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An Appraisal on Mechanical Properties of SCC with Varying Packing Factors

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ABSTRACT

The development of Self Compacting Concrete (SCC) by Professor Hajme Okamura in 1986 has made a remarkable impact on the construction industry by overcoming some of the problems associated with fresh concrete.SCC homogenously spread under its own weight without any additional compaction and does not entrap air.It improves the efficiency at the construction site enhances the working conditions and also the quality and appearance of concrete. For such applications the fresh concrete must possess high fluidity and good cohesiveness. The use of fine materials such as fly ash can ensure the required concrete properties.

In this present study the results of experimental program aimed at producing and evaluating SCC according to Nan su mix design and also a conventional concrete using ACI method. To qualify the developed SCC mix fresh properties like slump flow, J-Ring, V-funnel, L-flow tests were conducted and checked against EFNARC specifications. Then this mix is further modified based on packing factors (PF) varying from 1.12 to 1.18. The fresh and hardened properties of the new mixes were also validated to the satisfaction of EFNARC guidelines.[3] Then a relative study on the variability of the mechanical properties like compressive strength and split tensile strength were examined at 28 and 90 days of normal curing and with the mechanical properties of conventional concrete.

Keywords: Self Compacting Concrete, Packing Factor(PF) , Stress Strain , Nansu Mix Design

I. INTRODUCTION

The development of new technology in the material science is progressing rapidly. In last three decades, a lot of research was carried out throughout globe to improve the performance of concrete in terms of strength and durability qualities. Consequently concrete has no longer remained a construction material consisting of cement, aggregate, and water only, but has become an engineered custom tailored material with several new constituents to meet the specific needs of construction industry. The growing use of concrete in special architectural configurations and closely spaced reinforcing bars have made it very important to produce concrete that ensures proper filling ability, passing ability, good structural performance, and adequate durability without segregation and bleeding. In recent years, a lot of research was carried out throughout the world to improve the performance of concrete in terms of its most important properties, i.e. strength and durability. Concrete technology has under gone from macro to micro level study in the enhancement of strength and durability properties from 1980's onwards. Till 1980 the research study was focused only to flow ability of concrete, so as to enhance the strength however durability did not draw lot attention of the concrete technologists. This type of study has resulted in the development of self compacting concrete (SCC), a much needed revolution in concrete industry. Self compacting concrete is highly engineered concrete with much higher fluidity without segregation, bleeding and is capable of filling every corner of form work under its self-weight only (Okamura 1997) [5]. Thus SCC eliminates the needs of vibration either external or internal for the compaction of the concrete without compromising its engineering properties.

II. MATERIALS AND DISCUSSION

Ordinary Portland Cement of 53 grade confirming to IS 12269 with specific gravity 3.2 was used in the study. The aggregates should be of well graded and uniform in quality to attain properties of self compacted effortlessly. River sand(FA) confirming to Zone –II with specific gravity 2.6, fineness modulus 3.43 and dry bulk density 1400Kg/m3 was used. Coarse aggregate(CA) of size 20 mm and 10mm downgraded given by IS:2386 was used. The specific gravity fineness modulus and bulk density were 2.64, 2.86 and 1500kg/m3 respectively.

Ordinary potable water is used for mixing and curing the concrete specimen. Mineral admixture used in the project is Type-II fly ash from Vijayawada Thermal Power Station, AP confirming to IS:3812. Chemical admixtures used are Master Glenium SKY 8233 a new generation based on modified poly carboxylic ether and CAC- hyper in selected proportions were used in this project. Different trial mixes were investigated in the laboratory and the mix with the following constituents as shown in tables was arrived at and used in further investigation.

III. MIX-DESIGN

The design of SCC is based on a compressible packing model proposed by Nan Su (). The authors have proposed a modified simple mix-proportioning system assuming general supply from ready-mixed concrete plants. The coarse and fine aggregate contents are varied according to the Packing factor so that self compactability can be achieved easily by adjusting the water to powder volume ratio and superplasticizer dosage only.

IV. RESULTS AND DISCUSSION

The experimental work consisted of developing SCC mix proportions using Nan su mix design method[1].In the first stage, M40 of conventional mix was designed by using ACI mix design method and the obtained constituents are presented in Table 1 similarly the mix proportions for SCC was calculated by using Nan Su method and the obtained constituents are presented in Table 3.The mix proportions obtained were tested for the fresh properties and hardened properties in accordance with IS: 516 for conventional concrete. Different trial mixes were investigated in the laboratory and the mix of self compacting concrete (high performance concrete) M 40 with the following constituents as shown in Table 3 were arrived and used in further investigation. The mix is checked for the fresh properties laid by EFNARC. The hardened strength properties were verified based on tests conducted on test specimens.Then these mixes are further modified based on packing factors (PF) varying from 1.12 to 1.18. The fresh and hardened properties of the new mixes were also validated to the satisfaction of EFNARC guidelines.

Details of Mix proportion for M40 conventional concrete

Grade	Notation	Cement	F Agg	C Agg	Water
M 40	C11	1	1.2	2.6	0.45

TABLE II

s/a	w/c	w/f	Air content	SP%	Water in SP
0.56	0.4	0.28	1.5	0.009	0.4

Table 3: Details of M40 SCC grade concrete mix

PF	Specific gravity				Bulk Density	
	CA Gg	FA Gs	FlyAsh Gf	Cement Gc	CA Wgl	FA Wsl
1.12	2.64	2.6	2	3.2	1500	1400

Table 4 : Details of M40 SCC grade concrete mix with varying PF

PF	Identification	Cement	Fly ash	FA	CA	Water
1.12	S11	1	0.55	2.55	2.15	0.55
1.14	S12	1	0.5	2.6	2.19	0.53
1.16	S13	1	0.45	2.64	2.22	0.52
1.18	S14	1	0.4	3.69	2.26	0.51

Weighing of materials is done as per mix proportion and as per required quantity of mix. Initially, clean the mixer properly and add some water followed by coarse aggregate, Fly ash, cement and fine aggregate. Allow the mixer to rotate for few rotations for proper mixing. Now add remaining amount water and super platicizer periodically until attaining required fluidity. **Specimen preparation and Testing :** In the present experimental investigation cubes of size 100mm x 100mm x 100mm, beam of size 100mm x 100mm x500mm and cylinder of length 200mm and diameter of 100mm are casted with varying packing factors. After casting, the specimens are demoulded after 24 hours and after this period the specimens are marked and removed from the moulds and kept cured in clear fresh water until taken out prior to test.

Test results and Discussion:

Table 5 &6 shows the results of cube compressive strength of 100mm cubes and split tensile strength of 100mmx200mm cylinders for different specimens identified as C11 for cubes and cylinders made of conventional concrete, S11 for cubes and cylinders made of SCC of PF 1.12, S12 for cubes and cylinders made of SCC of PF 1.14, S13 for cubes and cylinders made of SCC of PF 1.16 and S14 for cubes and cylinders made of SCC of PF 1.18.

Table 5: Cube compressive strength of M40 grade concrete

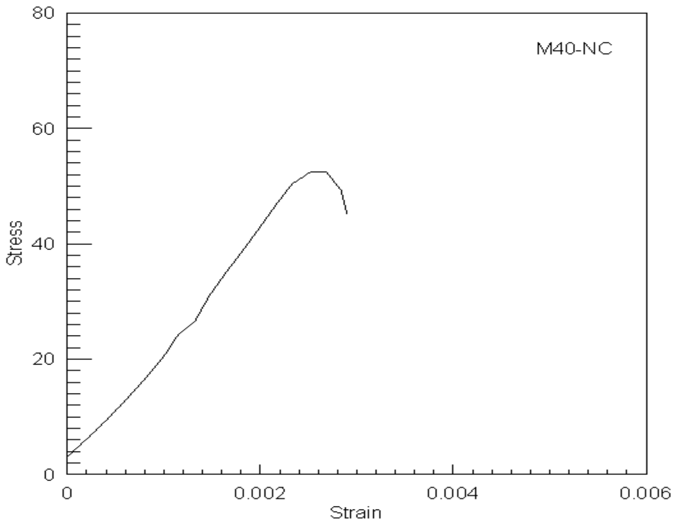
ID.No	PF	Load			Compressive Strength		
		7	28	90	7	28	90
C11		410	525	975	41	52.5	67.5
S11	1.12	294	450	651	29.4	45	65.1
S12	1.14	280	612	690	28	61.2	69
S13	1.16	370	500	540	37	50	54
S14	1.18	300	370	500	30	37	50

Table 6: Split tensile strength of M 40 grade concrete

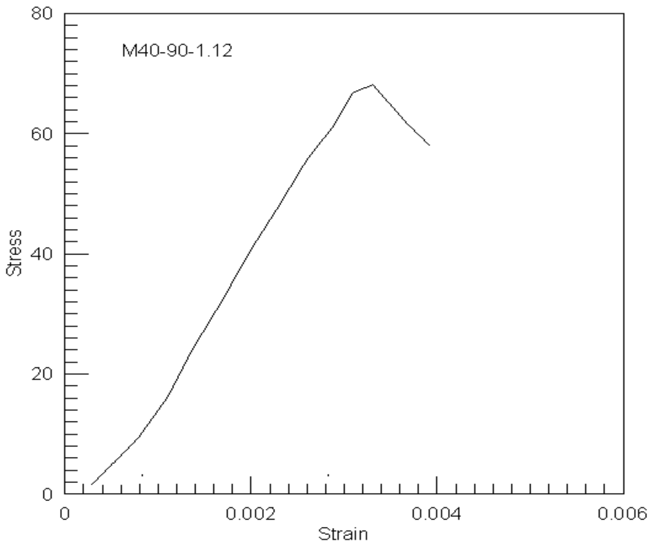
ID.No	PF	Load		Tensile Strength	
		28	90	28	90
C11	0	140	171.5	3.13	3.82
S11	1.12	97.3	137	2.16	3.04
S12	1.14	120.45	153	2.67	3.4
S13	1.16	112.45	145	2.5	3.22
S14	1.18	97.6	127	2.16	2.82

STRESS VS STRAIN GRAPHS FOR COMPRESSIVE STRENGTH OF M40

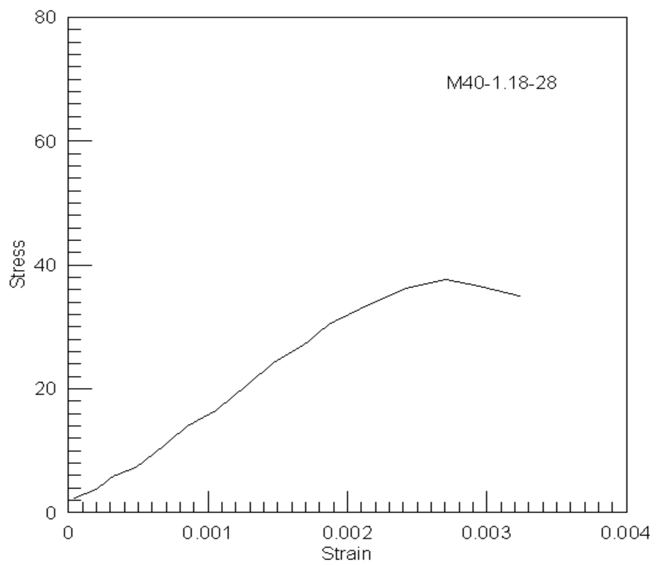
Graph-1 stress vs. strain Graph – M_{40} Grade 28 days



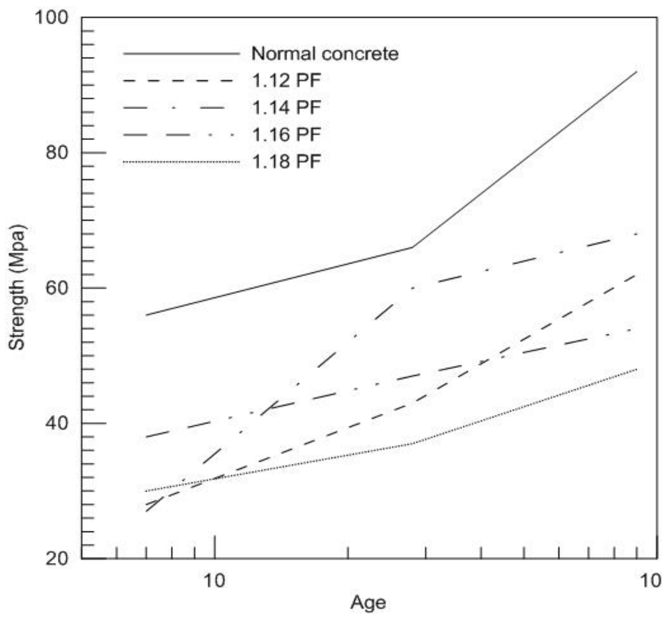
Graph-2stress vs. strain Graph – M_{40} Grade 90 days SCC Packing Factor 1.12



Graph-3stress vs. strain Graph – M_{40} Grade 90 days SCC Packing Factor 1.18



Graph-4 Variation of strength with Different packing facotr



V. CONCLUSION

From the mix proportions obtained on the basis of NAN-SU mix design, it was observed that packing factor mainly effect the aggregate content. The aggregate content increases with the increase in packing factor which has its effect on the fresh and hardened properties of concrete which influences the strength, flow-ability and self-compacting ability of the concrete

The designed medium and high strength self compacting concrete with different packing factors satisfies both flow-ability and strength characteristics. At packing factor 1.14 due to proper mix proportion we observed high strength and workability. At packing factor 1.16 and 1.18 we have less paste content than required. So more amount of chemical admixtures are required to achieve desired fresh properties which effect strength characteristics and setting time of concrete. In literature we observed that as packing factor increases the fresh and hardened decreases but in our study it was observed that at packing factor 1.14 we got optimum strength and workability. When compared with conventional concrete the workability of self compacting concrete is high when compared with conventional concrete the workability of self compacting concrete is high.

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