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Study of simulation about deflection and distortion during cutting process

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The parts deflection and distortion during cutting process are important issues because these become problems of parts quality and accuracy. But it is difficult to simulate these behaviors during cutting process because the results receive the effect by many factors like heat, force, stress and so on. We show physics-based models to predict the parts deflection and distortion by considering the appropriate physics for each problem in this presentation.

We calculated the cutting force via Physics-Based Methods which includes material parameters. The chipload on CAM model is divided into many small segments which are modeled as oblique turning. We developed the material database for this oblique turning using Finite Element method. The cutting force are able to be calculated using this material database on CAM model. We call this as Semi-Empirical Method.

We did the cutting simulation of milling process on engine block parts. Fig.1(a) shows this model. As we see, the toolpath geometry is not so complicated like 5-axis machining but engine block parts have many holes and complicated geometries around parts edge. Consequently, the complicated force behavior will be expected at various tool and teeth positions. Our group has shown the force profile during cutting process so far. So in this study we show the predicted deflection of workpiece by cutting force in Fig.1(b). It will be benefit to visualize the cutting force and workpiece behavior. The position of clamping and workpiece rigid can be considered in simulation.

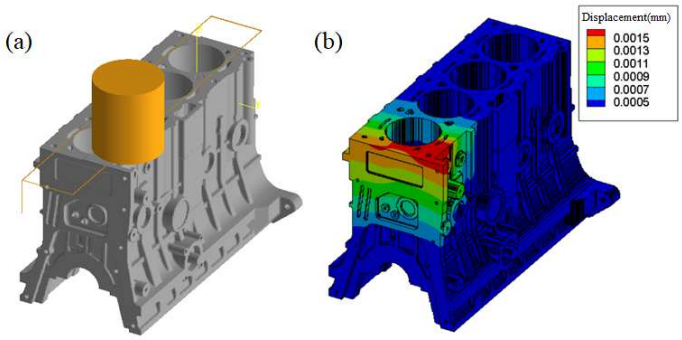

Fig.1 Model for engine block parts
(a)Toolpath, (b)Predicted deflection

Next, the bulk stress in workpiece should be considered for parts distortion. In this study, the bulk stress was prepared in the rolling simulation based on finite element method. Fig.2(a) show the workpiece geometry before cutting and this has the bulk stress. This workpiece will be distorted after cutting because a part of workpiece which has the bulk stress is deleted. This distortion is simulated from two positions like Fig.2(c). If the parts is prepared from upper area which is near rolling surface, the predicted distortion was large.

We used the calculation method which shows the cutting force via Physical-Based Method on CAD/CAM model. Consequently, the workpiece deflection was shown. This must be valuable to study the position of clamping and workpiece rigid. And the bulk stress in the workpiece is also considered in our calculation method. So these simulation results will be benefit to prepare any manufacturing process before actual process.

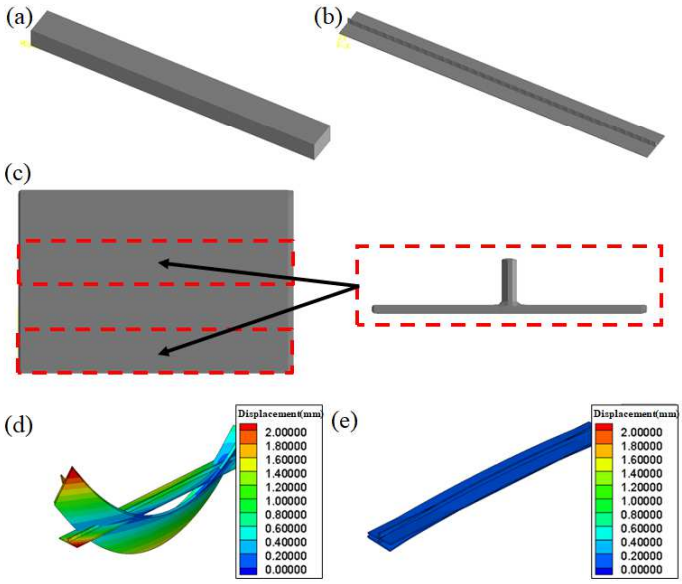

Fig.2 Model for thin parts
(a) Parts after rolling, (b) Parts after cutting, (c) Position for parts in cross section,
(d) Predicted distortion from upper area, (e) Predicted distortion from lower area