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EVALUATION OF SHEAR STRENGTH OF HYDRAFORM DRY STACK MASONRY

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Abstract — *Shear failure of the structure is the major causes of many structures. In case of dry stack masonry, the shear resistance is totally based on the friction between the surfaces. Rough surface will have more resistance to shear as compared to smooth surface. In this paper shear strength of Hydraform dry stack masonry were investigated with the varying vertical load. Triplet test were conducted for finding coefficient of friction. It was find from the experimental results that coefficient of friction of Hydraform block masonry is 0.55*

Keywords- *Hydraform, Shear strength, masonry triplet.*

I. INTRODUCTION

Masonry has a rich history as one of the oldest and most widely used construction material. It was used for thousands of years until modem materials (i.e., concrete and steel) appeared in the 19th century [1], [2]. The worldwide use of masonry construction is due to its economical and easy to construction [3]. The important characteristics in masonry construction are the simplicity in construction. Laying different masonry units such as blocks, bricks and stones on one another, and without or with mortar in their bedding joints, is a simple, however appropriate technique that has been effective since remote ages. Other significant features are the strength, aesthetics, low-cost maintenance, sound absorption, durability, fire protection and versatility." [4]. Masonry structure is made of different masonry unit known as brick masonry, block masonry and stone masonry. The further classification of masonry construction is the binding of masonry units with the use of mortar and without the use of mortar.

1.1. Dry-Stack block masonry

Dry stack masonry refers to the method of construction of masonry structure, in which most of the masonry units are bind together without mortar [5]. The masonry unit may be of brick or block. The shape of the masonry units usually incorporates geometry that will provide an interlocking mechanism which laid in a specified fashion. Masonry without mortar in their bedding joints is considered as an extreme case compared traditional masonry structures. This is because there is close to zero thickness of mortar in joints. Under this condition, compressive strength and elastic modulus are significantly affected by the connection between bricks. Roughness and the hardness of contact can greatly affect the Interface behavior and is considered as a significant nonlinear behavior [3].

In past, it was experienced that earthquakes result several damages to masonry buildings and killed many people. In Pakistan, the earthquakes have threatened several areas and left deeper impacts. This is due to the reason that these regions are located in highly active fault lines which make the population of about 207.7 million vulnerable to this disaster [6]. Most of the damages in the structure and to the people among the past several earthquakes was October 8th, 2005 earthquake. According to an estimate, more than 0.455 million buildings were either fully or partially damaged [7]. These damaged building includes residential, public and commercial buildings. The damages in buildings /infrastructures are due to inappropriate construction techniques and less availability of design parameters. To minimize these damages, there must be proper construction standards and practices available, so that the design of the structure will be appropriate and having resistance to the applied earthquake forces.

This paper presents an experimental investigation of shear strength of Hydraform dry interlocking blocks. The experimental work includes the determination of friction between the dry stacking blocks by varying different vertical stresses on the blocks.

II. EXPERIMENTAL WORK

Hydraform blocks were used for finding the shear strength of masonry by using triplet apparatus. The schematic isometric view and the three-dimensional view along with the dimension of the block is shown in figure 1.

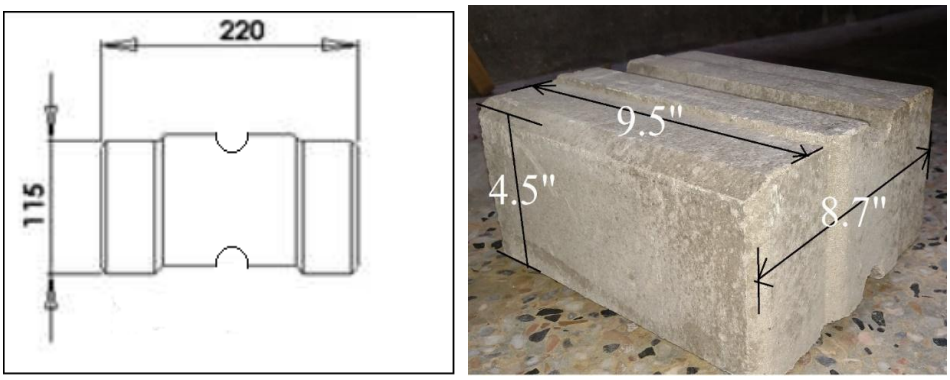

Figure 1 Schematic isometric view (left), Three dimensional view and average dimension of block (right).

Shear strength of masonry was found by using Triplet apparatus. The apparatus mainly consists of applying constant confining pressure (vertical load of the structure) to the control rate of shear force. Confining pressure was applied on the triplet of masonry manually, keeping the end blocks restrain, the middle block is sheared by control rate of shearing force. The shear force is applied by Universal Testing Machine (UTM). The apparatus used for finding the shear strength of masonry triplet is shown in Figure 2.

Figure 2 General setup of Triplet Apparatus (left), Middle block sheared in UTM (right)

Triplet apparatus consists of three steel plates having thickness 5/8" and length and width equals to 13" * 14" as shown in Figure 2. Out of three steel plates, hydraulic jack in installed in between two plates along with the proving ring (for the measurement of the stressed applied) and masonry triplet in between the other two plates. The middle block is kept free, while the end blocks were restrained. The surface resistance between the blocks was investigated by applying different confining pressure. The confining pressure was applied by hydraulic jack while force is recorded by data acquisition system of UTM. The shear strength is calculated as the total shearing load divided by the surface resisting area (2A). The relation between shear force and confining is developed and plotted. The experimental results are shown in Table 1.

Table 1 Shear resistance corresponding to the normal force in masonry triplets

Normal Stress (psi)	Shear Stress (psi)
40.60	32.48
58.00	29.58
69.60	32.19
69.60	28.71
69.60	23.78
87.00	62.64
87.00	52.78
98.60	70.47
87.00	47.27
116.00	58.58
116.00	63.22
116.00	56.84
127.60	69.02

Normal stress (vertical stress) on the block was calculated as the force divided by the two surfaces of the blocks while the shear force is calculated as the resistance force divided by the two shear resisting surface of the blocks.

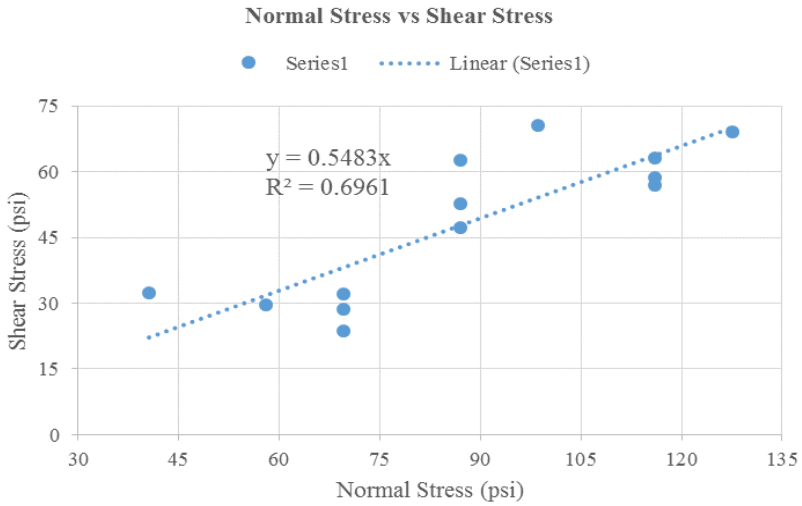

Figure 3 Linear regression analysis between normal and shear stress.

The graph is drawn between the shear stress and the normal stress through linear regression analysis. The intercept of the graph is zero because there will be zero cohesion in between the contact surface of the blocks. The average coefficient of friction is calculated as 0.55 with the fitness of the graph r^2=0.69.

III. CONCLUSIONS

The Co-efficient of friction of Hydraform is calculated as 0.55. The value of the coefficient of friction is compared with the normal clay bricks with mortar and without mortar and concluded as it is less than dry surface masonry (0.63-0.78) and almost equal to the normal clay brick masonry with mortar (0.57-0.60) report by [8].

IV. REFERENCES

[1] J. I. Velazquez-Dimas and M. R. Ehsani, “Modeling Out-of-Plane Behavior of URM Walls Retrofitted with Fiber Composites,” *ASCE J. Compos. Constr.*, vol. 4, no. 4, pp. 172–181, 2000.

[2] M. C. Francesco, “Sliding Shear Behaviour of Fibreglass Retrofitted Concrete Masonry,” McMaster University Hamilton, Ontario, 2006.

[3] K. Lin, Y. Z. Totoev, H. Liu, and C. Wei, “Experimental characteristics of dry stack masonry under compression and shear loading,” *Materials (Basel).*, vol. 8, no. 12, pp. 8731–8744, 2015.

[4] K. Mosalam, L. Glascoe, and J. Bernier, “Mechanical Properties of Unreinforced Brick Masonry,” pp. 1–26, 2009.

[5] R. Pave and H. Uzoegbo, “Structural Behaviour of Dry Stack Masonry Construction,” in *Sustainable Building Affordable to All: Low Cost Sustainable Solutions, Algarve, Portugal*, 2010, pp. 289–296.

[6] M. Ahmed, S. H. Lodi, S. S. Ali, and N. Alam, “Seismic Risk Assessment of Built Environment in Pakistan,” in *Earthquake Engineering and Seismology, Istanbul*, 2014, February 2016, pp. 25–29.

[7] K. Shahzada, “Improvement of Masonry Structures against Seismic Force,” Thesis, University of Engineering and Technology, Peshawar, Pakistan, 2007.

[8] M. . Hossain, Y. . Totoev, and M. . Masia, “Friction on mortar-less joints in semi interlocking masonry,” in *16th International Brick and Block Masonry Conference*, 2016, pp. 1635–1643.

[9] J. Hafeez, "Evaluation of Mechanical Properties of Dry Stack Block Masonry", Thesis, University of Engineering and Technology, Peshawar, Pakistan, 2018.

[10] Sturm, Thomas, Ramos Luís F, Lourenço Paulo B, " Characterization of dry-stack interlocking compressed earth blocks" *Materials and Structures/Materiaux et Constructions Structures*, vol 49, no9, pp. 3059-3074, 2015.

[11] M. . Hossain, Y. . Totoev, and M. . Masia, “Friction on mortar-less joints in semi interlocking masonry,” in *16th International Brick and Block Masonry Conference*, 2016, pp. 1635–1643.

