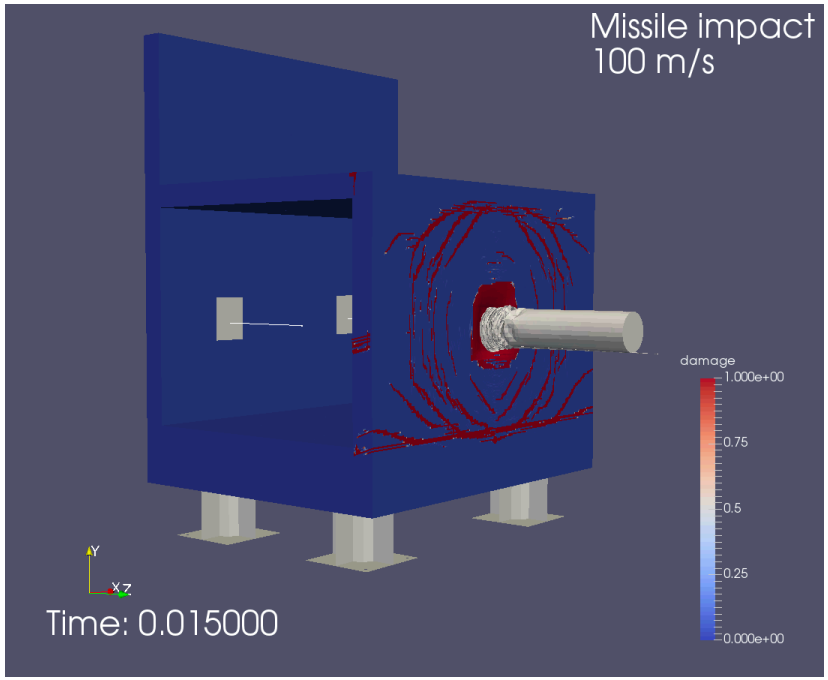
SAND2016-7799PE

Exceptional service in the national interest

Sandia National Laboratories

Structural Mechanics Simulations in Support of the Upcoming IRIS-3 Benchmark



Joshua Hogancamp
Texas A&M University

Supervised by
Chris Jones
Org. 6233

6220/6230 summer student mini-symposium
August, 16th 2016, Sandia Nat'l Labs, Albuquerque NM

Outline

Sandia National Laboratories

1. Project goal: Simulate a steel missile impact on reinforced concrete

2. Overview of methodology
    1. Fit material models for concrete and steel to experimental data
    2. Create 3D finite element mesh of final project
    3. Perform and record results from finite element analysis

3. Results: Outputs include material damage, pressure propagation, vibrations, accelerations, and resultant forces at connections and supports

4. Discussion

5. Conclusion

Overview

Sandia National Laboratories

IRIS: Improving the Robustness assessment of structures t medium velocity

Fig. 0-b 3D principle view of typical impact test

Introduction

Sandia National Laboratories

IRIS: Improving the Robustness assessment of structures Impacted by large miSsile at medium velocity

- This project is Phase 3 of the IRIS program
- Funded by USNRC Office of Research
- Finite element analysis (FEA) is the primary tool for numerically modeling the missile impact
- Mechanical testing supplements FEA with material data
- Numerical modeling of experiments is only as accurate as the data/models/user

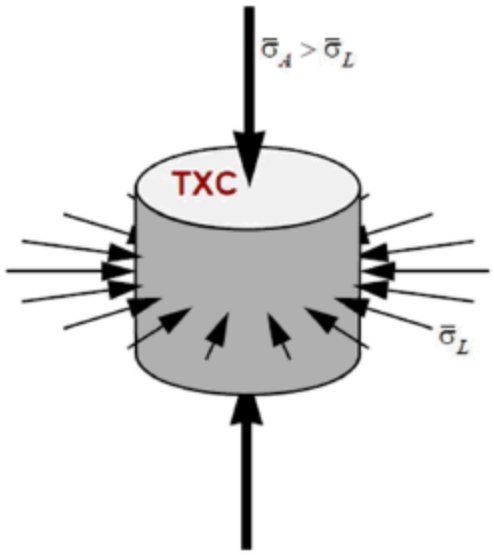
Description of the methodology

Sandia National Laboratories

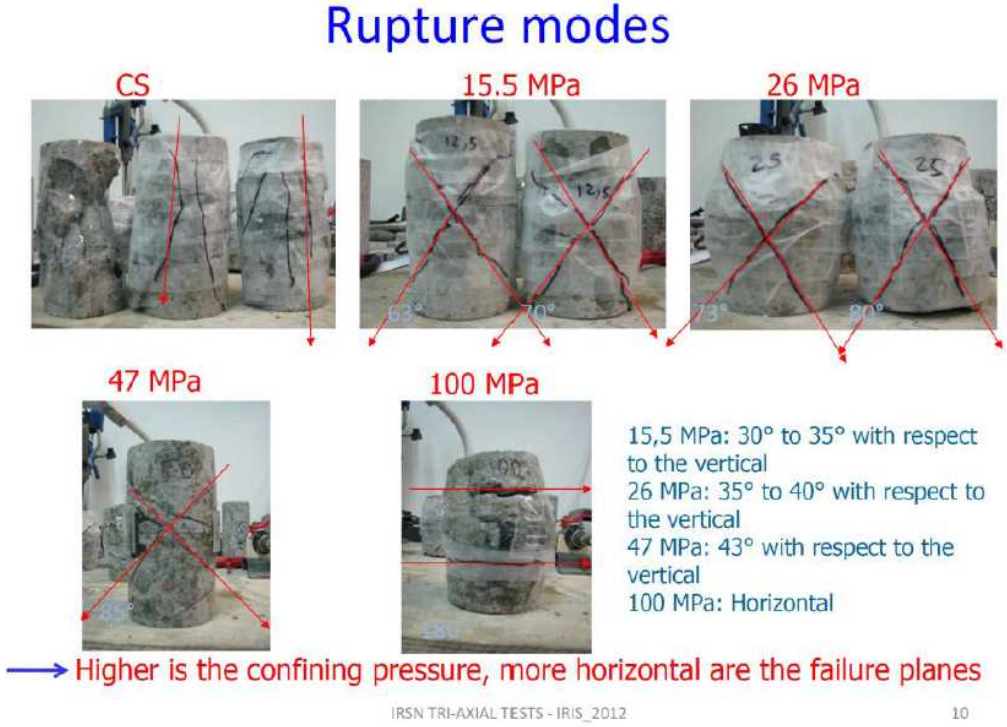
- Fit material model coefficients to data provided for concrete using trial and error (typically, not enough data is available)
- Create a 3D finite element mesh that replicates the actual experiment except with simplifications where possible
- Results are recorded on a MASSIVE spreadsheet and further post-processed to obtain pertinent data

Material model for concrete

- Triaxial concrete compression data was provided

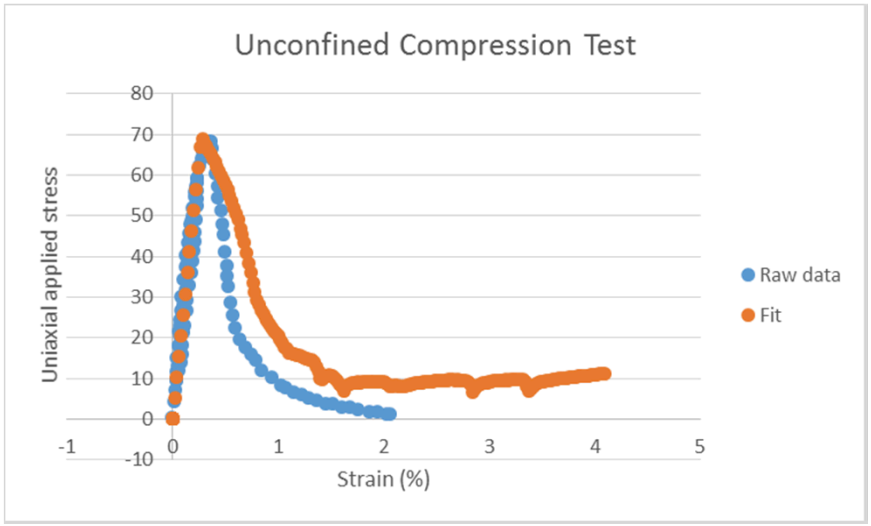


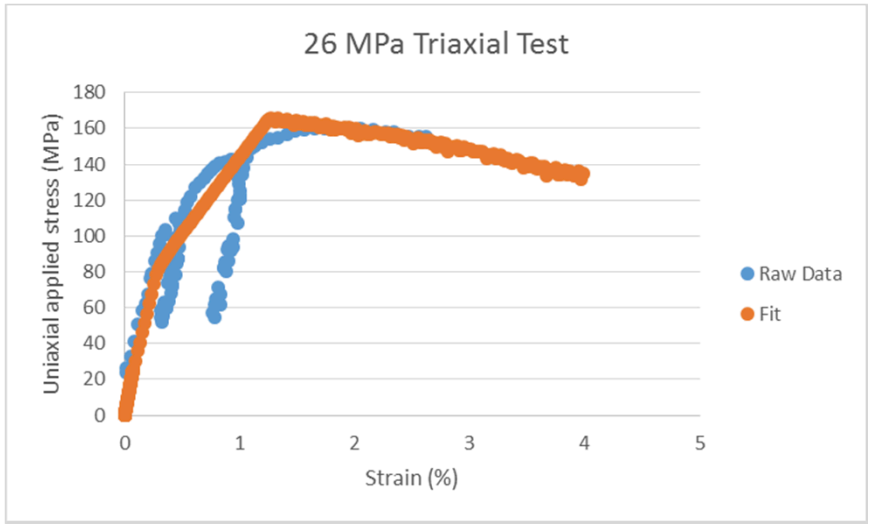
Triaxial Compression (TXC)

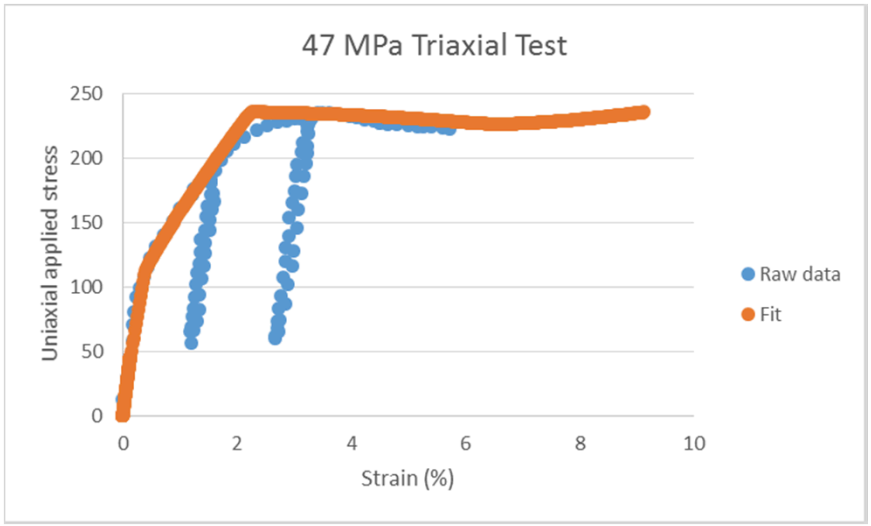


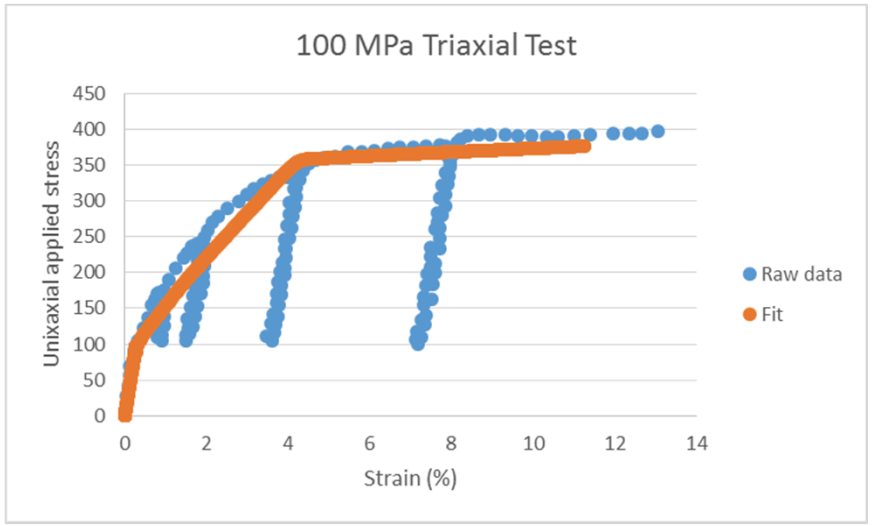
Johnson-Holmquist-Cook model for concrete

Sandia National Laboratories

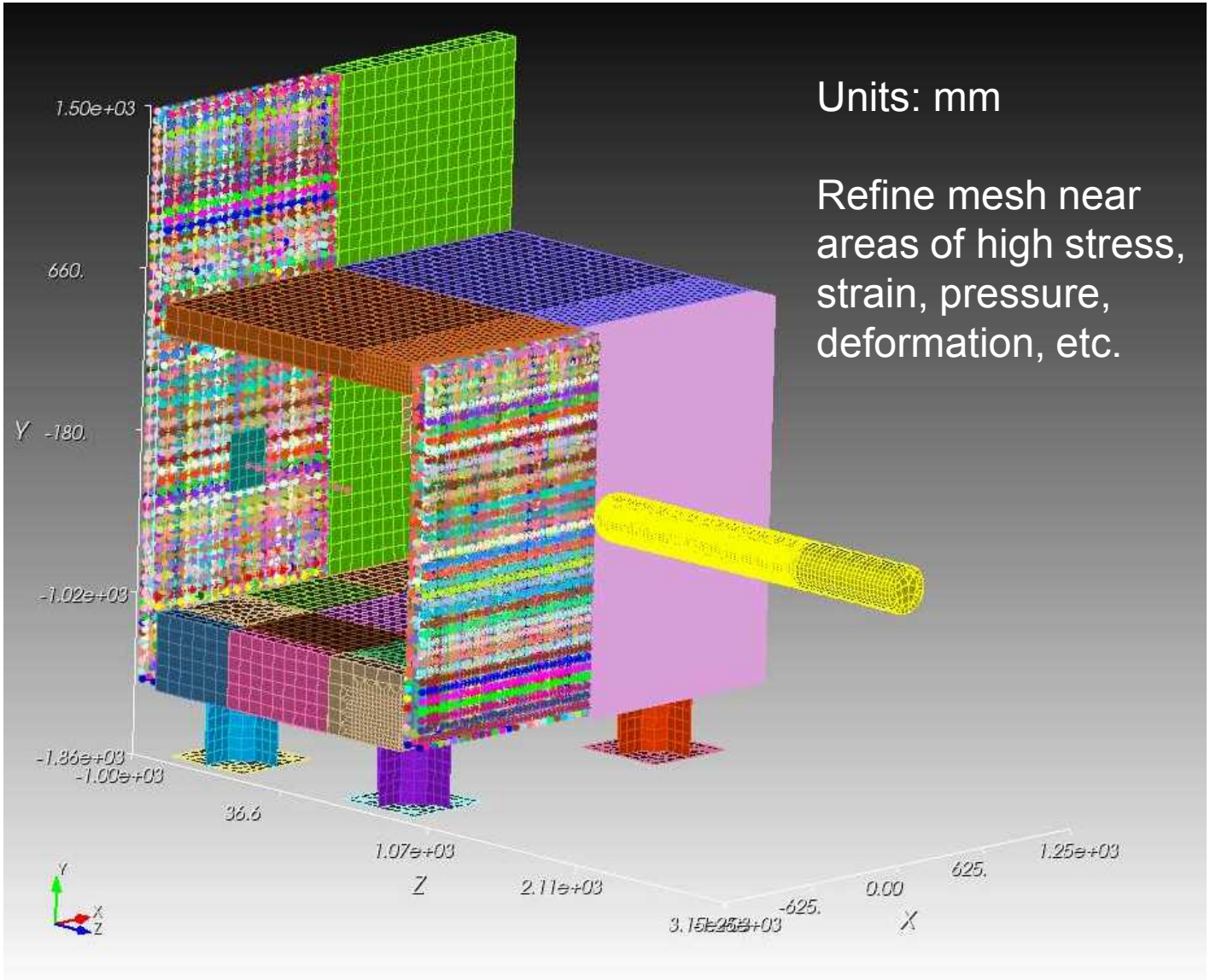








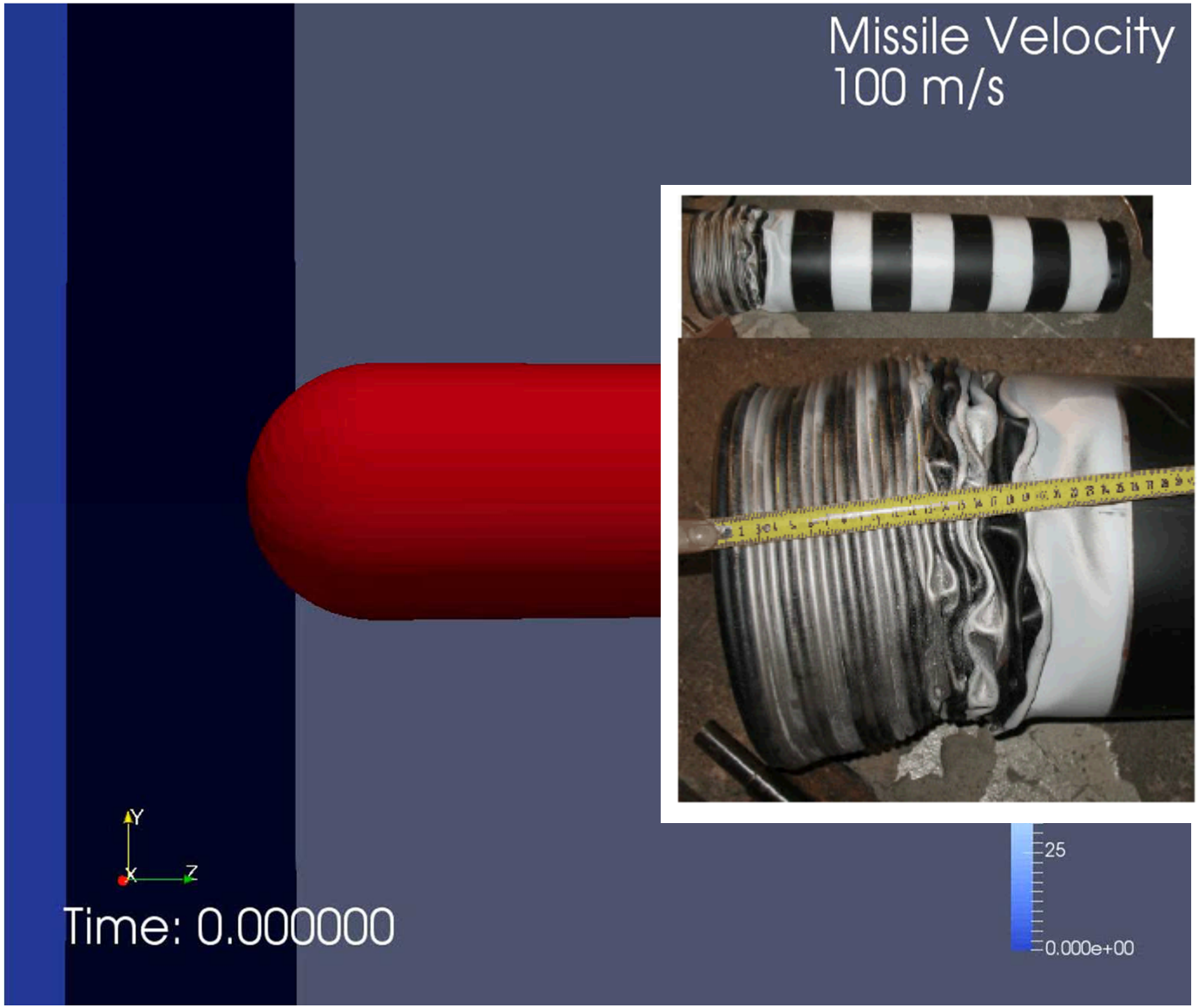
Finite element mesh



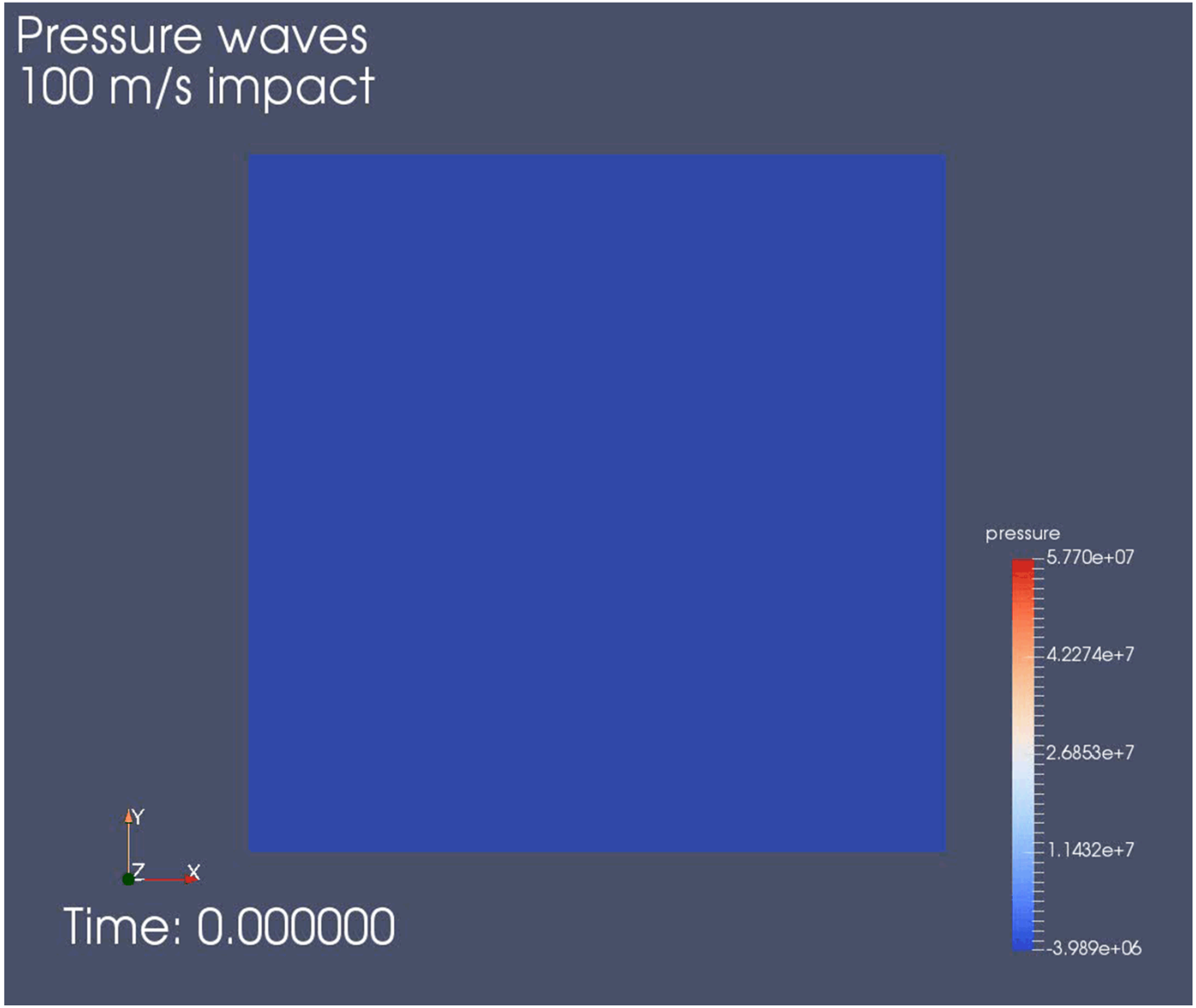
Units: mm

Refine mesh near areas of high stress, strain, pressure, deformation, etc.

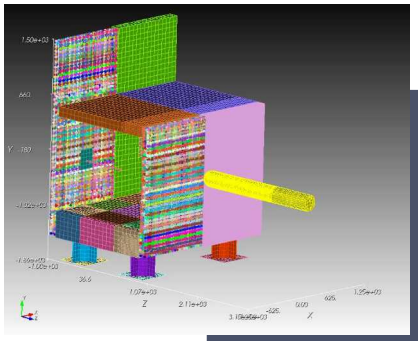
Discussion

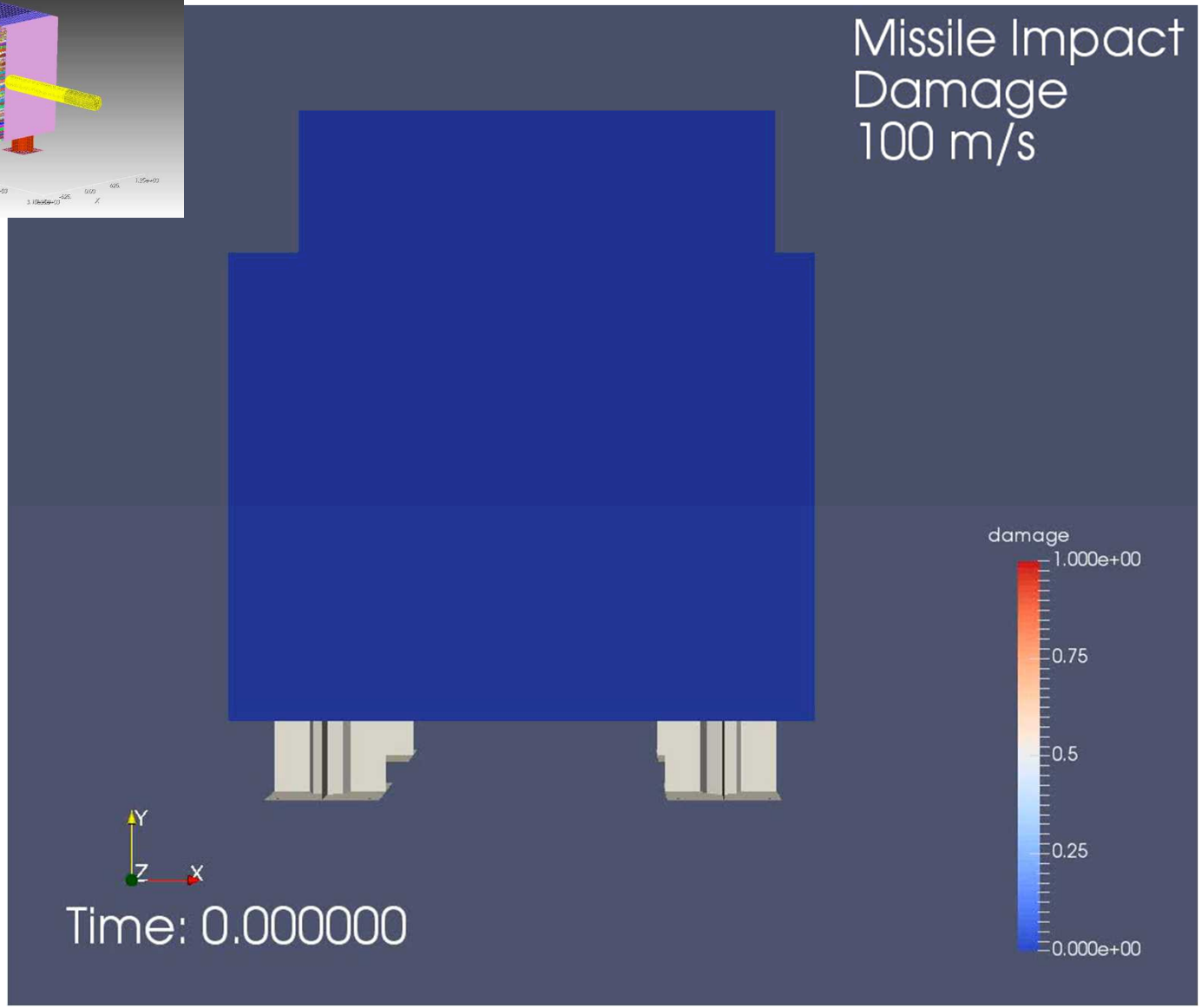


Discussion

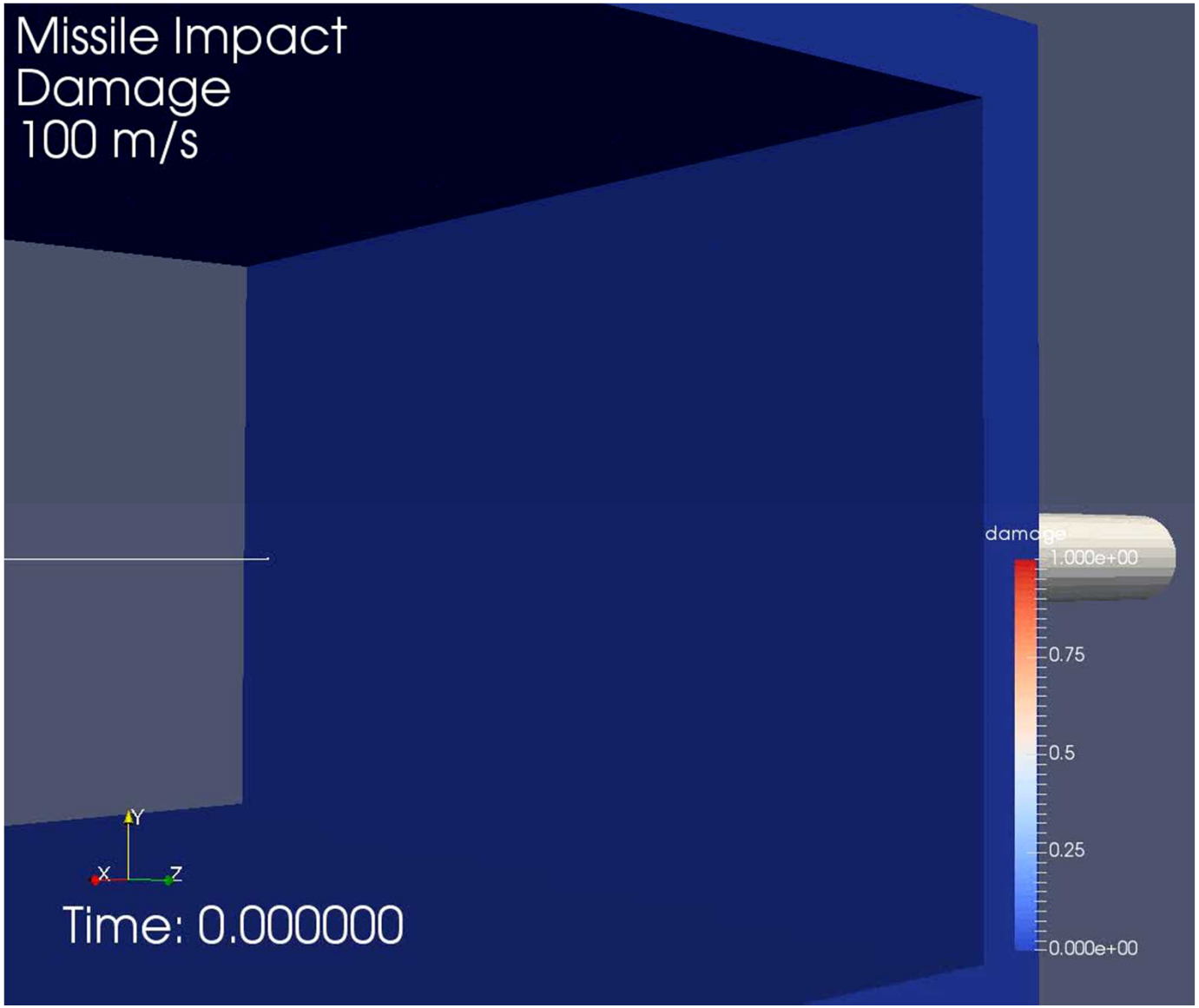

Pressure waves
100 m/s impact
pressure
5.770e+07
4.2274e+7
2.6853e+7
1.1432e+7
-3.989e+06
Y
Z
X
Time: 0.000000

Discussion




Missile Impact
Damage
100 m/s
damage
1.000e+00
0.75
0.5
0.25
0.000e+00
Y
Z
X
Time: 0.000000

Discussion


Missile Impact
Damage
100 m/s
damage
1.000e+00
0.75
0.5
0.25
0.000e+00
Y
X
Z
Time: 0.000000

Conclusion

Sandia National Laboratories

- Model accurately represents steel crumpling behavior
- Compare concrete structure failure to experiment
- Use model to simulate more scenarios that would otherwise be too expensive

- These modeling skills are applicable over an extremely wide range of industrial and academic applications

Personal: Joshua Hogancamp

Sandia National Laboratories

- Civil Engineering, PhD student
- Previous internship: US Army Corps of Engineers
- Previous research: Pervious concrete properties
- Current research: Carbon nanofiber reinforced cement pastes and mortars to enhance cracking resistance
- Future plans: *Graduate* (attempt to make crack-proof concrete in the process)