BASIC WELDING WORK

LEVEL – I

Based on March, 2022, Curriculum Version 1

Module Title: - Cutting and Joining Sheet Metal

Module code: IND BWW1 07 0322

Nominal duration: 100 Hour

Prepared by: Ministry of Labour and Skill

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Addis Ababa, Ethiopia

Table content

Acknowledgment

Ministry of labor and Skills wishes to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

I Introduction to the module

In basic welding work filed; the Cut and Join Sheet Metal helps to analyze work task, to plan and prepare work, to develop patterns as required, to cut and join sheet metal, to Quality assure work

This module is designed to meet the industry requirement under the machining occupational standard, particularly for the unit of competency: Cut and Join Sheet Metal.

I. This module covers the units:

- Analyze work task
- Plan and prepare work
- Develop patterns as required
- Cut and join sheet metal
- Qualities assure work and clean up

Learning Objective of the Module

- Analyze work task
- Plan and prepare work
- Develop patterns as required
- Cut and join sheet metal
- Clean up quality assure work

Module Instruction

For effectively use these modules trainee are expected to follow the following module instruction:

Read the information written in each unit

Accomplish the Self-checks at the end of each unit

Perform Operation Sheets which were provided at the end of units

Do the “LAP test” giver at the end of each unit and

Read the identified reference book for Examples and exercise

Unit One: Analyze Work Task

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- OHS requirements
- Task requirements.
- Quality assurance.

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Use OHS requirement
- Analyze tasks
- Apply Quality assurance

1.1. OHS requirements

1.1.1. OHS in cutting and joining sheet metal

Occupational Health and Safety require workers to assess, eliminate and control risks associated with plant. The Occupational Health and Safety require employers to assess employee and staff exposure to accident and to take measures to control that accident to minimize any risk to health and safety

Many injuries in the sheet metal fabrication industry a result of carelessness. Severe injuries can occur due to improper handling of tool or machines or other reasons. These injuries can be easily controlled by adopting various safety measures. To get the desired output, and for safe operation, you are required to follow some basic safety norms while using a sheet bending machine. Here are some of the major ones:

Proper Use of Tools

Every student should be skilled the proper use of a sheet metal fabrication tool. This is because improper use of these tools may lead to severe injuries. Also, trainees must be instructed to avoid wearing accessories or clothing that may get caught in the machine. All necessary guards and safety features of the equipment should be used, while working with them.

Hold the Sheet Parallel to the Bender

Placement of the sheet is very important. For a safe operation, you should always hold the sheet at a proper angle. Before you start the bending process, always ensure that the sheet is parallel to the bender. The wrong placement may cause the sheet to hit your body, and cause injury.

Mind your Hands

You should be careful while operating the bender. When you place the sheet on the bender, you should ensure that your hands are away from getting hurt. Lack of attention can lead to severe accidents, or even permanent injuries.

Safety precautions

Sheet metal work causes damage / accident. Sheet metal and plate metal worker should follow safety precautions required in terms of personal safety, work shop safety, and tools and equipment safety

Some of the safety precautions applicable to sheet metal tools and equipment have been mentioned throughout this module. Here are a few additional precautions that should be carefully observed when you are working with sheet metal.

Sheet metal can cause serious cuts. Handle it with care.

Wear steel-reinforced gloves whenever feasible.

- Treat every cut immediately, no matter how minor.
- Remove all burrs from the metal sheet before attempting to work on it further.
- Use a brush to clean the work area. NEVER brush metal with your hands.
- Use tools that are sharp.
- Keep your hands clear squaring shear
- A serious and painful foot injury will result if your foot is under the foot pedal of the squaring shears when a cut is made.
- Do not run your hands over the surface of sheet metal that has just been cut or drilled. Painful cuts can be received from the burrs.

- Get help when large pieces of sheet metal are being cut. Keep your helper well clear of the shears when you are making the cut.
- Keep your hands and fingers clear of the rotating parts on forming machines.
- Place scraps pieces of sheet metal in the scrap box.
- Always remember to keep a clean shop. Good housekeeping is the key to a safe shop.
- Do not use tools that are not in proper working condition: hammer heads loose on the handle, chisels with mushroomed heads, power tools with guards removed, and so forth.

1.2. Task requirements

Sheet metal is one of the fundamental forms used in metalworking and it can be cut and bent in to a variety of shapes. Many objects are fabricated from sheet metal. The larger the gauge number, the thinner the metal. The thickness of sheet metal is not above 3.5mm a metal thickness above 3.5mm is called a plate not sheet metal. Thicknesses can vary significantly; the extremely thin thicknesses are considered foil or leaf.

Cutting and forming operations performed on relatively thin sheets of metal

Thickness of sheet metal = 0.4 mm to 3.5 mm

Thickness of plate stock > 3.5 mm

Operations usually performed as cold working

A sheet metal worker is a skilled tradesman who creates, installs, and repairs sheet metal products. Most commonly these products include elements of heating, cooling, and ventilation systems, although sheet metal workers also fabricate and repair products for drainage and roofing applications etc.

Sheet metal workers typically do the following tasks:

Studying blueprints, drawings and specifications to determine job, material and equipment requirements

Select types of sheet metal, such as stainless steel, galvanized iron, mild steel, aluminum and copper, and checking sizes, gauges and other dimensions of metal stock against specifications

Measure and mark dimensions and reference lines on metal sheets by using templates, gauges and other measuring instruments.

Drill holes in metal for screws, bolts, and rivets, along guidelines using hand and power shears, guillotines and drills.

Shaping and forming cut metal stock into products using folding and bending machines, rollers, presses and hammers.

Fasten and assembling seams or joints by welding, bolting, riveting, soldering, brazing and otherwise into final products.

Finishing products by polishing, filing, sanding and cleaning assembled products

1.3. Quality assurance.

1.3.1. Definition of quality

Quality is the acceptable slandered. Once standard has been selected, a method is chosen for ensuring that the product meet the specification. Check the quality without affecting the product. A good product properly developed may lead to saving of time and money.

1.2.2. Quality assurance

Quality Assurance is defined as all the planned and systematic implemented within the quality system that can be demonstrated to provide confidence that a product or service will full-fill requirements for quality.

The Quality Assurance worker is charged with the responsibility for acquiring and analyzing data using appropriate statistical methods to facilitate process analysis and improvement. The Quality Assurance worker will develop standardized inspection methods for like process groups that will ensure critical characteristics are clarified and captured for statistical analysis.

Quality of Sheet Metal Working

A metal plate of thickness less than 4 mm is considered as sheet. The size of the sheet is specified by its length, width and thickness in mm. In British system, the thickness of sheet is specified by a number called Standard Wire Gauge (SWG). The commonly used gauge numbers and the equivalent thickness in mm are given below.

Table :-1.1 Standard Wire Gauge (SWG) and Thickness (mm)

SWG (No.)	16	17	18	19	20	22	24	27	30
Thickness (mm)	1.62	1.42	1.22	1.02	0.91	0.71	0.56	0.42	0.37

One of the most important decisions when working with sheet metal is deciding what thickness you will need. Sheet metal thickness is measured in gauges, with a higher number indicating a thinner sheet. To measure the thickness, you can use a sheet metal gauge, which will show you thickness in both gauge number. One important note is that ferrous and non-ferrous sheet metals of the same gauge have different thicknesses, so you'll need one gauge for ferrous metals, and one for non-ferrous.

Commonly used steel sheet metal ranges from 36 gauges to about 0 gauges. Gauge differs between ferrous (iron based) metals and a nonferrous metal such as aluminum or copper; copper thickness, for example are measured in ounces (and represents the thickness of 1 ounce of copper rolled out to an area of 1 square foot). In the rest of the world the sheet metal thickness is given in millimeters. Do not attempt to cut metal heavier than the designed capacity of the shears.

The maximum capacity of the machine is stamped on the manufacturer's specification plate on the front of the shears. Check the gauge of the metal against this size with a sheet metal gauge. This figure below shows the gauge used to measure the thickness of metal sheets. The gauge is a disc-shaped piece of metal, having slots of widths that correspond to the U.S. gauge numbers from 0 to 36 each gauge number is marked on the front and the corresponding decimal equivalent is marked on the back.

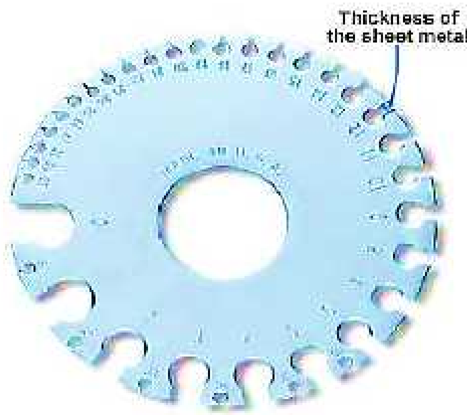


Fig.1.1. Sheet metal gauge.

Self-check-1

Part I: - <u>say True or False Answer all the questions listed below</u>

1. Drawing has dimension that show the shape of the object to be produced.
2. Larger the gauge number, shows the thinner the sheet metal.
3. Many injuries in the sheet metal fabrication industry a result of carelessness.
4. When you are working with sheet metal don't wear goggles when in the shop

Part II: - **<u>choose the best answers</u>**

5. To make a product of desired shape and size has to consider _______
   A. Interpret work as needed
   B. Make layout on sheet metals
   C. Read the dimension accurately
6. The extremely thin thicknesses are considered ________or __________.
   A. Sheet metal B. Foil or leaf C. Plates
7. The quality requirement for sheet metal work should depend on:
   A. The thickness B. Accuracy of measurement C. the accuracy of cutting
   D. Types of joints and the types of materials of sheet E. All are answer

8. ____requires workers to assess, eliminate and control risks associated with in work area/plant.

   A. PPE B.OHS C. Measuring tools D. Using tools and equipment

Operation Sheet 1

Operation title: **-** Methods of selecting PPE, Tools and Equipment

Purpose: - to protects from hazards during Cutting and Joining Sheet Metal

Instruction: Using the correct procedures of Cutting and Joining Sheet Metal accord to design

Steps1- Read the PPE user instructions carefully before every use, and seek assistance if needed or to ensure that the PPE meets the specifications

Step 2- If in doubt about what PPE to use, call the your teacher/instructor

Step 3- check labels, PPE instructions, and safety equipment catalogs detailed information.

Step 4- Make Sure PPE is Working Properly

Step 4- select the PPE required by the label

Step 4- Before and after every use, check for any type of deterioration of or damage to all the components, seams, etc.

LAP Test 1	Practical Demonstration

Name: _______________________________ Date: ________________

Time started: _________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2:00-2:50 hours.

Task 1: Select PPE, Tools and Equipment use for sheet metal work

Unit Two: Plan and Prepare Work

This unit to provide you the necessary information regarding the following content coverage and topics:

- Plan and tasks sequence.
- Tools, equipment and materials,
- Preparing work area.
- Sealants, fixing and sheet metal materials for compatibility

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Plan and sequence tasks.
- Select tools, equipment and materials,
- Prepare work area.
- Check Sealants, fixing and sheet metal materials

2.1. Plan and tasks sequence

2.1.1. Planning tasks

Planning means a set of preparation is to do in order to achieve something or any kind of task/work. Preparation means **programs drawings,** Materials requirement and their sources, time schedule, cost estimate, scheme and design and method of preparation etc.
It is a management function of defining goal of an individual / organizations.

It determines the task/work and resources necessary to achieve set goals.

It helps to save materials, labor, time, money efforts and process etc. so that any kind of work/task can be performed successfully without having any difficulty with full confidence.

Job planning is important prior to starting any task. The drawing should first be studied and understood. The drawing can initially be used to calculate the material requirement for the component to be manufactured. The work piece is marked out using the dimensions and datums as specified on the drawing. A basic level of mathematics is required such as addition, subtraction, multiplication, division, fractions, decimals and percentages.

One of the first steps in preparing to layout a pattern on metal is to square the bottom left-hand side of the piece of material. A steel square may be used for this purpose, or a sheet maybe squared using the squaring arm on the guillotine. The next step is to ensure that the sheet lies perfectly flat on the bench as a sheet that is not flat will cause measurements to be inaccurate.

Sheet metal articles are made of flat pieces of metal cut according to outlines that are drawn or traced on the sheets of metal. To obtain the current size and shapes, patterns are used. These patterns may be drawn on paper first, and then transferred to the metal, or they may be laid out directly on the metal.
Template or master pattern - that is used repeatedly and is made of metal.
Stretch-out – the distance across the flat pattern or flat piece of metal before it is formed into shape. The illustration in Figure 2.1. Shows the stretch-outs for square and cylindrical jobs.

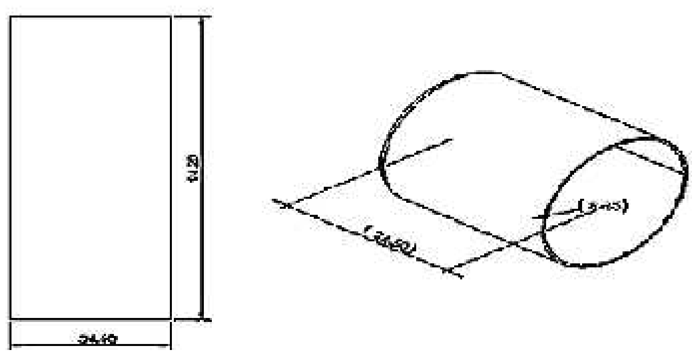


Fig.2.1. strech out for cylider

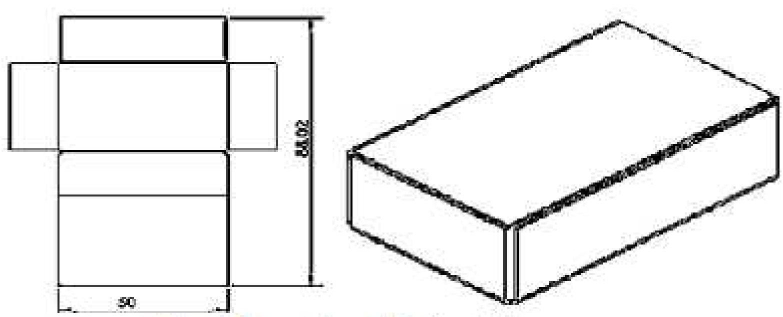


Fig.2.2. strech out for box/ cube

Pictorial drawings – show the object as it actually appears after formed into shaped. This is illustrated in Figure 2.3. Such a drawing cannot serve as means of giving accurate information for the fabrication of the project because the true shape and size of the object is not shown

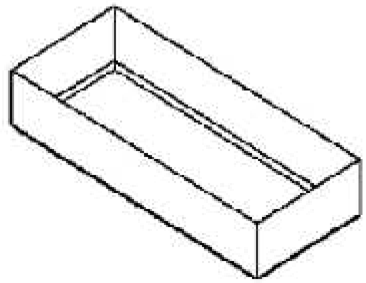


Fig 2.3. Pictorial drawing show the type of objects as they aper after formig

2.1.2. Tasks sequence

Sheet metal workers first study plans and specifications to determine the kind and quantity of materials they will need. Then measure, cut, bend, shape, and fasten pieces of sheet metal to make ductwork, counter tops and other custom products. In an increasing number of shops, sheet metal workers use computerized metalworking equipment.
They cut or form parts with computer-controlled saws, lasers, shears, presses, and plasma cutters. In shops without computerized equipment, and for products that cannot be made on such equipment, sheet metal workers use hand calculators to make the required calculations and use tapes, rulers, and other measuring devices for layout work. They then cut or stamp the parts on machine tools.
Before starting to any operation, you must plan the sequence of your tasks. While you are planning you have to set the sequences of operation to be performed that are listed in the plane. During planning you have to consider factors that affect your working procedure.
Plans, drawings and specifications are obtained from supervisor for planned work activity.
Tasks are planned and sequenced in conjunction with others involved in or affected by the work.
Sheet metal is marked out according to plans and specifications.

Work area is prepared to support efficient cutting and joining of sheet metal.

Selected sheet metal is checked for compliance with plans and specifications

Surface is prepared and cleaned of grease and other contaminants.

Laps are measured and shaped for joining using appropriate tools and equipment according to plans and specifications.

Work area is cleared and materials disposed of, reused or recycled according to legislation, regulations, and codes of practice and job specification.

Information is accessed and documentation completed according to workplace requirements.

Make a list of all of the tasks that you need to complete, and break everything down into single activities.

2.2. Tools, equipment and materials

2.2.1. Sheet metal tools and equipment

Sheet metal hand tools are used to scribe or measure lines, perform layout operations and shape or cut metals. Some of the hand tools in the following notes actually perform these operations while others, such as stakes and punches, serve as aids in performing them.

2.2.2. Layout tool and measuring Tools

Layout tools are used for drawing fabrication jobs on metal. Some of the more common layout tools are scriber, flat steel square, combination square, protractor, prick punch, dividers, trammel points, and circumference ruler.

A. Scratch awls (also called scribers)

This is used to mark lines on metal. It can be used in conjunction with a straight edge and square. There are three types Scratch awls perform the same function of marking lines on metals. Lines are marked on metal for a variety of purposes in laying out patterns.

Ring Scratch Awl: - the ring scratch awl is made of one solid piece of steel approximately eight inches long with a tapered point on one end and a ring on the other.

Socket Scratch Awl: - the socket scratch awl ha a steel blade approximately five inches long and is made with a replaceable wooden handle.

Shank Type Scratch Awl: - for general purposes, this shank type of scratch awl is preferred by most sheet metal mechanics since the steel blade passes through the handle, reinforcing the top.

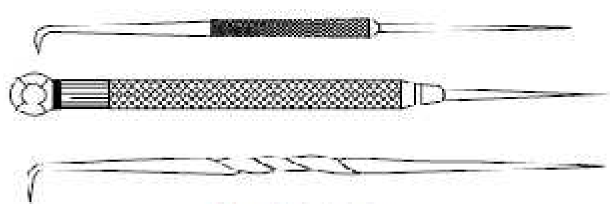


Fig. 2.4. Scriber

B. Steel Rule

Steel rules are manufactured in a variety of types and lengths; each of which is designed for measuring or laying out different work. Available in lengths from 100mm to 1000mm.

These are made up of stainless steel and are available in many sizes ranging from 1/2 ft. to 2 ft. These are marked in inches or millimeters. All the faces are machined true. The edges of steel rule should be protected from rough handling**.**

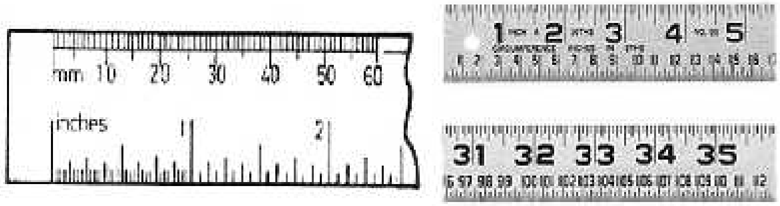


Fig.2.5: Steel Rules

C. Straight Edge

The Straight Edge is used as a guide for a scriber or pencil when marking or drawing a straight between two points. It is also used in conjunction with square to draw lines at right angles.

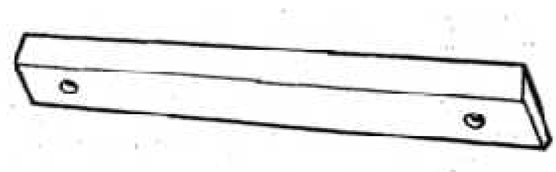


Fig.2.6. Straight edge

D. Dividers

This is made with each straight leg tapered to a needle point. Dividers are manufactured in various sizes and types and are used to space off equal distances, to divide lines into equal parts and to scribe arcs and circles. Spring loaded screw dividers are also available. Supplied in lengths from 150mm to 500mm. Spring dividers are also available in sizes from 75mm to 300mm.

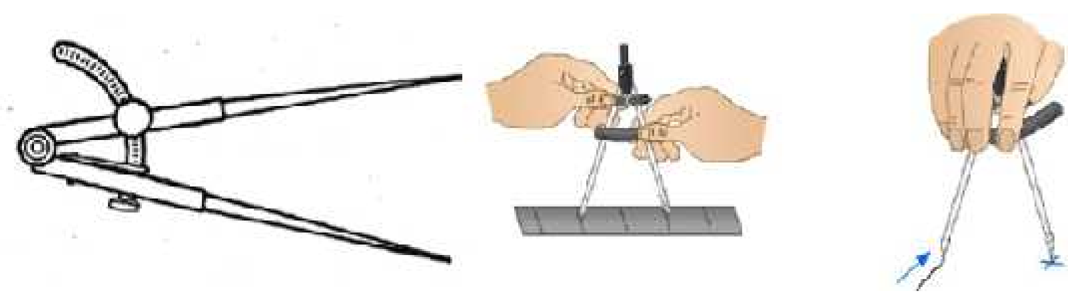


Fig.2.7. Divider and method of uses

E. Steel Square

The flat Steel Square is used to layout right angles (90°) and can also be used as a scale. It is an invaluable tool for accurate layout work in pattern drafting since all layouts must start from a square corner. The long arm is known as the body or blade, the short arm is known as the heel or tongue. These squares come in various sizes.

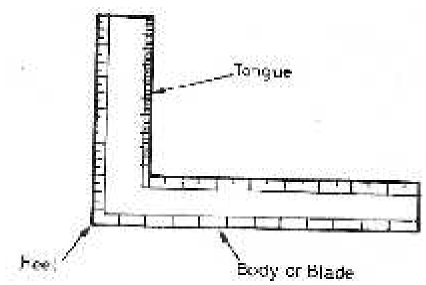


Fig.2.8. Steel square

F. Steel Try Square

It is used for marking and checking right angles (90°). These squares come in various sizes from 75mm to 300mm. Both the try square and engineers square are used to mark lines at 90° to an edge. A try square is used on timber and an engineer's square is used on metals. Both can be used for marking out plastics.

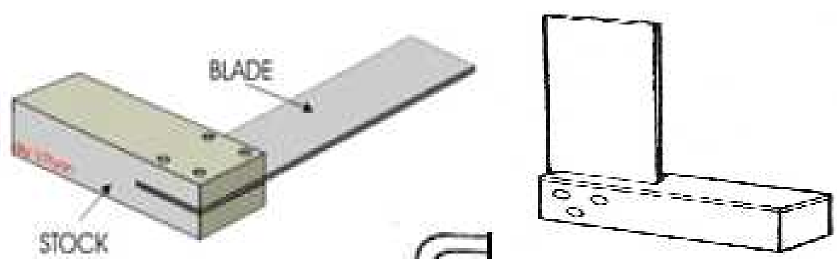


Fig.2.9. Steel Try Square

G. Combination Square

This is one of the most useful and convenient tools for laying out small work. It is used as a square for measuring or laying out 90° or 45° angles. A spirit level is mounted in the stock. It is available in 300mm lengths.

The combination set (Figure 2.2.9.) is an important tool in the workshop, because you can use it as a center square, a try square, a protractor for marking out, measuring and testing. There are three heads (protractor, square and center), which slide onto a rule, which can be fixed at any position using the nut provided.

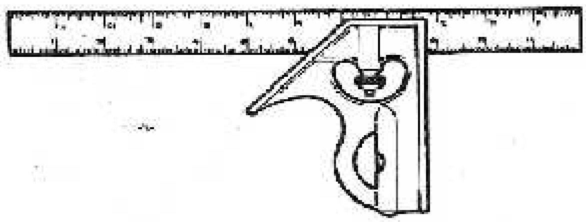


Fig.2.10: Combination square

H. Protractor

This is a device for measuring and laying out angles from the edge of the work. This protractor consists of a head and a movable blade. The head of the protractor has a semicircular scale graduated from zero to 180°.

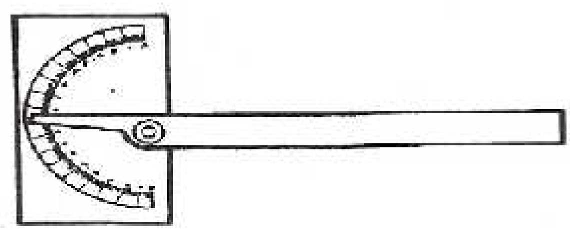


Fig. 2.11. Protractor

I. Trammel Points (sometimes called a beam compass)

These are used for scribing large arcs and circles. They are manufactured in various types with two straight, removable legs tapered to needle points and attached to separated heads or holders. The heads or holders slide on wood or steel beams and are held in place by thumb screws. Either of the points can be removed and often one point has adjustment for fine settings. A special clamp for a pencil can be attached to one of the points.

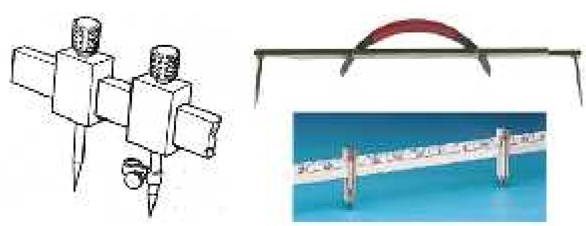


Fig.2.12 : Trammel Points

J. Prick Punches

Prick Punches are made of tool steel and having a tapered point ground to approximately 30° included angle. These punches are used for making small dents or indentations and/or establishing points for dividers and trammel points.

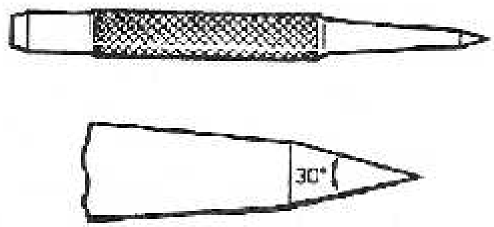


Fig. **2.13**: Prick punch

K. Centre Punch

Similar in design to the prick punch except that the tapered point is ground to an angle of 90° included. They are used primarily for marking the location of points and the centers of holes to be drilled. Such punches are manufactured in various sizes and may be purchased in sets.

Neither prick punches nor center punches should be used to punch holes. These are both intended for establishing points only.

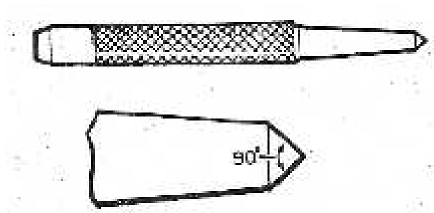


Fig. 2.14: Center Punch

L. Tape Rule

A **tape measure** or **measuring tape:-** is a flexible ruler used to measure length or distance.

It consists of a ribbon of cloth, plastic, fiber glass, or metal strip with linear measurement markings. It is a common measuring tool. Its design allows for a measure of great length to be easily carried in pocket or toolkit and permits one to measure around curves or corners

There are two basic types of tape measures with cases: spring return pocket tape measures and long tape measures. Spring return pocket tape measures will generally fit in a pocket

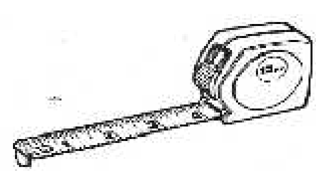


Fig.2.15: Tape Rule

2.2.3. Cutting Tools and equipment

1. **Hand Snips**

Various types of hand snips and hand shears are used for cutting and notching sheet metal. All of the snips, shears, and nibblers are either manual or power operated. Hand snips are necessary because the shape, construction, location, and position of the work to be cut frequently prevent the use of machine-cutting tools.

Hand snips are divided into two groups. Those for straight cuts are straight snips, combination snips, bulldog snips, and compound lever shears. Those for circular cuts are circle, hawk's bill, aviation, and Trojan snips. These snips are shown in *Figure bellows.* The following is a brief description of each type of snip.

Straight snips have straight jaws for straight-line cutting. To ensure strength, they are not pointed. These snips are available for right- or left-hand use.

Combination snips have straight jaws for straight cutting, but the inner faces of the jaws are sloped for cutting curves as well as irregular shapes. These snips are available in the same sizes and capacities as straight snips.

Circle snips have curved blades and are used for making circular cuts, as the name implies. They come in the same sizes and capacities as straight snips and either right- or left-hand types are available.

Hawk's bill snips are used to cut a small radius inside and outside a circle. The narrow, curved blades are beveled to allow sharp turns without buckling the sheet metal

Aviation snips have compound levers, enabling them to cut with less effort. These snips have hardened blades that enable them to cut hard material. They are also useful for cutting circles, squares, compound curves, and intricate designs in sheet metal.

Trojan snips are slim-bladed snips that are used for straight or curved cutting. The blades are small enough to allow sharp turning cuts without buckling the metal.

Pipe & Duct snips (Double Cut) have a straight cut blade pattern. This style of aviation snip cuts a narrow section equal to the width of the center blade as it cuts. The material on either side of the cut tends to stay flat, as only the narrow section takes a curl as it is cut.

Nibbler is for cutting sheet metal with minimal distortion. One type operates much like a punch and die, with a blade that moves in a linear fashion against a fixed die, removing small bits of metal and leaving a kerf approximately 6 mm wide.

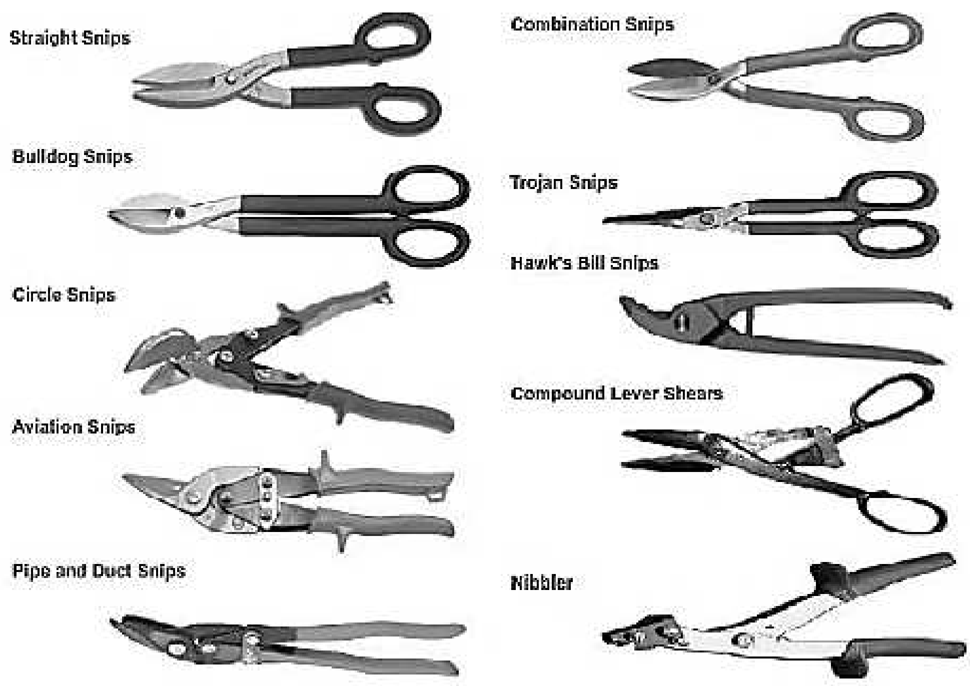


Fig.2.16: Types of hand snips

2. Bench shear

Bench shear sand hand shears have blades tha rotate about a pivot and it is this pivoting action that creates the shear angle. For more information observe this videos:

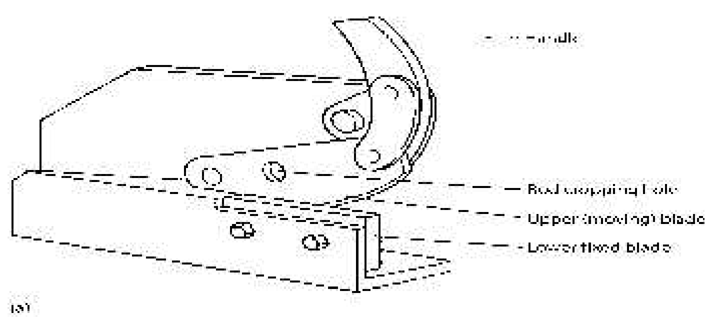


Fig. 217 : Bench shear

3. Chisels

They are generally used in sheet metal work for cutting sheets, rivets, bolts and chipping operations. A good number of cold chisels are used.

The flat chisel and round nose chisel are most widely used in sheet metal work.

The various types of chisels are used for cutting metal.

Flat cold Chisel. Sheet metal workers generally use this chisel more than the other types since it is used for cutting sheet metal, rivets, bolts, and in chipping operations.

Cape Chisel. Cape chisels are used for cutting grooves and keyways.

Diamond Point Chisel. These chisels are used for cutting V shaped grooves, for chipping corners, and sometimes for removing bolts whose heads have broken off.

Round Nose Chisel. Round nose chisels are used for roughing out the concave surfaces of corners arid also for cutting grooves.

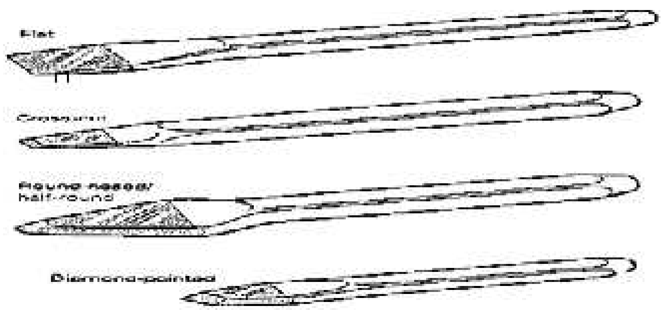


Fig.2.18. Types of Chisels

4. Files

There are many shapes and sizes of files available with various grades of cut. Files are used to remove burrs from sheets of metal, to straighten uneven edges and for various other operations that require a small amount of metal to be removed. They should always be used with a handle. Common types used by the industrial insulator are: flat, square, round, half-round.

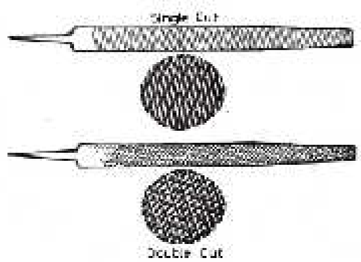


Fig.2.19. Single cut and double cut files

5. Guillotine machine

The principle of shearing is similar to punching except that the area being sheared is a relatively small continuous section, starting at one end of the sheet and ending at the other. A hold-down clamping stop holds the sheet rigid while the blade of the guillotine shears through the sheet.

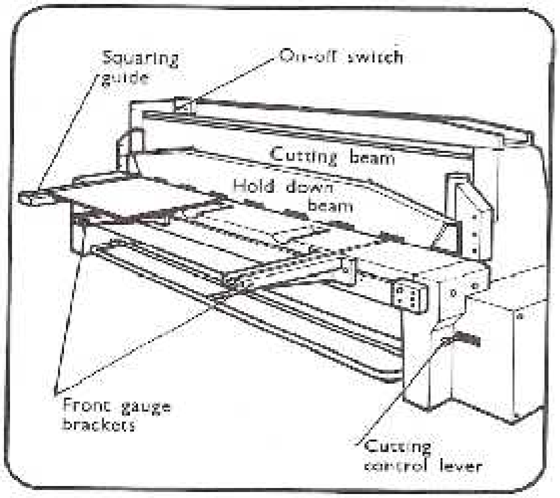


Fig.2.20: Guillotine

An important factor in the production of a good cut edge is the clearance between the blades as well as the sharpness of the blade edges. Some machines have provision for altering the blade clearance to suit the thickness of sheet being cut out, usually the clearance is set at manufacture and checked periodically. A reasonable guide is 0.1 mm increase in clearance for every 1 mm of sheet thickness. The shearing capacity of the guillotine should be more than the shearing strength of the material being cut.

6. Compound lever shears

Compound lever shears; view have levers designed that give additional to ease the cutting of heavy material. The lower blade is bent to allow the shears to be inserted in a hole in the bench or bench plate.

- Portable power shear
- Actuated squaring shears
- Ring and circular shear

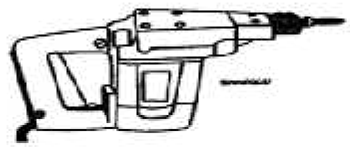


Figure 2-20.—Portable power shears

fig.2.21: Solid punch.

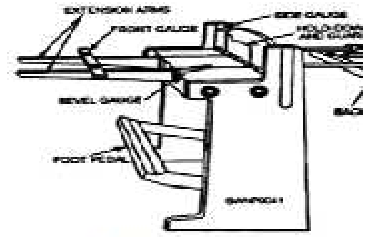


fig.2.22: Foot-actuated squaring she

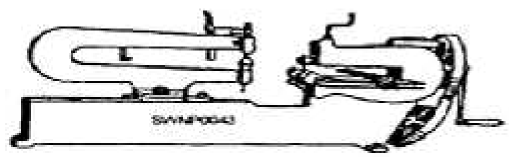


Fig 2.21.Compound lever shears

7. Pliers

There is a vast range of pliers used in the vehicle body building industry, with the most common being combination pliers, slip joint pliers, side cutters, circle pliers, long-nosed pliers and multi grips. The correct pliers to use depend on the type of vehicles being built.

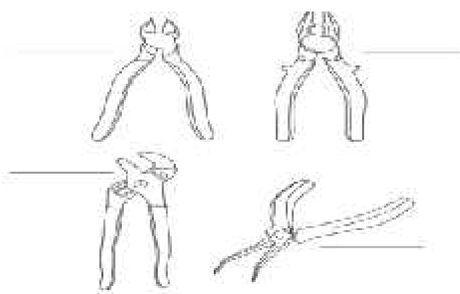


Fig.2.22: Side Cutting Pliers

2.2.4. Bending and forming tools and equipment

A. Hammers and Mallets

There are various types and sizes of hammer use in metal working.

- **Stretching Hammer**: - This is used for stretching edges and flanges on curved work. It is normally used in conjunction with a stake.
- **Planishing Hammer**: - The principal purpose of the Planishing Hammer is for smoothing and finalizing a surface after it has been roughed out to the required shape.

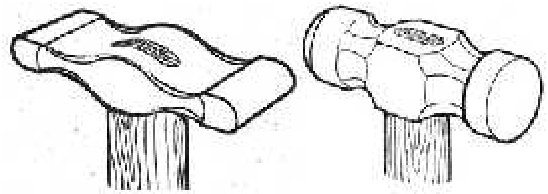


Fig. 2.23: Stretching Hammer and Planishing Hammer

- ❖ **Engineers Ball Pein hammers**:- This is used for striking chisels, punches, rivets etc. The ball peen or machinist's hammer has a round, slightly curved face and round head. It is a general purpose hammer for general engineering use.

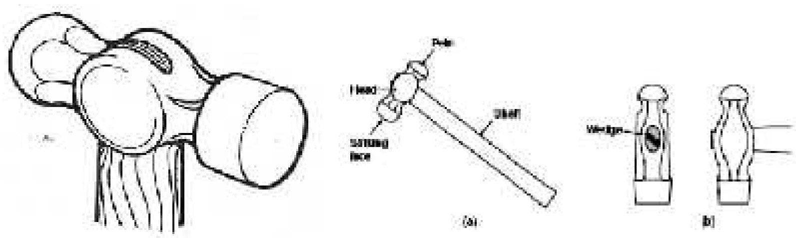


Fig.2.24: Ball Pein hammers

- ❖ **Boxwood and Rubber Mallets: -** It is Plastic-headed hammer of round or rectangular cross section. The striking face is made flat to the work. A mallet is used to give light blows to the Sheet metal in bending and finishing. Mallets are properly used where steel hammers would deface the work. These mallets can be used on mild steel, copper or aluminum to prevent marring the metal.

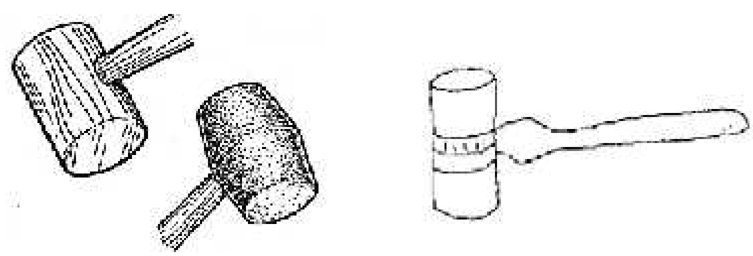


Fig.2.25: Boxwood and Rubber/plastic mallet

- ❖ **. Bench vice**

The most commonly used vice is parallel jaw vice. It is often fitted with a quick-release device that frees the screw from the nut so that the vice can be opened and closed quickly when changing between components of different widths in order to save time.

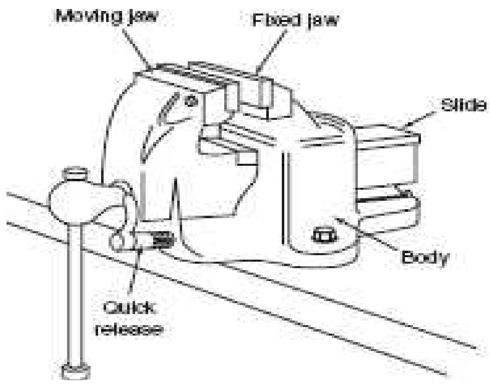


Fig. 2.26: Bench Vice

- **. Bench stakes**

Stakes are the sheet metal workers evils used for bending, seaming or forming, using a hammer or mallet. They actually work as supporting tools as well as forming tools. They also help in bending operation. They are made in different shape and sizes to suit the requirements of the work.

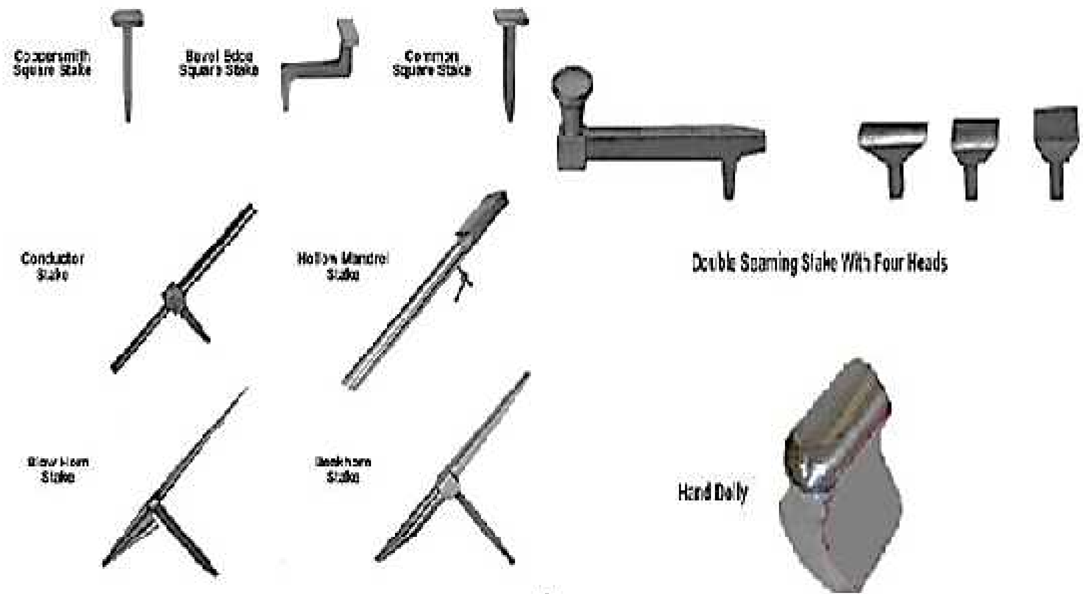
- **Bevel-Edge Stake**: this stake has a flat, square head *with a* bevel edge on the outside of the head for double seaming. It also has an offset shank which permits the work to clear the bench.

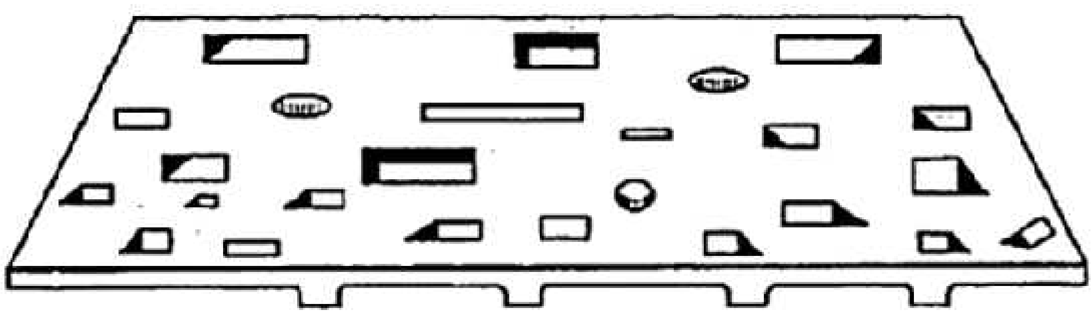
- **Common Square Stake:** the common, square stake has a flat square- shaped head with a long shank, and is used for general operations.

- **Coppersmith Stake**: The coppersmith stake has a rounded edge on one side of the head and a sharp rectangular edge on the other. The stake is used for general operations.

- **Bottom Stake**: this stake has a fan- shaped, beveled edge, slightly rounded. It is used for dressing burred edges on a disk, for special double seaming, and for turning small flanges.
- Hand Dolly Stake. The hand dolly stake is designed with a fiat face, two straight edges, one convex edge, and one concave edge. It is a handy stake for all general purposes such as bucking rivets and double seaming. Hand dolly stakes come in various shapes and sizes.
- **Care of Stakes**: the condition of the stake has much to do with the workmanship of the finished job. If a stake has been roughened by punch marks or is chisel marked, the completed job will look rough and lacking in craftsmanship. Therefore, a stake should not be used to back up the work directly when prick punching or cutting with a cold chisel.

- **Stake Holder:** - it is used in sheet metal shop is a rectangular bench plate .





Stake Holder.

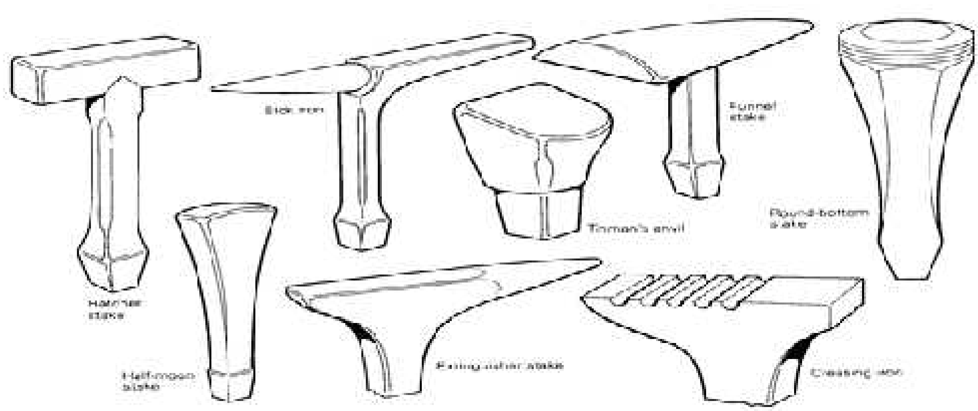


Fig.2.27: Bench stakes and stake holder

2.2.5. Sheet metal Folding Machine

This type of machine, while suitable for all types of bending operations, has special provision for folding pans, trays or boxes. No rods, wires or metal beyond the capacity of the machine should be bent on this machine.

The most important points when using this machine is to set the machine to suit the metal thickness being folded.

Never bend beyond the capacity of the machine. This strains the machine and will shorten the life-span and quality of the folders.

Never bend round bar etc. in the machine.

When removing or inserting the fingers (of machine) take care not to get your own hand or fingers squashed.

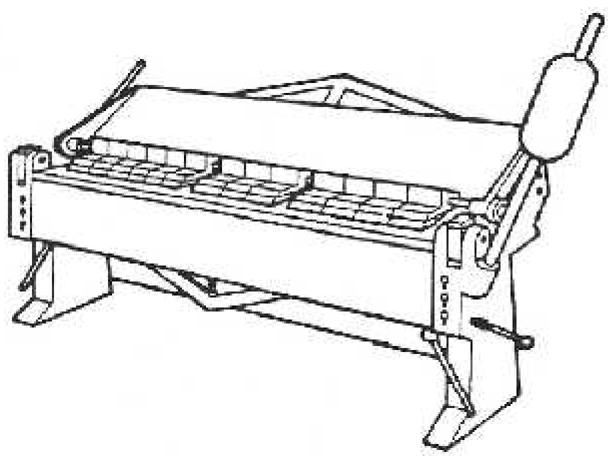


Fig.2.28. Folding Machine

2.2.6. The Bending Rolls

The two types of bending rolls used in sheet metal are the plain bending and slip bending rolls. These machines are for curving sheet metal. On the slip bending rolls the upper roll can be released and this facilitates the removal of the work piece. This can’t be done on plain rolls. There are power and manually operated types available.

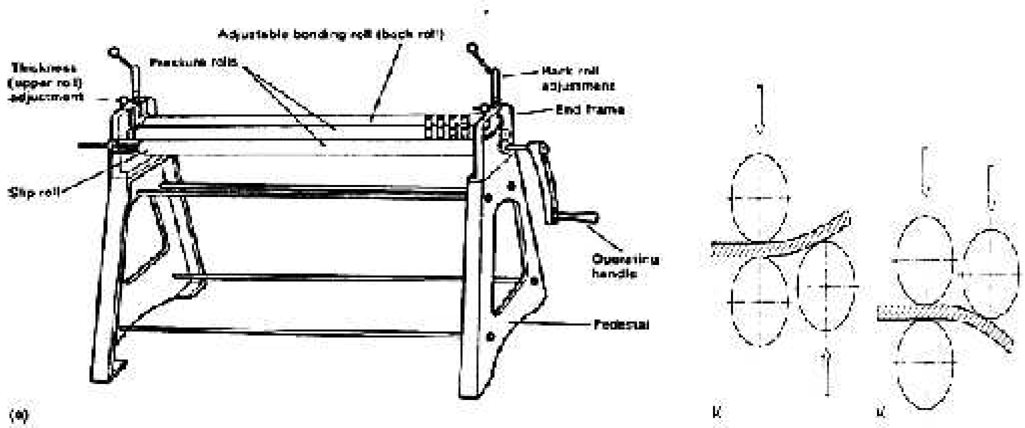


Fig. 2.29. (E): Bending Rolls

2.2.7. Pop **Riveting Guns**

“Pop” Riveting Guns are used extensively with “pop” rivets for the assembly of light fabrications and are particularly useful for the assembly of metal cladding where access is restricted to one side of the work only. There are three different types available: hand “pop” gun, lazy tongs and pneumatic (air).

Hand “Pop” Gun

Riveting in confined spaces requires the use of a hand “pop” gun. These are unsuitable for larger dimensions of rivets, due to the reduced amount of leverage available.

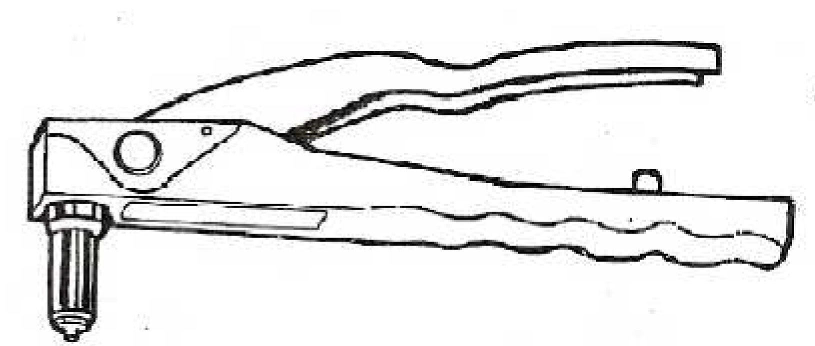


Fig. 2.30: Hand “Pop” Rivet Gun

2.2.8. Lazy Tongs

Lazy Tongs are used for the larger diameters of rivets, where sufficient working space is available to permit operation of the tool. The construction of the tool permits a moderate pressure on the handle to provide a strong pulling force on the rivet mandrel.

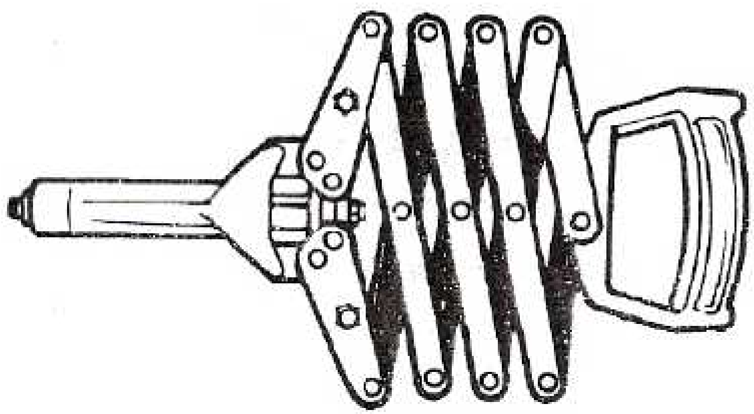


Fig.2.31 (G): Lazy Tongs

2.2.9. Type of sheet metal Materials

2.2.9.1. Introduction of common engineering materials

Common engineering materials are normally classified as metals and nonmetals. Metals and non-metals differ in their properties. The choice of materials for a given job depends very much on its properties, cost, availability and such other factors. Metals may conveniently be divided into ferrous and non-ferrous metals.

A. Ferrous metals

Ferrous metals may be defined as those metals whose main constituent is iron such as pig iron, wrought iron, cast iron, steel and their alloys. They are usually stronger and harder and are used in daily life products. They possess a special property that their characteristics can be altered by heat treatment processes or by addition of small quantity of alloying elements. Ferrous metals possess different physical properties according to their carbon content.

The most Ferrous metals are:

Cast iron: - It is primarily an alloy of iron and carbon.

White Cast Iron: - It is so called due to the whitish color shown by its fracture.

Grey Cast Iron: - It is the iron which is most commonly used in foundry work

Malleable Cast Iron: - Malleable cast iron is produced from white cast iron.

Nodular Cast Iron: - It is also known as “spheroid graphite iron” or ductile iron or “High strength Cast iron”.

Chilled Cast Iron: - Quick cooling is generally known as chilling and the iron so produced is “chilled iron”.

Alloy cast iron: - The cast irons as discussed above contain small percentages of other constituents like silicon, manganese, sculpture and phosphorus

B. Non-ferrous metals

Non-ferrous metals are those which do not contain significant quantity of iron or iron as base metal. These metals possess low strength at high temperatures, generally suffer from hot shortness and have more shrinkage than ferrous metals.

The various non-metals used in industry are: copper, aluminum, tin, lead, zinc, and nickel, etc., and their alloys

C. Galvanized Sheet Metal

It is a sheet steel coated with zinc. In the most common one, the steel is dipped in an acid both for cleaning and then is dipped into the zinc. Galvanized sheets are identified by their even grey color and are mainly used for their ability to resist corrosion.

2.3. Preparing work area

2.3.1. Safety First

Write a safe work practices plan after the hazard assessment is completed. It should include specific information for each department or job function. Safety for an office position might include keeping aisles and walkways free of boxes, using glare-free computer monitors and opening one file cabinet drawer at a time to prevent tipping. Manufacturing positions might follow policies including wearing protective gear, storing chemicals in labeled containers, and using safety guards on machinery and promptly reporting hazards to supervisors.

2.3.2. Hazards assessment

The first step in preparing a safe work practices plan involves completing a safety hazard assessment. Visit every department and note dangers such as machinery without safety guards, employees working without eye protection or piles of supplies blocking walkways. Observe the way employees perform their jobs to determine if they follow safety protocols or perform actions that put them at risk of injury.

2.3.3. Repair, Replace, Upgrade

Repair or replace defective or broken equipment, clean cluttered or dirty areas and replace worn carpeting or flooring. Inadequate lighting and uncomfortable work stations might make it difficult for employees to be productive, so consider replacing older furniture or cubicles. Don’t limit this phase of the process to noticeable hazards only. Inspect machinery to ensure that it’s in good working order and service and upgrade equipment as needed.

2.4. Sealants, fixing and sheet metal materials

2.4.1. Sealant is a type of mechanical seal that is widely used in domestic and industrial applications in order to fill up unwanted gaps and openings that may cause the seepage of water, gases or any particulate matter. Mating of two or more parts together results in gaps, which adversely affect the integrity and the performance of the object. Sealants are effectively used to fill up gaps between the surfaces and close off any spaces that may occur.

2.4.2. Types of sealants

Currently, there are more than forty types of sealants available in the market, out of these the most common industrially used sealants are as follows:

- **Silicone**

Silicone sealants are one of the most commonly used sealants. Silicone sealants exist in either neutral cure or acetoxy. The production of silicone sealants involves an extensive polymerization and hydrolysis process of siloxanes and silanes. Both the neutral and acetoxy silicone sealants cure at the room temperature and are compatible with a variety of materials.

Epoxy

Epoxy sealants are usually supplied in two-pack configurations consisting of a resin and a hardener. They are mixed together in pre-set ratio for the epoxy to perform its joint sealing. Epoxy sealants are well known for their high strengths, exceptional cure toughness and the ability to resist the environmental or chemical damage to the sealing.

Phenolic Sealant

Phenolic sealants are types of resins that provide effective bonding and have a good endurance rating against high temperature. Phenolic sealant is the only sealant that is available in powder, liquid and film form. The phenolic sealant is usually composed of phenol and formaldehyde chemicals.

2.4.3. Material compatibility of sealant

To decide which sealant to use of all the available sealants, it must be made sure before application that whether the joining material is compatible or not. Having a sealant being applied on an incompatible material may result in the degradation of the material and failure to seal off the joint.

Porous surfaces: porous surfaces have the best compatibility with sealants having a high viscosity or gel like texture. Silicone, polymers and epoxies are the best-suited sealants for porous materials.

Concrete: Concrete is the constructing material that is used for construction of buildings, walls and other structures. Polymer sealants are usually used to seal concrete joints.

Metal: Metal joints are usually sealed together using silicone and polymer based sealants. Silicone is highly compatible with iron, aluminum, steel and iron compounds.

Ceramics: Ceramics are the oxides and nitrides that are non-metal and have a high melting and boiling point. Ceramics can be sealed off using epoxy, silicone and acrylic sealants.

Textiles: Textiles are most compatible with silicone-based sealants.

Plastics: Plastics are the organic, process or synthetic materials obtained from

Polymer. Silicone and polymer acts as the most suitable sealants

2.4.4. Fixing materials

Fasteners join two thin materials together and must be purpose-designed for the application. These are generally either self –drilling stitcher screws with bonded sealing washers and integral laps, blind sealed rivet. Uses of fixing material on the building like, doors, windows, wall sheet metal part and roofs to prevent water, dust and air linking. Different types of fixing materials are explained bellow:

- **Rivets**

Rivets are used to make permanent joints in metal, to join metal to soft materials and for joining soft materials to each other.

Solid rivets

Snap or round head rivets are used for general purposes where a flush finish is not important and countersinking would weaken the job.

Countersunk head rivets are used for general purposes where a flush surface is needed. They are the most commonly used type.

Flat head rivets are used for joining thin plates which cannot be countersunk.

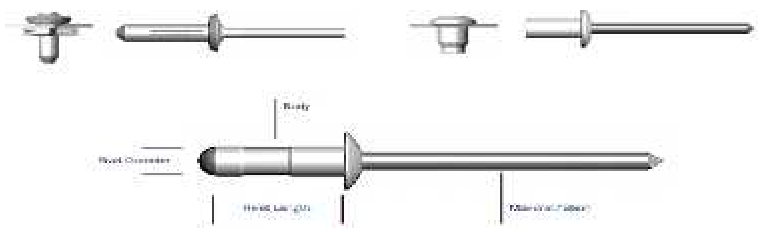


Fig.2.32 Rivets

2.4.5. Nuts, bolts and machine screws

All these fixings are usually made of steel or brass and can be coated either to rustproof the steel or to improve their appearance.

- Bolts usually have either a square or a hexagonal head. They are ordered by the diameter of the thread and the length to the underside of the head. Bolts may be threaded for all or part of their length.

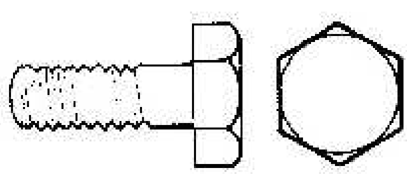


Fig.2.33. Bolts

- Coach bolts are used to join wood to wood or wood to other materials. They have a domed head with a square collar underneath which is pressed into the wood to prevent the bolt turning. They are usually used for strong structural woodwork.

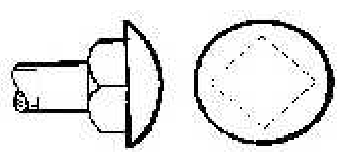


Fig.2.34. Coach bolts

- Machine screws are available in a wide range of thread diameters, lengths and head shapes.

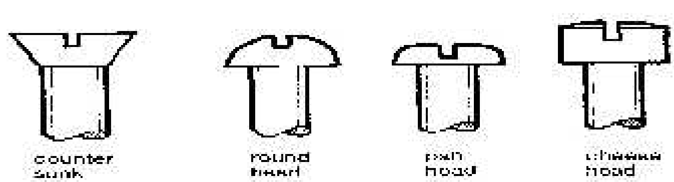


Fig.2.35: Machine screws

❖ Nuts are either Plain Square, plain hexagonal, wing nuts for easy removal, or special locking nuts to prevent vibration loosening them.

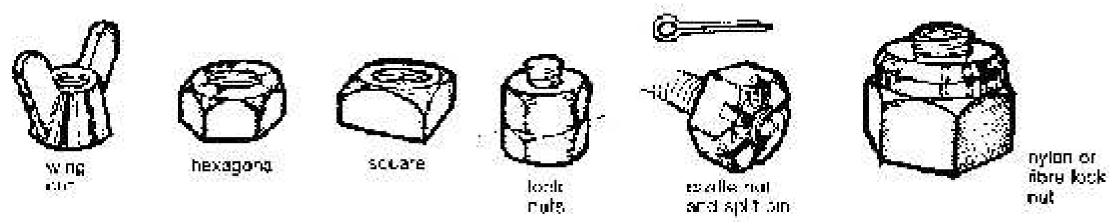


Fig. 2.36 different types of nuts

❖ Washers are used to protect the surface when the nut is tightened, to spread the load or to prevent vibration loosening the joint.

Fig. 2.37 Washers

❖ Self-tapping screws are used to join thin sheets of metal and plastics and as chipboard screws where ordinary woodscrews would cause the chipboard to crumble. They are made of hardened steel so that they can cut their own thread as they are screwed in. Common sizes are 6 mm to 50 mm with Phillips. Drill a tapping size hole equal to the core diameter of the screw.

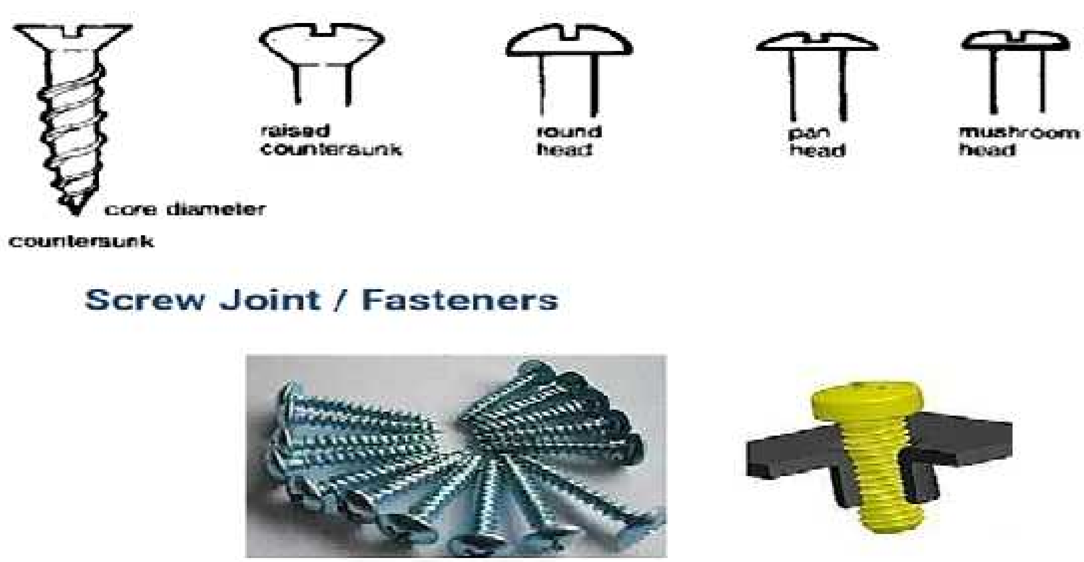


Fig 2.38 self –tapping screw

Self-Check -2	Written Test

Directions: Answer all the questions listed below.

1. In the work area _____________ should be observed.

A. Safety precaution B. safety equipment

C. Protective equipment D. All are answers

2. Good housekeeping is one of handling method in____.

A, work area B. Safety prevention C. A & B

3. The first step in preparing a safe work practices plan involves __________________.

A. Repair, Replace, Upgrade C. Hazards assessment

B.Safety First D. Spread the Word

4. It is used to make permanent joints in metal, to join metal to soft materials to each other.

A.Bolts B. Rivets C. Self-tapping screws D. All

5. Which one is used to join wood to wood or wood to other materials?

A.Machine screws B. Nuts C. Coach bolts D. All

6. Which sealant the most commonly used sealants?

A.Silicone B. Polymers C. Epoxy D. Phenolic Sealant

7. Which sealant is more compatible for metals?

A.Silicone B. Polymers C. Epoxy D. Phenolic Sealant E. A &B

Operation Sheet 2

Operation title: **-** Methods of prepare workplace for cut and join sheet metal

Purpose: **- ease to work and safe** the time du ring performe cut and join sheet metal

Instruction: Using the correct procedures of Cutting and Joining Sheet Metal accord to design

Methods of preparing workplace for cutting and joining sheet metal are:

Step 1- Do not block exits

Step 2- Change burned-out light fixtures in work areas, walkways, and exits

Step 3- Keep floors and work areas clean, dry, and grease-free

Step 4- Keep steps and ladders in serviceable condition

Step 5- Keep emergency equipment clean and unobstructed

Step 6- Ensure that all signs and caution labels are in good condition and visible

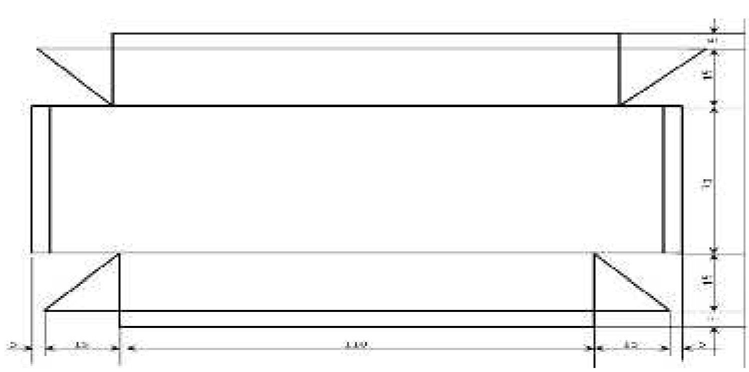
LAP Test 2	**Practical Demonstration**

Name: ______________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2 hours.

Task 3: prepare tray (rectangular dish) in mild steel sheet metal



Unit Three: Develop Patterns as Required

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Pattern development methods
- Allowances for fabrication and assembly

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Apply pattern development methods
- Determine and transfer allowances for fabrication and assembly

3.1. Pattern development methods

Making patterns or pattern developments is an important part of industrial drafting. Many different industries use them. Familiar items such as pipes, ducts for hot- or cold air systems, parts of buildings, aircraft, automobiles, storage tanks, cabinets, boxes and cartons, frozen food packages, and countless other items are designed using pattern developments. To make such items, a drafter must first draw them as a pattern or pattern development.

A pattern development, also called a stretch out or simply a development, is a full-size layout of an object made on a single flat plane. A development that is not full size is not a pattern; it is simply a drawing or representation of the pattern.

The pattern is the original part of the pattern development from which flat patterns can then be cut from flat sheets of material that are folded, rolled, or otherwise formed into the required shape (see Figure 3.1). Materials used include paper; wood; fiberboard; fabrics; various cardboards, plastics, and films; metals such as steel, tin copper, brass, and aluminum; and so on.

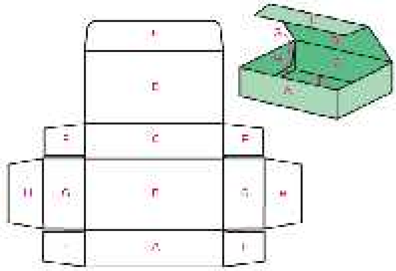


Figure 3.1 Pattern for a one-piece package with fold-down tabs

3.1.1. Types of Developments

The type of development needed for an individual object depends on the object's shape. The three basic types are parallel-line development, radial-line development, and triangulation.

❖ **Parallel Line Development**

The parallel line method of pattern development is based on a system of lines drawn parallel to one another on the surface of a sheet metal article and is used to develop items such as elbows, segmental bends, Tee-pieces or valve boxes for example. In general, it is used to develop square, rectangular and cylindrical shapes (prisms). An example of parallel development can be seen below.

Example:

Step 1:- Draw the required views which are the top view and side view. These two views provide the five pieces of information required to layout the pattern. Pattern development of rectangular prism

While learning about this pattern development, you will once again follow the six basic steps you learnt in both the previous

Step 2 :-Not only is there a need to identify each of the four corners in this example, but also the change of shape (C3 and F6) located mid-way along the long side of the rectangular prism which can only be seen in the side view. The seam or join is positioned at the corner A–1.

Step 3 :- Calculate the perimeter of this rectangle prism.

Perimeter = (length + width) × 2

Step 4 :- Commence the pattern by drawing its girth line which as you can see has been drawn to the right and on the same horizontal plane as the base line of the side view.

Step 5 :-Mark off the six top view measurements, AB, BC, CD, DE, EF and FA along the girth line of the development, as illustrated.

Step 6:-Construct the seven parallel lines from and perpendicular to the girth line. Each of these seven lines being A1, B2, C3, D4, E5, F6, and A1 a second time. To easily obtain the correct heights for these lines, project two horizontal construction lines from the side view; one from position 1–6 and the other from 4–5.

Note: Each of the seven vertical and parallel lines can be transferred from the side view to the pattern with a compass.

To finalize the pattern simply join each of the points 1–2, 2–3, 3–4, 4–5, 5–6 and 6–1 with an outline. Also outline the other three sides – A1, A1 and the girth line.

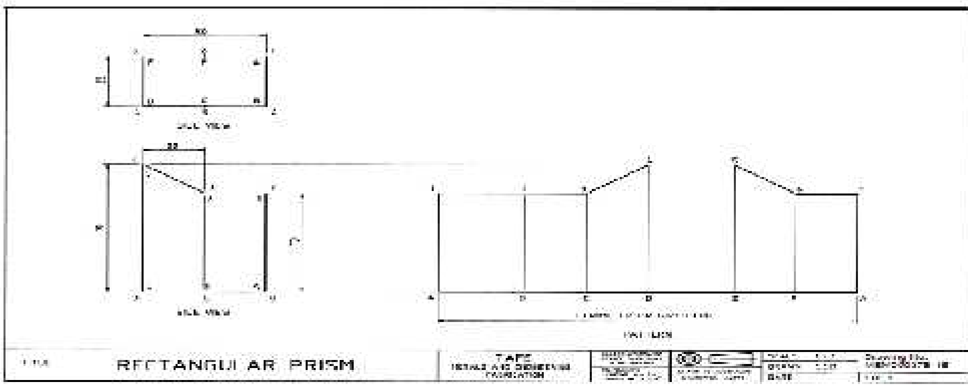


Figure 3.2 Parallel Line Developments

- **Radial-Line Development**

The edges on cones and pyramids are not parallel. Therefore, the stretch out line is not a continuous straight line. Also, instead of being parallel to each other, measuring lines radiate from a single point. This type of development is called radial-line development
To understand the development of the pattern, imagine rolling out each of these triangles, one after another, on a plane (flat surface). The resulting pattern would look like a sector of a circle. Its arc would be the length of the rim of the cone's base.

Terminology

The terminology used in radial line development can be listed under the following four headings:

Shapes Cone, right cone, pattern Points and Apex

Lines axis centerline radial lines base circle arc Surface curved surface

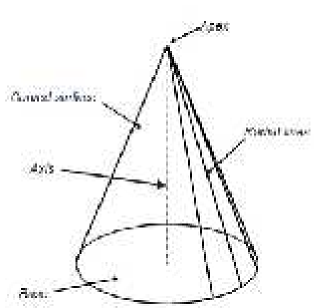


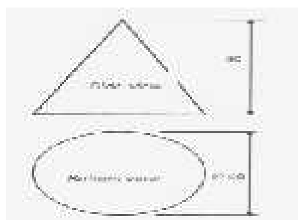
Fig .3.3. Radial-Line Development

Pattern development

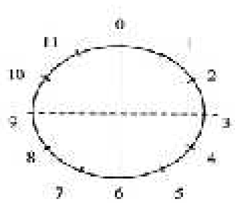
The following logical sequence of events is presented, to assist you to learn to develop patterns for right cones using the radial line pattern development technique

Steps 1 :- draw the required views; for example – the side view and the top or bottom view.

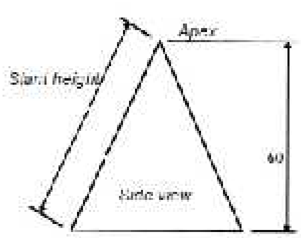
With these two views drawn the radial line pattern development for a right cone can be commenced.



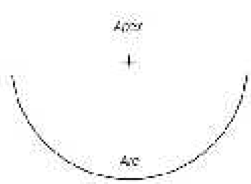
Step 2 Divide the circumference of the top/bottom view into 12 equal divisions.



Step 3 Set your compass to the slant height of the side view; apex to base.



Step 4 Commence the pattern by scribing an arc, which has a radius equal to the slant height of the side view.



Slant height = pattern radius

Step 5 Set your compass to 1/12th of the cone's base circumference.

The dimension can either be copied from one of the bottom view divisions or it can be calculated.

$1/12^{th}$ of circumference $= \pi$ x diameter

$= \pi\ (3.142 \text{ x } 40) \div 12$

$=126 \text{ mm} \div 12$

$=10.5 \text{ mm}$

Step 6 The pattern is completed by stepping off 1/12th of the base diameter of the cone (10.5 mm) twelve times along the arc of the pattern, to reproduce the cone's base circumference.

Outline the three sides of the pattern apex to 0, apex to 12 and the arc 0 to 12. Slant height

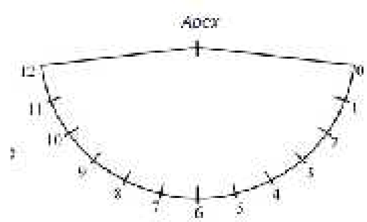


Fig.3.4. Pattern development

Pattern development of right cone

While learning about this pattern development, you will once again follow the six basic steps you learnt earlier in the introduction to radial line development.

Step 1 Draw the required views, which once again you will note are the top or bottom view and side view. These two views provide the two pieces of information required to layout the pattern for this right cone.

The vertical height, which is 95 mm.

The slant height which is used as the radius to commence the pattern layout.

The diameter of the base of the cone, which is 90 mm.

Step 2 Divide the circumference of the bottom view into 12 divisions, as illustrated in the drawing 2B. The lines drawn from each of these points on the circumference to the apex, represent those drawn from the cone's base to the apex in the side view.

Step 3 Set your compass to the slant height of the side view; apex to base.

Step 4 With your compass set at this measurement, scribe an arc to commence the pattern layout.

Step 5 Set your compass to 1/12th of the cone's base circumference, eg 0 to1 of the bottom view.

A more accurate method of obtaining 1/12th of the circumference of the cone's base is to calculate it.

1/12th of circumference x diameter = π 3.142 x 90 ÷ 12 282.75 ÷ 12 23.56 mm

1/12th of circumference = π x diameter

=3.142 x 90 ÷ 12

=282.75 ÷ 12

=23.56 mm

Step 6 with your compass set at this measurement, step it off 12 times along the arc of the pattern layout, so as to transfer the cone's base circumference to the pattern layout.

Finalize the pattern by outlining the two seam lines 0 to apex and apex to 0, and outline the portion of the arc required.

Note, each of the points 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11 on the arc of the pattern can be joined to the apex with a light construction line if you wish. These lines will assist you when rolling the cone into shape, but are of no other practical use to the pattern.

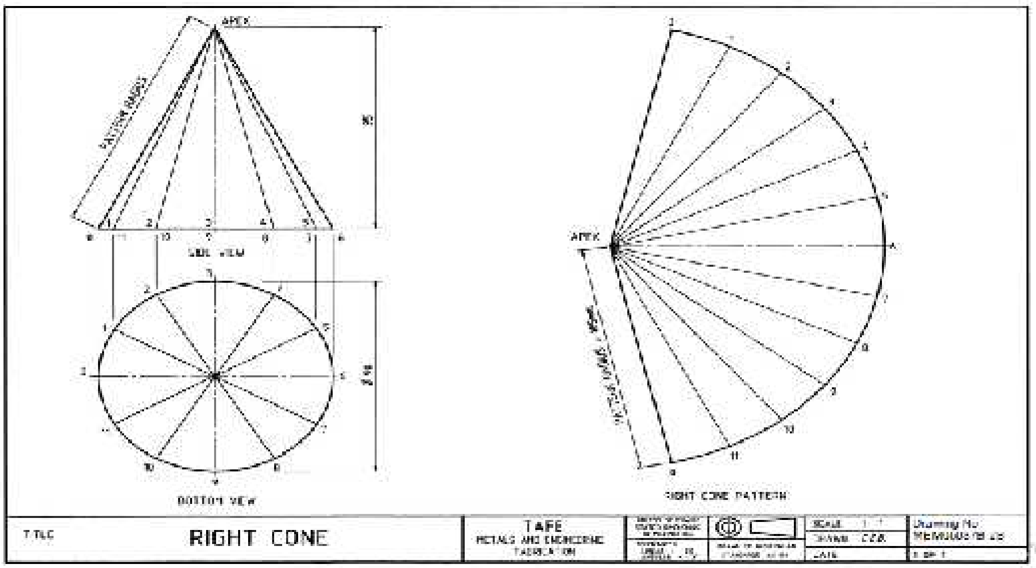


Fig 3.4. **Pattern development of right cone**

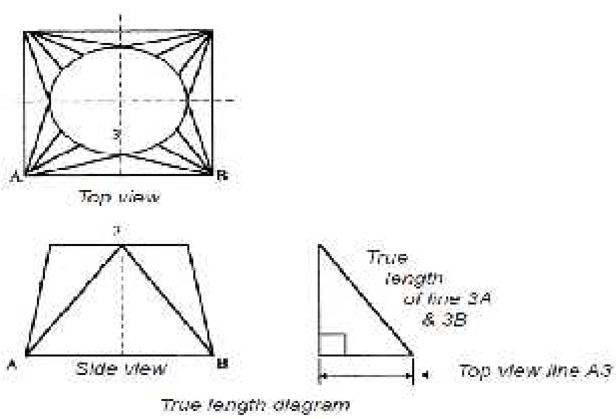
Triangulation

Triangulation is the name given to a pattern development method to develop the shapes, or more correctly the surfaces of shapes, which do not consist of either parallel or radial line elements. However, it must be made clear that all surface shapes can be developed using this triangulation method.

In this method the surface of the object to be developed is divided into a number of triangles, with each triangle (as a true shape and size) being placed next to each other to produce the pattern for the given object.

The golden rule of triangulation states:

The true length of a line is obtained by placing the top view (or bottom view) length of a line at right angles to its vertical height.



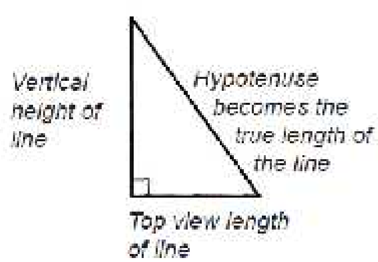


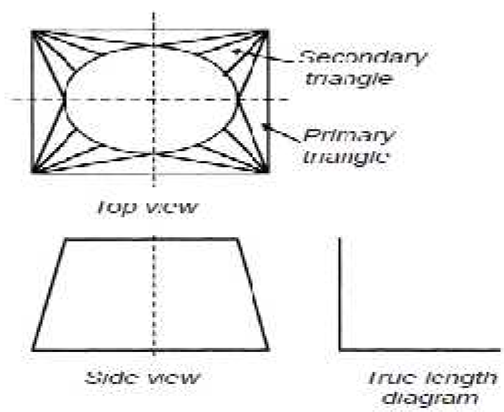
Fig 3.5. Triangulation

In the above example the top view line A3 has been placed at right angles to its vertical height, so as to obtain its true length which can be used in the pattern development of this square to round

Terminology: The terminology used in triangulation can be listed under the following headings.

Shapes

top view	rectangle to round
side view	primary triangle
true length diagram	secondary triangle
transition	pattern.
square to round	



Line

centerline	side view vertical height line
triangular (generator) lines	circumference
top view line	half circumference

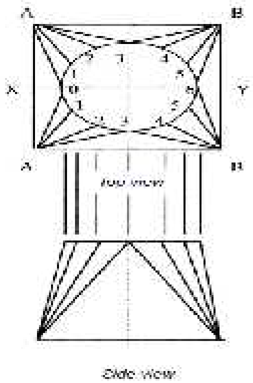


Fig 3.6.Two views

Step 2 Construct the true length diagram.

Note: With transition pieces such as this square to round, only one true length diagram is required. The height of this true length diagram is equal to the vertical height of the side view; as can be seen in Fig 2. You will also note that the true length diagram consists of a right angle.

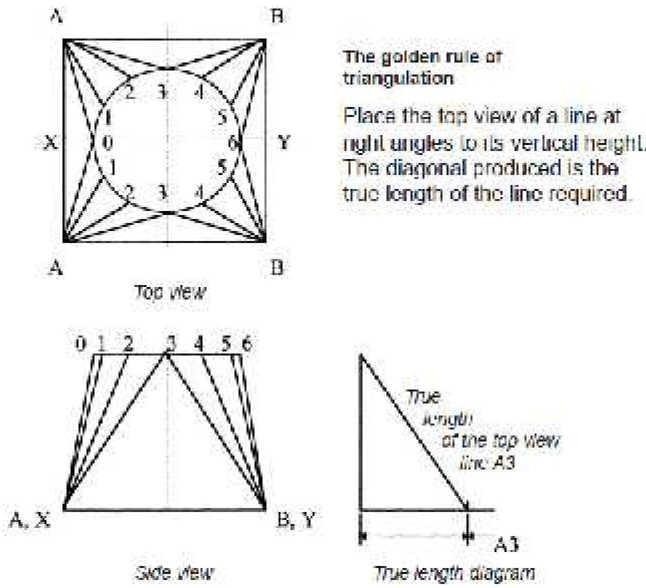


Fig 3.7. True length diagram

In Fig 3.7. the true length diagram (a right angle) can be seen constructed to the right of the side view. The vertical arm of this true length diagram being equal in height to the side view, while top view triangulation dimensions, such as A3 are transferred and located on its horizontal arm, as illustrated. The diagonal line created is the true length of the top view line A3,

Step 3 Commence the pattern development by constructing the primary triangle AB3. Note, in this example only a half pattern will be developed

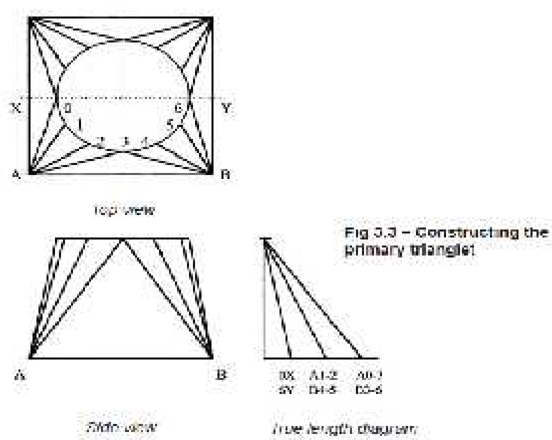


Fig 3.8. Primary triangle

The primary triangle AB3 is commenced by drawing a horizontal line, equal in length to the top view line AB.

Whereas to locate the position of 3 in the pattern the true length line A3 (which is also B3) is transferred from the true length diagram to the pattern with a compass.

Centre the compass on A, swing an arc above the line AB. This procedure is then repeated from point B of the pattern, producing the true location of point 3. That is where the two arcs intersect.

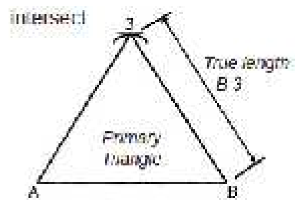


Fig 3.9. Pattern development

Step 4 Plot the location of the next two points in the pattern, which are points 2 and 4.

The locating of these next two points will create the next two triangles. These triangles being A–3–2 and B–3–4, both of which are secondary triangles.
To do this, the true length of the top view lines A2 and B4 need to be obtained from the true height diagram and transferred to the pattern, when centering at both A and B arcs are scribed either side of point 3.
Whereas the two measurements 3–2 and 3–4 are simply 1/12th of the circle's circumference. These are both stepped off from point 3. To the left to intersect the arc scribed from A to create the point 2 and similarly to the right from 3 to locate the point 4.
Calculation

1/12th of circumference = (3.142 x diameter)/12

= (3.142 x 80)/12

=188/12

=15.7mm

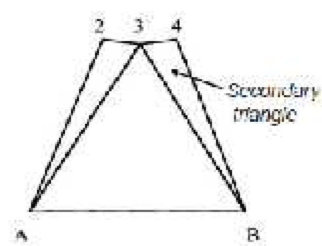


Fig 3.10. Secondary triangle (1)

Step 5 Plot the next two points 1 and 5, to create the next two secondary triangles in the pattern.

To do this, the true length of the top view lines A1 and B5 need to be obtained from the true height diagram and transferred to the pattern, in the same way as A2 and B4 were.

Whereas the two measurements 3–2 and 3–4, which are 15.7 mm in (1/12th of the circle's circumference), are stepped off, one from point 2 to locate point 1 and the other from point 4 to locate point 5.

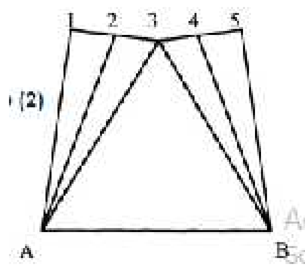


Fig 3.11. Secondary triangle (2)

Step 6 Locate the next two points 0 and 6, so as to add the next two primary triangles.

Begin by transferring the top view length A0 (B6) to the horizontal arm of the height diagram, so that its true length can be obtained.

Next, transfer the true length of A0 (B6) to the pattern. Centre the compass at A and scribe an arc to the left of point 1. Repeat this procedure from B.

Now with the compass set to 15.7 mm, scribe an arc from point 1 to intersect the arc scribed from A, to locate the point 0 to the left of point 1. Repeat this procedure from 5, to locate point 6.

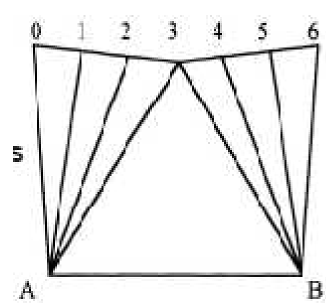


Fig 3.12.Adding primary triangles

Step 7 Complete the half pattern by locating the two points X and Y which can be found in the top view.

Transfer the top view true length line AX directly to the pattern. Centre the compass at A and scribe arc AX to the left of A. Repeat this procedure from B to produce arc BY to the right of B.

Now, transfer the top view line 0X to the true length diagram, to obtain its true length.

Next, transfer the true length of 0X to the pattern. Centre the compass on 0 and scribe arc 0X to intersect the arc scribed from A, to locate the point X. Repeat this procedure from point 6 to locate the point Y.

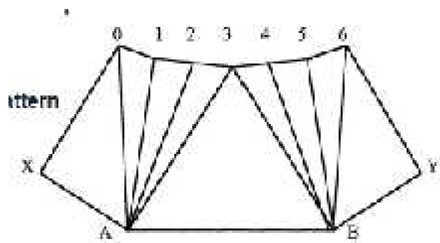


Fig 3.13. Finalizing the pattern

Finalize the pattern by outlining and draw light construction lines for each of the surface triangulation lines from A and B to points 0, 1, 2, 3, 4, 5 and 6 respectively.

3.2. Allowances for fabrication and assembly

Understanding the Bend Allowance and consequently the Bend Deduction of a part is a crucial first step to understanding how sheet metal parts are fabricated. When the sheet metal is put through the process of bending the metal around the bend is deformed and stretched. As this happens you gain a small amount of total length in your part.

These tests include bending some samples and then do some measurements and calculations.

Consider a sheet with a 20 mm thickness and a length of 300 mm as shown in Figure . We are going to review three bending scenarios with three different bending angles; 60, 90 and 120, and we will calculate K-Factor, Bend Allowance and Bend Deduction for them. The bending tool has a radius of 30 mm which means that our Inside Bend Radius (R) is 30 mm. Let's start with 90 degrees bend which is the simplest scenario.

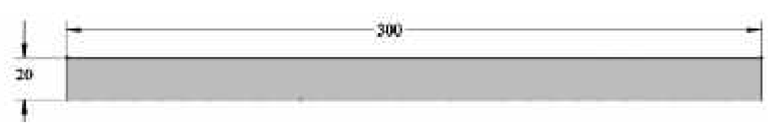


Figure 3.14: flat sheet

90 Degrees Bend Angle

Figure 2 illustrates the sheet that is bent with the bend angle of 90 degrees. We will start by calculating the Bend Allowance. From there we can calculate the K-Factor and the Bend Deduction. After bending the sheet we need to do some measurements as shown in Figure 2.

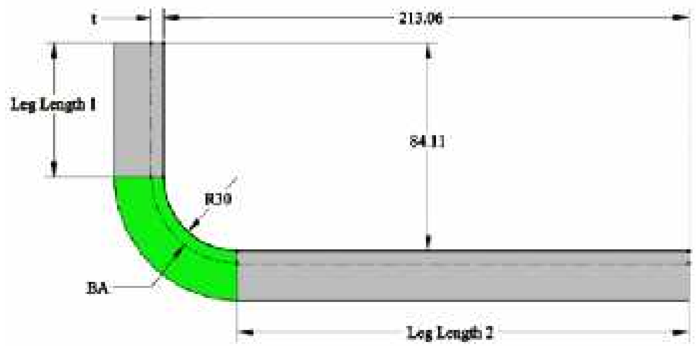


Figure 3.15. degree bend

We can calculate the Leg Length 1 and 2 as follows:

$$Leg\ Legnth\ 1 = 84.11 - R = 84.11 - 30 = 54.11$$

$$Leg\ Legnth\ 2 = 213.06 - R = 213.06 - 30 = 183.06$$

At the neutral axis we have:

$$Initial\ Length = Leg\ Legnth\ 1 + BA + Leg\ Length\ 2$$

In this formula the initial length is 300 mm. By replacing Initial Length, Leg Length 1 and 2 in the above equation we can calculate the Bend Allowance as follows:

$$300 = 54.11 + BA + 183.06$$

$$\text{BA} = 62.83$$

We know that BA is the length of the arc on the neutral axis. The length of the arc for this scenario can be calculated as:

$$BA = \frac{2 * \pi * R'}{4}$$

Where R' is the radius of the arc on the neutral axis. By inserting the Bend Allowance value in the above equation we reach to:

$$R' = \frac{2 * BA}{\pi} = \frac{2 * 62.83}{\pi} = 40$$

Now if we subtract R from R' we can find the distance of the neutral axis (t) from the inner face:

$$t = R' - R = 40 - 30 = 10\ mm$$

From the K-Factor equation we have:

$$K = \frac{t}{T} = \frac{10}{20} = 0.5$$

Bending Angles Less Than 90 degrees

For our second scenario we are going to discuss the calculations for bending angles less than 90 degrees. As an example, we are going to use 60 degrees as our bending angle. Again, we have to do some measurements as shown in Figure 3. Then we have to calculate Leg Length 1 and Leg Length 2.

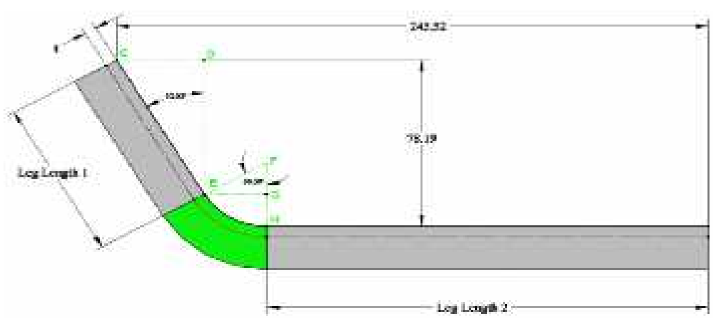


Figure 3.16. Degrees bend

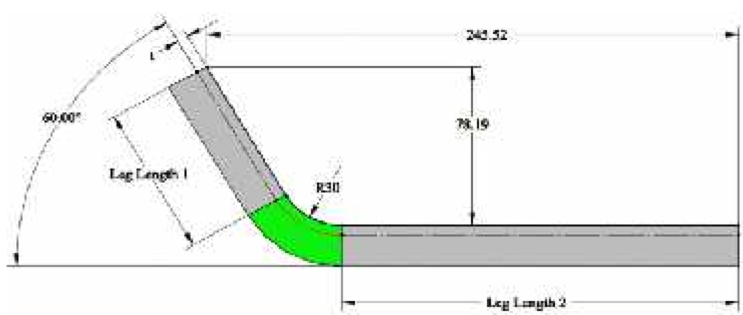


Fig 3.17 Degrees bend

Let's start by calculating Leg Length 1. From figure 3 .16we know that

$$\cos 60 = \frac{FG}{R} \rightarrow FG = R * \cos 60$$

Where R is the Inside bend radius which is equal to 30 mm in this example. We can calculate Leg Length 1 through a few simple equations as follow:

$$GH = FH - FG \rightarrow GF = R - FG \rightarrow GH = R - R * \cos 60 \rightarrow GH = 30(1 - \cos 60) \rightarrow GH = 15$$

$$78.19 = DE + GH \rightarrow DE = 78.19 - 15 = 63.19$$

$$\cos 30 = \frac{DE}{\text{Leg Length 1}}$$

$$\text{Leg Length 1} = \frac{63.19}{\cos 30} = 72.97$$

Now let’s calculate Leg Length 2:

$$\sin 60 = \frac{FG}{R} => FG = R * \sin 60 \rightarrow FG = 25.98$$

$$\sin 30 = \frac{CD}{Leg\ Length\ 1} \rightarrow CD = 72.97 * \sin 30 \rightarrow CD = 36.48$$

$$Leg\ Length\ 2 = 245.52 - CD - FG = 183.06$$

Now that we have both Leg Length 1 and 2 we can use the following equation again to calculate the Bend Allowance:

$$Initial\ Length = Leg\ Legnth\ 1 + BA + Leg\ Length\ 2$$

$$BA = 300 - 72.97 - 183.06 = 43.97$$

To calculate R’ which is the radius of the arc on the neutral axis we can use the following equation:

$$BA = \frac{2\pi R' A}{360} \rightarrow R' = \frac{360 * BA}{2\pi A}$$

A is the bending angle in the above equation so

$$R' = \frac{360 * 43.97}{2\pi * 60} = 42$$

To calculate the neutral axis distance from the inner face (t) we can subtract inside bend radius from R’:

$$t = R' - R = 42 - 30 = 12$$

And by having t and the sheet thickness (T) we can calculate the K-Factor as follow:

$$K = \frac{t}{T} = \frac{12}{20} = 0.6$$

Bending Angles Greater Than 90 degrees

Like previous scenarios let's start by calculating Leg Length 1.

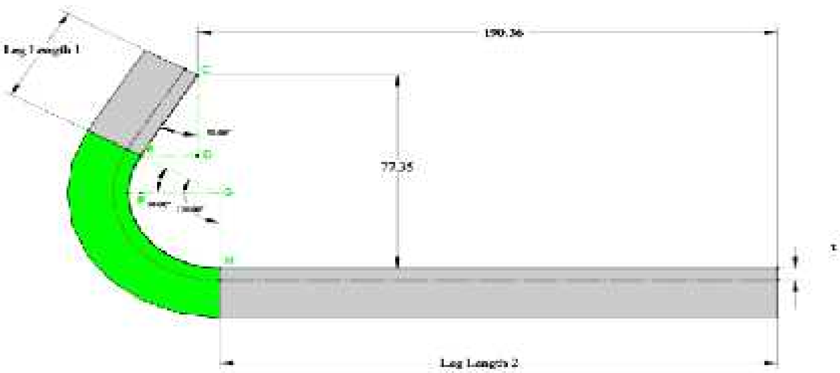


Figure 3.18. Degrees bend

Based on Figure 4 we have:

$$\sin 30 = \frac{EF}{EG} = \frac{EF}{R} \rightarrow EF = R \sin 30 = 15$$

$$77.35 = CD + EF + GH \rightarrow CD = 77.35 - EF - R \rightarrow CD = 77.35 - 15 - 30 = 32.35$$

$$\cos 30 = \frac{CD}{Leg\ Length\ 1}$$

$$Leg\ Length\ 1 = \frac{32.35}{\cos 30} = 37.35$$

Next, we calculate Leg Length 2:

$$\sin 30 = \frac{ED}{Leg\ Length\ 1} \rightarrow ED = 37.35 \sin 30 = 18.68$$

$$\cos 30 = \frac{FG}{EG} = \frac{FG}{R} \rightarrow FG = R \cos 30 = 25.98$$

$$Leg\ Length\ 3 = 190.36 + ED - FG = 190.36 + 18.68 - 25.98 = 183.06$$

Now we can calculate the Bending Allowance:

$$Initial\ Length = Leg\ Legnth\ 1 + BA + Leg\ Length\ 2$$

$$BA = 300 - 37.35 - 183.06 = 79.59$$

By having BA we can now calculate K-Factor:

$$BA = \frac{2\pi R' A}{360} \rightarrow R' = \frac{360 * BA}{2\pi A} = \frac{360 * 79.59}{2\pi * 120} = 38$$

$$t = R' - R = 38 - 30 = 8$$

$$K = \frac{t}{T} = \frac{8}{20} = 0.4$$

Bend Deduction Calculation

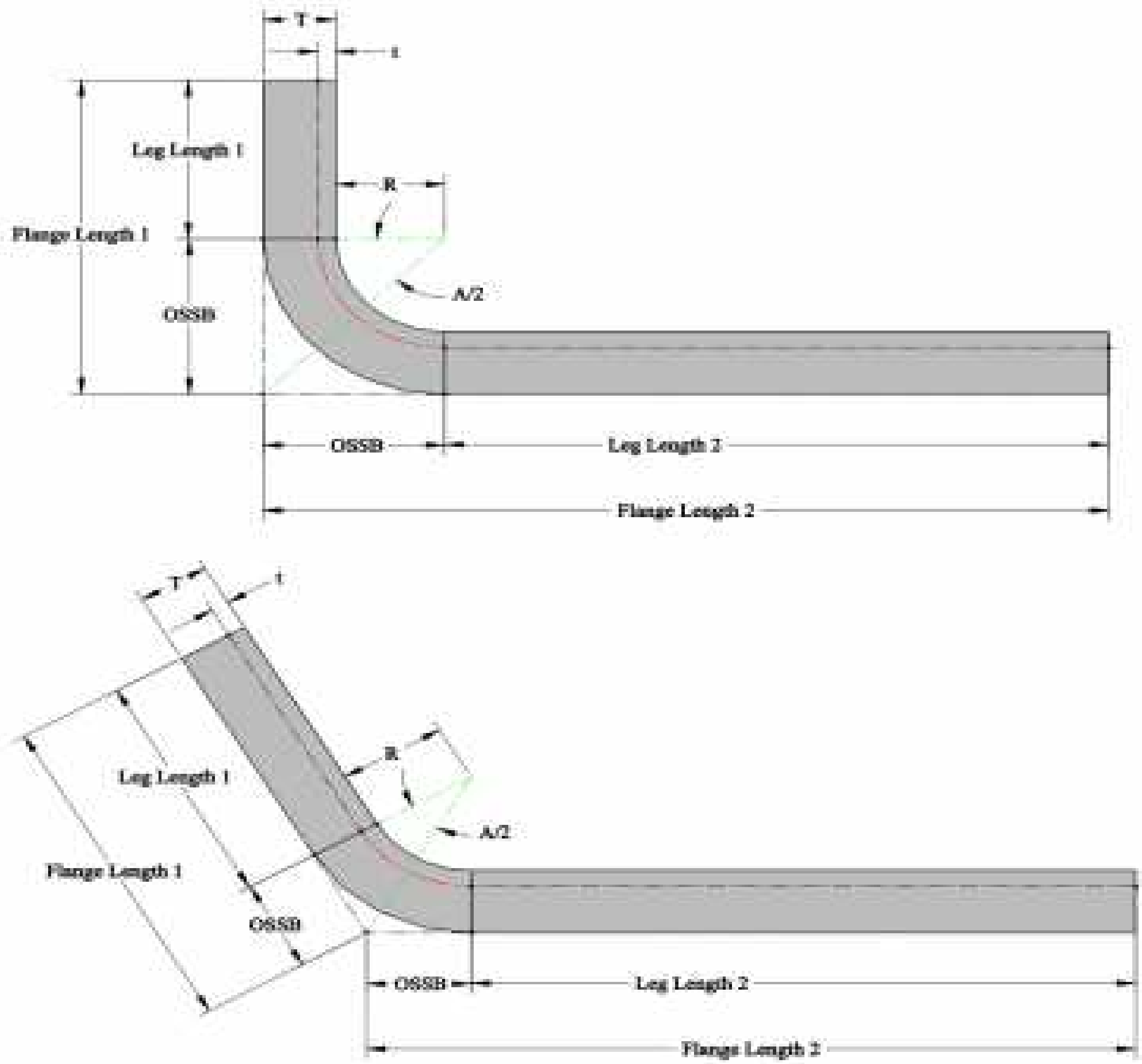
As explained in my first post the Bend Deduction can be calculated using the following equation:

$$BD = 2 \times OSSB - BA$$

Where OSSB is the outside setback. OSSB is defined as illustrated in figure 5 for different bending angles and can be calculated using the equation below:

$$\tan\frac{A}{2} = \frac{OSSB}{R+T} \rightarrow OSSB = (R+T)\tan\frac{A}{2}$$

Where A is the bending angle, T is the sheet thickness and R is the bending radius



Self-check-3

Say true or false

1. To draw a pattern using triangulation method it is a must to draw the top view of the solid to scale

2. The pattern of cones, pyramids and frustums can be prepared using radial line development

3. The pattern of all right cones and right pyramids falls on a circle whose radius is equal to the slant height

Part I I :- choose the best answers

4________ is the act of determining a target's size, length, weight, capacity, or other aspect.

A. Marking out
B. measurement
C. Method of layout
D. Development

5. The process of transferring measurements from a project drawing to the material from which the project is to be made.

A. Marking out
B. Drawing
C. Sketching
D. Pattern

6. A kind of pattern which is used in making cone-shaped objects such as funnels, buckets or tapered lamp shades.

A. Triangulation
B. Parallel line
C. Radial line
D. Square

Operation sheet-3

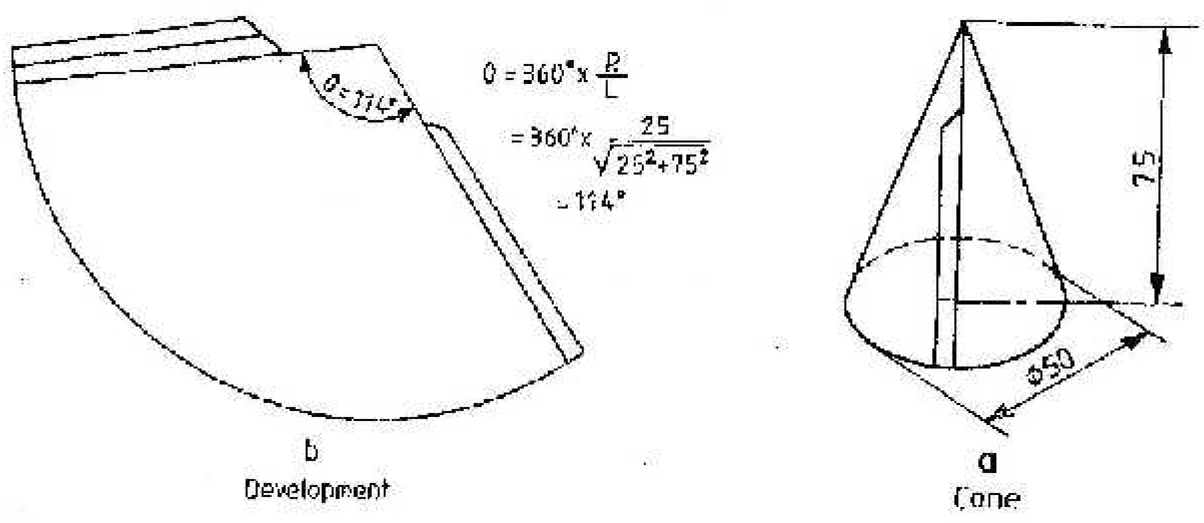
Operation title: - writ the steps of parallel development

Purpose: - makes software development easier, faster, and less risky for developers

Instruction: Using the correct procedures and correct tools when parallel development

Lap test 3	**practical**

Task 1: Make frustum of cone using the given G.I. Sheet or mild steel sheet



Unit Four: Cut and Join Sheet Metal

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Perform set –up operation
- Mark out sheet metal
- Cut sheet metal as to pattern
- Use cut tools and machine
- clean surface
- Join sheet metal
- Avoid damage to all surround surfaces

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform set –up operation
- Mark out sheet metal
- Cut sheet metal as to pattern
- Use cut tools and machine
- Prepare and clean surface
- Join sheet metal
- Avoid damage to all surround surfaces

4.1. Perform set –up operation

Setup can be understood as configuration, adjustment or calibration. That is, setup is the operation of interrupting production to perform tool change, so that machines and industrial equipment are adjusted. It is through the setup process that change in the manufacture of one type of product to another is performed.

Setup time is the duration during which manufacturing is interrupted for machinery and equipment to be adjusted. It's the time elapsed between manufacturing the last good part of a product A and the first good part of a product B, when a change in tools is needed. Changeover time is the time between the last good part of a production batch and the approved part of the next batch. Setup times vary, depending on the technology used, the equipment used, product variations, and the production planning performed by the industry.

Performing a setup operation involves four steps, illustrated below Figure

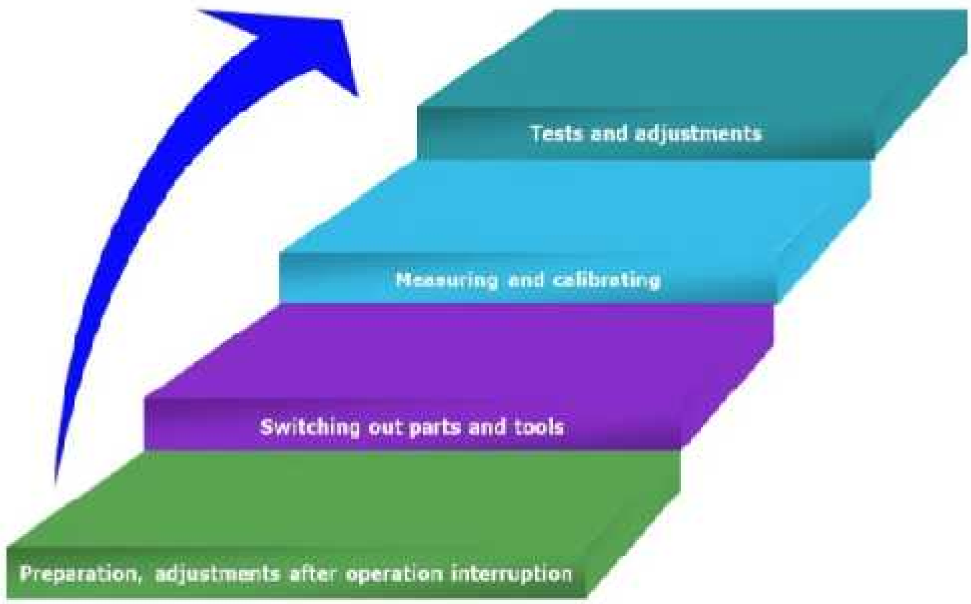


Fig 4.1. Set –up operation

Managing setup operations with reduced setup time results in a number of benefits for companies, including:

1) Possibility of small-batch manufacturing
2) Reduced lead time
3) Increased flexibility
4) Reduced inventories of in-process and finished products
5) Minimization of failures, reducing scrap and rework
6) Reduced delivery times
7) Increased productivity
8) Reduced production costs;
9) Improved customer satisfaction and company image with the market

4.2. Marking out Sheet metal

Marking out is the process of transferring measurements from a project drawing to the material or work piece. The resulting flat pattern made directly on the metal drawing on sheet metal is called the layout. It shows the shape and size of the object, the location of all holes or openings, and the areas to be machined or otherwise removed. A layout I similar to a working drawing laid out on a metal work piece. Accuracy is very important, if you make an error, your job can be ruined before you ever start it.

- To make a good lay-out, you must be able to
- Read and understand drawings and prints,
- Use lay-out tools correctly, and
- Transfer measurements accurately from a drawing to the material itself.

The following (fig.4.2.), shows you the pattern what look likes. it shows full information/ data about box , shown also by pictorial drawing.

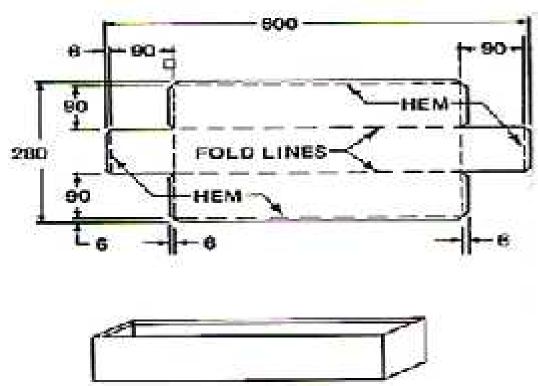


Fig 4.2. Marking or laying out box

4.3. Measuring and Cutting Sheet metal to pattern.

Measurement is the process of associating numbers with physical quantities and phenomena. Measurement is fundamental to the sciences; to engineering, construction, and other technical fields; and to almost all everyday activities. "Measurement" is the act of determining a target's size, length, weight, capacity, or other aspect.
Measurement methods

Direct measurement is measurement done by bringing the target into contact with the measurement system to read the length, height, or other aspect directly. Although direct measurement allows measurement results to be known as they are, errors may occur depending on the skill of the person doing the measurement.
Indirect measurement is done, for example, by using a dial gauge to measure the height difference between a measurement target and a gauge block and using that height to indirectly determine the target's height. Because this type of measurement is based on a reference, indirect measurement is also referred to as “comparative measurement.”

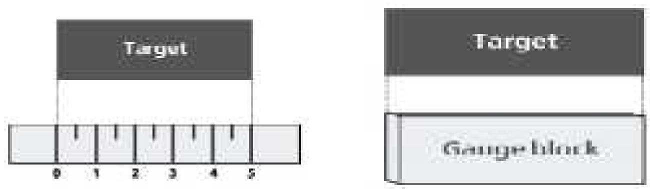


Fig.4.3: Measurement methods

4.3.1. Metric and English Systems

The metric system is an internationally agreed decimal system of measurement created in France in 1799. The International System of Units (SI), the official system of measurement in almost every country in the world, is based upon the metric system. In the metric system, each basic type of measurement (length, weight, capacity) has one basic unit of measure (meter, gram, and liter).

Table 4.1. Metric system,

10 millimeters (mm) =	1 centimeter (cm)	
10 centimeters =	1 decimeter (dm)	= 100 millimeters
10 decimeters =	1 meter (m)	= 1,000 millimeters
10 meters =	1 dekameter (dam)	
10 dekameters =	1 hectometer (hm)	= 100 meters
10 hectometers =	1 kilometer (km)	= 1,000 meters

- **English System**

While the metric system was lawfully accepted for use in the United States in 1866, the US has not adopted the metric system as its "official" system of measurement. The US English System of measurement grew out of the manner in which people secured measurements using body parts and familiar objects. For example, shorter ground distances were measured with the human foot and longer distances were measured by paces, with one mile being 1,000 paces. Capacities were measured with household items such as cups, pails (formerly called gallons) and baskets.

4.4. Use cut tools and machine

4.4.1. Cutting sheet metal

Cutting processes are those in which a piece of sheet metal is separated by applying a great enough force to cause the material to fail. The most common cutting processes are performed by applying a shearing force, and are therefore sometimes referred to as shearing processes.

In terms of cut-off machine operation, selecting the proper feed speed, angle of approach and cutting mode will minimize sample deformation. Wet abrasive sectioning involves the use of a recirculation system to supply a stream of coolant to the sample during the cut. This helps to prevent heat damage and to remove cutting debris from the wheel and specimen.

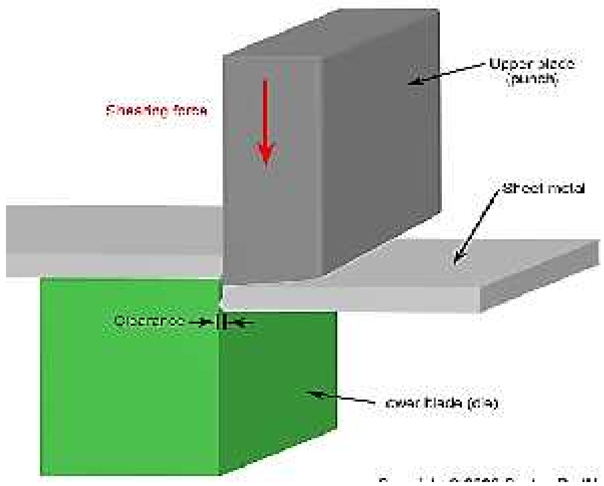


Fig 4.4. Shearing of sheet metal

Sheet metal cutting processes include the following:

õ **Shearing:** Shearing is a sheet metal cutting operation along a straight line between two cutting edges by means of a power shear.

õ **Cutting off:-** is the operation of shearing the piece from sheet metal with a cut along a single line.

õ **Parting:** This means that the strip is removed between the two pieces to part them.

õ **Piercing:-**is the operation of making a hole of any shape in a sheet metal by punch or die.

õ **Blanking** - sheet metal cutting to separate piece from surrounding stock õ **Notching -** Punching the edge of a sheet, forming a notch in the shape of a portion of the punch.

Fig.4.5. Notching operation

Different requirements and conditions place a variety of demands on clamping tools and cutting equipment.

Fig.4.6. Floor stands Cut-off Machines

õ **Punching** - sheet metal cutting similar to blanking except cut piece is scrap, called a *slug*

- Remaining stock is the desired part

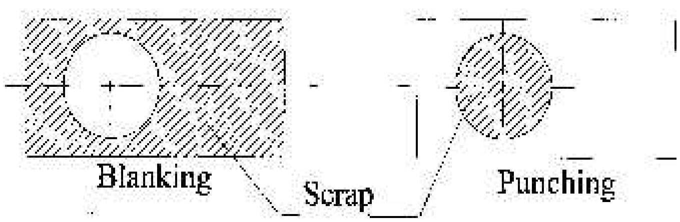


Fig.4.7. Punching

õ **Bending**: Bending is defined as the straining of the sheet metal around a straight edge

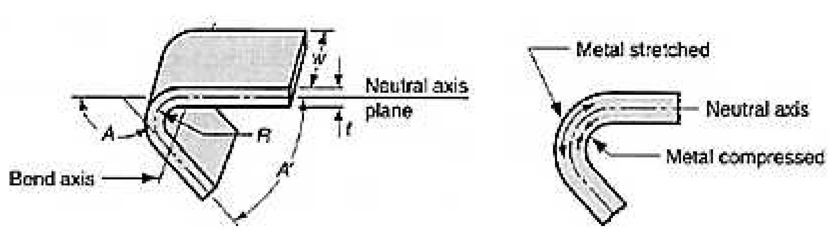


Fig. 4.8. Bending sheet metals

õ **Slitting:** It is the operation of cutting the sheet metal in a line along the length.

õ **Slotting** - A punching operation that forms rectangular holes in the sheet. Sometimes described as piercing despite the different shape.

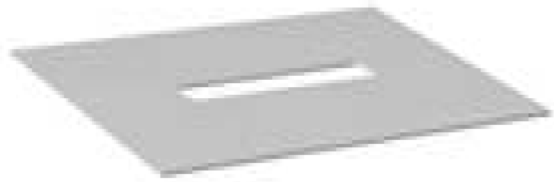


Fig. 4.9.Slotting

4.5. Clean surface

4.5.1. Cleaning surface of sheet metal

Identifying the sheet metal required for work. Before starting to perform your work, you should have to clean the surface of work pieces from sheet metal (foreign materials) like, grease, dust, rust, oil and others. Commonly there are two ways of cleaning surface of sheet metals. They are by mechanically and chemical. Mechanically by using abrasive paper, sand blasting, wire brush, and rage/ stracho, etc. and chemical by using solvents.

4.6. Join sheet metal

Sheet Metal Joints & Seams: Common Types Used in Welding & Metal Fabrication. Sheet metal joints are found in every sheet metal assembly. From ducts to frames to skins, these sheet metal joints are extremely common but generally unknown to the common viewer.
Riveting: Joining two Meta l pieces together by riveting involves a rivet, which is a metal fastener that has a cylindrical post with a head that is placed in a drilled or punched hole. The end of the cylindrical post is then upset by forming / expanding which holds the two pieces of metal in place by the rivet.
Appliance engineers have several options for joining sheet metal, including screws, rivets, welding, bonding, clinching and folding.
In this article, we will introduce the 6 types of sheet metal joining process that is often used in product design.

- Folding / Tab Joints.
- Pulling Rivet.

- Self-clinching.
- Screw Joint / Fasteners.
- Pressing Rivet.
- Welding Joints

Fig .4.10. Sheet metal joint

4.7. Avoid damage to all surround surfaces

Avoid costly home glass repairs near Houston, there are a few tips that can help protect the various glass surfaces of your home.

1. Clean Regularly

It is very important to clean all of your glass surfaces on a consistent basis. Your glass shower doors, glass table tops, and windows should not be left with stains, dust, or any sort of buildup. By not removing these stains and grime, the integrity of your glass surfaces can begin to breakdown and become more damaged in the end.

2: Cover Windows

Whenever you do a home improvement project, such as painting the interior or exterior of the house, cover your windows and glass surfaces to protect them from damage. You may think a few paint stains will not do much damage. However, if left to linger, those paint stains can become difficult to remove, meaning you may scratch your house windows during cleanup.

3: Consider Soft Water

Part of the common stains found on glass shower doors and the exterior of house windows is caused by hard water stains. The calcium and other minerals found in hard water can leave a thick residue that becomes very difficult to remove. Consider installing a soft water filtration system to help combat these stains, and do not use your garden hose on the exterior of your house windows. Using the hose will damage your windows with hard water stains, increasing the chance that you will need home glass repair.

Self-check-4

Directions: I Answer True or False for all the questions listed below

1. English (US) is an internationally agreed decimal system of measurement.

2. marking out is the process of transferring measurements from a project drawing material

3. Solvent is chemically to remove foreign material from sheet metal

Directions: II choose the best answers for all the questions listed below

4. _______ is the act of determining a target's size, length, weight, capacity, or other aspect.

   a. Marking out
   b. measurement
   c. Method of layout
   d. Development

5. A kind of pattern which is used in making cone-shaped objects such as funnels, buckets or tapered lamp shades.

   a. Triangulation
   b. Parallel line
   c. Radial line
   d. Square

6. The resulting flat pattern made directly on the metal.

   a. Drawing C. Triangulation
   b. Sketching D. Lay-out

Operation Sheet 4

Operation title: - Methods of preparing workplace for cutting and joining sheet metal

Purpose: - makes prepare workplace easier, faster, and less risky for cutting and joining sheet

Instruction: Using the correct procedures and correct tools for cutting sheet metal by snips

Methods of preparing workplace for cutting and joining sheet metal are:

Step 1- Do not block exits

Step 2- Change burned-out light fixtures in work areas, walkways, and exits

Step 3- Keep floors and work areas clean, dry, and grease-free

Step 4- Keep steps and ladders in serviceable condition

Step 5- Keep emergency equipment clean and unobstructed

Step 6- Ensure that all signs and caution labels are in good condition and visible

LAP Test 4	**Practical Demonstration**

Name: _______________________________ Date: _________________

Time started: __________________________ Time finished: _________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2 hours.

Task 1: perform Laying out and cutting operations

Unit Five : Quality assure work and clean up

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Measure aligns, join and seal components.
- Measure tools and equipment
- Clean, check, maintain and store work area, tools and equipment.

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Use Measurement aligns, join and seal components.
- Apply Clean, check, maintain and store work area, tools and equipment
- Complete workplace documentation.

5.1. Measure aligns, join and seal components

5.1.2. Inspection

Inspection is an organized examination or formal evaluation exercise. In engineering, inspection involves the measurements, tests, and gages applied to certain characteristics in regard to an object or activity. The results are usually compared to specified requirements and standards for determining whether the item or activity is in line with these targets.

Measure from line to line with the tape level with the floor. Measure again on the back sides of the tires. Make sure that the tape is level and the same distance above the ground as it was for the front reading.

The measurement alignment is the action to detect the processing position of a product whose expansion/shrinkage is large, such as a substrate.

The measurement alignment is the action to detect the processing position of a product whose expansion/shrinkage is large, such as a substrate.

These so-called alignment errors lead to an increased risk of breakage near the clamping area. Alignment errors can be especially common with brittle materials. Stiff and brittle materials break with seeming low tensile stress and strain in the area of the largest bending. This is where Zwick Roell alignment services come into play: a highly developed procedure enables visualization of the specific bending strain with the help of strain gauges and reporting to initiate required measures for alignment.

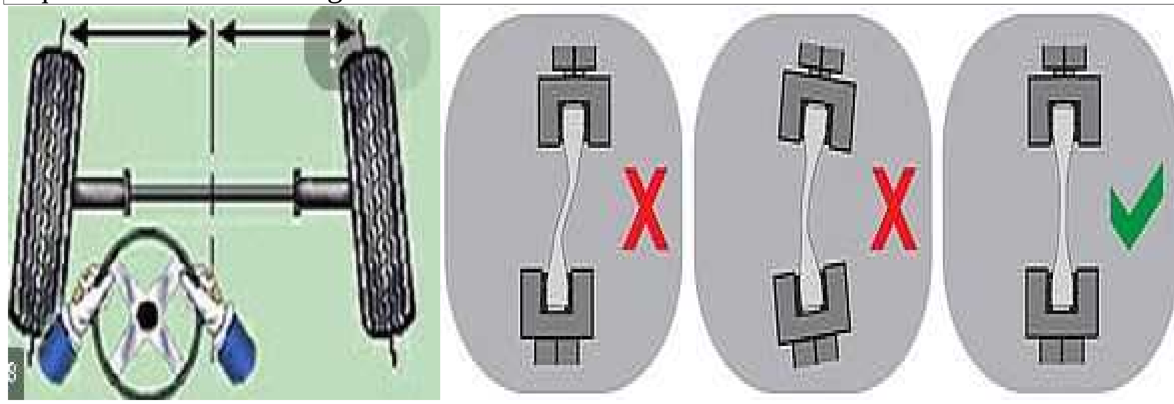


Fig alignment errors

5.1.3. Visual inspection of double seam defects

There are numerous double seam defects that can arise during the fabrication process. There is a list of the most common double seam defects that are detected by the product of double seam. We have several seam analysis products that can inspect double seams and provide easy-to-use information to ensure your double seam quality.

Seam Impression

As the rollers push the cover and body hook materials together, and against the seaming chuck, an impression is left on the inside of the can body. Too much pressure can cause this impression to damage the can liner.

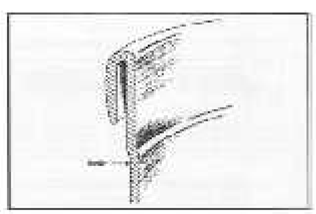


Fig.1.1: Seam impression

Seam bumps

A seam bump is a short area of the double seam where the seam thickness suddenly increases by .004″ or more.

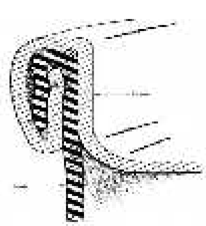


Fig. 1.2: Seam bups

5.2. Measure tools and equipment

5.2.1. Definition of Measurement

Long ago when people were building pyramids, they required a lot of measuring skills. It is interesting to look at how people developed a system of measures. They started by comparing two quantities, which led to phrases such as ‘taller than’, ‘longer than’, ‘heavier than’, ‘holds more than’, etc. People still do this by themselves when they are working on the land. Measurement is how we determine the exact capacity of something that is in solid, liquid or gas form.

5.2.2. Purpose of measurement

Measuring is necessary for accurate measurement and calculation of all construction quantities. For example on big projects a quantity surveyor is often employed to do this work. For house construction, it is often the job of the builder or contractor to carry out this work. In irrigation project also measurement is required and applied at stage of the project .The following are the main purpose of conducting measurement:

- To know the quantity of work
- To Estimate the quantity of Material required
- To determine the cost of the work
- To estimate the expect project completion time
- To know the amount of water supplied for irrigation filed

5.2.3. Type of measurement

There are two methods of measurement: A) direct comparison with the standard, and B) indirect comparison with the standard. Both the methods are discussed below:

❖ Direct Comparison with the Standard

In the direct comparison method of measurement, we compare the quantity directly with the standard. Say for instance, if we have to measure the length of the bar, we will measure it with the help of the measuring tape or scale that acts as the standard. Here we are comparing the quantity to be measured directly with the standard.

❖ Indirect Method of Measurement

There are number of quantities that cannot be measured directly by using some instrument. For instance we cannot measure the strain in the bar due to applied force directly. We may have to record the temperature and pressure in the deep depths of the ground or in some far off remote places. In such cases indirect methods of measurements are used.

5.2.4. Measurement equipment

For each type of measurement, there is a particular measuring instrument which is most suitable to do the job. It will be impossible to list all the possible measuring instruments, thus we will look at the most common instruments and welcome your knowledge and experience to enhance understanding of this unit.

A. Rulers

A ruler that is in good condition is a practical instrument for measuring shorter, straight lines (linear lines). We can measure millimetres and centimetres with a ruler. A ruler is not suitable to measure long lengths and round shapes. Figure 2.1 below present the typical type of ruler used for measurement.

Figure 2.1.Rurle

B. Venire Caliper

The venire caliper is used to make semi- accurate measurements for inside, outside and depth dimensions. Standard venire calipers are available in sizes 150mm to 250mm. Custom- made vernier calipers can be made to specifications if required. Graduations, (that determine the accuracy of the instrument) are usually 0,02mm or 0,05mm on the venire scale.

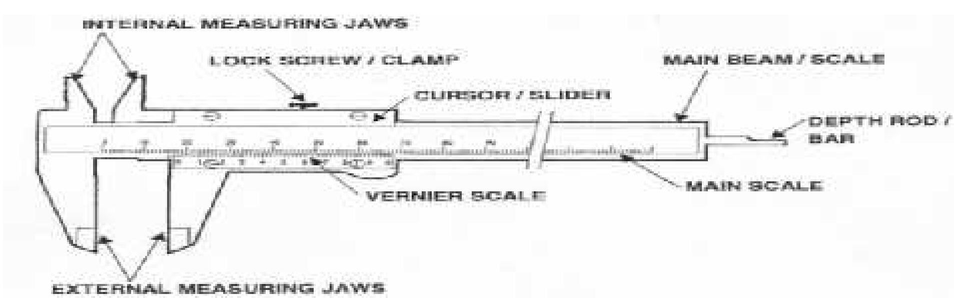


Figure 2.2 The venire caliper

C. . Measuring Tape

A measuring tape is used when a ruler is too short to measure the distance or length. We use the measuring tape to measure short distances in meters. Measuring tapes are usually gradated in millimetres, centimetres and meters.

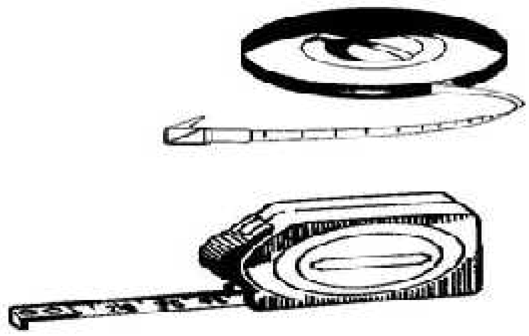


Figure 2.3.The different types of tapes

5.3. Clean, check, maintain and store work area, tools and equipment

5.3.1. Cleaning your work area

Cleaning your work area makes it a safe and pleasant environment for your customers to shop. The cleaning of your work area must be carried out on a regular basis. The quick and easy jobs can be carried out during the day, while other larger tasks such as vacuuming might be done before the shop opens, or at the end of the day's trading. In some larger retail stores, professional cleaners may be used for the larger tasks, but it is still your responsibility to keep your own work area clean and tidy

Poor housekeeping can be a cause of incidents, such as:

- tripping over loose objects on floors, stairs and platforms
- being hit by falling objects
- slipping on greasy, wet or dirty surfaces
- striking against projecting, poorly stacked items or misplaced material
- cutting, puncturing, or tearing the skin of hands or other parts of the body on projecting nails, wire or steel strapping

Effective housekeeping results in:

- reduced handling to ease the flow of materials
- fewer tripping and slipping incidents in clutter-free and spill-free work areas
- decreased fire hazards
- lower worker exposures to hazardous products (e.g. dusts, vapors)
- better control of tools and materials, including inventory and supplies

5.3.2. Checking and cleaning tools and equipment

Keeping tools properly storing, cleaning, and maintaining will save time and money. In order to keep tools in good working condition during storage, there are some basic preparatory steps that should be taken. It is important to follow the cleaning and storage instructions, especially for larger power tools such as power saws or plate compactor.

Tool housekeeping is very important, whether in the tool room, on the rack, in the yard, or on the bench. Tools require suitable fixtures with marked locations to provide an orderly arrangement. Returning tools promptly after use reduces the chance of it being misplaced or lost. Workers should regularly inspect, clean and repair all tools and take any damaged or worn tools out of service.

5.3.3. Maintaining of tools and equipment

The maintenance of tools and equipment may be the most important element of good housekeeping. Maintenance involves keeping tools, equipment and machinery in safe, efficient working order and in good repair. It includes maintaining sanitary facilities and regularly painting and cleaning walls. Broken windows, damaged doors, defective plumbing and broken floor surfaces can make a workplace look neglected; these conditions can cause incidents and affect work practices. So it is important to replace or fix broken or damaged items as quickly as possible. A good maintenance program provides for the inspection, maintenance, upkeep and repair of tools, equipment, machines and processes

Maintenance of equipment's: Maintenance of sheet metals machines

- Changing worn blade
- Changing deformed gasket
- Operating frequently

- Changing oil monthly
- Greasing rotating or vibratory parts
- Regular Lubrication
- replacement of worn parts

5.3.4. Storing tools and equipment

Good organization of stored materials is essential for overcoming material storage problems whether on a temporary or permanent basis. There will also be fewer strain injuries if the amount of handling is reduced, especially if less manual material handling is required. The location of the stockpiles should not interfere with work but they should still be readily available when required. Stored materials should allow at least one metre (or about three feet) of clear space under sprinkler head

5.3.5. How to Prepare and Store Tools

To keep tools tidy, it should be cleaned after use and wiped down with a rag or towel to be sure that they are free of dirt, grease and debris.

5.3.6. How to Prepare and Store Tools

1. To keep tools tidy, it should be cleaned after use and wiped down with a rag or towel to be sure that they are free of dirt, grease and debris.
2. After cleaning, damage or defects should be checked. If the tool cannot be repaired, it should be thrown to away.
3. Any soil and dirt should be scraped away from the metal surfaces with an approved solution. Before placing in storage it should be dried with a towel or rag.
4. The metal parts of the tools should be coated with a lubricant protector spray.
5. Tools is does not directly stored on the ground both small hand and power tools should be Placed on shelving.

5.4. Complete documentation

5.4.1. Documentation

A document is a material that provides official information as evidence. It is Information used to support effective and efficient manufacturing operations. Like design, process and finished products.

Design is the process of defining, visualizing and documenting fabrication requirements for sheet metal prior to the manufacturing process.

Fabrication is the process of taking the completed fabricated product or pieces to make a complete product and then fitting them into their required location off-site.

Installation is the process of taking the completed fabricated product or pieces to make a complete product and then fitting them into their required location off-site.

5.4.2. Product Instructions (directions, or requirements)

Specifications:- Describe in detail the requirements with which the products or materials used or obtained during manufacture have to conform. They serve as a basis for quality evaluation.

Manufacturing Formulae, Processing, Packaging and Testing Instructions: Provide detail all the starting materials, equipment and computerized systems (if any) to be used and specify all processing, packaging, sampling and testing instructions. In process controls and process analytical technologies to be employed should be specified where relevant, together with acceptance criteria.

Self-Check -5	Written Test

Directions: I answer all the questions listed below.

Which one is not the result of poor housekeeping?

a. Tripping over loose objects on floors, stairs and platforms

b. Being hit by falling objects

c. Slipping on greasy, wet or dirty surfaces

d. Decreased fire hazards

Keeping tools properly storing, cleaning, and maintaining will:

a. Increase the cost

b. Save time and money

c. Reduces the chance of it being misplaced or lost.

d. B&C

e. All

The maintenance of tools and equipment involves:

a. Keeping tools

b. Equipment and machinery in safe

c. Efficient working order and in good repair.

d. All of the above

It is the process of defining, visualizing and documenting fabrication requirements for sheet metal prior to the manufacturing process.

a. Fabrication

b. Design

c. installation

d. . None

Which one is used to give directions for performing certain operations?

A. Manufacturing formulae B Manufacturing testing C. procedures D.all

Part II Match part A to part B

Column A

______1. Seam Impression

______2. Expulsion of Metal Near Weld Site

______3. Crack at weld area

________4. False seam

________5. Cut over

Column B

A. Surface contamination

B. Defect where the metal is fractured at the top of the seaming chuck wall

C. Too much pressure causes it to damage the can liner.

D. Created by too little pressure

E. A defect which occurs when hooks do not interlock

Operation Sheet 5

Operation title: - **How to Prepare and Store Tools**

Purpose: - makes correct ordering tools and equipment easier, faster, and less risky from damage

Instruction: Using the correct procedures and correct tools when to Prepare and Store Tools

Lap Test 5

-

Task-1: Perform measurement using Venire Caliper

Task-2: Perform measurement using Tape

List of Reference Materials

1) “Layout and Fabrication of sheet metal and fiberglass duct”, NAVEDTRA 14250A, Chapter 13.
2) “student safety guidelines”: Technology,
3) Trade of industrial insulation: “Sheet Metal and Insulation Fundamentals”,
4) Trade of industrial insulation: “Sheet Metal and Insulation Fundamentals”, PHASE 2,
5) Shielded metal arc welding (SMAW),by ayuba Isaac
6) Finbar smith solas 2014
7) Advanced Welding Symbols
8) Tommaso Di Giamberardino - Davide Quintiliani Walter Tosto S.p.A., Chieti – Ital
9) Lab manual welding

No	Name	Qualification (Level)	Field of Study	Organization/ Institution	Mobile number	E-mail
1	Adugna Mosisa Ejeta	A(MSC)	Manufacturing Technology	Nekemte Poly Tec.	0911921931	
2	Ermiyas Ambaye Neway	A(MSC)	Manufacturing	Nefas SILK	0911169904	Ambayeermi@
3	Tadele Worku Bidika	A(MSC)	Manufacturing Technology	Asosa Poly Tec.	0913970611	Tadeworku09@gmail .com
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