International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

A Study on Design and Execution of White Topping Road

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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, White topping, fly ash, Polypropylene Fibers

1. 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.

2. Raw Materials

2.1Cement

An ordinary Portland cement of brand JK of type OPC 43 grade was used as binder. As per IS 8112:1989. 465kg/m3 of minimum cementations material was used as per IS 456-2000. Physical properties of cement are shown in table

Sr.no	*Properties*	*Cement*	*standards*
1	Compressive Strength (MPa) 28 days 7 days 3 days	 Min45.0 Min35.0 Min25.0	IS4031:1989 (Pt.6)
2	Setting time (min) Initial Final	 90 -120 Max 200	IS 4031:1988 (Pt.5)
3	Fineness	Min 2850	IS 4031:1988 (Pt.2)
4	Soundness Le-Chatelier expansion (mm) Autoclave expansion (%)	 Max 2.0 Max 0.10	IS 4031:1988 (Pt.3)

2.2 Fine aggregate

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. sand is a material of high quality, in contradiction to non-refined surplus from coarse aggregate production.

2.3 Course aggregate

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

Type of test	20mm size	Standards
Specific gravity	2.79	2.6 to 2.8
Water absorption test	2%	Not more than 3%
Impact value	15.3	Not more than 45%
Flakiness index	14.96	Not more than 40-45%
Elongation index	32.28%	Not more than 40-45%

2.4 Fly ash

Class F fly ash of different variations 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.

2.5 Polypropylene

900 gm/m3 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 1650C and can withstand temperatures of over 1000 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.

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/m^3)	946

2.6 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.

3. Mix Design

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 Polypropylene fibers were added to concrete mix as 900gm/m3 with water cement ratio of 0.4. Different mix design ratio of variation of fly ash.

4. Methodology

Concrete specimens were casted with different variation of fly ash. 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.

5. Results and tables

Table 1: Compressive Strength of (PCC) Cube Specimens

Cube No.	Curing day	Weight of cube (Kg)	Failure load (KN)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
S1	7	7.35	615	27.33	
S2	7	6.84	505	22.44	24.44
S3	7	7.21	530	23.55	
S4	14	8.12	690	30.66	
S5	14	8.23	765	34.00	33.10
S6	14	7.43	780	34.66	
S7	28	8.25	960	42.66	
S8	28	8.21	900	40.00	40.44
S9	28	7.63	870	38.66	

Table 2: Compressive Strength of 05% of Fly Ash (FRC) Cube Specimens

Cube No	Curing day	Weight of cube(kg)	Failure load(KN)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
S1	7	8.23	648	28.8	
S2	7	8	520	23.1	27.32
S3	7	8.01	677	30.08	
S4	14	8.04	900	40	
S5	14	7.89	935	41.55	40.96
S6	14	7.99	930	41.33	
S7	28	8.2	1090	48.44	
S8	28	8.11	1030	45.77	46.88
S9	28	7.98	1045	46.44	

Table 3: Compressive Strength of 10% of Fly Ash (FRC) Cube Specimens

Cube No.	Curing day	Weight of cube (Kg)	Failure load (KN)	Compressive strength (N/mm^2)	Average
S1	7	8.42	540	24.00	
S2	7	8.50	600	26.66	24.81
S3	7	8.00	535	23.77	
S4	14	8.10	868	38.57	
S5	14	7.67	907	40.31	39.58
S6	14	8.45	897	39.86	
S7	28	9.00	1090	48.44	
S8	28	7.80	1045	46.44	47.89
S9	28	8.99	1098	48.80	

Table 4: Compressive Strength of 15% of Fly Ash (FRC) Cube Specimens

Cube No.	Curing day	Weight of cube (Kg)	Failure load (KN)	Compressive strength (N/mm^2)	Average
S1	7	7.88	673	29.91	
S2	7	7.80	590	26.22	26.79
S3	7	8.45	546	24.26	
S4	14	8.45	802	35.64	
S5	14	7.68	879	39.06	38.52
S6	14	7.90	920	40.88	
S7	28	8.65	1033	45.91	

Table 5: Compressive Strength of 20% of Fly Ash (FRC) Cube Specimens

Cube No.	Curing day	Weight of cube (Kg)	Failure load (KN)	Compressive strength (N/mm^2)	Average
S1	7	8.13	645	28.6	
S2	7	8.03	600	26.6	28.36
S3	7	8.23	670	29.7	
S4	14	8.01	890	39.55	
S5	14	7.99	945	42.00	40.88
S6	14	7.96	925	41.11	
S7	28	8.12	1190	52.88	
S8	28	8.09	1130	50.22	49.84
S9	28	7.97	1045	46.44	

Table 6: Compressive Strength of 25% of Fly Ash (FRC) Cube Specimens

Cube No.	Curing day	Weight of cube (Kg)	Failure load (KN)	Compressive strength (N/mm^2)	Average
S1	7	7.80	595	26.40	
S2	7	7.89	620	27.50	27.73
S3	7	7.53	660	29.30	
S4	14	8.08	780	34.66	
S5	14	7.69	845	37.55	38.21
S6	14	8.03	955	42.44	
S7	28	7.74	1095	48.66	
S8	28	7.96	1120	49.77	48.43
S9	28	7.79	1055	46.88	

Table 7: Compressive Strength of 30% of Fly Ash (FRC) Cube Specimens

Cube No	Curing day	Weight of cube(kg)	Failure load(KN)	Compressive strength(N/mm^2)	Average
S1	7	8.01	445	19.77	
S2	7	7.33	532	23.64	22.70
S3	7	7.25	556	24.71	
S4	14	7.86	728	32.35	
S5	14	7.39	710	31.55	32.17
S6	14	6.99	734	32.62	
S7	28	7.91	1020	45.33	
S8	28	7.16	990	44.00	45.13
S9	28	7.67	1037	46.08	

Table 8: Compressive Strength of 35% of Fly Ash (FRC) Cube Specimens

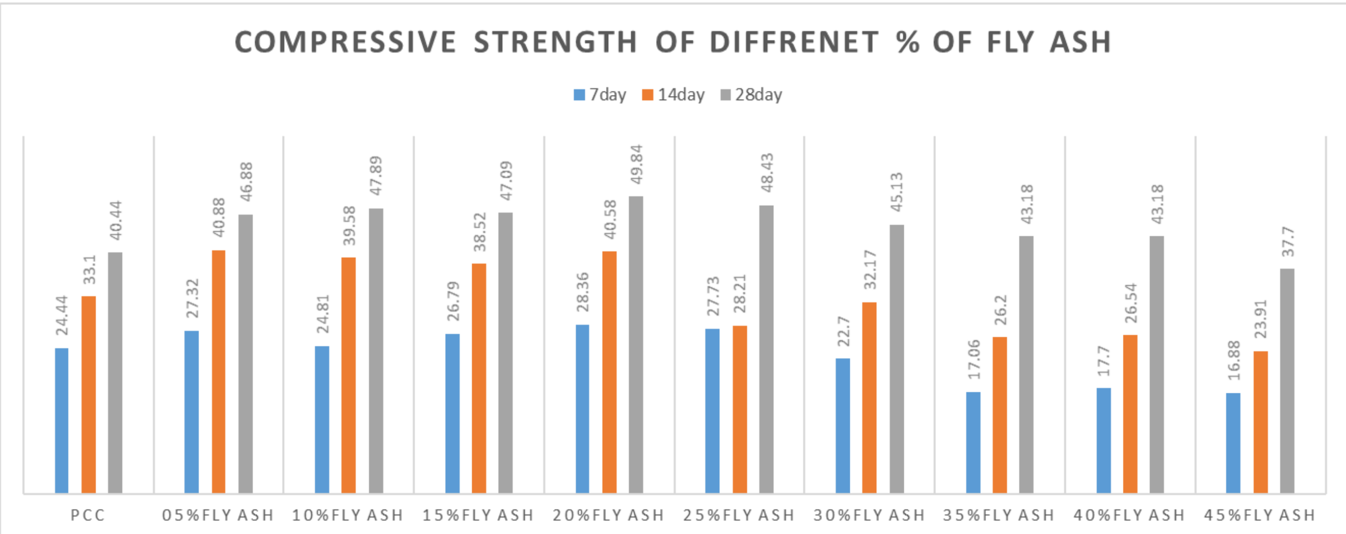
Cube No	Curing day	Weight of cube(kg)	Failure load(KN)	Compressive strength(N/mm^2)	Average
S1	7	7.67	450	17.10	
S2	7	7.33	455	17.70	17.06
S3	7	7.20	500	16.40	
S4	14	7.75	675	25.50	
S5	14	7.61	610	27.77	26.20
S6	14	7.39	700	25.33	
S7	28	7.44	975	43.33	
S8	28	7.14	960	42.66	43.18
S9	28	7.84	980	43.55	

Table 9: Compressive Strength of 40% of Fly Ash (FRC) Cube Specimens

Cube No	Curing day	Weight of cube(kg)	Failure load(KN)	Compressive strength(N/mm^2)	Average
S1	7	7.56	395	17.55	
S2	7	7.23	410	18.22	17.70
S3	7	7.89	390	13.33	
S4	14	7.75	592	26.31	
S5	14	7.92	610	27.11	26.54
S6	14	7.58	590	26.22	
S7	28	7.39	845	37.55	
S8	28	7.40	890	39.55	39.32
S9	28	8.10	920	40.88	

Table 10: Compressive Strength of 45% of Fly Ash (FRC) Cube Specimens

Cube No	Curing day	Weight of cube(kg)	Failure load(KN)	Compressive strength(N/mm^2)	Average
S1	7	7.67	390	17.33	
S2	7	7.33	345	15.33	16.88
S3	7	7.20	405	18.00	
S4	14	7.75	580	25.77	
S5	14	7.61	546	24.26	23.91
S6	14	7.39	490	21.77	
S7	28	7.44	795	35.33	
S8	28	7.14	880	39.11	37.7
S9	28	7.84	870	38.66	



Compressive strength of different variations of fly ash and PCC

6. Conclusion

White topping overlay is considered more environmentally and economically sustainable as compared to asphalt pavements. These concrete overlays do not require maintenance or repair for a longer duration and, therefore, consume fewer raw materials as compare to conventional bituminous pavement.

With additional points as follow;

- 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.
- The compressive strength of 05% ,10% and 15% increased as compared to ordinary mix at 28days. but the amount of fly ash is very less that's why I am doing some more test on with different percentage of fly ash.
- In 20%, 25%,30% and 35% fly ash was increased by 24.6%,21.07%.12.81% and 7.91% respectively; however, the compressive strength of 40% and 45% fly ash was decreased by 1.71% and 5.75% when compared to ordinary mix at 28 days.

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