Research Paper Engineering

Dry Stacked Masonry-Present Scenario - 2

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ABSTRACT

Greater speed of construction and better dimensional stability has generated lot of research interest in dry-stacked masonry. Researchers have also reported better structural response of dry- stacked masonry under lateral loads. In this paper we have discussed about some basic tests performed on self made interlocking masonry wall system. In present work, an attempt has been made to make people aware about the newly developed interlocking dry stacked masonry system and its advantages as compare to conventional block masonry.

Keywords : Dry-stacked masonry, Constructability, Structural response, Basic tests.

Introduction

Masonry is very well known building material in construction industry since years. Dry-stacked masonry is fast becoming an accepted form of masonry construction worldwide as it provides faster, easier and structurally sound construction. In this masonry system, masonry units are assembled together using the geometric features without the use of mortar at the joints. However, some systems use mortar as a base course whereas in few other systems geometric assembly is grouted. These masonry units may have solid or hollow shape. Concept of mortar less interlocking masonry started in mid 80s. Few of them got patented and are listed below,

1. Haener Block (http://www.haenerblock.com)
2. Azar Block (http://www.azargroup.com)
3. Sparlock (http://www.sparlock.com)
4. Endura block system (http://www.endurablock.com)
5. Hydraform system (http://www.hydraform.com)

Initial Trials and Arriving At the Shape of the Block:

First type of block was the normal 'C' shape in combination with 'I' shape. This shape was easy to cast and may have perform better under axial loading but under the lateral loading it might not have perform better. After that the next shape tried was the only 'I' shaped blocks but with this shape sufficient interlocking was not possible. Then the next shape tried was again 'C' shape but this time it was slightly modified than the older one and in this shape it was tried to overcome the last difficulty of getting out of block under lateral loading. The problem with this shape was that there were many internal corners in this shape of the block which makes casting of this type of block was very much difficult. In order to reduce this difficulty final shape of the block was arrived in which the numbers of corners were reduced. The block properties are listed in the table 4.1. The conventional masonry blocks were also casted in the laboratory to compare the performance of interlocking block masonry. Different mix designs had been also tried to get the idea about the strength, workability, w/c ratio for the casting of the blocks. And finally a mix proportion of 1: 2: 3 was used to cast the blocks with the water cement ratio of 0.6.

Compression Testing:
Experimental Setup:

We have fixed two small frames at 15cm c/c distance with two dial gauges provided for measuring the strain on both test specimen made up from interlocking blocks and conventional blocks. The deformation of the wall measured at the interval of every 5 units of the compression testing machine. The loading was applied till the failure of the wall. The load verses deflection diagram and stress-strain curve was plotted for both types of masonry wall pallets.

Figure 2: Experimental set up of compression test.

Result and Analysis:

The compression test was performed to obtain and compare the compressive strength of the interlocking block masonry. As the load increased the deformation in the dial gauges was also increased till the load reaches value of 113.5 KN after that the deformation was increasing but the load was decreased. The compressive strength of this comes out was 8.11 N/mm2. Where as in case of the interlocking block masonry as the load applied the deformation of the wall increased massively. This may be attributed to the closing of the gaps between the blocks. After the closing of the gaps the increment in the deformation of the wall was linearly with the loading till the maximum load of 150kN reached and then the wall pallet had not take much load and not shown much deformations as well and as it failed suddenly. The compressive strength of interlocking blocks masonry wall pallet was found out to be 10.107 N/mm2. Using these Results the stress-strain curve of both the wall pallets are plotted and compared in the graph below figure 3.

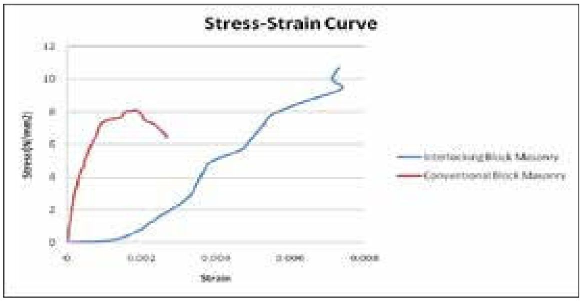


Figure 3: Stress-Strain curve of Interlocking & Conventional blocks masonry.

The stress-strain curve of the conventional masonry was very much linear from beginning of the test to the failure of the wall sample. However the stress-strain relationship of the interlocking block masonry was somewhat bilinear. The first part of the curve was resulted from the initial settlement of the block irregularities and uneven surface, while the second part of the curve was resulted due to deformation of the block units.

The failure pattern of both the wall pallet was also showed some differences. The failure of the conventional block masonry wall pallet was somewhat expected, the cracks started along the edge of head joint and propagates through the units above and below (Figure 4). Whereas the failures of interlocking block masonry wall pallet was very much different. The interlocking blocks masonry failed due to the shearing of at the flanges of the units rather than compression.

Figure 4: Failure pattern of Interlocking block masonry and Conventional block masonry.

Flexural loading test:
Experimental Setup:

To determine the flexural capacity of interlocking blocks masonry wall flexural loading test was performed. A wall pallet of size 350 mm X 750 mm was prepared using the interlocking blocks. It was rested on the two I sections as I section was used as a support (figure 4.7). A load was applied using the proving ring at the rate of 0.125mm per minute. A square iron rod was used to apply the load evenly on the wall sample. The deflection was measured at every five divisions using the dial gauge attached with the loading frame. The load was increased gradually and the test was conducted until the wall sample failed.

Figure 5: Experimental setup for flexural loading test

Result and Analysis

Load was applied at the gradually rate of 0.125mm per minute. After making some initial adjustments the wall started to take the load and the same indicated in the dial gauge as it shows the deformations after some time. The deformation increased linearly with the load till the load reached the maximum value after that the masonry failed suddenly.

The tensile strength of the masonry was also found out which came out to be around 12% of the compressive strength of interlocking block masonry. From this value it was quite clear that the flexural tensile strength of interlocking block masonry is higher than the flexural tensile strength of conventional masonry. The failure of the wall pallet was a sudden failure in which the cracks started to develop at the flanges and diagonally propagates through the joints

Shake table testing:
Experimental Setup:

In order to evaluate performance of interlocking block masonry under the earthquake loading out of plane shake table testing was carried out. A wall pallet of size 750 mm X 750 mm was casted. Dynamic loading was applied to the Wall pallates made from Conventional Block masonry and from interlocking block masonry to study their performance under earthquake conditions. Sixteen channel vibration analyzer was used to measure the acceleration of the shaketable and walls. Figure 6 Shows 1) Two walls resting on Shaketable. 2) Sensors fixed on wall by using sensorgum and paper tape. 3) Sixteen channel vibration analyzer. 4) Computer.

Figure 6: Experimental set up for Shake table testing.

Result and Analysis:

Dynamic loading was applied to the interlocking block masonry using the shake table to study its performance under earthquake conditions. Sixteen channels vibration analyzer was used to measure the acceleration of the shake table and wall. As soon as the intensity of the shaking was increased the wall built using the conventional block masonry failed (indicated with blue circle in figure 7(b). After that when again the intensity of shaking was increased the wall built using interlocking blocks failed (indicated with red circle in figure 7 (c)). The response of the both the wall was calculated using the methods based on interpolation of excitation (piecewise exact method) and the natural time period and maximum deformation was calculated. The natural time period for the conventional masonry wall pallet comes out to be 0.05 seconds whereas it was 0.2 second in case of interlocking block masonry wall pallet.

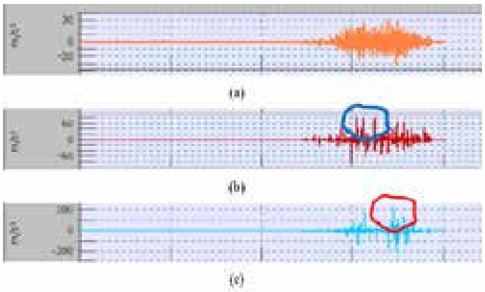
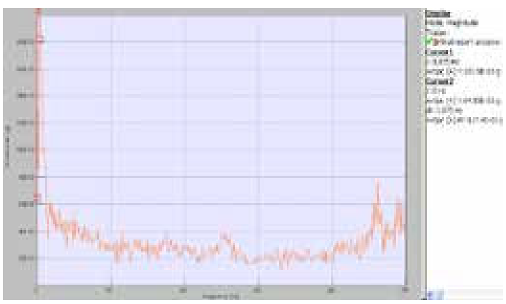
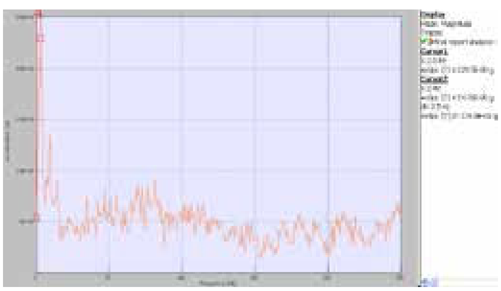


Figure 7:- Time v/s acceleration record obtained from vibration analyzer for (a) Shake table, (b) conventional masonry wall pallet, (c) Interlocking block masonry wall pallet

The response was plotted against time for conventional masonry wall pallet as well as for interlocking block masonry wall pallet. From this response it is quite clear that the maximum deformation of the interlocking block masonry is more than the conventional masonry and so it is clear that the interlocking block masonry wall has absorbed more energy than the conventional block masonry wall. This is also indicated through the analyzer that the interlocking block masonry failed at acceleration of 0.23g while the conventional block masonry failed at the acceleration of 0.18g (figure 8).



(a)



(b)

Figure 8: Frequency v/s acceleration diagram for (a) Conventional block masonry (b) Interlocking block masonry

Both the wall failed at the bottom of the wall figure 9 which was expected.

(a) - (b)

Figure 9: Failure of (a) Conventional masonry wall pallet, (b) Interlocking block masonry wall pallet

Conclusion:

Following are some of the conclusions drawn from the study

- The compressive strength of interlocking block masonry is better than the compressive strength of conventional masonry. The compressive strength of conventional block masonry wall pallet obtained was 8.71N/mm2 while it was 10.107N/mm2 for the interlocking block masonry wall pallet, which is around 16% more than the conventional block masonry.
- The initial deformation of the interlocking block masonry is very high, due to which the initial modulus of elasticity of interlocking block masonry is very low although that will increase with the advancement in the loading.
- The flexural strength of interlocking block masonry is higher than the conventional mortar joined block masonry. It was about 12% of its compressive strength.
- The interlocking block masonry has also performed better than the conventional block masonry in carrying the lateral loads amd interlocking block masonry has absorbed more energy than conventional masonry before failure.

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