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DETAILED STUDY ON CONSTRUCTION OF PAVEMENT BY USING WHITE TOPPING ROADS

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ABSTRACT:-Transportation is major factor in the world. In that bituminous pavements playing a prominent role in the world. The increasing truck weights and tyre pressures on pavements in recent years have pushed the demand on the performance of our pavements to a higher level. Many asphalt pavements have experienced rutting while many others have experienced longitudinal cracking. One of the possible solutions to the problem is the use of white topping (WT), which is a cement concrete layer placed over an existing asphalt pavement.Concrete overlays have been used to rehabilitate bituminous pavements. White topping is stronger than asphalt overlay, and thus more resistant to rutting and surface initiated cracking. Consequently white topping pose economical and technical benefits. However, they need to be effectively evaluated for feasibility and proper application of techniques, suitable for India, so that their use can provide the maximum benefits to the road users in particular and Indian economy at large.Ultra –thin white topping is one of the types of white topping in which a thin layer of concrete varying from 50 to 100 mm thick with fibres is placed over a prepared surface of distressed pavement. The factors affecting the white topping are: (a) thickness, (b) bonding, (c) joint spacing, and (d) deflections. Ultra-Thin White topping is an emerging and innovative technology for asphalt pavement rehabilitation in India.

I INTRODUCTION

Road traffic is increasing steadily over the years. This is an international phenomenon. An international forecast predicts that such increase will continue in future. Even in the case of the developed countries, there is a shortage of funds required for new infrastructure projects, both for constructing them and more significantly towards their maintenance and repairs. The increasing truck weights and tyre pressures on our pavements in recent years have pushed the demand on the performance of pavements to a higher level. As a result, more and more roads are deteriorating and the existing pavement structure as a whole is often found to be inadequate to cope up with the present. The cost of strengthening and repair by Conventional method of this large network will need huge resources both physical and financial which are quite scarce. Most of the existing flexible pavements in the network broadly have thin bituminous layers. The increasing truck weights and tyre pressures on our pavements in recent years have pushed the demand on the performance of our pavements to a higher level. Many asphalt pavements

have experienced rutting while many others have experienced longitudinal cracking. One of the possible solutions to this problem is the use of white topping (WT), which is a cement concrete layer placed over an existing asphalt pavement. Concrete overlays have been used to rehabilitate bituminous pavements since 1918 in USA. There has been a renewed interest in white topping, particularly on Thin White Topping (TWT) and Ultra-Thin White Topping (UTWT) over Conventional White Topping. Based on the types of interface, these bituminous pavements, in general, have a problem that they get deteriorated with time. Most of our roads exhibit, in general, the following deficiencies:

i. Rutting
ii. Fatigue cracking
iii. Block crack (D-cracking)

Thermo cracking is one of the possible solutions to this problem is the use of white topping (WT), which is a cement concrete layer placed over an existing asphalt pavement.

Types of White Topping(WT): The following are the three types of white topping they are explained below,

1. **Conventional White topping** – which consists of PCC overlay of thickness 200 mm or more, which is designed & constructed without consideration of any bond between existing overlay & underlying bituminous layer (without assuming any composite action).
2. **Thin White topping (TWT)** – which has PCC overlay between 100 – 200 mm. It is designed either considering bond between overlay & underlying bituminous layer or without consideration of bond. High strength concrete (M 40 or higher) is normally used to take care of flexure requirement. Joints are at shorter spacing of 0.6 to 1.25 m.
3. **Ultra-Thin White topping (UTWT)** – which has PCC overlay of less than 100 mm. Bonding between overlay & underlying bituminous layer is mandatory. To ensure this, the existing layer of bitumen is either milled (to a depth of 25 mm) or surface scrapped (with a non impact scrapper) or gently chiseled. Joints are provided at a spacing of 0.6 to 1.25 m.

Ultra Thin White Topping (UTWT) and Thin White Topping (TWT) are being increasingly practised in USA and West Europe. White topping is stronger than asphalt overlay, and thus more resistant to rutting and surface initiating cracking. However, they need to be effectively evaluated for feasibility and proper application techniques, suitable for India, so that their use can provide the maximum benefits to the road users in particular and Indian economy at large. Ultra-Thin White topping is an emerging and innovative technology for asphalt pavement.

Ultra-thin white topping is one of the types of white topping in which a thin layer of concrete varying from 50 to 100mm thick with fibers is placed over a prepared surface of distressed asphalt pavement. In addition to the thickness of the concrete overlay, other factors differentiate UTW from conventional concrete overlays are: (a) a substantial degree of bond between the concrete overlay and the prepared asphalt surface, and (b) much closer joint spacing. Ultra-Thin White topping is an emerging and

innovative technology for asphalt pavement rehabilitation in India. The type of bond between the PCC overlay and the underlying HMA layer is important, especially for UTWT, because the bond reduces the stresses in the thin PCC layer by transferring some of the load to the underlying HMA layer. If heating of bitumen is not allowed at any nearby location and if bituminous mix is brought from longer distances, it becomes so cold that it is difficult to be properly compacted.

Benefits of White Topping :-

- Long life, low maintenance, low life-cycle cost, improved safety and environmental benefits.
- Deformation like rutting and cracking predominant in case of bituminous pavements is normally absent with concrete surfaces of White topping. This is particularly true in a hot climate like India.
- Conventional White topping improves structural capacity of existing bituminous pavement, if built on a strong base course, and it impedes structural distresses.
- White topping requires much less maintenance and as such involves much less frequent lane closures of road, as compared to bituminous surfaces.
- White topping is quite cost-effective to tackle annual budget constraints and high traffic levels. It is, therefore, quite relevant to Indian conditions.
- White topping can uniformly fill ruts in the wheel path of bituminous pavements more effectively because concrete is far more stiff and consistent at high temperature than bituminous mixes.
- Concrete is relatively light in colour and hence concrete surface is more reflective to light, absorb less heat and reduce the urban heat island effect,
- Improved reflection of lights from vehicles enhances safety, lowers energy requirement of external lighting, lower contribution to heat in environment.
- Fuel consumption on concrete roads has been found to be less than the bituminous roads.

OBJECTIVES OF THE THESIS:-

The main objectives of the project work is

1. To study the present condition of existing pavement and suitability regarding laying of ultra-thin whitelayer.
2. To verify the various field aspects of UTWT pavement for actual site conditions and the factors affecting itsperformance.

To do various types of testing on existing bitumen pavement to obtain the good design such as CBR (California bearing ratio)test.

II LITERATURE REVIEW

Construction of ultra-thin whitetopping consists of three fundamental steps (ACPA 2002; Lin and Wang 2005):

- Prepare the existing HMA pavement surface by milling and cleaning or by blasting with water or an abrasive material. This step removes rutting, restores the surface profile, and provides a roughened surface to enhance the bonding between the new PCC and the existing HMA pavement (ACPA 1999). This activity should be done 24 to 48 hours before concrete placement (Cole 1997).

- Place, finish, and cure the concrete overlay by using conventional techniques.
- Cut saw joints early at the prescribed spacing.
- Control the curing of concrete mix in the field.

Milling existing HMA pavement is the most common pre-overlay treatment before whitetopping overlay application. Milling helps create a good PCC-HMA bond, eliminates rutting and other irregularities, and provides uniform surface preparation. Milling is especially useful for whitetopping projects in which controlling the grade is important to match curb and gutter or to maintain structure clearance.

To create a good PCC-HMA bond, sufficiently cleaning the milled surface is very important. When the PCC overlay and asphalt layer are fully bonded, the pavement behaves as a composite pavement, reducing the tensile stress/strain at the bottom of the PCC overlay. This is supported by 3D-FEM studies (Nishizawa et al. 2003 and Kumara et al. 2003) and by field observations (Vandenbossche 2003; Lin and Wang 2005). The lack of a good bond has been reported to be responsible for premature failure of whitetopping pavement (McMullen et al. 1998; Rasmussen et al. 2002). In reality, the field instrumentation has demonstrated that in most cases, the PCC overlay and HMA are partially bonded (Tarr et al. 1998). It is also reported that a milled HMA surface has better bonding than an unmilled HMA surface and reduces the tensile strain at the bottom of PCC overlay by an average of 25 percent compared to PCC overlay on unmilled asphalt surface (Tarr et al. 2000). This finding supported Rasmussen's (2002) hypotheses that the presence of voids in the underlying asphalt pavement is one of the major causes of the different types of failures observed on UTW overlay surfaces during the ALF UTW study. The exact reason for this behavior is not clear and requires further investigation.

Iowa #406 tests on whitetopping pavement cores have been widely used to determine the shear strength of the bond (Iowa DOT 2000; Qi et al. 2004). The test's apparatus consists of a loading jig to accommodate a 4–in. nominal diameter. The jig is designed to provide a direct shearing force at the bonded interface. The specimen is placed in the testing jig in such a manner that the bonded interface is placed in the space between the main halves of the jig. A uniform tensile load is applied at the rate of 400 to 500 psi per minute, until the specimen fails. The shear bond strength of the specimen is calculated by dividing the maximum load carried by the specimen during the test by the cross-sectional area of the sample. A shear strength of 200 psi is reported to be sufficient to withstand the shearing force caused by vehicles (Tawfiq 2001). It is noted that in the Iowa shear test, no axial load is applied to the specimen to simulate the field conditions.

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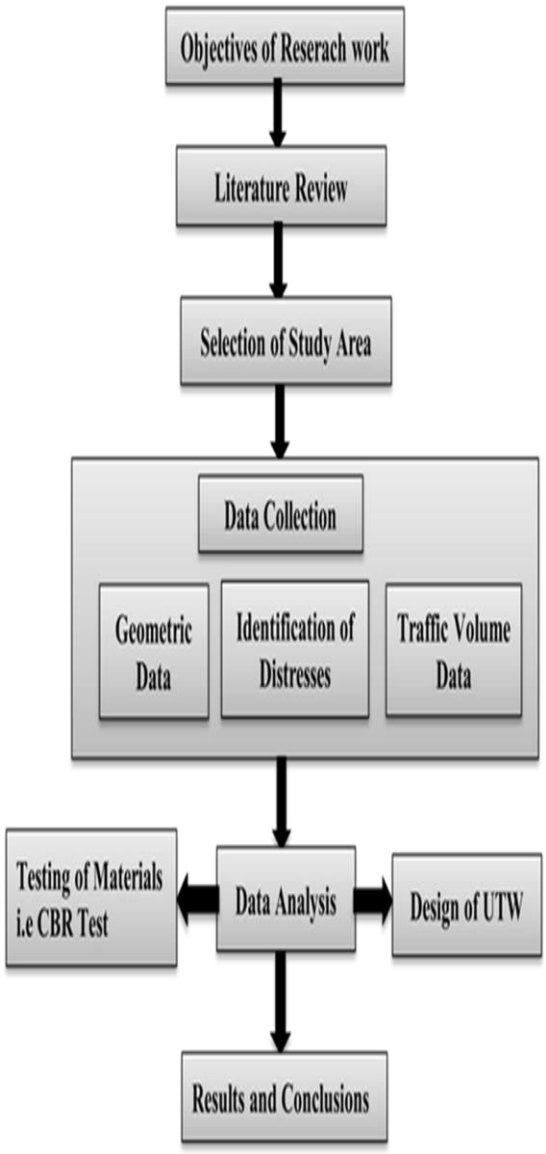
The ACPA white topping guideline (2002) and the National Cooperative Highway Research Program (NCHRP) bulletin on white topping and ultra-thin white topping (Rasmussen and Rozycki 2004) summarized recommendations for the construction of white topping pavement. Curing compound should be applied at twice the normal rate (Mack et al. 1998; ACPA 1999 as quoted by Lin and Wang 2005). Joint sawing should be accomplished by lightweight saws as early as possible to control cracking (ACPA 2002).It is important to mention the weather conditions during the curing of concrete material. Lin (2005) reported that an air temperature higher than 90oF can result in the separation of fibers on the surface of the finished white topping, as shown in Figure 3. It is not known how this behavior influences the performance of white topping pavement.

Selection of study area:

1. Name of Site selected – From Chilakanagar to Nacharam
2. Road Condition – The existing condition of pavement is very poor. Many distresses are observed during the study of selected site.
3. Traffic Density – It is observed that more number of heavy vehicles and Commercial vehicles are going every day on that road.
4. Industrial Area – Several small scale industries present around the road due to that number of commercial vehicles using the road is increasing day by day.
5. Maintenance – Due to heavy vehicles and regular traffic, road is distressing periodically, hence increases the maintenance cost.

III METHODOLOGY



Data Analysis:-

The above data are necessary to design the ultra thin white topping. In this project, we are designing the ultra thin white topping based on the following factors and the step by step procedure are calculated in design the UTWT discussed in next chapter.

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a. Analysis by IRC

b. Analysis by AASHTO

c. Analysis of Stresses such as Temperature stress, Edge load stress and Corner stress

d. Thickness of pavement.

IV RESULT& ANALYSIS

1Analysis by using IRC method.

The design principal adopted for UTW is similar to those of normal concrete rigid pavement as provided in IRC: 58 - 2002 and IRC: SP 76 - 2008. The other basic data are collected for the design of UTW and stepwise design procedure is given below:

5.1.1 Traffic data collection and analysis

The design traffic is considered in terms of the cumulative number of standard axles to be carried during the design life of the road. Its computation involves estimates of the initial volume of commercial vehicles per day, lateral distribution of traffic, the growth rate, the design life in years and the vehicle damage factor (number of standard axle per commercial vehicle) to convert commercial vehicles to standard axles as given by the following equation:

$C = (365 * A\ \{(1 + r)n - 1\}/r) * F$

Where,

C - The cumulative number of standard axles to be catered for in the design

A - Initial traffic, in the year of completion of construction, in terms of the number of commercial vehicles per day duly modified to account for lane distribution.

r - Design growth rate n - Design life in years

F- Vehicle Damage Factor

California bearing ratio - It is used to find the modulus of sub-grade reaction which is to be used in the design of ultra thin white topping overlay. It is conducted for four days and after loads applied on the specimen to obtain deflections values. From deflection values we need to find the CBRvalue.

Penetration (mm)	Standard load(kgf)	Unit standard load (Kg/cm^2)
2.5	1370	70
5	2055	105

Modified k- value from CBR – The modified sub-grade reaction is obtained from the graph which shows the modulus of sub-grade reaction from CBR and Modified k-value as shown in figure 4.2.

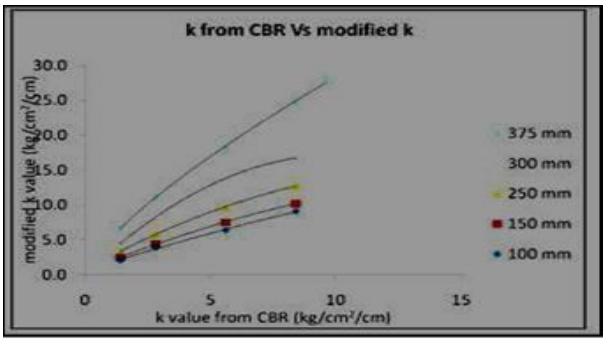

Figure 5.2: k-from CBR Vs modified k

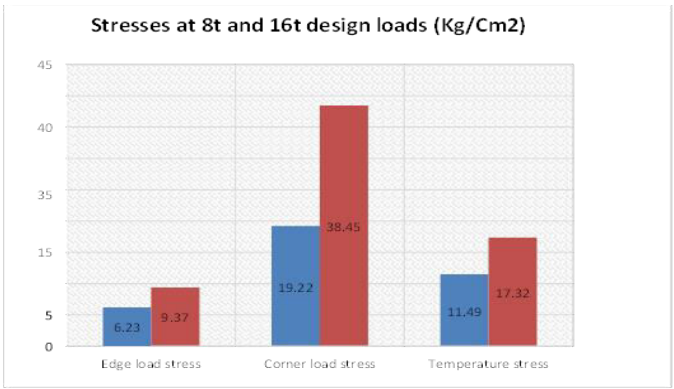

Figure:-5.3analysis of stresses

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Table 4.4: Pavement Distress measurements

Type of Distress	Depth (mm)
Pot holes (average)	103.5
Rutting	32

Type of Distress	Length
Corrugations	6m

Comparison between IRC and AASHTOmethods:

This represents the comparison between the both the methods that is IRC and AASHTO methods in obtaining the thickness of overlay in the form of bar graph as shown below in figure 4.6. As the ultra-thin white topping is a PCC overlay constructed less than or equal to 100mm thickness, So, by analysis of both the methods the IRC method shows the economical for designing of Ultra-thin whitetopping.

V CONCLUSION

The use of ultra-thin white topping improves performance i.e., (no rutting or wash boarding) and also ability to maintain surface grade- many installers mill off the amount of asphalt that will be replaced by the UTW so that they don't change the surface grade. And also white topping offers competitive with other resurfacing methods. This rehabilitation option has been used for many years on airport pavements, highways, secondary roads and other pavements.

Keys to ultra-thin white topping performance are adequate (HMA and Soil) support layers, PCC-HMA bond essential, slab size and joint spacing, Concrete material selection and design input (traffic, layer thickness, climate, etc.,). Its main advantage is to improve the structural capacity, reacts structurally as if on strong base course, it avoids reconstruction process when minimal rain delays and maintains traffic on existing surface. This ultra-thinwhite topping is safer in visibility (decreasing stopped sight distances, non-rutting, less work zone reconstruction and causes less accidents, etc.,). Effective concrete thickness quantifies the load carrying capacity of the UTW pavement, variation of the structural capacity as a function of distance along the roadway, and potentially the condition of the concrete–asphalt bond interface and the underlying asphalt concrete layer.

The following conclusions are made on the pavement design i.eultra-thin white topping in pavements. They are as follows

i. As the design load increases from 8t to 16t edge, corner and temperature stresses are increasing.

ii. As corner stresses is maximum it is considered as a crucial stress in thedesign.

iii. The design overlay thickness using IRC is 10cm and AASHTO is 25.4 cm. So the thickness adopted by using IRC method iseconomical.

iv. For the overlay thickness of 10 cm, as the design load is increased from 8t to 16t stresses are not within the

permissible limits which indicates that ultra thin white topping can only be used for trafficareas.

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