EXPERIMENTAL INVESTIGATION ON PERFORMANCE OF WHITE TOPPING OVER FLEXIBLE PAVEMENTS

Ms. Anusha H R[1], Mr. Darshan Gowda H[1], Mr. Nachiketh C N[1], Ms. Sindhu M[1],Mr. Shankaregowda[2]

[1]UG Students, Department of Civil Engineering, Maharaja Institute of Technology Mysore
[2]Assistant Professor, Department of Civil Engineering, Maharaja Institute of Technology Mysore

---

Abstract - *The main focus of the present era is to construct a long-lasting and better Performing pavement. Usually, with respect to the rehabilitation of the pavement, the construction agencies go with the bituminous overlays as their first priority without considering the condition of the existing pavement structure. But Cement Concrete (CC) pavements have proved that they perform better and are long-lasting as new pavement as well as when used for rehabilitation of the existing pavement.*

Hence it is the era, White Topping methods are gaining their popularity White topping is rehabilitation treatment on asphalt concrete. It is defined as Plain Cement Concrete overlay on asphalt concrete. It provides a new innovative method of rehabilitation at a very low cost with very good results and low maintenance cost.This method of rehabilitation/strengthening can be adopted for rural road network and district roads as these roads have low to moderate traffic. Even on the State Highways and some recently declared National Highways, where traffic is moderate, the above method of strengthening has a lot of promise. By adopting proper construction methods, we can rehabilitate large network of roads at reasonable cost and we get additional long life.

This study presents a methodology to adopt white topping as rehabilitation treatment and cost-effective rehabilitation alternative for preserving bituminous pavements on long-term basis and to compare & conclude which type of road is feasible and is good to have on a particular situation. The comparison of the study shows that the white topping of both types of roads improves the life span of the road & its withstanding capability.

Keywords:- White Topping, Potholes, Compressive Strength, Split Tensile Strength, Flexural Strength.

1. INTRODUCTION

India has the second largest road network in the world spanning about 4.69 million km comprising different categories of roads. Only half of the total road network is paved and of the paved roads, 90% of them are bituminous pavements. Pavement design is the process of developing the most economical combination of pavement layers to suit the soil foundation and the cumulative traffic to be carried during the design life. Highway pavement is deteriorating fast due to lack of timely maintenance Thus, timely maintenance of the highway pavement is essential. Road maintenance is one of the important components of the entire road system. Right maintenance treatment is to be given to the right place at the right time. Highway engineering is an engineering discipline branching from civil engineering that involves the planning, design, construction, operation, and maintenance of roads, bridges, and tunnels to ensure safe and effective transportation of people and goods. Some considerations are the adverse effects on the environment, such as noise pollution, air pollution, water pollution, and other ecological impacts. A flexible pavement failure is defined by formation of potholes, ruts, cracks, localized depressions, settlements, etc.

The Portland Cement Concrete (PCC) overlay on an existing bituminous pavement is termed as White topping. The main goal of concrete overlay is to maximize the strength of the existing asphalt structure by rebuilding it. While achieving this aim, the overlay also brings back the riding-quality of the existing structure which had undergone deformations like rutting. At present, the concrete technology and its applications have developed in a rapid rate and hence the concrete overlay has become a non-renewable option.

2. OBJECTIVES OF THE STUDY

[1] To evaluate the design and methodologies for repairing potholes by white topping layers.

[2] To compare the Performance of potholes repaired using white topping layers and bituminous concrete mix.

3. METHODOLOGY

To achieve the objectives stated above, an efficient working procedure has to be followed. Initially

the required materials for white topping are selected and basic tests are conducted, then mix proportion of M40 grade is designed as per IS: 10262 and IS: 456 codal specifications. By the obtained mix proportion moulds are prepared to test the properties of concrete such as compressive strength test, split tensile strength test and flexural strength test. When after reach the target strength the same proportion of mix is prepared to fill the potholes of known stretch of 50 meter road. Simultaneously bitumen mix is also prepared and filled in the same stretch of other potholes. Comparison is to be made after certain time and the conclusions are obtained.

4. MATERIALS USED

The materials used in experimental investigation are Cement, Fine aggregates, coarse aggregates and Water.

4.1 Cement

The Portland Pozzolana Cement (PPC) is a kind of Blended Cement which is produced by either inter-grinding of Ordinary Portland Cement (OPC) clinker along with gypsum and pozzolanic materials in certain proportions or grinding the OPC clinker, gypsum and Pozzolanic materials separately and thoroughly blending them in certain proportions and tests results are tabulated as shown in Table 1.

Table: 1 Basic Laboratory Tests on Cement

SL No	Tests on Cement	Test Results
1	Initial setting time Final setting time	240 min.. 300 min..
2	Normal Consistency	34%
3	Fineness of cement	2.83%
4	specific gravity of cement	3.0

4.2 Coarse Aggregate

20 mm and down size angular aggregates are used for experimental investigation and tests results are tabulated as shown in Table 2.

Table: 2 Basic Laboratory Tests on Coarse Aggregates

SL No	Tests on Coarse Aggregates	Test Results
1	Impact test	22.17%
2	Crushing test	27.45%
3	Abrasion test	32%
4	Soundness test	2.04%
5	Specific gravity and water absorption	2.50 and 0.5%

4.3 Fine Aggregate / Sand

Zone-2 aggregates are used for experimental investigation and tests results are tabulated as below Table 3 and the particle size distribution is as shown in Fig-1.

Table: 3 Basic Laboratory Tests on Fine Aggregates

SL No	Tests on Fine Aggregates	Test Results
1	Specific gravity	2.60
2	Sieve analysis	Well Graded

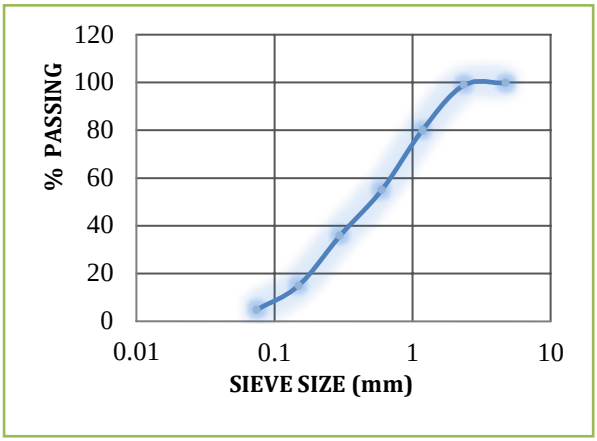


Fig: 1 Particle Size Distribution

4.4 Water

Locally available potable water used for mixing and curing was clean and free from injurious amounts of oils, acids, alkalis, salts and sugar, organic materials or other substances that may be deleterious to concrete.

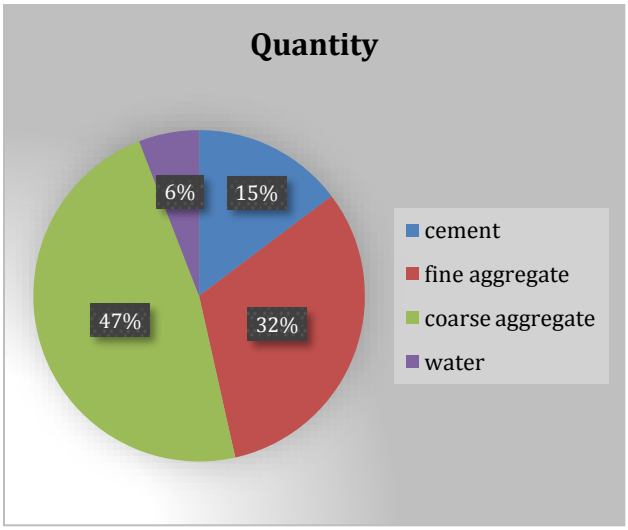
5. MIX DESIGN

From the results of materials basic tests, Mix design were conducted for M40 grade concrete mix using IS 10262 and IS 456:2000 codal provisions. The mix design ratio among cement, fine aggregate, coarse aggregate and water were originated as shown in Table 4 and percentage of proportions were shown in Fig 2.

Table: 4 Mix Proportions per Cubic Meter

Cement	Fine Aggregate	Coarse Aggregate	Water
894kg\m^3	850kg	1274kg	157.6kg
1	2.15	3.23	0.4

Fig-2: Mix Proportion



6. CASTING AND CURING

A total 9 cubes, 9 cylinders and 9 beams were cast for the compressive strength test, split tensile strength test and flexural strength test respectively. The appropriate mix proportion was maintained during the construction. After 24 hours of casting, the specimens were de-moulded and submerged under the water for curing which is shown in Fig 3.

Fig-3: Concrete Specimens after De-moulding

7. RESULTS AND DISCUSSIONS

The casted specimens are subjected to check the target strength for 3 days, 14 days and 28 days respectively.

7.1 Compressive Strength Test: The cubes were tested for compressive strength with respective ages of curing as 7, 14 and 28 days. A compressive strength test helps to determine concrete grading as shown in Fig-4.

Fig-4: Compressive Strength Test of Cubes

The compressive strength test results are tabulated as shown in Table: 5

Table: 5 Results of Compressive Strength Test

SL No	No of Days	Results
1	3	8.93
2	14	16.79
3	28	40.23

The Compressive strength results are plotted as shown in Fig-5.

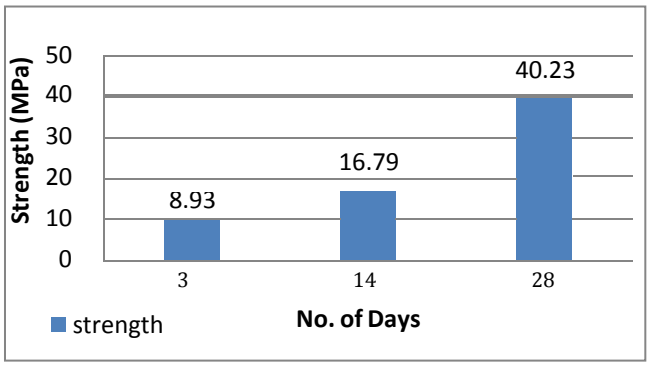


Fig-5: Result of Compressive Strength Test

7.2 Split Tensile Strength Test: The cylinders were tested for split tensile strength with respective age of curing as 7, 14 and 28 days. The split tensile test is a much used method to determine the tensile strength of concrete as shown in Fig-6.

Fig-6: Split Tensile Strength Test of Cylinders

The split tensile strength test results are tabulated as shown in Table: 6

Table: 6 Results of Split Tensile Strength Test

SL No	No of Days	Results
1	3	8.93
2	14	16.79
3	28	40.23

The Split Tensile strength results are plotted as shown in Fig-7.

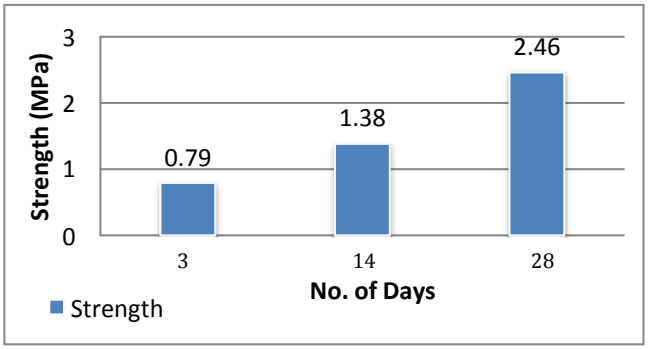


Fig-7: Result of Split Tensile Strength Test

7.3 Flexural Strength Test: The beams were tested for flexural strength with respective ages of curing as 7,

14 and 28 days. It tests the ability of unreinforced concrete beam or slab to withstand failure in bending as shown in Fig-8.

Fig-8: Flexural Strength Test of Beams

The flexural strength test results are tabulated as shown in Table: 7

Table: 7 Results of Flexural Strength Test

SL No	No of Days	Results
1	3	0.13
2	14	0.27
3	28	0.37

The flexural strength results are plotted as shown in Fig-9.

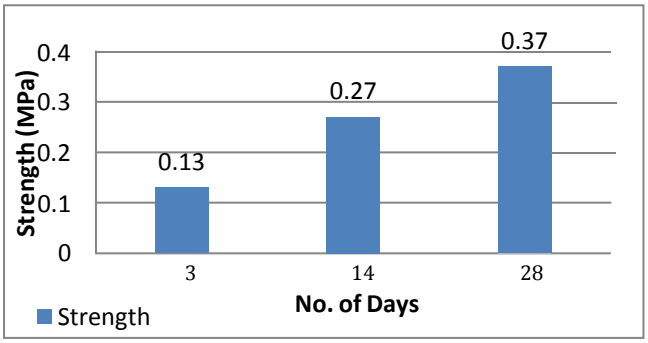


Fig-9: Result of Flexural Strength Test

7.4 Patching the Potholes with White Topping:

After the target strength achieved the same mix proportion has been adopted and laid for known stretch as shown in Fig-10.

Fig-10: White Topping Laying

7.5 Patching the Potholes with Bituminous Concrete Mix: On the other hand simultaneously bitumen mix is also prepared and filled in the same stretch of other potholes as shown in fig-11.

Fig-11: Bituminous Concrete Mix Laying

8. CONCLUSIONS

The following conclusions were drawn from the experimental investigation

[1] The results obtained for the M40 design concrete mix in terms of compressive strength, split tensile strength and flexural strength are in permissible limits.

[2] The white topping potholes have better visibility than bituminous concrete mix.

[3] The performance of potholes patched with white topping is better than potholes patched with bituminous concrete mix in terms of durability, weather resistance and longevity.

ACKNOWLEDGEMENT

Authors would like to thank the Department of Civil Engineering, MIT Mysore for providing them laboratory facilities throughout the completion of the experimental investigation.

REFERENCES

[1] A. K. Sehgal and S. N. Sachdeva A Review of Using Thin White Topping Overlays for Rehabilitation of J. Basic Appl. Eng. Res., 2, 182–187, 2015.

[2] Amaranatha Reddy, Muppireddy, Venkata Jogaro Bulusu et al, Elsevier:Transportation Research Procedia “A critical review of the PCA and IRC methods of thin white topping pavement design”,48 3764-3769, 2020.

[3] Balbo, J. T.—Applications of high performance concrete for ultra-thin pavement overlays (white topping) ACI special publication, vol. 186, 1991, pp.731- 744.

[4] CH. N. Satishkumar & U. Siva Rama Krishna, "Ultra- thin white topping concrete mix with sustainable concrete materials – a literature review” International Journal of Pavement Engineering, Vol. 7, No. 4, 251–260, December 2006.

[5] Concrete Overlays– White topping of roads, Cement Manufacturers Association, 2010.

[6] D. Abijith.C.C Studies on the Performance of Ultra-Thin Cement Concrete Overlays on Flexible Pavements VTU Belagavi 2013.

[7] Dave Amos —Pavement rehabilitation through ultra- thin white topping overlays‖ Missouri department of transportation research report ri 97-043, ri 99-012, Missouri, may, 2004.

[8] Deividi Da S. Pereira, José T. Balbo & Lev Khazanovich, "Theoretical and field evaluation of interaction between ultra-thin white topping and existing asphalt pavement" International Journal of Pavement Engineering, Vol. 7, No. 4, 251–260, December 2006.

[9] Guide to Concrete Overlays – Sustainable solutions for resurfacing and rehabilitating existing pavements, National Concrete Pavement Technology Centre, USA, Sept. 2008.

[10] IRC:SP:76 "Tentative guidelines for conventional, thin and ultra-thin white topping", Indian Roads Congress, New Delhi, 2008.

[11] IRC 58 – Guidelines for the design of plain jointed rigid pavements for highway, 2011.

[12] IRC:SP:76 "Guidelines for conventional, thin white topping", First Revision, Indian Roads Congress, New Delhi, 2015.

[13] IS: 516."Indian standard methods of tests for strength of concrete." Bureau of Indian Standards, 1959.

[14] Jundhare D.R, Khare K.C, Jain R.K (2012), Ultra-Thin White-topping in India: State of Practice, ACEE Int. J. on Transportation and Urban Development, Vol. 2, No. I, April 2012.

[15] Michael E. Ayers & Dale Harrington, Selection and use of concrete overlays, The Indian Concrete Journal, May 2010.

[16] Mitesh D. Patel, Prof. P.S. Ramanuj, Bhavin Parmar, Akash Parmar "White topping as a rehabilitation method: a case study of budhel-ghogha road" International Journal of Advanced Engineering Research and Studies Vol. I/ Issue IV/ July-Sept, 2012.

[17] M S Nagakumar et al, "An Analytical Approach to Analysis of Concrete Overlay (White Topping) Over Flexible Pavement (Hot Mix Asphalt) using ANSYS Software " Civil Engineering Trends and Challenges for Sustainability (CTCS-2020)

[18] Purvesh A. Raval, Prof. Jayeshkumar Pitroda, "A Cost Effective Solution for Repair and Resurfacing of Distressed Asphalt Pavement by Coating of Ultra-Thin Whitetopping" International Journal of Advance Engineering and Research Development (IJAERD) Volume 1,Issue 5,May 2014.

[19] Rashmi S M, K Rajesh Kumar, Basavaraj Akki and I Rajasri Reddy, "Performance Studies on white topping layers over flexible pavement" IOP Conf. Series: Materials Science and Engineering 981032076, 2020.

[20] Raval Purvesh, Belani Darsh, Pitroda Jayeshkumar, A literature review on UTW pavements in Indian context, journal of international academic research for multidisciplinary, volume 1, issue 9, pp 256-268, October2013.

[21] SINHA, Whitetopping-a Cost-Effective RehabilitationIRC, no. 538, 2007.

[22] S. Sultana Extending asphalt pavement life with thinwhite topping 2015.

BIOGRAPHIES

Name: Anusha H R
USN: 4MH19CV402
E-mail: anushahr31@gmail.com

Name: Darshan Gowda
HUSN: 4MH18CV019
E-mail: darshanhgowda47@gmail.com

Name: Nachiketh C
NUSN:
4MH18CV060
E-mail: nachikethcn93@gmail.com

Name: Sindhu M
USN: 4MH18CV100
E-mail: msindhu0007@gmail.com

Name: Shankaregowda
E-mail: sgowda1991@gmail.com