

中文核心期刊
中国科技核心期刊
RCCSE中国核心学术期刊
中国科学引文数据库来源期刊
EI、SCOPUS、CA、CSA、AJ、JST收录期刊

ISSN 1006-9941
CN 51-1489/TK
CODEN HACAQ

含能材料

CHINESE JOURNAL OF ENERGETIC MATERIALS

先进毁伤技术 特邀专题



岩不由衷
Not Be Rock Anymore

聚能杆式射流侵彻混凝土和岩石靶体试验与数值模拟
Experimental and Numerical Simulation of Shaped Charge Jet Penetrating Concrete and Rock Targets

HANNENG CAILIAO

2023 8
第31卷

聚能杆式射流侵彻混凝土和岩石靶体试验与数值模拟



混凝土、岩石等硬目标广泛应用于军事和民用建筑之中,研究其结构上的毁伤破坏效果是装备研制、防护工程等领域长期关注的热点。聚能装药具备穿透能力强、作用迅速及携带方便等特点,因此,可利用聚能杆式射流对岩石类靶体进行侵彻开孔。聚能杆式射流是一种介于爆炸成型弹丸和聚能射流之间的聚能侵彻体,与聚能射流相比速度梯度小,药型罩利用率高,不易被拉断,对炸高不敏感,可以兼顾聚能射流侵彻深度大,爆炸成型弹丸侵彻孔径大等优点,广泛用于串联战斗部的前级装药,并应用于对付多种目标。为此,来自南京理工大学张朝平、张先锋等研究人员设计并开展了带隔板聚能装药结构射流成型及侵彻混凝土和花岗岩靶的试验,并利用有限元模型,分析了带隔板聚能装药的射流成型过程,比较了炸药在不同状态方程下爆轰波的传播过程以及对射流侵彻体的侵彻过程及靶体的损伤情况进行分析研究,结果表明,混凝土靶形成的侵彻深度和侵彻孔径相较于岩石靶分别提高了46.7%和48.1%,岩石靶表面破坏程度和开坑区域均大于混凝土靶;与混凝土靶相比,岩石靶的裂纹长度和宽度均大于混凝土靶,靶体损伤范围较大,内部破坏严重。

岩不由衷

封面整体以岩石山为背景,着重表现了聚能杆式射流对岩石靶的侵彻破坏等特性研究。只见天空中飞行的已成型的带隔板聚能杆式射流侵彻体正朝岩石飞奔而来,并在岩石山上的通过精准定位来打击目标的场景。岩石山及旁边山体的开裂,表示聚能杆式射流侵彻体在侵彻过程中造成的损伤;背景飞入的字符则指代作者通过数据模拟对这一破坏过程的模型研究。整个图片设计简洁明快,重点突出,色彩分明。

封面效果 / @山鹰·翼简设计
责任编辑 / 姜梅 高毅 王馨逸
期刊基本参数 CN 51-1489/TK * 1993 * m * A4
* 116 * zh+en * P * ¥ 20.00 * 700 * 10 * 2023-08

2023年 第31卷 第8期
(总第214期)

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8月25日出版
(月刊)

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Advanced Damage Technology

Editorial

Energetic Express

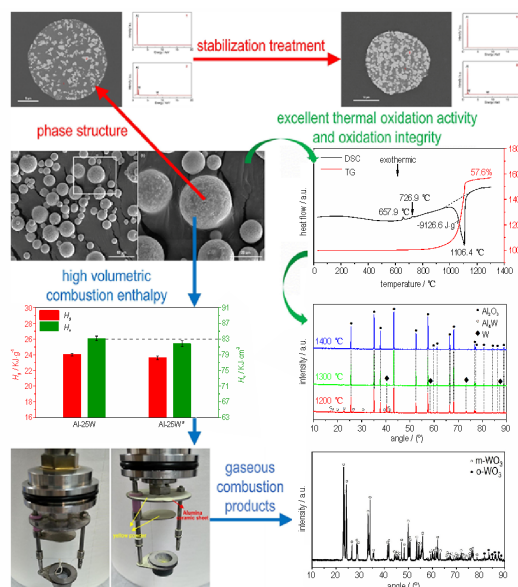
P741★

Explosion and Damage

Oxidation Behavior and Energy Performance of the Spherical Al-25W Alloy Fuel Powder

HU Ao-bo, CAI Shui-zhou, ZOU Hui

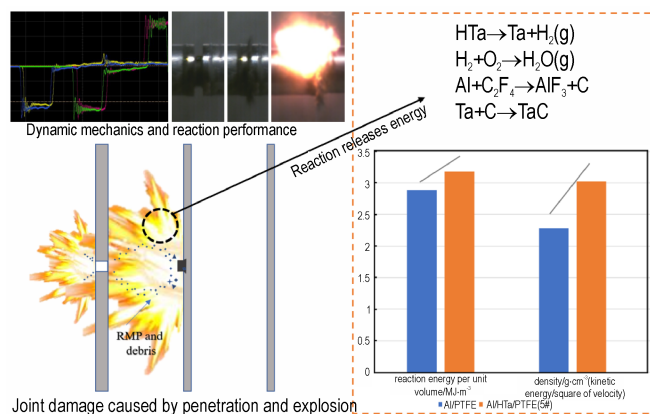
P743★ The spherical aluminum-tungsten alloy fuel powder (Al-25W) was prepared by the combination of aluminothermic reduction and ultra-high temperature gas atomization and was characterized by SEM/EDS, XRD, TG-DSC.



Mechanical Response and Penetration Damage of Al/PTFE Reactive Materials Filled with HTa

REN Xin-xin, LI Yu-chun, LIU Jin-chun

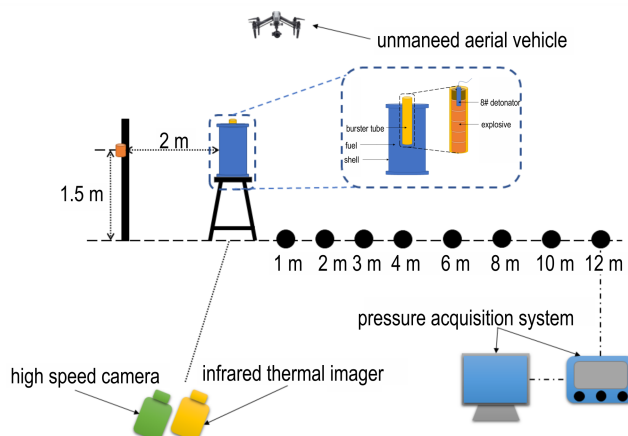
P753★ The high-density metal hydride (HTa) was innovatively applied to improve the material density and reaction energy density of Al/PTFE reactive materials, and Al/HTa/PTFE reactive materials were prepared. Based on the split Hopkinson pressure bar (SHPB) experiment and ballistic gun penetrating target experiment, the effects of HTa filler mass fraction on the dynamic mechanical properties, ignition reaction characteristics, and penetration and reaction energy release of Al/PTFE reactive materials were compared and analyzed.



Formula Optimization and Damage Analysis of High Energy Liquid-solid Hybrid Fuel

YANG Zhong-kun, XIA Yang-feng, AN Gao-jun, XU Xi-meng, WANG Yong-xu, Zhang Dan, XIE Li-feng, LI Bin

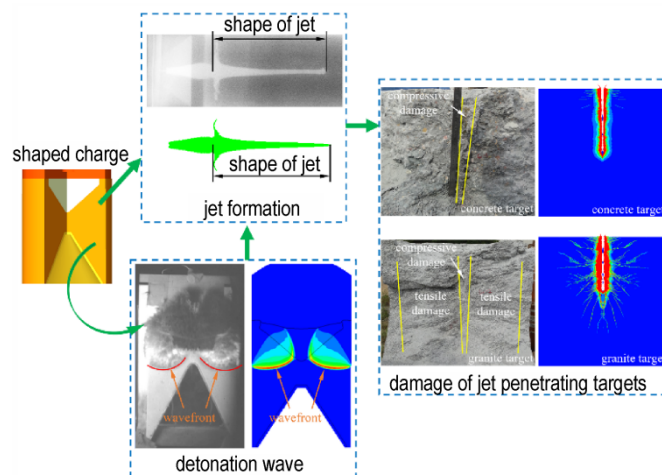
P763★ The explosion pressure and temperature of different FAE formulations were calculated and compared by numerical calculation software. The formulations of liquid FAE and liquid-solid FAE were screened and optimized by numerical simulations. The overpressure and temperature destructive effects of large equivalent unconfined cloudburst experiments were also quantitatively evaluated for both systems of FAE. Some references were provided in the optimal design of the cloudburst formulation.



Experimental and Numerical Simulation of Shaped Charge Jet Penetrating Concrete and Rock Targets

ZHANG Chao-ping, ZHANG Xian-feng, TAN Meng-ting, HOU Xian-wei, XIONG Wei, LIU Chuang, GU Xiao-hui

P773 ★ The shaped charge with large barrier was designed, and the jet forming X-ray test and penetration concrete target and rock target test were carried out. A numerical model was established to study the evolution process of detonation wave, rod-shaped jet forming process and target damage of shaped charge with large barrier.

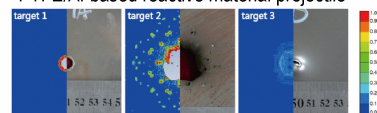


Investigation on Damage Characteristics of Multilayer Thin Steel Target Penetrated by Hypervelocity Spherical Reactive Materials Projectile

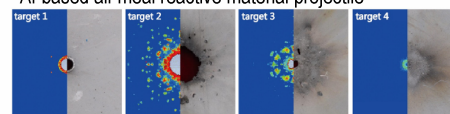
CAO Jin, CHEN Chun-lin, MA Kun, GAO Peng-fei, TIAN Hong-Chang, FENG Na, QIAN Bing-wen

P786 ★ The damage characteristics of the multilayer thin steel target penetrated by PTFE/Al based and Al-based all-metal reactive materials under hypervelocity impact condition was investigated by using two stage light gas gun equipment. The numerical simulation model and parameters efficiency of two kinds of reactive materials were proved by using penetration experiment and numerical simulation methods. The influence of reactive materials' penetration velocity on damage efficiency of multilayer steel target was investigated, and the reason to the damage efficiency difference between two kinds of reactive materials was carried out.

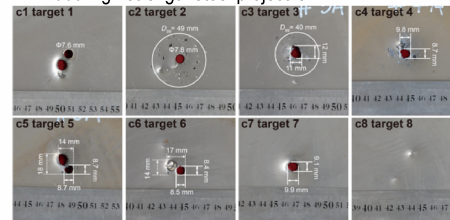
PTFE/Al-based reactive material projectile



Al-based all-metal reactive material projectile



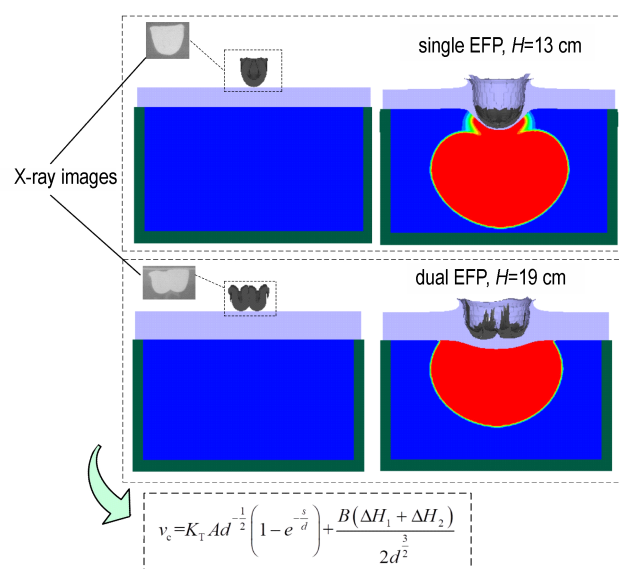
DT1900 high strength steel projectile



Cumulative Damage Effect on Shock Initiation of Covered Composition B by Dual EFP Impacts

GUO Chun, ZHANG Xian-feng, XIONG Wei

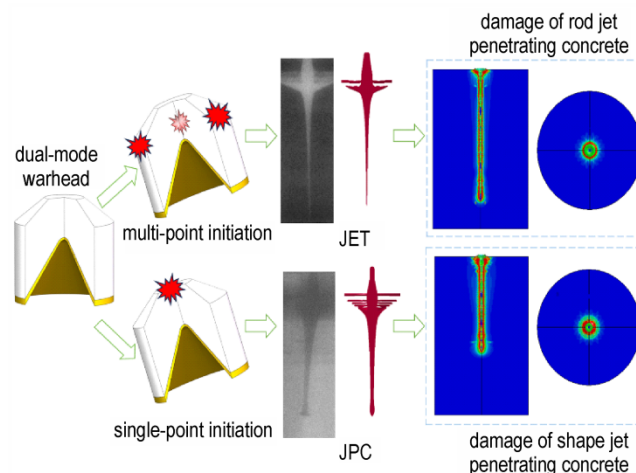
P797 ★ The initiation processes of covered Composition B by single EFP and dual EFP were studied by experiments. Based on the experimental results, the numerical simulations on shock initiation of covered Composition B by single EFP and dual EFP impact were carried out. Then an engineering calculation model of the critical initiation condition of covered charge with dual EFP was established. The research results can provide the reference for MEFP warhead design and cumulative damage assessment of warhead charge by MEFP impacts.



Numerical Simulation of the Optimization Design and the Penetration Performance of Dual-mode Warhead Structure

XU Peng, YAO Wen-jin, LI Wei-bing, ZHANG Xiao-ying

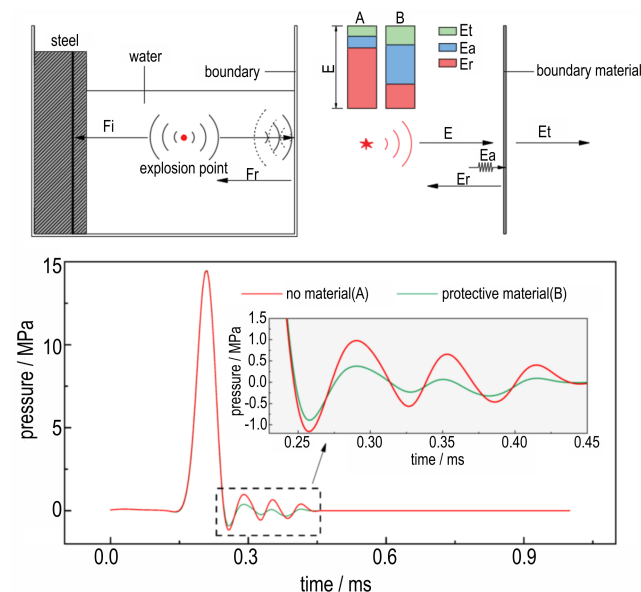
P808 ★ A dual-mode warhead was optimized and designed, and the X-ray test verification of the dual-mode damage element rod-shaped charge jet (JPC) and shaped charge jet (JET) was carried out. The numerical model of warhead penetrating concrete target was established, and the damage of target under the penetration of dual-mode damage element was compared and analyzed, which can provide reference for warhead structure design and penetration performance research.



Numerical Simulation on Shock Wave Propagation Characteristics in Centrifugal Tests of Underwater Explosion with Energy Absorbing Boundaries

LI Ming, ZHANG Qi-ling, LI Zhi

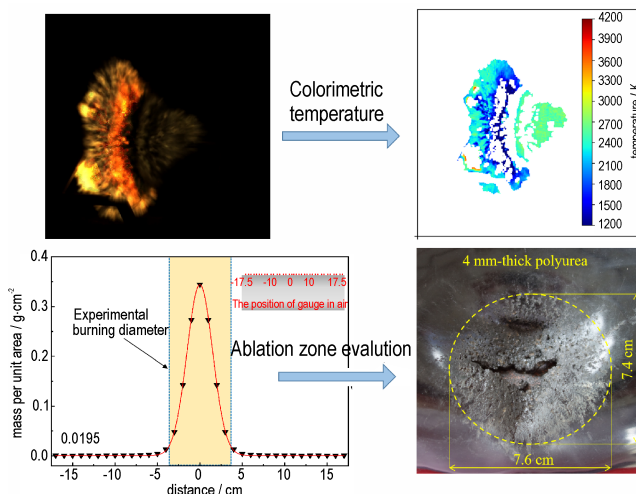
P820 In the context of the centrifugal test of underwater explosion, the shock wave resulting from the explosion undergoes reflection on the inner wall of the model chamber. The subsequent formation of the reflected wave, due to secondary action on the test object, leads to detrimental effects on the test structure and compromises the accuracy of the test. This study aims to mitigate these issues by implementing rubber and foam materials of varying thicknesses on the inner wall of the centrifuge. The objective is to absorb the blast shock waves exerted on the model chamber wall and diminish the boundary effect of the test. The secondary pressure peaks, deformations and impulses of the gauges on the steel plate structure reflect the wave absorption effect of rubber and foam materials, and the filtering effect of rubber and foam materials on underwater explosion shock waves is indicated by spectrum analysis.



Burning Damage Characteristics of Polyurea Layer under Transient Temperature Field by Near-field Explosion

TAO Chen, WANG Xin, JI Chong, WANG Yu-ting, ZHAO Chang-xiao, HAN Ze-yan

P832 ★ The explosion field temperature of passivated RDX was obtained by colorimetric temperature measurement. The burning of polyurea layer occurred on the surface, and heat conduction was the main reason for the thermal decomposition of polyurea. The density and velocity of detonation products were obtained by numerical simulation. The mass per unit area of detonation products was obtained to quantitatively evaluate the ablation of polyurea layer, which provides quantitative reference data for predicting the ignition degree of polyurea.

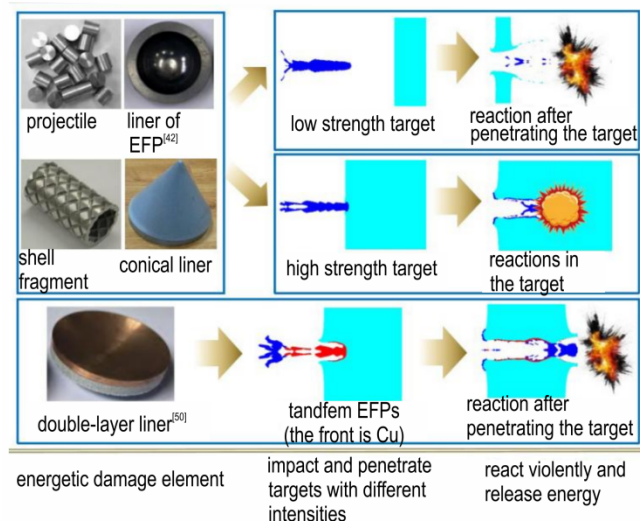


Reviews

Research Progress of Energy Release Behaviors and Damage Characteristics of Fluoropolymer-Matrix Reactive Materials

DING Jian, ZHU Shun-guan

P844 ★ Fluoropolymer-matrix active materials are normally insensitive, but they will burn or even explode under the action of high-speed collision or explosion. It can be used as projectiles, fragments, liners, etc. and applied to the warhead, which has a unique combined damage mechanism of invasion and explosion and can significantly enhance the terminal damage capability. Based on the research results of energy release and damage characteristics of active materials in recent years, some suggestions and prospects are put forward after analyzing the research status.



Executive editor: JIANG Mei GAO Yi WANG Xin-yi

- ◎ 国际标准连续出版物号 **ISSN 1006-9941**
◎ 国内统一连续出版物号 **CN 51-1489/TK**
◎ 国内邮发代号 62-31 国外发行代号 4681MO 国内定价 20元/期 240元/年

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ISSN 1006-9941

