New 2018

Civilittee

اللجنة الأكاديمية للهندسة المدنية

تقارير

مختبر مواد البناء

Contact us :

Civilittee HU | لجنة المدني

Civilittee Hashemite

www.civilittee-hu.com

Building Materials Laboratory

Experiment No.: 1

Normal Consistency
and Setting time of hydraulic cement

Name	Mark
سجود اسماعيل الحيد السعود	99/100

Student's number	Section number	Experiment day and date	Submission day and date
1732436	1	Sunday 27/1/2019	Sunday 3/2/2019

Experiment 1

Normal Consistency and Setting time of hydraulic cement

1.1. Objective

Determine the Normal consistency and Setting time
Determine the IST of cement from the experiment and the FST from equation (FST = 90 + 1.2IST), and to test cement quality.

1.2. Apparatus and Equipments

Named each Part in the apparatus below

(1): Base plate

(2): Conical mold

(3): 1mm needle

(4): 10 mm rod

(5): Scale

The Apparatus name is Vicat apparatus

Another Apparatus and Equipments:

mixer, Bowl, Gillmore, timer, Sharp edged trowel

Gloves, Container, Graduated cylinder, Vicat apparatus

ok

1.3. Materials

Cement

Water

1.4. Theory

1.4.1. Normal Consistency

The standard consistency of a cement paste is defined as the water to cement ratio which will permit a Vicat rod having 10 mm diameter and 50 mm length to settles to a point 10±1 mm below the original surface of the mould in 30 sec after being released.

1.4.2. Initial and Final Setting Time

I.S.T: The period elapsing between the time when water is added to the cement and the time at which the 1 mm needle settles to a point 25 mm below the original surface of the mould.

F.S.T: The period elapsing between the time when water is added to the cement and the time at which the 1 mm needle does not sink visibly into the paste.

Note: According to ASTM C150
Initial time of setting, not less than 45 min.
Final time of setting, not more than 375 min (6.25 hr).

1.5. Procedure

1.5.1. Normal Consistency

1- Place the dry paddle and the dry bowl in the mixing position in the mixer.
2- Place all the mixing water in the bowl.
3- Add the cement to the water and allow 30 s for a absorption of the water.
4- Start the mixer at low speed for 30 s
5- Stop for (15 s) and make sure no materials have collected on the sides of the bowel.
6- Start mixing at medium speed for (1 min).
7- Quickly form the cement paste into the approximate shape of a ball with gloved hands
8- Putting hand at (15cm) distance, throw the cement paste ball from hand to hand six times.
9- Press the ball into the larger end of the conical ring; completely fill the ring with paste.
10- Remove the excess at the larger end by a single movement of the palm of the hand. Place the ring on its larger end on the base of the plate of Vicat apparatus.
11- Slice off the excess paste at the smaller end at the top of the ring by a single sharp- ended trowel and smooth the top. (Take care not to compress the paste).
12- Center the paste under the plunger end which shall be brought in contact with the surface of the paste, and tighten the set-screw.
13- Set the movable indicator to the upper zero mark of the scale or take an initial reading, and release the rod immediately. This must not exceed 30 seconds after completion of mixing.
14- The paste shall be of normal consistency when the rod settles to a point 10±1mm below the original surface in 30 seconds after being released.
15- Make trial paste with varying percentages of water until the normal consistency is obtained. Make each trial with fresh cement.

1.5.2. Initial and Final Setting Time

1- Weigh (650) gm cement.
2- Prepare amount of water as to that calculated in normal consistency test.
Prepare a cement paste following same steps mentioned in the previous test (Normal consistency). Place in Vicat conical ring like the previous test. Don't forget to record the time since the cement is added to the water.
3- Allow the time of setting specimen to remain in the moist cabinet for 30 minutes after molding without being disturbed. Determine the Penetration of the 1mm needle at this time and every (15) minutes until a penetration of 25mm or more is obtained
4- To read the penetration, lower the needle of Vicat Apparatus until it touches the surface of the cement paste. Tighten the screw and take an initial reading. Release the set screw and allow the needle to settle for 30 seconds, and then take the reading to determine the penetration.

5- Note that no penetration shall be made closer than (6mm) from any previous penetration and no penetration shall be made closer than (9.5mm) from the inside of the mold. Record the results of all penetration, then by drawing a curve determine the time when a penetration of 25 mm is obtained. This is the initial setting time

6- The final setting time is when the needle does not sink visibly into the paste.

☒ Temperature and Humidity

The temperature of air in the vicinity of the mixing slab, the dry cement, mold, and base plates shall be maintained between (20 – 27.5)°C. The temperature of mixing water shall be 23±2 °C.

The relative humidity of the laboratory shall be not less than 50%.

1.6. Data and Calculations

1.6.1. 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.)
188.5	29	6	0.778
195	30	14	1.146
201.5	31	19	1.278

- Draw w/c% versus Log (penetration); Figure 1.1.
- From this curve (w/c% versus Log (pent.)), the normal consistency is 29.7%

1.6.2. Initial and Final Setting Time

Wt. of Cement = 650 g W/C% = 29.7% Water = 193.05 g

Table 1.2: variation of penetration with time

Time (min)	Penetration (mm)
15	40
30	38
45	35
60	32
75	30
90	26
105	21

- Draw the penetration versus time; Figure 1.2.
- From this curve (pent. versus time), initial setting time is 93.75 min
- Calculate/Find the Final setting time (using the three different ways; equations and graphically)

1. from the Curve (Figure 1.2) ≈ 142 min
2. FST = 1.2 IST + 90 min = (1.2 * 93.75 + 90) = 202.5 min
3. FST = 1.5 IST + 45 min = (1.5 * 93.75 + 45) = 185.625 min

1.7. Discussion

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

It's direct relationship in table [1.1] when the w/c ratio increase the penetration also increase. proof for that, w/c ratio was 29% when the penetration was 6mm and w/c ratio was 31% when the penetration was 19mm.

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

we knew that the normal consistancy and it was 29.7% So, we realised there is a direct and linear relationship between them.

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

We can see that when we increase time the penetration will decrease. proof for that at time «15» the penetration was «40mm» and at time «30» the penetration was «38 mm».

- Discuss figure1.2. (penetration versus time)

we can realise that the relationship between the penetration and time is inverse and non-linear.

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

The value 29.7% is accepted for reason that the standard N.C specify in ASTM is (26-33)%

- The initial setting time is accepted or not and why? It was 93.75 min and this time is accepted because the standard IST should be greater than or equal 45 min (IST ≥ 45min) when we used vicat apparuts according to (ASTM)

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

The FST is (202.5 min) (≈ 3hours) from equation (FST = 1.2IST + 90min), in ASTM when vicat apparuts used (FST < 6.25) So it's accepted.

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

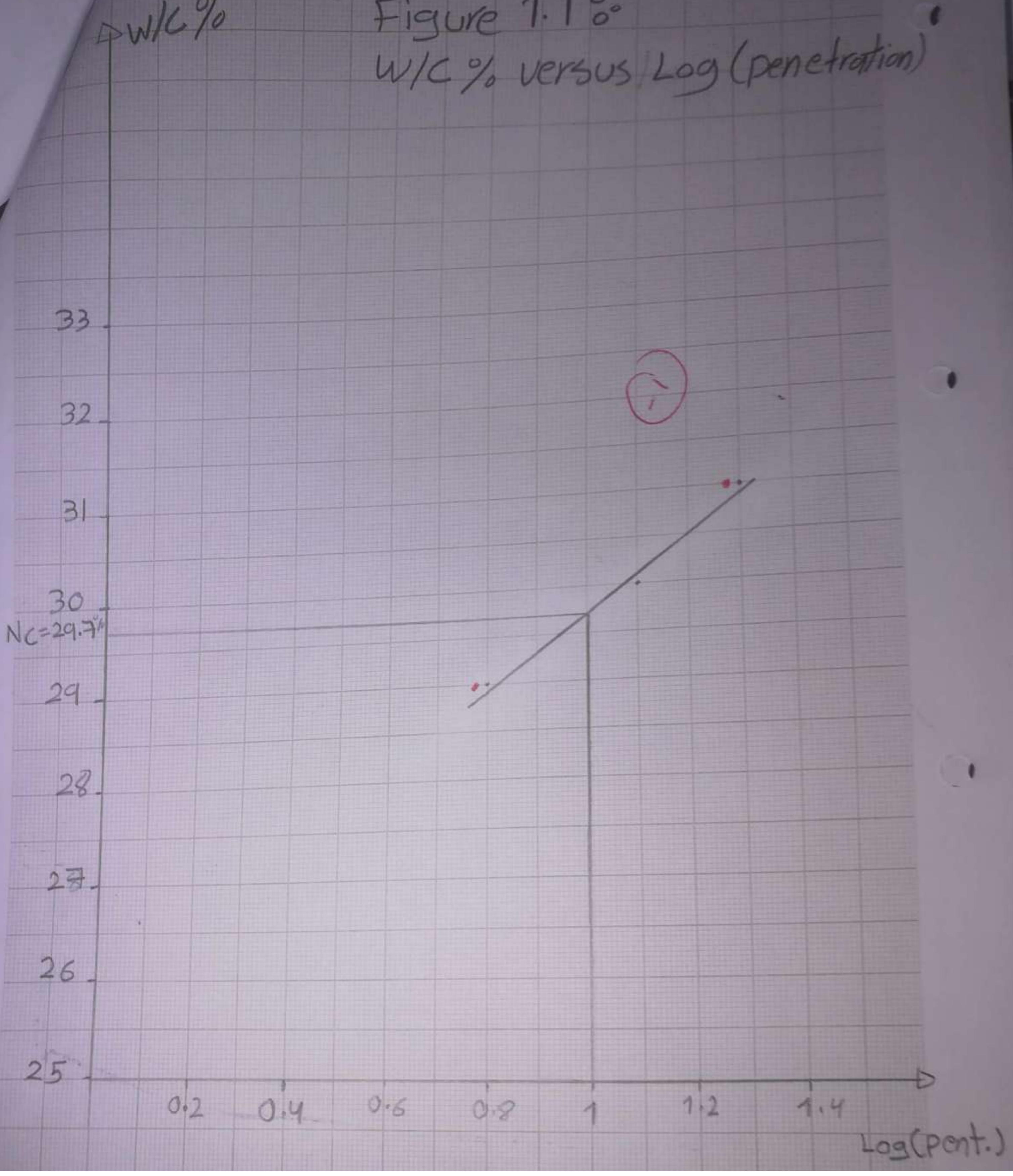
It can be used in the construction because the value of [NC, IST, FST] are accepted according the ASTM.

- Error sources:

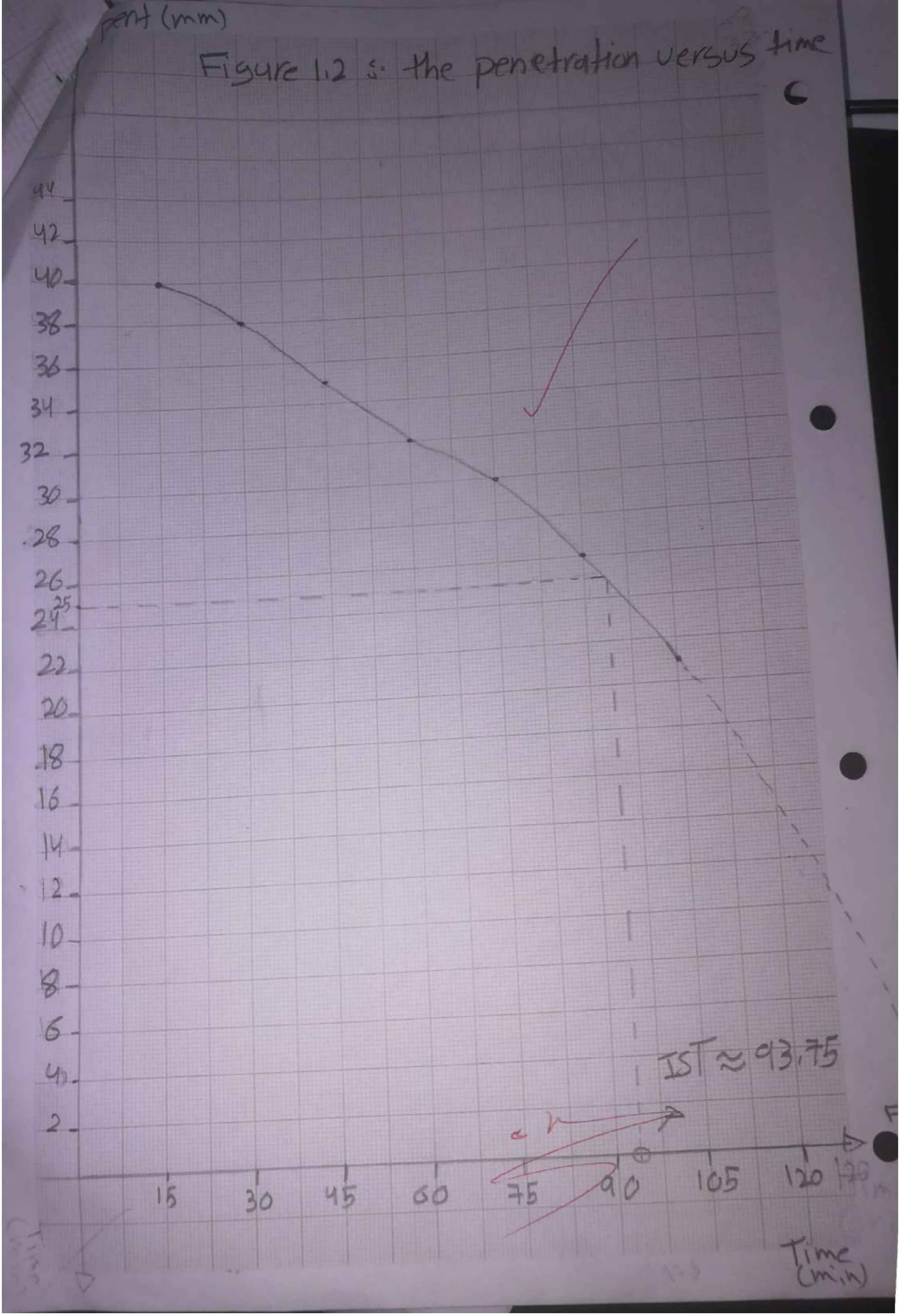
1- The cement paste was thrown less than six times.
2- Mistake when using the mixer.
3- The container was wet after wishing it.

1.8. Remember to make your report tidy and neat ☺

Figure 1.1 :
W/C % versus Log (penetration)



Scanned by CamScanner



Scanned by CamScanner

Building Materials Laboratory

Experiment No.: 2

Compressive and Tensile Strength
of Cement Mortar

Name	Mark
سجود اسماعيل الحميد السعود	91/100

Student's number	Section number	Experiment day and date	Submission day and date
1732436	1	Sunday 3/2/2019	10/2/2019 Sunday

Experiment 2

Compressive and Tensile Strength of Cement Mortar

2.1. Objectives

To determine the compressive and tensile strength of cement mortar, determine the quality of cement (if it accepted to used or not) and to calculate the strength of mortar in the Tension and compressive Test.

2.2. Apparatus and Equipment

- Trowel
- container
- Mixer, Timer
- Graduated glass (cylinder)
- Gloves
- Compression Test machine
- Briquite mold (25x25) mm
- Automatic Flexural tensile tester
- cubic mold (50x50) mm
- Bowl, paddle

2.3. Materials

- Cement (ordinary portland cement)
- water
- Sand (ottawa)

2.4. Theory

2.4.1. Compressive strength test

- The compressive strength of cement mortar can be calculated as follows:

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

  Where:
  σ: compressive strength [psi or MPa]
  P: total maximum load [Ibf or N], and
  A: area of loaded surface [in^2 or mm^2];
  [2in or 50mm] Cubic specimen

  - The maximum permissible range between specimens from the same mortar batch, at the same test age is 8.7% of the average strength. [$\sigma_{range} = \sigma_{average} \pm 0.1\ \sigma_{average}$]
  - Discard the result which lies out of the range then compute the average of the remaining specimens. Make a retest of the sample if less than two specimens remain after discarding faulty specimens.

- To convert from mortar compressive strength to concrete compressive strength, use this equation; if the mortar and the concrete have same age, same w/c ratio and made from same cement type:

  $$Y = 0.004\ X^2 + 1.3\ X$$

  Where:
  Y: Compressive strength of concrete (MPa)
  X: Compressive strength of mortar (MPa)

2.4.2. Tensile strength test

The tensile strength of cement mortar can be calculated as follows:

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

Where:
σ: tensile strength [psi or MPa]
P: total maximum load [Ibf or N], and
A: area of loaded surface [in^2 or mm^2]
[1in×1in] or [25mm×25mm] Briquet specimen

- Briquets that give strengths differing by more than 15% from the average value of all test briquettes made from the same sample and tested at the same period, shall not be considered in determining the tensile strength. [$\sigma_{range} = \sigma_{average} \pm 0.15\ \sigma_{average}$]
- Discard the result which lies out of the range then compute the average of the remaining specimens. Make a retest of the sample if less than two specimens remain after discarding faulty specimens.

2.5. Procedure

2.5.1. Compressive strength test

2.5.1.1. 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.

2.5.1.2. 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).

2.5.1.3. 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.

.5.2. Tensile strength Test

2.5.2.1. 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)

2.5.2.2. 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).

2.5.2.3. 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.

2.6 Data and Calculations

2.6.1. Compressive strength → Table 1.1

Cement Type: Modified Portland cement (II)

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	27.2	10.88	13.386	12.05-14.72	No	14.64
	36.5	14.6			yes	
	36.7	14.68			yes	
7	47.3	18.92	20.96	18.864-23.05	yes	19.72
	51.3	20.52			yes	
	58.6	23.44			No	
28	75.7	30.28	29.026	26.12-31.93	yes	30.96
	62.9	25.16			No	
	79.1	31.64			yes	

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

at 7 days ⇒ (1) $\sigma_1 = \frac{47.3 * 10^3}{2.5 * 10^{-3}} = 18.92$ Mpa

$\sigma_2 = \frac{51.3 * 10^3}{2.5 * 10^{-3}} = 20.52$ Mpa

$\sigma_3 = \frac{58.6 * 10^3}{2.5 * 10^{-3}} = 23.44$ Mpa

(3) σ_1 accepted ✓

σ_2 accepted ✓

σ_3 Not accepted ✗

(2) $\sigma_{average} = \frac{20.52 + 18.92 + 23.44}{3} = 20.96$ Mpa

average range = 18.864 - 23.05 ⇒ from accepted avg = $\sigma \pm 0.1\ \sigma_{avg}$

(4) Accepted avg strength, σ_1 ✓, σ_2 ✓

$= \frac{\sigma_1 + \sigma_2}{2} = \frac{18.92 + 20.52}{2} = 19.72$ Mpa

give just a sample

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

$y = 0.004X^2 + 1.3X$

$\sigma_{28days} = 0.004(30.96)^2 + 1.3(30.96)$

$\sigma_{28days} = 44.08$ Mpa

.6.2. Tensile strength

Cement Type: Modified Portland cement (II) Table 7.2

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	788	1.2608	1.194	1.01-1.37	yes	1.194
	707	1.1312			yes	
	745	1.192			yes	
7	1148	1.8368	1.909	1.62-2.19	yes	1.909
	1283	2.0528			yes	
	1150	1.84			yes	
28	1249	1.9984	1.712	1.45-1.96	No	1.88
	787	1.2592			No	
	1175	1.88			yes	

- Sample of calculations: $A = 25*25*10^{-6} = 625*10^{-6}$

at 28 days ⇒

$\sigma_1 = \frac{1249}{625*10^{-6}} = 1.9984$ Mpa

$\sigma_2 = \frac{787}{625*10^{-6}} = 1.2592$ Mpa

$\sigma_3 = \frac{1175}{625*10^{-6}} = 1.88$ Mpa

* accepted range = 1.45-1.96

from eqe ⇒ $\sigma_{avg} \pm 0.15\, \sigma_{avg}$

$\sigma_{avg} = \frac{1.9984+1.2592+1.88}{3}$

$\sigma_{avg} = 1.712$ Mpa

σ_1 ⇒ Not accepted X

σ_2 ⇒ Not accepted X

σ_3 ⇒ accepted ✓

* accepted Avg strength

$\frac{1.88}{1} = 1.88$ Mpa

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

2.7. Discussion

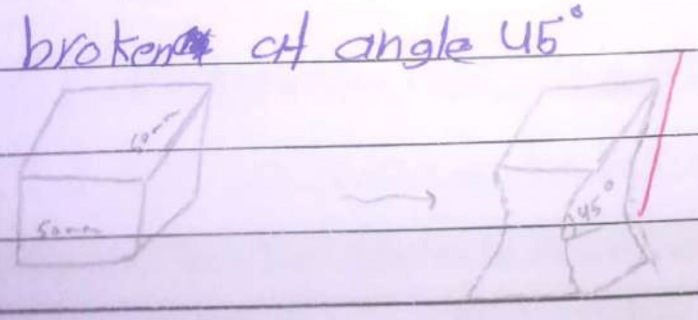
* compressive test :- It was noticed from table (1.1) that the strength increases with progress of days in the cement mortar. As a result of the curve between the compressive strength with days was observed that the Relation is direct and non-linear. As Follows :-

* Rate of strength along this Age (3-28) days In the First three days the cement mortar is very week. During the period from (3-7) days the strength of cement mortar is getting so Fast and the strength will be suitable in this case. Next, the degree of strength continuous from (28) days. However the slow speed that reachs it's strength equal to 30.96 Mpa.

* It was noticed also that the relation is direct and nonlinear in Tensile test. Due to curve (B) the strength of tensile is getting high slowly cuasing small value from 3days to 28day.

* Tensil Test Briquite mold will be broken at angle 90°

* compressive test cube of cement mortar will be broken at angle 45°



We can noticed from the table (2.7) that the value of accepted average strength [crossed out] (14.64 Mpa) at 3 days is larger than the value in ASTM and It is equal «10», So we can sayed that value (14.64 Mpa) accepted according the ASTM etc..

- From the tensile strength table (2) we can see that all valeue of accepted Average strength is accepted at 3 days and 7 days [crossed out] because It larger than the value of strength in the ASTM but at the value (1380 kPa) at 27 days isn't accepted according the ASTM.

We also [crossed out] realised that the accepted of the strength in compression is larger than accepted of strength in Tensile.

⇒ After All this notes we can sayed that the cement isn't accepted.

$$\frac{\sigma_{average\ com}}{\sigma_{avery\ ten}} = \frac{30.96}{1.88} = 16.46$$

Errors:

1] The sand isn't standard « ottawa sand »
2] The rod isn't standard
~~3] Temperature of water is Not standard (Not 23 ±2°)~~
4] Use a wood hammer and hit less than 32.

2.8. Remember to make your report...

5] The sample was wet when we used the compressive test machine

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)

Days	Accepted Avg Strength (MPa)	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	14.64 MPa	3	12.0 (1740)	10.0 (1450)	10.0 (450) ✓	8.0 (1160)	24.0 (3480)	19.0 (2760)	–	8.0 (1160)
7	19.72 MPa	7	19.0 (2760)	16.0 (2320)	17.0 (2470) ✓	14.0 (2030)	–	–	7.0 (1020)	15.0 (2180)
28	30.96	28	28.0ª (4060)	22.0ª (3190)	28.0ª (4080) ✓	22.0ª (3190)	–	–	17.0 (2470)	21.0 (3050)

cement morter type ((II)) Modified portland Cement

* 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

ª Optional

According to ASTM the value of Accepted avg strength (14.64 MPa) at the First 3 days is accepted according the ASTM

the value of Accepted avg strength (19.72) from (3-7) days is accepted according ASTM

the value of Accepted avg strength (30.96) " (7-28) " is accepted " "

CRD-C 260-01

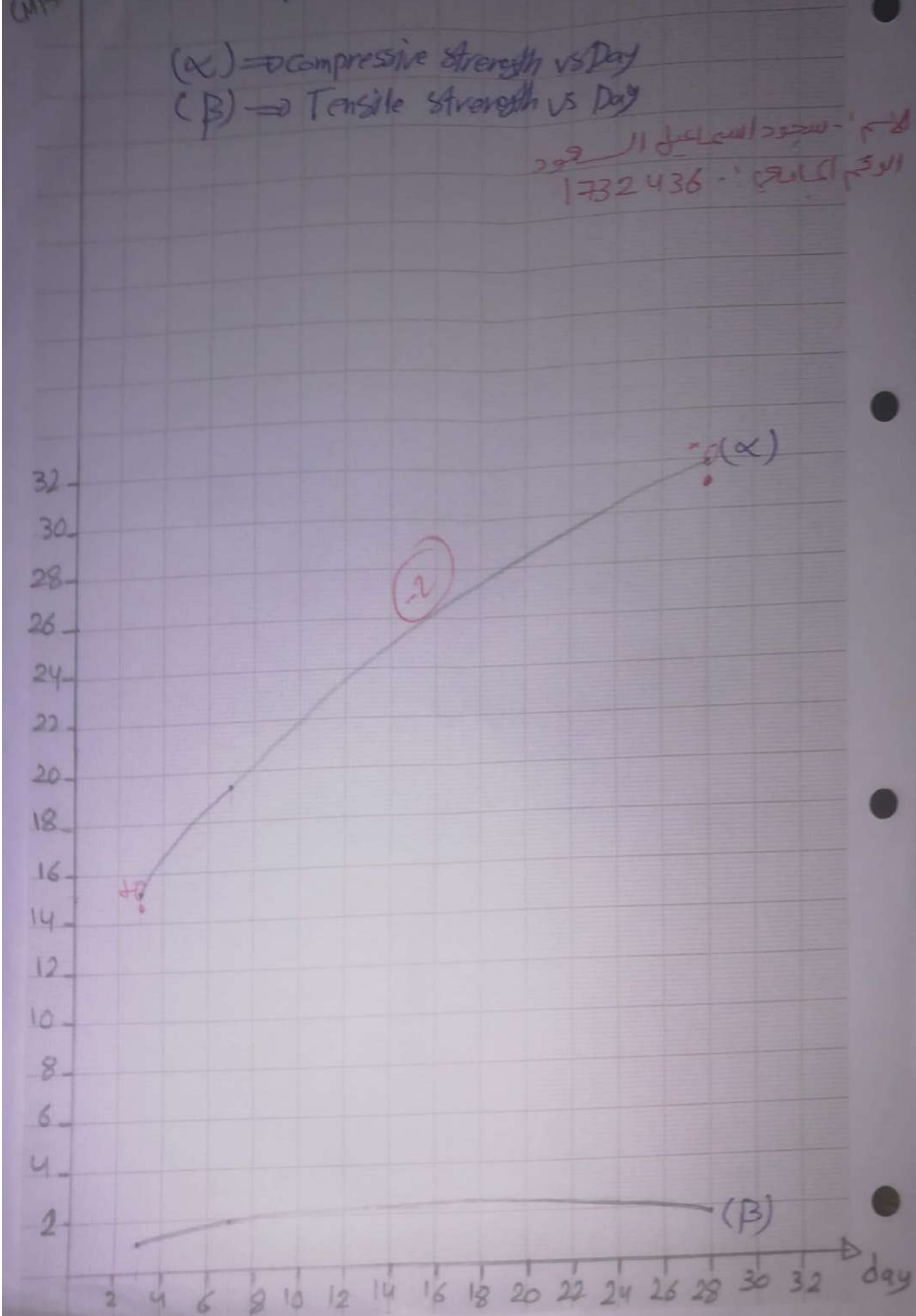
Table 2 Tensile Strength[A]

Accepted Avg Strength (kPa)		Cement Type I	II	III	IV	V
	1 day in moist air, psi (kPa)	. . .	. . .	275 (1896)	. . .	. . .
1994	1 day in moist air, 2 days in water, psi (kPa)	150 (1034)	125 (862) ✓	375 (2586)	. . .	. . .
1909	1 day in moist air, 6 days in water, psi (kPa)	275 (1896)	250 (1724) ✓	. . .	75 (1207)	250 (1724)
1880	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.

Figure(1.1)

« compressive and Tensile strength vs Time Day »



مختبر مواد البناء / التجربة الثالثة / شعبة 1 (الأحد)

Building Materials Laboratory

Experiment No.: 3

Tensile Strength of Steel

Name	Mark
Sujoud Ismail Al-Soud	86 / 100

Student's number	Section number	Experiment day and date	Submission day and date
1732436	1	Sunday 11/2/2019	Sunday 17/2/2019

Experiment 3

Tensile Strength of Steel

3.1. Objectives

To calculate The tensile and strain for steel by using universal testing mashine (UTM) and 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 Equipment

~~Universal testing [illegible]~~

- Universal testing machine (UTM)
- meter
- ~~[illegible]~~
- Computer software special for (UTM)
- Balance

3.3. Materials

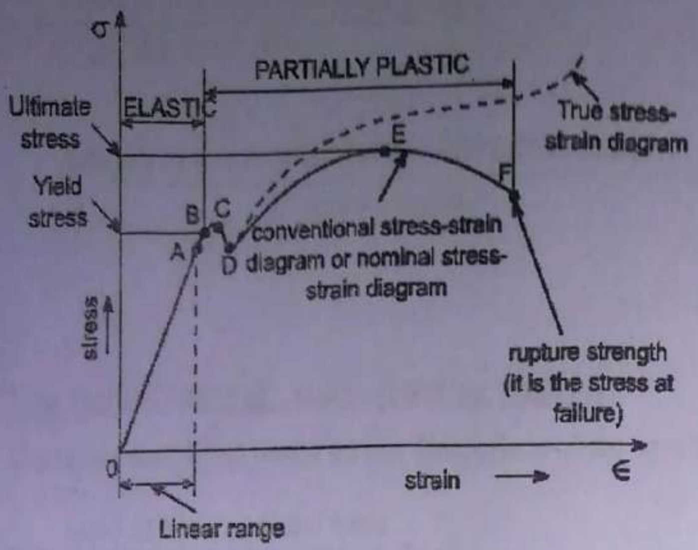
steel rod

3.4. Procedure

1. Check the specimen dimensions, measure the diameter or width, thickness of the specimen and compute the cross-sectional area and measure the gauge length.
2. Tight the specimen at the grippes located at the machine.
3. Calibrate the machine in such a manner that the extension and load are set to zero.
4. Choose a suitable loading rate.
5. Apply the tension load on the specimen until failure.
6. Obtain the load-deformation curve from the machine.

3.5. Theory

A typical tensile test curve for the mild steel has been shown below



A: Proportional Limit

B: Elastic Limit

C: Upper yield point

D: lower yield point

E: Ultimate stress

F: Rupture point

Nominal stress – Strain OR Engineering Stress – Strain diagrams:

Stresses are usually computed on the basis of the original area of the specimen; such stresses are often referred to as Engineering or nominal stresses.

True stress – Strain Diagram:

Since when a material is subjected to a uniaxial load, some contraction or expansion always takes place. Thus, dividing the applied force by the corresponding actual area of the specimen at the same instant gives the actual stresses so called true stress.

POINTS OF THE GRAPH:

(A) So it is evident form the graph that the strain is proportional to strain or elongation is proportional to the load giving a straight-line relationship. This law of proportionality is valid up to a point A. or we can say that point A is some ultimate point when the linear nature of the graph ceases or there is a deviation from the linear nature. This point is known as *the limit of proportionality or the proportionality limit.*

(B) For a short period beyond the point A, the material may still be elastic in the sense that the deformations are completely recovered when the load is removed. The limiting point B is termed as *Elastic Limit.*

(C) and (D) - Beyond the elastic limit plastic deformation occurs and strains are not totally recoverable. There will be thus permanent deformation or permanent set when load is removed. These two points are termed as *upper and lower yield points* respectively. The stress at the yield point is called the yield strength. For grade 40 the yield stress is 275MPa (40ksi) at least and for grade 60 is 415MPa (60ksi) at least.

(E) A further increase in the load will cause marked deformation in the whole volume of the metal. The maximum load which the specimen can with stand without failure is called the load at the ultimate strength. The highest point 'E' of the diagram corresponds to *the ultimate strength of a material.* For grade 40 the ultimate stress is 380MPa (55ksi) at least and for grade 60 is 520MPa (75ksi) at least.

(F) Beyond point E, the bar begins to forms neck. The load falling from the maximum until fracture occurs at F. Beyond point E, the cross-sectional area of the specimen begins to reduce rapidly over a relatively small length of bar and the bar is said to form a neck. This necking takes place whilst the load reduces, and fracture of the bar finally occurs at point F.

Engineering (normal) stress (σ), and engineering strain (ε)

These are quantities based on the original dimensions of the specimens and defined as:

$$\sigma = \frac{\text{Load at the required time}}{\text{Original Area}} = \frac{P_i}{A_o}$$

$$\varepsilon = \frac{\text{Length at the required time} - \mathit{Original\ Length}}{\text{Original Length}} = \frac{L_i - L_o}{L_o}$$

True (actual) stress (σ), and engineering strain (ε)

These are quantities based on the dimensions of the specimens at any time t during testing and defined as:

$$\sigma = \frac{\text{Load at the required time}}{\text{Area at the required time}} = \frac{P_i}{A_i}$$

$$\varepsilon = \frac{\text{Length at the required time} - \mathit{Original\ Length}}{\text{Length at the required time}} = \frac{L_i - L_o}{L_i}$$

The Modulus of elasticity (E)

Modulus of elasticity (Young's modulus) is the ratio of stress to strain in elastic range of deformation. For steel, modulus of elasticity is in the range between 190GPa to 210GPa. Modulus of elasticity is the slope of the stress-strain curve in the range of linear proportionality of stress to strain, and it is computed as follows:

$$\sigma = \frac{\Delta\sigma}{\Delta\varepsilon}$$

Poisson's ratio

It is the ratio of the relative contraction strain (transverse, lateral or radial strain) normal to the applied load - to the relative extension strain (or axial strain) in the direction of the applied load.

$$\mu = \frac{-\varepsilon_t}{\varepsilon_l}$$

Where:

μ = Poisson's ratio

ε_t = lateral or radial strain (m/m, ft/ft); $[\Delta D/Di]$

ε_l = longitudinal or axial strain (m/m, ft/ft); $[\Delta L/Li]$

The ductility of material

Is ability of material to deform under load, ductility is indicated by the tensile property of percentage of elongation and Percentage of reduction in cross-sectional area of a specimen.

- The percentage of elongation must be equal or greater than 16% and it is given by:

$$Ductility\% = \frac{\text{Final Length} - Original\ Length}{\text{Original Length}} * 100\%$$

$$Ductility\% = \frac{L_f - L_o}{L_o} * 100\%$$

- The Percentage of reduction in cross-sectional area is given by:

$$Ductility = \frac{\text{Cross sectional area at fracture} - Original\ cross\ sectional\ area}{\text{Original cross sectional area}} * 100\%$$

$$Ductility = \frac{A_f - A_o}{A_o} * 100\%$$

The Modulus of Resilience (UR)

It is the amount of energy stored in stressing the material to the elastic limit as given by the area under the elastic portion of σ - ε curve. This quantity is important in selecting materials for energy storage such as springs; the Modulus of Resilience is given by:

$$UR = \frac{\text{Area in } (P - \Delta)\ curve\ in\ elastic\ region}{\text{Original Volume of the specimen}} = Area\ in\ (\sigma - \varepsilon) curve\ in\ elastic\ region$$

The modulus of Toughness (UT)

It is the total energy absorption capabilities of the materials to failure and it is given by:

$$UT = \frac{\text{Total area in } (P - \Delta)\ curve}{\text{Original Volume of the specimen}} = Total\ area\ in\ (\sigma - \varepsilon) curve$$

3.4. Data and Calculations

3.4.1. Data

L_i mm=	410	L_F mm=	476
D_i mm=	14.2	A_i mm² =	158.3
D_F mm=	12.2	A_F mm² =	116.8

$$\sigma = \frac{P}{A_i} \rightarrow 158.3 * 10^{-6}$$

$$\varepsilon = \frac{\Delta e}{L_i} \rightarrow 410$$

	Load (KN)	Elongation (mm)	Eng. Stress (MPa)	Eng. Strain
1	0	0	0	0
2	2	2	12.6	$4.8*10^{-3}$
3	8	2.9	50.5	$7.1*10^{-3}$
4	19	3	120	$7.3*10^{-3}$
5	35	3.1	221.1	$7.56*10^{-3}$
6	47	3.2	296.9	$7.8*10^{-3}$
7	68	3.4	429.6	$8.3*10^{-3}$
8	69	5	435.8	$12*10^{-3}$
9	69	7	435.8	$17*10^{-3}$
10	70	10	442.2	$24*10^{-3}$
11	72	12	454.8	$29*10^{-3}$
12	77	15	486.4	$37*10^{-3}$
13	80	17	505.4	$41*10^{-3}$
14	82	18	518	$44*10^{-3}$
15	87	20	549.6	$49*10^{-3}$
16	92	23	581	$56*10^{-3}$
17	97	27	613	$66*10^{-3}$
18	102	30	644	$73*10^{-3}$
19	107	36	675.9	$88*10^{-3}$
20	109	42	688.5	$102*10^{-3}$
21	111	47	701	$115*10^{-3}$
22	112	49	707.5	$119*10^{-3}$
23	112	52	707.5	$127*10^{-3}$
24	113	54	713.8	$132*10^{-3}$
25	113	56	713.8	$136*10^{-3}$
26	113	60	713.8	$146*10^{-3}$
27	112	62	707.5	$151*10^{-3}$
28	110	64	694.8	$156*10^{-3}$
29	108	65	682	$158*10^{-3}$
30	102	66	644	$161*10^{-3}$

3.4.2. Sample of Calculations

$A_i = \frac{\pi}{4}(D_i)^2 = \frac{\pi}{4}(14.2)^2 = 158.3\ mm^2$

$A_F = \frac{\pi}{4}(D_f)^2 = \frac{\pi}{4}(12.2)^2 = 116.8\ mm^2$

$L_f = L_i + \text{max elongation} = 410 + 66 = 476\ mm$

Eng Stress $\sigma_E = \frac{P}{A_i}$ when $P = 102 \times 10^3$ the stress was $\sigma = \frac{102 \times 10^3}{158.3 \times 10^{-6}} = 644\ MPa$

Eng Strain $= \frac{\Delta \text{elongation}}{L_i}$ when elongation $= 66$ the strain was $\epsilon = \frac{66 \times 10^{-3}}{410 \times 10^{-3}} = 161 \times 10^{-3}$

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

(-5)

2. Determine:
   Proportional Limit = 435 MPa
   Yield Point = (strain, stress) → (0.0187, 440 MPa)
   Hardening Point = → (0.0298, 449 MPa) ok
   Ultimate Strength = → 715 MPa
   Fracture Point = → (0.169, 640 MPa)

3. Calculate:
   Modulus of Elasticity = the slope from point 5 to 4, we can take any point such as 3 to 4...

$E = \frac{\Delta \text{stress}}{\Delta \text{strain}} = \frac{(221.1 - 120) \times 10^6}{(7.56 - 7.3) \times 10^{-3}} = 3.888 \times 10^{11}$ unit

ok (-1)

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

$= \frac{476 - 410}{410} \times 100\% = 16.09\%$

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

$= \left| \frac{116.8 - 158.3}{158.3} \right| \times 100\% = -26.2\%$

True Stress at fracture Point = $\sigma = \frac{P}{A_F} = \frac{102 \times 10^3}{116.8 \times 10^{-6}} = 873.2\ MPa$

True Strain at Fracture Point = $\varepsilon = \frac{\Delta E}{L_f} = \frac{161 * 10^{-3}}{476 * 10^{-3}} = 0.338$

1.5

Modulus of Resilience = number of sequre under the elaptic region * Area of one square

N = 9

Area = 20 * 4 * 10^-3 = 0.08

M.R = 0.08 * 9 = 0.72 MJ/m^3

1

Modulus of Toughness = number of sequre * Area of one sequre
= 48 * (100 * (0.08 - 0.06))
= 48 * (100 * (0.02)) = 48 * 2 = 96 MJ/m^3

4. Assume: Poisson's ratio= 0.25 [Hint: $\mu = -\varepsilon_{lateral} / \varepsilon_{longitudinal}$]
Calculate:
- Actual stress at proportional limit

- Actual stress at 1/2 proportional limit

3.5. Discussion

- Stress - Strain diagram analysis :
1. elastic region : stress and strain connected with two relationship suchas linear and direct.
2. The slop is as equal as modulus of Elasticity.
3. By the end of the linear, it's the proptional Limit.
4. Modulus of Elasticity is reqaired to be between (190-210) Gpa
- But in our experiment the modulus of elasticity equal 3.888*10¹¹ so it is not accepted

[2] yeild reigion : we noted the the stress is constant where as we obseved the the strain getting increased, hardeing regions starts from harding period to the ultimate point.

[3] Ultimate stress : it is the maximum stress in stress-strain diagram the steel rod can stand without getting broken

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

[5] necking region : starts from the ultimate stress to the Fracture point at this reigion the stress is start decreasing while the strain increasing. in our experiment the elongation equals 16.09% and this value is accepted because this value is greater than 16%. the yield point was 440 Mpa So the type of our steel is G60
→ yeild ≥ 415 Mpa

-3

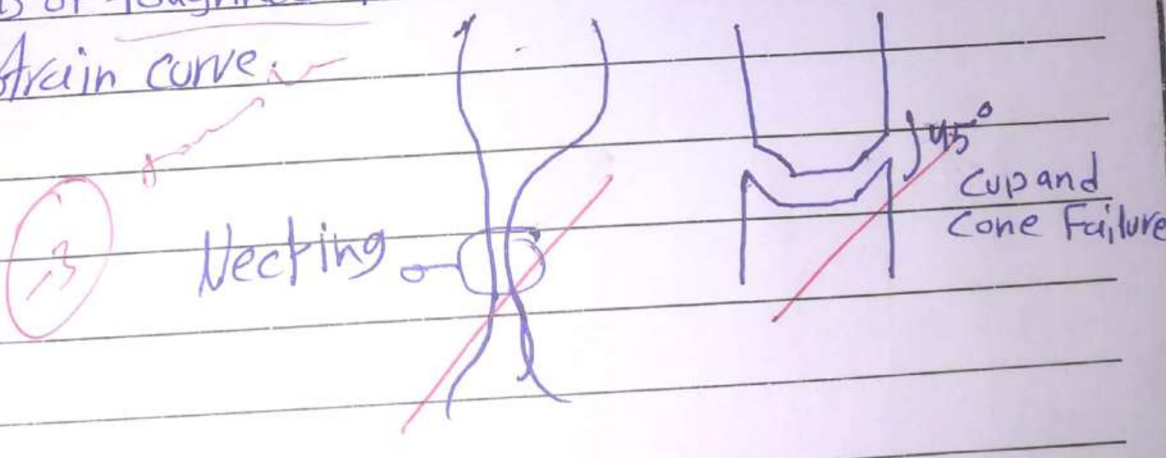
Scanned by CamScanner

* we fond that $6_{actual} > 6_{Eng}$ because $A_f > A_i$ from $6 = \frac{P}{A}$, when the area decrease the stress increase.
$\varepsilon_{actual} < \varepsilon_{Eng}$ because $L_f > L_i$ from $\varepsilon = \frac{\Delta E}{L}$ when the length increase the strain decrease.

* we get the steelrod tested in amachine called (UTM) by fixing the ends of the steel rod in the machine. then, we input the information to a software computer (special) for tensile test. As result of that the information we got it tellus that the mass of the steelrod and the Cross Section Area as well as the length of the rod Lead us to Find density of the rod. as the tension reaches to the max value it will take place anecking to the rod andit will break on ashap called cup and cone.

* Modalus of resilence in stress-strain diagram equal to the Area under the elastic region.

* modulus of toughness is the area under under the stress strain curve.



Error :- [1] when measure length and weight of rod
[2] Error in modulus of reselience
[3] Error in modulus of toughness

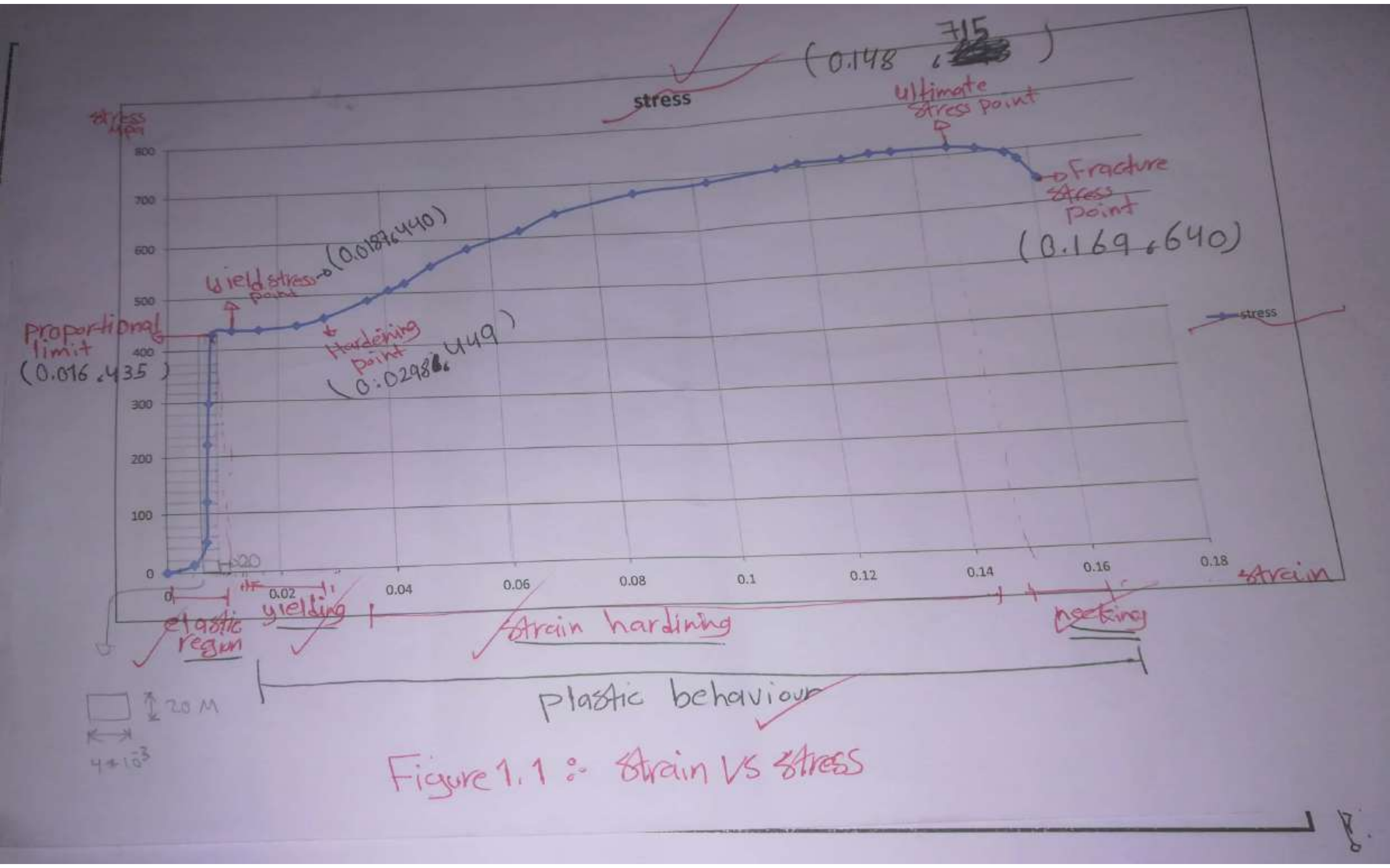


Figure 1.1 :- Strain VS Stress

Building Materials Laboratory

Experiment No.: 4

Specific Gravity and Absorption of Coarse and Fine Aggregate
Rodded Unit Weight of Coarse Aggregate

Name	Mark
SoJoud Ismail Al-Soud	94/100

Student's number	Section number	Experiment day and date	Submission day and date
1732436	1	Sunday 17/2/2019	Sunday 24/2/2019

مختبر مواد البناء / التجربة الرابعة / شعبة (1) [الأحد]

Experiment 4

Specific Gravity and Absorption of Coarse and Fine Aggregate

Rodded Unit Weight of Coarse Aggregate

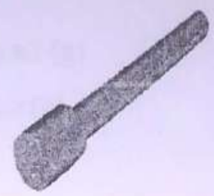
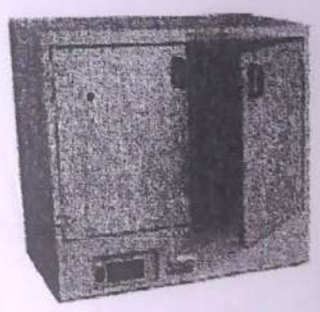
4.1. Objectives

to calculate speciefic gravity (Bulk and appearant) for Fine and coarse aggregate and to calculate absorption of coarse and fine aggregate to test the quality of aggregate

Bulk Density .3

4.2. Apparatus and Equipment

List the names of the following equipment and tools:

		
special balance with basket	steel rod	Cone mold
		
[redacted] Pycnometer	Bucket challenge	oven

4.3. Materials

Fine and Coarse aggregate water

ic Gravity and Absorption of Coarse and Fine Aggregate

arent Specific Gravity (Gsa): The ratio of the weight in air of a unit volume of the impermeable portion aggregate (does not include the permeable pores in aggregate) to the weight in air of an equal volume of as-free distilled water at the stated temperature.

Bulk SSD Specific Gravity (Gsb SSD): The ratio of the weight in air of a unit volume of aggregate, including the weight of water within the voids filled to the extent achieved by submerging in water for approximately 15 hours, to the weight in air of an equal volume of gas-free distilled water at the stated temperature.

Absorption: The increase in mass due to water in the pores of the material.

For coarse aggregate:

Gsa = A / (A-C)

Gsb SSD = B / (B-C)

% Abs = [(B-A) / A] x 100

Where: A = Weight of sample oven-dried in air (g)

B = Weight of saturated surface in air (g)

C = Weight of sample in water (g)

For fine aggregate:

Gsa = A / (B+A-C)

Gsb SSD = S / (B+S-C)

% Abs = [(S-A) / A] x 100

Where: A = Weigh of oven dry specimen in air (g)

B = Weight of Pycnometer filled with water (g)

S = Weight of saturated surface dry specimen (g)

C = Weight of Pycnometer with specimen and water to calibration mark (g)

Specifications:

Aggregate Type	Specific Gravity
Heavy weight	≥ 3
Normal weight	2.8 – 2.2
Light weight	≤ 2
Absorption% ≤ 5%	

d Unit Weight (Bulk Density) of coarse aggregate

k Density: The mass of unit volume of bulk aggregate material, in which the volume of the individual articles and the volume of the voids between the particles is included in the total volume.

M = (G – T)/V

Where: M = Bulk density of aggregate, kg/m³ (lb/ft3)

G = Mass of the aggregate plus the measure, kg (lb)

T = Mass of the measure, kg (lb/f)

V = volume of the measure, m³ (ft³)

Specifications:

Aggregate Type	Bulk Density (Kg/m³)
Heavy weight	> 2080
Normal weight	1520 - 1680
Light weight	< 1120

void ratio: The space between the aggregate particles that is not occupied by solid mineral matter. That is, voids within particles, whether permeable (open) or impermeable (closed), are not included. It is not less than 33%.

% voids = [1 – M/(S*W)] *100

Where: M = Bulk density of aggregate, kg/m³ (lb/ft3)

S = Specific gravity

W = Density of water, kg/m³ (lb/ft3)

Angularity number: The amount by which the percentage of voids in it after compacting in a prescribed manner exceeds 33. Where, "33" is the percentage of volume of voids, in a perfectly rounded aggregate. "67" is the percentage of volume of solids in a perfectly rounded aggregate. The normal aggregate suitable for making concrete have angularity number lying between 0 and 10. The rounded aggregate has Angularity Number zero.

Angularity Number = 67- Solid% = 67 – [100M/(S*W)]

. 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.

4.5.2. 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

ulk Density of coarse aggregate

1. Weigh the empty measure (cylinder)
2. Fill the cylinder to overflowing, discharging the aggregate from a height not to exceed 50mm above the top the cylinder edge. Level the surface of the aggregate with the fingers or straight edge
3. Determine the weight of the measure plus its contents, and calculate the weight of the aggregate
4. Fill the cylinder to one third of its height and rod the layer of aggregate with (25) strokes of the tamping rod evenly distributed over the surface. Fill the cylinder two-thirds full and again level and rod as previous. Finally, fill the cylinder to overflowing and rod again in the manner previously mentioned. Level the surface of the aggregate with the fingers or a straight edge in such way that any slight projections of the larger pieces of the coarse aggregate approximately balance the larger voids in the surface below the top of the cylinder
5. Determine the weight of the measure plus its contents and calculate the wt. of aggregate by subtracting the empty weight of the cylinder.
7. Fill the measure with water at room temperature and cover with a piece of plate glass in such away as to eliminate bubbles and excess water.
8. Determine the weight of the measure full with water, then calculate the weight of water.
9. Calculate the volume, V of the measure by dividing the weight of water required to fill the measure by its density.

4.6. Data and Calculations

4.6.1. Specific gravity and absorption of coarse aggregates

Data:

A: Weight of oven-dry test sample in air (g)	1485
B: Weight of S.S.D. sample in air (g)	1504
C: Weight of saturated sample in water (g)	937

Calculations:

1. Apparent Specific Gravity = $\frac{\text{weight of oven dried}}{\text{weight of oven dried - weight in water}} = \frac{1485}{1485-937} = 2.7$ ✓
2. Bulk Specific Gravity (SSD) = $\frac{\text{weight of SSD in air}}{\text{weight of SSD in air - weight in water}} = \frac{1504}{1504-937} = 2.653$ ✓
3. Absorption (%) = $\frac{\text{weight of SSD in air - weight of oven dried}}{\text{weight of oven dried}} = \frac{1504-1485}{1485} = 1.3\%$ ✓

pecific gravity and absorption of fine aggregate

A: Weight of oven —dry specimen in air (g)	497
B: Weight of Pycnometer filled with water (g)	1119
S: Weight of the saturated surface-dry specimen (g)	504
C: Weight of Pycnometer with specimen and water (g)	1445

Calculations:

1. Apparent Specific Gravity =

$$\frac{A}{A+B-C} = \frac{497}{497+1119-1445} \approx 2.9$$

2. Bulk Specific Gravity (SSD) =

$$\frac{S}{S+B-C} = \frac{504}{504+1119-1445} = 2.8$$

3. Absorption (%) =

$$\frac{S-A}{A} = \frac{504-497}{497} = 1.4\%$$

4.6.3. Compacted and Loose bulk density

Data:

Weight of measure plus compacted aggregate (kg)	20.30	→ A
Weight of measure plus loose aggregate (kg)	19.34	→ B
Weight of measure filled with water (kg)	15.26	→ C
Weight of measure (kg)	6.00	→ D
Density of water (kg/m^3)	1000	→ E
Specific gravity of aggregate	2.71	→ F

Calculations:

1. Volume of aggregate = Volume of water

$$= \frac{\text{mass full water}}{\text{density water}} = \frac{C-D}{E} = \frac{15.26-6}{1000} = 9.26 \times 10^{-3}\ m^3$$

Compacted Bulk density of aggregate = mass of agg compact = $\frac{A-D}{Volume}$

$= \frac{20.3-6}{9.26*10^{-3}} = 1544.3\ kg/m^3$

⇒ mass of compact agg = mass measure plus compact agg − mass measure

3. Voids (%) of compacted sample=

$\left(1-\frac{M}{S*W}\right)*100 = \left(1-\frac{1544.3}{2.71*1000}\right)*100 = 43\%$

M → density compacted agg
S → speciefic gravity
w → density water

4. Bulk density of loose aggregate =

$= \frac{\text{mass of loose aggregate}}{\text{volume}} = \frac{B-D}{Volume} = \frac{19.34-6}{9.26*10^{-3}}$

$= 1440.6\ kg/m^3$

mass of loose agg = mass measure pluse loose agg − mass measure

5. Voids (%) of loose sample =

$\left(1-\frac{M}{S*W}\right)*100 = \left(1-\frac{1440.6}{2.71*1000}\right)*100 = 46.8\%$

M → density of loose agg

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

Bulk density = 0.97 * compact density
$= 0.97*1544.3 = 1498\ kg/m^3$

Solid% = 100 − V%
$= 100-44.7 = 55.3\%$

$V\% = \left(1-\frac{1498}{2.71*1000}\right)*100 = 44.7$

Angulaity
= 67% − Solid%
= 67% − 55.3%
= 11.7%

1. Specific gravity and absorption

- The SSD weight in water is less than that in air. Why? The aggregate in water loss weight and It's equal weight of removed water, by oven the aggregate dried and It will not have any void, but SSD Coarse aggregate in Air have full voids and that increase the weight of the specimen.

  SSD in water < oven dried < SSD in air

- Our aggregate (coarse and fine) are Heavy, Normal, or Light weight? Why? We determine that according the value of S.G, we know that when (S.G > 3) is heavy and if (S.G < 2) is light and if (2.2 < S.G < 2.8) is Normal, so when we calculated the values of Bulk and apparent S.G For coarse aggregat was (2.653, 2.7) and the values of ~~Bulk~~ Bulk and apparent For Fine aggregat was (2.8, 2.9), and that indicate that coarse agg is Normal and the Fine agg is Transition cause between Normal and heavy.

- Absorption% of coarse and fine aggregate are accepted or not? Why? The Max allowable of absorption must be ≤ 5% and the Absorption For Coarse aggregat is 1.3% So It's accepted and the Absorption For Fine aggregate is 1.4% so It's accepted

- What is the effect of using glycerin to fill the pycnometer instead of water during the test of fine aggregate? Why? IF we used glycerin the volume will increase and according the ($\rho = \frac{M}{V}$) So the relation between Mass and density so the density will decrease and according the ($S.G = \frac{\rho}{\rho_{glesring}}$) So the S.G increase → ($\rho_{glaceryn} = 126\ kg/m^3$)

- The air bubbles must be eliminated from pycnometer. Why? We remove the bubbles For their effect on S.G, when we measure the specimen with bubbles the volume will be larger than the real measurement, the value of S.G is decrease and this is not correct, So we remove the bubbles to get the correct volume and there For the correct value of S.G

Bulk density of coarse aggregate

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

- Compacted Voids ratio when we calculated the compacted voids it was 43% and the range of voids must be larger than 33% → (voids > 33%) So, It's accepted.

- Angularity number
when we calculate the Angularity number was 11.7% and the range accepted For the Angularity must be less or equall 11% → (An ≤ 11%), So It is not accepted.

- Is our coarse aggregate normal? Why?

Agg type	Bulk density (kg/m³)
Heavy	> 2080
Normal	1520 - 1680
light	< 1120

the compacted density is 1544.3 kg/m³ So we can sayed that the aggregate is Normal.

- Compare the compacted results with loose.
When we calculated the compacted density was 1544.3 kg/m³ and the loose density was 1440.6, the compacted density larger than loose density Because it exposed for compacting
Voids For compacted density is 43% and the voids for loose density is 46.8%, the loose voids is larger Because it isn't compacted and inverse relation between density and voids.

- What is the relation between the roundness of the aggregate and the angularity number?
If the absence of roundness that means more angular So we can noticed that the relation between the roundness and the angularity number is inverse relation → (Higher the angularity number → less roundness)

4.7.4. Error sources:

1. when we stirred and mixed to remove air bubbles it had to last for 15 min and we didn't.
2. The air wasn't removed of pyncnometer
3. when we added the fine agg to the pycnometer, we didn't add the whole sample, some of it fell on the sides

4.8. Remember to make your report tidy and neat ☺

جواد نهاد

Building Materials Laboratory

Experiment No.: 5

Sieve Analysis of coarse and Fine Aggregates

Name	Mark
هداية اسامة محمود الموصلي	See 1737533 -7 ~~84~~ 77 / 100

Student's number	Section number	Experiment day and date	Submission day and date
1732488	1	24/2 Sunday	3/3 Sunday

Experiment 5

Sieve Analysis of coarse and Fine Aggregates

5.1. Objectives

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

5.2. Apparatus and Equipments

Balance

Pan

Shaker

sieves for coarse Agg

sieves for fine Agg

ok

5.3. Materials

coars aggregate

fine aggregate

5.4. Theory

1. % Loss is accepted if it is $\leq 0.3\%$

$$\% \text{ Loss} = \frac{sample\ weight - total\ weight\ retained}{sample\ weight} * 100\%$$

2. Percent of aggregate retained on n[th] sieve:

$$Rn = \frac{weight\ retained}{total\ weight\ retained} * 100\%$$

3. Cumulative percent of aggregate retained on n[th] sieve = $\sum_{i=0}^{n} Rn$

4. Cumulative percent of aggregate passing through the n[th] sieve (%Finer):

$$\%Finer = 100 - \sum_{i=0}^{n} Rn$$

5. Fineness modulus = $\frac{\sum cumulative\ retained\ on\ the\ standard\ sieves}{100}$

6. Maximum Size of Aggregate – the smallest sieve opening through which the entire amount of aggregate is required to pass.

7. Nominal Maximum Aggregate Size – one size larger than the first sieve that retains more than 15% aggregate.

5.5. 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.

5.6.1. Sieve analysis of coarse aggregates

Sample weight = 966 g

Table 6.1: Sieve analysis of coarse aggregates

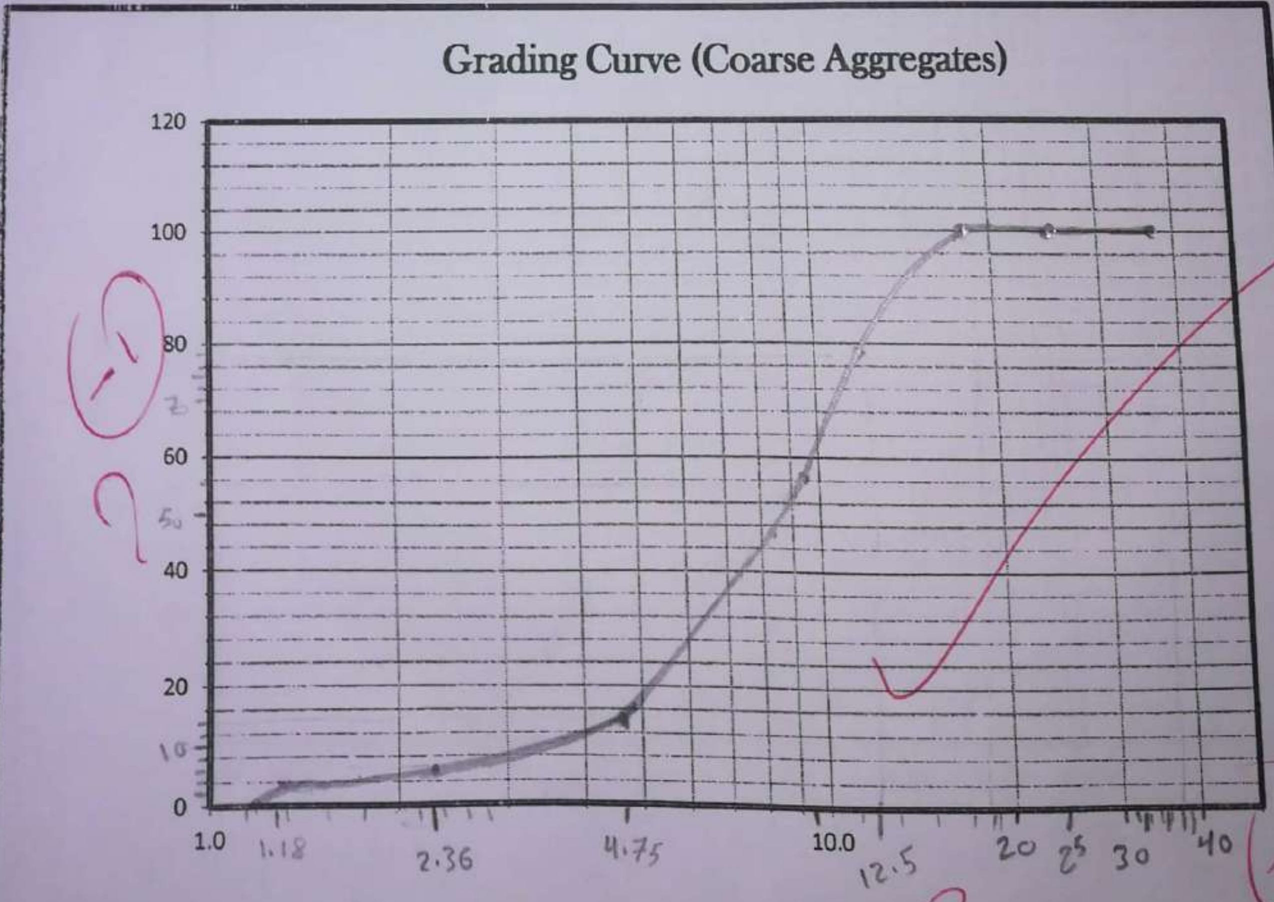
sieve size (mm)	sieve No.	sieve wt. (g)	sieve+ret. (g)	Ret. Wt. (g)	Retained (%)	Cum. Ret. (%)	Cum. Pass (%)
37.5	1 1/2"	496	490	0	0	0	100
25	1"	469	469	0	0	0	100
19	3/4"	468	468	0	0	0	100
12.5	1/2"	461	680	219	22.74	22.74	77.26
9.5	3/8"	471	681	210	21.806	44.546	55.454
4.75	4	439	833	394	40.913	85.459	14.541
2.36	8	385	466	81	8.411	93.87	6.13
1.18	16	418	431	13	1.349	95.219	4.781
0.075	200	245	277	32	3.322	98.541	1.459
pan		305	319	14	1.453	100	0
		Total weight retained		963			

Determine:

1. F.M. = $\frac{\sum \text{cum. Ret}(\%) \text{ for all standerd sieve}}{100} = \frac{0+0+44.546+85.459+93.87+95.219+3(100)}{100} = 6.19 > 5$

2. M.S. = 19 mm standerd
3. N.M.S. = 19 mm standerd

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



5.6.2. Sieve analysis of fine aggregates

Sample weight= 303 g

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			2	0.66	0.66	99.34
2.36	8			3	0.99	1.65	98.35
1.18	16			5	1.65	3.3	96.7
0.6	30			28	9.24	12.54	87.46
0.3	50			112	36.963	49.563	50.497
0.15	100			112	36.963	86.466	13.534
X 0.075	200			32	10.561	97.027	2.973
pan				9	2.970	100	0
		Total weight retained		303			

Determine:

1. F.M. = $\frac{\sum \text{Cum. Ret for all standerd sieve}}{100} = \frac{0.66+1.65+3.3+12.54+49.563+86.466}{100} =$ 1.54
2. M.S. = 9.5 mm
3. N.M.S. = 0.6

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

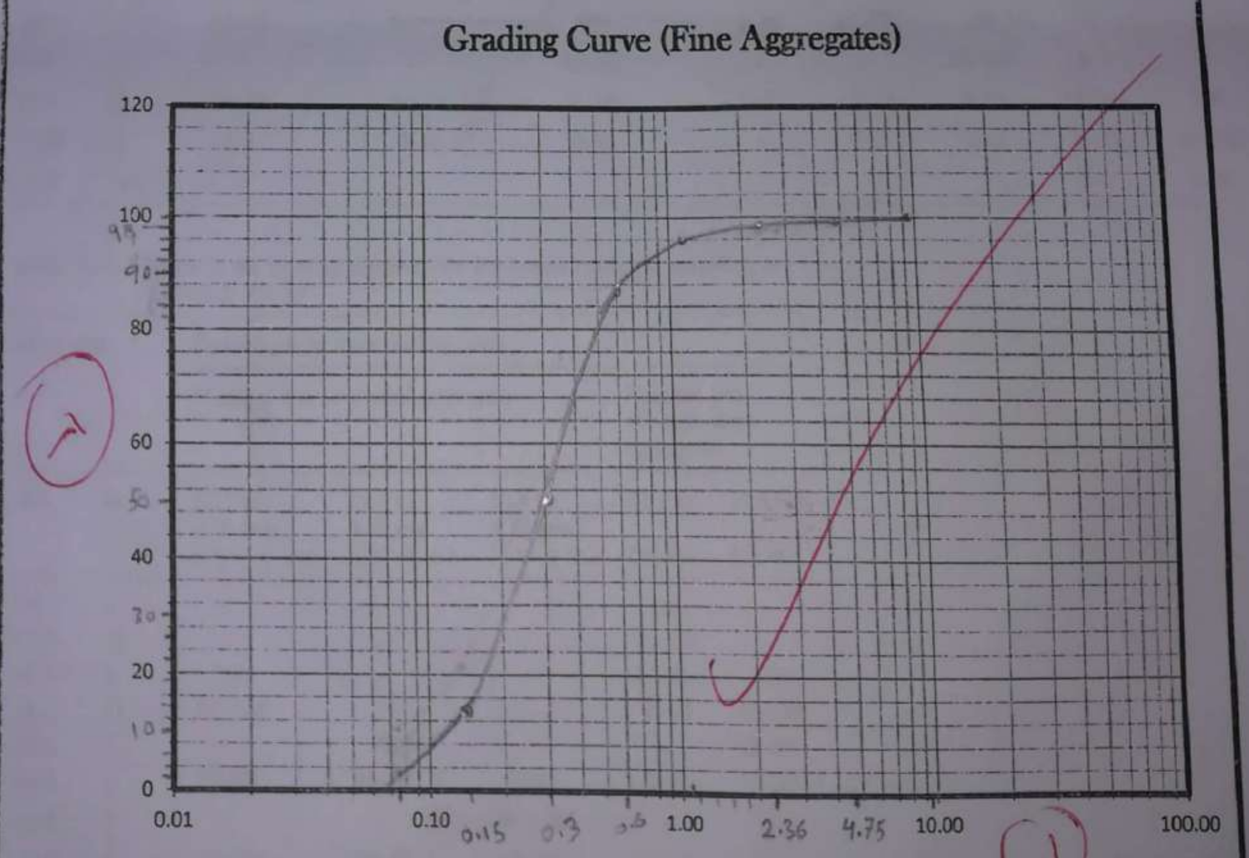


Table 3.8: BS and ASTM grading requirements for fine aggregate

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	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		Percentage by mass passing BS sieve							
		Nominal size of graded aggregate			Nominal size of single-sized aggregate				
mm	in.	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.)	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		Percentage by mass passing sieve				
		Nominal size of graded aggregate			Nominal size of single-sized aggregate	
mm	in.	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.)	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	–	–

المواصفة الاردنية للتحليل المنخلي

جدول رقم (1)
تدرج الركام الناعم

فتحة المنخل	رقم المنخل	النسبة المئوية للمار من المنخل بالوزن		
		تدرج (1) (سمسمية 9.5 ملم) (8/3 بوصه)	تدرج (2) (4.75 ملم) (منخل رقم 4)	تدرج (3) (1.18 ملم) (منخل رقم 16)
8/3 بوصة	9.5 ملم	100 - 95	100	
4.75 ملم	رقم 4	100 - 80	100 – 90	
2.36 ملم	رقم 8	80 - 50	100 – 75	100
1.18 ملم	رقم 16	70 - 20	90 – 55	100 – 90
600 ميكرون	رقم 30	35 - 10	59 – 35	90 – 60
300 ميكرون	رقم 50	15 - 5	30 – 8	60 – 20
150 ميكرون	رقم 100	5 - 0	10 – 0	20 – 0
75 ميكرون	رقم 200	5 - 0	5 - 0	10 - 0

جدول رقم (2)
تدرج الركام الخشن

فتحة المنخل	رقم المنخل	النسبة المئوية للمار من المنخل بالوزن			
		جوزية (40 ملم) (1 2/1 بوصة)	فولية (25 ملم) (1 بوصة)	حمصية (20 ملم) (4/3 بوصة)	عدسية (12 ملم) (2/1 بوصة)
2 بوصة	51 ملم	100			
1 2/1 بوصة	38 ملم	100 – 80	100		
1 بوصة	25.4 ملم	50 – 20	100 – 95	100	
4/3 بوصة	19 ملم	30 – 10	80 – 40	100 – 95	100
2/1 بوصة	12.7 ملم	---------	50 – 5	80 – 50	100 – 90
8/3 بوصة	9.5 ملم	10 – 0	15 – 0	60 – 25	100 – 80
4.75 ملم	رقم 4	5 – 0	5 – 0	10 – 0	50 – 5
2.36 ملم	رقم 8	2 – 0	5 – 0	10 – 0	25 – 0
0.075 ملم	رقم 200	2 - 0	2 - 0	2 - 0	2 - 0

5.8. Discussion

Fine Agg:- when we compare table 6.2 with table 3.81 for BS and ASTm we observed that: According to ASTm the fine Agg is not accepted becouse It's not accepted the requirments of ASTM also According to BS, the fine Agg is accepted to BS (overall limits) becouse the fine aggregate meet the requirments, and when tested the fine Agg we see that it's accepted for [fine sand] and according to the JS (table 1) we see that it's not accepted in sieve #16 becouse all the requirment are accepted to Jordenian Test requirments.

* FM = 1.406 < 2 It's accepted for [fine Sand]

in fine Agg [table 6.2], sieve (0.075 mm) #200 has 11.445 > 5 So it's not accepted to use in concrete becouse if the clay higher than 5% then it's not accepted

* The fine Agg 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 seive size increase the log of sieve size increase
* we use sieve 9.5 mm in fine Agg to ensure that we removed all impurities is > 5mm at sieve #200

* Coarse Agg 8- when we compar [table 6.1] with [table 3.9] for BS we found that

BS ⇒ not accepted

ASTm ⇒ not accepted

Jordain ⇒ not accepted

* The coarse Agg is well graded according ASTm becouse It's not accepted to the ASTm requiments Also The coarse Agg is well graded according to the BS requirments and well graded according to Jordanian test sieve requirments

Finess Modulus of coarse Agg in Our expirment = 6.19

so that this is Coarse Agg becouse 6.1975

* Errors 8-

Some of agg go Out from the shaker.

~~Error~~

Error in use shaker [the time less than 4 min]

Error in the order of sieves

Error in reading weight

Error in sieves not clean

5.9. Remember to make your report tidy and neat ☺

مختبر مواد البناء / التجربة ٦ / شعبة ١ (الأحد)

Building Materials Laboratory

Experiment No.: 6

Mix Design (ACI Method)

Name	Mark
Sojoud Ismail Al-Soud	100/100

Student's number	Section number	Experiment day and date	Submission day and date
1732436	1	Sunday	Sunday

Experiment 6

Mix Design (ACI Method)

Part (A):

Use the American Method to design a concrete mix that is required for columns. The specified strength is 32MPa (strength of cylinder) at 28 days with a slump of 80mm. The available coarse aggregate has a maximum nominal size of 20mm and rodded bulk density (unit weight) of 1501kg/m^3. The aggregates are of normal weight and their grading conforms to the appropriate standard with a fineness modulus of sand of 2.7.

Assume:

	Fine Aggregates	Coarse Aggregates
Bulk Specific Gravity (SSD)	2.73	2.70
Moisture Content (%)	1.00	0.50
Absorption (%)	2.00	2.50

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= 50mm
Entrapped Air= 1.5%

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

Remember to make your report tidy and neat ☺

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

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

Part A

$f_{str} = 32$ Mpa   M.N.S.A = 20 mm

Slump = 80 mm   F.M.S = 2.7

$\gamma_{rodded} = 1501\ kg/m^3$

* from table 17.3 :

$f_{mix}\ (f'_d) = f_{str} + \text{margin}$

$f'_d = 32 + 8.5$

$f'_d = 40.5$ Mpa ≈ 40 Mpa

* from table A1.5.3.4(a). For non-air-entrained concret

Strength → W/C

40 → 0.42

W/C = 0.42.

* from table ~~A1.5.3.6~~ A1.5.3.3

Slump = 80 mm , M.N.S.A = 20 mm

⇒ water content = 205

⇒ Air content = 2%

* Cement content

$$C = \frac{W}{W/C} = \frac{205}{0.42}$$

$C = 488.1\ kg/m^3$

* Coarse Aggregate → From table A1.5.3.6

F.M.S = 2.7 , M.N.S.A = 20 mm

F.M [redacted] → Volume of dry-rodded coarse agg

interpolations →

2.6 → 0.64

2.7 → X

2.8 → 0.62

$$\rightarrow \frac{2.8-2.6}{0.62-0.64} = \frac{2.7-2.6}{X-0.64}$$

$$\frac{0.2}{-0.02} = \frac{0.1}{X-0.64}$$

$$-10 = \frac{0.1}{X-0.64}$$

$$X-0.64 = -0.01$$

$$\boxed{X = 0.63} \rightarrow \text{V of Rodded C.A}$$

So, VCA = 0.63 m^3 and $\gamma_{rodded} = 1501\ kg/m^3$

⇒ weight C.A = γ_{rodded} * VCA

= 1501 * 0.63 = 945.63 Kg

* For Fine aggregate we use "Abselute Volume method"

* $\Sigma V = 1\ m^3$

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

$\Rightarrow V = \frac{W}{S.G * \gamma_w}$

$$\Rightarrow \frac{488.1}{3.15*1000} + \frac{205}{1*1000} + \frac{945.63}{2.7*1000} + \frac{W_{FA}}{2.73*1000} + \frac{2}{100} = 1$$

$W_{F.A} = 736.6$ Kg

Prepared by Eng. Buthaina Abu-Saleem

Part B

* Approximate density (ρ)
$= 205 + 488.1 + 945.63 + 736.6$
$= 2375.33 \ kg/m^3$

ok

* Required water :
Required water (needed) = water in the mix + Absorption − Moisture

$= \text{water in mix} + \left[\text{absorption} * W_{F.A} + \text{absorption} * W_{C.A} \right] - \left[\text{moisture} * W_{F.A} + \text{moisture} * W_{C.A} \right]$

$= 205 + \left[\frac{2}{100} * 736.6 + \frac{2.5}{100} * 945.63 \right] - \left[\frac{1}{100} * 736.6 + \frac{0.5}{100} * 945.63 \right]$

$= 231.3 \ kg$

part B

* practical slump = 50 mm = 5 cm
* practical Entrapped Air = 1.5%

− Add 2 kg of water to increase slump by 1 cm and vice versa

For practical Entrapped Air: we don't add water because the air reduced and that's better and it make the concret stronger

ok

For increase slump $(8-5)*2 = 6$ kg

- Add 6 kg of water

→ New water $= 205 + 6 = 211$ kg/m³

→ New cement $= \frac{211}{0.42} = 502.4$ kg/m³

ok

→ $W \cdot CA = 945.63$ kg

→ Air content = 2% ✓ → For the Air content the acceptable range is ±1 of the air content from part A so the range is {1 – 3}% and our Air content is 2% so It's accepted and no adjustment for it

- New Fine agg

$\sum V = 1.0$

$= \frac{502.4}{3.15*1000} + \frac{211}{1000} + \frac{945.63}{2.7*1000} + \frac{W_{FA}}{2.73*1000} + \frac{2}{100} = 1$

ok

$W_{FA} = 707.82$ kg/m³

- Approximate density $= 211 + 502.4 + 945.63 + 707.82 = 2366.85$ kg/m³

ok

- Required water $= 211 + \left(\frac{2}{100} * 707.82 + \frac{2.5}{100} * 945.63\right) - \left(\frac{1}{100} * 707.82 + \frac{0.5}{100} * 945.63\right)$

ok

$= 236.99 \approx 237$ kg

مختبر مواد البناء / التجربة السابعة / تجميع الشعب

Building Materials Laboratory

Experiment No.: 7

Concrete workability and Admixture

Name	Mark
Sojoud Ismail Al-soud	see 1737527 (-5) 87 → 82 / 100

Student's number	Section number	Experiment day and date	Submission day and date
1732436	1	Sunday	sunday

Experiment 7

Concrete workability and Admixture

7.1. Objective

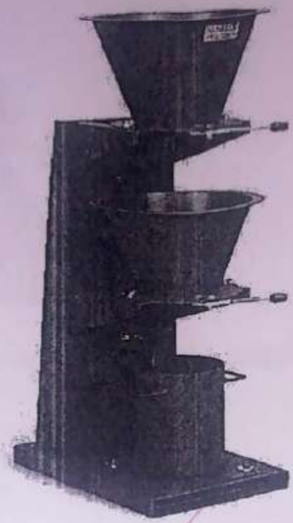
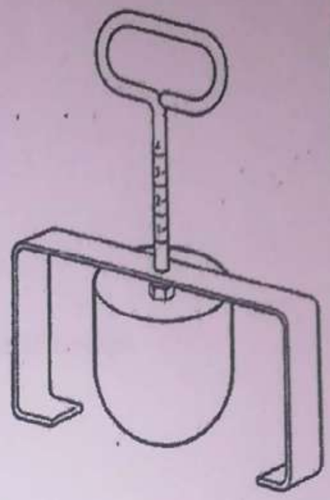
To check the workability of concret by used [slump test, vebe test, Flow table test, computing Factor test, kelly ball (ball penetration test). we added the admixture (super plasticizer) to see its effect.

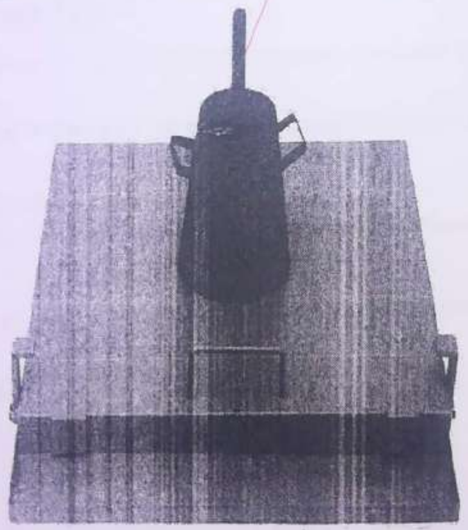
7.2. Materials

water   cement   fine agg   Coarse agg   Super plasticizer

7.3. Tests Apparatus and Equipment

Equipment / Tools			
Name	Slump test apparatus	rod	mixer

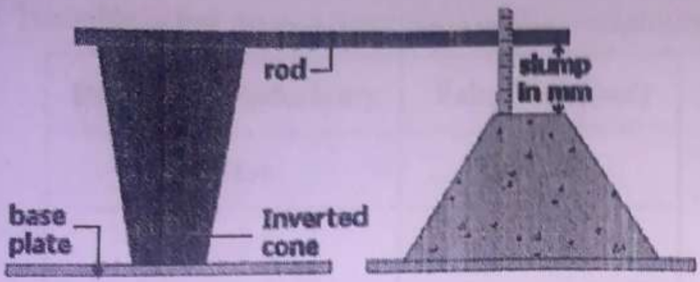
Equipment			
Name	vebe consistometer	compacting factor	kelly ball test apparatus

Equipment		
Name	flow table test	vibration table

4. Theory

Slump Test:

Slump: difference between height of the concrete before removing slump cone (mold) and height of the concrete after removing of slump cone.



The table below gives a description of the workability and the magnitude of slump:

Degree of Workability	Slump (mm)
very low	0 – 25
Low	25 – 50
Medium	50 – 100
High	100 - 175
Very High	> 175

Compacting Factor Test:

The ratio of the density of partially compacted concrete to the density of the concrete when fully compacted.

Compacting factor = Density of partially compacted concrete / Density of compacted concrete

If same mould (same volume), then:
Compacting factor = weight of partially compacted concrete / weight of compacted concrete

The table below shows the degree of workability for slump test and compacting factor:

Degree of Workability	Compacting Factor
very low	0.78
Low	0.85
Medium	0.92
High	0.95
Very High	-

Vebe Test:

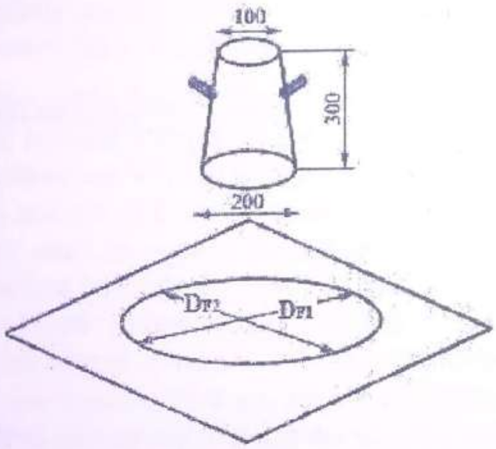
This test is based on measuring the time (Called VEBE time) needed to transfer the shape of a concrete mix from a frustum cone to a cylinder (these shapes are standardized by the apparatus of this test), by vibrating and compacting the mix.

The table below gives a description of the workability and the magnitude of slump:

Degree of Workability	Vebe Time (sec)
very low	20 - 40
Low	10 - 20
Medium	7 - 10
High	3 - 7
Very High	1 - 3

Flow table test:

The flow table test or flow test is a method to determine consistency of fresh concrete using table (700*700mm) and frustum cone (100*200*300mm). After testing, the concrete mix spreads approximately as a circle, and the maximum spread parallel to the two edges of the table is measured. The average of these two values, given to the nearest mm, represents the flow. A value of 400 mm indicates a medium workability, and 500 mm a high workability.



$D_{avg} = (D_{F1}+D_{F2})/2$

$\text{Flow Factor} = [(D_{avg}-20)/20]*100\%$

Admixture (Superplasticizer):

Superplasticizers (high range water reducers) are synthetic water-soluble organic substances used to increase the workability without any change in water to cement ratio or used to increase the strength of concrete by reducing w/c% without reducing the workability. Superplasticizer raising the slump from 75mm to 200mm.

.5. 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. VeBe 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 VeBe 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 Test

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 half the 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 is cleaned.
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 force against 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 two edges of the table is measured.

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.
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 around 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. Never continue vibration long enough to cause escape of froth from the sample. Over vibration may cause segregation and loss of intentionally entrained air. Usually, sufficient vibration has been applied as soon as the surface of the concrete becomes relatively smooth and has a glazed appearance.
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.

<u>7. Curing</u>

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.

7.6. Data and Results

Workability Test

7.6.1. Weights

Batch= 35kg

Cement= 5.00kg

Coarse Aggregate= 14.50kg

Fine Aggregate= 13.00kg

Water= 2.50kg

7.6.2. Slump Test

Cone Height (cm)	Slump (cm)	Slump Type
30	6	True

7.6.3. Vebe Test

Time (sec) *(Vebe Seconds)*
6 seconds

7.6.4. Flow Table Test

Dimensions (cm)	Readings (mm)	Diameters (mm)		$D_{f\text{-}avg}$ (mm)	Flow Factor (%)
Table	220	D_{f1}	40,5	402.5	$F.F = \frac{d_{f\,avg} - d_i}{d_i} \times 100\%$
70 x 70	7,50 → 750				$= \frac{402.5 - 200}{200} \times 100\%$
D_i	15,5 → 155	D_{f2}	400		$= 101.25\%$
20	14,5 → 145				

7.6.5 Compacting Factor Test

Wt. of Partially compacted concrete (kg)	Wt. of compacted concrete (kg)	Compacting Factor
14.08	14.36	3.28

-4 ??

Admixtures Test

7.6.6. Weights

Batch= 20kg

Cement =2.86kg

Coarse Aggregates= 8.29kg

Fine Aggregates= 7.43kg

Water= 1.39kg

Plasticizer= 1.15% of cement

Plasticizer= 1.25/100*2.86

Plasticizer= 0.036kg = 36g

New water = 1.39 + 0.36 = 1.426 kg

7.6.7 Results

Admixture Type and name	Cone Height (cm)	Slump (cm)	Slump Type
super plasticizer Name :- Floretes95	30	18cm	Collapse

-3

7.7. Sample of Calculations

Flow Table

$$d_{f1} = 70 - (17.5 + 8) = 40.5\,cm$$

$$d_{f2} = 70 - (13.5 + 12) = 40\,cm$$

$$d_{avg} = \frac{40.5 + 40}{2} = 40.25\,cm$$

ok

Flow Factor

$$= \frac{d_f - d_i}{d_i} \times 100\%$$

$$= \frac{40.25 - 20}{20} \times 100\% = 101.25\%$$

Compacting Factor

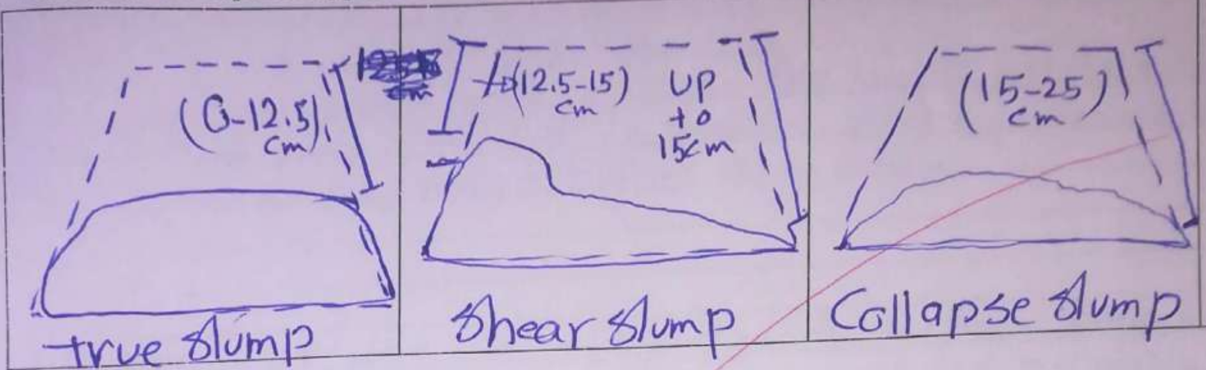
$$\frac{\gamma_{uncompacted}}{\gamma_{compacted}} = \frac{W_{uncompacted}}{W_{compacted}} = \frac{14.08}{14.36} = 0.98$$

ok

7.8. Plot no graphs are needed.

7.9. Discussion

7.9.1 Draw the expected types of slump in slump test.



7.9.2 comment on the results:

1. Slump test In our experiment the slump = 6 so It's true slump the degree of workability for slump test is: slump = 60 mm So It's medium workability (50-100) also observe that when the slump increase the workability also increase. We prepare the slump test by filled the cone on 3 layers every layer 25 push by the rod then we raise the cone in 5 second then we can know the type of slump.

(-3)

2. Vebe Test to its ease of using and low cost. vebe time = 6 sec according to table workability is a high workability (3-7) sec. We use vebe test to determine workability By measuring the time that concret needs to take the shape of the cone. vebe test is specifically used for measuring compactibility and also it measure slump. This test is best for very low workability. when V.b time increase the workability decreass.

3. Flow table This test to know the cohesivness and seggregation of the mixture. According to the ASTM when Davg = 400 mm → medium workability and if Davg = 500 mm is High workability and if Davg = 300 mm → Low workabity. in our experiment Df = 402.5mm So It's medium workability. when D increase the workability increase. Flow table specifically used for collapse slump. This apparutus is the best for measuring seggreagation and for very high workability

4. Compacting Factor In our experiment we found that compacting Factor = 0.98 and that less than 1 (It must be < 1), and accordding to the standard compacting Factor It's very high workability. why (-2)
when compacting factor increase the workability increase
Dis advantages: Not fit to measure very and low, high workability and it takes along time.

5. Admixtures: We use superplasticizer to increase workability without decreasing the strength of concret by maintaing w/c ration.

	before adding the admixture	after adding the admixture
C : W	5.00 : 2.50 = 1 : 0.5	2.86 : 1.426 = 1 : 0.498
C : F.A	5.00 : (14.05) = 1 : 2.81	2.86 : 7.43 = 1 : 2.59
C : CA	5.00 : (13.00) = 1 : 2.6	2.86 : 8.29 = 1 : 2.89

we note that the ratios are still constant after adding the admixture, so the strength of concrete remaine the same but with more workability, In our exp slump was = 100 mm so this sample is a collapse slump has very high workability according to ASTM and its accepted because its without segregation

7.9.3 Source of errors

1- Error in adding super plasticizer.
2- Error in using the apparatus.
3- Errors in using timer.
4- We used the same sand For all test.

~~we can't Reject~~

7.10. Remember to make your report tidy and neat ☺

مختبر مواد البناء / التجربة الثامنة / جميع الشعب

Building Materials Laboratory

Experiment No.: 8

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

Name	Mark
Sojoud Ismail Al-Soud	96/100

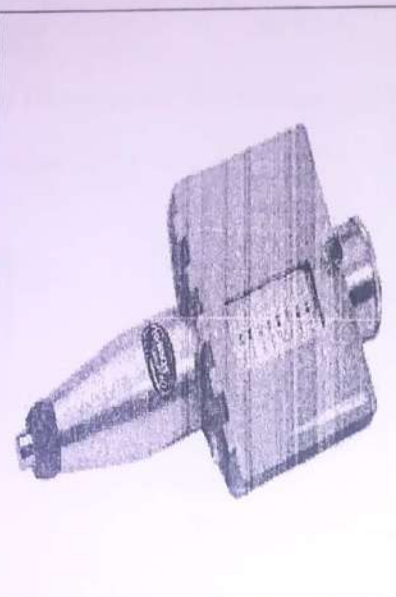
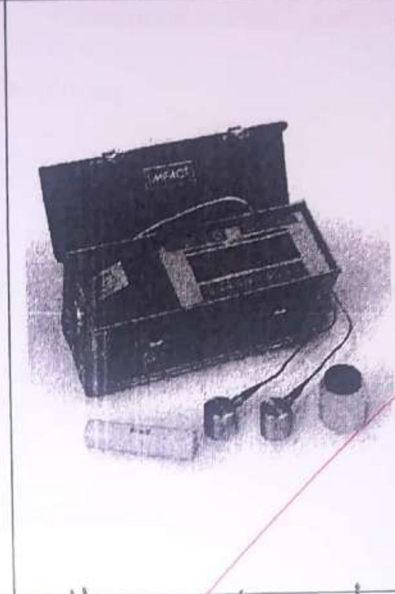
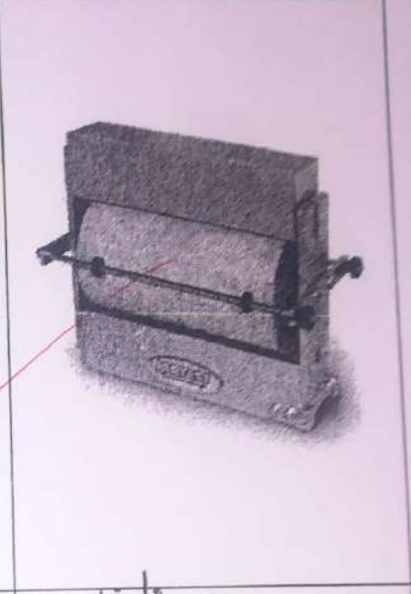
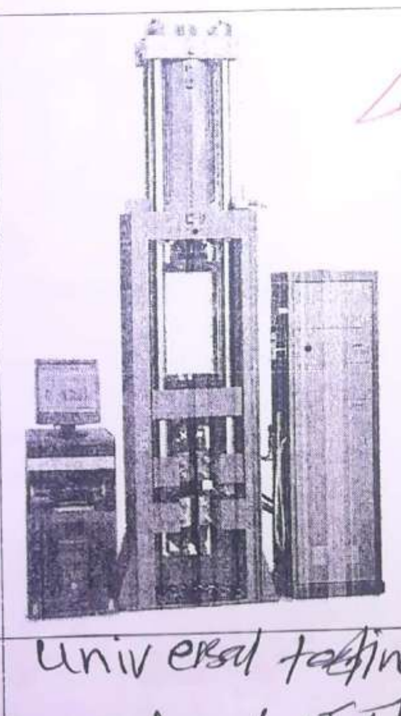
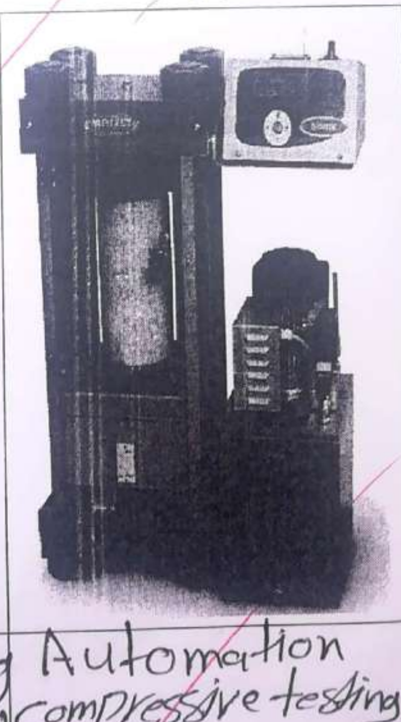
Student's number	Section number	Experiment day and date	Submission day and date
1732436	1	Sunday	Sunday

Experiment 8

Part.1: Concrete Strength by Non-Destructive Methods

Part.2: Concrete Strength by Destructive Methods

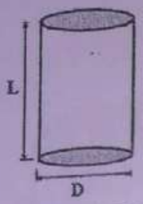
8.1. Apparatus and Equipment:

Apparatus			
Name	Re bawnd Hummar	ultra sonic pulse velocity test machine	spliting appartus
Apparatus			
Name	universal testing machine (UTM)	Automation compressive testing machine	Manual compressive testing machine

8.2. Theory

8.2.1 Destructive Tests

- **Compressive Strength of cylindrical Concrete Specimens**



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

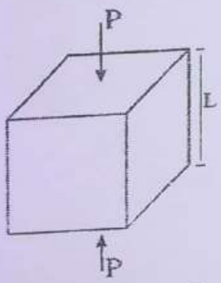
$$\sigma = \frac{P}{\pi r^2}$$

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

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

Failure Type:

- **Compressive Strength of cubic Concrete Specimens**



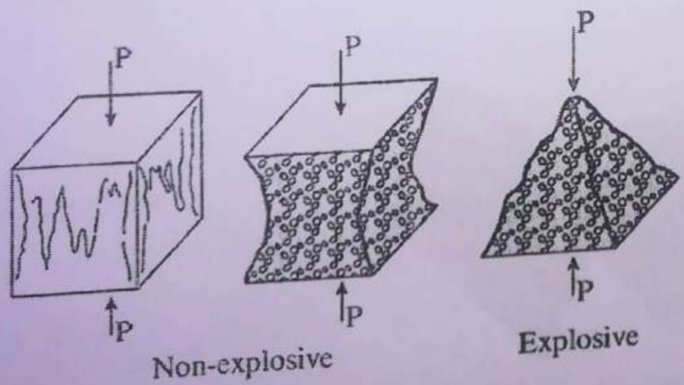
$$\sigma = \frac{P}{A}$$

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

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

Standard Dimension: L= 150mm

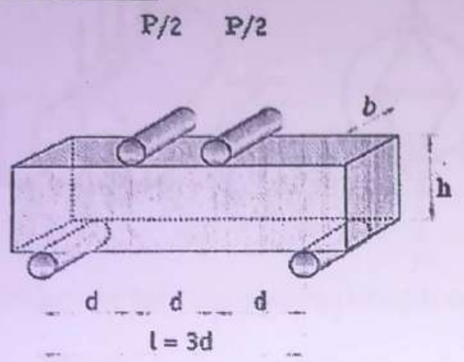
Failure Type:

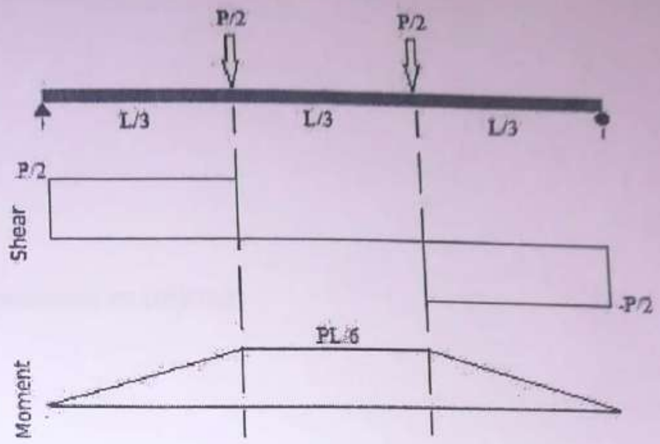


- **Flexural Strength of beam Concrete Specimens**

The flexural strength of the specimen shall be expressed as the modulus of rupture f_b.
Standard dimension: h= 150mm, b= 150mm, L= 450mm and total length= 700mm.

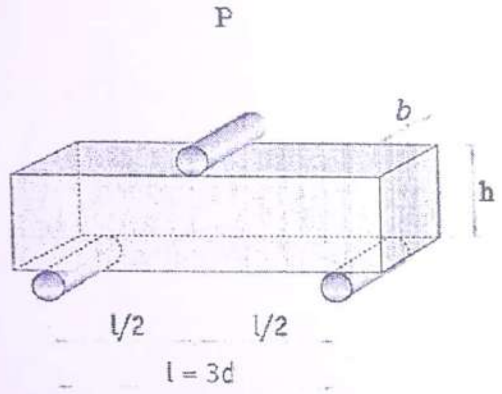
2 Point Load

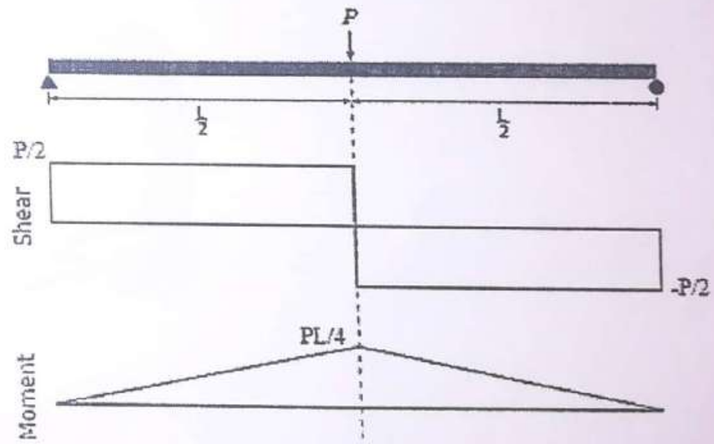




$$\sigma\,(f_b) = \frac{My}{I} \qquad y = \frac{h}{2} \qquad I = \frac{1}{12}bh^3 \qquad \sigma\,(f_b) = \frac{PL}{bh^2}$$

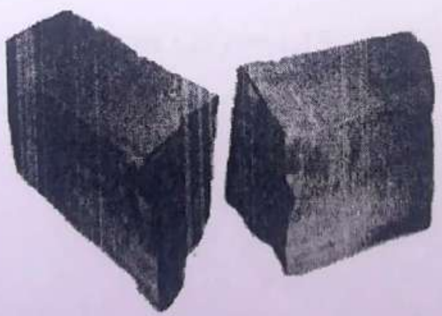
1 Point Load



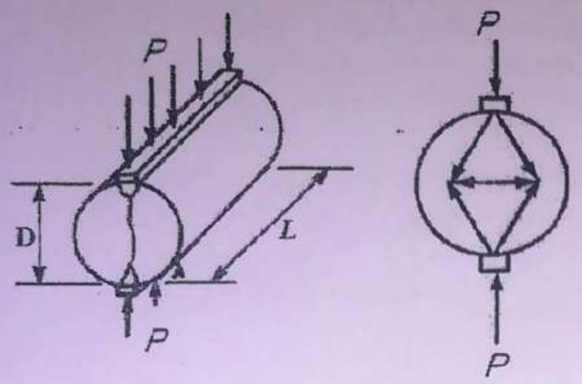


$$\sigma\,(f_b) = \frac{My}{I} \qquad y = \frac{h}{2} \qquad I = \frac{1}{12}bh^3 \qquad \sigma\,(f_b) = \frac{3PL}{2bh^2}$$

Failure Type:



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

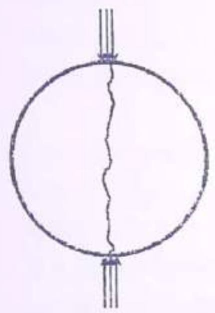


Calculate the splitting tensile strength of the specimen as follows:

$$\sigma = \frac{2P}{\pi DL}$$

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

Failure Type:



Destructive tests relations:

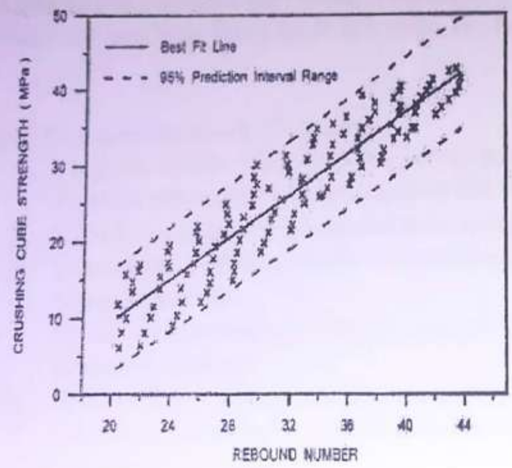
- Compressive strength of cube = 1.25 Compressive strength of cube
- Direct tension strength = 0.9 Splitting strength
- Compressive strength = (7 – 11) Tensile strength
- Flexural strength (Modulus of rupture (2P)) = 1.15 – 1.25 Splitting strength

8.2.2 Non-Destructive Tests

- **Rebound Number of Hardened Concrete**

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

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



- **Pulse Velocity Through Concrete**

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

  Calculate the pulse velocity as follows:

  V=L/T

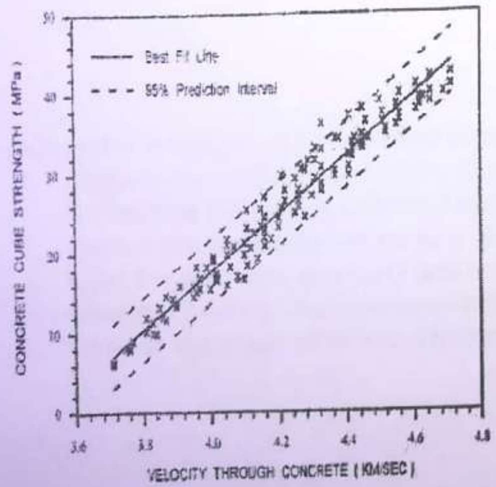
  Where:

  V= pulse velocity, m/s

  L= distance between transducers, m

  T = effective transmit time, s

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



8.2. 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.
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 (calibration base).
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 $N/mm^2.s$ to 0.4 $N/mm^2.s$) 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 689 to 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 fiber 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.

8.3. Data and Calculations

8.3.1. Non –Destructive Tests

8.3.1.1. Pulse Velocity

Reading #	1	2	3	4	5	6	7	8
T (μsec)	26	26	28.4	25.8	27.8	27.8	28	27

$T_{(avg)}= \frac{\Sigma T \text{ of reading}}{\# \text{ of reading}} = \frac{216.8}{8} = 27.1\ \mu sec$

$V_{(avg)}= \frac{L}{T_{avg}} = \frac{10 * 10^{-2}}{27.1 * 10^{-6}} =$ 3690 m/sec = 3.69 km/sec

σ_{avg} (Mpa)= 7 Mpa

σ_{range} (Mpa)= (3 – 11) Mpa

8.3.1.2. Rebound Number

Reading #	1	2	3	4	5	6	7	8	9	10
Re #	24	23	23	20	25	20	20	19	23	24

$Re_{(avg)}= \frac{24+23+23+20+25+20+20+19+23+24}{10} = 22.1$

$Re_{(range)}=$ Reavg ± 6 = (16.1 – 28.1) ⇒ all values are accepted

$Re_{(new\ avg)}=$ 22.1

σ_{avg} (Mpa)= 13 Mpa

σ_{range} (Mpa)= [6 – 20] Mpa

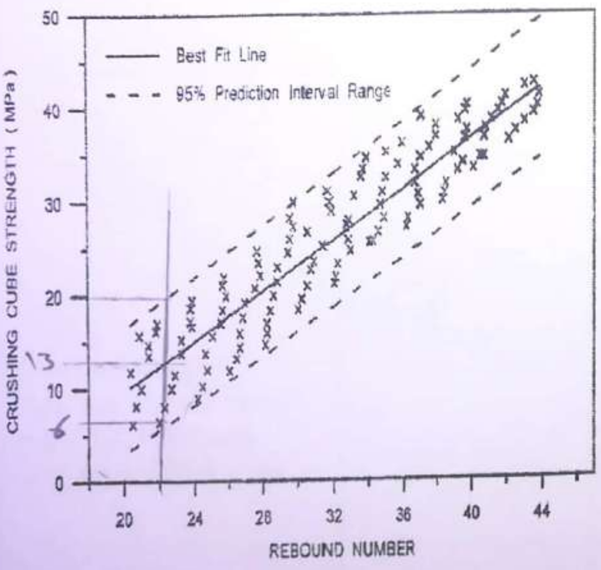


Fig. 1. Relationship between rebound number and crushing cube strength.

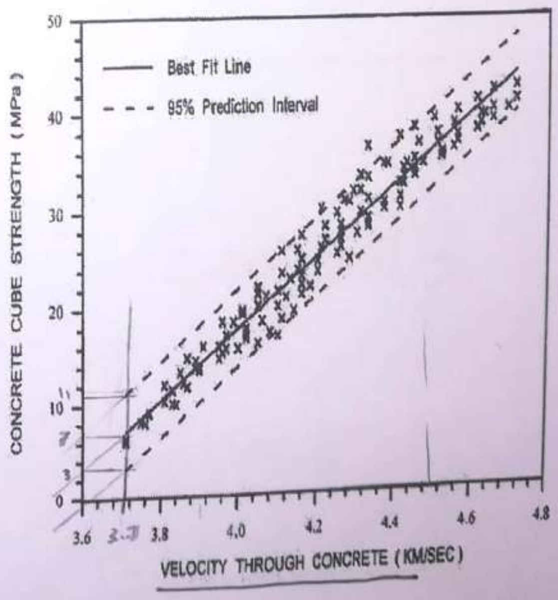


Fig. 2. Relationship between ultrasonic pulse velocity and crushing cube strength.

8.3.2. **Destructive Tests**

Test	Max. Load (KN)	Strength (MPa) Show your calculations
Compressive Strength [Cubes] (100*100*100)mm	379	~~$A = \frac{\pi}{4} D^2 = \frac{\pi}{4}(0.1)^2 = 7.85\times10^{-3}$~~ $\frac{P}{A} = \frac{379 \times 10^{3}}{10^{-2}} = 37.9$ Mpa Area = 0.01
Compressive Strength [Cylinders] (100*200)mm	185.9	$A = \frac{\pi}{4} D^2 = \frac{\pi}{4}(0.1)^2 = 7.85\times10^{-3}$ $\frac{P}{A} = \frac{185.9\times10^{3}}{7.85\times10^{-3}} =$ 23.67 Mpa
Tensile Strength Splitting Test (100*200)mm	100	$\frac{2P}{\pi L D} = \frac{2\times100\times10^{3}}{\pi \times 0.2 \times 0.1} = 3.18$ Mpa
Tensile Strength Flexural Test (2-Point) (100*100*~~200~~)mm (10*40) cm	22	طار العجة

B Flexural

Dim → 10 × 10 × 40 cm

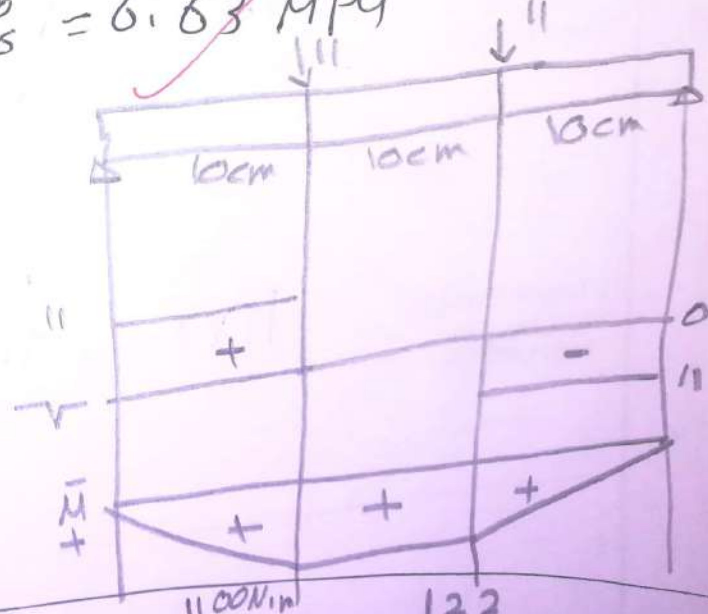
2 point load = 22 kN

$M = P * a = 11 * 10^3 * 0.1 = 11 * 10^2 \text{ N.m}$

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

$y = \frac{h}{2} = \frac{10 * 10^{-2}}{2} = 0.05 \text{ m}$

$\sigma = \frac{My}{I} = \frac{1100 * 0.05}{8.3 * 10^{-6}} = 6.63 \text{ MPa}$



8.4. Discussion

8.4.1. Non-Destructive Tests

1) Error% of Rebound Number Test

Re# = σavg = 13 Mpa

Compressive = σavg = 37.9

Error = |37.9 - 13 / 37.9| × 100% = 65.7 %

2) Error% of Pulse Velocity Test

pulse velocity = σavg = 7

Compressive = σavg cube = 37.9

|37.9 - 7| / 37.9 × 100% = 81.5 %

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

the plose Velocity is more accurate than Rebound and that because the Rebound hammer effect only at the surface of concert and It have more personal errors than the plus velocity.

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

to removed dust, Because the dust will make air bubly between the transmitter and receiver and between the spediem, and the speed in air will be less than in thes which gives as indecation that the concrete we used it

8.4.2. Destructive Tests

1) Fill the following table

	Experimental Results	Standards	Accepted or Not
Compressive Strength of Cube / Compressive Strength of Cylinder	37.9 / 23.67 = 1.6	1.25	Not accepted
Direct Tension (MPa)	3.18 × 0.9 = 2.862	σ direct / σ spliting = 0.9	—
Compressive Strength of Cube / Direct Tension	37.9 / 2.862 = 13.24	(7 – 11)	Not accepted
Flexural Strength (2P) / Splitting Strength	6.63 / 3.18 = 2.08	~~(1.15 – 1.35)~~ (1.15 – 1.25)	Not accepted

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

~~Flexural strength (1P) / Flexural strength (2P) = 9.94 / 6.63 = 1.49 and It is accepted because the standard is 1.5~~

because there is a shear + ~~the standard~~

If we [illegible] have the same load the result of P1, P2 will be equal but the load is changed So the result in P1 method will be larger than P2 method.

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

① Non - Explosive Failure ② Explosive Failure

And our case is non Explosive Failure

Draw it

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

① split-~~Fail~~ Faulire ② shear Faulire ③ shear & split

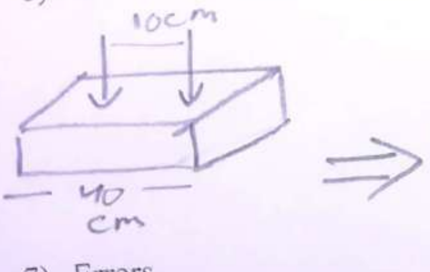
And our case is shear & split

Draw it

splitting faliur

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

6) Draw the failure of a flexural beam



7) Errors

✓ error in Reading the load (p) from the machine

when we used the rebaund hammer some of the hit were Slope

✓ ~~the UTM wasn't worked and we assumed that the load equal~~

8.5. Remember to make your report tidy and neat ☺

Building Materials Laboratory

Experiment No.: 6

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

Name	Mark
sujoud Ismail Al-Soud	90/100 → 9/10

Student's number	Section number	Experiment day and date	Submission day and date
1732436	1	sunday	sunday

Experiment 6

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

6.1. Objectives

to caculate L.A number of sample of CA. and to test the Hardness C.A and to Find the Resistance to abrasion

-0.5

6.2. Apparatus and Equipment

~~Coarse ag~~ sieve apparatus
L.A abarsion Test machine
pan , steal ball , balance

6.3. Materials

Coarse aggregate,

-0.25

6.3. Theory

Abrasive Charge-The abrasive charge shall consist of cast iron spheres or steel spheres approximately 48 mm in. diameter and each weight between 390 and 445 g. The number of charges depends on the required grading as shown in table 6.1.

Table 6.1. Specified abrasive charge

Grading	Number of spheres	weight of charge (g)
A	12	5000 ± 25
B	11	4584 ± 25
C	8	3330 ± 20
D	6	2500 ± 15
E	12	5000 ± 25
F	12	5000 ± 25
G	12	5000 ± 25

The test sample consist of clean aggregate which has been dried in an oven at 105°C to 110°C and it should conform to one of the grading shown in table 6.2.

Table 6.2. Grading of test samples

Sieve Size (mm)		Weight of Test Sample for Grade (g)			
Passing	Retained on	A	B	C	D
37.5	25	1250±25	-	-	-
25	19	1250±25	-	-	-
19	12.5	1250±10	2500±10	-	-
12.5	9.5	1250±10	2500±10	-	-
9.5	6.3	-	-	2500±10	-
6.3	4.75	-	-	2500±10	-
4.75	2.36	-	-	-	5000±10
Total	5000±10	5000±10	5000±10	5000±10	5000±10

The abrasion value calculated using the flowing equation:

$$\text{Abrasion\%} = \frac{\text{Weight of passing sieve\#12}}{\text{Weight of original sample}} * 100\%$$

OR:

$$\text{Abrasion\%} = \frac{\text{Weight og original sample - Weight of retained on sieve\#12}}{\text{Weight of original sample}} * 100\%$$

6.4. Procedure

1. The test sample shall consist of clean aggregate which has been dried in an oven at 105 to 110°C to substantially constant weight and shall conform to one of the gradings (A to D). The grading or gradings used shall be those most nearly representing the aggregate furnished for the work.
2. The test sample and the abrasive charge shall be placed in the Los Angeles abrasion testing machine and the machine rotated at a speed of 30 to 33 rev/min. For gradings A, B, C and D, the machine shall be rotated for 500 revolutions.
3. The machine shall be so driven and so counter-balanced as to maintain a substantially uniform peripheral speed. If an angle is used as the shelf, the machine shall be rotated in such a direction that the charge is caught on the outside surface of the angle.
4. At the completion of the test, the material shall be discharged from the machine and a preliminary separation of the sample made on a sieve coarser than the 1.70 mm IS Sieve.
5. The material coarser than the 1.70 mm IS Sieve shall be washed dried in an oven at 105 to 110°C to a substantially constant weight, and accurately weighed to the nearest gram.

6.5. Data and Calculations

Data:

W_1: Weight of aggregate before testing = 5000 g

W_2: Weight of aggregate retained on sieve #12 after testing = 2521 g

Calculations:

Calculate the Abrasion% = $\frac{5000 - 2521}{5000} \times 100\% = 49.58\%$

or

$\frac{\text{weight original sample} - \text{weight of agg retained}}{\text{weight origing}}$

6.6. Discussion

- What is the quality of our sample? Why?

can't be used according to the Standard L.A when th L.A > 45% it can't be used and in our experiment the L.A = 49.58%

- How the L.A. value is affected if the sample is subjected to 700 rpm?

~~If we increased the speed~~ the standard speed is between (30-33rpm) and IF we increased the speed to 700rpm then more crushing and the L.A will be larger

- The abrasion value found from Los Angeles test for two aggregates A and B are 12% and 22% respectively. Which aggregate is harder? Why? For what types of constructions are these suitable? ?? -0.5

the aggregate A is harder because the L.A number For sample A (12%) is less than the sample B (22%) and the relation between the L.A number and harding is inverse Increase L.A number the decreas Harding

6.7. Remember to make your report tidy and neat ☺