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Experimental investigation of the strength of concrete by partial replacement of cement with industrial wastes

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ABSTRACT

Cement the main binding ingredient in concrete is becoming expensive and its production contributing to environmental pollution by emitting CO_2 gases that is the main cause of global warming so efforts are being taken to utilize local natural or solid waste resources as a supplementary cementing material.RHA is a bye-product of paddy industry, highly reactive pozzolana which is produced by burning rice husk at controlled temperatures. FA is collected from the combustion air-stream exiting the power plant. Fly ash is pozzolanic, which means it's a siliceous or siliceous-and-aluminous material that reacts with calcium hydroxide to form a cement. WGP Glass is amorphous and contains large amount of silicon and calcium. Thus it can be claimed that it is pozzolanic or even cementious in nature even when it is finely ground, waste glass powder is formed from grinding industry by grinding waste glass obtained from lights bulbs, bottles and so on. The details of experimental investigations is done to study the effect of replacing a portion of cement with rice husk ash, fly ash and waste glass powder are reported in this paper. The main aim of this work is to determine the optimum percentage of RHA, FA and WGP as a partial replacement of cement for conventional grade of concrete and to study the strength variation in its percentage replacement with RHA, WGP and FA. The studies conducted on cement concrete reveal that 10% RHA,5%FA and 5% WGP give optimum results for cement replacement in concrete.

Keywords: *Cement concrete, Rice husk ash, Fly ash, Waste glass powder.*

1. INTRODUCTION

The use of industrial and biogenic wastes in concrete as supplementary cementing materials as the present vital issue to obtain a sustainable environmental solution save energy and resources. Some of the commonly used supplementary pozzolanic and cementing materials the industrial by products are ground granulated blast furnace slag, metakaolin, rice husk ash (RHA), silica fume, ground granulated furnace slag and fly ashes, waste glass powder as cement replacement blast furnace slag, fly ash and ash from wood etc. materials. Their utilization not only improves concrete also reduces environmental load. These hazardous by products are dumped into the environment there by polluting it and consequently increasing disposal problems and cost. India is next to china in rice in production huge quantity of husk is generated every year the husk when burned under controlled temperature produces husk which is a higly reactive pozzolana having 90-95% silica that can be used for cement replacement upto certain percentage. Fly ash re glassy spherical particles that are cementitious in nature i.e both siliceous and siliceous-and-aluminous material that reacts with calcium hydroxide to form a cement. Waste glass powder obtained milled waste glass industries shows pozzolanic property less than 200 mesh or 75µm.Therefore, the above mentioned products can be utilized as a cement replacing ingredient.

2. SCOPE OF PRESENT INVESTIGATION

- To determine the physical properties of RHA, FA, WGP.
- To determine the slump value of fresh concrete with various percentage replacements with above mentioned ingredients.
- To determine the optimum percentage of RHA, FA, WGP as partial replacement of cement.
- To determine the compressive strength, split tensile strength and flexural strength with various percentage replacements of RHA, FA and WGP.

3. EXPERIMENTAL PROGRAMME

Experimental programme comprises of tests on conventional grade of concrete and also by replacing cement partially with rice husk ash, fly ash, waste glass powder are discussed here.

Rice Husk Ash

Rice husk ash used in this is supplied by N.K industries located in Jharsuguda district of Odisha. The rice husk ash was grayish black in colour with specific gravity 1.77 and fineness 8.75%.

Fly Ash

The fly ash was collected from Talcher Thermal Power Plant (NTPC) located in Angul district of Odisha. The fly ash used was grey in colour with specific gravity 1.89 and fineness of 8.09%.

Waste Glass Powder

Waste glass powder was collected from Kolkata market. The glass powder used was whitish in colour with specific gravity 2.13 and fineness of 9.09%.

Tests on Concrete

An M_{25} and M_{35} mix is designed as per the guidelines IS 10262-1982 based on the preliminary studies conducted in the constituent materials. The materials used and their properties along with the mix proportion for the final mix are presented in Table-1.
Workability of Concrete

Addition of RHA in the concrete mix will increase the water demand compared to the control mix, but inclusion of FA and WGP do not demand much water so water was added for maintaining the workability and to get the desired slump value as that of control concrete.

Table-1 Properties of materials used and mix proportion for M_{25} and M_{35} mix

Materials	Quantity Kg/m^3		Test conducted	Result
	M_{25}	M_{35}		
Cement (OPC-43 grade)	383.2	410	Standard consistency Initial setting time Final setting time 28-day compressive strength	35% 125 min 420 min 42.7N/mm^2
Fine aggregate	560	595	Specific gravity	2.67
			Grain size distribution	Zone III
Coarse aggregate	1295	1255	Specific gravity	2.84
Water	191.6	186		

Tests on Hardened Concrete

Six specimens each are cast with different percentages of cement replacement varying from 0% to 15% by RHA,FA,WGP and RHA+FA+WGP to study the properties of hardened concrete.

Cube Compressive Strength

To study the effect of percentage replacement (0%to15%) of RHA, FA, WGP and RHA+FA+WGP each respectively added to concrete and the results on 28 days is shown in fig-1,2, 3 respectively.The strength at the age of 28 days is proximate with control concrete for the above mentioned grades are10%RHAand5%RHA,10%FAand 5%FA,10%WGPand 5%WGP,10%(RHA+FA+WGP)respectively.

Comparison of compressive strength of M_{25} and M_{35} with 5% replacement of cement at the age of 28 days is shown in fig-1.

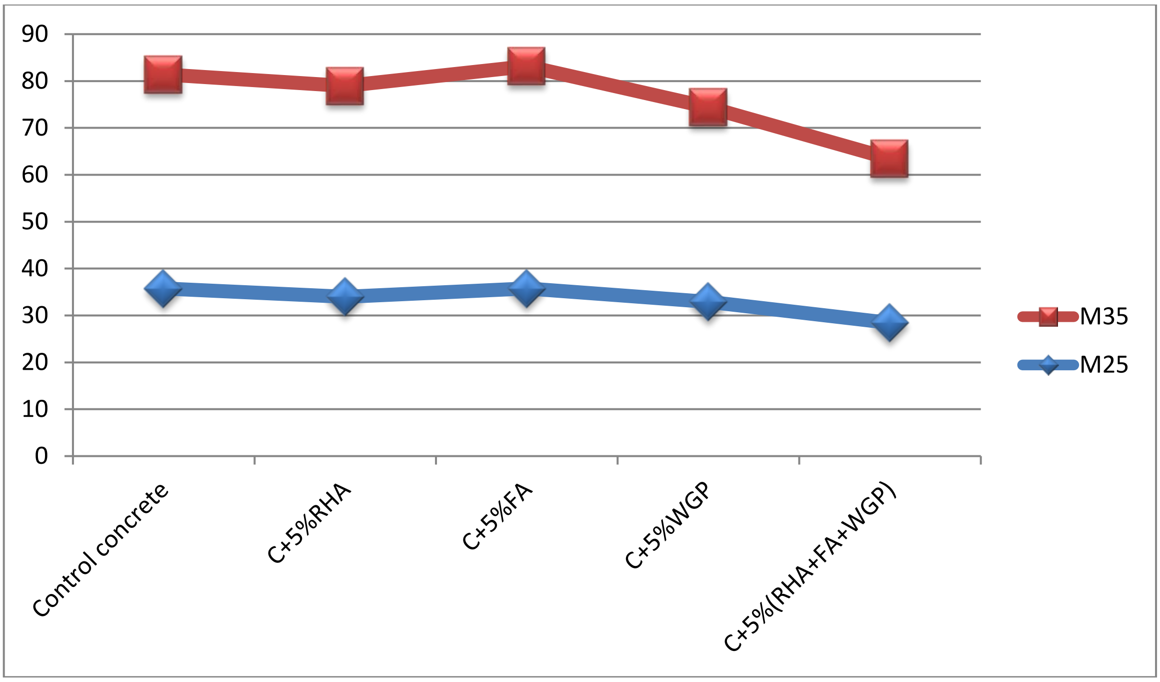

Fig-1 Variation of compressive strength at the age of 28 days

Comparison of compressive strength of M_{25} and M_{35} with 10% replacement of cement at the age of 28 days is shown in fig-2.

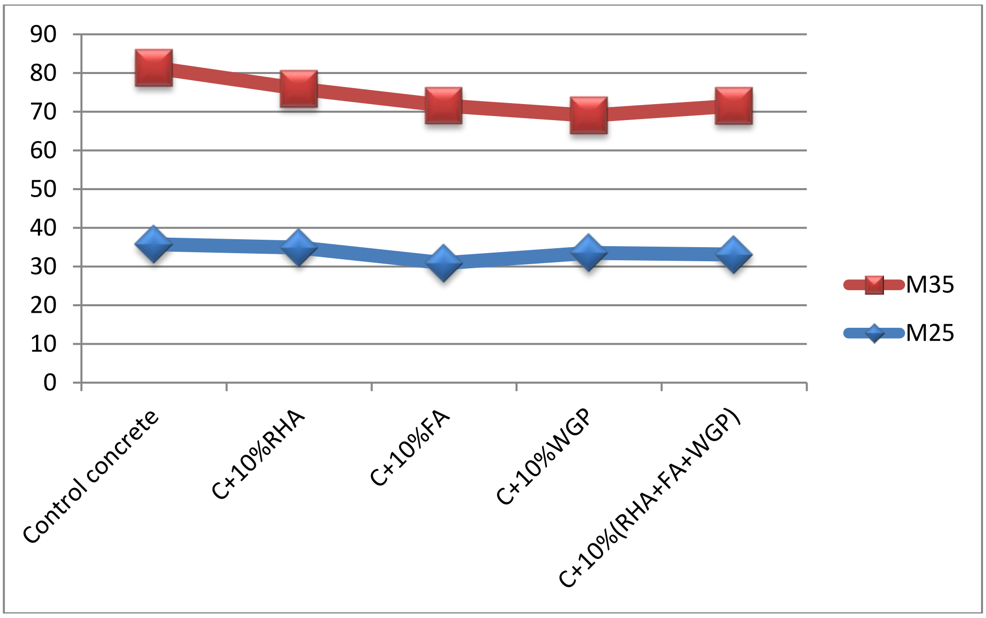

Fig-2 Variation of compressive strength at the age of 28 days

Comparison of compressive strength of M_{25} and M_{35} with 15% replacement of cement at the age of 28 days is shown in fig-3.

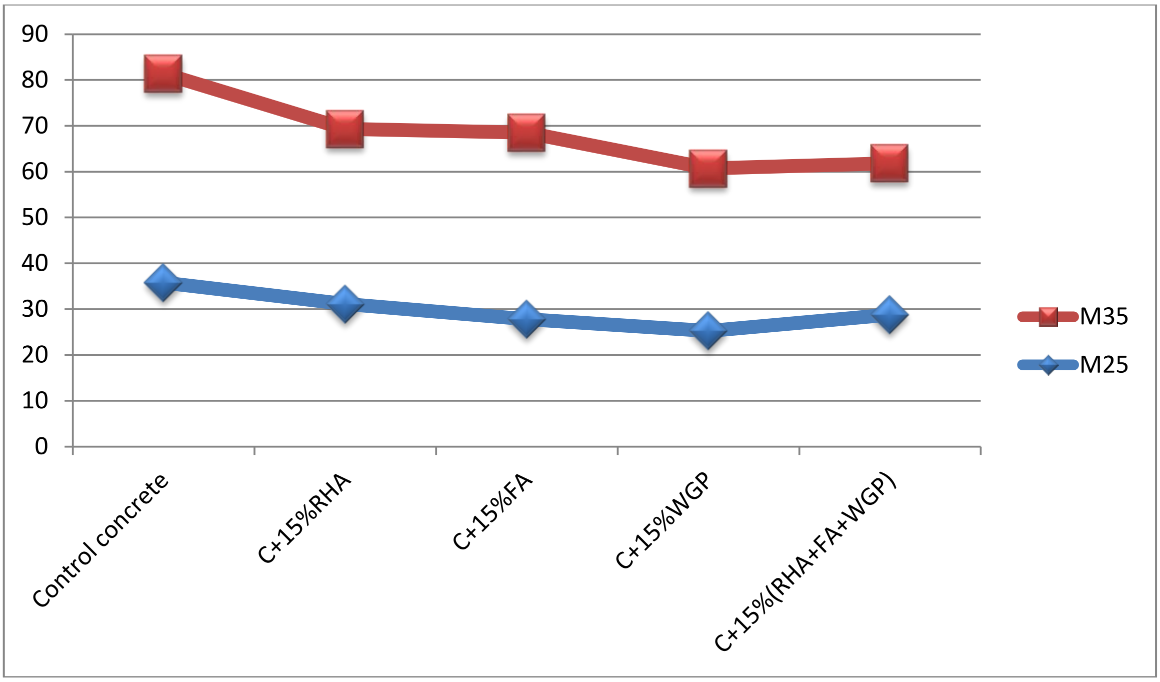

Fig-3 Variation of compressive strength at the age of 28 days

Split tensile strength

The optimal percentage of replacement of cement that remarked increase in split tensile strength than that control mix of M_{25} and M_{35} at the age 28 days are10%RHA,10%WGP(for both the grades),10%FA and 10%RHA+FA+WGP(for M_{35} mix) respectively. The split tensile strength is shown in figures-4,5and 6.

Comparison of split tensile strength of M_{25} and M_{35} with 5% replacement of cement at the age of 28 days in fig-4.

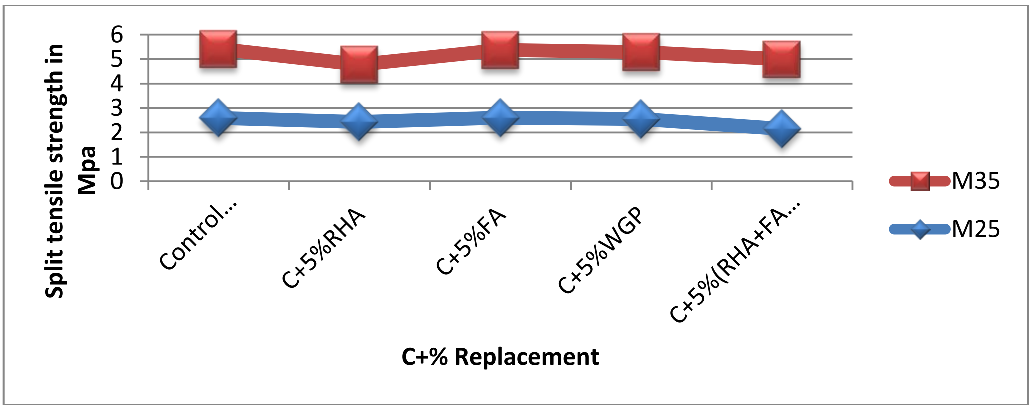

Fig-4 Variation of split tensile strength at the age of 28 days

Comparison of split tensile strength of M_{25} and M_{35} with 10% replacement of cement at the age of 28 days is shown in fig-5.

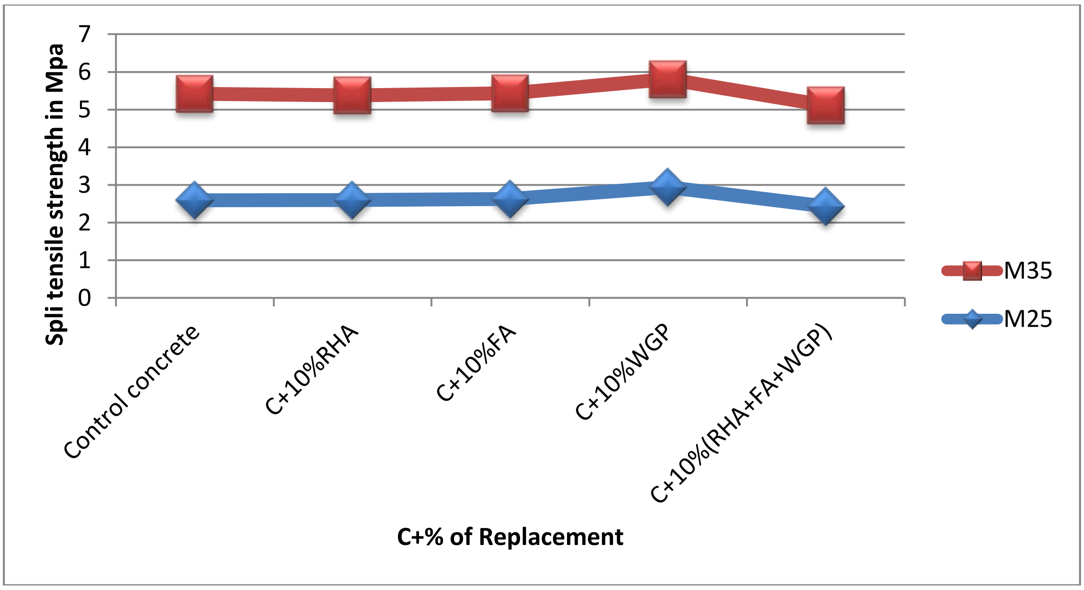

Fig-5 Variation of split tensile strength at the age of 28 days

Comparison of split tensile strength of M_{25} and M_{35} with 15% replacement of cement at the age of 28 days is shown in fig-6.

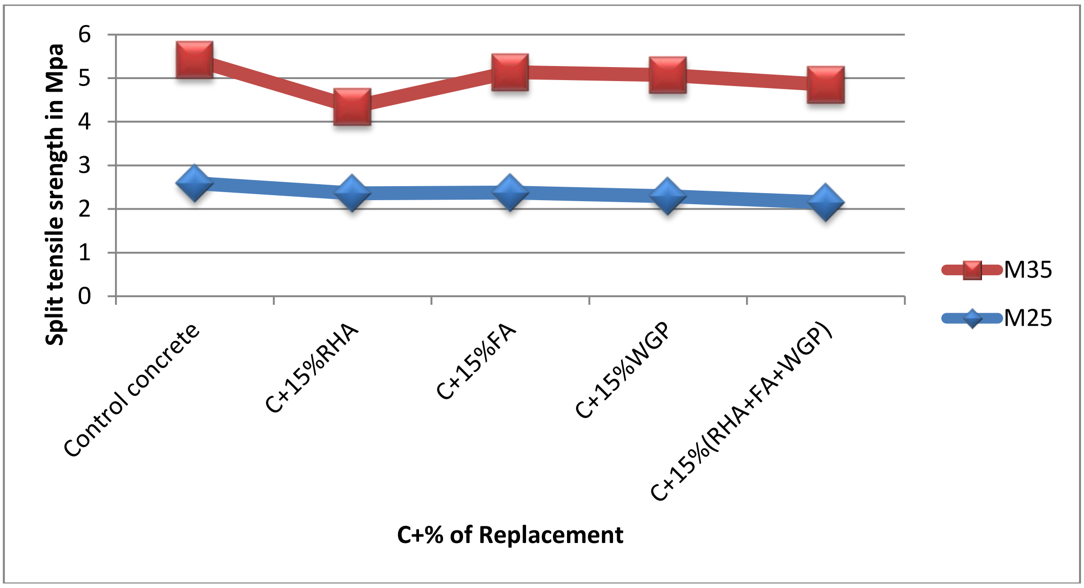

Fig-6 Variation of split tensile strength at the age of 28 days

Flexural strength

The flexural strength increases with increase in percentage replacement i.e from (5%-15%) of RHA,FA by (15.65%) for each respectively while with 10% replacement of WGP and RHA+FA+WGP remarks more strength than control concrete for the grade of M_{25} mix at the age of 28 days. Similarly, for the grade of M_{35} mix the strength increases by 44% with 15% replacement of cement with FA and strength also increases at 10% replacement of cement with RHA at the age of 28 days. The variation of flexural strength is shown in figures-7,8&9

Comparison of flexural strength of M_{25} and M_{35} with 5% replacement of cement at the age of 28 days is shown in fig-7.

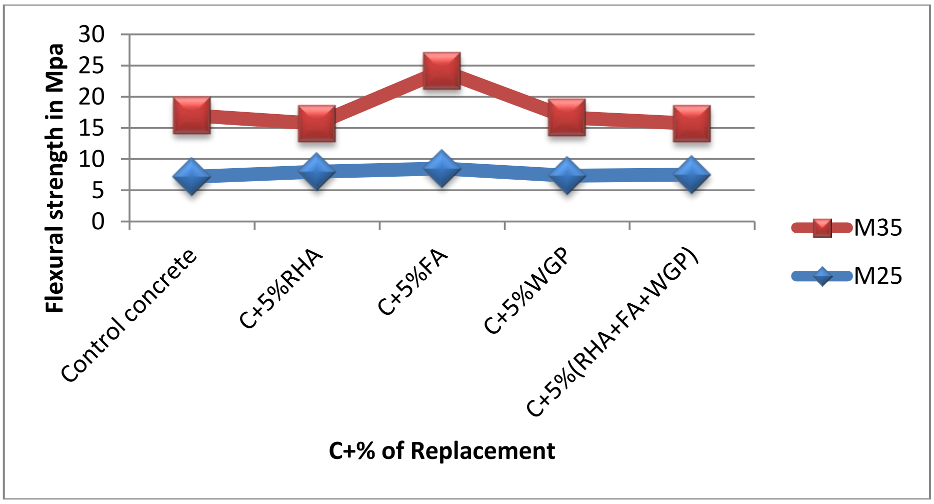

Fig-7 Variation of flexural strength at the age of 28 days

Comparison of flexural strength of M_{25} and M_{35} with 10% replacement of cement at the age of 28 days is shown in fig-8.

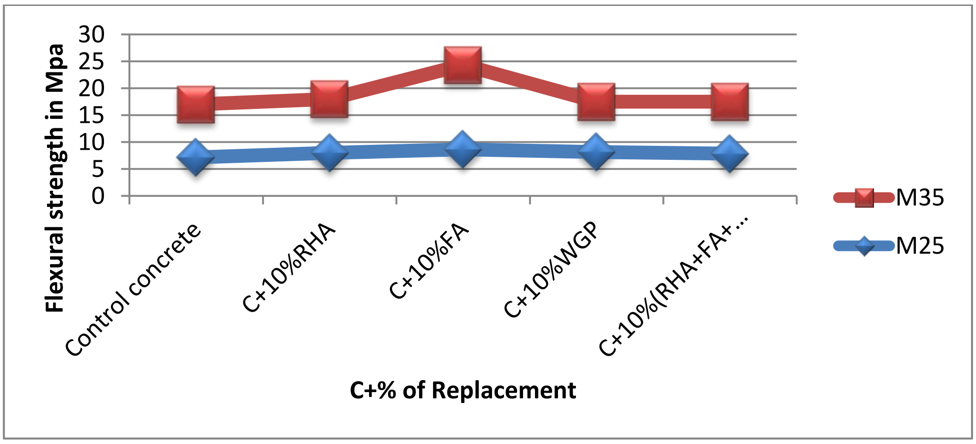

Fig-8 Variation of flexural strength at the age of 28 days

Comparison of flexural strength of M_{25} and M_{35} with 15% replacement of cement at the age of 28 days is shown in fig-9.

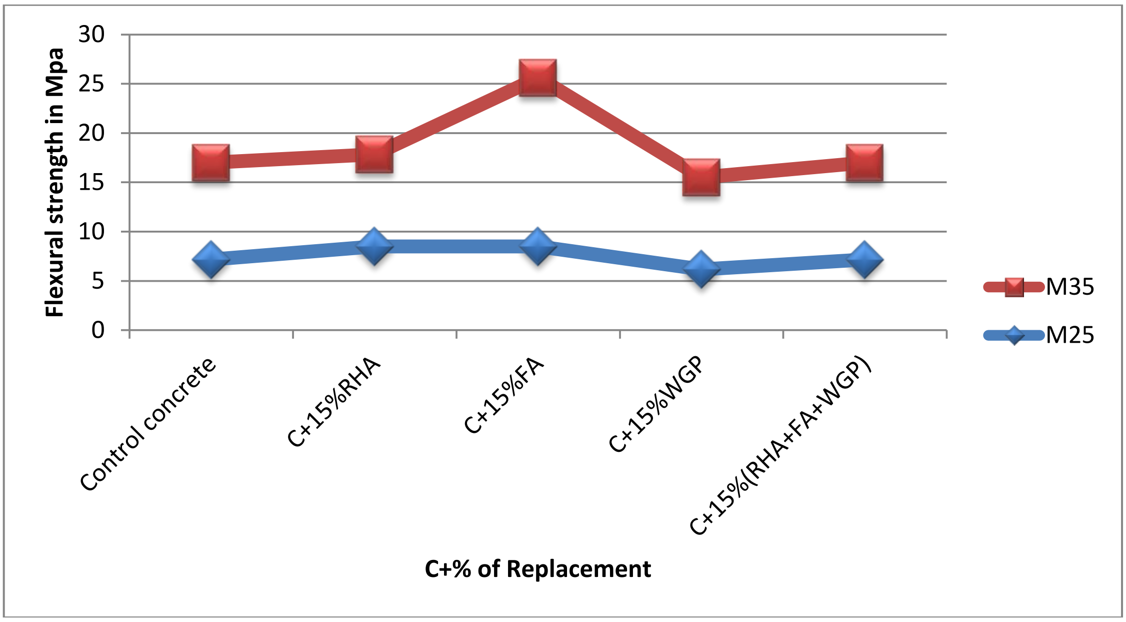

Fig-9 Variation of flexural strength at the age of 28 days

4. CONCLUSION

[1] Inclusion of RHA in cement demands more water being a porous material as compared to FA and WGP so workability was maintained by adding water.
[2] The compressive strength at 28 days is optimum in comparison to control concrete at 10% of (RHA, FA, WGP and RHA+FA+WGP) each respectively for the grade M_{25} mix. Similarly, the strength of M_{35} mix is optimum at 5%RHA and 5%FA than the conventional grade at the age of 28 days respectively.
[3] The split tensile strength increases at a optimum replacement of cement with 10%(RHA,FA and WGP) for the grade of concrete M_{25} mix than the control concrete while for M_{35} mix there was not much strength increment at the age of 28 days for each grade.
[4] The flexural strength increases at a optimum replacement of cement with 15%RHA, 10% (FA, WGP and RHA+FA+WGP) than the control concrete at the age of 28 days for M_{35} mix. Similarly, the flexural strength increases for percentage replacement of FA in cement i.e from (5%-15%) and the flexural strength increases by 44% with 15% replacement of cement with FA for the grade of M_{35} mix at the age of 28 days.

5. REFERENCE

[1] Agbede, I. O., and Obam, S. O. (2008), “Compressive Strength of Rice Husk Ash-Cement Sand Crete Blocks”, Global Journal of Engineering Research, 7 (1), pp.43-46, 2008.
[2] A.Muthadhi and S. Kothandaraman .(2013),”Experimental Investigations of Performance Characteristics of Rice Husk Ash–Blended Concrete.” J. Mater. Civ. Eng., 25(8), 1115–1118, 2013.
[3] Bashar Taha and Ghassan Nonu.(2008), “Properties of Concrete contains mixed colour waste recycled glass as sand and cement replacement”, Construction and Building Materials 22,pp731-720,2008.
[4] Caijun Shi,Yanzhhhong Wu,Chris Riefler,and Hugh Wang.(2005),“Characteristics and pozzolanic reactivity of glass powders”,Cement and Concrete Research 35,pp987-993,2005. Chindaprasirt P, Kanchanda P, Sathonsaowaphak A, Cao HT.(2007),“Sulfate resistance of blended cements containing fly ash and rice husk ash”. Construction and Building Materials 21 (6): 1356–1361, 2007.
[5] Jayasankar.R, Mahindran.N , and Ilangovan.R.(2010),“Studies on Concrete using Fly Ash, Rice Husk Ash and Egg Shell Powder”, International Journal Of Civil and StructuralEngineering, Volume 1, No 3, 2010.
[6] ManjitSingh, MridulGarg and K.K.Somani.(2006),“Experimental investigations in developing low cost masonry cement from industrial wastes”, The Indian Concrete Journal,pp31-36,2006.
R.E. Philleo,(1988), "Compressive Strength Of Low Cement/High Fly Ash Concrete", Cement And Concrete Research. Vol. 18, pp. 571-583, 1988.