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EVALUATION OF THE EFFECT OF HARPOON TIP SHAPE ON PENETRATION BEHAVIOR IN
TIPS THAT HAVE SEVERAL CONTACT POINTS FOR CAPTURING SPACE DEBRIS

Abstract

Recently, there have been problems with space debris threats, and space debris is desirable for active removal. We have studied shooting a harpoon to capture space debris into a target. In a previous study, we investigated the effect of penetrating various harpoon tip shapes on penetration behavior. A conical harpoon tip shape greatly influenced penetration behavior when the target was with a large oblique angle. This research objective is to devise a new harpoon tip shape that is hard to influence penetration behavior when the target has a large oblique angle and to obtain an insight into the feasibility of capturing space debris. We shot the harpoon that was devised newly into a fixed target with an oblique angle and investigated penetration behavior. We devised the harpoon tip shape whose contact point to the target is increased because we obtained that friction between the harpoon and the target greatly influences penetration behavior in a previous study. The new harpoon tip shape collides with the obliqued target at two or five points. We called “2-points contacting tip shape harpoon” and “5-points contacting tip shape harpoon”. We obtained many results by shooting these harpoon tip shapes. The minimum penetration velocity of a new harpoon tip shape is lower than that of the conical harpoon tip shape. The reasons why penetration velocity is lower than that of the conical harpoon tip shape are to collide with the obliqued target at multiple points, and the harpoon tip shape is easy to hook on the target. The penetration hole is generated like a petal shape expected to exert holding force when the harpoon captures the target. We obtained the following from these results. It is revealed that increasing the likelihood of capturing debris because of reducing minimum penetration velocity and generating suitable penetration holes by the new harpoon tip shapes colliding with the target at multiple contact points when they are shot into the target that has an oblique angle.