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97/100

Hashemite University

Faculty of Engineering

Civil Engineering Department

Materials of Construction Laboratory

Experiment No.:1

Normal Consistency and Setting time of hydraulic cement

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Section No.: 2

Day: Monday

Date: 16/10/2017

Experiment.1

Normal Consistency and Setting time of hydraulic cement

1.1. Objective

Determine the Normal consistency and setting time

Determine the IST from experiment and the FST from formula (Fst = 90 + 1.2 IsT)

Determine the quality of cement (good for use or not)

1.2. Apparatus and Equipments

Named each Part in the apparatus below

(1): Base plate

(2): Conical mold

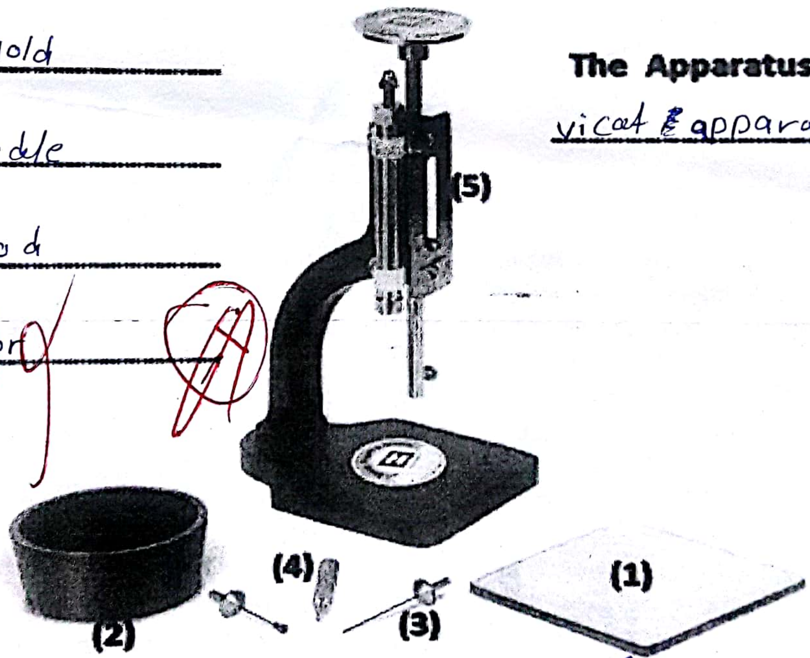
(3): 1mm needle

(4): 10mm rod

(5): indicator

Scale

The Apparatus name is vicat apparatus



Another Apparatus and Equipments:

timer , Gillmore

mixer , bowl , container

Gloves , graduated cylinder

sharp edged trowel

1.3. Materials

cement (650 g)

water

1.5. Data and Calculations

1.5.1. Normal Consistency

Wt. of Cement = 650 g

Table 1.1: variation of penetration with w/c ratio

Wt. of Water (g)	W/C %	Penetration (mm)	Log (Pent.)
195	30	5	0.698
201.5	31	8	0.903
208	32	16	1.204

- Draw w/c% versus Log(penetration); Figure 1.1.
- From this curve (w/c% versus Log(pent.)), the normal consistency is..31.25 %

1.5.1. Initial and Final Setting Time

Wt. of Cement = 650g W/C% = 31.25 % Water = 203.125 g

Table 1.2: variation of penetration with time

Time (min)	Penetration (mm)
15	40
30	38
45	36
60	33
75	27
90	20
105	14

- Draw the penetration versus time; Figure 1.2.
- From this curve (pent. versus time), initial setting time is...79 minutes
- Calculate/Find the Final setting time (using the three different ways)

1- From the curve (Table (Fig) 1.2) = 120 minutes

2- FST = 1.2 IST + 90 min = (1.2 * 79) + 90 = 184.8 minutes

3- FST = 1.5 IST + 45 min = (1.5 * 79) + 45 = 163.5 minutes

1.6. Discussion

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

its direct relationship in Table (1.1) when the w/c ratio increase the penetration also increase. evidence for that w/c ratio was 30% when the penetration was 5 mm and w/c ratio was 34% when the penetration was 8 mm.

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

we got the normal consistancy and it was 31.25% so, we can knew that there is a direct and Linear relationship between them.

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

we can note that when we increase time the penetration will decrease. evidence for that at time 15 the penetration was 40 mm and when time was 30 the penetration was 38 mm

- Discuss figure1.2. (penetration versus time)

we can see the relationship between penetration and time is inverse relationship and non Linear

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

(1) I is accepted because the standard N.C specify in ASTM is (26 – 33)%

- The initial setting time is accepted or not and why?

I was 79 min and this time is accepted because the standard IST must be greater than or equal 45 min (IST ≥45 min) when we use vicat apparatus according to (ASTM)

- The Final setting time is accepted or not and why?

From the equation {FST = 1.2 IST + 90 min} we get FST 184.8 and its equal to 3 hours (3 < 6.25) in ASTM when vicat apparatus used which mean accepted.

- Our cement can be used in the construction or not? Why?

from the Last 3 quistions we found all values are accepted by the (ASTM) so it can be used in construction

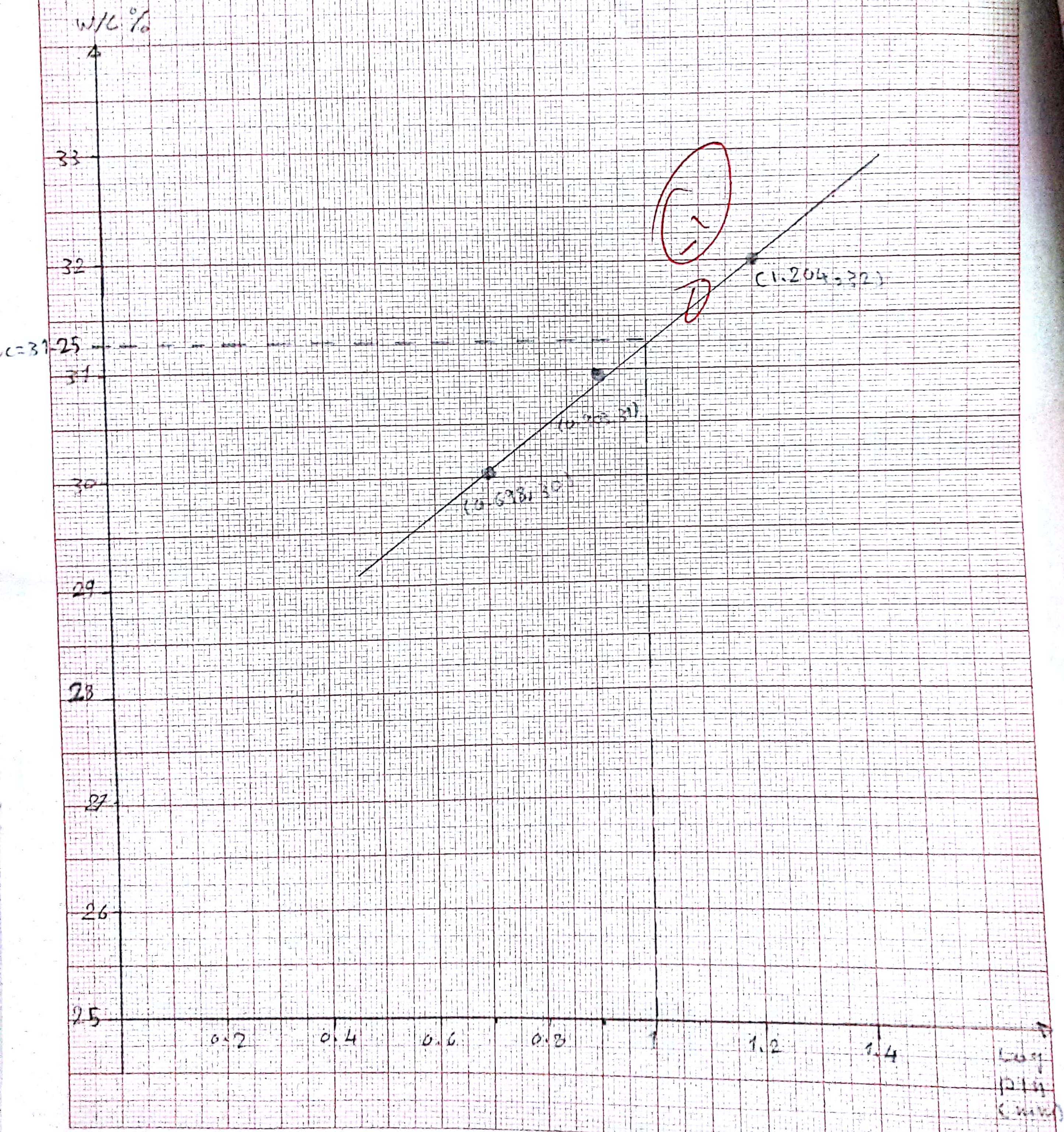
- Error sources:

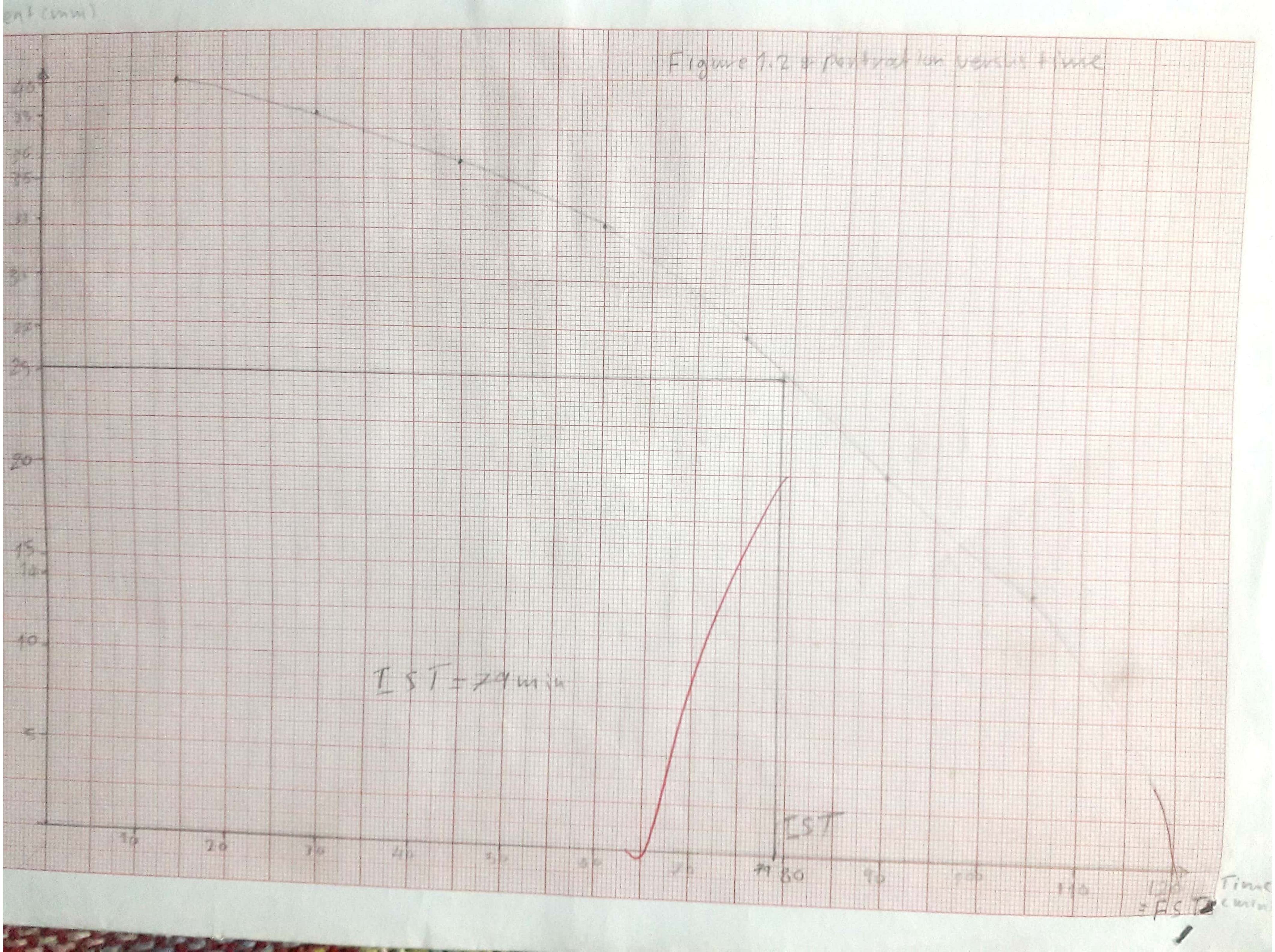
① Mistake when using the mixer
② the container was wet after washing it (increase the water amount)
③ the cement paste was thrown more than 6 times ④ the worker hand weren't vertical when throwing the cement paste

1.7. Remember to make your report tidy and neat ☺

⑤ pressure on the sample when used conical mold and base plate.

Figure 1.18- W/C % versus log penetration





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Experiment.2

Compressive and Tensile Strength of Cement Mortar

2.1. Objectives

To determine the compressive and tensile strength of cement mortar, determine compliance with specifical and determine the quality of cement to decide it is acceptable to used or not and to compare the strength of mortar in the two test (Tension and compression)

2.2. Apparatus and Equipment

Trowel	Tensile Test machine
container	Compression Test machine
Graduated glass "cylinder"	Briquite mold (25, 25)mm
gloves	cubic mold (50, 50, 50)mm
mixer, Timer	bowl, paddle

2.3. Materials

cement (ordinary portland cement) (OPC)

water

ottawa sand

2.4.2.2. Molding test specimens

1. Apply a thin film of oil (release agent) to the interior faces of the mold.
2. Immediately following completion of mixing, fill the all molds heaping full with mortar without compaction.
3. Press the mortar 12 times by thumbs to each briquette mold, try to include the entire surface.
4. Heap the mortar above the mold and smooth it off and cut off the extra mortar with trowel.
5. Store all test specimens, immediately after molding in the molds in moist closet or moist room from 20-24hrs.
6. Remove the specimens from the briquettes molds after 20-24hrs.
7. Immerse them in saturated lime water in noncorroding storage tanks until testing age (3, 7, and 28days).

2.4.2.3. Determination of tensile strength

1. At each testing age (3, 7, and 28days) remove the required number of specimens from water (in our experiment 3 briquettes for each age).
2. Wipe each briquette to a surface dry condition and remove any loose sand grains from the faces that will be in contact with the clips of the testing machine.
3. Carefully centre the first briquette in the clips and apply the load continuously at rate of 600±25lbf/min (2.67±0.11KN/min.
4. Repeat step 3 for the remaining briquettes for each age.

2.5. Data and Calculations

2.5.1. Compressive strength

Cement Type: Ordinary Portland cement (I)

Ratios:

Cement: Sand = 1 : 2.75

Water: Cement = 0.485

Weights: Cement = 740g

Sand = 2035g

Water = 359g

0.9 – 1.1

0.85 – 1.15

Age (Day)	Compressive Force (KN)	Compressive Strength (MPa)	Average Strength (Mpa)	Accepted range (Mpa)	Accepted or Not	Accepted Avg. Strength
3	9.4	3.76	3.76	3.384-4.136	yes	3.76
	8.9	3.56			yes	
	9.9	3.96			yes	
7	26.3	10.52	12.5	11.25-13.75	No	13.5
	34.1	13.64			yes	
	33.4	13.36			yes	
28	40.4	16.16	16.45	14.805-18.09	yes	15.54
	37.3	14.92			yes	
	45.7	18.28			no	

- Sample of calculations: Note:- $A = 50\times10^{-3} \times 50\times10^{-3} = 2.5\times10^{-3}$ mm² (cubic mold) 50 , 50

At 3 Days :- $\sigma_1 = \frac{P}{A} = \frac{9.4\times10^3}{2.5\times10^{-3}} = 3.67$ Mpa

$\sigma_2 = \frac{P}{A} = \frac{8.9\times10^3}{2.5\times10^{-3}} = 3.56$ mpa

$\sigma_3 = \frac{P}{A} = \frac{9.9\times10^3}{2.5\times10^{-3}} = 3.96$ Mpa

$\sigma_{avg} = \frac{\sigma_1+\sigma_2+\sigma_3}{3} = \frac{3.76+3.56+3.96}{3} = 3.76$

Range compressive = $0.9\sigma_{avg} - 1.1\sigma_{avg}$

$= 0.9(3.76) - 1.1(3.76)$

$= 3.384 - 4.136$

the accepted avg strength is $\frac{\sigma_1, \sigma_2, \sigma_3}{3}$

$\sigma_1, \sigma_2, \sigma_3$ acceptable they are within Range

- Estimate the compressive strength of concrete with the same w/c ratio as the cement mortar and same cement type at 28 days $\sigma_{28day} = 0.004X^2 + 1.3X$

$= 0.004 \times (15.454)^2 + 1.3\,(15.541) = 21.12$ Mpa

2.5.2. Tensile strength

Cement Type: Ordinary Portland cement (I)

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	399	0.6384	0.7354	0.625-0.845	yes	0.7354
	512	0.8192			yes	
	468	0.7488			yes	
7	638	1.0208	1.1402	0.969-1.311	yes	1.1402
	793	1.2688			yes	
	707	1.1312			yes	
28	881	1.4096	1.6826	1.430-1.934	no	1.8192
	1081	1.7296			yes	
	1193	1.9088			yes	

- Sample of calculations: $A = 25\times10^{-3} \times 25\times10^{-3} = 625\times10^{-6}\ mm^2$

At 7 Days: $\sigma_1 = \frac{P}{A} = \frac{638}{625\times10^{-6}} = 1.0208$ Mpa

$\sigma_2 = \frac{P}{A} = \frac{793}{625\times10^{-6}} = 1.2688$ Mpa

$\sigma_3 = \frac{P}{A} = \frac{707}{625\times10^{-6}} = 1.1312$ Mpa

$\sigma_{avg} = \frac{\sigma_1 + \sigma_2 + \sigma_3}{3} = \frac{1.0208 + 1.2688 + 1.1312}{3} = 1.1402$

Acceptable range $= 0.85\sigma_{avg} - 1.15\sigma_{avg}$

$= 0.85(1.1402) - 1.15(1.1402)$

$0.969 - 1.311$ so $\sigma_1, \sigma_2, \sigma_3$ acceptable

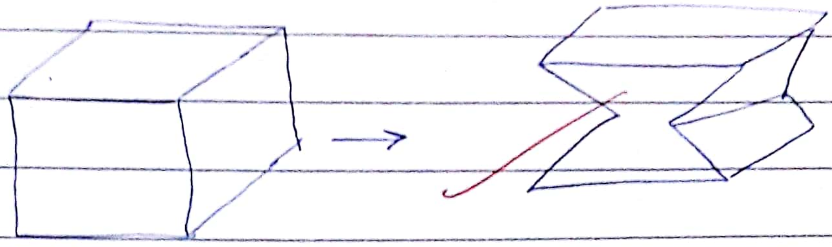
avg accepted strength $\frac{\sigma_1 + \sigma_2 + \sigma_3}{3} = 1.1402$

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

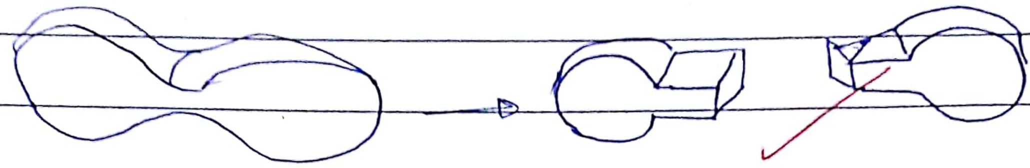
6. Discussion

*** Broken shape * :-**

1) Compressive Test cube of cement mortar will be broken at angle 45°



2) Tensile Test Briquette mold will be broken at angle 90°



As a result of the curve between the compression and the tensile strength with a period of time (days) we noticed :-

① through compression there is a 7- days interaction at the first 3 Days so the concrete will be soft.

② During the period from (3 – 7) days we keep in mind that the strength of the concrete is getting so fast and the strength in this case will be suitable for concrete.

③ next, the degree of strength continues from (7 – 28). However, the slow speed that reaches it's strength equal to 15.34 MPa

④ As a Tensile test had done, due to the curve, the strength is getting high slowly causing small value from 3 days to 28 days

As it's shown from the table (2.5.1) we found the accepted avg at 3 days strength 3.76 and the range (3.384 – 4.136) in return any value of strength is larger and slower than the range that is not acceptable but the values at 3 days are accepted according to (Astm), where as at (3-7) days we have a value that is not accepted according to (Astm) and this value equals (10.52) Mpa. furthermore, from 7 to 28, there will be a value that not be accepted which is (18.28) Mpa because it's out from the range according to (Astm).

From the tensile strength table (2.5.2) we noticed that all the values of strength at 3 days and 7 days are acceptable according to (Astm), while at 28 days the value which is equal (1.4096) is not accepted because it's far from the range (1.430 - 1.934).

In referrence to the curve (figure), we noticed that the relationship between compressive and Tensile strength versus time that is direct and non-Linear. As the time increased, the strength Also increased.

we also noticed that the accepted avg of the strength in compression is Larger than the accepted avg of strength in Tensile. 8.54 times 8-

$\frac{\sigma_{avg\ com}}{\sigma_{avg\ Ten}} = \frac{15.54}{1.8192} = 8.542$ So the cement is not accepted.

-1.5 ??

Errors 8- ① The rod Non-standerd,

② a wrong speed during mixing.

③ use NoN-ottawa sand.

④ The Humidity more than 50%.

⑤ water temperature not 20± 2.

⑥ No accuracy in reading from compressive and Tensile machine.

⑦ The worker not hit the sample.

⑧ The sample was wet when used the compressive test machine.

⑨ some of the sand and water were fallen out of the container.

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Impact → agg

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Faculty of Engineering

Civil Engineering Department

Materials of Construction Laboratory

Experiment No.: 3

Tensile Strength of Steel

Student Name: علي محمد محمود عودة

Student No.: 1632472

Section No.: 2

Day: Monday

Date: 29/10/2017

Experiment.3

Tensile Strength of Steel

3.1. Objectives

To calculate the tensile strength and strain for steel by using Universal Testing Mashine (UTM), To Draw the strength - strain diagram and to determine the elastic region, propotional 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 Equipments

Universal testing machine (UTM)

compter software speeial for UTM

Balance

meter

OK

3.3. Materials

steel rod

3.4. Data and Calculations

3.4.1. Data

L_i mm=	296	L_F mm=	364
D_i mm=	17.5	A_i mm^2 =	240.40
D_F mm=	14.1	A_F mm^2 =	156.06

ok

	Load (KN)	Elongation (mm)	Eng. Stress (MPa)	Eng. Strain
1	0	0	0	0
2	2	2	8.31	6.75×10^{-3}
3	6	2.7	24.95	9.12×10^{-3}
4	15	2.8	62.39	9.45×10^{-3}
5	27	2.9	112.31	9.79×10^{-3}
6	45	3.1	187.18	10.47×10^{-3}
7	66	3.3	274.54	11.14×10^{-3}
8	70	5	291.18	16.89×10^{-3}
9	70	8	291.18	27.02×10^{-3}
10	71	10	295.34	33.78×10^{-3}
11	73	11	303.66	37.16×10^{-3}
12	76	14	316.13	47.29×10^{-3}
13	81	17	336.93	57.43×10^{-3}
14	85	18	353.57	60.81×10^{-3}
15	87	20	361.89	67.56×10^{-3}
16	92	23	382.69	77.7×10^{-3}
17	97	27	403.49	91.21×10^{-3}
18	103	30	428.45	101.35×10^{-3}
19	108	36	449.25	121.62×10^{-3}
20	110	41	457.57	138.51×10^{-3}
21	112	50	465.89	168.91×10^{-3}
22	113	52	470.04	175.67×10^{-3}
23	114	55	474.2	185.81×10^{-3}
24	115	60	478.36	202.7×10^{-3}
25	115	61	478.36	206.08×10^{-3}
26	113	63	470.04	212.59×10^{-3}
27	109	65	453.41	219.97×10^{-3}
28	105	66	436.77	222.97×10^{-3}
29	101	67	420.13	226.35×10^{-3}
30	100	68	415.47	229.72×10^{-3}

3.4.2. Sample of Calculations

$A_i = \frac{\pi}{4}(D_i)^2 = \frac{\pi}{4}(17.5)^2 = 240.4\ mm^2$

$A_F = \frac{\pi}{4}(D_f)^2 = \frac{\pi}{4}(14.1)^2 = 156.06\ mm^2$

$L_f = L_i + \text{max elongation} = 296 + 68 = 364\ mm$

Eng stress $\sigma_E = \frac{P}{A_i}$ when P = 70 the stress was $\sigma = \frac{70}{240.4 \times 10^{-6}} = 291.1\ Mpa$ ok

Eng strain $= \frac{\Delta \text{elongation}}{L_i}$ when elongation = 10 the strain was $\epsilon = \frac{10 \times 10^{-3}}{296 \times 10^{-3}} = 33.78 \times 10^{-3}$

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 = 274.5 Mpa ✓
   Yield Point = 16.9×10^{-3}, 291.2 Mpa ✓
   Hardening Point = 33.78×10^{-3}, 295.34 Mpa ✓
   Ultimate Strength = 478.36 Mpa ✓
   Fracture Point = 229.72×10^{-3}, 415.9 Mpa ✓

3. Calculate:
   Modulus of Elasticity = the slope from point 4 to point 3

$$E = \frac{\Delta \text{stress}}{\Delta \text{strain}} = \frac{(62.39 - 24.95) \times 10^{6}}{(9.45 - 9.12) \times 10^{-3}} = 113.45\ Gpa$$

ok

Ductility (Elongation) = $\frac{L_f - L_i}{L_i} \times 100\%$

$$= \frac{364 - 296}{296} \times 100\% = 22.97\%$$

✓

Ductility (Reduction in area) =

$$\left|\frac{A_F - A_i}{A_i}\right| \times 100\% \Rightarrow \left|\frac{156.06 - 240.4}{240.4}\right| \times 100\%$$

$$= 35.08\%$$

True Stress at fracture Point =

$$\sigma = \frac{P}{A_F} = \frac{100 \times 10^3}{156.06 \times 10^{-6}} = 640.7 \text{ Mpa}$$

True Strain at Fracture Point =

$$\varepsilon = \frac{\Delta F}{L_f} = \frac{68 \times 10^{-3}}{364 \times 10^{-3}} = 186.813 \times 10^{-3}$$

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

$$195 \times 2 \times 10^6 \times 1.5 \times 10^{-3}$$

$$= 585 \times 10^3 \frac{J}{m^3}$$

OK

Modulus of Toughness = ~~Numb~~ Area = number of squares × Area of 1 square

$$= 27200 \times 2 \times 10^6 \times 1.5 \times 10^{-3}$$

$$= 81.6 \times 10^6 \frac{MJ}{m^3}$$

* stress - strain diagram analysis :-

(1) elastic region :- stress and strain were connected with two relationships such as Linear and direct. (2) the slope is as equal as modulus of Elasticity. (3) by the end of the Linear, it's the proptional Limit (4) modulus of Elasticity is required to be between (190 - 210) Gpa, but in our experiment the modulus of elasticity equals 113.45 Gpa so it's not acceptable.

(2) yield region :- we observed that the stress is constant, whereas we found the strain getting increased, hardening regions starts from hardening point to the ultimate point

(3) ultimate stress :- it's the maximum stress in stress-strain diagram the stress rod can stand without getting broken.

(4) fracture point :- the point which the steel rod can't stand the stress on it, so it's causes breaking.

(5) necking region :- starts from the ultimate stress to the fracture point at this region the stress is starts decreasing while the strain increasing

* in our experiment, the elongation equals 22.97% and this value is accepted because this value is greater than 16%. Also, the reduction of Area equals 35.08% And this value is Also Accepted because it's greater than 16% because Ductility must be ≥ 16%).

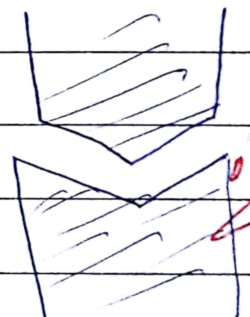
* we observed that the yield point in our experiment has $(16.9 \times 10^{-3}, 291.18)$ so, the type of our steel rod is G40 because G40 → Fy yield stress ≥ 280 mpa and (291.18 ≥ 280) mpa and we noticed G60 fy ≥ 420 mpa.

because the concrete is very weak in tension so we are forced to use steel rod consequently we improve its properties in Tension strength, And from this experiment, we can calculate two types of stress-strain

[1] Engineering stress :- we have use A_i not A_f ($A_f < A_i$)
Actual stress :- we use A_f

[2] Engineering strain:- we have use Li not Lf Lf > Li
Actual strain:- we use Lf, As a result if we observed the difference between Actual and Engineering.
we found:- σ actual > σ Eng because $A_F < A_i$ from $\sigma = \frac{P}{A}$ when the Area decreases, the stress increases
ε actual < ε Eng because Lf > Li from $\varepsilon = \frac{\Delta}{L}$ when the Length increases the strain decreases.

So 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 Tension tests). As a result of that the information we got tells us that the mass of the steel rod and the cross sectional Area as well as the Length of the rod Leads to find the density of the rod. as the tension reaches to the maximum value it will take place a necking to the rod and it will breake on a shape called (cup and cone)



modulus of resilence in stress-strain digram equal to the Area under the elastic region

modulus of toughness is the Area under the stress-strain curve

※ Errors:- 1- Error in modulus of reselience
2- // // // of toughness
3- // in calculation
4- // in computer
5- // when measure Length or weight of rod.

3.6. Remember to make your report tidy and neat ☺

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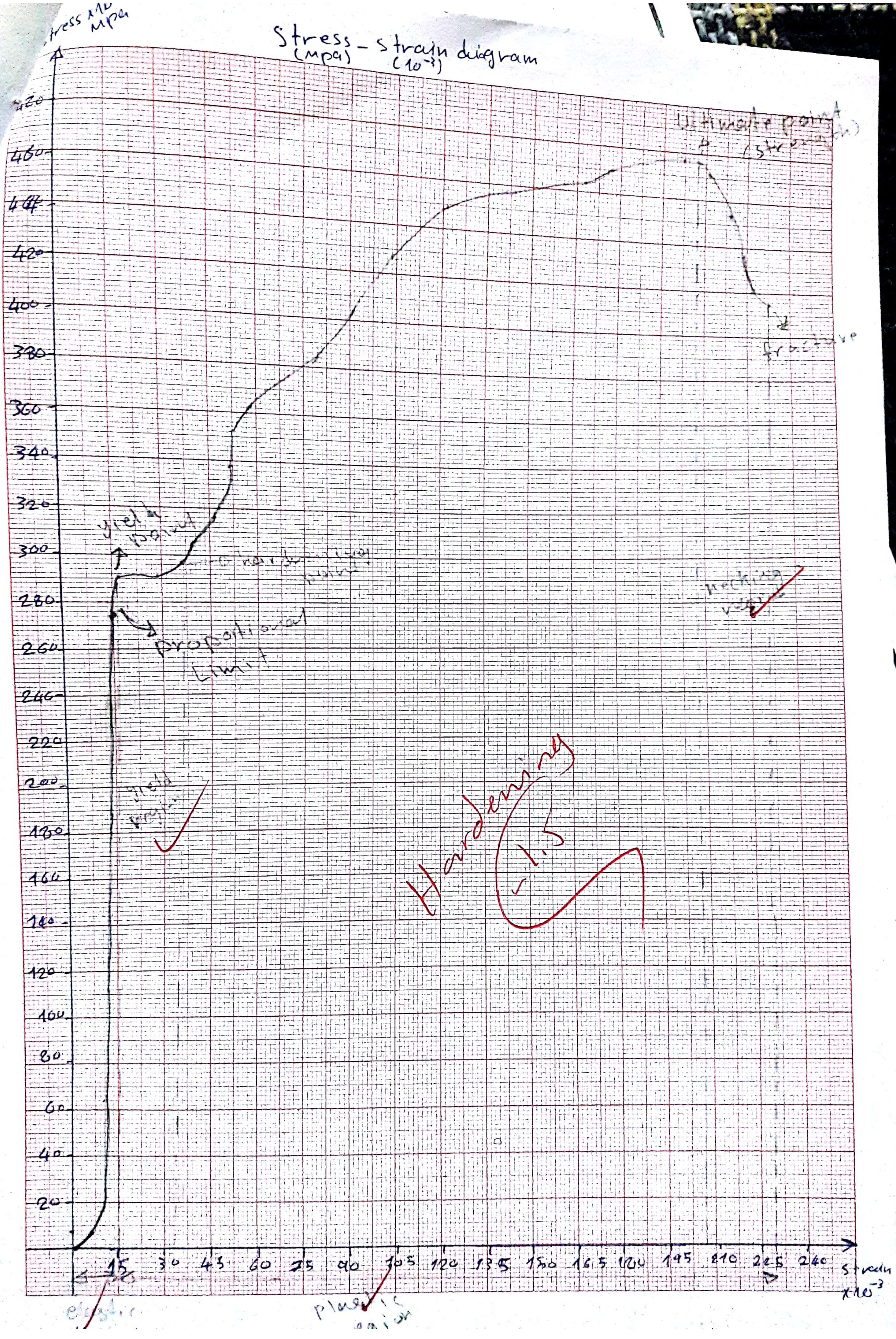

Stress - strain diagram
(mpa)
(10^-3)
Stress x10 Mpa
460
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
yield point
proportional Limit
Ultimate point (strength)
fracture
yield region
Hardening
1.5
15
30
45
60
75
90
105
120
135
150
165
180
195
210
225
240
strain x10^-3
elastic
plastic region

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$w_1 = 20$

$w_2 = 30$

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Faculty of Engineering

Civil Engineering Department

Materials of Construction Laboratory

Experiment No.4

Part.1: Specific Gravity and Absorption of Coarse and Fine Aggregate

Part.2: Compacted Bulk Density of Coarse Aggregate

Student Name: علي محمد محمود جودة

Student No.: 1632472

Section No.: 2

Day: Monday

Date: 6/11/2017

Experiment.4

~~Part.1: Specific Gravity and Absorption of Coarse and Fine Aggregate~~

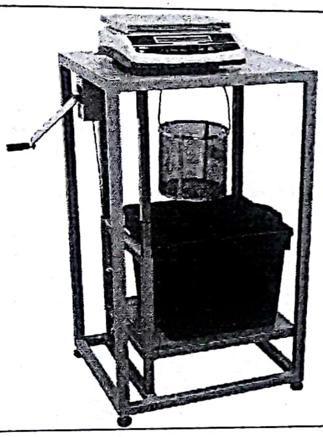
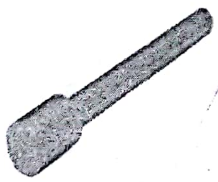
Part.2: Compacted Bulk Density (Rodded Unit Weight) of Coarse Aggregate

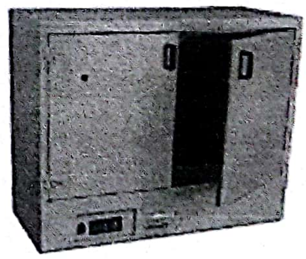
4.1. Objectives

To find the specific gravity Bulk and apparent for fine and coarse aggregate, To find the absorption of coarse and fine aggregate, to check the quality of aggregate, To find ~~the~~ compacted Bulk denesity of coare Aggregate to know aggregate's 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 S.G for fine agg	steel cylinder with rod	oven

4.3. Materials

water Aggregate (fine, coarse)

4.5 Data and Calculations

4.5.1. Specific gravity and absorption of coarse aggregates

Data:

A: Weight of oven-dry test sample in air = 1450 g
B: Weight of S.S.D. sample in air = 1501 g
C: Weight of saturated sample in water = 935.8 g

Calculations:

1. Apparent Specific Gravity = $\frac{\text{weight of oven dried}}{\text{weight of oven dried} - \text{weight in water}} = \frac{A}{A-C} = \frac{1450}{1450-935.8}$ $= 2.8199$

2. Bulk Specific Gravity (SSD) = $\frac{\text{weight of SSD}}{\text{weight of SSD} - \text{weight in water}} = \frac{B}{B-C} = \frac{1501}{1501-935.8}$ $= 2.6556$

3. Absorption (%) = $\frac{\text{weight of SSD} - \text{weight of oven dried}}{\text{weight of oven dried}} = \frac{B-A}{A} \times 100\%$

$= \frac{1501-1450}{1450} \times 100\% = 3.51\%$

4.5.2. Specific gravity and absorption of fine aggregate

Data:

A: Weight of oven —dry specimen in air = 475 g
w_1 **B:** Weight of pycnometer filled with water = 1606 g
S: Weight of the saturated surface-dry specimen = 500 g
w_2 **C:** Weight of pycnometer with specimen and water = 1913 g

Calculations:

1. Apparent Specific Gravity = $\frac{\text{weight of oven-dried}}{\text{weight of oven-dry} + w_1 - w_2} = \frac{475}{475+1606-1913}$ $= 2.8273$

2. Bulk Specific Gravity (SSD) = $\frac{\text{weight of SSD}}{\text{weight of SSD} + w_1 - w_2} = \frac{500}{500+1606-1913}$ $= 2.5906$

3. Absorption (%) = $\frac{\text{weight of SSD} - \text{weight of oven-dry}}{\text{weight of oven-dry}} \times 100\% = \frac{500-475}{475} \times 100\%$ $= 5.26\%$

3.5.3. Compacted bulk density

Data:

W_1: Weight of measure plus aggregate = .20.34 kg

~~W_2: Weight of measure filled with water = ..14..88 kg~~

M: Weight of measure = ..6..kg.

ρ_w: Density of water = 1000 kg/m³

G_S: Specific gravity of aggregate = ...2..8199

Calculations:

1. Volume of aggregate = $\frac{\text{weight of water}}{\gamma\ \text{water}} = \frac{14.88 - 6}{1000} = 8.88 * 10^{-3}$ m ✓

$\rho = \frac{w}{~~\delta V~~}$

2. Bulk density of aggregate = ~~$\frac{\text{weight of SSD}}{\text{weight of SSD} - \text{weight in water}} = \frac{1501}{1501 - 935.8}$~~

$\frac{\text{weight of aggregate}}{V\ \text{aggregate}} = \frac{20.34 - 6}{8.88 * 10^{-3}} = 1614.9$ ✓ kg/m³

3. Voids (%) = $\frac{V\ \text{voids}}{V} * 100\% = \left(1 - \frac{\gamma\ \text{Bulk}}{\gamma_w * S.G}\right) * 100\% = \left(1 - \frac{1614.86}{1000 * 2.8199}\right) * 100\%$

$= 42.73\%$

$\left[1 - \frac{\gamma}{S.G \gamma_w} * 100\right]$

5. **Assuming: Loose bulk density= 0.85*Compacted bulk density**
Calculate:

Loose bulk density= 0.85 * 1614.86 = 1372.631 kg/m³ ✓

Voids (%) = $\left(1 - \frac{\gamma\ \text{loose}}{\gamma_w * S.G}\right) * 100\% = \left(1 - \frac{1372.631}{1000 * 2.8199}\right) * 100\%$

$= 51.32\%$

Angularity number = $67\% - \frac{\gamma\ \text{loose}}{\gamma_w * S.G} * 100\%$

$= 67\% - \frac{1372.631}{1000 * 2.8199} * 100\% = 18.32\%$

4.6. Discussion

4.6.1. Specific gravity and absorption of coarse aggregate

- Which one is greater apparent or bulk Gs? Why? from the experiment S.G app = 2.8199 S.G bulk = 2.655.6 the Apparent specific gravity is Grater that S.G bulk Because in Bulk specific gravity there is avoids and solid volume we depend on them while in apparent specific gravity we depend on solid volume Just.

- Our aggregate is Heavy, Normal, or Light weight? Why? from our experiment we calculate our S.G = 2.8199 and from this information (S.G < 2 Light, 2.2-2.8 Normal, > 3 heavy) approximately normal, it Lies between normal and heavy

- Absorption% is accepted or not? Why? yes, it's accepted because absorption in our experiment equal 3.3519 and the accepted percentage for absorption should be Less that 5%

- What is the effect on the values of absorption and bulk specific gravity (SSD), if the sample is still wet on the surface? Why? Absorption will decrease because from the relation shown Abs = (Wssd − Woven) / Woven when Woven increase the abs will decrease. Bulk specific gravity no change as shown in the relation Bulk S.G = Wssd / (Wssd − W in water) no Woven.

4.6.2. Specific gravity and absorption of fine aggregate

- Our aggregate is Heavy, Normal, or Light weight? Why? Approximatly normal it Lies between heavy and normal and from the information above.

- Absorption% is accepted or not? Why? No, it is not accepted because in our experiment we calculate the Absorption equal to 5.26 and the acceptable Absorption should equal 5%

- The air bubbles must be eliminated from pycnometer. Why? Because the air bubbles will effect on our calculations by changing the volume in pycnometer so that well effect in our calculating to calculate S.G so the calculation will be incorrect

4.6.3. Bulk density of coarse aggregate

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

1. Compacted Bulk density

Bulk density from our experiment equal (1614.9) kg/m3 and it's accepted because it's between range (1450 - 1750).

2. Compacted Voids ratio

voids ratio from our experiment equal (42.73%) and it's accepted because it's grater than (33%.

3. Loose Angularity number in our experiment we found the Angularity number equal to 18.32%. so it's not accepted because it should be Less than 11%

- If the compacted results used instead of loose results; what is the effect on the value of the angularity number? and which one gives an indication of more rounded aggregate; compacted or loose?

If we used the compacted results instead of Loose, the angularity number will decrease, because the angularity number depends on γ but γw + S.G is constant so if γ increase the angularity number decrease and γ campacted > γ loose as a result angularity number will decrease, Also the voids percentage will decrease in compacted results so the compacted results give more rounded aggregate

4.6.4. Error sources:

1- the aggregate was not dried very well

2- the aggregate fill in water container instead of Basket during weighting process.

3- the air was not removed from the pycnometer

4- Error in tamping the sample

5- the time of rotation and horizontal movement Less than 15 min

4.7. Remember to make your report tidy and neat ☺

Experiment.6

Sieve Analysis of coarse and Fine Aggregates

6.1. Objectives

- to check whether the aggregate is accepted or not to use in concrete
- to determine the maximum size of Aggregate and nominal maximum size of Aggregate
- to determine the finess modulus for coarse and fine aggregate
- to determine the grading of aggregate and ~~[illegible]~~
It will indicate to the workability, strength, cohesion and resistance to friction

6.2. Apparatus and Equipments

Shaker

Balance

pan

sieves for coarse aggregate

sieves for fine aggregate

OK

6.3. Materials

coarse aggregates and fine aggregates

6.4. Procedure

1. Dry the sample to constant mass at a temperature of 110±5°C.
2. Select sieves with suitable openings depending on the material to be tested.
3. Determine the empty weight of each sieve and record.
4. Nest the sieves in order of decreasing size of opening from top to bottom and place the sample on the top sieve.
5. Agitate the sieves by placing the set on mechanical shaker for a sufficient period (10min).
6. Weigh each sieve with the residue; be careful not to lose any particle of the sample.
7. Make sure that the summation of the residue weights equals to the original sample weight with a difference not more than 0.3% of the original weight.

6.5. Data and Calculations

6.5.1. Sieve analysis of coarse aggregates

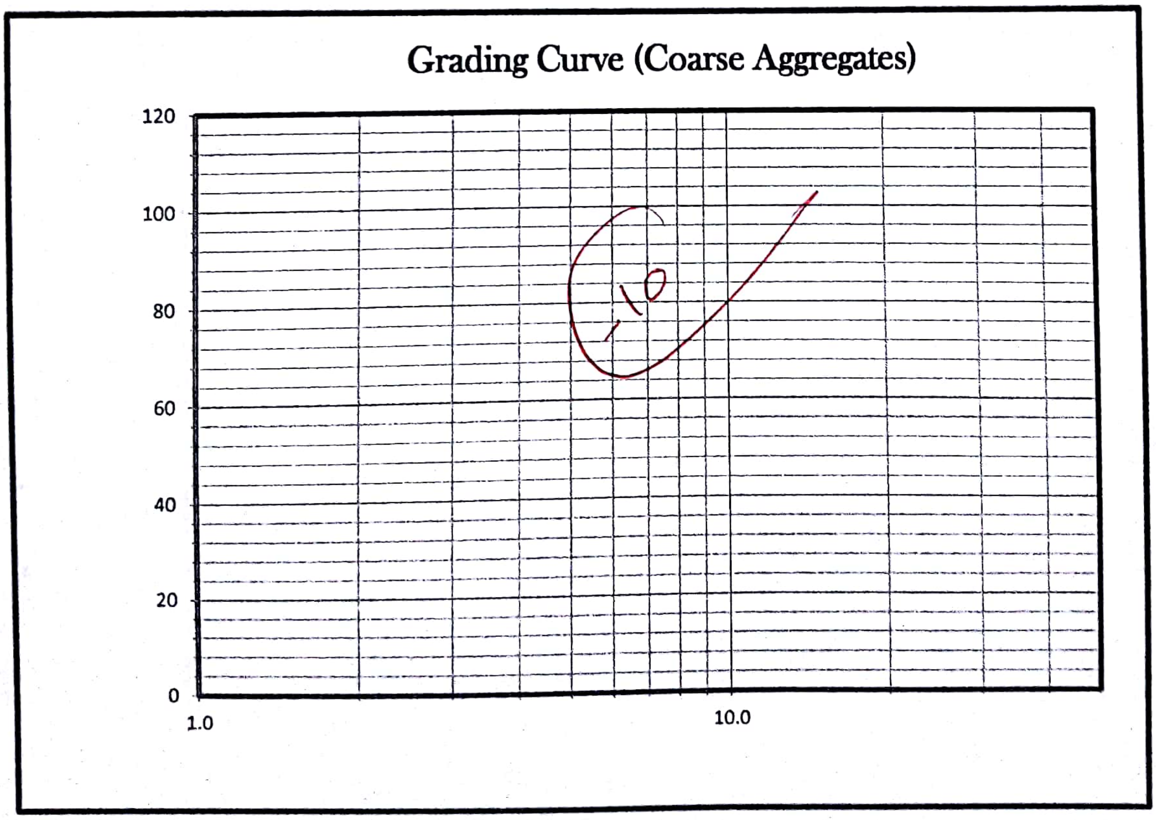
Table 6.1: Sieve analysis of coarse aggregates

sieve size (mm)	sieve No.	sieve wt. (g)	sieve+ret. (g)	Ret. Wt. (g)	Retained (%)	Cum. Ret. (%)	Cum. Pass (%)
37.5	1 1/2"	490	490	0	0	0	100
25	1"	464	464	0	0	0	100
19	3/4"	476	476	0	0	0	100
12.5	1/2"	460	604	144	17.102	17.102	82.898
9.5	3/8"	468	562	94	11.163	28.265	71.735
4.75	4	496	1049	553	65.676	93.941	6.059
2.36	8	385	415	30	3.562	97.503	2.497
1.18	16	417	421	4	0.475	97.978	2.022
pan		302	319	17	2.019	100	0
				842			

Determine:

1. F.M. = Σ com. Ret of all standard sieves / 100 = (0 + 0 + 28.265 + 93.9 + 97.503 + 97.978 + (3 × 100)) / 100 = 6.176 > 5
2. M.S. = 19 mm (seive 3/4")
3. N.M.S. = 19 mm 3/4"

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



6.2. Sieve analysis of fine aggregates

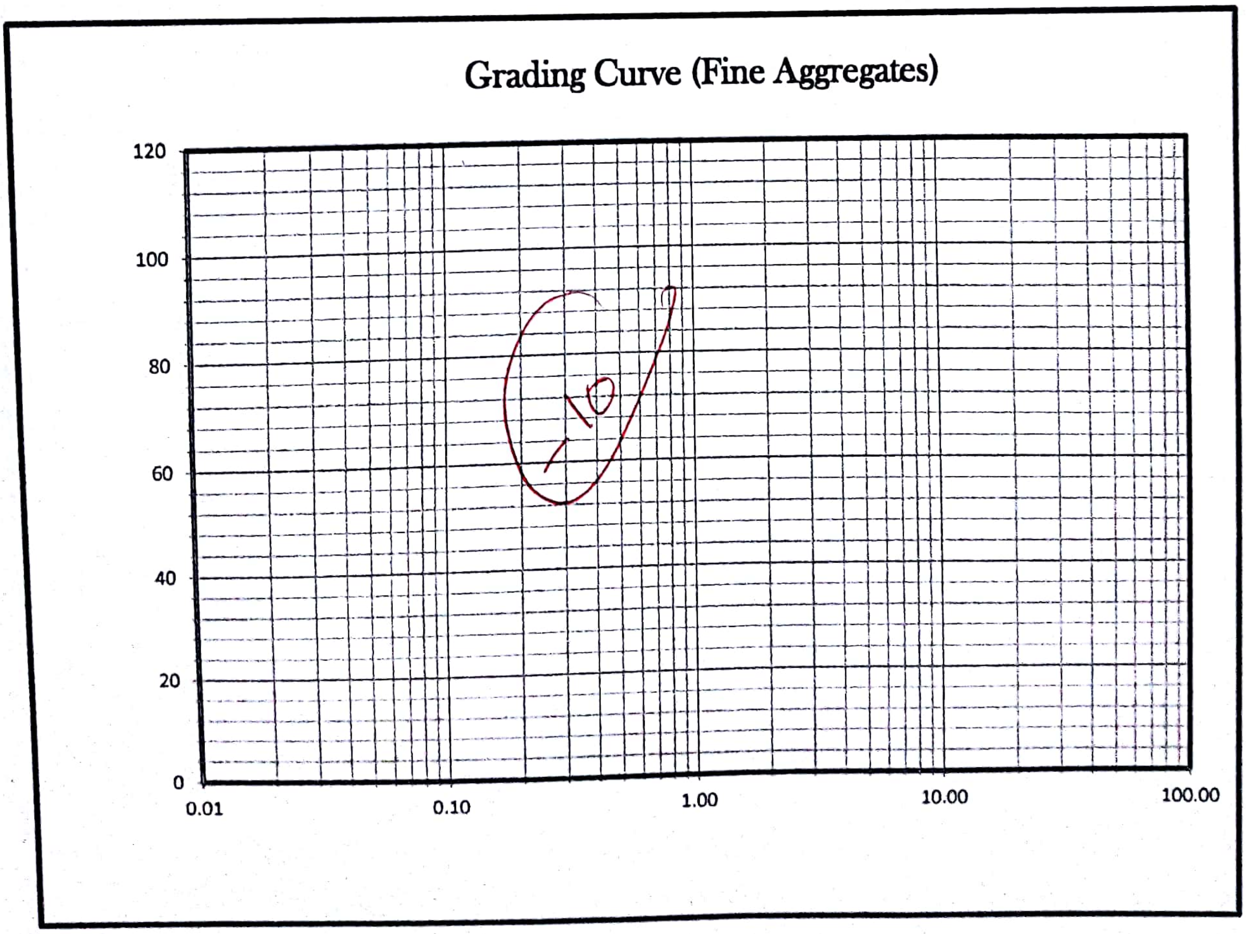
Table 6.2: Sieve analysis of fine aggregates

sieve size (mm)	sieve No.	sieve wt. (g)	sieve+ret. (g)	Ret. Wt. (g)	Retained (%)	Cum. Ret. (%)	Cum. Pass (%)
9.5	3/8"	468	468	0	0	0	100
4.75	4	496	496	0	0	0	100
2.36	8	385	388	3	0.852	0.852	99.148
1.18	16	417	421	4	1.136	1.988	98.012
0.6	30			77	21.875	23.863	76.137
0.3	50			197	55.965	79.828	20.172
0.15	100			44	12.5	92.328	7.672
0.075	200			14	3.977	96.305	3.695
pan				13	3.693	100	0
				352			

Determine:

1. F.M. = $\frac{\sum \text{cum.ret for All standard sieves}}{100}$ = $\frac{0.852 + 1.988 + 23.863 + 79.828 + 92.328}{100}$ = 1.988 < 5
2. M.S. = 4.75 mm ≈ 5 mm
3. N.M.S. = 1.18 ≈ 1.2 mm

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



6. Specifications

Table 3.8: BS and ASTM grading requirements for fine aggregate

Sieve size BS	Sieve size ASTM No.	Percentage by mass passing sieve: BS 882: 1992 Overall limits	BS 882: 1992 Additional limits* C	BS 882: 1992 Additional limits* M	BS 882: 1992 Additional limits* F	ASTM C 33–03
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 per cent, except when used for heavy duty floors.

Table 3.9: Grading requirements for coarse aggregate according to BS 882: 1992

Sieve size mm	Sieve size in.	Nominal size of graded aggregate: 40 to 5 mm ($\frac{1}{2}$ in. to $\frac{3}{16}$ in.)	20 to 5 mm ($\frac{3}{4}$ in. to $\frac{3}{16}$ in.)	14 to 5 mm ($\frac{1}{2}$ in. to $\frac{3}{16}$ in.)	Nominal size of single-sized aggregate: 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.)
50.0	2	100	–	–	100	–	–	–	–
37.5	$1\frac{1}{2}$	90–100	100	–	85–100	100	–	–	–
20.0	$\frac{3}{4}$	35–70	90–100	100	0–25	85–100	100	–	–
14.0	$\frac{1}{2}$	–	–	90–100	–	–	85–100	100	–
10.0	$\frac{3}{8}$	10–40	30–60	50–85	0–5	0–25	0–50	85–100	100
5.00	$\frac{3}{16}$	0–5	0–10	0–10	–	0–5	0–10	0–25	50–100
2.36	No. 7	–	–	–	–	–	–	0–5	0–30

Table 3.10: Some of the grading requirements for coarse aggregate according to ASTM C 33–03

Sieve size mm	Sieve size in.	Nominal size of graded aggregate: 37.5 to 4.75 mm ($1\frac{1}{2}$ to $\frac{3}{16}$ in.)	19.0 to 4.75 mm ($\frac{3}{4}$ to $\frac{3}{16}$ in.)	12.5 to 4.75 mm ($\frac{1}{2}$ to $\frac{3}{16}$ in.)	Nominal size of single-sized aggregate: 63 mm ($2\frac{1}{2}$ in.)	37.5 mm ($1\frac{1}{2}$ in.)
75	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	–	–

جدول رقم (١)
تدرج الركام الناعم

فتحة المنخل	رقم المنخل	النسبة المئوية للمار من المنخل بالوزن		
		تدرج (١) (سمسمية ٩,٥ ملم) (٨/٣ بوصه)	تدرج (٢) (٤,٧٥ ملم) (منخل رقم ٤)	تدرج (٣) (١,١٨ ملم) (منخل رقم ١٦)
٨/٣ بوصة	٩,٥ ملم	١٠٠ - ٩٥	١٠٠	
٤,٧٥ ملم	رقم ٤	١٠٠ - ٨٠	١٠٠ – ٩٠	
٢,٣٦ ملم	رقم ٨	٨٠ - ٥٠	١٠٠ – ٧٥	١٠٠
١,١٨ ملم	رقم ١٦	٧٠ - ٢٠	٩٠ – ٥٥	١٠٠ – ٩٠
٦٠٠ ميكرون	رقم ٣٠	٣٥ - ١٠	٥٩ – ٣٥	٩٠ – ٦٠
٣٠٠ ميكرون	رقم ٥٠	١٥ - ٥	٣٠ – ٨	٦٠ – ٢٠
١٥٠ ميكرون	رقم ١٠٠	٥ - ٠	١٠ – ٠	٢٠ – ٠
٧٥ ميكرون	رقم ٢٠٠	٥ - ٠	٥ - ٠	١٠ - ٠

جدول رقم (٢)
تدرج الركام الخشن

فتحة المنخل	رقم المنخل	النسبة المئوية للمار من المنخل بالوزن			
		جوزية (٤٠ ملم) (١ ٢/١ بوصة)	فولية (٢٥ ملم) (١ بوصة)	حمصية (٢٠ ملم) (٤/٣ بوصة)	عدسية (١٢ ملم) (٢/١ بوصة)
٢ بوصة	٥١ ملم	١٠٠			
١ ٢/١ بوصة	٣٨ ملم	١٠٠ – ٨٠	١٠٠		
١ بوصة	٢٥,٤ ملم	٥٠ – ٢٠	١٠٠ – ٩٥	١٠٠	
٤/٣ بوصة	١٩ ملم	٣٠ – ١٠	٨٠ – ٤٠	١٠٠ – ٩٥	١٠٠
٢/١ بوصة	١٢,٧ ملم	---------	٥٠ – ٥	٨٠ – ٥٠	١٠٠ – ٩٠
٨/٣ بوصة	٩,٥ ملم	١٠ – ٠	١٥ – ٠	٣٠ – ٢٥	١٠٠ – ٨٠
٤,٧٥ ملم	رقم ٤	٥ – ٠	٥ – ٠	١٠ – ٠	٥٠ – ٥
٢,٣٦ ملم	رقم ٨	٢ – ٠	٥ – ٠	١٠ – ٠	٢٥ – ٠
٠,٠٧٥ ملم	رقم ٢٠٠	٢ - ٠	٢ - ٠	٢ - ٠	٢ - ٠

7. Discussion

Coarse aggregate :- when we compare (table 6.1) with (table 3.9) For BS we found that the coarse aggregate in our experiment is not accepted and same table for ASTM is not accepted Also it is not accepted to Jordanian sieve test (table 2) ( ).

The coarse aggregate in table (6.1) is poor graded according to ASTM because it's not accepted to the ASTM requirments Also The coarse aggregate is poor - graded according to The BS requirments and poor graded according to Jordanian test sieve requirments.

Finess Modulus of coarse aggregate in our expirment = 6.176 so thats this is coarse aggregete because 6.176 > 5.

Fine aggregate :- when we compare (table 6.2) with (table 3.8) For BS and ASTM we observed that :- According to ASTM the fine agg is not accepted because it's not accepted the requirments of ASTM also According to BS, the fine aggregate is accepted all of overall Limits of sieves are accepted according to BS requirment, so we tested the fine aggregate to determine that is (coarse, medium, fine) sand so we find that is not accepted to be coarse sand but it is accepted to be medium sand. And According to Jordanian Test (table 2) we observe that it is accepted on seive # 16 because All the requirments are accepted to Jordanian test requirments.

* Finess modulus of fine aggregate = 1.988 < 5 so it is accepted to be fine aggregate.

fine sand

* in fine aggregate (table 6.2), sieve # 200 has cumulative passing equal to 3.695 < 5 % so it's accepted to use in concrete because if the clay higher than 5% then it's not accepted.

* we use sieve 9.5 mm in fine aggregate to ensure that we removed all impurities which is > 5mm.

* the fine aggregate is well-graded according to Jordanian test and BS, But poor-graded according to ASTM.

* From table (6.1) and (6.2) we found that as sieve size increase the Log of sieve size increase.

* Errors :-

1) Error in sieves (not clean)
2) Error in the order of sieves
3) Error in reading weight.
4) Error in use shaker (the time less than 4 minutes)
5) some of aggregate go out from the shaker while the process.

Hashemite University

Faculty of Engineering

Civil Engineering Department

87/100

Materials of Construction Laboratory

Experiment No.: 7

Workability and admixture test

Student Name: ALi Mohammed odeh

Student No.: 1632472

Section No.: 2

Day: Monday

Date: 4/12/2017

Experiment.7

Concrete workability and Admixture

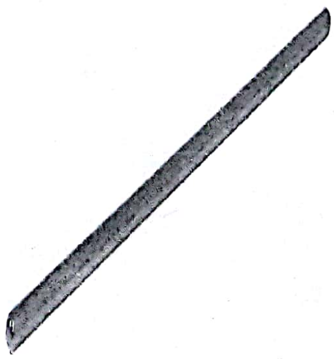
7.1. Objective

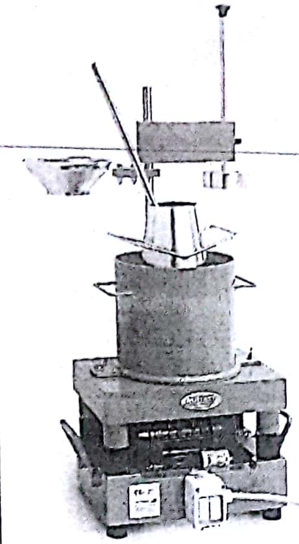
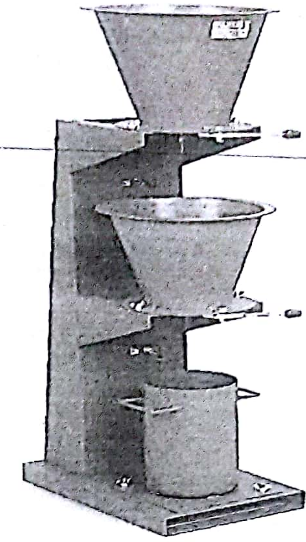
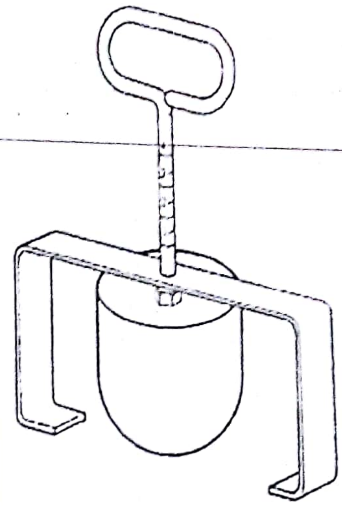
To know the workability of fresh concrete from the following tests:- (slump test, compacting factor test, vebe test, Flow table test). we added the admixture [super plasticizer] to see its effect (only in slump test)

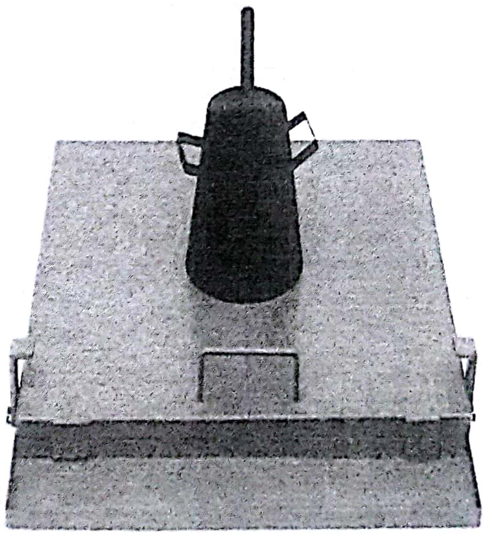
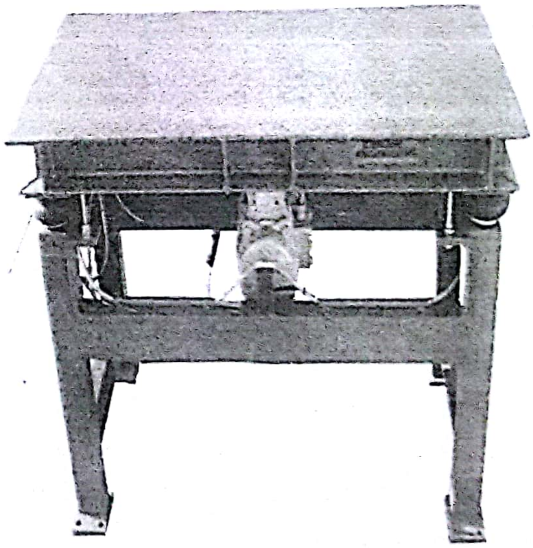
7.2. Materials

water   cement   fine aggregate   coarse aggregate   superplasticizer

7.3. Tests Apparatus and Equipment

Equipment / Tools			
Name	slump test apparatus	rod	mixer

Equipment			
Name	vebe test Apparater	compacting factor	Ball penetration test (Kelley ball test)

Equipment		
Name	flow table test	vibration table

7.4. Data and Results

Workability Test

7.4.1. Weights

Batch = 35kg

Cement = 5.2kg

Coarse Aggregate = 15.6kg

Fine Aggregate = 10.4kg

Water = 3.8kg

7.4.2. Slump Test

Cone Height (cm)	Slump (cm)	Slump Type
30	7	True

7.4.3. Vebe Test

Time (sec) *(Vebe Seconds)*
4 sec

7.4.4. Flow Table Test

Dimensions (cm)	Readings (mm)	Diameters (mm)		$D_{f\text{-}avg}$ (mm)	Flow Factor (%)
Table	13.5	D_{f1}	36.5	36.5	82.5
70 x 70	20				
D_i	14.5	D_{f2}	36.5		
20	19				

7.4.5 Compacting Factor Test

Wt. of un-compacted concrete (kg)	Wt. of compacted concrete (kg)	Compacting Factor
10.7	11.1	0.9639

Admixtures Test

7.4.6. Weights

Batch = 20kg

Cement = 2.97kg

Coarse Aggregates = 8.91kg

Fine Aggregates = 5.94kg

Water = 2.133kg

Plasticizer= 1.25% of cement

Plasticizer= 1.25/100*2.97

Plasticizer= 0.037kg = 37g

7.4.7 Results

Admixture Type and name	Cone Height (cm)	Slump (cm)	Slump Type
super plasticizer conplast SP 2000	30	22	collapse

7.5. Sample of Calculations

Flow Table

$df_1 = 70 - (13.5 + 20) = 36.5$ cm

$df_2 = 70 - (14.5 + 19) = 36.5$ cm

$D_{avg} = \frac{36.5 + 36.2}{2} = 36.5$ cm

Flow Factor % = $\frac{D_{avg} - D_i}{D_i} \times 100\% = \frac{36.5 - 20}{20} \times 100\% = 82.5\%$

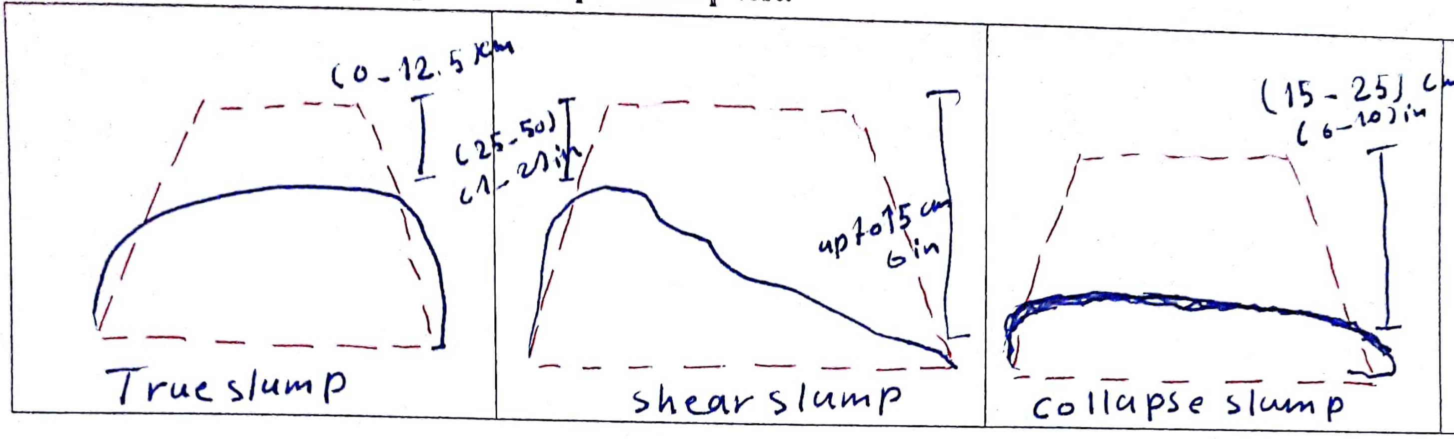
OK

Compacting Factor

$= \frac{\delta\ uncompacted}{\delta\ compacted} = \frac{W\ uncompacted}{W\ compacted} = \frac{10.7}{11.1} = 0.9639$

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 = 7 cm so it's true slump
the degree of workability for slump test is :- slump = 70 mm so it's medium workability (50 < 70 < 100)
when the slump increase the workability Also increase.
we prepare the slump test by fill the cone on 3 Layers every Layer 25 push then we raise the cone in 5 sec then we can know the type of slump.

2. Vebe Test
in our experiment the vebe time = 4 sec and from the table we found that the degree of workability is high (3-7)
Agg/cement = 5 : 1 According to ASTM and fig 5.8 the slump = 54 mm according to slump test the workability medium
we prepare the vebe test by fill the cone 3 Layers 25 push similar that cone in slump test After we fill the cone we raise the cone Like slump test we put the glass plate on the fresh concrete and start to push concrete to get rid of voids and we calculate the time at this moment # when vib increase the workability decrease

3. Flow table
This test to know the cohesiveness and seggregation of the mixture in our experiment Davg = 36.5 cm = 365 mm so we found that the workability is between low and medium workability (300 < 365 < 400)
when D avg Increased the workability increased.
we put the cone in the middle of table then we move the table 15 times we mesure the diameters by Length and width.

4. Compacting Factor

weight of uncompacted = 10.7 and weight of compacted = 11.1
So compacting factor = $\frac{W\ uncompacted}{W\ compacted} = \frac{10.7}{11.1}$ = 0.9634 < 1 must be < 1 ✓

and According to the table 0.9634 ≈ 0.95 so it's high workability 226 mm ✓
when C.F increased the workability increased

good ⊖1

5. Admixtures

we use superplasticizer to increase workability without decreasing the strength of ~~cement~~ concrete.

C/w	before adding superplasticizer			1 : 0.712
c/w	after	//	//	1 : 0.73
F/c (fine)	before	//	//	1 : 0.5
F/c	after	//	//	1 : 0.5
c/c (coarse)	before	//	//	1 : 0.33
c/c	after	//	//	1 : 0.33

How?! ⊖2.5 work. ⊖1

the cement to fine aggregate ratio Also cement to coarse agg ratio before and after adding superplasticizer is constant and don't affect but cement to water ratio is be changed but strength not change, and workability will change and when we test the workability on slump test we found collapse shape but it's accepted. ✓ without seg. ⊖1

7.7.3 Source of errors

1. error in mixing time
2. error in use the mixer
3. error in reading weight
4. ~~error in timer~~
5. misuse the apparatuses
6. ~~error in mixer~~ ok
7. 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

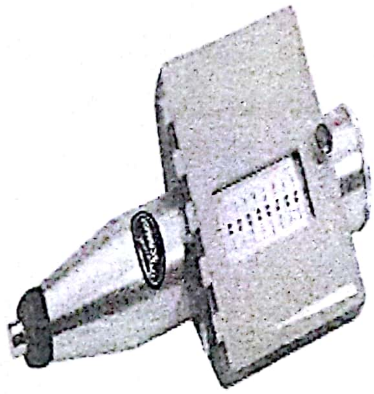
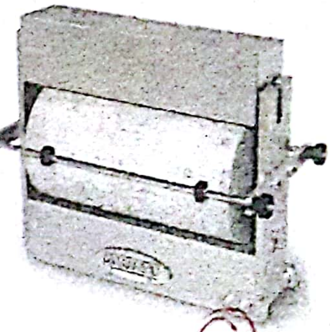
7.8. Remember to make your report tidy and neat ☺

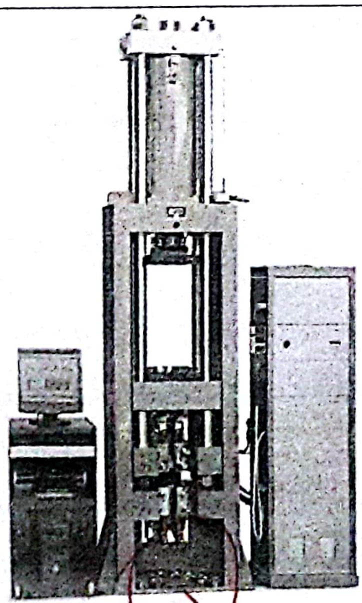
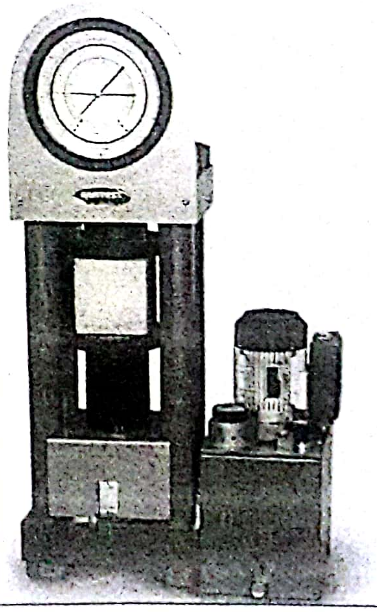
Scanned by CamScanner

Experiment.8

Part.1: Concrete Strength by Non-Destructive Methods
Part.2: Concrete Strength by Destructive Methods

8.1. Apparatus and Equipment:

Apparatus			 indirect
Name	Rebound hammer (shmit)	Ultra sonic pluse velocity test	tensile testing machine for splitting

Apparatus			
Name	denesity testing machine	Automatic compressive testing machine	Manual compressive testing machine

8.2. Data and Calculations

8.2.1. Non –Destructive Tests

8.2.1.1. Pulse Velocity

Reading #	1	2	3	4	5	6	7	8
T (μsec)	24	24.1	24.1	24	24.3	24.5	24.4	24.3

$T_{(avg)}$ = 24.2 μsec

$V_{(avg)} = \frac{L}{T_{avg}} = \frac{10 \times 10^{-2}}{24.2 \times 10^{-6}}$ = 4130.18 m/s = 4.13 km/sec

σ_{avg} (Mpa) = 21.7 Mpa

σ_{range} (Mpa) = [17 – 26] Mpa

8.2.1.2. Rebound Number

Reading #	1	2	3	4	5	6	7	8	9	10
Re #	21	24	19	18	23	21	18	19	24	24

$Re_{(avg)} = \frac{\Sigma Re}{n_R} = \frac{211}{10} = 21.1$

$Re_{(range)}$ = 21.1 ± 6 = [15.1 – 27.1] all values accepted

$Re_{(new\ avg)}$ = 21.1

σ_{avg} (Mpa) = 13 Mpa

σ_{range} (Mpa) = [5 – 19] Mpa

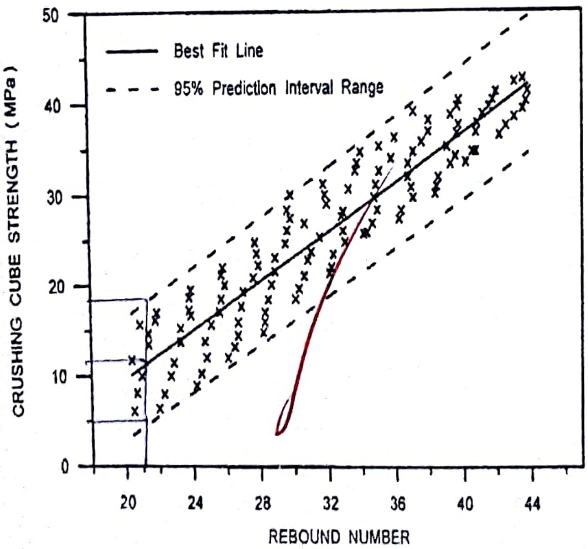


Fig. 1. Relationship between rebound number and crushing cube strength.

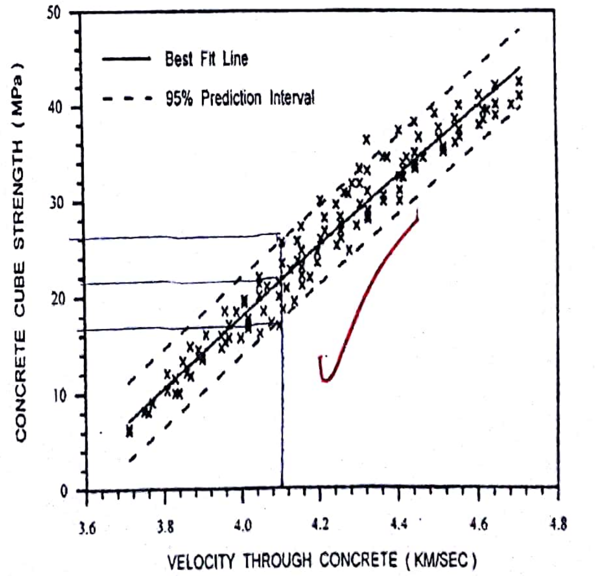


Fig. 2. Relationship between ultrasonic pulse velocity and crushing cube strength.

8.2.2. Destructive Tests

8.2.2.1. Compressive Strength

A. cubes

Dim.: 10*10*10 cm   Area = 0.01 m²

P = 225 kN

σ (Mpa) = $\frac{P}{A} = \frac{225 \times 10^3}{10 \times 10 \times 10^{-4}} = 22.5$ Mpa ✓

B. cylinders

Dim.: 10*20 cm

P = 75 kN $A = \frac{\pi}{4} D^2 = \frac{\pi}{4}(0.1)^2 = 7.85 \times 10^{-3}$ m²

σ (Mpa) = $\frac{P}{A} = \frac{75 \times 10^3}{7.85 \times 10^{-3}} = \frac{75}{7.85} \times 10^6 = 9.554$ Mpa ✓

8.2.2.2. Tensile Strength

A. Split

Dim.: 10*20 cm

P = 34 kN

σ (Mpa) = $\frac{2P}{\pi L D} = \frac{2 \times 34 \times 10^3}{\pi \times 20 \times 10^{-2} \times 10 \times 10^{-2}} = 1.08$ Mpa ✓

B. Flexural

Dim.: 10*10*40 cm

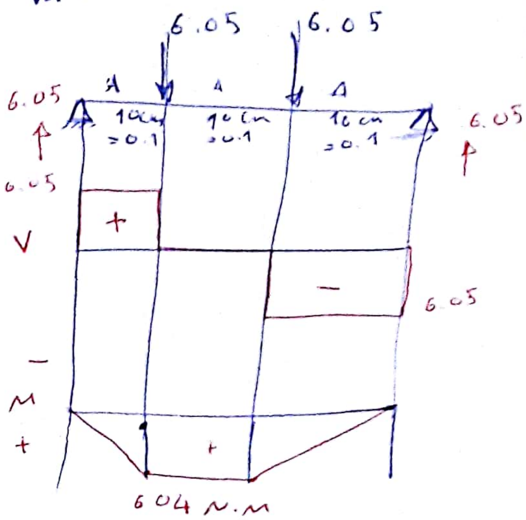
2 Point Load - 12.1 kN

$M = P * A = 6.05 * 10^3 * 0.1 = 604\ N.m$

$I = \frac{bh^3}{12} = \frac{0.1\ (0.1)^3}{12} = 8.3 * 10^{-6}\ m^4$

$y = \frac{h}{2} = \frac{0.1}{2} = 0.05\ m$

$\sigma = \frac{My}{I} = \frac{604 * 0.05}{8.3 * 10^{-6}} = 3.63\ Mpa$



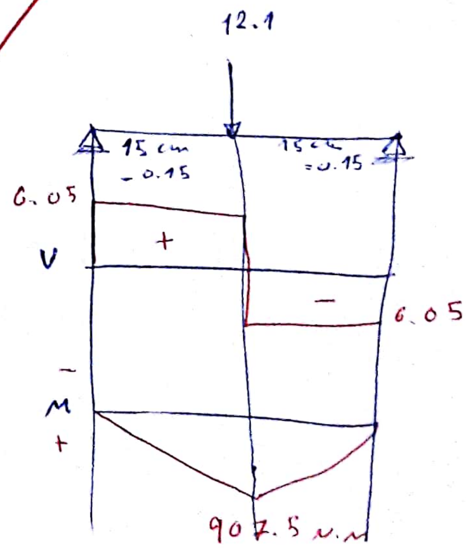
1 point Load - 12.1 kN

$M = \frac{P}{2} * A = \frac{12.1 * 10^3}{2} * 0.15 = 907.5\ N.m$

$I = 8.3 * 10^{-6}\ m^4$

$y = 0.05$

$\sigma = \frac{My}{I} = \frac{907.5 * 0.05}{8.3 * 10^{-6}} = 5.47\ Mpa$



3.3. Discussion

Non-Destructive test :-

① Ultra pluse velocity (Uspv)

The reciver and transmeter most be at the same Lovel in both sides.

when the strength is high the velocity will be high and the time will be lower.

a fatty substance 'vasline' used to close all the voide in order not to have higher reading in time and Lower velocity.

we should be sure that the device work using speeial calipration peice. this method is accurate the Rebound hamm

② Rebound hammer :-

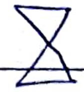
the relation between rebound number and strength is direct when rebound no. increase the strength of concrete incresed as well.

rebound hammer must be prependicular to the concrete so that the gravity wouldn't affect on Rebound no.

rebound hammer is not accurate because it's affect only on the surface and the hits must be at difference point.

Distructive test :-

- cube :- case 1:- non explosive (Longitudinal cracks) 

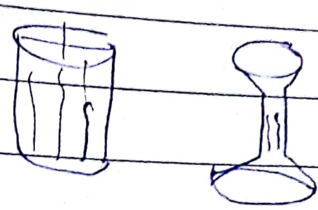
case 2:- explosive (fracture at angle 45°)  cone.

- cylinder :- case 1:- shear fracture at 45° 

our cases :2

Case 2 :- Spliting
Logitudinal crecks and

Case 3 :- shear & spliting



$\theta = 45$
non explosive

compressive $\frac{\sigma_{cube}}{\sigma_{cylinder}} = 1.25$ from our exp $= \frac{22.5 \times 10^6}{9.55 \times 10^6} = 2.356$

and it's rejected because it must equal 1.25

$\frac{\sigma_{comp}}{\sigma_{tensile\ direct}} = \frac{9.55 \times 10^6}{0.972 \times 10^6}$ $\sigma_{direct} = 0.9\ \sigma_{splite}$
$= 0.9 \times 1.08 = 0.972$ mpa
$= 9.82$ it's accepted because in between (7 – 11)

$\frac{\sigma_{1point}}{\sigma_{2point}} = \frac{5.46 \times 10^6}{3.36 \times 10^6} = 1.625$ accepted

$\frac{\sigma_{flexural}}{\sigma_{splite}} = \frac{3.36 \times 10^6}{1.08} = 3.11$ it's not accepted because it must be between (1.1 – 1.5)

$\sigma_{rebound} = 13$ Mpa $\sigma_{uspv} > \sigma_{Rebound}$ and σ_{uspv} in near
$\sigma_{uspv} = 21.7$ mpa than $\sigma_{rebound}$ to the actual σ

the brake at the same Level with Load

errors :- ① we don't use the capping from molten sulfer

② erron in Reading the Load (p) from the machine.

③ the UTM ~~wasn't~~ worked ~~and~~ we assumed that the load equal ~~45~~ KN

m part (A) :- $F_{structural}$ = 33 Mpa slump = 40 mm N.M.S = 10 mm
rodded denisty (γ compacted) = 1463 kg/m³ $F.M_{sand}$ = 2.5

rom table 17-3 :- F mix design = $f_{structural}$ + 8.5 Mpa
= 33 + 8.5 = 41.5 Mpa

from table A1.5.3.4 (w/c ratio)

40 ⟶ w/c = 0.42 $\xrightarrow{\text{نفرض}}$ 0.40

5/1

from table A1.5.3.3 slump = 40 N.M.S = 10 mm
water content = 207 kg/m³
Entrapped air = 3 %

cement = $\frac{w}{\frac{w}{c} \text{ ratio}} = \frac{207}{0.40}$ = 517.5 kg/m³

CA :- F.M = 2.5 N.M.S = 10 mm

From table A1.5.3.6 when F.M = 2.5 and N.M.S = 10 mm
V rodded CA = 0.49 m³

γ rodded = 1463 kg/m³

W CA = 0.49 m³ * 1463 = 716.9

FA : Σ V = 1 m³

$V = \frac{w}{S.G * \gamma w}$

Vw + Vc + V CA + V FA + air = 1

$\frac{207}{1*1000} + \frac{517.5}{3.15*1000} + \frac{716.9}{2.75*1000} + \frac{W_{FA}}{2.8*1000} + 0.03 = 1$

W_{FA} = 937.5 kg/m³

required water = free water + absorbtion − moisture

$= 207 + \left[\frac{0.8}{100} * 937.5 + \frac{1.2}{100} * 716.9\right] - \left[\frac{2}{100} * 937.5 + \frac{1}{100} * 716.9\right]$

= 197.2 kg/m³

4

part (B)

practical results slump = 75 mm Entrapped Air = 2

Add 2 kg of water to increase slump by 1 cm
Add 3 kg of water to decrease ~~slump~~ air by 1 %

new water = 207 + 2 [4 - 7.5] = 200 for slump
// // = 207 + 3 [2.5 - 3] = 205.5 for slump (.3)

we take 214 the Larger (.5)

new cement $\frac{205.5}{0.40}$ = 513.75 kg/m³ (.5)

CA = 716.9 kg/m³

$\sum v = 1$

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

$= \frac{214}{1 \times 1000} + \frac{513.75}{3.15 \times 1000} + \frac{716.9}{2.75 \times 1000} + \frac{W_{FA\,new}}{2.8 \times 1000} + 0.03 = 1$

= 921.3 kg/m³

new required water = $205.5 + [\frac{0.8}{100} \times 921.3 + \frac{1.2}{100} \times 716.9] - [\frac{2}{100} \times 921.3 + \frac{1}{100} \times 716.9]$

= 195.87 kg/m³

(.5)

Density?

BUILDING MATERIALS LABORATORY

EXP.9: Mix Design (ACI Method)

Data Sheet

Eng.Buthayna Abu-Saleem

Sec.2 (Monday)

Part (A):

Use the American Method to design a concrete mix that is required for foundations. The specified strength is 33MPa (strength of cylinder) at 28 days with a slump of 40mm. The available coarse aggregate has a maximum nominal size of 10mm and rodded bulk density (unit weight) of 1463kg/m^3. The aggregates are of normal weight and their grading conforms to the appropriate standard with a fineness modulus of sand of 2.5.

Assume:

	Fine Aggregates	Coarse Aggregates
Bulk Specific Gravity (SSD)	2.80	2.75
Moisture Content (%)	2.00	1.00
Absorption (%)	0.80	1.20

Part (B): Practical Part

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

Slump= 75mm
Entrapped Air= 2.5%

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

...LE A1.533 — APPROXIMATE MIXING WATER AND AIR CONTENT REQUIREMENTS FOR DIFFERENT SLUMPS AND NOMINAL MAXIMUM SIZES OF AGGREGATES (SI)

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	295	103	181	169	145	124
150 to 175	243	228	216	202	190	178	160	—
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	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 17.3: **Required increase in strength for specified compressive strength when no tests records are available, according to ACI 318–05**

Specified compressive strength: MPa	psi	Required increase in strength: MPa	psi
less than 21	less than 3000	7	1000
21 to 35	3000 to 5000	8.5	1200
35 or more	5000 or more	10.0	1400

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

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

TABLE A1.5.3.4(a) — RELATIONSHIPS BETWEEN WATER-CEMENT RATIO AND COMPRESSIVE STRENGTH OF CONCRETE (SI)

Compressive strength at 28 days, MPa*	Water-cement ratio, by mass: Non-air-entrained concrete	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 A1.5.3.6 — VOLUME OF COARSE AGGREGATE PER UNIT OF VOLUME OF CONCRETE (SI)

Nominal maximum size of aggregate, mm	Volume of dry-rodded coarse aggregate* per unit volume of concrete for different fineness moduli† of fine aggregate: 2.40	2.60	2.80	3.00
10	0.50	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.60
25	0.71	0.69	0.67	0.65
40	0.75	0.73	0.71	0.69
50	0.78	0.76	0.74	0.72
75	0.82	0.80	0.78	0.76
150	0.87	0.85	0.83	0.81