Finite element analysis of chip formation using ALE method

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Abstract. In recent times, many studies made in FEM on plain isotropic metal plate formulation. The stress analysis plays the significant role in the stability of structural safety and system. The stress and distortion estimation is very helpful for designing and manufacturing product well. Usually the residual stress and plastic strain determine the fatigue life of structure, it also plays the significant role in designing and choosing material. When the load magnitude increases the crack starts to form, decreasing the work load and the residual stress reduces the damage of the metal. The manufacturing process is a key parameter in process and forming the part of any system. However, machining operation involves complex thing like hot development, material property and other estimates based on transition of the plastic strain and residual stress. The reduction of residual stress plays the complexity role in the finite element study. This paper deals with the manufacturing process with less residual stress and strain. The results shows that, by applying the ALE method in machining we can reduce the load on the work piece hence the life type of the work piece can be increased. We also investigate the cutting tool wear and there efficiency since it is a essential machine member in fabrication technology. ABAQUS platform used to solve the machining operation

1. Introduction
The chip formation on the isotropic metal is very difficult since the property of the isotropic material behaves adversely to the removal of material. This paper deals about the continuity of the chip formation due to the residual stress and the plastic strain. We have used certain methods based on the references in metal removal process and there crucial benefits of specimen:
The ALE method was applied since,
(1) It calculates the short dynamic performance time of the analysis and to find the continual event of processin large model.
(2) It can be used in the exceptional analysis by complex contact. The contact algorithm compared with certain conditions which contains the relative thing. Therefore it is clear that forming a metal removal in complex contact is very difficult.
(3) It uses 11/11 algorithm to send, the large deformation of theoretical model which possibly carries on the big rotation and in the deformation.
(4) It can be used to carry out a heat insulation of stress analysis, if the inelastic dissipation estimate causes in the heat of material.
(5) It considers automatic or semi systems to clear about dynamics procedure. These characteristics to say ideally made for analyzing in the residual stress of metal removal
The part body is meshed into the element name: S4R: A 4-node doubly curved thin or thick shell, reduced integration, hourglass control, finite membrane strains and the element shape: quad.
Adiabatic analysis typically used for imitating the high-speed processes of manufacture of involvement much inelastic density and the acceptable heating. Description of discretization of the specimen has a specification of 66250 nodes and 239825 elements

1.1 Prediction of tool wears and tool life
The conventional way to classify tool wear for cutting operation in the many industrial sectors used to perform cutting test analysis under various types of cutting conditions and then analyzes the tool wear data using optimization and other techniques. The disadvantage of using this approach, we can’t get a good amount of accuracy in calculation of tool wear. The modelling procedure requires a large number of experimental test which is time and cost consuming. The finite element analysis successfully implemented in olden days to simulate various cutting operations. We used the Abacus software pyton coding to calibrate the required values.

1.2 Wear Mechanism and tool wear models
We have taken two types of model to study this chapter
1. Empirical tool life models
2. Tool wear rate models

2. Results and Discussion

Figure 1. Meshed chip model

The figure is the complete setup of the system; the work piece is meshed fine to visualize the formation of chip very uniform without breaking.

Figure 2. Von misses stress of plain carbon steel
When the tool touches the specimen the specimen starts to react for the deformation. That deformation is negligible but it can affect the material property. It can be avoided when the impact velocity of the tool is reduced.

**Figure 3.** Plastic strain of plain carbon steel

**Figure 4.** Reaction force of plain carbon steel

The reaction force of the specimen is zero, its shows that the magnitude of the force acting is very negligible range and the plastic strain after the chip formation shows the dissipation of the temperature is very good.
The kinetic energy and the plastic dissipation of the carbon steel is rapidly increasing with respect to the formation of chip. The chip formation of the specimen is very good since the kinetic energy is not dropping to the acceptable limit.
The displacement and the plastic strain magnitude for the mild steel is higher than the carbon steel.

**Figure 7.** Von misses stress of mild steel

**Figure 8.** Displacement of mild steel
Table 1. Stress comparison table

| Material | Stress N/m² | Plastic strain | Displacement (mm) |
|----------|-------------|----------------|-------------------|
| 1.143    | 0.286       | 0.593          | 0.286             |
| 1.143    | 0.067       | 0.796          | 0.067             |
| 1.143    | 0.077       | 0.782          | 0.286             |

Table 2. Tool wear rate

| Parameter         | Plain carbon steel | Mild steel        |
|-------------------|--------------------|-------------------|
|                   | HSS                | Carbide tool      | HSS               | Carbide tool      |
| Tool wear rate in mm | 0.03                   | 0.02              | 0.0034            | 0.015             |

3. Conclusion

The chip formation parameters of both mild steel and carbon steel predict that the machining of the carbon steel takes more loads during machining. The result concludes that load and the tool wear rate is directly proportional to the formation of the chip. The healthy chip gives better output finish and less wastage of the metals.

- The ALE method shows the wear rate with clarity to find the life span of the tool.
- The Johnson cook damage declares that the tool wear rate of the carbon steel is high when compared to the mild steel.

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