ACI Mix Design Equations

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

Concrete construction	Slump, mm (in.)	
	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.

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ACI Mix Design Equations

- **Step 4**. Estimation of mixing water and air content.

	Maximum aggregate 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%

	Maximum aggregate size (in.)							
Slump(in)	0.375	0.5	0.75	1	1.5	2	3	6
1 to 2	350	335	315	300	275	260	220	190
3 to 4	385	365	340	325	300	285	245	210
6 to 7	410	385	360	340	315	300	270	-
Air Content	3.0%	2.5%	2.0%	1.5%	1.0%	0.5%	0.3%	0.2%

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ACI Mix Design Equations

- **Step 5**. Water/cement ratio.

28-day Compressive Strength (psi)	Non-AE	AE
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	---

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

$$weight\ of\ cement = \frac{weight\ of\ water}{w/c}$$

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ACI Mix Design Equations

- **Step 7**. Estimation of coarse aggregate content.

	Fineness Modulus						
Max Aggregate (in.)	2.4	2.5	2.6	2.7	2.8	2.9	3
0.375	0.50	0.49	0.48	0.47	0.46	0.45	0.44
0.500	0.59	0.58	0.57	0.56	0.55	0.54	0.53
0.750	0.66	0.65	0.64	0.63	0.62	0.61	0.60
1.000	0.71	0.70	0.69	0.68	0.67	0.66	0.65
1.500	0.75	0.74	0.73	0.72	0.71	0.70	0.69
2.000	0.78	0.77	0.76	0.75	0.74	0.73	0.72
3.000	0.82	0.81	0.80	0.79	0.78	0.77	0.76
6.000	0.87	0.86	0.85	0.84	0.83	0.82	0.81

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ACI Mix Design Equations

- The coarse aggregate will occupy:

$$CA = \%\text{coarse aggregate} \times 27\,\text{ft.}^3/\text{yd.}^3$$

Value from Table 4

- The OD weight of the coarse aggregate

$$CA_{OD} = CA \times \text{dry rodded}\ \text{lb.}/\text{ft.}^3$$

Dry-Rodded Unit Weight

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ACI Mix Design Equations

- **Step 8**. Estimation of fine aggregate content by the absolute volume method.
  - Water: water/62.4 lb./ft.^{3}
  - Cement: cement/(3.15 x 62.4 lb./ft.^{3})
  - Coarse Aggregate: $CA_{OD}/(SG_{CA}$ x 62.4 lb./ft.^{3})
  - Air: air content x 27ft.^{3}/yd^3

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ACI Mix Design Equations

- Therefore, the fine aggregate must occupy a volume of:

$$FA_{volume} = 27\ \text{ft.}^3 - \sum volume$$

- The SSD weight of the fine aggregate is:

$$FA_{OD} = FA_{volume} \times SG_{FA} \times 62.4\ \text{lb./ft.}^3$$

Specific Gravity of Fine Aggregate

Unit Weight of Water

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ACI Mix Design Equations

- **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

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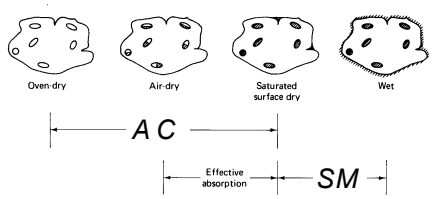
ACI Mix Design Equations

Mix Design Procedures

9. **Adjustment for moisture in the aggregate** -- The water content of the concrete will be affected by the moisture content of the aggregate.



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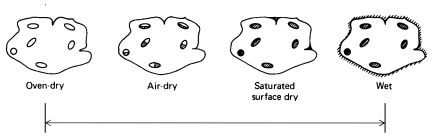
ACI Mix Design Equations

Mix Design Procedures

9. **Adjustment for moisture in the aggregate** -- The water content of the concrete will be affected by the moisture content of the aggregate.



$$\text{Moisture content } (MC) = AC + SM$$

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ACI Mix Design Equations

- **Step 9**. Stockpile adjustment for moisture in the aggregate.
- Stockpile fine aggregate required is:

$$FA_{stockpile} = FA_{OD}\ (1 + MC_{FA})$$

Moisture Content

- Stockpile coarse aggregate required is:

$$CA_{stockpile} = CA_{OD}\ (1 + MC_{CA})$$

Moisture Content

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ACI Mix Design Equations

- **Step 9**. Adjustment of required water

The water required is:

SM = MC - AC

Require water = water – FA_{OD} (SM) – CA_{OD} (SM)

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