Compressive and Flexural Tests on Adobe Samples Reinforced with Wire Mesh

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Abstract. Adobe is an economical, naturally available, and environment friendly construction material that offers excellent thermal and sound insulations as well as indoor air quality. It is important to understand and enhance the mechanical properties of this material, where a high degree of variation is reported in the literature owing to lack of research and standardization in this field. The present paper focuses first on the understanding of mechanical behaviour of adobe subjected to compressive stresses as well as flexure and then on enhancing the same with the help of steel wire mesh as reinforcement. A total of 22 samples were tested out of which, 12 cube samples were tested for compressive strength, whereas 10 beams samples were tested for modulus of rupture. Half of the samples in each category were control samples i.e. without wire mesh reinforcement, whereas the remaining half were reinforced with a single layer of wire mesh per sample. It has been found that the compressive strength of adobe increases by about 43% after adding a single layer of wire mesh reinforcement. The flexural response of adobe has also shown improvement with the addition of wire mesh reinforcement.

1 Introduction

The word 'adobe' originates from Arabic but has been extensively used in Spanish to mean building material made from earth or mud, possibly mixed with some organic material. The predominant use of adobe is found in the Arabic, Persian, and Spanish regions of the world. It is understood to be a readily available material without requiring extensive skills for its use and is commonly associated with low-cost construction [1]. Generally, it is believed that the involvement of engineers and architects, and detailed designs, is not required when it comes to building with adobe.

The historical use of adobe as a building material has been documented in several research articles. It has been reported, for example, that the natural soil, earth etc. have been used as building material for over 11,000 years [2-4]. From the ancient city of Jericho to the Mesopotamian Ziggurats and Athens, and from Great Wall of China in the east to the Andean cities in the West, we can observe the use of earth as a construction material. Moreover, the use of earth as a building material can also be found in the civilization of the Indus, Egypt, and Greece. Vaulted structures can be found in the Central Asia dating from 4th century BC [5]. In Central Asia, the use of adobe masonry has been observed in buildings of importance such as monumental or religious nature [6], especially domed structures as well regular traditional houses [5-11]. Mud bricks have been used in the construction of shelters for several millennia [12], and approximately 30% of the human population lives in earthen structures to the present day [13]. The city of Shibam in south Yemen and the walls of Marrakech in Morocco are also mainly constructed with adobe. A very rich cultural heritage of earth building can be found in the present world, notably; Africa, Iran, Afghanistan, Yemen, Iraq, and Syria. Moreover, the use of earth buildings can also be found in Europe including Spain, Germany, England, France, Portugal, Italy, Denmark, and Sweden [14].

There has been an increased interest in this construction material and method by scientific and engineering community over the past 3 decades [15] as it can be witnessed that the published research in this field has increased about ten folds in the past decade and a half compared to the previous decade [16]. This is partly due to the fact that earth building provides a sustainable alternative to other construction materials and techniques, which are relatively more polluting. However, the ubiquitous acceptance of earth as a primary building material is hindered by certain issues such as vulnerability of this kind of construction to extreme actions such as earthquakes [17-18]. Another important challenge facing earth building is that the participation of skilled technicians, engineers and architects is generally deemed unnecessary. This results in non-engineered construction invoking insurance providers to set very restrictive conditions for subscription to the insurance coverage for earthen dwellings [14]. Last but not the least, there is a notion of

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