Minimizing Wind and Water Intrusion by Covering the Underside of Elevated Buildings

FEMA

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Purpose

The purpose of this Hurricane Recovery Advisory is to describe practices for minimizing damage to the underside of elevated buildings (see Figure 1) resulting from high-wind events. The undersides of elevated coastal buildings are typically covered with paneling (vinyl or aluminum soffit sheeting) or sheathing (plywood) to protect the insulation and metal connectors used for the floor system. These undersides are often damaged by high winds during hurricanes, allowing water to be driven into the building.

Figure 1. Loss of the covering from the underside of an elevated building due to high winds (Plaquemines Parish, LA, Hurricane Isaac)

Key Issues

- Hurricane winds can pull off paneling or sheathing from the underside of elevated buildings.
- Lost paneling or sheathing can become wind-borne debris, which can damage property.
- Hurricane winds can drive large amounts of water through areas where paneling or sheathing has been lost or where gaps have been created.
- If the area underneath an elevated building is used for parking or storing small quantities of fuel or other potentially combustible materials, depending on how the space is categorized by the building code or local building official, these areas may be required to meet code requirements to partition these areas from living spaces. In addition, the use of fire-resistant-rated assemblies on the underside of elevated buildings are often not properly addressed.

The information in this recovery advisory is intended to help minimize the loss of underside paneling or sheathing on elevated coastal buildings during high-wind events. Minimizing damage to these underside coverings will prevent damage to floor systems as well as water infiltration.

Fire-Resistant-Rated Assemblies

Many elevated buildings use the space underneath as a parking or storage area. According to building codes, the barrier between this space and the living area should be treated as a partition between a garage or parking area and a living area. Garages and parking areas must be separated from living areas with a fire-resistant floor or wall assembly. A variety of materials can be used; typically gypsum or an approved equivalent material is required to meet the guidelines for a fire-resistant-rated assembly. The purpose of the assembly is to prevent a fire from a vehicle or flammable/combustible material from spreading too quickly into the living space, thereby allowing the occupants sufficient time to escape the building prior to the structure's collapse, while minimizing their exposure to fire and smoke.

Use of Space Below the Elevated Building

Key Issues

- Floodplain management regulations restrict the use of building space below the base flood elevation to vehicle parking, building access, and storage (see Figure 2).
- Local regulations may require parking/garage areas to be separated from the living space with a fire-resistant-rated floor assembly.

Codes and Guidelines

The building should be constructed in accordance with the International Residential Code or the International Building Code, depending on design requirements. Although these codes have slightly different requirements, depending on how the space is categorized by the building code, both may require a fire-resistant-rated assembly to be used between the parking area and living space.

In addition to meeting applicable code requirements, the area below the elevated building must also meet the requirements of the NFIP as described in NFIP Technical Bulletins (TBs) TB 1, *Openings in Foundation Walls and Walls of Enclosures*; TB 5, *Free-of-Obstruction Requirements*; and TB 9, *Design and Construction Guidance for Breakaway Walls*.

Figure 2. Space under an elevated building used as a parking area (St. Tammany Parish, LA, Hurricane Isaac)

Mitigation Guidance for Covering the Underside of an Elevated Building

Key Issues

- Underside paneling or sheathing assemblies for elevated structures should utilize flood-damage-resistant materials.
- These assemblies may be required to meet the fire-resistance-rating criteria for a garage depending on how the space is categorized by the building code or local building official.
- These assemblies should be designed to resist wind loads based on the adopted wind speed maps for the area where the building is located.

Material Selection

The materials selected for the underside of an elevated building need to meet the requirements of NFIP TB 2, *Flood Damage-Resistant Materials Requirements*, and any additional building code requirements related to flood protection. If required by the code in the building's jurisdiction, designers should research the materials to ensure that they can be used to construct a fire-resistant-rated assembly that will also resist wind loads.

Coastal areas are corrosive environments, and any fasteners used on the exterior of the building must be resistant to corrosion. Corrosion-resistant fasteners should be used for the entire floor system assembly and all paneling or sheathing materials. The compatibility of the fasteners with the materials must be verified. Ideally, corrosion-resistant fasteners should be used even in areas where the assembly is covered with paneling or sheathing material.

Creating a Fire-Resistant-Rated Assembly

FEMA post-disaster damage assessments have reported that plywood sheathing performs well in high-wind conditions. However, plywood sheathing alone is insufficient if the underside of the elevated building requires a fire-resistant-rated floor system. Although fire-retardant-treated plywood that meets some of the fire-resistance requirements is available, it is not a substitute for fire-resistive gypsum, a common material in many fire-resistant-rated assemblies.

Some alternative products may meet the fire-resistance requirement. The designer should contact the manufacturer to verify that the material will create a code-compliant assembly when used with the other materials in the assembly (floor system). The proposed design should be submitted to the local building official for approval. Building codes often require assemblies of a designated fire resistance to be documented by a recognized testing and listing organization/laboratory (e.g., Underwriters Laboratory). All structural elements, such as piles, posts, or columns, should be evaluated to determine if additional fire

protection is needed. For instance, sprinkler systems may be required to meet building code requirements in some jurisdictions.

Creating a Wind-Resistant Assembly

Currently, no design standards provide guidance on how to calculate wind loads underneath an elevated building. Although the wind loads underneath the building are significantly less than those on the roof system, designers should try to determine the potential loads imposed on the plywood sheathing system to determine the appropriate fastener size and spacing to adequately attach the plywood sheathing. If a refined wind load analysis will not be performed, it may be appropriate to use the plywood sheathing fastening requirements for low-slope roof systems with the design wind speed for the area where the building is located. In many cases, floor joists are spaced at 16 inches, rather than a roof truss spacing of approximately 24 inches on center, which may adjust typical fastener spacing due to the tighter spacing of support members (joists).

FEMA post-disaster assessments have observed that vinyl siding or soffit paneling material used to cover the underside of elevated buildings frequently fails, usually as a result of the vinyl tearing or fasteners pulling out (see Figure 3). FEMA has observed less damage to underside coverings from high-wind events where the covering material is wood (typically plywood sheathing). The use of wood or more rigid materials may not eliminate all damage during high-wind events, but it will minimize damage to the underside covering material from tear out around fasteners or buckling (see Figure 4).

Figure 3. Covering under an elevated building was lost when the vinyl soffit paneling tore around fastener heads during high winds (Plaquemines Parish, LA, Hurricane Isaac)

Figure 4. Wood sheathing under a house near the one shown in Figure 3 did not fail; this is not a fire-resistant-rated assembly (Plaquemines Parish, LA, Hurricane Isaac)

Designing the Complete Assembly

If the area underneath an elevated building is categorized, by the code or building code official, such that it requires a fire-resistant-rated assembly and must meet flood-resistance requirements and adequately resistant wind loads, it will result in a complex assembly of materials.

If common construction materials are to be used, a fire-resistant-rated assembly can be constructed using a standard plywood subfloor, floor joists with insulation between the joists, a layer of exterior-grade plywood sheathing, and a layer of 5/8-inch-thick Type X paperless gypsum wallboard. Although this approach exposes the gypsum wallboard to wind-borne debris, it will reduce the likelihood of plywood sheathing loss due to high winds. The plywood layer should be fastened to the floor joists to minimize plywood sheathing loss and deflection in high-wind events. The plywood sheathing layer will prevent the gypsum wallboard from deflecting in a high-wind event and thus minimize loss of the gypsum. (Reversing the drywall and the plywood layers requires the fasteners attaching the plywood to the floor joists to bridge the gypsum; these fasteners may then be a potential point of failure.)

As a final step, the gypsum wallboard should be covered with an exterior-grade paint or sealant consistent with the gypsum wallboard manufacturer's specifications. Any assembly requiring a fire-resistance rating must be verified with the appropriate building material listing service and by the local building official for building code compliance.

This Recovery Advisory describes one approach to designing an assembly, and while other techniques exist, designers must consider appropriate wind loads, use flood-damage-resistant materials, and provide fire resistance. For example, other materials, such as some fiber cement sheathing products, may meet the wind-loading requirements for the plywood sheathing and fire-resistance requirements of the gypsum wallboard. However, designers should always check with the manufacturer. The entire floor assembly should be assessed as a whole rather than as individual products.

References

APA, The Engineered Wood Association. 2009. *Fire-Retardant-Treated (FRT) Plywood*. (*http://www.apawood.org*)

APA, The Engineered Wood Association. 2005. *Fire-Rated Systems, Design/Construction Guide*. (*http://www.apawood.org*)

Federal Emergency Management Agency (FEMA). 2008a. National Flood Insurance Program (NFIP) Technical Bulletin 1, *Openings in Foundation Walls and Walls of Enclosures*. (*http://www.fema.gov/national-flood-insurance-program-2/nfip-technical-bulletins*)

FEMA. 2008b. NFIP Technical Bulletin 2, *Flood Damage-Resistant Materials Requirements*. (*http://www.fema.gov/national-flood-insurance-program-2/nfip-technical-bulletins*)

FEMA. 2008c. NFIP Technical Bulletin 5, *Free-of-Obstruction Requirements*. (*http://www.fema.gov/national-flood-insurance-program-2/nfip-technical-bulletins*)

FEMA. 2008d. NFIP Technical Bulletin 9, *Design and Construction Guidance for Breakaway Walls*. (*http://www.fema.gov/national-flood-insurance-program-2/nfip-technical-bulletins*)

International Code Council. *International Building Code*. 2006/2009/2012. (*http://www.iccsafe.org*)

International Code Council. *International Residential Code*. 2006/2009/2012. (*http://www.iccsafe.org*)