FRP STRENGTHENING OF FLANGED UNREINFORCED MASONRY WALLS SUBJECTED TO THE STRONG GROUND MOTIONS

Alireza MORTEZAEI
Assistant Professor, Islamic Azad University-Semnan Branch, Semnan, Iran
a.mortezaei@semnaniau.ac.ir

Mehdi KALANTARI
M.Sc. Student, Islamic Azad University-Semnan Branch, Semnan, Iran
Eng.mkalantari@gmail.com

Keywords: Flanged Masonry Wall, Seismic Rehabilitation, Seismic Behavior

The common heritage monuments in the world encompass unreinforced masonry structures, which are normally strong enough for the gravity loads, but are vulnerable against ground motion effects. Masonry walls are usually used as structural walls in these buildings. Properly maintained masonry walls can last a very long time and now they are used in particularly rural area of many countries in Europe, Middle East and so on.

Walls in masonry buildings usually have transversal walls, also called flanges (Figure 1). Those flanges increase the stiffness of the structural system and significantly improve the lateral capacity of the buildings (Haach et al., 2013).

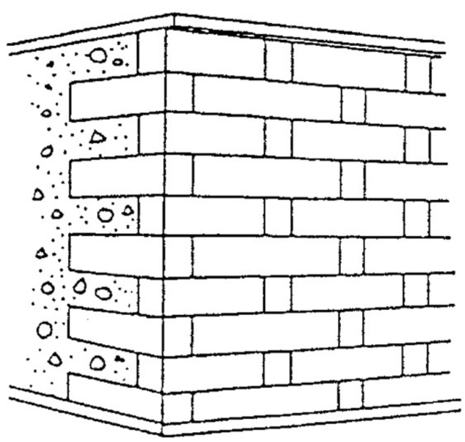

Figure 1. Typical flanged masonry wall

In seismic areas and in the load-bearing masonry buildings, walls are the main structural elements that declare the structural stability. These walls are often subjected to lateral loads from seismic actions, meaning that structural systems have to be designed to resist these types of loadings (Khanmohammadi et al., 2014).

Many of the existing unreinforced masonry buildings are seismically vulnerable and require retrofitting. In this study, the behaviour of 18 unreinforced masonry walls, before and after rehabilitation is investigated. Nonlinear dynamic analysis using a 3D-model is performed with the ABAQUS software program based on the finite element method. Each model was strengthened on the surface of two sides. A total of 7 records were selected to cover a range of frequency content, duration and amplitude. These records come from earthquakes having a magnitude (M_W) range of 6.2 to 7.3, and were recorded at closest fault distance of 0.0 to 7 km. Information pertinent to the ground motion data sets, including station, components of earthquake and peak ground acceleration (PGA) of components are presented in Table 1.

Table 1. Selected ground motion database

	Earthquake	Year	Station	Distance (km)	M_w	PGA-H_{max} (g)	PGA-H_{min} (g)
1	Gazli (USSR)	1976	Karakyr	5.46	7.1	0.718	0.608
2	Imperial Valley	1979	Bonds Corner	2.68	6.4	0.755	0.588
3	Morgan Hill	1984	Coyote Lake Dam	0.30	6.2	1.298	0.711
4	Erzican (Turkey)	1992	Erzincan	4.38	6.8	0.515	0.496
5	Landers	1992	Lucerne	2.19	7.3	0.785	0.721
6	Northridge	1994	Rinaldi Rec Stn	6.50	6.7	0.838	0.472
7	Kobe (Japan)	1995	KJMA	0.96	6.9	0.821	0.599

A parametrical analysis is carried out in order to define the influence of some parameters on the behavior of masonry walls. The results indicated that flanges have considerable influence on the behavior of masonry walls under flexure. Strengthening by means of GFRPs significantly improved the strength, deformation capacity, and energy absorption of the flanged masonry walls. The original failure mode of the perforated unreinforced brick wall clearly changed from shear to other failure modes, such as sliding mode, rocking mode, and mixed failure modes, due to FRP strengthening. The results show, FRP strengthening tend to increase the ultimate lateral displacement capacity up to 50%. The results also show that vertical and horizontal FRP sheets contributed to the closing of the diagonal cracks.

REFERENCES

Haach VG, Ramalho MA and Morrea MRS (2013) Parametrical study of unreinforced flanged masonry walls subjected to horizontal loading through numerical modeling, *Engineering Structures,* 56: 207–217

Khanmohammadi M, Behnam H and Marefat MS (2014) Seismic behavior prediction of flanged unreinforced masonry (FURM) walls, *Journal Earthquake Engineering,* 18: 759-784