Here is a comprehensive review of the fast growing, still developing fireproofing market

By M. E. Herrera

The use of fireproofing agents in commercial construction is a comparatively recent innovation which is constantly being improved and revised as our technology improves. During the past few years not only have there been significant changes in the products used but the various criteria utilized to measure performance have become more and more precise.

Fireproofing materials are probably best described as insulators which have been tested as capable of protecting a substratum from fire during a specific length of time.

In this country, among the original criteria for fire protection was the use of concrete. Concrete is not a good insulator, but it had such mass when applied in thicknesses of two inches or more that it was perceived as an ideal protection. More recently, testing has shown that concrete can be almost 20 percent water when fully hydrated. In intense fires, the boiling off of this water can cause extreme spalling and cracking. In severe conditions, the concrete itself might explode under pressure. Editor’s Note: In describing the use of concrete for fire protection the statement, “concrete can be almost 20 percent water when fully hydrated” is not technically correct. I’m sure Mr. Mohen meant that when the capillaries of the concrete are full of water (saturated concrete) the volume of water can be 20 percent of the volume of the concrete. The sudden boiling off of this free, not hydrated water, during fire conditions, can and does cause spalling.

When used in commercial construction, concrete is a common and familiar material which resists damage through its mass and tremendous weight of approximately 150 lbs. per cubic foot.

During the past fifty years, as sprayed mineral fiber and sprayed plaster fireproofing materials were developed, concrete has found less use as fireproofing for steel frame buildings.

Sprayed mineral fiber fireproofing is a highly efficient, lightweight fire-protective material. It is incombustible, chemically inert, and an excellent insulation. Most sprayed-mineral fiber fireproofing materials are a mixture of portland cement, inorganic proprietary binders and mineral fibers. This type of material is not mixed in a cement mixer prior to application but pumped...
TABLE 1

Estimated Values for Comparative Two Hour Fire Protection for Steel Columns*

<table>
<thead>
<tr>
<th>Product Class</th>
<th>Density lbs./ft³</th>
<th>Applied Thickness (inches)</th>
<th>Applied Weight lbs./ft²</th>
<th>Installed cost $/ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprayed Mineral Fiber</td>
<td>12 lbs.</td>
<td>½”/2¼”</td>
<td>1.0 lbs.</td>
<td>$ .25/$1.25</td>
</tr>
<tr>
<td>Sprayed Plaster</td>
<td>15 lbs.</td>
<td>½”/2¼”</td>
<td>1.25 lbs.</td>
<td>$ .25/$1.50</td>
</tr>
<tr>
<td>Intumescents</td>
<td>70 lbs.</td>
<td>1¼”</td>
<td>6.0 lbs.</td>
<td>$2.00/$3.00</td>
</tr>
<tr>
<td>Magnesium Oxychlorides</td>
<td>30 lbs.</td>
<td>1¼”</td>
<td>3.0 lbs.</td>
<td>$2.00/$3.00</td>
</tr>
<tr>
<td>Concrete</td>
<td>150 lbs.</td>
<td>2”</td>
<td>25.0 lbs.</td>
<td>$4.00/$8.00</td>
</tr>
</tbody>
</table>

*Note: All values are approximate. Consult manufacturer and governing code agencies for specific data. The values given are not intended for estimating or any purpose, other than generalized comparisons.

dry to a spraying nozzle where water is added to the mixture as it is sprayed onto the surface being insulated. Editor’s Note: Some recent mineral fiber formulations have, in addition to Portland Cement, other cements which contain hydrated water within the cement molecule. This hydrated water is an excellent “heat sink” during fire conditions and does not cause spalling.

Also Offers Insulation Value

Sprayed mineral fiber fireproofing is efficient and inexpensive. If sprayed to the underside of steel decks, it will be an excellent insulation since it has a “k” factor of 0.254 which may prove to be quite relevant in the face of our current demand for energy conservation.

The material is not suitable for exterior application, but it can be exposed temporarily with the proper coating. Editor’s Note: Current sprayed mineral fiber products do not need protective coatings for temporary exterior exposures. However, I question their use in permanent exterior applications even with a coating over them. It is virtually impossible to apply a weatherproof coating over any type of low density insulation-fireproofing without pin holes resulting in the coating, which could allow the penetration of water dice to rain, snow etc., into the fireprotective insulation.

Sprayed plasters are composed of gypsum-mineral plaster with perlite or vermiculite lightweight aggregates and inorganic proprietary binders. Gypsum-mineral is calcinated to obtain the base material for gypsum plasters. Water is added to the calcinated material during mixing which takes place on site in a cement mixing machine. The wet slurry is then pumped and spray applied. When exposed to a fire, heat is absorbed in removing the water of hydration and absorbed water.

Like sprayed mineral fiber, sprayed plaster is vulnerable when exposed to the weather.

During the past two decades, research has indicated that magnesium oxychloride cements might be used as fireproofing agents. The hydrated water content of magnesium oxychloride cements can exceed 50 percent and this chemically bound water is released when the cement reaches temperatures as low as 570 °F. Editor’s Note: More recent developments are the Magnesium Oxysulfate products. These products are easier to use within a wider range of ambient air temperature and humidity than the oxychloride products, but the main improvement over oxychloride systems is that they require only the addition of water to the dry powder mix, not the addition of a chloride salt solution, which has to be prepared ahead of time, to the dry powder mix in an oxychloride product.

Examination of other complex forms of chemical reactions revealed that certain organic compounds could function as intumescent fire protective coatings. Editor’s Note: An intumescent coating is one which chars, foams and expands when heated at the proper temperature.

The initial uses of both magnesium oxychloride cements and intumescent coatings were in areas where its characteristics, i.e., hardness and light weight when compared to concrete, were real assets.
Cost Problems
Limits Market

With additional research, many of these products are reported to be suitable for direct exterior exposure. Although they provide many benefits such as good adhesion plus durability and hardness with light weight, their cost has excluded them from many markets.

To date there has not been a complete, direct comparison made by independent test of the various materials currently available for commercial fireproofing work. An accurate analysis would have to include the fire protection properties together with the true cost effectiveness of any given product including equipment costs, plus labor and cleanup costs, as well as additional benefits which improve life-cycle costing such as any thermal insulation and/or acoustical correction values which the material might provide.

An extremely generalized comparison is shown in Table 1.

Fireproofing is among the most critical items utilized in the construction of a building. Unfortunately any criteria for evaluating the properties and application of the material which has been installed have been poorly defined when available, with little consistency for any of the various methods suggested.

Application standards and quality control in the field has varied in relation to the degree of inspection demanded. With no uniform criteria, though, it has not always been possible to guarantee that the material actually being applied had the same characteristics including thickness and density as had been tested by the various fire rating approval laboratories.

Editors’ Note: ASTM Committee E6 is currently balloting the final draft of “Standard Recommended Practice for Application of Sprayed Fire Resistant Materials”. This recommended practice will help significantly to assure correct and proper field application of all fire resistant products.

Recognizing this limitation, the Association of Wall and Ceiling Industries-International has taken a leadership position through its Technical Committee #4 which recently published a uniform guide entitled, “Inspection Procedure for Field Applied Sprayed Fireproofing Materials”. The significance of this work was its combination of the needs of specifiers, code authorities, insurance groups, manufacturers and contractors into one comprehensive standard.

Second Document Now Available

A second document entitled “Design Selection Utilizing Sprayed Fire Protection” has been in preparation for two years and its final draft should be available shortly. This publication will serve as a guide to proper design selection for various construction components including some conditions not specifically clarified in the various Fire Resistance Indices published by Underwriters Laboratories.

Editor’s Note: Both the “Inspection Procedure for Field Applied Sprayed Fire Protection Materials”, and “Design Selection Utilizing Sprayed Fire Protection” are AWCI Publications and are under the jurisdiction of AWCI Technical Committee #4. They can be acquired by calling (202) 783-2924.

In addition to these standards, AWCI has made available to its membership and other interested parties, a measuring tool described both by the AWCI standard and ASTM E-605, for use in confirming the applied thickness of sprayed mineral fiber. These can be secured by contacting the Washington, D.C. office of AWCI at 25 K Street, NE, Washington, D.C., or calling 202-783-2924.

Among the further concerns of the AWCI are standards for not only inspecting field applied sprayed fireproofing but also insuring that corrective measures are available and accurate when required.

The major concerns of Technical Committee #4, which also has the responsibility for this project, are field applied density and thickness of sprayed fireproofing.

Both density and thickness are physical characteristics included by both Underwriters Laboratories, Inc. and Underwriters Laboratories of Canada in their fire test reports and Fire Resistance Indices. These two aspects are the characteristics universally measured by inspectors when certifying field work.

If measurements indicate that applied thickness is less than required, the obvious solution is to add material sufficient to achieve the necessary thickness.

The solution to field application density problems is more complex. Density is more significant within materials of the same product line.
rather than in comparison of one material to another. As a result, until quite recently no independent criteria was available for inspection agencies to confirm proposed solutions to inadequate material density in the field.

Concrete is a common and familiar material which resists damage through its mass and tremendous weight.

One manufacturer, a member company of Technical Committee #4, has developed with Underwriters Laboratories, Inc, a correction formula. The results of this research are being considered by Technical Committee #4 and may become the basis for a new universal standard. Editor’s Note: The correction formula for density has become standard for other sprayed fiber products.

proofing contractors is neither material or workmanship. Analysis reveals that damage results principally from deliberate abuse by other trades which follow the application of the sprayed fireproofing.

The best solution to this dilemma is a strong contract requiring the general contractor to certify the satisfactory completion of whatever portion of the fireproofing job that has been finished. The general contractor should also be responsible for all subsequent job related damage caused by other trades.

Fireproofing is a necessary and basic requirement in modern construction. If fireproofing materials are to be exposed to the elements or subjected to continuous abuse, a more expensive material manufactured to the specific needs of the installation has probably the lowest life cycle cost. If, as most projects are, the material is to be enclosed and not exposed to weather or abuse, sprayed mineral fiber and sprayed plaster materials probably offer the optimum benefit.

The benefits of each of these materials do not currently answer all the problems of the fireproofing industry. They do however offer consistent improvements in fire protection at lower costs and some combine a variety of benefits more suited to our country’s needs during the energy crisis. Editor’s Note: The mandated removal of asbestos containing fire protective and insulation products from schools, hospitals, federal and state buildings etc., and the required removal of these products by owners or buyers of commercial buildings, has increased the use of all types of asbestos-free, sprayed-applied, fire resistive and insulation products, several fold.

(The author, ME. Herrera, is President of American Energy Products Corporation, and a chemist, with over 35 years in R & D, manufacturing and marketing of products for the construction industry. He is an active member of ASTM Committees E6 and C16, AWCI Tech 4 and Tolerance Committees, UL’s Industry Advisory Council (IAC), Professional Member: International Conference of Building Officials (ICBO), National Fire Protection Association (NFPA), and Mine Inspectors Institute of America.)

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