Digital Angle Checking Fixture For Fan Blade

Dashmeet Singh[1], Siddharth Khattar[2], Mohit Dhyani[3], Pankaj Shakkarwal[4]
[1, 2, 3]Depat of Mechanical Engineering
[4]Assistant Professor, Depat of Mechanical Engineering
[1, 2, 3, 4]MRIIRS

Abstract- *Successful mass production of any product depends on upon the concept of interchangeability to facilitate easy assembly of the products and overall reduction in the cost of production. The mass production demands the fast and easy method for positioning of the work for the accurate operations on it.*

Fixtures are the devices which helps in increasing the rate of production of identical parts and simultaneously reducing the human effort required for the production and it has variety of advantages that are associated with it which includes increase in the production rate, cost reduction, time saving, accuracy and use for heavy and complex components. The aim of this work is to design the fixture for measuring of the three required angles i.e. bend angle, twist angle and lift angle of the fan blade sponsored by M/s ABC. The phenomena of eliminating the traditional conventional method for measuring the angle manually with the help of bevel protractor which was not accurate in measurement and reducing the time consumed in the inspection of a fan blade by providing the technical support block, clamping devices like toggle clamp, down thrust clamp, locating devices and locating pins implementing the concept of interchangeability fool proofing to reduce cost and the time of inspection. The 3D modelling of angle measuring fixture and the assembly has been designed in Solid Edge ST8 software. The 2D drawings are drafted in cad 2016 software. The Inclinometer works on the concept of accelerometer, calculates the required angles lift, bend and twist by setting the different planes regarding the required angle and measures it and automatically displays its output digitally.

Keywords- Conventional Method, Interchangeability, calibration.

I. INTRODUCTION

A fixture is a work-holding or support device used in the Manufacturing and Production industry. They are used to securely locate and support the work, ensuring that all parts produced using the fixture will maintain conformity and interchangeability. Its primary purpose is to securely mount the workpiece and allowing for support during operation and increased accuracy, precision, and inter-changeability of the inspected part. It reduces the work time by allowing quick set-up, and also smoothing the transition from part to part. They must be designed with economics in mind, 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 and also high accuracy can be obtained. The main use of fixture are:-

- To reduce the inspection cost
- Less skilled labour
- Provide inter-changeability
- Reduce quality control expenses
- To assure high inspection accuracy of part

1.2 PROBLEM STATEMENT

The task of project is to develop a digitalize angle checking fixture for a fan blade for more accurate and easy calculations. Initially inspection is done manually with the help of bevel protectors and other measuring devices which took a lot's of time i.e., 11 minutes. So with the help of using inclinometer and a full-proof fixture we have made inspection more accurate and easy.

Table 1: Time required before fixture

1. S.no.	2. Different angles	3. Time required in seconds
4. 1.	5. Bend Angle	6. 300
7. 2.	8. Lift Angle	9. 360
10.	11. Total	12. 660 seconds

II. DESIGN OF INSPECTION FIXTURE

2.1. Design Procedure of Inspection Fixture:

In this design of inspection type of Fixture for a fan blade component can be explained in a systematic procedure.

Initially a 3D model of a workpiece is designed to get the necessary details for designing the fixture.

Secondly the individual parts such as Base plate, Toggle clamp, Locating block, Resting block and back plate has been developed. All these parts have been Designed, Modelled, Drafting has been done individually.

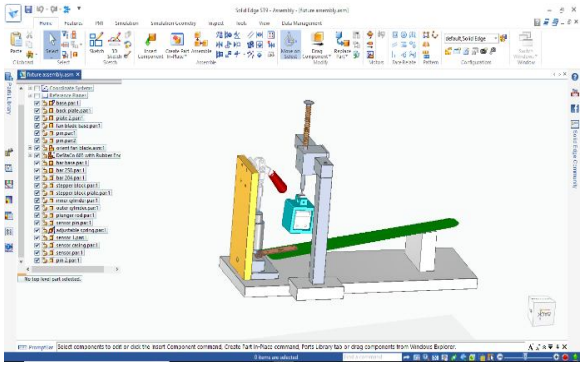

Fig 2: Isometric View of Fixture

The whole Design procedure was completed with the help of SOLIDEDGE software which helps for Designing, Drafting, Assembly, and Analysis.

APPLICATION:

Digitalised Inspection fixture is used to check the dimensions of the fan blade (the bend angle and the lift angle) accurately after getting finished with manufacturing operation. Different fan blade having different angles can be checked by changing the locator block.

- More efficient
- Increase the inspection rate
- Less time required for measuring angles
- Semi-skilled labour required

III. COMPONENT DETAILS

3.1 Fan Blade

The component for which the fixture is designed is made of stainless steel 316 which has 2 different angles i.e., bend angle and lift angle.

1. Name of the product: Fan Blade
2. Material: Stainless steel 316
3. Thickness: 1mm
4. Density: 8027.000 kg/m^3
5. Thermal Conductivity: 0.017 kW/m-C
6. Specific Heat: 502.000 J/kg-C
7. Modulus of Elasticity: 193053.196 Mega PA
8. Poisson's Ratio: 0.290
9. Yield Stress: 248.211 Mega PA
10. Ultimate Stress: 530.896 Mega PA

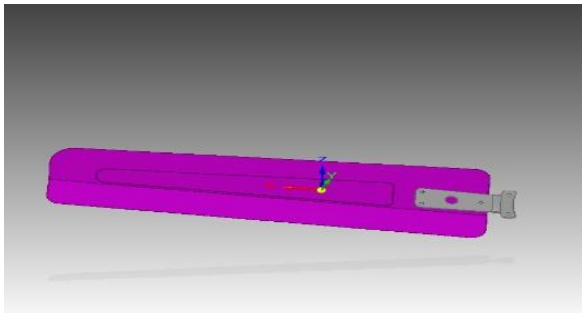

Fig 3: Fan Blade Component

3.2 Clamping Device

Clamping device is used to hold the workpiece tightly to restrict all degree of freedom. For holding the fan blade, a toggle clamp is used which has a holding capacity of 1.15kN which restrict the vertical movement of the fan blade.

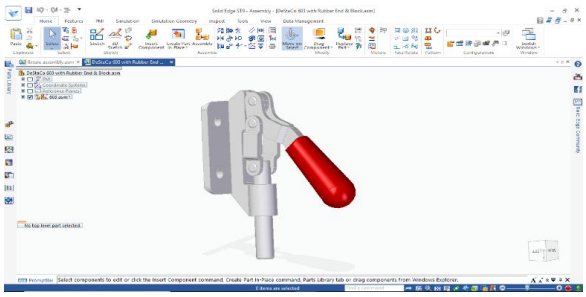

Fig 4: Toggle Clamp

3.3 Locating Pins

Pins of various designs made of hardened steel is used for locating the fan blade. Cylindrical pins are used which is inserted in holes of the shank. BY placing the fan blade in the locating pins can restrict the 5 degree of freedom of a fan blade.

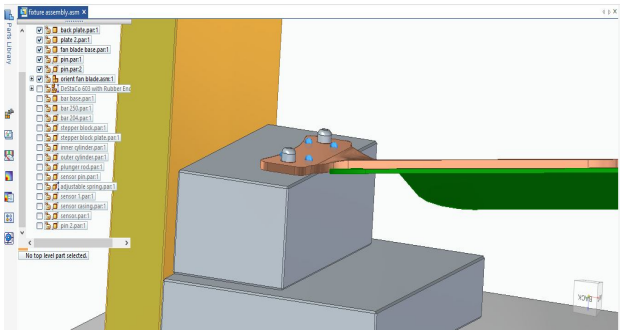

Fig 5: Locating pins

IV. CALCULATION

1. Force Calculation:

a) Input Force for Toggle Clamp:

$$\text{Input Force (P)} = \frac{4.\mu.d.R.\left(\frac{x+y}{L\times y}\right)}{}$$

$$= \frac{4\times 0.2\times 4.8\times 152.95\left(\frac{15.88+31.81}{72.2\times 31.8}\right)}{}$$

=2.33 Kg

μ= Coefficient of friction
d= diameter of pin
R= Output force
x= 15.88mm
y= 31.8mm
L= 72.2mm

b) Spring Deflection

$$\text{Spring Constant K} = \frac{G.d\text{^}4}{8D\text{^}3.n}$$

$$= \frac{80\times 10\text{^}3\times 3\text{^}4}{8\times 21\text{^}3\times 5}$$

= 17.49N/mm

G= modulus of rigidity
D= mean diameter of the spring
d= wire diameter
n= number of turns

$$K = \frac{f2-f1}{H}$$

$$H = \frac{22.85-0}{17.49}$$

=1.3mm

H= spring deflection
F_2= Force applied on the spring= 2.33Kg
F_1= Force not applied on the spring

2. Sensor Spring Deflection

$$\text{Spring Constant K} = \frac{G.d\text{^}4}{8D\text{^}3.n}$$

$$= \frac{80\times 10\text{^}3\times 1\text{^}4}{8\times 10\text{^}3\times 5}$$

= 8 N/mm

G= modulus of rigidity
D= mean diameter of the spring
d= wire diameter
n= number of turns

$$K = \frac{f2-f1}{H}$$

$$H = \frac{29.43-0}{8}$$

=3.67mm

H= spring deflection
F_2= Force applied on the spring= 3×9.81=29.43N
F_1= Force not applied on the spring

V. RESULTS AND DISCUSSION

- Input force for toggle clamp 2.33Kg
- Toggle clamp spring deflection 1.3mm.
- Sensor spring deflection 3.67mm.

5.1 Fan blade Total Deformation Representation:

The stress analysis is done to check the overall deformation in the fan blade profile when the toggle clamp force is applied. The below figure shows the stress distribution from minimum to maximum deflection areas.

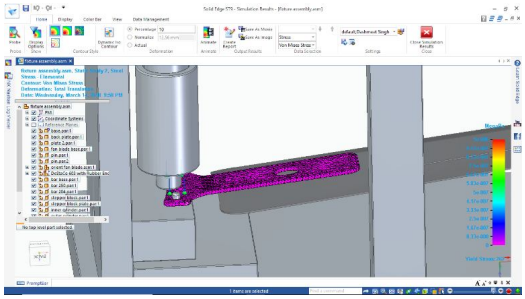

Fig 6: Fan Blade deformation representation.

Table 2: Comparison

S.No.	Existing Solution	Proposed Solution
1	Bend angle Measuring time= 300 sec	Bend Angle measuring time = 60 sec
2	Lift angle measuring time = 360 sec	Lift angle measuring time = 30 sec
	Total = 660 sec	Total= 90sec

VII. CONCLUSIONS

- The design of Inspection type of fixture for fan blade involved about 308x312mm dimensions.
- The assembly of the Inspection type of fixture is found satisfactory.
- The results obtained after inspection are found to be within the limit.
- Input force of toggle clamp is found to be 2.33 kg.

REFERENCES

[1] Guohua Qin, Weihong, Zhang Min Wan "Analysis and Optimal Design of Fixture Clamping Sequence ASME for publication in the JOURNAL OF MANUFACTURING SCIENCE AND ENGINEERING, 2006.

[2] Djordje Vukelic, Uros Zuperl & Janko Hodolic "Complex system for fixture selection, modification, and design" Int J Adv Manuf Technol 45:731–748 DOI 10.1007/s00170-009-2014-y, 2009.

[3] Nicholas Amaral · Joseph J. Rencis · Yiming (Kevin) Rong "Development of a finite element analysis tool for fixture design integrity verification and optimization" Int J Adv Manuf Technol 25: 409–419, 2005.

[4] Y. Wang, X. Chen. N, Gindy "Surface error decomposition for fixture development" Int J Adv Manuf Technol DOI 10.1007/s00170-005-0270-z, 2007.