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Fire and Plastic Foam Insulation Material

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Please note

The use of plastic foams as thermal insulating materials for building enclosures has increased rapidly in Canada in recent years. The most common are rigid polystyrene in board form and rigid polyurethane in board form or as spray foam. A general description of plastic foams may be found in **CBD 166**[1], specific descriptions of rigid thermosetting plastic foams in **CBD 168**[2] and of rigid thermoplastic foams in **CBD 167**[3]. The extent of their use in Canada is indicated in an article in Canadian Plastics[4].

The presence of plastic foam insulating materials in buildings is a matter of concern for several reasons. The potential for vertical spread of fire in cavity walls is a threat to building occupants, particularly those in high-rise buildings, for it is recognized that plastic foams present a difficult fire to extinguish. The high risk of fire during building construction when foam plastic insulation may be left exposed is of added concern. Such fires can present a threat to construction workers and can make control difficult for fire departments because of the speed with which they can develop. Fires in both categories have been experienced in Canada. In recent years, also, it has become quite common to leave plastic foam insulation materials permanently exposed so that they form the interior finish of buildings. This creates a potential for rapid fire development not only during construction but also following occupation. Concern for this problem was heightened when the United States Federal Trade Commission, following hearings, alleged that existing standard test methods relied on by Code authorities are not satisfactory for predicting the fire behaviour of plastic materials under actual fire conditions.

In view of this situation various authorities concerned with fire protection have had to consider remedial action. One of the first official actions was taken in June 1974 by the Association of Canadian Fire Marshals and Fire Commissioners at their annual meeting in Ottawa. The Association passed a resolution stating, in essence, that because there are no accepted testing procedures nor recognized Canadian specifications for either the manufacture or application of plastic foam insulation, legislation be introduced "to prohibit the use of exposed foamed-in-place plastics and sprayed-on urethanes as building components until the products can be properly tested and listed by a recognized Canadian testing organization."

Shortly thereafter the Department of National Defence issued a directive in line with this resolution. In turn, a number of other agencies, including the Department of Public Works, Central Mortgage and Housing Corporation, and the Associate Committee on the National Building Code, issued directives or regulations controlling the use of plastic foam insulating materials, including those in board form. At the same time, provincial authorities enacted control measures and the plastics industry issued recommendations concerning the use of plastic foam insulating materials.

Concern regarding the fire behaviour of foamed plastics falls into two broad categories: surface flammability and the quantity of smoke and toxic gases produced when they burn. Accordingly, research has proceeded in these areas.

Surface Flammability

Protective Covering Materials

The development of a test to determine the effectiveness of covering materials has received high priority in Canada following the introduction of interim measures stipulating that plastic foam insulation should be covered with a material that will limit temperature rise at the plastic foam face directly beneath the protective cover for a period of 10 to 15 minutes when subjected to heating in accordance with a standard time-temperature curve. By imposing this requirement authorities believe that fire involvement of plastic foams will be delayed long enough to allow occupants directly involved in fire to evacuate the area before being exposed to hazards, including smoke and toxic gases, presented by these materials when they burn. Work in this and other areas is under way at the Fire Research Section, DBR/NRC, in close cooperation with staff of the Underwriters' Laboratories of Canada (ULC) to produce information that will lead to the development of standard test procedures by the ULC Fire Test Committee. A test method is now being processed by the ULC Fire Test Committee utilizing a specimen about 30 in. square, positioned horizontally and heated in accordance with a standard time-temperature curve. Temperatures are measured at the interface of the plastic foam and protective covering. A criterion for acceptance is that the temperature rise shall not exceed prescribed values in 10 or 15 minutes.

In Canada, the combined efforts of DBR and ULC have subsequently been directed towards simulating actual fire conditions in order to assess the propensity of exposed plastic foams to propagate fire. Such testing techniques could provide a yardstick of the usefulness of standard test methods such as the existing ASTM E84 (ULC S102) tunnel test or a modified form of tunnel test in evaluating flame spread characteristics of plastic foams.

Two major problems are encountered in developing definitive techniques: the selection of suitable geometrical configurations of enclosing elements of a test assembly, and appropriate igniting sources. Studies have been undertaken of large and small corner wall, room, and corridor configurations utilizing igniting sources such as wood cribs or burners. With regard to the geometrical configuration of the enclosing elements, studies have been undertaken using a corner wall assembly including a skirt. Several forms of igniting source have been tried, such as baskets (solid or perforated) containing shredded kraft paper, wood cribs, and various types of gas burners. The choice is particularly difficult because the fire behaviour of plastic foams can vary with the igniting source. At DBR, experiments employing a small-scale corner wall assembly have been undertaken to investigate the influence of various igniting sources. They have reached a point where a draft standard is being prepared for consideration by the ULC Fire Test Committee.

Fire Spread in Cavity Walls

Another area of concern is the spread of fire within cavity walls containing plastic foam insulation material. In investigations undertaken by DBR/NRC an experimental cavity wall type of assembly was built, using a number of insulation materials with and without an air space. Work has progressed to the stage where a proposed draft test method has been submitted to the ULC Fire Test Committee for consideration.

Surface Burning Characteristics

A major investigation of longer duration is that related to the development of new or modified standard tests for evaluating the surface burning characteristics of materials involved in fire. In cooperation with other organizations DBR/NRC is studying the possibility of modifications to the ASTM E84 (ULC S102) tunnel test to improve its usefulness in evaluating the flame spread of finish materials, with particular reference to foam plastics. A number of factors have been considered that might influence the results of tests in the tunnel furnace. The main thrust to date has been with the effect of modifying the tunnel lining. It is believed that the heat transfer properties of lining materials in existing tunnels do not provide exposure comparable to that encountered in tests such as the corner wall. Various approaches have been taken such as lining one wall and the floor of the tunnel with the same material as that under test or with a good insulating material. One promising technique uses aluminum foil on the floor; results correspond closely to the fire behaviour encountered during corner wall tests. Several bench type test methods for evaluating flammability characteristics of plastic foams are also under study.

Evaluating Smoke and Toxic Gas Hazard

Smoke from plastic foams involved in fire presents a serious hazard for building occupants, particularly those in high-rise buildings. For many years the principal hazard of smoke was considered to be reduction of visibility, and to date the most widely accepted test method by regulatory authority has been the ASTM E84 (ULC S102) tunnel test. Of recent years, another method has attracted attention. It utilizes a smoke chamber in which the specimen is subjected to both a radiant heat source alone and the radiant heat source with a pilot flame present. This latter method is now being considered by the ULC Fire Test Committee with particular reference to its appropriateness for use in determining the smoke developed when plastic foams burn.

The toxicity of the combustion products from plastic foams involved in fire has become a subject of major concern in recent years. DBR/NRC has, therefore, been engaged in analysing the combustion products of plastic foams exposed to heat in atmospheres having varying amounts of air. Particular emphasis has been placed on determining the quantities of toxic products. A toxicity index procedure[5] has been developed that enables the toxicity hazard of plastic foams involved in fire to be derived if information is available regarding the toxicity of the products. Obviously there are limitations to the use of such a procedure because of the lack of information on the toxicity of many gases and vapours. Progress in this area will be governed by the speed with which toxicity information is produced, and this of necessity involves animal experiments. To date such work has not been undertaken in Canada, although many countries have felt it necessary to do so.

Co-operative Tests - Flammability of Plastic Foams

In the latter part of 1975 the NBS Fire Research Center and DBR/NRC agreed on a co-operative program concerned with the development of techniques for evaluating the flammability of plastic foams. The NBS Fire Research Center will carry out room burns and heat release tests; the Fire Research Section at DBR/NRC will carry out corner wall tests, modified tunnel tests, and heat release tests. Five selected materials from a central source will be used in these co-operative tests. It is intended that the program will be completed by the end of 1976 or early 1977.

Concluding Remarks

Certain factors have or will have considerable influence on the acceptance of plastic foams as thermal insulating materials in buildings. The position taken by both the plastics industry and regulatory authorities that existing standard fire tests do not of themselves always provide effective evaluation of the fire behaviour of plastic foams, including those which incorporate fire retardants, is an important consideration. Quality control of sprayed or foamed-in-place plastic foams is another. It is evident that for the immediate future at least, plastic foams will generally have to be provided with some form of protective covering, and that the development of such coverings will be of considerable importance to the plastic foam industry. Two important points in such development are cost and applicability to various geometrical configurations. The field of protective coverings has a wide spectrum inasmuch as the requirements for such coverings can vary with building use.

Regulatory authorities have emphasized the necessity for standard tests of fire behaviour of plastic foam to simulate actual fire exposures. Two problems arise: (1) to develop simulated fire exposure techniques that can be related to real life fire situations, and (2) to develop new or modify existing standard fire tests whose results will relate to the performance established by simulated fire exposures. Acceptance of exposed plastic foam insulation must inevitably await such developments and their acceptance by regulatory authorities. The first thrust in this area by many organizations is related to the surface flammability of plastic foams.

Regulatory authorities are also concerned about smoke development and toxic products of combustion, particularly where plastic foams incorporate fire retardants. Existing standard tests for determining smoke development are being studied with reference to their usefulness in evaluating plastic foams. Acceptable tests in this area should be available in the near future. With reference to evaluation of the toxicity of combustion products, it is unlikely that progress in this area will be rapid as it involves animal experiments as well as analytical procedures.

In summary, it is apparent that the extent to which plastic foam may be used and how it may be used as thermal insulation will depend not only on developments in plastic foams by the industry but on the development of acceptable evaluation techniques.

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