Trade of Metal Fabrication			
Module 4:	Structural Steel Fabrication		
Unit 2:	Connection Between Cross Pipes		
	Phase 2		

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Document Release History

Date	Version	Comments
31/01/07	First draft	
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Module 4 – Structural Steel Fabrication

Unit 2 – Connection Between Cross Pipes

Duration – 8 Hours

Learning Outcome:

By the end of this unit each apprentice will be able to:

- Read and interpret drawing
- Mark out, oxy/fuel cut, assemble, tack and weld a connection bracket between two pipes

Key Learning Points:

Sk M	Measurement, marking out, oxy-fuel gas cutting, drilling, assembly.
M Sk	Setting out on floor - 3, 4, 5 / 6, 8, 10 method. (Instructor to give practical).
M	Application of Pythagoras' Theorem.
Rk Sk	Identification of and description of fasteners used in structural steelwork. (For more information see Module 4 Unit 1).
Rk Sc	Load bearing capacities. (For more information see Module 4 Unit 1).
Rk	Advantages/disadvantages of bolting vs. welding. (For more information see Module 4 Unit 1).
Sk	Welding - manual metal arc process, A/C current, D.C. current.
Rk Sk	Use of centre lines for assembly. (For more information see Module 3 Unit 11).
M	Trigonometric ratios for any 90° triangle, ratios of common angles (30°-45°-60°).
P	Quality of work, maintenance of work area, safety awareness.

Training Resources:

- Fabrication workshop facilities, apprentice toolkit, P.P.E.
- M.M.A. plant and consumables
- Material as stated on drawing

Key Learning Points Code:



The 3:4:5 Right-Angle Triangle

The upper of the two drawings of Figure 1 shows a triangle with sides in the proportion 3: 4: 5. Such a triangle is always a right-angle triangle. This is because:

The square on the hypotenuse is equal to the sum of the squares on the other two sides.

Taking the 3: 4: 5 triangle:

- a) The square on the hypotenuse = $5 \times 5 = 25$.
- b) The square on the shortest side = $3 \times 3 = 9$.
- c) The square on the other side = $4 \times 4 = 16$; and 9 + 16 = 25.

Thus: if the sides of a triangle are 30 mm, 40 mm and 50 mm long, the triangle is a right-angled one.

If the sides are 27 mm, 36 mm and 45 mm in length the triangle is a right-angled one.

Other 3: 4: 5 triangles are found for example in a triangle ABC, in which AB = 28 mm, BC = 21 mm and AC = 35 mm.

And also in triangle XYZ in which: XY = 57 mm, YZ = 76 mm and XZ = 95 mm.



Figure 1 - Right-Angle Triangle

The square on the hypotenuse is equal to the sum of the squares on the other two sides.

Trigonometric Ratios for 90° Triangle







In calculations involving right-angled triangles, Pythagoras' theorem is used. This can be given briefly with reference to the triangles in Fig. 1 (note that each has a right-angle):

 $c^2 = a^2 + b^2$

where a, b and c are the lengths of the sides of the triangles, and c (the hypotenuse) is opposite the right-angle.

Fig. 2 shows the most common right-angled triangle.

In Fig. 3 the values 3, 4 and 5 have been divided by 10, multiplied by 2 and multiplied by 12 to give three other right-angled triangles.

Fig. 4 shows another right-angled triangle.

Be on the look-out for 3, 4, 5 and 5, 12, 13 triangles - they are right-angled!

Checking: $13^2 = 169$

 $5^2 + 12^2 = 25 + 144 = 169.$

Worked Example:

Using Fig. 5, find c when the sides making the right-angle are 10 and 7.

 $7^{2} + 10^{2} = 49 + 100 = 149$ $c^{2} = 149$ $c = \sqrt{149} = 12.21$ Answer c = 12.2

Trigonometry

30°/60°/90° Right Angled Triangle

Pythagoras' Theorem may be used to evaluate the third side of a right-angled triangle provided the other two sides are known. It does not however give us a method of calculating the angles of the triangle.

Trigonometry deals with the ratio between the sides of a right-angled triangle and it provides a method of calculating unknown sides and angles.

To enable the trigonometrical ratios to be evaluated, the sides of the triangle must be identified in relation to the angle considered. Figure 2 shows the right angled triangle A, B, C.



Figure 2 - Right Angled Triangle ABC

The Hypotenuse is the name give to the longest side which is also the side opposite the right angle. In relation to angle A the side opposite this angle is referred to as the opposite while the near side is referred to as the adjacent.

Consider the $30^{\circ}/60^{\circ}/90^{\circ}$ right angle triangle shown in Figure 3 with a Hypotenuse of length 200 mm and a vertical side of length 100 mm. The length of the horizontal side may be found from Pythagoras' Theorem.

Length of horizontal = $\sqrt{200^2 - 100^2}$



Figure 3 - 30°/60°/90° Right Angled Triangle

In relation to angle A, the opposite is 100 mm while the adjacent side is 173.2 mm. The three important trigonometrical ratios are sine, cosine and tangent and they are usually written Sin, Cos and Tan for short.

Sin of an angle	=	length of opposite side length of hypotenuse
Cos of an angle	=	length of adjacent side length of hypotenuse
Tan of an angle	=	<u>length of opposite side</u> length of adjacent side

In the $30^{\circ}/60^{\circ}/90^{\circ}$ triangle repeated below.

$\sin A = \sin 30^{\circ}$	= opposite/hypotenuse
	= 100/200
	= 0.5
	:. Sin $30^\circ = 0.5$
$\cos A = \cos 30^{\circ}$	= adjacent/hypotenuse
	= 173.2/200
	= 0.866
	:. $\cos 30^\circ = 0.866$
Tan A = Tan 30°	= opposite/adjacent
	= 100/173.2
	= 0.5774
	:. Tan $30^\circ = 0.5774$

In relation to angle C of the $30^{\circ}/60^{\circ}/90^{\circ}$ triangle shown in Figure 3, the opposite is 173.2 while the adjacent is 100 mm.

Sin C = opposite/hypotenuse Cos C = adjacent/hypotenuse

Tan C = opposite/adjacent

Trigonometrical Tables

One may construct right angle triangles with various angles and then by measurement, determine the trigonometrical ratio. This would be rather cumbersome and would not give very accurate results. Trigonometrical tables with a high degree of accuracy have been developed relating the ratios of Sin, Cos and Tan of any angle in degrees and minutes between 0° and 90° .

N.B.

There are 60 minutes (written 60') in 1 degree.

60' = 1°

Solution of Right Angled Triangles

Trigonometry may be usefully used in the solution of right angled triangles. Consider the right angled triangle ABC shown in the sketch below. The terms opposite, adjacent and hypotenuse have been shortened to opp, adj and hyp respectively.



Tan A =	opp/adj
Sin A =	opp/hyp
$\cos A =$	adj/hyp

Aid to Memory

The 3 above expressions may be remembered from the following:

Tom's Old Aunt	Tan = opp/adj
Sat On Her	Sin = opp/hyp
Coat And Hat	Cos = adj/hyp

In the solution of right angled triangles, an angle and one side may be given and it may be necessary to determine the other two sides of the triangle. The following diagram may be useful in transposing the above formula:



Draw a triangle as shown. Place the opp at the apex of the triangle. Sin and hyp are placed underneath. To determine the value of the opp place your finger over opp.

Opp = Sin x Hyp

To determine the hyp place your finger over hyp. The hyp equals the opp over Sin.



To determine Sin, place your finger over Sin, this gives the value of Sin equal to opp over hyp.



Example 1

Determine the dimensions h and x for triangle ABC shown below.



Solution to Example 1:



Example 2

The figure shown below shows the outline of a plate in which a slot must be accurately market out, estimate the values of the dimensions h, H, x, X.



Solution to Example 2:

Using the Zeus Chart Tables:



NB

The Cos tables are read from the right hand column of the Sin tables. The degrees increase as one moves upwards.

Use of Calculator

Your calculator will have the keys Sin, Cos and Tan and these keys may be used to find the value of Sin, Cos or Tan of any angle.

NB

Make sure the sign $\boxed{\text{Deg}}$ is displayed near the top left corner. To find Sin 30°, key in 30 Sin. The result is 0.5, hence Sin 30° = 0.5.

Similarly, to find the Cos 55° , key in 55 Cos, the result is 0.5735764 = 0.5736, correct to four decimal places.



Answers:

A)

i.	0.8290	iv.	0.9397
ii.	0.8290	v.	0.9397

iii. 14.3007

B)



Length AB = 0.5592 × 150 = 83.88 mm



NB

When using your calculator to find the Sin, Cos and Tan of angles expressed in degrees and minutes, it will be necessary to convert the angle expressed in degrees and minutes into decimal form.

Remember 60 minutes (60') = 1 degree (1°) .

Example:

Express the angles $5^{\circ}24'$ and $10^{\circ}40'$ in decimal form.

Solution:

5°24', 24'	=	24/60 part of a degree
	=	0.4 degrees
5°24'	=	5.4°
10°40', 40'	=	40/60 part of a degree 0.666 degrees
10°40'	=	10.666°

When a calculation is completed it may be necessary to convert the degrees in decimal form to degrees and minutes. This may be achieved by simple multiplying the number(s) to the right of the decimal point by 60.

Example:

Express the angles 8.72° and 20.33° in degrees and minutes.

Solution:

0.72 x 60	= 43.2,	8.72°	= 8°43'
0.33 x 60	= 19.8,	20.33°	$= 20^{\circ}20^{\circ}$

Self Assessment

Questions on Background Notes - Module 4.Unit 2

No Suggested Questions and Answers.

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