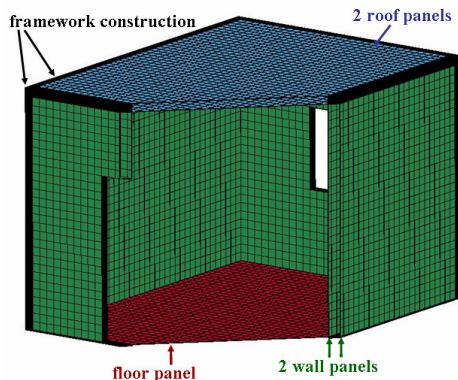


FI-BLAST

Fast Interface for Blast & Impact Load Analysis of Structures

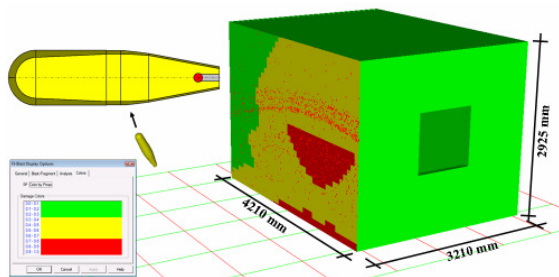
Introduction

FI-BLAST is an engineering tool developed by NUMERICS GmbH to support the rapid structural analysis of vehicles and buildings subject to the loads of blast and fragments from explosive devices.



FE model of a protective container.

Analysts often build detailed finite-element (FE) models of vehicles or buildings. Using these models to analyze the effects of explosive devices requires an adequate definition of loads. However, in most cases a fully coupled 3D hydrocode analysis including blast and fragment propagation is too expensive or not feasible at all.



Blast and fragment loads on a container.

The basic idea of FI-BLAST is to use existing FE-models and calculate the loads in a simplified and fast way. FI-BLAST incorporates projectile momentum and detailed blast functions to create time histories applicable to surfaces of finite element models of structures as stress boundary conditions. Trajectories of fragments are also provided so that safety areas based on damage and injury criteria can be analyzed and defined. Four major fields of application are currently offered by FI-BLAST:

- Export of load functions to FE analysis tools (e.g. LS-DYNA, AUTODYN)
- Analysis of the effects of fragments from an explosive device on a target structure

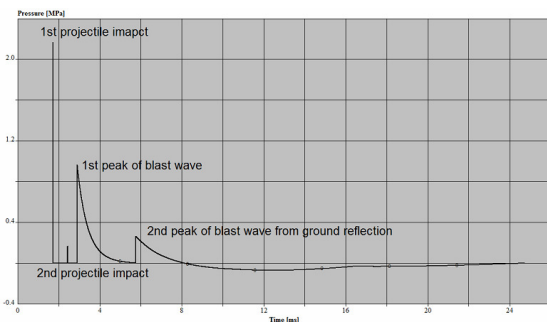
- Safety analysis of a vehicle or building given a certain projectile
- Analysis of safety ranges given an explosive device

Apart from the last, all of these tasks require the availability of an FE-model of the structure to be analyzed.

Export of Load Functions

The objective of this code feature is to provide a fast way of creating load functions for a structural analysis. The following steps can be carried out interactively within the graphical user interface:

- Import of the FE model of a structure
- Definition of an explosive device
- Set-up of the scenario, i.e. position, orientation, and velocity of the exploding device relative to the structure
- Calculation of blast and fragment loads on the surface of the structure
- Export of the loads as pressure boundaries $p(t)$ on each affected surface segment



Example of a $p(t)$ load curve.

Analysis of Fragments Effects

This type of analysis enables the user to set up vulnerability or safety analyses based on an existing FE-model of a structure. The following steps can be performed:

- Import of the FE model of a structure
- Assignment of strength properties to the relevant parts of the FE-model
- Specification of damage or safety criteria
- Definition of an explosive device
- Set-up of the scenario, i.e. position, orientation, and velocity of the exploding device relative to the structure
- Calculation of the effects of the fragments from the explosive device
- Generation of analysis reports

Analysis of Projectile Effects

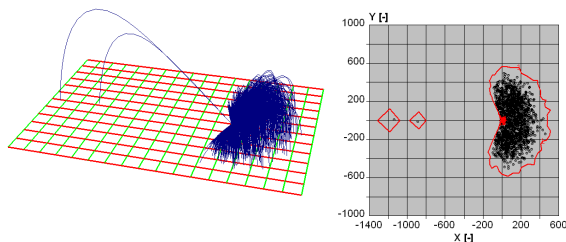
The objective of this feature is to analyze a specified projectile, e.g. a bullet or a standardized fragment, and to determine its effects on a structure. The steps of the analysis are:

- Import of the FE model of a structure
- Assignment of strength properties to the parts of the FE-model relevant for the penetration analysis
- Specification of damage or safety criteria
- Definition of a projectile
- Specification of an analysis grid and parameter space of the analysis: projectile velocity, azimuth and elevation of the shotlines
- Calculation of the effects of the projectile
- Generation of analysis reports

Analysis of Safety Ranges

Given an explosive device, this analysis option determines safety ranges with respect to blast and/or fragments:

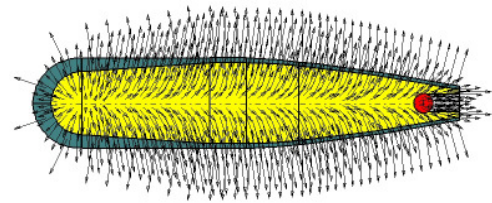
- Definition of an explosive device
- Set-up of the scenario, i.e. position, orientation, and velocity of the exploding device relative to the ground surface
- Selection of a safety criterion, e.g. blast peak overpressure or fragment energy
- Calculation of the safe area



Fragment trajectories and footprint on ground surface.

Analytical Background

FI-BLAST uses an approximate flow field of the detonation products and fragment velocities calculated by a modified Gurney method to determine the impulse imparted to a structure. This even allows for the generation of the highly anisotropic momentum distribution of non-spherical charges. Arrival times and duration of the blast wave are estimated from empirical relations taking into account the properties of the surrounding atmosphere.



Flow field and fragment velocities calculated by FI-BLAST.

Benefits

The FI-BLAST software offers a large set of benefits to the user

- **Cost Savings:** The program can be used to rapidly generate load cases for structural analysis codes.
- **High Productivity:** The code allows for a rapid identification and remedy of weak spots of a structure.
- **Continuous Development:** FI-BLAST is continuously developed to maintain and enhance its capabilities and to incorporate the suggestions of its users.

Hardware/Software

FI-BLAST is available for use on PC systems running under Microsoft® Windows.

Included in the delivery of the software are:

- Executable code
- Full user documentation including a tutorial and example analysis files.

Licences

FI-BLAST may be purchased as a paid-up license for perpetual use, or as an annual license.

In addition, a demonstration version valid for a testing period of a few months is available.

Services

NUMERICS offers support in tailoring FI-BLAST for specific structural codes and applications.

NUMERICS has a wealth of experience in the development and application of this and other analytical and numerical methods. We offer a broad range of supporting consultancy services designed to meet the clients' needs, including specialist software development, technical training & support, turnkey analyses and research & development.