Mix Proportion of Materials in Pervious Concrete

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Abstract - These days the concrete industry is looking for supplementary cementitious material with the objective of utilising solid waste, low-cost constructions and disposal problems caused by industries. The rice husk ash, GGBS and Fly ash are among the solid waste produced by rice milling industry, thermal power plant and iron manufacturing industry respectively. In order to overcome this problem, the partial replacement of cement with the above mentioned mineral admixtures can be an economic alternative. And the cement is partially mixed with the mineral admixtures up to 50%. So both the mechanical and physical properties of pervious concrete will be enhanced and it also helps to reduce the consumption of cement which intern helps the reduction in carbon emission to the environment.

Key Words: Pervious Concrete, GGBS, Fly Ash

1. INTRODUCTION

It is the need of an hour to use the other material than natural resources as it is consumed very heavily by rapid urbanization. The ecosystem should be conserved and the natural resources should be preserved. The roads of India face lot of problems like water logging, run off water, etc. If the pervious concrete is used in such areas then the results can be more promising. The cement can be replaced by the byproducts like fly ash and slag then there are many benefits to the environment. The pavements are constructed with the help of pervious concrete in order to capture the rainwater and it can be properly drain in to the ground. But the use of pervious concrete in the pavement has led to the development of lesser strength than the conventional concrete pavement.

The shape of the aggregate is also very important parameter and when used in the previous concrete then the permeability and compressive strength. Hence the shape of aggregate plays a very important role.

1.1 MATERIALS

The demand for the use of fly ash in construction is gaining momentum in India. One instance of the increasing concern to put fly ash to use rather than its disposal, is in the growing list of areas of application. Fly ash has a various application other than construction like agriculture, ceramics, metallurgy etc.... Common areas

<table>
<thead>
<tr>
<th>Name</th>
<th>ASTM C-618</th>
<th>European Specifications</th>
<th>IS 3812 2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂ minimum</td>
<td>En-450</td>
<td>En-197-1</td>
<td>En-3892 part-1</td>
</tr>
<tr>
<td>Reactive/soluble SiO₂ min.</td>
<td>25</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>SiO₂+Al₂O₃+Fe₂O₃ minimum</td>
<td>70</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>MgO, Maximum</td>
<td></td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>LOI (1hour) max.</td>
<td>6</td>
<td>5.7</td>
<td>5</td>
</tr>
<tr>
<td>Total alkalis, max.</td>
<td>1.5</td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>SO₃, maximum</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Free CaO, maximum</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total/reactive CaO, maximum</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Fineness, 45</td>
<td>34</td>
<td>40</td>
<td>12</td>
</tr>
</tbody>
</table>
micron, maximum
Blaines fineness
m²/kg min. 320
Cement activity 28 days 75 75 80 80
Lime reactivity, N/mm² 4.5
Soundness, Le-Chatelier, mm 10 10 10 10
Autoclave, Percent 0.8 0.8

The GGBS can be replaced for Portland cement in concrete mixes by as much as up to 50% and 28%-33% of fly ash.

2. Mix Design Calculations

2.1 Mix Proportion for M35 Grade of Pervious Concrete

Stipulation for Proportioning:
- Mix Grade: M35
- Type of cement: OPC 43 grade confirming to IS 269:2015
- Maximum nominal size aggregate: 20 mm
- Exposure condition: Severe – very severe
- Minimum cement content: 340 kg/m³
- Method of concrete placing: Pumping
- Maximum cement content: 450 kg/m³
- Specific gravity of cement: 3.00
- Specific gravity of coarse aggregate: 2.74
- Condition SSD
- Slump value 150-175 mm
- Specific gravity of fly ash: 3.00

2.1.1 Target Strength for Mix design

From Page-1 of IS 10262: 2009 the target strength is given by

\[ F_{\text{ck}} = f_{\text{ck}} + 1.65 \times S \]

Where:
- \( F_{\text{ck}} \) = target mean compressive strength at 28 days in N/mm²
- \( f_{\text{ck}} \) = characteristic compressive strength at 28 days in N/mm²
- \( S \) = standard deviation in N/mm²
- \( 1.65 \) is tolerance factor

The value of standard deviation can be assumed from Table B of IS 456:2000 or from Table 1 of IS 10262:2009

\[ F_{\text{ck}} = f_{\text{ck}} + 1.6 \times (S) \]
\[ F_{\text{ck}} = 35 + 1.65 \times (5) \]
\[ F_{\text{ck}} = 43.25 \text{ N/mm}^2 \]

2.1.2 Determination of water cement ratio

Basically water cement ratio depends upon the exposure conditions From Table 5 of IS-456:2000

Maximum water/cement ratio is 0.45
Adopt W/C ratio = 0.35

2.1.3 Determination of water content

- Water content depends upon the maximum size of aggregate
- From Table 2 of IS 10262:2009
- Maximum water content for 20 mm size aggregate is 186 liters
- The obtained 186 liters is for slump value of 25-50 mm (IS 10262:2009 Clause 4.2)
Volume of aggregate
Total volume of conc. - (volume of cement + volume of water + volume of voids)
\[1 - \left(0.15 + 0.2139 + 0.15\right) = 0.4861 \text{ m}^3\]
- Mass of coarse aggregate
\[0.4861 \times 1 \times 2.74 \times 1000 = 1331.914\]
- Mass of Fly Ash aggregate
Replacing 10\% of fly ash with cement
Assuming specific gravity of fly ash as 3.00
10\% of 450 Kg/m\(^3\) = 45kg

Cement: Fine Aggregate: Coarse Aggregate : Fly Ash
1: 0: 3.32: 0.1

3. CONCLUSION

The pervious concrete needs proper mix design. The proportion of cement, fly ash or GGBS, water, coarse aggregate and water-cement ratio have been calculated with the help of Indian standard code (IS: 10262 : 2009). To cast the concrete cubes the mix design is very essential. The testing such as compressive strength, split tensile strength, workability test, etc. can be conducted properly for the pervious concrete. The data obtained in this research paper is very useful for further procedure related to the concreting procedure.

REFERENCES

technologies, universita polytechnic dellemarche, Italy.


22. IS 10262:2009 guideline for concrete mix design proportioning
23. IS 456:2000 Indian Standard for Plain and Reinforced Concrete-Code of Practice