STUDY THE USE OF FIBRE-REINFORCED CONCRETEIN THE AREA OF FIRE

[1]Dr. Ajay Swarup and [2]Mohd Aijaz Uddin
[1]Professor, Sri Satya Sai University of Technology & Medical Science-Sehore, India.
[2]Research Scholar, Sri Satya Sai University of Technology & Medical Science-Sehore, India.

Abstract:

The improvements in material properties, which improve structural performance, have extended the use of fibre-reinforced concrete to applications in the area of fire. The presence of micro cracks in the mortar-aggregate interface is responsible for the inherent weakness of plain concrete. The weakness can be removed by inclusion of fibers in the mixture. Different types of fibers, such as those used in traditional composite materials can be introduced into the concrete mixture to increase its toughness, or ability to resist crack growth. Since the present design methods and approaches are limited to the property, strength, stiffness and ductility of PCC in-filled columns and beams this study will provide the detailed investigation of the actual and local, post buckling and flexural behaviour of SFRC in-filled light gauge steel box columns and beams subjected to various typical load conditions. The wider use of light gauge structural components in many areas of application has promoted considerable interest in the in-filled light gauge members. The main target of the examination is to investigate the conduct of hollow, Plain Cement Concrete (PCC) and Steel Fiber Reinforced Concrete (SFRC) in-filled stub, short and medium columns subjected to axial and eccentric loads and bars subjected to flexure. Trial, Theoretical and Numerical investigations have been completed. In the principal stage, trial investigations were completed to contemplate the conduct of hollow, PCC and SFRC in-filled light gauge steel stub, short and medium stature columns. 78 investigations were directed, out of which five tests were on stub columns, five tests were on short columns and 68 tests were on medium tallness columns.

Keywords: Fibre, reinforced, mixture, light, gauge, column.

1. INTRODUCTION

The styles of light gauge metal hollow people in filled with regular concrete are constantly completed based on arrangements endorsed by different codes of methods. Due to immense varieties in the attributes of the in filled concrete as well as the intricacy of the interaction that occurs in between the concrete and the outside shell, it a lot of the moment can make an uneconomical design of frameworks and people entirely on hypothetical premise. Furthermore, when adequate scientific design methods aren't accessible for the part or maybe composites, the assessment of the segments are recommended. The conduct of composite columns as well as pillars may usually be ascertained tentatively and sensible modifications can be integrated, any school crucial.

Present design hypotheses accept complete link between the steel shell as well as the concrete facility to streamline the determination of a definitive picture of obstruction. Be that as it might, in fact slippage at the steel concrete screen is actually unavoidable once the tractable cracking of the middle concrete. For an excellent comprehension of the intricate screen conduct, scientific investigations and trial tend to be more practical. Push out opposition testing on concrete are actually used to figure out the bond slip attributes between outside steel shell as well as in filled concrete with the heap versus slip reaction, that may similarly be used to evaluate the normal demonstration of the concrete filled metal sections. An excellent understanding is needed on the energy move instrument among concrete and metal when overwhelming turns as well as buckling occurs.

In the present investigation, an advancement of analyses was performed considering the conduct of hollow, PCC in filled and 3 assortments of SFRC in filled stub, short, medium columns as well as bars with accentuates on a definitive toughness, axial disfigurements, pliability, parallel diversions as well as post disappointment strength save in flexible just as in the clear plastic gets to with an interest on the relationship among concrete and steel. An exertion has likewise been created to contrast the test as well as the results and hypothetical results obtained utilizing mathematical models.

Out of eighty-eight examples set up for the test learn, seventy-eight assessments are led on columns as well as 10 assessments are guided on shafts. The columns are put through axial burden and uni-axial as well as bi axial eccentric lots. The shafts are actually subjected to thirty-three % point tons regarding its minor and major tomahawks. The impacts of arrangement of the infill, the eccentricity of the heap, the amount width to the slimness and thickness proportion proportion on the heap carrying boundaries of the columns as well as shafts are actually contemplated.

2. LITERATURE REVIEW

T. Arhaa et, al (2018) this study predicts the shear strength of steel fibre reinforced concrete (SFRC) members at elevated temperature using numerical modeling. The authors derived the stress-strain relation in the pure shear mode at ambient temperature based on a damage model calibrated at ambient and elevated temperatures. The model was validated on the special experimental arrangement for the pure shear mode of the SFRC in torsion. These results enable to determine the stress-strain diagram at elevated temperature. The shear strength of SFRC is compared with the compressive and tensile strength and used to observe reasons for experimentally observed failure model. The work is a part of comprehensive project focused on development of design models for the steel and SFRC composite columns with circular hollow section (CHS) at elevated temperature. Research includes two levels accuracy/complexity, allowing simplified or advanced approach to design following the coming changes in European standard for composite member design in fire, EN1994-1- 2:2021. Experimental studies of the project include mechanical material tests of heated fibre- concrete samples in tension and compression, thermal uniform and non-uniform tests of insulated fragments of CHS and tests of full scale SFRC CHS columns in steady-state and transient-state regimes.

E. Balaji (2017) Nano-technology is useful to study hydration and alkali silicate reactions of concrete which plays a major role to arrest segregation and micro cracks. In the present study Mechanical properties of M50 grade of Conventional concrete (CC) and Nanosilica concrete (NSC) were studied. Experimental results predict that NSC achieves superior properties than CC in strength criteria. This paper represents flexural behavior of CC and NSC in-filled in light gauge rectangular box cross sections under the criteria of pure bending. Here in this project used thickness of light gauge steel beams are 1.6 mm and 2.0 mm. Hence to arrest local buckling and to get internal support in cold formed steel members, these are infilled with concrete. It can increase the stiffness and flexural strength of the member by the moment of inertia of section. Hollow, conventional concrete in-filled and Nano silica concrete infilled beams in pure bending are to be tested until failure with respect to Zone of minor axis.

Ashraf Abdalkader et, al (2017) Steel fibers are added to concrete due to its ability to improve the tensile strength and control propagation of cracks in reinforced concrete members. Steel fiber reinforced concrete is made of cement, fine, water and coarse aggregate in addition to steel fibers. In this experimental work, flexural cracking behavior of reinforced concrete beams contains different percentage of hooked-end steel fibers with length of 50 mm and equivalent diameter of 0.5 mm was studied. The beams were tested under third-point loading test at 28 days. First cracking load, maximum crack width, cracks number, and load- deflection relations were investigated to evaluate the flexural cracking behavior of concrete beams with 34 MPa target mean strength. Workability, wet density, compressive and splitting tensile strength were also investigated. The results showed that the flexural crack width is significantly reduced with the addition of steel fibers.

Baarimah, A. O.; Syed Mohsin, S. M. (2017) This paper investigates the potential effect of steel fiber added into reinforced concrete slabs. Four-point bending test is conducted on six slabs to investigate the structural behaviour of the slabs by considering two different parameters; (i) thickness of slab (ii) volume fraction of steel fiber. The experimental work consists of six slabs, in which three slabs are designed in accordance to Eurocode 2 to fulfil shear capacity characteristic, whereas, the other three slabs are designed with 17% less thickness, intended to fail in shear. Both series of slabs are added with steel fiber with a volume fraction of $V_f = 0\%$, $V_f = 1\%$ and $V_f = 2\%$ in order to study the effect and potential of fiber to compensate the loss in shear capacity.

K. Perumal P, R. Srinivasan (2016) In modern construction, Concrete filled steel tubular (CFT) beam and column have better option in structural systems like buildings, bridges, caissons piers and deep foundations, because of its high compressive stiffness. These CFT members are applicable in curved bridge decks and where formwork is could not be provided. The CFT column has more stiffness and reduces local buckling failures. In present work study of torsional characteristics of steel beams, in-filled with plain cement concrete and fiber reinforced concrete Torsional moment and angle of twist has been studied of hollow steel tubular beam, tubular beam in-filled with Plain Cement Concrete (PCC) and Steel Fiber Reinforced Concrete (SFRC) beams under torsion. The volume fraction of fiber added to concrete mix as 1.5%. The aspect ratio of steel fiber is kept as 50, crimped shaped steel fiber are used and its length 50mm. The M20 grade concrete used to infill material of steel tube all beam specimens has been tested under two points loading on self-straining loading frame (40-ton capacity) under pure torsion. Finally, to compare the torsional behavior of hollow, PCC in-filled and SFRC in-filled steel beams.

3. MATERIAL CHRACTERISTICS

2.1 Steel Section

The hollow areas had been created utilizing mild gauge metal sheets, constantly welded at the facility along the length of its. The light gauge metal sections are been seen in Figure 1. The scale of the steel areas is hundred mm × fifty mm as well as two mm thick.

i) Specimens ii) Cleaning for oil, Grease and grit

Figure 1: Test specimens

Inside request to figure out the legitimate content attributes, 3 steel coupons have been cut from all of the 4 essences of the sections and also attempted to disappointment under stress based on ASTM A370 certain. Figure 1 reveals the subtleties of the example for the stress coupons. The test set up is actually been seen in Figure 2. The yield power of the light gauge metal is decided often by the offset method or even the strain under burden technique. Offset strategy is employed by and large for constant yielding metal and it's used to calculate the yield power of the material. Within the offset strategy, the yield strength is actually the pressure corresponding to the intersection of the stress strain bend as well as a line corresponding to the first straight line parcel offset by a predefined stress. The offset is frequently suggested as 0.2 %. The run of the mill stress strain conduct of the ductile coupon test is actually.

By the tests, the following regular attributes had been obtained. Yield anxiety fy = 270 N/mm^2, Ultimate anxiety fu = 410 N/mm^2, Elongation = thirteen % and also the Modulus of Elasticity = 2.05 × 105 N/mm^2. To forestall the nearby buckling frustration of the examples, the passable B/t proportion of the steel hollow sections to be used is actually provided by B/t ≤ fifty-two (235/fy) ½, as backed by Eurocode4 - 1994. The examples greatest B/t proportion is actually forty-six as well as the estimation of fifty-two (235/fy) ½ for the test instances are actually 48.51, therefore the picked sections fulfill the above-mentioned prerequisites what about this way all of the instances may be named decreased sections.

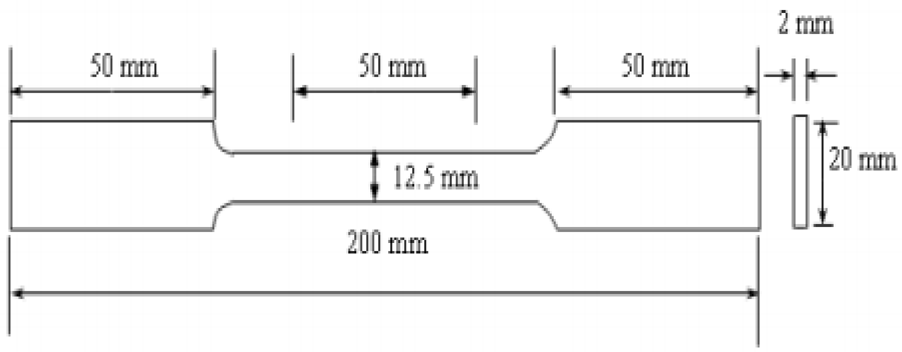

Figure 2 Details of tension coupons

4. COMPARISON OF TEST RESULTS WITH THE DESIGNCODES

With this section, the experimental information is actually in contrast to the values predicted by the design codes like British and Eurocode4 code BS 5400. Based on Eurocode4, the axial load capability (N_u) of CFT stub columns are actually determined by summing up the strengths of the steel tube as well as the concrete center as in situation (1). The EC4 does apply to CFT stub columns with concrete cylinder power as well as steel yield anxiety not higher than fifty as well as 355MPa, respectively.

$$\text{Axial load capacity } N_u = A_s f_y + A_c f_c' \quad (1)$$

As per the British code BS5400, the sturdiness of the stub column is actually driven using the situation (2). A coefficient of 0.675 was incorporated in the concrete cube strength to account for long-range and size consequences of concrete cube.

$$\text{Axial load capacity } N_c = A_s f_y + 0.675 A_c f_{cu} \quad (2)$$

The axial load carrying capability calculated using the expressions provided in codes are actually compared with the experimental outcomes for all the five specimens and are actually mentioned in Table 3.3. It demonstrates standard deviation and the mean of the theoretical load (P_{the}) and experimental load ($P_{exp.}$) ratio for the various design codes. The results indicate BS5400 predicts the column strength conservatively whereas the EC4 predicts it somewhat on the bigger side. The EC4 predicted about seven % more supreme load compared to the experimental outcomes for in filled columns and estimated 7.20 % lower values for hollow columns. The design strength predicted by BS5400 is actually nearer to the experimental values. The code BS5400 offers a mean worth of 0.969 and a regular deviation of 0.040 as compared to the experimental values and it is the very best predictor and hence are appropriate for the calculation of axial strength of SFRC in filled stub columns. The comparison is illustrated by Figure 3.

Table 1: Comparison of experimental and theoretical strengths of stub columns

Sl. No.	Specimen Type	Experimental Load (kN) Pexp.	Euro code 4		BS5400	
			Theoretical Load (kN) Pthe	(Pthe. / Pexp.)	Theoretical Load (kN) Pthe	(Pthe. / Pexp.)
1	A	170.00	157.68	0.928	157.68	0.928
2	B	261.60	275.37	1.053	254.38	0.972
3	C	300.00	312.11	1.040	282.22	0.941
4	D	320.00	366.07	1.144	329.91	1.031
5	E	280.00	297.40	1.062	272.74	0.974
Mean			1.045		0.969	
Standard Deviation			0.077		0.040	

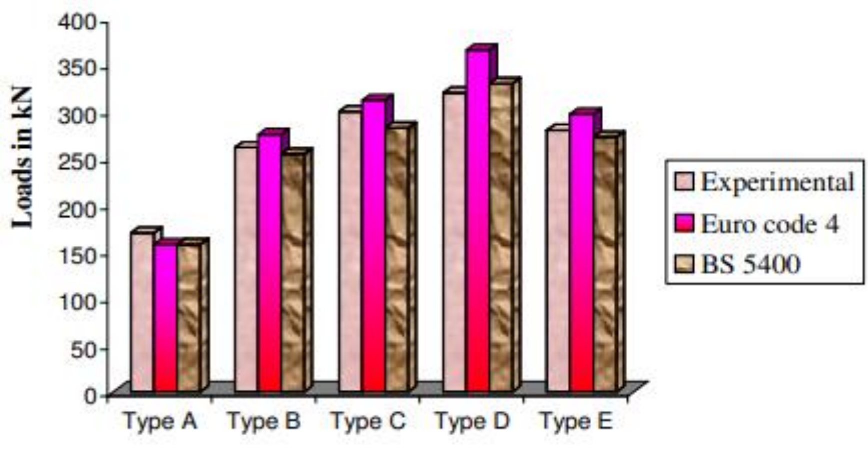

Figure 3: Comparison of experimental loads and theoretical loads

5. DISCUSSION OFRESULTS

An experimental system on five hollow as well as in filled mild gauge metal stub columns put through axial compression have been discussed. The strength boost resulting from confinement of high strength concrete by steel section was noticed. Comparisons of failure loads, the PCC in filled column had been taking 1.65 times more load as opposed to the hollow columns. The SFRC in filled columns were about 1.80 times as well as 1.15 times more lots than hollow and PCC in filled columns respectively. The comparisons of failure lots between the test lots as well as the design codes are offered. It suggests that EC4 is harmful to foresee the supreme capability of the in filled columns. On the flip side BS5400 predicts the failure lots at the experimental loads. The BS5400 strategy gives a mean worth of 0.969 and a regular deviation of 0.040 in contrast to experimental worth is the greatest predictor and hence are appropriate for the calculation of axial strength of SFRC in filled stub columns. Test results likewise manifested favourable ductility performance for hollow and SFRC in filled stub column specimens that had been ascertained by the load versus strain curves. For the lower load amounts i.e. up to 100kN the axial shortening was ten % less for one % SFRC in filled columns when compared with other columns. This particular aspect shows the effect of SFRC in fill in the stub columns.

6. CONCLUSION

Predictions by the 2 codes were traditional in computing the supreme loads. By the ratio of theoretical loads (P_{the}) to the experimental loads (P_{exp}) EC four gave a mean worth of 0.954 and a regular deviation of 0.054, and that is the very best predictor and hence appropriate for calculating the supreme load carrying capacities of SFRC and PCC in filled columns. SFRC in filled mild gauge metal package sections enhanced the supreme load carrying capability as well as ductility as opposed to the simple concrete in filled columns & hence these were suggested for wearing in higher seismic areas. The SFRC in filled columns with one % volume fraction of fiber was discovered to have higher toughness, lesser stiffness and ductility as opposed to the other 2 volume fraction of fibers (0.75 % as well as 1.25 %) studied. The codal provisions were intended for simple cement concrete in filled light gauge columns as well as can't be worn straight for SFRC in filled light gauge metal columns. Hence innovative provisions had been necessary for composite columns with good performance concrete in fills like SFRC.

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