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Design professional's duty to design to mitigate against damages from extreme weather events

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Extreme weather events, such as hurricanes and excessive rains causing severe flooding, seem to be increasingly in the news and on the public's mind. This briefing addresses the legal and ethical responsibilities that design professionals must consider with respect to climate volatility when designing projects. Is resiliency such an important obligation that a design professional must design for it based on current science – and the evidence and facts at hand – even if the law, regulations and government agencies do not require it?

If it is well-known that there is a high likelihood of flooding in an area, and that damages from such flooding could be significantly mitigated or reduced by elevating all new construction several feet, would the professional standard of care render a design professional liable for damages that could have been avoided if it had specified that foundations be built to higher elevations?

Flooding is just one of many impacts of climate volatility, but the scope of this briefing is limited to flood-related risks and impacts. This briefing explores widely-accepted risks related to sea-level rise, regulations and related common law liability for the design professional to identify and manage risks. (Spoiler alert: Adaptive and resilient design can be a great risk management solution in the face of climate volatility.)

Risks from sea-level rise and flooding

A February 2018 National Oceanic and Atmospheric Administration (NOAA) report published projections stating that sea-level rise is causing high-tide flooding to accelerate along many parts of the coastline. The report states that by 2100, "high-tide flooding will occur 'every other day' (182 days/year)" under what is called an "intermediate low scenario." If greenhouse gas emissions continue to increase at the current pace, the report states high-tide flooding could occur even more often.[1]

Storm events can significantly increase the damage consequences of sea-level rise in areas already experiencing or at-risk for tidal flooding. Boston had its highest tides in recorded history as it was battered by recent storms. Andrew Kemp, an assistant professor of Earth and Ocean Sciences at Tufts University, stated, "The record-breaking event of January 2018 would not have broken the record had it not been for relative sea level rise that carried the tide and storm surge above the level reached in 1978."[2]

A Washington Post article quotes Astrid Caldas, a senior climate scientist at the Union of Concerned Scientists, who tracks the effects of sea-level rise, as follows:

"By mid-century, the frequency of this type of 'minor' flooding would become so disruptive that business as usual would be practically impossible without significant adaptation measures. Without planning for flooding with measures such as protecting, elevating, accommodating the water, or even moving stuff out of the way, the impacts on the cities, their economy, and their residents would be immense."[3]

So what is to be done?

After Hurricane Sandy damaged New York, several architects were interviewed by Co. Design, an online magazine associated with Fast Company, to answer two questions: "What did you learn from Sandy?" and "How can architects prepare for the next storm?"[4]

One architect, Peter Gluck, emphasized the importance of designing buildings within flood zones to withstand a flood. He stated that his firm, when designing a project for Duke University, designed the building to withstand 140 mile-per-hour winds and the second floor to hold expensive lab equipment 25 feet above sea level, thereby allowing the first floor spaces to get destroyed without losing the valuable lab equipment above.[4]

In the same article, Michael A. Manfredi of Weiss/Manfredi Architecture explained how his firm designs to accommodate torrential rains and collect water in a safe but aesthetically pleasing manner. He states that rain gardens, and a 10,000 square foot green roof, were designed for the Brooklyn Botanical Garden to absorb large amounts of rainwater and then release it gradually over time. He states, "It is our belief that it is now time to design alternate strategies that support resilient and pliable sites capable of absorbing cycles of extreme, unpredictable events."[4]

Engineering News-Record article provides examples of what can be bone

The Engineering News-Record (ENR) published an extensive special report on sea-level rise in its August 7/14, 2017 issue. An article entitled "Rising Challenge" discusses the impacts of sea-level change on 14 different cities. In a highlight about Hampton Roads, Virginia, the article's author explains that the Naval Station Norfolk is only about 10 feet above sea level and tidal flooding is often a problem for the base. She states that the latest modeling suggests the area faces a sea-level rise of between 2.5 feet to almost seven feet by 2100.[5]

According to a Union of Concerned Scientists Report, low-lying locations in and around the base may experience about 280 tidal floods per year by 2050. And that is the intermediate scenario. A worst-case scenario suggests that the base would have 540 floods annually and render some areas of the base unusable within the next 35 years.[5]

Although there may be debate about what is causing climate change and sea-level rise, there is overwhelming evidence that the climate is changing and that sea level is rising. Since 1901, global sea levels have risen about 7.4 inches – at an average rate that doubled in the 1990s.[5]

Because of the lack of certainty as to how much sea level will rise beyond 2050, cities and their designers often take a pragmatic approach and build new seawalls to heights that can only handle sea-level increase that is foreseeable for the next 10 to 20 years, but can then be added to in future years as necessary. Rather than overbuild now, some engineers are designing and building short - or mid-term solutions.

As explained in the ENR article, "Adaptive design is an emerging engineering practice that addresses the uncertainty of climate change and sea-level rise. This design technique allows infrastructure to be built now, with the understanding that the underlying design assumptions might change."[5]

Current ASCE and FEMA guidelines

The National Flood Insurance Program (NFIP) enforces regulations for Special Flood Hazard Areas (SFHAs) to reduce the risk of flooding (see 44 CFR Parts 59 and 60). The International Code Series (I-Codes) include NFIP-consistent provisions. Communities that participate in the NFIP program can either adopt the I-Codes or adopt local floodplain management regulations that include detailed and specific requirements for buildings and structures.[6]

The American Society of Civil Engineers (ASCE) publishes ASCE-24, Flood Resistant Design and Construction. This is a referenced standard in the International Code Council's codes (I-Codes®). The ASCE 24 states the minimum requirements and expected performance for the siting and design and construction of buildings and structures in flood-hazard areas that are subject to building code requirements.[7]

The Federal Emergency Management Association (FEMA) accepts ASCE 24 as meeting or exceeding the minimum NFIP regulations for buildings and structures. It includes some additional requirements and specificity not included in the NFIP regulations. What is important is that buildings and structures that fall within the scope of the International Building Code (IBC) that will be located in a flood hazard area must meet the requirements set by the ASCE 24. The International Residential Code likewise requires that dwellings in floodways be designed consistent with the ASCE 24 requirements.[8]

The ASCE 24 lists four flood design classes. Depending upon which class of building is involved, the additional height will vary. For the majority of residential, commercial and industrial buildings (those which pose only a moderate risk to the public should they be damaged by flooding), the ASCE24 requires that their foundation be elevated a minimum of one foot above the base flood elevation (BFE) or the design flood elevation (DFE), whichever is higher.

Essential facilities, however, such as hospitals, fire and rescue, power generation, communication, and chemical storage facilities, generally must be designed for foundations at least two feet higher than the BFE, or meet the DFE or the 500-year flood elevation, whichever is higher.*

It should be noted that many FEMA flood maps do not necessarily reflect current science. Consequently, an official 100-year flood zone could be a 10-year flood zone. See "Status of Map Change Requests" found on the FEMA website.

* Note that the actual elevation will be determined more specifically by applying the detailed table set forth in ASCE24. Note also that for coastal areas the ASCE24 sets forth numerous requirements concerning flood openings in breakaway walls, various details for decks, porches, garages and carports, requirements concerning stairways and ramps that will breakaway and not pull the structure's foundation. ASCE24 goes into great detail and specificity with regard to requirements for these types of structures. See NFIP-2015 I-Codes and ASCE 24 Checklist.

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President Obama Executive Order and FEMA regulations

In reaction to the costs being incurred in rebuilding structures that have been destroyed or damaged in recent floods, President Obama issued Executive Order 13690 on January 30, 2015, directing FEMA to require higher-elevation foundations for structures being built in areas that have flooded.[9] This Executive Order contained more stringent requirements than those adopted by ASCE 24. This was the Administration's reactive way of getting around the fact that FEMA maps were not accurate. This Executive Order sought to avoid a repeat of a flood situation where a FEMA flood map might designate an area as 500-year – but the area has actually flooded every three years. This Executive Order would require design action even though the project was listed on a map location requiring no action.

Executive Order 13690 established the Federal Flood Risk Management Standard (FFRMS) "to increase resilience against flooding and help preserve the natural values of floodplains. It stated that the floodplain must be established using one of several different approaches, the most significant of which is "adding an additional 2 feet to the BFE for non-critical actions and by adding an additional 3 feet to the BFE for critical actions."[10]

A 2007 report by the U.S. Government Accountability Office (GAO) stated that for every $1 spent on disaster mitigation, the government would save $4 on post-disaster aid.

The Obama administration estimated the regulations would increase building costs by 0.25% to 1.25% but save taxpayers significant money in the future. A 2007 report by the U.S. Government Accountability Office (GAO) stated that for every $1 spent on disaster mitigation, the government would save $4 on post-disaster aid.10 An updated report suggests that $6 in damages is avoided by every dollar spent on mitigation efforts.[11]

In an interview with *Business Insider* magazine, Joel Scata, an attorney with the Natural Resources Defense Council, states that the Obama Executive Order was spurred in part by the huge costs of the disaster relief efforts following Hurricane Katrina in 2005 and Hurricane Sandy in 2012. He states, "This not only would have protected people and property from future flood events, but also was really meant to reduce the amount of disaster aid we spend on recovery.[12]

President Trump reverses the FEMA flood regulations

Before the new FEMA regulations could be fully adopted and implemented, President Donald Trump, on August 15, 2017, issued an Executive Order revoking Executive Order 13690. FEMA then rescinded the new regulations that would have established a FFRMS.

ASCE reacts to rescission of FEMA flood regulations

The ASCE was a signatory on a March 22, 2017, letter to the President stating its concern about the repeal of Executive Order 13690, the FFRMS. The letter states:

"The FFRMS represents a pragmatic and prudent disaster risk management strategy that will safeguard the nation's infrastructure, protect businesses and communities, and conserve taxpayer resources…We [ASCE and others] believe it should be preserved.

"The updated flood standard provides sound disaster and flood risk management guidance that involves assessing risks, avoiding them to the extent possible, and making appropriate financial arrangements, through insurance or otherwise, for risks that cannot be avoided. At its core, the FFRMS is a responsible, multi-layered risk management approach that ensures federal resources are spent wisely and efficiently. The pressing need for an updated approach to assessing and managing flood risk is borne out by an increasingly costly cycle of flooding and rebuilding that can and should be stemmed. From 1980 to 2013, flooding caused more than $260 billion in damage in the U.S.

Without the FFRMS, disaster relief and recovery policies will allow for and even encourage unprepared communities to build unwisely and subsequently rely upon federal help when flood disasters hit. We simply cannot afford to allow this pattern to continue. When federal funds are used for development in flood-prone areas, it is simply common sense to consider and mitigate those risks upfront in order to ensure the investment will be long lasting. That in a nutshell is the aim of the FFRMS.

When implemented, the FFRMS will help protect people and property, reduce federal expenses associated with rebuilding after tremendous flood losses, and make communities stronger. Repealing the FFRMS would be shortsighted and we ask the administration to strongly reconsider any repeal or rollback."[13]

U.S. HUD flood damage grants

Despite rollback of the Obama Administration Executive Order, Housing and Urban Development (HUD) is enforcing the requirements established by that Executive Order and the ASCE24 requirements on new block grants to the states damaged by floods in 2017. The HUD grants require the grant applicants to include in their application, "A description of how the grantee plans to: Promote sound, sustainable, long-term recovery planning informed by a post-disaster evaluation of risk…that takes into account continued sea-level rise."[14]

Residential housing and mixed-use structures located in the 100-year flood zone that are being rebuilt or substantially repaired are required by HUD to have their first floors a minimum of two feet above BFE. Hospitals, rescue and police stations, and other critical structures located in the 500-year floodplain are required to be elevated at least three feet above the BFE.[14]

What does the Standard of Care require of design professionals?

The issue of what professional responsibility a designer may have for failing to design buildings and structures to account for climate volatility and sea-level rise is beginning to get more attention in the press. *Engineering News-Record* (ENR) has published several recent articles on this subject. See for example, Rice, Justin. "Nor'easters Force Designers to Consider Climate Liability." *Engineering News-Record*. 22 March 2018.[15]

Michael Sanio, ASCE director of sustainability, is quoted as stating, "Taking into account the best science is a responsibility…designing to existing codes is insufficient."[15]

Designers may have to go beyond mere code requirements when designing to take into account what is appropriate due to climate conditions.

The code of ethics for engineers, as established by the National Society of Professional Engineers (NSPE) and adopted by many states, requires engineers to give top priority to health, safety and welfare. This may go beyond both their contractual obligations to a client and what is currently required by laws or codes.

There are numerous court decisions imposing liability on project owners and design professionals for damages and bodily injuries sustained due to their failure to provide a design sufficient for the safety of people that would use the facility – even though the designer satisfied the applicable building codes.

As stated by Jay Wickersham, president of the Boston Society of Architects, the law is one of the foundations of the professional standard of care, but the law is "the floor, not the ceiling. There can be circumstances in which design professionals know more protective measures beyond the building code and zone code and could be potentially held liable.[15]

An excellent law journal-style, in-depth paper by Jon Kusler, Esq. for the Association of State Floodplain Managers provides a more detailed analysis of the issues concerning potential responsibilities and liabilities of design professionals related to flood hazards.[16]

With all that is being reported concerning damages caused by high waters and floods, it is only natural to expect that fingers will start being pointed at design firms and contractors that design and construct structures that are damaged by foreseeable storms and floods. What consideration is a design professional required to give to the changing climate and flood frequency when designing new structures or renovating and repairing existing buildings?

Major floodplain areas throughout the country have been mapped by the FEMA, U.S. Army Corps of Engineers, state floodplain management agencies and local governments. The professional standard of care requires a design professional to learn about laws, codes and regulations applicable to the structures they are designing – and this naturally includes meeting the requirements concerning flood plains.

Design firms can be expected to reflect the risk from flood hazards in their designs when there are publicly-available flood maps for the area.17 The question is what enhanced risks must be considered in light of the increase in severe storms and flooding in certain areas?

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Meeting code may not be a sufficient defense with flood mitigation

Where damages are sustained by an individual due to a design firm or contractor's code violation, the violation is deemed negligence per se, and the injured party is entitled to recover its damages. What about the opposite scenario – one in which someone is injured as a result of how something was designed and built, but the designers and contractors met all applicable codes? Does that prove they satisfied the standard of care and cannot be found negligent and responsible for the injuries?

Compliance with all regulations and adherence to the generally-accepted standards of engineering or architectural practice in a community may not be sufficient to avoid liability.

Compliance with all regulations and adherence to the generally-accepted standards of engineering or architectural practice in a community may not be sufficient to avoid liability. This is particularly true where regulatory standards or practice in a community may be outdated. Reliance on industry standards does not mean that the design professional will not also be judged by whether his or her design was reasonable under the specific circumstances that should have been considered. Compliance with an ordinance or statute does not bar a negligence suit. "Unreasonable conduct is not an excuse when one merely complies with minimum regulatory requirements."[18] Regulatory standards or what is deemed generally-accepted practice in a community may become outdated due to changes that are occurring in the climate or weather.

Thus, even if code requirements are satisfied, the standard of care may render parties liable for not designing appropriate for conditions that could foreseeably lead to injury. Consider the case of *Henry Tang v. NBBJ, LP*, where the court addressed liability for a two-year-old child who fell to his death from the third floor of Staples Center in Los Angeles.[19] He was standing on a concrete shelf/banister that ran along the front of the seats in the luxury sky box and had a glass barrier from 26 inches to 10 inches mounted on it. An expert testified that even if the glass partition was code compliant, it constituted a dangerous condition because the shelf invited patrons to sit or stand on it, and they often did so.

It is particularly noteworthy that the court made a point of explaining that "Courts have generally not looked with favor upon the use of statutory compliance as a defense to tort liability," stating that a code merely establishes the "minimum standard of conduct," but does not preclude a finding that "a reasonable person would have taken additional precautions under the circumstances." [19]

This same principle could logically be applied to a design professional's responsibility when designing structures that while meeting current FEMA and building code requirements might nevertheless be deemed insufficient based on what a reasonable design professional should have known should be taken as "additional precautions under the circumstances."

Enhanced standard of care

The FEMA standards are national minimums. FEMA encourages communities to adopt higher standards where appropriate, and communities are rewarded by FEMA with Community Rating System insurance premium discounts. Communities may need to enforce the higher standards that are included in its FEMA-approved ordinance.

FEMA has published a number of technical bulletins setting standards applicable to flood issues. One such bulleting is the "Flood Damage-Resistant Materials Requirements." FEMA technical bulletins have been adopted by some state governments and made applicable to construction in their states (New Hampshire is an example).

Many state and community regulations exceed the minimum FEMA standards for construction in flood-hazard areas. Some have adopted more stringent regulations such as "freeboard" requirements for elevation of new structures on fill or flood proofing of structures to 100-year flood elevation, a "zero-rise" floodway, and prohibition of residences in floodplains or at least floodways.

Some communities that have adopted the IBC or the NFPA codes have also adopted enhanced floodplain construction standards that address freeboard flood elevations, the use of flood-resistant materials in construction, and additional requirements for the design of critical facilities. One example of a local entity issuing more detailed and specific flood-resistant design criteria is The Southern Tier Central Regional Planning and Development Board, representing three Appalachian counties within the State of New York. Their guidance states:

- Any proposed development in the regulated floodplain must be consistent with the need to minimize flood damage (emphasis in original). This can be accomplished, in part, by using materials, equipment, and construction techniques that are resistant to flood damage in locations that would be wet during a 100-year flood. [20]

- New construction and substantially improved structures (including accessory structures): It is required that materials and equipment located below the flood protection level (and outside of dry flood proofed areas) be resistant to flood damage. This may apply to foundations, floor beams, joists, enclosures, and equipment servicing the building (electrical, plumbing, mechanical, ducts, etc.). [20]
- Non-substantial improvements to existing (pre-FIRM) buildings and non-building development: New and replacement electrical, plumbing, and mechanical equipment must be located or designed to resist flood damage. The entire project should utilize flood-resistant design, materials, and practices to the greatest extent practical. [20]

The guidance states that "Flood-resistance requires structural and non-structural components be durable, resistant to flood forces (including buoyancy), and resistant to deterioration caused by inundation with floodwater." [20]

The document further provides:

Flood damage-resistant building materials

It is important that all parts of a building or other project that are susceptible to flooding (including fasteners and connectors) be made of materials that are resistant to flood damage. "Flood-resistant materials" include any building product capable of withstanding direct and prolonged contact with floodwaters without sustaining significant damage. "Prolonged contact" means at least 72 hours, and "significant damage" is any damage requiring more than cleaning or low-cost cosmetic repair (such as painting). The need to replace flood damaged drywall or other material is considered "significant damage" and is thus not acceptable. Components that are not inundated should be resistant to excessive humidity. [20]

Mechanical, plumbing and electrical systems

Location above the flood protection level is generally the best way to protect service equipment, such as heating, ventilating, air conditioning, plumbing appliances, plumbing fixtures, duct systems, and electrical equipment (service panels, meters, switches, and outlets). If these components are at a lower level, they must be designed to prevent damage from flooding. This may involve waterproof enclosures, barriers, protective coatings, or other techniques to protect vulnerable components. The municipality may require certification from a licensed professional that the standards for resistance to flood damage are met. [20]

Backflow and automatic shut-off valves

Flooding can cause sewage from sanitary sewer lines to back up into buildings through drain pipes, causing both damage and health hazards. Backflow valves are designed to temporarily block pipes and prevent flow into the building and should be installed on any pipes that leave the building or are connected to equipment located below the flood protection level. In addition to sanitary sewer and septic connections, this may include water lines, washing machine drain lines, laundry sinks, downspouts, and sump pumps. Fuel supply lines must be equipped with float operated automatic shut-off valves.[20]

This New York guideline is presented in this briefing as an example of how local authorities are adding meat to the bones of the various federal and state regulations. Design professionals working on projects in these communities must be cognizant of the guidelines as they enhance the requirements under the professional standard of care. But even if the specific local rules don't apply to a design professional because the project is located in a different state, an argument can be made that these local standards are influencing and affecting how the design firm will be judged in those other areas as well.

If these guidelines provide important protections for projects in the counties of New York, and a design firm could have avoided flood damage by applying these same guideline principles in a different state, would a judge or jury in that state find the designer liable for failing to implement the New York standards there because they might be considered the current state-of-the-art nationally?

Magnitude of flood risk must be considered

In an Arizona case, a court found an engineer liable for damage to a building that was destroyed by flooding as a result of a bridge the engineer designed blocking the free flow of water from a 100-year flood. In that case, the court rejected the engineer's argument that the case should be dismissed based on lack of foreseeability of damage. The court stated that "the question of whether this was a 25, 50 or 100-year flood is merely one fact to be considered by judge or jury on the question of foreseeability and negligence."[21]

A Kansas court held that both a consulting engineer and a county might be held liable for designing and constructing a bridge designed to "accommodate a 25-year flood and to raise the 100-year flood level upstream by no more than a foot" where inadequate consideration was given to downstream erosion. The issue here was not the reasonableness of the 25-year or 100-year flood levels per se, but whether erosion should have been considered.[22]

A North Carolina court held that a 100-year flood was foreseeable and that the state could not raise an "Act of God" defense against a "takings" claim where highway structures periodically caused flooding of private lands. The court held that "frequency of flooding sufficient to establish a taking generally will vary with the use to which the property is put". The court held that the flooding that could occur as frequently as once every 26 years constituted a taking of private property.[23]

A Colorado court held that a state agency should have considered a "maximum probable" flood in constructing a dam."[24]

As stated by Jon Kusler, Esq. in his Association of State Floodplain Managers paper, "These cases suggest that the magnitude of the flood used for planning and management purposes depends in large measure upon the types of uses which could be affected by flooding and the degree and type of risks involved." [25]

Foreseeability of harm may create independent duty of care

That same paper by Kusler reviews theories of liability against design professionals for flood risks and presents a discussion of several cases that demonstrate that a designer can be liable even if it met the applicable code and regulatory requirements.

Foreseeable of injury is an element necessary for finding that a design professional owes an independent duty of care to someone in addition to whatever contractual obligation it owes its own client. In the context of whether a designer would be liable for damages sustained by failure of its design structure to withstand adverse weather conditions, the court may look to whether the designer knew or could have reasonably known that damages could result from a design that did not take into proper account foreseeable climatic and weather conditions. It is not a defense for the designer to argue that it didn't have actual knowledge that its design would result in damages. The issue is whether a reasonable designer would foresee an appreciable risk and resulting damages from its actions.

Should a designer foresee the potential harm based on current rules and guidance documents of FEMA, state and local governments that put him or her on notice of potential flooding? Based on knowledge of recent storm and flooding events, should designers be on notice that harm will result if they fail to design to parameters greater than those required by current regulations and guidance?

Just because the extreme storm may be what is commonly known as an "Act of God," this does not necessarily relieve the designer of liability for failing to design to avoid or mitigate the losses that would be associated with such an event. An "Act of God" is such an unusual, extraordinary and unexpected manifestation of nature that it cannot be reasonably anticipated, guarded against, or resisted.[26]

An Act of God defense was rejected by a court that found that where a dam was designed for a maximum probable flood, it nevertheless failed due to a severe event that the court deemed was foreseeable. In recent years, courts have limited the Act of God defense, particularly for high-risk activities. For example, a Colorado court held that the state of Colorado could not successfully use the Act of God defense when a dam designed for a maximum probable flood failed because the court believed the event that occurred was predictable and foreseeable.[27]

Kusler notes, "Widespread availability of flood maps and flood predictions reduce the situations in which the Act of God defense may succeed since even very infrequent events are now 'expected'."* Moreover, recent flooding history of places like Houston with repeat 100-year floods occurring every few years would logically be considered by a judge and jury in rejecting an Act of God defense where a design firm could reasonably have foreseen the likelihood of floods exceeding what the official maps predicted.

*Kusler cites Hoge v. Burleigh Cty. Water Management Dist., 311 N.W. 2d 23 (N.D., 1981) in which the court held that the "act of God" was not the sole proximate cause of flood damages. [28]

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...design professionals may be held to an enhanced standard of care to consider the foreseeable risk of damages that can result from failure to design to mitigate flood loss and damages.

Conclusion

As storms seem to be increasing in severity and areas that were previously flooded once per hundred years are now being flooded multiple times in just a few years, design professionals may be held to an enhanced standard of care to consider the foreseeable risk of damages that can result from failure to design to mitigate flood loss and damages. Regardless of whether the President directed FEMA to rescind its Obama-era regulations, does the design professional nevertheless have a duty to meet those same rescinded regulations because they are the state-of-the-art when it comes to dealing with flooding? As seen in this briefing, regulations and codes don't set the limit on what is required – but merely the floor.

When the facts in the air and on the ground demonstrate that areas will be flooded every few years instead of every 100 or 500 years as predicted by current FEMA maps, does a design professional not have a duty to design to mitigate against the damages of the more severe and frequent floods? It can reasonably be anticipated that there will be an increasing amount of litigation against design professionals for damages that could have been avoided through prudent flood-resistant design.

Space considerations for this briefing did not permit us to address a variety of other risk management, liability and guidance issues emerging for architects and engineers in the face of climate change. Design firms should consider how attribution to science is affecting/improving the ability to forecast expected impacts from climate change – with sufficient certainty to potentially affect a professional's duty to act and warn – including changing design and construction criteria. Designers should also consider adaptive design, flood-resilient design, fire-resilient design, and a series of other practical solutions to manage this emerging risk.

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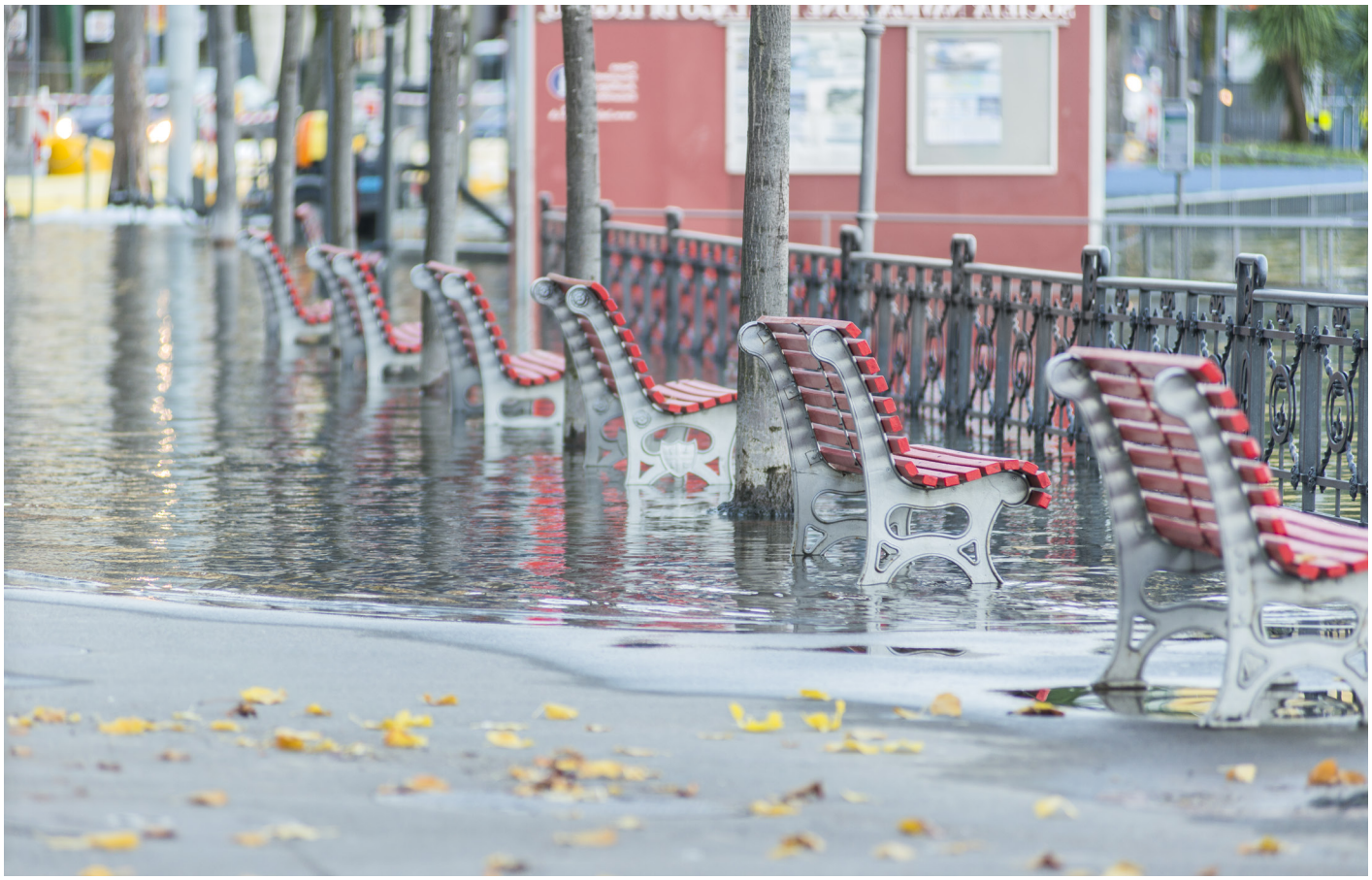

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