DESIGN AND FABRICATION OF A SQUARE BROACH CUTTING TOOL (VERTICAL BROACHING)

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ABSTRACT

Broach is multipoint cutting tool consisting of a bar having a surface containing a series of cutting teeth or edges which gradually increase in size from the starting or entering and to the rear end. Broaches are used for machining either internal or external surfaces (i.e.; sizing of holes and cutting of serrations, straight or helical planes, gun rifling and keyways).In this work a Broach cutting tool is designed to perform internal square holes in the required pre performed casting. In the present work Broach cutting tool is designed to perform square holes on vertical broaching machine. The Broach cutting tool is designed for generation of internal square holes for pre performed castings or forgings which are suitable for motion work end cap for clock making. A'C' program is developed to obtain different parameters of the Broach cutting tool. In the present work, the displacements and the stress analysis of Broach cutting tool tooth are carried out using finite element method. A sophisticated ANSYS 11FEM package is used for the solution assuming the tooth as three dimensional body. The tooth displacements and stress variations are studied by determining the loads for different parameters like rake angle, pitch and depth of cut and these loads are applied at the tip of the tooth by fixing the tooth at the root. All the stress distributions in the form of stress contours are plotted. The displacements and all the stress variations are plotted against rise/tooth for different pitch and rake angles.

Keywords: *Broach cutting tool, ANSYS, FEM.*

1.0 Literature Review

Chad Richards, a previous understudy of the Industrial and Systems Engineering division at Ohio University, built up an information based framework that plans the round gap suggests. The codification of the information base framework was finished utilizing procedural based programming. A large portion of the introducing devices have methodology based plan rules. The information based framework was produced Using Microsoft Quick essential programming. Chad Richards [10] utilized the outcomes from the information based framework to demonstrate a 2-measurement profile of the device. The point of his exploration was to lessen the time required to plan and manufacture them. Another understudy, Yean-JenqHuang, additionally a previous understudy of a similar division outlined a philosophy for the ideal incorporated suggesting fabricating process. This technique depended on the three assembling assessment criteria which were:

1. The most extreme creation rate was utilized to outline the propose plan parameters that can expand the quantity of items delivered in a unit time interim.
2. The base cost criteria which refers to the generation of the bit of the part in any event cost comparing to the propose plan parameters.
3. The greatest benefit rate criteria to decide the introduce plan parameters which can augment the benefit rate in a given interim of time.

4. Huang additionally inspected the conduct of a solitary level propose tooth utilizing limited component examination application.

2.0 Research Objectives

1. To bring down the cost of configuration process by decreasing the time required to plan and create propose devices.
2. To diminish the work doing the gaps with various machines by getting the gaps with a basic one push.
3. To give a rule to the future research went for the execution change of various types of introducing instruments.

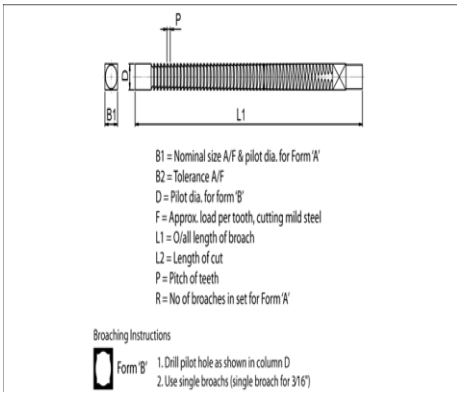
The principal objective was appeared by the parametric plan of the introduce, where the outline aim of the suggest device geometry is caught. A geometrical relationship is produced on the introduce apparatus geometry which is exceptionally adaptable and can be changed for a large portion of the devices with next to no client intercession. The second target was to diminish the work and cost execution by manufacturing a basic introduce with less cost. The model worked from the parametric outline was used to investigation the execution of hardware to anticipate the anxiety and removeance in the device.

3.0 Introduction:

Basically, the mention is a multipoint tool in which the cutting edges are distributed along the axis or inclined to axis (helical) or sometimes inclined about the axis of rotation. It finishes the operation in one or number of passes. The mentioning machine will have straight line ram movement to pull or push the mention while the component is held against the movement of the tool. Generally mentioning is done on pre machined component. Mentioning machine is unique as that it provides only one function that is cutting. So the machine can be build robust.

The main advantages of mentioning are:

1. The possibility of making external as well as internal intricate profiles in mass production without the need of skilled technician.
2. Roughing and finishing cuts are made in one pass only. Moreover, it can also incorporate burnishing surfaces to provide smooth surface finish
3. The accuracy and surface finish of the surfaces produced by mentioning are high (In general up to 5^{th} to 6^{th} Class)
4. Removes possible human error which leads curtailing of labour costs and rejects. As feed is predetermined it is independent of workers aptitude. Mentiones have long life in terms of component. Mentioning is a machining process used intensively for making internal and external
5. The chip flow in mentioning is unidirectional which Cost of manufacturing is less in mass production. The table 1 shows the comparative rate of production of holes between different processes and table 2 shows comparative cost of production between milling and mentioning
6. Reduces the clogging of chips and scoring of machined surface.
7. In process inspection is removed
8. The operation can be repeated any time without much los of setting time and dimensions are maintained to original component dimensions as the depend purely on tool.



Especially this is an advantage for odd shaped profile.

About the component

Type of material and the condition of the component for estimating

a. The volume of coefficient of the chip
b. Specific cutting resistance
c. Life of the mention

For abbressive chip the tool life will be shorter.

1. Operations carried prior to and after mentioning, so as to determine
a. The guiding path
b. Initial and final size of the mention
c. Burnishing teeth
2. Number of components to be manufactured so as to select the economical process
3. Kind of mentioning machine to select the holding portion, to determine maximum allowed length of mention and cutting load.
4. Surface finish required on the component so as to fix finishing and burning teeth.
5. Requirement of positional tolerance between the surfaces resulted by mentioning and other surfaces in the component so as to select the fixture if necessary or mentioning more than one surface in the same pass.
6. Possibility of getting the same profile in different lengths so as to design the mention for use in different components.
7. The expected accuracy of the component to fix the tolerance for the mention.
8. the wall thickness of the component, to estimate the shrinkage and for selecting mode of cutting.
9. Functional surface and its tolerance for selecting

4.0 Effect of tooth design on chatter:

Chatter in mentioning causes poor surfaces finish, excessive wear of teeth and loss of accuracy, sometimes causes breakage of mention also. Inherent interrupted cutting in mentioning operations increases this chatter. Circular mentiones are susceptible to chatter because of severe interrupted cutting. To reduce chatter the points to be considered in design are

1. Teeth can be staggered longitudinally to provide more uniform cutting for flat surface and spline mentiones.
2. For the round hole mentioning helical teeth instead of round teeth can be provided.
3. The pitch can be made less as for as possible so as the change in cutting load will be less.
4. Pitch can be varied for finishing teeth if required.

Points to be checked during designing mentions:

The point to be checked in view of the tool is the strength of the mention core cross-section which should withstand the cutting load for the specific component at the mis cross section.

Cutting load depends on the chip thickness, width of the chip, material to be

cut, maximum number of teeth in contact with the component in operation.

It is found out from the equation:

Pmax = Pz.n

Pz = a.b.Ks.k

Where Pz = cutting load acting on each tooth

n = number of tooth in action in operation

a = thickness of the chip

b = width of the chip

Ks is the specific cutting resistance depends on the material and chip thickness.

For a round mention the strength of the mention is found from the equation

Pb = 22/7 D2.ft

Where D= core diameter at the weakest point of mention

Ft =tensile strength of the mention material after hardening

Space of the tooth:

a. chip thickness or rise per tooth

b. space factor Kv

c. Height of gullet.

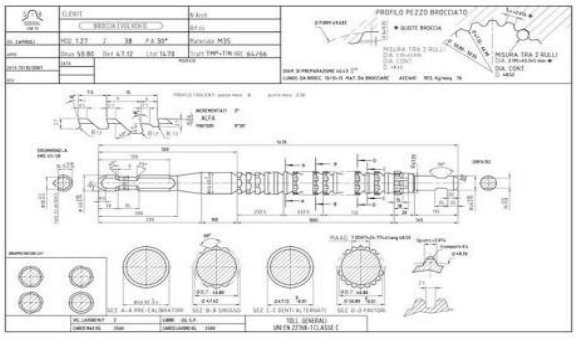
d. Expected life of the mention.

e. pitch and land.

f .max and min number of tooth working at a time.

g. tooth geometry

h. preparation of sketch for tooth.



5.0 FABRICATION OF A SQUARE MENTION CUTTING TOOL

The square mention cutting tool is mainly used to make square holes in the pre machined hole. It is mostly used to get a precise hole of our required width. The design of the square mention is fabricated by considering the basic design parameters .the selection of the material to fabricate a mention tool plays an important role. The hardness of the material is important criteria to be considered. The chemical properties have to be considered to know the toughness, strength of the materials.

Here we have considered a High Speed Steel (HSS) to fabricate a square mention. The strength of the HSS steel is high and the hardness is also high which makes the material; laligible to make the tool bit.

THE MATERIAL DESCRIPTION

Length of the raw material =100mm

Thickness of the raw material =8mm

Weight of the raw material = 9.77gm

THE CHEMICAL COMPOSITION OF THE MATERIAL

Carbon = 0.88%

Molebdynum = 5.44%

Scandium = 0.010%

Chromium = 3.99%

Manganese = 0.36%

Vanadium = 1.92%

Tungsten = 6.25%

These are chemical properties of the raw material which are found by the ASTM E 1019, ASTM E 1916 2011 TEST procedures.

Roughing teeth

Semi finishing teeth

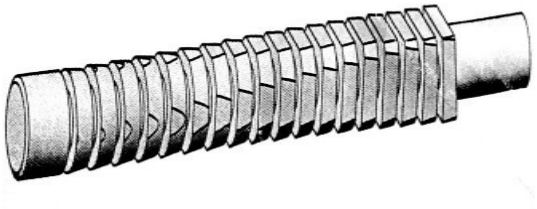
Finishing teeth

The front pilot

THE RADIUS OF CUT FOR EACH TOOTH

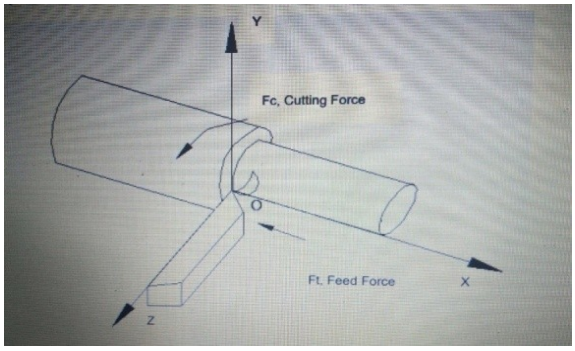
1. 2.39
2. 2.41
3. 2.43
4. 2.46
5. 2.49
6. 2.53
7. 2.57
8. 2.62
9. 2.67
10. 2.73
11. 2.79
12. 2.86
13. 2.93
14. 3.01
15. 3.09
16. 3.18
17. 3.27
18. 3.37

The final view of square mention



6.0 FORCE CALCULATIONS

The powers following up on the instrument are a critical part of machining. The information of power is required for assurance of energy and furthermore to outline the different components of machine apparatus, device holders and installations. The cutting powers change with the apparatus point and precise estimation of powers is valuable in advancing instrument plan. Dynamometers are equipped for measuring apparatus powers with expanding exactness. The piece of forces following up on the rake face of equipment, run of the mill to the forefront is called cutting force, i.e. at the line YO.



Coefficient of friction between chip-tool interface is given by $\mu = \tan \beta$

$$Fs = \frac{\tau t1b}{\sin\phi}$$

Cutting forces of a mention

No, of tooth cut simultaneously 'n'

$$n = \frac{L}{P}$$

Here L =100mm

P = 5.60

n = 17.85

= 18 tooth

Max force in the operation of grinding:

Fmax = a [mm^2] ×specific resistance × n

= (4.76 ×100)× 0.025 ×18

= 214.2 KN

Estimated load = width of cut (mm) × number of engaged cutting teeth × specific cutting resistance (KN/mm^2)

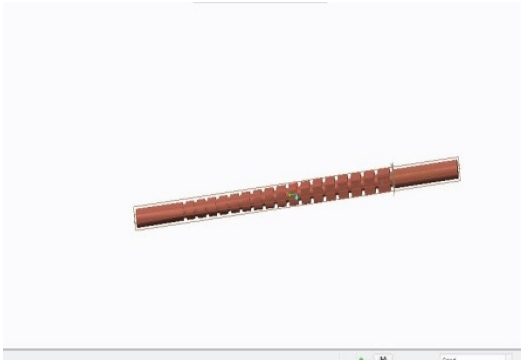
= 4.76×2.30×0.025

= 0.2737

Safety load (KN) = 0.2737 ×1.8

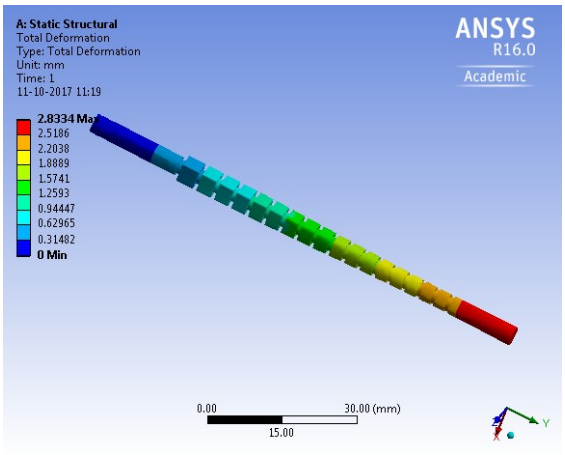
= 0.49266 KN

7.0 Modelling of mention in catia v5 Mechanistic Modelling

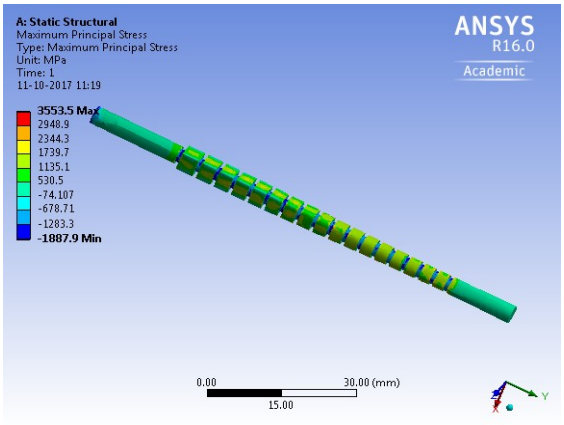


8.0 ANALYSIS OF THE BROACH TOOL USING ANYSYS

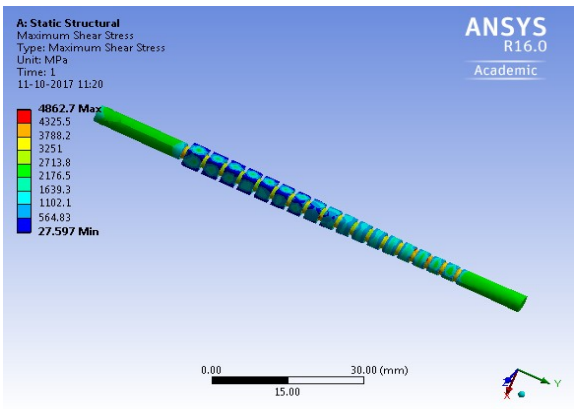
The total deformation in the broach tool is shown below



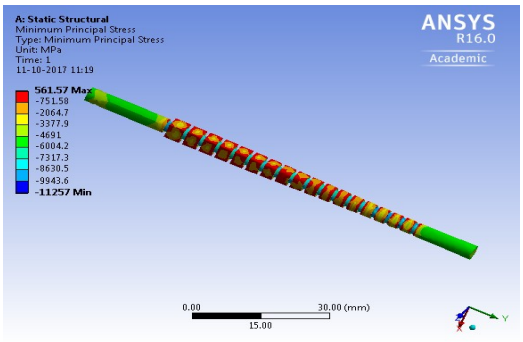
- The maximum principal stress of the broach tool



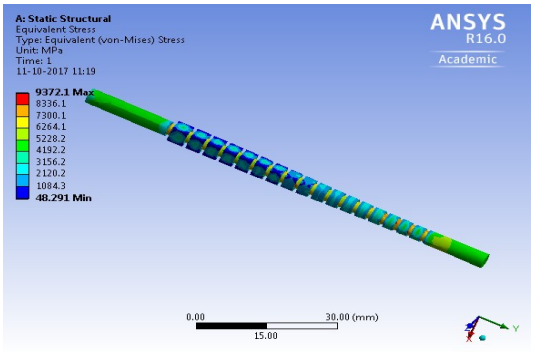
- The maximum shear stress of the broach tool



Minimum principal stress of the broach tool



The equivalent stress of the broach tool



9.0 CONCLUSION

By end of my research project I aimed to determine and fabricate a square mention for daily usage used for mentioning the square holes is successful. Fabricating and designing a broach making square holes from a round raw material of high speed steel material have been done by undergoing CNC grinding operation on a single piece rod. The mention obtained is a pudh type mention which does not need any special equipment to perform the process. It is kept on a work piece which is pre machined to obtain a small hole and is pressed under thrarborpress.

Thus the square hole of accurate whole diameter is obtained in only one pass. these square holes are mainly used in making of clocks ,car sensor holes, household mixers to hold the blades.

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