The 2010 Haiti Earthquake: Structural Vulnerabilities, Challenges and Opportunities for a Resilient, Sustainable Haiti

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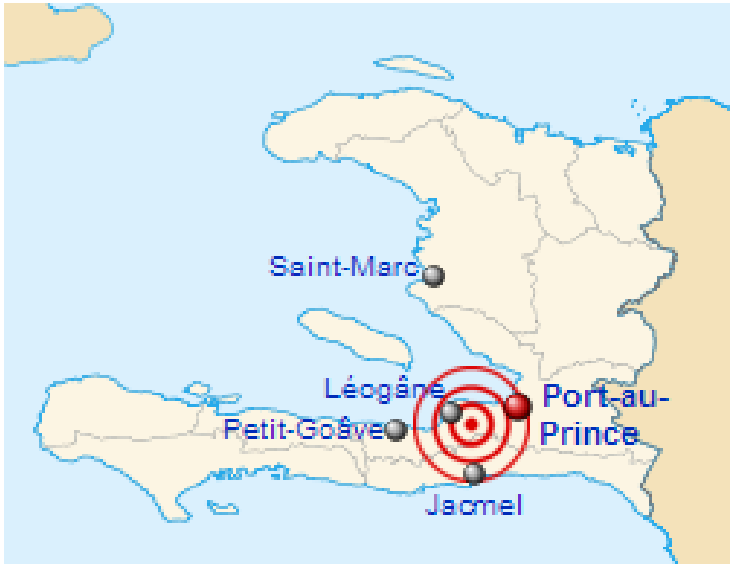
2010 Haiti Earthquake

- Mw 7.0 EQ, 4:53 PM
- Depth = 8.1 miles
- 220,000-250,000(Haiti Gov't)
  - Largest in History (per capita)
- 13 out of 15 Gov't buildings collapsed
- 250,000 homes collapsed
- 30,000 commercial buildings collapsed
- 300,000 injured
- 1-1.5 Million Homeless
- Estimated Cost of $14 Billion
  - Largest Cost for Natural Disaster in History (as function of GDP)



Confounding Factors

One of Highest Exposure to Hazards in the World

- 96% of the population is exposed to 1 or more hazards
- Two active seismic fault lines
- Highest hurricane hazard in Caribbean
- One the three most vulnerable countries to climate change impacts

Extremely High Vulnerability of Built Infrastructure

- High environmental degradation, housing and infrastructure in flood prone areas
- High level of poverty, limited public infrastructure, governance challenges and chronic financial deficit

High Risk

Trip 1:EESU Assessment Summary

- Hospitals/Medical Facilities: 34
- UN Buildings/Residences: 35
- Other private dwellings: 14
- Schools/Colleges: 7
- Warehouses: 6
- Commercial buildings: 5
- Orphanages: 2
- Government Buildings: 3
- Others:6
- **Total: 120**

~25% Red (unsafe), 25% Yellow (limited entry), ~50% Green (safe)

Trip 2: EERI/ASCE Earthquake Reconnaissance

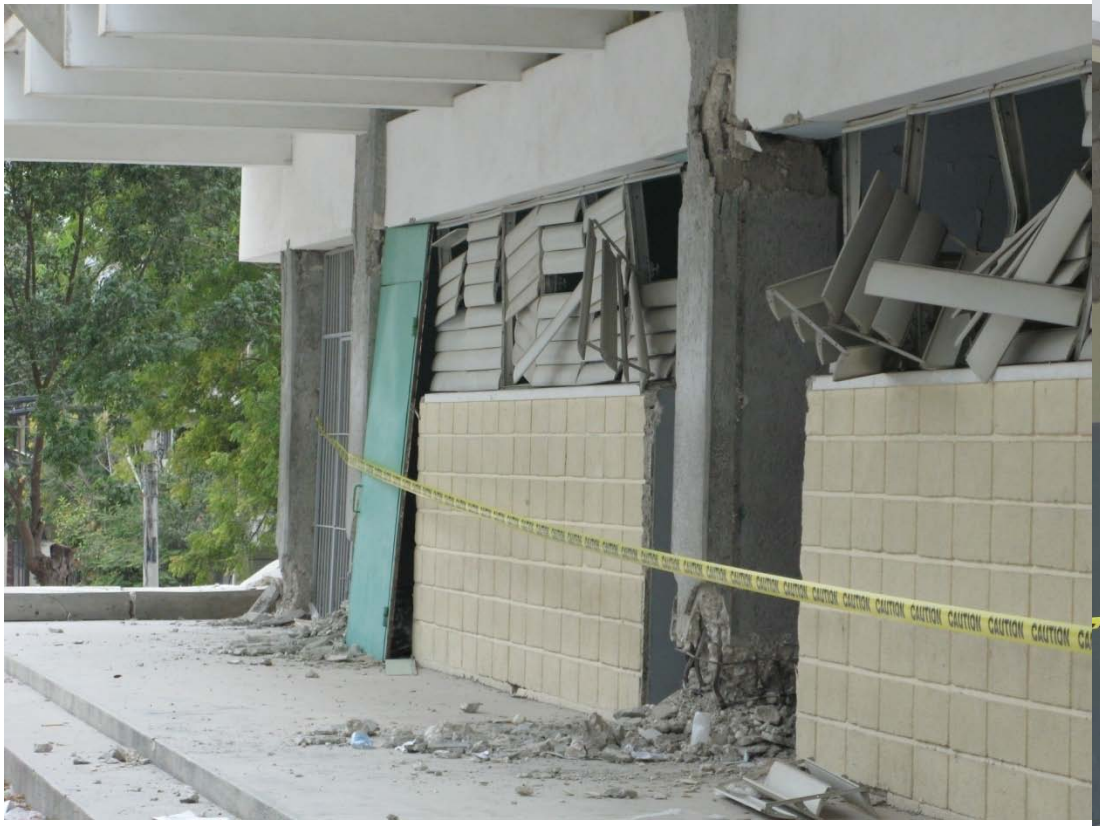
- March 6-13
- Team of 28 structural engineers, city planners, architects, geographers, emergency responders.
- Goal: Document damage, collect data, and meet with local officials and engineers.
- Make recommendations on rebuilding
- Visited over 500 facilities
- Office buildings, homes, government buildings, historical structures, industrial buildings, ports, telecommunications, water, power, and hospitals
- PaP, Leogane, Petit Goave, Jacmel, St. Marc

Government Buildings

Presidential Palace

Damage to Schools

Damage to Columns

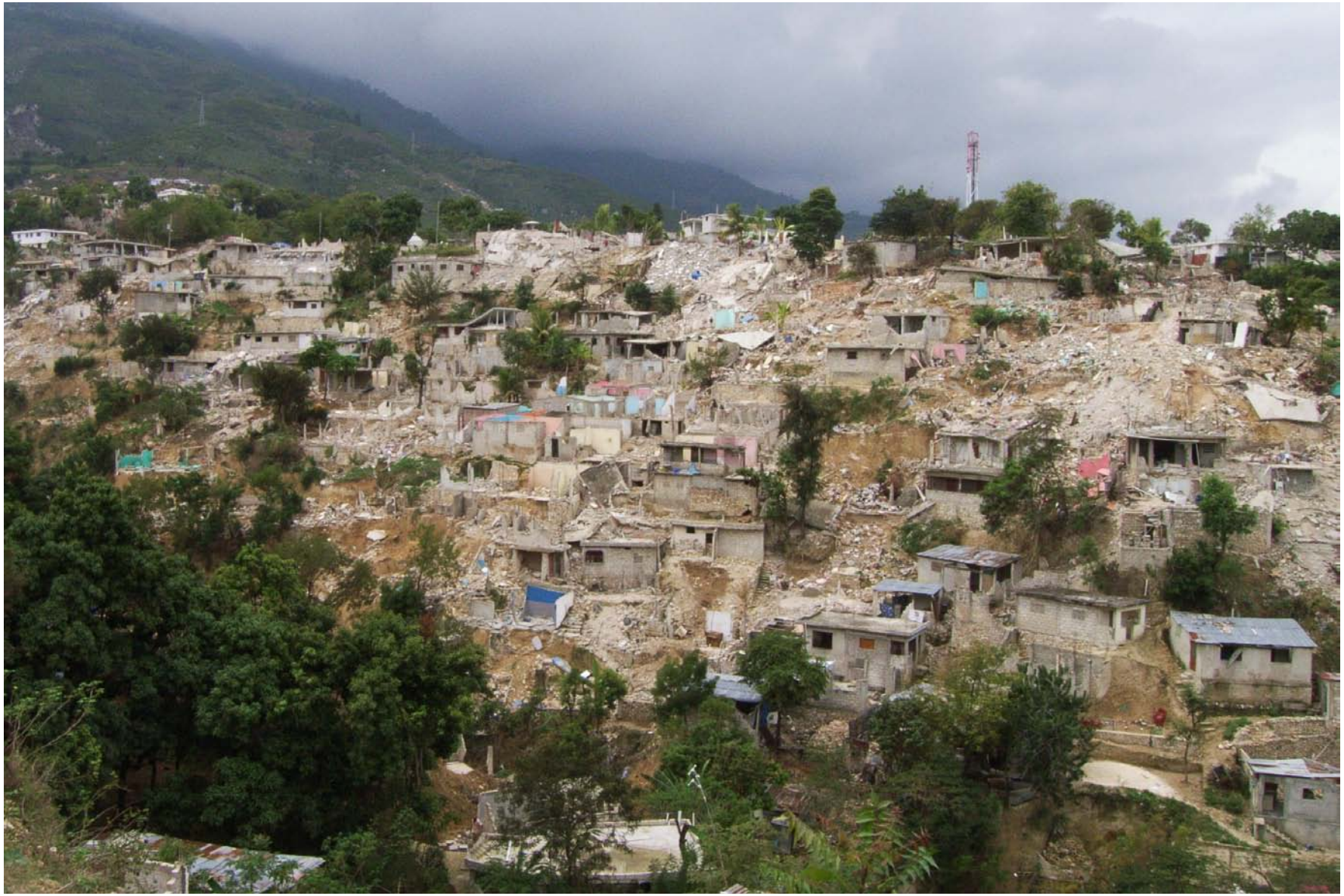


St. Louie de Gonzague School

Downtown PaP

Overcrowding in Haiti

Damage to Low-Rise Construction



Common Vulnerabilities

- Inadquate structural systems
  - Soft stories
  - Lack of symmetry
- Quality of Construction
  - Lack of trained/skilled labor
  - Lack of Heavy machinery
- Quality of Materials
  - Quality of cement, sand, water
  - Smooth steel bars
- Lack of Details
  - Insufficient longitudinal reinforcement
  - Lack of transverse reinforcement

Soft Story Failure

Common Vulnerablities

- Poor structural systems
  - Soft stories
  - Lack of symmetry
- Quality of Construction
  - Lack of trained/skilled labor
  - Lack of Heavy machinery
- Quality of Materials
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Quality of Construction

Lack of appropriate tools/heavy machinery, lack of training, and lack of quality control

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Concerns over Quality of Concrete

- Weak concrete due to too little cement
- Quality of water used in mix
- Quality of sand used in mix
- Excessive use of weak aggregates

Excessive Use of Smooth and Corroded Bars

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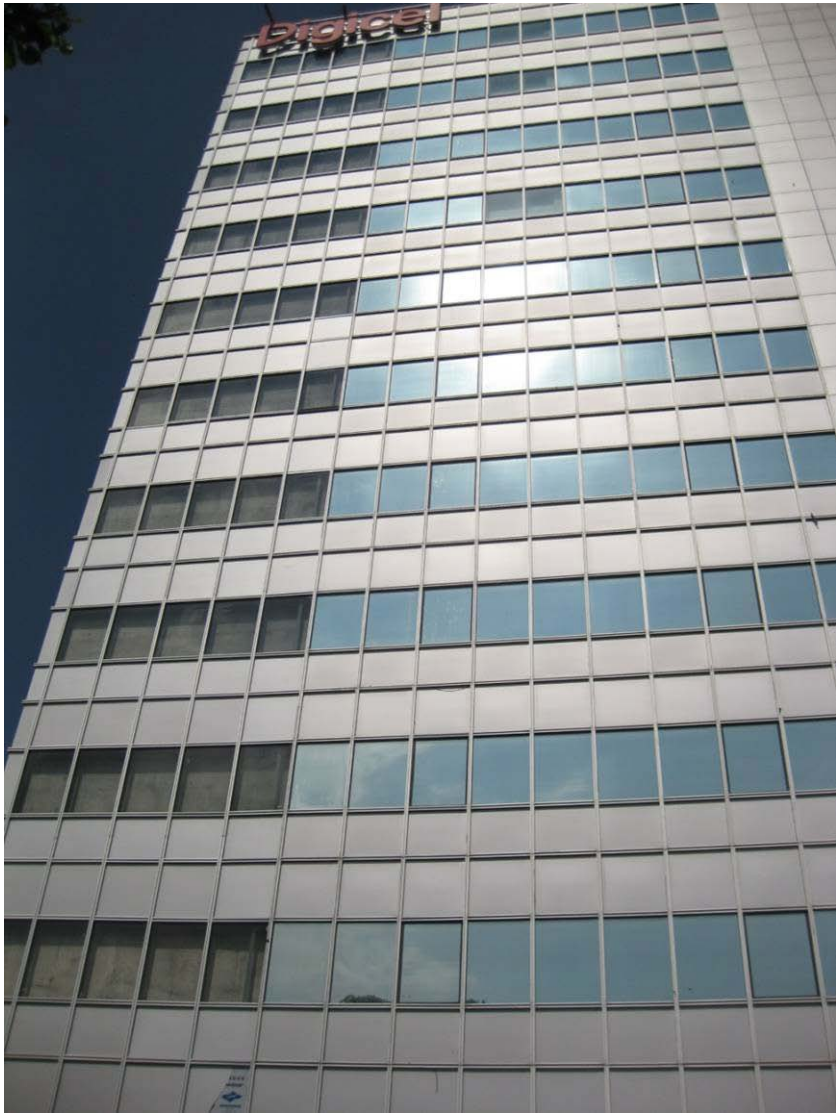
Lack of Longitudinal Steel Reinforcement

New Construction Site- Canape Vert.

6 #4 bars represents less than 1% steel area

Digicel Tower

- Digicel is largest cellular phone company in Haiti.
- 12 story concrete framed, curtain wall tower with two adjacent concrete framed, concrete block infill buildings and a space frame tower.
- Designed according to ACI 318
- Tower performed well while adjacent buildings were heavily damaged



Challenges for Rebuilding

- Poverty & Illiteracy
- Rainy season in May & hurricane beginning in Fall
- Large quantities of Debris
- Potential looming health issues
- Lack of capacity in Haitian government
- Collapse of the educational system in Haiti
  - 1300+ schools/universities destroyed or damaged
- Lack of available land

Needs for Rebuilding for Resilience (1)

- Solutions that appropriate for the socio-economic situation in Haiti, AND maintains the unique culture of Haiti
- Need to develop skilled labor force to ensure quality of construction
- Cost-effective rehabilitation methods
- Improvement in quality of materials
- Code development considering the multiple natural hazards in Haiti

Needs for Rebuilding for Resilience (2)

- Sustainable practices need to be included in rebuilding
  - Renewable energy (wind, solar, etc) , sustainable water systems, green buildings, sustainable materials, etc.
- Change in government and policies
- Training and Education

Keys to Successful Rebuilding….

- Leadership from Haitian government
- Support and leadership from Haitian Diaspora
- Need to rebuild education system
- Need to improve health system
- Training and job creation in Haiti
  - Must build technical capacity in Haiti
  - Rebuilding must serve as economic driver

The Future of Haiti….