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PRE DISASTER MANAGEMENT STUDY TO ASSESS STRENGTH OF MASONRY WALL DURING DISASTER IN COMPRESSION

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ABSTRACT

Masonry structures are durable in nature and are resistant to severe variations in climatic conditions. They also accommodate minor earth disturbances and normally will not result in differential settlement of foundations. This is due to the fact that each layer of masonry wall behaves as a string of pearls and the theory of continuum mechanics can be effectively applied. The bricks are like pearls and the connected mortar layer remains as the string. It is this quality that makes the masonry structures highly resistant to severe weather conditions. Many very old masonry constructions built by our kings still remain as engineering marvels and some of them are still in active service, like the Thirumalai Naicker Mahal at Madurai, South India. It is quite interesting to note that there are different techniques with which masonry walls are built in many parts of the world. For example, British men call that technique as English Bond. Similarly there are different bonds like Flemish Bond, Header Bond, Stretcher bonds, Brick on Edges, Quetta Bond. The authors conducted experimental research on masonry wall panels of450 mm X 450 mm size, built with C.M. 1:5 in a linear scale of 1:3 with different masonry bonds, against compressive loading.

KEYWORDS: Wall Panels, Masonry Bonds, Compressive loading, Strengthening methods

INTRODUCTION

Brick masonry structures are easily built with locally available semi-skilled workers without much technical supervision. Most of the rural constructions are built with non-engineered masonry. When laying (Rectangular block of clay baked by the sun or in a kiln; used as a building or paving material) bricks, the manner in which the bricks overlap is called the bond. A brick laid with its longest side exposed is called a stretcher, as opposed to a header, where only the end of the brick can be seen in the brickwork. The thickness of brickwork is measured in units of brick. If you put some bricks down end-to-end with the long side facing you (stretcher) and then another row on top, the wall thickness half a brick. Bonds serve a variety of purposes, depending on the type of brickwork that is designed and built. By definition, a bond is an arrangement of built-up brick or other units laid so that their overlapping thoroughly ties the units together, which enables the whole to act as a unit in resisting stresses. Masonry has many handicaps like poor workmanship and poor construction details. The main factors governing the strength of a brick structure include brick strength, mortar strength and elasticity, bricklayer workmanship, brick uniformity, and the method used to lay brick. In this section, we'll cover strength and elasticity. Every country has developed separate standards of code for masonry construction. The style in which the header and stretcher courses are built is called a masonry bond. There are many famous masonry bond like English bond, Flemish bond, Header bond, Stretcher bond, Quetta bond, English cross bond etc., every bond has got some unique feature. The authors make a sincere attempt to study the performance of various bonds adopting a model study of scaled down masonry wall panels with the linear scale factor of 1:3.The outcome of the project to support construction community the proper type of bond for extreme bonding conditions.

TEST SETUP

In order to conduct experimental test on the masonry wall panels it is decided to have model analyses using small sized brick adopting a linear scale factor 1:3. Special mould are prepared using teak wood shutters and the brick clay is used to cast the small sized brick of 70mm length, 40mm width and 25mm thick. Wall panels are built for a size of 450mm length, 450mm height and 70mm thick adopting scale factor of 1:3 representing the real size masonry of size 1350 X 1350mm wall panel. These wall panels are built employing all types of bond.English bond, Flemish bond, quota bond, stretcher bond, header bond, diagonal bond. In every type of bond control specimen and treated specimen are built using a cement mortar 1:5 adopting a mortar thickness of 7mm, which is one-third of the real mortar thickness. These specimens are subjected to out- of plane bending by incremental loading and the results are compared with that of the control specimen of same bond and with other types of bonds. Masonry wall panels are tested for vertical compressive loading and lateral out-of plane loading and the results are compared with that of different specimens built in different bonds.

1. These specimen were tested with Glass Fibre Reinforced Polymer lamination (GFRP lamination) and these wall specimen were tested by compression testing m/c for vertical loads.
2. Brick wall panels are treated with GFRP lamination of different configurations and they were tested for out-of plate bending by inducing lateral bonds using a hydraulic jack fitted on to a metal frames.
3. The authors have analysed these results and suggest suitable types of masonry bond for masonry construction.

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4. Load Vs deformation charts were plotted for different strengthening and the results are discussed with that of control specimens untreated for different type of bonds.

RESULTS AND DISCUSSIONS

English bond failed at 88KN and developed initial crack at 80KN, the vertical deformation at collapse was 1.5mm with a longitudinal strain of 0.0033. The horizontal strain was 0.001. This sample is taken as control specimen and the results are compared with that obtained with other type of bonds.

Flemish bond developed initial crack at 36KN and failed at 58KN. The vertical deformation at failure was noted as 1.88mm amounting to a strain of 0.0042, the horizontal deformation was around 0.35mm to the strain about 0.001.The strength of flemish bond was around 66% as that of english bond at ultimate load. The reduction in ultimate strength in flemish bond than the english bond may be due to near about close vertical joints in flemish bond, it was also absorbed that closely packed vertical cracks running through all vertical joints connecting horizontal joints also. The header bond developed initial crack at 45KN and collapsed at 56KN. The longitudinal deformation was about 1.48mm amounting to a strain of 0.003, the horizontal deformation was 1.62mm amounting to a lateral strain of 0.004. This indicates lateral bulging at collapse load. The strength of header bond was around 64% as that of english bond. The lateral strain is about 40% more than that of english bond. Thus header bond tends to develop vertical cracks because of close vertical joints which tends to lateral bulging.

The quetta bond developed after the earthquake at quetta is cellular in nature creating a vertical column gap and this gap could be filled with PCC in case of normal vertical gravity load. Quetta bond can also be strengthened using longitudinal reinforcement in column gap provided and packed with concrete. The nominal reinforcement used is either 8mm or 10mm rods. Quetta bond without steel developed the same strength as that of English bond and about 25% more than that of Flemish bond around 20% more than that of header bond.

CONCLUSIONS

1. The longitudinal deformation is about 3mm amounting to a strain of 0.0063 thus it is been that this bond could accommodate more longitudinal strain before collapse exhibiting more ductility.
2. The Quetta bond with steel performed extremely well with about 135KN at initial crack is 173KN at collapse. This amounts to an increase of 31% more strength than that of English bond.
3. The longitudinal strain and the lateral strain was around 0.0014 which shows that there is no much disturbance on the geometrical in both lateral and longitudinal direction even at the time of collapse.
4. The project participants hereby conclude the following observations which could be useful as a valid database to the construction industry for proper implementation.
5. The performance of English bond remains the superior when compared with Flemish bond, header bond and quetta bond showing a clear margin of 40% more strength than that of the next stronger flemish bond. This could be mainly due to the judicious planning of staggering of vertical joints in english bond.
6. Quetta bond with steel remains stonger than that of english bond by around 30% and can be used in case of construction with higher service load but the thickness of quetta bond has to be kept as 1.5 times that of normal bond i.e., the wall thickness will be .345mm.
7. Thus for one brick construction with 230mm thickness english bond remains superior when compared to other bonds. For higher service load quetta bond could be a better choice with increased wall thickness of 345mm.

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