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Experimental Study on Lightweight Concrete Made from Partial Replacement of Coarse Aggregate by Waste Polystyrene

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Abstract: ***In this present study the attempt has been made to study of light -weight concrete by replacing rice husk ash to cement & waste polystyrene to coarse aggregate size of 8-12 mm diameter used. The standard size cube 150 x 150 x 150 mm when casted & tested under UTM of capacity 1000 kN. The rice husk ash (RHA) replaced by 0, 10, 20, 30%by cement & waste polystyrene replaced by 0, 15, 30, 45% by coarse aggregate. Waste polystyrene in a granular form is used as lightweight aggregate to produce lightweight structural concrete. This paper reports the results of an experimental investigation into the engineering properties, such as dry density, compressive strength and modulus of elasticity.***
Keywords: Waste polystyrene, Rice husk Ash, Compressive strength, modulus of elasticity.

I. INTRODUCTION

In india rapidly increase in construction activities has resulted in shortage of conventional available construction materials. In the present condition, the high cost of conventional building materials is a major factor affecting housing cost. This has necessitated research into alternative materials of construction. the effective housing techniques deal with reduction in cost of construction as well as providing good strength to buildings. mostly gravel, sand and cement are used in the preparation of conventional concrete. while the use of agricultural by-product i.e. Rice husk ash (rha) as a partial replacement with the conventional cement & coarse aggregate a partial replacement with waste polystyrene (wps) is expected to serve the purpose of encouraging housing developers in building construction. Rice husk & waste polystyrene is produced in about millions of tons per annum in india. Twenty kg of rice husk (rh) are obtained from 100 kg of rice. It has contains organic substances and 20% inorganic material. Ash from rice is obtained as a result of combustion of rice husk at suitable temperature. waste polystyrene has good thermal insulation properties with stiffness and compression strength comparable to medium clay.

II. EXPERIMENTAL PROGRAMME

After normal concrete casting is to be completed for light weight concrete casting at the first stage cement and rice husk ash passing through 90 µm and 150 µm respectively. Then added fine sand passing through 2.36 mm sieve, adds aggregate of passing through 12 mm sieve and retained on 8 mm sieve throughout the work, then adds Waste Polystyrene of size 8-12 mm diameter. After dry mixing is completed using the drum mixer then add water by considering w/c ratio at 0.4. After mixing is completed check that the wet density of the concrete is close to what is required. Then light weight concrete is poured into assembled moulds of blocks in the 3 layer by giving 25 blows for each layer for better compaction. The dimensions of the blocks are 150 X 150X 150 mm. Then after 24 hrs moulds was erected and curing for 7, 14, 28 days and test is carried out on casted cubes under universal testing machine.

III.PROPERTIES AND TEST OF MATERIALS

Table No.1Physical Properties & test on cement

Sr.no	Description of Tests	Specifications as per IS:8112-1986	Testing Result
1.	Initial setting time	Min. 30 minutes	70.46 min
2.	Final setting time	Max. 600 minutes	370.46 min
3.	Fineness	Less than 10%	3.6%
4.	Compressive strength (3,7,28) days	(27,37,53) MPa	(27.6,39,55.86) MPa

Table No.2Physical Properties & test on RHA

Sr.no	Physical Properties Of Rice Husk	
1.	Specific Gravity	2.05
2.	Fineness (medium particle size)	Less than 15 %
3.	Nitrogen Absorption	20.6 m.sq/g
4.	Water Requirement	104%
5.	Pozzolonic Activity Index	99%

Table No.3 Aggregate Impact Value
Aggregate Impact Value =14%Waste Polystyrene Impact polystyrene = 0%

	Sample 1
Total weight of dry sample (W_1 gm)	400 gm
Weight of portion passing 2.36 mm sieve (W_2 gm)	56gm
Aggregate Impact Value (percent) = W_2 / W_1 X 100	14%

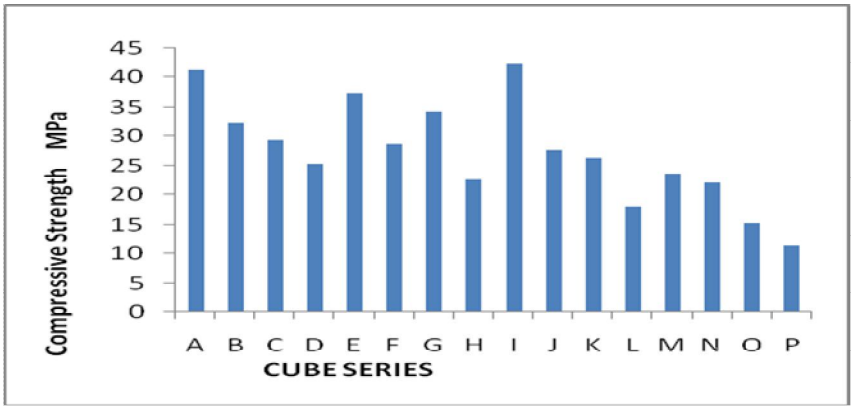
IV. M-35CONCRETE MIX DESIGN

A-1	Mix Proportions for One Cum of Concrete	
1	Mass of Cement in kg/m^3	450
2	Mass of Water in kg/m^3	186
3	Mass of Fine Aggregate in kg/m^3	630
4	Mass of Coarse Aggregate in kg/m^3	1170
	Mass of 12 mm in kg/m^3	1170
5	Water Cement Ratio	0.4

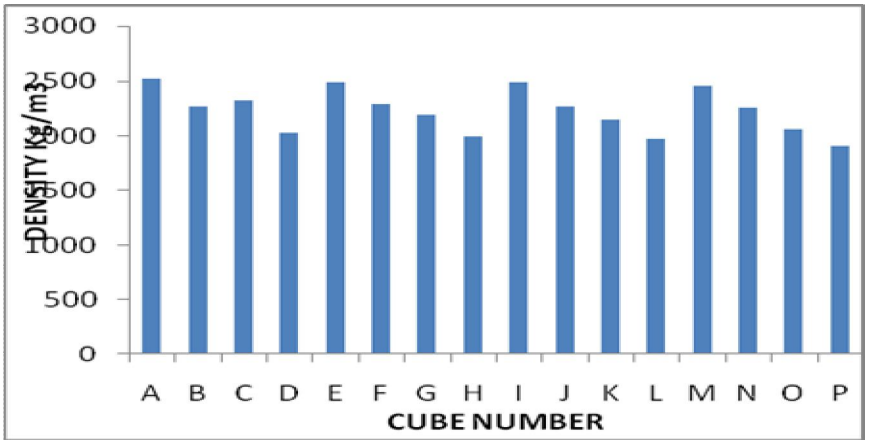
V. TESTING RESULTS

The results of experimental investigations on Portland cement was replaced with 0, 10, 20,30% (by volume) of rice husk ash .The natural fine sand /dust was not to be replaced with no any other materials. The natural coarse aggregate was partial waste polystyrene 0, 15, 30, 45% (by volume). The water to cement ratio (W/B) of 0.40 was used for all mixtures in concrete were analyzed. Results as follows-

Graph No.1compressive strength (28 days in Mpa)



Graph No.2Density of normal concrete & LWC.



VI. RESULT DISCUSSION

A. A Grade normal Concrete (0% Rice husk ash & 0% polystyrene) gives 41.33 N/mm^2 compressive strength .

B. B Grade Concrete (Cement- 100%, Ash-0%, Aggegate-85%, WPS-15%) gives 32.33 N/mm^2 compressive strength as compared normal concrete & compressive strength decrease up to 21.77 % of normal concrete.

C. C Grade Concrete (Cement- 100%, Ash-0%, Aggegate-70%, WPS-30%) gives 29.33 N/mm^2 compressive strength as compared normal concrete & compressive strength decrease up to 29.03 % of normal concrete.

D. D Grade Concrete (Cement- 100%, Ash-0%, Aggegate-70%, WPS-30%) gives 25.33 N/mm^2 compressive strength as compared normal concrete & compressive strength decrease up to 38.71 % of normal concrete.

E. E Grade Concrete (Cement- 90%, Ash-10%, Aggegate-100%, WPS-0%) gives 37.33 N/mm^2 compressive strength as compared normal concrete & compressive strength decrease up to 9.67 % of normal concrete.

F. F Grade Concrete (Cement- 90%, Ash-10%, Aggegate-85%, WPS-15%) gives 28.66 N/mm^2 compressive strength as compared normal concrete & compressive strength decrease up to 30.65 % of normal concrete.

G. G Grade Concrete (Cement- 90%, Ash-10%, Aggegate-70%, WPS-30%) gives 34.33 N/mm^2 compressive strength as compared normal concrete & compressive strength decrease up to 16.93 % of normal concrete.

H. H Grade Concrete (Cement- 90%, Ash-10%, Aggegate-55%, WPS-45%) gives 22.66 N/mm^2 compressive strength as compared normal concrete & compressive strength decrease up to 45.17 % of normal concrete.

I. J Grade Concrete (Cement- 80%, Ash-20%, Aggegate-85%, WPS-15%) gives 27.66 N/mm^2 compressive strength as compared normal concrete & compressive strength decrease up to 33.07 % of normal concrete.

J. K Grade Concrete (20% RHA & 45% WPS) give 26.33 N/mm^2 compressive strength as compared normal concrete.

K. L Grade Concrete (Cement- 80%, Ash-20%, Aggegate-55%, WPS-45%) gives 18 N/mm^2 compressive strength as compared normal concrete & compressive strength decrease up to 56.44 % of normal concrete.

L. M Grade Concrete (Cement- 70%, Ash-30%, Aggegate-100%, WPS-0%) gives 23.66 N/mm^2 compressive strength as compared normal concrete & compressive strength decrease up to 42.75 % of normal concrete.

M. N Grade Concrete (Cement- 70%, Ash-30%, Aggegate-85%, WPS-15%) gives 22 N/mm^2 compressive strength as compared normal concrete & compressive strength decrease up to 46.76 % of normal concrete.

N. Grade Concrete (Cement- 70%, Ash-30%, Aggegate-70%, WPS-30%) gives 15.33 N/mm^2 compressive strength as compared normal concrete & compressive strength decrease up to 62.90 % of normal concrete.

O. P Grade Concrete (Cement- 70%, Ash-30%, Aggegate-55%, WPS-45%) gives 11.33 N/mm^2 compressive strength as compared normal concrete & compressive strength decrease up to 72.58 % of normal concrete.

P. I Grade Concrete (20% Rice husk ash) economical as compared to normal grade concrete. This concrete reduce 10.5 % cost of concrete as well as increase compressive strength.

VII. STATIC MODULUS OF ELASTICITY OF LWC

The modulus of elasticity

$$E = \text{stress/ strain} = \frac{(Y2-Y1)}{(X2-X1)}$$

$$E = \frac{(420-310)10^3}{(2-1.7)} = 3.6x\ 10^5\ N/mm^2$$

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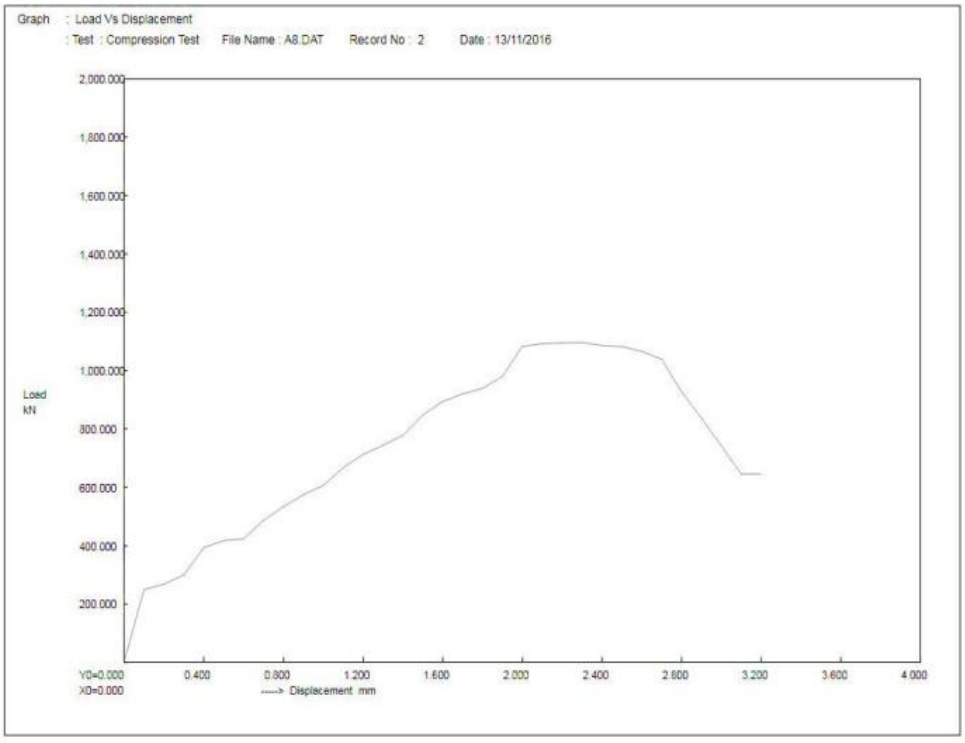


The Modulus of elasticity (A) grade concrete (Cement- 100%, Ash-0%, Aggegate-100%, WPS-0%)

The British Code of practice (BS-8110) recommends the following expression for static modulus of elasticity with cube compressive strength of concrete as:

$$Ec = 0.2x10^5 N/mm^2$$

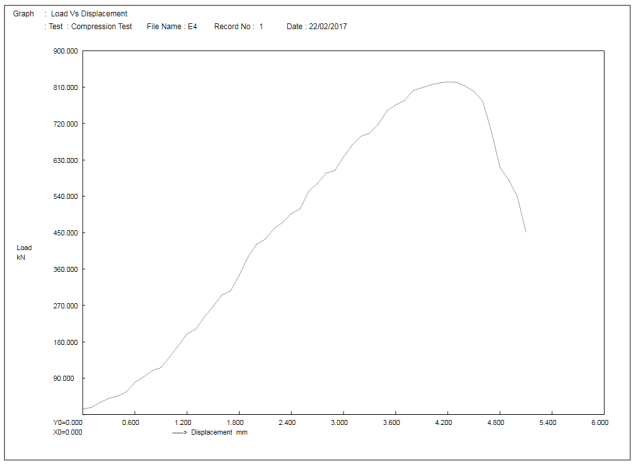
$$Ec = 20000 + 0.2fc$$

$$Ec = 20000 + 0.2x35$$

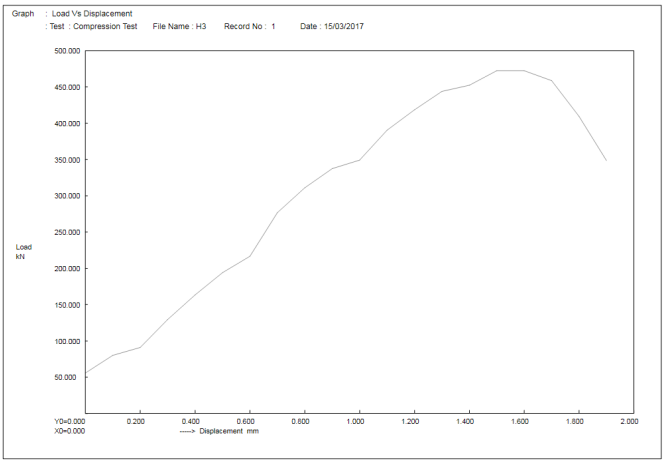
The Indian code of practice (IS: 456) recommends the empirical relation between the static modulus of elasticity and cube compressive strength of concrete as:

$$Ec = 5000\sqrt{fc}$$

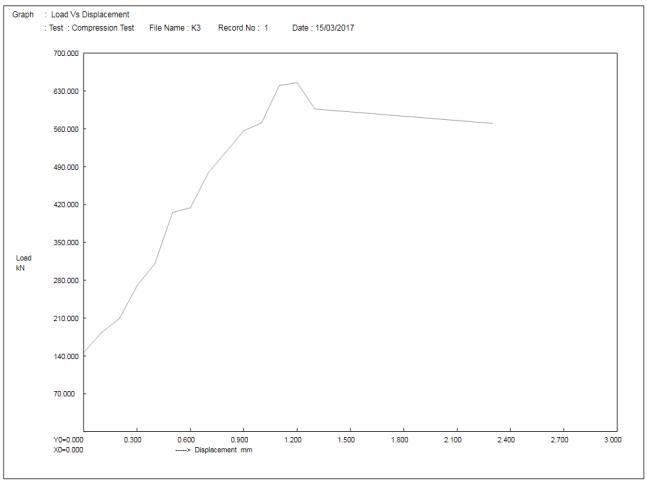
$$Ec = 5000\sqrt{35} = 0.29x10^5 N/mm^2$$



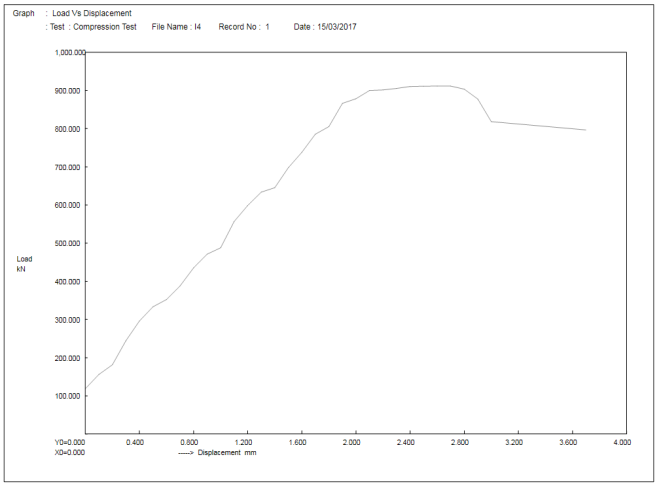
The Modulus of elasticity (E) grade concrete (Cement- 90%, RSH-10%, Aggegate-100%, WPS-0%)



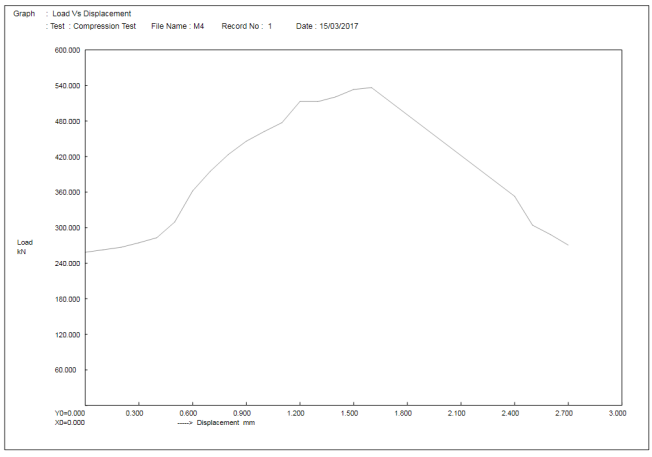
The Modulus of elasticity (H) grade concrete (Cement- 90%, Ash-10%, Aggegate-55%, WPS-45%)



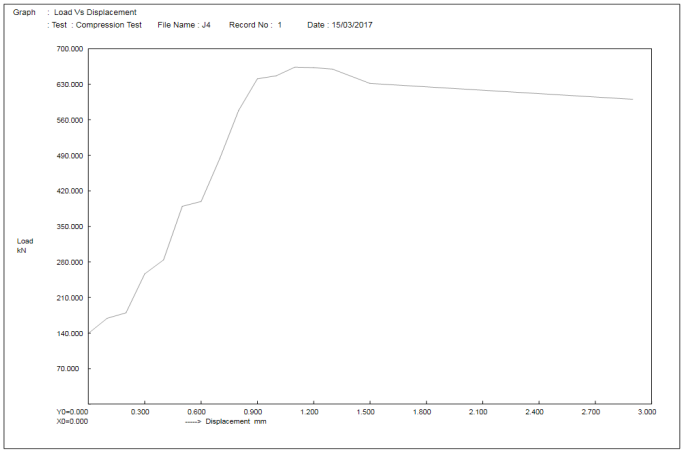
The Modulus of elasticity (K) grade concrete (Cement- 80%, Ash-20%, Aggegate-70%, WPS-30%)



The Modulus of elasticity (I) grade concrete (Cement- 80%, Ash-20%, Aggegate-100%, WPS-0%)



The Modulus of elasticity (M) grade concrete (Cement- 70%, RHA-30%, Aggegate-100%, WPS-0%)



The Modulus of elasticity (J) grade concrete (Cement- 80%, Ash-20%, Aggegate-85%, WPS-15%)

A. Static modulus of elasticity of LWC

Sr. No	Cube Name	Modulus of elasticity	As per IS-456 [5000√fc]	BS-8110 [20000+0.2xfc]
1	A	$5x10^5$ N/mm^2	$0.29x10^5$N/mm^2	$0.2x10^5$ N/mm^2
2	E	$3.6x10^5$ N/mm^2	$0.29x10^5$ N/mm^2	$0.2x10^5$ N/mm^2
3	H	$5.5x10^5$ N/mm^2	$0.29x10^5$ N/mm^2	$0.2x10^5$ N/mm^2
4	I	$7.4x10^5$ N/mm^2	$0.29x10^5$ N/mm^2	$0.2x10^5$ N/mm^2
5	J	$5x10^5$ N/mm^2	$0.29x10^5$ N/mm^2	$0.2x10^5$ N/mm^2
6	K	$7x10^5$ N/mm^2	$0.29x10^5$ N/mm^2	$0.2x10^5$ N/mm^2
7	M	$3.7x10^5$ N/mm^2	$0.29x10^5$ N/mm^2	$0.2x10^5$ N/mm^2

VIII. COST ANALYSIS

A. *Normal Concrete Per Cum*

Material for cubic meter	Quantity	Rate	Per	Amount (RS.)
OPC 53 G	465 Kg	310	50 Kg	2883
SAND	681.48 Kg	1.5	1Kg	1022.22
AGGREGATE	1244.44 Kg	0.70	1Kg	871.10
			TOTAL	4776.32 INR

B. *20% Rice husk ash Concrete per cum*

Material for cubic meter	Quantity	Rate	Per	Amount (RS.)
OPC 53 G	376.29 Kg	310	50 Kg	2333
SAND	681.48 Kg	1.5	1Kg	1022.22
AGGREGATE	1244.44 Kg	0.70	1Kg	871.10
RICE HUSK ASH	29.62 Kg	1.3	1Kg	38.50
			TOTAL	4264.82 INR

C. 20% Rice husk ash &15% polystyrene Concrete per cum

Material for cubic meter	Quantity	Rate	Per	Amount (RS.)
OPC 53 G	376.29 Kg	310	50 Kg	2333.33
SAND	681.48 Kg	1.5	1Kg	1022.22
AGGREGATE	1057.77 Kg	0.70	1Kg	740.439
RHA	29.62 Kg	1.3	1Kg	38.50
POLYSTYRENE	888.88 gm	90	1Kg	79.99
			TOTAL	4214.77 INR

D. *20% Rice husk ash & 30% polystyrene light weight Concrete per cum*

Material for cubic meter	Quantity	Rate	Per	Amount (RS.)
OPC 53 G	376 Kg	310	50 Kg	2333.33
SAND	681 Kg	1.5	1Kg	1022.22
AGGREGATE	871 Kg	0.70	1Kg	609.77
RICE HUSK ASH	29.5Kg	1.3	1Kg	38.50
POLYSTYRENE	1777gm	90	1Kg	159.99
			TOTAL	4240.04 INR

E. *10 % Rice husk ash & 45% polystyrene light weight Concrete per cum*

Material for cubic meter	Quantity	Rate	Per	Amount (RS.)
OPC 53 G	399 Kg	310	50 Kg	2479
SAND	681 Kg	1.5	1Kg	1022
AGGREGATE	684 Kg	0.70	1Kg	479
RICE HUSK ASH	14.81Kg	1.3	1Kg	19.2
POLYSTYRENE	2666 gm	90	1Kg	239.
			TOTAL	4239.56 INR

F. *10% Rice husk ash & 45% polystyrene light weight Concrete per cum*

Material for cubic meter	Quantity	Rate	Per	Amount (RS.)
OPC 53 G	465 Kg	310	50 Kg	2883
SAND	681.48Kg	1.5	1Kg	1022.22
AGG	684.44Kg	0.70	1Kg	479.10
POLYSTYRENE	2666.66gm	90	1Kg	239.99
			TOTAL	4624.31 INR

G. *30% polystyrene light weight Concrete per cum*

Material for cubic meter	Quantity	Rate	Per	Amount (RS.)
OPC 53 G	465 Kg	310	50 Kg	2883
SAND	681.48Kg	1.5	1Kg	1022.22
AGG	847.40Kg	0.70	1Kg	593.18
POLYSTYRENE	1777.77gm	90	1Kg	159.99
TOTAL				4658.39 INR

H. *10% Rice husk ash Concrete per cum*

Material for cubic meter	Quantity	Rate	Per	Amount (RS.)
OPC 53 G	400 Kg	310	50 Kg	2480
SAND	681.48 Kg	1.5	1Kg	1022.22
AGGREGATE	1244.44 Kg	0.70	1Kg	871.10
RICE HUSK ASH	14.81 Kg	1.3	1Kg	19.25
TOTAL				4392.67 INR

I. *30% Rice husk ash Concrete per cum*

Material for cubic meter	Quantity	Rate	Per	Amount (RS.)
OPC 53 G	331.85Kg	310	50 Kg	2057.47
SAND	681.48 Kg	1.5	1Kg	1022.22
AGGREGATE	1244.44 Kg	0.70	1Kg	871.10
RICE HUSK ASH	44.44 Kg	1.3	1Kg	57.77
TOTAL				4008.56 INR

IX. CONCLUSION

A. As the percentage of waste polystyrene increases, the compressive strength of concrete continuously decreases.

B. Replacement of rice husk ash and waste polystyrene in light weight concrete the compressive strength of concrete decreases as compared to normal grade concrete.

C. K Grade Concrete (20% Rice husk ash & 45% polystyrene) give 26.33 N/mm^2 compressive strength as compared normal concrete. So this type of concrete grade can be used in construction of partition walls, compound walls, plinth PCC.

D. From the cases it is concluded that the compressive strength of I Grade Concrete (20% Rice husk ash) increase continuously. I Grade Concrete (20% Rice husk ash) it is used in construction of structural member (i.e. Column, beams, footing, slab panels etc.)

E. I Grade Concrete (20% Rice husk ash) economical as compared to normal grade concrete. This concrete reduces 10.5 % cost of concrete as well as increase compressive strength.

F. Static modulus of elasticity of light weight concrete is more than, is of normal concrete compared by (IS-456 and BS-8110) equation.

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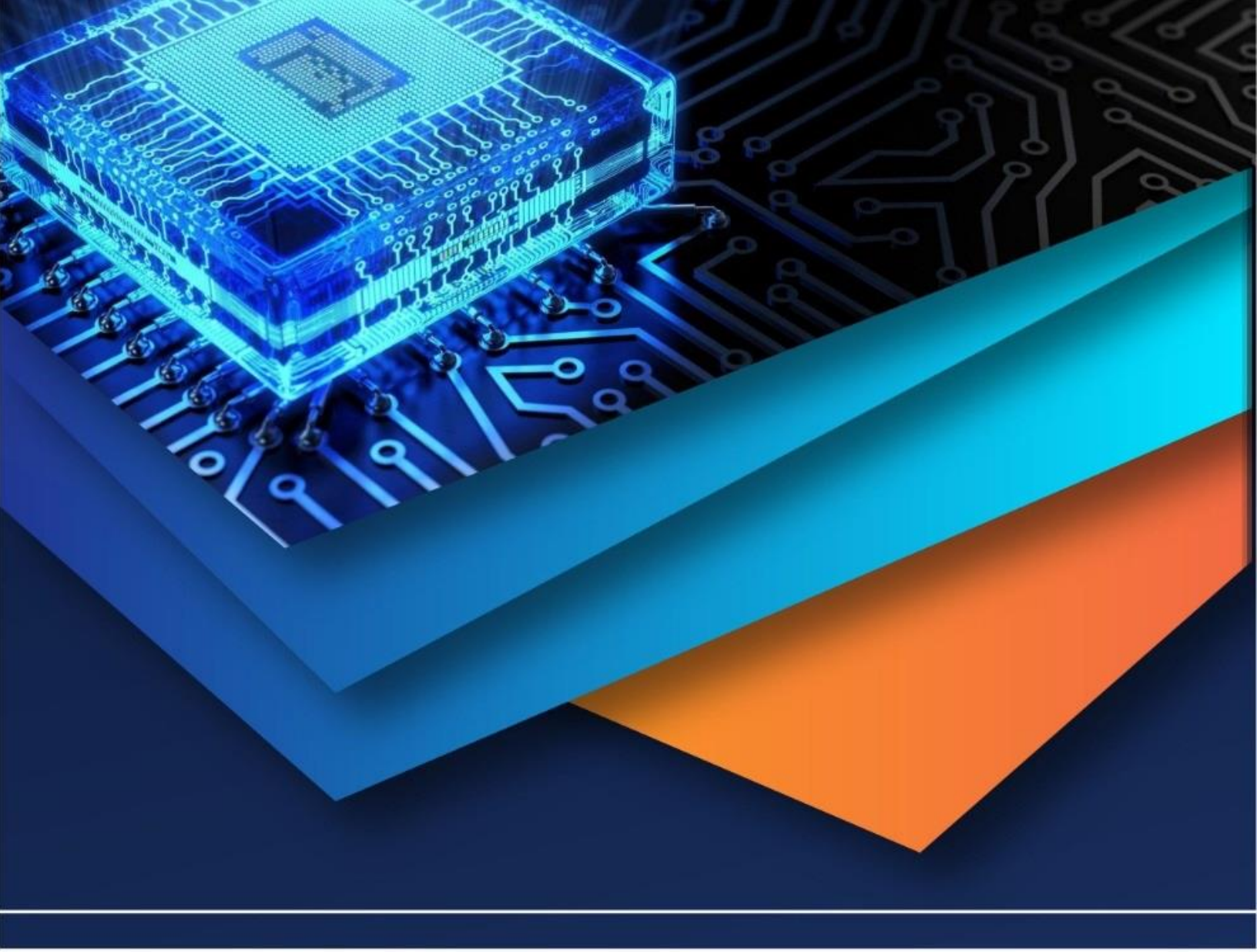

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