

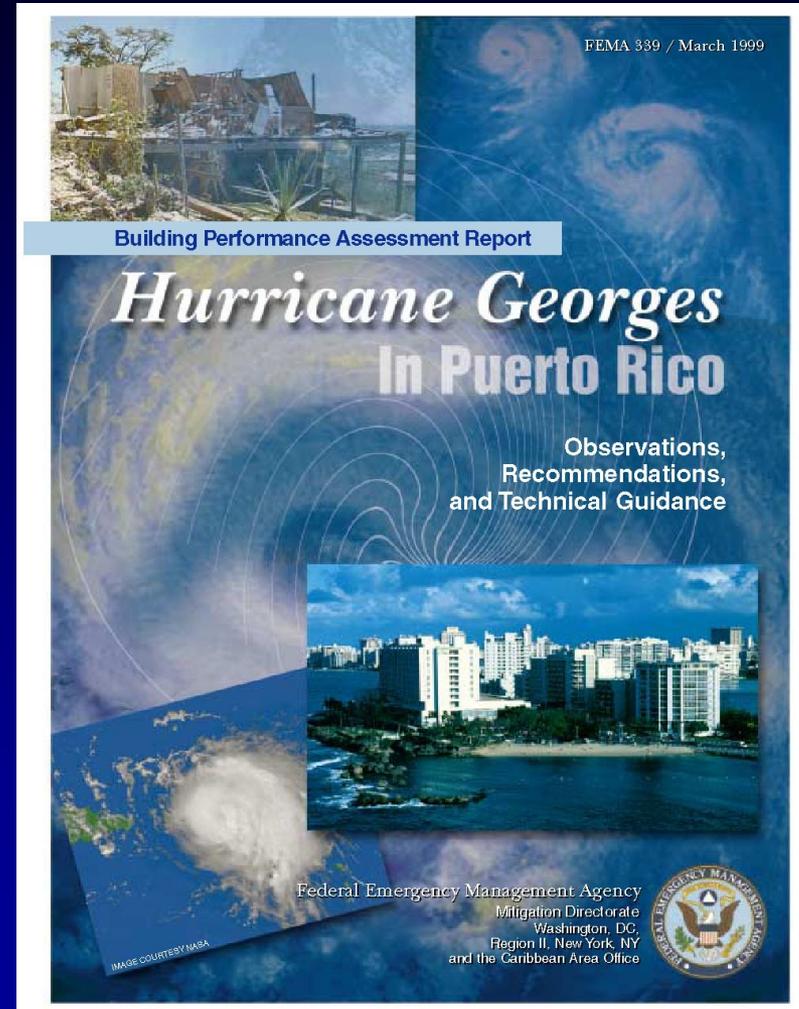
BUILDING PERFORMANCE ASSESSMENT TEAM

Hurricane Georges in Puerto Rico

OBSERVATIONS,
RECOMMENDATIONS, AND
TECHNICAL GUIDANCE



FEDERAL EMERGENCY MANAGEMENT AGENCY
MITIGATION DIRECTORATE





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FEMA Building Performance Assessment Teams

■ Team Members

- Representatives of public and private sectors and expertise in:
 - structural and civil engineering
 - building design and construction
 - building code development and enforcement
 - floodplain management

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FEMA Building Performance Assessment Teams

- **Team Objectives**
 - inspect damage to buildings
 - assess the performance of buildings
 - evaluate design / construction practices
 - make recommendations as necessary
 - focus on success stories

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LEGEND

- 1 Georges (1998) CAT 2
- 2 Hortense (1996) CAT 1
- 3 Marilyn (1995) CAT 2
- 4 Hugo (1998) CAT 3
- 5 Betsy (1956)
- 6 San Ciprian (1932) CAT 4
- 7 San Nicolas (1931)
- 8 San Felipe (1928) CAT 5
- 9 San Ciriaco (1899)
- 10 San Roque (1893)





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Observations

- **Wind Data**
 - **109-133 mph (3-second gust)**
 - **wind speeds did not exceed design conditions**



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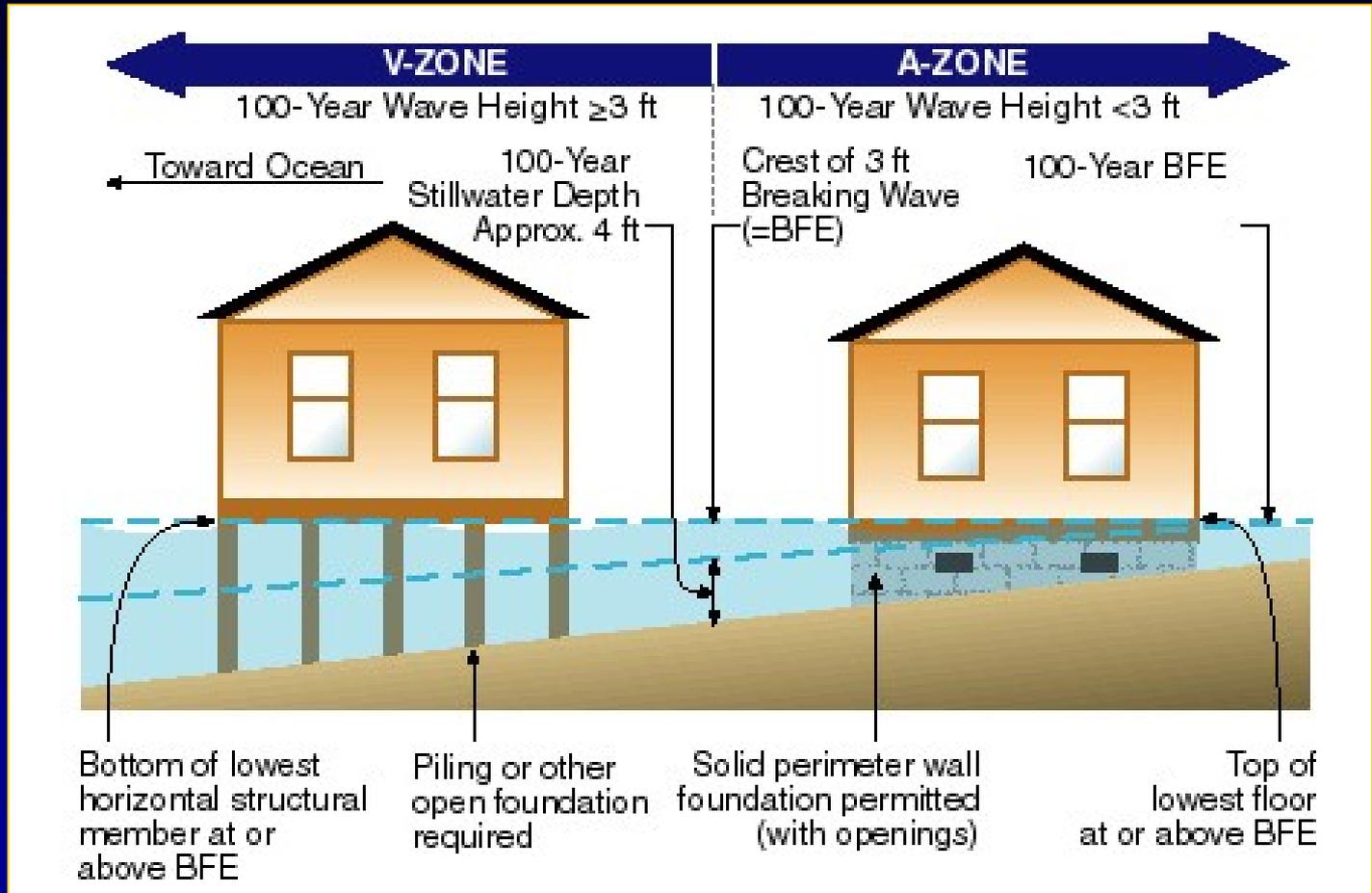
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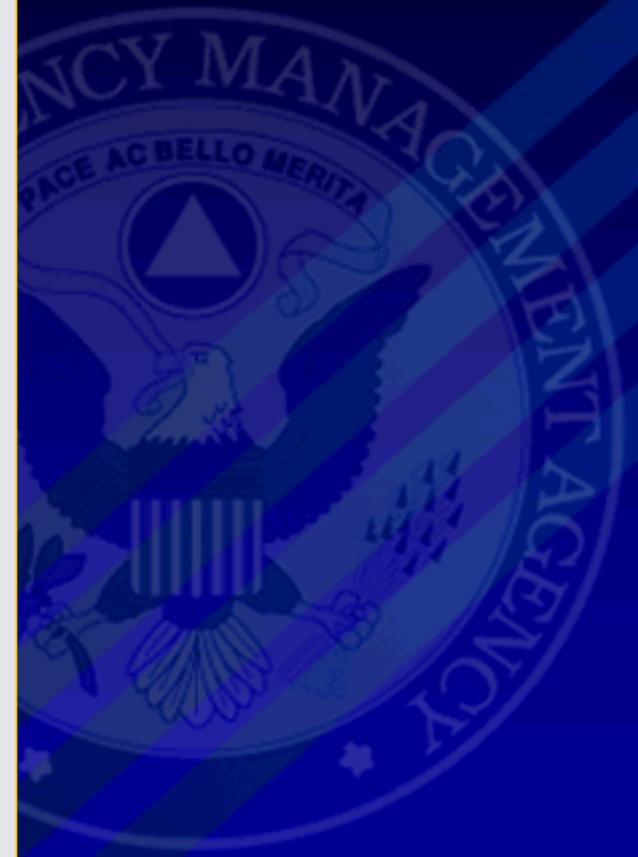
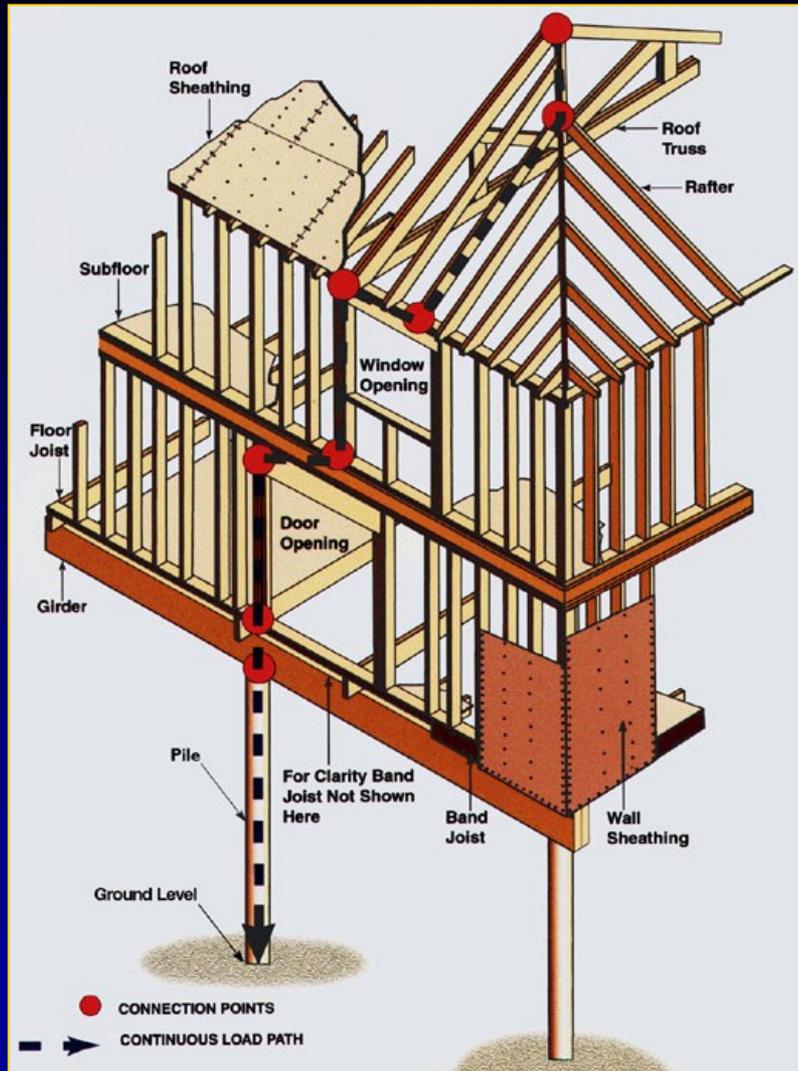
Structural Performance

- **Three Primary Construction Types Evaluated**
 - reinforced concrete
 - reinforced masonry
 - wood-frame

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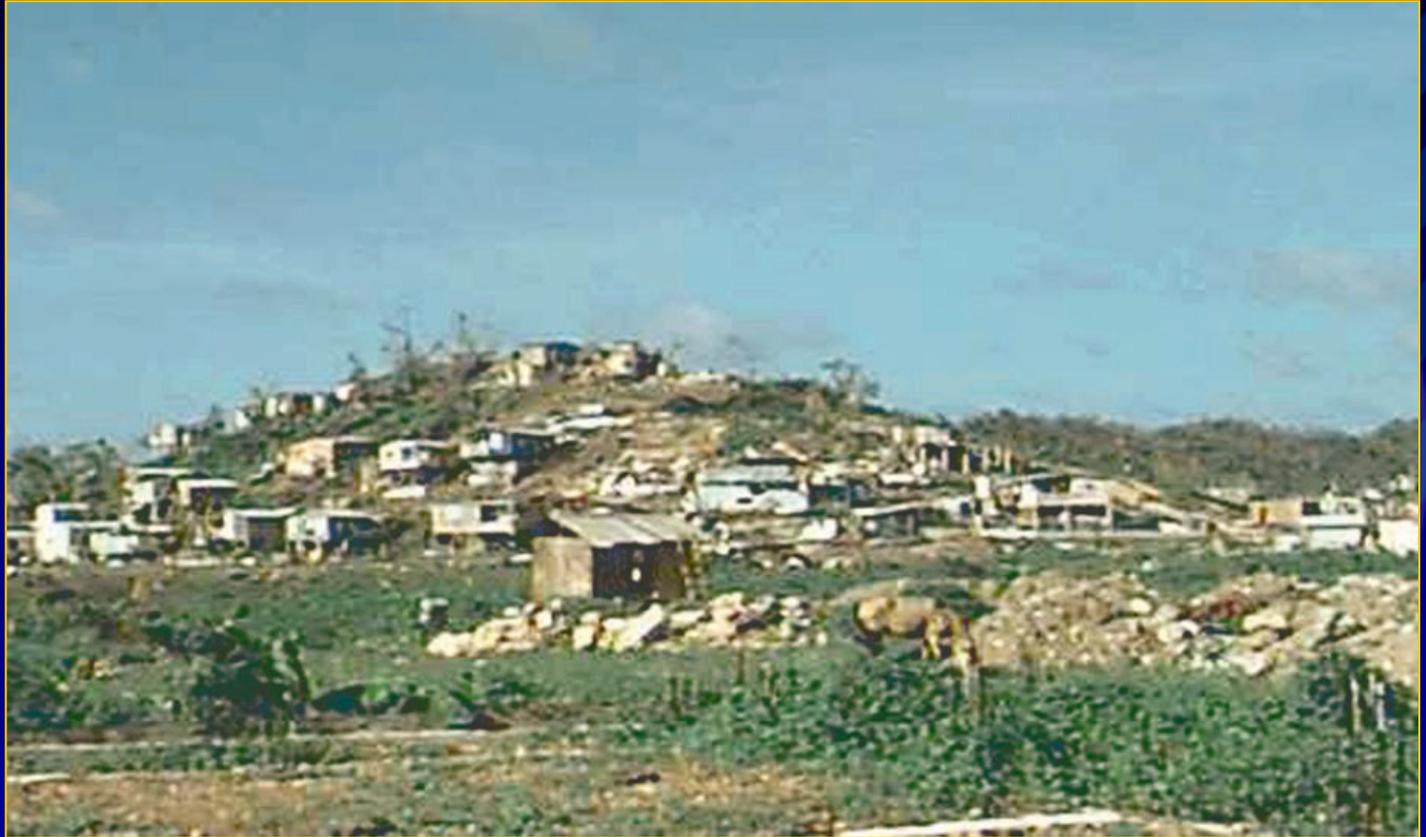
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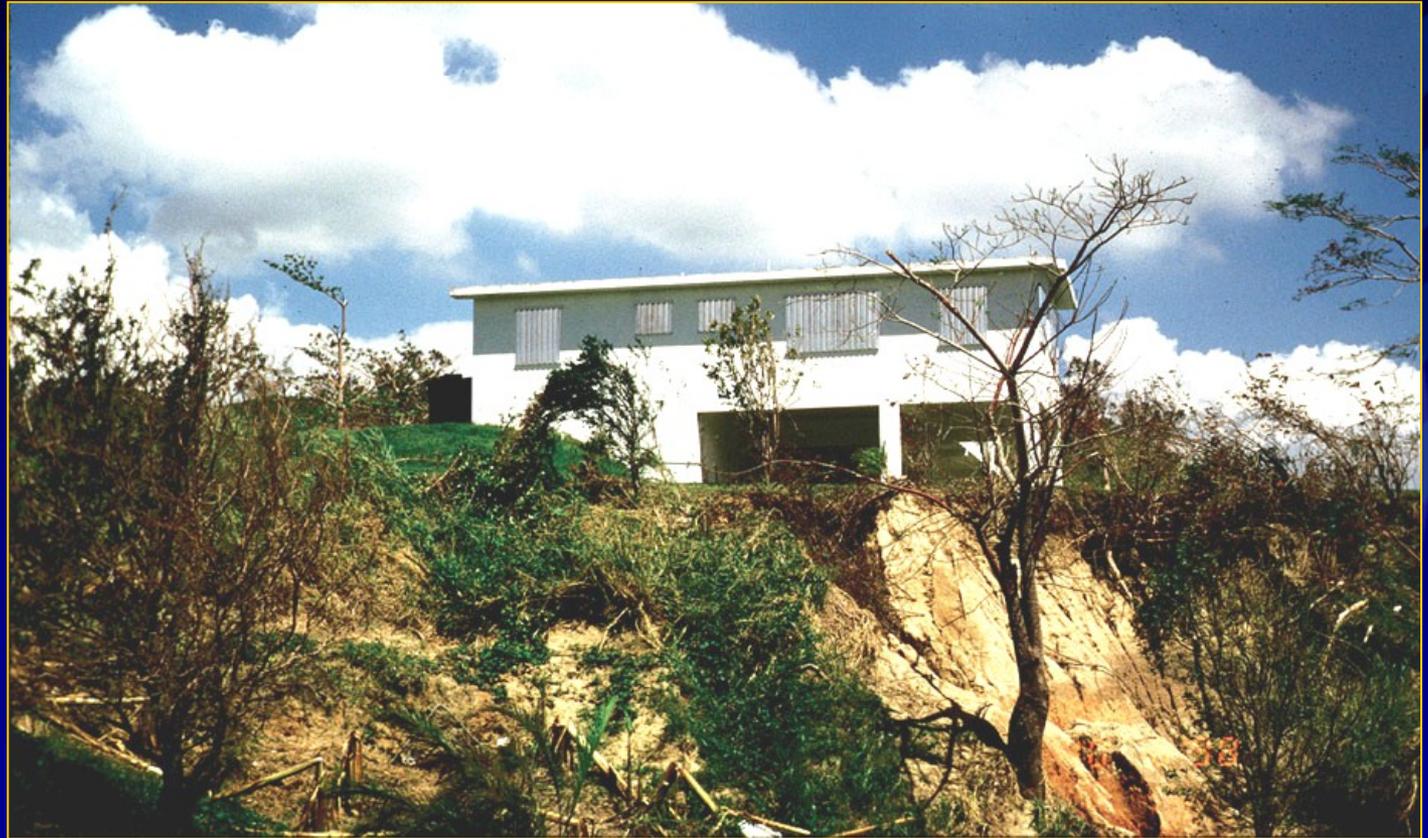
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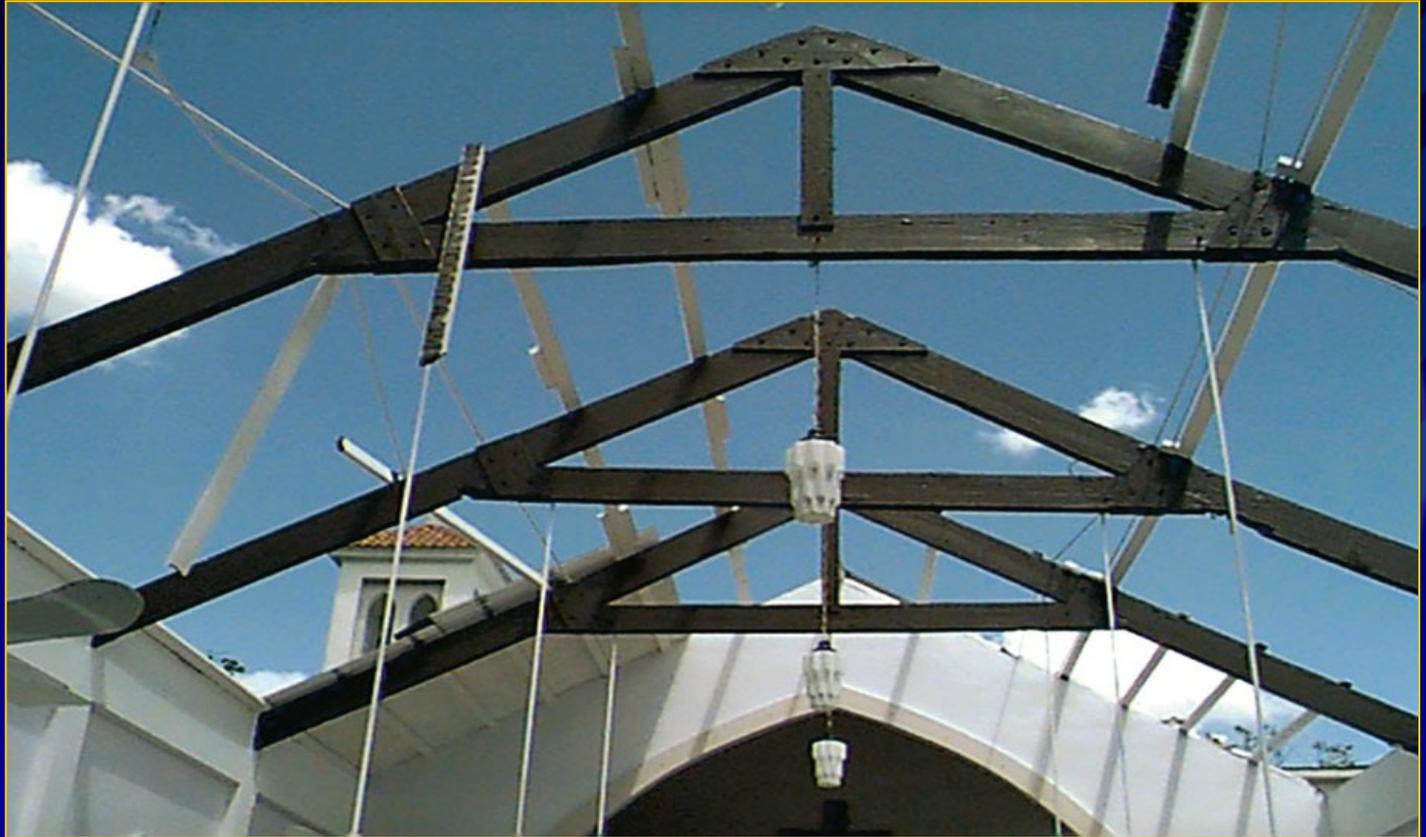
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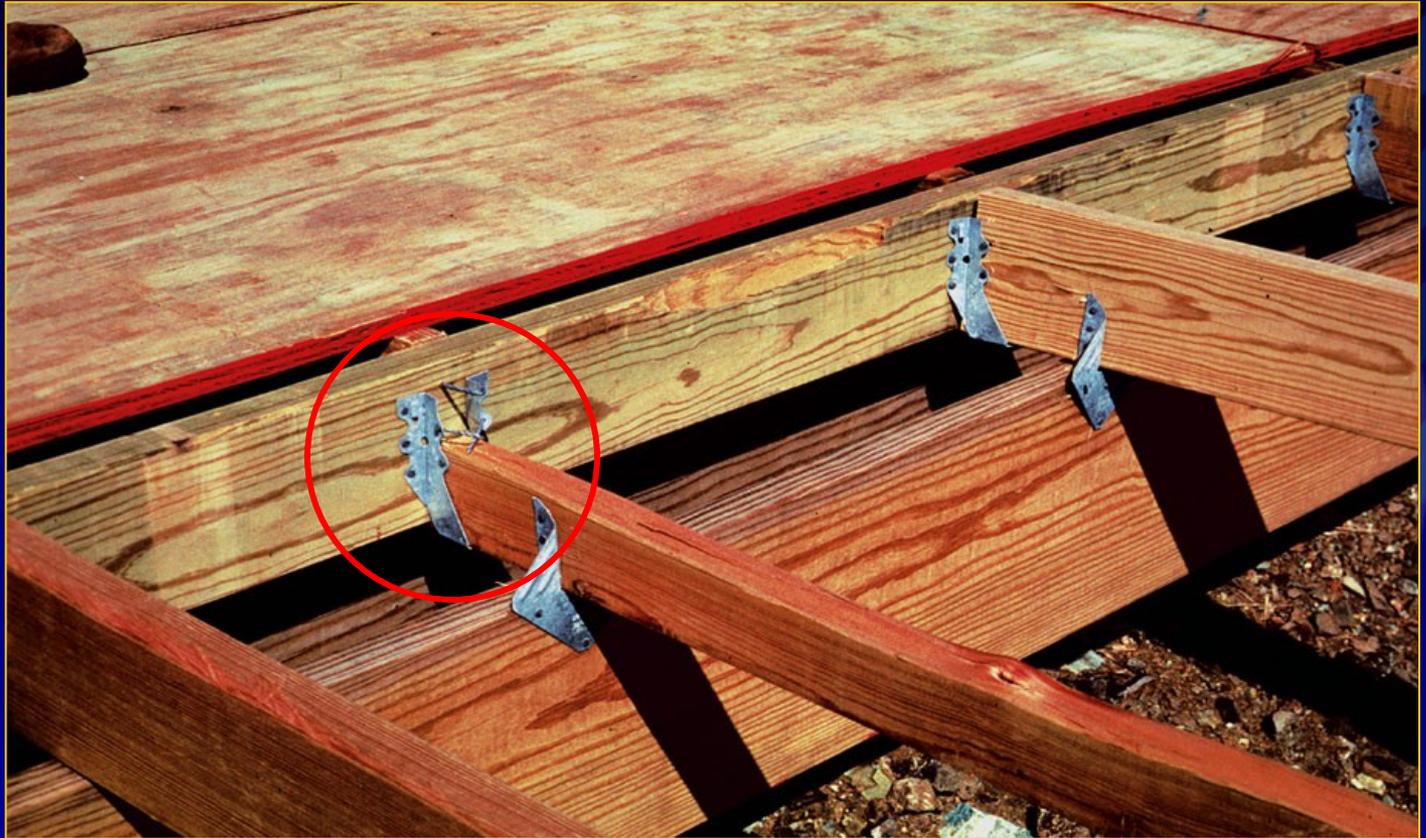
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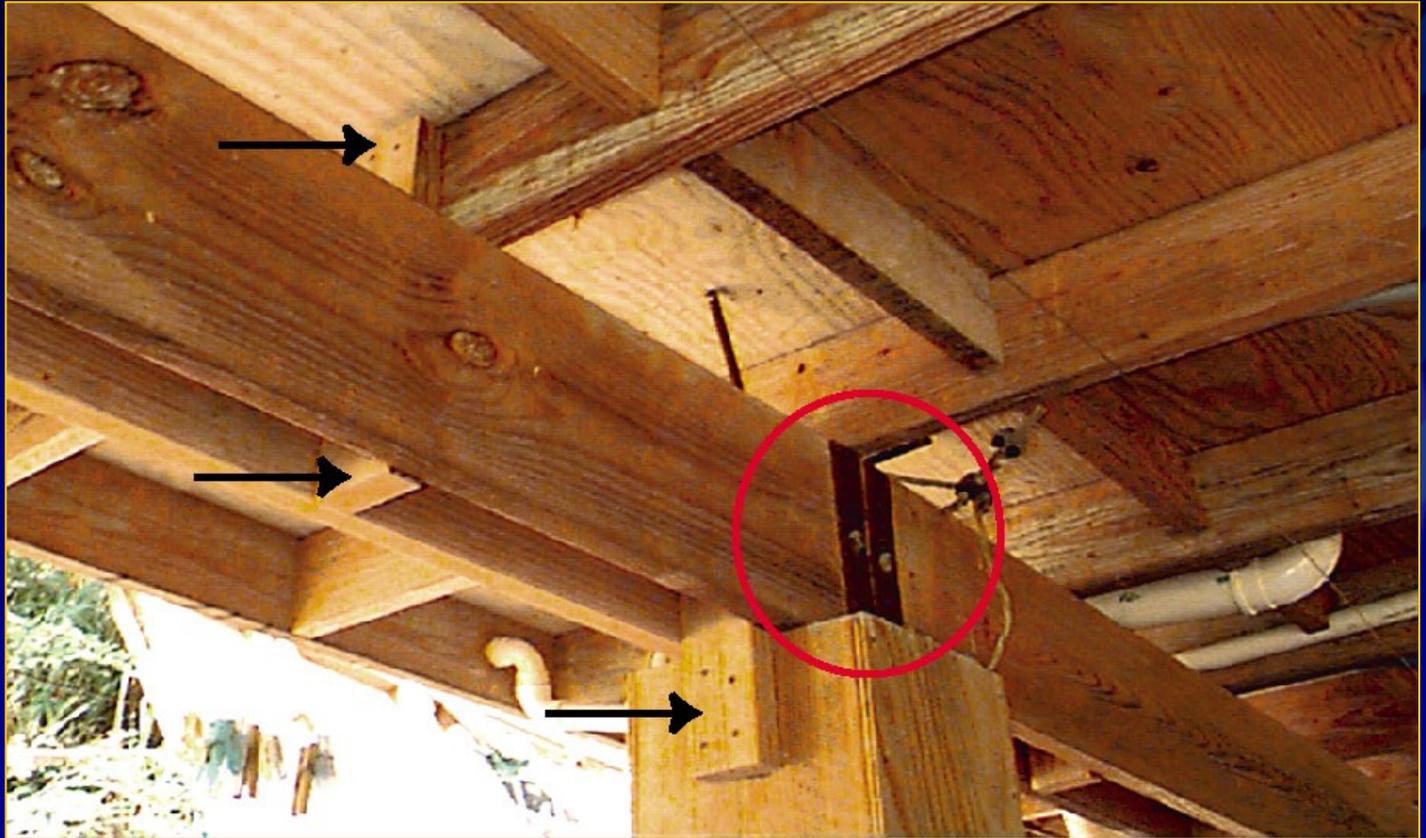
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Building Envelope Performance

- **Doors**
- **Non-load bearing walls / wall coverings**
- **Roof coverings**
- **Windows, shutters, and skylights**

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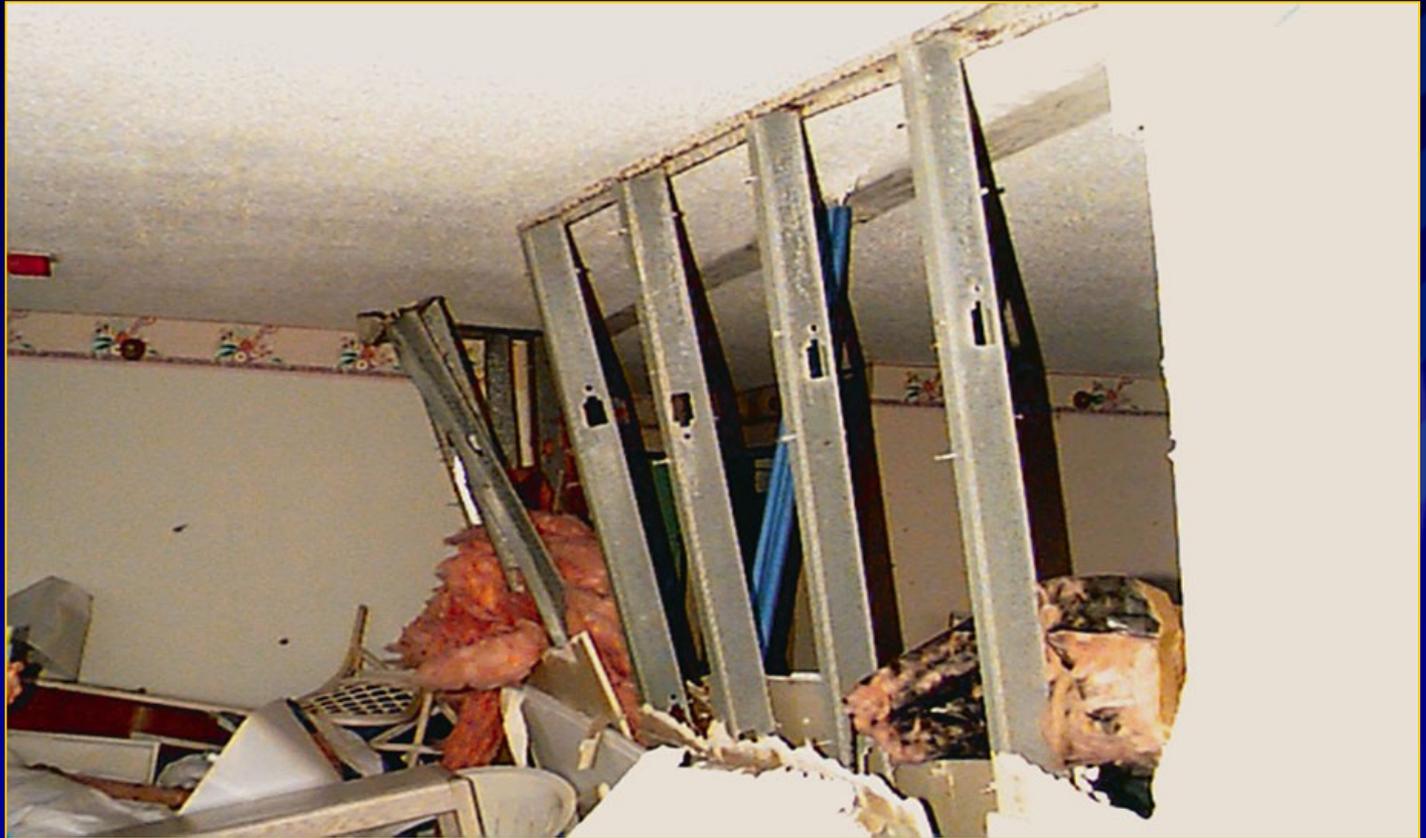
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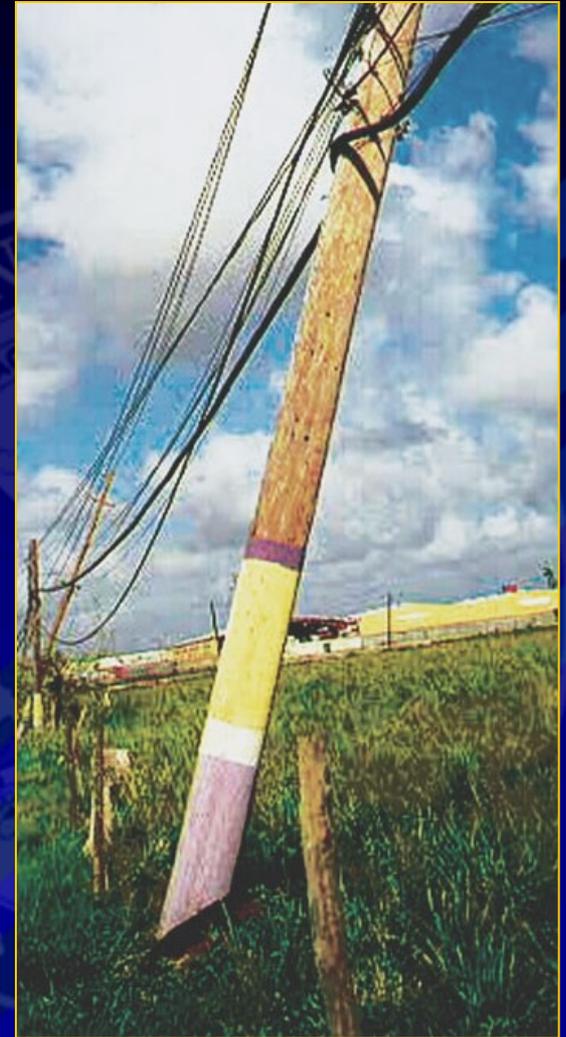
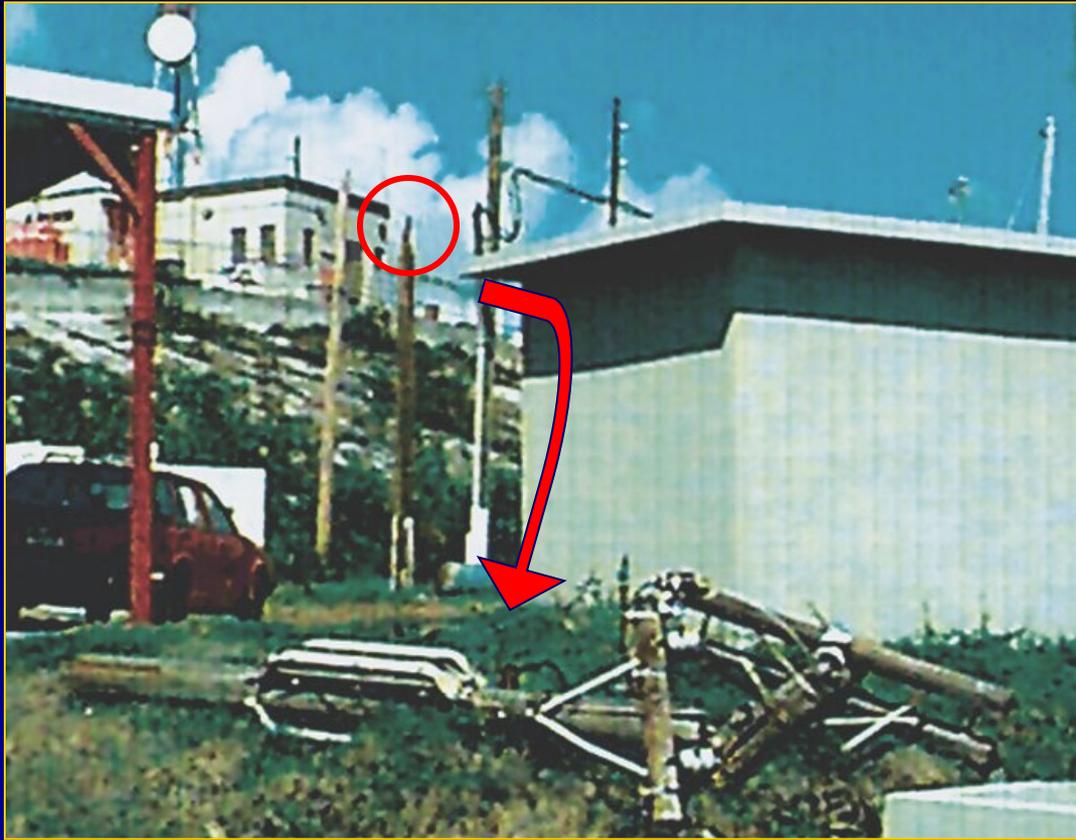
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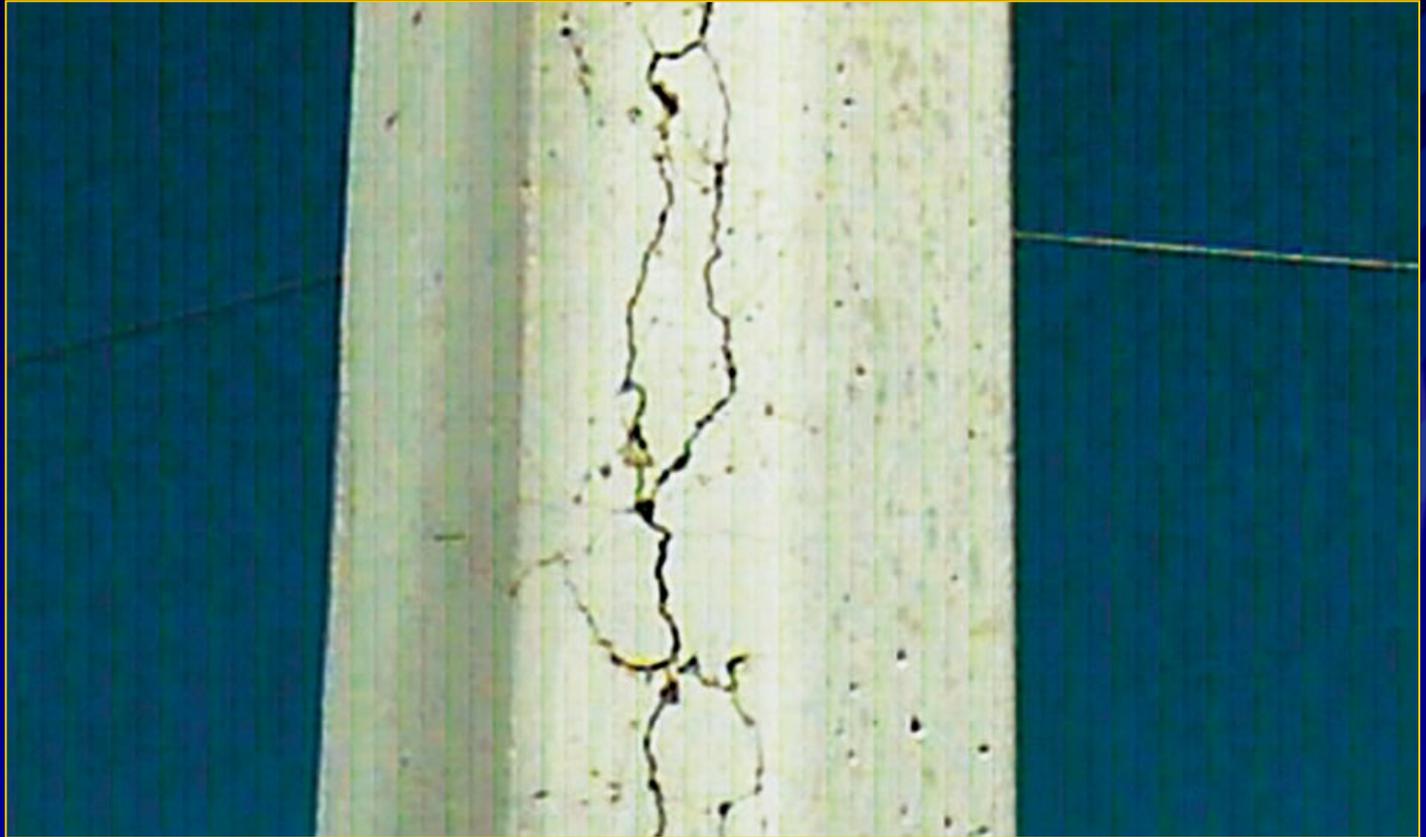
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Conclusions

- **BPAT's conclusions are intended to assist**
 - designers
 - contractors
 - building owners
 - government officials

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Conclusions

- **Wind Mitigation for Existing Buildings**
 - mitigation retrofits were not effective as they could have been
 - need to address the entire continuous load path



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Conclusions

- **Regulatory Administration and Enforcement**
 - **current practices allow for unregulated construction**
 - **contributed to damages from Georges**



Conclusions

- **Structural**
 - structural building elements that were not designed to the current building regulations failed
 - new wind codes will help improve future performance



Conclusions

- **Architectural - Building Envelope**
 - failure to design and/or to test components for wind load in the current code caused failures in the building envelope
 - more attention needs to be paid to weatherstripping



Conclusions

- **Exterior Mechanical and Electrical Equipment**
 - greater attention to attachment of rooftop equipment
 - on-site strengthening is necessary
 - equipment must be properly elevated in floodprone areas



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Recommendations

■ General

- all buildings should be properly permitted, designed, inspected and constructed
- 1997 UBC was adopted (using ASCE 7-95 for wind design)



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Recommendations

- **Code Recommendations**
 - require roof uplift testing
 - Include criteria for corrugated metal roofing
 - prohibit aggregate surface roofs
 - provide criteria for metal edge flashings / copings
 - tile roof should be prohibited

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Recommendations

- **Code Recommendations**
 - require wood preservative treatment or naturally decay resistant wood be used
 - require wind resistant glass
 - add provisions related to missile impact resistance for glass



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Recommendations

- **Education and Enforcement**
 - **Puerto Rico Planning Board should continue to educate homeowners**
 - **enforcement of the regulations during the rebuilding effort will reduce future damages**



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Recommendations

- **Evaluations, Submissions, Product Approval**
 - Issue a guideline for determining loads for rooftop HVAC equipment
 - consider product approvals / submittals for components and cladding
 - consider product approval for clips, fasteners, metal panels

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Recommendations

- **Essential Facilities**
 - **essential facilities should be evaluated under the provisions of the new building code**