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PROBLEMS IN DEVELOPMENT OF PERFORMANCE STANDARDS

by

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The performance concept in building has been the subject of a great deal of discussion and study during the past several years. A Building Research Advisory Board Committee on this subject has conducted two National conferences, and other groups are discussing the meaning and usefulness of the concept. At the National Bureau of Standards, the programs of the Building Research Division now have an emphasis in the direction of development of performance methods.

In the broadest sense, the performance concept is applicable to all segments of the building process, including determination of the functional requirements of the user, the design, the fabrication, and the operation and maintenance. It should be applied to materials, components, construction systems, or whole structures. The performance concept can bring about an orderly systematic approach to the whole of the building process. If fully developed, it could furnish also a powerful incentive for innovation, both in acceptance of new materials and the acceptance of new designs and building methods.

This brief discussion will be concerned only with the narrower field of performance requirements for materials and components. Performance is certainly nothing new to specification writers. Except in those cases where standards are deliberately written in such a manner as to exclude competitive products, the specification writer, or the test developer, strives to insure a material or product which will give satisfactory per-

formance under the conditions of its intended use. Some specifications are of the prescription type, and specify composition, proportions, sizes, and the like, which have been demonstrated by long-time experience to correlate with satisfactory performance. Often the specification will consist only partly of prescription-type requirements with the balance depending on performance-type test procedures such as those which measure properties like strength or viscosity, or which employ an accelerating aging process to estimate the long-time performance of the material or product. As an example, most portland cement specifications have a 5.0% maximum limit on magnesium oxide, because it is known that some forms of magnesium oxide which may occur in portland cement can, after several years, cause a substantial expansion of concrete. The autoclave expansion test, which subjects cement mortar to steam pressure at 420°F, a condition seldom approached in the use of concrete, is an accelerated performance-type test also included in U. S. cement specifications to give an indication of the expansion that may develop at later ages due to the presence of certain forms of magnesium oxide or of other constituents in the cement.

Prescription and performance-type requirements, such as those just mentioned, have usually served their purpose well, but with the continual development of new materials and new uses for these materials, efficient utilization makes it desirable to develop test procedures which not only are of the performance type, but also are applicable, with a certain amount of judgement, to all materials proposed or potentially suitable for a particular use.

Two recent projects in the Building Research Division have been conducted using the performance concept. They have been concerned primarily with test methods, leaving the setting of performance levels to other organizations. In developing performance requirements for external cladding, and test procedures to evaluate such performance for any type of proposed material, it was necessary first to decide on the functional requirements of the cladding. Among other things the cladding must serve to impede the movement of moisture and air. It must present an acceptable appearance, and one which may be readily maintained. It must satisfactorily resist indentation from objects such as hailstones or baseballs, and it should remain functional for a long period of time, usually for the expected life of the house. In drawing up a list of such properties, the Bureau staff quickly recognized that the level of performance of the cladding material is certain to be influenced by the other parts of the wall. The cladding must therefore be evaluated in combination with the other components with which it will be used in actual construction. And now other factors, such as rate of heat transfer, sound transmission, rate of moisture flow into the interior of the wall with its potential damage, production of smoke and fumes during a fire, and contribution to the strength of the wall system, also become of importance and must be tested.

In spite of all of the complicated interactions, it was possible to make a reasonable list of performance items for which established tests should be applied, or modified or new methods developed. The one variable

which was not adequately accounted for is time. The measurement of long-time durability under specific anticipated usage and environment is a particularly elusive, difficult task. Time was not neglected by choice and indeed some accelerated aging and cycling was included.

Much effort has been expended toward development of accelerated aging tests for specific materials. The very fact that these tests must be accelerated tests precludes, in most cases, the direct simulation of natural exposures, and of course there is no such thing as a standard natural exposure with which to make a correlation. The development of an accelerated aging test which would be applicable to all types of materials is even more difficult, because different materials react to the various elements of weathering in entirely different fashions. Organic materials, for example, are generally vulnerable to ultra-violet light and to elevated temperatures, whereas inorganic materials remain relatively unaffected. The absorption of moisture in inorganic materials, on the other hand, may bring about one or more destructive actions which might be totally absent in organic materials.

The second NBS program was directed at bathtubs. Considered in the study were porcelain-enameled cast-iron tubs, porcelain-enameled steel tubs, and reinforced plastic tubs and shower assemblies. Again it was necessary first to list the performance elements of importance in a bathtub. Such items as resistance to static and dynamic loads including sharp impacts, dimensional stability, the effects of changes in temperature, resistance to staining and burning, ease of cleaning, resistance to

cleansing agents and other chemicals which might come in contact with the fixture, and the overall useful life of an item whose replacement would, in many cases, create substantial structural problems, need to be evaluated.

Here again tests developed by others were in some cases adopted unchanged, and in some cases adopted in a modified form. In others, new test methods were improvised, and in all cases the test procedures were applied to representative samples of various types of available tubs. The program took a great deal of organized thinking, and it was built upon a great deal of previous thinking by other investigators. The tests recommended included cycling treatments of temperature, loads, cleaning, exposure to ultra-violet light, and the like, but again development of a procedure for estimating the long-time useful life was not accomplished.

In spite of difficulties, the performance concept is a most useful tool and a great amount of work should be done in developing test procedures whereby the performance of materials, composites, assemblies, and more complicated systems can be evaluated in terms of likely results to be anticipated under specific usage and situations. Many people prominent in the promotion of the performance concept are fully aware of the difficulties in developing adequate test methods. Unfortunately others appear to ignore the variable, time. There is a test method for measuring the strength of concrete at the age of 28 days. There is no

test method for predicting the strength at 28 years. There is an ASTM laboratory test procedure for measuring the rate of air leakage through windows. It is recognized that a procedure needs to be developed for measuring the leakage of the window actually in place in the building, because of the effects that installation may have on this property, but no-one knows how to develop a test which will predict the leakage of the window after it has been in place for ten years and subjected to deterioration of the calking, and the racking brought about by temperature differentials and wind-loads.

For some time to come, the perfomance-type tests will have to be supplemented by technical judgement rendered by experts experienced in the properties of materials, and the probable interactions as these materials are put together to form products, composite units, and larger and more complicated building systems.