Warm Mix Asphalt (WMA) Technology:-

General:-

Warm Mix Asphalt technology is comparatively new in India in which an additive is mixed with hot asphalt mixes in desired proportion so as to lower down the hot mix temperature from 160° C to 135° C-140° C for preparation of workable mix for laying. This leads to considerable energy saving in addition to minimizing the emission of GHG gases. Such technology is also eco-friendly as use of energy is minimized to certain extent in addition of supplementing the strength in pavement so constructed. The use of bitumen is also lowered down equal to quantity of additive and hence the process of WMA is comparatively economical.

Selection of Additive:-

Shell Thio-Pave is selected as an additive for use in asphalt paving mixture that can also significantly improve the mechanical performance of asphalt pavement. The IRC has also issued accreditation certificate to Shell – Thiopave materials vide their letter No. IRC-24(12) / 2007(Acc-6) dt. 8.10.09.

About Thiopave:

Thio-Pave acts as both a binder extender, replacing upto 25% of the bitumen in an asphalt mixture with all equivalent volume of Thio-Pave as well as an asphalt mixture modifier, which can lower the compaction temperature of paving mixtures.

- Thio-Pave comprises sulphur and a number of additives.
- Thio-Pave pallet contains upto 3% carbon black which acts as a plasticizer for improved dispersion in the mixture and mixture workability.
- Thio-Pave reduces emission of Hydrogen Sulphide (H2S) entrained in the Sulphur. Workability additive allows the asphalt mixture to be mixed at lower temperature than conventional asphalt, which limits H2S generation and saves energy in asphalt production.
- Thio-Pave is generally used at high concentrations in the binder (30% by volume of the total binder), surplus Sulphur dispersed in the bitumen eventually precipitates to form Sulphur crystals and lattices, which stiffens the asphalt paving mixture at high service temperatures and under slow or stationary loads.
- Binder content (Bitumen + thiopave) will remain the same by volume in comparison with conventional asphalt.

Application Process of Shell Thiopave –

- Shell Thiopave pellets are added to the preheated aggregates and bitumen during the asphalt mixing process.
- For a batch of 1800 kg of Dense bituminous macadam mix 1.65% of thiopave by weight of mix will be added in to the pug mill manually
- The mode of additional will be through a chute fabricated on one side of pug mill .
- Two bags of Thiopave @15 kg per bag shall be manually added.
- Scaffolding arrangements will be made at 2 locations on site.
    - At HMA plant- for transport of bags to the first level of HMP
    - 100 m from HMP in the route of movement of Tipper for taking temperatures of mix.

The temperature window for Thiopave asphalt mix production will be strictly 135 ± 5° C.

At these temperatures the Shell Thiopave pellet quickly melts, is easily dispersed throughout the mix and does not extend mixing time.

Ensuring that the temperature of any mixture containing Shell Thiopave is less than 145°C is important to minimize gaseous emissions, primarily H_2S and SO_2, during the production, laying and compaction work.

Operating at the low end of the temperature range reduces the likelihood of production and exposure to these gases, and reduces the amount of sulphur vapour created through the evaporation of molten sulphur as the mixture is being placed and compacted.

Experimental Stretch:-

The trial section was constructed in September 2010 on National Highway No. 3 near Nashik by Ashoka Buildcon Ltd under the guidance of AHRC and Shell Engineers into three section as under :-

(1) Thiopave + Thiopave DBM layer (km 429/595 to km 429/705)
(2) Thiopave + Conventional DBM layer (km 429/495 to km 429/595)
(3) Conventional + Conventional DBM layer (km 429/385 to km 429/495)

Scientist from Central Road Research Institute (CRRI) also visited the site during the construction of the Thiopave tests sections.The trial section pavement was evaluated after allowing the traffic on the trial section for about four months period.

Benkelman beam deflection studies were conducted on the test section, visual observation were also made by walking along the pavement test section and cores were taken using core cutting machine. The CRRI has also associated in the above processes.

Test Procedures:-

Following tests procedure was followed and testing data was tabulated to arrive at the conclusion

(1) Design of job mix formula for Dense Bituminous Macadam (DBM) with Thiopave.
(2) Trial stretches with the above job mix formula were constructed in September 2010 with association of Scientist from CRRI.
(3) Field core density test of bituminous material were taken in September 2010.
(4) Full traffic was allowed on test section for a period of about four months.
(5) Then after the Benkelman Beam deflection test were carried out on test track site and core samples were also collected for testing in the Laboratory in association with CRRI Delhi.
(6) The following analysis of test samples were carried out in Laboratory in association with CRRI.

- Bulk density and Air voids
- Marshal stability and indirect tensile strength (ITS)
- Indirect Tensile Stiffness Modulus (ITSM)
- Aggregate gradation of the core samples.
- Corrected Characteristic Rebound Deflection Value.

(7) Conclusions drawn from the above experimental track with the help of test data :-

- The Thiopave DBM mixtures have higher Marshal Stability values indicating that it is a rut resistant mixture.
- The Marshal Stability values were 14 to 18 % higher with Thiopave DBM mixture when compared with conventional DBM mixture.
- The Thiopave DBM mixture have highest stiffness value indicating better resistance to cracking and rutting compared to conventional DBM mixture.

- Benkelman Beam deflection values showed that the Thiopave + Thiopave section had the least deflection value (0.548 mm) when compared with the other two sections showing better structural adequacy of pavement. The deflection value was decreased by 10 % with Thiopave in two layers of DBM (120 mm) when compared with two layers of conventional DBM (120 mm). Similarly the deflection values were decreased by 5 % with Thiopave in one DBM layer (60 mm) and one layer of conventional DBM (60 mm) when compared with two layers of conventional DBM (120 mm)

- Initial pavement evaluation results have shown encouraging results with Thiopave as a bituminous mixture modifier in DBM layers. Further periodic evaluation studies are necessary to completely assess the advantages of the Thiopave DBM bituminous mixtures under heavy traffic and varying climatic conditions.

(8) Application of Thiopave Technology in construction:-

In view of the value added benefits of Thipave additive in Hot Asphalt Mixes as observed from the above experiment, Ashoka Highway Research Center has recommended Ashoka Buildcon Ltd. to use the above technology on experimental basis on their Toll way work of NH3 from Pimpalgaon Nashik Gonde (km 380 to 440) which is under construction for the present. Accordingly ABL has taken decision to utilize Thiopave as an additive for Hot Mix Hot Laid DBM mixes for maximum portions of the balance work after due consent from Independent Consultants of NHAI . The observations & periodical testing on the trial length of NH3 will be conducted periodically in days to come so as to assess long term effects of Thiopave additive. Separate arrangements will be made during construction of the above trial length to measure the energy savings in using the Shell- Thiopave & will be made available after the construction is over.