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Design and Modification of Milling Fixture for Square Shank

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Abstract:*A fixture's primary purpose is to create a secure mounting point for a work piece, allowing for support during operation and increased accuracy, precision, reliability, and interchangeability in the finished parts. It also serves to reduce working time by allowing quick set-up, and by smoothing the transition from part to part. It frequently reduces the complexity of a process, allowing for unskilled workers to perform it and effectively transferring the skill of the tool maker to the unskilled worker. Fixtures also allow for a higher degree of operator safety by reducing the concentration and effort required to hold a piece steady.*
Keywords:*Analysis in ANSYS, CATIA Modeling, Milling Fixture.*

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I. Introduction

A fixture is a work-holding or support device used in the manufacturing industry. Fixtures are used to securely locate (position in a specific location or orientation) and support the work, ensuring that all parts produced using the fixture will maintain conformity and interchangeability. Using a fixture improves the economy of production by allowing smooth operation and quick transition from part to part, reducing the requirement for skilled labour by simplifying how work pieces are mounted, and increasing conformity across a production run.

A fixture differs from a jig in that when a fixture is used, the tool must move relative to the work piece; a jig moves the piece while the tool remains stationary.

Fixture is also used in inspection welding and assembly. Fixture does not guide the cutting tool, but is always fixed to machine or bench. By using fixture, responsibility for accuracy shifts from the operator to the construction of machine tool.

When a few parts are to be machined, work piece clamp to the machine table without using fixture in many machining operations. However, when the numbers of parts are large enough to justify its cost, a fixture is generally used for holding and locating the work.

II. Objective

The main objective is to reduce the assembly time and increase worker efficiency.
To increase accuracy and minimize space required for the old fixture.
Increase the safety of worker by reducing traveling of heavy jobs

III. Problem Statement

Within the existing fixture due to insufficient support at the base of work holder the fixture tends to large amount of vibrations at this specific place which indirectly results in unwanted forces acting on fixture.

Due to this the continuous change in work holder carried within the fixture which results in the internal wear within the fixture and gradually leads to the decreased life span of the fixture. Following are some of the main problems within the existing fixture.

- Insufficient support at the base of work holder.
- Unwanted forces acting on fixture.
- Continuous change in the work holder every time had to be carried.
- Large amount of internal fixture wear is observed due to this continuous change of work holder which results in decreased life span.
- More handling time is consumed.
- Low productivity because of more time is consumed.

IV. Methodlogy

4.1 Study of components:

The study of the components includes the study of various fixture components like wedge, locating pin, double handed screw etc. required for mounting of the work piece. The study of components is the most important and the first step for the designer. The component drawings are carefully scrutinized to extract the maximum possible information. The important information available is the critical dimensions, locating and clamps areas.

4.2Geometric model of components:

Geometric models of components is important to make because it gives the over view of the components that is needed to be design. Geometric modeling of component is done using CREO 2.0 considering all the critical dimensions.

4.3 Selection of fixture materials:

Material to be selected for the fixture is selected by considering forces acting on the fixture as the material should be selected which can sustain the forces acting on the fixture. The material used in the manufacturing of fixture varies depending on the applications. Proper material selection and proper combination of alloys in varying percentages are required for finished fixture.

4.4 Step by step design calculations:

It is carried out to determine the various design parameters that determine cutting force induced on the component during milling operation.

4.5 Solid modeling:

3-D modeling of entire component is done using CATIAV5R19 software. For the better understanding of 2D drawings and visualization, modeling has been done. The required dimensions are determined by calculation, which is used during design of the fixture. For solid modeling we use CATIAV5R19 and we also plot orthographic projection of fixture.

4.6 Analysis:

Structural analysis is carried using ANSYS software to determine the total deformation and the stresses induced in the fixture during operation.

4.7 Finalization of Fixture Design:

After the testing designed fixture is finalized for require application.

V. Design Of Fixture Commencement

Overhang Milling (cutter milling):

Spindle Speed = 733rpm

Feed (f_n) = 0.3mm/rev

1. **Table Feed** (V_f) = $f_n * z_c * n$

   where,

   fz = feed per tooth

   zc = effective number of teeth = 4

   n = spindle speed = 733rpm

   Now, $f_n = f_z * z_c$

   $f_z = f_n / z_c$

   $f_z = 0.3/4$

   $f_z = 0.075$mm/tooth

   $V_f = 0.075*4*733$

   $= 219.9$mm/min

   $= 3.665$mm/sec

2. **Net Power** (P_c) = $(a_p * a_e * v_f * k_c)/(60*10^6)$

   where,

   a_p = axial depth of cut = 0.5mm

   a_e = radial depth of cut = 20mm

k_c= specific cutting force = 2520N/mm^2

P_c = (0.5*20*219.9*2520)/(60*10^6)
= 0.0923 KW

3. **Torque** (M_c) = (P_c*30*10^3)/(n*π)
= (0.0923*30*10^3)/(733*π)
= 1.202 N/m

4. **Force** (F) = [F_s*cos(β-α)]/[cos(θ+β-α)]
where,
β = friction angle = 90˚
α = tool angle = 45˚
θ = shear angle = 10˚
F_s = shear force =1112 N

F = [1112*cos(90-45)]/[cos(10+90-45)]
= **1370.87 N**

Pocket Milling(end milling):

1. **Force** (F) = [F_s*sin(β-α)]/[cos(θ+β-α)]
where,
β = friction angle = 90˚
α = tool angle = 10˚
θ = shear angle = 45˚
F_s = shear force =1112 N

F = [1112*sin(90-10)]/[cos(45+90-10)]
= **1909.25 N**

Drilling:

1. **Rotation per minute** (rpm):
RPM = (v_c*12)/(3.14*D)
where,
v_c = cutting speed = 120 m/min = 2 m/sec
D = diameter of drill = 0.006m

RPM = (2*12)/(3.14*0.006)
= 1273.88 rpm

2. **Power** (P_c) = [(D/4)*f*v_c*k_c]/[33000*η]
where,
D = diameter of drill
f = feed
v_c = cutting velocity
k_c = specific cutting force

P_c = [(6/4)*0.3*120*2520]/[33000*0.72]
= 5.72 HP
= 4.265 KW

3. **Torque** (M_c) = (Pc*5252)/RPM
= (5.72*5252)/1273.88
= 23.58 ft/lbs
= 32.54 N.m

4. **Force** (F) = 0.7*(D/2)*f*k_c
= 0.7*(6/2)*0.3*2520
= **1587.6 N**

Tapping:

1. **Force** (F) = S_s*π*D_p*L

where,
S_s = shear stress = St/√3 = 202.07 mpa
S_t = yield strength = 350 mpa
D_p = pitch diameter = 5mm
L = total axial length of full thread = 10mm
F = 202.07*π*5*10
= 31741.08 N

Assuming Factor of safety = 5
F = 31741.08/5
= **6348.21 N**

VI. Components Of Fixture Assembly

6.1 Basic Holder

It is the base of the fixture assembly which is connected to the fixture housing in which the square shank is hold. This is kind of parent part of assembly.

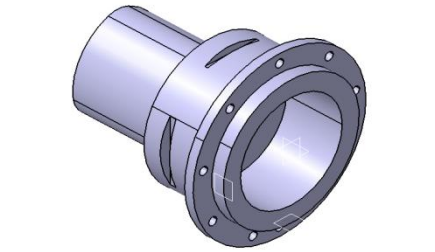

Fig.1:- Basic holder

6.2 Shank Housing

This Is the part which is fixed with help of bolts and nuts to the base plate. This part consists of two clamps which are used to tighten to hold the wokpiece.

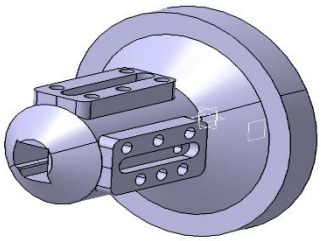

Fig.2:- Shank Housing

6.3 Base Plate

This is the plate which is going to be fixed in the fixture housing when we hold the workpiece which is going to be machined. The workpiece rest and is supported by this plate during milling operation is performed.

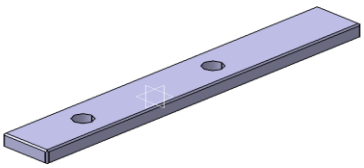

Fig.3:- Base plate

6.4 Side Plate

This plate is also fixed in fixture housing for providing support for the workpiece. The main function of side plate is to check the inclination of taper section of workpiece with the spherical pin shaped on plate and hold the workpiece in its place.

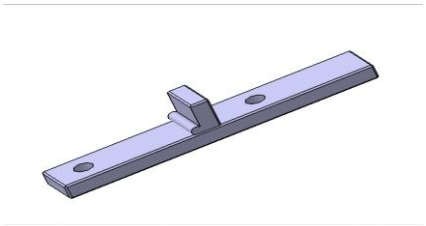

Fig.4:- Side plate

6.5 Tool Holder

This is the workpiece(i.e. tool holder) which is fixed in the fixture housing with the help of clamps and supported on the plates. The workpiece is in the form of square shank and then its is milled to make a tip seat on it to hold the insert.

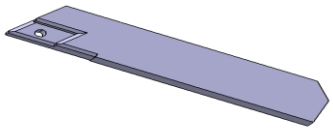

Fig.5:- Tool Holder

VII. Conclusion

The fixture was designed for a particular application and to reduce the space required by the old fixture. Some of the unwanted forces acting on obsolete fixture are reduced to a safe extent. Due to new implementation time consumption for all processes are being reduced. All the above problems are accomplished with this design and it will be implemented in the industry.

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