Drilling Modelling Using Computer Simulation

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Abstract: This paper presents an approach method to construct of finite element model of drilling. The purpose of this study was to proved the capble of computer simulation method through research the drilling. In this paper a drilling model was carried out using the Ls-Dyna software base on finite element technique. The simulation results will be compared with experimental test . The result of the model assures the exactly of proposed method and proved that numerical method is a practical approach to drilling problem.

Keyword: Finite element, Drilling, LS-DYNA, Simulation

1. INTRODUCTION

Drilling is easily the most common machining process. Drilling is the manufacturing process where a hole is created within a work piece or enlarged by rotating cutting tool. Drilling was particularly complex process due to the many physical phenomena involved, including large elasto-plastic deformation, friction, thermal and chip formation. Experimentation is the primary method to research drilling, which is expensive and time consuming method [1,2,3,4,5,6]. Simulation methods became a useful tool to investigate such complex process as drilling. Hence, many researchers used simulation method to predict results in drilling process[7,8,9,10,11,12,13]. Based on finite element theory, computer software is the good solution after many series of experiments. So, here is the purpose to get reliable solution more cheaper. The papers will presents a drilling modelling using LS DYNA software. Comparisons of the simulation result and experimentally measured showed that the computer simulation is a practical approach to predicts the drilling process results.

2. DRILLING

Drilling, as shown in Figure 1, is a machining operation used to create a round hole in a workpart. Drilling is usually performed with a rotating cylindrical tool that has two cutting edgeson its working end. The tool is called a drill or drill bit. The rotating drill feeds into the stationary workpart to form a hole whose diameter is equal to the drill diameter.

Figure 1. *Drilling machining [13]*

3. DRILLING EXPERIMENTAL SETUP

Experiments were carried out ,as shown in Fig.2. Cylindrical workpieces made from steel with length of 40 mm and diameter of 20 mm. The experiments were carried out with in the range of cutting conditions: drilling depth at 15 mm, feed rate from 0,2 to 0,25 mm/r, cutting speed from 600 to 900 r/min

***Fig.2**. Experimental drilling test [2]*

NUMERICAL MODELING OF DRILLING

Modeling was established under thefinite element method using LS-DYNA software. Workpiece was constructed by rectangular shape with dimensions 38 x38x14 mm. The SPH(Smoothed Particle Hydrodynamics) modelling technique is used because of its capability to simulate large deformations in metal cutting. Block use SPH techinque to simulate (nodes at the bottom with six degrees of freedom). The model consits 64000 nodes, as shown in Figue 3. Geometrical SPH properties in keyword SECTION_SPH and EOS-LINEAR POLYNOMAL. Material of workpiece is defined by card MAT-015-JONHSON-COOK [14,15]

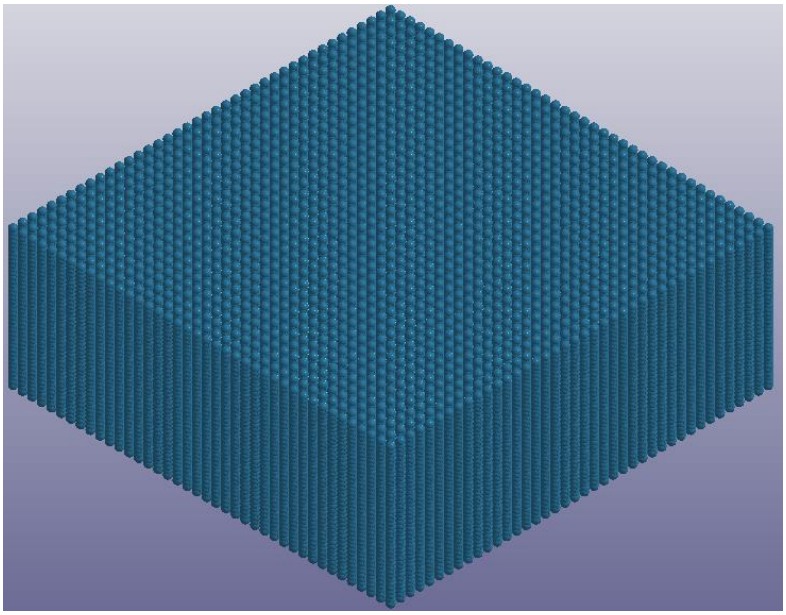

***Figure 3.** Workpiece model*

The meshing of drilling tool is performed solid elment, and meshed by 3D mesh (Solid 35678 elements).

Drilling tool is built as rigid body and defined with keyword MAT_RIGID, as shown in Figure 4. This keyword allows us to define not only physical properties but also tool path. The definition of tool path demands supplementary DEFINE_CURVE with movement law. Here you define the tool velocity, by defining the time and displacement, for example. Each movement law is defined also by BOUNDARY_PRESCREIBED_MOTION_RIGID keyword, be defining the DOF (degree of freedom).

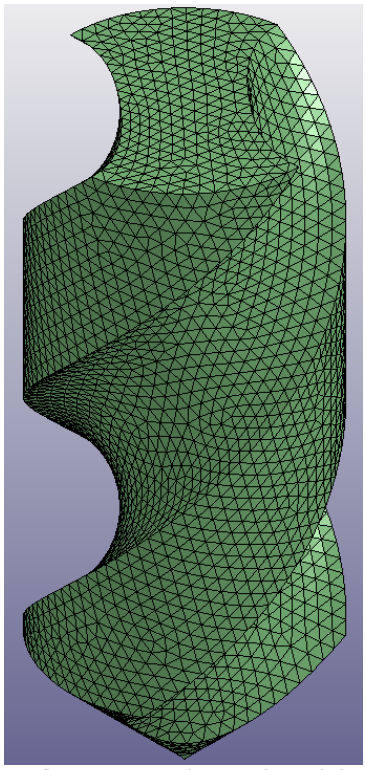

Figure 4. *Cutting tool model*

The contact between SPH parts and shell or solids elements is always CONTACT_AUTOMATIC_NODES_TO_SURFACE with soft constraint type 1 and VDC is equal to 20. The essential purpose of this keyword is to define the slave part and master part. Tool, a rigid body is defined as slave part. Workpiece, a deformable body is defined as master part. The units used for simulation: kN, GPa, kg, mm, ms. Finally all package of general common keywords used in high velocity explicit analysis was write in input K file to show the results simulation.

Drilling modelling results

Figure 5 presents the results of the drilling model. The result show that there was very close agreement was observed in the comparison results of the behavior between the experimental and simulation tests. Considering that drilling tool is working with rotation and translational motion, the chip removing process is very same like the experimental test. It is clear that the program works well for simulation of drilling. The chip formation is realistically captured, as well as the tool-workpiece contact zone This ensured that the model results conform to basic physics laws. In this research, the result is focused on the calculation of the plastic strain.

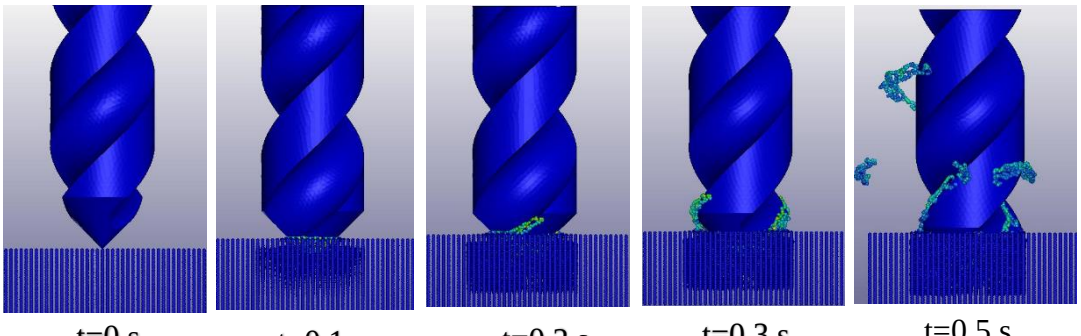

Fig 5.Sequential from drilling simulation

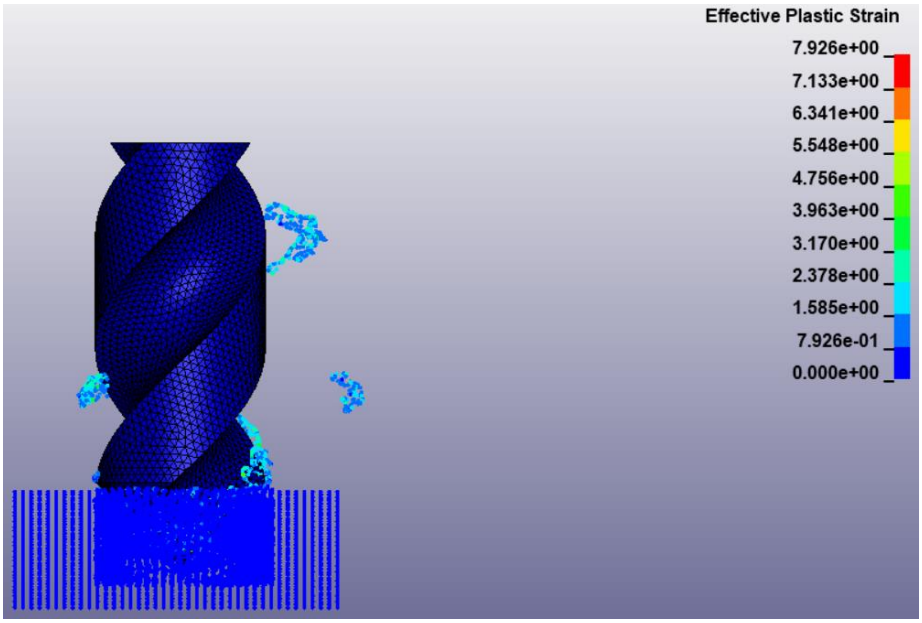

Figure 6. *Effective Plastic Strain plastic for simulation*

The Figure 5 and 6 show that a very closely chip separation, plastic train results value between experimental and simulation (maximum effective plastic strain approximate to 7.92) . The finite element model of the drilling model corresponds to reality.

CONCLUSION

The paper presented the method in order to perform drilling model using LS-DYNA software. This study proved the simulation test of drilling for assuring a reasonable and reliable result. The presented model can examine the behavior of the cutting tool in drilling and the many physical phenomena involved, including large elasto-plastic deformation, friction, thermal and chip formation. In addition, the results proved the capacity of a computer in researching drilling instead of using expensive experimental tests.

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