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REINFORCEMENT WITH FIBERGLASS COMPOSITES TO INCREASE THE SEISMIC STABILITY OF STEEL WALLS

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Annotation. This study aims to investigate the effectiveness of using fiberglass composite materials in the construction of brick walls to increase their seismic resistance.

Key words: brick walls, fiberglass composite, reinforcement, lateral forces, shear forces, seismic resistance.

G'ISHTLI DEVORLARNING SEYSMIK BARQARORLIGINI OSHIRISHDA SHISHA TOLALI KOMPOZITLAR BILAN MUSTAHKAMLASH

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Annotatsiya. Ushbu tadqiqot g'ishtli devorlarning seysmik ta'sirlarga bardoshliligini oshirish maqsadida ular konstruksiyasiga shisha tolali kompozit materiallarning qo'llash samaradorligini o'rganishga qaratilgan.

Kalit so'zlar: g'ishtli devorlar, shisha tolali kompozit (GFRP), mustahkamlash, lateral kuchlar, kesish kuchlari,seysmik bardoshlilik.

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Introduction. Brick walls are used as the main external and internal structural elements in many regions due to their low cost, widespread availability, and ease of construction. However, such walls are sensitive to earthquakes and have low strength, especially against lateral loads and shear forces. Therefore, in recent years, scientific research on strengthening brick structures with modern composite materials has been expanding. The study experimentally evaluated the effect of fiberglass fabrics and various reinforcement schemes on the resistance of brick walls to axial shear and bending forces. The results showed that fiberglass reinforcement slows down the rapid propagation of cracks in the walls, increases the ability to absorb deformation energy, and significantly improves the stability of the structure. Single-layer fiberglass reinforcement increased the compressive strength by an average of 31.2%, while double-layer reinforcement showed an increase of up to 19.7%. Resistance to shear forces is up to 43.5% improved. The strength indicators under axial load were recorded to increase by 16.7% -32.5%. Observations show that glass fiber composite layers reduce lateral deformations of brick walls, delay fracture in longitudinal compression and increase seismic resistance by more than 10%. The results obtained show that reinforcement with glass fiber composite materials is an effective and economically viable method for increasing the seismic stability, load-bearing capacity and overall structural reliability of brick walls. Main part. In this study, a comparison of clay brick walls reinforced with steel and fiberglass mesh with single brick walls, double brick walls and unreinforced walls was carried out, including experimental and numerical evaluation. The mechanical properties of fired clay bricks are related to compressive strength, splitting strength and water absorption. In addition, the compressive strength of prisms, The axial compressive strength of the walls and the shear strength of the walls are evaluated. Material properties and test methods. In this work, locally available clay bricks, steel mesh were also used in two layers. The dimensions of the bricks were 114.3x76x228.2 mm. Compressive strength, modulus of rupture and tensile strength tests were conducted for the single brick test. The average compressive strength of the bricks was 9.65 MPa as determined by ASTM C1314-23a (Figure 1a). The average modulus of rupture and tensile strength tested according to ASTM C1314-23a were 2.75 MPa and 0.65 MPa, respectively, as shown in Figure 1b,c. In addition, 50 mm mortar cubes were tested for compressive strength under ASTM C109 (Figure 1c). The average compressive strength of mortar cubes of type N (1:4 cement (relative to sand) was 18.509MPa after 28 days of hardening. The minimum required compressive strength of the mortar should not be less than 5MPa. The diameter of the steel wire mesh was 0.119 mm. The ultimate strength of the steel wire mesh was 0.06 MPa. The opening size of the steel wire mesh was 20x15 mm. The ultimate strength of the fiberglass mesh was 0.039MPa. The opening size of the steel wire mesh was 5x5 mm wide.

(a) (b) (c)

Mechanical testing: (a) compressive strength of brick (b) modulus of rupture of brick and (c) compressive strength of mortar cube. Wall preparation. The main objective of this work is to evaluate the strength of single and double brick walls reinforced with single and double layers of mesh and fiberglass mesh. To achieve this, 24 brick walls of the same size (700x700mm) for single and double brick walls were constructed in the laboratory according to ASTM C1717-19 for axial loading and ASTM E519/E519M-22 for diagonal loading, and were observed for at least 28 days.

The construction work was carried out by skilled craftsmen using materials that were convenient for the local population, including cement sand and clay bricks. Four walls were kept as controls for comparison. Twenty walls were reinforced with steel and fiberglass mesh in one and two layers using N type mortar (1:4 cement to sand ratio).

(a) (b)

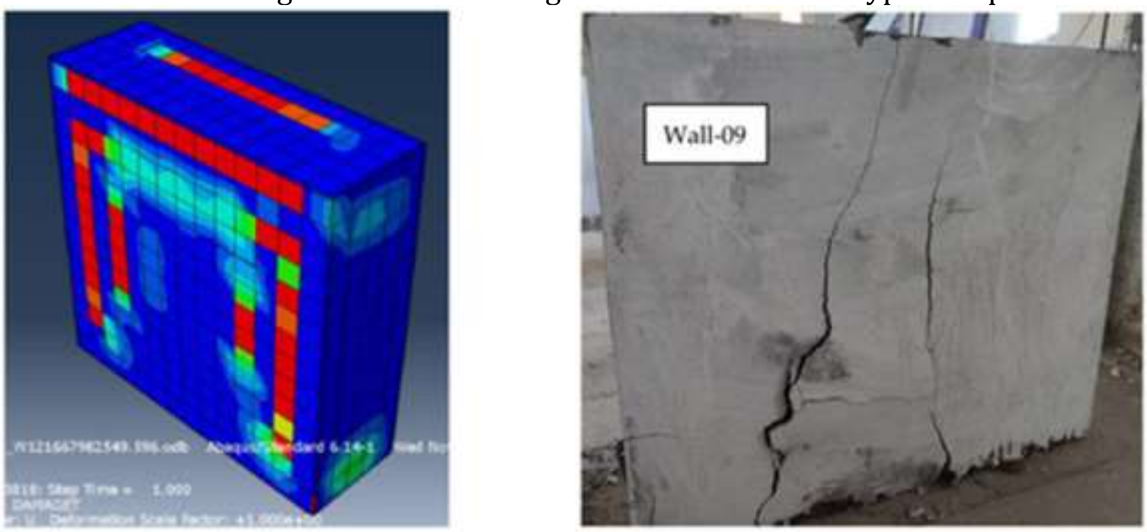
Figure 2. Prepared sample (a) unreinforced, (b) reinforced. As shown in Figure 3, the steel mesh samples were reinforced with steel mesh, and the fiberglass mesh samples were reinforced with fiberglass. All samples were reinforced symmetrically both horizontally and vertically on the front and back surfaces. The walls were then plastered with n-type mortar

(a) (b)

Illustrative views of different schemes: (a) steel mesh sample and (b) fiberglass mesh sample.

Single and double layer mesh and fiberglass mesh were used. The installation process was simple. First, a mesh grid was used to mark the points, then the walls were drilled at specific locations as shown in Figure 2. The mesh was secured using 1.2 mm thick Phillips screws and washers with inner and outer diameters of 5.5 mm and 40.6 mm, respectively. A total of 9 anchors were used on each face. The distance between each anchor was 345 mm in both directions. These meshes are significantly lighter than steel, making them easier to handle and install. However, they generally provide less improvement in compressive and shear strength compared to steel mesh. The steel mesh is placed diagonally, and the specimen was tested in the diagonal direction

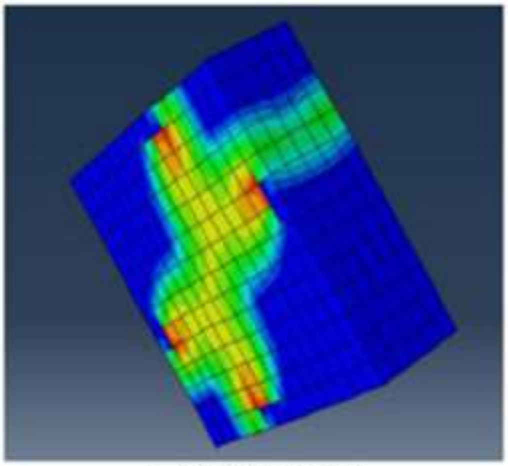
The load-deformation curves of the two-brick wall specimens are shown in Figure 4. The agreement between the experimental and Abaqus results was generally good, except for the two-layer mesh and the two-layer fiberglass mesh, where the differences were significantly higher in the maximum load values. This discrepancy is due to the non-uniform application of the wall mesh. The initial stiffness of the Abaqus models differed from the experimental results, which may be due to errors in load application and the uneven surfaces of the wall specimens. It is worth noting that the damage visualization of typical specimens is shown



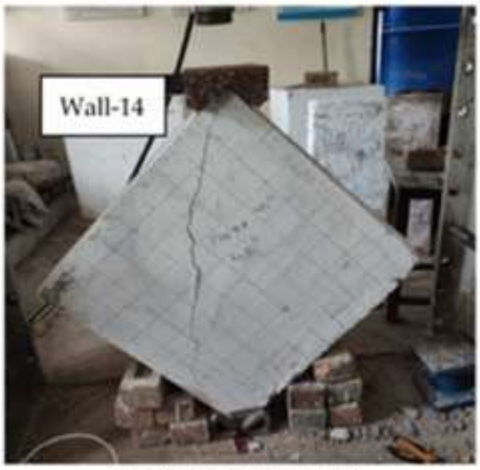
Wall-09-Analytical Wall-097-Experimental

Figure 5.

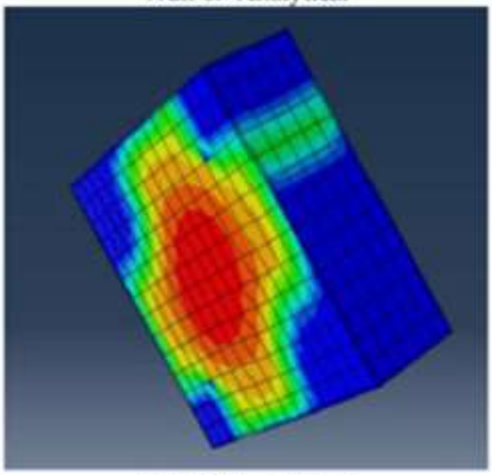
Typical comparison of failure modes. Brick walls were tested under axial and diagonal compression to evaluate their mechanical properties using one or two layers of steel and fiberglass mesh, and to evaluate the effect of reinforcement. Abaqus software was used to compare the experimental results with analytical simulations. Our next picture shows a typical comparison of incompetent regimes.



Wall-07-Analytical



Wall-07-Experimental



Wall-09-Analytical

Wall-097-Experimental

Conclusion. In this study, the strength properties of brick walls under axial and diagonal compression, as well as the effects of metal (steel), fiberglass mesh, and gypsum-based reinforcement, were studied experimentally and analytically. It was found that two-layer steel meshes had the highest axial and shear strength among all types of reinforcement. Fiberglass meshes also significantly increased the strength of the wall and improved its deformation capacity. Walls using gypsum, on the other hand, provided increased deformation, increased ductility, and had a positive effect on strength. According to the results of the study, the compressive strength of brick walls with two-layer steel mesh was significantly higher than that of single-layer reinforcement, increasing by 69.54%, 58.28%, and 25.83%, respectively. It was also found that the use of two-layer fiberglass mesh also increased the compressive strength by 80–112%. The comparison showed that the strength of brick walls using single-layer steel or fiberglass mesh increased by 19–39% compared to control samples. The results on shear strength also show that single-layer steel and fiberglass meshes increase the shear strength of walls by 46–117%. Double-layer steel meshes showed the highest results among all types of reinforcement and caused a significant increase in shear strength. The study shows that the effective transfer of load from brick to steel mesh improves the overall stress distribution of the wall and reduces crack propagation. In general, the use of steel and fiberglass reinforcements significantly improves the strength and deformation stability of brick walls. The effectiveness of double-layer reinforcements was proven to be higher than that of single-layer. These results are of great practical importance in increasing the strength of building structures, improving seismic resistance and ensuring safety.

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