

A DETAILED STUDY OF PERFORMANCE OF MODIFIED BINDER IN THE DESIGN MIXES

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Abstract

Bitumen is a mixture of different organic materials, mostly of carbon and hydrogen. It is produced through vacuum distillation of petroleum. The viscoelastic behavior changes with temperature from solid to fluid and by cooling back in the original consistence. The bitumen binder can go through various problems in the field such as stripping from the aggregate, which can lead to cracking, rutting, depressions and potholes etc. Thus the binders can be modified by adding an additive to enhance its various properties. This binder in which an additive is added to make it better in its performance is called as modified binder. Modified binders are those bituminous binders whose properties have been modified by the use of additives. Bitumen binders have been modified in order to:

- stiffen binders and mixes at high temperatures to minimize rutting
- soften binders at low temperatures to improve relaxation properties and strain tolerance thus minimizing non-load associated thermal cracking
- Improve fatigue resistance especially where higher strains are imposed on bituminous mixes.
- Improve aggregate-bitumen bonding to reduce stripping
- Improve bituminous pavement durability with accompanying net reduction in life cycle costs
- permit thicker films of bitumen on aggregate in special bituminous mixes such as open graded asphalt friction course (porous asphalt) and stone matrix.

Surfaced roads in India are very predominantly, if not entirely, constructed with the use of Bituminous binders. This is largely because these binders have been most suited to the major imperative of road development low initial cost, phased development, and ready availability. With the socio-economic progress in India, the road network has to be extended to more difficult environs. More importantly, traffic loads carried by the network have been growing heavier and heavier. These situations can be exemplified as follows:

- Heavy channelized traffic to be carried in tropical and sub-tropical locales with high temperatures; and high tyre pressures in trucks (need ability to resist permanent deformation/rutting).
- Higher potential for developing fatigue cracking due to repeated loads (need elasticity for fatigue resistance)

Higher potential for thermal cracking at sites where pavements are subjected to sub-zero temperatures for extended periods (need resistance to thermal cracking). Therefore, during the last two decades, highway engineers in India have become increasingly aware that there were indeed situations for which upgraded bituminous binders were needed.

Keywords : Bituminous mix, Marshall Test, Stability, Aggregates, nano- material, modifier, zycotherm.

INTRODUCTION Properties of modified binders depend upon type and quantity of modifier used and employed for their manufacture. The advantages of modified bitumen can include following for road works:

- Lower susceptibility to daily and seasonal temperature variations
- Higher resistance to deformation at elevated pavement temperature
- Better age resistance properties
- Higher fatigue life of mixes
- Delay of cracking and reflective cracking
- Overall improved performance in extreme climatic conditions and under heavy traffic conditions

Materials

Aggregate and bitumen are the basic ingredients of bituminous mixes. Further on the basis of size of particles aggregates are further divided into coarse aggregates, fine aggregates and filler fractions. Materials used in bituminous pavements are discussed below:-

➤ **Coarse Aggregate**

Impact value, abrasion value and crushing strength of coarse aggregates should be good enough to withstand the design loads within the design life span. All the stresses coming on the wheels are beard by coarse aggregates. Wear due to abrasion is also to be resisted by coarse aggregates. That portion of the mixture which is retained on 2.36 mm (No. 08) sieve according to the Asphalt Institute is termed as Coarse aggregates. The coarse aggregates for this study are taken from Ganderbal stone quarry and have following properties:

i) **Nominal size = 10 mm**

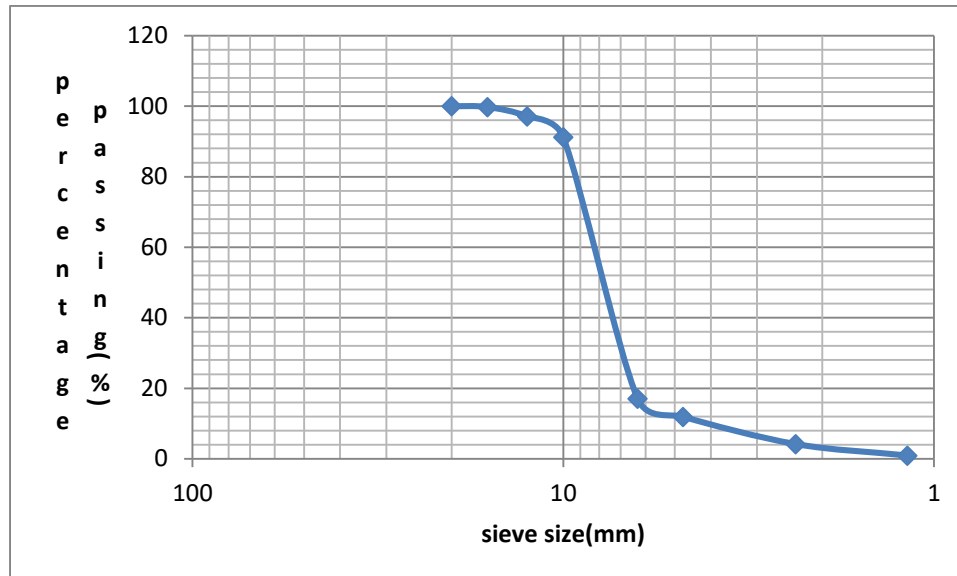


Fig. 1: Sieve analysis of 10 mm nominal size aggregates

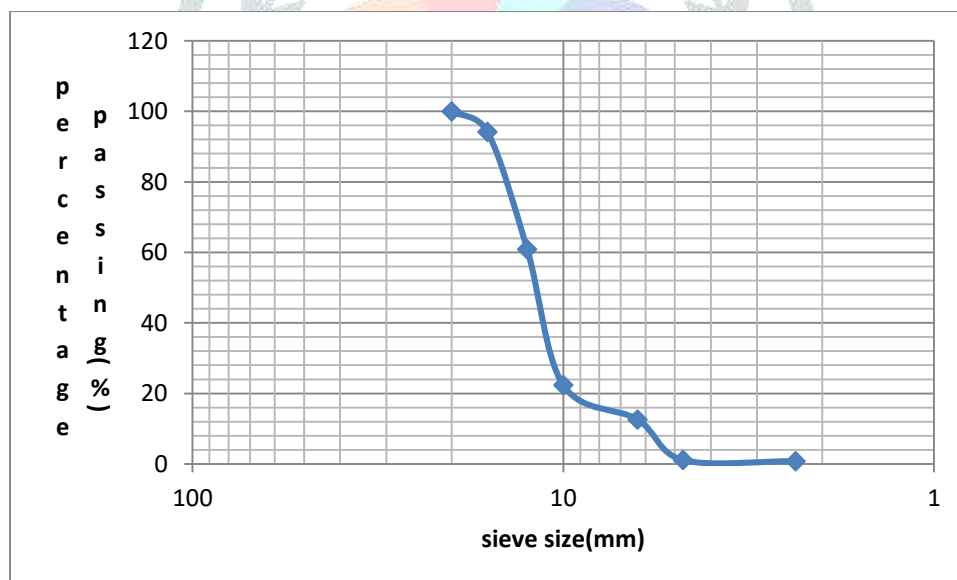


Fig. 2: Sieve analysis of 20 mm nominal size aggregates

Fine Aggregate

In coarse aggregates between the particles voids remain, those voids need to be filled. Those voids which remain there are filled by fine aggregates. So to fill the voids of coarse aggregates is the main function of Fine aggregates. Crushed stone or natural sand generally is termed as fine aggregates. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 3/8-inch sieve. Coarse aggregates are any particles greater than 0.19 inch, but generally range between 3/8 and 1.5 inches in diameter. They shall be the fraction passing 2.36 mm sieve and retained on 75 micron sieve, consisting of crusher run screening etc. They should be clean, hard, durable and free from any deleterious substances.

➤ **Filler**

After the voids are filled in coarse aggregates by fine aggregates, some of the voids still remain unfilled. Function of the fillers is to fill up the voids. Fillers used may be, stone dust, concrete dust. Filler can consist of finely divided mineral matter such as rock,

hydrated lime or cement. It should be free from impurities. Cement or hydrated lime is not required when the gravel is limestone. In this study the filler used was 53 Grade OPC

➤ Bitumen

Bitumen is used as a water repellent material.

BACKGROUND

The past decade (2001-10) marked a major surge in the use of modified bitumen for roads and airports, especially the use of crumb rubber modified bitumen (CRMB) and polymer modified bitumen (PMB). The Indian Roads Congress (IRC) brought out a special publication (IRC: SP: 53) in 1999 to provide tentative guidelines on the use of modified bitumen in road construction. Although that publication had four different specifications for PMB (elastomer), PMB (plastomer), CRMB, and natural rubber modified bitumen (NRMB), unfortunately it was implied that their performance was equal in absence of any recommendations for their use for specific traffic and/or climatic conditions. In another setback, IRC:SP:53 was revised in 2010 with one notable feature in that the specifications for different types of modified binders were unified into one specification irrespective of the modifier type or its concentration. Obviously, to accommodate the CRMB, the minimum elastic recovery requirement was reduced for all modified binders including PMB with elastomer.

Fortunately, most progressive contractors are not using the downgraded 2010 version of IRC: SP: 53; they would rather use PMB with elastomer which meet the enhanced elastic recovery requirement as in 1999 version of the IRC:SP:53.

There is gross inadequacy of published data in India on relative field performance with and without different binder modifications under typical conditions of loading, climate, and their combinations. Until relative field performance data is obtained in India, there is no other recourse but to rely on similar data or experience in the developed country.

OBJECTIVE

The main objectives of this investigation are:

- To compare the Marshall properties modified samples with conventional sample.
- To analyze the results of Marshall tests of modified binder mixes for deciding the optimum binder content (OBC) and best modifier for further studies.
- To study the characteristics of modified bitumen with the nano- material as additive.

SUMMARY

From the results it can be concluded that using zycotherm by weight of binder will improve and enhance the properties of hot mix asphalt concrete to a great extent and rutting and fatigue problems which mostly arise from moisture exposure and existence inside the asphalt will be decreased.

It can also be concluded that the zycotherm which is added as additive can be fuel efficient i.e., it can reduce the fuel cost by 11 – 14% to the conventional fuel cost. Also 0.15% of zycotherm is optimum additive content that to be mixed in the mix.

Thus, it is clearly reflected that utilization of 0.15% expansion of Zycotherm as Warm blend at 130°C temperature in development of Bituminous Concrete is eco-accommodating, cost effective and useful under precise supervision. The zycotherm applied in asphalt pavement engineering with their specific properties are categorized in the next points:

1. The physical properties were conducted on the aggregates and the binder used in the present studies satisfies the requirements as per the MORT&H specifications.
2. Increasing percentage of additive dosage to rate of Marshall Properties also increases and satisfies the MORT&H specifications.
3. The Marshall properties of HMA in the present studies satisfies the MORT&H specifications.
4. The optimum bitumen content was found to be 6% for HMA mix at 160^oc temperature.

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