Exhausted Jet Caused the Deformation of Front Metal Seal Covers in a Multiple Launch Rocket System

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Introduction

The front covers of Multiple Launch Rocket System (MLRS) launch tubes protect the rocket projectiles from external damage during storage, marching, and launching, which should be opened in time during launch. Several front seal covers on unlaunched tubes fell to the ground during multiple launch tests of the MLRS, making the unlaunched rocket projectiles directly subject to the impact of the exhausted jet. All covers on unlaunched tubes that fell to the ground have plastic deformation. The purpose of this study is to confirm the reason of plastic deformation of the front cover and improve its design to protect the unlaunched rocket projectiles.

Experimental Investigation

The front metal seal cover on adjacent launch tube was ablated and plastic deformation occurred after impact of exhausted jet after a single launch.

Figure 2 shows the distribution of launch tubes 14, 15, 19 and 27. Thermocouples and pressure sensors were installed on the front cover of launch tube 27 when rocket projectiles in launch tubes 14, 15 and 19 were launched. Figure 3a shows the mounting location of pressure sensor and thermocouples. Figure 3b shows the mounting location of triaxial strain

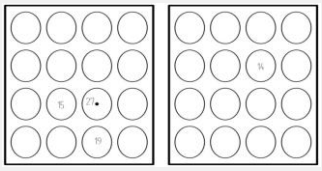


Figure 2. Launch tubes number distribution

Experimental Results

Temperature of exhausted jet acting on the front cover of launch tube 27. Line A represents the maximum value of W-Re5/26 thermocouple indexing meter.

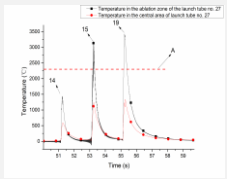
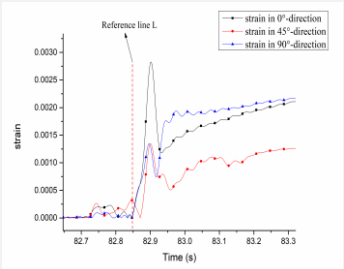


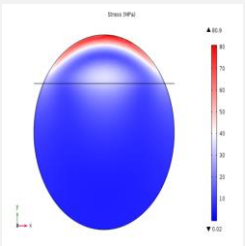
Table 1. The temperature of exhausted jet acting on the front cover on launch tube 27 for rocket projectiles in launch tubes 14, 15 and 19 were launched.

Tubes	Temperature in the ablation zone/°C	Acting time/ms	Temperature in the central area /°C	Acting time/ms
14	1439	93	586	144
15	Over 2300	165	1238	159
19	Over 2300	126	1335	167

The measured strain curves are divided into different stages by reference line L. The data on the left side of reference line L is the result of pressure action, and the data on the right side is greatly affected by the heat conduction temperature.

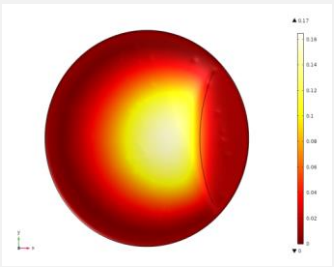


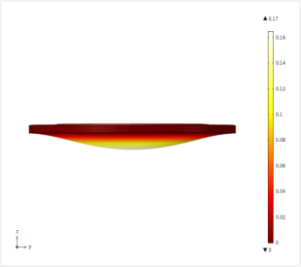
Theoretical Results



In the first working condition, the maximum pressure on the front of the whole metal plate was 0.99 MPa. In the strain test results, the time from the beginning of deformation to the beginning of temperature to affect the strain measurement was 120 ms.

In the second condition, the surface temperature distribution of the whole metal plate was not uniform. The temperature of the exhausted jet in the upper edge of the metal plate was set at 2300℃. The temperature of the exhausted jet in the center of the metal plate was set at 1238℃ The maximum deformation of the cover in the z-axis only under the action of high temperature exhausted jet reached 0.17mm, far exceeding the elastic deformation limit of the material





Conclusions

The experimental and theoretical results showed that pressure action of the exhausted jet alone can only cause the elastic deformation of the cover. The results of thermal deformation analysis demonstrated that high temperature was the main cause of plastic deformation of front metal seal covers. The material of the new cover was engineering plastic with low thermal conductivity. To ensure the structural strength of the cover, the thickness was increased to 15 mm. No plastic deformation was found in the modified covers during subsequent launch tests.

References

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