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STANDARD DEVIATION FOR THE COMPRESSIVE STRENGTH OF RECYCLED CONCRETE

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Abstract: Recycled asphalt aggregate is reclaimed and reprocessed pavement material containing asphalt and aggregate. Most recycled back into pavements and as a result, there is a general lack of data pertaining to the mechanical properties for recycled asphalt aggregate in other possible applications such as Portland pozzolana cement. In the present study, some mechanical properties of Portland cement concrete containing as coarse aggregate were investigated in the laboratory. Concrete mixes widely differing water/cement ratios and mix proportions were made using as coarse aggregate. The properties tested include the physical properties of recycled asphalt aggregate, the compressive strength, split tensile strength and flexural strength of concrete. These properties were compared with those of similar concrete made with natural aggregate. Results of the tests suggest that the strength of concrete made from recycled asphalt aggregate is dependent on the bond strength of Portland pozzolana cement. Coating on the aggregates and may not produce concrete with compressive strength above 25 Mpa. However for middle and low strength concrete, the material was found to compare favorably with natural conventional aggregate.

Keywords: Asphalt aggregate, Compressive strength, Recycled asphalt aggregate

1. INTRODUCTION

Concrete is one of the most widely used construction material today. The concrete consists of at least 75% by volume of aggregate materials which may be locally available but in some places it may be economical to substitute those natural aggregates by more cheaply and abundantly available materials. Several comprehensive studies over the years have dealt with the subject of aggregate supplies and needs and the possible use of waste materials as aggregates for concrete.

Collecting of sand from river causes flood during rainy season. So we need to avoid collecting of sand from river and hence as a replacement we can use waste tyre as fine aggregate. Attempts have been made therefore to replace natural aggregates in conventional concrete by locally available materials such as sintered domestic refuse, palm kernel shell, palletized blast furnace slag and most widely recycled concrete. Nevertheless, critical shortage of natural aggregate for production of concrete is still developing in many regions and the need for better methods of solid waste disposal and probably energy conservation have contributed to the increased interest in this technology. In most third world countries where technological develo1pment is still growing, some regions especially large urban areas already have a problem in obtaining adequate aggregate supplies at reasonable cost. At the same time, increasing quantities of demolished asphalt aggregate materials from road reconstruction projects are generated as a waste material close to these areas.

These waste asphalt aggregate materials are usually plowed back as sub-base material during the reconstruction process or used as embankment fill material which does not represent the most suitable use for the recycled asphalt aggregate. One of the possible ways to

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enhance the sample use of Recycled asphalt aggregate would be to incorporate the material into Portland cement. However, little research has been done to explore the potential of incorporating waste aggregate into concrete. This paper is a discussion of the results of tests carried out to assess the performance of waste asphalt as coarse aggregate in concrete.

1.1 Important description of RAAC

- Recycled rubberized asphalt aggregate can be used for residential buildings.
- RAAC mix design based on Indian standard.
- Our analysis and design are based on cost effectiveness.
- RAAC does not require any admixtures, it is an ordinary concrete.
- Water cement ratio is 0.45 for M25 grade.
- Waste Rubber tyre act as fiber.
- Recycled asphalt aggregate does not require any addition test because it is normal aggregate with asphalt coating.

Concrete are casted of M25 grade by replacing 0, 2, 4 percent of rubber with fine aggregate and full replacement of coarse aggregate with Recycled Asphalt aggregate

2. METHODOLOGY

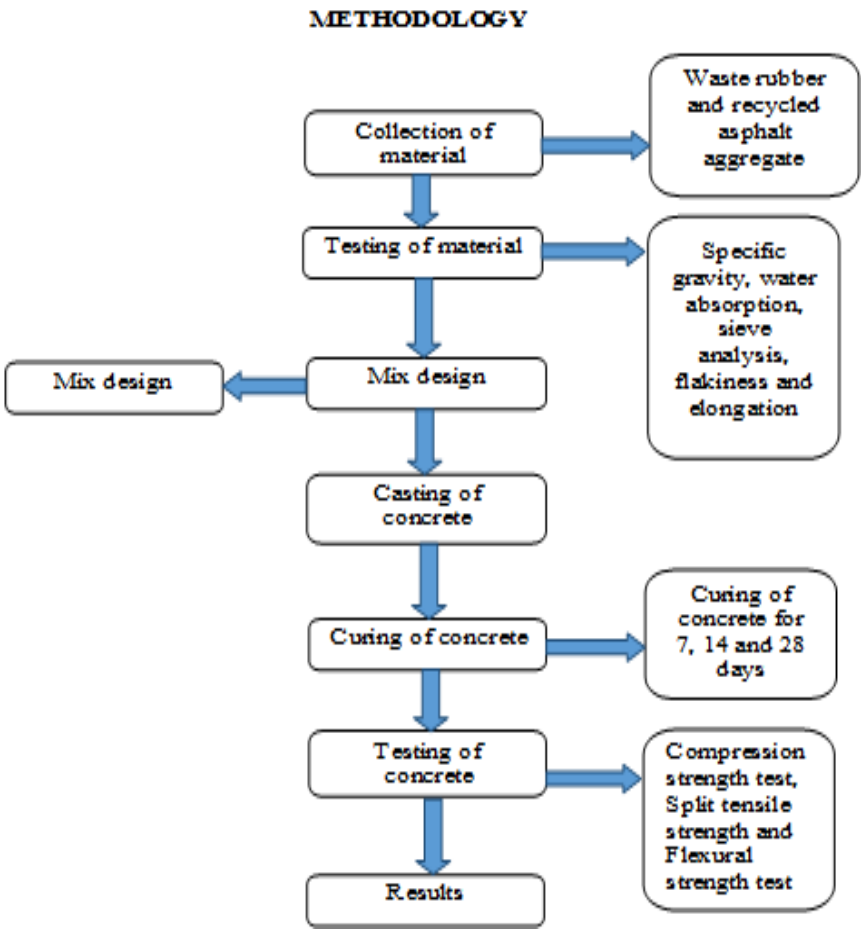

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Fig.1. Methodology of Mixing concrete

3. ANALYSIS OF MATERIAL PROPERTIES

3.1. Supplementary materials

Production of RAAC may not require any special materials. The following materials are used to make RAAC

- Portland Pozzolana Cement (PPC Grade 53)
- Waste tyre rubber
- Recycled asphalt aggregate (20 mm)
- Fine aggregate (river sand)
- Water

Table 1. Comparison of physical properties between CA and recycled AA

SL.NO	PROPERTIES	COARSE AGGREGATE(CA)	RECYCLED ASPHALT AGGREGATE(AA)
1	WATER ABSORBTION	1.5%	0.75%
2	SPECIFIC GRAVITY	2.60	2.256
3	ABRASION TEST	Not more than15%	9%
4	IMPACT TEST	15%	11%
5	GRADE OF AGGREGATE	Uniformity grade (20mm,12.5mm)	Uniformity grade (20mm)
6	SHAPE OF AGGREGATE	Angular or Rounded or Irregular	Angular shape with Asphalt coating
7	TEXTURE	Rough or smooth (Based on wet or dry)	Rough (Based of Asphalt coating)

4 TEST RESULTS AND DISCUSSION OF HARDENED CONCRETE

4.1 Casting of concrete cubes, cylinder and prism

The test moulds are kept ready before preparing the mix concrete. Tighten the bolts of the moulds carefully because if bolts of the moulds are not kept tight the concrete slurry coming out of the mould when vibration takes place. Then moulds are cleaned and oiled on all contact surfaces of the moulds and place the moulds on vibrating table. The concrete is filled into moulds in layers and then vibrated. The top surface of concrete is struck off level with a trowel. The number and date of casting are put on the top surface of the cubes, cylinders and moulds.

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4.2 Test for Compressive strength of concrete cubes

To calculate the compressive strength of concrete cubes, the Compressive Testing Machine (CTM) having capacity of 300 tons was used. In this test the strength obtained in tons. The measured compressive strength of the specimen shall be calculated by dividing the maximum load applied to the specimen during the test by the cross sectional area calculated from mean dimensions of the section and shall be expressed to the nearest N/mm^2.Out of many test applied to the concrete, this is the most important which gives an idea about all the characteristics of concrete.

The compressive strength shows durability of concrete and the concrete is prepared by sand, PPC (Grade 53), waste rubber tyre, recycled asphalt aggregate (AA) and water. The mix proportions of mix based on ISCB. The analysis and designing has included 24 number of cubes. By this single test one judge that whether concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used.

These specimens are tested by compression testing machine after 7 days curing, 14 days curing and 28 days curing. Load should be applied gradually at the rate of 140 kg/cm^2 per minute till the specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

Table 2 Comparison of compressive strength results

Days	**Fully replacement of Recycled asphalt aggregate with 2&4% of rubber**		**Conventional aggregate with 2& 4% of rubber**	
	% of rubber	Comp.stress F=P/A	% of rubber	Comp.stress F=P/A
7	2	17	2	16
	4	10	4	8
14	2	19.6	2	18.2
	4	12	4	12
28	2	25.7	2	25
	4	14.5	4	17

4.3 Test for Split tensile strength of concrete cylinders

As we know that the concrete is weak in tension. Tensile strength is one of the basic and important properties of the concrete. The concrete is not usually expected to resist the direct tension because of its low tensile strength and brittle nature. However, the determination of tensile strength of concrete is necessary to determine the load at which the

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concrete members may crack. The cracking is a form of tension failure. The usefulness of the splitting cube test for assessing the tensile strength of concrete in the laboratory is widely accepted.

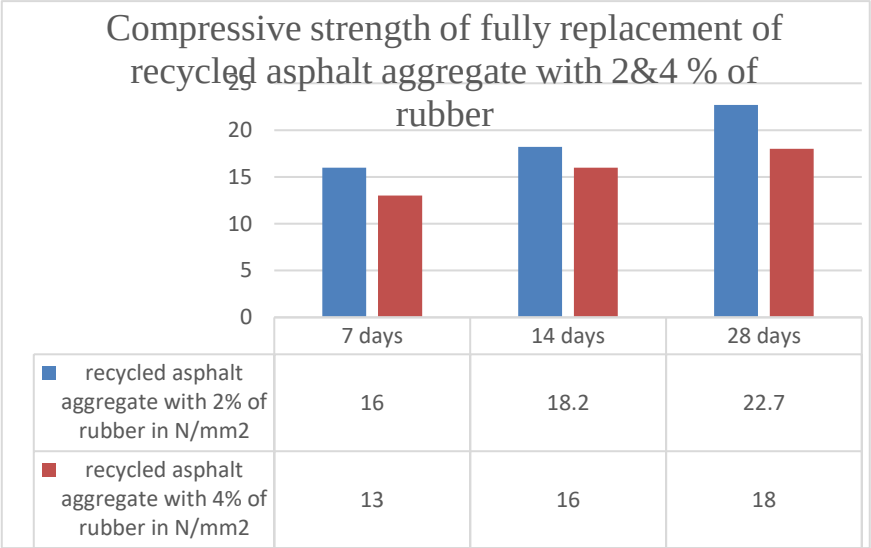

Fig. 2. Compressive strength values for fully replacement of aggregate

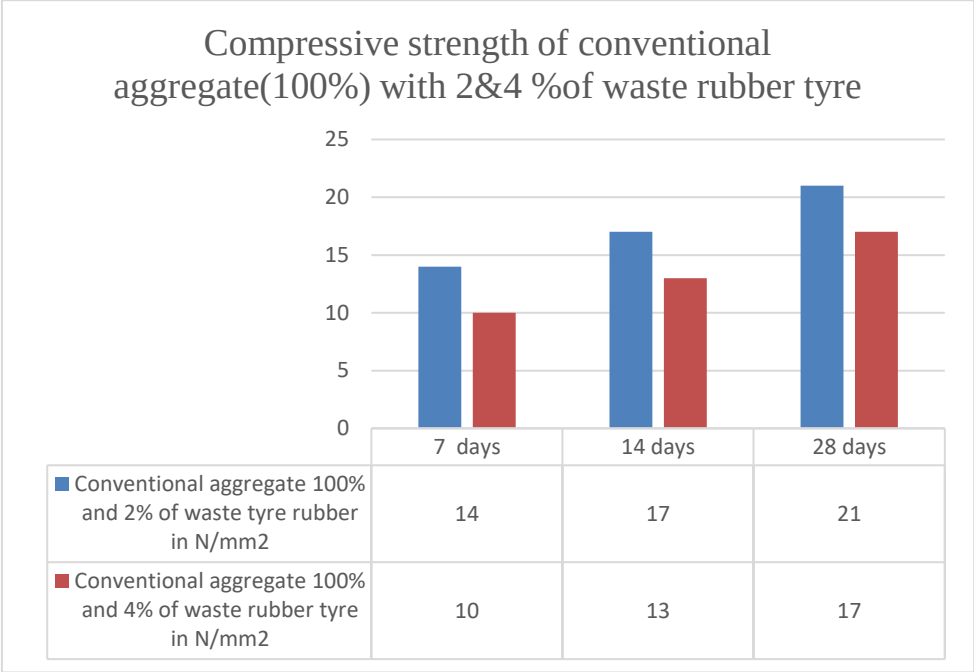

Fig. 3. Compressive strength values for conventional aggregate

The standard has been prepared with the testing procedure for this type of test for tensile strength of concrete. The load at which splitting of specimen takes place shall then be

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recorded. The compression testing machine (CTM) having capacity of 150tonne was used for the splitting tensile strength of the concrete cylinders.

Table 3 Values for split tensile strength T_{sp}= (2P/πdL)

Days	% of waste tyre rubber	Tensile. Stress f=(2P/πDL) In N/mm^2 and load in kN
7	2	0.7 (50 kN)
	4	0.5 (35 kN)
14	2	0.9 (65 kN)
	4	0.7 (50 kN)
28	2	0.9 (65kN)
	4	0.7 (50kN)

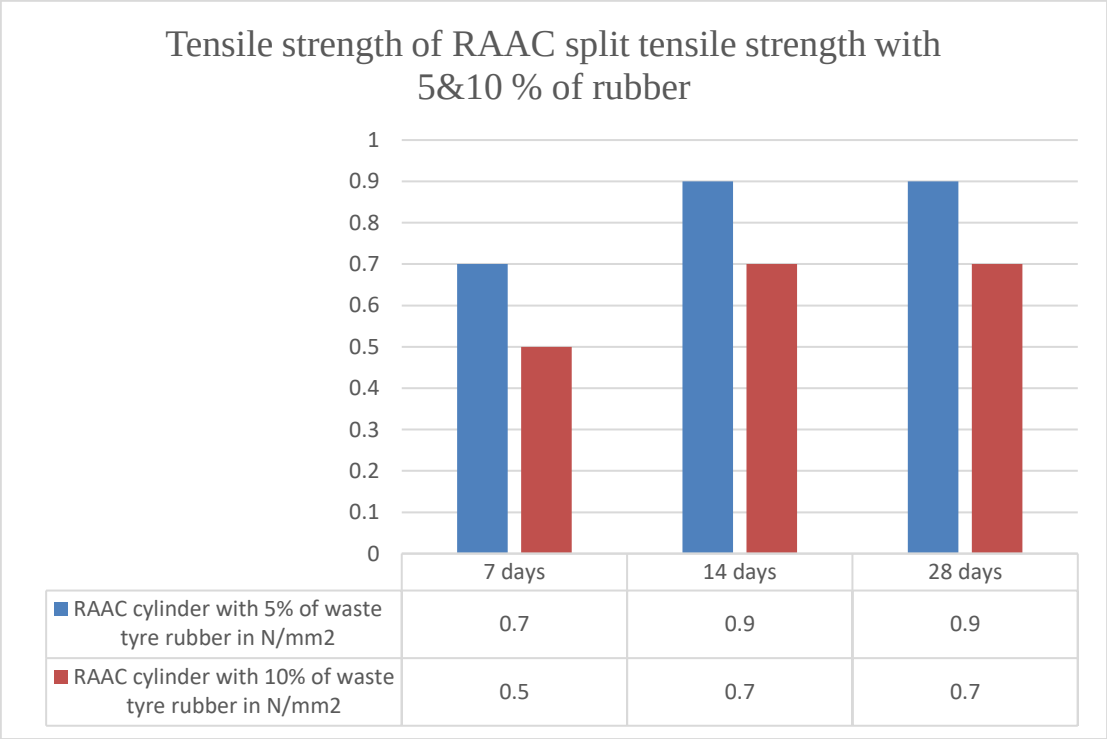

Fig. 4. Tensile strength of cylinder

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4.4 Test for Flexural strength of concrete beams

For this test the beams of dimension 100mm x 100mm x 500mm were casted. Flexural strength, also known as modulus of rupture, bend strength, or fracture strength, a mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load. The transverse bending test is most frequently employed, in which a rod specimen having either a circular or rectangular cross-section is bent until fracture using a three point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of rupture. The beam tests are found to be dependable to measure flexural strength.

The value of the modulus of rupture depends on the dimensions of the beam and manner of loading. In this investigation, to find the flexural strength by using third point loading. In symmetrical two points loading the critical crack may appear at any section not strong enough to resist the stress with in the middle third, where the banding moment is maximum. Flexural modulus of rupture is about 10 to 20 percent of compressive strength depending on the type, size and volume of coarse aggregate used.

Table 4. Values for flexural strength F= PL/bd^2

Days	% of waste tyre rubber	Flexural strengthf=(PL/bd^2) in N/mm^2 and load in kN
7	2	22.6
	4	20.7
14	2	28.3
	4	26.7
28	2	33.5
	4	31.5

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Fig. 5. Testing of prism

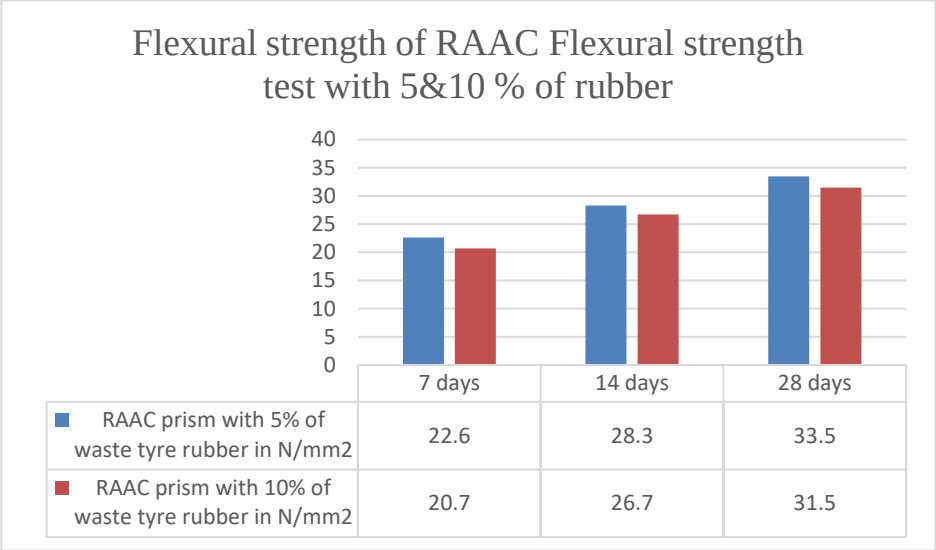

Fig. 6. Flexural strength of prism

5. COMPARISION OF RESULTS

Table 5. Comparison of results between Conventional concrete (CC) and Recycled Rubberized asphalt aggregate concrete

Days	Conventional concrete Comp.stress in N/mm^2 and load in Kn	Recycled Rubberized asphalt aggregate Concrete(RAAC) in N/mm^{2}and load in kN
7	16 (360 kN)	17 (382 kN)
14	18.4 (410 kN)	19.2 (440 kN)
28	25 (562 kN)	25.7 (571kN)

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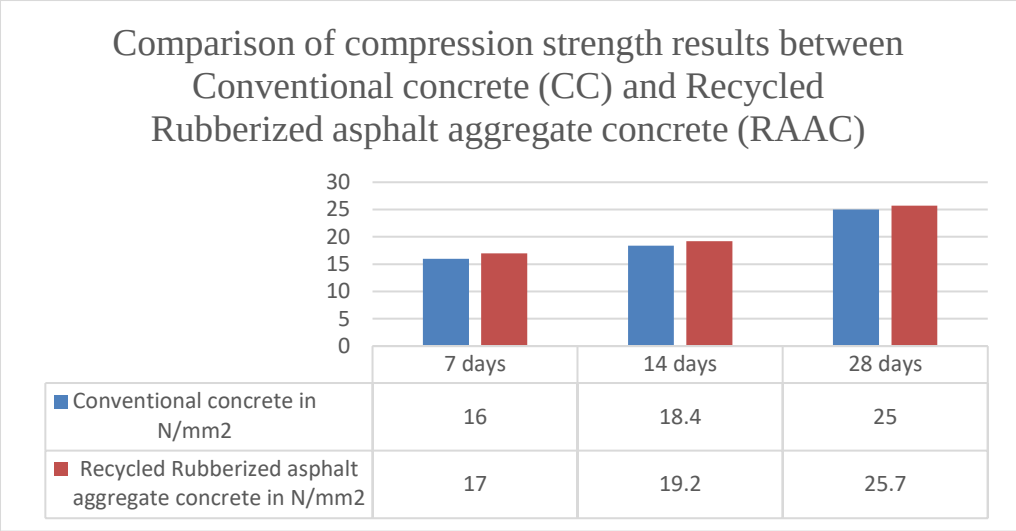

Fig. 7. Comparison of results between rubberized asphalt aggregate concrete (RAAC) and conventional concrete (CC)

6. CONCLUSION

From the laboratory study carried out to evaluate the performance of recycled asphalt as coarse aggregate and waste tyre in concrete, the following main conclusions: Recycled asphalt aggregate has lower specific gravity and water absorption than the natural aggregate. The crushing and impact value tests as prescribed in BS 812 for assessing the strength of aggregate should not be used in assessing the strength of recycled asphalt, a more appropriate assessment method is required. RAAC concrete is workable is same comparing with corresponding concrete produced with conventional aggregate. Recycled waste tyre has lower specific gravity and has no water absorption. The compressive and flexural strength of concrete produced with recycled asphalt as coarse aggregate were found those made from natural aggregate. The strength of RAAC concrete is dependent on the bond strength of the asphalt-mortar coating on the aggregate. The maximum compressive strength of concrete that can be produced using recycled asphalt aggregate as coarse aggregate is approximately 25 MPa. On the basis of this investigation, it is apparent that recycling of waste asphalt aggregate for concrete aggregate is feasible and may become a viable and routine process for the generation of aggregate for middle and low strength concrete.

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