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EXPERIMENTAL INVESTIGATION ON MASONRY WALL TO CONSTRUCT EARTHQUAKE RESISTING STRUCTURE USING COMPRESSION TEST

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ABSTRACT

Civil engineering is core branch and helping society long years ago. We know that there are three basic needs of human beings i.e. food, clothes & shelter. Among these needs for shelter, somehow people depend on Civil Engineers. Due to Natural Calamities such as Tsunami, Landslide, Earthquake etc, various structures get disturbed and lead to loss of life and property damage.

To overcome this issue there is need to construct earthquake resisting structure using various techniques. In this paper efforts made on the use binding wire to resist vibration during earthquake. Binding wire used holds the structure in place and provides strength and ductility to the structure.

Experimental work is carried out of different combinations of models for compression test using compression test machine. This study will play vital role in construction of earthquake resisting structure. This technique will prove revolutionary in modern construction technology.

Key Words: Masonry, Compression Test Machine,

I INTRODUCTION TO MASONRY

Basically two types of masonry are there:

1) Stone Masonry

2) Brick Masonry

1.1 Crack pattern

Cracks may appreciably vary in width from very thin hair crack barely visible to naked eye to gaping crack. Depending upon the crack width cracks are classified as :

(a) Thin Crack - less than 1 mm in width,

(b) Medium Crack - 1 to 2 mm in width,

(c) Wide Crack - more than 2 mm in width.

(d) Crazing - Occurrence of closely spaced fine cracks at the surface of a material is called crazing.

Cracks in walls

Cracks in walls can be further grouped as:

1. In masonry structure
2. In RCC frame structure
3. In free standing walls

Cracks at ceiling level in cross walls:

In load bearing structures, where a roof slab undergoes alternate expansion and contraction due to temperature variation, horizontal cracks may occur (shear cracks) in cross walls, due to inadequate thermal insulation or protective cover on the roof slab. To prevent such cracks, the following measures may be adopted:

a) Over flat roof stabs, a layer of some insulating material having good heat insulation capacity, preferably along with a high reflectivity finish, should be provided so as to reduce heat load on the roof slab. In Western India, it has been a common practice to lay a layer of broken china in lime mortar over lime concrete terracing which, because of high reflectivity coefficient reduces heat load on the roof and at the same time gives a good wearing and draining surface on the terrace.

b) Slip joint should be introduced between slab and its supporting wall, as well as between slab and cross walls.

Cracks at the base of a parapet wall:

An instance of very frequent occurrence of thermal cracks in buildings is the formation of horizontal crack at the support of a brick parapet wall or brick-cum-iron railing over an RCC cantilevered balcony. Factors, which contribute to this type of cracking, are:

a) Thermal coefficient of concrete is twice that of brickwork and thus differential expansion and contraction cause of horizontal shear stress at the junction of the two materials.

b) Drying shrinkage of concrete is 3 to 4 times that of brick masonry.

c) Parapets are generally built over the concrete slab before the latter undergone its drying shrinkage fully, and

d) Parapet or railing does not have much self-weight to resist horizontal shear force at its support caused by differential thermal movement and differential drying shrinkage.

The following measures may be adopted to reduce the severity of such cracking.

a) Concrete for slab should be of low shrinkage and low slump.

b) Construction of masonry over the slab should be deferred as much as possible (at least one month) so that concrete undergoes some drying shrinkage before construction of parapet.

c) Mortar for parapet masonry should be 1 cement: 1 lime: 6 sand and a good bond should be ensured between masonry and concrete.

d) Plastering on masonry and RCC work should be deferred as much as possible (at least one month) and made discontinuous at the junction by providing V-groove in plaster. This way the cracks if they occur, will get concealed behind the groove and will not be conspicuous. Alternatively, a 10 cm. Wide strip of metal mess or lathing may be fixed over the junction to act as reinforcement for plaster.

Binding wire

Binding wire shall be 16 or 18 gauge annealed wire conforming to IS 280. It shall be free from rust, oil, paint, grease, loose mill scale or any other deleterious material undesirable for the reinforcement and concrete or which may prevent adhesion of concrete with reinforcement. Binding wires are made from high quality carbon steel making them highly resistant to corrosion and abrasion. In RCC work where we use MS steel bars either plain or ribbed or tor, binding wires are used to bind the steel bars to each other at appropriate place according to design at a spacing defined by the drawing. The steel bars should not be disturbed while lying cements concrete in any of member such as column, beam, slab wall etc. If the bars are disturbed than it will reduced the strength of RCC. So proper binding is necessary to intact the steel bars. Binding is usually done by hand with the help of hand tool but in heavy work big diameter steel bars some time bind with the help of welding. Its tensile strength is half hard i.e. the Tensile Strength: 250-430 N/mm^2 and Elongation: 40 % @ measuring length of 5.0 x dia.

Fig: Binding Wire

II AIM

This research focuses on the study of Masonry wall to construct earthquake resisting structure. Within the scope of this study, the main goals were, to investigate the possibility of the following aims:

1. To study the effect of vibrations on the structure and provide alternative way to reduce it.

2. To determine the possible method to reduce the displacement in the structure.
3. To find the importance, feasibility and economical aspect during construction of the structure.

III OBJECTIVES

The aim of this research was achieved through the following objectives:

1. To investigates the effect of compressive strength on the model using CTM.
2. To find the comparative results of Experimental models.

IV SCOPE OF PROJECT WORK

A lot of research can be conducted in this field. Already, a lot of scientists are involved in extensive research in this field. This technology can become one of the major technologies in the near future. If this technology can be used efficiently, we might soon have no loss of life as well as property. It will be cleaner and greener and the future of mankind will be safe. As a multi-disciplinary field of engineering, the design of earthquake-resistant structures is at a threshold from where many exciting developments are possible in the coming years.
The idea collected from model made by IIT, Roorkee which was telecasted on NDTV. This concept is totally different from any other earthquake resistance techniques with unique creative method of use of waste for saving lives and preventing hazards of the earthquake.

V LITERATURE REVIEW

5.1 General

The research study began with a review of relevant literature reflected from textbook, professional journals, conference paper, referred publications & internet information captured background knowledge about study of Masonry Wall to construct Earthquake Resisting Structure. The objective the literature review was to develop a frame for a research study.

Various literature reviews on study of soft storey to construct earthquake resisting structure:

Vaibhav Singhal, et al. (2014)

In this research, they have focused on Experimental small-scale modeling of clay brick masonry for behavior up to failure. They made small-scale bricks and creating masonry that not only meets necessary similitude laws but also accommodates the requirement of artificial mass for shake-table tests. In addition, the stress and modulus ratios should be unity for model and prototype masonry in all loading conditions. The suitability of the half-scale bricks, produced in the same manner as the prototype, was studied through several material tests on brick units and masonry

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assemblages. Tests for compressive strength, water absorption, and initial rate of absorption were conducted on brick units. Axial compression, shear, tension bond, flexure, and diagonal compression tests were performed on brick masonry assemblages. These results validate the suitability of half-scale bricks to predict the behavior of prototype masonry assemblages up to failure under various loading conditions.

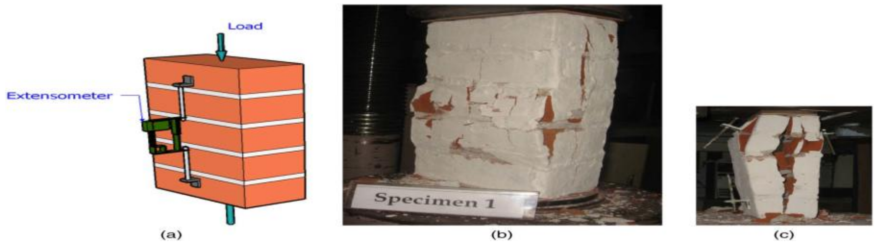

Figure: Compression Test [Source- Vaibhav Singhal]

Dr. Mizan Dogan, et al. (2002)

In this research, they have focused on the investigations on soft storey conducted in quake region of Izmit and Duzce, was on the investigation of effect of soft storey on the behaviour on the construction. Also solutions were investigated for making soft storeys in the present constructions and in the ones to be built resistant to quake. It covers the studies that were conducted in the quake area of Izmit (Mw= 7.4, August 17, 1999) and Duzce (Mw= 7.2, November 12, 1999). They have concluded the study with drawbacks and stages of preventing of soft storeys. They have surveyed the structures which were damaged due to earthquakes in Izmit and Duzce, they found out that nearly 85-90% of the collapsed and damaged buildings had soft storeys in them.

Fig: Damage of Izmit earthquake. [Source- Mizan Dogan]

During an earthquake, more moment and shear strength fall on the columns and walls in the entrance floors than the one in the upper storeys. Due to the fact that there is less rigidity in soft storeys, the structure is divided into two sections in terms of structural behaviour; the lower and the upper part of the soft storey. This can be called dangerous storey instead of soft storey. Upon investigation in the quake region, it was observed that constructions built in accordance with the previous Code of Earthquake (1975) underwent greater damage, and those built in accordance with the new Code (1998) underwent less damage, and some did not even undergo any damage.

To bring the present buildings into resistant state of being, proper one of the following method is applied:

1. Increasing the lateral rigidity of this storey by putting up additional walls between single structural elements on the soft storey

2. Increasing the lateral rigidity of this storey by placing steel diagonals between the columns and shear walls

3. Putting flexible material between columns and walls on the storey a top the soft storey thus preventing it to work together with the soft storey

4. Increasing the rigidity of the soft storey by reinforcing the columns of the soft storey.

P. Roca, et al.

This research work had carried out experiments on seven dry stone walls. The dimensions of the sandstone block used were 20*20*10 cm. The walls were tested for vertical loads of 30, 100, 200, and 250 KN producing compressive stresses of 0.15, 0.5, 1 and 1.25 MPa, respectively. The experimental results obtained were during a first branch while no sliding between blocks occurs the curves exhibits great stiffness up to 30% of the peak load. Large post failure branches were obtained for all cases. For lowest level f applied vertical stress (0.15MPa) failure occurred by rotation of the part of the wall so that a stepped separation line formed following diagonally the stone joints without visible cracking in the blocks. For vertical stresses 1.25MPa or larger the risk of failure by lateral buckling become important. On of the two specimens initially loaded to 250 KN failed prematurely with only a small amount of horizontal load.

The authors concluded that:

1) In axial compression dry joint masonry specimen resisted less and were more deformable than mortar joints ones.
2) When subject to moderate vertical stresses failure due to combined vertical and horizontal loading was governed by an almost linear failure envelope and
3) For larger vertical loads the capacity of the walls resulted severally limited by their out of plane buckling.

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Peter J. Walker, (2004)

Focus was made on methods currently used for strength and erosion resistance testing of earth blocks. An experimental study undertaken to assess the influence of test procedure and specimen geometry on strength and erosion characteristics is perform. Cement stabilized pressed earth blocks were fabricated using different blended soils and compacted using a constant volume manual press. The effects of specimen geometry on experimental compressive strength are described and aspect ratio correction factors for unconfined unit strength outlined. Proposals for a unified approach to compression strength testing are also suggested. Bending strength testing is commonly used as an indirect method of strength assessment, as it is more readily suited to in-situ quality control testing than compression testing.

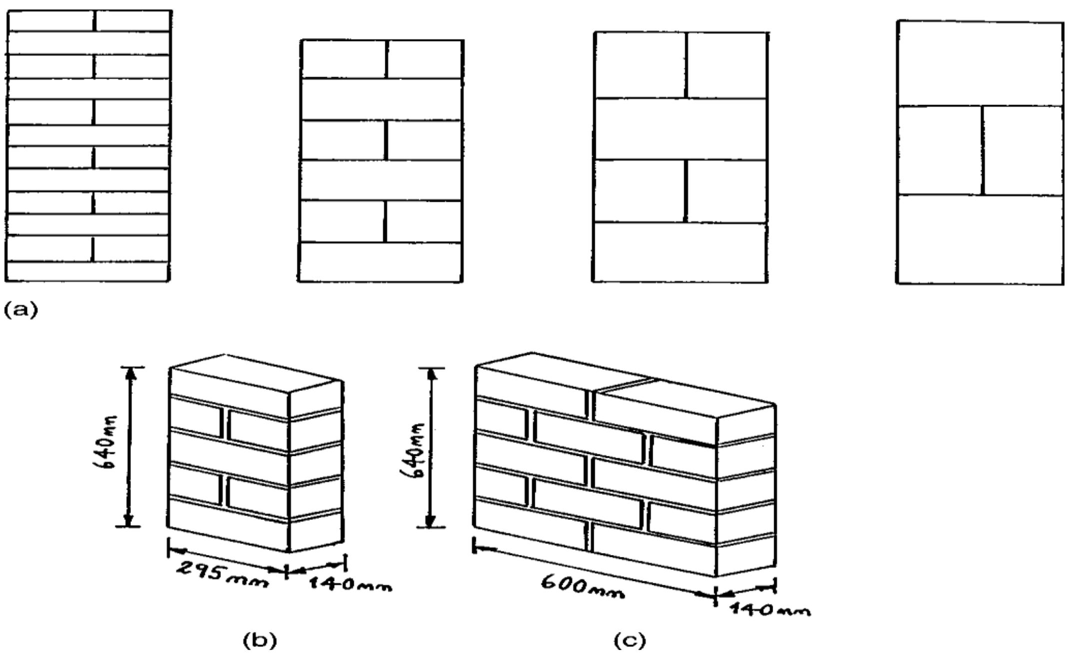

Fig: (a) Different Combination (b) Model 1, (c) Model 2 [Source- Peter J. Walker]

The influence of clay content on compressive strength is dependent on moisture content during testing. For the samples tested in this investigation, unit dry compressive strength improved as clay content increased. Wet block compressive strength is consistently lower than dry strength for identical specimens. It is proposed that uniaxial compression testing of earth blocks be undertaken on individual units. Specimens should normally be capped with mortar, plaster, plywood sheeting, or similar material. Due to platen restraint, block geometry has a significant influence on recorded compressive strength. These effects may, however, be taken into account using established aspect ratio correction factors. The behavior of pressed earth block masonry in compression is similar to other masonry units, such as fired clay bricks. Masonry compressive strength varied between 34% and 96% of unconfined block strength.

VI METHDOLOGY & INVESTIGATION

Compression test

Testing of regular model and advanced model for compression was perform using CTM.

Materials:

1) Brick: 19*9*9 cm.
2) Mortar: 1:6
3) Binding wire
4) Instrument: compression testing machine.

CTM is compression testing machine. The capacity of this machine is 3000 KN. This machine is manufactured by HEICO. The design of machine shall include the following features:

The machine shall be power operated and shall apply the load continuously. Rather than intermittently, and without shock. The space provided for test specimen shall be large enough to accommodate in the readable position and elastic calibration device which is of sufficient capacity to cover the potential loading range of the testing machine.

Test procedure:

1) The model was fixed on CTM.
2) Apply the load until the model fails.
3) The readings were noted down.
4) The results were compared.

Model A1

In this model prepared with conventional bricks. The bricks were kept on each other, and were bonded by the mortar having proportion of 1:6. Size of model is (200*100*400) in mm and having Cross section area (200*100).

Model A2

The advanced model was prepared with help of conventional bricks laying on each other and was bonded by the mortar having proportion as 1:6. Size of model is (200*100*400) in mm and having Cross section area (200*100).The advancement made in this model was that it was strengthened by providing vertical mesh of binding wire.

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Fig: Model A1 (without binding wire, before failure) [Source- college Lab]

Fig: Model A1 (without binding wire, after failure) [Source- college Lab]

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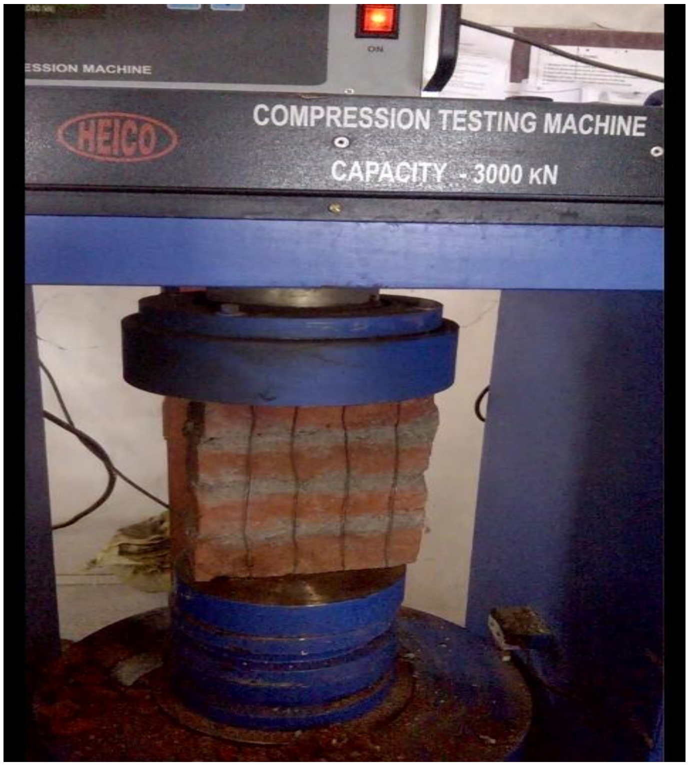

Fig: Model A2 (with binding wire, before failure) [Source- college Lab]

Fig: Model A2 (with binding wire, after failure) [Source- college Lab]

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VII RESULT AND DISCUSSION

Compression test

Model 1:

Compressive strength obtained: 24.1 KN

Model 2:

Compressive strength obtained: 32.4 KN

Table: Result of Compression Test

Model	Area (mm2)	Force(KN)	Strength (MPa)
Model 1	2000	24.1	12.05
Model 2	2000	32.4	16.2

Compressive strength increased by 34%.

VIII CONCLUSION

Model without binding wire collapsed at 24.1 KN & Model with binding wire collapsed at 32.4 KN, From above data we came to conclusion that model with binding is more resistant to earthquake as compare to Model without binding wire in which compressive capacity in increased.

Future work

1) Number of Models to be tested to get accurate results in future.
2) Compare Experiment Results of Compression test as well as Shake table test with help of software in detail to be studied.

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