WJE

PRIMER

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Structural Considerations for Reroofing Projects

It is common for a building to be reroofed multiple times, as the service life of a conventional roofing system is typically a fraction of the service life of the building as a whole. In this *WJE Primer*, we examine the structural implications of several building code provisions that should be considered when reroofing an existing building.

Several building code provisions with structural implications must be considered when replacing all or a portion of an existing building's roofing system.

When tasked with replacing all or a portion of a roofing system, design professionals and contractors should be aware of the potential requirement for structural evaluation and possible retrofit of the building structure that may be triggered by provisions in the applicable building code adopted by the local jurisdiction, commonly the *International Existing Building Code* (IEBC).[1]

Code Provision for Gravity Load-Carrying Structural Elements

Where a reroofing permit is required,[2] the following provision related to gravity load-carrying structural elements shall be considered:

706.2 Addition or Replacement of Roofing or Replacement of Equipment.[3] Any existing gravity load-carrying structural element for which an alteration causes an increase in design dead, live or snow load, including snow drift effects, of more than 5 percent shall be replaced or altered as needed to carry the gravity loads required by the *International Building Code* for new structures.

Exceptions:

1. Buildings of Group R occupancy with not more than five dwelling or sleeping units used solely for residential purposes where the altered building complies with the conventional light-frame construction methods of the *International Building Code* or the provisions of the *International Residential Code*.

2. Buildings in which the increased dead load is due entirely to the addition of a second layer of roof covering weighing 3 pounds per square foot (0.1437 kN/m^2) or less over an existing single layer of roof covering.

The above provision from the 2018 IEBC requires that the building's gravity-load carrying structural elements (not only structural elements at roof level, but also columns, foundations, and any other affected structural element) be evaluated and deemed capable of resisting design gravity loads required by the IBC for new buildings if the design dead, live, or snow load increases by more than 5 percent. The above provision may be triggered as a result of a variety of scenarios, including but not limited to the following:

- When replacing an existing roofing system with a new roofing system (or addition of roofing elements or coverings such as insulation, ballast, or pavers overtop of the existing roofing system) that causes the total weight of the roof assembly to increase by more than 5 percent.
- When installing roof insulation that results in a significant change in the thermal properties of the roof which, in turn, affects

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its snow-retaining properties, and results in an increase in the design snow load of more than 5 percent.

- When installing a steep-slope roof membrane or covering that changes the surface friction of a sloped roof and, in turn, changes its snow-retaining properties and results in an increase in the design snow load of more than 5 percent.
- When installing snow retention or snow guard systems that result in an increase in the design snow load of more than 5 percent.
- When increasing parapet height, such that new snow drifts will form.

Code Provision for Unreinforced Masonry Parapets

Post-earthquake reconnaissance has consistently led to the observation that unreinforced masonry parapets are seismically vulnerable and often fail under moderate levels of ground shaking, thus representing a major risk to nearby pedestrians and building occupants. To address this known vulnerability, the following provision related to unreinforced masonry parapets shall be considered:

706.3.1 Bracing for Unreinforced Masonry Bearing Wall Parapets. Where a permit is issued for reroofing for more than 25 percent of the roof area of a building assigned to Seismic Design Category D, E, or F that has parapets constructed of unreinforced masonry, the work shall include installation of parapet bracing unless an evaluation demonstrates compliance of such items. Reduced seismic forces shall be permitted.

The above provision is intended to address an exceptional hazard demonstrated by repeated poor performance of unreinforced masonry parapets in high seismic regions. The imposition of costs on a building owner is arguably justified by the abatement of a potentially significant latent danger to the public. The provision requires that existing unreinforced masonry parapets be evaluated and deemed capable of resisting earthquake loads calculated in accordance with the IBC for new buildings, if the following threshold criteria are met:

1. *Reroofing Area Criteria*: the existing roofing materials are removed from more than 25% of the roof.

2. *Seismic Design Criteria*: the building is assigned to Seismic Design Category D, E, or F, as determined in accordance with the IBC.

A photo of parapet bracing is shown below.

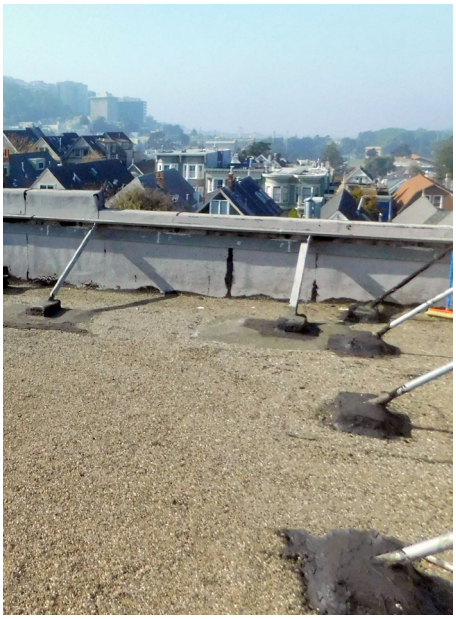

FIGURE 1. PARAPET BRACING OF AN UNREINFORCED MASONRY PARAPET IN A HIGH SEISMIC REGION

Code Provision for Wind Load-Carrying Structural Elements

If a building is in a high-wind region (i.e., the ultimate design wind speed is more than 115 mph) or is in a designated special wind region, the design professional may be forced to contend with the following provision:

706.3.2 Roof Diaphragms Resisting Wind Loads in High-Wind Regions. Where roofing materials are removed from more than 50 percent of the roof diaphragm or section of a building located where the ultimate design wind speed, V_{ult}, determined in accordance with Figure 1609.3(1) of the *International Building Code*, is greater than 115 mph (51 m/s) or in a special wind region, as defined in Section 1609 of the *International Building Code*, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in the *International Building Code*, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in the *International Building Code*.

Structural failures have been observed, primarily in coastal hurricane regions, due to insufficient wall-to-roof structure attachment and other diaphragm-related deficiencies. According to the IEBC Commentary, roofing removal provides an opportunity to observe and address such potential structural deficiencies that are otherwise obstructed from view. The above provision requires that existing roof structural elements be evaluated and deemed capable of resisting 75 percent of the design lateral and uplift wind loads

required by the IBC for new buildings, if both of the following threshold criteria are met:

1. *Reroofing Area Criteria*: the existing roofing materials are removed from more than 50 percent of the roof diaphragm or section of the building, and

2. *Design Wind Speed Criteria*: the building is located where the ultimate design wind speed (synonymous with the basic design wind speed) is greater than 115 mph, or in a special wind region.[4]

See *Figure 2* for a reproduction of the 2018 IBC Figure, which depicts the regions in which the above provision applies.

Practical Implications on Reroofing Projects

If triggered by any of the above IEBC provisions, in order to conform to the provisions and their stated intent, a structural evaluation (and potential retrofit) would be required. Such an evaluation by a qualified structural engineer would include the following:

1. Review the building's construction drawings to identify critical details of the supporting structure well in advance of the proposed roofing replacement work. In the absence of comprehensive construction documents, it may be necessary to make destructive openings through the roofing system to expose the parapets and/or top surface of the diaphragm at representative locations and to document below-deck conditions from the building interior.

2. Perform calculations and analysis to verify that the existing parapet, roof framing elements, roof diaphragm, and their connections have load-carrying capacities in excess of demands resulting from code-prescribed design loads, determined in accordance with IBC and reduced in accordance with the IEBC.

3. Design structural retrofits, if deemed necessary by the structural analysis.

4. Install necessary structural retrofits.

5. Install the new roofing assembly.

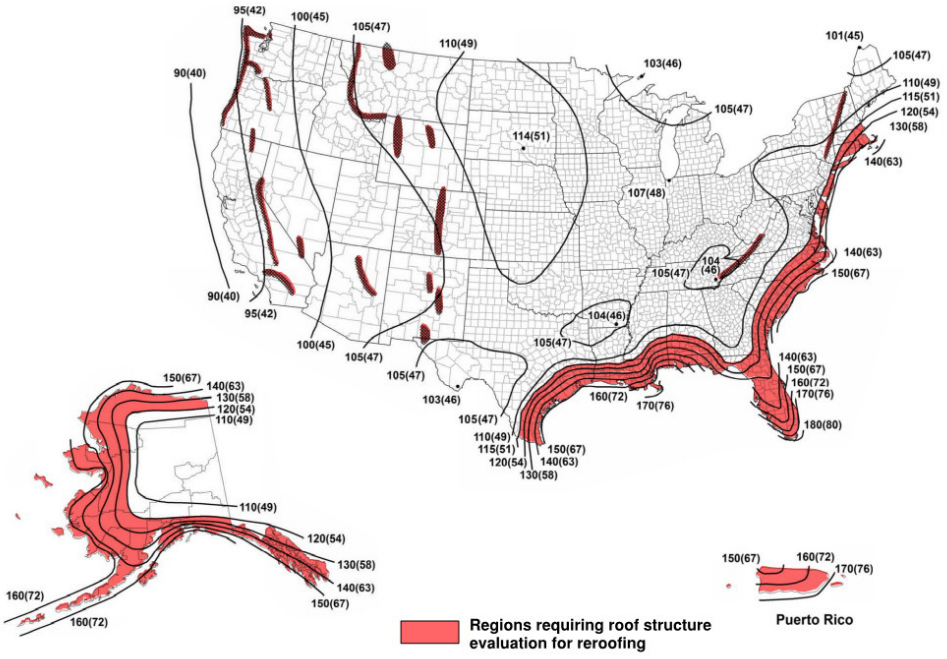

FIGURE 2. BASIC DESIGN WIND SPEEDS FOR RISK CATEGORY II BUILDINGS, REPRODUCTION OF FIGURE 1609.3(1) ANNOTATED FROM THE 2018 INTERNATIONAL BUILDING CODE

[1] The provisions cited herein are based on the model 2018 IEBC; however, local applicable code provisions may differ. Check with your local authority having jurisdiction to understand which codes apply to your project.

[2] Check with your local authority having jurisdiction to understand if a reroofing permit is required for your project.

[3] The provision in 706.2 of the 2018 IEBC differs from that in prior editions of the IEBC in a number of ways; most notably, the provision in prior editions requires that structural components shall comply with the gravity load requirements of the IBC, where the addition or replacement of roofing or replacement of equipment results in additional dead loads that increase the forces in the structural elements by more than 5 percent (i.e., there is no mention of live or snow loads, unlike in the 2018 IEBC provision).

[4] The provision in 706.3.2 of the 2021 IEBC has increased the threshold wind speed from 115 mph to 130 mph and has eliminated reference to special wind regions. The 2021 IEBC has also added an exception to the provision when the building was designed to comply with the wind load provisions of ASCE 7-88 or later provisions.

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