MODELLING OF IN-PLANE BEHAVIOR OF MASONRY WALLS USING DISTINCT ELEMENT METHOD

Mehdi karimi[1], Ali laki rouhani[2]

1- M.Sc, Department of Civil Engineering, Zanjan University, Zanjan, Iran
2- Assistant Professor, Department of Civil Engineering, Zanjan University, Zanjan, Iran

mehdikarimi@znu.ac.ir
rou001@znu.ac.ir

Abstract

In most of masonry structures, walls are known as the major load-resisting elements. When an earthquake occurs, damage or failure in these elements could lead to total destruction of masonry structure. Due to low flexibility and poor shearing and bending resistance, masonry structures are highly vulnerable. Hence, correct recognition of masonry walls behavior under applied forces and their failure mechanisms could help in determining the resistance of masonry structures against earthquake and if they need retrofitting. One of the approaches in behavior modeling of discontinuous environments is the distinct element method, which is suitable for blocky structures analysis. This study focuses on the investigation of masonry walls behavior under vertical and lateral loads and verification of the distinct element method results using 3Dec software. The results obtained from distinct element method analysis were compared to the data resulted from experimental tests on two specimens, one with and the other without opening. Acceptable results in shearing capacity and failure mechanisms of masonry walls were obtained. Therefore, it is concluded that the numerical distinct element method could be used as a reliable method for studying the behavior of masonry walls.

Keywords: Masonry walls, Distinct element method, In plane behavior

1. INTRODUCTION

When an earthquake occurs, horizontal inertia forces are generated in structures (usually situated at the floor levels). In masonry structures, these lateral inertia forces, are transferred by shear walls to the foundation and finally to the soil system underneath. So, these structural elements must be designed to safely transfer these inertia forces through them. In recent decades, numerical modeling of masonry structures behavior has been widely considered. Numerical methods used for continuum modeling like finite elements method are not able to simulate the behavior of such structures accurately, because they cannot estimate the dynamic behavior of separated elements and interactions between them [1]. Distinct element method (DEM) could be represented as an ideal alternative to successfully analyze the discontinuous materials such as masonry structures. DEM has been progressively developed over the past two decades. Cundall (1971) [2], first introduced DEM to simulate progressive movements in blocky rock systems and the model has been implemented into computer programs UDEC and 3DEC since then. In DEM method, a solid is represented as an assembly of discrete blocks while Joints are modeled as interface between distinct bodies. Similar to the Finite Element Method (FEM), the unknowns in the DEM are also the nodal displacements and rotations of the blocks. However, unlike FEM, DEM is a dynamic process and the unknowns are solved by the equations of motion [3]. The speed of propagation depends on the physical properties of the discrete system.

2. THEORY

2.1. In-Plane Failure Mechanisms of Masonry Walls

Failure mechanisms of masonry walls are divided into four categories as shown in figure (1). Generally, masonry walls reach destruction at relative deflections of 0.0006 to 0.001. Higher values are available in reinforced walls.