EFFECT OF FLY ASH AND MARBLE POWDER ON STRENGTH OF PAVEMENT QUALITY CONCRETE

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***Abstract**: In this era with growing industries, Uncontrolled disposal of industrial waste can lead to environmental pollutions and irreparable damages. Managing industrial waste is one of the ways to protect our environment from harmful pollutants. As such, manufacturers and companies should be held responsible for the waste they generate., we need to think about our environment and to overcome this issue Concrete pavement construction is growing throughout the country due to its strength, durability, excellent performance, and overall long-term savings. There is a need to develop better road sections that can withstand heavy loads. This can be achieved using high compressive strength concrete made from OPC cement with fine to coarse aggregate. In the construction, we will use industrial waste to carry out the construction. Fly ash is a by-product of burning coal in a thermal power plant, and marble powder is a by-product of the Marble industry. Fly ash and marble powder are used as additional cementitious materials to improve the properties of cement concrete. This study aims to develop paving concrete by partially replacing the cement with fly ash and marble powder 10% and 20%. The purpose of the study is to compare the resistance properties of concrete pavements achieved by the concrete mix. Fly ash is a waste product that is produced due to the burning of coal in power generating plants. And concrete consists of cement, sand, fine, and coarse aggregate. With the rise in industrial pollution global warming has been increasing at a steady pace. Smoke and greenhouse gases are being released by industries into the air, which causes an increase in global warming to make eco-friendly concrete, cement can be interchangeable with a certain amount of fly ash and marble powder this can improve the strength of pavement concrete. The fly ash has taken in this research is from HEG Limited. Mandideep, Near Bhopal, and exist in of Class F category This experiment pertaining to the replacement of OPC (Ordinary Portland Cement, 43 grades, IS 8112)[1] along with fly ash and marble powder is done and to get the desired compressive and flexural strength. Of grades M30, M40 Polymer-based superplasticizer is used. The compressive and flexural strength of PQC (Pavement Quality Concrete) with different percentages of fly ash has and marble powder studied for 7 and 28 days It is observed that the mixes with fly ash replacement showed higher flexural strengths for all water to cement ratios.*

Keywords; PQC, HEG fly ash, superplasticizer, compressive strength and flexural strength.

I. INTRODUCTION –

Concrete roads are classified as high quality / superior type roads made of cement concrete. These roads may or may not require sub-base or basic courses and can be built directly on a well-compacted soil sub grade. Its strength comes from its flexural strength, and is capable of supporting the load on the driving wheels and overcoming the weaknesses of the layers below. However, providing sub-base/base course below the cement concrete pavement will improve its performance significantly; therefore, a well-designed and well-constructed cement concrete pavement will be a rigid pavement capable of providing hassle-free and high-quality riding surface for high-volumes and heavy traffic loads for as long as 30 to 50 years. Portland cement concrete is well understood in its engineering behavior and hence, a concrete pavement can be rationally designed. Pavement Quality Concrete (PQC) is cementing concrete made with coarse aggregates according to IRC specifications and placed on a dry concrete base. This construction is specially used for highway and airport runway pavements as it can withstand heavy loads.

II. MATERIALS-

The properties of the material used to make the concrete mix are determined in the laboratory following the corresponding application as per the relevant code. The different materials used in the present study were cement, coarse aggregate, fine aggregate, fly ash, and Marble powder. The details of the different materials used in this study are given below

Cement- In general, the use of high-quality cement offers several advantages for the production of reinforced concrete. Although cheaper than low-quality cement, they save 10-20% on cement consumption, in addition to offering many hidden benefits. One of the most important benefits is the rapid development of strength. During the investigation, ordinary Portland cement (OPC) type 43 from the same batch was used. It was fresh and without any lumps. The physical properties of cement were determined by various tests as per Indian standards. IS: 8112:1989[1]

Coarse Aggregates- Aggregates constitute the main part of a concrete mix and ensure the dimensional stability of the concrete. To increase the density of the resulting mixture, aggregates of two or more sizes are often used. The most important function of fine aggregate is to help in producing workability and uniformity in the mixture. The aggregates provide about 75% of the concrete body and therefore their effect is extremely large. Therefore, certain requirements must be met for concrete to be viable, strong, durable, and economical. The aggregates must be proper shape, clean, hard, strong, and well graded[2], [3]

Fine Aggregates- The aggregates most of which pass through 4.75 mm IS sieve are considered fine aggregates. Depending upon the particle size distribution has divided the fine aggregate into four grading zones (Grade I to IV). The grading zones become progressively finer from grading zone I to IV. As per IS: 383-1970[4]

Fly Ash HEG Limited. Mandideep, Near Bhopal. Madhya Pradesh Fly ash is used for this study o produce concrete mix and it is of class F. Fly ashes are particularly rich in SiO_2, Al_2O_3, and Fe_2O_3, and also contain other oxides such as CaO, MgO, MnO, TiO_2, Na_2O, K_2O, SO_3, etc. Fly Ash with a high content of CaO (15 to 40%) may be regarded as potentially hydraulic and capable of causing unsoundness in mortars and concrete[5]

Marble Powder- Marble powder was obtained by crushing marble mud, waste from the marble industry, which was collected in marble cutting factories. MP characterization was carried out using international experimental tests.[6]

Chemical Admixture- Polymer-based Superplasticizer is used. superplasticizer A is approved for use by the Texas SDHPT and meets and exceeds all requirements for ASTM C494-86, Standard Specification for Chemical Admixtures for Concrete, Types A and F admixtures. It is a naphthalene sulfonate-based admixture having a specific gravity in the range of 1.18 to 1.23 at 77°F as reported by the manufacturer. The manufacturer's recommended dosage rate is 10 to 20 fluid ounces per hundred pounds of cement. The dosage of superplasticizer recommended is 0.6% to 1% by weight of cementitious material.

Water- It is one of the important components of concrete. Helps to evenly distribute cement and the concrete helps to lubricate the paste. The W / C ratio is an important parameter that controls the amount. The addition of water to the concrete mix is required. Changes in water content affect quality. As the number of water increases, durability, consistency, and resistance decrease. As performance improves. Portable water is used for concrete. Table 1 shows physical property and Table 2 *shows chemical property* of Cement, Fly Ash and Marble powder. Table 3 shows property of coarse aggregate and fine aggregate

Material	Specific gravity	Consistency	initial Setting Time	Final Setting Time
Cement	3.15	27%	29 min	260 min
Fly Ash	2.21	24%	35	282
Marble Powder	2.6	23%	50	301

Silica (SiO_2)	**OPC**	**FLY ASH**	**MP**
Alumina (Al_2O_3)	52.8	66.02	21.25
Ferric Oxide (Fe_2O_3)	4.33	3.65	4.36
Calcium=Oxide (CaO)	13.2	6.35	2.23
Magnesia (MgO)	6.2	39.20	3.09
Loss on Ignition (LOI)	1.81	12.98	1.65
Silica (SiO_2)			

Material	Specific Gravity	Fineness Modulus	Water Absorption (%)
Coarse Aggregates	2.74	7.66	0.55
Fine Aggregates	2.68	3.76	1.5

II TESTS ON MATERIALS –[2], [3], [7]

Tests on Coarse Aggregate	Obtained Value	Standard Value
Crushing Value	**13.5%**	**Not more than 30%**
Impact Value	**13.9%**	**Not more than 30%**
Abrasion Value	**21.3%**	**Not more than 30%**
Flakiness Index	**6.9%**	**Not more than 15%**
Elongation Index	**17.2%**	**Not more than 15%**

Sr No	**1**	**2**	**3**
Material	**Cement**	**Cement with Fly ash**	**Cement with Marble Powder**
Consistency	27%	24%	23%
Initial setting time(min)	29	35	50
water	93.5	81.6	78.2

III MIX PROPORTION – TABLE 4 TABLE 5 SHOWS THE MIX PROPORTION FOR M30 AND M40[8], [9]

III METHODOLOGY

The mix design was done as per IRC:44 2008[8], [10]

M30	cement	water	Fly Ash	Marble Powder	Coarse aggregate	fine aggregate
OPC	410	186	0	0	1170	675
10% Fly ash +90% cement	408	186	45	0	1148	648
20% Fly ash +80% cement	362	186	90	0	1137	632
10% Marble Powder +90% cement	408	186	0	45	1153	640
20% Marble Powder +90% cement	356	186	0	90	1144	647

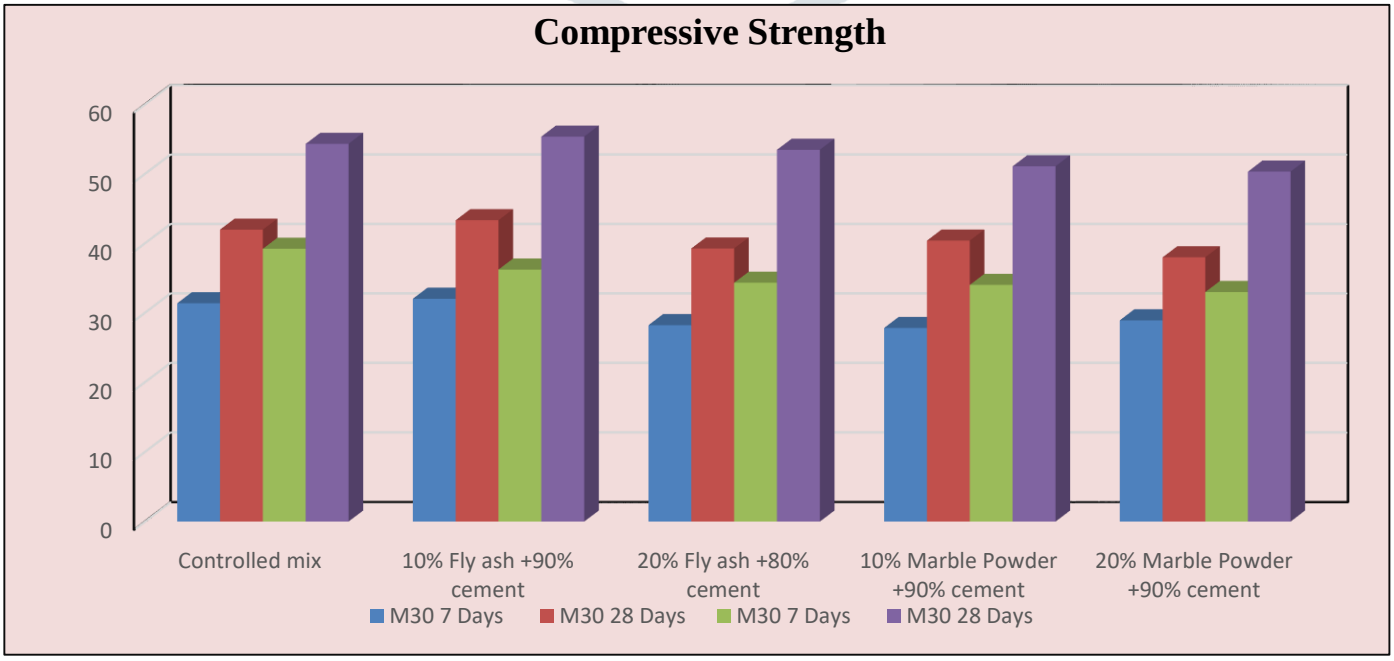
M40	cement	water	Fly Ash	Marble Powder	Coarse aggregate	fine aggregate
OPC	416	158	0	0	1210	643
10% Fly ash +90% cement	423	158	47	0	1208	631
20% Fly ash +80% cement	376	158	94	0	1227	629
10% Marble Powder +90% cement	423	158	0	47	1263	637
20% Marble Powder +90% cement	376	158	0	94	1208	627

IV RESULT AND DISCUSSIONS –

Compressive Strength- A test sample of size 150mm x 150mm x 150mm was prepared and tested for compressive strength. In this study, mixing was done manually. The cement and fine aggregate were first dried to a uniform color, then the coarse aggregate was added and mixed with the cement and fine mixture then the water will be added in the mix. The sample was then removed from the mold and stored in clean, freshwater for 28 days of curing. In the compression test, no cushioning material was placed between the specimen and the plates of the machine. The load was applied axially gradually till the specimen was crushed. Test results of the compressive strength test at the age of 28 days are given in Table 6 and Figure 1[11], [12]

For M30 Targeted strength 38.25 and for M50 48.25 Asper IRC:44 2008 [8]

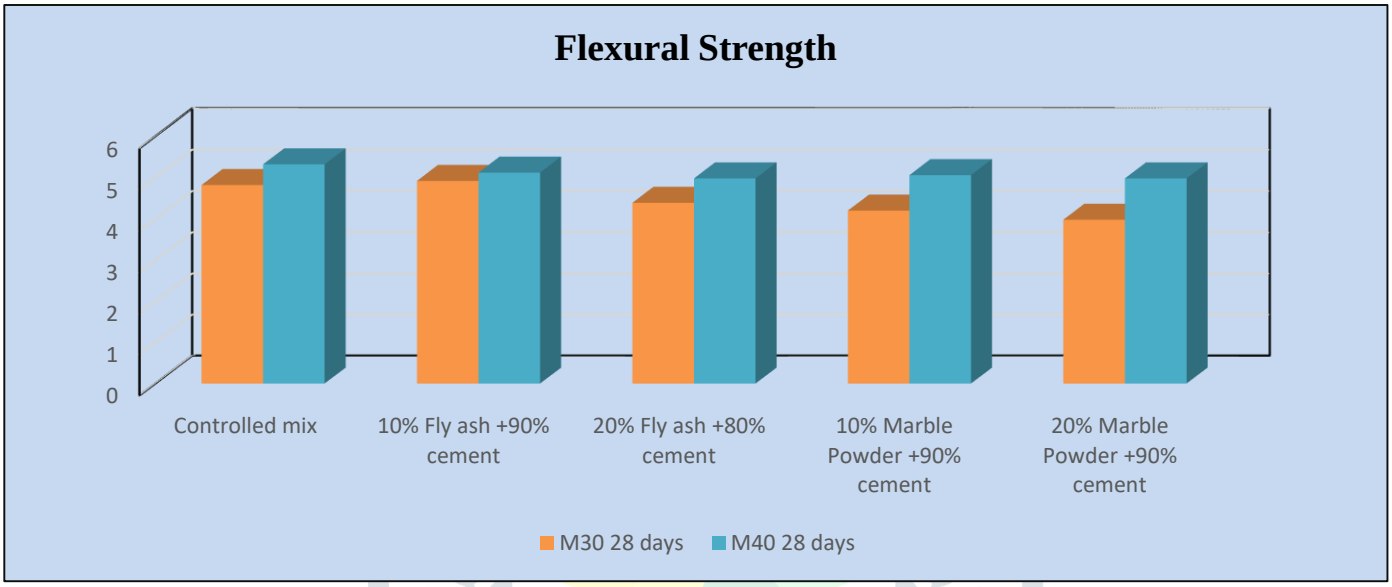
Compressive Strength	M30		M30	
	7 Days	28 Days	7 Days	28 Days
Controlled mix	31.36	41.96	39.21	54.32
10% Fly ash +90% cement	32.01	43.32	36.21	55.36
20% Fly ash +80% cement	28.21	39.25	34.32	53.46
10% Marble Powder +90% cement	27.8	40.38	34.01	51.09
20% Marble Powder +90% cement	28.9	37.98	32.98	50.32



Flexural Strength- A test sample of size 150mm x 150mm x 700mm was prepared and tested for compressive strength. In this study, mixing was done manually. The cement and fine aggregate were first dried to a uniform color, then the coarse aggregate was added and mixed with the cement and fine mixture then the water will be added in the mix. The sample was then removed from the mold and stored in clean, freshwater for 28 days of curing. In the compression test, no cushioning material was placed between the specimen and the plates of the machine the load was applied axially gradually till the specimen was crushed. Test results of the compressive strength test at the age of 28 days are given in Table 7 and Figure 2 [13], [14]

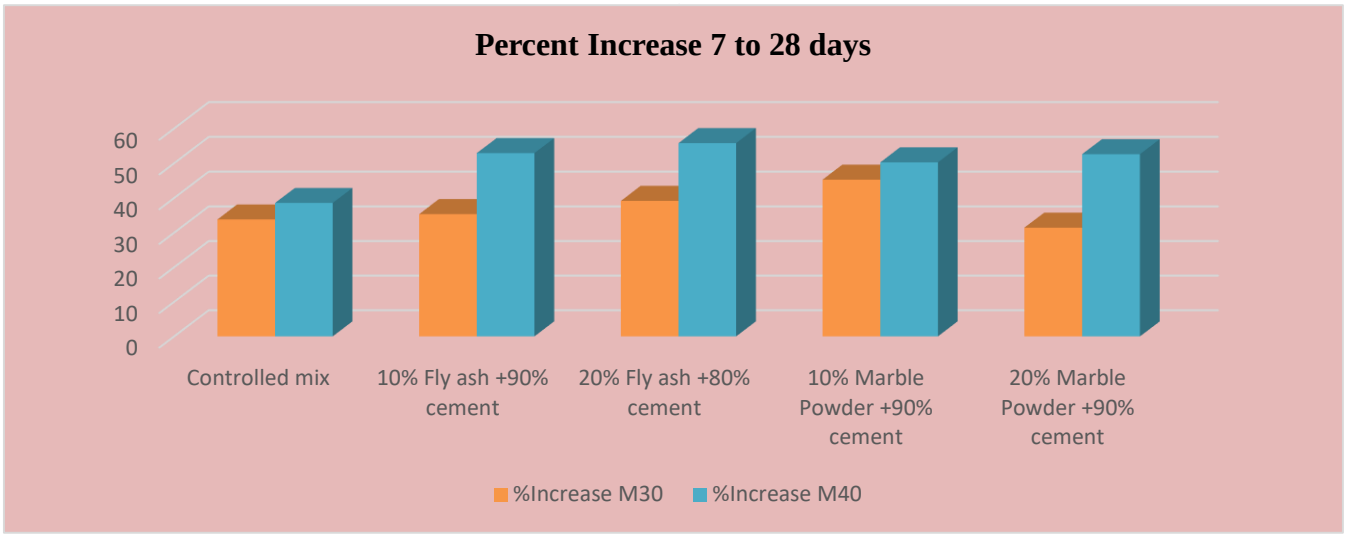
For M30 Targeted strength 4.32 and for M50 4.86 Asper IRC:44 2008[8]

Flexural Strength	M30	M40
	28 days	28 days
Controlled mix	4.82	5.32
10% Fly ash +90% cement	4.92	5.12
20% Fly ash +80% cement	4.39	4.98
10% Marble Powder +90% cement	4.20	5.06
20% Marble Powder +90% cement	3.98	4.98



Age of concrete 7 to 28 Days Table 8 Figure 3

Compressive Strength	M30		%Increase	M40		%Increase
	7 Days	28 Days		7 Days	28 Days	
Controlled mix	31.36	41.96	33.80%	39.21	54.32	38.54%
10% Fly ash +90% cement	32.01	43.32	35.33%	36.21	55.36	52.89%
20% Fly ash +80% cement	28.21	39.25	39.14%	34.32	53.46	55.77%
10% Marble Powder +90% cement	27.8	40.38	45.25%	34.01	51.09	50.22%
20% Marble Powder +90% cement	28.9	37.98	31.42%	32.98	50.32	52.58%



V DISCUSSIONS

Table 9 *and Figure 4* show the variation in compressive strength of pavement Quality concrete (PQC) with 10%, 20% of fly ash and marble powder exchange for 7-28 days. *Table 10 Figure 5* show the percentage increase in compressive strength values for all grades of concrete M30, M40, with aging (7 to 28 days), respectively. After analyzing the data, it can be seen that all the mixtures was able to achieve the target strength mix with 10% Fly ash and 10% marble powder could achieve more than controlled strength in case of M30 10% replace with marble powder and in case of M40 20% Fly Ash have higher rate of increase in strength it shows

Table 11 and Figure 6 shows the results of flexural strength at 28 days after analyzing the data it could be seen that in both grades M30 and M40 with replacement of 10% and 20% of fly ash and marble powder achieved the targeted strength with higher percentages. And only 10% Fly ash and 10 % marble powder could achieve the controlled strength

VI CONCLUSIONS-

This study was conducted to investigate the effect of partial replacement of cement by fly ash and marble dust ash on the compressive and flexural strength of concrete mixes. At two different substitution levels, cement was partially replaced by fly ash (10%, 20%,), marble powder, When. The test was performed 28 days after the concrete set. Cubes and beams were cast for determining compressive strength and flexural strength of concrete with different grades of concrete M30, and M40 respectively. Superplasticizer was used in the mixes at 0.6% to 0.8% level by weight of cementitious material The present study determined that fly ash can replace only achieve good strength replace with some amount and the lesser strength from 7 days to 28 days marble powder can achieve 80 percent of strength from 7 to 28 days when we talk about pavement quality concrete it depends on the flexural strength because of wheel load on the road and the next thing is The Beam word cast for the different grade of concrete which is M30 and M40 and of concrete Marble powder and fly ash replace with 10% and 20% could achieve the flexural strength in this study marble powder and fly ash could achieve the desired flexural strength in future we can reduce the water-cement ratio is future we can try to achieve the flexural strength.

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