ACI Mix Design Example

Concrete is required for an exterior column located above ground where substantial freezing and thawing may occur. The 28-day compressive strength should be 5,000 lb./in². The slump should be between 1 and 2 in. and the maximum aggregate size should not exceed ³/₄ in.

The properties of the materials are as follows:

- Cement : Type I, specific gravity = 3.15
- Coarse Aggregate: Bulk specific gravity (SSD) = 2.70; absorption capacity = 1%; dry-rodded unit weight = 100 lb./ft.³; surface moisture = 0%
- Fine Aggregate: Bulk specific gravity (SSD) = 2.65; absorption capacity = 1.3%; fineness modulus = 2.70; surface moisture = 3%

ACI Mix Design Example

Step 1. Required material information (already given).

Step 2. Choice of slump. The slump is given, consistent with Table 1.

	Slump,	Slump, mm (in.)		
Concrete construction	Maximum*	Minimum		
Reinforced foundation walls and footings	75 (3)	25 (1)		
Plain footings, caissons, and substructure walls	75 (3)	25 (1)		
Beams and reinforced walls	100 (4)	25 (1)		
Building columns	100 (4)	25 (1)		
Pavements and slabs	75 (3)	25 (1)		
Mass concrete	75 (3)	25 (1)		

Step 3. Maximum aggregate size. Given: 3/4 inches

ACI Mix Design Example

Step 4. Estimation of mixing water and air content. Since freezing and thawing is important, the concrete must be air-entrained.

			Maximum	aggregat	e size (in.)			
Slump(in)	0.375	0.5	0.75	1	1.5	2	3	6
1 to 2	305	295	280	270	250	240	225	180
3 to 4	340	325	305	295	275	265	250	200
6 to 7	365	345	325	310	290	280	270	-
Air Content								
Mild	4.5%	4.0%	3.5%	3.0%	2.5%	2.0%	1.5%	1.0%
Moderate	6.0%	5.5%	5.0%	4.5%	4.5%	4.0%	3.5%	3.0%
Extreme	7.5%	7.0%	6.0%	6.0%	5.5%	5.0%	4.5%	4.0%

From Table 2, the recommended air content is 6%; the water requirement is 280 lb./yd. 3

ACI Mix Design Example

Step 5. Water/cement ratio. From Table3, the estimate for required *w/c* ratio to give a 28-day strength of 5,000 psi.

28-day Compressive	Non-AE	AE
Strength (psi)		
2,000	0.82	0.74
3,000	0.68	0.59
4,000	0.57	0.48
5,000	0.48	0.40
6,000	0.41	0.32
7,000	0.33	

The w/c ratio to give a 28-day strength of 5,000 psi is 0.40

ACI Mix Design Example

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

weight of cement =
$$\frac{280^{\text{lb}/\text{yd}^3}}{0.4} = 700^{\text{lb}/\text{yd}^3}$$

ACI Mix Design Example Step 7. Estimation of coarse aggregate content. Interpolating Table 4 for the fineness modulus of the fine aggregate of 2.70 Fineness Modul 2.6 Aggregate (in.) 24 20 0.375 0.50 0.44 0.54 0.61 0.66 0.53 0.60 0.65 0.500 0.59 0.58 0.55 0.57 0.750 1.000 1.500 0.71 0.69 0.72 0.70 0.69 0.74 0.73 0.71 2.000 3.000 0.78 0.77 0.76 0.75 0.79 0.73 0.72 0.74 0.78 0.82 0.81 6.000 0.87 0.86 0.85 0.84 0.83





ACI Mix Design Example

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

Temperature, °F	Density, lb./ft. ³	62.4 lb./ft
60	62.368	
65	62.337	-
70	62.302	-
75	62.261	-
80	62.216	-
85	62.166	-

ACI Mix Design Example

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

water (ft ³)	$\frac{water(lb)}{62.4\frac{lb}{\hbar^3}}$
Cement (ft ³)	$\frac{cement(lb)}{3.15 \times 62.4 \frac{lb}{tt^3}}$
Coarse Aggregate (ft ³)	$\frac{\text{coarse aggregate}(\textit{lb})}{\text{SG}_{CA} \times 62.4 \frac{\textit{lb}}{\textit{ft}^3}}$
Air (ft ³)	$air(\%) \times 27 \frac{\hbar^3}{yd^3}$

> Water: 280 lb./62.4 lb./ft.³ = 4 > Cement: 700 lb./(3.15 x 62.4 lb./ft.³) = 3 > Coarse Aggregate: 1,701 lb./(2.70 x 62.4 lb./ft.³) = 10 > Air: 6% x 27ft.³/yd.³ = 1 Total 1	.49 ft. ³ .56 ft. ³). 10 ft. ³ .62 ft. ³ 9.77 ft.³		
> Water: 280 lb./62.4 lb./ft. ³ = 4 > Cement: 700 lb./(3.15 x 62.4 lb./ft. ³) = 3 > Coarse Aggregate: 1,701 lb./(2.70 x 62.4 lb./ft. ³) = 10 > Air: 6% x 27ft. ³ /yd. ³ = 1	.49 ft. ³ .56 ft. ³ 0.10 ft. ³ .62 ft. ³		
➤ Water: 280 lb./62.4 lb./ft. ³ = 4 ➤ Cement: 700 lb./(3.15 x 62.4 lb./ft. ³) = 3 ➤ Coarse Aggregate: 1,701 lb./(2.70 x 62.4 lb./ft. ³) = 10	.49 ft. ³ .56 ft. ³).10 ft. ³		
> Water: 280 lb./62.4 lb./ft. ³ = 4 > Cement: 700 lb./(3.15 x 62.4 lb./ft. ³) = 3	.49 ft. ³ .56 ft. ³		
> Water: 280 lb./62.4 lb./ft. ³ = 4	.49 ft. ³		
Step 8 . Estimation of fine aggregate content by the absolvolume method.	ute		
ACI Mix Design Example			





3/3

ACI Mix Design Example

Step 9. Adjustment for moisture in the aggregate.

- Since the moisture level of the fine aggregate in our storage bins can vary, we will apply a simple rule to adjust the water required.
- Decrease the amount of water required by surface moisture content of the weight of the fine aggregate
- Increase the amount of aggregate by the amount equal to the surface moisture

ACI Mix Design Example

Step 9. Adjustment for moisture in the aggregate.

The weight of aggregate from the stockpile is:

 $Weight_{Stock Pile} = Weight_{OD}(1 + MC)$

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

 $\Delta W eight_{Water} = W eight_{OD} (SM)$

Adjusted Weight_{Water} = Weight_{Water} - Δ Weight_{Water}





ACI Mix Design Example				
The estimated batch weights per yd. ³ are:				
Water	= 244 lb.			
Cement	= 700 lb.			
Coarse aggregate	= 1,718 lb.			
Fine aggregate (wet)	= 1,247 lb.			
Total	= 3,909 lb./yd. ³			
	= 144.8 lb./ft. ³			

