A Review - "Selection of Combination of Tool and Work Piece Material using MADM Methods for Turning Operation on CNC Machine"

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***Abstract* – The combination of tool and work piece materialhas a very significant role for surface finish in turning operation. There are many different types of tool inserts with different material and tool insert geometry which are used in turning operation. This review paper describes an optimal procedure to select best tool insert from various tool inserts for better surface finish in turning operation.MADM methods is been used in various areas such as society, economics, military, management, manufacturing etc., and is been receiving more and more attention over the last few years.In this research work we have given most of the priority for the optimum selection of combination of tool inserts and work piece for attaining the best possible results. A tool insert selection index is provided that evaluates and ranks the tool insert for good surface finish in turning operation.**

Keywords – MADM, Turning, Tool Insert, Surface Finish.

I. INTRODUCTION

The upcoming and modern machining industries is mainly focused towards the achievement of high quality, considering work piece factors such as dimensional accuracy, surface finish, high production rate, less wear of the cutting tools, economy of machining process in terms of cost saving and better performance of the product with reduction of impact on environment. Surface roughness plays an important role in many areas and is an important factor in the evaluation of machining accuracy. Tool selection parameters has an important role in determining the overall machining performance, including cutting forces, tool wear, surface finish, chip formation and chip breaking, tool life and quality of the machined surface. In other words, the proposed consideration does not complicate but simplifies the analysis of tool geometry. The selection of a proper tool-material depends upon anumber of factors such as type of machining operation, materialof the work piece, machine tool to be used and surface finish. The selection of tool material is of enormous economic significance in tool lifemaximization and surface roughness in machining. Over the past few years, many researches have been made to study the important effects of tool material and geometry on machining performance. Mostly all turning processes use single point cutting tools,which mean the tools that cut with only a single edge in contact with the work piece. Most turning process is done with coated indexable inserts, but the tool material can be high-speed steel, brazed carbide, ceramic, cubic boron nitride, or polycrystalline diamond. Generally, most of the turning operations use just a few basic tool geometries. When turning with tool inserts, much of the geometry is built into the tool holder itself rather than the actual insert. The geometry of an insert includes the insert's basic shape, its tool geometry, the insert type, the insert's nose radius, and the insert's chip breaker design.

In this turningmethod, 3 (three) tool inserts and 3 (three) different work piece is been taken for making the optimal selection of tool and work piece combination. Total 9(nine) machining experiments is done based on9(nine) tool and work piece combination. The surface finish of each 9 work piece is been tested by taking various readings using surface meter. In tool insert geometry the larger point angles are stronger, such as round inserts for contouring and square inserts for roughing and finishing. The smaller angles (35° and 55°) are the most versatile for complex work. Turning inserts may be molded or ground to their working shape. The molded types are more economical and have wide application. Ground inserts are needed for maximum accuracy and to produce well defined or sharp contours. Several angles are important when introducing the cutting tool's edge into a rotating work piece. These angles include the angle of inclination, rake angle, clearance or relief angle, approach angle, and tool nose radius. Since a sharp edge is weak and fractures easily, an insert's cutting edge is prepared with particular shapes to strengthen it. Those shapes include a honed radius, a chamfer, a land or a combination of the three.

A. MADM Method

Decision making becomes an integral part in our daily lives and will be used for complex problemsincluding problems with multiple conflicting criteria. Multi-criteria decision making (MCDM) is a well-known decision making process based on the progression of using methods and procedures of multiple conflicting criteria into the management planning process. In other words, MCDM refers to making decision in the presence of multiple, numerous and usually conflicting that involve numbers of criteria. MCDM provides a step by step procedure for which a consensus decision can be made by a group of decision makers. MCDM plays an important role in solving complicated problems. The development of MCDM discipline is closely related to the advancement of computing technology. With this development, it is possible to conduct systematic analysis of complex MCDM problems. The Multi criterion Decision-Making (MCDM) are gaining importance as potential tools for analyzing complex real problems due to their inherent ability to judge different alternatives (Choice, strategy, policy, scenario can also be used synonymously) on various criteria for possible selection of the best/suitable alternative (s). MCDM method is broadly classified into two categories : multiple attribute decision making and multiple objective decision making, depending on whether the problem is a selection problem or a design problem.

TABLE I. DECISION MATRIX IN MADM METHODS

Alter-native	Attribute					
	$B_1(W_1)$	$B_2(W_2)$	$B_3(W_3)$	-	-	$B_m(W_m)$
A_1	m_{11}	m_{12}	m_{13}	-	-	m_{1m}
A_2	m_{21}	m_{22}	m_{23}	-	-	m_{2m}
A_3	m_{31}	m_{32}	m_{33}	-	-	m_{3m}
-	-	-	-	-	-	-
-	-	-	-	-	-	-
A_n	m_{n1}	m_{n2}	m_{n3}	-	-	m_{nm}

Five MADM methods are commonly used: Weighted sum method(WSM),Weighted product method(WPM), Analytic hierarchy process(AHP), Revised analytic hierarchy process(RAHP) and Technique for order preference by similarity to ideal solution (TOPSIS). MADM is an approach employed to solve problems involving selection from among a finite number of alternatives. An MADM method specifies how attribute information is to be processed in order to arrive at a choice.Each decision matrix in MADM methods has four main parts, namely: (a) alternatives, (b) attributes, (c) weight or relative importance of each attribute and (d) measure of performance of alternatives with respect to the attributes. The decision matrix is shown in table I. The decision matrix shows alternatives, A_i (for i=1,2,.....,N), attributes, B_j (for j=1,2,....,M), weights of attributes, W_j(for j=1,2,.....,M) and the measure of performance of alternatives, m_{ij} (for i=1,2,......,M).

II. LITERATURE REVIEW

Dogra et al. studied about the effect of tool geometry (tool nose radius, rake angle, variable edge geometry) and their effect on tool wear, surface roughness and surface integrity of the machined surface during turning. They conclude that, the large edge hone produce higher force and higher surface roughness than small edge hone. The large tool nose radius gives good surface finish than small tool nose radius. The greater negative rake angle gives higher compressive stress which deeper affected zone below machined surface[1].Gokkeya and nalbant studied about the effect of tool geometry (insert radius: 1.2mm, 0.8mm, and 0.4mm) and process parameter such as depth of cut, feed rate on surface roughness of AISI 1030 steel on CNC lathe machine. They conclude that, a good combination among the insert radius, speed rate and depth of cut can provide better surface qualities [2].Neseli et al. have find out the influence of tool geometry i.e. nose radius, approach angle and rake angle and their effect on the surface finish obtained in turning of AISI 1040 steel on lathe machine by using AL_2O_3 coated tool inserts CNMG 120404-BF, CNMG 120408-BF, CNMG 120412-BF for finishing operation. They conclude that rake angle has the highest effect in reducing surface roughness and the effect of tool nose radius and approach angle increases with increases surface roughness [3]. Mannan et al. have studied the effect of inserts shapes (round and square), cutting edges, inserts rake types and nose radius on surfaceroughness and residual stresses where cutting speed, feed and depth of cut were maintained constant. They conclude that, round inserts generate lower surface finish than square inserts. The positive rake produces lower values when coolant is used and high value in dry cutting. The surface roughness increasing with nose radius increases and use of coolant generate lower values of surface roughness [4]. Guddat et al. investigated the effect of wiper PCBN inserts geometry (nose radius, edge radius, chamfer angle) on surface integrity. Wiper inserts produce smoother surfaces within the range of the experiments conducted and are more stable when it comes to changes in feed and nose radius [5]. Manshadi et al. proposed a numerical method for solving problem of material selection for cryogenic storage tank for transportation of liquid nitrogen from seven alternative materials. They used different MADM methods and from their results they provide rank and decided material number 3 SS 301-FH is the best and right choice for the tank [6]. Abhang et al. studied about selection of best lubricant in turning operation from alternative lubricants by using MADM methods. They applied TOPSIS and AHP model and conclude that lubricant index evaluate and ranks best lubricant during steel turning operation and combined TOPSIS and AHP method provides a convenient approach for solving complex MADM problems in manufacturing domains[7].B.Savant et al. have solved the problem of the selection of automated guided vehicle by using MADM methods. They applied Preference selection index (PSI) and TOPSIS MADM methods. From PSI and TOPSIS ranking results, they compared methods and average of the methods selects best AGV for the industrial application[8].Vijay Athawale and Shankar chakraborty have applied the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method for selection of best CNC machine from alternative machine in terms of specification and cost of machine [9]. Nikunj Patel et al. have studied a novel approach for selection of tool insert in CNC turning process using MADM methods in which AISI 4340 workpiece is used. They have used five different tool inserts like CCMT 09 T3 02 PF, VBMT 16 04 02 PF, DNMG 15 04 12 PF, TNMG 22 04 08 PF, SCMT 09 T3 04 PF. They have concluded that the ranking of tool insert based on its performance score is same (i.e. tool insert selection index) for Weighted sum method(WSM),Weighted product method(WPM).From the experiment, minimum surface roughness is achieved with the use of tool inserts DNMG 15 04 12 PF[10].They also have studied Insert selection for turning operation on CNC turning centre using MADM Methods.They have concluded that the best tool insert for better surface roughness in turning of alloy steel is same for AHP, RAHP and TOPSIS methods[11].

III. CONCLUSION

From different research papers of the different referred international journals were studied and tried to understand the various parameters affected on quality of part as well as methods used for the same after the review of these papers, it is concluded that, there are many factors affect on surface roughness and workpiece such as cutting speed, feed, depth of cut, tool geometry, tool material. Among of them, selection of workpiece and tool insert geometry is most important factor for surface roughness. So, it is necessary to select best combination of workpiece and tool inserts for better surface finish. From past research work and literature survey, it is clear that the MADM methods are applied for selection of workpiece material, CNC machine, lubricant, AGV vehicle, and many more but MADM methods are not applied for best combination of workpiece and tool inserts for better surface finish of alloy steel work part, which is considered as future work. So, here there is scope to apply MADM methods for selection of best combination of workpiece and tool inserts among available different tool inserts to be used in turning operation using CNC machine. So here selection of best combination of work`piece and tool inserts for better surface finish, the different attributes will be taken for study are tool geometry parameters such as nose radius, clearance angle, rake angle, approach angle and angle of inclination.

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