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Applying Building Codes to Existing Buildings

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This digest explores the process by which building code requirements, which are generally developed for new construction, can be applied to existing buildings.

The application of building regulations to an existing building can be triggered in several ways. An owner may voluntarily wish to rehabilitate a building, change its use or build an addition. Through his application for a permit to do any of these, which is normally required by law, he sets in motion a process by which his building and what he wishes to do with it are scrutinized by authorities in the light of prevailing building legislation. On the other hand, the owner may not wish to initiate changes, but some enforcement authority may decree that the building must be altered for the public good. The triggering process could be a provincial or municipal law directed at a special class of buildings, or a complaint or periodic inspection revealing an unsafe condition. These situations could result in the imposition of building regulations by the enforcing authority to ensure public safety.

Code enforcement agencies have taken different approaches in regulating the rehabilitation, renovation or repair of existing buildings. Although some agencies have developed separate "stand-alone" codes for this purpose, many attempt to apply the requirements for new buildings as contained in their building codes. Since Canada does not have a generally accepted model code for existing buildings, the latter approach would appear to be a practical solution at the present time for many municipalities.

Evaluating the Options

Applying building codes to existing buildings involves somewhat the same analytical process as is required to assess alternate design proposals for new construction: in both cases the alternatives need to be evaluated. The available economic design options are much more limited, however, for existing buildings than for new construction since each existing building presents a unique set of economic conditions or constraints.

Applying building code requirements to a new building is a reasonably straightforward process. Building codes, however, can describe only a limited number of design alternatives without becoming too complicated. Consequently, many combinations of health and safety measures that can satisfy code objectives are omitted. For this reason building codes allow for equivalents where it can be demonstrated that they will provide the level of safety intended by the codes. Innovative or alternate design features usually require special evaluations or judgements to determine whether they meet these safety levels. In evaluating alternate design solutions for both new and existing buildings, the objective of the requirement (or group of requirements) must be known. Usually it can be defined in a broad, general sense. The more specific one attempts to make the objective, however, the more difficult the task may be. On

the other hand, if it is not specific enough, the evaluation of equivalent solutions may be impossible. Determining the objective is therefore an essential starting point in the evaluation process.

Once the objective is defined, one must determine whether the alternative solutions will meet it. Since the methods for such evaluation are relatively primitive, subjective judgement normally forms a substantial component of the evaluation process.

Cost-Benefit Implications

The code requirements that establish minimum acceptable levels of health and safety in new construction are developed with an awareness of the cost of the provisions and the constraints they may impose on design. This is balanced by the perceived benefits in terms of safety or health. Although it may be easy in many instances to establish costs with reasonable accuracy, it is not as easy to establish benefits on a quantitative basis. Building code committees must therefore rely on their collective experience and expertise to make such evaluations and judgements.

In effect, the equation of costs and benefits must be balanced for each code provision or set of conditions. For new construction, the cost of a particular provision may be entirely different from that for construction undergoing renovation or rehabilitation. Perceived benefits may be much more expensive to achieve than in new construction if the code provisions are rigorously applied. Since the code provisions are developed primarily for new construction, they may have to be modified to reflect the cost-benefit equation that applies to existing construction. A design solution to achieve a desired level of safety in new construction may therefore be inappropriate for existing construction.

Applying code requirements to heritage buildings gives rise to special problems. Removing or changing an essential historic feature represents a loss of value (or cost) that cannot be determined with precision. The concern for authenticity may be so strong that the feature must be preserved, thus limiting the choice of design alternatives for that type of building.

Life Safety vs. Property Protection

Although building codes are primarily concerned with life safety, the traditional basis for many requirements is property protection. It may be difficult in many cases to distinguish clearly between life safety and property protection requirements, since there is usually a component of each in the other. With some, such as those relating to egress, the main objective is life safety, whereas with others, such as those relating to spatial separation, it is property protection. In the case of structural design requirements, both elements are important. Most building regulations are in this middle ground.

In considering the cost-benefit equation, it is much easier to deal objectively with matters where property protection is the principal component. Where life safety is the main issue, moral and ethical considerations restrain departures from the intent of codified requirements if there is any doubt about significantly increased risk.

Importance of Code Requirements

The code requirements do not all contribute equally to life safety or property protection. Little, if any, written information exists, however, about their relative importance or ranking. The degree to which a requirement can be modified without significantly changing the risk to life or property therefore varies. In evaluating alternative systems or in modifying code requirements for existing buildings, the designer and the enforcing official must exercise considerable judgement.

Structural Considerations

Although alternative solutions more commonly arise in the area of fire safety, they may also be a factor in structural sufficiency considerations. Again, in the case of new construction, applying building codes is relatively straightforward. Design loads and design procedures are well

established and codes make provision for unusual structures that may require special consideration. In most cases it is possible not only to assign costs accurately, but benefits as well. For an existing building, however, the cost of increasing the strength of an existing structure may exceed the potential benefits. As a result, some compromise may have to be sought, such as restrictions on future use.

Where a building has been standing for many years, and its condition or its relationship to adjacent buildings has not changed significantly, one may consider the building to be field tested. If a roof has withstood the effect of snow and wind for 50 or 60 years and shows no signs of distress, one may reasonably assume that it will continue to provide adequate service. The same may be assumed for walls in relation to wind loads. Earthquake loads are more difficult to assess on this basis because of their irregular occurrence. Nevertheless, some assessment may be made in the light of the recorded seismic activity of the area where the building is located.

Where the use of a building changes significantly, and new floor loads are introduced for which the building is not designed, then the only solution may be to increase the load-carrying capacity by modifying the structural components.

Typical Examples

Consider the problem of evaluating an existing apartment building which, because of some legal triggering mechanism, is to be upgraded. Suppose the building has corridors 1000 mm wide. If the occupant load is relatively low and does not require, say, more than one unit of exit width (550 mm) to satisfy the occupant load requirements of a building code, is it reasonable to require the corridor to be enlarged to 1100 mm which would normally be required in the case of new buildings?

The reason for requiring a 1100 mm minimum width for corridors is not known for certain, but presumably it is to allow two full units of exit width which would theoretically allow two people to walk side by side or to pass each other. It also facilitates the movement of furniture into and out of suites and establishes a level of convenience for the use of the corridor.

This requirement also has an essential life safety feature in that it provides sufficient width to allow for rapid evacuation of a floor area in a fire emergency. However, in this example the occupant load does not dictate two full units of exit width, so that a slight reduction should not significantly affect egress in an emergency.

If the corridor width were increased from 1000 mm to 1100 mm in a building about to be constructed, there would probably be no additional cost except for the possible loss of rentable space. In existing construction, however, the cost includes the demolition and reconstruction of the partition. Although the benefits are presumably the same in both cases, the cost may be justified for the former, but not for the latter.

Suppose the same existing building has two stairways serving the common corridors, one of which is unenclosed. If the cost of enclosing the stair is exorbitantly high because of the building layout, is it justified to require the stairs to be enclosed?

This is a much more serious problem. The enclosure of exit stairs has been a cornerstone in building regulations for many years. The obvious purpose is to restrict or prevent the spread of fire and smoke from floor to floor and to provide a safe egress route for the occupants. There have been numerous instances of life loss attributed to open stairs. Unless other compensating measures are taken to meet the objectives of the enclosure requirement, the stairs must be enclosed.

Since the exit stair is open to the corridors, one might try to isolate the egress path from the rooms or suites, where fires are most apt to originate. This can be done by ensuring that the fire separations between the corridors and adjacent rooms or suites are built to the same level of protection required for the separation of exits. In addition, the doors to the suites should have the same level of fire protection as would be required for doors to an exit enclosure. If the

floor area in question is not large, and if the building is only four or five storeys high, one might consider providing a fire separation across the corridor. This would establish two zones so that people on the fire side could pass through the fire separation to an area of safety. Additional safety conditions may also have to be considered, depending on the size, construction and configuration of the building to satisfy the need for a reasonable level of safety for that situation.

As one final example, suppose the same building was built in an era when it was fairly common to have heavy timber floors, and masonry walls up to five or six storeys high. Under modern code requirements, such buildings are required to be of fire-rated noncombustible construction and would not be permitted to have structural wood floor systems. It may not be economically feasible to replace the combustible structural components with noncombustible ones. If the building needs to be upgraded to provide an adequate level of safety, is it reasonable to insist that the building meet all the requirements for noncombustible construction?

It can be generally rationalized that fire-rated noncombustible construction is specified to reduce potential fire severity. Such construction reduces the combustible fuel or fire load by restricting the combustible elements permitted and limits the extent of building involvement in fire through compartmentation at each storey. The minimum rating specified for structural members is intended to prevent premature structural collapse in an uncontrolled fire. Limiting the flame spread rating of combustible components reduces the rate of fire progress. The combined effect of all these measures makes the fire easier to extinguish before it becomes too large.

The noncombustibility requirement has both life safety and property protection components. Life safety implications arise if either fire growth or structural collapse occurs so rapidly that the occupants are trapped in the building before they can be safely evacuated. The larger the building, the more time is needed to escape and the more significant the life safety component becomes. Although establishing a size limit on a combustible building of a particular occupancy is based to some extent on tradition, such decisions are arrived at essentially on the basis of collective committee judgement. Since no articulated basis exists for the specified limits in codes, determining an acceptable alternative is not easy. Other factors should also be considered. Older buildings with heavy masonry walls, even though they are technically combustible, have to their advantage major noncombustible components that do not contribute to a potential fire problem. In addition, heavy timber floors are not as easily ignited in a minor fire, nor are they consumed as rapidly as light wood-frame construction.

Several design options may be considered to compensate for the combustible floor system. Additional protection in the form of gypsum board or lath and plaster, for example, could be provided to prevent the ignition of the floor structure for a length of time equal to the fire resistance rating required for the assembly. Such thermal barrier protection, when properly applied, should effectively neutralize the effect of having a wood structural system for the time specified.

Adding a sprinkler system can also be considered. Although sprinkler systems should not be considered as a panacea in overcoming all building deficiencies, they do provide the designer with a reliable and effective tool that can be used in a variety of situations to help compensate for other deficiencies. When the building appearance is to be retained for esthetic or historic reasons, it may be the only practical alternative. By carefully considering the nature of the deficiencies and compensating for them, it may be feasible to raise the level of fire safety in such buildings to meet the spirit, if not the wording of the code without requiring other extensive and more costly changes.

The preceding examples merely illustrate how building codes could be used to apply to existing buildings. They are not intended as universal solutions because each existing building presents a unique set of conditions and must be evaluated accordingly. It may be necessary in some cases to apply the requirements as laid out in the code for new construction because there may be no reasonable alternative. In other cases, compensating measures may be required such as early-warning systems, compartmentation, or additional egress facilities including fire escapes.

Summary

1. The reason for the code requirement that the alternative design is intended to satisfy should be determined as precisely as possible. This would include establishing whether the requirement is for life safety or property protection.
2. The relative importance of the requirement should be evaluated, particularly with regard to life safety.
3. A cost-benefit assessment should be made if this is practicable.
4. On the basis of these considerations, it should be determined whether there is a reasonable basis for accepting the proposed design solution.

To successfully apply building codes to existing construction, two qualities are necessary: a knowledge of the subject and a constructive attitude. Both the designer, who develops the alternate solutions, and the building official, who must ensure that the standard for public safety has been maintained, have a responsibility to use the code effectively. Where reasonable and constructive attitudes prevail, it is usually possible to arrive at mutually satisfactory design solutions for most existing buildings; however, without adequate knowledge and experience such decisions cannot be made with reasonable confidence.