DESIGN AND FABRICATION OF COLD PRESSURE WELDING MACHINE

A DESIGN AND FABRICATION PROJECT REPORT

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BONAFIDE CERTIFICATE

Certified that this Report titled **"DESIGN AND FABRICATION OF TRACTION ENHANCING DEVICE"** is the bonafide work of **PRAVEEN S (191002080), RANJITH K (191002085), SRECHARAN S (191002105), VISHWA S (191002123)** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation based on which a degree or award was conferred on an earlier occasion on this or any other candidate.

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EXTERNAL EXAMINER

INTERNAL EXAMINER

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ABSTRACT

When you think of welding, normally fusion and heating come to your mind; however, in cold welding, as the name suggests, the welding or joining of two metal parts happens at ambient temperature and under pressure. Cold welding of ductile metals such as aluminum, copper, lead, etc., are very popular.

Cold pressure welding has been used as an industrial process with an increasing rate for several years.

The proposed work has an attachment made a cold pressure welding which is operated by a hydraulic power pack systems. There are basically 4 dies which facilitates the clamping of the work piece i.e 2 dies are used for clamping one work piece. Six double acting cylinders are used to facilitate motion of the dies for clamping as well as to provide the required pressure for the work piece to eventually join and form a strong weld. A hydraulic power pack system is used in this machine. Easy manual attachable and detachable attachment of the dies and the clamping part increases the range of size of the work piece we can input in this particular machine.

In this project, we will be designing and fabricating a cold pressure welding machine for the ease of welding of the ductile rods without the means of any source of heat involved. The designed model, calculations, objectives of the project, and the fabricated model are provided for the proposed work.

LIST OF FIGURES

1. INTRODUCTION

1.1 COLD PRESSURE WELDING

Cold pressure welding is a solid-state welding process that requires no heat or fusion to join two or more metals together. Instead, the energy used for creating a weld comes in the form of pressure. During cold welding process, unlike with fusion welding processes, no liquid or molten phase is present in the joint as can be seen in other techniques including arc welding, friction welding or laser welding.

This process to join metals without heat was first recognised in the 1940s, although the history of cold welding goes back much further. Widely used for joining wires as well as for joining two metals together in space, this process had a range of applications across industry.

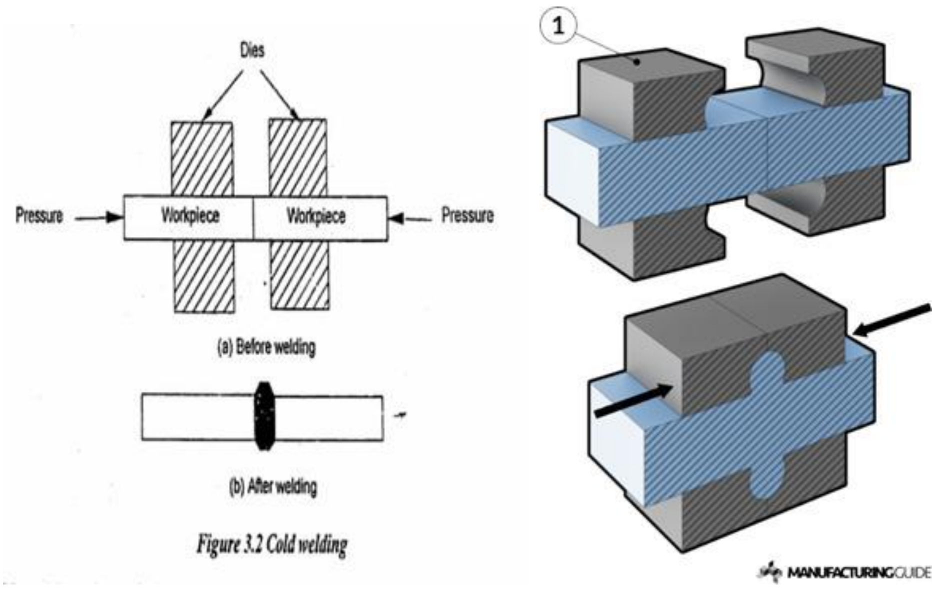


FIG 1.1 COLD WELDING PROCESS

1.2 HISTORY AND DISCOVERY

The first known example in Britain of hammer welding at ambient temperatures (therefore true cold pressure welding) dates back to the late Bronze Age, around 700 BC. The material used was gold, and gold boxes made by this process have been found during excavations.

The first scientific observation of cold pressure welding was made in 1724 by the Reverend J I Desaguliers. He demonstrated the phenomenon to the Royal Society and later published the details in the scientific journals of the time. Reverend Desaguliers discovered that if he took two lead balls about 25mm each in diameter, pressed them together and twisted them, then the two pieces would join together. The joint strength was measured on a steelyard and although the results were erratic, good bonds were produced, with some as strong as the parent material.

After Reverend Desaguliers' discovery in the 18th century, it appears that very little happened until the Second World War. This accelerated developments, especially in Germany, where light alloy cooler elements for aircraft were pressure welded, although it is understood that this welding was carried out at elevated temperatures.

Seen for the first time, cold pressure welding can appear an almost magical process. People unfamiliar with it are often reluctant to accept a method of welding that does not involve heat or electricity and some form of flux to make the joins. After a demonstration, they inevitably ask, "How are the two pieces of metal joined?"

There have been several explanations as to the actual mechanism by which a cold pressure weld is obtained. For example, it has been suggested that it happens via recrystallisation or by an energy hypothesis, but most explanations have been either experimentally disproved or refuted on theoretical grounds.

1.3 COLD WELDING IN NATURE

The cold welding process has caused mechanical problems in early satellites and other spacecraft as the process does not exclude the relative motion between surfaces to be joined. This means that adhesion, fretting galling, and sticking can overlap so, for example, cold welding and fretting can occur at the same time. However, on the plus side, being able to fuse metals together without a liquid or molten phase allows astronauts to work quickly and effectively outside a spacecraft to carry out any necessary repair work.

1.4 PRINCIPLE BEHIND WELDING

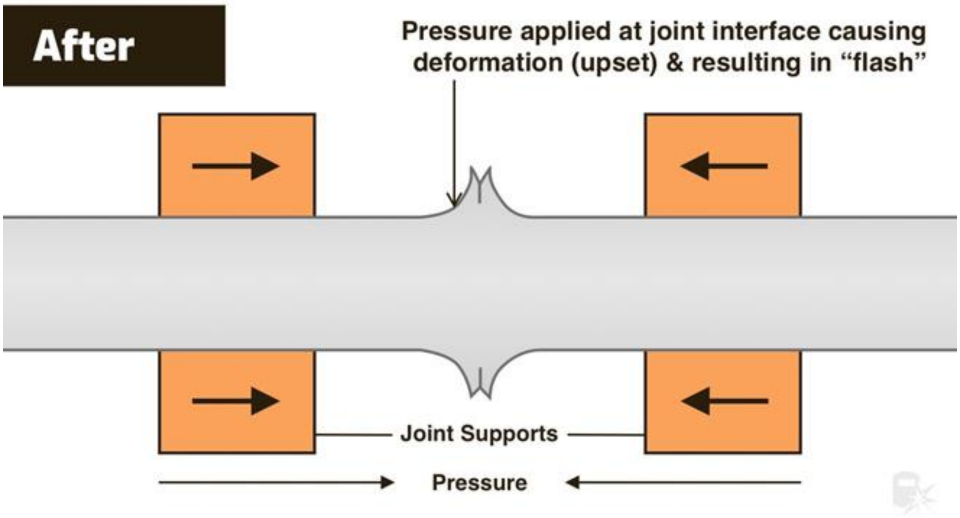


FIG 1.2 DEFORMATION AND FLASH

Explaining how cold welding works, Richard Feynman noted in his 'Feynman Lectures' that, "The reason for this unexpected behaviour is that when the atoms in contact are all of the same kind, there is no way for the atoms to 'know' that they are in different pieces of copper. When there are other atoms, in the oxides and greases and more complicated thin surface layers of contaminants in between, the atoms 'know' when they are not on the same part."

Therefore, if two metallic surfaces are brought together with only a few angstroms separation (there being 300 million angstroms to one centimetre) interaction between the free electrons and ionised atoms can occur. This will eliminate the potential barrier, allowing the electron cloud to become common. This, in turn, results in a bond and therefore a weld.

A simpler way of explaining this rather awesome process is that if two surfaces are put together, both being anatomically clean and anatomically flat when considered on an atomic scale, a bond is effected equal to that of the parent material.

1.5 CONDITION FOR WELDING

The main cold welding prerequisites are pristine cleaning the metal surface and preparing the joint's geometry. Flat joint surfaces work best, so flattening any irregularities in the shape is recommended.

The oxide layer and other impurities can be removed by degreasing, wire brushing, or mechanical and chemical methods. Grease and oil are typically present on the metal's surface and must be removed before wire brushing. This is essential because the brush can force these impurities deeper into the metal. Thanks to the wire brush sharp bristles, soft metals like aluminum, copper, gold, silver, and others are the most susceptible to getting surface oils embedded below the surface.

After you clean the oils, you can proceed to strip away the oxide layer itself. Depending on the metal, different bristle materials and brush types may be recommended. It's always good to check the metal's specification sheet.

1.6 METALS SUITABLE FOR WELD

Cold pressure welding is restricted to nonferrous materials or, at best, soft iron that has no carbon content. Most nonferrous metals can be cold welded, and while copper and aluminium are the most common, various alloys such as Aldrey, Triple E, Constantan, 70/30 brass, zinc, silver and silver alloys, nickel, gold and many others have good cold weldability. Plated wires, including tinned copper, silver plated and nickel-plated, can all be welded to themselves or to plain copper.

The usual methods of joining dissimilar metals such as copper and aluminium, namely resistance welding, friction welding or flame brazing, will all result in a rapid breakdown of the joint. This reaction in a copper/aluminium joint begins to take place as soon as the two metals are placed together.

The problem is created by the oxides and the air space, which are left between the interfaces during these methods of welding, rather than by the dissimilarity between the metals themselves. However, with cold pressure welding, these oxides and air spaces are squeezed out in the weld process and, since no heat is applied, only the metallurgical changes that operate at ambient temperatures occur.

Cold pressure welding provides the most satisfactory way of joining copper to aluminium without the formation of brittle inter-metallic compounds. The quality is excellent because it produces a worked structure as opposed to the cast structure obtained in fusion welding. Also, there is no heat-affected zone with unsuitable properties.

1.7 APPLICATIONS

For all of the challenges that the technique poses, cold welding has a range of different applications across industry.

The most common application for this method is for welding wires, where thermal energy can be a problem. Cold welding can ensure fast and strong joins in wires and is commonly used with aluminium, 70/30 brass, copper, gold, nickel, silver, silver alloys, and zinc.

Cold welding is also good for joining dissimilar metals that can otherwise be difficult to weld effectively. Particularly useful for joining copper and aluminium together, this method can also join welding aluminium 2xxx and 7xxx material series together.

Used in industries including aerospace and automotive, cold welding is often used to create butt joints or lap joints.

1.8 ADVANTAGES

Cold welding delivers a number of advantages over other welding procedures, including:

1. No Heat affected zones

Cold welding doesn't create a heat affected zone (HAZ), which greatly reduces the risk of negative chemical or mechanical changes to the base materials being joined.

2. Strong, Clean Welds

Cold welding can offer clean welds that are at least as strong as the weakest of the parent materials. This welding process doesn't form brittle intermetallic compounds at the join.

3. Joining Dissimilar Materials

Dissimilar metals that are difficult to join using other techniques, such as aluminium and copper, can be joined using cold welding.

4. Aluminium Welding

It isn't just when joining copper to aluminium when cold welding shows its benefits, as the technique can also be used for welding aluminium 2xxx and 7xxx series, which is not possible using any other metal welding technique.

1.9 DISADVANTAGE

While cold welding offers some notable advantages, there are also limitations associated with the technique. These drawbacks make it difficult for cold welding to be considered as a primary joining method in most instances. However, as shown above, cold welding can still be beneficial in some circumstances. The problems and challenges of cold welding include:

1. Cleanliness

The main problem with cold welding is that the materials need to be clean and oxide free to create a satisfactory weld. This can be hard to achieve as well as expensive and difficult to manage in a high-volume production environment.

2. Material Types

There are limitations to the types of material that can be cold welded together as the metals must be ductile and can't have undergone severe hardening processes. In addition, metals that contain any form of carbon cannot be joined using this technique.

3. Material Shape

Irregularities on metal surfaces can make it difficult to join them, even if all other steps have been taken. Cold welding requires the materials to be of a regular shape and to have no surface irregularities. The strongest cold welds are achieved with flat, regular surfaces.

2. OBJECTIVES

Our primary objectives

- To design and fabricate a high-quality industry usable cold pressure welding machine with all necessary features.

- To perform welds on rods of different diameter by making the dies replaceable.

- To optimise the machine to obtain quality welds.

- To perform welds on hollow pipes and rods using this machine.

3. DESIGN

3.1 CONCEPT OF DESIGN

Proposed work of the machine to butt weld rods or pipes together requires the 2 rods to be firmly pressed against each other. While pressing with force bending must be prevented to deform the rod.

For this basic function of the machine two separate operations are to be performed. Clamping of the rods individually and pressing of the rods against each others face.

Clamping of rods means to hold the rod tightly in a set up which carries it. The rod is clamped in vertical position.

Both the clamped rod placed along the same line such that the axis of the rod coinsides and the faces overlap each other.

In the pressing stage, the clamped rod are to be moved such that their faces collide with each other.

For hollow rods the material is not allowed to deform into cavities by placing the rod into a hardened and polished rod made available in the set up.

3.2 DESIGN CONSIDERATIONS

- The bending of rods should be prevented while forcing them.

- The deformed metal flash must be removed from the weld metal as the weld is performed.

- The clamping of the rod must be rigid enough that it must not get de-clamped when force is applied for welding.

- The material holding the rod must be hard and tough compared to material to be weld.

- The movement of both the rod should be in sync with each other. They must move in and out at the same time.

3.3 CONSTRUCTION

The rod is clamped using a die. The die is of two halves between which the rod is clamped. The die has a semi-circular slot on its merging face. The rod seats on this slot. Both the die press together to clamp and old the rod tightly.The die move together to clamp the rod along a guide rod which is fixed to a base.The base carries the hydraulic cylinders to clamp and lock the dies.Two of such a set up is present in the system which clamps the two rods to be weld separately.

The machine consists of a dovetail which is used as rail system for the movement of the rods clamped. The male and female part of the devotails mates togeher facilitates movement of the clamped dies againts each other in a straigth line in tandem. This movement of the die is given by another hydraulic cylinder set which acts on the base on which the die and its guide rod locates.The die is split into a holder and a central die which is assembled together.

3.4 PRIMARY PARTS

3.4.1 DIES

Dies are a cardinal part of a cold pressure welding system. They facilitate the clamping and pressing of the rod against each other. They have half a circle of slot in them to loccate the rod between two such dies. It is made of two integral parts assembled together. One which gets actuated by the cylinder on which the other part is held. This part has a slot to seat the rod. The die is designed is such a way that when they are in fully pressed state there must be space narrow space for the deformed metal to move out. The die has another duty to cut this defromed metal which move out through the narrow region.

3.4.2 GUIDE RODS

The guide rods allows the die halves to slide in them. These guide rods pair the two halves of the die together. This makes sure that the dies seat on a base and does not lift and moves in a non-linear path.

3.4.3 DOVETAIL RAIL

These dovetails provide linear movement of the clamped rods along with the dies. They act as a common path for both the rods to be weld. It has a male and a female part. One of them is fixed to a rigid bottom support and the other is to the base where the die and its guide rod seat. The base with the die, guide rod and the cylinder is made to slide into the dovetail. The other one on the other entry of the rail. In this way it provides a fixed and rigid path for the camped rod to slide againt each other for pressing.

3.4.4 HYDRAULIC CYLINDERS

Hydraulic cylinders are used to actuate the dies and provide movement to them. Double acting cylinders are used to clamp and declamp the rods which is useful for multipass weld procedure. Separate cylinders are used for clamping and pressing. Horizontal mounting type cylinders are used for this purpose. The specification the cylinders are calculated. The bore diameter and the stroke length are desided based on the load and diatance of movement.

3.4.5 ACTUATION AND ASSSEMBLY COMPONENTS

The cylinders are coupled to the respective parts by means of a intermediate part which connects them. They have a thread in them which is fit to the piston of the cylinder and the other end is screwed to the part to be controlled by the cylinder.

Many other child parts are used to assemble the whole set up into one.

3.5 DESIGN CALCULATIONS

3.5.1 FORCE REQUIRED FOR DEFORMATION

Tensile Ultimate Strength Of Copper = 210 N/mm^2

Diameter of rod = 15mm

Area of cross section = (pi/4) *d^2

= (pi/4) *15^2

=176.62 mm^2

Stress = Force/Area

210 N/mm^2 = Force/176.62 mm^2

F = 210*176.62

F = 37091.25 N

Force required to deform copper workpiece For Welding = 3.7 tons

3.5.2 HYDRAULIC CYLINDER SPECIFICATION:

Pressure applied = 75 Bars = 7.5 N/mm^2

Force Required = 3.7 Tons

Pressure = Force/Area

7.5 = 37091.25/Area

Areas Of Hydraulic Cylinder Bore = 37091.25/7.5

= 4945.50

Area = (pi/4)*d^2 = 4945.50 mm^2

= 79.37 mm

Hydraulic Cylinder Specification:

Bore Diameter = 80mm

Stroke Length = 50mm

3.6 CAD MODELS

Three different CAD software were used for our designing purpose. AutoCAD, Creo and Catia were used to design all of the parts.

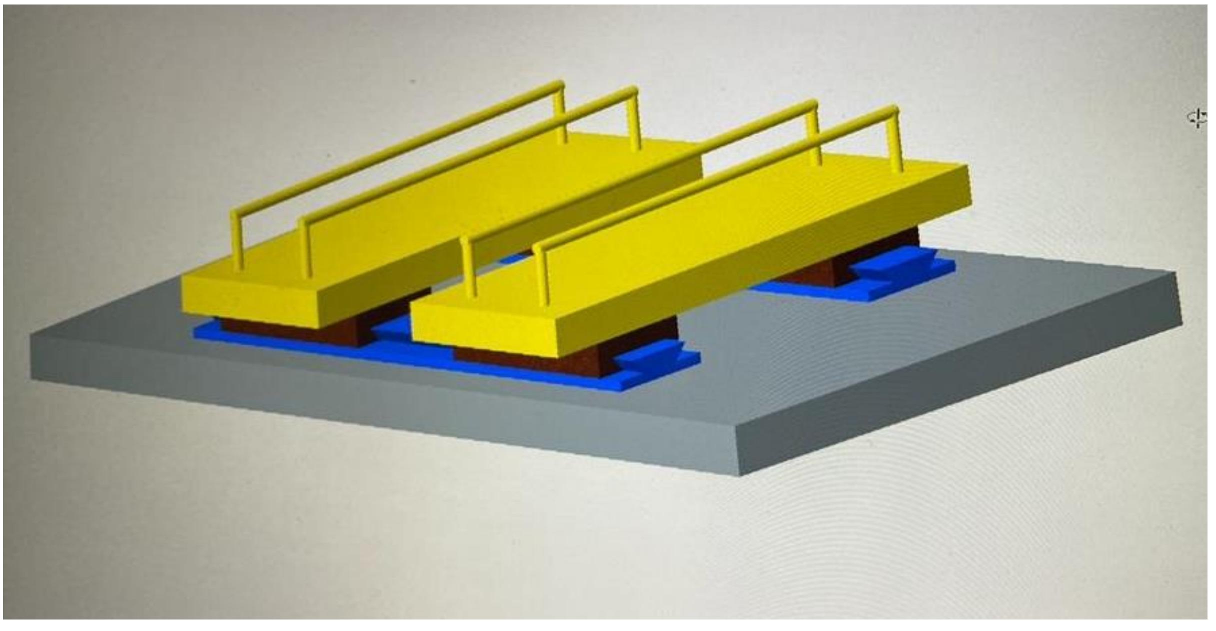


FIG 3.1 CONCEPT VISUALISATION

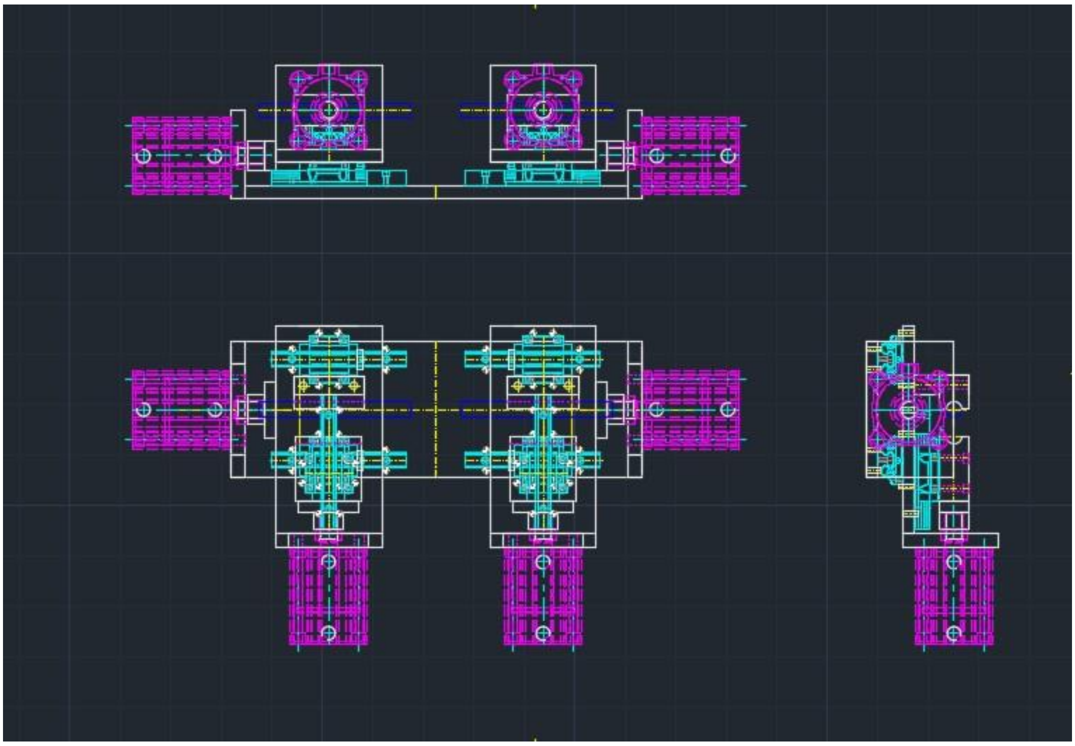
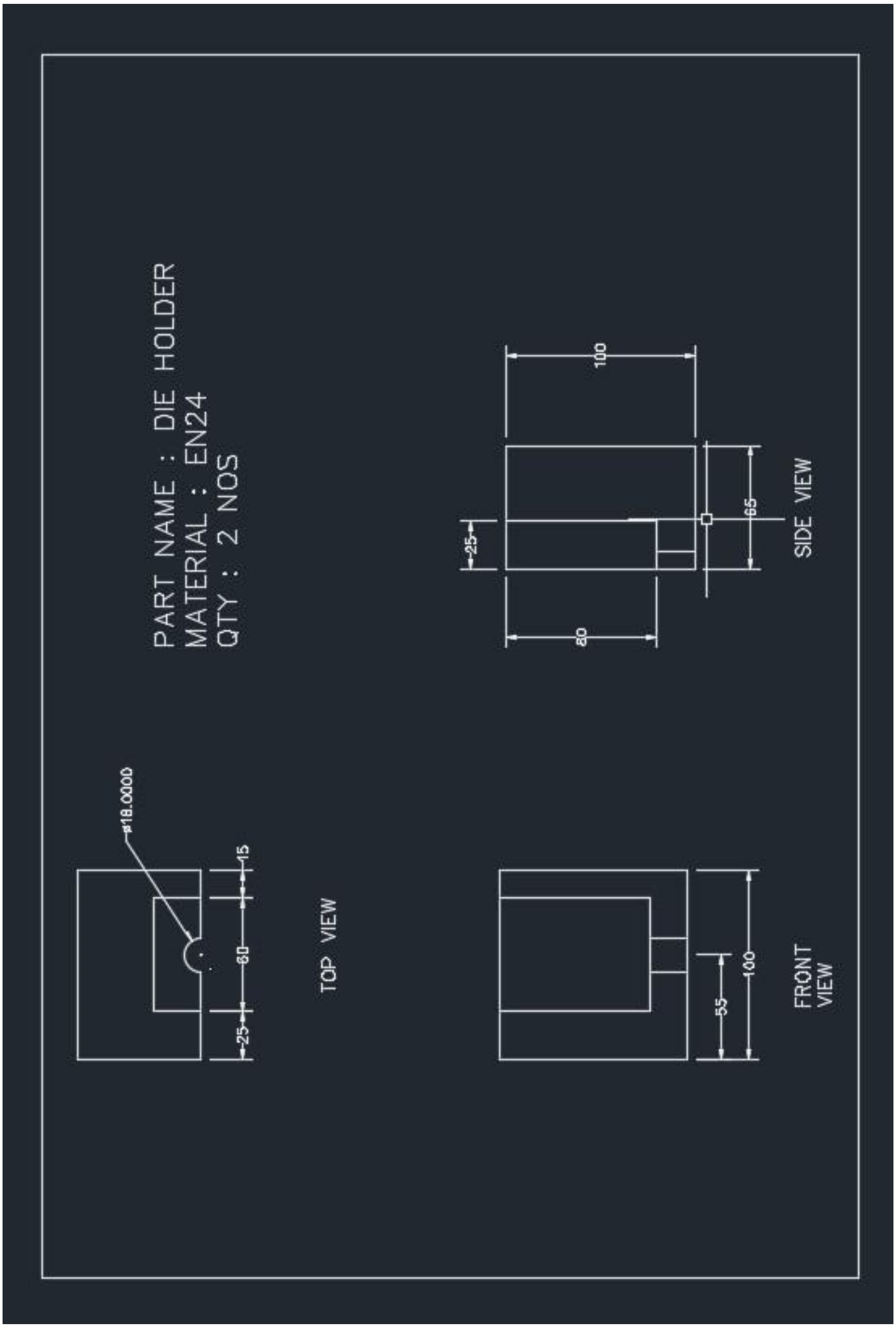
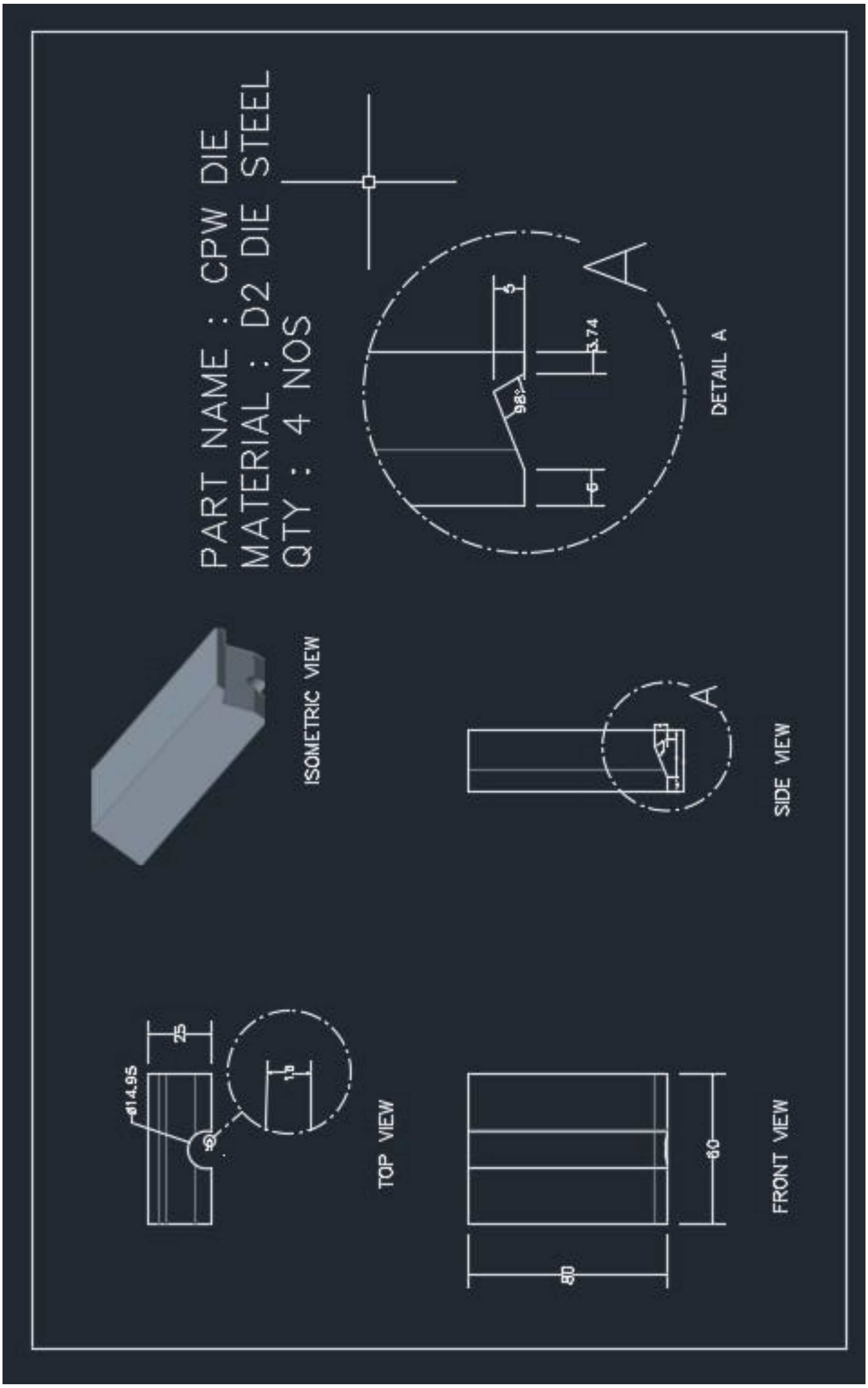


FIG 3.2   CYLINDER MOVEMENT VISUALISATION


PART NAME : DIE HOLDER
MATERIAL : EN24
QTY : 2 NOS
ø18.0000
15
60
25
TOP VIEW
100
65
25
80
SIDE VIEW
55
100
FRONT VIEW

FIG


PART NAME : CPW DIE
MATERIAL : D2 DIE STEEL
QTY : 4 NOS
ISOMETRIC VIEW
DETAIL A
SIDE VIEW
TOP VIEW
FRONT VIEW
ø14.95
25
3.74
98°
80
60
A

DRAWING

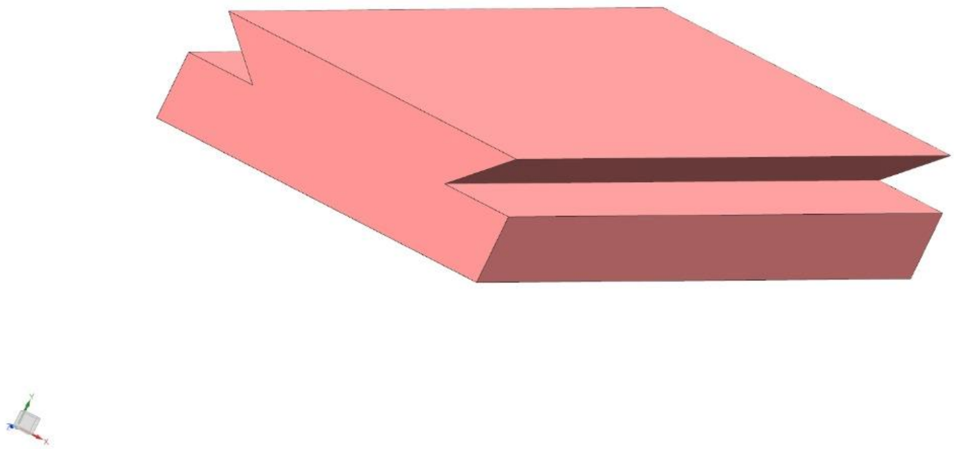


FIG 3.5 DOVETAIL MALE MODEL

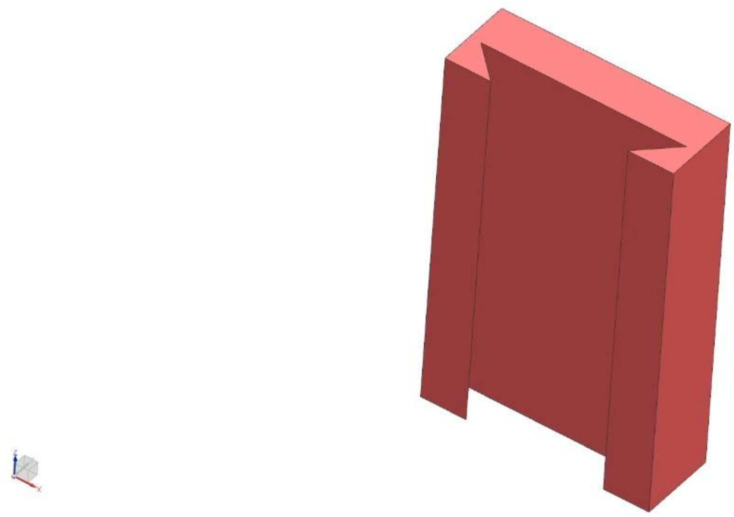


FIG 3.6 DOVETAIL FEMALE MODEL

4. FABRICATION

Several operations and process were used to manufacture the desired parts for the machine.

4.1 DIES

Dies were made using hard material. The outer holder was made of EN24 STEEL. The die was machine preliminarily in a shaping machine. The pockets, holes and taps were done in a vertical milling centre using endmill cutter of radius 10mm and respective drill and taps were used.

FIG 4.1 DIE HOLDERS

FIG 4.2 DIE MATING FACE

FIG 4.3 DIE FEATURES FOR FLASH TO BE CUT-OFF

This is the part of the die which is going to be in contact with the rod. This is made in D2 DIE STEEL. The whole piece was EDM wire cut as it has complicated shapes and close tolerance machining was required.

4.2 DOVETAIL RAILS

FIG 4.4 MALE PART OF THE DOVETAIL

FIG 4.5 FEMALE DEVOTAIL ALONG WITH A PLATE

The dovetail was cut in a vertical milling centre using a ball mill cutter. The holes were made using a drilling machine.

4.3 GUIDE RODS

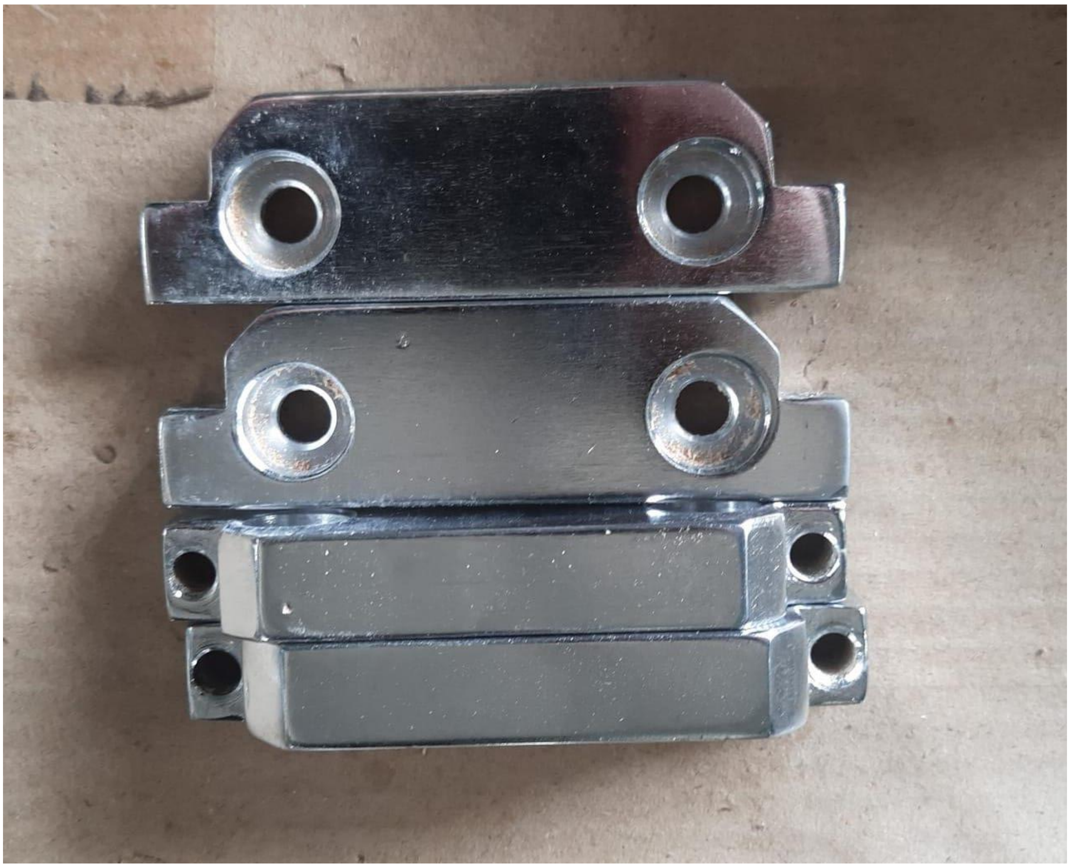


FIG 4.6 GUIDE ROD SUPPORT

A standard 18 diameter stainless steel rod was used as the guide rod. The guide rod was fixed between the support piece which was machined in a milling machine.

4.4 CYLINDERS

Horizontal mounting double acting cylinders of calculated specification were purchased. Classy brand cylinders were purchased.

Stroke length - 50mm Bore diameter - 50mm

FIG 4.7 HYDRAULIC CYLINDERS

4.5 OTHER CHILD PARTS

FIG 4.8 ACTUATOR OF CYLINDERS

Other parts were fabricated using lathe, milling machine and drilling machine. They were made out of mild steel material. These were fabricating according to their mating parts.

FIG 4.9 SUPPORT PIECE

4.6 ASSEMBLY

All these were assembled over a base plate made of mild steel. Fastening was done using suitable nuts and bolts. The set up was fixed to a steel table fabricated by welding L-angles. The table was fitted with wheels.

4.7 HYDRAULIC POWER PACK

A 50L hydraulic power pack with 4/3 direction control valve and 2 hp motor is used to control the cylinders.

5. RESULTS AND CONCLUSION

A cold pressure welding machine is successfully designed and fabricated which is capable of butt welding rods.

The primary objective of this project is to weld two work piece by means of pressure with out any source of heat involved.

This type of welding can be used in joining wires and rods of aluminium and aluminium with copper, sealing containers containing explosives and the manufacture of semiconductor device sensitive to heat.

Cold welding process is an important consideration in space due to absence of oxygen in space

6. COST ESTIMATION

SNO	DESCRIPTION	COST
1	HYDRAULIC CYLINDER - 6 NOS	44,000
2	MATERIAL COST - 200 KG	9000
3	MACHINING COST - VMC	2000
4	EDM WIRE CUT	2500
5	OTHER MACHINING	2000
6	FASTNERS	300
7	HYDRAULIC POWER PACK	60000
8	MACHINE TABLE	4500
9	HYDRAULIC FITTING	1500
10	GALVANISING	1300
11	PAINTING	200
	TOTAL	1,27,300

FIG 6.1 COST ESTIMATION

THANKYOU