



Structural Code Requirements for Modifying Existing Buildings

NCSEA Advocacy Committee – Code Officials & Government Agencies Subcommittee

With urban sprawl, land constraints, and an abundance of existing vacant buildings in many metropolitan locations, additions and upgrades to existing buildings or structures are an increasingly popular form of construction. Buildings and structures of all vintages, sizes, shapes, and uses are subject to these renovations. Given that the existing structure was often designed and constructed to an earlier building code, a common question presented at the onset of the renovation project is what building code requirements will govern the structural engineering and design. With the adoption of the International Building Code (IBC) back in 2000, designing and detailing to make existing buildings conform to the structural requirements of the building code became much more challenging. In many cases, it is impossible, either financially or physically, to bring an existing building into full compliance with the current, adopted building code.

In the past, building codes have included provisions to address the unique situations presented by altering, repairing, or adding to existing structures. However, the content of these provisions was very minimal. For example, the 1997 *Uniform Building Code* had only 2 pages devoted to existing structures. When the IBC 2000 was published, the chapter on existing structures expanded significantly to 14 pages. By the time the International Code Council was ready to publish their second edition (2003) of the International Codes, the family of codes grew by one to include the International Existing Building Code (IEBC). This new member of the International Codes took a dramatic leap by adding 67 pages of provisions, with an additional 214 pages of appendices and resource materials--a one-stop-shop for existing building code compliance. The IBC 2012 still has a chapter on existing structures (Chapter 34), but its content mimics much of the selected provisions in the IEBC.

Code Applicability

The question of whether to use the IEBC or not on a project is actually left to the project design team. IBC 2012 addresses the use of the IEBC in Section 3401.6.

3401.6 Alternative compliance. Work performed in accordance with the International Existing Building Code shall be deemed to comply with the provisions of this chapter.

The IEBC 2012 expounds further on the basis on this relationship with IBC in Chapter 1, Scope and Administration, Section 101.3.



101.3 Intent. *The intent of this code is to provide flexibility to permit the use of alternative approaches to achieve compliance with minimum requirements to safeguard the public health, safety and welfare insofar as they are affected by the repair, alteration, change of occupancy, addition and relocation of existing buildings.*

Obviously, building officials would like to see buildings comply with the current building code, such as the IBC, but older buildings, especially historic buildings, have unique conditions that make it literally impossible to fully comply with the building code. Therefore, this built-in flexibility provides the designer with some additional options to achieve a prudent structural design.

IEBC Format

The IEBC has a somewhat different format and organization in comparison to the IBC or any of its predecessors. Instead of chapters that provide provisions for various areas of building regulation, the chapter structure in the IEBC is based primarily on the classification of proposed changes to the existing building, which are outlined in Chapter 5. The classification types include repairs, alteration, change of occupancy, additions, historic buildings, and relocated buildings. Each classification type is assigned its own chapter, with the exception of alterations, which has three chapters based on the level of alteration work. Within each chapter, the sections follow a consistent structure that typically address discipline specific areas including structural design..

Classification of Work

The starting point when using IEBC 2012 is Chapter 5, entitled “Classification of Work.” The use of the building is classified in accordance with Chapter 3 of the IBC, which will assist the project design team in identifying the occupancy group or groups. In the next step, the design team determines which of the six sections of the IEBC will apply to the building under consideration. Under some conditions, more than one classification may apply. The six sections include the following:

1) Repairs - By definition, a “repair” according the IEBC, is the “restoration to good or sound condition of any part of an existing building for the purpose of its maintenance.” Essentially, if the work only “fixes” what was previously there, then it is classified as “repair” work. However, new materials must comply with the requirements for new construction. Structural damage, whether minor or substantial, will be required to comply with the provisions for new construction, with some exceptions.



2) Alterations - As previously mentioned there are three chapters applicable to alteration work. Each one applies to a degree of alternation work with Level 1 alterations involving new construction that is the least intrusive on existing construction and Level 3 being the most intrusive.

Level 1 alterations “include the removal and replacement or the covering of existing materials, elements, equipment or fixtures using new materials, elements, equipment or fixtures that serve the same purpose.” A Level 1 alteration is similar to a repair except that newer materials, elements, equipment or fixtures are installed that provide the same purpose of the previous items.

A Level 2 alteration includes the “reconfiguration of space, the addition or elimination of any door or window, the reconfiguration or extension of any system, or the installation of any additional equipment.” Level 2 alterations shall comply with the requirements for Level 1 alterations.

A Level 3 alteration applies “where the work area exceeds 50% of the aggregate area of the building. The work area, by IEBC definition, includes all reconfigured spaces. Additionally, Level 3 alterations shall comply with the requirements for Levels 1 and 2.

3) Change of Occupancy - This section will apply when the new occupancy of an existing building is different from the previously approved occupancy. It is important to note that in some situations as listed in Section 1002.1, the building will need to comply fully with the IBC if one of the special uses or occupancies listed applies to the project. These include, in part, covered and open mall buildings, atriums, motor vehicle and aircraft occupancies, stages and platforms, and ambulatory care facilities.

4) Additions – This section applies to any building or structure that has “an extension or increase in floor area, number of stories, or height.”

5) Historic Buildings - This section includes buildings that are listed in either a State or National Register of Historic Places, designated by local or state agencies as historic, certified as a contributing resource within a historic district, or are determined to be eligible for any type of official historic designation.

6) Relocated or Moved Buildings - Another self-explanatory classification. If a building is moved from one site to another, regardless of distance, it must comply with this section, which generally pertains to the structural needs of the building. If the building is modified either by repair, alternation, addition, or



change of use, then the applicable requirements in those sections will apply to the building in addition to the requirements in this chapter.

Code Issues

Chapter 34 of the IBC 2012 stipulates the requirements for repairs, additions, and alterations to existing structures. The primary building code requirements for structural engineering and design can be summarized as follows:

Materials:

Materials already in use in a building in compliance with requirements at the time of original construction can remain in use unless the building official deems them unsafe (Section 3401.4.1)

Additions:

If the addition causes an increase of more than 5 percent in any gravity load carrying structural element, then that element shall be strengthened or replaced per the building code requirements for new structures. (Section 3403.3)

Where the addition does not result in increased design live load, then the gravity load carrying structural elements can be designed for live loads approved prior to the addition. Where the addition does result in increased design live load, the new building code live loads from Section 1607 shall be used. (Section 3403.3.1)

Where the addition is structurally independent of the existing structure, no modifications are required for the existing lateral load-carrying structural elements. Where the addition is not independent, the addition and existing structure acting together must meet the new building code requirements for wind and earthquake loads. The building code grants an exception for any existing lateral load carrying element whose demand ratio is increased less than 10% by the new addition. For that case, the element does not require any modification. (Section 3403.4)

Alterations:

If the alteration causes an increase of more than 5 percent in any gravity load carrying structural element, then that element shall be strengthened or replaced per the building code requirements for new structures. (Section 3404.3)



Where the alteration does not result in increased design live load, then the gravity load carrying structural elements can be designed for live loads approved prior to the addition. Where the addition does result in increased design live load, the new building code live loads from Section 1607 shall be used. (Section 3404.3.1)

Where the alteration increases design lateral loads per new building code wind and earthquake loads, or where the alteration results in a structural irregularity, or where the alteration reduces the capacity of an existing lateral load carrying element, the structure of the altered building must meet the new building code requirements for wind and earthquake forces. The building code grants an exception for any existing lateral load carrying element whose demand ratio is increased less than 10% by the new alteration. For that case, the element does not require any modification. (Section 3404.4)

Alterations intended primarily to improve the existing structure seismic force-resisting system or the seismic capacity of nonstructural elements must be submitted with a structural engineering analysis to substantiate several issues. These issues include detailing the new structural elements per the new building code requirements, ensuring the altered state is no less compliant as the pre-altered condition, and that the altered condition does not produce a structural irregularity (Section 3404.5)

Repairs:

A structural evaluation of a damaged building must be conducted to establish if the building is repaired to its pre-damage state, would it comply with new building code lateral loads, specifically a full wind load but only 75% of the code prescribed earthquake load. (Section 3405.2.1)

If the afore mentioned structural evaluation of a damaged building finds it in compliance, then repairs shall be permitted to restore the structure to its pre-damaged state based on material properties and design strength applicable at the time of original construction. (Section 3405.2.2)

If the aforementioned structural evaluation of a damaged building finds it not in compliance, then the building shall be rehabilitated to withstand wind and earthquake loads codified at the time of original construction, but the earthquake loads cannot be less than 75% of those specified in the new building code. Another caveat is if the damage is due to wind, then the repairs must comply with the wind loads from the new building code. (Section 3405.2.3)



Exception: Buildings assigned to Seismic Design Category A, B, or C whose substantial structural damage was not caused by earthquake need not be evaluated or rehabilitated for load combinations that include earthquake effects. (Section 3405.2)

Gravity load carrying components that have suffered substantial structural damage must be rehabilitated to comply with dead and live loads as stipulated in the new building code. (Section 3405.3)

For components that suffer from less than substantial structural damage, repairs are allowed that restore the structure to its pre-damaged state based on material strengths and properties applicable at the time of original construction. (Section 3405.4)

IEBC 2012 essentially mimics the same structural requirements under each particular chapter as follows:

Repairs – Chapter 6, Section 606

Alterations Level 1 – Chapter 7, Section 706

Alterations Level 2 – Chapter 8, Section 807

Alterations Level 3 – Chapter 9, Section 907

Change of Occupancy – Chapter 10, Section 1007

Additions – Chapter 11, Section 1103

Historic Buildings – Chapter 12, Section 1206

Relocated or Moved Buildings – Chapter 13, Section 1302

Appendices and Resources

The IEBC 2012 includes three appendices and one resource. Appendix A, Guidelines for the Seismic Retrofit of Existing Buildings, is subdivided into 5 smaller appendices which can be adopted individually. Appendix A deals with the seismic retrofit of unreinforced masonry bearing wall buildings, reinforced masonry buildings, reinforced concrete buildings, and wood-frame residential buildings. Appendix B covers supplementary accessibility requirements for existing buildings and facilities. Appendix C, Guidelines for the Wind Retrofit of Existing Buildings, has 2 chapters which deal with gable end retrofits and roof deck fastening in high wind areas. Resource A, Guidelines on Fire Ratings of Archaic Materials and Assemblies, focuses primarily on fire-related performance of building materials.

Summary

Existing building renovations provide unique challenges, including code compliance stipulations, which typically are not encountered in new construction projects. Understanding the building code



requirements and the relevant alternatives and exception clauses, is essential in the early stages of the project's planning. The ability to navigate through the building code language will allow owners and their design teams to more accurately predict the cost and schedule of the building upgrade. The structural portion is a critical part of this equation, particularly when considering wind and seismic load impacts on the lateral load resisting system. Just as the physical process of upgrading existing building presents significant challenges, the same is true for both writing code requirements for existing building upgrades and succinctly interpreting them. This is due to several factors but mainly by the fact that it is difficult to anticipate and account for all the possible scenarios of a building modification project. The design engineer must appreciate the situations where what may initially appear to be minor modification (e.g., a new wall opening), the impact on the building's structural integrity may be disproportionately significant.

Once an owner decides to modify a building, compliance with the new building code often becomes very much applicable. But to the relief of many owners, full compliance with the new building code is not always necessary, so understanding what is required and what is not will minimize the impact on the owner's budget. The ultimate goal to code regulation for the modification of existing buildings is to retain, as a minimum, the same level of safety as exists in their current condition.