YILDIZ TECHNICAL UNIVERSITY
CIVIL ENGINEERING DEPARTMENT BUILDING MATERIALS DIVISION
CONSTRUCTION MATERIALS / PRACTICE 1b

QUESTION 3

Aggregate sample was taken from a stockpile at a ready mixed concrete plant and the mass and the volume of the sample were measured as 680 g and 500 cm^3, respectively. After drying, the oven dried mass was measured as 660.2 g and the water absorption rate of the aggregate was determined as 1.2%. 920 kg of aggregate from the same stockpile will be used in 1 m^3 of concrete batch. Considering the excess water on the aggregate surface calculate the reduction in the mixing water.

$W_H = 680\ g \qquad V_H = 500\ cm^3 \qquad W_{OD} = 660.2\ g \qquad a_m = 1.2\ \%$

$W_O = W_{OD} \times (1 + 0.012) \ \rightarrow\ W_O = 668.1\ g$

Moisture Content H%

$$H\% = \frac{W_H - W_O}{W_O} \times 100 = \frac{680 - 668.1}{668.1} \times 100 \cong 1.8\ \%$$

$$W_H = 920\ kg \qquad \rightarrow \quad W_O = \frac{920}{1 + 0.018} = 903.7\ kg$$

Excess water in 920 kg of moist aggregate

$\Delta W = excess\ water = 920 - 903.7 = 16.7\ kg$

QUESTION 4

The sieve analysis was performed on three groups of dry aggregates and the results are given below. According to the test results:

a) Calculate the percentage passing (P%) of each aggregate.

b) Find the appropriate mix ratio of each aggregate provided that the half of the aggregate in the mixture is coarser than 4 mm and 1/3 of the aggregate in the mixture is finer than 1 mm.

c) Check the conformity of the mixing values to the limit values of the reference curves.

d) Plot the grading curve of each aggregate and also the mix aggregate (4 curves in total) on the same graph.

e) Calculate the fineness modulus of the mix aggregate.

	AGGREGATE 1: Natural Sand ……….g			AGGREGATE 2: Crushed Stone #1 ……… g			AGGREGATE 3: Crushed Stone #2 ………. g			MIX AGGREGATE		D_{max}=16 mm		
Sieve Size d_i (mm)	Amount Retained (g)	Amount Passed (g)	Passing P_1%	Amount Retained (g)	Amount Passed (g)	Passing P_2%	Amount Retained (g)	Amount Passed (g)	Passing P_3%	Passing P_m%	100-P_m%	A_{16}	B_{16}	C_{16}
31.5	***0***			***0***			***0***					100	100	100
22.4	***0***			***0***			***0***					98	99	100
16	***0***			***90***			***420***					85	92	99
11.2	***0***			***270***			***1380***					68	79	90
8	***0***			***870***			***660***					48	63	77
4	***0***			***840***			***540***					33	49	64
2	***140***			***480***			***0***					22	37	52
1	***90***			***240***			***0***					15	28	41
0.5	***250***			***210***			***0***					10	20	30
0.25	***190***			***0***			***0***					6	13	20
0.15	***190***			***0***			***0***					3	7	11
Ratio in the mix										**Σ =**				

SOLUTION

a)

	AGGREGATE 1: Natural Sand ***1000*** **g**			AGGREGATE 2: Crushed Stone #1 ***3000*** **g**			AGGREGATE 3: Crushed Stone #2 ***30000*** **g**			MIX AGGREGATE		D_{max}=16 mm		
Sieve Size d_i (mm)	Amount Retained (g)	Amount Passed (g)	Passing P_1%	Amount Retained (g)	Amount Passed (g)	Passing P_2%	Amount Retained (g)	Amount Passed (g)	Passing P_3%	Passing P_m%	100-P_m%	A_{16}	B_{16}	C_{16}
31.5	0	***1000***	***100***	0	***3000***	***100***	0	***3000***	***100***	**100**	**0**	100	100	100
22.4	0	***1000***	***100***	0	***3000***	***100***	0	***3000***	***100***	**100**	**0**	98	99	100
16	0	***1000***	***100***	90	***2910***	***97***	420	***2580***	***86***	**95.2**	**4.8**	85	92	99
11.2	0	***1000***	***100***	270	***2640***	***88***	1380	***1200***	***40***	**79.6**	**20.4**	68	79	90
8	0	***1000***	***100***	870	***1770***	***59***	660	***540***	***18***	**64.1**	**35.9**	48	63	77
4	0	***1000***	***100***	840	***930***	***31***	540	***0***	***0***	**50.0**	**50.0**	33	49	64
2	140	***860***	***86***	480	***450***	***15***	0	***0***	***0***	**39.2**	**60.8**	22	37	52
1	90	***770***	***77***	240	***210***	***7***	0	***0***	***0***	**33.0**	**67.0**	15	28	41
0.5	250	***520***	***52***	210	***0***	***0***	0	***0***	***0***	**20.7**	**79.3**	10	20	30
0.25	190	***330***	***33***	0	***0***	***0***	0	***0***	***0***	**13.2**	**86.8**	6	13	20
0.15	190	***140***	***14***	0	***0***	***0***	0	***0***	***0***	**5.6**	**94.4**	3	7	11
Ratio in the mix	**39.9%**			**32.6%**			**27.5%**			**Σ =**	**499**			

b) According to the given constraints find the mixing ratios of aggregates

a + b + c = 100%

$P_{m,4}$ = 100 a + 31 b + 0 c = 50

$P_{m,1}$ = 77 a + 7 b + 0 c =33

By using three equations mixing ratios of the aggregates can be calculated.

a = 39.9 %   b = 32.6 % and c = 27.5 %

c) $\Sigma a_i\%=100\%$ and $P_{mix,d}=a_1.P_{1,d}+a_2.P_{2,d}+a_3.P_{3,d}+\ldots$

$P_{m,31.5}$=100.0.399+100.0.326+100.0.275=100 → Check: $A_{16,31.5}=100 \le 100 \le C_{16,31.5}=100$ ✓

$P_{m,22.4}$=100.0.399+100.0.326+100.0.275=100 → Check: $A_{16,22.4}=98 < 100 \le C_{16,22.4}=100$ ✓

$P_{m,16}$=100.0.399+97.0.326+86.0.275=95.2 → Check: $A_{16,16}=85 < 95.2 < C_{16,16}=99$ ✓

$P_{m,11.2}$=100.0.399+88.0.326+40.0.275=79.6 → Check: $A_{16,11.2}=68 < 79.6 < C_{16,11.2}=90$ ✓

$P_{m,8}$=100.0.399+59.0.326+18.0.275=64.1 → Check: $A_{16,8}$=48 < 64.1 < $C_{16,8}$=77 ✓

$P_{m,4}$=100.0.399+31.0.326+0.0.275=50.0 → Check: $A_{16,4}$=33 < 50.0 < $C_{16,4}$=64 ✓

$P_{m,2}$=86.0.399+15.0.326+0.0.275=39.2 → Check: $A_{16,2}$=22 < 39.2 < $C_{16,2}$=52 ✓

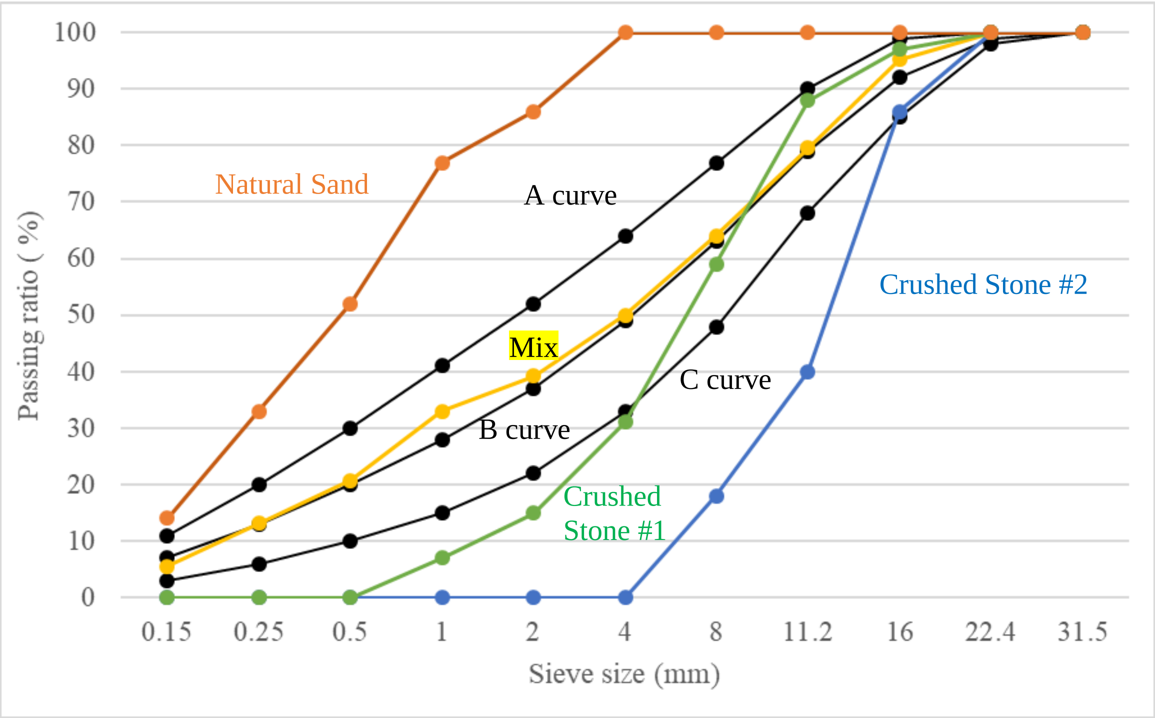
$P_{m,1}$=77.0.399+7.0.326+0.0.275=33.0 → Check: $A_{16,1}$=15 < 33.0 < $C_{16,1}$=41 ✓

$P_{m,0.5}$=52.0.399+0.0.326+0.0.275=20.7 → Check: $A_{16,0.5}$=10 < 20.7 < $C_{16,0.5}$=30 ✓

$P_{m,0.25}$=33.0.399+0.0.326+0.0.275=13.2 → Check: $A_{16,0.25}$=6 < 13.2 < $C_{16,0.25}$=20 ✓

$P_{m,0.15}$=14.0.399+0.0.326+0.0.275=5.6 → Check: $A_{16,0.15}$=3 < 5.6 < $C_{16,0.15}$=11 ✓

d)



e) Fineness Modulus: $F_m = \Sigma(100-P_i\%)/100$

$F_{m,mix} = \Sigma(100-P_{mix}\%)/100=499/100=4.99$