iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** III **Month of publication:** March 2019

DOI: http://doi.org/10.22214/ijraset.2019.3464

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 7 Issue III, Mar 2019- Available at www.ijraset.com

A Study on Properties of Self Compacting Concrete using Copper Slag and Metakaolin with Sea Sand

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Abstract: Now-a-days, researchers are endeavoring to discover new substitute materials to elucidate the scarcity of natural aggregates in the construction industry. One such alternate is copper slag (CS).Obtained as byproduct during the matte smelting process of copper metal. To fulfill the current shortage of fine aggregate and natural river sand sea sand is one of the option here in this research going to be tested. The present current scenario is aimed to assess the durability of self compacting concrete (SSC), by adding copper slag(CS) as fine aggregate and metakaolin (MK) as substitute when several number of concrete mixes were being prepared. Based on research it is found that compressive strength will not be affected with the use of metakaolin (MK).In this research 10% metakaolin of cement is being fixed for the study of behavior of various copper slag proportions of M30 grade of concrete. SCC mixes were being cast with 0%, 10%,20%, 30%, 40%,50%,60%,70% copper slag substitution. In this research fresh properties such test as V funnel, Slump flow test and L-box were being done. In this research check strength,durability and workability parameters (i.e. compressive strength, flexural strength, RCPT, acid attack, sulphate attack.)
Keywords: Fine ***Aggregate (FA),Copper Slag(CS), Metakaolin(Mk) ,Workability, Compressive Strength, Split Tensile Strength, Flexural Strength.***

I. INTRODUCTION

Concrete is the most widely used composite material today. The constituents of concrete are coarse aggregate, fine aggregate, binding material and water. Rapid increase in construction activities leads to acute shortage of conventional construction materials. Many studies were made on the inclusion of waste materials in concrete as ingredients, which has resulted in improved solutions for dealing with environmental issues such as natural source depletion, waste management, etc. And self comapacing concrete is one of the best charactristics as high flowable and spreading rapidly while pouring.self-consolidating concrete is a highly flowable type of concrete that spreads into the form without the need for mechanical vibration. Self-compacting concrete is a non-segregating concrete that is placed by means of its own weight. The importance of self-compacting concrete is that maintains all concrete's durability and characteristics, meeting expected performance requirements.in cerain instances the addition of superplasticizers and viscosity modifier are added to the mix, reducing bleeding and segregation. Concrete that segregates loses strength and results in honeycombed areas next to the formwork. A well designed scc mix does not segregate, has high deformability and excellent stability characteristics

Self-compacting concrete produces resistance to segregation by using mineral fillers or fines and using special admixtures. Self-consolidating concrete is required to flow and fill special forms under its own weight, it shall be flowable enough to pass through highly reinforced areas, and must be able to avoid aggregate segregation. This type of concrete must meet special project requirements in terms of placement and flow. Now-a-days, researchers are endeavoring to discover new substitute materials to elucidate the scarcity of natural aggregates in the construction industry. One such alternate is copper slag (cs).obtained as byproduct during the matte smelting process of copper metal.

II. MATERIALS

A. Cement

Cement is the binding material in the cement concrete. The Ordinary Portland Cement of 53 grade confirming to IS:12269-2013was used for this experimental work.

B. CoarseAggregate

Locally available 20mm and 10mm coarse aggregate isused for this experimental study. The coarse aggregate from crushed basalt rock confirming to IS:383-2016 isused. It is mixed in proportion of 60:40percent.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
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C. Fine Aggregate

The naturally available rivers and sea sand of Madhavpur is used as fine aggregate. The fine aggregate Zone-II passed through 4.75mm and retained on 150µ sieve isused confirming to the requirements of IS:383-2016.

D. Copper Slag

Copper Slag is collected from metsmelting industries; Max enterprise Rajkot. Particle size passed through 4.75mm and retained on 150µ sieve and specific gravity 2.52 consists of used.

E. Metakaolin

Metakaolin is anhydrous form of mineral kaolinite. It can be obtained by calicination of kaolinite mineral in controlled manner. Metakaolin is collected from Sadhana Enterprise vadodra.

F. Water

The potable water used in the present study.

Table1physicalpropertiesofexperimentalmaterials

Sr.No.	Test	CoarseAggregate	FineAggregate	Copper Slag	ISCode
1	SpecificGravity	2.62	2.66	2.52	IS:2386-1963(PartIII)
2	WaterAbsorption	0.51%	0.76%	0.94%	
3	FreeSurfaceMoisture	Nil	0.65%	Nil	
4	FinenessModulus	-	2.98	3.60	IS:383-2016
5	SieveAnalysis	-	Zone-II	Zone-II	

III.EXPERIMENATAL METHODOLOGY

A. Concrete Mix Design Proportions

A mix M30 grade was designed as per EFNARC and the same was used to prepare the test samples.

Table2 Concrete Mix Design Proportions Form30 Grade

Volume of Concrete	Cement	Fine Aggregate	Coarse Aggregate(20mm)	Metakaolin	Water	Super-plastisizer
ByWeight	450 kg/m³	910 kg/m³	590 kg/m³	50 kg/m³	205 litre	6 kg/m³
ByVolume	1.00	2.02	1.4283		0.45	0.013

B. Mixing and Casting Details of Specimen:

In this experimental study fine aggregate replaced by copper slag and Sea sand and Metakaolin with cement with different proportions. The details of mixing and specimen design is shown in Table-3. All the specimens used in this experimental work were recommended by IS-516-1959.

Cubical moulds of size 150x150x150mm were used for the finding compressive strength. Cylindrical moulds of 150mm diameter and 300mm length, concrete specimens were prepared for the determinations of split tensile strength. Beam shaving size of 100x100x500mm were prepared to evaluate the flexural strength.

TABLE 3
DETAILSOFMIXINGANDSPECIMENDESIGNATION

ConcreteMix	CS%	Fa%	MK %	Description
CS0-MK0	00	100	0	Control mix
CS10-MK0	10	90	0	10% replacement of the F.A with CS
CS20-MK0	20	80	0	20% replacement of the F.A with CS
CS30-MK0	30	70	0	30% replacement of the F.A with CS
CS40-MK0	40	60	0	40% replacement of the F.A with CS
CS50-MK0	50	50	0	50% replacement of the F.A with CS
CS60-MK0	60	40	0	60% replacement of the F.A with CS
CS70-MK0	70	30	0	70% replacement of the F.A with CS
CS0-MK10	00	100	10	10% replacement of the cement with MK
CS10-MK10	10	90	10	10% replacement of the F.A with CS and 10% MK with cement
CS20-MK10	20	80	10	20% replacement of the F.A with CS and 10% MK with cement
CS30-MK10	30	70	10	30% replacement of the F.A with CS and 10% MK with cement
CS40-MK10	40	60	10	40% replacement of the F.A with CS and 10% MK with cement
CS50-MK10	50	50	10	50% replacement of the F.A with CS and 10% MK with cement
CS60-MK10	60	40	10	10% replacement of the F.A with CS and 10% MK with cement
CS70-MK10	70	30	10	10% replacement of the F.A with CS and 10% MK with cement

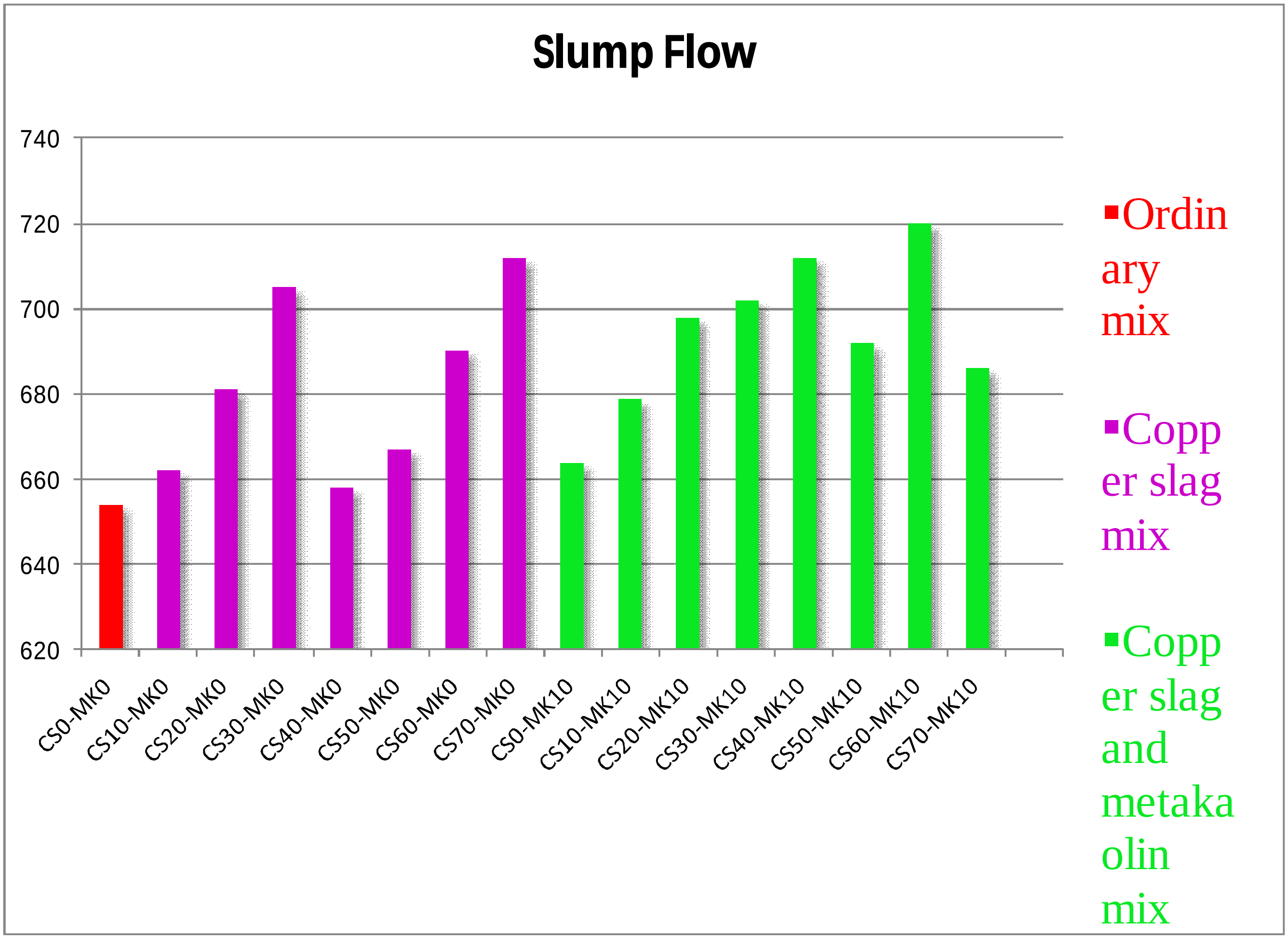
IV. RESULTS AND DISCUSSION

A. Fresh properties of self compacting concrete is shown in Table-4

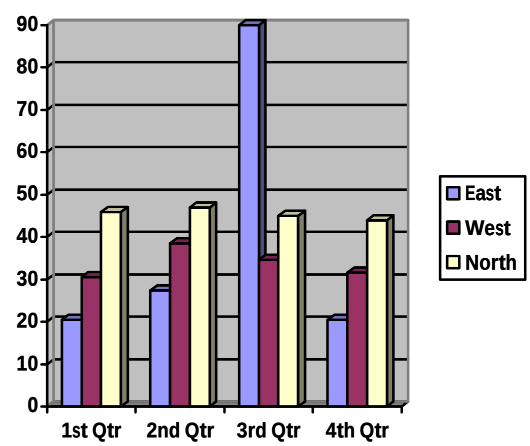
TABLE 4 FRESH CONCRETEPROPERTIES

Concrete Mix	CS%	Fa%	MK %	SlumpFlow Test	T50 cm Slump Flow	V-funnel	L-box
CS0-MK0	00	100	0	654	3.8	8.3	0.90
CS10-MK0	10	90	0	662	3.9	9.2	0.88
CS20-MK0	20	80	0	681	4.2	7.9	0.86
CS30-MK0	30	70	0	705	4.7	8.4	0.84
CS40-MK0	40	60	0	658	3.5	7.7	0.88
CS50-MK0	50	50	0	667	3.8	8.4	0.85
CS60-MK0	60	40	0	690	4.3	9.1	0.83
CS70-MK0	70	30	0	712	4.8	7.3	0.82
CS0-MK10	00	100	10	664	3.5	9.1	0.87
CS10-MK10	10	90	10	679	4.0	8.8	0.84
CS20-MK10	20	80	10	698	4.4	7.6	0.83
CS30-MK10	30	70	10	702	4.8	8.5	0.81
CS40-MK10	40	60	10	712	5.0	9.7	0.86
CS50-MK10	50	50	10	692	3.2	10.2	0.90
CS60-MK10	60	40	10	720	4.2	9.4	0.82
CS70-MK10	70	30	10	686	3.9	10.2	0.84

*CS=Copper Slag, MK= Metakaolin, FA=Sea sand



1) *Slump Flow Test:* From the Observation replacement of copper slag and metakaolin will improve the fresh properties of concrete. Optimum result for the slump flow test is being achieved with 70%CS and 0% MK and 60%CS and 10%MK. Increment of copper slag proportion will improve the slump flow of fresh concrete.



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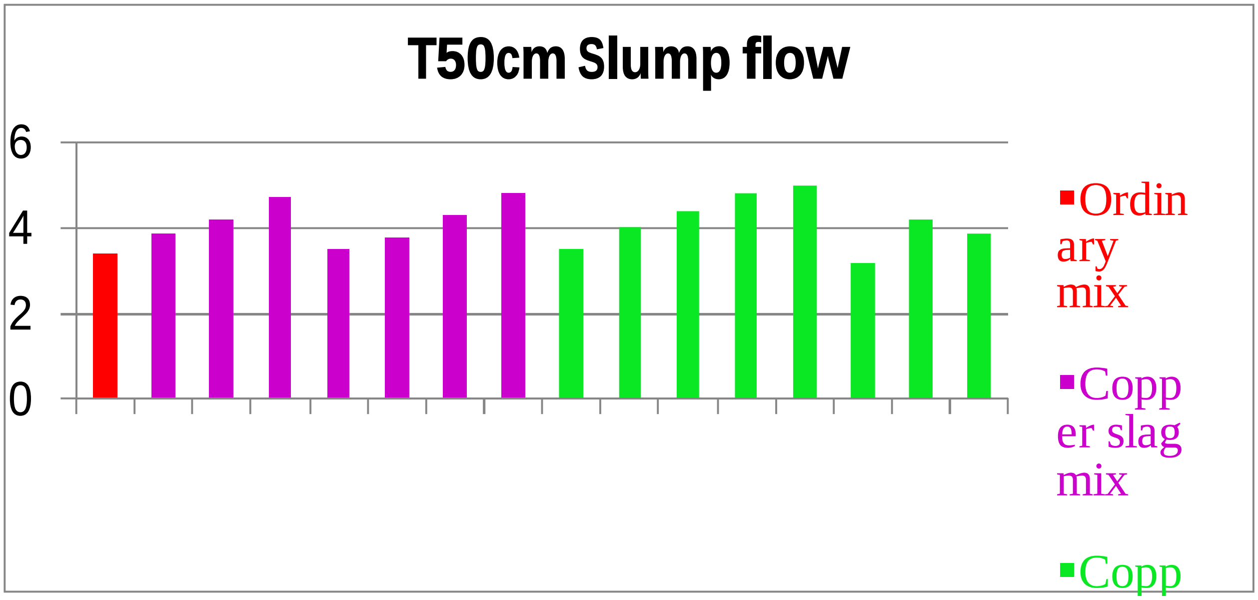
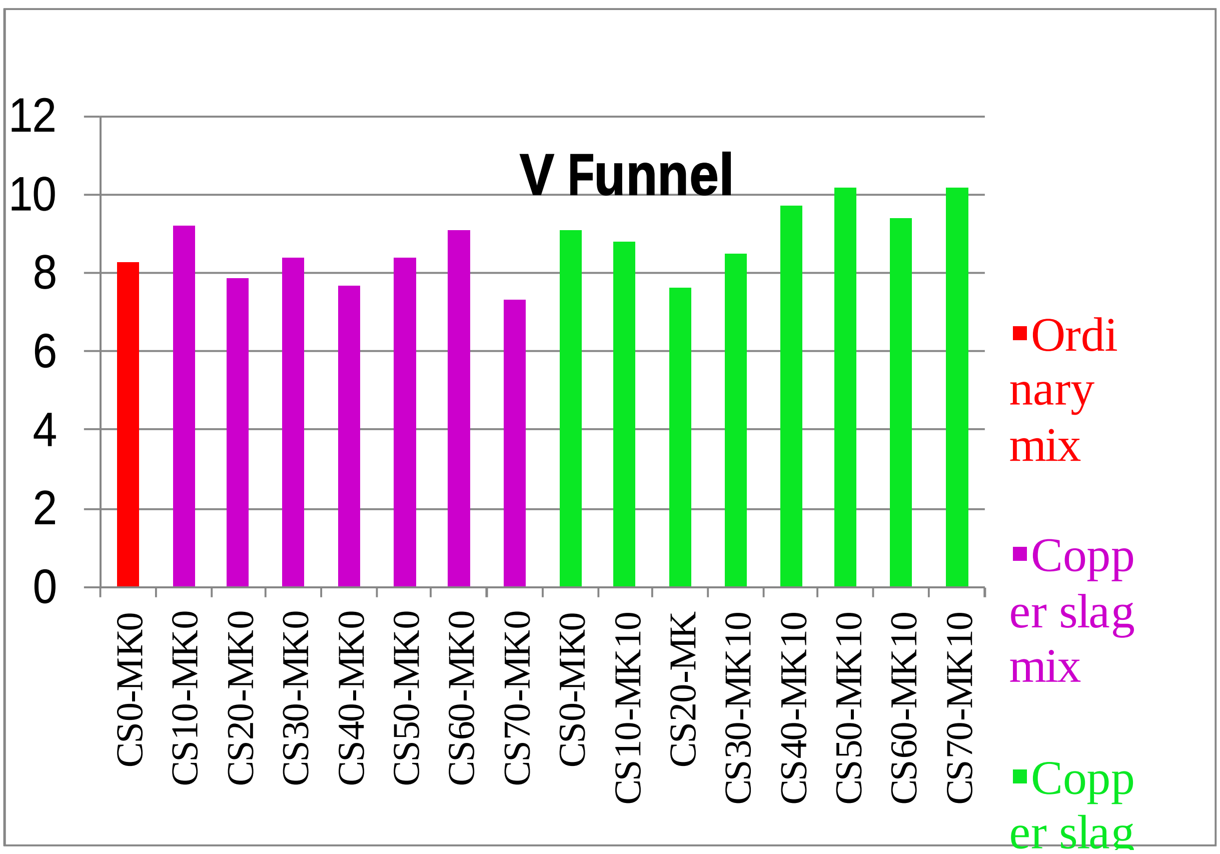


2) *T50 cm Slump flow Test:* From Observation T50 cm slump flow test results are being improved with slight increment of copper slag and Metakaolin. Optimum result for the test is achieved at CS40%-MK0% and CS50%-MK10%.



3) *V-funnel Test:* From the Observation optimum result for the v-funnel test is achieved from CS70%-MK0% and CS50%-MK10%. Higher replacement of Copper Slag improves the results for the fresh properties of self compacting concrete.

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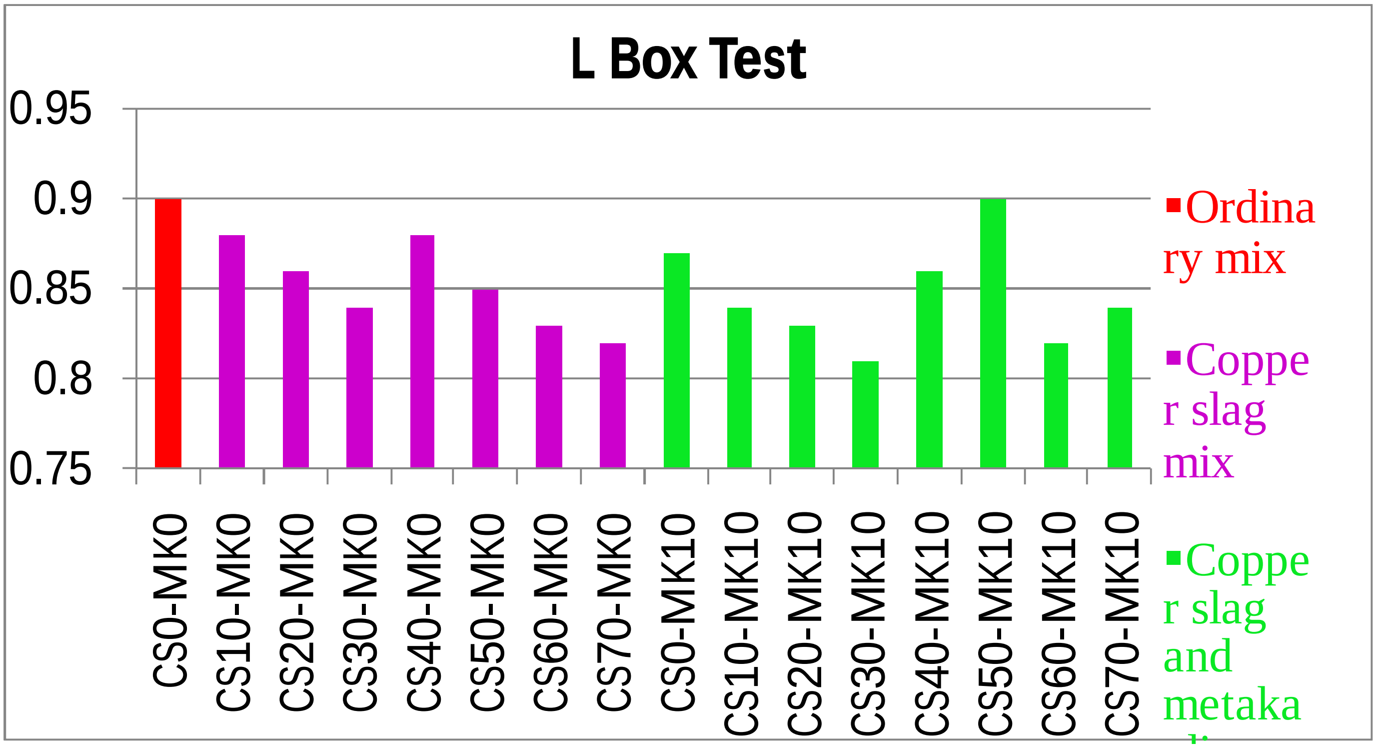

4) *L-box Test:* This test is very important for the checking of flow of self compacting concrete. Optimum result is achieved by replacement of CS70%-MK0% and CS30%-MK10%.

B. Hardened properties of Self compacting concrete is shown in Table-5

TABLE 5
Hardened Concrete Properties

Concrete Mix	*FA%*	*CS%*	*MK%*	*CompressiveStrength(N/mm²)*		*SplitTensileStrength(N/mm²)*	*Flexural Strength(N/mm²)*
				7Days	28Days	28Days	28Days
M1	100	0	0	28.47	38.73	3.2	4.4
M2	90	10	0	27.20	36.98	3.3	4.3
M3	50	20	0	21.00	42.52	3.0	4.7
M4	70	30	0	30.43	38.44	3.4	4.8
M5	60	40	0	29.71	41.65	3.1	5.1
M6	50	50	0	26.22	40.12	3.5	4.9
M7	40	60	0	23.71	37.31	3.53	5.2
M8	30	70	0	25.71	36.12	3.41	4.8
M9	100	0	10	25.50	38.21	3.3	4.3
M10	90	10	10	29.10	36.70	3.2	4.5
M11	80	20	10	28.70	40.21	3.1	4.7
M12	70	30	10	32.30	38.51	3.4	4.9
M13	60	40	10	29.40	39.52	3.44	4.2
M14	50	50	10	30.10	36.74	3.51	4.8
M15	40	60	10	27.23	38.81	3.54	5.3
M16	30	70	10	28.36	36.82	3.55	4.9

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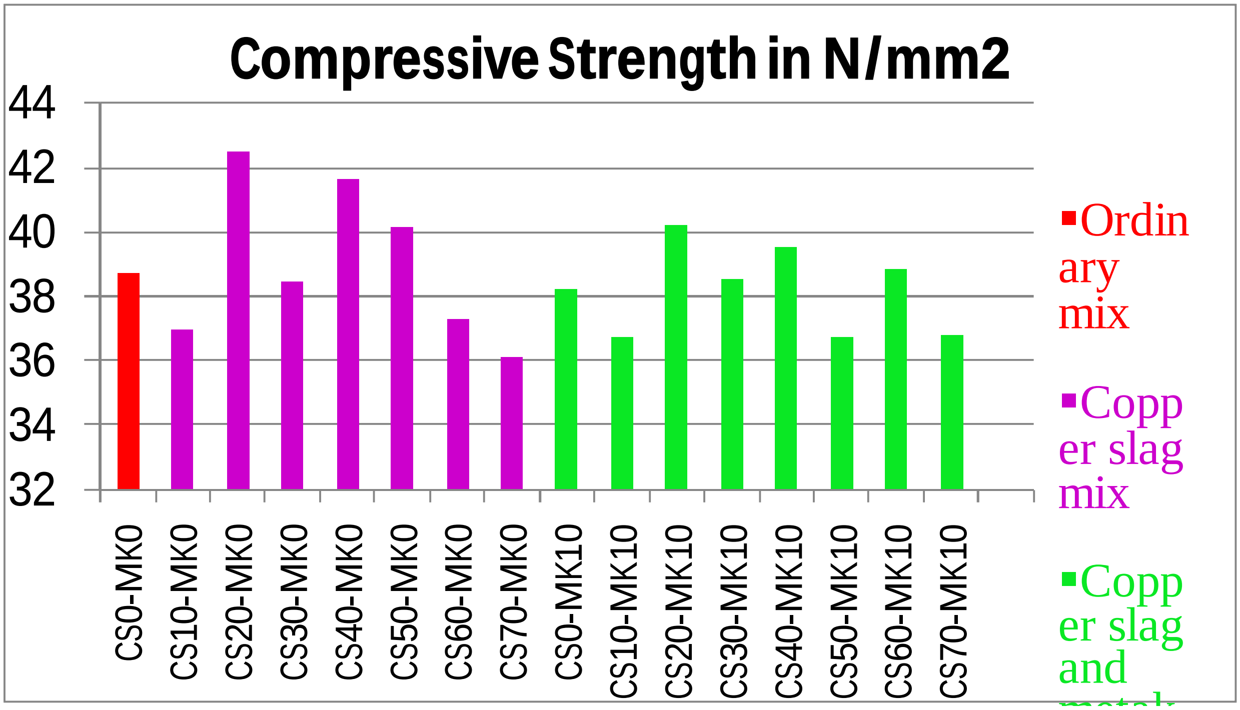
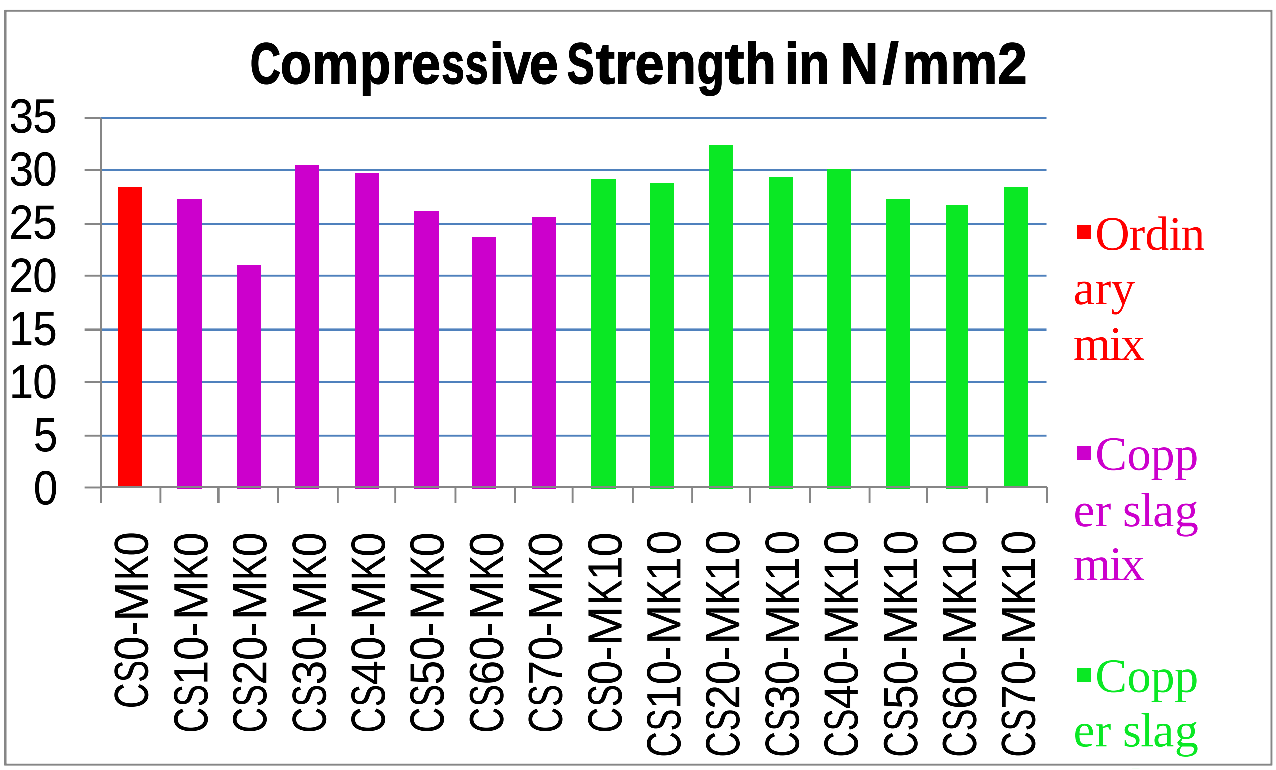
1) Compressive Strength (for 7 days)



2) Compressive Strength (for 28 days):



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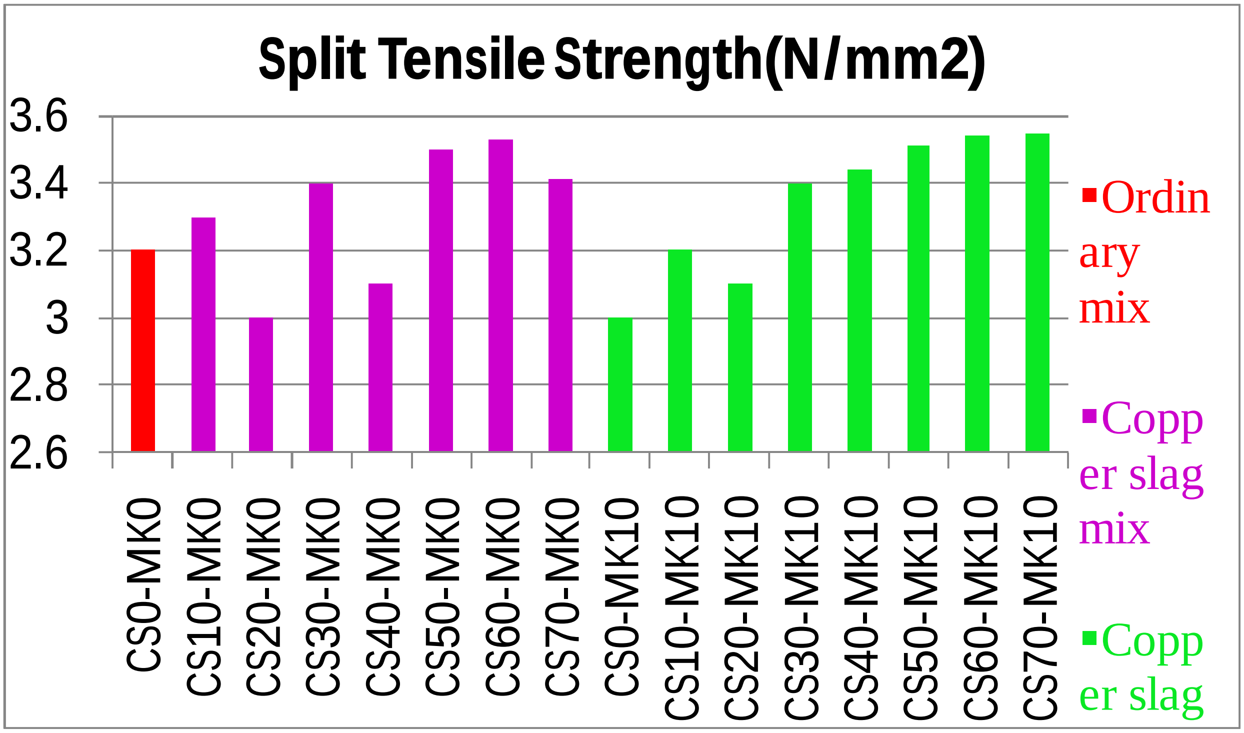
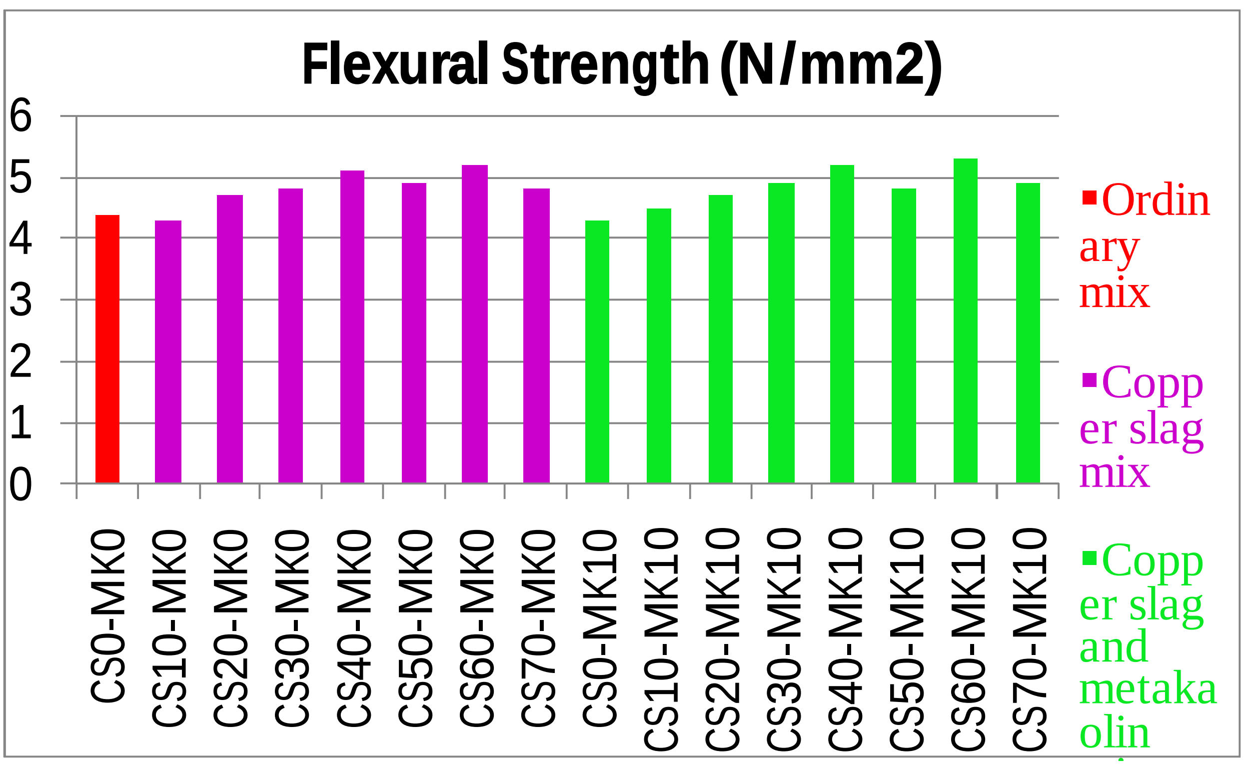
3) Split Tensile Test (for 28 days)



4) Flexural Strength (for 28 days):



V. CONCLUSION

A. Fresh properties of concrete is respectively increased over 50% of cs (copper slag).
B. Workability of concrete increases with presence of Metakaolin .
C. 10% of replaced Metakaolin gives better results of fresh properties over 0%.
D. Compressive strength of 7 day and 28 day is increased with increment of copper slag percentage and at 20% to 40% gives optimum result.
E. Compression test resut slightly decreased over 50% of cs(copper salg).
F. Split tensile and Flexural Strength of self compacting concrete is higher over 40% of copper slag replacement and gives optimum result at 60% and 70% respectively with 10% Metakaolin.
G. Metakaolin slightly increases the flowability and reduces slump flow time.

VI. ACKNOWLEDGMENT

This thesis consumed huge amount of work, research and dedication. Still, implementation would not have been possible if I did not have a support of many people. Therefore I would like to extend my sincere gratitude to all of them.

I would like to express my sincere gratitude to my thesis guide Prof.C.G.Solanki, Civil Engineering Department, DIET Rajkot, for his guidance, inspiration, moral support and affectionate relationship through the course of this research. I consider my self as very fortunate to get this opportunity to work under his guidance.

I express my sincere gratitude to lab staff member sand extend my thanks to faculty members of Civil Engineering Department and my friends for the irguidance. Last but not least; I thank my family, who has given me full support through out my student life.

REFERENCES

[1] Rahul Sharma,Rizwan A, Khan. Durability assessment of self compacting concrete incorporating copper slag as fine aggregates.(2017).
[2] Efstratios G. Badogiannis a,⇑, Ioannis P. Sfikas a, Dimitra V. Voukia a, Konstantinos G. Trezos a,Sotirios G. Tsivilis. Durability of metakaolin Self-Compacting Concrete.(2015).
[3] P. Dinakar , S.N. Manu. Concrete mix design for high strength self-compacting concrete using metakaolin.(2014).
[4] Anhad Singh Gill ⇑, Rafat Siddique. Durability properties of self-compacting concrete incorporating metakaolin and rice husk ash(2018).
[5] Rahul Sharma, Rizwan A. Khan. Sustainable Use of Copper Slag in Self Compacting Concrete Containing Supplementary Cementitious Materials.(2017).

I.S. Code :
IS: 383-1970 (SPECIFICATION FOR COARSE AND FINE AGREEGATES FROM NATURAL SOURCES FOR CONCRETE)
IS: 2386 (Part-1)-1963 (METHODS OF TEST FOR AGGREGATES FOR CONCRETE)
IS: 516 – 1959 (METHODS OF TEST FOR STRENGTH OF CONCRETE)
IS:5816-1999 (METHODS OF TEST FOR SPLIT TENSILE STRENGTH OF CONCRETE)
IS:9399-1959 (Specification for Apparatus for Flexural Testing of Concrete

EFNARC(GUIDELINES):
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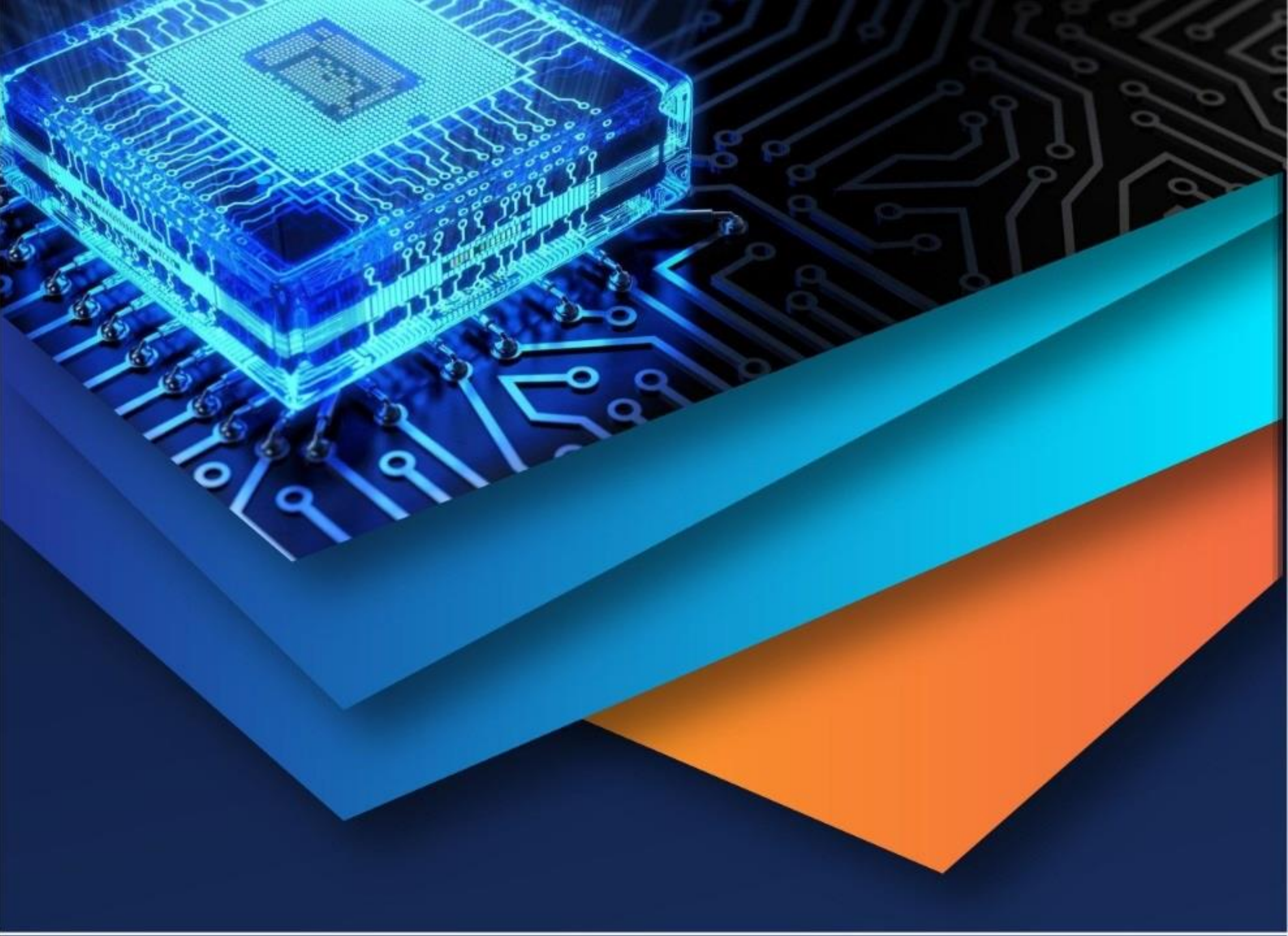

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