New 2018

اللجنة الأكاديمية للهندسة المدنية

تقارير

مواد البناء

محمد السفاريني وحازم الدراوشة

مختبر مواد البناء / التجربة الأولى / جميع الشعب

Building Materials Laboratory

Experiment No.: 1

Normal Consistency
and Setting time of hydraulic cement

Name	Mark
[redacted]	97/100

Student's number	Section number	Experiment day and date	Submission day and date
[redacted]	~~X~~ 1	30/9/2019 Monday	7/10/2019 Monday

Experiment 1

Normal Consistency and Setting time of hydraulic cement

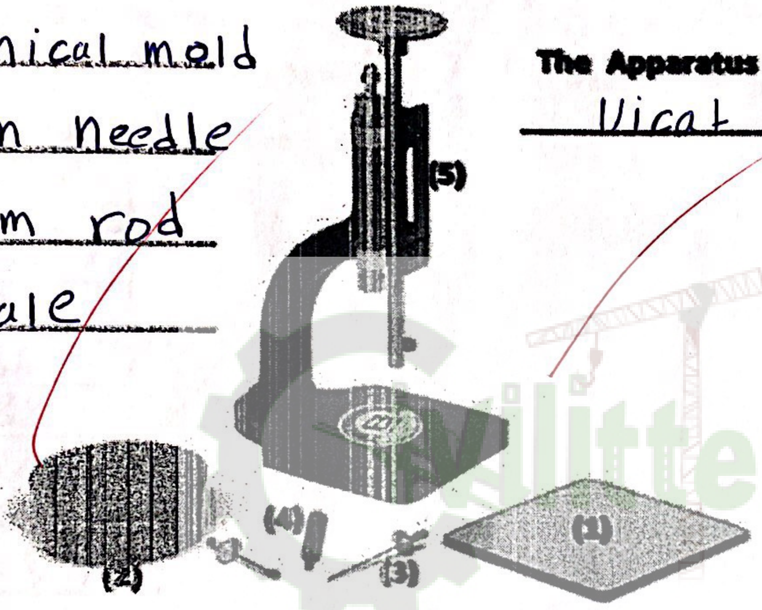
Objective

1- Determine the Normal consistency and Setting time for cement paste
2- Determine the IST and FST from the expereiment
FST = 90 + 1.2 IST
3- test cement quality
4- Determine the validity of cement paste

1.2. Apparatus and Equipment

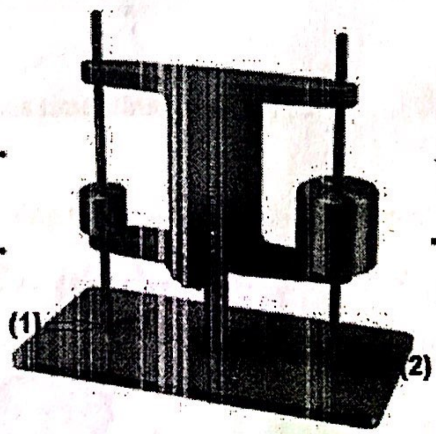
Named each Part in the apparatus below

(1): Base Plate
(2): Conical mold
(3): 1 mm needle
(4): 10 mm rod
(5): Scale



The Apparatus name is Vicat apparatus

Inital
(1): Nedle
(2): Final Nedle



The Apparatus name is Gillmore Apparatus

1.3. Materials

Cement water

...nd Calculations

...mal Consistency

...ement = 650 g

...e 1.1: variation of penetration with w/c ratio

Wt. of Water (g)	W/C %	Penetration (mm)	Log (Pent.)
~~30~~ 195	30	9	0.95
~~32~~ 208	32	15	1.17
~~33~~ 214.5	33	19	1.27

- Draw w/c% versus Log (penetration); Figure 1.1.
- From this curve (w/c% versus Log (pent.)), the normal consistency is...30.7 %.

1.4.2. Initial and Final Setting Time

Wt. of Cement = 650 g W/C% = 30.7 % Water = 199.55

Table 1.2: variation of penetration with time

Time (min)	Penetration (mm)
15	39
30	38
45	36
60	33
75	30
90	27
105	23

- Draw the penetration versus time; Figure 1.2.
- From this curve (pent. versus time), initial setting time is..100..min
- Calculate/Find the Final setting time (using the three different ways; equations and graphically)

1- From the curve figure (1.2) = 127 min

2- FST = 1.2 IST + 90 min = 1.2 * 100 + 90 = 210 min

3- FST = 1.5 IST + 45 min = 1.5 * 100 + 45 = 195 min

+½

- ...scuss the relation between the penetration and w/c ratio using table 1.1

As shown in the Sigure 1.1, direct relationship when $\frac{w}{c}$ % ratio increase the penentration also increase proos sor that, $\frac{w}{c}$ ratio was 30%. the pen was 9mm and $\frac{w}{c}$ ratio 33%. the pen was 19mm.

- Discuss figure1.1. (w/c% versus Log(penetration))

We got the normal consistancy and it was 30.7%, so we realised there is a direct and linear relationship between thim.

- Discuss the relation between the penetration and time using table 1.2

We can see that when we increase time the pentration will decrease. Proos sor that at time 15 min, the pen was 39mm and when the time 75min, the pen was 30mm

- Discuss figure1.2. (penetration versus time)

We can realise that the relationship between the pen and the time is inverse and not-linear.

- The normal consistency value is accepted or not and why?

The Value 30.7% is accepted sor reason that the Standard N.c specisy in ASTM is (25-33)%.

- The initial setting time is accepted or not and why? it was accepted, it was 100min and this time is accepted because the standard IST should be ≥ 45 min when we used Vicat apparats according to ASTM
- The Final setting time is accepted or not and why? From the equation FST = 1.2 IST + 90 we get FST 210 min and it equal 3.5 hour, 3 < 6.25 in ASTM when Vicat apparut used, so its Accepted.
- Our cement can be used in the construction or not? Why?

yes, All the Values {Nc, IST, FST} are accepted by the ASTM

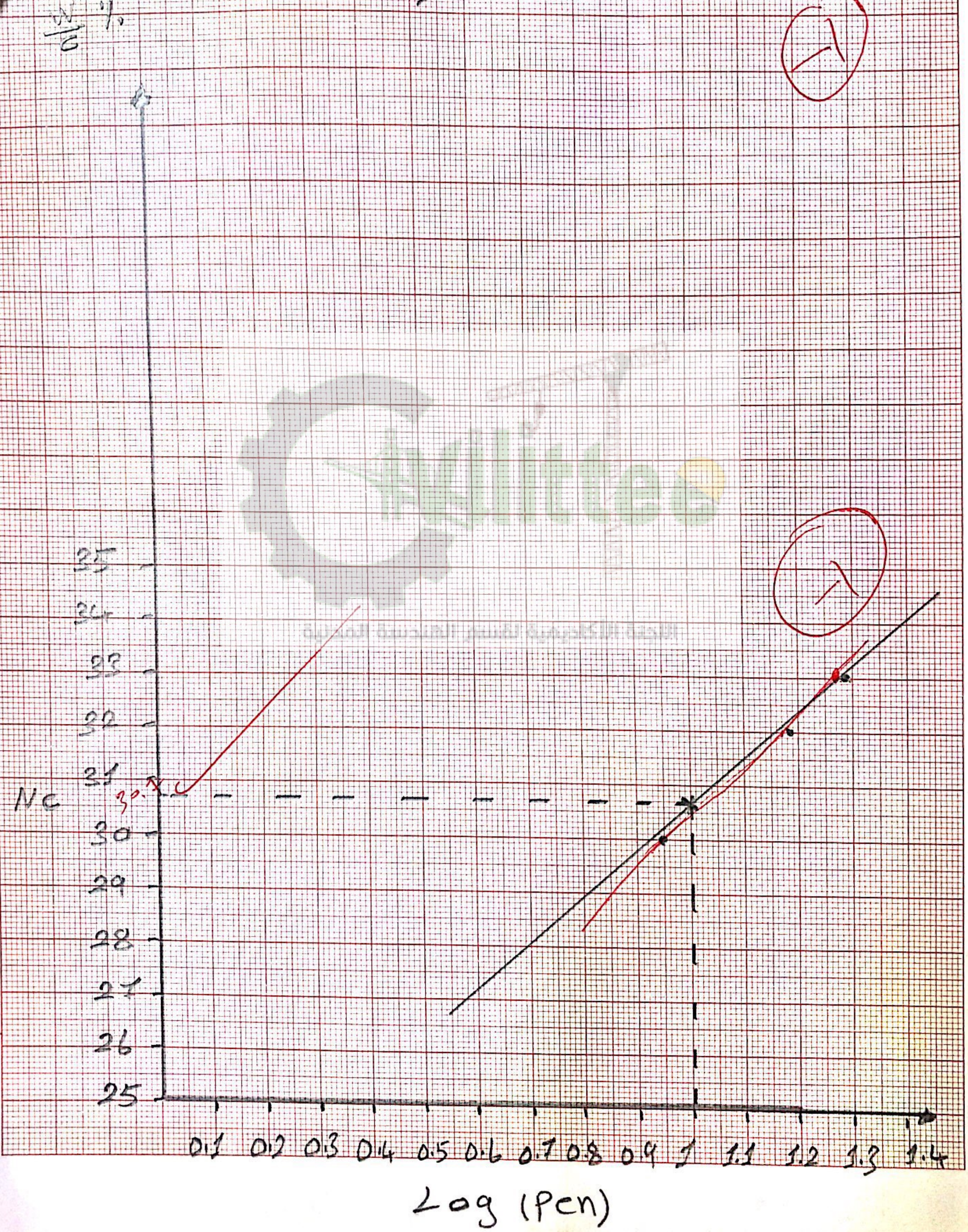
- Error sources:

Mistakes when using the Mixer
The cement paste was Thrown less than 6 times
The container was wet aster wishing it

1.6: Remember to make your report tidy and neat ☺

Figure 1.1

Tittle



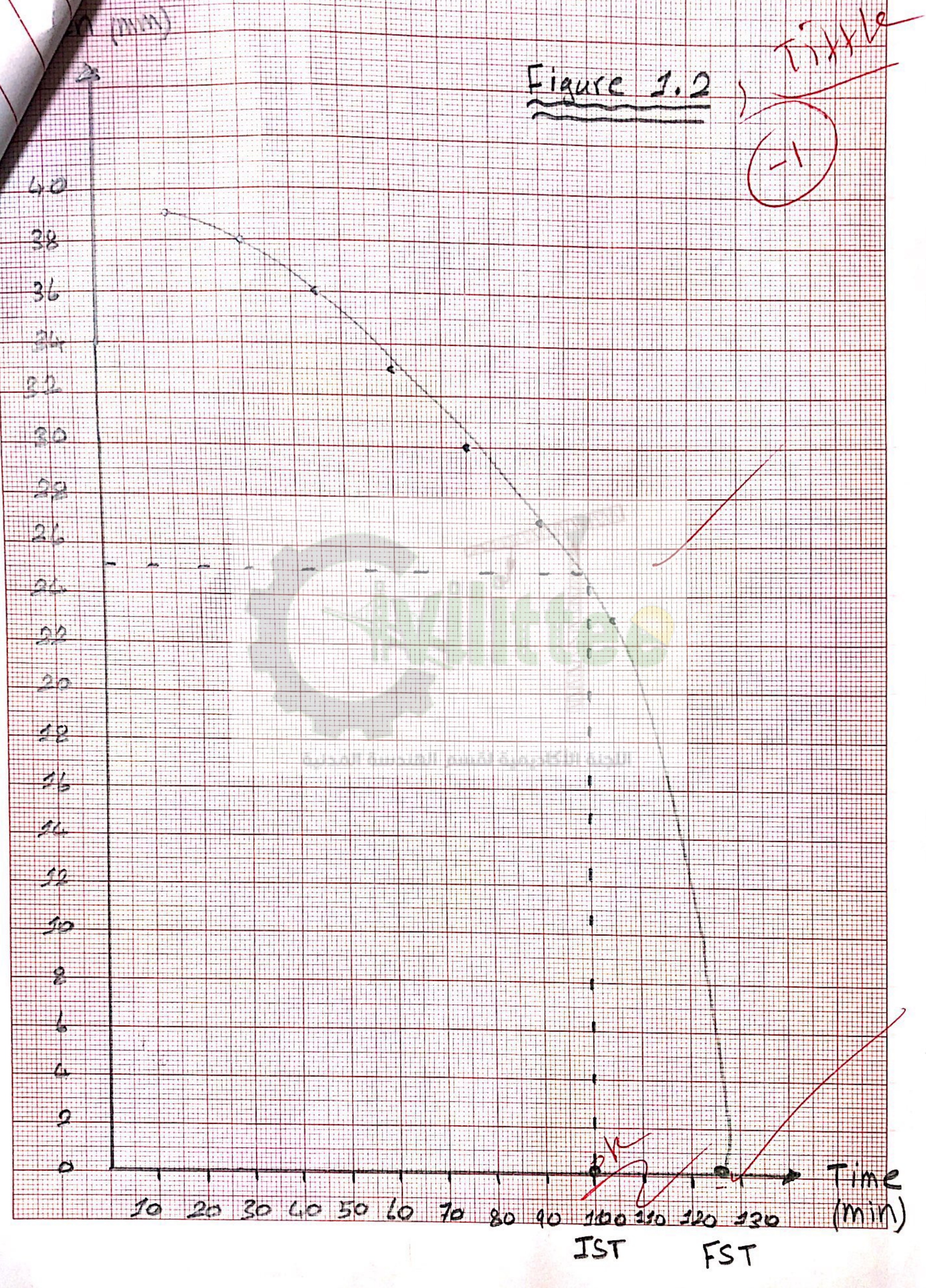

(mm)
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Time
(min)
IST
FST

Figure 1.2

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Building Materials Laboratory

Experiment No.: 2

Compressive and Tensile Strength of Cement Mortar

Name	Mark
حازم عمر دراوشة	97/100

Student's number	Section number	Experiment day and date	Submission day and date
1834046	4	Thursday 10/10/2019	Thursday 17/10/2019

Experiment 2

Compressive and Tensile Strength of Cement Mortar

2.1. Objectives

To determine the compressive and tensile strength of cement mortar, determine the quality of cement (if it accepted to use or not) and to calculate the strength of mortar in the tension and compression test.

2.2. Apparatus and Equipment

- Trowel
- container
- Mixer, timer
- Graduated glass (cylinder)
- compression test machine
- Briquette mold (25 x 25) mm
- Automatic Flexural tensile te
- cubic mold (50x50) mm
- Bowl, paddle
- Gloves

2.3. Materials

- Cement
- water
- sand

2.4. Data and Calculations

2.4.1. Compressive strength

Cement Type: Sulphate Resistance Portland Cement (V)

Ratios:

Cement: Sand = 1: 2.75

Water: Cement = 0.485

Weights: Cement = 740g

Sand = 2035g

Water = 359g

Age (Day)	Compressive Force (KN)	Compressive Strength (MPa)	Average Strength (Mpa)	Accepted range (Mpa)	Accepted or Not	Accepted Avg. Strength
3	10.3	4.12	4.12	3.708 – 4.532	yes	4.12
	9.8	3.92			yes	
	10.8	4.32			yes	
7	27.2	10.88	12.87	11.583 – 14.157	no	13.86
	35	14			yes	
	34.3	13.72			yes	
28	41.3	16.52	16.813	15.13 – 18.5	yes	15.9
	38.2	15.28			yes	
	46.6	18.64			no	

- Sample of calculations: $A = 50 * 50 * 10^{-6} = 2.5 * 10^{-3}\ m^2$

at 3 days: $\sigma_1 = \frac{10.3 * 10^3}{2.5 * 10^{-3}} = 4.12\ MPa$

$\sigma_2 = \frac{9.8 * 10^3}{2.5 * 10^{-3}} = 3.92\ MPa$

$\sigma_3 = \frac{10.8 * 10^3}{2.5 * 10^{-3}} = 4.32\ MPa$

accepted by following avg. range

$\sigma_{avg.} = \frac{4.12 + 3.92 + 4.32}{3} = 4.12\ MPa$

avg. range $= \sigma_{avg.} \pm 0.1\ \sigma_{avg.}$

$= 3.708 - 4.532$

accepted avg. strength $= \frac{4.12 + 3.92 + 4.32}{3} = 4.12\ MPa$ OK

- Estimate the compressive strength of concrete with the same w/c ratio as the cement mortar and same cement type at 28 days

$Y = 0.004 X^2 + 1.3 X$

X: σ_{comp} of mortar

$X = 15.9\ MPa$

$\sigma = 0.004(15.9)^2 + 1.3(15.9)$

$= 21.68\ MPa$

2.4.2. Tensile strength

Cement Type: Sulphate Resistance Portland Cement (V)

Ratios:

Cement: Sand = 1:3

Water: Cement = 0.46

Weights: Cement = 400g

Sand = 1200g

Water = 184g

Age (Day)	Tensile Force (N)	Tensile Strength (MPa)	Average Strength (Mpa)	Accepted range (Mpa)	Accepted or Not	Accepted Avg. Strength
3	449	0.7184	0.8155	0.6932 - 0.938	yes	0.8155
	562	0.8992			yes	
	518	0.8288			yes	
7	688	1.1008	1.2203	1.0373 - 1.4033	yes	1.2203
	843	1.3488			yes	
	757	1.2112			yes	
28	902	1.4432	1.7472	1.4852 - 2.0092	no	1.8992
	1131	1.8096			yes	
	1243	1.9888			yes	

- Sample of calculations: $A = 25 * 25 * 10^{-6} = 6.25 * 10^{-4}\ m^2$

at 28 days:

$\sigma_1 = \frac{902}{6.25 * 10^{-4}} = 1.4432\ MPa$

$\sigma_2 = \frac{1131}{6.25 * 10^{-4}} = 1.8096\ MPa$

$\sigma_3 = \frac{1243}{6.25 * 10^{-4}} = 1.9888\ MPa$

$\sigma_{avg.} = \frac{1.4432 + 1.8096 + 1.9888}{3} = 1.7472\ MPa$

accepted range = $\sigma_{avg} \pm 0.15\ \sigma_{avg}$

$= 1.4852 - 2.0092$

$\sigma_1 \rightarrow$ not accepted

$\sigma_2 \rightarrow$ accepted

$\sigma_3 \rightarrow$ accepted

ok

accepted avg. strength =

$\frac{1.8096 + 1.9888}{2} = 1.8992\ MPa$

- Draw the experimental accepted average Compressive and Tensile Strength (MPa) of Mortar versus Time (Days) on the same graph using arithmetic papers

Figure (1.1)

2.5. Discussion

* Compressive test:

It was observed from table (2.4.1): that strength increases with the progress of days in the cement sample, so bear loads stronger with each passing day

this means: Age ↑ Force (c) ↑ σ ↑

* Tensile test:

It was observed from table (2.4.2): whenever the age of cement increases, increased strength to tensile highest: Age ↑ Force (T) ↑ σ ↑

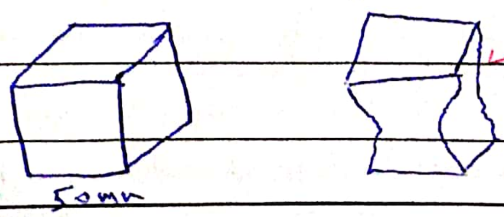
* From graph (1.1): compressive and tensile strength V.S time:

It was observed that the relation between the strength and time is direct and non-linear in compressive and tensile tests.

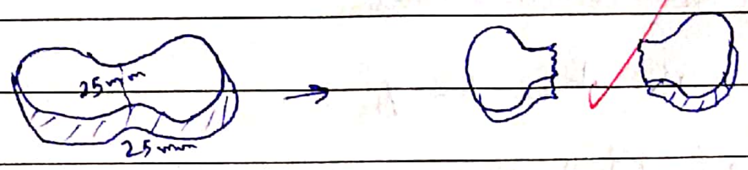
* Rate of strength along this age (3 → 28) days as follows:
- In the first 3 days → cement mortar is too weak.
- In the (3 - 7) days → high rate and clear change strength
- In the (7 - 28) days → small rate, slowly
- After 28 days → the sample of cement approximetly and the change in strength is constant.

* The sample shape after fracture:
- In compressive test:

the cube of mortar should be broken like the shape below: with angle = 45°



- In tensile test: Briquitte of mortar should be broken like the shape below with angle = 90°



* The cement is much more able to resist compression loads rather than tensile loads, and the cement is brittle material.

The ratio of $\frac{\sigma\ comp}{\sigma\ ten}$ = should be between (7-11)

at 28 days ratio = $\frac{15.9}{1.8992}$ = 8.37 ✓ accepted

ok

* comparing for compression:

Time (day)	σavg. comp. accepted (MPa)	ASTM	Accepted or not
3	4.12	8	not
7	13.86	15	not
28	15.9	21	not

* comparing for tensile:

Time (day)	σavg. Ten. accepted (MPa)	ASTM	Accepted or not
3	0.8155	—	—
7	1.2203	1.724	not
28	1.8992	2.241	not

* cement mortar type "V" sulphate resistance portland cement is ~~not~~ accepted

2.6. Remember to make your report tidy and neat ☺

2.7. Specifications

Table 2.1: ASTM C 150-05 requirements for minimum strength of cement (MPa (Psi))

Age (Days)	ASTM C 150 – 05 (mortar cube), cement type (table 4.4)							
	I	IA	II#	IIA#	III	IIIA	IV	V
1	-	-	-	-	12.0	10.0	-	-
	-	-	-	-	(1740)	(1450)	-	-
3	12.0	10.0	10.0	8.0	24.0	19.0	-	8.0
	(1740)	(1450)	(1450)	(1160)	(3480)	(2760)	-	(1160)
7	19.0	16.0	17.0	14.0	-	-	7.0	15.0
	(2760)	(2320)	(2470)	(2030)	-	-	(1020)	(2180)
28	28.0[a]	22.0[a]	28.0[a]	22[a]	-	-	17.0	21.0
	(4060)	(3190)	(4080)	(3190)	-	-	(2470)	(3050)

Strength values depend on specified heat of hydration or chemical limits of tricalcium silicate and tricalcium aluminate

[a] Optional

Table 2.2: ASTM C 190-85 requirements for minimum Tensile strength of cement [A] (Psi (KPa))

	Cement Type				
	I	II	III	IV	V
1 day in moist air, psi (KPa)	-	-	275	-	-
	-	-	(1896)	-	-
1 day in moist air, 2 days in water	150	125	375	-	-
	(1034)	(862)	(2586)	-	-
1 day in moist air, 6 days in water	275	250	-	7.50	2.50
	(1896)	(1724)	-	(1207)	(1724)
1 day in moist air, 27 days in water	350	325	-	300	325
	(2413)	(2241)	-	(2068)	(2241)

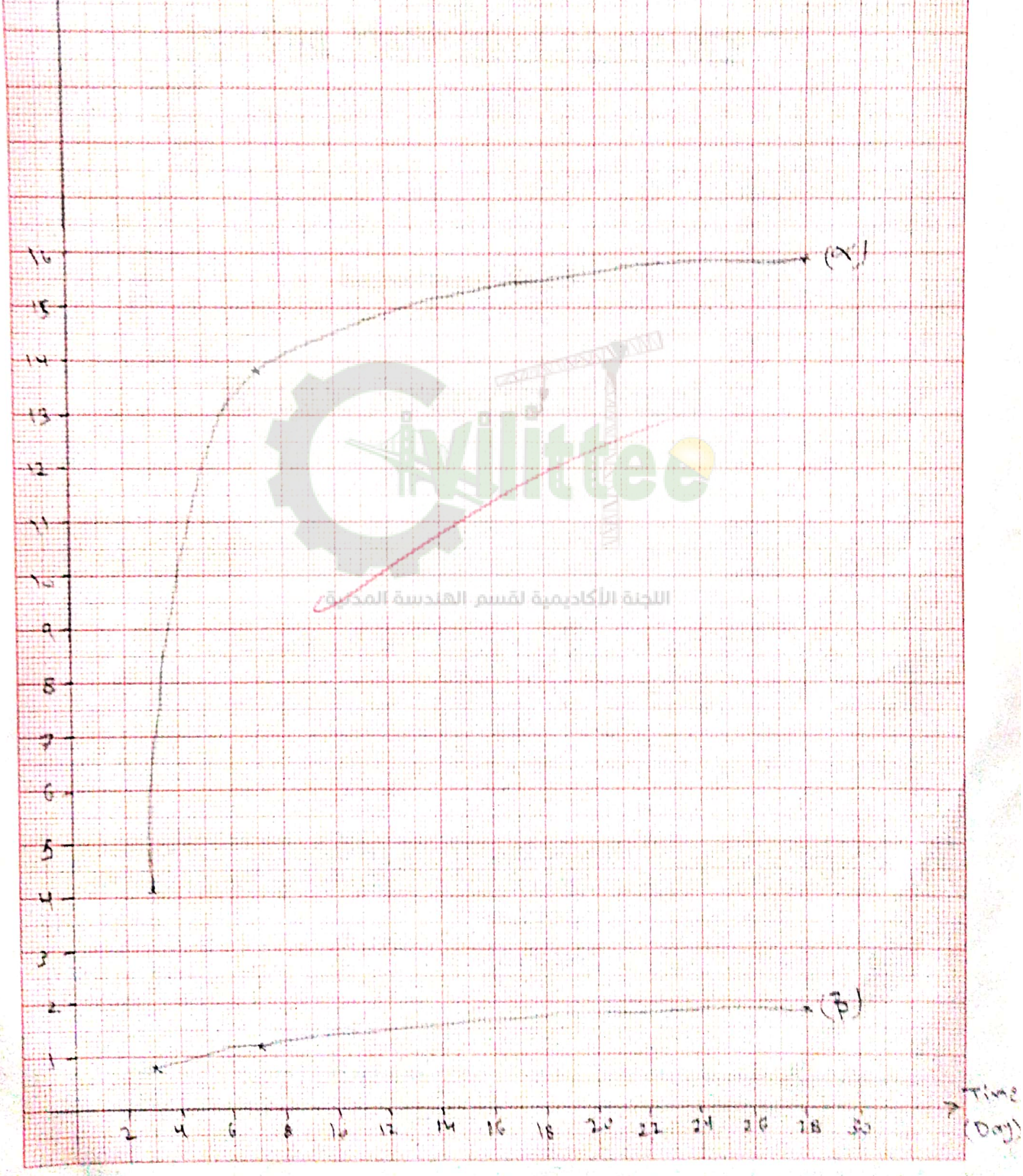
[A] taken from C 150 – 58 without change

Figure (I.1)

compressive and tensile strength V.s Time

(α) ⇒ Compressive strength V.s Time

(β) ⇒ Tensile strength V.s Time



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Building Materials Laboratory

Experiment No.: 3

Tensile Strength of Steel

Name	Mark
هازم عمر دراوشة	97 / 100 Thanks

Student's number	Section number	Experiment day and date	Submission day and date
1834046	4	Thursday 17/10/2019	Thursday 24/10/2019

Experiment 3

Tensile Strength of Steel

3.1. Objectives

To calculate the tensile and strain for steel by using universal testing machine (UTM) and to draw the strength-strain diagram and to determine the elastic region, proportional limit, yield stress, ultimate stress and rupture and to determine the elongation and ductility before and after the tensile stress process.

3.2. Apparatus and Equipment

* universal testing machine (UTM)
* Balance.
* meter
* computer software special for (UTM)

3.3. Materials

Steel rod.

ok

4.1. Data

L_i mm=	320	L_F mm=	390
D_i mm=	17.9	A_i mm² =	251.6
D_F mm=	14.8	A_F mm² =	172

	Load (KN)	Elongation (mm)	Eng. Stress (MPa)	Eng. Strain
1	0	0	0	0
2	1	1.5	3.9	4.7×10^{-3}
3	8	2.4	31.8	7.5×10^{-3}
4	18	2.5	71.5	7.8×10^{-3}
5	32	2.6	127.1	8.1×10^{-3}
6	46	2.7	182.8	8.4×10^{-3}
7	68	2.9	270.2	9×10^{-3}
8	76	5	302	15.6×10^{-3}
9	76	7	302	21.8×10^{-3}
10	76	11	302	34.3×10^{-3}
11	76	13	302	40.6×10^{-3}
12	78	16	310	50×10^{-3}
13	82	17	325.9	53.1×10^{-3}
14	85	18	337.8	56.2×10^{-3}
15	87	20	345.7	62.5×10^{-3}
16	92	23	365.6	71.8×10^{-3}
17	97	27	385.5	84.3×10^{-3}
18	103	30	409.3	93.7×10^{-3}
19	108	36	429.2	112.5×10^{-3}
20	110	41	437.2	128.1×10^{-3}
21	112	50	445.1	156.2×10^{-3}
22	113	52	449.1	162.5×10^{-3}
23	114	55	453.1	171.8×10^{-3}
24	115	60	457	187.5×10^{-3}
25	115	61	457	190.6×10^{-3}
26	113	63	449.1	196.8×10^{-3}
27	109	65	433.2	203.12×10^{-3}
28	105	66	417.3	206.2×10^{-3}
29	101	68	401.4	212.5×10^{-3}
30	99	70	393.4	218.7×10^{-3}

$$\sigma = \frac{P}{A_i \rightarrow 251.6 \times 10^{-6}}$$

$$\varepsilon = \frac{\Delta L \text{ (elongation)}}{L_i \rightarrow 320}$$

...mple of Calculations

Row (2):

$\sigma = \frac{P}{A_i} = \frac{1 * 10^3}{251.6 * 10^{-6}} = 3.9 * 10^6\ Pa = 3.9\ MPa$

$\varepsilon = \frac{\Delta L (elongation)}{L_i} = \frac{1.5}{320} = 4.7 * 10^{-3}$

OK

$A_i = \frac{\pi}{4}(D_i)^2 = \frac{\pi}{4}(17.9)^2 * 10^{-6} = 251.6\ mm^2$

$A_f = \frac{\pi}{4}(D_f)^2 = \frac{\pi}{4}(14.8)^2 * 10^{-6} = 172\ mm^2$

$L_f = L_i + Max.\ elongation$

$= 320 + 70$

$= 390\ mm$

3.4.3. Calculations

1. Draw the stress strain Diagram (if you want use Excel Program) and show on it these regions: Elastic, Plastic, Yield, Hardening, and Necking

2. Determine:

   Proportional Limit = 270.2 MPa

   Yield Point = $(15.6 * 10^{-3}, 302 * 10^6)$

   Hardening Point = $(50 * 10^{-3}, 310 * 10^6)$

   Ultimate Strength = 457 MPa

   Fracture Point = $(218.7 * 10^{-3}, 393.4 * 10^6)$

3. Calculate:

   Modulus of Elasticity = E = slope (in elastic region)

$E = \frac{\Delta\ stress}{\Delta\ strain} = \frac{(270.2 - 71.5) * 10^6}{(9 - 7.8) * 10^{-3}} = 165.5\ GPa$

OK

Ductility (Elongation) = $\left(\frac{L_f - L_i}{L_i}\right) * 100\%$

$= \left(\frac{390 - 320}{320}\right) * 100\% = 21.8\%$

Ductility (Reduction in area) = $\left|\frac{A_F - A_i}{A_i}\right| * 100\%$

$= \left|\frac{172 - 251.6}{251.6}\right| * 100\% = 31.6\%$

True Stress at fracture Point = $\sigma = \frac{P}{A_F} = \frac{99 * 10^3}{172 * 10^{-6}} = 575.6$ MPa

True Strain at Fracture Point = $\varepsilon = \frac{\Delta L}{L_F} = \frac{70 * 10^{-3}}{390 * 10^{-3}} = 179.5 * 10^{-3}$

Modulus of Resilience = Area = number of squares under the elastic region of elastic region * Area of 1 square

$= 31 (9.5 * 10^6 * 7 * 10^{-3}) = 206.15 * 10^4$ J/m^3

Modulus of Toughness = Area = number of squares * area of 1 square

$= 1156 (9.5 * 10^6 * 7 * 10^{-3})$

$= 76$ MJ/m^3

* stress - strain diagram analysis:

* ① elastic region: stress and strain connected with two relationship such as linear and direct.
- The slope is approximately equal modulus of Elasicity
- By the end of the linear, it's the proportional limit
- modulus of Elasicity is required to be between (190-210) but in our experiment (E) equal (165.5 GPa), so it is not accepted

OK

* ② yield region: we note that the stress is constant where as we observe that the strain is getting increased, hardening region starts from hardening point to the ultimate point.

③ ultimate stress: it is the maximum stress in stress-strain diagram which steel rod can stand without getting broken.

④ Fracture point: the point which the steel rod can't stand on it, so it's cause broken.

⑤ necking region: starts from the ultimate stress to the fracture point, at this region the stress starts decreasing while the strain increasing, in our experiment the ductility (elongation) equals (21.8%) and this value is accepted because this value is > 16%, the yield point was 302 MPa and ultimate stress = 457 MPa so the type of steel is G40

(275 < yield < 415) (380 < ultimate < 520)

OK

* we find that $\sigma_{actual} > \sigma_{eng}$ because $A_f < A_i$ from $\sigma = \frac{P}{A}$ when the area decrease the stress increase.

- $\varepsilon_{actual} < \varepsilon_{eng.}$ because $L_f > L_i$ from $\varepsilon = \frac{\Delta L}{L}$ when the length increase the strain decrease.

- we get the steel rod tested in a machine called (UTM) by fixing the ends of the steel rod in the machine, then, we input the information to a software computer (special) for tensile test. As a result of that the information we got tell us that the mass of steel rod and the cross sectional area as well as the length of the rod lead us to find density of the rod. as the tension reaches to the max value it will take place a necking to the rod and it will break on a shape called cup and cone.

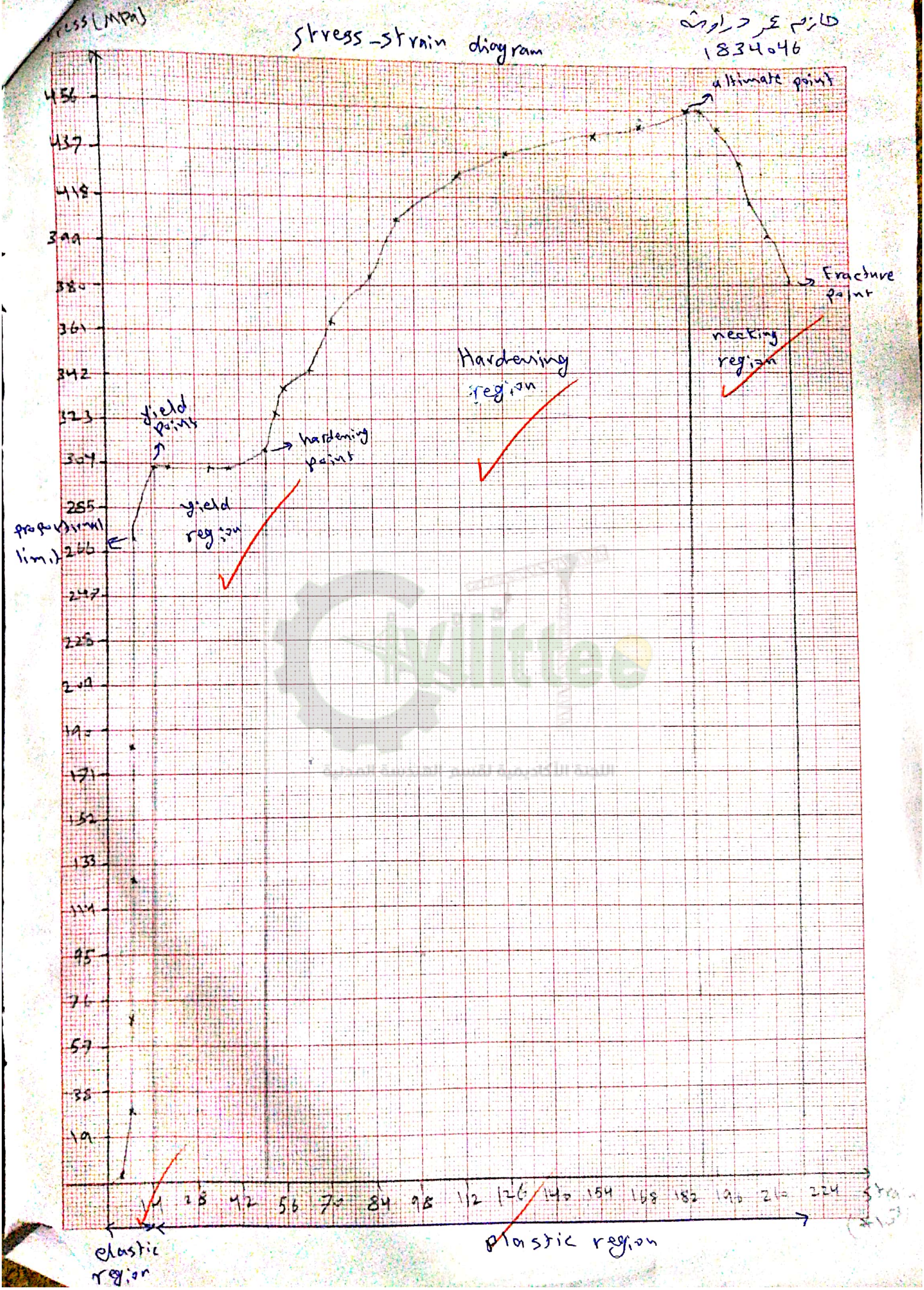
to...? -3

* modulus of resilience in stress-strain diagram equal to the area under the elastic region

* modulus of toughness is the area under stress-strain diagram

Errors: ① Error in moduluse of resilience
② Error in moduluse of toughness
③ Error in measuring length and weight of the rod
④ Error in calculations.

3.6. Remember to make your report tidy and neat ☺



stress (MPa)
stress_strain diagram
حازم عمر درويش
1834046
ultimate point
Fracture point
necking region
Hardening region
yield point
hardening point
yield region
proportional limit
elastic region
plastic region
strain
456
437
418
399
380
361
342
323
304
285
266
247
209
171
152
133
114
95
76
57
38
19
14
28
42
56
70
84
98
112
126
140
154
168
182
196
210
224

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Building Materials Laboratory

Experiment No.: 4

Specific Gravity and Absorption of Coarse and Fine Aggregate

Rodded Unit Weight of Coarse Aggregate

السفاريني

Name	Mark
محمد مصطفى أحمد السفاريني	96/100

Student's number	Section number	Experiment day and date	Submission day and date
[redacted]	1	Monday 21/10/2019	Monday 28/10/2019

Experiment 4

Specific Gravity and Absorption of Coarse and Fine Aggregate

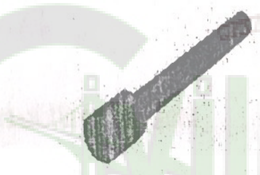
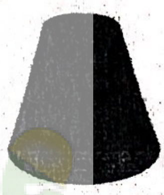
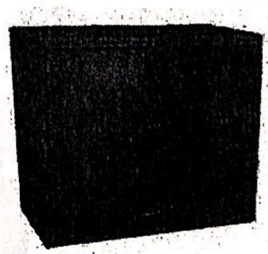
Rodded Unit Weight of Coarse Aggregate

4.1. Objectives

1- Finding Speciefic gravity and apparent for fine and coarse aggregate. 2- Find the absorbtion of coarse and fine aggregate check the quality of aggregate and to find compacted Bulk density of course aggregate to know aggregates weight by comparing S.G with scale and to know voids ratio and angularity number of aggregate.

4.2. Apparatus and Equipment

List the names of the following equipment and tools:

		
special balance with basket	Steel rod	cone mold
		
Pycnometer	Steel cylinder with rod	oven

4.3. Materials

Water

Fine and course aggregate

4.4. Data and Calculations

4.4.1. Specific gravity and absorption of coarse aggregates

Data:

A: Weight of oven-dry test sample in air (g)	1459
B: Weight of S.S.D. sample in air (g)	1500
C: Weight of saturated sample in water (g)	939.6

Calculations:

1. Apparent Specific Gravity = $\frac{\text{Weight of oven dried}}{\text{weight of oven dried} - \text{weight in water}} = \frac{1459}{1459 - 939.6} = 2.80$

2. Bulk Specific Gravity (SSD) = $\frac{\text{weight of SSD in air}}{\text{weight of SSD in air} - \text{weight in water}} = \frac{1500}{1500 - 939.6} = 2.676$

3. Absorption (%) = $\frac{\text{weight of SSD in air} - \text{weight of oven dried}}{\text{weight of oven dried}} = \left(\frac{1500 - 1459}{1459}\right) * 100 = 2.81\ \%$

4.4.2. Specific gravity and absorption of fine aggregate

Data:

A: Weight of oven – dry specimen in air (g)	494
B: Weight of Pycnometer filled with water (g)	1419
S: Weight of the saturated surface-dry specimen (g)	501
C: Weight of Pycnometer with specimen and water (g)	1730

Calculations:

1. Apparent Specific Gravity = $\frac{A}{A + B - C} = \frac{494}{494 + 1419 - 1730} = 2.699$

2. Bulk Specific Gravity (SSD) = $\frac{S}{S + B - C} = \frac{501}{501 + 1419 - 1730} = 2.63$

3. Absorption (%) = $\left(\frac{S - A}{A}\right) * 100 = \left(\frac{501 - 494}{494}\right) * 100 = 1.41\ \%$

4.4.3. Compacted and Loose bulk density

Data:

Weight of measure plus compacted aggregate (kg)	20.82	→ A
Weight of measure plus loose aggregate (kg)	19.2	→ B
Weight of measure filled with water (kg)	15.36	→ C
Weight of measure (kg)	6	→ D
Density of water (kg/m³)	1000	→ E
Specific gravity of aggregate	2.73	→ F

M1 → density compacted agg
M2 → density of loose agg
S → specific gravity
w → density water

Calculations:

1. Volume of aggregate = $\frac{\text{mass full water}}{\text{density water}} = \frac{C - D}{E}$

$\frac{15.36 - 6}{1000} = 9.36 * 10^{-3} \, m^3$

2. Compacted Bulk density of aggregate = mass of agg compact = $\frac{A - D}{\text{volume}}$

$\frac{20.82 - 6}{9.36 * 10^{-3}} = 1583.33 \, Kg/m^3$

3. Voids (%) of compacted sample= $\left(1 - \frac{M_1}{S * w}\right) * 100 = \left(1 - \frac{1583.33}{2.73 * 1000}\right) * 100$

$= 42 \%$

4. Bulk density of loose aggregate = $\frac{\text{mass of loose aggregate}}{\text{volume}} = \frac{B - D}{\text{volume}}$

$\frac{19.2 - 6}{9.36 * 10^{-3}} = 1410.25 \, Kg/m^3$

5. Voids (%) of loose sample = $\left(1 - \frac{M_2}{S * w}\right) * 100 = \left(1 - \frac{1410.25}{2.73 * 1000}\right) * 100$

$= 48.34 \%$

6. Calculate the angularity number if the bulk density (measured to calculate it) is 0.97 of the compacted bulk density.

Bulk density = 0.97 * compacted density = 0.97 * 1583.33 = 1535.83 Kg/m³

Solid % = 100% − V% → 100% − 44.72 = 55.28 %

$V\% = \left(1 - \frac{1498}{2.71 * 1000}\right) * 100 = 44.72$

ok

Angularity = 67% − Solid %

67% − 55.28% = 11.72%

4.5. Discussion

4.5.1. Specific gravity and absorption

- The SSD weight in water is less than that in air. Why?

The aggregate in water ~~the aggregate dried~~ ~~and~~ loss weight and its equal weight of removed wateer, by oven ~~coarse~~ the aggregate .dried and it will not have anguoid.

-3

- Our aggregate (coarse and fine) are Heavy, Normal, or Light weight? Why?

according the value of S.G, we Know that when S.G >3 is heavy and is S.G<2 is Light and is 2.2<S.G<2.8 is Normal so when we calculated the values of Bulk and apparent S.G For coarse aggregat was (2.676, 2.80) and the values of Bulk and apparent For fine aggregate was (2.63, 2.69) and that indicate that course agg is Normal and Fine agg is Normal

- Absorption% of coarse and fine aggregate are accepted or not? Why?

The Max allowable of absorption must be ≤5% and the absorption For coarse aggregate is 2.81% so its Accepted and the absorption For fine aggregate is 1.41 so its accepted.

- What is the effect of using alcohol instead of water to calculate the specific gravity of aggregate; i.e. [Gs=Mass of aggregate / Mass of alcohol] instead of [Gs=Mass of aggregate / Mass of water]?

If we used alcohol, the volume will increase and according to the $\rho = \frac{M}{V}$ so the relation between Mass and density so the density will decrease and according to the $S.G = \frac{\rho}{\rho_{alcohol}}$ so the S.G increase

density alcohol 789 kg/m^3

ok

- The air bubbles must be eliminated from pycnometer. Why?

we remove the bubbles for their effect on S.G when we measure the specimen with bubbles the volume will be larger than the real measurement, the value of S.G is decrease and this is not correct volume and there for the correct value of S.G.

-1

4.5.2. Bulk density of coarse aggregate

- Comment on the acceptability of the following measurements and explain why:

  - Compacted Voids ratio

Voids ratio Srom our experiment equal 42 %. and its accepted because its greater than 33 %.

  - Angularity number

Angularity number was 11.72 % and the range accepted Sor the Angularity must be Less or equal 11 %. So its not accepted

- Is our coarse aggregate normal? Why?

Agg type	Bulk density (Kg/m³)
Heavy	2880
Normal	1520 - 1680
light	1120

the compacted density is 1583.33 Kg/m³ So we can sayed that is normal aggregate.

OK

- Compare the compacted results with loose.

when we calculated the compacted density was 1583.33 Kg/m³ and the loose density was 1610.25 Kg/m³, the compacted density > loose density Because its exposed For compacting voids For compacted density and the voids For loose density is ?. the loose voids is larger Because it isn't compacted and inverse relation between density and voids.

- What is the relation between the roundness of the aggregate and the angularity number?

IF the obsence os roundness that means more angular So we can noticed that the relation between the roundness and the angularity number is inverse relation

4.5.3. Error sources:

1. When we Airred and mixed to remove air bubbles it had to last Sor 15 min and we didn't.
2. The air was not removed os Pycnometer
3. When we add the Fine Agg to the Pycnometer, we didn't add the whole sample, some os it Sell on the side.

4.6. Remember to make your report tidy and neat ☺

4- Error in tamping the Sample.

مختبر مواد البناء/ التجربة الخامسة / تجميع الصعب

Building Materials Laboratory

Experiment No.: 5

Sieve Analysis of coarse and Fine Aggregates

Name	Mark
محمد مصطفى أحمد الصفار غني	91 / 100

Student's number	Section number	Experiment day and date	Submission day and date
[redacted]	1	28/11 Monday	4/11 Monday

Experiment 5

Sieve Analysis of coarse and Fine Aggregates

5.1 Objectives

1- Determine the grading of agg 2- determine the finess modulus for coarse and fine agg
3- Determine if the aggregate is accepted or not to use in concrete 4- Determine the maximum of agg and nominal maximum size of agg.

5.2 Apparatus and Equipments

Pan

Shaker

Balance

Sieves for coarse Agg

Sieve for fine Agg

5.3 Materials

Coars aggregate

fine aggregate

5.4. Data and Calculations

5.4.1. Sieve analysis of coarse aggregates

Sample weight = 999 (g)

Table 6.1: Sieve analysis of coarse aggregates

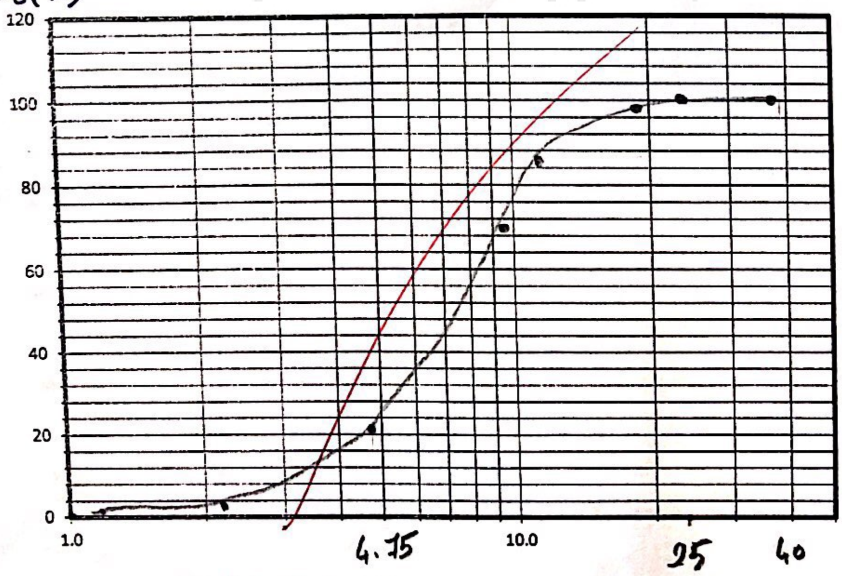
sieve size (mm)	sieve No.	sieve wt. (g)	sieve+ret. (g)	Ret. Wt. (g)	Retained (%)	Cum. Ret. (%)	Cum. Pass (%)
37.5	1 1/2"			0	0	0	100
✗ 25 (Not standard)	1"			0	0	0	100
19	3/4"			12	1.22	1.22	98.78
✗ 12.5 (Not)	1/2"			118	12	13.22	86.78
9.5	3/8"			125	12.71	25.93	74.07
4.75	4			523	53.20	79.13	20.87
2.36	8			187	19.02	98.15	1.85
1.18	16			8	0.81	98.96	1.04
✗ 0.075	200			4	0.40	99.36	0.64
✗ pan				6	0.61	99.97	0.03
			Total weight retained	983		≈ 100	≈ 0

Determine:

1. F.M. = $\frac{\Sigma \text{cum Ret (\%) for all standard sieve}}{100}$ = ~~0 + 1.22 + 12 + 12.71 + 53.20 + 19.02 + 0.81 + … / 100~~ = $\frac{0 + 1.22 + 25.93 + 79.13 + 98.15 + 98.96 + 3(100)}{100}$ = 6.03
2. M.S. = 25 mm , 1"
3. N.M.S. = 12.5 mm $\frac{1}{2}$"

Draw the [cumulative passing (%)] versus [sieve size (mm)]; ((Excluding sieve #200))

Grading Curve (Coarse Aggregates)



5.4.2. Sieve analysis of fine aggregates

Sample weight= -----300

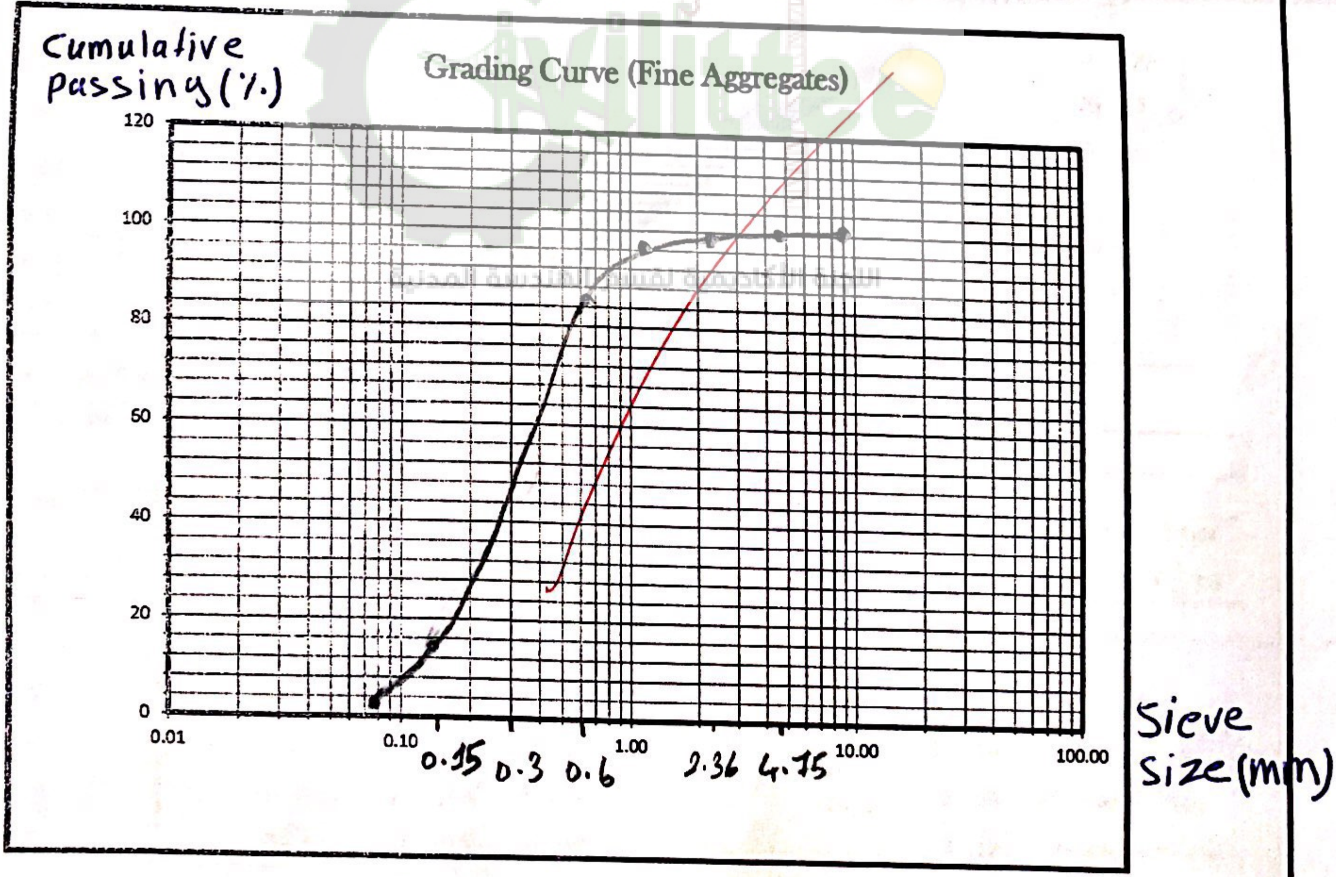
Table 5.2: Sieve analysis of fine aggregates

sieve size (mm)	sieve No.	sieve wt. (g)	sieve+ret. (g)	Ret. Wt. (g)	Retained (%)	Cum. Ret. (%)	Cum. Pass (%)
9.5	3/8"			0	0	0	100
4.75	4			0	0	0	100
2.36	8			3	1.003	1.003	98.997
1.18	16			4	1.337	2.34	97.660
0.6	30			26	8.695	11.035	88.965
0.3	50			112	37.458	48.493	51.507
0.15	100			113	37.792	86.285	13.715
X 0.075	200			34	11.371	97.656	2.344
X pan				7	2.341	100	0
		Total weight retained		299			

Determine:

1. F.M. = $\frac{\Sigma \text{Cum ret for all Standard Sieves}}{100} = \frac{0+1.003+2.34+11.035+48.493+86.285}{100}$ = 1.49
2. M.S. = 4.75mm , #4
3. N.M.S. = 0.6mm , #30

Draw the [cumulative passing (%)] versus [sieve size (mm)]



9.5. Specifications

Table 9.4.: BS and ASTM grading requirements for fine aggregate

Sieve size		Percentage by mass passing sieve				
		BS 882: 1992				ASTM C 33-92a
		Overall limits	Additional limits*			
BS	ASTM No.		C	M	F	
10 mm	$\frac{3}{8}$ in.	100	-	-	-	100
5 mm	$\frac{3}{16}$ in.	89 – 100	-	-	-	95 – 100
2.36 mm	8	60 – 100	60 – 100	65 – 100	80 – 100	80 – 100
1.18 mm	16	30 – 100	30 – 90	45 – 100	70 – 100	50 – 85
600 μm	30	15 – 100	15 – 54	25 – 80	55 – 100	25 – 60
300 μm	50	5 – 70	5 – 40	5 – 48	5 – 70	10 – 30
150 μm	100	0 – 15‡	-	-	-	2 – 10

* C = coarse; M = medium; F = fine.

‡ For crushed rock sands the permissible limit is increased to 20 percent, except when used for heavy duty floors.

Table 9.5.: Some of the grading requirements for coarse aggregate according to ASTM C 33-92a

Sieve size		Percentage by mass passing sieve				
		Nominal size of graded aggregate			Nominal size of single-sized aggregate	
mm	in.	37.5-4.75mm ($1\frac{1}{2}$ to $\frac{3}{16}$ in.)	19 – 4.75mm ($\frac{3}{4}$ to $\frac{3}{16}$ in.)	12.5-4.75mm ($\frac{1}{2}$ to $\frac{3}{16}$ in.)	63 mm ($2\frac{1}{2}$ in.)	37.5 mm ($1\frac{1}{2}$ in.)
75.0	3	-	-	-	100	-
63.0	$2\frac{1}{2}$	-	-	-	90 – 100	-
50.0	2	100	-	-	35 – 70	100
38.1	$1\frac{1}{2}$	95 – 100	-	-	0 – 15	90 – 100
25.0	1	-	100	-	-	20 – 55
19.0	$\frac{3}{4}$	35 – 70	90 – 100	100	0 – 5	0 – 15
12.5	$\frac{1}{2}$	-	-	90 – 100	-	-
9.5	$\frac{3}{8}$	10 – 30	20 – 55	40 – 70	-	0 – 5
4.75	$\frac{3}{16}$	0 – 5	0 – 10	0 – 15	-	-
2.36	No. 8	-	0 – 5	0 – 5	-	-

Table 9.6.: Grading requirements for coarse aggregate according to BS 882: 1992

Sieve size		Percentage by mass passing BS sieve							
		Nominal size of graded aggregate			Nominal size of single-sized aggregate				
mm	in.	40–5mm ($1\frac{1}{2}$ - $\frac{3}{16}$ in)	20–5mm ($\frac{3}{4}$ - $\frac{3}{16}$ in)	14–5mm ($\frac{1}{2}$ - $\frac{3}{16}$ in)	40 mm ($1\frac{1}{2}$ in.)	20 mm ($\frac{3}{4}$ in.)	14 mm ($\frac{1}{2}$ in.)	10 mm ($\frac{3}{8}$ in)	5 mm ($\frac{3}{16}$ in)
50	2	100	-	-	35 – 70	100	-	-	-
37.5	$1\frac{1}{2}$	95 - 100	-	-	0 – 15	90 – 100	-	-	-
20	$\frac{3}{4}$	35 – 70	90 – 100	100	0 – 5	0 – 15	100	-	-
14	$\frac{1}{2}$	-	-	90 – 100	-	-	85 – 100	100	-
10	$\frac{3}{8}$	10 – 30	20 – 55	40 – 70	-	0 – 5	0 – 50	85 - 100	100
5	$\frac{3}{16}$	0 – 5	0 – 10	0 – 15	-	-	0 – 10	0 – 25	50–100
2.36	#7	-	0 – 5	0 – 5	-	-	-	0 – 5	0 – 30

Table 9.7.: Grading requirements for coarse aggregate according to J.S. (Jordanian Standards)

Sieve size mm	Sieve size in.	40 mm ($1\frac{1}{2}$ in.)	25 mm (1 in.)	20 mm ($\frac{3}{4}$ in.)	12 mm ($\frac{1}{2}$ in.)
51	2	100	-	-	-
38	$1\frac{1}{2}$	80 – 100	100	-	-
25.4	1	20 – 50	95 – 100	100	-
19	$\frac{3}{4}$	10 – 30	40 – 80	95 – 100	100
12.7	$\frac{1}{2}$	-	5 – 50	50 – 80	90 – 100
9.5	$\frac{3}{8}$	0 – 10	0 – 15	25 – 60	80 – 100
4.75	$\frac{3}{16}$	0 – 5	0 – 5	0 – 10	5 – 50
2.36	#8	0 – 2	0 – 5	0 – 10	0 – 25
0.075	#200	0 – 2	0 – 2	0 – 2	0 – 2

(Percentage by mass passing sieve — Nominal size of graded aggregate)

Table 9.8.: Grading requirements for fine aggregate according to J.S. (Jordanian Standards)

Sieve size mm	Sieve size No.	9.5 mm ($\frac{3}{8}$ in.)	4.75 mm (No. 4)	1.18 mm (No. 8)
9.5mm	$\frac{3}{8}$ in.	95 – 100	100	-
4.75 mm	4	80 – 100	90 – 100	-
2.36 mm	8	50 – 80	75 – 100	100
1.18 mm	16	20 – 70	55 – 90	90 – 100
600 µm	30	10 – 35	35 – 59	60 – 90
300 µm	50	5 – 15	8 – 30	20 – 60
150 µm	100	0 – 5	0 – 10	0 – 20
75 µm	200	0 – 5	0 – 5	0 – 10

(Percentage by mass passing sieve — Nominal size of graded aggregate)

Fine Aggregate : when we compare table [5.2] with table [9.4] For BS And ASTM we observed that :- According to ASTM the FA is not accepted because its not accepted to the requirments of ASTM also according to BS the FA is accepted all of overall Limits of Sieves are accepted according to BS requirments. Also we tested the FA to determine that is (Coarse, medium, fine) Sand so we find that is not accepted to be coarse Sand and ~~not~~ its accepted to be Fine Sand and according to the JS table [9.8] we see that its not accepted in Sieve #16, 30, 50, 100 .

-3

Finess of Modlus 1.49 < 2 its accepted to be fine aggregate

<5 fine agg. fine sand.

In FA table [5.2] Sieve #200 has cumulative Passing 2.344 < 5 so its accepted to use in concrete because is the clay higher than 5% then its not Accepted.

We use Sieve 9.5 mm in FA to insure that we removed all impurities which is > 5 mm .

% loss -2

FA is well-graded according to BS and JS but poor graded according to ASTM .

OK

From table 6.1 and 5.2 we found that a seive size increase the Log of Sieve size increase .

⊛ Coarse aggregate :- when we compare table [6.1] with table [9.5] For BS we found that CA in our experiment is not accepted and table [9.6] for ASTM is not accepted Also it is not Accepted for Jordan standard table [9.7].

⊛ The CA is Poor graded according to ASTM because its not accepted to the ASTM requirments, Also CA is Poor graded according to Jordan and BS Requirements.

⊛ Finess Modulus of CA in our experiment = 6.03 So that this is CA because 6.03 > 5 According to table Fineness Modulus.

#200? (-2)

% Loss (-2)

Errors :-

1- Error in reading weight
2- Error in use shaker
3- Error in the order of Sieves
4- Error in Sieves (not clean)
5- Some of agg go out from shaker

5.7 Remember to make your report at units

Building Materials Laboratory

Experiment No.: 6

Resistance to degradation of small-size coarse aggregate by abrasion and impact in the Los Angeles machine

Name	Mark
هاشم عمر داود	9.5/10 — 95/100

Student's number	Section number	Experiment day and date	Submission day and date
1834046	4	Thursday 7/11/2019	Thursday 7/11/2019

Experiment 6

Resistance to degradation of small-size coarse aggregate by abrasion and impact in the Los Angeles machine

6.1. Objectives

to calculate L.A number (value)

To measure the hardness of agg.

ok 2

6.2. Apparatus and Equipment

Sieves, drum, timer, Pan, steel balls.

↳ #12, 3/4", 1/2", 3/8"

ok 2

6.3. Materials

Coarse aggregate

1 0.5

6.5. Data and Calculations

Data:

W_1: Weight of aggregate before testing = 5000 g

W_2: Weight of aggregate retained on sieve #12 after testing = 3085 g

Calculations:

Calculate the Abrasion%

$$\frac{W_1 - W_2}{W_1} * 100\% = 38.3\%$$

5.5

5.6. Discussion

- What is the quality of our sample? Why?

It's low quality because LA = 38.3 (35 – 45) according to LA standard.

- How will the L.A. value be affected if the number of steel balls in L.A. machine is 8?

L.A will decreased because w2 increases then (w1 – w2) → (w fine) decreases so L.A decreases

- The abrasion value found from Los Angeles test for two aggregates A and B are 22% and 13% respectively. Which aggregate is harder? Why? For what types of constructions are these suitable?

agg. B is harder than A, because LA number for A is larger than B and the relation between L.A number and hardness is inverse.
A → use for housing and structural using
B → use for Bridge and Dams.

5.7. Remember to make your report tidy and neat ☺.

Building Materials Laboratory

Experiment No.: 7

Concrete workability and Admixtur

Name	Mark
حازم عمر دراوشه	96/100

Student's number	Section number	Experiment day and date	Submissio day and da
1834046	4	Thursday 14/11/2019	Thursday 28/11/20

Experiment 7

Concrete workability and Admixture

Remember to make your report tidy and neat ☺

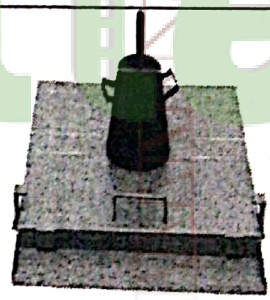
7.1. Objective

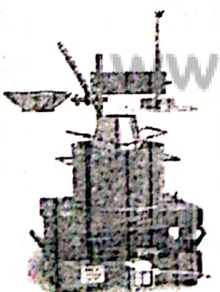
To know or check the workability of concrete by following tests: slump test, flow table test, Vebe test compacting factor test, Kelly ball test
we add admixture (superplasticizer) to observe it's effect

7.2. Materials

water | cement | coarse aggregate | fine aggregate | superplasticizer.

7.3. Tests Apparatus and Equipment

Apparatus / Tools				
Name	slump test apparatus	rod	mixer	flow table test

Apparatus / Tools				
Name	Vebe test apparatus	compacting factor	Kelley ball test apparatus	vibration table

Workability Test

7.4.1. Weights

Batch= 35kg

Cement= 4.7 kg

Coarse Aggregate= 18.6 kg

Fine Aggregate= 9.4 kg

Water= 2.35 kg

7.4.2. Slump Test

Cone Height (cm)	Slump (cm)	Slump Type
30	~~[illegible]~~ 10	True

7.4.3. Vebe Test

Time (sec) *(Vebe Seconds)*
3 Seconds

7.4.4. Flow Table Test

Dimensions (cm)	Readings (mm)	Diameters (mm)		$D_{f\text{-}avg}$ (mm)	Flow Factor (%)
Table 70 x 70	185	D_{f1}	365	$\frac{D_{f_1}+D_{f_2}}{2} = \frac{365+370}{2} = 367.5$	$F.F = \frac{D_{f\text{-}avg}-D_i}{D_i} \times 100\% = \frac{367.5-200}{200} \times 100\% = 83.75\%$
	170				
D_i 20	190	D_{f2}	370		
	140				

7.4.5 Compacting Factor Test

Wt. of Partially compacted concrete (kg)	Wt. of Fully compacted concrete (kg)	Compacting Factor
14.26-3.24	14.38-3.24	0.989

= 11.02 = 11.14

Admixtures Test

7.4.6. Weights

Batch= 20 kg

Cement =2.7 kg

Coarse Aggregates= 10.6 kg

Fine Aggregates= 5.4 kg

Water= 1.31 kg

Plasticizer= 1.11% of cement

Plasticizer= 1.11/100*2.7

Plasticizer= 0.03kg = 30g

7.4.7 Results

Admixture Type and name	Cone Height (cm)	Slump (cm)	Slump Type
super plasticizer (Flocrete SP95)	30	19.5	collapse

7.5. Sample of Calculations

Flow Table

$DF_1 = 70 - 16.5 - 17 = 36.5$ cm

$DF_2 = 70 - 19 - 14 = 37$ cm

$D_{avg} = \frac{36.5 + 37}{2} = 36.75$ cm

OK

$\text{Flow Factor} = \frac{D_{f\,avg} - D_i}{D_i} * 100\% = \frac{36.75 - 20}{20} * 100\% = 83.75\%$

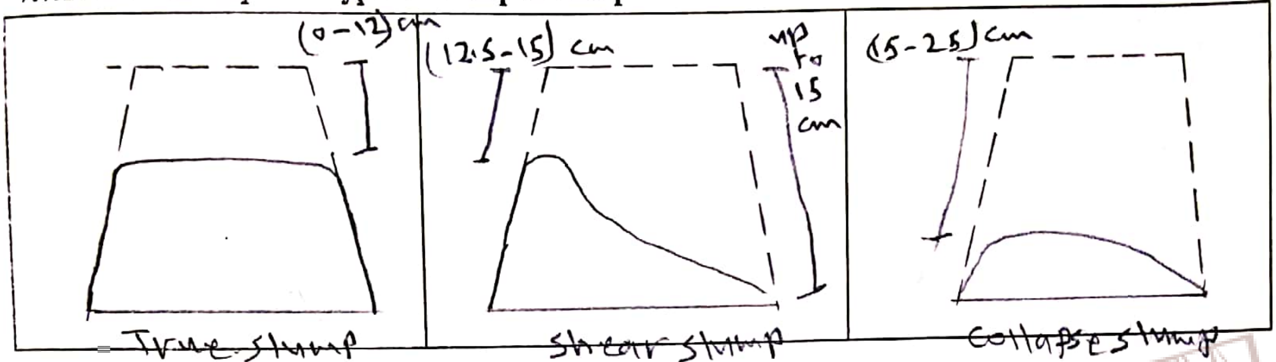
Compacting Factor

$\frac{\gamma_{uncompacted}}{\gamma_{compacted}} = \frac{W_{uncompacted}}{W_{compacted}} = \frac{14.26 - 3.24}{14.38 - 3.24} = 0.989$

. Plot no graphs are needed.

7.7. Discussion

7.7.1 Draw the expected types of slump in slump test.



7.7.2 comment on the results:

1. Slump test In our experiment the slump = 10 cm so it's true slump, the degree of workability for slump test is medium workability because it's equal (50-100) mm and the slump = 100 mm,
- when the slump increase the workability also increase,

we made the slump test by filled the cone on 3 layers, every layer rodded 25 time by then we raise the cone in 5 seconds then we can know the type of slump.

2. Vebe Test : it's easy to use and low cost so we use it to this reason vebe time = 3 seconds, according to table workability it's a high workability (3-7) sec., we use vebe test to determine workability by measuring the time that concrete needs to take the shape of the cone, vebe test is using specially for measuring compactability and also it's measuring slump
This test is best for very low workability.
- when v.b time increase the workability decrease.

3. Flow table This test is using to know the cohesiveness and seggregation of the concrete. according to ASTM Davg = 367.5 mm so the workability between low and medium (it's near to medium) because according to ASTM when the workability Davg = 300 mm (low workability), Davg = 400 mm (medium work), Davg = 500 mm (high work), when D increases the workability increases
- Flow table is specifically using for collapse slump
- This apparatus is the best for measuring seggregation and the very high workability.

4. Compacting Factor in our experiment we found that compacting factor = 0.989 < 1 (it should be < 1), according to the standard compacting factor it's high work. ✓

workability	comp. Factor
v. low	0.78
low	0.85
medium	0.92
high	0.95

- when compacting factor increases the work. increase ✓
- we calculate comp. factor by:

comp. Fact. = V uncomp. / V comp. = W uncomp. / W comp.

- Disadvantages: not fit to measure very high and ~~to~~ low work. and it takes along time. ok

5. Admixtures

* we use super plasticizer to increase workability with out decreasing the strength of concrete

	before adding the admixture	after adding the admixture
C: W	4.7 : 2.35 = 1 : 0.5	2.7 : 1.34 = 1 : 0.5
C: F.A	4.7 : 9.4 = 1 : 2	2.7 : 5.4 = 1 : 2
C: C.A	4.7 : 18.6 = 1 : 3.96	2.7 : 10.6 = 1 : 3.93

ok

we observe that the ratios as remain constant after adding the admixture, that means the strength of concrete doesn't differ but with more workability, the slump = 195 mm so this sample is a collapse slump and has a very high workability according to ASTM and it's accepted because seggregation ~~doesn't~~ didn't happen.

7.7.3 Source of errors

① Error in mixing time

② Error in using the mixer

③ error in reading weight

④ error in using the apparatus

⑤ we used the same sample of concrete for all tests so this is error because we should use a new concrete for a new test.

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Building Materials Laboratory

Experiment No.: 8

Part.1: Concrete Strength by Non-Destructive Methods

Part.2: Concrete Strength by Destructive Methods

Name	Mark
لازم عمر دراوشه	98/100

Student's number	Section number	Experiment day and date	Submission day and date
1834046	4	Thursday 31/11/2019	Thursday 5/12/2019

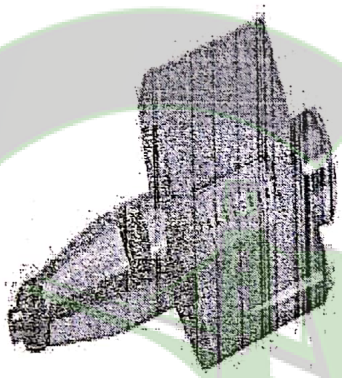
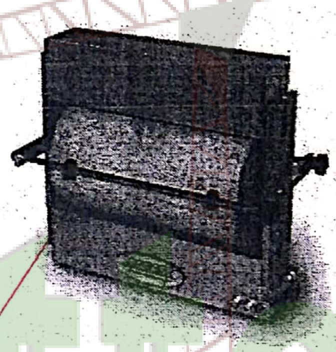
Experiment 8

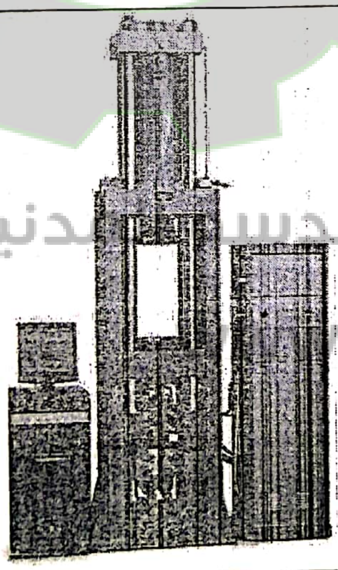
Part.1: Concrete Strength by Non-Destructive Methods

Part.2: Concrete Strength by Destructive Methods

Remember to make your report tidy and neat ☺

8.1. Apparatus and Equipment:

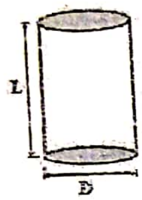
Apparatus			
Name	rebound hammer	ultrasonic pulse velocity test machine	spliting apparatus

Apparatus			
Name	universal testing machine (UTM)	Automatic compressive testing machine	manual compressive testing machine

8.2. Theory

8.2.1 Destructive Tests

- **Compressive Strength of cylindrical Concrete Specimens**



$$\sigma = \frac{P}{A}$$

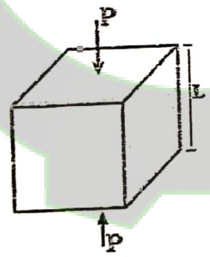
$$\sigma = \frac{P}{\pi r^2}$$

Where:
σ: compressive strength, MPa
P: maximum applied load indicating by testing machine, N
D: diameter of cylinder, mm
r: radius of cylinder, mm

Standard Dimensions: L= 300mm and D=150mm

Failure Type:

- **Compressive Strength of cubic Concrete Specimens**



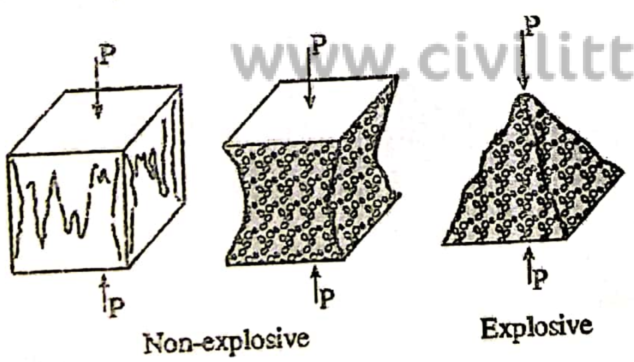
$$\sigma = \frac{P}{A}$$

$$\sigma = \frac{P}{L^2}$$

Where:
σ: compressive strength, MPa
P: maximum applied load indicating by testing machine, N
L: dimension of cube, mm

Standard Dimension: L= 150mm

Failure Type:

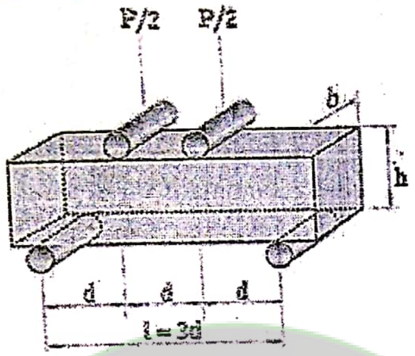


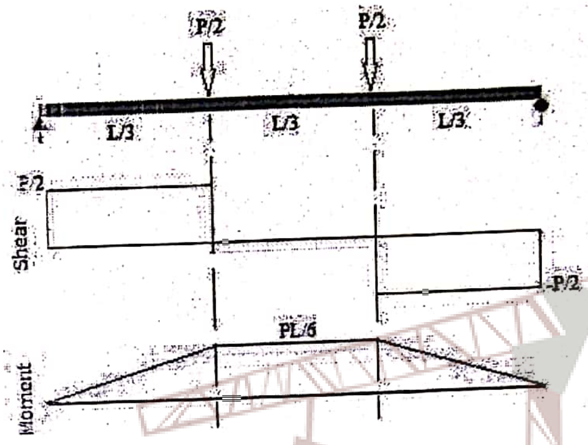
- **Flexural Strength of beam Concrete Specimens**

The flexural strength of the specimen shall be expressed as the modulus of rupture f_b.

Standard dimension: h= 150mm, b= 150mm, L= 450mm and total length= 700mm.

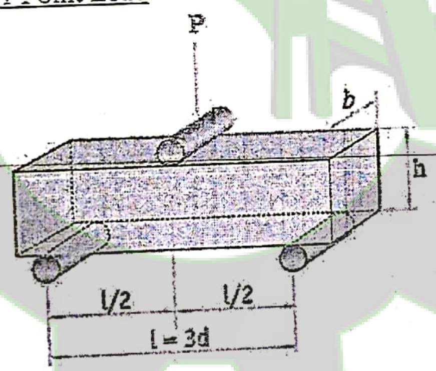
<u>2 Point Load</u>

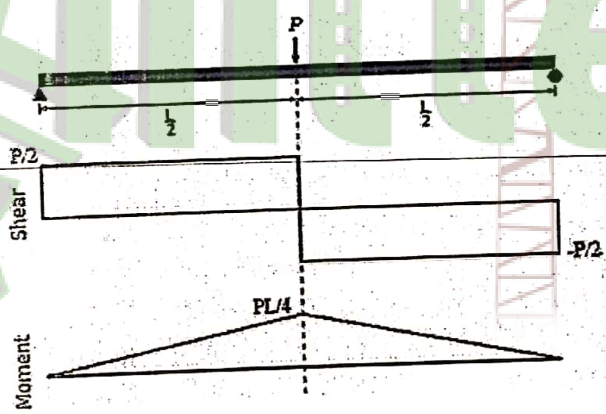




$$\sigma(f_b) = \frac{My}{I} \qquad y = \frac{h}{2} \qquad I = \frac{1}{12}bh^3 \qquad \sigma(f_b) = \frac{PL}{bh^2}$$

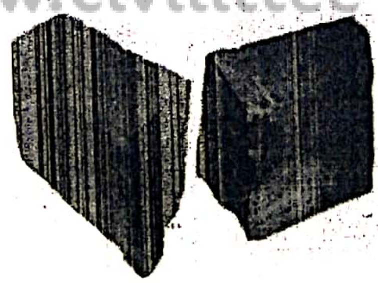
<u>1 Point Load</u>



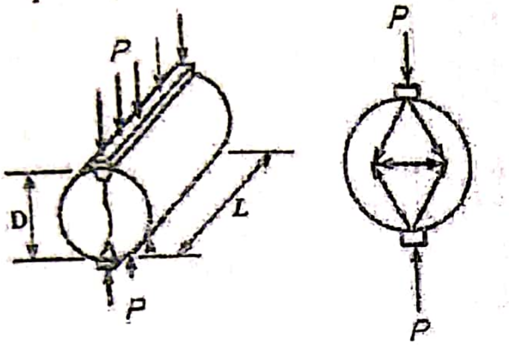


$$\sigma(f_b) = \frac{My}{I} \qquad y = \frac{h}{2} \qquad I = \frac{1}{12}bh^3 \qquad \sigma(f_b) = \frac{3PL}{2bh^2}$$

Failure Type:



- **Splitting Tensile Strength of Cylindrical Concrete Specimens**

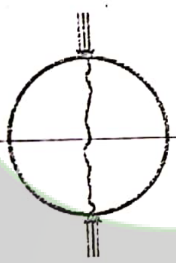


Calculate the splitting tensile strength of the specimen as follows:

$$\sigma = \frac{2P}{\pi D L}$$

Where:
σ: splitting tensile strength, MPa
P: maximum applied load indicating by testing machine, N
L: length of cylinder, mm
D: diameter of cylinder, mm

Failure Type:



Destructive tests relations:

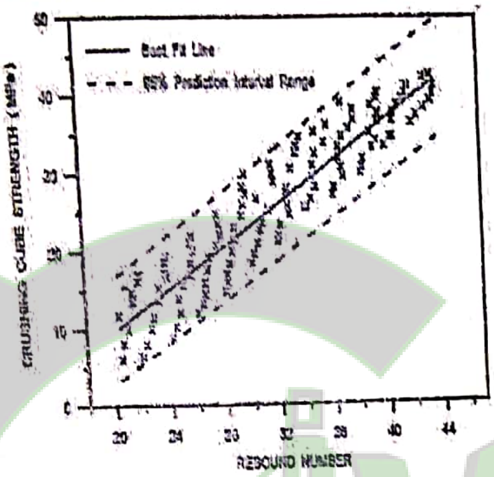
- Compressive strength of cube = 1.25 Compressive strength of cube
- Direct tension strength = 0.9 Splitting strength
- Compressive strength = (7 – 11) Tensile strength
- Flexural strength (Modulus of rupture (2P)) = (1.15 – 1.25) Splitting strength

8.2.2 Non-Destructive Tests

- **Rebound Number of Hardened Concrete**

Take ten readings and discard readings differing from the average of 10 readings by more than 6 units and determine the average of the remaining readings. If more than 2 readings differ from the average by 6 units, discard the entire set of readings. Use the final average to convert from rebound number to compressive strength.

Use the following chart to find σ_{avg} and σ_{range}



- **Pulse Velocity Through Concrete**

Take 8 readings (the time the waves need to pass from the transmitter to the receiver through the concrete), then calculate the average time (μsec).

Calculate the pulse velocity as follows:

V=L/T

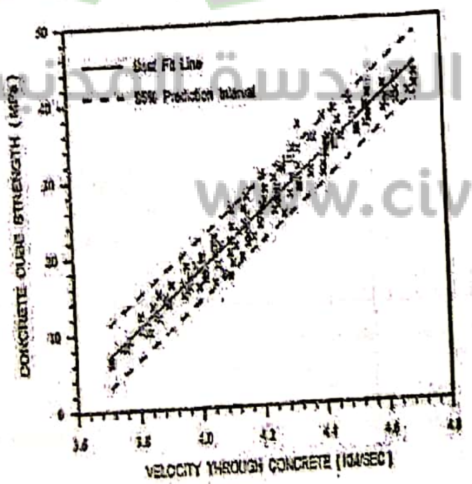
Where:

V= pulse velocity, m/s

L= distance between transducers, m

T = effective transmit time, s

Use the following chart to convert from pulse velocity to σ_{avg} and σ_{range}



8.3. Data and Calculations

8.3.1. Non –Destructive Tests

8.3.1.1. Pulse Velocity

Reading #	1	2	3	4	5	6	7	8
T (µsec)	27.8	27.4	28.6	27.3	27.5	27.1	27.3	27

$T_{(avg)} = \frac{\Sigma T}{8} = 27.5$ µsec

$V_{(avg)} = \frac{L}{T_{avg}} = \frac{100 * 10^{-3}}{27.5 * 10^{-6}} = 3636.36$ m/sec $= 3.636$ Km/sec

σ_{avg} (Mpa)= 4 Mpa

σ_{range} (Mpa)= (1 – 8) Mpa

8.3.1.2. Rebound Number

Reading #	1	2	3	4	5	6	7	8	9	10
Re #	21	22	23	23	24	21	22	25	26	22

$Re_{(avg)} = \frac{\Sigma Re\ \#}{10} = 23.7$

$Re_{(range)} = Re_{avg} \pm 6 = 17.7 - 29.7$ (all of these values are accepted)

$Re_{(new\ avg)} = 23.7$

σ_{avg} (Mpa)= 14 Mpa

σ_{range} (Mpa)= (8 – 21) Mpa

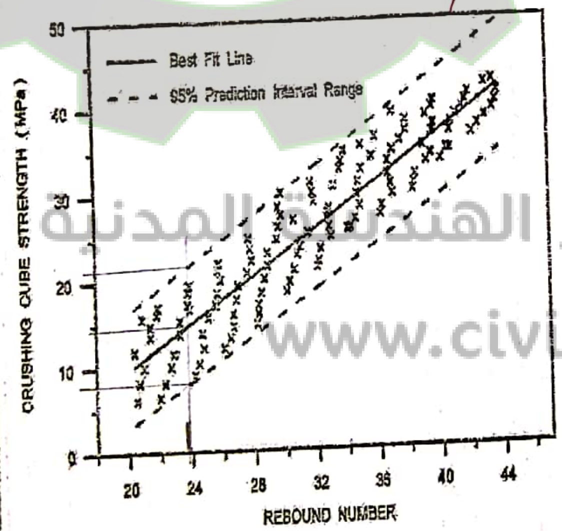


Fig. 1. Relationship between rebound number and crushing cube strength.

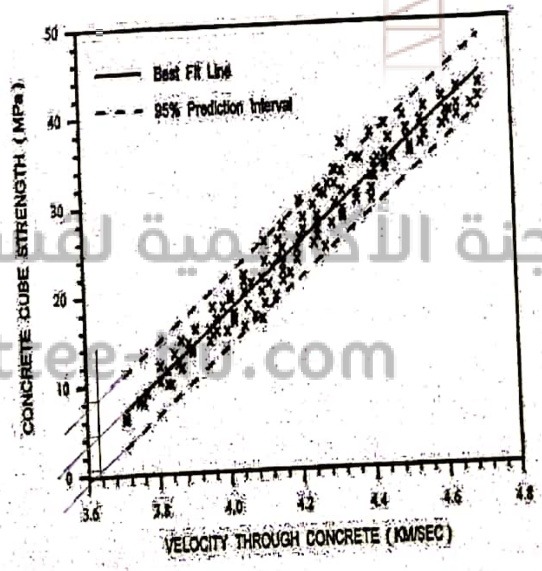
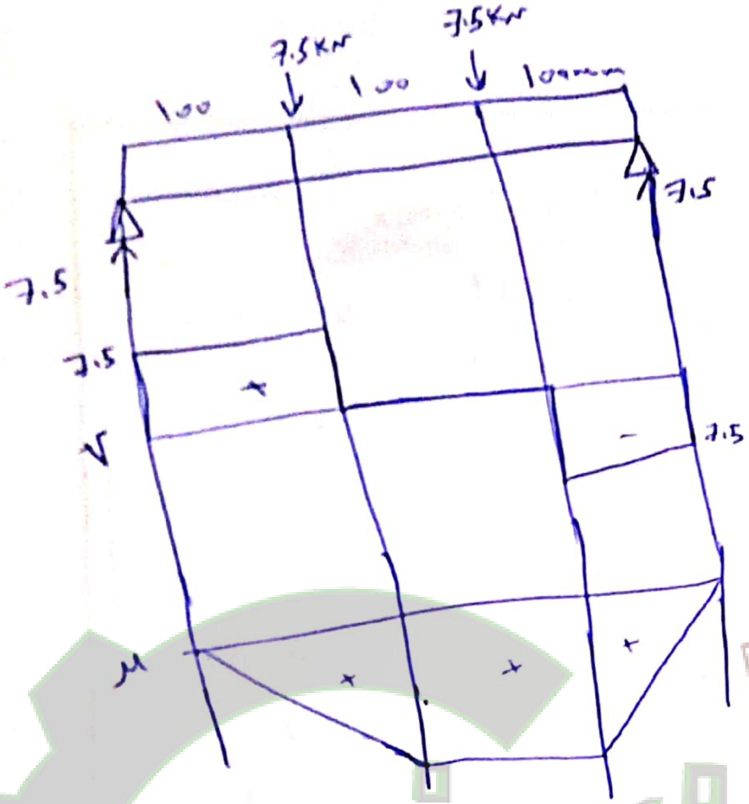


Fig. 2. Relationship between ultrasonic pulse velocity and crushing cube strength.

Prepared by Eng.Buthaina Abu-Saleem

8.3.2. Destructive Tests

Test	Max. Load (KN)	Strength (MPa) Show your calculations
Compressive Strength [Cubes] (100*100*100)mm	196	$\sigma = \frac{P}{A} = \frac{196 * 10^3}{100*100*10^{-6}} = 19.6$ MPa
Compressive Strength [Cylinders] (100*200)mm	188	$\sigma = \frac{P}{A} = \frac{188 * 10^3}{\frac{\pi}{4}(100)^2 * 10^{-6}} = 23.43$ MPa
Indirect Tensile Strength [Splitting Test] (100*200)mm	120	$\sigma = \frac{2P}{\pi d L} = \frac{2 * 120 * 10^3}{\pi * 100 * 200 * 10^{-6}} = 3.82$ MPa
Indirect Tensile Strength [Flexural Test] (2-Point) (100*100*300)mm	15	خلف الصفحة



$M = 7.5 \times 10^{3} \times 100 \times 10^{-3}$

$= 750\ N.m$

$\sigma = \frac{My}{I} = \frac{750 \times 50 \times 10^{-3}}{\frac{1}{12} \times 100 \times (100)^{3} \times 10^{-12}} = 4.5\ MPa$

8.4. Discussion

8.4.1. Non-Destructive Tests

1) Error% of Rebound Number Test

Re# = σavg = 14 MPa

Comp. = σavg cube = 19.6 mpa

$P.E = \left|\frac{19.6-14}{19.6}\right| * 100\%$

= 28.57%

2) Error% of Pulse Velocity Test

Pulse velocity = σavg = 4 Mpa

Comp. = σavg cube = 19.6 mpa

$P.E = \left|\frac{19.6-4}{19.6}\right| * 100\%$

= 79.59%

ok

3) Which one is more accurate Rebound or Pulse velocity test? Why?

pulse velocity is more accurate, because rebound hammer measure the strength of the surface of concrete (first 3 cm) and it have more personal errors. ok

4) Fatty substance must be used to grease the surfaces of the transmitter and receiver; why?

in order to get rid of the bubbles between the surface of specimen and transmitter and receiver, these bubbles are made by dust so we removed it. then?

8.4.2. Destructive Tests

1) Fill the following table

	Experimental Results	Standards	Accepted or Not
Compressive Strength of Cube / Compressive Strength of Cylinder	$= \frac{19.6}{23.93} = 0.82$	$\frac{\sigma_{comp.\,cube}}{\sigma_{comp\,cylinder}} = 1.25$	not accepted
Direct Tension (MPa)	$= 0.9 * \sigma_{splitting} = 0.9 * 3.82 = 3.4$ mpa		
Compressive Strength of Cube / Direct Tension	$= \frac{19.6}{3.4} = 5.76$	$\frac{\sigma_{comp.\,cube}}{\sigma_{tensile\,direct}} = 7-11$	not accepted
Flexural Strength (2P) / Splitting Strength	$\frac{4.5}{3.82} = 1.18$	$\frac{\sigma_{flex.}}{\sigma_{splitt}} = 1.15-1.25$	accepted

2) If we redo the test by 1-Point loading method, give an estimate of modulus of rupture based on the 2-Point loading result? Why?

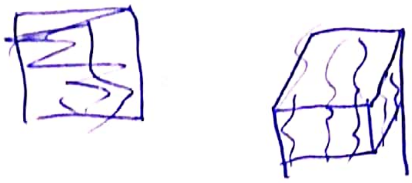
if we have the same load, the result of P_1, P_2 will be equal, ok but the load is changed so the result in P_1 will be larger than P_2 because there is a shear ≠ 0

The failure forms of a cube subjected to compressive strength are:

① Non-explosive failure ② Explosive failure

And our case is non explosive

Draw it



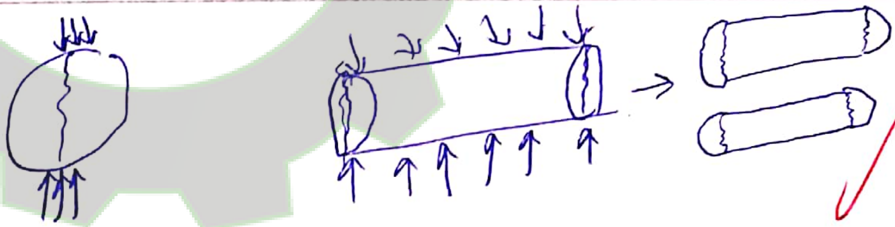
4) The failure forms of a cylinder subjected to compressive strength are:

① split failure ② shear failure ③ shear & split failure

And our case is shear and split

Draw it

5) Draw the failure of a cylinder subjected to splitting Load



6) Draw the failure of a flexural beam

7) Errors

✓ when we used rebound hammer, some of the hits were sloped

✓ error in using machines

مختبر مواد البناء / التجربة التاسعة / شعبة 4 (الخميس)

Building Materials Laboratory

Experiment No.: 9

Mix Design (ACI Method)

Name	Mark
حازم عمر دراوشه	88 / 100

Student's number	Section number	Experiment day and date	Submission day and date
1834046	4	Thursday 5/12/2019	Thursday 12/12/2019

Experiment 9

Mix Design (ACI Method)

5/6

Remember to make your report tidy and neat ☺

9.1. Data

9.1.1. PART (A)

Use the American Method to design a concrete mix that is required to a specified mean strength of 27MPa (strength of cylinder) at 28 days with a slump of 85mm. The available coarse aggregate has a maximum nominal size of 25mm and rodded bulk density (unit weight) of 1465kg/m^3. The aggregates are of normal weight and their grading conforms to the appropriate standard with a fineness modulus of sand of 2.8.

Assume:

	Fine Aggregates	Coarse Aggregates
Bulk Specific Gravity (SSD)	2.65	2.75
Moisture Content (%)	4.00	1.00
Absorption (%)	1.20	4.00

9.1.2. PART (B): Practical Part → ملغى

The calculated mix design (in part A) has been checked by making a trial mix and the results were as the following:

Slump= 45mm
Entrapped Air= 1%

Adjust your mix design (in part A) to achieve the required slump and entrapped air content?

9.2. Design Tables

$F_{MD} = F_{STRUC} + 1.34\ s$ MPa
$F_{MD} = F_{STRUC} + 2.33\ s - 3.5$ MPa

Table 9.1: Required increase in strength for specified compressive strength when no tests records are available, according to ACI 318-05

Specified compressive strength		Required increase in strength	
MPa	Psi	MPa	Psi
Less than 21	Less than 3000	7	1000
27 → 21 to 35	3000 to 5000	8.5	1200
35 or more	5000 or more	10	1400

Prepared by Eng Buthaina Abu-Saleem

Table 9.2: Relationships between water-cement ratio and compressive strength of concrete

Compressive strength at 28 days, MPa	Water-cement ratio, by mass: Non-air-entrained concrete	Water-cement ratio, by mass: Air-entrained concrete
40	0.42	—
35	0.47	0.39
30	0.54	0.45
25	0.61	0.52
20	0.69	0.60
15	0.79	0.70

Table 9.3: Approximate mixing water and air content requirements for different slumps and nominal maximum sizes of aggregates

Slump, mm	Water, kg/m³ of concrete for indicated nominal maximum sizes of aggregate: 10	12	20	25	40	50	75	150
Non-air-entrained concrete								
25 to 50	207	199	190	179	166	154	130	113
75 to 100	228	216	205	193	181	169	145	124
150 to 175	243	228	216	202	190	178	160	—
Approximate amount of entrapped air in non-air-entrained concrete, %	3.0	2.5	2.0	1.5	1.0	0.5	0.3	0.2
Air-entrained concrete								
25 to 50	181	175	168	160	150	142	122	107
75 to 100	202	193	184	175	165	157	133	119
150 to 175	216	205	197	184	174	166	154	—
Recommended average total air content, percent for level of exposure:								
Mild exposure	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0
Moderate exposure	6.0	5.5	5.0	4.5	4.5	4.0	3.5	3.0
Extreme exposure	7.5	7.0	6.0	6.0	5.5	5.0	4.5	4.0

Table 9.4: Volume of coarse aggregate per unit of volume of concrete

Nominal maximum size of aggregate, mm	Volume of dry-rodded coarse aggregate per unit volume of concrete for different fineness modulus of fine aggregate: 2.40	2.60	2.80	3.00
10.0	0.50	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20.0	0.66	0.64	0.62	0.60
25.0	0.71	0.69	0.67	0.65
40.0	0.75	0.73	0.71	0.69
50.0	0.78	0.76	0.74	0.72
75.0	0.82	0.80	0.78	0.76
150	0.87	0.85	0.83	0.81

9.3. Design

9.3.1. PART A

ACI method :

① strength

structural strength = 27 MPa

$F_{MD} = F_{struc.} + \text{Margin} (F.O.S)$

$= 27 + 8.5 = 35.5$ MPa

② w/c ratio

40	0.42
35.5 →	
35	0.47

⇒ w/c ratio = 0.465 (by interpolation)

0.25

How ??

③ water content :

slump = 85 mm (non air entrained)

max. nominal size of C.A = 25 mm.

∴ w = 193 Kg/m³ of concrete

④ Air content = 1.5 %

⑤ cement :

$C = \frac{w}{w/c} = \frac{193}{0.465} = 415.05$ Kg/m³ of concrete

⑥

(6) coarse aggregate:

F.M of sand = 2.8

V_{rodded} CA = 0.67 m^3 ✓

$W_{CA} = V_{rodded\ CA} * \gamma_{rodded}$

$= 0.67 * 1465 = 981.55$ Kg/m^3 of concrete ✓

(7) fine aggregate:

absolute volume:

$\sum V = 1\ m^3$

$V = \frac{W}{S.G * \gamma_{water}}$

$V_c + V_w + V_{CA} + V_{FA} + Air = 1$

$\frac{415.75}{3.15*1000} + \frac{193}{1*1000} + \frac{981.55}{2.75*1000} + \frac{W_{FA}}{2.65*1000} + 0.015 = 1$

$\Rightarrow W_{FA} = 803.77$ Kg/m^3 of concrete ✓

water adjusment:

(8) water req. = free water + absorption − moisture

$= 193 + \left(\frac{4}{100} * 981.55 + \frac{1.2}{100} * 803.77\right)$

$- \left(\frac{1}{100} * 981.55 + \frac{4}{100} * 803.77\right)$

$= 199.94$ Kg/m^3 of concrete ✓

Fresh Density ?!

−0.25

1834046

Name: طارق عودة   **Practical Mix Design**   4/5   section#4

The materials in the lab have been used to design a concrete mix according to ACI 211.1. The concrete mix will be used for the slab of a residential building in Zarqa. The required workability and strength for the building are 29 MPa and 40mm respectively and the required air content is 2.5%.

work.   29 MPa

— Aggregate properties:

	F.A.	C.A.
Specific Gravity	2.65	2.50
Moisture %	5.00	2.00
Absorption %	0.40	0.80

— The required proportions of the mix have been designed and the results are:

Free water = 190 Kg, w/c= 0.45 and C.A.= 991 Kg

— A trial mix has been prepared to check about slump and air content, and the results are:

Slump = 50 mm and air content = 1%

Adjust the mix to satisfy the required slump and air content

~~W/C = 190/0.45 = 422.22 Kg/m³ of concrete~~

remove 2 Kg of water to decrease slump by 1 cm

50 mm → req. = 40 mm

so we remove 2 * 1 cm (5-4) = 2 Kg   -0.5

remove 3 Kg of water to increase air content by 1%

1% → req. = 2.5%

so we remove 3 * (2.5% - 1%) = 3 * 1.5 = 4.5 Kg   larger

new water = 190 - 2 = 188 Kg/m³ of conc.   -0.5

new cement = 188/0.45 = 417.77 Kg/m³ of conc.

new CA = (no change) = 991 Kg/m³ of conc

new FA: ΣV = 1 m³

$$\frac{417.77}{3.15*1000} + \frac{188}{1*1000} + \frac{991}{2.5*1000} + \frac{W_{FA}}{2.65*1000} + \frac{2.5}{100} = 1$$

ok

~~$W_{FA} = 654.25$ kg/m³ of conc.~~

$W_{FA} =$ ~~684.93~~ 683.63 kg/m³ of conc.

Water adjusment:

water req. = free water + absorbtion − moisture

$= 188 + \left(\frac{0.4}{100} * 683.63 + \frac{0.8}{100} * 991\right) - \left(\frac{5}{100} * 683.63 + \frac{2}{100} * 991\right)$

$= 144.66$ kg/m³ of conc.