

DYNAMIC BEHAVIORAL ANALYSIS OF VARIOUS MATERIAL COATED CUTTING TOOL

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Abstract - Tool wear has a large influence on the tool life and surface quality of the components. The productivity will be increase when the tool life was increase. And when the tool life increased the machining cost and product cost will be reduced. In the turning operation the crater wear on tool and surface roughness on work piece are depends on the cutting parameters such as cutting speed, feed rate, depth of cut and the combination of cutting tool and work material, also the coating material on the tool insert. Hard turning is possible when the tool is coated with hard material. In my work focused on machining studies of uncoated WC tool and coated with Titanium and DLC to the effect of crater wear and surface roughness while machining with Martensitic stainless steel. In the hard turning operation, the tool life test was done by experimentally.

Keywords: Tool wear; Tool life; Surface roughness; Finite Element Method (FEM); Dynamic behavior; ANSYS.

1. INTRODUCTION

The performance and life of the cutting tool depends on the cutting condition are cutting speed, feed rate and depth of cut as well as the combination of tool material, work material, and the lubricant used. The useful life of a cutting tool and its operating conditions largely control the economical of the machining operations. The tool life is the main criteria to affect the productivity and manufacturing cost.

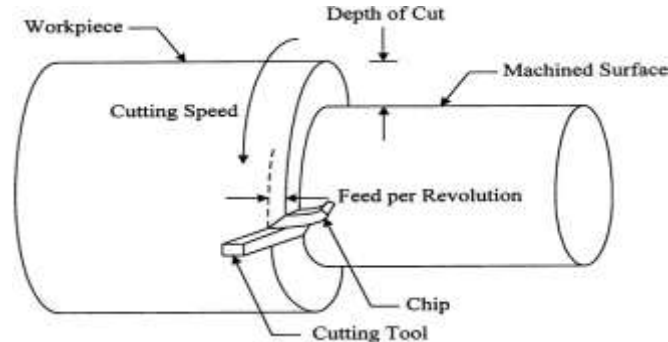


Fig-1: Cutting Parameters

Now the manufacturing industries are looking forward to development of the new cutting tools, which can be used in machining process without using of cutting fluids because, Many of the fluids contain environmentally harmful chemical constituents and have many detrimental effects can cause skin and lung disease and polluting the atmosphere also increasing disposal and cleaning cost.

Hence the solution of this problem is dry cutting process, is possible only when the cutting tools are coated with some hard materials such as TiN, TiC, Titanium, etc. Abrasive wear on the flank and clearance faces can be reduced by increased tool hardness.

Crater wear can be minimized by suppressing chemical interactions between the cut chip and the tool surface. In the turning operation the chips are flows over the rack face of the tool insert. Due to the friction the wear is occur on the rack face. This wear is called crater wear.

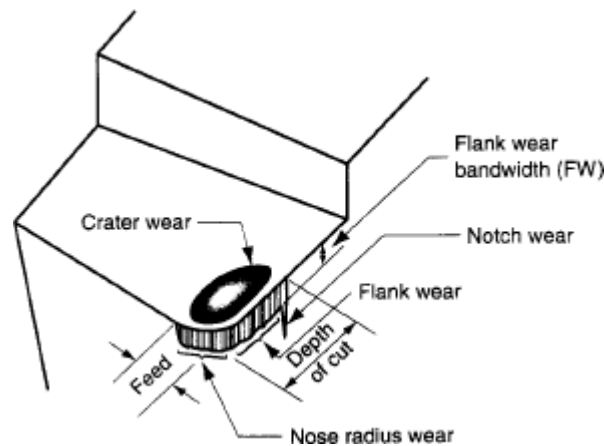


Fig-2: Wear on Tool Insert

2. LITERATURE SURVEY

M. Nouari proved that Titanium and Diamond coating extending the tool life with the better surface quality while drilling with Aluminium alloys.

Yueh-Jaw Lin and Ashutosh Agarwal are proved that the AlCrN coating improves tool life compared with uncoated cemented carbide tool insert.

3. PROBLEM DESCRIPTION

The recent advancement is using ceramic coated tools in the machining operations. TiC, TiN, TiCN and Al₂O₃ coatings exhibit very good wear resistance against ferrous materials.

The experimental analyses of uncoated, coated cutting tool and dynamic behavioral analyses using FEM is done.

4. OBJECTIVES

Titanium and Cubic Boron Nitride are coated with Carbide tool insert for experiment.

The tool life test will be conducted experimentally using kirloskar turn master 35. Study which tool gives better surface finish on Martensitic stainless steel work piece.

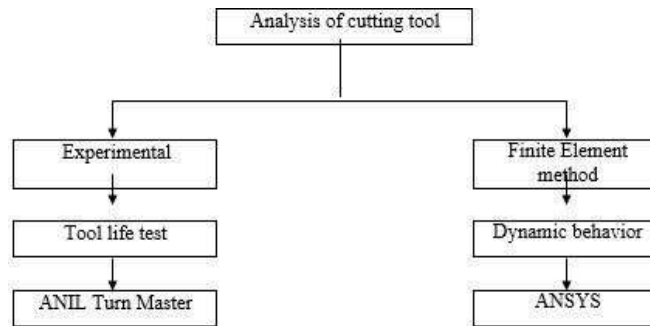
Analyze the dynamic behavior of the coated and uncoated cutting tool using FEM.

Noted the natural frequencies for various tool in modal analysis using ANSYS.

Noted the amplitude range of tool in harmonic analysis using ANSYS.

Analyze the dynamic stability of tool by time response in transient dynamic analysis using ANSYS.

5. RESEARCH METHODOLOGY



6. MATERIAL USED

Work material - Martensitic stainless steel

Tool holder - Stainless steel

Tool insert – Uncoated Carbide & coated with Titanium, Cubic Boron Nitride

7. CUTTING TOOL INSERT



8. CONDITIONS & LIMITATIONS

As per ISO - 3685,

Cutting speed = 60 to 330 m/min

Max. Feed = $0.8 \times \text{nose radius}$

Max. D.O.C = $10 \times F$

Min. D.O.C = $2 \times \text{nose radius}$

9. CUTTING PARAMETERS

Nose radius, $r_n = 0.4 \text{ mm}$

Feed rate, $F = 0.1 \text{ mm/rev}$

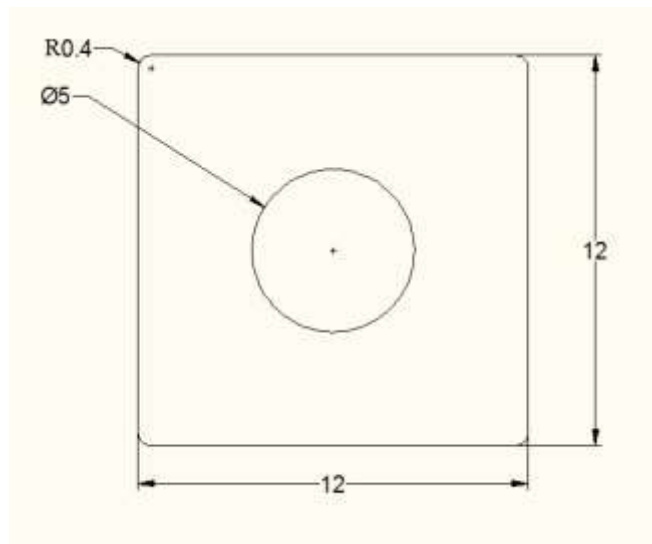
Depth of cut, $a_p = 1.0 \text{ mm}$

Crater wear, $K_T = 0.14$ mm

10. CONCLUSIONS

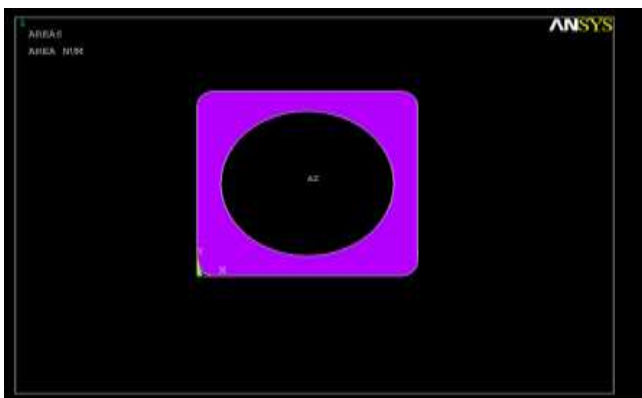
Cubic Boron Nitride, Titanium coating tool inserts are give better tool life compared with uncoated Carbide tool insert. Cubic Boron Nitride, Titanium coating tool inserts are give fine surface finish on work piece compared with uncoated Carbide tool insert. Cubic Boron Nitride, Titanium coated tool inserts have the better dynamic stability compared with uncoated Carbide tool insert.

The dynamic behavior of the tool insert is simulated using ANSYS for further analysis. The tool stiffness, natural frequency, damping ratio and time taken for complete decay of amplitude of vibration are observed. The model analysis, harmonic analysis and transient dynamic analysis using FEM havebeen performed to estimate the natural frequency and damping ratio of the work piece. Theaimofdynamicanalysisofthe equivalent system was to evaluate and enhance the system stability.

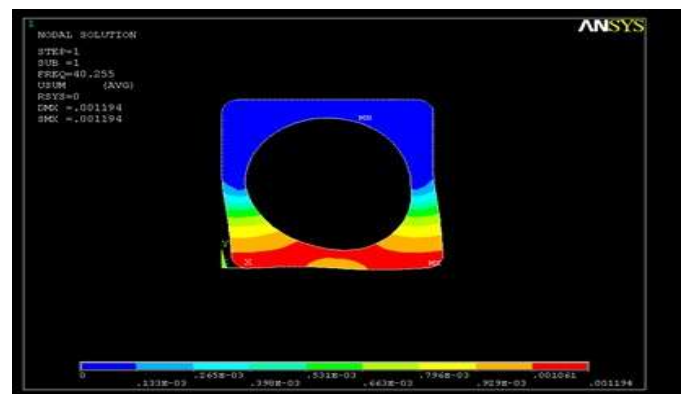


Dimension of Tool Insert

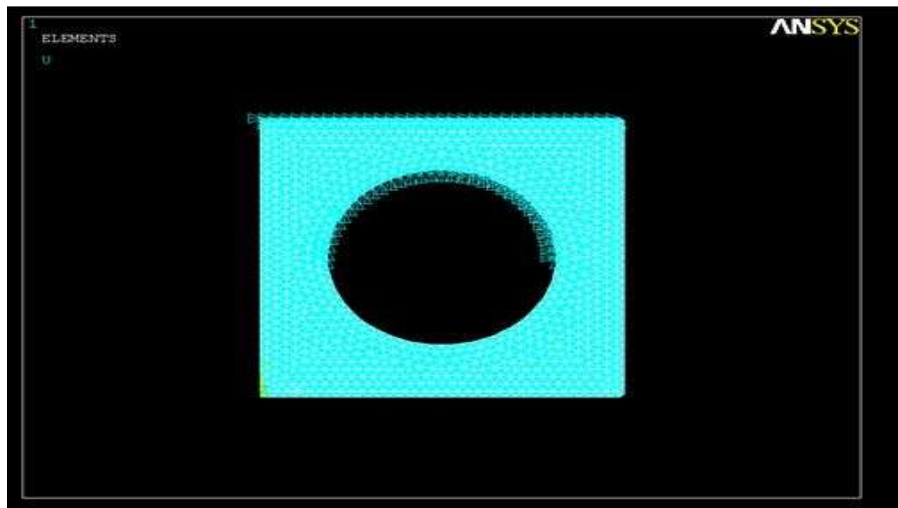
Modal analysis is to determine the vibration characteristics (natural frequencies and mode shapes) of a structure or a machine component while it is being designed.



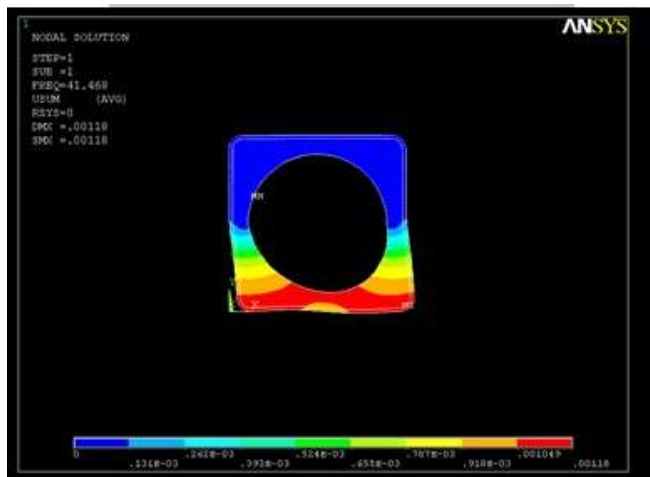
D Solid Model of Tool Insert



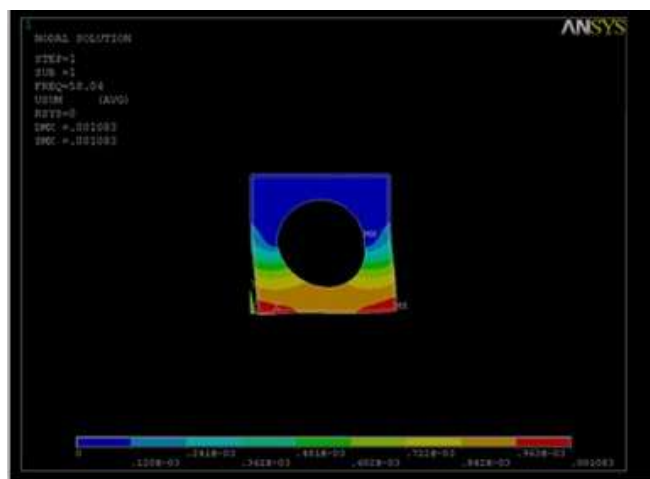
Apply BoundaryCondition



Mode Shape 1of CARBIDE Tool Insert



ModeShape 1of TitaniumToolInsert



Mode Shape 1 of CBN Tool Insert

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