

SYMPOSIUM ON METHODS OF TESTING BUILDING CONSTRUCTIONS

SUMMARY

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Seven excellent papers on testing, evaluation, and performance of building construction are presented in this Symposium. Some of the conclusions are based on research results or factual evidence, whereas others are expressions of the author's opinion. In all instances, however, they indicate how building construction may be improved and the need for further research.

In Mr. J. W. McBurney's presentation of Mr. H. L. Whittemore's paper as part of this Symposium, he stated that Mr. Whittemore frequently made comments or suggestions "just to get the lions to roar." The remark that we have made little progress in building construction since the Civil War is probably of this nature. Actually, a great deal of progress has been made through the use of insulation, vapor barriers, new sheathing materials, and better rigidity of construction. Nevertheless, many of our construction procedures have changed but little in this time, not only because of our adherence to long established standard practices, but because of prejudice and habit of the buying public. For example, stressed-skin construction, using plywood glued to 1 by 2-in. framing members, was developed at the U. S. Forest Products Laboratory some 25 years ago. Many years passed before this

type of construction found consumer acceptance. Yet today this principle is used by many prefabricators who presently produce 55,000 to 60,000 of the approximately 1,000,000 new houses built annually. Sandwich construction, using high-strength facing materials firmly bonded to lightweight, low-density cores, has been developed for use in building construction. At present little use is being made of this type of construction for houses, but like stressed-skin construction it will probably find favor and utilization in the future.

Mr. Whittemore suggested a deflection ratio other than the ratio of $\frac{1}{360}$ of the span at 40 lb per sq ft load as conventionally used. Larger deflections can, no doubt, be accepted without impairing the safety of the structure, and Mr. Whittemore, to excite comment, suggests a 2-in. deflection in a 12-ft span. He recognizes, however, that other considerations besides strength enter into the choice of a proper deflection ratio. During a research study on floor constructions, made at the U. S. Forest Products Laboratory, a study of "comfort factor" was made. This factor was an expression of consumer acceptance of floors having various deflection-span ratios. During evaluation of these floors by over 200 people from all walks of life, certain procedures were followed that would allow these persons to judge how the floors would perform in their homes.

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Ninety-one per cent of these persons voted the stiffest floor (deflection = $\frac{1}{338}$ span) as acceptable to them, 77 per cent accepted a floor having a deflection ratio of $\frac{1}{331}$, but only 16 per cent said the floor having a deflection ratio of $\frac{1}{233}$ would be accepted by them in their homes. Such a study indicates need for consideration of more than safe strength and stiffness requirements, if public acceptance is to be obtained in our construction.

As Mr. Whittemore and Mr. L. W. Wood point out, some standard procedures for testing full-size structural components have been developed. Based on these procedures, suggested performance standards have been established for building codes to indicate minimum requirements in strength and stiffness, as well as what the home owner will accept. The drafting of proper performance requirements for codes is not an easy matter, and the administration of these requirements is often difficult. However, performance codes are being developed, often with a short mandatory section and a detailed advisory section to make them more easily understood and simpler to enforce. They can and do provide for admission of new types of construction that will meet the established standards. Similarly, specification type codes can be so drawn and administered to admit new constructions. With either type of code, an enlightened administration can admit what is wanted and keep out what is unwanted. The specific need is education to promote uniformity in code administration. Broadly, it may be said that most codes are being administered to meet health and safety requirements, to give the public what it wants, and still permit progress in building construction.

A comprehensive series of laboratory and field tests to determine the strength and performance of brick masonry walls was discussed by Mr. C. B. Monk, Jr.

The results show comparable performance between 6-in. brick walls, 8-in. brick-block walls, and 10-in. cavity walls. They indicate, as well, an allowable load in tension for masonry walls, and it would be of interest to determine how this strength value would be affected by duration of load. More important, however, was the fact that in the field tests the wall failed as a plate, whereas in the original laboratory tests, the wall section failed as a beam and a marked difference in mean strength that reflected loading methods was obtained. This clearly indicates the need for proper correlation of testing procedures for laboratory and simulated service tests if comparable results are to be obtained, and the need for service or simulated service tests on typical structures to provide a true indication of performance.

Mr. A. J. Steiner, in his discussion of fire testing procedures, states that only complete wall, floor, or ceiling tests on full-size structures will suffice to evaluate properly fire and flame-spread resistance of the component materials as used in a building. Such tests provide data that can be used in codes. However, experience seems to indicate that there is also a need for standardized testing procedures that permit fire and flame-spread tests using smaller-size specimens. Such tests are far less costly than the full-size tests specified in Method E 119 - 53.² They permit measuring relative performance of different materials or constructions; they encourage development of more fire-resistant materials; and they can be made readily in many laboratories. Once a material is developed and proposed for use as a structural component of a building, then it should be evaluated as a

² Methods of Fire Tests of Building Construction and Materials (E 119 - 53), 1953 Supplement to Book of ASTM Standards, Part 4, p. 129.

full-size element. On this basis closer cooperation between Committee E-5 on Fire Tests of Materials and Constructions and the materials committees would appear desirable to develop standardized small-scale fire test procedures that will evaluate properly the materials for the purpose intended and that will receive Society approval. Through this cooperative effort, and only in this way, can the objectives of all committees be satisfactorily coalesced.

The subject of wood diaphragms is ably discussed in the papers of Mr. A. C. Horner and Mr. J. R. Stillinger. (The latter was presented by Mr. J. W. Johnson.) Mr. Horner defines a wood diaphragm as "a relatively thin, usually rectangular structural element that is capable of withstanding shear in its plane and which, by its rigidity, limits the skewing or racking deformation of a structure." This accurately describes this structural element. The primary purpose of a wood diaphragm is the transfer of stresses. Testing is required to evaluate their properties because they are not homogeneous. Walls, floors, and ceilings are actually diaphragms, although they may be designed for other purposes. An effective diaphragm is designed to resist lateral load, be it wind, blast, or seismic load. Because of required resistance to seismic load, diaphragms have been of great interest to West Coast engineers. Mr. Horner accurately documents the history of tests of wood diaphragms, and Mr. Stillinger's paper brings this up to the present with his description of test performance of ten 20 by 60-ft diaphragms. These latter studies indicate the advantages of herringbone and diagonal sheathing, the importance of nail bearing, and the need for strong rigid joints at the diaphragm corners. They indicate as well the need for additional work on this type of construction to de-

termine how performance can be improved and how openings in the diaphragms affect over-all performance.

The advantages that accrue from the use of the lightweight roof trusses in house construction are accurately outlined by Mr. R. F. Luxford. House construction may be simplified and costs reduced. Exterior walls and roof can be erected without placement of interior partitions. Ceilings, walls, and floors can be placed as one unit without partition interruptions. Interior partitions are non-load-bearing and can be readily moved to accommodate any floor plan or changes in floor plan that become desirable. When nailed trusses are of adequate design and well manufactured, they give good service. However, the question "Would glued trusses do a better job?" has been frequently raised. Mr. Luxford describes relative performance tests of nailed and glued trusses both before and after cycles of high and low relative humidity. Glued trusses are much more rigid and may offer some advantages such as less plaster cracking and less distortion in handling and erecting. Before exposure, the glued trusses are much stronger than nailed trusses. After rather severe exposure, glued trusses show some loss in stiffness and considerable loss in strength, but they are still equal to a nailed truss in strength and are much stiffer. Nailed trusses are reduced slightly in stiffness after exposure, but no reduction in strength was found. The study points out in a preliminary way the possibilities of a new fabrication procedure for building construction that must be substantiated by further testing.

It is obvious that these papers describe studies that will advance the science of building construction. They offer factual data and stimulate our thinking. They point out the need for further testing to improve building constructions and for

competent authority to pass on the adequacy of construction types. Much of this competence is assembled in Committee E-6 on Methods of Testing Building Constructions, which must accept the responsibility not only for establishing testing procedures but for

setting up standards of performance. We must agree with Mr. Whittemore that progress in building construction can come only with more experimental investigations, service or simulated service tests, and the application of these results to actual construction.