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by

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Building codes, test methods, and industrialised building

By R. F. Legget (Canada)

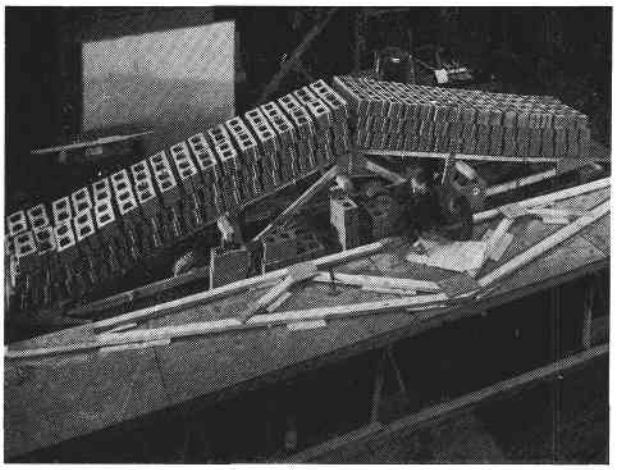

Fig. 1. Load test on a prefabricated timber roof truss for use in house construction being carried out at the Building Research Centre of the National Research Council in Ottawa, Canada.

Public regulation of the design and construction of buildings is today a generally accepted part of the over-all building process. It must, therefore, be considered in any review of the trend towards industrialised building, a trend that is now world-wide and which, as this Congress will probably show, may be expected to dominate construction in the more developed countries in the relatively near future. There are those who regard all such regulations as a brake upon progress, a statement such as that "all regulations increase costs" being a common misconception. On the other hand, there are those who are apprehensive of any departure from accepted methods of building and so have some vague idea that regulations should be "tightened up" for all buildings or components not constructed on the building site. Consideration of building regulations therefore appears to be an appropriate part of the broad review of industrialised building that this Congress will assemble.

From their inception, building regulations have been designed to protect the public. Initially, in North America, they related to fire hazards. These early building bylaws were naturally restrictive in an attempt to eliminate the dangers created by fire in relation to the simple wooden houses of the early settlers. Quite naturally, but rather unfortunately, the extension of building regulations to matters other than fire followed the same restrictive pattern, but not always in the same way. In consequence there grew up all over North America a heterogeneous assortment of local municipal building ordinances that followed no consistent order, differed in many matters of detail and were in general so specific in their restrictions that the introduction of new products or methods of building was made extremely difficult. And this despite the fact that the regulations were essentially for the protection of the public and not for any intentional limitation of building progress.

The same situation may possibly have existed in other countries; it certainly was the case in Canada. As the technology of building has advanced, despite such restrictions, and as public funds in many countries have been channelled into house construction, there has had to be in many parts of the world a reconsideration of building regulations. Canadian experience may be summarized, not as representing any ideal solution, but since it points at least to the way ahead and does take cognizance of the special needs of industrialised building.

It was decided in 1937 that the government of Canada, through its National Research Council and Department of Finance, should prepare a "model" building code that would be published as an advisory document, available to anyone at cost, but so prepared that it could be adopted or enacted by any municipality in Canada as its own building bylaw by passage of the necessary local enabling legislation. The first edition was published in 1941. The National Research Council assumed full responsibility for the Code in 1948, charging a special Associate Committee on the National Building Code with the task of keeping the Code up to date, and in keeping with advances in building technology. Further editions have been published in 1953, 1960 and 1965. It is planned to issue new editions hereafter at five-yearly intervals. Today, this national set of building regulations is in use in one way or another, by voluntary local adoption, by over two thirds of the population of Canada. There is, therefore, even today reasonable uniformity in building bylaws from coast to coast, despite differences in climate and local custom. If present progress continues, it will not be too long before the regulation of almost all building throughout Canada will be based on the same fundamental document.

Basic to the preparation of the National Building Code has been the protection of the public in its use of buildings with respect to structural sufficiency, fire prevention, and health hazards, these being the three "foundation stones" of the entire document. Measures for the elimination of health hazards, and for the prevention of fire hazards in buildings, can be seen to be but little affected by the way in which a building is constructed, on the site, or in a factory and then erected on the building site. But it became clear about ten years ago that there were questions that could be raised regarding structural regulations that were influenced by the method of construction.

The matter was first raised in relation to prefabricated housing. Why, it was asked, should factory-made houses have to adhere to the same regulations as were applied to houses built by traditional methods on the building site. The obvious reply was "Why not?". This exchange of views led to the formulation of what was really an obvious policy, once the basis of the Code (the protection of the public) was remembered. The requirements must be the same for any structural component or system, whether prefabricated or not, since it is called upon to perform the same function in the finished structure.

Development of the policy was easy as compared with its implementation. Consider house roofs, for example. Roof construction in timber frame houses, the normal type of single-family dwelling used in Canada, had followed a traditional form developed in practice, but not designed according to any structural theory. Roof construction using prefabricated wooden trusses had to meet the same performance requirements. The strength of traditional house roofs was not known and so an extensive research program was initiated jointly by the NRC Division of Building Research and the Canadian Forest Products Laboratories. From this has been developed a set of design criteria for roof trusses, and correspondingly an acceptable test method for house roofs. The *performance* of house roofs can now be specified, leaving quite free the choice as to the type of roof to be used to meet this requirement, either built on the job in the old style, or at least partially prefabricated in a factory.

This relatively simple example illustrates two main developments that appear to be essential if building regulations are to be ready for the great advance in the volume of industrialised building that is bound to occur in the near future. In the first place, building regulations must get away from the old specification type of document and trend much more in the direction of being performance codes. This will give new building systems that are developed with increased industrialisation an equal chance to compete with well accepted methods. The change will be a gradual process since many elements of building design, such as those with regard to exit requirements, must still be quite specific to be effective. Structural requirements, however, can well become much more flexible by the introduction of the concept of *performance*, rather than adherence to a specific structural type or design method.

The process of adaptation is more easily described than actually achieved. Reduced to bare essentials, a performance structural code could require merely that all structures shall be structurally sufficient for the loads to be imposed upon them. This

would be absurd, but the statement does point to the absolute necessity of an adequate and accurate knowledge of the loads that may be imposed on structures of different functional types, if performance is to be adequately assessed. Performance of different structural components will have to be described, even in the simplest of performance codes, and this involves the establishment of appropriate performance criteria, such as maximum permissible deflections under design loads. If such criteria are to be meaningful, and useful for comparative purposes, then the testing of structural components to see if they do conform to performance requirements must be carried out with standard and readily reproducible methods. The development, and wide acceptance, of such standard test methods is the second main development that must take place if building regulations are not to impede the inevitable wide use of industrialised building methods.

A start has been made in each of these directions but progress must be greatly accelerated if building regulations are even to keep pace with the growth of the industrialisation of building. Many national building codes, and the more advanced locally developed codes, do take cognizance of performance requirements even though they may still contain, of necessity, many specific design requirements. One means of avoiding any untoward restriction of new building methods is for regulations to contain also what is popularly called an "escape clause". In the Canadian Code, for example, there is a clause that says, in effect, that the owner of a proposed building may submit (naturally at his expense) to the authority having jurisdiction over his building sufficient evidence in the form of test reports or other proofs that the innovation he is proposing meets the performance requirements of the Code. In this way no really sound new development in building need be restricted, but its acceptance obviously depends upon the availability of standard test methods, the result of which will enable the building official to compare the performance of the new development with the known performance of the material component or system that it is designed to replace. Again, therefore, the need for an adequate set of standard test methods for building constructions will be obvious.

The relevance to CIB of what has so far been said will be clear since performance requirements for buildings, the loads to which buildings are subjected, and the test methods by which building constructions and materials can be tested are not peculiar to any one country, nor affected by political boundaries. They are truly international. A fine start has been made by CIB Working Commission W23 in its work on developing a set of standards *Loads on Buildings*. Other Working Commissions are making a start at some aspects of performance requirements. Little has yet been done, at the international level, with regard to standard test methods. Work of the American Society for Testing and Materials in this field may therefore be mentioned, since ASTM is in many ways an international body, despite its name. It has an active technical committee developing standard test methods for building constructions, about twelve of which have now been published.

Looking ahead, therefore, it may be said that building regulations must be accepted as a vital part of the building process; that every effort should be made to have these necessary, and usually local, legal documents of the performance rather than of the specification type; that the sooner international agreement can be reached regarding standard loads for building design the better; that corresponding accord with regard to performance criteria is similarly desirable even though it may be more difficult to achieve; and that all these developments necessitate adequate, and internationally accepted, standard test methods for building constructions. Here is the greatest need, if the progress of industrialised building is not to be impeded, and here is the greatest lack, If for no other reason than this, the existence of a body such as CIB is vitally necessary. It will require the united efforts of building experts from all developed countries in meeting the demands of their own and of the newly developing countries in the years that lie ahead, as the "building explosion" rapidly develops, to ensure the necessary and proper regulation of this vast world-wide building program in the interests of public safety, good building practice and sound economy. This is but one of the challenges that now faces CIB.