Abstract - There is just not enough time in the day? Well we have not reinvented the clock, but with a new modular fixturing system you might just think we did. Due to today’s heavy, growing competition environment, manufacturing companies have to develop and employ new emerging technologies to increase productivity, reduce production costs, improve product quality, and shorten lead time. Modular element makes fixture elements interchangeable and reusable, their design then becomes a task of selecting and assembling the proper elements together. This fixturing system is quick and easy to assemble for the first part and even easier to modify for additional part design. This fixturing system eliminates redundant design work by just picking up some standard components.

Here, in this project we have designed the modular welding fixture. This design consists of designing the frame structure for the maximum allowable load on the table. Here we have limited the maximum allowable load to 1500kg, and designed the frame structure from standard rolled angle section. We have designed the cast iron base plate for its thickness in bending consideration, and also designed the leg of the table for its diameter (hollow section) considering it as a long beam. In addition to that with the help of different locating accessories we have prepared models for welding setups for different type of assemblies in which parts are to be fixed on the table and welded.

In addition to that different angle plates, locators and clamps are required to be attached to the base plate rigidity to provide rigidity to the assembly. For this purpose people are using bolts with tapped holes in base plate but it is very time consuming task. So we have decided to go for alternatives. Here in this project we had started with jaw pins and gradually moved towards the ball lock pin. The pin which we have designed and manufactured is consisting of 4 numbers of balls. Three are of 6mm diameter and is of 10mm diameter. Outer diameter of pin is 16mm which will be inserted in the hole grid system to clamp the accessories with the fixture plate.

Here we have shown how different elements are used for location and how the same elements can be rearranged for different shapes and sizes of workpiece. And hence the same fixture can be used for infinite number of arrangements.

I. INTRODUCTION

A fixture is a device for locating, holding and supporting a workpiece during a manufacturing operation. This consists of locators, clamps, supports, and fixture body. Fixtures are essential elements of production processes as they are required in most of the automated manufacturing, inspection, and assembly operations.

Fixtures must correctly locate a workpiece in a given orientation with respect to a welding torch or measuring device, or with respect to another component. Whenever any component is in space it will have 6 degrees of freedom and for correct location of that component it is required to restrict those 6 degrees of freedom. These degrees of freedom can be restricted by 3-2-1 location system. Such location must be invariant in the sense that the devices must clamp and secure the workpiece in that location for the particular processing operation.

II. BENEFITS OF MODULAR FIXTURE OVER DEDICATED FIXTURE

- Appropriate for a wide variety of different parts and adaptable to changes in design, process plan and machine tool.

- Most often used for trial, prototype work and temporary replacement.

- Often applied to deal with small batch and short cycle production.

- Reduction of the requirement for large storage space because the fixturing elements can be re-used for other fixturing needs once dismantled.

- Fixture construction can often be performed without the need for engineering drawings.
Deduction of labour expenditure and maintenance costs.

Reduction in the lead-time between fixture design and fabrication.

Enable a faster response to customer’s needs.

III. DIFFERENT TYPE OF LOCATING ACCESSORIES USED IN MODULAR WELDING FIXTURE

- Locating bars
- Locating angles
- U-shape cube cases
- Adjustable “L” bracket (universal adjustable angle)
- Supporting angles
- V-block

IV. DESIGN OF DIFFERENT COMPONENTS OF MODULAR WELDING FIXTURE

A. Base Leg

- Maximum allowable load on the leg = 1500kg = 14715N
- Length of leg = 750mm

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\frac{P_c}{A_i} = 1.5
\]

\[
F.O.S = 3
\]

Considering the above condition, for a given crippling load (total weight on table x F.O.S.) applying Euler’s equation for a long beam, we have obtained the following dimension of the leg.

- Outer diameter = 22mm
- Inner diameter = 13mm

B. Design of Variable “L” Bracket

- Considering maximum allowable load on the angle = 100kg=981N
- Length of span = 200mm
- Rolled angle section of 50 x 50 mm

With thickness of 10 mm

C. Design of base plate

- Area of base plate = 1000mm x 1000 mm
- Grid hole diameter = 16mm (100mm apart)
- Plate thickness = 19mm

Considering above dimensions for the plate the effective length will be 1000 – (10 x 16) = 840mm.

Now designing the plat in worst condition considering it in simple bending we are getting bending stress = 48.53 Mpa. This is less than the allowable value of bending stress for a material.

D. Design of composite table frame

- Maximum allowable load =1000kg
- Rolled angle section of 50mm x 50mm with thickness of 5mm.
Considering above dimensions of a frame in composite section and applying the equation for bending stress, we are getting bending stress = 26.044 Mpa which is less than the allowable value.

V. BALL LOCK PIN

To obtain better geometrical relationship between the surfaces of the welded work piece in modular welding fixture, they are located against the locating clamp, locating angle, adjustable bracket, U shape cube case, etc... So our first requirement is to fasten the locator to the fixture plate. There are number of ways in which we can clamp or fasten the locating angle to the fixture plate.

One way of fastening the locating angles to the fixture plate is with the help of bolts with tapped hole in the fixture plate but it is very time consuming exercise. So to reduce the fastening time, we tried to have quick acting fastening arrangement. And in process of inventing this type of arrangement we came across no of possibilities which can be used for fastening arrangement. But from those we have chosen most efficient pin (Ball lock pin). Sketch of this pin is as shown in figure - 1. It consists of 5 main parts.

A. Body – It holds all the components and provides covering.
B. Bottom bush – It provide a guide way for the balls to move in radial direction.
C. Pin – It is used to give vertical movement to the larger ball and hence the smaller balls outward.
D. Button – It provides larger surface area for better grip and used to rotate the pin.
E. Balls (4nos.) – It projects outside of the body and used for locking accessories of the fixture.

VI. OPERATING MECHANISM OF BALL LOCK PIN

Here, fig. 2 shows the internal arrangement of various parts of ball lock pin. Now the point is how it operates and locks the different types of accessories with each other or locators with the fixture plate with quick action.

Fig-1 Dimensional sketch of a Ball Lock Pin
Assembly of the ball lock pin is as shown in figure-2. Bush is assembled at the bottom which provides the guide way to the balls. Ball of 6 mm diameter is placed in each slot. Ball with 10mm diameter is kept on the top of the three ball having point contact. Now as pin will be rotated with the help of button, rotation of the pin will give downward movement and hence it will apply the force on the top of the 10mm diameter ball. As this ball will move downward, it will push the balls (6mm dia.) outwards and made them to project outside. This projected surface of the ball will lock the pin against the chamfer provided at the bottom of the holes of the fixture plate as shown in figure-3.

VII. EXAMPLE OF FIXTURING ARRANGEMENT FOR ASSEMBLY ON MODULAR WILDING FIXTURE

Modular welding fixture is used in fabrication shop and it is obvious that the shape and size may vary from job to job. We know that modular fixture can be used to accommodate verities of workpieces. Here one example is given for better explanation and to give much clear idea that how different size and shape of the job can be accommodated with the same fixture plate and accessories provided.
As shown in figure - 4 it is required to weld three numbers of pipes with “T”. And probable fixturing arrangement for this setup is shown in figure - 5. In this arrangement pipes are located on V-block while the clamping force is applied from the top with the help of clamps. Its axial movement is restricted by the movement of angle clamp.

VIII. CONCLUSION

Modular fixtures are assembled from various quick acting universal elements designed and manufactured to meet the need for faster and economical fixturing. They enable us to assemble fixtures of different sizes as well as shapes, required to meet the fixturing requirements of components of different shape and size. The level of skill required to assemble and operate these fixturers are very low, making it more and more economically viable apart from reducing the cycle time required to fabricate the components.

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