iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** XI **Month of publication:** November 2021

DOI: https://doi.org/10.22214/ijraset.2021.38776

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue XI Nov 2021- Available at www.ijraset.com

Effect of Reclaimed Asphalt Pavement Aggregate on Hardened Properties of Concrete

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Abstract: ***This paper purpose of study is to find the properties of Reclaimed asphalt pavement (RAP) and compare the same with the concrete produced with natural aggregates. This thesis presents a study conducted on mechanical and durability properties of Reclaimed asphalt pavement (RAP) aggregates concrete. The investigation covered concrete mixes at water cementitious material with ratio of 0.4. Ordinary Portland cement of 43-grade was used in this study. The percentage of Reclaimed asphalt pavement (RAP) aggregates that partially replaced natural aggregates by weight were 0%, 25%, 50%, 75%, and 100% with glass fiber The results show that the optimum replacement of Reclaimed asphalt pavement (RAP) with natural aggregate then gain strength of concrete compare with normal mix. It is observed that compressive and tensile strength of concrete gain upto with mix 50% NA+50%RAPA+1%SF after that increase percentage of RAP with decrease both strength compare with normal mix.***
Keywords: RAP, steel fiber, design mix, compressive strength, split tensile strength.

I. INTRODUCTION

Reclaimed asphalt pavement (RAP) is the term given to removed and/or reprocessed pavement materials containing asphalt and aggregates. These materials are generated when asphalt pavements are removed for reconstruction, resurfacing, or to obtain access to buried utilities. When properly crushed and screened, RAP consists of high-quality, well-graded aggregates coated by asphalt cement. Asphalt pavement is generally removed either by milling or full-depth removal. Milling entails removal of the pavement surface using a milling machine, which can remove up to 50 mm (2 in) thickness in a single pass. Full-depth removal involves ripping and breaking the pavement using a rhino horn on a bulldozer and/or pneumatic pavement breakers. In most instances, the broken material is picked up and loaded into haul trucks by a front-end loader and transported to a central facility for processing.

II. LITERATURE REVIEWS

Oraimi (2007) Studies on Reclaimed Asphalt Pavement (RAP) is the result of removing old asphalt pavement material. RAP consists of high quality well-graded aggregate coated with asphalt cement. The removal of asphalt concrete is done for reconstruction purposes, resurfacing, or to obtain access to buried utilities. The disposal of RAP represents a large loss of valuable source of high quality aggregate. This research investigates the properties of concrete utilizing recycled reclaimed asphalt pavement (RAP). Two control mixes with normal aggregate were designed with water cement ratios of 0.45 and 0.5. The control mixes resulted in compressive strengths of 50 and 33 MPa after 28 days of curing. The coarse fraction of RAP was used to replace the coarse aggregate with 25, 50, 75, and 100% for both mixtures. In addition to the control mix (0%), the mixes containing RAP were evaluated for slump, compressive strength, flexural strength, and modulus of elasticity. Durability was evaluated using surface absorption test. **Pokorný (2020)** Investigated on Reclaimed asphalt pavement (RAP) is a valuable commodity originating during processes of road/highways rehabilitations, resurfacing in the cases of the revelation of underneath-placed layers. Removed material can be successfully recycled and utilized as a supplementing material for new hot asphalt mixes. This work aimed to investigate the optimal substitution of mined natural aggregate with commonly available RAP in order to produce composites with the comparable mechanical performance of reference ordinary Portland concrete. The aggregate substitutions up to 100% with RAP have been studied with a combination of mechanical and analytical techniques. Obtained experimental data showed changes in the porous structure, mineralogy, and in the amount of formed cement-related hydration products that influenced the mechanical performance of produced composites. **Surya Kant Sahdeo(2019)** investigated on the effect of utilizing coarse reclaimed asphalt pavement (RAP) aggregates as a replacement to natural coarse aggregates (NCAs) for the production of pervious concrete pavement (PCP) mixes. Coarse RAP (RC) aggregates were utilized in proportions of 0%, 25%, 50%, 75%, and 100%, respectively. It was observed that the porosity and permeability coefficient of the PCP mixes increases considerably as the RAP replacement level increases.

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III. MATERIALS AND METHODOLOGY

A. Cement

The most widely used of the construction cements is Ordinary Portland cement. It is a bluish-grey powder obtained by finely grinding the clinker made by strongly heating an intimate mixture of calcareous and argillaceous minerals. The chief raw material is a mixture of high-calcium limestone, known as cement rock. The colour of cement is chiefly due to the presence of iron oxide.Ordinary Portland cement of grade- 43 (Shree Ultra tech cement) conforming to Indian standards IS: 8112-1989 has been used in the present study.

B. Fine Aggregate

IS: 383-1963 defines the fine aggregate as the aggregate most of which will pass 4.75mmIS sieve. The fine aggregate is usually termed as Sand. The sand is generally considered to have a lower size limit of 0.007 mm. usually natural sand is used as a fine aggregate. The sand used for the experimental work is locally available and conformed to grading zone III..

C. Course Aggregate

The coarse aggregate is defined as an aggregate most of which is retained on 4.75 mm IS sieve. The broken stone is generally used as a coarse aggregate. Locally available coarse aggregate having the maximum size of 12.5 mm was used in the present work.

D. Reclaimed Asphalt Pavement (RAP)

Now a day observed that flexible bitumen road converted in to rigid pavement because bitumen road pavement less resistance impact load compare with rigid pavement. A large amount of Reclaimed asphalt pavement Aggregate obtained from flexible road These Reclaimed asphalt pavement Aggregate as a source of Recycled concrete aggregate. To The broken pieces of Reclaimed asphalt pavement Aggregate were sieved, the larger fraction passing through 20 mm IS sieve but retained on 10 mm IS sieve. The fraction passing through 4.75 IS sieve was discarded.

E. Steel Fiber

Steel fibers provide significant bridging effect on the cracking behavior of concrete and can control crack width and enhance shear capacity of RC members. Dramix Glued Hooked end type steel fibers Fig. 3.7, with diameter 0.5mm were used in the present investigation. The fibers were added in proportion of 1% by volume of concrete. The aspect ratio of the fiber adopted was 65.

IV. RESULT AND DISCUSSIONS

A. Compressive Strength

Cubes of sizes 150 x 150 x 150 mm were cast for strength testing. These cubes were cured for 28 days and tested in Compression testing machine having a capacity of 200 T. The specimens were allowed to dry in sunlight for 1 day and are placed centrally in testing machine and load was applied continuously, uniformly and without any shock The load was increased until the specimen fails. The maximum load taken by the specimen was noted. Experiment was repeated for two specimens of the same mix. The results of the strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The compressive strength test results of all the mixes at different curing ages are shown in Table - 4.3**.** Variation of compressive strength of all the mixes with curing age is shown in Fig. - 4.1**.**

Table 4.3. Compressive strength (MPa) values of all mixes at different curing ages

Mix	Compressive Strength MPa
100% NA+0%RAPA+0%SF	20.11
75% NA+25%RAPA+0%SF	19.21
50% NA+50%RAPA+0%SF	18.63
25% NA+75%RAPA+0%SF	15.5
0% NA+100%RAPA+0%SF	14.25
100% NA+0%RAPA+1%SF	31.71
75% NA+25%RAPA+1%SF	33.4
50% NA+50%RAPA+1%SF	29.3
25% NA+75%RAPA+1%SF	27.8
0% NA+100%RAPA+1%SF	26.6
100% NA+0%RAPA+0%SF	20.11

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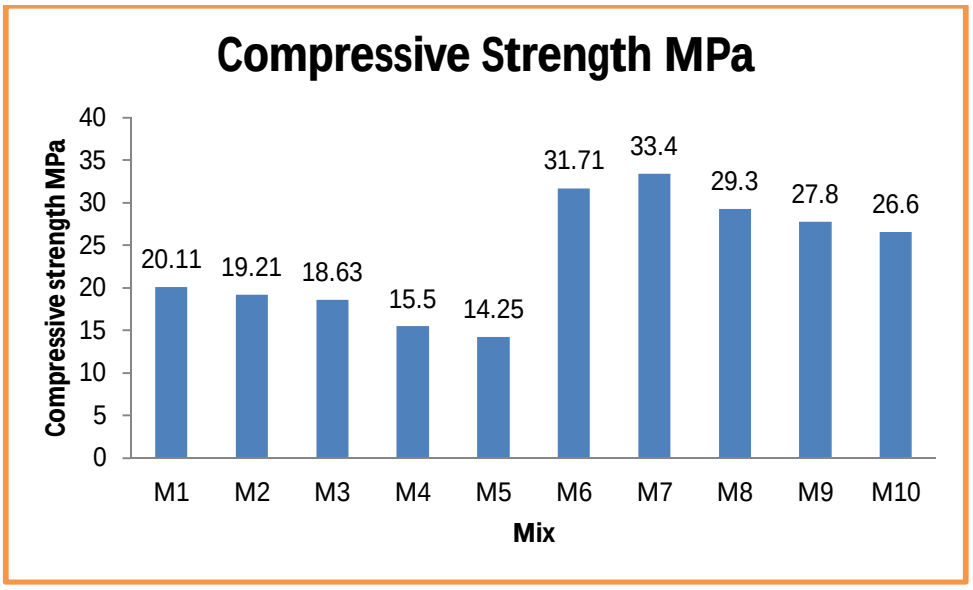

Fig 4.1. Variation in Compressive strength for all the mixes with curing ages.

From the above test results and the graphical variation as shown in Fig 4.1, it was observed that the compressive strength results of the concrete decrease with increase of recycled pavement aggregate are comparable with the mix M1. This shows that the compressive strength of recycled aggregate concrete increase with steel fiber compare with all without fiber concrete. Finally it was observed that use of recycled aggregate with fiber are more compressive strength obtained compare with without fiber concrete. the results showing decreasing trend in terms of compressive strength at all curing ages. Maximum compressive strength obtained from mix M7 is 33.4 MPa.

B. Split Tensile Strength results

Cubes of size 300×100mm were cast and cured for 28 days. After curing age the cubes were allowed to dry in the sunlight for 1 day and were tested under strength testing machine by placing the cubes diagonally in the centre. The load was increased until the specimen fails. The maximum load taken by the specimen was noted. Experiment was repeated for two specimens of the same mix and the average value was taken as final. The results of the strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The split tensile strength test results of all the mixes at different curing ages are shown in Table - 4.4**.** Variation of compressive strength of all the mixes with curing age is shown in Fig. - 4.2**.**

Table 4.4. Split tensile strength test(MPa) values of all mixes at different curing ages.

Mix	Tensile Strength MPa
100% NA+0%RAPA+0%SF	3.1
75% NA+25%RAPA+0%SF	2.9
50% NA+50%RAPA+0%SF	2.78
25% NA+75%RAPA+0%SF	2.75
0% NA+100%RAPA+0%SF	2.58
100% NA+0%RAPA+1%SF	3.5
75% NA+25%RAPA+1%SF	3.3
50% NA+50%RAPA+1%SF	2.98
25% NA+75%RAPA+1%SF	2.95
0% NA+100%RAPA+1%SF	2.9
100% NA+0%RAPA+0%SF	3.1

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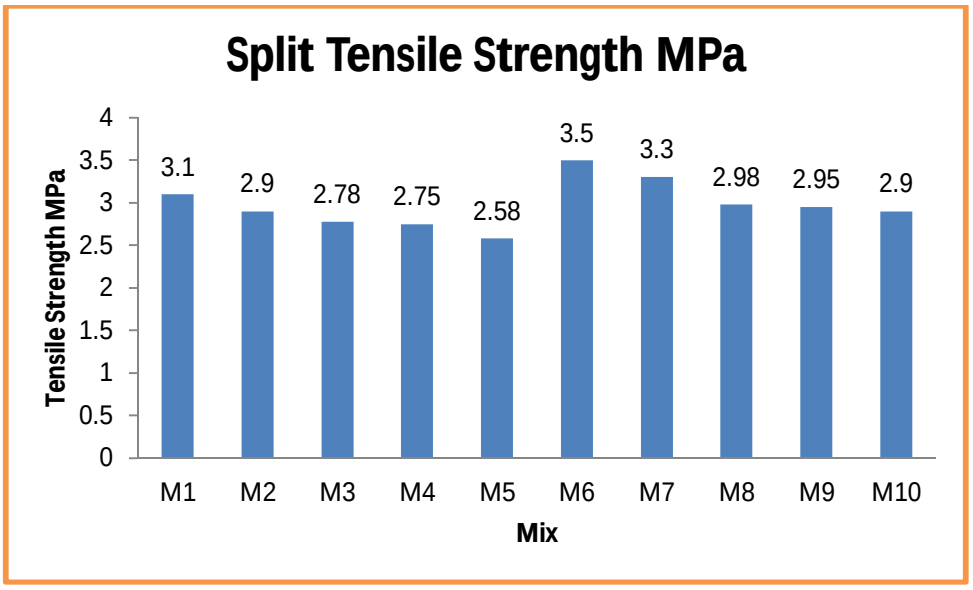

Fig 4.2. Variation in Split Tensile strength for all mixes with curing ages.

From the above test results and the graphical variation as shown in Fig 4.1, it was observed that the tensile strength results of the concrete decrease with increase of recycled pavement aggregate are comparable with the mix M1. This shows that the tensile strength of recycled aggregate concrete increase with steel fiber compare with all without fiber concrete. Finally it was observed that use of recycled pavement aggregate with fiber are more tensile strength obtained compare with without fiber concrete. the results showing decreasing trend in terms of tensile strength at all curing ages. Maximum tensile strength obtained from mix M6 is 3.5 MPa. at 28 day age of curing. So, recycled aggregate concrete performed better with less than 25-50% replacement in the initial stages with steel fiber.

V. CONCLUSIONS

A. Introduction

The following section presents the main conclusion which can be drawn based on the experimental results

1) It was observed that decrease compressive strength of concrete with increase recycled pavement aggregate in concrete mix compare with normal mix

2) The addition of steel fibre (1% by volume) in concrete mix shows an improvement in compressive strength for all replacement ratios. This improvement is in the range of 20-22% than without fibers.

3) It was observed that split tensile strength of concrete decrease with increase of percentage of recycled pavement aggregate.

4) On addition of steel fibres in concrete, the increase of tensile strength of recycled pavement concrete with all mix. Compare with without fiber concrete.

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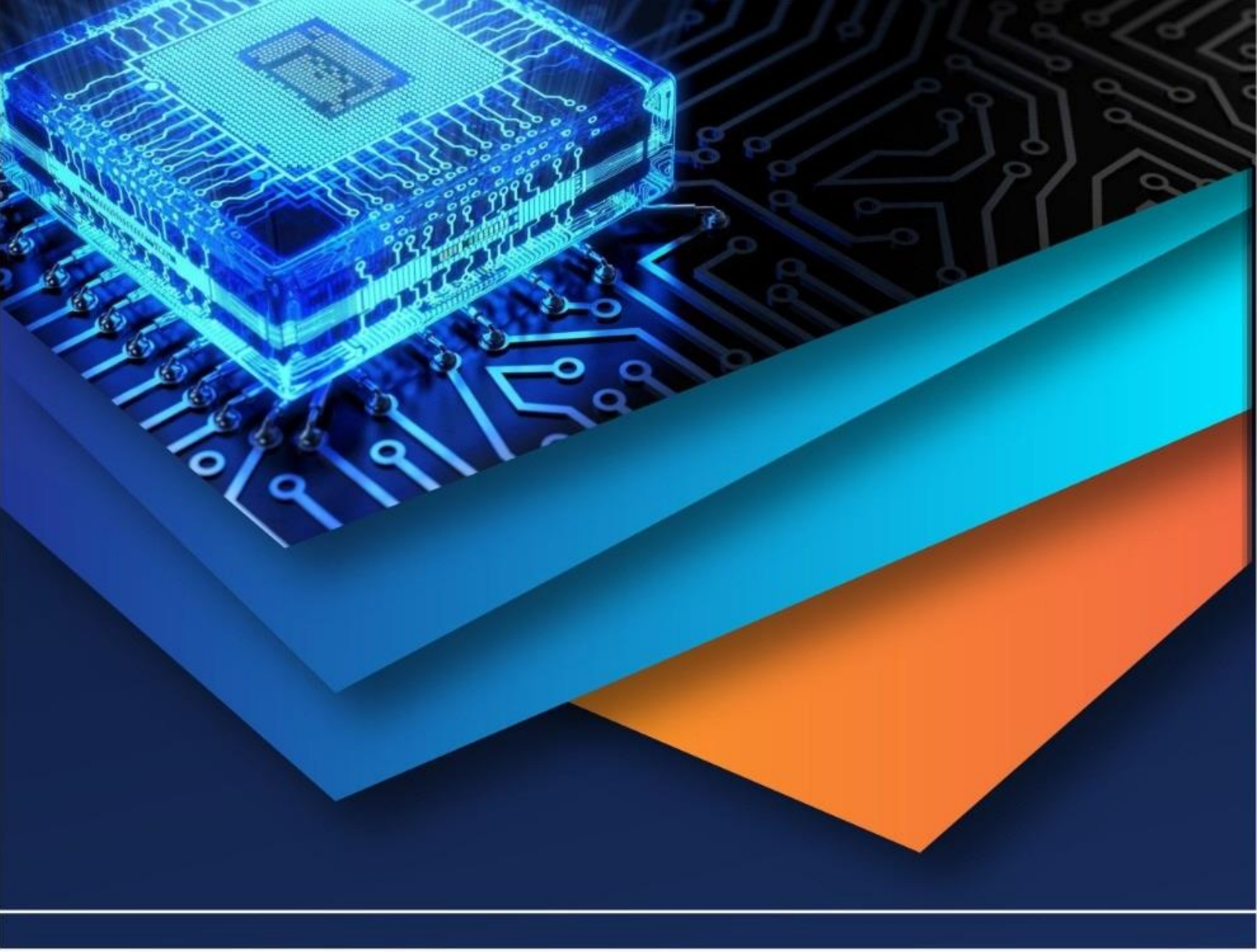

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