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Application of the Multi-directional Linear Cumulative Cutter

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Abstract: According to the characteristics of the drill-jamming accidents, a kind of multi-directional linear cumulative cutter in which twelve hollow copper pipes distributed evenly around the cylindrical explosive was designed. The linear cumulative cutter explosion principle and penetration process were studied through the numerical simulation method, which used the lagrange method of the LS-DYNA procedure, then the numerical calculations and experimental results were compared. The numerical simulation results showed that the twelve copper pipes formed twelve jets, slugs and 'tails' which moved after the jets under the pressure of detonation. Then these twelve jets moved along twelve different planes which were formed from the central axis of the copper pipes and explosive respectively (the angle between two neighboring planes was 30°). The velocity of the jet tip and slug were approximately up to 3530 m·s^{-1} and 1180 m·s^{-1} respectively. The target steel pipe primarily formed swell and fracture under the detonation pressure, then it was cut by twelve jets (the penetration velocity was about 2550 m·s^{-1}), eventually resulting in the formation of twelve slits. The steel pipe deformation results and the quantity of slits are in consistent with the experimental results, and this technology is applied successfully to the drill-jamming accident of three hundred meters deep drilling. Moreover, it is noted that the charge and cost are reduced respectively by 80% and 50% at least compared with existing normal cutter. In addition, the structure of cumulative cutter is simple and easy to be processed.

Key words: engineering mechanics; drill-jamming; multi-directional linear cumulative cutter; numerical simulation; jet; slit
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