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Fixture Design Method for Machining based on Eccentric Shaft

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Abstract

In the application of a ginning machine, the eccentric shaft is quite crucial. The task of machining keyways on the eccentric shaft is crucial. In comparison to the eccentric shaft, machining on a simple shaft is simple. Because machining keyways on eccentric shafts is a time-consuming procedure, cutting down on this time is a primary goal. The work is cylindrical in shape and requires a number of keyways in various locations. Because this is a difficult task for design engineers, the manufacturing industry has implemented Computer Aided Fixture Design (CAFD). It is concerned with the integration of CAD and CNC programming in CAM systems using fixture design software.Because there are no other options for holding cylindrical objects besides V blocks, a new form of fixture was created for this scenario, which may be utilised for machining the keyway on the eccentric shaft. Fixtures shorten operating times and boost productivity, allowing for high-quality operations.

Keywords-Eccentricity, Fixture design, Computer aided fixture design (CAFD)

1. Introduction

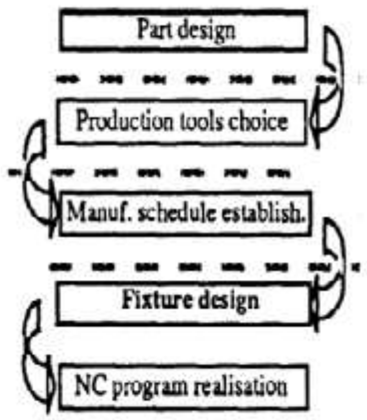
A fixture is a specific tool used to hold a work item in the correct position during machining. It comes with a device for clamping and supporting the work piece. In the manufacturing process, the fixture eliminates frequent checking, positioning, individual marking, and vacillate uniform quality. This boosts production and cuts down on time spent on the job. Because of its features and benefits, fixture is frequently employed in industrial practical production.An eccentric shaft is a circular or cam-shaped disc that is solidly attached to a rotating axel and has its centre offset from the axel's. The eccentric shaft is a crucial component in the ginning process.

Shaft gives moving knives an oscillating motion and is frequently praised for attributes such as effective performance, corrosion resistance, dependability, and extended service life. It's critical to reduce manufacturing cycle time and achieve high-quality operating fixture design. Designer creates a compact type eccentric shaft fixture to meet production targets, ensure high quality work, and boost efficiency.A manufacturing company's primary priority is its ability to produce high-quality items in a timely manner. It is critical to get a product to market quickly, ahead of any competitors, in order to secure a larger share of the market. Many manufacturing processes need the use of fixtures. During machining, they precisely locate and secure a work component so that it can be made according to designspecifications. As a result, fixtures have a direct impact on the quality of machining, productivity, and product cost.

2. Literature Review

The major lines of their process are that a fixture design support system is constructed on the basis of an expert system shell, according to the researchers. The researchers demonstrate how the employment of such a tool is a deciding factor for reactivity in the concurrent engineering fixture design process.

The focus of the paper is on the evolution of fixture designer support. In the expert system formalism, the researchers propose a structuring of the design approach and statement of the trade rules. SEACMU (System Expert d'Aideil la Conception des Montages d'Usinage for expert system for fixture design) was developed by researchers leveraging industrial expertise. That is a support system for fixture designers. SEACMU is based on a fixture design with fitted part modelling.RI rules are used to define the corresponding model from the part CAD/CAM data. The required link between the component CAD/CAM and the future design fixture design expert system is RI rules. The general arrangement is depicted in Figure 3 as the outcome of a rules-based decomposition.It is then possible to develop the fixture design, themanufacturing schedule, and the NC programmed design all at the same time[1].



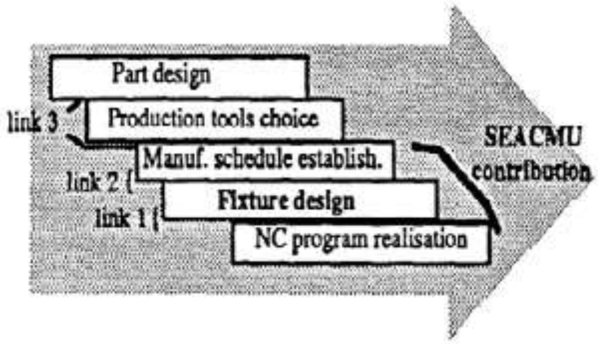


Fig.1.Sequential form of the steps Fig.2.Concurrent engineering of the part its machining Process.

The parts and components of the jig and fixture are split into the following categories: (a) Locating components, (b) Clamping mechanisms, (c) Tool guiding components, (d) Support components, (e) Fixing components for fixture, (f) Auxiliary mechanisms, (h) Operating elements, I Power mechanisms, and (j) Miscellaneous components The paper looked into the use of intelligence and optimization in the jigsaw puzzle process.

To account for global and local conformability, two conformability measures are introduced. The number and position of fixture elements, fixture element length, static coefficient, fixture element tip radius, and fixture primary stiffness direction are his design variables. Fixtures that are both force and displacement regulated are studied[2].

It was discovered that, depending on their proximity to the line of action of the external perturbation, conformability and stability can either increase or decrease with contact position. The effects of clamping intensity and primary stiffness directions on the stability of force and displacement controlled fixtures are opposite[3].

As L4 travels in the +XA direction, the local conformability metrics for Pcontrolled and U-controlled fixtures (CZ, and Cza, respectively) follow remarkably similar trajectories. The inclusion of L4 to scenario #2 (P2) resulted in an increase in both conformability metrics and stability when compared to the reference example. The lower section of the sphere is supported by Locator L4. This explains why stability increased from PI to P2. As L4 progresses from P2 to P5, its conformability and stability deteriorate.

The clamping force for the P-controlled fixture was changed from 800 N in PI to 900 N in P2 and to 1000 N in P3. Similarly, for P2, P3, and P4, the clamping displacements are 12.5, 15.0, and 17.5 pm, respectively. S and Czp rise with clamping intensity, as shown in Fig. 3. Czp rises when clamping loads rise, resulting in bigger work pieces and contact elastic deformations. In the case of the U-controlled fixture, stability drops slightly when clamping intensity increases, but Cz remains unaffected.

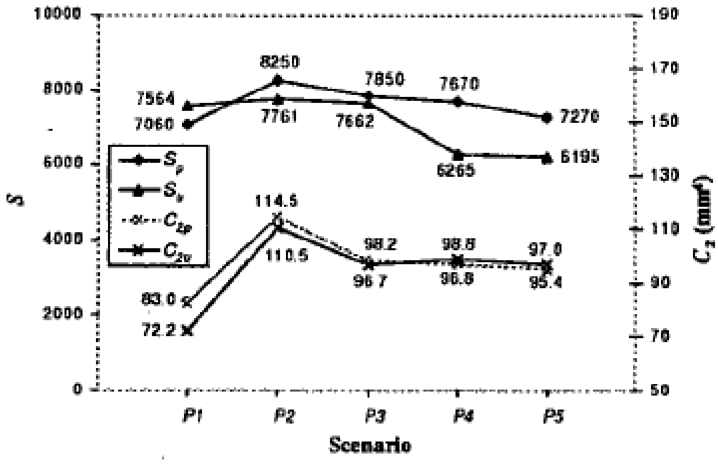


Fig.3. Effect of the number and position of fixture element

For a fixture, the following requirements must be met: (i)complete restraint of the work piece or form closure; (ii)accurate locating of the work piece; (iii)limited deformation of the work piece; no interference between fixture components and machine tool; (iv)ease of loading/unloading a work piece. The first two requirements are critical for fixture layout design and can be considered the first phase in fixturing system design for determining the number, type, and location of fixturing points. The researchers offer an efficient approach for identifying seven frictionless fixturing points that ensure form closure and a modest positioning error of the work piece from a dense set of data. The topic of designing a fixture pattern for a 3D curved work piece was addressed in this paper[4].The researcher describes a quick fixture design system that combines an automated modular fixture configuration design technique for fixture unit generation with interactive fixture design functionalities for locating techniques and clamping component options[5]

Fixture manufacturing and installation are costly for high volume production runs, as they are only concerned with achieving three point connections, which is required to reuse the fixture. The subject of fixture reusability is addressed in this study. In the context of modular fixtures, the researcher considers both types of variation. They provide a mechanism for comparing fixtures in terms of how much geometric tolerance they will allow before failing when it comes to tolerance variation. They identify design guidelines for design variation that can quickly assess if a proposed part design is consistent with a previous fixture[6].The evaluation method proposed in this paper will evaluate the clamping strategy in the following ways: Factor of area. Factors affecting stability and clamping point location Fixture planning automation is critical for increasing fixture design and manufacturing efficiency[7] .Several basic work holding parts, including as locators, supports, and clamps, make up a fixture. Fixture arrangement is the process of determining the quantity, kind, and position of work holding pieces. Fixture setup is the second task, and its primary goal is to avoid collisions and interference between the machine tool and the fixture. The locator, support, and clamps are the basic fixture components. Fixtures must meet six essential functional requirements: (a) steady resting,

(b) precise localization, and (c) accurate positioning. Support reinforcement, steady clamping, force-closure (or entire restraint), and quality performance are all factors to consider[8].The study paper focuses on efficient numerical algorithms for automatically creating, assessing, and optimising fixture layout designs for any complex-shaped 3D work piece.

3. CHALLENGES OF MACHINING OF KEY-WAYS ON ECCENTRIC SHAFT BY CONVENTIONAL METHOD

With the introduction of CNC machining technology and the capacity of multi-axis machines to conduct many operations while reducing the number of set-ups, the fixture design work has been reduced in terms of the number of fixtures required. However, there is a need to address the need for a faster response time and shorter lead time when designing and building new fixtures.Because the dimensions required by different industries fluctuate, the application for machining keyways with a fixture varies from industry to industry. Customer's main need is that keyways manufactured on eccentric shafts have a high degree of accuracy and be used in mass production. It can also endure the forces it faces during operation and run for a long time.

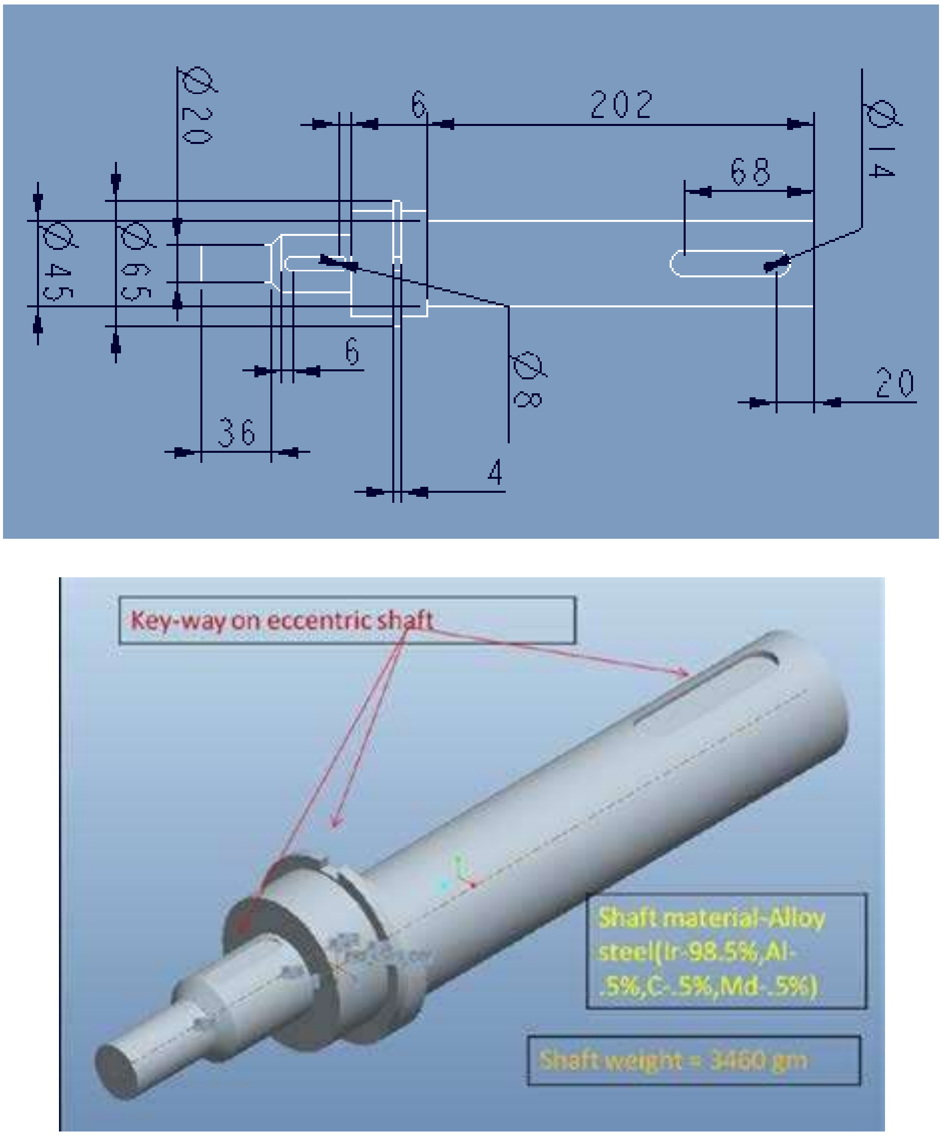


Fig.4.Machining of keyways on eccentric shaft

4.

5. DEVELOPMENT OF FIXTURE ASSEMBLY FOR MACHINING OF KEY WAYS

The following are the steps involved in developing a fixture for cutting keyways on an eccentric shaft:

• Analytical fixture design.
• PRO – ENGINEER Wildfire 5.0 3D Modeling
• Putting together the fixtures
• ANSYS is used for analysis.

Various Approaches for Fixture Design

The drawing of the work piece is analysed.

• Identifying candidate elements (machined surfaces for locating, possible clamp positions, critical work piece regions, tool path, possible tool interference points, and so on).
• Support, positioning, clamping, base, guiding, and fasteners are all taken into account.
• Techniques (modular, vice, v-block, point surface, angular structure, multiwork piece clamping, 3-2-1 principle, and so on).
• Solution identification (successful succession of local solutions and formation of a consistent solution, modular fixture pattern selection) (positioning of 2 or more work pieces)
• Fixture design • Assembly construction

6. Proposed Design of Fixture Parts

6.1 Base Plate Design

The base plate is created by taking into account the machine's characteristics. Because the fixture is mounted on a table, the length, width, and height of the base plate are taken into consideration when constructing the base plate.

Consider the length(l) of the base plate to be 300mm.

Consider the width(b) of the base plate to be 150mm.

Consider the height(h) of the base plate, which is 24mm.

6.2 v-Block Design

A machine's specs are used to design the base v-block. The length, breadth, and height of the base v-block are 250, 66, and 45, respectively, because the fixture is placed on a table and thus the dimension of a table is a critical issue when constructing the base v-block.

Consider the length(l) of the base v-block to be 250mm.

Consider the width(b)=66mm of the basic v-block.

Assume that the height(h) of the base v-block is 45mm.

5.4 Design of Threaded Block

The clamping element is supported by the threaded block. The size of the threaded block is determined by the amount of support that must be provided to the clamping element. Thread block dimensions can be measured in length, breadth, and height 46,26,45, and 46,26,45, respectively.

Consider the length(l)=46mm threaded block.

Consider a threaded block with a width of 26mm (b).

Consider the height(h) of a threaded block to be 45mm.

5.5 Clamp Design

A clamp is a fixture's force-actuating device. The clamps' forces keep a part firmly in place in the fixture in the face of all external influences.
a-distance between the central axis of the bolt and the clamp supporting one end.
e-distance between the bolt's central axis and the clamp's central axis.
clamp b-width of square c/s
x is the clamp's square c/s length.
C1,C2 – clamp hole radios a=49,C1=5,C2=5
b= C1+C2 b=10mm b=10mm b=10mm b=10mm b=10mm b=10mm b=10mm b=10mm b=10mm
polar moment of inertia(J) design:
J = л/64 x d4 J = 219,78 x 103 mm
Design of Torque of clamp:-
Calculating power(P):-
P =2лNT/60

P=3.75W
Torque resisting design (Tr):
T=Px60/2лN T=Px60/2лN T=Px60/2лN T=P (4)
N-mm=24.86 Tr
To find the maximum torque (max), use the following formula:
- Kts x Tr = max (5)
43.505x103 N-mm maximum

how to calculate tensile stress:
The eccentric shaft is made of SAE1040 alloy steel and transmits 5 horsepower at 1440 revolutions per minute.
The yield tensile stress (yt), ultimate tensile stress (ut), yield shear stress (ys), modulus of elasticity (E), and modulus of rigidity (G) are 350 MPa, 632 MPa, 210 MPa, 203 MPa, and 78 MPa, respectively.

Let F.s. be the factor of safety, P.s. be the clamp load, and A.s. be the clamp area, with t =yt/Fs.t = 87.5 N/mm2.
bending stress calculation:
- b=ys/Fs=210/4=52.5N/mm2 b=52.5N/mm2 b=52.5N/mm2
Combining Bending and Tensile Strength: - I = tb3/12 tb3/12 tb3/12 tb3/12 tb

I = 83.33t
(for tensile)
52.5 x 358.46 = 358.46/t (9)
t=6.82mm ———- (for tensile strength)
Fb =Mb/Z = p x e /Z =(136 x 54)/Z Fb =Mb/Z = p x e /Z =(136 x 54)/Z
Fb is the bending force.
Moment of bending Mb
According to the calculations, the thickness of the clamp is calculated for tensile, shearing, and bending, i.e. t=4.096mm –tensile = t=5mm t=6.82mm—-tensile= t=7mm, t=8.39mm—-bending= t=9mm. Take the thickness dimension as per your design, i.e. t=7mm because it gets the most tensile stress.

7. Result Analysis

The force acting on the fixture is 140N, and as a result, the fixture is subjected to deformation and von-misses.With analytical calculations, the deflection of the base of the v-block is.00141mm, but with ANSYS, it is 0.115364mm.

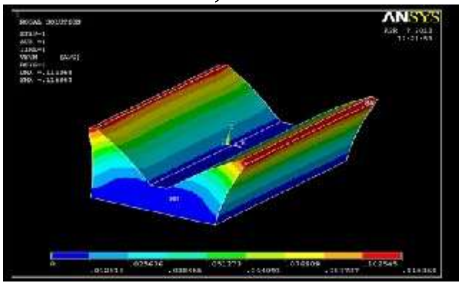


Fig.5.static structural Deformation of v-block.

The analytical value for von-misses stress operating on the base v-block is 515.26Mpa, while the ANSYS estimated value is 486.138Mpa.

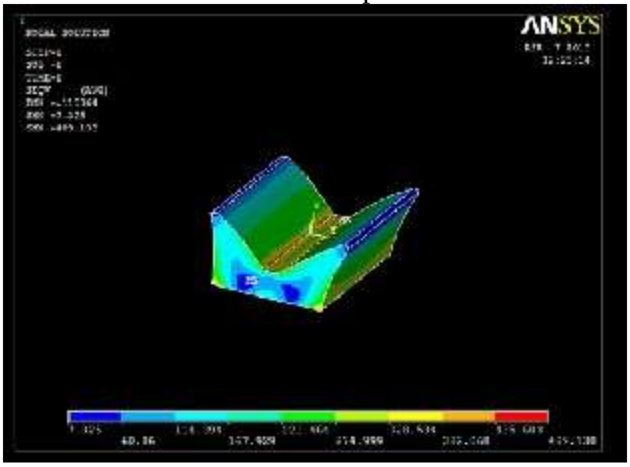


Fig.6.Shows stress Analysis of base block by ANSYS

The minimum and maximum Von misses stress (equivalent tensile stress) of the base v-block are shown in the diagram below.

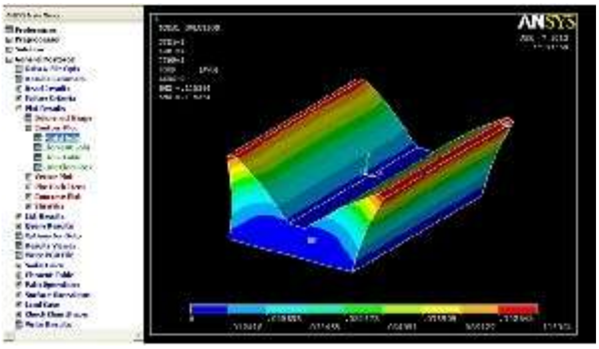


Fig.7.Minimum and maximum von misses stress or (equivalent tensile stresses)

8. Conclusion

In alloy steel, the standard permissible deflection deflection is 4.389 mm, and the von misses stress is 620.442 mpa. The deflection is 0.0014mm using analytical calculation and 0.115364 mm with ANSYS, both of which are less than permitted standard values, indicating that the design is safe. The von misses stress calculated analytically is 515.26 MPa and calculated with ANSYS is 489.138 MPa, both of which are lower than standard values. As a result, it is possible to conclude that design is risk-free.

• With the usage of this fixture, the industry person or user will be satisfied, and the user will be able to offer the best product to the client on time.In the machining of keyways, the user will provide a high level of accuracy. The user receives the best possible eccentric shaft fixture. Material handling and scrap costs are decreased.

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