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EXPERIMENTAL STUDY ON LIGHTWEIGHT SELF COMPACTING CONCRETE

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Abstract - *This experimental study compares the fresh and hardened concrete properties of conventional self compacting concrete and Light weight self compacting concrete with perlite stone as light weight aggregate. This paper also includes the study of fresh concrete and mechanical properties of light weight aggregate self compacting concrete with partial replacement of sustainable amount of metakaolin as binder in Light weight self compacting concrete (LWSCC). The fresh concrete test properties were examined using the slump flow, T500, and J-ring tests . Hardened concrete test properties incorporate 7, 14 and 28 days compressive and tensile strength tests. From the test results it is found that Lightweight self compacting concrete exhibits better flow property than conventional self compacting concrete and optimum replacement percentage of metakaolin in LWSCC was found to be at 8%.*

Key Words: Light weight self compacting concrete (LWSCC), Perlite, Metakaolin, Flow properties, Mechanical Strength.

1. INTRODUCTION

Concrete is the world's most broadly utilized construction material owing to its excellent versatility, availability and economy. Despite all advantages linked with the utilisation of concrete in engineering infrastructures, its use is sometimes restricted in some structures because of its high self weight. In this regard, the development of new types of high performance concretes, such as self-consolidating concrete and lightweight concrete were developed ,which responds to some of the urgent needs of the construction sector. The improvement of SCC has been regarded by many specialists as a giant step towards achieving high performance cement based materials. It also provides endless advantages in terms of durability, cost effectiveness, and site productivity. On the other hand, lightweight concrete can reduce the self weight of structures which can result in reduction in dead weight of the sections and simplify construction. The collaboration of Self compacting concrete and Lightweight concrete is regarded as main development in the construction of super structures.

2. LITERATURE REVIEW

Mix Design Procedure for Self Compacting Concrete- IOSR Journal of Engineering (sept 2012)- Krishna Murthy.N, Narasimha Rao. In this paper an experimental procedure for the design of self-compacting concrete mixes were studied. A simple procedure was designed for self compacting concrete (SCC) with various mix proportions, with replacement of cement with Metakaolin and fly ash. Coarse aggregates passing through 12.5mm sieve were used. It was concluded that water/binder ratio (by weight) of 0.36, the SCC exhibits better flow and mechanical property.

Light weight characteristics of self compacting concrete using aluminum powder and fine pumice powder -Revathy, Josina Thomas sept 2016.In this study the characteristics of three types of Light Weight Self Compacting Concrete, which are produced using fine pumice stone powder in one mix aluminum powder in second mix and for third mix combining both pumice powder and aluminum powder were studied. Polycarboxylic based super plasticizer was used. Lightweight aggregate SCC properties have been assessed regarding their ability to flow, segregation resistance and filling limit of fresh concrete according to the EFNARC standards. Results demonstrated that the LWSCC with Pumice stone powder showed better flow property.

Lightweight self-compacting concrete with light expanded clay aggregate in MATEC Web Conference January 2018 by Khaled Heiza, Fatma Eid. In this research ten different mix designs of (LWSCC) with light expanded clay aggregate were casted and tested to find out the values of slump flow, J-ring , V-funnel and 28 day compressive strength. It was recommended from the study that lightweight aggregate is recommended to be pre-wetted in the mixing device by batching light weight aggregate and water before the process of mixing. It was concluded that the mechanical properties such as the compressive strength increased with decrease in w/c upto 0.36.

3. MATERIAL PROPERTIES

OPC (Ordinary Portland Cement) of grade 53 was used based on IS : 12269 (2013) as cementitious material. The Fine aggregates utilized were passing through 4.75mm size sieve. The Specific gravity of fine aggregates used was 2.6 and the Fineness modulus is 2.94. The Coarse aggregates used were 12mm blue metal aggregates for conventional self compacting concrete. Potable faucet water was utilized for mixing and curing. Perlite is a volcanic glass that has generally high water content. It's a modern industrial mineral and it's known for its extreme light weight. It is used as light weight aggregate. Bulk density of perlite aggregate is 1100kg/m^3. Metakaolin is the anhydrous calcined type of mineral kaolinite, Traditionally utilized in the production of porcelain is used as cement replacement material The super plasticizer used is Poly-carboxylic type SP (1%) in order to reduce the w/b ratio and improve the ability to flow.The Viscosity modifying admixture is used (0.5%) in order to

achieve plastic viscosity and to prevent segregation of the concrete.

Fig -1: Perlite

Fig -2: Metakaolin

4.MIX PROPORTIONS

The Mix proportions were arrived by using the guidelines prescribed in EFNARC (European Federation of National Associations Representing for Concrete).Control sample1 was prepared with conventional bluemetal aggregate and in control sample 2 perlite was used as lightweight aggregate.Metakaolin was added in (6%,8%,10%,12%) as cement replacement material.

MIXTURE	Cement (Kg/m³)	Fine aggregate (Kg/m³)	Coarse aggregate (Kg/m³)	Perlite light weight aggregate (Kg/m³)	Metakaolin (Kg/m³)	W/B ratio	SP	VMA
Control1	536	836	772	0	0	0.36	1%	0.5
Control2	536	836	0	618	0	0.36	1%	0.5
Metakaolin 6%	503.84	836	0	618	32.16	0.36	1%	0.5
Metakaolin 8%	493.12	836	0	618	42.88	0.36	1%	0.5
Metakaolin 10%	482.4	836	0	618	53.6	0.36	1%	0.5
Metakaolin 12%	471.68	836	0	618	64.32	0.36	1%	0.5

Fig -3: Mix proportions

5.RESULTS AND DISCUSSIONS

5.1 Fresh Concrete Properties :

The fresh concrete properties is an critical component of Self compacting concrete which determines the flow property and their passing ability.Results of the fresh concrete tests such as slump flow test, V-funnel test, T-500 and J-ring test are listed in the table below.

Table -1: Flow property test results

MIXTURE	SLUMP FLOW MAX (mm)	T-500 (s)	V-FUNNEL (s)	J-RING HEIGHT DIFFERENCE (mm)
EFNARC LIMITS	**600-800**	**2-5**	**6-12**	**3-10**
CM 1	620	3.59	7.73	8.81
CM 2	689	3.15	7.21	7.17
METAKAOLIN 6%	671	3.23	7.33	7.45
METAKAOLIN 8%	663	3.30	7.39	7.55
METAKAOLIN 10%	653	3.36	7.45	7.88
METAKAOLIN 12%	645	3.41	7.60	8.08

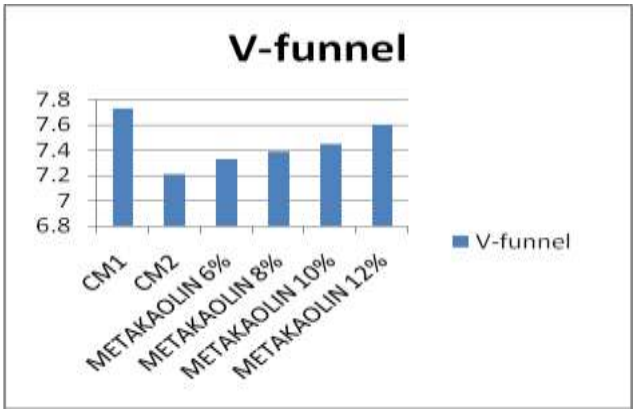

Chart -1: V-funnel test result graph

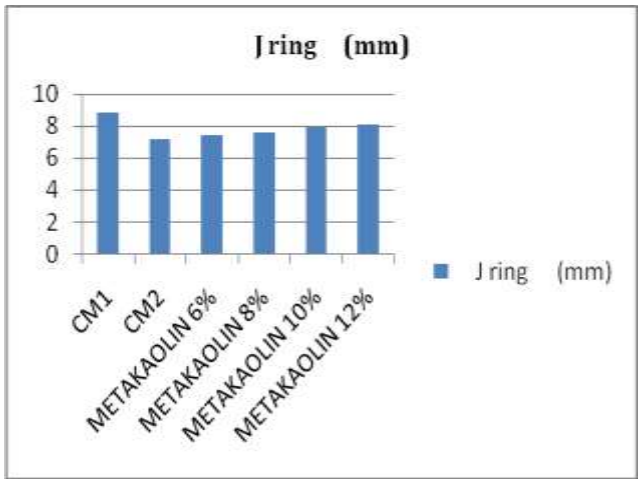

Chart -2: J-ring test result graph

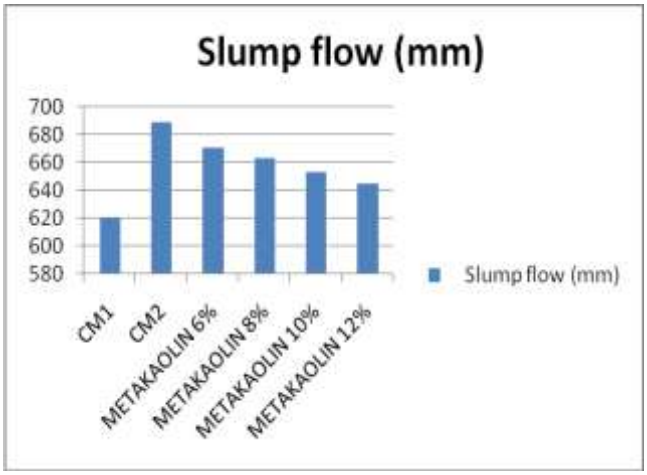

Chart -3: Slump flow test result graph

5.2 Mechannical Properties :

5.2.1 Compressive Strength test:

Cubes of size 100 mm x 100 mm x 100 mm were casted. The compressive strength test was tested in accordance to IS : 516 (1959).Results of compressive strength tests are shown below.

Table -2: Compressive strength test results

MIXTURE	7DAYS(Mpa)	14DAYS(Mpa)	28DAYS(Mpa)
CM1	33.7	41.1	48.3
CM2	19.9	22.8	26.3
METAKAOLIN 6%	20.8	23.6	27.7
METAKAOLIN 8%	23.1	25.1	29.3
METAKAOLIN 10%	22.3	24.3	28.1
METAKAOLIN 12%	21.2	23.4	26

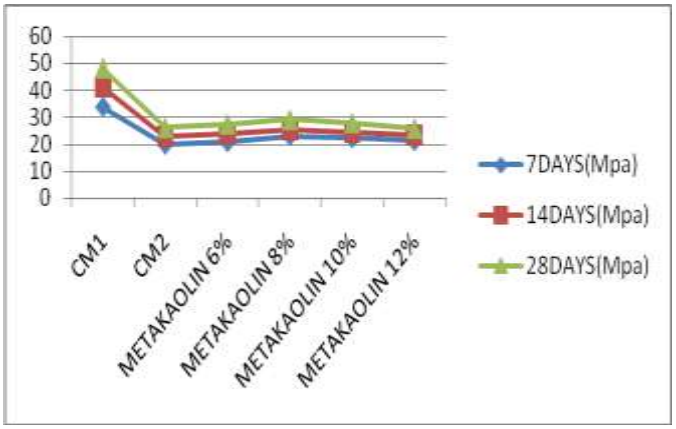

Chart -4: Compressive strength result graph

5.2.2 Splitting tensile strength test:

Cylinders of 100 mm diameter and 200 mm height were casted. The spltting tensile strength test was tested referring to IS : 5816 (1970).Results of the test shown below.

Table -3: Split tensile strength test results

MIXTURE	7DAYS(Mpa)	14DAYS(Mpa)	28DAYS(Mpa)
CM1	3.4	3.8	4.5
CM2	2.3	2.9	3.1
METAKAOLIN 6%	2.5	3.1	3.3
METAKAOLIN 8%	2.9	3.3	3.7
METAKAOLIN 10%	2.7	3	3.4
METAKAOLIN 12%	2.5	2.9	3.2

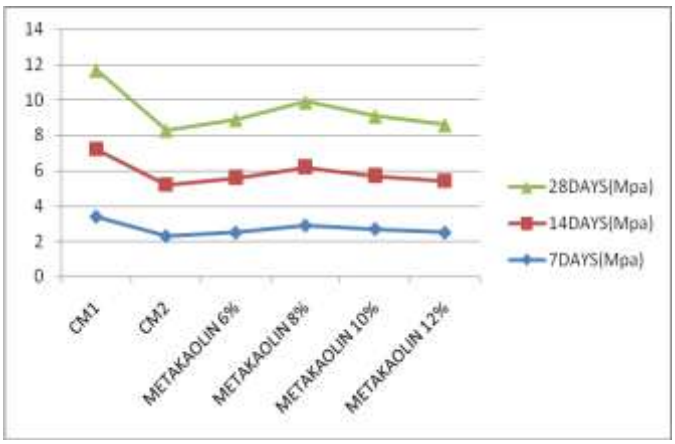

Chart -5: Split tensile strength result graph

5.2.3 Density test:

Density test is measurement of concrete's solidity and the self weight of the specimen.

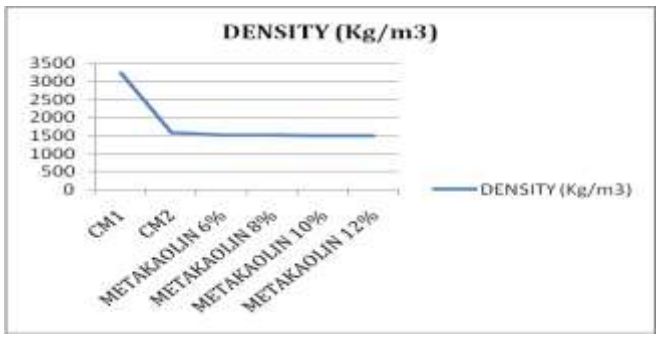

Chart -6: Density test result graph

Table -4: Density test results

MIXTURE	DENSITY (Kg/m^3)
CM1	3250
CM2	1590
METAKAOLIN 6%	1530
METAKAOLIN 8%	1520
METAKAOLIN 10%	1510
METAKAOLIN 12%	1500

6. CONCLUSIONS

1. Fresh concrete test results of all the test samples were within the EFNARC limit guidelines.

2. From the fresh concrete tests, the sample with perlite light weight aggregate exhibits better flow property.

3. The replacement of blue metal aggregate with perlite aggregate not only decreases the bulk density but also increases the flow property of concrete.

4. The addition of metakaolin in Light weight SCC increases the mechanical strength of concrete. It reaches its peak value at 8%, upon further addition which it decreases. Though the mechanical strength of conventional SCC is higher than the Light weight SCC, this is due to the low density of perlite aggregate.

5. The addition of metakaolin in Light weight SCC reduces the percentage of cement and also provides toughness to the concrete, the optimum percentage of metakaolin is at 8%.

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