International Journal of Innovative Research in Computer Science & Technology (IJIRCST)
ISSN: 2347-5552, Volume-10, Issue-3, May 2022
https://doi.org/10.55524/ijircst.2022.10.3.21
Article ID IRP1269, Pages 127-130
www.ijircst.org

Self-Healing Technology of Asphalt Pavements

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ABSTRACT- Cap heal reduces the environmental pollution and improves the performance of asphalt pavement. Since large amount of budget is allocated to road construction, so there is a need to implement more economically and environmentally sustainable practices. However rheological properties of the pavement after using rejuvenator were determined by penetration, softening point, viscosity and ductility. Cap heal as a rejuvenating agent is used to restore aged asphalt of different aging degree and the effect of cap heal on the reclaimed properties is investigated. The results indicate that cap heal can make the properties of aged asphalt restore its strength properties and make it durable, anticreeping and self healing. The main aim of using this cap heal is to make it economical and feasible by saving the maintenance cost. The mixing amount of cap heal increases with the aging degree. For the asphalt sample which aged for 5h, 2% of mixing amount can make the penetration, softening point, ductility of aged asphalt restores. For the asphalt sample which aged for 7.5h and 10h, 4% of mixing amount can make the penetration, softening point, ductility of aged asphalt restores. Compared with original asphalt, the construction temperature of regenerating asphalt increases slightly. Adhesion ability between aggregate and asphalt is affected by cap heal and anti-stripping materials are expected to be used.

Keywords- Asphalt Pavements, Self Healing, Ductility, Aggregate, Softening point

I. INTRODUCTION

Asphalt which is also known as asphalt concrete which is also sometimes known as flexible pavement because it easily distributes the loads and it is being used since 1920[1]. Asphalt concrete having the properties of plastic deformation form repetitive loading which is known as fatigue which is common failure mechanism due to over time loading[2]. Asphalt can be added with polypropylene and polyester geosynthetics this type of material is used to reduce or resist the flexible pavement from penetration of frost in subgrade layer of pavement[3]. Asphalt is categorized as hot mix asphalt, warm mix asphalt and cold mix asphalt. Hot, warm and cold denotes the temperature of mixing and lying on the top layer of flexible pavement[4]. Hot bituminous mix has temperature more than 300-degree Fahrenheit and warm mix bituminous mix has temperature of 200-250-degree Fahrenheit. Warm mix has the advantage of less heat requirement and less emissions also. Cold mix bituminous mix has the advantage that it can be applied in rural roads because if hot mix is applied then it will cool too much when transporting from plant to site of construction [5]. Bituminous mix can absorb traffic loads of up to 3000 vehicles per day. Bituminous mix is not able to resist too much hot weather as it becomes sticky and it cannot resist hydrocarbon contaminated soil and groundwater or polluted water drain in pavement[6]. Bituminous materials are recycled in order to reduce the dependency of many countries on imported crude oil, various methods are introduced for the self healing of reclaimed asphalt pavement (RAP). United States and many other countries have led the technological development of modern self healing methods for RAP, now it has become the common practice in many countries such as Germany, Turkey, Finland, France, India and South Africa[7]. Reclaiming of asphalt pavement is done by various rejuvenating agents and to solve problems faced by various countries cap heal is used as an alternative, it is proved that cap heal improves the low temperature properties of asphalt pavement and reduces the stiffening effect of reclaimed asphalt pavement(RAP)[8]. Both asphalt and oil are products of petroleum, the oil content of engine oil is higher than asphalt[9]. Asphaltenes is solid, hard brittle component and not effected by oxidation, whereas maltenes is a liquid one and oily. Both asphalt and cap heal are products of sunflower, however the oil content of engine oil is higher than asphalt[10].

II. MATERIAL AND METHODOLOGY

Asphalt: It is a product of petroleum which is in solid and semisolid form. It's also black in color. It is obtained both manually and naturally from various sources. Its properties are affected by the temperature, which indicates there is a fixed range where viscosity allows a adequate compaction by allowing lubrication between particles during compaction method.The movement of aggregate particles are stopped by lowering temperature and the achievements of required density is not possible.

Rejuvenating Agent: - To develop the properties of aged binder few chemical additives which is known as self healing agent which will be added with asphalt mixture. As we all know that self healing agent is by product of petrochemical and it is also made from aromatic oil. The objective of application of this oil is to recover the asphalt consistency. With addition of self healing agent into reclaimed asphalt pavement restore the binder properties, the sunflower oil is one type of agent which is used as self healing agent, it is estimated that in every year around 30 million tons which is produced from various processes in industry, which create problem of disposal in modern society. As an average 1 gallons of waste oil will destroy the large portion of marine life. There are various research going on for self healing processes such as vacuum distillation, hydro-treatment. As these self healing processes is costly and output is also not enough, with further research scientist and engineer, they find a eco-friendly way to use of sunflower oil, best way is to use as constructional material, specially use at pavement construction.

III. SUN FLOWER OIL

Cap heal is available from automobile industry and also obtained from sunflower. Earlier these waste products was directly thrown in river or lake which leads to environmental pollution. With increase in population day by day which leads to creating pressure on roads and highway also causes the early damage of the roads and highway which leads to increase in maintenance cost and also creating pressure of availability of materials which ultimately leads to hurting the nature and natural thing. Scientists and engineers are continuously doing the research work for searching of alternative material of feasible self healing of waste product. As the traffic is increasing day by day and climatic change is also affecting pavement surfaces and also damaging the inter layer bonding between surfaces of pavement and also affecting binder performance. Spending so many years in research, scientists found the way that is pavement surfaces can be recycled and processed, this process is known as reclaimed asphalt pavement (RAP). This is the method by which healing process is done with the help of rejuvenation. The Reclaimed asphalt pavement is added between 12% and 62% of gross weight. Suitable amount of RAP in mix causes better stiffness, if it is used in excess then it will be not good for pavement. With the help of rejuvenation process the properties of asphalt pavement is improved and also the hardening effect is improved, for improving binder properties also improved using oil, this also provide efficient binder coating with fresh aggregates from reclaimed asphalt bitumen mixture for making of pavement for long service for consistent service. This will make the pavement hard component and it is not affected by oxidation.

IV. RESULTS AND DISCUSSIONS

A. Aged Asphalt Regeneration Test

The related test results are shown in Table 1.

Table 1: Results of regeneration property test for aged asphalt blended with OIL

Cap heal ratio (%)	0				2			4			6		
Aging time(h)	0	5	7.5	10	5	7.5	10	5	7.5	10	5	7.5	10
Penetration,0.1mm, 25°C	75	56	49	39	67	59	53	90	78	73	98	94	90
Ductility 15°C	>100	>100	25.4	18.7	>100	45.8	>100	>100	>100	>100	>100	>100	>100
Softening point, 25°C	45.7	50.8	53.2	54.7	49.0	51.1	52.0	47.0	48.2	50.1	45.6	46.9	47.5
Viscosity, pa's	.467	.646	.755	.909	.484	.622	.670	.441	.492	.502	.326	.399	.485

with-OIL(Aging)

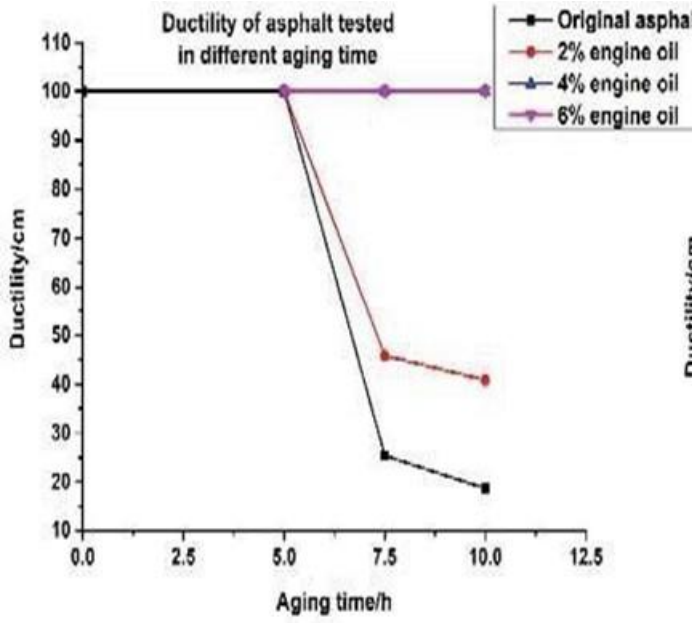

Figure 1: Ductility of reclaimed asphalt blended

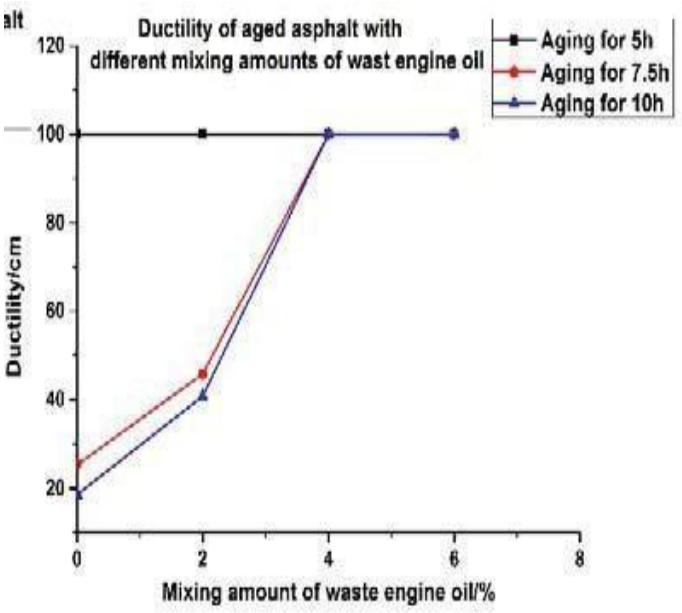

Figure 2: Ductility of reclaimed asphalt blended with-OIL

Figure 1 shows the Ductility of reclaimed asphalt blended
As shown in Table 1, for the original asphalt samples heated for 5h, 7.5h and 10h, the penetration that decreased from 75 (0.1mm) to 56 (0.1mm), 49 (0.1mm) and 39 (0.1 mm) respectively, had declined by up to 50 percent. After adding different ratio of oil, the penetration increased greatly. For the asphalt samples that had aged for 5h with 2% waste oil, the penetration was restored to 67(0.1mm) from 56(0.1mm), which could reach 89% of the original asphalt's. While for the asphalt samples that had aged for 7.5h, 10h with 4% oil, the penetration was restored to 78 (0.1mm) from 49 (0.1mm), 73 (0.1mm) to 39 (0.1mm), which could respectively reach 104%, 97% of the original-asphalt

B. Ductility Test

From Table 1, we can see that after original asphalt samples being heated for another 7.5h and 10h, the ductility decreased significantly, respectively from more than 100cm to 25.4cm and 18.7cm, which failed to meet the AH-70 asphalt A, B level requirements. While the ductility of the aged samples blended with 2% OIL was restored to a certain extent, still failing to meet the specification requirements that ductility must exceed 100cm. When the ratio of OIL increased to 4%, the ductility of aged asphalt samples was completely restored. The results indicate that it is good for the low temperature performance of asphalt pavement because OIL has the potential to counteract the stiffening and makes the ductility of aged asphalt recover. FIGURE-2 shows the Ductility of reclaimed asphalt blended with-OIL

V. CONCLUSIONS

OIL is also capable of self healing aged asphalt, achieving the effect of protecting the environment, saving resources and reducing project cost, which has important practical and long-term significance for the road maintenance. The purpose of this study is to give some practical guidance on the ratio of OIL and its ability for restoring aged asphalt.
1)-Using OIL increases the aromatic content of aged asphalt, decreases the viscosity of asphalt and increases the ductility of asphalt. This result matches what has been said in the literature about OIL acting to reduce fatigue and extend the cracking life of asphalt pavements. By using it, the problem of degradation of asphalt pavement performance is alleviated.
2)-The mixing ratio of OIL as the rejuvenator depends on the stiffness of the aged asphalt binder and the target binder. The more the asphalt aging seriously with the lower the penetration, the more OIL is required to compensate for the aging effect and obtain the target binder. Excessive softening may damage asphalt pavements, and care should be taken not to use too much OIL.

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