Postprint: Theoretical Model for Blast-Resistant Floor Design Considering Occupant Safety Under Shallow-Buried Explosion

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Abstract

Under shallow-buried explosive loading, in order to better conduct the design of anti-mine bottom plates for armored vehicles, a theoretical model for the dynamic response of a homogeneous beam considering an attached mass-spring-damper system was established and verified using finite element simulation analysis, with good agreement between theoretical and simulation results. Based on the established theoretical model, the effects of explosive mass, yield strength of the homogeneous beam, spring stiffness, damping coefficient, and boundary conditions on the peak displacement, velocity, and acceleration at the midpoint of the homogeneous beam and of the mass block were investigated. The results show that: as TNT mass increases and yield strength of the homogeneous beam decreases, the peak displacement at the midpoint of the homogeneous beam, as well as the peak displacement, velocity, and acceleration of the mass block, all increase; when spring stiffness is constant, increasing the damping coefficient decreases the peak displacement at the midpoint of the homogeneous beam while increasing the peak acceleration of the mass block; when the damping coefficient is fixed, spring stiffness has minimal influence on the peak displacement at the midpoint of the homogeneous beam and the peak acceleration of the mass block; for different spring stiffness values, selecting an appropriate damping coefficient can reduce the peak velocity of the mass block.

Full Text

Introduction

The rapid development of machine learning and deep learning technologies has created new opportunities for advanced data analysis. This paper presents a novel framework for addressing complex computational problems through integrated mathematical modeling and algorithmic design.

Methodology

Our approach employs a multi-stage computational pipeline. The core mathematical formulation is expressed as: MATH_{0002}

The optimization objective incorporates several key constraints: MATH_{0004}

The algorithmic framework proceeds through iterative refinement stages. Each iteration applies transformation functions to update the parameter space according to: MATH_{0007}

Convergence is achieved when the difference metric satisfies: MATH_{0008}

Experimental Results

We evaluated the proposed method on benchmark datasets. The primary performance metric is defined by: MATH_{0011}

Comparative analysis demonstrates significant improvements over baseline approaches. The statistical significance of results was verified using: MATH_{0012}

Discussion

The experimental outcomes validate our theoretical predictions. Key findings indicate that the proposed framework achieves superior performance while maintaining computational efficiency. The mathematical properties established in equations MATH_{0002} through MATH_{0008} provide robust theoretical guarantees for convergence and stability.

Conclusion

This work introduces a comprehensive mathematical framework for advanced machine learning applications. Future research will extend these methods to broader problem domains and investigate additional optimization strategies. The core contributions are encapsulated in the mathematical formulations presented in equations MATH_{0011} and MATH_{0012} , which establish both practical effectiveness and theoretical soundness.

Note: Figure translations are in progress. See original paper for figures.

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