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EXPERIMENTAL INVESTIGATION ON THE FLEXURAL BEHAVIOUR OF CHANNEL SLABS

Borusu Bhanu Prakash

M. Tech student (SE), Department of Civil Engineering, Aditya College of Engineering andTechnology, Surampalem, AP.
Email: Bhanu.borusu@gmail.com

C. Naga Dheeraj Kumar Reddy

Assistant Professor, Department of Civil Engineering, Aditya College of Engineering andTechnology, Surampalam, AP

***Abstract*: The construction of the slab ensures that it is capable of withstanding vertical load in general. On the other hand, noise and vibration from the slab are becoming increasingly crucial aspects to take into consideration because of the recent uptick in people's interest in the living environment. This is something that should be considered. In addition to this, the amount that the slab is deflected will expand in proportion to the length of the span that it is spanning. As a direct consequence of this, the slab's thickness will need to be raised. A heavier slab is the result of increasing the thickness of the slab, which in turn produces an increase in the size of the columns and the foundation. Because of this, the building industry uses a greater quantity of its raw materials than usual. In order to reduce the overall quantity of material that was being used, it was necessary to make use of slabs that had a lower overall weight. As a consequence of this, in this specific piece of study, we have sought to carry out an investigation into the precast closed channel slabs. Although the reinforcement in the web of the channel slabs varied, the flange reinforcement was made up of welded mesh with a 2.2 mm diameter and 32 mm x 32 mm spacing. There was not a consistent amount of reinforcement in the web of the channel slabs. The many different web reinforcements consist of 2.2mm diameter double-layered welded mesh with 32mm x 32mm spacing, vertical bars with 6mm diameter HYSD bars spaced at 50mm c/c, as well as vertical and diagonal bars with 6mm diameter bars spaced at 100mm c/c. It has been found that the performance of closed channel slabs is much better than that of traditional slabs.**

Keywords: HYSD bars, Spanning, Reinforcement, Traditional slabs

I INTRODUCTION

Reinforced Concrete slabs are a kind of component that is often employed in the building of a broad range of different regions, including floors, ceilings, garages, and a great many other places. It is easy to mould reinforced concrete into any shape or size, it provides resistance to high compressive and bending loads, and it is a highly cost-effective material to produce and build with. When it comes to floor solutions, reinforced concrete provides a wide variety of advantages, some of which are listed below.

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However, slabs have a number of drawbacks. Because it causes an increase in the size of all the other structural components, such as beams, columns, and footings, the high weight-to-strength ratio is the most critical concern.

II PRECAST CHANNEL SLABS

Precast Channel Unit is a full span precast RCC unit, trough shaped in section (Fig. 1). It can be used for floors and roofs supported on suitable structures like brick/stone walls and RCC beams. It does not require any intermediate temporary props or supports, since the unit will be strong enough to support the load.

In the present study, the Closed Channel slabs are studied. Each channel panel is of size 305mm X 1525mm X 64mm casted with M20 grade concrete. Each Rectangle Flat panel is ofsize 305mm X 1525mm X 12mm. The Closed channel slab consists of 5- single channel panels welded together in the longitudinal direction to form the bottomportion of Closed Channel slab and 5- single rectangular flat panels welded together in the longitudinal direction to form the top portion of the Closed Channel Slab of size 1525mm X 1525mm X 76mm as shown in Fig. 1.

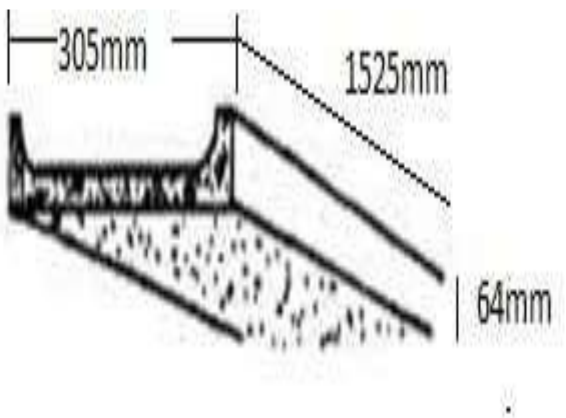

Fig 1 Cross section of C-channel

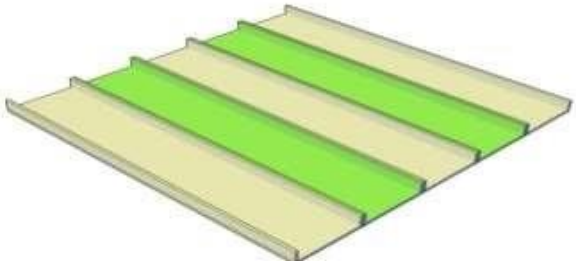

Fig.2 Bottom Portion of Closed Channel Slab

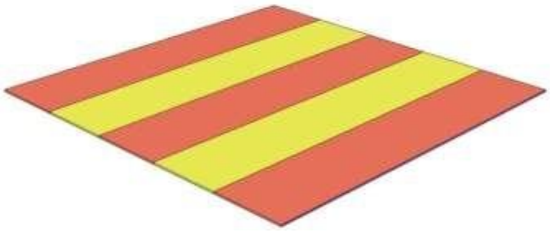

Fig.3 Top Portion of Closed Channel Slab

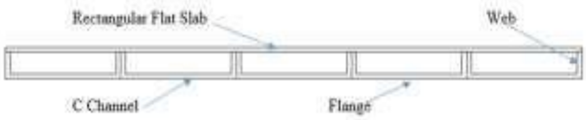

Fig.4 Cross section of Closed Channel Slabs.

The behavior of Closed Channel Slabs is compared with the Conventional slab of size 1525mm X 1525mm X 76mm, Gradeof concrete-M20, Reinforcement- HYSD bars of 6mm diameter at 200mm c/c.

The Web Reinforcement in the closed channel slab is varied in this study.

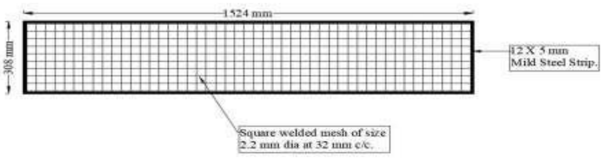

Fig. 5 Flange Reinforcement in C-Channel & Rectangle Slabs

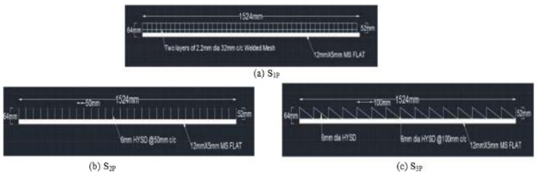

Fig.6 Web Reinforcements in C-Channel Panels

Fig. 7 Typical Closed Channel Slab

The Slabs are Designated as follows. S0: Conventional Slab of size 1524X1524X76mm.

S1P: Individual Closed Channel panel of size 305X1524X76mm consisting of two layers of welded mesh in web of C-Channel.(Fig 6(a))

S2P: Individual Closed Channel panel of size 305X1524X76mm consisting of vertical bars of 6mm diameter in web of C-Channel. [Fig.6(b)]

S3P: Individual Closed Channel panel of size 305X1524X76mm consisting of vertical and diagonal bars of 6mm diameter inweb of C-Channel. [Fig.6(c)]

S1: Closed Channel Slab which consist of five individual closed channel panels of S1P, welded together. S2: Closed Channel Slab which consist of five individual closed channel panels of S2P, welded together. S3: Closed Channel Slab which consist of five individual closed channel panels of S3P, welded together. (Fig. 7)

III CASTING PROCEDURE

First the MS metal strip of 12mm X 5mm is Welded to form a Metal Frame of 305mm X 1525mm X 12mm. Next the welded mesh of size 2.2mm dia and 32mm X 32mm spacing is welded to the mild steel frame to form the rectangular flat panels.

Later to form the C-channel panels the welded mesh was cut to a height of 52mm and length of 1515mm and welded vertically to the Metal frame along the length with the vertical height of 52mm to form rectangular channel panels. Similarly, the skeletal frames for five C-channel and five Rectangular flat panels were prepared.

After preparing these skeletal frames, they are placed on the flat surface with polythene membrane and wooden planks are placed in between each frame to form the formwork for the web of C-Channel panels.

Then, concrete is poured on the flat part of the C-Channel slab and compacted using the custom-made tamping rod which has the surface dimension of 100mm X 100mm. Once the concrete is poured in flat part of the C-Channel panel, the two more wooden planks are placed either side of C-Channel Panel in order to form the 20mm thick web of the C-Channel panel. The Rectangular flat panels are also casted in the same manner as the flat part of the C-Channel panel.

After 24 hours the form work of the C-Channel panels are striped and membrane cured for another 24 hours after which the panel are carefully lifted and placed in water tank for 28 days to cure.

After curing five C-Channel Panels are kept side by side and welded together to form a single member of size 1525mm X 1525mm X 64mm. Five Rectangular flat panels are welded in the same manner to form a member of size 1525mm X1525mmX12mm.

The above procedure is repeated for other two parameters of different web reinforcements.

IV TESTING PROCEDURE

After the specimens(slabs) were ready for testing, the specimens were coated with white wash so that the cracks will be clearly visible.

Once the white wash is dried, the centre of the slab on the bottom surface and on the web portion of C-Channel (centre panel) in the longitudinal direction are marked to fix the strain gauge. Before fixing the strain gauge, the surface is polished with the emery paper to obtain a smooth finish. After polishing the surface, the Strain Gauges were fixed with the help of adhesive. The electrodes are then soldered with the wire which is later connected to Strain Indicators.

The Specimens are placed on the open square frame of dimension 1650mm X 1650mm which acts as Simply Supported. The specimen is placed on the open square frame for testing and the dial gauge is placed at the centre of the bottom portion of slab to measure the deflection.

The slab is tested for uniformly distributed load, so the loading is done by placing 2' X 2' slabs in layers. Each layer consists of 4 slabs placed one beside the other to form a square platform of 4'X4'. Each layer consists of four slabs weighing 200kg±10kg. Six layers of these slabs were placed one above the other. It was observed that there was no yielding of slabs after placing six layers of slabs, further placing of slabs was found to be difficult.

Fig 8 Testing Arrangement

Hence over these slabs a box shaped channel section of dimension 1m X 1m is placed at the top of the sixth layer of slab. Above this box type channel section, a steel beam of 200mm depth is placed diagonally. The hollow section between steel beam and the box shaped channel section, sand bags were placed to transfer the load uniformly onto the slab.

On the Steel beam a hydraulic jack and load cell of weight 50kg is placed. The loading is carried out and the readings of Dial gauge and strain gauge were noted down at regular intervals of loading. (Fig 8)

V RESULTS AND DISCUSSIONS

Result of Closed Channel Slabs is discussed by comparing with Conventional slab in terms of Load-Deflection Behaviour,Stress- Strain Behavior, Performance Evaluation Factor (PEF) of Load vs Deflection and Ductility.
Ductility is defined as the ratio of ultimate deflection to deflection at yield.
Ductility of Slab =Ultimate Deflection / Yield Deflection
PEF for any quantity = Load or Deflection of Channel Slab / Load or Deflection of Conventional Slab

Loads vs Deflections

- Fig 9 presents the variation of load vs deflection of the closed channel slabs S_1, S_2 and $S_3$and the conventional slab S_0.
- From table 1 and fig. 9 The Closed Channel Slab S_3 has the highest load Carrying Capacity than the Conventional Slab S_0 and Closed Channel Slab S_1 & S_2.
- The performance of the Closed Channel Slab S_3 with respect to load is 16% higher compared to the Conventional Slab S_0.
- The performance of the Closed Channel Slab S_1 with respect to load is 4% higher compared to the ConventionalSlab S_0.
- The performance of the Closed Channel Slab S_2 with respect to load is 36% less compared to the Conventional Slab S_0.
- Area under the Load vs Deflection Graph shows the Stiffness of the Slab. From Fig.9,it is evident that the area under Closed Channel Slab $S_3$is more which indicates closed channel slab S_3 is Stiffer compared to other closed channel slabs and also conventional slab.
- With respect to the ultimate deflection all the three slabs i.e. S_1, S_2 and S_3, the PEF is 19%, 25% and 23% more compared to Conventional Slab S_0.[Table 1].

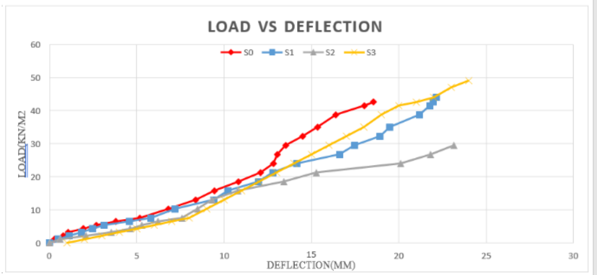

Fig 9 Load vs Deflection Curve.

Table 1 Ultimate load, Deflection and PEF of Slab Specimens

Sl No.	Specimen	Slab Designation	Ultimate load	Deflection @ Ultimate Load	Performance Evaluation Factor (PEF)	
			kN/m^2	mm	Load	Deflection
1	Conventional Slab	S_0	42.62	18.55	1.00	1.00
2	Closed Channel Slab	S_1	44.07 **(3.40%)**	22.12 **(19.25%)**	1.04	1.19
3	Closed Channel Slab	S_2	29.58 **(-36.5%)**	23.20 **(25.06%)**	0.64	1.25
4	Closed Channel Slab	S_3	49.14 **(15.30%)**	22.78 **(22.80%)**	1.16	1.23

Table 2 PEF with respect to Ductility

Sl No.	Specimen	Slab Designation	Yield Deflection	Ultimate Deflection	Ductility	Performance Evaluation Factor
			mm	mm		
1	Conventional Slab	S_0	12.82	18.55	1.25	1.00
2	Closed Channel Slab	S_1	16.70	22.12	1.32	1.06
3	Closed Channel Slab	S_2	14.90	23.20	1.56	1.25
4	Closed Channel Slab	S_3	17.72	22.78	1.30	1.05

Stress vs strain

- Fig. 10 presents the stress vs strain variation at the bottom of slabs S0, S1, S2 and S3.
- The Strain at the bottom surfaces of the Closed Channel Slab S1 and conventional slab S0 are 592 X 10^{-6} and516 X 10^{-6} respectively.
- The Strain in the Closed Channel SlabS2 and

conventional slab S_0 at bottom surfaces are 568 X 10^{-6} and 516 X10^{-6} respectively

- The Strain in the Closed Channel slab S_3 and conventional slab S_0 at bottom surfaces are 738 X 10^{-6} and 516 X10^{-6} respectively.
- Strain in bottom portion of S_3 is higher by 43%, 25% and 30% when compared to the strain in bottom portion ofS_0, S_1 and S_2 respectively.
- Area under the Stress vs Strain Graph denotes the Toughness of the slab. So it is seen that the Closed ChannelSlab is tougher compared to all other closed channel slabs and also conventional slab.
- Fig 10,11 and 12 RepresentStress vs strain variation in the web and at the bottom of Closed Channel Slabs S_1,S_2 andS_3respectively.
- Strain in bottom portion of $S_1$is higher by 33% compared to the strain in web portion of S_1.(Fig.10)
- Strain in bottom portion of $S_2$is higher by 27% compared to the strain in web portion of S_2.(Fig.11)
- Strain in bottom portion of $S_3$is higher by 32% compared to the strain in web portion of S_3.(Fig.12)
- Area under the Stress vs Strain Graph denotes the Toughness of the slab. So it is seen that area underthe stress vs strain at bottom portion of S1 is more than area under the stress vs strain in web portion which indicates that bottom portion of Closed Channel Slab S_1 is tougher compared to web portion of S_1.

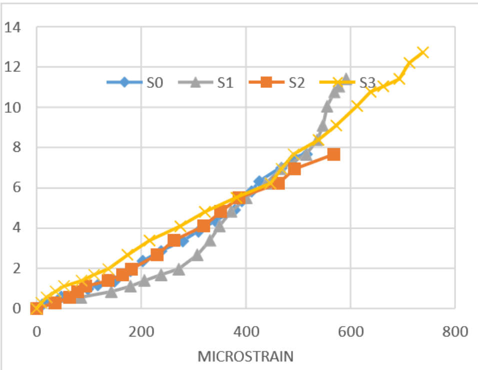

Fig 9 a Stress vs Strain at Bottom of Slabs

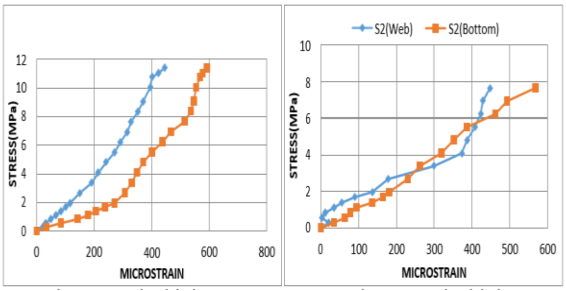

Fig 10, 11 Stress vs Strain variation in S_1 and S2

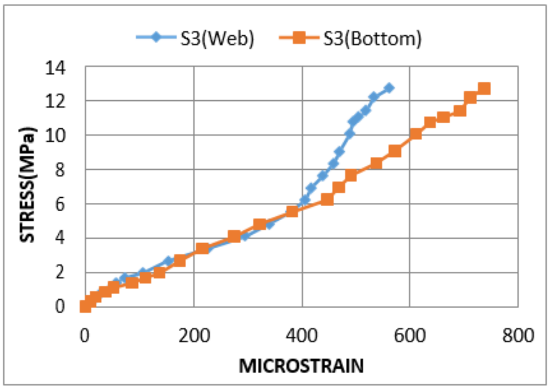

Fig 12 Stress vs Strain variation in S_3

Crack Pattern

- In the Closed Channel Slab S_1, vertical cracks were seen on the web portion of the C-Channel.
- In the middle panels of the C-channel Slabs the cracks were prominent in the web.
- There were no cracks developed on the Bottom of the channel slab nor on the top rectangle flat slab.
- Crushing of web portion was not observed in this slab.
- The cracks observed on the web portion were few in number (fig 13).
- In the Closed Channel Slab S_2, vertical cracks were seen on the web portion of the C-Channel and there werecracks observed at the junction of the web and the bottom slab.
- There were no cracks formed at the bottom of the C-Channel closed slab nor on the top rectangle flat slab.
- The number cracks on the web portion were more on slab S_2 compared to S_1.(fig 14)
- In the Closed Channel Slab S_3, vertical cracks and also diagonal cracks were seen on the web portion of the C-Channel.
- No cracks were observed on the bottom of the channel slab nor on the top rectangle flat slab.
- Crushing of web portion in central panel was observed.
- In the middle panels of the C-channel Slabs the cracks were prominent. (fig 15)
- On the conventional slab S_0, cracks were developed at the bottom surface, extended from the centre to edges(diagonal cracks). (fig. 16)

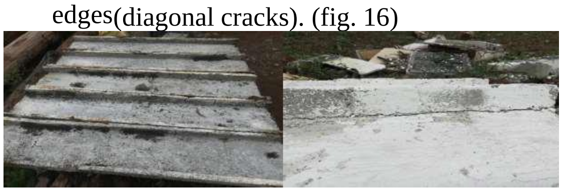

Fig. 13 Crack pattern on Web of Closed Channel Slab S_1


Fig.14, 15 Crack pattern on Web of Closed Channel Slab S1 and S2

Fig. 16 Crack Pattern on Conventional Slab at the Center Span.

CONCLUSIONS

- Closed Channel Slabs have shown considerable reduction in dead load. The Dead load of Closed Channel slab is about 52% less when compared with the conventional slab.
- The Closed Channel slab S3 has the highest load carrying capacity of all other slabs which are casted with the Load of 49.14kN/m^2.
- The performance of Closed Channel slab S1 with respect to Load carrying capacity is higher by 3.40% when compared to Conventional Slab S0.
- The performance of Closed Channel slab S2 with respect to Load carrying capacity is less by 36.50% when compared to Conventional Slab S0.
- The performance of Closed Channel slab S3 with respect to Load carrying capacity is higher by 15.30% when compared to Conventional Slab S0.
- Pattern of Load carried by individual panel of Closed Channel Slabs(1'X5'X3") is found to be similar to the Pattern of Load carried by Closed Channel Slabs(5'X5'X3").
- Closed Channel Slabs are found to be more ductile compared to Conventional Slab.
- The Closed Channel Slabs is more Safe as compared to the Conventionalslab.

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AUTHORS PROFILE

Borusu Bhanu Prakash is persuing M-tech (SE) Department of Civil Enginnering in Aditya College of Engineering and Technology, Surampalem, AP.