# Design and Execution of Thin White Topping Road

Mr.Shaikh Adil Nooruddin [1], Mr.samiullah[2], Mr.Mohd Safiuddin[3]

[#1,#2] *B.tech final year student, Department of Civil Engineering, Lords Institute of Engineering & Technology, Hyderabad*

[#3] *Associate Professor and HOD, Department of Civil Engineering, Lords Institute of Engineering & Technology, Hyderabad*

***Abstract***

*India has a second largest road network after USA and it is still called as a developing country. The reason is the poor condition of roads. Most of our roads are bituminous type, which have short life because of failures in the form of fatigue cracking, rutting and early signs of distresses. These distresses get more pronounced in hot climatic regions like India as bitumen is highly sensitive to temperature. White topping is the solution to such problem. Concrete is known to be relatively stiffer material and less sensitive to high temperature which gives better performance against rutting and cracking and also in terms of rehabilitation and repair. White topping over the bituminous pavement provides better durability, strength and additional life of 20-30 years. The objective of the project is to investigate experimentally by following the properties of mix concrete with varying percentage of fly ash as per Indian Road Congress (IRC) guidelines.*

**Keywords:** *Fiber Reinforced Concrete, Thin White topping, fly ash*

## I. INTRODUCTION

Most of the Indian roads are of bituminous type, with increasing truck weight and tyre pressure on pavement the surface of road is getting deteriorated many times which is subjected to rutting, shoving, cracking and formation of pits and pot holes. The current practices to overcome such problems are patching the bitumen which keeps on increasing the thickness of the pavement thus affecting the traffic and unpleasant driving conditions. The repairing and maintenance of bituminous pavement will be increasing in a very exorbitant way as the petroleum resources are depleting abundantly. In short period of time there will be no bitumen available even to repair the existing bitumen pavement. Roads are deteriorated many times due to poor construction practices. The white topping technology is very useful in such situation as it has great strength than asphalt overlay and many benefits compared to bituminous pavement. White topping is the overlaying of Portland cement concrete (PCC) over an existing distressed asphalt pavement. Concrete overlaying is a major rehabilitation technique for providing strong, long life, low maintenance to old pavement structure. There are three types of white topping depending on the thickness: a) Conventional White Topping b) Thin White Topping (TWT) c) Ultrathin White Topping (UTWT). Conventional white topping is a type of overlaying of concrete over an existing bitumen pavement where bond between the concrete and bitumen pavement is not needed. It has a thickness above 200mm which is generally preferred for National highways with heavy loaded vehicles. Thin white topping is a type of overlaying which can be constructed with or without bond between the concrete and bitumen pavement. It has a thickness between 100- 200mm which is generally preferred for city roads and medium traffic highways. Ultra thin white topping is a type of overlaying where bond between the concrete and bitumen pavement is needed. It has a thickness below 100mm which is generally preferred for village roads, parking lots and colony internal roads.

## II. RAW MATERIAL

### 1) *Cement*

An ordinary Portland cement of brand JK of type OPC 43 grade was used as binder.
As per IS 8112:1989. 465kg/$m^3$ of minimum cementations material was used As per IS 456-2000. Physical properties of cement are shown in table 1

### 2) *Robo Sand*

Robo Sand of size 600 micron of zone ii was used as replacement of river sand. As the demand for Natural River sand is surpassing the availability, has resulted in fast depletion of natural sand sources. It is produced by crushing stone, gravel, or slag. It is used for aggregate material less than 4.75 mm. Robo sand is a material of high quality, in contradiction to non-refined surplus from coarse aggregate production.

**Table 1 Physical Properties of Cement**

| Sr. no | Properties | Cement | Standards |
|---|---|---|---|
| 1 | Compressive Strength (MPa)<br>28 days<br>7 days<br>3 days | <br><br>Min 45.0<br>Min 35.0<br>Min 25.0 | <br><br>IS 4031:1989 (Pt.6) |

| | | | |
|---|---|---|---|
| **2** | Setting time (min)<br>Initial<br>Final | 90 -120<br>Max 200 | IS 4031:1988 (Pt.5) |
| **3** | Fineness | Min 2850 | IS 4031:1988 (Pt.2) |
| **4** | Soundness<br>Le-Chatelier expansion (mm)<br>Autoclave expansion (%) | Max 2.0<br>Max 0.10 | IS 4031:1988 (Pt.3) |

### *3) Coarse Aggrigate*

Coarse aggregate of angular shape of size 20mm was used. The physical properties of coarse aggregate like specific gravity, water adsorption, impact value, flakiness index and elongation index are tested in accordance with IS: 2386. As shown in table 2

**Table 2 Physical Properties of Coarse Aggregate**

| Type of test | 20mm size | Standard value |
|---|---|---|
| **Specific gravity** | 2.79 | 2.6 to 2.8 |
| **Water adsorption** | 2% | Not more than 3% |
| **Impact value** | 15.3 | Not more than 45% |
| **Flakiness index** | 14.96% | Not more than 40-45% |
| **Elongation index** | 31.28% | Not more than 40-45% |

### *4) Fly Ash*

Class F fly ash of different variations 20%, 25%, 30% and 35% was used as replacement of cement.fly ash not only reduces the cost of cement but also have properties to increase the workability, compressive strength and resistance to alkali silica reaction. Class F fly ash is pozzolanic in nature, and contains less than 7% lime (CaO). It requires a cementing agent, such as Portland cement, quicklime, or hydrated lime mixed with water to react and produce cementations compounds.

### *5) Polypropylene Fibers*

900 gm/m$^3$ of fibrillated Polypropylene fibers were used in concrete mix. Polypropylene fibers are inert to chemical reaction and they do not absorb water. They have high melting point of 165$^0$C and can withstand temperatures of over 100$^0$ C for short periods of time before softening. The addition of fibers in concrete mix bridges the cracks and restrains them from further opening this gains the addition strength to the concrete.

**Table 3 Properties of Polypropylene Fibers**

| Fiber type | Fibrillated |
|---|---|
| **Length (mm)** | 6 |
| **Diameter (mm)** | 0.25 |
| **Tensile strength (Mpa)** | 392.26 |
| **Modulus of elasticity (Gpa)** | 7 |
| **Density (kg/m³)** | 946 |

### *6) Water*

The water used in the concreting work was the tap water as supplied in the concrete laboratory of our college. 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. The water cement ratio used was 0.4 and maximum water content for nominal size of course aggregate was 160 liters as per IS 10262-2009

## III. MIX DESIGN

Five Mix designs were used in this project one with plain cement concrete (PCC) and another with fiber reinforced concrete (FRC) with different variations of fly ash 20%, 25%, 30% and 35%. Polypropylene fibers were added to concrete mix as 900gm/m$^3$ with water cement ratio of 0.4. Different mix design ratio of variation of fly ash are shown in table 4

**Table 4: Mix Design Ratio for Different Variations**

| Variations | Mix design |
|---|---|
| **20%** | 1:1.40:2.46 |
| **25%** | 1:1.39:2.45 |
| **30%** | 1:1.38:2.44 |
| **35%** | 1:1.37:2.43 |
| **PCC** | 1:1.20:2.52 |

## IV. METHODOLOGY

Concrete specimens were casted with different variation of fly ash 20%, 25%, 30% and 35%. Cubical specimens of size 150mm x 150mm x 150mm were casted and tested for compressive strength, Cylinder specimens of size 150mm x 300mm were casted and tested for tensile strength, Beam specimens of size 100mm x100mm x 500mm were casted and tested for flexural strength. The entire test was tested for 7, 14 and 28 days respectively and Slump cone was also tested for workability of concrete.

## V. RESULTS AND TABLES

### 1) *Plain Cement Concrete (PCC) Cube Testing:*

**Table 5: Compressive Strength of (PCC) Cube Specimens**

| Cube No. | Curing day | Failure load (KN) | Compressive strength (N/mm$^2$) | Average Compressive strength (N/mm$^2$) |
|---|---|---|---|---|
| **S1** | 7 | 615 | 27.33 | |
| **S2** | 7 | 505 | 22.44 | 24.44 |
| **S3** | 7 | 530 | 23.55 | |
| **S4** | 14 | 690 | 30.66 | |
| **S5** | 14 | 765 | 34.00 | 33.10 |
| **S6** | 14 | 780 | 34.66 | |
| **S7** | 28 | 960 | 42.66 | |
| **S8** | 28 | 900 | 40.00 | 40.44 |
| **S9** | 28 | 870 | 38.66 | |

### 2) *Fiber Reinforced Concrete (FRC) Cube Testing:*

**Table 6: Compressive Strength of 20% of Fly Ash (FRC) Cube Specimens**

| Cube No. | Curing day | Failure load (KN) | Compressive strength (N/mm$^2$) | Average Compressive strength (N/mm$^2$) |
|---|---|---|---|---|
| **S1** | 7 | 645 | 28.6 | |
| **S2** | 7 | 600 | 26.6 | 28.36 |
| **S3** | 7 | 670 | 29.7 | |
| **S4** | 14 | 890 | 39.55 | |
| **S5** | 14 | 945 | 42.00 | 40.88 |
| **S6** | 14 | 925 | 41.11 | |
| **S7** | 28 | 1190 | 52.88 | |
| **S8** | 28 | 1130 | 50.22 | 49.84 |
| **S9** | 28 | 1045 | 46.44 | |

**Table 7: Compressive Strength of 25% of Fly Ash (FRC) Cube Specimens**

| Cube No. | Curing day | Failure load (KN) | Compressive strength (N/mm$^2$) | Average Compressive strength (N/mm$^2$) |
|---|---|---|---|---|
| **S1** | 7 | 645 | 28.6 | |
| **S2** | 7 | 600 | 26.6 | 28.36 |
| **S3** | 7 | 670 | 29.7 | |
| **S4** | 14 | 890 | 39.55 | |
| **S5** | 14 | 945 | 42.00 | 40.88 |
| **S6** | 14 | 925 | 41.11 | |
| **S7** | 28 | 1190 | 52.88 | |
| **S8** | 28 | 1130 | 50.22 | 49.84 |
| **S9** | 28 | 1045 | 46.44 | |

**Table 8: Compressive Strength of 30% of Fly Ash (FRC) Cube Specimens**

| Cube No. | Curing day | Failure load (KN) | Compressive strength (N/mm$^2$) | Average Compressive strength (N/mm$^2$) |
|---|---|---|---|---|
| **S1** | 7 | 430 | 19.1 | |
| **S2** | 7 | 440 | 19.5 | 21.23 |
| **S3** | 7 | 565 | 25.1 | |
| **S4** | 14 | 720 | 32.00 | |
| **S5** | 14 | 680 | 30.22 | 30.37 |
| **S6** | 14 | 650 | 28.89 | |
| **S7** | 28 | 920 | 40.89 | |
| **S8** | 28 | 890 | 39.55 | 39.77 |
| **S9** | 28 | 875 | 38.88 | |

**Table 9: Compressive strength of 35% of fly ash (FRC) cube specimens**

| Cube No. | Curing day | Failure load (KN) | Compressive strength (N/mm$^2$) | Average Compressive strength (N/mm$^2$) |
|---|---|---|---|---|
| **S1** | 7 | 385 | 17.1 | |
| **S2** | 7 | 400 | 17.7 | 17.06 |
| **S3** | 7 | 370 | 16.4 | |
| **S4** | 14 | 580 | 25.50 | |
| **S5** | 14 | 625 | 27.77 | 26.2 |
| **S6** | 14 | 570 | 25.33 | |
| **S7** | 28 | 795 | 35.33 | |
| **S8** | 28 | 880 | 39.11 | 37.7 |
| **S9** | 28 | 870 | 38.66 | |

### 3) *Fiber Reinforced Concrete (FRC) Tensile Strength:*

**Table 10: Tensile Strength of Variations of Fly Ash (FRC) Cylinder Specimens**

| Cube No. | Fly ash | Curing day | Failure load (KN) | Tensile strength (N/mm$^2$) | |
|---|---|---|---|---|---|
| | | | | **14day** | **28day** |
| S1 | 20% | 14 | 230 | 3.25 | - |
| S2 | 20% | 28 | 280 | - | 3.96 |
| S1 | 25% | 14 | 200 | 2.83 | - |
| S2 | 25% | 28 | 275 | - | 3.82 |
| S1 | 30% | 14 | 150 | 2.12 | - |
| S2 | 30% | 28 | 180 | - | 2.54 |
| S1 | 35% | 14 | 120 | 1.69 | - |
| S2 | 35% | 2 8 | 165 | - | 2.33 |

**Table 11: Flexural Strength of Variation of Fly Ash (FRC) Beam Specimens**

| Cube No. | Fly ash | Curing Day | Failure load (KN) | flexural strength (N/mm$^2$) |
|---|---|---|---|---|
| | | | | **28day** |
| **S1** | 20% | 28 | 12 | 6 |
| **S1** | 25% | 28 | 11.5 | 5.75 |
| **S1** | 30% | 28 | 9 | 4.5 |
| **S1** | 35% | 28 | 7 | 3.5 |

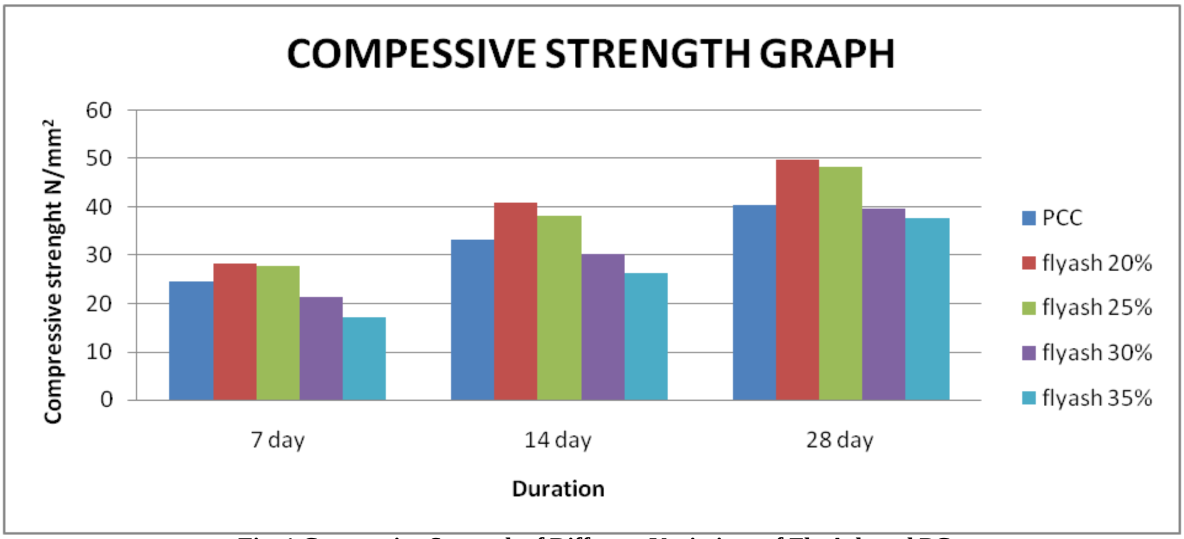


**Fig. 1.Compessive Strength of Different Variations of Fly Ash and PC**

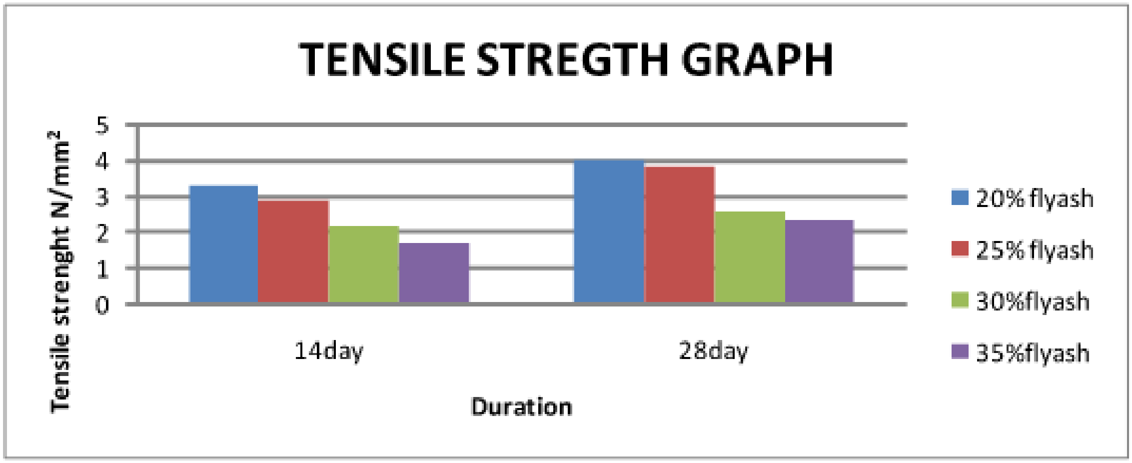


**Fig. 2.Tensile Strength of Different Variations of Fly Ash**

## VI. DISCUSSION

During the hydration process of cement, lime is released out and remains as surplus in the hydrated cement. The leached out surplus lime affects to concrete such that it makes the concrete porous and develops micro- cracks, weakening the bond with aggregates and thus affects the durability of concrete. Addition of fly ash in concrete mix makes the surplus lime becomes the source for pozzolanic reaction with fly ash and forms additional C-S-H gel having similar binding properties in the concrete as those produced by hydration of cement paste. The compression and tensile strength increases with addition of polypropylene fibers and reduces the formation of cracks, plastic shrinkage, settlement and water permeability. The compressive strength of 20% and 25% fly ash was increased by 18.86% and 16.49% respectively; however the compressive strength of 30% and 35% fly ash was decreased by 1.65% and 6.77% when compared to ordinary mix at 28 days.

## VII.CONCLUSION

- Polypropylene improves homogeneity of the concrete by reducing segregation of aggregates.
- Polypropylene fibers reduce the, plastic shrinkage, settlement and water permeability.
- Polypropylene fibers enhance the strength of concrete, without causing problems associated with steel fibers.
- The addition of fly ash for long life term improves the concrete strength.
- The concrete workability was improved with addition of fly ash.
- 30% and 35% fly ash shows increase of initial setting time up to 2 hours.
- Higher fly ash cement replacement in concrete reduces the comprehensive strength.
- Fly ash reduces the heat of hydration in concrete. 35% of fly ash results in a reduction of 55-65% heat of hydration.

## REFERANCES


[1] Jundhare, D. R., Khare, K. C., & Jain, R. K. (2012). Ultra-Thin Whitetopping in India: State-of-Practice. ACEE Int. J. on Transportation and Urban Development, 2(1).

[2] Madhavi, D. T. C., Raju, L. S., & Mathur, D. (2014, June). Polypropylene Fiber Reinforced Concrete-A Review. In International Conference on Advances in Civil Engineering and Chemistry of Innovative Materials (ACECIM'14) (pp. 114-9).

[3] Sehgal, A. K., & Sachdeva, S. N. A review of using thin white topping overlays for rehabilitation of asphalt pavements. Journal of Basic and Applied Engineering Research Print ISSN, 2350-0077.

[4] Raval, P. A., & Pitroda, J. A Cost Effective Solution for Repair and Resurfacing of Distressed Asphalt Pavement by Coating of Ultra-Thin Whitetopping.

[5] Sivaramakrishna, U., & Satishkumar, D. A Study On Design Concepts Of Ultra Thin White Topping For Village Roads In India.

[6] Peer, S., Mamatha, K. H., Shivaprakash, B. G., & Dinesh, S. V. Pavement evaluation and rehabilitation using concrete overlays for low volume roads.

[7] Hussein, L., & Amleh, L. (2015). Structural behavior of ultra-high performance fiber reinforced concrete-normal strength concrete or high strength concrete composite members. Construction and Building Materials, 93, 1105-1116.

[8] Patel, M. J., & Kulkarni, S. M. (2012). Effect of Polypropylene Fibre on The High Strength Concrete. Journal of Information, Knowledge And Research in Civil Engineering, 2(2), 127.