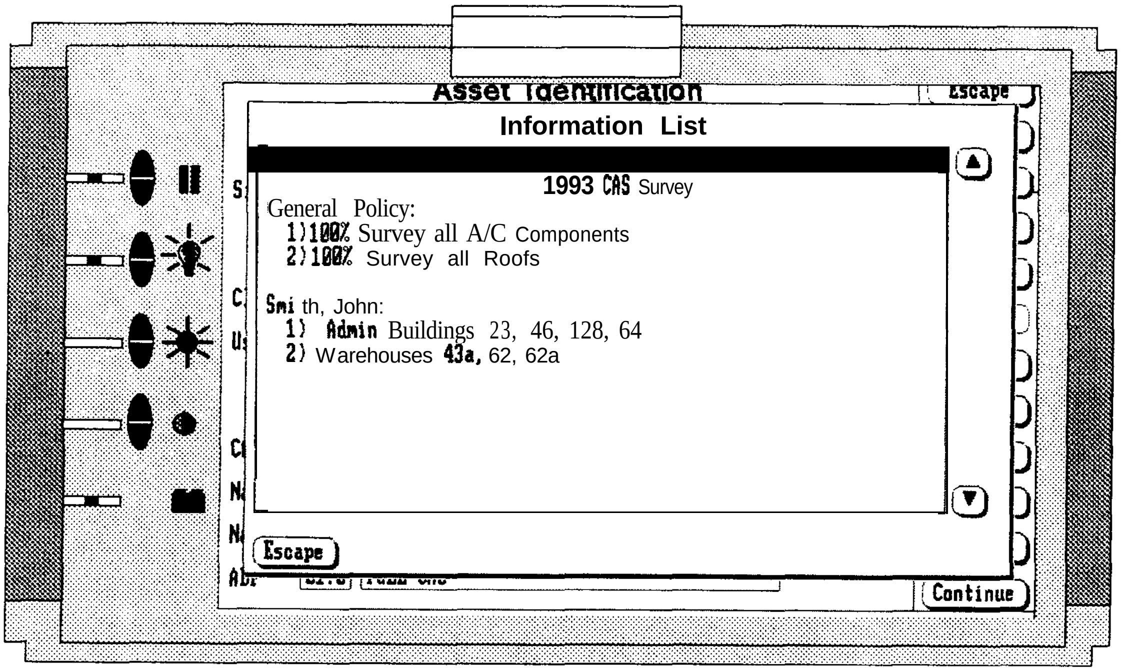
Screen 99.3



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 end return to previous screen	N/A
▲	Press scroll up button	Used to scroll up through information
▼	Press scrdl down button	Used to scroll down through information

DATA COLLECTION METHODS

END OF SUBSECTION

FEDERAL SPECIFICATIONS

FEDERAL SPECIFICATION	TITLE
FS FF-S-325	(Basic; Int Am 3; Notice 1) Shield, Expansion, Nail, Expansion and Nail, Drive Screw (Devices, Anchoring, Masonry)
FS HH-M-622	(Rev D) Mortar, Refractory, Heat Setting, Bonding (Wet and Dry Types)
FS MMM-A-001993	(Basic) Adhesive, Epoxy, Flexible, Filled (for Binding, Sealing and Grouting)
FS QQ-S-763	(Rev E; Am 1; Notice 1) Steel Bars, Wire, Shapes, and Forgings, Corrosion Resisting
FS QQ-S-775	(Rev E; Int Am 1) Steel Sheets, Carbon, Zinc-Coated (Galvanized) by the Hot-Dip Process
FS QQ-W-461	(Rev H) Wire, Steel, Carbon (Round, Bare, and Coated)
FS RR-B-191	(Rev B) Bedpan, Corrosion-Resisting Steel
FED-STD 66	(Rev D; Notice 1) 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, Pozzolana
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-Form.ing Compounds for Curing Concrete
USCE CRD C400	Requirements for Water for Use in Mixing or Curing Concrete

FEDERAL SPECIFICATIONS

END OF SUBSECTION

NATIONAL STANDARDS

AMERICAN CONCRETE INSTITUTE (ACI)

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 501	Specifications for Structural Concrete for Buildings
ACI 304	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R-89	Hot Weather Concreting
ACI 306R-88	Cold Weather Concreting
ACI 308	Standard Practice for Curing Concrete
ACI 309	Standard Practice for Consolidation of Concrete
ACI 316	Recommendations for Construction of Concrete Pavements and Concrete Bases
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 336.1-89	Standard Specification for the Construction of End Bearing Drilled Piers
ACI 347	Recommended Practice for Concrete Formwork
ACI 506	Guide to Shotcrete

AMERICAN SOCIETY FOR TESTING & MATERIALS (ASTM)

ASTM A36-89	Specification for Structural Steel
ASTM A82-88	Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM AI04	Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM AI05	Specification for Welded Steel Wire Fabric for Concrete Reinforcement
ASTM A252-09	Specification for Welded and Seamless Steel Pipe Piles
ASTM A416-88	Specification for Uncoated Seven-Wire Stress-Relieved Steel for Prestressed Concrete
ASTM A421	Specification for Uncoated Stress-Relieved Wire for Prestressed Concrete
ASTM A444-09	Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dipped Process for Storm Sewer and Drainage Pipe
ASTM A496	Specification for Deformed Steel Wire for Concrete Reinforcement
ASTM A497	Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement
ASTM A61 5-89	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A61 7	Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A767-89	Standard Specification for Zinc-Coated (Galvanized) Bars for Concrete Reinforcement
ASTM C5	Specification for Quicklime for Structural Purposes
ASTM C6	Specification for Normal Finishing Hydrated Lime
ASTM C29	Test for Unit Weight and Voids in Aggregate
ASTM C33	Specification for Concrete Aggregates
ASTM C40	Test for Organic Impurities in Sands for Concrete
ASTM C70	Test for Surface Moisture in Fine Aggregate
ASTM C87	Test for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C88	Test for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

NATIONAL STANDARDS

AMERICAN SOCIETY FOR TESTING & MATERIALS (ASTM)

ASTM **C91**	Specification for Masonry Cement
ASTM C94	Specification for Ready-Mixed Concrete
ASTM **C109**	Test for Compressive Strength of Hydraulic Cement Mortars
ASTM CI 14	Methods for Chemical Analysis of Portland Cement
ASTM CI 15	Test for Fineness of Portland Cement by the Turbidimeter
ASTM CI 17	Test for Materials Finer Than No. 200 Sieve in Mineral Aggregates by Washing
ASTM C 123	Test for Lightweight Pieces in Aggregate
ASTM CI25	Definitions of Terms Relating to Concrete and Concrete Aggregates
ASTM CI27	Test for Specific Gravity and Absorption of Coarse Aggregate
ASTM CI28	Test for Specific Gravity and Absorption of Fine Aggregate
ASTM CI31	Test for Resistance to Abrasion of Small Size Coarse Aggregate by use of the Los Angeles Machine
ASTM CI38	Test for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM CI41	Specification for Hydraulic Hydrated Lime for Structural Purposes
ASTM CI44	Specification for Aggregate for Masonry Mortar
ASTM C 150	Specification for Portland Cement (8 types)
ASTM CI51	Test for Autoclave Expansion of Portland Cement
ASTM CI58	Test for Water Retention by Concrete Curing Materials
ASTM CI 71	Specification for Sheet Materials for Curing Concrete
ASTM CI83	Methods of Sampling Hydraulic Cement
ASTM CI84	Test for Fineness of Hydraulic Cement by the No. 100 and No. 200 Sieves
ASTM CI88	Test for Heat of Hydration of Hydraulic Cement
ASTM CI87	Test for Normal Consistency of Hydraulic Cement
ASTM CI88	Test for Density of Hydraulic Cement
ASTM **C190**	Test for Tensile Strength of Hydraulic Cement Mortars
ASTM CI 91	Test for Time of Setting of Hydraulic Cement by Vicat Needle
ASTM **C204**	Test for Fineness of Portland Cement by Air Permeability Apparatus
ASTM **C206**	Specification for Finishing Hydrated Lime
ASTM **C207**	Specification for Hydrated Lime for Masonry Purposes
ASTM C219	Definitions of Terms Relating to Hydraulic Cement
ASTM C228	Specification for Air-Entraining Additions for Use in the Manufacture of Air-Entraining Portland Cement
ASTM C227	Test for Potential Alkali Reactivity of Cement-Aggregate Combinations
ASTM **C230**	Specification for Flow Table for Use in Tests of Hydraulic Cement
ASTM C233	Method of Testing Air-Entraining Admixtures for Concrete
ASTM C243	Test for Bleeding of Cement Pastes and Mortars
ASTM **C260**	Specification for Air-Entraining Admixtures for Concrete
ASTM C285	Test for Calcium Sulfate in Hydrated Portland Cement Mortar
ASTM C288	Test for Time of Setting of Hydraulic Cement by Gillmore Needles
ASTM C287	Test for Chemical Resistance of Mortars
ASTM **C270**	Specification for Mortar for Unit Masonry
ASTM C295	Recommended Practice for petrographic Examination of Aggregates for Concrete
ASTM **C309**	Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM **C311**	Sampling and Testing Fly Ash and Raw or Calcined natural Pozolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM **C330**	Specification for Lightweight Aggregates for Structural Concrete
ASTM C331	Specification for Lightweight Aggregates for Concrete Masonry Units

NATIONAL STANDARDS

AMERICAN SOCIETY FOR TESTING & MATERIALS (ASTM)

ASTM C332	Specification for Lightweight Aggregates for Insulating Concrete
ASTM C465	Specification for Processing Additions for Use in Manufacture of Hydraulic Cements
ASTM c535	Test for Resistance to Abrasion of large Size Coarse Aggregate by use of the Los Angeles Machine
ASTM C595	Specification for Blended Hydraulic Cements
ASTM C851	Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
ASTM C31-90	Standard Methods of Making and Curing Concrete Test Specimens in the Field
ASTM C33-90	Specification for Concrete Aggregate
ASTM C39-86	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94-86	Standard Test Method for Ready-Mixed Concrete
ASTM C94-90	Specification for Ready-Mixed Concrete
ASTM C143-90	Standard Test Method for Slump of Portland Cement Concrete
ASTM C150-89	Specification for Portland Cement
ASTM C150-90	Standard Specification for Portland Cement
ASTM CI 72-90	Standard Method of Sampling Freshly Mixed Concrete
ASTM C260-86	Specification for Air-Entraining Admixtures for Concrete
ASTM C494-86	Specification for Chemical Admixtures for Concrete
ASTM D75	Methods of Sampling Aggregates
ASTM D98	Specification for Calcium Chloride
ASTM D449	Specification for Standard Sizes of Coarse Aggregate for Highway Construction
ASTM D25-89	Specification for Round Timber Piles
ASTM D1143-91	Method of Testing Piles Under Static Axial Compressive Load
ASTM D2166-85	Standard Test Methods for Unconfined Compressive Strength of Cohesive Soil
ASTM D2216-80	Standard Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
ASTM EI 1	Specification for Wire Cloth Sieves for Testing Purposes

AMERICAN WOOD-PRESERVERS ASSOCIATION (AWPA)

AWPA C3-97	Piles - Preservative Treatment by Pressure Processes
AWPA Y4-94	Care of Pressure Treated Wood Products

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI	Specifications for Placing Reinforcement

PORTLAND CEMENT ASSOCIATION (PCA)

PCA	Specifications for Plain and Reinforced Concrete
PCA	Architectural Concrete Specifications

NATIONAL STANDARDS

END OF SUBSECTION

INDUSTRY PUBLICATIONS `

PUBLICATION	PUBLISHER
The NRCA Roofing & Waterproofing Manual	National Roofing Contractors Association 6250 River Road Rosemont, IL 60018
1991 ASTM Standards 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 Loss Prevention Dab 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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Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products. Presstressed Concrete Institute MNL-116.

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Spec-Data Sheet for Steel H-Piles. February 1990. Bethlehem Steel Corp., Bethlehem, PA 18016.

Standards and Specifications for the Foundation Drilling Industry, published by ADSC, an International Association of Foundation Drilling Contractors, P.O. Box 280379, Dallas, TX 75228.

Steel H-Piles. United States Steel Corp., Pittsburgh, PA 15230.

Technical Notes on Brick Construction. Reston, VA: Brick Institute of America.

Magazine **Articles:**

Annual Checkups Maintain Crack Repairs. Parking Technology. July, 1991.

Minimizing Concrete Surface Abrasion. Plant Engineering. July 3, 1991.

The Performance of Portland Cement. ASTM Standardization News. January, 1992.

OTHERRELATEDREFERENCES

END OF SUBSECTION

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
ABYA	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
AVQ	Average
AVLIS	Atomic Vapor Laser Isotope Separation
AWG	American Wire Gauge

APPENDIX A

AWS	American Welding Society
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
ccl-v	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	Ccupling
CPSC	Consumer Product Safety Commission
CPVC	Chlorinated Polyvinyl Chloride
CRI	Carpet and Rug Institute
CRT	Cathode Ray Tube
C_v	Flow coefficient
CW	Cold Water
CWA	Clean Water Act

APPENDIX A

CYL	Cylinder
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
DCG	Derived Concentration Guide
DCPA	Defense Civil Preparedness Agency
DC	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

APPENDIX A

Est	Estimated
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	Fiat 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
ft	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
CPM	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
Htr	Heater
HTW	High Temperature Water

APPENDIX A

HVAC	Heating, Ventilating, and Air-Conditioning
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
IFMSF	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

APPENDIX A

LV	Low Voltage
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
min	Minimum
Misc	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

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NEC	National Electrical Code
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
OCS	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

APPENDIX A

PCB	Polychlorinated biphenyls
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
RPFY	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

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SDWA	Safe Drinking Water Act
SF	Safety Factor
SOFT	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
s s c o	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.
s s s s	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

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UEU	Unirradiated Enriched Uranium
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

APPENDIX A

SYMBOLS

°R'	Degrees Rankine
°K	Degrees Kelvin
°F	Degrees Fahrenheit
°C	Degrees Centigrade (Celcius)
$>$	Greater Than
$<$	Less Than
$\geq$	Greater Than or Equal To
$\leq$	Less Than or Equal To
%	Percent
#	Pound, Number
α, A	Alpha
β, B	Beta
ϕ, Φ	Theta
λ, Λ	Lambda
μ, M	Mu
π, Π	Pi
σ, Σ	Sigma
ω, Ω	Omega

APPENDIX A

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APPENDIX B

GLOSSARY

Absorptlon (of brick): Obtained by immersion in either cold or boiling water for stated periods of time. It is usually expressed as a percent of the weight of the dry brick.

Abutment: That part of a structure which 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.

Area Wall: The masonry or concrete surrounding or partly surrounding an area. It also serves as a retaining wall.

Areaway: An open subsurface space adjacent to a building used to admit light or air or as a means of access to a basement.

Arris: A sharp edge forming an external corner at the junction of two surfaces.

Backfill: The replacement of excavated earth into a trench around and against a basement foundation.

Backfilling: (1) Earth, soil, or other material used to replace excavated materials around a newly constructed wall, (2) Rough masonry laid behind a facing, or between two faces; (3) Brickwork laid in the space between structural timbers.

Backing Up: The operation of building up that part of a piece of masonry other than its facing.

Backup: That part of a masonry wall behind the exterior facing and consisting of one or more widths or thicknesses of brick or other masonry material.

Base: The lowest part, or the lowest main division, of a building, column, pier or wall.

Base Course: The lowest course of masonry of a wall or pier. A footing course.

Bat: A piece of broken brick.

Batter Board: One of a pair of horizontal boards nailed to post set at the corners of an excavation, used to indicate the desired level; also as a fastening for stretched strings to indicate outlines of foundation walls.

APPENDIX B

Beam:	A structural member transversely supporting a load
Bearing:	That part of a lintel, beam, girder or truss, which 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 which receives the load concentration and transmits it to the masonry or concrete.
Bearing Wail:	A wall that supports any vertical load in addition to its own weight.
Bed:	The prepared soil, or layer of mortar, on or in which a piece of masonry material is laid.
Bed Joint:	A horizontal joint between stones, usually filled with mortar, lead, or sealant.
Belt Course:	Same as a string course.
Bevel:	The angle that one surface or line makes with another, when they are not at right angles.
Blank Wail:	One having no door, window or other opening.
Block:	A unit in terra cotta or cement building, differing from a brick in being larger and, usually, hollow.
Block (Hollow):	A shape made of clay, terra cotta or other material fashioned with one or more openings in its body for lightness, whose net sectional area does not exceed 75 percent of its gross sectional area.
Blocking:	A method of bonding two adjoining or intersecting walls, not built at the same time, by means of offsets and overhanging blocks consisting of several courses of masonry each.
Bond:	The tying or bonding of the various pieces and parts of a masonry wall, by laying one piece across two or more pieces; the entire system of bonding or breaking joints as used in masonry construction. The mortar between brick is sometimes termed a bond.
Bond (Course):	The header course.
Bond Stone:	Stones projecting laterally into the backup wall used to tie the wall together.
Brick:	A structural unit of burnt clay or shale, formed while plastic into a rectangular prism, usually solid, the net sectional area of which is not less than 75 percent of the gross sectional area.
Brick and Brick:	A method of laying brick whereby the brick are laid touching each other with only enough mortar to fill the irregularities of the surface.
Brick Veneer:	A facing of brick laid against and fastened to sheathing of a frame wall of tile wall construction.

APPENDIX B

Brickwork: Any structure or structural part, made of brick and mortar.

Bugged Finish: A smooth finish produced by grinding with power sanders.

Bull Nose: Convex rounding of a member.

Bull-header: A rowiok brick laid with its longest dimension perpendicular to the face of the wall.

Bull-stretcher: A rowlok brick laid with its longest dimension parallel to the face of the wall.

Buttering: Placing mortar on a brick with a trowel before brick is laid.

Buttress: A piece of masonry, like a pier, built against and bonded into a wall to strengthen the wall against side thrust.

Caisson: A foundation pier, either circular or rectilinear in plan, usually sunk to rock either by means of gravity, compressed air or by the open-well method.

Calcite **Streaks:** Description of a white or milky streak occurring in stone. It is a joint plane usually wider than a glass seam which has been recemented by deposition of calcite in the crack. It is structurally sound.

Camber: A slight upward curve of a structural member so that it becomes horizontal, or nearly so, when loaded.

Cap: The upper member of a column, pilaster, pile, caisson molding, and the like.

Capital: Column cap.

Caulking: The operation or method of rendering a joint tight against water by means of some plastic substances such as oakum and pitch, elastic cement, and the like.

C/B Ratio: The ratio of the weight of water 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.

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.

Closer: The last brick laid in a course; the end brick of a part of a course, fitted at the openings. A closer may be a whole brick or less in size.

Column: A pillar or pier of rather slender proportions which 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.

APPENDIX B

Congestion:	To fill to excess; overcrowd.
Construction Joint:	The interface/meeting surface between two successive concrete pours.
Connectors:	A device that holds two or more structural members intact.
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.
Corbel:	That part of the masonry built outward from the face of masonry by projecting successive courses of the masonry.
Corbel Out:	To build out one or more courses of brick or stone from the face of a wall, to form a support for timbers.
Counterfort:	A buttress or portion projecting from a wall and upward from the foundation to provide additional resistance to thrusts.
course:	One of the continuous horizontal layers (or rows) of masonry units which, bonded together, form a masonry structure.
Cramp:	An anchor for masonry, made of a short, flat bar of metal, with both ends turned down at right angles, and used for tying the masonry together by bedding the bent ends in holes provided in the masonry units.
Crawl Space:	A shallow space below the living quarters of a basementless structure, normally enclosed by the foundation wall.
Creep:	The time-dependent deformation of steel or concrete due to sustained load.
Crowfoot:	(Stylolite.) A dark gray to black zig-zag marking occurring in stone. Usually structurally sound.
Crown:	The top or high point of a horizontal surface.
Cut Stone:	Finished, dimensioned stone, ready to set in place.
Cutting:	Handwork required to finish a stone which cannot be done by machine.
Damp Course:	A course or layer of impervious material in a wall or floor to prevent the entrance of moisture from the ground or from a lower course.
Dampproofing:	One or more coatings of a compound that is impervious to water. Usually applied to the back of stone or face of back of wall.
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.
Diamond Sawed:	Finish produced by sawing with diamond toothed saws (either circular or gang).

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Dimensioned Stone: Stone precut and shaped to specified sizes.

Dope: Term used for additives used either to accelerate or retard the set of any type of mortar.

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-out: Soft, chalky mortar caused by water evaporating before setting.

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.

EffectiveArea of Brick Masonry: The area of a section which lies between the centroid of the tensile reinforcement and the compression face of the structural member.

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 which contain an excess of soluble salts will contribute to efflorescence of the masonry. 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.

Entablature: Consists of an architrave, frieze, and cornice.

Entasis: The curve resulting from the gradual diminishing of the diameter of the upper two-thirds of a column.

Epoxy **Resin:** A flexible usually thermal setting resin made by polymerization of an epoxide and used as an adhesive.

Expansion Anchor: A metal expandable unit inserted into a drilled hole that grips stone by expansion.

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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.
Exterior Wall:	Any outside wall or vertical enclosure of a building other than a party wall.
Face:	The front or exposed surface of a wall.
Faced Wall:	A wall in which the facing and backing are so bonded with masonry as to exert common action under load.
Facing:	Any material, forming a part of the wall, used on the exterior as a finishing surface.
Fat:	Material accumulated on the trowel during the finishing operation and used to fill in small imperfections. Also a term to describe working characteristics of any type mortar.
Fire Dlvislon Wall:	Any wall which subdivides a building so as to resist the spread of fire, but is not necessarily continuous through all stories to and above the roof.
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.
Fire stop:	Any piece or mass of fire resistant material used for filling in open spaces or close openings in order to prevent the passage of fire.
Fire Wall:	Any wall which subdivides a building so as to resist the spread of fire, by starting at the foundation and extending continuously through all stories to and above the roof.
Fireproofing:	Any material or combination of materials used to enclose structure members so as 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.
Footing:	A masonry section, usually concrete, in a rectangular form wider than the bottom of the foundation wall or pier it supports.
Footlng Form:	A wooden or steel structure, placed around the footing that will hold the concrete to the desired shape and size.
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.
Foundation:	The supporting portion of a structure below the first-floor construction, or below grade, including the footings.
Foundation Wall:	That portion of a load-bearing wall below the level of the adjacent grade, or below the first tier of floor beams or joists, which transmits the superimposed load to the footing.

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Frostline: The depth of frost penetration in soil. This depth varies in different parts of the country. Footings should be placed below this depth to prevent movement.

Gang Saw: A machine with multiple blades used to saw rough quarry blocks into slabs.

Glass Seam: Vein fillings of coarsely crystalline calcite, that do not necessarily decrease the strength of stone.

Granular Base: Evenly graded mixture of fine and course aggregates to provide, when compacted, a smooth and even surface below footings.

Grout: A mixture of cementitious material (cement, lime), sand and sufficient water to make a consistency that will flow without separation of ingredients.

Header: A brick laid lengthwise across a wall and serving as a bond. A masonry unit laid flat with its largest dimension perpendicular to the face of the wall. It is generally used to tie two wythes of masonry together.

High-Strength Adhesive: A bonding agent of high ultimate strength used to join individual pieces of stone into preassembled units.

Hollow Wall: A wall built of solid masonry units laid in and so constructed as to provide an air space within the wall.

Incise: To cut inwardly or engrave - as in an inscription.

Incombustible (Building Material): Any building material which contains no matter subject to Rapid oxidation within the temperature limits of a standard fire test of not less than 2.5 hours duration. NOTE: Materials which continued burning after this time period are combustible.

Inscription: Lettering cut in stone.

Interior Wall: Any wall entirely surrounded by the exterior walls of a building.

Joint: The space between the adjacent surfaces of two members or components joined and held together by nails, glue, cement, mortar, or other means.

Key: A section of concrete formed to lock into another pour to stop water penetration or provide easier joining of pieces.

Lacing **Course:** A course of brick, or several adjacent courses considered collectively, inserted at frequent intervals, as in a stone wall as a bond course.

Lintel: A horizontal structural member that supports the load over an opening such as a door or window.

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Masonry:	Stone, brick, concrete, hollow-tile, concrete-block, gypsum-block, or other similar building units or materials or a combination of the same, bonded together with mortar to form a wall, pier, buttress, or similar mass.
Mastic:	A pasty material used as a cement (as for setting tile) or a protective coating (as for thermal insulation or waterproofing).
Mineral **Fiber:**	Fibers formed from mineral slag, the most common being glass wool, which is used in loose or batt form for thermal and/or fireproofing.
Miter:	The junction of two units at an angle. The junction line usually bisects on a 45 degree angle.
Mortar:	A mixture of cementitious materials and aggregate, with or without the addition of plasticizers or other admixtures, reduced to a plastic state by the addition of water and suitable for use to bind masonry units together.
Natural **Bed:**	The horizontal stratification of stone as it was formed in the deposit.
Neat:	Generally, basecoat plaster, mortar or grout, to which sand is added at the job.
Non-Bearlng Wall:	Any wall which 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.
Parglng:	To coat or plaster with mortar or grout.
Party Wall:	A wall used, or adapted for use for joint service by adjoining buildings.
Paste:	Composed of Portland cement, water, and air.
Penn:	A measure of water vapor movement through a material (grains per square foot per hour per inch of mercury difference in vapor pressure).
Pier:	A column of masonry, usually rectangular in horizontal cross section, used to support other structural members.
Piers:	Masonry or concrete 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.
Piles:	Long posts driven into the soil in swampy locations or whenever it is difficult to secure a firm foundation, upon which the footing course of masonry or other timbers is laid. Consist of concrete, metal or wood.
Plate:	Sill plate - a horizontal member anchored to a masonry wall. Sole plate - bottom horizontal member of a frame wall. Top plate - top horizontal member of a frame wall supporting ceiling joists, rafters, or other members.

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plumb:	Exactly perpendicular; vertical.
pointing:	Pushing mortar into a joint after masonry is laid.
preassembled Units:	Two or more stones combined into a single unit by the use of epoxy resins, steel framing, or concrete backing.
Precast **Concrete:**	A concrete member that is cast and cured in other than its final position.
Quarry:	The location of an operation where a natural deposit of stone is removed from the ground.
Quoins:	Stones at the corners of a wall emphasized by size, projection, rustication, or by a different finish.
Raggle:	A groove or channel made in a mortar joint, or in the solid masonry material, to receive roofing, metal flashing or other material which is to be sealed in the masonry.
Recess:	A sinkage.
Reglet:	A recess to receive and secure metal flashing.
Reinforcing:	Steel rods or metal fabric placed in concrete slabs, beams, or columns to increase their strength.
Reinforced Brick Masonry (R-B-M):	Brick masonry in which metal is imbedded 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 imbedded or encased in brick or other masonry or concrete to increase its strength.
Relief or Relieve:	Projection of ornamentation.
Reprise:	Inside corner of a stone member with a profile other than a flat plane.
Retaining Wail:	Any wall designed to resist lateral pressure.
Retarder:	Any material added to concrete, mortar or grout that slows up its natural set.
Return or Return **Head:**	Stone facing with the finish appearing on both the face and the edge of the same stone -- as on the corner of a building.
Reveal:	The exposed portion of a stone between its outer face and a window or door set in an opening.
Rowiok:	A brick laid on its edge. Frequently spelled rolok.
Rubble Masonry:	Uncut stone, used for rough work, foundations, backing, and the like.
Rustication:	A recessed surface cut around or across the face of a stone to produce shadow accent.
Sand Fioat Finish:	Lime mixed with sand, resulting in a textured finish.
Scaffold or Staging:	A temporary structure or platform enabling workmen to reach high places.

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Sealant: A resilient compound used as the final weatherface in stone joints. (This term is sometimes misused to indicate clear water-repellent treatments which are sometimes sprayed or otherwise applied to masonry.)

Set-in: The amount that the lower edge of a brick on the outside face of a wall is held back from the line of the top edge of the brick directly below it. Also called set-off.

Shot Sawed: Description of a finish obtained by using steel shot in the gang sawing process to produce random markings for a rough surface texture.

Shrinkage: The volume change in concrete caused by drying normally occurring during the hardening process.

Sill Course: (See String Course.)

Sills: The horizontal timbers of a house which either rest upon the masonry foundation or, in the absence of such, form the foundations.

Skeleton Construction: A type of building construction in which all loads are transmitted to the foundations by a rigidly connected framework of suitable material.

Skew: Inclination in any direction.

Slab-on-Grade: A concrete slab placed on grade, sometimes having insulation board or an impervious membrane beneath it, on a granular base.

Slip Joint: A connection which permits vertical or horizontal movement of the cladding with respect to the structural frame.

Smooth **Finish:** A finish of minimum textural quality, presenting the least interruption of surface. Smooth finish may be applied to any surface, flat or molded. It is produced by a variety of machines.

Soldier: A brick laid on its end so that its longest dimension is parallel to the vertical axis of the face of the wall.

Solid Wall: A wall built of solid masonry units, laid contiguously, with the spaces between the units completely filled with mortar. Also walls built of solid concrete.

Spall: A small fragment removed from the face of stone, brick, masonry or concrete material by a blow or by the action of the elements.

Span: The distance between structural supports such as walls, columns, piers, piles, 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.

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Square: A unit of measure - 100 square feet (30.5 sq. meters) - usually applied to roofing material. Sidewall coverings are sometimes packed to cover 100 square feet (30.5 sq. meters) and are sold on that basis. A tool used by masons to obtain accuracy.

Stretcher: A masonry unit laid flat with its longest dimension parallel to the face of the wall.

String Course: A narrow, vertically faced and slightly projecting course in an elevation, such as window-sills which are made continuous. Also, horizontal moldings running under windows, separating the walls from the plain part of the parapets, dividing towers into stories and stages, and the like.

Stringing Mortar: The name applied to the method by which a brick-layer picks up sufficient mortar for a number of bricks and spreads it before laying the brick.

Stucco: Most commonly refers to an outside plaster made with portland cement as its base.

support: An angle, plate or other stone which carries a gravity load.

Surround: An enframement.

Sweat-Out: Soft, damp mortar caused by poor drying conditions.

Tail Beam: A relatively short beam or joist supported in a wall on one end and by a header at the other.

lapping: Setting a brick down on its bed of mortar with a light blow of the trowel blade or end of handle.

Temper: To moisten and mix clay, plaster, mortar and similar materials to the proper consistency for working.

Template: A pattern used in the fabrication operation.

Texture: Any finish other than a smooth finish.

Throat: The undercut of a projected molding to form a drip.

Tie: Any unit of material used to resist the spreading of a wall, or the separation of the two solid parts of a hollow wall.

Illth: Soil condition/suitability for plant growth.

Tolerance: Acceptable dimensional allowance, under or over ideal net sizes.

Tooling: Compressing and shaping the face of a mortar joint, usually with a special tool, other than a trowel.

Toothing: The temporary end of a wall built so that the end stretcher of every alternate course projects.

Trim: Stone used as sills, copings, enframements, etc., with the facing of another material.

luck Pointing: A method of refinishing old mortar joints, the loose mortar is dug out and the tuck is filled with fine mortar which is left projecting slightly or tooled.

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Undercut: Cut or molded so as to present an overhanging part, as a drip mold.

Vapor Barrier: Material used to retard the movement of water vapor into walls, and prevent condensation in them. Usually considered as having a perm value of less than 1 .0. Applied separately over the warm side of exposed walls or as a part of batt or blanket insulation.

Veneer: A facing of masonry material attached but not bonded to the backing.

W-Beam: A structural member of rolled steel whose cross section resembles the capital letter **I.**

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, Composlte: A wall in which the facing and backing materials are bonded together.

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.

Wall **Tle:** Strip of metal used for tying a facing veneer to the body of a wall.

Waterproofing: (See Dampproofing.)

Water Repellent: Any of several types of clear liquids used to render masonry walls less absorptive. These treatments are said to maintain a material's ability to breathe away moisture, as distinct from "sealers" which form impervious, non-breathing coatings.

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.

Water Table: A slight projection of the lower masonry or brickwork on the outside of a wall and slightly above the ground as a protection against water.

Weep Hole: A drainage opening usually inserted at the base of a stone unit to release moisture accumulating between the stone and backup.

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.

Wind **(wined):** A warp in a semi-finished stone slab - to be removed by further fabrication.

With(e) or **Wyth(e):** A continuous vertical 4-inch (lo-cm.) or greater section or thickness of masonry as the thickness of masonry separating flues in a chimney.

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Wooden Brick: Piece of seasoned wood, made the size of a brick, and laid where it is necessary to provide a nailing space in masonry walls.

Workability: An essential property of any mortar for masonry construction since it is only through this property that the mortar can be brought into intimate and complete contact with the masonry units, thereby incorporating the properties of the mortar into the masonry. Or, that property of freshly mixed concrete which determines the ease and homogeneity with which it can be mixed, placed, compacted and finished.

APPENDIX B

END OF SUBSECTION

APPENDIX C

TECHNICAL BULLETINS/UPDATES/ADVISORIES

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APPENDIX C

TECHNICAL ADVISORY **T0501-1**

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

REVISION SUMMARY

AT A GLANCE SUMMARY OF ALL

REVISIONS UP TO LATEST REVISION DATE

APPENDIX D

END OF SUBSECTION