Modal Analysis of Solid Rocket Motor
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Abstract. How to avoid the natural frequency closing to the environment disturbance frequency is a very complicated problem in the solid rocket motor engine. Once the resonance phenomenon happened, Solid rocket motors will be subjected to a larger dynamic stress environment, resulting in engine damage. In this paper, the modal analysis of a solid rocket motor under a certain constraint condition is analyzed by using the finite element software ANSYS. It utilizes the dynamic characteristics to appraise and provides for further research on structural improve and design work in the solid rocket motor engine.

Introduction
The driving force system of solid rocket engine is widely used in solid and liquid rocket missile. The reason is that the solid rocket engine is flexible, ready time and adaptability than the liquid rocket, and solid rocket motor has the advantages of simple operation, can be stored for a long time, high reliability in short time. How to avoid environment disturbance frequency becoming close to natural frequency of rocket engine itself is very a very complicated problem[1-2]. In this paper, it is found that the rocket motor exhibits different modes of vibration, and presents different forms of breathing, obtains various frequencies of rocket engine parameters, it need to decouple in the modal analysis. In this paper, modal analysis of a solid rocket motor under one point constraint is carried out by using the finite element software ANSYS.

Model of Solid Rocket Motor
In this paper, It study the two cases of solid rocket motor under the one point constraint condition. Modal analysis of a point constraint on the addition of the medicine column and none addition of the medicine column. The size parameters of solid rocket engine mainly comprises a shell thickness set to 4mm; shell diameter is 560mm, diameter is 570mm; nozzle thickness is 6mm; the nozzle throat is connected with the casing rigid parts of inner diameter is 50mm, external diameter is 55mm, nozzle port diameter is 160mm. As shown in figure 1.

![Figure 1. The solid rocket engine model.](image)

Modal Analysis of Solid Rocket Motor

Modal Analysis under One Point Constraint Condition without Adding Medicine Column
In this paper, The 6 order, 15 order and 26 order modes are given respectively in solid rocket motor. It is found that the rocket motor exhibits different modes of vibration, and presents different forms of breathing.

In Figure 2, the 6 order mode shape of the rocket engine is given by a point constraint, the
vibration deformation of the rocket engine mainly occurs at the tail end of the nozzle position. The vibration direction is cycle.

In Figure 3 describes the 15 order mode of the column with a little constraint. The main deformation position or the nozzle position at the end of the vibration pattern can be seen.

In Figure 4, the modal shape of the rocket engine is described at a certain moment in the first 30 order mode of the rocket engine under in a point constraint without the medicine column of solid rocket motor. Thirtieth order vibration type rocket engine is mainly on the breathing mode, at this moment for the downward breath, into the shape of a mushroom shape model, and can be seen from Figure 4 is the main deformation of the shell deformation in the absence of grain add constraints and a bit of constraint condition, the rocket engine shows is breathing mode.

**Modal Analysis under One Point Constraint Condition of Adding Medicine Column**

Figure 5 shows the all structure of the vibration, and its frequency value is 0. this is because of the first mode output, The main vibration mode of the rocket engine is the whole circulation vibration. The whole structure does not appear large deformation.
Figure 6 is the mode of the order mode shape, Figure 6 the vibration ring is in the main column and internal and external respiration. Other places are much greater than the local displacement angle.

Figure 7. 30 the stress cloud of the order one point constraint condition of adding medicine column.

In Figure 7 the main observation at the top of the rocket engine, It can be seen that the maximum stress value of the thirtieth order is 0.281256Mpa in the junction of nozzle and shell stress distribution situation in Figure 7.

Summary
1 The non medicine column with one appoint constraint condition
   The vibration of the shell in the rocket engine increases with the increasing of the order, and the constraint of the rocket engine will restrict the overall frequency of the solid rocket motor.
2 In addition medine column with one appoint constraint condition
   The effects of propellant rocket engine has been added, from grain constraints in the process of vibration, the vibration frequency variation decreases rapidly in various order number. Because the elastic modulus and the density of the medicine column is much smaller than the corresponding value of the shell, the main vibration of the rocket engine is the various types of respiratory mode.

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References