

Economic & Feasible Solution for Pavement Failure in BRTS Ahmedabad

Milan Kanzariya¹, Prof, Krupa Dave²

¹M.E. Student, Civil Engineering L.D.R.P. –ITR College of Engineering, Gujarat, India

²Associate Professor, Civil Engineering Department, LDRP-ITR College of Engineering, Gujarat, India

Abstract- Transportation contributes to the economy, industrial, social and cultural development in country. Transport demand in most Indian cities has increased substantially due to increases in population as a result of both natural increased and migration from rural and small town. In the Ahmedabad BRTS traffic at intersection and bus-stand is most serious problem for BRTS buses.

Non-destructive structural evaluation of pavements is an important part of the pavement management. In this research, emphasis has been laid on the non-destructive Structural Capacity Evaluation and pavement distress identification. Visual survey on the station like Maninagar, Swaminarayan Mandir, Danilimda, Chandranagar, Nehrunagar and Memnagar.

I had found pavement failures like rutting and fatigue failure at BRTS routes. I measured rut depth of pavement. For the solution of this problem I am planning to use Jute fibres in wearing course of pavement.

Stone Matrix Asphalt (SMA) is a gap graded mix, characterized by high coarse aggregates, high asphalt contents and polymer or fibre additives as stabilizers. High concentration of coarse aggregate maximizes stone-to-contact and interlocking in the mix which provides strength, and the rich mortar binder provides durability. The stabilizing additives composed of cellulose fibres, mineral fibres or polymers are added to SMA mixtures to prevent drain down from the mix. In comparison to dense graded mixtures SMA has higher proportion of coarse aggregate, lower proportion of middle size aggregate and higher proportion of mineral filler. It resists permanent deformation and has the potential for long term performance and durability.

Index Terms- Stone matrix asphalt, Jute fibre, Marshall Properties, cost analysis.

INTRODUCTION

In economic growth and development of country Transportation infrastructure plays a lead role. The

road transport is the oldest and most widely mode of transport of mankind. Pavements are the key elements of infrastructure of the country, whose functions are to promote transport activities, economic activities and to improve the standard of living life.

Janmarg also known as Ahmadabad BRTS is a Bus Rapid Transit in Ahmadabad. It is operated by Ahmadabad Janmarg Limited, a subsidiary of Ahmadabad. It is designed by CEPT University.

Bus Rapid Transit System (BRTS) takes part of its name from "Rapid Transit", which describes a high-capacity transport system with its own right-of-way, implemented using buses through infrastructural and scheduling improvements, to provide a high level of service. Complicated as it sounds, this is nothing but high-capacity articulated buses operating in lanes reserved for their exclusive use. The Bus Rapid Transit system is expected to revolutionize public transport with new buses, special lanes and new routes, all at a low cost. Bus Rapid Transit System, or 'High Capacity Bus System' as it is commonly referred to, is a flexible mass-transit mode that has the advantage of being the most economical amongst the mass-transit options. BRTS flexibility is both in terms of routes and areas of coverage as well as in terms of its amenability to features-up-gradation over time. BRTS, as a system, includes a number of broad elements such as running way, stations (or stops), vehicles, service and operating plans, fare collection, ITS (intelligent transportation system) etc., under which the different features of BRT are subsumed.

OBJECTIVES OF STUDY

- To determine the nature and extent of rutting on BRTS bus route.
- To evaluate typical alternate proposed solution.

- To study mixtures characterization that is susceptible to rutting and those that are not susceptible to rutting.
- Comparative analysis of other pavement with that of BRTS lanes, in terms of distress extent.

STUDY AREA LOCATION

The city of Ahmedabad, founded in 1411 AD as a walled city on the eastern bank of the river Sabarmati, the commercial capital of Gujarat is now the seventh largest metropolis in India and the largest in the state. With a population of 6 million (2001) within an area of 466 sq. kms, the city is preparing for the emerging challenges, more importantly in terms of sustaining its contributions to the growth of Gujarat State. It accounts for 25% of the State's urban population; 20% of the State's GDP (2001), and also has one of the largest informal sectors. Ahmedabad with its strong industrial base continues to be an attractive destination for investments. Its population is likely to rise to 11 Million by 2035. While the area is likely to increase from the present 440 sq. kms 1000 sq. kms by 2035, sustenance of this growth is possible only with the development of an efficient rapid mass transit system.

Ahmedabad is a compact city characterised by mixed land uses, high density development and balanced street network system with well-developed 5 ring and 17 radials. Total road length is about 2400 kms. There are 7 bridges to connect the eastern part of the city with west. Sixteen rail-over/under bridges enable crossing the railway lines at appropriate places. Two wheelers, both motorised and bicycles dominate the traffic on the streets of Ahmedabad. The city has 22 lakh registered vehicles of which two wheelers are about 73%. As per the household survey (CEPT, 2006), 8 lakh bicycles are in operation in the city accounting for 19% of the total trips. The share of four wheelers is still low. They constitute to about 12.5% of the total vehicles and 3% of total trips

- Memnagar
- Danilimda
- Chandranagar
- Nehrunagar
- Swaminarayan Mandir

The Various Survey Conducted

- Patch deteriorations

- Potholes
- Cracking
- Rutting

TYPE OF PAVEMENT

The pavements are classified into following three types:

- Flexible Pavement
- Rigid Pavement
- Composite Pavement

FLEXIBLE PAVEMENT

- A flexible pavement structure is typically composed of several layers of material with better quality materials on top where the intensity of stress from traffic loads is high and lower quality materials at the bottom where the stress intensity is low. Flexible pavements can be analysed as a multilayer system under loading.
- A typical flexible pavement structure consists of the surface course and underlying base and sub-base courses. Each of these layers contributes to structural support and drainage. When hot mix asphalt (HMA) is used as the surface course, it is the stiffest (as measured by resilient modulus) and may contribute the most (depending upon thickness) to pavement strength. The underlying layers are less stiff but are still important to pavement strength as well as drainage and frost protection. When a seal coat is used as the surface course, the base generally is the layer that contributes most to the structural stiffness. A typical structural design results in a series of layers that gradually decrease in material quality with depth.

PAVEMENT COMPOSITION

Computation of Design Traffic

$$N = \frac{365 \times [(1 + r)^n - 1]}{r} \times A \times D \times F$$

Where,

N = Cumulative number of standard axles to be catered for in the design in terms of msa.

A = Initial traffic in the year of completion of construction in terms of the number of Commercial Vehicles per Day (CVPD).

D = Lane distribution factor

F = Vehicle Damage Factor (VDF).

n = Design life in years.

r = Annual growth rate of vehicles in decimal

A = 800

D=0.50

F=4.5

n=20

r=0.075

$$N = \frac{365 * [(1 + 0.075)^{20} - 1]}{0.075} * 800 * 0.50 * 4.5$$

N= 30 msa

METHODOLOGY

Stone Matrix Asphalt consists of two parts, a coarse aggregate skeleton and a high binder content mortar. The coarse aggregate skeleton provides the mixture with stone-on-stone contact, giving it strength, while the high binder content mortar adds durability. The mortar is typically composed of fine aggregate, mineral filler, asphalt binder and a stabilizing additive. This stabilizing additive acts to hold the asphalt binder in the mixture during the high temperatures of production and placement.

Since the strength of SMA relies heavily on the stone-on-stone aggregate skeleton, it is imperative that the mixture be designed and placed with a strong coarse aggregate skeleton. Within the last five years the use of SMA in the United States has continued to grow. However, no testing has been performed on a routine basis during design and/or production to ensure that SMA mixtures have an adequate coarse aggregate skeleton. The work prescribed here is regarding details for the development of a method to establish when a stone-on-stone coarse aggregate skeleton exists in SMA mixtures.

REQUIREMENT OF A PAVEMENT

An ideal pavement should meet the following requirements:

1. Sufficient thickness to distribution the wheel load stresses to a safe value on the sub-grade soil.
2. Structurally strong to withstand all types of stresses imposed upon it.

3. Adequate coefficient of friction to prevent skidding of vehicles.
4. Smooth surface to provide comfort to road users even at high speed.
5. Produce least noise from moving vehicles.
6. Dust proof surface so that traffic safety is not impaired by reducing visibility.
7. Impervious surface so that sub-grade soil is well protected, and long design life with low maintenance cost.

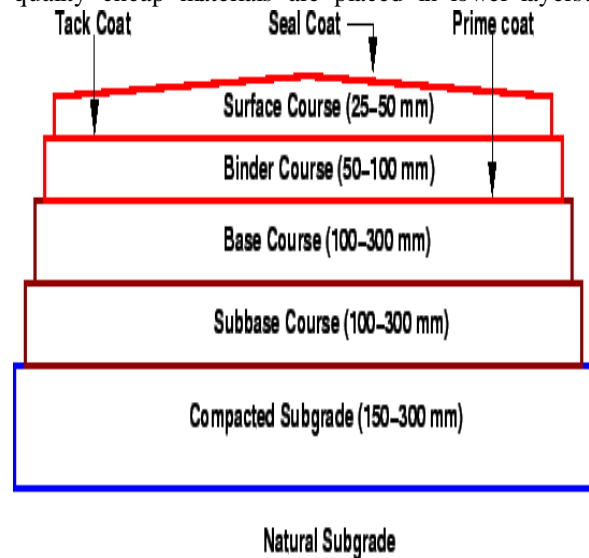
TYPES OF FLEXIBLE PAVEMENTS

The following types of construction have been used in flexible pavement:

- 1) Conventional layered flexible pavement.
- 2) Full-depth asphalt pavement.
- 3) Contained rock asphalt mats.

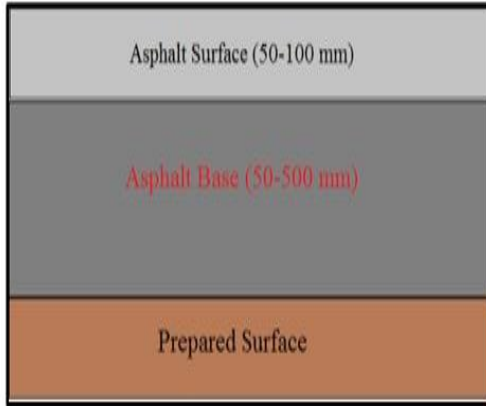
CONVENTIONAL LAYERED FLEXIBLE PAVEMENT

Conventional flexible pavements are layered systems with high quality expensive materials are placed in the top where stresses are high, and low quality cheap materials are placed in lower layers.



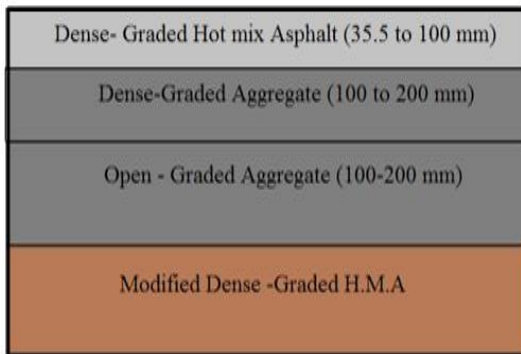
FULL-DEPTH ASPHALT PAVEMENTS

Full-depth asphalt pavements are constructed by placing bituminous layers directly on the soil sub-grade. This is more suitable when there is high traffic and local materials are not available



CONTAINED ROCK ASPHALT MATS

Contained rock asphalt mats are constructed by placing dense/open graded aggregate layers in between two asphalt layers. Modified dense graded asphalt concrete is placed above the sub-grade will significantly reduce the vertical compressive strain on soil sub-grade and protect from surface water.



TYPICAL LAYERS OF A FLEXIBLE PAVEMENT

Typical layers of a conventional flexible pavement include sealcoat, surface course, tack coat, binder course, prime coat, base course, sub-base course, compacted sub-grade, and natural sub-grade.

Seal Coat: Seal coat is a thin surface treatment used to water-proof the surface and to provide skid resistance.

Tack Coat: Tack coat is a very light application of asphalt, usually bitumen. Emulsion diluted with water. It provides proper bonding between two layers of binder course and must be thin, uniformly cover the entire surface, and set very fast.

Prime Coat: Prime coat is an application of low viscous cutback bitumen to an absorbent surface like granular bases on which binder layer is placed. It provides bonding between two layers. Unlike tack coat, prime coat penetrates into the layer below, plugs the voids, and forms a water tight surface.

Surface course: Surface course is the layer directly in contact with traffic loads and generally contains superior quality materials. They are usually constructed with dense graded asphalt concrete (AC). The functions and requirements of this layer are:

- It provided characteristics such as friction, smoothness, drainage, etc. Also, it will prevent the entrance of excessive quantities of surface water into the underlying be base, sub-base and sub-grade.
- It must be tough to resist the distortion under traffic and provide a smooth and skid-resistant riding surface.
- It must be waterproof to protect the entire base and sub-grade from the weakening effect of water.

Binder course: This layer provides the bulk of the asphalt concrete structure. Its main purpose is to distribute load to the base course the binder course generally consists of aggregates having less asphalt and doesn't require quality as high as the surface course, so replacing a part of the surface course by the binder course results in more economical design.

Base Course: The base course is the layer of material immediately the surface of binder course and it provides additional load distribution and contribute to the sub-surface drainage. It may be composed of crushed stone, crushed slag and other untreated or stabilized material.

Sub-base course: The sub-base course is the layer of material beneath the base course and the primary functions are to provide structural support, improve drainage, and reduce the intrusion of fines from the sub-grade in the pavement structure. If the base course is open graded, then the sub-base course with more fines can serve as a filler between sub-grade and the base course A sub-base course is not always

needed or used. For example, a pavement constructed over a high quality, stiff sub-grade may not need the additional features.

Sub-grade: The top soil or sub-grade is a layer of natural soil prepared to receive the stresses from the layers above. It is essential that at no time soil sub-grade is overstressed. It should be compacted to the desirable density, near the optimum Moisture content.

TESTING ON AGGREGATE

In order to decide the suitability of the recycled aggregate for use in pavement construction, following tests are decided to be carried out:

- (a) Gradation test
- (b) Impact test
- (c) Abrasion test
- (d) Shape test
- (e) Specific gravity test & Water absorption test.

FLEXIBLE PAVEMENT DESIGN FACTORS

Design factors can be divided into four broad categories.

- Traffic And Loading
- Material Characterization
- Environmental Factors
- Effects on Asphalt Layer

CONCLUSION

After the all data collection and survey related to my project with methodology and assessment will get,

- Reducing rutting of road
- Expand the life of pavements
- Use economic strategy
- Save the cost of rework & repair of pavements

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