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Experimental Study on Ultra-Thin White Topping Use in Village Road

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ABSTRACT

Road traffic is increasing steadily over the years. This is an international phenomenon.An international forecast predicts that such increase will continue in near future. Even in case of 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 position in the context of a developing country like India is obviously far worse.As a result, more and more roads are deteriorating.The proper strengthening and maintenance of roads is urgently required to ensure balanced regional development and alleviation of poverty as they connect the villages and other small town centres harbouring backwardness. A majority of these roads do not have traffic worthy pavement. 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. These bituminous pavements, in general, have a problem that they get deteriorated with time. Most of our roads exhibit, in general, the following deficiencies:

- ✓ Rutting
- ✓ Fatigue cracking
- ✓ Shoving
- ✓ Ravelling
- ✓ Pot holes

History

White topping- a relatively thin concrete overlay placed a top distressed asphalt created a need not only for the construction of new highways but also for the maintenance and rehabilitation of existing highway networks. Pavements are prone to damage due to the repeated wheel loads as well as temperature and other environmental effects. Instead of rehabilitation of Bitumen/Asphalt road by filling bitumen for better durability they must be rehabilitated by UTWT. UTWT is a technique which involves placement of a thinner (than normal) thickness ranging from 55 to 100 mm thickness with closely spaced joints and bonded to an existing bitumen/asphalt pavement. The application of UTWT has been targeted to rehabilitate deteriorated bitumen/asphalt pavements with fatigue and or rutting distress.

However this technique is giving good results in the city areas but not frequently used in rural areas where the deterioration of the road takes place in every Monsoon, which result in heavy maintenance cost and discomfort for the passenger travelling through such roads.

Keywords: Higher Grade Cement, Aggregate, River Sand/Crushed Sand, Fibre, Admixtures

I. INTRODUCTION

1.1 General

Road traffic is increasing steadily over the years. This is an international phenomenon. An international forecast predicts that such increase will continue in near future. Even in case of 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 position in the context of a developing country like India is obviously far worse. As a result, more and more roads are deteriorating. The proper strengthening and maintenance of roads is urgently required to ensure balanced regional development and alleviation of poverty as they connect the villages and other small town centres harbouring backwardness. A majority of these roads do not have traffic worthy pavement. 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. These bituminous pavements, in general, have a problem that they get deteriorated with time. Most of our roads exhibit, in general, the following deficiencies:

- ✓ Rutting
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- ✓ Pot holes

1.2 History

White topping- a relatively thin concrete overlay placed a top distressed asphalt pavement was introduced in the United States in 1918 and its use has continued through today. In1988 thin concrete overlay of thickness about 90mm was placed on existing asphalt pavement in Kentucky. The performance of outstanding in early 1991, a new form of white topping named as thin white topping (TWT) and ultra-thin white topping (UTWT)

(UTWT) emerged, which relies on a bond with the distressed pavement to act as a monolithic structure. From 1990 to 1996 more than 800 projects representing 1 million sq. m have placed in North America. The first bonded white topping sections were constructed in October of 1997 by the Minnesota Department of Transportation (Mn/DOT) on I-94 test sections at the Minnesota Road Research facility (Mn/ROAD).[3]

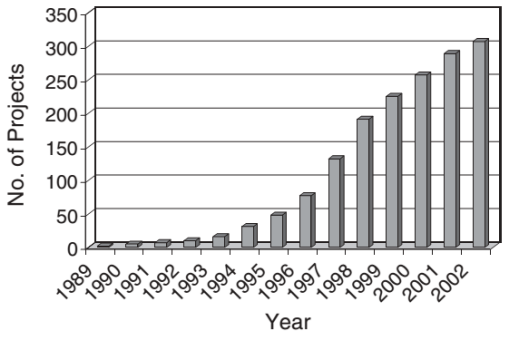

Figure 1. The progress in the adoptions of UTW technology in the USA[10]

White topping in its various forms have been used in U.S.A, Europe and other countries on Airports, Inter-state roads, Primary and Secondary Highways, Local roads, Streets and Parking lots. There have been several UTW projects completed in India, the first in Pune in 2003, subsequently in New Delhi, Ghaziabad, Mumbai, and Thane. All projects have shown good to excellent performance so far, indicating that this rehabilitation strategy can stand up to the Indian climate and traffic conditions. The suitability of UTW rehabilitation for a particular site is dependent on several factors including existing asphalt thickness, volume of truck traffic, base and subgrade support, and pavement condition.

Table.1 UTW Overlay Projects in India.

Sr. No.	Year	Location	Thickness (mm)
1.	2003	Pune (In front of P.M.C Office)	125
2.	2004	New Delhi (CRRI campus road)	40-75
3.	2006	New Delhi (Moolchanel and prembary under pass)	125
4.	2006	Ghaziabad (campune road of HRD Pune)	50
5.	2006	New Delhi (NDMC Office campus road at Parliament street)	100
6.	2006	New Delhi (Meetha Pur, Badarpur)	125
7.	2007	Mumbai (Mahul Road)	100
8.	2008	Thane (In Gaothan area)	125
9.	2009	Pune (Dahanukar colony, Kothrud)	125

1.3 Objective

1. To study the present condition of existing pavement and suitability regarding laying

of ultra-thin white layer.
2. To design and analysis of ultra-thin white topping layer as per IRC SP 76 2008.
3. To do economic analysis to compare and suggest suitable type of overlay in a village.

1.4 Scope of the project

A design procedure for Ultra-Thin White topping based upon research being conducted by agencies and concrete industries. This will also provide a better understanding of joint spacing requirement for thickness, traffic and environmental conditions. The specific requirements such as synthetic fibers in the mix for various traffic conditions or the absence of fibers under certain design conditions will be determined.

Common use of Ultra-Thin Whitetopping as a pavement rehabilitation and maintenance overlay technique. A composite pavement design with Ultra-Thin White topping as the surface course for improved light reflectivity and coolness in urban area. At the current juncture, when India has embarked upon massive programmers to upgrade its road infrastructure, we suggest that the adoption of TWT and UTW may be considered as an alternative to the rehabilitation with hot-mix asphalt. To begin with, some experimental stretches using these techniques may be laid immediately for gaining experience and confidence.

1.5 Organization

Chapter 1 consists of the present condition of the roads in India and general introduction of UTWT ultrathin white topping road its objectives and scope of UTWT.
Chapter 2 consists of literature review base on various methods of rehabilitation used across the world, the load transfer mechanism of the conventional and UTWT roads, Research and case study on Bitumen Overlay and UTWT overlay.
Chapter 3 consists of methodology having the information on the survey carried for the Design of UTWT and the Construction Practices done for the UTWT.

II. LITERATURE REVIEW

2.1 Introduction

In this chapter the various methods of rehabilitation of the existing pavement and the difference of the basic load transfer mechanism in Conventional overlay & UTWT, to understand behaviour of the UTWT pavements under loads and the distribution of the stresses in road has been explained. Various case studies has been studied to get the basic idea of the UTWT road with respect to the methodology, importance and its various characteristics over the other rehabilitation method.

2.2 Methods of rehabilitation of existing pavements

2.2.1 Pavement Reconstruction
It is the process in which whole road is reconstructed. Reconstruction is necessary in certain situation when there is/are:

- ✓ No redeemable pavement life
- ✓ Major subgrade correction
- ✓ Changes in the road way geometrics
- ✓ Planning and development of the pavement

2.2.2 Recycling Operations

In this type of rehabilitation method recycle materials are given first consideration during the selection of materials. Which makes the methods economical and environment friendly. Recycling reduced raw materials cost and also helps in level deformation and re-establishment of crowns. Recycling method id adopted when the pavement at end of its serviceable life. There are two types of the Recycling Operations mainly carried for the Rehabilitation of Existing Roads:

Cold in-place Recycling (CIR).

This is the on-side rehabilitation of asphalt pavement without the application of heat during recycling. Cold In-Place Recycling interrupts the existing cracks pattern produces cracks free layer for the new wearing course. Cold In-Place Recycling used when the engineering design required milled materials needs to be screened be of uniform sized and fully mixed in pugmil.

Full Depth Reclamation (FDR).

The full thickness of asphalt pavement and a predetermined portion of

the sub-base and subgrade is uniformly pulverised and blended to provide a homogeneous material. If new material is used not a sufficient base for anew surface course, the reclaimed materials are stabilised by the mechanical, chemical or bituminous means.

2.2.3 Bituminous Overlay

A new bituminous surface is paved over an existing bituminous pavement. There are two types of bituminous over bituminous overlays.

There are mainly two types of bitumen overlay depending on the purpose of the rehabilitation they are classified as:

Structural Overlay

In this overlay a thicker mat is used to increase a pavement strength of rehabilated road due to used of mat or grids. This type of overlay method is used in situation where the strength of the existing road is to be increased.

This type of road provides good subgrade and base but the thickness achieved is inadequate.

Non Structural Overlay

It is overlay generally used for a short term fixing of damaged road. This method of overlay is the basic method in this the normal defects such as potholes, rutting's, revelling are repaired. Due to use of good construction materials a good subgrade, base and cross section can be achieved. With an adequate strength where short term fix is acceptable.

2.2.4 Concrete Overlay

It is generally a concrete layer overlaid on the existing bituminous with or without the bonding between the existing bitumen pavement and the overlay concrete. The concrete overlay is classified on the basis of the thickness of the overlay, they are classified as:

i. 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).

ii. 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.

iii. 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 chiselled. Joints are provided at a spacing of 0.6 to 1.25 m.

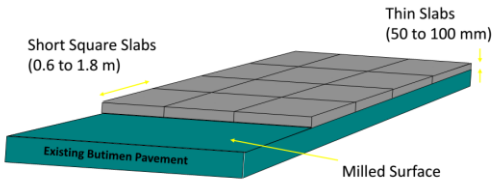

Figure 2. 3D view of Ultra-Thin White Topping

Table.2 Comparison between Bitumen, Conventional white topping & UTWT.

Sr. No.		Bituminous road	Conventional road	Ultra-thin white topping
1	Strength	Less strength	More strength as compared bituminous road and less strength as compared ultra-thin	More strength
2	Cost	Less costly	More cost as compared bituminous road and less cost as compared ultra-thin	More costly
3	Durability	Less durable	More durable	More durable
4	Life span	Less life span	More life span	More life span
5	Thickness	Large thickness provided	Less Thickness is provided nearly200mm.	Less thickness provided is 100mm
6	Surface	Not provide better riding surface	Provide better riding surface but not more better than ultra-thin	UTWT provides better riding surface which ultimately improves fuel efficiency of vehicles.
7	Maintenance	More maintenance	Less maintenance	Less maintenance
8	Environmental friendly	Not	Yes	Yes

Advantages Of Utw

- ✓ Economical cost.
- ✓ High standard of surface texture giving good skid resistance and reduced water spray.

- ✓ Reduced noise levels compared to dense-graded asphalt and sprayed seals.
- ✓ Good ride qualities.
- ✓ Flexible and tolerant to surface deflections.
- ✓ Assists waterproofing of the underlying surface.
- ✓ Thin layer reduces the need for cold planning, etc. to match adjoining surfaces.
- ✓ No loose aggregate such as in a spray seal

Disadvantages Of Utw

- ✓ Higher cost than sprayed seal.
- ✓ Effective treatment may require preliminary regulation and SAMI treatments.
- ✓ Low shear resistance may make it unsuitable in areas of high shear forces.
- ✓ Use of such innovation in concrete technology and batch making can lead to fast-track construction.
- ✓ The maintenance cost will be reduced.

III. CONCLUSION

Ultra-Thin Whitetopping overlay has been designed for the existing distressed HMA pavement for the roads at Asangaon Station, Shahpur, Thane, M.S. (India) as rehabilitation option. UTW overlay has been considered as best alternative in this case because these roads are subjected to moderate flow of traffic, having sound substrate of the HMA. Following conclusions can be drawn from the literature review carried out during this study and the experience gained during the planning of this UTW overlay:

1. UTW is used for airports; interstate, primary and secondary highways; local roads and streets; and parking lots to improve the performance, durability, and riding quality of deteriorated flexible pavement surfaces. Intersections with severe bituminous concrete rutting, or related distresses, can be successfully rehabilitated with an ultra-thin whitetopping.
2. IRC: 58 – 2002 and IRC: SP: 76 – 2008 are more realistic design guidelines than any other guidelines for Indian and traffic and climatic conditions.
3. UTW is an alternative that restores safety to the roadway, has a competitive cost, and creates minimum traffic disruption. Timely construction and proper staging of the project can minimize delay and burden to the facility users.
4. Fiber addition to the concrete mix enhanced durability of UTW overlay. It did not retard cracking and enhanced integrity across cracks.
5. Joint spacing should be minimum to prevent slab cracking due to curling stresses.

International experience on whitetopping is encouraging. Countries like France, Belgium, U.S.A., U.K. etc. have successfully designed and constructed whitetopping and their performance is satisfactory. But for the country like India this is an upcoming technology, therefore it is necessary to construct few trial sections using indigenous materials and techniques. Carrying out long term performance evaluation of the same is necessary to develop this technique for Indian traffic and climatic conditions.

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