STRUCTURAL STRENGTH ENHANCEMENT OF RIGID PAVEMENT USING SCRAP STEEL FIBRE REINFORCEMENT

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Abstract: There is developing enthusiasm for the development of Rigid Pavements, because of its high strength, toughness, better and usefulness and in general economy over the long run. The push these days is to create more slender and green pavement segments of better quality, which can carry heavy loads. These rigid pavements may sometimes experience pavement distress that results in premature failure. This research studies the application of fibers in concrete due to its enhancement resistance to cracking. Now–a-days steel fibers in concrete increase intensively as an engineering demand. The high strength scrap steel fiber concrete is having compressive strength more than 40 MPa, This research works assess on the study of the workability and mechanical strength properties of the concrete reinforced with industrialized waste fibers and The main Objective of the study is to find out effect of change of percentage of fibers in concrete mix proportion and find out thickness reduction of concrete slab with respect to loading. In this study, Cement is replaced with the scrap steel in the range of 0%, 0.6 %, 1.2%, 1.8 % and 2.4% by weight.

Keywords: Optimum percentage of steel scrap, Maintenance, Fatigue Life, sustainability, Flexural strength, workability, Tensile strength

1.1 INTRODUCTION

Right now India has taken a noteworthy activity on developing the infrastructures, for example, express Highways, power projects, ports and harbors, to meet the necessities of globalization, in the development of asphalts and different structures concrete assumes the key part and an extensive quantum of concrete is being used in each development homes. In structural designing, because of urbanization the interest for development materials increments, with the expansion sought after there is a solid need to use elective materials for practical improvement anyway the mindful administration of waste is a basic part of manageable building. There are various alternative materials such as Fly ash, Recron fibre, and scrap steel fibre, GGBS, Foundary sand, waste plastic etc.

Steel fibers have been needed for a large time in construction of roads and also in floorings, especially where more wear and tear is come into picture. Specifications and nomenclature are crucial for a material to be utilized as the tenders are invited based on specifications and nomenclature of the items. In a place where steel fiber reinforced concrete was applied for overlays like flooring, adopting nomenclature can be taking up for concreting of small thickness.
The purpose of concrete mix design is to ensure the most optimum properties of the constituent materials to meet the requirements of the structure being built. Mix design should ensure that the concrete:

- Complies with the specifications of structural strength laid down, which is usually stated in terms of the compressive strength of standard test specimens.
- Complies with the durability requirements to resist the environment in which the structure will serve its functional life.
- Be capable of being mixed, transported, and compacted as efficiently as possible without undue labour.
- And last, but not least, be as economical as possible.

### 1.3 STEEL SCRAP WASTE

Steel scrap used as fibre and its dimensions are average 1.5 mm thickness, average 25-30 mm length and 2 mm wide. The dimension of fiber varies from industry to industry. It is like a steel fiber but its properties are not same as steel fiber. The shape of steel scrap may be rectangular or twisted. Its shape depends upon industry and type of work done by industry.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Properties</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Shape</td>
<td>Corrugated</td>
</tr>
<tr>
<td>2.</td>
<td>Diameter</td>
<td>0.3-0.7mm (max 1mm)</td>
</tr>
<tr>
<td>No.</td>
<td>Property</td>
<td>Value</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>3.</td>
<td>Length</td>
<td>30 mm</td>
</tr>
<tr>
<td>4.</td>
<td>Density</td>
<td>78500 N/m³</td>
</tr>
<tr>
<td>5.</td>
<td>Young’s Modulus</td>
<td>2.1 x 10⁵ N/mm²</td>
</tr>
<tr>
<td>6.</td>
<td>Resistance to Alkalis</td>
<td>Good</td>
</tr>
<tr>
<td>7.</td>
<td>Resistance to Acids</td>
<td>Poor</td>
</tr>
<tr>
<td>8.</td>
<td>Heat resistivity</td>
<td>Good</td>
</tr>
<tr>
<td>9.</td>
<td>Tensile Strength</td>
<td>500-2000 N/mm²</td>
</tr>
<tr>
<td>10.</td>
<td>Specific Gravity</td>
<td>7.90</td>
</tr>
<tr>
<td>11.</td>
<td>Aspect Ratio</td>
<td>42</td>
</tr>
<tr>
<td>12.</td>
<td>General Use</td>
<td>10 kg/m³</td>
</tr>
<tr>
<td>13.</td>
<td>Thickness</td>
<td>0.7 mm</td>
</tr>
</tbody>
</table>

2.1 LITERATURE REVIEW ON SCRAP STEEL

Ms Dodle Prashantha et al did the study on Steel Fibre Reinforced Concrete Pavements for Roads. The purpose of Steel Fiber Reinforced Concrete (SFRC) as complex matrix is potentially reward from the point of opinion of its capacity to carry much larger stresses. Main aim of this study is to come out essence of change of percentage of fibres in concrete mix and getting out thickness simplification of concrete slab with regarding to loads coming on to the pavement. In this study, Experimental investigations and evaluation of results were conducted to observe the compressive & tensile behaviour of composite concrete with various percentages of such fibres delivered to it. The concrete mixes adopted have been M30 with varying percentage of fibres starting from 0.5, 1.0, 1.5 & 3%. The studies additionally establish that the residences of hardened SFRC, consisting of flexural electricity, are remarkably higher than those of conventional RCC. Thus, the use of metal fibre for powerful pavement construction can be cautioned undoubtedly.

Kolase Pramod K et al studied about the steel fiber reinforced concrete pavement. The paper reviews the studies, which establish the use of steel fiber in many effective ways improving the strength and an improvement in fatigue life of the pavement together with developing improved resistance to crack and et al., thus be considered as cost effective technology and design of road construction. The studies emphasize that fiber reinforcement in a cement bound road base has the potential to improve performance by improving fatigue life of the base and improved resistance to reflective cracking of the asphalt. The studies also establish that the properties of hardened SFRCC, such as flexural strength, are remarkably better than those of conventional RCC. Thus, the use of steel fiber for effective pavement construction can be suggested positively.
Shivam P. Darji et al analysed the compressive strength of concrete using steel scrap. This paper assesses the effective use of steel scrap in concrete. In this study, total 39 nos. concrete cubes of size 150 mm x 150 mm x 150 mm casted using steel scrap concrete grade M-20. Steel scrap used up to 2.4% by weight, at a gap of 0.2% (i.e. 0.2%, 0.4%, 0.6%, 0.8%, 1.0%, 1.2%, 1.4%, 1.6%, 1.8%, 2.0%, 2.2%, and 2.4%). As per Indian standard, after 28 days compressive strength test done on casted concrete cubes and test results are compared with plain cement concrete. The main objective of this study to find out optimum percentage of steel scrap in concrete up to which its compressive strength initially increased and then gradually decreased. At the end of the study, we found that up to 1.4% of steel scrap, compressive strength increased then after more percentage of steel scrap causes slight reduction in compressive strength.

Pooja Srivastava et al studied the reuse of Lathe Waste Steel Scrap in Concrete Pavements. This work focuses on the enhancement of structural strength and improvement in fatigue life of concrete pavements by reuse of scrap steel in concrete. These concrete roads with SSFRC promises an appreciably eminent design life, offer superior serviceability and minimize crack growth and corrosion. The pioneer idea of this work is the reuse of waste lathe scrap as recycled steel fibers, which provides more cost-effective and eco-friendly sustainable SFRC Pavements. However, results are found that mechanical properties of SSFRC increases up to addition of 1.5% fiber contents and on further increasing fiber contents it will decrease the strength. ACI and JSCE also recommend use of fiber contents up to 2% more than it needs further investigations. Due to increase in flexural strength of SFRC, fatigue behaviour of SFRC also analysis, stress ratio for SFRC obtained i.e. 0.65 to 0.90 and also IRC: SP-46-2013 recommends this stress ratio for SFRC pavements. With this results SSFRC are suitable for concrete pavements with flexural strength exceeds up to 40% and fatigue ratio 0.65 nominal.

3.1 MATERIALS

3.1.1 Cement
Ordinary Portland cement 53 grade cement was used in this experimental work. Cement satisfied all physical properties within its limit as given in IS 12269-1987. The weight of each bag is 50 kg. Cement is the expansive material among all ingredients of concrete. Cement acts as a binding material in concrete.

3.1.2 Coarse aggregates
The aggregate having size more than 4.75mm is termed as coarse aggregate. Generally, Aggregates are angular in shape. Flaky and elongated aggregate should not be used in concrete. It makes concrete porous and more permeable. The aggregates used in concrete should be durable, clean, tough and proper gradation. The average size of 20 mm aggregate used in experimental work. The specific gravity of coarse aggregate is 2.70 and water adsorption is 1%. Coarse aggregate obtained from grading zone III.

3.1.3 Fine Aggregates
The aggregate having size less than 4.75 mm is termed as fine aggregate. Locally available fine aggregate get from river bed used in experimental work. Fine aggregate obtained from grading zone III. Fine
aggregate having properties satisfied the requirement as per IS-383:1970 and it has divided the fine aggregate into four zones (i.e. I, II, III, IV). The specific gravity of fine aggregate can be found out by pycnometer bottle. The specific gravity of fine aggregate is 2.65.

3.1.4 Steel Scrap Waste
Mild steel fibres having 30 mm thickness and 60 mm length i.e. aspect ratio (l/d) 50 which are corrugated and obtained through cutting of steel wires have been used.

3.0 EXPERIMENTAL METHODOLOGY
Control mix containing cement, natural sand and coarse aggregates was designed as per Indian Standard Recommended Guidelines IS: 10262-2009. Cement was partially replaced with ETP Scrap steel in the range of 0%, 0.6 % 1.2%, 1.8 % and 2.4% by weight. The designed mix proportion for normal concrete is 1:1.38:1.83 with water cement ratio of 0.42. In this study five mix proportions were made. First is to control mix and the other four mixes contained Scrap steel which was partially replaced with cement. The mix designation and quantities of various materials for each designed concrete mix have been tabulated in Table 2.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Mix</th>
<th>Water</th>
<th>Cement</th>
<th>Weight of Scrap steel waste</th>
<th>Fine Agg. (Sand) (kg/m³)</th>
<th>Coarse Agg (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-0</td>
<td>Control</td>
<td>185</td>
<td>435</td>
<td>-</td>
<td>600.30</td>
<td>796.05</td>
</tr>
<tr>
<td>C-1</td>
<td>0.6%</td>
<td>185</td>
<td>432.39</td>
<td>2.61</td>
<td>600.30</td>
<td>796.05</td>
</tr>
<tr>
<td>C-2</td>
<td>1.2%</td>
<td>185</td>
<td>429.78</td>
<td>5.22</td>
<td>600.30</td>
<td>796.05</td>
</tr>
<tr>
<td>C-3</td>
<td>1.8%</td>
<td>185</td>
<td>427.17</td>
<td>7.83</td>
<td>600.30</td>
<td>796.05</td>
</tr>
<tr>
<td>C-4</td>
<td>2.4%</td>
<td>185</td>
<td>424.56</td>
<td>10.44</td>
<td>600.30</td>
<td>796.05</td>
</tr>
</tbody>
</table>
4.0 RESULTS & DISCUSSION

4.1 COMPRRESSIVE STRENGTH TEST

Figure 3: Compressive strength test results of various mixes

4.2 SPLIT TENSILE STRENGTH TEST

Figure 4: Split tensile strength test results of various mixes
4.2 FLEXURAL STRENGTH TEST

![Figure 4.4: Flexural strength test results of various mixes](image)

**CONCLUSION**

Following are the various conclusions drawn from this study:

1. The maximum compressive strength of concrete is achieved at 1.2 % replacement of Cement with Scrap steel.
2. The maximum split tensile strength of concrete is achieved at 18 % replacement of Cement with Scrap steel.
3. The maximum Flexural strength of concrete is achieved at 1.8 % replacement of Cement with Scrap steel.
4. Compressive strength and split tensile strength were slightly increased due to the increased percentage of fibre content.
5. The Experimental work also showed that the workability of SFRC gets reduced as we increased the fiber amount.
6. SFRC is a sustainable improvement inside the present technology.
7. The studies additionally establish that the residences of hardened SFRC, consisting of flexural electricity, are remarkably higher than those of conventional RCC. Thus, the use of metal fibre for powerful pavement construction can be cautioned undoubtedly.
8. Addition of metallic fibres reduces the workability of concrete; hence it becomes important to utilize top notch plasticizers. And those SFRC is used for foremost, high budget tasks only because Steel fibres are value effective.
REFERENCES

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