Effect of Limestone Filler on ternary blended cement concrete

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Abstract- *In this study, an attempt has been made to study the effect of Limestone filler on ternary blended cement concrete Ternary blended concrete is developed by partial replacement of cement with metakaolin and rice husk ash. In the last decade the use of supplementary cementing materials has become an integral part of high strength and high performance concrete mix design. Rice husk ash is a by-product material obtained from the controlled combustion of rice husk which consists of non crystalline silicon dioxide with high specific surface area and high pozzolanic reactivity. Metakaolin helps to reduce the amount of calcium hydroxide, thus resulting in stronger and durable concrete. Another advantage of using SCMs is increase in durability of concrete which consequently results increase in resource use efficiency of ingredients of concrete which are depleting at very fast rate. Long term performance of structure has become vital to the economies of all nations. In the present experimental investigation an attempt is made to evaluate the workability and compressive strength of M25 concrete for 7, 28 and 56 days curing period. Cement was replaced with rice husk ash at 0%, 2%, 4%, 6%,8% & 10% and metakaolin of 10% was choosen for all trail mixes. I have also check the durability aspects such as Water permeability and sorptivity.*

Keywords- Rice Husk Ash, Metakolin, Limestone Filler, ternary blended concrete.

I. INTRODUCTION

In recent years, many researchers have established that the use of pozzolanic materials like blast furnace slag, silica fume, metakaolin (MK), fly ash (FA) and rice husk ash (RHA) etc. can, not only improve the various properties of concrete, but also can contribute to economy in construction costs. The MK is a valuable pozzolanic and thermally activated aluminosilicate material obtained by calcining kaolin clay within the temperature range of 700–850 C. MK is usually added to concrete in amount of 5–15% by weight of cement. Addition of MK causes an increase in mechanical strength, enhancement of long term strengths, decrease of permeability, porosity, reduction of efflorescence, increase of resistance to soluble chemicals like sulfates, chlorides and acids. The addition of MK decreases workability of fresh concrete mix.

The use of RHA as a partial replacement to cement will provide an economic use of the by product and consequently produce cheaper materials for low cost construction materials. RHA are very high in silica content but the silica content depends on the type of rice husk, method of firing and period of combustion. RHA can produce a pozzolanic activity but the pozzolanicity of RHA depends on its chemical and physical properties. RHA with highly content silica in amorphous phase reported to react with cementitious binders to perform pozzolanic activity. at temperatures around 40 C and in the presence of water, the amorphous silica contained in rice husk ash (RHA) can react with Ca(OH)2 to form more C-S-H gel. The employment of RHA in cement and concrete has gained considerable importance because of the requirements of environmental safety and more durable construction in the future.The use of RHA in concrete has been associated with many advantages, such as increased compressive and flexural strengths (Rodriguez, 2006), reduced permeability, increased resistance to chemical attack,reduced effects of alkali-silica reactivity (ASR) Nicole et al., 2000, reduced shrinkage due to particle packing, making concrete denser, enhanced workability of concrete,reduced heat gain through the walls of buildings and reduced amount of super plasticizer.

In this study I have use of Rice husk ash and Metakolin Partially replacement along with the cement and also check the effect of lime stone filler to replace of fine aggregate. The fresh properties of concrete slump cone test and harden properties of concrete are Compressive strength ,Split tensile strength And Flexural strength of mixtures were evaluated and compared with the normal concrete. and also check the durability aspect.

II. EXPERIMENTAL PROGRAM

A. Materials

1. Cement

Ordinary Portland Cement 53 Grade (Ultratech) was used in production of concrete. The physical properties of cement are given in Table 1

Table 1. Physical Properties of Cement

Sr. No.	Physical Properties	Cement
1	Setting time in Min.	
	(a) Initial setting time (Minute)	43
	(b) Final setting time (Minute)	315
2	Soundness (By Le-chat Expansion in mm)	0.39
3	Compressive Strength in (MPa)	
	3 Days	29.53
	7 Days	40.78
	28 Days	57.34

2. Aggregate

The fine aggregate (specific gravity: 2.67) and course aggregate (specific gravity: 2.87 and 2.73) were used. The maximum size of aggregate was 20 mm.

3. Supplementary Cement

a) Metakolin

Metakaolin has pozzolanic properties. In this experimental work, Metakaolin is obtained from Locally vendor from Ahmedabad is used. And their chemical and physical properties are given below,

Table 2. Physical Properties of Metakaolin

Sr. No	properties	Values
1	Specific Gravity	2.44
2	Particle size	98% passing0.04 5 mm sieve
3	Colour	Whitish
4	Bulk density(g/Cc)	0.5

Table 3. Chemical Properties of Metakolin

Sr. No	Properties	Values (%)
1	Sio2	62.62
2	Al2O3	34.02
3	Fe2O3	1.07
4	TiO2	0.36
5	Cao	0.060
6	MgO	0.84
7	Loi	1.03

b) Rice Husk Ash

Rice husk ash has pozzolanic properties. In this experimental work, Rice husk ash is obtained vendor for Guru Corporation from Ahmedabad is used. And their chemical and physical properties are given below,

Table 4. Physical Properties of Rice husk ash

Sr. No	Properties	Values
1	Specific Gravity	2.10
2	Particle Size	90μ passing (100%) 45μ Passing (70%)
3	Finess (m2/kg)	25000
4	Colour	Black

Table 5. Chemical Properties of Rice husk ash

Sr. No	Properties	Values (%)
1	Sio2	86.85
2	Al2O3	2.43
3	Fe2o3	0.41
4	Cao	0.40
5	Mgo	0.99
6	Na2o	0.61
7	K2o	2.93
8	Lio	4.38

B. Design Mix

A normal mix M25 grade was designed as per Indian Standard method (IS 10262-2009). The concretes were prepared at cementitious material dosages of 400 kg/m3. For each binder content, the W/C ratio, were determined by trial mixtures. The mix design is given in Table

Table 6.

Grade of concrete	M-25
Cement	383.2 kg/m3
Water	191.6 kg/m3
Coarse Aggregate (20mm)	685 kg/m3
Coarse Aggregate (10mm)	457.27 kg/m3
Fine Aggregate	691.35 kg/m3
W/C Ratio	0.50

C. Testing Procedure

For preparing of concrete, a batch mixer was used. First coarse aggregates, fine aggregates, were mixed with ½ of the mixing water for 2 min. After I have mixed of cement ,rice husk and Metakaolin continued up to total 4 min. Slump cone test in fresh state to determine flow properties.

For Compressive strength tests were conducted on 150x150x150 mm cubic specimens, after standard curing. Three specimens were prepared and tested for each mixture.
For split tensile strength tests were conducted on cylinder specimens with a diameter of 150 mm and a height of 300 mm, after standard curing. Three specimens were prepared and tested for each mixture. For Flexural strength tests were conducted on 150x150x700 mm beam specimens, after standard curing. Three specimens were prepared and tested for each mixture.

D. Concrete Mix Proportions

Table 7. Variant A Mixes for M.K + R.H.A to replace with Cement

Sr. No.	Grade	Nominal mixes	% Replacement of (Metakaolin)	% Replacement of Rice husk ash
1.	M25	Mix-1	0	0
2.	M25	Mix-2	10	2
3.	M25	Mix-3	10	4
4.	M25	Mix-4	10	6
5.	M25	Mix-5	10	8
6.	M25	Mix-6	10	10

From the above mixes we are going to take the optimum value of % Replacement of Metakaolin and Rice husk ash then replacing Limestone filler to fine aggregate in varying proportion with that optimum value of metakaolin and Rice husk ash.

Table 8. Variant B Mixes for % optimum value of M.K+RHA to replace the Limestone filler to fine aggregate.

Sr. No.	Grade	Nominal mixes	% Replacement of Metakaolin + Rice husk ash)	% Replacement of Limestone filler
1.	M25	Mix-7	Optimum	25
2.	M25	Mix-8	Optimum	50
3.	M25	Mix-9	Optimum	75

III. RESULTS AND DISCUSSIONS

In the present work, proportions for concrete mix design of M25 were carried out according to IS: 10262-2009 recommendations. The mix proportions are presented in Table . The tests were carried out as per IS: 516-1959.The 150mm size cubes of various concrete mixtures were cast to test compressive strength, Split tensile strength and Flexure strength. The specimens after demoulding were stored in curing tanks and on removal of cubes from water the and al the mechanical properties were conducted at 7days, 28days and 56 days. The test results were compared with controlled concrete. The workability results are presented in Table.7.

Table 9. Slump test Results of M.K + R.H.A Replacements

Sr. No.	Mix	Properties		W/C Ratio	Slump value (mm)
		M.K	R.H.A		
1	Normal	0%	0%	0.5	70
2	Mix-1	10%	2%	0.5	72
3	Mix-2	10%	4%	0.5	68
4	Mix-3	10%	6%	0.5	65
5	Mix-4	10%	8%	0.5	55
6	Mix-5	10%	10%	0.5	50

Table 10. Slump test Results of optimum (M.K + R.H.A) and varying Limestone filler Replacements

Sr. No.	Mix	Properties		W/C Ratio	Slump value (mm)
		M.K+ R.H.A	Limestone		
1	Mix-7	Opt	25%	0.5	65
2	Mix-8	Opt	50%	0.5	60
3	Mix-9	Opt	75%	0.5	58

Table 11. Compressive strength of cube specimen at 7 and 28 days. And 56 days

Sr. No	Description	Cube (Avg. Compressive Strength) N/mm^2		
		7th (Days) Avg.	28th(Days) Avg.	56th (Days) Avg.
1	CM	19.93	31.48	31.6
2	R2M10	18.66	31.67	31.8
3	R4M10	20.61	32.27	33.2
4	R6M10	23.95	33.92	34.9
5	R8M10	22.37	30.75	30.8
6	R10M10	20.39	28.98	29.2

Table 12. Split Tensile strength result at 28 days

Sr. No	Description	Cylinder (Avg. Split tensile Strength) N/mm^2		
		7th (Days) Avg.	28th (Days) Avg.	56th (Days) Avg.
1	CM	1.89	2.67	2.7
2	R2M10	1.76	2.84	2.95
3	R4M10	1.72	2.43	2.53
4	R6M10	1.94	2.76	2.90
5	R8M10	1.91	2.62	2.65
6	R10M10	1.72	2.54	2.60

Table 13. Flexure strength result at 28 days

Sr. No	Description	Beam(Avg. Flexural Strength) N/mm2
		28th(Days) Avg.
1	CM	2.51
2	R2M10	2.59
3	R4M10	2.74
4	R6M10	2.91
5	R8M10	2.7
6	R10M10	2.2

Table 14. Compressive strength result of optimum of RHA & M.K at 28 days

Cube (Compressive Strength) N/mm^2			
SR. No	Description	7th (Days) Avg.	28th(Days) Avg.
1	R6M10L25	16.75	30.22
2	R6M10L50	14.8	25.6
3	R6M10L75	12.5	24.7

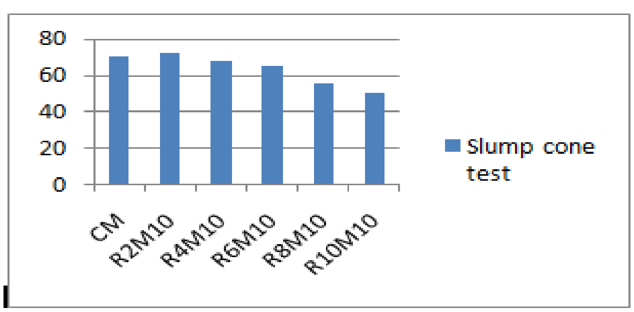

Figure 1. Graph for Slump cone test

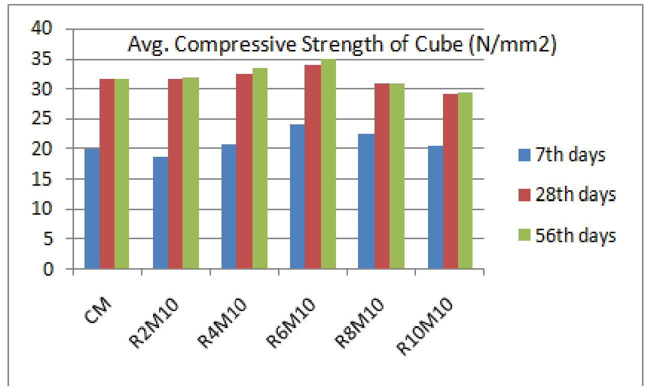

Figure 2. Graph for Compressive Strength of concrete

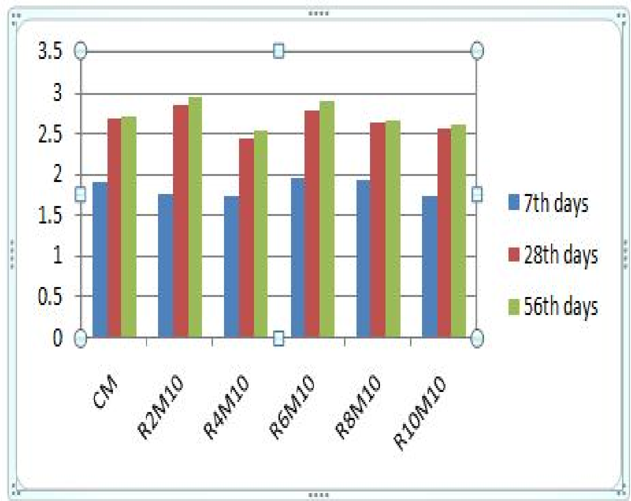

Figure 3. Graph for Split tensile strength of concrete

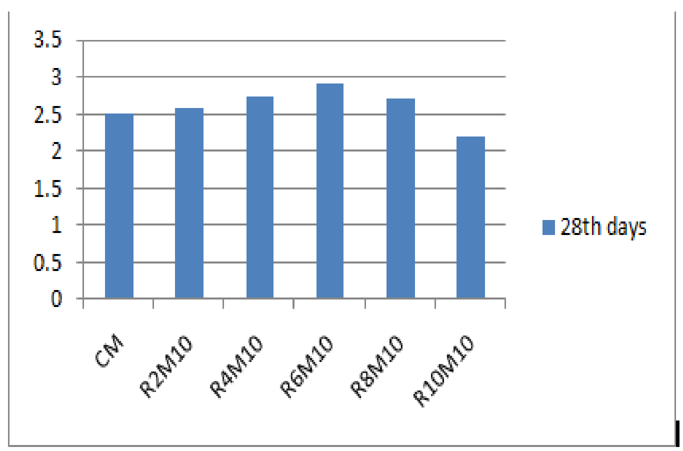

Figure 4. Graph for Flexural Strength of concrete

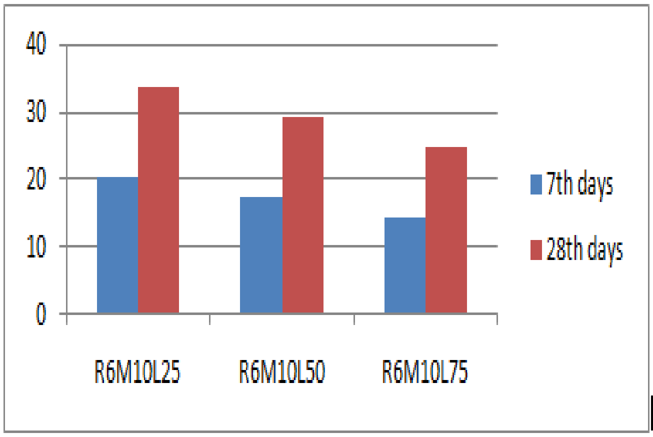

Figure 5. Graph for optimum results of RHA & M.K With replace of L.F

Results of Sorptivity And Water permeability

For the Above test the results are the if it is additions of Rice husk ash and Metakaolin the water flow is less as compared to normal concrete .

IV. CONCLUSION

1. In present study I have concluded the first are the fresh properties of cement concrete by slump cone test so that results are there for the increasing of rice husk ash the workability of concrete is decrease and consume more water.
2. The experimental results show that the maximum compressive strengths for seven and 28 days curing period achieved are 23.92 and 33.20 N/mm2 respectively with 6% replacement of cement by rice husk ash and 10% metakaolin.
3. For Durability aspect I have concluded that the increasing Rice husk ash the pores in concrete are less and the Absorptions of water is less compared to normal concrete.

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REFERENCES

[1] Nagrale,S,D. Hemant,H. and Pankaj,R,M., 2012. Utilization of Rice Husk Ash, International Journal of Engineering Research and Applications (IJERA), Vol. 2 (4),pp 1-5.

[2] Nagrale,S,D. Hemant,H. and Pankaj,R,M., 2012. Utilization of Rice Husk Ash, International Journal of Engineering Research and Applications (IJERA), Vol. 2 (4),pp 1-5.

[3] Indian standard code of practice for specification for Concrete slump test for apparatus IS: 7320- 1974. Bureau of Indian standards, New Delhi.

[4] Indian standard code of practice for specification for 53 grade Ordinary Portland Cement, IS: 12269- 1987. Bureau of Indian standards, New Delhi.

[5] Indian standard code of practice specification for Admixture for Concrete, (1st Revision), IS: 9103-1999. Bureau of Indian standards, New Delhi..

[6] Maria Georgescu , Nastasia Saca ,(2009) “Properties of blended cements with limestone filler and fly ash content”. U.P.B. Sci. Bull., Series B, Vol. 71, Iss. 3, 2009 ISSN 1454-2331