BEHAVIOUR OF WOOD-JOINTS UNDER SEISMIC LOADING

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Iran is located on one of the most important tectonic zones of earth, reaching from Portugal to the Himalayas with a lot of geographical crust. Statistic shows that there is nearly a heavy earthquake measured on the 6 Richter each 10 years whose results are large magnitudes of irreparable loss of life and property. The last one was Bam's earthquake measured on the 6.5 Richter scale in which 40,000 people were killed. Hence, design and construction of buildings based on technical rules is very important for our country. In this regard, utilization of construction materials which have good ratio of strength to weight and acceptable durability, and are light and more economic can improve the bahviour of structures under seismic loadings. This paper aims to show the behaviour of wood joints under seismic loadings. Table 1 shows the performance of wood-frame buildings in earthquakes. The low level of death in wood-frame constructions clears this fact that well-constructed wood-frame buildings provide safety to their occupants.

Table 1. Performance of wood-frame buildings in earthquakes (Building Performance Bulletin, 2003)

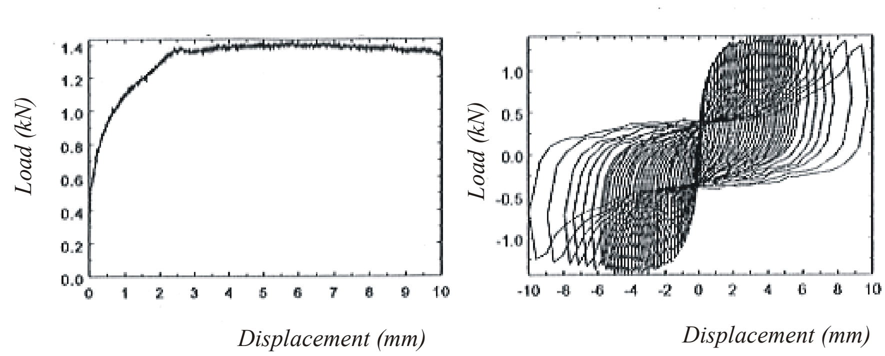
Earthquake	Richter Magnitude	No. of Persons Killed (Approximately)
San Fernando CA, 1971	6.7	63
Edgecumbe NZ, 1987	6.3	0
Saguenay QC, 1988	5.7	0
Loma Prieta CA, 1989	7.1	66
Northridge CA, 1994	6.7	60
Hyogo-ken Nambu, Kobe Japan, 1995	6.8	6300

Wood-frame constructions have the following acceptable features, which are critical for buildings' response under earthquake impact: strength and stiffness, ductility, weight, redundancy, connectivity. Compared with other materials such as masonry and concrete, wooden materials are light with acceptable stiffness. This is very critical for providing racking resistance during a heavy earthquake. Also, wood buildings are inherently more ductile which desirable for a building to have some flexing capability. This allows the structures to dissipate energy. Wood-frame construction is lightweight and if they are properly designed can perform well in earthquakes.

Connectivity is more important features for wood-frame buildings. Connections of walls, floors and roof farming make the frame a single structural unit which helps for holding of a building during an earthquake. Published literatures indicate that well designed wood-frame have acceptable performance and energy absorbing capability. The connections and their characteristics play important role in this regards, so the majority of investigations have been done in this filed.

Generally, wooden members show brittle failure under static load in tension, bending and shear. However, wood joints are capable of absorbing and dissipating energy, if they are designed appropriately. Smith et al. (1997) believe that the flexibility of connections enables cyclic forces to be distributed amongst fasteners (Figure 1).

Most published studies on the cyclic behaviour of timber joints are based on traditional fasteners, and has been reviewed in New Zealand. Ceccoti and Giorando (1990) stress that timber has a linear-elastic structural behaviour, but traditional fasteners embed themselves into the timber, which leads to plastic deformation.



(a) (b)

Figure 1. Load-displacement curves for single nail joints under (a) static load, (b) reversed cyclic load (Smith, 1997)

The performance of glued-in steel rods (as modern joints) under short cyclic loading was studied by Buchanan and Fairweather (1993) in New Zealand. They developed their test methods for designing new beam to column connections by use of epoxied steel rods and steel brackets. The results showed that in beam to column connections the use of steel brackets produced good results and they could be used in single or multi-story buildings. In general, they concluded that these joints have good potential for absorbing and dissipating energy between the members.

In this regard, glass fibre reinforced plastic rods were recommended as an alternative to steel rods in the UK, in 1996. The cyclic beahviour of these connections has been studied by Madhoushi and Ansell (2004). In general, the values of viscous damping ratio vary between 4% and 8%, which are reasonable magnitudes for this type connections (Figure 2). Finally, it can be concluded the connections are able to withstand reversed cyclic loading conditions although they are predominantly linear-elastic to failure under static loading. In generall, it can be said that ttraditional and modern timber connections can withstand the cyclic loadings conditions because of the energy dissipation.

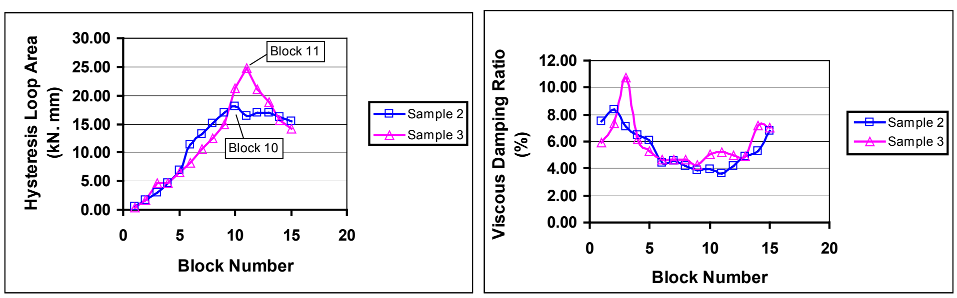


Figure 2. (left) Hysteresis loop area and (right) viscous damping ratio on the tension side of loop versus block number for frame samples under cyclic loading (Madhoushi and Ansell, 2004)

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