Design and Analysis of Work Holding Fixture

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Abstract— The fixture is a special tool for holding a work piece in proper position during manufacturing operation. For supporting and clamping the work piece, device is provided. Frequent checking, positioning, individual marking and non-uniform quality in manufacturing process is eliminated by fixture. This increase productivity and reduce operation time. Fixture is widely used in the industry practical production because of feature and advantages. To locate and immobilize workpieces 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 and orientation of a workpiece, whereas clamps exert clamping forces so that the workpiece is pressed firmly against locators .Clamping has to be appropriately planned at the stage of machining fixture design.

Key words: Fixture, product Quality

I. Introduction

Fixtures are the tool used to locate and hold the work piece in position during the manufacturing process. Fixtures are used to hold the parts firmly which are to be machined, it is used to produce the duplicate parts accurately. In order to produce parts with required accuracy and dimensions the parts must be firmly and accurately fixed to the fixtures. To do this, a fixture is designed and built to hold, support and locate the work piece to ensure that each work piece is machined within the specified limits. Set blocks, feeler or thickness gauges are used in the fixture to refer the work piece with the cutter tool.

A fixture should be securely fastened to the table of the machine upon which the work is to be done. Though largely used on milling machines, fixtures are also designed to hold the work for various operations on most of the standard machine tools. Fixtures vary in design based on the use of relatively simple tools to expensive or complicated devices. Fixture helps to simplify metalworking operations performed on special equipment's.

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II. Identified Gaps in the Literature

In existing design the fixture set up is done manually, so the aim of this project is to replace with fixture to save time for loading and unloading of component. Fixture provides the manufacturer for flexibility in holding forces and to optimize design for machine operation as well as process function ability.

III. Problem Formulation

Work piece is hold in to workspace holder and this all attachment fix in to the fixture plate. A rigid positioning of the work piece with least time takes place. Springs are design such a way to carry the pressure don't allow to deflect the work piece? Cam is used for mounting and unmounting purpose. Cam is fixed into frames slot. Base plate for rigid support to fixture. Two mesh bull gear are fitted to rotating purpose to take the advantages of rotation and increase the application of fixture. Fixed plate with centre attachment is provided to locking purpose. When fixture in use centre push in to the fixed plate hole so hole attachment is getting fix.

This fixture used in vertical milling machine. Different electrode profiles are easily manufactured by using this fixture. Mounting, unmounting and lockating of work piece is very easy and l than this electrode is used on electro discharge machine to manufacture moulds. Complicatedmould profile are done with this process. Graphite or bronze material is used to manufacture electrode.

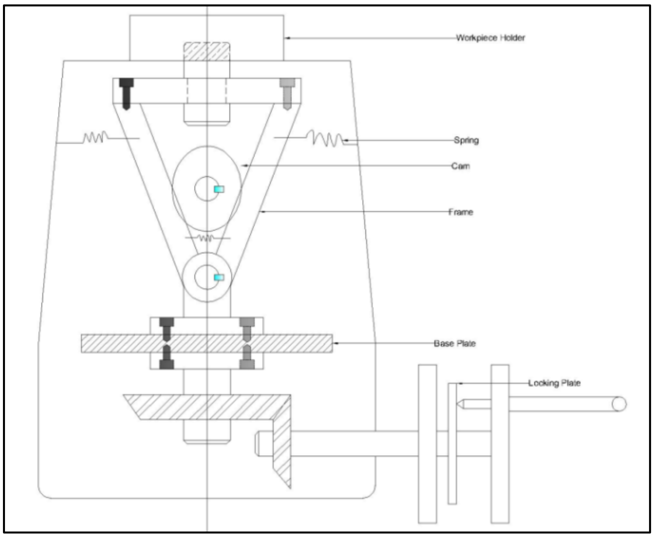


Fig. 1: Concept Design of Work Holding Fixture.

A. Objective

- The main objectives of the work is
- To easily mounting and un-mounting work piece.
- To rigidly holding and locating with less time consuming.

- Complicated profile machining by using vertical CNC milling machine.
- Design and Analysis of Spring for firmly holding the work piece.
- Design and Analysis of Bevel gear for providing rotary motion to hole assembly.
- Design of cam for work piece holding and relishing purpose.
- Make a better design with minimum costing

B. Methodology

- Modelling using solid works
- Static analysis of the model in order to solve the problem formulation

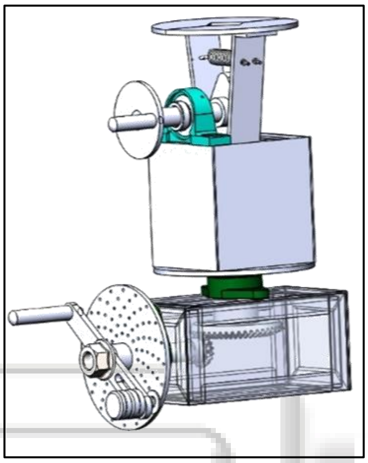


Fig. 2: CAD model of Work holding fixture

IV. HAND CALCULATION

Torque calculation**:**
The following are the basic parameters:
Width of block (w) = 20 mm
No .of teeth on the cutter (z) = 20 teeth
Diameter of cutter (D) = 100mm
Radial rake (α) = 10
Feed velocity of the table (f) = 50mm/min
Rpm (n) =60
Depth of cut = 2mm
Spring stiffness = 5N/mm
Total expansion = 14*2 = 28mm
Load applied to expand the spring = 28*5 = 140N
Torque applied = 140*4 = 5600N/mm
To start with lets us find out the angle of contact & the angle subtended by two consecutive cutting edge from relation
$\sin\beta = 2\sqrt{d/D} = 2\sqrt{2/100} = 0.28284$
SO, β =16.4
The angle between two consecutive teeth is 2Π/20 = 18 > β
Thus out of 3 possibilities we can go with 2Π/z >β

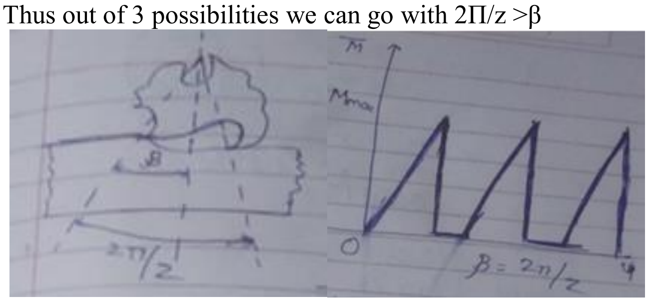


Fig. 1 & Fig. 2:

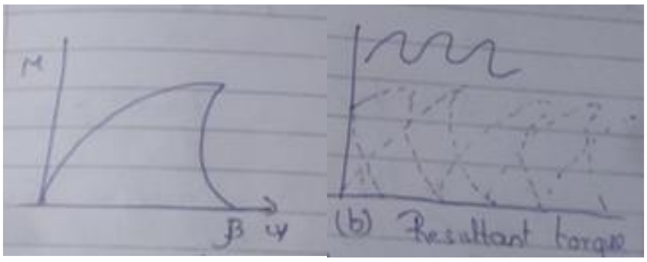


Fig. 3 & Fig. 4:
The maximum uncut thickness is found out using equation

$t_{1max} = (2*f/N*z)\sqrt{d/D} = (2*50/60*20)\sqrt{2/100}$
$= 100*0.1414/1200 = 0.0117$

The coefficient of friction at the rake face & the stress of the work material may be assumed to be 0.5 & 100 N/ mm^2

$ʎ = \tan^{-1}\mu = \tan^{-1} 0.5 = 26.57$

From the lee & Shaffer shear angle relationship, we get shear angle

$\Phi = 9.8$

The maximum value of the cutting component of the machine force is

$f_{cmax} = \{wt_{1max}\,\tau_s\cos(ʎ-\alpha)\}/\{\sin\varphi\cos(\varphi+ʎ-\alpha)\} = \{20*0.0117*100\cos(26.57-10)\}/\{\sin 9.8\cos(9.8+26.57-10)\} = 147.5N$

The variation of torque due to single tooth with arbor rotation is shown below

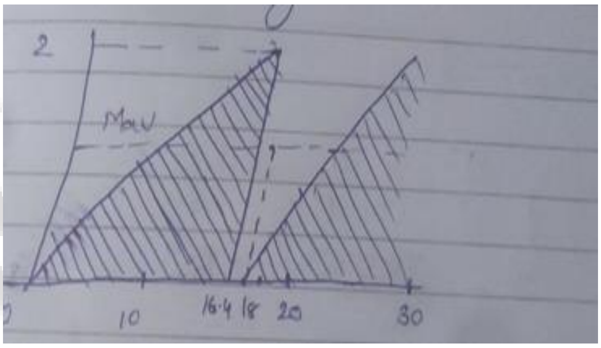


Fig. 5:
Mav = (0.5 *16.4*2)/18 =0.91N-mm
Spring calculation**:**
d = 2mm, load (p) = 140N, D = 14.04mm
S = Mc/J
$J = \Pi d^4/32 = (\Pi*2^4)/32 = 1.57$
M = PD/2
C = D/d = 14.04 /2 = 7.02
$K_{w1} = \{(4C-1)/(4C-4)\} + 0.615/C$
$= (27.08/24.08) + 0.0876 = 1.2121$
$S = (2.546PD/d^3)\,Kw$
$= (2.564*140*14.04*1.212)/2^3 = 758.16N = 0.75KN$
Deflection of coil = $f = (8PD^3Na)/Gd^4$
Where Na = no of active coils = 18
G = 76923.07
$f = (8*140*14.04^3*18)/(76923.07*2^4)$
= 45.33
Spring rate k = P/f = 140/45.33 =3.088

A. Design of Bottom Shaft

5600

$J = \Pi D^4/32 \quad = (3.14*10^4)/32$

$J = 981.55mm^4$

We know that,

$\frac{T}{J} = \frac{\tau}{R}$

$\tau = \frac{5600 \times 10}{981.25}$

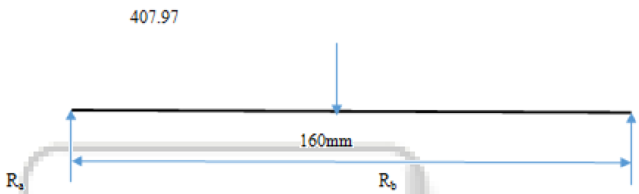
$\tau = 57.07\, N/mm2$

$\frac{T}{J} = \frac{G\square}{l}$

$= \frac{5600 \times 145.39}{981.25 * 80{,}000}$

$= 0.01$

B. Design of Bottom Frame



$\Sigma fy = 0$

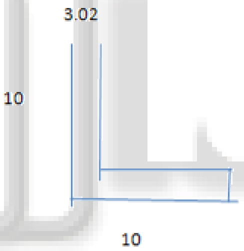
$Ra + Rb = 407.91N$

$\Sigma Ma = 0$

$407.91 \times 80 = R_b 160$

$32632 = 160R_b$

$R_a = R_b = 203.955N$



$\Sigma Mc = 203.955 \times 80$

$\Sigma Mc = 16316\ N/mm^2$

$I = 7345.72mm^4$

We know that,

$\frac{M}{I} = \frac{\sigma}{Y}$

$\sigma = \frac{16316.4 \times 10}{7848.72}$

$\sigma = 22.21\, N/mm2$

C. Stress Calculation of Work piece Holder

F = 407.91

σc = 407.91/109.77 = 3.71 N/ mm2

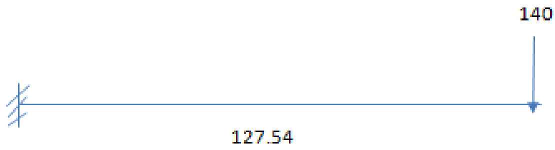
Considering one end fixed and other free

Pcr= Π2 EI/ 4l2

= (3.142 *200000* 3672.86)/ (4*942)

= 204.91 KN

D. Design of Lever Plate

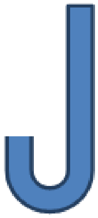


$R_a = 140N$

$\Sigma Ma = 140 \times 127.54$

$\Sigma Mc = 17855.6\ N/mm^2$

$I = 1406.25mm^4$



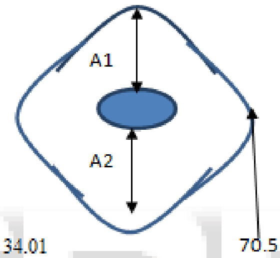
We know that,

$\frac{M}{I} = \frac{\sigma}{Y}$

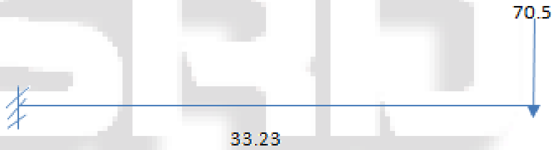
$\sigma = \frac{17855.6 \times 2.5}{1406.25}$

$\sigma = 31.74\, N/mm2$

E. Design of Cam



A1 =A2 = 34.01



$R_a = 70.5\ N$

$\Sigma Ma = 33.23 \times 70.5$

$\Sigma Mc = 2342.715N/mm^2$

$b = A1 + A2 = 34+34 = 68,\ d = 10$

$I = bd^3/12 = (68 * 10^3)/12 = 1406.25mm^4$

We know that,

$\frac{M}{I} = \frac{\sigma}{Y}$

$\square = \frac{2342.715 \times 34}{3666.66}$

$\square = 28.112\, \square/\square\square 2$

V. Conclusions

It reduces or sometimes eliminates the efforts of marking, measuring and setting of work piece on a machine and maintains the accuracy of performance. The work piece and tool are relatively located at their exact positions before the operation automatically within negligible time. So it reduces product cycle time. Variability of dimension in mass production is very low so manufacturing processes supported by use of jigs and fixtures maintain a consistent quality. Due to low variability in dimension assembly operation becomes easy, low rejection due to less defective production is observed. It reduces the production cycle time so increases production capacity. Simultaneously working by more than one tool on the same work piece is possible. The operating conditions like speed, feed rate and depth of cut can be set to higher values due to rigidity of clamping of work piece by fixtures. Operators working become comfortable as his efforts in setting the work piece can be eliminated. Semi-skilled operators can be assigned the work so it saves the cost of manpower also. There is no need to examine the quality of produce provided that quality of employed fixtures is ensured

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