EXPERIMENTAL INVESTIGATION OF EFFECTS OF CUTTING PARAMETERS ON SURFACE ROUGHNESS IN THE WEDM PROCESS

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ABSTRACT

The experimental study presented in this paper aims to select the most suitable cutting and offset parameter combination for the wire electrical discharge machining process in order to get the desired surface roughness value for the machined work pieces. A series of experiments have been performed on 1040 steel material of thicknesses 30, 60 and 80 mm, and on 2379 and 2738 steel materials of thicknesses 30 and 60 mm. The test specimens have been cut by using different cutting and offset parameter combinations of the "Sodick Mark XI A500 EDW" wire electrical discharge machine in the Middle East Technical University CAD/CAM/Robotics Centre. The surface roughness of the testpieces has been measured by using a surface roughness measuring device. The related tables and charts have been prepared for 1040, 2379, 2738 steel materials. The tables and charts can be practically used for WEDM parameter selection for the desired work piece surface roughness.

Keyword: - *WEDM; Surface roughness; Cutting parameters*

1. INTRODUCTION

In wire electrical discharge machining (WEDM), the cost of machining is rather high due to a high initial investment for the machine and the cost of the wire which is used as a tool in this process. The WEDM process is economical if it is used to cut complex work pieces and difficult to- machine materials. In manufacturing die and meld components like sheet metal press dies, extrusion dies, etc., prototype and special form inserts manufacturing, WEDM is commonly used. As surface roughness is one of the most important parameters in manufacturing, various investigations have been carried out by several researchers for improving the surface roughness of the WEDM process [1–8]. These investigations show that the surface roughness of the process is closely dependent on the machining parameters. However, the published papers available do not provide any specific information on the selection of machining parameters for various machining conditions and materials. Since WEDM is a necessary process with a high cost, it is required that the appropriate machining parameters are selected for an economical machining operation. The machining parameters can be set for optimum machining with the knowledge of the effect of the machining parameters on the surface roughness of the process, as a result of the experimental study [9].

2. EXPERIMENTAL TECHNIQUES AND PROCEDURES

Three different materials have been cut by using a five-axis A500 Fine Sodick Mark XI EDW [10, pp. 8-1, 8-2] and surface roughness values of the specimens are measured in order to find the effects of cutting parameters on surface roughness in the WEDM process. WEDM is used extensively in the fields of blanking, shearing, cold forming and plastic molding. So, for the selection of the materials, we have tried to choose the most commonly used cold work tool steel and plastic mold steel [11, pp. 19–43]. For the experiments, initially a 1040 steel specimen is used because of its cheapness and extensive use in manufacturing. The results of the experiments for the 1040 steel specimen are used to plan the experimental procedure for the cold work tool steel "2379" and plastic mold steel "2738" specimens. Cold work steels, with properties such as good machinability, dimensional stability on heat treatment, high wear resistance, sufficient toughness and compressive strength, are used generally in the fields of blanking, shearing and cold forming. 2379 is one of the most widely used cold work tool steels [11] and it has a chemical composition of 1.55 C, 12.0 Cr, 0.7 Mo, 1.0 V (in %) [11]. The increasing demands for tools in plastic moulding have necessitated the specific development of tool steels. Tools for the processing of plastics are mainly stressed with regard to pressure and wear. According to the type of plastics, there may in addition exist stressing by corrosion. The various types of plastics and different processing methods impose certain requirements on the tool steel, such as economic machinability or cold-hobbling ability, dimensional stability on heat treatment, good polish ability, great compressive strength, high wear resistance, sufficient corrosion resistance, etc. The selection of a steel for a given tool is governed by these requirements. 2738 is one of the most widely used plastic mold steels [11]and it has a chemical composition of 0.40 C, 1.5 Mn, 1.9 Cr, 0.2 Mo, 1.0 Ni (in %) [11]. For the control of A500 Fine Sodick Mark XI EDW, there are 11 cutting variables and the operator only sets two general purpose parameters, which are the cutting parameter "C" and the offset parameter "H". These two parameters arrange the conditions that are needed for cutting and offset, respectively. The rest of the parameters are adjusted automatically by the machine itself [10]. The cutting parameter "C" and offset parameter "H" are given in a form so that they are followed by three integer numbers. Each "C" parameter defined in this way includes the parameters which control the setting of the pulse energy and the cutting speed adjustment, for instance, pulse width, peak current value, no-load voltage, servo reference voltage, capacitor, servo speed, wire tension, wire speed, etc. [10].

During the cutting, dielectric water is used as the fluid type and the "open" condition is selected for the flushing. A dielectric flow pressure of 1 bar, tension of the wire of 1133 g, diameter of the brass wire of 0.25 mm and a wire speed of 1550 cm/min are kept as constant in all the experiments, since these values are recommended in the tables [10]. For the surface roughness measurements of the workpieces, a portable device called "Surftronic 3+" is used and the traverse length of the experimental measurements is calculated as 4.2 mm for this particular device [12, pp. 1–53]. This value is important, because it is used to decide the length of the experimental cuts. The experimental test section is chosen to be 20 mm in length to be on the safe side. As the wire breakage that may occur during the cuts increases the surface roughness values of that experimental section, the test results may deviate from the true surface roughness values. A 20-mm test cut for each parameter combination gives enough length to measure the true surface roughness values without being affected by the wire breakage. By using different cutting parameter "C" and offset parameter "H" combinations and keeping all the other variables and conditions constant, a series of cuts are performed on 1040, 2379 and 2738 steel specimens [9]. For each different "C" and "H" parameter combination, a section of the material is cut of length 20 mm and is defined as the "test section". At the end of each test section, a cut of 0.5 mm in depth is performed in order to indicate the border of the section.

3. REFERENCES

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