Wedge Clamping

\[ \Sigma F_x = 0 \Rightarrow \mu F_2 + \mu F_1 \cos \theta - F_1 \sin \theta - P = 0 \]
\[ \Rightarrow P = \mu F_2 + F_1 (\mu \cos \theta - \sin \theta) \tag{1} \]

\[ \Sigma F_y = 0 \Rightarrow F_2 = \mu F_1 \sin \theta + F_1 \cos \theta \]
\[ \Rightarrow F_2 = F_1 (\mu \sin \theta + \cos \theta) \tag{2} \]

Substituting \( F_2 \) from (2) to (1)
\[ P = \mu^2 F_1 \sin \theta + \mu F_1 \cos \theta + \mu F_1 \cos \theta - F_1 \sin \theta \]
\[ = \mu F_1 \sin \theta + F_1 \cos \theta \]
\[ = F_1 [\mu \cos \theta - \sin \theta] \tag{3} \]

Since \( \mu \) is a small quantity, therefore \( \mu^2 \) will be very small

Neglecting \( \mu^2 \)
\[ P = 2 \mu F_1 \cos \theta - F_1 \sin \theta \]
or
\[ P = F_1 [2 \mu \cos \theta - \sin \theta] \]

* For constant \( \mu \), \( P \) is +ve for small values of \( \theta \)
* \( P \) is -ve for larger values of \( \theta \) (will require an additional holding device like screw, cam etc.
* If \( \mu \) is greater, \( P \) is +ve for larger values of \( \theta \) (no additional device is required)
* Compromised values of \( \theta \) are in the range 6° to 18°
Fixtures

Dr. Dinesh Kumar
PIE, NITJSR
FIXTURES

• Used to hold workpiece during machining.
• Fixture is **always fixed to the m/c table.**
• Classified by the type of machine on which they are used.
VISE FIXTURES

LOCATORS

CLAMP

SOLID JAW

MOVABLE JAW

VISE BODY
MILLING MACHINE VISES

• Sometimes standard m/c vises are adapted with special jaws.
• Special jaws are designed for workpieces with irregular contours.
• Used with various types of m/c tools.
Parallel jaws for holding a round w/p

Parallel jaws for holding a thin nonmagnetic sheet

Parallel jaws with guide pin for holding a nonmagnetic long plate

Parallel jaws with tongue and groove for accurate alignment
Parallel jaws for applying pressure from different sides.

Parallel jaws used when tool tend to move the w/p upward direction.
MILLING FIXTURES

• Used to hold the workpiece in correct relation to the cutter.
• Attached to m/c table with T-slots.

Video Links
https://youtu.be/7eSVIX8SEv4
https://www.youtube.com/watch?v=rpsDUNgFdYI
https://www.youtube.com/watch?v=Utp-pghGckg
Base Plate

- Consists of base plate with flat & accurate under surface.
- Various components are mounted on it.
- It mates with the surface of milling m/c table.
- Used as reference plane.
- Has slots to clamp fixture to the table.
- It has a keyway running lengthwise in the base for two keys used to align the fixture on the milling machine table.
- The keys are pressed into the keyway at both ends of the fixture and held there by socket-head cap screws.
- *Welded hot rolled steel is better than welded cold rolled steel*
Cont.. **Base Plate**

- The fixture is attached to the milling-machine table and held in alignment by two keys attached to the fixture base.
- These keys fit very closely into the T slot of the mill table.
- The fixture is held firmly to the table by T bolts or hold-down clamps.
Prerequisites of milling fixture design

1. The type of milling machine
2. Dimensions of T slots
3. The center-to-center distance of T slots
4. The dimensions of the milling machine table
5. The length of table travel in all three feed movements
6. The center-to-center distance of T slots varies from machine to machine
7. If the fixture is to be used on more than one machine, it may be well to hold the fixture with strap clamps
Strap Clamp Holding Fixture to Machine Table
Effect of Cutting Forces on Workpiece at Beginning of Cut

- Cutting forces exerted by a milling cutter change as the cutter leaves or enters the work and throw an extra load on clamps.
- Clamps must not loosen by vibration caused by interrupted cutting of mill cutter.
- Interrupted cutting occurs at the beginning and end of the cut.
  (a) Conventional milling: work is lifted up at the beginning of cut.
  (b) Climb milling: work is forced down at one end but lifted up at the other.
Accuracy of Contact Between Bearing Surface and Workpiece

• A feeler gauge of predetermined thickness is inserted between the bearing surface and the workpiece resting upon it
• Bearing surfaces are usually in the form of pins, pads and plates
TYPES OF MILLING FIXTURES

(1) According to the way the workpiece is clamped, such as hand-clamping fixtures, power-clamping fixtures, toggle fixtures etc.

(2) According to the way the workpiece is located, such as center fixtures, V-block fixtures etc.

(3) According to the method of presenting the workpiece to the cutter, as rotary fixtures where the workpiece is rotated under the cutter. Indexing fixtures where the workpiece is indexed into the next position during the machining cycle.

(4) According to the milling operation performed on work, such as face-milling fixtures, slab-milling fixtures, slotting fixtures, string-milling fixtures etc.
MILLING FIXTURES

STRING or LINE MILLING FIXTURES:

- A number of components strung behind each other in a line
- The fixture moves relative to the cutters
MILLING FIXTURES

HYDRAULIC CLAMPING FIXTURE:
MILLING FIXTURES

CLAMP TYPE FIXTURE:
MILLING FIXTURES

VACUUM FIXTURE:
• It’s a suction holding device
• Used where holding without distortion is vital
• Uses a vacuum pump
• Part acted upon by atm. Pressure
• It exerts a downward force on all sides exposed to vacuum
BROACHING FIXTURES

• A **broach** is a series of progressively taller chisel points mounted on a single piece of steel

• Use of a broach is to cut splines or a square keyway on objects such as gears, driveshafts, pulleys etc.
INTERNAL BROACHING FIXTURES
EXTERNAL BROACHING FIXTURES

Diagram showing a broach fixture with labeled components: Broach, Workpiece, Locating block.
GRINDING FIXTURES (Magnetic chucking devices)

• Workpiece can be quickly mounted & removed
• Distortion caused by mechanical clamping eliminated
• Mild steel plates separated by nonferrous ones
• Magnetic flux passes from magnetic chuck through steel plates and workpiece
GRINDING FIXTURES
GRINDING FIXTURES (use of magnetic chuck parallels)
GRINDING FIXTURES (use of magnetic-chuck V block)
LATHE FIXTURES

Three-jaw Universal Chucks:

• Three-jaw chucks used for circular and hexagonal work
• Three-jaw chucks are usually self-centering
• Three jaws move simultaneously when adjusted
• This simultaneous movement is caused by a scroll plate into which all three jaws fit
• They are usually provided with two set of jaws, one for outside chucking and the other for inside chucking
THREE-JAW UNIVERSAL CHUCK
LATHE FIXTURES

Four-jaw Independent Chucks:

• 4-jaw chucks are usually non-self-centering
• Each jaw can be moved independently
• Ideal for gripping round, square, hexagonal and irregularly shaped workpieces
• The jaws can be reversed to hold work by inside diameter
• Multi-jaw chucks (6 or 8 jaws) for special purpose and high standards of accuracy
FOUR-JAW AND SIX-JAW CHUCKS
LATHE FIXTURES

Magnetic Chuck:
• It has the advantage of holding iron or steel parts
• The parts that are too thin or that may be damaged if held in a conventional chuck
• Suitable only for light operations
• A magnetic chuck consists of an accurately centered permanent magnet face
MAGNETIC CHUCKS
LATHE FIXTURES

Faceplates:

• Circular metal plate fixed to the end of spindle
• Used to hold work that is too large or of such a shape that it cannot be held in a chuck or between centers
• It has slots or threaded holes
• W.piece is clamped using T-nuts in the slots or threaded holes
FACEPLATE AND T-NUTS
FACEPLATES
FACEPLATES
LATHE FIXTURES

Collet Chucks:

• that forms a collar around the object to be held and exerts a strong clamping force on the object when it is tightened.

• A external collet is a sleeve with a (normally) cylindrical inner surface and a conical outer surface

• Used for very small parts
LATHE FIXTURES

Collet Chucks:
LATHE FIXTURES

Mandrels:

• Mandrels are internal locators used for machining of the outside diameter of the workpiece concentric with finished bores.

• Mandrels are shafts specially made to hold work to be machined concentrically around a previously bored or drilled hole

• There are two general types, plain and expanding

• Plain mandrels have a 0.006-in. taper per foot

• There must be a mandrel for each hole size
LATHE FIXTURES

Plain Mandrels:
LATHE FIXTURES

Sleeve-type Expanding Mandrels:
• It is used for high degree of concentricity.
• It provides the adjustment of locating diameter to suite the variation in the bore size of the workpiece.
LATHE FIXTURES

Mandrel for Threaded Parts:

• Used for holding previously threaded workpiece or w.p with internal threads
Quarry: What is the difference between collar and plug?

• Collar: There are various applications of collars eg. Shaft (to bear the axial thrust), clamps (to exert an uniform pressure throughout the contact surface) etc.

• Plug: A type of locator (or clamp) that may or may not have threads (May or may not have collar)