EFFECT OF METHYL CELLULOSE ON MECHANICAL PROPERTIES OF RICE HUSK ASH POLYMER MODIFIED CONCRETE

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ABSTRACT: *This paper investigates and addresses the effect of Methyl Cellulose on mechanical properties of Rice Husk Ash Polymer-modified Concrete. The Rice Husk Ash Polymer-modified Concrete (RHAPMC) is prepared by replacing 10% cement by the weight with the extracted rice husk ash and the addition of 2.5% re-dispersible polymer powder (RPP) by weight of cement. In order to study the effect of Methyl Cellulose in RHAPMC, the inclusion of Methyl Cellulose (MC) with dosages of 0.1 to 1.1 % by the weight of cement is made. A maximum increase (12.30%age) in tensile strength of RHAPMC at the addition of 0.7 %age dosage of Methyl Cellulose has been noticed and on further addition of MC a decreasing trend is observed in the tensile strength. Furthermore, a continuous decreasing trend in the compressive strength of RHAPMC at the addition of different dosage of Methyl Cellulose in the concrete has been observed.*

Key Words: Rice Husk Ash Polymer Modified Concrete, Methyl Cellulose, Re-dispersible Polymer Powder, Tensile Strength, Compressive Strength, Mechanical Properties.

1. INTRODUCTION

In dry-mix mortars water retention additives play a collective and effective role in state of art of building products [1]. Their job is to avert un-controlled moisture loss into permeable sub-strates: brick, lime stone, and aerated-concrete. The cellulose-ethers control industrial marketplace due to their suitable cost-effectiveness and because of good environmental friendness[2].

The first reports on the preparation of methyl cellulose and its derivate originate from Lilienfeld[3] and Dreyfus [2].

Main existing application of cellulose-ethers comprise wall-renders and wall-plasters, joint compounds for gypsum board paneling, cementitious tile-adhesives , floor screeds, self-leveling under-layments and water-proofing membranes [3]. In dry-mortars, cellulose-ethers serve to provide water-retention. Some types of cellulose ethers retard cement-hydration rigorously[4, 5]. Effectiveness of MC depends upon the specific composition (e.g. degree and type of substitution of the cellulose ether). Inclusion of MC may be between 0.1 and 1.5% by weight of binder that depends upon the desirable property of composites. The frequently used cellulose- ethers are methyl hydroxyethyl cellulose and methyl hydroxypropyl cellulose [6-8]. MHEC is predominantly applied in self leveling floor compounds and cementitious tile-adhesives while MHPC, due to its air entraining effect stemming from the hydrophobic-hydroxypropyl groups, is the product of choice for wall renders and plasters.

This paper encompasses the new approach of addition of Methyl Cellulose (MC) in rice husk ash polymer modified concrete and to investigate its effect on mechanical properties; compressive and tensile strength.

2. MATERIALS AND METHODS

2.1. Materials

2.1.1. Cement

OPC confirming to ASTM C 150 type-I was used in this experimental work. The physical & chemical properties of same cement are presented [9] as illustrated in Table 1.

2.1.2. Aggregate

Fine and coarse aggregate having maximum size of 4.75 mm and 19 mm respectively, has been used.

2.1.3. Rice Husk Ash

Rice husk ash extracted from the available rice husk in the vicinity of district Nawabshah, Sindh Pakistan has been used in this research study. The Physical and Chemical properties of the extracted ash are shown in Table 1

Table 1: Chemical and physical properties of Rice Husk Ash (RHA)

Material	Physical Properties		Chemical Analysis (%)						
	Specific Gravity	Blaine(cm^2/g)	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	LOI
Cement	3.15	3008	20.78	5.11	3.17	60.89	3	-	1.71
RHA	2.05	2251	70.38	1.59	0.86	3.19	3.32	2.88	4

2.1.4 Cement Modifier

A water re-dispersible polymer powder (VINNAPAS 5044 N) has been used as a Cement modifier

2.1.5. Plasticizer

In order to increase workability of RHAPMC, the SMF-10plasticizer was used.

2.1.6. Methyl Cellulose

GinShicel MH256-ALX3; a high viscosity grade of Hydroxy Propyl Methyl Cellulose, also known as HPMC/MHPC is used. Characteristics of HPMC are given in Table 2.

2.2 Concrete Mix

Mixing of the concrete is done as per mix design shown in Table 3.All the ingredients were dried mix first then wet mix. To observe

the influence of MC on mechanical property of RHAPMC, the concrete specimens were prepared by addition of various dosages of MC (0.1 to 1.1% with an increment of 0.2 %). The details are shown in Table 3.

Table 2: Characteristics of Methyl Cellulose

Specifications	
Powder	
Appearance	Whitish Powder Or Granules
Particle Size	99%<250µm
Water Content Max	5
Ash Content Max	3
Hydroxypropyl Content	4-12%
Methoxyl Content	19-24%
Packing	25kgs

Table 3: Concrete Mix Proportions

S.NO	Cement (Kg/m^3)	RHA	RPP	T. Binder	Plasticizer	MC %age	MC (Kg /m^3)	W/C	Water (Kg/m^3)	F.A	C.A
Cmix	346	0	0	346	0	0	0	0.55	190	692	1038
RHAPMC	311	35	8	346	0	0	0	0.55	206	623	1038
HPMC0.1	311	35	8	354	2.8	0.1	0.31	0.55	206	623	1038
HPMC0.3	311	35	8	354	2.8	0.3	0.93	0.55	206	623	1038
HPMC0.5	311	35	8	354	2.8	0.5	1.55	0.55	206	623	1038
HPMC0.7	311	35	8	354	2.8	0.7	2.18	0.55	206	623	1038
HPMC0.9	311	35	8	354	2.8	0.9	2.80	0.55	206	623	1038
HPMC01.1	311	35	8	354	2.8	1.1	3.42	0.55	206	623	1038

2.3. Specimen Preparation

Concrete specimen was made with 10 % cement substitution with RHA along with the inclusion of re-dispersible polymer2.5% by the weight cement and various dosages of MC. Seven concrete mixes in addition to the control mix were prepared. 6”x12” Cylindrical specimens were cast. After 24 hr the specimens were de-moulded. Specimens made from Rice Husk Ash Polymer Modified concrete having varying proportion of MC were kept wet for 7 days and 21 days for air dry curing, as per specification of JIS for curing of Polymer-modified concrete.

2.4 METHODS

The chemical composition of rice husk ash was determined through Energy Dispersive Spectrometry.

Specific-gravity and Blaine-fineness of RHA were determined as per ASTM.

X-ray diffraction (XRD) analysis was carried out to check crystalline behavior of produced rice husk ash.

Compressive and Splitting Tensile strength were determined as per ASTM C-39 and

ASTM C-496 by using Universal Testing Machine (UTM).

3. RESULTS AND DISCUSSION

3.1 Properties Of Rice Husk Ash

analysis indicates that Rice husk ash has around three and a half times higher silicon di-oxide than OPC. It could be observed the content of SiO_2 in

rice husk ash is 70.38 % along minor-oxides. Sum of SiO_2, $Al_2O_3$and Fe_2O_3 in RHA is 72.83 % that come up with requirement of ASTM C618-03. The XRD pattern generated by the XRD machine for the RHA is shown in Figure 1. It can be seen that broad diffused peak at 2θ angle of 22° confirming the formation of amorphous silica at the temperature of 677 ^{o}C for the duration of 3 hours[10].

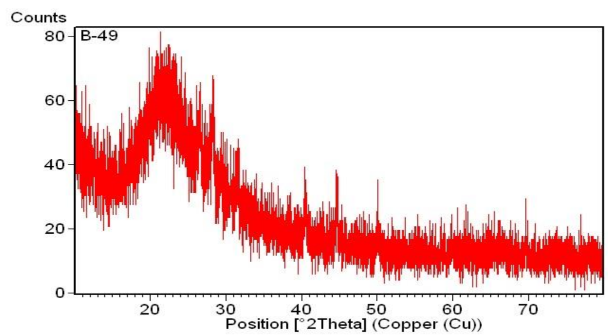

Figure.1: XRD pattern of RHA

3.2 Compressive and Splitting Tensile Strength

Compressive and splitting tensile strength of Rice husk Ash Polymer-Modified Concrete (RHAPMC) specimens were cast with substitute of cement with 10% the ash, addition of 2.5 % re-dispersible polymer and addition of MC with dosage from 0.1 to 1.1 % were tested and results are shown in Table 4and Figure2.

Table 4: Compressive and Tensile Strength

No	Concrete Mix	Admixture %				Compressive Strength (MPa)	%age incr/decr	Tensile Strength (MPa)	%age incr/decr
		MC	RHA	SMF	RPP				
1	Cmix	0	0	0	0	23		1.86	
2	RHAPMC	0	10	0	2.5	24.8	7.83	2.76	48.39
3	HPMC0.1	0.1	10	0.8	2.5	23.0	0.00	2.77	48.92
4	HPMC0.3	0.3	10	0.8	2.5	19.2	-16.52	2.84	52.69
5	HPMC0.5	0.5	10	0.8	2.5	16.9	-26.52	2.92	56.99
6	HPMC0.7	0.7	10	0.8	2.5	14.5	-36.96	3.10	66.67
7	HPMC0.9	0.9	10	0.8	2.5	13.7	-40.43	3.00	61.29
8	HPMC01.1	1.1	10	0.8	2.5	12.3	-46.52	2.38	27.96

Figure.2 Compressive and Tensile strength of control mix and RHAPMC with different dosages of Methyl Cellulose.

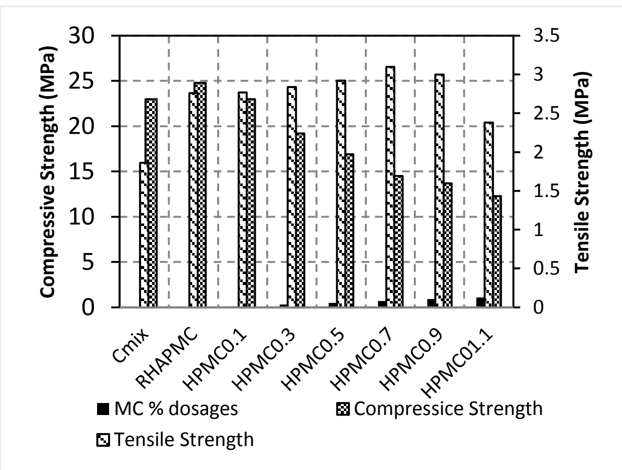

Table 5 & Figure 2 show the behavior of rice husk ash polymer-modified concrete with different dosage of MC in terms of compressive and splitting tensile strength. A decreasing trend in compressive strength of RHAPMC shows that MC has the adverse effect on compressive strength of the RHAPMC. The tensile strength kept on increasing up to 0.7 %age dosages of MC and on further increase in dosages the decreasing trend has been observed. The maximum tensile strength 3.10 MPa at 0.7 %age dosage of MC in the RHAPMC has been noticed with an increase of 66.67% and 12.30% as compare to control mix and rice husk ash polymer modified concrete respectively, such decreasing and increasing trend in mechanical properties of the cement and mortar are validated by the researchers[11, 12].

4. CONCLUSIONS

1. Methyl cellulose has the adverse effects as far as the compressive strength of the concrete is concerned; a continuous decreasing trend in the compressive strength of RHAPMC at the addition of different dosage of Methyl Cellulose in concrete has been observed.
2. An increasing and decreasing trend in tensile strength on RHAPMC has been observed at inclusion of Methyl cellulose in the mix; on the inclusion of MC from 0.1 to 0.7 %age dosages by the weight of cement the tensile strength increases and on the further inclusion of MC the tensile strength decreases.
3. At the inclusion of 0.7 % of Methyl Cellulose by the weight of cement in RHAPMC, the maximum tensile strength 3.10 MPa with an increase of 66.77% & 12.30% as compared to Control mix and RHAPMC have been observed respectively.

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REFERENCES

1. Lutz, H. and R. Bayer, *Dry mortars.* Ullmann's encyclopedia of industrial chemistry, 2010.
2. Grover, J.A., *Methylcellulose and its derivatives*, in *Industrial gums, polysaccharides and their derivatives*. 1993, Academic Press San Diego. p. 475-504.
3. Lilienfeld, L., *Alkyl ethers of cellulose and proces of making the same*. 1916, Google *Patents*.
4. Müller, I., *Influence of cellulose ethers on* the *kinetics of early Portland cement hydration*. 2006: Univ.-Verlag Karlsruhe.
5. Pourchez, J., P. Grosseau, and B. Ruot, *Current understanding of cellulose ethers impact on the hydration of C 3 A and C 3 A-sulphate systems.* Cement and Concrete Research, 2009. **39**(8): p. 664-669.
6. Thielking, H. and M. Schmidt, *Cellulose* ethers. Ullmann's encyclopedia of industrial chemistry, 2006.
7. Dönges, R., *Non-ionic cellulose ethers.* British polymer journal, 1990. **23**(4): p. 315-326.
8. Jenni, A., et al., *Influence of polymers on microstructure and adhesive strength of cementitious tile adhesive mortars.* Cement and Concrete Research, 2005. **35**(1): p. 35-50.
9. Ali, K., *Chemical Analysis and Comparison of Ordinary Portland Cement of Khyber Pakhtoon Khwa Pakistan.* Chemical Engineering Research Bulletin, 2010. **14**(1): p. 45-49.
10. A. Saand, D.K.B., M. A. Kerio, *Development of Polymer Modified Rice Husk Ash Concrete (PMRHAC).* Advanced Materials Research 2015. **1129 (2015)**: p. 500-507.

11. Xuli, F. and D. Chung, *Effect of methylcellulose admixture on the mechanical properties of cement.* Cement and Concrete Research, 1996. **26**(4): p. 535-538.
12. Zhou, M., et al., *Influences of carboxyl methyl cellulose on performances of mortar.* Journal of Wuhan University of Technology-Mater. Sci. Ed., 2007. **22**(1): p. 108-111.