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Designing Beyond Code

October 2024

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Designing Beyond Code

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Outline

1. Building Codes
2. Professional Standard of Care
3. The Role of Reference Standards & Guidance Documents
4. Changing Environmental Conditions
5. What does good practice look like?
6. Case Studies

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Leo E. Argiris, P.E.

Executive Managing Principal

- 37 Years Experience as a Practicing Professional Engineer
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Summary

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Engineers and Architects have traditionally been able to rely on building codes as the clear definition of good practice. Codes could be relied upon to be a primary determinant of the Standard of Care. Things are changing, however. Climate Change and a rapidly developing understanding of natural phenomena through active research is accelerating the pace that building codes are being updated. Engineers are increasingly finding themselves needing to develop a basis of design for their project that needs to account for change and for more rapidly evolving code provisions and guidance. This session will investigate how Engineers and Architects should be thinking about this changing environment and how they can mitigate risks in their practice.

Building Codes

What is a Building Code?

AI Overview

Building codes are **a set of regulations that establish the minimum requirements for the design and construction of buildings**. They are designed to ensure the safety and integrity of buildings and structures, and to protect the public's health and general welfare.

Building codes cover a wide range of topics, including:

- Fire safety: Requirements for fire escapes and evacuation
- Structural systems: Design practices for structural steel and concrete
- Plumbing: Minimum requirements for plumbing systems
- Heating, ventilation, and air conditioning (HVAC): Minimum requirements for HVAC systems
- Natural gas systems: Minimum requirements for natural gas systems
- Hazardous conditions: Requirements for withstanding wind, rain, hail, and other hazards
- Banned materials: Materials that are prohibited from being used in construction

Building codes are legally binding and must be complied with. Failure to comply with a building code may result in penalties or restrictions.

Building codes are written by city or county officials with the help of construction professionals. They are often based on a model code, which is a common draft language that is produced by the International Code Council (ICC). Local governments can then customize the model code to meet the needs of their state, county, or city.

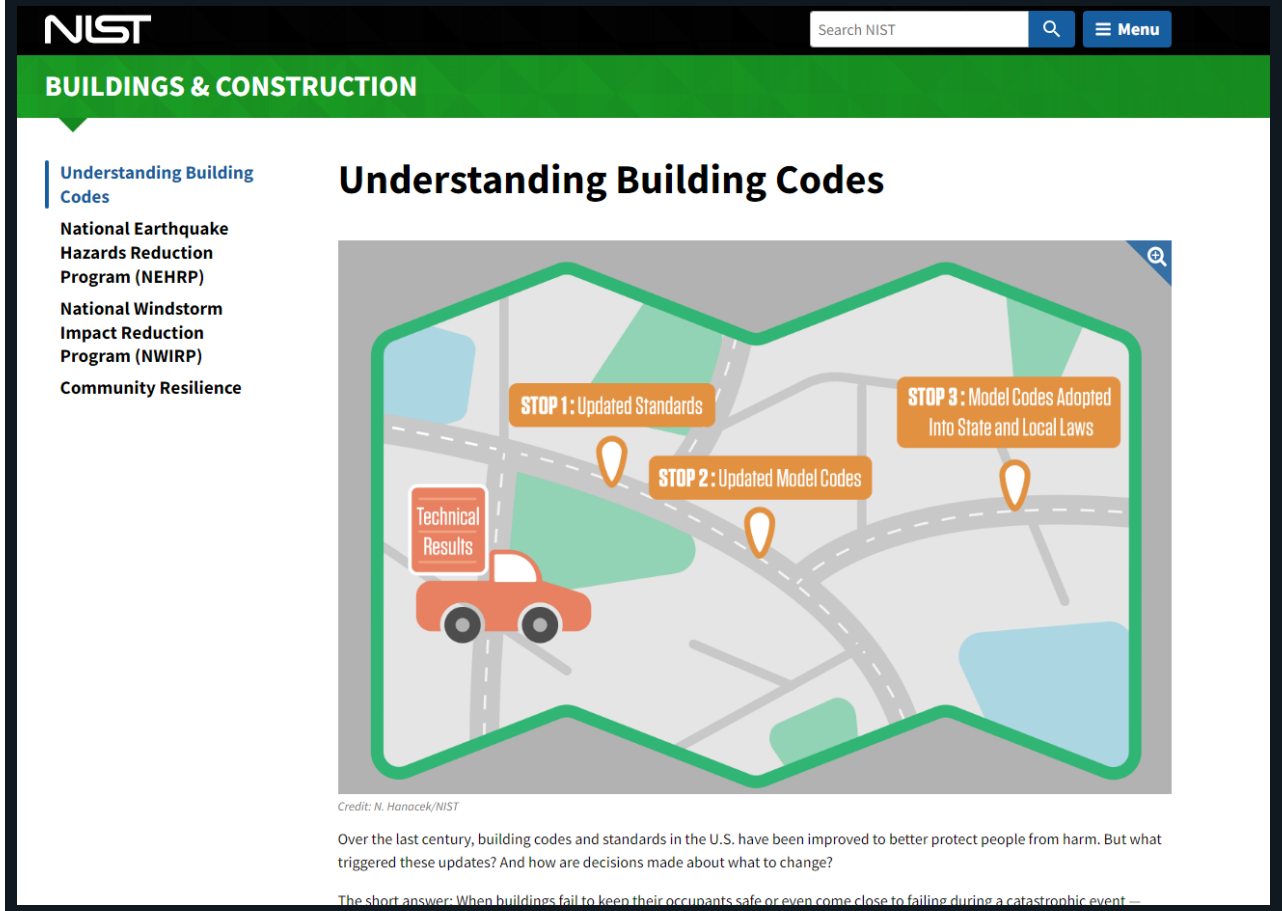
Building codes have a long history, with the earliest known written building code appearing in the Code of Hammurabi, which dates from around 1772 BC.

Key Points

- Building Codes establish the minimum requirements
- Building Codes are legally binding
- Building Codes are customized to the local city or county level with the help of construction professionals

How do Building Codes Happen?

- Technical Results & New Research
- Updated Standards
- Updated Model Codes
- Model Codes are adopted into state and local Laws
- Public review & comments at all steps of the way; each cycle takes years



https://www.nist.gov/buildings-construction/understanding-building-codes#:~:text=Building%20codes%20are%20laws%20that,concrete%2C%20windows%20and%20many%20more.

The Professional Standard of Care

The Standard of Care as per the AIA

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"The Architect shall perform its services consistent with the professional skill and care ordinarily provided by architects practicing in the same or similar locality under the same or similar circumstances. The Architect shall perform its services as expeditiously as is consistent with such professional skill and care and the orderly progress of the Project."

https://www.aia.org/resource-center/standard-care-should-i-care

Key Points

- Standard of Care relates to practice, no mention of codes or regulations
- Standard of Care relates to location
- Standard of Care is dependent of time. It evolves over time.
- In general courts look to the contract to establish the standard of care; however, the Design Professional's duty to health, safety and welfare of the public may create duty beyond the contract.

The Role of Reference Standards & Guidance Documents

Reference Standards & Guidance Documents Contribute to the Standard of Care

- Future Code provisions almost always begin life as content in a guidance document or reference standard.

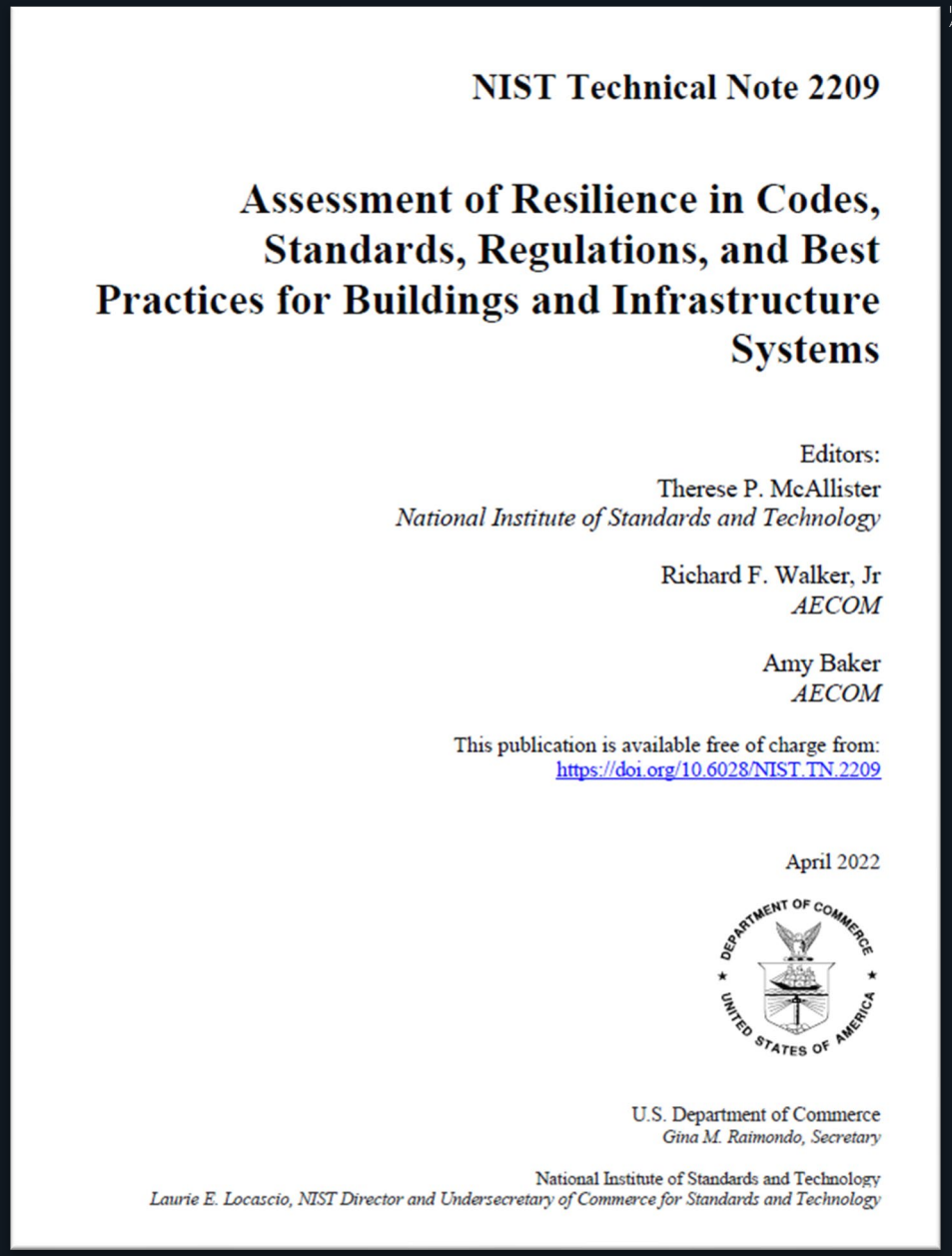
- The reality is that before a new provision is adopted by a jurisdiction, it is relatively widely understood by the local design community.

- Advocacy; Public Review & Comment; Outreach & Education.

An example Technical Report

This technical report, published by NIST raises the issue that building codes do not fully address community resiliency needs.

What impact do reports such as this have on the duty of the engineer?



NIST Technical Note 2209

Assessment of Resilience in Codes, Standards, Regulations, and Best Practices for Buildings and Infrastructure Systems

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U.S. Department of Commerce
Gina M. Raimondo, Secretary

National Institute of Standards and Technology
Laurie E. Locascio, NIST Director and Undersecretary of Commerce for Standards and Technology

https://www.nist.gov/publications/assessment-resilience-codes-standards-regulations-and-best-practices-buildings-and

2.5 Conclusions

Model building codes and standards provide minimum requirements to address life safety and structural stability and integrity; however, these provisions do not fully address community resilience considerations. Consistent performance criteria are needed for design hazards to support resilience, understanding that they may be varied in meeting community resilience goals.

There is limited data and guidance about post-event functional requirements and the time to recovery of function for a building after a hazard event. Building resilience objectives should consider the entire building's performance and functionality, including its performance and continued occupancy during repairs. Performance objectives for buildings in terms of damage levels and levels of functionality need to be developed in a quantitative format to provide a common foundation for individual projects and SDOs moving forward to address the gap between the current objectives of model building codes and achieving community-level resilience.

Current design criteria for building importance factors and Risk Category may or may not be aligned with a community's resilience goals. A community needs to understand its current vulnerabilities to the hazard events and properly address them by implementing design criteria in building codes. Guidance that develops a baseline set of community resilience goals and associated building performance objectives to support assessment of functional recovery would help bridge the gap between building performance and community resilience.

A broader understanding of interdependencies between buildings and infrastructure systems is needed. The impacts of variations between building and infrastructure codes and standards on community resilience also needs to be evaluated to identify any critical topics that need to be addressed.

https://www.nist.gov/publications/assessment-resilience-codes-standards-regulations-and-best-practices-buildings-and

Distinction between Life Safety & Serviceability

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Life Safety Considerations

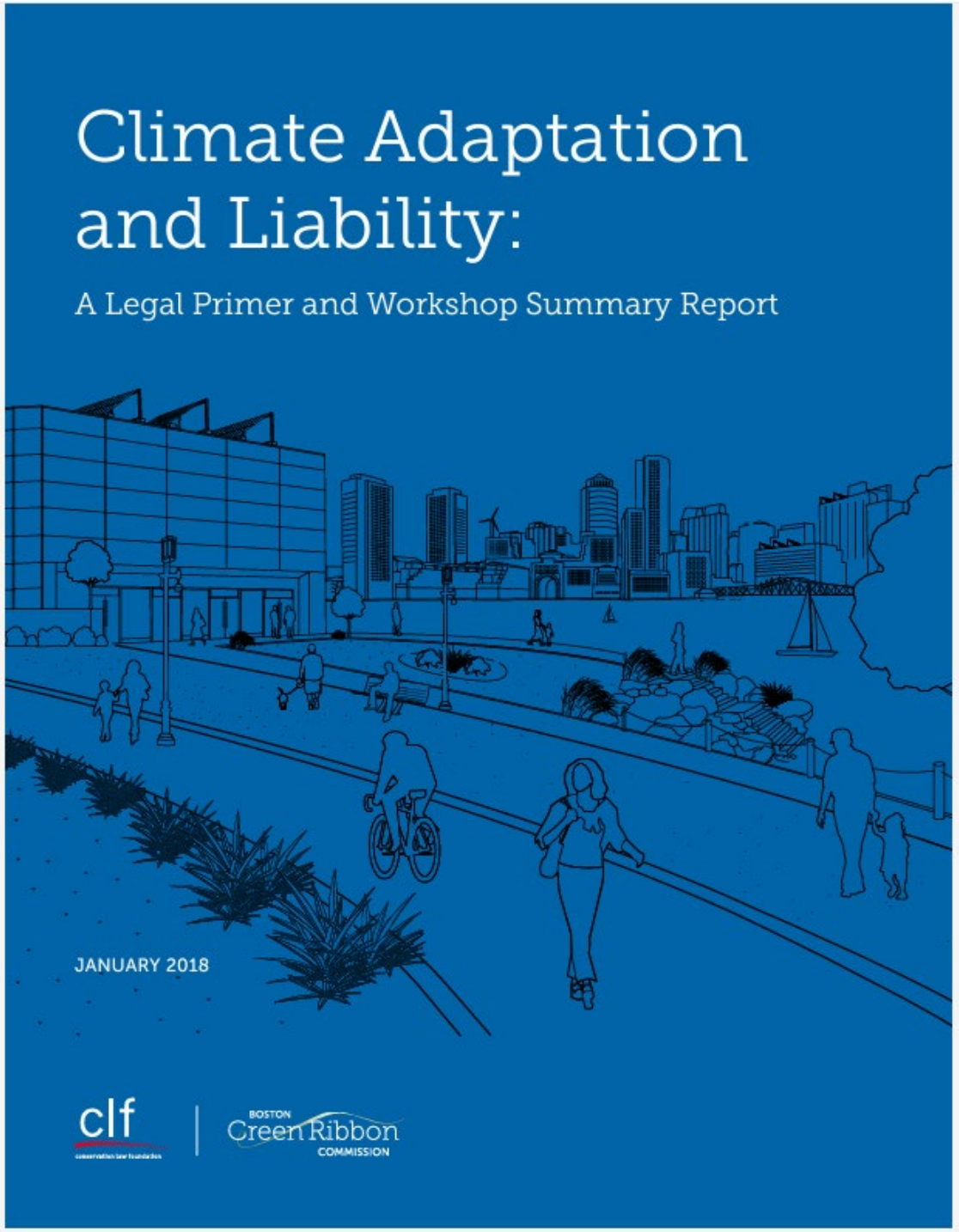
- Different Standard of Care for Life Safety.
- The Engineer's duty to protect public safety may impact the Standard of Care

Serviceability Considerations

- More judgement involved in establishing serviceability conditions.
- Compliance with established criteria is more subjective.
- Serviceability level criteria should be established explicitly by the design professional with the client.

Advocacy groups are looking for the professionals to take an active role in improving the built environment

https://www.clf.org/



Changing Environmental Conditions

On a 95-degree day this summer, New York City's Third Avenue Bridge, connecting the Bronx and Manhattan, got stuck in the open position for hours. As heat and flooding scorched and scoured the Midwest, a steel railroad bridge connecting Iowa with South Dakota collapsed under surging waters. In Lewiston, Maine, a bridge closed after the pavement buckled from fluctuating temperatures.

America's bridges, a quarter of which were built before 1960, were already in need of repair. But now, extreme heat and increased flooding linked to climate change are accelerating the disintegration of the nation's bridges, engineers say, essentially causing them to age prematurely.

The New York Times

Climate Change Can Cause Bridges to 'Fall Apart Like Tinkertoys,' Experts Say

Extreme heat and flooding are accelerating the deterioration of bridges, engineers say, posing a quiet but growing threat.

The Third Avenue Bridge, connecting Manhattan and the Bronx over the Harlem River. Earlier this summer, extreme heat caused a joint to expand and the bridge was stuck in its open position for hours. Graham Dickie/The New York Times

By Coral Davenport

Coral Davenport has reported on climate change policy and the impacts of climate change on the economy for 18 years.

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In Vermont, where heavy rainfall and heat have combined to damage an estimated 100 bridges over the past two years, the state is rebuilding them higher and wider, with deeper foundations and sturdier materials. And waterways below bridges are being made deeper and wider to be able to absorb more water.

But that all takes money and time. It is costing Vermont 30 to 40 percent more to build a more flood resistant bridge, said Jeremy Reed, chief engineer at the state transportation agency.

Scientists, engineers and government agencies are only now beginning to develop standards for how to build climate resilient bridges, said Jim Tymon, executive director of the American Association of State Highway and Transportation Officials. "We're learning from the events that are being thrown at us, and trying to change and build for what climate change throws next, but it's a moving target," he said.

https://propmodo.com/building-code-changes-are-increasing-rapidly-as-are-costs/#

The increase in changing building codes has had a lot to do with addressing issues around new technology, accessibility needs, and safety concerns due to climate events. States including Massachusetts, California, and Arizona have passed new building and energy codes aimed at achieving net zero targets and advancing climate goals. One of the most well-known building code changes recently was the passage of Local Law 97 in New York City in 2019. The landmark law requires owners of buildings larger than 25,000 square feet to reduce their carbon emissions by 40 percent by 2030 and 80 percent by 2050. The long-term goal for the city is to reach net zero emissions by 2050. Since it was passed, there has been widespread pushback to the law, with many owners—especially co-op apartment buildings—concerned over how to finance the needed improvements in order to stay compliant and avoid fines.

In another recent study from FEMA, the agency makes the case for adopting building codes by pointing to the protection of communities, and, in what seems like a contradiction of the reports from building owners on costs, for saving money. In its analysis, which is based on 18 million buildings across the country, FEMA researchers found that over a 20-year period, cities and counties with modern building codes would avoid at least $32 billion in losses from natural disasters compared to places without modern building codes. However, it also found that 65 percent of counties, cities, and towns across the U.S. still have not adopted modern building codes.

https://propmodo.com/building-code-changes-are-increasing-rapidly-as-are-costs/#

What Does Good Practice Look Like?

Work on these premises

- The relevant Building Codes are only minimum requirements.
- The relevant Building Codes may or may not incorporate the latest knowledge.
- The conditions your project will experience during its design life will likely be different than the conditions at the writing of the building code.
- Designing to code does not automatically satisfy the Standard of Care

Good Practice

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1. Become familiar with the latest knowledge on design conditions for your project. Differentiate between:
   - What does the code require?
   - What are the Reference Standards & Guidance Documents that are on the path to code acceptance saying?
   - What have other jurisdictions adopted as code provisions?
   - What is current published research indicating about future trends?

2. Develop a proposed Basis of Design for your project

3. Discuss the Basis of Design with your client and other members of the project team. Reach an explicit agreement on the appropriate Basis of Design for your project. Document the agreement.

4. Update the Basis of Design document through the life of the project. Communicate changes and secure approval for all changes.

5. As part of project closeout, demonstrate in writing that you have achieved the agreed basis of design to the extent feasible.

Case Studies

Case #1 – A hospital in a highly seismic location

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- Hospital System decides to design and construct a new replacement facility in a highly seismic location.
- The system owns a site and is determined to locate the hospital building on this site.
- By code the hospital has to be designed to an "Operational Continuity" performance level for the defined earthquake
- Hospital system hires an AE team to design the hospital and to a CM team to drive construction.
- The structural engineer researches the sight after being appointed and determines that records of recently measured seismic events indicate the site may experience high vertical accelerations. The current code does not require design to these accelerations.
- The structural engineer determines that a. the hospital must be designed to the vertical accelerations and b. the only way to achieve "operational continuity" is through a base isolation system.
- The CM estimates that the cost of the base isolation system will add $40 million to the cost of the project (add 10% to overall cost). The CM also advises the hospital client that there is no need for the system because the design earthquake being used is not an actual code requirement.

Case #1 – A hospital in a highly seismic location …cont….

- What should happen here?
- What did happen?
- The structural engineer took a hard line position and stated that he has an obligation to public safety that requires him to design to the best known knowledge. If the owner does not agree to a base isolation system, then he will withdraw from the project.
- The project is facing a time crunch and cannot afford to replace the engineer of record.
- The project proceeds with the base isolation.
- The hospital brings a claim against the Structural Engineer for the cost of the isolators.

Case #2 – Airport Tarmac Drainage

- An Airport Authority is renovating and expanding an existing airport terminal. The Authority hires an AE team and separately a CM team to respectively design and construct the project.

- During the Schematic Design phase, the AE team recognizes that the rainfall data that drainage of airside tarmac is to be designed to is not consistent with recent predictions of intensity and frequency of future storms in the region.

- The AE team approaches the Airport Authority, organizes a workshop, presents their data and undertakes an exercise to evaluate the implications of designing for greater rainfall amounts. The results of the study indicate that with upsizing drainage lines, an acceptable performance can be achieved. The additional cost to the project is a six-figure number.

- The project is now complete and has experienced rainfall of higher intensity than the original design storm.

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Discussion