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The Analysis of Strength Properties by Using Stone Dust and Recycled Crushed Concrete

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ABSTRACT- Concrete is one of the most widely used materials worldwide. In 2009, the International Energy Agency reported that approximately 25 Gt of concrete is used worldwide each year, equivalent to more than 3.8 tonnes of concrete per person per year. Total construction demand is expected to reach 48.3 billion tonnes by 2015. The highest consumption was in Asia and the Pacific. Demolition to build new buildings generates a lot of waste. Among the various construction and demolition wastes, concrete waste accounts for 50% of the total waste generation. The top five causes of large amounts of concrete waste are overordering, shipping damage, installation loss, poor technology and design changes. The most common way to dispose of this waste is to dump it in a landfill, which can pollute air and water because of its high alkalinity. Therefore, recycled aggregate concrete (RAC) is an alternative to using natural aggregate (NA) in concrete. Recycled Concrete Aggregate (RCA) is aggregate obtained by recycling clean concrete waste and demolished structures. The effect of different proportions of crushed stone dust and recycled concrete on the compressive strength of M30 concrete was studied. The effect of different ratios of crushed stone dust and ground recycle concrete on the flexural and tear strength of M30 concrete is also observed.

KEYWORDS- Secondary Crushed Stone, Stone Dust, Coarse Aggregate, Fine Aggregate, Cement, Water

I. INTRODUCTION

Globally, the need for sustainable development is increasing The main challenge for the industry is to make a profit by reducing the use of thin and thick mixes. It is possible if we use waste and recycling in concrete, which not only reduces construction costs but also reduces pollution. Recently, researchers have tried to improve the properties of stone using stone dust or crushed stone aggregate. Therefore, this research aims to examine the characteristics of effort to Compressive strength, tensile strength and flexural strength of concrete containing different proportions of nalastone powder and crushed recycled concrete aggregate.

II. LITERATURE REVIEW

A. D. Soares et al. [1]

Presented the results of an experimental campaign developed with the aim of evaluating the effect of the incorporation in concrete of recycled aggregates from crushed elements produced by the Pre-casting concrete industry. An extensive set of tests was performed to evaluate the mechanical and durability properties of all concrete mixes. The results proved that the concrete mixes with recycled aggregates have an equivalent performance to that of the reference concrete in most of the properties.

B. G. Dobbelaere et al. [2]

Intended to determine an equivalent functional unit in concrete with recycled aggregates (RA) to conventional structural concrete in the context of Life-Cycle Assessment (LCA) analyses. This study was developed particularly for slabs and beams, but remarks were made concerning other main structural elements, namely columns and footings. The results showed that the method is valid for slabs and beams and that the conversion formulas yield good results.

C. B. George Dimitriou et al. [3]

sPresented the process used to improve the performance o f RCA by reducing the effect of RCA on concrete and the amount of waste chemicals, thus improving the performa nce of recycled content (RAC). Improved the mechanical properties and durability of the RAC using the blueprint. Cost analysis shows that RAC composites will cost less t han NA composites.

D. J. Montero and S. Laserna [4]

Analyzed the influence of two different modes for estimating the volume of mixing water (total water and effective water) on the dosing and behavior of recycled aggregate concrete. The results suggested that recycled concrete requires a minimal time to achieve an adequate mix and demonstrate that an increase in total water in recycled concrete does not result in strength reduction when the mixtures were dosed with the same volume of effective water. Furthermore, these results conflicted with the recommendation to increase the cement content due to the extra volume of water needed for the recycled mix to maintain the slump and constant water /cement ratio.

E. *Kho Pin Verian et al. [5]*

Presented a review of the potential and challenge of using recycled concrete aggregate (RCA) as the substitute for natural aggregate (NA) in concrete mixtures. Using RCA in concrete preserves the environment by reducing the need for opening new aggregate quarries and decreases the amount of construction waste that goes into landfill. The properties of RCA such as specific gravity, absorption, and the amount of contaminant present in it contribute to the strength and durability of concrete. The quality of RCA depends on the features of the original aggregate and the condition of the demolished concrete. Some researchers have reported that the use of RCA degrades concrete properties while others have successfully produced RCA concrete with a performance that matched normal concrete (NC). In addition to the influence of RCA to concrete properties, this paper also evaluated multiple techniques to improve the performance of RCA concrete, reported cost savings in concrete production and recommendations regarding the application of RCA in concrete.

F. *Liam Butler et al. [6]*

Evaluated the effect of fully replacing natural aggregate (NA) with several sources of recycled concrete aggregate (RCA) on the various mechanical properties of multiple concrete mixtures having equivalent compressive strength and slump (compressive strengths between 40 and 60 MPa and slumps between 75 and 125 mm). The RCA concrete (having equivalent compressive strengths as the NA concrete) had modulus of elasticity values up to 19% lower than NA concrete. The average secant modulus of elasticity of bulk RCA was evaluated and was shown to be proportional to the modulus of elasticity of concrete incorporating the RCA as coarse aggregate. Fracture energy of RCA concrete was measured using single edge notched double-cantilevered (SENDC) beam specimens and was measured to be up to 32% lower in comparison to the NA concrete specimens. Fracture energy of RCA concrete was found to increase with an increase in aggregate strength.

III. METHODOLOGY AND MATERIAL USED

The experimental study was divided into the following stages

- Properties of material used in the study.
- Mix Design M30.
- Workability test of concrete mixes.
- Casting and curing of specimens.
- Strength tests on specimens.

A. *Materials used*

The following are the materials used

- OPC cement 43 grade.
- Crushed coarse stone aggregate.
- Jhelum river sand.
- Crushed waste stone dust from crusher plants.
- Crushed recycled concrete aggregate.

IV. MIX DESIGN

The ratio of raw materials in the stone is very important as it makes the quality and durability of the stone. The concrete mix model adopted for M 30 concrete in this study follows IS:10262-2009[13] (It state that concrete mix design requires following step by step process: 1. Calculation of target strength of concrete. 2. Selection of water-cement ratio. 3. Determination of aggregate air content. 4. Selection of water content for concrete. 5. Selection of cement content for concrete. 6. Calculation of aggregate ratio. 7. Calculation of aggregate content for concrete. 8. Trial mixes for testing concrete mix design strength. The porosity and water absorption of overbaked bricks are higher than natural aggregates. Soak the bricks in water for 24 hours due to its high porosity and water absorption table 1. The combinations for the M30 and table 1 shows the list of combinations.

Table 1: Concrete mix designations

Mix Designation	Fine aggregate replacement (in percentages)	Coarse aggregate replacement (in percentages)
M00	0	0
M02	0	20
M04	0	40
M06	0	60
M08	0	80
M20	20	0
M22	20	20
M24	20	40
M26	20	60
M28	20	80
M40	40	0
M42	40	20
M44	40	40
M46	40	60
M48	40	80
M60	60	0
M62	60	20
M64	60	40
M66	60	60
M68	60	80
M80	80	0
M82	80	20
M84	80	40
M86	80	60
M88	80	80

V. RESULT AND DISCUSSION

A. *Compressive Strength*

For each hybrid sample, compressive strength test was performed on 150 mm sample size according to IS 516-1959 (It state that compressive strength is measured when force is applied uniformly on one surface while the opposite face is fully supported and it is denoted by f_t which is obtained by characteristic compressive strength of concrete at 28 days (f_{ck}) and value of standard deviation (s) i.e., ft = f_{ck} + 1.65 s) on the 7th and 28th days of curing. Table 2 shows the c ompressive strength for different bricks with the percenta ge of cullet and jhama brick and is shown in figure 1.

Table 2: Compressive strength of M30 concrete

Mix Designation	W/C ratio	7th day (MPa	28th day (MPa
M00		25.09	38.65
M02		24.91	38.37
M04		24.68	38.02
M06		24.65	37.96
M08		24.58	37.89
M20		25.36	39.04
M22		25.11	38.69
M24		25.01	38.51
M26		24.98	38.48
M28		24.96	38.45
M40		25.99	39.35
M42		25.91	38.89
M44		25.84	38.71
M46		25.78	38.63
M48		25.63	38.59
M60		26.49	39.85
M62		26.31	39.18
M64		26.27	38.91
M66		26.21	39.87
M68		26.03	38.82
M80		27.19	37.33
M82		27.08	38.86
M84		26.92	38.09
M86		26.87	38.06
M88		26.72	38.02

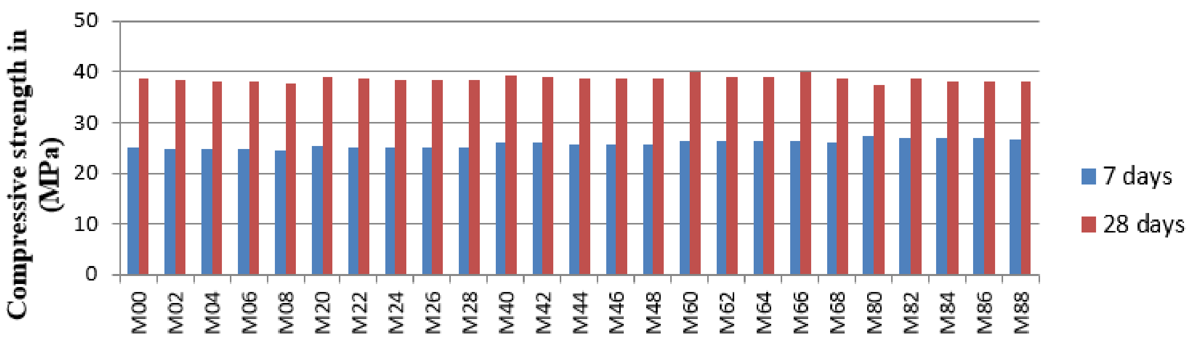

Figure 1: Compressive strength of concrete M30

B. *Flexural Strength*

Tests were performed 7 and 28 days after treatment. Bending tests were performed on 100×100×500 mm beams in accordance with IS 516-1959. (It state that Flexural Strength is measure by bending test. The material is supported on two points placed at the edges of the material while force is applied to its center i.e., F=PL/bd where, F= Flexural Strength, P= load applied, b= effective span & d= depth. Table 3 shows the bending results with different percentages of microsilica. The results are shown in the figure figure 2.

Table 3: Flexural strength of M30 concrete

Mix designation	W/C ratio	7th day (MPa	28th day (MPa
M00		3.21	4.96
M02		3..25	5.02
M04		3.31	5.11
M06		3.25	5.02
M08		3.2	4.98
M20		3.26	5.07
M22		3.24	5.06
M24		3.19	5.1
M26		3.14	5.02
M28		3.12	5
M40		3.45	5.13
M42		3.41	5.08
M44		3.37	5.13
M46		3.34	5.09
M48		3.31	5.04

M60		3.79	5.03
M62		3.71	5.01
M64		3.67	5.07
M66		3.62	5
M68		3.58	4.99
M80		4.01	4.98
M82		3.94	4.99
M84		3.9	5.06
M86		3.86	5.01
M88		3.81	4.97

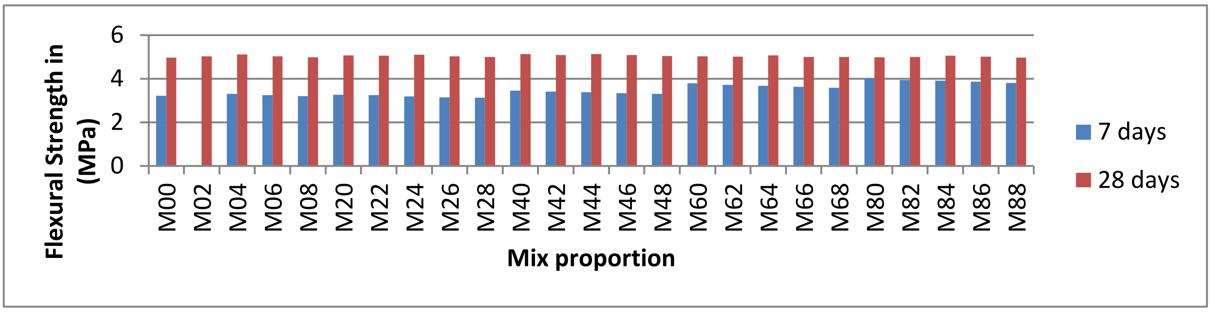

Figure 2: Flexural Strength of Concrete M30

C. *Splitting Tensile strength*

According to IS 5816-1999 (The splitting tensile test is indirect way of evaluating the tensile test of concrete. In this test, a standard cylindrical specimen is laid horizontally and the force is applied on the cylinder radially on the surface which causes formation of a vertical crack in the specimen along its diameter i.e., P=2P/IIDL where, P= splitting tensile strength, II=22/7, D= diameter 0f specimen & L=Length of cylindrical specimen), splitting tensile strength tests were carried out on cylinders with a diameter of 150 mm and a length of 3 00 mm after 7 and 28 days of curing. Table 4 shows the te nsile strength distribution for various percentages of culle t and Jhama bricks. The results are presented graphically (Figure 3).

Table 4: Splitting Tensile Strength of M30 concrete

Mix designation	W/C ratio	7th day (MPa	28th day (MPa
M00		2.16	3.31
M02		2.18	3.35
M04		2.22	3.39
M06		2.19	3.34
M08		2.15	3.31
M20		2.21	3.39
M22		2.19	3.34
M24		2.17	3.37
M26		2.16	3.35
M28		2.17	3.36
M40		2.46	3.42
M42		2.43	3.37
M44		2.4	3.39
M46		2.38	3.41
M48		2.35	3.35
M60		2.69	3.36
M62		2.65	3.34
M64		2.63	3.36
M66		2.59	3.38
M68		2.57	3.34
M80		2.97	3.31
M82		2.95	3.32
M84		2.92	3.34
M86		2.89	3.35
M88		2.86	3.3

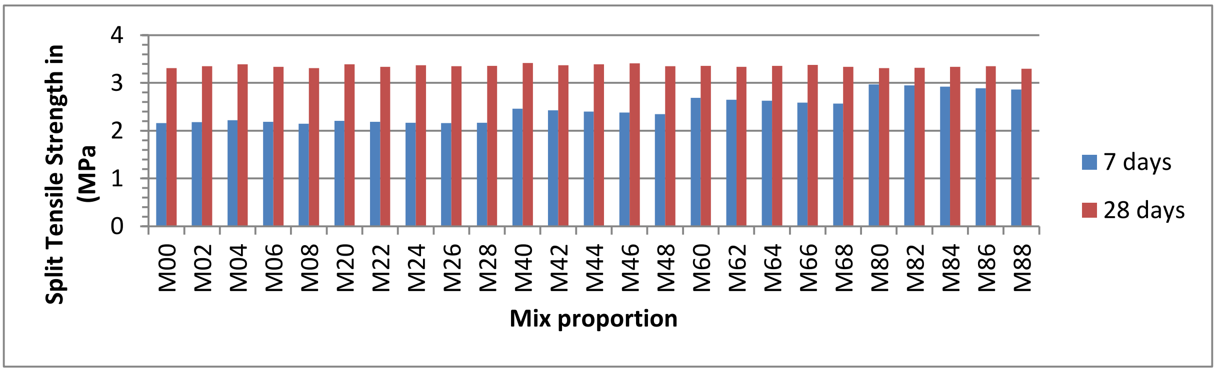

Figure 3: Splitting Tensile Strength of M30 concrete

VI. CONCLUSION AND FUTURE SCOPE

- Sustainability of maximum compressive strength was evaluated and compared at 0, where coarse aggregate was replaced at 0%, 20%, 40%, 60% and 80% with recycled crushed concrete. 50% a
- The compressive strength of the above recycled crushed stone was investigated by replacing 10%, 15%, 20%, 30% and 35% of the fine aggregate with Nallah stone powder, and the compressive maximum compressive strength gave a 35% change.
- one. The increase in compressive strength is greatest when coarse aggregate and cement are replaced with 0 part recycled crushed stone and Nallah stone powder.
- 5% and 11% were 36.2 N/mm2 for 7 days and 48.5 N/mm2 for 28 days, respectively, while control mix M40 was 27.8 N/mm2 for 7 days and 40.17 N/mm2 for 28 days. is
- The maximum tensile strength of the cylinder made by partially replacing the burnt brick with 1%, 0.50%, 1% and 1.5% coarse aggregate was investigated up to 1%.
- The tensile strength of the above burnt brick mixture was investigated by replacing 0%, 7%, 11% and 15% of the fine aggregate with Nallah stone powder and gave the highest tensile strength of 7%.
- one. When the coarse and fine aggregates were partially replaced with 1% and 7% recycled crushed concrete and 7% Nallah stone dust, respectively, the maximum tensile strength at 28 days was 13.3, while it was 12.7 for the M40 N / mm2 N control mix. mm2 in 28 days.
- Scope for future research
- Based on current trends in the use of different materials in concrete, research potential can be explored in the following areas.
- Recycling of waste glass and other waste materials; ceramic tile aggregate, marble waste, burnt brick aggregate etc.
- a 2.
- Steel fiber, polypropylene fiber, rubber fiber, plastic fiber etc. different fibers can be used.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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