# Design and development of fixture for adapted flange In industrial application

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*Abstract*— **Fixtures are designed for hold, support, and locate the component, which is to be machined within the specified limits. Various areas related to design of fixtures are very well described by various authors, but there is need to apply all these research works into an industrial application. This research paper describes the design and manufacturing of fixture for real industrial component. The component is adapted flange GD_SM53P56Z005 is weighing 100kg made of mild steel and is mainly used in horizontal milling center. Major operations to be performed are milling, drilling, counter boring, tapping, and reaming using the designed fixture. The designed fixture is specifically for circular components. The research work includes the 3D assembled and exploded view of fixture and fixture component by using solid works and Auto CAD 2014 in addition to assembly and detailed drawing of fixture.**

*Keywords*—**fixture, flange, manufacturing, design.**

## 1. INTRODCTION

The manufacturing industry adapts some changes as per the customer requirement of user engineering system altered. First it begins from manufacturing of general purpose machine tools. These old machines though offered higher flexibility were not suitable for mass production, because of longer set up time and the tedious adjustments of machine tools, and also requiring highly skillful labors.

Industries to meet the fast production for their growing, mass production machines are conceived. Hydraulic and pneumatic machines, special purpose automatic and semi automatic machines were introduced with advanced technology. The highly specialized machines were used for mass production and they have reduced the production costs through the reduction of machining time and labor costs. But these machines are inflexible, because these machines could not modified by units involved in small lot and piece production.

Because of the above, the machine tools that could bridge the gap between highly flexible general purpose machine tools(which are not economical for mass production)and highly specialized, but inflexible mass production machines. But computer numerical control machines with proper fixture set up have to take up this role very well. And this has excited this research work on application of fixture.

## 2. LITRATURE SERVEY

**Shailesh S.Pachbhai1et al. (2014) studied "A Review on Design of Fixtures".** In machining fixtures, decrease the work piece deformation due to clamping and cutting forces is critical to sustain the machining accuracy. Different methods used for clamping operation used in different application by various authors are reviewed in this paper. Fixture is most important for various industries according to their application. This can be achieved by selecting the best location of filtering elements such as locators and clamps. The fixture set up for component is done manually. For that more cycle time required for loading and unloading the machining component. So, there is necessary for increase system which can help in improving productivity and time. Fixtures are reduce operation time and improve productivity and high quality of operation is Possible. [1]

**Shrikant.V.Peshatwar et al (2013) studied "Design and Development of Fixture for eccentric shaft: A Review".** This paper presents a fixture design system of eccentric shaft for ginning machine. Fixtures are needed in various industries based on their application. Designer develop the fixture according to dimension required by industry to fulfill our production target. In usual manufacturing process performing operation on eccentric shaft is dangerous. So that holding a work piece in proper location during a manufacturing process. Fixture is very important. Because the shaft is eccentric so for this requirement of manufacturing process Designer design proper fixture for eccentric shaft. Fixtures decrease operation time and increases productivity and high quality of operation is possible. [2]

**K.M.Viramgama et al (2014) studied "A STUDY ON DESIGN OF FIXTURE FOR VALVE BODY FOR CNC MACHINE".** A fixture is designed and builds to hold, support and locate each component to ensure that each is drilled or machined with accuracy and manufactured independently. The fixture designing and manufacturing is considered as difficult process that requires the knowledge of different areas, such as geometry, dimensions, tolerances, procedures and manufacturing processes. This paper will give short overview about the 3-2-1 locating principle to design the fixture for complex parts and extra clamping principles. This paper also gives the suggestion and procedure for fixture design. This paper gives the idea about the modular fixture and dedicated fixture. [3]

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**N. P. Maniar et al (2013) studied "Design & Development of Fixture for CNC –**
**Reviews, Practices & Future Directions".** This segment reviews some of the developments in fixture design and proposes directions for potential research initiatives. The basic obligation of a fixture is to position and locked the work piece in the correct way and relationship so then manufacturing process can be carried out according to design specifications (Nee and Kumar 1991). A typical fixture consists of three components: locators, clamps, and supporters. Locators are used to position the work piece in Static equilibrium, thus remove all degrees of freedom. Clamps are for holding the workpiece definitely against the locators for the period of machining for stiffness. The external cutting forces and tool direction are the main considerations. Additional support is added to support the stability of the work piece. The use of these fixturing elements can be resolute manually or systematically.Fixtures have a direct impact upon product manufacturing quality, productivity and cost, so much concentration has alreadybeen paid to the research of computer aided fixture design(CAFD) and many achievements in this field have been reported. But still Fixture design requests to be tested and evaluated in real manufacturing environments. Another major research is on the incorporation of various techniques directly used in computer aided fixture design. As we know, abest fixture solution is a hybrid result of many different considerations, such as tolerance configuration, stiffness configuration, machining process, etc. So that the establishment of a systematic way of integrating various techniques, such as Computer Aided Mass Balancing Method (CAMBM) and FEA methods for work piece-fixture system. [4]

**J. F. Hurtado et al (2001) studied "Effect of fixture design variables on fixture-work piece conformability and static stability".** A parametric study of the result of fixture design variables on fixture-work piece conformability and static stability is presented. Conformability is defined as the geometric similarity between the work piece surface and the smallest polyhedron fit over all contacts. Two conformability metrics are introduced in worldwide and local conformability. The design variables of interest are: the number and position of fixture elements, fixture element length, clamping strength, fixture element direction, static coefficient of friction, fixture element tip radius and the direction of the fixture principal stiff nesses. Both force-controlled and displacement-controlled fixtures are considered the static stability was found to increase with the static coefficient of friction and with the fixture element tip radius. Clamping strength was found to have opposing effects on the stability of force-controlled and displacement-controlled fixtures. [5]

**Zhang Yuru et al (2005) studied "Development of an integrated system for setup planning and fixture design in CAPP".** The separation of CAPP and CAFD frequently causes disagree and delays for the product development. This paper overcomes these problems by relating a developed system that is able to carrying out setup planning and fixture design concurrently. An intelligent approach for setup planning is introduced. In this approach, the setups are automatically planned based on key factors of machining practice, tolerance requirement, manufacturing cost and fixturing limitation from the feedback of fixture design. Furthermore, a hybrid RBR and fuzzy evaluation method based automatic fixture design approach is also described. In projected system, the comment of fixture design is to ensure that the setup plan for machined part is generated on the basis of possible fixture plan. [6]

**Amaral N et al (2005) studied "Development of a finite element analysis tool for fixture design integrity verification and optimization"** Machining fixtures are used to locate and hold back a work piece during a machining operation. To make sure that the work piece is manufactured according to specified dimensions and tolerances, it must be suitably located and clamped. To reduce work piece and fixture tooling deflections due to clamping and cutting forces in machining is critical to machining accuracy. Ideal fixture designs take full advantage of locating accuracy and work piece stability, while minimizing displacements. The purpose of this research is to develop a method for modeling work piece boundary conditions and applied loads during a machining process, analyze modular fixture tool contact area deformation and optimize support locations, using finite element analysis (FEA). By applying FEA in a computer-aided-fixture-design surroundings, avoidable and wasteful "trial and error" experimentation on the shop floor is eliminated. [7]

**J. C. Trappey et al [1990] studied "A Literature Survey Of Fixture design Automation"** This paper gives a review of fixture-design research, most of it done in the 1980s. The major topics of the review are the fixturing work and (supporting, locating and clamping), automated fixture design and fixture hardware design. Fixture design can be classified as a part of process planning. The task wise explanation of process planning specifically states that fixture design for each work piece set-up is an essential planning task. But, the automation of fixture design has been ignored in most research into automated process planning. In this paper, a wide range of fixture-design literature is studied in order to tell the progress in the field and the important help to it in the 1980s.[8]

## 3. STATEMENT OF PROBLEM

"Design and development of fixture for machining the adapted flange-GD_SM53P56Z005 on HMC FNC 128 C32".The operations to be performed are milling, drilling, counter boring, tapping, and reaming.
different areas related to design of fixture like machining fixture knowledge, work piece setups, improving work piece location are already been very well detailed by different authors, this paper incorporates all these research works and transforms the theoretical knowledge of fixture design to

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practical application by designing fixture for a real industrial component.

## 4. COMPONENT DETAILS

The method proposed for design of fixture includes the realization of two stages. The first stage represents the information of the objects like part geometry, detailed fixture drawing, machining process. The second stage includes the knowledge of pressure test of that component. The component withstand the pressure up to 0.76Mpa pressure (As per the customer requirement)

As the part of first stage, component geometry is discussed here. The component is adapted flange-GD_SM53P56Z005 weighing is 100kg made of mild steel and is mainly used in horizontal milling center. Major operations to be performed are milling, drilling, counter boring, tapping and reaming using the designed fixture. As the Part of second stage, to design and manufacturing the fixture for pressure test and machining the surfaces to obtain the roughness of 6.3Ra (As per the customer requirement).hence each part of the component is machined by rotating work piece using rotating table. The fixture design provides locating and clamping arrangement for machining that eccentric component (flange is offset by 20mm from its center point).the component drawing is shown in fig-1.The fixture is developed based on that component. Material composition of component is shown in table-1 & table-2

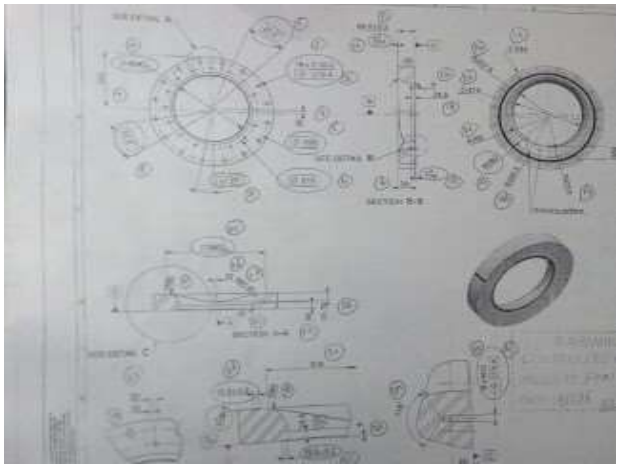

**Fig-1 component drawing**

Table 1. CHEMICAL PROPERTIES

| | |
|---|---|
| Si | 0.7-1.3 |
| Fe | Less than 0.50 |
| Cu | Less than 0.4 |
| Mn | 0.4-1.0 |
| Mg | 0.6-1.2 |
| Cr | Less than 0.25 |
| Zn | Less than 0.20 |
| Ti | Less than0.10 |

Table 2 MECHANICAL PROPERTIES

| | |
|---|---|
| Material designation | EN AW 6082 |
| Metallurgical condition | Generally T6 |
| Tensile strength | 270-310 Mpa |
| Elongation | 5-10% |
| Hardness | 89BHN |

## 5. MATERIAL OF FIXTURE

Fixture is made of mild steel material, grade of SAE 1017 first two digit indicates the class to which the steel belongs, the last two digit indicate the carbon contain. Generally the steels are specified by SAE (society of automotive engineers) and AISI (American iron and steel institute).composition of fixture material is given in table-3 & table-4.

Table 3 CHEMICAL COMPOSITION

| | |
|---|---|
| Carbon | 0.16-0.18% |
| Silicon | 0.40%max |
| Manganese | 0.70-0.90% |
| Sulphur | 0.040%max |
| Phosphorus | 0.040%max |

Table 4 MECHANICAL COMPOSITION

| | |
|---|---|
| Max stress | 1.5*10^3 – 2*10^3 |
| Elongation | 10-14% |
| Hardness | 95BHN |

The material of the fixture is selected based on the hardness of the component.

## 6. DESIGN OF FIXTURE

Fig-2 shows the concept drawing of fixture and component. The fixture is specially designed for that particular component, and also designs the fixture toward pressure test (Fig-3). Due to the component withstand the pressure up to 0.76Mpa (As per the customer requirement).so that the fixture is required for holding and supporting the component, during the test. Both fixture designs (fixture for holding component during machining and pressure test fixture) are different from each other.

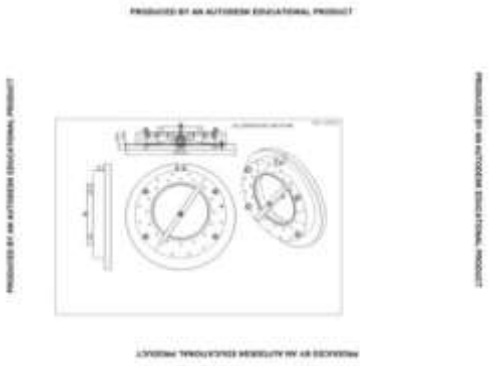

**Fig-2 concept drawing of fixture and component**

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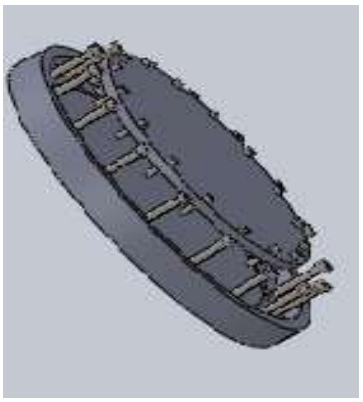

**Fig 3 fixture for pressure test**

## 5. CONCLUSION

An incorporated approach of modeling, designing and manufacturing of fixture has been modified in this work. This approach is essential for manufacturing plant. This paper covers the design of fixture for adapted flange in horizontal milling center. The eccentricity level of that component is maintained at very accurate. So the Fixture is designed for that particular component. This work transforms the theoretical knowledge of fixture design to practical application. The fixture reduces the setting time and cycle time of the machine. It leads to reduce the total manufacturing cost.

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