FUTURE OF FIRE-RESISTIVE COATINGS IN WOOD CONSTRUCTION

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INTRODUCTION

The wood industry is currently trying to reduce its dependency on the one - and two-family housing market by expanding into the nonresidential market for wood construction. One difference between nonresidential structures and one- and two-family dwellings is the requirement for fire-rated assemblies. Fire resistance requirements have generally been met in wood construction either by adding gypsum board as an interior finish or by adding sacrificial wood. Another method that could be used to meet fire resistance ratings involves the use of fire-resistive coatings. At the present time, no commercial fire-resistive coatings are marketed in the United States for use on wood.

A fire-resistive coating is capable of withstanding a fire and giving protection from it. Commercial fire-resistive coatings are primarily marketed for use on steel. Some coatings have recently been marketed as thermal barriers for foam plastics. Coatings marketed for use on wood are fire-retardant coatings. A fire-retardant or flame-retardant coating delays ignition and combustion of the combustible substrate when the coating is exposed to fire.

In this paper, I review some of the comments, ideas, and recommendations of the April 29, 1988, workshop on the future of fire-resistive coatings in wood construction, held at the Forest Products Laboratory (FPL) in Madison, Wisconsin. The approximately 30 attendees represented both the wood and coating industries as well as other interests such as testing laboratories and insurance companies. The workshop was held in response to a recommendation of the National Forest Products Association (NFPA).

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NONRESIDENTIAL MARKET

The potential market for fire-resistive coatings in wood construction is in nonresidential structures. Although this market is currently small, it is growing. At the April 1988 workshop, Henry Spelter of FPL discussed wood use in nonresidential building construction. Additional discussion was provided by Robert Anderson of the American Plywood Association (APA). Their remarks were based primarily on several studies of the nonresidential markets (1,4). The studies provided estimates of the amounts of lumber, glued-laminated lumber, trusses, plywood, particleboard, hardboard, and wood shingles used in new nonresidential building construction in the United States.

Trusses, I-beams, and other engineered wood products are increasingly being used. Of the estimated consumption of lumber in nonresidential construction, 20 percent was in trusses. Forty percent of the lumber in nonresidential construction was used in roofs. However, wood truss framing was used for only 20 percent of the roofs compared with 60 percent using metal.

Steel framing and other noncombustible materials are replacing some lumber framing. Economic considerations are important. For low loads, wood can effectively compete with steel. However, wood becomes less competitive with higher load requirements. Only 18 percent of upper floor framing was of wood, compared with 63 percent of concrete and metal. Greater use of wood was found in smaller buildings than larger buildings.

POTENTIAL APPLICATIONS FOR FIRE-RESISTIVE COATINGS

One of the issues brought up at the workshop by participants from the coating industry was the question of market needs. During the workshop, several market needs or applications were suggested.

One general market need is 1- and 2-h-rated wood systems for the nonresidential market. The need for 2-h-rated systems was questioned on the basis that such buildings usually are limited to noncombustible materials. One exception is the requirement for 2-h fire resistance for the floor between the underground parking garage and the rest of the building.

More specific market needs were additional rated systems for wood trusses or I-joists. Charles Goehring of the Truss Plate Institute (TPI) discussed the needs of the truss industry for rated systems. Donald Sharp of the Truss Joist Corporation discussed the needs of the wood I-joist manufacturers. In the case of I-joists, there may be a market for a Is-rein-rated I-joist for areas where joists are left exposed, such as in basements.

The potential use of coatings in fire-rated doors was raised several times. The need for coatings in the rehabilitation of old wooden structures was also mentioned. When future remodeling involving ceilings is considered likely, protection of the individual structural members is more advantageous than protecting the entire assembly with a ceiling membrane. In some buildings such as warehouses, a ceiling membrane may not be desirable.

PERFORMANCE OF FIRE-RESISTIVE COATINGS

Several studies have been conducted on the fire performance of fire-resistive and fire-retardant coatings. The work at FPL in this area was reviewed in a presentation at the 1985 Fire Retardant Chemicals Association (FRCA) conference on flame-retardant coatings (2,5,6). At the April 1988 workshop, Les Richardson of Forintek Canada Corp. reviewed his study on the

potential use of flame-retardant coatings to improve the fire resistance of timber planks in heavy timber construction (3). He found that application of these flame-retardant coatings to the exposed surfaces of the planks should increase their fire resistance by at least 30 min.

MARKET NEED ISSUES

Several issues relating to the market need for fire-resistive coatings were discussed at the workshop. A theme stressed by all three members of the coating panel (John Danko of Isolatek International Corporation, John Stahl of Barrier Systems, Inc., and V. Radovic of American Vamag Co.) was the necessity for the wood industry to more clearly define their specific market needs and the necessary performance requirements of the coating. This will require further discussions between the wood and coating industries. It was also pointed out that the wood industry does not fully know what the coating industry has to offer. The coating industry has many different products. It has successfully introduced coated foam plastic panels into the marketplace. To facilitate this communication, it was suggested that a task group be formed to discuss specific needs in greater detail.

The members of the wood industry panel (Charles Goehring, Donald Sharp, and James Shaw of Weyerhaeuser Co.) were united in their receptiveness to fire-resistive coatings being a solution to their needs for fire-rated structural systems. Issues related to fire performance of structural wood members need to be addressed if wood construction is to be successful in the nonresidential market.

In considering market needs, cost effectiveness is one of the questions that is often raised about fire-resistive coatings. A manufacturer needs to know what costs can be added to wood construction and still have a competitive product. George Harpole of FPL generally discussed comparative cost analysis and the results of a preliminary investigation of the costs of fire-resistive and flame-retardant coatings. Comparative costs can be determined on the basis of life cycle costs, which include service and maintenance costs as well as the initial material and installation costs. A wide range of cost figures were obtained. For example, cost estimates ranged from $2.15 to $42.00 per square foot for a coating that will provide a Ib-min thermal barrier when applied to l/4-in. plywood. Some of the items that would need to be included in a cost analysis are site specific. In the discussion, it was noted that a major cost is labor. Factory-applied coatings may be a cost-saving alternative.

The issue of noncombustibility requirements in the building codes was also raised. In a market analysis, two markets can be considered: (1) that presently allowed by the building codes and (2) the potential market for wood construction if noncombustibility requirements were modified or eliminated. Noncombustibility requirements limit the allowable areas and building heights of wood construction. Another code issue is whether coated wood should be considered equivalent to pressure-treated fire-retardant wood if it passes the extended 30-min ASTM E 84 test.

FUTURE DEVELOPMENT ISSUES

Several issues may need to be resolved before progress can be made in the use of fire-resistive coatings in wood construction. The fragmentary nature of both the coating and wood industries makes it difficult to organize cooperative efforts. While NFPA and the National Paint and Coating

Association (NPCA) have formed a joint committee, its interests are in ordinary paints and finishes. Within the coating industry, there are several types of fire-resistive coatings, including intumescent mastics, cementitious, and sprayed fibrous, which are usually represented by different companies. In addition, there are intumescent flame-retardant coatings. While NFPA represents the wood industry, its membership is a diversified group of companies and associations. The traditional wood joists, trusses, and I-joists are competitive products in the marketplace.

The issue of proprietary or generic development of fire-resistive coatings for wood was raised by James Shaw. He indicated that both generic and proprietary developments are appropriate and needed. The issue of proprietary products is not limited to the coatings. The wood industry is increasingly using engineered structural products that are very often proprietary products. Charles Goehring noted that TPI has used proprietary gypsum products with generic trusses in their testing program.

The issue of proper terminology was also raised, usually in reference to the difference between fire-retardant coatings that have been evaluated according to ASTM E 84 and fire-resistive coatings that have been evaluated according to ASTM E 119. Experiences with sales representatives of the coating industry who did not know the distinction were recounted.

The technical performance of the coatings must also be evaluated. In specific applications, coatings must be evaluated for durability, impact resistance, weatherability, and other properties in addition to fire performance. The coatings may add structural strength to the wood member or improve the acoustics of the building. These properties can be more fully considered once the specific application or market need has been identified.

The standard ASTM E 119 test is expensive. The need for smaller scale tests to supplement the standard test was discussed. While small-scale tests can provide useful information, such tests are not substitutes for the full-scale test.

ROLE OF VARIOUS ORGANIZATIONS

One of the issues related to future progress is the role of various organizations. In addition to individual companies, there are trade associations, testing laboratories, and standard-making organizations. The roles of some of these other organizations were discussed at the workshop.

FPL, the principal federal government laboratory for wood products research, can continue its research efforts in evaluating the performance of fire-resistive coatings on wood.

The activities of NFPA were reviewed by Robert Glowinski of NFPA. It is a broad-based organization having a wide range of competitive interests. Because of its diversified interests, its potential role may be limited. However, NFPA has an active research program in fire endurance modeling and other fire research areas. The fire endurance models may have applications in expanding the potential use of fire-resistive coatings. It is also part of the North American Wood Products Fire Research Consortium, which includes FPL, Forintek Canada Corp., and the Canadian Wood Council.

A task group of NFPA considered the feasibility of fire-resistive coatings. The task group concluded that there were more questions than answers. Questions included marketability, economic feasibility, and adhesion-cohesion problems. The task group concluded that the necessary research should come from proprietary interests.

Because of its more specific interests, TPI will have more flexibility in pursuing the use of fire-resistive coatings on trusses. TPI has been active in developing fire-rated truss assemblies.

Testing will be an important part of future development of fire-resistive coatings in wood construction. Walter Haas of Underwriters Laboratory (UL) discussed the role of testing laboratories such as UL, which is involved in testing, product safety certification, and standard development. Product safety certification is not limited to the initial testing of the product. It also includes quality assurance and product identification. Rated assemblies are listed in the UL Fire Resistance Directory.

Standards pertaining to the serviceability of sprayed fiber and cementitious fire-resistive materials are the responsibility of ASTM Committee E 6 on the Performance of Building Constructions. John Danko reviewed these standards. Some of the standards included in the review were ASTM E 759 on effect of deflection on the material, E 736 on cohesion-adhesion of the material, and E 760 on effect of impact on the material. The fire resistance test method, ASTM E 119, is the responsibility of ASTM Committee E 5 on Fire Standards.

RECOMMENDATIONS

The primary conclusion of the workshop was that a task group should be created to coordinate activities between the coating industry and the wood products industry. I hereby solicit the support of FRCA in the creation of such a task group.

Other recommendations included the following:

- Proper use of terminology related to fire performance of coatings should be clarified and encouraged.
- The wood industry should compile short scenarios of appropriate uses of fire-resistive coatings on wood.
- As a supplement to full-scale ASTM E 119 tests, small-scale test procedures should be developed for evaluating fire-resistive coatings on wood.
- Cost analyses should be done on those applications that are permissible within the present building codes.
- Procedures for developing cost analyses of proprietary products should be developed.
- Efforts should be made to remove noncombustible requirements in the building codes.

CONCLUSIONS

In this paper, I review some of the discussions that took place at the workshop on the future of fire-resistive coatings in wood construction. The workshop was successful in developing contacts between the wood and coating industries. Information was exchanged on the current status of use, technology, and standards; potential applications and markets; and the roles of different organizations. However, the workshop was only a beginning in developing the full potential of fire-resistive coatings in wood construction. The recommendations of the workshop are designed to continue the process.

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