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Laboratory Evaluation of Shear Strength for Ultra-Thin White Topping

Prabhat Ranjan 1(P.G. Sholar)
Dept of Civil Engg.
RNTU Bhopal, INDIA

Neeraj Jain 2(Asst. Prof.)
Dept of Civil Engg.
RNTU Bhopal, INDIA

ABSTRACT

As a rehabilitation technique, Ultra-Thin Whitetopping (UTW) is a process that creates a 50-100 mm thick cement concrete overlay on deteriorated asphalt pavement. From 2003 to 2011, twelve conventional, ultra-thin, and thin whitetopping overlay projects were built in India, althoughthere has been no detailed follow-up on their performance. As a result, usingappropriate techniques, it is necessary to investigate the performance evaluation of UTW for Indian traffic and climatic circumstances. The performance of the UTW is evaluated in this study using the Benkelman BeamDeflection Test (BBD) as described in IRC: 81-1997.

The purpose of this research is to investigate the interface bond strengthof UTW overlays that have been treated to various interface treatment approaches. Because UTW overlay composite behaviour is affected by bond loss and layer delamination. This will lead to premature failure and reductionin design service life of UTW overlays. To improve the interface bond strength and satisfy the design service life of UTW overlays, a good surface preparation process is necessary. Experiments were carried out in the lab to attain the goal of the current project. The cylindrical HMA mixture specimenswere casted and were tested in universal testing machine (UTM). HMA-UTW composite specimens were used, each with a varied proportion of bonding atthe interface. Two test methods, the direct shear test and the flexural test, were used to determine the interface bond strength for Various interface treatment approaches. Both tests were carried out under static and dynamic loadingconditions.

Key Words : Ultra-Thin Whitetopping, Shear Strength, Marshall Stability, Hot mix asphalt, Compressive Strength and Bitumen.

1.0 INTRODUCTION

The emphasis today is on the construction of long haul performing pavement, since pavement are the costliest constructions. In India the greater part of the pavement are bituminous pavement with meager folio course. Bituminous pavement are giving early indication of distress around the world, because of expansion in load, force of traffic high tire pressure and so forth The distresses like aging rutting and cracking and so forth are very normal. Intelligent breaking is one more type of pain in bituminous overlay. These bothers get more shown in hot climatic areas like India, since bitumen is exceptionally touchy to temperature. Execution of bituminous pavements in hot climatic locales is hence turning out to be fairly dicey. Concrete then again is known to be somewhat stiffer material and less delicate to high temperature. Likewise, substantial pavements being progressively taken on as an option in contrast to conventional bituminous pavements. Indeed, even in wording restoration and fix the utilization of cement is supplanting conventional bituminous overlay due to better execution against rutting and breaking.

The performance of whitetopping, especially UTW pavement has been found to be related to the special composite structure resulting from the bond at the PCC/HMA interface. The bond reduced the stresses in the PCC slabs by transferring more load to the underlying HMA layer. A few major design and construction features affect the performance of whitetopping pavements, including the condition of the existing HMA, the pre-overlay treatment, concrete materials, joint spacing, and design method.

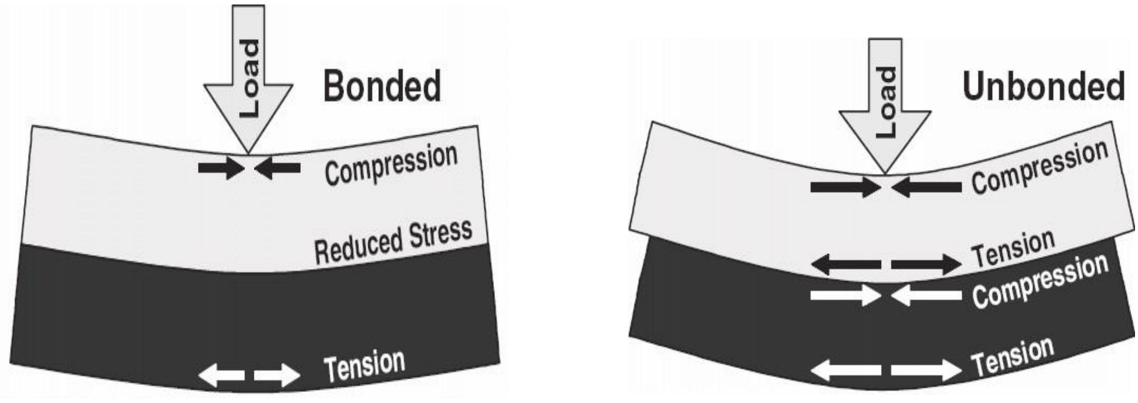


Figure 1: Bonded Vs. Unbonded behavior

2.0 LITERATURE REVIEW

Dong-Ho Kim et al, evaluated performance of cement concrete overlays over existing bituminous pavement surface layers. The essential goal of this report is to sum up the discoveries of the writing survey on the exhibition of whitetopping test areas and plan systems. Two inquiries face asphalt engineers who consider utilizing Portland concrete cement (PCC) overlays over hot blend black-top cement (HMAC) xiaojun li et al, assessed the presentation of whitetopping pavement as a restoration procedure and study the falling weight deflectometer (FWD) backcalculation technique for whitetopping. The essential targets of this postulation are to assess the exhibition of whitetopping asphalt as a restoration technique and study the falling weight deflectometer (FWD) back computation strategy for whitetopping.

Daniel King et al, worked on the structural behaviour of UTW on roadways and parking lots. A presentation assessment of super meager whitetopping (UTW) asphalts in Illinois was attempted in 2012–2014 to assess current plan methods and to decide plan life measures for future activities. The two primary parts of this assessment were (1) visual pain overviews of 20 existing UTW projects across the state to record and measure upsets and (2) falling weight deflectometer (FWD) testing of eight of these UTW activities to assess underlying execution. The discoveries of the overviews are definite in this report.

Nelson et al, studied on distress surveying and failure identification of UTW pavement. They observed mainly distress types including: debonding and interface cracking, corner cracking, and mid-slab transverse and longitudinal cracking. The amount of cracking that occurred in sections under study was found to be a function of the joint layout. Reducing the panel size will reduce the curling/warping and the traffic load related flexural stress. Many of the observed transverse cracks are a result of previously existing temperature cracks in the asphalt reflecting up through the concrete.

Mampearachchi W.K. et al, made examination endeavors to concentrate on the attainability of whitetopping for reemerging of slight black-top asphalts (under 100 mm) in tropical and sub-tropical nations. Whitetopping asphalt test track developed at the speed increase testing office in a heat and humidity, at the Florida Department of Transportation (FDOT), was utilized for the review. A three-dimensional (three dimensional) limited component model (FEM) was created to reenact the field conditions utilizing SAP2000 primary examination programming. The created model was confirmed with field estimated strain information.

Mohammad R. Suliman et al, Several thin whitetopping (TWT) projects function differently in terms of distress type and severity. Severe corner cracking happened under thetyre tracks in the driving lane in several projects. Cracking in the panels on the driving lanenear the shoulder was more apparent in other projects

3.0 EXPERIMENTAL ANALYSIS

Cube compressive strength and flexural strength tests were conducted on concrete mix(M40). Marshall Test was conducted on dense bituminous macadam concrete mix with lime (2%) filler to determine optimum bitumen content, Marshall Stability, Flow, bulk density, total air voids, voids in mineral aggregates and voids filled with bitumen.

Table 3.1 Cube Compressive Strength Test Results

SlNo	**No. of days of curing**	**Cubes compressive strength, N/mm^2**			
		Trial -1	Trial -2	Trial -3	Average
1	7	38.7	36.4	37.9	37.66
2	14	43.9	45.5	44.6	44.66
3	28	52.7	49.5	50.4	50.86

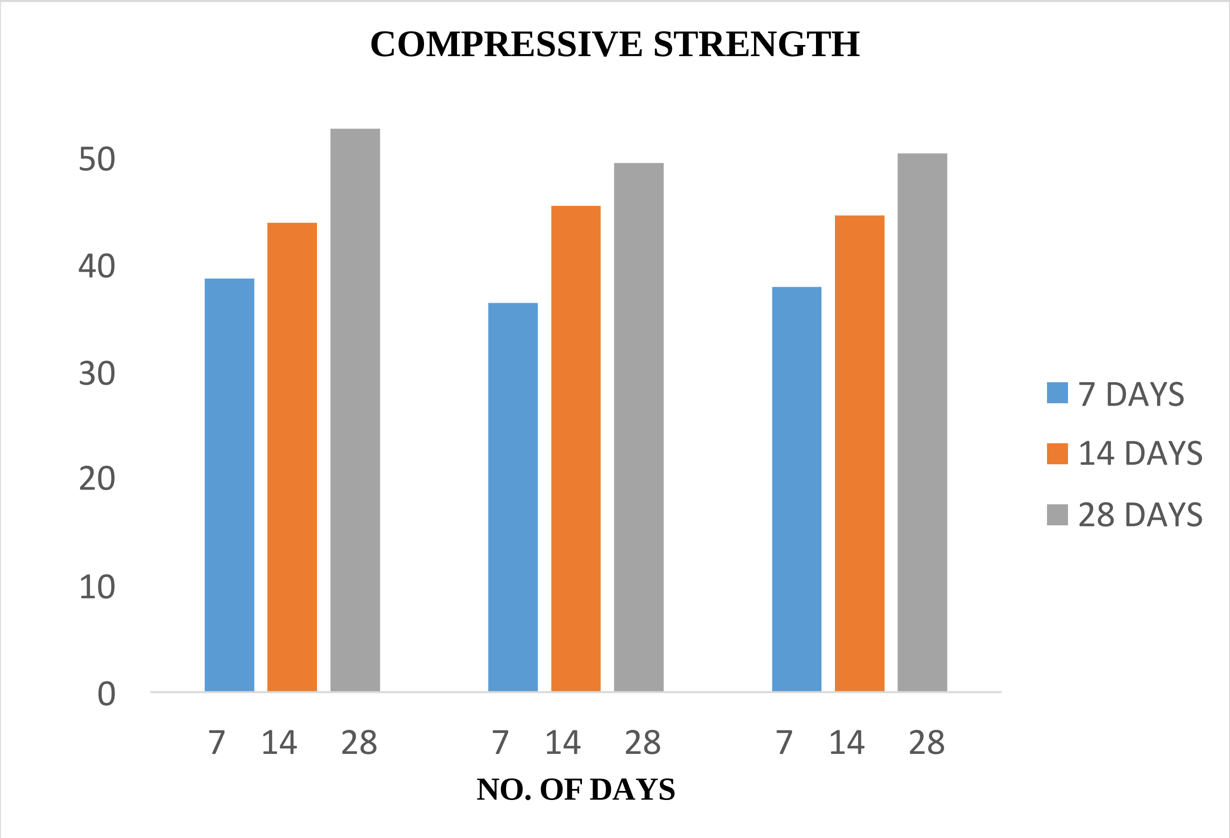


Table 3.2 Flexural Strength Test Results

SlNo	No. of days of curing	Flexural strength, N/mm^2			
		Trial -1	Trial -2	Trial -3	Average
1	7	3.6	4	3.4	3.67
2	14	4.1	4.2	3.9	4.06
3	28	4.8	4.4	4.4	4.53

Table 3.3 Marshall Properties of Dense Bituminous Concrete mix with lime (2%)Filler

Bitumen content %	Marshal stability,kg	Flow,mm	Bulk density,g/cc	Total air voids, %	Voids in Mineral Aggregates, %	Voids filled with bitumen, %
4.5	1035.4	2.85	2.283	8.421	17.375	64.544
5	1220.1	2.95	2.305	5.899	17.069	69.598
5.5	1331.25	3.09	2.328	5.306	16.723	68.31
6	1087.45	3.36	2.322	3.824	16.538	72.812
6.5	999.45	3.68	2.312	2.758	16.253	79.435

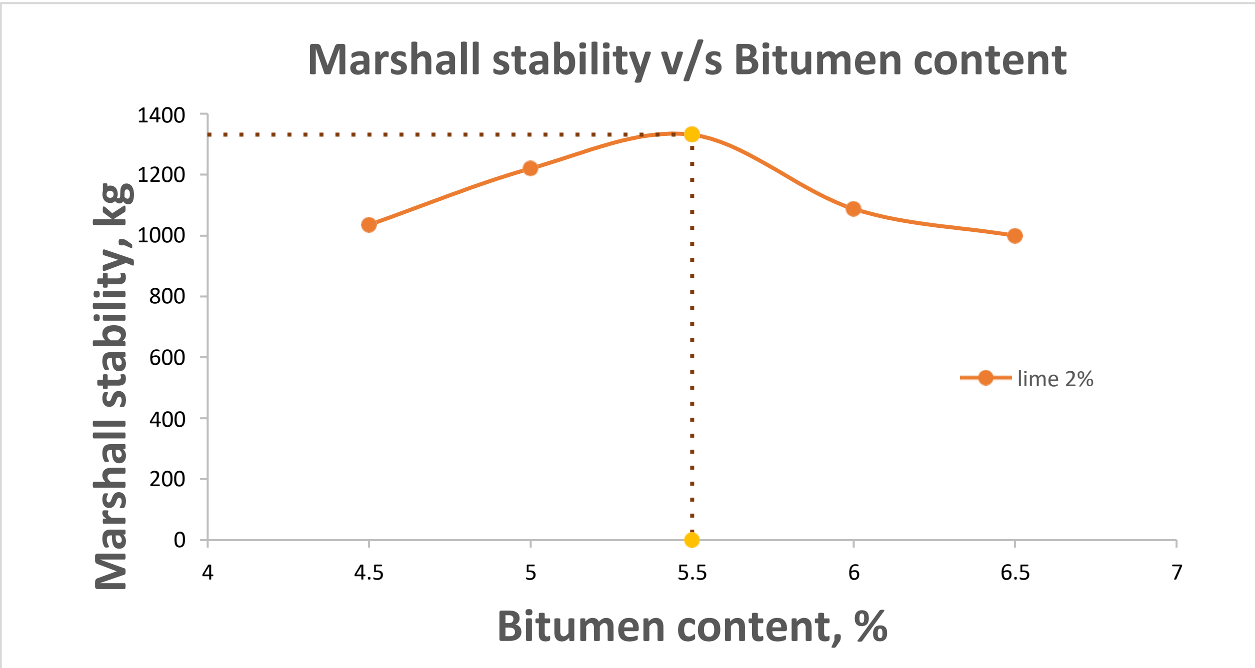
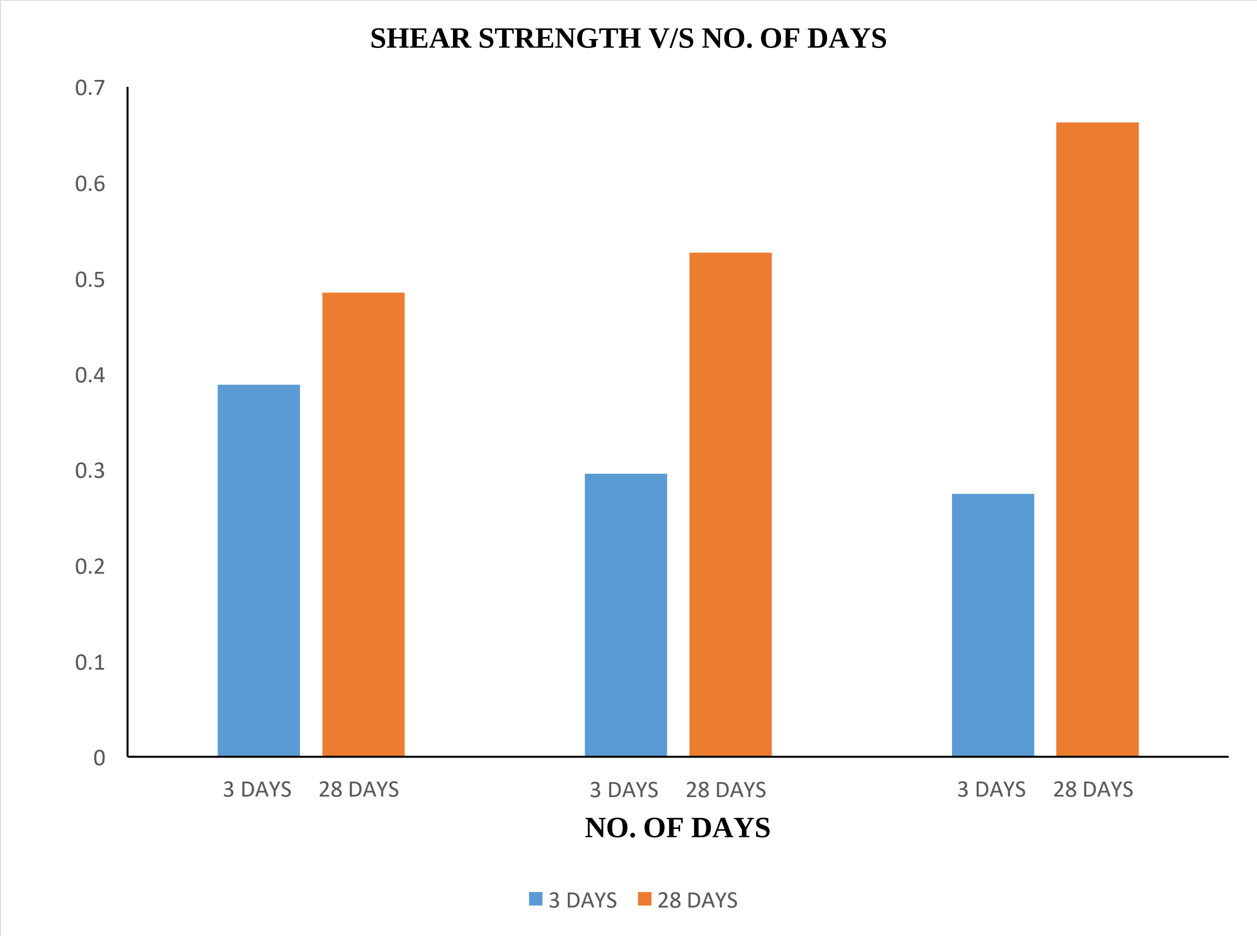


Figure 3.1 Marshall Stability v/s Bitumen Content

Table 3.4: Interface shear strength values of plane composites without nanotac interfacetreatment

Sl No	**No. ofdays of curing**	**Shear strength, N/mm^2**			
		Trial -1	Trial -2	Trial -3	Average
1	3	0.387	0.296	0.275	0.32
2	28	0.485	0.527	0.663	0.55



4.0 DISCUSSION AND CONCLUSION

1. Based on the observation, the Cube Compressive Strength was found to be 37.66 N/mm^2 , 44.66 N/mm^2, 50.58 N/mm^2 after curing period of 7,14 and 28 days respectively.
2. Based on the observation, Flexural strength of the beam was found to be 3.67 N/mm^2, 4.06 N/mm^2, 4.53 N/mm^2 after curing period of 7,14 and 28 days respectively.
3. Based on the observation, shear strength of plane composite specimen with nanotac interface treatment for curing 3 and 28 days was found to be 0.58 N/mm^2 and 0.77 N/mm^{2}respectively.
4. Based on the observation, shear strength of plane composite specimen without nanotac interface treatment for curing 3 and 28 days was found to be 0.32 N/mm^2 and 0.55 N/mm^{2}respectively.
5. Based on the observation, shear strength of grooved specimen with the nanotac interface treatment for curing 3 and 28 days was found to be 0.64 N/mm^2 and 1.15 N/mm^2 respectively.
6. Based on the observation, shear strength of plane composite specimen without nanotac interface treatment for curing 3 and 28 days was found to be 0.52 N/mm^2 and 0.94 N/mm^{2}respectively.

Conclusion:

1. The interface shear strength increases when Nanotac additive is added to tack coat emulsion due to its bond strength.

5.0 REFERENCES

- Compilation And Review Of Existing Performance Data And Information Prepared by Manik Barman Dr. Julie Vandenbossche Feng Mu Kerri Gatti.
- Cho, Y. H., and Koo, H. M. (2006). "UTW behavior on asphalt pavements tested with HWLS." Transportation Engineering, 132(11), 880-887.
- Extending Asphalt Pavement Life Using Thin Whitetopping Mustaque Hossain Kansas State University Sharmin Sultana Kansas State University.
- Evaluation of Applicability of Ultrathin Whitetopping in Florida (wayne)
- Fatigue and Fracture of Engineering Materials and Structures, 40(4), 496-511.
- IRC: SP-76 (2008). "Tentative Guidelines for Conventional, Thin and Ultra-Thin White topping" Indian road Congress, New Delhi. Tyler Ley and HariRotithot, "Performance of Ultra-Thin White topping in Oklahoma", Final report FHWA-OK-10-05, 2010.
- IRC:81-1997 "Guidelines for strengthening of flexible pavement using Benkelman Beam

Deflection Technique"

- IRC:58-2002 "Guidelines for the design of plain jointed rigid pavements for highways (Second Revision) STAC Road Report of PMCPerformance evaluation on thin-white topping B.N. Skanda Kumar 1, Suhas R2, Bhavan V3.
- IS: 383-1970 "Indian standard specification for coarse and fine aggregates from natural sources for concrete". Bureau of Indian Standards, New Delhi, India.
- IS: 516-1991. "Indian standard methods of tests for strength of concrete". Bureau of Indian Standards, New Delhi, India.
- IS: 73-2013. "Indian standard specification for paving bitumen". Bureau of Indian
- Standards, New Delhi, India.
- "Investigation of bonding between asphalt layers on road construction"Transportation Engineering, 121(04), 309-316.
- Literature Review on Concrete Pavement Overlays over Existing Asphalt Structures(dong and sulaiman moon won).