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EXPERIMENTAL INVESTIGATION ON TWO POINT LOADING OF COLD-FORMED BEAM WITH EPS BEADS CONCRETE

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***Abstract*:** In the civil engineering field design of cost efficient is highly important. So we prefer cold-formed steel structures(CFS) for construction. An advanced CFS structure is implemented in this paper, which uses a special type of polystyrene aggregate concrete (PAC) as bracing material. Three cold formed built-up sections has been chosen, which are channel section connected back to back by welding, back to back channel section connected by welding and it is encased by Expanded Polystyrene beads(EPS) concrete and box section which is infill by EPS beads concrete. The project comprises the review of the existing literature on the flexural behaviour of cold-formed steel sections and testing of materials are conducted for cement, fine aggregate, lightweight aggregate (EPS). Mix design for EPS beads concrete also derived. The beam is to be experimentally tested under two point loading and load bearing capacity of different sections will be compared.

Keywords: *cold-formed steel, polystyrene aggregate concrete, flexural behaviour, Mix design*

1. INTRODUCTION

GENERAL

Cold-formed steel (CFS) is type of steel fabricated by cold forming process. During the construction of CFS residential buildings, however, one of the disadvantageous features is that the several requirements arising during design can only be satisfied by several different materials (heat insulation, insulation against moist, finishing of surface).This drawback can be avoided if a single material with optimized material properties is used. Such building material may be the polystyrene aggregate concrete (PAC).

EXPANDED POLYSTYRENE BEADS CONCRETE

The Expanded Polystyrene is a stable, low density Foam, which consists of 98% of air and 2% of polystyrene material. The EPS used in this project was spherical in shape and size varying between 1.18 to 2.36 mm in diameter. The polystyrene beads can be easily merged into mortar or concrete to produce lightweight concrete with a wide range of density. Polystyrene concrete was used to produce load bearing concrete wall, also as the material of construction for floating marine structures. EPS beads can be used to produce low density concretes required for building applications like cladding panels, curtain walls, composite flooring system, and load bearing concrete blocks. The strength of light weight concrete using EPS beads are low for lower density mixture This resulted in increment of voids throughout the sample caused by the Air entraining admixture. Thus the decrease in compressive strength of the concrete. Expanded polystyrene beads concrete was popular through the ages. The polystyrene beads can be easily merged into mortar or concrete to produce lightweight concrete with a wide range of density. These increased water contents requires higher cement contents, even without any benefit.

OBJECTIVES OF THE STUDY

- ✓ To study the various modes of failure occurs in the various built-up sections.
- ✓ To study the properties of materials and to derive the mix design for expanded polystyrene beads concrete.
- ✓ To analyse the load versus deflection behavior under flexure.
- ✓ To evaluate the bending resistance of cold-formed steel built-up sections subjected to flexure.

SCOPE OF THE PROJECT

- ✓ Higher load bearing capacity by using built-up section with bracing.
- ✓ Reduce the weight of the section by using EPS beads concrete.
- ✓ Higher ductility.

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- ✓ It should be economical.

2. SUMMARY ON REVIEW OF LITERATURE

The behavior of cold-formed built up sections are deeply studied, with help of literature different points had been taken for the project.

- ✓ Use of two (or) more profile in a beam can increase its strength to width ratio.
- ✓ Load carrying capacity for the different type of connection on cold formed steel beam has been determined under flexure.
- ✓ Use of braced web profile can increase the load-bearing capacity of the beam.
- ✓ Overall weight of the section can be reduce using polystyrene aggregate concrete (PAC) as a bracing material.

3. EXPERIMENTAL PROGRAMME

In this experimental programme involves various processes of material testing, mix proportioning, mixing, casting and curing of test specimens. All the testing on materials was done in material testing laboratory, Valliammai engineering college Chennai.

3.1 Materials Used

The materials used in the preparation of concrete mix include cement, fine aggregates, EPS beads. All the materials were tested and its physical properties are described below.

3.1.1 Cement

A cement is a blinder, a substance used in construction that sets, hardens and adheres to other materials, blinding them together. Ordinary Portland cement of 53 grade were used and its physical properties are described below.

Table 1 Properties of OPC

TEST	VALUE	AS PER IS STANDARDS
Consistency	28%	25%-30%
Initial setting time	38min	Not less than 30 min.
Final setting ti+me	455min	Not more than 600 min
Specific gravity	3.06	2.5 – 3.1
Fineness	5%	Less than 10%

3.1.2 Fine Aggregate

Fine aggregate generally consist of natural sand or crushed stone.Coarse sand locally available is taken as fine aggregate and its physical properties are described below.

Table 2 Properties of Fine Aggregate

TEST	VALUE	AS PER IS STANDARDS
Fineness Modulus	2.65	2.2-3.2
Specific Gravity	2.75	2.6-2.8
Water absorption	2.5%	<4%

3.1.3 Expanded polystyrene beads

The Expanded Polystyrene beads used in this project was spherical in shape and size varying between 1.18 to 2.36 mm in diameter. Density test and water absorption test is conducted for EPS beads. Density of EPS beads should be 10-30kg/m^3 and the water absorption should not be more than 4%. the values are tabulated below.

Table 3 test value of eps beads

S.NO	METHOD	OBTAINED VALUES
1	Density (kg/m^3)	22
2	Water absorption	2.5%

3.2 Mix proportion of eps beads concrete

There are no separate design codes for expanded polystyrene concrete. Mix design for M20 is calculated. The mix proportion of EPS beads concrete taken by replacing coarse aggregate by EPS beads and also by changing proportions of all other ingredients.

Table 4 Mix proportion for M20 concrete

Cement	Fine aggregate	Coarse aggregate	Water
347kg	584kg	1223.8kg	180ltr
1	1.62	3.40	0.5

Increase cement content by 10% = 381.7kg
Increase fine aggregate content by 10%
= 642.4kg
Decrease coarse aggregate by 20% = 979.04kg
Density of coarse aggregate = 1560 kg/m^3
Density of EPS beads = 22 kg/m^3
Ratio of aggregate to EPS bead = (1560/22)
= 71

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Table 5 Mix proportion for EPS beads concrete

Cement	Fine aggregate	EPS beads	Water
381.7kg	642.4kg	13.8kg	180ltr
1	1.68	0.036	0.5

3.3 Instrumentation and test procedure

3.3.1 Compressive Strength Test:

Table 6 Compressive strength for cubes

Trial	Load (kN)	Compressive strength N/mm^2
Trial 1	318	14.1
Trial 2	307	13.6
Trial 3	325	14.4

Fig 1 Compressive Strength Test

4. COLD-FORMED SECTION PROPERTIES

The cold-formed steel sections are not made like hot rolled sections, but they are manufactured from steel sheets. The steel sheet is cut, bent and then formed into the desired shape.The cold-formed steel is also known as light gauge steel because of its minimum thickness when compared with hot rolled section.

Table 7 properties of section

S.No	Designation	Size(mm)
1	Depth of beam	150
2	Width of beam	100
3	Span of beam	1200
4	Thickness of sheet	1.8

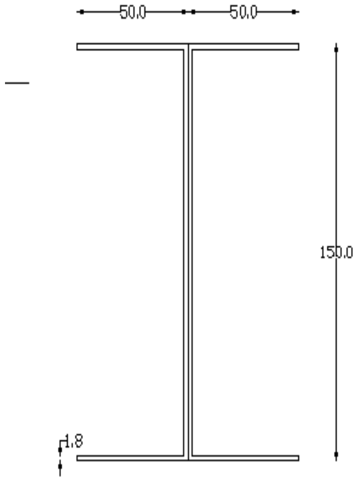

Fig 2 back to back channel connection

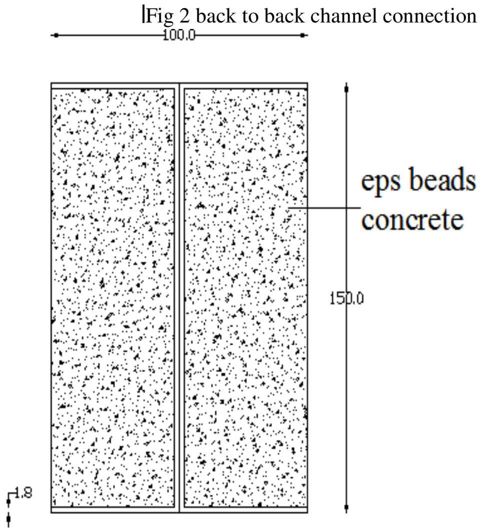

Fig 3 concrete encased section

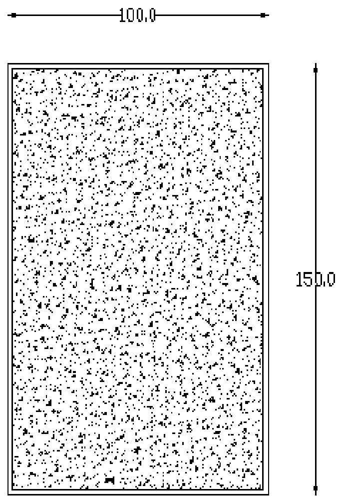

Fig 4 concrete infill section all dimensions are in mm

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5. CASTING OF SPECIMENS

Three cold formed built-up sections has been choosen,which are channel section connected back to back by welding, back to back channel section connected by welding and it is encased by Expanded Polystyrene beads(EPS) concrete and box section which is infill by EPS beads concrete.

Fig 4 casted sections

6. EXPERIMENTAL INVESTIGATION

All the specimens were tested for flexural strength under two point loading. The specimens were arranged with simply supported conditions having an effective span of 1.0 m. Loads were applied at one-third distance from the supports at a uniform rate till the ultimate failure of the specimens occurred. Beam deflections were measured at the loading points and at the centre of the beam using deflection meters. The testing was carried out in a loading frame of 400kN capacity. A loading frame is a high stiffness support structure against which the test forces can react.

6.1 Testing of back to back channel built-up section

Fig 5 back to back channel section

The results of load vs deflection is represented graphically below

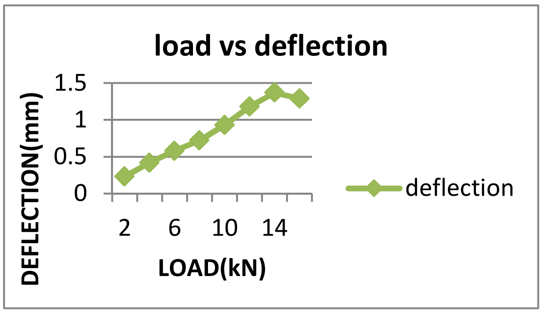

Fig 6 load vs deflection curve

Ultimate load = 14 kN
Ultimate deflection = 1.37 mm

Fig 7 failure of back to back channel section

6.2 Testing of concrete encased section

Fig 8 concrete encased section

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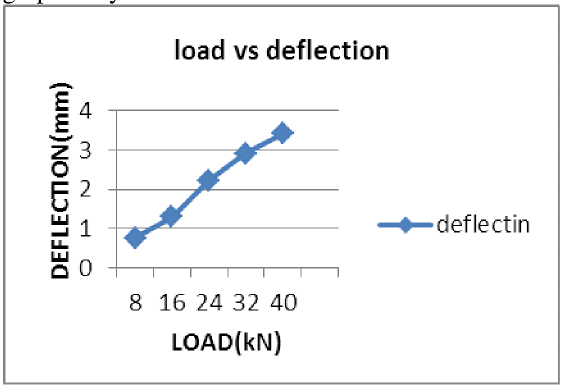

Fig 9 load vs deflection curve

Ultimate load = 40 kN
Ultimate deflection = 3.42 mm

Fig 10 crack pattern in encased beam

6.3 Testing of concrete infill beam

Fig 11 concrete infill beam

The results of load vs deflection is represented graphically below

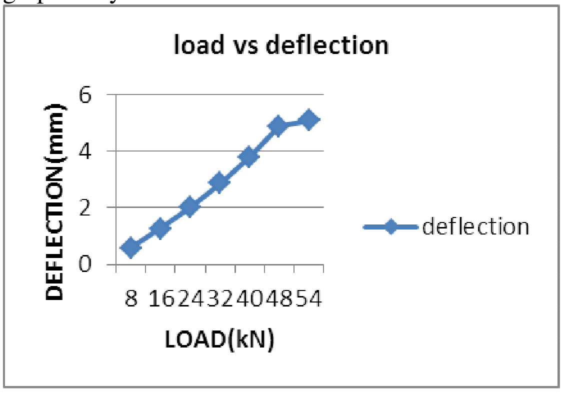

Fig 12 load vs deflection curve

Ultimate load = 52 kN
Ultimate deflection = 5.28 mm

7. RESULTS AND DISCUSSION

Based on test result infill section has higher load bearing capacity. The compressive strength of EPS beads concrete is 14 N/mm^2, which is less than M20 concrete. But to improve the load bearing capacity of cold-formed built up sections and to restrain global and distortion failure EPS beads concrete uses as a bracing material

Table 8 Comparison between ultimate loads of Specimens

section	Ultimate load(kN)	Deflection (mm)
I section	14	1.37
Encased	40	3.42
Infill	52	5.28

8. CONCLUSION

Preliminary work to carry out the main objective of the project was studied and the literatures related to the project were summarized briefly. The properties of cold-formed steel, Expanded Polystyrene beads (EPS), cement and fine aggregate were studied. Further mix design for EPS beads concrete was derived. Assumed w/c ratio = 0.50, the proportion of concrete mix is, 1:1.68:0.036. The ultimate load carrying capacity of back to back channel section, PAC encased section and infill section are 14 kN, 40 kN and 52 kN. From the experimental results ultimate load bearing capacity of encased and infill sections are 2.85 and 3.7 times more than back to back channel section. PAC bracings are used to restrain global and distortion failure also.

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