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FLEXURAL BEHAVOIUR OF BEAM MADE OF HOLLOW CONCRETE BLOCK INCORPORATING REINFORCEMENT.

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Abstract: *Economy of structure is one of the basic aspect upon which any design is based .stability plays an important role .but best designer is one who comes out with a design which gives the stable and economic structure .the development of construction technology is closely related to the development of adequate mechanization and handling technology. Hollow concrete block is an important addition to the types of masonry units available to the builder and its use for masonry is a constantly increases. An investigation on construction of hollow concrete block masonry emphasizing in the present to study the crack patterns developed in the structural elements such as reinforced beam. Though the strength of beam constructed with hollow concrete block give the less strength as compared to crick masonry but cost of construction is very less.*

***Key Words**: block masonry, hollow concrete block, strength of masonry.*

I Introduction:

The demand for the continued use of masonry led to evaluation of reinforced masonry. The recent research investigations and the development of improved design and construction techniques, has established the reinforced concrete masonry as a proven structural system. Hence, the reinforced concrete masonry has become one of the new developments of engineered construction.
Reinforced hollow unit concrete masonry is a method in which steel reinforcement is embedded in grout within the concrete block such that the masonry, grout and steel act together to resist applied forces.

The basic objective of present study is to find the moment carrying capacity of reinforced concrete masonry beams. Beside this, crack patterns in beams and columns have also been studied.

Four singly reinforced beams were casted using hollow concrete blocks. The grout used for filling the cells of blocks was of proportion 1:2.5:3.0.

Beams were tested in pure bending. Tests on beams reveal that moment carrying capacity of beams increases with increases in percentage tensile reinforcement.

In beams, cracks initiated at middle third portion of the beam where bending moment happens to be maximum in pure bending case. Cracks appeared at tensile zone and progressed upward with the increase of load. Almost all cracks appeared at mortar a joint which happens to be the weakest portion of masonry beams.

The achievement of lateral stability by gravity places a practical economical limit on the size of the structure. This has led designers and builders to seek ways in which these massive bearing walls could be decreased in thickness without losing their stability in the process.

These demand led to evolution of plain masonry into the composite system which is termed as reinforced masonry.

Concrete block work strengthened by steel bars is termed as reinforced block work or reinforced masonry. The principal aim of introducing steel in block work is to make it ductile and to enable it to resist tensile forces.

II Materials And Specimens

2.1 Masonry Units:

Hollow concrete blocks used as masonry units shall conform to IS: 2185-1967. The materials to be used in casting hollow concrete block and specifications for hollow concrete block has already been described in previous chapter.

2.2 Mortar:
Mortar influence the compressive strength, durability and resistance to rain penetration of block work, consequently it is important to select carefully, and then correctly use, the mortar for any particular application.

Mortars are intimate mixture of some cementing materials, such as cement, lime etc. and fine aggregate, such as sand, burnt clay/surkhi, cinder etc.
The cement used in mortar shall conform to IS: 269-1958.
Sand shall generally conform to the requirements of IS: 382-1963.

2.3 Cement:
The cement that will be used generally for ordinary work is ordinary Portland cement. Conforming to, IS: 269-1958.

2.4 Reinforcement:
Type of steel used to reinforced masonry is the same as that used in reinforced concrete. Conforming to, IS: 456-2000.

III Description Of Beams:

Each beam consists of two courses of grouted of grouted hollow block masonry. All beams were singly reinforced. The reinforcement descriptions in various beams are shown in Table 1.

TABLE 1 BEAM DETAILS

Sr.No.	Designation	Dimension of beam (b x d) (mm x mm)	Longitudinal reinforcement	Shear stirrups
1.	B1	140 x 320	2 - Ø 8	2 lgd- Ø 6 @ 200 c/c
2.	B2	140 x 320	2 - Ø 10	2 lgd- Ø 6 @ 200 c/c
3.	B3	140 x 320	2 - Ø 12	2 lgd- Ø 6 @ 200 c/c
4.	B4	140 x 305	2 - Ø 10	2 lgd- Ø 6 @ 200 c/c

- Overall dimension of each beam = 140 x 390 mm
- Holding bars in each beams = 2 nos. 8 mm Ø

IV Construction Of Beams

Constructions of beams were done polythene sheets spread on the floor. Lower course of beam was constructed with block type “B” (channel shaped) which enables easy placing of reinforcement. Mortar mix used for assembling block was having proportion 1:3. Reinforcement cage was prepared by testing the longitudinal reinforcement with shear stirrups. This cage was then placed in the lower course of beam. After placing reinforcement, upper course of beam was constructed using block type “C”. After bars were placed in position at top of upper course of blocks by inserting them in shear stirrups.
Grout of proportion 1:2.5:3 was then filled in cavities of two courses of blocks and compacted

V Testing Of Beams

For testing beams, special setup was prepared between plates compression testing machine.
Since the test span of beam was more than the length of trolley of machine, beams were tested upside down i.e. compression face of beam was placed at bottom and rollers of lower trolley were used as means of applying concentrated load .

Load was gradually applied to the beam. On appearance of initial crack, reading of load indicating dial was taken. Then, loading was continued till ultimate failure of beam occurred.

FIGURE 1 TEST SET UP FOR BEAMS

TABLE 2.TEST RESULTS OF MASONRY BEAMS

Designation	Dimension of beam (b x d) (mm x mm)	Percentage tensile reinforcement	Initial load (in tonne)	Failure load (in tonne) (W)*	Ultimate moment (M) (in kN-m)
B1	140 x 320	0.22	3.00	3.3	17.82
B2	140 x 320	0.35	3.40	3.6	19.44
B3	140 x 320	0.50	3.85	4.0	21.60
B4	140 x 305	0.74	4.15	4.5	24.30

- W is the concentrated load at each third point of beam.

VI Discussion On Beam Results

The moment carrying capacity of beams increases with increases of percentage tensile reinforcement. The ratio of experimental load to theoretical load obtained from working stress method varies between4.2 to 4.6. These values are quite high. Also, looking to the analysis carried by working stress method, it appears that beams might be over reinforced but experiments showed that cracks initiated at tensile face i.e. beams were under reinforced. These contradictions are due to lesser value of permissible stress taken for masonry.

On the other hand, ratio of experimental load to theoretical load obtained from ultimate load theory varies between 1.1 to 1.7. It proves that experimental results are in good agreement with theoretical values from ultimate theory.

VII Failure Pattern And Causes Of Failure

In beams, cracks initiated at middle third portion of beam where bending moment was maximum. Cracks appeared at tensile face of beam and started propagating towards compressive face with the gradual increase of load.

Almost all cracks appeared at mortar a joint which happens to be weakest portion of masonry beams.

At ultimate load, reinforcing started to yield which cause mortar joint to open and hence cracks appeared at mortar joint.

In beams B1 to B3, only flexural cracks appeared at middle third portion of beam while on beam B4, shear cracks also developed along with flexural crack. Shear cracks initiated from support and propagate diagonally. It indicates that shear reinforcement was insufficient in beam B4.

VIII. Conclusions

1. The characteristic compressive strength of concrete block masonry assemblage must be obtained through actual field test instead of directly taking from codes.
2. The moment carrying capacity of beam increases with increase in percentage tensile reinforcement.
3. The ratio of experimental failure load to working load obtained from working stress method varies from 4.2 to 4.6.
4. The ratio of experimental failure load to ultimate load obtained from ultimate theory varies from 1.1-1.7. The lower value of ratio indicates that ultimate theory is most appropriate theory applicable to reinforced masonry beams.
5. Cracks initiated from bottom face of beam which proves that beams were under – reinforced.
6. The initial cracks become visible at mortar a joint which happens to be weakest portion of masonry. Cracks propagated along mortar joint and some cracks also propagated through blocks.
7. The initial cracks appeared at middle third portion of beam where the bending moment happens to be maximum in pure bending case. No shear cracks appeared in beam B1 to B3 which indicates that beams were safe in shear. In beam B4, diagonal cracks become visible at supports just before the failure.

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