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Review on investigation on bituminous mixes using various additives

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ABSTRACT

The addition of polymers to asphalt binders helps to increase the interfacial cohesiveness of the bond between the aggregate and the binder which can enhance many properties of the asphalt pavements to help meet these increased demands. Bituminous mixes are most commonly used all over the world in flexible pavement construction. It consists of asphalt or bitumen and mineral aggregate which are mixed together, laid down in layers and then compacted. Under normal circumstances, conventional bituminous pavements if designed and executed properly perform quite satisfactorily but the performance of bituminous mixes is very poor under various situations. In addition, the performance of bituminous pavements is found to be very poor in moisture induced situations. Considering this a lot of work has been done on use of additives in bituminous mixtures and as well as on modification of bitumen. However, the additive that is to be used for modification of mix or binder should satisfy both the strength requirements as well as economical aspects.

Key Words: Bituminous concrete (BC), asphalt, polyethylene, tensile strength, creep Test.

INTRODUCTION

Bituminous binders are widely used by paving industry. In general pavements are categorized into 2 groups, i.e. flexible and rigid pavement. Flexible Pavement Flexible pavements are those, which on the whole have low flexural strength and are rather flexible in their structural action under loads. These types of pavement layers reflect the deformation of lower layers on-to the surface of the layer. Rigid Pavement If the surface course of a pavement is of Plain Cement Concrete then it is called as rigid pavement since the total pavement structure can't bend or deflect due to traffic loads. Pavement design and the mix design are two major considerations in case of pavement engineering. The present study is only related to the mix design of flexible pavement considerations. The design of asphalt paving mixtures is a multi-step process of selecting binders and aggregate materials and proportioning them to provide an appropriate compromise among several variables that affect mixture behaviour, considering external factors such as traffic loading and climate conditions.

Bitumen is a useful binder for road construction. Different grades of bitumen like 30/40, 60/70 and 80/ 100 are available on the basis of their penetration values. The steady increase in high traffic intensity in terms of commercial vehicles, and the significant variation in daily and seasonal temperature demand improved road characteristics. Any improvement in the property of the binder is the needed. Today the availability of the waste plastics is enormous, as the plastic materials have become part and parcel of daily life. They either get mixed with Municipal Solid Waste and/or thrown over land area. If not recycled, their present disposal is either by land filling or by incineration. Both the processes have certain impact on the environment. Under this circumstance, an alternate use for the waste plastics is also the needed. Thinner polythene carry bags are most abundantly disposed of wastes, which do not attract the attending rag pickers for collection for onward recycling, for lesser value. Again, these polythene/polypropylene bags are easily compatible with Bitumen at specified conditions. The waste polymer bitumen blend can be prepared and a study of the properties can throw more light on their use for road laying.

BINDER AND MODIFIER

Waste plastics (polythene carry bags, etc.) on heating soften at around 130°C. thermogravimetric analysis has shown that there is no gas evolution in the temperature range of130-180°C. Moreover the softened plastics have a binding property. Hence, the molten plastics materials can be used as a binder and/or they can be mixed with binder like bitumen to enhance their binding property. This may be a good modifier for the bitumen, used for road construction.

NEED FOR THE STUDY

1) Disposal of waste plastic is a major problem
2) It is non-biodegradable
3) Burning of these waste plastic bags causes environmental pollution.
4) It mainly consists of low-density polyethylene
5) To find its utility in bituminous mixes for road construction
6) Laboratory performance studies were conducted on bituminous mixes. Laboratory studies proved that waste plastic enhances the property of the mix
7) Improvement in properties of bituminous mix provides the solution for disposal in a useful way been done since 2000 in India. They can return to the earth as beneficial additives in bitumen roads. One such technologies are reviewed below, two for waste-polymer-modified bitumen roads.

A group of students of B.E. degree course in Chemical Engineering of this college under the guidance of the concerned teaching staff carried out their final year project work for studying the possibility of using of the processed plastic bags with bitumen and bituminous mixes. As some encouraging results were reported in this study, M/s K.K. Poly Flex Pvt. Ltd. later approached the Centre for Transportation Engineering of Bangalore University with the request to carry out further research studies on the effects of using the processed plastic bags with bituminous mixes for road construction works. In practice, such a "plastic road" laid in Bangalore (at the busy Rajarajeshwari Junction)in March 2001 as a technology demonstration for the Chief Minister, showed superior smoothness and uniformity and less rutting as compared to a plastics-free road laid at the same time, which has begun to develop "crocodile cracks". As a result, by now 25 km of plastic roads" have been laid in Bangalore, unfortunately without another same-day plastics-free normal road. All these 25 km are performing well.

The process was also approved in 2003 by the CRRI=Central Road Research Institute Delhi, and has thereafter been included in the Govt of Karnataka's PWD Schedule of Rates. Road life improves through improved tackiness and viscosity of the bituminous mix, thereby binding the stones more firmly together and improving the water-resistance of the mix to rain etc.For the same reason, the temperature of the mix both at the plant and at the point of lying needs to be 20°C higher than normal. The Bruhat Bengaluru Mahanagara Palike (BBMP) has used plastic on about 600 km of roads, including many thoroughfares and arterial roads. It uses the plastic blend in at least25% of the road-laying works, including the present project to upgrade about 45 roads in the city.

REVIEW & RELATED WORK

According to WSDOT (2000) the Federal Highway Administration, McLean Virginia, has suggested the following characteristics for aggregates used in bituminous mixture. The aggregates must possess -

- A highly cubic shape and rough texture to resist rutting and movements
- A hardness which can resist fracturing under heavy traffic loads
- A high resistance to polishing and
- A high resistance to abrasion

During 1900's, the technique, of using bitumen in pavements, was first used on rural roads in order to prevent rapid removal of the fine particles such as dust, from Water Bound Macadam, which was caused due to fast growth of automobiles [Roberts et al. 2002]. At initial stages, heavy oils were used as dust palliative. An eye estimation process which is called pat test, was used to estimate the required quantities of the heavy oil, in the mix.

Fransis Hveem, 1942; who was a project engineer of California Department of Highways, has developed the Hveem stabilometer in 1927. He did not have any previous experience on judging, the required mix from its colour, hence he decided to measure various mixture parameters to find the optimum quantity of bitumen [Vallerga and Lovering 1985]. He had used the surface area calculation concept, (which was already in use, at that time for the cement concrete mix design), to estimate the quantity of bitumen actually required.

The 1st formal method of mix design was Habbard field method, which was actually developed on sand-bitumen mixture. Mixtures with larger sized aggregate particles could not be handled in this method. This was one limitation of this procedure.

Shukla and Jain (1984) described that the effect of wax in bitumen can be reduced by adding EVA (Ethyl Vinyl Acetate), aromatic resin and SBS in the waxy bitumen. The addition of 4% EVA or 6% SBS or 8% resin in waxy bitumen effectively reduces the Susceptibility to high temperatures, bleeding at high temperature and brittleness at low temperature of the mixes.

Bahia and Anderson, 1984; studied the visco-elastic nature of binders and found that, the complex modulus & phase angles of the binders, need to be measured, at temperatures and loading rates which different resemble climatic and loading conditions.

Bruce Marshall developed the Marshall testing machine just before the World War-II. It was adopted in the US Army Corpes of Engineers in 1930's and subsequently modified in 1940's and 50's.

Collins et al. (1991) and Baker (1998) observed that SBS modified asphalt mixes have longer lives than unmodified asphalt mixes. The addition of SBS polymer to unmodified bitumen also increases its resistance to low temperature cracking.

Shuler et al. (1987) found that the tensile strength of SBS modified binder increased significantly as compared to unmodified asphalt mix at minus 21, 25 and 410C.

Mustafa Karasahin et al. (2006) used waste marble dust obtained from shaping process of marble blocks and lime stone as filler and optimum binder content was determined by Marshall Test and showed good result.

Yongjie Xue et al. (2008) utilized municipal solid waste incinerator (MSWI) fly ash as a partial replacement of fine aggregate or mineral filler in stone matrix asphalt mixtures. They made a comparative study of the performance of the design mixes using Superpave and Marshall Mix design procedures.

Chiu and Lu (2007) used asphalt rubber (AR) produced by blending ground tire rubber (GTR) (i) 30% of a coarse GTR with a maximum size of #20 sieve and (ii) 20% of a fine with a maximum size of #30 sieve with an asphalt, as a binder for SMA and found AR-SMA mixtures were not significantly different from conventional SMA in terms of moisture susceptibility and showed better rutting resistance than that of conventional dense graded mixture.

Shaopeng Wu et al. (2007) used basic oxygen slag as aggregate with PG76-22 modified binder and lime stone as filler and chopped polyester fibre in SMA and concluded that experimental SMA is superior than convectional SMA.

Xue et al. (2008) used municipal solid waste incinerator (MSWI) fly ash as a partial replacement of fine aggregate or mineral filler and Basic Oxygen Furnace (BOF) Slag as part of coarse aggregate with polyester fibre of 6.35 mm in length obtained from recycled raw materials, PG76-22 binder in the SMA mix and performed Marshall and super pave method of design and found it's suitability for use in the SMA mix.

The review of papers gives an overview of the researches were done on bituminous mixture like stone matrix asphalt (SMA) and Dense graded mixtures. Keeping the important points of the researches in mind, the materials of SMA and Bituminous concrete (BC) with its composition and the corresponding test methods for the present investigation have been chosen. Here an attempt has been made to compare the different properties of SMA and BC through different test like Marshall Test, Indirect Tensile stress Test, Static Creep Test where 60/70 penetration grade bitumen is taken as binder and fly ash as filler. . In this research work the MORTH gradation has been adopted. . Investigators mainly have focused on uses of cellulose fiber and other materials in the mixes to prevent drain down of binder mortar from the mix. Use of a non conventional fiber such as SISAL fiber which primarily contain cellulose on its outer part and is widely and cheaply available all over the world, is not available in past literature, particularly in SMA mixes.

Hence this material has been used as the stabilizing additive in the preparation of BC and SMA mixes. This would solve to good extent the problem of solid waste management and at the same time explore the possibility of using a non conventional waste material in a typically non conventional mix like SMA.

The findings of the studies conducted by the Shell Research and Technology Centre in Amsterdam indicated that the rutting rate is greatly reduced as a result of SBS modification of the binder. Button and Little (1998) on the basis of stress controlled fatigue testing at 20 and 00C, reported that SBS polymer exhibited superior fatigue properties as compared to straight AC-5 bitumen.

GENERALLY USED MATERIALS

For preparation of Bituminous mixes (SMA, DBM, BC) aggregates as per MORTH grading as given in Table.1, Table 2 and Table 3 respectively, a particular type of binder and polyethylene in required quantities were mixes as per Marshall Procedure. The specific gravity and physical properties of aggregate are given.

Test performed on aggregate

Firstly, the author deals with the experiments carried out on the material (aggregate etc.), second part deals with the tests carried out on bituminous mixes. Aggregate are the major material used in pavement construction. Most of the roads aggregate are prepared from the rock. Gravel aggregates are small rounded stones of different sizes which are generally obtained as such from some river beds. Sand is fine aggregate from weathering of rock. Texture are important factor, it is affecting the properties of rock and its fragments. The aggregate gradations used for preparing Marshall Samples are as per the MORTH specification. Following tests are conducted on the aggregate used in this research work:

1. - Impact value test.
2. - Flakiness index test.
3. - Elongation index test.
4. - Los Abrasion value test.

CONCLUSION

On the basis of this review, it has been concluded that the use of recycled waste plastic in pavement asphalt represents a valuable outlet for such materials. The use of modified bitumen with the addition of processed waste plastic of about 5-10% by weight of bitumen helps in substantially improving the Marshall stability, strength, fatigue life and other desirable properties of bituminous concrete mix, resulting which improves the longevity and pavement performance with marginal saving in bitumen usage. The process is environment friendly. The use of waste plastics in the manufacture of roads and laminated roofing also help to consume large quantity of waste plastics.

REFERENCES

[1]. Qadir A, Imam M., “Use of recycled plastic waste aggregate as a partial substitution material in pavement structure”. In: Proceedings of the International Symposium on Pavement Recycling; 2005.

[2]. P K Jain, Shanta Kumar & J B Sengupta, “Mitigation of rutting in bituminous roads by use of waste polymeric packaging materials” Indian Journal of Engineering & Materials Sciences Vol. 18, June 2011, pp. 233-238

[3]. R Vasudevan., Nigam S.K., Velkennedy R., Ramalinga Chandra Sekar A.,Sundarakannan B. “Utilization of Waste Polymers for Flexible Pavement and Easy Disposal of Waste Polymers”, International Conference on Sustainable Solid Waste Management, 5 - 7, Chennai, India pp-105-111, 2007.

[4]. Dr. Y. P. Gupta, Chairman, YASTK, and Consultant, Allahabad bypass project Professor (Rtd.) Civil Engineering, MNNIT, Allahabad, and Shailendra Tiwari & J. K. Pandey, QC Engineer HCC Ltd and BCEOM, Allahabad Bypass Project.

[5]. Nibudey R.N., Nagarnaik P. B., Parbat D.K., Pande A.M., (2013), " Cube and cylinder compressive strengths of waste plastic fiber reinforced concrete", International Journal Of Civil And Structural Engineering, ISSN 0976 – 4399, Issue 2, Volume 4, 2013, pp 1818 - 1825.

[6]. Md. Moinul Islam and Md. Saiful Islam, (2010), "Strength Behavior of Mortar using Fly Ash as Partial Replacement of Cement", Concrete Research Letters, Issue 3, Volume 1, pp 98 - 106.

[7]. Baboo R., Tabin R., Bhavesh K., Duggal S.K., (2012), "Study of Waste Plastic Mix Concrete with Plasticizer", International Scholarly Research Network Civil Engineering, Article ID 469272.

[8]. Viswanadham B.V.S., Das Arghya, Jayashree Ch., (2009) “Effect of randomly distributed geofibers on the piping behaviour of embankments constructed with fly ash as a fill material” Geotextiles and Geomembranes 27 (2009) 341–349.

[9]. Kaniraj, S.R and Gayathri V. (2003). Geotechnical behavior of flyash mixed with randomly oriented fiber inclusions, Geotextiles and Geomembranes, 21, 123-149.

[10]. BCA Specification for Stone Mastic Asphalt, BCA 9808, New Zealand Pavement & Bitumen Contractors’ Association, August, 1-10, (1999).

[11]. Ibrahim M. Asi (2005), “Laboratory Comparison Study for the Use of Stone Matrix Asphalt in Hot Weather Climates”, Construction and Building Materials, Volume 20, Issue 10, pp 982-989.

[12]. Karasahin Mustafa, Terzi Serdal (2007), “Evaluation of marbal waste dust in mixture of asphalt matrix”, Construction and Building Materials, Volume 21, Issue 5, pp 616-620

[13]. Kamraj C., Kumar G., Sharma G., Jain P.K. and Venkanna Babu P. (2004), “Laboratory Studies on the Behaviour of Stone Matrix Asphalt vis-à-vis Dense Graded Bituminous Mixes using Natural Rubber Powder (Wet Process)”, Highway Research Bulletin, No 71, IRC, New Delhi, pp 39-60.

[14]. Khanna S.K. and Justo C.E.G. (2001), “Highway Engineering”, Nem Chand andBros, Roorkee, pp315-321

[15]. Kumar Pawan, Chandra Satish and Bose Sunil (2007), 'Laboratory Investigations on SMA mixes with Different Additives', International Journal of Pavement Engineering, Volume 8, Issue1, pp 11-18.

[16]. 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

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

[18]. 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.

[19]. 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.