Learning From Full-Scale Testing of a Rubble House

1. Overview
- The 2010 earthquake in Haiti killed over 300,000 people, and left thousands of families homeless and tons of rubble in urban areas.
- In response to this tragedy, replacement houses are being built by NGOs using welded wire baskets and rubble as an immediate and inexpensive solution for the needy.
- In August 2011, Southern Polytechnic State University and Conscience International initiated a research study to understand the seismic resistance of rubble houses.
- A 14’ wide, 20’ long and 8’ tall rubble house was built on SPSU campus, and then subjected to a series of static loads.
- The project depended on voluntary collaboration; over 600 labor hours was spent between students, faculty, and sponsors for construction.

2. Objectives
- Create a student-centered environment to support research and apply learned knowledge to real-life problems
- Increase students’ sensitivity to community issues; promote volunteerism
- Promote team-based learning and interdisciplinary collaboration
- Test and evaluate construction techniques on a full scale Rubble House

3. Participation

3.1 Summary of Construction Volunteer Hours

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture</td>
<td>67</td>
</tr>
<tr>
<td>Civil Engineering &amp; Technology</td>
<td>61</td>
</tr>
<tr>
<td>Computer Engineering</td>
<td>54</td>
</tr>
<tr>
<td>Construction Management</td>
<td>41</td>
</tr>
<tr>
<td>Computer Science</td>
<td>20</td>
</tr>
<tr>
<td>English</td>
<td>17</td>
</tr>
<tr>
<td>Industrial Engineering Technology</td>
<td>17</td>
</tr>
<tr>
<td>Mechanical Engineering &amp; Technology</td>
<td>12</td>
</tr>
<tr>
<td>Mechanical Engineering &amp; Technology</td>
<td>12</td>
</tr>
<tr>
<td>Other</td>
<td>11</td>
</tr>
</tbody>
</table>

Total: 431 Hours

3.2 Summary of Non-Construction Support Hours

<table>
<thead>
<tr>
<th>Support Activity</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty Support</td>
<td>50</td>
</tr>
<tr>
<td>Lab Testing</td>
<td>27</td>
</tr>
<tr>
<td>Public Relations</td>
<td>18</td>
</tr>
<tr>
<td>Project Management</td>
<td>15</td>
</tr>
<tr>
<td>Surveying &amp; Data Collected</td>
<td>6</td>
</tr>
</tbody>
</table>

Total: 792 Hours

Grand Total: 1223 Hours

4. Construction

4.1 3 Days Preparing/Pouring Foundation

4.2 5 Days Making Wire Basket Walls

4.3 12 Days Filling Wire Baskets with Loose Rubble

4.4 4 Days Applying Cement Wall Finish

5. Field Tests On SPSU Campus

Three field tests were conducted to assess mechanical behavior of rubble walls under static loads. Measurements were taken using displacement gauges, total stations, and 3-D point cloud laser scanner.

5.1 In-Plane Wall Test

5.2 Out-of-Plane Wall Test

5.3 Destructive Test

6. Results

Displacements were measured at varying load increments. The diagrams below display images acquired by the point cloud scanner, along with maximum deflection measured for each field test.

6.1 In-Plane Wall Test

6.2 Out-of-Plane Wall Test

6.3 Destructive Test

South Wall moved 3.5 feet before failure occurred

7. Conclusions & Future Plans

- Surveys indicate students involved were able to develop and apply skills learned in the classroom to the field, while helping the community. Further activities are being planned to engage more students and faculty.
- The rubble house demonstrated great resistance and ductility against applied static loads (more than anticipated seismic loads), proving to be a viable solution for low-income residents in earthquake stricken areas.
- Full-scale shake table tests are strongly recommended to verify seismic resistance of rubble houses as a future study.

Core Team Members

SPSU Faculty:
- Fatih Oncul, Ph.D, Asst. Professor
- Wasim Barham, Ph.D, Asst. Professor
- Metin Oguzmert, Ph.D, Asst. Professor
- Pavan Meadati, Ph.D, Asst. Professor
- John Lee, RLS, Lecturer
- Daniel Branham, RLS, Lecturer

SPSU Administration:
- Robin Fort, Ph.D, Dean
- Steve Kitchen, Senior Director

Field Supervisor:
- Jeremy Holloman, Conscience International, Inc.

SPSU Students:
- Jeffrey Lytle (CE)
- William Lotz (CE)
- Fatih Oncul (CE)
- Christian Bougoullion (CE)

Other:
- Bri Mason (CS)

Sponsors

- Applied Technical Services
- Atlanta Demolition
- C&W Contracting
- Steel, LLC
- Paul Lee