Improvement of concrete by using Alternative Materials for conventional ones for thin and ultrathin white topping pavement

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Abstract—Concrete has been a widely used building material for centuries. Designing against impact and large loads continues to be one of the engineering profession's top priorities with regard to the safety and expansion of brittle and obsolete infrastructure as well as the safety of road traffic. Impact loads could pose a severe threat to our built environment and have disastrous effects. Therefore, structures must be made more resilient to impact and have their ability to absorb energy boosted. Standard concrete materials need to be replaced for a structure to have better load transmission, ductility, and compressive strength. This study examines the impacts of adopting several alternatives to conventional concrete in terms of strength, material use, and ultimately the influence on construction costs. In order to create Thin White Topping, Ultrathin White Topping, and other concrete projects in high- and low-traffic areas, it is necessary to know the correct mix ratio of fibres and plastic in concrete. Knowing the proper mix ratio of plastic and fibres in concrete is essential when producing Thin White Topping, Ultrathin White Topping, and other concrete projects in high- and low-traffic regions.

Index Terms—Thin White Topping, Ultrathin White Topping, Copper slag, Rice husk ash, Polypropylene terephthalate, glassfibers

I. INTRODUCTION

Impact loads could pose a severe threat to our built environment and have disastrous effects. These impact pressures can also be caused by debris hurled at structures during a storm, fallen trees, and car crashes in addition to impacts from heavy vehicles impacting bridge piers. The structures used in airports, highway pavements, concrete guardrails, industrial floors, wall panels, base pads, and shock absorbers that are subject to abrupt and excessive loading conditions must thus be strengthened against impact and improved in terms of energy absorption capacity. The nation's existing road network is experiencing more traffic congestion as a result of the rapid urbanization and industrialization. India's road network is used to convey more than two thirds of all commodities. The majority of pavement degradation is brought on by constant wheel loads, temperature variations, and other environmental conditions. "White topping" refers to the process of applying a layer of cement concrete over asphalt pavement. A thin white topping is a bonded layer of concrete that is between 100 and 150 mm thick, whereas an ultrathin layer is between 50 and 100 mm thick. For worn-out, rut-damaged asphalt pavements, ultrathin white topping (UTW) is preferred.

Research Objective

- Should look into substitutes for concrete that won't affect the quality of the thin and ultrathin white topping, such as fly ash, glass fibres, copper slag, rice husk ash, and polyethylene terephthalate.
- To determine the ideal ratio of alternative materials used in thin and ultrathin white topping for concrete (fly ash, glass fibres, copper slag, rice husk ash, etc.).

Methodology

Identification of Sources → Collection of Samples → Testing (Geological, Physical & Mechanical Properties) → Preparing MIX Design → Result Analysis and interpretation → Laboratory Compressive Strength Test of Concrete cubes → Curing of Concrete cubes → Mixing and Concrete Cube Casting

Thin and Ultrathin White Topping Concept —

Our bituminous roads, which make up the majority of them, have a short lifespan due to defects including fatigue cracking, rutting, and early indications of distress. These issues are even worse in hot areas like India since bitumen is particularly temperature sensitive.
Applying a coating of Portland cement concrete over an existing asphalt pavement is known as "white topping." For the thin white topping, a layer of bonded concrete 10-15cm (4-6") thick is employed. A layer that is ultrathin ranges in thickness from 5 to 10 cm (2-4").

**Data collection and Analysis**

**Materials Used**
- Coarse aggregate
- Fine aggregate
- Cement
- Water
- Glass fibers
- Fly ash
- Copper Slag
- Rice husk Ash
- Polyethylene terephthalate

**Steps for Concrete Mix Design as Per IS10262:2019**

- Stipulations for proportioning
- Test data for materials
- Target strength for mix proportioning
- Approximate air content
- Selection of water cement ratio
- Selection of water content
- Calculation of cement and fly ash content
- Proportion of volume of coarse aggregate and fine aggregate

**Mix proportion for trial number 1**
- Cement = 376 kg/m³
- Fly ash = 161 kg/m³
- Water (Net mixing) = 192 kg/m³
- Fine aggregate (SSD) = 677 kg/m³
- Coarse aggregate (SSD) = 1003 kg/m³
- Free water- cementitious materials ratio = 0.357

MIX PROPORTION= 1:1.8:2.66

**Mix Proportion for Trial No. 2 Use Of Glass Fibers**
- Cement = 376 kg/m³
- Fly ash = 161 kg/m³
- Water = 192 kg/m³
- Course Aggregate = 1003 kg/m³
- Glass fiber = 2% of fine aggregate = (2/100) * 677 = 13.54 kg/m³

MIX Proportion = 1:1.8:2.66:2% fiber

**Mix Proportions for trail 3 (Copper slag and Rice husk ash)**
- Cement = 9.785 kg
- Rice husk = 10% of cement content = 1.0872 kg
- Water = 3.88 Lit
- Course Aggregate = 20.31 kg
- Fine Aggregate = 6.84 kg
- Copper Slag = 50% of Fine Aggregate = 6.84 kg

MIX Proportion = 1:1.4:2.07:10% rice husk

**Mix Proportions for trail 4 (Polyethylene terephthalate and Rice husk ash)**
- Coarse Aggregate = 20.31 kg
- Fine Aggregate = 12.312 kg
- Water = 3.88 Lit
- Cement = 9.785 kg
- Rice husk = 10% of Cement content = 1.0872 kg
- Polyethylene terephthalate = 5% of Fine Aggregate = 1.368 kg

MIX Proportion = 1:1.4:2.07:10% rice husk

**Cube casting procedure**
- Preparation of mould- Moulds (150*150*150) mm in size are cleaned and greased
- Weighing materials
- Prepare mix of concrete
Fill mould in three layers
De mould cubes after 24 hrs
Keep cubes for curing in water

RESULT AND DISCUSSION

Trial 1

<table>
<thead>
<tr>
<th>Specimen 1 @ 7 days</th>
<th>Specimen 2 @ 7 days</th>
<th>Specimen 3 @ 14 days</th>
<th>Specimen 4 @ 14 days</th>
<th>Specimen 5 @ 24 days</th>
<th>Specimen 6 @ 24 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max load that specimen bear (KN)</td>
<td>730</td>
<td>725</td>
<td>980</td>
<td>982</td>
<td>992</td>
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<tr>
<td>Average load</td>
<td>727.5</td>
<td>727.5</td>
<td>981</td>
<td>981</td>
<td>991</td>
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<tr>
<td>Compressive strength (N/mm²)</td>
<td>32.33</td>
<td>32.33</td>
<td>43.6</td>
<td>43.6</td>
<td>44.04</td>
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<tr>
<td>Maximum strength to be achieved at different days</td>
<td>65 % @ 7 days=32.5</td>
<td>65 % @ 7 days=32.5</td>
<td>90% @ 14 days=45</td>
<td>90 % @ 14 days=45</td>
<td>99 % @ 24 days=49.5</td>
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Trial 2 –

<table>
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<th>Specimen 1 @ 7 days</th>
<th>Specimen 2 @ 7 days</th>
<th>Specimen 3 @ 14 days</th>
<th>Specimen 4 @ 14 days</th>
<th>Specimen 5 @ 24 days</th>
<th>Specimen 6 @ 24 days</th>
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<tbody>
<tr>
<td>Max load that specimen bear (KN)</td>
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<td>530</td>
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<td>778</td>
<td>785</td>
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<tr>
<td>Average Load</td>
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<td>776.5</td>
<td>776.5</td>
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<tr>
<td>Compressive strength (N/mm²)</td>
<td>23.88</td>
<td>23.88</td>
<td>34.51</td>
<td>34.51</td>
<td>35</td>
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<td>Maximum strength to be achieved at different days</td>
<td>65 % @ 7 days=32.5</td>
<td>65 % @ 7 days=32.5</td>
<td>90% @ 14 days=45</td>
<td>90 % @ 14 days=45</td>
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Result Of Trial 3-

<table>
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<th>Specimen 1 @ 7 days</th>
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<th>Specimen 3 @ 14 days</th>
<th>Specimen 4 @ 14 days</th>
<th>Specimen 5 @ 28 days</th>
<th>Specimen 6 @ 28 days</th>
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<tbody>
<tr>
<td>Max load that specimen bear (KN)</td>
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<td>65 % @ 7 days=32.5</td>
<td>65 % @ 7 days=32.5</td>
<td>90% @ 14 days=45</td>
<td>90 % @ 14 days=45</td>
<td>99 % @ 28 days=49.5</td>
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Trial no. 4-

<table>
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<th>Specimen 1 @ 7 days</th>
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<th>Specimen 3 @ 14 days</th>
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<th>Specimen 5 @ 24 days</th>
<th>Specimen 6 @ 24 days</th>
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</thead>
<tbody>
<tr>
<td>Max load that specimen bear (KN)</td>
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<td>65 % @ 7 days=32.5</td>
<td>90% @ 14 days=45</td>
<td>90 % @ 14 days=45</td>
<td>99 % @ 24 days=49.5</td>
</tr>
</tbody>
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Conclusion-

- A quality concrete should display approximate minimum compressive strength at the appropriate days hence using concrete which contains flyash 10% of cement content is safe.
- A quality concrete should not display a minimum compressive strength at the appropriate days, using concrete which contain flyash 10% of cement and glass fibers 2% of fine aggregate is not safe.
- A quality concrete should display approximate minimum compressive strength at the appropriate days hence using concrete which contains Rice husk ash 10% of cement and copper slag 50% of fine aggregate is safe.
- A quality concrete should not display a minimum compressive strength at the appropriate days, using concrete which contain Rice husk ash 10% of cement and polypropylene terephthalate 5% of fine aggregate is not safe.

REFERENCES