Computer Aided Modelling and Simulation of Single Point Cutting Tool using Different Tool Content

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Abstract:- *The single point cutting tool is used in machines like lathe, shaper and planer machine to remove the excess material from work surface. In order to get a good work finish it requires a good cutting tool which can essentially do the required task quickly, with ease and if having a longer tool life too will be an additional advantage. In order to gets an idea that which material will be the best we performed the finite elemental analysis using ANSYS explicit dynamic solver. For modeling of the work piece and tool assembly we used CATIA V5R12 software and the two different tool contents are used to analyze their effect on various depth of cut to analyze the deformation values. Here the tool materials used are HSS (High Speed Steel) and HCHC (High chromium high carbon steel) whereas the work material is taken as nickel.*

Key Words: FEA, ANSYS Explicit dynamics, CATIA, HSS, HCHC, Nickel.

1. INTRODUCTION

A shaper machine is considered a one-point cutting tool because the single cutting edge remains in contact with the tool throughout the operation, sometimes known as the leading edge of the tool.

A multipoint tool is one in which the actual cutting operation is performed with more than one cutting edge and therefore has a different cutter geometry, depending on the type of operation performed in the working material.

Although the structure of the shaper and the planer are similar, the only difference is that the former machine can do small jobs, while the later can handle the weight of work up to several tones

1.1Shaper Applications:

Its applications include machining flat surfaces in different planes.

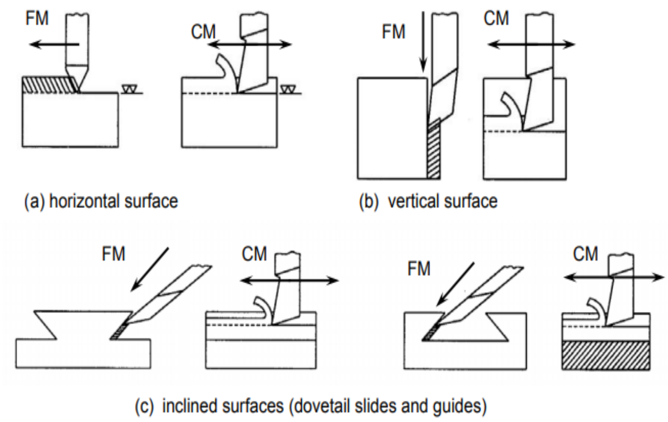

Figure 1 Machining of flat surfaces in shaping machines

The main applications are:

- Create features such as slots, steps, etc., which are also limited by flat surfaces.
- Form grooves delimited by curved surfaces of small width using a single tool but a molding tool.
- Cutting the keyway and outer splines, smooth or cut smoothly, cut off the bracket for repair, etc. with simple simple or molded tools. If necessary, unusual work can also be done by developing and using special attachments

2. INTRODUCTION TO EXPLICIT DYNAMICS

An explicit dynamic analysis is used to determine the dynamic response of a structure due to the propagation of the stress wave, the impact, or the rapid change of the time-dependent loads. The momentum exchange between moving bodies and inertial effects are usually important aspects of the type of analysis performed. This type of analysis can also be used to model mechanical phenomena that are highly nonlinear. Non-linearity can arise from materials (eg, hyper-elastic, plastic flows, defects), contacts (eg, high-speed collisions and impacts), and geometric deformations (eg, buckling and collapsing). Events with time scales less than 1 second (typically of the order of 1 millisecond) are efficiently simulated with this type of analysis. For longer duration events, consider using a transient analyzer.

3. Flow Chart of Analysis

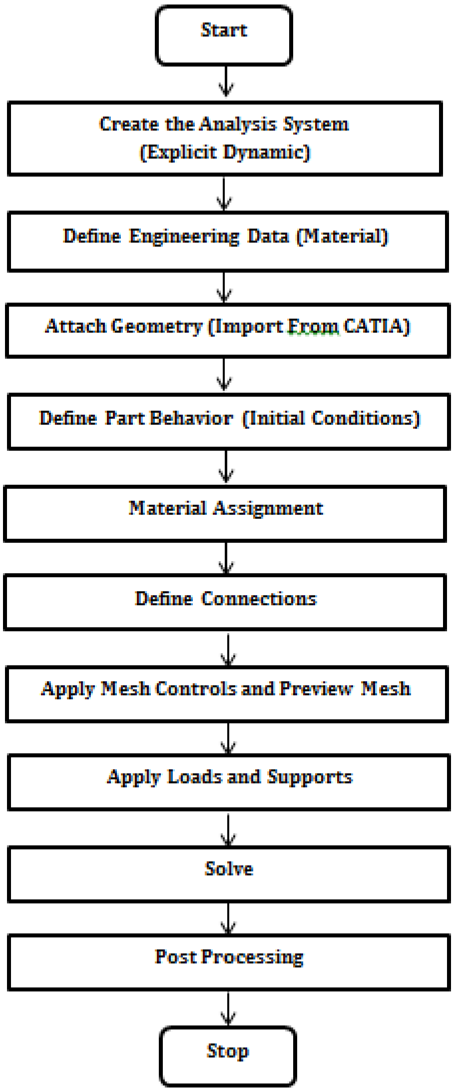

Figure 2: Flow Chart for Analysis

4. LITERATURE REVIEW

A lot of research is being carried out from the last decade in manufacturing field and the productivity is one of the main concerns and is always play an important role in a quality component. Tool design and its content is not only effect the cost of manufacturing but also affect the quality of surface produced and the material removing rates. Some of the key research is presented in this section to get an idea for the associated problems and their solution in a shaper tool.

P. P. Mane et al [1] intends to use the pneumatic forming machine for the high production of automatic gear cutting with automatic sub-assembly. Rui Liua et al [2] carried out an experimental investigation of the lateral flow with different cutting conditions by comparing the profiles of the cross section of the machined chip in the machining of aluminum alloys. C.J.Rao et al [3] it proposes an alternative approach to determine the optimal process parameters used to predict cutting forces, tool life and surface finish. In this work aluminum is used as working material and tungsten carbide as tool material. Roman Wdowik et al [4] It focuses on the function and application of process parameters in the planning of technological processes (TPP) and the technological documentation (TD). M.Yu. Kulikov et al. [5] have described an improved combined finishing process. M.Sadilek et al [6] He has studied the problems to increase the efficiency of the turning cycles. Describes and suggests the possibility of using effective strategies and their applications in the programming of CNC turning centers. Daniel Johansson et al [7] has studied the accuracy of using the equivalent Woxén chip thickness to illustrate the feed, depth of cut, radius of the tip, and the larger angle of intersection when modeling tool life for low alloy steel machining while rotating in the longitudinal direction.

5. MODELING AND SIMULATION

The modeling and simulation of single point cutting tool using CATIA and ANSYS simulation software is being discussed. The model is made using CATIA V5R12 software and the analysis is done using ANSYS Explicit environment. The analysis is carried out taking two different tool materials namely High speed Steel (HSS) and high carbon high chromium steel (HCHC) the cutting velocity of tool is kept as 14 m/s^2.

Table 1 Material properties for HCHC as tool Material

HCHC Tool	Properties
Density	7700 kg/m^3
Elasticity	210000 Mpa
Position ratio	0.3

Table 2 Material properties for HSS as tool Material

HSS Tool	Properties
Density	8160 kg/m^3
Elasticity	210000 Mpa
Position ratio	0.3

Table 3 Material properties for Nickel as work material

HSS Tool	Properties
Density	8900 kg/m^3
Elasticity	210000 Mpa
Position ratio	0.305

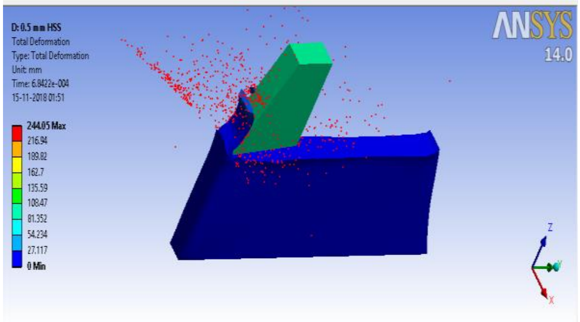

Figure 3 Deformation in mm for 0.5 mm Depth of cut for HSS as tool material

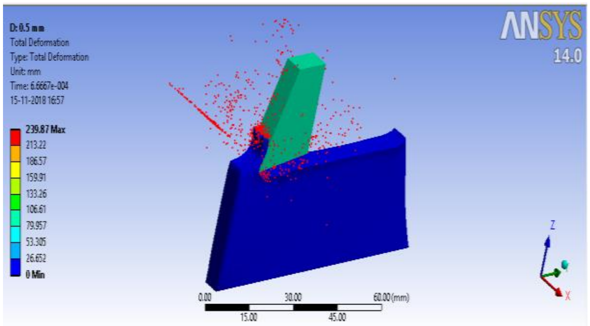

Figure 4 Deformation in mm for 0.5 mm Depth of cut for HCHC as tool material

6. RESULTS AND DISCUSSION

After the analysis a comparative graph is plotted between the stress and deformation values at different time increments for HSS and HCHC as tool content and it is seen that for same work material i.e., nickel and with same depth of cut the both materials behaves almost same but as the tool progresses the HCHC material experiences lesser stress as compared to the HSS material and so, for same operating conditions HCHC tool content can be preferred as tool material instead of using HSS.

The following figure replicates the stress vs. deformation curve for a tool with depth of cut of 0.5 mm on nickel work material.

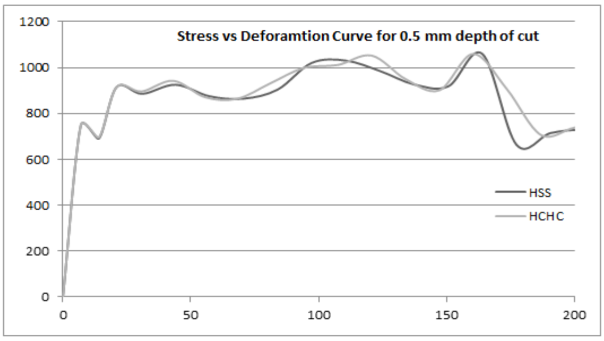

Figure 5 Stresses vs. Deformation Curves for HSS and HCHC material for 0.5 mm Depth of Cut

7. CONCLUSION AND FUTURE SCOPE

7.1 CONCLUSIONS:

1. The value of maximum stress is of the range of 1000 to 1200 MPa for a speed of 140 m/s in both HSS and HCHC tools.
2. The value of maximum deformation is in the range of 200 to 250 mm for feed length of 100 mm of the work material.

7.2 FUTURE SCOPE

1. The same analysis can be carried out using different depth of cut see the variation on tool life due to variable depth.
2. The same analysis can be carried out using different cutting speeds also to see the variation on tool life due to speed.
3. The work piece material can also be changed and the stress deformation pattern can be observed for that too.
4. Instead of linear to and fro movement some analysis can also be performed taking the cylindrical work part like in lathe machine.

REFERENCES

1. Mane, P. P., Burande, S. H., Thikane, S., Mane, P. P., Burande, S. H., & Thikane, S. Experimental Analysis of Hydraulic Shaper Machine. International Journal, 2, 497-500.
2. Liu, R., Eaton, E., Yu, M., & Kuang, J. (2017). An investigation of side flow during chip formation in orthogonal cutting. Procedia Manufacturing, 10, 568-577.
3. Rao, C. J., Sreeamulu, D., & Mathew, A. T. (2014). Analysis of tool life during turning operation by determining optimal process parameters. Procedia Engineering, 97, 241-250.
4. Wdowik, R., Magdziak, M., Ratnayake, R. C., & Borsellino, C. (2018). Application of process parameters in planning and technological documentation: CNC machine tools and CMMs programming perspective. Procedia CIRP, 78, 43-48.
5. Kulikov, M. Y., Inozemtsev, V. E., & Bocharov, A. A. (2016). Complex Quality Assurance Methods for Surface Machining. Procedia Engineering, 150, 953-958.
6. Sadilek, M., Dubský, J., Sadílková, Z., & Poruba, Z. (2016). Cutting forces during turning with variable depth of cut. Perspectives in Science, 7, 357-363.
7. Johansson, D., Lindvall, R., Fröström, M., Bushlya, V., & Ståhl, J. E. (2018). Equivalent Chip Thickness and its Influence on Tool Life. Procedia Manufacturing, 25, 344-350.