Rehabilitation Guidelines 1986

8 Guidelines on Fire Ratings of Archaic Materials and Assemblies

THE SECRETARY OF HOUSING AND URBAN DEVELOPMENT
WASHINGTON, D.C. 20410

The world in which fire ratings exist changes so rapidly that construction thirty or more years old is considered "archaic". Given this terminology, it is understandable that building officials unfamiliar with materials of such an age may require them to be replaced before assessing the building's fire safety.

This unique volume offers a guide to evaluating the fire-related performance of archaic materials and construction. It does not set standards—that is the community's responsibility—but its approach should in many cases eliminate the need to fire test the construction or to replace the materials, neither of which may be economically feasible.

The importance of this guideline is clear. It gives architects, engineers, and code officials a tool with which to judge the viability of their community's aging housing stock.

The quality of this guideline and the seven others in the series is the result of the invaluable efforts of Robert Kapsch, program manager for HUD's Office of Policy Development and Research; William Brenner, project manager for the National Institute of Building Sciences; and David Hattis, consultant from Building Technology, Inc.

Samuel R. Pierce, Jr.
Secretary

The Rehabilitation Guideline Series

The *Rehabilitation Guidelines* were prepared by the National Institute of Building Sciences for the Department of Housing and Urban Development in response to the requirements of Section 903 of the Housing and Community Development Amendments of 1978.

As Congress intended, the *Rehabilitation Guidelines* are not a code, nor are they written in code language. Rather, they are designed for voluntary adoption and use by States and communities as a means to upgrade and preserve the nation's building stock, while maintaining reasonable standards for health and safety. The term "rehabilitation", as used in the guidelines, includes any set of activities related to the general view of existing buildings as a resource to be conserved, rehabilitated, or reused.

This initial edition of the *Rehabilitation Guidelines* is published in eight separate volumes. The first four guidelines are designed for use by building officials, members of the executive and legislative branches of government, and related commissions and organizations involved in developing or implementing building regulations. These guidelines cover the following topics:

1 The *Guideline for Setting and Adopting Standards for Building Rehabilitation* provides an introduction and background to the building regulations that affect rehabilitation. It describes methods for identifying regulatory problems in a community, and recommends ways to amend, modify, or supplement existing regulations to encourage rehabilitation.

2 The *Guideline for Municipal Approval of Building Rehabilitation* examines the inherent differences between regulating new construction and regulating rehabilitation, and presents specific recommendations for dealing with rehabilitation within municipal building departments.

3 The *Statutory Guideline for Building Rehabilitation* contains enabling legislation that can be directly adopted by communities to provide the legal basis for promoting rehabilitation through more effective regulation.

4 The *Guideline for Managing Official Liability Associated with Building Rehabilitation* addresses the liability of code officials

involved with the administration and enforcement of rehabilitation, and provides recommendations for minimizing liability problems.

The remaining four guidelines are technical in nature, and are intended for use by code officials, inspectors, designers, and builders. They cover the following topics:

5 The *Egress Guideline for Residential Rehabilitation* lists design alternatives for the components of egress that are regulated by current codes such as number and arrangement of exits, corridors, and stairs, travel distance, dead-end travel, and exit capacity and width.

6 The *Electrical Guideline for Residential Rehabilitation* outlines procedures for conducting inspections of electrical systems in existing buildings, and presents solutions to common problems associated with electrical rehabilitation such as eliminating hazardous conditions, grounding, undersized service, number of receptacle outlets, and incompatible materials.

7 The *Plumbing DWV Guideline for Residential Rehabilitation* presents criteria and methods for inspecting and testing existing drain, waste, and vent (DWV) systems, relocating fixtures, adding new fixtures to existing DWV systems, extending existing DWV systems, and installing new DWV systems in existing buildings.

8 The *Guideline on Fire Ratings of Archaic Materials and Assemblies* contains the fire ratings of building materials and assemblies that are no longer listed in current building codes or related reference standards. Introductory material discusses flame spread, the effects of penetrations, and methods for determining the ratings of assemblies not listed in the guideline.

The *Rehabilitation Guidelines* are also available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

Table of Contents

Introduction..... 1

1 Fire-Related Performance of Archaic Materials and Assemblies..... 2

1.1 Fire Performance Measures..... 2

1.2 Combustible Construction Types.... 5

2 Building Evaluation..... 6

2.1 Preliminary Evaluation..... 6

2.2 Fire Resistance of Existing Building Elements..... 13

2.3 Effects of Penetrations in Fire Resistant Assemblies..... 14

3 Final Evaluation and Design Solutions.. 15

3.1 The Experimental Approach..... 15

3.2 The Theoretical Approach..... 16

3.3 "Thickness Design" Strategy..... 27

3.4 Evaluation of Doors..... 28

4 Summary..... 31

Appendix:

Table of Contents..... A-1

Introduction..... A-4

Section I, Walls..... A-6

Section II, Columns..... A-59

Section III, Floor/Ceiling Assemblies.. A-90

Section IV, Beams..... A-106

Section V, Doors..... A-111

Bibliography

Acknowledgments

The material herein was prepared by the National Institute of Building Sciences on the basis of research conducted by Brady Williamson, principal author, and Cecile Grant, editor, of the J. Bradford Corporation; Joseph Zicherman, Fred Fisher, and Harry Hasegawa, of IFT, Inc., coauthors; and Herman Spaeth, Harriet Watson, Vytenis Babrauskas, and Norman Kornsand, consultants. Technical reviewers for the Institute included Harold Nelson, Richard Bletzacker, and Russel Parks. Final editing of the guideline was performed by Howard Markman, aided by Ruth Fidelman and Duncan Wilson.

Overall management and production of the *Rehabilitation Guidelines* was directed by William Brenner of the Institute, with David Hattis of Building Technology, Inc. the principal technical consultant. Guideline cover graphics and layouts were designed by the Design Communication Collaborative.

Introduction

The *Guideline on Fire Ratings of Archaic Materials and Assemblies* focuses upon the fire-related performance of archaic construction. "Archaic" encompasses construction typical of an earlier time, generally prior to 1950. "Fire-related performance" includes fire resistance, flame spread, smoke production, and degree of combustibility.

The purpose of this guideline is to update the information which was available at the time of original construction, for use by architects, engineers, and code officials when evaluating the fire safety of a rehabilitation project. In addition, information relevant to the evaluation of general classes of materials and types of construction is presented for those cases when documentation of the fire performance of a particular archaic material or assembly cannot be found.

It has been assumed that the building materials and their fastening, joining, and incorporation into the building structure are sound mechanically. Therefore, some determination must be made that the original manufacture, the original construction practice, and the rigors of aging and use have not weakened the building. This assessment can often be difficult because process and quality control was not good in many industries, and variations among locally available raw materials and manufacturing techniques often resulted in a product which varied widely in its strength and durability. The properties of iron and steel, for example, varied widely, depending on the mill and the process used.

There is nothing inherently inferior about archaic materials or construction techniques. The pressures that promote fundamental change are most often economic or technological—matters not necessarily related to concerns for safety. The high cost of labor made wood lath and plaster uneconomical. The high cost of land and the congestion of the cities provided the impetus for high-rise construction. Improved technology made it possible. The difficulty with archaic materials is not a question of suitability, but familiarity.

Code requirements for the fire performance of key building elements (e.g., walls, floor/ceiling assemblies, doors, shaft enclosures) are stated in performance terms: hours of fire

resistance. It matters not whether these elements were built in 1908 or 1980, only that they provide the required degree of fire resistance. The level of performance will be defined by the local community, primarily through the enactment of a building or rehabilitation code. This guideline is only a tool to help evaluate the various building elements, regardless of what the level of performance is required to be.

The problem with archaic materials is simply that documentation of their fire performance is not readily available. The application of engineering judgment is more difficult because building officials may not be familiar with the materials or construction method involved. As a result, either a full-scale fire test is required or the archaic construction in question removed and replaced. Both alternatives are time consuming and wasteful.

This guideline and the accompanying Appendix are designed to help fill this information void. By providing the necessary documentation, there will be a firm basis for the continued acceptance of archaic materials and assemblies.

1
Fire-Related Performance of Archaic Materials and Assemblies

1.1
Fire Performance Measures

This guideline does not specify the level of performance required for the various building components. These requirements are controlled by the building occupancy and use and are set forth in the local building or rehabilitation code.

The fire resistance of a given building element is established by subjecting a sample of the assembly to a "standard" fire test which follows a "standard" time-temperature curve. This test method has changed little since the 1920's. The test results tabulated in the Appendix have been adjusted to reflect current test methods.

The current model building codes cite other fire-related properties not always tested for in earlier years: flame spread, smoke production, and degree of combustibility. However, they can

generally be assumed to fall within well defined values because the principal combustible component of archaic materials is cellulose. Smoke production is more important today because of the increased use of plastics. However, the early flame spread tests, developed in the early 1940's, also included a test for smoke production.

"Plastics", one of the most important classes of contemporary materials, were not found in the review of archaic materials. If plastics are to be used in a rehabilitated building, they should be evaluated by contemporary standards. Information and documentation of their fire-related properties and performance is widely available.

Flame spread, smoke production and degree of combustibility are discussed in detail below. Test results for eight common species of lumber, published in an Underwriter's Laboratories' report (104), are noted in the following table:

TUNNEL TEST RESULTS FOR EIGHT SPECIES OF LUMBER

Species of Lumber	Flame Spread	Fuel Contributed	Smoke Developed
Western White Pine	75	50-60	50
Northern White Pine	120-215	120-140	60-65
Ponderosa Pine	80-215	120-135	100-110
Yellow Pine	180-190	130-145	275-305
Red Gum	140-155	125-175	40-60
Yellow Birch	105-110	100-105	45-65
Douglas Fir	65-100	50-80	10-100
Western Hemlock	60-75	40-65	40-120

FLAME SPREAD

The flame spread of interior finishes is most often measured by the ASTM E-84 "tunnel test". This test measures how far and how fast the flames spread across the surface of the test sample. The resulting flame spread rating (FSR) is expressed as a number on a continuous scale where cement-asbestos board is 0 and red oak is 100. (Materials with a flame spread greater than red oak have a FSR greater than 100.) The scale is divided into distinct groups or classes. The most commonly used flame spread classifi-

cations are: Class I or A*, with a 0-25 FSR; Class II or B, with a 26-75 FSR; and Class III or C, with a 76-200 FSR. The NFPA Life Safety Code also has a Class D (201-500 FSR) and Class E (over 500 FSR) interior finish.

These classifications are typically used in modern building codes to restrict the rate of fire spread. Only the first three classifications are normally permitted, though not all classes of materials can be used in all places throughout a building. For example, the interior finish of building materials used in exits or in corridors leading to exits is more strictly regulated than materials used within private dwelling units.

In general, inorganic archaic materials (e.g., bricks or tile) can be expected to be in Class I. Materials of whole wood are mostly Class II. Whole wood is defined as wood used in the same form as sawn from the tree. This is in contrast to the contemporary reconstituted wood products such as plywood, fiberboard, hardboard, or particle board. If the organic archaic material is not whole wood, the flame spread classification could be well over 200 and thus would be particularly unsuited for use in exits and other critical locations in a building. Some plywoods and various wood fiberboards have flame spreads over 200. Although they can be treated with fire retardants to reduce their flame spread, it would be advisable to assume that all such products have a flame spread over 200 unless there is information to the contrary.

SMOKE PRODUCTION

The evaluation of smoke density is part of the ASTM E-84 tunnel test. For the eight species of lumber shown in the table above, the highest levels are 275-305 for Yellow Pine, but most of the others are less smoky than red oak which has an index of 100. The advent of plastics caused substantial increases in the smoke density values measured by the tunnel test. The ensuing limitation of the smoke production for wall and ceiling materials by the model building codes has been a reaction to the introduction of plastic materials. In general, cellulosic materials fall in the 50-300 range of smoke density which is below the general limitation of 450 adopted by many codes.

* Some codes use Roman numerals, others use letters.

DEGREE OF COMBUSTIBILITY

The model building codes tend to define "noncombustibility" on the basis of having passed ASTM E-136 or if the material is totally inorganic. The acceptance of gypsum wallboard as noncombustible is based on limiting paper thickness to not over 1/8 inch and a 0-50 flame spread rating by ASTM E-84. At times there were provisions to define a Class I or A material (0-25 FSR) as noncombustible, but this is not currently recognized by most model building codes.

If there is any doubt whether or not an archaic material is noncombustible, it would be appropriate to send out samples for evaluation. If an archaic material is determined to be noncombustible according to ASTM E-136, it can be expected that it will not contribute fuel to the fire.

1.2
Combustible Construction Types

One of the earliest forms of timber construction used exterior load-bearing masonry walls with columns and/or wooden walls supporting wooden beams and floors in the interior of the building. This form of construction, often called "mill" or "heavy timber" construction, has approximately 1 hour fire resistance. The exterior walls will generally contain the fire within the building.

With the development of dimensional lumber, there was a switch from heavy timber to "balloon frame" construction. The balloon frame uses load-bearing exterior wooden walls which have long timbers often extending from foundation to roof. When longer lumber became scarce, another form of construction, "platform" framing, replaced the balloon framing. The difference between the two systems is significant because platform framing is automatically fire-blocked at every floor while balloon framing commonly has concealed spaces that extend unblocked from basement to attic. The architect, engineer, and code official must be alert to the details of construction and the ease with which fire can spread in concealed spaces.

2
Building Evaluation

A given rehabilitation project will most likely go through several stages. The preliminary evaluation process involves the designer in surveying the prospective building. The fire resistance of existing building materials and construction systems is identified; potential problems are noted for closer study. The final evaluation phase includes: developing design solutions to upgrade the fire resistance of building elements, if necessary; preparing working drawings and specifications; and the securing of the necessary code approvals.

2.1
Preliminary Evaluation

A preliminary evaluation should begin with a building survey to determine the existing materials, the general arrangement of the structure and the use of the occupied spaces, and the details of construction. The designer needs to know "what is there" before a decision can be reached about what to keep and what to remove during the rehabilitation process. This preliminary evaluation should be as detailed as necessary to make initial plans. The fire-related properties need to be determined from the applicable building or rehabilitation code, and the materials and assemblies existing in the building then need to be evaluated for these properties. Two work sheets are shown below to facilitate the preliminary evaluation.

Two possible sources of information helpful in the preliminary evaluation are the original building plans and the building code in effect at the time of original construction. Plans may be on file with the local building department or in the offices of the original designers (e.g., architect, engineer) or their successors. If plans are available, the investigator should verify that the building was actually constructed as called for in the plans, as well as incorporate any later alterations or changes to the building. Earlier editions of the local building code should be on file with the building official. The code in effect at the time of construction will contain fire performance criteria. While this is no guarantee that the required performance was actually provided, it does give the investigator some guidance as to the level of performance which may be expected. Under some code administration and

enforcement systems, the code in effect at the time of construction also defines the level of performance that must be provided at the time of rehabilitation.

Figure 1 illustrates one method for organizing preliminary field notes. Space is provided for the materials, dimensions, and condition of the principal building elements. Each floor of the structure should be visited and the appropriate information obtained. In practice, there will often be identical materials and construction on every floor, but the exception may be of vital importance. A schematic diagram should be prepared of each floor showing the layout of exits and hallways and indicating where each element described in the field notes fits into the structure as a whole. The exact arrangement of interior walls within apartments is of secondary importance from a fire safety point of view and need not be shown on the drawings unless these walls are required by code to have a fire resistance rating.

The location of stairways and elevators should be clearly marked on the drawings. All exterior means of escape (e.g., fire escapes) should be identified.*

The following notes explain the entries in Figure 1.

Exterior Bearing Walls: Many old buildings utilize heavily constructed walls to support the floor/ceiling assemblies at the exterior of the building. There may be columns and/or interior bearing walls within the structure, but the exterior walls are an important factor in assessing the fire safety of a building.

The field investigator should note how the floor/ceiling assemblies are supported at the exterior of the building. If columns are incorporated in the exterior walls, the walls may be considered non-bearing.

Interior Bearing Walls: It may be difficult to determine whether or not an interior wall is load bearing, but the field investigator should attempt to make this determination. At a later stage of the rehabilitation process, this question will need to be determined exactly. Therefore, the field notes should be as accurate as possible.

---

* Problems providing adequate exiting are discussed at length in the *Egress Guideline for Residential Rehabilitation.*

FIGURE 1 **PRELIMINARY EVALUATION FIELD NOTES**

Building Element		Materials	Thickness	Condition	Notes
Exterior Bearing Walls					
Interior Bearing Walls					
Exterior Non-Bearing Walls					
Interior Non-Bearing Walls or Partitions:	A				
	B				
Structural Frame: Columns					
Beams					
Other					
Floor/Ceiling Structural System Spanning					
Roofs					
Doors (including frame and hardware): a) Enclosed vertical exitway					
b) Enclosed horizontal exitway					
c) Other					

Exterior Non-Bearing Walls: The fire resistance of the exterior walls is important for two reasons. These walls (both bearing and non-bearing) are depended upon to: a) contain a fire *within* the building of origin; or b) keep an exterior fire *outside* the building. It is therefore important to indicate on the drawings where any openings are located as well as the materials and construction of all doors or shutters. The drawings should indicate the presence of wired glass, its thickness and framing, and identify the materials used for windows and door frames. The protection of openings adjacent to exterior means of escape (e.g., exterior stairs, fire escapes) is particularly important. The ground floor drawing should locate the building on the property and indicate the precise distances to adjacent buildings.

Interior Non-Bearing Walls (Partitions): A partition is a "wall that extends from floor to ceiling and subdivides space within any story of a building". (48) Figure 1 has two categories (A & B) for Interior Non-Bearing Walls (Partitions) which can be used for different walls, such as hallway walls as compared to inter-apartment walls. Under some circumstances there may be only one type of wall construction; in others, three or more types of wall construction may occur.

The field investigator should be alert for differences in function as well as in materials and construction details. In general, the details within apartments are not as important as the major exit paths and stairwells. The preliminary field investigation should attempt to determine the thickness of all walls. A term introduced below called "thickness design" will depend on an accurate ($\pm$ 1/4 inch) determination. Even though this initial field survey is called "preliminary", the data generated should be as accurate and complete as possible.

The field investigator should note the exact location from which his or her observations are recorded. For instance, if a hole is found through a stairwell wall which allows a cataloguing of the construction details, the field investigation notes should reflect the location of the "find". At the preliminary stage it is not necessary to core every wall; the interior details of construction can usually be determined at some location.

Structural Frame: There may or may not be a complete skeletal frame, but usually there are columns, beams, trusses, or other like elements. The dimensions and spacing of the structural elements should be measured and indicated on the drawings. For

instance, if there are ten inch square columns located on a thirty foot square grid throughout the building, this should be noted. The structural material and cover or protective materials should be identified wherever possible. The thickness of the cover materials should be determined to an accuracy of $\pm$ 1/4 inch. As discussed above, the preliminary field survey usually relies on accidental openings in the cover materials rather than a systematic coring technique.

Floor/Ceiling Structural Systems: The span between supports should be measured. If possible, a sketch of the cross-section of the system should be made. If there is no location where accidental damage has opened the floor/ceiling construction to visual inspection, it is necessary to make such an opening. An evaluation of the fire resistance of a floor/ceiling assembly requires detailed knowledge of the materials and their arrangement. Special attention should be paid to the cover on structural steel elements and the condition of suspended ceilings and similar membranes.

Roofs: The preliminary field survey of the roof system is initially concerned with water-tightness. However, once it is apparent that the roof is sound for ordinary use and can be retained in the rehabilitated building, it becomes necessary to evaluate the fire performance. The field investigator must measure the thickness and identify the types of materials which have been used. Be aware that there may be several layers of roof materials.

Doors: Doors to stairways and hallways represent some of the most important fire elements to be considered within a building. The uses of the spaces separated largely controls the level of fire performance necessary. Walls and doors enclosing stairs or elevator shafts would normally require a higher level of performance than between a the bedroom and bath. The various uses are differentiated in Figure 1.

Careful measurements of the thickness of door panels must be made, and the type of core material within each door must be determined. It should be noted whether doors have self-closing devices; the general operation of the doors should be checked. The latch should engage and the door should fit tightly in the frame. The hinges should be in good condition. If glass is used in the doors, it should be identified as either plain glass or wired glass mounted in either a wood or steel frame.

Materials: The field investigator should be able to identify ordinary building materials. In situations where an unfamiliar material is found, a sample should be obtained. This sample should measure at least 10 cubic inches so that an ASTM E-136 fire test can be conducted to determine if it is combustible.

Thickness: The thickness of all materials should be measured accurately since, under certain circumstances, the level of fire resistance is very sensitive to the material thickness.

Condition: The method attaching the various layers and facings to one another or to the supporting structural element should be noted under the appropriate building element. The "secureness" of the attachmnent and the general condition of the layers and facings should be noted here.

Notes: The "Notes" column can be used for many purposes, but it might be a good idea to make specific references to other field notes or drawings.

After the building survey is completed, the data collected must be analyzed. A suggested work sheet for organizing this information is given below as Figure 2.

The required fire resistance and flame spread for each building element are normally established by the local building or rehabilitation code. The fire performance of the existing materials and assemblies should then be estimated, using one of the techniques described below. If the fire performance of the existing building element(s) is equal to or greater than that required, the materials and assemblies may remain. If the fire performance is less than required, then corrective measures must be taken.

The most common methods of upgrading the level of protection are to either remove and replace the existing building element(s) or to repair and upgrade the existing materials and assemblies. Other fire protection measures, such as automatic sprinklers or detection and alarm systems, also could be considered, though they are beyond the scope of this guideline. If the upgraded protection is still less than that required or deemed to be acceptable, additional corrective measures must be taken. This process must continue until an acceptable level of performance is obtained.

FIGURE 2 PRELIMINARY EVALUATION WORKSHEET

Building Element		Required Fire Resistance	Required Flame Spread	Estimated Fire Resistance	Estimated Flame Spread	Method of Upgrading	Estimated Upgraded Protection	Notes
Exterior Bearing Walls								
Interior Bearing Walls								
Exterior Non-Bearing Walls								
Interior Non-Bearing Walls or Partitions	A							
	B							
Structural Frame: Columns								
Beams								
Other								
Floor/ Ceiling Structural System Spanning								
Roofs								
Doors (including frame and hardware): a) Enclosed vertical exitway								
b) Enclosed horizontal exitway								
c) Others								

2.2
Fire Resistance of Existing Building Elements

The fire resistance of the existing building elements can be estimated from the tables and histograms contained in the Appendix. The Appendix is organized first by type of building element: walls, columns, floor/ceiling assemblies, beams, and doors. Within each building element, the tables are organized by type of construction (e.g., masonry, metal, wood frame), and then further divided by minimum dimensions or thickness of the building element.

A histogram precedes every table that has 10 or more entries. The X-axis measures fire resistance in hours; the Y-axis shows the number of entries in that table having a given level of fire resistance. The histograms also contain the location of each entry within that table for easy cross-referencing.

The histograms, because they are keyed to the tables, can speed the preliminary investigation. For example, Table 1.3.2, *Wood Frame Walls 4" to Less Than 6" Thick*, contains 96 entries. Rather than study each table entry, the histogram shows that every wall assembly listed in that table has a fire resistance of less than 2 hours. If the building code required the wall to have 2 hours fire resistance, the designer, with a minimum of effort, is made aware of a problem that requires closer study.

Suppose the code had only required a wall of 1 hour fire resistance. The histogram shows far fewer complying elements (19) than non-complying ones (77). If the existing assembly is not one of the 19 complying entries, there is a strong possibility the existing assembly is deficient. The histograms can also be used in the converse situation. If the existing assembly is not one of the smaller number of entries with a lower than required fire resistance, there is a strong possibility the existing assembly will be acceptable.

At some point the existing building component or assembly must be located within the tables. Otherwise, the fire resistance must be determined through one of the other techniques presented in the guideline. Locating the building component in the Appendix Tables not only guarantees the accuracy of the fire resistance rating, but also provides a source of documentation for the building official.

2.3
Effects of Penetrations in Fire Resistant Assemblies

There are often many features in existing walls or floor/ceiling assemblies which were not included in the original certification or fire testing. The most common examples are pipes and utility wires passed through holes poked through an assembly. During the life of the building many penetrations are added, and by the time a building is ready for rehabilitation it is not sufficient to just consider the fire resistance of the assembly as originally constructed. It is necessary to consider all penetrations and their relative impact upon fire performance. For instance, the fire resistance of the corridor wall may be less important than the effect of plain glass doors or transoms. In fact, doors are the most important single class of penetrations.

A fully developed fire generates substantial quantities of heat and excess gaseous fuel capable of penetrating any holes which might be present in the walls or ceiling of the fire compartment. In general, this leads to a severe degradation of the fire resistance of those building elements and to a greater potential for fire spread. This is particularly applicable to penetrations located high in a compartment where the positive pressure of the fire can force the unburned gases through the penetration.

Penetrations in a floor/ceiling assembly will generally completely negate the barrier qualities of the assembly and will lead to rapid spread of fire to the space above. It will not be a problem, however, if the penetrations are filled with non-combustible materials strongly fastened to the structure. The upper half of walls are similar to the floor/ceiling assembly in that a positive pressure can reasonably be expected in the top of the room, and this will push hot and/or burning gases through the penetration unless it is completely sealed.

Building codes require doors installed in fire resistive walls to resist the passage of fire for a specified period of time. If the door to a fully involved room is not closed, a large plume of fire will typically escape through the doorway, preventing anyone from using the space outside the door while allowing the fire to spread. This is why door closers are so important. Glass in doors and transoms can be expected to rapidly shatter unless constructed of listed or approved wire glass in a steel frame. As with other building elements, penetrations or non-rated

portions of doors and transoms must be upgraded or otherwise protected.

Table 5.1 in Section V of the Appendix contains 41 entries of doors mounted in sound tightfitting frames. Part 3.4 below outlines one procedure for evaluating and possibly upgrading existing doors.

3
Final Evaluation and Design Solution

The final evaluation begins after the rehabilitation project has reached the final design stage and the choices made to keep certain archaic materials and assemblies in the rehabilitated building. The final evaluation process is essentially a more refined and detailed version of the preliminary evaluation. The specific fire resistance and flame spread requirements are determined for the project. This may involve local building and fire officials reviewing the preliminary evaluation as depicted in Figures 1 and 2 and the field drawings and notes. When necessary, provisions must be made to upgrade existing building elements to provide the required level of fire performance.

There are several approaches to design solutions that can make possible the continued use of archaic materials and assemblies in the rehabilitated structure. The simplest case occurs when the materials and assembly in question are found within the Appendix Tables and the fire performance properties satisfy code requirements. Other approaches must be used, though, if the assembly cannot be found within the Appendix or the fire performance needs to be upgraded. These approaches have been grouped into two classes: experimental and theoretical.

3.1
The Experimental Approach

If a material or assembly found in a building is not listed in the Appendix Tables, there are several other ways to evaluate fire performance. One approach is to conduct the appropriate fire test(s) and thereby determine the fire-related properties directly. There are a number of laboratories in the United States which routinely conduct the various fire tests. A current list can be

obtained by writing the Center for Fire Research, National Bureau of Standards, Washington, D.C. 20234.

The contract with any of these testing laboratories should require their observation of specimen preparation as well as the testing of the specimen. A complete description of where and how the specimen was obtained from the building, the transportation of the specimen, and its preparation for testing should be noted in detail so that the building official can be satisfied that the fire test is representative of the actual use.

The test report should describe the fire test procedure and the response of the material or assembly. The laboratory usually submits a cover letter with the report to describe the provisions of the fire test that were satisfied by the material or assembly under investigation. A building official will generally require this cover letter, but will also read the report to confirm that the material or assembly complies with the code requirements. Local code officials should be involved in all phases of the testing process.

The experimental approach can be costly and time consuming because specimens must be taken from the building and transported to the testing laboratory. When a load bearing assembly has continuous reinforcement, the test specimen must be removed from the building, transported, and tested in one piece. However, when the fire performance cannot be determined by other means, there may be no alternative to a full-scale test.

A "non-standard" small-scale test can be used in special cases. Sample sizes need only be 10-25 square feet, while full-scale tests require test samples of either 100 or 180 square feet in size. This small-scale test is best suited for testing non-load bearing assemblies against thermal transmission only.

3.2 The Theoretical Approach

There will be instances when materials and assemblies in a building undergoing rehabilitation cannot be found in the Appendix Tables. Even where test results are available for more or less

similar construction, the proper classification may not be immediately apparent. Variations in dimensions, loading conditions, materials, or workmanship may markedly affect the performance of the individual building elements, and the extent of such a possible effect cannot be evaluated from the tables.

Theoretical methods being developed offer an alternative to the full-scale fire tests discussed above. For example, Section 4302(b) of the 1979 Edition of the Uniform Building Code specifically allows an engineering design for fire resistance in lieu of conducting full scale tests. These techniques draw upon computer simulation and mathematical modeling, thermodynamics, heat-flow analysis, and materials science to predict the fire performance of building materials and assemblies.

One theoretical method known as the "Ten Rules of Fire Endurance Ratings" was published by T. Z. Harmathy in the May, 1965 edition of *Fire Technology*. (35) Harmathy's Rules provide a foundation for extending the data within the Appendix Tables to analyze or upgrade current as well as archaic building materials or assemblies.

Harmathy's Ten Rules

Rule 1: The "thermal" fire endurance of a construction consisting of a number of parallel layers is greater than the sum of the "thermal" fire endurances characteristic of the individual layers when exposed separately to fire.*

The minimum performance of an untested assembly can be estimated if the fire endurance of the individual components is known. Though the exact rating of the assembly cannot be stated, the endurance of the assembly is greater than the sum of the endurance of the components.

---

* The "thermal" fire endurance is the time at which the average temperature on the unexposed side of a construction exceeds its initial value by 250° when the other side is exposed to the "standard" fire specified by ASTM Test Method E-19.

When a building assembly or component is found to be deficient, the fire endurance can be upgraded by providing a protective membrane. This membrane could be a new layer of brick, plaster, or drywall. The fire endurance of this membrane is called the "finish rating." Appendix Tables 1.5.1 and 1.5.2 contain the finish ratings for the most commonly employed materials. (See also the notes to Rule 2).

The test criteria for the finish rating is the same as for the thermal fire endurance of the total assembly: average temperature increases of 250°F above ambient or 325°F above ambient at any one place with the membrane being exposed to the fire. The temperature is measured at the interface of the assembly and the protective membrane.

Rule 2: The fire endurance of a construction does not decrease with the addition of further layers.

Harmathy notes that this rule is a consequence of the previous rule. Its validity follows from the fact that the additional layers increase both the resistance to heat flow and the heat capacity of the construction. This, in turn, reduces the rate of temperature rise at the unexposed surface.

This rule is not just restricted to "thermal" performance but affects the other fire test criteria: direct flame passage, cotton waste ignition, and load bearing performance. This means that certain restrictions must be imposed on the materials to be added and on the loading conditions. One restriction is that a new layer, if applied to the exposed surface, must not produce additional thermal stresses in the construction, i.e., its thermal expansion characteristics must be similar to those of the adjacent layer. Each new layer must also be capable of contributing enough additional strength to the assembly to sustain the added dead load. If this requirement is not fulfilled, the allowable live load must be reduced by an amount equal to the weight of the new layer. Because of these limitations, this rule should not be applied without careful consideration.

Particular care must be taken if the material added is a good thermal insulator. Properly located, the added insulation could improve the "thermal" performance of the assembly. Improperly located, the insulation could block necessary thermal transmission

through the assembly, thereby subjecting the structural elements to greater temperatures for longer periods of time, and could cause premature structural failure of the supporting members.

Rule 3: The fire endurance of constructions containing continuous air gaps or cavities is greater than the fire endurance of similar constructions of the same weight, but containing no air gaps or cavities.

By providing for voids in a construction, additional resistances are produced in the path of heat flow. Numerical heat flow analyses indicate that a 10 to 15 percent increase in fire endurance can be achieved by creating an air gap at the mid-plane of a brick wall. Since the gross volume is also increased by the presence of voids, the air gaps and cavities have a beneficial effect on stability as well. However, constructions containing combustible materials within an air gap may be regarded as exceptions to this rule because of the possible development of burning in the gap.

There are numerous examples of this rule in the tables. For instance:

Table 1.1.4; Item W-8-M-82: Cored concrete masonry, nominal 8 inch thick wall with one unit in wall thickness and with 62% minimum of solid material in each unit, load bearing (80 PSI). Fire endurance: 2-1/2 hours.

Table 1.1.5; Item W-10-M-11: Cored concrete mansonry, nominal 10 inch thick wall with two units in wall thickness and a 2 inch air space, load bearing (80 PSI). The units are essentially the same as item W-8-M-82. Fire endurance: 3-1/2 hours.

These walls show 1 hour greater fire endurance by the addition of the 2 inch air space.

Rule 4: The farther an air gap or cavity is located from the exposed surface, the more beneficial is its effect on the fire endurance.

Radiation dominates the heat transfer across an air gap or cavity, and it is markedly higher where the temperature is

higher. The air gap or cavity is thus a poor insulator if it is located in a region which attains high temperatures during fire exposure.

Some of the clay tile designs take advantage of these factors. The double cell design, for instance, insures that there is a cavity near the unexposed face. Some floor/ceiling assemblies have air gaps or cavities near the top surface and these enhance their thermal performance.

Rule 5: The fire endurance of a construction cannot be increased by increasing the thickness of a completely enclosed air layer.

Harmathy notes that there is evidence that if the thickness of the air layer is larger than about 1/2 inch, the heat transfer through the air layer depends only on the temperature of the bounding surfaces, and is practically independent of the distance between them. This rule is not applicable if the air layer is not completely enclosed, i.e., if there is a possibility of fresh air entering the gap at an appreciable rate.

Rule 6: Layers of materials of low thermal conductivity are better utilized on that side of the construction on which fire is more likely to happen.

As in Rule 4, the reason lies in the heat transfer process, though the conductivity of the solid is much less dependent on the ambient temperature of the materials. The low thermal conductor creates a substantial temperature differential to be established across its thickness under transient heat flow conditions. This rule may not be applicable to materials undergoing physico-chemical changes accompanied by significant heat absorption or heat evolution.

Rule 7: The fire endurance of asymmetrical constructions depends on the direction of heat flow.

This rule is a consequence of Rules 4 and 6 as well as other factors. This rule is useful in determining the relative protection of corridors and stairwells from the surrounding spaces. In addition, there are often situations where a fire is more likely, or potentially more severe, from one side or the other.

Rule 8: The presence of moisture, if it does not result in explosive spalling, increases the fire endurance.

The flow of heat into an assembly is greatly hindered by the release and evaporation of the moisture found within cementitious materials such as gypsum, portland cement, or magnesium oxychloride. Harmathy has shown that the gain in fire endurance may be as high as 8 percent for each percent (by volume) of moisture in the construction. It is the moisture chemically bound within the construction material at the time of manufacture or processing that leads to increased fire endurance. There is no direct relationship between the relative humidity of the air in the pores of the material and the increase in fire endurance.

Under certain conditions there may be explosive spalling of low permeability cementitious materials such as dense concrete. In general, one can assume that extremely old concrete has developed enough minor cracking that this factor should not be significant.

Rule 9: Load-supporting elements, such as beams, girders and joists, yield higher fire endurances when subjected to fire endurance tests as parts of floor, roof, or ceiling assemblies than they would when tested separately.

One of the fire endurance test criteria is the ability of a load-supporting element to carry its design load. The element will be deemed to have failed when the load can no longer be supported.

Failure usually results for two reasons. Some materials, particularly steel and other metals, lose much of their structural strength at elevated temperatures. Physical deflection of the supporting element, due to decreased strength or thermal expansion, causes a redistribution of the load forces and stresses throughout the element. Structural failure often results because the supporting element is not designed to carry the redistributed load.

Roof, floor, and ceiling assemblies have primary (e.g., beams) and secondary (e.g., floor joists) structural members. Since the primary load-supporting elements span the largest distances, their deflection becomes significant at a stage when the strength of the secondary members (including the roof or floor surface) is

hardly affected by the heat. As the secondary members follow the deflection of the primary load-supporting element, an increasingly larger portion of the load is transferred to the secondary members.

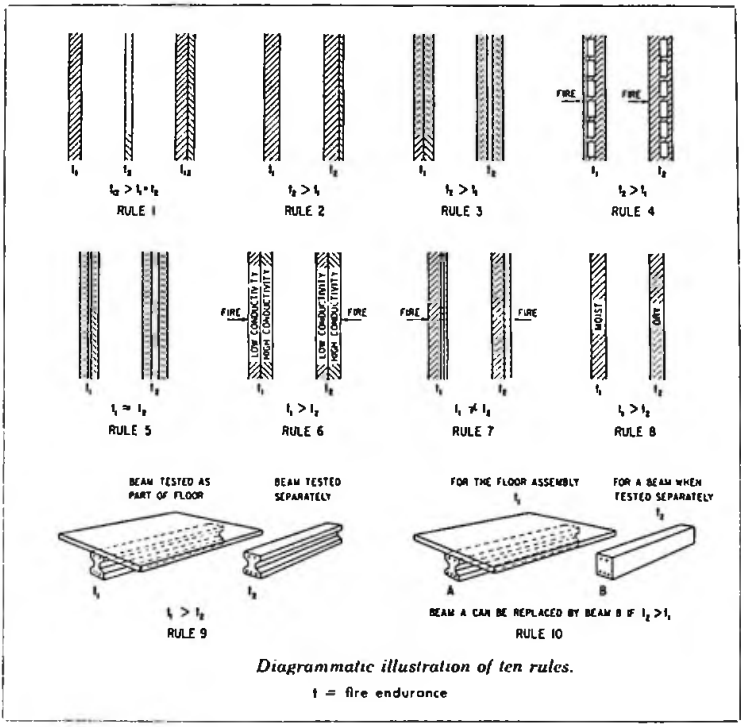
When load-supporting elements are tested separately, the imposed load is constant and equal to the design load throughout the test. By definition, no distribution of the load is possible because the element is being tested by itself. Without any other structural members to which the load could be transferred, the individual elements cannot yield a higher fire endurance than they do when tested as parts of a floor, roof or ceiling assembly.

Rule 10: The load-supporting elements (beams, girders, joists, etc.) of a floor, roof, or ceiling assembly can be replaced by such other load-supporting elements which, when tested separately, yielded fire endurances not less than that of the assembly.

This rule depends on Rule 9 for its validity. A beam or girder, if capable of yielding a certain performance when tested separately, will yield an equally good or better performance when it forms a part of a floor, roof, or ceiling assembly. It must be emphasized that the supporting element of one assembly must not be replaced by the supporting element of another assembly if the performance of this latter element is not known from a separate (beam) test. Because of the load-reducing effect of the secondary elements that results from a test performed on an assembly, the performance of the supporting element alone cannot be evaluated by simple arithmetic. This rule also indicates the advantage of performing separate fire tests on primary load-supporting elements.

Illustration of Harmathy's Rules

Harmathy provided one schematic figure which illustrated his Rules.* It should be useful as a quick reference to assist in applying his Rules.



Diagrammatic illustration of ten rules.

t = fire endurance

Example Application of Harmathy's Rules

The following examples, based in whole or in part upon those presented in Harmathy's paper (35), show how the Rules can be applied to practical cases.

EXAMPLE 1

Problem

A contractor would like to keep a partition which consists of a 3-3/4 inch thick layer of red clay brick, a 1-1/4 inch thick layer of plywood, and a 3/8 inch thick layer of gypsum wall-

board, at a location where 2 hour fire endurance is required. Is this assembly capable of providing a 2 hour protection?

Solution

(1) This partition does not appear in the Appendix Tables.

(2) Bricks of this thickness yield fire endurances of approximately 75 minutes (Table 1.1.2, Item W-4-M-2).

(3) The 1-1/4 inch thick plywood has a finish rating of 30 minutes.

(4) The 3/8 inch gypsum wallboard has a finish rating of 10 minutes.

(5) Using the recommended values from the tables and applying Rule 1, the fire endurance (FI) of the assembly is larger than the sum of the individual layers, or

$$FI > 75 + 30 + 10 = 115 \text{ minutes}$$

Discussion

This example illustrates how the Appendix Tables can be utilized to determine the fire resistance of assemblies not explicitly listed.

EXAMPLE 2

Problem

(1) A number of buildings to be rehabilitated have the same type of roof slab which is supported with different structural elements.

(2) The designer and contractor would like to determine whether or not this roof slab is capable of yielding a 2 hour fire endurance. According to a rigorous interpretation of ASTM E-119, however, only the roof assembly, including the roof slab as well as the cover and the supporting elements, can be subjected to a fire test. Therefore, a fire endurance classification cannot be issued for the slabs separately.

(3) The designer and contractor believe this slab will yield a 2 hour fire endurance even without the cover, and any beam of at least 2 hour fire endurance will provide satisfactory support. Is it possible to obtain a classification for the slab separately?

Solution

(1) The answer to the question is yes.

(2) According to Rule 10 it is not contrary to common sense to test and classify roofs and supporting elements separately. Furthermore, according to Rule 2, if the roof slabs actually yield a 2 hour fire endurance, the endurance of an assembly, including the slabs, cannot be less than 2 hours.

(3) The recommended procedure would be to review the tables to see if the slab appears as part of any tested roof or floor/ceiling assembly. The supporting system can be regarded as separate from the slab specimen, and the fire endurance of the assembly listed in the table is at least the fire endurance of the slab. There would have to be an adjustment for the weight of the roof cover in the allowable load if the test specimen did not contain a cover.

(4) The supporting structure or element would have to have at least a 2 hour fire endurance when tested separately.

Discussion

If the tables did not include tests on assemblies which contained the slab, one procedure would be to assemble the roof slabs on any convenient supporting system (not regarded as part of the specimen) and to subject them to a load which, besides the usually required superimposed load, includes some allowances for the weight of the cover.

EXAMPLE 3

Problem

A steel-joisted floor and ceiling assembly is known to have yielded a fire endurance of 1 hour and 35 minutes. At a certain location, a 2 hour endurance is required. What is the most economical way of increasing the fire endurance by at least 25 minutes?

Solution

(1) The most effective technique would be to increase the ceiling plaster thickness. Existing coats of paint would have to be removed and the surface properly prepared before the new plaster could be applied. Other materials (e.g., gypsum wallboard) could also be considered.

(2) There may be other techniques based on other principles, but an examination of the drawings would be necessary.

Discussion

(1) The additional plaster has at least three effects:

a) The layer of plaster is increased and thus there is a gain of fire endurance (Rule 1).

b) There is a gain due to shifting the air gap farther from the exposed surface (Rule 4).

c) There is more moisture in the path of heat flow to the structural elements (Rules 7 and 8).

(2) The increase in fire endurance would be at least as large as that of the finish rating for the added thickness of plaster. The combined effects in (1) above would further increase this by a factor of 2 or more, depending upon the geometry of the assembly.

EXAMPLE 4

Problem

The fire endurance of item W-10-M-1 in Table 1.1.5 is 4 hours. This wall consists of two 3-3/4 inch thick layers of structural tiles separated by a 2 inch air gap and 3/4 inch portland cement plaster or stucco on both sides. If the actual wall in the building is identical to item W-10-M-1 except that it has a 4 inch air gap, can the fire endurance be estimated at 5 hours?

Solution

The answer to the question is no for the reasons contained in Rule 5.

EXAMPLE 5

Problem

In order to increase the insulating value of its precast roof slabs, a company has decided to use two layers of different concretes. The lower layer of the slabs, where the strength of the concrete is immaterial (all the tensile load is carried by the steel reinforcement), would be made with a concrete of low strength but good insulating value. The upper layer, where the concrete is supposed to carry the compressive load, would remain the original high strength, high thermal conductivity concrete. How will the fire endurance of the slabs be affected by the change?

Solution

The effect on the thermal fire endurance is beneficial:

(1) The total resistance to heat flow of the new slabs has been increased due to the replacement of a layer of high thermal conductivity by one of low conductivity.

(2) The layer of low conductivity is on the side more likely to be exposed to fire, where it is more effectively utilized according to Rule 6. The layer of low thermal conductivity also provides better protection for the steel reinforcement, thereby extending the time before reaching the temperature at which the creep of steel becomes significant.

3.3 "Thickness Design" Strategy

The "thickness design" strategy is based upon Harmathy's Rules 1 and 2. This design approach can be used when the construction materials have been identified and measured, but the specific assembly cannot be located within the tables. The tables should be surveyed again for thinner walls of like material and construction detail that have yielded the desired or greater fire endurance. If such an assembly can be found, then the thicker walls in the building have more than enough fire resistance. The thickness of the walls thus becomes the principal concern.

This approach can also be used for floor/ceiling assemblies, except that the thickness of the cover* and the slab become the central concern. The fire resistance of the untested assembly will be at least the fire resistance of an assembly listed in the table having a similar design but with less cover and/or thinner slabs. For other structural elements (e.g., beams and columns), the element listed in the table must also be of a similar design but with less cover thickness.

3.4
Evaluation of Doors

A separate section on doors has been included because the process for evaluation presented below differs from those suggested previously for other building elements. The impact of unprotected openings or penetrations in fire resistant assemblies has been detailed in Part 2.3 above. It is sufficient to note here that openings left unprotected will likely lead to failure of the barrier under actual fire conditions.

For other types of building elements (e.g., beams, columns), the Appendix Tables can be used to establish a minimum level of fire performance. The benefit to rehabilitation is that the need for a full-scale fire test is then eliminated. For doors, however, this cannot be done. The data contained in Appendix Table 5.1, *Resistance of Doors to Fire Exposure*, can only provide guidance as to whether a successful fire test is even feasible.

For example, a door required to have 1 hour fire resistance is noted in the tables as providing only 5 minutes. The likelihood of achieving the required 1 hour, even if the door is upgraded, is remote. The ultimate need for replacement of the doors is reasonably clear, and the expense and time needed for testing can be saved. However, if the performance documented in the table is near or in excess of what is being required, then a fire test should be conducted. The test documentation can then be used as evidence of compliance with the required level of performance.

* Cover: the protective layer or membrane of material which slows the flow of heat to the structural elements.

The table entries cannot be used as the sole proof of performance of the door in question because there are too many unknown variables which could measurably affect fire performance. The wood may have dried over the years; coats of flammable varnish could have been added. Minor deviations in the internal construction of a door can result in significant differences in performance. Methods of securing inserts in panel doors can vary. The major non-destructive method of analysis, an x-ray, often cannot provide the necessary detail. It is for these, and similar reasons, that a fire test is still felt to be necessary.

It is often possible to upgrade the fire performance of an existing door. Sometimes, "as is" and modified doors are evaluated in a single series of tests when failure of the unmodified door is expected. Because doors upgraded after an initial failure must be tested again, there is a potential savings of time and money.

The most common problems encountered are plain glass, panel inserts of insufficient thickness, and improper fit of a door in its frame. The latter problem can be significant because a fire can develop a substantial positive pressure, and the fire will work its way through otherwise innocent-looking gaps between door and frame.

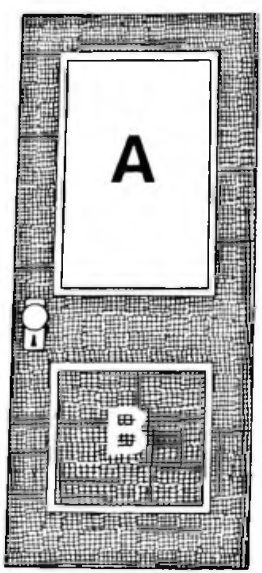
One approach to solving these problems is as follows. The plain glass is replaced with approved or listed wire glass in a steel frame. The panel inserts can be upgraded by adding an additional layer of material. Gypsum wallboard is often used for this purpose. Intumescent paint applied to the edges of the door and frame will expand when exposed to fire, forming an effective seal around the edges. This seal, coupled with the generally even thermal expansion of a wood door in a wood frame, can prevent the passage of flames and other fire gases. Figure 3 below illustrates these solutions.

Because the interior construction of a door cannot be determined by a visual inspection, there is no absolute guarantee that the remaining doors are identical to the one(s) removed from the building and tested. But the same is true for doors constructed today, and reason and judgment must be applied. Doors that appear identical upon visual inspection can be weighed. If the weights are reasonably close, the doors can be assumed to be identical and therefore provide the same level of fire perfor-

mance. Another approach is to fire test more than one door or to dismantle doors selected at random to see if they had been constructed in the same manner. Original building plans showing door details or other records showing that doors were purchased at one time or obtained from a single supplier can also be evidence of similar construction.

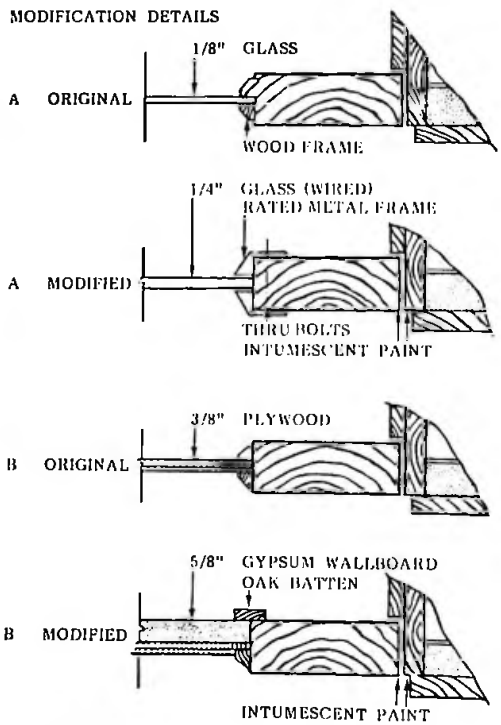
More often though, it is what is visible to the eye that is most significant. The investigator should carefully check the condition and fit of the door and frame, and for frames out of plumb or separating from the wall. Door closers, latches, and hinges must be examined to see that they function properly and are tightly secured. If these are in order and the door and frame have passed a full-scale test, there can be a reasonable basis for allowing the existing doors to remain.

FIGURE 3



TEST DOOR

MODIFICATION DETAILS



4
Summary

This section summarizes the various approaches and design solutions discussed in the preceeding sections of the guideline. The term "structural system" includes: frames, beams, columns, and other structural elements. "Cover" is a protective layer(s) of materials or membrane which slows the flow of heat to the structural elements. It cannot be stressed too strongly that the fire endurance of actual building elements can be greatly reduced or totally negated by removing part of the cover to allow pipes, ducts, or conduits to pass through the element. This must be repaired in the rehabilitation process.

The following approaches shall be considered equivalent.

4.1 The fire resistance of a building element can be established from the Appendix Tables. This is subject to the following limitations:

- The building element in the rehabilitated building shall be constructed of the same materials with the same nominal dimensions as stated in the tables.

- All penetrations in the building element or its cover for services such as electricity, plumbing, and HVAC shall be packed with noncombustible cementitious materials and so fixed that the packing material will not fall out when it loses its water of hydration.

- The effects of age and wear and tear shall be repaired so that the building element is sound and the original thickness of all components, particularly covers and floor slabs, is maintained.

This approach essentially follows the approach taken by model building codes. The assembly must appear in a table either published in or accepted by the code for a given fire resistance rating to be recognized and accepted.

4.2 The fire resistance of a building element which does not explicitly appear in the Appendix Tables can be established if one

or more elements of same design but different dimensions have been listed in the tables. For walls, the existing element must be thicker than the one listed. For floor/ceiling assemblies, the assembly listed in the table must have the same or less cover and the same or thinner slab constructed of the same material as the actual floor/ceiling assembly. For other structural elements, the element listed in the table must be of a similar design but with less cover thickness. The fire resistance in all instances shall be the fire resistance recommended in the table. This is subject to the following limitations:

- The actual element in the rehabilitated building shall be constructed of the same materials as listed in the table. Only the following dimensions may vary from those specified: for walls, the overall thickness must exceed that specified in the table; for floor/ceiling assemblies, the thickness of the cover and the slab must be greater than, or equal to, that specified in the table; for other structural elements, the thickness of the cover must be greater than that specified in the table.

- All penetrations in the building element or its cover for services such as electricity, plumbing, or HVAC shall be packed with noncombustible cementitious materials and so fixed that the packing material will not fall out when it loses its water of hydration.

- The effects of age and wear and tear shall be repaired so that the building element is sound and the original thickness of all components, particularly covers and floor slabs, is maintained.

This approach is an application of the "thickness design" concept presented in Part 3.3 of the guideline. There should be many instances when a thicker building element was utilized than the one listed in the Appendix Tables. This guideline recognizes the inherent superiority of a thicker design. Note: "thickness design" for floor/ceiling assemblies and structural elements refers to cover and slab thickness rather than total thickness.

The "thickness design" concept is essentially a special case of Harmathy's Rules (specifically Rules 1 and 2). It should be recognized that the only source of data is the Appendix Tables. If other data are used, it must be in connection with the approach below.

4.3 The fire resistance of building elements can be established by applying Harmathy's Ten Rules of Fire Resistance Ratings as set forth in Part 3.2 of the Guideline. This is subject to the following limitations:

- The data from the tables can be utilized subject to the limitations in 4.2 above.
- Test reports from recognized journals or published papers can be used to support data utilized in applying Harmathy's Rules.
- Calculations utilizing recognized and well established computational techniques can be used in applying Harmathy's Rules. These include, but are not limited to, analysis of heat flow, mechanical properties, deflections, and load bearing capacity.

Appendix

Table of Contents

Introduction A-4

Section I — Walls

1.1.1	Masonry	0" - 4" thick	A-6
1.1.2	Masonry	4" - 6" thick	A-9
1.1.3	Masonry	6" - 8" thick	A-16
1.1.4	Masonry	8" - 10" thick	A-22
1.1.5	Masonry	10" - 12" thick	A-29
1.1.6	Masonry	12" - 14" thick	A-32
1.1.7	Masonry	14" or more thick	A-37
1.2.1	Metal Frame	0" - 4" thick	A-40
1.2.2	Metal Frame	4" - 6" thick	A-43
1.2.3	Metal Frame	6" - 8" thick	A-45
1.2.4	Metal Frame	8" - 10" thick	A-46
1.3.1	Wood Frame	0" - 4" thick	A-47
1.3.2	Wood Frame	4" - 6" thick	A-48
1.3.3	Wood Frame	6" - 8" thick	A-55
1.4.1	Misc. Materials	0" - 4" thick	A-56
1.4.2	Misc. Materials	4" - 6" thick	A-56
1.5.1	Finish Ratings/Inorganic Materials	Thickness	A-57
1.5.2	Finish Ratings/Organic Materials	Thickness	A-58

Section II — Columns

2.1.1	Reinforced Concrete	Min. Dim. 0" - 6"	A-59
2.1.2	Reinforced Concret	Min. Dim. 10" - 12"	A-60
2.1.3	Reinforced Concrete	Min. Dim. 12" - 14"	A-63
2.1.4	Reinforced Concrete	Min. Dim. 14" - 16"	A-64
2.1.5	Reinforced Concrete	Min. Dim. 16" - 18"	A-65
2.1.6	Reinforced Concrete	Min. Dim. 18" - 20"	A-67
2.1.7	Reinforced Concrete	Min. Dim. 20" - 22"	A-68

2.1.8	Hexagonal Rein. Concrete	Diameter - 12" - 14"	A-70
2.1.9	Hexagonal Rein. Concrete	Diameter - 14" - 16"	A-70
2.1.10	Hexagonal Rein. Concrete	Diameter - 16" - 18"	A-71
2.1.11	Hexagonal Rein. Concrete	Diameter - 20" - 22"	A-71
2.2	Round Cast Iron Column	Minimum Dimension	A-72
2.3	Steel - Gypsum Encasements	Minimum Area of Solid Material	A-72
2.4	Timber	Minimum Dimension	A-73
2.5.1.1	Steel/Concrete Encasements	Minimum Dimension less than 6"	A-74
2.5.1.2	Steel/Concrete Encasements	Minimum Dimension 6" - 8"	A-74
2.5.1.3	Steel/Concrete Encasements	Minimum Dimension 8" - 10"	A-75
2.5.1.4	Steel/Concrete Encasements	Minimum Dimension 10" - 12"	A-77
2.5.1.5	Steel/Concrete Encasements	Minimum Dimension 12" - 14"	A-80
2.5.1.6	Steel/Concrete Encasements	Minimum Dimension 14" - 16"	A-82
2.5.1.7	Steel/Concrete Encasements	Minimum Dimension 16" - 18"	A-84
2.5.2.1	Steel/Plaster Encasements	Minimum Dimension 10" - 12"	A-85
2.5.2.2	Steel/Brick & Block Encasements	Minimum Dimension 12" - 14"	A-86
2.5.2.3	Steel/Brick & Block Encasements	Minimum Dimension 14" - 16"	A-86
2.5.3.1	Steel/Plaster Encasements	Minimum Dimension 6" - 8"	A-87
2.5.3.2	Steel/Plaster Encasements	Minimum Dimension 8" - 10"	A-87
2.5.4.1	Steel/Miscellaneous Encasements	Minimum Dimension 6" - 8"	A-88
2.5.4.2	Steel/Miscellaneous Encasements	Minimum Dimension 8" - 10"	A-88
2.5.4.3	Steel/Miscellaneous Encasements	Minimum Dimension 10" - 12"	A-89

2.5.4.4	Steel/Miscellaneous Encasements	Minimum Dimension 12" - 14"	A-89

Section III — Floor / Ceiling Assemblies

3.1	Reinforced Concrete	Assembly thickness	A-90
3.2	Steel Structural Elements	Membrane thickness	A-95
3.3	Wood Joist	Membrane thickness	A-100
3.4	Hollow Clay Tile with Reinforced Concrete	Assembly thickness	A-103

Section IV — Beams

4.1.1	Reinforced Concrete	Depth - 10" - 12"	A-106
4.1.2	Reincorced Concrete	Depth - 12" - 14"	A-108
4.1.3	Reinforced Concrete	Depth - 14" - 16"	A-109
4.2.1	Steel/Unprotected	Depth - 10" - 12"	A-110
4.2.2	Steel/Concrete Protection	Depth - 10" - 12"	A-110

Section V — Doors

5.1	Resistance of Doors to Fire Exposure	Thickness	A-111

Introduction

The tables and histograms which follow are to be used *only* within the analytical framework detailed in the main body of this guideline.

Histograms precede any table with 10 or more entries. The use and interpretation of these histograms is explained in Part 2 of the guideline. The tables are in a format similar to that found in the model building codes. The following example, taken from an entry in Table 1.1.2, best explains the table format.

Item Code	Thickness	Contruction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-4-M-50	4⅛"	Core: structural clay tile; See notes 12, 16, 21. Facings on unexposed side only; see note 18	n/a	25 min.		1		3, 4, 24	½

1. Item Code: The item code consists of a four place series in the general form w-x-y-z in which each member of the series denotes the following:
   w = Type of building element (e.g., W=Walls; F=Floors, etc.)
   x = The building element thickness rounded down to the nearest one inch increment (e.g., 4-5/8" is rounded off to 4")
   y = The general type of material from which the building element is constructed (e.g., M=Masonry; W=Wood, etc.)
   z = The item number of the particular building element in a given table

   The item code shown in the example W-4-M-50 denotes the following:
   W = Wall, as the building element
   4 = Wall thickness in the range of 4" to less than 5"
   M = Masonry construction
   50 = The 50th entry in Table 1.1.2

2. The specific name or heading of this column identifies the dimensions which, if varied, has the greatest impact on fire resistance. The critical dimension for walls, the example here, is thickness. It is different for other building elements (e.g., depth for beams; membrane thickness for some floor/ceiling assemblies). The table entry is the named dimension of the building element measured at the time of actual testing to within ± 1/8 inch tolerance. The thickness tabulated includes facings where facings are a part of the wall construction.

3. Construction Details: The construction details provide a brief description of the manner in which the building element was constructed.

4. Performance: This heading is subdivided into two columns. The column labeled "Load" will either list the load that the building element was subjected to during the fire test or it will contain a note number which will list the load and any other significant details. If the building element was not subjected to a load during the test this column will contain "n/a", which means "not applicable".

   The second column under performance is labeled "Time" and denotes the actual fire endurance time observed in the fire test.

5. Reference Number: This heading is subdivided into three columns: Pre-BMS-92; BMS-92; and Post BMS-92. The table entry under this column is the number in the Bibliography of the original source reference for the test data.

6. Notes: Notes are provded at the end of each table to allow a more detailed explanation of certain aspects of the test. In certain tables the notes given to this column have also been listed under the "Construction Details" and/or "Load columns.

7. Rec Hours: This column lists the recommended fire endurance rating, in hours, of a building element. In some cases, the recommended fire endurance will be less than that listed under the "Time" column. In no case is the "Rec Hours" greater than given in the "Time" column.

Section I—Walls

Figure 1.1.1
Walls - Masonry

0" to less than 4" thick

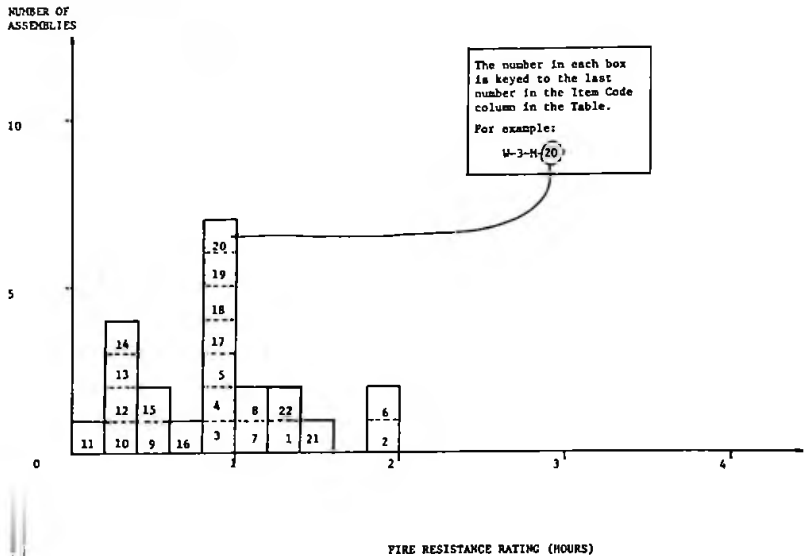


Table 1.1.1
Masonry Walls

0" to less than 4" thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Re. Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-2-M-1	2½"	Solid partition; 3/4" gypsum plank - 10'x 1'6"; 3/4"+ gypsum plaster each side.	n/a	1 hr. 22min			7	1	1-1/4
W-3-M-2	3"	Concrete block (18"x 9"x 3") of fuel ash, portland cement and plasticizer; Cement/sand mortar.	n/a	2 hr.			7	2,3	2
W-2-M-3	2"	Solid gypsum block wall; No facings.	n/a	1 hr.		1		4	1
W-3-M-4	3"	Solid gypsum blocks, laid in 1:3 sanded gypsum mortar	n/a	1 hr.		1		4	1
W-3-M-5	3"	Magnesium oxysulfate wood fiber blocks; 2" thick; Laid in portland cement-lime mortar; Facings: ½" of 1:3 sanded gypsum plaster on both sides.	n/a	1 hr.		1		4	1
W-3-M-6	3"	Magnesium oxysulfate bound wood fiber blocks; 3" thick; Laid in portland cement-lime mortar; Facings: ½" of 1:3 sanded gypsum plaster on both sides.	n/a	2 hr.		1		4	2
W-3-M-7	3"	Clay tile; Ohio fire clay; single cell thick; Face plaster 5/8" (both sides) 1:3 sanded gypsum; Construction "A"; Design E.	n/a	1 hr. 6 min.			2	5,6,7 11,12 39	1

Walls Less Than 4" Thick

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-3-M-8	3"	Clay tile; Illinois surface clay; single cell thick; face plaster 5/8" (both sides) 1:3 sanded gypsum; Design A; Construction "E".	n/a	1 hr 1 min			2	5,8,9 11,12 39	
W-3-M-9	3"	Clay tile; Illinois surface clay; single cell thick; no face plaster; Construction "C", Design "A".	n/a	25min			2	5,10 11,12 39	1/3
W-3-M-10	3-7/8"	8"x 4-7/8" glass blocks; weight 4 lb. each; portland cement-lime mortar; horizontal mortar joints reinforced with metal lath.	n/a	15min		1		4	1/4
W-3-M-11	3"	Core: Structural clay tile; See notes 14,18,23 No facings.	n/a	10min		1		5,11, 26	1/6
W-3-M-12	3"	Core: Structural clay tile; See notes 14,19,23 No facings.	n/a	20min		1		5,11, 26	1/3
W-3-M-13	3-5/8"	Core: Structural clay tile; See notes 14,18,23 Facings on unexposed side per note 20.	n/a	20min		1		5,11, 26	1/3
W-3-M-14	3-5/8"	Core: Structural clay tile; See notes 14,19,23; Facings on unexposed side only per note 20.	n/a	20min		1		5,11 26	1/3
W-3-M-15	3-5/8"	Core: Clay structural tile; See notes 14,18,23; Facings on side exposed to fire per note 20.	n/a	30min		1		5,11 26	1/2
W-3-M-16	3-5/8"	Core: Clay structural tile; See notes 14,19,23; Facing on side exposed to fire per note 20.	n/a	45min		1		5,11 26	3/4
W-2-M-17	2"	2" thick solid gypsum blocks; See note 27.	n/a	1 hr.		1		27	1
W-3-M-18	3"	Core: 3" thick gypsum blocks 70% solid; See note 2.; No facings.	n/a	1 hr.		1		27	1
W-3-M-19	3"	Core: Hollow concrete units; See notes 29,35, 36,38; No facings	n/a	1 hr.		1		27	1
W-3-M-20	3"	Core: Hollow concrete units; See notes 28,35, 36,37,38; No facings.	n/a	1 hr.		1			1
W-3-M-21	3¼"	Core: Hollow concrete units; See notes 28,35, 36,37,38; Facings on one side, see note 37.	n/a	1½ hr.		1			1½
W-3-M-22	3¼"	Core: Hollow concrete units; See notes 29,35, 36,38; Facings on one side per note 37.	n/a	1¼ hr.		1			1¼

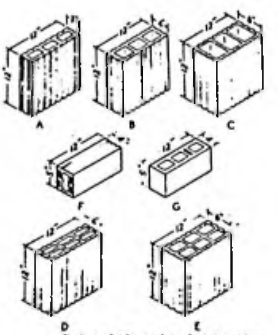
Notes:

TABLE 1.1.1

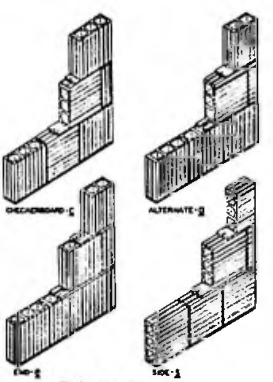
1. Failure mode - flame thru
2. Passed 2 hr. fire test (Grade "C" fire res. - British).
3. Passed hose stream test.
4. Tested at NBS under ASA. Spec. No. A2-1934. As non-load bearing partitions.
5. Tested at NBS under ASA Spec. No. 42-1934 (ASTM C-19-33) except that hose stream testing where carried out was run on test specimens exposed for full test duration, not for a reduced period as is contemporarily done.
6. Failure by thermal criteria - maximum temperature rise 181°C (325°F).
7. Hose stream failure.
8. Hose stream - pass.
9. Specimen removed prior to any failure occurring.
10. Failure mode - collapse.
11. For clay tile walls, unless the source or density of the clay can be positively identified or determined, it is suggested that the lowest hourly rating for the fire endurance of a clay tile partition of that thickness be followed. Identified sources of clay showing longer fire endurance can lead to longer time recommendations.
12. See appendix for construction and design details for clay tile walls.

NOTES

13. Load - 80 PSI for gross wall area.
14. One cell in wall thickness.
15. Two cells in wall thickness.
16. Double shells plus one cell in wall thickness.
17. One cell in wall thickness, cells filled with broken tile, crushed stone, slag cinders or sand mixed with mortar.
18. Dense hard-burned clay or shale tile.
19. Medium-burned clay tile.
20. Not less than 5/8" thickness of 1:3 sanded gypsum plaster.
21. Units of not less than 30% solid material.
22. Units of not less than 40% solid material.
23. Units of not less than 50% solid material.
24. Units of not less than 45% solid material.
25. Units of not less than 60% solid material.
26. All tiles laid in portland cement-lime mortar.
27. Blocks laid in 1:3 sanded gypsum mortar voids in blocks not to exceed 30%.
28. Units of expanded slag or pumice aggregates.
29. Units of crushed limestone, blast furnace slag, cinders and expanded clay or shale.
30. Units of calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.
31. Units of siliceous sand and gravel. 90% or more quartz, chert or flint.
32. Unit at least 49% solid.
33. Unit at least 62% solid.
34. Unit at least 65% solid.
35. Unit at least 73% solid.
36. Ratings based on one unit and one cell in wall thickness.
37. Minimum of ½" - 1:3 sanded gypsum plaster.
38. Non-load bearing.
39. See Clay Tile Partition Design Construction drawings, below.



Designs of tiles used in fire-test partitions.



The four types of construction used in fire-test partitions.

Figure 1.1.2
Walls- Masonry

4" to less than 6" thick

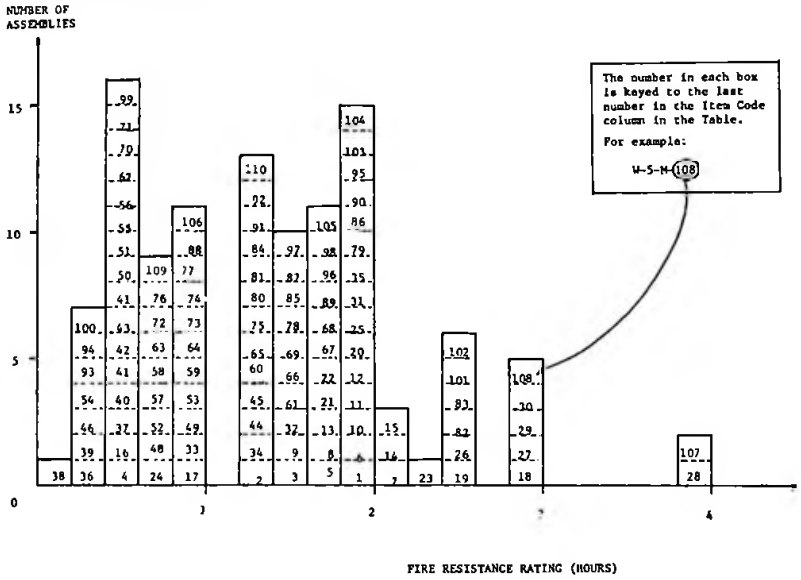


Table 1.1.2
Masonry Walls

4" to less than 6" thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-4-M-1	4"	Solid 3" thick, gypsum blocks laid in 1:3 sanded gypsum mortar; Facings: ½" of 1:3 sanded gypsum plaster(both sides).	n/a	2 hr.		1		1	2
W-4-M-2	4"	Solid clay or shale brick.	n/a	1 hr. 15min		1		1,2	1-1/4
W-4-M-3	4"	Concrete; No facings.	n/a	1 hr. 30min		1		1	1¼
W-4-M-4	4"	Clay tile; Illinois surface clay; Single cell thick; No face plaster; Constr."C"; Design "B".	n/a	25min			2	3-7 36	1/3
W-4-M-5	4"	Solid sand-lime brick	n/a	1 hr. 45min		1		1	1-3/4
W-4-M-6	4"	Solid wall; 3" thick block; ½" plaster each side; 17-3/4"x 8-3/4" x 3" "Breeze Blocks"; portland cement/sand mortar.	n/a	1 hr. 52min			7	2	1-3/4
W-4-M-7	4"	Concrete (4020 PSI); Reinforcement: Vertical 3/8"; horizontal ¼"; 6"x 6" grid;	3.4 tons/ foot	2 hr. 10min			7	2	2

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec. Hour
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-4-M-8	4"	Concrete wall(4340 PSI Crush); Reinforcement: ½" diameter rebar on 8" centers (vertical and horizontal);	n/a	1 hr. 40min.			7	2	1-2/3
W-4-M-9	4-3/16"	4-3/16"x 2-5/8" cellular flatton brick (1873 PSI) with ½" sand mortar; bricks are U-shaped yielding hollow cover (approx. 2"x 4") in final (cross-section)configuration.	n/a	1 hr. 25min.			7	2	1-1/3
W-4-M-10	4½"	4½"x 2½" flatton (1831 PSI) brick in ½" sand mortar.	n/a	1 hr. 53min.			7	2	1-3/4
W-4-M-11	4½"	4½"x 2½" London stock (683 PSI) brick; ½" grout.	n/a	1 hr. 52min.			7	2	1-3/4
W-4-M-12	4½"	4½" x 2½" Leicester Red, Wire-cut brick (4465 PSI) in ½" sand mortar.	n/a	1 hr. 56min.			7	6	1-3/4
W-4-M-13	4½"	4½" x 2½" Stairfoot brick (7527 PSI) ½" sand mortar.	n/a	1 hr. 37min.			7	2	1½
W-4-M-14	4½"	4½"x 2½" Sandlime brick (2603 PSI) ½" sand mortar.	n/a	2 hr. 6 min.			7	2	2
W-4-M-15	4½"	4½"x 2½" concrete brick (2527 PSI) 1/2" sand mortar.	n/a	2 hr. 10min.			7	2	2
W-4-M-16	4½"	4" thick clay tile; Ohio Fire Clay; Single cell thick; No plaster exposed face; ½" 1:2 gypsum back face; Constr. S; Design "F".	n/a	31min.			2	3-6 36	½
W-4-M-17	4½"	4" thick clay tile; Ohio fire clay; Single cell thick; plaster exposed face: ½"; 1:2 sanded gypsum; back face: none; Design "F"; Constr. "S".	80 PSI	50min.			2	3-5,8 36	3/4
W-4-M-18	4½"	Core: Solid sand-lime brick; 1/2" sanded gypsum plaster facings on both sides.	80 PSI	3 hr.		1		1,11	3
W-4-M-19	4½"	Core: Solid sand-lime brick; ½" sanded gypsum plaster facings on both sides.	80 PSI	2 hr. 30min.		1		1,11	2½
W-4-M-20	4½"	Core: Concretebrick ½" of 1:3 sanded gypsum plaster facings on both sides.	80 PSI	2 hr.		1		1,11	2
W-4-M-21	4½"	Core: Solid clay or shale bricks; ½" thick, 1:3 sanded gypsum plaster facings on fire sides.	80 PSI	1 hr. 45 min.		1		1,2 11	1-3/4
W-4-M-22	4-3/4"	4" thick clay tile; Ohio fire clay; single cell thick; cells filled with cement and broken tile concrete; plaster on exposed face: none on unexposed face3/4" 1:3 sanded gypsum; Constr. "S"; Design "G".	n/a	1 hr. 48 min.			2	2,3-5 9 36	1-3/4
W-4-M-23	4-3/4"	4" thick clay tile; Ohio fire clay; single cell thick; cells filled with cement and broken tile concrete; no plaster exposed face; 3/4" neat gypsum plaster on unexposed face; Design "G"; Constr. "S".	n/a	2 hr. 14 min.			2	2,3-5 9 36	2
W-5-M-24	5"	3"x 13" airspace; 1" thick metal reinforced concrete facings on both sides; faces connected with wood splines.	4,250 lb/ft.	45min.		1		1	3/4
W-5-M-25	5"	Core: 3" thick void filled with "nodulated" mineral wool weighing 10 lbs/ft^3; 1" thick metal reinforced concrete facings on both sides.	2,250 lb/ft	2 hr.		1		1	2
W-5-M-26	5"	Core: Solid clay or shale brick; ½" thick, 1:3 sanded gypsum plaster facings on both sides.	40 PSI	2 hr. 30min.		1		1,2 11	2½
W-5-M-27	5"	Core: Solid 4" thick gypsum blocks, laid in 1:3 sanded gypsum mortar; ½" of 1:3 sanded gypsum plaster facings on both sides.	n/a	3 hr.		1		1	3
W-5-M-28	5"	Core: 4" thick hollow gypsum blocks with 30% voids; blocks laid in 1:3 sanded gypsum mortar No facings.	n/a	4 hr.		1		1	4
W-5-M-29	5"	Core: concrete brick; ½" of 1:3 sanded gypsum plaster facings on both sides.	160 PSI	3 hr.		1		1	3

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-5-M-30	5⅛"	4" thick clay tile; Illinois surface clay; double cell thick; plaster - 5/8" thick sanded gypsum 1:3 both faces; Design "P"; Constr. "S".	n/a	2 hr. 53min.			2	2-5,9 36	2-3/4
W-5-M-31	5⅛"	4" thick clay tile; New Jersey fire clay; double cell thick; plaster - 5/8" sanded gypsum 1:3 both faces; Design"D"; Constr."S".	n/a	1 hr. 52min.			2	2-5,9 36	1-3/4
W-5-M-32	5⅛"	4" thick clay tile; New Jersey fire clay; single cell thick; 5/8" plaster on both sides; 1:3 sanded gypsum; Design"D"; Constr."S"	n/a	1 hr. 34min.			2	2-5,9 36	1½
W-5-M-33	5⅛"	4" thick clay tile; New Jersey Fire Clay; single cell thick; face plaster - 5/8" both sides; 1:3 sanded gypsum; Constr. "S"; Design "B".	n/a	50min.			2	3-5,8 36	3/4
W-5-M-34	5⅛"	4" thick clay tile; Ohio fire clay; single cell thick; face plaster - 5/8" both sides; 1:3 sanded gypsum; Constr. "A"; Design "B".	n/a	1 hr. 19min.			2	2-5,9 36	1¼
W-5-M-35	5⅛"	4" thick clay tile; Illinois Surface Clay; single cell thick; face plaster - 5/8" both sides; 1:3 sanded gypsum; Constr."S"; Design "B".	n/a	1 hr. 59min.			2	2-5, 10 36	1-3/4
W-4-M-36	4"	Core: Structural clay tile; See notes 12,16,21; No facings.	n/a	15min.		1		3,4, 24	¼
W-4-M-37	4"	Core: structural clay tile; See notes 12,17,21; No facings.	n/a	25min.		1		3,4, 24	1/3
W-4-M-38	4"	Core: structural clay tile; See notes 12,16,20; No facings.	n/a	10 min		1		3,4, 24	1/6
W-4-M-39	4"	Core: structural clay tile; See notes 12,17,20; No facings.	n/a	20 min		1		3,4, 24	1/3
W-4-M-40	4"	Core: structural clay tile; See notes 13,16,23; No facings.	n/a	30 min		1		3,4 24	½
W-4-M-41	4"	Core: structural clay tile; See notes 13,17,23; No facings.	n/a	35 min		1		3,4, 24	½
W-4-M-42	4"	Core: structural clay tile; See notes 13,16,21 No facings.	n/a	25 min		1		3,4, 24	1/3
W-4-M-43	4"	Core: structural clay tile; See notes 13,17,21 No facings.	n/a	30 min		1		3,4, 24	1/2
W-4-M-44	4"	Core: structural clay tile; see notes 15,16,20; No facings.	n/a	1 hr. 15 min		1		3,4 24	1¼
W-4-M-45	4"	Core: structural clay tile; See notes 15,17,20; No facings.	n/a	1 hr. 15 min		1		3,4 24	1¼
W-4-M-46	4"	Core: structural clay tile; See notes 14,16,22; No facings.	n/a	20 min		1		3,4, 24	1/3
W-4-M-47	4"	Core: strucutural clay tile; See notes 14,17,22 No facings.	n/a	25 min		1		3,4 24	1/3
W-4-M-48	4⅛"	Core: clay structural tile; See notes 12,16,21; Facings on both sides; see note 18.	n/a	45 min		1		3,4 24	3/4
W-4-M-49	4⅛"	Core: clay structural tile; See notes 12,17,21; Facings on both sides; see note 18.	n/a	1 hr.		1		3,4 24	1
W-4-M-50	4-5/8"	Core: structural clay tile; See notes 12,16,21; Facings on unexposed side only; see note 18.	n/a	25 min		1		3,4, 24	1/3

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-4-M-51	4-5/8"	Core: structural clay tile; See notes 12,17,21; Facings on unexposed side only; see note 18.	n/a	30 min		1		3,4, 24	½
W-4-M-52	4-5/8"	Core: structural clay tile; See notes 12,16,21; Facings exposed side only, See note 18.	n/a	45 min		1		3,4 24	3/4
W-4-M-53	4-5/8	Core: structural clay tile; See notes 12,17,21; Facings: fire side only; see note 18.	n/a	1 hr.		1		3,4 24	1
W-4-M-54	4-5/8"	Core: structural clay tile; See notes 12,16,20; Facings on unexposed side; see note 18.	n/a	20 min		1		3,4, 24	1/3
W-4-M-55	4-5/8"	Core: structural clay tile; See notes 12,17,20; Facings: on unexposed side; see note 18.	n/a	25 min		1		3,4 24	1/3
W-4-M-56	4-5/8"	Core: structural clay tile; See notes 12,16,20; Facings on fire side only ;see note 18.	n/a	30 min		1		3,4 24	½
W-4-M-57	4-5/8"	Core: structural clay tile; See notes 12,17,20; Facings on fire side only; see note 18.	n/a	45 min		1		3,4 24	3/4
W-4-M-58	4-5/8"	Core: structural clay tile; See notes 13,16,23; Facings on unexposed side only; see note 18.	n/a	40 min		1		3,4, 24	2/3
W-4-M-59	4-5/8"	Core: structural clay tile; See notes 13,17,23; Facing: on unexposed side only; see note 18.	n/a	1 hr.		1		3,4, 24	1
W-4-M-60	4-5/8"	Core: structural clay tile; See notes 13,16,23 Facing on fire side only; see note 18.	n/a	1 hr. 15 min		1		3,4 24	1¼
W-4-M-61	4-5/8"	Core: structural clay tile; See notes 13,17,23; Facing on fire side only; See note 18.	n/a	1 hr. 30 min		1		3,4, 24	1½
W-4-M-62	4-5/8"	Core: structural clay tile; See notes 13,16,21; Facing on unexposed side only; See note 18.	n/a	35 min		1		3,4 24	½
W-4-M-63	4-5/8"	Core: structural clay tile; See notes 13,17,21; Facing on unexposed face only; See note 18.	n/a	45 min		1		3,4, 24	3/4
W-4-M-64	4-5/8"	Core: structural clay tile; See notes 13,16,23; Facing on exposed face only; See note 18.	n/a	1 hr.		1		3,4, 24	1
W-4-M-65	4-5/8"	Core: structural clay tile; See notes 13,17,21; Facing on exposed side only; See note 18.	n/a	1 hr. 15 min		1		3,4, 24	1¼
W-4-M-66	4-5/8"	Core: structural clay tile; See notes 15,17,20; Facings on unexposed side only; See note 18.	n/a	1 hr. 30 min		1		3,4, 24	1½
W-4-M-67	4-5/8"	Core: structural clay tile; See notes 15,16,20; Facings on exposed side only, See note 18.	n/a	1 hr. 45 min		1		3,4, 24	1-3/4
W-4-M-68	4-5/8"	Core: structural clay tile: See notes 15,17,20; Facings on exposed side only, see note 18.	n/a	1 hr. 45 min		1		3,4, 24	1-3/4
W-4-M-69	4-5/8"	Core: structural clay tile; See notes 15,16,20; Facings on unexposed side only, see note 18.	n/a	1 hr. 30 min		1		3,4 24	1½
W-4-M-70	4-5/8"	Core: structural clay tile; See notes 14,16,22; Facings on unexposed side only, See note 18.	n/a	30 min		1		3,4, 24	½
W-4-M-71	4-5/8"	Core: structural clay tile; See notes 14,17,22; Facings on unexposed side only; see note 18.	n/a	35 min		1		3,4, 24	½
W-4-M-72	4-5/8"	Core: structural clay tile: See notes 14,16,22; Facings on fire side of wall only; See note 18	n/a	45 min		1		3,4 24	3/4
W-4-M-73	4-5/8"	Core: structural clay tile; See notes 14,17,22; Facings on fire side of wall only; See note 18.	n/a	1 hr.		1		3,4, 24	1
W-5-M-74	5⅛"	Core: structural clay tile; see notes 12,16,21; Facings on both sides; see note 18.	n/a	1 hr.		1		3,4, 24	1
W-5-M-75	5⅛"	Core: structural clay tile: see notes 12,17,21; Facings on both sides; see note 18.	n/a	1 hr. 15 min		1		3,4 24	1¼
W-5-M-76	5⅛"	Core: structural clay tile: see notes 12,16,20; Facings on both sides; see note 18.	n/a	45 min		1		3,4, 24	3/4

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-5-M-77	5½"	Core: structural clay tile; see notes 12,17,20; Facings on both sides; see note 18.	n/a	1 hr.		1		3,4, 24	1
W-5-M-78	5½"	Core: structural clay tile; see notes 13,16,23; Facings on both sides of wall; see note 18.	n/a	1 hr. 30 min		1		3,4, 24	1½
W-5-M-79	5½"	Core: structural clay tile; see notes 13,17,23; Facings on both sides of wall, see note 18.	n/a	2 hrs.		1		3,4, 24	2
W-5-M-80	5½"	Core: structural clay tile; see notes 13,16,21; Facings on both sides of wall; see note 18.	n/a	1 hr. 15 min		1		3,4, 24	1¼
W-5-M-81	5½"	Core: structural clay tile; See notes 13,16,21; Facing on both sides of wall; see note 18.	n/a	1 hr. 30 min		1		3,4 24	1½
W-5-M-82	5½"	Core: structural clay tile; see notes 15,16,20; Facings on both sides; see note 18.	n/a	2 hrs 30 min		1		3,4, 24	2½
W-5-M-83	5½"	Core: structural clay tile; see notes 15,17,20; Facings on both sides; see note 18.	n/a	2 hrs. 30 min		1		3,4, 24	2½
W-5-M-84	5½"	Core: structural clay tile; see notes 14,16,22; Facings on both sides of wall; see note 18.	n/a	1 hr. 15 min		1		3,4 24	1¼
W-5-M-85	5½"	Core: structural clay tile; see notes 14,17,22 Facings on both sides of wall; see note 18.	n/a	1 hr. 30 min		1		3,4, 24	1½
W-4-M-86	4"	Core: 3" thick gypsum blocks 70% solid; see note 26; Facings on both sides per note 25.	n/a	2 hrs.		1			2
W-4-M-87	4"	Core: hollow concrete units; see notes 27,34, 35; No facings.	n/a	1 hr. 30 min		1			1½
W-4-M-88	4"	Core: hollow concrete units; see notes 28,33, 35; No facings.	n/a	1 hr.		1			1
W-4-M-89	4"	Core: hollow concrete units; see notes 28,34, 35; Facings on both sides per note 25.	n/a	1 hr. 45min		1			1-3/4
W-4-M-90	4"	Core: hollow concrete units; see notes 27,34, 35; Facings on both sides per note 25.	n/a	2 hrs.		1			2
W-4-M-91	4"	Core: hollow concrete units; see notes 27,32, 35; No facings.	n/a	1 hr. 15 min		1			1¼
W-4-M-92	4"	Core: hollow concrete units; see notes 28,34, 35; No facings.	n/a	1 hr. 15 min		1			1¼
W-4-M-93	4"	Core: hollow concrete units; see notes 29,32, 35; No facings.	n/a	20 min		1			1/3
W-4-M-94	4"	Core: hollow concrete units; see notes 30,34, 35; No facings.	n/a	15 min		1			¼
W-4-M-95	4½"	Core: hollow concrete units; see notes 27,34, 35; Facing on one side only, see note 25.	n/a	2 hrs.		1			2
W-4-M-96	4½"	Core: hollow concrete units; see notes 27,32, 35; Facing on one side only, see note 25.	n/a	1 hr. 45 min		1			1-3/4
W-4-M-97	4½"	Core: hollow concrete units; see notes 28,33, 35; Facings on one side per note 25.	n/a	1 hr. 30 min		1			1½
W-4-M-98	4½"	Core: hollow concrete units; see notes 28,34, 35; Facings on one side only per note 25.	n/a	1 hr. 45 min		1			1-3/4
W-4-M-99	4½"	Core: hollow concrete units; see notes 29,32, 35; Facing on one side per note 25.	n/a	30 min		1			½
W-4-M-100	4½"	Core: hollow concrete units; see notes 30,34, 35; Facing on one side per note 25.	n/a	20 min		1			1/3
W-5-M-101	5"	Core: hollow concrete units; see notes 27,34, 35; Facings on both sides, see note 25.	n/a	2 hrs. 30 min		1			2½

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-5-M-102	5"	Core: hollow concrete units; see notes 27,32, 35; Facings on both sides per note 25.	n/a	2 hrs. 30 min		1			2½
W-5-M-103	5"	Core: hollow concrete units; see notes 28,33 35; Facings on both sides per note 25.	n/a	2 hrs.		1			2
W-5-M-104	5"	Core: hollow concrete units; see notes 28,31, 35; Facings on both sides per note 25.	n/a	2 hrs.		1			2
W-5-M-105	5"	Core: hollow concrete units; see notes 29,32, 35; Facings on both sides per note 25.	n/a	1 hr. 45 min		1			1-3/4
W-5-M-106	5"	Core: hollow concrete units; see notes 30,34, 35; Facings on both sides per note 25.	n/a	1 hr.		1			1
W-5-M-107	5"	Core: 5" thick solid gypsum blocks; see note 26; No facings.	n/a	4 hrs.		1			4
W-5-M-108	5"	Core: 4" thick hollow gypsum blocks; see note 26; Facings on both sides per note 25.	n/a	3 hrs.		1			3
W-5-M-109	4"	Concrete with 4"x 4" No. 6 welded wire mesh at wall center.	100 PSI	45 min			43	2	3/4
W-5-M-110	4"	Concrete with 6"x 4" No. 6 welded wire mesh at wall center.	n/a	1 hr. 15 min			43	2	1¼

Notes:

TABLE 1.1.2

1. Tested at NBS under ASA Spec No. A 2-1934.
2. Failure mode - maximum temperature rise.
3. Tested at NBS under ASA Spec. No. 42-1934 (ASTM C-19-53) except that hose stream testing where carried out was run on test specimens exposed for full test duration, not for or reduced period as is contemporarily done.
4. For clay tile walls, unless the source of the clay can be positively identified, it is suggested that the most pessimistic hour rating for the fire endurance of a clay tile partition of that thickness be followed. Identified sources of clay showing longer fire endurance can lead to longer time recommendations.
5. See appendix for construction and design details for clay tile walls.
6. Failure mode - flame thru or crack formation showing flames.
7. Hole formed at 25 min.; partition collapsed at 42 min. on removal from furnace.
8. Failure mode - collapse.
9. Hose stream pass.
10. Hose stream hole formed in specimen.
11. Load - 80 PSI for gross wall cross sectioned area.
12. One cell in wall thickness.
13. Two cells in wall thickness.

NOTES

14. Double cells plus one cell in wall thickness.

15. One cell in wall thickness, cells filled with broken tile, crushed stone, slag, cinders or sand mixed with mortar.

16. Dense hard-burned clay or shale tile.

17. Medium-burned clay tile.

18. Not less than 5/8" thickness of 1:3 sanded gypsum plaster.

19. Units of not less than 30% solid material.

20. Units of not less than 40% solid material.

21. Units of not less than 50% solid material.

22. Units of not less than 45% solid material.

23. Units of not less than 60% solid material.

24. All tiles laid in portland cement-lime mortar.

25. Minimum ½" - 1:3 sanded gypsum plaster.

26. Laid in 1:3 sanded gypsum mortar. Voids in hollow units not to exceed 30%.

27. Units of expanded slag or pumice aggregate.

28. Units of crushed limestone, blast furnace slag, cinders, and expanded clay or shale.

29. Units of calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.

30. Units of siliceous sand and gravel. 90% or more quartz, chert or flint.

31. Unit at least 49% solid.

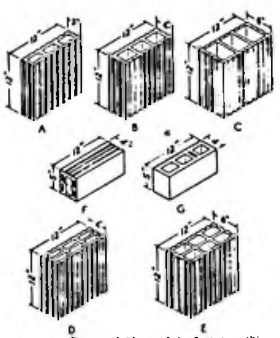
32. Unit at least 62% solid.

33. Unit at least 65% solid.

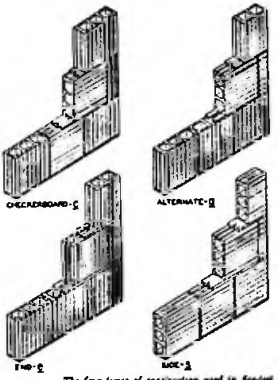
34. Unit at least 73% solid.

35. Ratings based on one unit and one cell in wall thickness.

36. See Clay Tile Partition Design Construction drawings, below.



Designs of tiles used in fire-test partitions



The four types of construction used in fire-test partitions.

Figure 1.1.3
Walls- Masonry

6" to less than 8" thick

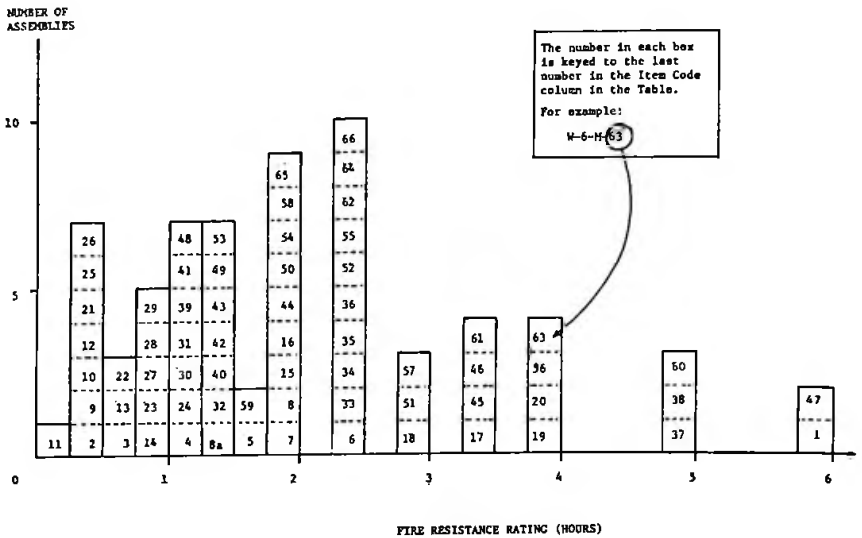


Table 1.1.3
Masonry Walls

6" to less than 8" thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-6-M-1	6"	Core: 5" thick, solid gypsum blocks laid in 1:3 sanded gypsum mortar; ½" of 1:3 sanded gypsum plaster facings on both sides.	n/a	6 hr.		1			6
W-6-M-2	6"	6" clay tile; Ohio fire clay; single cell thick; plaster - none; Design "C"; Constr. "A".	n/a	17 min			2	1,3,4 6 55	¼
W-6-M-3	6"	6" clay tile; Illinois surface clay; double cell thick; No plaster; Design "E"; Constr. "C".	n/a	45 min			2	1-4,7 55	3/4
W-6-M-4	6"	6" clay tile; New Jersey fire clay; double cell thick; No plaster; Design "E"; Constr."S".	n/a	1 hr. 1 min			2	1-4,8 55	1
W-7-M-5	7¼"	6" clay tile; Illinois surface clay; double cell thick; Plaster: 5/8" - 1:3 sanded gypsum both faces; Design"E"; Constr."A".	n/a	1 hr. 41 min			2	1-4 55	1-2/3
W-7-M-6	7¼"	6" clay tile New Jersey Fire Clay; Double cell thick; Plaster: 5/8" - 1:3 sanded gypsum both faces; Design "E"; Constr."S".	n/a	2 hr. 23 min			2	1-4,9 55	2-1/3
W-7-M-7	7¼"	6" clay tile; Ohio fire clay; single cell thick; Plaster: 5/8" sanded gypsum; 1:3 both faces; Design"C"; Constr."A".	n/a	1 hr. 54 min			2	1-4,9 55	2-3/4

Walls 6" Thick to Less Than 8"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-7-M-8	7½"	6" clay tile; Illinois surface clay; single cell thick; Plaster: 5/8" sanded gypsum 1:3 both faces; Design "C"; Constr."S".	n/a	2 hrs.			2	1,3,4 9,10 55	2
W-7-M-8a	7½"	6" clay tile; Illinois surface clay; single cell thick; Plaster: 5/8" sanded gypsum 1:3 both faces; Design "C"; Constr."E".	n/a	1 hr. 23 min			2	1-4 9,10 55	1½
W-6-M-9	6"	Core: Structural clay tile; See notes 12,16,20; No facings.	n/a	20 min		1		3,5, 24	1/3
W-6-M-10	6"	Core: structural clay tile; See notes 12,17,20; No facings.	n/a	25 min		1		3,5, 24	1/3
W-6-M-11	6"	Core: structural clay tile; See notes 12,16,19; No facings.	n/a	15 min		1		3,5 24	½
W-6-M-12	6"	Core: structural clay tile; See notes 12,17,19; No facings.	n/a	20 min		1		3,5 24	1/3
W-6-M-13	6"	Core: structural clay tile; See note 13,16,22; No facings.	n/a	45 min		1		3,5 24	3/4
W-6-M-14	6"	Core: structural clay tile; See notes 13,17,22; No facings.	n/a	1 hr.		1		3,5, 24	1
W-6-M-15	6"	Core: structural clay tile; See notes 15,17,19; No facings.	n/a	2 hr.		1		3,5, 24	2
W-6-M-16	6"	Core: structural clay tile; See notes 15,16,19; No facings.	n/a	2 hrs.		1		3,5, 24	2
W-6-M-17	6"	Cored concrete masonry; See notes 12,34,36,38, 41; No facings.	80 PSI	3 hrs. 30 min		1		5,25	3½
W-6-M-18	6"	Cored concrete masonry; See notes 12,33,36,38, 41; No facings.	80 PSI	3 hrs.		1		5,25	3
W-6-M-19	6½"	Cored concrete masonry; See notes 12,34,36,38, 41; Facings: See note 35 for side 1.	80 PSI	4 hrs.		1		5,25	4
W-6-M-20	6½"	Cored concrete masonry; See notes 12,33,36,38, 41; Facings: See note 35 for side 1.	80 PSI	4 hrs.		1		5,25	4
W-6-M-21	6-5/8"	Core: structural clay tile; See notes 12,16,20; Facing: unexposed face only, see note 18.	n/a	30min.		1		3,5, 24	½
W-6-M-22	6-5/8"	Core: structural clay tile; see notes 12,17,20; Facing: unexposed face only, see note 18.	n/a	40 min		1		3,5, 24,	2/3
W-6-M-23	6-5/8"	Core: structural clay tile; see notes 12,16,20; Facing: exposed face only, see note 18.	n/a	1 hr.		1		3,5 24	1
W-6-M-24	6-5/8"	Core: structural clay tile; see notes 12,17,20 Facing: exposed face only, see note 18.	n/a	1 hr. 5 min		1		3,5, 24	1
W-6-M-25	6-5/8"	Core: structural clay tile; see notes 12,16,19; Facing unexposed side only, see note 18.	n/a	25 min		1		3,5,24	1/3
W-6-M-26	6-5/8"	Core: structural clay tile; see notes 12,7,19; Facings: On unexposed side only, see note 18.	n/a	30min		1		3,5, 24	½
W-6-M-27	6-5/8"	Core: structural clay tile; see notes 12,16,19; Facings: on exposed side only, see note 18.	n/a	1 hr.		1		3,5, 24	1
W-6-M-28	6-5/8"	Core: structural clay tile; see notes 12,17,19 Facings: on fire side only, see note 18.	n/a	1 hr.		1		3,5, 24	1
W-6-M-29	6-5/8"	Core: structural clay tile; see notes 13,16,22; Facings: on unexposed side only, see note 18.	n/a	1 hr.		1		3,5, 24	1
W-6-M-30	6-5/8"	Core: structural clay tile; see notes 13,17,22; Facings: on unexposed side only, see note 18.	n/a	1 hr. 15min		1		3,5, 24	1½
W-6-M-31	6-5/8"	Core: structural clay tile; see notes 13,16,22; Facings: on fire side only, see note 18.	n/a	1 hr. 15min		1		3,5, 24	1½
W-6-M-32	6-5/8"	Core: structural clay tile; see notes 13,17,22 Facing: on fire side only, see note 18.	n/a	1 hr. 30 min		1		3,5 24	1½

Wall 6" Thick to Less Than 8"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-6-M-33	6-5/8"	Core: structural clay tile; see notes 15,16,19; Facings: on unexposed side only, see note 18.	n/a	2 hr. 30 min		1		3,5 24	2½
W-6-M-34	6-5/8"	Core: structural clay tile; see notes 15,17,19; Facings: on unexposed side only, see note 18.	n/a	2 hr. 30 min		1		3,5, 24	2½
W-6-M-35	6-5/8"	Core: structural clay tile; see notes 15,16,19; Facings: on fire side only, see note 18.	n/a	2 hr. 30 min		1		3,5, 24	2½
W-6-M-36	6-5/8"	Core: structural clay tile; see notes 15,17,19; Facings: on fire side only, see note 18.	n/a	2 hr. 30 min		1		3,5, 24	2½
W-7-M-37	7"	Cored concrete masonry; see notes 12,34,36,38, 41; See note 35 for facings on both sides.	80 PSI	5 hr.		1		5,25	5
W-7-M-38	7"	Cored concrete masonry; see notes 12,33,36,38, 41; See note 35 for facings.	80 PSI	5 hr.		1		5,25	5
W-7-M-39	7⅛"	Core: structural clay tile; see notes 12,16,20; See note 18 for facings on both sides.	n/a	1 hr. 15 min		1		3,5, 24	1½
W-7-M-40	7⅛"	Core: structural clay tile; see notes 12,17,20 See note 18 for facings on both sides.	n/a	1 hr. 30 min		1		3,5, 24	1½
W-7-M-41	7⅛"	Core: structural clay tile; see notes 12,16,19; See note 18 for facings on both sides.	n/a	1 hr. 15 min		1		3,5, 24	1½
W-7-M-42	7⅛"	Core: structural clay tile; see notes 12,17,19; See note 18 for facings on both sides.	n/a	1 hr. 30 min		1		3,5, 24	1½
W-7-M-43	7⅛"	Core: structural clay tile; see notes 13,16,22 Facings: on both sides of wall, see note 18.	n/a	1 hr. 30 min		1		3,5 24	1½
W-7-M-44	7⅛"	Core: structural clay tile, see notes 13,17,22; Facings: on both sides of wall, see note 18.	n/a	2 hr.		1		3,5, 24	2
W-7-M-45	7⅛"	Core: structural clay tile; see notes 15,16,19 Facings: both sides, see note 18.	n/a	3 hr. 00 min		1		3,5, 24	3½
W-7-M-46	7⅛"	Core: structural clay tile; see notes 15,17,19; Facings: both sides, see note 18.	n/a	3 hr. 30 min		1		3,5 24	3½
W-6-M-47	6"	Core: 5" thick solid gypsum blocks; See note 45; Facings: both sides per note 35.	n/a	6 hr.		1			6
W-6-M-48	6"	Core: hollow concrete units; see notes 47,50, 54; No facings.	n/a	1 hr. 15 min		1			1¼
W-6-M-49	6"	Core: hollow concrete units; see notes 46,50, 54; No facings.	n/a	1 hr. 30 min		1			1½
W-6-M-50	6"	Core: hollow concrete units; see notes 46,41, 54; No facings.	n/a	2 hr.		1			2
W-6-M-51	6"	Core: hollow concrete units; see notes 46,53, 54; No facings.	n/a	3 hr.		1			3
W-6-M-52	6"	Core: hollow concrete units; see notes 47,53, 54; No facings.	n/a	2 hr. 30 min		1			2½
W-6-M-53	6"	Core: hollow concrete units; see notes 47,51, 54; No facings.	n/a	1 hr. 30min		1			1½
W-6-M-54	6½"	Core: hollow concrete units; see notes 46,50, 54; Facing: one side only per note 35.	n/a	2 hr.		1			2
W-6-M-55	6½"	Core: hollow concrete units; see notes 4,51,54 Facings: one side per note 35.	n/a	2 hr. 30 min		1			2½

1.1.3 (cont'd)

Wall 6" Thick to Less Than 8"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-6-M-56	6½"	Core: hollow concrete units; see notes 46,53, 54; Facings: one side per note 35.	n/a	4 hrs.		1			4
W-6-M-57	6½"	Core: hollow concrete units; see notes 47,53, 54; Facing: One side per note 35.	n/a	3 hrs.		1			3
W-6-M-58	6½"	Core: hollow concrete units; See notes 47,51, 54; Facing: one side per note 35.	n/a	2 hrs.		1			2
W-6-M-59	6½"	Core: hollow concrete units; see notes 47,50, 54; Facings: one side per note 35.	n/a	1 hr. 45 min		1			1-3/4
W-7-M-60	7"	Core: hollow concrete units; see notes 46,53, 54; Facings: both sides per note 35.	n/a	5 hrs.		1			5
W-7-M-61	7"	Core: hollow concrete units; see notes 46,51, 54; Facings: both sides per note 35.	n/a	3 hrs. 30 min		1			3½
W-7-M-62	7"	Core: hollow concrete units; see notes 46,50, 54; Facings: both sides per note 35.	n/a	2 hrs. 30 min		1			2½
W-7-M-63	7"	Core: hollow concrete units; see notes 47,53, 54; Facing: both sides per note 35.	n/a	4 hrs.		1			4
W-7-M-64	7"	Core: hollow concrete units, see notes 47,51,54 Facing: both sides per note 35.	n/a	2 hrs. 30 min		1			2½
W-7-M-65	7"	Core: hollow concrete units; see notes 47,50, 54; Facing: both sides per note 35.	n/a	2 hrs.		1			2
W-6-M-66	6"	Concrete wall with 4"x4" No. 6 wire fabric(welded) near wall center for reinforcement.	300 PSI	2 hrs. 30 min			43	2	2½

Notes:

TABLE 1.1.3

1. Tested at NBS under ASA Spec. No. 42-1934 (ASTM C-19-53) except that hose stream testing where carried out was run on test specimens exposed for full test duration, not for a reduced period as is contemporarily done.
2. Failure by thermal criteria - maximum temperature rise.
3. For clay tile walls, unless the source or density of the clay can be positively identified or determined, it is suggested that the lowest hourly rating for the fire endurance of a clay tile partition of that thickness be followed. Identified sources of clay showing longer fire endurance can lead to longer time recommendations.
4. See note 55 for construction and design details for clay tile walls.
5. Tested at NBS under ASA Spec. No. A2-1934.
6. Failure mode - collapse.
7. Collapsed on removal from furnace @ 1 hour 9 minutes.
8. Hose stream - failed.
9. Hose stream - passed.
10. No end point met in test.
11. Wall collapsed at 1 hour 28 minutes.

NOTES

12. One cell in wall thickness.

13. Two cells in wall thickness.

14. Double shells plus one cell in wall thickness.

15. One cell in wall thickness, cells filled with broken tile, crushed stone, slag, cinders or sand mixed with mortar.

16. Dense hard-burned clay or shale tile.

17. Medium-burned clay tile.

18. Not less than 5/8" thickness of 1:3 sanded gypsum plaster.

19. Units of not less than 30% solid material.

20. Units of not less than 40% solid material.

21. Units of not less than 50% solid material.

22. Units of not less than 45% solid material.

23. Units of not less than 60% solid material.

24. All tiles laid in portland cement-lime mortar.

25. Load - 80 PSI for gross cross sectional area of wall.

26. 3 cells in wall thickness.

27. Minimum % of solid material in concrete units = 52.

28. Minimum % of solid material in concrete units = 54.

29. Minimum % of solid material in concrete units = 55.

30. Minimum % of solid material in concrete units = 57.

31. Minimum % of solid material in concrete units = 62.

32. Minimum % of solid material in concrete units = 65.

33. Minimum % of solid material in concrete units = 70.

34. Minimum % of solid material in concrete units = 76.

35. Not less than ½" of 1:3 sanded gypsum plaster.

36. Noncombustible or no members framed into wall.

37. Combustible members framed into wall.

38. 1 unit in wall thickness.

39. 2 units in wall thickness.

40. 3 units in wall thickness.

41. Concrete units made with expanded slag or pumice aggregates.

42. Concrete units made with expanded burned clay or shale, crushed limestone, air cooled slag or cinders.

43. Concrete units made with calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.

44. Concrete units made with siliceous sand and gravel. 90% or more quartz, chert, or flint.

45. Laid in 1:3 sanded gypsum mortar.

NOTES

46. Units of expanded slag or pumice aggregate.

47. Units of crushed limestone, blast furnace slag, cinders and expanded clay or shale.

48. Units of calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.

49. Units of siliceous sand and gravel. 90% or more quartz, chert or flint.

50. Unit minimum 49% solid.

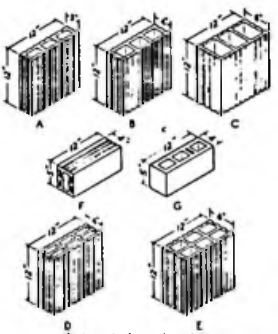
51. Unit minimum 62% solid.

52. Unit minimum 65% solid.

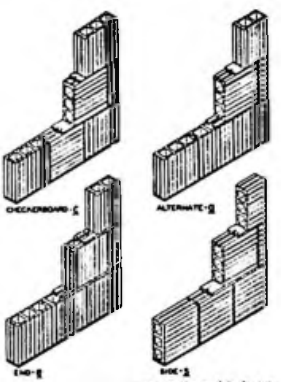
53. Unit minimum 73% solid.

54. Ratings based on 1 unit and 1 cell in wall section.

55. See Clay Tile Partition Design Construction drawings, below.



Designs of tiles used in fire-rated partitions



The four types of construction used in fire-rated partitions.

Figure 1.1.4
Walls- Masonry

8" to less than 10" thick

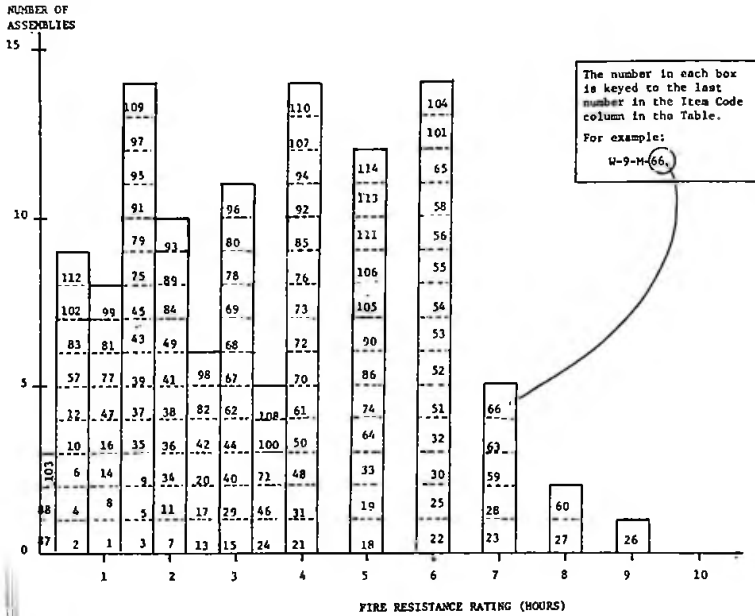


Table 1.1.4
Masonry Walls

8" to less than 10" thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-8-M-1	8"	Core: clay or shale structural tile; Units in wall thickness: 1; Cells in wall thickness: 2 Minimum % solids in units: 40.	80 PSI	1 hr 15min.		1		1, 20	1½
W-8-M-2	8"	Core: clay or shale structural tile; Units in wall thickness: 1; Cell in wall thickness: 2; Minimum % solids in units: 40; Facings: None; Result for wall with combustible members framed into interior.	80 PSI	45min.		1		1, 20	3/4
W-8-M-3	8"	Core: clay or shale structural tile; Units in wall thickness: 1; Cells in wall thickness: 2; Minimum % solids in units: 43.	80 PSI	1 hr 30min.		1		1, 20	1½
W-8-M-4	8"	Core: clay or shale structural tile: Units in wall thickness: 1; Cells in wall thickness: 2; Minimum % solids in units: 43; No facings; Combustible members framed into wall.	80 PSI	45min.		1		1, 20	3/4
W-8-M-5	8"	Core: clay or shale structural tile; No facings.	See Notes	1 hr 30min.		1		1,2,5 10,18 20,21	1½
W-8-M-6	8"	Core: Clay or shale structural tile; No facings.	See Notes	45min.		1		1,2,5 10, 19-21	3/4

1.1.4 (cont'd)

Thickness - 8" to Less Than 10"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-8-M-7	8"	Core: clay or shale structural tile; No facings.	See Notes	2 hr.		1		1,2,5 13,18 20,21	2
W-8-M-8	8"	Core: clay or shale structural tile; No facings.	See Notes	1 hr. 15min		1		1,2,5, 13,19, 20,21	1½
W-8-M-9	8"	Core: clay or shale structural tile; No facings.	See Notes	1 hr. 45min.		1		1,2,6, 9,18, 20,21	1-3/4
W-8-M-10	8"	Core: Clay or shale structural tile; No facings.	See Notes	45min		1		1,2,6, 9,19, 20,21	3/4
W-8-M-11	8"	Core: clay or shale structural tile; No facings.	See Notes	2 hr.		1		1,2,6, 10,18, 20,21	2
W-8-M-12	8"	Core: clay or shale structural tile; No facings.	See Notes	45min		1		1,2,6, 10,19, 20,21	3/4
W-8-M-13	8"	Core: clay or shale structural tile; No facings.	See Notes	2 hr. 30min		1		1,3,6, 12,18, 20,21	2½
W-8-M-14	8"	Core: clay or shale structural tile; No facings	See Notes	1 hr.		1		1,2,6, 12,19 20,21	1
W-8-M-15	8"	Core: clay or shale structural tile; No facings.	See Notes	3 hr.		1		1,2,6, 16,18, 20,21	3
W-8-M-16	8"	Core: clay or shale structural tile; No facings.	See Notes	1 hr. 15min.		1		1,2,6, 16,19, 20,21	1½
W-8-M-17	8"	Units in Wall Thickness: 1; Cells in wall thickness: 1; Minimum % solids: 70; Cored clay or shale brick; No facings.	See Notes	2 hr. 30min.		1		1, 44	2½
W-8-M-18	8"	Cored clay or shale bricks; Units in wall thickness: 2; Cells in wall thickness: 2; Min. % solids: 87; No facings.	See Notes	5 hr.		1		1,45	5
W-8-M-19	8"	Core: Solid clay or shale brick; No facings.	See Notes	5 hr.		1		1,45 22	5
W-8-M-20	8"	Core: Hollow rolok of clay or shale.	See Notes	2 hr. 30min		1		1,45 22	2½
W-8-M-21	8"	Core: Hollow rolok bak of clay or shale; No facings.	See Notes	4 hr.		1		1,45	4
W-8-M-22	8"	Core: concrete brick; No facings.	See Notes	6 hr.		1		1,45	6
W-8-M-23	8"	Core: sand-lime brick; No facings.	See Notes	7 hr		1		1, 45	7
W-8-M-24	8"	Core: 4", 40% solid clay or shale structural tile; 1 side 4" brick facing;	See Notes	3 hr. 30min.		1		1,20	3½
W-8-M-25	8"	Concrete wall (3220 PSI); Reinforcing vertical rods 1" from each face and 1" dia.; horizontal rods 3/8" dia.	22,200 lb/ft.	6 hr.			7		6
W-8-M-26	8"	Core: Sand-lime brick; 1/2" of 1:3 sanded gypsum plaster facing on one side.	See Notes	9 hr.		1		1,45	9
W-8-M-27	8½"	Core: sand-lime brick; ½" of 1:3 sanded gypsum plaster facing on one side.	See Notes	8 hr.		1		1,45	8
W-8-M-28	8½"	Core: concrete; ½" of 1:3 sanded gypsum plaster facing on one side.	See Notes	7 hr.		1		1,45	7
W-8-M-29	8½"	Core: hollow rolok of clay or shale; ½" of 1:3 sanded gypsum plaster facing on one side.	See Notes	3 hr.		1		1,45	3

Thickness - 8" to Less Than 10"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-8-M-30	8½"	Core: Solid clay or shale brick; ½" thick, 1:3 sanded gypsum plaster facing on one side.	See Notes	6 hr.		1		1,45 22	6
W-8-M-31	8½"	Core: Cored clay or shale brick; Units in wall thickness: 1; Cells in wall thickness: 1; Min. % solids: 70; ½" of 1:3 sanded gypsum plaster facing on both sides.	See Notes	4 hr.		1		1,44	4
W-8-M-32	8½"	Cored clay or shale bricks; Units in wall thickness: 2; Cells in wall thickness: 2; Min. % solids: 87; ½" of 1:3 sanded gypsum plaster facing on one side.	See Notes	6 hr.		1		1,45	6
W-8-M-33	8½"	Hollow Rolok Bak of clay or shale core; ½" of 1:3 sanded gypsum plaster facing on one side.	See Notes	5 hr.		1		1,45	5
W-8-M-34	8-5/8"	Core: clay or shale structural tile; units in wall thickness: 1; cells in wall thickness: 2; Min. % solids in units: 40; 5/8" of 1:3 sanded gypsum plaster facing on one side.	See Notes	2 hr.		1		1,20, 21	2
W-8-M-35	8-5/8"	Core: clay or shale structural tile; units in wall thickness: 1; cells in wall thickness: 2; Min. % solids in units: 40; Exposed face: 5/8" of 1:3 sanded gypsum plaster.	See Notes	1 hr. 30min.		1		1,20, 21	1½
W-8-M-36	8-5/8"	Core: clay or shale structural tile; Units in wall thickness: 1; cells in wall thickness: 2; Min. % solids in units: 43; 5/8" of 1:3 sanded gypsum plaster facing on one side.	See Notes	2 hr.				1,20 21	2
W-8-M-37	8-5/8"	Core: clay or shale structural tile; units in wall thickness: 1; cells in wall thickness: 2; Min. % solids in units: 43; 5/8" of 1:3 sanded gypsum plaster of the exposed face only.	See Notes	1 hr. 30min.		1		1,20 21	1½
W-8-M-38	8-5/8"	Core: clay or shale structural tile; See note 17 for facing side 1.	See Notes	2 hr.		1		1,2,5, 10,18 20,21	2
W-8-M-39	8-5/8"	Core: clay or shale structural tile; Facings: on exposed side only, see note 17.	See Notes	1 hr. 30min.		1		1,2,5, 10,19, 20,21	1½
W-8-M-40	8-5/8"	Core; clay or shale structural tile; Facings on exposed side only, see note 17.	See Notes	3 hr.		1		1,2,5, 13,18, 20,21	3
W-8-M-41	8-5/8"	Core: clay or shale structural tile; Facings on exposed side only, see note 17.	See Notes	2 hr.		1		1,2,5, 13,19, 20,21	2
W-8-M-42	8-5/8"	Core: clay or shale structural tile; facings on side 1, see note 17.	See Notes	2 hr. 30min.		1		1,2,6, 9,18, 20,21	2½
W-8-M-43	8-5/8"	Core: clay or shale structural tile; Facings on exposed side only as per note 17.	See Notes	1 hr. 30min.		1		1,2,6, 9,19, 20,21	1½
W-8-M-44	8-5/8"	Core: clay or shale structural tile ; Facings Side 1: see note 17; Side 2: none.	See Notes	3 hr.		1		1,2,6, 10,18, 20,21	3
W-8-M-45	8-5/8"	Core: Clay or shale structural tile; Facings on fire side only, see note 17.	See Notes	1 hr. 30min		1		1,2,6, 10,19, 20,21	1½
W-8-M-46	8-5/8"	Core: clay or shale structural tile; facings: Side 1: see note 17; Side 2: none.	See Notes	3 hr. 30min.		1		1,2,6, 12,18, 20,21	3½
W-8-M-47	8-5/8"	Core: clay or shale structural tile; Facings exposed side only, see note 17.	See Notes	1 hr. 45min		1		1,2,6, 12,19, 20,21	1-3/4
W-8-M-48	8-5/8"	Core: clay or shale structural tile; Facings: Side 1: See note 17; Side 2: None.	See Notes	4 hr.		1		1,2,6, 16,18, 20,21	4
W-8-M-49	8-5/8"	Core: clay or shale structural tile; Facings: fire side only, see note 17.	See Notes	2 hr.		1		1,2,6, 16,19, 20,21	2

Thickness - 8" to Less Than 10"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-8-M-50	8-5/8"	Core: 4", 40% solid clay or shale structural tile; 4" brick plus 5/8" of 1:3 sanded gypsum plaster facing on one side.	See Notes	4 hr.		1		1,20	4
W-8-M-51	8-3/4"	8-3/4"x 2½" and 4"x 2½" Cellular fletton (1873 PSI) single and triple cell hollow bricks set in ½" sand mortar in alt. courses.	3.6 ton/ foot	6 hr.			7	23,29	6
W-8-M-52	8-3/4"	8-3/4" thick cement brick (2527 PSI) with P.C. and sand mortar.	3.6 ton/ft	6 hr.			7	23,24	6
W-8-M-53	8-3/4"	8-3/4"x 2½" fletton brick (1831 PSI) in ½" sand mortar.	3.6 ton/ft	6 hr.			7	23,24	6
W-8-M-54	8-3/4"	8-3/4"x 2½" London stock brick (683 PSI) in ½" P.C.-sand mortar	7.2 ton/ft	6 hr.			7	23,24	6
W-9-M-55	9"	9"x 2½" Leicester Red Wire cut brick(4465 PSI) in ½" P.C. - sand mortar.	6.0 ton/ft	hr.			7	24,23	6
W-9-M-56	9"	9"x 3" sandlime brick (2603 PSI) in ½" P.C. sand mortar.	3.6 ton/ft	6 hr.			7	23,24	6
W-9-M-57	9"	2 layers 2-7/8 fletton brick (1910 PSI) with 3½" air space; Cement and sand mortar.	1.5 ton/ft	32min.			7	23,25	1/3
W-9-M-58	9"	9"x 3" stairfoot brick (7527 PSI) in ½" sand-cement mortar.	7.2 ton/ft	6 hr.			7	23,24	6
W-9-M-59	9"	Core: Solid clay or shale bricks; ½" thick; 1:3 sanded gypsum plaster facing on both sides	See Notes	7 hr.		1		1,45 22	7
W-9-M-60	9"	Core: Concrete brick; ½" of 1:3 sanded gypsum plaster facings on both sides.	See Notes	8 hr.		1		1,45	8
W-9-M-61	9"	Core: Hollow Rolok of clay or shale; ½" of 1:3 sanded gypsum plaster facings on both sides.	See Notes	4 hr.		1		1,45	4
W-9-M-62	9"	Cored clay or shale brick; Units in wall thickness: 1; cells in wall thickness: 1; Min. % solids: 70; ½" of 1:3 sanded gypsum plaster facing on one side.	See Notes	3 hr.		1		1,44	3
W-9-M-63	9"	Cored clay or shale bricks; Units in wall thickness: 2; cells in wall thickness: 2; Min. % solids: 87; ½" of 1:3 sanded gypsum plaster facing on both sides.	See Notes	7 hr.		1		1,45	7
W-9-M-64	9-10"	Core: Cavity wall of clay or shale brick; No facings.	See Notes	5 hr.		1		1,45	5
W-9-M-65	9"-10"	Core: Cavity construction of clay or shale brick; ½" of 1:3 sanded gypsum plaster facing on one side.	See Notes	6 hr.		1		1,45	6
W-9-M-66	9"-10"	Core: Cavity construction of clay or shale brick; ½" of 1:3 sanded gypsum plaster facing on both sides.	See Notes	7 hr.		1		1,45	7
W-9-M-67	9½"	Core: clay or shale structural tile; Units in wall thickness: 1; cells in wall thickness: 2; Min.% solids in units: 40; 5/8" of 1:3 sanded gypsum plaster facing on both sides.	See Notes	3 hr.		1		1,20, 21	3
W-9-M-68	9½"	Core: Clay or shale structural tile; Units in wall thickness: 1; cells in wall thickness: 2; Min. % solids in units: 43; 5/8" of 1:3 sanded gypsum plaster facings on both sides.	See Notes	3 hr.		1		1,20 21	3
W-9-M-69	9½"	Core: clay or shale structural tile; Facings: Side 1: See note 17; Side 2: See note 17.	See Notes	3 hr.		1		1,2,5 10,18 20,21	3
W-9-M-70	9½"	Core: clay or shale structural tile; Facings: Side 1 and 2: See note 17.	See Notes	4 hr.		1		1,2,5 13,18 20,21	4
W-9-M-71	9½"	Core: clay or shale structural tile; Facings: Side 1 and 2: See note 17.	See Notes	3 hr. 30min.		1		1,2,6, 9,18, 20,21	3½

Thickness - 8" to Less Than 10"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-9-M-72	9½"	Core: clay or shale structural tile; Facings: Side 1 and 2: See note 17.	See Notes	4 hr.		1		1,2,6, 10,18, 20,21	4
W-9-M-73	9½"	Core: clay or shale structural tile; Facings: Side 1 and 2: See note 17.	See Notes	4 hr.		1		,2,6, 12,18, 20,21	4
W-9-M-74	9½"	Core: clay or shale structural tile; Facings: Side 1 and 2: See note 17.	See Notes	5 hr.		1		1,2,6, 16,18, 20,21	5
W-8-M-75	8"	Cored concrete masonry; See notes 2,19,26,34,40 No facings.	80 PSI	1 hr. 30 min		1		1,20	1½
W-8-M-76	8"	Cored concrete masonry; See notes 2,18,26,34,40 No facings.	80 PSI	4 hrs.		1		1,20	4
W-8-M-77	8"	Cored concrete masonry; See notes 2,26,31,19,40 No facings.	80 PSI	1 hr. 15 min		1		1,20	1¼
W-8-M-78	8"	Cored concrete masonry; See notes 2,18,26,31,40 No facings.	80 PSI	3 hrs.		1		1,20	3
W-8-M-79	8"	Cored concrete masonry; See notes 2,19,26,36,41 No facings.	80 PSI	1 hr. 30 min		1		1,20	1½
W-8-M-80	8"	Cored concrete masonry; See notes 2,26,36,18,41 No facings.	80 PSI	hrs.		1		1,20	3
W-8-M-81	8"	Cored concrete masonry; See notes 2,19,26,34,41 No facings.	80 PSI	1 hr.		1		1,20	1
W-8-M-82	8"	Cored concrete masonry; See notes 2,18,26,34,41 No facings.	80 PSI	2 hrs. 30 min		1		1,20	2½
W-8-M-83	8"	Cored concrete masonry; See notes 2,19,26,29,41 No facings.	80 PSI	45 min		1		1,20	3/4
W-8-M-84	8"	Cored concrete masonry; See notes 2,18,26,29,41 No facings.	80 PSI	2 hrs.		1		1,20	2
W-8-M-85	8½"	Cored concrete masonry; See notes 3,18,26,34,41 Facings: 2¼" brick.	80 PSI	hrs.		1		1,20	4
W-8-M-86	8"	Cored concrete masonry; See notes 3,18,26,34,41 Facings: 3-3/4" brick face.	80 PSI	5 hrs.		1		1,20	5
W-8-M-87	8"	Cored concrete masonry; See notes 2,19,26,30,43 No facings.	80 PSI	12 min		1		1,20	1/5
W-8-M-88	8"	Cored concrete masonry; See notes 2,18,26,30,43 No facings.	80 PSI	12 min		1		1,20	1/5
W-8-M-89	8½"	Cored concrete masonry; See notes 2,19,26,34,40 Facings: on fire side only; see note 38.	80 PSI	hrs.		1		1,20	2
W-8-M-90	8½"	Cored concrete masonry; See notes 2,18,26,34,40 Facings: see note 38 for side 1.	80 PSI	5 hrs.		1		1,20	5
W-8-M-91	8½"	Cored concrete masonry; See notes 2,26,31,19, 40; Facings on fire side only; see note 38.	80 PSI	1 hr. 45min		1		1,20	1-3/4
W-8-M-92	8½"	Cored concrete masonry; See notes 2,26,18,31, 40; Facings on one side; see note 38.	80 PSI	4 hrs		1		1,20	4
W-8-M-93	8½"	Cored concrete masonry; See notes 2,19,26,36, 41; Facings on fire side only; see note 38.	80 PSI	2 hrs		1		1,20	2
W-8-M-94	8½"	Cored concrete masonry; see notes 2,18,26,36, 41; Facings on fire side only; see note 38.	80 PSI	4 hrs		1		1,20	4
W-8-M-95	8½"	Cored concrete masonry; See notes 2,19,26,34, 41; Facings on fire side only; see note 38.	80 PSI	1 hr. 30min		1		1,20	1½
W-8-M-96	8½"	Cored concrete masonry; See notes 2,26,34,18, 41; Facings on one side; see note 38.	80 PSI	3 hrs		1		1,20	3
W-8-M-97	8½"	Cored concrete masonry; See notes 2,19,26,29, 41; Facings on fire side only; see note 38.	80 PSI	1 hr. 30min		1		1,20	1½

1.1.4 (cont'd)

Thickness - 8" to Less Than 10"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-8-M-98	8½"	Cored concrete masonry; See notes 2,18,26,29, 41; Facings on one side; see note 38.	80 PSI	2 hrs 30min		1		1,20	2½
W-8-M-99	8½"	Cored concrete masonry; See notes 3,19,23,27, 41; No facings.	80 PSI	1 hr. 15min		1		1,20	1½
W-8-M-100	8½"	Cored concrete masonry; See notes 3,18,23,27, 41; No facings.	80 PSI	3 hrs 30min		1		1,20	3½
W-8-M-101	8½"	Cored concrete masonry; See notes 3,18,26,34,41 Facings 3-3/4" brick face; one side only; see note 38.	80 PSI	6 hrs		1		1,20	6
W-8-M-102	8½"	Cored concrete masonry; See notes 2,19,26,30, 43; Facings on fire side only; see note 38.	80 PSI	30min.		1		1,20	½
W-8-M-103	8½"	Cored concrete masonry; See notes 2,18,26,30, 43; Facings on one side only; see note 38.	80 PSI	12min.		1		1,20	1/5
W-9-M-104	9"	Cored concrete masonry; see notes 2,18,26,34,40 Facings on both sides; see note 38.	80 PSI	6 hrs.		1		1,20	6
W-9-M-105	9"	Cored concrete masonry, See notes 2,18,26,31,40 Facings on both sides; see note 38.	80 PSI	5 hrs.		1		1,20	5
W-9-M-106	9"	Cored concrete masonry; See notes 2,18,26,36,41 Facings on both sides of wall; see note 38.	80 PSI	5 hrs.		1		1,20	5
W-9-M-107	9"	Cored concrete masonry; See notes 2,18,26,34,41 Facings on both sides; see note 38.	80 PSI	4 hrs.		1		1,20	4
W-9-M-108	9"	Cored concrete masonry; See notes 2,18,26,29,41 Facings on both sides; See note 38.	80 PSI	3 hrs. 30min.		1		1,20	3½
W-9-M-109	9"	Cored concrete masonry; See notes 3,19,23,27,40 Facing on fire side only; see note 38.	80 PSI	1 hr. 45min.		1		1,20	1-3/4
W-9-M-110	9"	Cored concrete masonry; See notes 3,18,27,23,41 Facings on one side only; see note 38.	80 PSI	4 hrs.		1		1,20	4
W-9-M-111	9"	Cored concrete masonry; See notes 3,18,26,34,41 2½" brick face on one side only; see note 38.	80 PSI	5 hrs.		1		1,20	5
W-9-M-112	9"	Cored concrete masonry; See notes 2,18,26,30,43 Facings on both sides; see note 38.	80 PSI	30min.		1		1,20	½
W-9-M-113	9½"	Cored concrete masonry; See notes 3,18,23,27,41 Facings on both sides; see note 38.	80 PSI	5 hrs.		1		1,20	5
W-8-M-114	8"		200 PSI	5 hrs.			43	22	5

Notes:

TABLE 1.1.4

1. Tested at NBS under ASA Spec. No. 42-1934 (ASTM C-19-53)
2. 1 unit in wall thickness.
3. 2 units in wall thickness.
4. 2 or 3 units in wall thickness.
5. 2 cells in wall thickness.
6. 3 or 4 cells in wall thickness.
7. 4 or 5 cells in wall thickness.
8. 5 or 6 cells in wall thickness.
9. Minimum % of solid materials in units: 40%.
10. Minimum % of solid materials in units: 43%.
11. Minimum % of solid materials in units: 46%.
12. Minimum % of solid materials in units: 48%.
13. Minimum % of solid materials in units: 49%.
14. Minimum % of solid materials in units: 45%.
15. Minimum % of solid materials in units: 51%.
16. Minimum % of solid materials in units: 53%.
17. Not less than 5/8" thickness of 1:3 sanded gypsum plaster.
18. Non combustible or no members framed into wall.
19. Combustible members framed into wall.
20. Load: 80 PSI for gross cross sectional area of wall.
21. Portland cement lime mortar.
22. Failure mode thermal.
23. British test.
24. Passed all criteria.
25. Failed by sudden collapse with no preceding signs of impending failure.
26. 1 cell in wall thickness.
27. 2 cells in wall thickness.
28. 3 cells in wall thickness.
29. Minimum % of solid material in concrete units = 52.
30. Minimum % of solid material in concrete units = 54.
31. Minimum % of solid material in concrete units = 55.
32. Minimum % of solid material in concrete units = 57.
33. Minimum % of solid material in concrete units = 60.
34. Minimum % of solid material in concrete units = 62.
35. Minimum % of solid material in concrete units = 65.
36. Minimum % of solid material in concrete units = 70.
37. Minimum % of solid material in concrete units = 76.
38. Not less than ½" of 1:3 sanded gypsum plaster.
39. 3 units in wall thickness.
40. Concrete units made with expanded slag or pumice aggregates.
41. Concrete units made with expanded burned clay or shale, crushed limestone, air cooled slag or cinders.
42. Concrete units made with calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.
43. Concrete units made with siliceous sand and gravel. 90% or more quartz, chert and dolomite.
44. Load: 120 psi for gross cross-sectional area of wall.
45. Load: 160 psi for gross cross-sectional area of wall.

Figure 1.1.5
Walls- Masonry

10″ to less than 12″ thick

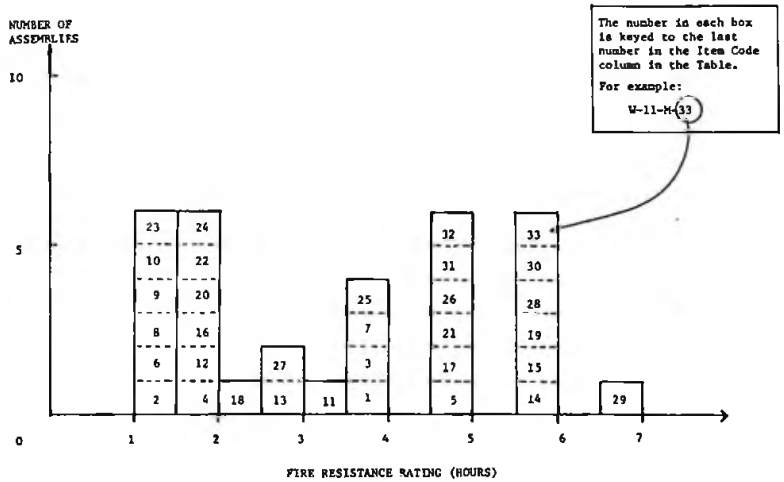


Table 1.1.5
Walls- Masonry

10″ to less than 12″ thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-10-M-1	10"	Core: Two, 3-3/4", 40% solid clay or shale structural tiles with 2" air space between; Facings: 3/4" portland cement plaster or stucco on both sides.	80 PSI	4 hrs		1		1,20	4
W-10-M-2	10"	Core: Cored concrete masonry, 2" air cavity; See notes 27,34,19,3,40; Facings: None.	80 PSI	1 hr. 30min		1		1,20	1½
W-10-M-3	10"	Cored concrete masonry; See notes 27,34,18,3, 40; Facings: None.	80 PSI	4 hrs		1		1,20	4
W-10-M-4	10"	Cored concrete masonry; See notes 26,33,19,2, 40; Facings: None.	80 PSI	2 hrs		1		1,20	2
W-10-M-5	10"	Cored concrete masonry; See notes 26,33,18,2, 40; No facings.	80 PSI	5 hrs		1		1,20	5
W-10-M-6	10"	Cored concrete masonry; See notes 26,33,19,2, 41; No facings.	80 PSI	1 hr. 30min		1		1,20	1½
W-10-M-7	10"	Cored concrete masonry; See notes 26,33,18,2, 41; No facings.	80 PSI	4 hrs		1		1,20	4
W-10-M-8	10"	Cored concrete masonry (cavity type 2" air space) See notes 27,34,19,3,42; No facings.	80 PSI	1 hr. 15min		1		1,20	1¼
W-10-M-9	10"	Cored concrete masonry (cavity type 2" air space); See notes 3, 27,34,18,42; No facings.	80 PSI	1 hr. 15 min		1		1,20	1¼
W-10-M-10	10"	Cored concrete masonry (cavity type 2" air space) See notes 3,19,27,34,41; No facings.	80 PSI	1 hr. 15 min		1		1,20	1¼
W-10-M-11	10"	Cored concrete masonry (cavity type 2" air space) See notes 3,18,27,34,41; No facings	80 PSI	3 hrs 30 min		1		1,20	3½

Thickness - 10" to Less Than 12"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-10-M-12	10"	9" thick concrete block (11-3/4"x 9"x 4⅝") with 2 - 2" thick voids included; 3/8" P.C. plaster 1/8" neat gypsum.	n/a	1 hr. 53 min			7	23,44	1-3/4
W-10-M-13	10"	Hollow clay tile block wall - 8½" block with 2 - 3" voids in each 8½" section; 3/4" gypsum plaster - each face.	n/a	2 hrs. 42 min			7	23,25	2½
W-10-M-14	10"	2 layers 4½" brick with 1½" air space - no ties sand cement mortar. (Fletton brick - 1910 PSI)	n/a	6 hrs.			7	23,24	6
W-10-M-15	10"	2 layers 4½" thick Fletton brick - 1910 PSI brick; 1½" air space; Ties - 18" O.C. vertical; 3' O.C. - horizontal.	n/a	6 hrs.			7	23,24	6
W-10-M-16	10½"	Cored concrete masonry; 2" air cavity; See note 3,19,27,34,40; Facings: Fire side only; See note 38.	80 PSI	1 hrs.		1		1,20	2
W-10-M-17	10½"	Cored concrete masonry; See notes 3,27,34,18,40 Facings: Only side one; See note 38.	80 PSI	5 hrs.		1		1,20	5
W-10-M-18	10½"	Cored concrete masonry; See notes 2,19,26,33, 40; Facings on fire side only; See note 38.	80 PSI	2 hrs 30min.		1		1,20	2½
W-10-M-19	10½"	Cored concrete masonry; See notes 2,18,26,33, 40; Facings on one side; See note 38.	80 PSI	6 hrs.		1		1,20	6
W-10-M-20	10½"	Cored concrete masonry; See notes 2,19,26,33, 41; Facing on fire side of wall only; See note 38.	80 PSI	2 hrs.		1		1,20	2
W-10-M-21	10½"	Cored concrete masonry; See notes 2,18,26,33, 41; Facings on one side only; See note 38.	80 PSI	5 hrs.		1		1,20	5
W-10-M-22	10½"	Cored concrete masonry (cavity type 2" air space); See notes 3,19,27,34,42; Facing on fire side only; See note 38.	80 PSI	1 hr. 45min.		1		1,20	1-3/4
W-10-M-23	10½"	Cored concrete masonry (cavity type 2" air space); See notes 3,18,27,34,42; Facings on one side only; See note 38.	80 PSI	1 hr. 15min.		1		1,20	1¼
W-10-M-24	10½"	Cored concrete masonry (cavity type 2" air space); See notes 3,27,34,19,41; Facings on fire side only; See note 38.	80 PSI	2 hrs.		1		1,20	2
W-10-M-25	10½"	Cored concrete masonry (cavity type 2" air space); See notes 3,18,27,34,41; Facings on one side only; See note 38.	80 PSI	4 hrs.		1		1,20	4
W-10-M-26	10-5/8"	Core: 8", 40% solid tile plus 2" furring tile. 5/8" sanded gypsum plaster between tile types; Facings on both sides 3/4" portland cement plaster or stucco.	80PSI	5 hrs.		1		1,20	5
W-10-M-27	10-5/8"	Core: 8", 40% solid tile plus 2" furring tile. 5/8" sanded gypsum plaster between tile types. Facings on one side 3/4" portland cement plaster or stucco.	80 PSI	3 hrs 30min		1		1,20	3½
W-11-M-28	11"	Cored concrete masonry; See notes 3,18,27,34, 40; Facings on both sides; See note 38.	80 PSI	6 hrs.		1		1,20	6
W-11-M-29	11"	Cored concrete masonry; See notes 2,18,26,33, 40; Facings on both sides; See note 38.	80 PSI	7 hrs.		1		1,20	7
W-11-M-30	11"	Cored concrete masonry; See notes 2,18,26,33, 41; Facings on both sides of wall; See note 38	80 PSI	6 hrs.		1		1,20	6
W-11-M-31	11"	Cored concrete masonry (cavity type 2" air space); See notes 3,18,27,34,42; Facings on both sides; See note 38.	80 PSI	5 hrs.		1		1,20	5
W-11-M-32	11"	Cored concrete masonry (cavity type 2" air space). See notes 3,18,27,34,41; Facings on both sides; See note 38.	80 PSI	5 hrs.		1		1,20	5
W-11-M-33	11"	2 layers brick (4½" fletton 2428 PSI) 2" air space; Galv. ties - 18" O.C. - Horizontal; 3' O.C. - Vertical.	3 ton/ ft.	6 hrs.			7	23,24	6

Notes:

TABLE 1.1.5

1. Tested at NBS - ASA Spec. A2-1934.
2. One unit in wall thickness.
3. Two units in wall thickness.
4. Two or three units in wall thickness.
5. Two cells in wall thickness.
6. Three or four cells in wall thickness.
7. Four or five cells in wall thickness.
8. Five or six cells in wall thickness.
9. Minimum % of solid materials in units: 40%.
10. Minimum % of solid materials in units: 43%.
11. Minimum % of solid materials in units: 46%.
12. Minimum % of solid materials in units: 48%.
13. Minimum % of solid materials in units: 49%.
14. Minimum % of solid materials in units: 45%.
15. Minimum % of solid materials in units: 51%.
16. Minimum % of solid materials in units: 53%.
17. Not less than 5/8" thickness of 1:3 sanded gypsum plaster.
18. Non-combustible or no members framed into wall.
19. Combustible members framed into wall.
20. Load: 80PSI for gross cross sectional area.
21. Portland cement - lime mortar.
22. Failure mode - thermal.
23. British test.
24. Passed all criteria.
25. Failed by sudden collapse with no preceding signs of impending failure.
26. One cell in wall thickness.
27. Two cells in wall thickness.
28. Three cells in wall thickness.
29. Minimum % of solid material in concrete units: 52%.
30. Minimum % of solid material in concrete units: 54%.
31. Minimum % of solid material in concrete units: 55%.
32. Minimum % of solid material in concrete units: 57%.
33. Minimum % of solid material in concrete units: 60%.
34. Minimum % of solid material in concrete units: 62%.
35. Minimum % of solid material in concrete units: 65%.
36. Minimum % of solid material in concrete units: 70%.
37. Minimum % of solid material in concrete units: 76%.
38. Not less than ½" of 1:3 sanded gypsum plaster.
39. Three units in wall thickness.
40. Concrete units made with expanded slag or pumice aggregates.
41. Concrete units made with expanded burned clay or shale, crushed limestone, air cooled slag or cinders.
42. Concrete units made with calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.

Figure 1.1.6
Walls- Masonry

12" to less than 14" thick

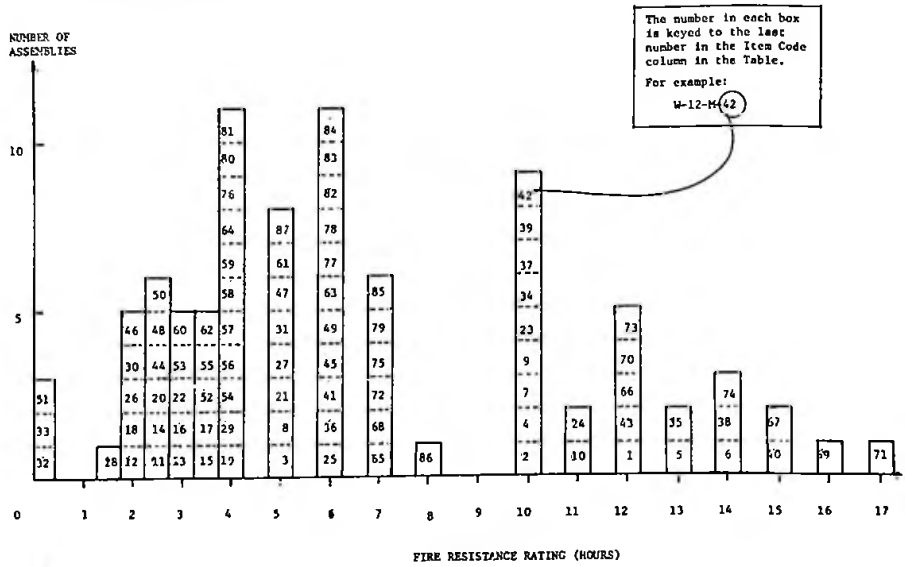


Table 1.1.6
Walls- Masonry

12" to less than 14" thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BHS-92	BHS-92	Post-BHS-92		
W-12-M-1	12"	Core: Solid clay or shale brick; No facings.	n/a	12 hr		1		1	12
W-12-M-2	12"	Core: Solid clay or shale brick; No facings.	160 PSI	10 hr		1		1,44	10
W-12-M-3	12"	Core: Hollow Rolok of clay or shale; No facing	160 PSI	5 hr.		1		1,44	5
W-12-M-4	12"	Core: Hollow Rolok Bak of Clay or Shale; No facings.	160 PSI	10 hr		1		1,44	10
W-12-M-5	12"	Core: Concrete brick; No facings.	160 PSI	13 hr		1		1,44	13
W-12-M-6	12"	Core: Sand-lime brick; No facings.	n/a	14 hr		1		1	14
W-12-M-7	12"	Core: Sand-lime brick; No facings.	160 PSI	10 hr.		1		1,44	10
W-12-M-8	12"	Cored clay or shale bricks; Units in wall thickness: 1; Cells in wall thickness: 2; Min. % solids: 70; No facings.	120 PSI	5 hr.		1		1,45	5
W-12-M-9	12"	Cored clay or shale bricks; Units in wall thickness: 3; Cells in wall thickness: 3; Min. % solids: 87; No facings.	160 PSI	10 hr		1		1,44	10
W-12-M-10	12"	Cored clay or shale bricks; Units in wall thickness:3; Cells in wall thickness: 3; Min. % solids: 87; No facings.	n/a	11 hr		1		1	11
W-12-M-11	12"	Core: Clay or shale structural tile; See notes 2,6,9,18; No facings.	80 PSI	2½ hr.		1		1,20	2½
W-12-M-12	12"	Core: Clay or shale structural tile; See notes 2,4,9,19; No facings.	80 PSI	2 hr.		1		1,20	2

Thickness - 12" to Less Than 14"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec. Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-12-M-13	12"	Core: Clay or shale structural tile; See notes 2,6,14,19; No facings.	80 PSI	3 hr.		1		1,20	3
W-12-M-14	12"	Core: Clay or shale structural tile; See notes 2,6,14,18; No facings.	80 PSI	2½ hr.		1		1,20	2½
W-12-M-15	12"	Core: Clay or shale structural tile; See notes 2,4,13,18; No facings.	80 PSI	3½hr.		1		1,20	3½
W-12-M-16	12"	Core: Clay or shale structural tile; See notes 2,4,13,19; No facings.	80 PSI	3 hr.		1		1,20	3
W-12-M-17	12"	Core: Clay or shale structural tile; See notes 3,6,9,18; No facings.	80 PSI	3½ hr.		1		1,20	3½
W-12-M-18	12"	Core: Clay or shale structural tile; See notes 3,6,9,19; No facings.	80 PSI	2 hr.		1		1,20	2
W-12-M-19	12"	Core: Clay or shale structural tile; See notes 3,6,14,18; No facings.	80 PSI	4 hr.		1		1,20	4
W-12-M-20	12"	Core: Clay or shale structural tile; See notes 3,6,14,19; No facings.	80 PSI	2½ hr.		1		1,20	2½
W-12-M-21	12"	Core: Clay or shale structural tile; See notes 3,6,16,18; No facings.	80 PSI	5 hr.		1		1,20	5
W-12-M-22	12"	Core: Clay or shale structural tile; See notes 3,6,16,19; No facings.	80 PSI	3 hr.		1		1,20	3
W-12-M-23	12"	Core: 8", 70% solid clay or shale structural tile; 4" brick facing on one side.	80 PSI	10 hr.		1		1,20	10
W-12-M-24	12"	Core: 8", 70% solid clay or shale structural tile; 4" brick facing on one side.	n/a	11 hr.		1		1	11
W-12-M-25	12"	Core: 8", 40% solid clay or shale structural tile; 4" brick facing on one side.	80 PSI	6 hr.		1		1,20	6
W-12-M-26	12"	Cored concrete masonry; See notes 1,9,15,16 & 20; No facings.	80 PSI	2 hr.		1		1,20	2
W-12-M-27	12"	Cored concrete masonry; See notes 26,34,18,2,41 No facings.	80 PSI	5 hr.		1		1,20	5
W-12-M-28	12"	Cored concrete masonry; See notes 26,31,19,2, 41; No facings.	80 PSI	1½ hr.		1		1,20	1½
W-12-M-29	12"	Cored concrete masonry; See notes 26,31,18,2, 41; No facings.	80 PSI	4 hr.		1		1,20	4
W-12-M-30	12"	Cored concrete masonry; See notes 27,31,19,3, 43; No facings.	80 PSI	2 hr.		1		1,20	2
W-12-M-31	12"	Cored concrete masonry; See notes 27,31,18,3, 43; No facings.	80 PSI	5 hr.		1		1,20	5
W-12-M-32	12"	Cored concrete masonry; See notes 26,32,19,2, 43; No facings.	80 PSI	25 min		1		1,20	1/3
W-12-M-33	12"	Cored concrete masonry; See notes 26,32,18,2, 43; No facings.	80 PSI	25 min		1		1,20	1/3
W-12-M-34	12½"	Core: Solid clay or shale brick; ½" of 1:3 sanded gypsum plaster facing on one side.	160 PSI	10 hr		1		1,44	10
W-12-M-35	12½"	Core: Solid clay or shale brick; ½" of 1:3 sanded gypsum plaster facing on one side	n/a	13 hr		1		1	13
W-12-M-36	12½"	Core: Hollow Rolock of clay or shale; ½" of 1:3 sanded gypsum plaster facing on one side.	160 PSI	6 hr.		1		1,44	6
W-12-M-37	12½"	Core: Hollow Rolok Bak of clay or shale; ½" of 1:3 sanded gypsum plaster facing on one side.	160 PSI	10 hr.		1		1,44	10
W-12-M-38	12½"	Core: Concrete; ½" of 1:3 sanded gypsum plaster facing on one side.	160 PSI	14 hr.		1		1,44	14
W-12-M-39	12½"	Core: Sand-lime brick; ½" of 1:3 sanded gypsum plaster facing on one side.	160 PSI	10 hr.		1		1,44	10
W-12-M-40	12½"	Core: Sand-lime brick; ½" of 1:3 sanded gypsum plaster facing on one side.	n/a	15 hr.		1		1	15

Thickness - 12" to Less Than 14"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-12-M-41	12½"	Units in wall thickness: 1; Cells in wall thickness: 2; Min. % solids: 70; Cored clay or shale brick; ½" of 1:3 sanded gypsum plaster facing on one side.	120 PSI	6 hr.		1		1,45	6
W-12-M-42	12½"	Cored clay or shale bricks; Units in wall thickness: 3; Cells in wall thickness: 3; Min. % solids: 87; ½" of 1:3 sanded gypsum plaster facings on one side.	160 PSI	10 hr.		1		1,44	10
W-12-M-43	12½"	Cored clay or shale bricks; Units in wall thickness: 3; Cells in wall thickness: 3; Min. % solids: 87; ½" of 1:3 sanded gypsum plaster facing on one side.	n/a	12 hr.		1		1	12
W-12-M-44	12½"	Cored concrete masonry; See notes 26,34.19,2,41 Facing on fire side only - See note 38.	80 PSI	2½ hr		1		1,20	2½
W-12-M-45	12½"	Cored concrete masonry; See notes 26,34,18,39,2 41; Facing on one side only - See note 38.	80 PSI	6 hr.		1		1,20	6
W-12-M-46	12½"	Cored concrete masonry; See notes 26,31,19,2,41 Facing on fire side only - see note 38.	80 PSI	2 hr.		1		1,20	2
W-12-M-47	12½"	Cored concrete masonry; See notes 26,31,18,2,41 Facings one side of wall only - See note 38.	80 PSI	5 hr.		1		1,20	5
W-12-M-48	12½"	Cored concrete masonry; See notes 27,31,19,3,43 Facing on fire side only - See note 38.	80 PSI	2½ hr.		1		1,20	2½
W-12-M-49	12½"	Cored concrete masonry; See notes 27,31,18,3, 43; Facing one side only - See note 38.	80 PSI	6 hr.		1		1,20	6
W-12-M-50	12½"	Cored concrete masonry; See notes 26,32,19,2,43 Facing on fire side only - See note 38.	80 PSI	2½ hr.		1		1,20	2½
W-12-M-51	12½"	Cored concrete masonry; See notes 26,32,18,2,43 Facing one side only - See note 38.	80 PSI	25 min		1		1,20	1/3
W-12-M-52	12-5/8"	Clay or shale structural tile; See notes 2,6,9 18; Facing: Side 1 - See note 17; Side 2: none	80 PSI	3½ hr.		1		1,20	3½
W-12-M-53	12-5/8"	Clay or shale structural tile; See notes 2,6,9, 19; Facing on fire side only; See note 17.	80 PSI	3 hr.		1		1,20	3
W-12-M-54	12-5/8"	Clay or shale structural tile; See notes 2,6, 14, 19; Facing: Side 1 - See note 17; Side 2 - none.	80 PSI	4 hr.		1		1,20	4
W-12-M-55	12-5/8"	Clay or shale structural tile; See notes 2,6, 14,18; Facings on exposed side only - See note 17.	80 PSI	3½ hr.		1		1,20	3½
W-12-M-56	12-5/8"	Clay or shale structural tile; See notes 2,4, 13,18; Facings: Side 1 - See note 17; Side 2 - None	80 PSI	4 hr.		1		1,20	4
W-12-M-57	12-5/8"	Clay or shale structural tile; See notes 1,4, 13,19; Facings on fire side only; See note 17.	80 PSI	4 hr.		1		1,20	4
W-12-M-58	12-5/8"	Clay or shale structural tile; See notes 3,6,9 18; Facings: Side 1 - See note 17; Side 2: none	80 PSI	4 hr.		1		1,20	4
W-12-M-59	12-5/8"	Clay or shale structural tile; See notes 3,6,9, 19; Facings on fire side only - See note 17.	80 PSI	3 hr.		1		1,20	3
W-12-M-60	12-5/8"	Clay or shale structural tile; See notes 3,6, 14,18; Facings: Side 1 - See note 17; Side 2: None.	80 PSI	5 hr.		1		1,20	5
W-12-M-61	12-5/8"	Clay or shale structural tile; See notes 3,6, 14,19; Facings: fire side only; See note 17.	80 PSI	3 hr 30min.		1		1,20	3½
W-12-M-62	12-5/8"	Clay or shale structural tile; See notes: 3,6, 16,18; Facings: Side 1 - See note 17; Side 2 - None.	80 PSI	6 hr.		1		1,20	6
W-12-M-63	12-5/8"	Clay or shale structural tile; See notes 3, 6, 16,19; Facings on fire side only; See note 17.	80 PSI	4 hr.		1		1,20	4
W-12-M-64	12-5/8"	Core: 8", 40% solid clay or shale structural tile; Facings 4" brick plus 5/8" of 1:3 sanded gypsum plaster on one side.	80 PSI	7 hr.		1		1,20	7

Thickness - 12" to Less Than 14"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-13-M-65	13"	Core: Solid clay or shale brick; ½" of 1:3 sanded gypsum plaster facing on both sides.	160 PSI	12 hr.		1		1,44	12
W-13-M-66	13"	Core: Solid clay or shale brick; ½" of 1:3 sanded gypsum plaster facing on both sides.	n/a	15 hr.		1		1,20	15
W-13-M-67	13"	Core: Solid clay or shale brick; ½" of 1:3 sanded gypsum plaster facings on both sides.	n/a	15 hr.		1		1-	15
W-13-M-68	13"	Core: Hollow Rolok of clay or shale; ½" of 1:3 sanded gypsum plaster facings on both sides.	80 PSI	7 hr.		1		1,20	7
W-13-M-69	13"	Core: Concrete brick; ½" of 1:3 sanded gypsum plaster facings on both sides.	160 PSI	16 hr.		1		1,44	16
W-13-M-70	13"	Core: Sand-lime brick; ½" of 1:3 sanded gypsum plaster facings on both sides.	160 PSI	12 hr.		1		1,44	12
W-13-M-71	13"	Core: Sand-lime brick; ½" of 1:3 sanded gypsum plaster facings on both sides.	n/a	17 hr.		1		1	17
W-13-M-72	13"	Cored clay or shale bricks; units in wall thickness: 1; Cells in wall thickness: 2; Min. % solids: 70; ½" of 1:3 sanded gypsum plaster facings on both sides.	120 PSI	7 hr.		1		1,45	7
W-13-M-73	13"	Cored clay or shale bricks; Units in wall thickness: 3; Cells in wall thickness: 3; Min. % solids: 87; ½" of 1:3 sanded gypsum plaster facings on both sides.	160 PSI	12 hr.		1		1,44	12
W-13-M-74	13"	Cored clay or shale bricks; Units in wall thickness: 3; Cells in wall thickness: 2; Min. % solids: 87; ½" of 1:3 sanded gypsum plaster facings on both sides.	n/a	14 hr.		1		1	14
W-13-M-75	13"	Cored concrete masonry; See notes 28,23,18,39, 41; No facings.	80 PSI	7 hr.		1		1,20	7
W-13-M-76	13"	Cored concrete masonry; See notes 28,23,19,39, 41; No facings	80 PSI	4 hr.		1		1,20	4
W-13-M-77	13"	Cored concrete masonry; See notes 27,31,18,3, 43; Facings on both sides; See note 38.	80 PSI	6 hr.		1		1,20	6
W-13-M-78	13"	Cored concrete masonry; See notes 26,31,18,2, 41; Facings on both sides; See note 38.	80 PSI	6 hr.		1		1,20	6
W-13-M-79	13"	Cored concrete masonry; See notes 26,34,18,2, 41; Facings on both sides of wall; See note 38.	80 PSI	7 hr.		1		1,20	7
W-13-M-80	13¼"	Core: Clay or shale structural tile: See notes 2,6,9,18; Facings: See note 17 for both sides.	80 PSI	4 hr.		1		1,20	4
W-13-M-81	13¼"	Core: Clay or shale structural tile; See notes 2,6,14,19; Facings: See note 17 for both sides.	80 PSI	4 hr.		1		1,20	4
W-13-M-82	13¼"	Core: Clay or shale structural tile; See notes 2,4,13,18; Facings: See note 17 for both sides.	80 PSI	6 hr.		1		1,20	6
W-13-M-83	13¼"	Core: Clay or shale structural tile; See notes 3,6,9,18; Facings: See note 17 for both sides.	80 PSI	6 hr.		1		1,20	6
W-13-M-84	13¼"	Core: Clay or shale structural tile; See notes 3,6,14,18; Facings: See note 17 for both sides.	80 PSI	6 hr.		1		1,20	6
W-13-M-85	13¼"	Core: Clay or shale structural tile; See notes 3,6,16,18; Facings: See note 17 for both sides.	80 PSI	7 hr.		1		1,20	7
W-13-M-86	13½"	Cored concrete masonry; See notes 28,23,18,39, 41; Facing on one side only; See note 38.	80 PSI	8 hr.		1		1,20	8
W-13-M-87	13½"	Cored concrete masonry; See notes 28,23,19,39, 41; Facing on fire side only; See note 38.	80 PSI	5 hr.		1		1,20	5

Notes:

1. Tested at NBS - ASA Spec. A2-1934.
2. One unit in wall thickness.
3. Two units in wall thickness.
4. Two or three units in wall thickness.
5. Two cells in wall thickness.
6. Three or four cells in wall thickness.
7. Four or five cells in wall thickness.
8. Five or six cells in wall thickness.
9. Minimum % of solid materials in units: 40%.
10. Minimum % of solid materials in units: 43%.
11. Minimum % of solid materials in units: 46%.
12. Minimum % of solid materials in units: 48%.
13. Minimum % of solid materials in units: 49%.
14. Minimum % of solid materials in units: 45%.
15. Minimum % of solid materials in units: 51%.
16. Minimum % of solid materials in units: 53%.
17. Not less than 5/8" thickness of 1:3 sanded gypsum plaster.
18. Non-combustible or no members framed into wall.
19. Combustible members framed into wall.
20. Load: 80PSI for gross area.
21. Portland cement - lime mortar.
22. Failure mode - thermal.
23. British test.
24. Passed all criteria.
25. Failed by sudden collapse with no preceding signs of impending failure.
26. One cell in wall thickness.
27. Two cells in wall thickness.
28. Three cells in wall thickness.
29. Minimum % of solid material in concrete units: 52%.
30. Minimum % of solid material in concrete units: 54%.
31. Minimum % of solid material in concrete units: 55%.
32. Minimum % of solid material in concrete units: 57%.
33. Minimum % of solid material in concrete units: 60%.
34. Minimum % of solid material in concrete units: 62%.
35. Minimum % of solid material in concrete units: 65%.
36. Minimum % of solid material in concrete units: 70%.
37. Minimum % of solid material in concrete units: 76%.
38. Not less than ½" of 1:3 sanded gypsum plaster.
39. Three units in wall thickness.
40. Concrete units made with expanded slag or pumice aggregates.
41. Concrete units made with expanded burned clay or shale, crushed limestone, air cooled slag or cinders.
42. Concrete units made with calcareous sand and gravel. Course aggregate, 60% or more calcite and dolomite.
43. Concrete units made with siliceous sand and gravel. 90% or more quartz, chert, or flint.
44. Load: 160 psi of gross wall cross-sectional area.
45. Load: 120 psi of gross wall cross-sectional area.

Figure 1.1.7
Walls- Masonry

14" or more thick

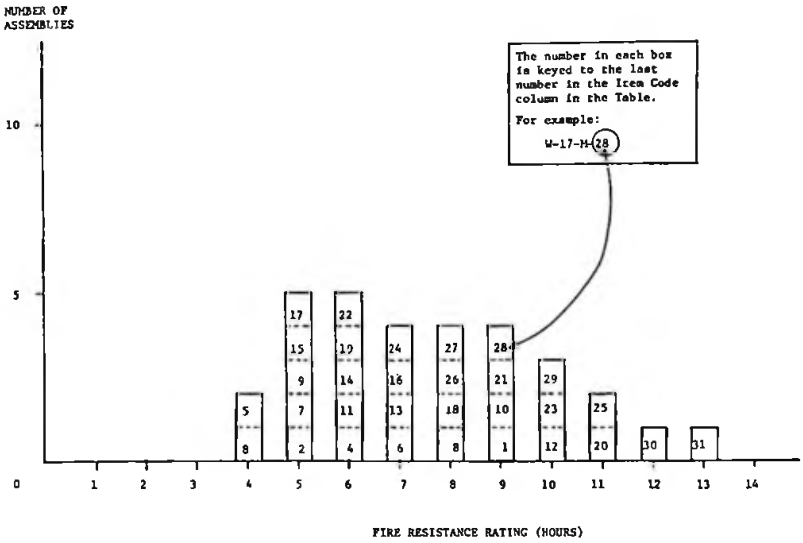


Table 1.1.7
Walls- Masonry

14" or more thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-14-M-1	14"	Core: Cored concrete masonry; See notes 18,28, 35,39,41; Facings: Both sides, see note 38.	80 PSI	9 hr.		1		1,20	9
W-16-M-2	16"	Core: Clay or shale structural tile; See notes 4,7,9,19; No facings.	80 PSI	5 hr.		1		1,20	5
W-16-M-3	16"	Core: Clay or shale structural tile; See notes 4,7,9,19; No facings.	80 PSI	4 hr.		1		1,20	4
W-16-M-4	16"	Core: Clay or shale structural tile: See notes 4,7,10,18; No facings.	80 PSI	6 hr.		1		1,20	6
W-16-M-5	16"	Core: Clay or shale structural tile; See notes 4,7,10,19; No facings.	80 PSI	4 hr.		1		1,20	4
W-16-M-6	16"	Core: Clay or shale structural tile; See notes 4,7,11,18; No facings.	80 PSI	7 hr.		1		1,20	7
W-16-M-7	16"	Core: Clay or shale structural tile; See notes 4,7,11,19; No facings.	80 PSI	5 hr.		1		1,20	5
W-16-M-8	16"	Core: Clay or shale structural tile; See notes 4,8,13,18; No facings.	80 PSI	8 hr.		1		1,20	8
W-16-M-9	16"	Core: Clay or shale structural tile; See notes 4,8,13,19; No facings.	80 PSI	5 hr.		1		1,20	5

Walls - 14" or More Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-16-M-10	16"	Clay or shale structural tile core; see notes 4,8,15,18; No facings.	80 PSI	9 hr.		1		1,20	9
W-16-M-11	16"	Clay or shale structural tile core; See notes 3,7,14,18; No facings.	80 PSI	6 hr.		1		1,20	6
W-16-M-12	16"	Clay or shale structural tile core; See notes 4,8,16,18; No facings.	80 PSI	10 hr.		1		1,20	10
W-16-M-13	16"	Clay or shale structural tile core; See notes 4,6,16,19; No facings.	80 PSI	7 hr.		1		1,20	7
W-16-M-14	16-5/8"	Clay or shale structural tile core; See notes 4,7,9,18; Facings: Side 1 - See note 17; Side 2 None.	80 PSI	6 hr.		1		1,20	6
W-16-M-15	16-5/8"	Clay or shale structural tile core; See notes 4,7,9,19; Facings: Fire side only; See note 17.	80 PSI	5 hr.		1		1,20	5
W-16-M-16	16-5/8"	Clay or shale structural tile core; See notes 4,7,10,18; Facings:Side 1-See note 17; Side 2-None.	80 PSI	7 hr.		1		1,20	7
W-16-M-17	16-5/8"	Clay or shale structural tile core; See notes 4,7,10,19; Facings: Fire side only; See note 17.	80 PSI	5 hr.		1		1,20	5
W-16-M-18	16-5/8"	Clay or shale structural tile core; See notes 4,7,11,18; Facings: Side 1-See note 17; Side 2 None.	80 PSI	8 hr.		1		1,20	8
W-16-M-19	16-5/8"	Clay or shale structural tile core; See notes 4,7,11,19; Facings: Fire side only; See note 17.	80 PSI	6 hr.		1		1,20	6
W-16-M-20	16-5/8"	Clay or shale structural tile core; See notes 4,8,13,18; Facings: Side 1-See note 17; Side 2-Same as side 1.	80 PSI	11 hr.		1		1,20	11
W-16-M-21	16-5/8"	Clay or shale structural tile core; See notes 4,8,13,18; Facings: Side 1-See note 17; Side 2 None.	80 PSI	9 hr.		1		1,20	9
W-16-M-22	16-5/8"	Clay or shale structural tile core; See notes 4,8,13,19; Facings: Fire side only; See note 17.	80 PSI	6 hr.		1		1,20	6
W-16-M-23	16-5/8"	Clay or shale structural tile core; See notes 4,8,15,18; Facings: Side 1-See note 17; Side 2 None.	80 PSI	10 hr.		1		1,20	10
W-16-M-24	16-5/8"	Clay or shale structural tile core; See notes 4,8,15,19; Facings: Fire side only; See note 17.	80 PSI	7 hr.		1		1,20	7
W-16-M-25	16-5/8"	Clay or shale structural tile core; See notes 4,6,16,18; Facings: Side 1-See note 17; Side 2-None	80 PSI	11 hr.		1		1,20	11
W-16-M-26	16-5/8"	Clay or shale structural tile core; See notes 4,6,16,19; Facings: Fire side only, see note 17.	80 PSI	8 hr.		1		1,20	8
W-17-M-27	17⅛"	Clay or shale structural tile core; See notes 4,7,9,18; Facings: Side 1 & 2 - See note 17.	80 PSI	8 hr.		1		1,20	8
W-17-M-28	17⅛"	Clay or shale structural tile core; See notes 4,7,10,18; Facings: Side 1 & 2: See note 17.	80 PSI	9 hr.		1		1,20	9
W-17-M-29	17⅛"	Clay or shale structural tile core; See notes 4,7,11,18; Facings: Side 1 & 2: See note 17.	80 PSI	10 hr.		1		1,20	10
W-17-M-30	17⅛"	Clay or shale structural tile core; See notes 4,8,15,18; Facings: Side 1 & 2: See note 17.	80 PSI	12 hr.		1		1,20	12
W-17-M-31	17⅛"	Clay or shale structural tile core; See notes 4,6,16,18; Facings: Side 1 & 2: See note 17.	80 PSI	13 hr.		1		1,20	13

Notes:

1. Tested at NBS - ASA Spec. A2-1934.
2. One unit in wall thickness.
3. Two units in wall thickness.
4. Two or three units in wall thickness.
5. Two cells in wall thickness.
6. Three or four cells in wall thickness.
7. Four or five cells in wall thickness.
8. Five or six cells in wall thickness.
9. Minimum % of solid materials in units: 40%.
10. Minimum % of solid materials in units: 43%.
11. Minimum % of solid materials in units: 46%.
12. Minimum % of solid materials in units: 48%.
13. Minimum % of solid materials in units: 49%.
14. Minimum % of solid materials in units: 45%.
15. Minimum % of solid materials in units: 51%.
16. Minimum % of solid materials in units: 53%.
17. Not less than 5/8" thickness of 1:3 sanded gypsum plaster.
18. Non-combustible or no members framed into wall.
19. Combustible members framed into wall.
20. Load: 80 PSI for gross area.
21. Portland cement - lime mortar.
22. Failure mode - thermal.
23. British test.
24. Passed all criteria.
25. Failed by sudden collapse with no preceding signs of impending failure.
26. One cell in wall thickness.
27. Two cells in wall thickness.
28. Three cells in wall thickness.
29. Minimum % of solid material in concrete units: 52%.
30. Minimum % of solid material in concrete units: 54%.
31. Minimum % of solid material in concrete units: 55%.
32. Minimum % of solid material in concrete units: 57%.
33. Minimum % of solid material in concrete units: 60%.
34. Minimum % of solid material in concrete units: 62%.
35. Minimum % of solid material in concrete units: 65%.
36. Minimum % of solid material in concrete units: 70%.
37. Minimum % of solid material in concrete units: 76%.
38. Not less than ½" of 1:3 sanded gypsum plaster.
39. Three units in wall thickness.
40. Concrete units made with expanded slag or pumice aggregates.
41. Concrete units made with expanded burned clay or shale, crushed limestone, air cooled slag or cinders.
42. Concrete units made with calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.
43. Concrete units made with siliceous sand and gravel. 90% or more quartz, chert, or flint.

Figure 1.2.1
Walls- Metal Frame

0" to less than 4" thick

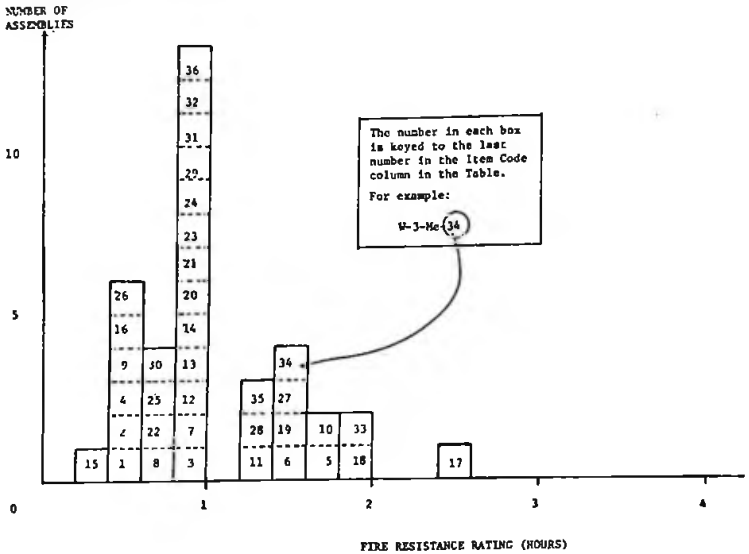


Table 1.2.1
Walls- Metal Frame

0" to less than 4" thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-3-Me-1	3"	Core: Steel channels having 3 rows of 4"x 1/8" staggered slots in web. Core filled with heat expanded vermiculite weighing 1.5 lb/ft^2 of wall area; Facings: Side 1 - 18 gage steel, spot welded to core; Side 2 - Same as side 1.	n/a	25min		1			1/3
W-3-Me-2	3"	Core: Steel channels having 3 rows of 4"x 1/8" staggered slots in web; core filled with heat expanded vermiculite weighing 2 lb/ft^2 of wall area; Facings: Side 1 and 2 - 18 gage steel, spot welded to core.	n/a	30min		1			½
W-2-Me-3	2½"	Solid partition - 3/8" tension rods (vertical) 3' O.C. with metal lath; Scratch coat - cement/sand/lime plaster; float coats - cement/sand/lime plaster; finish coats - neat gypsum plaster.	n/a	1 hr.			7	1	1
W-2-Me-4	2"	Solid wall: steel channel per note 1, 2" thickness of 1:2, 1:3 portland cement on metal lath.	n/a	30min.		1			½
W-2-Me-5	2"	Solid wall: steel channel per note 1, 2" thickness of neat gypsum plaster on metal lath.	n/a	1 hr. 45 min		1			1-3/4
W-2-Me-6	2"	Solid wall: steel channel per note 1, 2" thickness of 1:½, 1:½ gypsum plaster on metal lath.	n/a	1 hr. 30 min		1			1½

Thickness 0" to Less Than 4"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-2-He-7	2"	Solid wall: steel channel per note 2, 2" thickness of 1:1, 1:1 gypsum plaster on metal lath.	n/a	1 hr.		1			1
W-2-He-8	2"	Solid wall: steel channel per note 1, 2" thickness of 1:2, 1:2 gypsum plaster on metal lath.	n/a	45 min		1			3/4
W-2-He-9	2¼"	Solid wall: steel channel per note 2, 2¼" thickness of 1:2, 1:3 portland cement on metal lath	n/a	30 min		1			½
W-2-He-10	2¼"	Solid wall: steel channel per note 2, 2¼" thickness of neat gypsum plaster on metal lath.	n/a	2 hrs.		1			2
W-2-He-11	2¼"	Solid wall: steel channel per note 2, 2¼" thickness of 1:½, 1:½ gypsum plaster on metal lath.	n/a	1 hr. 45 min		1			1-3/4
W-2-He-12	2¼"	Solid wall: steel channel per note 2, 2¼" thickness of 1:1, 1:1 gypsum plaster on metal lath.	n/a	1 hr. 15 min		1			1½
W-2-He-13	2¼"	Solid wall: steel channel per note 2, 2¼" thickness of 1:2, 1:2 gypsum plaster on metal lath.	n/a	1 hr.		1			1
W-2-He-14	2½"	Solid wall: steel channel per note 1; 2½" thickness of 4.5:1:7, 4.5:1:7 portland cement, sawdust, and sand sprayed on wire mesh. (see note 3 for wire mesh).	n/a	1 hr.		1			1
W-2-He-15	2½"	Solid wall: steel channel per note 2; 2½" thickness of 1:4, 1:4 portland cement spray on wire mesh (per note 3).	n/a	20 min		1			1/3
W-2-He-16	2½"	Solid Wall: steel channel per note 2, 2½" thickness of 1:2, 1:3 portland cement on metal lath	n/a	30min		1			½
W-2-He-17	2½"	Solid wall: steel channel per note 2, 2½" thickness of neat gypsum plaster on metal lath.	n/a	2 hr. 30 min		1			2½
W-2-He-18	2½"	Solid wall: steel channel per note 2, 2½" thickness of 1:½, 1:½ gypsum plaster on metal lath.	n/a	2 hr.		1			2
W-2-He-19	2½"	Solid wall: steel channel per note 2, 2½" thickness of 1:1, 1:1 gypsum plaster on metal lath.	n/a	1 hr. 30min		1			1½
W-2-He-20	2½"	Solid wall: steel channel per note 2, 2½" thickness of 1:2, 1:2, gypsum plaster on metal lath.	n/a	1 hr.		1			1
W-2-He-21	2½"	Solid wall: steel channel per note 2, 2½" thickness of 1:2, 1:3 gypsum plaster on metal lath.	n/a	1 hr.		1			1
W-3-He-22	3"	Core: steel channels per note 2, 1:2, 1:2 gypsum plaster on 3/4" soft asbestos lath, plaster thickness 2".	n/a	45min		1			3/4
W-3-He-23	3½"	Solid wall: steel channel per note 2, 2½" thickness of 1:2, 1:2 gypsum plaster on 3/4" asbestos lath.	n/a	1 hr.		1			1
W-3-He-24	3½"	Solid wall: steel channel per note 2, lath over and 1:2½, 1:2½ gypsum plaster on 1" magnesium oxysulfate wood fiberboard, plaster thickness 2¼".	n/a	1 hr.		1			1

Thickness 0" to Less than 4"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-3-Me-25	3½"	Core: steel studs, note 4; Facings 3/4" thickness of 1:1/30:2, 1:1/30:3 portland cement and asbestos fiber plaster.	n/a	45min		1			3/4
W-3-Me-26	3½"	Core: steel studs, note 4; Facings: both sides 3/4" thickness of 1:2, 1:3 portland cement.	n/a	30min		1			½
W-3-Me-27	3½"	Core: steel studs per note 4; Facings: both sides 3/4" thickness of neat gypsum plaster.	n/a	1 hr. 30min		1			1½
W-3-Me-28	3½"	Core: steel studs per note 4; Facings: both sides 3/4" thickness of 1:½, 1:½ gypsum plaster.	n/a	1 hr. 15min		1			1½
W-3-Me-29	3½"	Core: steel studs, note 4; Facings: both sides 3/4" thickness of 1:2, 1:2 gypsum plaster.	n/a	1 hr.		1			1
W-3-Me-30	3½"	Core: steel studs, note 4; Facings: both sides 3/4" thickness of 1:2, 1:3 gypsum plaster.	n/a	45min		1			3/4
W-3-Me-31	3-3/4"	Core: steel studs, note 4; Facings: both sides 7/8" thickness of 1:1/30:2, 1:1/30:3 portland cement and asbestos fiber plaster.	n/a	1 hr.		1			1
W-3-Me-32	3-3/4"	Core: steel studs, note 4; Facings: both sides 7/8" thickness of 1:2, 1:3 portland cement.	n/a	45 min		1			3/4
W-3-Me-33	3-3/4"	Core: steel studs, note 4; Facings: both sides 7/8" thickness of neat gypsum plaster.	n/a	2 hr.		1			2
W-3-Me-34	3-3/4"	Core: steel studs per note 4; Facings: both sides 7/8" thickness of 1:½, 1:½ gypsum plaster.	n/a	1 hr. 30min		1			1½
W-3-Me-35	3-3/4"	Core: steel studs per note 4; Facings: both sides 7/8" thickness of 1:2, 1:2 gypsum plaster	n/a	1 hr. 15min		1			1½
W-3-Me-36	3-3/4"	Core: steel per note 4; Facings: 7/8" thickness of 1:2, 1:3 gypsum plaster on both sides.	n/a	1 hr.		1			1

Notes:

TABLE 1.2.1

1. Failure mode - local temperature rise - back face.
2. 3/4" or 1" channel framing - hot-rolled or strip-steel channels.
3. Reinforcement is 4" square mesh of No. 6 wire welded at intersections (no channels).
4. Ratings are for any usual type of non-load-bearing metal framing providing 2"(or more) air space.

General Note:

The construction details of the wall assemblies are as complete as the source documentation will permit. Data on the method of attachment of facings and the gauge of steel studs was provided when known. The cross-sectional area of the steel stud can be computed, thereby permitting a reasoned estimate of actual loading conditions. For load-bearing assemblies, the maximum allowable stress for the steel studs has been provided in the table "Notes". More often, it is the thermal properties of the facing materials, rather than the specific gauge of the steel, that will determine the degree of fire resistance. This is particularly true for non-bearing wall assemblies.

Figure 1.2.2
Walls- Metal Frame

4" to less than 6" thick

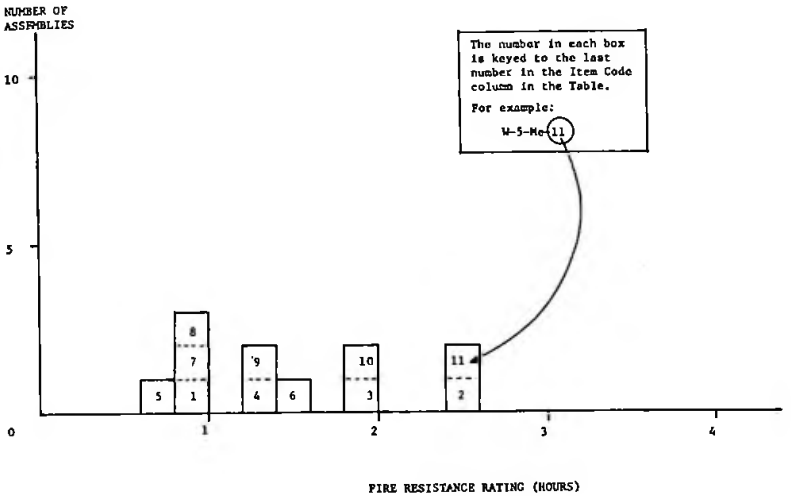


Table 1.2.2
Walls- Metal Frame

4" to less than 6" thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-5-Me-1	5½"	3" cavity with 16 ga. channel studs (3½' O.C.) of ½"x ½" channel and 3" spacer. Metal lath on ribs with plaster (3 coats) 3/4" over face of lath. Plaster (each side) - scratch coat - cement/lime/sand with hair; float coat - cement/lime/sand; finish coat - neat gypsum.	n/a	1 hr. 11min.			7	1	1
W-4-Me-2	4"	Core: Steel studs per note 2; Facings: Both sides 1" thickness of neat gypsum plaster.	n/a	2½ hr.		1			2½
W-4-Me-3	4"	Core: Steel studs, note 2; Facings: both sides 1" thickness of 1:¼, 1:½ gypsum plaster.	n/a	2 hr.		1			2
W-4-Me-4	4"	Core: Steel per note 2; Facings: Both sides 1" thickness of 1:2, 1:3 gypsum plaster.	n/a	1¼ hr.		1			1¼
W-4-Me-5	4½"	Core: Lightweight steel stud 3" in depth; Facings: Both sides 3/4" thick sanded gypsum plaster, 1:2 scratch coat, 1:3 brown coat applied on metal lath.	See Note 4	45min.		1		5	3/4
W-4-Me-6	4½"	Core: lightweight steel studs 3" in depth; Facings: both sides 3/4" thick neat gypsum plaster on metal lath.	See Note 4	1 hr. 30min.		1		5	1½

Thickness 4" to Less Than 6"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-4-Me-7	4½"	Core: lightweight steel studs 3" in depth; Facings: both sides 3/4" thick sanded gypsum plaster, 1:2 scratch and brown coats applied over metal lath.	See Note 4	1 hr.		1		5	1
W-4-Me-8	4-3/4"	Core: lightweight steel studs 3" in depth; Facings: both sides 7/8" thick sanded gypsum plaster, 1:2 scratch, 1:3 brown, applied over metal lath.	See Note 4	1 hr.		1		5	1
W-4-Me-9	4-3/4"	Core: lightweight steel studs 3" in depth; Facings: both sides 7/8" thick sanded gypsum plaster 1:2 scratch and brown coats applied on metal lath.	See Note 4	1 hr. 15 min		1		5	1¼
W-5-Me-10	5"	Core: lightweight steel studs 3" in depth; Facings: both sides 1" thick neat gypsum plaster on metal lath.	See Note 4	2 hr.		1		5	2
W-5-Me-11	5"	Core: lightweight steel studs 3" in depth; Facings: both sides 1" thick neat gypsum plaster on metal lath.	See Note 4	2 hr. 30 min.		1		5,6	2½

Notes:

TABLE 1.2.2

1. Failure mode - local back face temperature rise.
2. Ratings are for any usual type of non-bearing metal framing providing a minimum 2" air space.
3. Facing materials secured to lightweight steel studs not less than 3" deep.
4. Rating based on loading to develop a maximum stress of 7270 PSI for net area of each stud.
5. Spacing of steel studs must be sufficient to develop adequate rigidity in the metal-lath or gypsum-plaster base.
6. As per note 4 but load/stud not to exceed 5120 PSI.

General Note:

The construction details of the wall assemblies are as complete as the source documentation will permit. Data on the method of attachment of facings and the gauge of steel studs was provided when known. The cross-sectional area of the steel stud can be computed, thereby permitting a reasoned estimate of actual loading conditions. For load-bearing assemblies, the maximum allowable stress for the steel studs has been provided in the table "Notes". More often, it is the thermal properties of the facing materials, rather than the specific gauge of the steel, that will determine the degree of fire resistance. This is particularly true for non-bearing wall assemblies.

Table 1.2.3
Walls- Metal Frame

6" to less than 8" thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-6-Me-1	6-5/8"	On one side of 1" magnesium oxysulfate wood fiberboard sheathing attached to steel studs (see notes 1 and 2), 1" air space, and 3-3/4" brick secured with metal ties to steel frame every fifth course; Inside facing of 7/8" 1:2 sanded gypsum plaster on metal lath secured directly to studs; Plaster side exposed to fire.	See Note 2	1-3/4 hour		1		1	1-3/4
W-6-Me-2	6-5/8"	On one side, of 1" magnesium oxysulfate wood fiberboard sheathing attached to steel studs (see notes 1 and 2), 1" air space, and 3-3/4" brick secured with metal ties to steel frame every 5th course. Inside facing of 7/8" 1:2 sanded gypsum plaster on metal lath secured directly to studs; Brick face exposed to fire.	See Note 2	4 hr.		1		1	4
W-6-Me-3	6-5/8"	On one side of 1" magnesium oxysulfate wood fiberboard sheathing attached to steel studs (see notes 1 and 2), 1" air space, and 3-3/4" brick secured with metal ties to steel frame every 5th course. Inside facing of 7/8" vermiculite plaster on metal lath secured directly to studs. Plaster side exposed to fire.	See Note 2	2 hr.		1		1	2

Notes:

TABLE 1.2.3

1. Lightweight steel studs (minimum 3" deep) used. Stud spacing dependent on loading, but in each case, spacing is to be such that adequate rigidity is provided to the metal lath plaster base.

2. Load is such that stress developed in studs is not greater than 5120 PSI calculated from net stud area.

General Note:

The construction details of the wall assemblies are as complete as the source documentation will permit. Data on the method of attachment of facings and the gauge of steel studs was provided when known. The cross-sectional area of the steel stud can be computed, thereby permitting a reasoned estimate of actual loading conditions. For load-bearing assemblies, the maximum allowable stress for the steel studs has been provided in the table "Notes". More often, it is the thermal properties of the facing materials, rather than the specific gauge of the steel, that will determine the degree of fire resistance. This is particularly true for non-bearing wall assemblies.

Table 1.2.4
Walls- Metal Frame

8" to less than 10" thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-9-Me-1	9-1/16"	On one side of ½" wood fiberboard sheathing next to studs, 3/4" air space formed with 3/4" x 1-5/8" wood strips placed over the fiberboard and secured to the studs; paper backed wire lath nailed to strips 3-3/4" brick veneer held in place by filling a 3/4" space between the brick and paper backed lath with mortar. Inside facing of 3/4" neat gypsum plaster on metal lath attached to 5/16" plywood strips secured to edges of steel studs. Rated as combustible because of the sheathing. See notes 1 and 2. Plaster exposed.	See Note 2	1½ hr		1		1	1½
W-9-Me-2	9-1/16"	Same as above with brick exposed.	See Note 2	4 hr.		1		1	4
W-8-Me-3	8½"	On one side, of paper backed wire lath attached to studs and 3-3/4" brick veneer held in place by filling a 1" space between the brick and lath with mortar. Inside facing of 1" paper-enclosed mineral wool blanket weighing .6 lb/ft^2 attached to studs, metal lath or paper backed wire lath laid over the blanket and attached to the studs, and 3/4" sanded gypsum plaster 1:2 for the scratch and 1:3 for the brown coat. (See notes 1 and 2.) Plaster face exposed.	See Note 2	4 hr.		1		1	4
W-8-Me-4	8½"	Same as above with brick exposed.	See Note 2	5 hr.		1		1	5

Notes:

TABLE 1.2.4

1. Lightweight steel studs $\geq$ 3" in depth. Stud spacing is dependent upon loading but in any case the spacing is to be such that adequate rigidity is provided to the metal-lath plaster base.

2. Load is such that the stress developed in the steel studs is $\leq$ 5,120 psi calculated from the net area of the stud.

General Note:

The construction details of the wall assemblies are as complete as the source documentation will permit. Data on the method of attachment of facings and the gauge of steel studs was provided when known. The cross-sectional area of the steel stud can be computed, thereby permitting a reasoned estimate of actual loading conditions. For load-bearing assemblies, the maximum allowable stress for the steel studs has been provided in the table "Notes". More often, it is the thermal properties of the facing materials, rather than the specific gauge of the steel, that will determine the degree of fire resistance. This is particularly true for non-bearing wall assemblies.

Table 1.3.1
Wood Frame Walls

0" to less than 4" thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-3-W-1	3-3/4	Solid Wall - 2½" Wood-Wool Slab Core; 3/4" Gypsum Plaster Each Side	N/A	2 hrs			7	1,6	2
W-3-W-2	3-7/8"	2 x 4 stud wall, 3/16" thick cement asbestos board on both sides of wall.	360PSI net area	10 min		1		2-5	1/6
W-3-W-3	3-7/8"	Same as W-3-W-2 but stud cavities filled with 1 lb/ft^2 mineral wool batts.	360PSI net area	40 min		1		2-5	2/3

Notes:

TABLE 1.3.1

1. Achieved "Grade C" Fire Resistance (British).
2. Nominal 2 x 4 wood studs of No. 1 Common or better lumber set edgewise, 2 x 4 plates at top and bottom and blocking at mid-height of wall.
3. All horizontal joints in facing material backed by 2 x 4 blocking in wall.
4. Load = 360 psi of net stud cross-sectional area.
5. Facings secured with 6 d casing nails. Nail holes predrilled and 0.02"- 0.03" smaller than nail diameter.
6. The wood-wool core is a pressed excelsior slab which possesses insulating properties similar to cellulosic insulation.

Figure 1.3.2
Wood Frame Walls

4" to less than 6" thick

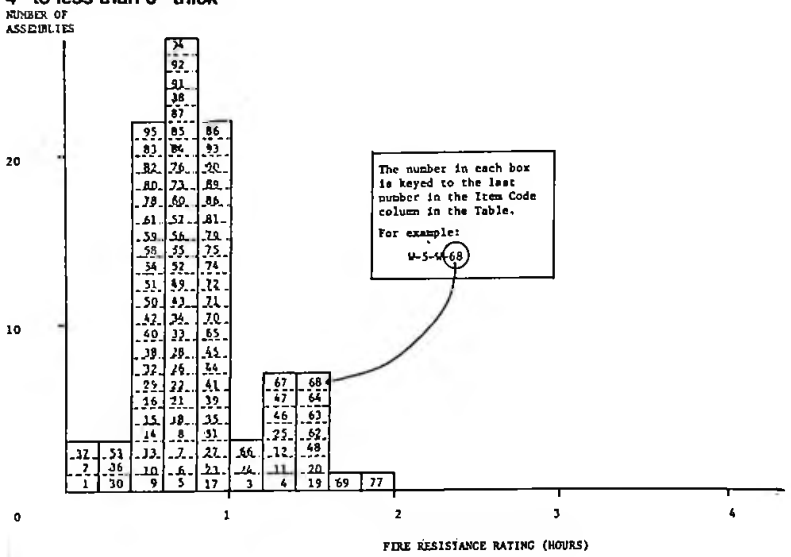


Table 1.3.2
Wood Frame Walls

4" to less than 6" thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-4-W-1	4"	2" x 4" Stud Wall; 3/16" CAB; No insulation Design A.	35min.	10min.			4	1-10	1/6
W-4-W-2	4-1/8"	2" x 4" Stud Wall; 3/16" CAB; No insulation Design A.	38min.	9 min.			4	1-10	1/6
W-4-W-3	4-3/4"	2" x 4" Stud Wall; 3/16" CAB and 3/8" Gypsum board face (both sides); Design B.	62min.	64min.			4	1-10	1
W-5-W-4	5"	2" x 4" Stud Wall; 3/16" CAB and 1/2" Gypsum board face (both sides); Design B.	79min.	Greater than 90 min.			4	1-10	1
W-4-W-5	4-3/4"	2" x 4" Stud Wall; 3/16" CAB and 3/8" Gypsum board (both sides); Design B.	45min.	45min.			4	1-12	—
W-5-W-6	5"	2" x 4" Stud Wall; 3/16" CAB and 1/2" Gypsum board face (both sides); Design B.	45min.	45min.			4	1-10 12-13	—
W-4-W-7	4"	2" x 4" Stud Wall; 3/16" CAB face; 3½"Mineral Wool Insulation; Design C.	40min.	42min.			4	1-10	2/3
W-4-W-8	4"	2" x 4" Stud Wall; 3/16" CAB face; 3½"Mineral Wool Insulation; Design C.	46min.	46min.			4	1-10, 43	2/3
W-4-W-9	4"	2" x 4" Stud Wall; 3/16"CAB face; 3½" Mineral Wool Insulation; Design C.	30min.	30min.			4	1-10, 12,14	—

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-4-W-10	4-1/8"	2" x 4" Stud Wall; 3/16" CAB face; 3½" Mineral Wool Insulation; Design C.	—	30min.			4	1-8 12,14	—
W-4-W-11	4-3/4"	2" x 4" Stud Wall; 3/16" CAB face; 3/8" Gypsum Strips over Studs; 5½" Mineral Wool Insulation Design D.	79min.	79min.			4	1-10	1
W-4-W-12	4-3/4"	2" x 4" Stud Wall; 3/16" CAB face; 3/8" Gypsum Strips @ Stud Edges; 7½" Mineral Wool Insul.; Design D.	82min.	82min.			4	1-10	1
W-4-W-13	4-3/4"	2" x 4" Stud Wall; 3/16" CAB face; 3/8" Gypsum board strips over studs; 5½" Mineral Wool Ins. Design D.	30min.	30min.			4	1-12	—
W-4-W-14	4-3/4"	2" x 4" Stud Wall; 3/16" CAB face; 3/8" Gypsum board strips over studs; 7" Mineral Wool Ins.; Design D.	30min.	30min.			4	1-12	—
W-5-W-15	5½"	2" x 4" Stud Wall; Exposed face - CAB Shingles over 1" x 6"; Unexposed face - 1/8" CAB Sheet; 7/16" fiberboard (Wood); Design E.	34min.	—			4	1-10	½
W-5-W-16	5½"	2" x 4" Stud Wall; Exposed face - 1/8" CAB Sheet; 7/16 Fiberboard; Unexposed face - CAB Shingles over 1" x 6"; Design E.	32min.	33min.			4	1-10	½
W-5-W-17	5½"	2" x 4" Stud Wall; Exposed face - CAB Shingles over 1" x 6"; Unexposed face - 1/8" CAB Sheet; Gypsum @ stud edges; 3½" Mineral Wool Ins.; Design F.	51min.	—			4	1-10	3/4
W-5-W-18	5½"	2" x 4" Stud Wall; Exposed face - 1/8" CAB Sheet; Gypsum board @ Stud Edges; Unexposed face - CAB Shingles over 1" x 6"; 3½" Mineral Wool Insulation; Design F.	42min	—			4	1-10	2/3
W-5-W-19	5-5/8"	2" x 4" Stud Wall; Exposed face - CAB Shingles over 1" x 6"; Unexposed face - 1/8" CAB Sheet, Gypsum board @ Stud edges; 5½" Mineral Wool Insulation; Design G.	74min	85min			4	1-10	1
W-5-W-20	5-5/8"	2" x 4" Stud Wall; Unexposed face - CAB Shingles over 1"x6"; Exposed face - 1/8" CAB Sheet, Gypsum board @ 3/16" Stud edges; 7/16" Fiberboard; 5½" Mineral Wool Insul.; Design G.	79min	85min			4	1-10	1½
W-5-W-21	5-5/8"	2" x 4" Stud Wall; Exposed face - CAB Shingles 1"x 6" sheathing; Unexposed face - CAB Sheet, Gypsum board @ Stud edges; 5½" Mineral Wool Insulation; Design G.	38min	38min			4	1-10 12,14	—
W-5-W-22	5-5/8"	2" x 4" Stud Wall; Exposed face- CAB Sheet, Gypsum board @ Stud edges; Unexposed face - CAB Shingles 1"x 6" sheathing; 5½" Mineral Wood Insulation; Design G.	38min	38min			4	1-12	—
W-6-W-23	6"	2" x 4" Stud Wall; 16" O.C.; ½" Gypsum board each side; ½" gypsum plaster each side.	N/A	60min.			7	15	1
W-6-W-24	6"	2" x 4" Stud Wall; 16" O.C.; ½" Gypsum board each side; ½" Gypsum plaster each side.	N/A	68min.			7	16	1
W-6-W-25	6-7/8"	2" x 4" Stud Wall; 18" O.C.; 3/4" Gypsum plank each side; 3/16" Gypsum plaster each side.	N/A	80min.			7	15	1-1/3
W-5-W-26	5-1/8"	2" x 4" Stud Wall; 16" O.C.; 3/8" Gypsum board each side; 3/16" Gypsum plaster each side.	N/A	37min.			7	15	½
W-5-W-27	5-3/4"	2" x 4" Stud Wall; 16" O.C.; 3/8" Gypsum lath each side; ½" Gypsum plaster each side.	N/A	52min.			7	15	3/4
W-5-W-28	5"	2" x 4" Stud Wall; 16" O.C.; ½" Gypsum board each side.	N/A	37min.			7	16	½
W-5-W-29	5"	2" x 4" Stud Wall; 1/2" Fiberboard both sides 14% M.C. with F.R. Point @ 35 gm/ft^2.	N/A	28min.			7	15	1/3
W-4-W-30	4-3/4"	2" x 4" Stud Wall; Fire Side - ½"(Wood) Fiberboard; Back face - ½" CAB; 16" O.C.	N/A	17min.			7	15,16	¼

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-5-W-31	5-1/8"	2" x 4" Stud Wall; 16" O.C.; ½" Fiberboard Insulation with 1/32" Asbestos (both sides of each board).	N/A	50min.			7	16	3/4
W-4-W-32	4½"	2"x4" Stud Wall; 3/8" thick gypsum wallboard on both faces; insulated cavities.	note 23	25min.		1		17,18 23	1/3
W-4-W-33	4½"	2"x 4" Stud Wall; ½" thick gypsum wallboard on both faces.	note 17	40min.		1		17,23	2/3
W-4-W-34	4½"	2"x 4" Stud Wall; ½" thick gypsum wallboard on both faces; insulated cavities.	note 17	45min.		1		17,18 23	3/4
W-4-W-35	4½"	2"x 4" Stud Wall; ½" thick gypsum wallboard on both faces; insulated cavities.	N/A	1 hr.		1		17,18 24	1
W-4-W-36	4½"	2"x 4" Stud Wall; ½" thick, 1.1lb/ft^2 wood fiberboard sheathing on both faces.	note 23	15min.		1		17,23	1/4
W-4-W-37	4½"	2"x 4" Stud Wall; ½" thick, 0.7lb/ft^2 wood fiberboard sheathing on both faces.	note 23	10min.		1		17,23	1/6
W-4-W-38	4½"	2"x 4" Stud Wall; ½", "flameproofed", 1.6lb/ft^2 wood fiberboard sheathing on both faces.	note 23	30min.		1		17,23	½
W-4-W-39	4½"	2"x 4" Stud Wall; ½" thick gypsum wallboard on both faces; insulated cavities.	note 23	hr.		1		17,18 23	1
W-4-W-40	4½"	2"x 4" Stud Wall; ½" thick, 1:2, 1:3 gypsum plaster on wood lath on both faces.	note 23	30min.		1		17,21, 23	½
W-4-W-41	4½"	2"x 4" Stud Wall; ½" thick, 1:2, 1:3 gypsum plaster on wood lath on both faces; insulated cavities.	note 23	hr.		1		17,18, 21,23	1
W-4-W-42	4½"	2"x 4" Stud Wall; ½" thick, 1:5, 1:7.5 lime plaster on wood lath on both wall faces.	note 23	30min.		1		17,21, 23	½
W-4-W-43	4½"	2"x 4" Stud Wall; ½" thick 1:5, 1:7.5 lime plaster on wood lath on both faces, insulated cavities.	note 23	45 min		1		17,18, 21,23	3/4
W-4-W-44	4-5/8"	2" x 4" stud wall; 3/16" thick cement-asbestos over 3/8" thick gypsum board on both faces.	note 23	1 hr.		1		25,26, 23,27	1
W-4-W-45	4-5/8"	2"x 4" Stud Wall; studs faced with 4" wide strips of 3/8" thick gypsum board; 3/16" thick cement-asbestos board on both faces; insulated cavities.	note 23	1 hr.		1		23,25, 28,27	1
W-4-W-46	4-5/8"	Same as W-4-W-45 but non-load bearing.	N/A	1¼ hr		1		24,28	1¼
W-4-W-47	4-7/8"	2" x 4" Stud wall; 3/16 thick cement asbestos board over ½" thick gypsum sheathing on both faces.	note 23	1¼ hr.		1		23,25, 27,26	1¼
W-4-W-48	4-7/8"	Same as W-4-W-47 but non-load bearing.	N/A	1¼ hr.		1		24,27	1¼
W-5-W-49	5"	2"x 4" Stud Wall; exterior face: 3/4" wood sheathing, asbestos felt 14 lb/100 ft^2 and 5/32" cement-asbestos shingles. Interior face: 4" wide strips of 3/8" gypsum board over studs; wall faced with 3/16" thick cement asbestos board.	note 23	40min		1		18,23, 25,26, 29	2/3
W-5-W-50	5"	2"x 4" Stud Wall; exterior face as per W-5-W-49; Interior face: 9/16" composite board consisting of 7/16" thick wood fiber board faced with 1/8" thick cement asbestos board; Exterior side exposed to fire.	note 23	30 min		1		23,25 26, 30	½
W-5-W-51	5"	Same as W-5-W-50 but interior side exposed to fire.	note 23	30min		1		23,25 26	½
W-5-W-52	5"	Same as W-5-W-49 but exterior side exposed to fire.	note 23	45min		1		18,23 25,26	3/4
W-5-W-53	5"	2"x 4" Stud Wall; 3/4" thick T&G wood boards on both sides.	note 23	20min		1		17,23	1/3

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-S-W-54	5"	Same as W-S-W-53 but with insulated cavities.	note 23	35min.		1		17,18 23	½
W-S-W-55	5"	2"x 4" Stud Wall; 3/4" thick T&G wood boards on both sides with 30 lb/100 ft^2 asbestos, paper between studs and boards.	note 23	45min		1		17,23	3/4
W-S-W-56	5"	2"x 4" Stud Wall; ½" thick, 1:2, 1:3 gypsum plaster on metal lath on both sides of wall.	note 23	45min		1		17,21 23	3/4
W-S-W-57	5"	2"x 4" Stud Wall; 3/4" thick 2:1:8, 2:1:12 lime and Keene's cement plaster on metal lath, both sides of wall.	note 23	45min.		1		17,21 23	3/4
W-S-W-58	5"	2"x 4" Stud Wall; 3/4" thick 2:1:8, 2:1:10 lime portland cement plaster over metal lath on both sides of wall.	note 23	30min.		1		17,21 23	½
W-S-W-59	5"	2"x 4" Stud Wall, 3/4" Thick 1:5, 1:7,5 lime plaster on metal lath on both sides of wall.	note 23	30min.		1		17,21 23	½
W-S-W-60	5"	2"x 4" Stud Wall, 3/4" thick, 1:1/30:2, 1:1/30: 3 portland cement, asbestos fiber plaster on metal lath on both sides of wall.	note 23	45min.		1		17,21, 23	3/4
W-S-W-61	5"	2"x 4" Stud Wall, 3/4" thick 1:2, 1:3 portland cement plaster on metal lath on both sides of wall.	note 23	30min.		1		17,21, 23	½
W-S-W-62	5"	2"x 4" Stud Wall, 3/4" thick neat plaster on metal lath on both sides of wall.	N/A	1 hr. 30min.		1		17,22, 24	1½
W-S-W-63	5"	2"x 4" Stud Wall, 3/4" thick neat gypsum plaster on metal lath on both sides of wall.	note 23	1 hr. 30min.		1		17,21, 23	1½
W-S-W-64	5"	2"x 4" Stud Wall, 3/4" thick 1:2, 1:2 gypsum plaster on metal lath on both sides of wall, insulated cavities.	note 23	1 hr. 30min.		1		17,18, 21,23	1½
W-S-W-65	5"	2"x 4" Stud Wall, same as W-S-W-64 but wall cavities not insulated.	note 23	1 hr.		1		17,21 23	1
W-S-W-66	5"	2"x 4" Stud Wall, 3/4" thick 1:2, 1:3 gypsum plaster on metal lath on both sides of wall, insulated cavities.	note 23	1 hr. 15min.		1		17,18, 21,23	1¼
W-S-W-67	5-1/16"	Same as W-S-W-49 except cavity insulation of 1-3/4 lb/ft^2 mineral wool bats. Rating applies when either wall side exposed to fire.	note 23	1 hr. 15min		1		23,26 25	1¼
W-S-W-68	5¼"	2"x 4" stud wall, 7/8" thick 1:2, 1:3 gypsum plaster on metal lath on both sides of wall, insulated cavities.	note 21	1 hr. 30min		1		17,18 21,23	1½
W-S-W-69	5¼"	2"x 4" Stud wall; 7/8" thick neat gypsum plaster applied on metal lath, on both sides of wall.	N/A	1 hr. 45min		1		17,22 24	1-3/4
W-S-W-70	5¼"	2"x 4" stud wall; ½" thick neat gypsum plaster on 3/8" plain gypsum lath, both sides of wall.	note 23	1 hr.		1		17,22 23	1
W-S-W-71	5¼"	2"x 4" stud wall; ½" thick, 1:2, 1:2 gypsum plaster on 3/8" thick plain gypsum lath with 1-3/4"x 1-3/4" metal lath pads nailed 8" O.C. vertically, 16" O.C. horizontally, both sides of wall.	note 23	1 hr.		1		17,21 23	1
W-S-W-72	5¼"	2"x 4" stud wall, ½" thick 1:2, 1:2 gypsum plaster on 3/8" perforated gypsum lath, one 3/4" diameter hole or larger per 16" sq. in. of lath surface, both sides of wall.	note 23	1 hr.		1		17,21 23	1
W-S-W-73	5¼"	2"x 4" stud wall, ½" thick 1:2, 1:2 gypsum plaster on 3/8" gypsum lath (plain, indented or perforated) both sides of wall.	note 23	45min		1		17,21 23	3/4

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-5-W-74	5½"	2"x 4" Stud Wall, 7/8" thick 1:2, 1:3 gypsum plaster over metal lath on both sides of wall.	note 23	1 hr.		1		17,21 23	1
W-5-W-75	5½"	2"x 4" Stud Wall, 7/8" thick 1:1/30:2, 1:1/30:3 portland cement, asbestos plaster applied over metal lath on both sides of wall.	note 23	1 hr.		1		17,21 23	1
W-5-W-76	5½"	2"x 4" Stud Wall, 7/8" thick 1:2, 1:3 portland cement plaster over metal lath on both sides of wall.	note 23	45min.		1		17,21 23	3/4
W-5-W-77	5½"	2"x 4" Stud Wall, 1" thick neat gypsum plaster over metal lath on both sides of wall, non-load bearing.	N/A	2 hr.		1		17,22 24	2
W-5-W-78	5½"	2"x 4" Stud Wall, ½" thick, 1:2, 1:2 gypsum plaster on ½" thick, 0.7 lb/ft^2 wood fiberboard both sides of wall.	note 23	35min.		1		17,21 23	½
W-4-W-79	4-3/4"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over wood lath on both sides of wall. Mineral wool insulation.	N/A	1 hr.			43	21,31 35,38	1
W-4-W-80	4-3/4"	Same as W-4-W-79 but uninsulated.	N/A	35min.			43	21,31 35	½
W-4-W-81	4-3/4"	2"x 4" wood stud wall. ½" thick, 3:1:8, 3:1:12 lime, Keene's cement, sand plaster over wood lath both sides of wall. Mineral wool insulation.	N/A	1 hr.			43	21,31 35, 40	1
W-4-W-82	4-3/4"	2"x 4" wood stud wall. ½" thick 1:6½, 1:6½ lime Keene's cement plaster over wood lath both sides of wall. Mineral wool insulation.	N/A	30min			43	21,31, 35,40	½
W-4-W-83	4-3/4"	2"x 4" wood stud wall. ½" thick, 1:5, 1:7.5 lime plaster over wood lath on both sides of wall.	N/A	30min.			43	21,31 35	½
W-5-W-84	5-1/8"	2"x 4" wood stud wall. 11/16" thick 1:5, 1:7.5 lime plaster over wood lath on both sides of wall. Mineral wool insulation.	N/A	45min.			43	21,31 35,39	½
W-5-W-85	5½"	2"x 4" wood stud wall. 3/4" thick 1:5, 1:7 lime plaster over wood lath on both sides of wall. Mineral wool insulation.	N/A	40min.			43	21,31 35,40	2/3
W-5-W-86	5½"	2"x 4" wood stud wall. ½" thick 2:1:12 lime, Keene's cement and sand scratch coat, ½" thick 2:1:18 lime, Keene's cement, sand sand brown coat over wood lath on both sides of wall. Mineral wool insulation.	N/A	1 hr.			43	21,31, 35,40	1
W-5-W-87	5½"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over 3/8" thick plaster board on both sides of wall.	N/A	45min.			43	21,31	3/4
W-5-W-88	5½"	2"x 4" wood stud wall, ½" thick 1:2, 1:2 gypsum plaster over 3/8" thick gypsum lath on both sides of wall.	N/A	45min.			43	21,31	3/4
W-5-W-89	5½"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over 3/8" gypsum lath, on both sides of wall.	N/A	1 hr.			43	21.31 33	1
W-5-W-90	5½"	2"x 4" wood stud wall. ½" thick neat plaster over 3/8" thick gypsum lath, on both sides of wall.	N/A	1 hr.			43	21,22, 31	1
W-5-W-91	5½"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over 3/8" thick indented gypsum lath, on both sides of wall.	N/A	45min			43	21,31	3/4
W-5-W-92	5½"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over perforated gypsum lath, 3/8" thick on both wall faces.	N/A	45min			43	21,31 34	3/4
W-5-W-93	5½"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over 3/8" thick perforated gypsum lath on both sides of wall.	N/A	1 hr.			43	21,31	1

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-5-W-94	5¼"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over perforated gypsum lath 3/8" thick over both sides of wall.	N/A	45min			43	21,31 34	3/4
W-5-W-95	5¼"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over ½" thick wood fiberboard plaster base on both sides of wall.	N/A	35min			43	21,31, 36	½
W-5-W-96	5-3/4"	2"x 4" wood stud wall. 1/2" thick 1:2, 1:2 gypsum plaster over 7/8" thick flameproofed wood fiberboard, on both sides of wall.	N/A	1 hr.			43	21,31 37	1

Notes:

TABLE 1.3.2

1. All specimens 8' or 8'8" x 10'4" - i.e., ½ of furnace size. See note 42 for design cross section.
2. Specimens tested in tandem (two per exposure).
3. Test per ASA No. A-2-1934 except where unloaded. Also, panels were of "half" size of furnace opening. Time value signifies a thermal failure time.
4. 2 x 4 Studs - 16" O.C.; where 10'4", blocking @ 2'4" height.
5. Facing 4' x 8' - cement asbestos board sheets - 3/16" thick.
6. Sheathing (diagonal)- 25/32" x 5½" - 1" x 6" pine.
7. Facing Shingles - 24" x 12" x 5/32" where used.
8. Asbestos felt - asphalt sat between sheathing and shingles.
9. Load - 30,500 lbs or 360 PSI/stud where load was tested.
10. Walls were tested beyond achievement of first test end point. A load bearing time in excess of performance time indicates that although thermal criteria were exceeded load bearing ability continued.
11. Wall was rated for 1 hr. combustible use in original source.
12. Hose stream test specimen. See table entry of similar design above for recommended rating.
13. Rated 1¼ hour load bearing. Rated 1½ hour none-load bearing.
14. Failed hose stream.
15. Test terminated due to flame penetration.
16. Test terminated - local back face temperature rise.
17. Nominal 2 x 4 wood studs of No. 1 common or better lumber set edgewise. 2 x 4 plates at top and bottom and blocking at mid-height of wall.
18. Cavity insulation consists of rock wool bats 1.0 lb/ft^2 of filled cavity area.
19. Cavity insulation consists of glass-wool bats 0.6 lb/ft^2 of filled cavity area.
20. Cavity insulation consists of blown-in forck wool 2.0 lb/ft^2 of filled cavity area.
21. Mix proportions for plastered walls as follows: first ratio indicates scratch coat mix, weight of dry plaster: dry sand; second ratio indicates brown coat mix.
22. "Neat" plaster is taken to mean unsanded wood-fiber gypsum plaster.
23. Load = 360 psi of net stud cross-sectional area.
24. Rated as non load bearing.

NOTES

25. Nominal 2 x 4 studs per note 17, spaced at 16" on center.

26. Horizontal joints in facing material supported by 2 x 4 blocking within wall.

27. Facings secured with 6 d casing nails. Nail holes predrilled and were 0.02" - 0.03" smaller than nail diameter.

28. Cavity insulation consists of mineral wool bats weighing 2lb/ft^2 of filled cavity area.

29. Interior wall face exposed to fire.

30. Exterior wall face exposed to fire.

31. Nominal 2 x 4 studs of yellow pine or Douglas-fir spaced 16" on center in a single row.

32. Studs as in note 31 except double row, with studs in rows staggered.

33. Six roofing nails with metal-lath pads around heads to each 16"x 48" lath.

34. Areas of holes less than 2-3/4% of area of lath.

35. Wood laths were nailed with either 3 d or 4 d nails, one nail to each bearing, and the end joining broken every 7th course.

36. ½" thick fiberboard plaster base nailed with 3 d or 4 d common wire nails spaced 4" - 6" on center.

37. 7/8" thick fiberboard plaster base nailed with 5 d common wire nails spaced 4" - 6" on center.

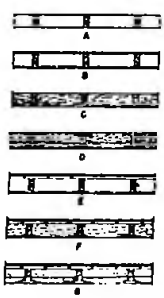
38. Mineral wool bats 1.05-1.25 lb/ft^2 with waterproofed-paper backing.

39. Blown-in mineral wool insulation, 2.2 lb/ft^2.

40. Mineral wool bats, 1.4 lb/fc^2 with waterproofed-paper backing.

41. Mineral wool bats, 0.9 lb/ft^2.

42. See wall design diagram, below.



43. Duplicate specimen of W-4-W-7, tested simultaneously with W-4-W-7 in 18 ft. test furnace.

Table 1.3.3

6" to less than 8" thick

WOOD FRAMED WALLS

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-6-W-1	6¼"	2 x 4 stud wall, ½" thick, 1:2, 1:2 gypsum plaster on 7/8" "Flame-proofed" wood fiberboard weighing 2.8 lb/ft^2 - both sides of wall.	note 3	1 hr		1		1-3	1
W-6-W-2	6½"	2 x 4 stud wall, ½" thick, 1:3, 1:3 gypsum plaster on 1" thick magnesium oxysulfate wood fiberboard - both sides of wall.	note 3	45min		1		1-3	3/4
W-7-W-3	7¼"	Double row of 2 x 4 studs, ½" thick 1:2, 1:2 gypsum plaster applied over 3/8" thick perforated gypsum lath on both sides of wall. Mineral wool insulation.	n/a	1 hr			43	2,4,5	1
W-7-W-4	7½"	Double row of 2 x 4 studs, 5/8" thick 1:2, 1:2 gypsum plaster applied over 3/8" thick perforated gypsum lath over laid with 2" x 2", 16 gage wire fabric, on both sides of wall.	n/a	1 hr 15min			43	2,4	1¼

Notes:

1. Nominal 2 x 4 wood studs of No. 1 common or better lumber set edgewise. 2 x 4 plates at top and bottom and blocking at mid-height of wall.
2. Mix proportions for plastered walls as follows: first ratio indicates scratch coat mix, weight of dry plaster; dry sand; second ration indicates brown coat mix.
3. Load = 360 psi of net stud cross-sectional area.
4. Nominal 2 x 4 studs of yellow pine of Douglas-fir spaced 16" in a double row, with studs in rows staggered.
5. Mineral wool bats, 0.19 lb/ft^2.

Table 1.4.1
Walls- Miscellaneous Materials

0" to less than 4" thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-3-M1-1	3-7/8"	Glass brick wall - (bricks 5-3/4"x 5-3/4"x 3-7/8") ½" mortar bed - cement/lime/sand; mounted in brick (9") wall with mastic and ½" asbestos rope.	n/a	1 hr.			7	1,2	1
W-3-M1-2	3"	Core: 2" magnesium oxysulfate wood-fiber blocks laid in portland cement-lime mortar; Facings on both sides; See note 3.	n/a	1 hr.		1		3	1
W-3-M1-3	3-7/8"	Core: 8" x 4-7/8" glass blocks 3-7/8" thick weighing 4 lbs. each. Laid in portland cement lime mortar, horizontal mortar joints reinforced with metal lath.	n/a	¾ hr.		1			¼

Notes:

TABLE 1.4.1

1. No failure reached at 1 hour.

2. These glass blocks are assumed to be solid based on other test data available for similar but hollow units which show significantly reduced fire endurance.

3. Minimum of ½" of 1:3 sanded gypsum plaster required to develop this rating.

Table 1.4.2
Walls- Miscellaneous Materials

4" to less than 6" thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-4-M1-1	4"	Core: 3" magnesium oxysulfate wood-fiber blocks laid in portland cement mortar; Facings: both sides per note 1.	n/a	2 hr.		1			2

Notes:

TABLE 1.4.2

1. ½" sanded gypsum plaster. Voids in hollow blocks to be not more than 30%.

Figure 1.5.1
Finish Ratings—Inorganic Materials

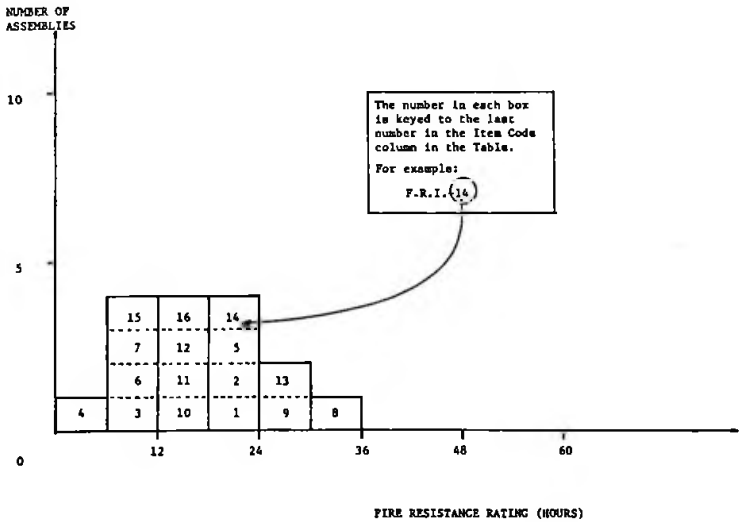


Table 1.5.1
Finish Ratings—Inorganic Materials

Item Code	Thickness	Construction Details	Performance	Reference Number			Notes	Rec F. R. (min.)
			Finish Rating	Pre-BMS-92	BMS-92	Post-BMS-92		
F.R.-I-1	9/16"	3/8" gypsum wallboard faced with 3/16" cement asbestos board.	20 minutes		1		1, 2	15
F.R.-I-2	11/16"	½" gypsum sheathing faced with 3/16" cement asbestos board.	20 minutes		1		1, 2	20
F.R.-I-3	3/16"	3/16" cement asbestos board over uninsulated cavity.	10 minutes		1		1, 2	5
F.R.-I-4	3/16"	3/16" cement asbestos board over insulated cavities.	5 minutes		1		1, 2	5
F.R.-I-5	3/4"	3/4" thick 1:2, 1:3 gypsum plaster over paper backed metal lath.	20 minutes		1		1-3	20
F.R.-I-6	3/4"	3/4" thick portland cement plaster on metal lath.	10 minutes		1		1, 2	10
F.R.-I-7	3/4"	3/4" thick, 1:5, 1:7.5 lime plaster on metal lath.	10 minutes		1		1, 2	10
F.R.-I-8	1"	1" thick neat gypsum plaster on metal lath.	35minutes		1		1,2,4	35
F.R.-I-9	3/4"	3/4" thick neat gypsum plaster on metal lath.	30 minutes		1		1,2,4	30
F.R.-I-10	3/4"	3/4" thick 1:2, 1:2 gypsum plaster on metal lath	15 minutes		1		1-3	15
F.R.-I-11	½"	Same as F.R.-I-7, except ½" thick on wood lath	15 minutes		1		1-3	15
F.R.I-12	½"	½" thick, 1:2, 1:3 gypsum plaster on wood lath	15 minutes		1		1-3	15
F.R.I-13	7/8"	½" thick, 1:2, 1:2 gypsum plaster on 3/8" perforated gypsum lath.	30 minutes		1		1-3	30
F.R.I-14	7/8"	½" thick, 1:2, 1:2 gypsum plaster on 3/8" thick plain or indented gypsum plaster.	20 minutes		1		1-3	20
F.R.I-15	3/8"	3/8" gypsum wallboard.	10 minutes		1		1, 2	10
F.R.I-16	½"	½" gypsum wallboard.	15 minutes		1		1, 2	15

Notes:

TABLE 1.5.1

1. The finish rating is the time required to obtain an average temperature rise of 250 °F, or a single point rise of 325 °F, at the interface between the material being rated and the substrate being protected.

2. Tested in accordance with the Standard Specifications for Fire Tests of Building Construction and Materials, ASA No. A2-1932.

3. Mix proportions for plaster as follows: first ration, dry weight of plaster: dry weight of sand for scratch coat; second ratio, plaster: sand for brown coat.

4. Neat plaster means unsanded wood-fiber gypsum plaster.

General Note:

The finish rating of modern building materials can be found in the current literature.

Table 1.5.2
Finish Rating — Organic Materials

Item Code	Thickness	Construction Details	Performance	Reference Number			Notes	Rec F.R. (min.)
			Finish Rating	Pre-BMS-92	BMS-92	Post-BMS-92		
FR-O-1	9/16"	7/16"wood fiber board faced with 1/8" cement asbestos board.	15 minutes		1		1, 2	15
FR-O-2	29/32"	3/4" wood sheathing, asbestos felt weighing 14 lb/100 ft^2 and 5/32" cement asbestos shingles.	20 minutes		1		1, 2	20
FR-O-3	1½"	1" thick magnesium oxysulfate wood fiberboard faced with 1:3, 1:3 gypsum plaster, 1/2" thick.	20 minutes.		1		1-3	20
FR-O-4	½"	½" thick wood fiberboard.	5 minutes		1		1, 2	5
FR-O-5	½"	½" thick flameproofed wood fiberboard.	10 minutes		1		1, 2	10
FR-O-6	1"	½" thick wood fiberboard faced with ½" thick 1:2, 1:2 gypsum plaster.	15 minutes		1		1-3	15
FR-O-7	1-3/8"	7/8" thick flameproofed wood fiberboard faced with ½" thick 1:2, 1:2 gypsum plaster.	30 minutes		1		1-3	30
FR-O-8	1-1/4"	1-1/4" thick plywood	30 minutes			35		30

Notes:

1. The finish rating is the time required to obtain an average temperature rise of 250°F, or a single point rise of 325°F, at the interface between the material being rated and the substrate being protected.

2. Tested in accordance with the Standard Specifications for Fire Tests of Building Construction and Materials, ASA No. A2-1932.

3. Plaster ratios as follows: first ratio is for scratch coat, weight of dry plaster: weight of dry sand; second ratio is for the brown coat.

General Note:

The finish rating of thinner materials, particularly thinner woods, have not been listed because the possible effects of shrinkage, warpage, and aging cannot be predicted.

Section II—Columns

Table 2.1.1
Reinforced Concrete Columns

Minimum Dimension 0" to less than 6"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-6-RC-1	6"	6" x 6" Square Columns; Gravel Aggregate Concrete (4030 PSI); Reinforcement - Vertical 4-7/8" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	34.7 tons	62min			7	1,2	1
C-6-RC-2	6"	6" x 6" Square Columns; Gravel Aggregate Concrete (4200 PSI); Reinforcement - Vertical 4-½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover - 1".	21 tons	69min			7	1,2	1

Notes:

TABLE 2.1.1

1. Collapse

2. British Test.

Figure 2.1.2
Reinforced Concrete Columns

Minimum Dimension 10" to less than 12"

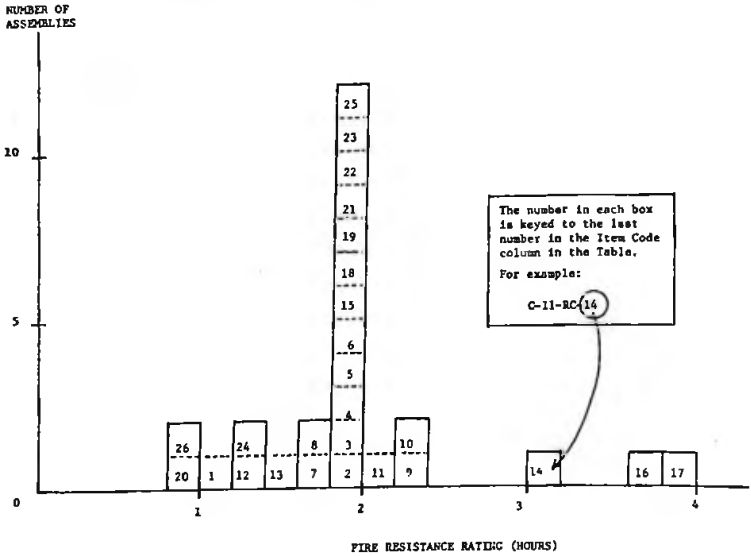


Table 2.1.2
Reinforced Concrete Columns

Minimum Dimension 10" to less than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-10-RC-1	10"	10" Square Column; Aggregate concrete (4260 PSI); Reinforcement - Vertical 4- 1½" rebars; Horizontal - 3/8" Ties @ 6" pitch; Cover 1½".	92.2 tons	1 hr. 2min.			7	1	1
C-10-RC-2	10"	10" Square Column; Aggregate concrete (2325 PSI); Reinforcement - Vertical 4- ½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	46.7 tons	1 hr. 52min			7	1	1-3/4
C-10-RC-3	10"	10" Square Column; Aggregate concrete (5370 PSI); Reinforcement - Vertical 4- ½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	46.5 tons	2hr.			7	2,3 11	2
C-10-RC-4	10"	10" Square Column;Aggregate concrete (5206 PSI); Reinforcement - Vertical 4- ½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	46.5 tons	2 hr.			7	2,7	2
C-10-RC-5	10"	10" Square Column;Aggregate concrete (5674 PSI); Reinforcement - Vertical 4- ½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	46.7 tons	2 hr.			7	1	2
C-10-RC-6	10"	10" Square Column;Aggregate concrete (5150 PSI); Reinforcement - Vertical 4- 1½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	66 tons	1 hr. 43 min			7	1	1-3/4
C-10-RC-7	10"	10" Square Column;Aggregate concrete (5580 PSI); Reinforcement - Vertical 4- ½" rebars;	62.5 tons	1 hr. 38min			7	1	1½

Columns with Minimum Dimension 10" to Less Than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-10-RC-7		Continued - Horizontal - 5/16" Ties @ 6" pitch; 1" Cover.							
C-10-RC-8	10"	10" Square Columns;Aggregate concrete(4080 PSI) Reinforcement - Vertical 4- 1-1/8" rebars; Horizontal - 5/16" Ties @ 6" pitch; 1-1/8" Cover	72.8 tons	1 hr. 48min.			7	1	1-3/4
C-10-RC-9	10"	10" Square Columns;Aggregate concrete(2510 PSI) Reinforcement - Vertical 4- ½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	51 tons	2 hr. 16min			7	1	2¼
C-10-RC-10	10"	10" Square Columns;Aggregate concrete(2170 PSI) Reinforcement - Vertical 4- ½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	45 tons	2 hr. 14min			7	12	2¼
C-10-RC-11	10"	10" Square Columns;Gravel aggregate concrete (4015 PSI); Reinforcement - Vertical 4- ½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	46.5 tons	2 hr. 6 min			7	1	2
C-11-RC-12	11"	11" Square Columns;Gravel aggregate concrete (4150 PSI); Reinforcement: Vertical 4- 1¼" rebars; Horizontal 3/8" Ties @ 7½" pitch; Cover 1½".	61 tons	1 hr. 23min			7	1	1¾
C-11-RC-13	11"	11" Square Columns;Gravel aggregate concrete (4380 PSI); Reinforcement: Vertical 4- 1¼" rebars; Horizontal 3/8" Ties @ 7½" pitch; Cover 1½".	61 tons	1 hr. 26min			7	1	1¾
C-11-RC-14	11"	11" Square Columns;Gravel aggregate concrete (4140 PSI); Reinforcement: Vertical 4- 1¼" rebars; Horizontal 3/8"Ties @ 7½" pitch; Steel mesh around reinforcement; Cover 1½".	61 tons	3 hr. 9 min.			7	1	3
C-11-RC-15	11"	11" Square Columns; Slag aggregate concrete (3690 PSI); Reinforcement: Vertical 4- 1¼" rebar; Horizontal 3/8" Ties @ 7½" pitch; Cover 1½".	91	2 hr.			7	2-5	2
C-11-RC-16	11"	11" Square Columns; Limestone aggregate concrete (5230 PSI); Reinforcement: Vertical 4- 1¼" rebars; Horizontal 3/8" Ties @ 7½" pitch; Cover 1½".	91.5 tons	3 hr. 41min			7	1	3½
C-11-RC-17	11"	11" Square Columns;Limestone aggregate concrete (5530 PSI); Reinforcement: Vertical 4- 1¼" rebars; Horizontal 3/8" Ties @ 7½" pitch; Cover 1½".	91.5 tons	3 hr. 47min.			7	1	3½
C-11-RC-18	11"	11" Square Columns; Limestone aggregate concrete (5280 PSI); Reinforcement: Vertical 4- 1¼" rebars; Horizontal 3/8" Ties @ 7½" pitch; Cover 1½".	91.5 tons	2 hr.			7	2-4,6	2
C-11-RC-19	11"	11" Square Columns;Limestone aggregate concrete (4180 PSI); Reinforcement: Vertical 4- 5/8" rebars; Horizontal 3/8" Ties @ 7" pitch; Cover 1½".	71.4 tons	2 hr.			7	2,7	2

Columns with Minimum Dimension 10" to Less Than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
C-11-RC-20	11"	11" Square Column: Gravel Concrete (4530 PSI) Reinforcement: Vertical 4- 5/8" rebars; Horizontal 3/8" Ties @ 7" pitch; Cover 1½" with ½" plaster.	58.8	2 hrs.			7	2,3,9,	1¼
C-11-RC-21	11"	11" Square Column; Gravel concrete (3520 PSI) Reinforcement: Vertical 4- 5/8" rebars; Horizontal 3/8" Ties @ 7" pitch; Cover 1½".	vari-able	1 hr. 24min.			7	1,8	2
C-11-RC-22	11"	11" Square Column; Aggregate concrete (3710 PSI); Reinforcement: Vertical 4- 5/8" rebars; Horizontal 3/8" Ties @ 7" pitch; Cover 1½".	58.8 tons	2 hr.			7	2,3 10	2
C-11-RC-23	11"	11" Square Column; Aggregate concrete (3790 PSI); Reinforcement: Vertical 4- 5/8" rebars; Horizontal 3/8" Ties @ 7" pitch; Cover 1½".	58.8 tons	2 hr.			7	2,3 10	2
C-11-RC-24	11"	11" Square Column; Aggregate concrete (4860 PSI); Reinforcement: Vertical 4- 5/8" rebars; Horizontal 3/8" ties @ 7" pitch; Cover 1½".	86.1 tons	1 hr. 20min			7	1	1-1/3
C-11-RC-25	11"	11" Square Column; Aggregate concrete (4850 PSI); Reinforcement: Vertical 4- 5/8" rebars; Horizontal 3/8" ties @ 7" pitch; Cover 1½".	58.8 tons	1 hr. 59min.			7	1	1-3/4
C-11-RC-26	11"	11" Square Column; Aggregate concrete (3834 PSI); Reinforcement: Vertical 4- 5/8" rebars; Horizontal 5/16" ties @ 4½"pitch; Cover 1½".	71.4 tons	53min			7	1	3/4

Notes:

TABLE 2.1.2

1. Failure mode - collapse.
2. Passed two hour fire exposure.
3. Passed hose stream test.
4. Reloaded effectively after 48 hours but collapsed at load in excess of original test load.
5. Failing load was 150 tons.
6. Failing load was 112 tons.
7. Failed during hose stream test.
8. Range of load 58.8 tons (initial) to 92 tons (92 min.) to 60 tons (80 min.).
9. Collapsed at 44 tons in reload after 96 hours.
10. Withstood reload after 72 hours.
11. Collapsed on reload after 48 hours.

Table 2.1.3
Reinforced Concrete Columns

Minimum Dimension 12" to less than 14"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-12-RC-1	12"	12" Square Columns;Gravel Aggregate Concrete (2647 PSI); Reinforcement: Vertical 4- 5/8" rebars; Horizontal 5/16" ties @ 4½ pitch; Cover 2".	78.2 tons	38min.		1	7	1	½
C-12-RC-2	12"	Reinforced Columns with 1½" concrete outside of reinforced steel; gross diameter or side of column: 12";Group I, Column A.	—	6 hrs.		1		2,3	6
C-12-RC-3	12"	Description as per C-12-RC-2; Group I, Column B.	—	4 hrs.		1		2,3	4
C-12-RC-4	12"	Description as per C-12-RC-2; Group II, Column A.	—	4 hrs.		1		2,3	4
C-12-RC-5	12"	Description as per C-12-RC-2; Group II, Column B.	—	2 hrs. 30 min		1		2,3	2½
C-12-RC-6	12"	Description as per C-12-RC-2; Group III, Column A.	—	4 hrs.		1		2,3	3
C-12-RC-7	12"	Description as per C-12-RC-2; Group III, Column B	—	4 hrs.		1		2,3	2
C-12-RC-8	12"	Description as per C-12-RC-2; Group IV, Column A.	—	2 hrs		1		2,3	2
C-12-RC-9	12"	Description as per C-12-RC-2; Group IV, Column B.	—	1 hr. 30min.		1		2,3	1½

Notes:

TABLE 2.1.3

1. Failure mode - unspecified structural.

2. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

3. Groupings of aggregates and ties are the same as for structural steel columns protected solidly with concrete, the ties to be placed over the vertical reinforcing bars and the mesh, where required, to be placed within 1 in. from the surface of the column.

   Column A - working loads are assumed as carried by the area of the column inside of the lines circumscribing the reinforcing steel.

   Column B - working loads are assumed as carried by the gross area of the column.

Table 2.1.4
Reinforced Concrete Columns

Minimum Dimension 14" to less than 16"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-14-RC-1	14"	14" Square Columns; Gravel aggregate concrete (4295 PSI); Reinforcement: Vertical 4- 3/4" rebars; Horizontal ¼" ties @ 9" pitch; Cover 1½".	86 TONS	1 hr. 22 min			7	1	1¼"
C-14-RC-2	14"	Reinforced concrete columns with 1½" concrete outside reinforcing steel; gross diameter or side of column 14"; Group I; Column A.	—	7 hrs		1		2,3	7
C-14-RC-3	14"	Description as per item C-14-RC-2; Group II, Column B.	—	5 hrs		1		2,3	5
C-14-RC-4	14"	Description as per item C-14-RC-2; Group III; Column A.	—	5 hrs		1		2,3	5
C-14-RC-5	14"	Description as per item C-14-RC-2; Group IV; Column B.	—	3 hrs 30min		1		2,3	3½
C-14-RC-6	14"	Description as per item C-14-RC-2; Group III, Column A.	—	4 hrs		1		2,3	4
C-14-RC-7	14"	Description as per item C-14-RC-2; Group III, Column B.	—	2 hrs 30min		1		2,3	2½
C-14-RC-8	14"	Description as per item C-14-RC-2; Group IV, Column A.	—	2 hrs 30min		1		2,3	2½
C-14-RC-9	14"	Description as per item C-14-RC-2; Group IV; Column B.	—	1 hr 30 min		1		2,3	1½

Notes:

TABLE 2.1.4

1. Failure mode - main rebars buckled between links at various points.

2. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

3. Groupings of aggregates and ties are the same as for structural steel columns protected solidly with concrete, the ties to be placed over the vertical reinforcing bars and the mesh, where required, to be placed within 1 in. from the surface of the column.

   Column A - working loads are assumed as carried by the area of the column inside of the lines circumscribing the reinforcing steel.

   Column B - working loads are assumed as carried by the gross area of the column.

Figure 2.1.5
Reinforced Concrete Columns

Minimum Dimension 16" to less than 18"

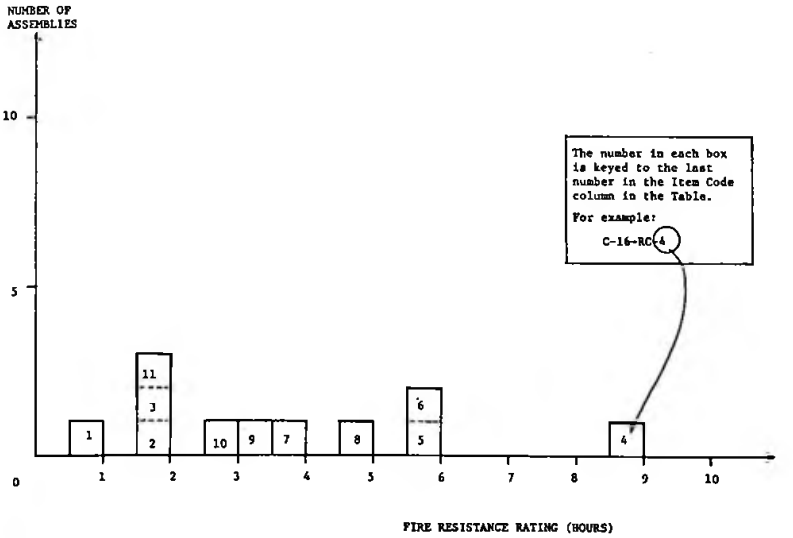


Table 2.1.5
Reinforced Concrete Columns

Minimum Dimension 16" to less than 18"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-16-RC-1	16"	16" Square Columns; Gravel aggregate concrete (4550 PSI); Reinforcement: Vertical 8- 1-3/8" rebars; Horizontal 5/16" ties @ 6" pitch 1-3/8" below column surface and 5/16" ties at 6" pitch linking center rebars of each face forming a smaller square in column cross section.	237 tons	1 hr.			7	1-3	1
C-16-RC-2	16"	16" Square Columns; Gravel aggregate concrete (3360 PSI); Reinforcement: Vertical 8- 1-3/8" rebars; Horizontal 5/16" ties at 6" pitch; Cover 1-3/8"	210	2 hr.			7	2,4-6	2
C-16-RC-3	16"	16" Square Columns; Gravel aggregate concrete (3980 PSI); Reinforcement: Vertical 4- 7/8" rebars; Horizontal 3/8" ties @ 6" pitch; Cover 1".	123.5 tons	2 hr.			7	2,4,7	2
C-16-RC-4	16"	Reinforced concrete columns with 1½" concrete outside reinforcing steel; gross diameter or side of column: 16"; Group I, Column A.	—	9 hrs		1		8,9	9
C-16-RC-5	16"	Description as per C-16-RC-4; Group I, Column B	—	6 hrs		1		8,9	6
C-16-RC-6	16"	Description as per C-16-RC-4; Group II, Column A.	—	6 hrs		1		8,9	6

Minimum Dimension 16" to Less Than 18"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-16-RC-7	16"	Description as per C-16-RC-4; Group II; Column B.	—	4 hrs		1		8,9	4
C-16-RC-8	16"	Description as per C-16-RC-4; Group III, Column A.	—	5 hrs.		1		8,9	5
C-16-RC-9	16"	Description as per C-16-RC-4; Group III, Column B.	—	3 hrs. 30min.		1		8,9	3½
C-16-RC-10	16"	Description as per C-16-RC-4; Group IV, Column A.	—	3 hrs.		1		8,9	3
C-16-RC-11	16"	Description as per C-16-RC-4; Group IV, Column B.	—	2 hrs.		1		8,9	2

Notes:

TABLE 2.1.5

1. Column passed 1 hour fire test.
2. Column passed hose stream test.
3. No reload specified.
4. Column passed 2 hour fire test.
5. Column reloaded successfully after 24 hours.
6. Reinforcing details same as C-16-RC-1.
7. Column passed reload after 72 hours.
8. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

9. Groupings of aggregates and ties are the same as for structural steel columns protected solidly with concrete, the ties to be placed over the vertical reinforcing bars and the mesh, where required, to be placed within 1 in. from the surface of the column.

   Column A - working loads are assumed as carried by the area of the column inside of the lines circumscribing the reinforcing steel.

   Column B - working loads are assumed as carried by the gross area of the column.

Table 2.1.6
Reinforced Concrete Columns

Minimum Dimension 18" to less than 20"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-18-RC-1	18"	Reinforced Concrete Columns with 1½" concrete outside reinforced steel; gross diameter or side of column: 18"; Group I, Column A.	—	21 hrs		1		1,2	11
C-18-RC-2	18"	Description as per C-18-RC-1; Group I, Column B.	—	8 hrs.		1		1,2	8
C-18-RC-3	18"	Description as per C-18-RC-1; Group II, Column A.	—	7 hrs		1		1,2	7
C-18-RC-4	18"	Description as per C-18-RC-1; Group II, Column B.	—	5 hrs		1		1,2	5
C-18-RC-5	18"	Description as per C-18-RC-1; Group III, Column A.	—	6 hrs		1		1,2	6
C-18-RC-6	18"	Description as per C-18-RC-1; Group III, Column B.	—	4 hrs		1		1,2	4
C-18-RC-7	18	Description as per C-18-RC-1; Group IV, Column A.	—	3 hrs 30 min		1		1,2	3½
C-18-RC-8	18"	Description as per C-18-RC-1; Group IV, Column B.	—	2 hrs 30 min		1		1,2	2½

Notes:

TABLE 2.1.6

1. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

2. Groupings of aggregates and ties are the same as for structural steel columns protected solidly with concrete, the ties to be placed over the vertical reinforcing bars and the mesh, where required, to be placed within 1 in. from the surface of the column.

   Column A - working loads are assumed as carried by the area of the column inside of the lines circumscribing the reinforcing steel.

   Column B - working loads are assumed as carried by the gross area of the column.

Figure 2.1.7
Reinforced Concrete Columns

Minimum Dimension 20" to less than 22"

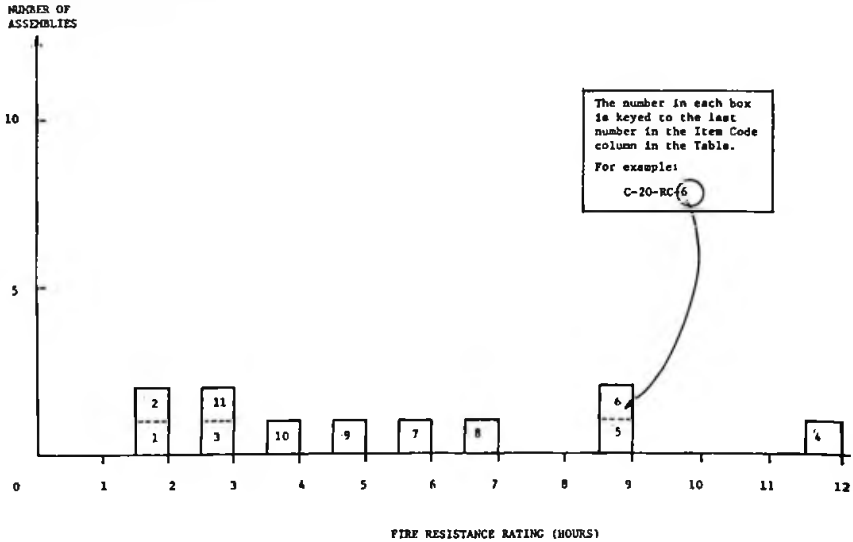


Table 2.1.7
Reinforced Concrete Columns

Minimum Dimension 20" to less than 22"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-20-RC-1	20"	20" Square Column; Gravel aggregate concrete (6690 PSI); Reinforcement: Vertical 4- 1-3/4" rebars; Horizontal 3/8" wire @ 6" pitch; Cover 1-3/4".	367 tons	2 hr.			7	1-3	2
C-20-RC-2	20"	20" Square Column; Gravel aggregate concrete (4330 PSI); Reinforcement: Vertical 4- 1-3/4" rebars; Horizontal 3/8" Ties @ 6" pitch; Cover 1-3/4"	327 tons	2 hr.			7	1,2,4	2
C-20-RC-3	20¼"	20¼" Square Column; Gravel aggregate concrete (4230 PSI); Reinforcement: Vertical 4- 1-1/8" rebar; Horizontal 3/8" wire @ 5" pitch; Cover 1-1/8".	199 tons	2 hr. 36min.			7	5	2-3/4
C-20-RC-4	20"	Reinforced Concrete Column with 1½" concrete outside of reinforcing steel; gross diameter or side of column: 20"; Group I, Column A.	—	12 hr		1		6,7	12
C-20-RC-5	20"	Description as per C-20-RC-4; Group I, Column B.	—	9 hrs		1		6,7	9
C-20-RC-6	20"	Description as per C-20-RC-4; Group II, Column A.	—	9 hrs		1		6,7	9
C-20-RC-7	20"	Description as per C-20-RC-4; Group II, Column B.	—	6 hrs		1		6,7	6

Minimum Dimension 20" to Less Than 22"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
C-20-RC-8	20"	Description as per C-20-RC-4; Group III, Column A.	—	7 hrs.		1		6,7	7
C-20-RC-9	20"	Description as per C-20-RC-4; Group III, Column B.	—	5 hrs.		1		6,7	5
C-20-RC-10	20"	Description as per C-20-RC-4; Group IV, Column A.	—	4 hrs.		1		6,7	4
C-20-RC-11	20"	Description as per C-20-RC-4; Group IV, Column B.	—	3 hrs.		1		6,7	3

Notes:

TABLE 2.1.7

1. Passed 2 hr. fire test.

2. Passed hose stream test.

3. Failed during reload at 300 tons.

4. Passed reload after 72 hours.

5. Failure mode - collapse.

6. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

7. Groupings of aggregates and ties are the same as for structural steel columns protected solidly with concrete, the ties to be placed over the vertical reinforcing bars and the mesh, where required, to be placed within 1 in. from the surface of the column.

   Column A - working loads are assumed as carried by the area of the column inside of the lines circumscribing the reinforcing steel.

   Column B - working loads are assumed as carried by the gross area of the column.

Table 2.1.8
Hexagonal Reinforced Concrete Columns

Minimum Dimension 12" to less than 14"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-12-HRC-1	12"	12" Hexagonal Columns;Gravel aggregate concrete (4420 PSI); Vertical Reinforcement 8¼" rebars; Horizontal Reinforcement - helical 5/16" winding on 1½" pitch; cover 1/2".	88 tons	58 min			7	1	3/4
C-12-HRC-2	12"	12" Hexagonal Columns;Gravel aggregate concrete (3460 PSI); Vertical Reinforcement 8- ¼" rebar; Horizontal Reinforcement 5/16" helical winding @ 1½" pitch; Cover ½".	78.7 tons	1 hr.			7	2	1

Notes:

TABLE 2.1.8

1. Failure Mode - collapse.
2. Test stopped at 1 hour.

Table 2.1.9
Hexagonal Reinforced Concrete Columns

Minimum Dimension 14" to less than 16"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-14-HRC-1	14"	14" Hexagonal Columns;Gravel aggregate concrete (4970 PSI); Vertical Reinforcement 8- 1/2" rebar; Horizontal 5/16" helical winding on 2" pitch; Cover ½".	90 tons	2 hr.			7	1-3	2

Notes:

TABLE 2.1.9

1. Withstood 2 hour fire test.
2. Withstood hose stream test.
3. Withstood reload after 48 hours.

Table 2.1.10
Hexagonal Reinforced Concrete Columns

Diameter—16" to less than 18"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-16-HRC-1	16"	16" Hexagonal Column; Gravel concrete (6320 PSI); Vertical Reinforcement 8- 5/8" rebar; Horizontal Reinforcement 5/16" helical winding on 3/4" pitch; Cover ½".	140 tons	1 hr. 55 min			7	1	1-3/4
C-16-HRC-2	16"	16" Hexagonal Column; Gravel aggregate concrete (5580 PSI); Vertical Reinforcement 8- 5/8" rebar; Horizontal Reinforcement 5/16" helical winding on 1-3/4" pitch; Cover ½".	124 tons	2 hr.			7	2	2

Notes:

TABLE 2.1.10

1. Failure Mode - Collapse
2. Failed on furnace removal.

Table 2.1.11
Hexagonal Reinforced Concrete Columns

Diameter—20" to less than 22"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-20-HRC-1	20"	20" Hexagonal Column; Gravel Concrete (6 80 PSI); Vertical Reinforcement: 3/4" rebar; Horizontal Reinforcement: 5/16" helical winding on 1-3/4" pitch; Cover ½".	211 tons	2 hr.			7	1	2
C-20-HRC-2	20"	20" Hexagonal Column; Gravel Concrete (5080 PSI); Vertical Reinforcement: 3/4" rebar; Horizontal Reinforcement: 5/16" wire on 1-3/4" pitch; Cover ½".	184 tons	2 hr. 15min			7	2,3,4	2¼

Notes:

TABLE 2.1.11

1. Column collapsed on furnace removal.
2. Passed 2¼ hr. fire test.
3. Passed hose stream test.
4. Withstood reload after 48 hours.

Table 2.2
Round Cast Iron Columns

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-7-CI-1	7" O.D.	Column: .6" min. thickness metal, unprotected.	--	30min.		1			1/2
C-7-CI-2	7" O.D.	Column: .6" min. metal thickness concrete filled, outside unprotected.	--	45min.		1			3/4
C-11-CI-3	11" O.D.	Column: .6" minimum metal thickness; Protection: 1¼" portland cement plaster on high ribbed metal lath, ½" broken air space.	--	3 hrs.		1			3
C-11-CI-4	11" O.D.	Column: .6" min. metal thickness; Protection: 2" concrete other than siliceous aggregate.	--	2 hrs. 30 min		1			2-1/2
C-12-CI-5	12.5"O.D.	Column: 7" O.D. .6" min. metal thickness; Protection: 2" porous hollow tile, 3/4" morter between tile and column, outside wire ties.	--	3 hrs.		1			3
C-7-CI-6	7.6" O.D.	Column: 7" I.D., 3/10" min. thickness metal, concrete filled unprotected.	--	30min.		1			1/2
C-8-CI-7	8.6" O.D.	Column: 8" I.D., 3/10" min. thickness metal, concrete filled reinforced with 4- 3½"x 3/8" angles, in fill; unprotected outside.	--	1 hr.		1			1

Figure 2.3
Steel Columns-
Gypsum Encasements

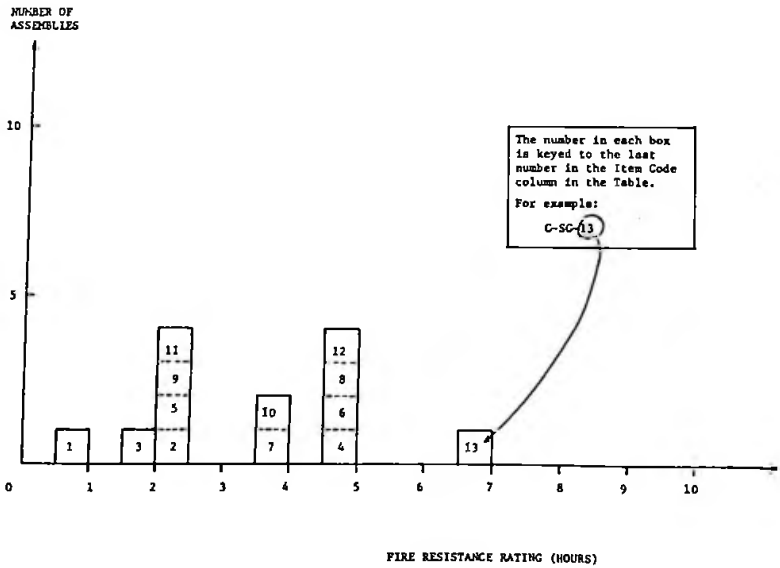


Table 2.3
Steel Columns-
Gypsum Encasements

Item Code	Minimum Area of Solid Material	Construction Details	Performance		Reference Number			Notes	Recc. Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-SC-1	--	Steel protected with 3/4" 1:3 sanded gypsum or 1" 1:2½ portland cement plaster on wire or lath; one layer.	--	1 hr.		1			1
C-SC-2	--	Same as C-SC-1; two layers.	--	2 hrs 30min		1			2-1/2
C-SC-3	130 in^2	2" solid blocks with wire mesh in horizontal joints, 1" mortar on flange, reentrant space filled with block and mortar.	--	2 hrs		1			2.
C-SC-4	150 $in.^2$	Same as C-130-SG-3 with ½" sanded gypsum plaster.	--	5 hrs		1			5
C-SC-5	130 $in.^2$	2" solid blocks with wire mesh in horizontal joints, 1" mortar on flange, reentrant space filled with gypsum concrete.	--	2 hrs 30 min		1			2-1/2
C-SC-6	150 $in.^2$	Same as C-130-SG-5 with ½" sanded gypsum plaster.	--	5 hrs.		1			5
C-SG-7	300 $in.^2$	4" solid blocks with wire mesh in horizontal joints, 1" mortar on flange reentrant space filled with block and mortar.	--	4 hrs		1			4
C-SG-8	300 $in.^2$	Same as C-300-SG-7 with reentrant space filled with gypsum concrete.	--	5 hrs.		1			5
C-SG-9	85 $in.^2$	2" solid blocks with cramps at horizontal joints, mortar on flange only at horizontal joints, reentrant space not filled.	--	2 hrs. 30 min		1			2-1/2
C-SG-10	105 $in.^2$	Same as C-85-SG-9 with ½" sanded gypsum plaster	--	4 hrs.		1			4
C-SG-11	95 $in.^2$	3" hollow blocks with cramps at horizontal joints, mortar on flange only at horizontal joints, reentrant space not filled.	--	2 hrs. 30 min		1			2-1/2
C-SG-12	120 $in.^2$	Same as C-95-SG-11 with ½" sanded gypsum plaster.	--	5 hrs.		1			5
C-SG-13	130 $in.^2$	2" neat fibered gypsum reentrant space filled poured solid and reinforced with 4"x 4" wire mesh ½" sanded gypsum plaster.	--	7 hrs.		1			7

Table 2.4
Timber Columns

Minimum Dimension

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-11-TC-1	11"	With unprotected steel plate cap	--	30min		1		1,2	½
C-11-TC-2	11"	With unprotected cast iron cap and pintle	--	45min		1		1,2	3/4
C-11-TC-3	11"	With concrete or protected steel or cast iron cap.	--	1 hr. 15min		1		1,2	1¼
C-11-TC-4	11"	With 3/8" gypsum wallboard over column and over cast iron or steel cap.	--	1 hr. 15min		1		1,2	1¼
C-11-TC-5	11"	With 1" portland cement plaster on wire lath over column and over cast iron or steel cap; 3/4" air space.	--	2 hrs		1		1,2	2

Notes:

TABLE 2.4

1. Minimum Area: 120 $in.^2$
2. Type of wood: Long leaf pine or douglas fir.

Table 2.5.1.1
Steel Columns-
Concrete Encasements

Minimum Dimension less than 6"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-5-SC-1	5"	5" x 6" Outer dimensions; 4" x 3" x 10 lbs. - H Beam; Protection - Gravel Concrete (4900 PSI) 6" x 4" - 13 SWG mesh.	12 tons	1 hr. 29min			7	1	1¼

Notes:

TABLE 2.5.1.1

1. Failure mode - collapse.

Table 2.5.1.2
Steel Columns-
Concrete Encasements

6" to less than 8" thick

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-7-SC-1	7"	7" x 8" Column; 4" x 3" x 10" H Beam; Protection - Brick filled concrete (6220 PSI); 6"x 4" mesh - 13 S.W.G.; mesh 1" below column surface.	12 tons	2 hrs. 46 min			7	1	3
C-7-SC-2	7"	7" x 8" Column; 4" x 3" x 10 lbs. H Beam; Protection: Gravel concrete (5140 PSI) 6" x 4" 13 S.W.G. mesh 1" below surface.	12 tons	3 hrs. 1 min.			7	1	2-3/4
C-7-SC-3	7"	7" x 8" Column; 4"x 3" x 10 lbs. H Beam; Protection: Concrete (4540 PSI) 6" x 4" - 13 SWG mesh; 1" below column surface.	12 tons	3 hr. 9 min.			7	1	3
C-7-SC-4	7"	7" x 8" Column; 4"x 3"x 10 lbs. H. Beam; Protection: Gravel concrete (5520 PSI); 4"x 4" mesh; 16 SWG .	12 tons	2 hr. 50min.			7	1	2-3/4

Notes:

TABLE 2.5.1.2

1. Failure mode - collapse.

Figure 2.5.1.3
Steel Columns-
Concrete Encasements

Minimum Dimension 8" to less than 10"

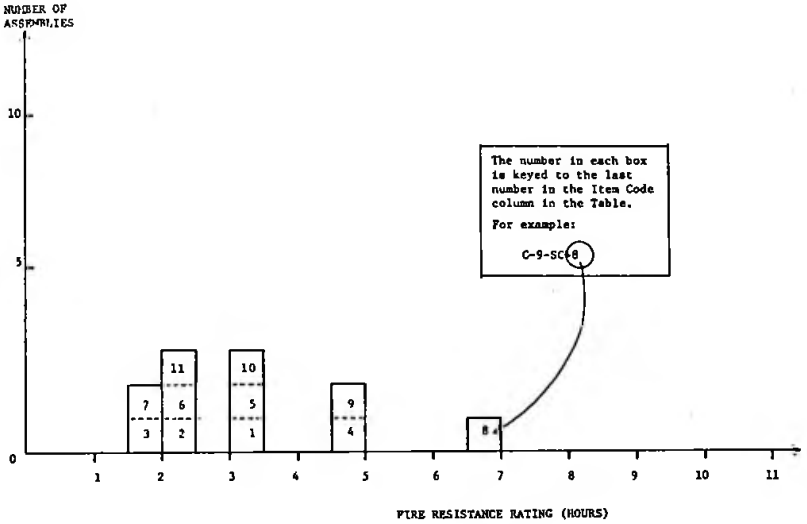


Table 2.5.1.3
Steel Columns-
Concrete Encasements

Minimum Dimension 8" to less than 10"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-8-SC-1	8½"	8½"x 10" Column; 6"x 4½" x 20 lbs. H Beam; Protection: Gravel Concrete (5140 PSI) 6" x 4" 13 SWG mesh.	39 tons	3 hr. 8 min.			7	1	3
C-8-SC-2	8"	8"x 10" Column; 8"x 6"x 35lbs I Beam; Protection: Gravel concrete (4240 PSI) 4"x 6" mesh; 13 SWG with ½" cover.	90 tons	2 hr. 1 min.			7	1	2
C-8-SC-3	8"	8"x 10" Concrete encased column; 8"x 6" x 35 lb H Beam; Protection: Aggregate concrete (3750 PSI) with 4" mesh - 16 SWG reinforcing ½" below column surface.	90 tons	1 hr. 58min.			7	1	1-3/4
C-8-SC-4	8"	6"x 6" Steel Column with 2" outside protection. Group I.	—	5 hrs		1		2	5
C-8-SC-5	8"	6"x 6" Steel Column with 2" outside protection. Group II.	—	3 hrs 30 min		1		2	3½
C-8-SC-6	8"	6"x 6" Steel Column with 2" outside protection. Group III.	—	2 hrs 30 min		1		2	2½
C-8-SC-7	8"	6"x 6" Steel Column with 2" outside protection. Group IV.	—	1 hr. 45 min		1		2	1-3/4

Smallest Dimension - 8" to Less Than 10"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
C-9-SC-8	9"	6"x 6" Steel Column with 3" outside protection Group I.	—	7 hrs.		1		2	7
C-9-SC-9	9"	6"x 6" Steel Column with 3" outside protection Group II.	—	5 hrs		1		2	5
C-9-SC-10	9"	6"x 6" Steel Column with 3" outside protection Group III.	—	3 hrs. 30 min		1		2	3½
C-9-SC-11	9"	6"x 6" Steel Column with 3" outside protection Group IV.	—	2 hrs. 30 min		1		2	2½

Notes:

TABLE 2.5.1.3

1. Failure mode - collapse.

2. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

Figure 2.5.1.4
Steel Columns-
Concrete Encasements

Minimum Dimension 10" to less than 12"

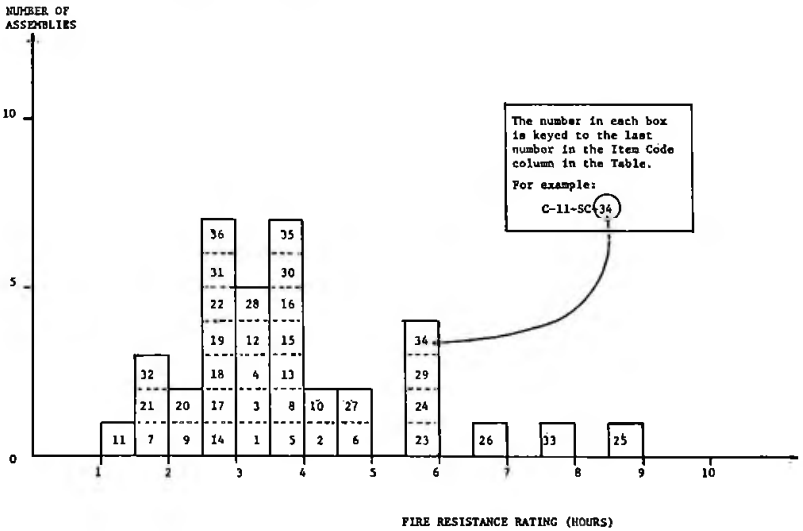


Table 2.5.1.4
Steel Columns-
Concrete Encasements

Minimum Dimension 10" to less than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-10-SC-1	10"	10"x 12" concrete encased steel column; 8"x 6"x 35 lb. "H" Beam; Protection: Gravel aggregate concrete (3640 PSI); Mesh 6"x 4"; 13 SWG, 1" below column surface.	90 tons	3 hr. 7 min			7	1,2	3
C-10-SC-2	10"	Column: 10"x 16"; 8"x 6"x 35 lb. "H" beam; Protection: Clay brick concrete (3630 PSI); 6" x 4" mesh; 13 SWG, mesh 1" below column surface.	90 tons	4 hr. 6 min			7	2	4
C-10-SC-3	10"	Column: 10"x 12"; 8"x 6"x 35 lb. "H" beam; Protection: Concrete of crushed stone and sand (3930 PSI) 6"x 4" - 13 SWG mesh; 1" below column surface.	90 tons	3 hr. 17min			7	2	3-¼
C-10-SC-4	10"	Column: 10"x 12"; 8"x 6"x 35 lb. "H" beam; Protection: Concrete of crushed basalt and sand (4350 PSI) 6"x 4" 13 SWG mesh; 1" below column surface.	90 tons	3 hr. 22min			7	2	3-1/3
C-10-SC-5	10"	Column: 10"x 12"; 8"x 6"x 35 lb. "H" beam; Protection: Concrete gravel aggregate (5570 PSI); 6"x 4" mesh; 13 SWG.	90 tons	3 hr. 39min			7	2	3½
C-10-SC-6	10"	Column: 10"x 16"; 8"x 6"x 35 lb "I" beam; Protection: gravel concrete (4950 PSI); mesh 6"x 4" 13 SWG; 1" below column surface.	90 tons	4 hr. 32min			7	2	4½
C-10-SC-7	10"	10"x 12" concrete encased steel column; 8"x6" x 35 lb. "H" beam; Protection: aggregate concrete (1370 PSI) with 6"x 4" mesh; 13 SWG reinforcing 1" below column surface.	90 tons	2 hr.			7	3,4	2

Minimum Dimension = 10" to Less Than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-10-SC-8	10"	10"x 12" Concrete encased steel column; 8"x 6"x 35 lb. "H" column; Protection: aggregate concrete (4000 PSI) with 13 SWG iron wire loosely wound around column @ 6" pitch about 2" beneath column surface.	86 tons	3 hr. 36min			7	2	3⅓
C-10-SC-9	10"	10"x 12" concrete encased steel column; 8"x 6" x 35 lb. "H" beam; Protection: aggregate concrete (3290 PSI); 2" cover minimum.	86 tons	2 hr. 8 min			7	2	2
C-10-SC-10	10"	10"x 14" concrete encased steel column; 8"x 6" x 35 lb. "H" column; Protection: crushed brick filled concrete (5310 PSI) with 6"x 4" mesh 13 SWG reinforcement 1" beneath column surface	90 tons	4 hr. 28min			7	2	4-1/3
C-10-SC-11	10"	10"x 12" concrete encased column; 8"x 6"x 35lb "H" beam; Protection: aggregate concrete (342 PSI) with 6"x 4" mesh; 13 SWG reinforcements 1" below surface.	90 tons	1 hr. 2 min			7	2	1
C-10-SC-12	10"	10"x 12" concrete encased steel column; 8"x 6" x 35 lb. "H" beams; Protection: aggregate concrete (4480 PSI) 4- 3/8" vertical rebars @ H beam edges with 3/16" spacers @ beam surface @ 3" pitch and 3/16 binders @ 10" pitch; 2" concrete cover.	90 tons	3 hr. 2 min			7	2	3
C-10-SC-13	10"	10"x 12" Concrete encased steel column; 8"x 6" x 35 lb "H" beam; Protection: aggregate concrete (5070 PSI) with 6"x 4" mesh; 13 SWG reinforcing @ 6" beam sides wrapped and held by wire ties across (open) 8" beam face; Reinforcements wrapped in 6"x 4" mesh; 13 SWG throughout with ½" cover to column surface.	90 tons	3 hr. 59min			7	2	3-3/4
C-10-SC-14	10"	10"x 12" concrete encased steel column; 8"x 6" x 35 lb. "H" column; Protection: aggregate concrete (4410 PSI) with 6"x 4" mesh; 13 SWG reinforcement 1½" below column surface; ½" lime-cement plaster with 3/8" gypsum plaster finish	90 tons	2 hr. 50min			7	2	2-3/4
C-10-SC-15	10"	10"x 12" concrete encased steel column; 8"x 6" x 35 lb. "H" beam; Protection: crushed clay brick filled concrete (4260 PSI) with 6"x 4" mesh; 13 SWG reinforcing 1" below column surface.	90 tons	3 hr. 54min			7	2	3-3/4
C-10-SC-16	10"	10"x 12" concrete encased steel columns; 8"x 6"x 35 lb. "H" beams; Protection: Limestone aggregate concrete (4350 PSI) 6"x 4" mesh; 13 SWG reinforcing 1" below column surface.	90 tons	3 hr. 54min			7	2	3-3/4
C-10-SC-17	10"	10"x 12" concrete encased steel column; 8"x 6" x 35 lb. "H" beam; Protection: Limestone aggregate concrete(5300 PSI) with 6"x 4"; 13 SWG wire mesh 1" below column surface.	90 tons	3 hr.			7	4,5	3
C-10-SC-18	10"	10"x 12" concrete encased steel column; 8"x 6" x 35 lb. "H" beam; Protection: Limestone aggregate concrete (4800 PSI) with 6"x 4"; 13 SWG mesh reinforcement 1" below surface.	90 tons	3 hr.			7	4,5	3
C-10-SC-19	10"	10"x 14" concrete encased steel column; 12"x 8"x 65 lb. "H" beam; Protection: aggregate concrete (3900 PSI) 4" mesh; 16 SWG reinforcing ½" below column surface.	118 tons	2 hr. 42min			7	2	2
C-10-SC-20	10"	10"x 14" concrete encased steel column; 12"x 8"x 65 lb. "H" beam; Protection: aggregate concrete (4930 PSI); 4" mesh; 16 SWG reinforcing ½" below column surface.	177 tons	2 hr. 8 min			7	2	2
C-10-SC-21	10-3/8"	10-3/8"x 12-3/8" concrete encased steel column 8"x 6"x 35 lb. "H" beam; Protection: aggregate concrete (835 PSI) with 6"x 4" mesh; 13 SWG reinforcing 1-3/16" below column surface; 3/16" gypsum plaster finish.	90 tons	2 hr.			7	3,4	2
C-11-SC-22	11"	11"x 13" concrete encased steel column; 8"x 6" x 35 lb. "H" beam; Protection: "open texture" brick filled concrete (890 PSI) with 6" x 4" mesh; 13 SWG reinforcing 1½" below column surface; 3/8" lime cement plaster; 1/8" gypsum plaster finish.	90 tons	3 hr.			7	6,7	3

Minimum Dimension - 10" to Less Than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-11-SC-23	11"	11"x 12" column; 4"x 3"x 10 lb. "H" beam; gravel concrete (4550 PSI); 6"x 4" - 13 SWG mesh reinforcing; 1" below column surface.	12 tons	6 hr.			7	7,8	6
C-11-SC-24	11"	11"x 12" column; 4"x 3"x 10 lb. "H" beam; Protection: gravel aggregate concrete (3830 PSI) with 4"x 4" mesh; 16 SWG; 1" below column surface.	16 tons	5 hr. 32min			7	2	5½
C-10-SC-25	10"	6"x 6" steel column with 4" outside protection Group I.	—	9 hrs		1		9	9
C-10-SC-26	10"	Description as per C-10-SC-25; Group II.	—	7 hrs		1		9	7
C-10-SC-27	10"	Description as per C-10-SC-25; Group III.	—	5 hrs		1		9	5
C-10-SC-28	10"	Description as per C-10-SC-25; Group IV.	—	3 hrs 30 min		1		9	3½
C-10-SC-29	10"	8"x 8" steel column with 2" outside protection Group I.	—	6 hrs		1		9	6
C-10-SC-30	10"	Description as per C-10-SC-29; Group II.	—	4 hrs		1		9	4
C-10-SC-31	10"	Description as per C-10-SC-29; Group III.	—	3 hrs		1		9	3
C-10-SC-32	10"	Description as per C-10-SC-29; Group IV.	—	2 hrs		1		9	2
C-11-SC-33	11"	8"x 8" steel column with 3" outside protection; Group I.	—	8 hrs.		1		9	8
C-11-SC-34	11"	Description as per C-11-SC-33; Group II.	—	6 hrs.		1		9	6
C-11-SC-35	11"	Description as per C-11-SC-33; Group III.	—	4 hrs.		1		9	4
C-11-SC-36	11"	Description as per C-11-SC-33; Group IV.	—	3 hrs.		1		9	3

Notes:

TABLE 2.5.1.4

1. Tested under total restraint load to prevent expansion - minimum load 90 tons.
2. Failure mode - collapse.
3. Passed 2 hour fire test ("Grade C" - British).
4. Passed hose stream test.
5. Column tested and passed 3 hour grade fire resistance (British).
6. Column passed 3 hour fire test.
7. Column collapsed during hose stream testing.
8. Column passed 6 hour fire test.
9. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

Figure 2.5.1.5
Steel Columns-
Concrete Encasements

Minimum Dimension 12" to less than 14"

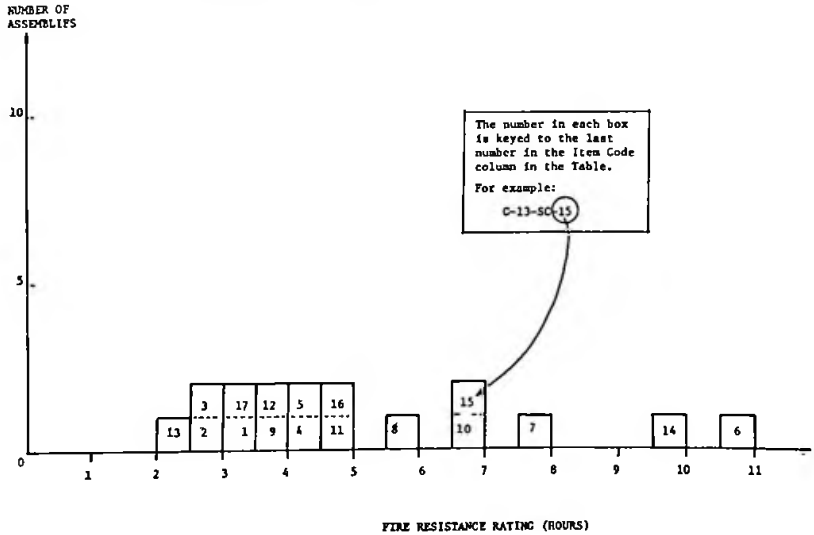


Table 2.5.1.5
Steel Columns-
Concrete Encasements

Minimum Dimension 12" to less than 14"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-12-SC-1	12"	12"x 14" Concrete encased steel column; 8"x 6" x 35lb "H" beam; Protection: Aggregate concrete(4150 PSI) with 4" mesh; 16 SWG reinforcing 1" below column surface.	120 tons	3 hr. 24min			7	1	3-1/3
C-12-SC-2	12"	12"x 16" Concrete encased column; 8"x 6"x 35lb. "H" beam; Protection: Aggregate concrete (4300 PSI) with 4" mesh; 16 SWG reinforcing 1" below surface.	90 tons	2 hr. 52min			7	1	2-3/4
C-12-SC-3	12"	12"x 16" Concrete encased steel column; 12"x 8" x 65 lb "H" column; Protection: Gravel aggregate concrete (3550 PSI) with 4" mesh; 16 SWG reinforcement 1" below column surface.	177 tons	2 hr. 31min			7	1	2¼
C-12-SC-4	12"	12"x 16" concrete encased column; 12"x 8"x 65lb "H" beam; Protection: Aggregate concrete (3450 PSI) with 4" - 16 SWG mesh reinforcement 1" below column surface.	118 tons	4 hr. 4 min			7	1	4
C-12-SC-5	12½"	12½"x 14" Column; 6" x 4½" x 20 lb. "H" beam; Protection: Gravel aggregate concrete (3750 PSI) with 4"x 4" mesh; 16 SWG reinforcing 1" below column surface.	52 tons	4 hr. 29min			7	1	4-1/3
C-12-SC-6	12"	8"x 8" steel column; 2" outside protection; Group I.	—	11 hr			1	2	11

Minimum Dimension - 12" to Less Than 14"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
C-12-SC-6	12"	Description as per C-12-SC-6; Group II.	--	8 hrs.		1		2	8
C-12-SC-8	12"	Description as per C-12-SC-6; Group III.	--	6 hrs.		1		2	6
C-12-SC-9	12"	Description as per C-12-SC-6; Group IV.	--	4 hrs.		1		2	4
C-12-SC-10	12"	10"x 10" steel column with 2" outside protection; Group I.	--	7 hrs.		1		2	7
C-12-SC-11	12"	Description as per C-12-SC-10; Group II.	--	5 hrs.		1		2	5
C-12-SC-12	12"	Description as per C-12-SC-10; Group III.	--	4 hrs.		1		2	4
C-12-SC-13	12"	Description as per C-12-SC-10; Group IV.	--	2 hrs. 30 min		1		2	2½
C-13-SC-14	13"	10"x 10" steel column with 3" outside protection; Group I.	--	10 hrs		1		2	10
C-13-SC-15	13"	Description as per C-13-SC-14; Group II.	--	7 hrs.		1		2	7
C-13-SC-16	13"	Description as per C-13-SC-14; Group III.	--	5 hrs.		1		2	5
C-13-SC-17	13"	Description as per C-13-SC-14; Group IV.	--	3 hrs. 30 min		1		2	3½

Notes:

TABLE 2.5.1.5

1. Failure mode - collapse.

2. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sand.tone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

Figure 2.5.1.6
Steel Columns-
Concrete Encasements

Minimum Dimension 14" to less than 16"

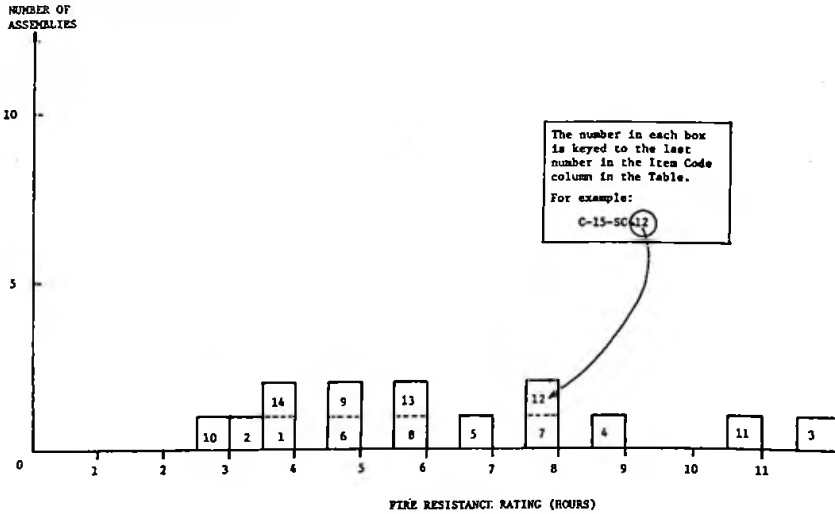


Table 2.5.1.6
Steel Columns-
Concrete Encasements

Minimum Dimension 14" to less than 16"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-14-SC-1	14"	14" x 16" Concrete encased steel column; 8" x 6" x 35 lbs. H column; Protection - Aggregate concrete (4240 PSI) - 4" mesh - 16 S.W. G reinforcing - 1" below column surface.	90 tons	3 hr. 40min.			7	1	3
C-14-SC-2	14"	14" x 18" Concrete encased steel column; 12" x 8" x 65 lbs. "H" Beam; Protection - Gravel aggregate concrete (4000 PSI) with 4" - 16 S.W.G. wire mesh reinforcement 1" below column surface.	177 tons	3 hr. 20min.			7	1	3
C-14-SC-3	14"	10"x 10" steel column with 4" outside protection; Group I.	—	12 hrs		1		2	12
C-14-SC-4	14"	Description as per C-14-SC-3; Group II.	—	9 hrs		1		2	9
C-14-SC-5	14"	Description as per C-14-SC-3; Group III.	—	7 hrs		1		2	7
C-14-SC-6	14"	Description as per C-14-SC-3; Group IV.	—	5 hrs		1		2	5
C-14-SC-7	14"	12"x 12" steel column with 2" outside protection; Group I.	—	8 hrs		1		2	8
C-14-SC-8	14"	Description as per C-14-SC-7; Group II.	—	6 hrs		1		2	6

2.5.1.6 (cont'd)

Minimum Dimension - 14" to Less Than 16"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
C-14-SC-9	14"	Description as per C-14-SC-7; Group III.	—	5 hrs		1		2	5
C-14-SC-10	14"	Description as per C-14-SC-7; Group IV.	—	3 hrs		1		2	3
C-15-SC-11	15"	12"x 12" steel column with 3" outside protection; Group I.	—	11 hrs		1		2	11
C-15-SC-12	15"	Description as per C-15-SC-11; Group II.	—	8 hrs		1		2	8
C-15-SC-13	15"	Description as per C-15-SC-11; Group III.	—	6 hrs		1		2	6
C-15-SC-14	15"	Description as per C-15-SC-11; Group IV.	—	4 hrs		1		2	4

Notes:

TABLE 2.5.1.6

1. Collapse.

2. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

Table 2.5.1.7
Steel Columns-
Concrete Encasements

Minimum Dimension 16" to less than 18"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-RMS-92	RMS-92	Post-RMS-92		
C-16-SC-1	16"	12"x 12" steel column with 4" outside protection; Group I.	—	14 hr		1		1	14
C-16-SC-2	16"	Description as per C-16-SC-1; Group II.	—	10 hr		1		1	10
C-16-SC-3	16"	Description as per C-16-SC-1; Group III.	—	8 hrs		1		1	8
C-16-SC-4	16"	Description as per C-16-SC-1; Group IV.	—	5 hrs		1		1	5

Notes:

TABLE 2.5.1.7

1. Group I - Includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- Includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-Includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- Includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

Table 2.5.2.1
Steel Columns-
Brick & Block Encasements

Minimum Dimension 10" to less than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-10-SB-1	10½"	10½"x 13" Brick encased steel columns;8"x 6"x 35 lb. "H" Beam; Protection: Fill of broken brick and mortar; 2" brick on edge, joints broken in alt. courses. Cement-sand grout; 13 SWG wire reinforcement in every third Horizontal joint.	90 tons	3 hr. 6 min.			7	1	3
C-10-SB-2	10½"	10½"x 13" brick encased steel columns;8"x 6"x 35 lb. "H" beam; Protection: 2" brick, joints broken in alt. courses; Cement-sand grout; 13 SWG iron wire reinforcement in alternate horizontal joints.	90 tons	4 hr.			7	2-4	2
C-10-SB-3	10"	10"x 12" block encased columns; 8"x 6"x 35lb. "H" beam; Protection: 2" foamed slag concrete blocks; 13 SWG wire at each horizontal joint; mortar at each joint.	90 tons	2 hr.			7	5	2
C-10-SB-4	10½"	10½" x 12" block encased steel columns; 8"x 6" x 35 lb. "H" beam; Protection: Gravel aggregate concrete fill (unconsolidated) 2" thick hollow clay tiles with mortar at edges.	86 tons	56min.			7	1	3/4
C-10-SB-5	10½"	10½" x 12" block encased steel columns; 8"x 6" x 35 lb. "H" beam; Protection: 2" hollow clay tiles with mortar at edges.	86 tons	22min.			7	1	1/4

Notes:

TABLE 2.5.2.1

1. Failure mode - collapse.
2. Passed 2 hr. fire test (Grade "C" British).
3. Passed hose stream test.
4. Passed reload test.
5. Passed 2 hour fire exposure but collapsed immediately following hose stream test.

Table 2.5.2.2
Steel Columns-
Brick & Block Encasements

Minimum Dimension 12" to less than 14"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-12-SB-1	12"	12" x 15" brick encased steel columns; 8"x 6" x 35 lb. "H" beam; Protection: 2-5/8" thick brick; joints broken in alt. courses; Cement-sand grout. Fill of broken brick and mortar.	90 tons	1 hr. 49 min			7	1	1-3/4

Notes:

TABLE 2.5.2.2

1. Failure mode - collapse.

Table 2.5.2.3
Steel Columns-
Brick & Block Encasements

Minimum Dimension 14" to less than 16"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-15-SB-1	15"	15" x 17" brick encased steel columns; 8" x 6"x 35 lb. "H" beam; Protection: 4-1/2" thick brick; joints broken in alt. courses; Cement-sand grout; Fill of broken brick and mortar	45 tons	6 hr.			7	1	6
C-15-SB-2	15"	15"x 17" brick encased steel columns; 8"x 6"x 35 lb. "H" beam; Protection: Fill of broken brick and mortar; 4½" brick, joints broken in alt. courses; Cement-sand grout.	86 tons	6 hr.			7	2-4	6
C-15-SB-3	15"	15"x 18" brick encased steel columns; 8"x 6"x 35 lb. "H" beam; Protection: 4½" brick work; joints alternating; Cement-sand grout.	90 tons	4 hr.			7	5,6	4
C-14-SB-4	14"	14"x 16" block encased steel columns; 8"x 6"x 35 lb. "H" beam; Protection: 4" thick foam slag concrete blocks; 13 SWG wire reinforcement in each horizontal joint; mortar in joints.	90 tons	5 hr. 52min			7	7	4-3/4

Notes:

TABLE 2.5.2.3

1. Only a nominal load was applied to specimen.
2. Passed 6 hr. fire test (Grade "A" - British).
3. Passed (6 min.) hose stream test.
4. Reload not specified.
5. Passed 4 hour fire exposure.
6. Failed by collapse between 1st and 2nd minute of hose stream exposure.
7. Mode of failure - collapse.

Table 2.5.3.1
Steel Columns-
Plaster Encasements

Minimum Dimension 6" to less than 8"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-7-SP-1	7½"	7½"x 9½" Plaster protected steel column; 8"x 6" x 35 lb. "H" beam; Protection: 24 SWG wire metal lath; 1½" lime plaster.	90 tons	57min			7	1	3/4
C-7-SP-2	7-7/8"	7-7/8"x 10" plaster protected steel column; 8"x 6"x 35 lb. "H" beam; Protection: 3/8" gypsum bal. wire wound with 16 SWG wire helically wound @ 4" pitch; ½" gypsum plaster.	90 tons	1 hr. 13min			7	1	1
C-7-SP-3	7½"	7½"x 9-3/8" plaster protected steel column; 8"x 6"x 35 lb "H" beam; Protection: 3/8" gypsum board; wire helically wound 16 SWG @ 4" pitch; ½" gypsum plaster finish.	90 tons	1 hr. 14min			7	1	1

Notes:

TABLE 2.5.3.1

1. Failure mode - collapse.

Table 2.5.3.2
Steel Columns-
Plaster Encasements

Minimum Dimension 8" to less than 10"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-8-SP-1	8"	8"x 10" plaster protected steel column; 8"x 6" x 35 lb. "H" beam; Protection: 24 SWG wire lath with 1" gypsum plaster.	86 tons	1 hr. 23min.			7	1	1½
C-8-SP-2	8½"	8½"x 10½" plaster protected steel column; 8"x 6"x 35 lb."H" beam; Protection: 24 SWG metal lath wrap; 1½" gypsum plaster.	90 tons	1 hr. 36min			7	1	1½
C-9-SP-3	9"	9"x 11" plaster protected steel column; 8"x 6"x 35 lb. "H" beam; Protection: 24 SWG metal lath wrap; 3/8" M.S. ties at 12" pitch wire netting 1½" x 22 SWG between 1st and 2nd plaster coats; 1½" gypsum plaster.	90 tons	1 hr. 33min			7	1	1½
C-8-SP-4	8-3/4"	8-3/4"x 10-3/4" plaster protected steel column 8"x 6"x 35 lb. "H" beam; Protection: 3/4" gypsum board - wire wound spirally (#16 SWG) @ 1½" pitch; ½" gypsum plaster.	90 tons	2 hr.			7	2-4	2

Notes:

TABLE 2.5.3.2

1. Failure mode - collapse.
2. Passed 2 hr. fire exposure test (Grade "C" - British).
3. Passed hose stream test.
4. Passed reloa[illegible] test.

Table 2.5.4.1
Steel Columns-
Miscellaneous Encasements

Minimum Dimension 6" to less than 8"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-7-SM-1	7-5/8"	7-5/8"x 9½" (Asbestos plaster) protected steel columns;8"x 6"x 35 lb. "H" beam; Protection: 20 Ga. ½" metal lath; 9/16" asbestos plaster (min.)	90 tons	1 hr. 52min			7	1	1-3/4

Notes:

TABLE 2.5.4.1

1. Failure mode - collapse.

Table 2.5.4.2
Steel Columns-
Miscellaneous Encasements

Minimum Dimension 8" to less than 10"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-9-SM-1	9-5/8"	9-5/8"x 11-3/8" Asbestos slab and cement plaster protected columns;8"x 6"x 35 lb. "H" beam; Protection: 1" asbestos slabs, wire wound, 5/8" plaster.	90 tons	2 hr.			7	1,2	2

Notes:

TABLE 2.5.4.2

1. Passed 2 hr. fire exposure test.

2. Collapsed during hose stream test.

Table 2.5.4.3
Steel Columns-
Miscellaneous Encasements

Minimum Dimension 10" to less than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-11-SM-1	11½"	11½"x 13½" Wood wool and plaster protected steel columns;8" x 6" x 35 lb. "H" beam; Protection: Wood-wool-cement paste as fill and to 2" cover over beam; 3/4" gypsum plaster finish.	90 tons	2 hr.			7	1-3	2
C-10-SM-2	10"	10"x 12" asbestos protected steel columns;8"x 6"x 35 lb. "H" beam; Protection: sprayed on asbestos paste to 2" cover over colum.	90 tons	½ hr.			7	2-4	4

Notes:

TABLE 2.5.4.3

1. Passed 2 hr. fire exposure (Grade "C" - British).
2. Passed hose stream test.
3. Passed reload test.
4. Passed 4-hour fire exposure test.

Table 2.5.4.4
Steel Columns-
Miscellaneous Encasements

Minimum Dimension 12" to less than 14"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-12-SM-1	12"	12"x 14¼" Cement and asbestos protected colum 8"x 6"x 35 lb. "H" beam; Protection: Fill of asbestos packing pieces 1" thick 1'3" O.C.; Cover of 2" molded asbestos inner layer; 1" molded asbestos, outer layer; held in position by 16 SWG nichrome wire ties; Wash of refractory cement on outer surface.	86 tons	½ hr. 43min.			7	1-3	4-2/3

Notes:

TABLE 2.5.4.4

1. Passed 4 hour fire exposure ("Grade B" - British)
2. Passed hose stream test.
3. Passed reload test.

Section III — Floor/Ceiling Assemblies

Figure 3.1
Floor/Ceiling Assemblies-
Reinforced Concrete

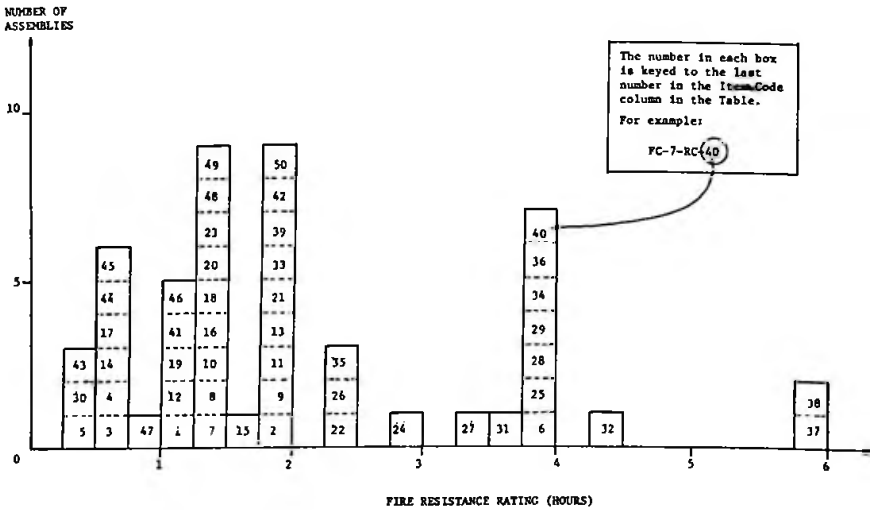


Table 3.1
Floor/Ceiling Assemblies-
Reinforced Concrete

Item Code	Assembly Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
FC-3-RC-1	3-3/4"	3-3/4" thick floor; 3½" (5475 PSI) concrete deck; ½" plaster under deck; 3/8" main rein. bars @ 5½" pitch with 7/8" concrete cover; 3/8" main rein. bars @ 4½" pitch perpendicular with ½" concrete cover. 13'1" span restrained.	195 PSF	24min			7	1,2	1
FC-3-RC-2	3½"	3½" deep (3540 PSI) concrete deck; 3/8" main rein. bars @ 5½" pitch with 7/8" cover; 3/8" main rein. bars @ 4½" pitch perpendicular with ½" cover. 13'1" span restrained.	195 PSF	2 hr.			7	1,3, 4	3-3/4
FC-3-RC-3	3½"	3½" deep (4175 PSI) concrete deck; 3/8" main rein. bars @ 5½" pitch with 7/8" cover; 3/8" main rein. bars @ 4½" pitch perpendicular with ½" cover; 13'1" span restrained.	195 PSF	31min			7	1,5	½
FC-3-RC-4	3½"	3½" deep (4355 PSI) concrete deck; 3/8" main rein. bars @ 5½" pitch with 7/8" cover; 3/8" main rein. bars @ 4½" pitch perpendicular with ½" cover; 13'1" span restrained.	195 PSF	41min			7	1,5, 6	½
FC-3-RC-5	3½"	3½" thick (3800 PSI) concrete deck; 3/8" main rein. bars @ 5½" pitch with 7/8" cover; 3/8" main rein. bars @ 4½" pitch perpendicular with ½" cover.; 13'1" span restrained.	195 PSF	1 hr. 5 min			7	1,5	¼
FC-4-RC-6	4¼"	4¼" thick; 3¼" concrete deck (4000 PSI); 1" sprayed asbestos lower surface; 3/8" main rein bars @ 5-7/8" pitch with 7/8" concrete cover; 3/8" main rein. bars @ 4½" pitch perpendicular with ½" concrete cover; 13'1" span restrained.	195 PSF	4 hr.			7	1,7	4
FC-4-RC-7	4"	4" deck (5025 PSI); ¼" rein bars @ 7½" pitch with 3/4" cover; 3/8" main rein. bars @ 3-3/4" pitch perpendicular with ½" cover; 13'1" span restrained.	140 PSF	1 hr. 16 min			7	1,2	1¼

TABLE 3.1 (cont'd)

Floor Ceiling Assemblies - Reinforced Concrete

Item Code	Assembly Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
FC-4-RC-8	4"	4" thick (4905 PSI) deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3-3/4" pitch perpendicular with ½" cover; 13' 1" span restrained.	100 PSF	1 hr. 23 min			7	1,2	1-1/3
FC-4-RC-9	4"	4" deep (4370 PSI); ¼" rein. bars @ 6" pitch with 3/4" cover; ¼" main rein. bars @ 4" pitch perpendicular with ½" cover; 13'1" span restrained.	150 PSF	2 hr.			7	1,3	2
FC-4-RC-10	4"	4" thick (3140 PSI) deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3-3/4" pitch perpendicular with ½" cover; 13'1" span restrained.	140 PSF	1 hr. 16 min			7	1,5	1¼
FC-4-RC-11	4"	4" thick (4000 PSI) concrete deck; 3"x1½"x4 lb. R.S.J.; 2'6" C.R.S.; flush with top surface; 4"x6"x13 S.W.G. mesh rein. 1" from bottom of slab; 6'6" span restrained.	150 PSF	2 hr.			7	1,3	2
FC-4-RC-12	4"	4" deep (2380 PSI) concrete deck; 3"x 1½"x 4 lb. R.S.J.; 2'6" C.R.S.; flush with top surface; 4"x6"x13 S.W.G. mesh rein. 1" from bottom surface; 6'6" span restrained.	150 PSF	1 hr. 3 min.			7	1,2	1
FC-4-RC-13	4½"	4½" thick (5200 PSI) deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3-3/4" pitch perpendicular with ½" cover; 13'1" span restrained.	140 PSF	2 hr.			7	1,3	2
FC-4-RC-14	4½"	4½" deep (2525 PSI) concrete deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3-3/8" pitch perpendicular with ½" cover; 13'1" span restrained.	150 PSF	42 min			7	1,5	2/3
FC-4-RC-15	4½"	4½" deep (4830 PSI) concrete deck; 1½"x No. 15 gauge wire mesh; 3/8" rein. bar @ 15" pitch with 1" cover; ½" main rein. bars @ 6" pitch perpendicular with ½" cover; 12' span simply supported.	75 PSF	1 hr. 02 min			7	1,8	1½
FC-4-RC-16	4½"	4½" deep (4595 PSI) concrete deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with ½" cover; 12' span simply supported.	75 PSF	1 hr. 20 min			7	1,8	1-1/3
FC-4-RC-17	4½"	4½" deep (3625 PSI) concrete deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with ½" cover; 12' span simply supported.	75 PSF	35 min			7	1,8	½
FC-4-RC-18	4½"	4½" deep (4410 PSI) concrete deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with ½" cover; 12' span simply supported.	85 PSF	1 hr. 27 min			7	1,8	1-1/3
FC-4-RC-19	4½"	4½" deep (4850 PSI) deck; 3/8" rein. bars @ 15" pitch with 1" cover; ½" main rein. bars @ 6" pitch perpendicular with ½" cover; 12' span simply supported.	75 PSF	2 hr. 15 min			7	1,9	1¼
FC-4-RC-20	4½"	4½" deep (3610 PSI) deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with ½" cover; 12' span simply supported.	75 PSF	1 hr. 22 min			7	1,8	1-1/3
FC-5-RC-21	5"	5" deep; 4½" (5830 PSI) concrete deck; ½" plaster finish bottom of slab; ¼" rein. bars 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with ½" cover; 12' span simply supported.	69 PSF	2 hr.			7	1,3	2
FC-5-RC-22	5"	4½" (5290 PSI) concrete deck; ½" plaster finish bottom of slab; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with ½" cover; 12' span simply supported.	No Load	2 hr. 28 min			7	1,10, 11	2¼
FC-5-RC-23	5"	5" Deep (3020 PSI) concrete deck; 3"x1½"x 4 lb. R.S.J. 2' C.R.S with 1" cover on bottom and top flanges; 8' span restrained.	172 PSF	1 hr. 24 min			7	1,2, 12	1½

Floor Ceiling Assemblies - Reinforced Concrete

Item Code	Assembly Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
FC-5-RC-24	5½"	5" (5180 PSI) concrete deck; ½" retarded plaster underneath slab; ½" rein. bars @ 7½" pitch with 1-3/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with 1" cover; 12' span simply supported.	60 PSF	2 hr. 48min.			7	1,10	2-3/4
FC-6-RC-25	6"	6" deep (4800 PSI) concrete deck; ½" rein. bars @ 7½" pitch 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with 7/8" cover; 13'1" span restrained.	195 PSF	4 hr.			7	1,7	4
FC-6-RC-26	6"	6" (4650 PSI) concrete deck; ½" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein bars @ 3½" pitch perpendicular with ½" cover; 13'1" span restrained.	195 PSF	2 hr. 23 min			7	1,2	2½
FC-6-RC-27	6"	6" deep (6050 PSI) concrete deck; ½" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with ½" cover; 13'1" span restrained.	195 PSF	½ hr. 30 min			7	1,10	3½
FC-6-RC-28	6"	6" deep (5180 PSI) concrete deck; ½" bars @ 8" pitch 3/4" cover; ½" bars @ 5½" pitch with ½" cover perpendicular; 13'1" span restrained.	150 PSF	4 hr.			7	1,7	4
FC-6-RC-29	6"	6" thick (4180 PSI) concrete deck; 4"x3"x 10 lb R.S.J.; 2'6" C.R.S. with 1" cover on both bottom and top flanges; 13'1" span restrained.	160 PSF	½ hr. 48 min			7	1,10	3-3/4
FC-6-RC-30	6"	6" thick (3720 PSI) concrete deck; 4"x3"x10 lb. R.S.J; 2'6" C.R.S. with 1" cover on both top & bottom flanges; 12' span simply supported.	115 PSF	29 min			7	1,5, 13	½
FC-6-RC-31	6"	6" deep (3450 PSI) concrete deck; 4"x 1-3/4" x 5 lb. R.S.J; 2'6" C.R.S. with 1" cover on both top and bottom flanges; 12' span simply supported.	25 PSF	3 hr. 35 min			7	1,2	3½
FC-6-RC-32	6"	6" deep (4460 PSI) concrete deck; 4"x 1-3/4" x 5 lb. R.S.J; 2' C.R.S; with 1" cover on both top and bottom flanges; 12'span simply supported.	60 PSF	4 hr. 30 min			7	1,10	4½
FC-6-RC-33	6"	6" deep (4360 PSI) concrete deck; 4"x1-3/4"x5 lb. R.S.J; 2' C.R.S; 1" cover on both bottom & top flanges; 13'1" span restrained.	60 PSF	2 hr.			7	1,3	2
FC-6-RC-34	6½"	6½" thick; 4-3/4" (5120 PSI) concrete core; 1" T&C board flooring; ½" plaster undercoat; 4"x 3"x 10 lb. R.S.J; 3' C.R.S. flush with top surface concrete 12' span simply supported; 2"x 1' 3" clinker concrete insert.	100 PSF	4 hr.			7	1,7	4
FC-6-RC-35	6½"	4-3/4" (3600 PSI) concrete core; 1" T&G board flooring; ½" plaster undercoat; 4"x 3"x 10 lb. R.S.J; 3' C.R.S; flush with top surface concrete; 12' span simply supported; 2"x1'3" clinker concrete insert.	100 PSF	½ hr. 30 min			7	1,5	2½
FC-6-RC-36	6½"	4-3/4" (2800 PSI) concrete core; 1" T&G board flooring; ½" plaster undercoat; 4"x 3"x 10 lb. R.S.J; 3' C.R.S; flush with top surface concrete; 12' span simply supported; 2"x 1'3" clinker concrete insert.	80 PSF	4 hr.			7	1,7	4
FC-7-RC-37	7"	(3640 PSI) concrete deck; ½" rein. bars @ 6" pitch 1½" cover; ½" rein. bars @ 5" pitch 1½" cover perpendicular; 13'1" span restrained.	169 PSF	6 hr.			7	1,14	6
FC-7-RC-38	7"	(4060 PSI) concrete deck; 4"x3"x10 lb. R.S.J. 2'6" C.R.S. with 1½' cover on both top & bottom flanges; 4"x6"x13 S.W.G. mesh rein. 1½" from bottom of slab; 13'1" span restrained.	175 PSF	6 hr.			7	1,14	6
FC-7-RC-39	7½"	5-3/4" (4010 PSI) concrete core; 1" T&C board flooring; ½" plaster undercoat; 4"x3"x10 lb. R.S.J., 2'6" C.R.S.; 1" down from top surface of concrete; 12' simply supported span; 2"x1'3" clinker concrete insert.	95 PSF	2 hr.			7	1,3	2
FC-7-RC-40	7½"	5-3/4" (3220 PSI) concrete core; 1" T&G board flooring; ½" plaster undercoat; 4"x3"x10 lb. R.S.J.; 2'6" C.R.S.; 1"down from top surface of concrete; 12' simply supported span; 2"x1'3" clinker concrete insert.	95 PSF	4 hr.			7	1,7	4

Floor Ceiling Assemblies - Reinforced Concrete

Item Code	Assembly Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
FC-7-RC-41	10" (2½" Slab)	Ribbed floor - see detail - Note #15; Slab 2½" deep (3020 PSI); ½" rein. bars @ 6" pitch with 3/4" cover; Beams 7½" deep x 5" wide; 24" CRS; 5/8" rein. bars 2 rows ½" vertically apart with 1" cover; 13'1" span restrained.	195 PSF	1 hr. 4 min.			7	1,2, 15	1
FC-5-RC-42	5½"	Composite ribbed concrete slab assembly; See note #17 for details.	See Note 16	2 hr.			43	16,17	2
FC-3-RC-43	3"	2500 PSI concrete, 5/8" cover; fully restrained at test	See Note 16	30 min			43	16	½
FC-3-RC-44	3"	2000 PSI concrete; 5/8" cover; free or partial restraint at test.	See Note 16	45 min			43	16	3/4
FC-4-RC-45	4"	2500 PSI concrete, 5/8" cover; fully restrained at test.	See Note 16	40 min			43	16	2/3
FC-4-RC-46	4"	2000 PSI concrete, 3/4" cover; free or partial restraint at test.	See Note 16	1 hr. 15 min			43	16	1¼
FC-5-RC-47	5"	2500 PSI concrete; 3/4" cover; fully restrained at test.	See Note 16	1 hr.			43	16	1
FC-5-RC-48	5"	2000 PSI concrete, 3/4" cover; free or partial restraint at test.	See Note 16	1 hr. 30 min			43	16	1½
FC-6-RC-49	6"	2500 PSI concrete; 1" cover; fully restrained at test.	See Note 16	1 hr. 30 min			43	16	1½
FC-6-RC-50	6"	2000 PSI concrete, 1" cover free or partial restraint at test.	See Note 16	2 hrs.			43	16	2

Notes:

TABLE 3.1

1. British test.
2. Failure mode - local back face temperature rise.
3. Tested for grade "C" (2 hr.) fire resistance.
4. Collapse immenent following hose stream.
5. Failure mode: flame-thru.
6. Void formed with explosive force and report.
7. Achieved grade "B" (4 hour) fire resistance (British).
8. Failure mode - collapse.
9. Test was run to 2 hr., but specimen was partially supported by the furnace at 1¾ hrs.
10. Failure mode: average back face temperature.

NOTES

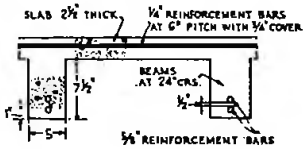
11. Recommended endurance is for non-load bearing performance only.

12. Floor maintained load-bearing ability to 2 hours at which point test was terminated.

13. Test was run to 3 hours at which time failure mode 2 (above) was reached in spite of crack formation at 29 min.

14. Tested for grade "A" (6 hour) fire resistance.

15.



16. Load unspecified.

17. Total assembly thickness 5⅛". 3" thick blocks of molded excelsior bonded with portland cement used as inserts with 2½" cover (concrete) above blocks and 3/4" gypsum plaster below. 9" wide ribs containing reinforcing steel of unspecified size interrupted 20" wide segments of slab composite (i.e. plaster, excelsior blocks, concrete cover).

Figure 3.2
Floor/Ceiling Assemblies-
Steel Structural Elements

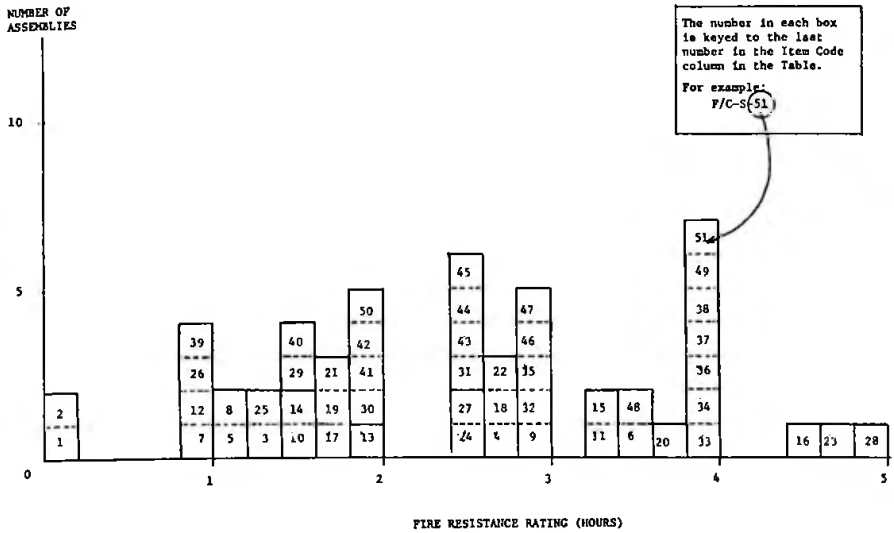


Table 3.2
Floor/Ceiling Assemblies-
Steel Structural Elements

Item Code	Membrane Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
F/C-S-1	0"	- 10'x 13'6"; S.J. 103-24" O.C.; Deck 2" concrete; Membrane: None.	145 PSF	7 min.			3	1,2,3 8	0
F/C-S-2	0"	- 10'x 13'6" S.J. 103-24" O.C.; Deck 2" concrete; Membrane: None.	145 PSF	7 min.			3	1,2,3 8	0
F/C-S-3	½"	- 10'x 13'6"; S.J. 103-24" O.C.; Deck 2" concrete 1:2:4; Membrane - 12" O.C. furring clips - ABC; No extra reinforcement; Plaster ½" 1.5:2.5	145 PSF	1 hr. 15min.			3	2,3,8	1¼
F/C-S-4	½"	- 10'x 13'6"; S.J. 103-24" O.C.; Deck 2" concrete 1:2:4; membrane - 16" O.C. furring clips - DEFG; Diagonal wire reinforcement; ½" plaster 1.5:2.5	145 PSF	2 hr. 46min.			3	3,8	2-3/4
F/C-S-5	½"	- 10'x 13'6" S.J. 103-24" O.C.; Deck 2" concrete 1:2:4; membrane - furring 16" O.C.; Clip A,B,G; No extra reinforcement; Plaster ½" 1.5:2.5.	145 PSF	1 hr. 4 min.			3	2,3,8	1
F/C-S-6	½"	10'x 13'6"; S.J. 103-24" O.C.; Deck 2" concrete 1:2:4; Membrane - furring 16" O.C.; Clips - DEFG; Hexagonal mesh reinforcement ½" plaster	145 PSF	3 hr. 28min.			3	2,4,8	2-1/3

STEEL STRUCTURAL ELEMENTS

Item Code	Membrane Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
F/C-S-7	½"	10'x 13'6"; S.J. 103-24" O.C.; Deck 4 lb rib lath; 6"x 6"-10x 10 ga. reinforcement; 2" deck gravel concrete; Membrane - furring 16" O.C.; clips - C,E.; Reinforcement - No.; 1/2" plaster - 1.5:2.5 mill mix.	N/A	55min			3	5,8	3/4
F/C-S-8	½"	. spec. 9'x 4'4"; S.J. 103 Bar Joists - 18" O.C.; Membrane: Furring - 3/4" C.R.S. - 16" O.C.; clips - C,E; Reinforcement - No ; 1/2" plaster - 1.5:2.5 mill mix; Deck: 4 lb. rib lath base; 6"x 6" - 10x 10 ga. reinforcement; 2" deck 1:2:4 gravel concrete.	300 PSF	1 hr. 10min			3	2,3,8	1
F/C-S-9	5/8"	10'x 13'6"; S.J. 103-24" O.C.; Deck 2" concrete 1:2:4; Membrane: furring 12" O.C.; Clips ABC; Extra "A" clips reinforcement; 5/8" plaster - 1.5:2; 1.5:3.	145 PSF	3 hr.			3	6,8	3
F/C-S-10	5/8"	18'x13'6"; Joists - S.J. - 103-24"O.C.; Deck: 4 lb. rib lath; 6"x 6" - 10x 10 ga. reinforcement; 2" deck - 1:2:3.5 gravel concrete Membrane - furring, spacing - 16" O.C.; clips C.E.; Reinforcement - No ; 5/8" plaster - 1.5:2.5 mill mix.	145 PSF	1 hr. 25min			3	2,3,8	1-1/3
F/C-S-11	5/8"	10'x 13'6", S.J. 103 - 24" O.C.; Deck 2" concrete 1:2:4; Membrane: furring 12" O.C.; clips - D,E,F,G., Diagonal wire reinforcement; 5/8" plaster - 1.5:2; 0.5:3	145 PSF	3 hr. 15min			3	2,4,8	3½
F/C-S-12	5/8"	10'x13'6"; Joists -SJ 103 - 24" OC; Deck: 3.4 lb. rib lath; Reinforcement - 6"x6" 10 x 10 ga.; 2" deck - 1:2:4 gravel concrete; Membrane: furring 16" O.C.; Clips - D,E,F,G; No reinforcement; 5/8" plaster - 1.5:2.5.	145 PSF	1 hr.			3	7,8	1
F/C-S-13	3/4"	Spec. 9'x 4'4"; SJ 103 - 18" O.C.; Deck - 41b. rib. lath; 6"x6" - 10 x 10 ga. reinforcement; 2" deck 1:2:4 gravel concrete; Membrane - furring 3/4" CRS 16" O.C.; Clips - C,E; Reinforcement - None; 3/4" plaster - 1.5:2.5 mill mix	300 PSF	1 hr. 56min.			3	3,8	1-3/4
F/C-S-14	7/8"	Floor finish - 1" concrete; plate cont. weld; 4" - 7.7 lb, I beams; Ceiling - ½" rods 12" O.C.; 7/8" gyp. sand plaster.	105 PSF	1 hr. 35min.			6	2,4,9 10	1-1/2
F/C-S-15	1"	floor finish - 1½" L.W. concrete; ½" lime-stone cement; plate cont. weld; 5" - 10 lb. I beams; Ceiling - ½" rods - 12" O.C. Tack welded to beams metal lath - 1" P.C. plaster.	165 PSF	3 hr. 20min			6	4,9,11	
F/C-S-16	1"	10'x 13'6"; SJ 103 - 24" .C.; Deck: 2" concrete - 1:2:4; Membrane: furring 12" O.C.; clips D,E,F,G; Plaster - hexagonal mesh reinforcement; 1" thick - 1.5:2; 1.5:3.	145 PSF	4 hr. 26min			3	2,4,8	4-1/3
F/C-S-17	1"	10'x13'6"; Joists - SJ 103 - 24" O.C.; Deck 3.4 lb. rib lath; Reinforcement: 6"x6" - 10x10 ga.; 2" deck 1:2:4 gravel concrete; Membrane: furring 16"O.C.; clips D,E,F,G; 1" plaste	145 PSF	1 hr. 42min			3	2,4,8	1-2/3
F/C-S-18	1-1/8"	10'x13'6" S.J. 103 - 24" O.C.; Deck: 2" concrete 1:2:4; Membrane: furring 12" O.C. clips C,E,F,G; Diag. wire reinforcement; 1-1/8" plaster.	145 PSF	2 hr. 44min			3	2,4 8	2-2/3
F/C-S-19	1-1/8"	10'x13'6"; Joists - S.J. 103 - 24" O.C. Deck - 1½" Gypsum concrete over; ½" gypsum board base; Membrane furring 12" O.C. Plaster 1-1/8" 1.5:2; 1.5:3; Clips D,E,F,G.	165 PSF	1 hr. 40min			3	2,3,8	1-2/3
F/C-S-20	1-1/8"	2½" cinder concrete; ½" topping; plate 6." welds 12" O.C.; 5" - 18.9 lb. "H" center; 5" - 10 lb "I" ends; 1" channel 18" O.C.; 1-1/8" gypsum sand plaster.	150 PSF	3 hr. 43min			6	2,4,9 11	3-2/3
F/C-S-21	1¼"	10'x 13'6"; Joists - SJ 103 - 24" O.C.; Deck: 1½" gypsum concrete over; ½" gypsum board base; Membrane: furring 12" O.C. Clips D,E,F,G; 1¼" plaster 1.5:2; 1.5:3.	145 PSF	1 hr. 48min			3	2,3,8	1-2/3

STEEL STRUCTURAL ELEMENTS

Item Code	Membrane Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
F/C-S-22	1½"	Floor finish 1½" limestone concrete; ½" sand cement topping; plate to beam 3½"; 12" O.C. welded; 5" 10 lb "I" beam; 1" channels 18" O.C.; 1½" wood fiber gypsum sand plaster on metal lath.	292 PSF	2 hr. 45min			6	2,4,9 10	2-3/4
F/C-S-23	1½"	2½" L.W. (gas. exp.) concrete; Deck: 1/2" topping; plate 6½" welds 12" O.C.; Beams: 5"-18.9 lb. "H" center; 5"-10 lb. "I" ends; Membrane: 1" channel 18" OC; 1½" gyp. sand plaster.	150 PSF	4 hr. 42min			6	2,4,9	4-2/3
F/C-S-24	1½"	floor finish 1½" limestone concrete; ½" cement topping; plate 3½" - 12" O.C. welded; 5" - 10 lb "I" beam; Ceiling: 1" channel - 18" O.C.; 1½" gypsum plaster.	292 PSF	2 hr. 34min			6	2,4,9 10	2½
F/C-S-25	1½"	floor finish 1½" gravel concrete on exp. metal; plate - cont. weld; 4" 7.7 lb. "I" beams; Ceiling ½" rods - 12"O.C. welded to beams; 1½" fiber gypsum sand plaster.	70 PSF	1 hr. 24min.			6	4,9, 10	1-1/3
F/C-S-26	2½"	floor finish - bare plate; 6½" welding - 12" O.C.; 5"-18.9 lb. "H" girden (inner); 5" 10 lb. "I" girder (2 outer); 1" channel 18" O.C 2" reinforced gypsum tile; ½" gypsum sand plaster.	122 PSF	1 hr.			6	7,9, 11	1
F/C-S-27	2½"	floor finish - 2" gravel concrete; plate to beam 3½ - 12" O.C. welded; 4" 7.7 lb. "I" beams; 2" gypsum ceiling tiles; ½" 1:3 gypsum sand plaster.	105 PSF	2 hr. 31 min			6	2,4,9 10	2½
F/C-S-28	2½"	floor finish - 1½" gravel concrete; ½" gypsum ashphalt; plate continuous weld 4"-7.7 lb. "I" beam; 12" 31.8 lb. "I" beam - girder @ 5' from 1 end; 1" channels 18" O.C.; 2" reinforcement gypsum tile; ½" 1:3 gypsum sand plaster.	200 PSF	4 hr. 55min			6	2,4,9 11	4-2/3
F/C-S-29	3/4"	Floor: 2" rein. concrete or 2" precast rein. gypsum tile; Ceiling: 3/4" portland cement sand plaster 1:2 scratch and 1:3 brown coat with 15 lb. hydrated lime and 3 lb. of short asbestos fiber bag per cement or 3/4" sanded gypsum plaster 1:2 scratch and 1:3 brown coat	See Note 12	1 hr. 30min		1		12,13 14	1 ½
F/C-S-30	3/4"	Floor: 2½" rein. concrete or 2" rein. gypsum tile; the latter with ½" mortar finish; Ceiling 3/4" sanded gypsum plaster; 1:2 for scratch cost and 1:3 for brown coat.	See Note 12	2 hrs		1		12,13 14	2
F/C-S-31	3/4"	Floor: 2½" rein. concrete or 2" rein. gypsum tile; the latter with ½" mortar finish; Ceiling: 1" neat gypsum plaster or 3/4" gypsum vermiculite plaster ratio of gypsum to fine vermiculite 2:1 to 3:1.	See Note 12	2 hrs 30min		1		12,13 14	2½
F/C-S-32	3/4"	Floor: 2½" rein. concrete or 2" rein. gypsum tile; the latter with ½" mortar finish; Ceiling 1" neat gypsum plaster or 3/4" gypsum-vermiculite plaster, ratio of gypsum to fine vermiculite 2:1 to 3:1	See Note 12	3 hrs		1		12,13 14	3
F/C-S-33	1"	Floor: 2½" rein. concrete, or 2" rein. gypsum slabs, the latter with ½" mortar finish; Ceiling: 1" gypsum vermiculite plaster applied on metal lath and ratio 2:1 to 3:1 gypsum to vermiculite by weight.	See Note 12	4 hrs		1		12,13 14	4
F/C-S-34	2½"	Floor: 2" rein. concrete or 2" precast rein. portland cement concrete or gypsum slabs, precast slabs to be finished with ½" mortar top coat; Ceiling: 2" precast reinforced gypsum tile, anchored into beams with metal ties or clips and covered with ½" 1:3 sanded gypsum plaster.	See Note 12	4 hrs.		1		12,13 14	4
F/C-S-35	1"	Floor: 1:3:6 portland cement, sand, and gravel concrete applied directly to the top of steel units and 1½" thick at top of cells, plus ½" 1:2½" cement-sand finish, total thickness at top of cells, 2"; Ceiling: 1" neat gypsum plaster, back of lath 2" or more from underside of cellular steel.	See Note 15	3 hrs.		1		15,16 17,18	3

STEEL STRUCTURAL ELEMENTS

Item Code	Membrane Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
F/C-S-36	1"	Floor: Same as F/C-S-35 Ceiling: 1" gypsum vermiculite plaster (ratio of gypsum to vermiculite 2:1 to 3:1), the back of lath 2" or more from underside of cellular steel.	See Note 15	4 hrs.		1		15,16 17,18	4
F/C-S-37	1"	Floor: Same as F/C-S-35 Ceiling: 1" neat gypsum plaster; back of lath 9" or more from underside of cellular steel.	See Note 15	4 hrs		1		15,16 17,18	4
F/C-S-38	1"	Floor: Same as F/C-S-35 Ceiling: 1" gypsum vermiculite plaster (ratio of gypsum to vermiculite 2:1 to 3:1) the back of lath being 9" or more from underside of cellular steel.	See Note 15.	5 hrs.		1		15,16 17,18	5
F/C-S-39	3/4"	Floor: Asbestos paper 14 lb/100 ft.^{2} cemented to steel deck with waterproof linoleum cement, wood screeds and 7/8" wood floor; Ceiling: 3/4" sanded gypsum plaster 1:2 for scratch and 1:3 for brown coat.	Note 19	1 hr.		1		19,20 21,22	1
F/C-S-40	3/4"	Floor: 1½" 1:2:4 portland cement concrete; Ceiling: 3/4" sanded gypsum plaster 1:2 for scratch and 1:3 brown coat.	Note 19	1 hr. 30 min		1		19,20 21,22	1½
F/C-S-41	3/4"	Floor: 2", 1:2:4 portland cement concrete; Ceiling: 3/4" sanded gypsum plaster, 1:2 for scratch and 1:3 for brown coat.	Note 19	2 hrs.		1		19,20 12,22	2
F/C-S-42	1"	Floor: 2", 1:2:4 portland cement-concrete; Ceiling: 1" portland cement-sand plaster with 10 lb. of hydrated lime for @ bag of cement 1:2½ for brown coat. 1:2 scratch coat.	Note 19	2 hrs.		1		19,20 21,22	2
F/C-S-43	1½"	Floor: 2", 1:2:4 portland cement concrete; Ceiling: 1½", 1:2 sanded gypsum plaster on ribbed metal lath.	Note 19	2 hrs. 30 min		1		19,20 21,22	2½
F/C-S-44	1-1/8"	Floor: 2", 1:2:4 portland cement concrete; Ceiling: 1-1/8", 1:1 sanded gypsum plaster.	Note 19	2 hrs. 30 min		1		19,20 21,22	2½
F/C-S-45	1"	Floor: 2½", 1:2:4 portland cement concrete; Ceiling: 1", 1:2 sanded gypsum plaster.	Note 19	2 hrs. 30 min		1		19,20 21,22	2½
F/C-S-46	3/4"	Floor: 2½", 1:2:4 portland cement concrete; Ceiling: 1" neat gypsum plaster or 3/4" gypsum vermiculite plaster, ratio of gypsum to vermiculite 2:1 to 3:1	Note 19	3 hrs.		1		19,20 21,22	3
F/C-S-47	1-1/8"	Floor: 2½", 1:2:4 portland cement, sand and cinder concrete plus ½", 1:2½ cement-sand finish; total thickness 3"; Ceiling: 1-1/8", 1:1 sanded gypsum plaster.	Note 19	3 hrs.		1		19,20 21,22	3
F/C-S-48	1-1/8"	Floor: 2½" gas expanded portland cement-sand concrete plus ½", 1:2½ cement-sand finish; total thickness 3"; Ceiling; 1-1/8", 1:1 sanded gypsum plaster.	Note 19	3 hrs. 30 min		1		19,20 21,22	3½
F/C-S-49	1"	Floor: 2½", 1:2:4 portland cement concrete; Ceiling: 1" gypsum vermiculite plaster; ratio of gypsum to vermiculite 2:1 to 3:1.	Note 19	4 hrs.		1		19,20 21,22	4
F/C-S-50	2½"	Floor: 2", 1:2:4 portland cement concrete; Ceiling: 2" interlocking gypsum tile supported on upper face of lower beam flange, 1/2" 1:3 sanded gypsum plaster.	Note 19	2 hrs.		1		19,20 21,22	2
F/C-S-51	2½"	Floor: 2" 1:2:4 portland cement concrete; Ceiling: 2" precast metal rein. gypsum tile ½" 1:3 sanded gypsum plaster (tile clipped to channels which are clipped to lower flange of beams).	Note 19	4 hrs		1		19,20 21,22	4

Notes:

TABLE 3.2

1. No protective membrane over structural steel.
2. Performance time indicates first end point reached only several tests were continued to points where other failures occurred.
3. Load failure.
4. Thermal failure.
5. This is an estimated time to load bearing failure. The same joist and deck specimen was used for a later test with different membrane protection.
6. Test stopped at 3 hr. to reuse specimen; No endpoint reached.
7. Test stopped at 1 hour to reuse specimen; No endpoint reached.
8. All plaster used = gypsum.
9. Specimen size - 18'x 13½'. Floor Deck - base material - ¼" x 18' steel plate welded to "I" beam.
10. I beams - 24" O.C.
11. I beams - 48" O.C.
12. Apply to open web joists, pressed steel joists, or rolled steel beams, which are not stressed beyond 18,000 lb/in.^{2} in flexure for open-web pressed, or light rolled steel joists and 20,000 lb/in.^{2} for American standard or heavier rolled beams.
13. Ratio of weight of portland cement to fine and coarse aggregates combined for floor slabs shall not be less than 1:6½.
14. Plaster for ceiling shall be applied on metal lath which shall be tied to supports to give the equivalent of single No. 18 gage steel wires 5" O.C.
15. Load: Maximum fiber stress in steel not to exceed 16,000 PSI.
16. Prefabricated units 2 ft. wide with length equal to the span, composed of 2 pieces of No.18 gage formed steel welded together to give 4 longitudinal cells.
17. Depth not less than 3" and distance between cells not less than 2".
18. Ceiling: metal lath tied to furring channels secured to runner channels hung from cellular steel.
19. Load: Rolled steel supporting beams and steel plate base shall not be stressed beyond 20,000 PSI in flexure.

    Formed steel (with wide upper flange) construction shall not be stressed beyond 16,000 PSI.
20. Some type of expanded metal or woven wire shall be imbedded to prevent cracking in concrete flooring.
21. Ceiling plaster shall be on metal lath wired to rods or channels which are clipped or welded to steel construction. Lath shall be no smaller than 18 gage steel wire and not more than 7" O.C.
22. The securing rods or channels shall be at least as effective as single 3/16" rods with 1" of their length bent over the lower flanges of beams with the rods or channels tied to this clip with 14 gage iron wire.

Figure 3.3
Floor/Ceiling Assemblies-
Wood Joist

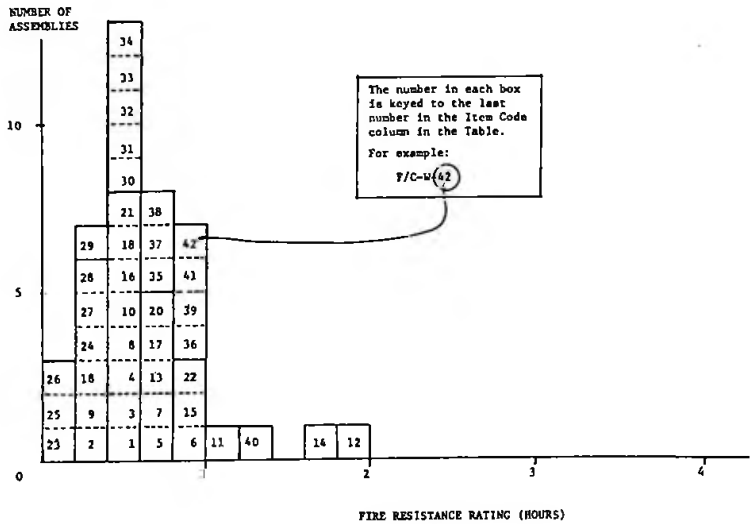


Table 3.3
Floor/Ceiling Assemblies-
Wood Joist

Item Code	Membrane Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
F/C-W-1	3/8"	12' clear span - 2"x 9" wood joists - 18" O.C. Deck - 1" T&G; Filler: 3" of ashes on ½" boards nailed to joist sides 2" from bottom; 2" air space; Membrane 3/8" gypsum board.	60 PSF	36min.			7	1,2	½
F/C-W-2	½"	12' clear span - 2"x7" joists; 15" O.C.; 2"x 1½" center bridging at center; Deck - 1" nominal lumber; membrane - ½" fiber board.	60 PSF	22min.			7	1,2,3	½
F/C-W-3	½"	12' clear span - 2"x 7" wood joists, 16" O.C. 2"x1½" bridging at center; deck - 1" T&G; membrane - ½" fiberboard; 2 coats "distemper" paint.	30 PSF	28 min			7	1,3, 15	1/3
F/C-W-4	3/16"	12' clear span - 2"x 7" wood joists, 16" O.C. 2 x 1½ bridging at center span; Deck - 1" nominal lumber; membrane - ½" fiberboard under 3/16" gypsum plaster.	30 PSF	32min			7	1,2	½
F/C-W-5	5/8"	As per previous F/C-W-4 except membrane is 5/8" lime plaster.	70 PSF	48min			7	1,2	3/4
F/C-W-6	5/8"	As per previous F/C-W-5 except membrane is 5/8" gypsum plaster on 22 gauge 3/8" metal lath.	70 PSF	49min			7	1,2	3/4
F/C-W-7	½"	As per previous F/C-W-6 except membrane is ½" fiberboard under ½" gypsum plaster.	60 PSF	43min			7	1,2,3	2/3
F/C-W-8	½"	As per previous F/C-W-7 except membrane is ½" gypsum board.	60 PSF	33min			7	1,2,3	½

FLOOR/CEILING ASSEMBLIES

WOOD JOIST

Item Code	Membrane Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
F/C-W-9	9/16"	12' clear span - 2"x 7" wood joists; 15" O.C. 2"x 1½" center bridging; Deck - 1" nominal lumber; membrane - 3/8" gypsum board; 3/16" gypsum plaster.	60 PSF	24min			7	1,2,3	1/3
F/C-W-10	5/8"	As per F/C-W-9 except membrane is 5/8" gypsum plaster on wood lath.	60 PSF	27min.			7	1,2,3	1/3
F/C-W-11	7/8"	12' clear span - 2"x 9" wood joists; 15" O.C. 2"x 1½" bridging at center span; Deck - 1" T&G Membrane - original ceiling joists have 3/8" plaster on wood lath. 4" metal hangers attached below joists creating 15" chases filled with mineral wood and closed with 7/8" plaster (gypsum) on 3/8" S.W.M. metal lath to form new ceiling surface.	75 PSF	1 hr. 10min.			7	1,2	1
F/C-W-12	7/8"	12' clear span - 2"x 9" wood joists - 15" O.C. 2"x 1½" bridging at center; Deck - 1" T&G; Membrane - 3" mineral wood below joists; 3" hangers to channel below joists; 7/8" gypsum plaster on metal lath attached to channels.	75 PSF	1 hr.			7	1,4	2
F/C-W-13	7/8"	12' clear span - 2"x 9" wood joists - 16" O.C. with 2" x 1½" bridging at center span; Deck - 1" T&G on 1" bottoms on 3/4" glass wool strips on 3/8" gypsum board nailed to joists; Membrane 3/4" glass wood strips on joists; 3/8" perf. gypsum lath; ½" gypsum plaster.	60 PSF	41min			7	1,3	2/3
F/C-W-14	7/8"	12' clear span - 2" x 9" wood joists - 15" O.C. Deck - 1" T&G; Membrane - 3" foam concrete in cavity on ½" boards nailed to joists; wood lath nailed to 1"x 1½" straps 14" O.C. across joists; 7/8" gypsum plaster.	60 PSF	1 hr. 40min.			7	1,5	1-2/3
F/C-W-15	7/8"	12' clear span - 2"x 9" wood joists - 18" O.C. Deck - 1" T&G; Membrane - 2" foam concrete on ½" boards nailed to joist sides 2" from joist bottom; 2" airspace; 1"x 1½" wood straps 14" O.C. across joists; 7/8" lime plaster on wood lath.	60 PSF	53min.			7	1,2	3/4
F/C-W-16	7/8"	12' clear span - 2"x 9" wood joists; Deck - 1" T&G; Membrane - 3" ashes on ½" boards nailed to joist sides 2" from joist bottom; 2" air space; 1"x 1½" straps (wood) 14" O.C.; 7/8" gypsum plaster on wood lath.	60 PSF	28min.			7	1,2	1/3
F/C-W-17	7/8"	As per previous F/C-W-16 but with lime plaster mix.	60 PSF	41min.			7	1,2	2/3
F/C-W-18	7/8"	12' clear span - 2"x 9" wood joists - 18" O.C. 2"x 1½" center bridging; Deck - 1" T&G; Membrane - 7/8" gypsum plaster on wood lath.	60 PSF	36min.			7	1,2	½
F/C-W-19	7/8	As per previous F/C-W-18 except with lime plaster membrane and deck is 1" nominal boards (plain edge).	60 PSF	19min.			7	1,2	½
F/C-W-20	7/8"	As per F/C-W-19 except deck is 1" T&G boards.	60 PSF	43min.			7	1,2	2/3
F/C-W-21	1"	12' clear span - 2" x 9" wood joists - 16" O.C. 2"x 1½" center bridging; deck - 1" T&C; Membrane - 3/8" gypsum base board; 5/8" gypsum plaster.	70 PSF	29min.			7	1,2	1/3
F/C-W-22	1-1/8"	12' clear span - 2"x 9" wood joists - 16" O.C. bridging - 2"x 2" wood at center; deck - 1" T&C; membrane - hangers, channel with 3/8" gypsum baseboard affixed under 3/4" gypsum plaster.	60 PSF	1 hr.			7	1,2,3	1
F/C-W-23	3/8"	Deck: 1" nominal lumber; Joists: 2"x 7", 15" O.C.; Membrane: 3/8" plasterboard with plaster skim coat.	60 PSF	11½ min.			12	2,6	1/6
F/C-W-24	½"	Deck: 1" T&C lumber; Joists: 2"x 9", 16" O.C.; Membrane: ½" plasterboard.	60 PSF	18 min			12	2,7	½
F/C-W-25	½"	Deck: 1" T&G lumber; Joists: 2"x 7", 16" O.C.; Membrane: ½" fiber insulation board.	30 PSF	8 min.			12	2,8	2/15

FLOOR/CEILING ASSEMBLIES

WOOD JOIST

Item Code	Membrane Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
F/C-W-26	½"	Deck: 1" nominal lumber; Joists: 2"x 7", 15" O.C.; Membrane: ½" fiber insulation board.	60 PSF	8 min.			12	2,9	2/15
F/C-W-27	5/8"	Deck: 1" nominal lumber; Joists: 2"x 7", 15" O.C.; Mem.: 5/8" gypsum plaster on wood lath.	60 PSF	17 min			12	2,10	¼
F/C-W-28	5/8"	Deck: 1" T&G lumber; Joists: 2"x 9", 16" O.C.; Mem.: ½" fiber insulation board; ½" plaster.	60 PSF	20 min			12	2,11	1/3
F/C-W-29	No Membrane	Exposed wood joists	See Note 13	15 min		1		1,12, 13,14	¼
F/C-W-30	3/8"	Gypsum wallboard- 3/8" or ½" with 1½" No. 15 gage nails with 3/16" heads spaced 6" centers with asbestos paper applied with paperhangers paste and finished with casein paint.	See Note 13	25 min		1		1,12 13,14	½
F/C-W-31	½"	Gypsum wallboard- ½" with 1-3/4" No.12 gage nails with ½" heads, 6" O.C. and finished with casein paint.	See Note 13	25 min		1		1,12, 13,14	½
F/C-W-32	½"	Gypsum wallboard- ½" with 1½" No. 12 gage nails with ½" heads, 16" C.C. with asbestos paper applied with paper hangers paste and secured with 1½" No. 15 gage nails with 3/16" heads and finished with casein paint; combined nail spacing 6" O.C.	See Note 13	30 min		1		1,12 13,14	½
F/C-W-33	3/8"	Gypsum wallboard- 2 layers 3/8" secured with 1½" No. 15 gage nails with 3/8" heads, 6" O.C.	See Note 13	30 min		1		1,12, 13,14	½
F/C-W-34	½"	3/8" perforated gypsum lath- plastered with 1-1/8" No. 13 gage nails with 5/16" heads; 4" O.C.; ½" sanded gypsum plaster.	See Note 13	30min.		1		1,12, 13,14	½
F/C-W-35	½"	Same as F/C-W-34. Except with 1-1/8" No. 13 gage nails with 3/8" heads; 4" O.C.	See Note 13	45 min		1		1,12, 13,14	3/4
F/C-W-36	½"	3/8" perforated gypsum lath nailed with 1-1/8" No. 13 nails with 3/8" heads; 4" O.C.; Joints covered with 3" strips of metal lath; with 1-3/4"; No. 12 nails with ½" heads; 5" O.C. ½" sanded gypsum plaster.	See Note 13	1 hr.		1		1,12, 13,14	1
F/C-W-37	½"	Gypsum lath - 3/8" and lower layer of 3/8" perforated gypsum lath nailed with 1-3/4" No. 13 nails with 5/16" heads and 4" O.C.; ½" sanded gypsum plaster or ½" portland cement plaster.	See Note 13	45 min		1		1,12 13,14	3/4
F/C-W-38	3/4"	Metal lath - nailed with 1½" NO. 11 nails with 3/8" heads or 6 d common driven 1" and bent over; 6" O.C.; 3/4" sanded gypsum plaster.	See Note 13	45 min		1		1,12 13,14	3/4
F/C-W-39	3/4"	Same as F/C-W-38 except nailed with 1½" No. 11 barbed roof nails with 7/16" heads, 6" O.C.	See Note 13	1 hr.		1		1,12 13,14	1
F/C-W-40	3/4"	Same as F/C-W-38 except with lath nailed to joists with additional supports for lath 27" O.C.; attached to alternate joists and consisting of 2 nails driven 1½", 2" above bottom on opposite sides of the joists, one loop of No 18 wire slipped over each nail; the ends twisted together below lath.	See Note 13	1 hr. 15 min		1 1		1,12, 13,14	1¼
F/C-W-41	3/4"	Metal lath with 1½" No.11 barbed roof nails with 7/16" heads, 6" O.C. with 3/4" portland cement plaster for scratch and 1:3 for brown coat, 3 lb. of asbestos fiber and 15 lb. of hydrated lime/94 lb. bag of cement.	See Note 13	1 hr.		1		1,12, 13,14	1
F/C-W-42	3/4"	Metal lath nailed with 8d, 11½ gage barbed box nails 2½" driven 1¼" on slant and bent over; 6" O.C.; 3/4" sanded gypsum plaster 1:2 scratch coat and 1:3 below coat.	See Note 13	1 hr.		1		1,12, 13,14	1

Notes:

TABLE 3.3

1. Thickness indicates thickness of first membrane protection on ceiling surface.
2. Failure mode - flame thru.
3. Failure mode - collapse.
4. No endpoint reached at termination of test.
5. Failure immenent - test terminated.
6. Joist failure - 11.5 min., flame thru - 13.0 min., collapse - 24 min.
7. Joist failure - 17 min., flame thru - 18 min., collapse - 33 min.
8. Joist failure - 18 min., flame thru - 8 min., collapse - 30 min.
9. Joist failure - 12 min., flame thru - 8 min., collapse - 22 min.
10. Joist failure - 11 min., flame thru - 17 min., collapse - 27 min.
11. Joist failure - 17 min., flame thru - 20 min., collapse - 43 min.
12. Joists: 2"x 10" southern pine or douglas fir; No.1 common or better; Subfloor: 3/4" wood sheathing diaphram of asbestos paper, and finish of tongue and grove wood flooring.
13. Loadings: not more than 1,000 PSI maximum fiber strass in joists.
14. Perforations in gypsum lath are to be not less than 3/4" diameter with one perforation for not more than 16/in^2 diameter.
15. "Distemper" is a British term for a water-based paint such as white wash or calcimine.

Figure 3.4
Floor/Ceiling Assemblies-
Hollow Clay Tile With
Reinforced Concrete

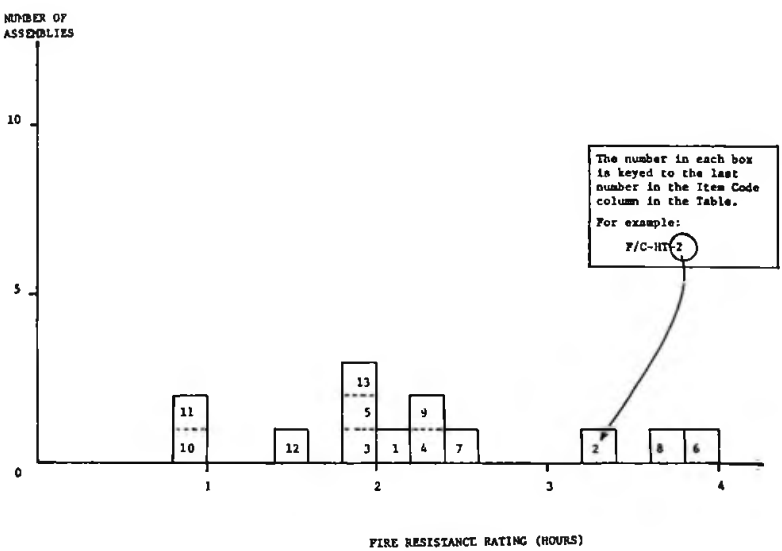


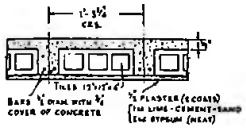
Table 3.4
Floor/Ceiling Assemblies-
Hollow Clay Tile With
Reinforced Concrete

Item Code	Assembly Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
F/C-HT-1	6"	Cover 1½" concrete (6080 PSI); 3 cell hollow clay tile; 12"x 12"x 4"; ¾" concrete between tiles including 2- ½" rebars with 3/4" concrete cover; ½" plaster cover (lower)	75 PSF	2 hr. 7 min.			7	1,2,3	2
F/C-HT-2	6"	Cover 1½" concrete (5840 PSI); 3 cells hollow clay tiles; 12"x 12"x 4"; ¾" concrete between tile including 2- ½" rebars each with ½" concrete cover and 5/8" filler tiles between hollow tiles; ½" plaster cover, lower.	61 PSF	3 hr. 23min.			7	3,4,6	3-1/3
F/C-HT-3	6"	Cover: 1½" concrete (6280 PSI); 3 cell hollow clay tiles 12"x 12"x 4"; ¾" concrete between tiles including 2- ½" rebars with ½" cover; ½" plaster cover, lower.	122 PSF	2 hr.			7	1,3,5, 8	2
F/C-HT-4	6"	Cover: 1½" concrete (6280 PSI); 3 cell hollow clay tiles; 12" x 12"x 4"; ¾" concrete between tiles including 2- ½" rebars with 3/4" concrete cover; ½" plaster cover, lower.	115 PSF	2 hr. 23min.			7	1,3,7	2-1/3
F/C-HT-5	6"	Cover: 1½" concrete (6470 PSI); 3 cell hollow clay tiles 12"x 12"x 4"; ¾" concrete between tiles including 2- ½" rebars with ½" cover; ½" plaster cover, lower.	122 PSF	2 hr.			7	1,3,5 8	2
F/C-HT-6	8"	Floor cover: 1½" gravel cement (4300 PSI); tiles: 3 cell 12"x 12"x 6"; 3½" space between tiles including 2- ½" rebars with 1" cover from concrete bottom ; cover: ½" plaster, lower	165 PSF	4 hr.			7	1,3,9, 10	4
F/C-HT-7	9"(nom)	Deck: 7/8" T & G on 2"x 1½" bottoms (18" O.C.) 1½" concrete cover (4600 PSI); 3 cell hollow clay tiles 12"x 12"x 4"; 3" concrete between tiles including 1- 3/4" rebar 3/4" from tile bottom ; ½" plaster cover.	95 PSF	2 hr. 26min.			7	4,11, 12,13	2-1/3
F/C-HT-8	9"(nom)	Deck: 7/8" T&G on 2"x 1½" bottoms (18" O.C.) 1½" concrete cover with 3850 PSI; 3 cell hollow clay tiles 12"x 12"x 4"; 3" concrete between tiles including 1- 3/4" rebar 3/4" from tile bottoms; ½" plaster cover.	95 PSF	hr. 28min.			7	4,11, 12,13	
F/C-HT-9	9"(nom)	Deck: 7/8" T&G on 2"x 1½" bottoms (18"O.C.) 1½" concrete cover (4200 PSI); 3 cell hollow clay tiles 12"x 12"x 4"; 3" concrete between tiles including 1- 3/4" rebar 3/4" from tile bottoms; ½" plaster cover.	95 PSF	2 hr. 14min			7	3,5,8 11	
F/C-HT-10	5½"	Fire clay tile (4" thick); 1½" concrete cover. For general details see note 15.	See Note 14	1 hr.			43	15	1
F/C-HT-11	8"	Fire clay tile (6" thick); 2" cover.	See Note 14	1 hr.			43	15	1
F/C-HT-12	5½"	Fire clay tile (4" thick); 1½" cover. 5/8" gypsum plaster lower.	See Note 14	1½ hr			43	15	1½
F/C-HT-13	8"	Fire clay tile (6" thick); 2" cover. 5/8" gypsum plaster lower.	See Note 14	2 hr.			43	15	1½

Notes:

TABLE 3.4

1. A generalized cross-section of this floor type follows.



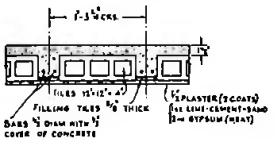
2. Failure mode - structural.

3. Plaster - base coat - lime - cement - sand; top coat - gypsum (neat).

4. Failure mode - collapse.

5. Test stopped before any end points were reached.

6. A generalized cross-section of this floor type follows.



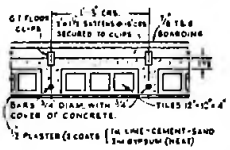
7. Failure mode - thermal -back face temperature rise.

8. Passed hose stream test.

9. Failed hose stream test.

10. Test stopped at 4 hours before any end points were reached.

11. A generalized cross-section of this floor type follows.



12. Plaster-base coat - retarded hemihydrate gypsum-sand; 2nd coat - neat gypsum.

13. Concrete in item 7 is P.C. based but with crushed brick aggregates while in item 8 river sand and river gravels are used with the P.C.

14. Load - unspecified.

15. The 12" x 12" fire-clay tiles were laid end to end in rows spaced 2½" or 4" apart. The reinforcing steel was placed between these rows and the concrete cast around them and over the tile to form the structural floor.

Section IV — Beams

Table 4.1.1
Reinforced Concrete Beams

Depth 10" to less than 12"

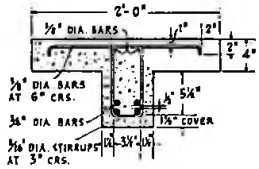
Item Code	Depth	Construction Details	Performance		Reference Number			Notes	Rec. Hours
			Load	Time	Pre-RMS-92	RMS-92	Post-RMS-92		
B-11-RC-1	11"	24" wide x 11" deep reinforced concrete "T" beam (3290 PSI); Details - See figure, Note 5.	8.8 tons	4 hr. 2 min.			7	1,2 14	4
B-10-RC-2	10"	24" wide x 10" deep reinforced concrete "T" beam (4370 PSI); Details - See figure, Note 6.	8.8 tons	1 hr. 53 min			7	1,3	1-3/4
B-10-RC-3	10½"	24" wide x 10-1/2" deep reinforced "T" beam (4450 PSI) concrete; Details - See figure, Note 7.	8.8 tons	2 hr 40 min			7	1,3	2-2/3
B-11-RC-4	11"	24" wide x 11" deep reinforced concrete "T" beam (2400 PSI); Details - See figure, Note 8.	8.8 tons	3 hr 32 min			7	1,3 14	3-1/2
B-11-RC-5	11"	24" wide x 11" deep reinforced concrete "T" beam (4250 PSI); Details - See figure, Note 9	8.8 tons	3 hr 3 min			7	1,3 14	3
B-11-RC-6	11"	Concrete flange: 4" deep x 2' wide (4895 PSI) concrete; 7" deep 6½ wide beam; I beam reinforcement: 10" x 4½" x 25 lb. R.S.J.; 1" cover on flange; Rein.: 3/8" diam. bars @ 6" pitch parallel to T; ¼" diam. bars perpendicular to T; 4" x 6" wire mesh #13 SWG; Span - 11' restrained. Details - See figure, Note 10.	10 tons	6 hr			7	1,4	6
B-11-RC-7	11"	Concrete flange: 6" deep x 1'6½" wide (3525 PSI) concrete; 5" deep x 8" wide precast concrete blocks 8-3/4" long; I beam reinforcement 7" x 4" x 16 lb. R.S.J. 2" cover on bottom; 1½" cover on top; 2 rows ½" diam. rods parallel to T; 1/8" wire mesh perpendicular to 1" span 1'3" simply supported. Details - See figure, Note 11.	3.9 tons	4 hr			7	1,2	4
B-11-RC-8	11"	Concrete flange: 4" x 2' (3525 PSI) concrete; 7" x 4½" (scaled fr. drawing) I beam reinforcement: 10" x 4½" x 25 lb. R.S.J.; No concrete cover on bottom. Rein.: 3/8" diam. bars @ 6" pitch parallel to T; ¼" diam. bars perpendicular to T; span: 11" restricted	10 tons	4 hr			7	1,2 12	4
B-11-RC-9	11½"	24" wide x 11½" deep reinforced concrete "T" beam (4390 PSI_; Details - See figure, Note 12.	8.8 tons	3 hr 24 min			7	1,3	3-1/3

Notes:

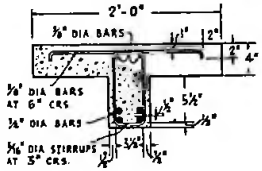
TABLE 4.1.1

1. Load concentrated at mid-span.
2. Achieved 4 hour performance (Class-B, British)
3. Failure mode - collapse.
4. Achieved 6 hour performance (Class-A, British)

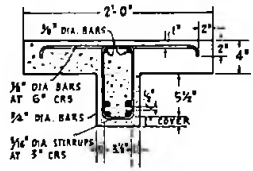
5.



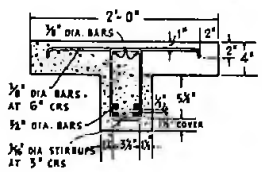
6.



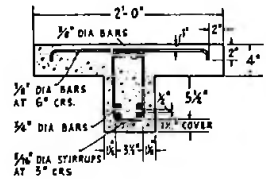
7.



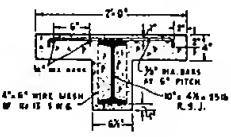
8.



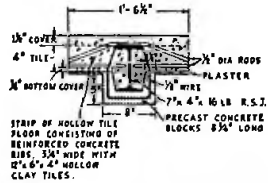
9.



10.

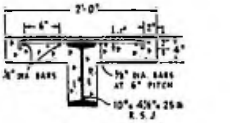


11.



Span and End Conditions :—10'—3" (Clear). Simply Supported.

12.



13.

14. The different performances achieved by B-11-RC-1, B-11-RC-4, and B-11-RC-5 are attributable to differences in concrete aggregate compositions reported in the source document but unreported in this table. This demonstrates the significance of material composition in addition to other details.

Table 4.1.2
Reinforced Concrete Beams

Depth 12" to less than 14"

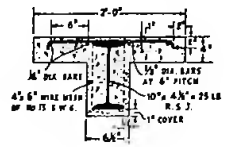
Item Code	Depth	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
B-12-RC-1	12"	12"x 8" section; 4160 PSI aggregate concrete; Reinforcing 4- 7/8" rebars at corners; 1" below each surface; ¼" stirrups 10" O.C.	5.5 tons	2 hr.			7	1	2
B-12-RC-2	12"	Concrete flange: 4" deep x 2' wide (3045 PSI) @ 35 days; Concrete beam: 8" deep; I beam reinforcement: 10"x 4½"x 25 lb. R.S.J.; 1" cover on flanges; Reinforcement: Flange 3/8" diam. bars @ 6" pitch parallel to T; flange ½" diam. bars perpendicular to T; beam 4"x 6" wire mesh #13 S.W.G.; Span: 10'3" simply supported.	10 tons	4 hr.			7	2,3 5	4
B-13-RC-3	13"	Concrete flange: 4" deep x 2' wide; (3825 PSI) @ 46 days; Concrete beam: 9" deep x 8½" wide; (scaled from dwg.); I beam reinforcement: 10"x 4½"x 25 lb. R.S.J.; 3" cover on bottom flange 1" cover on top flange; Reinforcement: flange 3/8" diam. bars @ 6" pitch, parallel to T; ½" diam. bars perpendicular to T; Beam 4"x 6" wire mesh #13 S.W.G.; Span 11' restrained.	10 tons	6 hr.			7	2,3,6, 8,9	4
B-12-RC-4	12"	Concrete flange: 4" deep x 2' wide; (3720 PSI) @ 42 days; Con. beam: 8" deep x 8½" wide; (scaled fr. dwg.) I beam reinforcement: 10"x 4½"x 25 lb. R.S.J.; 2" cover bottom flange; 1" cover top flange: Reinforcement: flange 3/8" diam. bars @ 6" pitch parallel to T; ½" diam. bars perpendicular to T; beam; 4"x 6" wire mesh, #13 S.W.G.; Span: 11' restrained.	10 tons	6 hr.			7	2-4, 7-9 1	4

Notes:

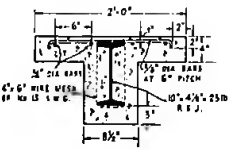
TABLE 4.1.2

1. Qualified for 2 hr. use. (Grade C - British) test included hose stream and reload at 48 hours.
2. Load concentrated at mid-span.
3. British test.
4. British test - qualified for 6 hour use (Grade A).

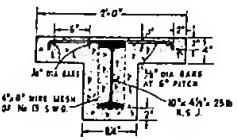
5.



6.



7.



8. See Table 4.1.3, Note 5.

9. Hourly rating based upon B-12-RC-2 above.

Table 4.1.3
Reinforced Concrete Beams

Depth 14" to less than 16"

Item Code	Depth	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
B-15-RC-1	15"	Concrete Flange: 4" Deep x 2' wide; (3290 PSI) concrete; Concrete beam: 10" deep x 8½" wide; I beam reinforcement: 10"x 4½"x 25 lb. R.S.J.; 4" cover on bottom flange; 1" cover on top flange; Reinforcement: Flange ; 3/8" diam. bars @ 6" pitch parallel to T; ¼" dia. bars perpendicular to T; beam 4"x 6" wire mesh No. 13 S.W.G., Span: 11' restrained.	10 tons	6 hr.			7	1,2,3 5,6	4
B-15-RC-2	15"	Concrete flange: 4" deep x 2' wide (4820 PSI) concrete; Concrete beams: 10" deep x 8½" wide; I beam reinforcement: 10"x 4½" x 25 lb. R.S.J.; 1" cover on top flange; 1" cover over wire mesh on bottom; Reinforcement: Flange 3/8" diam. bars @ 6" pitch parallel to "T", ¼" diam. bars perpendicular to "T"; beam 4"x 6" wire mesh No. 13 S.W.G.; Span 11' restrained.	10 tons	6 hr.			7	1,2,4 5,6	4

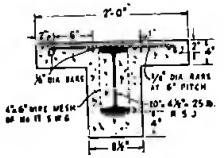
Notes:

TABLE 4.1.3

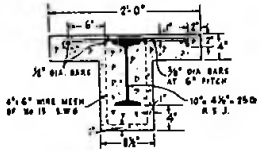
1. Load concentrated at mid-span.

2. Achieved 6 hour fire rating (Class "A" - British).

3.



4.



5. Section 43.147 of the 1979 Edition of the Uniform Building Code Standards provides:

"A restrained condition in fire tests, as used in this standard, is one in which expansion at the supports of a load-carrying element resulting from the effects of the fire is resisted by forces external to the element. An unrestrained condition is one in which the load-carrying element is free to expand and rotate at its support.

"(R)estraint in buildings is defined as follows: Floor and roof assemblies and individual beams in buildings shall be considered restrained when the surrounding or supporting structure is capable of resisting the thermal expansion throughout the range of anticipated elevated temperatures. Construction not complying ... is assumed to be free to rotate and expand and shall be considered as unrestrained.

"Restraint may be provided by the lateral stiffness of supports for floor and roof assemblies and intermediate beams forming part of the assembly. In order to develop restraint, connections must adequately transfer thermal thrusts to such supports. The rigidity of adjoining panels or structures shall be considered in assessing the capability of a structure to resist thermal expansion."

Because it is difficult to determine whether an existing building's structural system is capable of providing the required restraint, the lower hourly ratings of a similar, but unrestrained assembly have been recommended.

6. Hourly rating based upon Table 4.1.2, Item B-12-RC-2.

Table 4.2.1
Reinforced Concrete Beams-
Unprotected

Depth 10" to less than 12"

Item Code	Depth	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
B-SU-1	10"	10"x 4½"x 25 lb. "I" beam.	10 tons	39min.			7	1	1/3

Notes:

TABLE 4.2.1

1. Concentrated at midspan.

Table 4.2.2
Steel Beams-
Concrete Protection

Depth 10" to less than 12"

Item Code	Depth	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
B-SC-1	10"	10"x 8" rectangle. Aggregate concrete (4170 PSI) with 1" cover - top and 2" cover bottom; No. 13 S.W.G. iron wire loosely wrapped at approximately 6" pitch about 7"x 4"x 16 lb. I beam.	3.9 tons	3 hr. 46min			7	1,2,3	3-3/4
B-SC-2	10"	10"x 8" rectangle. Aggregate concrete (3630 PSI) with 1" cover - Top and 2" cover bottom; No. 13 S.W.G. iron wire loosely wrapped at approx. 6" pitch about 7"x 4"x 16 lb. I beam.	5.5 tons	5 hr. 26min			7	1,4,5, 6,7	3-3/4

Notes:

TABLE 4.2.2

1. Load concentrated at midspan.
2. Specimen 10'3" clear span simply supported.
3. Passed grade "C" fire resistance (British) including hose stream and reload.
4. Specimen 11' clear span - restrained.
5. Passed "Grade B" fire resistance (British) including hose stream and reload.
6. See Table 4.1.3, Note 5.
7. Hourly rating based upon B-SC-1 above.

Section V — Doors

Figure 5.1
Resistance of Doors to Fire Exposure

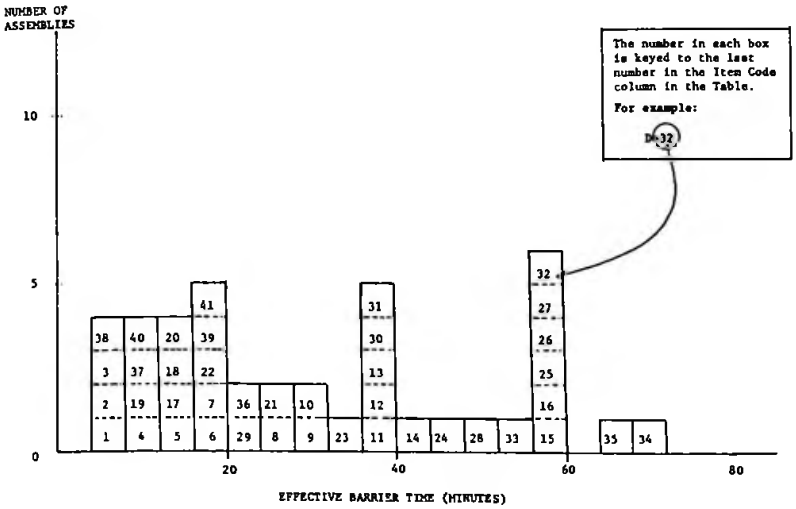


Table 5.1
Resistance of Doors to Fire Exposure

Item Code	Door Minimum Thickness	Construction Details	Performance		Reference Number			Notes	Rec (min.)
			Effective Barrier	Edge Flaming	Pre-BMS-92	BMS-92	Post-BMS-92		
D-1	3/8"	Panel door, pine perimeter (1-3/8"). Painted (enamel).	5 min. 10 sec	n/a			90	1,2	5
D-2	3/8"	As above, with 2 coats U.L. listed intumescent coating.	5 min. 30 sec	5 min			90	1,2,7	5
D-3	3/8"	As D-1 with standard primer and flat interior paint.	5 min. 55 sec	n/a			90	1,3,4	5
D-4	2-5/8"	As D-1 with panels covered each side with ¼" plywood, edge grouted with sawdust filled plaster; door faced with 1/8" hardboard each side; paint see (5)	11 min 15 sec	3 min 45sec			90	1,2,5, 7	10
D-5	3/8"	As D-1 but surface protected with glass fiber reinforced intumescent fire retardant coating.	16 min	n/a			90	1,3,4 7	15
D-6	1-5/8"	Door detail: As D-4but with 1/8" cement asbestos board facings with aluminum foil. Door edges protected by sheet metal.	17 min.	10min 15sec			90	1,3,4	15
D-7	1-5/8"	Door detail with 1/8" hardboard cover each side as facings. Glass fiber reinforced intumescent coating applied.	20 min	n/a			90	1,3,4 7	20
D-8	1-5/8"	Door detail as D-4. Paint was glass reinforced Epoxy intumescent.	26 min	24min 45sec			90	1,3,4 6,7	25

RESISTANCE OF DOORS TO FIRE EXPOSURE

Item Code	Door Minimum Thickness	Construction Details	Performance	Reference Number			Notes	Rec (min.)
			Effective Edge Flaming	Pre-NMS-92	NMS -92	Post-NMS-92		
D-9	1-5/8"	Door detail as D-4 with facings of 1/8" cement asbestos board.	29 min. 3min 15sec			90	1,2	5
D-10	1-5/8"	As per D-9.	31min. 7min 30sec. 20sec.			90	1,3,4	6
D-11	1-5/8"	As per D-7 painted with epoxy intumescent coating including glass fiber roving.	36min. n/a 25sec.			90	1,3,4	35
D-12	1-5/8"	As per D-4 with intumescent fire retardant paint.	37min. 24min 30sec. 40sec			90	1,3,4	30
D-13	1½ (nom)	As per D-4 but with 24 ga. galv. sheet metal facings.	39min. 39min			90	1,3,4	39
D-14	1-5/8"	As per D-9.	41min. 17min 30sec. 20sec			90	1,3,4 6	20
D-15	—	Class C steel fire door.	60min. 58min			90	7,8	60
D-16	—	Class B steel fire door.	60min. 57min			90	7,8	60
D-17	1-3/4"	Solid core flush door; core staves laminated to facings but not each other. Birch plywood facings ¼" rebate in door frame for door; 3/32" clearance between door and wood frame.	15min. 13min			37	11	13
D-18	1-3/4"	As per D-17	14min. 13min			37	11	13
D-19	1-3/4"	Door as per D-17; but with 16 ga. steel; 3/32" door frame clearance.	12min. --			37	9,11	10
D-20	1-3/4	As per D-19.	16min. --			37	10,11	10
D-21	1-3/4"	Door as per D-17 intumescent paint applied to top and side edges.	26min. --			37	11	25
D-22	1-3/4"	Door as per D-17 but with ¼"x1/8" steel strip set into edges of door at top and side facing stops. Matching strip on stop.	18min. 6min			37	11	18
D-23	1-3/4"	Solid Oak Door	36min.22min			15	13	25
D-24	1-7/8"	Solid Oak Door	45min.35min			15	13	35
D-25	1-7/8"	Solid Teak Door	58min.34min			15	13	35
D-26	1-7/8"	Solid (Pitch) Pine Door	57min.36min			15	13	35
D-27	1-7/8"	Solid Deal (Pine) Door	57min.30min			15	13	30
D-28	1-7/8"	Solid Mahogany Door	49min.40min			15	13	45
D-29	1-7/8"	Solid Poplar Door	24min. 3min			15	13,14	5
D-30	1-7/8"	Solid Oak Door	40min.33min			15	13	35
D-31	1-7/8"	Solid Walnut Door	40min.15min			15	13	20
D-32	2-5/8"	Solid Quebec Pine	60min 60min			15	13	60
D-33	2-5/8"	Solid Pine Door	55min.39min			15	13	40

RESISTANCE OF DOORS TO FIRE EXPOSURE

Item Code	Door Minimum Thickness	Construction Details	Performance Effective Barrier	Edge Flaming	Reference Number Pre-NMS-92	Post-NMS-92	Notes	Rec (min.)
D-34	2-5/8"	Solid Oak Door	69 min	60 min		15	13	60
D-35	2-5/8"	Solid Teak Door	65 min	17 min		15	13	60
D-36	1¾"	Solid Softwood Door	23 min	8½ min		15	13	10
D-37	3/4"	Panel Door	8 min	7½ min		15	13	5
D-38	5/16"	Panel Door	5 min	5 min		15	13	5
D-39	3/4"	Panel Door - Fire Retardant Treated	17½ min	13 min		15	13	8
D-40	3/4"	Panel Door - Fire Retardant Treated	8½ min	8½ min		15	13	8
D-41	3/4"	Panel Door - Fire Retardant Treated	16-3/4 min.	11½ min.		15	13	8

Notes:

TABLE 5.1

1. All door frames were of standard lumber construction.
2. Wood door stop protected by asbestos millboard.
3. Wood door stop protected by sheet metal.
4. Door frame protected with sheet metal and weather strip.
5. Surface painted with intumescent coating.
6. Door edge sheet metal protected.
7. Door edge intumescent paint protected.
8. Formal steel frame and door stop.
9. Door opened into furnace at 12'.
10. Similar door opened into furnace at 12'.
11. The doors reported in these tests represent the type contemporaries used as 20 minute solid core wood doors. The test results demonstrate the necessity of having wall anchored metal frames, minimum clearers possible between door, frame and stops. They also indicate the utility of long throw latches and the possible use of intumescent paints to seal doors to frames in event of a fire.
12. Minimum working clearance and good latch closure are absolute necessities for effective containment for all such working door assemblies.
13. Based on British Tests.
14. Failure at door - frame interface.

Bibliography

1. Central Housing Committee on Research, Design, and Construction; Subcommittee on Fire Resistance Classifications, "Fire-Resistance Classifications of Building Constructions", Building Materials and Structures, Report BMS 92, National Bureau of Standards, Washington, Oct. 1942. (Available from NTIS No. COM-73-10974)

2. Foster, H. D., Pinkston, E. R., and Ingberg, S. H., "Fire Resistance of Structural Clay Tile Partitions", Building Materials and Structures, Report BMS 113, National Bureau of Standards, Washington, Oct. 1948.

3. Ryan, J. V., and Bender, E. W., "Fire Endurance of Open-Web Steel-Joist Floors with Concrete Slabs and Gypsum Ceilings", Building Materials and Structures, Report BMS 141, National Bureau of Standards, Washington, Aug. 1954.

4. Mitchell, N. D., "Fire Tests of Wood-Framed Walls and Partitions with Asbestos-Cement Facings", Building Materials and Structures, Report BMS 123, National Bureau of Standards, Washington, May 1951.

5. Robinson, H. E., Cosgrove, L. A., and Powell, F. J., "Thermal Resistance of Airspace and Fibrous Insulations Bounded by Reflective Surfaces", Building Materials and Structures, Report BMS 151, National Bureau of Standards, Washington, Nov. 1957.

6. Shoub, H., and Ingberg, S. H., "Fire Resistance of Steel Deck Floor Assemblies", Building Science Series, 11, National Bureau of Standards, Washington, Dec. 1967.

7. Davey, N., and Ashton, L. A., "Investigations on Building Fires, Part V: Fire Tests of Structural Elements", National Building Studies, Research Paper, No. 12, Dept. of Scientific and Industrial Research (Building Research Station), London, 1953.

8. National Board of Fire Underwriters, Fire Resistance Ratings of Beam, Girder, and Truss Protections, Ceiling Constructions, Column Protections, Floor and Ceiling Constructions, Roof Constructions, Walls and Partitions, New York, April 1959.

9. Mitchell, N. D., Bender, E. D., and Ryan, J. V., "Fire Resistance of Shutters for Moving-Stairway Openings", Building Materials and Structures, Report BMS 129, National Bureau of Standards, Washington, March 1952.

10. National Board of Fire Underwriters, National Building Code; an Ordinance Providing for Fire Limits, and Regulations Governing the Construction, Alteration, Equipment, or Removal of Buildings or Structures, New York, 1949.

11. Department of Scientific and Industrial Research and of the Fire Offices' Committee, Joint Committee of the Building Research Board, "Fire Gradings of Buildings, Part I: General Principles and Structural Precautions", Post-War Building Studies, No. 20, Ministry of Works, London, 1946.

12. Lawson, D. I., Webster, C. T., and Ashton, L. A., "Fire Endurance of Timber Beams and Floors", National Building Studies, Bulletin, No. 13, Dept. of Scientific and Industrial Research and Fire Offices' Committee (Joint Fire Research Organization), London, 1951.

13. Parker, T. W., Nurse, R. W., and Bessey, G. E., "Investigations on Building Fires. Part I: The Estimation of the Maximum Temperature Attained in Building Fires from Examination of the Debris, and Part II: The Visible Change in Concrete or Mortar Exposed to High Temperatures", National Building Studies, Technical Paper, No. 4, Dept. of Scientific and Industrial Research (Building Research Station), London, 1950.

14. Bevan, R. C., and Webster, C. T., "Investigations on Building Fires, Part III: Radiation from Building Fires", National Building Studies, Technical Paper, No. 5, Dept. of Scientific and Industrial Research (Building Research Station), London, 1950.

15. Webster, D. J., and Ashton, L. A., "Investigations on Building Fires, Part IV: Fire Resistance of Timber Doors", National Building Studies, Technical Paper, No. 6, Dept. of Scientific and Industrial Research (Building Research Station), London, 1951.

16. Kidder, F. E., Architects' and Builders' Handbook: Data for Architects, Structural Engineers, Contractors, and Draughtsmen, comp. by a Staff of Specialists and H. Parker, editor-in-chief, 18th ed., enl., J. Wiley, New York, 1936.

17. Parker, H., Gay, C. M., and MacGuire, J. W., Materials and Methods of Architectural Construction, 3rd ed., J. Wiley, New York, 1958.

18. Dietz, A. G. H., Dwelling House Construction, The MIT Press, Cambridge, 1971.

19. Crosby, E. U., and Fiske, H. A., Handbook of Fire Protection, 5th ed., The Insurance Field Company, Louisville, Ky., 1914.

20. Crosby, E. U., Fiske, H. A., and Forster, H. W., Handbook of Fire Protection, 8th ed., R. S. Moulton, general editor, National Fire Protection Association, Boston, 1936.

21. Kidder, F. E., Building Construction and Superintendence, rev. and enl., by T. Nolan, W. T. Comstock, New York, 1909-1913, 2 vols.

22. National Fire Protection Association, Committee on Fire-Resistive Construction, The Baltimore Conflagration, 2nd ed., Chicago, 1904.

23. Przetak, L., Standard Details for Fire-Resistive Building Construction, McGraw-Hill Book Co., New York, 1977.

24. Hird, D., and Fischl, C. F., "Fire Hazard of Internal Linings," National Building Studies, Special Report, No. 22, Dept. of Scientific and Industrial Research and Fire Offices' Committee (Joint Fire Research Organization), London, 1954.

25. Menzel, C. A., Tests of the Fire-Resistance and Strength of Walls Concrete Masonry Units, Portland Cement Association, Chicago, 1934.

26. Hamilton, S. B., "A Short History of the Structural Fire Protection of Buildings Particularly in England", National Building Studies, Special Report, No. 27, Dept. of Scientific and Industrial Research (Building Research Station), London, 1958.

27. Sachs, E. O., and Marsland, E., "The Fire Resistance of Doors and Shutters being Tabulated Results of Fire Tests Conducted by the Committee", Journal of the British Fire Prevention Committee, No. VII, London, 1912.

28. Egan, M. D., Concepts in Building Firesafety, J. Wiley, New York, 1978.

29. Sachs, E. O., and Marsland, E., "The Fire Resistance of Floors being Tabulated Results of Fire Tests Conducted by the Committee", Journal of the British Fire Prevention Committee, No. VI, London, 1911.

30. Sachs, E. O., and Marsland, E., "The Fire Resistance of Partitions being Tabulated Results of Fire Tests Conducted by the Committee", Journal of the British Fire Prevention Committee, No. IX, London, 1914.

31. Ryan, J. V., and Bender, E. W., "Fire Tests of Precast Cellular Concrete Floors and Roofs", National Bureau of Standards Monograph, 45, Washington, April 1962.

32. Kingberg, S. H., and Foster, H. D., "Fire Resistance of Hollow Load-Bearing Wall Tile", National Bureau of Standards Research Paper, No. 37, (Reprint from NBS Journal of Research, Vol. 2) Washington, 1929.

33. Hull, W. A., and Ingberg, S. H., "Fire Resistance of Concrete Columns", Technologic Papers of the Bureau of Standards, No. 272, Vol. 18, Washington, 1925, pp. 635-708.

34. National Board of Fire Underwriters, Fire Resistance Ratings of Less than One Hour, New York, Aug. 1956.

35. Harmathy, T. Z., "Ten Rules of Fire Endurance Rating", Fire Technology, Vol. 1, May 1965, pp. 93-102.

36. Son, B. C., "Fire Endurance Test on a Steel Tubular Column Protected with Gypsum Board", National Bureau of Standards, NBSIR, 73-165, Washington, 1973.

37. Galbreath, M., "Fire Tests of Wood Door Assemblies", Fire Study, No. 36, Div. of Building Research, National Research Council Canada, Ottawa, May 1975.

38. Morris, W. A., "An Investigation into the Fire Resistance of Timber Doors", Fire Research Note, No. 855, Fire Research Station, Boreham Wood, Jan. 1971.

39. Hall, G. S., "Fire Resistance Tests of Laminated Timber Beams", Timber Association Research Report, WR/RR/1, High Sycombe, July 1968.

40. Goalwin, D. S., "Fire Resistance of Concrete Floors", Building Materials and Structures, Report BMS 134, National Bureau of Standards, Washington, Dec. 1952.

41. Mitchell, N. D., and Ryan, J. V., "Fire Tests of Steel Columns Encased with Gypsum Lath and Plaster", Building Materials and Structures, Report BMS 135, National Bureau of Standard: Washington, April 1953.

42. Ingberg, S. H., "Fire Tests of Brick Walls", Building Materials and Structures, Report BMS 143, National Bureau of Standards, Washington, Nov. 1954.

43. National Bureau of Standards, "Fire Resistance and Sound-Insulation Ratings for Walls, Partitions, and Floors", Technical Report on Building Materials, 44, Washington, 195_.

44. Malhotra, H. L., "Fire Resistance of Brick and Block Walls", Fire Note, No. 6, Ministry of Technology and Fire Offices' Committee Joint Fire Research Organization, London, HMSO, 1966.

45. Mitchell, N. D., "Fire Tests of Steel Columns Protected with Siliceous Aggregate Concrete", Building Materials and Structures, Report BMS 124, National Bureau of Standards, Washington, May 1951.

46. Freitag, J. K., Fire Prevention and Fire Protection as Applied to Building Construction; a Handbook of Theory and Practice, 2nd ed., J. Wiley, New York, 1921.

47. Ingberg, S. H., and Mitchell, N. D., "Fire Tests of Wood and Metal-Framed Partition", Building Materials and Structures, Report BMS 71, National Bureau of Standards, Washington, 1941.

48. Central Housing Committee on Research, Design, and Construction, Subcommittee on Definitions, "A Glossary of Housing Terms", Building Materials and Structures, Report BMS 91, National Bureau of Standards, Washington, Sept. 1942.

49. Crosby, E. U., Fiske, H. A., and Forster, H. W., Handbook of Fire Protection, 7th ed., D. Van Nostrand Co., New York 1924.

50. Bird, E. L., and Docking, S. J., Fire in Buildings, A. & C. Black, London, 1949.

51. American Institute of Steel Construction, Fire Resistant Construction in Modern Steel-Framed Buildings, New York, 1959.

52. Central Dockyard Laboratory, "Fire Retardant Paint Tests - a Critical Review", CDL Technical Memorandum, No. P87/73, H. M. Naval Base, Portsmouth, Dec. 1973.

53. Malhotra, H. L., "Fire Resistance of Structural Concrete Beams", Fire Research Note, No. 741, Fire Research Station, Borehamwood, May 1969.

54. Abrams, M. S., and Gustaferro, A. H., "Fire Tests of Poke-Thru Assemblies", Research and Development Bulletin, 1481-1, Portland Cement Association, Skokie, 1971.

55. Bullen, M. L., "A Note on the Relationship between Scale Fire Experiments and Standard Test Results", Building Research Establishment Note, N51/75, Borehamwood, May 1975.

56. The America Fore Group of Insurance Companies, Research Department, Some Characteristic Fires in Fire Resistive Buildings, Selected from twenty years record in the files of the N.F.P.A. "Quarterly", New York, c. 1933.

57. Spiegelhalter, F., "Guide to Design of Cavity Barriers and Fire Stops", Current Paper, CP 7/77, Building Research Establishment, Borehamwood, Feb. 1977.

58. Wardle, T. M. "Notes on the Fire Resistance of Heavy Timber Construction", Information Series, No. 53, New Zealand Forest Service, Wellington, 1966.

59. Fisher, R. W., and Smart, P. M. T., "Results of Fire Resistance Tests on Elements of Building Construction", Building Research Establishment Report, G R6, London, HMSO, 1975.

60. Serex, E. R., "Fire Resistance of Alta Bates Gypsum Block Non-Load Bearing Wall", Report to Alta Bates Community Hospital, Structural Research Laboratory Report, ES-7000, University of Calif., Berkeley, 1969.

61. Thomas, F. G., and Webster, C. T., "Investigations on Building Fires, Part VI: The Fire Resistance of Reinforced Concrete Columns", National Building Studies, Research Paper, No. 18, Dept. of Scientific and Industrial Research (Building Research Station), London, HMSO, 1953.

62. Building Research Establishment, "Timber Fire Doors", Digest 220, Borehamwood, Nov. 1978.

63. Massachusetts State Building Code; Recommended Provisions, Article 22: Repairs, Alterations, Additions, and Change of Use of Existing Buildings, Boston, Oct. 23, 1978.

64. Freitag, J. K., Architectural Engineering; with Especial Reference to High Building Construction, Including Many Examples of Prominent Office Buildings, 2nd ed., rewritten, J. Wiley, New York, 1906.

65. Architectural Record, Sweet's Indexed Catalogue of Building Construction for the Year 1906, New York, 1906.

66. Dept. of Commerce, Building Code Committee, "Recommended Minimum Requirements for Fire Resistance in Buildings," Building and Housing, No. 14, National Bureau of Standards, Washington, 1931.

67. British Standards Institution, "Fire Tests on Building Materials and Structures", British Standards, 476, Pt. 1, London, 1953.

68. Lönberg-Holm, K., "Glass", The Architectural Record, Oct. 1930, pp. 345-357.

69. Structural Clay Products Institute, "Fire Resistance", Technical Notes on Brick and Tile Construction, 16 rev., Washington, 1964.

70. Ramsey, C. G., and Sleeper, H. R., Architectural Graphic Standards for Architects, Engineers, Decorators, Builders, and Draftsmen, 3rd ed., J. Wiley, New York, 1941.

71. Underwriters' Laboratories, Fire Protection Equipment List, Chicago, Jan. 1957.

72. Underwriters' Laboratories, Fire Resistance Directory; with Hourly Ratings for Beams, Columns, Floors, Roofs, Walls, and Partitions, Chicago, Jan. 1977.

73. Mitchell, N. D., "Fire Tests of Gunite Slabs and Partitions", Building Materials and Structures, Report BMS 131, National Bureau of Standards, Washington, May 1952.

74. Woolson, I. H., and Miller, R. P., "Fire Tests of Floors in the United States", Proceedings International Association for Testing Materials, VIth Congress, New York, 1912, Section C, pp. 36-41.

75. Underwriters' Laboratories, "An Investigation of the Effects of Fire Exposure upon Hollow Concrete Building Units, Conducted for American Concrete Institute, Concrete Products Association, Portland Cement Association, Joint Submittors", Retardant Report, No. 1555, Chicago, May 1924.

76. Dept. of Scientific & Industrial Research and of the Fire Offices' Committee, Joint Committee of the Building Research Board, "Fire Gradings of Buildings. Part IV: Chimneys and Flues", Post-War Building Studies, No. 29, London, HMSO, 1952.

77. National Research Council of Canada. Associate Committee on the National Building Code, Fire Performance Ratings, Suppl. No. 2 to the National Building Code of Canada, Ottawa, 1965.

78. Associated Factory Mutual Fire Insurance Companies, The National Board of Fire Underwriters, and the Bureau of Standards, Fire Tests of Building Columns; an Experimental Investigation of the Resistance of Columns, Loaded and Exposed to Fire or to Fire and Water, with Record of Characteristic Effects, Jointly Conducted at Underwriters' Laboratories, Chicago, 1917-19.

79. Malhotra, H. L., "Effect of Age on the Fire Resistance of Reinforced Concrete Columns", Fire Research Memorandum, No. 1, Fire Research Station, Borehamwood, April 1970.

80. Bond, H., ed., Research on Fire; a Description of the Facilities, Personnel and Management of Agencies Engaged in Research on Fire, a Staff Report, National Fire Protection Association, Boston, 1957.

81. California State Historical Building Code, Draft, 1978.

82. Fisher, F. L., et al., "A Study of Potential Flashover Fires in Wheeler Hall and the Results from a Full Scale Fire Test of a Modified Wheeler Hall Door Assembly", Fire Research Laboratory Report, UCX 77-3; UCX-2480, University of Calif., Dept. of Civil Eng., Berkeley, 1977.

83. Freitag, J. K., The Fireproofing of Steel Buildings, 1st ed., J. Wiley, New York, 1906.

84. Gross, D., "Field Burnout Tests of Apartment Dwellings Units", Building Science Series, 10, National Bureau of Standards, Washington, 1967.

85. Dunlap, M. E., and Cartwright, F. P., "Standard Fire Tests for Combustible Building Materials", Proceedings of the American Society for Testing Materials, vol. 27, Philadelphia, 1927, pp. 534-546.

86. Menzel, C. A., "Tests of the Fire Resistance and Stability of Walls of Concrete Masonry Units", Proceedings of the American Society for Testing Materials, vol. 31, Philadelphia, 1931, pp. 607-660.

87. Steiner, A. J., "Method of Fire-Hazard Classification of Building Materials", Bulletin of the American Society for Testing and Materials, March 1943, Philadelphia, 1943, pp. 19-22.

88. Heselden, A. J. M., Smith, P. G., and Theobald, C. R., "Fires in a Large Compartment Containing Structural Steelwork; Detailed Measurements of Fire Behavior", Fire Research Note, No. 646, Fire Research Station, Borehamwood, Dec. 1966.

89. Ministry of Technology and Fire Offices' Committee Joint Fire Research Organization, "Fire and Structural Use of Timber in Buildings; Proceedings of the Symposium Held at the Fire Research Station, Borehamwood, Herts on 25th October, 1967", Symposium, No. 3, London, HMSO, 1970.

90. Shoub, H., and Gross, D., "Doors as Barriers to Fire and Smoke", Building Science Series, 3, National Bureau of Standards, Washington, 1966.

91. Ingberg, S. H., "The Fire Resistance of Gypsum Partitions", Proceedings of the American Society for Testing and Materials, vol. 25, Philadelphia, 1925, pp. 299-314.

92. Ingberg, S. H., "Influence of Mineral Composition of Aggregates on Fire Resistance of Concrete", Proceedings of the American Society for Testing and Materials, vol. 29, Philadelphia, 1929, pp. 824-829.

93. Ingberg, S. H., "The Fire Resistive Properties of Gypsum", Proceedings of the American Society for Testing and Materials, vol. 23, Philadelphia, 1923, pp. 254-256.

94. Gottschalk, F. W., "Some Factors in the Interpretation of Small-Scale Tests for Fire-Retardant Wood", Bulletin of the American Society for Testing and Materials, October 1945, pp. 40-43.

95. Ministry of Technology and Fire Offices' Committee Joint Fire Research Organization, "Behaviour of Structural Steel in Fire; Proceedings of the Symposium Held at the Fire Research Station Borehamwood, Herts on 24th January, 1967", Symposium, No. 2, London, HMSO, 1968.

96. Gustaferro, A. H., and Martin, L. D., Design for Fire Resistance of Pre-cast Concrete, prep. for the Prestressed Concrete Institute Fire Committee, 1st ed., Chicago, PCI, 1977.

97. "The Fire Endurance of Concrete; a Special Issue", Concrete Construction, vol. 18, no. 8, Aug. 1974, pp. 345-440.

98. The British Constructional Steelwork Association, "Modern Fire Protection for Structural Steelwork", Publication, No. FP1, London, 1961.

99. Underwriters' Laboratories, "Fire Hazard Classification of Building Materials", Bulletin, No. 32, Sept. 1944, Chicago, 1959.

100. Central Housing Committee on Research, Design, and C struction, Subcommittee on Building Codes, "Recommend Building Code Requirements for New Dwelling Constructi with Special Reference to War Housing; Report", Building Materials and Structures, Report BMS 88, National Bureau of Standards, Washington, Sept. 1942.

101. De Coppet Bergh, D., Safe Building Construction; a Treatise Giving in Simplest Forms Possible Practical and Theoretical Rules and Formulae Used in Construction of Buildings and General Instruction, new ed., thoroughly rev. Macmillan Co., New York, 1908.

102. Cyclopedia of Fire Prevention and Insurance; a General Reference Work on Fire and Fire Losses, Fireproof Construction, Building Inspection..., prep. by architects, engineers, underwriters and practical insurance men. American School of Correspondence, Chicago, 1912.

103. Setchkin, N. P., and Ingberg, S. H., "Test Criterion for an Incombustible Material", Proceedings of the American Society for Testing Materials, vol. 45, Philadelphia, 1945, pp. 866-877.

104. Underwriters' Laboratories, "Report on Fire Hazard Classification of Various Species of Lumber", Retardant, 3365, Chicago, 1952.

105. Steingiser, S., "A Philosophy of Fire Testing", Journal of Fire & Flammability, vol. 3, July 1972, pp. 238-253.

106. Yuill, C. H., Bauerschlag, W. H., and Smith, H. M., "An Evaluation of the Comparative Performance of 2.4.1 Plywood and Two-Inch Lumber Roof Decking under Equivalent Fire Exposure", Fire Protection Section, Final Report, Project No. 717A-3-211, Southwest Research Institute, Dept. of Structural Research, San Antonio, Dec. 1962.

107. Ashton, L. A., and Smart, P. M. T., Sponsored Fire-Resistance Tests on Structural Elements, London, Dept. of Scientific and Industrial Research and Fire Offices' Committee, London, 1960.

108. Butcher, E. G., Chitty, T. B., and Ashton, L. A., "The Temperature Attained by Steel in Building Fires", Fire Research Technical Paper, No. 15, Ministry of Technology and Fire Offices' Committee, Joint Fire Research Organization, London, HMSO, 1966.

109. Dept. of the Environment and Fire Offices' Committee, Joint Fire Research Organization, "Fire-Resistance Requirements for Buildings - a New Approach; Proceedings of the Symposium Held at the Connaught Rooms, London, 28 September 1971", Symposium, No. 5, London, HMSO, 1973.

110. Langdon Thomas, G. J., "Roofs and Fire", Fire Note, No. 3, Dept. of Scientific and Industrial Research and Fire Offices' Committee, Joint Fire Research Organization, London, HMSO, 1963.

111. National Fire Protection Association and the National Board of Fire Underwriters, Report on Fire the Edison Phonograph Works, Thomas A. Edison, Inc., West Orange, N.J., December 9, 1914, Boston, 1915.

112. Thompson, J. P., Fire Resistance of Reinforced Concrete Floors, Portland Cement Association, Chicago, 1963.

113. Forest Products Laboratory, "Fire Resistance Tests of PlywoodCovered Wall Panels", Information reviewed and reaffirmed, Forest Service Report, No. 1257, Madison, April 1961.

114. Forest Products Laboratory, "Charring Rate of Selected Woods - Transverse to Grain", Forest Service Research Paper, FLP 69, Madison, April 1967.

115. Bird, G. I., "Protection of Structural Steel Against Fire", Fire Note, No. 2, Dept. of Scientific and Industrial Research and Fire Offices' Committee, Joint Fire Research Organization, London, HMSO, 1961.

116. Robinson, W. C., The Parker Building Fire, Underwriters' Laboratories, Chicago, c. 1908.

117. Ferris, J. E., "Fire Hazards of Combustible Wallboards", Commonwealth Experimental Building Station Special Report, No. 18, Sydney, Oct. 1955.

118. Markwardt, L. J., Bruce, H. D., and Freas, A. D., "Brief Description of Some Fire-Test Methods Used for Wood and Wood-Base Materials", Forest Service Report, No. 1976, Forest Products Laboratory, Madison, 1976.

119. Foster, H. D., Pinkston, E. R., and Ingberg, S. H., "Fire Resistance of Walls of Gravel-Aggregate Concrete Masonry Units", Building Materials and Structures, Report, BMS 120, National Bureau of Standards, Washington, March 1951.

120. Foster, H. D., Pinkston, E.R., and Ingberg, S. H., "Fire Resistance of Walls of Lightweight-Aggregate Concrete Masonry Units", Building Materials and Structures, Report BMS 117, National Bureau of Standards, Washington, May 1950.

121. Structural Clay Products Institute, "Structural Clay Tile Fireproofing", Technical Notes on Brick & Tile Construction, vol. 1, no. 11, San Francisco, Nov. 1950.

122. Structural Clay Products Institute, "Fire Resistance Ratings of Clay Masonry Walls - I", Technical Notes on Brick & Tile Construction, vol. 3, no. 12, San Francisco, Dec. 1952.

123. Structural Clay Products Institute, "Estimating the Fire Resistance of Clay Masonry Walls - II", Technical Notes on Brick & Tile Construction, vol. 4, no. 1, San Francisco, Jan. 1953.

124. Building Research Station, "Fire: Materials and Structures", Digest, No. 106, London, HMSO, 1958.

125. Mitchell, N. D., "Fire Hazard Tests with Masonry Chimneys", NFPA Publication, No. Q-43-7, Boston, Oct. 1949.

126. Clinton Wire Cloth Company, Some Test Data on Fireproof Floor Construction Relating to Cinder Concrete, Terra Cotta and Gypsum, Clinton, 1913.

127. Structural Engineers Association of Southern California, Fire Ratings Subcommittee, "Fire Ratings, a Report", part of Annual Report, Los Angeles, 1962, pp. 30-38.

128. Lawson, D. I., Fox, L. L., and Webster, C. T., "The Heating of Panels by Flue Pipes", Fire Research, Special Report, No. 1, Dept. of Scientific and Industrial Research and Fire Offices' Committee, London, HMSO, 1952.

129. Forest Products Laboratory, "Fire Resistance of Wood Construction", Excerpt from 'Wood Handbook - Basic Information on Wood as a Material of Construction with Data for its Use in Design and Specification', Dept. of Agriculture Handbook, No. 72, Washington, 195_, pp. 337-350.

130. Goolwin, D. S., "Properties of Cavity Walls", Building Materials and Structures, Report BMS 136, National Bureau of Standards, Washington, May 1953.

131. Humphrey, R. L., "The Fire-Resistive Properties of Various Building Materials", Geological Survey Bulletin, 370, Washington, 1909.

132. National Lumber Manufacturers Association, "Comparative Fire Test on Wood and Steel Joists", Technical Report, No. 1, Washington, 1961.

133. National Lumber Manufacturers Association, "Comparative Fire Test of Timber and Steel Beams", Technical Report, No. 3, Washington, 1963.

134. Malhotra, H. L., and Morris, W. A., "Tests on Roof Construction Subjected to External Fire", Fire Note, No. 4, Dept. of Scientific and Industrial Research and Fire Offices' Committee, Joint Fire Research Organization, London, HMSO, 1963.

135. Brown, C. R., "Fire Tests of Treated and Untreated Wood Partitions", Research Paper, RP 1076, part of Journal of Research of the National Bureau of Standards, vol. 20, Washington, Feb. 1938, pp. 217-237.

136. Underwriters' Laboratories, "Report on Investigation of Fire Resistance of Wood Lath and Lime Plaster Interior Finish", Publication, SP. 1. 230, Chicago, Nov. 1922.

137. Underwriters' Laboratories, "Report on Interior Building Construction Consisting of Metal Lath and Gypsum Plaster on Wood Supports", Retardant, No. 1355, Chicago, 1922.

138. Underwriters' Laboratories, "An Investigation of the Effects of Fire Exposure upon Hollow Concrete Building Units", Retardant, No. 1555, Chicago, May 1924.

139. Moran, T. H., "Comparative Fire Resistance Ratings of Douglas Fir Plywood", Douglas Fir Plywood Association Laboratory Bulletin, 57-A, Tacoma, 1957.

140. Gage Babcock & Association, "The Performance of Fire-Protective Materials under Varying Conditions of Fire Severity", Report 6924, Chicago, 1969.

141. International Conference of Building Officials, Uniform Building Code (1979 ed.), Whittier, CA, 1979.

142. Babrauskas, V., and Williamson, R. B., "The Historical Basis of Fire Resistance Testing, Part I and Part II", Fire Technology, vol. 14, no. 3 & 4, Aug. & Nov. 1978, pp. 184-194, 205, 304-316.

143. Underwriters' Laboratories, "Fire Tests of Building Construction and Materials", 8th ed., Standard for Safety, UL263, Chicago, 1971.

144. Hold, H. G., Fire Protection in Buildings, Crosby, Lockwood, London, 1913.

145. Kollbrunner, C. F., "Steel Buildings and Fire Protection in Europe", Journal of the Structural Division, ASCE, vol. 85, no. ST9, Proc. Paper 2264, Nov. 1959, pp. 125-149.

146. Smith, P., "Investigation and Repair of Damage to Concrete Caused by Formwork and Falsework Fire", Journal of the American Concrete Institute, vol. 60, Title no. 60-66, Nov. 1963, pp. 1535-1566.

147. "Repair of Fire Damage", 3 parts, Concrete Construction, March-May, 1972.

148. National Fire Protection Association, National Fire Codes; a Compilation of NFPA Codes, Standards, Recommended Practices and Manuals, 16 vols., Boston, 1978.

149. Ingberg, S. H. "Tests of Severity of Building Fires", NFPA Quarterly, vol. 22, no. 1, July 1928, pp. 43-61.

150. Underwriters' Laboratories, "Fire Exposure Tests of Ordinary Wood Doors", Bulletin of Research, no. 6, Dec. 1938, Chicago, 1942.

151. Parson, H., "The Tall Building under Test of fire", Red Book, no. 17, British Fire Prevention Committee, London, 1899.

152. Sachs, E. O., "The British Fire Prevention Committee Testing Station", Red Book, no. 13, British Fire Prevention Committee, London, 1899.

153. Sachs, E. O., "Fire Tests with Unprotected Columns", Red Book, no. 11, British Fire Prevention Committee, London, 1899.

154. British Fire Prevention Committee, "Fire Tests with Floors a Floor by the Expended Metal Company", Red Book, no. 14, London, 1899.

155. Engineering News, vol. 56, Aug. 9, 1906, pp. 135-140.

156. Engineering News, vol. 36, Aug. 6, 1896, pp. 92-94.

157. Bauschinger, J., Mittheilungen de Mech.-Tech. Lab. der K. Tech. Hochschule, München, vol. 12, 1885.

158. Engineering News, vol. 46, Dec. 26, 1901, pp. 482-486, 489-490.

159. The American Architect and Building News, vol. 31, March 28, 1891, pp. 195-201.

160. British Fire Prevention Committee, First International Fire Prevention Congress, Official Congress Report, London, 1903.

161. American Society for Testing Materials, Standard Specifications for Fire Tests of Materials and Construction (C19-18), Philadelphia, 1918.

162. International Organization for Standardization, Fire Resistance Tests on Elements of Building Construction (R834), London, 1968.

163. Engineering Record, vol. 35, Jan. 2, 1897, pp. 93-94; May 29, 1897, pp. 558-560; vol. 36, Sept. 18, 1897, pp. 337-340; Sept. 25, 1897, pp. 359-363; Oct. 2, 1897, pp. 382-387; Oct. 9, 1897, pp. 402-405.

164. Babrauskas, Vytenis, "Fire Endurance in Buildings", PhD Thesis. Fire Research Group, Report, No. UCB FRG 76-16, University of California, Berkeley, Nov. 1976.

165. The Institution of Structural Engineers and The Concrete Society, Fire Resistance of Concrete Structures, London, Aug. 1975.