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Effect of Acid and Sea Water Curing in Recycled Aggregate Concrete and Strength & Mass Loss Comparison with Nominal Concrete

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Abstract: **Environmental issues such as climate change and associated global warming, depletion of natural resource and biodiversity, water and soil pollution, generation of huge amount of waste materials and their disposal are some of great challenges faced by present day civilization. Recycling of materials and reuse of the material is very important. Recycled concrete aggregates are used in concrete in replacement of nominal concrete aggregates 20mm and grit aggregates, replacement of 50%. Different various percentage of aggregate replacement gives optimum replacement content 50% in mix design of M20 without admixture using. Cubes are curing in sea water solution and H_2SO_4 + HCl acid solution. After duration of 28 day, 56 day and 90 day considering mass loss of 0.07633%, 0.157% and 8.4767% recycled aggregates to nominal cubes for acid curing, and strength will achieved at end of 28 days and 56 day, strength is decreased 4% and at the end of 90 days strength will decreased 4% and same as mass loss. The porosity and voids are generated due to curing of specific condition.**

Keywords: **Acid water Curing, Sea Water curing, Recycled Aggregate concrete, compressive strength.**

I. INTRODUCTION

Construction materials are increasingly judged by their ecological characteristics. Concrete recycling gains importance because it protects natural resources and eliminates the need for disposal by using the readily available concrete as an aggregate source for new concrete or other applications. Recycling of concrete is a relatively simple process. It involves breaking, removing, and crushing existing concrete into a material with a specified size and quality. The crushing characteristics of hardened concrete are similar to those of natural rock and are not significantly affected by the grade or quality of the original concrete. Recycled concrete aggregates produced from all but the poorest quality original concrete can be expected to pass the same tests required of conventional aggregates. [1]

INDIA: PRESENT SCENARIO OF CONSTRUCTION AND DEMOLITION WASTE:

Asian institute of technology, Thailand had conducted a survey in various Asian countries and published a report on reduce, reuse and recycle (3r) practices in construction and demolition waste management in Asia in May 2008. Presently, C & D waste generation in India accounts up to 23.75 million tons annually and these figures are likely to double fold up to 2016. C&D waste and specifically concrete has been seen as a resource in developed countries. Sadhan Ghosh, president of the International Society of Waste Management, India reports that estimated waste generation during construction is 40 to 60 Kg. per sq. m. Similarly, waste generation during renovation/ repair work is estimated to be 40 to 50 kg/sq. m. The highest contribution to waste generation is due to demolition of buildings. Demolition of Pucca and

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Semi-Pucca buildings, on an average generates 500 & 300 kg/ sq.m of waste respectively. In India nearly 50% of Construction & Demolition waste is being re-used and recycled, while the remainder is mostly landfilled.

The cost of construction materials is increasing enormously. In India, the cost of cement during 1995 was Rs. 125/kg and in 2015 the price increased to Rs. 280/bag. In case of bricks the price was Rs. 0.66 per brick in 1995 and the present rate is Rs. 5 per brick in 2015. With the environmental hazards caused by excessive and illegal extraction of river sand, the mining of river sand is banned since April 1, 2012. The raw materials used in construction are largely non-renewable natural resources hence meticulous use of these materials is essential. The demand for aggregates in 2007 has seen an increase by five percent, to over 21 billion tones, the largest being in developing countries like China, India, etc. [2]

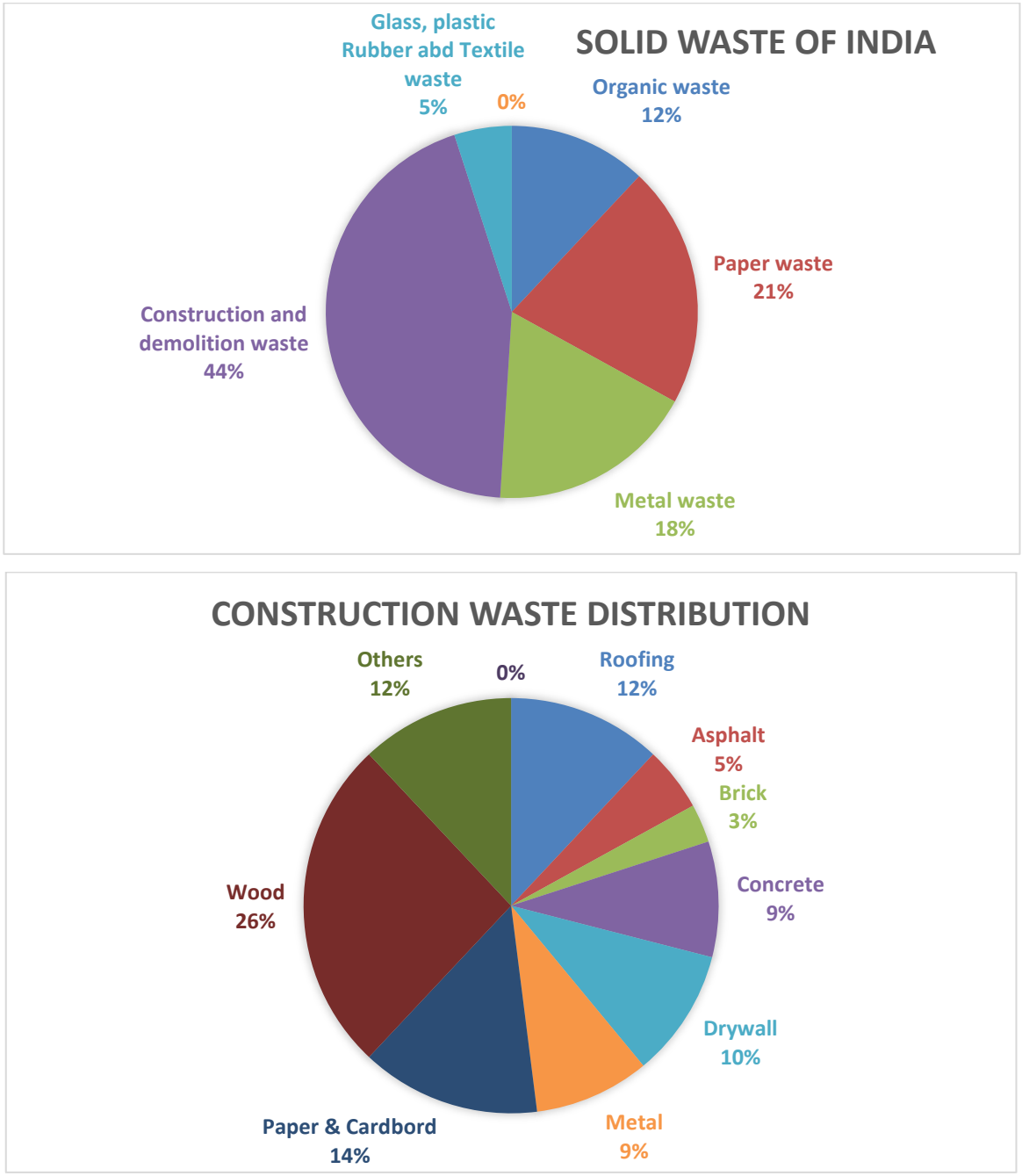

Figure: 1 Construction and Demolition Overview, 2012

This figure [1] shows the basic data of general solid waste in India and contribution of construction materials wastage in India and data is collected from the review paper on demolished material in 2012.

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II. LITERATURE REVIEW

Ferrari, Surico, Brocchi, Banfi, Maltese, Squinzi, "*Method for recycling concrete*" European Journal, June-2012, analysis of this paper we get that A method for recycling reclaimed concrete is disclosed, comprising the addition of a) flash setting accelerators and b) super-absorbent polymers to the unset residual fresh unset concrete and blending this mixture until granular materials are formed in mix design M25 mix design. [3]

Preeti Saini, Deepakar Kr. Ashish "*A Review on Recycled Concrete Aggregates*"SSRG International Journal of Civil Engineering (SSRG-IJCE), April-2015, anaylsis of this paper get that collecting the used concrete and breaking it up, recycled concrete aggregates generated, The application of recycled concrete aggregate as course aggregate in concrete mix has been initiated, to make effective use of the waste materials. If recycled aggregate more than 60% than its impact on concrete properties reduced 25-30%. [4]

P. Saravanakumar and G. Dhinakaran "*Mechanical and Durability Properties of Slag Based Recycled Aggregate Concrete*" IJST, Feb 2015, analysis of this paper get the information that Compressive and tensile strength of admixed RAC has been found to be lower than strength of NAC.90 day strength gain improves concrete more than 20% cement replacement GGBFS without GGBFS.40% GGBFS gives higher strength with 50% RA. Chloride ion penetration test was observed higher replacement (50%) cement extent of 12% GGBFS for 25 to 100% RA. Compressive and tensile strength of admixed RAC has been found to be lower than strength of NAC. 90 day strength gain improves concrete more than 20% cement replacement GGBFS without GGBFS. [5]

Jitender Sharma, Sandeep Singla, **"***Study of Recycled Concrete Aggregates***",** International Journal of Engineering Trends and Technology (IJETT),July-2014, the analysis of this paper gives basic idea about introduction and production of recycled concrete aggregates from demolished waste, reduce consumption of natural aggregates and reduce cost of concrete, general analysis of recycled aggregate. When to W/C ratio used in RA mix is reduced, tensile strength and modules of elasticity are improved, High water absorption and porosity.100% replacement of NA by RCA in concrete mixture may affect on chloride ions resistance, if proper design is not adopted. [6]

Manish Kumar Singh, Dilip Kumar "*Physical Properties of Construction & Demolished Waste Concrete*"**,** IJSRD - International Journal for Scientific Research & Development, 2014 this paper analysis gives the idea about the crushed construction and demolished concrete wastes is segregated by sieving to obtain required sizes of aggregate, several tests were conducted to determine the aggregate properties before recycling it into new concrete. Construction and Demolished waste is used as the coarse aggregate in new concrete. Use of the waste aggregate in the new concrete as the recycled concrete aggregate reduces the environmental pollution as well as providing an economic value for the waste material. [7]

III. EXPERIMENTAL STUDY

The demolished concrete material is collected from 22 year old residential demolished flat located in Ahmedabad area. The material is crushed in concrete lab in Jaw crusher at college lab. After sieve analysis of materials are separated and considered 16 to 20 mm aggregate as Kapchi, and 6.5 to 10 mm aggregate as Grit in replacement of nominal aggregate. Nominal aggregate and sand used locally available. Physical properties test is done on aggregate like aggregate crushing test, Los angelos test, Impact value test, elongation and flakiness index test, moisture content and water absorption test. After checking all physical properties making mix design M20 and getting proportion C: S: A = 1:2.0167:3.40 according the code IS 10262:2009. W/c ratio is considered 0.50. Mix proportion of M20 mix design without adding any admixture is showing in following table for 1 m^3.

M20 mix design for 1m^3	
Cement	372Kg.
Water	186 lit./Kg.
Fine aggregate(Sand)	750.1802 Kg.
Coarse aggregate	1265.354 Kg.
CA (20mm)	759.212 Kg.
CA(10mm)	506.1416 Kg.

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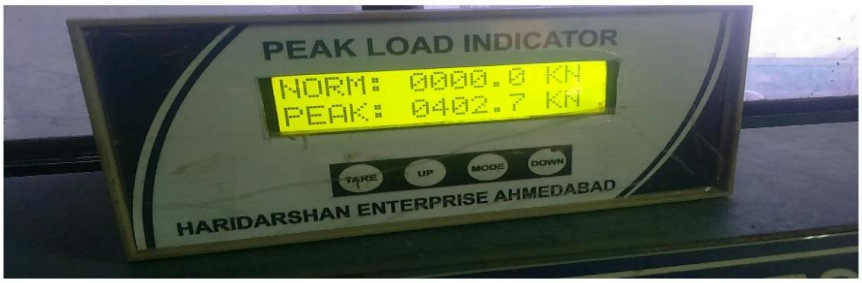
The cubes are curing in 10% of H_2SO_4 + HCl acid curing and another solution is Sea water curing for 28 day, 56 day and 90 day curing period. Weight of cubes are taking at initial stage and final stage. And compared the mass loss and strength loss and their percentage.

IV. EXPERIMENTAL RESULTS

Different test results are shown in below tables. Results of Acid curing cube test, Sea water curing cube test, Mass loss of cubes, strength comparison of cubes to the nominal cubes.

(1) Acid water curing and compressive strength:

Cubes are casting in mix design of M20 with nominal concrete mix design and M20 with recycled aggregate concrete of 50% of replacement of normal aggregate. Cubes are curing for 28 day, 56 day and 90 day curing period. Curing is done in H_2SO_4 + HCl Solution of 10%. At the expiration of each curing age, cubes were tested for compressive strength.



Average of three readings was recorded for each curing age result. All the concrete cubes were cured under the laboratory conditions, with average minimum and maximum temperatures within 25°C and 35 °C respectively.

Acid curing (H_2SO_4+HCl) 28 day compressive and weight loss								
Replacement %	M20 0%	M20 50%	M20 0% initial weight	M20 0% final weight	Weight loss % 0%	M20 50% initial weight	M20 50% final weight	Weight loss % 0%
Compressive strength (1) N/mm^2	20.2533	21.4977	8.750	8.740	0.114	8.190	8.180	0.122
Compressive strength (2) N/mm^2	23.2711	20.928	8.690	8.680	0.115	8.320	8.310	0.12
Compressive strength (3) N/mm^2	21.911	21.8088	8.830	8.830	0	8.460	8.460	0
Average compressive strength	21.8118	21.4115	-	-	-	-	-	-
Weight loss average			-	-	0.07633	-	--	0.0806

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Acid curing (H_2SO_4+HCl) 56 day compressive and weight loss								
Replacement %	M20 0%	M20 50%	M20 0% initial weight	M20 0% final weight	Weight loss % 0%	M20 50% initial weight	M20 50% final weight	Weight loss % 0%
Compressive strength (1) N/mm^2	14.04	20.0355	8.750	8.730	0.228	8.660	8.650	0.115
Compressive strength (2) N/mm^2	23.75	23.95	8.980	8.940	0.445	8.450	8.430	0.236
Compressive strength (3) N/mm^2	24.22	28.048	8.450	8.420	0.355	8.280	8.270	0.12
Average compressive strength	20.67	24.011	-	-	-	-	-	-
Weight loss average	-	-	-	-	0.342	-	--	0.157

Acid curing (H_2SO_4+HCl) 90 day compressive and weight loss								
Replacement %	M20 0%	M20 50%	M20 0% initial weight	M20 0% final weight	Weight loss % 0%	M20 50% initial weight	M20 50% final weight	Weight loss % 0%
Compressive strength (1) N/mm^2	23.311	9.768	8.620	8.180	5.39	8.420	7.670	8.90
Compressive strength (2) N/mm^2	27.9422	14.235	8.870	8.240	7.10	8.460	7.890	6.73
Compressive strength (3) N/mm^2	23.2844	16.09	8.830	8.600	2.604	8.260	7.450	9.80
Average compressive strength	24.845	13.364	-	-	-	-	-	-
Weight loss average			-	-	5.031	-	--	8.4767

Mass of the concrete cubes is observed to be gradually reducing. This effect may be attributed to the effect of curing in sulphuric acid solution. Mass is reduced very high at 90 days and strength is also decreased gradually.

2. Sea water curing:

Surfaces of the specimens were washed carefully with plain water for the visual examination of outer surfaces of all the specimens. Concrete specimens made by using both plain and sea water as mixing water showed change in color from dark grey to whitish grey when exposed to sea water.

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The compressive strength of different grades of concrete cast and cured with plain water and sea water with different exposure period for 28 day, 56 day and 90 days.

sea curing 28 day compressive and weight loss								
Replacement %	M20 0%	M20 50%	M20 0% initial weight	M20 0% final weight	Weight loss % 0%	M20 50% initial weight	M20 50% final weight	Weight loss % 50%
Compressive strength (1) N/mm^2	21.2733	22.706	8.750	8.740	0.114	8.660	8.650	0.115
Compressive strength (2) N/mm^2	21.684	24.3466	8.830	8.830	0	8.500	8.490	0.117
Compressive strength (3) N/mm^2	22.3066	23.5866	8.880	8.870	0.112	8.450	8.450	0
Average compressive strength	21.787	23.5464	-	-	-	-	-	-
Weight loss average	-	-	-	-	0.07533	-	--	0.07733

sea curing 56 day compressive and weight loss								
Replacement %	M20 0%	M20 50%	M20 0% initial weight	M20 0% final weight	Weight loss % 0%	M20 50% initial weight	M20 50% final weight	Weight loss % 50%
Compressive strength (1) N/mm^2	25.115	27.235	8.280	8.260	0.241	8.270	8.260	0.12
Compressive	21.595	25.235	8.840	8.830	0.113	8.540	8.530	0.117

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strength (2) N/mm^2								
Compressive strength (3) N/mm^2	22.68	25.373	8.630	8.620	0.115	8.590	8.580	0.116
Average compressive strength	23.13	25.9476	-	-	-	-	-	-
Weight loss average	-	-	-	-	0.1563	-	-	0.1176

sea curing 90 day compressive and weight loss								
Replacement %	M20 0%	M20 50%	M20 0% initial weight	M20 0% final weight	Weight loss % 0%	M20 50% initial weight	M20 50% final weight	Weight loss % 50%
Compressive strength (1) N/mm^2	17.897	10.844	8.750	8.570	2.057	8.450	8.130	3.786
Compressive strength (2) N/mm^2	22.573	21.84	8.690	8.370	3.682	8.750	8.470	3.2
Compressive strength (3) N/mm^2	25.3466	16.48	8.340	8.340	3.248	8.430	8.140	3.44
Average compressive strength	21.9389	16.388	-	-	-	-	-	-
Weight loss average	-	-	-	-	2.99	-	--	3.475

Mass is reduced of cubes and strength is decreased at end of 90 day curing period. Salt effect is shown in cubes.

V. CONCLUSION

Form the results, getting high strength at the end of 28 days in nominal concrete M20, in these test procedure weight loss of cube is 0.07633% for nominal concrete and 0.0806% for Recycled aggregate concrete in Acid curing. For nominal concrete and recycled aggregate concrete cube strength is 21.8118 N/mm^2 and 21.4115 N/mm^2 at the end of 28 days in H_2SO_4+HCl acid curing. For sea water curing concrete cube strength is 21.787 N/mm^2 and 23.546 N/mm^2 for nominal concrete and recycled aggregate concrete at the end of 28 days and mass loss is 0.07533% and 0.07733% for nominal concrete and recycled aggregate concrete. For same at end of 56 day compressive strength and mass loss are 20.67 N/mm^2 and 24.011 N/mm^2 and 0.342% and 0.157% for Nominal concrete M20 mix and Recycled concrete in acid curing. For same at end of 56 day compressive strength and mass loss are 23.13 N/mm^2 and 25.9476N/mm^2 and 0.1563% and 0.1176% for Nominal concrete M20 mix and Recycled concrete in sea water curing. For same at end of 90 day compressive strength and mass loss are 24.845 N/mm^2 and 13.364 N/mm^2 and 02.4845% and 8.4767% for Nominal concrete M20 mix and Recycled concrete in acid curing, which is very high mass loss and strength loss. For same at end of 90 day compressive strength and mass loss are 21.9383 N/mm^2 and 16.388 N/mm^2 and 2.99 and 3.475 % for Nominal concrete M20 mix and Recycled concrete in sea water curing which is very high to reduce strength and mass loss.

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