International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** V **Month of publication:** May 2021

DOI: https://doi.org/10.22214/ijraset.2021.34333

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue V May 2021- Available at www.ijraset.com

Design and Development of Broaching Fixture for Machine Pulley

Mr. Shekhar Chavan[1], Mr. Rutwik Chitnis[2], Mr. Rahul Deshpande[3], Mr. Atharva Kulkarni[4], Prof. Sukhadip Chougule[5]
[1, 2, 3, 4, 5]*Pimpri Chinchwad College of Engineering & Research , Ravet*

Abstract: Fixture plays an vital role in the manufacturing industry. Due to its wide application in the production plant the "Broaching fixture for machine pulley" has been designed and manufactured. A systematic method was developed to generate a cutting strategy for the broach.
The fixture is the necessary link between the part to be machined and the machine tool. In machining fixtures, minimizing work piece deformation due to clamping and cutting forces is essential to maintain the machining accuracy. The various methodology used for clamping operation used in different application by various authors are reviewed. It is required in various industries according to their application.
This can be achieved by selecting the optimal location of fixturing elements such as clamps. Fixtures reduce operation time and increases productivity and high quality of operation is possible. Due to the need of slot of dimension 6*2.8 in the machine pulley part the usage of fixture was inculcated due to which the pulley can be manufactured with accuracy, less human effort, reduced cyclic time and in mass quantity.
"Shree Gajanan Industries" has the high demand of this pulley and it is periodically so that the fixture is to be used again. The fixture block should be mobile means it can be reused later when there is again need of same manufacturing plant. Later the force has to calculated on the fixture and the broaching tools nomenclature are studied and introduced.

I. INTRODUCTION

To locate and position the work pieces for machining, inspection, assembly and other operations fixtures are used. A fixture consists of a set of locators and clamps. Locators are used to determine the position, setting the job and orientation of a work piece, whereas clamps apply clamping forces so that the work piece is pressed and set-up firmly against locators. Clamping has to be appropriately planned at the stage of machining fixture design.
The design of a fixture is an highly complex and intuitive process, which require proper knowledge. Fixture design plays an important and vital role at the setup planning phase. Perfect fixture design is crucial for developing product quality in different terms of accuracy, surface finish and precision of the machined parts. In existing design the fixture set up is done manually, so the aim of this project is to replace with the traditional method to save time for loading and unloading of component. This mechanical fixture provides the manufacturer for flexibility in holding forces and to optimize design for machine operation as well as process function ability.

II. PROBLEM STATEMENT

The manufactured part is the pulley which is to be design and analysed. In which the specific notch was to be made has the pulley was to be manufactured in the mass quantity and there was increase demand for the workpiece repeatedly. So for that purpose the fixture was required which can help in for loading and unloading of the workpiece and increase the productivity by reducing the settling time of workpiece.
Has the broaching machine been readily available so we according the specifications of the machine the fixture were required to be design. Before the design of the fixture when broaching operation was performed the excessive material was removed due to the misalignment of the tool or rapid movement of the broaching tool. Due to which the required dimensional notch was not obtained so to manufacture the 6*2.8 dimensional slot fixture was to be design accordingly. Fixture was to be design accordingly so that the tool can be perpendicular to the workpiece.
Along with that clamp should be also designed so that the fixture is maintained correctly or positioned on T-slot table of the broaching machine. So for that the force calculations is also required on the clamping device.

III. METHODOLOGY

A method for designing a broaching tool comprising the steps of:

A. Providing a geometry of a slot to be broached
B. Providing a material dependent initial minimum tooth rise for a broach tool that includes multiple broach inserts.
C. Calculating a number of broach inserts and teeth per insert based upon steps
D. Performing the broach inserts
E. Calculating the stresses on the broach tool and deformation of the slot
F. Determining whether the slot dimensions are within desired specifications
G. Revising the broach tool if the slot is outside the desired specifications, and performing the operation until the slot is within desired specifications
H. design characteristics of the broach tool resulting from performing

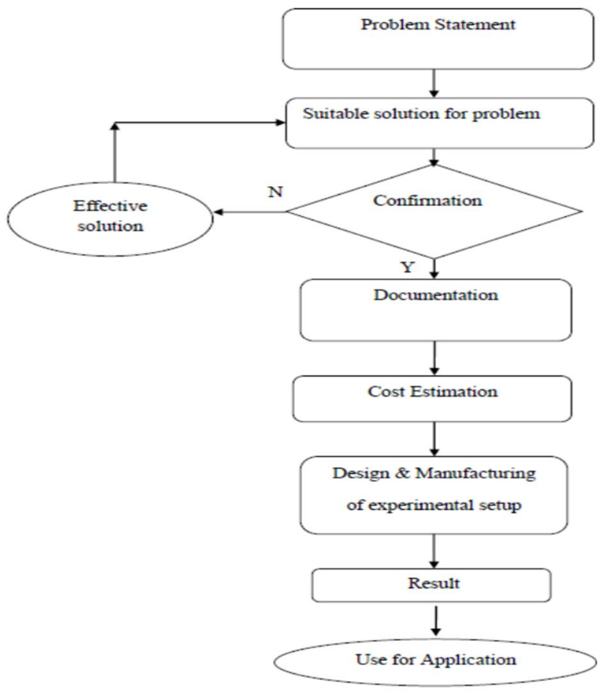


Fig. No.1: Methodology Flowchart

IV. DESIGN OF FIXTURE

To meet all design criteria for work holder is impossible, compromise is inevitable. The most important hint of optimal design objectives is positioning, holding & supporting functions that fixtures must fulfil.

1) *Position:* Fixture must above all else hold the work piece, precisely in place to prevent 12 degrees of freedom, linear movement in the either direction about each axis.
2) *Repeatability:* Identical work piece specimens should be located by work holder in precisely the same space on repeated loading & unloading cycles. It should be impossible to hold the work piece incorrectly.
3) *Adequate Clamping Forces:* The work holder must hold the work piece immobile against the forces of gravity. Centrifugal force, inertia force, wetting force, milling & the design must calculate these machines forces against the fixture holding capacity. The device must be rigid: clamping forces must be maintained.
4) *Care During Loading Cycles:* As the work holders usually receive more punishment during the loading & unloading cycle than during the machining operation. The device must endure impact & aberration for at least the life of the job.

Designing a fixture is a very complex task and it involves taking into consideration very minute details of manufacturing process. Even if a single detail is missed out then it may result in false design of fixture.

Broaching tool is a straight multi tooth cutter in which several cutting edges engage with the work piece simultaneously and each tooth removes a portion of material from the workpiece surface. Broaching cutter has a tapered flat or round profile with a series of teeth on its surface. Each successive tooth in a broaching tool is higher than the preceding one to perform the cutting action and remove material from the workpiece surface. Broaching tools in their general form can be geometrically divided into three main sections, namely, roughing, semi-finishing, and finishing. Roughing teeth remove the bulk of material from the workpiece, semi-finishing teeth produce the basic surface finish (surface quality), and finishing teeth provide the final surface finish and set geometrical and dimensional tolerances. In broaching operation the broach tool slides in or out of the workpiece to convert the raw input material into finished product within just one stroke. The fixture should be designed in such a way that it should not block the path of the broach tool. Along with this the fixture should also help in proper alignment of the product aiding to lower cycle time.
The main function of the fixture is to hold the workpiece which is achieved by locking the various degrees of freedom of the fixture. To restrict the movement of the workpiece 3-2-1 location principle is used. To restrict complete movement of the product total 6 degrees of freedom are to be restricted which comprises of rotary and linear 3 each. Another Considerations in fixture design are specifications of the machine used. The fixture should also compensate for any vibrations from the machine and should be designed for the maximum working force. Before moving towards any calculations we must firstly understand the tool geometry so as to calculate maximum force and then design the force accordingly.

A. Broach tool Geometry

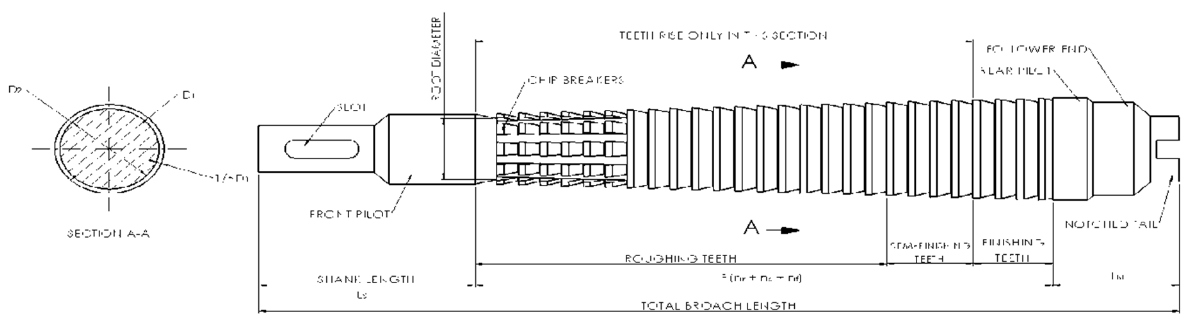


Fig. No.2: Broach tool Terminologies

V. CALCULATIONS

1) In the case of broaching operation cutting speed V = speed at which the broach is pushed/pulled.
2) Apparent cutting edge engagement b = width of the broach = 6mm.
3) Actual cutting edge engagement ba = b/cos θs
4) (θS = angle of inclination of the tooth w.r.t. the normal to the cutting velocity)
   = 6/cos(15)
   = 6.211 mm
5) Apparent uncut chip thickness f = difference in heights of two consecutive teeth.
   f = 0.05 mm
6) Effective or actual uncut chip thickness fa = f cos θS
   = 0.05*cos(15)
   = 0.04827mm
7) Area of uncut chip = fb
   = 0.05 x 6 = 0.3 mm2
8) Metal removal rate/tooth = fbV
   = 0.05 x 6 x 6 = 1.8mm3/sec
9) Machining time = (lw + lb)/V
   (lw = length of workpiece and lb = length of broach)
   = (15 + 908)/6
   =153.833 sec

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue V May 2021- Available at www.ijraset.com

In broaching operation, only one motion, i.e. the primary cutting motion is provided by the machine (cutting speed is around 6 mm/sec). The feed motion is obtained by designing the teeth to be deeper progressively. (The cut per tooth is kept around 0.05 to 0.09 mm). Thus the shape of the broach determines the shape of the machined part.

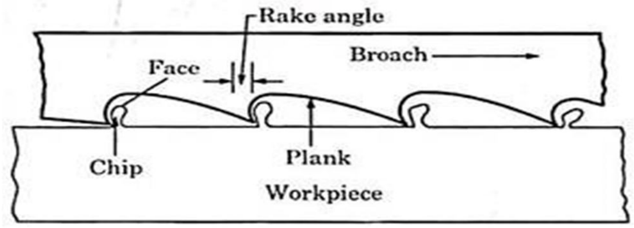


Fig. 17.4

Fig. No.3: Cutting Parameters

$$\text{Cutting force per tooth} = \frac{w \times s_s \times \cos(\lambda - \alpha)}{\sin\phi \cos(\phi + \lambda - \alpha)} \text{ Newtons}$$

Where,

w = width of cut (In case of circular hole, w = circumference)

ϕ = shear angle = 900

Co-efficient of friction = 0.42 (between MS and EN-19)

λ = friction angle = tan-1 μ = tan-1 (0.42) = 22.780

α = radial rake = 100

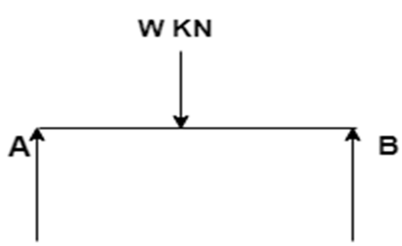
f = cut per tooth = 0.05mm

ss = ultimate shear stress of work material = 300 N/mm2

Cutting force per tooth = 7935.55 N

10) Instantaneous broaching load = cutting force per tooth x number of teeth in contact.

= 7935.55 x 2 = 15871.10 N



Assuming equilibrium condition,

Σ Fx = 0, Σ Fy = 0, ΣMA = 0;

RA = RB = 7935.55 N

Therefore the clamping force is 7935.55 N.

Now to find the compressive stress,

Compressive stress (σc) actual = Clamping force / Resisting Area

= 7935.55/245.43

= 32.333 N/mm2

σc (permissible) for MS = 465.97 N/mm2

(σc) actual < σc (permissible)

Hence the material is safe

VI. STEPS FOR FIXTURE MANUFACTURING

A. Define the Requirements
To start the fixture-design process, clearly state the problem to be resolved or needs to be meet after the fixture. State these requirements on the paper as broadly possible, but pin point or specifically enough to define the scope of the design project. The designer should ask some basic questions: Is there any new tooling required for first-time production or to improve existing production?

B. Gather or Obtain Information
Collect all the relevant data and assemble it for proper evaluation. The main sources of information are the part print of the job, process sheets of the process, and machine specifications. Make sure that part documents and records are of the current job or required job. For example, verify and re-check that the shop print is the current revision, and the processing information is up-to-date. Check with the design department shop for pending part revisions in the process. An important part of the evaluation process should be note down which can be implemented later. Complete, accurate notes allow designers to record the important information. With these notes which are mentioned properly, the manufacturer should be able to fill in all items on the "Checklist for Design Considerations."

C. Implement the Design
The final or last phase of the fixture-design process consists of making the chosen design approach into reality. Final details are chosen wisely and decided, final drawings are made, and the tooling is built and tested. The following guidelines should be considered and during the final-design process to make the fixture less costly while improving its efficiency. These rules are a mix of practical considerations, sound design practices, and common sense
Manufacturing of fixture is final step in design process. This converts design into reality. In this final drawing is made using all details. Material is chosen and according to that suitable and appropriate manufacturing process is selected.
Broaching fixture manufacturing done in two phases, first operations are performed over lathe machine and then with the use of VMC machine slot is provided.

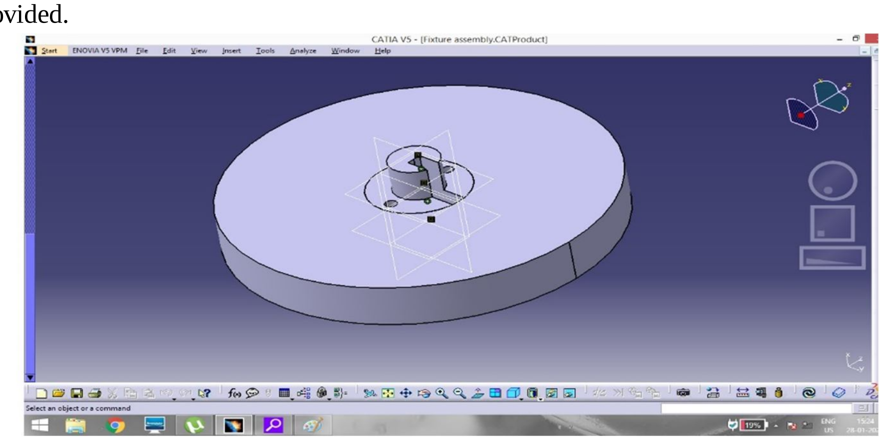


Fig. No.4: Broaching Fixture

Over turret lathe machine first facing operation is done on the workpiece to remove the material from the end of the machine. After that turning is perform first 20 mm diameter is made over a length of 15mm.after that 40mm diameter is made over 20mm length.

1) By using Following Parameter
Spindle speed=1200 rpm
Feed=0.5 mm/rev
After completion of operation over lathe machine one slot (6.2mm x 20mm) is provided over the workpiece in order to give some space to broaching tool to perform the broaching operation. Also, two holes are drilled to clamp the fixture to machine table.

2) Type of Machine
Vertical machine center

3) Operation

a) Slot milling

b) Drilling

4) Machine Parameter For Slot Milling

Cutter diameter 6mm Number of flutes 2
Spindle speed 3000rpm Feed 0.5mm/rev
Radial depth 35mm

5) Machining Parameters for Drilling

Cutter diameter 5mm Number of flutes 4
Spindle speed 1000rpm Feed 0.15 mm/rev
Radial depth 15mm

One disk of 150mm diameter is made over a length of 20mm on lathe machine and 40mm internal hole is provided, in order to fix the fixture in the disk. Thus, manufacturing of fixture is done.

D. Stress Analysis By ANSYS

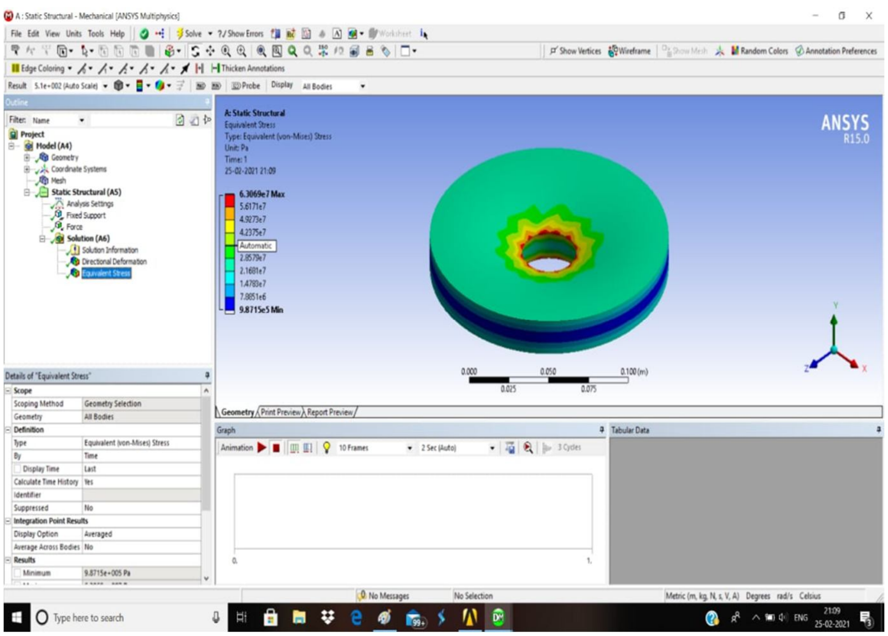


Fig. No.4: Stress Analysis By Ansys

VII. CONCLUSION

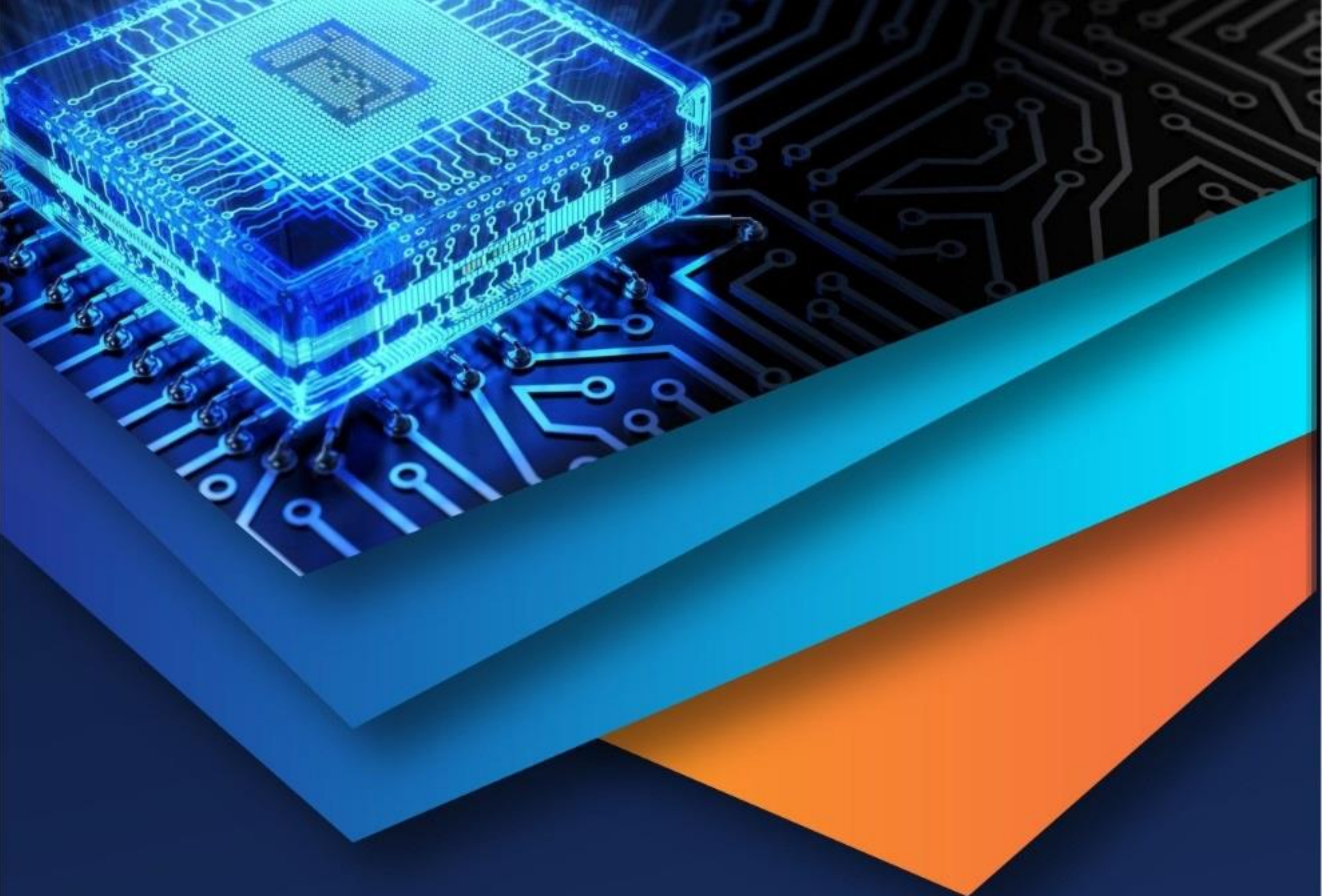
In a modern manufacturing environment, organizations must be responsive to the requirements of the customers and their specific needs and to fluctuating global market demands. To maintain its competitiveness in market share, the manufacturing firms must manufacture with minimum amount of waste. The main focus of this research is to reduce the setup time for the machining process performed on a high accuracy product, Machine Pulley.

VIII. ACKNOWLEDGEMENT

First and foremost, I would like to express my sincere gratitude to my project guide Mr. Sukhadip Chougule who has in the literal sense, guided and supervised me. I am indebted with a deep sense of gratitude for the constant inspiration and valuable guidance throughout the work.

REFERENCES

[1] Shrikant. Peshatwar, L.P Raut "Design and development of Fixture for eccentric shaft: A Review" International Journal of Engineering Research and Applications.
[2] Blogspot (2010). "Introduction to Jigs and Fixtures" [Online] engineeringhut.blogspot.com/2010/11/jigs-and- fixtures.html[Accessed 5 May 2015].
[3] Spogel (2014). "Mini project on Jigs and Fixtures" [Online] http://files.spogel.com/miniprojectsin-mech/p-0027--Jigs-and- Fixtures.pdf[Accessed 18 May 2015].
[4] Kaija, T. and Heino, P. (2006). "The Optimization of On- wafer Shield-Based Test Fixture Layout" IEEE Transactions on Microwave Theory and Techniques, Vol. 54, No. 5.
[5] Meduettaxila (2012). "Jigs and Fixtures Module" [Online] https://2k9meduettaxila.files.wordpress.com/2012/04/scan- jigs-and-fixtures.pdf [Accessed 22 May 2015].
[6] Mechnol (2015). "Applications of Jigs and Fixtures" [Online] http://www.mechnol.com/applications-of-jigs-and- fixtures.html [Accessed 11 July 2015].
[7] Pachbhai, S. and Raut, L. (2014). "A Review on Design of Fixtures" International Journal of Engineering Research and General Science, Vol. 2, Issue 2.



crossref
10.22214/IJRASET

INDEX COPERNICUS
45.98

ISRA JIF
IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY