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EFFECT OF MARBLE SLURRY AND RECYCLED AGGREGATE IN DIFFERENT GRADE OF CONCRETE

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Abstract - *In the construction industry concrete is the most widely used material. This consumes natural resources like aggregate and water. Different types of raw materials, e.g. marble slurry (MS), fly ash, marble dust, silica, sugarcane ash, rice husk ash, bottom ash, silica fume etc. can be used to produce concrete at a lower cost. In present study effect of MS and recycled aggregate (RA) have been used to replace cement and natural aggregate. Cement was replaced with MS by 0%, 5%, 7.5%, 10% and 12%. Effect of replacement of cement by MS was studied on consistency, IST & FST and compressive strength of cement. Also, the effect of replacement of cement & natural aggregate by MS and RA (50%) on fresh and hardened properties of concrete (M25 & M40) was investigated experimentally.*

Key Words: marble slurry. Compressive strength, flexural strength, split tensile strength,recycled aggregate,

1. INTRODUCTION

The present study concerns about the probable use of stone waste in construction engineering, which would reduce both environmental impacts and the construction cost. Development of concrete in the construction industry is most important as it is not only responsible for consuming natural resources and energy but also its ability to absorb other industrial waste. Presently huge quantities of stone wastes are produced in natural stone plants. Disposal of stone waste is a matter of concern and has an adverse effect on the environment. [1]

Al-Zboon et al. [2] utilized stone waste in the production of bricks. It was concluded and specified that the combinations of aggregates with added quantity of stone waste up to 50 % were used successfully in the manufacturing of bricks. Almeida et al. [3] Used natural marble slurry to replace fine aggregates in concrete mixtures. The authors found that the hardened properties of the formed samples were suitable for concrete mix.

Kota stone waste aggregate [4] was used to investigate the effect of stone waste on properties of concrete and has been found that the reduction in compressive strength was only 15.7 %, in comparison by sandstone cement concrete. Higher quantities of sand replacement with slurry were accepted by Misra and Mathur [5], and authors found that up to 40 % replacement of sand with marble slurry has a positive effect on the compressive strength and flexural strength.

High consumption of basic raw materials by the construction industry produces serious reduction on mineral resources and impact on ecological condition. In present paper effect of MS and recycled aggregate on mortar, fresh and hardened properties of concrete respectively have been discussed. Cement was replaced with MS by 0%, 5%, 7.5%, 10% and 15% & recycled aggregate were used to replace coarse aggregate by 50%.

2. MATERIALS

a. Cement

Cement is a binder material that sets and hardens and can bind other materials together. Ordinary Portland Cement-Grade 43 confirming with IS 8112:1989 standards has been used in test practice. [9]

b. Aggregate

Aggregates are the raw materials that are an important component in concrete and it is the wide class of coarse particulate material used in construction, with sand, grit, crushed stone, and slag. For construction work, aggregates need to be tough, fresh, durable and particles free from absorbed chemicals. Aggregates are the greatest mined materials in the ecosphere. [10]

c. Fine aggregate

Natural river sand used in this study have an extreme size of 4.75 mm confirming to IS-383-1970. Fineness modulus of aggregate has been shown in Table 1.

d. Coarse aggregate

The coarse aggregates may be made artificially or available naturally. The coarse aggregate used in this study has an extreme size of 20 mm with confirming to IS-383-1970. [11] Fineness modulus of aggregate has been shown in Table1.

e. Recycled aggregate

Recycled aggregate is formed by crushing concrete for feasible use. Recycled Aggregate contains gravel, sand, dust or crushed stone powder. In the present investigation, the recycled aggregates were produced by crushing 150 mm size concrete cubes (about 5-8-month-old and uncontaminated) manually by a hammer. The crushed products were then sieved and recombined to obtain required grading. Fineness modulus of aggregate showed in Table 1.

Table 1: Various properties of FA, CA and RA

S. No	Properties	FA	CA	RA
1.	Specific gravity	2.667	2.81	2.48
2.	Fineness modulus	2.63	10mm = 6.79	7.33
			20mm = 7.20	
			10&20mm=7.48	
3.	Impact test	__	10mm = 13%	
			20mm = 14%	
			10&20mm=12%	14%

Water
Tap water available in the concrete lab was utilized to prepare concrete mix proportion.

Marble slurry
Marble slurry is a semi-liquid material containing particles originating from the cutting and the polishing processes and water used to cool the sawing and polishing machines.

Super Plasticizer
To improve the workability of the fresh concrete, Master Gallium SKY 8777 super plasticizer was used.

3. Concrete Mix Design And Test Specimens

Mix design of M25 and M40 grade of concrete has been carried out with reference IS 10262-2009, IS 383-1970 and IS 456-2000. MS was used to replace the cement by 0%, 5%, 7.5%, 10% and 15% by weight of cement. The other equivalent mixes were obtained by replacing natural aggregate with 50% recycled aggregate. Mix proportions have been shown in Table 2.

Table 3: Mix proportion for M25 and M40

MIX	Cement	FA	CA	Water	SP
M25	1	1.3	2.8	0.43	__
M40	1	1.42	2.65	0.34	1%

4. Experimental Work

Experimental study of concrete

1. Replacement of cement with MS & NA

In the present experimental work the ratio of cement, fine aggregate and coarse aggregate was fixed as 1:1.3:2.8 after several trials. In the present work cement was replaced with MS by 0%, 5%, 7.5%, 10% and 15%. Mix proportion material quantity with MS & NA showed in Table 4.

2. Replacement of cement by MS with RA

In the present experimental work the ratio of cement, fine aggregate and coarse aggregate was fixed as 1:1.3:2.8 after several trials. In the present work cement was replaced with MS by 0%, 5%, 7.5%, 10% and 15% & recycled aggregate were used to replace coarse aggregate by 50%.

Table 4: Mix proportion material quantity with MS & NA

M25 grade	Replacement of MS (%)	Cement (Kg)	F.A (Kg)	C.A (Kg)	Water (Kg)	MS (Kg)
MIX 1	**M25**	**W/C =0.43**				
CM1	0	350.00	455	980	150.5	0.00
CM2	5	332.50	455	980	150.5	17.50
CM3	7.5	323.75	455	980	150.5	26.25
CM4	10	315.00	455	980	150.5	35.00
CM5	15	297.5	455	980	150.5	52.50
MIX3	**M40**	**W/C =0.35** SP 1%(4.63g)				
CM6	0	463.00	661	1228	162	0.00
CM7	5	439.85	661	1228	162	23.15
CM8	7.5	428.26	661	1228	162	34.73
CM9	10	416.70	661	1228	162	46.30
CM10	15	393.55	661	1228	162	69.45

Table 5: Mix proportion material quantity with MS & RA

M25 grade	Replacement of MS (%)	Cement (Kg)	F.A (Kg)	R.A (Kg)	Water (Kg)	MS (Kg)
MIX 1	**M25**	**W/C =0.43**				
CM1	0	350.00	455	490	150.5	0.00
CM2	5	332.50	455	490	150.5	17.50
CM3	7.5	323.75	455	490	150.5	26.25
CM4	10	315.00	455	490	150.5	35.00
CM5	15	297.5	455	490	150.5	52.50
MIX3	**M40**	**W/C =0.35** SP 1%(4.63g)				
CM6	0	463.00	661	614	162	0.00
CM7	5	439.85	661	614	162	23.15
CM8	7.5	428.26	661	614	162	34.73
CM9	10	416.70	661	614	162	46.30
CM10	15	393.55	661	614	162	69.45

5. Test Programme

- **Fresh Properties**

A number of different methods are available for measuring the workability of fresh concrete, but none of them is wholly satisfactory. Consistency, workability, IST & FST studied for various replacement of MS. Each test measures only a particular aspect of it and there is really no method which measures the workability of concrete in its totality.

Replacement With Ms	IST (Minuts)	FST (Minuts)	Soundness (mm)
0%	200	360	2
5%	207	356	2.3
7.5%	212	342	2.5
10%	215	336	2.5
15%	232	313	2.5

Slump Test

The concrete slump is an empirical test that measures workability of fresh concrete. The test measures the consistency of concrete in that specific batch. It is performed to check the consistency of freshly made concrete.

Table 7: Workability with NA & RA

With N.A		**With R.A**	
M25		**M25**	
MIX	**SLUMP(mm)**	**MIX**	**SLUMP(mm)**
CM1	54	RM1	53
CM2	67	RM2	69
CM3	78	RM3	80
CM4	95	RM4	97
CM5	98	RM5	99
M40		**M40**	
CM6	59	RM6	56
CM7	56	RM7	61
CM8	62	RM8	78
CM9	76	RM9	91
CM10	90	RM10	93

6. Hardened Properties

a. Compressive strength
The concrete cube specimens were tested at the age of 7 days and 28 days in Compression Testing Machine (CTM) after drying at room temperature according to IS: 516-1959.

b. Split tensile strength
The specimen were tested at the age of 7 days and 28 days in Compression Testing Machine (CTM). The tests were conducted on cylinders.

Fig 1: Split Tensile strength test

c. Flexural strength
Testing of flexural strength of beam were tested in CTM at 7 days and 28 days for various mix proportions.

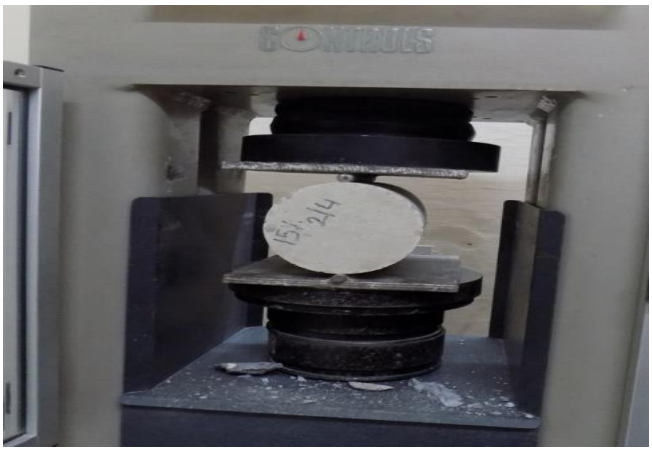

Fig 2: flexural testing of specimen

Table: 8 Various strength of M25 and M40 grade at 7 days and 28 days with NA & RA

COMPRESSIVE STRENGTH					
NATURAL AGGREGATE			**RECYCLED AGGREGATE**		
Mix	7 days	28 days	**Mix**	7days	28 days
CM1	19.66	31.08	RM1	18.69	29.32
CM2	20.34	33.83	RM2	19.45	32.26
CM3	21.85	35.56	RM3	21.08	34.22
CM4	20.44	29.7	RM4	18.03	28.63
CM5	18.65	28.33	RM5	16.89	25.81
CM6	38.97	50.16	RM6	36.16	48.63
CM7	39.16	53.64	RM7	38.06	52.23
CM8	40.57	54.63	RM8	39.87	53.54
CM9	42.53	56.02	RM9	42.12	54.93
CM10	39.11	52.53	RM10	38.64	50.16
SPLIT TENSILE STRENGTH					
Mix	7 days	28 days	**Mix**	7days	28 days
CM1	1.24	1.41	RM1	1.31	1.44
CM2	1.28	1.43	RM2	1.43	1.55
CM3	1.52	1.65	RM3	1.59	1.61
CM4	1.43	1.60	RM4	1.53	1.56
CM5	1.57	1.63	RM5	1.48	1.52
CM6	1.46	1.81	RM6	1.39	1.74
CM7	1.49	1.92	RM7	1.45	1.79
CM8	1.56	2.01	RM8	1.53	1.82
CM9	1.78	2.08	RM9	1.71	1.96
CM10	1.49	1.89	RM10	1.46	1.83
FLEXURAL STRENGTH					
Mix	7 days	28 days	**Mix**	7days	28 days
CM1	1.49	1.61	RM1	1.39	1.52
CM2	1.56	1.63	RM2	1.42	1.56
CM3	1.72	1.75	RM3	1.58	1.59
CM4	1.63	1.70	RM4	1.61	1.69
CM5	1.67	1.69	RM5	1.58	1.62
CM6	1.53	1.81	RM6	1.48	1.77
CM7	1.64	1.86	RM7	1.56	1.82
CM8	1.73	1.91	RM8	1.66	1.86
CM9	1.79	2.01	RM9	1.73	1.94
CM10	1.69	1.97	RM10	1.52	1.89

7. Result:

The total no of 60 cubes, beams specimens and cylinders each for both mix proportions i.e. M25 & M40 were tested for compressive strength, flexural strength and split tensile strength respectively at different ages to study the following aspects.

a. The effect of replacement of cement with MS on consistency, initial & final setting time and compressive strength of mortar.

b. The effect of marble slurry & recycled aggregate on workability of fresh concrete.

c. The effect on fresh and hardened properties of concrete using stone slurry in varying percentage as a partial replacement of cement.

d. Effect of MS in various proportion with recycled aggregate on fresh and hardened properties of concrete using marble slurry in varying percentage as a partial replacement of cement.

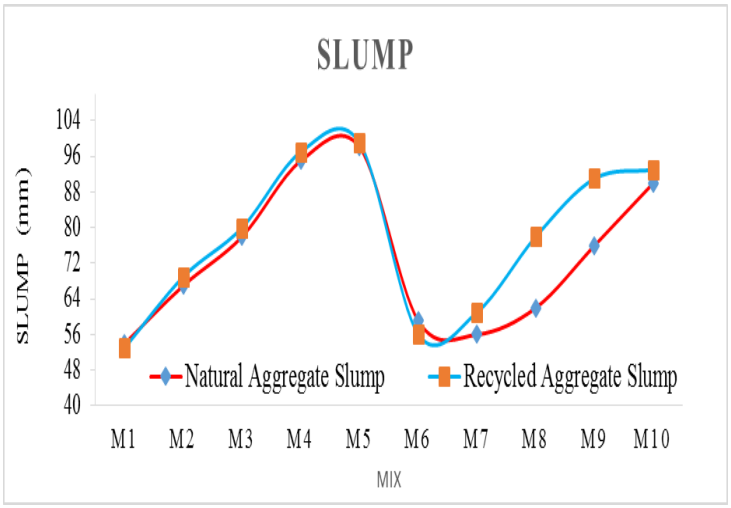

Chart 3: Slump with NA & RA

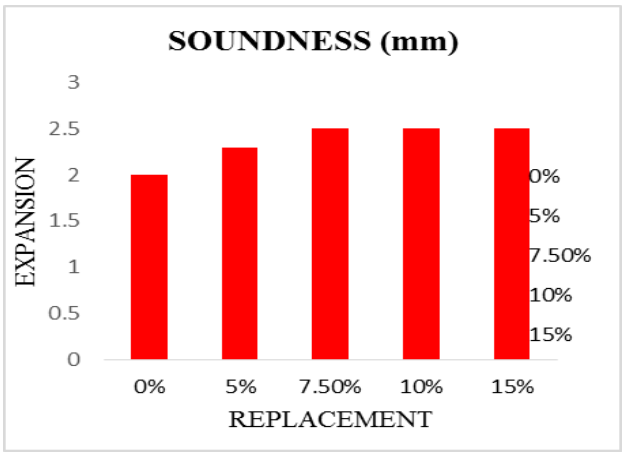

Chart 1: IST & FST

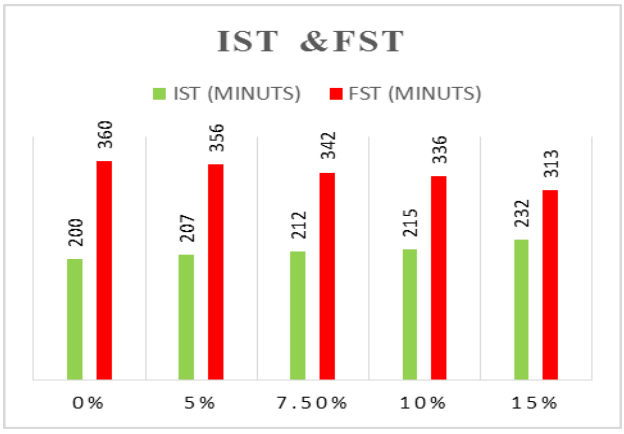

Chart 2: Soundness

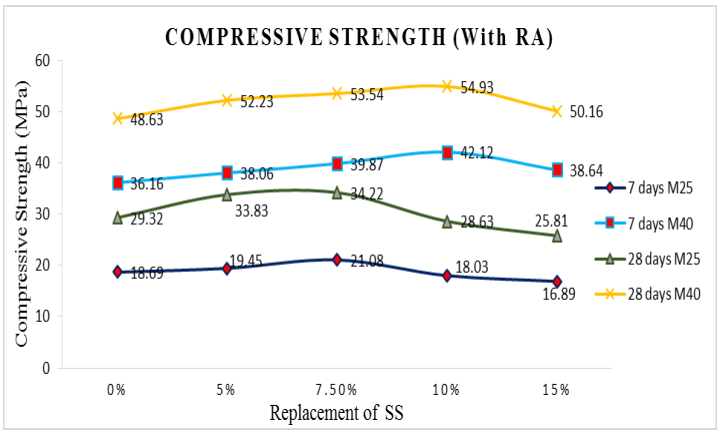

Chart 4: Compressive strength with RA

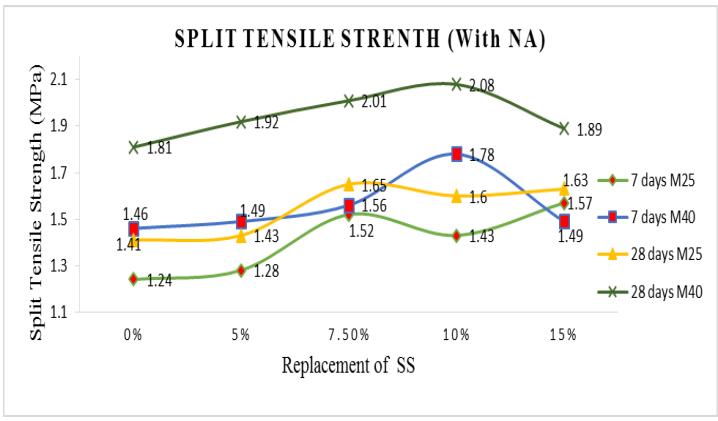

Chart 5: Compressive strength with NA

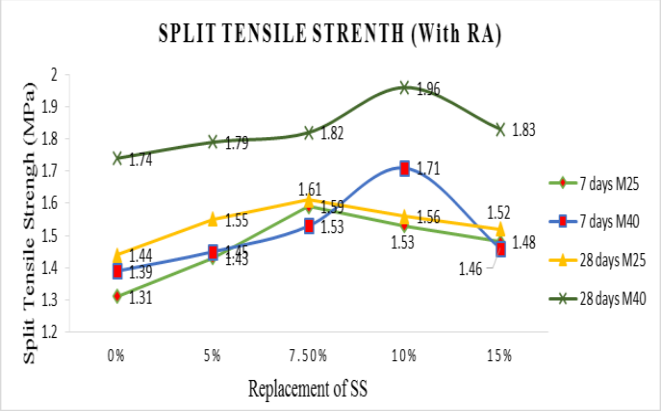

Chart 6: Split tensile strength with RA

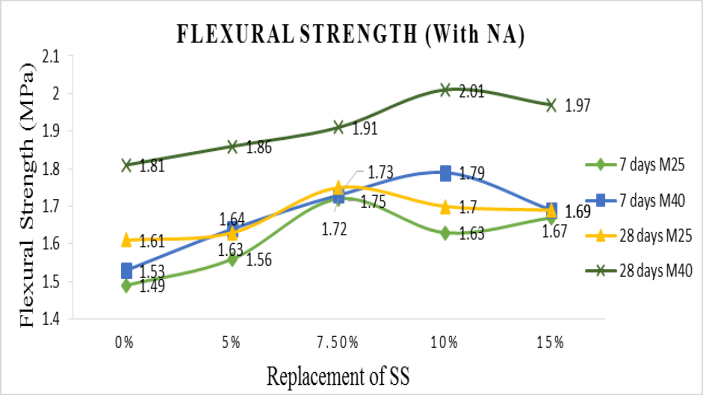

Chart 7: Split tensile strength with NA

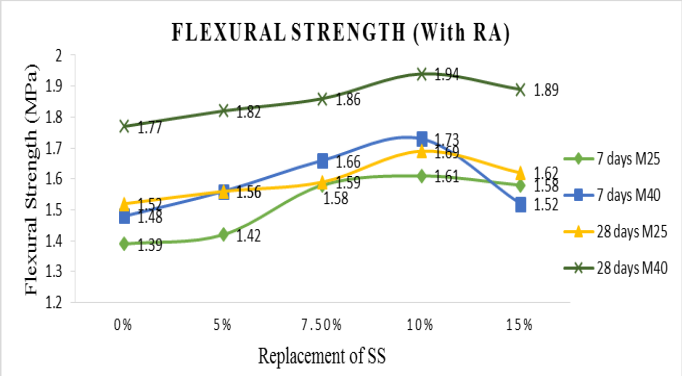

Chart 8: flexural strength with NA

8. CONCLUSIONS

CEMENT

- ✓ Normal consistency increases from 27.5% to 29.5% with replacement of MS at 7.5%.
- ✓ The IST increased by 10.71% at 15% replacement of cement with MS. The FST increased by 10.84% at 15% replacement of cement with MS.

CONCRETE

- ✓ Slump of concrete mix proportions increased with addition of recycled aggregate.
- ✓ Maximum compressive strength increased by 11.29% and 14.41% for CM3 at 7 and 28 days respectively. Maximum compressive strength increased by 9.13% and 11.66% for CM9 at 7 and 28 days respectively.
- ✓ Maximum compressive strength increased by 12.78% and 16.71% for RM3 at 7 and 28 days respectively. Maximum Compressive Strength increased by 16.48% and 12.98% for CM9 at 7 and 28 days respectively.
- ✓ Maximum split tensile Strength increased by 22.58% and 17.02% for CM3 at 7 and 28 days respectively. Maximum split tensile Strength increased by 21.91% and 18.85% for CM9 at 7 and 28 days respectively.
- ✓ Maximum split tensile strength increased by 22.9% and 10.41% for RM3 at 7 and 28 days respectively. Maximum split tensile Strength increased by 23.02% and 12.64% for RM9 at 7 and 28 days respectively.
- ✓ Maximum flexural Strength increased by 15.43% and 8.69% for CM3 at 7 and 28 days respectively. Maximum flexural strength increased by 16.99% and 11.04% for CM9 at 7 and 28 days respectively.
- ✓ Maximum flexural Strength increased by 15.82% and 11.18% for RM3 at 7 and 28 days respectively.
- ✓ Maximum weight loss was affected at 5% replacement of MS in 7 and 28 days.

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