REDUCING RUTTING EFFECT IN FLEXIBLE PAVEMENT

MD ILYAS AHMED
CIVIL ENGINEERIN DEPARTMENT
LORDS INSTITUTE OF ENGINEERING AND TECHNOLOGY. HIMAYATH SAGAR, HYDERABAD-500091
Mdilyas012@gmail.com

MOHAMMED ABDUL HAMEED (PhD)
ASSOC.PROF CIVIL ENGINEERIN DEPARTMENT
LORDS INSTITUTE OF ENGINEERING AND TECHNOLOGY. HIMAYATH SAGAR, HYDERABAD-500091
ma_hameed@lords.ac.in

MOHAMMED SAFIUDDIN
Associate Professor
LORDS INSTITUTE OF ENGINEERING AND TECHNOLOGY.
HIMAYATH SAGAR, HYDERABAD-500091
msafiuddin@lords.ac

MOHD AZEEM UL HUSSAIN
Asst.prof CIVIL ENGINEERING DEPARTMENT
LORDS INTITUTE OF ENGINEERING AND TECHNOLOGY
HUSSAIN_1100@YAHOO.COM

Abstract *Flexible pavements are construction of roads in India. Bitumen as a binder is known to be highly sensitive to high temperatures. The form of ruts, cracking, ageing etc. are common on Flexible pavements. These are still observed on pavements presently with thick layers of binder courses at high cost. Rutting one of the commonly observed permanent is the subject matter of this case study. The effect of high pavement temperature on the stability of mix in conjunction with lower softening point of bitumen in the context of prevailing high temperature in top pavement layers. Study brings out the existing specifications and some follow up actions to improve the existing specifications. Use of the top binder courses like DBM to enhance the dependent of the bituminous mixes is one of the recommendations. It type performance biased specifications covering different climatic regions of the country is also suggested*.

Keywords—Road engineering, Asphalt pavement, Mechanical properties Laboratory testing, Field durability.

Introduction

Flexible pavements have been normal provided on most of the important highways of the country. Thick bituminous pavement layer mainly comprising of a DBM layer of 160 to 180 mm topped with 50 mm bituminous concrete are being provided by way of strength. The bitumen used in the design of mixes for DBM and BM is typically of 60/70 grade. The bituminous thick is also being provided with modified bitumen. Use of modifiers, however, is not common. The design of mixes done with normal 75 blows for all locations without considering the effects of climatic, traffic variations etc.

Such bituminous pavements from rutting usually in totally early age. Such deformations in the form of rutting are more plain at locations of junction, curves and in stretches where heavy traffic operates with low speed and is subject to periodic stop/start condition. The rutting of the flexible pavements should cover all highway engineers .when construction long performing all highway in view of great investment being made on the construction of such highways.

Permanent deformation of rutting is one of the most important distress (failure) mechanisms in asphalt pavements. Increase in truck tire pressure, rutting has become the ruling mode of flexible pavement failure. Which results in a ruling pavement surface, is first caused by the collection of permanent deformation of the layers in the pavement structure. Rutting can also be caused by wear of pavements from use of studded tires. Length ways coarseness in the magnitude of rutting. Water may become in resulting in a reduced skid resistance; Progression of rutting can lead to cracking and finally to complete failure. Rutting accounts for a significant portion of maintenance and associated costs in both main highways and secondary roads.

The truck transportation has caused the average gross weight of trucks. So that a majority of trucks are operating close to the axle loads limits. In countries enforcement of the axle load limits is relaxed or non-existent (typical of developing countries), trucks at axle loads, and the axle load limit the use of higher tire pressures has become more popular in the trucking industry. The contact area between the tire and the pavement, resulting in high stress which to greater deformation in flexible pavements, wheel track rutting.

As increased tire pressure and axle load, the asphalt layer to increased stresses, which result in permanent deformations The permanent deformation with increasing number of load applications. The permanent in the layer accounts for a major of rutting on flexible pavements subjected to heavy axle loads and high tire pressures.

THE PROBLEM OF RUTTING IN FLEXIBLE PAVEMENTS

Rutting is one of the major distress mechanisms in flexible pavements. Because of the increase in tire pressure and axle loads in recent years, rutting has become the dominant mode of failure of flexible pavements in many countries. There are various causes of rutting depending on configuration and structural capacity of the various layers and environmental conditions. In this chapter, the problem and the mechanisms of rutting in flexible pavements in general and the rutting caused by permanent deformation in the asphalt layer in particular are discussed. The considerations of rutting at the pavement design and mixture design stages are also discussed.

Rutting is a longitudinal surface depression in the wheel path accompanied, in most cases, by pavement upheaval along the sides of the rut. Significant rutting can lead to major structural failure and hydroplaning, which is a safety hazard. Rutting can occur in all layers of the pavement structure and results from lateral distortion and densification. Moreover, rutting represents a continuous accumulation of incrementally small permanent deformations from each load application.

Generally there are three causes of rutting in asphalt pavements: accumulation of permanent deformation in the asphalt surfacing layer, permanent deformation of sub grade, and wear of pavements caused by studded tires. In the past sub grade deformation was considered to be the primary cause of rutting and many pavement design methods applied limiting criteria on vertical strain at the sub grade level. However recent research indicates that most of the rutting occurs in the upper part of the asphalt surfacing layer. These three causes of rutting can act in combination, i.e., the rutting could be the sum of permanent deformation in all layers and wear from studded tires

RUTTING CAUSED BY WEAK ASPHALT MIXTURE

Rutting resulting of permanent deformation in the asphalt layer is now considered to be the principal component of flexible pavement rutting. This is because of the increase in truck tire pressures and axle loads, which puts asphalt mixtures nearest the pavement surface under increasingly high stresses.

Causes of Rutting in Flexible Pavements

Generally there are three causes of rutting in asphalt pavements: accumulation of permanent deformation in the asphalt surfacing layer, permanent deformation of sub grade, and wear of pavements caused by studded tires. In the past sub grade deformation was considered to be the Primary cause of rutting and many pavement design methods applied limiting criteria on vertical strain at the sub grade level. However recent research indicates that most of the rutting occurs in the upper part of the asphalt surfacing layer. These three causes of rutting can act in combination, i.e., the rutting could be the sum of permanent deformation in all layers and wear from studded tires.

Rutting caused mainly by studded tire wear

RUTTING CONSIDERATION IN MIXTURE DESIGN

The purpose of mix design is to determine the proportions of aggregate and binder that would
Produce a mix, which is economical and has the following desirable properties:

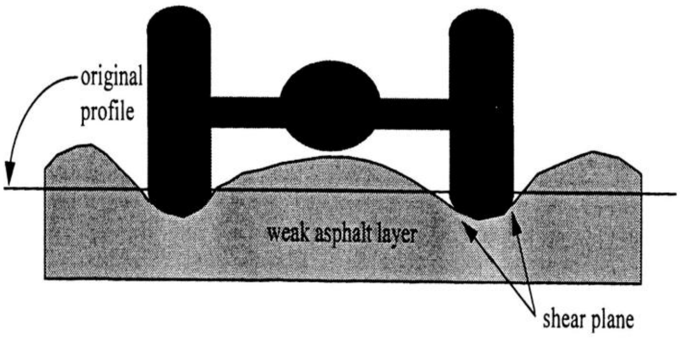
• Sufficient binder to ensure durability

• Sufficient voids in mineral aggregate, so as to minimize post construction compaction without loss of stability and without causing bleeding, and to minimize harmful effects of air and water.

• Sufficient workability to permit laying of the mix without risk of segregation, and

• Sufficient performance characteristics over the service life of the pavement

In the volumetric mix design method, design binder content and aggregate gradation are chosen by analyzing the proportional volume of air voids, binder and aggregate for mixtures which have been compacted using a compaction procedure that is assumed to reproduce, in the laboratory, the in situ compaction process. No tests are conducted on the mechanical properties of the mixtures. Volumetric mix design method is expected to produce mixtures that would perform satisfactorily under low traffic conditions. This method has to be supplemented by some sort of mechanical tests if it is to be used for design of mixtures that would be subjected to medium or heavy traffic conditions. A prime example of the volumetric mix design method is the level 1 of the Super mix design system developed in the Strategic Highway Research Program (SHRP). In the Superpose method,. This method also utilizes performance - based bitumen specifications and empirical performance - related specifications for the aggregates.

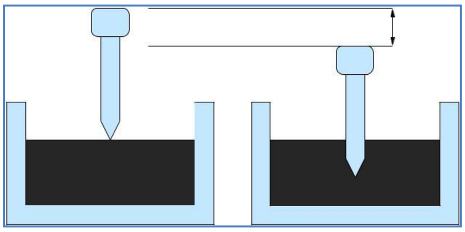


Rutting caused by weak asphalt layer.

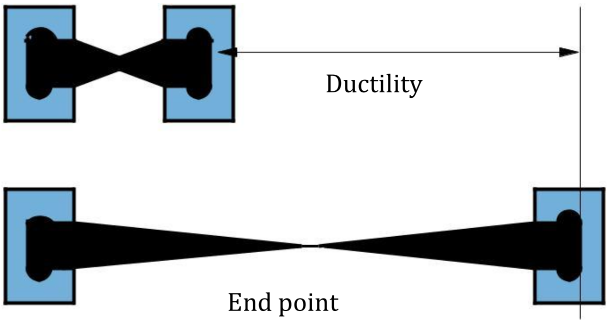
TESTS ON BITUMEN & AGGREGATE

There are a number of tests to assess the properties of bituminous materials. The following tests are usually the different of bituminous materials

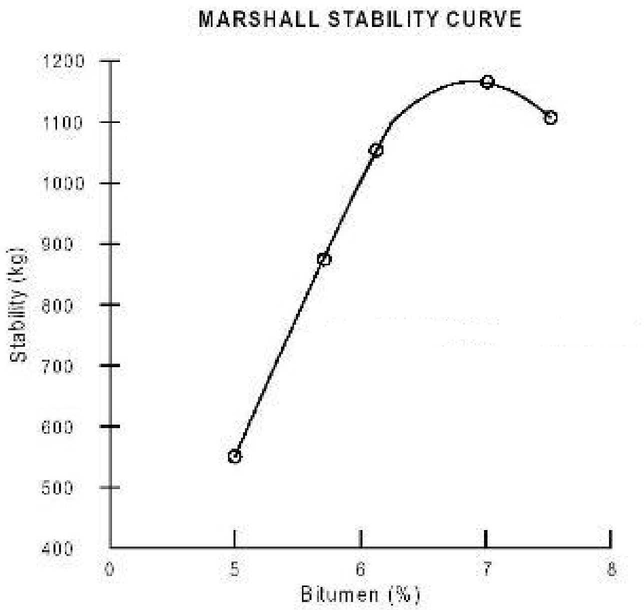
i. Penetration test
ii. Ductility test
iii. Softening point test
iv. Specific gravity test
v.Viscosity test
vi. Impact test
vii. Abrasion test
viii. Marshall test



PENETRATION TEST



DUCTILITY TEST



ANALYSES OF TEST RESULTS AND DISCUSSIONS

- Penetration test:

∴ Penetration value is = 21mm

- Ductility test:

Bitumen grade 75a

Pouring temperature °C= 44%
Test temperature °C = 40%
Periods of cooling, minutes = 18

S.No	Name	1	2	3
1	a)Initial reading	0	0	0
2	b)Final reading	51	58	62
3	c)Ductility =b-a(cm)	51	58	62
4	Ductility value	51	58	62

∴ Ductility value is = 57.3cm

- Softening point test

S.No	Name	1	2
1	Temperature when the ball touches bottom ° C	88	92
2	Average	90	90
3	Softening point of bitumen	90	90

THE SOFTENING POINT TEST VALUE IS = 90°C

- Abrasion Test

BC with filler type	Max. Stability(KN)	Corresponding Binder Content (%)
Bitumen	14.78	5
Stone dust	14.48	5
Aggregate	14.38	5

Formula: - $\frac{w1+w2}{2} = \frac{10.8+10.6}{2}$ = 10.70%

∴The Average value of Los Angeles Abrasion test is = 10.70 %

- Impact Test

S.No	Details of sample	Trial 1	Trial 2	Trial 3
1	Total Weight of Aggregate Sample Filing the Cylinder measure =w1g	313	330	320
2	Weight of Aggregate passing 2.36mm IS sieve after the Test =w2g	235	245	240
3	Aggregate impact value= (w2/w1)*100 percent	75.07	74.24	75.00

Formula: - $\frac{w1+w2+w3}{3} = \frac{75.07+74.24+75.00}{3}$

=74.77%

∴The Average value of impact test is = 74.77%

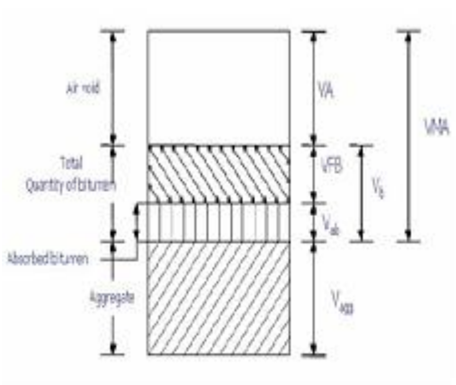


Fig 4.1 Phase Diagram of bituminous mix

S.No	Details of sample	Trial 1	Trial 2
1	Weight of sample = w1g	5000	5000
2	Weight of sample after abrasion test, coarser than 1.70mm IS sieve =w2g	4460	4470
3	Percentage wear = ((w1-w2)/w1)*100	10.8	10.6

EFFECT OF DIFFERENT TYPE OF FILLER ON BC:-

Variation of Marshall Properties of bituminous concrete (BC) with different type of filler is explained below.

EFFECT OF BC:

For preparation of mix binder content from 4 to 7% and vary from 0.3% to 0.5%. Here OBC, OFC and other Marshall properties is calculated by Marshall Method.

Marshall Stability

It is observed that stability value increases with binder content up to certain binder content; then stability value decreases. Also stability value increases variation of Marshall Stability value with different binder content with different is given.

CONCLUSIONS

Based on the results and discussion of experimental Investigation carried out on mixes i.e.
SMA and BC following conclusion are drawn.

BC with different type of filler

As per MORTH Specification mix design requirements of bituminous mix .

Based on the present study, the conclusions drawn are presented in three sections as given below:

RELATIONSHIP OF PAVEMENT STRENGTH AND PAVEMENT COMPOSITION

- The strength of the pavement represented by the measured deflection at the surface on mature soil sub grades is influenced by the sub grade soil properties and layer composition on an in-service pavement in urban conditions.
- There is good correlation between deflection and Modified Structural Number for various classes of Pavement Condition Index for sub grade soil types SM and SC.
- In the case of pavement in good condition, ie, for the PCI range 60-80, linear relationship give better correlation.
- In the case of soil type SM, power function relationship showed better correlation.
- In general, either power function or linear relationships can be used for finding the deflection in order to arrive at a suitable maintenance option.
- The parameters such as Field Dry Density, Field Moisture Content, Optimum Moisture Content, Maximum Dry Density, Atterberg Limits, CBR, Soil composition and the fraction of Silt & Clay of the sub grade soil have influence on the strength of the pavement.

REFERENCES

ASTM D 1559 (1989), "Test Method for Resistance of Bituminous Mixtures Using Marshall Apparatus"

ASTM D 6931 (2007), " Strength for Bituminous Mixtures"

Brown E.R. and Mallick R.B. (1994), "Stone Matrix Asphalt Properties Related to Mixture Design", NCAT

Asphalt (SMA) – A Long Life Pavement Surface", International Seminar on Innovations in Construction and Maintenance of Flexible Pavements, Agra, 2-4 September, Technical Papers, Volume 1, pp 169-17

Chui-Te Chiu and Li-Cheng Lu (2007), "A Laboratory study on Stone Matrix Asphalt using Ground Tire Rubber", Construction and Building Materials, Volume 21, Issue 5, pp 1027-103

C.S Bindu, Beena K.S.(2010),"Waste Plastic as a Stabilizing additive in SMA", International Journal of Engineering and Technology, Volume 2, Issue6, pp 379-387

Das A. and Chakroborty P. (2010), "Principles of Transportation Engineering", *Prentice Hall of India, New Delhi, pp 294-299*

Das A., Deol, M. S. Ohri S. and Pandey B. B.(2004). "Evolution of non-standard bituminous mix – a study on

Indian specification", *The International Journal of Pavement Engineering, Vol 5(1), pp. 39-46.*

H. Jony Hassan, Y. Jahad Israa (2010), "The Effect of Using Glass Power filler on Hot Asphalt Concrete Mixture Properties", *Engg and Technology journal, vol.29, Issue1, pp44-57*

IS: 2386 (1963), "Methods of Test for Aggregates for Concrete (P - I): Particle Size and Shape", *Bureau of Indian Standards, New Delhi*

IS: 2386 (1963), "Methods of Test for Aggregates for Concrete (P-III): Specific Gravity, Density, Voids, Absorption, Bulking", *Bureau of Indian Standards, New Delhi*

IS: 2386 (1963), "Methods of Test for Aggregates for Concrete (P-IV): Mechanical Properties", *Bureau of Indian Standards, New Delhi*

http://www.pavementinterective.org/article/hma-types/

IS: 1203 (1978), "Methods for Testing Tar and Bituminous Materials: Determination of Penetration", *Bureau of Indian Standards, New Delhi.*

http://www.pavementinterective.org/article/hma-performance- test/

http://www.pavementinterective.org/article/hma-types/

http://www.pavementinterective.org/article/hma-performance- test/