and fringe thickness will keeps on ↑ in outward dirn. In case of concave, at the centre we will get alternatively white and black fringe.

28/9/2016

MACHINE TOOLS

* **ACCEPTANCE TEST** → Acceptance Tests are perfomed on the new machine before interacting into mass production. In dynamic Test, free cutting spe

Dynamic Test — Free cutting steel

Static Test (Alignment)

steels are machined at some standard speed, feed and depth of cut combination and if the dimension is within the tooleance & surface finish is also within some tooleable limit, machine is inducted to mass production.

LATHE :- ① **Speed Lathe (1200-3600 rpm)** :- It is the initial m/c developed in the Lathe category. There is no carriage in the m/c and spindle, tailstock & toolpost are mounted on adjustable slide. only 2 to 3 cutting speeds are available for use.

② **Engine/Centre Lathe - $1\frac{1}{2}$ axis** :- There is carriage in this machine. over the carriage, there is cross-slide & over the cross-slide, there is Toolpost. It is $1\frac{1}{2}$ axis machine.

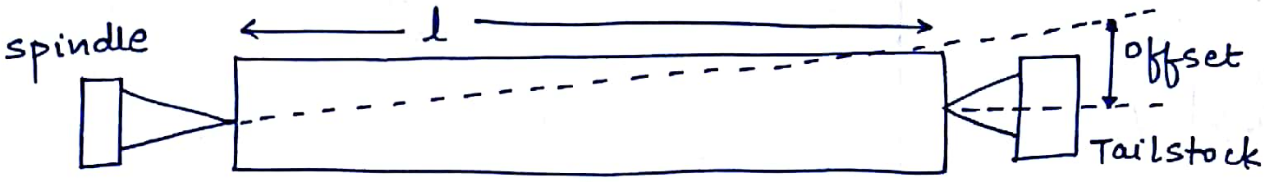
③ **Tool Room Lathe** :- This machine is similar to the engine lathe but varieties of cutting speeds are available for use. These lathes are used to optimize the cutting parameters.

④ **Bench Lathe** :- These are small capacity Engine lathes meant for small size workpieces.

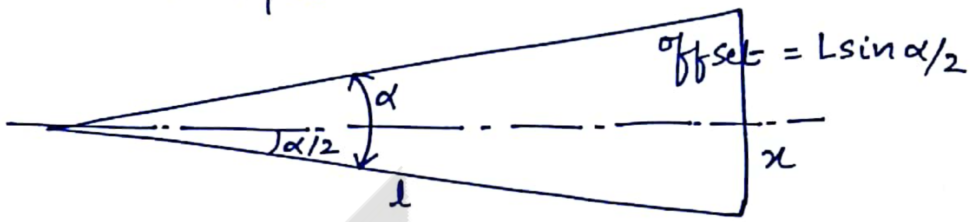
Collet → holds the W/P.

⑤ **Capstan and Turret lathe** :- In these machines there is no tailstock, and it is replaced by a hexagonal turret. At each and every phase of this turret, there is a Tool. So on such machines, 7 Tools can be mounted simultaneously. These are hard automated machines meant for small size workpieces.

Taper
1. cross slide
2. Tailstock offset



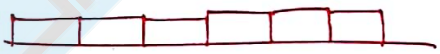
α = Taper



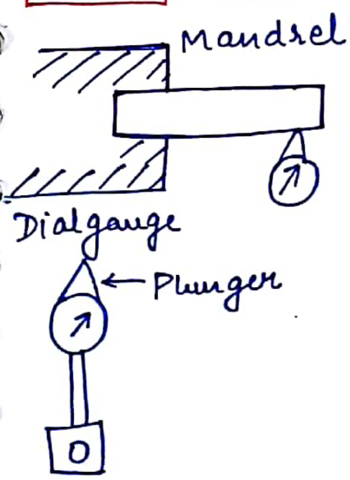
* Size of the Lathe is defined by :-
1. distance b/w the live and the dead centre.
2. Maximum swing diameter.
3. Height of spindle axis from Bed.

* Acceptance for a Lathe machine / Alignment Test :-

Test 1 :- whenever the bed is flat :- Bed area is divided into segments with segment size equal to size of spirit level. By keeping the spirit level from segment to segment, if the Bubble movement of spirit level is within some tolerable limit, bed is considered as Flat.

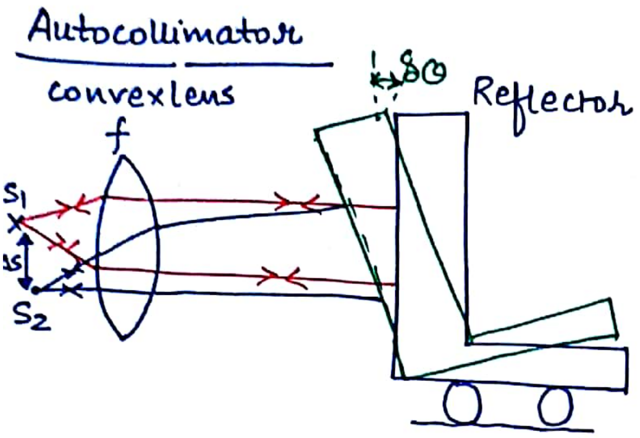


Test 2 :- Whether spindle axis is ∥ to the carriage movement :-

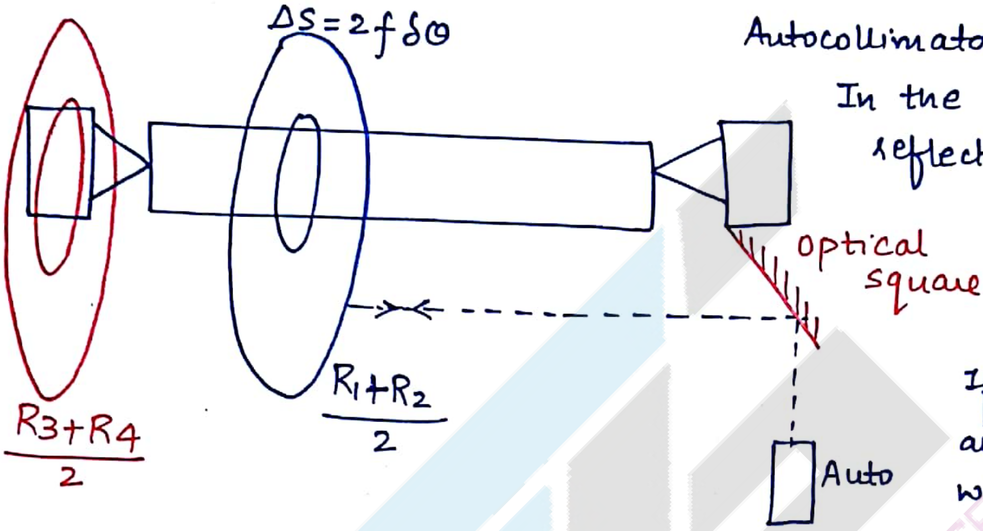


A mandrel is fitted in the spindle with plunger touching one of its corner. Base of the dial gauge is fixed over the carriage. By moving the carriage towards the spindle. If there is no variation in the dial gauge. It means spindle axis is ∥ to the carriage movement. It is not possible to have this error zero. so this error is permissible in the vertical dirn. and also towards the Tool. This permissible errors are < 0.03mm.

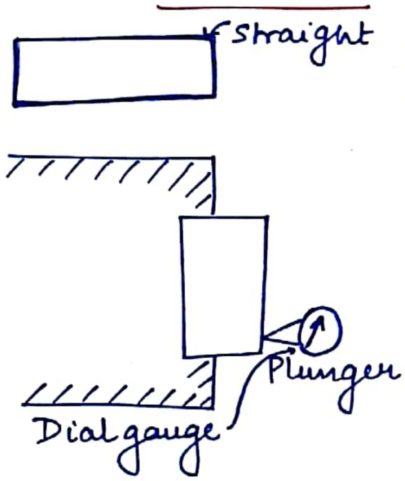
Test 3 :- Whether axis of work is parallel to the spindle axis:-



large w/ps has to be held b/w the headstock and Tailstock. In this ~~Saturation~~ situation, work axis may not coincide with the spindle axis. Reflector of Autocollimator is initially placed on the work and with 180° phase difference, Autocollimator readings are taken. In the second setting, reflector is placed on the spindle and same experimentation is being repeated. If both axis are parallel autocollimator readings will match.

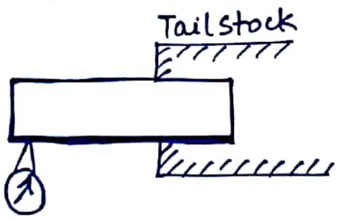


Test 4 :- Whether cross slide movements are perpendicular to the workaxis.

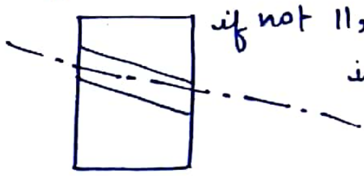


one straight edge is fixed in the spindle with plunger of dial gauge touching one of its side. Base of the dial gauge is fixed over the cross slide. ~~wh~~ By moving cross-slide, if there is no variation in the dial gauge, it means crossslide movements are normal.

Test 5 :- Whether Tailstock ~~with~~ quill

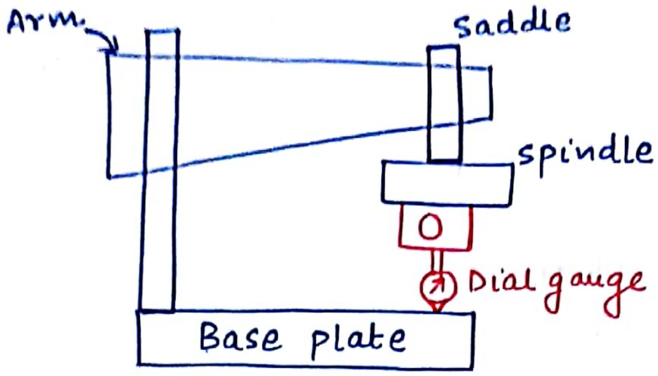


as in previous test no. 2, if tailstock is ‖ to the axis of the quill.



if not ‖, then hole is in inclined dirn.

* Radial Drilling M/C.

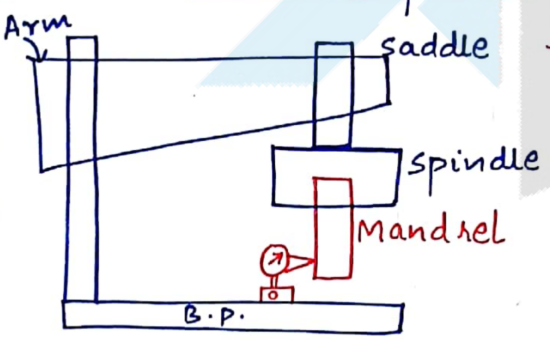


Test 1 :- Whether arm and saddle movements are parallel to the Base plate.

Base of the dial gauge is fixed over the spindle with plunger touching the Base plate. Initially, saddle is fixed and arm is rotated. If there is no variation in the dial gauge, it means arm movements are parallel.

In the second setting, arm is fixed and the saddle is moved over the arm. If there is no variation in the dial gauge, it means saddle movements are parallel.

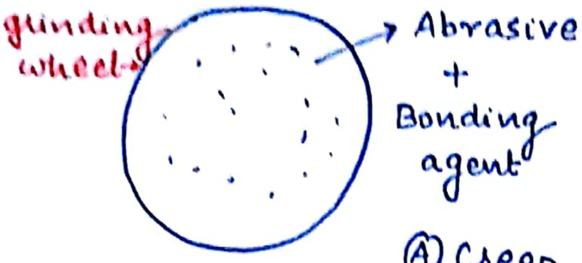
Test 2 :- Whether spindle axis is parallel to the drill axis and normal to the Base plate.



A Mandrel is fitted in the spindle with plunger of the dial gauge touching at the bottom. Base of the dial gauge will be on the base plate. By giving downward motion to the spindle, if there is no variation in the dial gauge. it means spindle axis is parallel to the drill axis.

GRINDING :-

R.S. parwar vol-1
⇓
Welding → CH-1
Read must

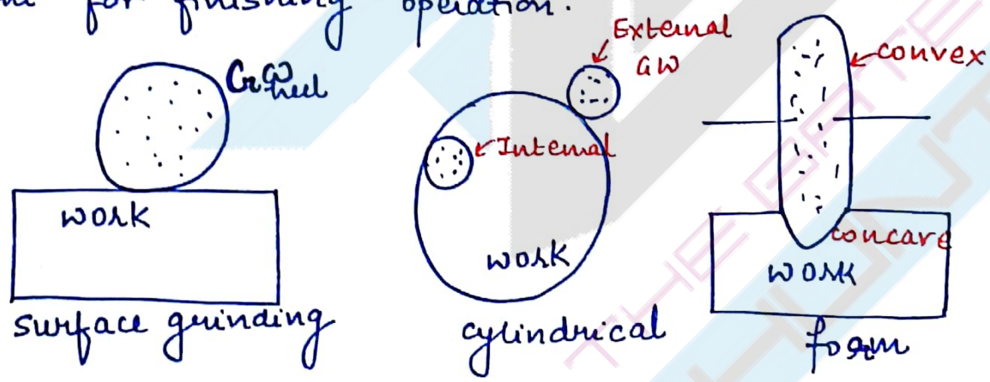


Infeed
Throughfeed

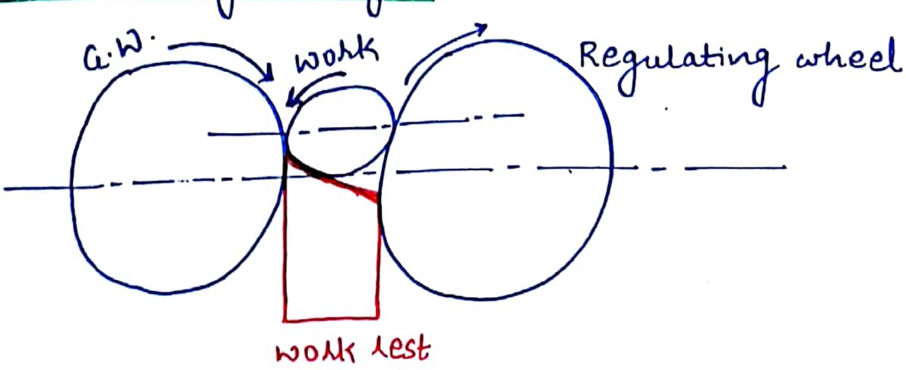
Ⓐ Creep feed grinding
infeed ↑ N ↓

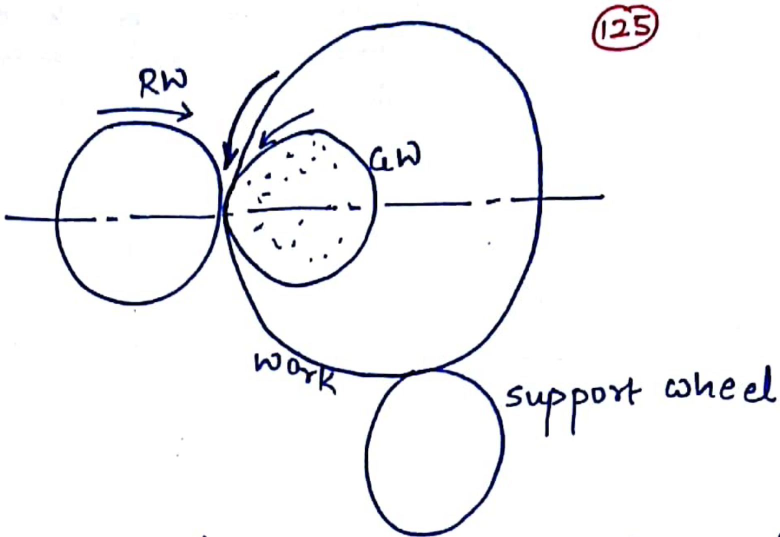
Ⓑ High speed grinding
infeed ↓ N ↑

In feeds are feeds experienced by the grinding wheel normal to the surface of grinding wheel.
Throughfeed is feed experienced by the grinding wheel ‖ to the axis of wheel. In creep feed grinding, infeeds are high and speeds are low. and it is meant for Bulk material Removal that is Roughning operation. In high speed grinding, Infeeds are low and speeds are high and it is meant for finishing operation.



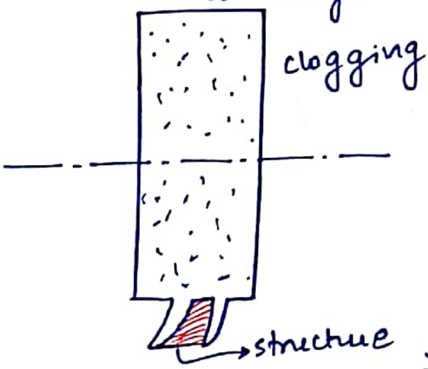
Centreless Grinding





The process is used to m/c small size balls, fragile workpieces, rods and other symmetric parts. during the machining, w/p centre is not fixed. work axis will always be slightly higher than the common axis of Regulating wheel and grinding wheel. Regulating wheel is slightly at an angle from the axis of grinding wheel. because force will always be normal to the surface of grinding wheel. One component of this force will be normal to the surface of grinding wheel and hence it provide infeeds. The other component of this force will be parallel to the axis of grinding wheel and it provides thrughfeed. so, workpiece will be grinded & automatic will be comeout from the other side.

$$F_c V = F_s V_s + \underline{F V_c}$$



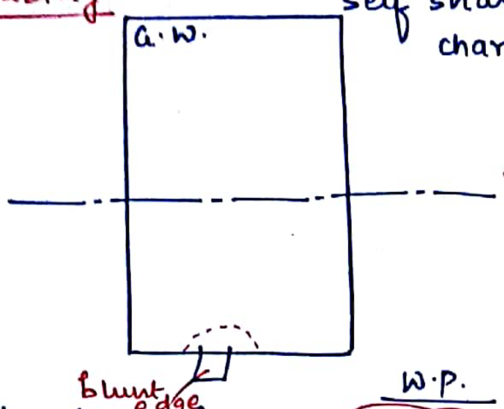
$$\frac{F_c V}{V_w t_1} \quad \parallel \quad V_c w t_2$$

Space b/w the 2 consecutive abrasive is called structure. If the space is more, it is called open structure and when the space is less, it is called closed structure. For m/cing ductile materials, we use open structure and for m/cing Brittle material, we use closed structure. During machining, continuous chips goes into this space and ~~hence~~, when this portion of the material is not in contact with the work, then due to centrifugal action, chips will go away. If Ductile materials are machined using closed structure, hot chips will be forced to enter into the space which is not sufficient to accomodate them. so, there will be welding b/w the abrasives. If such cutting conditions continues, all the abrasives will be welding and after certain period, grinding wheel is rubbing over the work without any cutting. This phenomenhan is called loading.

open - ductile

close (dense) - Brittle

Glazing



self sharpening characteristics

As soon as fresh cutting edge comes in contact with the work, sharp edges will become blunt. This will increase the drag between the abrasive and the workpiece. If the Bonding agent is weak, the abrasive will automatic comeout from the wheel and the fresh abrasive from the background start cutting action. It is called self sharpening characteristic. The wheels in which self sharpening phenomenan is predominant are called soft wheels. and the grinding wheels in which blunt cutting edge does not come out automatically are called Hard wheels. for machining soft materials, hard wheels are used and vice-versa. It is because Brittle materials require sharp cutting edges because it needs higher cutting forces. when hard materials are being machined using hard Tools, slowly all the abrasives will become blunt and after sometime, wheel is rubbing over the ~~curve~~ work without any cutting. This phenomenan is called glazing.

Soft wheels (Tools) - Hard (W.P.)

Hard - Soft

* ISO DESIGNATION

C 25 M 5 V

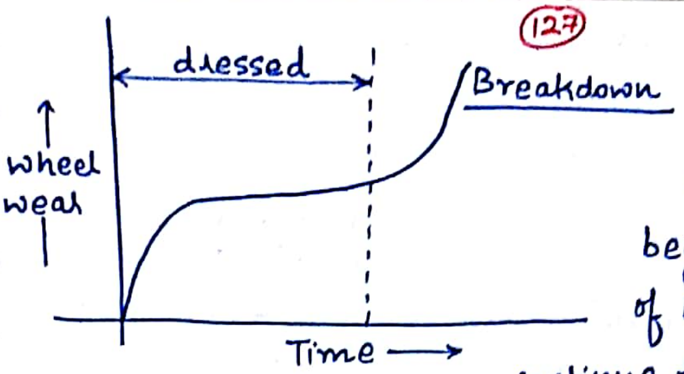
Type of Abrasive
- A → Al_2O_3
- C → carbide
- D → diamond

Size of Abrasive
- 10-24 Roughery
- 30-60 Medium
- 70-180 finish
- 220-600 superfinish

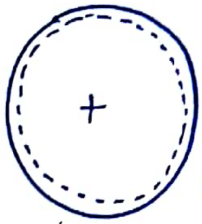
Hardness →
- A-H – soft wheel
- I-P – Medium
- Q-Z – Hard

structure
- 0 - dense
- 16 - open

Type of Bond
- V → vitrified (clay)
- S → silicate
- B → Resonoid
- R → Rubber
- M → Metal



As soon as fresh Grinding wheel comes in contact with the workpiece, sharpe edges are trying to roundoff, so wheel wear will be high in the begining. after a certain period, conditions of loading (or) glazing will exist and if we continue to use the same wheel, there will be wheel Breakdown. Before this condition arises, wheel needs to be withdraw from the workshop and dressed. Time between the two dressings is called wheel life. During Dressing, wheel looses its cylindricity. The process of making it again cylinder is called wheel Truing.



29/9/2016

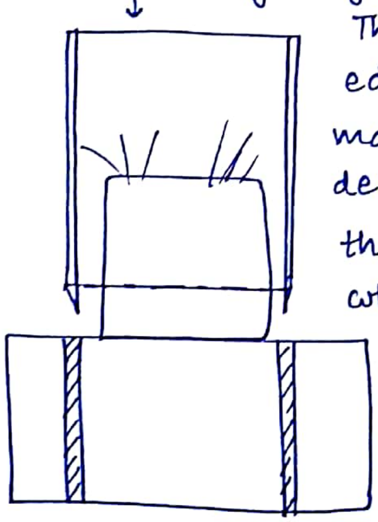
DRILLING

DRILLING :- Drilling is a process of creating a hole and the hole produced will be slightly smaller in size because some margin is kept for reaming operation. Reaming is a process of finishing (or) exacting the hole.

Drills are made slightly tapered because due to unbalanced masses, its body may rub the finished part and spoil the surface finish.

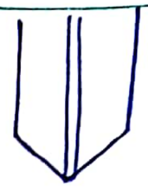
BORING :- It's a process of enlarging the Hole and generally it is done by using a single point cutting tools but multiple point cutting tools are also available.

TREPANNING :- very large diameter holes are produced by trepanning.

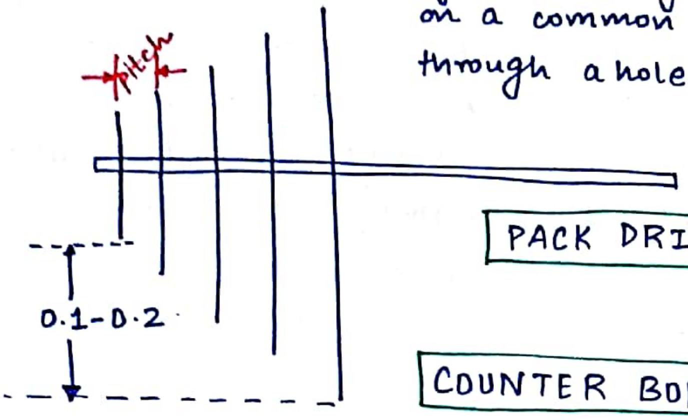


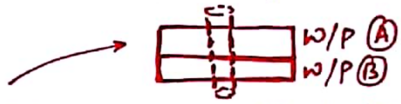
The Tool is in the form of a Tube with cutting edges on the periphery. only small amount of material will be removed in machining. very deep holes are produced by gun drill. Through the centre of a Drill, there is a hole through which we are injecting cutting fluid in the machining area. This cutting fluid not only takes away the heat from the machining area but also helps in disposing the chips.

Gun drills



BROACHING :- Gradually increasing diameter cutting edges are mounted on a common shaft and when the Broach is pulled through a hole, we get mirror like surface finish.

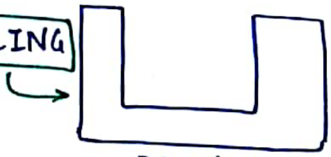




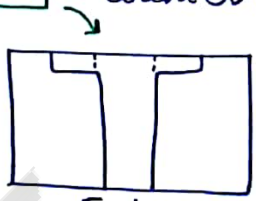
PACK DRILLING :- Put the one W/P to/over another W/P and drill it simultaneously.

COUNTER BORING :- Counter Boring is a process of enlarging the hole in the begining by end milling process and it is a seating place for bolts heads and nuts.

BLIND DRILLING

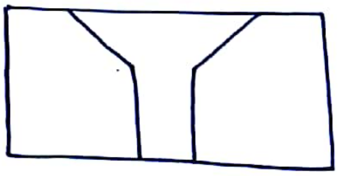


Blind Hole

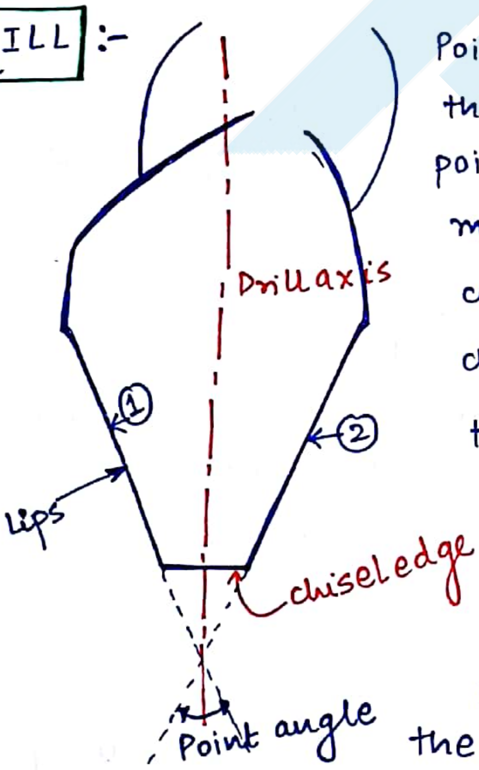


End Milling

COUNTER SINKING :- Countersinking is a process of making the hole slightly taper in the begining by sinking Tools or drills of slightly larger diameter.

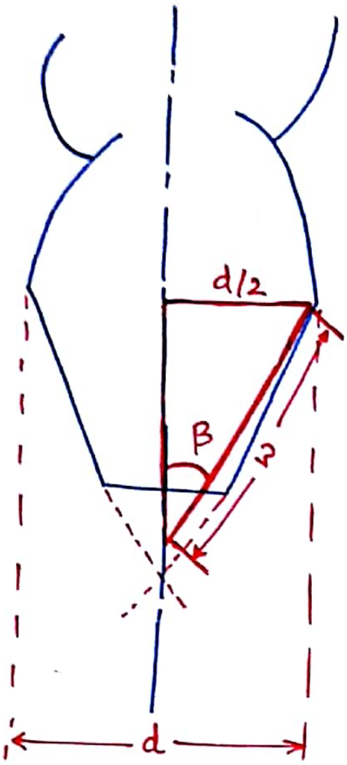


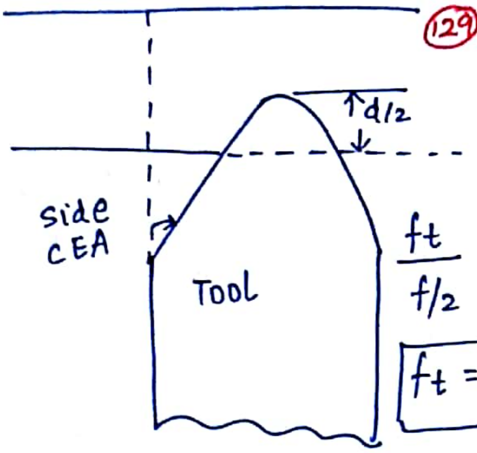
DRILL :-

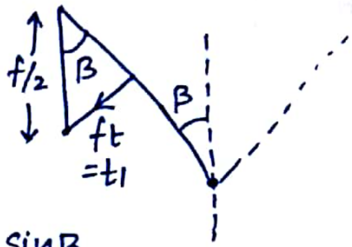


Point angle in drill is having exactly same fn. as that of side cutting edge angle in the single point cutting Tool. width of chip in any machining process is the length of principal cutting edge covered by the chip and uncut chip thickness is the true feed experienced by the cutting edge in the normal direction.

As it can be seen in the analysis that by decreasing the point angle, chips becomes thinner and wider. while machining ductile material since we get continuous chips, if the chips are thicker, due to work hardening, chips will be accumulated in the helix and will not come out. That's the reason for machining ductile materials, we use smaller point ∠ so that chips are thinner.

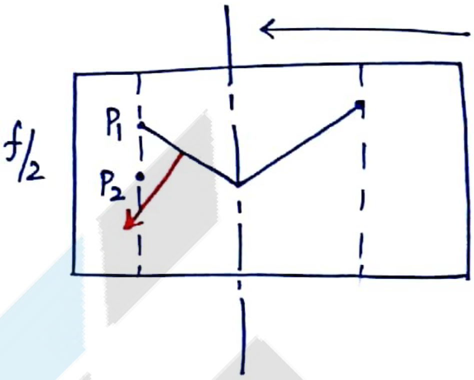






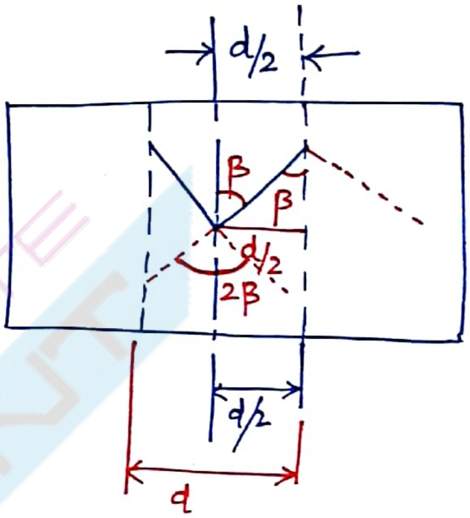
$$\frac{f_t}{f/2} = \sin\beta$$

$$\boxed{f_t = t_1 = f/2 \sin\beta}$$

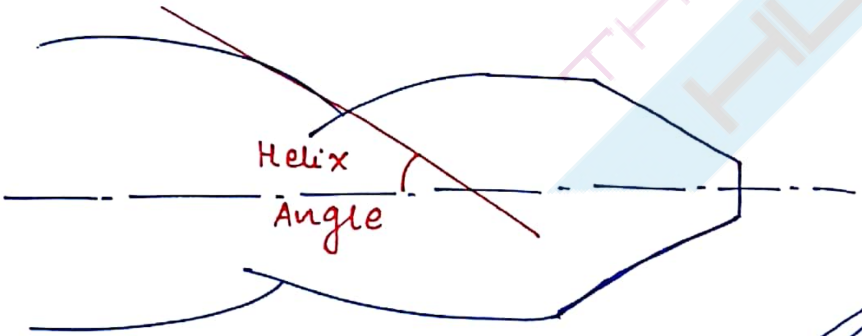


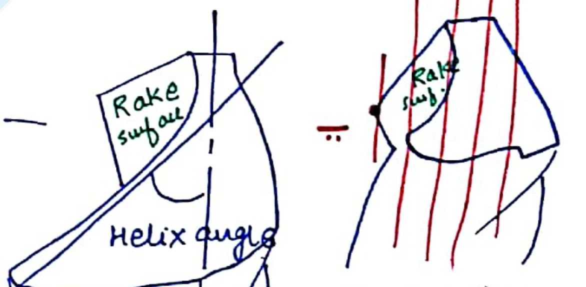
$$\frac{d/2}{w} = \sin\beta$$

$$\boxed{w = \frac{d/2}{\sin\beta}}$$



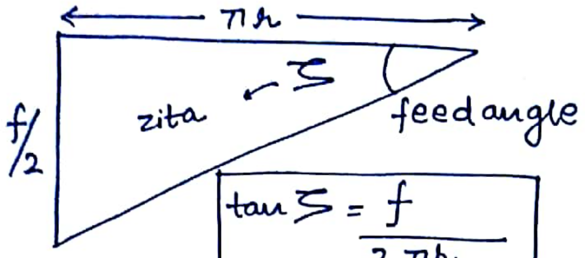
* Rake ∠ in Drill :-





at the centre of the drill, since cutting edge merges into the chiesel edge so Rake angle will be zero. In the outward direction, Rake angle keeps on increasing and on the periphery, since cutting edge merges into the helix, rake ∠ becomes equal to the helix angle.

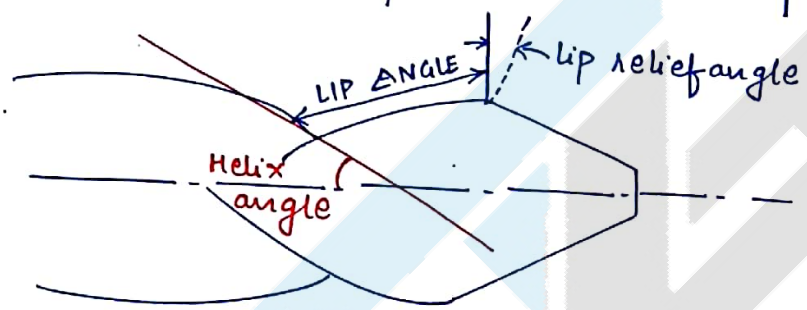
feed angle



$$\tan \zeta = \frac{f}{2\pi r}$$

The workpiece material that is going from the backside of the cutting edge forms an angle from the plane ⊥r to the drill axis, called "Feed angle." Due to this feed angle, workpiece material will try to hit the cutting edge from the Back side. To avoid this collision, clearance ∠ is provided on the drills. For machining ductile materials, since there will be more elastic recovery, so clearance angles has to be more.

	Ductile Material	Brittle material
clearance	8-12°	6-9°
Point	118°	135°



CH # 6

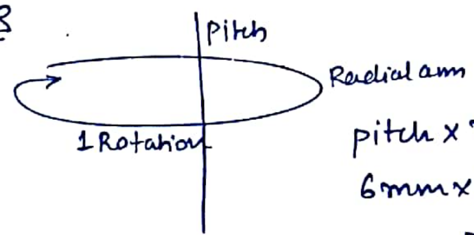
Q1> a

(2) d/2 b ✓

(3) $v = 3.9\,m/min$ $p = 6\,mm$

$d = 30\,mm$

S|R

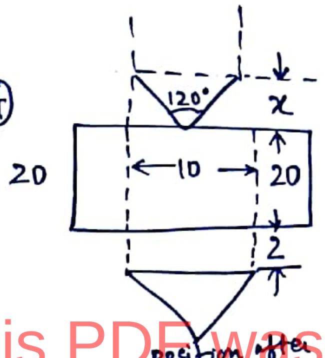


pitch × rpm = speed

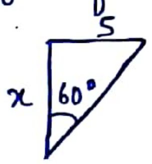
$6\,mm \times N = 3.9 \times 1000\,mm$

$\boxed{N = 650}$ ✓ (a) ✓

(4)



length of cut $= l = x + 20 + 2$



$5/x = \tan 60°$

$x = 2.88$

$\Rightarrow$ time $= \dfrac{\text{No. of Rev}}{\text{rpm}}$

$= \dfrac{l}{0.2}$

No. of Revolutions req. = $\frac{L}{feed}$ = $\frac{24.88}{0.2}$ = 124.43 rev

and time = $\frac{\text{No. of Rev}}{rpm}$ = $\frac{124.43}{300}$ min = 24.88 sec

(131)

(5) c

(6) d

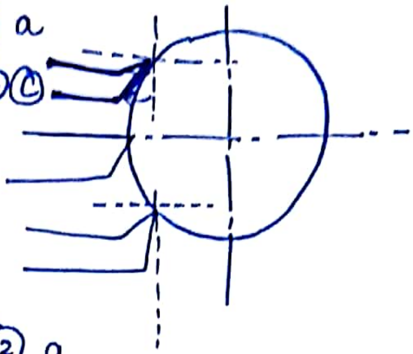
(7) a (End milling cutter)

(8) d

(9) a

(10) a

(11) c



(12) a

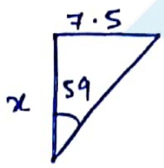
(13) t = 50 mm

d = 15 mm

N = 500 rpm

f = 0.2 mm/rev

118° 2 mm



$\tan 59 = \frac{7.5}{x}$

x = 4.50

l = 282.5

$\frac{58.50}{0.2}$

$\frac{292.5}{500}$

35.10

(a)

(14) c

(15) b

(16) b

(17) c

(18) d

(19) D = 10 mm

d = 50 mm

N = 600 rpm

f = 0.2 mm/rev

120° = β

T = 0.44

(20) 10 mm (d/2)

(21) Drill life = ___ min

T_{m_1} → machining Time for making one hole

Drill life = $\frac{\text{\_\_\_ min}}{T_{m_1}}$ = ___

Mean = T_{m_1} + idle Time (no Tool changing Time included).

ME

20 m/min = V

f.R. = 0.2 mm/rev

D.L. = 100 min

l = 45 mm

20 sec

(225)

$\frac{\pi D N}{60} = V$

$\Rightarrow \frac{\pi (15/1000) N}{60} = \frac{20 \times 1m}{60\ sec}$

N = 424

SIR

l = 45

no. of Rev = $\frac{45}{0.2}$ rev

V = πDN

20 = π × 0.015 N

$Tm = \frac{n_0}{N}$

= 0.53 min

$n = \frac{100}{0.53}$

$0.53 + \frac{20}{60} =$

(i) 188

(ii) 0.88 min.

(22) $D = 20\,mm$
$t = 30\,mm$
lip $\angle = 120^0$
overtravel $= 2\,mm$
$N = 500\,rpm$
$f/tooth = 0.01$

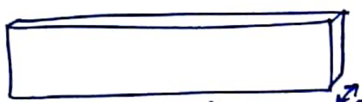
$\boxed{245\,sec}$ ✓

$x = 3\,mm$

$\frac{l}{0.2} = 3500$
$420\,sec$

CH #9 (Grinding)

1. b
2. b
3. cbn → are only use to make single point cutting Tools
   (d)
4. b
5. c
6. a
7. c
8. c flexible wheels
   (clay / vitrified)
9. b
10. c
11. b
12. c
13. c
14.

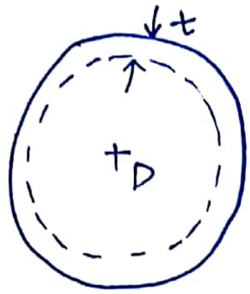


200mm
2.5mm

(14) SIR

Grinding ratio = $\frac{\text{work}}{\text{Total mass}}$

$= \frac{2.5 \times 200 \times 5}{\pi \times 300 \times 20 \times 10^{-3} \times 25} = \underline{5.305}$



t
D

$\underline{\pi D t \omega_1}$

(15) Sol

G.W.

$D = 220\,mm$
$N = 3600\,rpm$

$w = 22\,m$
$d = 0.04$

SIR specific energy × MRR = energy

$40 \times 22 \times 0.04 \times \frac{1180}{60} = f \cdot V$

cutting power

$V = \pi D N$

$f_c = \underline{16.6\ N.}$

AA60K5V8

300mm (d)
25mm (side)

CH ④

① $D_1 = 6.25mm$, $D_2 = 25mm$ $\Big\rangle$ $V = 18 \frac{m}{min}$

$V = \frac{\pi D N}{60}$

$\frac{18m}{60} = \frac{\pi D N}{60}$

① SIR $v = 18 \ m/min$

$d_1 = 6.25 = 6.25mm$

$d_2 = 25$

$18 = \pi d_1 N_1 \rightarrow 916$

$18 = \pi d_2 N_2 \rightarrow 229$

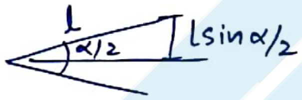
$\frac{N_2}{N_1} = (8)^{1/5}$

② b ✓

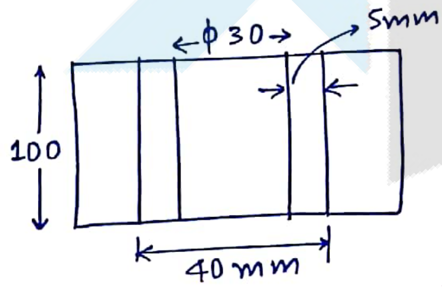
| | | | | |

(b) ✓

③ (b) ✓



④



$v = 30 m/min$

$f = 0.1 mm/rev$

① $d = 2$

$30 \rightarrow 34$

$d_{mean} = 32$

$v = \pi d_m N_1 \rightarrow 298$

$no. = \frac{\frac{100}{0.1}}{N_1} = T_1$

$\downarrow$ 3.35

② $d = 2$

$34 \rightarrow 38$

$d_m = 36 mm$

$T_2 = \frac{100/0.1}{N_2 \rightarrow 265}$ 3.77

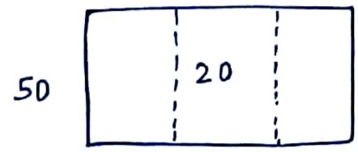
③ $d = 1$

$38 \rightarrow 40$

$d_m = 39$

$T_3 = \frac{100/0.1}{N_3 \rightarrow 146} \rightarrow 6.84$

⑤ (133)



no. of Revolutions req. $= \frac{50}{0.2} = 250$

① $d_1 = 10mm$ ② $d_2 = 20$

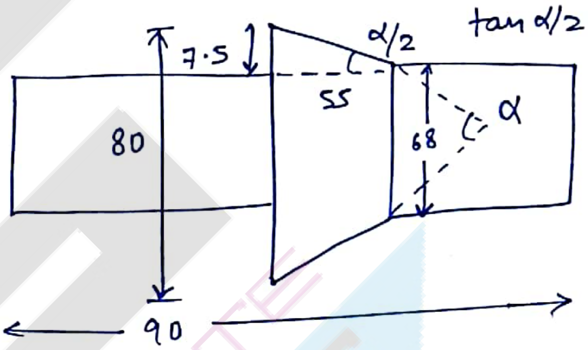
$V = \pi d_1 N_1 \rightarrow 319$ $V = \pi d_2 N_2 \rightarrow 160$

$T_1 = \frac{250}{N_1} + T_2 = \frac{250}{N_2}$

2.35 ✓ (d) ✓

⑥ $\frac{500}{60 sec} \times \frac{360°}{30°}$ Hz (c) ✓

⑦



$\tan \alpha/2 = \frac{7.5}{55}$

offset $= 90 \sin \alpha/2$

(a) ✓

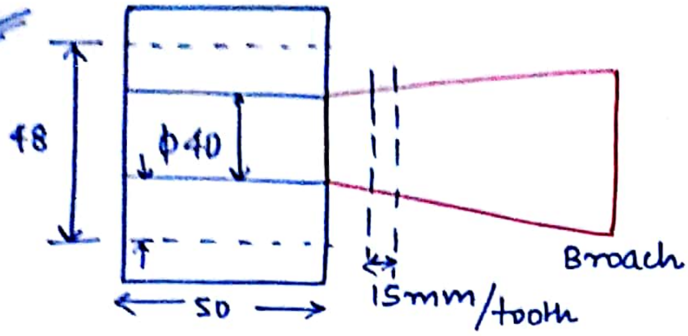
$T_1 + T_2 + T_3 =$

Ans 11.08 min

⑧ 4mm/rev

⑨ x_x_x_ = 60,000 ✓

(10)



$d = 4\,mm$

no. of Teeths $= \dfrac{4}{0.01} = 400$

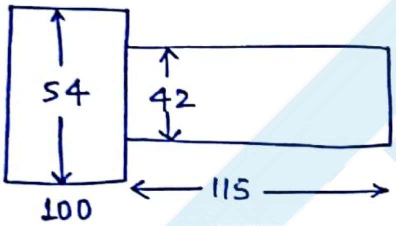
$l = 50 + 399 \times 15$

Time $= \dfrac{l}{0.35} = \underline{17.24}$

(11) $\phi 60$

$f = 1.2$ mm/rev

$v = 20$ m/min



$V = \pi d_m N_1$

(1) 60 → 54 $\quad d = 3$

$d_m = 57$

$l = 215\,mm$

no. of rev. $= \dfrac{215}{1.2}$ rev

$T_{m_1} = \dfrac{no}{N_1}$

(2) 54 → 42 12mm

$d = 3$

54 → 48

$d_m = 51$

$t = 115$

$T_2 =$

(3) $d = 3mm$

48 → 42

$d_m = 45$

T_3

$\underline{3.04\,sec}$ Ans

$T_1 + T_2 + T_3$

(12) $l = 15 + 1 = 16\,cm$

no. of threads $= 48$

$t_1 = \dfrac{48}{rpm} \times 7$

$V = \pi D N$

$\boxed{3.82\,min}$ Ans

(13) 4 cm → 3.5 $\quad D_m = 3.75$ cm

$L = 15\,cm$

$\dfrac{}{N}$

~~12.5~~

16.25

$\boxed{1.47\,\cancel{sec}\,min}$

(14) $D_m = 46\,mm$

$L = 50\,mm$

$N = 450\,rpm$

$L = 3\,mm$

$f = 0.2$ mm/rev

all $= 3mm$

rev $= \dfrac{56}{0.2}$

0.622

$\boxed{1.17\,min}$

(14) SIR $\quad \phi 50 \to 42$

$N = 450\,rpm$

$d = 3mm$

$l = 50$

$f = 0.2 \dfrac{mm}{rev}$ $\quad L = 53$

No. of rev $= \dfrac{53}{0.2} = 265$

(1) $d = 3$ $\quad \phi 50$ to 44

$\dfrac{53/0.2 \times 2}{450}$

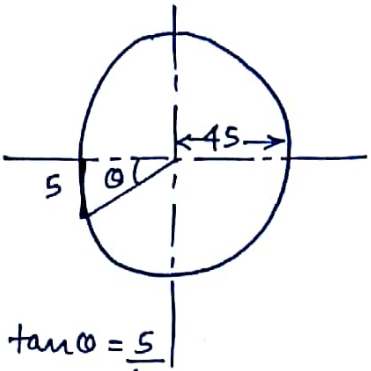
1.17 min

(15) 52mm → 44mm

$L = 200mm$

$\underline{8.8\,min}$

⑯



$\tan\theta = \frac{5}{45}$

$\theta = 6.30°$

$10 - 6.8 = 3.62$ ✓

$5 + 6.8 = 11.$~ ✓

⑰ 4.5

$8 \times 0.0125 = \cancel{1}\,0.1\ mm$

$\frac{4.4}{0.1} = 44$

$= 22 \times 43 + \ \ 8 \times 20 + 4 \times 20$

$=$ ——— .

CH #5

Q① c ✓

② c ✓

③ t_1 = cutting time

t_2 = return time

$t_1 + t_2 = 2$ → $1.6 t_2 = 2$ → $t_2 = 1.25$

$\left(\frac{t_1}{t_2}\right) = 0.6$ → $t_2 = 0.6 t_1$

$t_1 = 0.75$

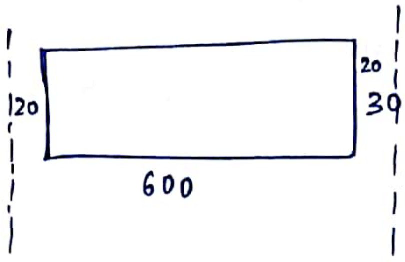
$t_2 = 1.25$

$l = 250$

$v = l/t_1$

⑫ ✓

Q4 (135)



$V = 8\ m/min$

$f = 0.3\ mm/s$

$\frac{t_2}{t_1} = ½$

no. of st $= \frac{30}{0.3} = 100$

$t_1 = \frac{0.640}{8}$ min

$t_1 = 0.08$ min

$t_2 = 0.04$ min

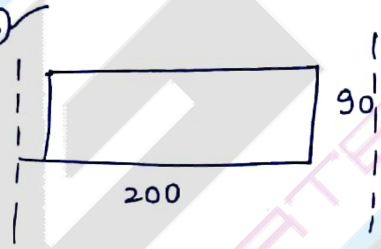
$t = t_1 + t_2 = 0.12$ (Time consume in 1stroke)

So in 100 strokes, $t = 0.12 \times 100$

(b) ✓ $t = \boxed{12\ min}$

⑤ ⑥ ✓

⑥



$V = 13.5\ m/min$

$f = 0.57\ mm/$

$l = 240\ mm$

$w = 98\ mm$

no. of st. $= \frac{98}{0.57}$

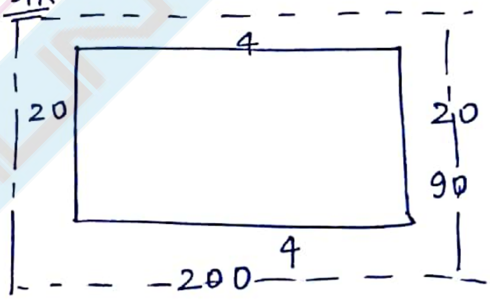
$t_1 = \frac{240}{13.5}$

$t = t_1 + t_2$

$\frac{t_2}{t_1} = 0.83$

(a) ✓

⑥ SIR



⑦ SIR

Specific energy × MRR = Energy

$1.49 \times 4 \times 0.25 \times 200 =$

MRR = $w t_1 V$

$w = \frac{d}{\cos\psi}$

$t_1 = 1 sec$

$V = \frac{200}{1} = \frac{200\ mm}{s}$

$t_1 = f\cos\psi$

(8) $V = 18\,m/min$

$rpm = \frac{1}{t_1 + t_2}$

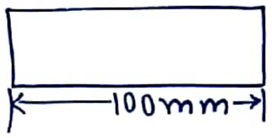
$\frac{t_1}{t_2} = 3/2$

$t_1 = \frac{0.2}{18}$ min

$rpm = 54.54$ Ans

$l = 200$
$V = 18\,m/min$

(9) $f = 0.001\,mm$



$V = ?$ $\quad \frac{V_R}{V_c} = \frac{2}{1}$

$L = 150\,mm.$

SIR

$\frac{100}{0.001} = 10^5$ strokes

$\frac{t_2}{t_1} = \frac{1}{2}$

$l = 150\,mm$

$t_1 = \frac{0.15}{V}$

$t_2 = \frac{t_1}{2}$

$t = (t_1 + t_2) \times 10^5 = 10 \times 60.$

$t_1 + t_2 = 0.006$ ✓

$2t_2 + t_2 = \text{—}$

$t_2 = 0.002$ ✓

$t_1 = 0.004$

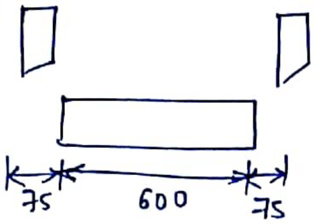
$V = 37.5$ ✓

(10) $l = 200$

$\frac{t_2}{t_1} = \frac{2}{3}$

0.167 m/s ✓

(11)



$V = 9\,m/min$

$\frac{t_2}{t_1} = \frac{1}{4}$ $\quad$ 3.12 min ✓

$f = 3\,mm$

$c = 75$ ✓

(12) $W = 310\,mm$

$l = 2000\,mm$

$f = 1\,mm/stroke$

$t_1 = 2\,sec$

$t_2 = 1\,sec$

$t = 3\,sec$

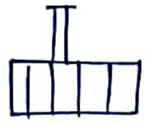
Total time $= 3 \times 310 = \frac{930}{2}$ sec

$\Rightarrow 465$ sec

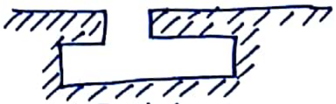
(13) 4.25 ~~sec~~ min.

MILLING

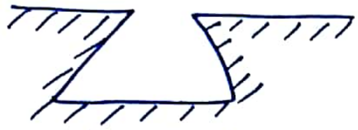
① VERTICAL



It was the initial m/c developed in the milling category and it is also called fixed Bed Type. Milling cutters are mounted with individual spindles. T-slot and Dovetail slots can easily be machined on this machine.



T-slot

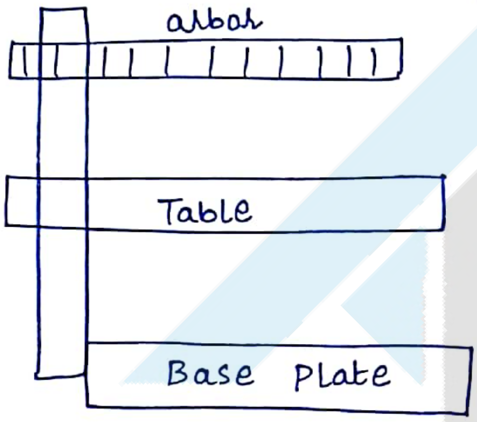


Dovetail

Generatrix is the path of cutting and Directrix is the path of feed.

② COLUMN & knee Type

:→ In column and knee type milling m/c, table is at the knee of the machine. multiple milling cutters can be mounted on the arbour. Biaxial feed can be controlled in two planes simultaneously. It is $2\frac{1}{2}$ axis machine. In universal



③ Universal Milling M/c (vertically adjusted)

:- In universal milling m/c. all the features of column and knee type are present. additionally, Table can be given rotation 45° on both the sides. In ④ Rotary milling machine, complete rotation of Table can be given. cutters are mounted on individual spindle and machining can take place simultaneously at 2 different places.

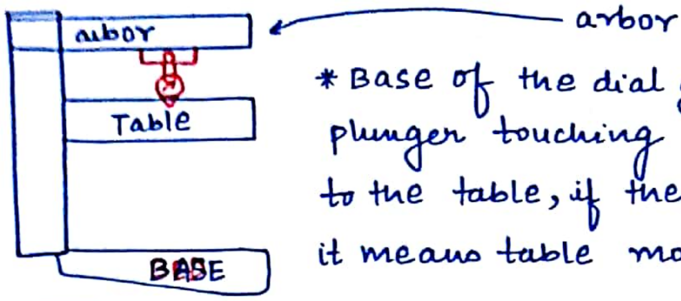
⑤ Plano Miller

:- Constructionwise it is also similar to a planning machine. But in place of single point cutting tool, there is milling cutter. It is meant for heavy workpieces. In a planning machine, cutting action is provided by the movement of table but in a milling m/c, cutting action is provided by the rotation of cutter.

Size of a Milling machine :- is defined by maxm. moment that can be given to the table in x, y and z direction.

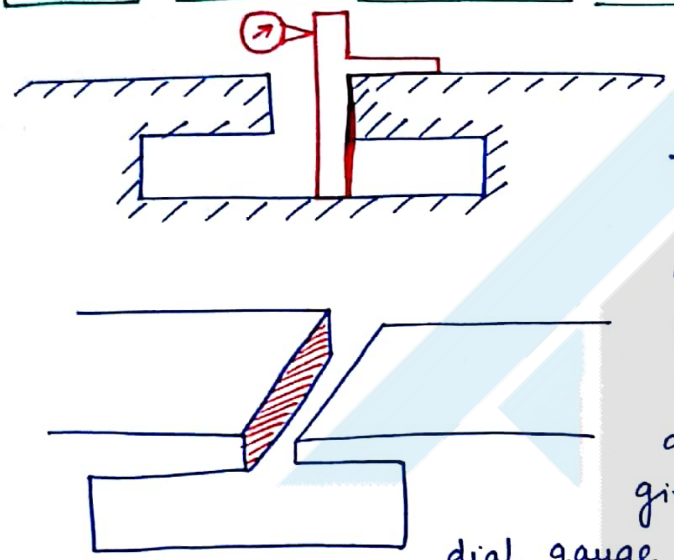
* ACCEPTANCE TEST of a Milling machine :-

Test 1 :- whether arbor axis is parallel to the table movement.



* Base of the dial gauge is fixed over the arbor with plunger touching the table. By giving Biaxial movement to the table, if there is no variation in the dial gauge, it means table movements are ∥ to the arbour axis.

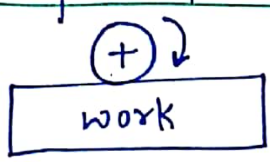
Test 2 :- whether central T-slot is square



Accuracy of central T-slot is important because workpieces and other machining fixtures are mounted on the central T-slot. To check the perpendicularity, a magnetic T is inserted in the slot with plunger of dial gauge touching the Top surface as shown in fig. Base of the dial gauge is fixed over the arbor. By giving vertical moment to the table, dial gauge moves over the T. if there is no variation in the dial gauge, it means slot is perpendicular. To check the parallel nature of the slot, plunger of the dial gauge is moved over the surface of the Tslot by giving horizontal movement to the table.

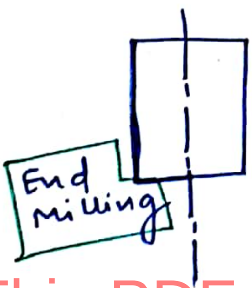
3/10/2016

* Milling :- ① Peripheral / slab



when the axis of rotation of the cutter is ∥ to the machine surface, it is called peripheral /slab milling operation. If the axis of Rotation of cutter is ⊥r to the machined surface, it is called face milling operation. when the milling cutter is such that partly the material is removed by face milling and partly by slab. It is called end milling operation.

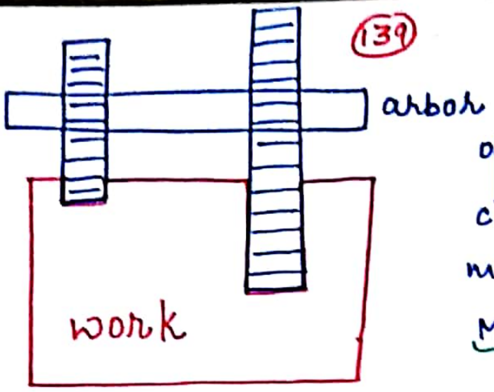
② Face Milling



③

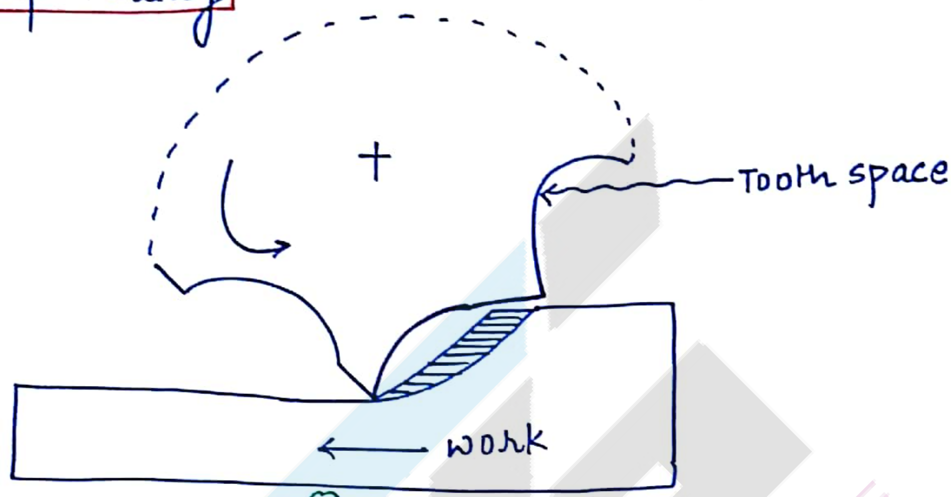
139

④ Straddle Milling :- when two cutters are mounted on arbor to perform machining operations at two different locations. It is called straddle milling. But when there are more than 2 cutters; it is called a Gang Milling.

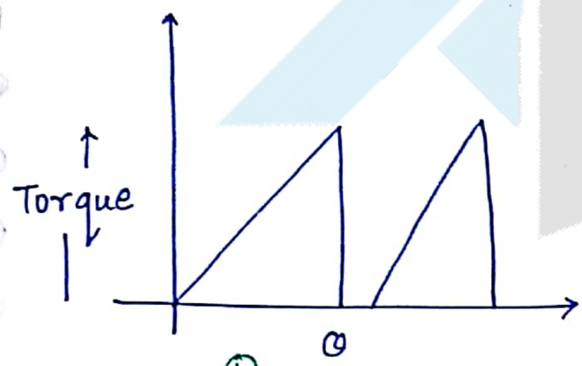


straddle

* Up-Milling

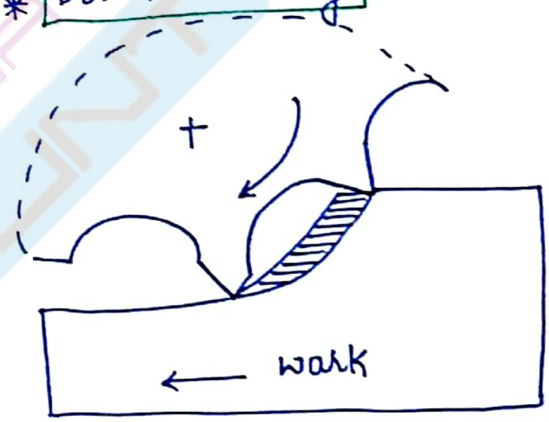


ⓐ

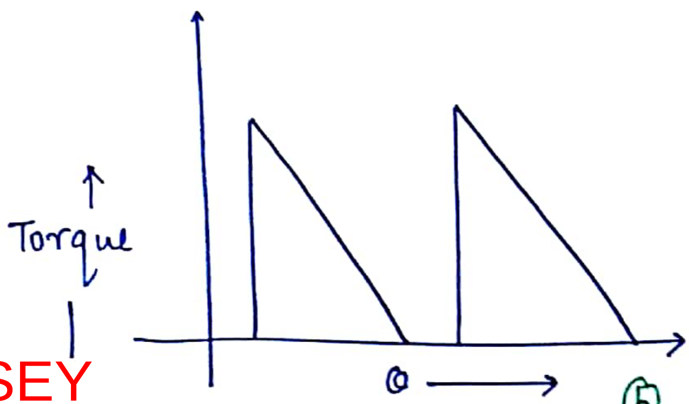


ⓑ

* Down - Milling



ⓐ



ⓑ

Points :- (a) In upmilling process, cutter and workpiece motions are in opposite directions.

(b) In upmilling chip thickness varies minm. in the beginning and maxm at the end. In downmilling, since maxm. chip thickness is in the beginning, so cutting edge will experience a shock.

(c) In upmilling, Before starting the cutting, cutting edge rubs over the finished part and hence spoils the surface finish so the surface finish will be better in the down milling.

(d) In the upmilling process, since hot chips goes to the tooth space and stays there for longer period of time so due to diffusion, cutting edge will become weaker and weaker, so Tool life will be more on down milling.

(e) In the upmilling process, since the fasteners are will be under tension, so Backlash error will not have any effect so more accurate products can be machined in up-milling.

* FEED PER TOOTH

$$\boxed{f_t = \frac{f\,(mm/rev)}{n_t}}$$

Total ~~tooth~~ feed

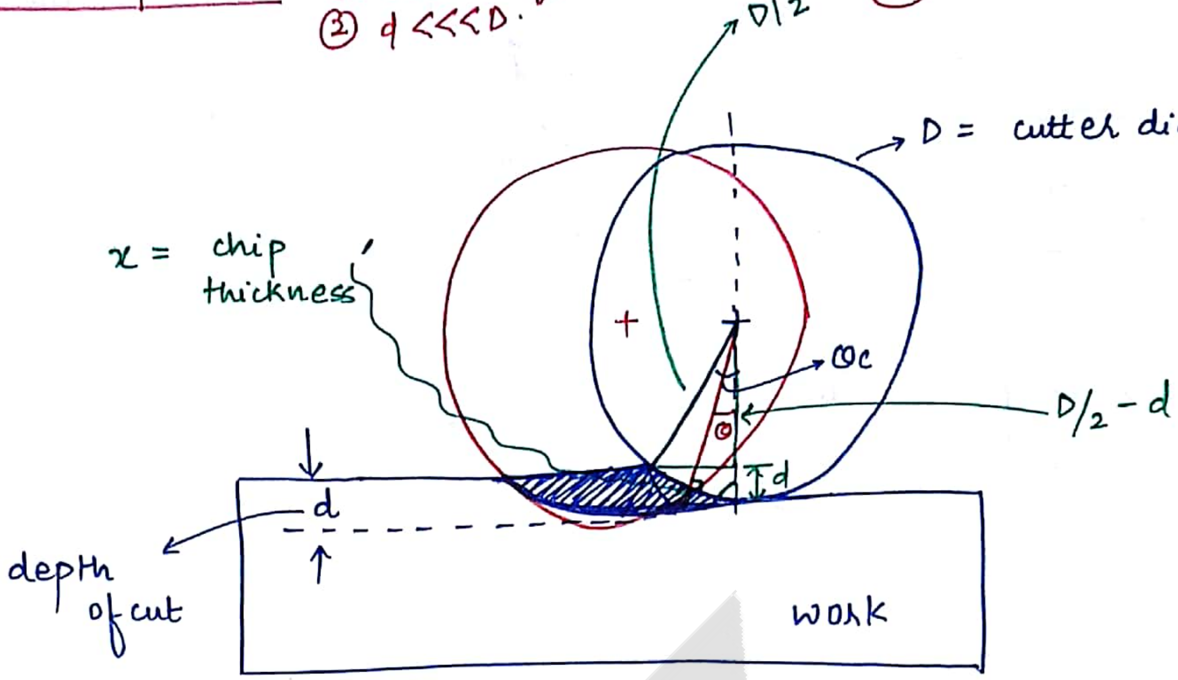
No. of teeths on cutter

✓ $\theta = 0°$, $x = 0$

✓ $\theta = \theta_c \Rightarrow x = x_{max}$

MOHIT CHOUKSEY

assumptions :- (1) $\theta = 90°$.
(2) $d <<< D$.



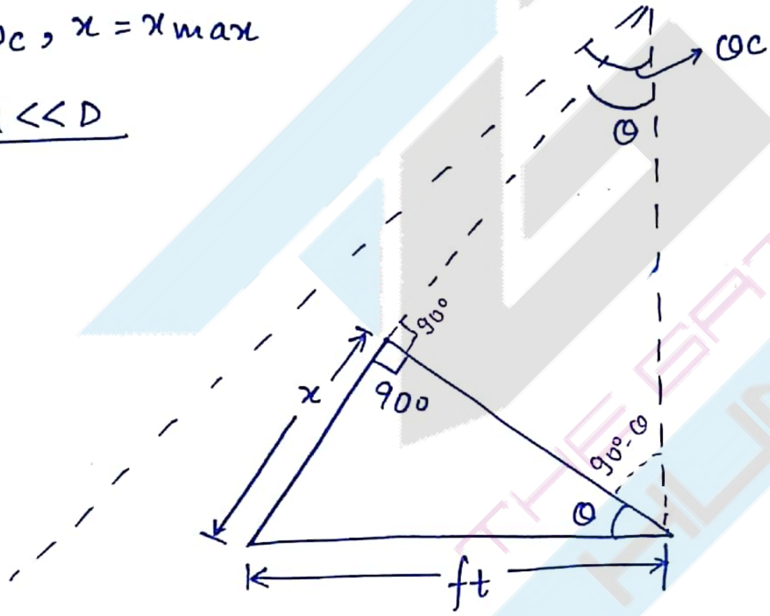
$\theta = 0, \; x = 0$

$\theta = \theta_c, \; x = x_{max}$

$d << D$

$$\cos\theta_c = \frac{(D/2 - d)}{(D/2)}$$

$$\boxed{\cos\theta_c = 1 - \left(\frac{2d}{D}\right)}$$



$$x = f_t \sin\theta$$

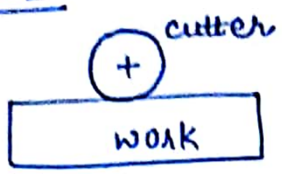
$$x_{max} = f_t \sin\theta_c = f_t\sqrt{1 - \left(1 - (2d/D)\right)^2}$$

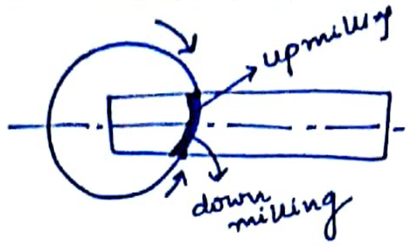
$$\boxed{x_{max} = 2f_t\sqrt{d/D\,(1 - d/D)}}$$

$$x_{mean} = \frac{0 + x_{max}}{2}$$

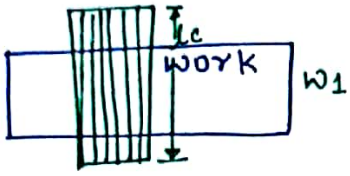
$$\boxed{x_{mean} = f_t\sqrt{d/D\,(1 - d/D)}}$$

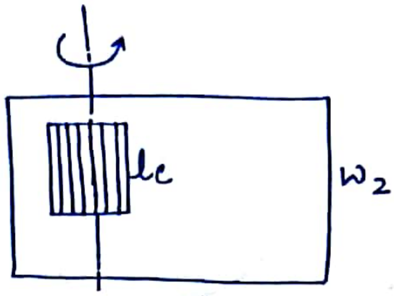
$V_c \omega t_1$
$\parallel$
$V_c \omega t_2$





Face milling is combination of (up + down) milling





$w = l_c$

$\omega = \omega_1$

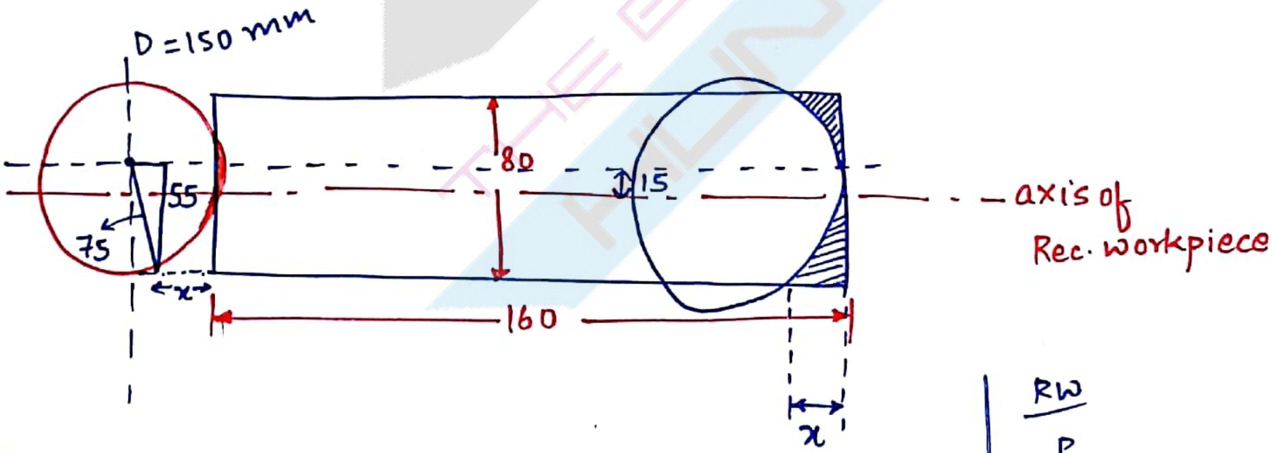
Q A surface $80 \times 160\ mm^2$ is rough machine using a face milling cutter of diameter 150 mm having 10 Teeths. The cutter centre is offset by 15 mm from the line of symmetry of workpiece. If the feed per tooth is 0.25 mm, cutting speed is $V = 20\ m/min$.

Calculate :- ① Time to run machine.

② with 5mm approach and 5mm overrun, what is single pass feed time.

③ If the cutter is symmetric what is rough and finish machine time.

Sol



$n_t = 10$

$f_t = 0.25\ mm$

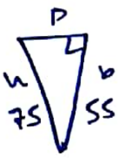
$V = 20\ m/min$

length of cut $= 160 + x$

$= 160 + 24$

$= 184$

RW



$p^2 + b^2 = h^2$

$p^2 + 55^2 = 75^2$

$f = 10 \times 0.25 = 2.5\ mm/rev$

$V = 20$

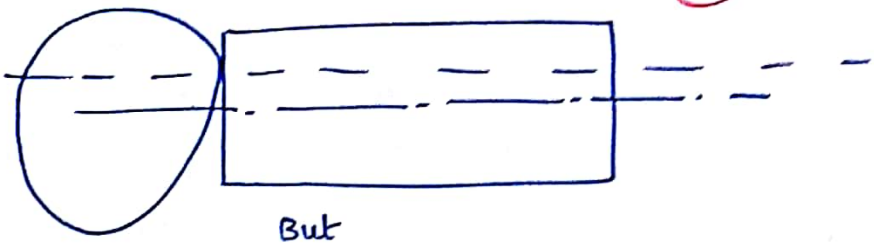
$\pi \times 0.15 \times N = 20$

$N = $

no. of Rev $= \frac{184}{2.5}$ $= T_1$

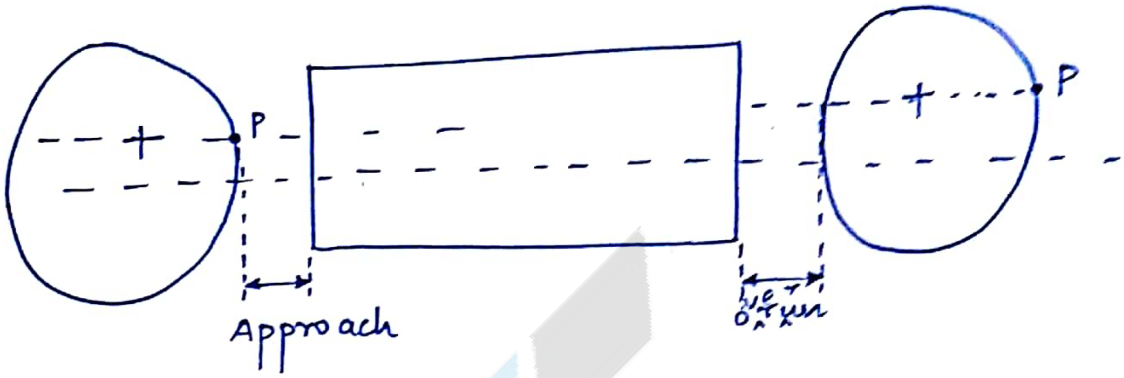
N

$T_1 = $ time $= 1.73\ min$



But

↓



$l = 5 + 160 + 5 + 150$

$l = 320\,mm$

$f = 2.5\,mm/rev$

No. of Rev. $= \frac{184}{2.5} = \frac{320}{2.5} = 128$

$20 = \pi \times 0.15 \times N$

$N = 43$

$T_{M_2} = \frac{\frac{320}{2.5}}{43}$

$\boxed{T_{M_2} = 3.01\,min}$

(iii) symmetric means w/p k cutter axis same.

↓

$T_1 = 1.61$ min. (Rough machining)

T_2 ← finish m/c $= 3.01$ min

MOHIT CHOUKSEY

Q The thickness of a rectangular Brass plate of length L_w and width B_w has to be reduced by t mm in one pass by slab milling cutter of length l_c greater than B_w. Diameter of cutter is D_c, no. of teeths Z_c, cutting velocity V_c, feed per tooth is S_o. calculate the machining time.

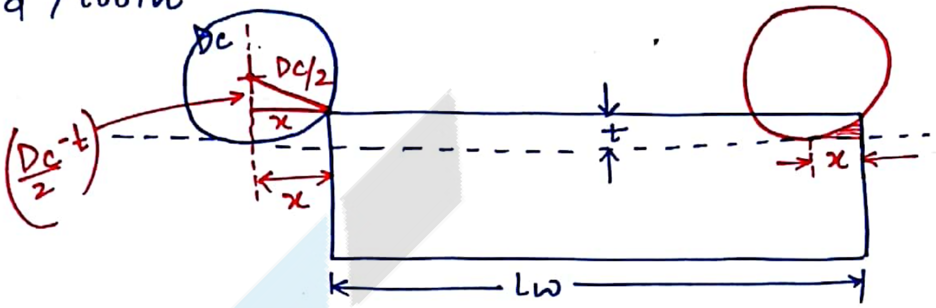
Sol.

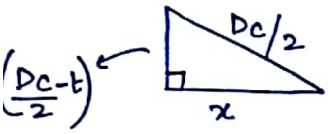
Z_c = no. of teeths

V_c = cutting velocity

S_o = feed / tooth

$\boxed{l_c > B_w}$ → length of cut





Length of cut $= L_w + \sqrt{t(D_c - t)}$

$$x = \sqrt{\left(\frac{D_c}{2}\right)^2 - \left(\frac{D_c - t}{2}\right)^2}$$

$$x = \sqrt{t(D_c - t)}$$

$$\text{Time} = \frac{\left\{L_w + \sqrt{t(D_c - t)}\right\}\pi D_c}{S_o Z_c V_c} \quad \text{Ans}$$

feed/rev $= S_o Z_c$

$V_c = \pi D_c N$

$$N = \frac{V_c}{\pi D_c}$$

Q Estimate the power required during upmilling of mild steel Block of 20 mm width with a slab milling cutter having 10 teeths, (75 mm diameter), & 10° Radial Rake. The feed velocity of the table is 100mm/min, coefficient of friction is 0.5 and shear strength of material is 400 MPa, the depth of cut is 5mm and the cutter rotates at 60 rpm.

MOHIT CHOUKSEY

Sol→ width = 20mm

$n_t = 10$ → $\frac{360^\circ}{10} = 36^\circ$

$D = 75$ mm

$\alpha = 10^\circ$

$f = 100$ mm/min

$\mu = 0.5$

$\tau_s = 400$ MPa

$d = 5$ mm

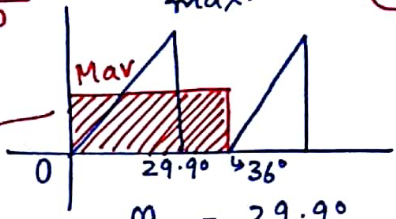
$N = 60$ rpm

$f_1 = \frac{100}{60}$ mm/rev

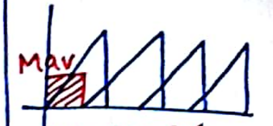
$f_t = \frac{f_1}{10}$

(145)

max.



$\theta_c = 29.9^\circ$



$\cancel{Z} \neq 20$ ~~tht~~

$\frac{360}{18} = 20^\circ$

$\frac{1}{2} M_{max} \times 29.9 = M_{av} \times 18$

$x_{max} = 2f_t \sqrt{d/D\,(1 - d/D)}$

$= 0.083$ mm

$\boxed{\text{Power} = M_{av} \times \omega}$

$M_{av} \times 36 = \frac{1}{2} M_{max} \times 29.9$

Lee & shaffer,

$\phi + \beta - \alpha = 45^\circ$

$F_s = \tau_s \frac{w t_1}{\sin\phi}$

$\frac{F_c}{F_s} = \frac{\cos(\beta - \alpha)}{\cos(\phi + \beta - \alpha)}$

β → $\tan^{-1}\mu$

$M_{max} = F_c \times D/2$

$\boxed{F_c = 1893\text{N}}$

$M_{max} = 70231.61$

$\boxed{P = 185\text{W}}$

ME $\tan^{-1}\mu = \beta$

$\beta = 26.56$

$\phi + 26.56 - 10 = 45$

$\phi = 28.44^\circ$

$F_s = \frac{400 \times 10^6 \frac{N}{m^2} \times 20 \times 0.083}{\sin 28.44}$

$F_s = 1394.26$

ME $F_c = \frac{0.95 \times 1394}{0.702}$

MOHIT CHOUKSEY

WB ① → b

② → c

③ → one face

$l = 100$

$\text{Time} = \left(\frac{110}{30}\ \text{min} + 2\right) \times 6$

④ → ⓓ ✓

⑤ → ⓓ ✓

⑥ → ⓓ ✓

⑦ → ⓐ ✓

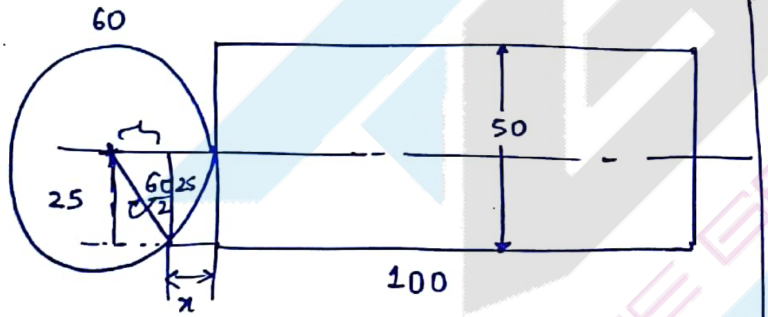
⑧ → ⓐ ✓

⑨ → ⓐ

⑩ $D = 60\ mm$

$z = 20$

$t = 15$



$l = 100 + x$

ⓐ $\cancel{60^2 = 25^2 + ?^2}$

$30^2 = 25^2 + ?^2$

$x = 13.41$

⑪ ⓒ ✓

⑫ c ✓

⑬ b ✓

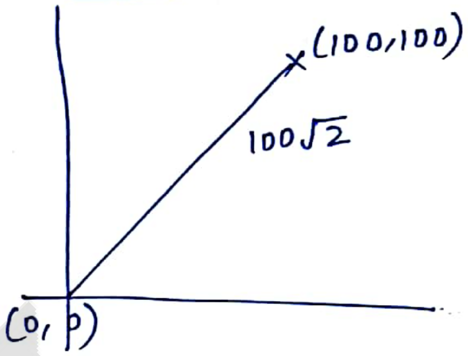
⑭ b ✓

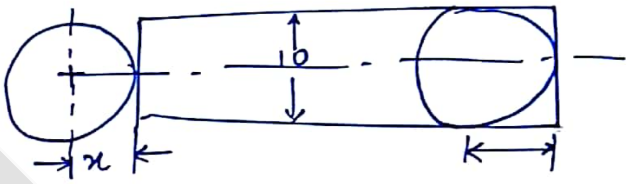
⑮ c ✓

⑯ later

⑰ GATE

$l = \frac{100}{\sqrt{2}} + x$





$l = 100\sqrt{2} + 5$

$l = 146.42$

$\frac{146.42}{50}$

2.92

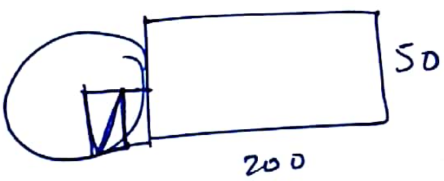
175 ✓

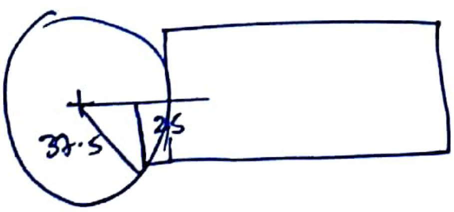
⑱ $x_m = ft\sqrt{d/D\,(1 - d/D)} \to 1$

$d << D$

0.707 ✓

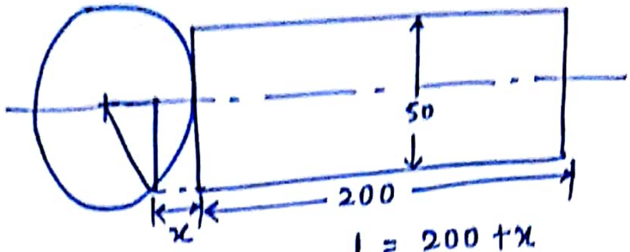
⑲





MOHIT CHOUKSEY

(19)

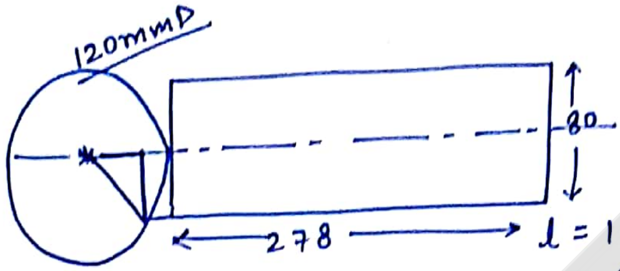


$l = 200 + x$

$l = 209.54$ ✓

(20)

10 teeth = Z



$l = 1 + 278 + 1 + 120$ ✓

(6) ✓

$\boxed{l = 400 \text{ mm}}$

(22) → wrong qn.

* JIGS AND FIXTURES :- These are auxiliary devices used in the mass production, if we want to maintain accuracy in machining, it is important that the m/cing is taken place in a single plane of reference only. fixture ensures that every ~~wh~~ time workpiece is loaded in a single plane fixture also decreases the loading and unloading time. Jig is having one additional fn. to perform that is guiding the Tool. Jigs are used in drilling, Boring, reaming, Broaching etc.

1/10/2016

other Topic :- Machinability :-

① Tool life.

② Surface finish.

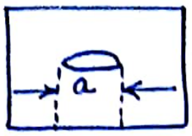
③ Cutting forces.

→ $\dot{\epsilon}_z = 0$ Plane strain ⇒ $k' = \frac{\sigma_0}{\sqrt{3}}$

$\sigma_1 - \sigma_2 = 2k'$ Stress $= \frac{\sigma_0}{2} = k'$

$\boxed{2k' = \sigma_0}$

IES 5.52 — **Material science.**



fracture toughness

$K_c = y\,\sigma\sqrt{\pi a}$

y → variable; σ → strength

$(a) \longrightarrow$ for internal cracks.

$(a/2) \longrightarrow$ for external cracks.

IES 5.53

$$\boxed{\frac{1}{\rho} = \Sigma \frac{x_i}{\rho_i}}$$

5.53

Q.> Lateron.

Jigs conti....

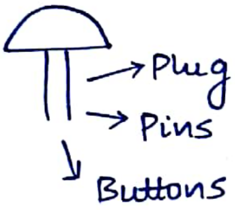
* **Components of Jig** :- ① Locating elements.

② clamping elements. — Pneumatic. / Toggles and wedges.

③ Tool guiding elements.

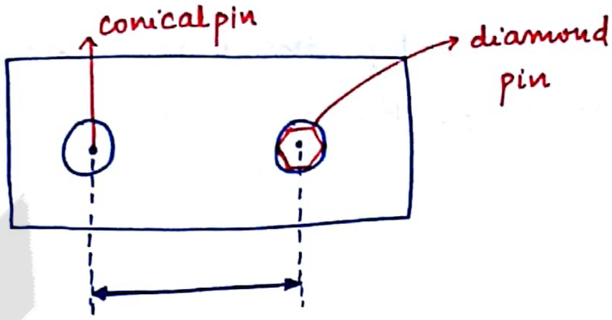
④ Jig Body.

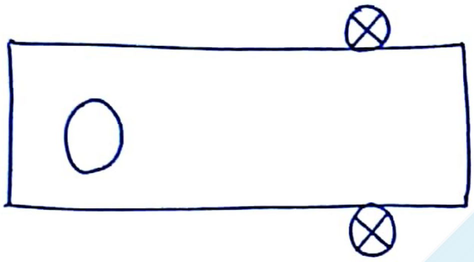
① **3-2-1 Principle** :- There are 12 degrees of freedom of any workpiece in machining that is movement along +ve and -ve direction along the axis and also clockwise and anticlockwise rotation along x, y, z-axis. Three hemispherical pins are provided in the base. so when the flat surface rest on these pins, it will be a 3-point contact. Three points can define a plane. This ensures that everytime machining is taking place in a single plane only. These 3 pins arrest 5 degrees of freedom that is movement along -z dirn. and clockwise and anticlockwise rotation along x and y axis. Two pins are provided on a plane ⊥r to the Base along the length direction. These pins

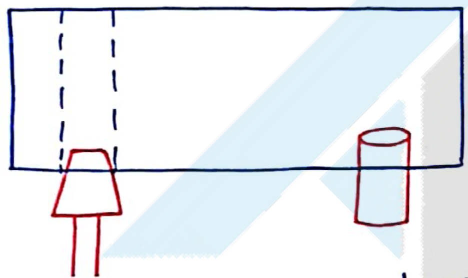


arrest 3 more degrees of freedom that is movement along -x dirn, and clockwise & anticlockwise rotation along z-axis. A 6th pin is provided on a plane ⊥r to the previous 2 planes and this pin arrest's one more degrees of freedom that is movement along -y direction. so by providing these 6 pins, 9 degrees of freedom will be arrested. Remaining 2 degrees of freedom will be arrested by clamping elements. Before starting the machining, 11 degrees of freedom must be arrested.

② RADIAL LOCATION :-

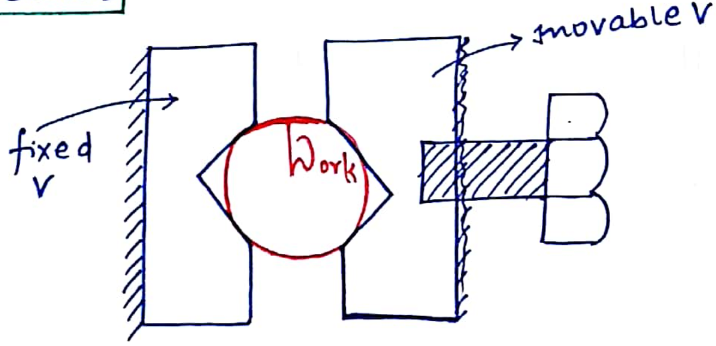






A Radial locations are used when in the workpiece, there is already one drilled hole. By Inserting the conical pin into the hole, 9 DOF can be arrested. conical pins are used to accomodate any variation in the size of hole. Two more degrees of freedom (DOF) are arrested by providing cylindrical pins on the side of the work. If there are 2 holes in the work, one conical pin is inserted in the smaller hole and one diamond pin is inserted in the larger hole. Two surfaces of the diamond pin are relieved to facilitate the variation in the centre to centre distance in the hole.

③ V-locators :-



w/p. (when fixed b/w),
✓ loose all the DOF.
✓ used for cylindrical and spherical w/p's.

* Steps in designing a Jig :-

Step 1 :- The W/P for which the jig has to be design, its plan, elevation and end view are drawn with RED PENCIL.

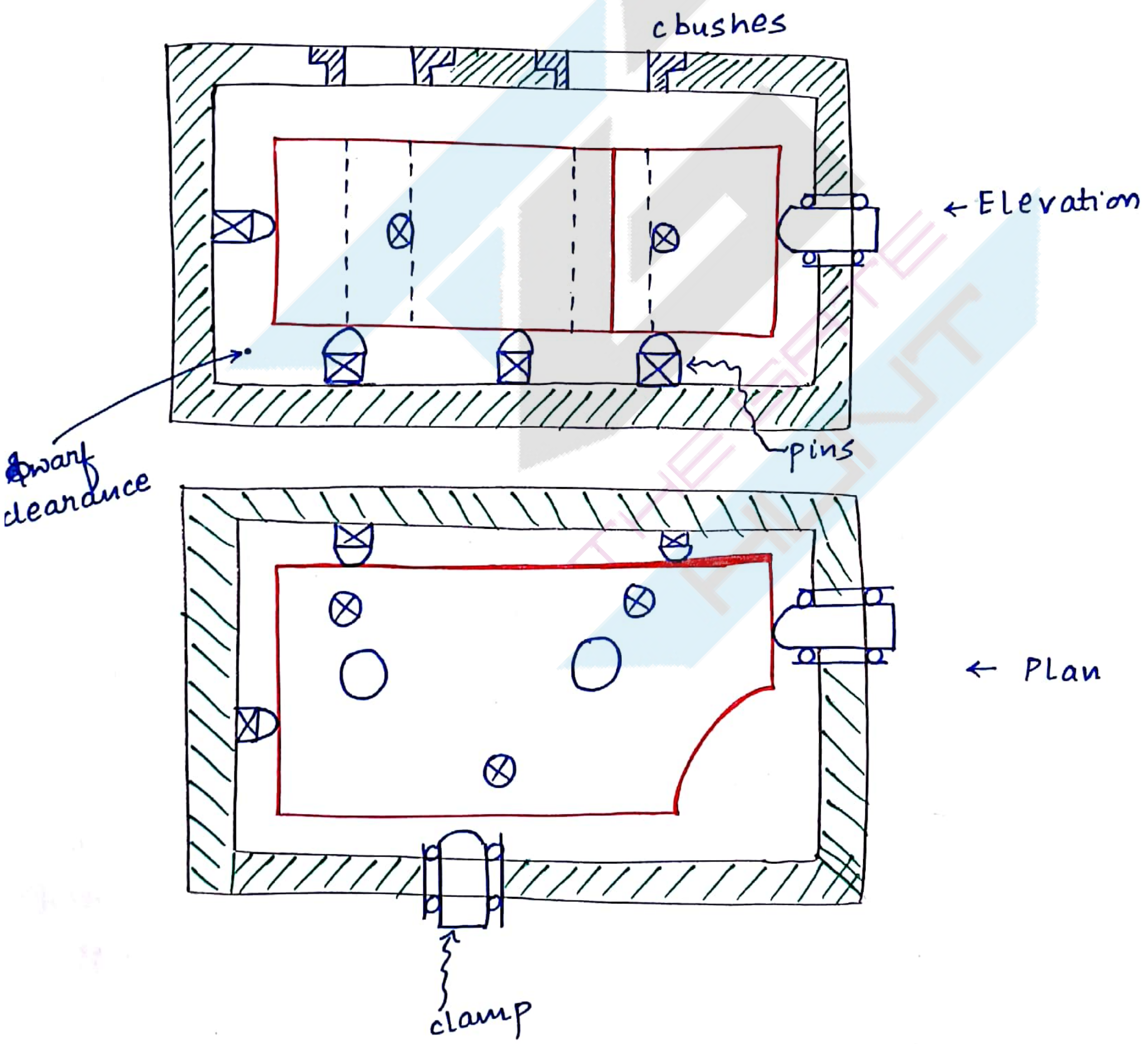
Step 2 :- Identify the places where machining has to be perform.

Step 3 :- Identify the type of locating element.

Step 4 :- Identify the places where locating elements has to be provided.

Step 5 :- Identify the places where clamping has to be performed.

Step 6 :- Draw the Jig Body.

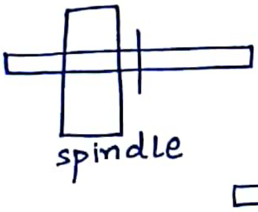


MOHIT CHOUKSEY

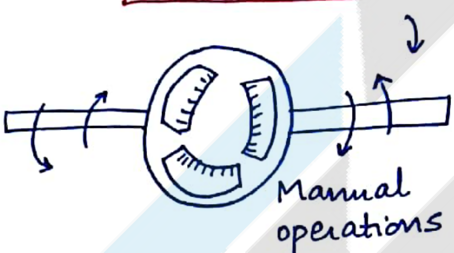
WB ch-12
① → d
② → b.
③ → c.
④ → c.

SCREW & GEAR Manufacturing

SCREW :- Producing screws over a lathe is called thread chasing. A hard automated lathe targetted to produce screw thread in mass is called swiss automate.



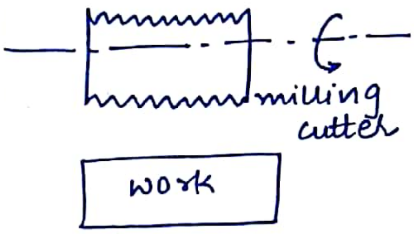
DIE THREADING :-



Tapping is a process to produce internal threads manually and
Die threading is a process of producing external threads manually.

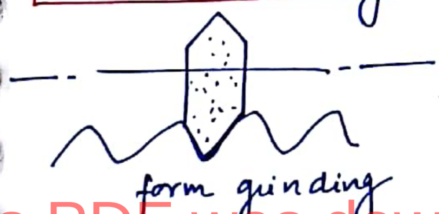
But threads can be produced only in a certain diameter range.

Thread Milling :- In case of milling once the req. tooth depth is achieved, milling cutter is withdrawn and work blank is indexed. although any type of thread can be produced on a milling m/c but since indexing mechanism is not accurate so threads produced will not be accurate.



Thread Rolling :- workblank is pressed b/w the two flat dies and the impressions of die appears on the work. Since the threads are produced purely by plastic deformation, so threads will be stronger but the process can be used only in the mass production. Internal threads can also not be produced by this process.

Thread Grinding :- Most accurate threads are produced by grinding but since the wheel wear will be quite high so threads will be expensive.



Gear Material → (a) Cast Iron

(b) steel

(c) Bronze

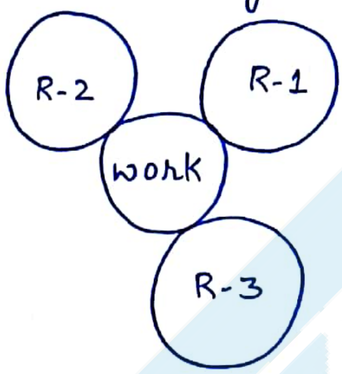
(d) Aluminium

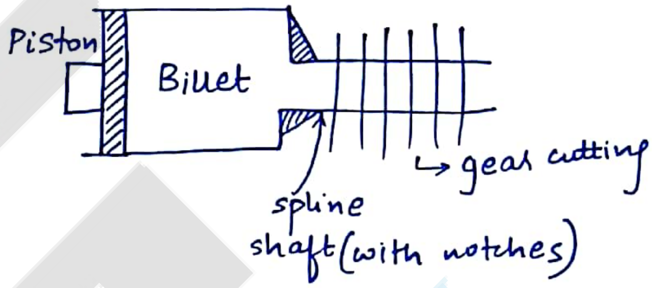
(e) plastic and Nylon

↓ Toys; ↳ Xerox machine

Manufacturing of Gears :- FORMING

Rolling; Extrusion

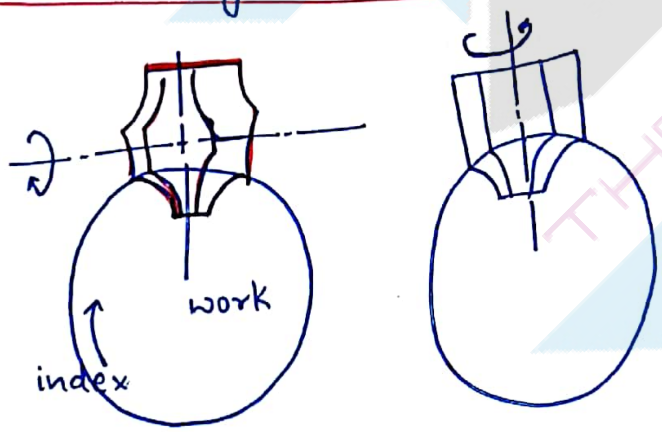




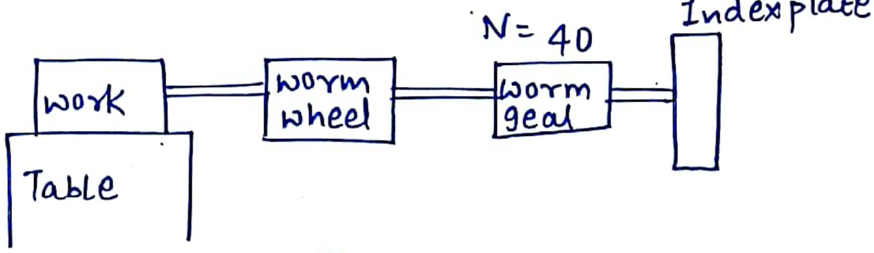
Gear Milling (Method) :-

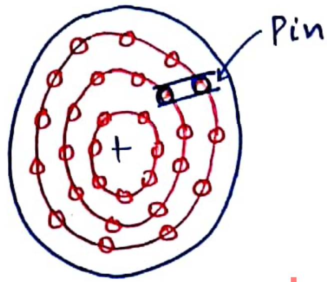
$$\frac{40}{N} = \frac{40}{30} = \frac{4}{3} = 1 + \frac{1}{3} = 1 + \frac{7}{21}$$

$N = 30$



N = 40





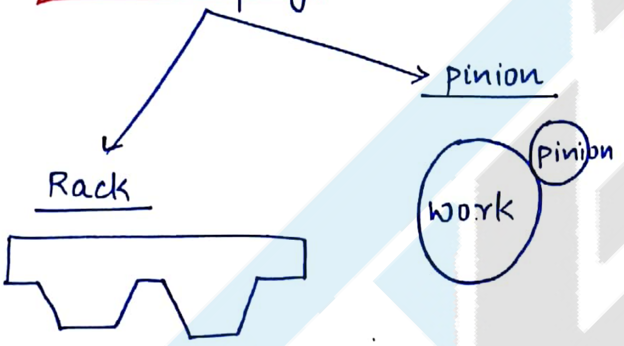
19, 20, 21

$$\frac{40}{50} = \frac{4}{5} = \frac{16}{20}$$

Both slab and end milling cutters can be used to machined gears. After producing one teeth, cutter is withdrawn and the work is advanced by one pitch. Since this indexing mechanism is controlled by a gear train and there will be backlash error in the measurement of pitch. so gears produced will not be accurate. but any type of gear can be cut on the machine.

* **Gear Broaching** :- Splined Broaches are used in the gear manufacturing. Initially a finite hole has to be drilled and when we pull the Broach through the hole; all the teeth will be generated. The processes can be used to make external gears also and the process is called ~~part~~ of Broaching. since broaches are expensive, process can be used only in the mass production.

* **Gear Shaping** :-

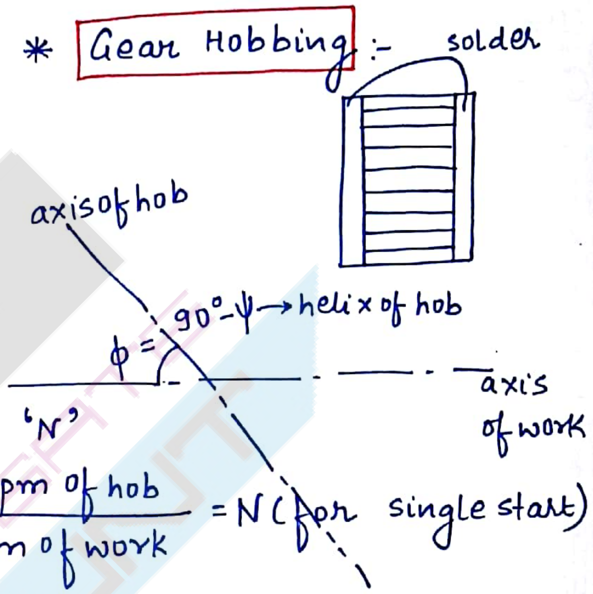


Gear shaping with rack type cutter, once the required tooth depth is achieved, cutter is withdrawn and the workblank is indexed. so only external gears can be produced and Because of indexing mechanisms, gears produced will not be accurate.

In pinion type cutter, there is a continuous indexing once the req. tooth depth is achieved, 3 motions are started simultaneously :- (a) Rotary motion of work (b) Rotary motion of pinion (c) Reciprocating motion of pinion.

Both internal & external gears can be produced by pinion cutter. both helical and spur gears can be cut on a Shaper but when helical gears has to be produced, work has to be mounted on a helical drive.

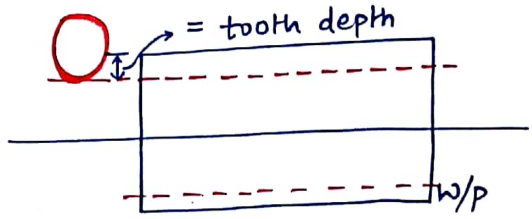
* **Gear Hobbing** :-



$$\frac{\text{rpm of hob}}{\text{rpm of work}} = N \text{ (for single start)}$$

Double start $= N/2$

$= N/3$



Gear Hobbing → It is the fastest method of producing gears. Hob is just like a splined screw and by using the single hob, any type of helix can be cut on the work just by changing the angle between the hob axis and the work.

For producing spur gears, angle b/w these two axis should be equal to 90° − helix angle on the hob. Initially, hob is lowered to a point to achieve the required Tooth depth, then 3 motions are started simultaneously :- ① Rotation of work. ② Rotation of hob. ③ Axial movement of work. when hob moves from one side of work to other side, all the teeths will be produced.

{ Most accurate gears → By Broaching }

CH#8

① → ⑥

2> → c

3 → d

4 → b

5 → a

6 → d

7 → d

8 → a

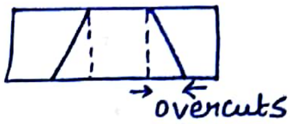
9 → a

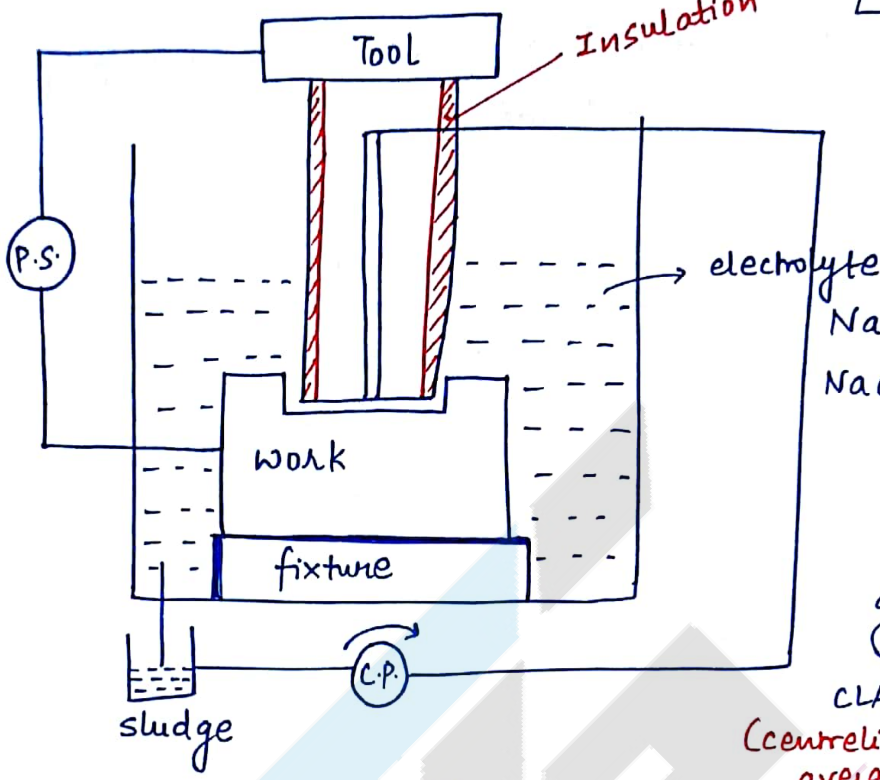
10 → 20

UNCONVENTIONAL MACHINING

* Electrochemical machining

I ↑ V ↓





$NaCl \rightarrow$ rough

$NaClO_3 \rightarrow$ finish

gap → 0.03 - 0.5 mm

CLA Ra → 0.2 - 0.8 μ (microns)

(centreline average)

$$Fe \rightarrow Fe^{+2} + 2e^-$$

$$NaCl \rightarrow Na^+ + Cl^-$$

$$2H_2O + 2e^- \rightarrow H_2\uparrow + 2OH^-$$

$$Fe^{+2} + 2OH^- \rightarrow \underset{\text{sludge}}{Fe(OH)_2\downarrow}$$

electrochemical grinding

(ECG)

95% electro

5% grinding

* In ECM process, the mechanics of material removal is electrolysis. which is reverse of electroplating. material is removed atom by atom that is anodic dissolution. It is high current, low voltage process and higher is the current, more will be the material Removal Rate. Tool is made up of some conducting material like Copper alloys and its surface is insulated, so that Reaction doesn't takes place sideways. Before pumping the electrolyte back to the machining area, it needs to be cooled otherwise it leads to overcut. * In electrochemical grinding, in grinding wheel, the Bonding agent is some conducting material and 95% of m/c takes place by electrolysis and 5% by pure grinding.

Since hydrogen gas is produced in the electrolysis Rxn., so there will be a safe passage for its removal.

- Small size steam turbine blades are manufactured by ECM process.
- medium size gas turbine blades are —" —"– investment casting.
- large size water turbine blades are produced in a copying lathe using Sialon as a tool material.

*5/10/2016

ECM

Mass $\propto$ charge

$\propto It$

$m = ZIt$ (gm)

Z → Electrochemical equivalent

$Z = \frac{e}{F}$ — e → chemical equivalent, F → Faraday's constant

$e = \frac{\text{Atomic wt.}}{\text{valency}}$

MRR → cm^3/s

$MRR = \frac{eI}{F\rho}$

$s = \frac{e}{F\rho}$ (specific MRR)

Electrode feed Rate $= s \times S_1$ ← current density

$S_1 = I/A$

$I = \frac{\Delta V}{R}$

$R = \rho_s \frac{l}{A}$ ← gap

WB Pg 31

Q6> $\rho = 6000\ kg/m^3$

At. wt. = 56

v = 2

S1R

	At. wt	val	
P	24	4	x
Fe	56	2	$(1-x)$

(put units in CGS)

$$1/e = \frac{x \cdot 4}{24} + \frac{(1-x)2}{56}$$

$$MRR = \frac{eI}{F\rho}$$

$$50\ (mm^3/s) = \frac{e\,(2000A)}{96500 \times 6000 \times 1000g}\ m^3$$ 157

$$50 \times \left(\frac{1}{10}\right)^3 = \frac{e\,(2000)\,(100)^3}{96500 \times 6000 \times 1000}$$

$$= 3.45 \times 10^{-3}$$

$$e = 14.49$$

$$\frac{1}{14.49} = \frac{x}{6} + \frac{2-2x}{56}$$

$$\frac{1}{14.49} = \frac{56x + 12 - 12x}{336}$$

$\boxed{x = 0.25}$ 25 % Ans

Q10

$wt = 56$

$v = 2$

$\rho = 7.8\ gm/cm^3$

$I = ?$

$MRR = 2\ cm^3/min$

$$MRR = \frac{eI}{F\rho}$$

(a) ✓

(27) Fe $(56 = wt,\ v = 2)$

$e = \frac{56}{2}$

$I = 1000A$ $MRR = 0.26\ gm/s$

$$MRR = \frac{eI}{F\rho}$$

$\eta_I = 90\%$

Ti $wt = 48$ $I = 2000A$

$v = 3$ $90\% = \eta_I$ $MRR = ?$

0.29 Ans

$I_1 \rightarrow 0.9 \times I$ ✓

$I_2 \rightarrow 0.9 \times I$ ✓

(28) ~~[illegible]~~

$\cancel{R = \rho_s \frac{l}{A} = 6 \times 0.6}$

$e = \frac{56}{2} = 28$

$MRR = \frac{e I}{F \rho}$

$= \frac{28 \times 480}{96500 \times 7.6}$

$MRR = 0.018 \frac{cm^3}{s}$

(29) $MRR = 0.036$

$feed = 5.88 \times 10^{-3}\ cm/s$

$A = 25 \times 25\ mm^2$

cas

$A = 625 \left(\frac{1}{10}\right)^2$

$l = 0.25$

$\rho_s = 3\ \Omega\ cm$

$$R = \frac{3 \times 0.25 (1/10)}{625 (1/10)^2} = 0.012$$

$$I = \frac{\Delta V}{R} = \frac{12}{0.012} = 1000 A$$

$$MRR = \frac{\frac{55.85}{2} \times 1000}{96500 \times 7860 \times 1000 \times 1/(100)^3}$$

$\boxed{MRR = 0.036}$

$$\delta = \frac{e}{F \rho} = \frac{\frac{55.85}{2} \times 100^3}{96500 \times 1000 \times 7860 \times 10^3}$$

$\delta = 3.68 \times 10^{-8}$

$Feed = \delta \times \delta_1$

$= \delta \times \frac{I}{A} = \frac{3.68 \times 10^{-8} \times 1000}{(25 \times 25)(1/10)^2}$

$F = 5.88 \times 10^{-3}\ cm/s.$

30 $l = 2\,mm$

over voltage $= 2.5\,V$

$\rho_s = 50\,\Omega\text{-}mm$

Feed rate $= 0.25\,mm/min$

$\rho = 7.86\,gm/cm^3$

$A = 56$

$z = 2$

$\Delta V = ?$

Supply $= \Delta V -$ over.

$$R = \rho_s \frac{l}{A} = \frac{7.86 \times (2)(1/10)}{}$$

$$\frac{0.25\,(1/10)}{(60)} = \frac{e}{F\rho} \times \frac{I}{A}$$

$$\frac{0.25}{60 \times 10} = \frac{\left(\frac{56}{2}\right)}{96500 \times 7.86} \times \frac{I}{A}$$

$$4.16 \times 10^{-4} = 3.69 \times 10^{-5} \times \frac{I}{A}$$

$$11.29 = \frac{I}{A}$$

$$11.29 = \frac{\frac{\Delta V}{R}}{A} = \frac{\Delta V}{R}\,A = \Delta V\, \rho_s \frac{L}{\cancel{A}}\,\cancel{A}$$

$$= \Delta V\ 50 \times 1/10 \times 2/10$$

$\Delta V = 11.29$

Supply voltage $= 11.29 - 2.5$

$= 8.79\,V$ ✓ Ans

T1

	Wt	V
Co	58.93	2
Ni	58.71	2
Cr	51.99	6

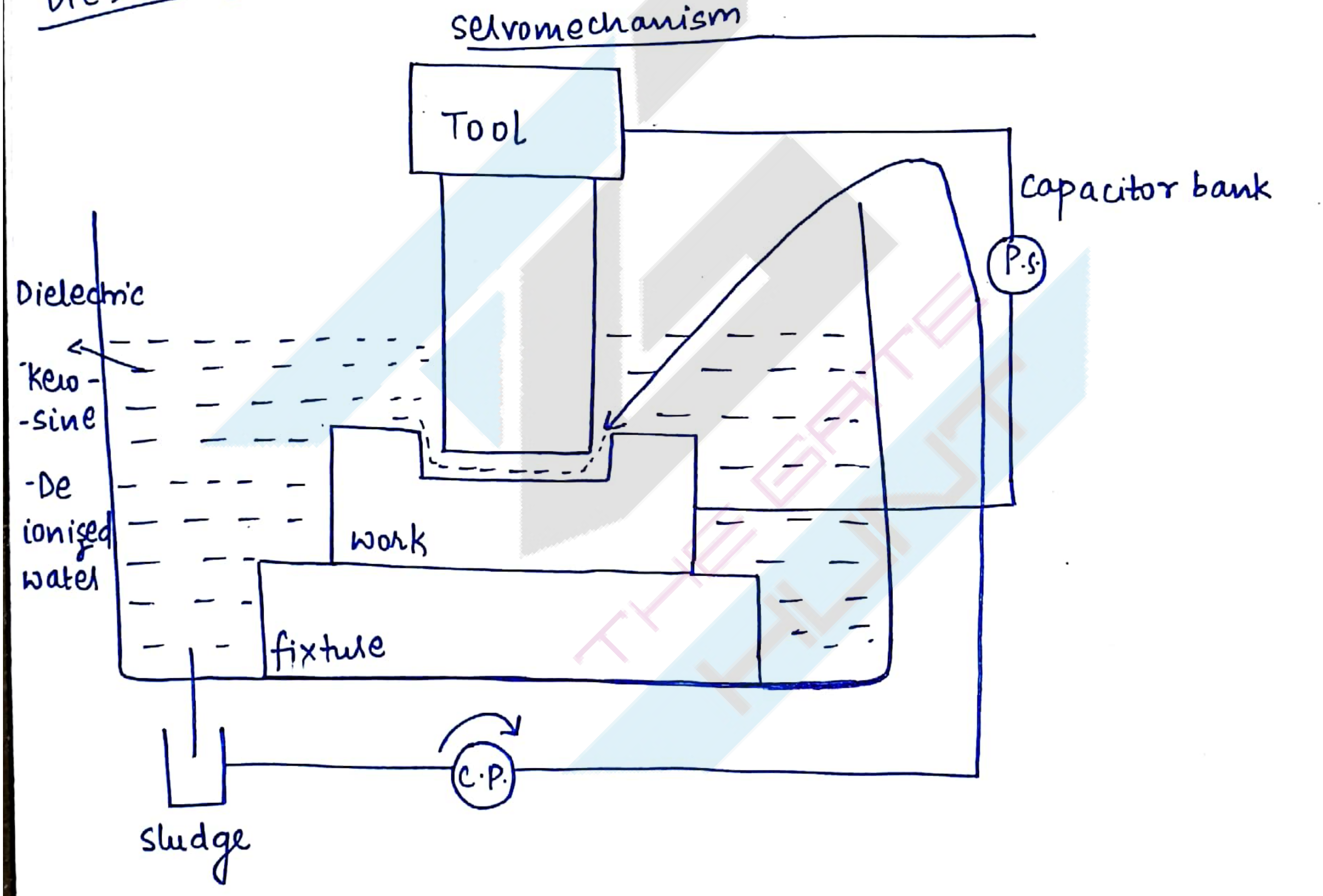
HW

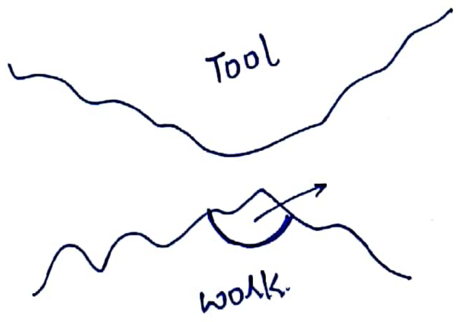
* ELECTRODISCHARGE MACHINING (EDM)

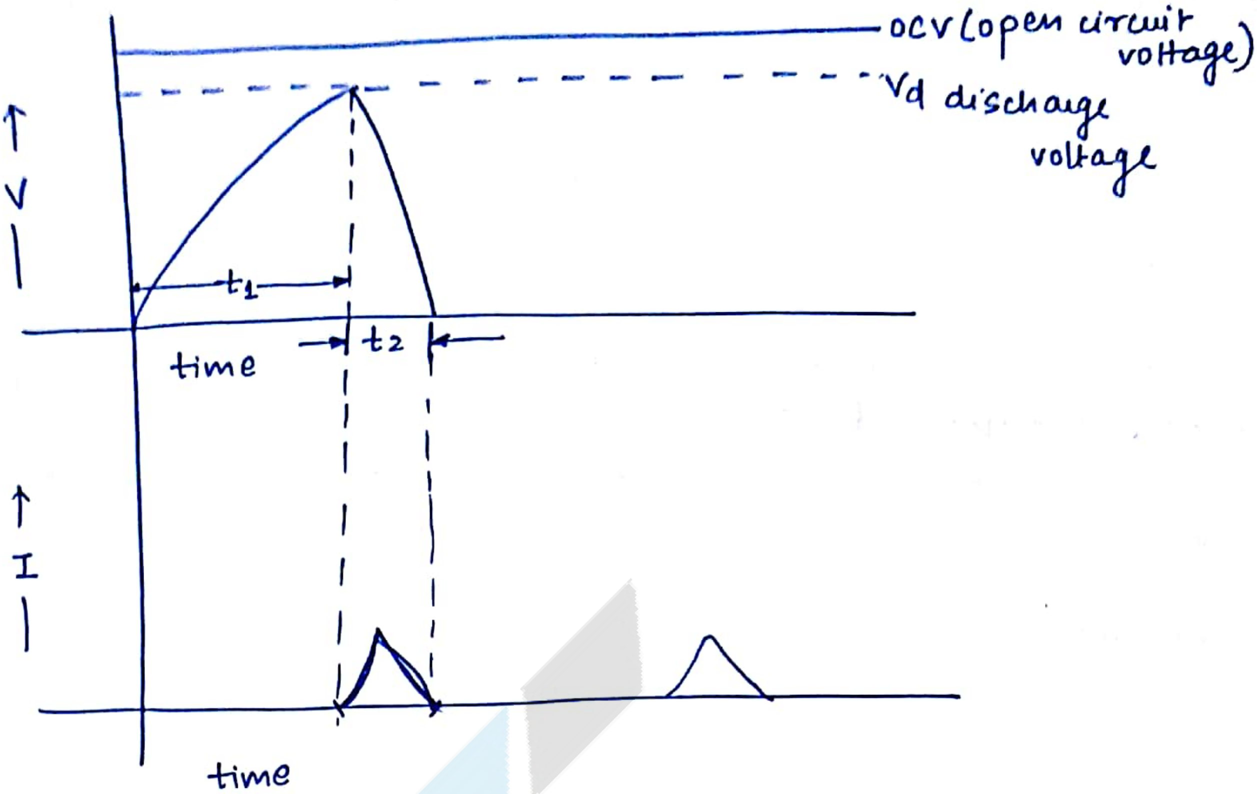
$V \uparrow I \downarrow$

Pulsed DC

Diesinking







wire cut EDM

→ EDM is high voltage, low current process. Transformer is a power bank of capacitors and during the major portion of the cycle, capacitor bank charges. The movement voltage across capacitor reaches the discharge voltage, entire capacitor bank discharges. This produces spark at the Tool. This spark will developed at the point where there is a minm. gap b/w the Tool and the work. Di-electric which was initially non-conducting turns to conduct into very small region. so arc will be transported though this dielectric & bombard the W/P. This produces crater over the work. As the spark is being transported, a portion of kerosene will also burn leaving carbon residue. These carbon residues acts like a solid lubricant which helps in chipping the material so the surface within the crater will be very smooth. Mechanics of material removal is melting, vapourization and errosion (obj → ~~corrosion~~ dont include).

The removed material if it gets accumulated in the machining area, it will decrease the material removal rate. It is because the spark will first interact with these removed material and the portion of that energy will be lost. A servomechanism is connected to a tool which senses the voltage between tool and the work. If this voltage decreases below the certain value, servomechanism withdraws the tool and flushing mechanism removes the material from the machining area. servomechanism also/again places the tool back to its original position. The process is generally used in Die sinking. Principle of wire cut EDM is exactly same and the process is used in cutting any profile in the workpiece. we keep on moving the wire so that wear on the wire is uniform. graphite is the material used as tool in EDM because not only its Melting point is high but also it can be machined to a great degree of accuracy.

$$Gap = 0.025 - 0.05 \text{ mm}$$

$$R_a \sim 0.25 \mu s \text{ (microns)}.$$

$$V_d = V_0 \left(1 - e^{-t/RC}\right)$$

$t \rightarrow$ time

$R \rightarrow$ Resistance

$C \rightarrow$ capacitance

$$\frac{V_d}{V_0} = 1 - e^{-t/RC}$$

$$e^{-t/RC} = 1 - \frac{V_d}{V_0} = \left(\frac{V_0 - V_d}{V_0}\right)$$

$$-t/RC = \ln\left(\frac{V_0 - V_d}{V_0}\right)$$

$$-t = RC \ln\left(\frac{V_0 - V_d}{V_0}\right)$$

$$\boxed{t = RC \ln\left(\frac{V_0}{V_0 - V_d}\right)}$$

$$\text{frequency} = 1/t = f$$

Energy transfer/spark

$$E = \frac{1}{2} C V_d^2$$

Avg. Power

$$P = \frac{E}{t_1 + t_2}$$

$$t_2 << t_1$$

$$P = \frac{E}{t} = \frac{C V_d^2}{2t}$$

$$P = \frac{C R V_0^2}{2t R} (1 - e^{-t/RC})^2$$

Let $\boxed{\frac{t}{RC} = N}$

$$P = \frac{V_0^2}{2NR} (1 - e^{-N})^2$$

$$\frac{V_0^2}{2NR} (1-e^{-N})^2$$

$$\frac{V_0^2}{2R} \frac{(1-e^{-N})^2}{N}$$

$$\frac{1 + e^{-2N} - 2e^{-N}}{N}$$

$$\frac{1}{N} + \frac{e^{-2N}}{N} - \frac{2e^{-N}}{N}$$

$x^n \quad n x^{n-1}$

$x^{-1} = -1 x^{-1-1}$
$= \frac{-1}{x^2}$

$\frac{-1}{N^2}$

$$\frac{dP}{dN} = 0$$

$N = 1.26$

$V_d = 72\% \, V_0$

WB Q17
Pg 33

$V_d = 100V$

$t = 25 \mu s$

$P = 1 kW$

$C = ?$

$$P = \frac{C V_d^2}{2t}$$

$$P = \frac{C (100)^2}{2 \times 25}$$

(b) ✓

Q31 $V_c = V_s \times 0.716$

$R = 10 \Omega \rightarrow 10^{-6}$

$C = 200 \mu F$

Ans: 2.54ms

$$\frac{V_c}{V_s} = 0.716 = 1 - e^{-t/RC}$$

$$0.716 = 1 - e^{-t/2\times10^{-3}}$$

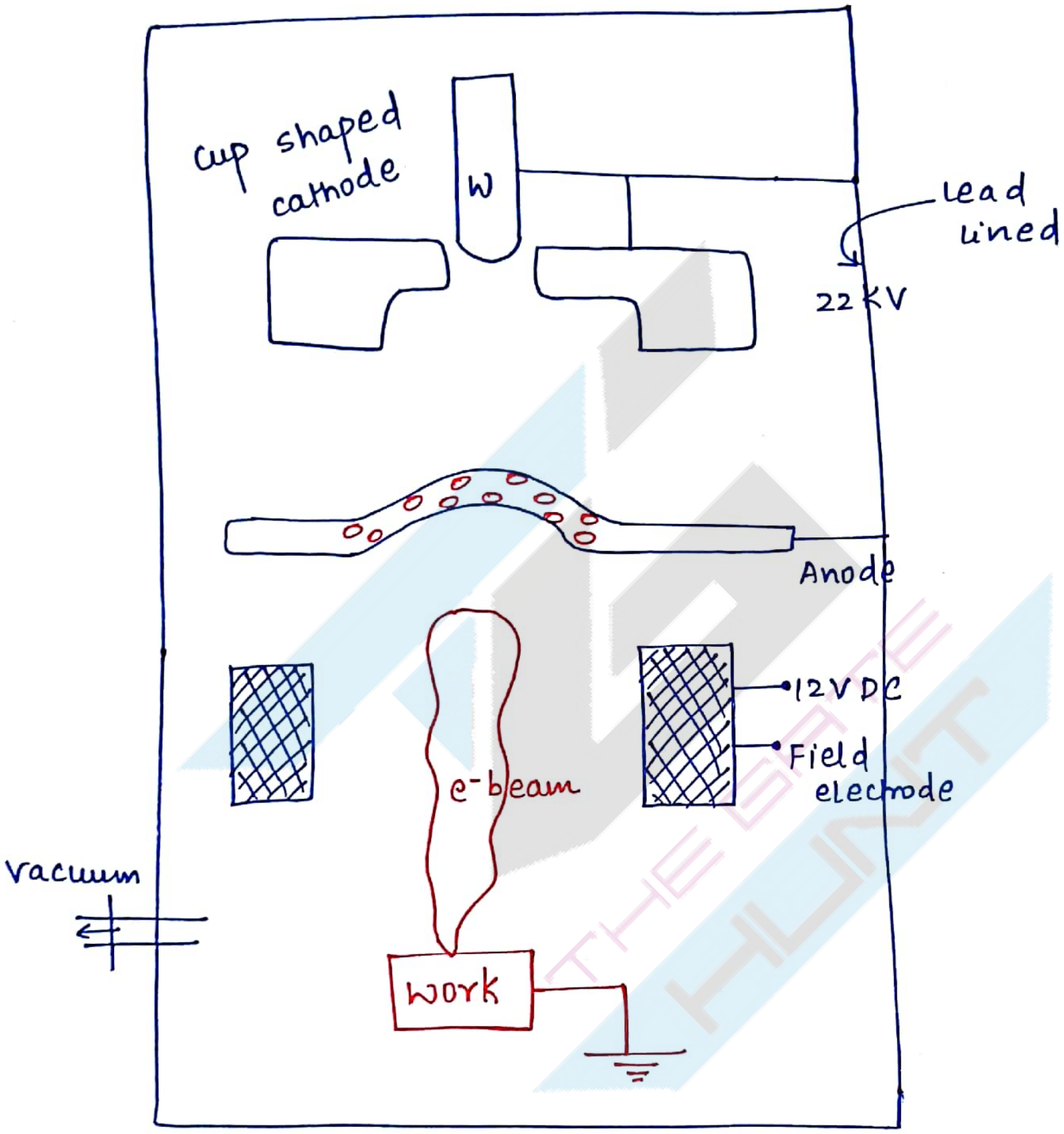
$$0.998 = e^{-t/2\times10^{-3}}$$

$$-2.002 \times 10^{-3} = -t/2\times10^{-3}$$

T2 $R = 40\,\Omega$

$C = 20\,\mu F$ =

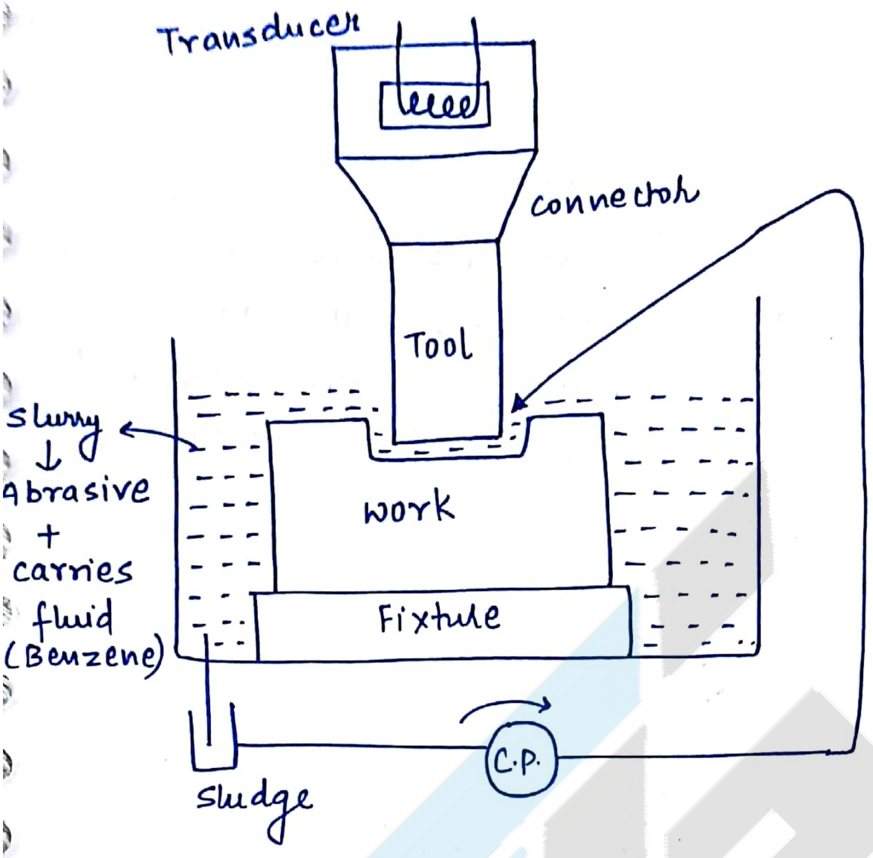
* EBW ($e^{\ominus}$ Beam welding):-



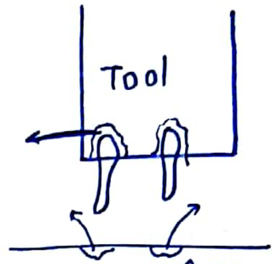
* Ultrasonic (USM) Machining :-

Magnetostrictive

Piezoelectric



Tool wear ↑ USM, EDM, ECM ↓ MRR



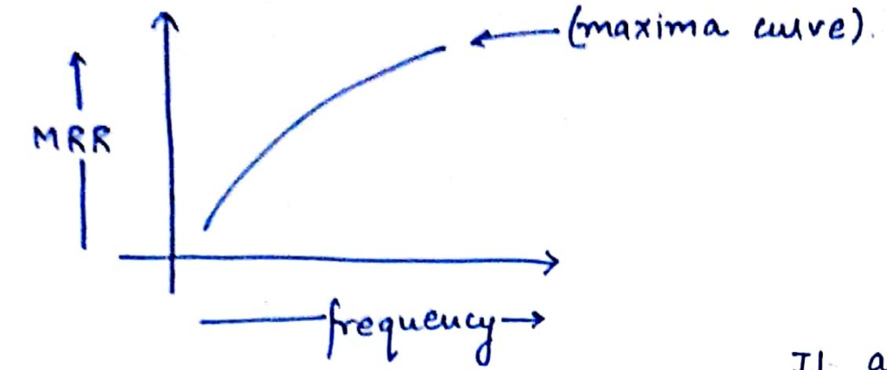
Gap = 0.25 mm

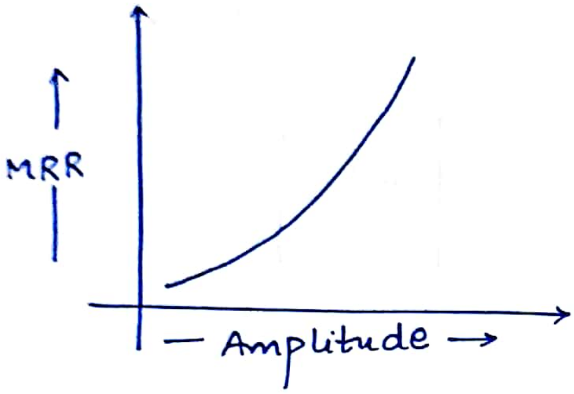
Ra = 0.25 - 0.75 μs

(CLA value)

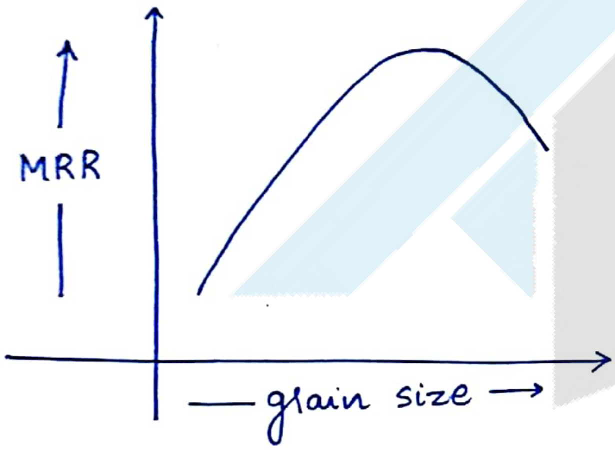
work material needs to be conducting when ECM & EDM processes
has to be used. For machining glasses & other ceramic materials,
USM is used. High frequency vibrations are produced by a
transducer and with the help of a connector, it is transported to the
tool. Tool is made up of some ductile material; so abrasives are
/will be embedded into the tool. During the downward Journey
of a tool, abrasives will hammer the work material and small
portion of the material will be chipped out. The process will be
uneconomical for machining ductile materials because after
machining, abrasives will remain into the w/P, so a separate
process is required to clean the workpiece. The Tool is slightly
tapered to maintain linearity in the machining process.

By increasing the frequency, impact on the
work will be there more no. of times per unit time so MRR
will go up.

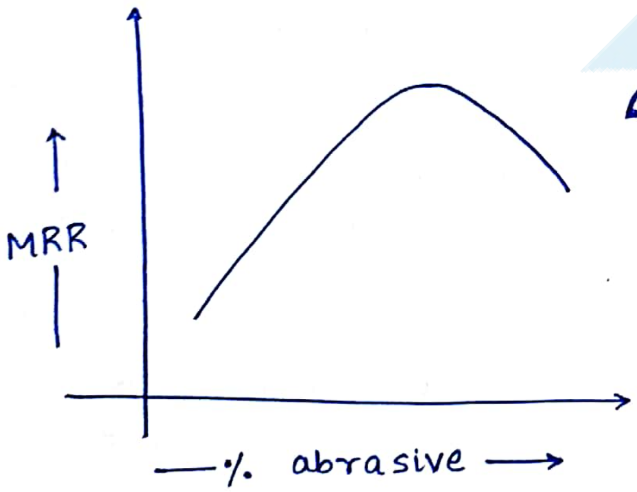




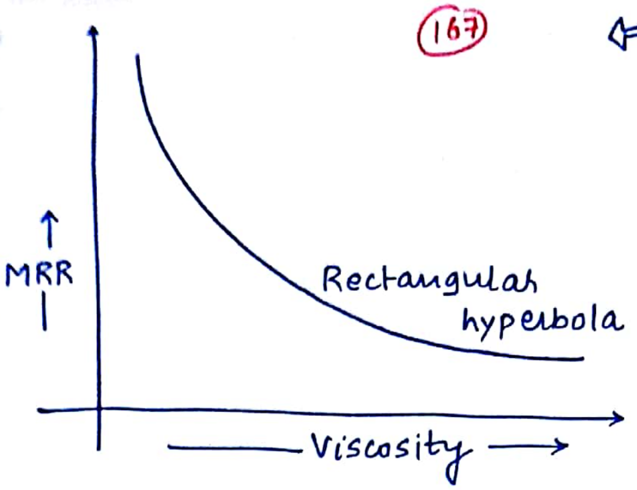
If amplitude is high, abrasives will get more time to accelerate this will ↑ the momentum of abrasives and hence MRR will increase.



By increasing the size of abrasives, impact will be there on the larger area, so the MRR will go up. But when the size of abrasive goes beyond a certain value, it approaches towards the amplitude, so abrasives will not have sufficient time to accelerate. This will decrease MRR.

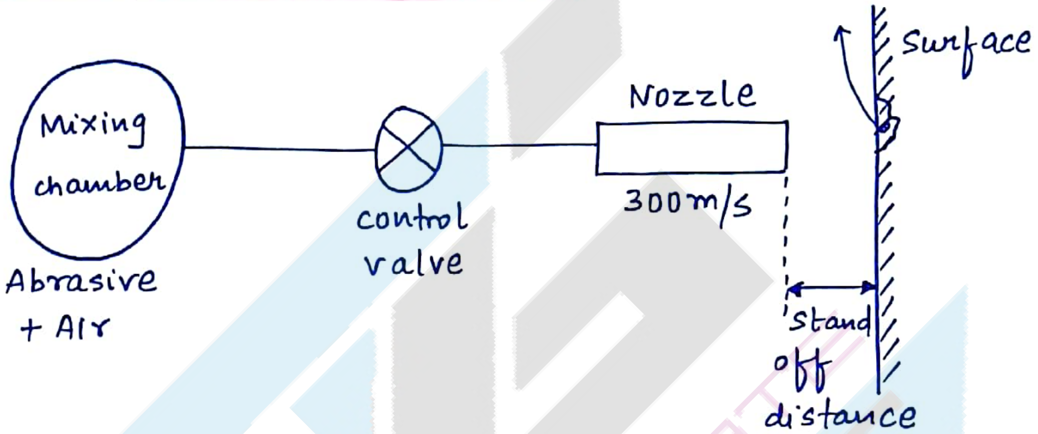


Initially by increasing the concentration of abrasives, impact will be there at more no. of places, so MRR will go up. But when concentration exceeds beyond a certain value, there will be collision b/w the abrasives and a portion of momentum will be loss, so this will decrease MRR.



If the viscosity of the carrier fluid is high, disposing the chips from the machining area will be difficult, so a portion of Removed material will always remain in the tool workpiece gap. So abrasives will first collide with the removed material and hence a portion of their energy will be lost. So, MRR will keep on decreasing.

* ABRASIVE JET MACHINING :-



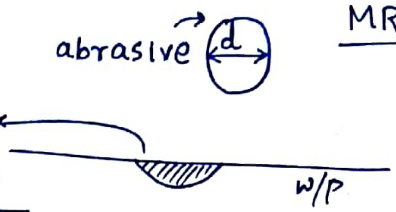
Mixture of abrasive and carrier fluid comes out through the nozzle and when abrasives bombard the work, there will be localized crack. Due to high speed wind, the crack will be propogated and the chips will blow away. The process is used in :- (a) making very fine holes. (in the Tool).

(b) M/cing inaccessible areas.

(c) Cleaning metallic moulds.

(d) Cutting flash from forged component.

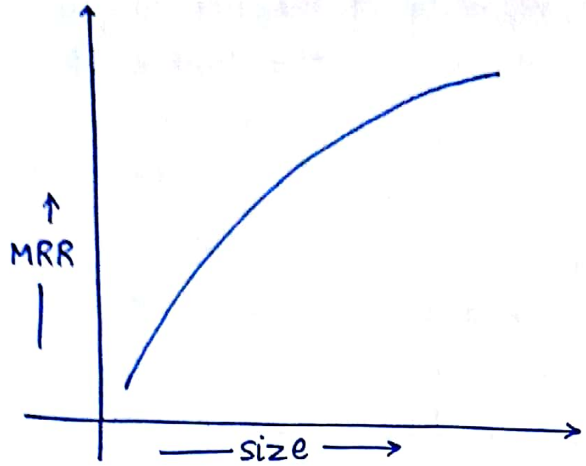
(e) Removing parting lines, etc.



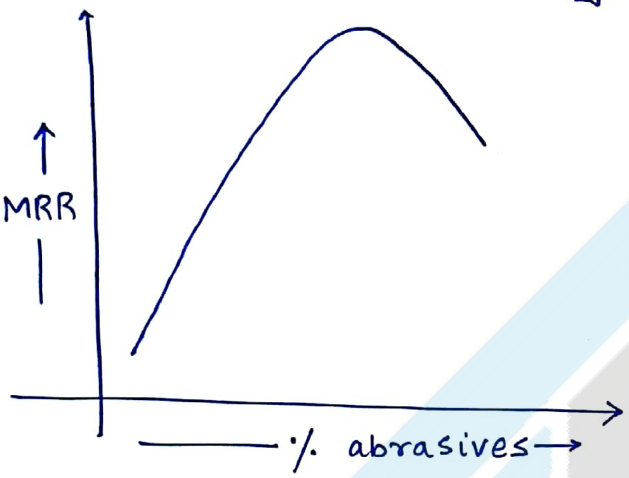
MRR = volume of crater × No. of Abrasi/time

$\propto d^3$

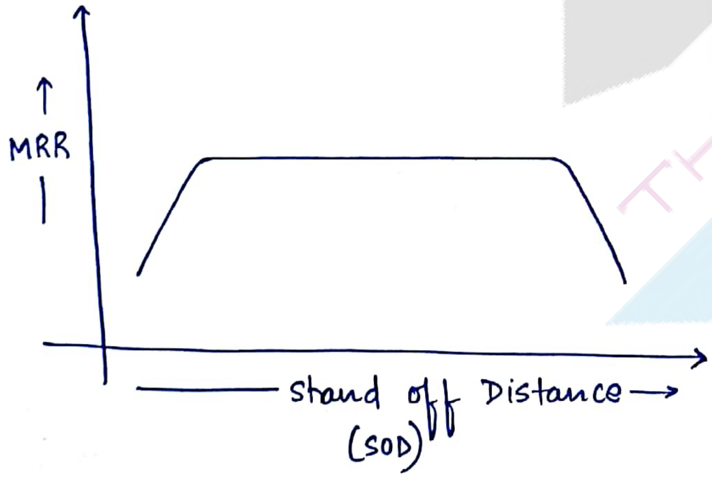
$MRR \propto d^3$



⇐ as the size ↑, abrasive will impact the larger area, hence MRR ↑.

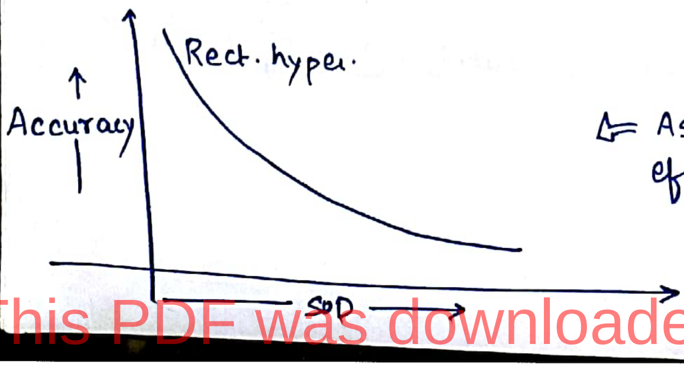


⇐ (same as previous one)



⇐ {initially when SOD ↑, more time for accl^r. } ↳ momentum ↑ MRR ↑.
In middle, Balance b/w accl^r. & drag (momentum kha gaya), when stand off dis. ↓, MRR ↓ }

SIR → as the SOD increases, there will be more time for acceleration, so MRR will also increase.
In B/w there will be a Balance, b/w acceleration and air drag, so constant MRR will observed. after a certain distance, drag overpowers and hence, MRR will go down.



⇐ As SOD increases, due to mushrooming effect, accuracy will be lost.

CH # 10

1 → b
2 → b
3 → d
4 → b
5 → d
6 → a → b(25)
7
8 b
9 d 11 b
12 d
13 d
14 b
15 d
16 c
17 ✓
18 d ← lean the sequence
19 a ←
20 a
21 c (not deposition)
22 d
23 c
24 c
25 Repeat
26 a
27 ✓

32 specific energy × MRR = Energy

169

$12 \times W \times t_1 \times V = 12$

$W \to 150\,\mu s$, $t_1 \to 1\,mm$, $V \to ?$

$$V = \frac{1}{150 \times 10^{-6} \times 1}$$