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Effect of mineral admixtures and polypropylene fibers on mechanical properties of high strength scc.

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Abstract— Concrete has become basic material in day to day life of humans. Low tensile strength and brittle nature are the basic defects in concrete. These defects are enhanced due to improper compaction due to congested reinforcement in detailing. Addition of fibers enhance energy absorption capacity and delays crack propagation. Self-compacting concrete is being developed in recent years to avoid these defects. It is the concrete which consolidates due to its own weight without any compaction. The present investigation is mainly focused on the effect of mechanical properties of SCC with supplementary materials. In this investigation concrete having compressive strength M80 with Lime sludge (LS) and polypropylene fibers. LS added to the concrete with 0 to 20 % by weight of cement. Polypropylene fibers are added to the concrete with 0 to 0.2 % to volume of concrete.

Index Terms - (Micro cracks, Crack propagation, Polypropylene Fibers, Lime Sludge, Mechanical Properties, Workability)

I. Introduction

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 of 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 and is capable of filling every corner of form work under its self weight only (Okamura 1999) Thus SCC eliminates the needs of vibration either external or internal for the compaction of the concrete without compromising its engineering properties. Compaction for conventional concrete is done by vibrating. Over vibration can easily cause segregation. In conventional concrete, it is difficult to ensure uniform material quality and good density in heavily reinforced locations. If steel is not properly surrounded by concrete it leads to durability problems. The SCC concept can be stated as the concrete that meets special performance and uniformity requirements that cannot always be obtained by using conventional ingredients, normal mixing procedure and curing practices. The SCC is an engineered material consisting of cement, aggregates, water and admixtures with several new constituents like colloidal silica, pozzolanic materials, and chemical admixtures to take care of specific requirements, such as, high-flow ability, compressive strength, high workability, enhanced resistances to chemical or mechanical stresses, lower permeability, durability, resistance against

Use of SCC overcomes the problem of concrete placement in heavily reinforced sections and it helps to shorten construction period. Self-compacting concrete is growing rapidly, especially in the precast market where its advantages are rapidly understood and utilized. in view of global warming ,efforts are on to reduce the emission of carbon di oxide to the environment .cement industry is a major contributor in the emission of carbon di oxide as well as using up high levels of energy resources in the production of cement .by replacing cement with a material of pozzolanic characterstic ,such as industrial wastes fly ash ,silica fumes ,lime sludge (these are industrial wastes and recently, agricultural wastes are also being used as pozzolanic materials in concrete) ,the cement and concrete industry together can meet the growing demand in the construction industry as well as help in reducing the environmental pollution. incorporated in the crack wake provide a load transfer path to maintain load carrying capacity and restrict crack growth. The addition of multiscale fiber reinforcement optimizes fiber-crack interactions through the process of delaying macro crack formation and providing post cracking ductility. **P. Rossi (1997)** started the concept of multi scale fiber incorporation into concrete in which the studies focused on steel fiber and multi fiber additions respectively.

II. literature review

Dr. T. Bhagavathi pushpa and S. Rajesh Kumar (2016) investigated on the "Behaviour of concrete partially replacement of cement by steatite and polypropylene fiber. The interest in the use of fibers for the reinforcement of composites has increased during the last several years. Use of fibers show considerable improvement in tensile properties of concrete and also reduce shrinkage and cracks. In this study,

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the results of the Strength properties of concrete, setting time and pozzolanic activity of cement using polypropylene fiber and steatite have been presented. Steatite powder and polypropylene are used as a replacement for cement. Cement is replaced with steatite powder by 30%, 25%, 20%, and 15%, mass of cement and 0.5 % of polypropylene fiber by weight of concrete is constantly added for all mixes. Ordinary Portland cement of 53 grade is used. The strength properties will be compared with the conventional concrete for curing periods of 7, 14 and 28 days. The grade of concrete used in this project is M30.

Padmanapam and N.Sakthieswaren (2015) investigated on Mechanical properties of self -compacting concrete containing silica fume and steatite powder. Self- Compacting Concrete which flows under its own weight and homogeneity while completely filling any formwork and passing around congested reinforcement. The experimentation is performed in M30 grade concrete, by nansu method for the volume fractions of Natural Steatite Powder were 0 to 15% by weight of cement content with 1.8% of conplast 430 as super plasticizer in SCC. Many different fresh concrete test methods slump flow, v-funnel and L-box have been developed in attempt to characterize the property of Self-Compacting concrete. The specimens of size 150mm x 150mm cube, 150mm diameter with 300mm height cylinder and 100mm x 100mm x 500mm beam are used. Then the specimen is to tested on 7th and 28th days. The compressive strength, Split Tensile Strength and Flexural Strength are being determined.

E.Sureshkumar et al (2013), this paper examines the possibility of using copper slag as partial replacement of sand and Nano Silica as partial replacement of cement and super plasticizer and Viscosity Modifying Agent are used in self compacting concrete, in order to overcome problems associated with cast-in-place concrete. Self compacting concrete does not require skilled labours. The percentage of copper slag to be added is 10%, 20%, 30% of total weight of sand. The percentage of Nano Silica to be added is 2%, 4%, 6%, and 8% of total weight of cement. According to ACI: 211.4R code of practice, control specimen is casted for M40. Finally the workability and strength characteristics of concrete have been compared with conventional concrete.

Cengiz (2005) used fly-ash with SCC in different proportional limit of 0%, 50% and 70% replacement of normal Portland cement (NPC). He investigated the strength properties of self compacted concrete prepared using HVFA (high volume fly ash). Concrete mixtures made with water-cementitious material ratios ranged from 0.28 to 0.43 were cured at moist and dry curing conditions. He investigated the strength properties of the mix and developed a relationship between compressive strength and flexural tensile strength. The study proved that it is possible to convert an RCC (zero slump) concrete to a workable concrete with the use of suitable superplasticizer.

III. materials

Cement:
Ordinary Portland cement of 53 grade, conforming to IS: 12269-1999 with particle size of 90µ has been used in the present investigation. The specific gravity, standard consistency was 3.12 and 32% respectively.

Fine Aggregates:
Locally available river sand conforming to Zone-II as per IS: 383-1999 has been used. The bulk density, specific gravity, and fineness modulus of the sand were 1.41g/cc, 2.68, and 2.9.

Coarse Aggregates:
Crushed granite aggregate of maximum 16 mm size conforming to IS: 383-1999 has been used. The bulk density, specific gravity and fineness modulus of the coarse aggregate were 1.46g/cc, 2.7 and 7.1.

Lime Sludge:
Lime sludge is generated from paper, acetylene, sugar, fertilizer, sodium chromate and soda ash industries. Approximately 4.5 million tons of sludge in total are generated annually from these industries. The lime sludge from paper industry has been found suitable as blending material for manufacture of masonry cement in the proportion of up to 30 percent conforming the Indian Standard specification of IS:3466-1988.

Polypropylene Fibers:
Tensile strength of polypropylene fibers was 350 N/mm^2, with an aspect ratio of 545.

Water:
Water plays a vital role in achieving the strength of concrete. For complete hydration it requires about 3/10th of its weight of water. It is practically proved that minimum water-cement ratio 0.35 is required for conventional concrete. Water participates in chemical reaction with cement and cement paste is formed and binds with coarse aggregate and fine aggregates. If more water is used, segregation and bleeding take place, so that the concrete becomes weak, but most of the water will absorb by the fibers.

Mix	Slump	T_{500}	J- ring	V-	V-

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Designation	Flow (mm)	mm (sec)	(mm)	funnel (sec)	funnel T5 min (sec)
EFNARC Limits	**550-850**	**2-5**	**0-10**	**6-12**	**6-15**
SCC Plain	785	2.3	6	7	9
SCC-LS 10	770	2.6	7	8	12
SCC-LS 20	755	2.8	9	11	15
SCC Plain-0.05%	765	2.6	7	8	12
SCC-LS 10-0.05%	740	2.8	8	10	14
SCC-LS 20-0.05%	725	3.1	10	11	15
SCC Plain-0.1%	750	2.8	8	9	13
SCC-LS 10-0.1%	715	3.1	9	11	15
SCC-LS 20-0.1%	680	3.4	11	13	16
SCC Plain-0.2%	710	2.9	8	10	12
SCC-LS 10-0.2%	655	3.5	10	12	16
SCC-LS 20-0.2%	630	4.1	12	14	17

IV. experimental program

The investigation was aimed at studying the effect of Lime Sludge and polypropylene fibers on compressive strength, split tensile strength, flexural strength of M80 grade of concrete. Mix proportioning of concrete will be done based on NanSu mix design method. To study on strength of concrete the specimens will be tested for 28 days of curing. Standard cubes (150 x 150 x 150 mm), cylinders (150 mm diameter, 300 mm height), prisms (100 x 100 x 500 mm) will be cast to investigate the behaviour on mechanical properties. Tests on fresh properties will be done according to EFNARC specifications. The replacement of LS ash will be varied from 0 to 20% with an increment of 10% i.e 0, 10%, and 20% replacement to cement. PF will be varied from 0 to 0.2% with 0, 0.05%, 0.1% and 0.2% replacement to cement.

Table 1 - Mix Proportions of M80 grade in kg/m^3

Cement	Fine Aggregate	Coarse Aggregate	Water
495	812	995	188

V. results and discussion

Workability:

Workability tests were performed on the fresh concrete of SCC by slump cone and compaction factor test. The results of workability tests for M80 grade of concrete with polypropylene fibers and Lime sludge is shown in table 2.

Table 2 – Fresh Properties of SCC with 0-0.2% PF Dosage and LS 0-20%

Mechanical Properties:

Fresh properties of concrete like workability has performed using EFNARC. Compression testing machine of 2000 kN used for the compression test and 600 kN UTM has been used for the split tensile test and flexural test. The results of compressive strength, split tensile strength and flexural strength are given in the Table 3 respectively.

Table 3 – Mechanical properties of SCC with Lime sludge and polypropylene fiber Dosage

Mix Designation	Compressive Strength (MPa)	Split tensile Strength (MPa)	Flexural Strength (MPa)
SCC Plain	88.2	4.27	6.57
SCC-LS 10	90.2	4.32	6.65

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SCC-LS 20	86.2	4.22	6.50
SCC Plain-0.05%	91.2	4.48	6.88
SCC-LS 10-0.05%	93.6	4.53	6.97
SCC-LS 20-0.05%	90.2	4.26	6.55
SCC Plain-0.1%	91.4	4.41	6.79
SCC-LS 10-0.1%	95.4	4.68	7.19
SCC-LS 20-0.1%	92.4	4.44	6.83
SCC Plain-0.2%	86.2	4.35	6.70
SCC-LS 10-0.2%	88.2	4.40	6.77
SCC-LS 20-0.2%	85.2	4.20	6.46

Figure 3: Variation of Compressive strength with Lime Sludge and Polypropylene fibers

Figure 4: Variation of Split tensile strength with Lime Sludge and Polypropylene fibers

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Figure 5: Variation of Flexural strength with Lime Sludge and Polypropylene fibers

VI. conclusions

A. The workability of concrete is marginally effected with the addition of Lime sludge compared to Lime sludge with polypropylene fibers. Polypropylene fibers at initial dosages has shown less effect on slump and compaction factor.
B. Inclusion of polypropylene fibers to concrete has increased the mechanical properties of concrete with and without Lime sludge.
C. Upto 0.1% dosage of polypropylene fiber the strength properties have increased but later with the increase in dosage decrement is observed for 0.2 % dosage.
D. Similarly, the decrease in mechanical properties is observed with the increase in Lime sludge at 20 % replacement.
E. Highest decrement was observed incase of 20% lime sludge with 0.2% fiber dosage. But the decrease in mechanical properties due to lime sludge is compensated by the use polypropylene fibers.
F. Finally, optimum dosage of polypropylene fibers was observed to 0.1% to volume of concrete. Whereas, lime sludge can be used upto10 %.

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