STUDY ON EFFECT OF RECLAIMED ASPHALT PAVEMENT ON PERMEABILITY OF SUBGRADE

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Abstract: The suitability as sub-grade soils with the aim to determine the geotechnical basis for the observed state of the highway pavement failure. The work was carried out in two major stages; field sampling and laboratory analysis. Field sampling involved the study of physical and geological settings of the area, sample collection which include description and preparation for laboratory tests. Laboratory analysis involved permeability test, grain size distribution analysis, consistency limit test, compaction test, linear shrinkage and clay mineralogical analysis. The results showed that all the sub-grade soils belong to group A-2-4 of the Highway Research Board classification system they are thus good to fair as subgrade materials. The stability of the pavement in stable locations is thus due to good drainage in the locations. Therefore, the practice of designing road pavement without adequate drainage system should be abolished to reduce or prevent contact between water and subgrade soils.

***Key words* –Permeability, Reclaimed Asphalt Pavement.**

1. INTRODUCTION

1.1 Subgrade

As per Ministry of Roads Transportation Highways (MORTH) Specifications, subgrade can be defined as a compacted layer, generally of naturally occurring local soil, assumed to be 500 mm in thickness, just beneath the pavement crust, providing a suitable foundation for the pavement. The subgrade in embankment is compacted in two layers, usually to a higher standard than the lower part of the embankment. In cuttings, the cut formation, which serves as the subgrade, is treated similarly to provide a suitable foundation for the pavement. Where the naturally occurring local subgrade soils have poor engineering properties and low strength in terms of CBR, for example in Black Cotton soil areas, improved subgrades are provided by way of lime/cement treatment or by mechanical stabilization and other similar techniques. The subgrade, whether in cutting or in embankment, should be well compacted to utilize its full strength and to economize on the overall pavement thickness. The current MORTH specifications require that the subgrade should be compacted to 100% maximum dry density achieved by the modified proctor test (IS 2720-Part 7). The material used for subgrade construction should have a dry unit weight of not less than 16.5kN/m^3.

1.2 Reclaimed Asphalt Pavement

The use of Recycled Asphalt Pavement (RAP) is allowed and encouraged in the construction of new roadways and pavements. Its use reduces cost and environmental impacts of road construction by reusing existing asphalt pavement. In Minnesota, existing asphalt pavement material is often crushed and blended with other aggregates to create aggregate base or shouldering materials, or RAP is transported to an asphalt plant, crushed, and incorporated into new asphalt mixture. Both strategies reduce demand for virgin aggregates. Incorporation into new asphalt mixture has the additional benefit of reducing the required amount of new asphalt binder. Incorporating RAP into new asphalt pavement provides greater economic and environmental benefit than using RAP for base or shoulder material.

1.3 Permeability

Permeability is defined as the ability to transmit fluid through a network of void spaces contained within a material or porous medium. Permeability is typically referred to void. Many engineering designed are heavily influenced by the degree of hydraulic conductivity associated with surrounding soil and strata.

The measure of hydraulic conductivity is essential for project involving earthen dams, retention ponds, dewatering system, hydraulic structure, well, landfills and many other engineered facilities. Retention ponds are particularly of interest because in these basins, water exits in two stages: an initial stage which is due to vertical infiltration; followed by second stage consisting of predominately horizontal flow. The accuracy of determining hydraulic conductivity is critical and plays a pivotal role in determining the economy and effectiveness of the resulting of the design.

2. LITERATURE REVIEW

2.1 Permeability

Bayewu, O, O. Olufemi, S.T. and Adewoye, A. O. (2013), according to their experiment the permeability values obtained using the constant head permeability test shows slight agreement with the once estimated from grain size parameters. In both cases, the permeability values are generally low. These low values are not good for subgrade soil because they retain water which will weaken the soil or pavement.

2.2 Reclaimed Asphalt Pavement

Akinwumi (2014), describes that the specific gravity of RAP and soil sample are 2.93 and 2.54, respectively. Variation of specific gravity of soil with RAP content is positive correlation between the percentage of RAP added to the soil and the specific gravity of the blend. The specific gravity of the natural soil was increased by 3.9% after adding 12% of RAP to soil. The decrease in the plasticity index makes the soil-RAP blend more workable.

Brajesh Mishra (2015), has concluded that the RAP has a higher content of fines as a result of degradation of material during milling and crushing operation it can be easily used for stabilization purpose to increase the CBR value of subgrade and hence the crust thickness of road will be reduced resulting in reduction of construction. The problem of disposal of RAP wastes can be easily solved and adverse effect on environment may be avoided by using RAP materials in flexible pavement construction.

3. OBJECTIVE OF THE STUDY

- Providing comparative statement for representative soil sample blended with varied RAP contents through analysis of laboratory test results.

4. METHOLODOGY

We procured the representative soil sample and RAP. The basic laboratory tests were conducted for the soil sample and RAP. Then the comparative statement between with or without adding RAP is given.

5. MATERIALS USED

a. Soil

- As we require weaken soil sample so we procured it near Varuna Lake T. Narsipura Road, Mysore, as shown in **Fig 5.1**. Because the road had been collapsed due to heavy traffic and some other reasons so we had to procure this soil sample. The procured soil sample and RAP have undergone the following basic test: Grain size analysis, Specific Gravity, Moisture content, Standard proctor test and Consistency limits and the results are shown in **Table 5.1**.

  The disturbed soil sample was sieved using sieve with mesh size of 75µ. The soil passing through this sieve was less than 30%, using the HRB classification we came to know that it is a Coarse Grained and A-2-4 soil group.

Fig 5.1: Soil Sample Procured Near Varuna Lake

Table 5.1: Basic Test Results on Soil Sample

Tests	Results	IS Standards
Moisture Content (%)	8.24	IS: 2720 (Part 2) - 1973
Grain Size Analysis Silt and Clay (%) Gravel (%) Sand (%)	 34 34 32	IS: 2720 (Part 5) - 1985
Specific Gravity	2.56	IS: 2720 (Part 3) - 1980
Liquid Limit (%)	30.5	IS: 2720 (Part 5) -1970
Plastic Limit (%)	22.39	IS: 2720 (Part 5) - 1985
Plasticity Index	8.11	IS: 2720 (Part 5) - 1985
Standard Proctor Test MDD (%) OMC (%)	 19.42 10.4	IS: 2720 (Part 7) – 1980/1987

a. RECLAIMED ASPHALT PAVEMENT

The reclaimed asphalt pavement is procured from Pandavapura where the existing road had been reconstructed; the bituminous layer is extracted or scraped out and dumped beside the highway as show in **Fig 5.2.** And we conducted the basic laboratory tests for the RAP as shown in **Table 5.2.**

Fig 5.2: Reclaimed Asphalt Pavement

Table 5.2: Test Results on RAP

Tests	**Values**
Unit weight (Kg/m^3)	1900-2250
Specific gravity	2.54
Moisture content (%)	6.57
Compacted unit weight (Kg/m^3)	1500-1950

Fig 5.1: Constant Head Permeability Apparatus

6. RESULTS AND DISCUSSIONS

a. Permeability Test Results

This test is conducted to find out the co-efficient of permeability with varying percentage of RAP as show in the **Table 6.1.** And it is also graphically represented as shown in **Fig 6.1**

Table 6.1: Variation of Co-efficient of Permeability with Varying Percentage of RAP

Permeability Test	Average Permeability (cm/s)
Without adding RAP	$5.47x10^{-4}$
With adding RAP 5%	$7.09x10^{-4}$
10%	$7.52x10^{-4}$
15%	$7.87x10^{-4}$
20%	$8.51x10^{-4}$
25%	$10.83x10^{-4}$
30%	$6.92x10^{-4}$
35%	$5.60x10^{-4}$

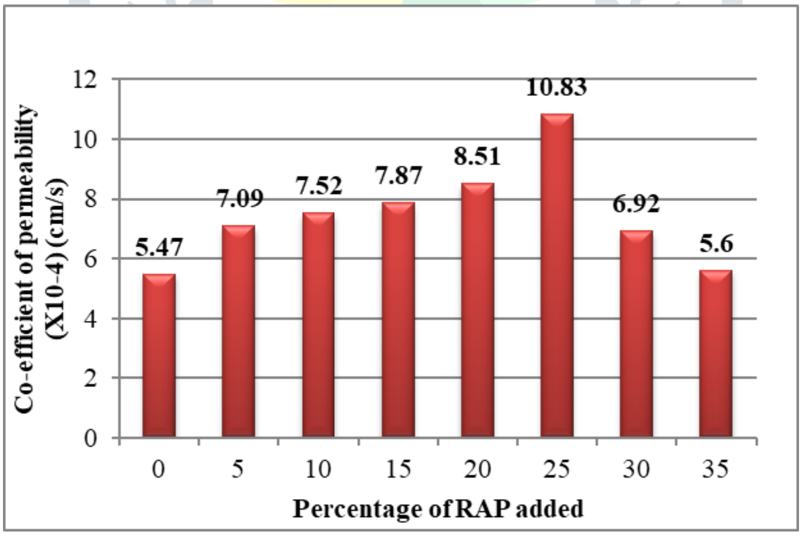

Fig 6.1: Graphical Representation of Co-efficient of Permeability with Varying Percentages of RAP

Calculation:

The co-efficient of Permeability is given by

$$k = \frac{qL}{Aht} cm/s$$

Where q = Discharge in cm^3/s

L= Length of the Specimen in cm

A= Cross sectional area of specimen in cm

H= Constant head causing flow in cm

TRIAL 1: With adding 5% RAP

$$k = \frac{qL}{Aht} = \frac{148\times12.6}{78.54\times108.5\times300} = 7.29X10^{-4} \text{ cm/s}$$

$$k = \frac{qL}{Aht} = \frac{142\times12.6}{78.54\times108.5\times300} = 6.99X10^{-4} \text{ cm/s}$$

$$k = \frac{qL}{Aht} = \frac{142\times12.6}{78.54\times108.5\times300} = 6.99X10^{-4} \text{ cm/s}$$

Average Co-Efficient of Permeability = k = 7.09x10^{-4} cm/s

7. CONCLUSIONS

- Improvement of stability of soil is achieved by adding RAP
- Use of RAP in subgrade is cost effective than any other conventional materials

The above mentioned conclusions are based on laboratory test results conducted on only one type of soil and RAP material of one source.

For further generalization, wide variety of soil and RAP sources can be selected and tested in a study that can be pursued in a future research. The above findings can be useful in researches and practicing pavement engineers for initial understanding of effect of RAP in subgrade soil.

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