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Structural and Thermal Analysis of AXMT 0903 Milling Insert using Finite Element Analysis

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ABSTRACT

The focus of this paper is to investigate the result of cutting tool insert, the insert contains tungsten carbide and the cutting forces are involved along the implement insert throughout machining. After an exhaustive analysis with experimentation, the cutting parameters such as the victual and withal depth of cut for that utmost stress and then deformation are customarily apperceived. To procure that, AA6082T6 is machined at the dry condition with different cutting forces upon a knee milling machines utilizing single insert. The end milling insert (AXMT0903) has been employed in the milling and the cutting forces acting on an implement insert are quantified around the Kistler dynamometer. The insert can be designed and additionally analysed through CATIAV5 software and ANSYS11 software. The results procured with the assistance upon ANSYS software for stresses are assessed to analytical values upon stresses. Conclusively, the most efficacious cutting parameters such as the victual and depth of cut are known.

Key words: End milling insert, Tungsten carbide, Catia, Ansys, Stress.

1. INTRODUCTION

Milling machines are the most multifarious and subsidiary machine implements due to their capabilities to perform a variety of operations. Milling is the process of machining flat, curved, or aberrant surfaces by victualing the work piece against a rotating containing a number of cutting edges. The milling machine consists fundamentally of a motor driven spindle, which mounts a and revolves the milling cutters, and a reciprocating adjustable work piece. Most milling machines have self-contained electric drive motors, coolant systems, variable spindle haste, power-operated and table aliments. These machines are withal relegated as knee-type, ram-type, manufacturing or bed-type and planar-type. It is utilized for general purport-milling operations. Column and knee type of milling machines are the most mundane milling machines. The spindle to which the milling cutter is may be horizontal (slab milling) or vertical (face milling and culminate milling). Chaintanya and Kaladhar [1] developed an indiscriminate model of Special Shaped milling cutter composed of high speed steel material for the purport of presaging stress and deformation. Gummadi and Tippa [2] proposed a design aspects of plain milling cutter is analysed. He concluded that the stress and deformation of a cutter are decrementing with increase in speed i.e. they are inversely proportional to each other. Virginija and Ostasevicius [3] investigate an experimental and numerical study of the terminus-milling process. The aim of the study is to define the force acting on a single cutting implement insert. It was accomplished by transforming cutting force signals from coordinate system of Kistler dynamometer into milling implement coordinate system. Atan et al [4] proposed a methodology for simulating the cutting process in flat end milling operation and presaging the chip flow, cutting forces, implement stresses and temperatures utilizing Finite Element Analysis (FEA). These temperatures increase at the primary cutting edge. He concluded that the highest implement temperatures were prognosticated at the primary cutting edge of the flat end mill insert regardless of cutting cutting edge. Sai et al [5] presented a numerical analysis to prognosticate temperature distribution in a 3D model describing at a ball end milling operation. The effects of different cutting conditions as cutting celerity, aliment rate and implement rotation angle are studied. The FEM model results show that temperature increases when incrementing of cutting parameters.

Balasubramanyam et al [6] stuided abot the model the go kart chassis in solid works and perform the impact analysis of the motor conveyance chassis in Ansys. They are conclude that this design is gratifying all the safety conditions as well as ergonomically designed. Mohan et al [7] analysed the mechanical (coupled filed) analysis on cylinder liner of 4-stroke diesel motor of Trucks Major R350 / 365 performed. The result shows thickness of liner is 6mm, the strain vitality is 0.598 N/mm2. Kancheti et al [8] studied the taking three material properties where as Aluminium, Cast iron, Structural steel. The total deformation values of aluminium, cast iron and structural steel as 0.0090835, 0.0060103 and 0.0033044 respectively. They conclude that structural steel got high load compare to other two materials. Reddy et al [9] studied the FEA investigation to compare the Tungsten carbide and D2 metallic drill bit. The result shows D2 steel equipollent stress is 532.32N compare to tungsten carbide.

Kadirgama and Bakar [10] presented a finite element analysis to study the stress distribution of nickel predicated super alloy haste alloy C-2000 in end milling operation. Commercial finite element software was habituated to develop modeling and analysis the distribution of stress components on the machined surface after end milling of haste alloy C-22 hrs utilizing coated carbide implements. It was found that the stress has lower values under the cut surface and incremented gradually near the cutting edge.

Samhan et al [11] presented the factors that influence the thermal stresses developed in adhesive bonded carbide tip face milling cutters utilizing numerical analysis. He concluded that the thermal stresses developed in bonds carbide tip face milling cutter decrease tremendously with applying cutting coolant. Li et al [12] presented the distribution of force density function and stress state on the rake face of H-slot blade. Dmitry et.al [13] developed a 3-D model of a cessation mill and work piece in the software package Solid Works. A virtual finite - element model of end milling is presented. The calculation of temperature fields in the cutting implement and the work piece under dynamic loading with utilization of an ecumenical program system ANSYS. Tugrul [14] developed a finite element model of meso/micro end milling process with presages of forces, stresses and temperature distributions in the presence of implement edge ploughing are presented.

Bharath et al [15] studied the automotive front bumper analysis. The result designates honeycomb structure can minimize the bumper distortion forces and impact force. Devi [16] studied work deals with the thermal performance of variable density multilayer insulation with different configurations and spacers. Report that an internal temperature of the VDMLI is maxed heat transfer rate and no.of shields increases in each segment and cryogenic insulation concepts. Balasubramanyam et al [17] studied the design and vigor comparison of a model chassis frame implemented with dynamic braking composed of different composite materials utilizing ANSYS 17.2.

The other authors are discussed about the milling process and proved the milling is best opportune to work in most of the metals and give better performance [18-21]. The above literature survey, we are understood the stress and thermal analysis is felicitous for End milling Insert, we are applying the stress distribution of AA6068T6 Aluminium alloy utilizing ANSYS 11. Patil [22] studied the static analysis of front axle optimization. Chatterjee [23] studied the cooling helmet using CFD analysis.

2. EXPERIMENTAL SETUP

The Experimental conducted on Knee type milling machine (UF-1, 1200 x 900 Bed size) with maximum spindle haste of 2000 rpm. Fig.1 shows the experimental set up cutting test conditions on end milling for machining of AA6082T6 with Tungsten Carbide inserts in single side. The cutting forces are quantified (Fx, Fy and Fz) with avail of Kistler Dynamometer.

A. Experimental Design

The design of the experiments has an effect on the number of experiments required. Consequently, it is paramount to have a well-designed experiment to minimize the number of experiments which often are carried out desultorily. The cutting force values obtained utilizing Tungsten carbide insert are presented in Table 1.

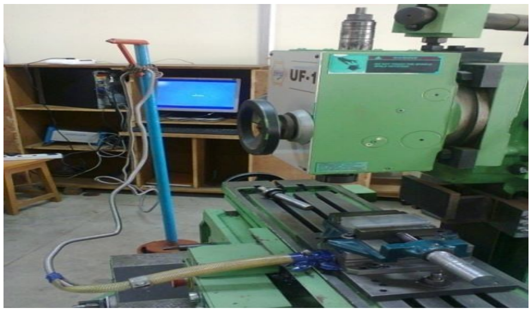

Fig. 1 Knee type milling machine

Table 1 Cutting Force

S.No	Cutting speed (m/min)	Feed (mm/min)	Depth (mm)	Cutting Forces (N)		
				F_x (N)	F_y (N)	F_z (N)
1	1000	40	0.5	1.13	10.16	19.42
2	1000	40	0.75	12.83	19.82	22.69
3	1000	40	1	22.65	23.29	24.05
4	1000	63	0.5	1.95	12.14	22.33
5	1000	63	0.75	22.91	23.69	25.27
6	1000	63	1	22.88	29.68	29.97
7	1000	100	0.5	1.19	13.97	16.82
8	1000	100	0.75	15.44	27.88	23.54
9	1000	100	1	18.5	32.03	25.06

B Tool (inserts)

Grade: AXMT 0903 PER-EML; Insert material: Tungsten carbide; working condition: light to medium milling. For insert geometry refer to Table 2 and Fig.2.

Table 2 Insert Geometry Values

d mm	d_1 mm	a mm	t mm	R mm
9.5	6.198	1.245	6.608	0.508

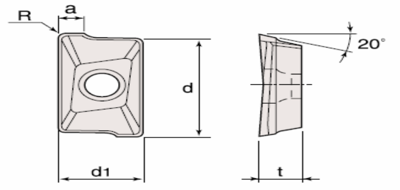

Fig. 2 Insert Shape and geometry

3. MATERIAL PROPERTIES FOR TUNGSTEN CARBIDE

Young modulus = 627Gpa

Poisson ratio = 0.238

4. ANALYSIS OF MILLING INSERT USING ANSYS

The Cutting Forces on the insert for different feed and depth of cut speeds are calculated and the same are applied on the tip of the insert modal. The variation in stresses and deformation on insert from ANSYS are Shown in following Figure. The results are tabulated in table 3. For F_z = 19.42N. The following image represents FEA based stress and strain variations.

Table.3 Results Obtained

S. No	Deformation (mm)	Stress (N/mm^2) (ANSYS Results)	Deflection (mm)	Stress (N/mm^2) (Theoretical Results)
1	2.4208E-7	1.3669 E7	2.6E-7	1.53 E7
2	2.8284 E-7	1.5971 E7	3.1 E-7	1.96 E7
3	2.9967 E-7	1.6921 E7	3.3 E-7	2.07 E7
4	2.7836 E-7	1.5717 E7	3.00 E-7	1.93 E7
5	3.1501 E-7	1.7786 E7	3.4 E-7	2.18 E7
6	3.6847 E-7	2.0602 E7	4.00 E-7	2.53 E7
7	2.0967 E-7	1.1839 E7	2.3 E-7	1.4 E7
8	2.9344 E-7	1.6569 E7	3.2 E-7	2.03 E7
9	3.123E-7	1.7639E7	3.4E-7	2.16E7

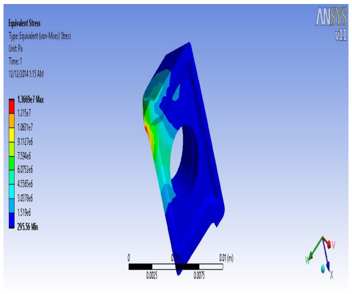

Fig. 3 Result of Stress

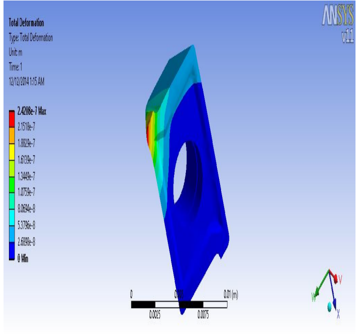

Fig. 4 Result of Deformation

7. RESULT AND DISCUSSION

The model of the milling insert is designed in CATIA and analysis is carried out using ANSYS. The results obtained are tabulated in the result table 3. The input parameters taken for the analysis and load are varied. The outputs values for stress and deformation obtained at different loads are tabulated in table no 3.

By analysis the developed model, it has been also observed at the feed (40mm) the stress level decreases at the first portion than that of second portion. An increase the feed the stress level gradually increases at the middle portion. After that the increase the feed decreases the stress as same as feed against deformation shown in Fig 3 and 4.

The feed Vs stress, Feed Vs deformation as shown in Fig 5 and 6. Fig 7 shows increase the depth of cut increases the stress. Fig 8 shows depth of cut increased stress decreased.

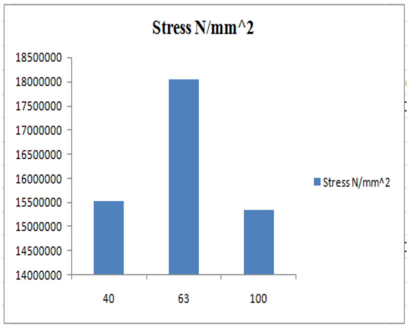

Fig.5 Feed vs. Stress

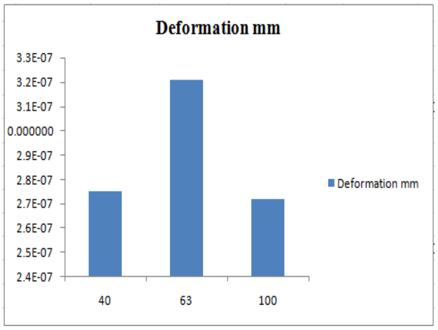

Fig. 6 Feed vs. Deformation

Graph represents variation in deformation with respect to variation in feed for Figure 8. Graph represents the variation in stress with respect to variation in depth of cut for Figure 9

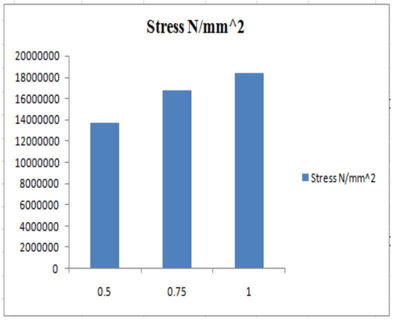

Fig. 7 Depth of cut vs. Stress

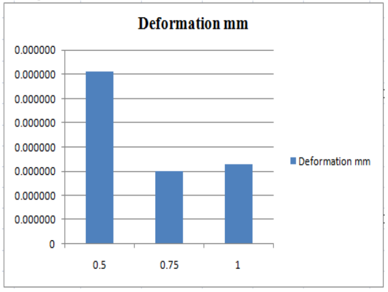

Fig. 8 Depth of cut vs. Deformation

CONCLUSIONS

This work illustrates an advanced modeling paradigm that can be acclimated to accurately model a special shaped milling insert. And thus, opens up paths to define conveniently sundry customized inserts. Here, different design activities, such as geometric modeling, finite element analysis and design ameliorations have been integrated. As is conspicuous, the approach illustrated in this paper is flexible and facile to utilize. This approach can additionally be habituated to design any intricate mechanical component, concretely for the insert design, it engendered the cutting variables that yield the minimum cost of manufacturing. The different design activities, such as design solid modeling, and finite element analysis, have been integrated. It was optically canvassed from the results, both stresses and deformation values were less for 1000 rpm of speed, 100 mm/min of feed, and 0.5 mm of depth of cut.

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