Experimental Studies on M 25 Grade of Self Compacting Concrete

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Abstract - ***Concrete is the most abundantly used man-made material which is commonly utilized for the construction purposes all over the world. This material is obtained by mixing of cementitious materials, aggregates (coarse and fine) and water with some amount of admixtures in proper proportions. In the present experimental work a simple design mix method is proposed by Nan Su was used and calculate all the ingredients required for SCC mix, by changing the Nan Su's coefficient and w/c ratio to achieve M25 grade SCC. Present work using fly ash as a filler material along with Portland cement of 43 grade, a wide range of SCC mix were developed. To qualify Self-Compacting Concrete mixes Slump flow, V-funnel, L-Box, U-Box tests were conducted and the fresh properties obtained are checked against the specifications given by EFNARC guidelines. Compressive strength tests were conducted to know the strength properties of the mixes at the age of 7 and 28 days of curing. After observing all the results, for Nan Su's coefficient 12 at w/c=0.55 of M25 grade SCC is achieved by satisfying all the requirements given by EFNARC guidelines, strength criteria and durability criteria as per IS: 456-2000.***

Key Words: *Nan Su, water-cement, compressive strength, strength criteria, durability criteria, SCC.*

1. INTRODUCTION

The concrete it can be freely placed and compacted into each and every place of the formwork purely by means of its own weight by eliminating the vibrators or any other compacting efforts. In late 1980's, Japan was the first country to introduce Self compacting concrete. This new concept of SCC spreads rapidly to Europe and other continents. In the U.S, SCC is comparatively an innovative technology which is suitable in precast field. This concept permits major developments associated to normal concrete, in terms of workability. Compaction is not required (tunnel constructions, dome structures, concrete products like blocks, culvert, wall, water tank, slab and segment etc.) and superior quality of concrete can be produced. By these advantages are valuable for precasters, contractors, clients and designers additionally helps in make an inventive plans, more composite shapes, speedier development of construction, improved durability and better appearance.

1.1 Basic Principles of SCC[5]

The SCC which can gets compacted by its own because of its self-weight and it fills each and every corner of the formwork in presence of confined reinforcements also, SCC consists of ingredients like cement, aggregates, water, and admixtures. However, for getting satisfactory workability, optimum dosage of superplasticizer is utilized to reduce the water content. The huge powder content acts as 'lubricant' for the coarse aggregates, and also use of VMA to increase the viscosity of the concrete.

Superplasticizer develops deformability and decreases the w/c ratio leads to increase the segregation resistance. By confining the quantity of coarse aggregate obtained a huge deformability and better segregation resistance. These are main two things of mortar and concrete is turn lead to self-compactability limitation of coarse aggregate content.

2. REVIEW OF LITERATURE

Nan Su et al[11] proposes a simple design mix method for Self-compacting concrete in 2001. Primarily, required quantities of aggregates are evaluated and binder paste is then poured in to space of aggregates to make sure that concrete attained flowability, its own compactability and other properties of SCC. To observe the behavior of SCC compressive test were carried out. Obtained result indicates this method could produce successfully high quality of self-compacting concrete. As compare to the Japanese Ready-Mixed Concrete Association this method is easier, simple for execution, time consumption is less and cost effective.

Hajime Okamura et al[4] presented an "Experimental studies on self-compacting concrete" in 2003. For creating SCC as a standard concrete so many experiments, testing methods and some investigation for proposing rational mix design methods have been carried out.

Hardik Upadhyay et al[5] carried out an a "Testing and mix design method Self-compacting concrete" in 2011. They discussed the history development of SCC, basic principles, various tests methods, segregation resistance and pass ability. By utilizing different ingredient's some various design mix method are discussed in this paper and self-compactability influenced by the mix proportions and material characteristics

Reena.K et al[13] carried out an "Experimental Studies on M-20 Self-Compacting Concrete" in 2014. In this experiment Nan Su simple design mix was utilized by varying Nan Su coefficients for getting quantity of cement and water-powder ratio to achieve M-20 SCC. To attain SCC mixes some tests were conducted those as Slump flow, L-flow, U-Box and V-funnel after verifying against the specifications provided by EFNARC guidelines. To know the hardened properties of SCC compressive strength was conducted at period of 7 and 28 days of curing. It has been observed that for Nan-Su coefficient 11 i.e. C=11f^1c and at w/c=0.59 the grade M-20 of SCC accomplished by satisfying all prerequisites given by EFNARC guidelines.

3. EXERIMENTAL PROGRAMME

3.1 Materials

Cement: OPC 43 grade with brand name Ultra Tech is utilized for all SCC mixes. Specific gravity 3.12, the initial and final setting time were found as 50 and 380 min, respectively.

Fine aggregates: These are passing through IS sieve 4.75 mm[22] were used it is obtained from locally existing river sand ,the specific gravity 2.61, fineness modulus of 2.98, bulk density of 1595kg/m3.

Coarse aggregate: Crushed granite coarse aggregate of 12.5 mm down size with specific gravity of 2.68 and bulk density of 1265 kg/m3.

Admixture: AUROMIX-400 is using as a Superplasticizer (chemical admixture) in this work. The main reason of utilizing superplasticizer in SCC it gives good flowability with very high slump that is to be used in heavily reinforced structural member. And fly ash is used as a mineral admixture with specific gravity 2.1.

3.2 Mix design

Nan Su[11] is the name of a scientist who initially introduced the mix design on SCC, based on that we have collected the all required materials for experimental work and tested accordingly with many trail mixes were calculated for Nan Su's co-efficients (7,8,9,10,11, and 12) by changing water cement ratio. Tests are conducted on fresh properties of SCC like Slump flow, V- Funnel, L-Box and L-Box tests after obtaining the suitable results as per EFNARC guidelines, for the same mix cubes are casted to determine the compressive strength and results are tabulated.

The design mix procedure adopted to get M25 grade concrete as per Nan Su's method,for **Nan Su's co-efficient 12** is as follows.

- Max size of aggregate = 10 mm
- The volume ratio of fine aggregates to total aggregates [11] =S/a= 54% (50% to 57%)
- Sp gravity of Cement (Gc) = 3.12
- Sp gravity of CA (Gg) = 2.68
- Bulk density of CA (Wgl) = 1265 Kg / m3
- Sp gravity of FA (Gs) = 2.61
- Bulk density of FA (Wsl) = 1595 Kg / m3
- Sp gravity of Flyash (Gf) = 2.1
- Sp gravity of water (Gw) = 1.0
- Packing factor (PF)= 1.04
- Super Plasticizer dosage= 0.80% (Auromix-400 Fosroc Constructive Solutions)
- Air content (Va) = 1.5 %
- Designed compressive strength (psi) f^1c = 25 MPa

Table -1: Mix proportions

Cement (Kg)	F.A (Kg)	C.A (Kg)	Flyash (Kg)	Water (Lit)	S.P (Kg/m³)
300	895.1	604.6	167.5	240.4	3.7
1	2.98	2.01	0.55	0.801	0.012

4. RESULTS

SCC fresh properties like, slump flow, V- funnel flow, L-box ratio and U-box results, are shown in the table-2.

Table -2: Workability test results with EFNARC limits.

Nan Su Coefficient	W/C ratio	S.P in %	Cement content in kg/m³	Slump flow(mm)	V-funnel flow (sec)	L-Box test Results(h_2/h_1)	U-Box test Results(mm)
7	0.38	0.80	175	706	09	0.86	22
8	0.43	0.80	200	720	10	0.90	25
9	0.47	0.80	225	729	08	0.83	27
10	0.50	0.80	250	735	09	0.91	24
11	0.53	0.80	275	746	11	0.85	26
12	0.55	0.80	300	753	09	0.89	25
Recommended Results	--	--	--	600 – 800 mm	8 – 12 Sec	0.8 – 1	0 – 30 mm

Table-3 Shows the compressive strength results for coefficient 12 at water-cement ratio=0.55

Nan Su's coefficient	Age in days	Weight in (kg)	Load in (kN)	Compressive Strength in (MPa)	Avg. Compressive Strength (MPa)
12	7	8.154	640	28.43	27.39
		8.032	590	26.21	
		7.911	620	27.54	
	28	7.893	820	36.42	39.83
		8.113	900	39.98	
		8.120	970	43.09	

From chart-1 is observed that as Nan Su's coefficient increases, 7 days compressive strength also gets increased.

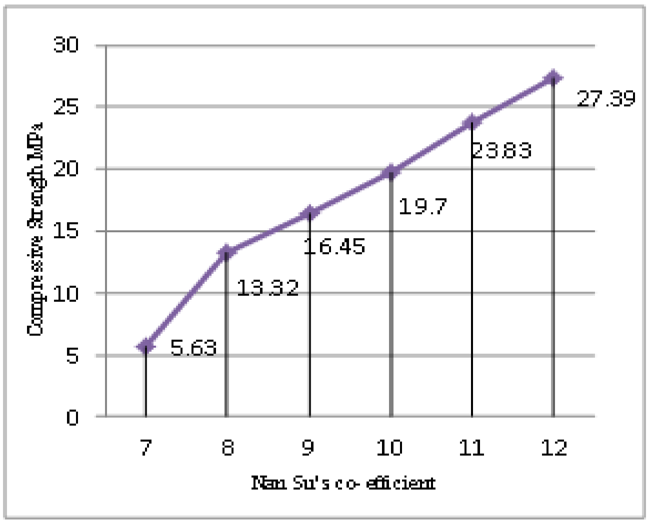

Chart-1: Showing comparison between Nan Su's coefficients versus 7 days Compressive Strength.

From chart-2 is observed that as Nan Su's coefficient increases, 28 days compressive strength also gets increased.

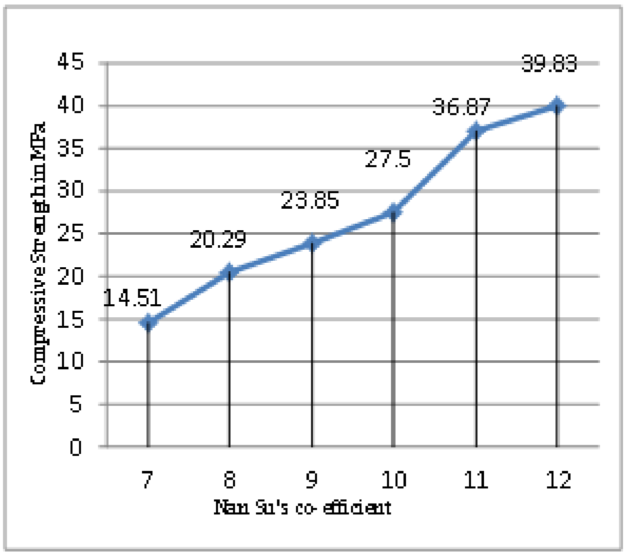

Chart-2: Showing comparison between Nan Su's coefficients versus 28 days Compressive Strength.

4.1 Recommended Mix Design For M 25 SCC Mix

After observing all the results, for Nan- Su's coefficient 12 at w/c=0.55 the M25 grade SCC is achieved by satisfying all the requirements given by EFNARC guidelines, strength and durability criteria and it is tabulated in table-3.

Table -3: Recommended Mix Design For M 25 SCC Mix.

Nan-Su's coefficient		**12**	**Recommended limits**
W/C ratio		0.55	--------
S P in %		0.80	
Quantity of Materials Per m³	**Cement**	300 kg	
	F A	895.19 kg	
	C A	604.69 kg	
	Fly Ash	167.59 kg	
	Water	240.41 lit	
	S P	3.70 kg	
Slump flow test (mm)		753	600 – 800 mm
V-Funnel test (sec)		09	8 – 12 sec
L-box test (h_2/h_1)		0.89	0.8 – 10
U-box test (mm)		25	0-30 mm
7 Days Strength (MPa)		27.39	--------
28 Days Strength (MPa)		39.83	

5. CONCLUSIONS

As per obtained results some of the conclusions can be drawn.

1. In this experimental work as the Nan Su's co-efficient increases, the w/c ratio also get increased to satisfy the requirements of SCC.
2. As the w/c ratio increases, the flow ability of the concrete also increased. This we can observe in the test results of slump flow.
3. In this experimental work as increases the Nan Su's co-efficient, the amount of cement per m³ get increased hence, and strength also get increased. And the quantity of mineral admixture per m³get decreases.
4. The amount of coarse aggregates is less and finer materials are more in the mix, so the passing ability of concrete through congested reinforcement can be enhanced.
5. Nan Su's co-efficient increases, the compressive strength also get increased for both 7 and 28 days of curing.
6. And finally, the Nan Su C-11 enhanced only strength criteria and EFNARC limitations but, C-12 achieve the limitations provided by EFNARC, strength and durability criteria as per IS 456-2000.

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