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Necessity and Importance of Modification to Enhance the Present Bitumen or Asphalt Available for Bangladesh

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ABSTRACT: In this paper describes the importance and necessity the modification to enhance the property of present grade bitumen in Bangladesh. Bangladesh is fast developing country now a days. Bangladesh covered square kilometres (57,320 sq mi). Under this area Bangladesh have more than 375,000 km road network all over the country. Because of global warming and temperature rising affects the road network mostly.

The main objectives of this study are to find out the importance of modification o bitumen. Modification process, admixtures or modifiers, advantages and disadvantages. This paper helps us find the suitable process of modification for Bangladesh perspectives. How to implements in Bangladesh and challenges.

KEYWORDS: Bitumen Pavement, Modification, Temperature, Global Warming, Bitumen Performance

I. INTRODUCTION

Modification of something makes that thing work or perform better from its previous performance. Modification of asphalt or bitumen, it makes the performance better from previous performance. Bangladesh now a days has been taken large number of road projects for improving the road network around the country. Bangladesh Road and Highway Department (RHD) is working on highway master plan for Bangladesh. That's interlink the country road network by twelve (12) expressway routes. So that it can establish an extensive internal and cross border connectivity.

Every country has their own master plan for their road network. Bangladesh also target to get their target and complete these master plan within 2041. It's a long-term project. These projects will complete by GoB funds and also Project Aid. All projects have flexible pavements and bridges.

But now a days, global warming and increasing temperature makes the road complicated for movements. Specially for Bangladesh region the temperature is now over 40⁰ Celsius. It makes the pavement surfaces melt and sticky. The height temperature recorded in Bangladesh in South-West region Chuadanga 43⁰ Celsius. Second highest temperature reordered in same region Jashore 42.6⁰ Celsius. The highest recorded temperature since independence was 45.1 degrees Celsius on May 18, 1972. Bangladesh Eastern Refinery and Bashundhara Refinery plant are responsible for supply bitumen or asphalt. Imports In 2022, Bangladesh imported \$23.6k in Bitumen and asphalt.

Because of dollar rate hike and maintain the development of the road network Bangladesh need to reduce importing bitumen and try to improve the available bitumen by modification or improvement. Improving the property of bitumen or modify the property makes roads more suitable for higher temperature and enhance their service life's.

1.1 Scope of the project

- The objective of this paper is finding out the modification process;
- Find out the suitable process and modifiers for Bangladesh road;
- Their advantages and challengers for Bangladesh;

II. RELATED WORK

The concept modification or improvement of asphalt or bitumen has been long time ago. Different country like developed country already using modified bitumen for their road network related work. Because of developing country and limited resources Bangladesh is now looking for alternatives to replace or improve the available bitumen or asphalt. Also, Bangladesh government tries to reduce importing bitumen and increase own bitumen production. The work has two stages. 1) Find modification process 2) Implementing according to the Bangladesh.

M. M. Islam¹, M.S. Shirin², T. R. Tonoy², S. A. Sweet² (2021) Among numerous ways of disposal of waste plastics, one can be using it in flexible pavement construction. According to the Bangladesh Waste Database 2014, Dhaka city alone produces 25.44% (5,925.51 tons/day) of waste, of which 8.45% is plastic. Due to the addition of plastic waste, the ductility always gets affected. But overall, a significant improvement in the properties of bitumen is noticeable. [1]

Harun-or-rashid, G, M & Islam, M. M. (2020) This problem can be reduced to a significant extent by using plastics in road construction. Most of constructed roads over here is bituminous road. In the construction of bituminous pavement, plastics, as well as construction debris, are being used in the form of aggregate and filler materials popularly [2]

Dhruv Shakyai¹, Krishna Dwivedi², Lakshay Mishra³, Sourabh Sharma⁴, Pulkit Shokeens⁵, Mr. Aashish Malik⁶ (2023) The results show that the addition of crumb rubber and PVC to bitumen improves its viscosity and elastic recovery properties, while reducing its penetration and softening point. The study also explores the optimal percentage of crumb rubber and PVC for modifying bitumen to achieve the desired mechanical and rheological properties. Overall, the study highlights the potential of using crumb rubber and PVC as sustainable additives for improving the performance of bitumen in road construction. [17]

Siyu Chen^{a,f}, Tiankai Che^{b,c,*}, Alaeddin Mohseni^d, Haleh Azari^d, Patricia A. Heiden^e, Zhanping You^{c,*} (2021) Three different thermoplastics were used with a dosage of 4 wt%. and a co-reactant maleic anhydride was added with a content of 2 wt% by weight of the binder. Based upon results obtained, it can be concluded that the performance of the resulting asphalt can be improved when maleic anhydride was used to treat the added thermoplastics. [72]

Nuha S. Mashaan (2022) Along these lines, in this work, nano-silica with a content from 2% to 8% and an increment of 2% was utilized in modifying the bitumen binder. Interestingly, much of the content of nano-silica leads to higher rutting resistance. However, the rutting resistance was affected by the size of the nano-silica coated with the silane coupling agent. [110]

Sepehr Saedi¹, Seref Oruc² (2020) The current study investigates the effects of Fiber Reinforce Polymer (FRP) additive on the performance of Stone Mastic Asphalt (SMA) mixtures with SBS and Viatop Premium additives. The asphalt mixture used in the current study included SBS (Styrene-Butadiene-Styrene) additive modified at the rate of 5% according to the necessary preliminary studies, and some SMA mixture modified by adding FRP (Fiber Reinforced Polymers) additive prepared in dimensions of 5 cm in different proportions (0.3%, 0.5%, 0.7% and 0.9%). The FRP contribution rate that improves the performance characteristics of the SMA mixture to the highest level was found to be 0.7%. [107]

Dr. Hassan H. Jony^{*}, Mays F. Al-Rubaie^{*} & Israa Y. Jahad^{*} (2010) In this research glass powder is proposed as an alternative to traditional lime stone powder (Gubraa) and ordinary Portland cement fillers in hot asphalt mixtures. Where, the effect of using waste glass powder as mineral filler on Marshall Properties of hot asphalt concrete mixtures is investigated.

It is found that using of glass powder as filler with such replacement leading to produce asphalt mixture with higher stability (% of increase up to 13%), lower flow (% of decrease up to 39%) and lower density (% of decrease up to 10%) comparing to corresponding ordinary Portland cement or lime stone powder mixtures. [118]

Nuha S. Mashaan^{*}, Asim H. Ali, Mohamed Rehan Karim and Mahrez Abdelaziz (2011) The performance properties of rubberised bitumen binder are influenced by the blending conditions and crumb rubber content. The rubberised bitumen binder with higher crumb rubber content has an obvious effect on the rheological properties (increase in complex shear modulus G^* , storage modulus G' , loss modulus G'' and decrease in phase angle δ). The

results indicated that the rubber content has the potential to resist rutting deformation that occurs in road pavement as result of increased traffic loading. [32]

Nuha S. Mashaan*, **Asim Hassan Ali**, **Mohamed Rehan Karim** and **Mahrez Abdelaziz** (2011) the laboratory investigation was conducted on crumb rubber modified asphalt binder properties as a function of two blending times (30 minutes and 60 minutes) and five crumb rubber contents (4, 8, 12, 16 and 20% by weight of asphalt binder). The asphalt binder with higher crumb rubber content and longer blending time of 60 minutes exhibited a higher value of elastic recovery. This indicates that crumb rubber modified asphalt binder has better resistance to rutting as compared to conventional asphalt binder. [33]

B.Durga Priyanka¹, **P.V.Ajay Kumar²**, **K.Dedeepya³**, **A.Shabuddin⁴**, **S.Krishna Rao⁵** (2014) This study is the possibility of using fly ash as mineral filler in Bituminous paving mixes where in general cement, stone dust are used. By replacing the stone dust with fly ash at the levels 4%, 8%, 12% the results are compared. The variation of properties, optimum bitumen and fly ash contents are evaluated. It is observed that the mixes with fly ash as filler not differ much in properties when compared with control mix and satisfy desired criteria specified by a much higher margin. Hence, it has been recommended to utilize fly ash wherever available, not only reducing the cost of execution, but also partly solve the fly ash utilization and disposal problems. [36]

R.Manju*; **Sathya S**; **Sheema K**, (2017) the waste plastic used are poly-ethylene, poly-styrene, poly-propylene. The waste plastic is shredded & coated over aggregate & mixed with hot bitumen and resulted mix is used for pavement construction. The use of plastic mix will reduce the bitumen content by 10% and increases the strength and performance of the road. This new technology is eco-friendly. The use of smoke absorbent material (titanium di-oxide) by 10% of polymer content can reduce the vehicular pollution. [20]

Imran M. Khan, **Shahid Kabir**, **Majed A. Alhussain**, **Feras F. Almansoor** (2016) Low Density and High-Density Polyethylene and Crumb rubber were used as additions to base bitumen (PG 64-10). Complex modulus (G^*) and phase angle (δ) obtained from Dynamic Shear Rheometer (DSR) are the basic parameters used to evaluate the behavior of the binder in respect to rutting and fatigue cracking. It was concluded that Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), and Crumb Rubber (CR) modified binder showed significant improvement in rheological properties of the binder. [58]

Freshnel Adou¹ Boateng Ampadu¹* **Nana Kwesi Agyepong² Olivia Naa-Afi Soli²** (2018) In this research, Plastic waste was coated around aggregate and subsequently mixed with bitumen to produce asphalt with plastic wastes and the samples obtained were subjected to various tests in the laboratory to determine its properties. The results show that, plastic waste improved the quality of aggregates, enhancing its properties. The use of this innovative technology will increase the strength and life span of roads; and more importantly, will help improve the quality of the environment by reducing and removing plastic waste, which comes at a lower cost. [75]

Bajpai Raghvendra et al (2017) The experimentation at several institutes indicated that the waste plastic, when added to hot aggregate will form a fine coat of plastic over the aggregate and such aggregate, when mixed with the binder is found to give higher strength, higher resistance to water and better performance over a period of time. [76]

Poorna Prajna.S*, **Dr. Mohamed Ilyas Anjum**** (2014) Investigations have revealed that modifiers can be used to improve rheological properties of bitumen and bituminous mixes to make it more suitable for road construction. Also, there are many materials that may be tried as modifiers in bitumen. The present investigation comprises of determining the Marshall test properties of Bituminous Concrete Mixes Using 60/70 penetration grade bitumen modified with Fly Ash as Modifier. The results such as stability, flow, volume of air voids, voids in mineral aggregates, voids filled with bitumen, bulk density etc was determined. The study helps to ascertain the suitability of Fly Ash as modifier. [68]

III. METHODOLOGY

Methodology as follows:

- Study different research paper;
- Identify their target and process of modify or improve asphalt or bitumen;
- Identify their experimental process for modify or improve asphalt or bitumen;
- Identify suitable process for Bangladesh perspective;
- Identify available recourses like lab equipment's for lab and filed test

- Identify, types and availability of modifiers;
- Finalize Suitable modifiers and their optimum percentage for modification.

3.1 Temperature Impact on Bangladesh Road: At present road network one of major transport facility around the Bangladesh. Major goods and other movement depend on road network. Because of temperature increase, friction of wheels, engine temperature causes the surface layer melt. Now days Jashore, Chuadanga and Shariatpur faces major road melting problem. Most of the road in Bangladesh use 60/70 grade bitumen. Whose melting point 60⁰ Celsius. Because of weather temperature, friction of wheels and black colour of the bitumen absorb more heat and make it melt.

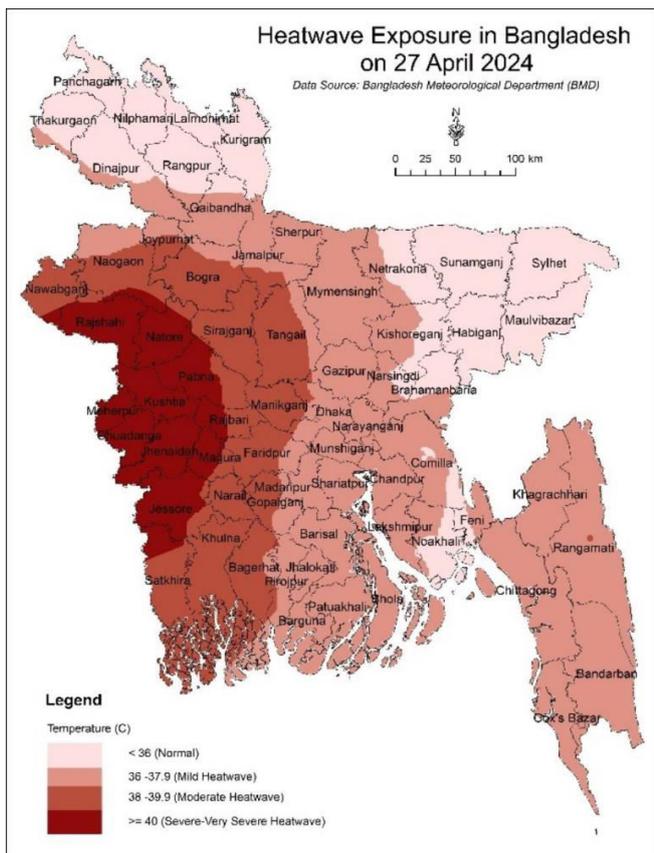


Fig 1: Heat wave exposure in Bangladesh



Fig 2: Heat wave Impact on Road in Bangladesh

IV. EXPERIMENTAL RESULTS

Figures 3 & 4 shows that with addition of crumb rubber ductility decreases, elastic recovery increases with the increase of crumb rubber. Similarly figure 5 & 6 shows increasing crumb rubber increasing the complex shear modulus and decreasing phase angle of the modified bitumen. It means crumb rubber improve the property of bitumen. [32]

Table 1 shows plastic waste modified bitumen help to upgrade properties of bitumen, Table 2 shows that modified bitumen has less water absorption, improve impact value, more resistance to abrasion action mean good resistance against wearing and tearing.

Table 3 shows Marshal stability and flow that represents that plastic modified bitumen perform better than normal bitumen.

Figure 7 & 8 shows the bitumen properties improved by adding Nano silica as a modifier.

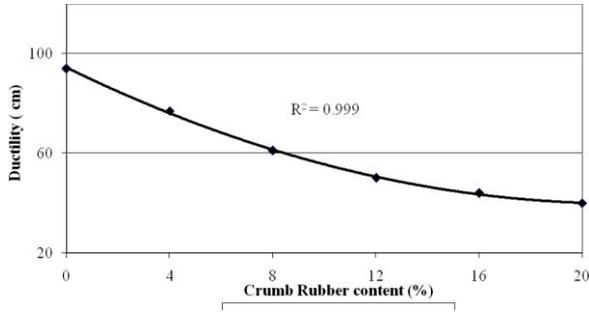


Fig 3: Ductility vs Crumb Rubber

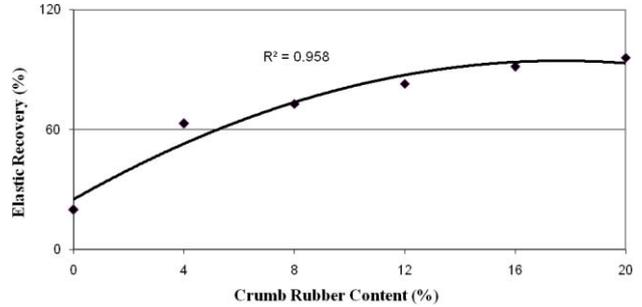


Fig 4: Elastic Recovery vs Crumb Rubber

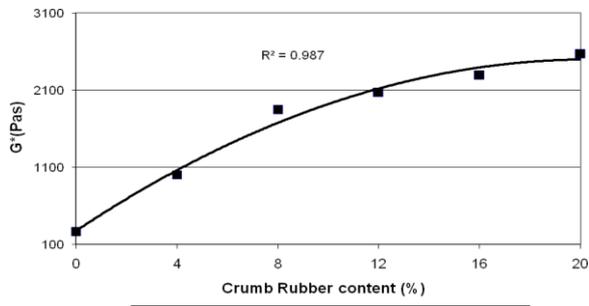


Fig 5: Complex shear modulus vs Crumb Rubber

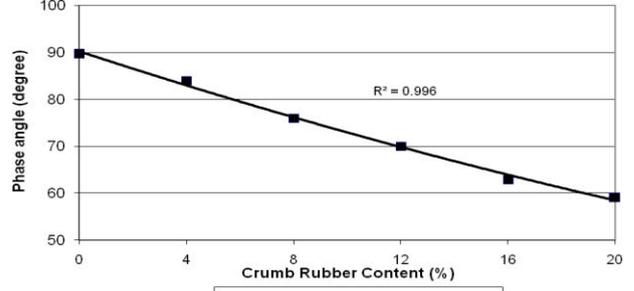


Fig 6: Phase angle test vs Crumb Rubber

Sample ID	Plastic waste added(%)	Weight of bitumen (g)	Temperature (°c)	Torgue value (%)	Viscosity (cp)
Control (AC 20)	0	250	60°C	12.9	2030
PMB	2	250	135°C	10.9	545
PMB	4	250	135°C	11.8	590
PMB	6	250	135°C	12.3	615
PMB	8	250	135°C	12.7	640

Table 1: Summarized results of Viscosity Test [75]

Sample ID	Plastic waste added (g)	Weight of aggregate (kg)	Various tests performed			
			Water absorption (%)	Impact Test (%)	Los Angeles Abrasion (%)	Soundness (%)
Control	0	2	1.22	33	24	0.15
PCA	400	2	1.05	20	19	0.08

Table 2: Summarized results of various test Performed on PCA [75]

Sample ID	Bitumen Added (%)	Plastic Waste Added (%)	Specimen Diameter (mm)	Specimen Height (mm)	Air Void (%)	Flow Value (mm)	Specific Bulk Gravity (g/cm³)	Marshall Stability Value (KN)
Control	5	0	101.45	62.43	5.75	4.0	2.56	17.8
PA	5	8	101.50	70.98	9.52	4.9	2.27	20.3

Table 3: Test results of Marshall Stability and Flow [75]

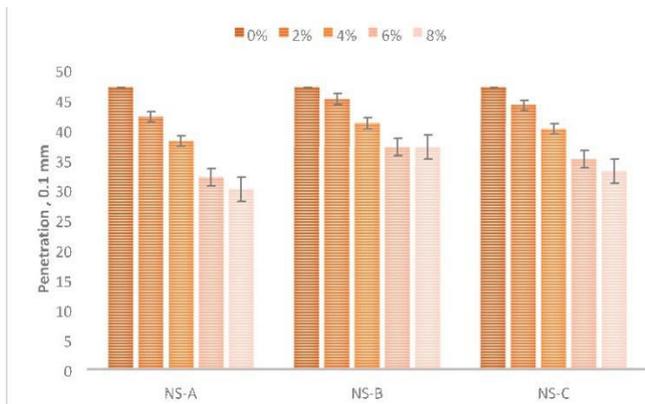


Fig 7: Result of Nano Silica Modified Bitumen

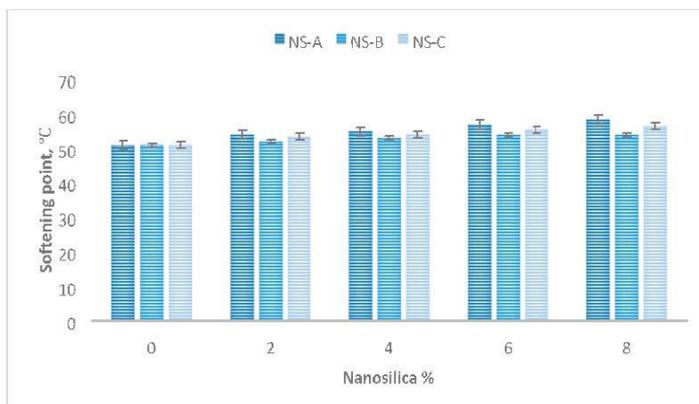


Fig 8: Result of Nano Silica Modified Bitumen

4.1 Summary: Literature review and experimental result shows that various types materials used for modifiers and filler materials for improvement bitumen properties in different experiments. For example, waste materials like plastic, rubber, nano silica, flyash, steel slug. For Bangladesh plastic, rubber, nano silica, available from daily use and recycling materials.

4.2 Advantages for Bangladesh:

- Improve quality of pavements;
- Reduce waste materials;
- Increase economic growth;
- Reduce dependency on import;
- Reduce maintenance cost of road;
- Increase job opportunities.

4.3 Challenges for Bangladesh:

- Need proper experimental equipment’s;
- Proper experience man power for guide;
- Proper quality check and control;
- Regular attempts for improvements

V. CONCLUSION

After all analysis of above result it can conclude that recycling materials can be a modifier or admixture. So that, the bitumen property can be improved and pavement quality, service life enhanced. By using waste materials as modifiers or admixture, its not only help to pavement also helps to maintain waste management. Reduce waste materials also help for generating jobs sector for the country.

Bangladesh government should take necessary steps to take it seriously and improve pavement quality and life. It helps Bangladesh economy grow with time also helps to reduce from dependency of importing bitumen.

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