INDIAN INSTITUTE OF TECHNOLOGY

DATE | EXPERIMENT No. 4 | SHEET NO.

STUDY OF DCG- COORDINATE MEASURING MACHINE AND EXPLORING FEW DIMENSIONAL FEATURES OF AN ARTEFACT

- **Aim:**
  - To study the functions of different parts of CMM
  - To study the conventions used for Machine Coordinate system and workpiece Coordinate system.
  - To calibrate the probe tip at three different angles.
  - To check different dimensional attributes like circularity, cylindricity, flatness, run out, etc and the corresponding tolerance values.
- **Theory:** It is used for geometrical feature measurement. The typical "bridge" CMM is composed of three axes, X, Y and Z. These axes are orthogonal to each other in a typical three dimensional coordinate system. Each axis has a scale system or encoder that indicates the translation of the axes. The machine will read the input points from the touch probe by touching the required location, as directed by the operator or programmer. The machine then uses the X, Y, Z coordinates of each of these points to determine size and position of the job. The the measurands can be determined by those points. A coordinate measuring machine (CMM) is also a device used in manufacturing and assembly processes to test a part or assembly against the design intent. By precisely recording the X, Y and Z coordinates of the target, points are generated which can then be analyzed via regression algorithms for the construction of features.

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These points are collected by using a probe that is positioned manually by an operator or automatically via direct computer control (DCC). DCC CMMs can be programmed to repeatedly measure identical parts; thus a CMM is a specialized form of industrial robot. In CMM there are mainly two major parts. There are structural system and probing system. Machine structure, bridge, bearings for moving the bridge, granite table to support the workpiece, vibration isolation system and are included in the structural systems.

Air bearings are the chosen method for ensuring friction free travel. compressed air is forced through a series of very small holes in a flat bearing surface to provide a smooth but controlled air cushion on which the CMM can move in a frictionless manner. In probing system one touch trigger probe is attached to the Z-axis quill of the bridge.

When probe is rotated about X axis it is then called as angle A, and when probe is rotated about Z axis, then it is called as angle B.

Tesastar-P is the probe used in this machine. This probe can rotate in two directions viz A and B

Range of angles

Angle A: Probe can rotate from +90 to -115 about X-axis

Angle B: Probe can rotate from +180 to -180 about Z-axis.

Measuring Modes: Manual Mode and Automatic Mode.

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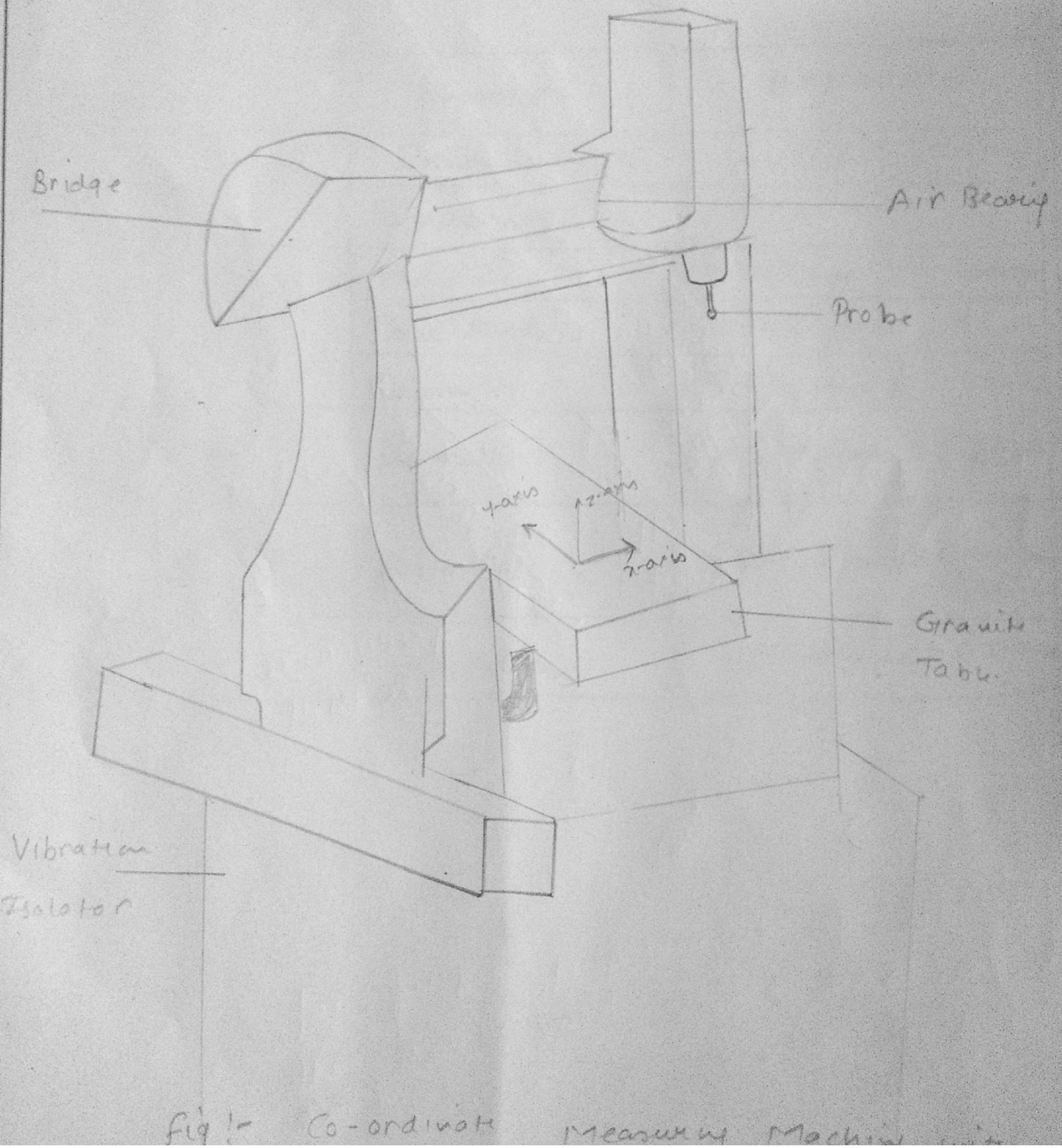

fig :- Co-ordinate Measuring Machine

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OBSERVATION TABLE

Feature	Dimension	Measurement.
Bigger Hole	Inner diameter	(61.018 ± 0.01) mm
	Circularity.	0.104
Cone	Height	13.948 mm ± 0.01 mm
	Cone Angle	30.198° ± 0.01°
	Diameter.	15.420 mm ± 0.01 mm
Round Slot	Diameter.	3.557 mm ± 0.01 mm
Holes in polar array.	Diameter	86.055 mm ± 0.461 mm (sd)
Sphere	Diameter	12.284 mm ± 0.01 mm

Discussions

Q1) Comment on why a sphere has been chosen for the tip.

A. During contact with a sphere, point contact is possible. Also from any point on the sphere, the distance from its center will be the same (the radius).

Q2) What is the material for probe tip and why is it chosen?

A. The material chosen is "ruby".

This is because the property the material for probe should possess is hardness, but it should not be too hard since it can damage the workpiece.

Hence, ruby is chosen over diamond.

Q3) Why is it better to use a bigger diameter tip for measurement?

A. The contact between probe tip and workpiece is never a point contact, i.e., contact is over an area.

For bigger diameter tip the area of contact will be more. So, for the same force P the stress, i.e., $\sigma = P/A$ will be less if the contact area is more.

Hence, there will be less stress concentration if probe tip has bigger diameter.

Q4) What is the principle of slide-guide mechanism for all the three machine axes?

A. In slide-guide we use air-bearings for ensuring friction free travel.

Compressed air is forced through a series of very small holes in a flat bearing surface to provide a smooth but controlled air cushion on which the CMM can move in a frictionless manner.