Assessment of Traditional Masonry-Wooden Building in Taiwan

Lin, Yu-Chun
PhD Candidate, Department of Architecture,
National Cheng Kung University, Taiwan

Chang, Ja-Shian
Professor, Department of Architecture,
National Cheng Kung University, Taiwan

Chen, To-Nan
Postdoctoral Fellow, Department of Architecture,
National Cheng Kung University, Taiwan

Shih, Chung-Hsien
Assistant Professor,
Tainan University of Technology, Taiwan
Outline

- Introduction
- Modeling and Assumptions
- Result of Pushover analysis
- Seismic Assessment by Capacity spectrum method
- Conclusion
Introduction

• The assessment is focusing on the system combined by **mortise-tenon jointed wooden frames**, **infilled wooden panel** and surrounding **masonry walls**.

• Multi-story cases are limited in Taiwan, and need to be well conserved and assessed for seismic performance.
Restoration Problem in Taiwan:

How do we know the strengthening is enough and not over-designed?
Octagonal Hall –
A case of Traditional masonry-wood historic building
FEM modeling
FEM modeling
Mortise-tenon joint behavior
Nonlinear hinge

Shear Hinge of Brick Wall (In Plane)

<table>
<thead>
<tr>
<th>Force/SF</th>
<th>Displacement/SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>0.5</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>0.9</td>
</tr>
<tr>
<td>E</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Axial Hinge of Wooden Panel Wall

<table>
<thead>
<tr>
<th>Force/SF</th>
<th>Displacement/SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>Pu/Pv</td>
</tr>
<tr>
<td>D</td>
<td>0.5</td>
</tr>
<tr>
<td>E</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Moment Hinge of Brick Wall (Out-of-plane)

<table>
<thead>
<tr>
<th>Moment/SF</th>
<th>Rotation/SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>0.95</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>0.9</td>
</tr>
<tr>
<td>E</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Moment Hinge of Mortise-tenon Joint

<table>
<thead>
<tr>
<th>Moment/SF</th>
<th>Rotation/SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>0.01</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>Mp/Mv</td>
</tr>
<tr>
<td>E</td>
<td>Mp/Mv</td>
</tr>
</tbody>
</table>
Result of Pushover analysis

**Y-dir Pushover Curve**
- Brick Wall + Wood Panel + Mortise-tenon
- Wood Panel + Mortise-tenon
- Mortise-tenon Joint

**X-dir Pushover Curve**
- Brick Wall + Wood Panel + Mortise-tenon
- Wood Panel + Mortise-tenon
- Mortise-tenon Joint

- **Drift of roof ridge (%)**
  - Base shear (Tf)
  - Wood panel failure
  - Brick wall out-of-plane failure
  - Brick wall in plane failure

- **Drift (%)**
  - Base shear (Tf)
  - Wood panel failure
  - Brick wall out-of-plane failure
  - Brick wall in plane failure

- **Drift (%)**
  - 0.59%
  - 4.9%
  - 0.62%
  - 9.9%
Capacity spectrum method – model simplification
Capacity spectrum method – Result of Y-dir

The graph illustrates the capacity spectrum method for the Y-direction. The x-axis represents the spectral displacement (Sd) in cm, while the y-axis represents the spectral acceleration (Sa) in g (g = 9.8 m/s²). The graph includes the capacity spectrum, demand spectrum (with PGA = 0.308g), and reduced demand spectrum (with PGA = 0.308g). Points P1, P2, P2', and P3 are significant points on the graph, each corresponding to specific spectral displacement and acceleration values. The damping ratios (ξ) for different points are indicated on the graph, with ξ = 5% and ξ = 9.0%.
Capacity spectrum method – Result of X-dir
Conclusion

1. The difference between x and y-dir is related to the layout of surrounding masonry wall and wooden panel wall.

2. If mortise-tenon joints are not pulled out, the wooden structure would not collapse even in large lateral deformation.

3. The wooden panel wall provides its major contribution to this performance.

4. For CSM, the flexible diaphragm of wood structural system could be simplified by story average displacements.
Detail of this paper:
No. 1383

Thanks for your kindly attention.

Detail of wooden wall panel:
Paper No. 1914