مختبر مواد البناء التجربة الأولى

[redacted]

١٠ قروش

Hashemite University

Faculty of Engineering

Civil Engineering Department

Materials of Construction Laboratory

Experiment No.:1

Normal Consistency and Setting time of hydraulic cement

Student Name: ....

Student No.: ....

Section No.: ....

Day:..................

Date:.................

Experiment.1

Normal Consistency and Setting time of hydraulic cement

1.1. Objective

Determine normal consistency and setting time.

Calculate initial setting time (Ist) from the experiment and final setting time (fst) from the experiment.

Determine the quality of cement.

1.2. Apparatus and Equipments

Named each Part in the apparatus below

(1): Base plates

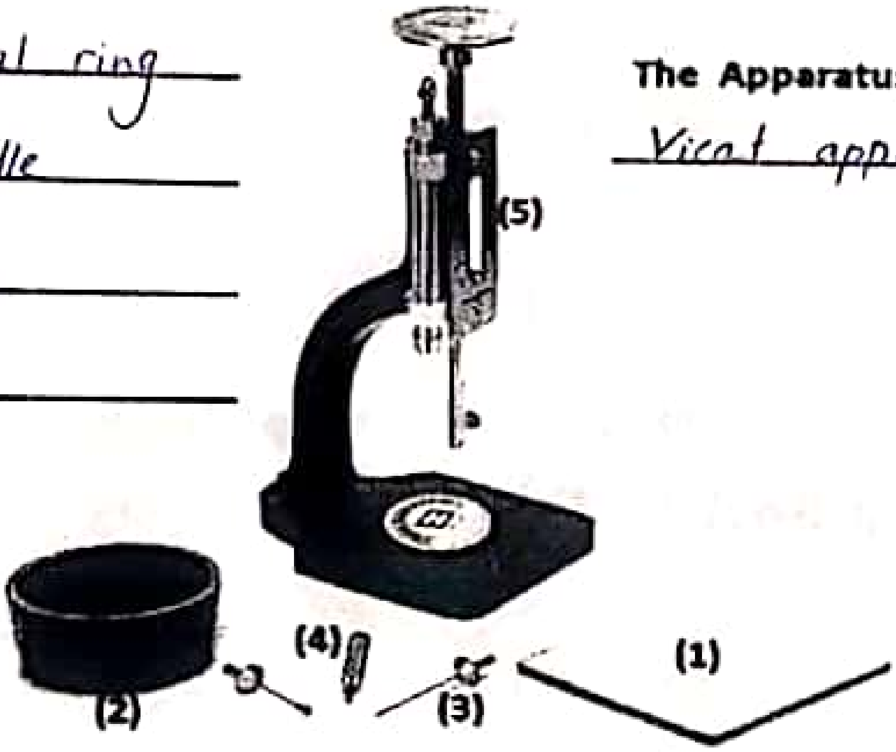
(2): conical ring

(3): Needle

(4): Rod

(5): Scale

The Apparatus name is Vicat apparatus



Another Apparatus and Equipments:

Trowel , Gilmore

water pipe

timer , graduated cylinder

gloves + cement mixer

1.3. Materials

Cement

water

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.)
201.5	31	5	,69
208	32	11	1.04
211.25	32.5	14	1.14

- Draw w/c% versus Log (penetration); Figure 1.1.
- From this curve (w/c% versus Log (pent.)), the normal consistency is..32.2%

1.5.1. Initial and Final Setting Time

Wt. of Cement = 650 W/C% = 32.2 Water = 209.1 g

Table 1.2: variation of penetration with time

Time (min)	Penetration (mm)
15	38
30	37
45	36
60	34
75	27
90	20
105	14

- Draw the penetration versus time; Figure 1.2.
- From this curve (pent. versus time), initial setting time is…80…..
- Calculate/Find the Final setting time (using the three different ways; equations and graphically)

(FST) - from the figure = 121 min

- FST = 1.2 (IST) + 90 min
  1.2 (80) + 90 = 186 min
- FST = 1.5 (IST) + 45 min ⇒ 1.5 (80) + 45 = 165 min

scussion

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

As shown in the table (1.1), when (W/C)% increase the penetration increases too. e.g: when (W/C)% = 32 the penetration is (11), and when the (W/C)% increases to (32.5), the penetration also increases to (14) mm.

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

from the figure, we find out the normal consistency and it is 32.2% and we can see that their is a (Direct linear relationship) between (W/C) ratio and Log(penetration).

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

As shown in table (1.2), when time increases the penetration decreases. e.g: when time = 15, the penetration is 38 mm. and when time = 45, the penetration decreases to 36 mm.

- Discuss figure1.2. (penetration versus time)

The relation from the figure is indirect and non-Linear. We obtain from the figure (IST = 80 min) and (FST = 121 min)

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

Yes, it is accepted, because the normal consistency = 32.2% and it is in the accepted range which is (25 - 33)%.

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

Yes, because the minimum (IST) is 45 min and the initial setting time we obtained is 80 min (80 > 45)

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

Yes, it is accepted, because the result is 121 min and the Maxmum FST = 6 1/4 hour.

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

Yes, it can be used in the construction, because the (IST), (FST) and (N.C) are accepted values according to the experiment (ASTM)

- Error sources:

1. Error ~~to~~ using time (not start counting from zero).
2. Error using mixer. 3. Error when the hands aren't vertical
4. Error using too much pressure on the sample. 5. Error reading water pipe.

1.7- Remember to make your report tidy and neat ☺

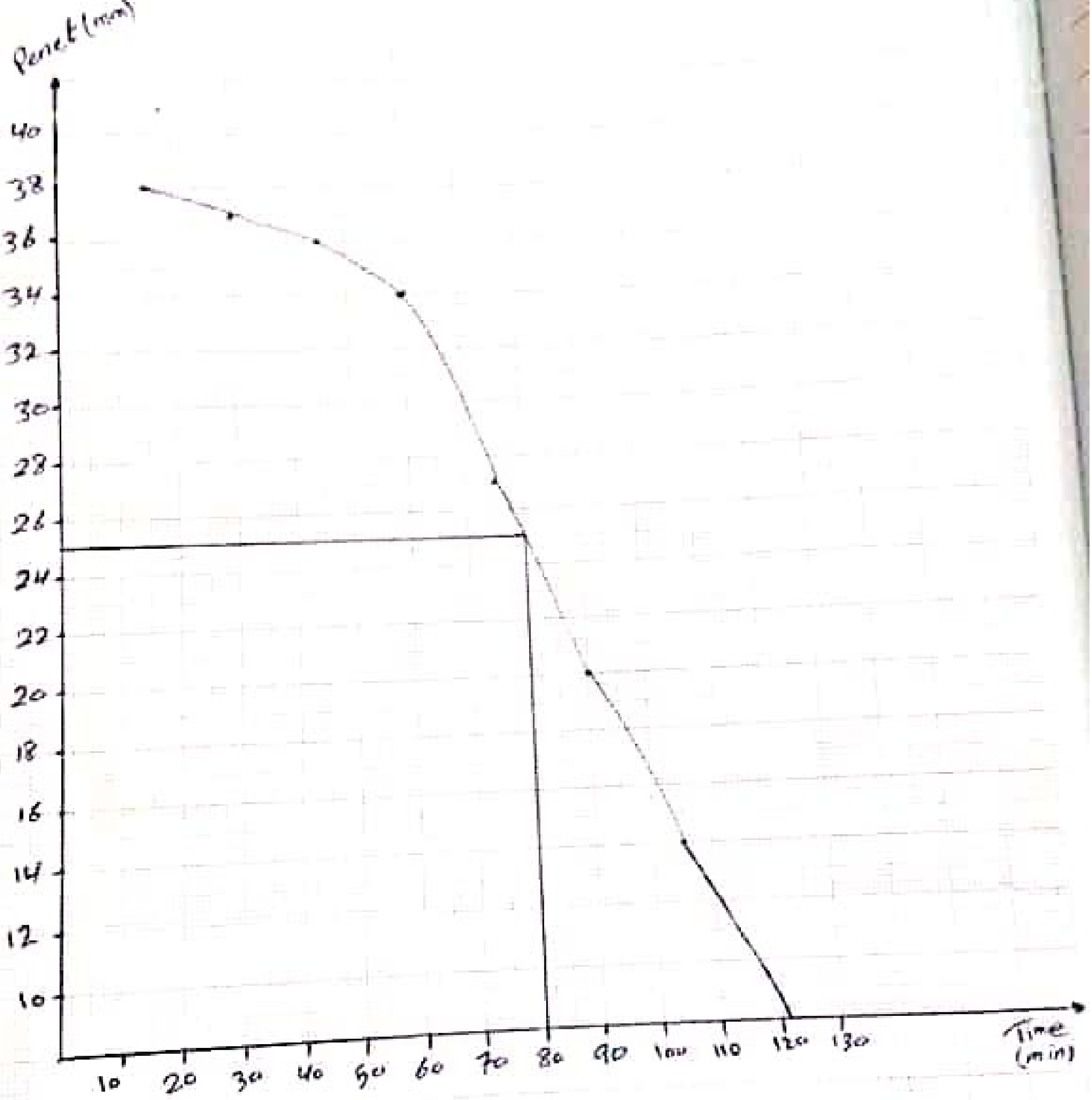


Figure 1:2 ⇒ Penetration versus time

مختبر مواد البناء / التجربة الثانية / الشعبة ٤ (الخميس)

Hashemite University

Faculty of Engineering

Civil Engineering Department

92/100

Materials of Construction Laboratory

Experiment No.: 2

Compressive and Tensile Strength of Cement Mortar

Student Name: وليد غسان الحسن دواس

Student No.: 1732492

Section No.: 4

Day: الخميس

Date: 4/10/2018

Experiment.2

Compressive and Tensile Strength of Cement Mortar

2.1. Objectives

1) Cheack quality of cement

2) To determine compresive and tensile strength of cement mortar

✓

2.2. Apparatus and Equipment

mixer

Timer

Trowel

Gloves

Oil Hydrolics

Rod (Tamper)

compressive test machine

Automatic flextural tensil te

bowl

Briquttes cube

0.5

2.3. Materials

cement

water

Sand (attaw sand OR swelch sand

Procedure

4.1. Compressive strength test

2.4.1.1. Preparation of mortar

1. Prepare the quantities of standard mortar components to satisfy that C:S:W= 1:2.75:0.485, where cement= 740g, sand= 2035g, and water= 359ml for making 9 specimens
2. Place the mixing water in the bowl of the mixer, then add the cement and allow 30s for the absorption of water.
3. Start the mixer and mix at low speed (140±5rpm) for 30s
4. Add the certain quantity of sand to the cement paste gradually during the next 30s where the mixer still on slow speed.
5. Immediately, alter the mixer to medium speed (285±10rpm) for 30s.
6. Stop the mixer for 1.5min and during this time scrape down into the batch any mortar that may have collected on sides of the bowl.
7. Start the mixer at medium speed for 60s.

2.4.1.2. Molding test specimens

1. Apply a thin coat of oil to the interior faces of the mold.
2. Immediately following completion of mixing, start molding the specimens within 2.5min.
3. Place a layer of mortar about 1in (25mm) [one half of the depth of the mold] in all of the cube compartments (in our experiment it is 9cubes).
4. For each cube compartment, tamp the first layer of mortar 32times in 10sec in 4 rounds (complete the 4 rounds in one cube before the going to the next one).
5. When the tamping procedure is finished for all cube compartments, fill the remaining depth of cubes (1in) with second layer of mortar.
6. When the filling of all cube compartments is completed, repeat the tamping procedure as in the first layer (mortar should extend slightly above the tops of the molds).
7. Bring in the mortar that has been forced out onto tops of the molds and level the mortar surface, then cut off the extra mortar above the top of mold using a trowel (straight edge).
8. Store all test specimens, immediately after molding in the moist closet or moist room from 20-27hrs.
9. Remove the specimens from the molds after 20-27hrs.
10. Immerse them in saturated lime water for curing until testing age (3, 7, and 28days).

2.4.1.3. Determination of compressive strength

1. At each testing age (3, 7, and 28days), remove the required number of specimens from water (in our experiment 3 specimens for each age).
2. Wipe each specimen to a surface dry condition and remove any loose sand grains from the faces that will be in contact with the bearing blocks of the testing machine.
3. Apply the load to the smooth faces of the first specimen at rate of 200-400lb/s (900-1800N/s) and record the max load indicating by testing machine.
4. Repeat step 5 for the remaining specimens for each age.

2.4.2. Tensile strength Test

2.4.2.1. Preparation of mortar

1. Prepare the quantities of the cement and sand such that C:S= 1:3.
2. Determine the percentage and quantity of water used in the standard cement mortar depending on the percentage of water required to produce neat cement paste of normal consistency and prepare it.

Hint: See table 1 (Percentage of water for Standard Mortar according to ASTM C190-85)

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: Low heat cement (IV)

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	8.4	3.36	3.653	3.28-4.01	✓	3.653
	9.1	3.64			✓	
	9.9	3.96			✓	
7	24.9	9.96	9.45	8.505-10.39	✓	10.08
	25.5	10.2			✓	
	20.5	8.2			X	
28	42.1	16.84	17.12	15.4-18.83	✓	17.12
	45.3	18.12			✓	
	41.0	16.4			✓	

- Sample of calculations:

$* \sigma_{comp} = \frac{8.4 * 10^3}{(50)^2} = 3.36 MPa$; $\sigma_{avg} = \frac{3.36+3.64+3.96}{3} = 3.$

ok

$* Range = 3.653 \pm 0.1(3.653) =$ → upper Limit = 4.01
→ lower Limit = 3.28

$* New\ accepted\ avg = \frac{3.36+3.64+3.96}{3} = 3.653 MPa$

mortar

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

- y = strength of concrete
- x: strength of mortar.

$$y = 0.004x^2 + 1.3x$$

$$y = 0.004(17.12)^2 + 1.3(17.12)$$

$$y = 23.423 \text{ MPa}$$

2.5.2. Tensile strength

Cement Type: Low heat cement (IV)

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	923	1.47	1.504	1.278 1.728	✓	1.504
	1042	1.667			✓	
	860	1.376			✓	
7	1368	2.18	2.213	1.88-2.54	✓	2.18
	1802	2.36			✗	
	987	1.579			✗	
28	1774	2.838	2.601	2.21-2.99	✓	2.601
	1461	2.337			✓	
	1643	2.628			✓	

- Sample of calculations:

$$* \ \sigma_{tension} = \frac{923}{(25)^2} = 1.47 \text{ MPa} \quad , \sigma_{avg} = \frac{1.47 + 1.667 + 1.376}{3} = 1.504 \text{ MPa}$$

$$* \ \text{Range} = 1.504 \pm 0.15(1.504) \longrightarrow \begin{cases} \text{upper limit} = 1.729 \\ \text{lower limit} = 1.278 \end{cases}$$

$$* \ \text{New accepted avg.} = \frac{1.47 + 1.667 + 1.376}{3} = 1.504 \text{ MPa}$$

ok

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

2.6. Discussion

1- compression test :- from the first table, we may observed that as day pass by, the compression strength of cement mortar increase as well as bearing stronger Load as the time pass.

Time (age) ↑ comp. Load ↑ σ_{comp} ↑

2- Tension Test :- from table No. 2 we may observe that in same way, the tensile strength is also increasing.

Time (age) ↑ tensile Load ↑ $\sigma_{Tension}$ ↑

In the Figure :-

We might have noticed that the strength (Both tensile ~~and~~ and compressive increased with age (Time). and the relationship between (age and strength) non-linear.

Rate of strength from 3 day to infinty

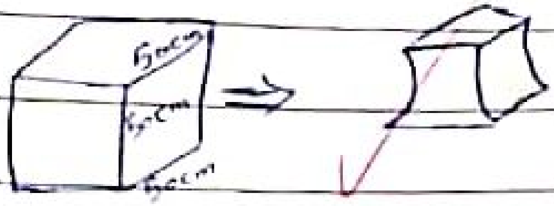
- In the first three days, the cement mortar is very weaker
- from (3-7) days, cement mortar is stronger than the first 3 day but it's a small rate in increasing [slow in increasing].
- from (7-28) days: the tensile strength, cement mortar has increased very slow. for the compressive strength, the cement mortar has increased very faster than the first week, and was a high change in strength.
- After 28th day → cement mortar strength is almost constant.

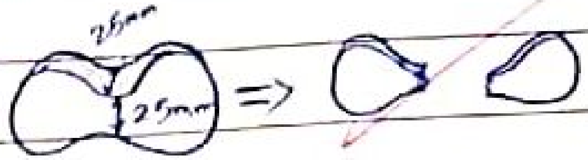
Conc. & moist (-1)

Errors (-4) Rate (-2)

* Broken Shape :

[1] due to comp   [2] due to tension





Ø = 45°   Ø = 90° with Load

angle of fracture   angle of Break

* The cement is much more able to resist ~~compression~~ compresion Loads rathar than tensile loads. and the cement is Brittle materal.

- the ratio of $\frac{\sigma comp}{\sigma Tensile}$ = ~~[illegible]~~ should be between (7-11)

at 3 day ⟹ $\frac{\sigma comP}{\sigma Tensile} = \frac{3.653}{1.504}$ = 2.42 ⟹ Not expected

at 28 day

comparing for compression :-

Age (day)	σavg.comp.accepted (MPa)	ASTM	Accepted or not
3	3.653	—	—
7	10.08	7	Accepted
28	17.12	17	Accepted

* cement mortar type "IV" LHPC ~~[illegible]~~ Accepted

comparing for tension :-

Age (day)	σavg.tensile accepted (MPa)	ASTM (MPa)	Accepted or not
3	1.504	—	—
7	2.18	1207	Accepted
28	2.601	2068	Accepted

2.7. Remember to make your report tidy and neat ☺

2.8. Specifications

Table 2.6: **BS EN 197-1: 2000 and ASTM C 150-05 requirements for minimum strength of cement (MPa (psi))**

Age (days)	BS EN 197-1: 2000 (mortar prism), strength class					
	32.5 N	32.5 R	42.5 N	42.5 R	52.5 N	62.5 R
2	– –	10 (1450)	10 (1450)	20 (2900)	20 (2900)	20 (2900)
7	16 (2300)	– –	– –	– –	– –	– –
28	32.5* (4700)	32.5* (4700)	42.5 (6200)	42.5** (6200)	52.5 (7600)	62.5 (9100)

Age (days)	ASTM C 150-05 (mortar cube), cement type (Table 2.7)							
	I	IA	II*	IIA*	III	IIIA	IV	V
1	– –	– –	– –	– –	12.0 (1740)	10.0 (1450)	– –	– –
3	12.0 (1740)	10.0 (1450)	10.0 (450)	8.0 (1160)	24.0 (3480)	19.0 (2760)	– –	8.0 (1160)
7	19.0 (2760)	16.0 (2320)	17.0 (2470)	14.0 (2030)	– –	– –	7.0 (1020)	15.0 (2180)
28	28.0* (4060)	22.0* (3190)	28.0* (4080)	22.0* (3190)	– –	– –	17.0 (2470)	21.0 (3050)

* and not more than 52.5 (7600); ** and not more than 62.5 (9100)

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

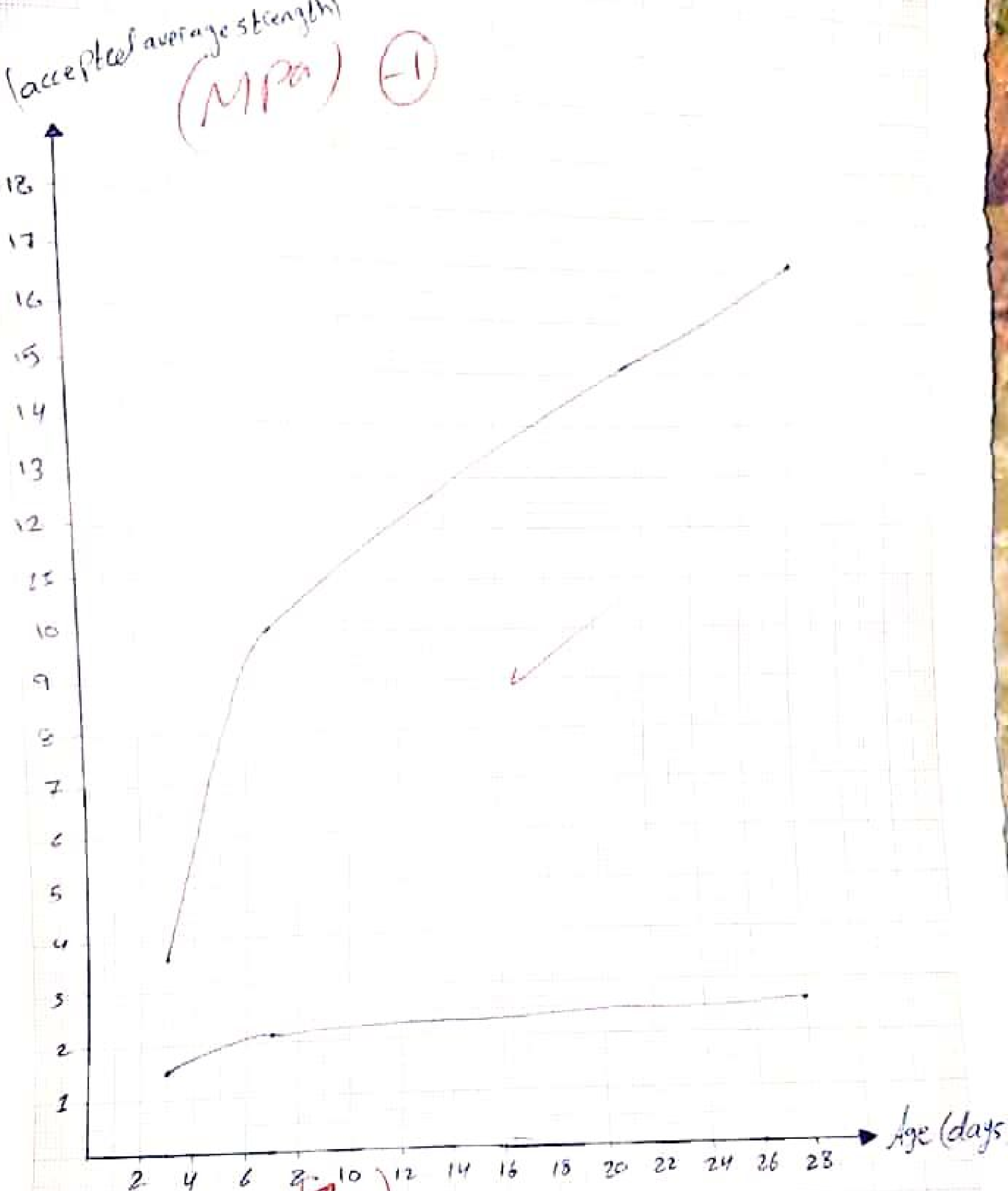
* Optional

CRD-C 260-01

Table 2 Tensile Strength[A]

	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, psi (kPa)	150 (1034)	125 (862)	375 (2586)	. . .	. . .
1 day in moist air, 6 days in water, psi (kPa)	275 (1896)	250 (1724)	. . .	75 (1207)	250 (1724)
1 day in moist air, 27 days in water, psi (kPa)	350 (2413)	325 (2241)	. .	300 (2068)	325 (2241)

[A] Taken from Specification C 150 - 58 without change.



(7.1)

Figure - Compressive and tensile Strength of mortor VS time.

١٥ قرش

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كل الشعب

Hashemite University

Faculty of Engineering

Civil Engineering Department

96/100

Materials of Construction Laboratory

Experiment No.: 3

Specific Gravity and Absorption of Coarse and Fine Aggregate

Student Name: Waleed Ghassan Dawas / حسام ثائر بونية

Student No.: 1732492 / 1539736

Section No.: 4

Day: الخميس

Date: 11/10/2018

Experiment.3

Specific Gravity and Absorption of Coarse and Fine Aggregate

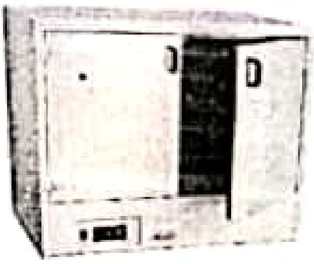
3.1. Objectives

To find a specific gravity and cheak quality of agglegate by calculating appeacant and bulk specific gravity and absorption for fine and coarse agglegate.

3.2. Apparatus and Equipment

List the names of the following equipment and tools:

		
special balance with basket	steel rod	cone mold

		
pycnometer	Balance (electronic)	oven

3.3. Materials

coarse and fine agglegate   water

Procedure

3.4.1. Specific gravity and absorption of coarse aggregates

1. Sieve the sample with 4.75mm sieves and ignore the materials passing through No.4.75 sieve.
2. Wash the sample to remove dust.
3. Put the sample in the oven at 110 ±5°C for 24hours.
4. Get the sample out of the oven, leave it to cool to a temperature that is comfortable to handle.
5. Submerge the sample in water for 24hours.
6. Remove the sample from the water and roll it in a large absorbent cloth until all visible films of water are removed. Wipe the larger particles individually. Take care to avoid evaporation of water from aggregate pores during the operation of surface- drying.
7. Take the required weight of the sample in its (S.S.D) (saturated surface dry) condition.
8. After weighing, immediately place the S.S.D sample in the sample container and determine its weight in water at 23±1°C. Take care to remove all entrapped air before weighing by shaking the container while immersed.
9. Dry the test sample to constant weight at a temperature of 110±5°C. Cool in air at room temperature 1 to 3 hours, or until the aggregate has cooled to a temperature that is comfortable to handle, and weigh.

3.4.2. Specific gravity and absorption of fine aggregates

1. Obtain approximately 1kg of the fine aggregate using sample splitter.
2. Dry it in a suitable pan or vessel to constant weight at 110°C. Allow it to cool to a comfortable handling temperature, cover with water by immersion and permit to stand for 24 hours.
3. Decant excess water with care to avoid loss of fines, spread the sample on a flat nonabsorbent surface exposed to a gently moving current of warm air.
4. Stir frequently to get homogeneous drying until achieving the saturated surface dry condition. Use cone test for surface moisture.
5. Hold the mold firmly on a smooth nonabsorbent surface with the large diameter down. Place a portion of partially dried fine aggregate loosely in the mold by filling it to over following and heaping additional materials above the top of the mold.
6. Lightly tamp the sand into the mold with 25 light drops of the tamper. Each drop should start about 5mm above the top surface of the sand. Permit the tamper to fall freely under gravitational attraction on each drop.
7. Adjust the surface, remove loose sand from the base and lift the mold vertically.
   If:
   - Surface moisture is still present the sand will retain the molded shape
   - The sand slumps slightly, it indicates that it has reached S.S.D condition.
   - The sand slumps fully, it indicates that the sand has been dried past the saturated surface dry condition. In this case, mix additional few millimeters of water with the fine aggregate and leave it in a covered container for 30 min. then resume the process of drying and cone testing until SSD condition is reached.
8. Weigh 500gm of the S.S.D sample.
9. Partially fill the pycnometer with water. Immediately put into the pycnometer 500gm saturated surface dry aggregate.
10. Then fill with additional water to approximately 90%of capacity.
11. Manually roll and invert or mechanically agitate the pycnometer to eliminate all air bubbles.
12. Bring the water level in the pycnometer to its calibrated capacity.
13. Determine the total weight of the pycnometer, specimen and water.
14. Remove the fine aggregate from the pycnometer, dry to constant weight at temp. 110±5°C, cool in air at room temperature for one hour, and weigh.
15. Determine the weight of the pycnometer filled to its capacity with water at 23±1.7°C

3.6.1.

3.5.1. Specific gravity and absorption of coarse aggregates

Data:

A: Weight of oven-dry test sample in air = 1490 g
B: Weight of S.S.D. sample in air = 1500 g
C: Weight of saturated sample in water = 934 g

Calculations:

1. Apparent Specific Gravity = $\frac{W_{oven}}{W_{oven} - W_{water}} = \frac{1490}{1490 - 934} = \boxed{2.679}$ ✓

2. Bulk Specific Gravity (SSD) = $\frac{W_{SSD}}{W_{SSD} - W_{water}} = \frac{1500}{1500 - 934} = \boxed{2.650}$ ✓

3. Absorption (%) = $\frac{W_{SSD} - W_{oven}}{W_{oven}} * 100\% = \frac{1500 - 1490}{1490} * 100\% = \boxed{0.671\%}$ ✓

3.5.2. Specific gravity and absorption of fine aggregate

Data:

A: Weight of oven —dry specimen in air = 256 g
B: Weight of pycnometer filled with water = 1524 g
S: Weight of the saturated surface-dry specimen = 501 g
C: Weight of pycnometer with specimen and water = 1679 g

Calculations:

1. Apparent Specific Gravity = $\frac{W_{oven}}{W_{oven} + W_{pyc+water} - W_{pyc+water+spec}}$

$= \frac{256}{256 + 1524 - 1679} = \boxed{2.534}$ ✓

2. Bulk Specific Gravity (SSD) = $\frac{W_{SSD}}{W_{SSD} + W_{pyc+water} - W_{pyc+water+spec}}$

$= \frac{501}{501 + 1524 - 1679} = \boxed{1.448}$ ✓

3. Absorption (%) = $\frac{W_{SSD} - W_{oven}}{W_{oven}} * 100\% = \frac{501 - 256}{256} * 100\% = \boxed{95.7\%}$ ✗

Discussion

3.6.1. Specific gravity and absorption of coarse aggregate

- Which one is greater apparent or bulk Gs? Why?

* Apparent (Gs) is greater than bulk (Gs); because the apparent (Gs) depend on oven-dry weight without voids, but bulk (Gs) depends on SSD weight with voids (total weight) which ~~[illegible]~~ decrease Gs.

-3

- Make a comparison between the weights (O.D., SSD in air, SSD in water)

Weight of SSD in water < weight of O.D < weight of SSD in air because the agg in water loss weight ~~=~~ equal weight of removed water, and the O.D haven't any void because it's heat, but the SSD in air have fully saturated voids which increase the weight of specimen.

- Our aggregate is Heavy, Normal, or Light weight? Why?

Heavy : Gs > 3
Normal : 2.2 < Gs < 2.8
Light : Gs < 2

~~Our sample [illegible] is Normal~~
* Our aggregate is Normal weight because the Apparent Specific Gravity = 2.679

- Absorption% is accepted or not? Why?

The accepted absorption should be less than 5%.
in our experiment absorption is 0.671% so It's accepted.

- What is the effect of the oven drying of the aggregate (before soaking) on the values of absorption and bulk specific gravity (SSD)? Why?

* Before soaking the absorption and bulk will be increase because the capillary pore will take amount of water bigger than when air dry.

3.6.2. Specific gravity and absorption of fine aggregate

- Our aggregate is Heavy, Normal, or Light weight? Why?

* In our experiment the Apparent Specific Gravity = 2.534 then our aggregate is Normal weight because between (2.2-2.8)

- Absorption% is accepted or not? Why?

The accepted absorption is less than 5%

*your sample has absorption = 95.7% so it's not accepted

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

*~~When Percentage of absorption increase the concrete mix will be bad because the percentage absorption will~~ • Because when you measure the mass of the liquid you measure it without the trapped bubbles and hence the mass measurement should be correct with the bubbles in the pipet however the volume measurement is incorrect, it is too large. Thus in the calculation density = mass/volume the denominator is increased by the volume of the bubbles and when you increase the denominator of a fraction the value of the fraction decreases. Thus the density you obtain from this calculation is too small.

- How can the percentage of absorption affects on a concrete mix?

* When percentage of absorption increase the concrete mix will be bad because the percentage absorption will effect on (w/c) for the concrete mix and this ratio (w/c) is an important factor that ~~effect~~ effect on workability and the strength of concrete. So that when % of absorption increase (w/c) will change and then the quality of concrete about the accepted range will decrease.

⇒ % of absorption ↑ ⇒ W ↑ ⇒ workability ↑ ⇒ strength ↓

(when increasing water with cement)

3.6.4. Error sources:

[1] The accuracy of measurement and balancing..

[2] The air was not removed from the pycnometer.

[3] The aggregate not dried well.

[4] The drop of rod more than 5mm above the top of surface of the sand when compacting in the rod (error in tamping)

[5] The fine aggregate don't moving by maker for it's accepted time.

[6] The aggregate fell in water instead of basket during weighting process.

3.7. Remember to make your report tidy and neat ☺

مختبر مواد البناء / التجربة الرابعة / جميع الشعب

٢٠ قرش

Hashemite University

Faculty of Engineering

Civil Engineering Department

Materials of Construction Laboratory

76/100

cheating

Experiment No.: 4

Sieve Analysis
of coarse and Fine Aggregates

Student Name: ولي غسان د و أنس ع محمد ابوامرنه

Student No.: 17361961 / 1732492

Section No.: ٤

Day: Thursday
Date: 18/10/2018

Sieve Analysis of coarse and Fine Aggregates

4.1. Objectives

① Determine if the aggregate is accepted or not to use in concrete ② Determi
the maximum size of aggregate and nominal maximum size of aggregate
③ Determining the finess modulus for coarse and fine aggregate

4.2. Apparatus and Equipments

Balance
Pan
Shaker
sieves for coarse aggregate

sieves for fine aggregate

4.3. Materials

Coarse and fine aggregate

4.4. 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.

ata and Calculations

.1. Sieve analysis of coarse aggregates

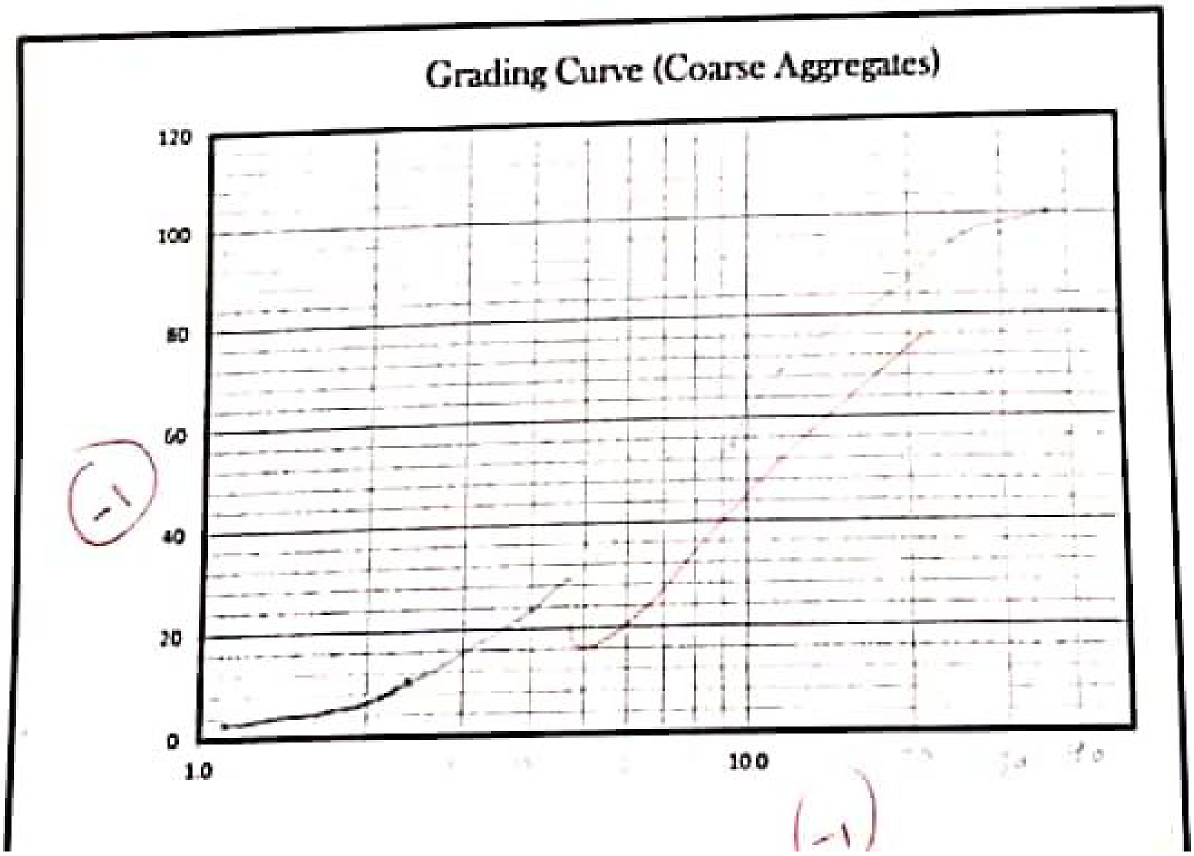
able 6.1: Sieve analysis of coarse aggregates

sieve size (mm)	sieve No.	sieve wt. (g)	sieve+ret. (g)	Ret. Wt. (g)	Retained (%)	Cum. Ret. (%)	Cum. Pass (%)
37.5	1 1/2"	496	496	0	0%	0%	100%
* 25	1"	468	495	27	3.47%	3.47%	96.53%
19	3/4"	468	580	112	14.39%	17.86%	82.14%
12.5	1/2"	461	579	118	15.16%	33.02%	66.98%
9.5	3/8"	471	544	73	9.38%	42.4%	57.6%
4.75	4	440	637	197	25.32%	67.72	32.28%
2.36	8	385	562	177	22.75%	90.47%	9.53%
1.18	16	418	435	17	2.18%	92.65%	7.35%
*0.075	200	246	283	37	4.75%	97.4%	2.6%
pan		305	325	20	2.57%	99.97%	~~[illegible]~~ 0.03%
				778		≈100	

Determine:

1. F.M. = $\frac{\Sigma \text{ cum. Ret for all standard sieves}}{100}$ = (0 + 17.86 + 33.02 + 42.4 + 67.72 + 90.47 + 92.65 + 3(100)) / 100 ~~= [illegible]~~ 6.5 = 6.442 > 5
2. M.S. = 37.5mm (sieve no 1 1/2)
3. N.M.S. = ~~sieve~~ 25mm (siev no 1) → not standard / 37.5mm (sieve no 1 1/2) → standard

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



(-1)

(-1)

4. 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"			0	0%	0	100%
4.75	4			5	1.04%	1.04%	98.96
2.36	8			6	1.25%	2.29%	97.71
1.18	16			8	1.66%	3.95%	96.05
0.6	30			48	10%	13.95%	86.05
0.3	50			189	39.37%	53.32%	46.68
0.15	100			178	37%	90.32%	9.68
0.075	200			42	8.75%	99.07%	0.93
pan				4	0.83%	100	0
				480			

✓

Determine:

1. F.M. = $\frac{\Sigma \text{ cum. Ret of all standard sieves}}{100}$ = ~~[illegible]~~

$= \frac{0 + 1.04 + 2.29 + 3.95 + 13.95 + 53.32 + 90.32}{100}$

$= 1.6487 < 6$ ✓

2. M.S. = 9.5 mm ✓
3. N.M.S. = 0.6 mm ✓

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

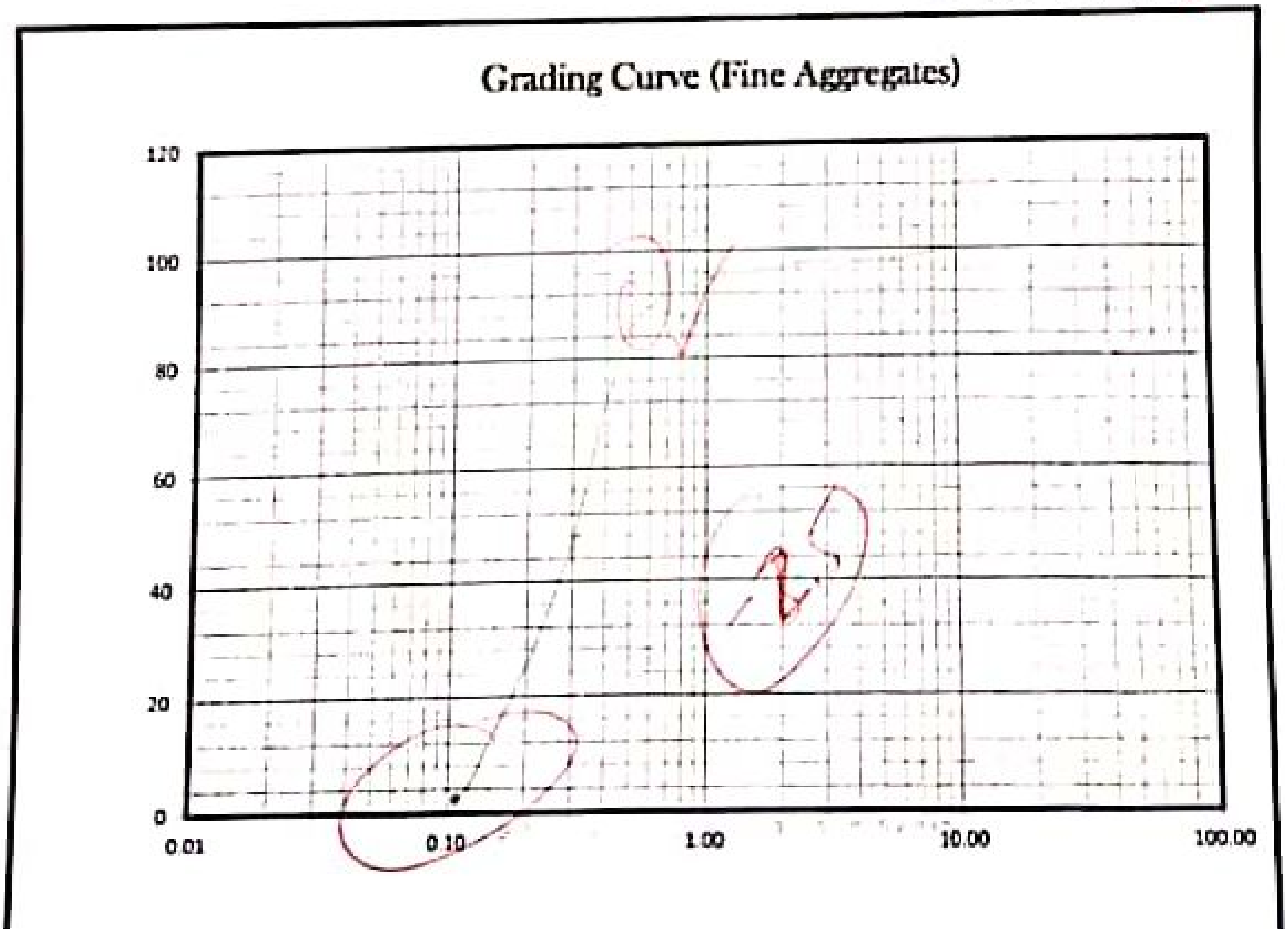

Grading Curve (Fine Aggregates)

Table 3.8: **BS and ASTM grading requirements for fine aggregate**

Sieve size		Percentage by mass passing sieve				
		BS 882: 1992				ASTM C 33-03
BS	ASTM No.	Overall limits	Additional limits*			
			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 X	45-100 ✓	70-100 ✓	50-85 X
600 μm	30	15-100 ✓	15-54	25-80 X	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		Percentage by mass passing BS sieve							
		Nominal size of graded aggregate			Nominal size of single-sized aggregate				
mm	in.	40 to 5 mm (1½ in. to $\frac{3}{16}$ in.)	20 to 5 mm (¾ in. to $\frac{3}{16}$ in.)	14 to 5 mm (½ in. to $\frac{3}{16}$ in.)	40 mm (1½ in.)	20 mm (¾ in.)	14 mm (½ in.)	10 mm ($\frac{3}{8}$ in.)	5 mm ($\frac{3}{16}$ in.)
50.0	2	100	-	-	100	-	-	-	-
37.5	1½	90-100 ✓	100		85-100	100			
20.0	¾	35-70 X	90-100	100	0-25	85-100	100	-	-
14.0	½			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		Percentage by mass passing sieve				
		Nominal size of graded aggregate			Nominal size of single-sized aggregate	
mm	in.	37.5 to 4.75 mm (1½ to $\frac{3}{16}$ in.)	19.0 to 4.75 mm (¾ to $\frac{3}{16}$ in.)	12.5 to 4.75 mm (½ to $\frac{3}{16}$ in.)	63 mm (2½ in.)	37.5 mm (1½ in.)
75	3	-	-	-	100	
63.0	2½		-		90-100	-
50.0	2	100	-		35-70	100
38.1	1½	95-100 ✓	-	-	0-15	90-100
25.0	1	-	100	-		20-55
19.0	¾	35-70 X	90-100	100	0-5	0-15
12.5	½	-	-	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	-	-

المواصفة الاردنية للتحليل المنخلي

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	٩٥ ـ ١٠٠ ✓	١٠٠ ✓	
٤,٧٥ ملم	رقم ٤	٨٠ ـ ١٠٠ ✓	٩٠ ـ ١٠٠ ✓	
٢,٣٦ ملم	رقم ٨	٥٠ ـ ٨٠ ✗	٧٥ ـ ١٠٠ ✓	١٠٠ ✓
١,١٨ ملم	رقم ١٦	٢٠ ـ ٧٠	٥٥ ـ ٩٠ ✗	٩٠ ـ ١٠٠ ✓
٦٠٠ ميكرون	رقم ٣٠	١٠ ـ ٣٥	٣٥ ـ ٥٩	٦٠ ـ ٩٠ ✓
٣٠٠ ميكرون	رقم ٥٠	٥ ـ ١٥	٨ ـ ٣٠	٢٠ ـ ٦٠ ✓
١٥٠ ميكرون	رقم ١٠٠	٠ ـ ٥	٠ ـ ١٠	٠ ـ ٢٠ ✓
٧٥ ميكرون	رقم ٢٠٠	٠ ـ ٥	٠ ـ ٥	٠ ـ ١٠ ✓

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	٨٠ ـ ١٠٠ ✓	١٠٠ ✓		
١ بوصة	٢٥,٤ ملم	٢٠ ـ ٥٠ ✗	٩٥ ـ ١٠٠ ✓	١٠٠ ✓	
٤/٣ بوصة	١٩ ملم	١٠ ـ ٣٠	٤٠ ـ ٨٠ ✗	٩٥ ـ ١٠٠ ✓	١٠٠ ✓
٢/١ بوصة	١٢,٧ ملم	———	٥ ـ ٥٠	٥٠ ـ ٨٠ ✓	٩٠ ـ ١٠٠ ✓
٨/٣ بوصة	٩,٥ ملم	٠ ـ ١٠	٠ ـ ١٥	٢٥ ـ ٦٠ ✓	٨٠ ـ ١٠٠ ✓
٤,٧٥ ملم	رقم ٤	٠ ـ ٥	٠ ـ ٥	٠ ـ ١٠ ✗	٥ ـ ٥٠ ✓
٢,٣٦ ملم	رقم ٨	٠ ـ ٢	٠ ـ ٥	٠ ـ ١٠	٠ ـ ٢٥ ✓
٠,٠٧٥ ملم	رقم ٢٠٠	٠ ـ ٢	٠ ـ ٢	٠ ـ ٢	٠ ـ ٢ ✗

* Coarse Aggregate - The coarse Aggregate is not Accepted because when we compared table 6.1 with table 3.9, we found out the aggregate doesn't meet BS requirments, and it's also not accepted for ASTM and to the Jordanian spacification in table 2.

* The coarse aggregate in table 6.1 is poor graded for BS, ASTM, JS

* FM = ~~3.4452~~ 6.4412 ~~< 5~~ > 5 → it's ~~not~~ coarse aggregate

2.0 ?

(-2)

* Fine Aggregate: The Fine Aggregate when compared table 6.2 with table 3.2, for BS and ASTM → we observe that the fine aggregate is not accepted to ASTM because it doesn't meet their requirments However, the fine aggregate is accepted to BS (overall limits) because the fine aggregate meet the requirments, and when tested (the fine aggregate) we see that it's accepted for (Fine sand), And According to the JS (table 2) we see that it's accepted on sieve #16 because all the requirment are accepted to Jordanian test requirments.

FM = 1.6487 < 5 → it's accepted for fine aggregate

fine Sand ?!

(-2)

5.8: Remember to m[illegible]

scussion

* Errors

① Error in using the shaker
(time less than 4 minutes)
② Error in order & the sieves
③ Not cleaning the sieves well.
④ Error in weight reading.

x we use sieve 9.5mm in fine aggregate to ensure that we removed all impurities which is > 5mm. #200?!

(-3)

* The fine agg is well-graded according to Jordanian test and BS, but poor-graded according to ASTM.

(-1)

x from table (6.1) and (6.2) we found that ~~[illegible]~~ sieve size increase The Log of sive size increase.

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مختبر مواد البناء / التجربة السابعة / شعبة ٤ (~~[illegible]~~ الخميس)

٣٠ قرش

Hashemite University

Faculty of Engineering

Civil Engineering Department

Materials of Construction Laboratory

Experiment No.: 7

Tensile Strength of Steel

~~93~~ 43
100

-50

see 1539736
1741002

Student Name: وليد غسان دراس

Student No.: 1732492

Section No.: 4

Day: الخميس

Date: 25/10/2018

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Experiment.7

Tensile Strength of Steel

7.1. Objectives

1) To calculate the tensile strength and strain for steel by universal testing machine (UTM).

2) To draw the (strength - strain) diagram and determine [elastic regin proportional limit, Yield and Ultimate strength.

3) To know the quality of steel (ductility and strength) and determine elongation.

7.2. Apparatus and Equipments

Universal testing machine (UTM)

computer software

Special program for (UTM)

Balance

Metre

7.3. Materials

Steel rod

7.4. Data and Calculations

7.4.1. Data

L_i mm= 320	L_F mm= 390
D_i mm= 17.6	A_i mm^2 = 243.28
D_F mm= 13.8	A_F mm^2 = 149.57

	Load (KN)	Elongation (mm)	Eng. Stress (MPa)	Eng. Strain $*10^{-3}$
1	0	0	0	0
2	1	1.5	4.11	4.68
3	8	2.4	32.88	7.5
4	18	2.5	73.98	7.81
5	32	2.6	131.53	8.12
6	46	2.7	189.08	8.43
7	68	2.9	279.51	9.06
8	76	5	312.39	15.62
9	76	7	312.39	21.87
10	76	11	312.39	34.37
11	76	13	312.39	40.62
12	78	16	320.61	50
13	82	17	337.06	53.12
14	85	18	349.39	56.25
15	87	20	357.61	62.5
16	92	23	378.16	71.87
17	97	27	398.71	84.37
18	103	30	423.38	93.75
19	108	36	443.93	112.5
20	110	41	452.15	128.12
21	112	50	460.37	156.25
22	113	52	464.48	162.5
23	114	55	468.59	171.87
24	115	60	472.70	187.5
25	115	61	472.70	190.62
26	113	63	464.48	196.87
27	109	65	448.04	203.12
28	105	66	431.60	206.25
29	101	68	415.16	212.5
30	99	70	406.93	218.75

$$A_i = \frac{\pi}{4}(D_i)^2 = \frac{\pi}{4} * (17.6)^2 = 243.28\ mm^2$$

$$A_f = \frac{\pi}{4}(D_f)^2 = \frac{\pi}{4}(13.8)^2 = 149.57\ mm^2$$

$$L_f = \Delta L + L_i = 70 + 320 = 390 mm$$

$$\sigma_{eng} = \frac{P}{A_i} = \frac{1*10^3}{243.28} = 4.11 Mpa$$

ok

$$\varepsilon_{eng} = \frac{\Delta L}{L_i} = \frac{1.5}{320} = 4.68*10^{-3} = 0.00468$$

7.4.3. 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 = 279.51 Mpa

Yield Point = (0.0156 , 312.39 *10^6)

Hardening Point = (0.05 , 320.68 * 10^6)

Ultimate Strength = ~~[illegible]~~ 472.7 Mpa

Fracture Point = (0.218 , 406.93 * 10^6)

3. Calculate:

Modulus of Elasticity = $\frac{\Delta \sigma}{\Delta \varepsilon} = \frac{73.98 - 32.88}{0.00781 - 0.0075} = 132.6 Gpa$

ok

→ slope in elastic region = Modulus of Elasticity

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

$$= \frac{390 - 320}{320} * 100\% = 21.9\%$$

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

$$= \left|\frac{149.57 - 243.28}{243.28}\right| * 100\% = 38.5\%$$

True Stress at fracture Point = $\frac{P}{Af} = \frac{99 \times 10^3}{149.57 \times 10^{-6}} = 661.89$ Mpa

True Strain at Fracture Point = $\frac{\Delta L}{Lf} = \frac{70}{390} = 0.179$

Modulus of Resilience = Area under stress-strain diagram in elastic

$= \frac{1}{2}(0.0075 - 0.00468) \times 32.88 + (0.0156 - 0.0075) \times 279.51$

$+ \frac{1}{2}(312.39 - 279.51) \times (0.0156 - 0.0075)$

$= 2.443 \text{ MJ/m}^3$

Modulus of Toughness = Area under stress-strain diagram in (elastic + plastic)

$= 2.443 + \underbrace{821}_{\text{\# of square}} \times \underbrace{(0.01 \times 10)}_{\text{Area of one square}}$

$= 84.54 \text{ MJ/m}^3$

7.5. Discussion

The basic idea of a tensile test is to place a sample of a material between two fixtures called "grips" which clamp the material. The material has known dimensions, like length and cross sectional area. We the begin to apply weight to material grapped at one end while the other is fixed. We keep increasing the weight while at the same time measuring the change in length of the sample. steel resist the action because concrete is very weak tension, so we add steel rods to improve it's properties.

There are two type of stress and strain includes stress and strain actual and engineer

- Actual stress: is the applied load divided by the actual cross-sectional area of the specimen at the load.

- Eng. stress: is the applied load divided by the original cross-sectional area of material.

- Actual strain: equals the natural log of the qoutient of current length over the original length.

- Eng. strain: is the amount that a material deforms per unit length in a tensil test.

* Actual σ > eng. σ

* Actual ε < eng. ε

* Ductility of steel can measured by percentage elongation and percentage reduction of area.

→ % Elongation = 21.9% > 16% ; so it's accepted

→ % Reduction of area = 38.5% > 16% , so it's accepted

* There are two grade of steel → 1. Grade 40 → yield ≥ 275 MPa ; 2. Grade 60 → yield ≥ 415 MPa → same modulus of elasticity.

* 6yield = 312.39 MPa ≥ 275 MPa, so this rod is grade 40 in our exp.

(-2)

* Stress - Strain diagram *

[1] Elastic region :- The material will return to it's original shape if the Load is removed, slope in this region equal Modulus of Elastic.
Modulus of Elastic (E) should be [190 - 210] GPa, in our exp. E = 132.6 GPa (not accepted)

[2] Yeild region : Stress is constant where as strain increase

[3] Harding region : Start at hardening point and end at Ultimate stress, and the stress increase suddinly.

[4] Necking Region : start at Ultimate stress and end at fracture point, and at this region the stress decreasing where as the strain increasing.  necking

[5] Ultimate ~~point~~ stress :- is the maximum Load the sample can resist.

[6] Fracture point : at this point the sample will be fracture.

→ The sample will fracture with angle 45° with shape Like this 

(-2)

* Modulus of elasticity is the shape of elastic region.
* Modulus of resilience is area under elastic in (6-E) curve.
* Modulus of Toughness is area under elastic and plastic region in (6-E) curve.

(-3)

Errors
(1) error in measure length and weight of steel rod (2) in computer and software program
(3) error in machin (UTM) (4) error in drawing Graph

7.6. Remember to make your report tidy and neat ☺

(Prepared by Eng.Buthayna Abu-Saleem)

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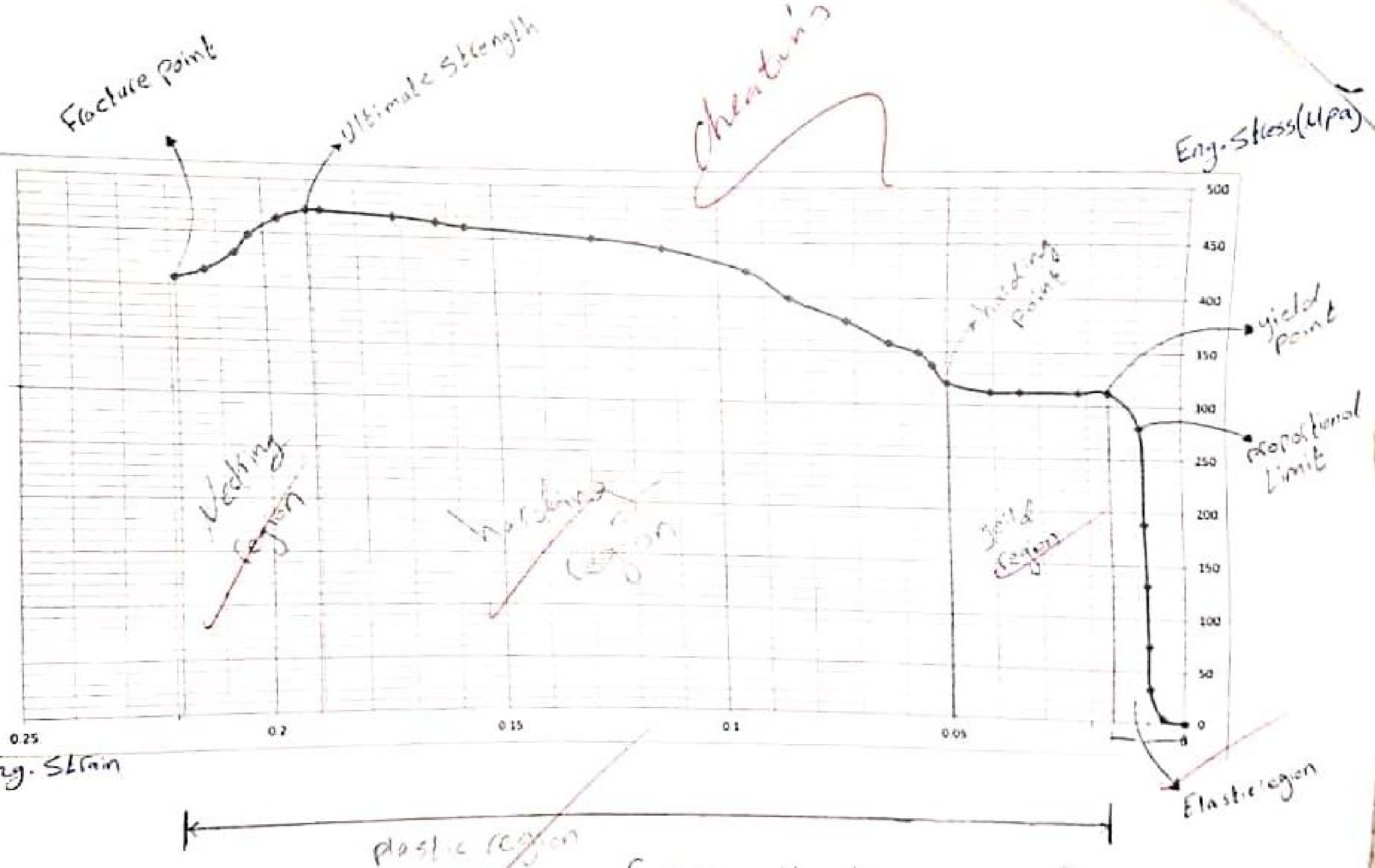

{ Stress Vs strain Diagram }

الزرقاء ١٤١٦هـ - ١٩٩٥م

~~94~~ → 74
100

20
Sec 1579736

Web ....

1/11/2018 ....

Instructor: ....

Name: وليد غسان دراس ....

ID#: 1732492 ....

وليد غسان دواس
1732492
W.G.D

BUILDING MATERIALS LABORATORY

EXP.8: Mix Design (ACI Method)

Data Sheet

Eng.Buthayna Abu-Saleem

Sec.4 (Thursday)

Part (A):

Use the American Method to design a concrete mix that is required for foundations. The specified strength is 34MPa (strength of cylinder) at 28 days with a slump of 50mm. The available coarse aggregate has a maximum nominal size of 12.5mm and rodded bulk density (unit weight) of 1605kg/m^3. The aggregates are of normal weight and their grading conforms to the appropriate standard with a fineness modulus of sand of 2.4.

Assume:

	Fine Aggregates	Coarse Aggregates
Bulk Specific Gravity (SSD)	2.8	2.76
Moisture Content (%)	3.00	2.00
Absorption (%)	0.95	1.2

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= 80mm
Entrapped Air= 2%

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

TABLE A1.5.3.3 — 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	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, 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		Required increase in strength	
MPa	psi	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

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

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

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

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

uilding Materials . . .

{ Mix Design } ACI method

* part A:

$F_c = 34$ Mpa

slump = 50mm

MNSA = 12.5mm

$\gamma_{rodded} = 1605$ Kg/m^3

F.M = 2.4

Sol

① strength:

FMD = Fc + margin

= 34 + 8.5

FMD = 42.5

• margin = 8.5 (from table 17.3)

② w/c ratio:

(from table A1.5.3.4(a))

• non-air-entrained concrete

strength → w/c

40 ~~35~~ → 0.42

42.5 ~~34~~ → X

45 ~~30~~ → ~~0.54~~ 0.37

??

$$\frac{\overset{42.5}{\cancel{34}} - \overset{40}{\cancel{30}}}{X - 042} = \frac{\overset{45}{\cancel{35}} - 40}{0.37 - 0.42}$$

~~X = 0.484~~

X = 0.395

-3

③ water contents

(from table A1.5.3.5)

• non-air-entrained concrete

slump = 50mm

M.N.SA → water content

20 → 190

12.5 → X

12 → 199

$$\frac{12.5 - 12}{X - 199} = \frac{20 - 12}{190 - 199}$$

X = 198.44 Kg/m^3

ok

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Air content:

(from table A1.5.3.3)

slump = 50mm

M.N.SA ⟶ Approximate amount of entrapped air in non-air-entrained concrete, percent

$$\left.\begin{array}{l} 20 \longrightarrow 2 \\ 12.5 \longrightarrow X \\ 12 \longrightarrow 2.5 \end{array}\right\} \Rightarrow \frac{12.5-12}{X-2.5} = \frac{20-12}{2-2.5}$$

$$X = 2.47\%$$

ok

⑤ cement content:

$$C = \frac{W}{W/C} = \frac{198.44}{\overset{\cancel{0.434}}{0.395}} = \overset{502.379}{\cancel{416}}\ \text{kg/m}^3$$

ok

⑥ Coarse Aggregate:

(from table A1.5 3.6) • M.N.S.A = 12.5mm • γ_{rodded} = 1605 kg/m³

F.M ~~M.N.S.A~~ ⟶ Volume of dry-rodded Coarse aggregate

2.4 ⟶ 0.59

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

$$= 0.59 \times 1605$$

$$W_{CA} = 946.95\ \text{kg/m}^3$$

⑦ Fine aggregate:

• $V = \frac{W}{S.G \times \gamma_w}$

$$\Sigma V = 1.00\ m^3$$

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

$$\frac{\overset{502.379}{\cancel{416}}}{3.15 \times 1000} + \frac{198.44}{1 \times 1000} + \frac{946.95}{2.76 \times 1000} + \frac{W_{FA}}{2.8 \times 1000} + \frac{2.47}{100} = 1.0$$

$$W_{FA} = \overset{\cancel{850.09}}{767.974}\ \text{kg/m}^3$$

Scanned by CamScanner

art B :-

$$\overset{502.379}{}\quad\overset{767.974}{}$$

- Approximate density = 198.44 + ~~410~~ + 946.95 + ~~[illegible]~~
  = $\boxed{2415243}$ kg/m³

- required water :

water required = Free water + Absorption - moisture

$$= 198.44 + \left(\frac{1.2}{100} * 946.95 + \frac{0.95}{100} * \cancel{[illegible]}^{767.974}\right)$$

$$- \left(\frac{2}{100} * 946.95 + \frac{3}{100} * \cancel{[illegible]}_{767.974}\right)$$

water required = ~~175.98~~ kg
175.121

- slump = 80mm ⟶ 50mm
- Entrapped Air = 2% ⟶ 2.47%

ASTM
- Add 2kg of water to increase slump by 1cm
- Add 3kg of water to decreasing air by 1%

- For increase slump = (8cm - 5cm) × 2 = 6 Kg ✓
- For decrease air = (2.47 - 2) * 3 = 1.41 kg (-) why not ?!

- New water = 198.44 - 6 = 192.44 Kg/m³
- New cement = $\frac{192.44}{\cancel{0.48\%}\ 0.395}$ = ~~397.6 Kg/m³~~ 487.189 kg/m³
- Coarse agg = 946.95 kg/m³
- New Fine agg :

$$\sum V = 1.0$$

$$\frac{\overset{487.189}{\cancel{397.6}}}{3.15*1000} + \frac{192.44}{1*1000} + \frac{946.95}{2.76*1000} + \frac{W_{FA}}{2.8*1000} + \frac{2.47}{100} = 1$$

W_{FA} = ~~877.91~~ kg/m³
798.277

* Approximate density = 192.44 + $\overset{487.189}{\cancel{397.6}}$ + 946.95 + $\underset{798.277}{\cancel{877.91}}$

= ~~2424.956~~ kg/m³ 2424.856 kg/m³

* Required water = 192.44 + $\left(\frac{1.2}{100} * 946.95 + \frac{0.95}{100} * \underset{798.277}{\cancel{877.91}}\right)$

$- \left(\frac{2}{100} * 946.95 + \frac{3}{100} * \underset{798.277}{\cancel{877.91}}\right)$

= ~~166.87~~ kg

168.499 kg

الاسم : وليد غسان حسين دراس

الرقم الجامعي : 1732492

الشعبة : 4

التاريخ : 1/11/2018

٢٥ قرش

81/100

Hashemite University

Faculty of Engineering

Civil Engineering Department

Materials of Construction Laboratory

Experiment No.:9

Workability and admixture test

Student Name: وليد حسان جبرايل

Student No.: 1732492

Section No.: 4

Day: الخميس

Date: 8/11/2018

Experiment.9

Concrete workability and Admixture

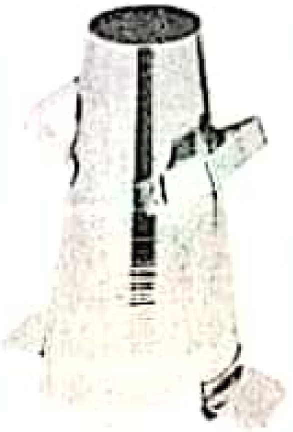
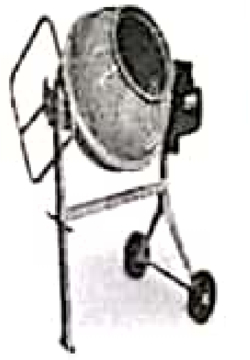
9.1.Objective

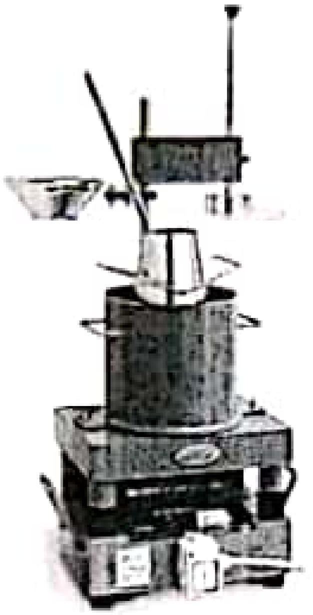
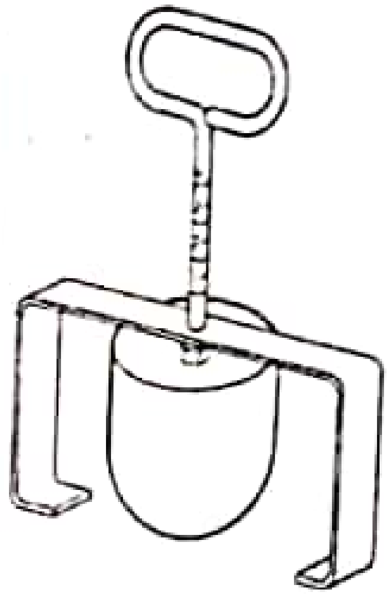
The objectives of this epeliment is to know the workability of fresh concrete by using (Slump test, Vebe test, Compacting factor, flow table test) and then we add ~~supe~~ super plasticizer to mixing to show affect in slump test and at workability.

9.2. Materials

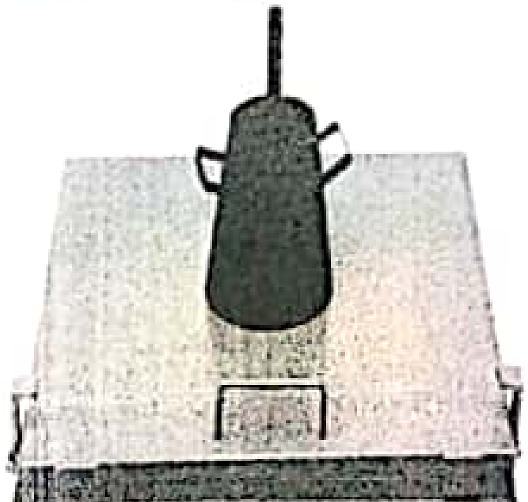
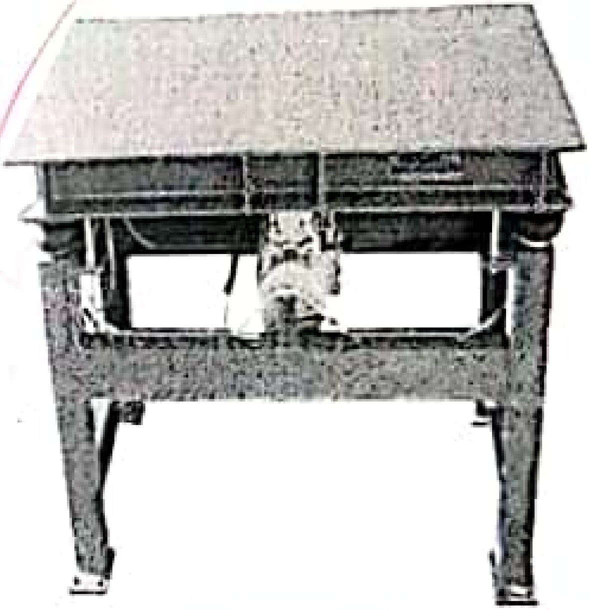
cement water coarseagg Fine agg ~~[illegible]~~ super ~~[illegible]~~ plasticizer

9.3.Tests Apparatus and Equipment

Equipment / Tools			
Name	slump cone shaped mold	rod	mixer

Equipment			
Name	Vebe consistometer	compacting factor test	kelly-ball test

ok

Equipment		
Name	Flow table	Vibrating table

9.4. Procedure

1. Machine Mixing

1. Put the coarse aggregate in the mixer, add some of the mixing water. If admixture is used, add the admixture to water and mix thoroughly.
2. Start the mixer, then add the fine aggregate, cement and water with the mixer running .If it is impractical to add the fine aggregate, cement and water with the mixer is running, these components may be added to the stopped mixer after permitting it to turn a few revolutions following charging with coarse aggregate and some of the water.
3. Mix the concrete, after all integrates are in the mixer, for 3 minutes followed by 3 minutes rest, following by 2-minutes final mixing.

1. Slump Test

1. Dampen the mold and place it on a flat, moist, nonabsorbent (rigid) surface. It shall be held firmly in place during filling by the operator standing on the two foot pieces. Immediately fill the mold in three layers, each approximately one third the volume of the mold.
2. Rod each layer with 25 strokes of the tamping rod. Uniformly distribute the strokes over the cross section of each layer.
3. In filling and rodding the top layer, heap the concrete above the mold before rodding start. If the rodding operation results in subsidence of the concrete below the top edge of the mold, add additional concrete to keep an excess of concrete above the top of the mold at all time.
4. After the top layer has been rodded, strike off the surface of the concrete by means of screeding and rolling motion of the tamping rod.
5. Remove the mold immediately from the concrete by raising it carefully in the vertical direction. Raise the mold a distance of 300 mm in 5 ± 2 sec by a steady upward lift with no lateral or torsional motion.
6. Immediately measure the slump by determining the vertical difference between top of the mold and then displaces original center of the top surface of the specimen. Complete the entire test from the start of the filling through removal of the mold without interruption and complete it within 2½ min.
7. If a decided falling away or shearing off of concrete from one side or portion of the mass occurs, disregard the test and make a new test on another portion of the sample. If two consecutive tests on a sample of concrete show a falling away or shearing off of a portion of concrete from the mass of specimen, the concrete lacks necessary plasticity and cohesiveness for the slump test to be applicable.

2. Compacting Factor Test

1. The internal surface of the hoppers and cylinder shall be thoroughly clean and free from superfluous moisture and any set of concrete commencing the test.
2. The sample of concrete to be tested shall be placed gently in the upper hopper using the scoop. The trap door shall be opened immediately after filling or approximately 6 min after water is added so that the concrete fails into the lower hopper. During this process the cylinder shall be covered.
3. Immediately after the concrete has come to the rest the cylinder shall be uncovered, the trap door of the lower hopper opened and the concrete allowed falling to into the cylinder.
4. For some mixes have a tendency to stick in one or both of the hoppers. If this occurs the concrete shall be helped through by pushing the tamping rod gently into the concrete from the top.
5. The excess of concrete remaining above the level of the top of the cylinder shall then be cut off by holding a trowel in each hand, with the plane of the blades horizontal, and moving them simultaneously one from each side across the top of the cylinder, at the same time keeping them pressed on the top edge of the cylinder. The outside of the cylinder shall then be wiped clean. This entire process shall be carried out at a place free from vibration or shock.
6. Determine the weight of concrete to the nearest 10 g. This is known as "weight of partially compacted concrete", Wp.

7. Refill the cylinder with concrete from the same sample in layers approximately 50 mm depth. The layers being heavily rammed with the compacting rod or vibrated to obtain full compaction. The top surface of the fully compacted concrete shall be carefully struck off and finished level with the top of the cylinder. Clean up the outside of the cylinder.
8. Determine the weight of concrete to the nearest 10 g. This is known as "weight of fully compacted concrete", Wf.

3. V.B. TEST

1. Slump test as described earlier is performed, placing the slump cone inside the sheet metal cylindrical pot of the consistometer.
2. The glass disc attached to the swivel arm is turned and placed on the top of the concrete in the pot. The electrical vibrator is then switched on and simultaneously a stop watch started.
3. The vibration is continued till such a time as the conical shape of the concrete disappears and the concrete assumes a cylindrical shape. This can be judged by observing the glass disc from the top for disappearance of transparency.
4. Immediately when the concrete fully assumes a cylindrical shape, the stop watch is switched off. The time required for the shape of concrete to change from slump cone shape to cylindrical shape in seconds is known as Vee Bee Degree.
5. This method is very suitable for very dry concrete whose slump value cannot be measured by Slump Test, but the vibration is too vigorous for concrete with a slump greater than about 50 mm.

4. Flow Table

1. Moist the table top and the frustum of the cone.
2. Try lifting and dropping the table then, keep the table horizontal.
3. Hold the mold firmly in place and fill in two layers, each approximately one halfthe volume of the mold. Rod each layer with 10 strokes with the wooden tamper.
4. Before lifting the mould , excess concrete is removed, the surrounding table top iscleaned.
5. After an interval of 30 seconds, the mould is vertically, slowly removed within 3-6seconds.
6. The table top is lifted slowly and allowed to drop, avoiding a significant forceagainst the stop, 15 times, each cycle taking not less than 3.5 and not more than5 sec.
7. In consequence, the concrete spreads and the maximum spread parallel to the twoedges of the table is measured.
8. The average of these two values, given to the nearest mm, represents the flow.
9. A value of 400 mm indicates a medium workability, and 500 mm a high workability.

5. Kelly Ball Test

1. Dampen the cylindrical part of the apparatus.
2. Gently flatten the surface of concrete without any compaction.
3. Hold the device vertically by the handle. Lower it slowly over the flattened area until the feet of the yoke touch the surface of the concrete.
4. Free the apparatus allowing the ball to slide through the yoke.
5. Once the apparatus touches concrete take the initial reading.
6. Carefully lower the ball penetrator into the concrete, maintaining enough restraint on the handle so that penetration is due to the dead load of the ball only.
7. Take the final reading of the scale.
8. Transfer the apparatus to take next readings. Individual measurements shall be at least 250mm between centres. The minimum horizontal distance from the centreline of the handle to the nearest edge of the level surface on which the test is made shall be at least 150mm.
9. Take at least three readings the penetration as the difference between the two readings.

6. Making Specimens

Place of Molding:

1. Mold specimens as near as practicable to the place where they are to be stored during the first 24 hours.
2. Place molds on a rigid surface free from vibration and other disturbances
3. If it is not practicable to mold the specimens where they will be stored, move them to the place of storage immediately after being struck off.

Placing:

1. Place the concrete in the molds using a scoop, blunted trowel, or shovel. Select each scoopful, trowelful, or shovelful of concrete from the mixing pan to ensure that it is representative of the batch.
2. It may be necessary to remix the concrete in the mixing pan with a shovel to prevent segregation during the molding of specimens.
3. Move the scoop or trowel a round the top edge of the mold as the concrete is discharged in order to ensure symmetrical distribution of the concrete and for minimize segregation of coarse aggregate within the mold.
4. Further distribute the concrete by use of a tamping rod prior to the start of consolidation.

Methods of Consolidation

Preparation of satisfactory specimens requires different methods of consolidation. The methods of consolidation are: a) Rodding, b) Internal vibration, c) External vibration.

- **Rodding:**

1. Place the concrete in the mold in the required number of layers of approximately equal volume .Rod each layer with the rounded end of the rod using the number of strokes.
2. Rod the bottom layer throughout its depth. Distribute the strokes uniformly over the cross-section of the mold and for each upper layer allow the rod to penetrate about 12mm into the underlying layer when the depth of the layer is less than 100mm and about (25mm) when the depth is (100mm) or more.
3. After each layer is rodded, tap the outside of the mold lightly 10-15 times with the mallet to close any holes left by rodding.

- **Vibration:**

1. The duration of vibration required will depend upon the workability of the concrete and the effectiveness of the vibrator. Continue vibration only long enough to achieve proper consolidation of the concrete.
2. Fill the molds and vibrate in the required number of approximately equal layers. Place all the concrete for each layer in the mold before starting vibration of that layer.
3. Add the final layer, so as to avoid over filling by more than (6 mm). Then finish the surface.

Finishing:

After consolidation, strike off the surface of the concrete and float or trowel it with a wood or magnesium float.

7. Curing

1. The test specimens shall be stored in a place, free from vibration, in moist air of at least 90 percent relative humidity and at a temperature of 22° ± 2°C for 24 hours ± ½ hour from the time of addition of water to the dry ingredients.
2. After this period, the specimens shall be marked and removed from the moulds and, unless required for test within 24 hours, immediately submerged in clean, fresh water or saturated lime solution and kept there until taken out just prior to test.
3. The water or solution in which the specimens are submerged shall be renewed every seven days and shall be maintained at a temperature of 22° ± 2°C. The specimens shall not be allowed to become dry at any time until they have been tested.

9.5. Data and Results

Workability Test

9.5.1. Weights

Batch= 35kg

Cement= 5.85kg

Coarse Aggregate= 14.22kg

Fine Aggregate= 10.93kg

Water= 4kg

9.5.2. Slump Test

Cone Height (cm)	Slump (cm)	Slump Type
30	4cm	True

9.5.3. Vebe Test

Time (sec) *(Vebe Seconds)*
5 sec

9.5.4. Flow Table Test

Dimensions (cm)	Readings (mm)	Diameters (mm)		$D_{f,avg}$ (mm)	Flow Factor (%)
Table 70 x 70	~~[illegible]~~ 125 160	D_{f1}	415mm	407.5	103.75%
D_o 20	200 100	D_{f2}	400 mm		

9.5.5 Compacting Factor Test

Wt. of un-compacted concrete (kg)	Wt. of compacted concrete (kg)	Compacting Factor
10.78kg	11.07	0.974

-1 ✓

Admixtures Test

9.5.6.Weights

Batch= 20kg

Cement =3.34kg

Coarse Aggregates= 8.13kg

Fine Aggregates= 6.25kg

Water= 2.248kg

Plasticizer= 1.25% of cement

Plasticizer= 1.25/100*3.34

Plasticizer= 0.042kg = 42g

9.5.7 Results

?

Admixture Type and name	Cone Height (cm)	Slump (cm)	Slump Type
super plasticizer	30	26cm	collapse

ok

9.6. Sample of Calculations

Flow Table

$Df_1 = 70 - (12.5 + 16) = \cancel{[illegible]}\ 41.5cm \rightarrow 415mm$

$Df_2 = 70 - (20 + 10) = 40cm \rightarrow 400mm$

$\Big\} \rightarrow Df_{avg} = \frac{415 + 400}{2}$

$\text{Flow factor} = \frac{Df_{avg} - 200}{200} * 100\% = 103.75\%$

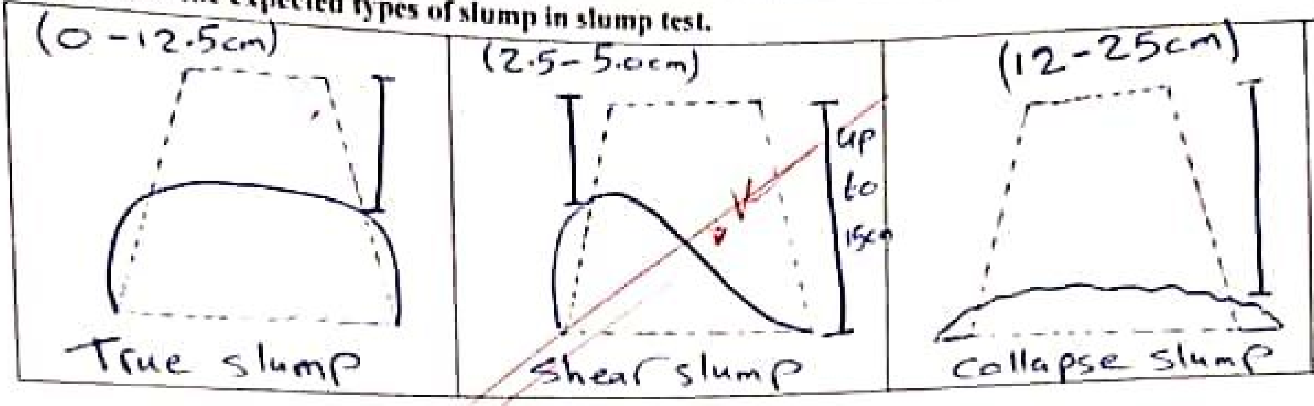
Compacting Factor $= \frac{W_{uncompacted}}{W_{compacted}} = \frac{10.78}{11.07}$

$= 0.974$

ok

9.8. Discussion

7.8.1 Draw the expected types of slump in slump test.



9.8.2 comment on the results:

1. Slump test In our experiment the slump was 4cm and according to the standards It's workability (Low) as can be seen (25-50)mm → Low workability.
- when increase ~~the~~ slump the workability will increase too
- we calculate slump from highest point.
- In slump test we make three layers in cone and Tamp each layer 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mold. For the subsequent layers, the tamping should penetrate (1-1.5 cm) into the underlying layer. we remove the cone vertically.

2. Vebe Test

In our experiment the vebe test was 5sec and according to standards ~~a~~ It's workability (High) As can be seen (3-7)sec → high workability.
- when vebe time increase the workability decrease.
- In vebe test the fresh concrete is compacted into a conical slump mould (3layers) (25 Strokes). The mold is removed and clear plastic disc is placed on the top of the concrete. The vibrating table is started and the time taken for the transparent disc to be fully in contact with concrete (the Vebe time).

3. Flow table

we using this test when the slump is collapse and we check if it has seggregation or not. in our experiment the Davg = $\frac{D_1+D_2}{2}$, As can be seen (415+400)/2 = 407.5 mm it is (medium - high) workability according to standards. ? (-1)
- when ~~t~~ flow table increase the workability also increase.
- we Fill the slump cone with concrete in two equal layers and tamp each layer 15 times with the help of wooden tamping bar then we raise the cone vertically slowly using the handles and measure the diameter of spread concrete in two dimensions parallel to the table edges.

2

4. Compacting Factor In our experiment the compacting factor was 0.974, we use the ratio of the weight of ~~t~~ partially compacted concrete to the weight of fully compacted concrete.

-1

- according the standards compacting factor (6) this is [illegible] Very High workability
- when compacting factor increase, workability increase.

5. Admixtures -1 : we add the super plasticizer to increase workability ~~whithout~~ without effect on strength of concrete. it has same density of water (Flowence SP 25)

Percentage Material	before adding (S.P) %	After ~~ad~~ adding (S.P) %
$\frac{w}{c}$ ×100%	$\frac{4}{5.25}$ ×100% = 68.376%	$\frac{2.248}{3.34}$ ×100% = 67.3%
$\frac{w}{coarse\,agg}$ ×100%	$\frac{4}{14.22}$ ×100% = 28.129%	$\frac{2.248}{8.13}$ ×100% = 27.65%
$\frac{w}{fine\,agg}$ ×100%	$\frac{4}{10.93}$ ×100% = 36.596%	$\frac{2.248}{6.25}$ ×100% = ~~54~~ 35.968%

-2

9.7.3 Source of errors

1. Errors in using timer.
2. Error in adding super plasticizer
3. Error in mixing time and the mixer
4. we use same sand for all test
5. Error in using the Apparatus.

9.10. Specifications

Degree of workability for slump test and compacting factor

Degree of Workability	Slump (mm)	Vebe Time (sec)	Compacting Factor
very low	0 – 25	20-40	0.78
Low	25 – 50	10-20	0.85
Medium	50 – 100	7-10	0.92
High	100 - 175	3-7	0.95
Very High	> 175	1-3	-

Flow Table:

500 mm High workability

400 mm Medium Workability

300 mm Low workability

96/100

Hashemite University

Faculty of Engineering

Civil Engineering Department

Materials of Construction Laboratory

Experiment No.: 10

Part.1: Concrete Strength by Non-Destructive Methods

Part.2: Concrete Strength by Destructive Methods

Student Name: حليم غسان محسن دراس

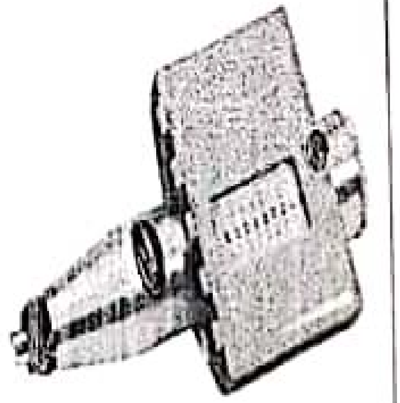
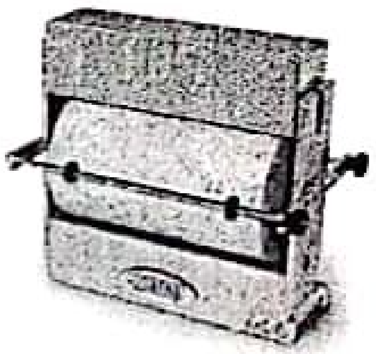
Student No.: 1732492

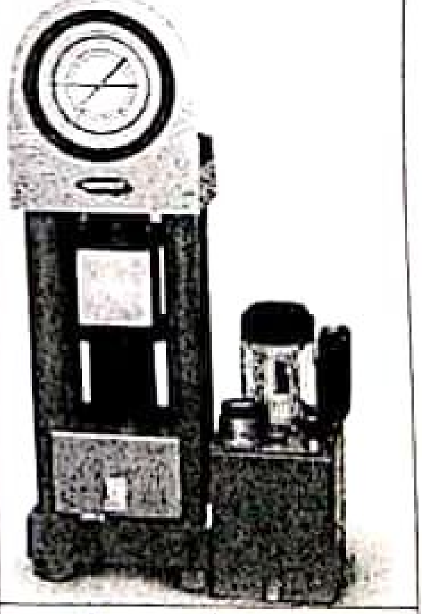
Section No.: 4

Day: الخميس

Date: 22/11/2018

0.1. Apparatus and Equipment:

Apparatus			
Name	Rebound hummar	Ultra sonic pulse velocity Machine	spliting apparatus

Apparatus			
Name	Univesal testing machine (UTM)	Automation compressive testing machine	Manual compressive testing machine

10.2 Procedure

Non-Destructive Tests

Rebound Number of Hardened Concrete

1. Firmly hold the instrument in a position that allows the plunger to strike perpendicularly to the surface tested. Gradually increase the pressure on the plunger until the hammer impacts.
2. After impact, record the rebound number to two significant figures.
3. Take ten readings from each test area. No two impact tests shall be closer together than 25 mm.

Pulse Velocity through Concrete

1. Plug the mains cable into the 3 way socket mounted on the rear panel, switch the P.S.S. to MAINS and depress the reset button to switch the PUNDIT ON.
2. Check accuracy of measurements using the reference bar.
3. Grease the surfaces of the transmitter and receiver. Use the smooth sides of the cube.
4. Turn power on.
5. Press the transducers firmly against the surfaces. Continue pressing until the time indicator gives a constant reading.
6. Record the reading in microseconds, t.
7. Measure the direct distance between the centers of the transducers locations.

Destructive Tests

Compressive Strength of Cubic Concrete Specimens

1. Take cubes from water bath and dry them to SSD.
2. Ensure that all testing machine bearing surfaces are wiped clean.
3. Carefully center the cube on the lower platen and ensure that the load will be applied to two opposite cast faces of the cube.
4. Without shock, apply and increase the load continuously at a nominal rate within the range of (0.2 N/mm2.s to 0.4 N/mm2.s) until no greater load can be sustained. On manually controlled machines, as failure is approached, the loading rate will decrease, at this stage operate the controls to maintain, as far as possible, the specified loading rate. Record the maximum load applied to each cube.
5. Observe the shape of failure.

Compressive Strength of Cylindrical Concrete Specimens

1. Remove the cylindrical samples from the curing tank and dry the surface using an absorbent cloth. Ensure that the cube is saturated surface dry.
2. Prepare the top unsmooth surface of the cylinder.
3. Load the specimen gradually and continuously at a constant rate of 9 to 21 MPa per minute.
4. Continue loading until specimen breaks. Record the load at failure, P.
5. Observe the shape of failure. Discard cylinders that show incorrect failure patterns.

Splitting Tensile Strength of Cylindrical Concrete Specimens

1. Remove the cylindrical samples from the curing tank and dry the surface using an absorbent cloth. Ensure that the cube is saturated surface dry.
2. Determine the length of the cylinder by taking at least two measurements. Record the average as the length of the sample.
3. Position the cylinder in the testing machine between the two plywood strips. Make sure that the cylinder in the correct position of the marked planes drawn in step one.
4. The bearing strips are placed between the specimen and both upper and lower bearing blocks of the testing machine or between the specimen and the supplemental bars or plates.
5. Place the specimen on the plywood strip and align so that the lines marked on the ends of the specimen are vertical and centered over the plywood strip.
6. Place a second plywood strip lengthwise on the cylinder, centered on the lines marked on the ends of the cylinder.
7. Apply the load continuously and without shock, at a constant rate within, the range of 689to 1380kPa/min splitting tensile stress until failure of the specimen.
8. Record the maximum applied load indicated by the testing machine at failure. Note the type of failure and appearance of fracture.

Flexural Strength of Concrete Specimens

1. The bearing surfaces of the supporting and loading rollers shall be wiped clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with the rollers.
2. The specimen shall then be placed in the machine in such a manner that the load shall be applied to the uppermost surface as cast in the mould, along two lines spaced 20.0 or 13.3 cm apart.
3. The axis of the specimen shall be carefully aligned with the axis of the loading device. No packing shall be used between the bearing surfaces of the specimen and the rollers.
4. The load shall be applied without shock and increasing continuously at a rate such that the extreme fibre stress increases at approximately 7 kg/sq cm/min, that is, at a rate of loading of 400 kg/min for the 15.0 cm specimens and at a rate of 180 kg/min for the 10.0 cm specimens.
5. The load shall be increased until the specimen fails, and the maximum load applied to the specimen during the test shall be recorded. The appearance of the fractured faces of concrete and any unusual features in the type of failure shall be noted.

10.3. Data and Calculations

10.3.1. Non –Destructive Tests

10.3.1.1. Pulse Velocity

Reading #	1	2	3	4	5	6	7	8
T (μsec)	23	22	22.5	21.7	21.5	22	22.3	21

$T_{(avg)} = \frac{23+22+22.5+21.7+21.5+22+22.3+21}{8} = 22\ \mu sec$

$V_{(avg)} = \frac{L}{T_{avg}} = \frac{10*10^{-2}}{22*10^{-6}} = 4545.45\ m/sec = 4.545\ km/sec$

σ_{avg} (Mpa)= 36 Mpa

σ_{range} (Mpa)= (32 – 40) Mpa

} → from chart

10.3.1.2. Rebound Number → based on Impact resistance

Reading #	1	2	3	4	5	6	7	8	9	10
Re #	19	16	19	19	19	17	17	16	19	18

$Re_{(avg)} = \frac{19+16+19+19+19+17+17+16+19+18}{10} = 17.9$

$Re_{(range)} = Re_{(avg)} \pm 6 = (11.9 - 23.9)$

$Re_{(new\ avg)} = (11.9 - 23.9) \Rightarrow$ all values are accepted

σ_{avg} (Mpa)= 5 Mpa

σ_{range} (Mpa)= (0 – 12.5) Mpa

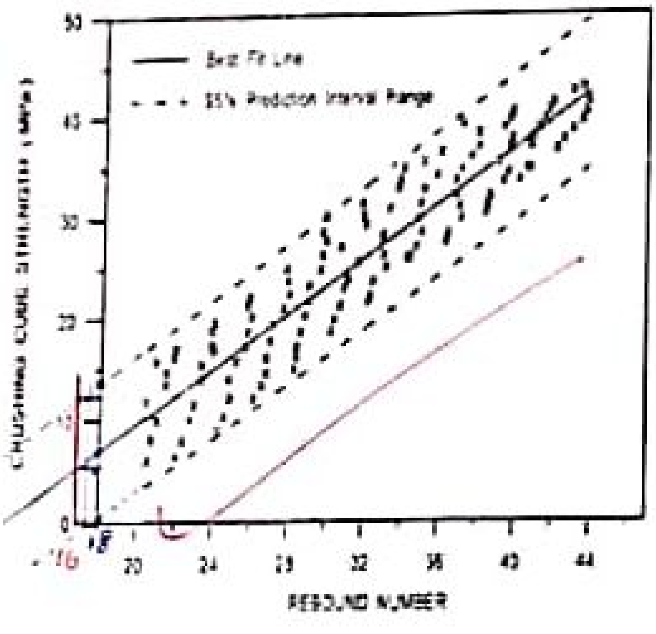


Fig. 1. Relationship between rebound number and crushing cube strength.

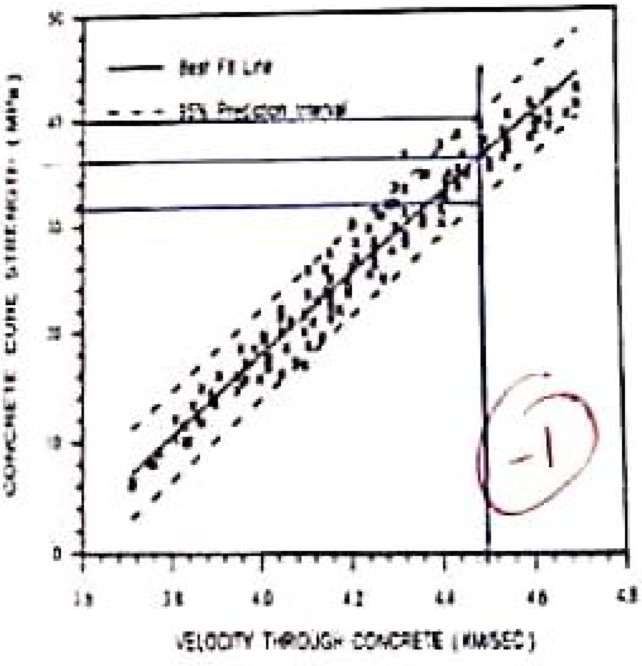


Fig. 2. Relationship between ultrasonic pulse velocity and crushing cube strength.

10.3.2. Destructive Tests

10.3.2.1. Compressive Strength

A.cubes

Dim.: 10*10*10 cm → standard

P = 68.7 KN

σ (Mpa) = $\frac{P}{A} = \frac{68.7 * 10^3 N}{100 * 10^{-4}} = 6.87$ Mpa

B.cylinders

Dim.: 10*20 cm → standard

P = 150 KN

σ (Mpa) = $\frac{P}{A} = \frac{150 * 10^3}{\frac{\pi}{4}(100 * 10^{-3})^2} = 19.098$ Mpa

10.3.2.2. Tensile Strength

A.Split

Dim.: 10*20 cm

P = 100 KN

σ (Mpa) = $\frac{2P}{\pi DL} = \frac{2 * 100 * 10^3}{\pi * 0.1 * 0.2} = 3.183$ Mpa

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* $\sigma(\text{splitting}) = 1.1\ \sigma(\text{direct})$

* $\sigma(\text{flexural}) = (1.15 - 1.25)\ \sigma(\text{direct})$

* $\sigma(\text{flex}) = 0.7 \sqrt{\sigma_{comp\ cyl}}$

* $\sigma_{ta} = \left(\frac{1}{7} - \frac{1}{11}\right) \sigma\ comp$ $\approx \frac{1}{10}$

* $\sigma_{\substack{comp \\ (cube)}} = (1.5 - \underset{\approx}{1.25})\ \sigma_{\substack{com \\ (cyl)}}$

B.Flexural

Dim.: 10*10*40 cm

2 Point Load = 11 KN

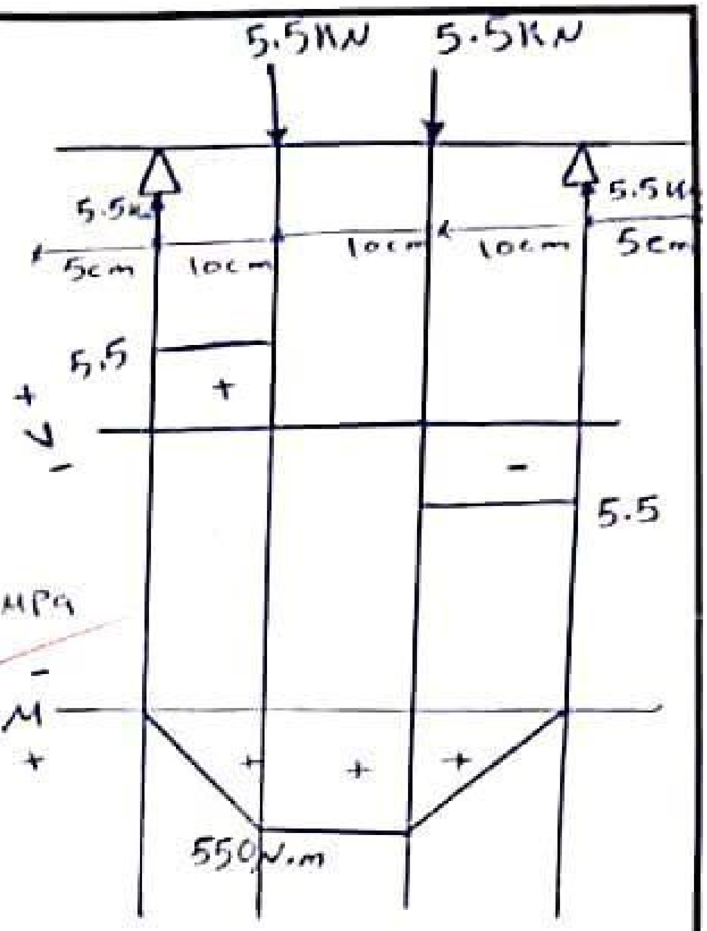
P= 5.5KN

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

$I = \frac{bh^3}{12} = \frac{0.1*(0.1)^3}{12} = 8.33*10^{-6} m^4$

$M = 5.5 * 10^3 * 10*10^{-2} = 550 N.m$

$\sigma = \frac{Mc}{I} = \frac{550*0.05}{8.33*10^{-6}} = 3.301 MPa$



1 point Load = 11kN

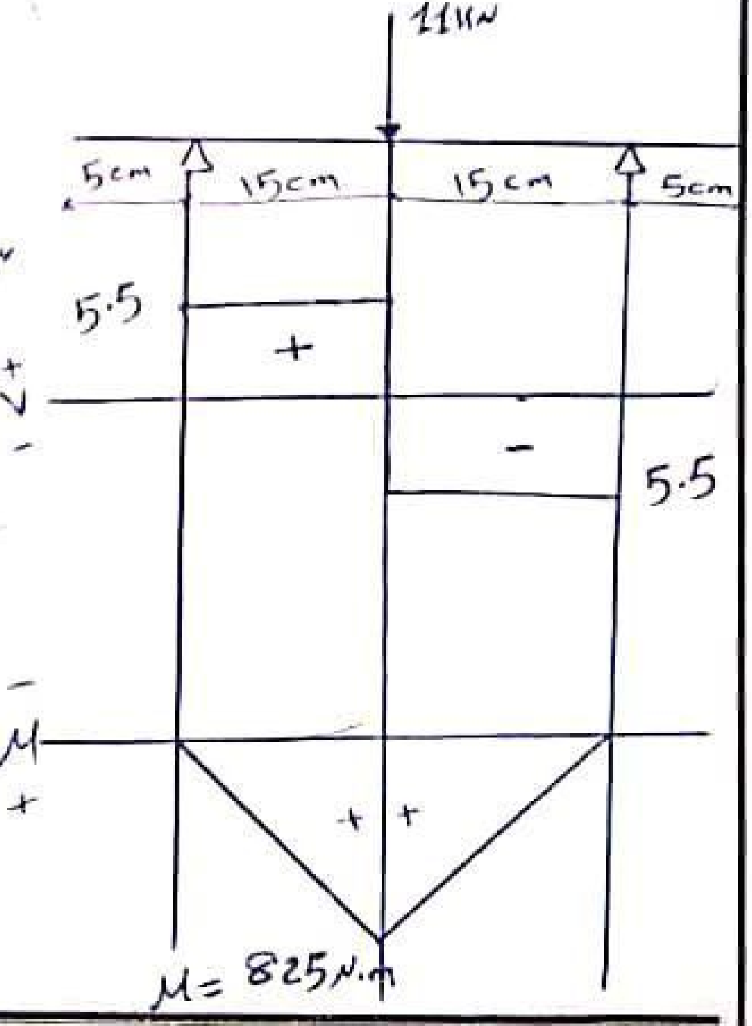
$C = \frac{h}{2} = \frac{0.1}{2} = 0.05$

$I = \frac{bh^3}{12} = \frac{(0.1)(0.1)^3}{12} = 8.33*10^{-6} m^4$

$M = \frac{P}{2} * A = \frac{11*10^3}{2} * 15*10^{-2} = 825 N.m$

$\sigma = \frac{Mc}{I} = \frac{825 x 0.05}{8.33*10^{-6}}$

$\sigma = 4.952 MPa$



10.4. Discussion

10.4.1. Non-Destructive Tests

1) Error% of Rebound Number Test

Re # : σ_{avg} = 5 MPa

compressive : σ_{avg} = 6.87 MPa

$\frac{|6.87-5|}{6.87} * 100\% = Error\%$

$\boxed{27.219\% = Error\%}$

2) Error% of Pulse Velocity Test

pulse Velocity : σ_{avg} = 36 MPa

Compressive : σ_{avg} = 6.87 MPa

$Error\% = \frac{|6.87-36|}{6.87} * 100\%$ = ~~424~~ $\boxed{424.017\%}$

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

pulse velocity test is more accurate than Rebound, because the pulse velocity have less Personal errors than the rebound number

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

to remove dust, because the dust will make air
bubles between transmitter and receiver and between
the sample, and the speed in Air will be less than in thesp
which gives as indecation that the concrete we used is

ok

10.4.2. Destructive Tests

1) Fill the following table

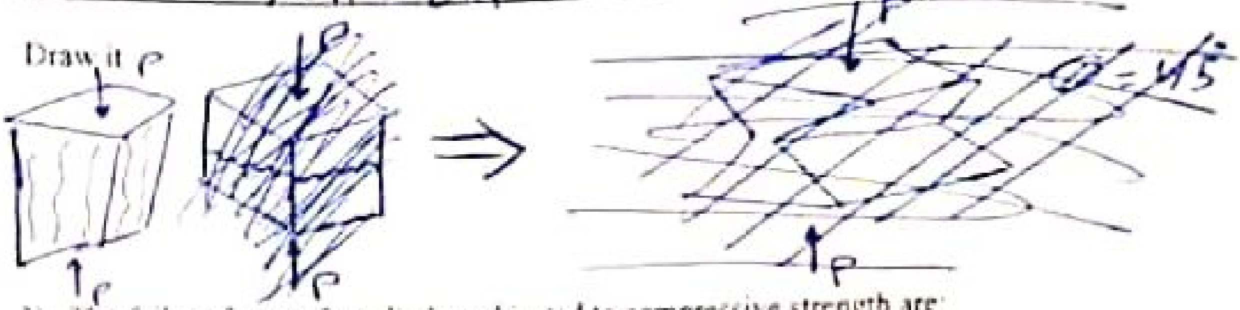
	Experimental Results	Standards	Accepted or Not
$\frac{\text{Compressive Strength of Cube}}{\text{Compressive Strength of Cylinder}}$	$\frac{6.87}{3.18} = 2.16$	1.25	not accepted
Direct Tension (MPa)	$0.9 * \sigma_{spiliting}$ $0.9 * 3.183 = 2.862$ MPa	$\frac{\sigma_{direct}}{\sigma_{spiliting}} = 0.9$	—
$\frac{\text{Compressive Strength of Cube}}{\text{Direct Tension}}$	$\frac{6.87}{2.862} = 2.4$ MPa	(7 − 11)	Not accepted
$\frac{\text{Flexural Strength (2P)}}{\text{Splitting Strength}}$	$\frac{3.3}{3.18} = 1.038$	(1.1 − 1.5) (−1)	Not accepted
$\frac{\text{Flexural Strength (1P)}}{\text{Flexural Strength (2P)}}$	$\frac{4.95}{3.3} = 1.5$	1.5	accepted

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

a) Non-Explosive Failure b) Explosive failure

And our case is Non-Explosive Failure

Draw it

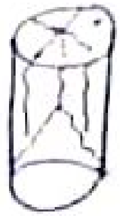


3) The failure forms of a cylinder subjected to compressive strength are:

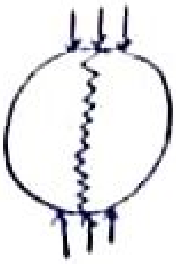
a) split Failure b) shear Failure c) shear and split

And our case is shear and split

Draw it

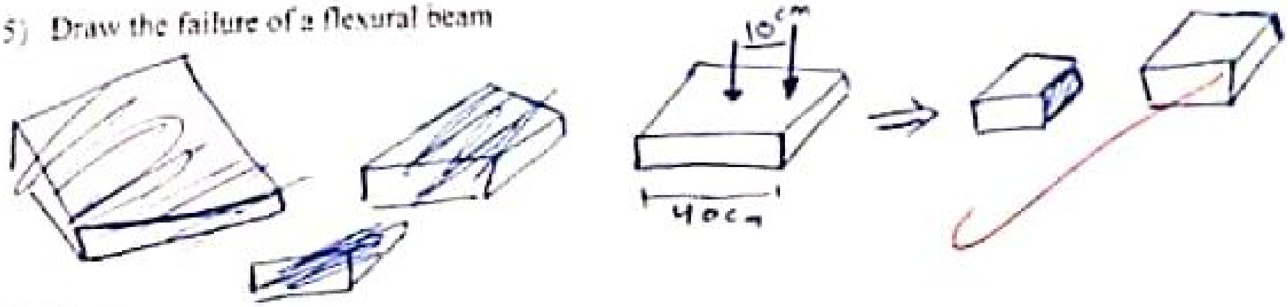


4) Draw the failure of a cylinder subjected to splitting Load



-1

5) Draw the failure of a flexural beam

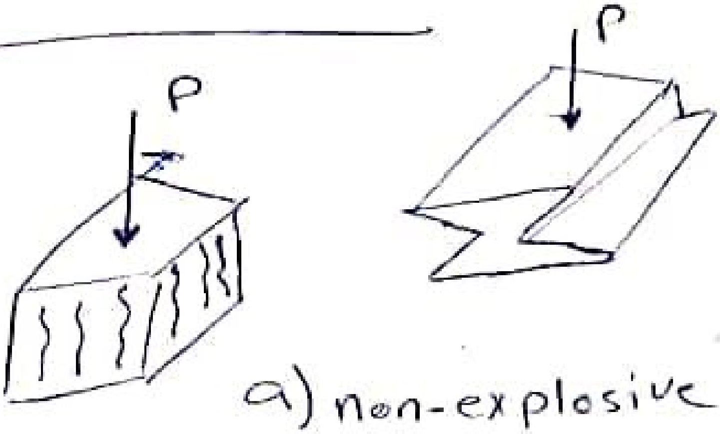


6) Errors

✓ When we used ~~the~~ the rebound hammer some of the hit were slated.

✓ ~~The~~ Error in using machines.

Fracture shape :-

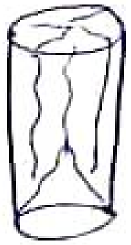


a) non-explosive

b) explosive

a) splitting

b) shear



c) shear and splitting