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EXPERIMENTAL INVESTIGATION ON THE SHEAR AND FLEXURAL BEHAVIOUR OF UNREINFORCED MASONRY WALL WITH FIBER GLASS MESH

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Abstract: Past earthquakes witnessed the poor performance of unreinforced masonry walls (URM) structures resulting into huge economic loss and large number of casualties. In this context, the present paper is aimed to investigate the shear behavior of a series of masonry walls under Diagonal compressive loading. To improve the wall behavior in shear, Polypropylene band (PP-band) and fiber glass mesh (FGM) are used as retrofitting material. Both faces of wall are wrapped to get full tightening effect during loading. This paper compares the shear behavior and flexural behavior of the unreinforced masonry walls with fiber glass mesh. The walls are constructed of full scale and half scale sizes. These walls are also compared with shear wall and the results of each particular wall are obtained. It has been observed that retrofitted walls exhibit significant improvement in terms of load carrying capacity and shear behavior. Failure mode of the walls are computed using analytical formulations. It was observed that both the strengthening materials not only increase the load carrying capacity but also helps in changing the failure mode from brittle to ductile in some extent. During the study, it may be concluded that the use of PP band and fiber glass mesh are effective in improving the shear behavior of masonry walls for all types of walls.

***Index Terms* - Unreinforced masonry wall, diagonal compression test, polypropylene band, fiber glass mesh.**

I. INTRODUCTION

Developing countries like India prefers living in brick masonry buildings as the cost of the brick masonry is lesser than other construction. Masonry building can withstand the gravity load. When the unreinforced masonry building is subject to an seismic loading it will brittle and collapse. The shear behavior refers to the shear capacity, transfer mechanisms and failure patterns exhibited by RAC beams under shear loading including cracking pattern, morphology, and propagation. The main parameters that influence the flexural behaviour are flexural reinforcement, concrete compressive strength, loading conditions, cross-section shape, shear span/depth ratio, and concrete mix design. To improve the masonry buildings ductility. The fibre glass mesh has been place over the PP-band for strengthening the wall. Fly ash bricks and clay bricks are been used to construct the walls. After riseing the wall pp-band were placed both the sides of wall in both fly ash brick wall and clay brick wall. Fiber class mesh has been placed over a PP-band to with stand the seismic loading. PP strapping is a tool used for packaging and bundling items. PP strapping is made of polypropylene (PP) material, and the strapping surface is made up of a woven pattern. The two available types include one for manual strapping and one for automatic strapping machines. Fiberglass mesh is used in insulation systems as a reinforcing layer external plaster, it is meant to prevent it from cracking and the appearance of cracks during usage. Crushed clay brick material has been used as aggregate in concrete since at least Roman times. 368,369. In modern times brick aggregate is used in some refractory concretes and sometimes as a medium-weight aggregate for structural concrete. Fly ash bricks competitive in comparison to the conventional clay bricks and provide enormous indirect benefits. As a result, construction of load-bearing unreinforced brick masonry structures has dwindled in these countries, and alternative forms of construction such as confined masonry or reinforced masonry, considered less vulnerable, have been developed instead. Masonry shear walls have distributed flexural reinforcement, while reinforced concrete shear walls often have longitudinal reinforcement concentrated in confined boundary regions. The diagonal compression test is usually adopted to determine the diagonal tensile strength of masonry fdt. It is worth pointing out that fdt corresponds to the tensile strength of masonry for a ratio $\sigma I/\sigma II \simeq -0.3$ and a loading direction angle 45°.

1.1 Objective

- Cost effective.
- This study presents a method for improving the shear and flexural behaviour of unreinforced masonry walls by using fibre glass mesh as reinforcing materiel.
- Diagonal compression test is conducted to find the in-plane and out-plane behaviour of the walls.

2. Materials and methods

2.1 polypropylene band

Polypropylene (PP), also known as polypropene, is a thermoplastic polymer used in a wide variety of applications. It is produced via chain-growth polymerization from the monomer propylene. Polypropylene belongs to the group of polyolefins and is partially crystalline and non-polar. Its properties are similar to polyethylene, but it is slightly harder and more heat resistant. It is a white, mechanically rugged material and has a high chemical resistance.

1.2 Fibre glass mesh

Fiberglass mesh is a neatly woven, crisscross pattern of fiberglass thread that is used to create new products such as tape and filters. When it is used as a filter, it is not uncommon for the manufacturer to spray a PVC coating to make it stronger and last longer. The most common place to find fiberglass mesh is in tape products. Dry wall finishers use the mesh frequently. In fact, it is common to replace the paper tape used to float the joint between two pieces of drywall. The mesh that drywall finishers use comes on a roll just like paper drywall tape. The added benefit for the drywall finisher is to roll out the mesh over a great distance before having to apply the first coat of joint compound. Not only does it help them in this manner, but it also causes a stronger bond between the joint compound, the tape and the wall. Dry wall finishers also use this tape to patch holes. The most common hole in the drywall generally occurs where a doorknob has hit a wall too many times. If it is only slightly damaged, a couple of short pieces of the tape will be formed into a square and placed over the hole. A joint compound will then be applied directly to it. If the hole is too large to patch with fiberglass mesh alone, a piece of metal flashing can be added behind the tape before applying joint compound. Construction work is not the only use for fiberglass mesh.

1.3 Fly ash brick

Fly ash bricks are well improved quality bricks. Which is for used for construction of masonry structures. From the industries and homes coal dust waste has been collected. In nineteenth century coal dust was used in the local brick works. Were the ash would be mixed with clay. Using this fly ash bricks is eco-friendly.

2.4 Clay brick

A clay brick is used for the construction of masonry structures. A brick is a Blocks composed of dried clay. Bricks are joint using mortar, adhesives and interlocking.

3 Result and discussion

3.1 water absorption test

The water absorption test is done with the oven dried specimens. For a specified time and at a specified temperature. After dried the specimen is cooled. After cooling it down the specimen is weighed. Then the specimen is emerged in water for 24 hours. After 24 hours the specimen is removed from the water and dried with cloth and the weighed. Both fly ash brick and clay brick are been tested.

3.2 Compressive strength test

Compressive strength test on bricks are done to find the load carrying capacity of the brick under compression test machine. Placing the specimen on the flat surface. And applying the axial load in a uniform rate. The loading will be done till the specimen fails. The load at failure is the maximum load at which the specimen fails.

3.3 Diagonal compression test

Diagonal compression test is done to determine the diagonal tensile strength of masonry are shear strength of masonry. It is assembled by loading them in compression strength along one diagonal causing a diagonal tension failure with specimen it splitting apart parallel to the direction of the load. The test setup consists of the loading shoes placed on two diagonally opposite corners of panel connected by four high strength steel rods fixed along compress diagonal.

3.4 Construction process

Full scale wall has a dimension of 500x500x300mm height, breadth and depth. Half scale wall has a dimension of 250x250x150mm height, breadth and depth. Both the sample are consisting of bricks, PP band and fiber glass mesh. PP-band has been placed over the masonry wall as a strengthening material. After one day of construction of wall. The PP band is placed over the wall and nailed. Another strengthening material fiber glass mesh is pasted over masonry surface. The walls are then plastered and the samples are cured.

Table 1 Compressive Strength Testing Results of bricks

Type of brick	Property	Value
Clay brick	Dimension (mm)	230x110x75mm
	Water absorption	16 %
	Compressive strength	3.434N/mm^2
Fly ash brick	Dimension (mm)	112x50x37mm
	Water absorption	18%
	Compressive strength	6.66N/mm^2

Table 2 Strengthening material properties

Type of material	Property	Value
PP band	Width	10mm
	Thickness	0.85mm
	Density	0.91 g/cm2
	Ultimate strength	142.22 MPa
Fiber glass mesh	Size of each rectangle in the mesh	5mmx5mm
	Diameter of the fiberglass mesh	2.5mm
	Ultimate strength	124.2 MPa

4 RESULT AND DISCUSSIONS

4.1 Shear Stress

The shear stress of masonry panel can be obtained by assuming the Centre of the panel is in the state of pure shear and the principal direction coincides with the two diagonals of the masonry wall. Therefore, shear stress which is identical to principal tensile stress can be obtained as:

$$\sigma_1 = \tau \max$$
$$= 0.707 \text{ P/An}$$

Being P is equal to the applied load and An is the net area of the wall which is equal to (w+h/2) t

where,

w and h are the dimension of the face and t is the thickness of the wall.

Assuming the applied load equals to the failure load (Pull), shear strength of masonry can be expressed

As τ_0 =o.707 Pult/An

Another explanation has been made by modelling masonry as a homogeneous and isotropic material that the centre of panel is not in a pure shear condition though principal plane still coincides with two diagonals. The values of the principal stress which is localized at the centre are as follows:

σ_{11} = 0.5 P/An;

σ_{11} = -1.62 P/An

To evaluate the shear strength of masonry, two different interpretations has been made. In first explanation, masonry shear strength is assumed to be equal to the ultimate principal tensile stress

$$\sigma_1 = \tau_0$$
$$= 0.5 \text{ Pult /An}$$

The second explanation calculates the masonry shear strength by adopting the Turnsek–Cacovic criterion in the values of ultimate principal tensile stress as follows

$$\tau_0 = 1/1.5 \text{ (0.5 Pult/An}$$
$$= 0.33 \text{ Pult/An}$$

n addition, shear strain of wallet is also computed to observe the deformation ability of wallet, by considering the normal strain, due to the diagonal compressive load as principal strain. The expression for maximum shear strain of masonry can be taken as:

$$\gamma\text{max} = \quad \theta c + \theta t$$

Where θ c and θ t are the compressive strain and tensile strain, respectively, along the diagonal direction. In present study, the relation of shear stress (τ_0) and shear strain (θ) of all the types masonry wall, is computed by analysing the recorded data of load and extension from load cell and LVDTs, respectively.

Table 4.1 Shear Strength

Type of wall	**Type of specimen**	**Failure load (kN)**	**Shear strength (MPa)**		
			τ_0= 0.707 Pult/An	**τ_0= 0.5 P ult/An**	**τ_0 = 0.33 P ult/An**
Full scale	Unreinforced	40.18	0.46	0.36	0.25
	Strengthened with PP band	54.92	0.62	0.43	0.4
	Strengthened with fiber glass mesh	60.18	0.69	0.52	0.36
Half scale	Unreinforced	21.02	0.98	0.67	0.48
	Strengthened with PP band	22.42	1.03	0.79	0.53
	Strengthened with fiber glass mesh	26.73	1.32	0.91	0.61

5 CONCLUSIONS

The following conclusions are drawn from the test resultsand discussions of this investigation.

- Diagonal compression test was done for unreinforced wall and strengthened wall.
- The PP-band and fiber glass mesh are the strengthened material used in the construction of masonry wall.
- The brittle failure of masonry wall was effectively prevented after using the strengthening material.
- The initiation crack along the loading direction was a failure in unreinforced masonry and PP band.
- Then fiber glass mesh has been placed as a retrofitting then the crac 2019)k has been noticed at the edge of mesh as it is an unreinforced region.
- Using fiber glass mesh support towards the shear strength of masonry wall.
- The shear strength of fiber glass mesh have strengthened the masonry wall as compared to unreinforced and PP brand strengthened

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