ACI Mix Design Example #3

Consider the following example: The 28-day compressive strength should be 6,000 psi. The slump should be between 3 and 4 in. and the maximum aggregate size should not exceed 1 in. The coarse and fine aggregates in the storage bins are wet. This application will be in a moderate exposure environment.

The properties of the materials are as follows:

- Cement: Type I, specific gravity = 3.15
- Coarse Aggregate: Bulk specific gravity (SSD) = 2.65; absorption capacity = 0.5%; dry-rodded unit weight = 96 lb./ft.³; surface moisture = 0.5%
- Fine Aggregate: Bulk specific gravity (SSD) = 2.60; absorption capacity = 1.1%; fineness modulus = 2.70; surface moisture = 2.0%

Class ACI Mix Design Example

Step 1. Required material information (already given).
Step 2. The slump is given, consistent with Table 1.


Step 4. Estimation of mixing water and air content. From Table 2, the recommended air content is 4.5%; the water requirement is 295 lb./yd.³.

<table>
<thead>
<tr>
<th>Slump (in.)</th>
<th>Maximum Aggregate Size (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.375</td>
<td>265</td>
</tr>
<tr>
<td>0.500</td>
<td>235</td>
</tr>
<tr>
<td>0.750</td>
<td>205</td>
</tr>
<tr>
<td>1.000</td>
<td>175</td>
</tr>
<tr>
<td>1.500</td>
<td>135</td>
</tr>
<tr>
<td>2.000</td>
<td>100</td>
</tr>
<tr>
<td>3.000</td>
<td>65</td>
</tr>
</tbody>
</table>

Step 5. Water/cement ratio. From Table 3, the estimate for required w/c ratio to give a 28-day strength of 6,000 psi is 0.32.

Step 6. Calculation of cement content. Based on steps 4 and 5, the required cement content is:

\[
\text{weight of cement} = \frac{295 \text{ lb./yd.}^3}{0.32} = 922 \text{ lb./yd.}^3
\]

Step 7. Estimation of coarse aggregate content. Interpolating Table 4 for the fineness modulus of the fine aggregate of 2.70
Class ACI Mix Design Example

- The coarse aggregate will occupy:
  \[ \text{Volume} \times 27 \text{ ft}^3/\text{yd}^3 = \frac{\text{Volume}}{\text{yd}^3} \]

- The OD weight of the coarse aggregate
  \[ \frac{\text{Volume} \times \text{lb/ft}^3}{\text{yd}^3} = \frac{\text{OD Weight}}{\text{yd}^3} \]

Value from Table 4

**Dry-Rodded Unit Weight**

Class ACI Mix Design Example

- **Step 8**. Estimation of fine aggregate content by the absolute volume method.

<table>
<thead>
<tr>
<th>Component</th>
<th>Volume (ft³)</th>
<th>Weight (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Water: \[ 295 \text{ lb}/(62.4 \text{ lb}/\text{ft}^3) = 4.73 \text{ ft}^3 \]
- Cement: \[ 922 \text{ lb}/(3.15 \times 62.4 \text{ lb}/\text{ft}^3) = 4.69 \text{ ft}^3 \]
- Coarse Aggregate: \[ 1,763 \text{ lb}/(2.65 \times 62.4 \text{ lb}/\text{ft}^3) = 10.66 \text{ ft}^3 \]
- Air: \[ 4.5\% \times 27 \text{ ft}^3/\text{yd}^3 = 1.22 \text{ ft}^3 \]

**Total**: \[ 21.30 \text{ ft}^3 \]

Class ACI Mix Design Example

- Therefore, the fine aggregate must occupy a volume of:
  \[ 27 \text{ ft}^3 - \text{Volume} \text{ ft}^3 = \text{Volume}_{\text{FA}} \text{ ft}^3 \]

- The SSD weight of the fine aggregate is:
  \[ \text{Volume}_{\text{FA}} \times \text{SG}_{\text{FA}} \times 62.4 \text{ lb}/\text{ft}^3 = \text{FA}_{\text{SSD}} \text{ lb} \]
Step 9. Adjustment for moisture in the aggregate.

The weight of aggregate from the stock pile is:

\[ \text{Weight}_{\text{Stock Pile}} = \text{Weight}_{\text{OD}} (1 + \text{MC}) \]

The change in the weight water due to the moisture of the aggregate from the stock pile is:

\[ \Delta \text{Weight}_{\text{Water}} = \text{Weight}_{\text{OD}} (\text{SM}) \]

Adjusted Weight Water = Weight Water - \Delta Weight Water

Step 9. Compute fine aggregate weight

- Fine aggregate required from the stockpile is:
  \[ 925 \text{ lb.} (1 + 0.031) = 954 \text{ lb./yd.}^3 \]

Moisture Content 3.1%

- Coarse aggregate required from the stockpile is:
  \[ 1,763 \text{ lb.} (1 + 0.01) = 1,781 \text{ lb./yd.}^3 \]

Moisture Content 1%

Step 9. Adjust the amount of water based on moisture content

The required mixing water required is:

295 lb. - 925 lb. (0.02) \( \leftarrow \) fine aggregate

- 1,763 lb. (0.005) \( \leftarrow \) coarse aggregate

= 268 lb./yd.³

Thus the estimated batch weights per yd.³ are:

<table>
<thead>
<tr>
<th>Material</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>268 lb.</td>
</tr>
<tr>
<td>Cement</td>
<td>922 lb.</td>
</tr>
<tr>
<td>Coarse aggregate (wet)</td>
<td>1,781 lb.</td>
</tr>
<tr>
<td>Fine aggregate (wet)</td>
<td>954 lb.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,925 lb./yd.³</strong></td>
</tr>
<tr>
<td></td>
<td><strong>145.4 lb./ft.³</strong></td>
</tr>
</tbody>
</table>