Timber Framed Masonry buildings, an earthquake resistance influenced traditional architecture

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Summary

1. Introduction
2. Study on existing buildings
3. Retrofit solution for heritage buildings with TFM structure
Timber framed masonry (TFM) buildings in non-seismic countries

- Germany
- Czech Republic
- Denmark
- United Kingdom

Heritage buildings
Timber framed masonry (TFM) buildings in seismic countries

- Romania
- Portugal
- Greece
- China
- Japan
- Turkey
- Italy
- Haiti
- India

Heritage buildings

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Recent earthquakes showed TFM houses exhibit slight to moderate, but don’t usually collapse. The damages are due to poor construction details and/or biological degradation. Out of plane collapse of the masonry panels also occurred, without producing total collapse.

Poor construction details for the connections

- Slide at column base
- Fractured beam end
- Pulled-out tenon

Less than 5% of TFM houses (Gingerbread) collapsed. The rest of them experienced light to moderate damages, just like in the Lushan earthquake, most likely due to poor construction details.

Experimental study on TFM mechanical behaviour – Tokyo Tech
Loading protocol – CUREE – Caltech standard protocol
Hysteresis of the TFM wall (S2 specimen)
Component materials tests
Experimental study vs. FEM analysis
Conclusions:

- TFM is very ductile! The masonry ensures strength and stiffness, while timber is responsible for the significant deformation capacity;
- The key points are the weak mortar and the embedment of the timber;
- Numerical modeling with FINAL software was successful, but it needs to be simplified.
- Considering the fact that for some countries the TFM are important heritage… we must protect them even from experiencing those light to moderate damages. So we further focused on a strengthening method using AFRP sheets.
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Conclusions:

- AFRP retrofit is beneficial for strength and stiffness of TFM;
- It is a suitable method for TFM walls located at the interior of the building, or if they are covered with finishing;
- FRP is very easy to apply;
- Simplified evaluation method estimates the contribution of the application of one AFRP strip as an increase of almost 15 kN to the shear strength of the wall;
- Design method will further be developed.
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