Turkish Journal of Computer and Mathematics Education *Do not touch during review process(xxxx)*
Research Article

MODELLING AND ANALYSIS OF SINGLE POINT CUTTING TOOL USING FEM METHOD

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Abstract:
The finite element method is used to study the effect of different rake angles on the force exerted on the tool during cutting. Researchers use this method to better understand the mechanisms of chip formation, the generation of heat in cutting zones, as well as the characteristics of tool-chip interfacial friction on machined surfaces. This study investigates the variation in values of Vonmisses stress for three different rake angles for specified applied forces. The value of Vonmisses stress decreases as rake angle is increased. In present study, mesh is created in ANSYS and the boundary conditions are applied and the analysis is carried out for the applied constraints. The results calculated on software can be verified

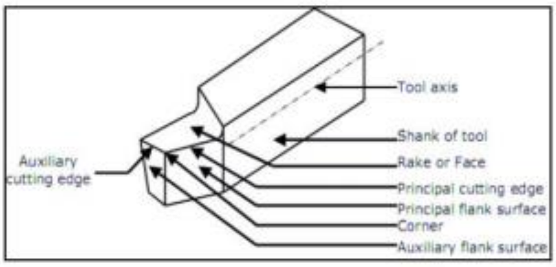
Keywords: Rake angles, Vonmisses stress, ANSYS, boundary conditions.

1. Introduction

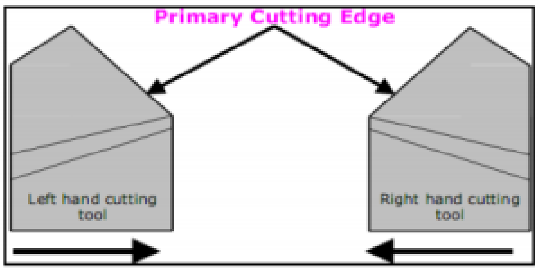
Turning operation is one of the most effective machining processes for the manufacturing of metal and non-metal components used in different industries. Turning is a conventional machining process in which a cutting tool is fed into a rotating work piece to produce an external or internal surface that is concentric with the axis of rotation. A lathe is one of the most versatile conventional machines. A turning tool is generally held in place by a translating carriage, turret, or tailstock. The carriage or turret travels on the bed ways parallel to the part axis (Z-axis), while the mount of a cross slide or the X-axis provides motion perpendicular to the part axis. Using a chuck, collect, faceplate, or mandrel to mount the work piece, or between pointed conical centers, the work piece rotates around a rotating spindle.

Chucking the Work Piece: Work pieces up to six inches can be safely turned in the three-jaw chuck without support. Work pieces longer than six inches would need to be faced and center drilled and supported by a dead or live centre in the tailstock, Without such support, If the tool is too forceful on the work piece, it will bend away from the tool, resulting in a strange shape.

Tool Geometry: The geometry of a cutting tool consists of the following elements: face or rake surface, flank, cutting edges and the corner. For cutting tools, geometry depends mainly on the properties of the tool material and the work material. A single point cutting tool may be either right or left hand cut tool depending on the direction of feed.The standard terminology is shown in the following figure. Angles such as rake, relief, and end are important when designing single point tools.



(a)



(b)

Figure.1: (a) Shows elements of single point cutting tool (b) Left hand right hand cutting tool

2. Literature Review:

A review of past research efforts related to single-point cutting tools and finite element analysis is presented in this chapter. There is also a review of other relevant research studies.
Rogério Fernandes Brito, Solidônio Rodrigues de Carvalho, Sandro Metrevelle Marcondes de Lima e Silva, João Roberto Ferreira [1] investigate the heat effects on cutting tools considering coating thickness and heat flux. Diamond tools, K10 substrates, and TiN and Al_2O_3 coatings were used. Numerical methods are implemented using ANSYS CFX software. Numerical analysis involves solids with known boundary conditions and constant thermophysical properties. An experiment is used to validate the proposed methodology.

L.B.Abhang and M. Hameedullah [2] analyzed experimental data for the development of first and second order mathematical models in terms of machining parameters using response surface methodology. Using a tool-work thermocouple technique, EN-31 steel alloy with tungsten carbide inserts were turned. Analyses of the results are conducted statistically and graphically. For metal cutting, speeds, feed rates, depths of cut, and tool nose radius are relevant.

Maheshwari N Patil, Shreepad Sarange [3] described how tool forces and temperatures can be calculated for use in numerical modeling of metal cutting processes. In the experiment, it is clearly observed that with increasing depth of cut, temperature at the tool tip also increases. Furthermore, as tool forces increase with depth of cut, also increases the depth of cut. Failure of tools is primarily caused by this issue. Additionally, we observe that the tool vibrates approximately 2.5 mm into the cut depth. Heat is dissipated more at this condition, resulting in blunted tools. A set-up is created for force measurement during cutting on a dynamometer and analysis of the tool's response.

According to Sambhav et al. [4], the generic definition of a drill that is used in grinding parameters was directly represented using CAD as opposed to NURBS. Nonetheless, a mathematical model that entails a generalized SPCT to facilitate grinding needs to be developed, as described in this paper.

3.Materials and Methods:

High-speed tool steels: Tool steels with high cutting speeds are so named for their ability to machine materials quickly. Carbon, vanadium, chromium, molybdenum, and tungsten, or combinations thereof, are provided by these iron-based alloys, sometimes with substantial amounts of cobalt, as well.

Alumina or aluminium oxide (Al_2O_3): Carbon, vanadium, chromium, molybdenum, and tungsten, or combinations thereof, are contained in iron-based alloys, often accompanied by significant amounts of cobalt. There are many different types of ceramic materials available with varying properties, all of which can be customized with a targeted matrix design. There are both coarse and fine-grained varieties.

Examples of advanced ceramics made from aluminium oxide are used for hard forming tools, substrates, and resistor cores in the electronics industry, protective tiles, thread guides, and seal and regulator discs in water taps., heat-sinks for lighting systems, protection tubes in thermal processes or catalyst carriers for the chemicals industry.

Properties of Alumina/Aluminium Oxide (Al_2O_3)

- Very good electrical insulation ($1x10^{14}$ to $1x10^{15}$ Ω-cm)
- Moderate to extremely high mechanical strength (300 to 630 MPa)
- Very high compressive strength (2,000 to 4,000 MPa)
- High hardness (15 to 19 GPA)
- Moderate thermal conductivity (20 to 30 W/m-K)
- High corrosion and wear resistance
- Good gliding properties
- Low density (3.75 to 3.95 g/cm3)
- Operating temperature without mechanical load 1,000 to 1,500°C.
- Bioinert and food compatible.

Brass is an alloy of copper and zinc that is hard and workable and has a long history.

4. Modelling And Analysis

Computer-aided design (CAD) is using pc structures (or workstations) to resource within the advent, modification, evaluation, or optimization of a format. CAD software improves fashion designer productivity, improves the format, facilitates communication and creation of manufacturing databases. CAD output is regularly within the shape of electronic documents for print, machining, or different manufacturing operations. The time period CADD (for Computer Aided Design and Drafting) is also used. Its use in designing virtual systems is called digital design automation, or EDA. Mechanical format automation (MDA) or computer-aided drafting (CAD), which refers to the process of creating technical drawings with the assistance of computer programs, is what we call in mechanical design. CAD software program for mechanical design uses both vector-primarily based completely snap shots to depict the gadgets of traditional drafting, or can also moreover produce raster photos showing the general look of designed gadgets.

Introduction to CREO

PTC CREO, Formerly known as Pro/ENGINEER, it is a three-dimensional modeling software for mechanical engineering, design, manufacturing, and CAD drafting. CAD programs that use parametric rule-based devices to capture the behavior of products. These programs use parameters, dimensions and capabilities. The call changed into changed in 2010 from Pro/ENGINEER Wildfire to CREO. It changed into introduced by way of the use of the enterprise who advanced it, Parametric Technology Company (PTC), at some stageinside the release of its suite of layout products that includes programs which consist of assembly modeling, 2D orthographic views for technical drawing, finite detail evaluation and additional. CREO says it may offer a greater efficient layout experience than different modeling software because of its unique competencies which includes the integration of parametric and direct modeling in a single platform. The complete suite of applications spans the spectrum of product improvement, giving designers alternatives to use in every step of the system. The software program additionally has a greater customer excellent interface that provides a higher revel in for designers. It additionally has collaborative capacities that make it clean to share designs and make modifications. There are countless benefits to the use of PTC CREO. We'll test them on this -element series.

First up, the maximum critical gain is expanded productiveness because of its green and flexible design capabilities. It ends up designed to be easier to use and have capabilities that allow for format methods to move briefer, creating a fashion designer's productivity degree increase.

A particular characteristic is that the software program is available in 10 languages. PTC knows they have got human beings from all around the worldwide using their software, in order that they provide it in a couple of languages so almost sincerely everybody who desires to use it can achieve this

Introduction to Ansys

Structural Analysis: ANSYS Autodyne is pc simulation device for simulating the response of materials to brief period immoderate loadings from impact, high strain or explosions. ANSYS Mechanical ANSYS Mechanical is a finite element analysis device for structural assessment, together with linear, nonlinear and dynamic research. This pc simulation product gives finite elements to version conduct, and helps cloth models and equation solvers for an extensive variety of mechanical design issues. ANSYS Mechanical also consists of thermal assessment and matched-physics abilities regarding acoustics, piezoelectric, thermal–structural and thermo-electric assessment.

Fluid Dynamics: ANSYS Fluent, CFD, CFX, FENSAP-ICE and associated software program software are Computational Fluid Dynamics software program equipment used by engineers for layout and assessment. This equipment can simulate fluid flows in a digital environment — as an instance, the fluid dynamics of ship hulls; gas turbine engines (which consist of the compressors, combustion chamber, mills and afterburners); aircraft aerodynamics; pumps, enthusiasts, HVAC structures, blending vessels, hydro cyclones, vacuum cleaners, and so forth.

STATIC AND THERMAL ANALYSIS

Save Creo Model as. Ages format

→Ansys → Workbench→ Select evaluation device → static structural → double click on →Select geometry → proper click on → import geometry → pick out browse →open element → good enough

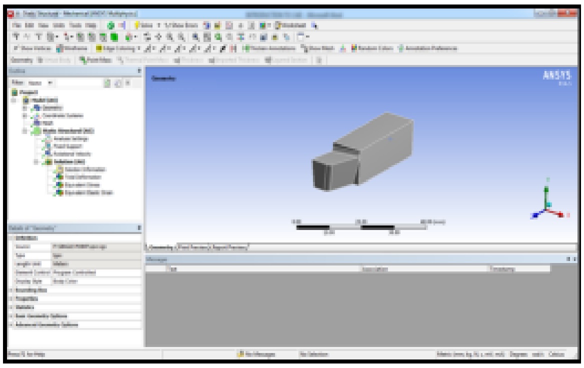


Figure.2: Shows 3D Model

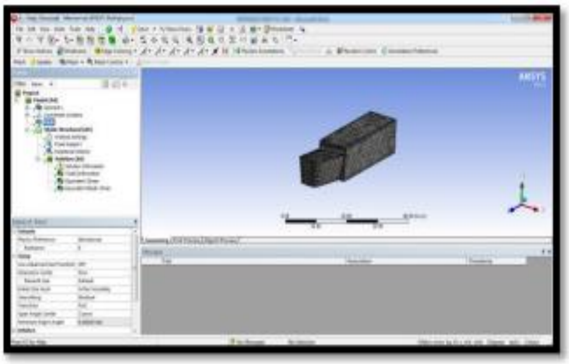


Figure.3: Shows Meshing Model

Select mesh on work bench → proper click on →edit →Double click on geometry → choose MSBR → edit cloth →Select mesh on left side part tree → right click → generate mesh

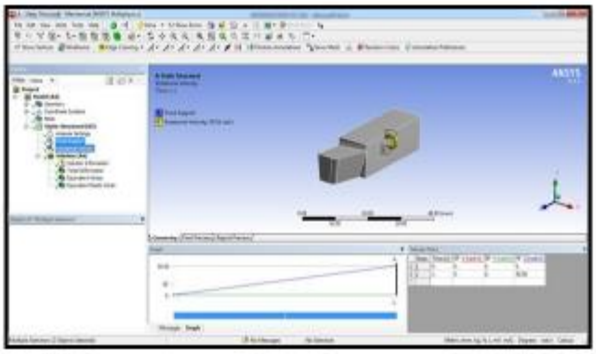


Figure.4: Shows 3D Model

Select static structural right click on → insert → pick rotational velocity and stuck assist → Select displacement → select required area → click on practice → positioned X, Y, Z factor 0 → Select force → pick required place → click on follow → enter rotational speed
Select solution proper click on → remedy → Solution right clicks on → insert → deformation → general → Solution proper click on → insert → strain → equivalent (von-mises) → Solution proper click → insert → stress → equivalent (von-mises) → Right click on deformation → examine all result

Material HSS

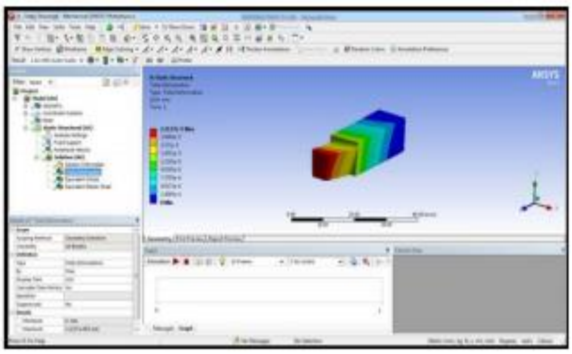


Figure.5: Total Deformation

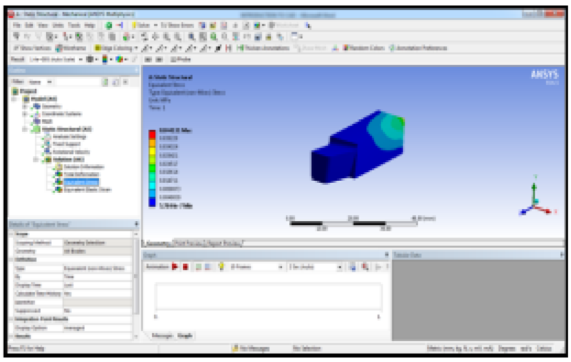


Figure.6: Equivalent stress

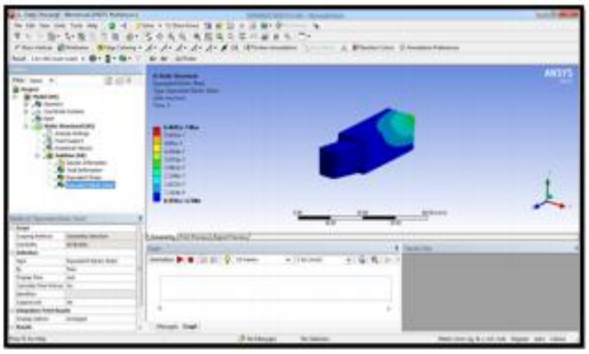


Figure.7: Equivalent strain

HSS WITH COATED AL2O3

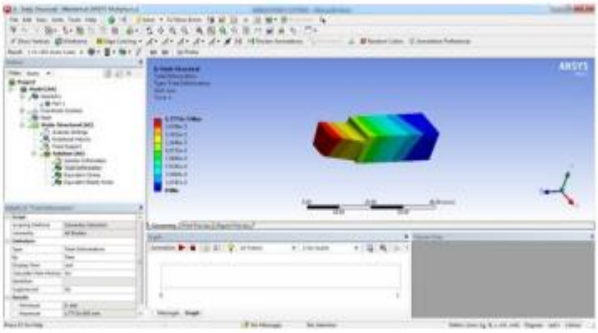


Figure.8: Total Deformation

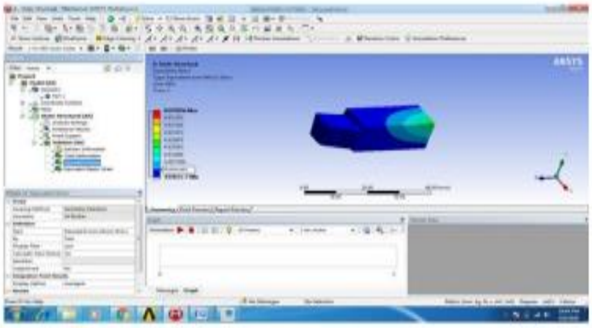


Figure.9: Equivalent stress

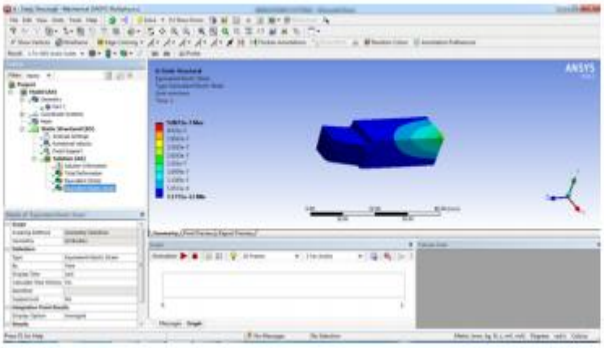


Figure.10: Equivalent strian

HSS WITH COATED BRASS

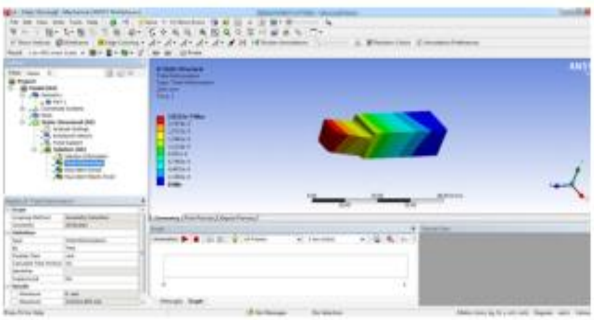


Figure.11: Total Deformation

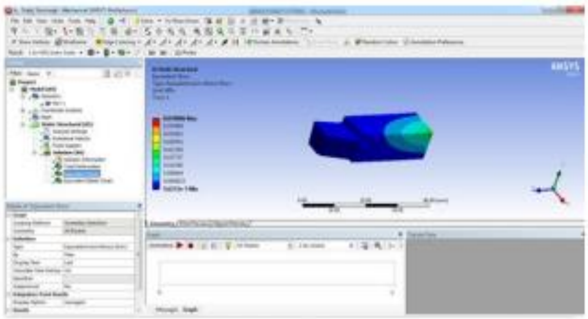


Figure.12: Equivalent stress

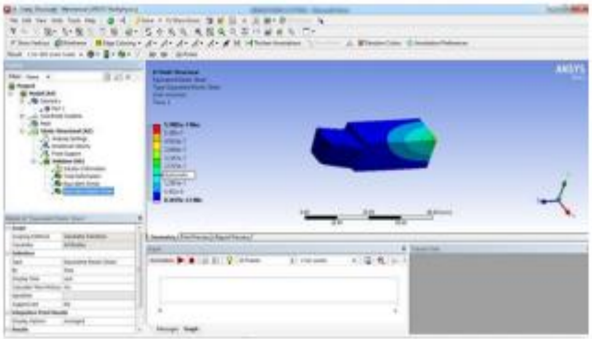


Figure.11: Equivalent strain

Thermal Analysis

HSS

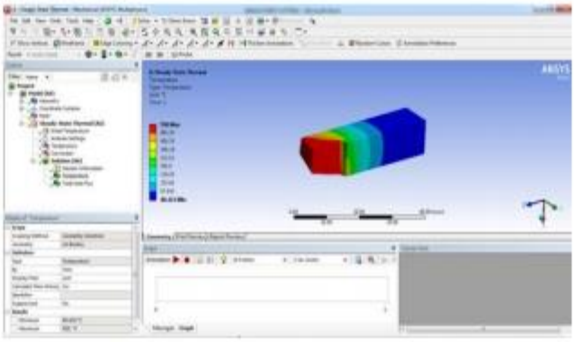


Figure.12: Temperature Distribution

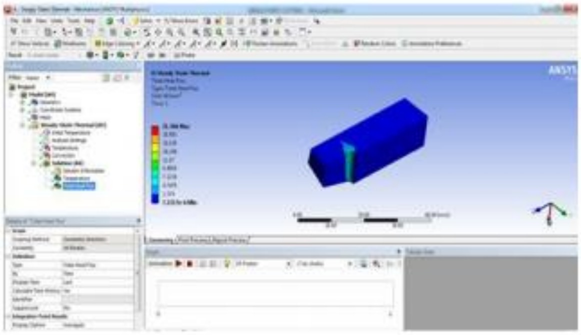


Figure.13: Flux

Material-HSS With Coated Al_2O_3

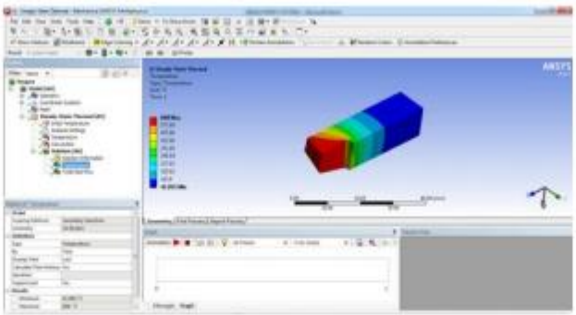


Figure.14: Temperature Distribution

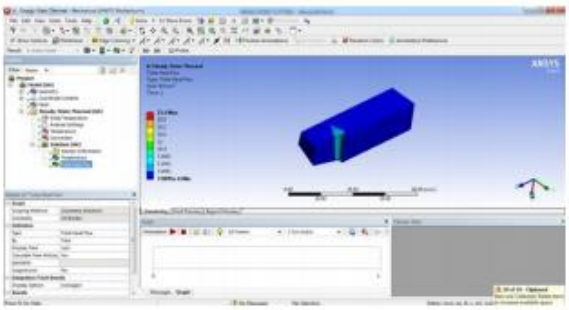


Figure.15: Flux

Material-HSS With Coated Brass

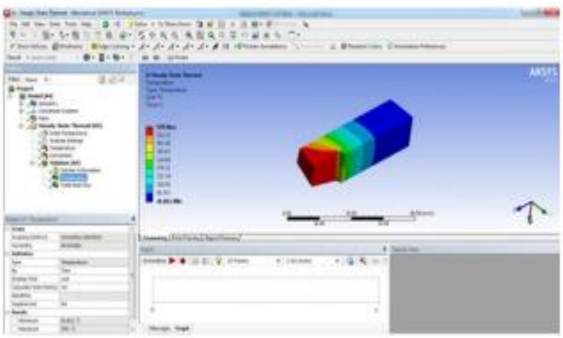


Figure.16: Temperature Distribution

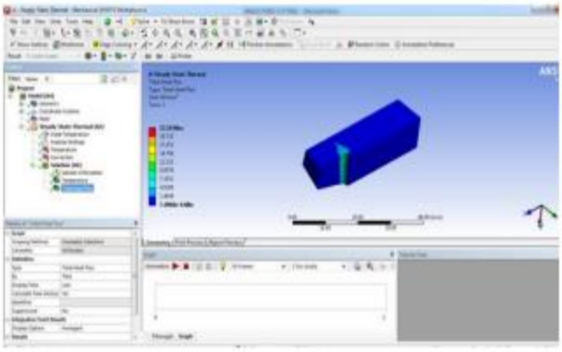


Figure.17: Flux

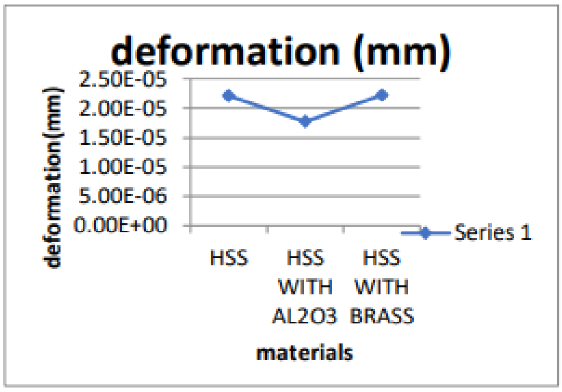
Results And Discussion

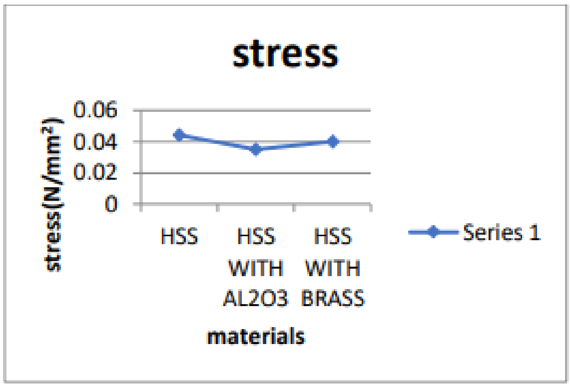
Static Analysis

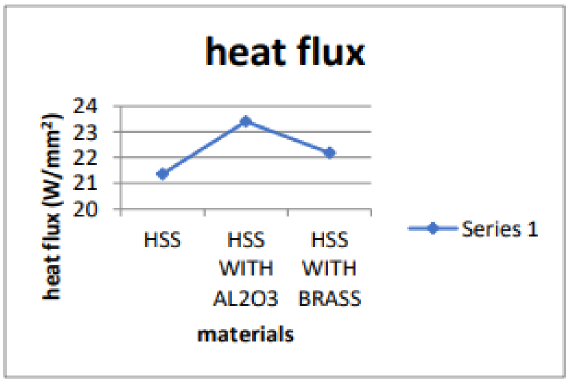
Type of material	Deformation(mm)	Equivalent stress	Equivalent strain
HSS	2.212e-5	0.04413 1	6.4e-9
HSS with Al2O3	1.77e-5	0.03505 6	5.0872e -7
HSS with Brass	2.221e-5	0.03988 6	5.7881e -7

Thermal Analysis

Type of material	Temperature		Heat flux
	Min	Max	
HSS	40.423	550	21.366
HSS with Al2O3	41.892	550	23.4
HSS with Brass	41.011	550	22.18







CONCLUSION:

In this experiment, a coating and uncoated tool bits are studied to determine the variation in Vonmisses stress values. As we increase the rake angle , the value of Vonmisses stress decreases. The mesh that is created in Ansys is applied to the boundary conditions and the analysis is performed on the applied constraints.The results calculated on software can be verified By observing the static analysis results, the stress value less at coated tool (HSS with Al2O3) when we compared to other coated and UN coated materials (HSS with brass). By observing the thermal analysis results, the heat flux value more at coated tool (HSS with Al2O3) when we compared to other coated and UN coated materials (HSS with brass). So, it can be concluded that HSS with Al2O3 coated material suitable for single point cutting tool.

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