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APPENDIX-A

CONCRETE MIX DESIGN
APPENDIX: A

Concrete Mix Design (IS: 10262:2009) for M35 grade concrete

Table: A-1- Design Stipulation

<table>
<thead>
<tr>
<th>Characteristic compressive strength Required in the field at 28 Days:</th>
<th>35N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum size of aggregate:</td>
<td>20 mm (angular)</td>
</tr>
<tr>
<td>Degree of workability:</td>
<td>0.9 compacting</td>
</tr>
<tr>
<td>Degree of quality control:</td>
<td>Good</td>
</tr>
<tr>
<td>Type of exposure:</td>
<td>Severe</td>
</tr>
<tr>
<td>Specific gravity of cement</td>
<td>3.15</td>
</tr>
<tr>
<td>Specific gravity of coarse aggregates</td>
<td>2.84</td>
</tr>
<tr>
<td>Specific gravity of fine aggregates</td>
<td>2.5</td>
</tr>
<tr>
<td>Water absorption</td>
<td></td>
</tr>
<tr>
<td>(A). Coarse aggregates:</td>
<td>Nil</td>
</tr>
<tr>
<td>(B). Fine aggregates:</td>
<td>0.4%</td>
</tr>
</tbody>
</table>

Coarse Aggregates is conforming as per IS: 383-1970 and Fine aggregate is conforming to Zone -2 as per Table of IS: 385-1970.

Step 1:- To find Target mean strength for of concrete

\[ F_{ck} = f_{ck} + t \times s \]

\[ = 35 + 1.65 \times 5.3 = 43.75 \text{ N/mm}^2 \]

The value of \( s \) is taken from table 1 of IS 10262 – 1982 pg. no. 5 for M35, \( s = 5.3 \)

5% low workability is acceptable from table 2 of IS 10262 – 1982 pg. no. 6, 5% means 1 in 20 so \( t = 1.65 \).

Where, \( F_{ck} \) = Target mean strength

\( f_{ck} \) = Characteristic compressive strength at 28 Days

\( s \) = standard deviation.

\( t \) = tolerance factor

Step 2:- Selection of Water Cement Ratio

From figure 1, IS: 10262-1982, pg. no. 7
W/C ratio = 0.40
From figure 2, IS: 10262-1982, pg. no. 853 grade of cement we have to take E line
So W/C ratio = 0.45
From IS 456-2000, Table 5, page no. 20 for severe condition maximum water-cement ratio = 0.45.
So adopt the minimum of three w/c ratio as 0.40

Step 3:– Selection of Water and sand Content
From Table 4, IS: 10262-1982, pg. no. 9 for 20 mm size aggregate,
Maximum Water content = 186 lit. (25 to 50 mm slump range)
Sand content = 35%
From table 6, IS: 10262 – 1982, pg. no. 11

<table>
<thead>
<tr>
<th>Change in condition</th>
<th>Percent adjustment required</th>
<th>Change in condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water content</td>
<td>Sand in total aggregate</td>
</tr>
<tr>
<td>For zone II IS : 383-1979</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Increase or decrease in compacting</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>factor 0.9 – 0.8 = 0.1 increase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Each 0.05 increase or decrease in</td>
<td>0</td>
<td>-3</td>
</tr>
<tr>
<td>water cement ratio 0.60 – 0.45 = 0.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>decreases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>-3</td>
</tr>
</tbody>
</table>

Required sand content as per table = 35% - 3% = 32%
Required water content = 186 + (186 * 3/100) = 191.6 litre

Step 4:– Determination of Cement Content
Water cement Ratio = 0.40
Cement content = 191.6/0.40 = 479 kg/m³
From table 5, IS: 456-2000, pg. no. 20 for severe condition
479 kg/m³ > 320 kg/m³ hence, OK.

Step 5:– Determination of Coarse Aggregate and Fine aggregate
From table no 3, IS: 10262-1982, pg. no. 9, max. size of aggregate is 20 mm so entrapped air is 2%.
Therefore total volume will be = 100 - 0.02= 0.98%
From IS: 10262-1982, pg. no. 11

\[ V = [W + (C/Sc) + \{(1/p) * (Fa/Sfa)\} ] * 1/1000 \]
\[ 0.98 = [191.6 + (479/3.15) + \{(1/0.32) * (Fa / 2.5)\} ] * 1/1000 \]

\[ Fa = 509.64 \text{kg/m}^3 \]

\[ Ca = [(1 – p)/p] * Fa * (Sca / Sfa) \]

\[ Ca = (1 – 0.32 / 0.32) * 485.75 * 2.76/2.38 \]

\[ Ca = 1231.33 \text{ kg/m}^3 \]

**Step 6:- Mix proportion**

A mix M35 grade was designed as per Indian Standard method and the same was used to prepare the test samples.

**Table: A-3 Material calculation for design M35**

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>Cement</th>
<th>Fine aggregate</th>
<th>Coarse Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>By weight, [kg]</td>
<td>191.6</td>
<td>479</td>
<td>509.64</td>
<td>1231.33</td>
</tr>
<tr>
<td>By volume</td>
<td>0.40</td>
<td>1</td>
<td>1.06</td>
<td>2.57</td>
</tr>
</tbody>
</table>

**Step 7:- Actual quantities required for the mix per bag of cement**

Cement = 50 kg

Water = 20 litre

Fine aggregate = 53.20 kg

Coarse aggregate = 128.5 kg
APPENDIX-B

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