International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 06 | June -2018 www.irjet.net p-ISSN: 2395-0072

FRESH PROPERTIES OF SELF COMPACTING CONCRETE USING HYPO SLUDGE AND FIBRES

G Sasikala[1], K Vidhya[2], M H Sai Varma[3] B M Phani Varma[4]

[1]Assistant Professor, Department of Civil Engineering, S.R.K.R. Engineering College, A.P, India
[2,3,4]P.G Student, Department of Civil Engineering, S.R.K.R. Engineering College, A.P, India

---

Abstract - *The mix design for Self-Compacting Concrete is arrived as per the guidelines of EFNARC. In this investigation, self-compacting concrete is made by usual ingredients such as cement, fine aggregates, coarse aggregates, water and mineral admixture. In this study M30 grade of self-compacting concrete is designed for Ordinary Portland Cement (OPC). Master Gelenium SKY 8777 is used as super plasticizer and Gelenium stream 2 as Viscosity Modifying Agent (VMA). Fresh characteristics are evaluated based on its passing ability, filling ability, and segregation resistance using slump flow, L-Box, J-Ring, V-Funnel and U-Box tests.*

The main aim of this paper is to design the SCC mix using hypo sludge as replacement material in cement and with addition of polyester fibres of 6 mm cut length on fresh properties of concrete. The current trend all over world is to utilize the treated and untreated industrial by-products, domestic wastes etc. This study mainly focuses on the possibility of utilization of hypo sludge from paper industry.

Key Words: Self-Compacting Concrete (SCC), Ordinary Portland Cement (OPC), EFNARC Guidelines, Fibre Reinforced Concrete, Hypo Sludge, Recron 3S Fibres, Super Plasticizer (SP) and Viscosity Modifying Agent (VMA).

1. INTRODUCTION

SCC is an innovative concrete that does not require vibration during placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete.

1.1 Advantages of SCC

- Easier and rapid placement in members with dense reinforcement and complicated formwork results in faster construction and reduction in cost of production.
- Good bond between concrete and reinforcement is obtained, even in congested reinforcement.
- Reduction on site man power for all operations.
- Relatively low water-to-cement ratio results in rapid strength development, improved quality, strength and durability.
- Produces good surface finish particularly for slabs.
- Cost efficient and rational solution in thin overlays on prefabricated elements-thinner concrete sections can be cast easily.
- Reduced noise levels in the plants and at construction sites due to absence of vibration.
- Safer and cleaner working environment.

1.2 Objective of work

Industrial waste like hypo sludge is used as partial replacement of cement, because hypo sludge behaves like cement due to its silica and magnesium properties. The silica and magnesium improve the setting of concrete. By utilizing hypo sludge as a replacement material in cement, the strength of concrete will be increased and also cost reduction in the concrete is achieved. Fibre reinforcement is one the effective way to improve the properties of concrete. Use of fibres, produces more closely spaced cracks and resists deformations of structural elements.

In this work, M30 grade of concrete mix is designed for OPC. For this mix design hypo sludge is replaced by weight of cement with different percentages of 2, 4, 6 and 8% in OPC. The optimum percentage of hypo sludge mix is found in OPC (i.e., 4% for OPC). Different percentages of polyester fibres such as 0.2, 0.3 and 0.4% of 12 mm cut length were added to the optimum percentage of hypo sludge mix in OPC.

2. MATERIALS

2.1 Cement

53 grade of cement is used for M30 grade SCC conforming to OPC, IS 12269:2013. From the experiment, the physical properties of OPC are standard consistency 31%, initial setting time 45 min, final setting time 450 min and specific gravity 3.10.

2.2 Fine Aggregate

From the experiment, the obtained fineness modulus is 2.64, so the sand is medium and it comes under zone II. The SCC mixes are prepared by using clean dry river sand used as fine aggregate. The sand is free from clay, silt and organic impurities. It is conformed to IS: 383 - 1970. The specific gravity of sand is 2.64. The properties

of fine aggregate are found those are specific gravity 2.64, bulk density 1635 kN/m^3 and fineness modulus 2.64.

2.3 Coarse Aggregate

Coarse aggregate of pulverized granite stone conforming to IS: 383 - 1970 with grain size of maximum 12.5 mm used. The physical properties of coarse aggregate are obtained, specific gravity 2.67 and bulk density 1465 kN/m^3.

2.4 Water

This is the least expensive but most important ingredient of concrete. The water, which is used for making concrete, should be clean and free from harmful impurities such as oil, alkali, acid, etc. Hence locally available clean drinking water was used in the present work.

2.5 Hypo sludge

In this paper we have utilized hypo sludge as a replacement material for cement. Hypo Sludge is a material obtained from paper production. Paper fibres can be recycled only a limited number of times before they become too short or weak to make high quality paper. This paper mill sludge consumes a large percentage of local land fill space for each and every year.

Fig – 1: Hypo Sludge

Table -1: Chemical properties of Hypo Sludge

Sr. No.	Constituents	%
1.	Lime	49
2.	Silica	5.5
3.	Alumina	2
4.	Magnesium	1.6
5	Sodium oxide	1.6
6.	Potassium oxide	1.6

2.6 Fibres

Polyester fibres of 6 mm cut length were used. These fibres were obtained from Reliance Industries Limited and it is named as Recron 3s. The physical and chemical properties of fibres are shown in Table 2.

Table -2: Physical and chemical composition of Polyester fibres

Product type	CTP-2017, Polyester
Cross-section	Triangular
Cut Length	6 mm
Diameter	30-35µ
Tensile Strength	4000-6000kg/cm^2
Melting Point	>250°C
Dispersion	Excellent
Acid Resistance	Excellent
Specific gravity	1.38
Moisture regain	0.40 %
Elasticity	Good
Elongation at break	15-30 %

Fig-2 : Polyester Fibres

2.7 Super Plasticizer

Super Plasticizer is an essential component of SCC to provide the necessary workability. BASF Master Gelenium SKY 8777 is the super plasticizer based on second generation poly carboxylic ether polymers, developed by using Nano-technology. Master Gelenium SKY 8777 is free of chloride & low alkali. It is compatible with all types of cements

2.8 Viscosity Modifying Agent

BASF Master Matrix 2 (formerly known as GLENIUM STREAM 2) is used as viscosity modifying agent for producing Rheon dynamic Concrete, capable of self-compaction, even in the presence of dense reinforcement. The use of VMA gives more possibilities of controlling segregation when the amount of powder is limited. This admixture helps to provide very good homogeneity and reduces the tendency to segregation.

3. MIX DESIGN

In the present investigation mix proportioning is done using IS 10262: 2009 for M30 grade concrete. The resulting mixes are modified after conducting trials at laboratory by duly following the EFNARC guidelines to achieve the self-compacting concrete mix proportion.

3.1 SCC Mix Details

In this study on SCC, the OPC is replaced by hypo sludge with different percentages namely 0, 2, 4, 6 and 8 %; those mixes are designated as SCC0, SCC2, SCC4, SCC6 and SCC8 respectively. The optimum percentage of hypo sludge was significantly found for the mix SCC4 (i.e., 4% of replacement). For that optimum mix SCC4 Recron 3S polyester fibres of 6 mm cut length were added with different percentages namely 0.2, 0.3 and 0.4%; those mixes are designated as PYFR-SCC1, PYFR-SCC2 and PYFR-SCC3 respectively. These mixes are shown in the following Fig-3.

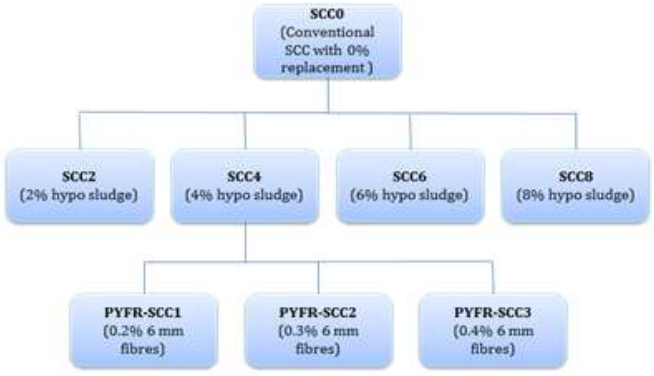

Fig-3: SCC Mix Details

3.2 Test methods of fresh SCC

According to EFFNARC guidelines a concrete mix can only be classified as SCC if it satisfies the requirements for below three characteristics are fulfilled.

- Passing ability
- Filling ability
- Stability or segregation resistance

Different test methods have been developed in attempts to characterize the above properties of SCC in fresh state and are given below with their limiting value.

3.2.3 Slump Flow Test

The test is performed in a similar way as that of conventional concrete but instead of measuring vertical slump distance, the mean spread of concrete horizontally is measured. From the experiment, the flow table value is 675 mm and it is satisfied the EFNARC guidelines.

Fig-4: Slump Flow Test

3.2.4 J-Ring Test

The Visual Blocking Index is used to rate the segregation of the mixture during the test. From the experiment, the workability of SCC value is obtained 8 mm in J-Ring test and it is satisfied the EFNARC guidelines.

Fig-5: J-Ring Test

3.2.5 L-Box Test

This test evaluates the passing ability of SCC in which the concrete is placed inside the testing apparatus and a grill accompanied with the testing apparatus simulates reinforcement and the height of concrete in vertically and the end of the horizontal portion of the apparatus are measured. The ratio of these two is then used to measure the passing ability. From the experiment, the workability of self compacting concrete (SCC) value is obtained 0.827 mm in L-Box test and it is satisfied the EFNARC guidelines.

Fig-6: L-Box Test

3.2.6 V-Funnel Test

The viscosity of the mixture is measured by the time taken to empty the funnel. Using the V-funnel test,

the viscosity and the ability to pass through opening at bottom can be obtained. A number of factors along with viscosity, slump flow, size distribution and amount and shape of coarse aggregate affects the V-funnel flow time, not much research has been done so far on the effects of shape of aggregates of SCC. From the experiment, the workability of SCC value is obtained 10.40 sec in V-Funnel test and it is satisfied the EFNARC guidelines.

Fig-7: V-Funnel Test

3.2.7 U-Box Test

The test is used to measure the filing ability of self-compacting concrete.

Fig-8: U-Box Test

4. RESULTS

4.1 Flow table values for SCC

The results of workability of SCC of different mixes are studied in this paper. The flow table results for OPC with polyester fibres of 6 mm cut length are discussed. The flow table value of conventional SCC mix (i.e., SCC0) is obtained 678 mm. The flow table value of 2 per cent hypo sludge replaced in ordinary portland self-compacting concrete (i.e.,

SCC2) is obtained 672 mm. Similarly, the flow table values of OPSCC4, OPSCC6 and OPSCC8 are obtained 667, 663 and 659 mm respectively. The flow table value of 0.2 per cent polyester fibre reinforced self-compacting concrete with optimum percentage of hypo sludge (PYFR-SCC1) is obtained 656 mm. Similarly, the flow table values of PPFR-SCC2 and PPFR-SCC3 are obtained 651 and 647 respectively. The flow table values of all mixes are satisfied with EFNARC guidelines recommended value 550 to 800 mm. Flow table results are given in Table

Table- 3: Flow table results for SCC

Sr. No.	Mix details	Percentage of hypo sludge (%)	Percentage of fibre (%)	Flow table value (mm)
1	SSC0	0	-	678
2	SSC2	2	-	672
3	SSC4	4	-	667
4	SSC6	6	-	663
5	SSC8	8	-	659
6	PYFR-SCC1	4	0.2	656
7	PYFR-SCC2	4	0.3	651
8	PYFR-SCC3	4	0.4	647

5. CONCLUSIONS

Based on the findings, the comparative assessment of conventional SCC and fibre reinforced SCC, the following conclusions are drawn.

- Rheological properties of conventional and fibre reinforced SCC are quite different.
- Water-cement ratio influences the strength properties of SCC as much as it does in conventional SCC, but its effect on the plastic properties of SCC is almost negligible compared conventional SCC.
- In this project to utilize the hypo sludge as a replacement of cement in construction industry. The percentage replacements varied from 0 to 8% in M30 grade concrete.
- The 4% replacement of hypo sludge is selected in the optimum mix.
- Bleeding and segregation were controlled by dispersion of polyester fibres in the concrete mixtures.
- It can be observed from experimental, on addition of different percentages of polyester fibres in SSC, decreases the flowability, passing ability and segregation resistance.
- Studied the behavior of VMA used in cement-based materials.

- Studied the effect of super plasticizer with the increase of fibre percentage.

6. REFERENCES

The European Guidelines for Self-Compacting Concrete (EFNARC), 2005.

Guidelines for Viscosity Modifying Admixtures for concrete (EFNARC), 2006.

M.S. Shetty, Concrete Technology Theory and Practice.

S. Chand and Company Pvt. Ltd.

[1] IS 12269: 2013, "Ordinary Portland Cement, 53 Grade-Specification" (Fifth Revision), Bureau of Indian Standards, New Delhi.

[2] IS 456: 2000, "Plain and reinforced concrete-code of practice" (Fourth Revision), Bureau of Indian Standards, New Delhi.

[3] Sasikala Guthurthi, S. Adhiseshu, Phani Kumar G.D.B.L.N.S and Sudhamani. J, "An experimental study on the strength characteristics of self-compacting concrete with partial replacement of hypo sludge and addition of polyester fibres", special issues, 2016, ISSN: 0974-5572.

[4] N. Dharani, A. Ashwini, G. Pavitha and G. Prince Arulraj, " Experimental Investigation on Mechanical properties of Recron 3s Fibre Reinforced Hypo sludge concrete" , International Journal of Civil Engineering and Technology (IJCIET), Volume 4, Issue 1, February2013. Pp. 182-189.

[5] Mehtab Alam, Vebhav Berera, "An experimental study on use of hypo sludge in cement concrete". International journal of progresses in civil engineering (IJPCE), volume 2, issue 1, 2015.

[6] Sri S.K.V.S.T. Lava kumar, Sasikala Guthurthi, Gouri. B, Anjali Lakshmi devi, "the influence of hyposludge and polypropylene fibres on the mechanical properties of selfcompacting concrete, volume 10, Issues, November 26, 2017.

[7] Dr P.j.patel, D. Prajapathi, Mr. Arjun, "innovate use of hyposludge in self compacting concrete and effect on workability, mechanical and durability of selfcompacting concrete", volume 3, Issues, may, 2016.

[8] Hajime Okamura and Masahiro Ouchi, "Selfcompacting concrete", Journal of concrete technology, vol. 1 April 2003.

[9] Mallesh M, Shwetha GC, Reena K, and Madhukaran, "Experimental Studies on M30 Grade Self Compacting Concrete", International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 9, September 2015.

[10] Mehtab Alam, Vebhav Berera, "An experimental study on use of hypo sludge in cement concrete". International journal of progresses in civil engineering (IJPCE), volume 2, issue-1, 2015.

[11] Pradeepa "An Experimental Study on Properties of Fibre Reinforced Self Consolidating Concrete", National Conference on Research Advanced in Communication, Computation, Electrical science and structure (NCRACCESS) ISSN 2348-8352 (2015) pp: 38-41.

[12] Prof. Jayeshkumar Pitroda1, Dr. L.B.Zala2, Dr.F.S.Umrigar,"Innovative use of paper industry waste (hypo sludge) in design mix concrete", International Journal of Advanced Engineering Technology.

[13] Rahul Dubey1, Pardeep Kumar2, "Effect of super plasticizer dosages on compressive strength of Self-Compacting concrete", International journal of civil and structural engineering volume 3, no 2, 2012.

[14] R.Balamurugan1, R.Karthickraja2, "An Experimental Investigation of Partial Replacement of Cement by Industrial Waste (Hypo Sludge)", Journal of Engineering Research and Applications, April 2014.

[15] Sajad Ahmad, M. Iqbal Malik, Muzaffar Bashir Wani, Rafiq Ahmad: "Study of Concrete Involving Use of Waste Paper Sludge Ash as Partial Replacement of Cement". IOSR Journal of Engineering (IOSRJEN). e-ISSN: 22503021, p-ISSN: 2278-8719. Vol. 3, Issue 11 (November. 2013), ||V3|| PP 06-15.

[16] R. Srinivasan, K. Sathiya and Palanisamy, "Experimental Investigation in Developing Low Cost Concrete from Paper Industry Waste", in Sectia, Constructii. Architechtura, 2010, pp 43-56.

[17] Abhinandan Singh Gill: Hypo Sludge, "Study of Utilisation of Hypo Sludge in High Performance Concrete". International Journal of Engineering Trends and Technology (IJETT) – Volume 15 Number 6 – Sep 2014.