

# Design & Development of Fixture for Bracket Weldment: A Review

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## Abstract

*In this paper, a thorough review of the available literature on design and development of fixture for bracket weldment is presented. A part created from an assembly of smaller components that are joined by welding known as weldment. Weldments can be joined either partially or completely in the fixture. A fixture is a work-holding or support device used in the manufacturing industry. Fixtures are used to securely locate (position in a specific location or orientation) and support the work, ensuring that all parts produced using the fixture will maintain conformity and interchangeability. Using a fixture improves the economy of production of the company by allowing smooth operation and quick transition from part to part, reducing the requirement for skilled labour by simplifying how workpieces are mounted, and increasing conformity across a production run. For this re-tapping process two workers are required one to hold the workpiece and other to perform the operation.*

**Keywords** — *Fixture, Weldment, Tapping operation.*

## I. INTRODUCTION

The assembly of the parts to be joined by welding is the first step in almost every welding operation. This assembly can be just placing two pieces of metal flat on a table and tack welding them together for practice welding, at the very basic level. At a higher level is the assembly of buildings, ships, complex equipment or other large welded structures. However, no matter how large or complicated the welded structure, it is assembled one piece at a time is the important thing to remember. A fabrication is an assembly whose parts may be joined by a combination of methods including welds, bolts, screws, adhesives, and so on, but a weldment is an assembly whose parts are all welded together, is a difference between fabrication and welding. Not all fabrications are weldments, but all weldments are fabrications. In addition to straight welding, to form a weldment, welders are often required to assemble parts together. A weldment may form a completed project or may only be a part of larger structure some weldments are composed of two or three parts others may have hundreds or even thousands of individual parts. Depending on the complexity and size of the finished weldment the number and type of steps required to take a plan and create a completed project will vary. All welding projects start with a plan. This plan can range from simple one that may exist only in mind of welder, or it can be complex and composed of set of drawings.

During manufacturing operation for holding a work piece in proper position the fixture is used as a special tool. Device is provided, for supporting and clamping the work piece. By use of fixture, positioning, individual marking, frequent checking and nonuniform quality in manufacturing process are eliminated. This reduce operation time and increase productivity. Because of features and advantages, fixture is widely used in the industrial practical application. A fixture's primary purpose is to create a safe mounting point for a workpiece, allowing for support during operation and increased reliability, accuracy, precision, and interchangeability in the finished parts. By allowing quick set-up, and by smoothing the transition from part to part it also serves to reduce working time. It frequently reduces the complexity of a process, allowing for unskilled workers to perform it and effectively transferring the skill of the tool maker to the unskilled worker. By reducing the concentration and effort required to hold a workpiece steady fixtures allow for a higher degree of operator safety. The most valuable function of a fixture is to reduce labour costs as per economical aspect. Without a fixture, two or more operators may require for operating a machine or process; by securing the workpiece using a fixture can eliminate one of the operators. The purpose of these devices is to reduce costs, and so they must be designed in such a way that the cost reduction outweighs the cost of implementing the fixture; fixtures must always be designed with economics in mind. To reduce the cycle time required for the operation was the aim behind to develop the fixture

i.e. to maintain the quality of product and increase the productivity by reducing cycle time for loading and unloading of product.

In India, one can come across factories with modern and highly sophisticated technology and also factories with outdated and inefficient technology. The technological advancement that has taken place in the developed countries has been, achieved in stages, depending upon the changed conditions and requirements the main reason for the latter is the fact that the latest technological developments from the already developed countries have been transplanted. For example, many of the developments in industrially more advanced countries require minimum labour force because of the fact that increasing wages, shortage of skilled labour, and lower productivity. For their production process many industries nowadays are using automation. Over manual labour automation has great advantages.

Our aim is to make an arrangement which will reduce the time consumed in marking the centre of the hole for tapping operation on work piece and to prevent the requirement to make jigs. Instead of making the whole guideway automated we will develop a fixture which will automatically adjust the centre of the hole of work piece. By using this method, the production will be increased with reducing human efforts.

## **II. LIETERATURE REVIEW**

A critical review of the existing literature is literature review. In-depth analysis of the current literature should be performed and general insight should be obtained. A literature review helps to put the current state of the literature in perspective and ties important advances together from seemingly disparate studies. In this section the study of various aspects regarding this research paper were carried out such as study of weldment, fixture and tapping operation.

### **A. Weldment**

Cover R. et al. [1]: The fatigue of steel weldments has been reviewed and the effect on fatigue strength of weld geometry, testing conditions, residual stress, weld metal soundness and the microstructure of the weld metal and heat-affected zone has been examined. In determining the fatigue properties of a weld, it has been clearly shown that weld geometry is the most important factor. For a given weld geometry, the fatigue strength is determined by the harshness of the stress concentration at the weld toe or, with the weld reinforcement removed, by the stress concentration at weld metal defects. By producing welds with different degrees of surface roughness and weld metal soundness different welding processes

influence fatigue strength. By thermal stress relief a moderate increase in fatigue strength is obtained under conditions of alternating loading for fatigue strength affects due to residual stress. By the much greater effects of weld geometry and weld defects, the microstructures of the weld metal and heat-affected zone have only a minor effect upon the fatigue strength of welds and are usually masked. Wahid A. et al. [2]: Corrosion failures of welds occur in spite of the fact that the proper base metal and filler metal have been selected, industry codes and standards have been followed, and welds have been accumulated that possess full weld penetration. It is not strange to find that, although the wrought form of a metal is resistant to corrosion in a particular environment. Further welds can be made with the addition of filler metal. However, superior to that of the unwelded base metal there are also many instances in which the weld exhibits corrosion resistance. Displaying both resistance and susceptibility to corrosive attack when the weld behaves in an erratic manner. Factors influencing corrosion of weldments. It is sometimes difficult to determine why welds corrode; however, one or more of the following factors often are implicated: fabrication technique, weldment design, welding sequence, welding practice, organic or inorganic chemical species, moisture contamination, weld slag and spatter, oxide film and scale, improper choice of filler metal, incomplete weld penetration or fusion, porosity, cracks, final surface finish, high residual stresses, etc. Kumar K. et al. [3]: Development of dissimilar weldments represents major challenge in modern manufacturing processes. The relative lack of basic understanding of the process is one of the main reasons for the poor progress in this area. In particular, very little is known about the weldments both in terms of fluid flow, heat transfer and the microstructure development. From a basic point of view, we have embarked on a major programme of understanding dissimilar weldments. Primarily using laser as the heat source some of the recent results are given. Work is initiated with model systems, in order to understand the process that take place during MIG welding. In the present letter, two copper plates are welded with an iron filler rod where we report some early work on a model system. The choice of the system arises from two facts. Firstly, fusion welding of copper to iron, if acknowledged, has great technological importance. The system lies in the fact that they are unmixable in solid state while mixable in liquid state. However, in undercooled temperature there exist a liquid miscibility gap. Thus, fluid flow, heat transfer and mass transfer will leave its effect on the weld pool microstructure which will allow us to understand the microstructure development.

### **B. Fixture**

Pachbhai S. et al. [4]: In machining fixtures, to maintain the machining accuracy minimizing workpiece deformation due to clamping and cutting forces is essential. By various authors the various methodology used for clamping operation used in different application are reviewed in this paper. In various industries fixture is required as per their application, by selecting the optimal location of fixturing components such as locators and clamps this can be achieved. The fixture set up is done manually for components. Which requires more cycle time for loading and unloading the material. So, to improve productivity and time there is need to develop system. High quality of operation is possible by using fixture which reduces operation time and increases productivity. During manufacturing operation, the fixture is an exceptional tool for holding a work piece in proper position. Device is provided, for clamping and supporting the work piece. Frequent checking, positioning, individual marking and non-uniform quality in manufacturing process is eliminated by fixture. This increase productivity and reduce operation time. Because of feature and advantages fixture is widely used in the industry practical production. Okpala C. et al. [5]: The people's quest for manufactured goods has been growing rapidly over the years. Therefore, manufacturers have reacted by introducing innovative ways of manufacturing high quality products at a faster rate, to meet up with the high demand. The production processes have witnessed numerous changes and evolution with the introduction of numerous innovative manufacturing concepts which include lean production system, cellular manufacturing, single minute exchange of dies, as well as takt time analysis. The need for a reliable and cheaper tools and work-holding devices have necessitated these creative approaches. As the efficient running of a manufacturing company which demands a efficient and simple work positioning plan for correct operations depends largely on the interchangeability of machine components and work-pieces, to ensure ease of assembly, and unit cost reduction, as well as to become competitive, reduce the excessive manufacturing cost, and also increase their profitability, the industry has resorted to consolidate its supply chain in a bid to maintaining a very low amount of supply. This has also led to the demand for a better and cost-effective work-holding device which will ensure better quality products, reduce lead time, and also increase throughput. Abouhenidi H. [6]: Fixture can be defined as A) a strong and rigid mechanical device which attaches to a machine and allows the stock to slide while being held firmly enabling simple, quick and persistently accurate locating, supporting and clamping, blanks against cutting tool(s) and result quick and exact machining with consistent quality, functional capability and

exchangeability. B) A device which secures a single object to a location in territory relative to a specific reference plane and/or point by specifying at least four of its possible six degrees of movement in space. As the name implies fixture is fixed to the machine bed clamping in such a location that the work is in the correct relationship to the cutter. The cutter is not guided into location ready for machining to initiate. Before production begins a setting, a gauge is often provided to enable the initial setting of work to the cutter. Mengawade S. et al. [7]: The design of a fixture is a highly complex and intuitive process, which require knowledge. At the setup planning phase fixture design plays an important role. For developing product quality in different terms of surface finish, precision and accuracy of the machined parts proper fixture design is crucial. So, the aim of this project is to replace fixture to save time for mounting and dismounting of component. To optimize design for machine operation as well as process function ability fixture provides the manufacturer for flexibility in holding forces. The table of the machine upon which the work is to be done a fixture should be securely fastened. For various operations on most of the standard machine tools fixtures are designed to hold the workpiece. Based on the use of relatively simple tools to expensive or complicated devices fixtures vary in design. On special equipment's fixture helps to simplify metalworking operations performed. Dalvi H. et al. [8]: Fixture is most important equipment used in mechanical industries to hold, locate and support the work piece during the operation. The purpose of the project is to reduce the human effort require to unload the valve assembly from assembly line which is much heavier in weight and this project is developed to handle the control valve assembly on assembly line in an industry. In an industry the issue of safety and fatigue of the worker is most important factor which is analysed in this project. At shop floor the completion of the work will drastically reduce fatigue of the worker and also provide safe working conditions to worker. This fixture works automatically with the help of some electronic and mechanical components such as solenoid valve, pneumatic cylinder, switch mode power supply, direction control valve, etc. On the completion of project, one may gain the knowledge of design, fabrication and also about the pneumatic systems and these all will make the machine efficient. Also, this can be used where manually handling components like valves are present. Because of features and advantages fixture is widely used in the industry practical production. Reddy D. et al. [9]: The objective of this paper is the design and simulation of beam and clamping fixture. The welding beams are main parts used in pallet storage systems for the purpose of load carrier. Clamping fixture uses two pneumatic cylinders which enables

more accurate than manual effort. According to our welding specifications, with the help of solenoid control equipment by using pneumatic power, so that human effort is reduced and minimizes the idle time and optimizing the production rate the two cylinders are used to support the beams. We introduced guide rails for the purpose of adjusting fixtures according to changing the beam lengths. The design will be different from the existing MIG welding fixture in the market as this fixture was design especially for the use of the MIG welding machine in welding research lab. The same thing applies to the companies such as automotive company who have their own welding jig which is customized for their products. Jayaweera N. et al. [10]: In the aerospace industry many components used are complex shaped, without symmetric axes and parallel surfaces. To support manufacturing processes such as drilling, surface finishing, inspections and assembly fabricating and repairing these components often require fixturing system. Dedicated and flexible fixtures are currently available fixturing systems. Among these, the flexible fixtures are suitable for handling several complex shaped components and rapidly changing fabricating processes using same fixturing system. To fix complex shaped components, background research suggested that the pin type fixturing system is the predominant design used in such applications. force is applied to a single point of contact, in case of pin type fixturing systems. There is possibility of damaging these components and this increases the pressure applied to the workpiece. Further, rigid designs which cannot adapt to the shape of the work piece use conventional pins. This increases the possibility of slipping and the reduces the clamping force. This paper describes a fixturing system to address these problems by developing a distributed force fixing method with conformance to complex shapes. Proposed fixturing system uses jamming granular materials with negative pressure. A flexible rubber container fill with granular material is attached to the tip of a modified pin. When the container touches the work piece it conforms to the shape of the work piece. Then the rubber container vacuumed, which rigidifies the container and fix the shape, through granular jamming. Series of experiments were carried out to decide the best suited granular material in terms of highest holding force with best adaptability to a complex surface. According to the experimental results proposed system successfully provide required holding forces to manipulate complex shaped components.

### **C. Tapping**

Patel H. et al. [11]: Now days, there is a tremendous development in the production industry and their relevant machinery to improve the productivity. The conventional methods in some of the operations are still used in small, medium and

some large-scale industries. Thread tapping is one of them. The production of the fine thread inside the drilled hole on the plate is known as Tapping Operation. The conventional method hand tapping is used in most of the industries. This conventional method of hand tapping is very time-consuming process, includes higher labour cost and less accurate, and ultimately less productivity. So, there is an opportunity to evolve the machine for tapping operation. For fastening purpose tapping operation is very important and normally performed as end operation. There are so many efforts taken by the researchers on tapping operation which includes the accuracy in dimensions, vibration assisted tapping, alignment of tapping tool with centre of drilled hole, machine tapping, application of different lubricants and its effect on quality, tapping tool breakages, quality of tapped hole, and parametric study and its analysis. For pneumatic application there is a scope to work on tapping operation and can be perform parametric study on it. To reduce the problems like tapping tool breakage in machine tapping and hand tapping as well as for better quality of tapped hole and improvement in productivity this study is helpful. K. Manoj et al. [12]: Using a real time multi station automated rotary transfer line used for Drilling, tapping and inspecting a standard block of size 60 X 60 X 75 mm with drill size diameter 5 x 15 mm long and tapping the drill by M6 machine Tap this paper discusses the case study and, comparison of productivity of a component. Using electro-pneumatics, the clamping of the component, part transfer and feed of the drilling machine spindle is done. Low cost automation with the micro controller is the logic behind this system. The following studies are carried out 1. Using pneumatic clamping time saved by component handling, 2. Both qualitative and quantitative productivity increase, 3. Improved accuracy and repeatability, 4. Indirectly reduction in operator fatigue, less human intervention, 5. Due to automatic controls, less rejection, and 6. Minimization of production costs.

### **III. REMARK OF LIETERATURE REVIEW FOR FIXTURE IN BRACKET WELDMENT APPLICATION**

The function of a fixture is to facilitate a positional relationship between the workpieces themselves or between the workpieces and a tool during the assembly of a weldment. High-quality weldments produced at a higher rate of productivity with less distortion and at lower costs due to the use of fixtures promotes good fit-up tolerances. In the fixture weldment can be joined either partially or completely. The device used is typically called a tacking or fitting fixture, if the assembly is tack welded together and removed prior to welding. Fixtures serve three major purposes. They are used

as tacking fixtures, welding fixtures, and holding fixtures. The advantages of fixturing include the following:

1. Minimized decision making and measurements required of the operator with respect to the location and orientation of the weldment.
2. Improved identification of workpieces that are out of tolerance.
3. Enhanced fit-up of workpieces to achieve tighter tolerances.
4. Minimized weld distortion.
5. Less manufacturing labour needed to produce the weldment.
6. Improved weld consistency and quality, and
7. Fewer product errors as a result of appropriate fixture identification.

By maximizing the orientation of the weld joint to permit welding in the flat position Fixtures and positioners enhance the execution of semi-automatic, fully automated and manual welding processes. Depending on the complexity of their design, fixtures can be expensive to build. Nonetheless, due to the higher productivity and improved weld quality that result from their use they are cost effective. The number of weldments to be produced should reflect the design and manufacture of fixtures. Small quantities may be produced on temporary fixtures.

#### IV. PROCESS LAYOUT FIXTURE FOR BRACKET WELDMENT

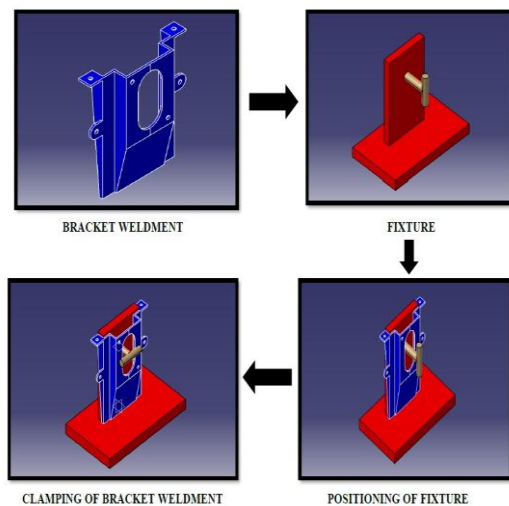


Fig. 1. Layout of Design & Development of Fixture for Bracket Weldment

With a logical and systematic plan successful fixture designs begin. Very few design problems occur, with a complete analysis of the fixture's functional requirements. When they do, chances are some design requisites were forgotten or

miscalculated. The extent of planning needed may affect the workpiece, tooling, processing and available machine tools. For more complicated fixture designs preliminary analysis may take from a few hours up to several days. Fixture design is a five-step problem-solving process.

Step 1: Define requirements to initiate the fixture-design process, clearly state the problem to be solved or needs to be met. To define the scope of the design project state these requirements as broadly as possible, but specifically enough.

Step 2: Gather/Analyse information collect all relevant data and assemble it for evaluation. The part print process sheets, and machine specifications are the main sources of information. Part documents and records should be latest. For example, verify that, the processing information is up-to-date and the shop print is the current revision. Pending part revisions check with the design department. Note taking is an important part of the evaluation process. To record important information complete, accurate notes are required. With these notes, they should be able to fill in all items on the "checklist for design considerations." All ideas, thoughts, observations, and any other data about the part or fixture are then available for later reference. Four categories of design considerations need to be taken into consideration: operation variables, workpiece specifications, personnel and availability of equipment. These categories are actually interdependent.

Step 3: Develop several options, most creativity requires this phase of the fixture-design process. In several different ways a typical workpiece can be located and clamped. The natural habit is to think of one explanation, then cultivate and clarify it while blocking out other, perhaps better solutions. Perhaps just choose one path right away a designer should brainstorm for several good tooling alternatives. During this phase, the designer's aim should be adding better options, instead of discarding them. Alternative designs should be developed only far enough to make sure they are feasible and to do a cost estimate, in the interest of economy. The designer usually starts with: modular, permanent, and general-purpose work holding device. Many clamping and locating options of its own has each of these options. Areas for locating a part include cylindrical and curved exterior surfaces, flat exterior surfaces. the items sketched is important compared to the exact procedure used to construct the preliminary design sketches. Generally, the part to be fixtured is preliminary sketched. The next items added should be the required locating and supporting elements, including a base. Then sketch the clamping devices. Finally, add the machine tool and cutting tools. In the design of the complete fixture

sketching these items together helps to identify any problem areas.

Step 4: Choose the best option: the sum of per-piece run cost, setup cost, and tooling cost is the total cost to manufacture a part. These variables are described below with sample values from three tooling options: a hydraulically powered permanent fixture, a permanent fixture, and a modular fixture.

Step 5: Implement the design: turning the chosen design approach into reality is the final phase of the fixture-design process. Final technicalities are decided, final outline of drawings is made, and the tooling is built and tested. To make the fixture less costly while improving its efficiency the following guidelines should be considered during the final-design process. These rules are a mix of sound design practices, common sense, and practical considerations.

## V. CONCLUSIONS

In this study a review of the available literature on fixture for weldment. For locating and holding the workpiece fixture is used. It is always fixed to machine or bench for holding the workpiece. Fixture is generally used for mass production. Fixture reduces operator's fatigue. Principle of locating and clamping is followed by fixture. By reducing the concentration and effort required to hold a piece steady fixtures also allow for a higher degree of operator safety.

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