WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

STANDARD METHOD FOR DETERMINATION OF Ā OF THE TOTAL SOLIDS IN PORTLAND CEMENT CONCRETE

1. PURPOSE

1.1 To establish a procedure for determining the Ā of the total solids contained in portland cement concrete.

1.2 To establish a uniform definition of Ā.

2. SCOPE

2.1 This procedure shall apply in all cases where the specification requires the determination of Ā of the total solids in portland cement concrete.

3. DEFINITIONS

3.1 Ā (A-Bar) – A factor that characterizes the gradation of an aggregate. The size of the factor is very highly correlated with the aggregate surface area. The Ā factor is used as a control in concrete mix designs.

4. PROCEDURE

4.1 Since the solids contained in a portland cement concrete mix consist of coarse aggregate, fine aggregate, and portland cement, this procedure will address the determination of Ā of these solids in combination.

4.1.1 The mass of the solid materials used in the mix proportions shall be used to determine the percent of each constituent material in the total solids.

4.1.1.1 Determine the total mass of solids: $M_{ca} + M_{fa} + M_c = M_t$

Where:

M_{ca} = mass of coarse aggregate (SSD) used in one cubic yard (meter) of concrete.
M_{fa} = mass of fine aggregate (SSD) used in one cubic yard (meter) of concrete.
M_c = mass of cement used in one cubic yard (meter) of concrete.

M_t = total mass of solids in one cubic yard (meter) of concrete.

Determine the fractional part of each solid (solid fraction):

$\frac{M_{ca}}{M_t}$ = fractional part of coarse aggregate in the mix

$\frac{M_{fa}}{M_t}$ = fractional part of fine aggregate in the mix

$\frac{M_c}{M_t}$ = fractional part of cement in the mix

4.1.2 Determine the gradation of each of the individual materials using standard procedures with the following modifications.

4.1.2.1 When determining the fine aggregate gradation, include Standard Sieve sizes 3/8 inch (9.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 µm), No. 50 (300 µm), No. 100 (150 µm), and No. 200 (75 µm).

4.1.2.2 When determining the coarse aggregate gradation, all material passing the smallest specification sieve shall be sieved through either eight or twelve inch sieves. Only a minor amount of material will be retained on any sieves above the No. 200. This amount of material is considered to be insignificant and is added to the amount retained on the No. 200 sieve.

4.1.3 Determine the Solid Ā's. The Solid Ā of each constituent shall be determined by adding the cumulative percentages by mass of material passing each of Standard Sieve sizes 1 1/2 inch (37.5 mm), 3/4 inch (19 mm), 3/8 inch (9.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 µm), No. 50 (300 µm), No. 100 (150 µm), and No. 200 (75 µm) and dividing by 100.

4.1.4 Determine the Ā of each of the solids using the fractional parts (solid fractions) from 4.1.1.2 and the Solid Ā of each constituent from 4.1.3.

$\bar{A}_{ca}$ = fractional part of coarse aggregate x Solid Ā of coarse aggregate

$\bar{A}_{fa}$ = fractional part of fine aggregate x Solid Ā of fine aggregate

$\bar{A}_{c}$ = fractional part of cement x Solid Ā of cement

Where:

$\bar{A}_{ca}$ = Ā of coarse aggregate
$\bar{A}_{fa}$ = Ā of fine aggregate
$\bar{A}_{c}$ = Ā of cement

4.1.5 Determine the Ā of the Total Solids:

$\bar{A}$ Total Solids = $\bar{A}_{ca} + \bar{A}_{fa} + \bar{A}_{c}$

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RLS:T
ATTACHMENT

EXAMPLE OF CALCULATIONS
Ā TOTAL SOLIDS

1. Total mass of solids in one cubic yard (meter) of concrete:

M_{ca} = Mass of SSD Coarse Aggregate = 1800 lb. (816 kg) M_{fa} =

Mass of SSD Fine Aggregate = 1100 lb. (499 kg) M_c = Mass of

cement = 600 lb. (272 kg)

M_t = Total mass of Solids

$M_t = M_{ca} + M_{fa} + M_c$

M_t = 1800 lb. (816 kg) + 1100 lb. (499 kg) + 600 lb. (272 kg) = 3500 lb. (1587 kg)

2. Fractional part of each solid:

$$\frac{M_{ca}}{M_t} = \frac{1800 \text{ lb.} \quad (816 \text{ kg})}{3500 \text{ lb.} \quad (1587 \text{ kg})} = 0.514$$

$$\frac{M_{fa}}{M_t} = \frac{1100 \text{ lb.} \quad (499 \text{ kg})}{3500 \text{ lb.} \quad (1587 \text{ kg})} = 0.314$$

$$\frac{M_c}{M_t} = \frac{600 \text{ lb.} \quad (272 \text{ kg})}{3500 \text{ lb.} \quad (1587 \text{ kg})} = 0.171$$

3. Determination of the Solid Ā of each constituent:

PERCENT PASSING

Sieve Size		Coarse Aggregate	Fine Aggregate	Cement
1 1/2 in.	(37.5 mm)	100	100	100
3/4 in.	(19.0 mm)	84	100	100
3/8 in.	(9.5 mm)	21	100	100
No. 4	(4.75 mm)	2	98	100
No. 8	(2.36 mm)	1	83	100
No. 16	(1.18 mm)	0	65	100
No. 30	(600 µm)	0	48	100
No. 50	(300 µm)	0	13	100
No. 100	(150 µm)	0	3	100
No. 200	(75 µm)	0.5	1.5	100
Totals		208.5	611.5	1000
Solid Ā's		2.08	6.12	10

4. Determine the Ā of each of the solids:

$\bar{A}_{ca} = 0.514 \times 2.08 = 1.07$
$\bar{A}_{fa} = 0.314 \times 6.12 = 1.92$
$\bar{A}_{c} = 0.171 \times 10 = 1.71$

5. Determine the Ā of the Total Solids:

Ā Total Solids = 1.07 + 1.92 + 1.71 = 4.70