# LAB REPORT
# ON
# CIVIL ENGINEERING MATERIALS

To determine the normal consistency of cement

Objective

- The objective of this experiment is to find the percentage of water required for preparing cement paste of standard consistency.

Apparatus

a. Vicat's apparatus with plunger 10mm dia
b. weighing balance/weighing machine
c. Towel
d. Measuring glass
e. Clean plate to make cement paste

Materials

a. cement
b. water

Theory

consistency: A certain minimum quantity of water is required to be mixed with cement so as to complete chemical reaction between water and cement, less water than this quantity would not complete chemical reaction thus resulting in reduction of strength and more water would increase water cement ratio and so would reduce its strength. So correct proportion of water to cement is required to be known to achieve proper strength while using cement in structure. This can be found out knowing standard consistency of cement paste.

Standard consistency (normal consistency)

Standard consistency of cement paste is defined as that cement paste in which vicat's plunger of 10mm dia. penetrates 30 to 35 mm from top of vicat mould in the test. It is expressed as amount of water as a percentage (by weight) of dry cement.

Necessity and uses of standard consistency

Generally normal consistency of cement is 30% but cement from different factories may not have same properties so it is necessary to standardize the consistency.

The knowledge of standard (normal) consistency is required for performing other test like setting time, soundness, etc. as these tests are performed on cement paste using a certain percentage of water required for normal consistency.

Gauging time: It is the period observed from the time water is added to cement for making cement paste till starting the filling of mould of vicat apparatus.

Vicat's apparatus: It consists of metal frame to which a movable rod weighing 300g (along with cap and attachment) with 10mm dia and 50mm length is attached. The movable rod is provided with releasing pin to let rod free and is attached with an indicator to take readings on a vertical scale graduated from 0 to 50mm which gives penetration. The vicat mould is in form of cylinder and is placed on a non-porous plate. The whole apparatus may be made of gun metal, aluminium or steel. The attachments are -

(i) square needle : used for initial setting time test;

(ii) plunger : used for consistency test (as in this experiment);

(iii) Annular collar : used for final setting time test.

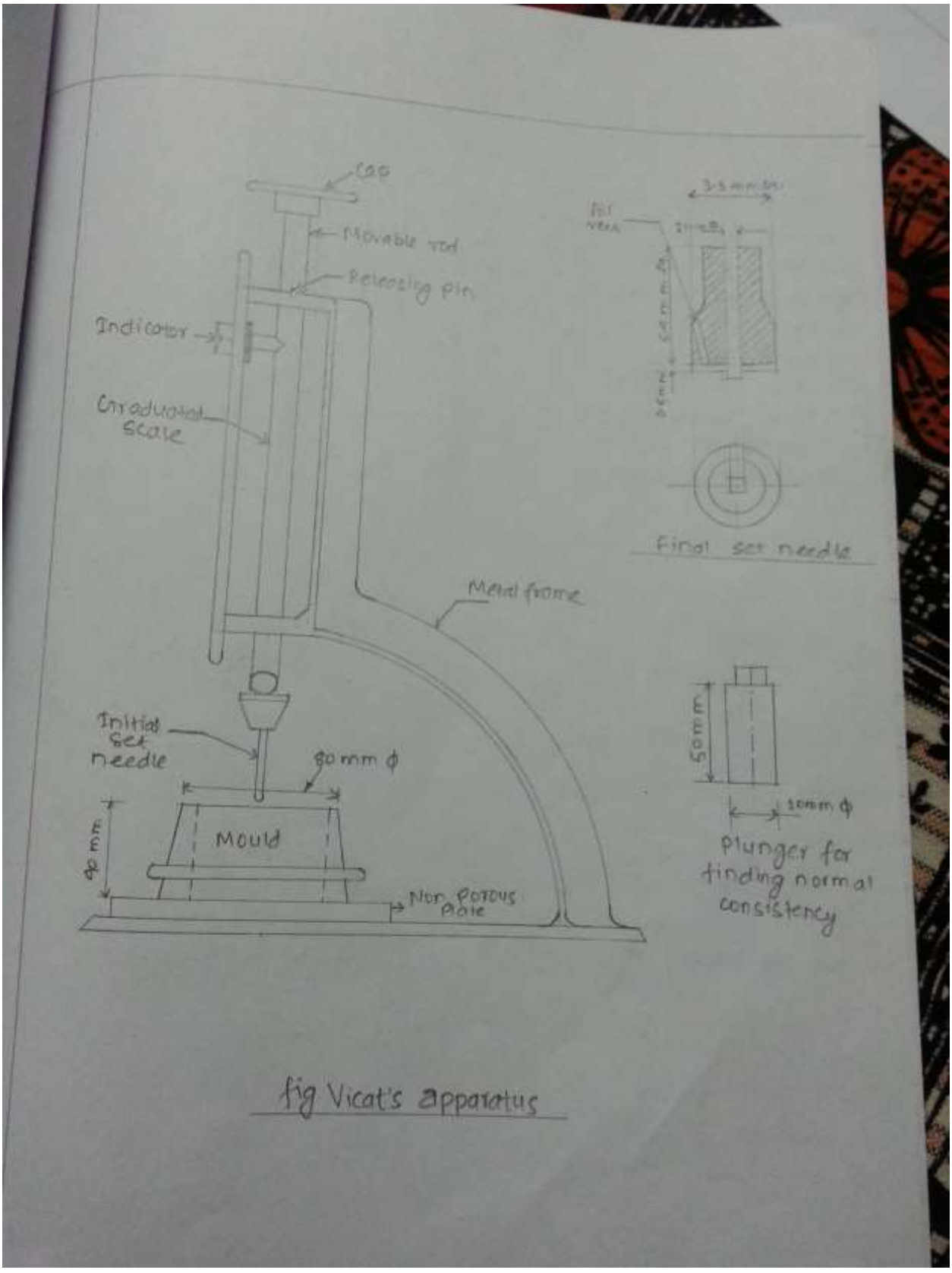


fig Vicat's apparatus

## Procedure

300g cement was weighed then water, equal to 45% of weight of cement, was added to cement and it was mixed to form paste of cement then the paste is poured into vicat's mould. After preparing mould, plunger of 10mm diameter was penetrated into it. Penetrated distance was noted from graduated scale of vicat's apparatus. By hit and trial method, different amount of water was chosen and same process was carried out until the penetration was obtained within 30mm to 35mm in order to prepare cement paste of standard consistency.

## Observation

| weight of cement (g) | % of water added | penetration (mm) |
|---|---|---|
| 300 | 45 | 41 |
| 300 | 33 | 25 |
| 300 | 40 | 43 |
| 300 | 35 | 34 |

## Result

Normal consistency of cement was found to be 35%.

## Conclusion

In this way the normal consistency of cement can be determined using vicat's apparatus.

To determine the initial and final setting time of cement

## Objective

- The objective of this test is to know the time to be allowed to pass between mixing of concrete and placing in position in structure.

## Apparatus

a. Vicat's apparatus
b. weighing machine
c. Trowel
d. Measuring glass
e. Clean plate to make cement paste

## Materials

a. Cement
b. Water

## Theory

When cement is mixed with water (25 to 30% by weight), sticky paste is formed which remains plastic for a short period. With the passage of time, the plasticity gradually disappears and the cement paste becomes stiff due to initial hydration of cement. This phenomenon by virtue of which the plastic cement changes into a solid mass is known as setting of cement. On setting, the cement binds the aggregates into a solid mass which gains strength as the time elapses till the hydration of cement is complete (hydration of cement is the chemical reaction between cement and water).

## Initial setting time

It is the time interval between the time when water is added to cement and the time of partial loss of plasticity, as determined by a standard test in which the needle of cross sectional area 1 $mm^2$ penetrates the block to a depth of 5mm from bottom.

## Final setting time

It is the time interval between the time when water is added to cement and the time it acquires a certain firmness to resist certain definite pressure, as determined by standard test in which needle makes an impression on the test block.

## Significance of setting times

As loss of plasticity starts at the end of initial setting time, the concrete must be mixed, transported and placed in position before initial setting time. As final setting time approaches, cement becomes harder and harder and concrete can't be placed or deposited.

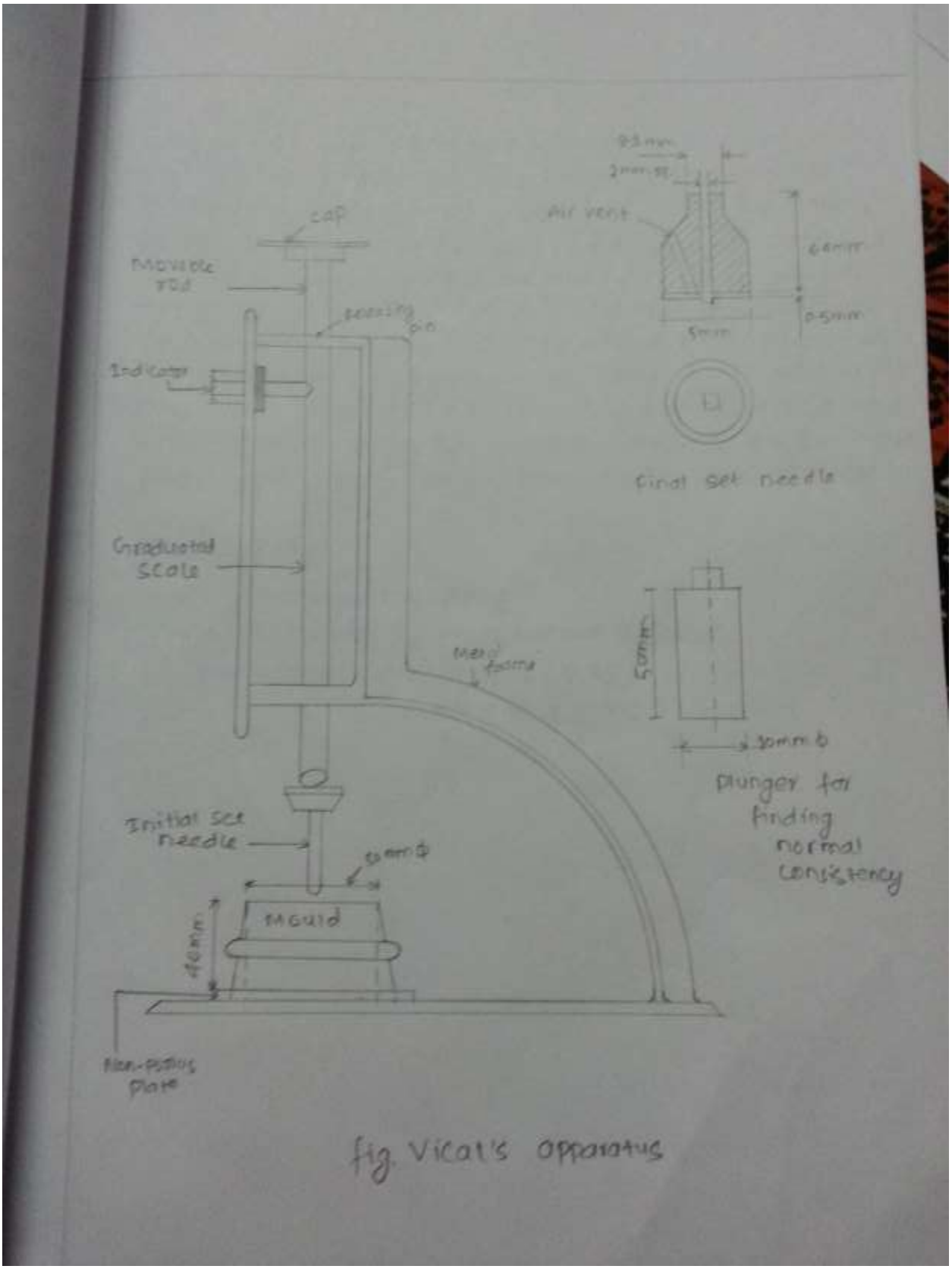


fig. Vicat's apparatus

## Procedure

300g cement was taken and required amount of water was added to form paste of cement then paste was poured in vicat's apparatus(mould). With the help of square needle of 1 $mm^2$ cross-sectional area, attached to vicat's apparatus, penetration was checked after every five minutes. Then initial setting time was obtained as the difference of initial time (when water and cement were mixed) and time when penetration was 5mm from bottom. Then the mould was tested with annular collar. If it made impression on mould, final setting time was considered to have occurred.

## Observations

Wt of Cement = 300g

water added = wt of cement x 0.85P

(P = normal consistency = 0.35)

= 300 x 0.85 x 0.35 = 89.25ml

≈ 90ml

To determine the compressive strength of cement sample

## Objective

- The objective of this test is to determine the suitability of cement for developing required compressive strength of concrete and mortar.

## Apparatus

a. Standard mould of size 70mm x 70mm x 70mm
b. Vibrating machine
c. Weighing balance
d. Trowel
e. Clean plate to make cement paste
f. Compression testing machine

## Materials

a. Cement (185g)
b. fine sand (185 g)
c. medium sand (185 g)
d. Coarse sand (185 g)

## Theory

As shrinkage, cracks are formed in dried cement paste, test cannot be properly carried out on a block of cement paste so the test is carried out indirectly on blocks of mortar made of cement, sand and water.

As quality of sand varies with sources, it is necessary to use sand of standard quality for this test.

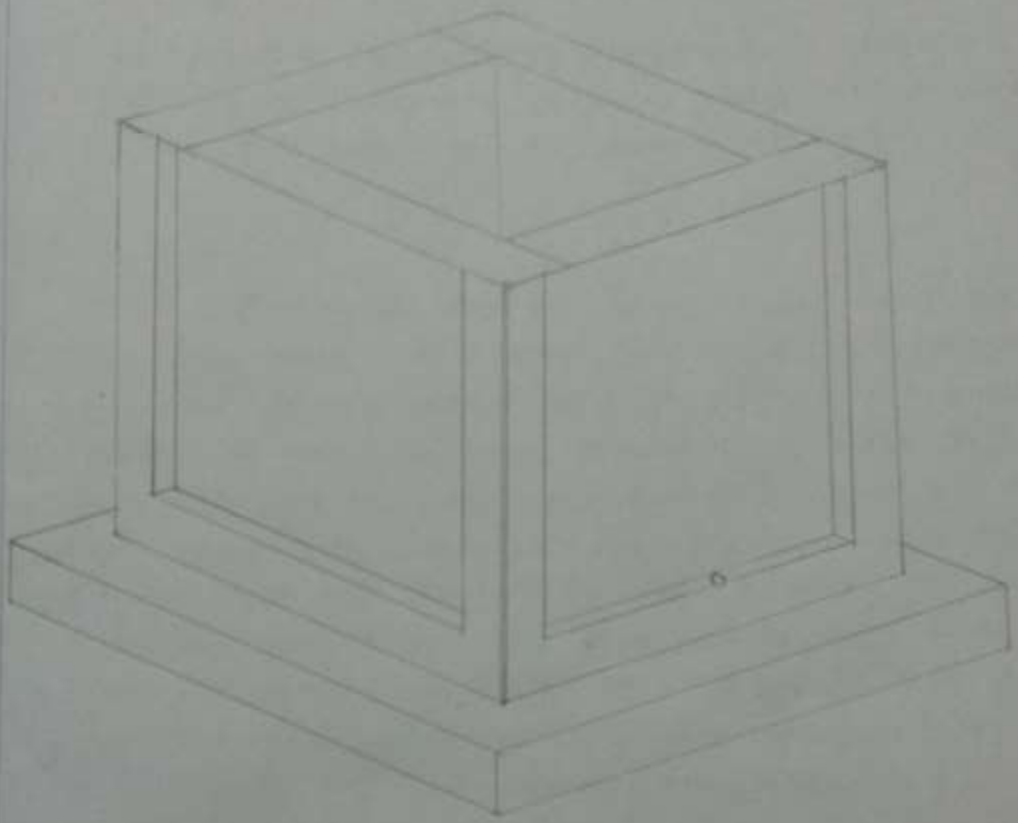

fig: CUBE MOULD (7cm x 7cm x 7cm)

## Significance of the test

(a) Many other properties of cement concrete or cement mortar such as durability, porosity, shear or tensile strength are related to its compressive strength

(b) Compressive strength of cements from different sources or cements of different kinds are different. Thus this test indicates quality of cement.

## Procedure

Cement, fine sand, medium sand, coarse sand each of 185g were mixed and then calculated amount of water (90 ml) was added to prepare mortar. Then with trowel it was poured in a cube of 7mm side and the cube was placed on vibrating machine which freed some space in cube. The space was filled with mortar and then after 24 hours the cube of mortar was taken out from mould and kept in water for seven days. After seven days, it was dried and its compressive strength was measured in compressive strength testing machine.

## Observation

Weight of cement = 185g
weight of fine sand = 185g
weight of medium sand = 185g
weight of coarse sand = 185g
water added = $\left(\frac{P}{4} + 3.5\right)\%$ of total weight
(P = normal consistency, here P = 35 obtained from normal consistency test)
$= \left(\frac{35}{4} + 3.5\right)\% \times (185 \times 4) = 90 ml$

weight of dried cube of cement, sand, water mixture
= 744 g

volume of cube = 7cm x 7cm x 7cm
= $(7 \times 7 \times 7)\ mm^3 = 343 \times 10^3\ mm^3$

Area of cross-section of cube, A = 70mm x 70mm
= $4900\ mm^2$

Breaking load = 38kN

compressive strength = $\frac{38 \times 10^3}{4900} = 7.755\ N/mm^2$
after 7 days

## Result

The compressive strength of cement mortar at the age of 7 days is 7.755 $N/mm^2$.

## Conclusion

To test the soundness of cement sample

## Objective

- The objective of this test is to detect whether there is presence of lime and magnesia which are uncombined in cement.

## Apparatus

(1) Le Chatelier split cylinder mould with two indicators
(2) weighing balance
(3) Measuring cylinder
(4) Glass plates
(5) Temperature control water bath
(6) Scale to measure distance

## Material

(1) 100g cement
(2) water

## Theory

Any cement is said to be sound if it doesn't contain uncombined lime and/or magnesia. Any structure has to be durable. Its durability depends on how sound the material is. For cement, soundness depends on its ingredients. Especially excess of lime and/or magnesia present in (uncombined) cement causes unsoundness. These material expand in structure so concrete or mortar also expands causing disintegration. This test is designed to increase expansion in cement by application of heat. Expansion beyond certain limit results in unsoundness of cement.

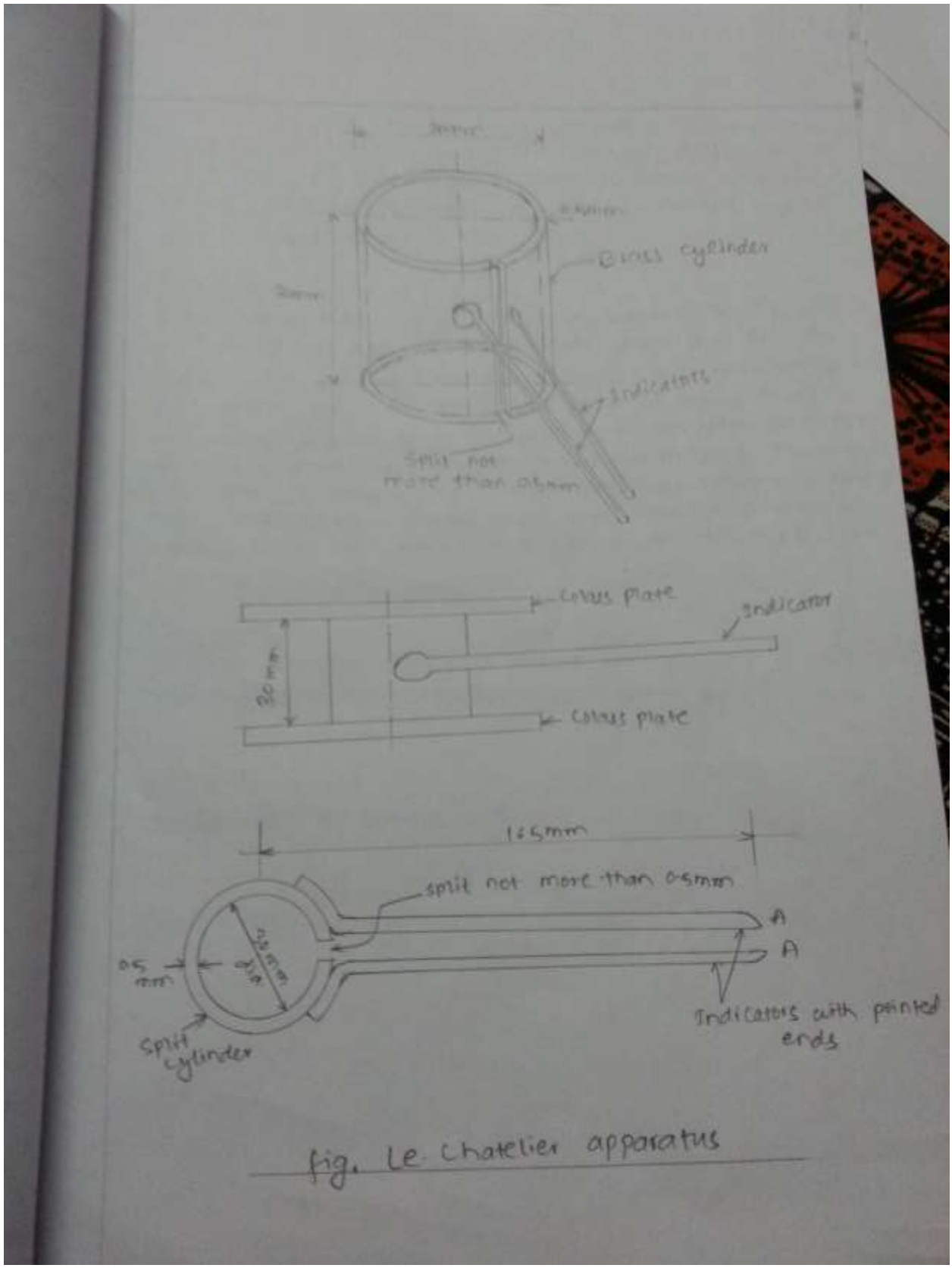


fig. Le Chatelier apparatus

le chatelier apparatus is used to determine the soundness of cement. It consists of small brass cylinder (30 mm dia., 30mm high and 0.5mm thick). Two indicator arms with pointed ends of 165mm are attached to the cylinder one on each side of the split.

## Procedure

100g cement was weighed and water equal to 35% (P) by weight (i.e. 35ml) was added to it to make paste and then the paste was poured into split cylinder of le chatelier apparatus with glass plate on both sides to cover mould. Then it was fully submerged in temperature control water bath. After 24 hours, distance between indicators ($d_1$) was measured. Then mould was kept in water which was heated and brought to boiling point. After nearly 1 hours, mould was removed from water, allowed it to cool and distance between the indicators ($d_2$) was measured.

## OBSERVATION

Distance between indicators before boiling, $d_1$ = mm

Distance between indicators after boiling, $d_2$ = mm

## Result

Expansion of cement = E =

## Conclusion

OBJECTIVE:-
TO DETERMINE THE WATER ABSORPTION CAPACITY OF BRICK SAMPLE.

APPARATUS REQUIRED:-
1) Weighing Machine

MATERIALS REQUIRED:-
1) Bricks
2) Water

THEORY:-
Water absorption of brick is defined as the ratio of weight of water absorbed to the dry weight of the brick in a standard period of time. Water absorption indicates degree of porosity in a brick. Less water absorption (<20%) is good quality brick and suitable for construction work. Strength, stiffness and other properties decreases with porosity.

| Class of brick | Water absorption |
|---|---|
| First | 20% |
| Second | 25% |
| Third | 25% |

PROCEDURE
Nepali and Chinese bricks were weighed in dry condition and then kept submerged fully in water for 24 hours. Then, their weights were measured. Finally, water absorption capacity was calculated.

OBSERVATION
Initial weight of Nepali brick
Final weight of Nepali brick

Initial weight of Chinese brick
Final weight of Chinese brick

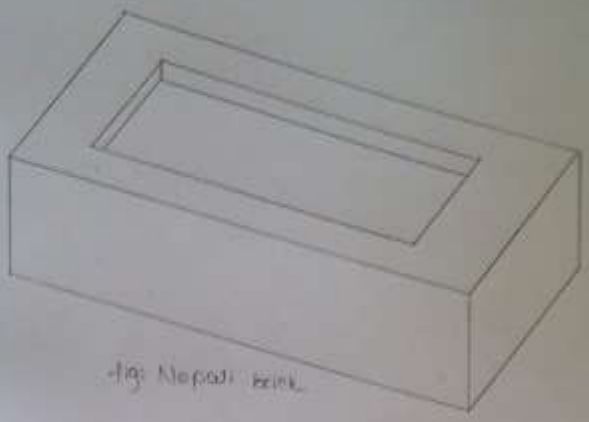

fig: Nepali brick

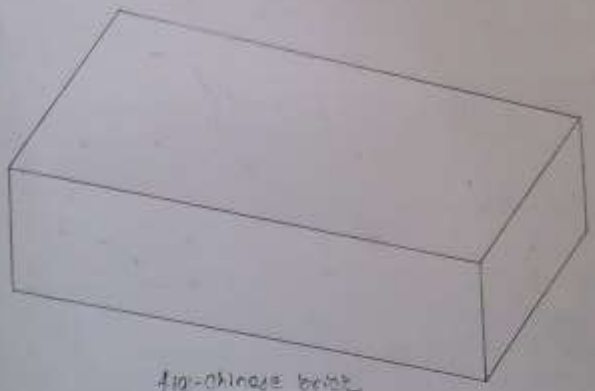

fig- chinese brick

OBJECTIVE

To determine the compressive strength of brick sample.

APPARATUS REQUIRED:-

1) Compression testing machine
2) Weighing machine
3) Trowel
4) Measuring cylinder
5) Clean plate

MATERIALS REQUIRED:-

1) Brick
2) Cement
3) Sand
4) Water

THEORY:-

Bricks used in construction work should have adequate compressive strength to resist loads.

| Class of brick | Compressive strength ($N/mm^2$) |
|---|---|
| First | more than 10.5 |
| Second | 7.0 to 10.5 |
| Third | 3.5 to 7.0 |

$$\text{Compressive strength} = \frac{\text{maximum load of failure}}{\text{loaded area of brick}}$$

PROCEDURE:-

1) Mortar was prepared by mixing cement and sand in 1:3 ratio
2) Frog and voids of brick was then filled with it so as to make the faces parallel and smooth.
3) Then it was left to dry and after 7 days its strength was measured. For this, the brick sample was placed in the compression testing machine and maximum load at failure was noted.
4) Compressive strength was obtained by dividing maximum load of failure by area of brick of loaded surface.

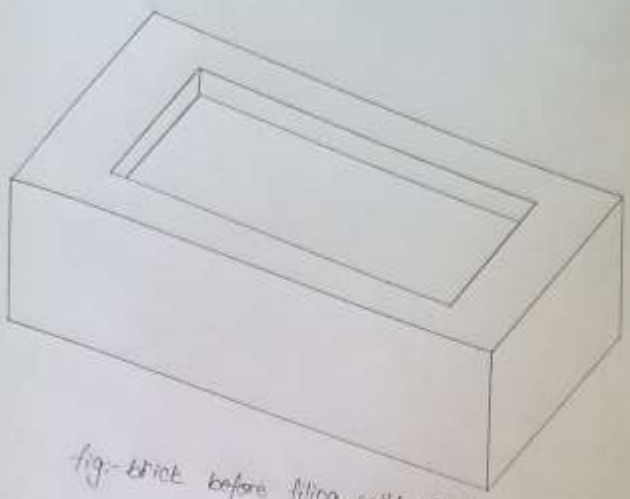

fig:- brick before filling with mortar

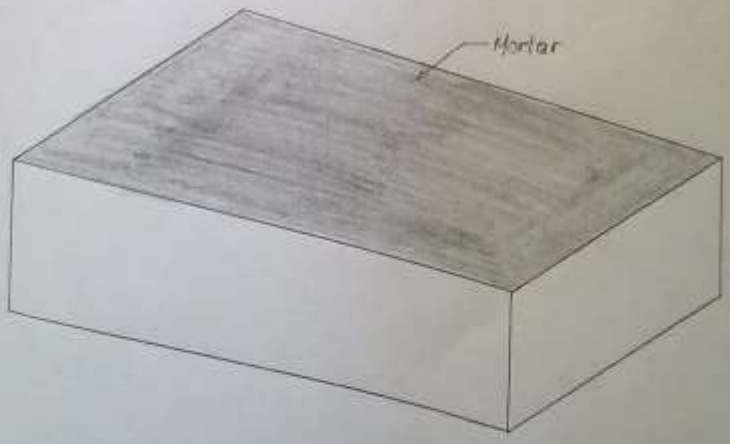


fig - brick after filling with mortar