Trade of Metal Fabrication	
Module 3:	Plate Fabrication
Unit 4:	Tank Support
	Phase 2

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Document Release History

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Module 3 – Plate Fabrication

Unit 4 – Tank Support

Duration – 9 Hours

Learning Outcome:

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

- Read and interpret of drawing
- Mark out, flame cut, bend, assemble and weld components to make a tank support

Key Learning Points:

D	Reading and interpretation of drawing.
Sk	Marking out, template making.
M	Calculation of Plate Length.
Sk Rk	Oxy-fuel gas cutting - pressures, nozzle sizes, cutting attachments. *(Also see Module 2 Unit 1).*
Sk Rk	Manual metal arc welding equipment process - electrode sizes welding currents. Weld symbols. *(Also see Module 2 Unit 3).*
Sk	Assembly procedures -dimensional accuracy.
H	Safety procedures when using bending and welding equipment. *(Also see Module 2 Unit 3).*
Sk Rk	Vernier height gauge.
Sc	Friction and its effects on material.
P	Ability, initiative, standard of work.

Training Resources:

- Fabrication workshop
- Apprentice tool kit
- Safety equipment oxy/fuel cutting equipment
- Press brake
- M.A.G.s welding plant and equipment
- 150mm wide flat bar in 10mm, 6mm and 5mm

Key Learning Points Code:

M = Maths D= Drawing RK = Related Knowledge Sc = Science

P = Personal Skills Sk = Skill H = Hazards

Vernier Height Gauge

The vernier height gauge is a development of the vernier caliper.

The graduated frame is held in the vertical position in an accurately ground base.

The gauge is read in exactly the same way as the vernier calipers, except that the readings are taken from the moveable jaw to the base.

The height gauge is usually used on a surface plate or marking out table. It is designed for accurate marking out or checking heights.

Several attachments are available which may be clamped to the measuring bar of the height gauge.

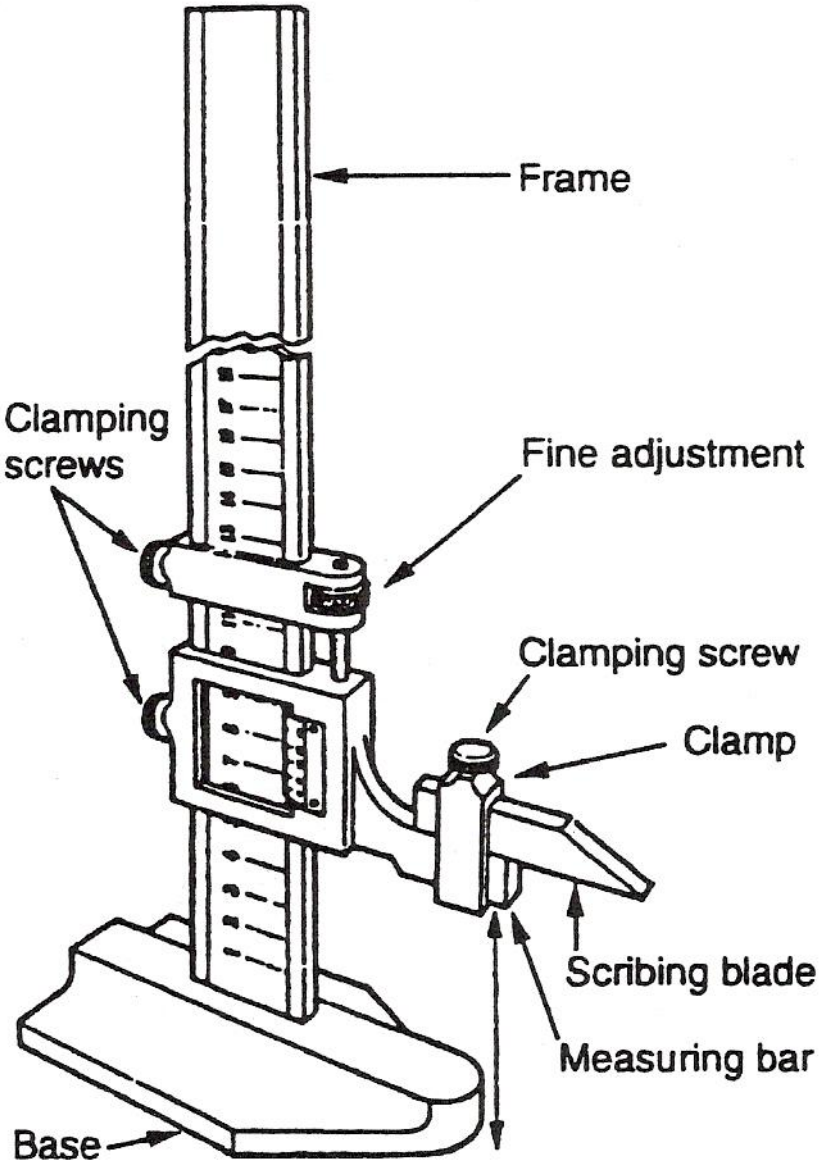


Figure 1 - Vernier Height Gauge

Friction and Lubrication

Friction

When a block is placed on a horizontal surface and a force is applied to it, the block will not move until the force reaches a value sufficient to overcome an opposing force called friction (Figure 2). The force required to initially cause sliding is termed the limiting frictional force and once this has been overcome a smaller force will keep the block moving.

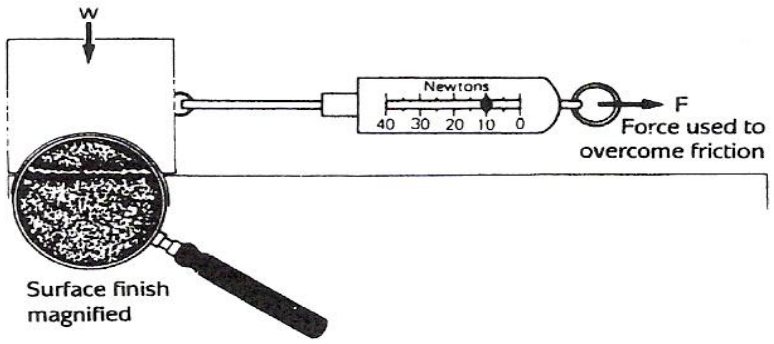


Figure 2 - Demonstration of Frictional Force

Sometimes friction is a disadvantage, but if it did not exist many things that we do would be impossible, e.g. walking - no grip between the shoe and the ground would mean that a new method of propulsion would be needed.

With motor vehicles it is possible to consider the effects of friction and group these effects into situations where friction is an advantage and a disadvantage. Situations where friction is usefully employed:

1. *clutch* - drive is made possible by the friction between the plates;
2. *brakes* - energy of motion is converted to heat by rubbing one surface against another;
3. *tyres* - the wheel rim drives the tyre by friction; the tyre 'grips' the road;
4. *fan belt* - drive to the fan and generator is made possible by friction;
5. *steering wheel* - friction between the driver's hand and the steering wheel.

Situations where friction is disadvantageous:

1. *piston* - for high efficiency the piston should slide easily in the cylinder;
2. *bearings* - shafts must turn as freely as possible - friction in bearings results in a reduction in the power applied to drive the vehicle; 'rolling friction' is much smaller than sliding friction, so ball or roller bearings are efficient types of bearing.

In cases where friction is essential the designer selects his material to give the appropriate grip between the surfaces. All the time this friction is maintained the component will perform its task, but if friction is decreased due to wear or other reasons then slip will occur.

The frictional resistance between two surfaces depends on:

a) the nature of the materials - there is more friction between asbestos substitutes and iron than between steel and bronze;

b) the condition of the surfaces - smooth or rough, wet or dry;

c) the force pressing the surfaces together - friction is proportional to the force, i.e. when the force thrusting one surface against another is doubled, the friction force is doubled.

Lubrication

It is believed that friction is caused by the interlocking action of the two surfaces and also by the attraction of one material to another. Placing two surfaces together causes the load to be supported by small 'crests'. If one surface is now slid over the other, the crests will attain a very high temperature and will tend to weld the two materials together. Further movement will break these welds, 'tear' the surface, and cause rapid wear. A reduction in the energy lost to friction and longer component life can be obtained if the surfaces can be separated; this is achieved by lubrication.

A lubricant introduced between the surfaces may be considered as a series of globular liquid particles which easily slide over each other. Provided there is no metal-to-metal contact, any friction which exists will be caused by the resistance of one particle to leave its neighbour - this resistance is called the viscosity of a lubricant.

The type of lubricant is governed by the conditions under which it operates.

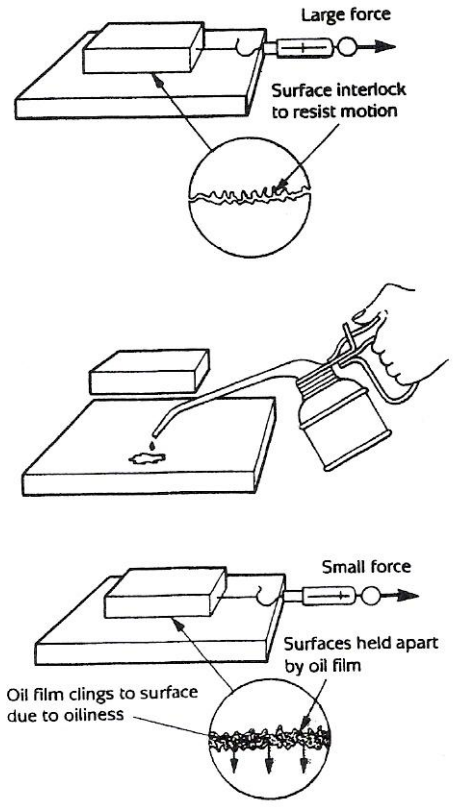
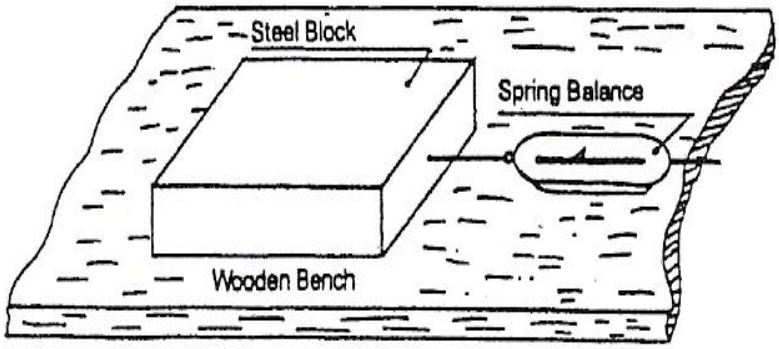


Figure 3 - Boundary Lubrication

Friction

When you rub your hands together very quickly you will feel them heating up. This heat is caused by friction. Friction is a force which tries to stop things from sliding over each other. The force of friction may be demonstrated very easily by attaching a spring balance to a block of wood or steel and pulling until the block just beings to move. The reading on the spring balance is the force necessary to overcome friction.



Test Yourself

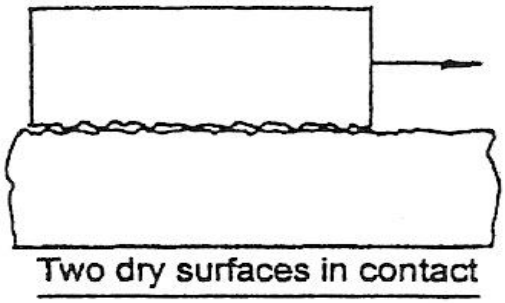
Select a block of steel of mass approximately 1 kg and secure a spring balance to it as shown in the figure above.

a) Pull on free end of spring balance and record force necessary to overcome friction.

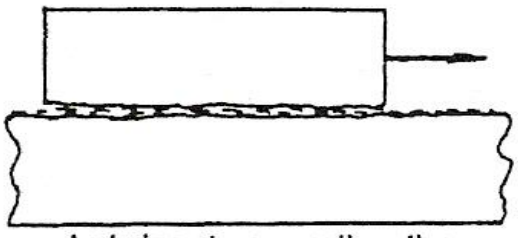
b) Stand the block of steel on its edge and repeat as in (a) above.

c) Rub a small quantity of grease to underside of block and repeat as in (a) above.

Friction is a force which opposes motion between two objects in contact. Friction is caused by the fact that even polished surfaces have tiny humps and hollows on their surface. When one surface moves relative to the other surface the humps on one surface catch and stick to the humps on the other surface. Friction can cause wear of machine parts which are constantly sliding over each other. Lubrication has the effect of reducing the force necessary to overcome friction. The figure here shows two surfaces with a thin film of lubrication adhering to each surface, when motion takes place the friction between these two films of lubricant is much less than the friction between the dry surfaces. In a lathe, friction between the carriage and the bed is a disadvantage while friction between the brake shoes and brake discs is an advantage.



Two dry surfaces in contact



Lubricant separating the two surfaces

Template Making (Large Fabrication Shops)

Large fabrication workshops are often provided with an area reserved for template making, known as the 'template shop' or 'loft'.

Such shops are usually situated above the normal shop floor level, but those situated at ground level are fitted with an overhead runway and lifting tackle to handle steel plates for the making of steel templates.

A template shop should be well glazed to ensure good lighting during daylight hours, and provided with adequate artificial lighting for use in the darker hours.

Specialist template makers are employed in the template shop to produce accurate templates for use in the various fabrication shops by the· croppers, smiths, benders, platers and welders when cutting, marking for drilling, punching, forming and welding the steel parts. Skilled template makers must possess a sound knowledge of the principles of plane geometry and be able to apply workshop calculations. They must be able to interpret detailed drawings and also have the ability to use carpenter's tools.

Much of the machinery used in a template shop is of the type normally used for woodworking, such as a circular saw, fret-saw, planing machine and woodworker's drilling machine. It also includes a cardboard shearing machine to cut the special template paper.

The Setting-Out Floor

It is essential that the floor used for full-size laying-out consists of floor boarding placed diagonally across the floor joists. If the floor boards were laid in the conventional manner (lengthways) or square across the shop, the joints between the boards (which tend to shrink) would offer a serious handicap, as most lines are marked on the floor in these directions. The joints between the boards may easily be mistaken for lines, or some portion of a line may coincide with an open joint. Such problems are eliminated when the boards are laid diagonally.

The floor is given a coat of 'lamp black' and 'size' to ensure that the lines (made with a 'chalkline') can be clearly seen. Working from scale drawings, the template maker marks out full-size sets of steelwork on this black surface. The laying out of the drawing full size on the template shop floor is called 'lofting'.

Templates as a Means of Checking

These are usually made of sheet metal or wood, although for some applications template-making paper may be used.

Material	Applications
Template paper	Outlines for small bent shapes, such as brackets, small pipe bends and bevelled cleats may be set out on template paper. Used for developing patterns for sheet metal work.
Hardboard	Templates for gusset plates to be produced in small quantities.
Timber	Used in considerable quantities for steel-work templates. Easy to drill and cut to shape. Whitewood timber strips (battens) up to 153 mm wide and 12.7 mm thickness are used to represent steel members. Plywood used for making templates for use with oxy-fuel gas profiling machines.
Sheet metal	Used for making patterns for repetition sheet metal components. Templates for checking purposes. Steel, 3.2 mm thick, is used for profiling templates on oxy-fuel gas profiling machines fitted with a magnetic spindle head.
Steel plate	Light steel plate fitted with drilling bushes is used as templates for batch drilling of large gusset plates.

Table 1 - Materials for templates

Self Assessment

Questions on Background Notes – Module 3.Unit 4

1. Give three examples of Friction.

2. Explain what Templates are used for and list three pieces of information that would be on a Template.

Answers to Questions 1-2. Module3. Unit 4

1.

Friction:

When a block is placed on a horizontal surface and a force is applied to it, the block will not move until the force reaches a value sufficient to overcome an opposing force called friction. The force required to initially cause sliding is termed the limiting frictional force and once this has been overcome a smaller force will keep the block moving.

Clutch	-	Drive is made possible by the friction.
Brakes	-	Energy of motion is converted to heat by rubbing one surface against another.
Tyres	-	The wheel rim drives the tyre by friction, the tyre grips the road.
Fan Belt	-	Drive to the fan and generator is made possible by friction.
Steering wheel	-	Friction between the driver's hand and the steering wheel
Walking	-	The grip between the ground and the shoe.

2.

Templates:

Templates are used in various fabrication shops by croppers smiths, benders, platers and welders when cutting, marking for drilling punching, forming and welding the steel parts.

Large fabrication workshops often provide an area for template making, known as the ‘template room’ or the ‘loft’.

Skilled template makers must possess a sound knowledge of the principles of plane geometry and be able to apply workshop calculations, interpret detailed drawings and the ability to use carpenter’s tools.

Three pieces of information found on a template:

a. Left hand or right hand.

b. Job number or contract number.

c. Thickness of material.

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