An Experimental Study on Cement Concrete Using Marble Waste as Partial Replacement for Fine Aggregate

Malar Vannan S[1], Dr.P.Senthamilselvi[2]
[1]PG Scholar, Department of Structural Engineering, Government college of Engineering – Salem-11, Tamilnadu, India
[2]Assistant professor, Department of Civil Engineering, Government college of Engineering – Salem-11, Tamilnadu, India

Abstract: Concrete is one of the most widely used construction materials in the world. It can be cast in diverse shapes. Concrete is a composite material forming by the combination of cement, sand, coarse aggregate and water in a particular proportion in sucha way that the concrete produced meets the needs as regards its workability, strength, durability and economically. Portland cement is normally an essential binder ingredient used in concrete. Cement productionconsumes a considerable amount of raw material and energy and releases a large quantity of CO2. Several researchers have made efforts to utilize industrial andagricultural by-products or waste materials for mixed cement production to reduce costs, save resources,reduce energy consumption, and decrease the amountof CO2 generated during OPC production. To reduce carbon emissions, attempts have been made to find substitutes for cement to minimize the environmental impact of the concrete industry. With rapid industrial and agricultural development, large quantities of industrial and agricultural waste have been generated.Disposal of these wastes is a serious environmental problem, as most final wastes go to landfills, which notonly reduces useful land area but also pollutes the environment.

Keywords: **Marble waste powder, Copper slag Compressive strength, Split tensile strength, paver block.**

1. INTRODUCTION

Concrete is a commonly used building material dueto its strength, durability, and affordability. However, it is not immune to cracking and damage over time, which can lead to structural weakness andthe need for costly repairs.Self-healing concrete offers a promising solution to this problem by incorporating healing agents withinthe concrete mixture.When cracks form, these agents are activated and repair the damage, effectively closing the crack and restoring the concrete's strength. This technology has the potential to significantly extend the lifespan of concrete structures and reduce maintenance costs,

1.1 MATERIAL PROPERTIES

MATERIALS USED

- Cement (OPC 53)
- Fine Aggregate
- Coarse Aggregate
- Water
- Marble waste powder (MWP).

CEMENT

S.NO	DESCRIPTION	VALUE
1	CONSISTENCY	29%
2	INTIAL SETTING TIME	45 min
3	FINENESS	8.3%
4	SPECIFIC GRAVITY	3.15

FINE AGGREGATE

S.NO	DESCRIPTION	VALUE
1	FINENESS	10%
2	SPECIFIC GRAVITY	2.53
3	BULK DENSITY	0.01573N/cm^3
4	WATER ABSORPTION	1.5%

COARSE AGGREGATE

S.NO	DESCRIPTION	VALUE
1	CRUSHING VALUE	19.6%
2	SPECIFIC GRAVITY	2.78
3	BULK DENSITY	0.0137N/cm^3
4	WATER ABSORPTION	0.8%
5	IMPACT VALUE	12.5%

2. MIX PROPORTION

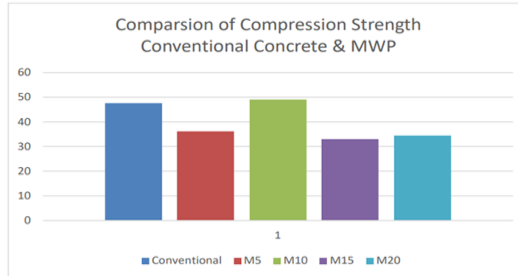
CEMENT(Kg/m^3)	FINE AGGREGATE(Kg/m^3)	COARSE AGGREGATE(Kg/m^3)	WATER/ CEMENT RATIO (Kg/m^3)
383	606	1293	153
1	1.32	2.69	0.45

3. CASTING OF MARBLE WASTE POWDER

S.NO	MIX ID	DEFINITIONS
1	MW1	10% MWP replace of fineaggregate
2	MW2	20% MWP replace of fineaggregate
3	MW3	30%MWP replace of fineaggregate
4	MW4	40%MWP replace of fineaggregate

4. MWP CUBE TEST ON COMPRESSIVE STRENGTH

Curing period	MIXID	Marble waste %	Avg compressive strength(N/mm^2)
28 Days	MW1	5	36
	MW2	10	49
	MW3	15	33
	MW4	20	34.3



5.DURABILITY TEST

- WATER ABSORPTION TEST
- ACID ATTACK TEST
- SULPHATE RESISTANCE TEST
- CHLORIDE ATTACK TEST
- SORPTIVITY

5.1 WATER ABSORPTION TEST

CURING	SPECIMEN NO	CONVENTIONAL			
		DRY WEIGHT(KG)	FINAL WEIGHT(KG)	WATER ABSORPTION(%)	AVG(%)
15 Days	1	2.76	2.82	2.16	2.185
	2	2.72	2.78	2,21	
30 Days	1	2.65	2.71	2.3	2.33
	2	2.85	2.91	2.36	
5 Days	1	2.8	2.86	2.42	2.46
	2	2.83	2.9	2.5	
60 Days	1	2.82	2.86	2.53	2.57
	2	2.76	2.81	2.61	

AVERAGE VALUE WATER ABSORPTION

CURING	SPECIMENNO	DRYWEIGHT (KG)	FINAL WEIGHT (KG)	WATER ABSORPTION(%)	AVG (%)
15 Days	1	2.7	2.74	1.6	1.615
	2	2.78	2.83	1.63	
30 Days	1	2.71	2.76	1.79	1.755
	2	2.55	2.59	1.72	

5.2 ACID RESISTANCE TEST

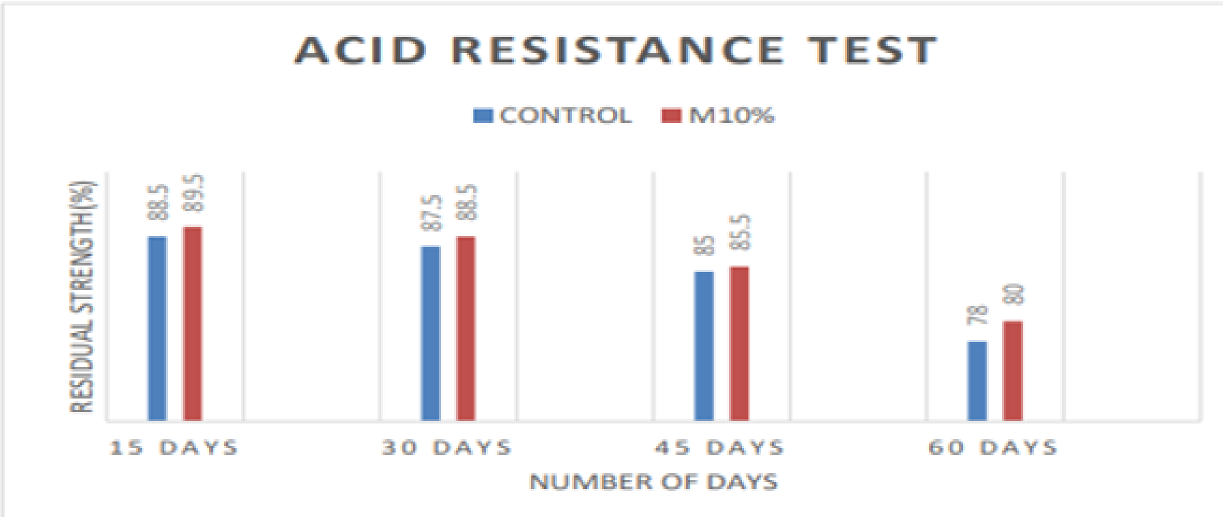
MWP WEIGHT GAIN ACID RESISTANCE TEST

CURING	SPECIMENNO	DRY WEIGHT (KG)	FINAL WEIGHT (KG)	INCREASE IN MASS (%)	AVG (%)
15 Days	1	2.83	2.86	1.4	1.465
	2	2.62	2.66	1.53	
30 Days	1	2.67	2.71	1.68	1.735
	2	2.73	2.77	1.79	
45 Days	1	2.69	2.73	1.85	1.88
	2	2.81	2.86	1.91	
60 Days	1	2.82	2.87	1.94	1.955
	2	2.7	2.8	1.97	

COMPRESSIVE STRENGTH ON MARBLE WASTE POWDER CONCRETE ACID TEST

CURING	SPECIMENNO	INITIAL (N/mm^2)	FINAL (N/mm^2)	DECREASEIN STRENGTH (%)	Avg(%)	RESIDUAL STRENGTH (%)	Avg (%)
15 DAYS	1	49	43.12	12	10.5	88	89.5
	2	49	44.59	9		91	

30 DAYS	1	49	43.61	11	11.5	89	88.5
	2	49	43.12	12		88	
45 DAYS	1	49	42.14	14	14.5	86	85.5
	2	49	41.65	15		85	
60 DAYS	1	49	39.69	19	20	81	80
	2	49	38.71	21		79	



5.3 CHLORIDE TEST

WEIGHT GAIN MARBLE WASTE POWDER CONCRETE CHLORIDE TEST

CURING	SPECIMENNO	DRY WEIGHT (KG)	DRY WEIGHT (KG)	FINAL WEIGHT(KG)	INCREASEIN MASS (%)	AVG(%)
15 DAYS	1	2.82	2.82	2.86	1.5	1.8
	2	2.76	2.76	2.81	2.16	
30 DAYS	1	2.65	2.65	2.71	2.3	2.2
	2	2.63	2.63	2.68	2.14	
45 DAYS	1	2.67	2.67	2.73	2.62	2.5
	2	2.72	2.72	2.78	2.41	
60 DAYS	1	2.8	2.8	2.87	2.54	2.6
	2	2.61	2.61	2.67	2.64	

5.4 SULPHATE TEST

WEIGHT GAIN MARBLE WASTE POWDER SULPHATE TEST

CURING	SPECIMENNO	DRY WEIGHT(KG)	FINAL WEIGHT(KG)	INCREASE IN MASS (%)	AVG (%)
15 Days	1	2.61	2.65	1.8	1.775
	2	2.55	2.59	1.75	
30 Days	1	2.61	2.65	1.82	1.795
	2	2.63	2.67	1.77	
45 Days	1	2.65	2.7	1.9	1.895
	2	2.71	2.76	1.89	
60 Days	1	2.76	2.81	1.91	1.925
	2	2.79	2.84	1.94	

COMPRESSIVE STRENGTH ON MARBLE WASTE POWDER SULPHATE TEST

CURING	SPECIMENNO	INITIAL	FINAL (Kg)	DECREASEIN STRENGTH(%)	Avg(%)	RESIDUAL STRENGTH(%)	Avg(%)
15 DAYS	1	49	43.904	10.4		89.6	

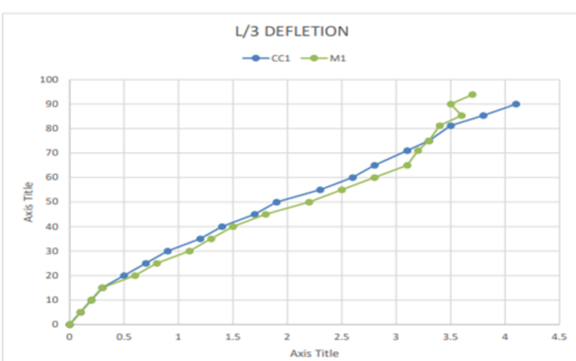
	2	49	43.659	10.9	10.65	89.1	89.35
30 DAYS	1	49	43.512	11.2	11.65	88.8	88.35
	2	49	43.071	12.1		87.9	
45 DAYS	1	49	42.728	12.8	12.95	87.2	87.05
	2	49	42.581	13.1		86.9	
60 DAYS	1	49	42.483	13.3	13.5	86.7	86.5
	2	49	42.287	13.7		86.3	

5.5 SORPTIVITY VALUE OF SPECIMENS AT 28 DAYS

MIX	SPECIMEN 1	SPECIMEN 2	AVERAGE
CONVENTIONAL	0.0538	0.0513	0.05255
M10%	0.0298	0.0312	0.0305

6. FLEXURAL BEHAVIOUR TEST RESULTS ON MARBLE WASTE POWDER REINFORCED CONCERTE BEAM

LOAD(kN)	L/2	L/3	REMARK
25	0.8	0.8	
30	1	1.1	
35	1.3	1.3	
40	1.4	1.5	First Crack
45	1.6	1.8	
50	1.8	2.2	
55	1.9	2.5	
60	2	2.8	
65	2.1	3.1	
71	2.3	3.2	
75	2.5	3.3	
81.2	2.6	3.4	
85.3	2.7	3.6	U.L
90	3	3.5	



7. CONCLUSION

- The conventional concrete cube obtained the compressive strength in 28 daysis 47.53 N/mm$^{2.}$
- The marble waste powder concrete cube obtained the compressive strength in28 days is 49 N/mm$^{2.}$
- The conventional paver block can attain the compressive strength of 28 days 41.04 N/mm^2.
- The paver block can attain the compressive strength of marble waste powder28 days 41.86 N/mm$^{2.}$
- The conventional paver block to attain the flexural strength of 28 days 3.19N/mm^2
- The conventional paver block to attain the flexural strength of 28 days 3.19N/mm^2

Impact value on paver block is 17.14 %.

- The compressive strength of concrete was comparable up to the 10% level of replacement of marble waste for fine aggregate. However, a reduction in the workability was observed beyond 10% level of replacement of marble waste.
- Therefore 10% marble waste replacement of fine aggregate suggested as the optimum level of replacement without compromising the strength and workability.
- The optimum replacement level of crusher sand with marble waste to be 10% and the optimum replacement level
- The compressive strength of conventional paver block in 28 days is 41.04 N/mm^2
- The flexural strength of paver block obtained as 3.19 N/mm^2 in 28 days.
- A reduction in the compressive strength was observed for 5% 15% and 20% replacement level of marble waste with the fine aggregate. Hence 10% replacement of river sand with marble waste is suggested as an optimum level.
- In durability test such as acid resistance, chloride attack, sulphate resistance tests the M10% specimen is found to have 2-3.04% higher compressive strength as compared to control specimen.
- The rate of water absorption of M10% was 0.6% less than conventional mix.
- The residual compressive strength of M10% in

acid resistance test was 1.13% more than the conventional mix.

- The residual compressive strength of M10% in sulphate test was 0.95% more than the conventional mix.

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