
ISSN: 2321-2152
IJMECE
International Journal of modern
electronics and communication engineering
E-Mail
editor.ijmece@gmail.com
editor@ijmece.com
www.ijmece.com

ISSN2321-2152

www.ijmece .com

Vol 8, Issue 1, 2020

RESULTS OF USING FOUNDRY SAND AND METAKAOLIN IN SELF-CONTACTING CONCRETE TO A LIMITED DEGREE

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ABSTRACT:

One new development in concrete technology, self-compacting concrete (SCC) offers several benefits over older forms of the material. As its name suggests, self-compacting concrete doesn't need any external or internal compaction to level and consolidate; it accomplishes it all by itself. Without the need of vibration or any kind of consolidating action, SCC may spread and cover all corners of the formwork only by virtue of its own weight.Metakaolin (MK), a cementitious additive with a high reactivity, is gaining popularity in the concrete industry. MK is a kind of ultrafine pozzolana, meaning its particles are much smaller than cement particles, often measuring less than 2µm. In the casting industries, both ferrous and non-ferrous metals are cast using foundry sand, a kind of high-quality silica sand. Used or wasted foundry sand (UFS or SFS) is a byproduct of the foundry industry that may be recycled several times before becoming useless. This study showcases the research conducted to assess the hardening characteristics of SCC. The material was tested with five different weight percentages of waste foundry sand substituted for natural sand: 0%, 10%, 15%, 20%, and 25%. Cement was discovered to be 10% metakaolin. At7,14, and 28 days of age, the strength characteristics were assessed. We used a water-to-cement ratio of 0.43. We used a 1% admixture (Auramix 200) to improve the workability. Incorporating waste foundry sand as a partial replacement by natural sand up to 10% increases strength qualities, according to the results.

KEY WORDS: Metakaolin, Foundry sand, Coarse aggregate, Fine aggregate, Cement, Compressive strength test, Split tensile test, Flexural strength test.

ISSN2321-2152
www.ijmece .com
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1. INTRODUCTION

Worldwide, concrete is the most widely used man-made substance. Because of this, there are significant issues with its design and preparation that need fixing before we can get an accurate estimate of the product's economic cost over both the short and long term. In addition to being aesthetically pleasing and "environmentally friendly" when utilised in construction, the material must also be safe for the environment. In order to meet the demands of society, concrete's performance has been steadily improving. Using additives and super-plasticizers in concrete with a lower water content to improve workability has been the subject of several investigations. Because of this, long-lasting, high-performance concretes are created.

FIG. 1.Metakaolin

Dehydroxylated kaolinite, a clay mineral, is known as metakaolin. Metakaolin is a cement substitute in concrete and a frequent ingredient in ceramics. Metakaolin outperforms portland cement in terms of surface area and particle size (~1-2 µm), but it lags behind SF in terms of particle size.

When fine aggregate is not available, foundry sand might be used in its substitute. The amount of foundry sand used to replace the fine aggregate in this study ranges from 10% to 60%,

with 10% intervals in between. The concrete mixtures were evaluated for their compressive strength, workability, and cost.

Fig.2. Foundry sand

1.1 DEVELOPMENT OF SELF COMPACTING CONCRETE

A lot of people in Japan were talking about how long concrete buildings wouldn't last in 1983. Durable concrete buildings need thorough compaction by trained workers. Using SCC, which can be compressed into every corner of a formwork by its own weight alone, without the requirement for vibration compaction, is one way to build long-lasting concrete structures that are not reliant on the quality of the construction work. In 1986, Professor Hajime Okamura suggested that this particular sort of concrete be

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necessary.Research at the University of Tokyo was conducted by Ozawa and Maekawa in an effort to produce SCC. This research included an essential examination of concrete's workability.

Fig.3.Self compacting concrete

2. OBJECTIVE

- To study the impact on compressive strength and finding the optimum percentage of replacement to gain the maximum strength and comparing it with the strength of ordinary concrete.
- To study the Fresh properties and Hardened properties of concrete for all the mixes.
- To study the possible use of Metakaolin and Foundry sand in concrete production, which would reduce production cost.
- To achieve the desired durability in the given environment conditions.

3.LITERATURE REVIEW

3.1 METAKAOLIN

Luc Courard (2003): Investigated the effects of Metakaolin on properties of mortar.Cement is replaced on mass basis of 5% to 20% for metakaolin. For metakaolin the optimum percentage is between 10% and 15% with regard to inhibition effect on chloride diffusion and sulfate attack.

E.Badogiannis et al(2005): Investigation aimed at the use of produced metakaolin as supplementary cementitious material. Samples of poor Greek kaolin and a high purity commercial kaolin were teste. Evidence was found that poor kaolins can be efficiently used for the production of highly reactive metakaolin.

Rafat Siddique et al (2009): Stated an overview on the use of MK as partial replacement of cement in mortar and concrete. He concluded the Reduction in the slump values and increase in the setting times of concrete. Concrete containing 10% and 15% Metalaolin replacements showed excellent durability to sulphate attack.

3.2 WASTE FOUNDRY SAND

Rafat Siddique et al. (2008): Looked at using recycled foundry sand in self-compacting concrete instead of fine aggregate. He substituted foundry sand for the fine aggregate. Their research shown that admixtures improved the split tensile strength by 19%, the compressive strength by 14.5 %, and the durability by 12 % when compared to regular concrete.

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Rafat Siddique et al. (2013): Investigated the hardening and durability characteristics of self-compacting concrete using a combination of natural sand and recycled foundry sand via controlled experiments. The following weight replacements were made:0%, 10%, 15%, and 20%. The capabilities of hardening and durability were enhanced. Improved resistance to sulphate assaults and increased permeability to chloride were noted.

S.RamakrishnaRaju et al(2016): Various weight percentages of foundry sand (ranging from 0% to 100% by weight) were used to replace fine aggregate in the prepared samples. His research shown that although strength is increased by increasing the percentage of foundry sand, workability is reduced. The best outcome was seen when sand was used in lieu of 25% foundry sand.

4. MATERIALS

Portland Cement:

The binder substance used in concrete mixes is Portland cement. The primary objective is to construct cohesive properties at boom in order to get excellent strength.In order to create a cement mix, all of the material's physical and chemical qualities are considered. After curing, the hydration process is tested for strength.

Coarse Aggregate

Aggregates establish the bulk of a concrete mixture and give order firmness to concrete. They should therefore meet certain provisions if the concrete is to be workable, strong, durable and reasonable. The aggregates must be proper shape, clean, hard, strong and well graded. The maximum sized aggregate used is of 10 mm in size.

Fine Aggregates

The aggregates greatest of which permit through 4.75 mm IS sieve are called as fine aggregates. The sand was sieved through 4.75 mm sieve to remove particles greater than 4.75 mm size. Sieve analysis and physical properties of fine aggregate are tested as per IS: 383-1970.

Water

The potable water is usually measured reasonable for mingling and curing of concrete. This was free from any detrimental contaminants and was good potable quality.

Admixtures

Auramix 200 combines the properties of water reduction and workability retention. Auramix 200 is a strong super plasticiser allowing production of consistent concrete properties around the required dosage.

Design Mix

Researchers have mentioned that the most popular mix design method for SCC has been introduced by Okamura.to proceed toward

TR1 - First cement was taken as 480kg/m3, Sand was taken as 977kg/m3 and 10mm aggregates was taken as 570kg/m3 at water cement ratio 0.4 and admixtures 1%.

TR2 - Therefore, cement was increased to 500kg/m3 and water cement ratio to 0.43 and others kept constant.

TR3 - Therefore, cement was again increased to 530kg/m3 and water cement ratio to 0.43 and others kept constant.

After obtained the trial mix, different mix proportions were made by replacement of cement with metakaolin by 10% (constant) and sand is replaced with foundry sand at 10%, 15%, 20% and 25% with a water -cement 0.43 and admixture 1% kept constant

Table-3.1.Mix proportions for various trial

Sr.no.	Mix	Cement(kg/m)		F.A(kg/m)		C.A (kg/m)	S.P(%)	W/c ratio	Slump Flow (mm)
			%(MK)		%(FS)				
1	Nominal mix	500		977		570	1%	0.45	420
2	TR 1	450	50(10%)	977	0(0%)	570	1%	0.45	490
3	TR 2	450	50(10%)	879.3	97.7(10%)	570	1%	0.45	660
4	TR 3	450	50(10%)	830.45	146.5(15%)	570	1%	0.45	670
5	TR 4	450	50(10%)	781.6	195.4(20%)	570	1%	0.45	690
6	TR 6	450	50(10%)	732.75	244.2(25%)	570	1%	0.45	710

5.METHODOLOGY

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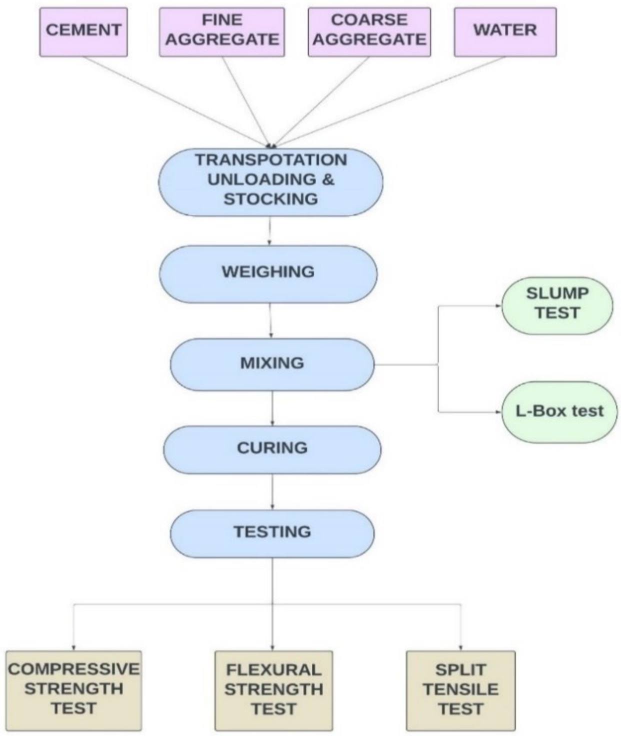

6.EXPERIMENTAL TESTS

6.1 Slump Flow Test

The slump flow test is used to assess the horizontal free flow of SCC in the absence of obstructions. On lifting the slump cone, filled with concrete, the concrete flows. The average diameter of the concrete circle is a measure for the filling ability of the concrete.

6.2 L-Box Test

The passing ability is determined using the L-box test. The vertical section of the L-Box is filled with concrete, and then the gate lifted to let the concrete flow into the horizontal section. The height of the concrete at the end of the horizontal section is expressed as a proportion of that remaining in the vertical section (H2/H1).

6.3 Compressive Strength of Concrete

At7,14, and 28 days after curing, cube specimens measuring 150 mm x 150 mm x 150 mm were removed from the tank and examined on the spot. The compressive strength was determined by applying a load (P) at a slow rate (5.1 KN/sec.) without shock until the specimen failed. In an evenly loaded cube, the amount of the compressive stress (C) may be expressed as follows:

$$C=P/A$$

Where P = Applied load, A = Area of cube

Fig.1.Compressive Strength test of Cube

6.4 Split Tensile Strength of Concrete

The 100 mm x 200 mm casting cylinders are used to determine the concrete's split tensile strength. By evenly spacing them out, the cylinders were put through their paces. After7,14, and 28 days of wet curing, specimens were removed from the curing tank and

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evaluated when surface water dropped down from the specimens.With a rate of 2.1 KN/sec, the load (P) is slowly applied. A tensile stress (T) measurement taken perpendicular to the loading direction may be expressed as follows:

$$T = 0.637P/DL$$

Where,

T = Split Tensile Strength in MPa

P = Applied load, D = Diameter of Concrete cylinder sample in mm.

L =Length of Concrete cylinder sample in mm.

Fig.2.Split Tensile Strength test of cylinder

6.5 Flexural Strength of Concrete

The flexural strength of concrete is determined by casting beam of size 100 mm x100 mm x 500mm.Specimens were taken out from curing tank at age of 7, 14 and 28 days of moist curing and tested after surface water dipped down from specimens. The load (P) is applied gradually i.e. 0.1KN/sec. Beams are tested for two point loading. At 1/3rd from support from both ends. Formula used for flexural strength 'fb'

$$fb = PL/bd2$$

Where,

a = the distance between the line of fracture and the nearer support, measured on the centre line of the tensile side of the specimen

b = width of specimen d = failure point depth.

(When a > 20.0cm for 15.0cm specimen or > 13.0cm for 10cm specimen) or fb = 3Pa/bd2 (when a < 20.0cm but > 17.0 for 15.0cm specimen or < 13.3 cm but > 11.0cm for 10.0cm specimen.)

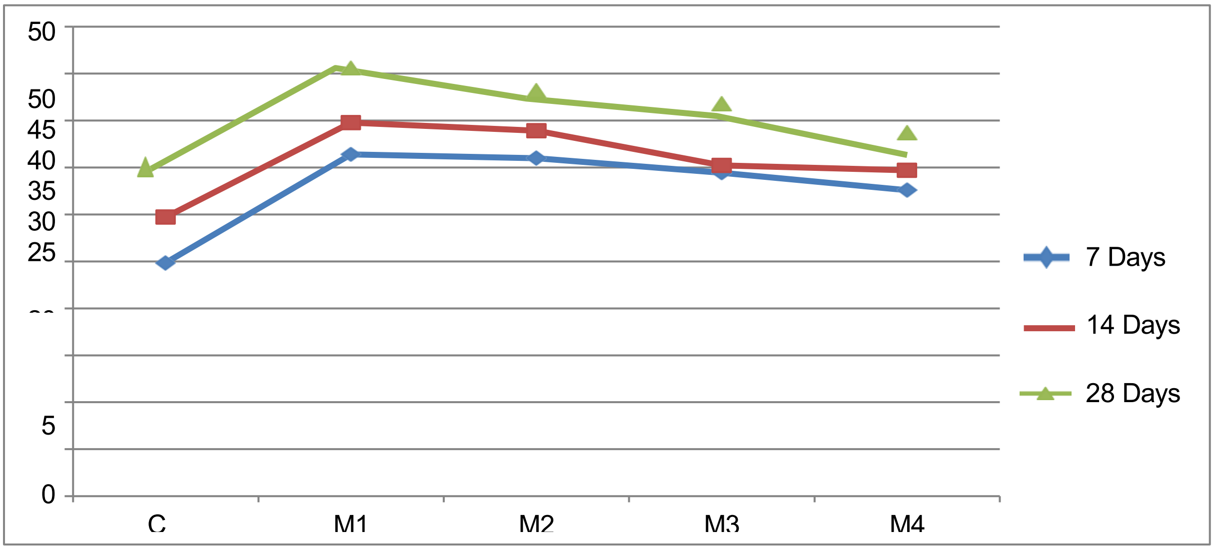
Fig.3.Flexural strength test

7. OBSERVATIONS AND RESULTS

7.1. COMPRESSIVE STRENGTH TEST

Table.1.compressive strength test

Compressive Strength (MPa)										
Curing age (days)	0% MK		10% MK		10% MK		10% MK		10% MK	
	0% FS		10% FS		15% FS		20% FS		25% FS	
7	23.1	24.86	36.18	36.4	33.67	35.98	33.34	34.43	30.21	32.6
	26.49		35.76		35.99		35.84		35.1	
	24.99		37.28		38.28		34.12		32.51	
14	26.56	29.72	39.75	39.78	37.12	38.92	32.39	35.23	36.77	34.71
	30.8		41.69		39.45		38.42		34.45	
	31.79		37.9		40.19		34.88		32.9	
28	35.39	37.37	45.91	45.6	42.99	43.18	39.37	41.8	40.12	38.73
	38.23		44.29		44.67		42.34		37.76	
	38.5		46.78		41.89		43.7		38.32	



Compressive Strength test result

7.2. SPLIT TENSILE STRENGTH TEST

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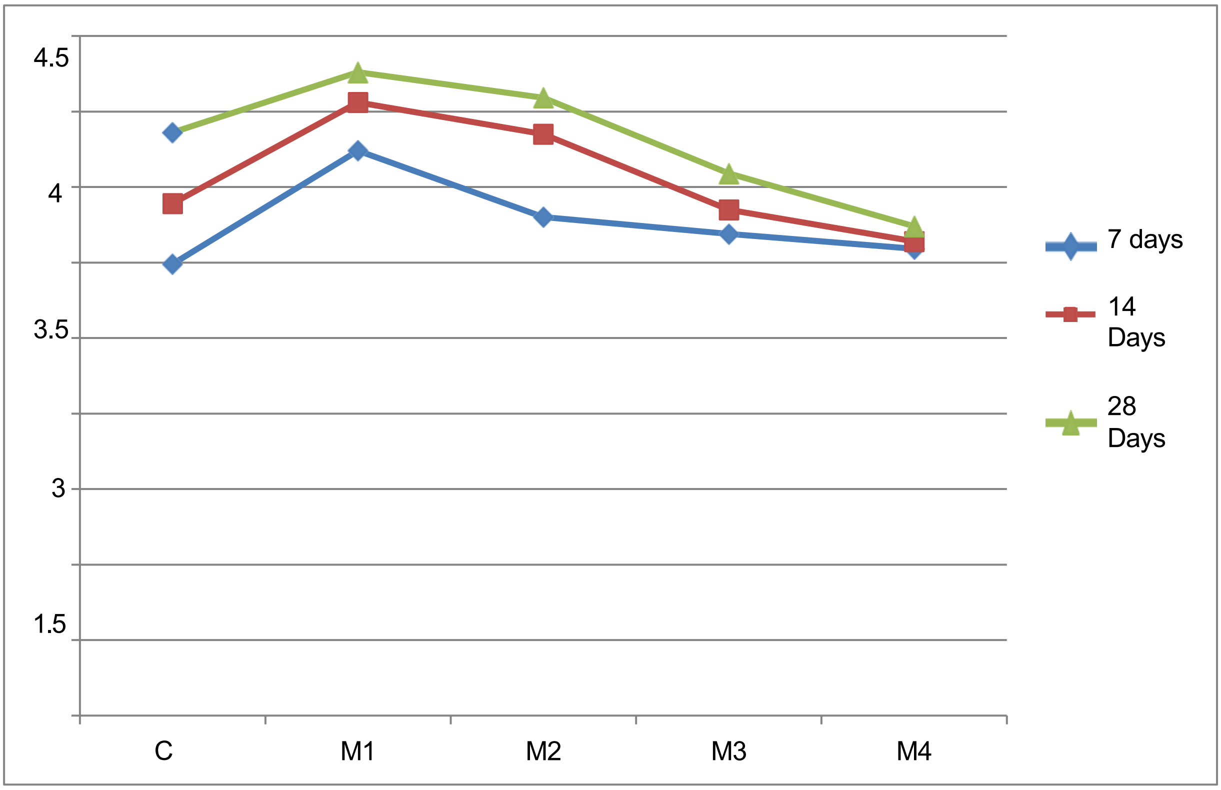
Table.2.split tensile strength test

Split Tensile Strength (MPa)										
Curing age (days)	0% MK 0% FS		10% MK 10% FS		10% MK 15% FS		10% MK 20% FS		10% MK 25% FS	
7	2.98	2.99	3.75	3.74	3.99	3.3	3.55	3.19	2.81	3.09
	3		3.89		3.21		2.89		3.12	
	2.99		3.59		2.71		3.15		3.33	
14	3.37	3.39	3.97	4.06	4.12	3.85	3.45	3.35	2.92	3.14
	3.39		4.45		3.8		3.32		3.12	
	3.41		3.78		3.62		3.27		3.39	
28	3.81	3.86	4.24	4.26	4.2	4.09	3.36	3.59	2.9	3.24
	3.91		4.59		3.88		3.4		3.26	
	3.86		3.95		4.18		4.01		3.57	



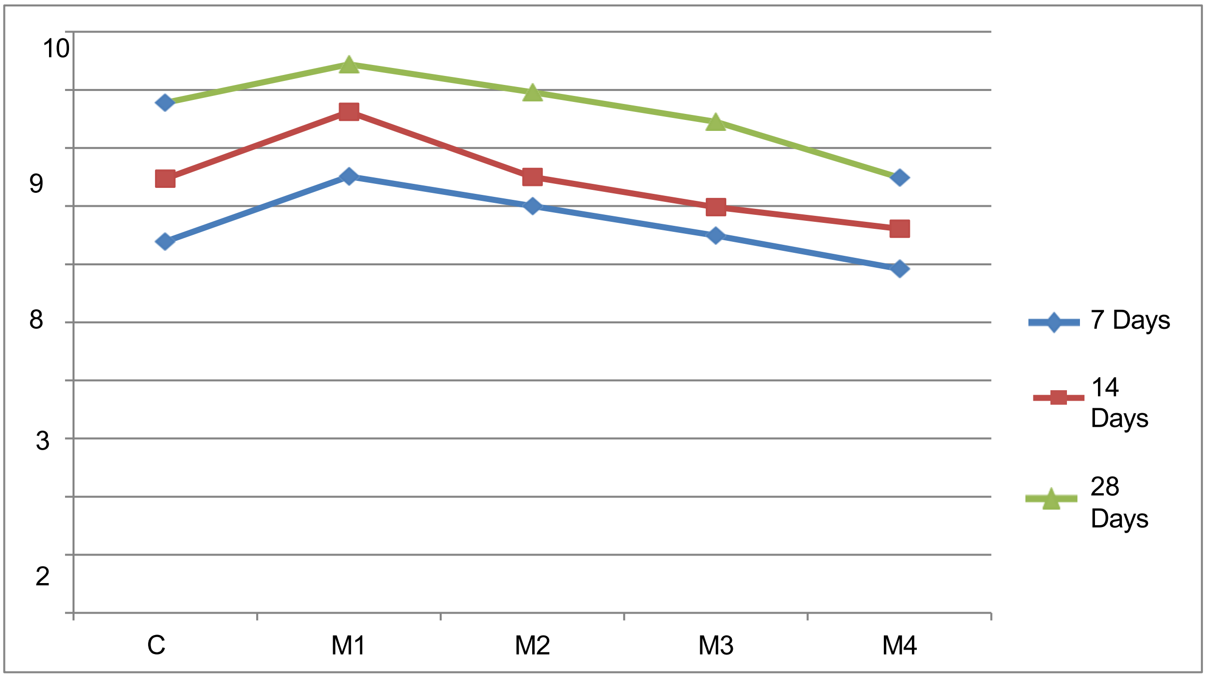
Split tensile strength test results

7.3. FLEXURAL STRENGTH TEST

Table.3.flexural strength test

Flexural strength (MPa)										
Curing age (days)	**0% MK**		**10% MK**		**10% MK**		**10% MK**		**10% MK**	
	0% FS		**10% FS**		**15% FS**		**20% FS**		**25% FS**	
7	6.38	6.39	7.61	7.51	7.2	7	6.48	6.49	6.43	5.92
	6.42		7.89		6.93		5.9		5.77	
	6.37		7.32		6.89		7.09		5.58	
14	7.44	7.47	8.22	8.62	7.99	7.5	6.75	6.98	6.97	6.61
	7.49		9.14		7.13		7.2		6.53	
	7.48		8.5		7.38		7		6.34	
28	8.76	8.78	9.45	9.44	9	8.96	8.23	8.45	7.15	7.49
	8.78		9.1		9.09		8.51		7.9	

	8.8		9.77		8.8		8.6		7.43	



Flexural Strength test results

CONCLUSION

- The presence of smaller particles causes the workability to diminish as the proportion of foundry sand rises, as was noted ().
- High initial strengths were noted in the mixture as a result of the use of 10% metakaolin.
- After 28 days, a 22% increase in compressive strength was seen compared to the control mix.
- The split tensile strength increased by 10.36% after 28 days as compared to the control mix.
- In comparison to the control mix after 28 days, a 7.5% increase in flexural strength was also noted.
- With a 10% substitution of foundry sand for sand, concrete reaches its maximum flexural strength. Removing more sand and replacing it with foundry sand reduces the flexural strength.

REFERENCE

1.Luc courard “durability of motar modified with metakaolin”, cement and concrete research, 2003.

2.E. Badogiannis, G. Kakali and S. Tsivilis

ISSN2321-2152
www.ijmece .com
Vol 8, Issue 1, 2020

"Metakaolin as Supplementary Cementitious Material", Journal Of Thermal Analysis and Calorimetry, Vol. 81 (2005) 457–462.

3. Rafat Siddique "Influence of metakaolin on the properties of mortar and concrete", Applied Clay Science 43 (2009).

4.Rafat Siddique "Effect of used-foundry sand on the mechanical properties of concrete" Construction and Building Materials 23 (2009).

5. M. Shekarchi "Transport properties in metakaolin blended concrete", Construction and Building Materials 24 (2010).

6. Rafat SIDDIQUE " Properties of Self-Compacting Concrete Incorporating Waste Foundry Sand" 23, July-December 2013.

7. Shakir A. Al-Mishhadani "The Effect Of Nano Metakaolin Material On Some Properties Of Concrete",Diyala Journal of Engineering Sciences, 2013.

8. Kiran K. Shetty " self compacting concrete using red mud and used foundry sand" Volume: 03 Special Issue: 03 | May-2014 | NCRIET-2014.

9. Sadaqat Ullah Khan "Effects of Different Mineral Admixtures onthe Properties of Fresh Concrete,Scientific World Journal Volume 2014.

10. Guang Jiang "Effects of metakaolin on mechanical properties, pore structureand hydration heat of mortars at 0.17 w/b ratio", Construction and Building Materials 93 (2015).

11. O.R. Kavitha " Fresh, micro- and macrolevel studies of metakaolin blended self-compacting concrete", Applied Clay Science 114 (2015).

12.Preeti Pandey "Utilization of Waste Foundry Sand as Partial Replacement of Fine Aggregate for Low Cost Concrete" Dec 2015.

13. P YAZHINI "Experimental investigation on self compacting concrete with foundry sand and tile powder" June 2016.

14.Prof. S.R. Vaniya "A Study on Properties of Self-Compacting Concrete with Manufactured Sand as Fine Aggregate: A Critical Review" *Jan. - Feb. 2016.*

15.S.RamaKrishna Raju "A Study on Compressive Strength of Self-Compacting Concrete Using Portland Slag Cement with Partial Replacement of Fine Aggregate by Foundry Sand" April 2015.