Influence of Metal Internal Defect on the Propagation of Shock Wave

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Summary. In this paper we studied on the influence of metal internal transverse crack and gap on the propagation of shock wave using the Lagrangian finite element method. Studies show that transverse crack and gap inside the metal parts have notable influence on the propagation of shock wave and local shape of the interface. Distortion of the interface waveform is greater with transverse crack. The influence of transverse gap on the propagation of shock wave is similar with the transverse crack and the change of the middle interface is more violent. The influence of transverse crack and gap on the propagation of shock wave is related to the material type.

Introduction

For complex device with certain configuration, various defects are unavoidable inside the metal parts due to machining and assembling. When metal parts undergo various loading such as shock, the propagation of shock wave and the final shape of interface will be influenced by these defects. Furthermore, understanding of the physical rules and evaluation of the experiment results will be influenced. Therefore it is very meaningful to study the influence of metal internal defect on the propagation of shock wave.

In this paper we studied on the influence of metal internal transverse crack and gap on the propagation of shock wave using the Lagrangian finite element method. Studies show that transverse crack and gap inside the metal parts have notable influence on the propagation of shock wave and local shape of the interface. Change of interface waveform is more violent with transverse crack or gap.

Modeling and method

The calculation model is shown in figure 1. Metal parts are divided into two layers. The transverse gap inside the metal is simulated by an initial void between two layers, and the transverse crack is simulated by different type of slide lines between two layers without void of the metal parts.

In this paper we use the Lagrangian finite element method. Lagrangian method can accurately describe the interface, so it is applicable for the study of shock wave propagation and interface waveform problem. The space is dispersed by the four-point finite element method, and the time integral utilizes the central difference algorithm.

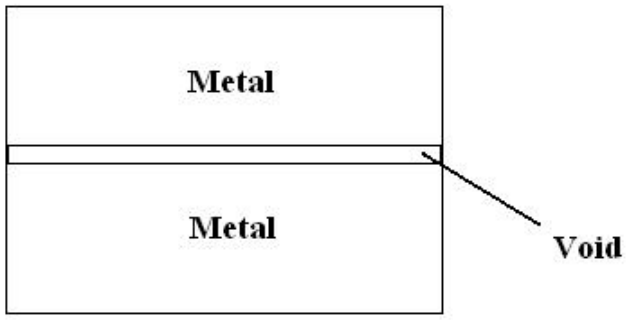

Figure 1. Calculation model

Calculation results

Figure 2 is the result with transverse crack inside the metal. The red line is the waveform of interface without defect and the blue line is the waveform with crack. The transverse crack has no effect on the outside interface, has some effect on the inside interface, and has obvious effect on the middle interface. Distortion of the interface waveform is greater with transverse crack.

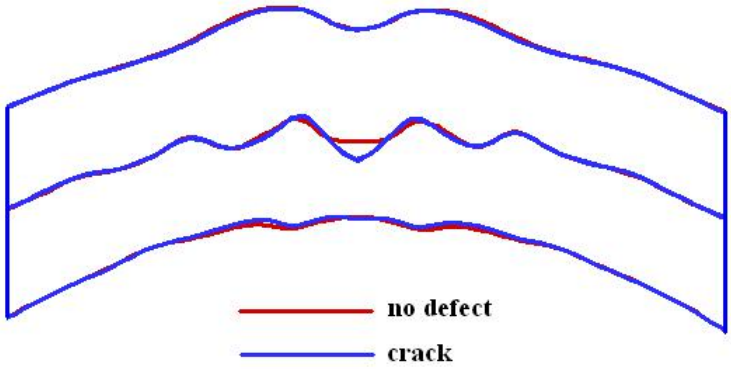

Figure 2. Waveform of interface with crack

Figure 3 is the result with transverse gap inside the metal. The red line is the waveform of interface without defect and the black line is the waveform with gap. The influence of transverse gap on the propagation of shock wave is similar with the transverse crack and the change of the middle interface is more violent.

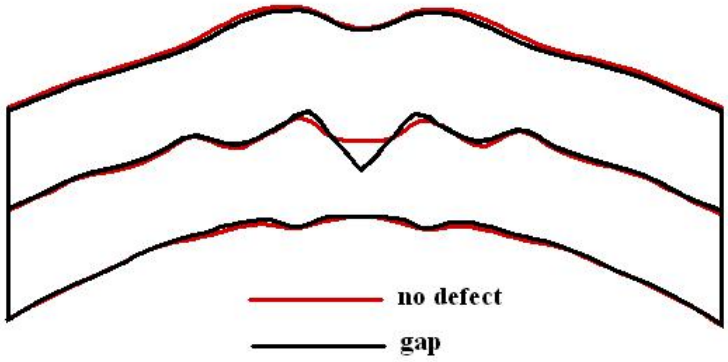

Figure 3. Waveform of interface with crack

Material types of two flyers of the metal parts can be set as the same or different, so that the influence of material type can be studied. Results show that the influence of transverse crack and gap on the propagation of shock wave is related to the material type.

Concluding remarks

In this paper we studied on the influence of metal internal transverse crack and gap on the propagation of shock wave using the Lagrangian finite element method. Simulation results show that transverse crack and gap inside the metal parts have notable influence on the propagation of shock wave and local shape of the interface and the influence of transverse crack and gap on the propagation of shock wave is related to the material type.