International Journal of Advanced Research in Science Management and Technology
ISSN(Online)-2454-4159 Volume 3, Issue 6, June 2017

"Design and Analysis of welding fixture of Rack and Pinion Assembly"

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ABSTRACT— All manufacturing industry used for assembly of component for used the welding fixture. The fixtures are the important part of the welding as fixtures are used in manufacturing of different products during welding to hold the different parts of that respective product. Fixture having direct impact for the productivity and quality of product. welding fixture are design for the component which have difficult to weld. In normal way welding of different parts of component not possible for without holding device. The welding fixtures are important holding device. The number of parts to be welded in proper position in fixture and tightened. When the fixture are holding work piece for produced by the welding stress. The proposes a design and analysis approach in fixture of sheet metal assemblies for rack and pinion Cross member component. The design of an assembly fixture for a particular tail cone has been completed convenient to the existing locating principles. In rack and pinion assembly manual clamping done due to different force produce. Which have analysis by Stress deformation of component The design of welding fixture for this assembly component using for Pro-E and CAD software. using the Finite Element Analysis (FEA) by using ANSYS software that provides best output within few seconds. All part parts have design in Pro-E and different Load analysis done by ANSYS 14.5.

Keywords— Design, Analysis, Welding Fixture, Assembly of Cross Member, Assembly bracket.

I. INTRODUCTION

In these troubling economic times, companies are trying to find methods to optimize the production and utilization of their assets. Now more than ever, companies are trying to manufacture and fabricate their goods as cheaply as possible by maintaining high production variability and sustaining low error counts. Additionally, companies are asking younger, less experienced workers to manage projects that are typically selected for more experienced engineers to maintain the knowledge, while reducing the number of workers. The sudden shift in industry has caused additional focus on cost cutting devices and tools that facilitate the acquisition of and maintenance of company specific knowledge and experience from engineer to engineer. An example of a cost cutting device is a fixture. A fixture is a tool that is used to accurately locate and hold a work-piece in a manufacturing or fabrication process. Fixtures can have applications in machining, assembly, and turning. Fixtures are made for easy loading and unloading and guarantee that a work-piece can be held in the same location repeatedly with minimal variation. The time needed for the fabrication process is reduced and costs are lowered by diminishing the need of potential rework on parts. The focus of this thesis is on welding fixtures which are a type of assembly fixture. These fixtures are made specifically to hold multiple parts together, allow adequate tool passage, resist high heat and sputter, permit passage of weld runoff, and in some cases conduct electricity and provide grounding. Fixture design has much to do with experience, which the younger engineers generally have been unable to acquire. It can take engineers many years to learn the nuances of the craft. Fixture design can be dived into four major steps, setup planning, fixture planning, fixture unit design and verification. These steps can be generalized as analyze the part, define suitable locating and clamping points, identify tooling and environmental requirements, and create a fixture to satisfy criteria. A fixture is a device for locating, holding and supporting a work-piece 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 work-piece 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 work-piece in that location for the particular processing operation.

II. OBJECTIVES

1. The main objective of the project is behind the modify of the fixture are reduction in manpower involved.
2. To reduce operator fatigue.
3. To reduce damage and reworks of component on rack and pinion assembly.
4. Increase quality of welding Reduction in manufacturing cycle time of component.

III. PROBLEM DEFINITION

In the manufacturing industries different products are manufactured. In every product at some of the joints there is requirement of welding to bind them together. These products or these parts undergo different stresses like tension, fatigue stresses etc. and hence these forces and stresses ultimately affect the joints as stress concentration is maximum at joints. Now these factors should be considered during the actual welding process i.e. during welding the extra care should be taken for alignment of the parts and the welding torch. That means the important part of the welding process is fixture which is used to hold the part to be joined in proper alignment.

- The manually operated toggle clamp; that's why improper force is applied.
- To improper force applied due to the parts are bend
- Maximum force to be applied at a component; that time crack occur and component will be damage.
- Due to rack & pinion bracket and cross member tube in between gap is produce that why in proper welding

IV. METHODOLOGY

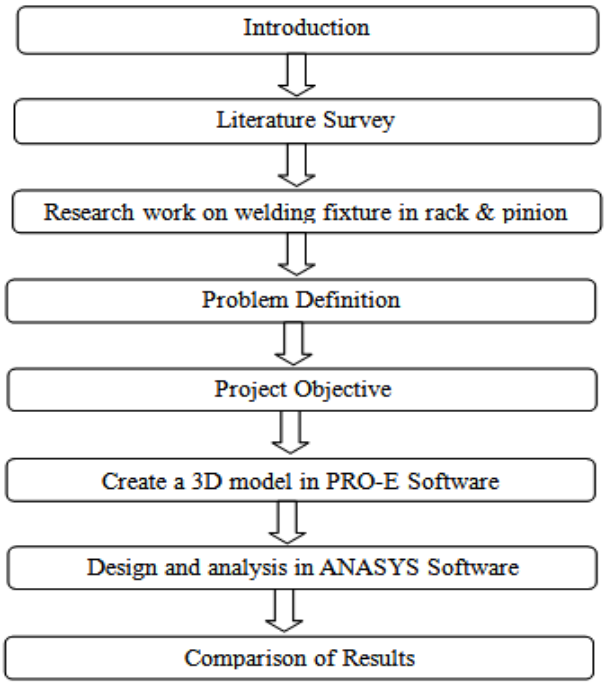

Fig.1 Methodology of dissertation work

V. DIFFERENT TYPES OF FIXTURES

- Turning fixtures
- Milling fixtures
- Fixture for grinding
- Fixture for broaching
- Fixture for boring/drilling
- Tapping fixture
- Fixture for welding
- Assembling fixture

Welding Fixture- This fixture is use to locate the various plates on their respective positions on Base plate, with the help of which following operations will going to perform on component sequentially:

- Perfect positioning
- Proper aligning
- Proper supporting
- Welding

Elements of Fixture Design- Mass production aims at high productivity to reduce unit cost and interchangeability to facilitate easy assembly. This necessitates production devices to increase the rate of manufacturing and inspection devices to speed up inspection procedure. Fixture planning is to conceptualize a basic fixture configuration through analyzing all the available information regarding the material and geometry of the work piece, operations required, processing equipment for the operations and the operator.

Generally, all the jigs and fixtures consist of

- Locating Elements:-

A locator is usually a fixed component of a fixture. It is used to establish and maintain the position of a part in the fixture by constraining the movement of the part. For work pieces of greater variability in shapes and surface conditions, a locator can also be adjustable. These position the work piece accurately with to the tool guiding or setting elements in the fixture.

- Clamping Elements:-

These hold the work piece securely in the located position during operation. A clamp is a force-actuating mechanism of a fixture. The forces exerted by the clamps hold a part securely in the fixture against all other external forces.

- Tool Guiding Elements:-

This aid guiding or setting of the tools in correct position with respect to the work piece. Welding gun guide the Weld accurately to the work piece. Welding fixtures use setting pieces for correct positioning of Welding with respect to the work piece. Every part has 6 degrees of Freedom (3 Linear + 3 Rotary) which need to be arrested to ensure proper location of the part in space. Fig. 3.1 shows the locating principles.

Fixture Design Fundamentals-Fixture design consists of a number of distinct activities: fixture planning, fixture layout design, fixture element design, tool body design, etc. They are listed in Figure 3.2 in their natural sequence, although they may be developed in parallel and not necessarily as a series of isolated activities in actual execution.

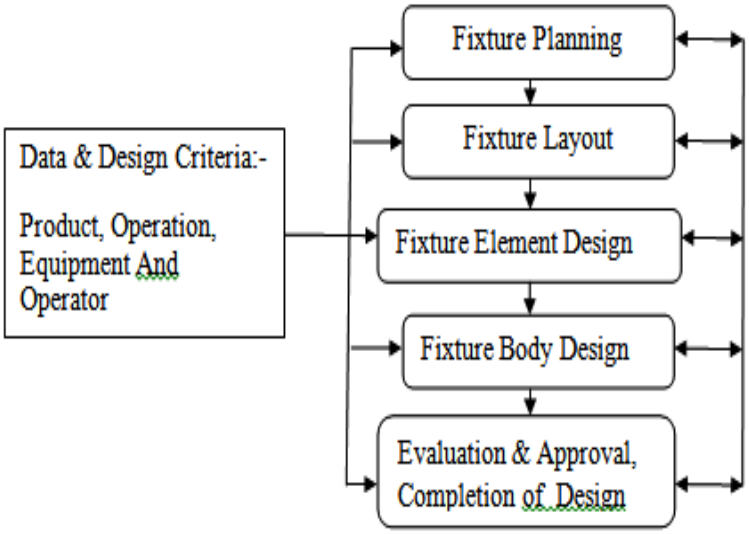

Fig.2 Various aspect of fixture design

Fixture Design Procedure- In the design of a fixture, a definite sequence of design stages is involved. They can be grouped into three broad stages of design development. Stage One deals with information gathering and analysis. These include product analysis such as the study of design specifications, process planning, examining the processing equipment and considering operator safety and ease of use. In this stage, all the critical dimensions and feasible datum areas are examined in detail. Stage Two involves the consideration of clamping and locating schemes. A clamping scheme is devised in such a way that it will not interfere with the welding gun (torch) are fully compatible with proposed locating surfaces or areas. The locating scheme, using standard elements such as pins, pads, etc. is designed to be consistent with clamping and tool-guiding arrangements. Stage Three is the design of the structure of the fixture body frame. This is usually built around the work piece as a single element which links all the other elements used for locating, clamping tool-guiding, etc. into an integral frame work. The above procedures are quite general and can be modified depending on the relative importance of the various elements in providing for the required accuracy of the workpiece to be located and secured into the fixturing device. With the popular adaptation of modular fixturing elements, the fixture body frame is usually a standard block with fixed arrays of locating and fixing holes or slots. It becomes a matter of selecting the most suitable body frame to accommodate the various elements, provide good support of the work piece and access to welding torch.

Computer Aided Fixture Design- Computer aided fixture design (CAFD) is the use of computers to help aid in the design of fixtures. These computer based programs help facilitate the designer in steps that were previously very complex. CAFD programs take the creation of fixtures in CAD packages further by not only allowing the building of fixtures but also have assistive properties to help expedite design. These programs contain information on tolerances, forces, and even materials, in order to assist in the production. The additions of 3D modeling and simulation features have improved fixture design and implementation immensely. This is especially important in the development of modular fixtures. These fixtures are generally used multiple times for numerous situations. The ability to simulate production and analyze the forces in multiple configurations eliminates the need for multiple prototypes and saves money as well as time.

Some areas of CAFD are still in development. Integration of CAFD with Computer Aided Manufacturing (CAM) systems is being researched. When CAFD is integrated with CAM systems a designer will be able to virtually create a work piece, create fixtures, mount fixtures in desired locations, test tool paths, and run simulations from start to finish. This will allow a designer to go through all the steps for manufacturing without testing on a prototype. This will help reduce costs and prevent many potential mistakes. CAD/CAM integration by way of Computer Aided Process

Planning (CAPP) is studied in the work of Yuru and Gaoliang (2005). In this article an integrated system is proposed that is composed of two modules that handle different aspects of setup planning and fixture design. The articles goal is to add fixture design to process planning so that there can be an easy transition by using CAPP. This type of research is not the only category of research being pursued in CAFD. There has been substantial research in the areas of optimizing fixture locations and verification of fixtures and fixture solutions.

Optimizing fixture locations- CAFD packages allow the visualization of fixture locations due to the integration in CAD packages, but little information is provided that allows a less experienced engineer to determine the best locating and clamping methods. Researchers are working on methods to help aid in optimization.

VI. FINITE ELEMENT AND ANALYSIS OF RACK AND PINIPON AND ASSEMBLY

Assembly of Rack and pinion Component with Welding Fitxuer

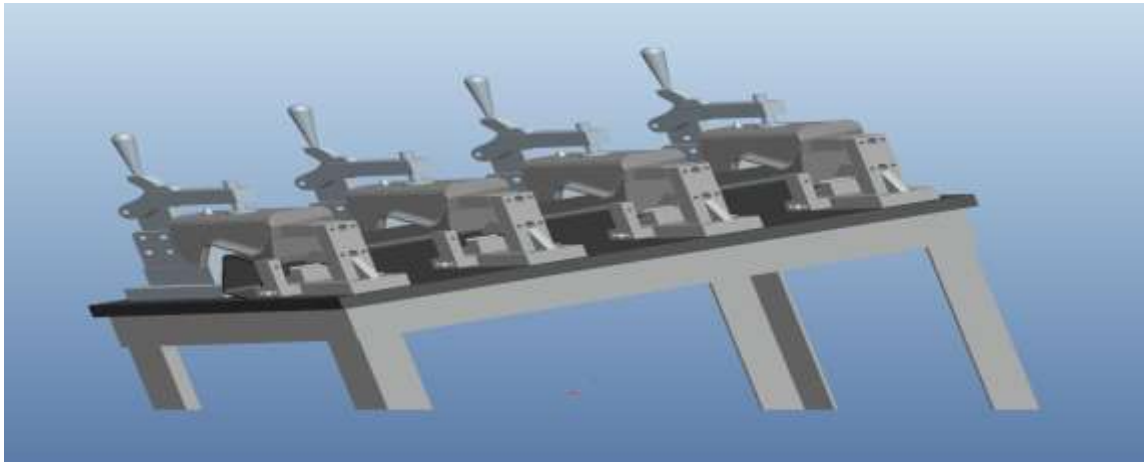

Fig.3 Assembly of Rack and pinion Component with Welding Fixture

Model Of Rack And Pinion Bracket Create In Pro-E Software

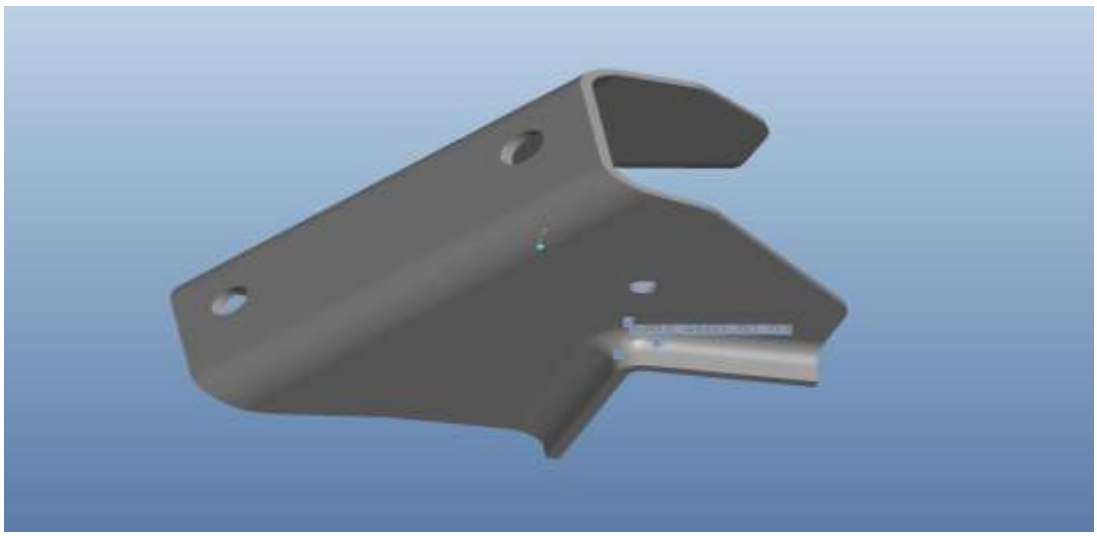

Fig.4 Modeling of assembly Bracket in Pro-E

FEA-RESULT Analysis of Rack And Pinion Assembly Bracket

1.Static Structural Analysis For Bending Stress And Deflection At Various Loading

2.Application of Load on Rack and Pinion Assembly Bracket =1571 N

International Journal of Advanced Research in Science Management and Technology
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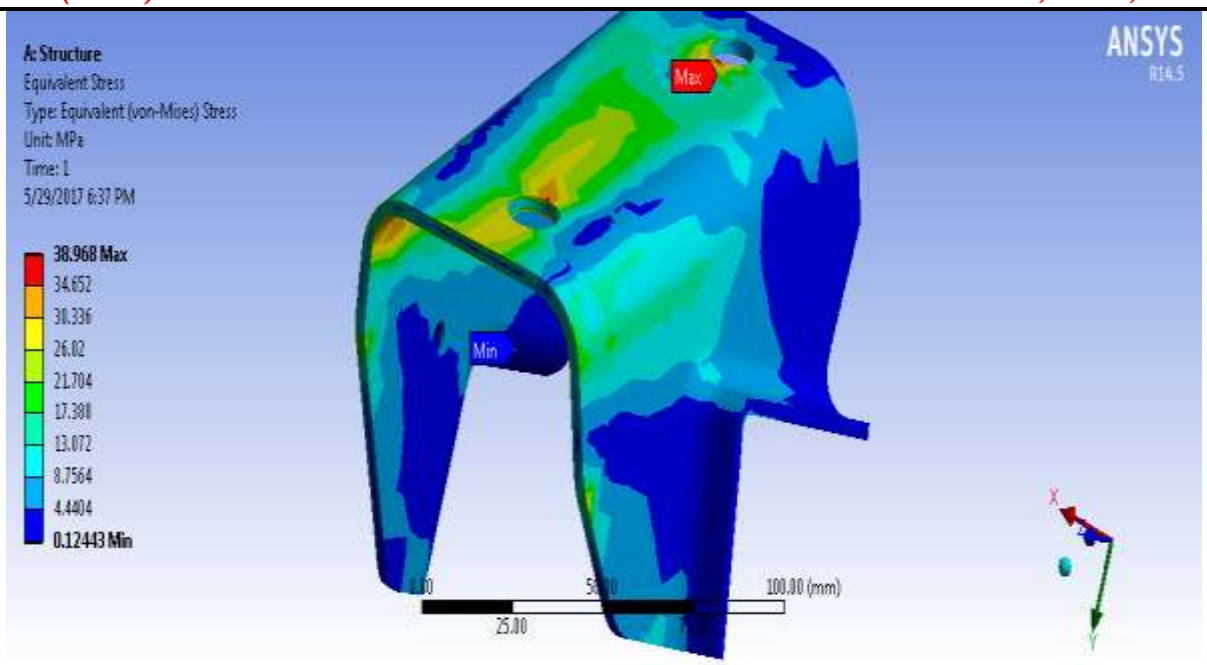

Fig.5 Equivalent (Von-mises) stress contour of Rack and Pinion Assembly Bracket at 1571 N

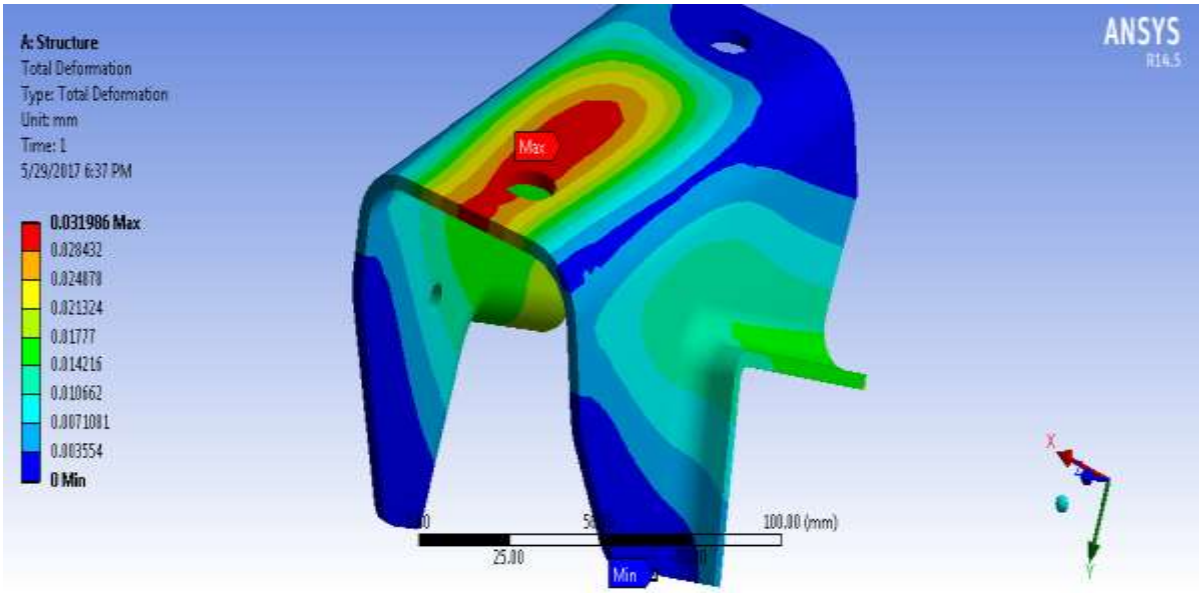

Fig.6 Maximum deflection contour of Rack and Pinion Assembly Bracket at 1571 N

FEA-ANSYS Results for Stress and Deflection values at various loads

Sr. No.	Load applied (N)	Bending Stress (σ_b) Occurred in (MPa)	Deflection (y) occurred in (mm)
1)	1571	38.968	0.031986
2)	3141	77.911	0.063843
3)	4712	116.88	0.095939
4)	6283	155.85	0.12792
5)	7854	194.82	0.15991

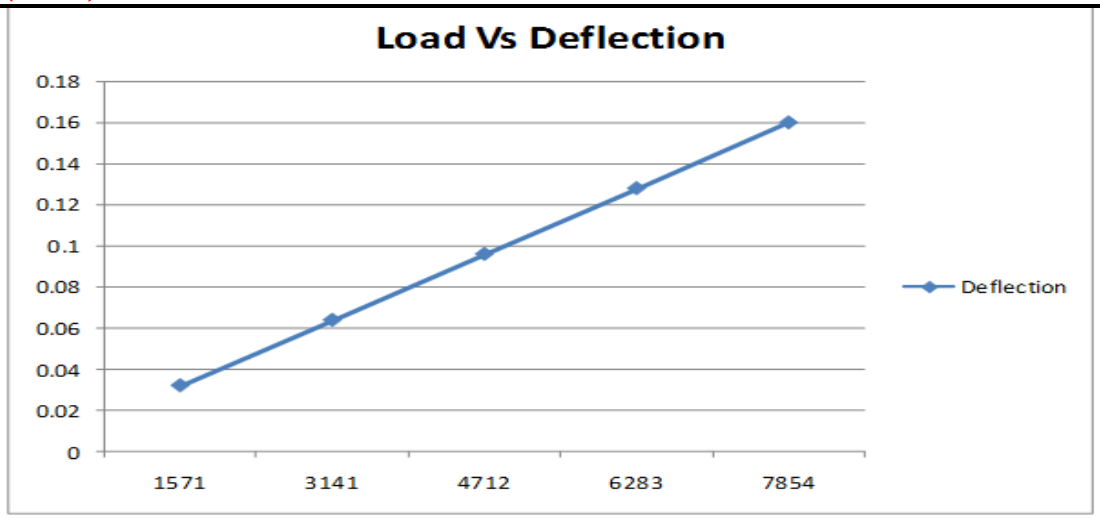

Fig.7 Load Vs Deflection of rack pinion bracket assembly

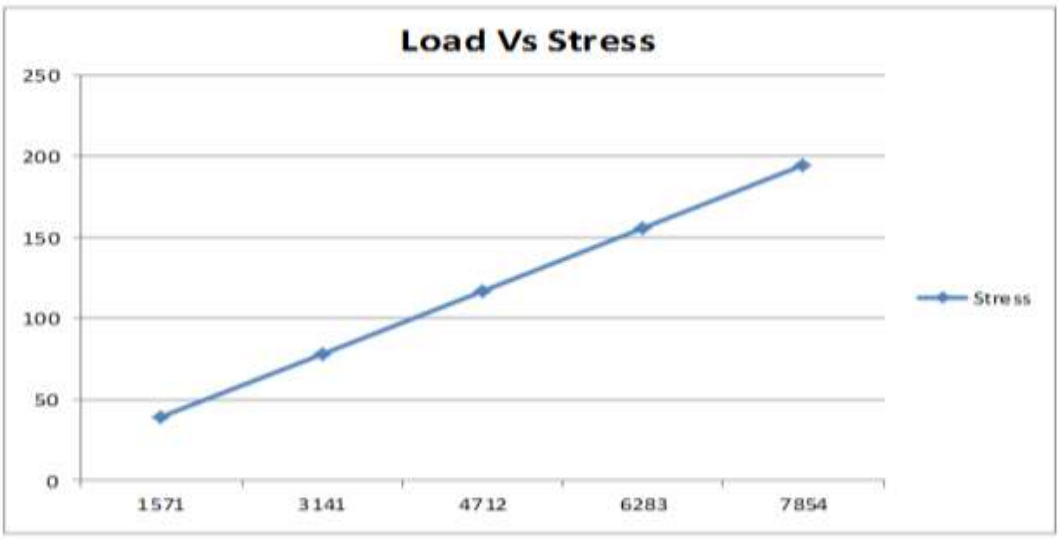

Fig.8 Load Vs stress of rack pinion bracket assembly

VII. CONCLUSION

The main purpose, objective of rack and pinion bracket assembly fixture have the bracket of assembly welded to the cross member tube in proper location. A series or bunch or numerous weld fixtures together work in an automated industry in providing the better gripping as well as the location of the part that are being manufactured. The model of a weld fixture by using PRO-E software which is one of the software used for modeling components in most of the design based industries. While the modeling of the components the material selection is carried out simultaneously based on the design considerations related to loads, etc. Later the stress and strain concentration, deformation on the assembly bracket of the weld fixture have been found by applying certain load on the bracket, using the Finite Element Analysis (FEA) by using ANSYS Workbench 14.5. From result of the load analysis we observed that the Equivalent (Von-mises) stress and Maximum deflection of assembly bracket for clamping location point.

VIII. FUTURE SCOPE

In these Fixtures clamping are done by manually, but in future by using automated clamping such as pneumatic or hydraulic clamping we can achieve higher production rate. By making the fixture adjustable and by increasing the size of the fixture, bodies of various sizes can be welded on the same fixture, which is resulting in increase of the production rate.

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