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A Review on Workability and Strength Behavior of Self-Compacted Concrete

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Abstract: ***Infrastructure industries are an important indicator of the development of country and now a day it is very fast-growing sector around world. For any infrastructure development, concrete play a virtual role in various structures and non-structures elements because of its uniqueness property such as toughness, strengthening and durability etc. and in concrete cement is key material. With a current production capacity of around 366 million tonnes, India is the second largest producer of cement in the world. [6] At present scenario concrete mix design prepare for more economic and technical benefits and self-compacted concrete (SCC) is given most significant benefits through avoidance of vibration even in congested high grid reinforcement because of its flow able property. Additionally, SCC technology has improved surface quality, strength, and durability and because of self-flowing concrete by its own weight, reduces vibration noise and improved safety. It improves the filling capacity of highly congested structural members like beam column joint in seismically active region, doubly – reinforcement beams, shear walls, bridge piers and abutments, etc. Additionally, SCC technology has improved the performance in terms of hardened concrete properties like surface quality, strength and durability.***
Key Words: Durability, Engineering property, SCC, Self-flowing

I. INTRODUCTION

Self-compacting concrete (SCC) is a flowing concrete mixture that is able to consolidate under its own weight. The highly fluid nature of SCC makes it suitable for placing in difficult conditions and in section with congested reinforcement. SCC was conceptualized in 1986 by prof. Okamura at Ouchi university, japan and popular in 2000 while SCC is used in prefabricated products, and ready mixed concrete (RMC)

A. Generally, SCC has two different and mandatory materials

Super plasticizers which are necessary for dispersing the cement grains and inhibiting their agglomeration, which reduces the viscosity and yield strength of the fresh material. (Lignosulphonates, Sulphonated melamine formaldehyde (SMF), Sulphonated naphthalene formaldehyde (SNF), Poly carboxylic ether (PCE), Modified Poly Carboxylate ether (MPCE))

Viscosity modifying agent which is necessary to compensate the viscosity decrease due to high dosage of High Range Water Reducer Agent HRWRA or high-water content of concrete. Viscosity enhancement can be achieved by using Viscosity Modifying Admixtures (VMAs), fine powders (fly-ash, micro silica, fillers, cement types etc)

Table 1: -PROPERTIES OF MOSTLY USED SUPERPLASTICIZERS [15]

Sr No	Name of the admixture	Relative density	Colour	Dosage
1	SNF	1.24 at 25ºC	Dark Brown	0.5-2%
2	PCE	1.08 at 25ºC	Honey Brown	0.4-1.2%
3	MPCE	1.08 at 25ºC	Golden Brown	0.6-1.2%

Concrete that must not be vibrated is a challenge to the building industries. The use of SCC offers a more industrialised production. Not only it will reduce the unhealthy tasks for workers, it can also reduce the technical costs of in situ cast concrete constructions,

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due to improved casting cycle, quality, durability, surface finish and reliability of concrete structures and eliminating some of the potential for human error. Evaluation for the workability of fresh concrete [1].

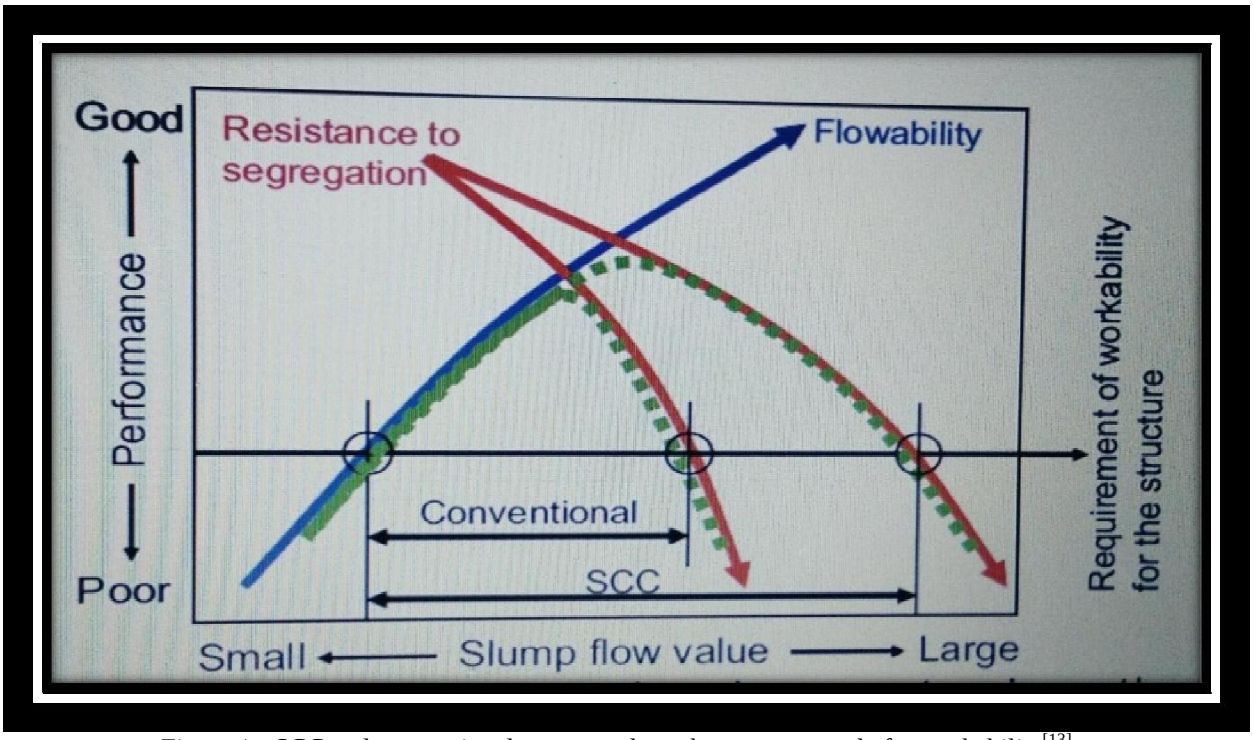


Figure 1:- SCC and conventional concrete along the common scale for workability[13]

Figure 1 shows performance of concrete v/s slump flow value graph. In, this graph workability means the degree of compaction of fresh concrete into the formwork and it was defined as the combination or balance between the flow ability and the resistance to the segregation. This concept is applicable to both conventional concrete and self-compacting concrete (SCC). In this concept, the scale of the slump value is common. [12]

II. LITERATURE REVIEW

Aref sadeghi nik, et al., [1] in this research work, author has investigated compressive strength of self-compacted concrete of M-40 grade in which cement was replaced with 0, 2, 4 and 6% volume of Nano-silica respectively. Ultrasonic pulse velocity test and compressive strength of the cube specimens (100mm*100mm*100mm) at the age of 7, 28 and 94 days for M-40 grade mix design. Experimental result is shows different type of fibres and Nano-silica with different percentage increasing the pulse transmission velocity, increasing the compressive strength. It seems that increasing the volumetric 4% nano silica will cause an increase in pulse velocity means it purely flowable and well compactable so, there is no pores found and shows uniform quality of concrete without any external vibration and that's why we say that pulse velocity directly proportional to compressive strength, but if low velocity would indicate low strength of concrete.

Jabbar Ali Zakeri, et al., [2] carried out investigation on durability related parameters of SSC such as chloride diffusivity, electrical resistivity and porosity. For this test he was took conventional concrete(cc), self-compacted concrete was mix-designed containing different addition such as limestone powder(LSP), viscosity modifying agent (use Polyethylene based polymer as VMA) and hybrid type(LSP+VMA) with 0.4 and 0.5 w/c. Generally, higher porosity is found in greater water to cement ratio and more pores concrete means it will be weaker, but result shows that Powder types of SCC mix is given less porosity compare to nominal concrete. Hence, this powder type SSC mix is more conventional for porosity. For chloride diffusivity test, RCPT is not valid because of high amount of fly-ash and high range water reducing admixtures, so as per standard test method three cubic samples with dimensions of 15*15*15 cm were selected and curing for 28 days and then immersed in NaCl solution (3%) for 90 days and then chloride concentration measured at depth 5,10,15,20,30 and 40 mm of specimens. Result of chloride diffusivity test is lower chloride penetration in powder type of SCC and higher in VMA SCC. In electrical resistivity test is following two electrode techniques with 10*10*10 cm specimens was evaluated at age of 28 days and result shows highest resistivity in powder type SCC compare to all.

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Rohan S Gaurav, et al., [7] examined T-Slump test, T500mm Slump test, U-Box test, L-Box Test-Funnel test, V5min test, compressive strength and split tensile strength, water absorption test at7,14 &28 days. In this experimental work, Fine Aggregate replaced with pond ash and quarry dust by 0, 20% and 30%. And from test procedure filling ability and passing ability full filled fresh property ranges of SCC as per "The European Federation of Specialist Construction Chemicals and Concrete Systems" (EFNARC)specifications. Also, compressive strength of SCC is increases with increases of percentage of quarry dust and pond ash, split tensile strength increase with some amount of pond ash and quarry dust after its decreases. At the end of research paper conclusion is, replacement of coarse aggregate by pond ash and quarry dust up to 20% gives good result in good compressive strength and gives good split tensile strength about 3.09 N/mm^2.

Dr.K. Chandra Sekhar Reddy, et al., [3] in this experiment work, author has investigated compressive strength and split tensile strength of M-50 grade SCC. Generally, in order to increase the workability, the water content is to be increased provided a corresponding quantity of cement is also added to keep the water cement ratio constant, so that the strength remains the same but in this investigation, they were used superplasticizer to increase workability without adding more water and decreases the segregation in SCC. Viscosity Modifying Admixtures used to reduce the bleeding and segregation. Generally used chemically VMA but in this research, they used 40% fly-ash plus VMA. Fly-ash is also a small insoluble and small enough to remain suspended in water without settling. In this research work they were increases uses of fly-ash and 55% total aggregate of nominal concrete taken as fine aggregate and replacing cement 40% by fly ash in SCC. And final mix design's compressive and tensile strength values are listed below in Fig 2.split tensile compressive

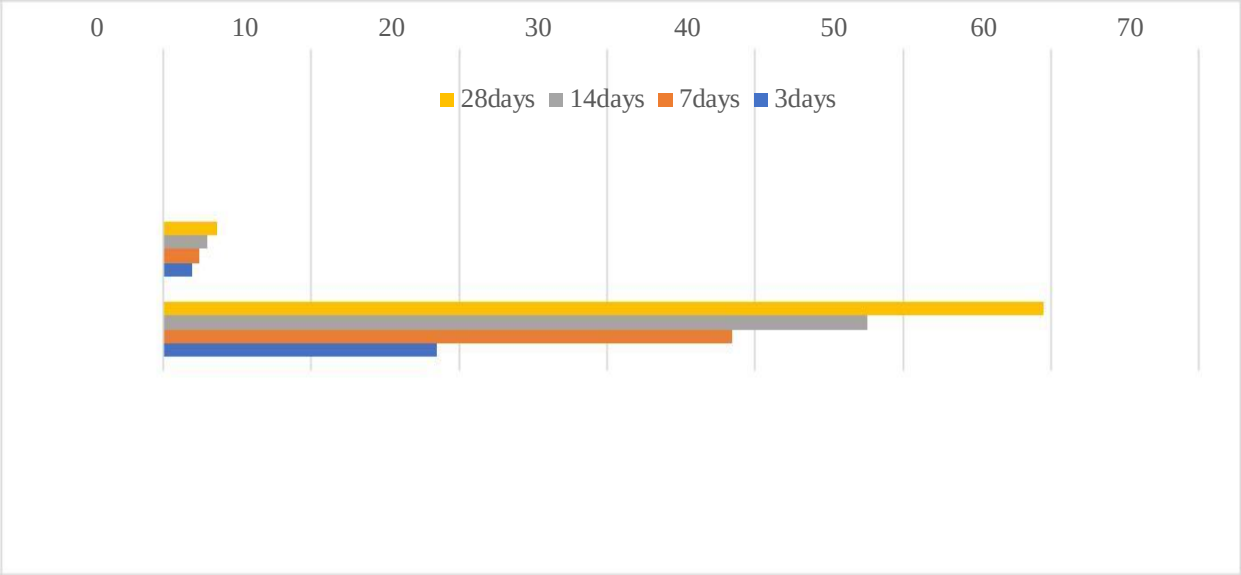


Figure 2:- Compressive and Tensile Strength of SCC Mix

Ajay Kumar, et al., [8] carried out compressive strength of M-70 grade high strength self-compacted concrete. As per IS:456-2000(code of practice for plain and reinforced concrete), concrete ranging 25-55 Mpa are called as a standard concrete, above 55Mpa called high strength concrete and above 120/150 Mpa called ultrahigh strength concrete. In that research paper size of coarse aggregates are taken as 10mm ,12.5 mm, and 20 mm as per EFNARC guidelines and check compressive strength at 3days,7days, & 28 days and result shows that as the effective size of aggregates has decreased, the strength of self-compacted concrete was increased. Also result showed that 10 mm coarse aggregates give max compressive strength at 28 days and value is 79.44N/mm^2.

K. Rajasekhar, et al., [6]in this research, author has investigated the effect of combined application of fly-ash and nano-silica on compressive strength, split tensile strength, flexural strength and modulus of elasticity of M-25 grade of concrete. Fly-ash(FA) replacement is 20%,30% and nano silica(NS) replacement is 1.5%,3% & 4.5% by cement and mix proportions. Using the investigation outcomes, the different quality properties of cement are expanded up to 3% of nano silica & 20% fly-ash and with further increment in the nano-silica and fly-ash, the properties of cement are diminished. The reduction in the quality attributes of cement with expansion in the nano-silica content past 3% is because of the low quality of cover shaped in the vicinity of high

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Substance of nano-silica and fly cinder. At partially replacement of 3% nano silica and 20% fly-ash with cement gives us compressive strength, flexural strength and split tensile strength values at 28 days are respectively given 36.90 Mpa, 5.20Mpa, 3.84Mpa.

F.rouis, et al.,[9]in their paper entitled "Effect of slag on the rheology of fresh self-compacted concrete". Here they studied mixture proportions were based on OKAMURA's method, with improvements made on the methods of selecting the fine aggregate content. The sand–mortar (Vs/Vm), the water–powder (Vw/Vp) and the superplasticiser–powder (Sp/P) ratios were selected by a simple evaluation test for assessing the stress transferability of fresh mortar. Water demand decreased with increase of slag content in the mortar mix, which means that the need of water absorption is higher for cement than for slag, which means also that an increase in flow ability can be obtained with an increase in slag content. [9]

Rahmat madandoust, et al., [11] in this research, he Used lightweight aggregates in the production of concrete. It can decrease the self-weight of structures. This can result in reduced members' sections and, therefore, it will save on overall construction costs. Lightweight aggregates are generally classified either as natural or artificial. Expanded polystyrene (EPS) beads are a type of artificial ultra-lightweight non-absorbent aggregate and have a closed cell structure consisting essentially of 98% air. With different replacement of silica fume, nano silica and EPS they found out Segregation resistance (V-5min-Funnel test), passing ability (U-box test values in mm) and filling ability (t-slump flow, T500mm slump flow, V-Funnel test) and compressive strength. And found out using EPS aggregates increased both V-funnel and T50 times. Moreover, the nano-SiO2 addition or decreasing W/C ratio leads to higher V-funnel or T50 times which indicated higher viscosity.

Dhiyaneshwaran, S, et al., [5] in this research author, has investigate Workability of the fresh concrete is determined by using tests such as: slump flow, T50, V-funnel, L-Box and U-box tests and the Durability of concrete is tested by acid resistance, sulphate attack and saturated water absorption at the age of 28, 56 and 90 days. SCC was made by usual ingredients such as cement, fine aggregate, coarse aggregate, water and mineral admixture fly ash at various replacement levels (10%, 20%, 30%, 40% and 50%). The super plasticizer used was Glenium-B233 and the viscosity modifying agent used was Glenium-Stream 2. Acid resistance was tested for concrete, for this test cubes were weighed and immersed in water diluted with one percent by weight of sulphuric acid for 28, 56 and 90 days. And then cubes were taken outside and clean them. Then, the weight and the compressive strength of the specimens were found out.

A. Major Outcomes

1) Fly-ash act as a filler material which fills the pores and thereby reduces the water absorption of concrete.
2) With Increasing dosage of Super-plasticiser increases the flowability of concrete with containing same amount of water.
3) By ionic interaction of silica of VMA and calcium from the cement create a three-dimensional gel and increased the viscosity of the concrete paste which helps to reducing the bleeding and segregation
4) SCC made by limestone Powder given better result than equivalent SCC in Durability parameter such as chloride diffusion, resistivity and porosity
5) 4 to 8 percent by mass replacement of silica fume for cement gives the highest strength for.
6) From workability retention test we conclude that, 15% of GGBS content workability is maintained till about 60 minutes after mixing, which gives suitable content of slag.
7) In L-box test, blocking ratio increases with the replacement of 10% EPC this may be done because of spherical shape and relatively smooth surface of EPC.
8) Increased nano silica up to 3% by replacement of cement and fly-ash up to 15% byre placement of cement there was increment in pulse velocity as well as in compressive strength only [1] but with, increased nano silica up to 3% by replacement of cement and fly-ash up to 20% there was increment in compressive strength, split tensile strength and flexural strength also. [6]
9) For Segregation resistance (V-5min-Funnel test), passing ability (U-box test values in mm)and filling ability (t-slump flow, T500mm slump flow, V-Funnel test) mechanical properties and durability properties ,30% replacement of Fly-ash is optimum. [5]

III. CONCLUSION

From the study of workability and durability properties of SCC with using different type of material proved that with replacement of GGBS, flow ability and workability were increased. With use of fly-ash mechanical properties, segregation resistance, filling ability and mechanical properties were significantly increases. With adding the Nano-silica in concrete, behaviour of mechanical property increases compare to nominal concrete. As well as with use of these materials concrete appears as an environmental-friendly

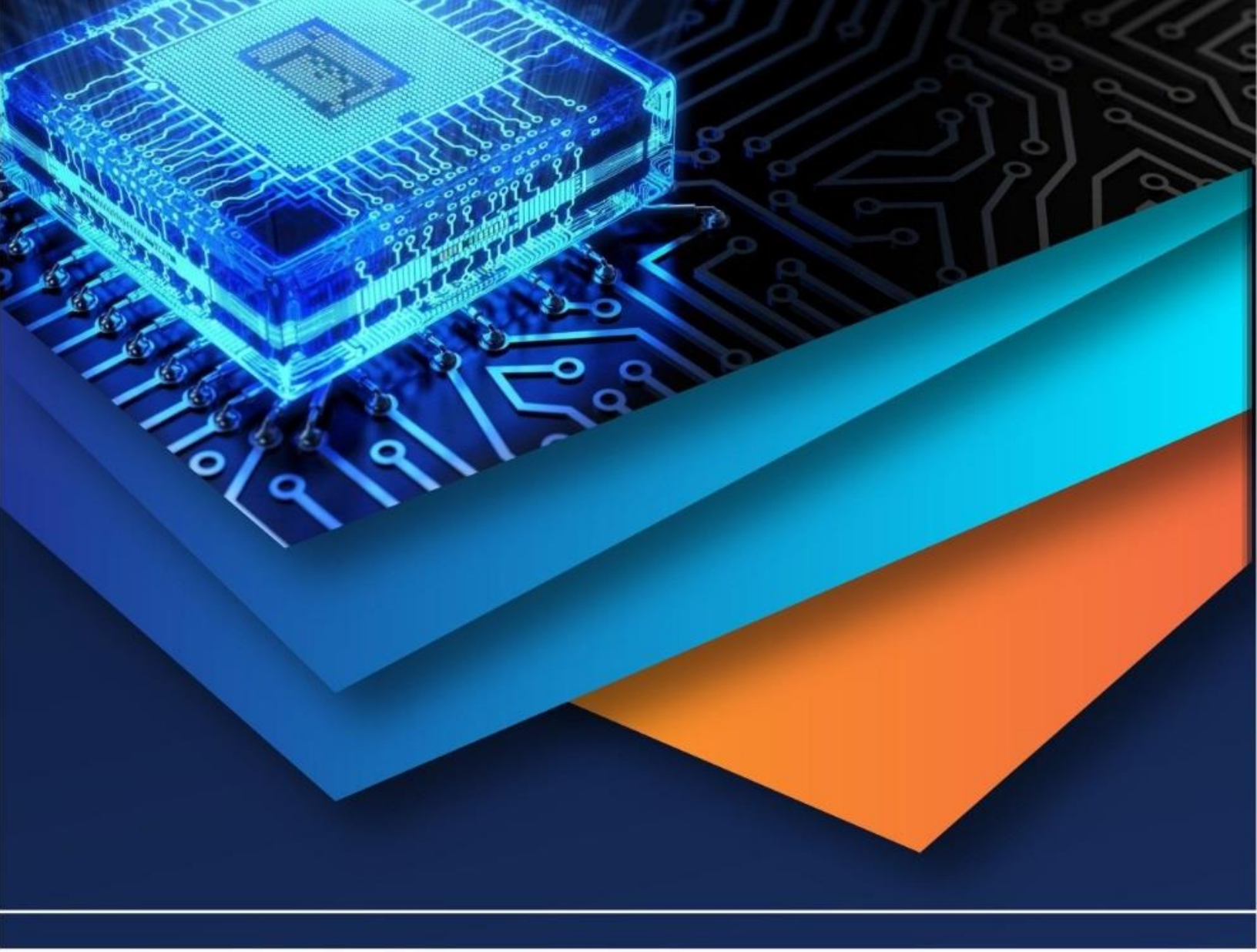
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material. Hence use of SCC gives many benefits like low cost, high strength, no need to vibration, environmentally-friendly etc. compare to nominal concrete.

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