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BEHAVIOR OF CONCRETE-FILLED STEEL TUBULAR BEAM WITH PARTIAL REPLACEMENT OF DEMOLITION WASTE AS A COARSE AGGREGATE

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Abstract - *Investigation of flexural properties of concrete filled steel tube with partial replacement of coarse aggregate for M_{30} grade of concrete with proportion of 1: 1.70: 3.09 with w/c ratio of 0.40 with 28 days of curing. This chapter discus importance of concrete filled steel tube beam its application and experimental reason that has made the use of these structural material so widely used in the world today. The paper shows the use of concrete filled steel tube beam with partial replacement of coarse aggregate with 10% and 30% under loading In this paper an attempt has been made using recycled aggregate instead of convention aggregate the advantage of using such construction waste material provided a low cost of construction effective waste management technique. In order to reduce the cost and its bond strength with the recycled coarse aggregate concrete and steel in order to reduce the cost and improve the overall strength of the structure*

All the specimens which are made in this research are tested with properties of fresh and hardened concrete with the behavior of beam subjected to bending and recycled coarse aggregate is obtained from demolishing waste concrete with and are also tested for their properties as per IS specification

Key Words: Composite beam, steel tubular sections, replacement coarse aggregate, normal concrete

1. INTRODUCTION

The basic reason for the use of concrete filled steel tube is its composite as concrete is strong in compression and steel is strong in tension with this composite action the advantage of both concrete and steel can be utilized and hence Concrete filled steel tubes (CFST) beam are consider for research. They are used in high-rise building and low-rise industrial building. They are different type of steel tube shape like square, circular and rectangular. This type of composite beam can cover a large space without any intermediate columns and also the deflection is lesser in this type of beam when compared with steel beams. CSFT posses high ductility high strength and hence this are widely used in engineering project and attempt has been made to study the behavior of csft beam in loading. Many studies shows that the csft elements are affected due to their concrete core and Poisson ratio .The steel tube has a confining effect as its Poisson ratio is lower than concrete. The recycled aggregate utilizes demolition material from concrete structure or concrete burnt clay brick masonry as construction aggregate use of this type of coarse recycled aggregate avoid problem of wastage and also reduces the demand of natural granite aggregate. The use of recycling aggregate obtain from construction and demolition waste has been long recognized and it has a potential aspect of concave natural resource and also to reduced the overall cost used in production. Studies shows that demolition waste has lower bulk density and higher water absorption the undesirable effects of recycled aggregate or concrete quality limit the use of the material in structural concrete and hence the partial replacement of 10% to 30% is carried on the study CFST beam with M_{30} grade of concrete with axial load for its ultimate loading capacity at 28days of curing. All the specimens made in this research are tested with properties of fresh and hardened concrete and consequently with the behavior of beam subjected to deflection, up to 30% replacement of natural coarse aggregate with recycled coarse aggregate and its interaction with CSFT is taken into consideration in this paper .The prime reason of use of steel tube is that it provides a sufficient effect to concrete with respect to its confining action and also steel tube this acts as a longitudinal and transverse reinforcement. Several research work has been carried on with respect to the behavior of CSFT with cross-sectional thicknesses and steel material [1-2]. It was shown that CFST improves the compression behavior .The flexure behavior of CFST has recently got the attention of researchers to study the feasibility of utilizing as this has advantage to overcome the limitation than that of plain normal concrete [3-5].Concrete is confined in steel tube and the steel tube yields before the concrete crush this reduces the local bulking [3-5]. Han tested 16 CFST beams with square and

rectangular cross-sections to study their flexural behavior [3]. The concrete cube strength for these CFST beams ranged from 27 MPa to 40 MPa, and steel yield strength from 294 MPa to 330 MPa.

Material used

The Portland cement with 53 grade was used for preparation of test specimen

Specific gravity =3.15

Fine aggregate

Natural river sand confirming to zone III of IS: 383-1970 TABLE 3

Specific gravity =2.65

Natural coarse aggregate

Crushed granite aggregate with 20mm minimum size are used.

- With specific gravity of 2.79
- Water absorption 1.5%
- Bulk density 1779 kg/m^3
- Fineness modulus 6.7
- Crushing strength 20.2%

Recycled coarse aggregate

Recycled coarse aggregate is obtained by crushing with a nominal size of 20mm are used and properties of recycled aggregate is tested and given below

- With specific gravity of 2.73
- Water absorption 1.4%
- Bulk density 1703 kg/m^3
- Crushing strength 17.03%

Water

Portable water available in laboratory are used for mixing and curing for concrete specimen.

Physical properties of steel tube used

Square steel tube

- Outer Diameter(mm)- 120
- Inner Diameter(mm)- 140.6
- Thickness of Steel tube (t) mm – 6
- Length of beam (mm)- 700mm

1.1 experimental programs

RESEARCH SCOPE

To study the strength and ultimate load carrying capacity of CSFT beam made with recycled aggregate after investigating the compressive and split tensile and flexural behavior of recycled aggregate are discussed in paper.

1.2 Test set up and procedure

In total 9cube, 9 cylinder and 9prism specimen are casted and tested for their compressive, split tensile and flexural strength. The following size of standard specimen where used for research cube moulds (150x150x150)mm , cylinder mould of size (150x300)mm ,prism mould of size (100x100x500)mm. The mould have been cleared of dust particles and applied with mineral oil and the specimen are cured for 28 days for present work. The cube specimen where placed over compression testing machine of capacity 200 tones. The test is carried out by placing cylindrical specimen horizontal between the loading surface of testing machine. And the load is applied until the failure of cylinder specimen along the vertical diameter so that the specimen can be subjected to horizontal stress. Prism mould of size (100x100x500)mm is tested using universal testing machine. The machine with two line spaced at 133.3 mm apart the load shall be applied on the prisms which are placed above the rollers with bearing of 50mm from each support.

The hallow steel tubular beam and other composite beam specimen are tested in universal test machine. The load is applied with help of hydraulic jack, at the center a dial gauge is used for recording the defection of beam. The load is applied at uniform rate. A total of 8 specimen are casted the beam of 150mm diameter and 700mm in length the specimen are classified in different set of groups. For cube cylinder and prism a total of 3set where casted which consist of 3specimen each and for beam specimen a total of 4set are casted which

consists of 2 specimen each .The first set represented by 'S 'of hollow square reference beam, second set represented by 'SP' of steel tube beam infill with concrete and third set represented by 'SP-10' with 10% partial replacement of coarse aggregate and 'SP-30' with 30% partial replacement of coarse aggregate

Concrete Specimen	Notation	No of Testing Specimens	Avg Strength
Cubes	S	NA	NA
	Sp	3	28.09
	Sp-30	3	27.68
	Sp-60	3	26.11
Cylinder	S	NA	NA
	Sp	3	3.33
	Sp-30	3	3.25
	Sp-60	3	3.19
Prism	S	NA	NA
	Sp	3	2.72
	Sp-30	3	2.69
	Sp-60	3	2.61

Table-1: Results for Compressive split tensile, flexural strength for 28 days of curing (Avg of 3 Specimens)

BEAM TYPE	MODEL SIZE (BxDxL) mm	THICKNES(t)	Steel strength F_y (Mpa)	d/t ratio	Ultimate load
S	150x150x700	6	350	25	190.64
SP	150x150x700	6	350	25	330.41
SP-10%	150x150x700	6	350	25	321.63
SP-30%	150x150x700	6	350	25	316.57

Table: 2 Result of beam model with ultimate load carrying capacity

Beam-S		Beam-SP		Beam-SP10%		Beam-SP30%	
Deflection (mm)	Load (KN)	Deflection (mm)	Load (KN)	Deflection (mm)	Load (KN)	Deflection (mm)	Load (KN)
0	0	0	0	0	0	0	0
0.55	20	0.43	20	0.51	20	0.81	20
0.63	40	0.57	40	0.62	40	1.13	40
0.71	60	0.64	60	0.71	60	1.68	60
0.93	80	0.78	80	0.84	80	1.97	80
1.07	100	0.97	100	1.03	100	2.21	100
1.29	129.31*	1.12	150	1.33	150	2.56	150
1.51	164	1.51	200	1.61	200	2.83	200
2.01	171	1.87	250	1.94	250	3.04	250
2.49	190.64**	2.17	288.3*	2.34	270.17*	3.44	270
		2.34	300	3.01	300	3.76	277.74*
		2.79	310	3.34	310	4.03	300
		3.31	330.7**	3.61	321.63**	4.37	310
						4.56	316.57**

Table 3 :Load Carrying Capacity of Specimen with deflection

*First crack
** Ultimate Crack

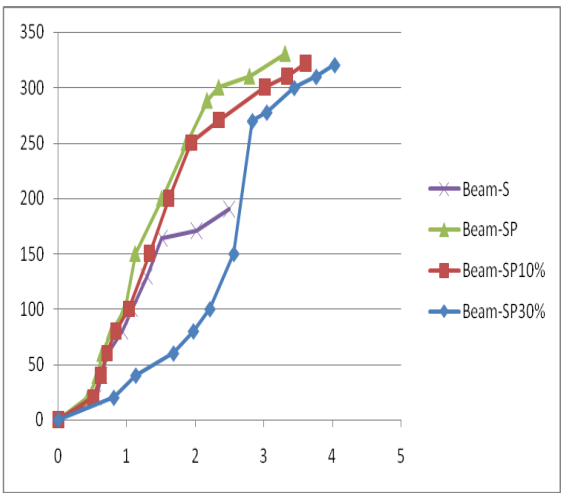

Table 3: Load vs. Deflection

Crack Behavior of Specimen After Application of tensile load for 28 days

Freshly Prepared Specimen

Crack Behavior of Specimen After Application of Flexural load for 28 days

Specimens under Curing Process

3. CONCLUSIONS

It can be concluded that the use of recycled aggregate up to 30% in CFST have similar strength when compared with that of normal plain reinforced beam. Crack behavior is at the lower end of beam specimen when tested under loading with increase in percentage variation of recycled aggregate the strength and ultimate load bearing capacity of CSFT beam is decreased but this decrease in strength and load bearing capacity can be enhanced by more advance and sophisticated treatment of recycled aggregate method. The ultimate load of steel tubular

beam infill with normal concrete(SP) has about 42.30% increase than that of hollow tubular reference beam(S) and the percentage decrease of partially replaced coarse aggregate with infill normal concrete(SP) is about 2.73%, 4.37% for (SP-10) and (SP-30).

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BIOGRAPHIES

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