Effects of Limestone Dust and Marble Dust on Properties of High Strength Concrete

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Abstract— Because of constantly expanding amounts of waste materials and developing ecological mindfulness, solid waste management is the prime concern in the world. Scarcity of resources and daily increasing demand, the world is increasingly turning to investigate properties of waste material and finding its valuable properties so that it may use as a replacement of these natural resources. The experimental investigation was performed to evaluate the strength and durability properties of high strength concrete M40 and M60 grades of concrete mixes, in which natural sand was partial replaced with Marble dust, Limestone dust and mix of Marble dust & limestone dust (LIMA), with five percentage (0%,25%,50%,75%,100%). Slump test, compression test and flexural strength test were carried out to evaluate the strength properties of concrete. Test results showed that there is increase in compressive strength and flexural strength for both grades of concrete mixes (M40 and M60) with inclusion of Marble dust, Limestone dust and mix of Marble dust & limestone dust (LIMA) up to 50% replacement. Percentage increase of strength is higher in marble dust for both grades of concrete with any percentage replacement

Key words: Concrete, Marble Dust, Lime Stone Dust, Fine aggregate, High Strength Concrete, Compressive Strength, Flexural strength, Workability

I. INTRODUCTION

Due to decreasing natural resources increasing cost the concrete construction industry tried alternate which is economical and easy available and has realized that the waste material are costless and widely available waste product that can be used as a partial replacement of natural sand [9]. It offers a best solution to the problem of increasing demand for concrete and make it economical. By this study we can decrease the pollution of the environment that are more important to economic development. The need of the study also offer the technology of limestone dust and marble dust concrete, which are needed for infrastructure and housing in accost effective and ecological manner [17]. The use of waste material like marble dust and limestone dust will help to enhance the sustainability of the concrete industry and also preserve the environment. There is a direct link is attached between durability and resource productivity. Industrial waste material limestone dust and marble dust are creating serious environmental threat and ways are being thought of being dispose them.[4] Therefore we trying to use more and more waste material in construction and consume the natural resource as well. Marble dust and limestone dust are such a non-conventional materials which are found easily and can be used in concrete industry to provide good strength at lower cost.[1]

Replacement of natural sand by waste material in concrete the following aims are to be performed:

- To find out the optimum percentage of replacement of natural sand in concrete by waste product such as limestone dust and marble dust
- The replacement is done in high strength concrete M40 and M60
- Mix design of high strength concrete is created and various proportion of replacement 0%, 25%,50%,75%and 100% are taken
- The workability, compressive strength and flexural strength test are performed in the concrete by making cubes and beams.

II. METHODOLOGY

Ordinary Portland cement of grade 43, with natural sand as fine aggregate and natural crushed stone as coarse aggregate is used along with marble dust and lime stone dust is collected from local areas. Water reducer superplasticizer is also used. Mix design of M40 and M60 concrete is done as IS 10262 : 2009, 15*15*15 cm cube and 15*15*70cm beam is casted, curing is done at room temperature and clean water and on fresh concrete slump cone test is performed to check workability, on hardened concrete compressive strength and flexural strength test is performed.

Replacement of Sand (%)	Percentage of Limestone Dust	Percentage of Marble Dust	Mix Name
0	0	0	A
25	0	25	A1
50	0	50	A2
75	0	75	A3
100	0	100	A4
25	25	0	B1
50	50	0	B2
75	75	0	B3
100	100	0	B4
25	12.5	12.5	C1
50	25	25	C2
75	37.5	37.5	C3
100	50	50	C4

Table 1: Mix Designation Of M40 Grade Of Concrete

Replacement of Sand (%)	Percentage of Limestone Dust	Percentage of Marble Dust	Mix Name
0	0	0	E
25	0	125	E1
50	0	50	E2
75	0	75	E3
100	0	100	E4
25	25	0	F1

50	50	0	F2
75	75	0	F3
100	100	0	F4
25	12.5	12.5	G1
50	25	25	G2
75	37.5	37.5	G3
100	50	50	G4

Table 2: Mix Designation of M60 Grade of Concrete

III. RESULT AND DISCUSSION

A. Workability:

Workability of concrete is checked by Slump cone test was conducted for each mix design. result of slump test of M40 and M60 at various percentage of Marble Dust, Limestone Dust and mix of Marble dust and Limestone Dust shows that introduction of these waste material in concrete is reduces the workability of concrete.

MIX PROPORTION	SLUMP (mm)
A	70
A1	65
A2	55
A3	50
A4	45
B1	75
B2	85
B3	90
B4	105
C1	65
C2	60
C3	60
C4	55

Table 3: Slump Test Result of M40 Grade of Concrete

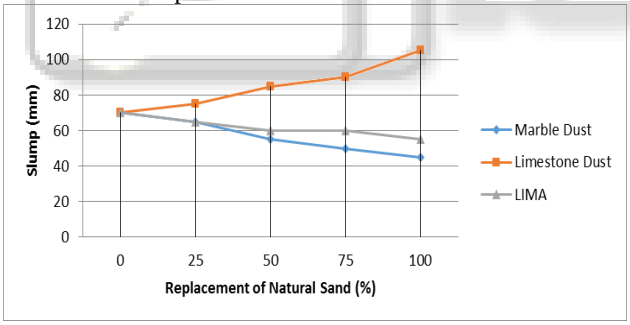

Fig. 1: Comparison of Slump at Varying Percentage of Replacement (M40)

MIX PROPORTION	SLUMP (mm)
E	60
E1	55
E2	50
E3	40
E4	35
F1	65
F2	70
F3	80
F4	85
G1	55
G2	55
G3	50
G4	45

Table 4: Slump Test Result of M60 Grade of Concrete

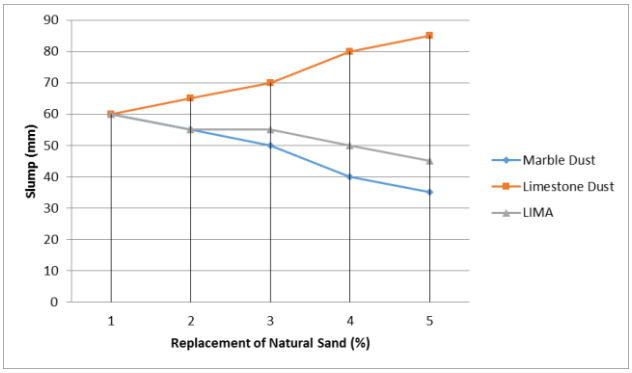

Fig. 2: Comparison of Slump at Varying Percentage of Lima (M60)

IV. COMPRESSIVE STRENGTH

A. Compressive Strength of M40 Concrete:

Using marble dust as a replacement of natural sand in concrete results that compressive strength increased about 12.92,16,14.6,19 and 12.2,18.55, 9.72,7.9 in 7 and 28 days for 25%,50%,75%,100% replacement respectively. using limestone dust as a replacement of natural sand in concrete results that compressive strength increased about 7.3,6.2,7,8.4 and 9.7,6.78,5.88,1.33 in 7 and 28 days for 25%,50%,75%,100% replacement respectively: Effect of mix of marble and limestone dust (LIMA) on concrete is using mix of marble and limestone dust as a replacement of natural sand in concrete results that compressive strength increased about 8.98, 5.33,10.11,13.48and 2.78,6.1,2.78,-0.678 in 7 and 28 days for 25%,50%,75%,100% replacement respectively

Mix	Average Compressive Strength		% Increase or Decrease to Control Concrete	
	7 Days	28 Days	7 Days	28 Days
A	35.6	44.2	0	0
A1	40.2	49.6	+12.92	+12.2
A2	41.3	52.4	+16	+18.55
A3	40.8	48.5	+14.6	+9.72
A4	42.4	47.7	+19	+7.9

Table 5: Compressive Strength of Concrete with Marble Dust

Mix	Average Compressive Strength		% Increase or Decrease to Control Concrete	
	7 Days	28 Days	7 Days	28 Days
A	35.6	44.2	0	0
B1	38.2	48.5	+7.3	+9.7
B2	37.8	47.2	+6.2	+6.78
B3	38.1	46.8	+7	+5.88
B4	38.6	44.7	+8.4	+1.13

Table 6: Compressive Strength of Concrete with Limestone Dust

Mix	Average Compressive Strength		% Increase or Decrease to Control Concrete	
	7 Days	28 Days	7 Days	28 Days
A	35.6	44.2	0	0
C1	38.8	45.43	+8.98	+2.78
C2	37.5	46.9	+5.33	+6.1

C3	39.2	45.4	+10.11	+2.78
C4	40.4	43.9	+13.48	-0.678

Table 7: Compressive Strength of Concrete with Mix of Limestone Dust and Marble Dust (Lima)

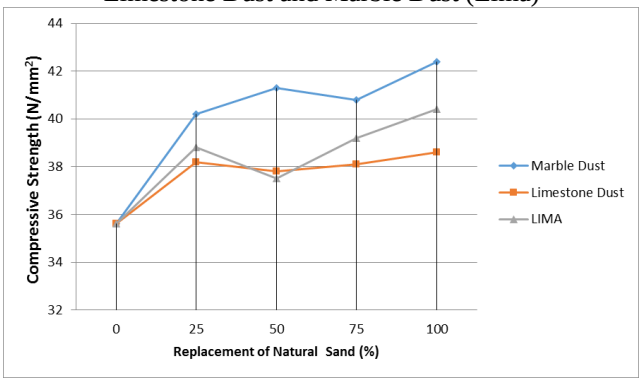

Fig. 3: 7 Days Strength at Various Percentage Marble Dust, Limestone Dust and Lima

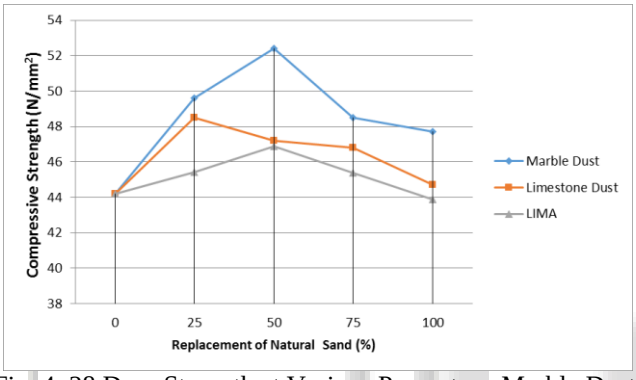

Fig. 4: 28 Days Strength at Various Percentage Marble Dust, Limestone Dust and Lima

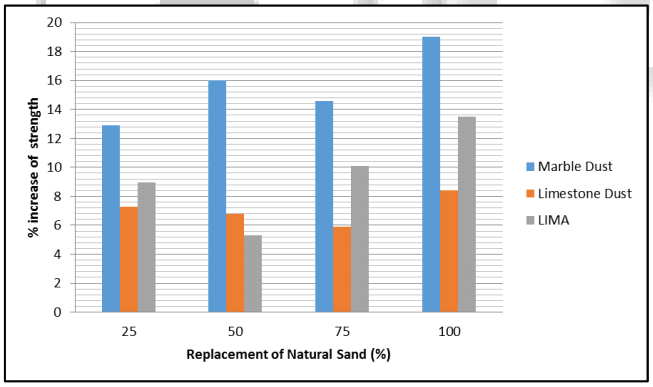

Fig. 5: Comparison in Increase of Strength in 7 Days

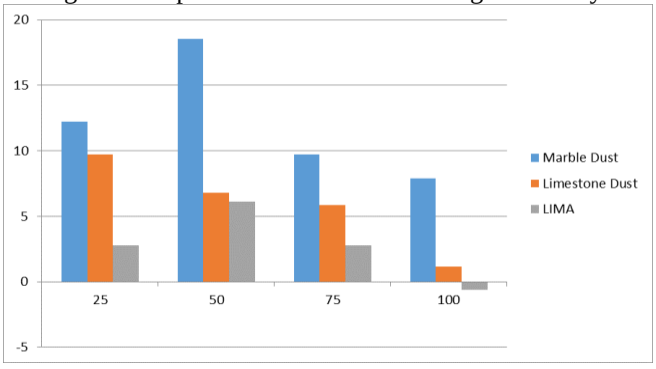

Fig. 6: Comparison in Increase of Strength in 28 Days

B. Compressive Strength of M60 Concrete:

Using marble dust as a replacement of natural sand in concrete results that compressive strength increased about 3.57,8.6,6.9,9.66 and 3.1,5.27,3.88,2.17 in 7 and 28 days for 25%,50%,75%,100% replacement respectively. using limestone dust as a replacement of natural sand in concrete results that compressive strength increased about 2.7,4.2,1.4,0.63 and 2.7,2.3,0.62,-1.08 in 7 and 28 days for 25%,50%,75%,100% replacement respectively. using mix of marble and limestone dust as a replacement of natural sand in concrete results that compressive strength increased about 2.1,4.8,4,1.4 and 4.65,3.88,2,-.0.3 in 7 and 28 days for 25%,50%,75%,100% replacement respectively.

Mix	Average Compressive Strength		% Increase or Decrease to Control Concrete	
	7 Days	28 Days	7 Days	28 Days
E	47.6	64.4	0	0
E1	49.3	66.4	+3.57	+3.1
E2	51.7	67.8	+8.6	+5.27
E3	50.9	66.9	+6.9	+3.88
E4	52.2	65.8	+9.66	+2.17

Table 8: Compressive Strength of Concrete with Marble Dust

Mix	Average Compressive Strength		% Increase or Decrease to Control Concrete	
	7 Days	28 Days	7 Days	28 Days
E	47.6	64.4	0	0
F1	48.8	66.2	+2.52	+2.7
F2	49.6	65.9	+4.2	+2.3
F3	48.3	64.8	+1.4	+0.62
F4	47.9	63.7	+0.63	-1.08

Table 9: Compressive Strength of Concrete with Limestone Dust

Mix	Average Compressive Strength		% Increase or Decrease to Control Concrete	
	7 Days	28 Days	7 Days	28 Days
E	47.6	64.4	0	0
G1	48.6	67.4	+2.1	+4.65
G2	49.9	66.9	+4.8	+3.88
G3	49.5	65.7	+4	+2
G4	48.3	64.2	+1.4	-0.3

Table 10: Compressive Strength of Concrete with Mix of Limestone Dust and Marble Dust (Lima)

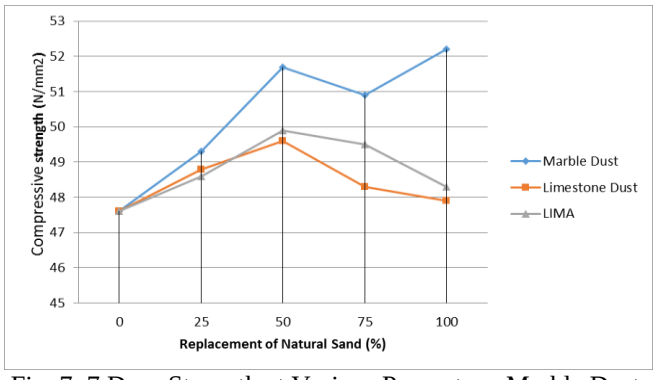

Fig. 7: 7 Days Strength at Various Percentage Marble Dust, Limestone Dust And Lima

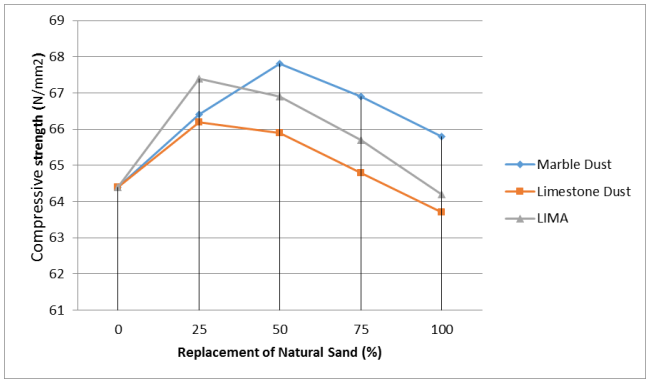

Fig. 8: 28 Days Strength At Various Percentage Marble Dust, Limestone Dust And Lima

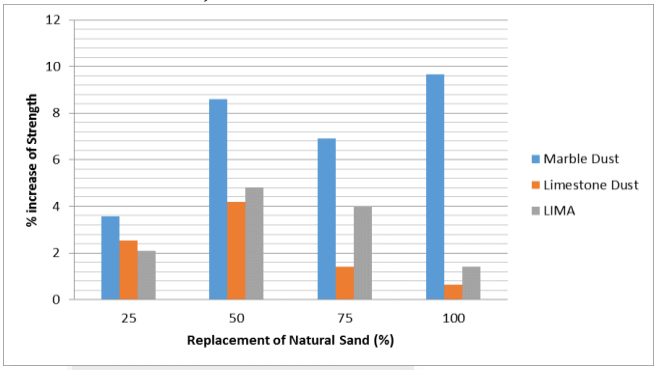

Fig. 9: Comparison in Increase of Strength in 7 Days

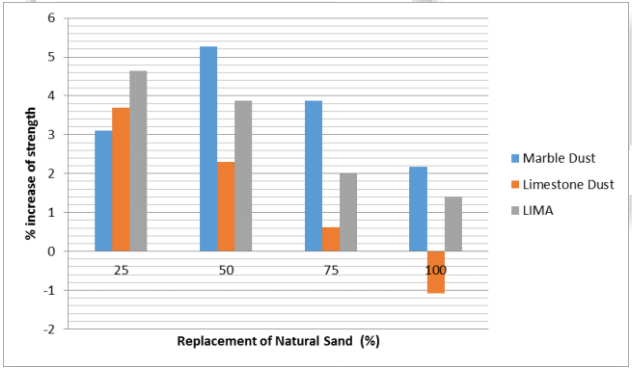

Fig. 10: Comparison in Increase of Strength in 28 Days

V. FLEXURAL STRENGTH TEST

A. Flexural Strength of M40 Concrete:

Using marble dust as a replacement of natural sand in concrete results that flexural strength increased about 2.16,3.24,13.5,6.48 in 28 days for 25%,50%,75%,100% replacement respectively. using limestone dust as a replacement of natural sand in concrete results that flexural strength increased or decreased about 0.54,1.62,-2.7,-4.3 in 28 days for 25%,50%,75%,100% replacement respectively. using mix limestone dust and marble dust as a replacement of natural sand in concrete results that flexural strength increased about 1.08,16.2,10.81,8.1 in 28 days for 25%,50%,75%,100% replacement respectively.

MIX DESIGNATION	AVERAGE FLEXURAL TENSILE STRENGTH	PERCENTAGE INCREASE OR DECREASE TO CONTROL CONCRETE
A (CM)	3.7	0
A1 (25%)	3.78	+2.16
A2 (50%)	3.82	+3.24
A3 (75%)	4.2	+13.5
A4 (100%)	3.94	+6.48

Table 11: Flexural Strength of Concrete with Marble Dust

MIX DESIGNATION	AVERAGE FLEXURAL TENSILE STRENGTH	PERCENTAGE INCREASE OR DECREASE TO CONTROL CONCRETE
A (CM)	3.7	0
B1 (25%)	3.72	+0.54
B2 (50%)	3.76	+1.62
B3 (75%)	3.6	-2.7
B4 (100%)	3.54	-4.3

Table 12: Flexural Strength of Concrete with Limestone Dust

MIX DESIGNATION	AVERAGE FLEXURAL TENSILE STRENGTH	PERCENTAGE INCREASE OR DECREASE TO CONTROL CONCRETE
A (CM)	3.7	0
C1 (25%)	3.74	+1.08
C2 (50%)	4.3	+16.2
C3 (75%)	4.1	+10.81
C4 (100%)	4	+8.1

Table 13: Flexural Strength of Concrete with Mix of Marble Dust and Limestone Dust (Lima)

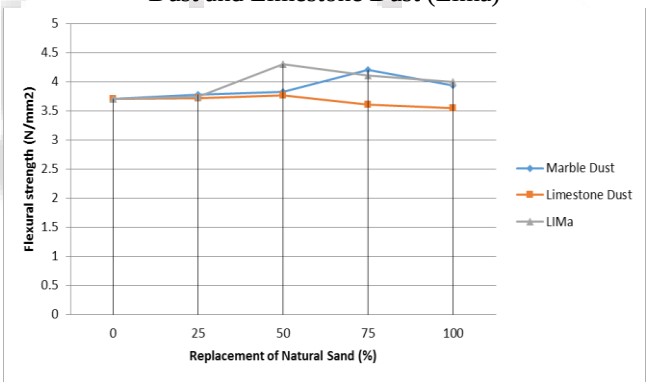

Fig. 11: Flexural Strength at Various Percentage

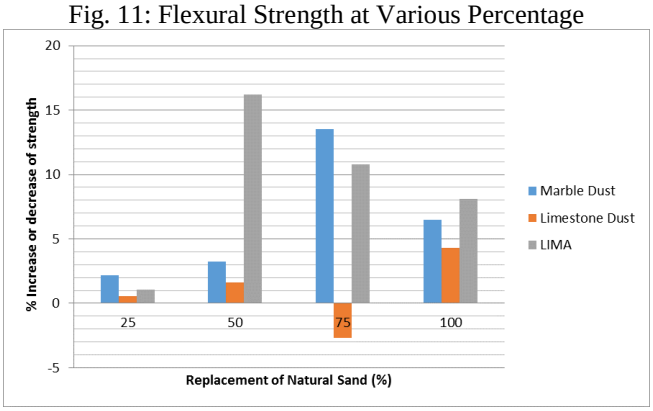

Fig. 12: Percentage Increase and Decrease of Flexural Strength (M40)

VI. FLEXURAL STRENGTH OF M60 CONCRETE

using marble dust as a replacement of natural sand in concrete results that flexural strength increased about 6.52,13,16,13 in 28 days for 25%,50%,75%,100% replacement respectively.

using limestone dust as a replacement of natural sand in concrete results that flexural strength increased about 4.34,10.86,6.52,2.17 in 28 days for 25%,50%,75%,100% replacement respectively. using mix Marble dust and Limestone Dust as a replacement of natural sand in concrete results that flexural strength increased about 4.78,10.8,8.69,10.81 in 28 days for 25%,50%,75%,100% replacement respectively

MIX DESIGNATION	AVERAGE FLEXURAL TENSILE STRENGTH	PERCENTAGE INCREASE OR DECREASE TO CONTROL CONCRETE
E (CM)	4.6	0
E1 (25%)	4.9	+6.52
E2 (50%)	5.2	+13
E3 (75%)	5.34	+16
E4 (100%)	5.2	+13

Table 14: Flexural Strength of Concrete with Marble Dust

MIX DESIGNATION	AVERAGE FLEXURAL TENSILE STRENGTH	PERCENTAGE INCREASE OR DECREASE TO CONTROL CONCRETE
E (CM)	4.6	0
F1 (25%)	4.8	+4.34
F2 (50%)	5.1	+10.86
F3 (75%)	4.9	+6.52
F4 (100%)	4.7	+2.17

Table 15: Flexural Strength of Concrete with Limestone Dust

MIX DESIGNATION	AVERAGE FLEXURAL TENSILE STRENGTH	PERCENTAGE INCREASE OR DECREASE TO CONTROL CONCRETE
E (CM)	4.6	0
G1 (25%)	4.82	+4.78
G2 (50%)	5.1	+10.8
G3 (75%)	5	+8.69
G4 (100%)	5.3	+15.21

Table 16: Flexural Strength of Concrete with Mix of Marble Dust And Limestone Dust (Lima)

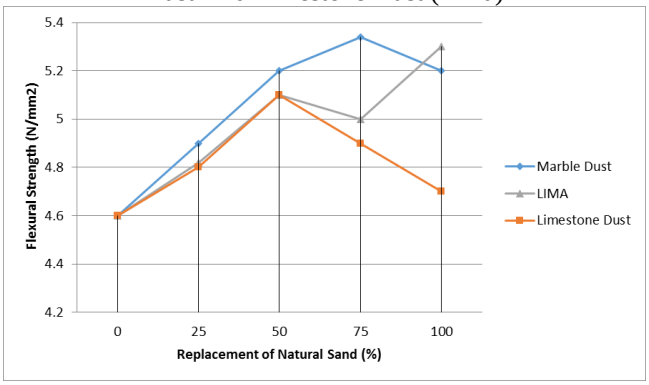

Fig. 13: Flexural Strength at Various Percentage (M60)

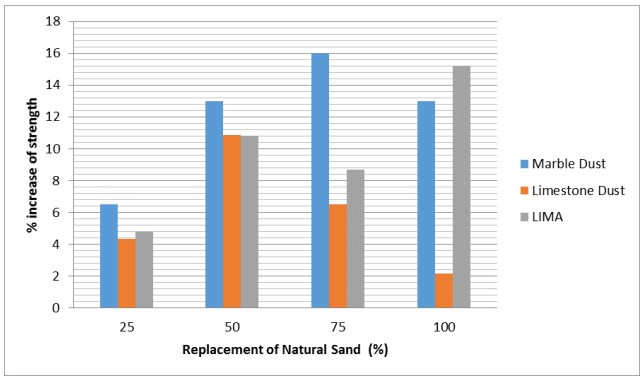

Fig. 14: Percentage Increase and Decrease of Flexural Strength (M60)

VII. CONCLUSION

The Conclusion drawn from the current study is, The compressive and flexural strength is greater in marble dust replacement as compared to limestone dust replacement and combination of both marble dust & limestone dust mix replacements. Initial strength and final strength of concrete (M40 & M60) with marble dust or combination of both marble dust & limestone dust is always increases with any percentage replacement of natural sand as compared to control concrete of same grade. By increasing the grade of concrete, the flexural strength of limestone dust concrete and marble dust concrete increases suddenly. Slump value of marble dust concrete decreases with increase in marble dust percentage and slump value of limestone dust concrete increases with increases in limestone dust percentage. Natural sand can be fully replaced by marble dust or combination of both marble dust & limestone dust. For maximum increment in strength of concrete, the optimum replacement of natural sand by marble dust or a combination of both marble dust & limestone dust is about 50%. Limestone dust cannot be fully replaced by the natural sand in concrete because decrement of strength occurs above 50% replacement as compared to control concrete. So 50% is maximum replacement of sand with limestone dust. Limestone dust and marble dust are the waste materials and its use in civil construction besides reducing environmental polluter factors, will bring several improvements to concrete characteristics.

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