Journal of Structural and Transportation Studies
Volume 1 Issue 3

White Topping In Roads: Review

[1]Prof. Shrikant Harle , [2]Prof. Prakash S. Pajgade

[1]Assistant Professor, Department of Civil Engineering, Prof. Ram Meghe College of Engineering & Management, Badnera.

[2]Professor, Department of Civil Engineering, Prof. Ram Meghe Institute of Technology & Research, Badnera

Email: [1]shrikantharle@gmail.com, [2]ppajgade@gmail.com

Abstract

In India the roads get deteriorated many a times because of using improper way of construction of bituminous roads. The whitetopping technology is very useful in such situations as the construction of another bituminous layer shall be costly and the life of the roads shall be very short. Therefore this technology is being used in India at a faster rate in many cities. This has many benefits like low cost as compared to the concrete roads, low maintenance, etc. In the comparatively low traffic roads get better advantage of this technology. Several researchers have contributed in this field and found to be successful. The type of whitetopping includes conventional, thin and ultrathin whitetopping depending upon the thickness of the road which varies from four to ten inches. As this concrete layer has to be laid upon the distressed bituminous layer this can be considered as bounded and unbounded. Researchers have found that these are alternative solution for light to moderate traffic roads.

Keywords : *White Topping, Asphalt concrete overlay, ultra thin white topping, thin white topping, bituminous overlay*

INTRODUCTION

GENERAL

The world is gaining more attention in the concept of sustainable development as the climate change and global warming is being the important issue nowadays. Since the concept of whitetopping involves the use of the thin layer of concrete and therefore it utilizes fewer raw materials, contribute towards the sustainability. This technology also contributes to minimization of the waste. Since most of the existing and worn out bituminous or asphalt pavement serves the base layer for

the whitetopping and therefore it totally eliminates the cost and the process of tear up the asphalt and throw away [1,2].

LITERATURE SURVEY

Jain et al. (2005) attempted to create road deterioration models contained inHDM-4 to model the complex interaction between vehicles, the environment and the pavement structure and surface. This study attempted to calibrate the HDM- 4 pavement deterioration models for a National Highway Network located in Uttar Pradesh and Uttaranchal states of India. To test the efficiency of the calibrated model, models have been validated that can be adopted for prediction of distress and development of maintenance management strategies for the Indian National Highway network. As per IRC: SP: 76-2008, White topping is classified into three types. Conventional White topping It consist of a PCC overlay of thickness 200 mm or more (on the top of the existing bituminous layer) which is designed and constructed without consideration of any bond between the concrete overlay and underlying bituminous layer. Thin White topping PCC overlay of thickness greater than 100mm and less than 200mm is classified as Thin White topping. The bond between the overlaid PCC and underlying bituminous layer is often a consideration but is not mandatory.

Goel and Das (2003) discussed about the design principles, construction,maintenance and experience of Ultra-Thin White topping technology. A schematic diagram of Ultra-Thin White topping is given in Fig 1.

Sinha et al (2007) attempted to bring forth the concept of White topping. Theactual cost savings per kilometer wise in case of Ultra-Thin & Thin White topping are demonstrated. The Paper concluded based on analysis that White topping with the thickness between 100 mm to 250 mm can be used in rehabilitating our large network of existing bituminous roads having low to moderate traffic [3-5].

TYPES OF WHITE TOPPING

It is seen that PCC overlay of white topping can be of two types, namely, bounded type and un-bonded type. These are similar to un-bonded type except that in such cases PCC overlays are laid directly on the existing bituminous pavement without much of surface preparation [6-8].

Bonded Types

Ultra ThinWhitetopping is an example of bonded type. These are used at locations

like intersections, round-abouts, parking lots etc. Bonding of PCC overlay to the underlying bituminous pavement surface is done by mechanical process known as milling, which achieves the monolithic behavior of the two layers. It is a very economical and efficient means of enhancing the structural capacity of the bituminous pavement. The only disadvantage to bonded type is that, if it is laid on a badly cracked surface the cracks will reappear. Thus the removal of such cracks on bituminous road is compulsory.

One of the pre-requisite for the construction of PCC overlay is the uniform support condition of the PCC Overlay on the existing surface. In the absence of uniform support condition, satisfactory performance of any concrete pavement including overlay like White topping cannot take place. Most of the premature PCC overlay failures are observed due to violation of this single requirement i.e. lack of uniform support.

On the basis of degree of bonding and thickness of overlay white topping can be classified as below:-

i)Conventional White topping – which consists of PCC overlay of thickness 200mm or more, which is designed & constructed without consideration of any bond between existing overlay &underlying bituminous layer (without assuming any composite action). Similar to a new concrete White topping pavement it can be directly laid on the existing bituminous pavement without much surface preparation. Thickness usually is equal to or more than 200 mm. However, Thin White topping and Conventional White topping do not have a very rigid demarcation line and a thickness between 150 mm to 250 mm is quite common.

ii) Thin White topping (TWT) – Thin White topping is in the middle of conventional and Ultra-thin White topping and accordingly can be used on bituminous roads having light to moderate traffic. which has PCC overlay between 100 – 200mm. 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 than100 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.

Un-bonded type

Thicker PCC overlays of un-bonded type commonly known as Conventional white topping can be used on deteriorated bituminous pavements. This type of white topping is suitable for strengthening of distressed bituminous pavement on moderate to heavy trafficked roads. In India stage construction has been adopted for the bituminous pavements. All these pavements, which have now become badly due for strengthening, are the potential candidates for White topping. Conventional White topping is known to extend the life of bituminous pavement by 20 to 25 years. Technically they are similar to a newly laid concrete pavement except that bituminous surface is the sub-base instead of Dry Lean Concrete (DLC) and no separation membrane or bond breaking film is provided.

Benefits of White topping

It does not develop any cracks as develops in a bituminous roads, repair is easy, it improves safety conditions, it is less affected by seasonal variations, and it provides high level of serviceability. Moreover, construction of white topping is quick and convenient. Existing pavement can provide support, there is no need for extensive pre-overlay preparation, normal paving systems can be used, and overlaid pavement can be opened to traffic quickly.

Feasibility of White topping

White toppings can be applied to almost all existing pavements. In certain conditions, it is more cost effective than an AC overlay. From the research paper it is found that, white toppings are generally not feasible under the following conditions:

1. When the existing AC pavement is not highly deteriorated and other alternatives would be more cost effective.
2. When there is not adequate vertical clearance to accommodate the white topping.
3. When the existing AC pavement is prone to settlement and requires removal of the AC layer and stabilization of base layer.

Factors that should be considered in evaluating overall feasibility of white topping are listed in Table 1.

METHODOLOGY

PCC mixtures used in UTWT are often high strength and high performance concrete. Considerations regarding the existing HMA pavement shall be evaluated by examining pavement deficiencies and the causes of

deterioration prior to the selection of the mix, grade of concrete and thickness of UTWT.

UTWT projects are generally constructed with concrete of mix having lower water cement ratio (<0.4). The slump requirement (75 – 100mm) for construction and placing and flow are achieved conveniently by the use of high range water reducers. The mixes may have high cement content (but not greater than 540 kg/m3). A typical mix proportion given in Table 2.maybe tried to achieve characteristic minimum compressive strength of M 50.

Material

As per Federal Highway Association, USA, Ultra-Thin White Topping is defined as a concrete product reinforced with synthetic fibers that restores deteriorated asphalt pavement that has sufficient structure, but a poor surface. Therefore, ultra-thin white topping may involves the use fly ash grade I, granulated blast furnace slag and silica fume, which are byproducts of thermal power plants, iron industries and Ferro-silicon industries respectively.

Application of these three mineral admixtures in concrete is specified in IS: 456-2000. By using these mineral admixtures, total heat of hydration is reduced. When these mineral admixtures used together, they improve the density of concrete due to particle packing theory. To improve the ductility of high performance high strength concrete, polymeric or steel fibers may be added in the concrete. As ultra-thin white topping requires very high strength concrete, so it is made up of high performance fiber reinforced concrete or ultra-high performance concrete, using special polymeric fibers up to 0.2% of steel fibers, additives, admixtures, very hard and smaller size aggregates (maximum 20mm) etc.

By using above mentioned materials in the concrete, there is improvement in toughness, long term mechanical properties, early high strength, ease of placement and consolidation, volume stability, longer life, less abrasion, least permeability, improvement in the interlocking of aggregate at the joints and bond between aggregate - cement mortar and existing bituminous layers etc. These properties are required for construction of Ultra Thin White Topping based on Indian Climatic conditions.

Design Parameters

The design process starts with the determination of structural performance

requirements and expected design life. Generally, the design process of White Topping consists of the following steps:

1. **Characterization of Existing Pavement**: The condition of the pavement is an important factor in the selection of a design process. It can be subcategorized into the following steps

i. **Surface condition**: The existing surface condition is important for both bonded and unbonded concrete overlays. The remaining pavement thickness after milling should be investigated, because this thickness needs to provide structural support of the new overlay. Depending on the surface distresses, the decision is made whether the overlay will be bonded or unbonded.

ii. **Structural condition:** Investigation into what structural support the existing pavement can provide is needed. Joint condition and inhibitors for load transfer are also determined.

2. **Traffic Characterization**: Pavement truck loads are accurately determined. Additional detailed information is also necessary for exact prediction of traffic, such as axle-load spectra, seasonal distribution of traffic, growth, and day-night duration.

3. **Concrete Materials**: Concrete strength, coefficient of thermal expansion, aggregate properties, supplementary cementitious materials, and admixtures should be considered carefully.

4. **Climatic Factor:** Climatic conditions during both construction and service life affect overlay behavior. Material should be compatible with weather conditions and joints should be provided depending on seasonal changes in pavement temperatures.

5. **White topping thickness**: Determination of white topping thickness reliability is the main factor. Reliability is determined depending on the importance of the roadway. After white topping thickness is selected, it is checked for overhead clearance, and 13 curb and gutter. Reduction of the existing AC thickness is also a factor at this stage.

6**. Joint Spacing**: In white topping, shorter joints are provided for reducing corner cracking and providing proper aggregate interlocking. The most common rule of thumb for white topping is the joint spacing (in inches) should be 12 to 18 times the slab thickness in inches. In many white topping projects, dowel and tie bars are provided to minimize movement along longitudinal joints, reducing the significance of joints.

7. **Transition Area**: During the design process, the transition area between the overlay and the adjacent Asphalt Concrete layer should be given proper

consideration. A thickened slab is recommended for these types of transitions.

Details of Construction

In order to achieve the desired advantages of concrete roads, three essential conditions need to be satisfied.

i) Production of concrete in a RMC plant or in a dedicated batching plant.

ii) Using either fixed form or slip form mechanical pavers.

Strict quality control at site including testing of fresh hardened and extracts specimens of concrete and tests on pavement quality.

COST ANALYSIS

From the reference of the Table 3, the savings in the initial cost of doing white topping against conventional bituminous overlay is evidently convincing. The comparison is based on a relatively crude analysis done on current cost basis without considering the likely variations in the future cost of bituminous materials and concrete materials. Higher cost of white topping is considered because of lower thickness and more number of joints than for conventional rigid pavement. This again goes against the cost assumed for white topping, because as per the present trend the likely futuristic variations in the cost of bitumen is expected to be more steep than those in concrete. The design of white topping particularly in UTWT & TWT scenario is relatively quiet conservative in terms of the expected capabilities of UTWT & TWT to carry heavier loads as compared to the corresponding capabilities of bituminous overlays.

The advantage of thinner white toppings is quite obvious in terms of cost savings due to small panel sizes. The advantage is apparently getting reduced significantly when the panel sizes are increased to 4.5 m x 4.5 m being typically adopted in case of concrete pavements constructed at present in the country. The temperature stresses with large panel sizes become quite large to leave room to accommodate load stresses. The thickness of such slabs is likely to be in the vicinity of 250 to 300 mm.

CONCLUSIONS

1. From the information reviewed, both thin white topping (TWT) and ultra-thin white topping (UTW) overlays have been used successfully on hundreds of projects worldwide. When designed and constructed properly, these types of overlays serve as an important option for hot-mix asphalt (HMA) rehabilitation.

2.Although TWT and UTW overlays cannot be used everywhere, they are available alternative for roads of light- to-moderate traffic, which still constitute a large percentage of the nation's highways.

3. Since white topping overlays were first used more than 80 years ago, a knowledge base has been developing. Through field trials under a wide range of conditions, best practices have emerged for design and construction of these overlays. This synthesis has identified many of these best practices.

4. White topping overlays, including UTW and TWT, have proven to be successful rehabilitation methods when used properly.

5. The performance of UTW and some TWT overlays are closely correlated with the characteristics of the support layers, especially the bituminous layer. If specific and careful consideration is not made toward characterizing the existing pavement system, the white topping overlay may be designed or constructed improperly.

6. For UTW and TWT overlays to continue to be considered a viable rehabilitation alternative, specifiers and designersshould recognize its limitations. As with other Portland cement concrete pavements, UTW and TWT overlays have their inherent benefits**.**

Table 1 *Summary of White topping Overlays*

(Source-Sharmin Sultana, KANSAS STATE UNIVERSITY Manhattan, Kansas.)

Particulars	Conventional white topping	Ultra Thin white topping
Typical Thickness	100 to 300 mm (4 to 12 m)	50 to 100 mm (2 to 4 m)
condition of existing pavement	All deteriorated HMA pavements	Low-volume deteriorated HMA pavements
Bonding Condition	Designed as unbonded, but some partial bonding occurs (and may enhance pavement performance)	Strong bond required between existing HMA pavement and new Pcc Overlay
Preoverlay Repair	Limited repair (failed areas only) Possible milling to correct profile	Repairs of areas unable to contribute to load carrying capacity Milling on HMA surface
Minimum Thickness of HMA	50 mm (2inch) (after any milling)	75 to 150 mm (3 to 6 inch) (after any milling)
Special Design and Construction Consideration	Adequate support critical to performance	Bonding with HMA pavement PCC mix design is often high strength

	Adequate Joint design (including joint spacing and load transfer) Placement of white wash on HMA surface on hot days	and/or fiber modified Extremely short joint spacing (typically between 0.6 and 108 m[2 to 6 ft)
PCC overlay Types	JPCP JRCP	JPCP

Table 2: *Typical mix proportions for UTWT*

(Source-Guidelines for the Design and Construction of Ultra-Thin White Topping, AnkitSharma)

SR NO.	Ingredients or Property	-
1	Cement 43 or 53 Grade	440.32
2	Coarse Aggregate	947.38
3	Fine Aggregate	59603
4	Total Air Content	0.5%
5	Polypropylene/polyester Fibre	0.88
6	Water/Cement Ratio	0.28
7	Water	170
8	Fly ash/granulated blast furnace slag	88.0
9	Silica Fumes	58.69

COST ANALYSIS

Table 3.*Comparative Cost Of Bituminous/Whitetopping Overlay(Per Km Basis)*

Source-WHITETOPPING - A COST-EFFECTIVE REHABILITATION ALTERNATIVE FOR PRESERVING BITUMINOUS PAVEMENTS ON LONG-TERM BASIS,

By V.K.Sinha

Scenario	Bituminous Overlay thickness	White topping type & thickness	Total coast of bituminous overlay I/c (Rs.)	Total coast of white topping I/c maintenance	Savings in white topping(Rs. Lakh)/(Rs.) % savings
I	90 mm BM	100 mm UTWT	53 lakh	42.69 lakh	10.31 Lakh (19.04%)
Ii	150 mm BM	150 mm TWT	107 lakh	85.26 lakh	21.74 Lakh (20.32%)
Iii	200 mm BM	200 mm conventional	141 lakh	98.64 lakh	42.36 lakh (30.04%)

REFERENCES

1. Jundhare, D. R., *Ultra-Thin White topping in India: State-of- Practice*, ACEE Int. J. on Transportation and Urban Development, Vol. 2, No. 1, April 2012.
2. *NCHRP Synthesis 204*, Transportation Research Board, 1994
3. Ramachandra, Dr. V. *WHITETOPPING–A Viable & Sustainable Option for Rehabilitation ofUrban Roads***,** *Zonal Head (Tech), UltraTech Cement Ltd., Bangalore*
4. Sharma Ankit (Department Of Civil Engineering ,*Guidelines for the Design and Construction ofUltra Thin White Topping*, DeenbandhuChhotu Ram University Of Science AndTechnology,Murthal (Sonepat)-131039,Haryana,INDIA)
5. SINHA, V.K., STANDER KUMAR & RAKE. White topping - a cost-effective rehabilitation alternative for preserving bituminous pavements on long-term.

6. Sultana, Sharmin, B.S., Bangladesh University of Engineering and Technology, 2007,A Thesis submitted in partial fulfillment of the requirements for the degree master of science, Department of Civil Engineering College of Engineering, KANSAS STATE UNIVERSITY Manhattan, Kansas 2010.
7. *U. S. Department of Transportation Federal Highway Administration*, 2002, Technical Brief Conventional White topping Overlays, Publication No. FHWA-IF-03-008, May 2002
8. *US. Department of Transportation Federal Highway Administration*, 2002, Technical BriefBonded Cement Concrete Overlays, Publication No. FHWA-IF-02-009, May 2002