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Please note

Building codes are essentially sets of safety regulations in respect of structure, fire, and health. They were originally developed in response to frequently demonstrated hazards of structural collapse, catastrophic fires, and the spread of disease. Closely related to the life of the community, these matters became municipal responsibilities. They remain so today, being delegated by the provinces which have the over-all responsibility for civil rights, including safety.

Fire was and still is the most common form of disaster. Complete villages and towns were frequently destroyed by fire in times past. On many occasions between 1845 and 1905 fire destroyed 1,000 or more homes at a time in larger cities in Canada, leaving as many as 10,000 people homeless. As Ritchie has said in *Canada Builds*, *1867-1967*, it was the threat of fire "rather than the convenience of the householder that led to the installation of waterworks in most Canadian cities and towns. The pipes that were laid in many communities during the latter half of the nineteenth century brought water not to houses but to hydrants."

There were compelling reasons for the development of building bylaws by municipalities. Along with other developments, they have been very effective in reducing markedly the probabilities of disaster.

There are some who protest the restrictions that building codes impose and argue that they are not needed. Yet every time loss of life from fire or collapse of scaffolding qualifies as an important item of news of the day there is a public outcry against the laxity of laws or officials and a demand that something be done to prevent a recurrence. Legislation to promote safety continues to be demanded and building codes will probably be necessary for some time, despite the many difficulties encountered in their formulation and application.

Safety can only be measured in terms of the probability that an undesirable event will occur. This probability is an extreme value occurrence, to use a statistical term. An event usually depends on the simultaneous occurrence of several conditions; safety consists of ensuring that all will not occur together. Safety is often difficult to predict out of knowledge, and may have to be measured in terms of the frequency with which events occur. Such experience of events is always in the past and presents some unavoidable difficulties if used as a means of prediction. If events occur, on the average, every ten years, a very considerable period of time is required, say 50 years, to produce a statistically significant record of events for analysis. During this time, the factors that gave rise to the past events may have changed completely, while other

new factors not covered by past recorded experience may have been introduced. Thus accumulated experience may be invalid or inadequate as a basis for establishing probabilities of future events.

Some persons, including a few building officials, approach the matter of regulating for safety with a zeal that demands perfection. But the only way to eliminate all possibility of hazards is to refuse to build buildings; and buildings must continue to be built. Building involves the greatest set of compromises with which man is regularly faced. It is inevitable that safety should be involved. In a conservative approach, one would rule out all innovations simply because it is not known whether they will create some hazard. If innovation is allowed, one will always be defeated by the events the human mind is unable to predict.

It cannot be argued seriously that all innovations should be accepted automatically until experience shows that they constitute some hazard. A building code must impose some restriction, but it should also accept a reasonable probability of failure. It ought, in fact, to concern itself with the establishment of minimum acceptable limits in respect of major items related to safety below which compromise must not be allowed to go.

Codes can never be made to guarantee, by themselves, any consistent level of safety so long as there is freedom to choose the form that the building and its parts may take. Only man, thinking, can identify new possibilities for hazards arising in new designs in advance of actual experience with them. A code cannot deal with these without unduly inhibiting design. It ought to ensure on the average a probability of failure that is tolerable and in balance with the price to be paid for the restrictions imposed. The designer must then ensure that the tolerable probability of failure will not be exceeded because of those particular features he has introduced.

The designer may also concern himself, on behalf of his client, with a further reduction of probabilities by various choices that provide somewhat more than the minimum called for in the code. This, in fact, ought to be the normal case, the tolerable probabilities envisaged by the code being reached only on occasions when the advantage to be gained by compromising safety in a particular choice is worth while. *Maximum freedom in design becomes possible only when safety can be included and adequately treated as a design consideration.*

This philosophy can be associated quite closely with the present situation in structural design. It is now obvious that no practical set of restrictions can guarantee complete structural safety. It is also fairly clear that design codes, applied without thought, are inadequate. A satisfactory compromise is only obtained by the application of a design code in the hands of a competent professional. The design code reflects the best general guide that can be produced from the cumulative experience of the professional group which developed it. The professional consultant must be further concerned with the specific design case and must introduce his own knowledge and judgement in dealing with any new or unusual features.

Building structures have been the subject of intense study for at least 100 years. There is an active and competent group of consultants who can bring the best thinking of the profession to bear on any specific structural design problem; and they are regularly retained for such purposes. Structural safety is thus closely related to the practice of structural engineering. Building codes can add little beyond confirming which design code is to be regarded as the basis for determining compliance with the bylaw and in confirming, by reference to particular items, what degree of safety society wishes to ensure. It is a paradox that codes must be devised with the aid and expertise of the very people whom, in practice, they undertake to instruct. This must be regarded as a mature stage, however, in which safety can be left to the specialist practitioners.

Safety in respect of health is not so well developed, but neither is it critical since accepted practices are generally well above the level at which there is concern for health today. Certain restrictions, however, need to be reaffirmed about hazards such as cross connections between supply and waste piping. Building codes confirm the level of practice that society wants and is willing to pay for, as for ventilation rates.

In the field of fire safety an entirely different set of circumstances exists. There are 70,000 fire incidents and 600 deaths in Canada each year. It is true that regulations and other developments have practically eliminated the possibility of catastrophic fires involving many separate buildings. It is not at all certain that the possibility of a catastrophic event in a single large building is equally remote.

Within the last twenty years, as a direct consequence of improved air conditioning and lighting, the block plan building has been developed. This plan provides a very large floor area, which may be used as one large area for mercantile purposes or for modern open office use. Alternatively, it may be rented as one large space and later subdivided by the tenant. The control exercised through building bylaws applicable to new buildings is not always so readily arranged and in this case some hazardous arrangements have been allowed to develop.

Mezzanines and escalators may prevent the development of barriers to fire spread upward at each floor. Multiple-level parking garages are being incorporated in buildings. In some modern office buildings there is a problem of "poke-through" construction, in which successive sets of holes are drilled in floors to accommodate the telephone and electrical connections for tenants.

Many of the remarkable new materials being introduced are organic and therefore combustible. They are used most frequently in exposed locations where they can most readily become involved in fire. Some of them produce unusual toxic products and large quantities of smoke when burned. Some metal components, such as ductwork that had some capability to contain fire, are being replaced by components made of organic materials. Air conditioning is now almost universal, so that all spaces are interconnected by air systems which can become the paths for fire and smoke spread.

In addition to these changes, some very large building complexes are being constructed, either under one roof or with interconnections through tunnels. There has recently been a marked increase in the number of very tall buildings. These new features of size, complexity and height introduce new dimensions to the fire and smoke hazard and the prevention and fighting of fire. When combined with the other changes noted, they represent new situations not yet tested by time and will determine the fire experience of cities over the next 35 years.

When one compares fire safety with structural safety and looks for the extensive background of past research that has produced a large body of codified knowledge, and for the very large and highly qualified body of specialist consultants regularly serving throughout the country, one looks in vain. It must be concluded that the fire situation is still at a relatively elementary stage of development in this respect. There is no real choice for the next decade but to accept a highly regulated approach in building codes where potential fire hazards are concerned.

If this situation is to be changed, fire research must be greatly increased and fire protection engineering must be developed as a professional specialty. Only when it becomes possible to bring competent professional judgement to bear reliably and consistently in support of fire safety and fire protection at the design stage of building will it be possible to relax the highly regulatory aspect of building codes.

There will be an unavoidable restriction on new developments and on rate of change. This cannot be avoided unless a greatly increased probability of disaster can be accepted. All who accept the challenge of working toward the improvement of building codes so that they may become the best possible documents under the circumstances, holding the line on fire safety while inhibiting new developments as little as necessary, deserve full support, cooperation and understanding.