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# Experimental Study on Performance of Recycled Coarse Aggregate as Natural Aggregate and Fly Ash as Fractional Replacement for Cement with Water Binding Ratio.

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**ABSTRACT:** In the current study, experimental investigation is conducted to study the properties of concrete, when the Natural Coarse Aggregate (NCA) is replaced with 30% Recycled Coarse Aggregate (RCA) and fly ash as a fractional replacement for cement in the range of 10%, 20% and 30% with different W/B ratio as 0.38, 0.40 and 0.42. Specimens are prepared with natural, recycled coarse aggregate and to be tested after a curing period of 7, 14, 28, 56, days. The investigation was carried for workability, Compressive strength, split tensile strength. The investigation deals with the flexural behaviour of beams using fly ash at various cement replacement levels of 10 %, 20% and 30% with W/B ratio of 0.38, 0.40 and 0.42. The use of recycled aggregates in concrete creates a lot of possibilities in the reuse of materials in the building industry.

**KEYWORDS:** Natural coarse aggregate, Reused coarse aggregate, Water Binding ratio, Fly ash, Compressive strength, Tensile strength.

### I. INTRODUCTION

Concrete is the premier construction material used widely across the world in all types of engineering works, it plays an important role in shaping our environment and sustainability of construction industry. Sustainable construction is widely used concept now. In addition to the 1.5 billion tons of cement used worldwide, the concrete industry is consuming 10 billion tons of sand and rocks and 1 billion tons of water mixing is annually used. It's the world's most widely used construction materials but it is not eco-friendly materials too.

In latest years, the potential for recyclable construction and demolition waste has made it a target of interest and the main focus of waste management policies on encouraging minimization, reuse, recycling and valorisation of waste as opposed to its final disposal in landfills. It is important to encourage the use of waste from the construction sites, in the case of recycled aggregate. There are various Efforts to improve the properties of concrete are made continuously by many researchers. In the last two decade, construction industry has been conducted various research on the utilization of waste products from concrete.

### II. LITERATURE REVIEW

**Prafulla Kumar Tiwari<sup>1</sup>, Dr. Raman Nateriya<sup>2</sup>** has conducted an experiment on Replacement of recycled coarse aggregate with natural coarse aggregate in concrete. In this study we replaced natural aggregates with recycled aggregates in concrete cubes. This is the first part of the study we have to do. Here we are trying to see a pattern of how the strength decrease once we replace natural coarse aggregate (NCA) with recycled coarse aggregates (RCA). The

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percentages of replacement will be 0%, 50% and 100%. The test and design are done with reference to Indian standard code. The concrete cubes are designed for M30 as per Indian standard codes. The cubes are already made in the lab. They are broken by manual means. Then they are taken from the chunks in the sizes of 20 mm. then various tests are performed like impact test, abrasion test compressive test on 100% recycled coarse aggregates, 100% natural aggregates and 50% natural aggregates+50% recycled coarse aggregates. This is done to see and verify the various patterns. After getting sufficient values a mix design is prepared for 0% 50% and 100% recycled coarse aggregates. IS 10262 code is used for Mix design. The aggregate are placed as per volume in the cubes but the specific gravity of N.C.A. & R.C.A. are different. Thus we can't replace recycled coarse aggregate (R.C.A.) directly with the same amount of natural coarse aggregate (N.C.A.). We know the fact that volume of both aggregates should be equal.

**U.Sridhar, B.Karthick** has conducted an investigation on recycled concrete aggregate and m-sand as aggregate replacement in concrete to study the properties of concrete with replacement of 50% of nature sand by m-sand and coarse aggregates by altered proportions with recycled coarse aggregates (RCA). A mix proportion for M20 grade concrete is referred from IS codes. RCA was fractionally replaced by coarse aggregate in the proportions of 10%, 20%, 30% and 40% and fine aggregate by M-sand for 50% as constant. Finally it showed that RCA reduces the workability of concrete. But that can be easily avoided with plasticizers. The new property of fresh and hardened part of concrete was studied and compared with conventional concrete. The compressive strength RCA is found to be higher than that of conventional concrete when fractioned by up to a 50 %. Finally conclude that the RCA fractioned up to 50 % can be used for obtaining good concrete.

**Dr S L Pati1, J N Kale, S Suman** has conducted a technical analysis for compressive strength of fly ash concrete. Fly ash is a by-product waste generated from thermal power plants is as such a big ecology concern. This investigation report state that the use of fly ash in cement concrete as a partial replacement of cement as well as an chemical so as to provide an eco-friendly consistent way of its disposal and reuse. This work is a case study from deep thermal power plant of Jalgaon District. The cement in concrete matrix is exchanged from 5% to 25% by step in steps of 5%. It is observed that exchange of cement in any proportion reduces the compressive strength of concrete as well as delays its hardening. This puts an eco-friendly method of Deep Nagar fly ash disposal. Hence recycled coarse aggregate can be used as partial replacement for coarse aggregate.

**T.G.S Kiran, M.K.M.V Ratnam** has conducted on study of partial replacement fly ash by cement in concrete and durability study of fly ash in acidic sulphuric environment. Cement production gives rise to CO<sub>2</sub> emissions generated by the calcinations of CaCO<sub>3</sub> and by the fossil, being responsible for about 5% of the CO<sub>2</sub> emissions in the world. This can be substantially reduced if cement replacement materials such as a fly ash are used within the frame work of a comprehensive research concerning this residual of coal industries, gives some strength characteristics of concretes made with Fly ash. In this project report the results of the tests carried out on Sulphate attack on concrete cubes in water with H<sub>2</sub>SO<sub>4</sub> solution. Also, targeting the use of fly-ash as the exchange for cement. The current experimental examination were carried on fly ash and has been chemically and physically characterized, and partially replaced in the ratio of 0%, 5%, 10%, 15%, 20% by weight of cement in concrete. Fresh concrete tests like compaction factor test was hardened concrete tests like compressive Strength at the age of 28 days, 60 days, 90days was obtained and also durability aspect of fly ash concrete for sulphates occurrence was tested. This result gives that fly ash improves concrete strength.

**A.Dhanasekaran, Dr.V.M.Shanthi** had conducted an study on use of recycled concrete aggregate as partial replacement for natural aggregate. In this paper an attempt is made to examine the possibility of using recycled concrete aggregate (RCA) as a substitute to natural coarse aggregate (NCA). In the second part of the experimental investigation mechanical properties of concrete made with fly ash as a partial replacement of cement in proportions of 0%, 10, 20 and 30% at water binder ratio of 0.4 was studied with recycled concrete aggregate as a partial replacement of natural coarse aggregate. an attempt is made to examine the possibility of using recycled concrete aggregate (RCA) as a substitute to natural aggregate (NCA). In the second part of the paper concrete specimens were cast by partially replacing cement by silica fume, and NCA was replaced by 30% RCA. 20% replacement of cement by fly ash gave the optimum results.

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## III.MATERIAL USED

**Recycled coarse aggregate:** Unwanted concrete and brickwork can get by arranging, crushing and separating into recycled aggregate. Aggregates normally constituent up to 55% to 70% of the capacity of a concrete mixture. The managing of growing considerable amount of demolition's rubble waste, lack of dumping spots, rise in shipping and clearance cost. But most of the industries companies are still not aware of this environmental dangerous wastages and its recycling.

Properties	10% RCA	20% RCA	30% RCA	40% RCA	50% RCA
Specific gravity	2.85	2.70	2.85	3.05	3.27
Impact value in percentage(%)	20.8	21	22	22.7	23.6
Los Angeles Abrasion value in percentage(%)	29	29.5	29.7	30.6	31.4
Aggregate Crushing Value(%)	29.45	29.25	29.5	32	33.25

Table 3.1 Properties of RCA

**Fly ash:** Fly ash particles are almost totally spherical in shape, allowing them to flow and blend freely in mixtures. These materials greatly improve the strength of concrete through control of high thermal gradients, pore refinement, depletion of cement alkalis, resistance to chloride and sulphate penetration, and continued micro through a long-term hydration and pozzolanic reaction. The use of by-products as the fractional replacement of cement has important economical, environmental and technical benefits such as the reduced amount of waste materials, cleaner environment, reduced energy requirement.

Chemical Properties	IS:3812-1981	Fly ash
SiO <sub>2</sub> +Al <sub>2</sub> O <sub>3</sub> +Fe <sub>2</sub> O <sub>3</sub> min% by mass	70.0	90.5
SiO <sub>2</sub> min% by mass	35.0	58
CaO max% by mass	5.0	3.6
SO <sub>3</sub> max% by mass	2.75	1.8
Na <sub>2</sub> O max% by mass	1.5	2
L.O.I max% by mass	12.0	2
MgO max% by mass	5.0	1.91

Table 3.2 Properties of Fly ash

**Cement:** Cement used in this investigation was 53 grade ordinary Portland cement confirming IS: 12269: 1987.

S.No	Test Particulars	Result obtained	From IS8112-1989
1	Specific gravity	3.15	3.15
2	Normal Consistency	32	30-35
3	Initial Setting time (min)	40	>30
4	Final Setting time (min)	590	<600

Table 3.3 Properties of Cement

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**Fine aggregate specification:** The fine aggregate used was obtained from our college campus. The fine aggregate conforming to zone II according to IS: 383-1970 was used for this study.

Properties	Values
Specific gravity	2.67
Grading Zone	II
Fineness modulus	2.72
Type	River Sand
Total water absorption	1.0%
Net water absorption	0.86%

**Table 3.4 Properties of Fine aggregate**

**Super Plasticizer:**

Properties	Description
Colour	Brown
Specific gravity	1.220 to 1.225 at 30 <sup>0</sup> C
Air Entrainment	Approximately 1% additional air is entrained

**Table 3.5 Properties of Super Plasticizer**

**Natural Coarse Aggregate:** The coarse aggregate is according to IS: 383-1970 was used. Locally available aggregate from quarries in Tirunelveli were used in this study. Single size aggregate of 20 mm size was used for the entire investigation.

Property	Values
Specific gravity	2.76
Fineness Modulus	6.81
Type	Crushed
Total water absorption	0.5%
Moisture content	Nil

**Table 3.6 Property of NCA**

**Mix Design**

### MIX PROPORTIONS

Unit	Water	Cement	Fine aggregate	Coarse aggregate
Kg/m <sup>3</sup>	158	395	782	1099
Ratio	0.40	1.00	1.90	2.7

Various Mix Proportions in different W/B ratio

Mix	Mix ratio
M1	1 : 1.8 : 2.64 : 0.38
MII	1 : 1.9 : 2.7 : 0.40
MIII	1 : 2.07 : 2.9 : 0.42

**Table 3.7 Mix Proportion**

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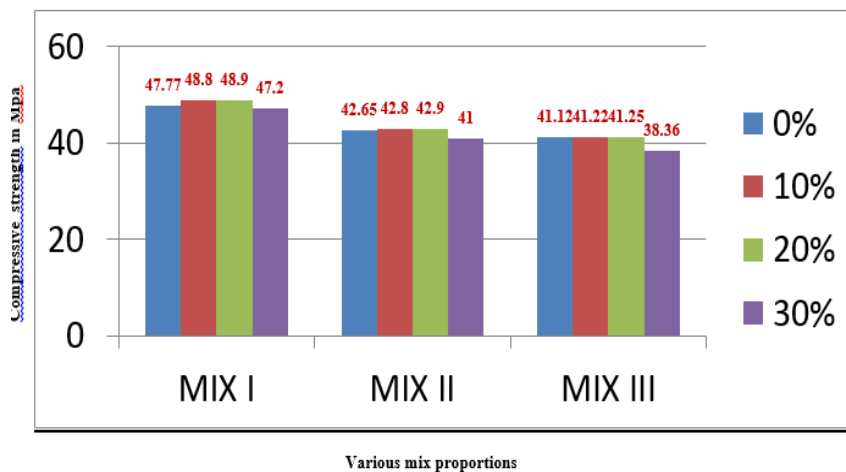
### IV. EXPERIMENTAL INVESTIGATION AND RESULT ANALYSIS

**Comparison of Compressive Strength in different mix proportion:**

% Fly ash	0%	10%	20%	30%
MIX I (N/mm <sup>2</sup> )	47.77	48.8	48.9	47.2
MIX II (N/mm <sup>2</sup> )	42.65	42.8	42.9	41
MIXIII (N/mm <sup>2</sup> )	41.12	41.22	41.25	38.36

**Table 5.1 Comparison of Compressive Strength in different mix proportion**

**Graph for comparison of compressive strength in different mix proportion**



The above Figure shows the compressive strength of 28 days result observed for 30% of RCA and different % of fly ash in various mix proportion of concrete. The above result 28 days result observed the optimum percentage of compressive strength. This result higher than the control mix I result.

**Comparisons of Split Tensile strength of various mix proportions:**

% FLYASH	0%	10%	20%	30%
MIX I (N/mm <sup>2</sup> )	3.89	3.54	3.4	3.27
MIX II (N/mm <sup>2</sup> )	3.72	3.38	3.34	3.16
MIX III (N/mm <sup>2</sup> )	3.47	3.3	3.34	2.98

**Table 5.2 Comparison of Split Tensile strength of various mix proportions**

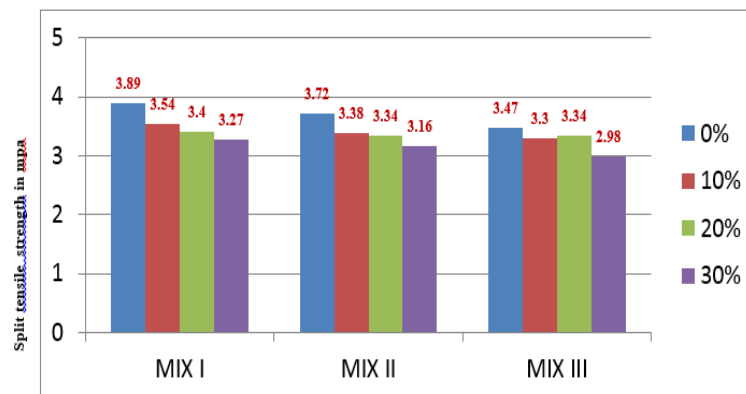
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### Graph for split tensile test in various mix proportion



The above Figure shows the split tensile strength of 28 days result observed for 30% of RCA and different % of fly ash in various mix proportion of concrete. The above result 28 days result observed the optimum percentage of split tensile strength. This result higher than the control mix I days result.

### V.CONCLUSION

In cube compressive strength of the optimum level of RCA replacement with natural coarse aggregate was found to be 30%. In cube compressive strength the Optimum level of cement replacement was found to be 20 % of Fly ash. In cylinder, strength of the Optimum level of cement replacement was found to be 20 % of Fly ash. From the test results natural coarse aggregate can be replaced by recycled concrete aggregate up to 30 % and cement can be replaced up to 20 % by Fly ash. By replacing NAC by RAC economy can be achieved and also to certain extend environmental pollution can be reduced.

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