

WORKSHOP CALCULATION

Module : Fabrication calculation

Faculty : Course co-ordinators (DRM, CPP, SIS)

Demonstrator: Workmen from Shops

Duration : Maximum 16 Hours

Participants : Max. 06 / Module (Workmen from shops)

No.	Topics	Time
1	Introduction to SRMs.	30 Min.
2	Pre test	30 Min.
3	Classroom training	6.0 Hrs.
4	Demonstration	3.0 Hrs.
5	Practical	3.0 Hrs.
6	Skill test	2.0 Hrs.
7	Post test and feed back	1.0 Hrs.

Unit : 1 Module : Workshop Calculation

<u>Topics</u>	<u>Time</u>
✉ Introduction and induction test 10 examples	1.0 hr
✉ Units of length, Area, Volume, Weight, Temperature and Pressure	1.0 hr
✉ Pythagoras theorem and demonstration	0.5 hr
✉ Trigonometric functions demonstration	0.5 hr
✉ Practice 10 examples	1.0 hr

MODULE : WORKSHOP CALCULATION

UNIT : 2

→ Weight calculation and weld deposition

weight = with demonstration

2hours

→ WEP calculation, 1:3 and 1:5 taper

calculation

1 hour

→ Practice examples = 10 nos.

1 hour

MODULE : WORKSHOP CALCULATION

UNIT : 3

- **Measure tape error correction and circumference calculation = with demonstration (1 hour)**
- **Orientation marking (0.5 hour)**
- **Offset and kink, web and flange tilt, flange unbalance calculation (1 hour)**
- **Arc length and chord length calculation for web layout= with demonstration (0.5 hour)**
- **Practice examples = 10 nos. (1 hour)**

MODULE : WORKSHOP CALCULATION

UNIT : 4

- Tank rotator location calculation and sling angle for handling a job calculation (0.5hour)
- Machining allowance calculation for overlay and machining allowance for bracket calculation (0.5 hour)
- Marking PCD and holes for flange calculation = with demonstration (0.5 hour)
- Practice examples = 5 Nos. (0.5hour)
- Test => theory = 10 questions
- Practical= 4 questions (2 hours)

Unit : 1 Module : Workshop Calculation

<u>Topics</u>	<u>Time</u>
✉ Introduction and induction test 10 examples	1.0 hr
✉ Units of length, Area, Volume, Weight , Temperature and Pressure	1.0 hr
✉ Pythagoras theorem and demonstration	0.5 hr
✉ Trigonometric functions demonstration	0.5 hr
✉ Practice 10 examples	1.0 hr

Introduction to Units (Pressure)

PRESSURE CONVERSION

$$1 \text{ Kg / cm}^2 = 14.223 \text{ psi (Lb / In}^2 \text{)}$$

$$1 \text{ Kg / cm}^2 = 0.9807 \text{ Bar.}$$

$$1 \text{ PSI} = 0.07031 \text{ Kg / cm}^2$$

Introduction to Units (Length)

$$1\text{m} = 100 \text{ cm}$$

$$1\text{cm} = 10 \text{ mm}$$

$$1\text{m} = 1000 \text{ mm}$$

$$1\text{in.} = 25.4 \text{ mm}$$

Introduction to Units (Temperature)

Temperature unit = degree centigrade
or
degree Fahrenheit

$$C = 5/9(f-32)$$

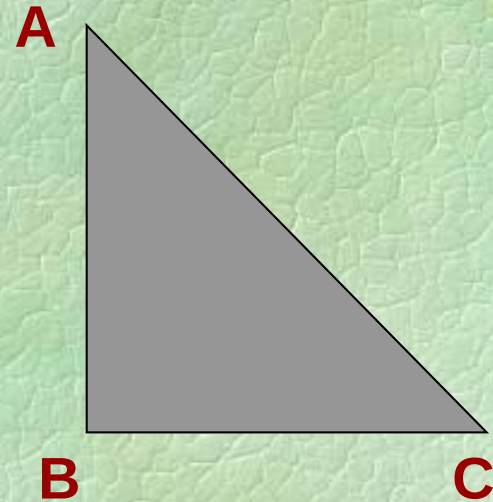
If Temp. Is 100°f, Then $C=5/9(100-32)$
So, $C=37.7$

If Preheat Temp. Is 150°c, Then $F=302$

PYTHAGORAS PRINCIPLE APPLICATION

Pythagoras Principle :

In Any Right Angled Triangle a Sum of Adjacent Side Square Is Always Equal to It Hypotenuse Square.



LET US SAY ♦ ABC is right angle triangle .

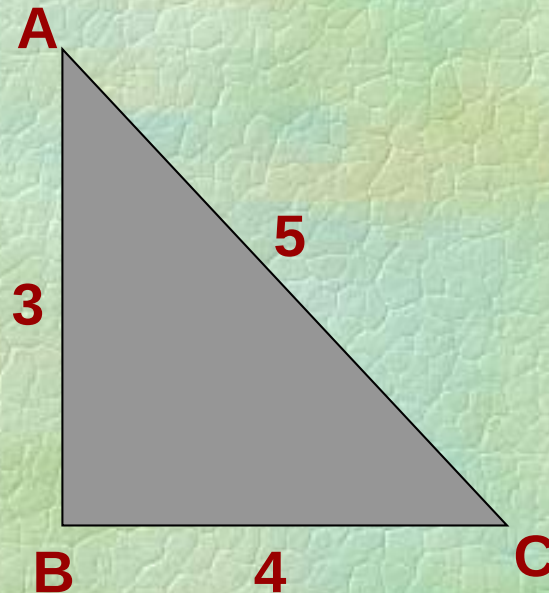
AB and BC = Adjacent sides and AC = Hypotenuse.

So based on pythagoras theory ,

$$AB^2 + BC^2 = AC^2$$

PYTHAGORAS PRINCIPLE APPLICATION

Example :



Proof of theory in triangle ABC

$AB = 3$, $BC = 4$ and $AC = 5$

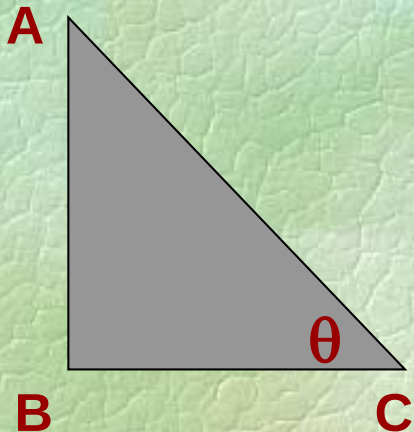
SO $AC^2 = AB^2 + BC^2$

$$= 3^2 + 4^2 = 25$$

By taking $AC = 5$ so $AC^2 = 25$ It means that

LHS = RHS

TRIGONOMETRIC FUNCTIONS

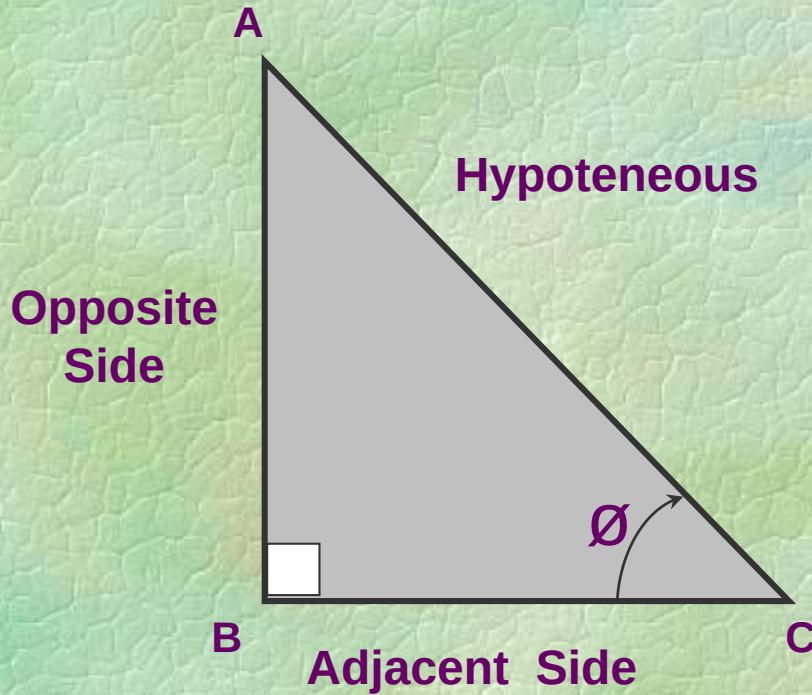


Trigonometric functions are used to solve the problems of different types of triangle.

We will see some simple formulas to solve right angle triangle which we are using in day to day work.

Let us consider ♦ ABC is a right angled triangle,
Angle $\angle ABC = \theta$, AB & BC are sides of triangle.
So for this triangle.

TRIGONOMETRY



$$\sin \theta = \frac{\text{Opposite Side}}{\text{Hypoteneous}} = \frac{AB}{AC}$$

$$\tan \theta = \frac{\text{Opposite Side}}{\text{Adjacent Side}} = \frac{AB}{BC}$$

$$\cos \theta = \frac{\text{Adjacent Side}}{\text{Hypoteneous}} = \frac{BC}{AC}$$

TRIGONOMETRIC FUNCTIONS

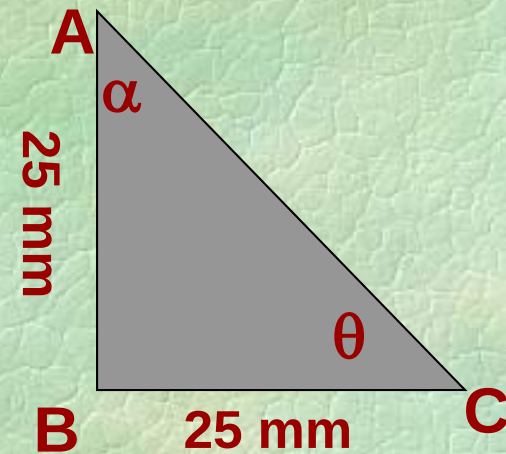
Example : For triangle ABC find out value of θ and α .

We Will Find Value Of θ By Tangent Formula So ,

$$\begin{aligned}\tan \theta &= \text{Opposite Side} / \text{Adjacent Side} \\ &= AB / BC = 25/25 = 1\end{aligned}$$

$$\tan \theta = 1$$

$$\therefore \theta = \text{Inv. Tan}(1) = 45^\circ$$



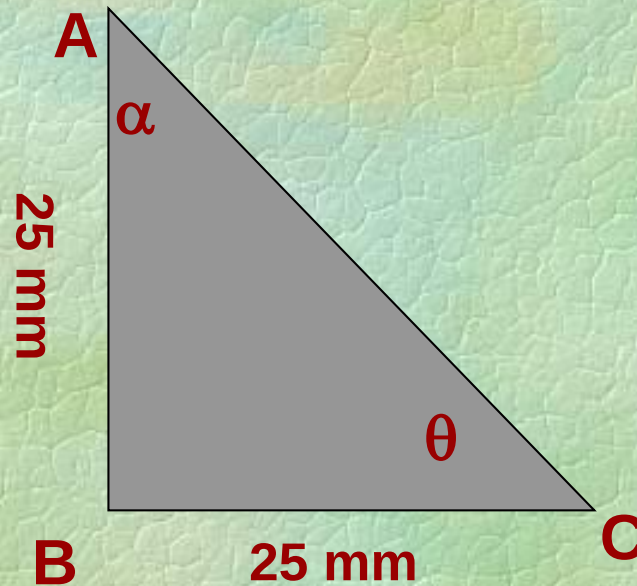
Now, We Will Find AC By Using Sine Formula

$$\begin{aligned}\sin \theta &= \text{Opposite Side} / \text{Hypotenuse} \\ &= AB / AC\end{aligned}$$

$$\therefore AC = AB / \sin \theta = 25 / \sin 45 = 25 / 0.7071 = 35.3556 \text{ mm}$$

TRIGONOMETRIC FUNCTIONS

Example: We Will Find Value Of α By Cosine Formula

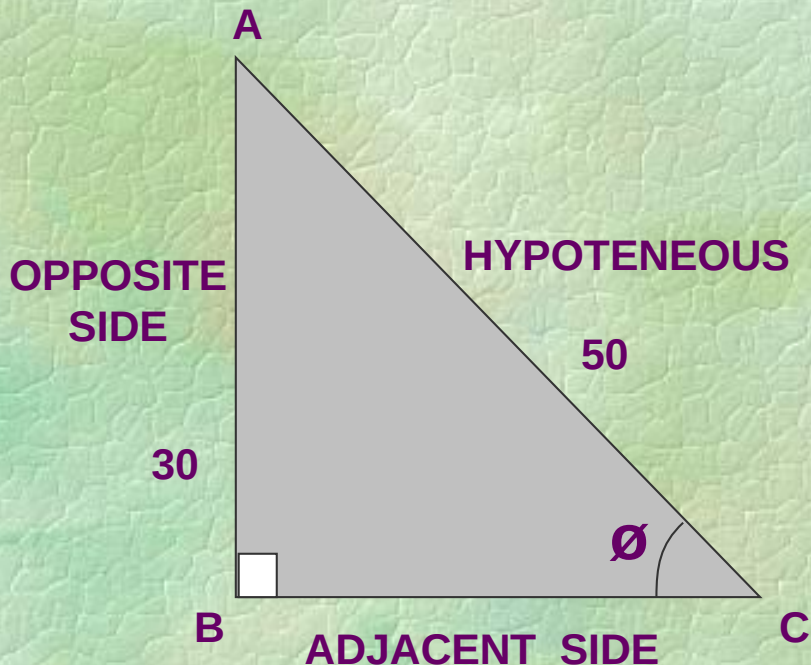


$$\begin{aligned}\cos \alpha &= \text{Adjacent Side} / \text{Hypotenuse} \\ &= AB / AC = 25 / 35.3556 \\ &= 0.7071\end{aligned}$$

$$\therefore \alpha = \text{Inv Cos}(0.7071) = 45^\circ$$

TRIGONOMETRY

Example: FIND OUT ANGLE 'Ø' OF A TRIANGLE



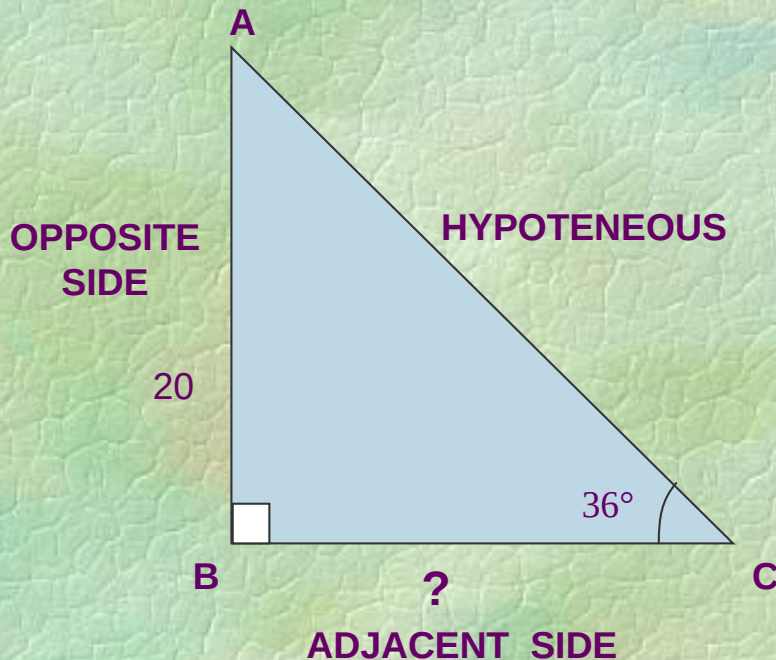
$$\begin{aligned}\sin \theta &= \frac{\text{OPPOSITE SIDE}}{\text{HYPOTENEUS}} = \frac{AB}{AC} \\ &= \frac{30}{50} \\ &= 0.60\end{aligned}$$

$$\theta = \text{SINE VALUE OF } 0.60$$

$$\theta = 36^{\circ} - 52'$$

FIND OUT SIDE 'Ø' OF A TRIANGLE

Example:



$$\tan \theta = \frac{\text{OPPOSITE SIDE}}{\text{ADJACENT SIDE}} = \frac{AB}{BC}$$

$$\tan 36^\circ = \frac{20}{BC}$$

$$\therefore BC = \frac{20}{\text{TAN VALUE OF } 36^\circ}$$

$$\therefore BC = \frac{20}{0.727}$$

$$\therefore BC = 27.51 \text{ mm}$$

AREA

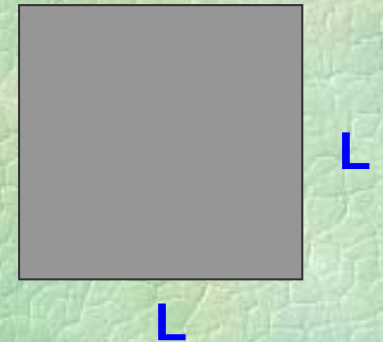
Definition : A surface covered by specific Shape is called area of that shape.
i.e. area of square, circle etc.

1. Square : *Area Of Square = $L \times L = L^2$*

Where L = Length Of Side

So If L = 5cm

Then Area = $5 \times 5 = 25\text{cm}^2$



AREA

2. Rectangle:

$$\text{Area Of Rectangle} = L \times B$$

Where, L = Length

B = Width

If L= 10 mm, And B = 6 mm

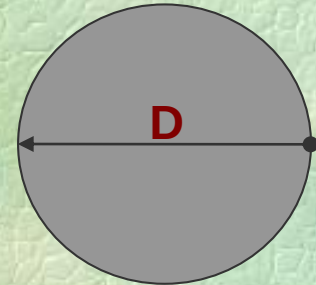
Then, Area = 10 X 6 = 60mm²



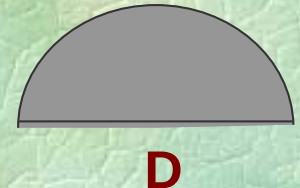
3. Circle :

$$\text{Area Of Circle} = \pi / 4 \times D^2$$

Where D= Diameter Of The Circle



$$\text{Area Of Half Circle} = \pi/8 \times D^2$$



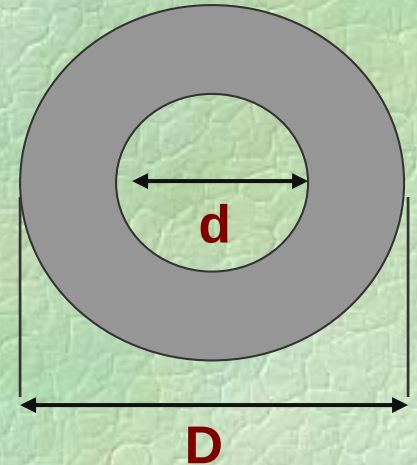
Same way we can find out area of quarter of circle

AREA

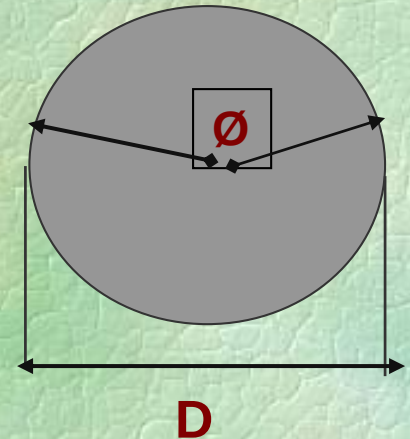
3 . Circle :

$$\text{Hollow Circle} = \frac{\pi \times (D^2 - d^2)}{4}$$

WHERE D = Diameter of Greater Circle
d = Diameter of Smaller Circle



$$\text{Sector Of Circle} = \frac{\pi \times D^2 \times \theta}{4 \times 360}$$

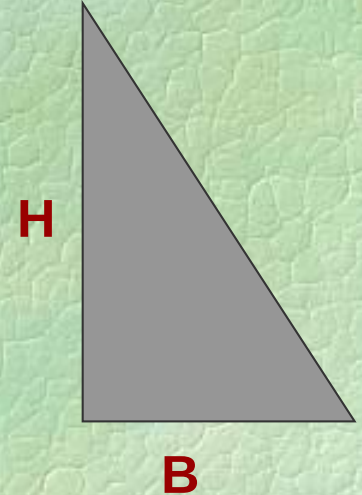


AREA

4. Triangle :

$$\text{Area Of Triangle} = \frac{1}{2} B \times H$$

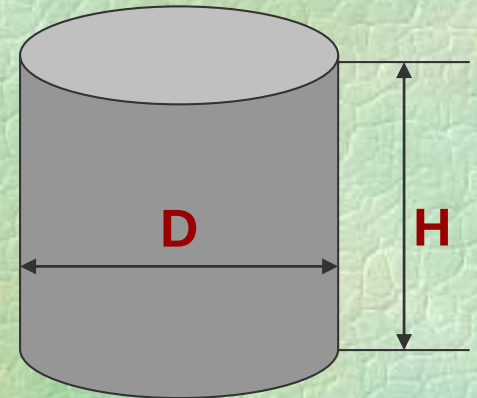
Where B = Base Of Triangle
H = Height Of Triangle



5. Cylinder :

$$\text{Surface area of Cylinder} = \pi \times D \times H$$

Where H = Height Of Cylinder
D = Diameter Of Cylinder

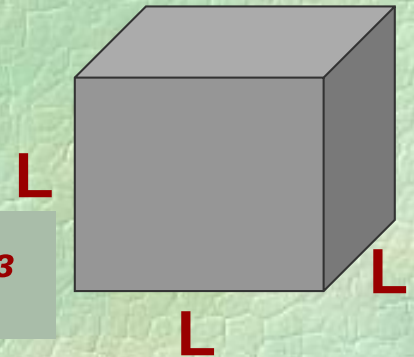


VOLUME

Defination : A space covered by any object is called volume of that object.

1. Square block : In square block; length, width and height are equal, so

$$\text{Volume Of Sq. Block} = L \times L \times L = L^3$$



2. Rectangular Block :

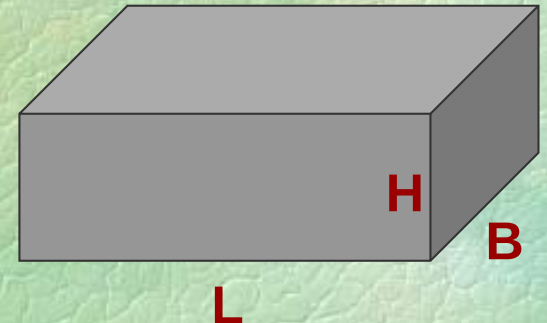
$$\text{Volume} = L \times B \times H$$

Where

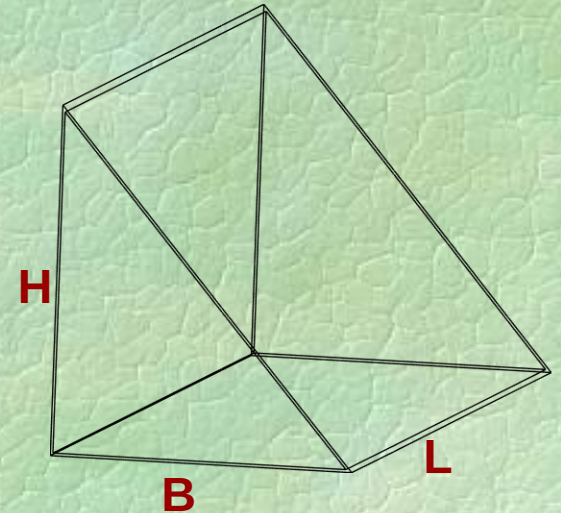
L = Length

B = Width

H = Height



VOLUME



4.Prism or Triangle Block :

Volume of Triangular Block

= Cross Section Area of Triangle x Length

(Area of Right Angle Triangle = $\frac{1}{2} B H$)

$$\text{Volume} = \frac{1}{2} B H \times L$$

Where

B = Base of R.A.Triangle

H = Height of R.A.Triangle

L = Length of R.A.Triangle

VOLUME

3. Cylinder :

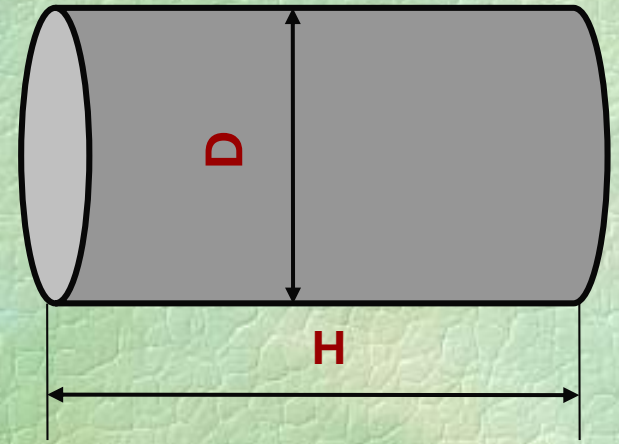
Volume of Cylinder = Cross Section Area x Length of Cylinder

$$Volume = \frac{1}{4} \pi D^2 \times H$$

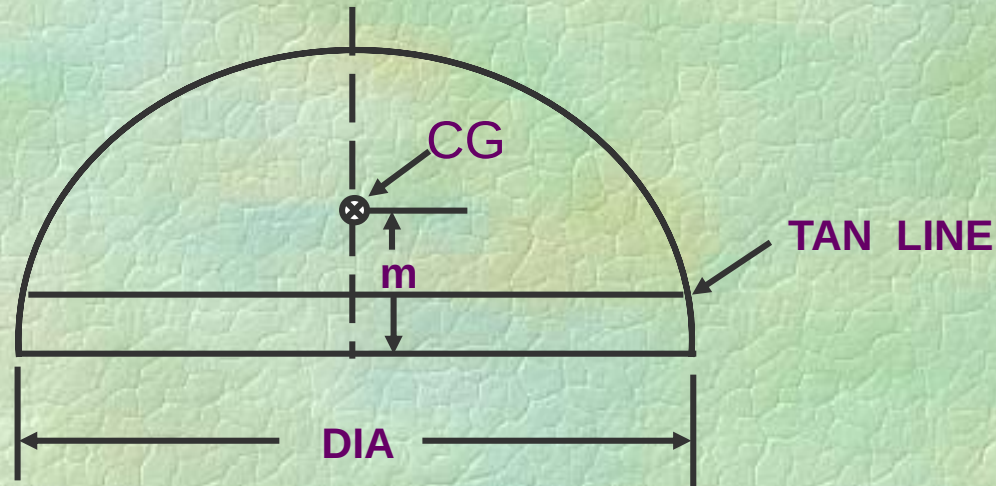
Where :

D = Diameter Of The Cylinder

H = Length Of Cylinder



CG CALCULATION



CENTRE OF GRAVITY OF D'ENDS (CG)

- | | | |
|-------|------------------|------------------------------------|
| (1) | HEMISPHERICAL | (m) = $0.2878 \times \text{DIA}$ |
| (2) | 2:1 ELLIPSOIDALS | (m) = $0.1439 \times \text{DIA}$ |
| (3) | TORI - SPHERICAL | (m) = $0.1000 \times \text{DIA}$ |

MODULE : WORKSHOP CALCULATION

UNIT : 2

→ Weight calculation and weld deposition

weight = with demonstration

2hours

→ WEP calculation, 1:3 and 1:5 taper

calculation

1 hour

→ Practice examples = 10 nos.

1 hour

WEIGHT CALCULATION

Examples :

Weight calculation of different items:

- Rectangular plate
- Circular plate
- Circular plate with cutout
- Circular sector
- Shell course

Specific gravity for

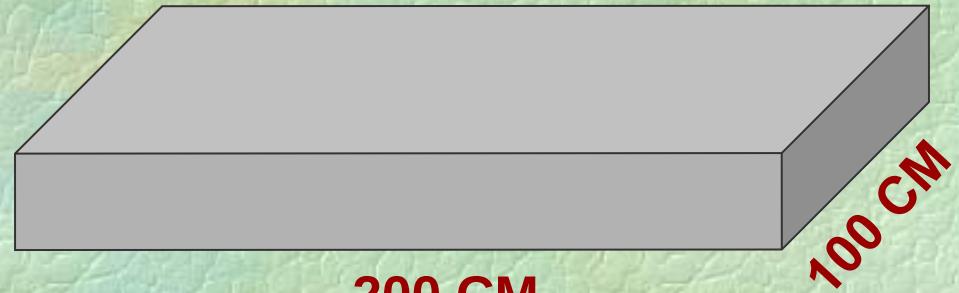
(i) C.S.= 7.86 g/cm^3

(ii) S.S.= 8.00 g/cm^3

WEIGHT CALCULATION

Examples :

1. Rectangular plate :



Weight of This Plate

= Volume x Sp.Gravity

= L x B x H x 7.86gm / CC

Here L = 200cm, B = Width = 100cm And H = Thk = 3.5 cm

So Volume = $200 \times 100 \times 3.5 \text{ cm}^3$

= 70000 cm^3

Now Weight Of Plate = Volume x Sp .Gravity

= $70000 \times 7.86 \text{ gm/cc}$

= 546000 gms

= 546 kgs

WEIGHT CALCULATION

Examples :

2. CIRCULAR PLATE :

Weight= V X Sp. Gravity

Volume V= Cross Section Area X Thk

$$= \frac{1}{4}\pi D^2 \times 4\text{cm}$$

$$= \frac{1}{4}\pi \times 300^2 \times 4\text{cm}$$

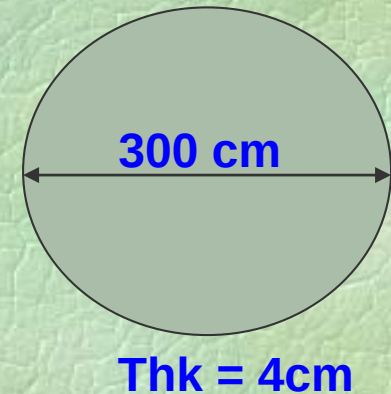
$$= \underline{282743.33 \text{ cm}^3}$$

So W = V X sp.Gravity

$$= 282743.33 \times 7.86 \text{ gms/cc}$$

$$= 2222362.5738 \text{ gms}$$

$$= \underline{2222.362 \text{ kgs}}$$



WEIGHT CALCULATION

Examples :

Circular sector :

Weight of Circular Plate Segment :

$W = \text{Volume} \times \text{Sp.Gravty.}$

Now Volume = Cross Sec.Area $\times$ Thk

$$= \frac{\pi \times (R1^2 - R2^2) \times \emptyset \times 2 \text{ cm}}{360}$$

$$= \frac{\pi \times (400^2 - 350^2) \times 120 \times 2}{360}$$

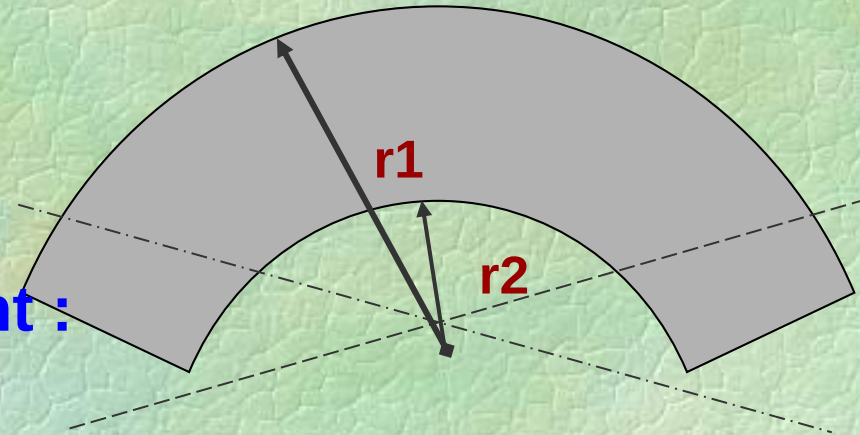
$$= 78539.81 \text{ cm}^3$$

Now Weight = $V \times \text{Sp. Gravity}$

$$= 78539.81 \times 7.86 \text{ gms/cc}$$

$$= 617322.95 \text{ gms}$$

$$= 617.323 \text{ kgs}$$



$$R1 = 400 \text{ cm}$$

$$R2 = 350 \text{ cm}$$

$$\text{THK} = 2 \text{ cm}$$

$$\emptyset = 120^\circ$$

WEIGHT CALCULATION

Examples :

Shell :

$$W = V \times \text{Sp.Gravity}$$

$$V = \frac{1}{4} \pi \times (OD^2 - ID^2) \times \text{Length}$$

$$\text{Here } OD = 400 + 10 = 410\text{cm}$$

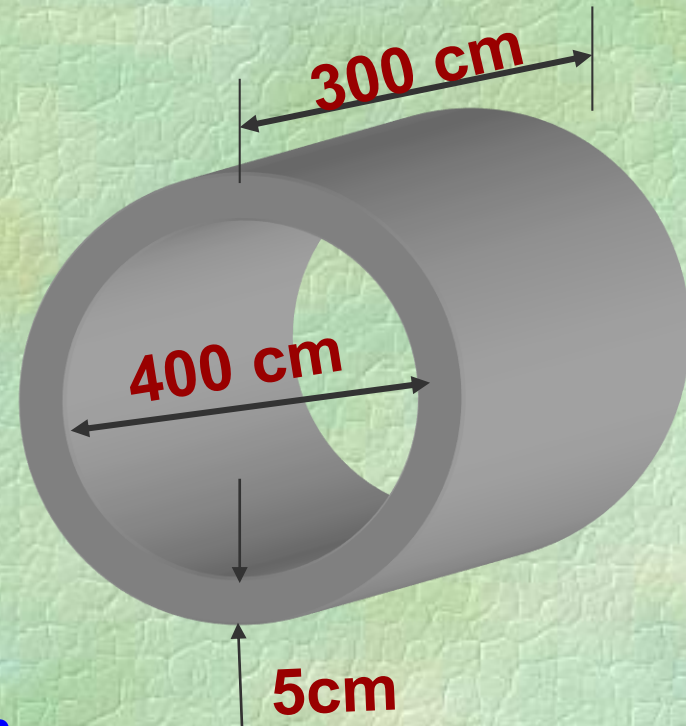
$$ID = 400\text{cm}$$

$$\text{Length} = 300\text{cm}$$

$$\begin{aligned}\text{So } V &= \frac{1}{4} \pi \times (410^2 - 400^2) \times 300\text{cm} \\ &= 1908517.54\text{cm}^3\end{aligned}$$

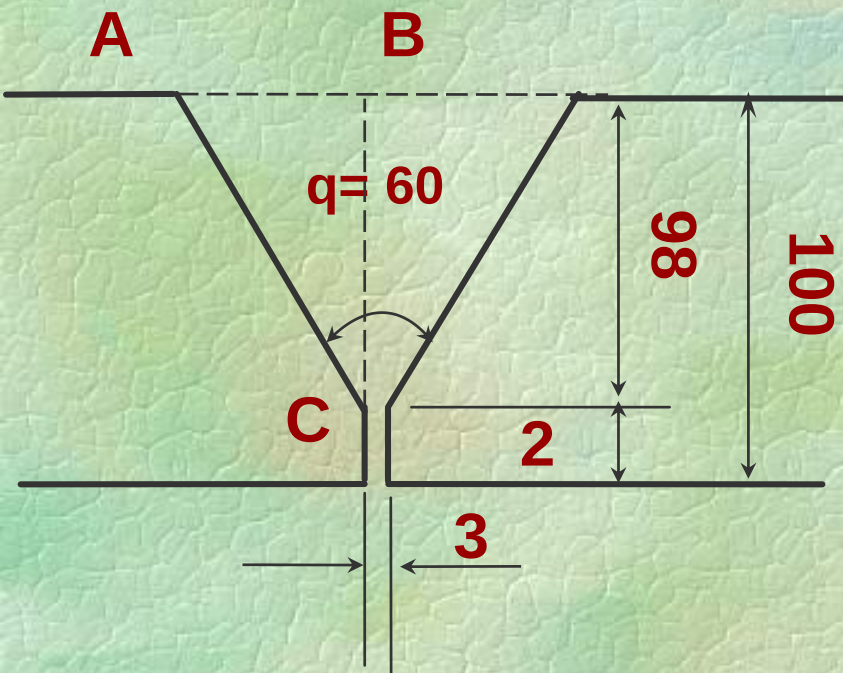
Now Weight

$$\begin{aligned}W &= V \times \text{Sp. Gravity} \\ &= 1908517.54 \times 7.86 = 15000947\text{gms} \\ &= 15000.947\text{kgs} = @ 15 \text{ Ton}\end{aligned}$$



WEP CALCULATION

SINGLE 'V'



In given figure, to find out

Distance, we will use

Trigonometric formula.

$$\tan Q / 2 = AB / BC$$

Here $AB = ?$, $BC = 98$, $Q / 2 = 30^\circ$

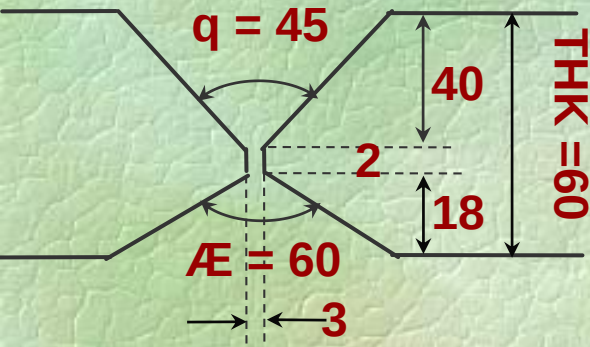
$$\therefore \tan 30 = AB / 98$$

$$\therefore AB = \tan 30 \times 98 = 0.577 \times 98$$

$$= 56.54 \text{ mm}$$

WEP CALCULATION

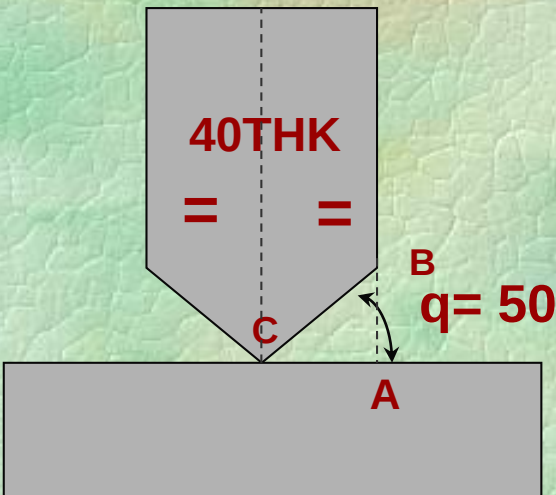
Double 'V'



For double v also we can calculate distance by same trigonometric formula. Double v are of two types:

1. Equal v
2. 2/3 rd & 1/3 rd.

T joint



- In t joint also by tan formula we can find WEP dimensions:

$$AC = 20, q = 50, AB = ?$$

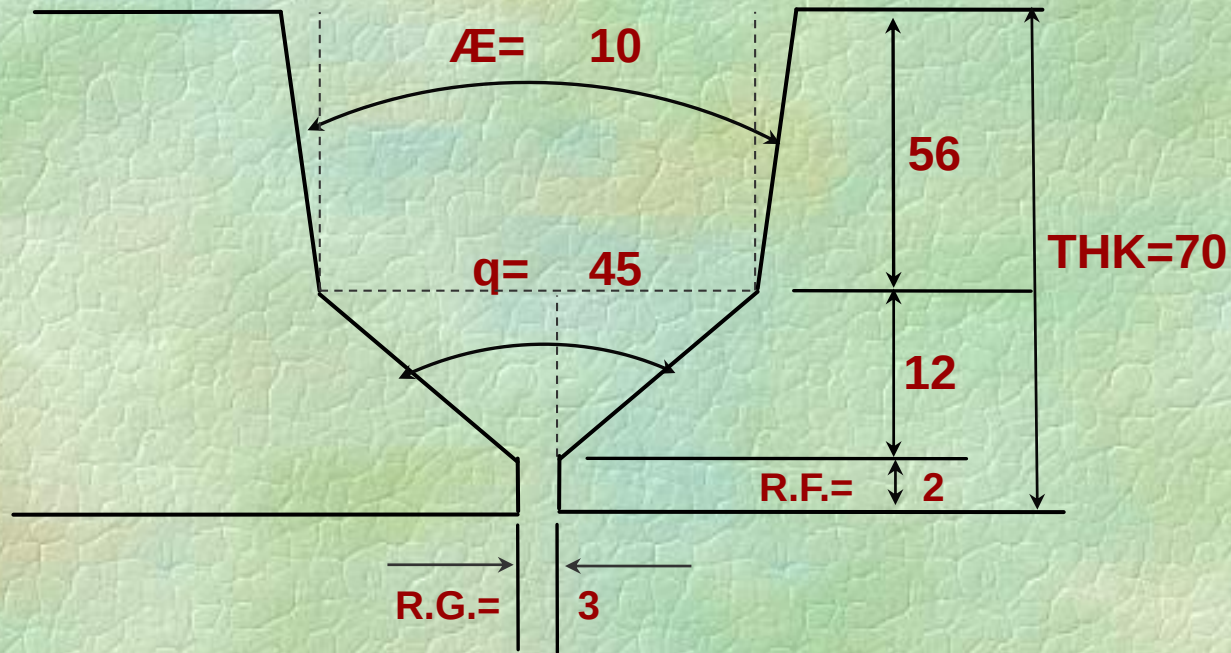
$$\tan q = AB / AC$$

$$AB = 20 \times \tan 50$$

$$AB = 23.83$$

WEP CALCULATION

COMPOUND 'V'



In such kind of compound “V”, we always do machining to take care of all calculation.

As shown by dotted line, we can calculate WEP dimensions by sine or tangent formula.

WELD METAL WEIGHT CALCULATION

Weld metal weight =

Cross section area of particular WEP x
length / circumference of seam x density

Basically weld metal weight calculation involves

Calculation of volume, trigonometry and

Weight calculation.

WELD METAL WEIGHT CALCULATION

Basic fundamentals of weld metal weight Calculation

1. Single v for long seam and circseam

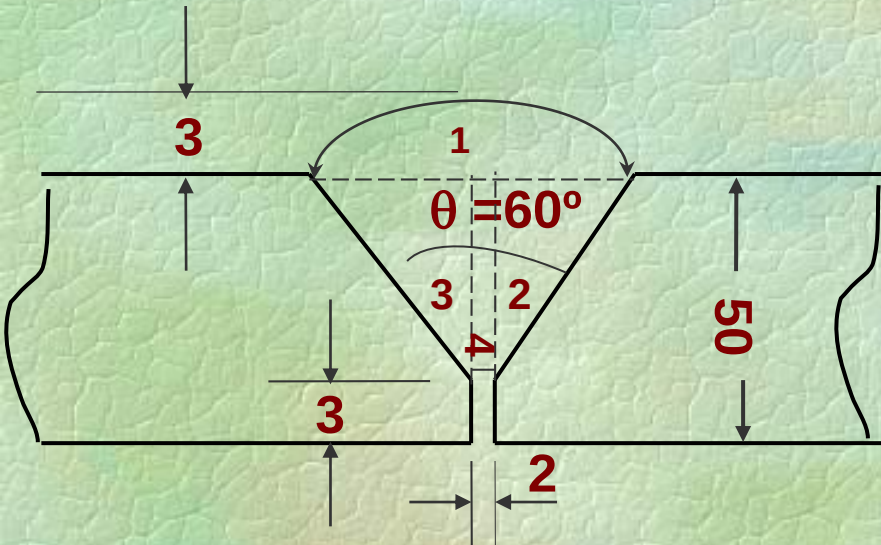
- Long seam weld weight

= Cross section area x length of seam x density

- Circ. seam weld weight

= Cross section area x mean circ. of seam x density

WELD METAL WEIGHT CALCULATION



1. Cross-section Area Of Joint

$$A = A1 + A2 + A3 + A4$$

$$\text{Now } A = 1.2 + 6.38 + 6.38 + 0.94 \text{ cm}^2$$

$$A = 14.9 \text{ cm}^2$$

$$\text{Now } A1 = \frac{2}{3} \times H \times \text{Bead Width}$$

$$\therefore A1 = \frac{2}{3} \times 0.3 \times 6 \text{ cm}^2 = 1.2 \text{ cm}^2$$

$$\text{Now } A2 = A3$$

$$A2 = \frac{1}{2} \times B \times h = 0.5 \times B \times 4.7 \text{ cm}^2$$

$$\text{Here } B = 47 \tan 30^\circ = 2.713 \text{ cm}$$

$$\therefore A2 = 0.5 \times 2.713 \times 4.7 \text{ cm}^2$$

$$= 6.38 \text{ cm}^2$$

$$A3 = 6.38 \text{ cm}^2$$

$$A4 = 0.2 \times 4.7 \text{ cm}^2$$

WELD METAL WEIGHT CALCULATION

For long seam weld weight

= Cross section area x Length of seam x density

= $14.9\text{cm}^2 \times 100\text{cm} \times 7.86\text{gm/cm}^3$

= 11711.4gms = 11.712kgs for 1 mtr long seam

For circ. seam

= Cross section area x Mean circ. x Density

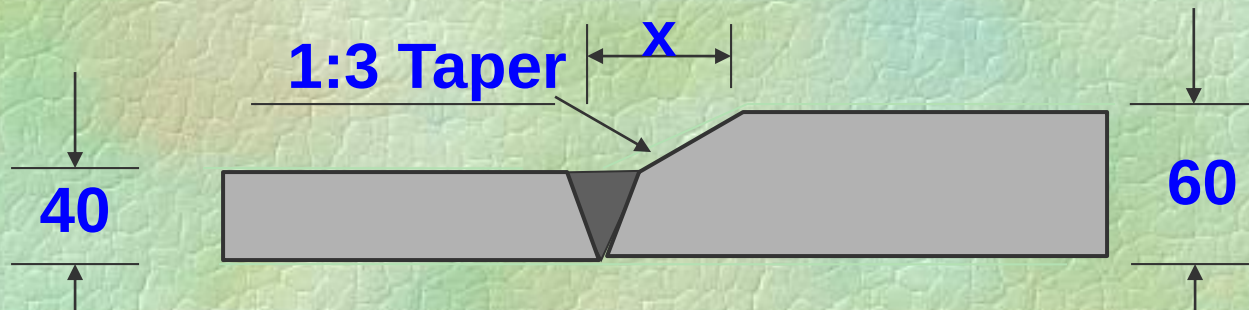
For Circ. seam having OD = 4000 mm and Thk. = 50 mm

Weld Weight = $14.9\text{cm}^2 \times 1272.3 \text{ cm} \times 7.86 \text{ gms/cc}$

= 149009gms = 149.009kgs.

TAPER CALCULATIONS

→ Whenever a Butt joint is to be made between two plates of different thickness, a taper is generally provided on thicker plate to avoid mainly stress concentration.



Thickness Difference = $60 - 40 = 20\text{mm}$.

$$X = 20 \times 3 = 60\text{mm}.$$

Instead of 1:3 taper, if 1: 5 Taper is required;

$$X = 20 \times 5 = 100 \text{ mm}.$$

MODULE : WORKSHOP CALCULATION

UNIT : 3

- Measure tape error correction and circumference calculation = with demonstration (1 hour)
- Orientation marking (0.5 hour)
- Offset and kink, web and flange tilt, flange unbalance calculation (1 hour)
- Arc length and chord length calculation for web layout= with demonstration (0.5 hour)
- Practice examples = 10 nos. (1 hour)

USE OF CALIBRATION TAPE

How to refer calibration report?

Consider total error for calculation.

Standard error & relative error are for calibration purpose only.

How to use calibration report?

Marking - Add the error. (Mad)

Measuring - Subtract the error (Mes)

During calculation, always put error value in brackets.

USE OF CALIBRATION TAPE.

Example: Cut 1meter long bulbar

Tape-01

Total error at 1m (+1)



Marking of 1 m (add the error)

$1000\text{mm} + (+1)\text{mm}$

Marking at 1001mm

measure the length(subtract the error)

Length found 1001mm

$1001 - (+1)\text{mm}$

1000mm actual length

Tape 02

Total error at 1m (-1)



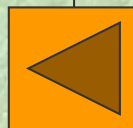
$1000\text{mm} + (-1)\text{mm}$

Marking at 999mm

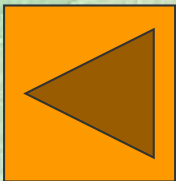
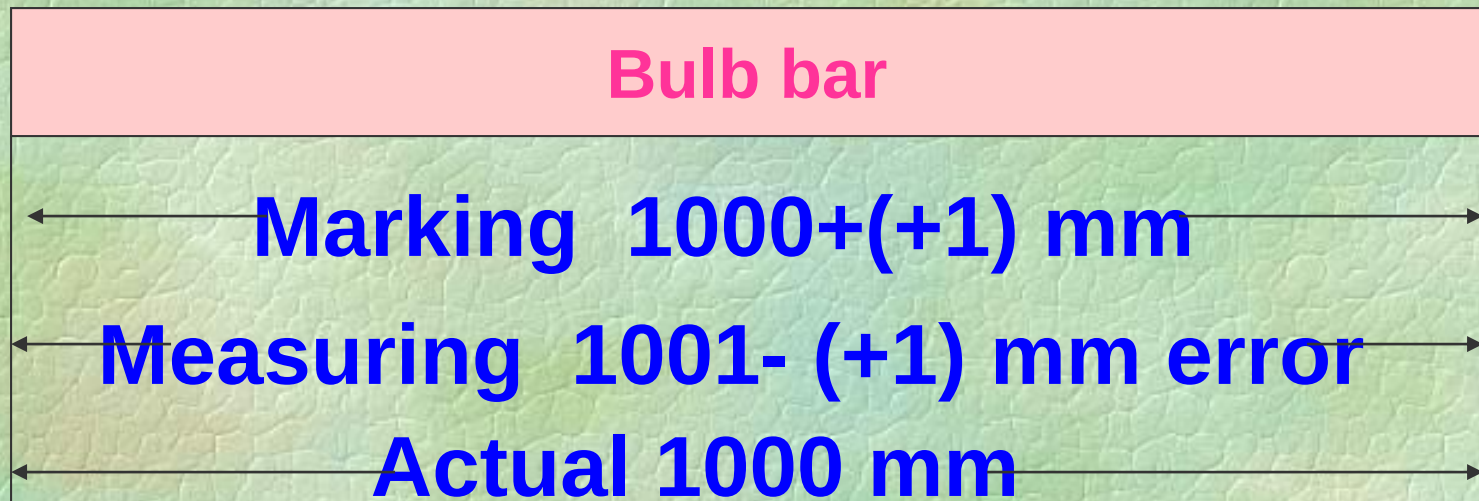
Length found 999mm

$999 - (-1)\text{mm}$

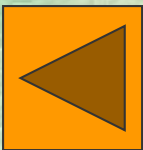
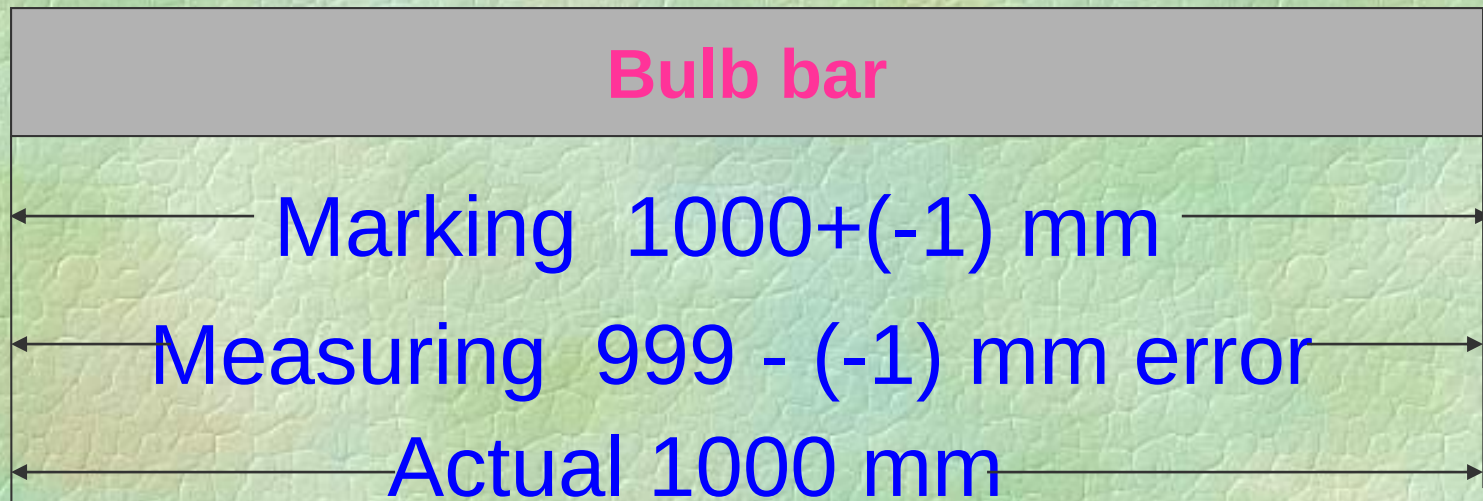
1000mm actual length



Tape 01 (+1 mm error)



Tape 02 (-1 mm error)



CIRCUMFERENCE CALCULATION

Circumference = Pie x Diameter of job

If I/D is known and O/S circ. Is required then,

Circumference = Pie x (I/D + 2 x thick)

Here Pie value is very important.

Which is the correct value of pie?

22/7

3.14

3.1415926 (Direct from calculator/ computer)

CIRCUMFERENCE CALCULATION

Example 1 : O/S Dia of the job is 10000mm, calculate O/S circumference.

1) $10000\text{mm} \times 22/7 = 31428.571\text{mm}$

2) $10000\text{mm} \times 3.14 = 31400.00\text{mm}$

3) $10000\text{mm} \times 3.1415926 = 31415.926\text{mm}$

CIRCUMFERENCE CALCULATION

Example 2 : Internal T-frame o/d - 9998mm

Shell thickness - 34mm ,Root gap - 0.5mm

Calculate shell o/s circumference.

$$\begin{aligned}\text{Shell o/d} &= \text{T - fr o/d } 9998\text{mm} + \text{root gap} \\ &\quad (0.5\text{mm} \times 2) + \text{thickness } (34 \times 2\text{mm}) \\ &= 10067\text{mm}\end{aligned}$$

$$\text{Circumference} = \text{Pie} \times 10067\text{mm}$$

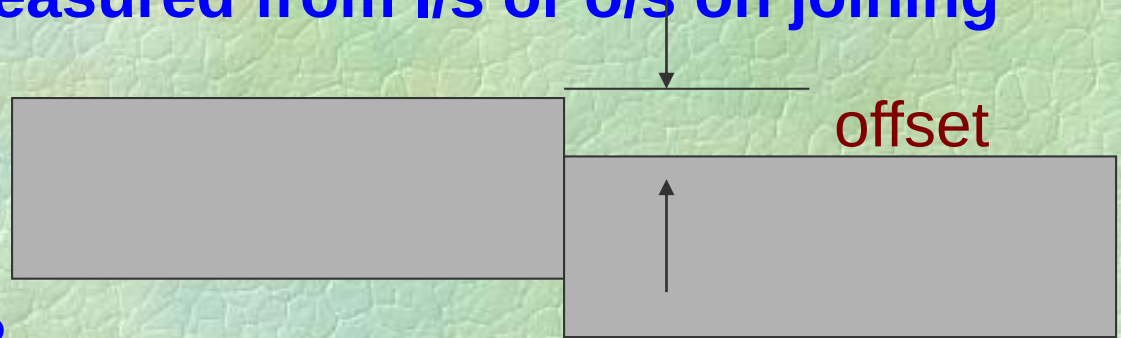
$$\text{If pie} = 3.1415926 \quad \text{then circ.} = 31626.4\text{mm}$$

$$\text{If Pie} = 22/7 \quad \text{then circ.} = 31639.14\text{mm}$$

$$\text{If Pie} = 3.14 \quad \text{then circ.} = 31610.38\text{mm}$$

OFFSET CALCULATION

Thickness difference measured from I/s or o/s on joining edges is called offset.



Tolerance as per P-1402

0.1T but $\leq 2\text{mm}$ for web & $\leq 3\text{mm}$ for flange

Say $T = 34\text{ mm}$ than, Offset = $0.1 \times 34\text{mm} = 3.4\text{mm}$

But max. 3mm allowed as mentioned above.

If by mistake 0.1% T considered than,

$0.1 \times 34/100 = 0.034\text{ mm}$ offset which is wrong.

OFFSET CALCULATION

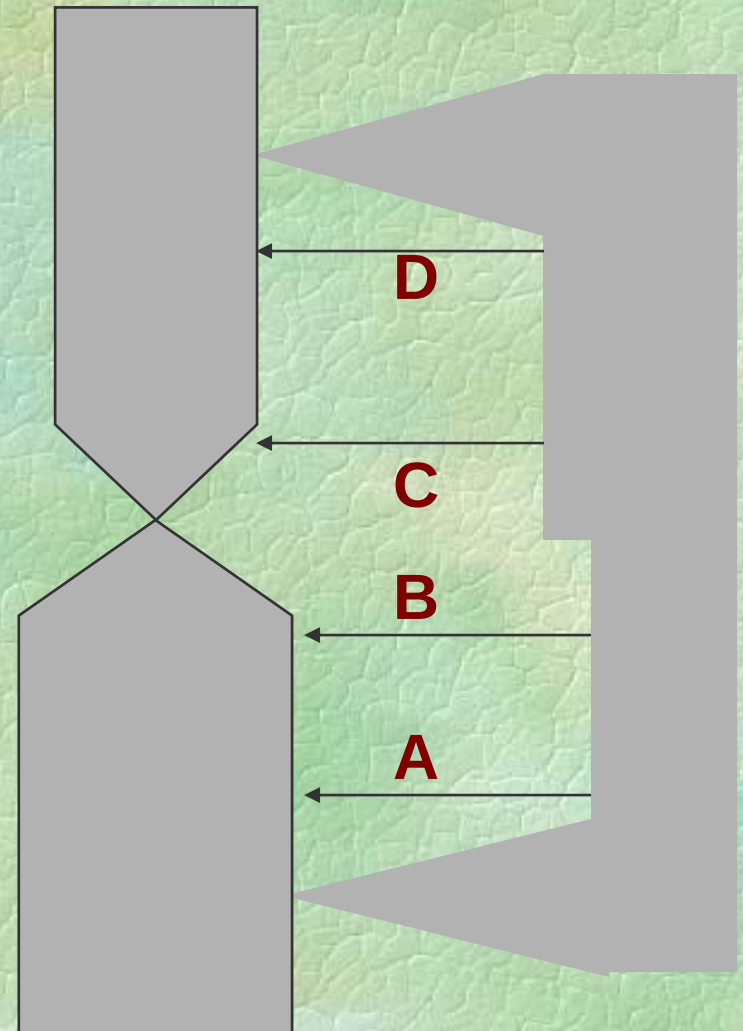
How to measure offset & kink ?

Here $A = D$

Offset = $B - C$

Kink = ($A - B$ or $C - D$)
which ever is max.

Kink is nothing but
peak-in/ peak-out



OFFSET CALCULATION

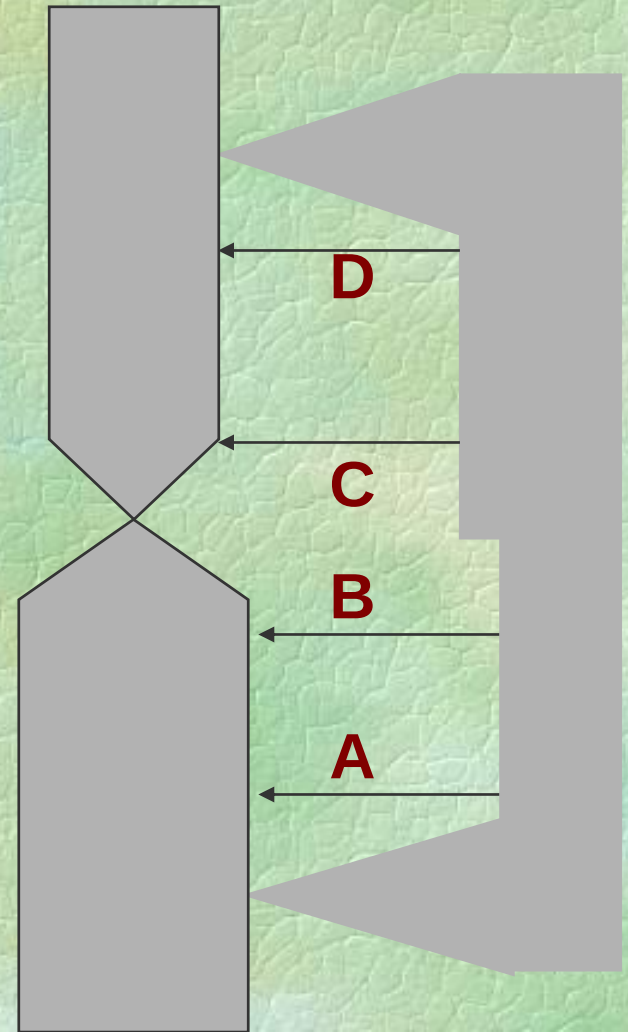
How to measure offset& kink in case of thickness difference?

Here $A = D$

Offset = $B - C$

Kink = ($A - B$ or $C - D$)
which ever is max.

Kink is nothing but
peak-in/ peak-out



ORIENTATION MARKING

Start orientation in following steps.

- Measure circumference.
- Check long seam orientation from drawing.
- Find out arc length for long seam from 0 degree.
- Arc length = $(\text{circ.}/360) \times \text{Orientation}$.

Always take all digits of orientation given in drawing.

ORIENTATION MARKING

Example : O/s circ.= 25300mm

L/s orientation = 75.162 degree

Find out arc length for 75.167

Arc length for l/s = (25300/360) x 75.1 = 5277.86mm

= (25300/360) x 75.16 = 5282.07mm

= (25300/360) x 75.167 = 5282.56mm

TOLERANCES

Always read the drawing carefully to interpret tolerance correctly.

(1) Pre-tilt of web :

For 101 mm to 150 mm frame height --

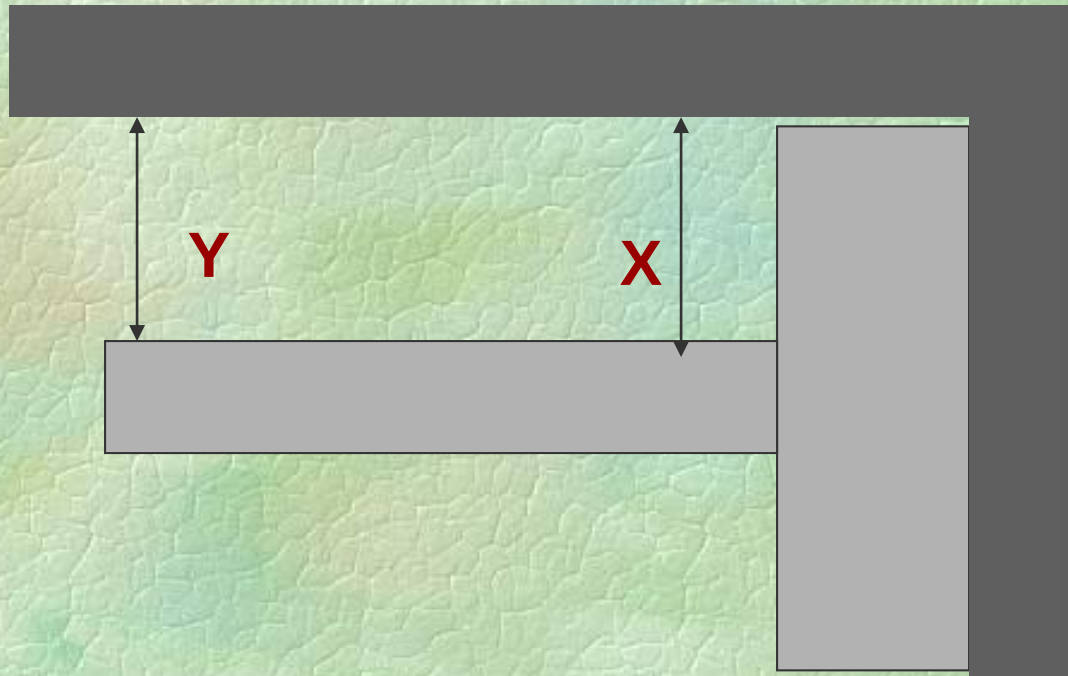
$0.025H$ but $\leq 3\text{mm}$

Example:

$H = 120\text{mm}$ then, pre tilt = $0.025 \times 120 = 3\text{mm}$

TOLERANCES

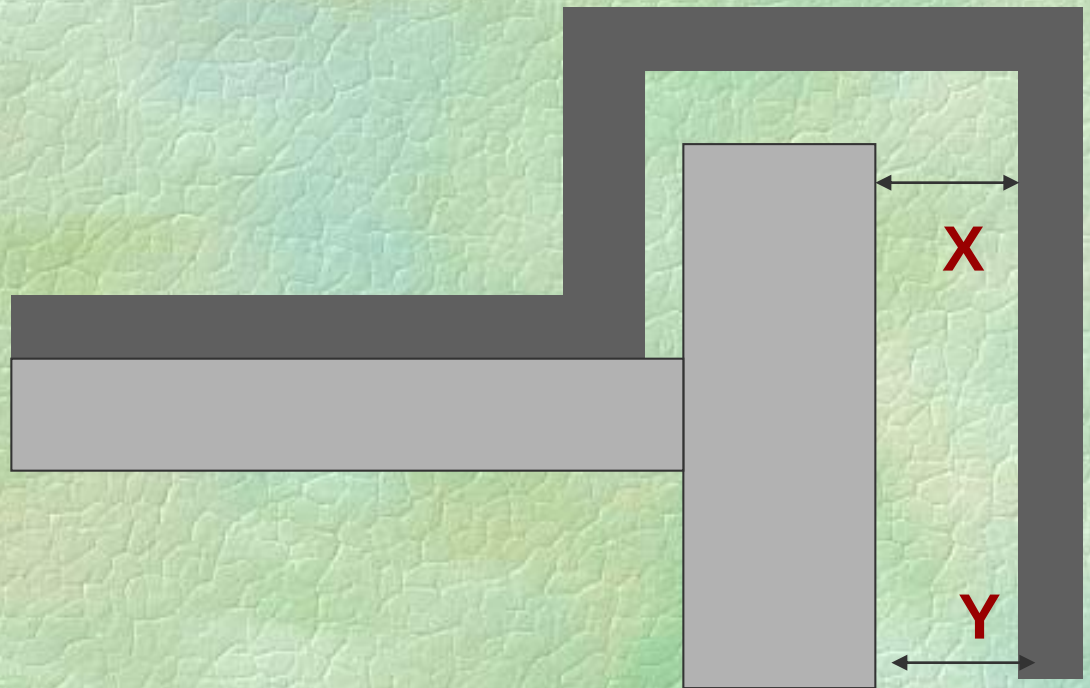
How to check Pre tilt of web :[X-Y] = pre tilt



TOLERANCES

(2) Flange pre tilt : $\leq 3\text{mm}$

[X-Y] = Pre tilt



TOLERANCES

(4) Out of circularity (OOC) :

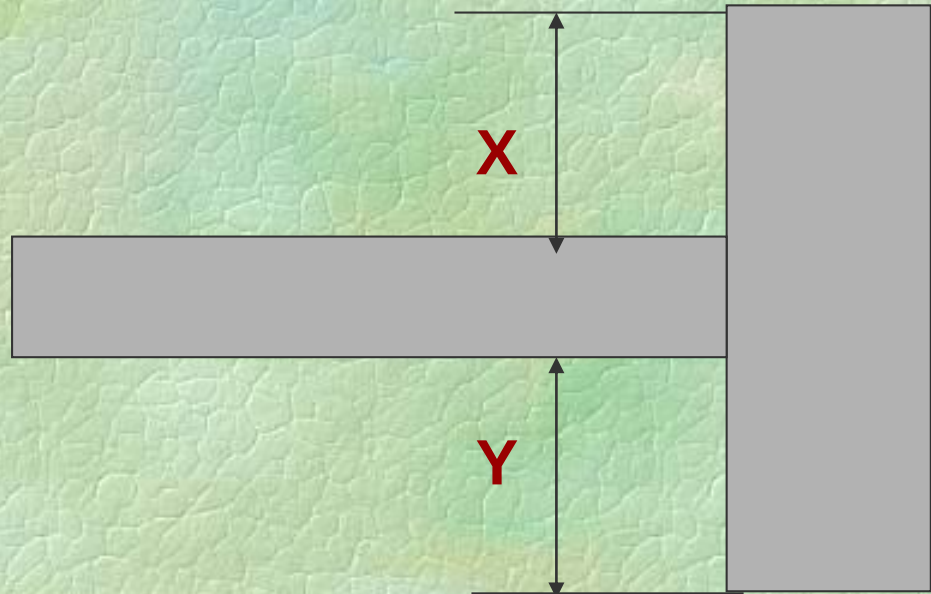
0.2 % R (R-theoretical radius of PRB)

Example : $R = 4000\text{mm}$ $\text{OOC} = 0.2 \times 4000/100$
 $= 8\text{mm}$

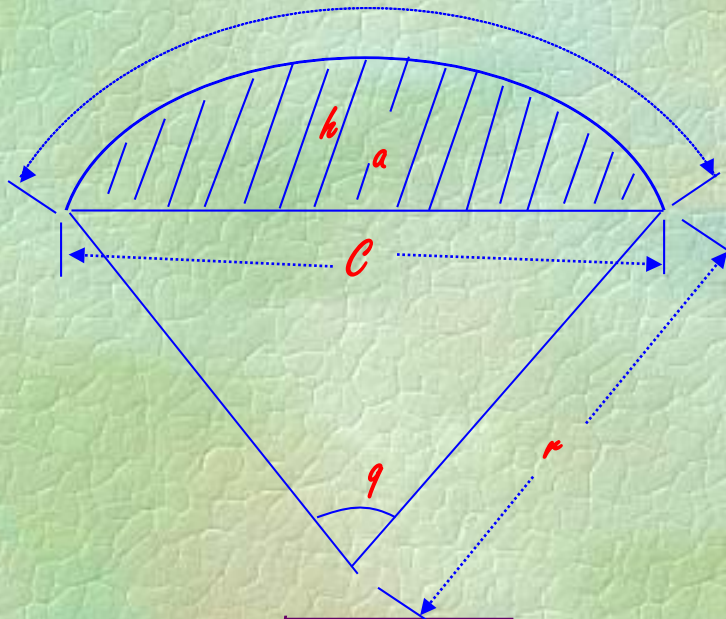
(5) Flange position w.r.t web :

(Flange unbalance) : $\pm 1\text{mm}$

$[X - Y] = 2\text{mm}$



Example:



l = ARC / LENGTH

a = AREA OF SEGMENT

c = CHORD LENGTH

q = ANGLE

r = RADIUS

h = HEIGHT BETWEEN CHORD TO ARC

$$(1) c = 2 \sqrt{h(2r - h)}$$

$$(2) a = 1/2 [rl - c(r - h)]$$

$$(3) h = r - 1/2 \sqrt{4r^2 - c^2}$$

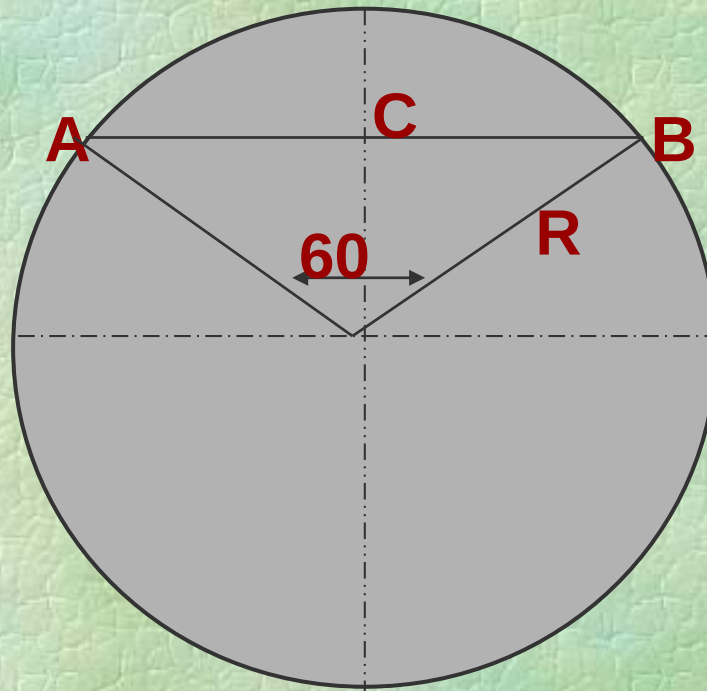
$$(4) r = \frac{c^2 + 4h^2}{8h}$$

$$(5) l = 0.01745 \times r \times q$$

$$(6) q = \frac{57.296}{r} \times l$$

$$(7) h = r[1 - \cos(q/2)]$$

CHORD LENGTH



Example :

Web segment size - 60°

Inside radius R - 4000mm

Sine 30 = CB/4000mm

1/2 chord length CB = $0.5 \times 4000\text{mm}$
= 2000mm

Full chord length = 4000mm

MODULE : WORKSHOP CALCULATION

UNIT : 4

- Tank rotator location calculation and sling angle for handling a job calculation (0.5hour)
- Machining allowance calculation for overlay and machining allowance for bracket calculation (0.5 hour)
- Marking PCD and holes for flange calculation = with demonstration (0.5 hour)
- Practice examples = 5 Nos. (0.5hour)
- Test => theory = 10 questions
- Practical= 4 questions (2 hours)

PYTHAGORAS PRINCIPLE APPLICATION

Trimming height calculation in hemispherical D'end

For matching OD / ID of D'end to shell OD / ID we have to do actual

Marking on D'end for trimming height

We can find out trimming height by

Pythagoras theory

As shown in figure, we can have

Following dimension before

Marking trimming

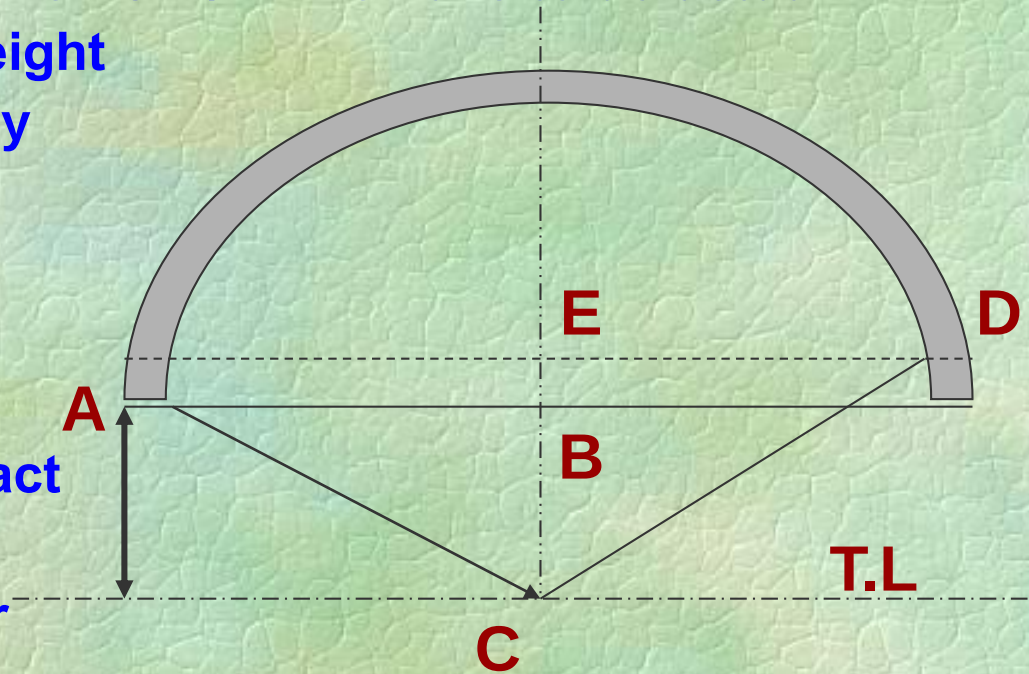
**AB = Radius of D'end. Based on act
Circumference at that end**

AC = CD = D'end I/S Radius as per DRG. from T.L

BC = Straight face or height from T.L TO D'end. edge

ED = D'end radius calculated from its matching part's Circumference

BE = Trimming height req to maintain for req circumference of Matching part circumference



PYTHAGORAS PRINCIPLE APPLICATION

Example :

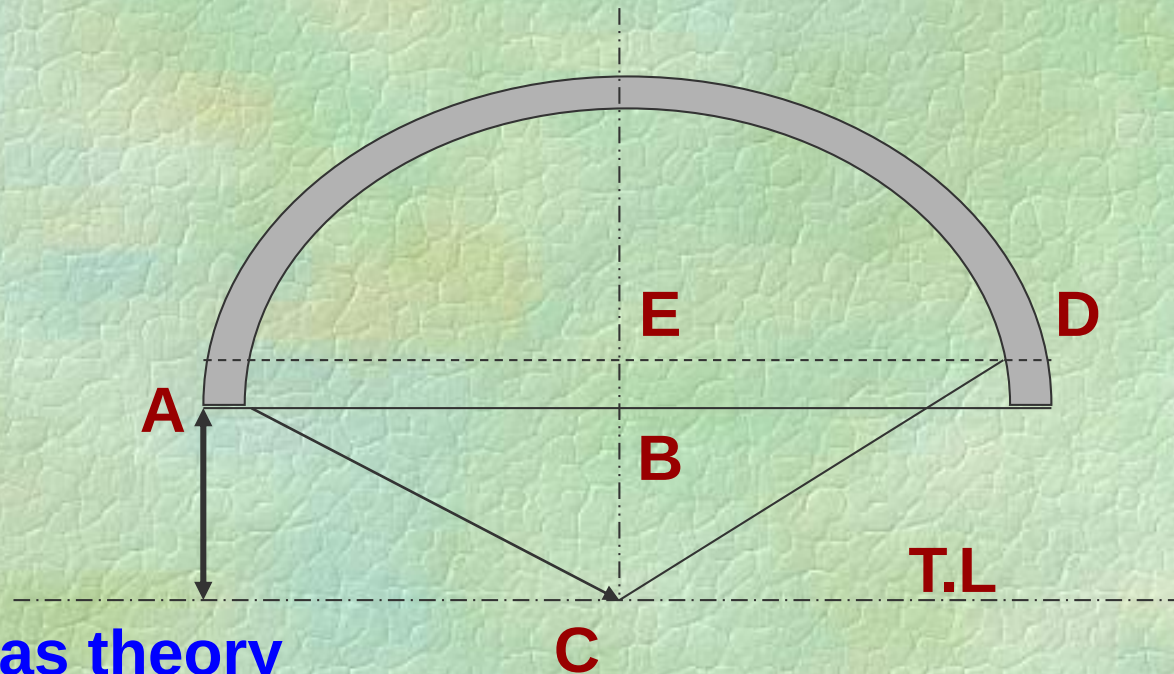
AB = 1500mm

AC = CD = 1510mm

BC = 173.5mm

ED = 1495mm

BE = ?



Based on Pythagoras theory

In triangle $\triangle CED$ $CE^2 + ED^2 = CD^2$

$$\therefore CE^2 = CD^2 - ED^2 = 1510^2 - 1495^2$$

$$\therefore CE = 212.3\text{mm}$$

Now $CE = CB + BE$

$$\begin{aligned}\therefore BE &= CE - CB = 212.3 - 173.5 \\ &= 38.8\text{mm}\end{aligned}$$

TRIGONOMETRIC FUNCTIONS

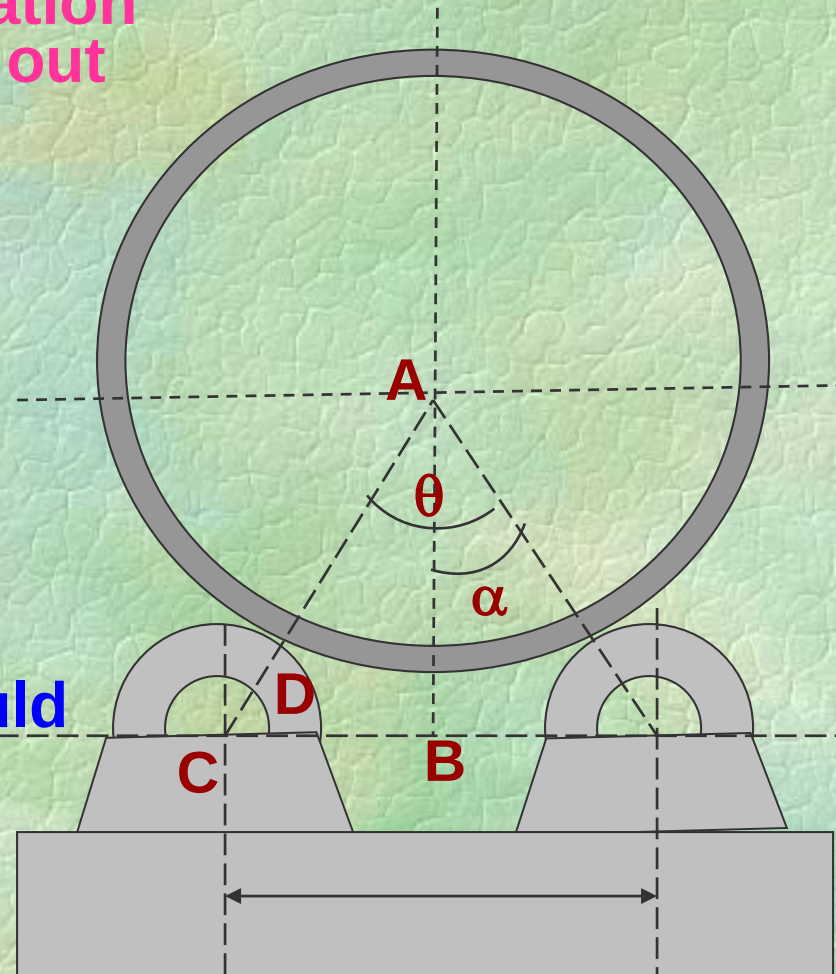
Tank rotator rollers dist. Calculation
As shown in figure we can find out

Two things :

1. Angle θ between two rollers
2. Dist. Between two roller for specific diameter of shell .

We will check it one by one.

For safe working, angle θ Should be between 45° - 60°



TRIGONOMETRIC FUNCTIONS

Tank rotator rollers dist calculation

1. Angle θ between 2 roller: As shown in figure

BC = Half of the dist between two rollers

AD = Shell o/s radius

DC = Roller radius

So we can get above dimensions from DRG and

Actual dist from tank rotator

Now as per sine formula $\sin \theta/2 = BC/AC$

$AC = AD + DC$ (Shell OD + Roller DIA)

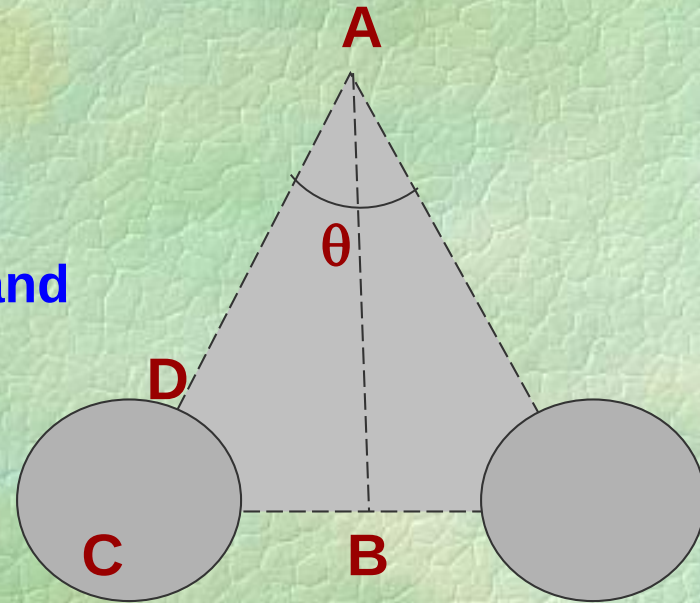
$\sin \theta/2 = BC / (AD + DC)$

Now If We Take $BC = 1500$ mm, $AD = 2000$ mm AND $DC = 400$ mm

Then $\sin \theta / 2 = 1500 / (2000 + 400) = 1500 / 2400 = 0.625$

$\sin \theta / 2 = 0.625 \therefore \theta / 2 = \text{INV Sin } 0.625 = 38.68^\circ$

$\therefore \theta = 2 \times 38.68^\circ = 77.36^\circ$



TRIGONOMETRIC FUNCTIONS

Tank rotator rollers dist calculation :

2. Roller dist. By deciding angle

Between two roller

If We Keep Roller Angle = 75°

AD = Shell O/s Radius = 3000mm

DC = Roller Radius = 400mm

CE = Dist. Between Two Roller

$$= CH + BE = 2 \times CH \text{ (CH = CE)}$$

Now By Sine Law

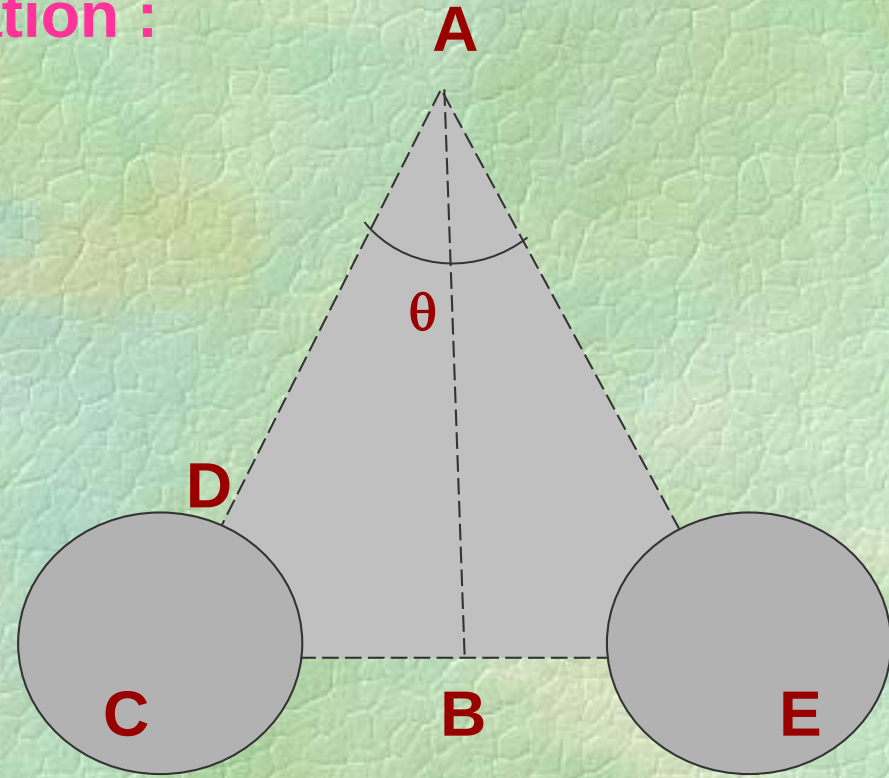
$$\sin \theta / 2 = BC / AC \therefore BC = \sin \theta / 2 \times AC$$

$$\therefore BC = \sin 37.5^\circ \times 3400 \text{ (}\theta = 75^\circ \therefore \theta / 2 = 37.5^\circ, AC = AD + DC = 3000 + 400\text{)}$$

$$\therefore BC = 0.6087 \times 3400 = 2069.78 \text{ mm}$$

$$\therefore \text{Dist. Between Roller CE} = 2 \times BC = 2 \times 2069.78$$

$$= 4139.56 \text{ mm}$$



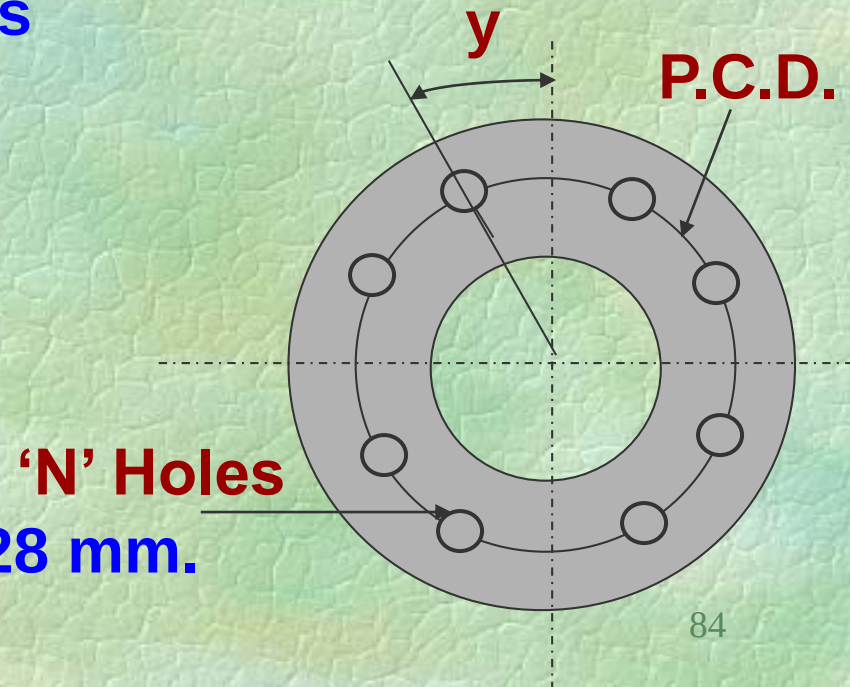
PCD & HOLE MARKING CALCULATIONS

- For Example, consider a flange 14"-1500# with P.C.D.=600 mm & No. of Holes $N = 12$.
- Mark P.C.D. = 600 mm.
- Angular distance $y = 360 / N = 360/12 = 30$ degrees.
- Chord length between holes

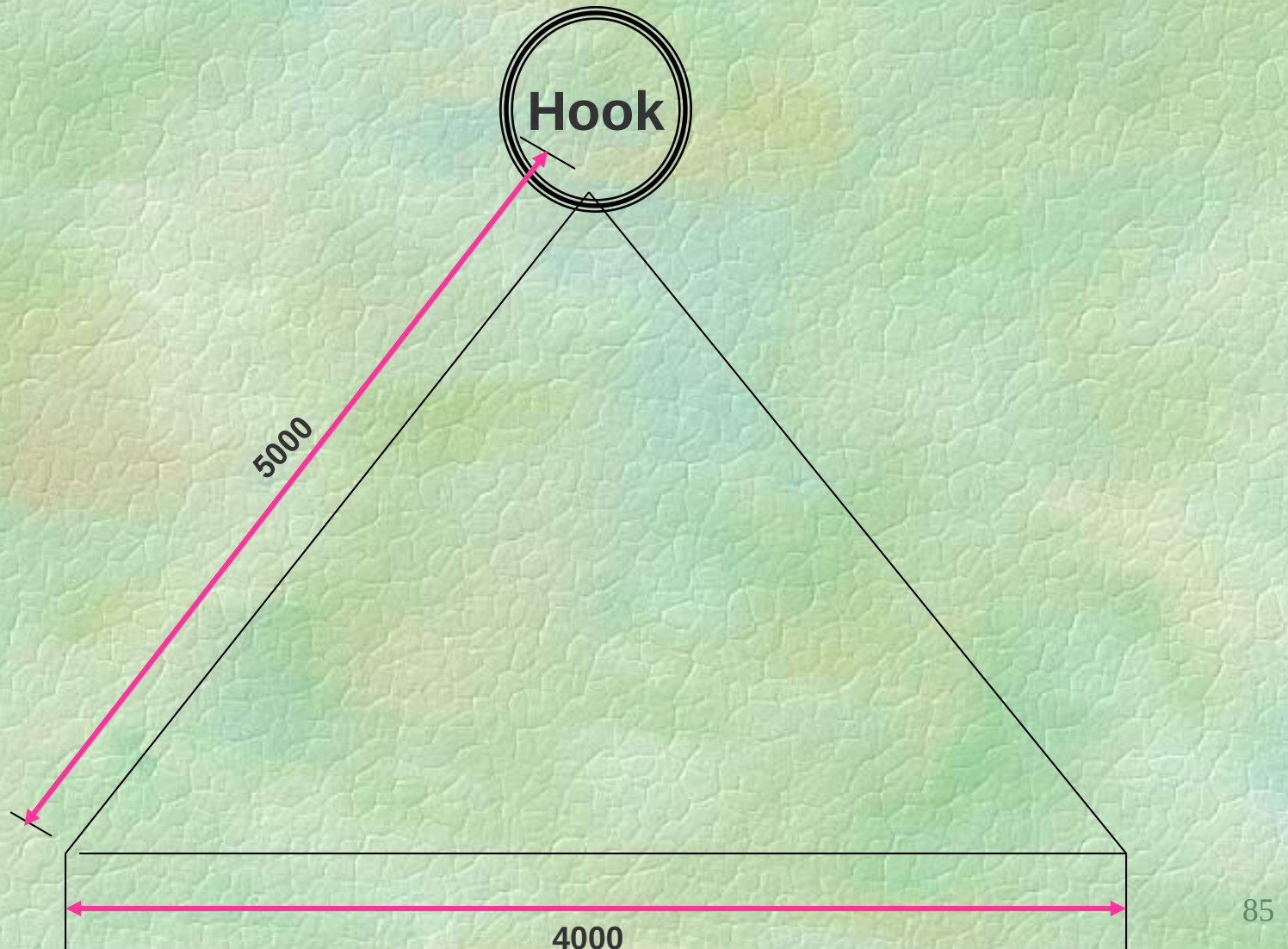
$$= 2 \times \frac{\text{PCD}}{2} \times \sin \left(\frac{y}{2} \right)$$

$$= 2 \times \frac{600}{2} \times \sin \left(\frac{30}{2} \right)$$

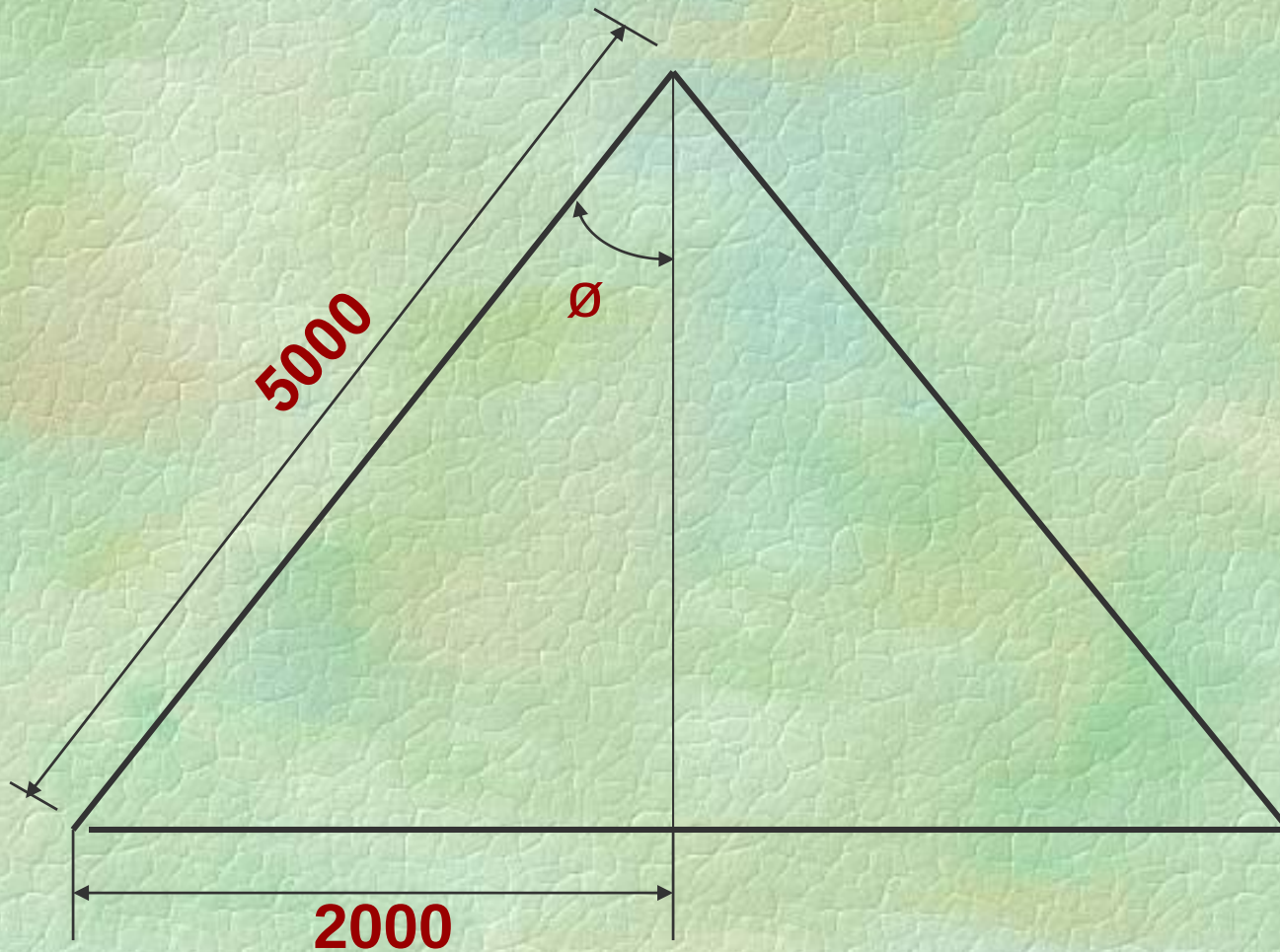
$$= 2 \times \frac{600}{2} \times 0.2588 = 155.28 \text{ mm.}$$



SLING ANGLE CALCULATION.



SLING ANGLE CALCULATION.



CALCULATIONS

$$\sin \theta = x/y$$

$$x = 2000 \quad \& \quad y = 5000$$

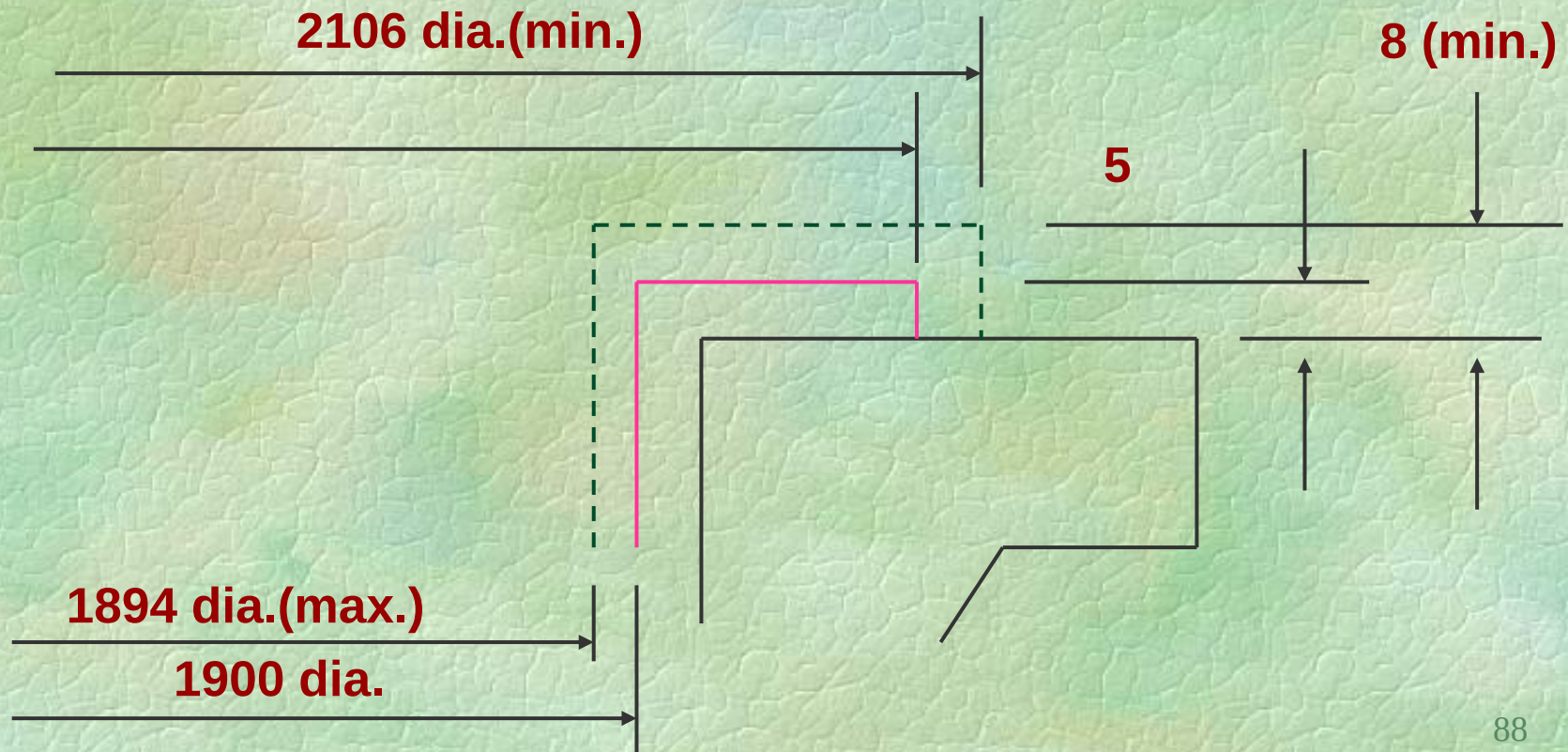

$$\theta = 23.5^\circ$$


$$2\theta = 23.5 \times 2 = 47^\circ$$

M/CING ALLOWANCES

Add 3 mm (min.) on all dimensions to provide for m/cing allowances.

Example of O/Lay on Gasket face of Flange:



PRACTICAL EXAMINATION

ORIENTATION MARKING

→ Marking On Shell

→ Orientation = 237'

PRACTICAL EXAMINATION MARK WEB SEGMENT

- **Inside Radius = 3800 mm**
- **Outside Radius = 4200 mm**
- **Segment Angle = 45°**

PRACTICAL EXAMINATION

WEP MARKING

→ **Shell Thickness** = 32 mm

→ **WEP Included Angle** = 50°

→ **Root Face** = 2 mm

→ **Root Gap** = 3 mm

PRACTICAL EXAMINATION HOLES MARKING ON FLANGE

→ Plate OD = 800 mm

→ Plate ID = 450 mm

→ P.C.D. = 600 mm

→ No. Of Holes = 16 Nos.

→ Dia. Of Holes = 32 mm