Trade of Metal Fabrication	
Module 3:	Plate Fabrication
Unit 11:	Cylindrical Elbow Piece
	Phase 2

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Document Release History

Date	Version	Comments
22/12/06	First draft	
13/12/13	SOLAS transfer	

Module 3 – Plate Fabrication

Unit 11 – Cylindrical Elbow Piece

Duration – 17 Hours

Learning Outcome:

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

- Read and interpret drawing
- Mark out material
- Set out and oxy-fuel cut
- Pre-set, roll, assemble and weld an offset elbow joint

Key Learning Points:

Sk Rk	Parallel line development. *(Instructor explains this in classroom).*
Rk	Economic use of materials. *(Also see Module 3 Unit 7).*
Rk	Centre lines - assembly.
Rk	Flanges - types, their use, pitch circle diameter.
Rk	Position of flanges on pipes.
Rk	Gussets, bracing and stiffners, load distribution.
Rk	Interpretation of weld symbols. *(Also see Module 2 Unit 5).*
Sk Rk	Recap flame cutting, pressures, nozzle sizes, stitch cutting. *(Also see Module 2 Unit 1).*
Sk D	Sections - development. *(Instructor explains this in classroom).*
Rk	Position of welded seams.
H	Safety procedures when using equipment.
P	Neatness and standard of work.

Training Resources:

- Fabrication workshop
- Apprentice tool kit
- Oxy fuel gas equipment
- Press brake
- Pyramid rolls
- Pedestal drill
- M.M.A plant and consumables
- P.P.E.

Key Learning Points Code:

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

P = Personal Skills Sk = Skill H = Hazards

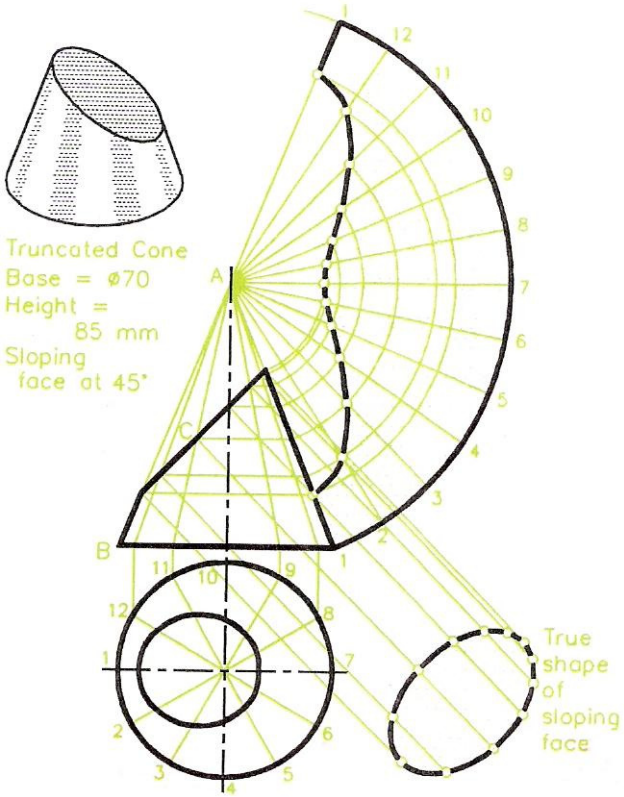


Figure 1 - Seam Normally Placed on Shortest Side (Welding Purposes)

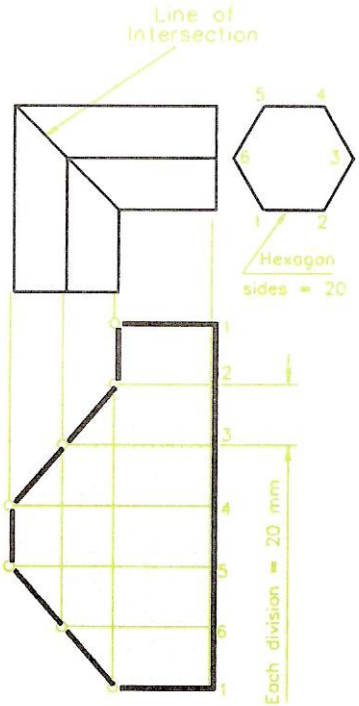


Figure 2 - Seam on Shortest Side again to Facilitate Welding

Flanges – Types

As you will see on the accompanying diagrams different joining sections go with flanges. Although gate valves are used as examples flanges have a wide varied use in all forms of fabrication.

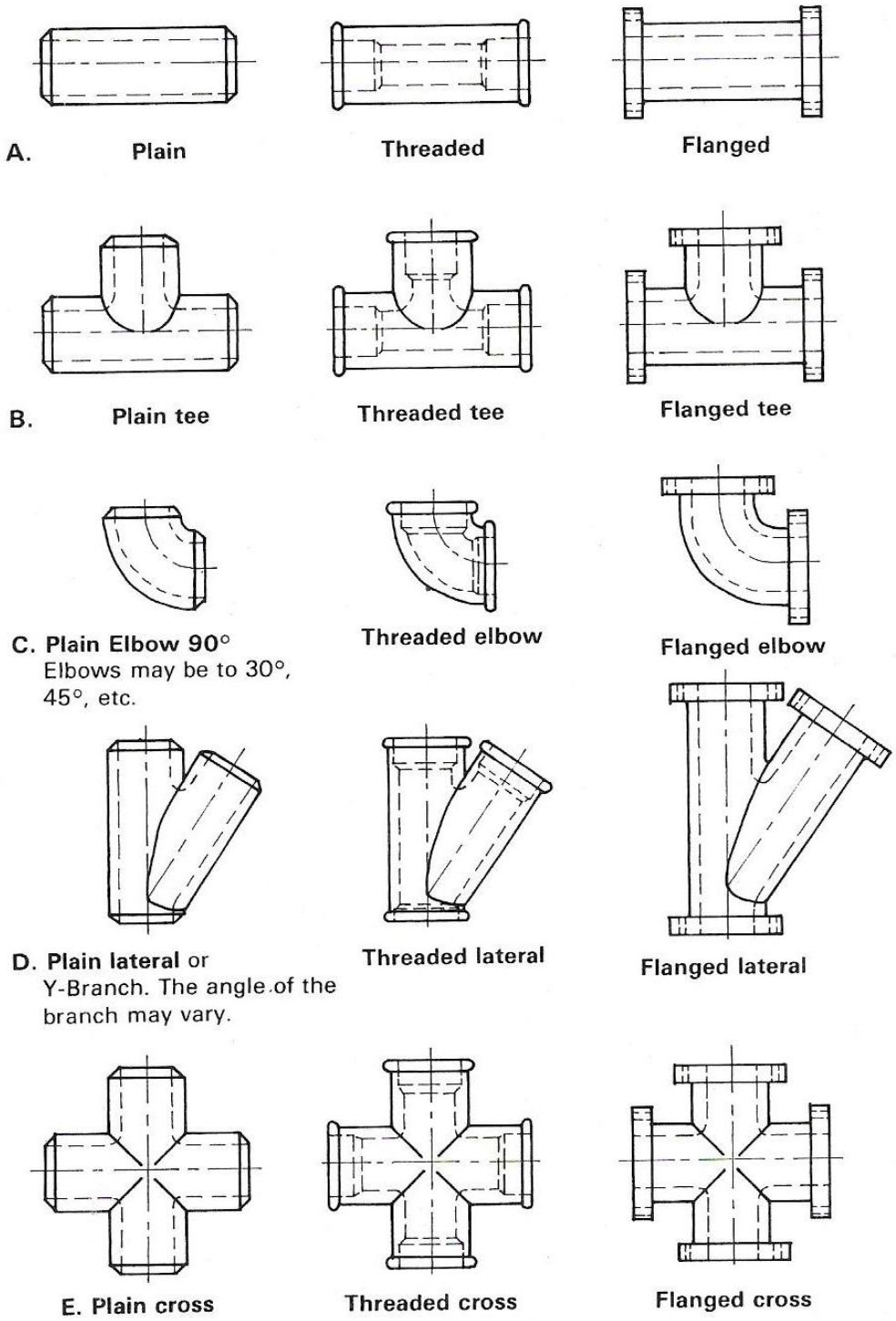
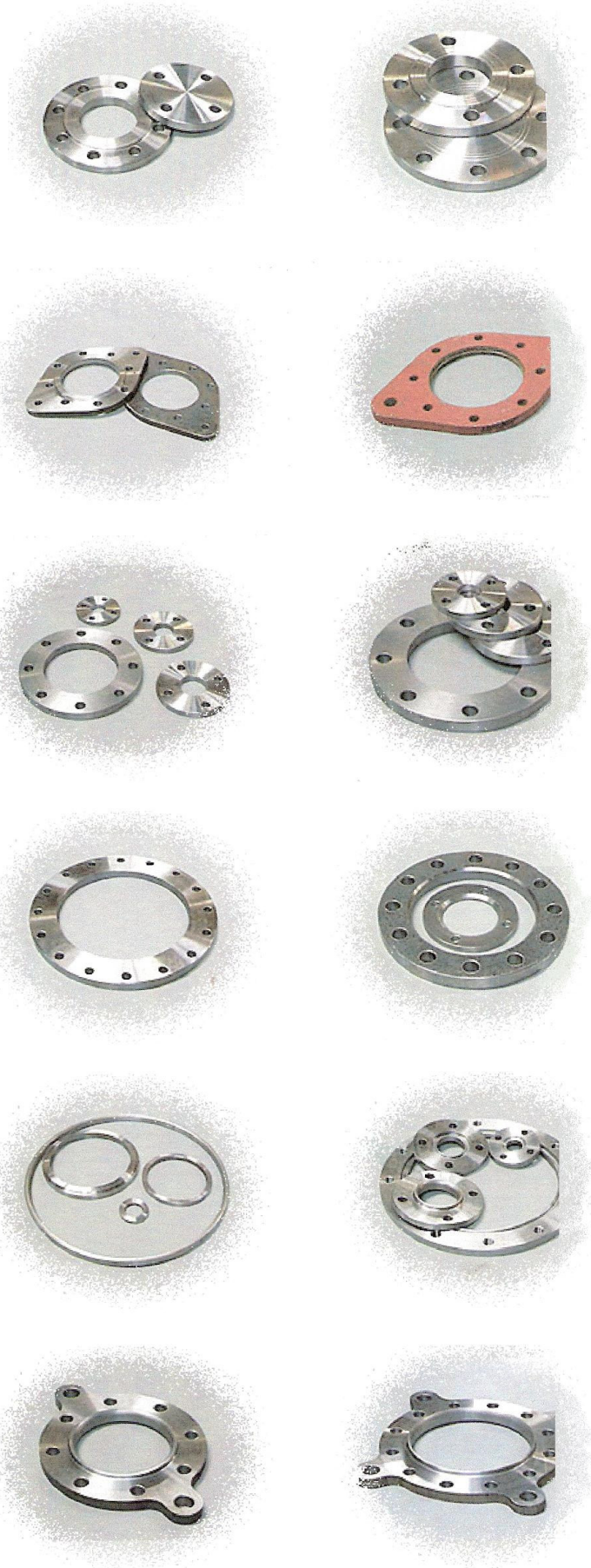


Figure 3 - Standard Pipe Fittings

Shown in plain, threaded and flanged forms.



Lever Gate Valve

Lever gate valve is intended for quick operation (QO) and two principal designs exist: (a) the sliding stem and (b) the rotary stem. The former is usually fitted with a vertical stem which slides instead of being turned by a screw as is done in the conventional gate valve. The stem, actuated by a hand lever, rapidly moves the gate or disc into or out of the flow passage.

Type (b) requires the rotation of a stem which is parallel to the line of flow of the valve. The disc is attached at right angles to the end of the stem or shaft and a quarter turn of the handle opens or closes the valve.

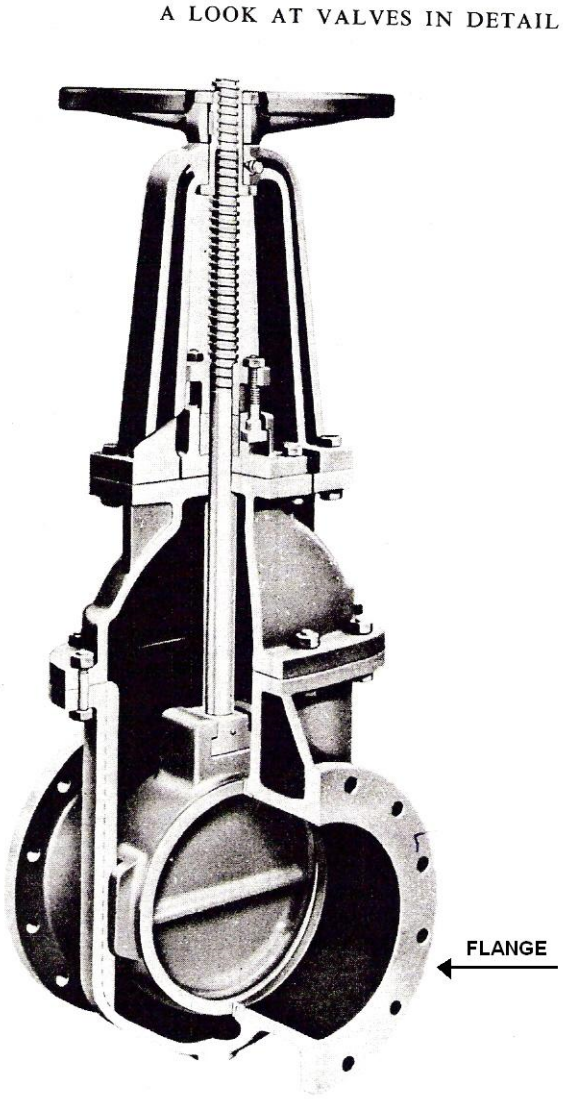


Figure 4 - Sluice Valve

Wafer Gate Valve

Wafer gate valve is a parallel slide valve of compact bubble-tight design, made in a wide range of sizes from 8inch (203mm) to 60 inch (1524mm) bore.

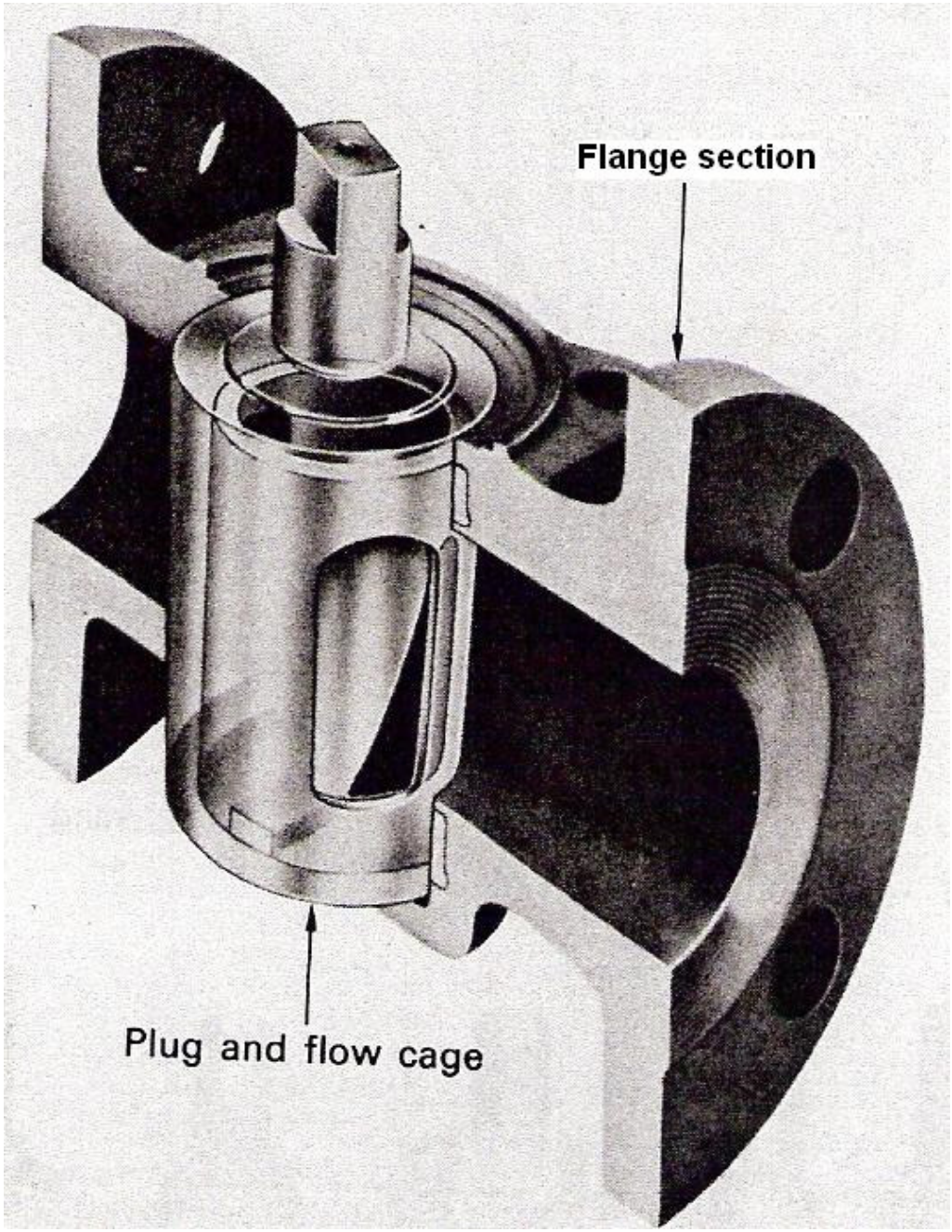


Figure 5 - Wafer Gate Valve

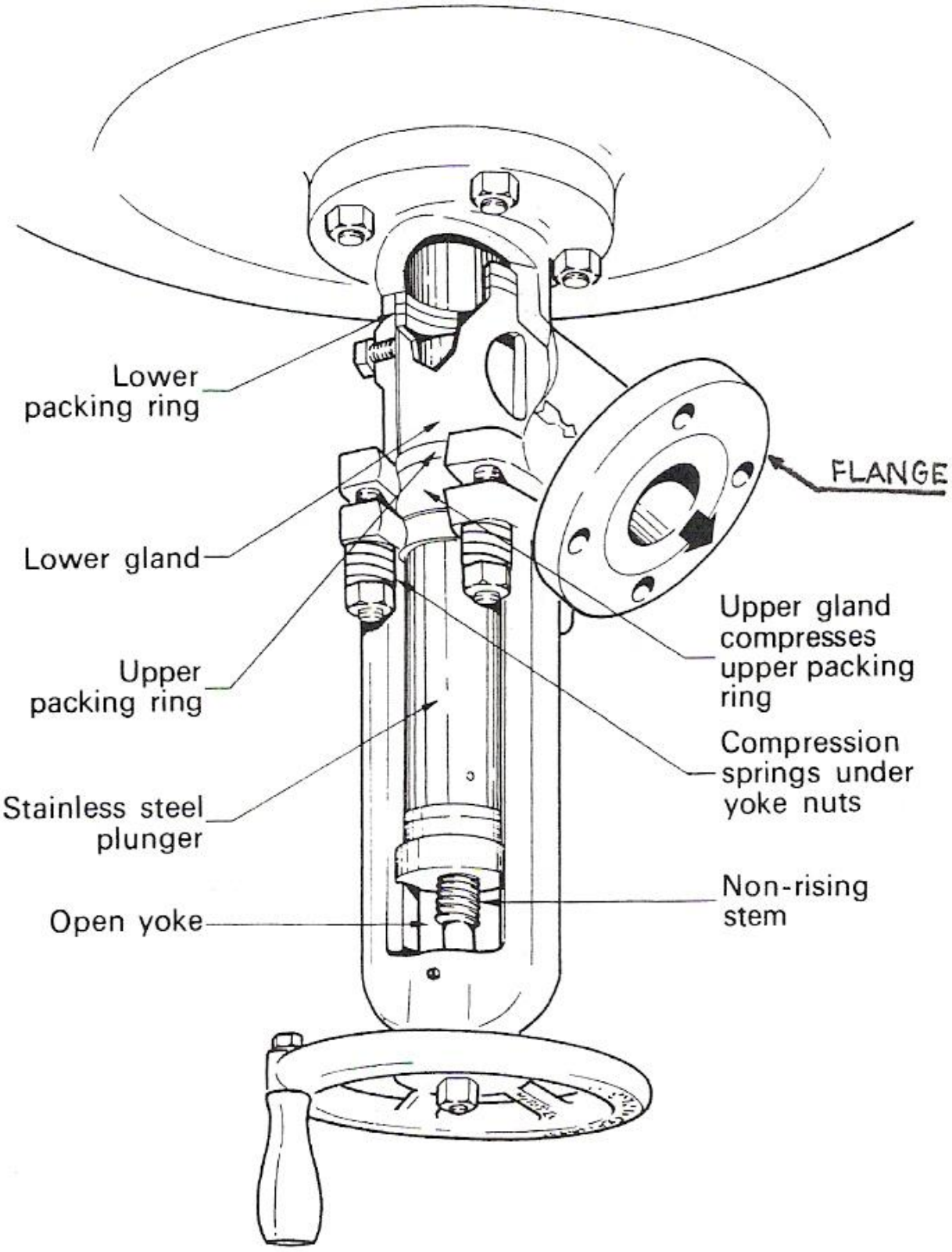


Figure 6 - Flush Bottom Outlet Valve

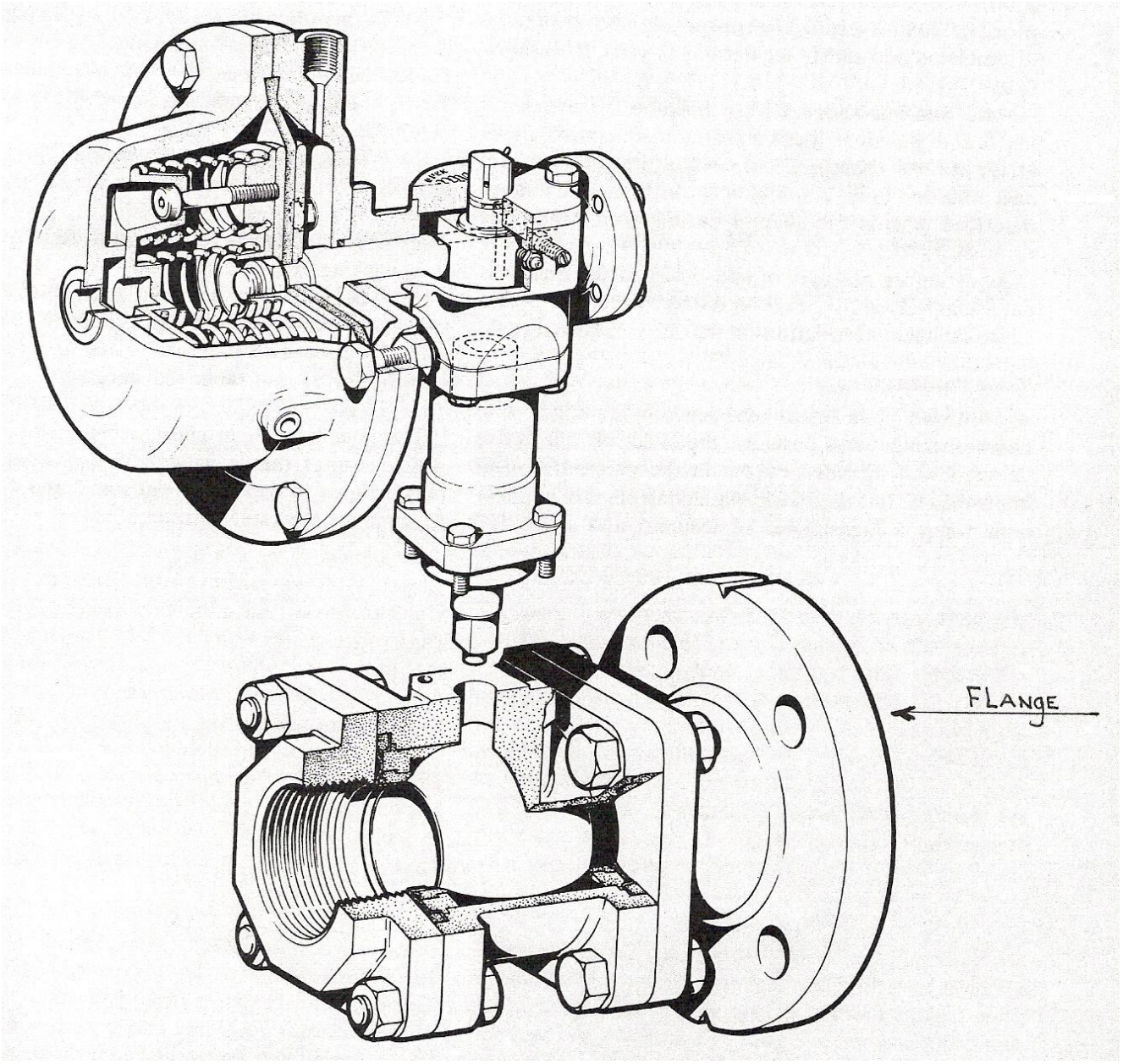


Figure 7 - Diaphragm Operated Actuator mounted on Ball Valve

Pitch Circle Diameter

The Pitch Circle Diameter (PCD) is the measured distance across the diameter of the flange illustrated in the following diagrams as the distance from point A to point B.

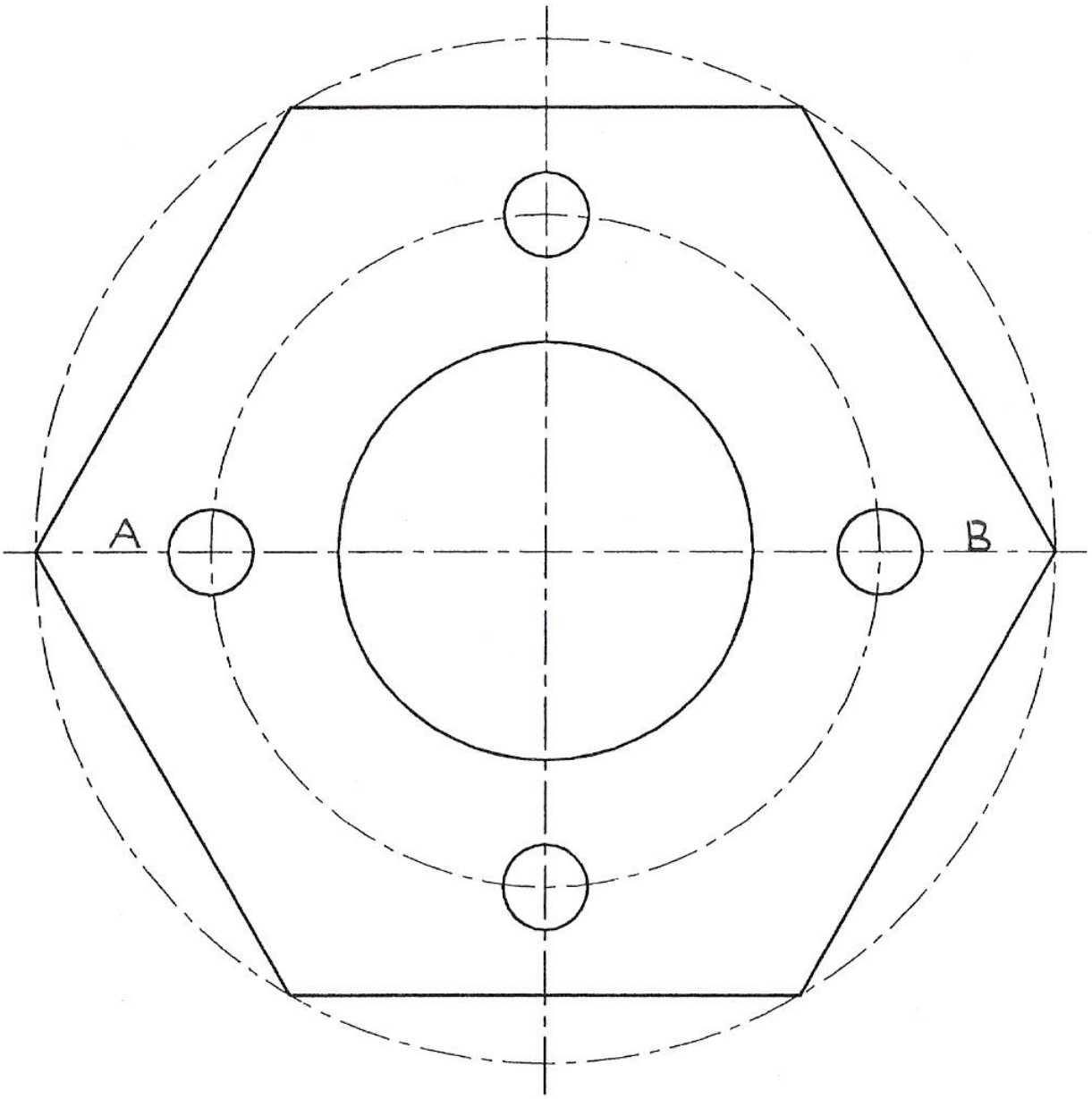


Figure 8 - Standard Conventions

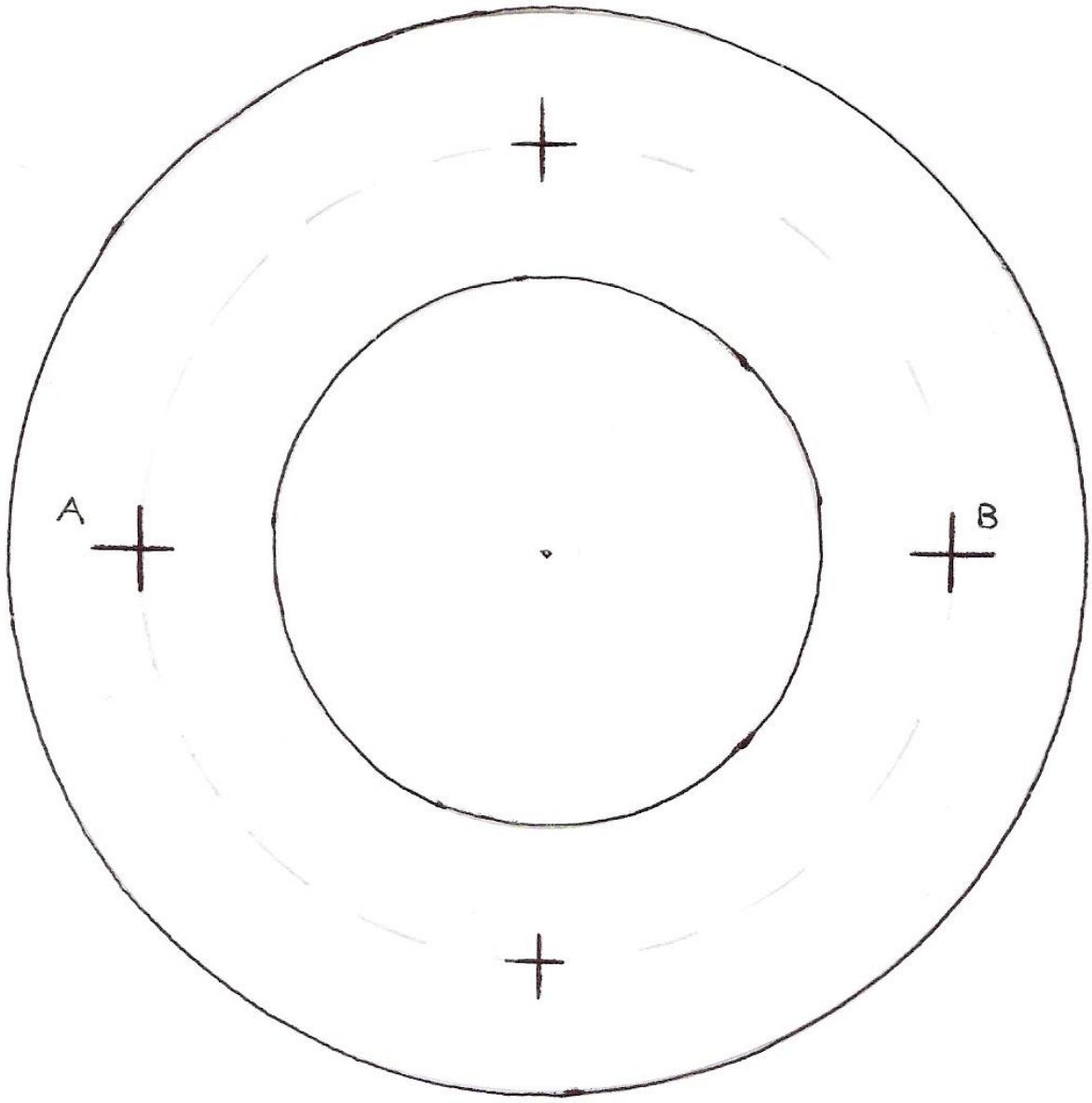


Figure 9 - Pitch Circle Diameter

Health and Safety: Protective Clothing and Equipment

The legal requirement of the new Health and Safety at Work Act 1974 has created for both employers and employees a more acute awareness of the need to take care in avoiding accidents, injury and disease. The Act states: "It shall be the duty of EVERY employee while at work to take reasonable care for the health and safety of himself and of other persons who may be affected by his acts or omissions at work" (e.g. screening of the arc, wearing goggles, grinding and chipping away from others, replacing guards, keeping gangways clear, marking hot metal, etc.).

It is the duty of the employer to ensure that adequate protective equipment is available, and that adequate guarding of machines is maintained so that they are SAFE when PROPERLY USED (mechanical and photo-electric).

The employee (you) is required by law to wear certain protective devices in designated areas, for example eye protection. In addition to protective equipment such as helmets, goggles, spectacles, visors, ear muffs (noise), gloves, fireproof aprons and spats, toetector boots, etc. there are other factors to be considered to ensure your health and safety.

Factors to be Aware of to Avoid Injury

1. Never line up holes with your fingers.

2. When using rotating machines (drills), beware of hanging hair, ties, clothing, scarves or belts getting caught.

3. Lift weights correctly with a straight back using the strength of leg and beware of sharp edges (gloves). Rings should not be worn.

4. Know where the first aid room, the nearest phone, the fire alarm and fire extinguishers are.

5. Lift gas cylinders with rope slings and do not use as rollers.

6. Be aware of electrical hazards such as bare wires, poor earth return connections, wet floors (use duck boards to stand on).

7. Do not use oxygen as a substitute for compressed air and never use as a "sweetener" in compartments where the air is stale.

8. Do not use compressed air to blow down clothes as the pressure can cause serious injury to eyes, ears and internal organs.

9. Stack plate, sheets or components tidily and not too high.

10. NEVER remove guards whilst a machine is running (it is illegal) and know where the STOP button is. Do not start a machine without guards in position.

11. Keep your work place clean and tidy and don't use defective tools.

12. Do not fool around in the workshop and always walk not run.

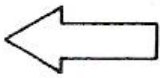
13. Know the warning signs and safety colours and watch out for them.

14. Know your crane signals.

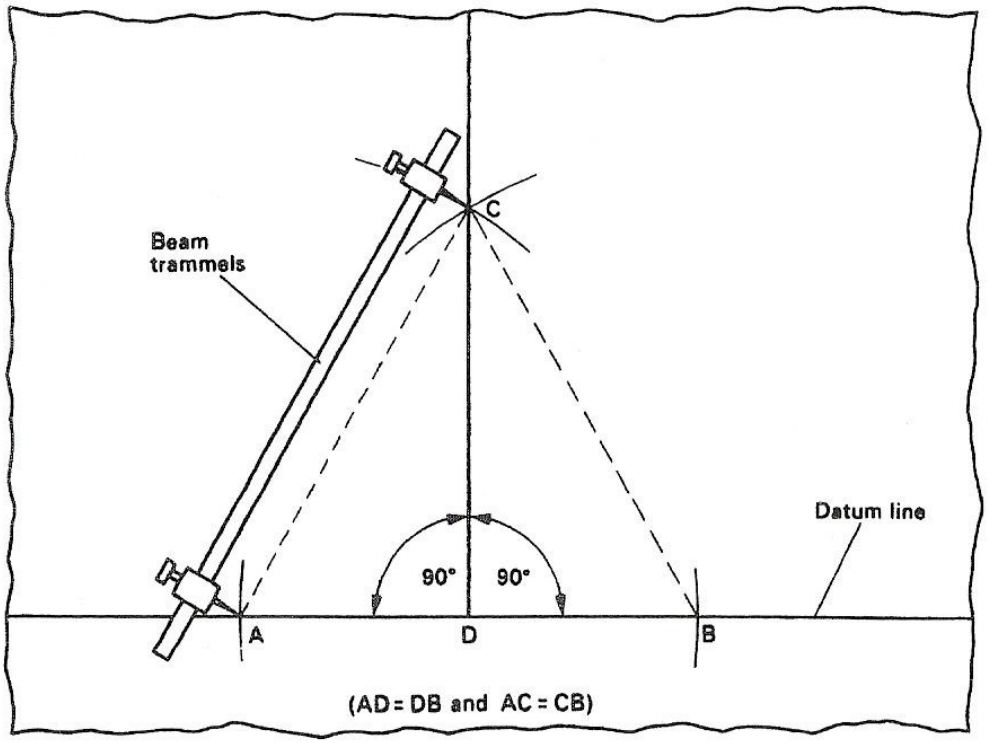
15. Use ventilation equipment to avoid dangerous concentrations of oxides of nitrogen, ozone, fumes from metals such as lead, zinc and cadmium. The following solvents also give off dangerous vapours: benzene, carbon tetrachloride, trichloroethylene and perchloroethylene (poisonous phosgene gas). Never allow the following to come in contact with the skin: lead paint, corrosive acids, paraffin or oils.

16. Learn the different types of fire extinguisher.

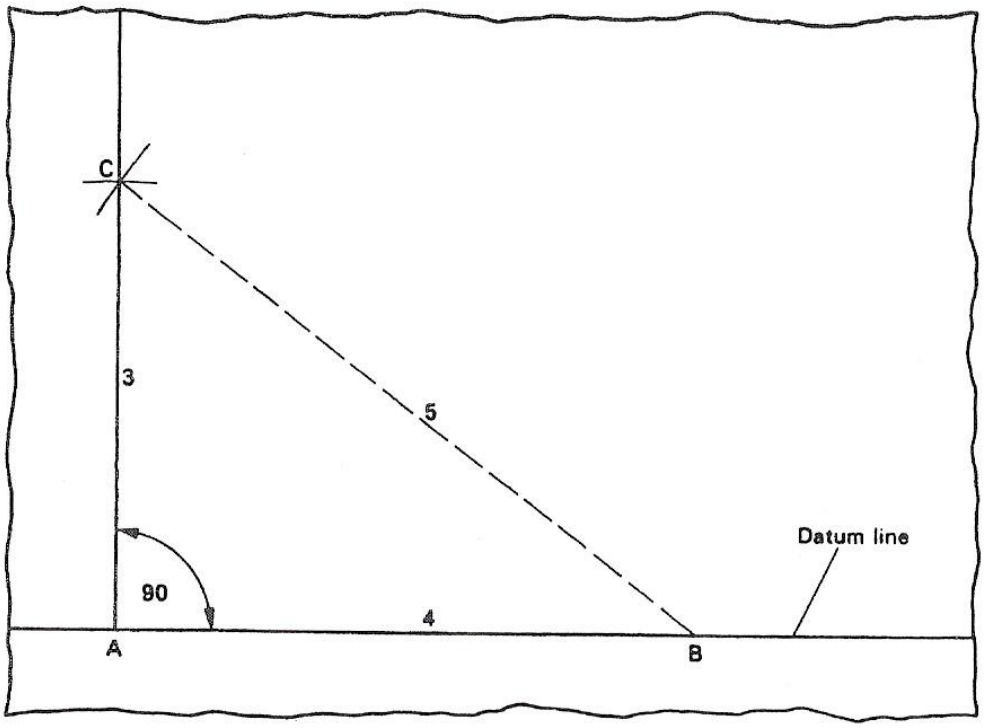
CIRCLE		An order
TRIANGLE		Caution
RECTANGLE		Safety information

Red	Obstruction
Orange-yellow	Hazard (Tiger stripes with black diagonals)
Green	Safe route 

Centre Lines



(a) **Use of trammels to construct a right angle**



(b) **Use of trammels and steel tape to construct a right angle**

Figure 10 - Applications of Beam Trammels and Steel Tape (Marking-Out)

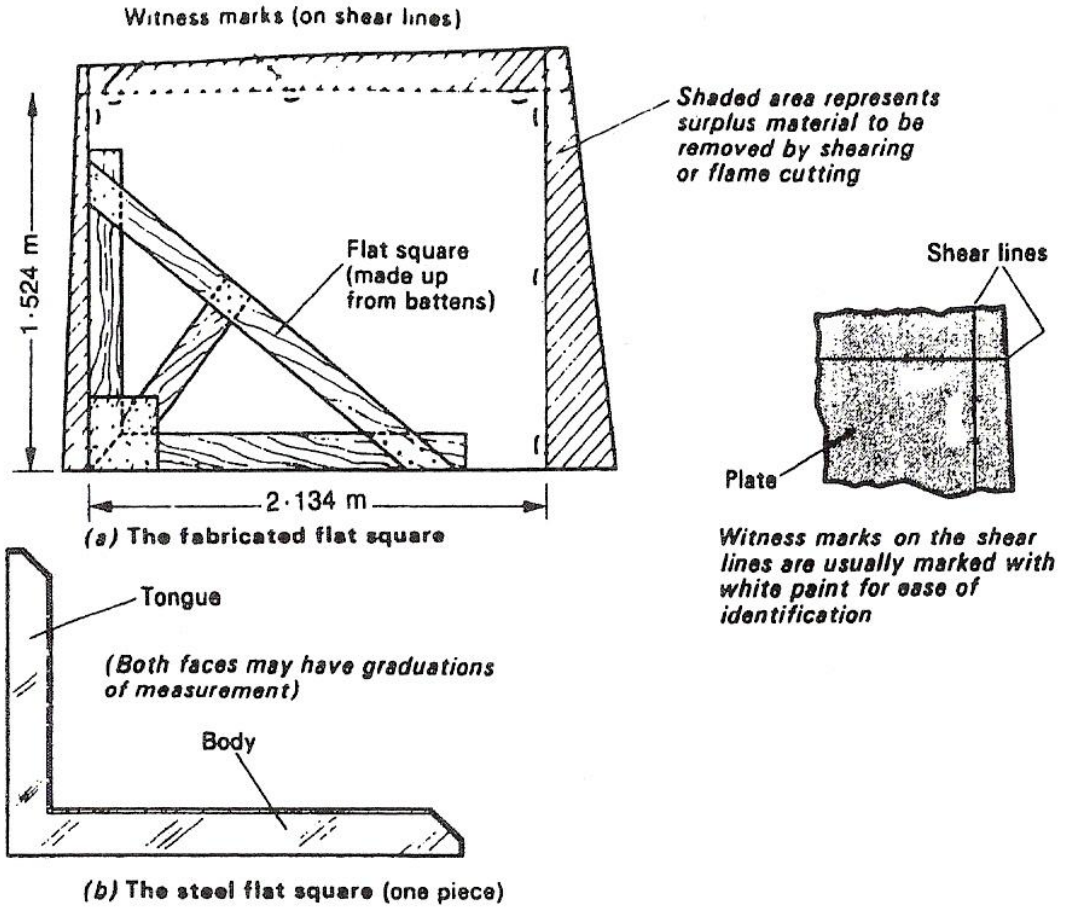


Figure 11 - The Flat Square

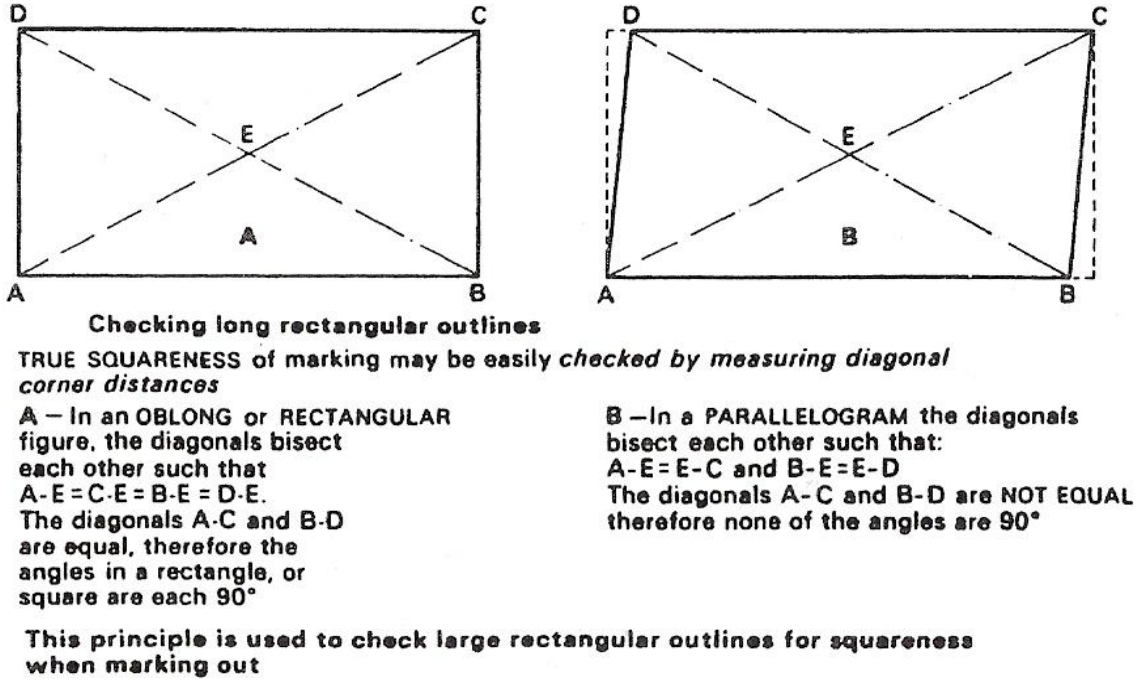


Figure 12 - Checking Large Rectangular Outlines

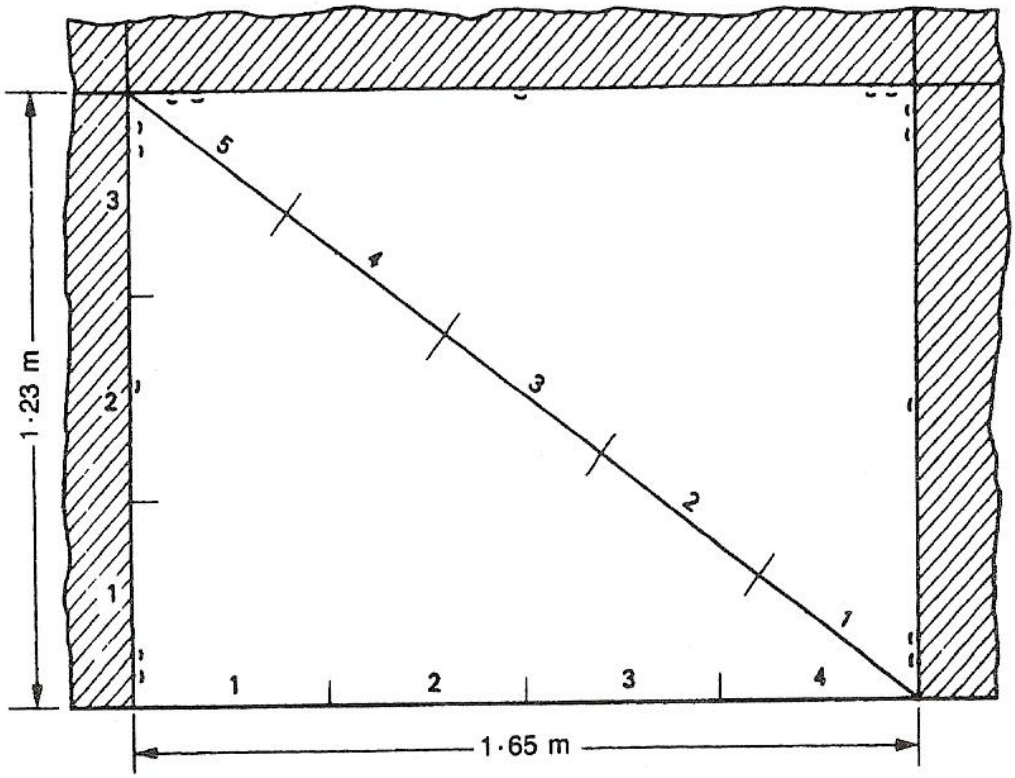


Figure 13 - Use of the Steel Tape for Marking-Off

Select one straight edge on the plate, and with the aid of a flat square and a stick of French chalk, mark a line at 900 to this datum. Extend this line using a chalkline. From these two datums the required dimensions are marked off with French chalk. A steel tape is used for measuring all dimensions. The shear lines are completed with the aid of a chalkline, and witness marks are made on them with a centre punch.

Before commencing to mark out a large plate:

1. Always check for squareness.

2. Where possible, select one straight edge and use as a base datum.

Figure 11 shows how square and steel tapes are used for marking-off steel plate for cutting. Figure 12 shows how squareness may be checked.

In this example the plate is required to be marked out 1.23 m by 1.65 m, using a steel tape only.

The method employed has been explained in Figure 11.

In this case the most suitable measurement to be used for the 3:4:5 ratio of the sides of a 90° triangle will be 410 mm, giving the following dimensions to be used for the steel tape:

1230 mm (3 x 410): 1640 mm (4 x 410): 2050 mm (5 x 410)

Once a line has been constructed at 90° to the base datum, the dimensions of the sides are measured with the steel tape, the outlines made with a chalkline and witness marked.

The outline is checked for true squareness as explained in Figure 12.

Arcs may be swung with a steel tape by holding the French chalk in the hook at the zero end of the tape.

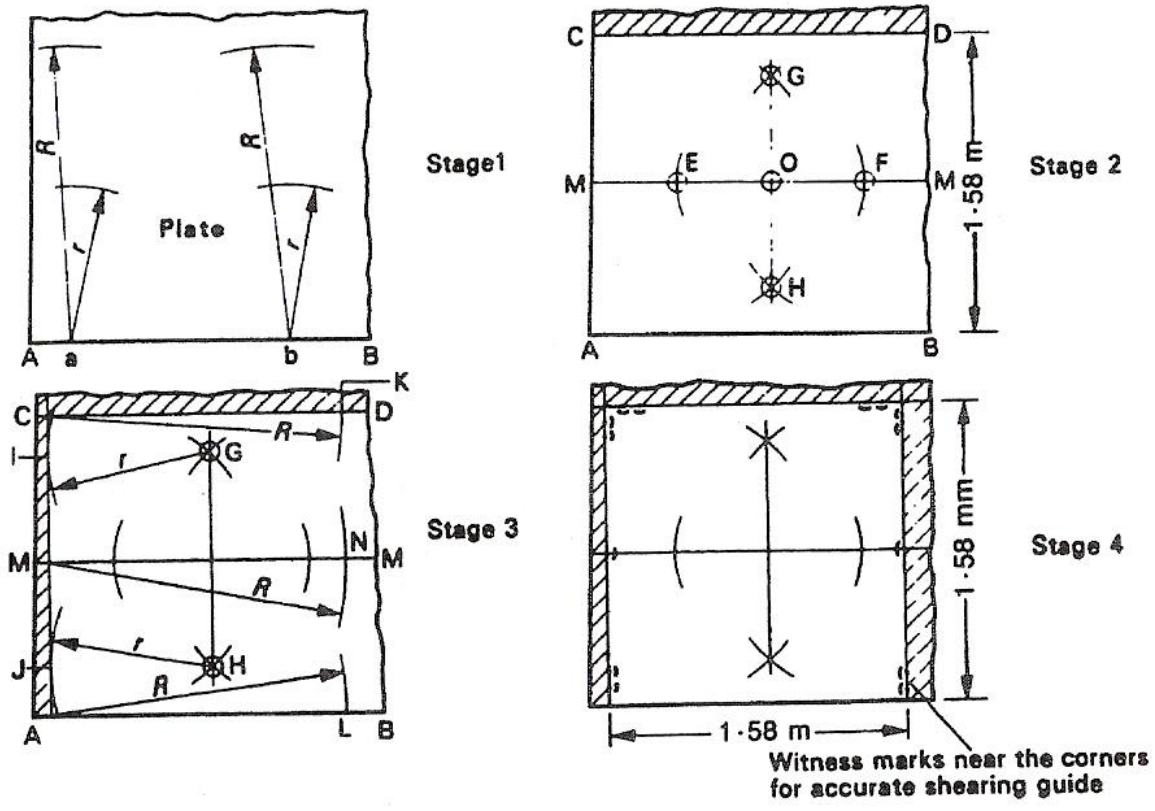


Figure 14 - Marking-Off with a Steel Tape and Trammels

Angle Frames as Stiffeners

The stiffness and rigidity of square-cornered frames may be considerably increased simply by welding, bolting or riveting diagonal members across the corners. The diagonal members also help to ensure squareness. Several of these identical units may be joined to provide very strong rigid frames. It is important from a safety point of view that diagonal members are securely fastened before lifting and erecting to prevent collapse. The two common types of welded connection are the mitre corner and the notched corner, the notched corner being more favourable as location is provided and distortion due to welding is minimised.

Sketches of these two types of corner joint are shown in Figure 15.

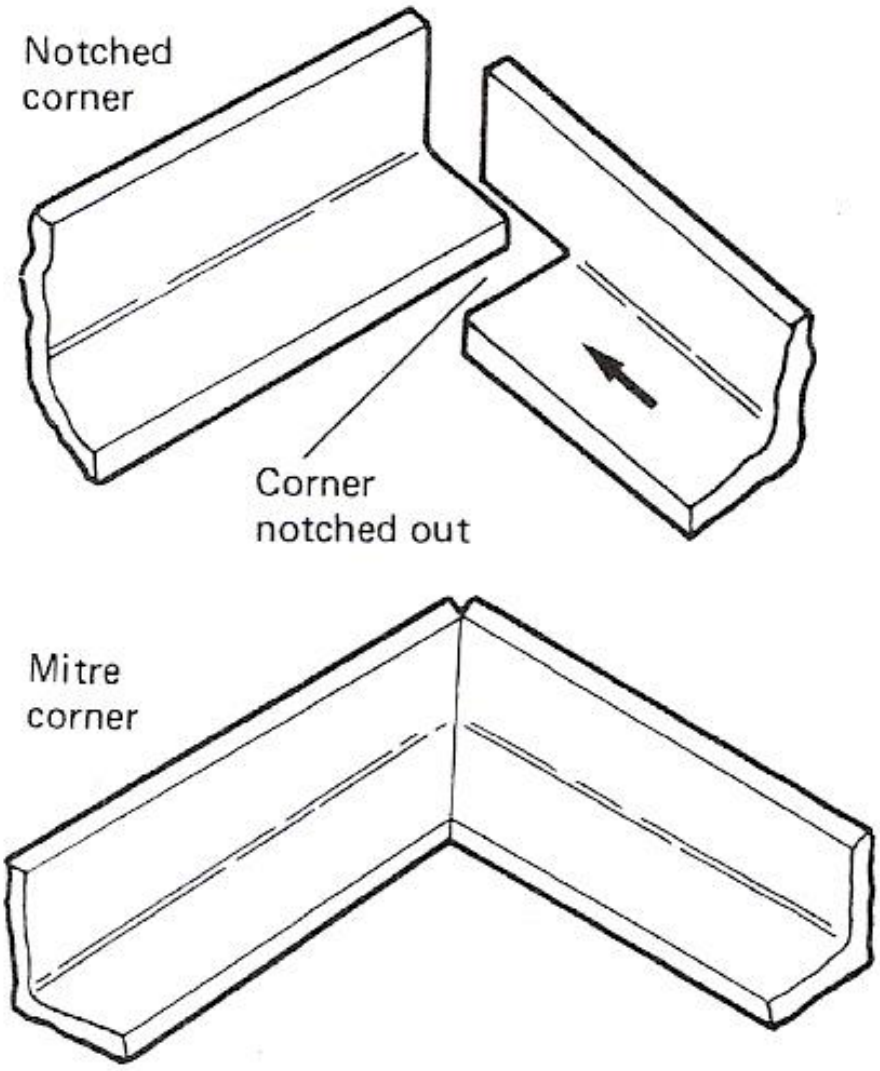


Figure 15 - Corner Joints

Appearance, Strength and Safety in Fabricated Structural Members

When structural steelwork is designed, fabricated and erected, certain important points must be considered. The three most important points are as follows (not necessarily in order of importance).

Appearance

A fabrication should always be pleasant to look at whether it is a ship, an aeroplane, a bridge or a barn. Cambers are often introduced into structural work because they are pleasant to look at as well as providing stiffness and clearance. Sharp or abrupt angles, especially on welded beam connections, are nowadays smoothed into radii where possible, which improves both appearance and fatigue life. With the introduction of welding into highly stressed fabrications, beautiful modern designs are possible, providing smooth contours, which can also attain the highest joint strength.

Appearance is largely in the hands of the designer, but the fabricator who takes a pride in his work can certainly, by good workmanship, improve the general appearance - for example, not leaving snap and hammer marks or stray arcing on plates and sections, deslagging welds, and removing buckles. Friction grip bolts should have a uniform appearance, i.e. all heads or nuts on the same side with uniform thread. Fit-up of plates is extremely important and rivets should be uniform and not burnt. Long length flanges and stiffeners, if buckled or twisted, look most unsightly and should be avoided. Excessive drifting and straining of members should always be avoided. Surface weld defects and excessive spatter not only indicate poor workmanship and appearance, but very often that the joint strength is not of the highest.

Stanchions and trusses should be aligned to prevent sagging during assembly on a previously levelled bench area or block, and marked clearly for site erection, where required. Remember, a general tolerance for fabricated steelwork is usually ± 1 mm for single dimensions, to ±2 mm for multiple dimensions.

Strength

It is said that a chain is as strong as its weakest link, and this may be said with regard to fabricated structures. The tensile strength of low carbon structural steel is 450 N/mm² and 700 N/mm² for low alloy structural steel, but it is the joint strength of the connecting members which is important. If the joint is incorrectly or badly made, either during riveting, bolting or welding, then failure may occur during service.

Butt joints and stanchion splices which transmit compressive stress should be assembled with care and accuracy to prevent unequal loading. Base gussets, angles or channels should be fixed with such accuracy that they are not reduced in thickness after machining by more than 1.6 mm. Care should be taken to ensure that the clearances specified are worked to. The erection clearance for cleated ends of members connecting steel to steel should not be greater than 1.6 mm at each end. The erection clearance at the ends of beams without web cleats should not be more than 3.8 mm at each end. If, for practical reasons, the clearance has to be increased, the seating should be suitably designed. The correct standard back marks and edge distances should be worked to unless otherwise stated.

Holes through more than one thickness, such as compound stanchions and girder flanges, should be clamped or bolted together and drilled. Punching is permitted before assembly if the holes are punched 3.2 mm less and reamed to final size after assembly. The thickness of material punched should not be more than 16 mm and all sharp burrs removed.

Care should be taken when lifting and slinging, especially with roof trusses, otherwise straining will take place and make erection extremely difficult. The sequence of erection should be correct and bracing should be safe and adequate.

Web Stiffeners

As the name implies, these are (1) for making the webs of built-up members more rigid to withstand buckling and twisting due to imposed loads and (2) to transmit the load and prevent the toes of flanges buckling upwards (Figure 17). The stiffeners may be welded (Figure 16) or bolted or riveted (Figure 17). The welding of stiffeners to a tension flange of a fabrication subject to fatigue loading is not recommended due to the lowering of fatigue life. An overhead crane and its supporting girders are typical examples of fatigue loading.

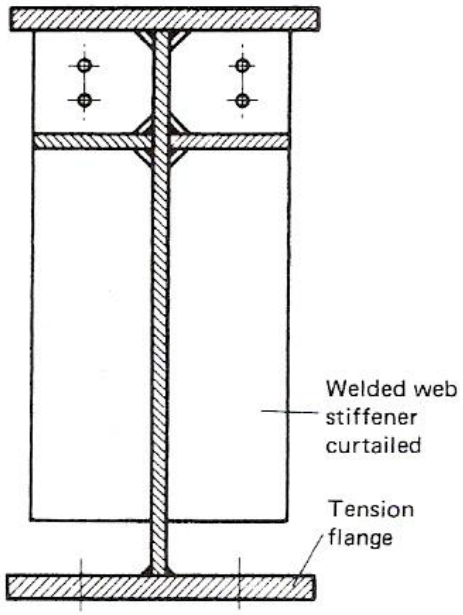


Figure 16 - Welded Fabricated Beam

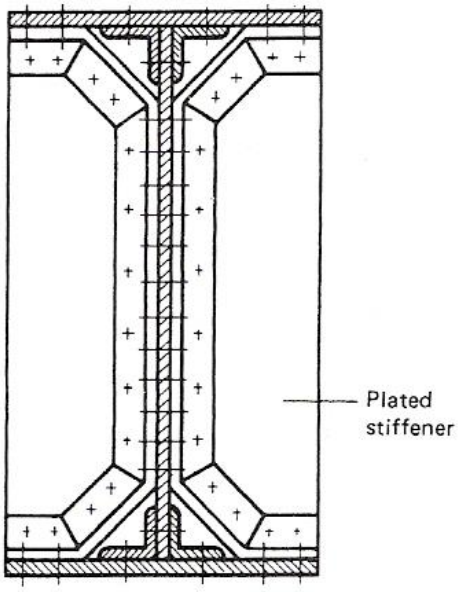
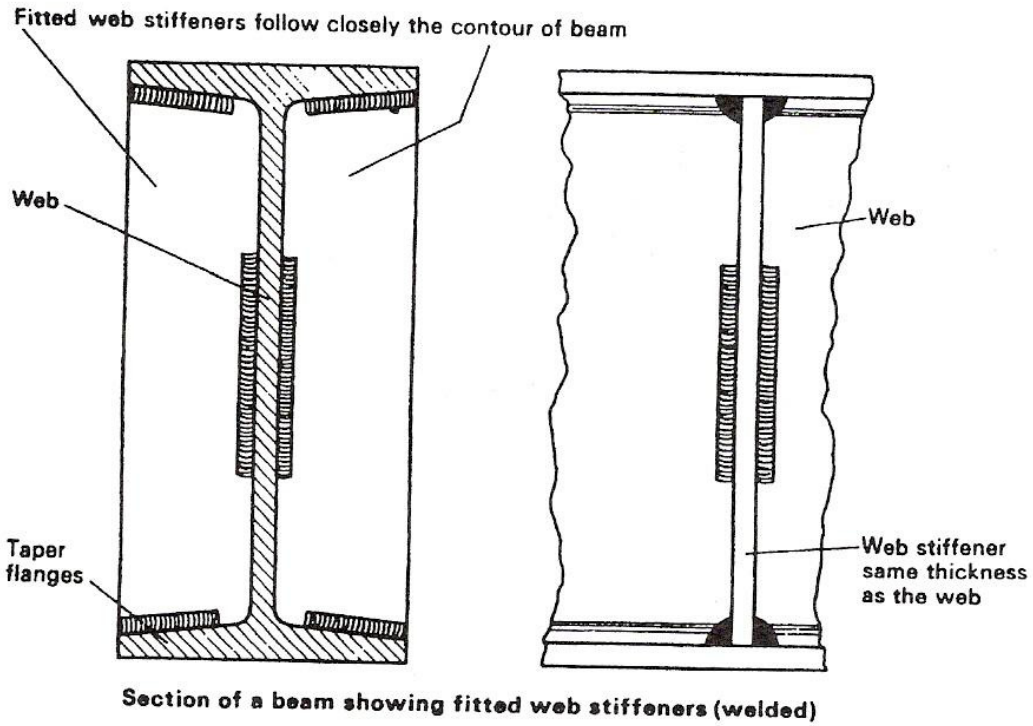
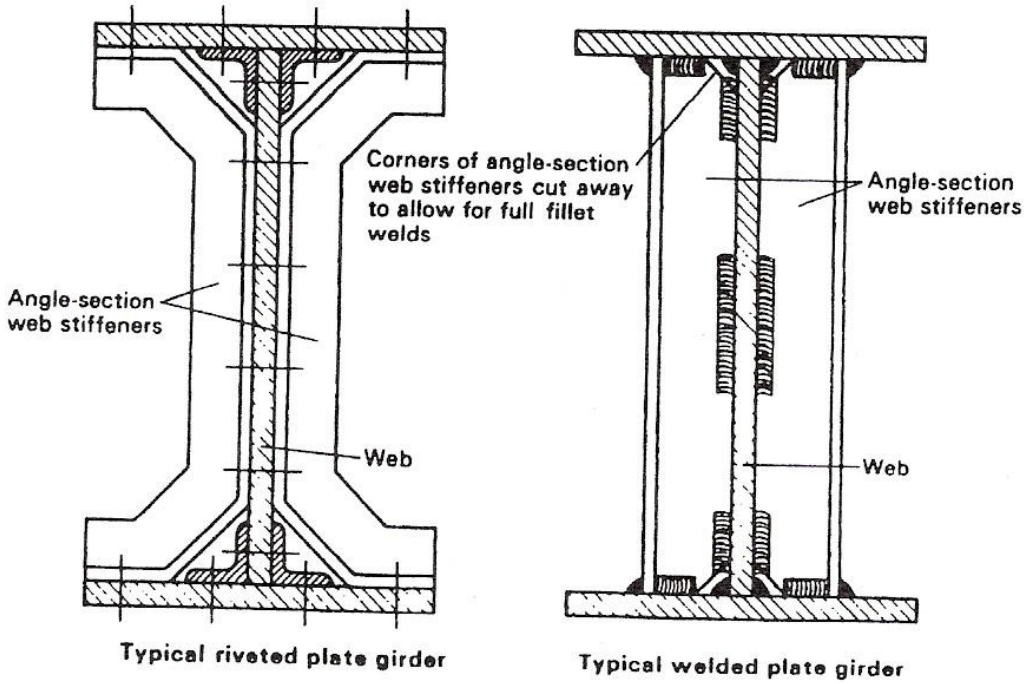


Figure 17 - Riveted or H.S.F.G. Bolted Beam



Section of a beam showing fitted web stiffeners (welded)



Typical riveted plate girder

Typical welded plate girder

Figure 18 - Web Stiffeners

Self Assessment

Questions on Background Notes – Module 3.Unit 11

No Suggested Questions and Answers.

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