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An Alternative Approach to use Marble Powder & Fly Ash as Partial Replacement of Natural Fine Aggregate in Concrete

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ABSTRACT

Due to excess cost of transportation from natural sources natural sand is expensive& large scale depletion of these sources creates environmental problems. A substitute or replacement product for concrete industry needs to be found because environment, transportation and other constraints make the availability and use of natural sand less feasible in mix design. Natural sand used as fine aggregates in production of concrete poses the problem of acute shortage in all parts of country. In this study, the possibility of using fly ash & marble powder in concrete production was examined by studying the effects of blending of fly ash &marble powder with natural sand on the performance of fresh and hardened concrete. This study represents the results of experimental investigation carried out to determine compressive strength and flexural strength of concrete mixes i.e. M25 & M30 in which natural sand was partially replaced with varying percentage of fly ash & marble powder in equal amount ranging from 2.5% to 15% of natural sand by weight. A total of eighteen trial mixes along with universal & compatibility mix were prepared for both grades of concrete. The tests for compressive strength and flexural strength were conducted for each mix at 7 & 28 days and 28 days respectively. Test results indicated significant increment in the strength of concrete with addition of fly ash & marble powder up to a certain percentage replacement of natural sand. However after further increasing the percentage of marble powder & fly ash, a drop in strength of concrete was noted.The concrete technology become advanced which wants to reduce the consumption of natural sources & to improve the quality of environment by using the waste generated from thermal plants & industries.

***Keywords*:** marble powder, fly ash, compressive strength and flexural strength, fine sand, concrete

INTRODUCTION

Concrete is a material synonymous with strength and longevity. It has emerged as the dominant construction material for the infrastructure needs of the twenty-first century. In addition to being durable, concrete is easily prepared and fabricated from readily available constituents and is therefore widely used in all types of structural systems. The challenge for the civil engineering community in the near future is to realize projects in harmony with the concept of sustainable development and this involves the use of high performance material sand products manufactured at reasonable cost with the lowest possible environmental impact.

Nowadays, some industrial wastes are also used as blending material to produce economic & efficient concrete. Most common blending materials used in concrete production are marble powder, silica fume, fly ash, pumice powder and ground granulated blast furnace slag. This is due to the fact that recycling of industrial wastes as blending materials has technical, economical and environmental benefits. On Indian scenario it is observed that at very few places good quality of sand may be available in plenty. All metro and mega cities in India are facing acute shortages of good quality of sand. At some places sand available is coarser than Zone I sand and hence not suitable for construction work. In contrast to the sand, bottom ash is available in huge quantity due to more and more thermal power plants in India.

The technical importance of using wastes and by-products in concrete production is expressed by performance improvement of concrete. The economical benefit usually attributes to the reduction of the amount of expensive and or scarce ingredients with cheap materials. Environmentally, when industrial wastes are recycled not only the CO2 emissions are reduced but residual products from other industries are reused and therefore less material is dumped as landfill and more natural resources are saved.

In addition to pozzolanas, other inert by-products and waste materials have been used in concrete and mortar production as inert filler for similar reasons. Among these, Fly Ash, by-product of coal based thermal power plant &marble waste powder which is a by-product of marble processing factory was studied by many researchers for their use in concrete and mortar production as sand replacing or cement replacing materials. Most of the researches showed positive results and benefits. This study explores the possibility of replacing part of fine aggregate with fly ash & marble powder as a means of incorporating significant amounts. In this literature review, formation and properties of both fly ash and marble powder are presented.

OBJECTIVES & METHODOLOGY

A. Objectives of the Work:

- To study the about concrete materials, Marble Powder & Fly Ash & its properties.

- To construct the concrete cubes by replacing the fine sand with Marble Powder & Fly Ash.
- To perform the test of various specimen of concrete.
- To find different result parameters.
- To find optimum mix percentage of partial replacement of Marble Powder & Fly Ash for fine sand in Concrete**.**

B. Mix replacement methodology:

Various models are framed for analysis and assessment of structure to accomplish the foresaid objectives of the current study.

Natural Banas sand along with fly ash & marble powder were mixed. Each eight sets of replacement for each M-25 and M-30 grade as per IS-383/2386 are taken.

[1]. A mixture of 97.5% Natural Banas Sand + 1.25% fly ash+1.25% marble powder.
[2]. A mixture of 95% Natural Banas Sand + 2.5% fly ash+2.5% marble powder.
[3]. A mixture of 92.5% Natural Banas Sand + 3.75% fly ash+3.75% marble powder.
[4]. A mixture of 90% Natural Banas Sand + 5% fly ash+5% marble powder.
[5]. A mixture of 87.5% Natural Banas Sand + 6.25% fly ash+6.25% marble powder.
[6]. A mixture of 85% Natural Banas Sand + 7.5% fly ash+7.5% marble powder.
[7]. A mixture of 90% Natural Banas Sand + 10% fly ash

Fig 1 : A) Sand **Fig B) Marble Powder** **c)** Fly Ash



Mixing Proportions

Table 1 : Fine Aggregate Blend Mix Proportion (M-25 Grade of Concrete)

Mix Name	**Cement (kg)**	**Coarse Aggregate**		**NS (Natural Sand)**	**FA (Fly Ash) (kg)**	**MP (Marble Powder)**	**Water (kg)**
		20mm (kg)	**10mm (kg)**				
NS+FA+MP (97.5+1.25+1.25)	350	683.15	448.59	726.75	9.32	9.32	185.42
NS+FA+MP (95+2.5+2.5)	350	683.15	448.59	708.11	18.64	18.64	185.42
NS+FA+MP (92.5+3.75+3.75)	350	683.15	448.59	689.48	27.95	27.95	185.42
NS+FA+MP (90+5+5)	350	683.15	448.59	670.84	37.27	37.27	185.42
NS+FA+MP (87.5+6.25+6.25)	350	683.15	448.59	652.21	46.59	46.59	185.42
NS+FA+MP (85+7.5+7.5)	350	683.15	448.59	633.57	55.91	55.91	185.42

NS+FA+MP (90+10+0)	350	683.15	448.59	670.84	74.54	0	185.42
NS+FA+MP (90+0+10)	350	683.15	448.59	670.84	0	74.54	185.42

Table 2 : Fine Aggregate Blend Mix Proportion (M-30 Grade of Concrete)

Mix Name	**Cement (kg)**	**Coarse Aggregate**		**NS (Natural Sand) (kg)**	**FA (Fly Ash) (kg)**	**MP (Marble Powder) (kg)**	**Water (kg)**
		20mm (kg)	**10mm (kg)**				
NS+FA+MP (97.5+1.25+1.25)	360	685.79	450.32	729.55	9.36	9.36	179.5
NS+FA+MP (95+2.5+2.5)	360	685.79	450.32	710.85	18.71	18.71	179.5
NS+FA+MP (92.5+3.75+3.75)	360	685.79	450.32	692.26	28.06	28.06	179.5
NS+FA+MP (90+5+5)	360	685.79	450.32	673.54	37.42	37.42	179.5
NS+FA+MP (87.5+6.25+6.25)	360	685.79	450.32	654.83	46.78	46.78	179.5
NS+FA+MP (85+7.5+7.5)	360	685.79	450.32	737.12	56.13	56.13	179.5
NS+FA+MP (90+10+0)	360	685.79	450.32	673.54	74.84	0	179.5
NS+FA+MP (90+0+10)	360	685.79	450.32	673.54	0	74.84	179.5

RESULTS AND DISCUSSIONS

A) Result of Fresh Concrete: **Workability (Slump Test Results):** The Slump for the mixes tested are tabulated below in table. The control mix is designed for the slump 100mm±10mm. The slump of blended mixes is increased up to 10% replacement of Natural Sand by Fly Ash & Marble Power and after that it will decrease. The slump was highly dependent on the amount of admixture added in the mix. The slump of M-25 control mix is 110mm & that of M-30 mix is 105mm

Table 3: Natural Sand Blend study Slump Results of M25 & M 30 Concrete

S. No	Mix (OPC+FA+MP)	**Slump (mm)** M25Concrete	**Slump (mm)**M30 Concrete
1.	NS+FA+MP (97.5+1.25+1.25)	120	115
2.	NS+FA+MP (95+2.5+2.5)	125	120
3.	NS+FA+MP (92.5+3.75+3.75)	135	130
4.	NS+FA+MP (90+5+5)	85	90
5.	NS+FA+MP (87.5+6.25+6.25)	45	50
6.	NS+FA+MP (85+7.5+7.5)	15	10
7.	NS+FA+MP (90+10+0)	135	140
8.	NS+FA+MP (90+0+10)	70	75

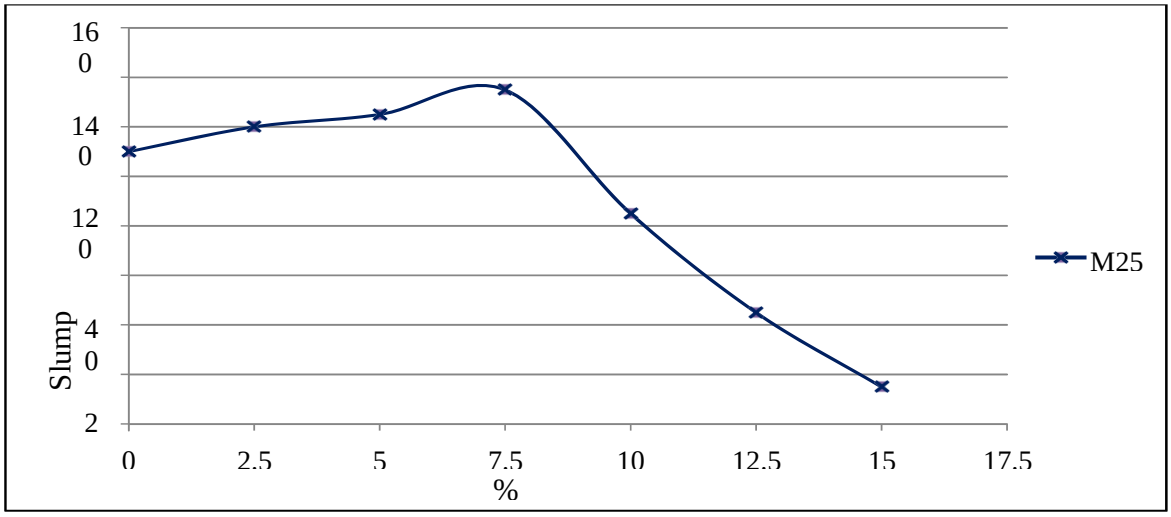

Fig. 2: Effect of Fly Ash & Marble Powder on Slump of Concrete (M-25)

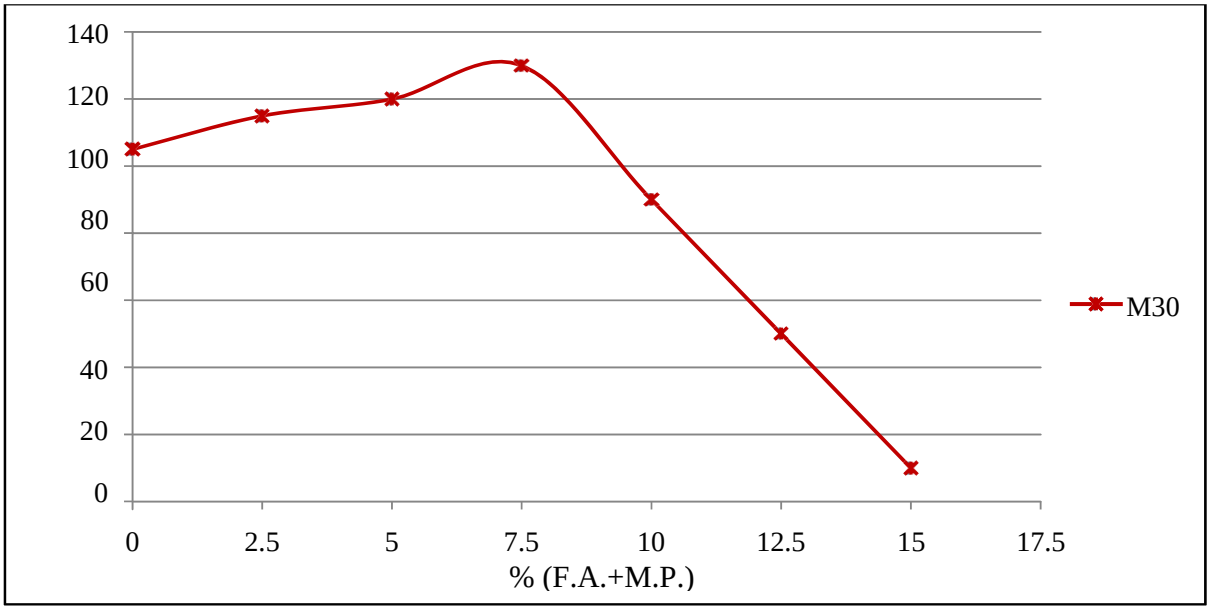

Fig. 3: Effect of Fly Ash & Marble Powder on Slump of Concrete (M-30)

B) Hardened Concrete Properties

Compressive Strength

Table 4: 7 & 28 Days Compressive Strength of M-25 grade Concrete

% (F.A.+M.P.)	AVERAGE			
	M25 (7 DAYS)		M25 (28 DAYS)	
	LOAD (KN)	STRENGTH (N/mm^2)	LOAD (KN)	STRENGTH(N/mm^2)
0	479.7	21.32	643.5	28.6
1.25+1.25	436	19.38	608.57	27.05
2.5+2.5	490.83	21.81	694.37	30.86
3.75+3.75	503.53	22.38	718.27	31.92
5+5	550.33	24.46	770.53	34.25
6.25+6.25	474.67	21.1	650.23	28.9
7.5+7.5	441	19.6	627.33	27.88
10+0	572.57	25.45	809.13	35.96
0+10	563.83	25.06	789.1	35.07

Table 5: 7 & 28 Days Compressive Strength of M-30 grade Concrete

% (F.A.+M.P.)	AVERAGE			
	M30(7 DAYS)		M30 (28 DAYS)	
	LOAD (KN)	STRENGTH(N/mm^2)	LOAD (KN)	STRENGTH(N/mm^2)
0	583.47	25.93	845.325	37.57
1.25+1.25	570.67	25.36	811.8	36.08
2.5+2.5	602	26.76	859.95	38.22
3.75+3.75	628.27	27.92	892.125	39.65
5+5	649.47	28.87	906.975	40.31
6.25+6.25	607.17	26.99	860.175	38.23
7.5+7.5	589.7	26.21	834.75	37.1
10+0	648.23	28.81	922.95	41.02
0+10	639.3	28.41	916.425	40.73

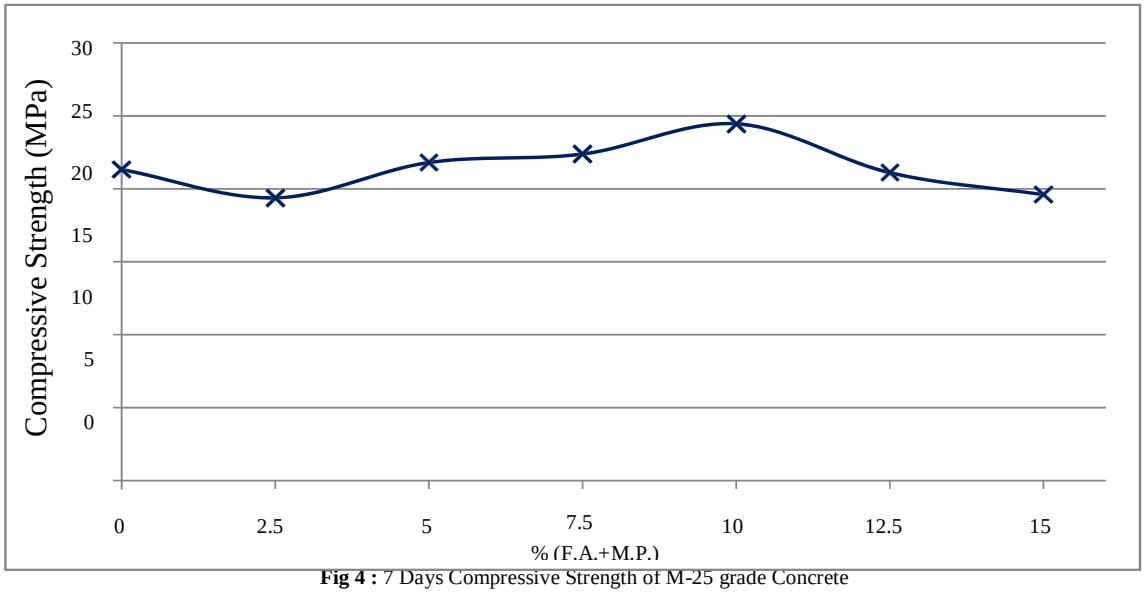

Fig 4 : 7 Days Compressive Strength of M-25 grade Concrete

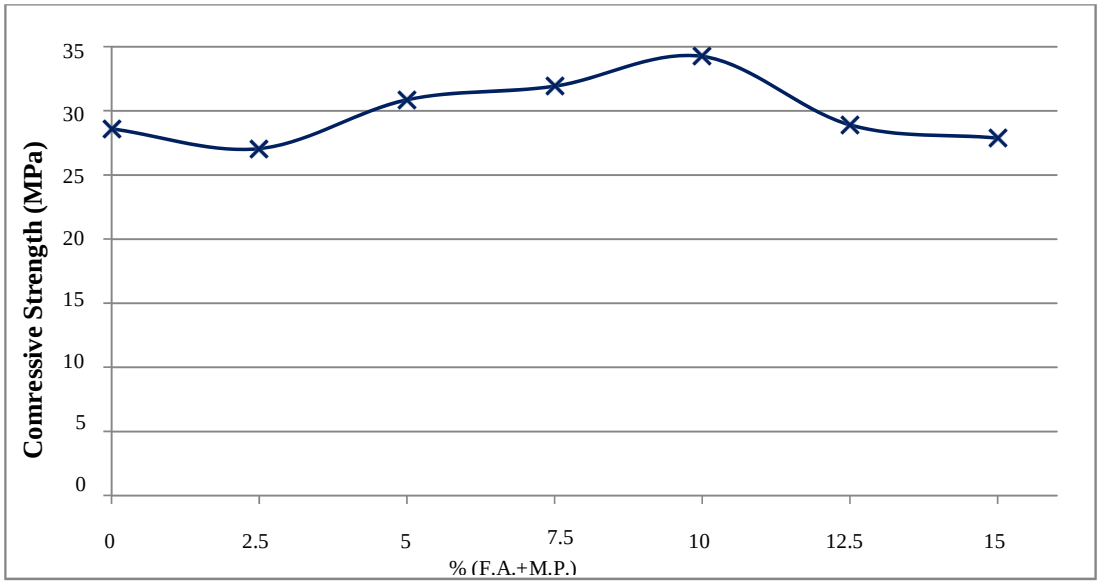

Fig 5: 28 Days Compressive Strength of M-25 grade Concrete

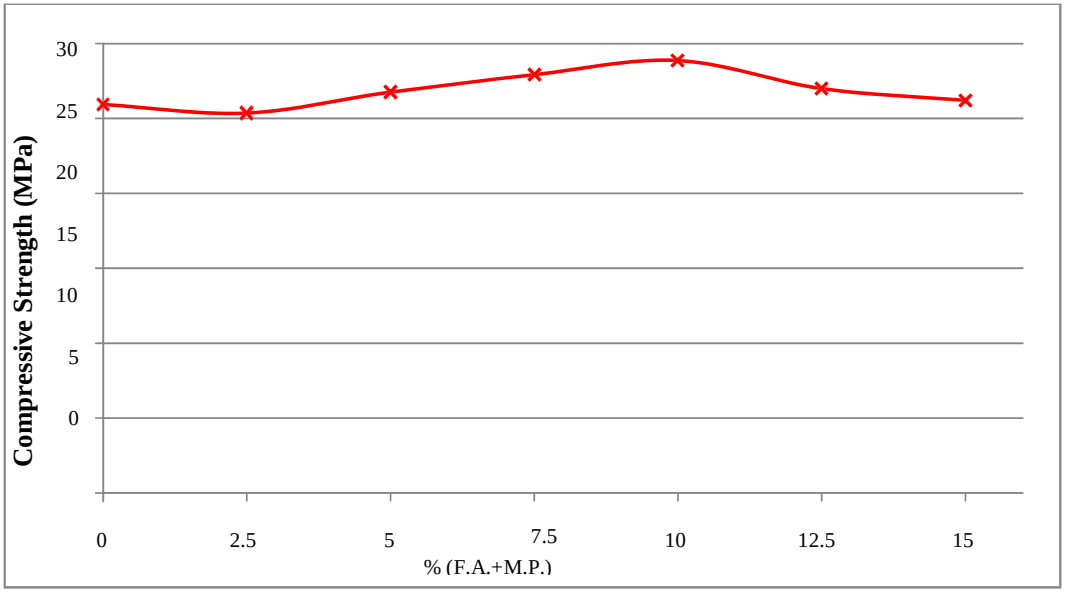

Fig 6: 7 Days Compressive Strength of M-30 grade Concrete

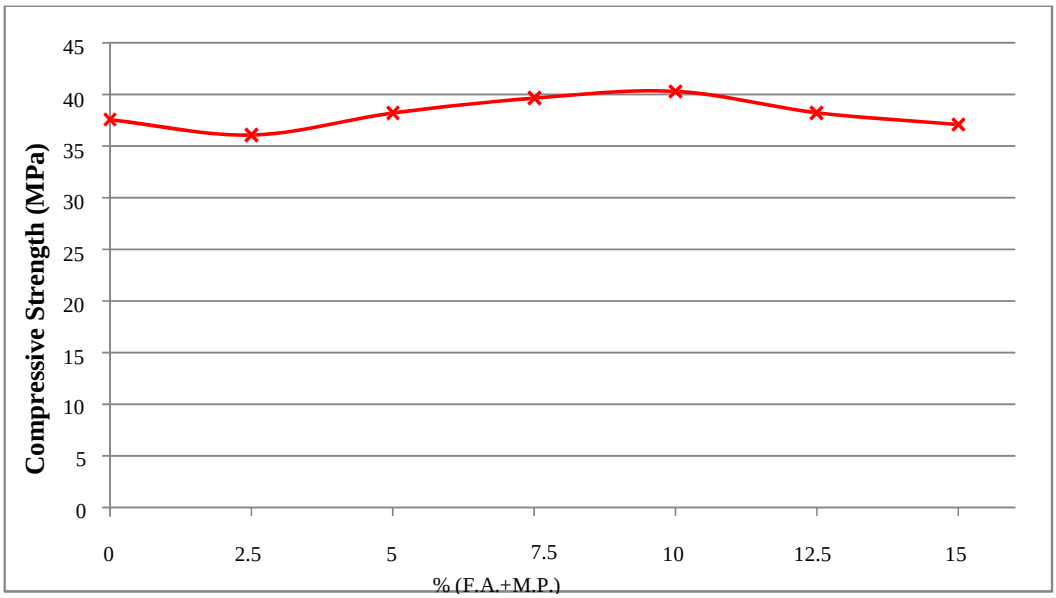

Fig 7: 28 Days Compressive Strength of M-30 grade Concrete

Table 6: 28 Days Flexural Strength of M-25 & M30 grade Concrete

% (F.A.+M.P.)	AVERAGE			
	M-25 (28 DAYS)		M-30 (28 DAYS)	
	LOAD (KN)	STRENGTH (N/mm^2)	LOAD (KN)	STRENGTH (N/mm^2)
0	18.5	4.93	22.9	6.11
1.25+1.25	17.7	4.72	19.5	5.2
2.5+2.5	18.9	5.04	21	5.6
3.75+3.75	19.8	5.28	22.7	6.05
5+5	21.7	5.79	24.75	6.6
6.25+6.25	18.1	4.83	23.4	6.24
7.5+7.5	16.3	4.35	22.38	5.97
10+0	21.4	5.71	24.2	6.45
0+10	19.5	5.2	23	6.13

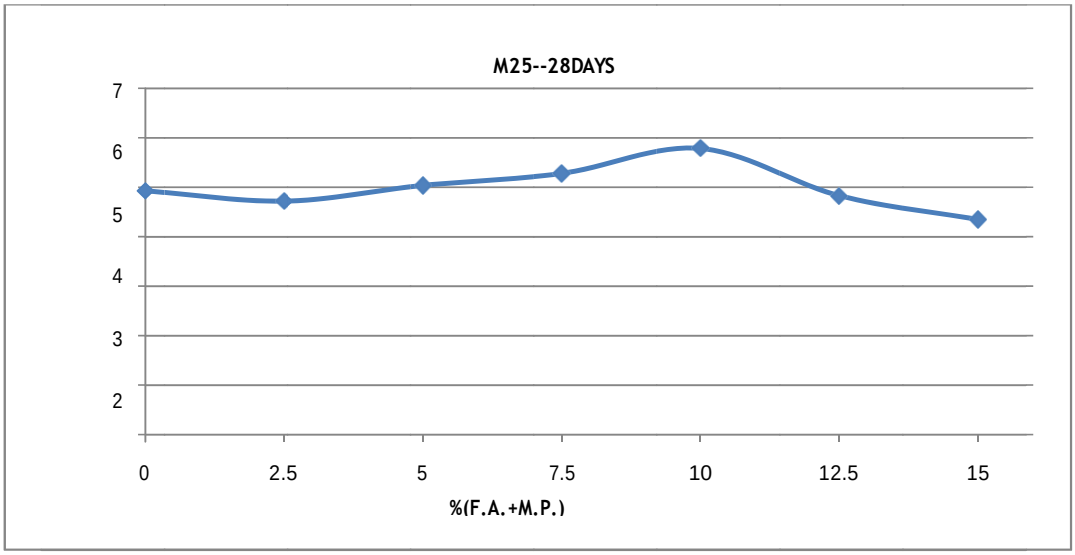

Fig 8: 28 Days Flexural Strength of M-25 grade Concrete

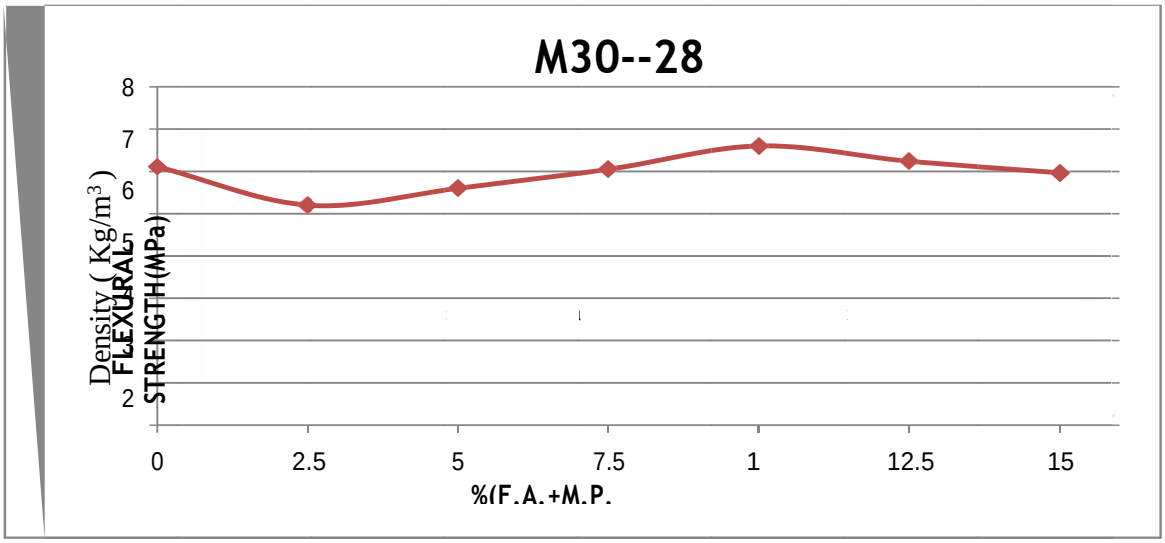

Fig 9: 28 Days Flexural Strength of M-30 grade Concre

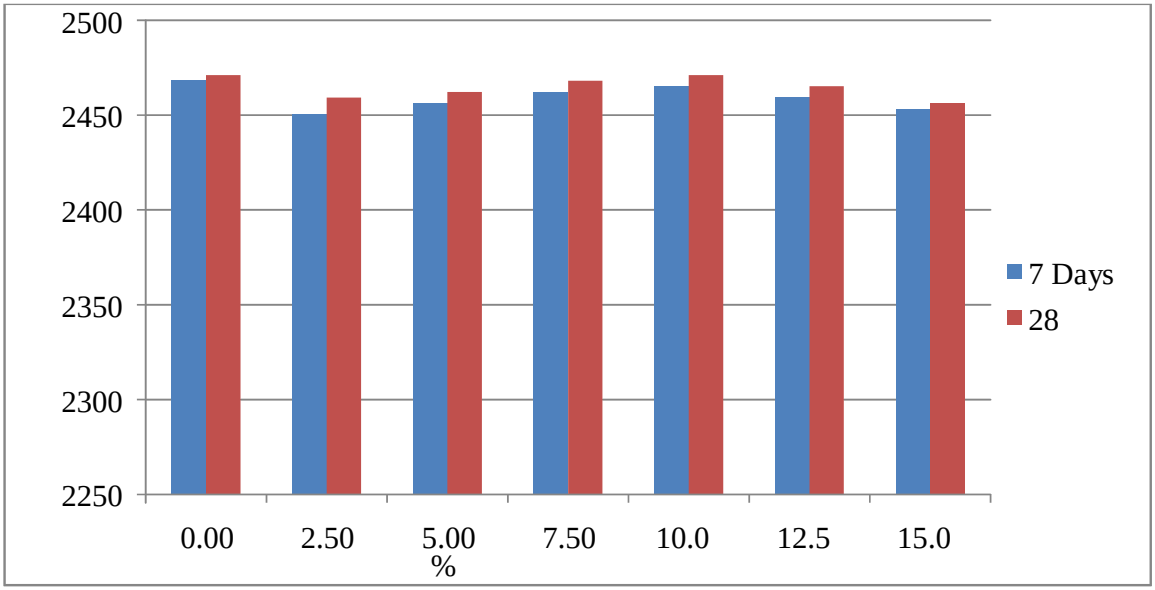

Fig 10 : Effect of Fly Ash & Marble Powder on Density of Hardened Concrete of M-25 grade with age

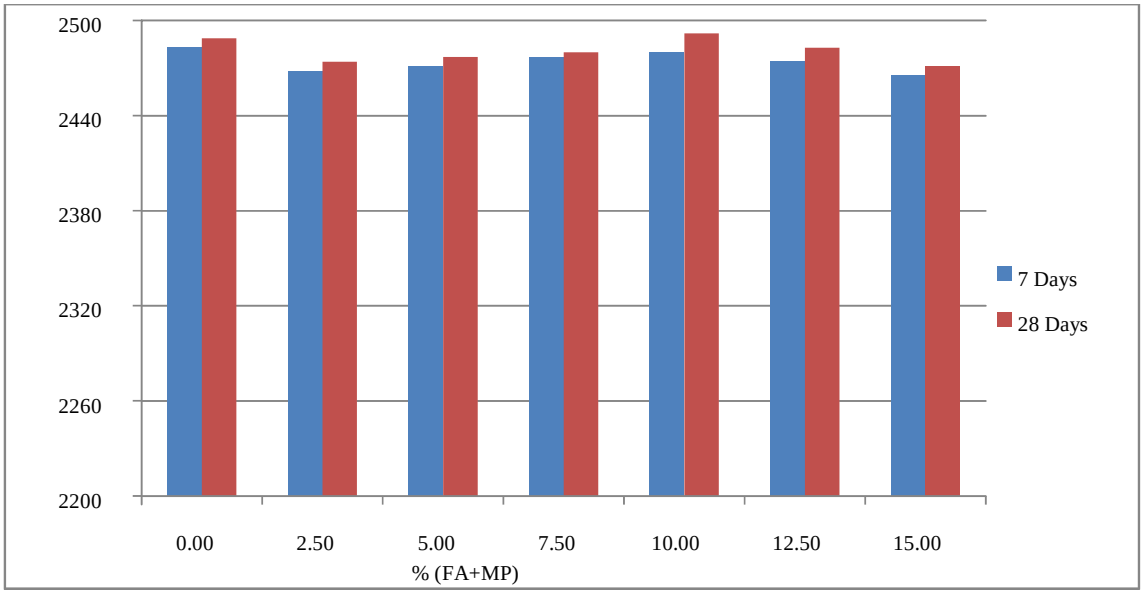

Fig 11: Effect of Fly Ash & Marble Powder on Density of Hardened Concrete of M-30 grade with age

CONCLUSIONS

The conclusions can be pointed out are as follows:-

Study Related Strategic Goals

The research program helps to meet the construction Industry strategic goal of environmental study such that Fly Ash & Marble Powder can replace natural sand in concrete mix.

Using less natural sand leads to a decrease in river dredging and the disruption of river environments. From various research on fly ash it has been observed that fly ash is one of the most common replacement for fine aggregate as compared to marble powder.

The Aggregate mining locations may also be located closer to construction sites, lowering the amount of carbon dioxide emitted from the transportation of the aggregate.

Conclusions

1. The compressive strength of blended concrete mix is increased upto 10 % replacement of natural sand with equal amount of fly ash & marble powder and after that compressive strength was decreased.
2. The flexural strength was increased up to 10% replacement of natural sand with equal amount of fly ash & marble powder as compared to controlled concrete & after that it was decreased. The beam specimen of size 150 mm × 150 mm × 700 mm was tested for single point load at the midpoint under the UTM of capacity 100 ton.
3. Environment friendly approach is most important aspect and is touched due to understanding of earth life balance along with pollution free society.
4. The surface finish of cube and beam manufactured by blended concrete mix is better than the surface finish of cube and beam manufactured by control mix.
5. The slump of blended concrete mix is increased up to 7.5% replacement of natural sand and after that it will decreased.
6. The densities of hardened concrete specimens with different percentage replacement of natural sand by fly ash and marble powder with respect to controlled concrete was shown in Fig 4.9 & Fig 4.10 respectively. The density of hardened concrete was linearly
7. decreased as the replacement ratio of fly ash and marble powder was increased upto 7.5% but at 10% replacement the density is equals the control mix.

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