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Experimental Investigation on High Performance Concrete with Flyash And Alccofine

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ABSTRACT—

The aim of this project was to evaluate the performance of high performance concretes(HPC) Containing supplementary cementitious materials. In the last millennium concrete had demanding requirements both in terms technical performance and economy and yet greatly varied from architectural masterpieces to the simplest of utilities. The main aim of the project is first to prepare the Strength of concrete of grade M40 with locally available ingredients and then to study the effects of different proportions of Alccofine and fly ash in the mix and to find optimum range of Alccofine and fly ash content in the mix. The Alccofine and fly ash is added by weight of cement as a replacement. The concrete specimens will test at different age level for mechanical properties of concrete, namely, cube compressive strength, flexural Strength.

Keywords—HPC, Fly ash, Industrial by-product, Alccofine.

I. INTRODUCTION

Concrete filled steel tubular (CFST) members utilize the advantages of both steel and concrete. They comprise of a steel hollow section of circular or rectangular shape filled with plain or reinforced concrete. They are widely used in high-rise and multi-storey buildings as columns and beam- columns, and as beams in low-rise industrial buildings where a robust and efficient structural system is required.

There are a number of distinct advantages related to such structural systems in both terms of structural performance and construction sequence. The inherent buckling problem related to thin-walled steel tubes is either prevented or delayed due to the presence of the concrete core. Furthermore, the performance of the concrete in-fill is improved due to confinement effect exerted by the steel shell. The distribution of materials in the cross section also makes the system very efficient in term of its structural performance. The steel lies at the outer perimeter where it performs most effectively in tension and bending. It also provides the greatest stiffness as the material lies furthest from the centroid. This, combined with the steel's much greater modulus of elasticity, provides the greatest contribution to the moment of inertia. The concrete core gives the greater contribution to resisting axial compression.

The use of concrete filled steel tubes in building construction has seen resurgence in recent years due mainly to its simple construction sequence, apart from its superior structural performance. Typically, it was used in composite frame structures. The hollow steel tubes that are either fabricated or rolled were erected first to support the construction load of the upper floors. The floor structures consist of steel beams supporting steel sheeting decks on which a reinforced concrete slab is poured.

Such structural system has the advantage of both steel and reinforced concrete frame. It has the structural stiffness and integrity of a cast- on-site reinforced concrete building, and the ease of handling and erection of a structural steelwork.

The hollow tubes alone were designed in such a way that they are capable of supporting the floor load up to three or four storey height. Once the upper floors were completed, the concrete was pumped into the tubes from the bottom. To facilitate easy pumping the tubes were continuous at the floor level. Modern pumping facility and high performance concrete make pumping three or four storey readily achievable. Due to the simplicity of the construction sequence, the project can be completed in great pace.

II. REVIEW OF LITERATURES

N.E. Shanmugam , B. Lakshmi studied the the state of art knowledge on steel–concrete composite columns including experimental and analytical studies. A summary of experiments reported in literature is presented in a tabular form. The discussion includes behavior of short and slender composite columns. Use of high strength concrete in composite columns is briefly outlined. A detailed discussion on the effect of local buckling, bond strength, confinement of concrete, seismic behaviour and secondary stresses on composite columns are presented. Considerable progress has been made during the last two decades in the investigation of steel–concrete composite columns, and information available is summarized in this paper. Intensive research is required on the interaction between steel and concrete, the effect of concrete restraining local buckling of steel plate elements, effect of steel section, confining concrete, etc.

Z.H. Lu and Y.G. Zhao presented the simple formula for predicting the axial capacity of circular concrete-filled steel tube (CFT) stub columns is proposed. The concrete confinement, which depends mainly on the ratio of the external diameter of the steel tube to the plate thickness, the yield stress of the steel tube and the unconfined compressive strength of the filled concrete, is empirically deduced. A comparison with the experimental data published in the literature indicates that the present method provides more efficient representation of the ultimate strength of circular CFT stub columns than the existing codes, such as ACI2005, AIJ-2001, Eurocode-2004 and DL/T-1999. An accurate formula for predicting the axial capacity of circular CFT stub columns with normal- and high-strength steel and concrete is proposed. The scale effect on the strength of the filled concrete and the enhancement of CFT columns due to the composite action between steel tube and concrete core are taken into account in the proposed formula. A sharp decrease of concrete confinement is found when the diameter-to- thickness ratio is small, and it tends to be moderate when the diameter-to- thickness ratio is greater than 60. The concrete confinement increases linearly when the yield stress of the steel tube increases, and it decreases as the unconfined compressive strength of the concrete core increases, respectively. ACI (2005) give a sectional capacity about 22.4% lower than the experimental results, and AIJ (2001) and DL/T (1999) give a sectional capacity about 8% and 4.3% lower than the experimental results, respectively, while the Erurocode 4 (2004) predicts unconservative results with 2.6% higher than the results obtained in the tests. The values predicted using the present formula are in good agreement with the experimental results for circular CFT stub columns not only within a large range of diameter-tothickness ratios but also with normal-strength of concrete and steel tubes and high-strength of concrete and steel tube.

Soner Guler, Erol Lale and Metin Aydogan presented the experimental study of square high strength steel fiber reinforced concrete (SFRC) filled steel tube columns under axial load. A series of tests are performed to investigate the effects of D/t ratio, the bond strength between concrete and the steel tube on behavior and axial load capacity of the high strength SFRC filled steel tube columns. The specimens are separated as greased and non-greased to investigate the bond effect on the axial load capacity. A total of 13 specimens are tested and compared to Eurocode 4, ACI, AS and AISC Codes. The results show that the difference of the axial load capacity between the greased and the non-greased square high strength SFRC filled tube columns is notable. The all design codes overestimate the axial load capacity for the specimens with thinner (D/t ratio is 33.3) steel tube thickness. The main conclusion that we observed from current study as highlighted below. The Poisson ratio is slightly less and the amount of shrinkage is much higher of the high strength concrete than the medium or low strength concrete. Because of these reasons, the confining effect of the steel tube to the concrete core is not seen much for high strength concrete compared to the low or medium strength concrete.

Xiao.Y. and Chin.C.S in his paper examines a numerical program to analyze the behavior of the concrete filled steel tubular (CFT) stub columns, and predict various modes of lateral interactions between steel tube and filled- in-concrete under axial compression. The behavior of CFT columns is controlled by both the strength and the confinement effect of steel tube and filled-in-concrete in the columns. Various lateral interactions between steel tube and filled-in-concrete in CFT columns are classified into eight different cases by the contact between steel tube and filled-in concrete at different stages.

Giakoumelis.G. et al., studied the behavior of circular concrete-filled steel tubes (CFT) with various concrete strengths under axial loads. The effects of steel tube thickness, the bond strength between the concrete and the steel tube, and the confinement of concrete are examined. Measured column strengths are compared with the values predicted by Eurocode 4, Australian Standardards and American Codes. All three codes predicted lower values than that measured during the experiments.

Lakshmi.B. et al. conducted study on the effects of local buckling, bond strength, seismic loading, confinement of concrete and secondary stresses on the behavior of hollow steel tube and steel–concrete composite columns. Experiments were conducted both encased and in-filled composite columns tested by various researchers with a view to establish their behaviour and load-carrying capacity. The tests were conducted on two (14 m) long, (0.33m) diameter pipe columns, one empty and the other filled with concrete. It was concluded that infilled concrete increases the load and moment carrying capacity without increasing the size of the column.

O’shea and Bridge tried to estimate the strength of CFTs under different loading conditions with small eccentricities. All the specimens were short with a length-to-diameter ratio of 3.5 and a diameter thickness ratio between 60 and 220. The internal concrete had a compressive strength of 50, 80 and 120 MPa. From those experiments, O’Shea and Bridge concluded that the degree of confinement offered by a thinwalled circular steel tube to the internal concrete is dependent upon the loading condition. The greatest concrete confinement occurs for axially loaded thin-walled steel with only the concrete being loaded and the steel tube used as pure circumferential restraint. Eurocode 4 has been shown to provide the best method for estimating the strength of circular CFTs with the concrete and steel loaded simultaneously.

III. EXPERIMENTAL INVESTIGATION

All the materials tests were conducted in the laboratory as per Indian Standard codes. The proportions of ingredients for the control concrete of grade M30 had to be determined by mix design as per IS code. For that, basic tests were conducted for fine aggregate, coarse aggregate and cement to check their suitability for concrete making.

The specimens were cast. The various tests such as compression test, flexural tests and load carrying capacity of RCC and CFST columns were carried out on the specimens.

A. Theoritical Investigation oncrete filled tubular columns are clearly intermediate between steel and reinforced concrete columns. However, the design philosophy for each of these two structural members is fundamentally different. Steel columns are treated as concentric in that they are loaded through their centroids, but with the allowances being made for residual stresses. The basis of the design of the steel column is instability or buckling and any moments which act at the ends of the column are proceeded by reducing the axial load by way of an interaction equation.

On the course of time, the moulds are cleaned and applied with thin film of oil. The fresh concrete is filled inthe mould in three layers of 5 cm depth. Each layer is compacted with tamping rod uniformly with 25 blows. The purpose of compaction is to avoid entrapped air inside the concrete moulds. After the top layer has been compacted, level top surface with a trowel. During pouring of concrete, it is better to avoid wasting of concrete for effective and economical usage. The specimens are demoulded after 24 hours from the process of moulding. If the concrete has not achieved sufficient strength to enable demoulding the specimens, then the process must be delayed for another 24 hours care should be taken not to damage the specimen during the process because, if any damage is caused, the strength of the concrete may get reduced.

TABLE I. MATERIALS FOR THE PREPARATION OF SPECIMEN

TYPE	**CEMENT (Kg)**	**GP (Kg)**	**FA (Kg)**	**CA (Kg)**	**BB (Kg)**	**WATER (*l*)**
Normal concrete	96	0	16.78	28.68	0	4.794
10% GP & 10% BB	96	1.678	15.102	25.812	2.868	4.794
10% GP & 20% BB	96	1.678	15.102	22.944	5.736	4.794
10% GP & 30% BB	96	1.678	15.102	20.076	8.604	4.794
10% GP & 40% BB	96	1.678	15.102	17.208	11.472	4.794
10% GP & 50% BB	96	1.678	15.102	14.34	14.34	4.794

FIGI. CASTED CUBE AFTER REMOLDING

B. Test Setup

Remove the specimen from water after specified curing time and wipe out excess water from the surface. Take the dimension of the specimen to the nearest 0.2 m. Clean the bearing surface of the testing machine. Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast. Align the specimen centrally on the base plate of the machine. Rotate the movable portion gently by hand so that it touches the top surface of the specimen. Apply the loadgradually without shock and continuously at the rate of 140 Kg/cm²/minute till the specimen fails. Record the maximum load and note any unusual features in the type of failure.

C. Results

The results of compressive strength test, split tensile are presented here.

TABLE II. COMPRESSIVE STRENGTH FOR 14 DAYS CURING

Combination	**Dimension (mm x mm)**	**Load (N)**	**Compressive Stength (N/mm²)**	**Average Compressive Strength (N/mm²)**
NORMAL MIX	155 X 150	280000	12.04	15.28
	149 X 150	360000	16.10	
	143 X 150	380000	17.71	
10 % GP & 10% BB	142 X 153	200000	9.2	8.11
	147 X 152	150000	6.71	
	156 X 152	200000	8.43	
10% GP & 20% BB	142 X 149	210000	9.92	8.33
	139 X 151	160000	7.62	
	135 X 159	160000	7.45	
10% GP & 30% BB	152 X 150	300000	13.15	12.09
	152 X 152	170000	7.35	
	150 X 152	360000	15.78	
10% GP & 40% BB	157 X 145	150000	6.58	8.04
	152 X 150	250000	10.96	
	150 X 152	150000	6.57	
10% GP & 50% BB	156 X 140	150000	6.86	6.67
	150 X 150	100000	4.44	
	157 X 146	200000	8.72	

TABLE III. MIX FOR SPECIMENS OF ANSYS 15.0 MODEL OF THE SPECIMEN

Combination	**Dimension (mm x mm)**	**Load (N)**	**Compressive Stength (N/mm^2)**	**Average Compressive Strength (N/mm^2)**
NORMAL MIX	155 X 150	500000	21.64	26.90
	149 X 150	600000	25.97	
	143 X 150	750000	33.11	
10 % GP & 10% BB	142 X 153	240000	11.03	15.33
	147 X 152	410000	17.98	
	156 X 152	380000	17.00	
10% GP & 20% BB	142 X 149	300000	13.07	17.06
	139 X 151	400000	18.77	
	135 X 159	450000	19.34	
10% GP & 30% BB	152 X 150	600000	26.67	25.28
	152 X 152	520000	23.74	
	150 X 152	500000	25.44	
10% GP & 40% BB	157 X 145	250000	11.65	12.74
	152 X 150	300000	13.24	
	150 X 152	300000	13.33	
10% GP & 50% BB	156 X 140	280000	16.02	11.31
	150 X 150	150000	6.57	
	157 X 146	250000	11.34	

TABLE IV. SPLIT TENSILE STRENGTH TEST

COMBINATION	**7 DAYS (N/mm^2)**	**14 DAYS (N/mm^2)**	**28 DAYS (N/mm^2)**
NORMAL MIX	1.65	2.25	2.46
10 % GP & 10% BB	1.82	2.35	2.56
10% GP & 20% BB	1.85	2.4	2.65
20% GP & 30% BB	1.52	2.13	2.33
30% GP & 30% BB	1.35	2.09	2.2
30% GP & 40% BB	1.2	1.89	1.98

IV. CONCLUSION

The replacement of fine and coarse aggregate by glass powder and brick ballast respectively found was formed as remarkable method for reducing the material quantity of concrete giving sufficient strength. The pozzolanic reaction of glass powder increases the strength of concrete. The result obtained from the experiments shows that there is a great potential for utilization of best glass powder in concrete as partial replacement of cement. Partial replacement of fine aggregate in concrete by 10% of glass powder will give maximum result. The compressive strength of the concrete can be increased by using glass powder as partial replacement of fine aggregate. However, the result shows that strength of brick ballast specimens were gradually increased up to 30% replacement of brick ballast and then it gradually decreases up to 50% replacement of brick ballast. The test result showed that the concrete specimen with 30% replacement of brick ballast get highest compressive strength when compare to concrete specimen with different percentage of brick ballast.

Also in split tensile strength 10% glass powder replacement and 20% brick ballast replacement give more tensile strengths compared to other percentages. Natural aggregates which are using for concrete is nonrenewable resources, so we can reduce the uses of natural aggregate by the replacement of brick ballast. This modified concrete with sufficient strength will also be a best solution for the disposal problem of brick waste and glass waste materials. Also the cost of construction also can be reduced by using this modified concrete.

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