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"Ultra White Thin Topping"

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Abstract: *Ultra-Thin White topping (UTW) is a technology to construct 50-100mm thick cement concrete overlay on distressed asphalt pavement as a rehabilitation technique. There have been several UTW projects completed in India, the first in Pune, 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 sub-grade support, and pavement conditions. This paper outlines the state-of practice in India for construction of UTW considering mix traffic, extreme climatic conditions, use of indigenous materials and design aspects as per Indian Road Congress (IRC) guidelines.*

Keywords: *Deflection, Hot Mix Asphalt, Stress, Ultra- Thin White topping*

I. INTRODUCTION

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

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 nonimpactscrapper) or gently chiseled. Joints are provided at a spacing of 0.6 to 1.25 m.

White topping is stronger than asphalt overlay, and thus more resistant to rutting and surface initiated cracking. Consequently, white topping pavements pose potential economical and technical benefits. 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 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.

1.1Research problem

Design and analysis of Ultra thin White Topping by using ANSYS software.
We are going to reduce the layer thickness of topping so as to achieve economy in project.

II. Objectives of research work

2.1 To study the present condition of existing pavement and suitability regarding laying of ultra thin white layer.
2.2 To do various types of testing on existing bitumen pavement to obtain the good design.
2.3 To design the ultra thin white topping with fibers so as study the effect of fibers on strength.
2.4 To design and analysis of ultra thin white topping layer on ANSYS software.
2.5 To do economic analysis to compare and suggest suitable type of overlay.

III. Literature review

3.1 "Ultra-Thin White topping in India: State-of- Practice"
By: D. R. Jundhare, K.C. Khare, and R. K. Jain
This paper outlines the state-of practice in India for construction of UTW considering mix traffic, extreme climatic conditions, use of indigenous materials and design aspects as per Indian Road Congress (IRC) underlines.

3.2 "Assessment of Wisconsin's white topping and ultra thin white topping project"
By: Haifang Wen, PhD, P.E., Xiaojun Li, Wilfung Martono
The primary objectives of this study are to catalog the white topping (WT) and UTW projects in Wisconsin, document pertinent design and construction elements, assess performance and estimate a service life of these projects. A comprehensive literature review was performed. A database of the WT and UTW projects was established covering 18 projects built from 1995 to 2007 in Wisconsin.

3.3 Synthesis of Current Minnesota Practices Of Thin and Ultra-Thin White topping
Author: Chunhua Han, Ph.D., P.E. Braun Intertec Corporation
This paper outlines what has been done and what has been learned:

4.3.1 When and when not to use thin and ultra-thin white topping,
4.3.2 Which type of white topping fits best,
4.3.3 How to choose materials, thickness, joint spacing and other physical design
4.3.4How to choose construction techniques, and
4.3.5 Risks associated with this rehabilitation process.

3.4 "Pavement Rehabilitation Through Ultra-Thin White topping (UTW) Overlays"
Author: Dave Amos, Intermediate Research Assistant, Missouri Department of trans.
The objective of this study has been to determine the feasibility of placing an ultra-thin white topping (UTW) overlay as a viable pavement rehabilitation method on low to medium volume asphaltic concrete (AC) pavements where rutting or shoving or both have become a problem, particularly at urban intersections. The procedure of milling and overlaying with asphaltic concrete is the least expensive and most commonly used practice in these areas.

3.5 "Performance Evaluation of Ultra-thin White topping in India by BBD Test"
Author: D. R. Jundhare, Dr. K. C. Khare; and Dr. R. K. Jain
This paper give information about performance evaluation of ultra thin white topping in Pune city by using BBD test.

IV. Project planning

4.1 Methodology/ Laboratory Work:

5.1.1 Selection of suitable site for case study.
5.1.2 Physical feasibility survey of site.
5.1.3 Traffic analysis of selected site and collection of data regarding volume study.
5.1.4 Then carrying out benkelman beam deflection test on existing asphalt pavement
5.1.5 Determination of subgrade reaction value (k) from deflection test results.
5.1.6 Design procedure of UTW is carried out as per IRC 58;2002 guideline and SP 76;2008.
5.1.7 Calculation of temp. stress and wheel load stress according to IRC37 guideline
5.1.8 Concrete mix design it is carried out as per IS456,IS19262,IRC44;2008.
5.1.9 Design and Analysis on ANSYS software.
5.1.10 Finalization of layer thickness and its feasibility.

4.2 Outline Of Project Work

SR.NO.	NAME OF WORK	TIME PERIOD
1	Selection of site	August
2	Physical feasibility survey	September
3	Collection of traffic data and analysis	October
4	Carrying out Benkelman beam deflection test on selected pavement	December
5	Calculation of Subgrade reaction k with help of deflection test results	January
6	Stress calculations	January
7	Preparing the design	February
8	Design and analysis of UTW by ANSYS Software	March
9	Finalization of layer thickness and its Feasibility	March
10	Submission of Report	April

1. Project Survey

6.1 Details Of Site :

6.1.1	SELECTION OF SITE	:	DATE -11/09/2015
6.1.2	NAME OF SITE	:	INFOSYS CHOWK TO MAANGAO
6.1.3	LENGTH OF ROAD	:	3.0 KM
6.1.4	LENGTH OF STRIP	:	1.5 KM
6.1.5	CARRAIGE WAY	:	6.0 Meters
6.1.6	CONDITION OF PAVEMENT	:	POOR

6.2 CAUSES TO SELECT THE SITE FOR ULTRA THIN WHITE TOPPING:

6.2.1 ROAD CONDITION: Road condition of selected site is poor . During observation it was found that so much rutting of surface course took place. Cracking also observed. During survey potholes also observed. This all shows that existing bitumen road is distressed which is main condition for ultra thin white topping.

6.2.2 TRAFFIC DENSITY: By observation it is observed that lots of heavy vehicles are going every day and there are lots of commercial vehicles also going on that road.

6.2.3 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.

6.2.4 MAINTENANCE: Due to heavy vehicles and regular traffic ,road is distressing periodically and Which directly increasing the maintenance cost. So to reduce the maintenance cost and increase the durability there is need to adopt some new rehabilitation techniques is needed that is Ultra thin white topping.

2.Physical feasibility survey

Before starting the work or designing the ultra thin white topping layer what is needed to first observe the condition of road . For this our project group conducted the physical feasibility survey. The length of road considered for the survey is 2.0km. We took details for every 60.00 m chainage. Data collected shown in Table No.01 and Table No.02.

Table No:01 Physical Feasibility Survey

Sr. No.	Chainage	Rutting (mm)	Cracking	Pot Hole (cm)
01	000 m To 060 m	15	Major	3(30*44*15)
02	060 m To 120 m	10	Major	None
03	120 m To 180 m	10	Minor	None
04	180 m To 240 m	00	Minor	2(10*14*10)
05	240 m To 300 m	12	Medium	None
06	300 m To 360 m	12	None	None
07	360 m To 420 m	10	Medium	2(40*30*12)
08	420 m To 480 m	10	Major	4(35*27*8)
09	480 m To 540 m	00	Minor	None
10	540 m To 600 m	12	Medium	None
11	600 m To 660 m	10	Major	1(20*15*10)
12	660 m To 720 m	15	Major	1(50*40*8)
13	720 m To 780 m	10	Medium	5(29*17*15)

Sr. No	Chainage	Rutting	Cracking	Pot Hole (cm)
14	780 m To 840 m	10	Major	None
15	840 m To 900 m	10	Minor	None
16	900 m To 960 m	00	Medium	None
17	960 m To 1020 m	10	Medium	None
18	1020 m To 1080 m	12	Major	3(17*13*10)
19	1080 m To 1140 m	12	Medium	None
20	1140 m To 1200 m	10	Major	None
21	1200 m To 1260 m	10	Major	9(45*60*14)
22	1260 m To 1320 m	00	Minor	None
23	1320 m To 1380 m	00	Medium	None
24	1380 m To 1440 m	13	None	5(30*33*11)
25	1440 m To 1500 m	11	Medium	None

3.Some site images showing physical feasibility survey:

8.1 RUTTING OBSERVED:

8.2 POTHOLES AND CRACKING:

8.3 WHILE DOING SURVEY:

4.Traffic data collection and analysis:

From this point actually design procedure starts ie. Collection of traffic data and its analysis. For this project we conducted 3 days survey of traffic in which only commercial vehicles counted. Traffic data collected in terms of only commercial vehicles per day (CPVD). Traffic data collected shown in Table No. 3,4,5,6,7&8.

Day 1 Infosys Chowk to Maangao Date: 05/10/2015

Table No.02

Time	Truck	Bus	Tempo	Mini Bus	Tractor	Total
7am to 8am	1	0	3	113	0	117
8am to 9am	0	2	5	130	1	138
9am to 10am	1	9	29	265	1	305
10am to 11am	8	16	32	221	3	280
11am to 12pm	6	8	15	285	3	317
12pm to 1:00pm	21	9	46	175	0	251
1:00pm to 2:00pm	40	10	43	177	2	272
2:00pm to 3:00pm	18	8	19	39	5	89
3:00pm to 4:00pm	19	10	19	171	1	220
4:00pm to 5:00pm	9	13	11	135	2	170
5:00pm to 6:00pm	7	14	9	100	1	131
6:00pm to 7:00pm	3	2	6	83	1	95

Total commercial Vehicles: 2385
Peak Time: 9:00 am to 11:00 am

Day 1 Maangao to Infosys Chowk Date: 05/10/2015

Table No.03

Time	Truck	Bus	Tempo	Mini Bus	Tractor	Total
7am to 8am	1	2	3	47	0	53
8am to 9am	5	4	7	70	1	87
9am to 10am	11	15	23	115	2	166
10am to 11am	12	12	29	72	2	127
11am to 12pm	4	8	21	123	1	157
12pm to 1:00pm	31	16	42	96	1	186
1:00pm to 2:00pm	64	14	30	105	1	214
2:00pm to 3:00pm	33	8	18	80	2	141
3:00pm to 4:00pm	13	4	19	110	4	150
4:00pm to 5:00pm	11	22	15	155	6	209
5:00pm to 6:00pm	15	8	14	192	1	230
6:00pm to 7:00pm	5	17	6	169	5	202

Total Commercial Vehicles = 1922
Peak Time: 5:00 pm to 7:00 pm
Total Commercial Vehicles Per Day On Existing Pavement = 4307

Day 2 Infosys Chowk to MaangaoDate 06/10/2015

Table No.04

Time	Truck	Bus	Tempo	Mini Bus	Tractor	Total
7am to 8am	0	0	4	75	0	79
8am to 9am	1	4	11	87	1	104
9am to 10am	1	8	24	270	1	304
10am to 11am	7	16	33	219	2	277

11am to 12pm	8	9	17	280	3	317
12pm to 1:00pm	11	7	40	170	1	229
1:00pm to 2:00pm	47	13	47	177	2	286
2:00pm to 3:00pm	25	17	23	48	5	118
3:00pm to 4:00pm	17	10	19	180	1	227
4:00pm To 5:00pm	13	8	13	135	3	172
5:00pm To 6:00pm	6	13	9	111	2	141
6:00pm To 7:00pm	2	2	6	83	3	96

Total Commercial Vehicles = 2350
Peak Time: 9:00 am to 11:00 am

Day 2 Maangao to Infosys Chowk Date 06/10/2015

Table No.05

Time	Truck	Bus	Tempo	Mini Bus	Tractor	Total
7am to 8am	0	2	2	47	0	51
8am to 9am	5	4	8	68	3	88
9am to 10am	11	15	17	115	2	160
10am to 11am	13	8	23	79	3	126
11am to 12pm	3	17	28	135	1	184
12pm to 1:00pm	35	16	47	88	0	186
1:00pm to 2:00pm	54	15	23	107	0	199
2:00pm to 3:00pm	48	8	18	85	3	162
3:00pm to 4:00pm	13	6	25	135	5	184
4:00pm to 5:00pm	20	21	17	138	6	202
5:00pm to 6:00pm	17	7	14	180	5	223
6:00pm to 7:00pm	8	18	7	170	1	204

Total Commercial Vehicles = 1969
Peak Time: 5:00 pm to 7:00 pm
Total Commercial Vehicles Per Day On Existing Pavement = 4319

Day 3 Infosys Chowk to Maangao Date 07/10/2015

Table No.06

Time	Truck	Bus	Tempo	Mini Bus	Tractor	Total
7am to8am	1	3	9	90	0	103
8am to 9am	2	4	11	160	1	178
9am to 10am	7	7	23	260	1	298
10am to 11am	7	16	27	221	3	274
11am to 12pm	6	8	17	297	1	329
12pm to 1:00pm	5	9	40	187	0	241
1:00pm to 2:00pm	40	13	47	77	1	178
2:00pm to 3:00pm	18	8	25	180	5	236
3:00pm to 4:00pm	19	11	37	137	1	205
4:00pm to 5:00pm	47	14	11	100	7	179
5:00pm to 6:00pm	7	15	17	88	6	133
6:00pm to 7:00pm	3	3	6	80	2	94

Total Commercial Vehicles = 2448
Peak Time: 9:00 am to 11:00 am

Day 3 Maangao to Infosys Chowk Date 07/10/2015

Table No.07

Time	Truck	Bus	Tempo	Mini Bus	Tractor	Total
7am to8am	0	4	8	77	0	89
8am to 9am	5	7	15	113	1	141
9am to 10am	11	13	23	117	2	166
10am to 11am	17	12	18	87	1	135
11am to 12pm	5	18	38	117	2	180
12pm to 1:00pm	33	17	45	118	1	214
1:00pm to 2:00pm	65	15	37	105	2	224
2:00pm to 3:00pm	33	18	18	107	3	179
3:00pm to 4:00pm	13	4	19	115	4	155
4:00pm to 5:00pm	17	22	14	192	6	251
5:00pm to 6:00pm	20	17	15	170	2	224
6:00pm to 7:00pm	7	18	6	180	5	216

Total Commercial Vehicles = 2174
Peak Time: 5:00 pm to 7:00 pm
Total Commercial Vehicles Per Day On Existing Pavement = 4622

V. Design traffic in terms of cummulative repitition:

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.

The following equation may be used to make the required calculation:

$$C = \frac{365 * A\left\{(1+r)^n - 1\right\}}{r}$$

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 for calculations;
Take
r = 7.0%
n = 10 years
A = 4416 value taken from Table.No.8
Table.No.8 Traffic data in terms of commercial vehicles per day

SR.NO	DAY 1	DAY 2	DAY 3	AVERAGE
1.	4307	4319	4622	4416

SOLUTION:

$$C=\frac{365 x 4416\,((1+0.07)^{\wedge}10-1)}{0.07} x\ 3.5$$

C= 77944662.19

Design traffic = 25% of the total repetition of commercial
vehicles =19486165.55
Here ,
F= Vehicle damage factor (number of standard axles per commercial vehicle)
F = 3.5 ----------------as per **IRC81-1997 Clause: 5.4.3**

VI. Calculation of deflection of pavemebt by using 'benkleman beam' apparatus:

Modulus of subgrade reaction (k-value) has been determined by conducting Benkelman Beam Deflection (BBD)on the surface of Hot Mix Asphalt (HMA). The maximum value of deflection obtained from BBD has been used to find out k-value.

Benkelman Beam Apparatus

Procedure:

10.1 The point on the pavement to be tested is selected and marked. For highways, point should be located 60 cm from the pavement edge if lane width is less than 3.5 m and 90 cm from the pavement edge for wider lanes. For divided four lane highway, the measurement points should be 1.5 m from the pavement edge.
10.2 The dual wheels of the truck are centered above the selected point.
10.3 The probe of the Benkelman beam is inserted between the duals and placed on the selected point.
10.4 The locking pin is removed from the beam and the legs are adjusted so that the plunger of the beam is in contact with the stem o(the dial gauge. The beam pivot arms are checked for free movement.
10.5 The dial gauge is set at approximately 1 cm. The initial reading is recorded when the rate of deformation of the pavement is equal or less than 0.025 mm per minute.
10.6 The truck is slowly driven a distance of 270 cm and slopped.
10.7 An intermediate reading is recorded when the rate of recovery of the pavement is equal to or less than 0.025 mm per minute.
10.8 The truck is driven forward a further 9 m.
10.9 Final reading is recorded when rate of recovery of pavement is equal to or less than 0.025 mm per minute.

VII. Conclusion

International experience on white topping is encouraging. Countries like France, Belgium, U.S.A., U.K. etc. have successfully designed and constructed white topping 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. We are suggesting the thickness of UTW by use of manual design and the ANSYS software

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