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STRENGTH CHARACTERISTICS OF CONCRETE MADE WITH RECYCLED COARSE AGGREGATES

Aquib Javid[1], Er. Mohit Bajaj[2]
M.tech Scholar in GEC, Panipat,
Assistant Professor in Architecture Engineering, Chandigarh University

Abstract: Concrete is one of the most widely used construction materials in the world, mainly due to its favorable features such as durability, versatility, satisfactory compressive strength, cost effectiveness. But with the depleting natural resources and the huge amount of concrete waste produced, it becomes essential to identify an effective way to solve the need of the moment. In this rapid industrialized world, recycling construction material plays an important role to preserve the natural resources. In this research, Recycled Coarse Aggregates (RCA) from demolished slab pieces was used. These demolished slab pieces are crushed to suitable size and reused as recycled coarse aggregate. Natural sand used as fine aggregate. Concrete industry, uses 12.6 billion tons of raw materials each year, is the largest user of natural resources in the world. The environmental impact of production of raw ingredients of concrete (such as cement and coarse and fine aggregates) is considerable. In this paper The mix design has been done by trial and error method. The mix proportions are calculated as per IS code. The design procedure as per IS code and IRC: 44-2008 is used in mix design of M30 grade cement concrete. The w/c ratio is taken 0.5% for all the mixes. Hence, Coarse aggregates was replaced in percentages of 0%, 25%, 50%, 75%, 100 % with recycled coarse aggregates 150 × 150 × 150mm, Beam and Cylinder moulds were used for casting.

Keywords: Recycled Aggregates, Compressive strength, Fresh Concrete, Waste management.

1.0 INTRODUCTION

As we know that concrete is the main construction material across the world and the mostly used in all types of civil engineering works. As aggregate represents about 70-80% of concrete components so it will be beneficial to recycle the aggregate for construction works and also to solve the environmental problems. To minimize the problem of excess of waste material it is a good step to utilize the recycled aggregates provides that the desired final product will meet the standards. The Cost of Recycled Concrete Aggregate may be less than 20 to 30 % less than natural aggregate in some regions. By using the recycled aggregate the consumption of natural aggregate can be reduced. Indian construction industry today is amongst the five largest in the world and at the current rate of growth, it is slated to be amongst the top two in the next century. With the shortage as likely seen today the future seems to be in dark for the construction sector. The requirements of natural aggregates are not only required to fulfill the demand for the upcoming projects, but also are the needs of the extensive repairs or replacements required for the existing infrastructure and dilapidated buildings built few decades back. Construction and demolition disposal has also emerged as a problem in India. India is presently generating construction and demolition waste to the tune of 23.75 million tons annually as per the Hindu online of March 2007, which is comparable to some of the developed nations and these figures are likely to double fold in the next 7 years. The management of construction and demolition waste is a major concern due to increased quantity of demolition rubble, continuing shortage of dumping sites, increase in cost of disposal and transportation and above all the concern about environment degradation. The increasing problems associated with construction and demolition waste have led to a rethinking in developed countries and many of these countries have started viewing this waste as resource and presently have fulfilled a part of their demand for raw material. Since concrete composes 35% of the waste as per the survey conducted by Municipal Corporation of Delhi, India may also have to seriously think of reusing demolished rubble and concrete for production of recycled construction material. Work on recycled concrete has been carried out at few places in India but waste and quality of raw material produced being site specific, tremendous inputs are necessary if recycled material has to be used in construction for producing high grade concrete. Aggregate form a major portion of the pavement structure and they form the prime material used in pavement construction. Aggregates have to bear stresses occurring due to the wheel loads on the pavement and on the surface course they have to resist wear due to abrasive action of traffic. These are used in pavement construction in cement concrete, bituminous concrete and other bituminous construction and also as granular base course underlying the superior pavement layers. Most of the road aggregates are prepared by crushing natural rock. Natural materials are of limited availability and its quantities are declining rapidly creating an acute shortage.

1.1 ENVIRONMENTAL IMPACT

There is following a major factor which highly depends on the environment on the basis of recycling aggregate during any type of construction:

- Dust
- Noise
-

1.3.1 Dust

Dust sources associated with mineral, waste and construction type activities fall into two types: Material crushing, screening and segregation plant and conveyor transfer of material, large stockpiles/spoil heaps with no containment where the surface is vulnerable to wind erosion. Vehicles travelling over unmade surfaces, particularly at high speeds, cause particles to be elevated with the finer particles capable of being carried long distances beyond site boundaries. Transportation and handling of material using loaders, excavators, and Lorries can produce dust through spillage and wind erosion. The following help eliminate wind entrainment of dust and therefore stop the dust becoming airborne at source.

Crushers and screeners operating inside would need specialist dust collection and filtration equipment for the working environment and to reduce dust escaping, through material access and exit from the building. Free falling fine material can be taken by the wind and larger material can fragment on compaction, therefore discharge of the material from chutes should be as close as possible to the stockpile.

1.3.2 Noise

Noise created through the process of aggregate recycling can have a significant impact on the environment. It is therefore important to recognize this and manage it carefully. Noise from the production of recycled aggregates is normally not sufficiently high to cause physical damage to property or hearing, but it may well be high enough to cause disturbance. Noise is therefore a 'nuisance' issue for recycled aggregates operations. Crushing and screening plants are normally hydraulically activated with the hydraulic pressure generated by a diesel engine, which is one source of noise. In both, noise is also created by material impacting the metal hoppers and chutes of the machine. The crusher produces noise from the impact of the jaws or hammers on the material. In screens, the movement of the material across the screen surface can cause noise

1.2 IMPORTANCE OF RESEARCH TOPIC

The topic "Effect of recycled coarse aggregate on concrete properties" has been selected for the present study to examine the physical and the mechanical properties of RCA incorporated in cement concrete.

The aim of this project is to determine the strength characteristic of RCA for application in high strength concrete, which will give a better understanding on the properties of concrete with RCA as an alternative material to fresh coarse aggregate in concrete. This will help in achieving economy in road construction as well as saving environmental degradation in term of reduced mining and less pollution. Use of RCA will also conserves resources, landfill space and will generate profit for the recyclers.

LITERATURE ON USE OF RECYCLED AGGREGATES

Md. Safiuddin reviewed the **Use of recycled concrete aggregate in concrete.** The use of recycled concrete aggregate (RCA) in concrete as partial and full replacements of natural coarse aggregate is growing interest in the construction industry, as it reduces the demand for virgin aggregate. In addition, the use of RCA leads to a possible solution to the environmental problem caused by concrete waste and reduces the negative environmental impact of the aggregate extraction from natural resources. This paper presents a comprehensive review on the use of RCA in concrete based on the experimental data available in the published research. The most important physical, mechanical, and chemical properties of RCA are discussed in this paper. However, more emphasis has been given to discuss the effects of RCA on the fresh and hardened properties and durability of concrete. This paper also identifies the gaps existing in the present state of knowledge on RCA and RCA concrete and provides some recommendations for future research.

Paine, K. A et al to develop this performance-related approach, concrete mixes were cast and tested using combinations of unbound stone, crushed concretes and crushed bricks. From the results, three classes of recycled aggregates have been derived based on Los Angeles coefficient, aggregate absorption, density and drying shrinkage of the combined coarse aggregate. The concept is that the highest quality recycled aggregates will be suitable for high-performance applications, meeting the relevant standards and specifications, while the two lower classes will be more appropriate for lower performance applications. Given this approach, material that is currently not fully specified for use in BS 8500 may be classified and considered for relevant applications. This should remove the main technical barrier that is preventing the uptake of recycled aggregates in concrete, and lead to greater confidence in specifying and using recycled aggregates.

Rakshvir M et al studied the recycled aggregates-based concrete. In this study various physical and mechanical properties of recycled concrete aggregates were examined. Recycled concrete aggregates are different from natural aggregates and concrete made from them has specific properties. The percentages of recycled concrete aggregates were varied and it was observed that properties such as compressive strength showed a decrease of up to 10% as the percentage of recycled concrete aggregates increased. Water absorption of recycled aggregates was found to be greater than natural aggregates, and this needs to be compensated during mix design.

Marinković S et al studied on the Comparative environmental assessment of natural and recycled aggregate concrete. The main purpose of this study is to determine the potentials of recycled aggregate concrete (concrete made with recycled concrete aggregate) for structural applications and to compare the environmental impact of the production of two types of ready-mixed concrete: natural aggregate concrete (NAC) made entirely with river aggregate and recycled aggregate concrete (RAC) made with natural fine and recycled coarse aggregate. Based on the analysis of up-to-date experimental evidence, including own tests results, it is concluded that utilization of RAC for low-to-middle strength structural concrete and non-aggressive exposure conditions is technically feasible. The Life Cycle Assessment (LCA) is performed for raw material extraction and material production part of the concrete life cycle including transport. Assessment is based on local LCI data and on typical conditions in Serbia. Results of this specific case study show that impacts of aggregate and cement production phases are slightly larger for RAC than for NAC but the total environmental impacts depend on the natural and recycled aggregates transport distances and on transport types. Limit natural aggregate transport distances above which the environmental impacts of RAC can be equal or even lower than the impacts of NAC are calculated for the specific case study.

Siddique R et al reviewed the Use of recycled plastic in concrete. The use of waste products in concrete not only makes it economical, but also helps in reducing disposal problems. Reuse of bulky wastes is considered the best environmental alternative for solving the problem of disposal. One such waste is plastic, which could be used in various applications. However, efforts have also been made to explore its use in concrete/asphalt concrete. The development of new construction materials using recycled plastics is important to both the construction and the plastic recycling industries. This paper presents a detailed review about waste and recycled plastics, waste management options, and research published on the effect of recycled plastic on the fresh and hardened properties of concrete. The effect of recycled and waste plastic on bulk density, air content, workability, and compressive strength, splitting tensile strength, modulus of elasticity, impact resistance, permeability, and abrasion resistance is discussed in this paper.

López-Gayarre F et al studied the influence of recycled aggregate quality and proportioning criteria on recycled concrete properties. This paper presents the results of experimental research using concrete produced by substituting part of the natural coarse aggregates with recycled aggregates from concrete demolition. The influence of the quality of the recycled aggregate (amount of declassified and source of aggregate), the percentage of replacement on the targeted quality of the concrete to be produced (strength and workability) has been evaluated. The granular structure of concrete and replacement criteria were analyzed in this study, factors which have not been analyzed in other studies. The following properties of recycled concretes were analyzed: density, absorption, compressive strength, elastic modulus, amount of occluded air, penetration of water under pressure and splitting tensile strength. A simplified test program was designed to control the costs of the testing while still producing sufficient data to develop reliable conclusions in order to make the number of tests viable whilst guaranteeing the reliability of the conclusions. Several factors were analyzed including the type of aggregate, the percentage of replacement, the type of sieve curve, the declassified content, the strength of concrete and workability of concrete and the replacement criteria. The type of aggregate and the percentage of replacement were the only factors that showed a clear influence on most of the properties. Compressive strength is clearly affected by the quality of recycled aggregates. If the water-cement ratio is kept constant and the loss of workability due to the effect of using recycled aggregate is compensated for with additives, the percentage of replacement of the recycled aggregate will not affect the compressive strength. The elastic modulus is affected by the percentage of replacement. If the percentage of replacement does not exceed 50%, the elastic modulus will only change slightly.

Sim J et al studied the compressive strength and resistance to chloride ion penetration and carbonation of recycled aggregate concrete with varying amount of fly ash and fine recycled aggregate. This study investigates the fundamental characteristics of concrete using recycled concrete aggregate (RCA) for its application to structural concrete members. The specimens used 100% coarse RCA, various replacement levels of natural aggregate with fine RCA, and several levels of fly ash addition. Compressive strength of mortar and concrete which used RCA gradually decreased as the amount of the recycled materials increased. Regardless of curing conditions and fly ash addition, the 28 days strength of the recycled aggregate concrete was greater than the design strength, 40 MPa, with a complete replacement of coarse aggregate and a replacement level of natural fine aggregate by fine RCA up to 60%. The recycled aggregate concrete achieved sufficient resistance to the chloride ion penetration. The measured carbonation depth did not indicate a clear relationship to the fine RCA replacement ratio but the recycled aggregate concrete could also attain adequate carbonation resistance. Based on the results from the experimental investigations, it is believed that the recycled aggregate concrete can be successfully applied to structural concrete members.

3.0 EXPERIMENTAL METHDOLOGY

The mix design has been done by trial and error method. The mix proportions are calculated as per IS code. The design procedure as per IS code and IRC: 44-2008 is used in mix design of M30 grade cement concrete. The material required in the design of M30 grade concrete is as follows and shows the test result of material which is generally required in the mix design of M30. The raw materials are mixed through hand mixing and compacted through the vibrators of casted cubes and beams. The total mixing time was 3 minutes; the samples were then casted and left for 24 hrs before demoulding .They were then placed in the curing tank. The w/c ratio is taken 0.5% for all the mixes. Hence, Coarse aggregates was replaced in percentages of 0%, 25%, 50%, 75%, 100 % with recycled coarse aggregates 150 × 150 × 150mm, Beam and Cylinder moulds were used for casting. The concrete was left in the mould and allowed to set for 24 hours before the cubes were demoulded and placed in curing tank. The concrete cubes were cured in the tank for 7, 28 days. . The mix design of the concrete is shown in Table 1

Table 3.4: Mix Specification for 1 cubic meter Concrete

DESIGNATIONS	**C 0**	**C1**	**C2**	**C3**	**C4**
Particulars	**Plain**	**25%**	**50%**	**75%**	**100 %**
Cement in kg/m^3	390	390	390	390	390
Sand in kg/m^3	702.60	702.60	702.60	702.60	702.60
Coarse aggregate in	1185.27	888.95	592.635	296.31	0
Recycled Aggregates	0	296.31	592.635	888.95	1185.27

4.0 COMPRESSIVE STRENGTH TEST

Compressive strength of concrete can be defined as the measured maximum resistance of a concrete to axial loading. Compression test is the most common test used to test the hardened concrete specimens because the testing is easy to make. The strength of the concrete specimens with different percentage of recycled aggregate replacement can be indicating through the compression test. The specimens used in the compression test were 150mmx150mmx150mm. The compressive strength for recycled concrete and control concrete were tested at the end of 7 days, 28 days using compressive strength testing machine. The water cement ratios were taken as 0.50. Two cubes were casted and the average of two test results is taken for the accuracy of the results. The concrete cubes were cured at room temperature. The average reduction in compressive strength is nearly 5- 10%. This reduction in compressive strength is attributed to the decrease in adhesive strength between the RCA aggregates and the cement binder. The compressive strength of recycled aggregate concrete are shown in table 1 and figure 1

Table 1: Compressive strength of various mixes

Sr No	**Mix Designation**	**Material used in Mix**	**w/c ratio**	**Compressive strength, Mpa**	
				7 Days	**28 Days**
1.	**C 0**	**0 % RCA**	0.5	18.2	34.56
2.	**C 1**	**25 % RCA**	0.5	15.45	33.42
3.	**C 2**	**50 % RCA**	0.5	15.40	32.56
4.	**C 3**	**75 % RCA**	0.5	14.56	31.87
5.	**C 4**	**100 % RCA**	0.2	13.30	30.32

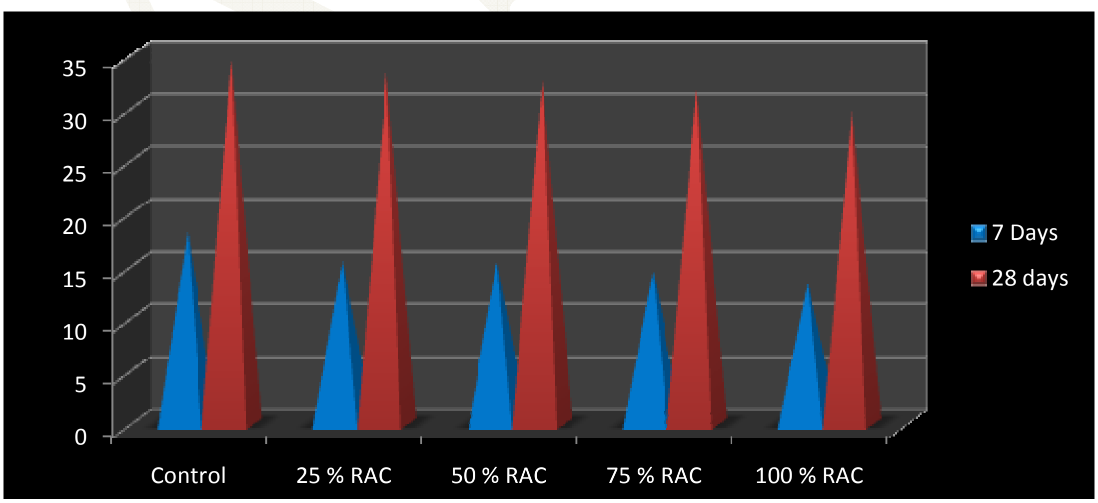

Figure 1: Compressive strength of various mixes

4.1 SPLIT TENSILE STRENGTH TEST

The split tensile strength of concrete with conventional aggregates and use of conventional coarse aggregates with AS is similar. Split cylinder test was carried out to ascertain tensile strength of standard cylinders cast from each mix. The Split strength of recycled aggregate concrete are shown in table 2 and figure 2

Table 2: Split tensile strength of various mixes

Sr No	Mix Designation	Material used in Mix	w/c ratio	Split tensile strength, Mpa	
				7 Days	28 Days
1.	**C 0**	**0 % RCA**	0.5	3.08	3.18
2.	**C 1**	**25 % RCA**	0.5	2.86	2.94
3.	**C 2**	**50 % RCA**	0.5	2.20	2.67
4.	**C 3**	**75 % RCA**	0.5	2.13	2.54
5.	**C 4**	**100 % RCA**	0.2	1.98	2.32

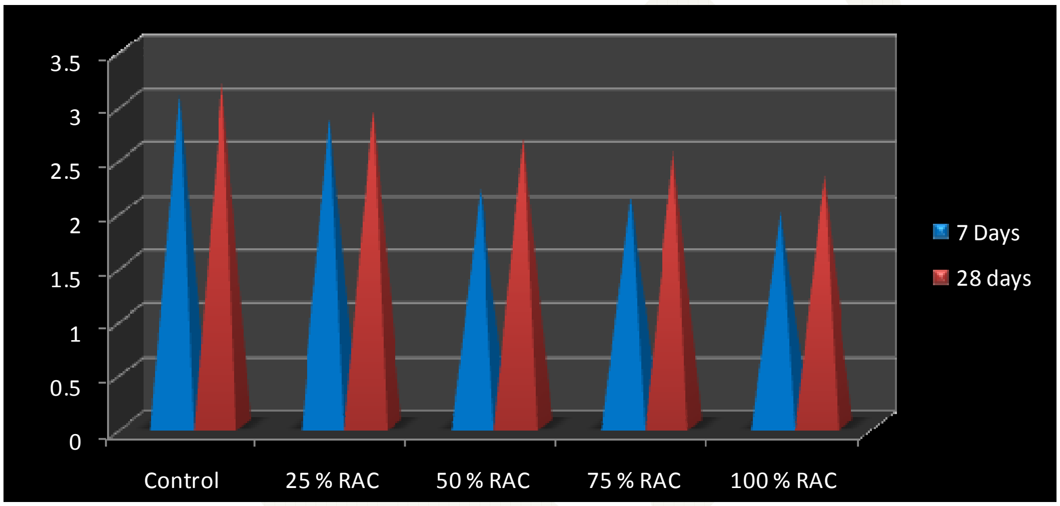

Figure 2: Split tensile strength of various mixes

CONCLUSION

1. The 28-day target compressive strength for all six mixes was achieved to 34.56 MPa even though the RAC strength is lower than NAC. The compressive strength for RAC is within the same range compared to NAC and reaching up to 33.42 MPa at day 28 of curing.
2. The 28-day target Split tensile strength for all six mixes was achieved to 3.18 MPa even though the RAC strength is lower than NAC. The Split tensile strength for RAC is within the same range compared to NAC and reaching up to 2.94 MPa at day 28 of curing.
3. The 28-day target Flexural strength for all six mixes was achieved to 4.97 MPa even though the RAC strength is lower than NAC. The Flexural strength for RAC is within the same range compared to NAC and reaching up to 4.74 MPa at day 28 of curing.
4. The workability tests it is observed that the optimum workability achieved in fresh concrete mix with 40% replacement of RCA.
5. The compressive strength of the concrete is slightly decreased by replacing recycled aggregates.
6. Use of recycled aggregate up to 25 % does not affect the functional requirements of the structure as per the findings of the test results.

REFERNCES

1. Ankit Sahay, "Construction Industry Waste Management- An Experimental Case Study of Recycled Aggregate Concrete", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X.
2. Hardik Gandhi, "Study on Use of Recycled Coarse Aggregate in Concrete", National Conference on Recent Trends in Engineering & Technology 2011.
3. Ismail Abdul Rahman, "Assessment of Recycled Aggregate Concrete", Vol. 3, No. 10 Modern Applied Science 2009.
4. Myle Nguyen James et al, "Use of Recycled Aggregate and Fly Ash in Concrete Pavement", American J. of Engineering and Applied Sciences 4 (2): 201-208, 2011 ISSN 1941-7020.
5. K. Usha Nandhini, "Flexural Strength Properties of Recycled Aggregate Concrete", International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 5, Issue 5, May 2016 ISSN 2319 – 4847.

6. S Ganesh Kumar, "APPLICATION OF GEOPOLYMER CONCRETE", International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 02 Issue: 09, Dec-2015.
7. Jitender Sharma, "Study of Recycled Concrete Aggregates", International Journal of Engineering Trends and Technology (IJETT) – Volume 13 Number 3 – Jul 2014.
8. Vikas Gill, "Study on Bituminous Pavement Wastes Used As Replacement Material in Cement Concrete", International Journal for Research in Applied Science & Engineering Technology (IJRASET)
9. Ahmed, S.F.U., N. Ahmad and H. Mihashi, 2009. Restrained shrinkage-induced cracking of light weight high performance fiber reinforced cementitious composites. Am. J. Eng. Applied Sci., 2: 775-780. DOI: 10.3844/ajeassp.2009.775.780.
10. Anderson, K.W., J.S. Uhlmeyer and M.A. Russell. 2009, Use of Recycled Concrete Aggregate in PCCP: Literature Search. Transportation Research Board. http://144.171.11.39/view.aspx?id=902140 Bekoe, P.A., M. Tia and M.J. Bergin, 2010. Concrete containing recycled concrete aggregate for use in concrete pavement. Trans. Res. Record. J. Trans. Res. Board., 2164: 113-121. DOI: 10.3141/2164.
11. Chandramouli, K., P.S. Rao, N. Pannirselvam, T.S. Sekhar and P. Sravana, 2010. Chloride penetration resistance studies on concretes modified with alkali resistant glass fibers. Am. J. Applied Sci., 7: 371- 375. DOI: 10.3844/ajassp.2010.371.375
12. Hamoush, S., M. Picornell-Darder, T. Abu-Lebdeh and A. Mohamed, 2011. Freezing and thawing durability of very high strength concrete. Am. J. Eng. Applied Sci., 4: 42-51. DOI: 10.3844/ajeassp.2011.42.51