

My Project is in a Flood Zone... What Do I Do?

Business Practice Tips for the Structural Engineer

By Kevin H. Chamberlain, P.E.

Long before Cheryl's "she-shed" was struck by lightning... my shed was destroyed by a rotted oak tree blown over during Hurricane Irene. My home and office were without power for several days. All the while, calls were coming in from clients to evaluate the damage to their buildings. Although I had been engineering structures in flood zones for many years by then, when you are personally and professionally affected by storm damage, it makes a lasting impact.

Most structural engineers will, at some point, take on a project that involves designing a building located in a flood zone. Such projects require an understanding of the technical engineering issues involved with the site topography, geology, sources of flooding, and how wind and water will affect the proposed building structures and foundations. Beyond that, structural engineers need to understand the business practice issues associated with such projects, including client evaluation, assessing the risk/reward curve, and knowing when to ask for help or pull the plug. Moreover, an emergency management plan for your firm is time well spent to make sure your clients are taken care of following a disaster, and your business can operate.

- **Pull up a flood map for every project.**

Flood prone areas for a community are delineated on a series of Flood Insurance Rate Maps (FIRMs) published by FEMA. The current FIRM for a given property can be accessed on FEMA's Map Service Center website, free of charge, either using the street address or latitude/longitude (<https://msc.fema.gov/portal/home>). It is easy to print an 8½ x 11 excerpt of the flood map showing the property you are interested in – called a "FIRMette." The printout is free and only takes a few minutes once you have the property location. The FIRMette is also a rough double-check that the civil engineer is showing any flood boundaries and flood elevations accurately on the site plan. If there is a discrepancy, ask.

- **Are you practicing in your area of competence?** If you have never designed a foundation subject to scour or had to calculate wave forces, are you comfortable going it alone? What about a submerged basement design; what should the design water table be based on, flooding or

groundwater? The project's geotechnical engineer can provide crucial guidance on erodibility, liquefaction potential, and soil permeability and its effect on the design water table for a flood event. Do your foundations constitute an impermissible obstruction in a V zone? ("V" stands for velocity. V zones are Coastal High Hazard Areas – essentially, they are areas of high energy flooding with wave action.) A coastal engineer expert in modeling storm events, wave runup, scour depth, and calculation of pressures may also be a team member you will want. Speak up about what you are knowledgeable about and what areas of the project warrant additional consultants.

- **Do not over-promise.** As with earthquakes, you are designing to minimum code requirements for structural integrity and life-safety. That does not mean a structure will not sustain damage. Some damage is all but guaranteed. For instance, a building supported on deep foundations will still be standing after a flood scours the soils from underneath it, but then the crater left behind will need to be filled in. Breakaway walls and slabs on grade will breakaway and need to be replaced. There will be a loss of landscaping and hardscaping. Roofing and siding materials may be blown off the building. Water and moisture can damage finishes. And, incoming utilities may be severed. Flood insurance will cover some but not all damage. Be sure to temper the Owner's expectations with a dose of reality.
- **When the client insists on having a basement . . .** even when it is a really bad idea. When a basement is permitted in a flood zone, do not count on pumping to avoid designing for hydrostatic pressure and buoyancy. Pumps will eventually fail, as can backup power sources. Although basements in limited circumstances are permitted in flood zones, they are expensive, risky, and usually a bad idea. When the flood regulations allow a basement, and the project must have one, NEVER count on sump pumps to depress the water table and keep the basement dry.



Hurricane Irene barrels towards coastal buildings in Fairfield, CT, August 2011.

DO design the basement as an "inverted bathtub" (like a bathtub but with the water on the outside) for the full effects of hydrostatic pressure and buoyancy. This will mean using a mat slab foundation for the basement floor instead of a thin slab on grade. ALWAYS have a fail-safe in case water levels are higher than anticipated. For low-rise light-frame buildings, the building and foundation together will not weigh enough to resist buoyancy. Thickening concrete to add mass is usually counterproductive. Anchor the foundation walls and mat slab into the ground using rock or soil anchors. Or, provide hydrostatic relief through openings in the slab with raised rims that will allow floodwaters to overtop the rim to relieve pressure once the maximum design water table height is exceeded. The last thing you want is for the foundation to heave and fail from hydrostatic pressure, because such a catastrophe may prove fatal for the building – and your livelihood. When you explain to the client all the weak links involved in submerging a basement, the proposed basement will go away – if you are lucky.

- **Higher is better – if you can.** An owner and their designer can choose to elevate a building higher than necessary. Often, in coastal communities, the design team is simultaneously working to fit in the maximum number of stories possible under the zoning height limit, so you may not get much higher than the minimum. That also means you will be pressed to minimize structural depth to fit everything in.
- **Know the FEMA Technical Bulletins.** Although not law, FEMA publishes a series of Technical Bulletins to explain various common design and construction issues for buildings in flood zones.

The bulletins are written by FEMA's staff and consultants and are important guidance on how to interpret and implement FEMA's model regulations adopted by local jurisdictions. Perhaps more importantly, the Technical Bulletins are a window into how the jurisdiction, and FEMA itself, will judge your design.

- **"Yes, but so-and-so said we could do it," doesn't take you off the hook.** Have you received a schematic design from an architect that shows something non-compliant? Like a solid foundation in a V zone? An addition that is set below the BFE to match the existing building? (BFE = Base Flood Elevation, which is typically found on the FIRM). Are you told that deep foundations are not required when you know your building sits on erodible beach sand? Raise the issue. Most communities that participate in the National Flood Insurance Program (NFIP) are on top of their game and are the gatekeepers preventing non-compliant buildings from getting built by owners inclined to push the limits. Maybe the community is a small town with part-time zoning and building staff not in tune with flood-resistant design. If you are told "shut up and stamp it"

– do not do it. FEMA takes violations of the NFIP very seriously, and they do not hesitate to bring enforcement actions against participating communities. If your Owner has to retrofit their new building to appease FEMA (or their flood insurance provider), that Owner may come looking for a pocket to reach into; avoid letting it be your pocket.

- **Non-residential projects have more leeway.** There are a few reasons for this. Commercial or institutional projects typically engage a full design team, with a project architect, structural engineer, and other consultants. Single-family and town-home-style residential projects may not have a structural engineer or even an architect. That is one reason, for example, why a basement below the BFE is not permitted for a residential project but is permitted for a mixed-use or non-residential project. Another factor is the risk associated with the building's use. If an office building or store is flooded, people cannot shop or go to work; if residences are flooded, people may be displaced from their homes.
- **What about your business?** If you practice in a region of the country subject to flooding, it is not just your projects you have to worry about. Is your office located

in a flood zone? How about your employees' homes? When a disaster strikes, can they get to work? Will you be able to respond to your clients? Power may be out for some time; does your office need backup power? Are your files kept in a basement? Being prepared for a flood could be crucial to your business' survival. Plan ahead.

- **When in doubt, take a pass.** There is no harm in declining a project that is a no-win situation. The same criteria you use to select clients can be applied to projects in flood zones. Has the existing building been damaged before? Will the proposed project make conditions better or worse? Are you building on an erodible site? Does the client insist on spread footings instead of piles, when you know the soils are prone to scour? If you know the design will not comply with the flood regulations – walk away. It is not worth the risk. Some of your best projects may be the ones you never take in the first place. ■



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