



An Experimental Investigation into the Mechanical Properties of Brick Vaults and Adobe Piers- A Historical Case Study

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Abstract

Mechanical properties of masonry as a composite are strongly dependent upon the properties of its constituents. A comprehensive research study on the seismic behaviour of a masonry vault belongs to a historical building located in Yazd city has been carried out at the Yazd University, Iran. In this paper, the mechanical properties of brick vaults and adobe piers which are estimated by testing are reported. These results are employed for numerical investigation. The mechanical properties of units and mortars are also determined for comparing with the prism properties.

Keywords: units, mortar, prism, compressive strength, tensile strength.

1. INTRODUCTION

Masonry is a heterogeneous material composed of units connected by dry or mortar joints. As units, stones, adobes and bricks have been used which, can be joined together using mortar. In general, the approach towards its numerical representation is the micro-modelling of the individual components, viz. unit (brick, adobe, etc.) and mortar, or the macro-modelling of masonry as a composite [1].

In macro-modelling, units, mortar and unit-mortar interface are smeared out in the continuum. This approach does not make a distinction between individual units and joints but treats masonry as a homogeneous anisotropic continuum. One modelling strategy can not be preferred over another because different application fields exist for micro- and macro-models. Clearly, macro-modelling is more practice oriented due to the reduced time and memory requirements as well as a user-friendly mesh generation. This type of modelling is more valuable when a compromise between accuracy and efficiency is needed. Accurate numerical modelling of masonry structures requires a thorough experimental description of the material. However, the properties of masonry are influenced by a large number of factors, such as material properties of the units and mortar, arrangement of bed and head joints, anisotropy of units, dimension of units, joint width, quality of workmanship, degree of curing, environment and age. That is why one result to another can be distinct between two different case studies [2].

Several past studies have been carried out on the mechanical behaviour of the units and prism masonry. For example, Maheri performed standard tests on brick units, gypsum-clay mortar, and brickwork. These studies have focused on the design of jack arc masonry slabs that have been made by lightweight perforated brick and gypsum-clay mortar [3,4]. Recently, Ghannad et al. [5] and Kuata et al. [6] have determined some mechanical properties of local adobes. However, the mechanical properties of this kind of units, adobe prism and brick vault that have been calculated in our study, were not available anywhere.

Yazd, is one of the most ancient cities of Iran and many attractive historical buildings are located in this city which have been built by adobe with clay mortar and/or brick with gypsum-clay mortar. For retrofitting these cultural heritages, it needs to determine the mechanical properties of the building materials. In this study, the mechanical properties of a brick masonry vault that belongs to the Egbal historical complex are estimated by testing. This complex building was built for a textile factory called Egbal between 1932 and 1935. In the recent years, several restorations were made by the Yazd Science and Technology Park, including recovering and partitioning of the main saloon, and now the main office of many new established research and development companies are accommodated in there. The structural system of the roof is covered by brick vaulting systems, while the side piers are made by adobe. Figure 1 shows an external view and the geometry of the section in this case study building.