APPENDIX 1

REINFORCEMENT DETAILS

Length of the Beam = 1200 mm = 1.2 metre
Breadth of the Beam = 100 mm = 0.1 metre
Depth of the Beam = 150 mm = 0.15 metre

The main reinforcement’s are 10 mm diameter, 1.2 metre length placed at all the four corners. 6 mm diameter stirrups are placed at 100 mm centre to centre for the whole length of 1200 mm i.e 1.2 metre as shown in Figure A1.1.

![Figure A1.1 Reinforcement arrangements](image)

Figure A1.1 Reinforcement arrangements
APPENDIX 2

MIX DESIGN FOR M\textsubscript{20} GRADE CONCRETE

1. Design Stipulations
   - Characteristic compressive strength
     required at the end of 28 days = 20 N/mm\textsuperscript{2}
   - Maximum Size of aggregate = 20 mm (angular)
   - Degree of workability = 0.9 CF
   - Degree of quality control = Good
   - Type of exposure = Mild

2. Test Data of Materials
   - Specific gravity of cement = 3.15
   - Specific gravity of coarse aggregate = 2.6
   - Specific gravity of fine aggregate = 2.54
   - Water absorption of coarse aggregate = 2%
   - Water absorption of fine aggregate = 4%
   - Free surface moisture of coarse aggregate = Nil
   - Free surface moisture of fine aggregate = Nil
3. **Target mean strength of concrete**

\[
(f_{ck}) = f_{ck} + ts
\]

where

- \(f_{ck}\) - Target mean compressive strength
- \(f_{ck}\) - characteristic compressive strength at 28 days
- \(t\) - Statistical value
- \(s\) - Standard deviation

\[
s = 20 + (1.65 \times 4) = 26.6 \text{ MPa}
\]

4. **Selection of w/c ratio**

From IS 10262-1982 (1998)

\[
w/c = 0.50
\]

5. **Selection of water and sand content**

From (Shetty 2003) for 20 mm maximum size of aggregate and sand conforming to grading zone II, the water content per \(m^3\) of concrete is 186 kg and sand content as % of total aggregate by absolute volume = 35%

For change in value in w/c, compaction factor for sand belonging to zone II, the following adjustment is required.

For required sand content percentage of total aggregate by absolute volume

\[
= 35 - 3.5
\]

\[
= 31.5\%
\]

\[
= 0.315
\]

Water content

\[
= 186 + 3\% \text{ of } 186
\]

\[
= 186 + 5.58
\]

\[
= 191.58 \text{ lit/m}^3
\]
6. **Determination of cement content**

\[
\frac{W}{C} = \frac{\text{wt. of water}}{\text{wt. of cement (C)}}
\]

\[
0.5 = \frac{191.58}{C}
\]

\[
C = 383.16 \text{ kg/m}^3
\]

7. **Determination of coarse and fine aggregate contents**

Fine aggregate

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

where,

\[
V = \text{absolute of coarse and fine aggregate}
\]

\[
= 100\% - 2\%
\]

\[
= 98\% = 0.98
\]

\[
W = \text{Mass of water (kg) per m}^3 \text{ of concrete}
\]

\[
c = \text{Mass of concrete (kg) per m}^3 \text{ of concrete}
\]

\[
s_c = \text{Specific gravity of cement}
\]

\[
P = \text{Ratio of FA to total aggregate by absolute volume}
\]

\[
f_a, c_a = \text{Total masses of fine aggregate and coarse aggregate (kg) per m}^3 \text{ of concrete respectively}
\]

\[
s_{fa}, s_{ca} = \text{Specific gravity fine aggregate and coarse aggregate}
\]

\[
0.98 = \left( 191.58 + 383.16/3.15 + 1/0.315 \times f_a / 2.54 \right) \times (1/1000)
\]

\[
f_a = 537.72 \text{ kg/m}^3
\]

Coarse aggregate

\[
V = (1-P) / P \times f_a \times \left( s_{ca} / s_{fa} \right)
\]

\[
= (1-0.315)/0.315 \times 537.72 \times (2.6/2.54)
\]

\[
C_a = 1190 \text{ kg/m}^3
\]

Result:

**Mix Design** = 1: 1.40: 3.10 and \( w/c = 0.5 \)