A REVIEW ON WASTE PLASTIC ON THE DETERIORATION OF BITUMINOUS MIXES IN COLD CLIMATES

[1]Rizwan Mustafa, [2] Manish Goel
[1.2]Department Of Civil Engineering
[1]Desh Bhagat University, Amloh Gobindgarh, Punjab, India

Abstract: The modifications in bitumen can be carried by addition of various types of additives. Polymers can be categorized as one of the types of additive. By the addition of Polymers to the bitumen, the temperature susceptibility and also the stiffness get increased. Due to this increase in stiffness, the resistance of the mix to rutting in hot climates is generally improved and thus we can use comparatively softer base bitumen, which results in improved performances at low temperatures. Mixes having waste plastic bags can be utilized in the construction of BC pavements. It was observed that after comparing the results of the mixes prepared by the addition of both Anti stripping material with Varying percentages and WPB, and the mixes containing only WPB, the latter provided better results in terms of Retained Marshall stability and Marshall Quotient

IndexTerms **- BC, WPB, SDBC,BC, Waste plastic.**

1. INTRODUCTION

1.1ROAD NETWORK IN INDIA

Transportation is an essential component for the infrastructure of all the countries. The economy and economic status of any country is determined by its network of roads, railways, waterways, airways, pipes and ports. It is well known that road network is the largest and most important connecting way and so is its maintenance. A good and long lasting road network requires proper designing, construction and maintenance approach. To enhance the economy and social status of a community roads are of great importance. The road network of India is the second biggest in the globe. It is responsible for carrying about more than half of the goods of country (60%) and the majority of passengers as well(85%).The total length of roadways is estimated as 5.4million Km. In the northern areas of the country, roads are the most important source of connectivity. Due to cold weather conditions which include factors like snow, rain, frost, and these roads suffer excessive damage and thus hamper the movement of people as well as goods across these parts of the country. To improve the conditions of the road connectivity in such areas huge amount of money is being invested. The central government has awarded a contract of Rs 23,000 crore for building 5 all-weather tunnels in Jammu and Kashmir by 2024.Huge reserves of money have been invested in the four laning of nation highways in the state of Himachal Pradesh .Along with the construction of these new roads, the maintenance of such roads and tunnels is important for increasing their life span.

1.2. BITUMINOUS MIXES

Bituminous mixes are broadly utilized in Pavement constructions. There are generally two groups of pavements, i) Flexible and ii) Rigid. Bituminous mixes are most generally utilized everywhere in flexible pavement Construction.

1.3TYPES OF PAVEMENTS

1.3.1Flexible Pavement

These can be defined as the pavements, which in general have low flexural strength and are somewhat flexible when acted upon by loads. In such pavements the disfigurement in the lower layers gets mirrored on the top layers as well. It ordinarily comprises of: sub grade made of naturally available soil, a sub base of 100-300 mm, a base course of granular material, a binder course (made of usually coarse graded aggregate) and a wearing course. The transfer of load in a flexible pavement is due to distribution pattern which takes places laterally with increase in the depth. Because of the lower qualities of flexure of such pavements, they redirect quickly when acted upon by loads yet bounce back on the evacuation of such loads. . The design for thickness of the pavement is such that the stress on the soil sub grade is inside the bearing force and hence is kept from distortion of extravagant nature. The pavement quality is decided mainly on the basis of such distortions endured by the sub-grade and also by its ability to resist such distortions.

1.3.2Rigid Pavement

On the off chance that wearing course is made of cement concrete, it is then known as the rigid pavement because of the fact that the aggregate asphalt structure will not twist or redirect because of activity loads. These kinds of pavements have higher stiffness as compared to others because of higher elasticity modulus of the material of which they are made of. Critically, for the joint diminishing and disposal strengthening bars can be utilized.

1.3.3Layers of Flexible pavement

In General, customary black-top pavement comprises of:

1. Surface Course: is normally built of bituminous concrete and largely comprises of material having high qualities. It forms the top layer and is sometimes, also known as wearing course. The vehicle load is directly taken by this layer. Capacities and necessities of the surface course are as:

- Imparts riding qualities, for example, friction, smoothness, besides resisting the traffic load.
- It keeps the passageway of excess amounts of surface water away from the layers which are underneath
- Should have the ability to oppose the deformations which may take place due to movement, thus give a slip safe surface for riding.
- Should be resistant to water and thus ensure the protection of underlying layers from the detritus impact, if exposed to moisture.

2. Binder Course: The primary intention of this layer is the appropriate distribution of the load to the base course .This layer by and large comprises of aggregate with lower amount of bitumen than the surface layer. It gives the major portion of our structure.

3. Base Course: It comes quickly underneath the binder and wearing course. This layer helps to distribute load and also adds to the seepage. Its thickness is generally kept as 100-300 mm.

4. Sub-base Course: The main aim of this layer is to provide additional assistance to the structure, improvement of the drainage quality. The invasion of fines into the structure of the pavement is also prevented due to this layer. It is not always required.

5. Sub-grade or top soil is arranged to get the stress from the layers above. It is mostly a layer of natural soil. This layer should never be allowed get overstressed which is very fundamental. The compaction of this layer is done to the required thickness, close to the OMC.

1.4 MATERIALS USED IN A FLEXIBLE PAVEMENT

1.4.1Aggregate

Aggregate may be defined as a vast group which includes coarse and medium grained material. It is generally used for construction purposes and consists of rock, slag, stones which are in crushed form etc. It is utilized to provide strength to the material. It may additional be utilized in the pavement layers as in base course.

1.4.2 Bitumen

It may be defined as a black mixture which is made up of hydrocarbons and is viscous in nature. It can either be obtained in residual form at the process of distillation of petroleum or naturally. The reliance on responsive mechanical properties of such material at the time of loading is an imperative factor in the expressway designing. These properties should be properly estimated at loads and temperatures which compare or resemble the conditions to which the pavement will be exposed. As such there are 4 levels of viscosity which have greater significance. These include:

- Thickness amid compaction.
- Viscosity when the material is being mixed.
- Viscosity of bitumen when the pavement is exposed to the most elevated temperature.

- Viscosity of bitumen when the pavement is exposed to the lowest temperature.

1.4.3Criteria for selection of Bitumen

Following things should be kept into consideration while selecting a type of bitumen binder:

- Climate of the place including moisture and rainfall.
- Whether maintenance and repair or a new construction work
- Availability of materials and plante
- Whether it's a spraying or mixing specification

2. RELATIED WORK

2.1 REVIEW OF LITERATURE

Ahmadinia E., Zargar M., Karim M. R., Abdelaziz M., finished a test request about the usage of waste plastic holders (Polyethylene Terephthalate (PET)) as an additional substance in stone mastic black-top (SMA). Wheel following, sogginess shortcoming, mass modulus and channel down tests were finished in their examination on the blends that included various rates of waste PET as 0%, 2%, 4%, 6%, 8% and 10% by weight of bitumen content. Their results exhibit that the including of waste PET into the blend has an enormous valuable result on the properties of SMA which could improve the blend's security against never-ending deforming (rutting), increase the quality of the blend, give low cover channel down and progression of re-use and reusing of waste materials in an even more biologically and productive way.

Awwad M.T. and Shbeeb L., exhibited that the modified blend has a higher solidness and VMA rate as contrasted and the non-modified blends and thusly firmly sway the rutting insurance of these blends. As demonstrated by them modifying black-top blend with HDPE polyethylene improves its properties fundamentally more than the upgrades recognized by utilizing LDPE polyethylene.

Bindu C.S and Beana K.S., thought about how Waste plastic goes about as an additional substance functioning as a stabilizer in Stone Mastic Asphalt when the blends were exposed to tests tallying Marshall Stability, unbending nature, compressive quality tests and Tri-pivotal tests. There out comes exhibited that adaptable pavement of high solidness and more prominent execution can be gained with expansion of 10% destroyed plastic.

Chavan M., reasoned that Plastic covering on totals is used for the better execution of streets. This aides in predominant authoritative of bitumen with plastic waste secured total on account of expanded holding and extended zone of contact among polymers and bitumen. The polymer covering also diminishes the voids. This averts the moistness assimilation and oxidation of bitumen by caught air. In short we can assume that, using plastic waste in blend will help decline utilization of bitumen by around 10%, expansion the quality and execution of road, keep away from use of hostile to stripping operator, and inevitably develop an advancement, which is eco very much arranged.

Gawande A., Zamare G., Renge V. C., Tayde S., and BharsakaleG., gave a survey on waste plastic use in asphalting street by using both wet and dry procedure. They said that use of modified bitumen arranged by including waste plastic of around 5-10% by weight of bitumen helps in upgrading the life expectancy and execution of pavement with minor sparing in bitumen use and as shown by them use of waste plastics really taking shape of streets and overlaid material moreover help to use immense measure of waste plastics. Along these lines, these structures are socially significantly appropriate, furnishing us with better foundation.

Gundaliya P. J., communicated that the technique of adjusting of bitumen with waste polythene improves insurance from part, pothole course of action and rutting by improving relaxing point, hardness and decreasing stripping due to water, as such upgrading the general execution and execution of streets over a drawn out stretch of time. As demonstrated by them the waste polythene utilized in the blend shapes covering over totals of the blend which diminishes porosity, ingestion of moistness and improves restricting property.

Herndon D., analyzed moistness powerlessness of black-top blend using phosphorylated reused polythene. They exhibited that there is a colossal lessening in soddenness weakness by expansion of reused unmodified polyethylene to black-top solid blends in both the Wet Procedure and the Dry Process.

Karim R., Islam N., Sajjad M. and Habib A., gave a potential response for quality loss of bituminous pavement submerged. They examined execution of bituminous blend submerged with and without polyethylene admixture and came to reason that bitumen blends with polyethylene performed well when submerged and demonstrated much unrivaled Marshall Stability than

average bituminous blend under run of the mill condition. Additionally shielding the earth from tainting will be an exceptional reward

Moghaddam T .B, Karim M. R., and Soltani M., uncovered that the utilization of waste material in black-top pavement would be beneficial remembering the true objective to find a response for addition in advantage life of black-top pavement and reduce environmental pollution moreover. From their examination it is contemplated that Polyethylene Terephthalate (PET) sustained blends have higher soundness worth, stream, and exhaustion life in connection with the blends without PET.

Rajasekaran S., Vasudevan R., Samuvel P., has clarified the Reuse of Waste Plastics Coated Aggregates-Bitumen Mix Composite for Road Application by Green Method. Their conditioning differs between 1100C – 1400C and they don't deliver any poisonous gases during warming however the mellowed plastics have propensity to frame a film like structure over the total, when it is splashed over the hot total at 160C.The example demonstrated higher Marshall Stability esteem in the scope of 18-20KN and the heap bearing limit of the street is expanded also. It is useful for substantial traffic because of better official, expanded quality and better surface condition for a drawn out time of presentation to variety in climatic changes.

Sabina, Khan Tabrez A, Sangita, Sharma DK & Sharma BM., considered the relative execution of properties of bituminous mixes containing plastic/polymer (PP) (8% and 15% by the heaviness of bitumen) with regular bituminous blend. Huge improvement in properties like Marshall Stability, Retained Stability, Indirect Tensile Strength and Rutting was seen in PP modified bituminous cement mixes. Consequently squander PP modified bituminous cement mixes are required to be increasingly solid, less vulnerable to dampness in real field conditions and improved execution.

Sangita, Reena, and Verinder .K., proposed a technique to manage improving street quality by utilizing plastic waste in road improvement. As demonstrated by her India spends Rs 35,000 crores per year on street improvement and fixes, including Rs 100,000 crores consistently just to upkeep usefulness and just by bitumen streets props up 2-3 times longer, which will save us Rs 33,000 crores every year in fixes, notwithstanding reduced vehicle breakdowns and fixes.

Reedevi B.G., Salini P.N., considered that on streets surfaced utilizing bituminous blend with plastic covered totals. Research facility studies led on Semi Dense Bituminous Concrete (SDBC), Bituminous Concrete (BC) and Dense Bituminous Macadam (DBM) demonstrate that the Marshall Stability estimation of bituminous mixes increment by 1.5 to multiple times by utilizing Plastic Coated Aggregates. Likewise bitumen utilization can be decreased by over 10% by weight. Better quality parameters and street condition show increment in life of pavement and postponed and moderate decay, improved execution as far as better surface condition, deferred pot opening and break commencement and movement, alluring slip obstruction and surface.

Verma S .S., thought about that plastic grows the purpose of dissolving of the bitumen and makes the street adaptable in the midst of winters realizing its long life. As demonstrated by maker while a normal "roadway quality" road props up four to five years, plastic-bitumen lanes can last as long as 10 years and it would be an aid for India's hot and extraordinarily moist environment, where temperatures a significant part of the time cross 50°C and substantial downpours make pulverization, leaving a huge bit of the lanes with tremendous potholes.

3.CONCLUSION

A very low amount of work has been done on the behavior of plastic roads in harsh subzero climatic conditions existing in the northern parts of our country. Most of the findings are based on laboratory investigations. Very little work is done based on field data. Thus behavioral appraisal of materials is missing. In the previous works only some guidelines have been established for the use of plastic along with bitumen with respect to its quantity. However more research is needed to determine the appropriate/optimum size of plastic for addition in bitumen mixes. Use of Plastic results in improvement of anti-stripping quality of the mix but no or little work has been done on the use of other anti-stripping agents along with plastic. By Marshall Method, evaluation of flow and stability is done at 60°C which correlates to most critical conditions in hot conditions. This evaluation may not be relevant to cold climate. Hence it is necessary to develop methods to evaluate mix properties at low temperatures and establish co relation with existing field conditions.

4. REFERENCES

1. **Ahmadinia E., Zargar M., Karim M. R., Abdelaziz M**., "Performance evaluation of utilization of waste Polyethylene Terephthalate (PET) in stone mastic asphalt," *Constr. Build. Mater.*, vol. 36, pp. 984–989, 2012.
2. **Awwad M.T. and Shbeeb L**., "The use of polyethylene in hot asphalt mixtures," Am. J. A ppl.Sci.,vol. 4, no. 6, pp. 390–396, 2007.
3. **BinduC.S and Beana K.S**, "Influence of Additives on the Characteristics of Stone Matrix asphalt," Int. J. Res. Eng. Technol., vol. 3, no. 7, pp. 83–88, 2014.
4. **Chavan M.,** "Use of Plastic Waste in Flexible Pavements," International Journal ofApplication or Innovation in Engineerring& Technology, vol. 2, no. 4, pp. 540–552, 2013.
5. **Gawande A., Zamare G., RengeV. C., Tayde S., and Bharsakale G**., "An overview on waste plastic utilization in Asphalting of roads," J. Eng. Res., vol. III, no. II, pp. 1–5, 2012.
6. Ghorpade M. R "A Study of Enhancement of Bituminous Mix by Use of Modifiers,"Imperial Journal of Interdisciplinary Research, vol. 2018, no. 1, 2018.
7. **Gundaliya P. J**., "Utilization Of Waste Polyethylene Materials In Bituminous Concrete Mix For Improved Performance Of Flexible Pavements,"Indian Journal Of Applied Research Vol.1 Issue 12 . pp. 2–3, September, 2012.
8. **Herndon D.,** "Moisture Susceptibility of Asphalt Mixes Using Phosphonylated Recycled Polyethylene," 2009.
9. **Karim R., Islam N., Sajjad M. and Habib A.** "Polyethylene, a potential solution to strength loss of bituminous pavement under water", International symposium on geodisasters, infrastructure management and protection of world heritage sites, pp. 204-207, 2013.
10. **Moghaddam T .B, Karim M. R., and Soltani M.**, "Utilization of waste plastic bottles in asphalt mixture," J. Eng. Sci. Technol., vol. 8, no. 3, pp. 264–271, 2013.
11. **Rajasekaran S., Vasudevan R.,Samuvel P.,** "Reuse Of Waste Plastic coated Aggregate- Bitumen Mix Composite For Road Application-Green Method," American Journal of Engineering research e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-02, Issue-11, pp-01-,2013.
12. **Sabina, Khan Tabrez A, Sangita, Sharma DK & Sharma BM,** "Performance Evaluation Of Waste Plastic/Polymer Bituminous Concrete Mix," Journal Of Scientific & Industrial Research Vol. 68,Nov 2009, pp. 975-979.
13. **Sangita, Reena, and Verinder .K,** "A Novel Approach to Improve Road Quality by Utilizing Plastic Waste in Road Construction," J. Environ. Res. Dev., vol. 5, no. 4, pp. 1036–1042, 2011.
14. **Soni K. and Punjabi K. K,** "Improving the Performance of Bituminous Concrete Mix by Waste Plastic .,"Int. Journal of Engineering Research and Applications, vol. 3, no. 5, pp. 863– 868, 2013.
15. **Sreedevi B. G., Salini P. N**.,"Pavement performance studies on roads surfaced using bituminous mix with plastic coated aggregates,"Int. Journal of Engineering Research & Technology ISSN: 2278-0181 vol. 2 issue 9, September - 2013
16. **ThakurShivani and Duggal A. K.,** "Review on Reutilization of Plastic Waste in Paving Mixes.," Int. J. Res. App. Sci. & Eng. Technol.,vol. 5, no.Viii, pp. 1156–1159, 2017.
17. Verma S .S., "Roads from plastic waste," Indian Concr. J., vol. 82, no. 11, pp. 43–44, 2008.