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THE EFFECT OF STRING ELASTOPLASTOMER ADDITIVE ON DURABILITY OF MIX ASPHALT

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ABSTRACT

Today, given to the fact that roads are considered as an infrastructure investments for countries, repairing and maintenance of them is very important but this issue bring an extensive cost, therefore; it has been tried to find a way for long life and durability of mix asphalt by doing research about components of mix asphalt and analyzing the effect of various factors on it. This study is aimed to analyze string elastoplastomer polymer to produce polymer asphalt and to see obtained results in future costs of repair and maintenance of path during long time. The method of the research is laboratorial and a research study was done by using Tehran's refinerybitumen and the stone material of mines around this city in place ofsoil mechanics and technical laboratory company of ministry of roads & urban development in order toanalyze the effect of using string elastoplastomer polymer in performance and durability of hot mix asphalt. The results of tests show thatbitumen modification by usingstring elastoplastomer polymer and producing mix asphalt by using this kind of polymer causes the durability of hot mix asphalt to be increased and also causes damages of roads pavement such asalligator cracking due to fatigue, and rutting and damages of naked singularities to be delayed.

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KEY WORDS

String elastoplastomer, cracking, alligator cracking, polymer, bitumen hardening and ageing phenomena

INTRODUCTION

Given to the issue that bitumen is used in asphalt less than stone material it seems that the role of bitumen in behavior, durability and performance of asphalt pavement layers is not very important and considerable, but the fact is that bitumen and its physical and chemical properties has a major effect on good performance, durability and stability of asphalt mixtures. For proper functioning and durability of asphalt pavement, the bitumen not only must have durability but it also must have proper behavior and function in the range of high, low and middle temperatures[1]. Today in addition to bitumen and stone material, the additive material or bitumen modifiers are also used. These components which consist the wide range of material are applied as follow in order to repairing and improving some of the bitumen properties and subsequences asphalt mixtures:

Preventing from naked singularities of asphalt mixtures gravel
Preventing from thermal and contraction cracking
Reducing deformations and asphalt paving bituminous phenomena
Preventing from asphalt cracks and reflective cracks manifestation
Reducing the phenomenon of hardening and ageing of bitumen
Increasing the resistance of mix asphalt fatigue

The following conditions must be provided by an additive in order to be effective,
:applicable and economical

-it must be easy to reach and economical
-Do not be damaged at mixture temperatures of mix asphalt
-Easily mixed with bitumen and with lowest costs
-It must increases resistance againstfluencyin high temperatures of pavement, without making bitumen very soft or very hard in mixture temperature or making it fragile in low temperatures of pavement.
-Preserving the first characteristics of bitumen during storage, execution and servicing.
-To be sustainable during storage, execution and servicing time both physically and chemically.
-To be reached to desire rotational at ordinary temperatures of asphalt mixtures execution, and it should be injectable and pumpable.

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MATERIALS AND METHODS

Laboratorial research methods was used to study the use of elastomers in asphalt, and a research study was done by using Tehran's refinery bitumen and the stone material of mines around this city in place of soil mechanics and technical laboratory company of Ministry of Roads & Urban Development in order to analyze the effect of using string elastoplastomer polymer in performance and durability of hot mix asphalt and functional properties of ordinary hot asphalt mixes and modified hot asphalt with string polymer was evaluated by doingfunctional tests including four-point bending beams fatigue test, resilient modulus and wheel rutting of Hamburg wheel track loading cycle.Rheological[1] behavior and properties of modified and pure bitumen with string polymerwas also evaluated by doing performance tests and determination performance rating of the bitumen. [2]

RESULTS

The project of mix asphalt mixture Topeka layer 0-19 mm was done with limitation of grading specifications number 4 inserted in publication No. 234, Iranian roads asphalt pavement bylaw, by determining the optimum bitumen at a rate of 6/1. It is worth noting that for providing and preparing of modified bitumen, at first bitumen is heated to 150 ° C. temperature and the process of mixing began at low speed through the gradual addition of additives to 20 weight percent of bitumen. Then with use of high shear mixer and rotation speed of 3000 revolutions per minute mixing process was performed for 15 minutes.

Functional tests of bitumen including RTFO[2] and PAV[3] and DSR[4] and BBR[5] and RV[6] tests was performed on the pure and modified bitumen with string polymer and these bitumen were classified respectively with functional grading PG 64-22 and PG 76-28. The results showed that the modification of bitumen by using string polymer causes its properties to increase and enhance in a range of high and low temperatures of paving services, so that the functional degree of high temperature of bitumen would be improved two unit of measures and functional degree of low temperature would be improved one unit of measures. The tests show that modified bitumen against rutting damages, thermal cracking and fatigue cracking can provide strength and long life than pure bitumen. [3]

Dynamic creep test of ordinary and modified asphalt samples with string polymer was done at a temperature of 45 ° C. based on BSDD226 standard. In accordance with standard the testing time has been 3600 seconds and during this time 1800 loading cycle have been applied, in each cycle the time of loading with amount of 100 kilopascal is equal to a second. The results of test are presented in **table 1**. The results of test show that modified asphalt with string polymer has more resistance against permanent deformation, so that at the end of loading, the strain of modified asphalt sample is 1/5 time less than its amount for ordinary hot asphalt made by pure bitumen. Based on the obtained results the durability and life of modified asphalt mixtures with string polymer in danger of rutting in high temperature of servicing is more than ordinary asphalt mixture. [4]

Table 1. The results of dynamic creep test after 1800 loading cycles

final cumulative strain (percent)	type of asphalt mixture
1.156	Ordinary asphalt mixture
0.749	modified asphalt mixture with string polymer

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The test of four-point bending beams fatigue of ordinary and modified asphalt samples with string polymer was performed in accordance with standard procedure of AASHTO T321. The test results of mentioned samples at temperature of 20 ° C and 250 and 400 micro-strains are presented in **table 2**. The results show that the number of loading cycles of fatigue life of modified samples with string polymer in loading 250 and 400 micro strains are respectively 1/9 and 2/9 time more than ordinary hot asphalt mixture containing pure bitumen. These results show that the behavior and function of modified mix fatigue with string polymerase significant improvement in comparison with control mixture which is made by pure bitumen. Therefore, modification of hot mix asphalt with string polymer causes the tensile strength of mixture and its resistance against cracks due to fatigue (alligator cracking) to be increased. [5] , [6]

Table 2: the results of bending beams fatigue test of asphalt mixture

The number of final cycles	Micro strain	Type of asphalt mix
2347670	250	
61320	400	Ordinary asphalt mixture
6798500	250	
114160	400	modified asphalt mixture with string polymer

Rutting test of modified and ordinary hot asphalt mixtures with string polymer was done by Homburg wheel track rutting machine that is shown in **figure 1** in accordance with AASHTO T324 standard. In this machine, the loading wheel with constant load on sample level moves in form of reciprocating and sample is tested in dry or flooding conditions.

The dimensions of used sample in this machine are of 5 × 30 × 30 cm. Wheeled loading of machine is 20 cm in diameter and 5 cm in width. The samples were compacted by roller compactor machine in which friction method is used for compaction and is shown in **figure 2**.Asphalt slab samples immersed in water at 50 ° C,705 newton wheeled load and reciprocating motion speed 50 passes per minute, were passed under 20000 wheel load motion (10000 reciprocate). The size of furrow depth in various cycles for modified and ordinary hot asphalt mixture with string polymer is presented **in figure** 3&4. The size of furrow depth of modified and ordinary asphalt mixture samples after 20000 loading wheel passes, has been respectively 6/62 and 0/13 mm. Control hot asphalt mixture made by pure bitumen in the path of loading wheel motion was destructed because of naked singularity under the influence of water and rutting continued with more intensity. The results of the test show that modification of bitumen by using string elastoplastomer polymer cause to increase the hot asphalt strength against permanent deformations and wheel J rutting in pavement. Moreover, considering that ordinary hot asphalt mixture was damaged because of naked singularity, not happen to modified mixture, modification of bitumen with string polymer also cause to increase moisture durable of asphalt mixture and its resistance against naked singularities as well as the damages due to sand and fatigue cracking.

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Fig: 1. Humbug wheel track rutting machine

Fig: 2. Roller compactor machine

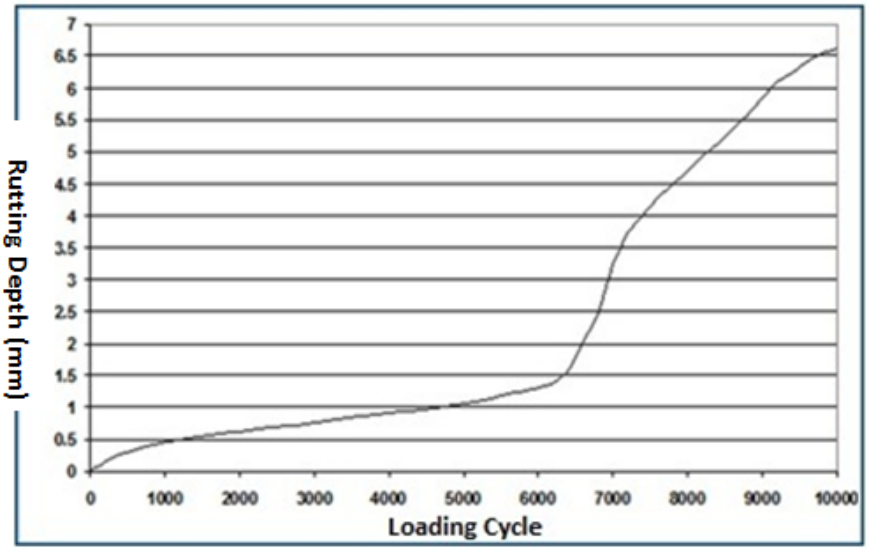

Fig: 3. Ordinary asphalt mixture rutting against the number of loading cycle

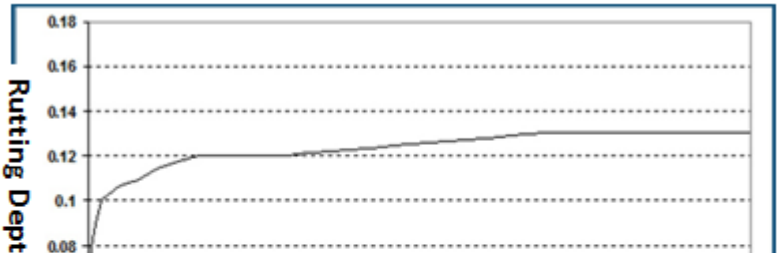

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Fig: 4. Polymer asphalt mixture rutting against number of loading cycle

The results of the tests show that modification of bitumen by using string elastoplastomer polymer and producing asphalt mixture by using this type of polymer, causes to increase the durability of hot asphalt mixture and also causes to postpone the common damages of roads pavement including alligator cracking due to fatigue, rutting and damages of naked singularities.[7]

Mosaic and alligator cracks in projects causes to pavement with asphaltmilling machine and high costs during long time and blocking the roads, by using %8 of string elastoplastomer polymer to consuming bitumen, the polymer asphalt pavement was applied by 20 percent decreasing of paving thickness and after more than three years of testing and frequent reviews, the issuance of confirmation shows successfulness of this plan. [7]

DISCUSSION AND CONCLUSION

Given to the issue that bitumen is used in asphalt less than stone material it seems that the role of bitumen in behavior, durability and performance of asphalt pavement layers is not very important and considerable, but the fact is that bitumen and its physical and chemical properties has a major effect on good performance, durability and stability of asphalt mixtures. For proper functioning and durability of asphalt pavement, the bitumen not only must have durability but it also must have proper behavior and function in the range of high, low and middle temperatures. Today in addition to bitumen and stone material, the additive material or bitumen modifiers are also used. These components which consist the wide range of material, are applied as follow in order to repairing and improving some of the bitumen properties and subsequences asphalt mixture:

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- Reducing the phenomenon of hardening and ageing of bitumen
- Increasing the resistance of mix asphalt fatigue

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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None declared.

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REFERENCES

[1] pavement Technology and Materials " M.R. Keymanesh (Ph.D) , S.Shaker (M.Sc) , 2015

[2] Improve the Quality Of Instruction Asphalt", Ministry of Roads & Urban Development,Road,Housing & Urban Development Research Center

[3] pavement Technology and Materials " M.R. Keymanesh (Ph.D) , S.Shaker (M.Sc) , 2015

[4] Ziyari,H.& Tabatabaei,A. "Practical Guide Asphalt Tests",University of Science & Technology,2006

[5] American Association of State Highway and Transportation Official (AASHTO) 2007 , Guide for design of pavement structure , , 27th edition , Washington

[6] American Society of Testing and Materials (ASTM) , Technical Standards for a materials, bitumens asphalt mix, …

[7] Flexible Pavement Repair & Rehabilitation Guide",No.296,Management & Planning Organization,Ministry of Roads & Transportion,2004

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