

**Ministry of Higher Education and Scientific
Research**

Middle Euphrates Technical University

College of Polytechnic/Karbala

**Department of Mechanical Engineering
Technologies**



Manufacturing Process Laboratory

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Supervision

Prof. Dr. Maher Hamid Majeed

Dr. Zainab Abdul Rahim Abdul Hassan

By

Eng. Benin Nazim Aziz

Ali Karim Thamer

Week (1)

Experiment Name :-

Measurement with a sliding vernier caliper.

Purpose of the experiment :-

Identify the different types of foot .

Identify the components of a foot .

Identify and calculate the accuracy of a foot .

Identify and calculate the range of a foot .

Use a foot to measure external and internal dimensions and depths .

Equipment and tools used:-

Calipers with varying precision and measuring ranges .

Various metal models for measuring dimensions .

Experience :-

Various types of vernier calipers are used in practice for measuring, depending on their accuracy and range. There are calipers with an accuracy **of 0.1 mm, 0.05 mm, and 0.02 mm**. The sliding vernier caliper is considered one of the most important measuring tools used in metalworking. Vernier calipers are used in workshops and laboratories to measure external and internal dimensions and hole depths in parts and work pieces.

Parts of the foot:-

Fixed jaws .

Movable jaws .

Fixed.

Vernier scale display.

Stem.

Depth gauge .

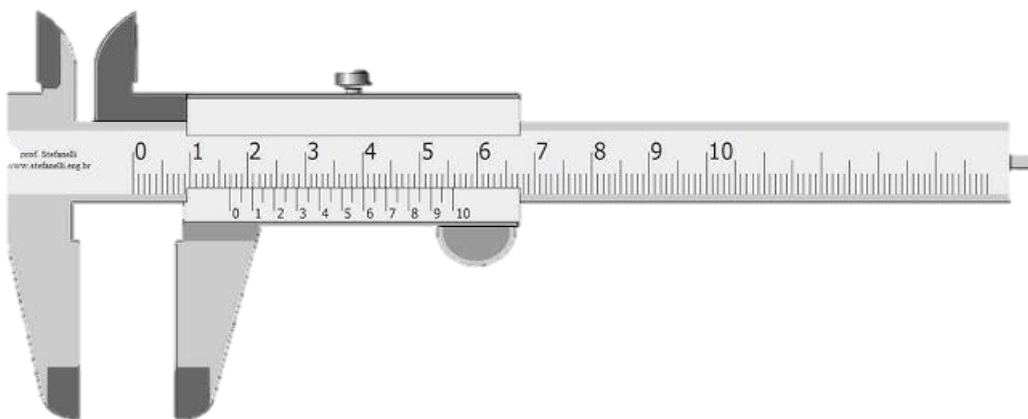


Fig (1-1)

Types of foot :-

Vernier foot .

Electronic foot .

Depth measuring foot .

Height measuring foot .

Gear tooth measuring foot .

How to calculate the accuracy of a vernier scale:-

It is the smallest graduation on the vernier scale

It is calculated using the following equation

$$\text{Accuracy} = 1/n .$$

In general

If the number of graduations on the vernier is $n = 50$ (this is called a 50-digit vernier) accuracy is $1/50 = 0.02 \text{ mm}$.

If the number of graduations on the vernier is $n = 20$ (this is called a 20-digit vernier), its accuracy is $1/20 = 0.05 \text{ mm}$.

If the number of graduations on the vernier is $n = 10$ (this is called a decimal vernier), its accuracy is $1/10 = 0.1$.

Measuring Range:-

This is the largest measurement that can be measured using a caliper. The caliper cannot be used to measure the total length of the caliper stem itself. This is because the length of the vernier scale remains within the measurement. The following relationship illustrates this

Measuring Range = Length of Caliper Stem - Length of Vernier Stem

Vernier Caliper Measurement Method:-

The process of reading a vernier caliper measurement is carried out in two basic steps:-

First:-

We look at the vernier caliper, specifically at the zero position, and read the number to its left, which is recorded on the main measuring ruler. We record the reading (A) in millimeters .

Second:-

We look starting from the vernier caliper's zero position and determine the first exact match between the ruler's and vernier caliper's graduations. Then, we read the number of vernier graduations recorded with the matching. This number is multiplied by the vernier's accuracy, resulting in the vernier reading (B) in millimeters.

The sum of the values (A) and (B) gives the value of the measurement on the vernier caliper.

Work steps :-

Measuring external dimensions:-

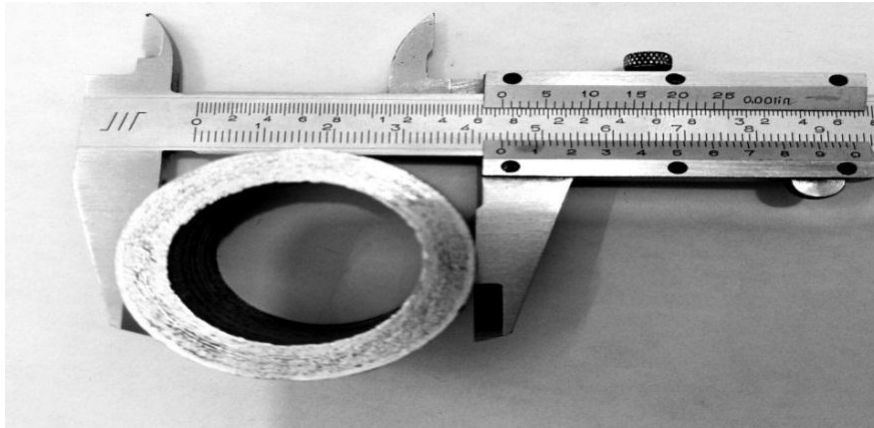


Fig (1-2)

Measuring internal dimension:-

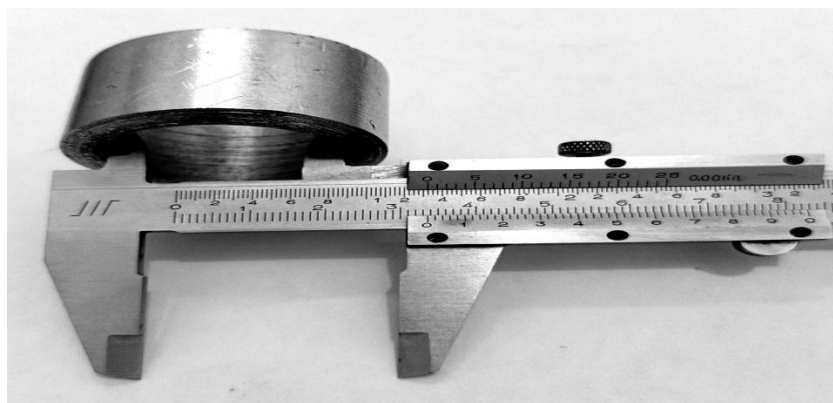


Fig (1-3)

Measuring depths:-



Fig (1-4)

A practical example with an accuracy of (0.02) is given:-

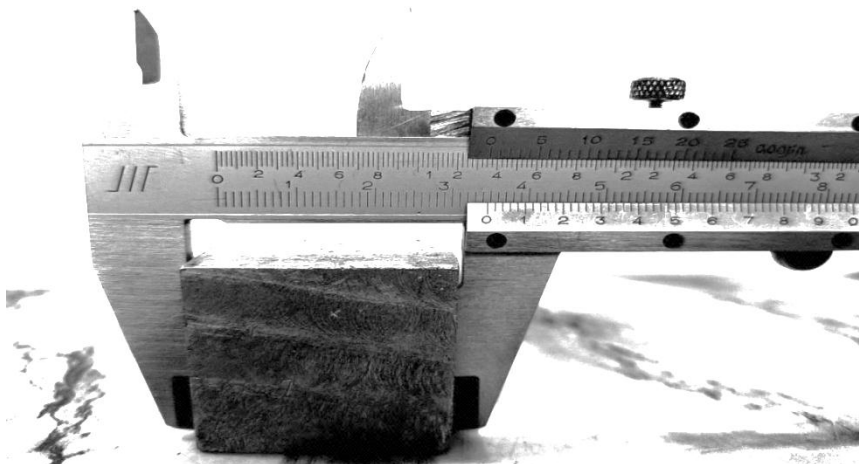


Fig (1-5)

The basic scale in millimeters is $A = 34 \text{ mm}$

The vernier value in millimeters is $B = 7 \text{ mm}$

The vernier value (B) is multiplied by the accuracy of the foot, giving the following result :

$$B = 7 * 0.02$$

$$= 0.14 \text{ mm}$$

Measurement value = $A + B$

$$= 0.14 + 34 = 34.14 \text{ mm}$$

Discussion:-

Q1/ What is the relationship between the accuracy of the caliper and the calculated reading?

Q2/ What is the relationship between the measurement range and accuracy ?

Q3/ Compare the regular caliper and the special-purpose caliper in terms of (its caliper measures depth and its caliper measures height) ?

Week (2)

Experiment Name:-

Measurement with a Micrometer

Experimental Purpose :-

- * Identify different types of micrometers.
- * Identify the components of a micrometer and their function.
- * Identify and understand the accuracy of a micrometer.
- * Perform measurements with different micrometers .
- * Check the accuracy of the micrometer and make corrections.

Equipment and tools used:-

- * Micrometers of varying precision and measuring range.
- * Various metal models for measuring dimensions.

Experience:-

The micrometer is one of the most accurate dimensional measuring devices available in workshops and laboratories. Its accuracy is typically 0.01 mm, but some devices may reach even lower values, such as 0.001 mm. In addition to its accuracy, the micrometer is distinguished by its multiple uses in dimensional measurement and its ease of use. The micrometer's operating principle is based on the axial rotational motion of a screw. The micrometer is characterized by its ease of use, high accuracy, small size, low cost, and easy readability .

Device parts :-

- * Fixed bumper
- * Frame
- * Micrometer shaft
- * Fixed cylinder
- * Movable cylinder
- * Dropper
- * Fixator



Fig (1-2)

Types of micrometers:-

- * External measuring micrometer
- * Internal measuring micrometer
- * Depth measuring micrometer

Special micrometers, which are divided into :-

- 1- Three-point micrometer .
- 2- Dial micrometer .
- 3- Screw thread micrometer .
- 4- Gear tooth micrometer.
- 5- Pipe thickness micrometer .

How to Calculate Micrometer Accuracy

The accuracy of a micrometer's measurement depends on the relationship between the circular motion of the moving cylinder and its horizontal motion. When the cylinder rotates a full revolution around its axis, it moves horizontally by one tooth step .

$$\text{Accuracy} = (\text{step}) / (\text{number of graduations})$$

In general

If the tooth step of the micrometer is (0.5) mm and the moving cylinder is graduated to (50) graduations

$$\text{Accuracy} = (\text{step}) / (\text{number of graduations}) = 0.5/50 = 0.01 \text{ mm}$$

There are several types of micrometers used, and they differ from each other in the following

Measurement accuracy: -

The measurement accuracy of regular micrometers is 0.01 mm, while in other types, the accuracy is 0.002 mm or 0.001 mm

Measurement capacity: -

The micrometers used are in graduated sets with a measurement range of (25), for example (0.25 mm) (25–50) mm

To ensure the accuracy of the micrometer reading, we use measuring blocks when reading. The length of the measuring block is read and the reading is matched with the actual length of the measuring block. If they match, the micrometer is accurate. However, if they do not match, the micrometer is corrected (i.e. the reading is set to zero when the ends of the micrometer shaft and the fixed stop are in contact) .

Micrometer Measurement Method

Reading the Main Measurement:-

Look at the edge of the measuring sleeve and read the graduation value recorded on the longitudinal graduation cylinder in millimeters. Record the value (A)

Note the presence (or absence) of any graduation (0.5) mm on the longitudinal graduation cylinder after the value (A). If this graduation is present, add the value (B) = 0.5 to the measurement .

If there is no graduation, add (B) = 0

Reading the measurement on the sleeve: -

Determine the alignment between the graduation on the measuring sleeve and the main line on the longitudinal graduation cylinder. Multiply the graduation value recorded on the sleeve by the measurement accuracy. The result is the value of the reading on the sleeve, symbolized by the symbol (C) .

The measurement result is the sum of $(A + B + C)$.

Steps to perform :-

Measuring external dimensions:-

The model shown in the figure below can be used in the measurement experiment .

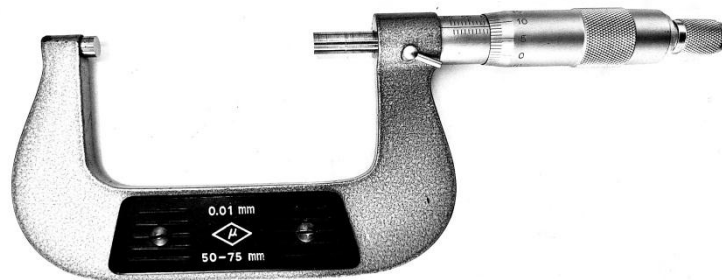


Fig (2-2)

Measuring internal dimensions:-

The model shown in the figure below can be used in the measurement experiment .

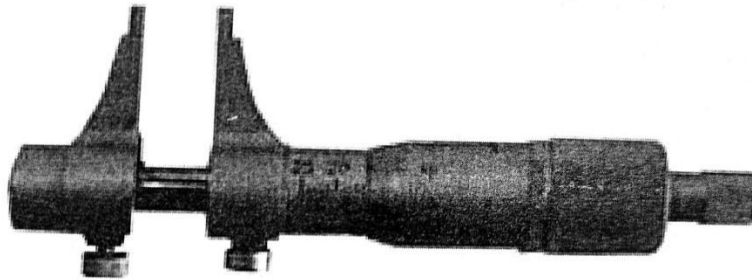


Fig (3-2)

Measuring depth:-

The depth micrometer is used to measure the holes made, as shown in the following figure .

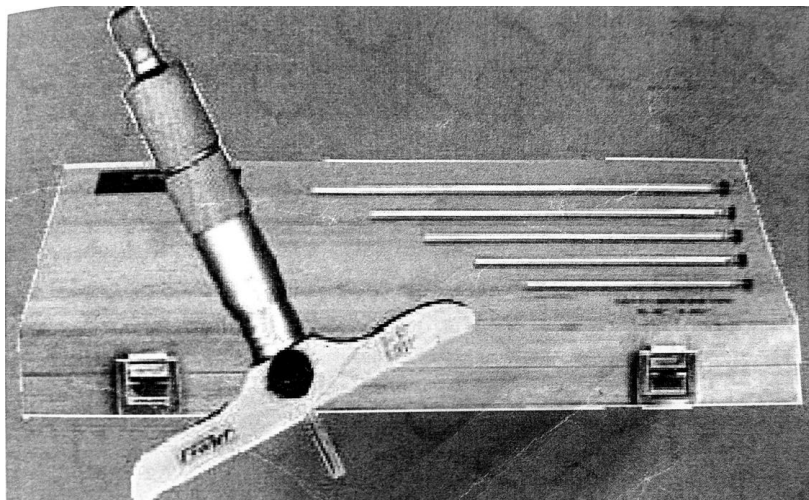


Fig (4-2)

A practical example of a micrometer with a resolution of 0.01 mm:-

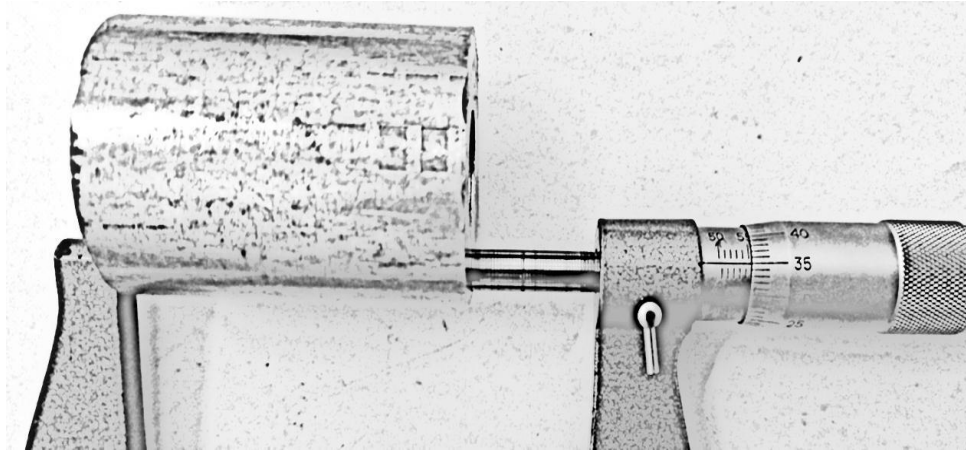


Fig (5-2)

A = 55 mm (integer in millimeters)

B = 0 mm (integer in millimeters)

C = 35 mm (reading on the measuring sleeve)

$$C = 35 * 0.01 = 0.35 \text{ mm}$$

A + B + C = final measurement result

$$55 + 0 + 0.35 = 55.35 \text{ mm .}$$

Week (3)

Experiment Name:-

Using a Mechanical Comparator with Measuring Blocks

Purpose of the Experiment:-

- *To understand the concept of the device and its use in measurement.
- *To understand its component parts.
- *To understand the disc's graduations and accuracy.
- *To understand measuring blocks.
- *To perform measurements using the device and measuring blocks.

Equipment and tools used:-

- *Mechanical comparator .
- *Various metal models for measuring their dimensions.
- *Measuring dies.

Experiment:-

Comparators are high-precision measuring devices used to compare a specific object's dimension with another known dimension and determine the difference between them by displaying this difference on scales with known values. The mechanical comparator is one type of comparator used, in which the length difference between the object's dimension to be measured and the known dimension is transmitted by mechanical means, including measuring blocks, to the dial indicator.

This device features the following:-

- 1- A mechanical comparator can achieve high measurement accuracy due to the precision of the scales shown on the dial .
- 2- The amount of measurement error resulting from the amount of pressure on the part to be measured is minimal due to the sensitivity of the dial indicator.

Components of the device :-

- * Magnetic base .
- * Stand .
- *Arms and levers for holding the dial .
- *Diagram .
- *Pointer .
- *Measuring arm .



(1-3)



(2-3)

Types of comparators:-

- 1- Electrical comparator .
- 2-Mechanical comparator .
- 3- Optical comparator .

Measuring Templates :-

Measuring templates are usually made of hardened, wear-resistant alloy steel and subjected to a special heat treatment to eliminate internal stresses and prevent dimensional changes. Measuring templates are used to check and calibrate other measuring devices, as well as as direct measuring tools in various measuring operations. A measuring template has two parallel surfaces, distinguished from other surfaces by their high level of flatness and smoothness. These surfaces are called measuring surfaces.

Measuring templates are manufactured in sets containing varying numbers of templates of different lengths. When stacked together, several of these can be used to create the desired dimension.

Among the things that must be taken into account when using measuring templates are :-

- 1- Measuring templates should not be left in contact with each other for extended periods of time .
- 2- Templates should be cleaned of fingerprints after use using special wipes .
- 3- Templates should not be handled by hand for extended periods of time .



Measurement Method Using a Mechanical Comparator:-

To compare and determine the length of a specific work piece using different comparators, we follow these steps:-

- 1- A certain number of measuring dies are placed together on a measuring table so that their total length is close to the length of the dimension to be measured .
- 2- The comparator is zeroed after the measuring head is fixed in contact with the dies .
- 3- The measuring dies are removed, and the part to be measured is placed in their place. The reading indicated by the device is taken (due to the height or depth of the measuring head compared to its previous position) .
- 4- The difference obtained from the previous reading is added to the total length of the measuring dies. The result represents the true measurement of the dimension of the part to be measured.

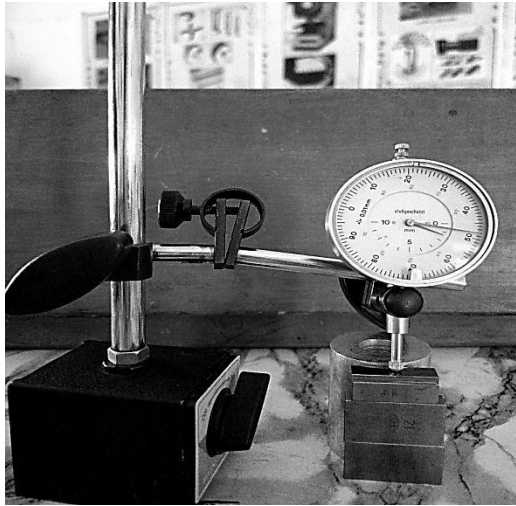
A practical example of measurement templates: -

Arrange the templates to create the required dimension (28.608 mm) using the 88-template measurement templates in the set.

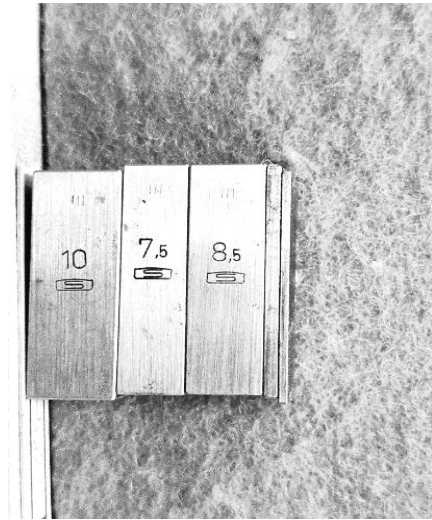
$$1.008+10+1.6+7.5+8.5=28.608 \text{ mm}$$



(4-3)



(5-3)



(6-3)

1- The sum of the molds: -

$$20+21+9.5+1.38+1.31+1.005 = 54.195\text{mm}$$

2- Device reading: -

$$1 + (48 * 0.01) =$$

$$1 + 0.48 = 1.48 \text{ mm}$$

3- Measuring the work: -

$$54.195 + 1.48 = 55.675 \text{ mm}$$

Discussion:-

Q1 - Why is the mechanical comparator called by this name?.

Q2 - What is the difference between the accuracy of readings calculated using this device and their accuracy using a vernier caliper? .

Q3 - Explain why measuring plates should not be left stuck together for a long time? .

Q4 - Why are measuring plates heat-treated? .

Week (4)

Experiment Name:-

Measuring angles using a vernier protractor

Experimental Purpose :-

Identifying the different types of angle measuring instruments

Understanding the components of the instrument

Determining and understanding measurement accuracy

Performing various measurements using the instrument

Equipment and tools used:-

1- A vernier protractor

2- Metal templates of varying angles for taking measurements. Other angle measuring tools, such as angle templates or a sine bar, can also be used, if available and depending on the type of measurement being used

Experience:-

It is one of the most accurate angle measuring devices for mechanical parts and workpieces used in workshops and laboratories. Special instruments and tools are used when measuring angles of shapes, different from those used for length measurements. The principle of the vernier caliper used in a straightedge can be applied to measuring angles with a simple protractor. The accuracy of the protractor measurement in this case is better than that of a simple protractor

Units of Angle Measurement

The units of angle measurement are

Degrees: A degree is an angle measuring $1/360$ of a circle. Therefore, a circle has 360 degrees

Minutes: A minute is $1/60$ of a degree there are 60 minutes in a degree

Seconds: A second is $1/60$ of a minute (there are 60 seconds in a minute)

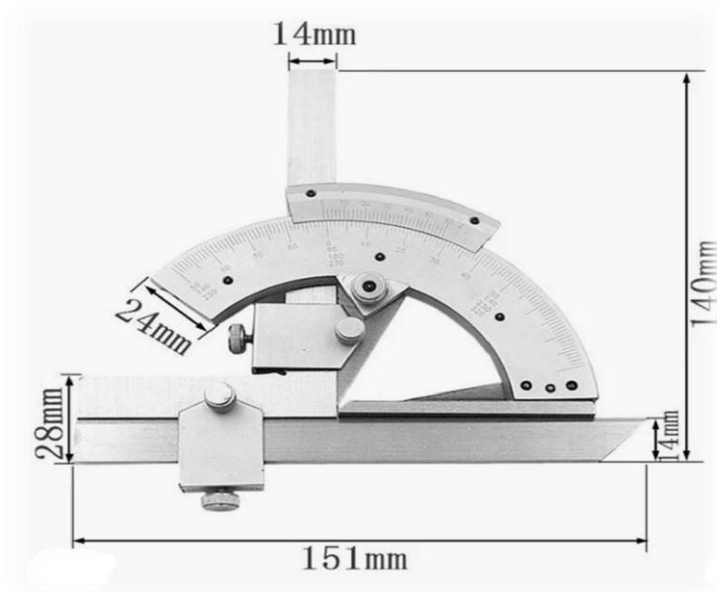


Fig (1-3)

:Components of the apparatus

Vernier ruler

Main measuring ruler

Base ruler .

Protractor parts holder

Clamping levers

Workpiece holder

:Types of Angle Measuring Tools

Right Angle Gauge

Simple Protractor

Vernier Protractor

Combined Protractor

Angle Measuring Molds

Sine Bar

Measuring Rods

Measurement Method Using a Vernier Protractor

The process of reading a vernier protractor reading is as follows

First: Look at the main measurement, specifically at the zero mark, and read the number to its left, which is recorded on the main measuring scale. Record this reading as (A).

Second: Starting from the zero mark on the vernier scale, identify the first point of perfect alignment between the scale's graduations and the vernier scale. Then, read the number of vernier scale graduations recorded at this point of alignment. Multiply this number by the vernier protractor's accuracy to obtain the reading value (B).

Third: The value of these graduations equals the number of vernier scale graduations multiplied by the accuracy .

Fourth: The final reading is the angle value

Discussion

*What other types of protractors are used in the laboratory .

*Which is more accurate: a mechanical comparator or a vernier axis protractor? Explain .

*What are the units of measurement for angles .

Week (5)

Experiment Name:-

Using a standard micrometer projector

The purpose of the experiment:-

- * To understand the concept and uses of a standard projector.
- * To identify the components of the device.
- * To perform measurements using the device.

Equipment and tools used:-

- * A standard projector.
- * Various metal models for measuring their dimensions.

Experiment:-

The operating principle of a standard light projector is based on magnifying the image of the object whose dimensions are to be measured using a known number of projected light beams. The magnified image is then projected onto the device's screen to perform the measurements. Tooth dimensions are measured using the micrometer within the standard light projector. This allows for the measurement of tooth pitch, tooth

depth, and tooth angle. A standard micrometer or a thread-measuring micrometer can also be used, as well as the external and internal diameters of the tooth.

Device components:-

- * Light source
- * Light condenser
- * Magnifying lenses
- * Device base
- * Reflecting mirror
- * Micrometers for adjusting the base

Types of projection equipment:-

- * Standard projector
- * Digital projector

Measurement steps:-

***Tooth pitch measurement:-**

This is the distance between the apex of two adjacent teeth.

***Tooth angle measurement:-**

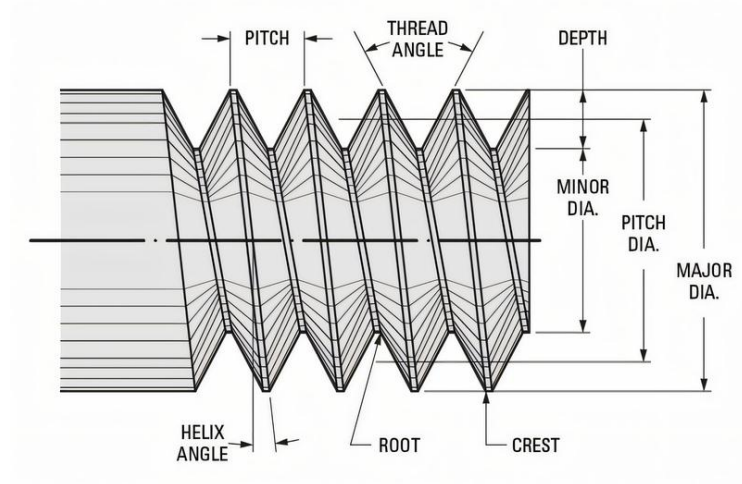
This is the angle between the surfaces of two adjacent teeth.

*** Tooth depth measurement:-**

This is the distance between the apex of the tooth and its root.



(1-4)



(2-4)

Discussion:-

Q1- What are the potential sources of measurement error when using a standard light projector?

Q2- What is the accuracy of a standard light projector?

Q3- What are the advantages of a standard light projector?

Q4- Explain how tooth pitch is measured using this device?

Q5- Are there other methods for measuring tooth pitch? If so, please list them.

Week (6)

Experiment Name:-

Digital Projector

The purpose of the experiment:-

- *To understand the concept and uses of a digital projector.
- * To identify the components of the device.
- *To perform measurements using the device.

Equipment and tools used:-

- 1- Digital projector.
- 2- Various metal models to measure their dimensions.

Experiment:-

The operation of a standard projector relies on the principle of magnifying the image of the object whose dimensions are to be measured using projected light beams a known number of times. The magnified image is then projected onto the projector's screen to perform the measurements. The accuracy of a digital projector is very high (0.0001 mm). It is used to measure and locate points, distances, diameters of circles, and angles. This device is called a digital projector because it is operated via an electronic screen. Information is fed through this screen, and the measurement results are also displayed on the screen

Device components:-

- 1- Electric lamp .
- 2- Light condenser .
- 3- Magnifying lenses .
- 4- Reflecting mirror .
- 5- Device screen .
- 7- Prism .
- 8- Base for placing the object .

Measurement steps:-

- * Measuring a point .
- * Measuring a straight line .
- * Measuring a circle .



(1-5)



(2-5)

Discussion:-

Q1/ What are the advantages of a digital projector?

Q2/ What is the accuracy of the device used?

Q3/ Explain how a point is measured using this device?

Q4/ Why is this device called by this name?

Q5/ Can the diameter of a hollow cylinder be measured using a digital projector? Why or why not?

Week (7)

Experiment Name:-

Sand Mixing Machine

Experimental Purpose :-

The purpose of this experiment is to prepare a quantity of foundry sand by mixing its components—resins, silicates, water, and sand—in standard proportions for each component. This is done to conduct the necessary tests to achieve the ideal specifications for foundry sand.

Equipment and tools used:-

- 1-Foundry sand .
- 2- Binding materials and resins .
- 3-Water .
- 4-Sand mixing machine .
- 5-Sensitive balance for measuring the quantity of sand .

Experience:-

A sand mixing machine is designed for mixing silicates, resins, water, and sand in the laboratory in specific, standard quantities. This machine consists of a cylindrical container with a set of rotating metal blades that move and mix the sand inside. The mixing process is electrically controlled, and the machine also includes a precise timer, graduated from 0 to 10 minutes, used to control the mixing time. The machine also has a discharge port for the homogenized, mixed sand.

Components of Foundry Sand: Green foundry sand consists of the following three main components:

- Silica sand SiO_2
- Binding materials
- Water

Foundry sand must be suitable for mold making and producing defect-free castings. Therefore, it must possess the following properties:

- Cohesion and shape retention.
- Durability of dry sand at high temperatures.
- High melting point.
- Permeability, collapseability, and reusability. Foundry sand comes in two types: wet sand and dry sand.



Fig(1-6)

Device components:

1-Timer

2. Sand outlet gate.

Operating Instructions:

- 1- Mix the dry components of the foundry sand together and place approximately 1-2.5 kg of the mixture in the designated compartment of the machine.
- 2- Run the machine for 10 minutes to mix the dry sand.
- 3- Once the mixing process is complete, add the liquids (water, silicate, etc.) and run the machine for 3-5 minutes.

- 4- Pull the sand outlet door while the machine is running. The mixture will discharge itself. Turn the motor counterclockwise, then disconnect the machine from the main circuit breaker.
- 5- Take a sample of sand to prepare a standard sand sample measuring 50 x 50 cm. The standard weight should be 150-170 grams. This weight can be determined using a pressure scale.
- 6- Remove any remaining mixture from the container using a brush.
- 7- Clean the machine.

Discussion :-

Q1/ Why are the dry ingredients for foundry sand mixed first, then the liquids added?

Q2/ Foundry sand comes in two types. Name them and which is better for use?

Q3/ What are the components of foundry sand?

Q4/ Why are the following materials added to foundry sand (asphalt powder, fuel oil, and ground coal)? Discuss this.

Experiment Name:-

Standard test sample preparation device

Experimental Purpose :-

The purpose of the experiment: To prepare a standard cylindrical sample of foundry sand with dimensions of (50 x 50 mm) for use in:-

- 1- Conducting a permeability test of foundry sand.
- 2- Conducting a stress-bearing test.
- 3- Calculating the moisture content.
- 4- Calculating the clay content in the sand.
- 5- Calculating the fineness of the sand.

Equipment and tools used:-

Tools and equipment used:-

- 1- Foundry sand.
- 2- Sand sample preparation apparatus.
- 3- Balance for weighing the quantity of sand required for the test.

Experience:-

This is a device designed to prepare standard samples of foundry sand used in tensile, shear, permeability, compressive, and durability tests. The device consists of a cylinder with an internal diameter of 50 mm, a piston, and a sliding weight of 6.5 kg that moves up and down. It also includes a displacement shaft used to remove the sample from the cylinder after preparation. This is achieved by compacting the sand with a tamping rod of a known weight several times, using a known weight for the sand itself.



Fig(2-6)

Device parts :-

- 1- Tamper.
- 1- Sample preparation cylinder.
- 4- Base.
- 2- Displacement column.

Procedure:-

The standard sample preparation apparatus contains a metal cylinder into which sand is placed for testing. The test procedure is as follows:

1. Spray the metal cylinder with a liquid to moisten it, thus facilitating the sand's release without sticking.
2. Weigh approximately 150-170 g of the foundry sand prepared in the previous experiment to obtain a standard sample with a diameter of 50 mm and a height of 50 mm.
3. Place the weighed sand into the designated cylinder, place the cap on it, and manually rotate the cylinder to ensure even sand distribution.
4. Raise the trowel of the sample preparation apparatus using the designated lever. Then, place the cylinder on the apparatus base.
5. Using the same lever, lower the trowel and insert it into the cylinder containing the sand. Rotate the cylinder to ensure the trowel moves centrally within it.
6. Raise the tamper and compact the sand three or more times using the same lever to achieve the required height (50 mm). This is reached when the top of the tamper points to the level of line (0)
7. After compacting the sample, raise the cylinder and gently insert the sample displacement rod into the cylinder to push the sample out.

Discussion:-

Q1/ Why is a standard foundry sand sample with standard dimensions of 50 x 50 mm prepared?

Q2/ Why is the sand compacted three times? Discuss.

Q3/ What are the components of a standard foundry sand sample preparation apparatus?

Q4/ What is the relationship between the weight of the sand and the dimensions of the standard sample?

Experiment Name:-

Permeability Meter

Experimental Purpose :-

Testing the permeability of foundry sand using a standard sand sample with an electrical permeability meter and calculating its value.

1. Standard sand sample with dimensions (50 x 50 mm)
2. Standard sand sample preparation cylinder
3. Permeability Meter.

Equipment and tools used:-

This meter is designed to calculate the permeability of a previously prepared standard sand sample. It is electrically operated and calculates permeability by applying a standard air pressure of 100 mmHg and a column of water through the sand sample. After the air has passed through the sample, the permeability value is displayed directly on the meter's screen.



Fig (1-7)

Device parts :-

1. Permeability gauges
2. Test control lever
3. Power switch
4. Speed regulator
5. Sample holder

Experience:-

1. Turn on the meter to allow air in by switching the switch to the ON position. Allow the meter to run for at least one minute until the reading stabilizes.
2. Select the appropriate orifice size for the sample type as follows:

*If the permeability value is greater than 50, select the larger orifice, denoted by the symbol (L).

*If the permeability value is less than 50, select the smaller orifice, denoted by the symbol (S).

3. Place the standard sample cylinder in its designated position at the top of the apparatus by rotating the ring at the top of the apparatus counterclockwise to secure the cylinder.
4. Set the lever on the left side of the apparatus to the (CHECK) position.
5. Adjust the speed regulator to achieve a pressure of 100 mm² of water column, with the permeability reading at 0.
6. Move the lever to the (test) position and read the permeability on the gauge according to the orifice size used.
7. Return the lever to the "CHECK" position and ensure the pressure reading is still 100 mm.
8. Remove the sample cylinder from the apparatus by rotating the ring clockwise.

Discussion:-

Q1/ What happens when the larger aperture is used instead of the smaller one, and vice versa?

Q2/ What happens when additional materials are added to the standard sand sample?

Q3/ Does adding these additional materials to the standard sand sample affect the permeability Discuss?.

Q4/ There are three readings on the permeability meter. Explain these readings.?

Week (8)

Experiment Name:-

Stress testing device (mechanical tests for foundry sand)

Experimental Purpose :-

Conducting various tests on foundry sand to obtain the required specifications and determine the ideal number for foundry sand.

Equipment and tools used:-

1. A standard sand sample.
2. A stress testing device.

Experience:-

This machine is used to conduct certain tests and consists of four main parts:-

- The frame and base.
- The pendulum.
- The weight (15 kg).
- The thrust arm.

The pendulum moves via the thrust arm, which is powered by an electric motor. The motor drives the weight and the arm as it rotates along the arc at a specific speed, ensuring a constant rate of force increase on the sand sample. The tests are performed using the appropriate jaws for each test. The measuring panel on the machine displays several gauges indicating whether the sample is dry or wet, and whether the test is shear or compression. Readings are in m^2/kN .

Tests performed on a standard sand sample include:-

- 1- Compressive Strength Test:-** This test determines the direction of compression required to break the standard sand sample.

- 2- Shear Strength Test:-** This test is performed using the same apparatus, but with shear jaws replaced by compression jaws. The compression surfaces of these jaws are two-plane.

- 3- Tensile Strength Test:-** This test uses a special wet sand sample prepared using a tensile strength test mold and its associated piston. The same strength testing apparatus is also used for this test, but with the jaws used for the tensile test replaced by those used for the tensile test.

- 4- Flexural Strength Test:-** This test uses a special sand sample prepared using a bending test mold. The same apparatus is used, but with the jaws replaced by those used for the bending test.

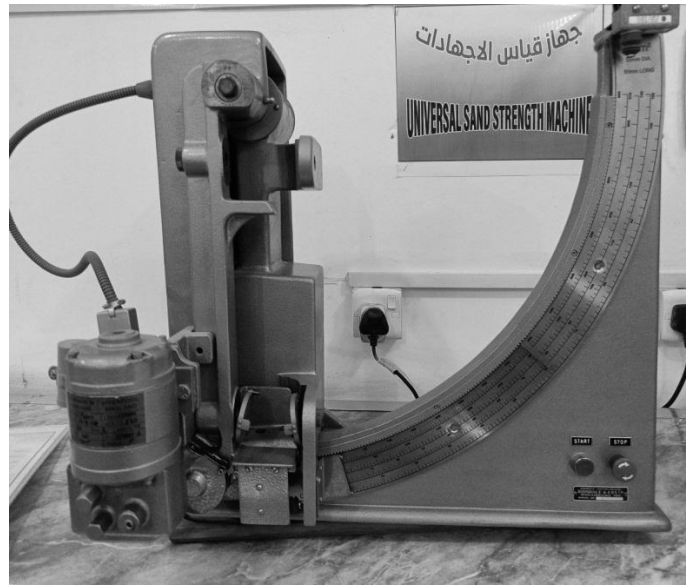


Fig (1-8)

Device parts :-

1. Dry sample placement area.
2. Wet sample placement area.
3. Electric motor.
4. Pendulum.
5. Weight (15 kg).
6. Power switch.
7. Reading panel.

Procedure:-

1. Raise the weight arm slightly and carefully place the standard sample, removed from the cylinder, in its designated slot to ensure its safety.
2. Place the magnetic piece provided with the device, which acts as the indicator on the measuring scale, at the end of the pendulum to take the reading after the test.
3. Press the start button. The pendulum will then press the weight, which in turn will press the sample, causing it to break. The pendulum will return to zero, leaving the magnetic piece to mark the point of breakage for the reading.
4. When taking the reading, ensure it is taken from the lower edge of the magnet. Also, be sure to check the reading panel if the test is being performed on a wet or dry sample.
5. Clean the device thoroughly to remove any sand.

Discussion:-

Q1/ Is dry foundry sand more resistant than wet foundry sand, and why?

Q2/ Why does the dry sample not perform the test?

Q3/ Is this test considered a destructive test or a non-destructive test?

Week (9)

Experiment Name:-

Clay content measuring device

Experimental Purpose :-

The purpose of this experiment is to measure the percentage of clay in the foundry sand and whether it is within the acceptable percentage for foundry work or not ?

Equipment and tools used:-

1. A dry sample of foundry sand containing a percentage of clay.
2. A sand washing machine and its accessories.
3. Sodium hydroxide.
4. A dryer.
5. A siphon pipe.

Experience:-

The device operates on the principle of washing a dry sand sample of known weight from clay, reweighing it, and then determining the percentage of clay in the foundry sand. The device consists of parts that enable this process, including a sample container, a mixer, an electrical control panel with a timer, and a siphon tube.



Fig (1-9)

Procedure:-

1. Weigh 50 g of a wet sample of foundry sand.
2. Dry the wet sample and weigh it accurately.
3. Mix the dry sample with 475 cm³ of distilled water and 25 cm³ of sodium tetrapyrophosphate or sodium hydroxide solution, which helps dissolve the clay.
4. Fill the flask with water and solution to the top of the fill line. Place the mixing unit in the flask and ensure that the "continuous" switch on the control panel is set to "off" and the "mains" switch is set to "on".
5. Set the timer for 5 minutes. Mix the solution for 5 minutes.
6. Allow the solution to settle for 10 minutes.
7. Remove the solution from the top of the flask using a siphon tube. Remove the flask from the apparatus, fill the siphon tube with water, then block the straight end with your finger and place the curved end into the flask. Discard the solution at the top of the flask, taking care not to remove any of the precipitated sand.
8. Refill the flask with distilled water to the top of the fill line. Mix for 5 minutes and allow to settle for 10 minutes. Then remove the solution using the siphon tube.
9. Repeat the above process, mixing the sand for 5 minutes and allowing it to settle for 5 minutes. Then remove the solution using the siphon tube.
10. Repeat the above process several times until the water becomes clear.
11. The remaining sand grains are dried, weighed, and the clay content is calculated as follows:
$$\text{Clay content} = (\text{Weight of dry sand sample} - \text{Weight of sand sample after clay removal} / \text{Weight of dry sand sample}) * 100\%.$$

Discussion :-

Q1/ How to calculate the percentage of clay mathematically?

Q2/ Why is the sample dried before use ?

Q3/ Why is sodium hydroxide solution used?