The Fireproofing Dilemma

Getting on the Right Definitions Can Eliminate Many of the Problems to an Acceptable Fireproofing Application

Restrained and unrestrained—these words won't cause a problem for most people—unless they happen to be structural engineers, architects, building officials, or fireproofing salespersons. For these it's a most confusing choice of words because "moment restraint" of a rigid frame comes to mind, and that isn't what is meant-exactly.

ASTME E 119, the test for fire resistive construction, requires that all floor test samples be grouted and therefore fully restrained within the top of the massive concrete furnace structure. Prior to 1971, restraint of the sample in the furnace structure allowed some unexpected things to occur, such as . . .

1. A steel beam protected with ½-inch of fireproofing had a temperature of 1200° F. at one hour. The end point temperature of that beam, which was granted a 4-hour rating, must have approached 2000° F. At this temperature, steel has no strength, and the sample should have collapsed, but did not. In another similar test the beam actually sagged away from the steel floor without collapse.
2. In a test of a Lin-T assembly, all of the concrete encasing the bonded tendons in the stem of the "T" spalled off, and the wire were directly exposed to full furnace temperature.

The phenomenon was, of course, that with the perimeter of the sample fully restrained, stresses caused by temperature expansion were so great the slab became a horizontal compression member. This post-stressing helped the slab to carry all vertical loads by itself. Obviously, something was wrong with the test procedure.

SPRAY FIREPROOFING—ASTM STANDARDS

ASTME E 605-77 — Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material applied to Structural Members. *Basic properties of thickness and density are determined using a thickness gage, scales and a steel rule.*

ASTME E 736-80 — Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members. *Properties determined using a metal dish with a hook, a two-component urethane-resin system, and a scale.*

ASTME E 759-80 — Standard Test Method for the Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members.

ASTME E 761-80 — standard Test Method for Compressive Strength of Sprayed Fire-Resisitive Material applied to Structural Members.

ASTM and UL Ratings

In 1971, ASTM and UL attempted to deal with the problem by establishing restrained and unrestrained ratings. Unfortunately, they neglected to properly distinguish them as *thermally* restrained and *thermally* unrestrained. The 1979 UL *Fire Resistance Directory* defines restraint as follows:

> "Floor and roof assemblies and individual beams in buildings shall be considered thermally restrained when the surrounding or supporting structure is capable of *resisting substantial thermal expansion* throughout the range of anticipated elevated temperatures. Constructions not complying with this definition are assumed to be free to rotate and expand and shall therefore be considered as thermally unrestrained." (1)

The directory continues . . .

> "This definition requires the exercise of engineering judg-

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ment to determine what constitutes restraint to *substantial thermal expansion." (2)*

A Uniform Building Code change was approved at the October 1978 annual meeting of ICBO, which substantially says that *all designs shall be considered thermally unrestrained, unless the structural engineer in charge of the design furnishes the responsible code authority with appropriate data to substantiate that his design is, in fact, thermally restrained.*

Actual wording of the code change is . . .

"Fire-resistive assemblies tested under UBC Standard No. 43-1 shall not be considered to be restrained unless evidence satisfactory to the building official is furnished by the person responsible for the structural design showing that the construction qualifies for a restrained classification in accordance with Section 43.147 of UBC Standard No. 43-1. Restrained construction shall be identified on the plans."(3)

Suggestion on Specs . . .

Until such time as the state of the art is sufficiently advanced so that an engineering judgment can be reliably made as to what constitutes "restraint to thermal expansion", we urge that all fireproofing specifications for buildings be written to include this statement:

"Fireproofing thicknesses shall be applied as required to provide unrestrained ratings."

An ICBO Research Recommendation is issued to cover a product or system. When a system is involved, to be acceptable all components of such system must be used exactly as outlined. Taking one component and using it with something else by "extrapolation" is not permitted.

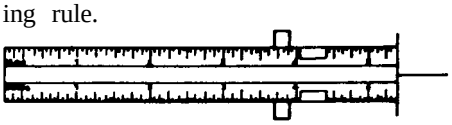
Whenever a component alone is suggested for use be certain there is a Recommendation for its use.

(1) (2) Underwriters Laboratories, Inc. Fire Resistance Directory, January 1979. P. 13, "Guide for Determining Conditions of Restraint for Floor and Roof Assemblies and for Individual Beams."

(3) Uniform Building Code, 1979 Edition, Chapter 43, "Fire Resistive Standards", Section 4302 (b).

Thickness Gauge . . .

A thickness gauge to measure the depth of sprayed fireproofing is a handy gadget to have on the job. It consists of a 1-1/8-inch (29mm) diameter disc. a needle and a measuring rule.



THICKNESS GAUGE

The rule uses both standard and metric increments. It can be ordered from AWCI (Association of the Wall and Ceiling Industries—International) Suite 300, 25 K Street, N.E., Washington, D.C. 20002. Price is $3 or $3.75 each for 10 or more.

Measuring thickness . . .

Underwriters Laboratories has adopted a procedure for measuring thickness of fireproofing which has been added to the General Design Information Section of UL's Fire Resistance Directory.

Sprayed Material — The type of material is specified in each design. Materials that have been evaluated for exterior application are so indicated on the individual designs.

Regulations governing the application and use of spray materials have been promulgated by many governmental agencies. Authorities having jurisdiction should be consulted for local requirements.

The surfaces on to which the material is to be applied must be free of dirt, oil and scale. Mixing and spraying instructions are printed on each bag of material.

The densities shown on the designs may be obtained by removing at least

There is no ASTM designation for plastic cement.

6 inch square sections randomly selected from the building, subjecting them to 120° F in an oven until constant weight is obtained, followed by accurate weighing, measuring and calculation of the density of pound per cubic feet. Constant weight is usually obtained after 24 to 48 hours exposure within a 120° F oven.

The cementitious mixture or sprayed fiber thickness specification given in a design may be considered the minimum average thickness of the individual thickness readings measured in accordance with the Standard Test Methods for Thickness and Density of Sprayed Fire Resistive Material Applied to Structural Members, ASTM E605-77.

Individual measured thickness readings, used in calculating the average thickness, which exceed the thickness specified in a design by 1/8 inch or more shall be recorded as the thickness specified in the design plus 1/8 inch. No individual measured thickness shall be more than 1/8 inch less than the thickness specified in a design.

The thickness of the cementitious mixture or sprayed fiber shall be corrected by applying additional material at any location where: (1) the calculated average thickness of the material is less than that required by the design or (2) an individual measured thickness reading is more than 1/8 inch less than the specified thickness required by the design.

Selected areas of the structural frame and/or floor area are to be chosen to obtain representative average thicknesses. Thickness readings on floor or wall areas, are to be taken symmetrically over the selected area. The average of all measurements is to be considered the average thickness of the area. Thickness measurements on beams and/or columns are to be made around the member at sections within 12 inches of each other. The average thickness is to be considered the average of the readings taken at both sections.

Requirement for thickness of portland cement plaster (stucco) on exterior walls is 7/8-inch over anything, except masonry or concrete. On framed construction there is no occasion when a 3/4-inch membrane is acceptable.