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Strength and Water Permeation Characteristics of Concrete Made With Reclaimed Asphalt Pavement Aggregate

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ABSTRACT

The removal of old asphalt pavement material results in reclaimed asphalt pavement (RAP). RAP is made up of high-quality, well-graded aggregate that has been covered in asphalt cement. Asphalt concrete is removed for a variety of reasons, including reconstruction, resurfacing, and gaining access to subsurface utilities. RAP disposal results in a significant loss of a valuable source of high-quality aggregate. This study looks into the qualities of concrete made from recovered asphalt pavement (RAP). By weight, reclaimed asphalt pavement (RAP) aggregates partially replaced natural aggregates at a rate of 0%, 25%, 50%, 75%, and 100%. Water absorption and ultrasonic pulse velocity (UPV) tests were carried out. The results suggest that replacing reclaimed asphalt pavement (RAP) with natural aggregate improves concrete strength when compared to a standard mix. It has been discovered that the compressive and tensile strength of concrete increases up to 50 percent NA+50 percent RAPA+1 percent SF, and then decreases when the proportion of RAP is increased, compared to the standard mix. It was also discovered that the quality of concrete obtained by the application of RAP, as well as water absorption, was good up to a certain point.

Keywords: - RAP, steel fiber, design mix, UPV test, water absorption.

1. INTRODUCTION

Due to environmental challenges such as air pollution and recycling, pavement experts have refocused their efforts in recent years on employing foamed asphalt. In the early 1980s, the use of foamed asphalt as a recycling technology for reclaimed asphalt pavement (RAP) was popular in the United States, European countries, and is currently popular in African countries. However, due to the lack of strength and durability of the combinations, the foamed asphalt process has been limited to low traffic volume roads. To improve the strength and longevity of foamed asphalt and recycled foamed asphalt, two reinforcing methods were utilized (RFA). The use of Portland cement as an addition is one option, while the semihot RFA technique is another. Both reinforcing methods are said to offer a constant quality of mixture that is comparable to that of hot-mix asphalt (HMA). One of the most significant advantages of RFA is its capacity to keep the mixture at the same temperature as Portland cement, and the semihot technique reduces storage time to just a few hours. for several weeks at ambient temperatures The Portland cement and semihot technique, on the other hand, limit the storage time to only a few hours.

2. LITERATURE REVIEWS

The use of reclaimed asphalt pavement (RAP) in place of virgin crushed stone aggregate is becoming a widely accepted method for a variety of building applications, particularly pavement base courses, according to Kevin C. Foye (2011). Several laboratory RAP research have looked at the mechanical properties of RAP bases in order to support RAP-based pavement designs. Several interesting correlations between RAP moisture content, compaction, and stiffness have been discovered as a result of these research. During the reconstruction of a 1.95 ha asphalt parking lot, a design-build contractor integrated a geosynthetic ground improvement program with a RAP basis, as described in this work. Some of the ramifications of laboratory findings are explored through field observations of base course construction with RAP. The project challenges and the use of RAP have resulted in a number of fascinating observations on technical, construction, and economic issues. Kim, Yongjoo (2018) The strengthening effects of adding short polypropylene fibers to a recycled foamed asphalt (RFA) mixture have been studied. Short polypropylene fibers with a 10mm length and a 0.15 percent by weight fiber to asphalt binder mixing ratio were used. The RFA mixes were subjected to the Marshall stability test, indirect tensile strength test, resilientmodulus test, and wheel tracking test. The results of the tests were compared to those of the other mixtures, which included conventional recycled foamed asphalt (RFA) mixtures, cement reinforced recycled foamed asphalt (CRFA) mixtures, semihot recycled foamed asphalt (SRFA) mixtures, and recycled hot-mix asphalt (RHMA) mixtures, in order to determine the reinforcing effects of the fiber inclusion. According to the wheel tracking test, the FRFA mixture has higher Marshall stability than the RFA and SRFA mixtures, higher indirect tensile strength than the RFA mixture, and higher rut resistance than the RFA, SRFA, and RHMA mixtures. Alwetaishi (2021) investigates the effects of various RAP percentages on the characteristics of asphalt mixtures in an experimental investigation. In addition, the thermal properties of employing asphalt mixes containing RAP in asphalt concrete blocks for long-term use in building construction were investigated. This study looked at four combinations that were made up of varying ratios of RAP materials, such as 0 percent, 30 percent, 60 percent, and 90 percent, as well as virgin aggregates. A large-scale experiment was carried out to determine the greatest RAP ratio in asphalt mixes while maintaining acceptable physical and mechanical qualities. This found that 90%

of RAP has a level that is tolerable. Finally, utilizing TAS EDSL, the thermal parameters of asphalt concrete blocks used in building construction were examined analytically. This software was first tested by constructing a realistic model of walls out of asphalt concrete blocks, with temperature and humidity measurements obtained using data loggers in both the inside and outdoor areas. In order to determine how energy efficient this material is in four distinct climate situations, a comparison study was done. It was determined that asphalt concrete mixes containing 90% RAP are useful materials for use as a thermal mass in building construction, but that they are only acceptable for cold climates.

3. MATERIALS AND METHODOLOGY

3.1 Cement

Ordinary Portland cement is the most extensively utilized of the construction cements. It's a bluish-grey powder formed by finely grinding clinker made by heating an intimate mixture of calcareous and argillaceous minerals to high temperatures. The main raw ingredient is cement rock, which is a blend of high-calcium limestone. Cement's color is primarily due to the presence of iron oxide. In this investigation, ordinary Portland cement of grade 43 (Shree Ultra tech cement) that met Indian norms IS: 8112-1989 was used.

3.2 Fine aggregate

Fine aggregate is defined by IS: 383-1963 as aggregate that passes the 4.75mmIS sieve the majority of the time. Sand is the most common name for fine aggregate. The sand is commonly thought to have a size limit of 0.007 mm. As a fine aggregate, natural sand is commonly employed. The sand used in the experiment was locally sourced and grading zone III compliant.

3.3 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.

3.4 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.

3.5 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.

4. RESULT AND DISCUSSIONS

4.1UPV test

Cubes of size 150×150×150mm were cast and cured for 28 days. After 28 days cubes were taken out and allowed to dry in sunlight for 1 day. Then the ultrasonic pulse velocity (UPV) test was performed on the cubes as described in the previous chapter. The results of the different mixes at different curing ages were shown in the Table 4.5 below. The standard UPV values are shown in Table4.6.

Table 4.5. UPV Test Results at 28 days

Specimen	Average pulse velocity (km/sec)	Quality of concrete
100% NA+0%RAPA+0%SF	4.765	Excellent
75% NA+25%RAPA+0%SF	4.484	Good
50% NA+50%RAPA+0%SF	4.350	Good
25% NA+75%RAPA+0%SF	4.317	Good
0% NA+100%RAPA+0%SF	3.637	Good
100% NA+0%RAPA+1%SF	4.770	Excellent
75% NA+25%RAPA+1%SF	4.820	Excellent
50% NA+50%RAPA+1%SF	4.710	Excellent
25% NA+75%RAPA+1%SF	4.600	Excellent
0% NA+100%RAPA+1%SF	4.510	Excellent
100% NA+0%RAPA+0%SF	4.765	Excellent

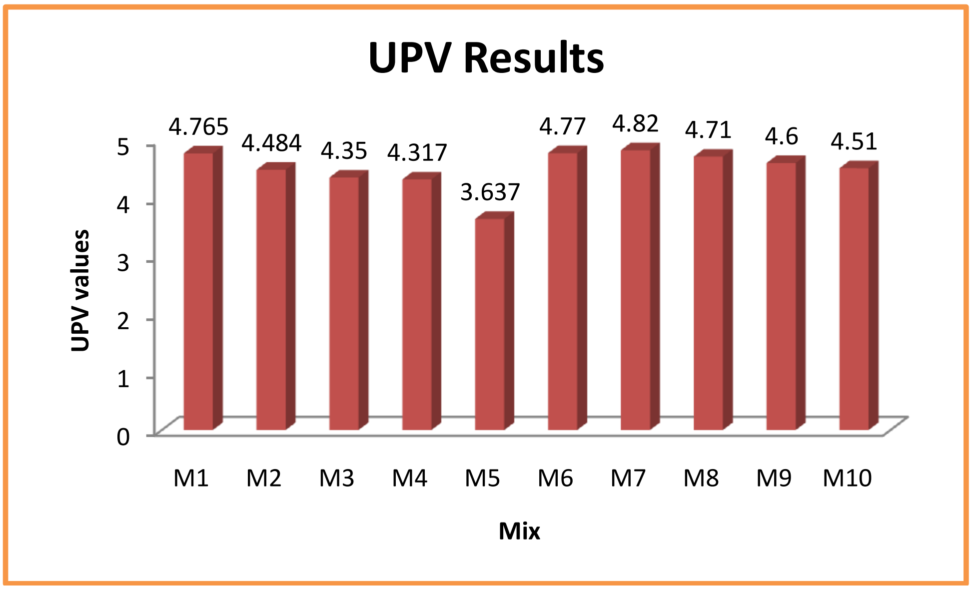

Fig 4.3. Variation in UPV for all mixes with curing ages.

Show that Better quality concrete obtained from use of recycled pavement aggregate with steel fiber compare with without steel fiber concrete. But all these UPV values come under good quality for all the mixes. So it can be concluded that the recycled pavement aggregate concrete performed well in terms of UPV value.

4.2 Water absorption test

The results of the water absorption tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The cube that is cured for different days are taken and weight is measured and that cube is placed in oven and after every 24hrs weight is measured this process is carried out until we get constant weight. The test results are shown in Table 4.3

Specimen	Water Absorption of concrete (%) 28 Days
100% NA+0%RAPA+0%SF	6.15
75% NA+25%RAPA+0%SF	6.56
50% NA+50%RAPA+0%SF	6.66
25% NA+75%RAPA+0%SF	6.75
0% NA+100%RAPA+0%SF	6.85
100% NA+0%RAPA+1%SF	6.10
75% NA+25%RAPA+1%SF	5.99
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25% NA+75%RAPA+1%SF	6.50
0% NA+100%RAPA+1%SF	6.55

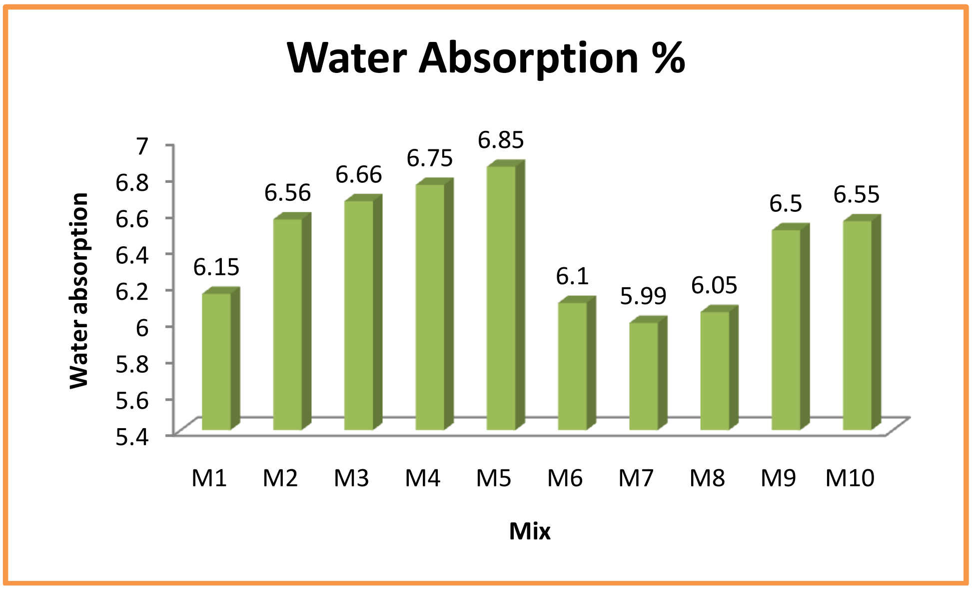

Fig 4.4. Variation in Water Absorption for all mixes with curing ages.

From Table 4.3 it was observed that as the recycled aggregate pavement content increases the water absorption capacity of concrete is increased initially compare with normal mix when addition of fiber in concrete then decrease water absorption value compare with without fiber concrete mix.

5. CONCLUSIONS

5.1 Introduction

The reuse of recycled materials derived from construction and demolition waste is growing all over the world. Many governments are promoting policies and laws aimed at reducing the use of naural resources and increasing recycling of pavement aggregate. One of the most environmentally responsible ways of meeting the challenges of sustainability in construction is the use of Recycled pavement aggregates in new construction.

I. The quality of concrete decrease with increase recycled aggregate when make concrete with fibre to increase quality of concrete compare with without fiber concrete.

II. It was observed that rate of water absorption increase with increase of recycled pavement aggregate. But made with steel fiber recycled pavement aggregate less water absorption compare with without fibre concrete.

III. 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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