Design of Flexible Pavement using Plastic Waste for Sit Sports Village

M.Vignesh[1]V.Rajkumar[2], R.Rajesh[3], K.Sethupathi[4]
[1]*Assistant Professor (Senior Grade), Department of Civil Engineering, Anna University.*
[2,3,4]*Final Year Department of CivilEngineering, Annauniversity*
Sethu institute of technology, Pulloor, kariapatti -626 115, Virudhunagar, India.

Abstract

The main objective is to discuss the significance of utilization of waste plastic in road construction to reduce the cost, increase the strength and durability when these plastics are heated and coated upon the aggregates (160°C) to compensate the air voids with plastic and binds with aggregate to provide stability. Polymer coated aggregate blended with Bitumen (4%, 4.5%, 5%, 5.5%, 6%) shows higher Marshall Value and better stripping value showing that the mix is more suited for road laying. If the waste plasticsare utilized in road construction, the air pollution and disposal problems may be reduced.

Keywords: *Aggregates, Plastic Waste, Marshall Stability, Bitumen Content.*

I. INTRODUCTION

Flexible pavements are those, which on the whole have low flexural strength and are rather flexible in their structural action under loads. These types of pavement layers reflect the deformation of lower layers on-to the surface of the layer. A comparative study has been made in this investigation between Dense Bituminous Macadam (DBM) mixes with varying binder contents (4% - 6%) and plastic contents (1-5%).To study the physical properties of aggregates and harder grade bitumen (VG-30) for DBM Grade II.To evaluate the engineering properties including Marshall Stability, Marshall Flow, Density, Voids in Mix and Voids Filled with Bitumen.To utilize the plastic waste and to reduce its impact on environment. The optimum proportion of waste plastic to be added in the bitumen mix for getting the required strength is identified.

II. MATERIALS USED

The basic material used are as follows
1) Aggregates

2) Bituminous Binder

3) Plastic

Why use plastic

Plastic have a number of very important properties which exploited along or together make a Significance and expanding contribution to construction needs. Durable and corrosion resistant. Maintenance free.Good insulation for cold heat and sound saving energy and reducing noise pollution. It is economical and longer life.

III. LABORATORY TEST

The laboratory tests are conducted for aggregate, soil and bitumen. To know the properties and the stability of each particle for the road construction purpose.

A. Aggregate Test

Aggregate constitutes the granular part in bituminous mixtures which contributes up to 90-95 % of the mixture weight and contributes to most of the loadbearing & strength characteristics of the mixture. To get a good pavement the quality and physical properties of the aggregates should be controlled.The properties that aggregates should have to be used in pavement are shown below.Aggregates should have minimal plasticity. The presence of clay fines in bituminous mix can result in problems like swelling and adhesion of bitumen to therock which may cause stripping problems. Clay lumps and friable particles should be limited to utmost 1%.Durability or resistance toweatheringshould be measured by sulphate soundness testing.It is recommended AASHTO T-85 to be used for determining the maximum specific gravity of bituminous mixes.

Table 1
Gradation of Aggregates

Sieve size(mm)	Weight of aggregate(g)
12.5	72
10	312
4.75	84
Filler	684

Table 2
Results for aggregate test

Impact value	24.03%
Specific gravity of coarse aggregate	2.6
Specific gravity of fine aggregate	2.13
Specific gravity of filler	1.72

B.Soil Test

Soil tests are conducted to ensure the soil has the capability of withstand the load produced by the vehicles after the construction of road. If the bearing capacity of the soil is low to withstand the load, it will undergo a soil stabilization.
The test conducted on the soil is,

a) Specific gravity of the soil
b) CBR test (un-soaked)
c) Unconfined compression test
d) Sieve analysis test
e) CBR test (soaked)

a) specific gravity of the soil

The knowledge of specific gravity is required in calculation of soil properties like void ratio, degree of saturation and also weight-volume relationship.
Specific gravity G is defined as the ratio of the unit weight of soil solids only to unit weight of water.

b) California bearing ratio

The CBR is a penetration test for evaluation of the mechanical strength of natural ground, subgrades and base courses beneath new carriage construction. The CBR can also be used for measuring the load-bearing capacity of unimproved airstrips or of soils under paved airstrips. The harder the surface, the higher the CBR rating. The test is performed by measuring the pressure required to penetrate a soil sample with a plunger of standard area. The measured pressure is then divided by the pressure required to achieve an equal penetration on a standard crushed rock material. The CBR test is fully described in IS: 2720 part 16 (1987).

c) Unconfined compressive strength

The purpose of this laboratory is to determine the unconfined compressive strength of a soil sample. We will measure this with the unconfined compression test, which is an unconsolidated un-drained test where the lateral confining pressure is equal to zero. In accordance with IS:2720 part 10 (1973) UCS test is performed. The sample sizes were of 76 mm length and 38 mm diameter.

Table 3
Result for soil test

Specific Gravity test on fine aggregate	2.7
Sieve analysis test(fines modulus)	4.898
CBR (un-soaked)	6%
CBR (soaked)	5%
UCC(Kg/cm^2)	0.14

C.Bitumen Test

Bitumen: It is obtained by the partial distillation of crude petroleum. It is also known as mineral tar. It contains 87% carbon, 11% hydrogen and 2% oxygen. One conventional commonly used bituminous binder, namely VG-30 penetration grade bitumen was used to prepare the samples. Conventional tests were performed to determine the physical properties of these binders.

The following are the tests that are conducted on bitumen,

a) Softening point of bitumen
b) Flash point and Fire Point of bitumen
c) Bitumen Penetration test
d) Ductility test
e) Specific gravity test on bitumen

a)Softening Point of Bitumen

This test is used to determine the temperature at which the substance attains a particular degree of softening. The code book refer for this test is IS: 1205-1978.

b)Flash point and Fire point of Bitumen

Flash point: The flash point of a material is the lowest temperature at which the vapour of substance momentarily takes fire in the form of a flash under specified condition of test.
Fire point: The fire point is the lowest temperature at which the material gets ignited and burns under specified condition of test.

The code refer for this test is IS: 1209 – 1978

c)Penetration test of Bitumen

A measure of hardness or consistency of bituminous material. The code refer for this test is IS: 1203-1978.

d)Ductility Test of Bitumen

It is the measure of adhesiveness of bitumen and its ability to stretch. The code refer of ductility is IS: 1208-1978.

e)Specific Gravity test of Bitumen

Useful in making volume corrections based on temperature. The code refer for this test is IS: 1202-1978.

Table 4
Results for Bitumen tests

Softening point	74.5^{o}C
Flash point value Fire point value	104.3^{o}C 193^{o}C
Penetration Test	177.3mm
Ductility value	51.16cm
Specific Gravity Test	0.99

IV.DESIGN OF FLEXIBLE PAVEMENT

Distribution factor (para 33.5) =1
Cumulative number of standard axles to be catered for in the design.
N= 365 ((1+r)^n-1) (A x D x F) / r
N= 365((1+0.02)^{20}-1) (100 x 1x 1.5) / 0.02
N= 1.33 msa

a) Total Pavement thickness for CBR 6% and traffic 1.33msa = 410mm.
b) Pavement composition interpolated from plate 1, CBR 6%
c) Bituminous surfacing= 20mm PC + 16.66 BM
d) Road Base= 225mm WBM
e) Sub base= 168.33mm

V. RESULT AND DISCUSSION

A. Aggregate

Aggregates should have minimal plasticity. The presence of clay fines in bituminous mix can result in problems like swelling and adhesion of bitumen to the rock which may cause stripping problems. Clay lumps and friable particles should be limited to utmost 1%.Durability or resistance to weathering should be measured by sulphate soundness testing. It is recommended AASHTO T-85 to be used for determining the maximum specific gravity of bituminous mixes.

B. Soil Result

a) *Cbr Un-Soaked:*

Table 5
Results for CBR UnSoaked

CBR (UNSOAKED)	
PENETRATION (mm)	**CBR (%)**
2.5	5.93
5.0	6.15

CBR = 6%

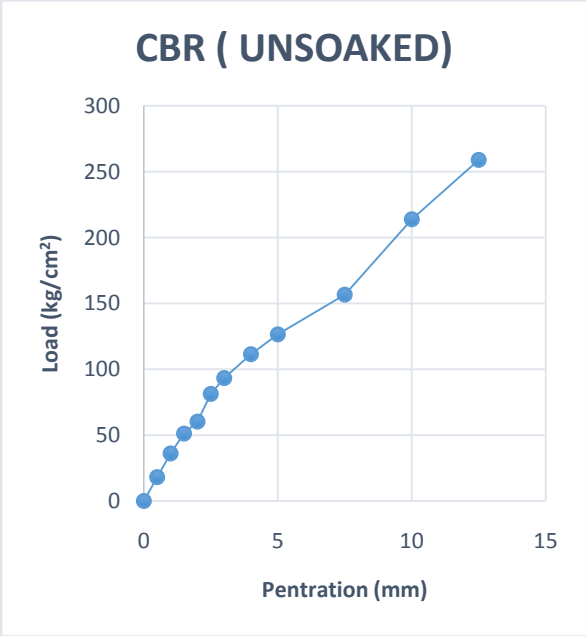


Figure 1 CBR Unsoaked

b) *Cbr Soaked*

Table 5
Results for CBR Soaked

CBR (SOAKED)	
PENETRATION (mm)	**CBR (%)**
2.5	5.17
5.0	5.37

CBR = 5%

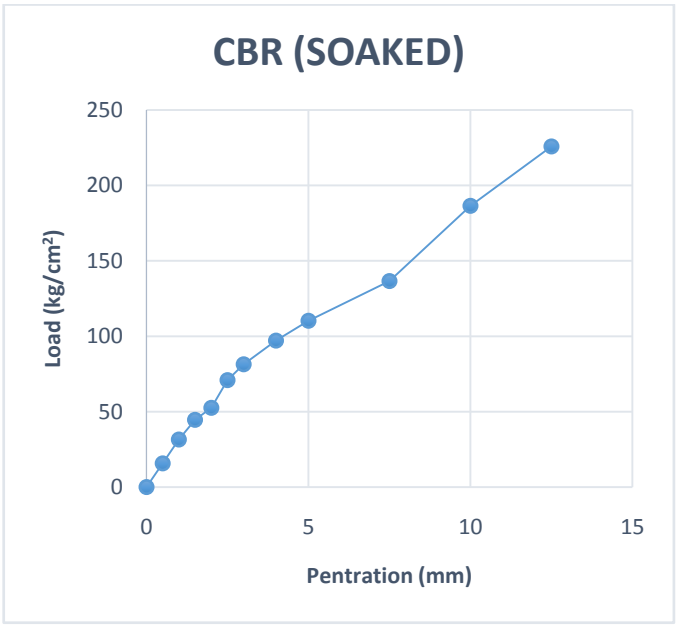
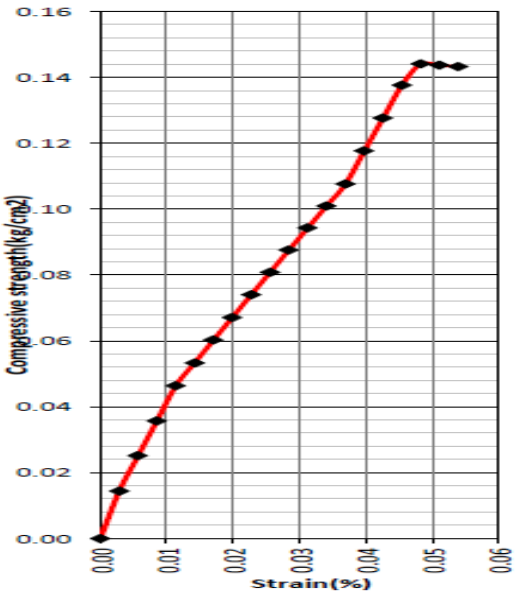


Figure 1 CBR soaked

c) *Unconfined Compression*



Compressive Strength (qu)= 0.14 kg/cm^2

Cohesion (c) = 0.07 kg/cm^2

VI. CONCLUSION

Utilization of waste plastic improves the binding property of mix. The optimum result of waste plastic came out to be 4% from the experiments as we are expected. The properties of bitumen such as penetration, softening point improved with the addition of waste plastic. Plastic roads can also be constructed in the areas having high temperatures (50°C). The stability value and durability is increased by adding plastic waste in roads.

REFERENCE

[1] Gawande, A., Zamre, G.S., Renge, V.C., Bharsakalea, G.R. and Tayde, S. (2012) Utilization of Waste Plastic in Asphalting of Roads. Scientific Reviews & Chemical Communications IJAET Vol.2, pp.147-157.

[2] Swami, V., et al. (2012) Use of Waste Plastic in Construction of Bituminous Roads. International Journal ofEngineering Science andTechnology (IJEST) Vol.4, pp.2351-2355.

[3] Bale, A.S. (2011) 'Potential Reuse of Plastic Waste in Road Construction', A Review International Journal of Advances in Engineering & Technology (IJAET) Vol.2, pp.233-236.

[4] Punith, V.S (2010) Study of the Effect of Plastic Modifier on Bituminous Mix Properties, IJERST Vol.43, pp.291-312.

[5] AslamShahan-ur-Rahman 'Use of Waste Plastic in Construction of Flexible Pavemen', New Building Materials & Construction World, 2009, IJSR Vol.34, pp.435-445.

[6] Verma, S.S. (2008) Roads from Plastic Waste. The Indian Concrete Journal, November, IJERST Vol.5, pp.43-44.

[7] Justo C.E.G. and Veeraragavan A 'Utilization of Waste Plastic Bags in Bituminous Mix for Improved Performance of Roads', Centre for Transportation Engineering, Bangalore University (2002), IJAET Vol.21, pp.289-298.