

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 ($=V_{C330+RCA} / V_{agg,SSD}$)	%						

- Indicate if aggregate is ASTM C330 compliant (C330) or recycled concrete aggregate (RCA).
- Ratio of total aggregate volume (in percent) compared to the total volume of concrete (min. allowable is 30%)
- 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, %.
- adm_x** = 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 adm_x}** = 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_{adm_x}** = 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:

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

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

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

$$W_{SSD} = \left(1 + \frac{Abs}{100\%}\right) * W_{OD}$$

$$w_{free} = W_{OD} \times \left(\frac{MC_{free}}{100\%}\right)$$

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: $w_{batch} = w - (w_{free} + \sum w_{adm})$

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

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

The following formula should be applied to liquid dyes only:

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