Opportunities & Challenges in Resilient Building Design

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- Replace and relocate mechanical equipment to above design flood elevation
- Relocate electrical equipment to above the design flood elevation
- Dry floodproof all walls to 1' above design flood elevation
- Install floodproof door and floodproof windows to 2' above design flood elevation (refer to the toolbox in the Appendix for more details)
- Install sump pump
- Fill in basement per FEMA guidelines
- Reconfigure water and natural gas piping
Agenda

Who is Arup?
Approach to Resilient Design
Lessons Learned
Project Case Studies
Who is Arup?
We are truly global. From some 90 offices worldwide, more than 13,000 planners, designers, engineers and consultants deliver innovative projects around the globe.
Integrated Engineering, Planning & Design

- Acoustic consulting
- Audiovisual consulting
- Bridge design
- Building design
- Civil engineering
- Construction planning
- Controls and commissioning
- Cost management
- Development planning
- Electrical engineering
- Energy consulting
- Environmental consulting
- Façade engineering
- Fire/life safety consulting
- Geotechnical engineering
- Highway engineering
- Impact and blast engineering
- IT and communications systems
- Lighting design
- Logistics consulting
- Management consulting
- Maritime engineering
- Mechanical engineering
- Offshore engineering
- Plumbing engineering
- Project management
- Rail engineering
- Risk consulting
- Security consulting
- Seismic design
- Structural engineering
- Sustainability consulting
- Transaction advice
- Transport planning
- Tunnel engineering
- Venue consulting
- Visualization and modeling
- Water engineering
- Wind engineering
Total design is the integration of the design and construction process and the interdependence of all the professionals involved; the creative and innovative nature of engineering design…
Approach to Resilient Design
Educate client and the design team on the hazards and potential risks at the project site

Establish operational goals
Establish a clear definition of what resilience means to the client and how they expect the building to function

Develop suite of strategies
Develop a suite of strategies that will mitigate risks and also meet client goals for resilience

Revise and iterate
Revise and/or adjust strategies based on the client and design team evaluation

Evaluate strategies
Work with client and design team to evaluate the strategies and make sure they meet client and design team goals (design aesthetic, programming, cost, etc.)
Lessons Learned
<table>
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<tr>
<th>01</th>
<th>Dedicate time to education</th>
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<tbody>
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<td>Resilience is still a fairly new concept and it’s important that the client and the design team fully understand the hazards.</td>
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<th>02</th>
<th>Establish clear project goals</th>
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<td>Establish clear goals related to resilience and expected performance of the building is vital to guide the design process.</td>
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<th>03</th>
<th>Stay engaged throughout</th>
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<td>The resilience team should remain engaged throughout the process to ensure that the goals are being met, even as the design changes.</td>
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<th>Develop flexible solutions</th>
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<td>Solutions should be adaptable to the changing context (new science, expected lifespan of the asset, cost constraints, etc.)</td>
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<th>Consider external context</th>
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<td>Understanding the external risks that are not in the client’s control is important to understanding the full context of being resilient (utilities, transportation systems, changing regulatory context, etc.)</td>
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Project Case Studies
Public Housing Renovation, Brooklyn, NY
Lily Pads
Flood Protection

Earth lifted to median FFE height

<5% slopes provide barrier-free access

Surface programmed for residents

Passive barriers deployed in flood
Flood Protection Planning Concepts

Lily pad in fair weather conditions

Lily pad in hurricane conditions
DISTRIBUTION PLANTS & PODS
will protect heat and electricity during future storms.
Single Story Utility Pod Option
Strategies

Dry Floodproofing

BASEMENT FLOOD PROTECTION: "DRY" BASEMENT OPTION

CELLAR DOES NOT MEET ASCE 24 DEFINITION OF DRY FLOOD PROOFED. PROTECT BASEMENT PERIMETER AND PROVIDE PASSIVE LOUVERS AND DOORS AT OPENINGS

PERIMETER:
P-1. EXISTING RAMPS TO REMAIN. PROVIDE FLOOD PROOF DOOR AT CELLAR ENTRANCE.
P-2. CLOSE EXISTING OPENINGS WITH WATERPROOFED MASONRY AND BRICK FACING EXTERIOR. PROVIDE WATER STOP JOINT BETWEEN EXISTING AND NEW CONSTRUCTION
P-3. PROVIDE PASSIVE BARRIER AT REQUIRED VENTILATION OPENINGS
P-4. EXISTING BRICK BASED TO BE LEFT IN PLACE, WHERE EXISTING BRICK IS PAINTED, STRIP, PREPARE, REPAINT.

STRUCTURAL:
S-1. PERIMETER WALL REINFORCING REQUIRED.
S-2. NO PRESSURE SLAB (PENDING ADDITIONAL TESTING)

INTERIOR:
I-1. UNCONTROLLED SEEPAGE THROUGH CRACKS TO BE PUMPED OUT WITHIN 24 HOURS AFTER A FLOOD EVENT. SEEPAGE LEVEL TBD
I-2. RAISE CRITICAL EQUIPMENT ABOVE THE LEVEL OF ANTICIPATED SEEPAGE
I-3. EXISTING STAIRS TO BE RE OPENED AS REQUIRED TO MEET EGRESS CRITERIA
I-4. NO EXISTING WALL DEMOLITION
I-5. NEW REINFORCED MASONRY WALL AT BOUNDARY OF CRAWL SPACE
Strategies

Wet Floodproofing

BASEMENT FLOOD PROTECTION:
"WET" BASEMENT ALTERNATE

CELLAR DOES NOT MEET ASCE 24 DEFINITION OF WET FLOOD PROOFED. LOCALLY PROTECT CRITICAL ROOMS, OTHER BASEMENT AREAS FLOOD

PERIMETER:

P-1. EXISTING RAMPS AND CELLAR ENTRY DOORS TO REMAIN
P-2. EXISTING PASSIVE VENTILATION OPENINGS TO REMAIN, MODIFY OPENING PER MEP REQUIREMENTS, PROVIDE PASSIVE LOUVERS WHERE INDICATED
P-3. EXISTING BRICK BASED TO BE LEFT IN PLACE, WHERE EXISTING BRICK IS PAINTED, STRIP, PREPARE, REFAINT.

STRUCTURAL:

S-1. NO PRESSURE SLAB OR WALL REINFORCEMENT

INTERIOR:

I-1. LOCALLY FLOOD PROOF (WALLS TO BE FLOOD PROOFED AND REINFORCED, FLOOD DOORS TO BE PROVIDED) CRITICAL EQUIPMENT AND ROOMS, INCLUDING TRASH, CONDENSATE PUMP RETURN, LV SECURITY/IIT.
I-2. NO EXISTING WALL DEMOLITION
I-3. EXISTING STAIRS TO BE RE OPENED AS REQUIRED TO MEET EGRESS CRITERIA
Portfolio-wide Resilience Planning, MA
Strategic Resilience Plan

PHASE 1
Climate Scenarios
Hazard Assessment

- Climate Analysis
- Hazard Priorities:
  - SLR / Storm Surge
  - Precipitation
  - Temperature
  - Wind
  - Seismic

Completed

PHASE 2
Vulnerability Assessment

- Critical Facilities and Operations
- 5 Elements Checklist Risk Assessment
- Prioritize Needs Across System

Probability

Consequence

PHASE 3
Implementation

- Facility Resilience
- Capital Prioritization
- Operations enhancement
- Long-term Adaptation

Capital
Investment
Our project approach is defined by six (6) core tasks:

1. Develop **Prioritization Criteria** to rank ordering of mitigation strategies
2. Identify **Priority Projects** for each site based on Phase 2 results
3. Establish **Mitigation Strategies** which will include cross-cutting solutions across impacts, facility types and other relevant, programmatic criteria. (New and existing buildings)
4. Analyze **Return on Investment**
5. Generate a **Resilience Capital Improvement Plan** tool
6. Develop Schematic Designs
Portfolio-wide Guidance

Design Guidelines

Miami-Dade Code Review

Roof Tie-Downs

Flood Barrier Guidance
Key Takeaways

01. Dedicate time to education
02. Establish clear project goals
03. Stay engaged throughout
04. Develop flexible solutions
05. Consider external context
Thank you!