Post-earthquake inspections have highlighted that out-of-plane failure of unreinforced masonry (URM) walls is one of the most life threatening hazards related to earthquakes. Connections between structural elements and interlocking across the wall section play an important role in the capacity of a URM building to withstand earthquakes. Consequently, the seismic assessment of existing URM buildings requires an appropriate methodology to correctly estimate the performance of the investigated element. International standards and guidelines for seismic assessment are often based on simplified methodologies that incorporate assumptions regarding the collapse mechanism and general behaviour of the wall. Alternatively, the Discrete Element Method (DEM) is an advanced modelling technique that can accurately predict and simulate from wall behaviour to full scale buildings without any prior assumption about the failure mechanism. Solid rigid and deformable elements were used to represent the distinct clay brick units and an inelastic law was assigned to the contact surfaces to simulate the mortar joints. Pushover and non-linear time history analyses were conducted and the resultant capacity curves and collapse mechanisms of each analysis were studied.