# 5. How Confined Masonry Buildings Performed in Past Earthquakes

## *5.1 Introduction*

Confined masonry (CM) construction has evolved through an informal process based on its satisfactory performance in past earthquakes. The first reported use of CM construction was in the reconstruction of buildings destroyed by the 1908 Messina, Italy, earthquake (M 7.2), which killed over 70,000 people. Well-built CM buildings have survived the effects of major earthquakes without collapse, and in most cases without significant damage. CM tends to be forgiving of minor design and construction flaws, as well as material deficiencies, provided that the buildings have regular floor plans and adequate wall index *(WI)* values. Poor seismic performance has been noted only where gross construction errors, design flaws, and/or material deficiencies have been present in the building design and construction process. Poor seismic performance is usually associated with an insufficient amount of CM walls in one or both plan directions as quantified through *WI*, introduced in Chapter 4 and illustrated in Chapter 7. Other reasons for poor performance include inadequate size of RC tie-columns, deficiencies in RC tie-column reinforcement in terms of amount and detailing, discontinuous RC tie-beams, inadequate diaphragm connections, and inappropriate structural configuration (Meli et al. 2011). Earthquake-induced life loss in CM buildings has been insignificant in countries and regions where this technology has been practiced. This chapter provides an overview of the key factors which influence seismic performance of CM buildings and discusses performance of these buildings in past earthquakes which occurred in various countries.

## *5.2 Key Factors Influencing Seismic Performance of CM Buildings*

### Wall Index

Several research studies in countries like Mexico and Chile have confirmed a correlation between the *WI* and the extent of earthquake damage in masonry and RC shear wall buildings. Chilean researchers have correlated the *WI* values and the observed damage in more than 280 surveyed masonry buildings affected by the 1985 Llolleo, Chile earthquake (M 7.8) (Moroni, Astroza, and Acevedo, 2004). The surveyed buildings were of reinforced, confined, and hybrid masonry construction (consisting of a mix of CM and RC shear walls). The buildings were one- to four-storey high. It was concluded that a minimum *WI* of 1.15% or higher for each direction was required to avoid earthquake damage in these buildings. Masonry buildings with a *WI* in the range of 0.50 to 1.15% suffered moderate to severe damage, while buildings with a *WI* of less than 0.50% suffered heavy damage. An average *WI* for the Chilean CM buildings surveyed after the 1985 earthquake was estimated to be on the order of 3.3%. A study of CM buildings affected by the 2010 Maule, Chile earthquake (M 8.8) showed that, in general, CM buildings with a *WI* of 0.9% and higher remained undamaged, while buildings with a *WI* of 0.75% or less experienced damage for MSK shaking intensity of VII or higher (Astroza et al. 2012).