METHOD OF SAMPLING AND TESTING
MT 120-04
METHOD FOR FIGURING YIELD OF CONCRETE
(*Montana Method*)

1 Scope:

1.1 This method is intended to be used to figure the yield of a mix design for Portland cement concrete, either by a one sack mix or a one cubic foot mix, when critical values of the various ingredients are known.

1.2 An example of a basic mix design, as furnished by the Materials Bureau might be:

Class "A" = 94 – 213-190-190

1.3 Cubic yard quantities are obtained by multiplying the individual weights, as shown, by the number of sacks of cement required for the class of concrete being used.

2 Requested Number of Sacks of Cement

2.1 The number of sacks of cement required for various classes of concrete are as follows:

Plain	***With Additive***
Class A & D = 5.5	**Class AA & DA = 5.0**
Class AD & DD = 6.5	**Class ADA & DDA = 5.9**
Class AP & DP = 6.0	**Class APA & DPA = 5.5**
Class AS & DS = 7.0	**Class Pre. Min = 6.5**
Class AC & DC = 4.5	

3 Water:

3.1 Water content is not stated as it is controlled by slump requirements but for mix design purpose it is always figured as 6 gallons per sack, total water, in the mix. This figure includes free water added, moisture in material, additives, air entraining agents, etc.

4 Total Paste:

4.1 Total paste for a one sack mix need not be figured as it is always the same, 1.28 cubic feet, arrived at as follows: 6 gals. Water divided by 7.5 (gallons of water per cubic foot) equals .80 cubic foot. One bag of cement, 94 pounds, divided by 196.6 pounds (solid weight of cement) = .48 cubic foot. Then .80 + .48 =1.28 cubic feet. This figure multiplied by sacks of cement used gives the total paste in a cubic yard of concrete.

5 Fine Aggregate:

5.1 Volume of fine aggregate is determined by dividing the weight of sand used in the mix by the solid weight of that sand which is the specific gravity of the sand multiplied by the weight of water per cubic foot (62.4). Example:

Specific gravity of sand 2.61 x 62.4 =162.9 solid weight of sand. 213 pounds sand divided by 162.9 = 1.3075 cubic feet of sand per sack of cement.

1.3075 times the total number of sacks of cement used will give the volume of sand in one cubic yard of concrete.

6 Medium and Coarse Aggregate:

6.1 The volume of the medium and coarse aggregates are figured in the same manner as the sand or they may be combined and figured as total coarse aggregate which is usually done. The total coarse aggregate in the mix above is 380 pounds. The specific gravity of the medium aggregate is 2.61 and the specific gravity of the coarse aggregate. 380 pounds of aggregate divided by 163.5 = 2.324 cubic feet of rock per sack of cement.

7 Yield:

7.1 Yield may be figured on a one sack basis or on a one cubic yard basis, whichever is most convenient. Yield is the sum of the solid volumes of all of the ingredients, which go to make a yard of concrete, including air.

7.1.1 One sack mix:

Paste - 6 gallons water, 1 sack cement = 1.28 cubic feet

Sand - 213 pounds divided by 162.9 = 1.3075 cubic feet

Rock - 380 pounds divided by 163.5 = 2.3240 cubic feet

Total volume for each sack of cement = 4.9115 cubic feet

Total Volume per cubic yard = 4.9115 x 5.5 = 27.0132 cubic feet.

7.1.2 One Cubic Yard Mix:

Paste - 5.5 x 1.28 = 7.04 cu. ft

Sand - 5.5 x 213 = 1172 lbs. Sand divided by 162.9 = 7.1945 cu ft.

Rock - 5.5 x 380 = 2090 lbs. Coarse divided by 163.5 = 12.7828 cu. Ft.

Total volume per cubic yard = 27.0173 cu. Ft.

8 Data for Figuring Concrete Yield:

The following data is recorded as a convenient reference:

8.1 Cement:

8.1.1 Weight per sack = 94 lbs

8.1.2 Absolute volume per sack = .48 cu ft

8.1.3 Specific gravity = 3.15

8.2 Water:

8.2.1 Weight per gallon = 8.33 lbs.

8.2.2 Weight per cu. Ft. = 62.4 lbs

8.2.3 Gal. Per cu ft. = 7.5

8.4 Volume of varying Amounts of Water in Cubic Feet:

8.4.1 1 gal = .1334 5 gals = .667 5.5 gals = .734 6.0 gals.= .80

9 Volume of Varying Amounts of Water Plus 1 Sack of Cement in Cubic Feet:

9.1 5.0 gal. + 94 cement = 1.15

9.2 5.5 gal. + 94 cement = 1.21

9.3 6.0 gal. = 94 cement = 1.28

10 Weight of Materials Divided by Specific Gravity x Weight of Water = Volume of Materials:

$$\frac{150}{2.65x62.4} = \frac{150}{165.4} = .90711cu.ft.$$

11 Specific Gravity x Weight of Water x Volume of Material = Weight of Material:

2.65 x 62.4 = 165.4 x .90711 = 150 pounds.

12 Percent Voids:

$$\frac{\text{S. G. x } 62.355 - \text{Wt.}}{\text{S. G. x } 62.355} \times 100$$

2.65 x 62.355 = 165.24 – 105 = 60.24 divided by 165.24 = 36.46 %

13 Solid Weights of Material for Various Specific Gravities:

S. G.	Solid WT.	S.G.	Solid WT.	S.G.	Solid WT.	S.G.	Solid WT
2.50 =	156.0	2.58 =	161.0	2.66 =	166.0	2.74 =	171.0
2.51 =	156.6	2.59 =	161.6	2.67 =	166.6	2.75 =	171.6
2.52 =	157.2	2.60 =	162.2	2.68 =	167.2	2.76 =	172.2
2.53 =	157.9	2.61 =	162.9	2.69 =	167.9	2.77 =	172.8
2.54 =	158.5	2.62 =	163.5	2.70 =	163.5	2.70 =	173.5
2.55 =	159.1	2.63 =	164.1	2.71 =	169.1	2.79 =	174.1
2.56 =	159.7	2.64 =	164.7	2.72 =	169.7	2.72 =	174.7
2.57 =	160.4	2.65 =	165.4	2.73 =	170.4	2.73 =	196.6