DEPARTMENT OF MECHANICAL ENGINEERING
MANUFACTURING PROCESS-R19

DEPARTMENT OF MECHANICAL ENGINEERING
SVR ENGINEERING COLLEGE
NANDYAL-518501

MANUFACTURING TECHNOLOGY LAB

LIST OF EXPERIMENTS

1. **Design and calculation of gating system.**
2. **Moulding melting properties and compositions.**
3. **Preparation Sand properties testing – Exercise -for strengths, and permeability.**
4. **Preparation Moulding, melting and casting.**
5. **Preparation of Butt joint by Arc welding.**
6. **Preparation of Lap joint by Arc welding.**
7. **Preparation of Butt joint by Tungsten inert gas welding.**
8. **Blanking and punching operations.**
9. **Bending operation by using Hydraulic press.**
10. **Additive manufacturing with reverse engineering.**

1.GATING SYSTEM

Aim: Design a gating system to achieve a defects free casting

Gate: Agate is a channel which connect runner with the mould cavity and through which molten metal flow to fill the mould cavity.

•A small gate is used forecasting which solidifies slowly and vice versa.
•Agateshouldnothavesharpedgesastheymaybreakduringpouringandsandpiecesthusmaybecarriedwiththemoltenmetalinthemouldcavity.

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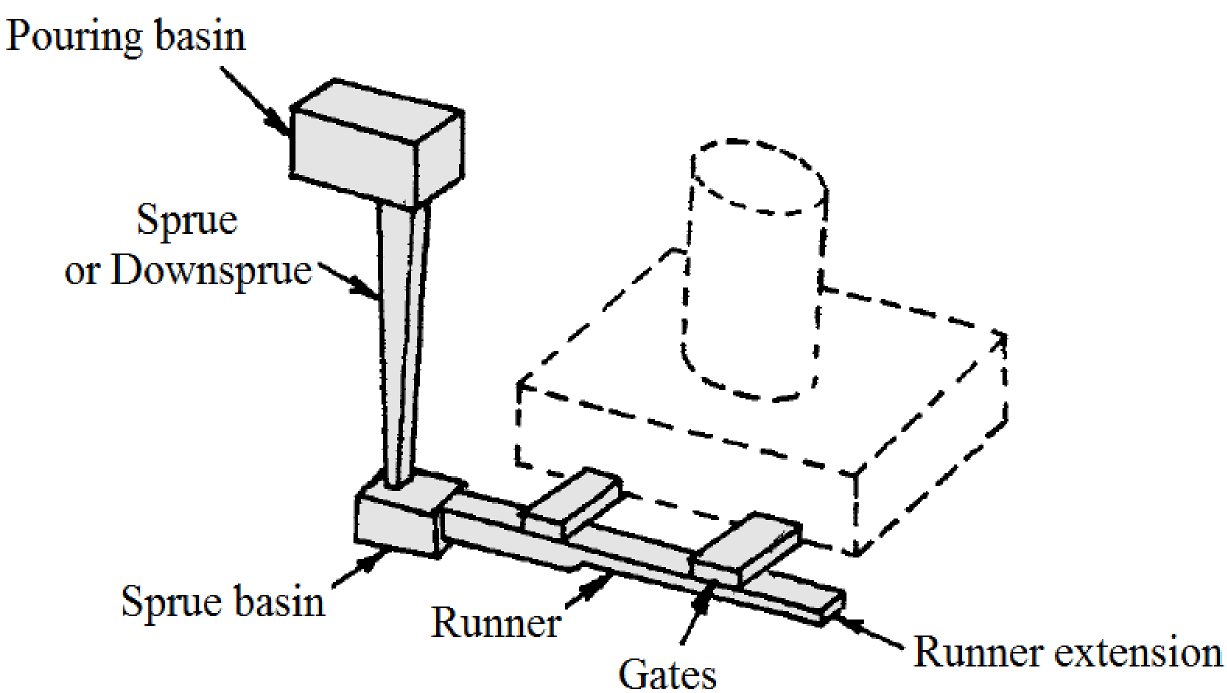
Elements of Gating System: The term gating system refers to all passageways through which the molten metal passes to enter the mould cavity. The gating system is composed of

- Pouring basin
- Sprue
- Runner
- Gates
- Risers



Procedure:

1. Calculating pouring time : The time for complete filling of a mould .
   Too long pouring time means maintain higher pouring temperature. And Too less pouring time means turbulent flow in mould.Optimum time is required.

The pouring time depends on:

Casting materials, casting complexity, Casting size, and Section thickness.

1-Gray cast iron: mass less than 450 kg:

Pouring Time

Grey cast iron, mass less than 450 kg

$$\text{Pouring time, } t = K\left(1.41 + \frac{T}{14.59}\right)\sqrt{W} \text{ s}$$

where

$$K = \frac{\text{Fluidity of iron in inches}}{40}$$

T = average section thickness, mm

W = mass of the casting, kg

Grey cast iron, mass greater than 450 kg

$$\text{Pouring time, } t = K\left(1.236 + \frac{T}{16.65}\right)\sqrt[3]{W} \text{ s}$$

Steel castings

$$\text{Pouring time, } t = (2.4335 - 0.3953 \log W)\sqrt{W}$$

2. Choke Area

It is the main control area which meters the metal flow into the mould cavity so that the mould is completely filed within the calculated pouring time.

$$C_A = \frac{W}{c.dt\sqrt{2gH}}$$

C_A is choke area
W is the weight of casting
C is nozzle coefficient
d is density of liquid metal
t is pouring time
H effective liquid metal head

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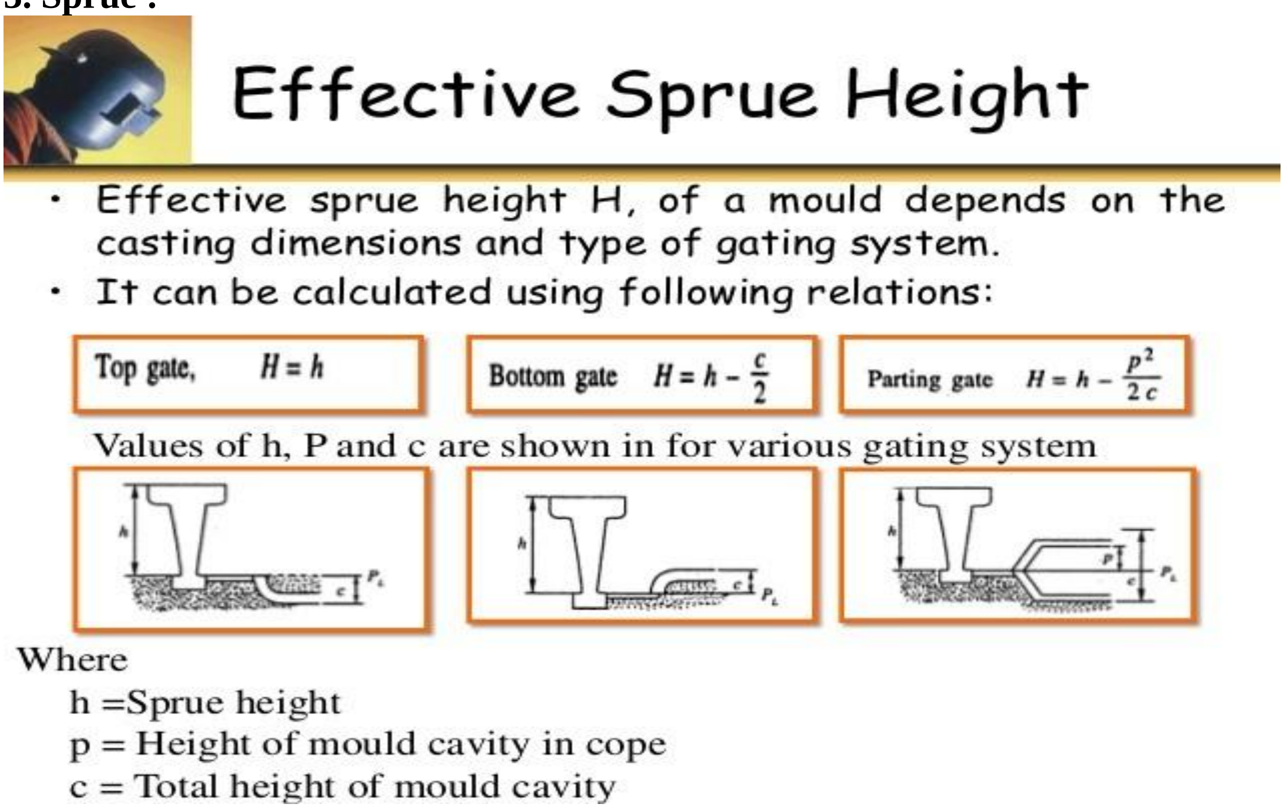
3. Sprue :



Mass flow rate

$$\boxed{\dot{m} = \rho\,\dot{V} = \frac{\dot{V}}{v} = \rho\,A\,\vec{V} = \frac{A\,\vec{V}}{v}}$$

where: $\dot{m}$ is the mass flow rate $\left[\mathrm{kg}/\mathrm{s}\right]$

$\dot{V}$ is the volumetric flow rate $\left[\mathrm{m}^3/\mathrm{s}\right]$

ρ is the density $\left[\mathrm{kg}/\mathrm{m}^3\right]$, v is the specific volume $\left[\mathrm{m}^3/\mathrm{kg}\right]$

$\vec{V}$ is the velocity $\left[\mathrm{m}/\mathrm{s}\right]$, A is the flow area $\left[\mathrm{m}^2\right]$

Continuity equation Q=A1*V1=A2*V2

Actual shape of sprue is Parabola But in order to avoid manufacturing difficulty we use tapered cylinder shape.

RESULT:

2.TESTING SAND PROPERTIES

AIM: Testing properties of the standard sand

SAND PREPARATION:

Tests are conducted on a sample of the standard sand. The moulding sand should be prepared exactly as is done in the shop on the standard equipment and then carefully enclosed in a closed container to safeguard its moisture content.

MOISTURE CONTENT:

Moisture is an important element of the moulding sand as it affects many properties. To test the moisture of a moulding sand a carefully weighted test sample of 50g is dried at a temperature of 105^{0}C to 110^{0} C for 2 hours by which time all the moisture in the sand would have been evaporated. The sample is then weighted. The weight difference in grams when multiplied by 2 would give the percentage of moisture contained in the moulding sand.

Alternatively a moisture teller can also be used for measuring the moisture content. In this sand is dried by suspending the sample on a fine metallic screen and allowing hot air to flow through the sample. This method of drying completes the removal of moisture in a matter of minutes compared to 2 hours as in the earlier method.

Another moisture teller utilizes calcium carbide to measure the moisture content. The apparatus is then shaken vigorously such that the following reaction takes place.

$CaC_2+2H_2O \longrightarrow C_2H_2+Ca\ (OH)_2$

The acetylene (C_2H_2) coming out will be collected in the space above the sand raising the pressure. A pressure gauge connected to the apparatus would give directly the amount of acetylene generated which is proportional to the moisture present. It is possible to calibrate the pressure gauge to directly read the amount of moisture.

CLAY CONTENT:

The clay content of moulding sand is determined by dissolving of washing it off the send. To determine the clay percentage a 50g sample is dried at 105 to 110^{o} C and the dried sample is taken in one litre glass flask and added with 475 ml of distilled water and 25 ml of a percent solution of caustic soda (NaOH 25g per litre). This sample is thoroughly stirred.

After the stirring, for a period of five minutes the sample is diluted with fresh water up to a l50mm graduation mark and the sample is left undisturbed for 10 minutes to settle. The sand settles at the bottom and the clay particles washed from the sand would be floating in the water. 125mm of this water is siphoned off the flask and it is again topped to the same level and allowed to settle for five minutes. The above operation is repeated till the water above the sand becomes clear, which is an indication that all the clay in the moulding sand has been removed. Now the sand is removed from the flask and dried by heating. The difference in weight of the dried sand and 50g when multiplied by two gives the clay percentage in the moulding sand. Sand **grain size:** To find out the sand grain size, a sand sample which is devoid of moisture and clay such as the one obtained after the previous testing is to be used. The dried clay-free sand grains are placed on the top sieve of a sieve shaker which contains a series of sieves one upon the other with gradually decreasing mesh sizes. The sieves are shaken continuously for a period of 15min. After this shaking operation, the sieves are taken apart and the sand left over on each of the sieve is carefully weighed.

Strength: Measurement of strength of moulding sands can be carried out on the universal sand strength testing machine. The strength can be measured in compression, shear and tension. The sands could be tested are green sand, Dry sand and core sand. The compression and shear test involve the standard cylindrical specimen that was used for the permeability test.

Green compression strength: Green compression strength or simply green strength generally refers to the stress required to rupture the sand specimen under compressive loading. The sand specimen is taken out of the specimen tube and is immediately (any delay causes the drying of the sample which increases the strength) put on the strength testing machine and the force required to cause the compression failure is determined. The green strength of sands is generally in the range of 30 to l90kPa.

Green shear strength: With a sand sample similar to the above test, a difference adapter is fitted in the universal machine so that the loading now be made.for the shearing of the sand sample. The stress required to shear the specimen along the axis is then represented as the green shear strength. The green shear strengths may vary from 10 to 50 kPa.

Dry strength: The tests similar to the above can also be carried with the standard specimens dried between 105 and 110^{0}C for 2 hours. Since the strength greatly increases with

be necessary to apply larger stresses than the previous tests. The range of dry compression strengths found in moulding sands is from 140 to 1800 kPa, depending on the sand sample.

Mould hardness: the mould hardness is measured-by a method similar to the Brinell hardness test. A spring loaded steel ball with a mass of 0.9kg is indented into the standard sand specimen prepared. The depth of indentation can be directly measured on the scale which shows units 0 to 100. When no penetration occurs then it is a mould hardness of 100 and when it sinks completely, the reading is zero indicating a very soft mould.

3. PERMEABILITY TEST

AIM: To find the effect of water content and degree of ramming on green sand.

APPARATUS: Standard Permeability Meter, Stop Watch, Standard Specimen, Beam Balance, Sand Rammer, Weighing Pan, Steel Rule, Measuring Jar, Specimen Tube, Stripper, Specimen Tube Cup.

THEORY: Permeability is defined as that physical property of the moulding sand mixture, which allows gas to pass through it freely. Permeability depends on the grain size, grain shape, grain distribution, binder and its content, degree of ramming and water content of moulding sand. It is one of the most important properties affecting the characteristics of moulds and thereby quality of castings produced. Permeability number is defined as the volume of air in cc that will pass per minute under a pressure of 1 gm which is 1 sq cm in cross sectional area and 1 cm deep.

The sand used for casting must be porous enough, so as to allow the gaseous material, water and steam. Vapors to escape freely when the molten metal is poured into the mould. Insufficient porosity of moulding sand leads to casting defects such as gas holes and pores. The moulder has some control over permeability; hard ramming lowers the permeability, but this is relieved by hbera1 venting.

PROCEDURE:

Conduct the experiment in two parts. In the first case vary water percentage keeping clay percentage constant. In the second case vary clay content percentage and keep water percentage constant.

Take weighed proportions of sand and clay and dry mix them together in a muller for three minutes. Then add water and wet mix for another two minutes. A uniform sand mixture is obtained. Prepare the specimen by ramming.

Place the standard specimen along with the tube in the inverted position on the rubber seal or on the mercury cup of permeability meter.

Operate valve and start the stopwatch simultaneously. When the zero mark on the inverted jar just touches the top of water tank, of the permeability apparatus, note down the manometer reading.

Note down the time required to pass 2000cc of air through the specimen. Calculate permeability number by using formula.

Table 1: Percentage of clay constant and vary the percentage of water

Sl No.	**Percentage of Water**	**Pressure in gm/cm^2**	**Time in min**	**Permeability Number**	
				Indicated	**Calculated**

Specimen Calculation:

$$\text{Permeability Number} = \frac{VH}{PAT}$$

Where:

V= Volume of air passed through specimen = 2000 c.c

H= height of the specimen = 5.08 cm

P= Pressure reading from manometer in g/cm^2

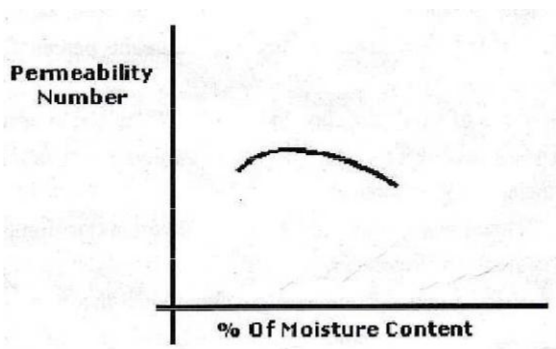
A= Area of the specimen i.e.,

d= Dia, of the specimen in mm

T= Time in minutes for 2000 c.c of air pass through the sand specimen

Graphs to be drawn:

1. Graph drawn Permeability Number Vs Percent of Moisture content



RESULT:

4. MOULDING, MELTING AND CASTING

AIM: To make the mould and pour molten metal into the mould.

TOOLS & EQUIPMENT: Pattern, moulding flasks, sand, moulding tools, furnace, pouring ladle, etc.

MATERIAL USED: Moulding sand, Parting sand and bentonite powder.

THEORY: The important step in the making of casting is the melting of metal. A melting process must be capable of providing molten metal not only at the proper temperature but also in the desired quantity, with an acceptable quality, and within a reasonable cost. In order to transfer the metal from the furnace into the moulds, some type of pouring device, or ladle, must be used. The primary considerations are to maintain the metal at the proper temperature for pouring and to ensure that only quality metal will get into the moulds. After complete solidification, the castings are removed from the mould. Most castings require some cleaning and finishing operations, such as removal of cores, removal of gates and risers, removal of fins and flash, cleaning of surfaces, etc.

PROCEDURE:

Take a mould box, which is in proper condition and place the pattern at the centre of the box. Using shovel fill the box with moulding sand.

Using rammers, ram the sand gently under uniform pressure, till the box is filled with sand.

Using strike off bar strike out excess sands on the box and finish the top surface.

Reverse the mould box and place another box over it. Place the runner and riser in the appropriate position and again fill the sand and repeat the steps 3 and 4.

Remove the runner and riser and place the boxes side by side. Cut the gate manually using gate cutter.

Remove the pattern slowly without disturbing the mould cavity.

Perform finishing on edges and mould surfaces.

The mould is ready for pouring molten metal.

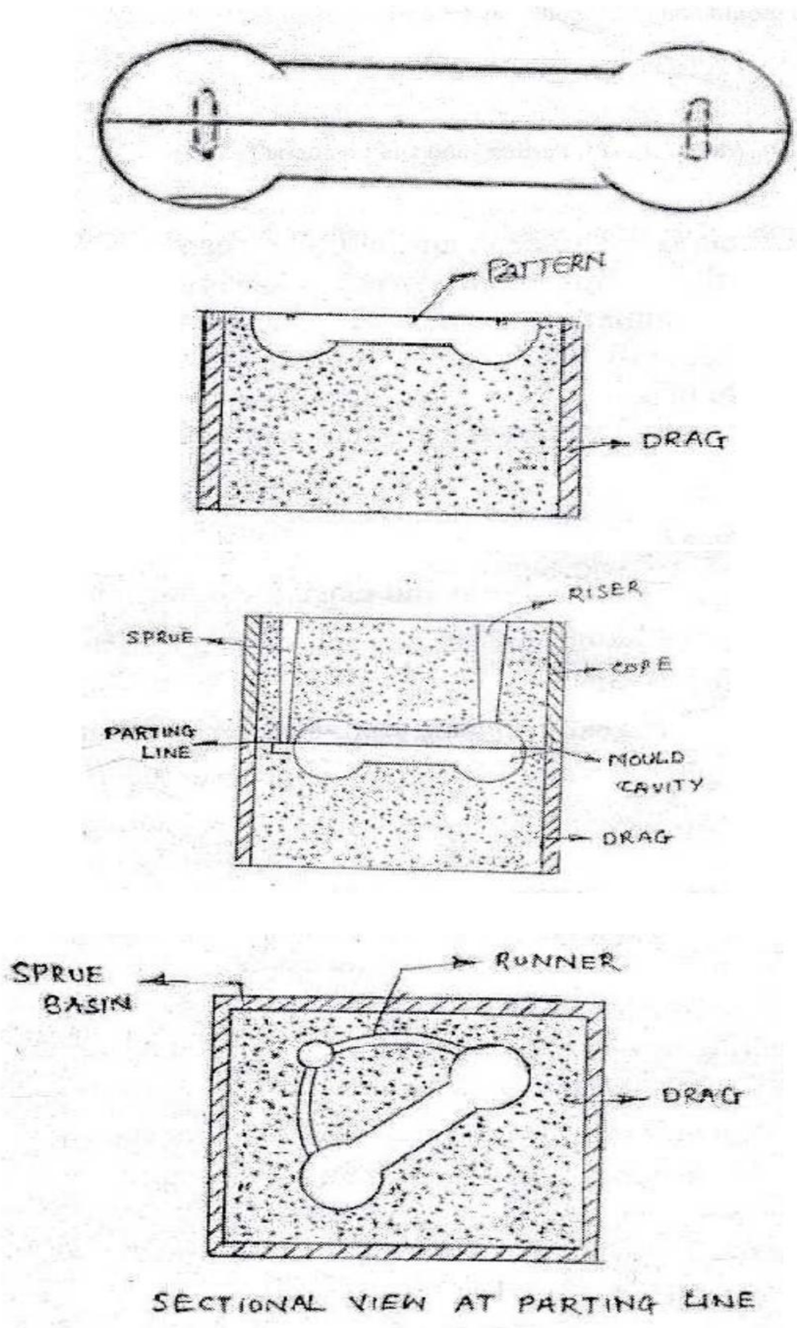
The metal is melted in furnace to correct temperature.

The metal is poured into the mould and then allowed to solidify and cool.

After cooling the casting is extracted by breaking the moulding sand.

Cut of the gate and the entire surface is cleaned.

EXPERIMENTAL DIAGRAM:



RESULT: Casting process is completed as per the given procedure.

5. PREPARATION OF BUTT JOINT

AIM: To prepare a butt joint as shown in fig. using shielded metal arc welding process.

MATERIAL REQUIRED: 2 M.S Flat pieces of size 50x50x6 mm.

TOOLS REQUIRED: Welding transformer, connecting cables, electrode holder, ground clamp, electrodes, chipping hammer, welding shield, tong, hand gloves, etc.

THEORY: Arc welding is a fusion welding process. Arc welding is a process of joining two metallic pieces by the application of heat, where heat is obtained from the electric arc between two electrodes. In this process two metallic pieces will act as base metal or parent metal and electrode will act filler metal. The electrode is coated with flux which prevents oxidation of parent metals.

Butt Joint: The butt joint is join the ends or edges of plates or surfaces located approximately in the same plate with each other. Preparation of edge varies according to the thickness of the material and welding process used.

PROCEDURE:

The given metallic pieces filled to the desired size.
On both sides beveled in order to have V groove.

The metallic pieces are thoroughly cleaned from rust grease, oil, etc.
The metallic pieces are connected based to terminals of Transformer.

Select electrode diameter based on thickness of work piece and holds it on the electrode holder. Select suitable range of current for selected dia.

Switch on the power supply and initiates the arc by either striking arc method or touch and drag method.

Tack welding to be done before full welding.

In full welding process after completion one part before going to second part. Slag is removed from the weld bed. With the metal wire brush or chipping hammer.

Then the above process will be repeated until to fill the groove with weld bed or weld metal.

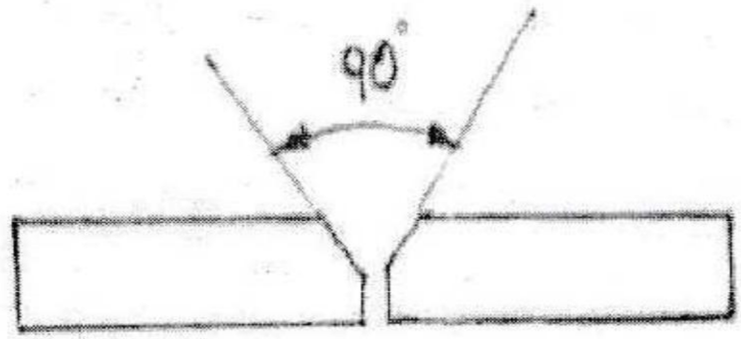
PRECAUTIONS:

Use goggles, gloves in order to protect the human body.
Maintain the constant arc length.

Wear apron and shoes while doing arc welding process.

RESULT: Thus the desired butt joint is prepared by using arc welding process.

EXPERIMENT DIAGRAM:



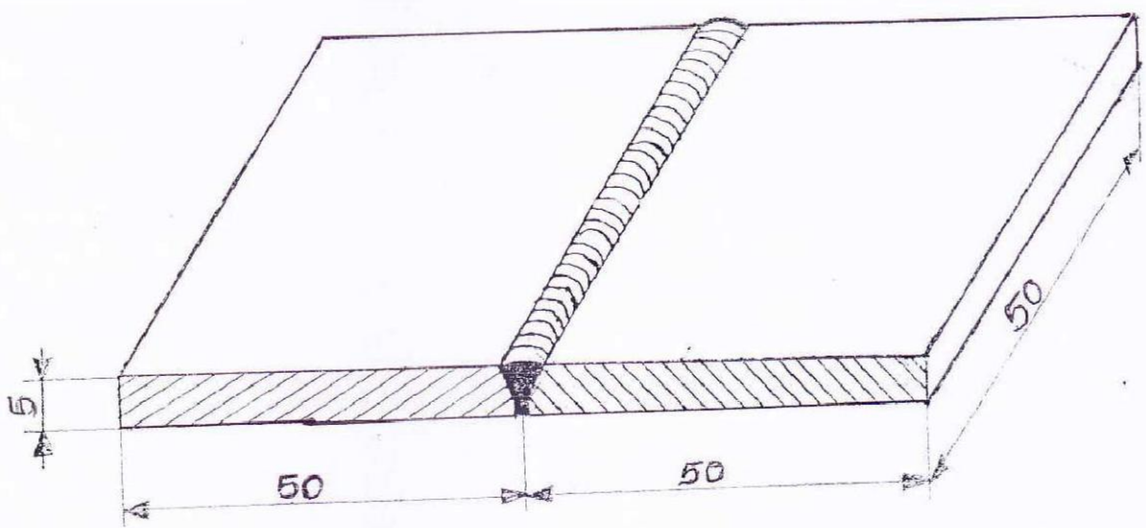


FIG. SINGLE V-BUTT JOINT

ALL DIMENSIONS ARE IN mm

6. PREPARATION OF LAP JOINT

AIM: To prepare a double welded lap joint as shown in fig. using shielded metal arc welding process.

MATERIAL REQUIRED: 2 M.S Flat pieces of size 50x50x6 mm.

TOOLS REQUIRED: Welding transformer, connecting cables, electrode holder, ground clamp, electrodes, chipping hammer, welding shield, tong, hand gloves, etc.

THEORY: Arc welding is a fusion welding process. Arc welding is a process of joining two metallic pieces by the application of heat, where heat is obtained from the electric arc between two electrodes. In this process two metallic pieces will act as base metal or parent metal and electrode will act filler metal. The electrode is coated with flux which prevents oxidation of parent metals.

Lap Joint: The lap joint is used in joining two overlapping plates so that edge of each plate is welded to the surface of the other. The overlapping portion is called lap. The width of lap may be 3 to 5 times the thickness of the plates to be welded. Welds usually run each side of the lap. No edge preparation is required for a lap joint.

PROCEDURE:

The given metallic pieces are prepared to given sizes by filling.

The metallic pieces are thoroughly cleaned from rust grease, oil, etc.

Now given metallic pieces were assembled as shown in fig. select the electrodes, based on thickness of metal piece and hold it in the electrode holder.

Switch on the supply and initiate the arc by either striking arc method or drag.

Tack welding to be done before full welding.

The full welding process is carried after completion of one pass slag is removed from the full weld bed with help of chipping hammer and metallic wire brush.

Then the above process is repeated until to reach desired height of the weld.

PRECAUTIONS:

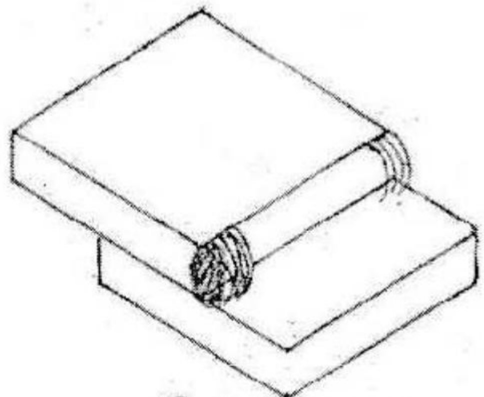
Use goggles, gloves in order to protect the human body.

Maintain the constant arc length.

Wear apron and shoes while doing arc welding process.

RESULT: Thus the desired butt joint is prepared by using arc welding process.

EXPERIMENT DIAGRAM:



TACK WELDING

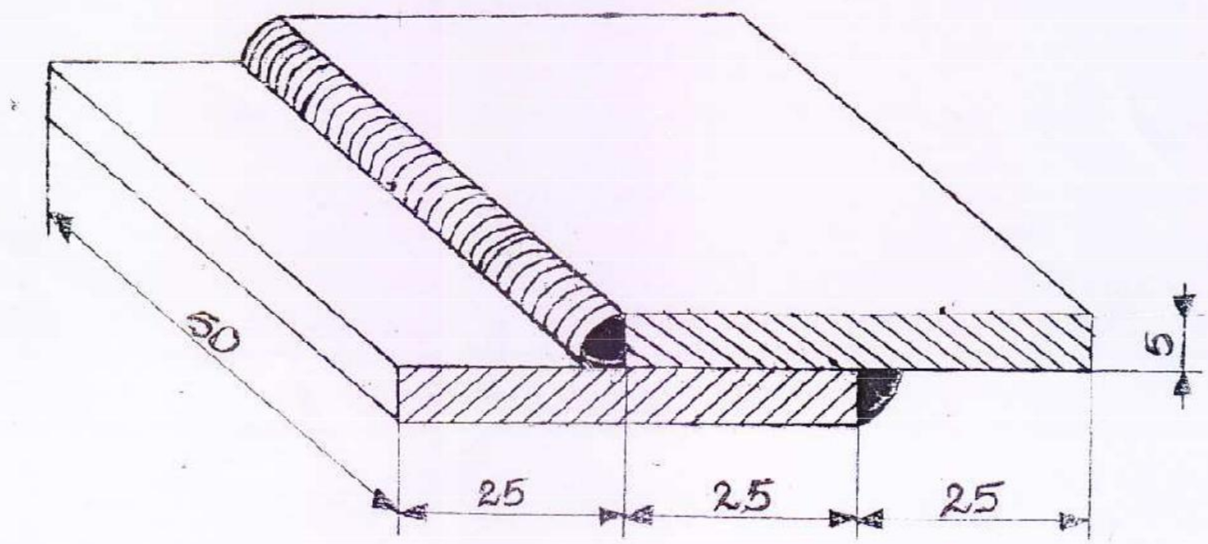


FIG. LAP JOINT

ALL DIMENSIONS ARE IN mm

7. PREPARATION OF BUTT JOINT BY TUNGSTEN INERT GAS WELDING

AIM: To prepare a butt joint with metal strips using Tungsten Inert Gas (TIG) welding technique.

MATERIAL REQUIRED: 2 M.S Flat pieces of size 50x50x5.

TOOLS REQUIRED: Welding equipment, Non-consumable electrode, consumable mild steel wire, steel strips, argon gas, Tongs etc.

THEORY: Solid materials need to be joined together in order that they may be fabricated into useful shapes for various applications such as industrial, commercial, domestic, art ware and other uses. Depending on the material and the application, different joining processes are adopted such as, mechanical (bolts, rivets etc.), chemical (adhesive) or thermal (welding, blazing or soldering). Thermal processes are extensively used for joining of most common engineering materials, namely, metals.

Gas Tungsten Arc Welding (GTAW) is frequently referred to as TIG welding. TIG welding is a commonly used high quality welding process. TIG welding has become a popular choice of welding processes when high quality, precision welding is required. In TIG welding an arc is formed between a non-consumable tungsten e1ectrode and the metal being welded. Gas is fed through the torch to shield the electrode and molten weld pool. If filler wire is used, it is added to the weld pool separately.

PROCEDURE:

Two metal strips are cut to proper size.

Insert the required electrode in the electrode holder nozzle.

Adjust the argon gas flow and adjust the proper current flow in welding unit.

Spark gap is maintained between metal pieces and electrode tip since the welding set up has high frequency unit.

Apply the spark from the electrode between the plates with one hand and filler metal is used on other hand to join the pieces.

Finally welded joint is cleaned.

PRECAUTIONS:

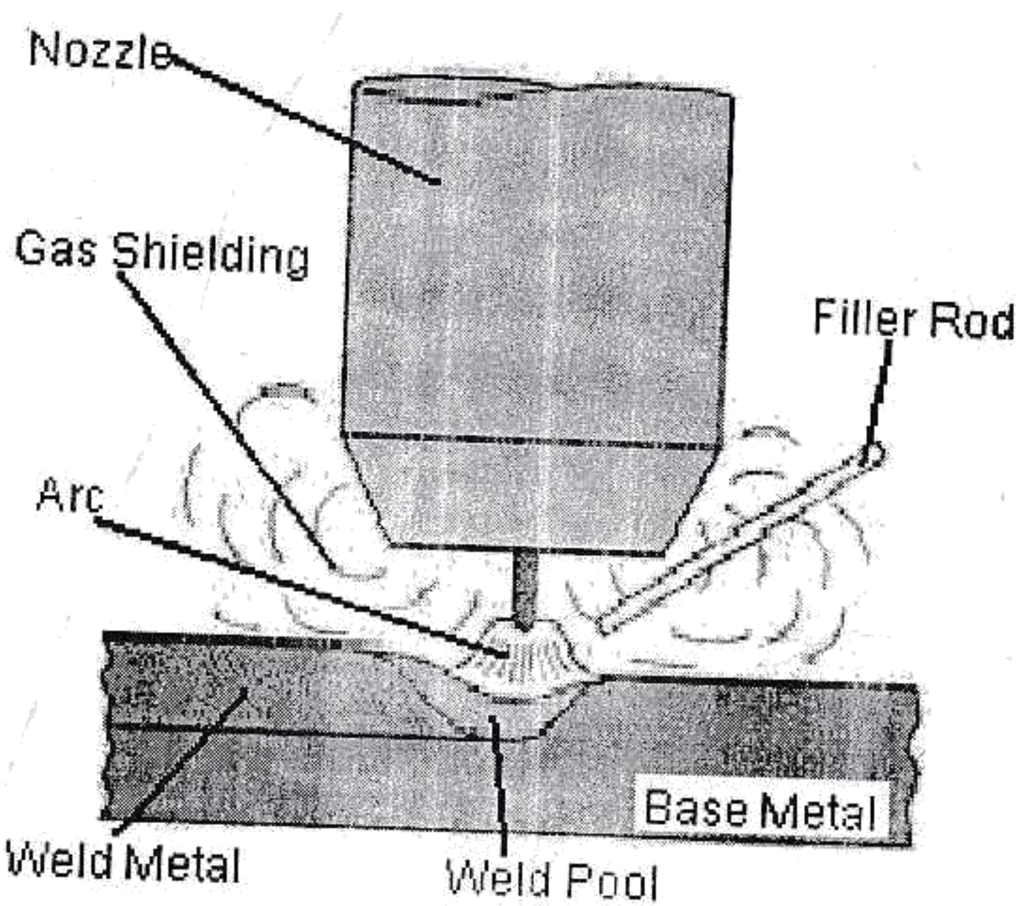
Wear apron, shoes, gloves and welding helmet.

Be careful and attentive while working on welding job.

Don’t see the welding light rays directly without using goggles.

RESULT: Butt joint is prepared by using TIG welding equipment.

EXPERIMENT DIAGRAM:



8. BLANKING & PUNCHING OPERATIONS

AIM: To perform a Blanking and Punching operations on the sheet metal.

TOOLS & EQUIPMENT: Die sets for Blanking and Punching, Scriber, Steel rule, Fly press.

MATERIAL REQUIRED: Mild steel sheets (1.5 thickness).

THEORY: Sheet metal is simply metal formed into thin and flat pieces. It is one of the fundamental forms used in metal working and can be cut and bent into a variety of different shapes. Countless everyday objects are constructed of the material. Thicknesses can vary significantly, although extremely thin thicknesses are considered foil or leaf and pieces thicker than 6mm (0.25 in) are considered plate.

Shearing processes are the processes which apply shearing forces to cut, fracture, or separate the material. This includes punching, blanking, perforating, parting, notching and lancing.

PROCEDURE:

Cut the required size of the sheet metal strip.

Fix the required die set in the Fly press.

Check the alignment of the die and punch.

Clamp the die properly.

Insert the sheet metal between the die and punch.

Apply the force by pressing the handle to cut the required part from the sheet.

Remove the finished part.

PRECAUTIONS:

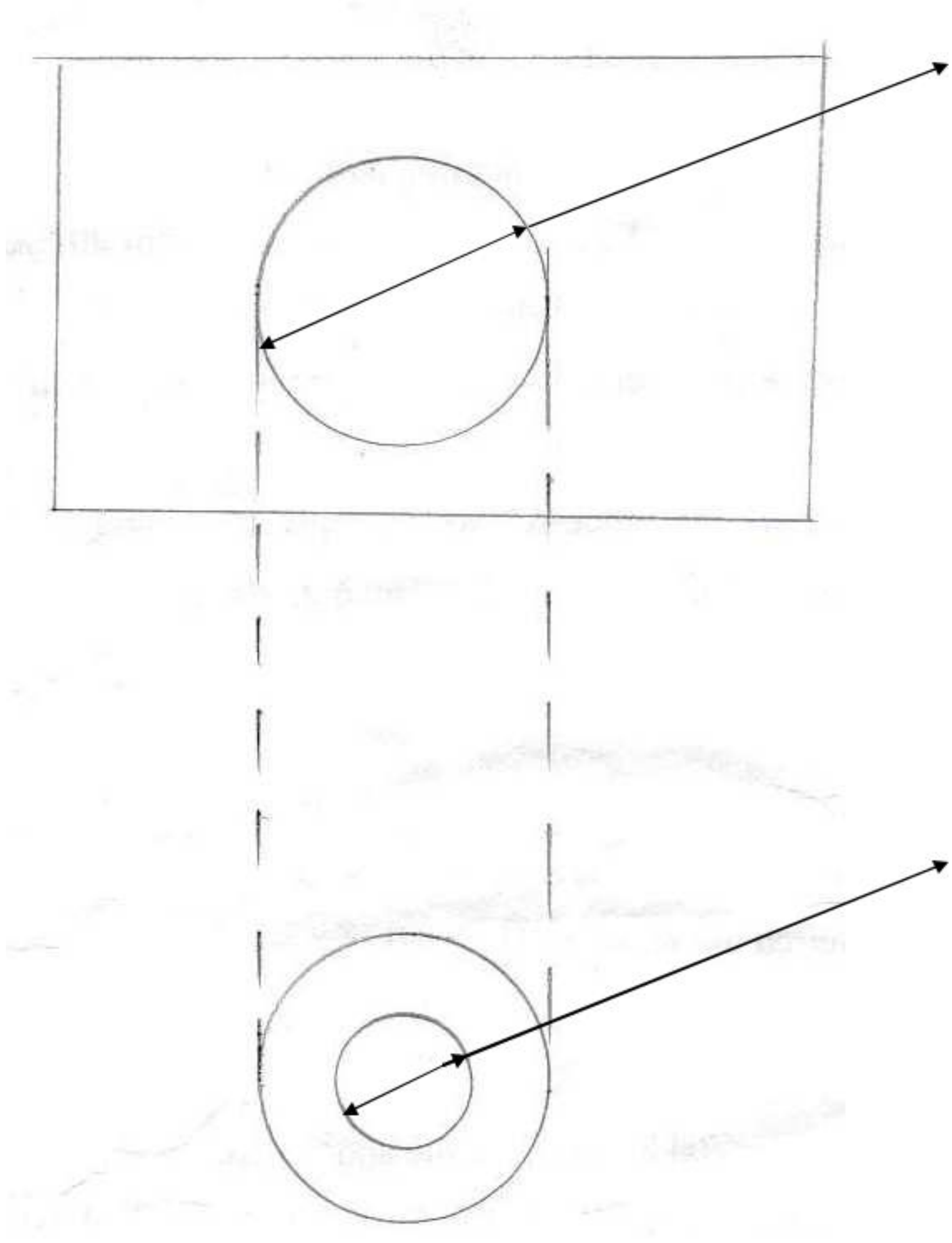
Be careful while fixing the dies.

Wear apron and shoes while doing the operations.

RESULT: Blanking and punching operations are performed as per the given procedure.

EXPERIMENT DIAGRAM:

Blanking & Punching



25mm

10mm

9. BENDING OPERATION

AIM: To perform the bending operation on the M.S plate.

TOOLS & EQUIPMENT: Hydraulic press, Die set for bending, steel rule and scriber.

MATERIAL REQUIRED: Mild steel plate of size.

THEORY: Sheet metal is simply metal formed into thin and flat pieces. It is one of the fundamental forms used in metal working, and can be cut and bent into a variety of different shapes. Countless everyday objects are constructed of the material. Thicknesses can vary significantly, although extremely thin thicknesses are considered foil or leaf, and pieces

thicker than 6 mm (0.25 in) are considered plate. Forming processes arc the processes which

cause the metal to undergo desired shape changes without failure, excessive thinning, or cracking. This includes bending, stretching, drawing, roll forming.

PROCEDURE:

Cut the required size of the M.S plate from the strip.

Fix the required die set in the Hydraulic press.

Check the alignment of the die and punch.

Clamp the die properly.

Insert the blank between the die and punch.

Apply the force by pressing the handle to undergo desired shape changes.

Remove the finished part.

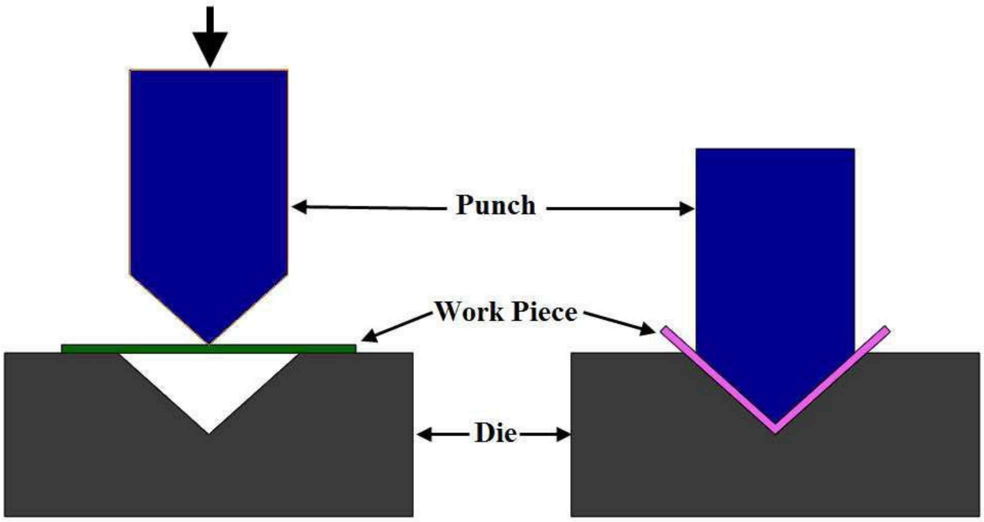
PRECAUTIONS:

Be careful while fixing the dies.

Wear apron and shoes while doing the operations.

RESULT: Bending operation is performed as per the given procedure on Hydraulic Press.

EXPERIMENT DIAGRAM:



Common Die-Bending