

MIXTURE:

CEMENTITIOUS MATERIALS							
Component	Specific Gravity	Volume	Amount of CM				
Cement, <i>c</i>		ft ³	lb/yd ³	Total cm (includes <i>c</i>) _____ lb/yd ³ <i>c/cm</i> ratio, by mass _____			
Cementitious Material 1, <i>cm₁</i>		ft ³	lb/yd ³				
Cementitious Material 2, <i>cm₂</i>		ft ³	lb/yd ³				
Cementitious Material 3, <i>cm₃</i>		ft ³	lb/yd ³				
FIBERS							
Component	Specific Gravity	Volume	Amount of Fibers				
Fiber 1, <i>f₁</i>		ft ³	lb/yd ³	Total Amount of Fibers _____ lb/yd ³			
Fiber 2, <i>f₂</i>		ft ³	lb/yd ³				
AGGREGATES (EXCLUDING MINERAL FILLERS PASSING NO. 200 SIEVE)							
Aggregates	ASTM C330 or RCA ¹	Abs (%)	SG _{OD}	SG _{SSD}	Base Quantity, <i>W</i>		Volume, <i>V_{agg, SSD}</i>
					<i>W_{OD}</i>	<i>W_{SSD}</i>	
Aggregate 1, <i>agg₁</i>	Yes / No	%			lb/yd ³	lb/yd ³	ft ³
Aggregate 2, <i>agg₂</i>	Yes / No	%			lb/yd ³	lb/yd ³	ft ³
Aggregate 3, <i>agg₃</i>	Yes / No	%			lb/yd ³	lb/yd ³	ft ³
LIQUID ADMIXTURES							
Admixture	lb/ US gal	Dosage (fl. oz / cwt)	% Solids	Amount of Water in Admixture			
Liquid Dye, <i>ld</i>			%	lb/yd ³	Total Water from Liquid Admixtures, $\sum W_{adm}$ _____ lb/yd ³		
Admixture 1, <i>adm_{x1}</i>			%	lb/yd ³			
Admixture 2, <i>adm_{x2}</i>			%	lb/yd ³			
SOLIDS (DYES, POWDERED ADMIXTURES, AND MINERAL FILLERS)							
Component	Specific Gravity	Volume (ft ³)	Amount (lb/yd ³)				
Solid Component of Liquid Dye, <i>S_{ld}</i>		ft ³	lb/yd ³	Total Solids, <i>S_{total}</i> _____ lb/yd ³			
Powdered Admixture, <i>S_{p admix}</i>		ft ³	lb/yd ³				
Mineral Filler (Passing No. 200 sieve), <i>mf</i>		ft ³	lb/yd ³				
WATER							
			Amount		Volume		
Water, <i>w</i> , [$=\sum (w_{free} + w_{adm} + w_{batch})$]			w/c ratio, by mass _____	lb/yd ³	ft ³		
Total Free Water from All Aggregates, $\sum w_{free}$				lb/yd ³			
Total Water from All Admixtures, $\sum w_{adm}$			w/cm ratio, by mass _____	lb/yd ³			
Batch Water, <i>w_{batch}</i>			_____	lb/yd ³			
DENSITIES, AIR CONTENT, RATIOS, AND SLUMP							
Values for 1 cy of concrete	cm	Fibers	Aggregate (SSD)	Solids, <i>S_{total}</i>	Water, <i>w</i>	Total	
Mass, <i>M</i>	lb	lb	lb	lb	lb	$\sum M$: lb	
Absolute Volume, <i>V</i>	ft ³	ft ³	ft ³	ft ³	ft ³	$\sum V$: ft ³	
Theoretical Density, <i>T</i> , ($=\sum M / \sum V$)	lb/ft ³		Air Content, Air, [$= (T - D)/T \times 100\%$]			%	
Measured Density, <i>D</i>	lb/ft ³		Air Content, Air, [$= (27 - \sum V)/27 \times 100\%$]			%	
Total Aggregate Ratio ² ($=V_{agg, SSD} / 27$)	%		Slump, Slump flow, Spread (as applicable)			in.	
C330+RCA Ratio ³ ($=V_{C330+RCA} / V_{agg, SSD}$)	%						

1. Indicate if aggregate is ASTM C330 compliant (C330) or recycled concrete aggregate (RCA).
2. Ratio of total aggregate volume (in percent) compared to the total volume of concrete (min. allowable is 30%)
3. Ratio of combined volume of C330 and RCA ($V_{C330+RCA}$ (in percent)) compared to the total aggregate volume of aggregate in SSD condition ($V_{agg, SSD}$); (min. allowable is 50%)

TERMS AND FORMULAS

- Abs** = absorption of an aggregate, whether taken as a whole, the coarse, or the fine aggregate, %.
- admx** = admixtures
- air** = gravimetric air content, per ASTM C138, %.
- agg** = aggregate
- c** = cement
- cm** = cementitious materials (including cement)
- c/cm** = ratio of cement to cementitious materials, by mass, *dimensionless*
- cwt** = hundred weight of cementitious material (example 750 lb/yd³ of cm is 7.5 cwt)
- f** = fibers
- ld** = liquid dyes
- M** = mass, *lb*.
- MC_{total}** = total moisture content referenced to the oven-dried condition of the aggregate, %.
- MC_{free}** = free moisture content, referenced to the saturated, surface-dry condition (SSD), of the aggregate, %.
- mf** = mineral fillers (i.e., aggregate-like materials passing the No. 200 sieve (75µm))
- D** = measured density (wet, plastic) of concrete test cylinders, per ASTM C138, *lb/ft³*.
- T** = theoretical density of concrete (zero air voids), per ASTM C138, *lb/ft³*.
- S_{ld}** = solids in liquid dyes
- S_{p admx}** = solids of powdered admixtures
- S_{total}** = total solids of liquid dyes, powdered admixtures, and mineral fillers, *lb/yd³*.
- SG_{SSD}** = specific gravity, in the saturated, surface-dry condition, of aggregate, *dimensionless*.
- SG_{OD}** = specific gravity, in the oven-dried condition, of aggregate, *dimensionless*.
- V** = volume, *ft³*.
- V_{agg,SSD}** = volume, in the saturated, surface-dry condition, of aggregate, *ft³*.
- C330** = aggregate that is ASTM C330 compliant
- RCA** = recycled concrete aggregate
- V_{C330+RCA}** = volume, in the saturated, surface-dry condition, of aggregate classified as ASTM C330 compliant or as recycled concrete aggregate, *ft³*.
- W_{SSD}** = mass, in the saturated, surface-dry condition, of aggregate per unit volume of concrete, *lb/yd³*.
- W_{OD}** = mass, in the oven-dried condition, of aggregate per unit volume of concrete, *lb/yd³*.
- W_{stk}** = mass, in the stock moisture condition, of the aggregate per unit volume of concrete, *lb/yd³*.
- w_{admx}** = the mass of water in the admixtures, per unit volume of concrete, *lb/yd³*.
- w_{batch}** = the mass of water to be batched per unit volume of concrete when the aggregates are in a stock moisture condition, *lb/yd³*.
- w_{free}** = free water carried into the batch by a wet per unit volume of concrete, *lb/yd³*.
- w/c** = water to cement ratio, by mass, *dimensionless*.
- w/cm** = water to cementitious material ratio, by mass, *dimensionless*.

TERMS AND FORMULAS

Each one of these formulas should be applied to each aggregate source:

$$Abs = \frac{W_{ssd} - W_{od}}{W_{od}} \quad 100\%$$

$$MC_{total} = \frac{W_{stk} - W_{od}}{W_{od}} \quad 100\%$$

$$MC_{free} = MC_{total} - Abs$$

$$W_{SSD} = 1 + \frac{Abs}{100\%} * W_{OD}$$

$$w_{free} = W_{OD} \frac{MC_{free}}{100\%}$$

Note that w_{free} can be a negative number indicating a dry and absorptive aggregate.

$$W_{stk} = W_{SSD} + w_{free}$$

Then, for the mixture as a whole:

$$W_{batch} = W_{OD} + w_{free} + W_{adm}$$

The following formula should be applied to all admixtures in liquid form:

$$w_{adm} = dosage \text{ (fl oz/cwt)} * cwt \text{ of cm} * water \text{ content } (\%) * 1 \text{ gal}/128 \text{ fl oz} * lb/\text{gal of admixture}$$

The following formula should be applied to liquid dyes only:

$$S = dosage \text{ (fl oz/cwt)} * cwt \text{ of cm} * solid \text{ content } (\%) * 1 \text{ gal}/128 \text{ fl oz} * lb/\text{gal of admixture}$$