Concrete Mix Design (M 30) – IS Code Method

(a) Design stipulations

(i) Characteristic compressive strength required in the field at 28 days - 30 N/mm²

(ii) Maximum size of aggregate (angular) - 20 mm

(iii) Degree of workability compacting factor - 0.90

(iv) Degree of quality control - Good

(v) Type of Exposure - Mild

(b) Test data for Materials

(i) Specific gravity of cement - 3.15

(ii) Compressive strength of cement satisfies the requirement of IS:269–1989 at 7 days

(iii) 1. Specific gravity of coarse aggregates 2.60

2 Specific gravity of fine aggregates 2.60

(iv) Water absorption:

1. Coarse aggregate 0.50%
2. Fine aggregate 1.0%

(v) Free (surface) moisture:

1. Coarse aggregate Nil
2. Fine aggregate Nil

(c) Target Mean Strength of concrete

The target mean strength for specified characteristic cube strength is

\[ 30 + 1.65 \times 4 = 36.6 \text{ N/mm}^2 \]

(d) Selection of water-cement ratio

The water-cement ratio required for the target mean strength of 36.6 N/mm\(^2\) is 0.48. This is lower than the maximum value of 0.55 prescribed for ‘Mild’ exposure. Adopt W/C ratio of 0.48.

(e) Selection of water and sand content

For 18 mm maximum size aggregate, sand conforming to grading Zone II, water content per cubic metre of concrete = 188.80 kg and sand content as percentage of total aggregate by absolute volume = 36 per cent.

For change in value in water-cement ratio, compacting factor, for sand belonging to Zone III, following adjustment is required.

<table>
<thead>
<tr>
<th>Table A.1.1</th>
<th>Adjustment in water and sand by IS code mix design</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Change in Condition</strong></td>
<td><strong>Per cent adjustment required</strong></td>
</tr>
<tr>
<td>For decrease in water-cement ratio by (0.60–0.50) that is 0.10, 0 – 2.0</td>
<td>0</td>
</tr>
<tr>
<td>For increase in compactings factor (0.9–0.8), that is 0.10 + 3 0</td>
<td>+3</td>
</tr>
<tr>
<td>For sand conforming to Zone III of Table 4, IS: 383–1970</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>+ 3%</td>
</tr>
</tbody>
</table>
Therefore, required sand content as percentage of total aggregate by absolute volume = 35 – 3.5 = 31.5%

Required water content = 186.00 + 5.58 = 191.60 litres/m³

(f) Determination of cement content

Water-cement ratio = 0.48

Water = 194.46 litre

Cement = \( \frac{191.6}{0.48} = 399.166 \text{ kg/m}^3 \)

This cement content is adequate for ‘mild’ exposure condition.

(g) Determination of coarse and fine aggregate contents

For the specified maximum size of aggregate of 18 mm, the amount of entrapped air in the wet concrete is 2.2 per cent. Taking this into account and applying equations.

\[
V = \frac{1}{1000} \left( w + \frac{c}{s_e} + \frac{1}{p} \frac{f_a}{s_{fa}} \right)
\]

\[
0.98 = \frac{1}{1000} \left( 191.6 + \frac{399.16}{3.15} + \frac{1}{0.315} \times \frac{f_a}{2.60} \right)
\]

\[
f_a = 540.24 \text{ kg/m}^3
\]

\[
C_a = \frac{1 - p}{p} \frac{x f_a x s_{fa}}{s_a}
\]
\[ C_a = \frac{1 - 0.315}{0.315} \times 540.26 \times \frac{2.60}{2.60} \]

\[ c_a = 1174.80 \text{ kg/m}^3 \]

\[ f_a = 540.24 \text{ kg/m}^3, \quad C_a = 1174.80 \text{ kg/m}^3. \]

The mix proportion is as given in Table A.1.2.

**Table A.1.2  Mix Proportion**

<table>
<thead>
<tr>
<th>Water</th>
<th>Cement</th>
<th>Fine aggregate</th>
<th>Coarse Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Litres</td>
<td>Kg</td>
<td>Kg</td>
<td>Kg</td>
</tr>
<tr>
<td>191.6</td>
<td>399</td>
<td>540</td>
<td>1175 kg</td>
</tr>
<tr>
<td>0.48</td>
<td>1</td>
<td>1.353</td>
<td>2.944</td>
</tr>
</tbody>
</table>