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Research Article

Design and Development of BIW Fixture for Front Windshield With Manual Loading, Unloading & Welding

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I N F O

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A B S T R A C T

Today's welding fixtures for the automotive industry are crucial for auxiliary welding. The body of the car is welded together using numerous intricate sheet sections and additional support pieces. The welding fixture's supporting role is an essential element in this project's process.

The phrase "Body in White" (BIW) is frequently used in the automotive industry to refer to the sheet metal-welded construction of the car. Automobile BIW is currently constructed of steel and an aluminum alloy. The BIW component is joined using a variety of metal joining techniques, such as MIG welding, to create a welded metal shell known as Body in White.

We need to construct a BIW fixture in order to weld it together. Fixtures are used to firmly anchor in a particular spot or to assist work, assuring the interchangeability and conformance of all parts produced using the fixture. The placement of the spot welds is to be determined in the welding fixture design. The clamps, locators, rest mylar, riser, clamp cylinder are included in the location and orientation of the fixture. At the setup planning stage, fixture design is crucial. The fixture setup is done manually in the current design due to the surface finish and precision of the machined pieces. Software called Catia is used to design the fixture.

Keywords: Fixture, Windshield, Design, Mylar, Drafting, Assembly, Model

Introduction

Car Body-In-White (BIW) is a complex steel structure comprising 300–500 sheets of steel with intricate shapes that are assembled using welding in rapid succession at 55–75 robotic workstations.[1] A robotic welding station typically consists of the following components: a robot with a welding gun; a control system for the robot; welding equipmen, if necessary, auxiliary devices. A welding fixture is also included to retain the automobile panels in the appropriate position despite thermal distortions.[2] Automobile manufacturers are under ongoing market pressure to provide customers with more product and variant options in shorter lead times while also seeking reduced production costs.[3] A single station or cell must be able to handle various models

without necessitating a complete redesign of its apparatus to satisfy these obviously incompatible objectives.[4] Body in White refers to an automobile's unpainted body shell. Any car's external and interior design are determined by BIW joinery.[7] With the aid of various brackets or nuts put on the BIW, all interior parts (often used in automobiles) such as the dashboard, trim (door trim, pillar trims, roof liner, seats are mounted on the BIW shell.[5] With the use of various brackets or mounting systems, exterior (a term commonly used in the automotive industry) components[6] such as the front bumper, rear bumper, fender LH/RH, side mirrors are attached on the BIW shell.

Elements In Fixture

The toolbody serves as the mounting framework for the entire fixture. It can shape the primary bulk of the fixture and be produced from a variety of materials using various processes. Elements for enduring the force include supports. The bulk of the component, machining forces (if any), clamping forces are some of these forces. Supports are properly positioning their contact points and supporting the part against these forces. Locators are utilised to maintain the part in its proper location.Together with supports, they establish a special technique for maintaining the part's proper orientation and position. As implied by the name, clamps are objects that grab hold of fixture components. They are making sure the part will be held in the fixture firmly and tightly throughout the procedure. Optional components include Lifting Devices, Ejectors, Spring-Stop Buttons, Spring Locating Pins. Their use depends on the fixture's size, price, intended use.are used to actuate the Rover, which is supported by a bridge circuit and may travel in any direction.

Input Parameter and Customer Requirement

- Loading and Unloading of panel should be easily
- Fixture height should be not be more of 3 ft
- Fixture will be done by considering full-proof concept
- Fixture should be such that in doesn't fall in path of welding Gun
- All rest and Clamp Mylar must be follow all PLP points
- Open clamp arm which is opposite to operator side

Component Assembly

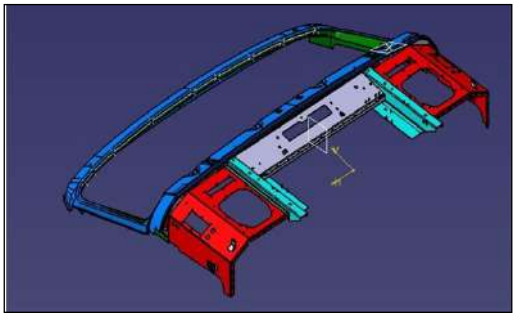


Figure 1.Front Wind Shield

Stage I assembly & Stage I assembly & Welding

Marked highlighted area consider first loading

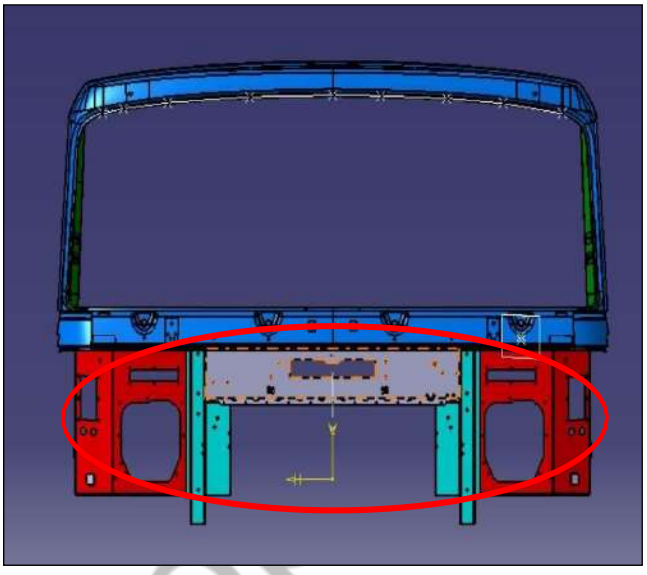


Figure 3.Assembly & Welding

Stage 2 Assembly & Welding

Marked highlighted area Consider Loading Panel

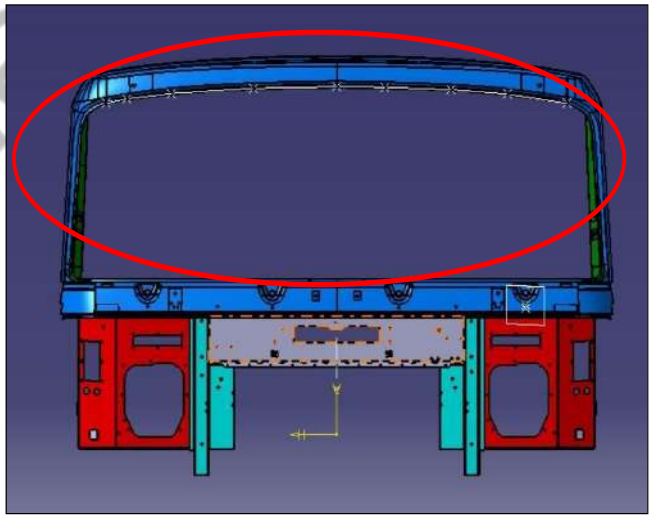


Figure 3.Assembly & Welding

Procedure to Design BIW Welding Fixture

The following sequence points consider design of BIW fixture.

Input From Customer

- Fixture require to make manual
- Welding spot and arc also manual
- Use manual toggle clamp
- Mylar should be 3 Hole or 4 Holes
- Use part size 20mm x20mm
- Riser height up to 250mm then thickness riser take 25mm and above take 30mm

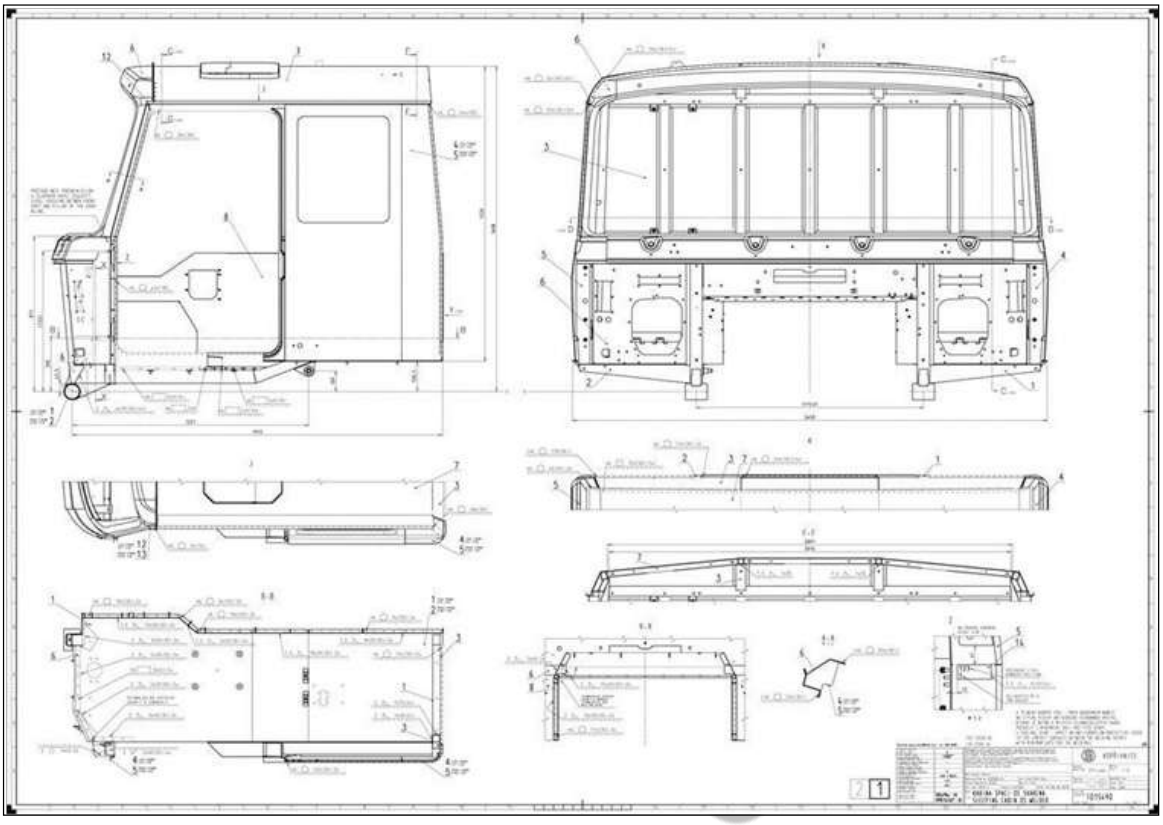


Figure 4.Panel Data

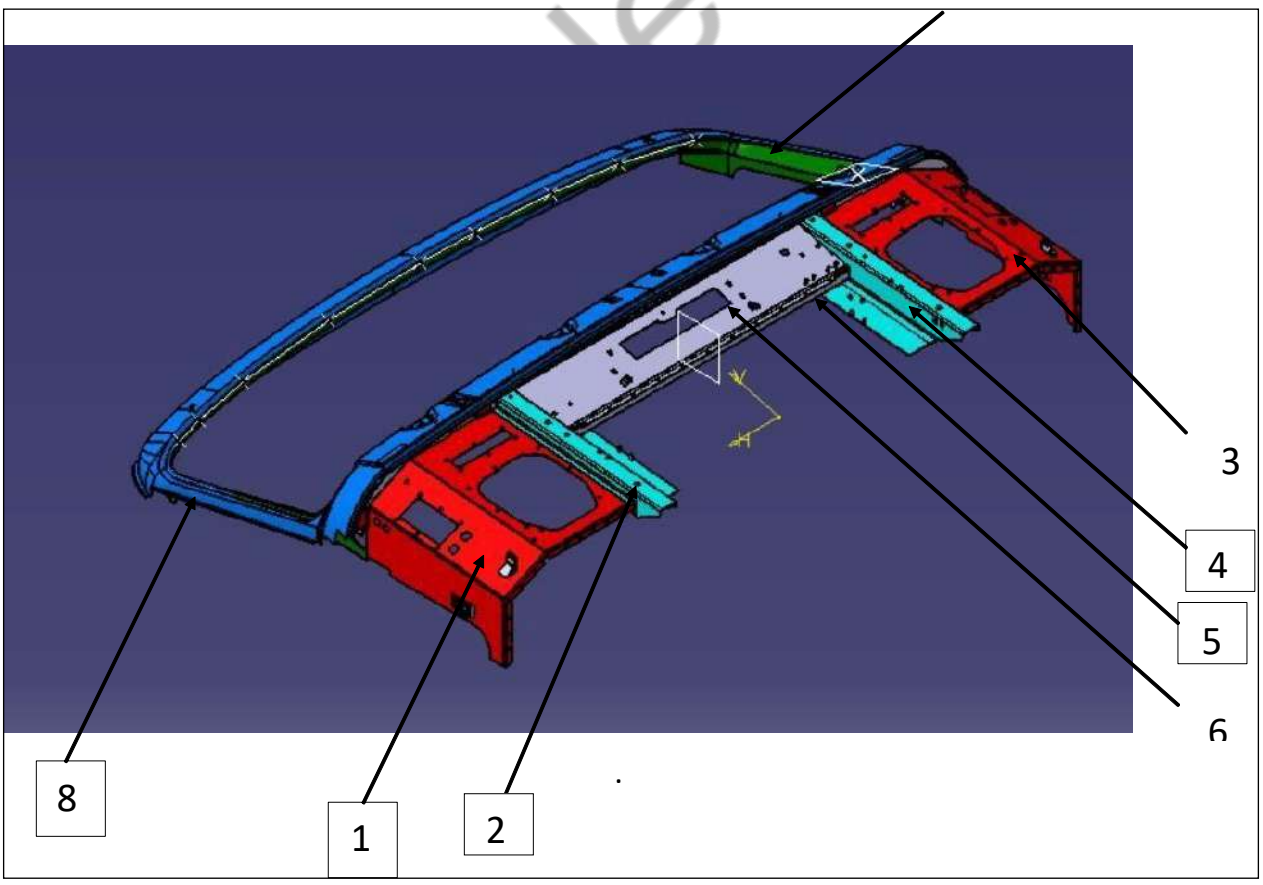


Figure 5.Sequence of panel loading

The Sequence of Panel Loading

While designing BIW fixture require considering the sequence of panel loading.

Following sequence-wise panel loading considered.

2D Guideline For Design Gun Study:

This is an important study in fixture design. This gives the details of where the weld gun is located, what kind of weld gun (resistance spot welding, seam welding) is Used. The entire fixture design depends on it.

Types of weld & Gun used In BIW Fixture

Spot welding

Many basic types of guns are available, the two most commonly used for Spot welding, being the direct-acting type, generally known as a "C"-Type gun, where the operating cylinder is connected directly to the moving electrode, the "X" Type (also known as "Scissors" or "Pinch") where the operating cylinder is remote from the moving electrode, the force being applied to it by means of a lever arm. C guns are generally the cheapest and the most commonly used. There are many variations available in each basic type with regard to the shape and style of the frame and arms, also the duty for which the gun is designed with reference to welding pressure and current.

Figure 6.X Type Gun

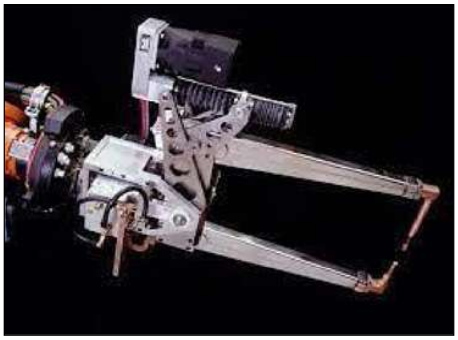


Figure 7.C Type Gun

Mig Welding

MIG welders use a tool called a spool gun, which feeds a spooled wire electrode at a selected speed. The gun also emits a shielding gas as it lays the weld. This gas protects the weld area from atmospheric gases such as nitrogen and oxygen, which can cause problems if they come in contact with the electrode, the arc, or the welding metal. According to given welding data we require to add gun in 3d model which x type gun & C type gun and some arc welding also. Gun access should be important for welding after this we can build units to clear gun.

Following Gun given By Customer:

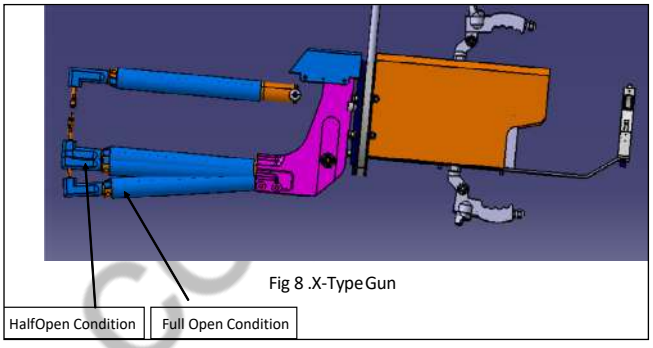


Figure 8.X-Type Gun

The above 3d model which is actual gun, used when welding. The gun have this actual dimension with position of gun arm while welding and open with full and half condition. This is mandatory gun data require about gun so easy to build a unit to clear gun.

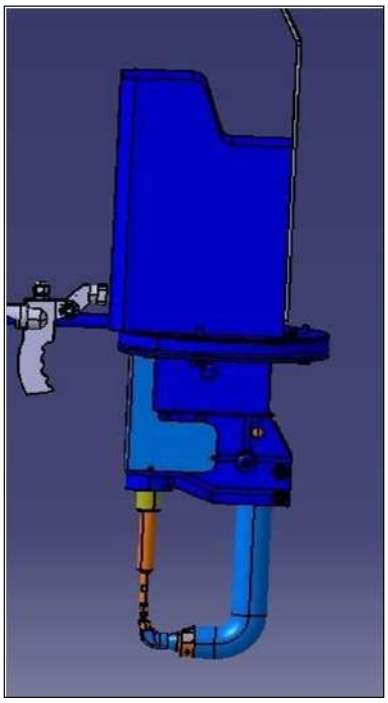


Figure 9.C Type Gun

This type of gun is usually used when a horizontal gun is not possible which is falling to panels & units.

Final Gun Study Data

Below image shows panel with gun study data.

For Stage 1 Panel welding

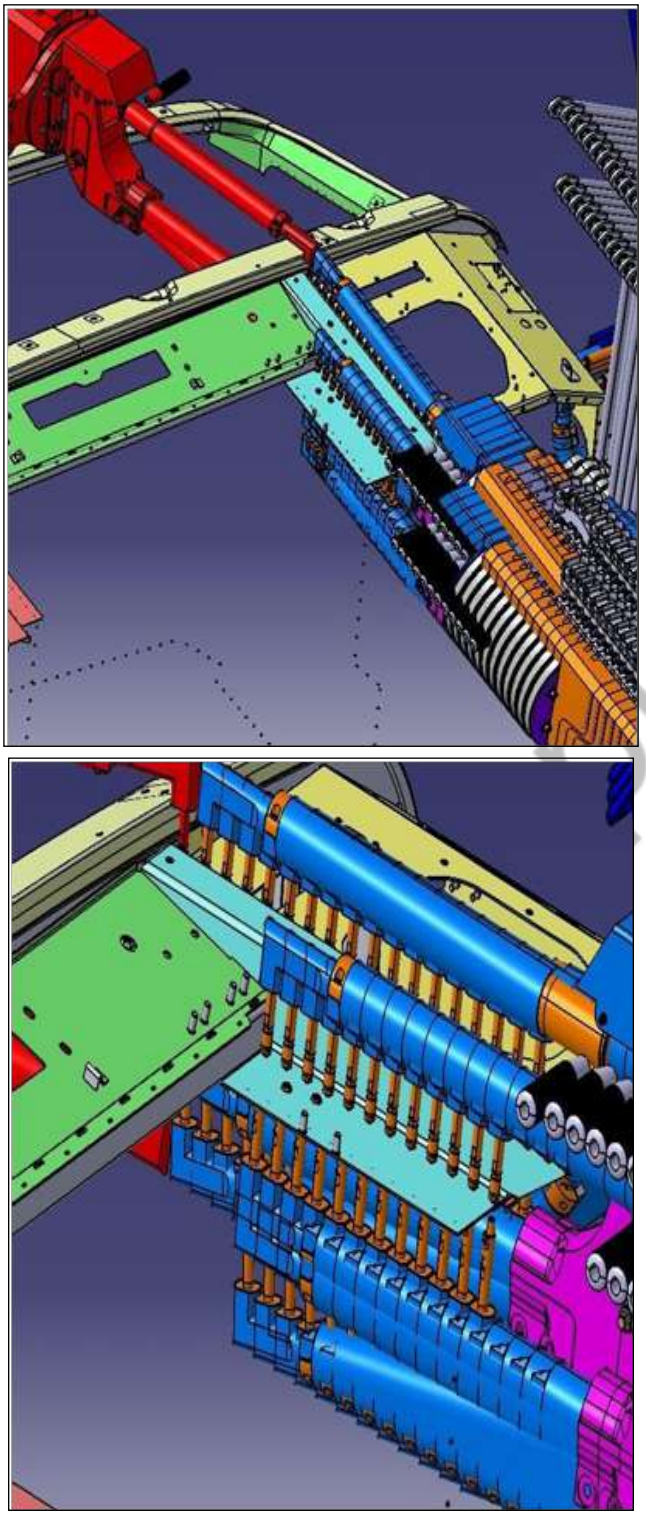


Figure 10.Gun Data in 3D

Following Standard Parts Given from Customer

Shim

Shims are the small part that comes with a thickness of 0.1mm, 0.2mm, 0.5mm, etc. These will compensate the stack-up tolerance which reflects at the panel holding part called Mylars. We give tolerance to all the parts of the fixture. Due to this tolerance the Mylar's will either lift up or goes down from its defined position. If the Mylar's goes down from the defined height it will make impression or dent on the panel. If the Mylar's lift up then there will be a distortion due to welding stress. To adjust the Mylar's At its defined position we use shims so the panel won't deformed & also don't get any impression on it. Shim are required to use 3 or 4 Slotted depends on hole on Mylar

Figure 11.4 slotted Shim

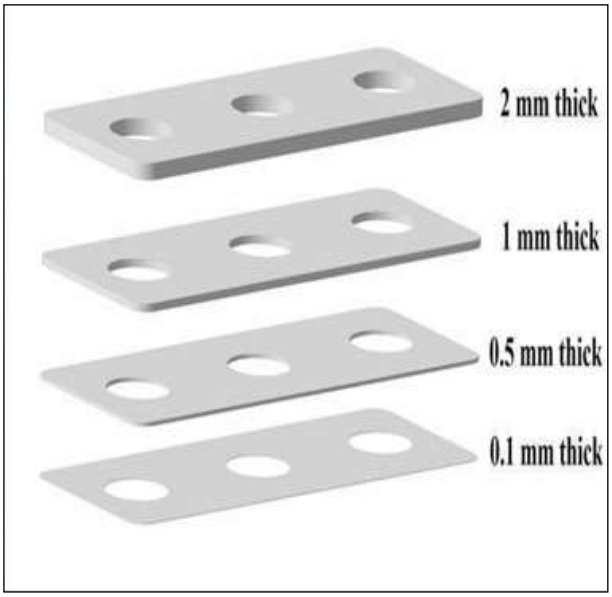


Figure 12.Pack of shim

Teel Smith Clamp

Toggle clamps hold the car part firmly and prevent the part from distortion while carrying out the spot welding operation.

a) HV-700-H& HV-700-V

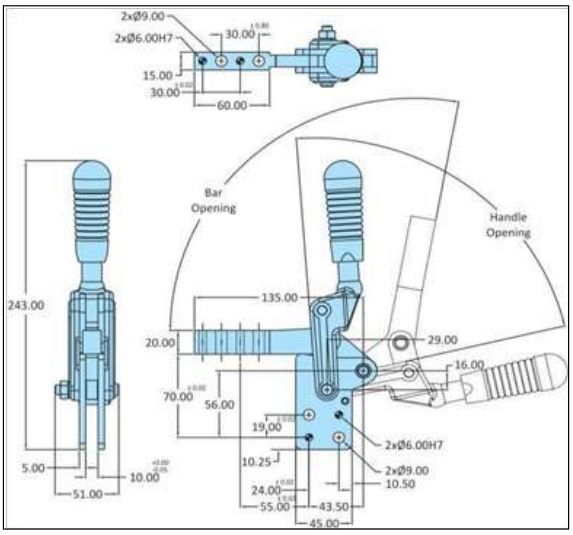


Figure 13.HV-700-H & HV-700-V

Table 1.HV-700-H & HV-700-V

Model No.	HV-700-H
Type	H.V. Series Toggle Clamps Straight Base
Material	Steel
Finish	Black ED* Coating
Arm Type	Solid Horizontal Arm
Base Type	Straight Base
Handle Opening (± 3°)	82
Clamp Bar Opening (+3°)	100
Holding Capacity	6.90 KN
Length	126.00 mm
Width	20.00 mm
Height	243.00 mm
Weight	1.180 Kg

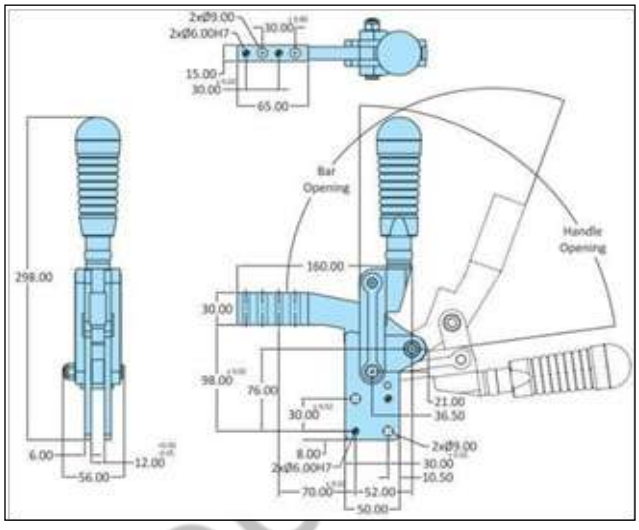


Figure 14.HV-1200-H& HV-1200-V

Table 2.HV-1200-H& HV-1200-V

Model No.	HV-1200-H-TM-TU
Type	H.V. Series Toggle Clamps Straight Base
Material	Steel
Finish	Black ED* Coating
Arm Type	Solid Horizontal Arm
Base Type	Straight Base
Handle Opening (± 3°)	82°
Clamp Bar Opening (± 3°)	110
Holding Capacity	11.80 KN
Length	149.00 mm
Width	24.00 mm
Height	298.00 mm
Weight	1.800 Kg

Pin Slider

It is subassembly Unit which used for pin sliding mechanism. After completing welding operation pin required to retract then this mechanism used. Customer make some standard sub assembly which used to make unit.

Block Slider

It is a subassembly Unit used for Mylar or rests sliding mechanism. After completing the welding operation pin is required to retract then this mechanism is used. Customers make some standard subassembly which is used to make units.

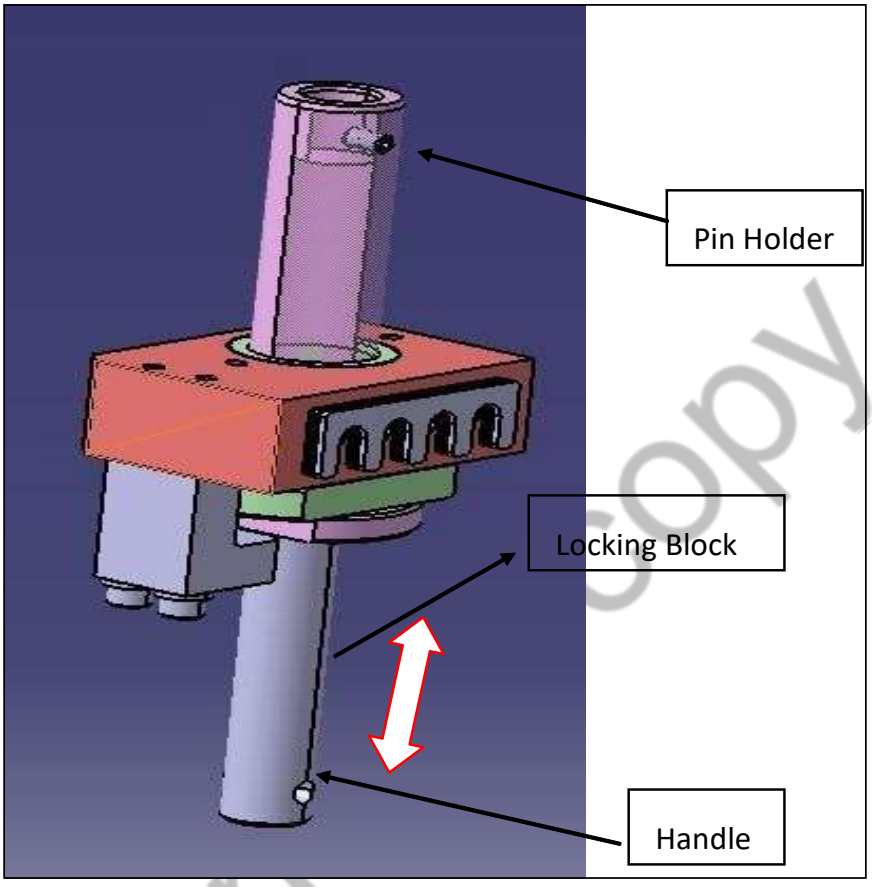


Figure 15.Pin Slider

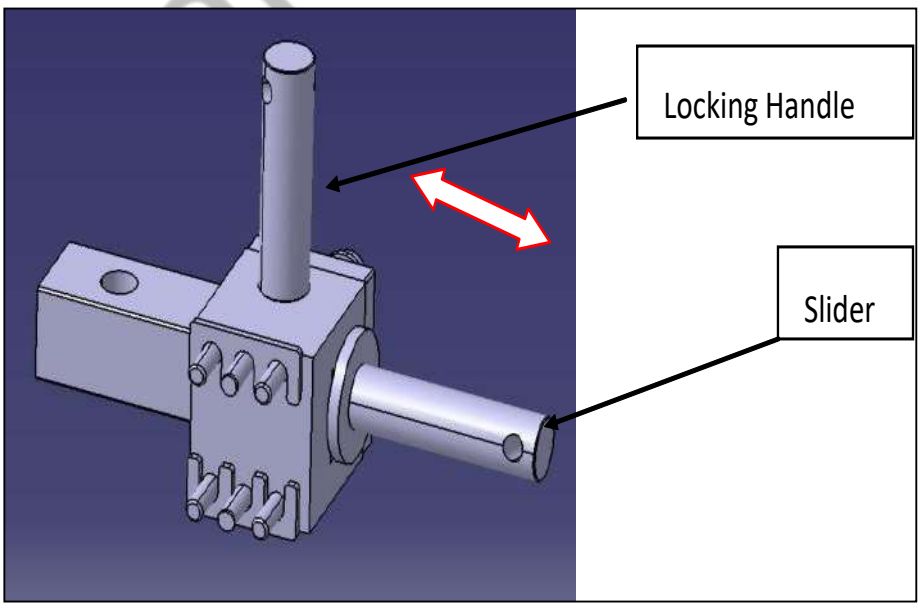


Figure 16.Block Slider

Concept Design

As per panel sequence loading data, gun data & customer standard part we going to design clamp unit, Pin unit & rest unit to restrict 12 DOF of each panel. As discuss with team leader we decide no clamp which holds the panel while welding. For panel No.2 we make a pin unit and a rest and stopper unit which fix anti-rotation of that panel. All this units we build to clear with Gun access.

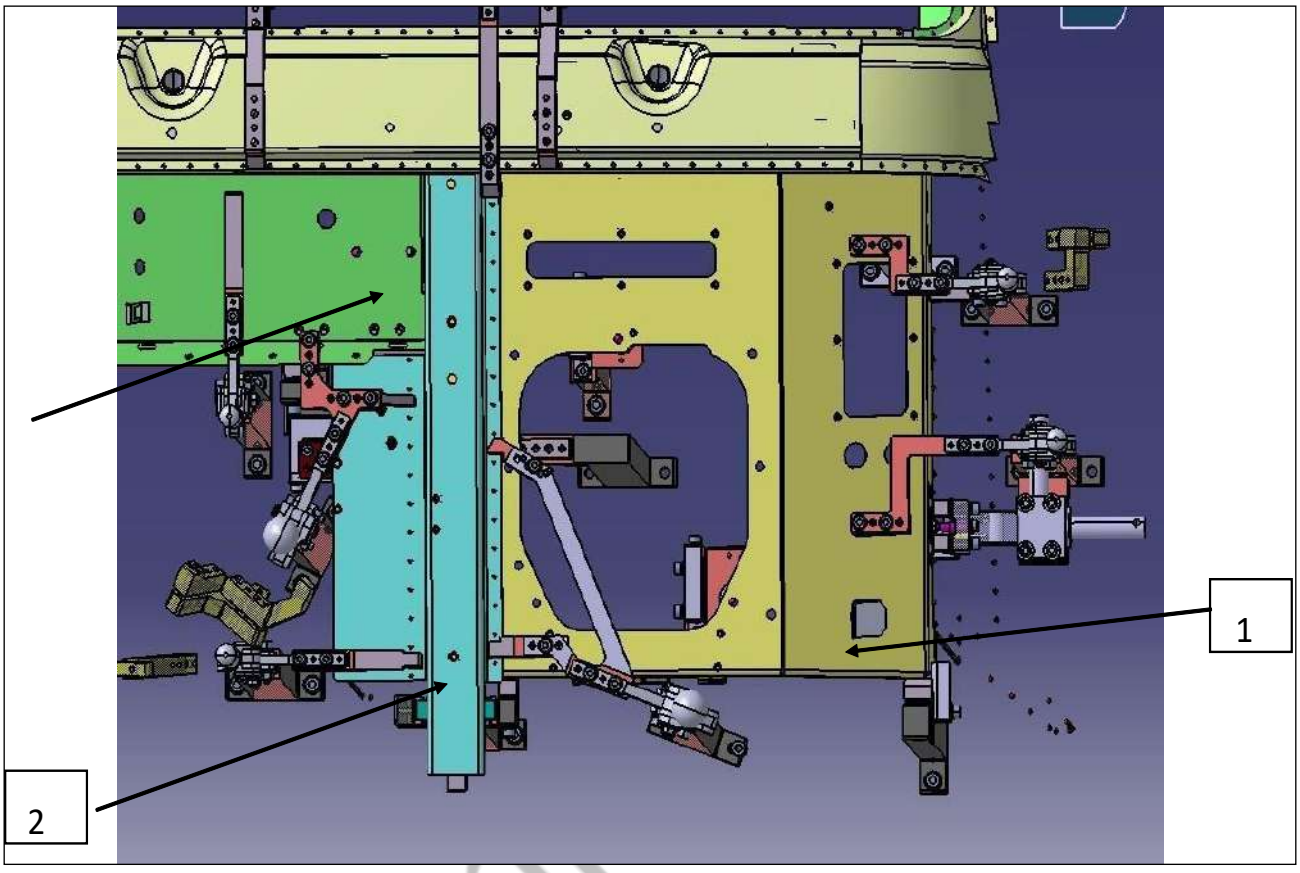


Figure 17.Design for 1st stage Right side Panel

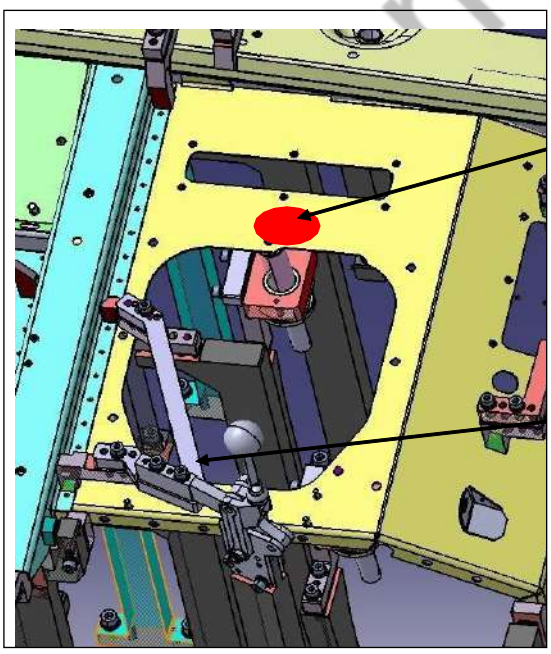


Figure 18.Panel No. 1

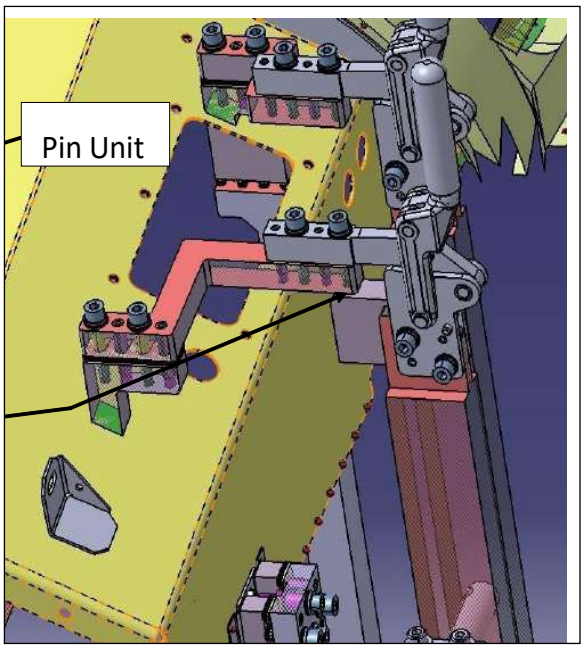


Figure 19.Panel No. 2

Guideline for Design for Ballon

Make Part -1to10

STD Part- (Shim, Riser, Cylinder, Sensor)-141 to160
Hardware-161 to 180

For Pin

Material-20MnCr5 (Round part)

Heat treatment-50-55 HRC Surface Treatment-Chrome plating

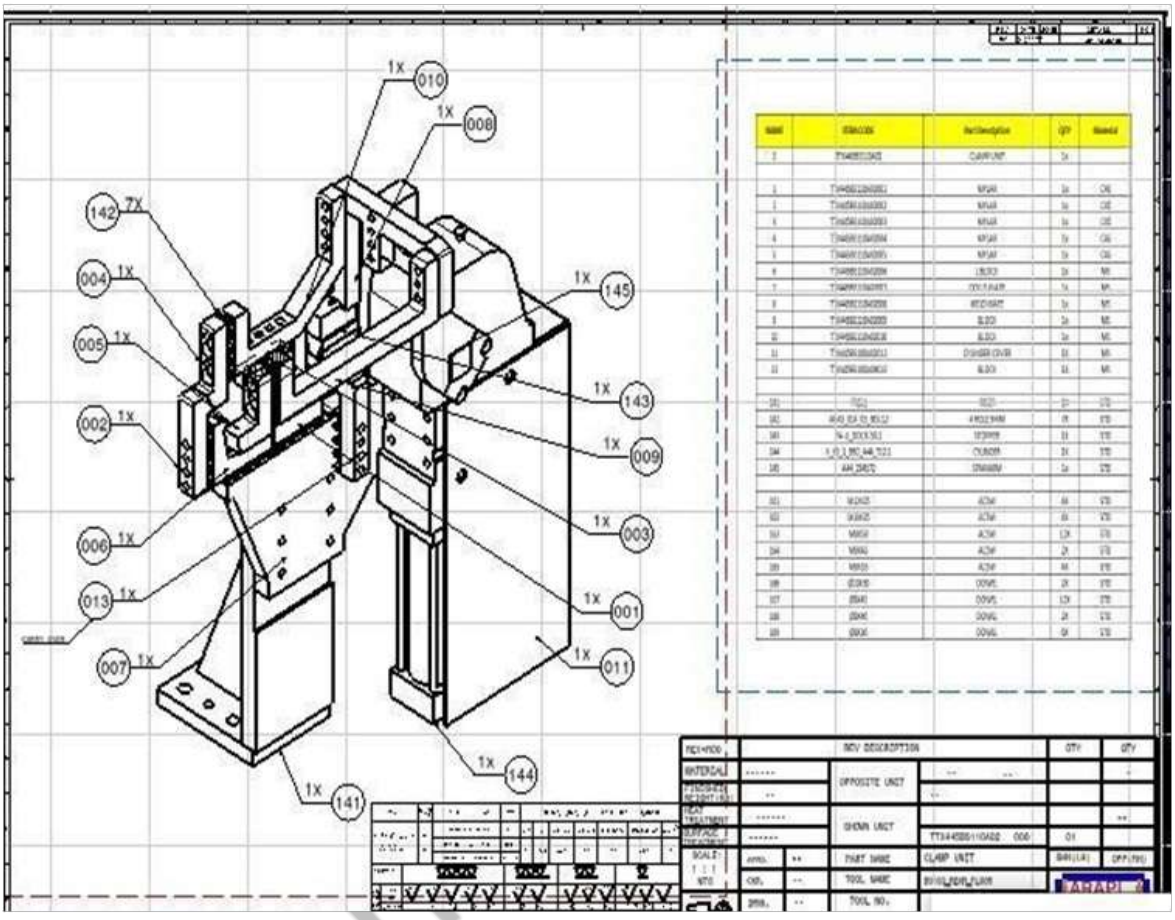


Figure 20.For Ballon

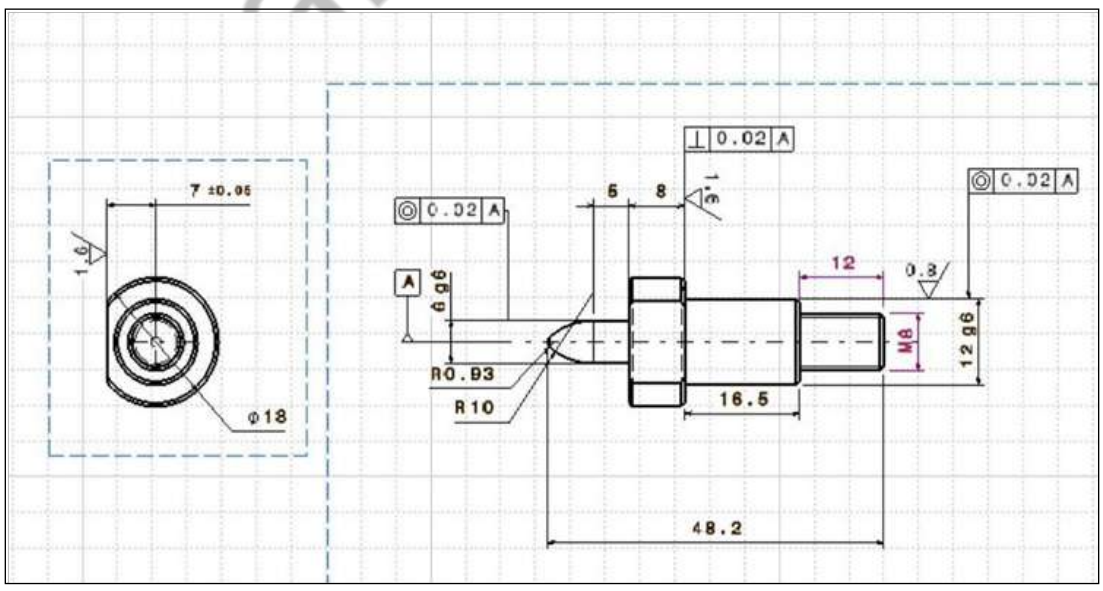


Figure 21.Pin

For Mylar

Material-C45

Heat treatment-50-55 HRC Surface Treatment-Chrome plating

For Make Part

Material-MS

Surface Treatment- Blackodise Available Plate Thickness in (mm):- 8,10,12,15,20,22,25,30,35,40

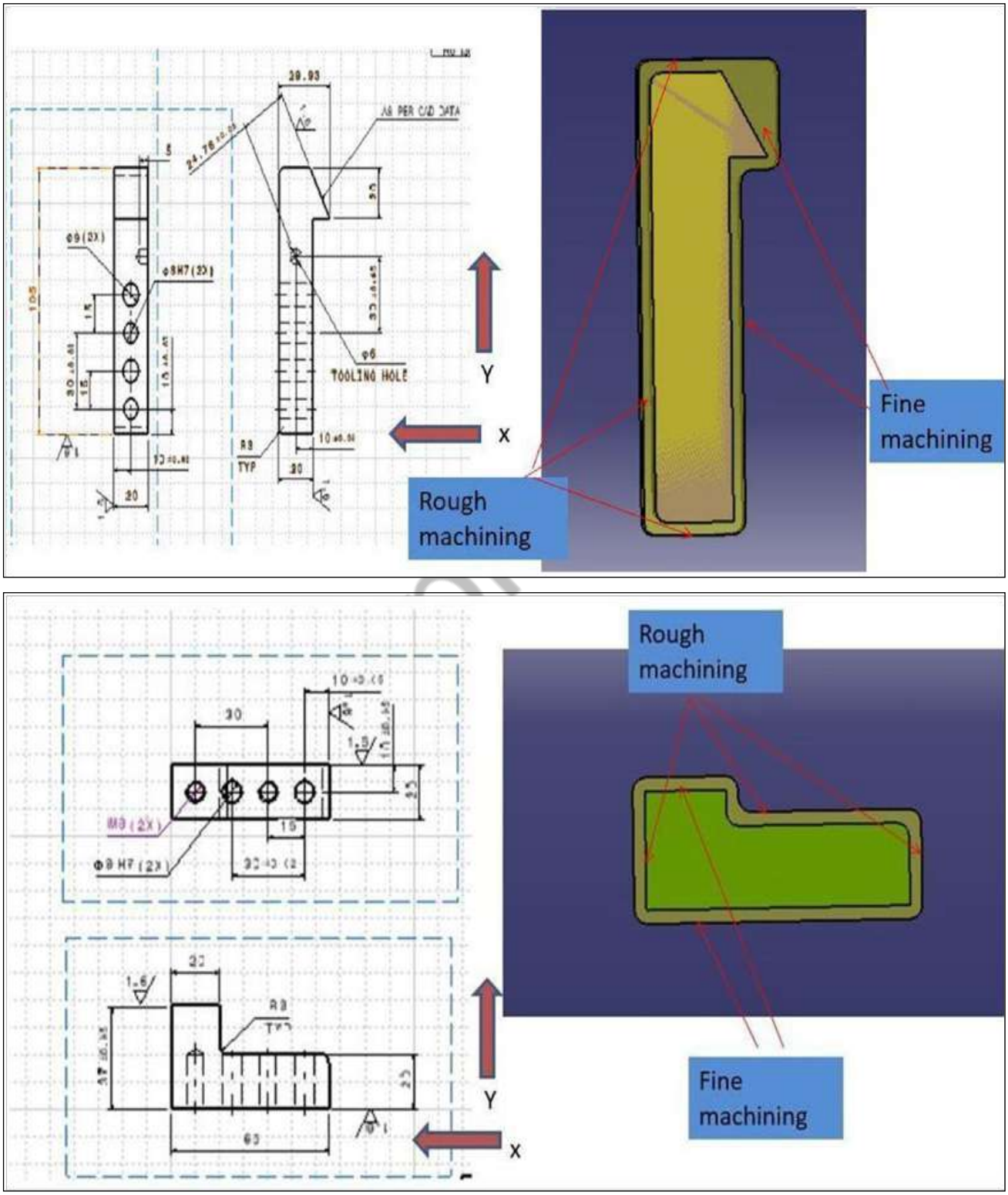
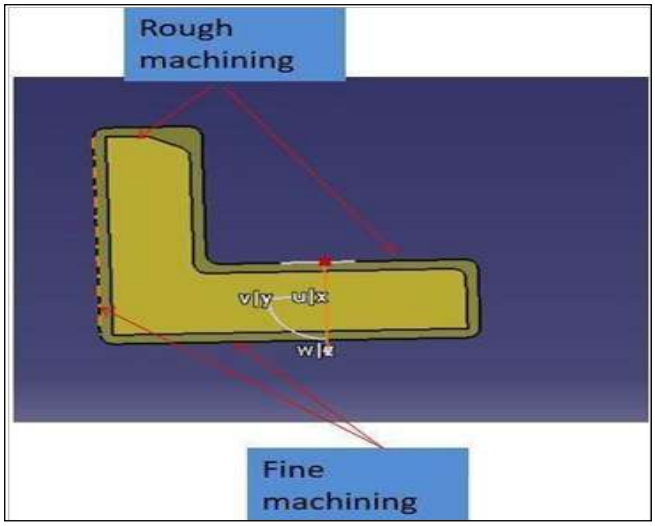


Figure 22.Mylar



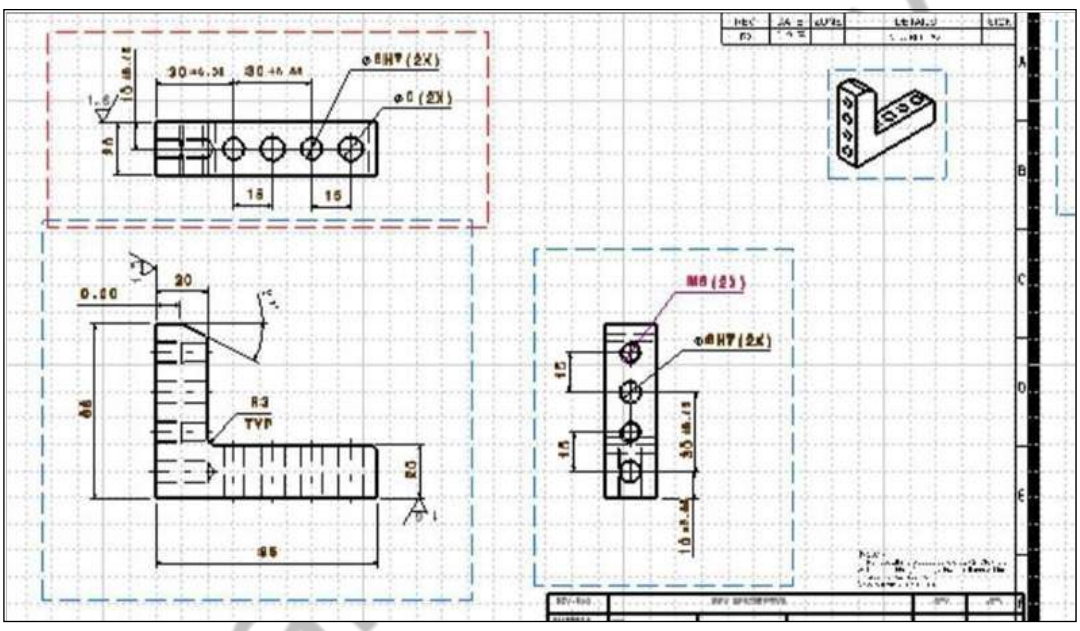


Figure 23.For Make Part

Material Selection

Mylar & Clamp Mylar

C45 is a high-carbon alloy steel that is commonly used in the automotive industry for its strength, toughness, machinability. It is also relatively inexpensive, making it a costeffective option for BIW fixtures.

C45 is a good choice for BIW fixtures because it can withstand the high forces that are applied during the manufacturing process. It is also resistant to wear and tear, which is important in a fixture that will be used repeatedly. Additionally, C45 is relatively easy to machine, which can save time and money during the manufacturing process.

Here is a comparison of C45 to other materials that are commonly used for BIW fixtures:

As you can see, C45 is a good all-around material for BIW fixtures. It is strong, tough, machinable, relatively inexpensive. If you are looking for a cost-effective option that can withstand the rigors of the manufacturing process, C45 is a good choice. Model No.

Table 3

S. No.	Material	Strength	Toughness	Machinability	Cost
1	C45	Good	Good	Good	Inexpensive
2	AISI 4140	Excellent	Excellent	Good	Expensive
3	Stainless steel	Good	Excellent	Poor	Expensive

Make Part, Clamp Arm, L-Block Riser

Here are some of the advantages of using MS material for making parts of BIW fixtures:

1. **Strength:** MS material is very strong and can withstand a lot of force. This makes it ideal for use in fixtures that need to support heavy loads.
2. **Durability:** MS material is also very durable and can withstand a lot of wear and tear. This makes it a good choice for fixtures that will be used in harsh environments.
3. **Cost-effectiveness:** MS material is relatively inexpensive, making it a cost-effective option for many applications.
4. **Ease of fabrication:** MS material is easy to fabricate, which can save time and money on production.
5. **Environmentally friendly:** MS material is recyclable, which makes it a more environmentally friendly option than some other materials.

Here are some of the other materials that are commonly used for making parts of BIW fixtures:

1. **Steel:** Steel is a strong and durable material, but it can be more expensive than MS material.
2. **Aluminum:** Aluminum is a lightweight and corrosion-resistant material, but it is not as strong as steel or MS material.
3. **Plastic:** Plastic is a low-cost material that is easy to fabricate, but it is not as strong or durable as steel, aluminum, or MS material. Overall, MS material is a good choice for making parts of BIW fixtures because it is strong, durable, cost-effective, easy to fabricate, environmentally friendly.

Here are some of the reasons why 20MnCr5 is the best material for PIN BIW fixtures:

1. **High strength:** 20MnCr5 has a high tensile strength of 1000 MPa, which makes it ideal for applications where high loads are applied.
2. **Good toughness:** 20MnCr5 has good toughness, which means that it can resist impact and deformation. This is important for applications where there is a risk of the fixture being dropped or hit.
3. **Good Machinability:** 20MnCr5 is easy to machine, which makes it cost-effective to produce fixtures from this material.
4. **Corrosion Resistance:** 20MnCr5 has good corrosion resistance, which is important for applications where the fixture will be exposed to harsh environments.

Here is a comparison of 20MnCr5 to other materials used for PIN BIW fixtures:

As you can see, 20MnCr5 has the highest tensile strength and toughness of the materials listed. It also has good machinability and corrosion resistance. This makes it the best material for PIN BIW fixtures.

Rest Mylar

Here are some of the advantages of using Teflon material for the rest mylar of BIW fixtures:

1. **Low friction:** Teflon has a very low coefficient of friction, which means that it resists movement and wear. This is important in BIW fixtures, as it helps to prevent the workpiece from moving during the manufacturing process.
2. **Chemical Resistance:** Teflon is resistant to a wide range of chemicals, including acids, bases, solvents. This makes it a good choice for fixtures that will be used in harsh environments.
3. **Heat Resistance:** Teflon can withstand high temperatures without melting or deforming. This makes it a good choice for fixtures that will be used in hightemperature applications.
4. **Durability:** Teflon is a very durable material that can withstand a lot of wear and tear. This makes it a good choice for fixtures that will be used in high-volume production environments.
5. **Non-Stick:** Teflon is a non-stick material, which means that it does not stick to food or other materials. This is important in BIW fixtures, as it helps to prevent the workpiece from sticking to the fixture.

Here are some of the other materials that are commonly used for the rest mylar of BIW fixtures:

1. **Nylon:** Nylon is a strong, lightweight material that is resistant to chemicals and solvents. However, nylon is not as resistant to heat as Teflon.
2. **Aluminum:** Aluminum is a strong, lightweight material that is easy to machine and fabricate. However, aluminum is not as resistant to chemicals and solvents as Teflon.
3. **Polycarbonate:** Polycarbonate is a strong, lightweight material that is resistant to impact and chemicals. However, polycarbonate is not as resistant to heat as Teflon.

Overall, Teflon is a good choice for the rest Mylar of BIW fixtures because it is low friction, chemical resistant, heat resistant, durable, non-stick, easy to clean.

Table 4

Material	Tensile Strength (MPa)	Toughness (J/cm2)	Machinability	Corrosion Resistance
20 MnCr5	1000	270	Good	Good
SAE 1045	860	220	Good	Fair
AISI 4140	1000	240	Good	Good

Component Fixture Drawing: Mylar

Mylar is a type of polyester film that is used in a variety of applications, including BIW fixtures. Mylar is strong and lightweight, it is also resistant to chemicals and heat. This makes it a good choice for use in fixtures that will be used to hold and support car body panels.

Clamp Mylar

Clamp Mylar is a type of Mylar that is specifically designed for use in BIW fixtures.

Clamp Mylar is thicker and stronger than regular Mylar, it is also coated with a special adhesive that helps to prevent the panel from slipping.

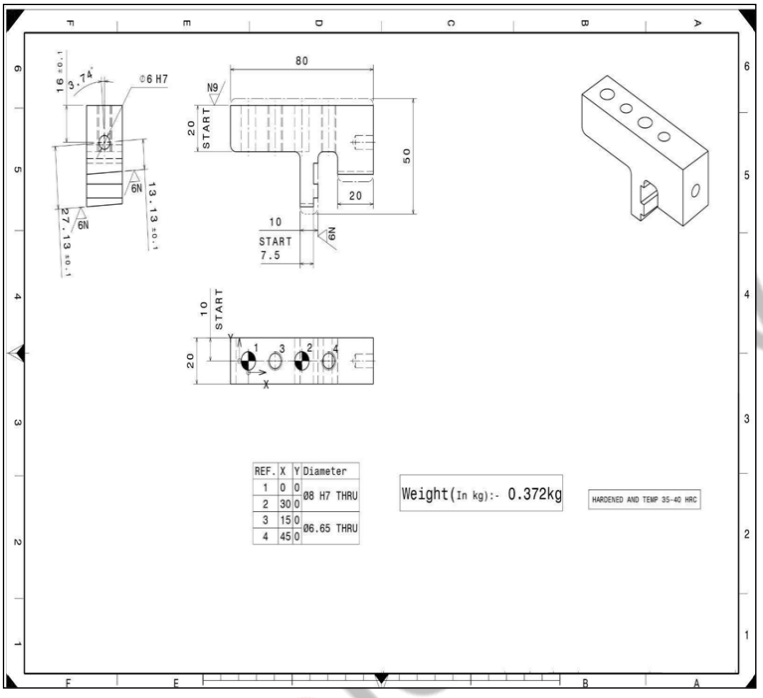


Figure 24.Mylar

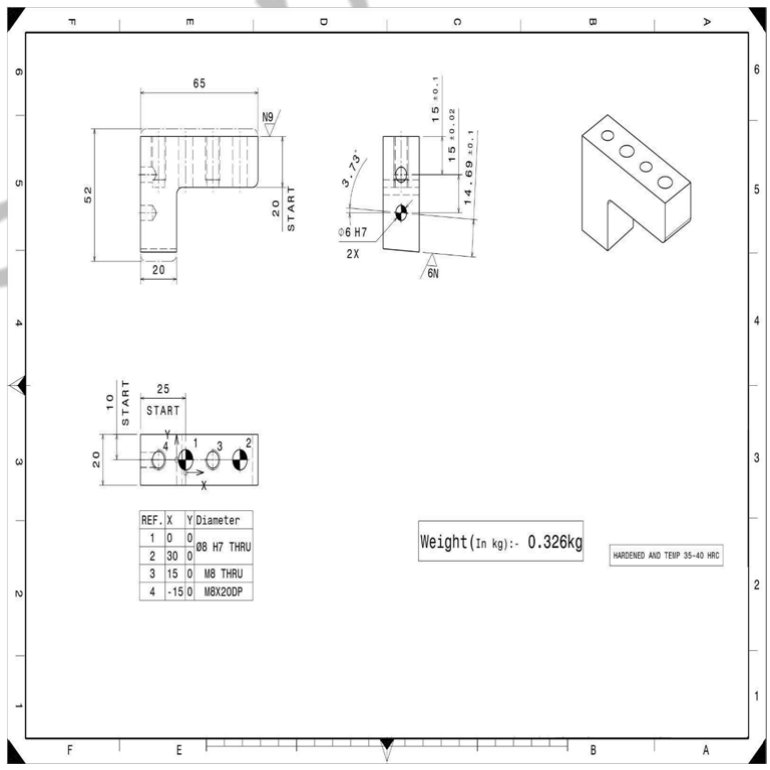


Figure 25.Clamp Mylar

Rest Mylar

Rest Mylar is a type of Mylar that is used to support car body panels in biw fixtures. Rest Mylar is typically thinner than clamp Mylar, and it is not coated with an adhesive. This allows the panel to move freely, which is important for preventing damage to the panel during the manufacturing process.

Clamp Arm

The clamp arm is the part of the fixture that holds the panel in place. The clamp arm is typically made of steel or aluminum, and it is attached to the fixture base with a pneumatic cylinder. The pneumatic cylinder allows the clamp arm to be opened and closed, which allows the panel to be inserted and removed from the fixture.

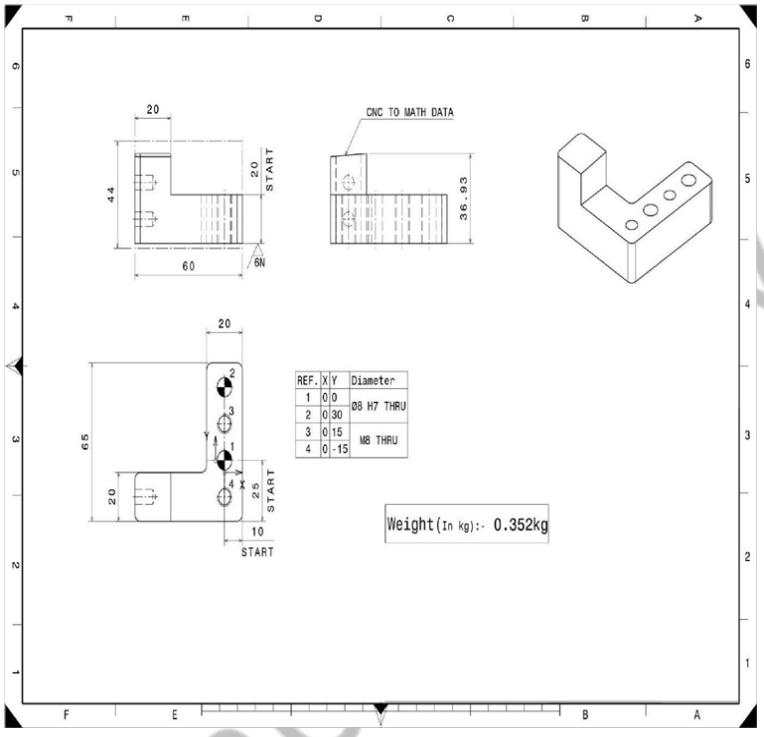


Figure 26.Rest Mylar

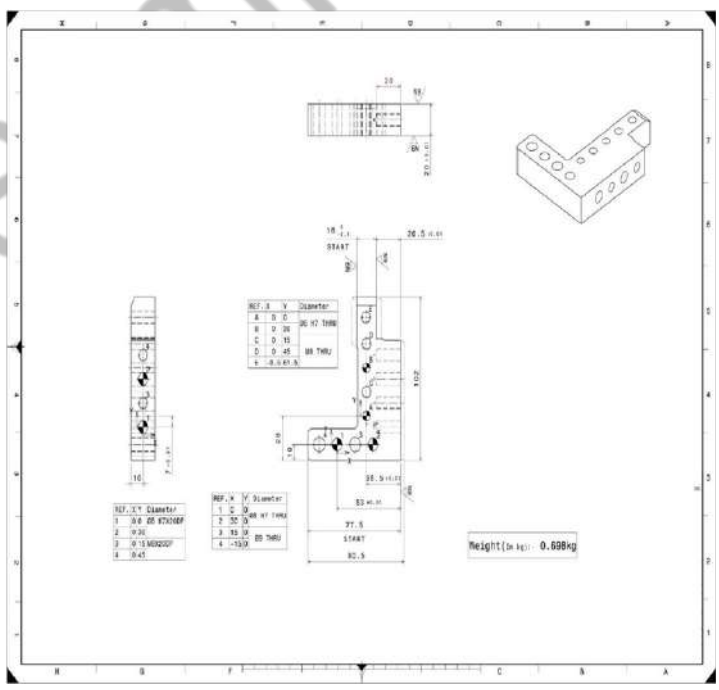


Figure 27.Clamp Arm

L-Block

The L-block is a type of block that is used to support the clamp arm. The L-block is typically made of steel or aluminum, and it is attached to the fixture base with bolts. The L-block helps to distribute the force of the clamp arm evenly, which prevents the fixture from becoming damaged.

Riser

The riser is the part of the fixture that raises the clamp arm above the base. The riser is typically made of steel or aluminum, and it is attached to the clamp arm with bolts. The riser allows the clamp arm to be positioned at the correct height for the panel that is being worked on.

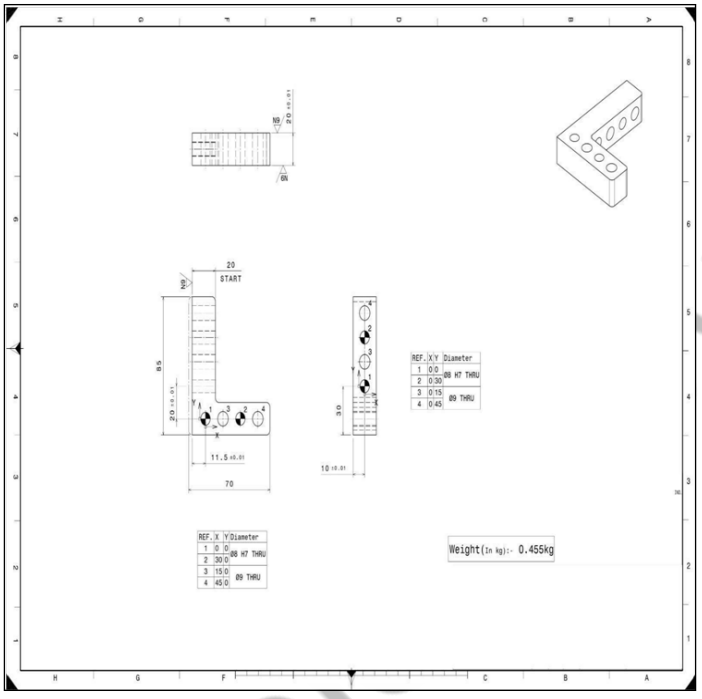


Figure 28.L-block

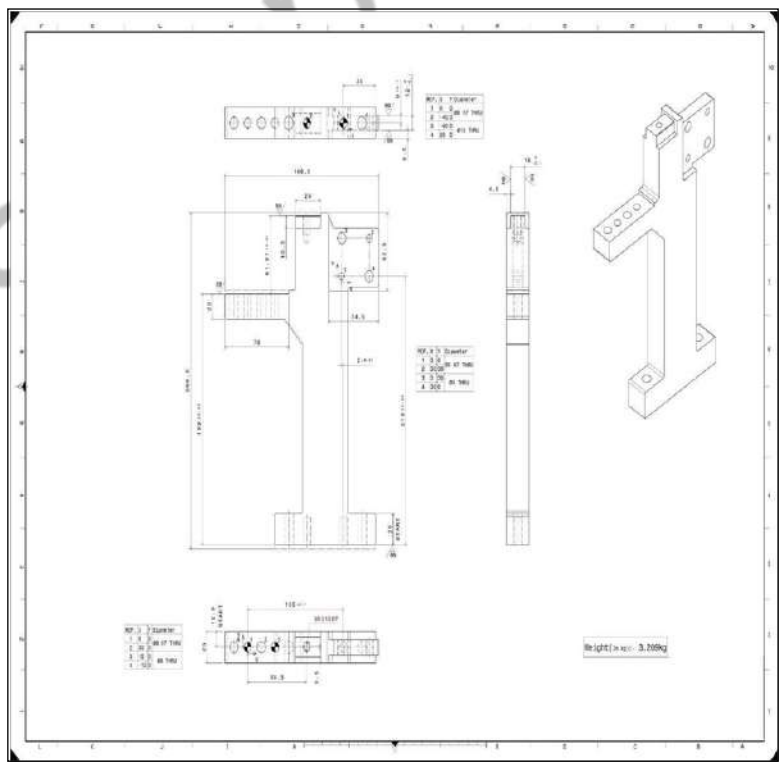


Figure 29.Riser

Drafting of Main Assembly

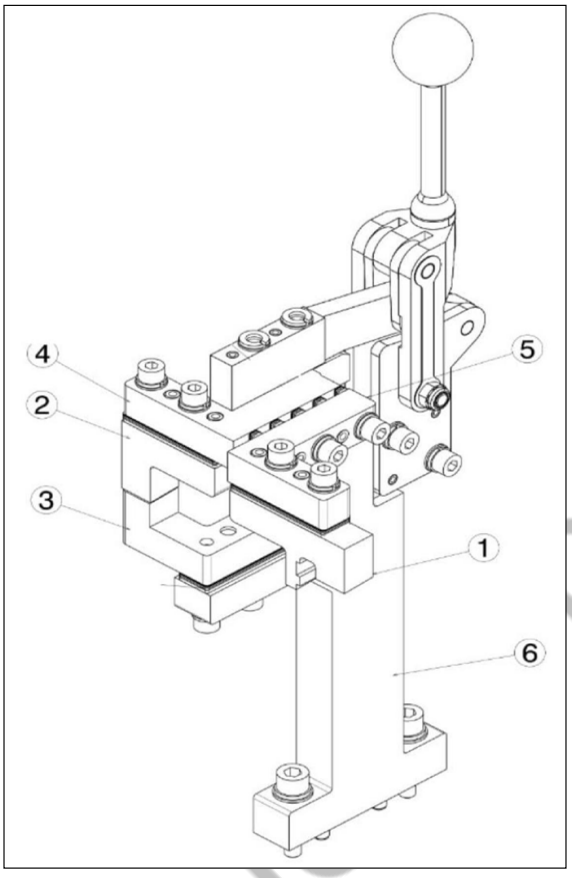


Figure 30.Drafting Of Main Assembly

3D Model of Fixture

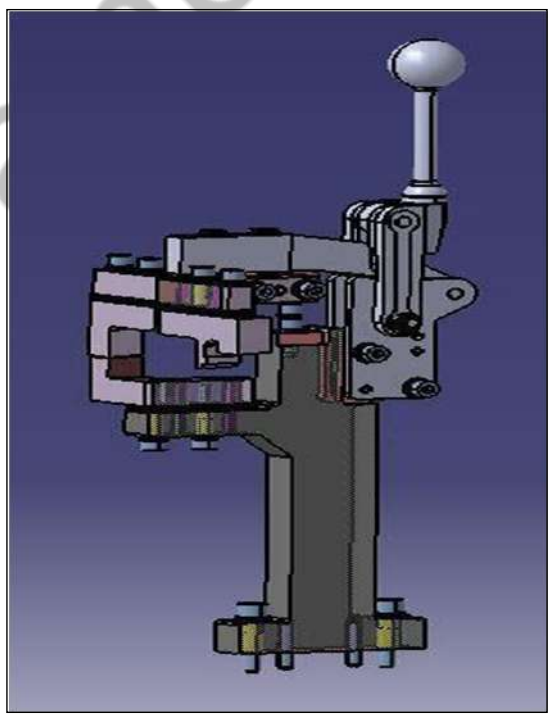


Figure 31.3D Model of Fixture

List of Fixture Components

Table 5.List Of Fixture Components

Item No.	Part No.	Product Description	QTY	Material	Weight
1.	W-11S-20-001	MYLAR	1	C45	0.372kg
2.	W-11S-20-002	CLAMP MYLAR	1	C45	0.326kg
3.	W-11S-20-003	REST MYLAR	1	TEFLON	0.352kg
4.	W-11S-20-004	CLAMP ARM	1	MS	0.698kg
5.	W-11S-20-005	L BLOCK	1	MS	0.455kg
6.	W-11S-20-006	RISER	1	MS	3.209kg
7.	DE-21-003	SLOTTED SHIM- 5 SLOTS-5THK	5	STD	0.11kg
8.	HV-1200- HTM-TU	Heavy Duty Horizontal TOGGLE			
CLAMP HV1200- HTMTU	1	STD	-		

Conclusion

In this project, a BIW fixture for front windshield with manual loading unloading and welding was designed and developed. The fixture was designed to meet the following requirements:

- It should be simple for manual labour to operate and strong enough to withstand the stresses created during welding.
- Steel was used to manufacture the fixture, which was created using SolidWorks. The fixture passed all of the tests and was judged to be in compliance. The windscreens of several different automobiles were successfully welded using the device.
- From this project, the following conclusions can be made: o The effectiveness and calibre of the welding process can both be greatly enhanced by the use of a fixture.
- A fixture may be made so that manual labourers may utilise it with ease.
- It is possible to create fixtures that can withstand the forces produced during welding. A fixture is a useful instrument for enhancing the effectiveness and calibre of the welding.

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