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Effect of Mineral Admixture on Fresh and Hardened Properties of Self Compacting Concrete

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Abstract: Self-compacting concrete (SCC) is one of the High Performance Concrète with excellent strength and durability properties. However, its mix proportioning and testing methods for flow characteristics are different from those of the ordinary concrete. SCC has high powder content and a super plasticizer for enabling flow while keeping coarse aggregate in a viscous suspension. The powder is usually cement and a filler material.

In this paper an attempt has been made to study fresh and hardened properties of self compacting concrete using cement klin dust (CKD) as partial replacement of cement in different percentages in addition to filler.Modified Nan-su method has been used for design mix as the study was carried out for medium strength of concrete.

Keywords – Cement Kiln Dust (CKD), Self Compacting Concrete, Strength, Durability, Modified Nan-su Method.

I. INTRODUCTION

Self-compacting concrete (SCC) is an innovative concrete that does not requires vibration for 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 mechanical properties and durability as traditional vibrated concrete. Popularity of using self-compacting concrete (SCC) in concrete construction is increased in many countries, since SCC is effectively applied for improving durability of structures while reducing the need of skilled workers at the construction site.

Self-compacting concrete (SCC) offers various advantages in the construction process due to its improved quality, and productivity. SCC has higher powder content and a lower coarse aggregate volume ratio as compared to normally vibrated concrete (NVC) in order to ensure SCC's filling ability, passing ability and segregation resistance. If Only cement is used in SCC, then it become costly, susceptible to be attacked and produces much thermal crack. It is therefore necessary to replace some of the cement by addition of filler to achieve an economical and durable concrete.

Nowadays, the ecological trend aims at limiting the use of natural raw materials in the Field of building materials and hence there is an increased interest in the use of alternative materials (waste) from various industrial activities, which presents significant advantages in economic, energetic and environmental terms. In this paper cement kiln dust is used as a mineral admixture which is byproduct of the manufacturing of OPC produced by the dry process. Cement kiln dust (CKD) is a fine powder material similar in appearance to Portland cement. The amount of CKD produced can be estimated as equivalent to about 1.5-2.0% of the weight of clinker production. Approximately 15 million tons of CKD are produced annually by the Cement industry. Medium type of Cement plant may produce up to 20,000 tons of CKD annually. Based on an analysis of existing data.

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Fig.1 Cement kiln dust

II. LITERATURE REVIEW

Ali S. Al-Harthy, Ramzi Taha, et.al.[1] Investigated the use of CKD in concrete mixtures and to study the effect on strength and durability aspect. They also studied that addition of 5% CKD has no negative effects on strength properties.

Iliana Rodríguez Viacava, et.al.[2] Presented theoretically and practically, the feasibility of developing SCC in the range of medium strength using CKD as a filler and investigated six mixtures with different percentages of cement replacement by CKD. Properties at fresh and hardened state were studied.

Naveen Kr. C.kiran, et.al.[3] Presented a result of experimental studies on different mineral admixtures used in SCC as filler. The results showed that SCC can be produced with cement content, as low as 200kg/m^3 of concrete together with rest of the powder coming from fly ash.

Vilas V. Kirjinni & Shrishail B. Anadinn.[4] They emphasized on the mixture proportion which is one of the important parameter in the self compacting concrete. They have used modified Nan-su method and obtained mix design in normal grades with different mineral admixtures & the compressive strength and flow properties of SCC were also studied.

Vilas V. Karjinni, Shrishail B.Anadinni, Dada S. Patil et al.[5] Presented a comparative evaluations of fresh and hardened properties of SCC using different mineral admixture with Nan-su and Modified Nan-su mix design method.

On the basis of above studies, the objective of this investigation was to study the behavior of SCC with different percentages of CKD in addition to filler, to understand effect of mineral admixture on fresh and hardened properties of SCC. The modified Nan-su method was used for mix design of SCC and also investigated the compatibility of CKD in SCC along with chemical admixture such as superplasticizer and to study the durability aspect of SCC.

III. RESEARCH SIGNIFICANCE

Self-compacting concrete (SCC) has recently been one of the most important developments in the concrete technology. For a newly developing material like Self compacting concrete, studies on durability is of paramount importance for instilling confidence among the engineers and builders.

The literature indicates that some studies are available on the SCC with different mineral admixture as powder content (filler) but comprehensive studies are not available on fresh and hardened properties of self compacting concrete with different percentages of mineral admixture in addition to filler which involves compressive strength, flexural strength, split tensile strength and water absorption test.

Hence, considering the gap in the existing literature, an attempt has been made to study the effect of mineral admixture (CKD) on the fresh and hardened properties of self compacting concrete.

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Vol. 2, Issue 10, October 2013

IV. MATERIALS

A. Cement

In this experimental study, Ordinary Portland Cement conforming to IS: 8112-1989 [6] was used. The physical and mechanical properties of the cement used are shown in Table1.

Table 1: Properties of cement

Physical property	Results
Fineness (retained on 90-µm) sieve)	8%
Normal Consistency	28%
Vicat initial setting time(minutes)	75
Vicat final setting time (minutes)	215
Specific gravity	3.15
Compressive strength at 7-days	20.6 MPa
Compressive strength at 28-days	51.2 MPa

B. Aggregates

Locally available natural sand with 4.75 mm maximum size was used as fine aggregate, having specific gravity, fineness modulus and unit weight as given in Table 3 and crushed stone with 16mm maximum size having specific gravity, fineness modulus and unit weight as given in Table 2 was used as coarse aggregate.

Table 2. Physical properties of coarse and fine aggregates

Property	Fine Aggregate	Coarse Aggregate
Specific Gravity	2.66	2.95
Fineness Modulus	3.1	7.69
Surface Texture	Smooth	--
Particle Shape	Rounded	Angular
Crushing Value	---	17.40

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Vol. 2, Issue 10, October 2013

C. Cement kiln Dust (CKD)

Cement kiln dust (CKD) is a waste product generated by the cement industry; it is a powder mainly composed of micron-sized particles collected from electrostatic precipitators during the manufacture of cement clinker. For this work CKD was obtained from Cement factory at Chandrapur.

Table 3: Chemical composition of CKD

SiO_2	14.65
Fe_2O_3	2.13
Al_2O_3	4.75
CaO	41.72
MgO	1.12
SO_3	0.72
Na_2O	0.9
K_2O	0.6

Table 4: Physical properties of CKD.

Physical Properties	Results
Fineness (retained on 90-µm)	1%
Specific Gravity	2.24
Colour	Greenish

D. Super plasticizer (SP)

The admixture CONPLAST SP 430 G8 was used a superplasticizer with a density of 1.2 kg/l.It was used to provide necessary workability.

Table 5: Physical Properties of Super plasticizer

Physical Properties	Results Results
Colour	Black
Specific Gravity	2.11

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V. MIX PROPORTIONING

The mix proportion was done based on the Modified Nan-Su method. The mix design was carried out for M30 normal grade of self compacting concrete with CKD as partial replacement of cement with a fraction of 0%, 10%, 20% & 30%.

Table 6: Quantities of Materials for 1m^{3}of SCC mixes.

Mix	Cement (kg/m^3)	CKD (Filler) (kg/m^3)	CKD as Cement Replacement (kg/m^3)	Total Powder Content (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	W/P (0.38) (kg/m^3)	SP (1.2 %) (kg/m^3)
Mix-0	382	295	0.00	677	710	612	258	8.124
Mix-1	343.8	295	38.2	677	710	612	258	8.124
Mix-2	305.6	295	76.4	677	710	612	258	8.124
Mix-3	267.2	295	114.8	677	710	612	258	8.124

Mix-0:- 0% Replacement of Cement with CKD.
Mix-1:- 10% Replacement of Cement with CKD.
Mix-2:- 20% Replacement of Cement with CKD.
Mix-3:- 30% Replacement of Cement with CKD.

A. Self Compactability Tests on SCC mixes

Various tests were conducted on the trial mixes to check the quality control test for SCC are performed to ensure that the requirement of Filling ability, Passing ability and flow ability are as required.

Table 7: Requirement of Fresh SCC

Method	Properties	Range of values
Flow value	Filling ability	650-800mm
V-funnel	Viscosity	6-12 sec
L-box	Passing ability	0.8 - 1.0

VI. RESULT AND DISCUSSION

A. Fresh properties SCC

CKD was used to replace the cement content by three various percentages (10, 20 and 30%). The partial replacement with CKD was carried out for M30 grades of concrete. To fulfill the requirement of SCC in fresh state and evaluate flow characteristic using slump cone, V-funnel, & L-box tests and to fix dosage of superplasticizer (HRWRA) as per EFNARC guidelines and fix the dosage of water /powder ratio was needed. The test results are presented in the table 7.

Table 8: Fresh properties of SCC.

Mixes	Mix-0	Mix-1	Mix-2	Mix-3
Slump Flow Test	660 mm	680 mm	680 mm	650 mm
V-Funnel Test	6.65 Sec	6.60 Sec	6.76 Sec	6.47 Sec
L-Box Test	0.86	0.86	0.907	0.88

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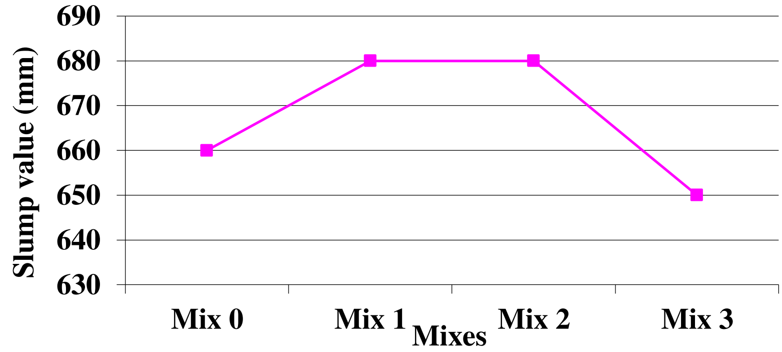

Fig. 2: Slump flow value with CKD

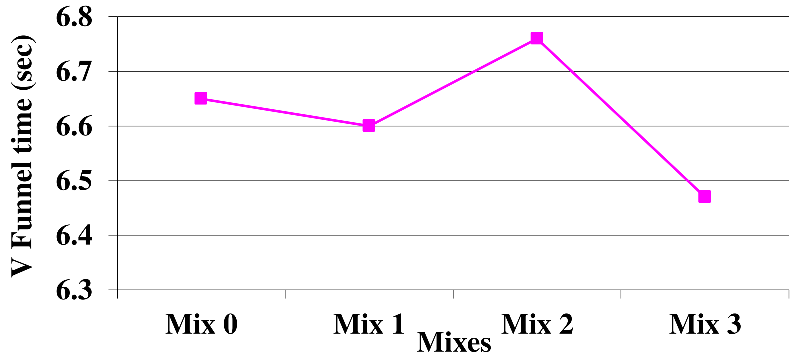

Fig. 3: V-Funnel value with CKD

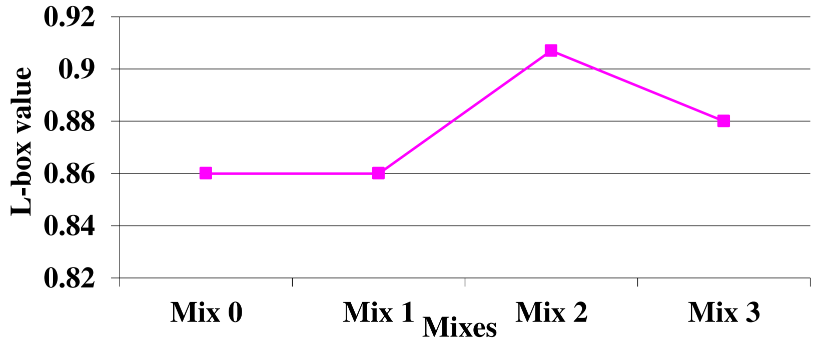

Fig. 4: L-Box value with CKD

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Vol. 2, Issue 10, October 2013

B. Hardened Properties of SCC

All the mixes were tested for various hardened properties like compressive strength, flexural strength & Split Tensile Strength and water absorption test as per Indian Standards.

Up to 20% addition of CKD (**Mix-2**), the compressive strength, flexural strength & Split Tensile Strength were obtained nearly same. After addition of 20% CKD the above results were found in decreasing order.

Fig 4 to Fig 6 shows the variation in compressive strength, flexural strength & Split Tensile Strength obtained for SCC.

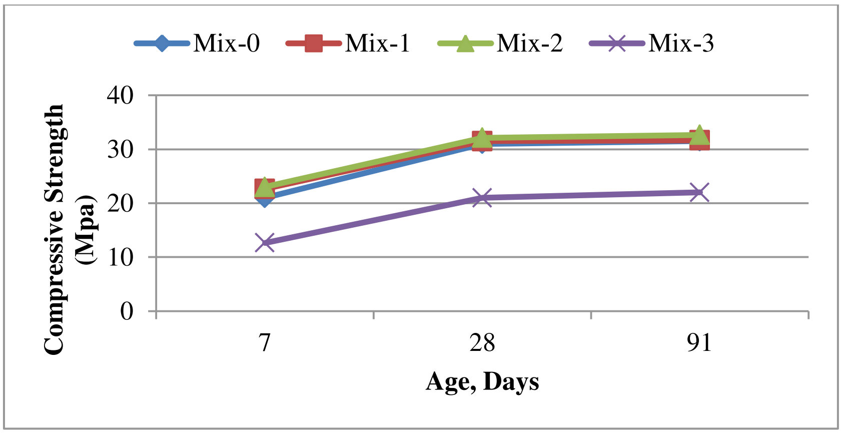

Fig. 4: Variation of compressive strength with age

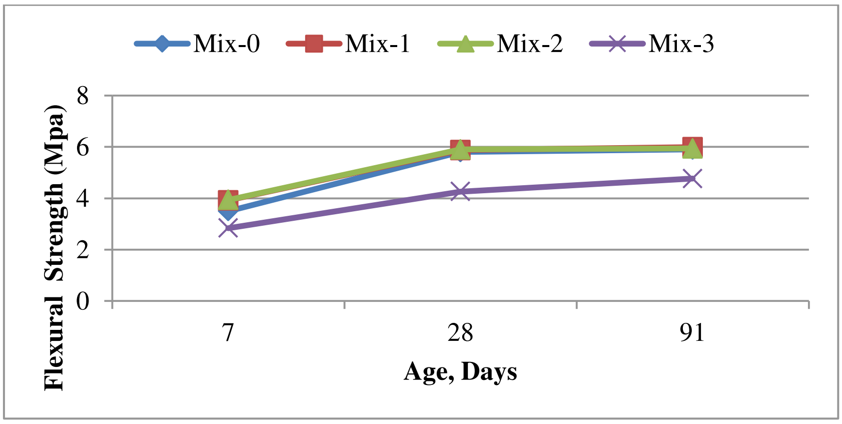

Fig. 5: Variation of flexural strength with age

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Vol. 2, Issue 10, October 2013

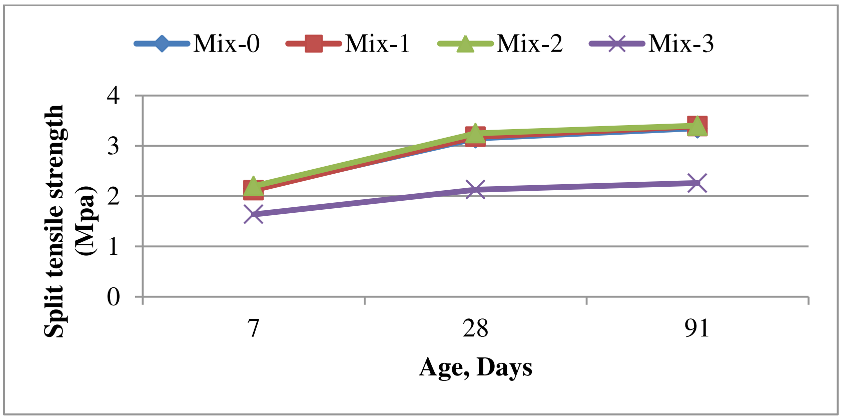

Fig. 6: Variation of split tensile strength with age

VII. CONCLUSIONS

On the basis of experimental investigations carried out, it is concluded that,

i. The brief literature review of SCC mixes made with CKD as a filler and addition of CKD as a partial replacement of cement used in SCC whenever economic, environmental and easy availability considerations predominate, without much apprehension.
ii. The slump flow value was same up to 20% CKD and decreased after 20% CKD.
iii. The V-funnel & L-box Test showed acceptable value on 20% CKD compared to other mixes.
iv. It is observed that CKD can be used in large quantity in SCC and cement content can be reduced to as low 305.6 kg/m^3 without losing the requisite characteristic of SCC. However this result in obtaining lower grades of concrete in terms of 28-days compressive strength. This may be acceptable for many applications where high 28-days compressive strengths are not necessary.
v. The SCC mixes with the addition of 20% CKD gave an optimum strength for M30 grade.
vi. The compressive strength of M30 grade of concrete monitored up to 91 days and showed an increased 1 to 2% over its 28 day strength. Similarly the split tensile strength and flexural strength increased by 2 to 3% compared to the 28 day strength.

REFERENCES

[1] Ali S. Al-Harthy, Ramzi Taha, Faisal Al-Maamary. *"Effect of Cement Kiln Dust (CKD) On Mortar and Concrete Mixtures"* Construction and Building Materials Vol.17, 2003-pp, 353–360.
[2] Iliana Rodríguez Viacava, Antonio Aguado de Cea, Gemma Rodríguez de Sensale, *"Self-compacting Concrete of Medium Characteristic Strength"* Construction and Building Materials Vol.30, 2012-pp, 776–782.
[3] Naveen Kr. C. Kiran, et.al. *"Self Compacting Concrete with Fly Ash and Metakaoline"* Indian concrete journal April. 2006 pp, 33-39.
[4] Vilas V. Karjinni, Shrishail B. Anadinni, *"Mixture Proportion Procedure for SCC"* Indian Concrete Journal June 2009 pp 35-41.
[5] Vilas V. Karjinni, Shrishail B. Anadinni, Dada S. Patil *"An Investigation On the Characteristic Properties of High Performance SCC With Mineral Admixture"* Indian concrete journal Sept. 2009-pp, 15-19.
[6] IS 8112:1989 Ordinary Portland cement, 43 Grade, may 2005
[7] Nan Su, Kung-Chung Hsu, His-Wen Chai. *"A Simple Mix Design Method for Self-compacting Concrete"*, Cement and Concrete Research Vol.31, 2001-pp, 799–1807.
[8] EFNARC. *"Specification and Guidelines for Self-compacting Concrete. European Federation of Producers and Applicators of Specialist Products for Structures",* 2002.www.efnarc.org
[9] Portland cement association (PCA). http://www.cement.org.