National Rural Infrastructure Development Agency
Ministry of Rural Development
Government of India

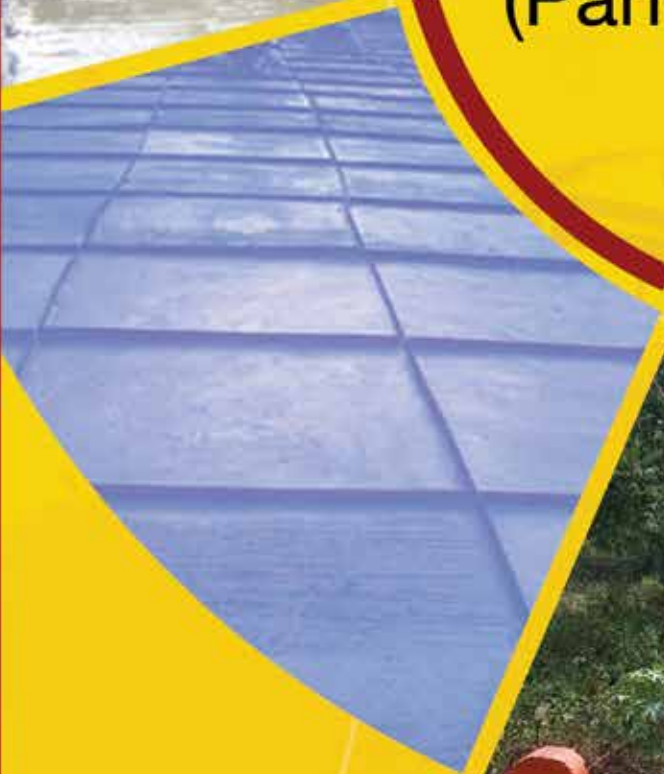
Azadi Ka Amrit Mahotsav

Pradhan Mantri
Gram Sadak Yojana

WHITETOPPING

(Panelled Concrete)

May 2022



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This document is for wide dissemination amongst the stakeholders connected with construction and maintenance of Rural (low volume) Roads, such as PTAs/STAs, Engineers, Quality Monitors, Contractors, Field Supervisors etc.

ग्रामीण विकास मंत्रालय राष्ट्रीय
ग्रामीण अवसरंचना विकास एजेंसी
भारत सरकार

Azadi Ka Amrit Mahotsav

प्रधान मंत्री
ग्राम सड़क योजना

साध्वी निरंजन ज्योति
मा० राज्यमंत्री ग्रामीण विकास एवं उपभोक्ता मामले, खाद्य और सार्वजनिक वितरण मंत्रालय, भारत सरकार

श्री गिरिराज सिंह
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श्री फग्गन सिंह कुलस्ते
मा० राज्यमंत्री
ग्रामीण विकास एवं इस्पात मंत्रालय, भारत सरकार

के प्रेरणादायी और कुशल नेतृत्व एवं मार्गदर्शन में
प्रधान मंत्री ग्राम सड़क योजना का सफल क्रियान्वयन हो रहा है।

यह योजना देश की ग्रामीण आबादी को सड़क संपर्क
उपलब्ध करा कर उनके चहुंमुखी विकास में सहायक सिद्ध हो रही है।

इस प्रकार ग्रामीण विकास मंत्रालय राष्ट्र निर्माण
के क्षेत्र में उत्तरोत्तर प्रगति के पथ पर अग्रसर है और निरंतर सफलता की
नई ऊंचाइयों को छू रहा है।

Shri Nagendra Nath Sinha, IAS
Secretary
Ministry of Rural Development
Government of India

MESSAGE

Rural road connectivity is a key component of Rural Development for promoting access to economic and social services. Pradhan Mantri Gram Sadak Yojana (PMGSY) plays a vital role in this direction and the roads constructed thereunder play an important role in increasing access to resources thereby mitigating poverty. Their continued existence is absolutely essential to achieve the intended objective. PMGSY was launched in the year 2000 with an objective of providing all-weather road connectivity to all eligible unconnected habitations in rural areas of country.

Aiming to cover upgradation of existing selected rural roads based on their economic potential and their role in facilitating the growth of rural market centres and rural hubs, PMGSY-II and PMGSY-III schemes were launched in 2013 & 2019 respectively. In the last 21 years, more than 7 lakh kms of rural roads have been constructed under the PMGSY. They have provided major fillip to the rural economy.

With a view to achieve optimal use of non-conventional materials and cost-effective environment friendly "Green Technologies" in the construction of PMGSY roads, the Ministry has come out with a New Technology Vision 2022 for use of new technologies in construction of PMGSY roads. Out of 112,930 km road length sanctioned under new materials/ green technologies till now, approximately 70,000 km road length has been constructed till 31st March 2022.

Whitetopping is one of those technologies that are being implemented on a large scale under PMGSY. Whitetopping can provide better serviceability, longer service life, lower life-cycle cost, and improved safety compared to the conventional concrete pavement. This technology can be a good long-term solution to the perpetual maintenance problem of the roads with poor drainage. I am sure this document on Whitetopping would help various stakeholders, such as state government departments, consultants, field engineers, implementers etc. for effective use of Whitetopping in the field.

Dr. Ashish Kumar Goel, IAS
Additional Secretary,
Ministry of Rural Development
& Director General, NRIDA
Government of India

FOREWORD

The Government of India, as a part of the poverty reduction strategy, launched the Pradhan Mantri Gram Sadak Yojana (PMGSY-I) on 25th December 2000 as a Centrally Sponsored Scheme to assist the states for construction of rural roads. The primary objective of the PMGSY was to provide all-weather road connectivity to the eligible unconnected habitations in the rural India. The mandate of PMGSY has been subsequently widened to include new interventions. PMGSY-II was launched in 2013, with a target to upgrade 50,000 km of the existing rural roads. Road Connectivity Project for Left Wing Extremism Affected Areas (RCPLWEA) was launched in 2016 for construction/upgradation of strategically important roads in the remote areas of the country. PMGSY-III was launched in 2019 for consolidation of 1,25,000 km through routes and major rural links connecting habitations to various socio-economic centres. Since inception till 31st March 2022, more than 7 lakh km road length has been completed under various verticals of PMGSY.

PMGSY has helped in better access of marketplace for the rural masses and generated employment in various forms. It has also helped in improving socio- economic condition of rural populace. An evaluation of Centrally Sponsored Schemes in Rural Development Sector, including Pradhan Mantri Gram Sadak Yojana was carried out by the Development Monitoring and Evaluation Office (DMEO) of NITI Aayog in 2020 and it was found that the scheme is well aligned with India's international goals and is seen to contribute to SDGs (Sustainable Development Goals) 2 & 9 as it addresses the issues of poverty, hunger and infrastructure for growth. Roads constructed under PMGSY have been observed to create positive impacts at the level of the household and community. Roads have impacted in increase access to market and livelihood opportunities, health and education facilities of people.

PMGSY has been pioneer in adopting new and green technologies in construction of rural roads. A new technology vision was formulated in 2013, and as a result more than 1 lakh km of roads have been sanctioned under PMGSY, which have adopted one or more new technologies. Recently, the adoption of new technology has seen an enhanced emphasis. A new Technology Vision 2022 is being adopted by the Ministry.

India being a developing country is required to have a road network which sustains for a longer life with less maintenance cost. Whitetopping (Panelled Concrete) is being adopted in PMGSY roads to fulfill these requirements. Whitetopping is a Portland Cement Concrete (PCC) overlay that is constructed on top of an existing bituminous road. Although, the initial cost of Whitetopping may be higher than the flexible overlay; however, in terms of life cycle cost Whitetopping is an effective and economic solution of overlay on existing bituminous pavement. Till 31st of March 2022, Ministry has sanctioned 4831 km of road length under Whitetopping.

This document has been prepared with contributions and suggestions of my NRIDA colleagues Shri B.C. Pradhan, Consultant Director (Technical), Dr. I.K. Pateriya, Director P-III, Shri Pradeep Agrawal, Director P-I, Shri Devinder Kumar, Director (P-II), Shri Satyendra Prasad, Joint Director (Technical), Shri Ashish Srivastava, Joint Director (Technical), Shri Sunil Kumar, Joint Director (P-III), Shri Navneet Kumar, Joint Director (P-I), Shri Pankaj Sharma, YCE, Shri Surendra Choudhary, YCE and Shri Galli Kiran Kumar, YCE.

I also acknowledge the immense contribution made by Shri Binod Kumar, Principal Scientist, CRRI, and Dr. U.C. Sahoo, Asst. Professor, IIT Bhubaneswar without whose support and vital guidance, it would not have been possible for us to produce this document.

Finally, I am grateful to Hon'ble Minister, Rural Development, Shri Giriraj Singh Ji for his tremendous encouragement and mentorship of new technology. I am thankful to Hon'ble Ministers of State, Rural Development Sadhvi Niranjan Jyoti and Shri Faggan Singh Kulaste for their constant guidance. I am indebted to Shri Nagendra Nath Sinha, Secretary, Ministry of Rural Development for his invaluable support in developing a vision and strategy for adoption of new technologies and innovative approaches in PMGSY.

CONTENTS

WHITETOPPING

1. INTRODUCTION

Whitetopping is defined as a Portland Cement Concrete (PCC) overlay constructed on the top of an existing bituminous pavement. Whitetopping is thus PCC resurfacing (overlay) as rehabilitation or structural strengthening alternative on bituminous pavements. The PCC overlay may or may not be bonded to the layer below.

Whitetopping is classified into two categories based on the types of interfaces (Bonded and Unbonded) and the thickness of overlay. These two distinct categories are given below:

1. **Conventional Whitetopping (CWT)**

   This consists of a concrete overlay of thickness 200 mm or more, designed and constructed without consideration of the bond between the concrete overlay and underlying bituminous surface.

2. **Thin Whitetopping (TWT)**

   This consists of a concrete overlay of thickness greater than 100 mm and less than 200 mm, usually designed and constructed with consideration of the bond between the concrete overlay and underlying bituminous surface (bonding consideration is not mandatory in all cases). In this type of Whitetopping, high strength concrete with fibres is commonly used and joints are provided at shorter spacing of 1m to 1.25 m. This is also known as panelled concrete. It can also be laid on a new water-bound macadam (WBM) or wet-mix macadam (WMM) layer.

In most cases, the presence of a bond between the new concrete and existing hot mix asphalt (HMA) layers has not been assumed during design; if a bond is created by milling, it would improve the performance of Whitetopping. The success of this bond, leading to composite action, has been found to be critical to the successful performance of this pavement-resurfacing alternative.

Rutting of bituminous pavement is a real problem in regions of hot climate like India, with heavy truckloads, operating under frequent start/stop conditions. Asphalt Concrete Pavement (APC) overlay is commonly applied where rutting of bituminous pavements is a recurring problem. Concrete overlays offer the potential for extended service life, increased structural and functional capacity, reduced maintenance requirements, and lower life-cycle cost when compared with bituminous overlay alternative. Details guidelines for design and construction of Whitetopping can be referred from IRC: SP:76-2015.

Concrete overlays have been used to rehabilitate both the existing bituminous (flexible) pavement since 1918 and existing concrete pavement since 1913. Whitetopping in its various forms has been used in USA and Europe in airports, inter-state roads, primary & secondary highways, local roads, streets and parking lots to improve the performance, durability and riding quality of deteriorated bituminous pavement surfaces. Whitetopping with 15-20 years of design life offer immense potential as a rehabilitation strategy for Indian roads. Several successful projects have been executed at Pune, Mumbai, Delhi, Nagpur, Jaipur and Bangalore in the last few years. The performance of these sections has been found to be satisfactory.

Conventional Whitetopping overlays are most appropriate for asphalt pavements that are extensively deteriorated. Thin Whitetopping should be used only when the condition of the existing bituminous surface is fair without wide cracks and material/sub-grade related problems. For most of the rural roads, thin Whitetopping overlay on the existing WBM layer or over an additional WBM layer can provide good riding surface for its design life.

2. BENEFITS OF WHITETOPPING (BOTH FOR CWT AND TWT)

Whitetopping on existing bituminous pavements provides many additional benefits as compared to the conventional bituminous overlay alternative. Some of the benefits are the following:

- Long life, low maintenance, low life-cycle cost, improved safety and environmental benefits.
- Bituminous overlays exhibit a more rapid loss of serviceability as compared to concrete Whitetopping at some critical locations. The life of successive bituminous overlays become progressively shorter after the first overlay.
- Deformation like rutting and cracking predominant in the case of bituminous pavements are normally absent with concrete surfaces of Whitetopping. This is particularly true in a hot region like India.
- Conventional Whitetopping improves structural capacity of existing bituminous pavement, if built on a strong base course, and it impedes structural distresses.
- Whitetopping requires much less maintenance and as such involves much less frequent lane closures of road, as compared to bituminous surfaces.
- Whitetopping is quite cost-effective to tackle annual budget constraints and high traffic levels. It is, therefore, relevant to Indian conditions.
- Whitetopping can uniformly fill ruts in the wheel path of bituminous pavements more effectively because concrete is far stiffer and more consistent at high temperature than bituminous mixes. Broadly, for similar reasons, the occurrence of cracks is also relatively much less in the case of Whitetopping.
- Concrete is relatively light in colour and hence concrete surfaces are more reflective to light, absorb less heat and reduce the "urban heat island" effect. Improved reflection of light 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.

3. IMPORTANT FEATURES OF WHITETOPPING

- Short panel size – 1 m x 1 m to 1.25 m x 1.25 m (for thin Whitetopping)
- Partial bonding with underlying asphalt layer

- Use of synthetic fibres (not mandatory)
- Dowel bars only at transverse construction joints
- Tie bars only at longitudinal construction joints
- Joint sealing (optional)

4. BEHAVIOUR MECHANISM OF WHITETOPPING

Thin Whitetopping overlays are designed on the principle of a composite pavement structure, which distributes traffic and environmental loading in a different manner than done in the case of conventional PCC or flexible pavement. In the case of such bonded system, due to the composite action between the concrete and flexible layer, the neutral axis shifts downward, with the result that much of the area of the PCC slab comes under compression (refer Figure 1). Therefore, a lesser thickness is required to carry the load than the conventional PCC layer.

FIGURE 1: Stress Distribution in Unbonded and Bonded Overlays

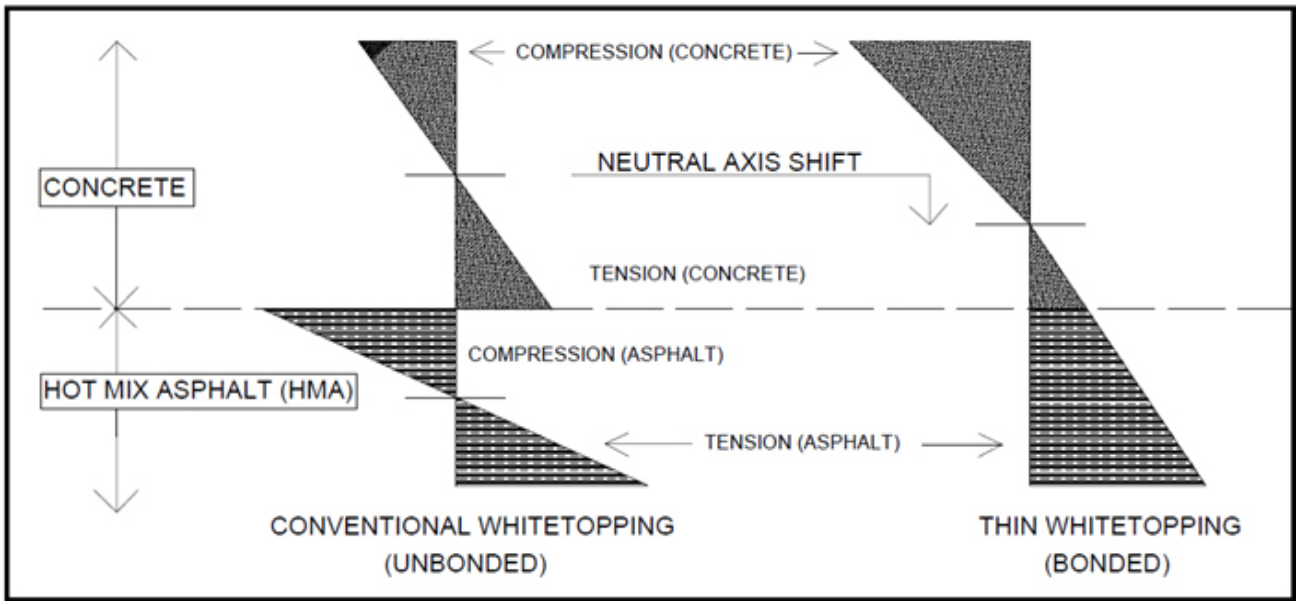
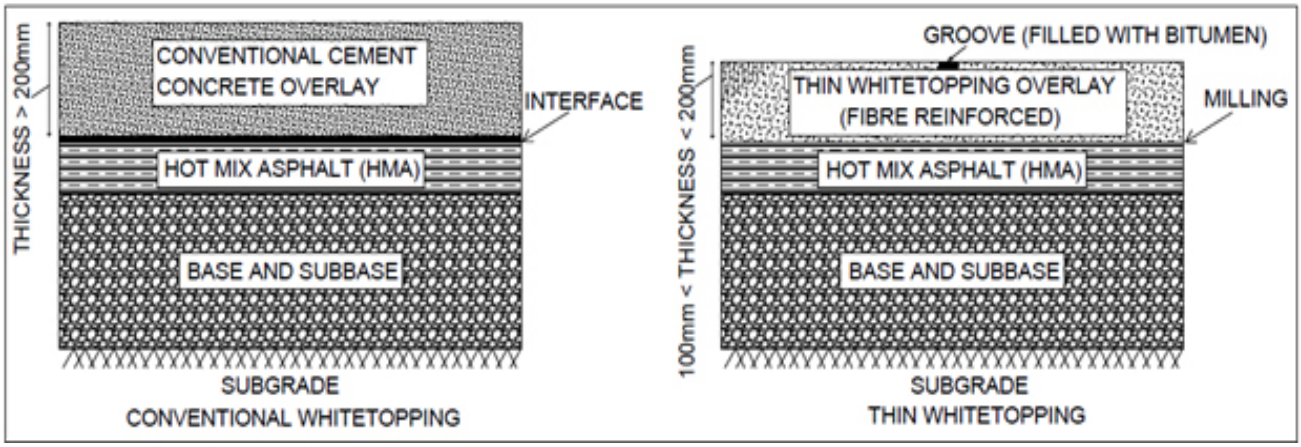


FIGURE 2: Typical Crust Composition of Conventional and Thin Whitetopping



5. DIFFERENT TYPES OF OVERLAYS ON EXISTING BT AND CC PAVEMENTS

On Existing BT & CC pavement both CC and Bituminous overlay can be done.

- Bituminous overlays require less construction time, which can reduce user costs during construction. However, it may not be the most economical solution for long-term rehabilitation. Because of their relatively short service life, bituminous overlays may require maintenance sooner than rigid overlays. And one of the more critical distresses that effectively determine the life span of the structure is reflection cracking.
- CC overlays are also placed on existing concrete surfaces, as rehabilitation/strengthening measure. Such overlays, even though used on experimental basis for rehabilitation of existing concrete roads are not called Whitetopping (as the existing surface is not bituminous).

I. Conventional Whitetopping Overlay (CWT)

Conventional Whitetopping is most appropriate for asphalt pavements that have excessive rutting, shoving, or alligator cracking because these problems are not easily corrected with a hot-mix asphalt overlay. Conventional Whitetopping is usually done in the form of Jointed Plain Concrete Pavement (JPCP) or Continuously Reinforced Concrete Pavement (CRCP) with a thickness usually ranging from 150 mm to 250 mm.

For conventional Whitetopping no extra effort is required to encourage the bonding between the overlay and the underlying bituminous surface. The PCC overlay can be laid directly on the existing bituminous surface. However, the surface to lay PCC should be made uniform before placing PCC overlay.

The design principle adopted for conventional Whitetopping is similar to those of regular concrete pavements as provided in IRC:58 "Guidelines for the Design of Plain Jointed Rigid Pavements for Highways" and IRC:15 "Standard Specifications and Code of Practice for Construction of Concrete Roads".

II. Thin Whitetopping Overlay(TWT)

Thin Whitetopping is an innovative design concept. For thin Whitetopping, the development of an effective bond between the PCC overlay and the existing bituminous pavements is desirable.

Thin Whitetopping is usually provided in the form of panels. Panel size may vary from 1 m x 1 m to 1.25 m x 1.25 m for 3.75 m carriageway & more for higher width of carriageway. Rectangular spacing wherever given should have a ratio not exceeding 1.2 m between the long and the short arms.

The cement concrete slab is cut with one third deep grooves (by thickness of slab) by a stone cutter so that the slab forms interlocking panels. These grooves may be filled with bitumen.

The cost of 100 mm thick panelled concrete is almost 60% of the cost of 200 mm thick standard concrete pavement.

Milling is done to make the bituminous surface rough. Sometimes chiseling may also be done where milling is difficult.

6. MATERIALS

I. Cement

Any of the following types of cement capable of achieving the design strength may be used with prior approval of the engineer:

- Ordinary Portland Cement, 43 Grade, IS:8112
- Ordinary Portland Cement, 53 Grade, IS:12269
- Portland Pozzolana Cement, IS:1489
- Portland Slag Cement, IS:455

Preference should, however, be to use 43/53 Grade cement, as the grade of required concrete is M40 or more. While using 53 Grade Cement, Fly ash upto 25% by weight of cementitious material may be added.

II. Admixtures

Admixtures conforming to IS:6925 and IS:9103 may (upto 2% by weight of cement as per IS: 456) be used to improve the quality of concrete, on satisfactory evidence that they will not have any adverse effect on the properties of concrete with respect to strength, volume change and durability.

III. Air Entraining Agents

The air entraining agents may be added up to 6.5% to increase the durability of the pavement in freezing and thawing regions.

IV. Fibres

These shall be of steel/polypropylene/polyester/polyethylene/nylon fibres and shall be uniformly dispersed in the concrete mass. Use of fibres in concrete reduces its tendency to plastic shrinkage cracking and increases its ductility and abrasion resistance. IRC: SP:46-2013 should be referred for the use of fibres in concrete.

V. Aggregates

Aggregates for pavement concrete shall be natural material complying with IS:383 with a Los Angeles (LA) Abrasion/Aggregate Impact Value (AIV) not more than 35%. The limits of deleterious materials shall not exceed the requirements set out in IS:383.

VI. Water

Water used for mixing and curing of concrete shall be clean and free from injurious amount of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS:456. Potable water is generally considered satisfactory for mixing and curing.

7. MIX PROPORTIONING & STRENGTH OF CONCRETE

Concrete used should be so proportioned that the concrete mix generally produces concrete with a minimum characteristic compressive strength of M40 or more. Water cement ratio for TWT should be below

0.40 (preferably in the range of 0.30 to 0.38). Cement content in the mix should not exceed 450 kg/m³. Concrete should have a minimum flexural strength or modulus of rupture (by Third Point Loading) of 4.5 MPa. It is, however, preferred to have a flexural strength of 5.0-6.0 MPa (Third Point Loading).

8. DESIGN OF WHITETOPPING AND JOINTS

The design principle for conventional and thin Whitetopping design is mentioned in IRC: SP:76-2015 "Guidelines for conventional and thin Whitetopping."

The design principle adopted for conventional Whitetopping are also mentioned in the IRC:58 "Guidelines for the Design of Plain Jointed Rigid Pavements for Highways" and IRC:15 "Standard Specifications and Code of Practice for Construction of Concrete Roads" codes.

9. CONSTRUCTION STEPS

I. Evaluation of Existing Pavement

Before placing the Whitetopping overlay on the Existing pavement, the existing pavement shall be evaluated using one or a combination of the following techniques.

- Visual inspection of condition
- Rut measurements
- Lab testing [tensile strength (HMA), moisture & density (base & subbase)]
- Falling weight deflectometer (FWD) for subbase/HMA
- Dynamic cone penetrometer (DCP) for base/subgrade
- Cores (thickness)

II. Pre-overlay Repair

Pre-overlay repair of the existing HMA pavement is required to obtain the desired level of performance because the existing HMA pavement will be carrying part of the traffic loading.

Some of repair consideration are described in following:

- Localized repair of failed areas caused by loss of base or subgrade support
- Filling of medium and high-severity potholes
- Localized repair of medium to severe alligator cracking

If significant alligator cracking exists throughout the project, this suggests a structural inadequacy and the pavement may not be a suitable candidate for Whitetopping.

III. Surface Preparation

If surface distortions on the existing HMA pavement are excessive (greater than 2 inches), either milling or a levelling course may be necessary to provide proper grading before Whitetopping is placed, the temperature of the prepared asphalt surface should be considered. Placing PCC on a HMA surface can lead to cracking due to shrinkage.

A clean surface is required for proper bond. Milling the surface followed by cleaning improves bond because it exposes more of the aggregate of the asphalt pavement. The milling creates a rough surface that also enhances the bond between the two layers. If milling is not done, water or abrasive blasting should be used to clean the asphalt surface. When water blasting is used, the surface must be allowed to air dry before the concrete is placed.

IV. Placement and Finishing

The procedures for placing and finishing PCC for thin Whitetopping are the same as those for new concrete pavements.

After surface preparation, there must be enough asphalt remaining to form a sufficient composite section that can carry the load. There must be enough asphalt to minimize concrete tensile stresses, and enough concrete to minimize asphalt strains.

V. Texturing

Texturing of the finished PCC pavement surface is required to provide adequate surface friction of the roadway.

VI. Curing

Curing of Whitetopping is similar to curing new PCC pavements. CWT/TWT requires curing the entire pavement surface and edges as soon as surface conditions permit after the finishing operations.

Proper curing is critical to avoiding shrinkage cracking in the concrete overlay and to prevent de-bonding between the asphalt and concrete. Because the overlay is a thin concrete slab, it has high surface area to volume ratio and can lose water rapidly due to evaporation.

VII. Joint Sawing and Sealing

As with new PCC pavements, timely sawing is critical to avoid random cracking in Whitetopping. Partial-depth saw cutting operations should commence immediately after the concrete has gained enough strength to prevent ravelling and spalling of the joint. The same procedures and recommendations given for new pavements are applicable to Whitetopping.

VIII. Drainage

Drains, inlets and manholes must be raised to match the elevation of the new pavement. The drainage pipe shall be below the drainage layer, if provided. The slabs around the manhole shall preferably be with Reinforced Cement Concrete (RCC) using nominal reinforcement of 10 mm diameter plain bars at 150 mm c/c at neutral axis.

10. FACTORS WHICH AFFECT THE PERFORMANCE OF WHITETOPPING

Factors which affect the performance of conventional and thin Whitetopping are the following:

- Condition of the existing pavement (type, severity, and extent of distress)
- Pre-overlay repair (all areas of subgrade or base failures)

- Overlay design features (overlay thickness, joint spacing, load transfer design, bathtub section design, reinforcement design, and drainage design)
- Traffic (axle weights and number)
- Climate (temperature and moisture conditions)
- Construction quality and curing

11. QUALITY CONTROL AND QUALITY ASSURANCE

In controlling the processes of Whitetopping concrete production and placement, the contractor/engineer must conduct tests to quantify the level of quality being achieved. Recommended QC tests include the following:

- Mixture temperature as it arrives at the site
- Concrete slump
- Final water–cement ratio as it is placed
- Cement factor
- Admixture dosage
- Aggregate moisture content, both coarse and fine aggregates
- Aggregate gradation
- Fine aggregate fineness modulus or sand equivalent
- Unit weight or air content of fresh concrete

In contrast to QC tests, acceptance tests measure the finished product; either at the time of placement or after the concrete has hardened. Recommended acceptance tests include the following:

- Strength – Compressive – Flexural – Splitting tensile
- Thickness
- Unit weight or air content
- Smoothness.

12. LIFE CYCLE COST ANALYSIS (LCCA) OF BITUMINOUS OVERLAYS AND CONCRETE WHITETOPPING

Concrete pavements are a good alternative to bituminous pavements, these pavements perform for a long term and even have a very low maintenance cost, though the initial cost of these pavements is high when life cycle cost is considered the overall cost of these pavement is less than that of overall cost of bituminous pavements. An attempt has been made to evaluate the life cycle cost (LCC) of bituminous overlays and concrete Whitetopping with the help of the net present value method of life cycle cost analysis.

Life Cycle Cost Comparison of New Bituminous and Concrete Pavements (Ashok & Ashwini, 2017)

NPV Bituminous Overlays					NPV Concrete Overlays (Thin Whitetopping Thickness - 150 mm)				
S. No.	Year	Construction & Maintenance Cost	(1/1.12)^n	NPV	S. No.	Year	Construction & Maintenance Cost	(1/1.12)^n	NPV
1.	2016	89,59,050	1.00	89,59,050	1.	2016	88,13,275	1.00	88,13,275
2.	2017		0.89	0	2.	2017		0.89	0
3.	2018		0.80	0	3.	2018		0.80	0
4.	1019		0.71	0	4.	1019		0.71	0
5.	2020		0.64	0	5.	2020		0.64	0
6.	2021	28,20,422	0.57	16,00,383	6.	2021	11,49,035	0.57	6,51,993
7.	2022		0.51	0	7.	2022		0.51	0
8.	2023		0.45	0	8.	2023		0.45	0
9.	2024		0.40	0	9.	2024		0.40	0
10.	2025		0.36	0	10.	2025		0.36	0
11.	2026	1,61,45,035	0.32	51,98,269	11.	2026	18,46,203	0.32	5,94,428
12.	2027		0.29	0	12.	2027		0.29	0
13.	2028		0.26	0	13.	2028		0.26	0
14.	2029		0.23	0	14.	2029		0.23	0
15.	2030		0.20	0	15.	2030		0.20	0
16.	2031	45,66,530	0.18	8,34,288	16.	2031	19,62,718	0.18	3,58,581
17.	2032		0.16	0	17.	2032		0.16	0
18.	2033		0.15	0	18.	2033		0.15	0
19.	2034		0.13	0	19.	2034		0.13	0
20.	2035		0.12	0	20.	2035		0.12	0
21.	2036	56,57,130	0.10	5,86,456	21.	2036	25,65,195	0.10	2,65,925
			Total	**1,71,78,446**				**Total**	**1,06,84,202**

- Life cycle cost analysis shows that the net present value of concrete pavements is less than bituminous pavements.
- When life cycle (20 years) cost of bituminous overlays and concrete Whitetopping is considered the total cost of bituminous overlays is Rs. 1,71,78,446 and that of thin concrete Whitetopping is Rs. 1,06,84,202, which is 38% lesser than bituminous overlays.
- LCCA concludes that concrete pavements are more beneficial than bituminous pavements and concrete overlays can be considered as beneficial.

13. TENTATIVE RATE ANALYSIS OF WHITETOPPING

Rate analysis of Whitetoping considering the SoR rates for year 2019-20 of Karnataka state is attached at Annexure A.

Summary of cost analysis for upgradation of existing BT pavement to New BT surface/Various Whitetopping surface for single Lane (Based on enclosed Rate Analysis):

It may be seen in the below table that the construction cost for up-gradation of the existing BT to Conventional Whitetopping is 189% higher than the existing BT to BT pavement cost for T7 Traffic category. In contrast, the construction cost for up-gradation of existing BT to Thin Whitetopping is 55% higher than the existing BT to BT pavement cost for T7 Traffic category.

Upgradation (3.75 m to 3.75 m)	Tentative Cost/km (Lakhs/km) (Traffic Category Wise)		
	T5	T7	T9
Existing BT to BT	14.63	19.80	27.37
Existing BT to Conventional Whitetopping	50.80	57.15	63.50
Existing BT to Thin WT (Panelled Cement Concrete)	24.64	30.78	36.92

Summary of cost analysis for upgradation of existing BT pavement to New BT surface / Various Whitetopping surface for intermediate Lane (Based on enclosed Rate Analysis):

It may be seen in the below table that the construction cost for up-gradation of the existing BT to Conventional Whitetopping is 187% higher than the existing BT to BT pavement cost for T7 Traffic category. In contrast, the construction cost for up-gradation of existing BT to Thin Whitetopping is 66% higher than the existing BT to BT pavement cost for T7 Traffic category.

Upgradation (3.75 m to 5.5 m)	Tentative Cost/km (Lakhs/km) (Traffic Category Wise)		
	T5	T7	T9
Existing BT to BT	24.49	31.82	42.92
Existing BT to Conventional Whitetopping	82.17	91.48	100.79
Existing BT to Thin WT (Panelled Cement Concrete)	43.76	52.76	54.10

Finally, it can be concluded from the life cycle and construction cost analysis tables that the initial cost for Whitetopping may be higher than BT overlay. Still, life cycle cost comes less in Whitetopping overlay.

Therefore, In the long term, Whitetopping overlay is more economical and sustainable than BT overlay.

14. IRC CODES

IRC: SP:76-2015 "Guidelines for Conventional and Thin Whitetopping" is recommended for Whitetopping overlay.

15. EXAMPLES OF ROADS PAVED WITH WHITETOPPING

It is pertinent to mention here that Whitetopping has been executed in the past under the PMGSY programme in some of the roads in state of Maharashtra, Karnataka and Chhattisgarh. Details of some of these roads are given below.

S. No.	State	District	Package No.	Road Name
1.	Maharashtra	Thane	MH3048	Kunde - Bangarwadi Road
2.	Karnataka	Bellary	KN0576	MRL2-Ippitheri To T-09
3.	Karnataka	Hassan	KN1686	MRL4-Muddanahally To Guddenahally
4.	Karnataka	Hassan	KN16-110	MRL02-B T Koppalu To SalagameRoad Via Yadiyur
5.	Karnataka	Hassan	KN16-114	MRL37-SH Near Hoovinahalli To Kuppalli Via Haralahalli
6.	Karnataka	Uttara Kannada	KN2758	MRL1-Viranjol To Pradhani Via Patilwada
7.	Chhattisgarh	Bilaspur	CG02126ii	T14-T02 Tekar To Selar Via Kabripara
8.	Chhattisgarh	Mungeli	CG27129	T15-Amlidihi To Salheghori Dindori
9.	Chhattisgarh	Rajnandgaon	CG15142	T10-Limo To Penderwani To Chilguda
10.	Chhattisgarh	Surguja	CG1628 P-II	T04-Keora Kataipara To Parri

Photographs of some of these roads are enclosed at Annexure B.

REFERENCES

a. IRC: SP:76-2015 "Guidelines for conventional and thin Whitetopping.

b. Ashok, S. P., & Ashwini, P. (2017). Life Cycle Cost Analysis of Flexible Pavements and Rigid Pavements in Urban Areas. International Journal of Innovative Science and Research Technology, 2(6), 48-54.

c. "Report of the Expert Group on Measures for Achieving Economy in Construction of Rural Roads under PMGSY" published by NRIDA (2017).

d. National Academies of Sciences, Engineering, and Medicine (2004). Thin and Ultra-Thin Whitetopping. Washington, DC: The National Academies Press. https://doi.org/10.17226/23333.

ANNEXURE A

SoR Rates of Karnataka state for year 2019-20

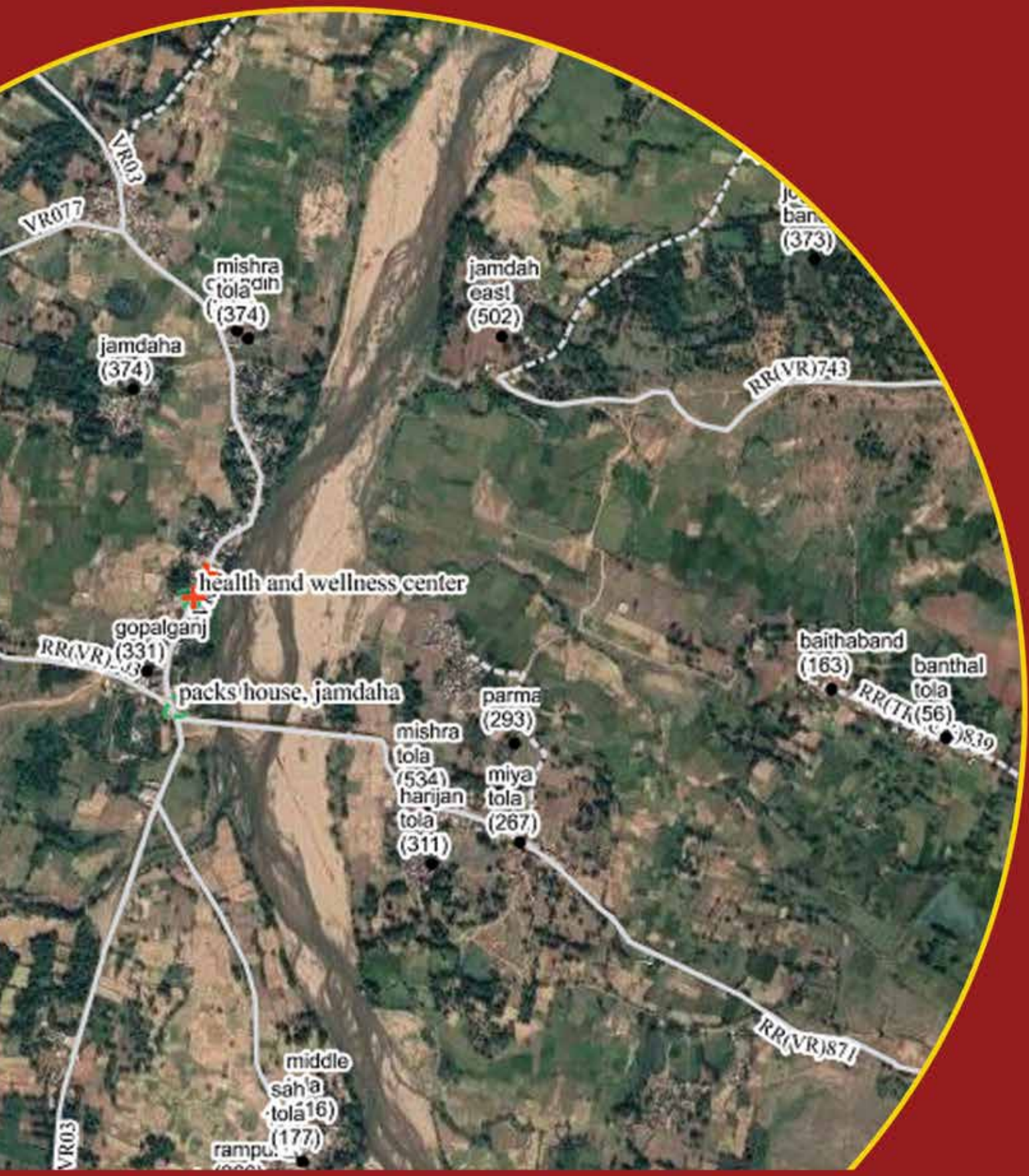
Analysis of Panel Concrete Pavement				
Construction of Panel concrete, plain cement concrete pavement, thickness as per design, over a prepared sub base, with 43 grade cement or any other type as per Clause 1501.2.2 M30 (Grade) coarse and fine aggregates conforming to IS:383, maximum size of coarse aggregate not exceeding 25 mm, mixed in a concrete mixer of not less than 0.2 cum capacity and appropriate weigh batcher using approved mix design, laid in approved fixed side formwork (steel channel, laying and fixing of 125 micron thick polythene film, wedges, steel plates including levelling the formwork as per drawing), spreading the concrete with shovels, rakes, compacted using needle, screed and plate vibrators and finished in continuous operation including provision of contraction and expansion, construction joints, applying debonding strips, primer, sealant, dowel bars, near approaches to bridge/culvert and construction joints, admixture as approved, curing of concrete slabs for 14 days. Curing compound (where specified) and water finishing to lines and grade as per drawing and technical specification Clause 1501. PCC Grade M-30 Each Panel (0.50 x 0.50) thickness 100 mm.				
Taking Out put = 75 Cum/Ref from Standard Data Book MoRD (Each panel 500 mm x 500 mm)				
Unit = cum	**Unit**	**Quantity**	**Rate**	**Amount**
A. For Labour				
Mate	day	7.00	421.20	2948.40
Mason (1st Class)	day	5.00	436.20	2181.00
Mason (2nd Class)	day	5.00	421.20	2106.00
Mazdoor (Unskilled)	day	129.00	411.20	53044.80
Mazdoor (Skilled)	day	6.00	411.20	2467.20
Mazdoor (Semiskilled)	day	6.00	411.20	2467.20
Bhisti	day	14.00	411.20	5756.80
Total Cost for Labour				**70971.40**
B. Machinery				
Concrete Mixer 0.28/0.40 Cum. Capacity with Weigh batcher and Suitable Capacity Calibrated Water Tanker	Hrs	36.00	169.50	6102.00
Needle vibrator	Hrs	9.00	37.12	334.08
Screed vibrator	Hrs	9.00	42.00	378.00
Plate vibrator	Hrs	9.00	31.75	285.75
Concrete joint Cutting Machine	Hrs	8.00	165.75	1326.00
Water Tanker 6 Kl Capacity	Hrs	5.00	254.23	1271.15
Air Compressor (1 hr initial = 1 hr Final)	Hrs	2.00	244.12	488.24
Generator Set KVA	Hrs	1.00	534.00	534.00
Total Cost for Machinery				**10719.22**

Unit = cum	Unit	Quantity	Rate	Amount
C. Material				
Polythene sheet 125 Micron	sqm	750.00	11.44	8580.00
Plasticizer 50% of cement Quantity	L	150.00	169.49	25423.50
Water For Curing	KL	18.00	40.00	720.00
Total Cost for Material				**34723.50**
Total Cost for 75 Cum Material (A+B+C)				**116414.12**
D. Rate per cum = (A+B+C)/75	cum			**1552.19**
E. Other Materials				
Cement - 43 grade	t	0.400	4906.00	1962.40
Coarse sand	cum	0.450	1680.95	756.43
20 mm aggregate (22.4 mm)	cum	0.540	1091.43	589.37
10 mm aggregate (11.2 mm)	cum	0.360	1091.43	392.91
Bitumen Primer SS-1 1400 @ 200 ml per Joint = 28000 ml/1.087 gm per ml = 0.516 Mt/75 cum = 6.88 kg	t	0.007	64152.92	441.37
Total Cost for Other Materials				**4142.49**
F. Formwork @ 3% of cost of Other Materials				**124.27**
G. Rate per cum = (E+F+D)				**5818.95**
H. Add 12.5 % Contractor's Profit (G)				**727.37**
Rate per cum = (G+H)				**6546.32**

ANNEXURE B

Whitetopping (Panelled Concrete)

Whitetopping with short panels of 0.5 m x 0.5 m



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