Non-Traditional Building Materials and Systems

Purpose: *To provide guidance on non-traditional building materials and techniques and their appropriate application in coastal environments.*

Key Issues

- Determination of whether a material or system is appropriate for the site-specific hazards.
- Evaluation of whether new materials and construction systems should be resistant to flood and wind damage, wind-driven rain, corrosion, moisture, and decay.
- All coastal buildings will require maintenance and repairs (more so than inland construction). When considering using a non-traditional material or system, it is important to ask, "What are some considerations for various new materials and systems?"

Figure 1. Construction of a modular home.

Every year, new construction materials are introduced into the market. These building materials cover every part of the home from the foundation system to the roof system. New materials often offer a variety of benefits — a cost-effective solution, energy efficiency, aesthetics, ease of installation, or eco-friendly solutions.

This fact sheet will focus on providing information on building materials and systems that while not being considered traditional materials are not uncommon to the industry. The sheet is not intended to encourage any one material or system, but will provide information so that the user can make a more informed choice about whether something is an appropriate material or system for a given situation. While the fact sheet does not cover all materials, it provides readers with an idea of what criteria they may need to be mindful of when selecting materials and systems. While many are reasonable alternatives to traditional materials and systems, their uses should be carefully considered. The same factors used to consider the applicability of traditional building materials and systems should be used to determine whether new materials and systems are appropriate for use in a coastal environment. Some of these factors include overall hazard resistance for flood and wind, durability, maintenance, and repair requirements. Additionally, when considering a particular building component, it is important to consider the installation and constructability of the component. When selecting a material or a system for a coastal environment it is important to consider available information in addition to technical data from the manufacturer or supplier. Some examples of considerations are:

- Contact the local building official about the acceptability of the material or system.
- Review test results on the material or system's use in coastal environments.
- Review product code evaluation reports.
- Review field reports or a history of these materials or systems performing well in similar coastal environments, including experience in high winds and flooding.
- Review the manufacturer's installation and maintenance instructions.

Not all materials and systems will be specifically addressed by local building code requirements. Some products or systems may be absent from the code and may require engineering calculations or studies in order to determine that they are appropriate for use in a particular area.

NOTE: When considering using new materials or systems, the application of load path connectors should be carefully evaluated. Connectors should be evaluated by testing to demonstrate adequate performance for their intended application. Installation of the connectors should be considered and the ease of installation should be a primary consideration. An improper installation of a connector can result in significant losses in strength.

System Options

Engineered Wood Products

A variety of Engineering Wood Products (EWPs) are recognized in the model building codes. Examples include wood structural panels such as plywood and oriented strand board (OSB) and products commonly used as columns and beams such as structural glued laminated timber (glulam) and structural composite lumber (SCL). Glulam is an engineered, stress-rated product of a timber laminating plant comprised of wood laminations of nominal 2 inches or less in thickness bonded together with adhesive. SCL refers to either laminated veneer lumber (LVL), laminated strand lumber (LSL), or oriented strand lumber (OSL), which are comprised of wood in various forms (e.g., veneer, veneer strands, or flaked strands) and structural adhesive. For floor systems, conventional sawn lumber joists and girders (either solid or built-up) are recognized as flood-resistant. If EWPs are used for floor framing they should be either flood-resistant or elevated to a height where they are not expected to be wetted.

Advantages:

- EWPs are available in dimensions (length, width, and thickness) that are economical or, in some instances, not possible with sawn lumber.
- Due to availability of larger sizes, EWPs are able to resist greater loads than sawn lumber.
- EWPs are manufactured in a dry condition and are more dimensionally stable than sawn lumber, which may warp and twist during drying.

Things to consider if building with EWPs:

- **Cost:** While EWPs can be used to offer greater spans and exceed the loading properties of conventional lumber, they cost more.
- **Availability:** Certain sizes of Glulam or SCL may be difficult to obtain. They may require special ordering and fabrication, which may not meet the project schedule for the building.
- **Installation:** Installation issues include conditions for storing materials, dimensional compatibility with other materials, and requirements for use of metal connectors and fasteners to ensure accordance with the manufacturer's installation instructions.

Structural Insulated Panels (SIPs)

Structural Insulated Panels (SIPs) are manufactured panels made of a foam insulation core bonded between two structural facings. SIPs are commonly manufactured with OSB facings as discussed in the 2009 International Residential Code (IRC) Section R613.3.2, but are also available with steel, aluminum, or concrete facings. SIPs can be used for walls (see Figure 2), floors, and roofs, and are compatible with light-framed construction.

Figure 2. Construction of a Structural Insulated Panel house.

Advantages:

- SIPs offer an efficient construction method and quick assembly. Insulation is built-in, and wall openings and utility chases are precut by the manufacturer per the building plans, reducing on-site coordination and adjustments.
- They increase thermal resistance, reducing heat gain and loss from the building, which allows smaller HVAC equipment to be used in the building.

Things to consider if building with SIPs:

- Evaluate the design loading values of the SIP and verify that the product is appropriate for the wind loading requirements for the building location.
- SIPS are an engineered assembly. SIPS should not be used where they can be flooded unless the entire assembly has been tested for flood resistance. Many SIPs utilize OSB facings. Generally, SIPs should only be used above the base flood elevation (BFE) so that they maintain their structural integrity. Refer to IRC R322.1.8 for requirements for flood-resistant materials. Otherwise, if the SIP is exposed to water damage during flooding, the panel may need to be opened, allowed to dry out, and repaired or, in some instances, even replaced.

Figure 3. An example of ICF walls and reinforcing steel prior to placement of the concrete. The forms are left in place following placement of the concrete.

- As with conventional construction techniques, SIPs may sustain windborne debris damage. This may require cutting out a section of the SIPs and repairing it with either conventional framing techniques or a replacement SIP.
- The foam core of SIPs is inert and provides no food value to termites and other pests. However, pests may still nest within the foam. Always incorporate pest control methods into the design in conformance with local jurisdictional requirements. Some manufacturers sell pre-treated SIPs.
- Always use approved connectors and connection methods for panel-to-panel, panel-to-foundation, and panel-to-roof connections. For guidance on SIPs connections, refer to IRC R613.5. It is important to consider that not all connectors are compatible with SIPs and in some instances specific connectors may be required in order to maintain the load path.
- Follow manufacturer's installation instructions and product use requirements in the manufacturer's code evaluation report.

Insulating Concrete Forms (ICFs)

ICFs are made of molded expanded polystyrene (MEPS) foam and are used to form cast-in-place concrete walls (see Figure 3). Unlike conventional cast-in-place concrete construction, the ICFs are left in place after the concrete cures to provide insulation, an attachment surface for interior and exterior finishes, and space to run plumbing and electrical lines within the wall.

Advantages:

- ICF provides improved energy efficiency and allows the use of smaller HVAC equipment than some other construction methods.
- The concrete and insulation walls are durable and require little maintenance.
- The combination of thick concrete walls and continuous insulation provide significant noise reduction over other construction methods.
- ICF provides good wind, windborne debris, and flood resistance.

Things to consider if building with ICFs:

- Special connectors may be required for the connection of the roof system, floor system, doors, and windows.
- For material and construction requirements for concrete walls, refer to IRC R611.
- Exterior foam must be protected from sunlight and physical damage by the application of an approved exterior wall covering. Refer to IRC 611.4 for requirements for stay-in-place concrete forms.
- ICF foam is inert and provides no food value to termites and other pests. However, pests may still nest within the foam. Always incorporate pest control methods into the design in conformance with requirements of the authority having jurisdiction.
- In some seismically active areas, constructing large, heavy structures on pile foundations can present significant design challenges. As with any

construction system, construction in areas subject to high erosion or scour could present design challenges due to the mass of an ICF structure.

- Foundation walls built with ICF (with appropriate openings) can be an appropriate foundation system in an A Zone. In V Zones, open foundation systems are required and in Coastal A Zones recommended. ICF and other solid foundation walls are not appropriate to be used in these areas.
- Follow manufacturer's installation instructions and product use requirements in the manufacturer's code evaluation report.

Prefabricated Shear Walls and Moment Frames

Many companies now offer prefabricated shear wall and moment frames that are pre-designed and available in standard sizes. The wall sections and moment frames (see Figure 4) are connected to the rest of the structural framing with bolted, screwed, or nailed connections. Sections are ordered and brought to the site on trucks as one piece or constructed with either bolted or proprietary connectors.

Advantages:

- Prefabricated shear walls are often designed to provide for quick installation and compatibility with other framing methods, where narrow wall solutions may not be practical with other framing options.
- Moment frames take the place of shear walls to allow large continuous spaces for windows and other wall openings. Much like the prefabricated shear walls they can be assembled quickly and incorporated into the house framing.

Things to consider if building with prefabricated shear walls and ordinary moment frames:

- Some systems may be limited in their application due to seismic or wind loading requirements.

Figure 4. Installation of a prefabricated ordinary moment frame.

- Verify that the members and connections used in the prefabricated sections are designed for the corrosive, moist coastal environment. Preservative-treated wood and galvanized or stainless steel connectors may be required for a coastal application.
- Not all prefabricated shear wall or moment frame systems will be allowed in all locations. It is important to consider that panel substitutions are subject to requirements of the applicable building code. Refer to IRC R602.10 for more information on wall bracing requirements.
- Maintaining the load path is important with any system. Because these systems provide lateral support for the structure, it is important to make sure that the load path will be transferred through the wall system and transferred down to the lower story of foundation and into the ground. Follow the manufacturer's installation instruction and product use requirements in the manufacturer's code evaluation report.

Sprayed Closed-Cell Foam Insulation

Sprayed closed-cell foam polyurethane insulation is used to fill wall cavities in framed construction (see Figure 5). When sprayed, it expands and hardens forming a rigid air barrier and acting as a moisture retardant.

Advantages:

- Sprayed closed-cell foam insulation expands to fill wall cavities, small holes, and gaps as it expands, producing a rigid barrier that results in reduced energy costs.
- It is quick to apply and may require less time to install than conventional batt insulation.
- It offers acceptable flood resistance, which is shown in NFIP Technical Bulletin 2-08, *Flood-Resistant Material Requirements for Buildings Located in Special Flood Hazard Areas* in accordance with the National Flood Insurance Program, Table 2.

Things to consider if building with sprayed closed-cell foam insulation:

- Tests have shown that sprayed foam insulation can improve the strength of structural framing systems and connections. However, structural framing systems and connections must be designed and constructed in accordance with all applicable building codes.
- While closed-cell foam is a flood-resistant material, it should be used in conjunction with preservative-treated, or naturally durable, wood or corrosion-resistant metal framing.

Figure 5. An example of a wall cavity filled with sprayed closed-cell foam insulation.

- Closed-cell foam should not be confused with other types of insulation. Some varieties of insulation on the market may be more cost-effective and more environmentally friendly; however, many of these products are not considered flood-resistant materials. Testing reports and provisions of the building code should be consulted for applicability in a coastal environment.
- Sprayed foam systems (such as those used in a wall system) create an assembly that when inundated by floodwaters may not be easily dried. For this reason, they are not appropriate to use below the BFE and are not considered flood-resistant material unless the entire assembly has been determined to be flood-resistant.

NOTE: Some framing materials such as prefabricated wood I-joists (e.g., a prefabricated I-joist constructed with sawn lumber or composite lumber flanges and plywood or OSB webs) should not be used below the BFE or where subject to flooding (see FEMA Technical Bulletin 2 *Flood-Damage Resistant Materials Requirements*).

Methods

Advanced Wall Framing

Advanced wall framing refers to methods designed to reduce the amount of lumber and construction waste generated during home construction. These methods include spacing wall studs up at 24 inches on center rather than 16 inches, and using smaller structural headers and single top plates on interior non-bearing walls.

Advantages:

- In most instances, the primary benefit of such techniques is the reduced lumber cost.
- The increased energy efficiency from the reduced number of wall studs and increased wall cavity space for insulation.

Things to consider if using advanced wall framing techniques:

- Not all wall framing techniques are applicable for hurricane-prone regions. The designer should carefully consider if this is an appropriate construction method for the area.
- Increasing wall stud spacing, even when using larger lumber sizes, can reduce the ability of a wall to resist transverse loads. For more information on designing framed walls to resist transverse loading, refer to IRC R602.10 or IBC 2305.

Construction crews may be unfamiliar with advanced wall framing techniques, which may increase construction time. Construction plans for advanced framing should be detailed enough for construction crews to recognize differences from conventional techniques, and additional training for construction crews may be required.

Modular Houses

Modular houses provide an alternative construction method by constructing a traditional wood- or steel-framed house in sections in a manufacturing facility and then delivering the sections to a construction site where they are assembled onto a foundation (see Figure 1). The interior and exterior of the house are finished on site. These houses should not be confused with manufactured homes. Unlike

manufactured homes, modular homes are required to meet the same building code requirements as houses constructed on site.

Advantages:

- Sections can be assembled in a controlled environment and construction time is less sensitive to poor weather conditions at the house site.
- Due to the sections being constructed at a manufacturing facility, materials use is often more efficient and fabrication is more efficient than site-built construction, resulting in reduced costs.

Things to consider if using modular houses:

- Proper installation of the house is important. Due to the sections of the house being constructed in another location, tight construction tolerances with the foundation are important in order for the sections to fit together properly.
- Modular homes are to be constructed to the same tolerances and locally enforced building codes as traditional site-built homes. The locally enforced building code where the house will be sited is the standard to which the modular house shall be constructed.
- The manufacturer needs to be aware of the location of the house and the materials that should be used in order to resist the site-specific hazards. Building component choices for flood, wind, and windborne debris-resistant materials should be identified prior to ordering the house and checked before installation begins.
- Extra care should be taken to verify that modular components are properly fastened to building foundations and load path connections are properly completed to transfer building loads from the roof to the foundation.