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## 超空泡射弹尾拍结构动力学响应分析

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### DYNAMIC RESPONSES OF SUPERCAVITATING PROJECTILE IMPACTED BY TAIL FORCES

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#### 摘要

超空泡射弹在运动过程中存在尾拍现象, 导致结构发生振动, 影响射弹的弹道稳定性, 降低射弹结构的可靠性。该文建立了射弹无约束动力学方程, 使用有限元法求解得到了超空泡射弹在尾拍载荷作用下的动力学响应, 并对射弹的加固模型进行了分析, 给出了环状加强筋个数、直径以及间距对降低射弹振幅效果的影响。研究表明: 超空泡射弹在尾拍运动过程中转动周期和幅值随加强筋个数的增大而增大; 射弹头部的弹性振动幅值随加强筋个数和直径的增大而减小, 振动周期亦随加强筋个数的增大而减小; 加强筋距离的减小, 对于降低射弹中部振幅效果明显, 但对射弹头部的振动几乎没有影响。

关键词: 超空泡射弹 尾拍 动力学响应 有限元法 加强筋

#### Abstract:

When supercavitating projectiles move at a high speed, the periodic impacts ("tail-slap") with interior surface of the cavity will generally occur. The interactions between the vehicle and the water/cavity interface are sources of structural vibrations, which affect the guidance of the vehicle and undermine the structural reliability. In this paper, the dynamic equation of supercavitating projectile with no constraints is established and solved by finite element method. The dynamic behaviour of supercavitating projectile operating in tail-slap conditions is obtained. And, the effectiveness of periodically placed stiffening rings in reducing the amplitude of the vibrations induced by tail-slap impacts is investigated by considering the difference in number, thickness and spaces-between for the rings. The results show: supercavitating projectile oscillates periodically | larger ring number causes longer impact duration and the penetration distance for the stiffened body is high compared to the plain body | the amplitude of elastic vibrations on projectile nose decreases as the number and the thickness of stiffeners increase | similarly, the period of oscillation decreases with the increment of the stiffener | as for the influence of space-between of stiffeners, the smaller it is, the effect of reducing the oscillation amplitude of mid-part is more obvious | however, the location of the stiffeners almost has no influences on the vibrations of projectile's nose.

Key words: supercavitating projectile tail-slap dynamic response finite element method periodic stiffeners

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