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Computer Aided Fixture Design for Stool Welding on Welding Robot

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ABSTRACT: In the era of automation, product with up most accuracy and fastest production rate is preferred ,various techniques are used to make process automated. Fixture design is one of the most commonly used technique to accelerate the rate of production with accuracy.

Current paper describes the innovative welding fixture design used for making a metallic (steel) stool. This is a most suitable MIG welding fixture design which can be applicable for making metallic (steel) stool just by holding the four steel bars in given frame, the angle amongst the four legs of a stool is maintained. This particular fixture not only reduces the setting time but also increases the precision . It improves the quality to a greater extent and operators fatigue is reduced to a considerable extent.

KEY WORDS: Fixture, Steel stool, Accuracy, Fatigue etc.

I. INTRODUCTION

Fixture is special tool for holding a work piece in a proper position during manufacturing. It is used for supporting and clamping the work piece. Fixture eliminates frequent checking of positions, markings, facilitate uniform quality in manufacturing. A fixture improves the economy of production 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.

Fixture plays an important role in manufacturing process. This fixture belongs to welding fixture category. It holds all the parts with accuracy and grip while robotic welding. It gives high accuracy and low irregularities.

II. LITERATURE REVIEW

1. F. Mervyn and A. Senthil Kumar in the paper “Development of an Internet-enabled interactive fixture design system” gives a detailed information of fixture designing . In this paper it is stated that computer aided fixture designing is mainly interactive in nature. This designing of fixture is easier by integrating the systems with fixture element databases, fixture base points ,clamping points, locating points are required that has been selected by designer as per need. Fixture should be flexible so that one can change according to dimensional variations. Author has discussed about roles of fixture designer in this paper[1].

2. Hui Wang ,Yiming (Kevin) Rong ,Hua Li and Price Shaun in “Computer aided fixture design, Recent research and trends” gives brief idea about computer aided fixture design and automation over the past decade. Paper states that fixture is a mechanism used in manufacturing to hold a workpiece in position correctly with respect to a machine tool. Also it supports during machining. Fixture design reduces manufacturing time and cost. Welding fixture is generally a

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Vol. 8, Issue 10, October 2019

fixture to weld assembly. Fixing forces and machining forces in a welding process commonly are smaller than in machining. In addition to thermal conductivity, while selecting fixture material, thermal expansion properties also should be considered. (Fig.1) [2], (Fig.2)

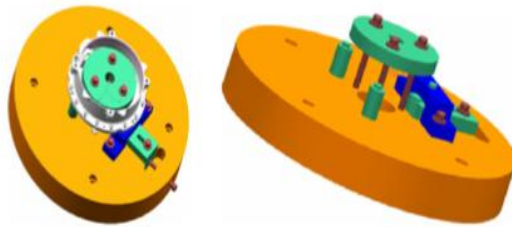


Fig.1 Machining fixture

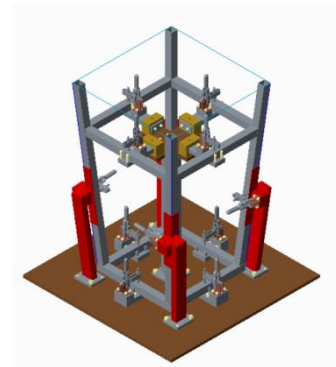


Fig.2 welding fixture

3. Y. C. Nee, A. Senthil Kumar in “A Framework for an Object/Rule-Based Automated Fixture Design System” it gives information about rules based automated fixture. It also states The automation of the fixture design process can be accomplished with the use of a solid modeller, an object/rule-based expert system and a feature recogniser coupled with external analysis routines. Automated fixture design is particularly useful for prototyping and small batch production where lead time is critical and dedicated conventional fixtures are too expensive to design and build.[3]

4. S.B. Tor · G.A. Britton , W.Y. Zhang in “A knowledge-based black board frame work for stamping process planning in progressive die design” paper presents a knowledge-based blackboard framework for stamping process planning. The knowledge architecture consists of specialist KSs controlled by a strategy KS. A prototype system has been implemented in CLIPS interfaced with Solid Edge CAD system through C++. The system contains 120 KS rules. The system has been partially validated. The power of the current system is limited by its KS rule set. Future work is aimed at increasing the rule set forth especial KSs and including new strategy KS to provide more powerful reasoning strategies. In addition, new graph theoretic strategy rules are being developed to solve specific sub-problems.[4]

5. Shailesh S. Pachbhai , Laukik P .Raut in “A Review on Design of Fixtures” steps to fixture design are given information about clamping and locators. It states that, the cycle time required for loading and unloading of part can be reduced if the said steps are used. If modern CAE, CAD are used in designing the systems then significant improvement can be assured. To fulfil the multifunctional and high performance fixturing requirements optimum design approach can be used to provide comprehensive analyses and determine an overall optimal design .[5]

III. ATERIAL OF FIXTURE

Fixture can be made from steel which is specified by SAE (Society of Automobile Engineers) and AISI (American Iron and Steel Institute) , example SAE 2310 first two digits indicates class of steel last two digits indicates carbon contain in steel .

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Vol. 8, Issue 10, October 2019

SR . NO	CLASS	TYPES OF STEEL
1.	10XX	Plain carbon steel
2.	13XX	Manganese steel
3.	31XX	Nickel-chromium steel
4.	23XX	Nickel steel
5.	41XX	Chromium-molybdenum steel
6.	11XX	Free cutting steel
7.	7XXX	Tungsten steel

For this fixture plain carbon steel is used due to its durability and strength to bear pressure .

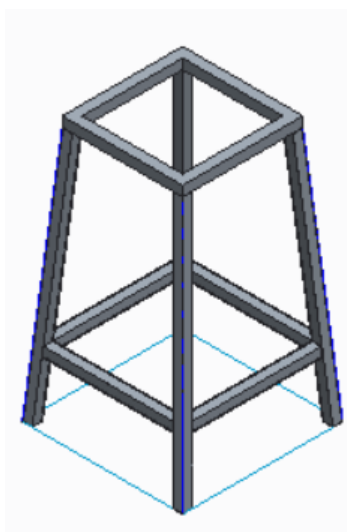
IV. CHALLENGES IN MANUFACTURING OF STOOL BY CONVENTIONAL METHODE

Stool consists of many parts hence manual manufacturing is time consuming . It is difficult to maintain precision of parts manually and while also welding parts must be held in a specific position because while welding there are chances of miss positioning of parts so without using fixture it is difficult to manufacture and to maintain alignment of object.

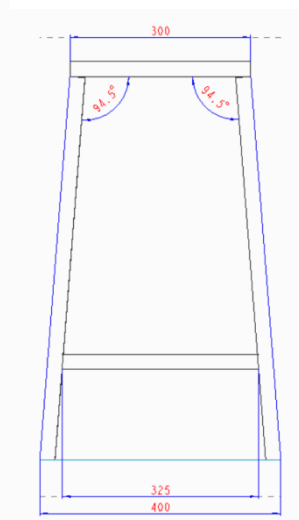
Problems occurs while welding in stool manufacturing by manual method are:-

- Poor repeatability and accuracy
- It is time consuming which leads to fatigue of an operator

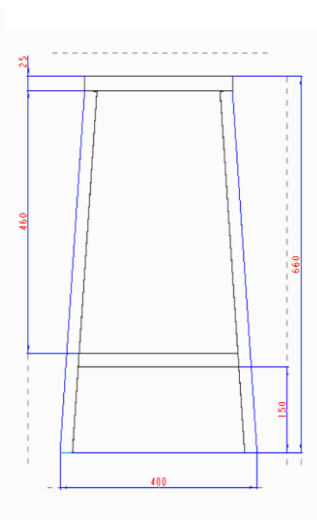
An application of manufacturing of stool defers from industry to industry but their common requirement is to manufacture stool in less time and with accuracy. Fixture helps to manufacture stools in varying sizes. Fixture withstand stresses acting while welding operation. (Fig.3) shoes isometric view of stool, (Fig 4,5) shows dimension of stool from front view and side view respectively.



Fig(3)



Fig(4)



Fig(5)

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 8, Issue 10, October 2019

V. DEVELOPMENT OF FIXTURE ASSEMBLY FOR STOOL WELDING

Steps to development of fixture are

- Fixture design
- 3-D modelling in PTC CREO 4.0
- Fixture assembly
- Analysis by using ANSYS

A. Analytic design for fixture

It consists of base plate, clamp, supports, locator pins, nut and bolt by analytic method using suitable formulas

B. 3-D Modelling in PTC CREO

It includes 3D model generation of all parts of fixture including base plate, locator pins, supports, clamp nut and bolt , each part is individually modelled in PTC CREO software.

•

C. Fixture assembly

In 3D modelling each part is individually designed PTC CREO consist of assembly portal using that portal, each part is assembled and final model of fixture is made .

D. Analysis using ANSYS software

ANSYS is software of simulation of 3D models analysis of their deformation ,stress while clamping this analysis helps us to know the strength of component to withstand various while welding .

VI. DESIGN OF VARIOUS PARTS OF FIXTURE

A. Design of base plate

Base plate (Fig.6) is part on which all parts of fixture are mounted , considering this factor base part is designed. mounting factors of each mounting is given with respect to stool assembly standard holes for bolting is given on base plate considering all factors length , breadth , thickness

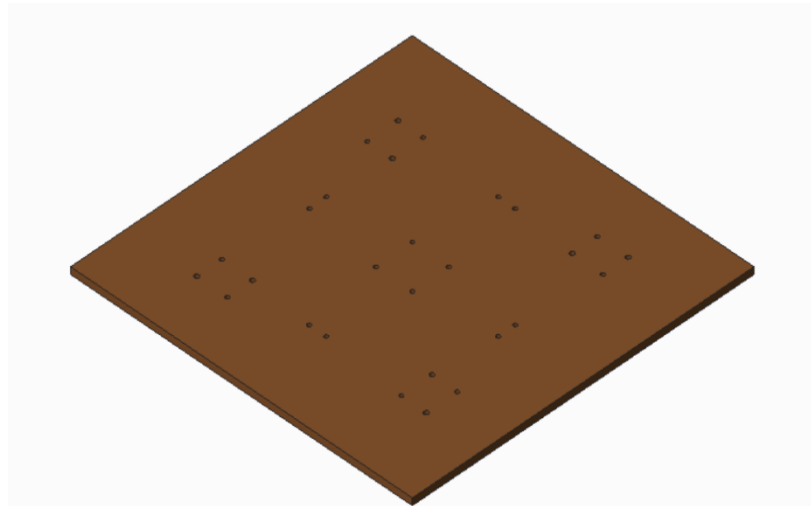
Consider base plate of square as $(600*600)\text{mm}^2$ and thickness 10 mm.

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 8, Issue 10, October 2019



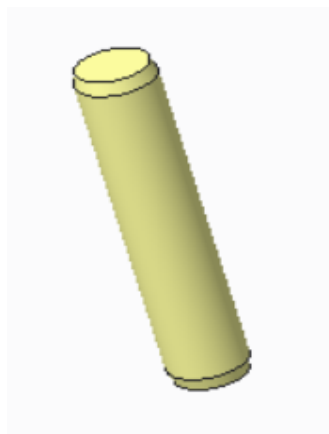
(Fig.6)

B. Design of locator pin

By considering specification of stool locator pin (Fig.7) is designed .base frame rest on blocks mounted on base to locate those square baes of stool locator pin is designed . diameter, height , respectively taken as

Height of locator pin = 40mm

Diameter of locator pin = 8 mm



(Fig. 7)

C. Design of supports

There are three types of supports

- Base frame holder
- Leg supports

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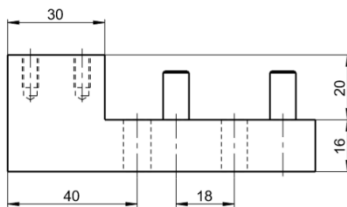
Vol. 8, Issue 10, October 2019

c. Leg position holder supports

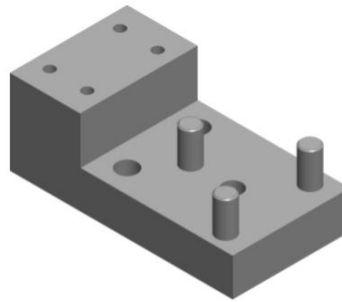
d. Toggle clamp

a. Design of base frame holder

Base frame holder is part that give support to the base frame of stool. There are four in number placed according to the position of stool on the base plate on base frame holder holes of 8 mm are given for locator pins it helps to locate square hollow bar of base frame of stool dimensions and support are given as follows in (fig. 8,9)



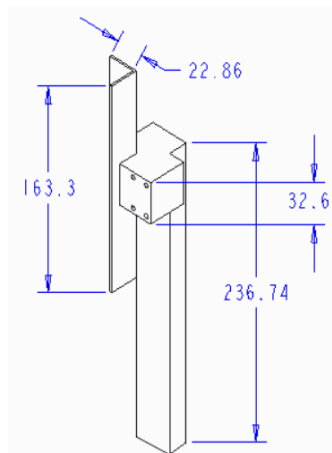
(Fig.8)



(Fig.9)

b. Leg support

This support is to support the legs of stool made of steel hollow pipe. These supports helps to give desired angle to legs of stool. holes are given on it to attach toggle clamp. This part is bolted to base plate. Dimensions are as follows in (Fig.10)



(Fig. 10)

c. Leg position holder supports

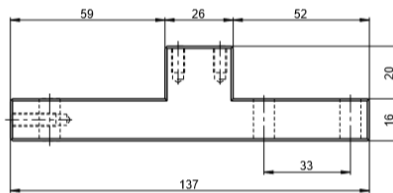
This holder is used to give support to part that holds two legs together in position. This holder has given holes for mounting of clamps. This holder can move forward and backward this motion helps to remove final welded stool dimensions of holder as follows in (fig.11,12)

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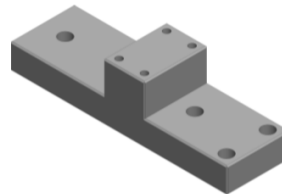
(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 8, Issue 10, October 2019



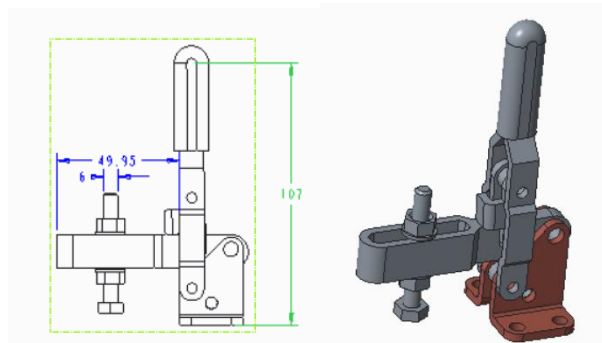
(Fig .11)



(Fig.12)

d. Design of toggle clamp

Toggle clamp is type of clamp that holds work. When work is fixed in it, force is applied on it due to this force work will not displace during operations. Force applied by toggle clamp is 5N on work. Dimensions of clamp are as follows in (Fig.13,14)



(Fig.13)

(Fig.14)

VII. ASSEMBLY OF FIXTURE

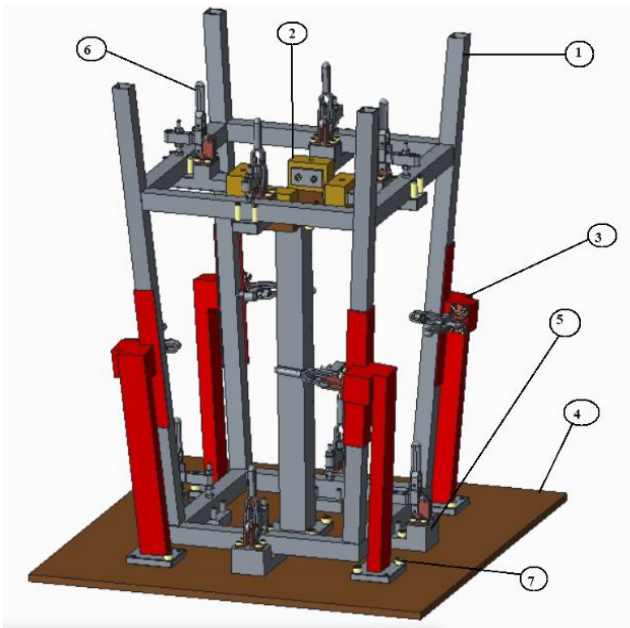
After designing of individual parts assembly is done part by part. In this stool welding fixture, first part is base plate on that base plate base frame supporters are placed they are four in number then leg supporter is mounted and then leg position holder supporters are mounted they are fixed with allenbolts and nuts then toggle clamps are mounted, assembly of welding fixture is given in (Fig.15)

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 8, Issue 10, October 2019



POS NO.	PART NAME	QTY	material
1	stool	1	Mild steel
2	Slider	4	steel
3	leg supports	4	steel
4	Base plate	1	steel
5	Baseplate supports	4	steel
6	Toggle clamp	12	steel
7	Leg supporter holder	4	steel

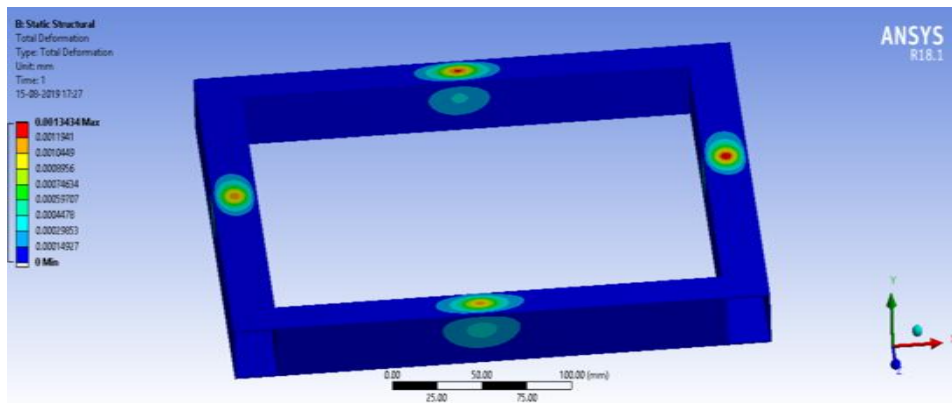
VIII. RESULT AND DISCUSSION

Steps of analysis

- Import IGES file of model in ANSYS-18.1
- Mesh model with suitable method.
- Apply fixed supports.
- Apply forces.
- Request of results.
- Solve for stress and total deformation calculation.

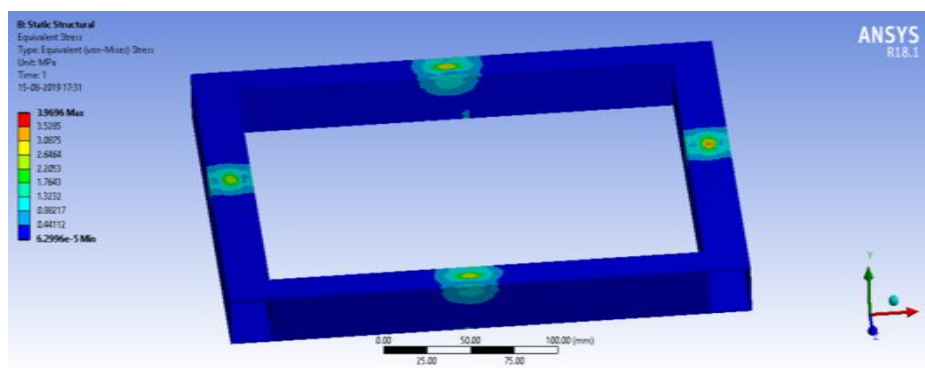
A. Analysis of base frame of stool (Fig.16,17)

Force at each member of base frame is 5N this force is acting at the centre of each rod and rod is rested at bottom after performing all stapes in ANSYS results are as follows



(Fig 16)

It is found that maximum deformation by clamp on each is 0.0013434 mm

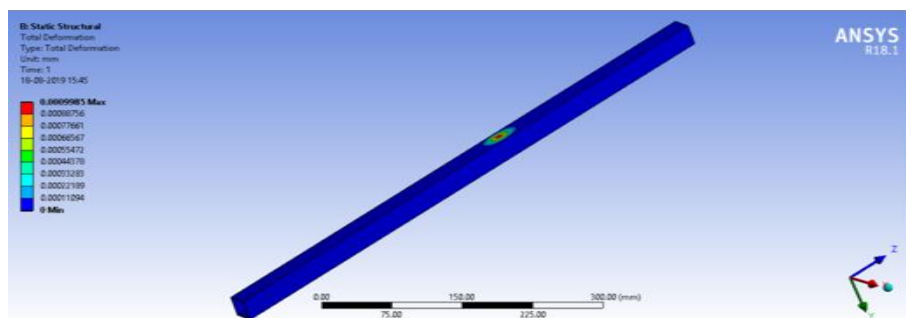


(Fig,17)

It is found that maximum Von Mises stress is 3.9696 MPa

B. Analysis of legs of stool (Fig.18,19)

Legs are fixed by clamp this clamp , fixes legs centrally Force acting on it is 5N analysis of leg of stool is as follows



(Fig.18)

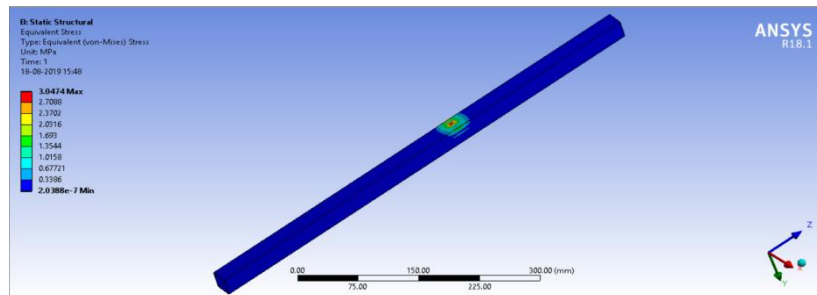
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(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 8, Issue 10, October 2019

It is found that maximum deformation is 0.0009985mm



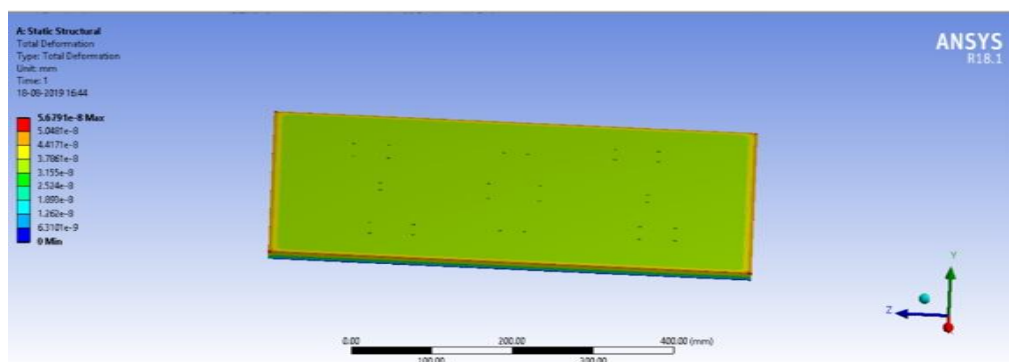
(Fig. 19)

It is found that maximum von misses stress is 3.0474 MPa

C. Analysis of base plate of fixture (Fig.20,21)

Base plate of fixture is part that have to sustain all weight of fixture and stool so, it should have minimum deformation it

After analysis in ANSYS 18.1 maximum deformation is 5.6791 mm an in limit



(Fig.20)

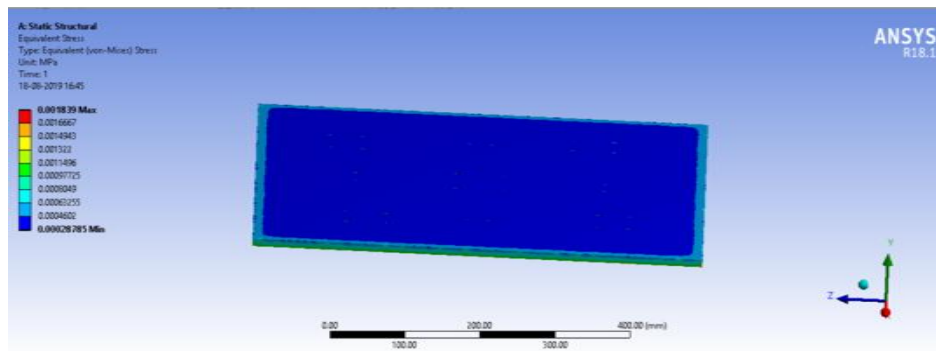
Analysis of stress of base of stool fixture maximum stress value is 0.0018

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 8, Issue 10, October 2019



(Fig21)

IX. CONCLUSION

The results after analysis of parts it is found that results of maximum deformations are below the standard value of their material and maximum value of von misses stresses are also below the allowable von misses stress.

A. maximum deformation

Part name	ANSYS result
Base frame	0.0013434 mm
Legs of stool	0.0009985mm
Base plate of fixture	5.6791 mm

B. Maximum stress

Part name	ANSYS result	Permissible stress value	rank
Base frame	3.9696 MPa	250MPa	safe
legs of stool	3.0474 MPa	250MPa	safe
base plate of fixture	0.0018MPa	250MPa	safe

(a)Safe use of fixture for industrial use.

(b)Fixture provides quality product with increased productivity.

(c)User will get high accuracy .

(d)Human efforts are reduced of user.

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International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 8, Issue 10, October 2019

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