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# FOAMED BITUMEN

**Sarvesh Kumrawat[1], Prof. Vinay Deulkar[2]**

*[1]M.E. Student JIT Borawan Khargone (M.P.) INDIA*
*[2]Asst. Professor JIT Borawan Khargone(M.P.) INDIA*

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**Abstract -** The research presented in the effects of foamed bitumen on the deformational behavior and performance of pavement materials. The research was conducted in the laboratory and the field. This study aimed to report the preliminary study of the foamed bitumen properties. In India about 90% of roads are paved with bitumen. Pavement industry has developed rapidly during the last few decades all over the world, especially in developing countries. Following the rapid development, increased traffic load, higher traffic volume, and insufficient maintenance causes distresses of road surfaces. The demand for quality bitumen was increased. Considering all these problems the use of plain bitumen is not sufficient now a day due to increase in distress therefore the need of modification of bitumen leads towards foaming of bitumen.

**Key words-** foamed bitumen, properties and tests.

## INTRODUCTION

The bitumen foam was used as a binder. Since then foaming has been used in various countries, including USA, Australia and Europe. Aggregates particles are only partially coated in foamed bitumen mixes; moisture susceptibility is an important consideration. The presence of moisture in pavement layers has been regarded as the principal cause of their failure. Foamed bitumen is a hot bituminous binder that has been temporarily converted from a liquid state into a foam state by the addition of a small percentage of water and pressurized air (He, Wong 2008). This is mainly a physical process rather than a chemical process. The life of the foam at ambient temperature is very short, measured in seconds. Foaming characteristics are affected by bitumen type, grade. The optimum moisture content is essential for good foam in the mix. Foamed bitumen consists of hot bitumen, small quantities of water (typically 2%-3% by weight of the bitumen) and air. It is produced when water and air are injected into hot bitumen at 150 $^0$C -180 $^0$C. Under these production conditions, the binder is more likely to be exposed to ageing due to the presence of air and water which promote ageing. Thus there is a need to know whether any changes in binder composition occurred during the foam production process.

## METHEDOLOGY

Foaming of bitumen is carried out in a continuous process, essentially by introducing small amounts of water into hot (175 $^0$C) bitumen under high pressure. The water (~5%) added to the bitumen in the foaming process is instantly released as steam during mixing and has no other significant effect on the properties of the final product than by temporarily modifying the bitumen. The interaction of water and hot bitumen leads to heat exchange occurring between water and bitumen. As a result, water is converted into steam, which is forced into the bitumen continuum under pressure forming various bitumen bubbles enclosing steam.

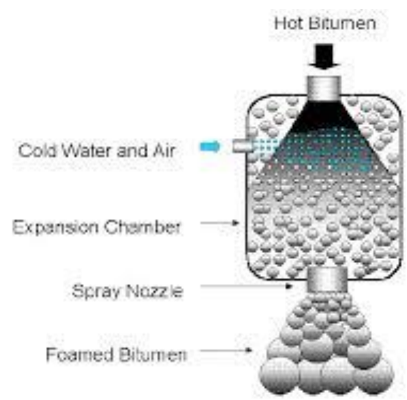


Fig: foaming of bitumen

It is supposed that foamed bitumen contains comprises air, steam gas, liquid bitumen and a little remaining water. When foam is investigated in a measuring cylinder, steam gas is seen clearly forming bubbles which are wrapped by liquid bitumen. The gas bubbles appear to be rising to the surface boundary while the liquid bitumen descends during foam dissipation due to the gravity effect. Foam bubbles appear larger when foam volume reduces. It is also understood that bitumen temperature during foaming is around the boiling point of water. Thus, foam properties changes i.e. temperature, gas content; volume, density, and bubbles expand & collapses. The bitumen also changes from liquid to foam, returns back to liquid, and then moves to a viscous and solid condition. Thus, foamed bitumen is an unstable material with various properties.

## LITERATURE RIVEW

**Yue Huan*, Komsun Siripun, Peerapong Jitsangiam and Hamid Nikraz** a mix design in which four different aggregate mixtures treated with three different foamed bitumen contents compacted with 1% hydrated Lime at

100% of optimum moisture content and cured for 7 days at room temperature, was observed under laboratory conditions. The mechanical behaviors of these mixtures were then investigated by means of indirect tensile strength tests, unconfined compressive strength tests, resilient modulus tests and permanent deformation tests in order to determine both optimum foamed bitumen content and optimum aggregate proportion.

**M. Iwański & A. Chomicz-Kowalska Kielce University of Technology, Kielce, Poland** the recycled material with the 2.5% foamed bitumen content has more favourable mechanical properties, higher Marshall stability and stiffness than in the case of the use of bitumen emulsion. The use of foamed bitumen in the deep cold recycling technology should guarantee that the rehabilited pavement will be more resistant to plastic deformations than the pavement produced with bitumen emulsion. An increase in the bitumen binder content form 2.0% to 3.5% results in an increase in indirect tensile strength of the base course material. The application of foamed bitumen results in higher indirect tensile strength of the recycled material in comparison to the application of bitumen emulsion.

**Martin Kendall, Bruce Baker, Peter Evans & Jothi Ramanujam** The use of foamed bitumen is growing in popularity and general acceptance both in Queensland and throughout the world as a result of recent research and extensive trials. Rehabilitation using foamed bitumen is successful due to its ease and speed of construction, its compatibility with a wide range of aggregate types and its relative immunity to the effects of weather. There are now well developed procedures for the design of foamed bitumen stabilisation which should be followed..Foamed bitumen has the potential to be used throughout Queensland another useful tool for the rehabilitation of heavily thin high plasticity heavily trafficked pavements.

**Allen Browne Hiway Stabilizers New Zealand Ltd** The FBS pavement rehabilitation process when combined with thorough investigation, pavement design and mix design provides a very robust treatment option. New Zealand pavement structure and materials particularly those in urban settings are extremely heterogeneous, and on occasion present a number of challenges with respect to providing a low risk structural repair that does not involve full materials replacement. Hiway Stabilizers have undertaken dozens of FBS contracts per year for the last three years, and the outcome has been very successful in terms of construction processes and as-built performance. This confirms that provided basic design elements are achieved, as outlined earlier in this paper, the FBS process can accommodate a wide variety of materials and environments.

**Maurizio Crispino and Claudio Brovelli** Bitumen emulsion and foam bitumen induced very different behavior in the mix. In presence of emulsion, both coarse and fine aggregate are completely coated by asphalt and the mix appears as a solution of water and bitumen. The tiny bitumen particles that are produced when the foamed bitumen bubbles burst have only enough energy to warm the smaller aggregate particles sufficiently to permit adhesion. The dispersed bitumen bubbles only partially coat the larger aggregate. High cement or lime content could induce a concrete-type behavior in the cold mix (high stiffness, low deformability) reducing the mechanical properties for long periods so a fine balance between the cement and bitumen must be considered by the addition of an active filler. The optimal strength and flexibility must be taken into account on the structural design. No unique curing procedure could be found for both emulsion and foam materials in the laboratory. The most used procedures suggest 72h at 40°C or 60°C (23). Temperature strongly influences curing time. By keeping the performance constant, an increase in temperature reduces time required for curing.

**Ashutosh Tejankar, Abhishek Chintawar** Based upon the laboratory foaming experiment, 2.5% water content was selected as the optimum foaming water content, along with 170ºC 60-70 grade bitumen, to produce the foam bitumen with expansion ratio of 2.5-3 times that of the original and half-life was around 10 seconds. The addition of foamed bitumen improved the performance of the pavements. From penetration test on foam bitumen, it is found that the penetration value is reduced because foam bitumen has higher stiffness and it gets harder. Due to foaming of bitumen penetration value decreases the consistency increases. In warmer region to avoid softening of bitumen lower penetration grades are preferred. Ductility of the bitumen is increased due to foaming.

**Chra Khalid** A lot of factors affect the performance and behaviour of foamed bitumen mixtures and all these factors should be taken into consideration when designing. From the literature, it can be seen that, with the development of highway design and rehabilitation, lots of waste is produced from using asphalt mixture. This waste is environmentally unfavourable and reuse of this waste is important. Foamed bitumen cold recycling can be used as the solution for this problem. Foamed bitumen cold mixtures have achieved popularity because of their excellent performance and enabling the use of a wide range of aggregate types.

**Alvaro Gonzalez1, Misko Cubrinovski, Bryan Pidwerbesky, David Alabaster** The rutting measured in the sections with foamed bitumen plus 1% cement as the lowest, showing that the addition of foamed bitumen significantly improved the performance of the pavements. The sections B00C10 and B22C00 and the control untreated section (B00C00) showed large amounts of rutting and heaving. The deflections of section B28C10 were lower than those of the other sections, while the untreated section

(B00C00) showed the largest values. To differentiate the rutting performance of the sections stabilized with foam bitumen and cement, water was introduced through surface cuts. After the application of additional accelerated traffic load, section B12C10 started to show surface cracking, while sections B14C10 and B28C10 performed well. Two types of models were fitted to the rutting measurements. The first model described the stable and unstable rutting of the pavement sections while second model only considered the stable phase in where a steady increase in rutting with the number of cycles is observed.

**Aleksander Ljubic, Roman Baselj, Natasa Zavrtanik, Mitja Kozamernik, Damijan Zore** foam mixes and layers that were designed and recycled in-situ according to experiences gained in Slovenia and also considering a lot of expertise and advice in the literature from countries that already have a longer tradition and more knowledge in terms of foamed bitumen stabilization such as South Africa and Australia, was partially expected and predicted but some findings are also a little surprising and need more evaluation and are still to validate on a larger scale. The existing materials that are to be recycled in-situ are always unpredictable to a certain extent, but with a thorough preliminary testing and with a proper mix design suited to the actual road purpose and with a conscientious construction on site it should be able to achieve the goal of high-quality stabilized layers.

**CONCLUSION AND EXPECTED OUTCOMES**

From the study of various research papers we can conclude that many other factors, such as moisture contents, gradations, curing methods and active filler content, were constrained. These factors can affect the strength of foamed bitumen. Foamed bitumen is a soft material with complex behavior. It is generated by a heat transfer process between hot bitumen and cold water and is successfully formed by the presence of a surfactant which is primarily contained in asphaltenes. Low penetration bitumen with high asphaltene content will therefore tend to produce a longer foam life, but high viscosity bitumen also makes the bubbles difficult to develop and hence the quality of foam reduces. The heat energy of hot bitumen is needed by the water to develop steam bubbles, but high bitumen temperature also causes the bitumen viscosity and surface tension to decrease, which initiates bubble collapse viscosity and surface tension have complex effects and they are interrelated. Bitumen with low viscosity enhances foam quality. The surface tension, which is strongly dependent upon viscosity, is not only primarily required by thin lamella to balance the internal pressure of an explosive bubble but also required to balance Plateau border suction, in order to resist liquid drainage. All these complex aspects of the behavior of foamed bitumen are likely to be linked with its temperature, as a result of the heat transfer process. Thus, an essential balance is required in order to generate foamed bitumen with optimum properties. Bitumen emulsion and foam bitumen induced a different behavior in the mix. In presence of emulsion, coarse and fine aggregate both are completely coated by asphalt and the mix appears as a solution of water and bitumen. The bitumen particles that are produced when the foamed bitumen bubbles burst have only enough energy to warm the smaller aggregate particles. The dispersed bitumen bubbles are partially coat the larger aggregate. There is better adhesion in between bitumen and aggregates after foaming of bitumen, thereby reducing water susceptibility. A pavement shows good performance even in presence of water and behaves like a ductile material. We studied the following in our research:

[1] The important factor in attaining optimum mixture performance is the predetermined aggregate moisture is correct that the quantity of fine particles is sufficient that proper design is made.
[2] It exhibits good structural capability to support traffic load and has a good ability to spread load.
[3] The evidence of rutting in FAM is mainly due to densification and the weakness of bonds during early life.
[4] Kinematic viscosity', ratio between viscosity and density is likely to be a more suitable representation of the resistance to foam flow since foam viscosity is dependent on its density, viscosity increasing at lower density.
[5] Both viscosity and surface tension have complex effects and they are interrelated.
[6] All these complex aspects of the behaviour of foamed bitumen are likely to be linked with its temperature, as a result of the heat transfer process.
[7] The effect of foaming water content (FWC) on foamed bitumen characteristics in terms of maximum expansion ratio (ERm) and half-life (HL) has been identified.

**REFRENCES**

[1] AdityaBhardwaj.et.al. Int. Journal of Engineering Research and Application April 2017

[2] Yue Huan, Komsun Siripun, Peerapong Jitsangiam and Hamid Nikraz 'A preliminary study on foamed bitumen stabilisation for Western Australian pavements'(2010), Scientific Research and Essays Vol. 5(23), pp. 3687-3700.

[3] Pengcheng Fu,David Jones, John T. Harvey, Syed A. Bukhari 'Laboratory Test Methods for FoamedAsphalt Mix Resilient Modulus'(2009) Road Materials and Pavement Design. Volume 10 – No. 1/2009, pp 187-212.

[4] Allen Browne 'Foamed Bitumen Stabilisation in New Zealand'Hiway Stabilizers New Zealand Ltd.

[5] J.M.Ramanujam, J.D.Jones 'Characterisation of Foam Bitumen Stabilisation' (2000), Road System and Engineering Technology Forum.

[6]Martin Kendall, Bruce Baker, Peter Evans, JothiRamanujam 'Foamed Bitumen Stabilisation'.

[7] D Alabaster, J Patrick, Haran Arampamoorthy, Dr A Gonzalez have done study on 'The design of stabilised pavements in New Zealand' (2013),New Zealand Transport Agency research report 498.

[8] Lee DY (1981). Treating marginal aggregates and soil with foamed asphalt. Association of Asphalt Paving Technologists. 50: 211-250.

[9] Leek C (2009). Review of the Performance Properties of Insitu Foamed Bitumen Stabilised Pavements, ARRB: Perth, pp. 1-25.

[10] Long FM ,Theyse HL (2002). LaboratoryTesting for the HVS Sections on Road P243/1.

[11] MAIN ROADS Western Australia (2010). Specification 501 Pavements. MAIN ROADS Western Australia: Western Australia, p. 70.

[11] Mallick RB, Hendrix G (2004). Use of foamed asphalt in recycling incinerator ash for construction of stabilised base course. Resources,

[12] Conservation and Recycling, 42(3): 239-248.

[13] Muthen KM (1998). Foamed Asphalt Mixes- Mix Design Procedure, SANOTA Ltd and CSIR Transportek.

[14] Nataatmadja A (2001). Some Characteristics of Foamed Bitmen Mixes.