Use of Eco-Friendly additive like Fly ash to check the physical properties of rigid pavement

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Abstract **- In the field of pavement construction, two types of pavements are generally constructed; rigid pavement & flexible pavement. The growth of flexible pavement as compared to rigid pavement is higher due to its low initial cost. On the other side rigid pavement has lower life cycle cost compared to flexible pavement due to its low maintenance cost & long life. The life of rigid pavement is about 30-40 years which is approximately 2.5 times the life of flexible pavement. Our aim is to reduce the initial cost or construction cost of rigid pavement. This can be done by replacing ingredients of rigid pavement such as replacement of cement by industrial waste like fly ash in the base layer. Fly ash is generated in huge quantities everyday as industrial waste. It has pozzolanic properties so it can be used as a replacement of cement. Use of fly ash in rigid pavement will be beneficial to transportation system, ecosystem, urban growth & rural development. In the present study different amount of fly ash 10,20 & 30% as a replacement of cement by weight in concrete is tested for various physical parameters of rigid pavement, like: compressive strength & flexural strength, skid resistance & cost reduction.**

IndexTerms **- Rigid pavement, reduce initial cost, fly ash.**

I. INTRODUCTION

A pavement is a structure consisting of superimposed layers of processed materials above the natural soil sub-grade, whose primary function is to distribute the applied vehicle loads to the sub-grade. The pavement structure should be able to provide a surface of acceptable riding quality, adequate skid resistance, favourable light reacting characteristics, and low noise pollution.Paving materials include asphalt, concrete, stone, bricks, tiles, and sometimes wood.

II. PROBLEM IN RIGID PAVEMENT

The development of transportation plays a significant role in the economic development of the country. In the transportation system especially roads or pavements are one of the most important parts. In the construction of road networks growth of flexible pavements is more in comparison with rigid pavement. Despite its characteristics like low maintenance cost and long life, rigid pavements are not constructed widely due to its high initial cost.

At present, addition of fly ash as a replacement is one of the common methods applied for controlling the construction cost. It is widely believed that the addition of fly ash will maintain strength and decrease the initial cost of the rigid pavement.

III. MATERIALS

1) Cement - Ordinary Portland Cement of 53 grade confirming to IS12269-1987(9) is used in the present study. The properties of cement are shown in Table 1&2.

Table 1 Physical properties of OPC 53 grade cement

Types of cement	Setting time		Compressive strength (N/mm^2 28
	IST	FST	
OPC – 53 grade (IS 12269 -	30	600	53

Table 2 Chemical properties of OPC 53 grade cement

Magnesium Oxide (MgO)	6 % Max
Chloride (Cl^-)	0.10 % Max
Alumina Iron ratio(A/F)	0.66 % Max
Sulphuric Anyhydride (SO3)	2.5 % Max

2) Fine aggregate (sand) - Natural sand as per IS: 383-1987 is used. Locally available river sand with bulk density1860 kg/m^3, specific gravity 2.72 & fineness modulus 2.28 is used.
3) Coarse Aggregate - Crushed aggregate confirming to IS: 383-1987 is used. Aggregates of size 20mm, 16mm and 12.5 mm of specific gravity 2.74 and fineness modulus 7.20 are used.

4) Fly ash - The fly ash used in this study is the unprocessed F-Class fly ash obtained from the local industry. The whole amount of fly ash is obtained from one batch.

Table 3 Chemical composition of fly ash

Chemical Composition	% weight Fly ash
SiO_2	53.79
Al_2O_3	32.97
Fe_2O_3	5.51
CaO	1.84
MgO	0.92
NaO	0.37
K_2O	1.76
TiO_2	2.10
SO_2	0.46
P_2O_5	0.15

IV. MIX PROPORTIONS

Table 4 Mix Proportions

Type of concrete	% reduction in cement	Materials				W/C Ratio
		Cement kg/m^3	Fine aggregate kg/m^3	Coarse aggregate kg/m^3	Fly ash kg/m^3	
A1-M25	0	436	563	1149	0	0.44
B1-M25	10	392.4	563	1149	43.6	0.44
B2-M25	20	348.8	563	1149	87.2	0.44
B3-M25	30	305.2	563	1149	130.8	0.44

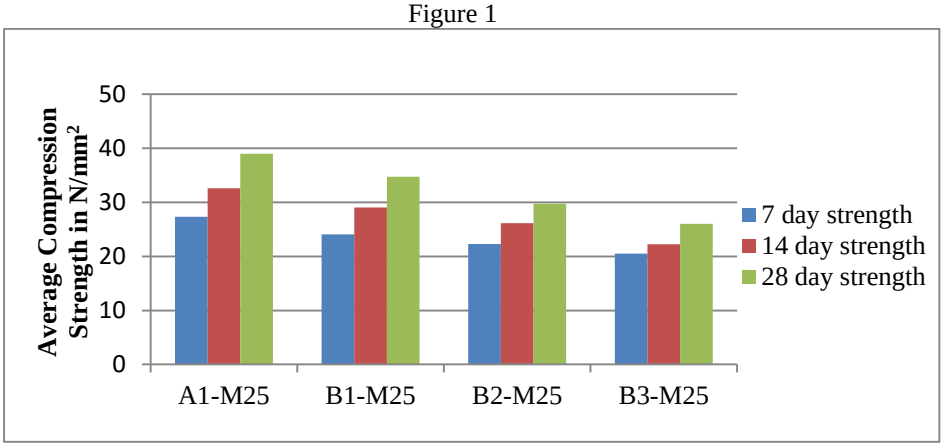
V. COMPRESSIVE STRENGTH TEST

Compressive strength test is carried out for concrete to check the strength of concrete in rigid pavement's base layer. Test results obtained on cubes of size 150x150x150 mm after 7,14 & 28 days of curing are as follow.

Table 5 Compression strength results

Type	% replacement	Compression strength N/mm^2		
		7 day	14 day	28 day
A1-M25	0%	27.31	32.57	38.97
B1-M25	10%	24.07	29.04	34.69
B2-M25	20%	22.29	26.16	29.73
B3-M25	30%	20.5	22.25	26.02

Figure 1

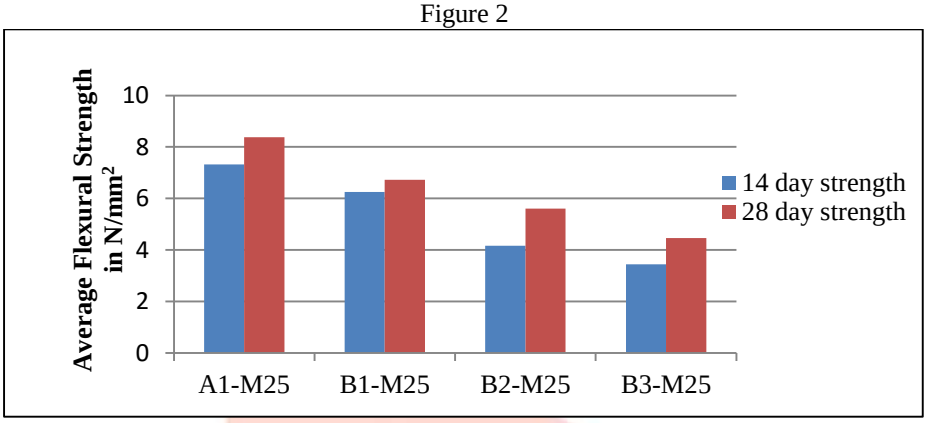


VI. FLEXURAL STRENGTH TEST

Table 6 Flexural strength results

Type	% replacement	Flexural Strength N/mm^2	
		14 day	28 day
A1-M25	0%	7.32	8.38
B1-M25	10%	6.25	6.72
B2-M25	20%	4.17	5.61
B3-M25	30%	3.45	4.46

Figure 2



VII. SKID RESISTANCE TEST

Concrete Beam of size 500x100x100 mm after 28days curing was tested on British pendulum tester for skid resistance value. For 10% replacement, skid resistance value is found to be 65.

VIII. ECONOMIC ANALYSIS

Table 7 Present market rates

Sr. No.	Materials	Rate (Rs/kg)
1	Cement	5.60
2	Fine aggregate	0.60
3	Coarse aggregate	0.65
4	Fly ash	0.60

Table 8 Total cost analysis per m^3

Type of concrete	Materials				Total cost in Rs/m^3	% reduction in cost
	Cement kg/m^3	Fine aggregate kg/m^3	Coarse aggregate kg/m^3	Fly ash kg/m^3		
A1-M25	436	563	1149	0	3526.25	0
B1-M25	392.4	563	1149	43.6	3308.25	6.18
B2-M25	348.8	563	1149	87.2	3090.25	12.36
B3-M25	305.2	563	1149	130.8	2872.25	18.55

IX. CONCLUSIONS

As we use fly ash with replacement proportions 10,20 & 30% we get favourable results of physical properties of rigid pavement and are in acceptable limit. Fly ash can be used effectively as cementitious material for development of rural roads of low cost. Due to low cost of fly ash initial cost of rigid pavement is reduced. Cost reduction is found to be 6.18% for 10% replacement. Effective utilization of fly ash can save the thermal power industry's disposal costs and also reduces pollution.

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