NTNU
Norwegian University of
Science and Technology

TKT4950 - Structural engineering
Master's thesis

# On the representation of fluid-structure interaction by artificial neural networks in blast loadings

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# Contents

# Chapter 1

# Introduction

Background, motivation and overview of thesis. Blast loads can be unintentional (accidental explosion, Beirut explosion), or intentional (terrorism, IED, Oslo 2011). Want to design structures that are resilient to blast loads. Structures has the potential to protect people from blast loads, but structural collapse can cause harm. Example: Pakistan Mosque suicide bombing. Fluid-structure interaction. Numerical simulation. Machine learning to represent fsi effects.

# Chapter 2

# Theory

Blast load, what is it, how do we study it? Experiments, simulations. Artifical neural networks as universal function approximators, the mathematics and implementation.

# Chapter 3

# Method

Run simulations of plates with defects using cheap FSI by multiplying the lagrangian pressure with cosine of angle. Train a ANN and see if it can replicate this cheap FSI, (it should pretty much 100%). Integrate the neural net with abaqus.

Simulate the plate using fully coupled FSI in Europlexus. Train an AI on this. Evaluate. Investigate if the material properties can be accounted for in the neural net.

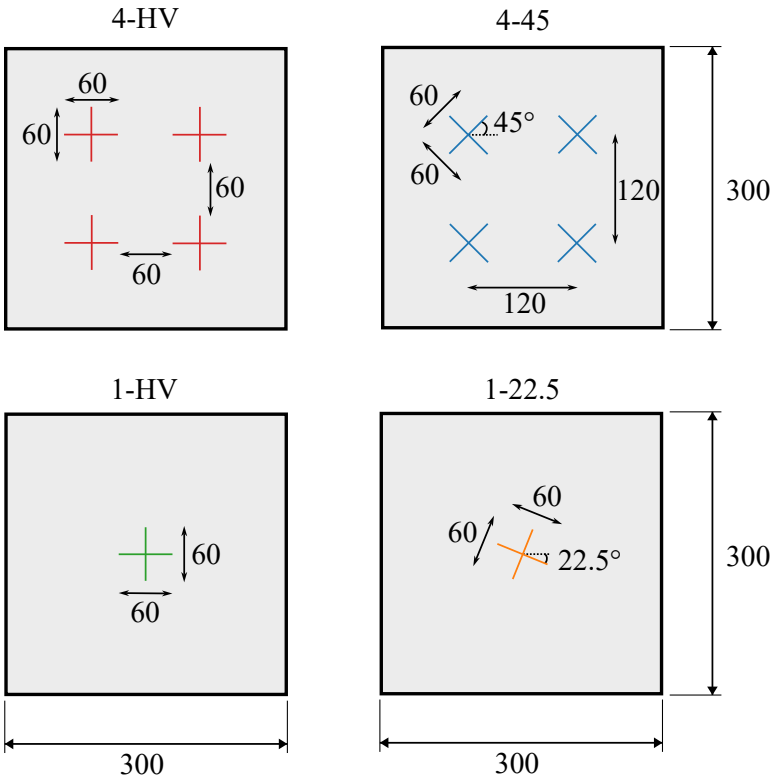
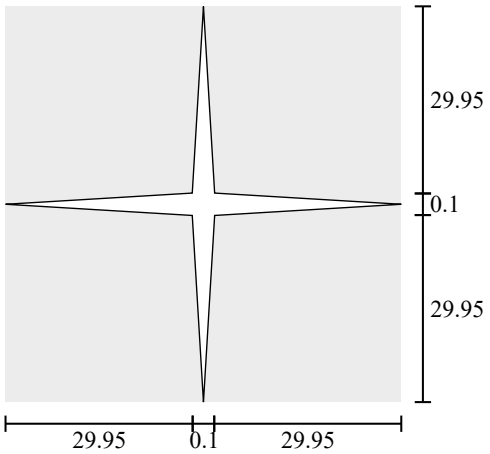



Figure 3.1: Bottom text

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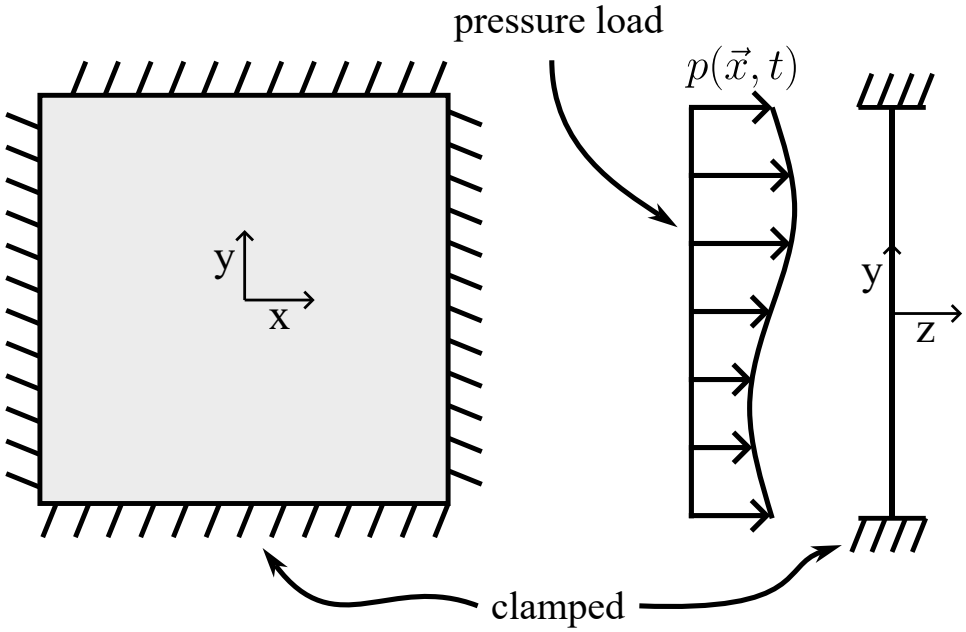


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# Chapter 4

# Results

Present the results from following the procedures in Method, note some observations, but do not discuss them.

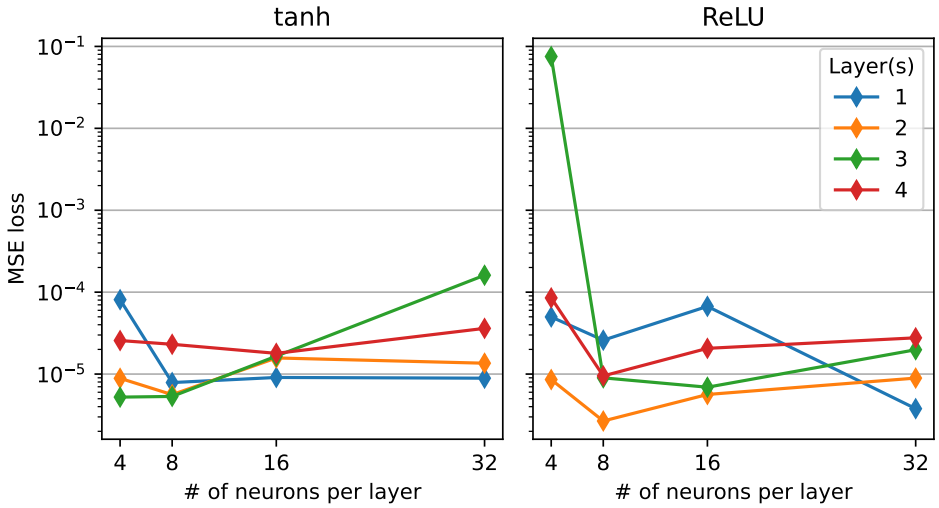
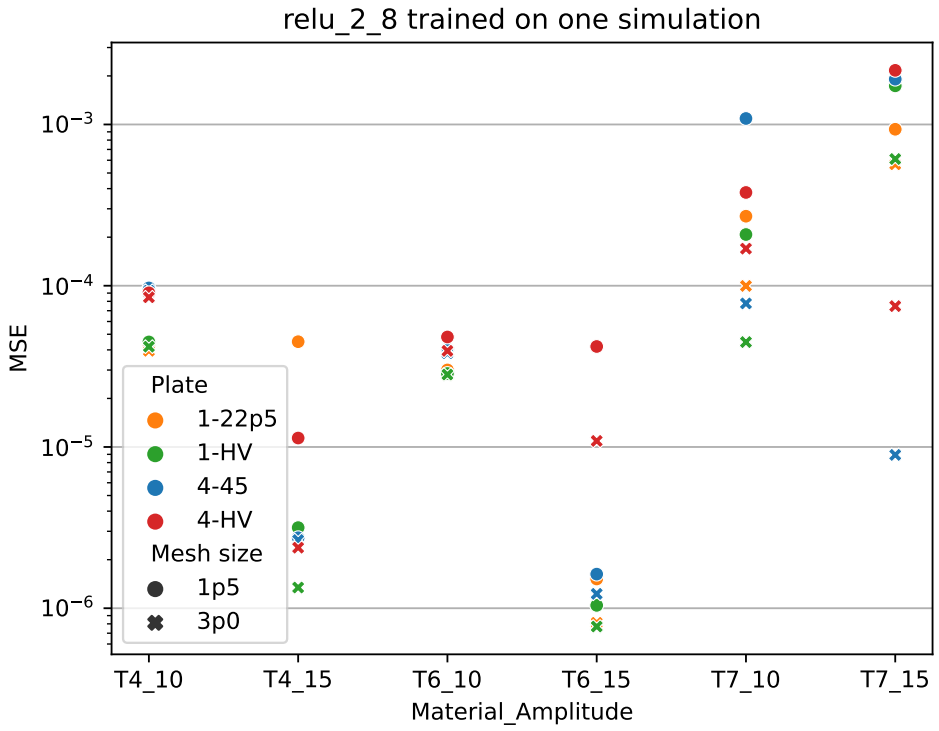



Figure 4.1: Final training losses for different network architectures defined by activation function, number of hidden layers and number of neurons per hidden layer

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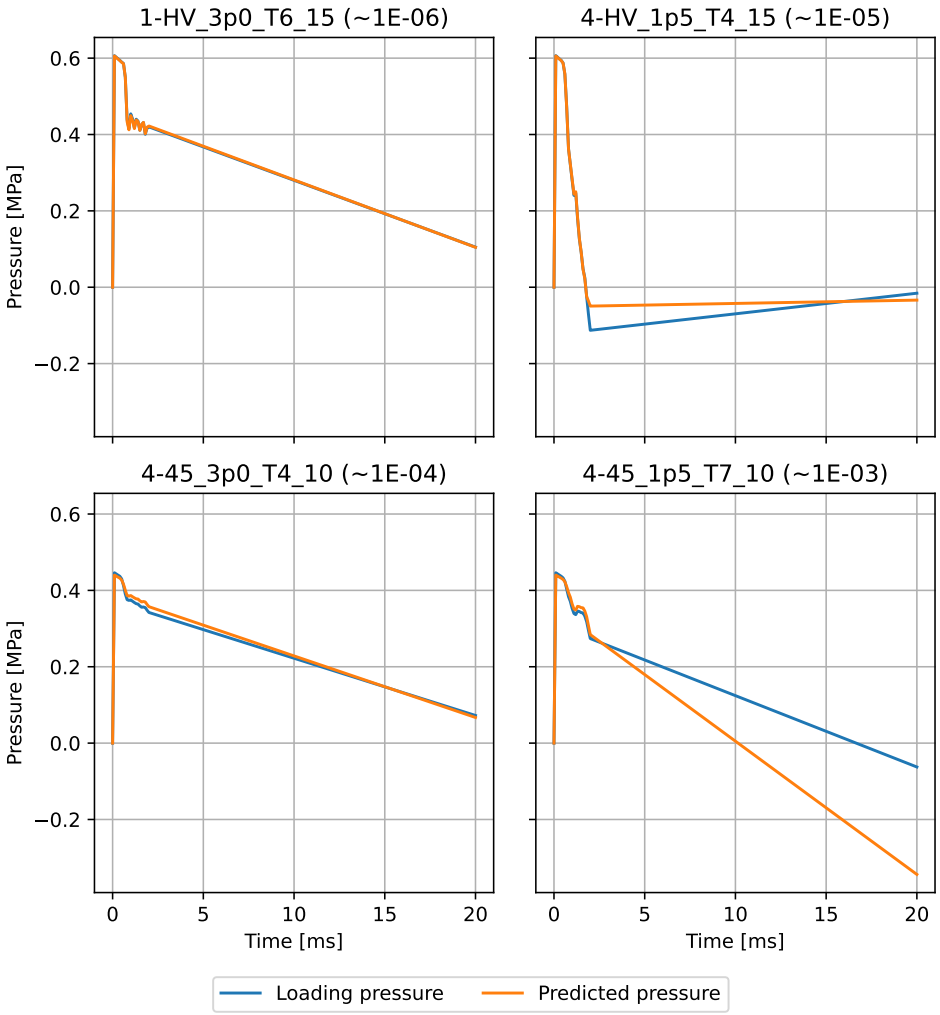


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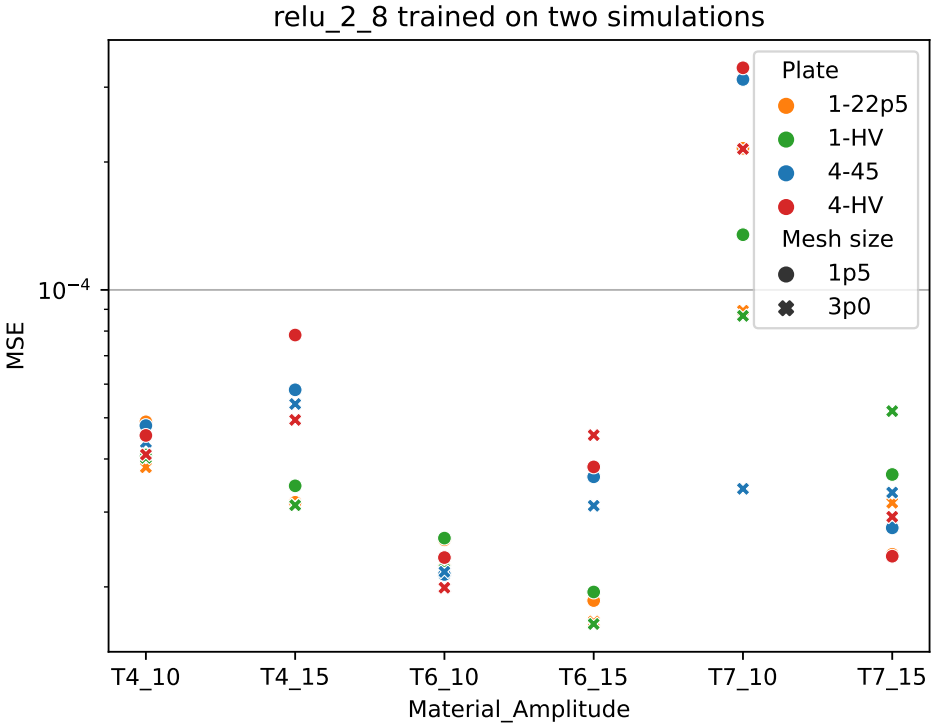


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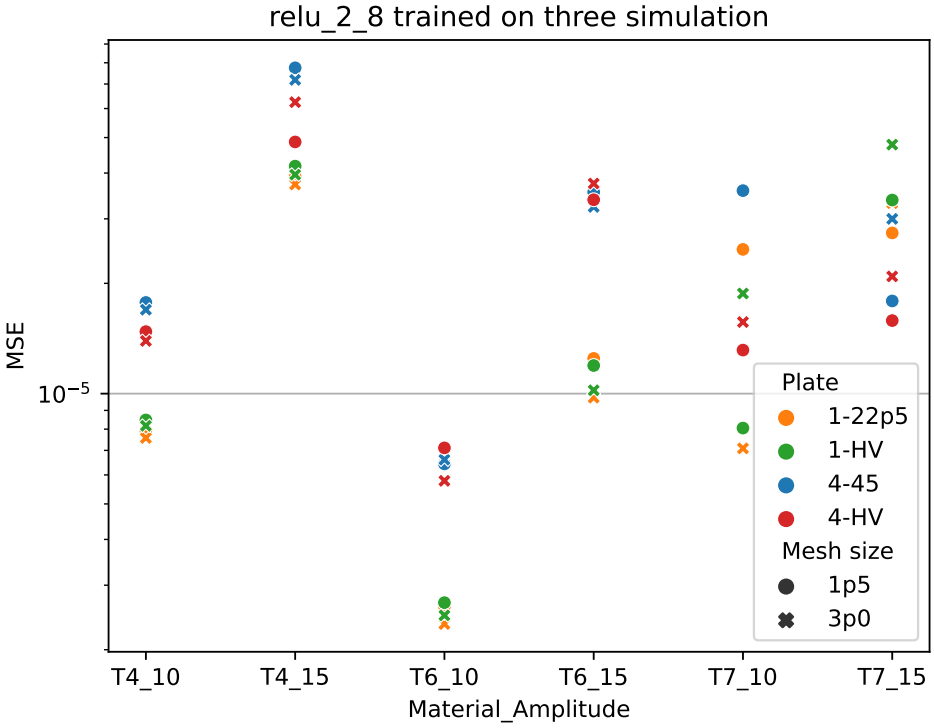


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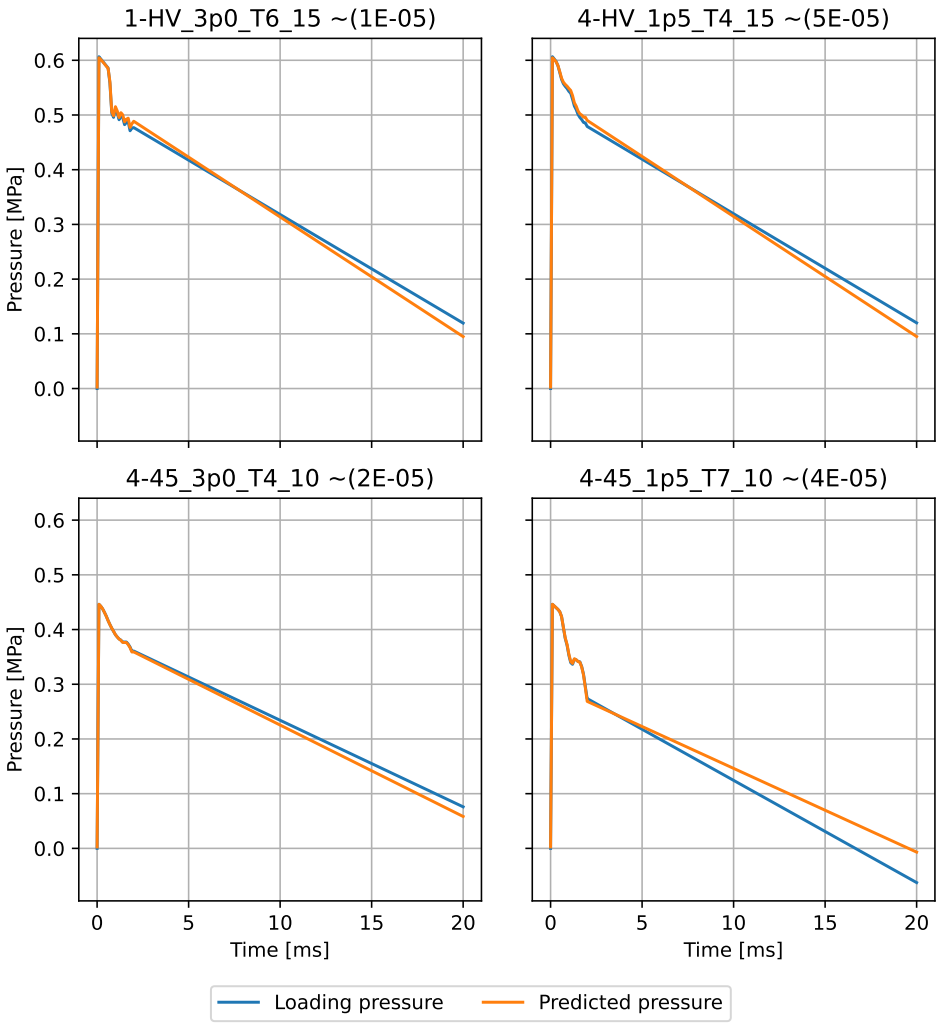


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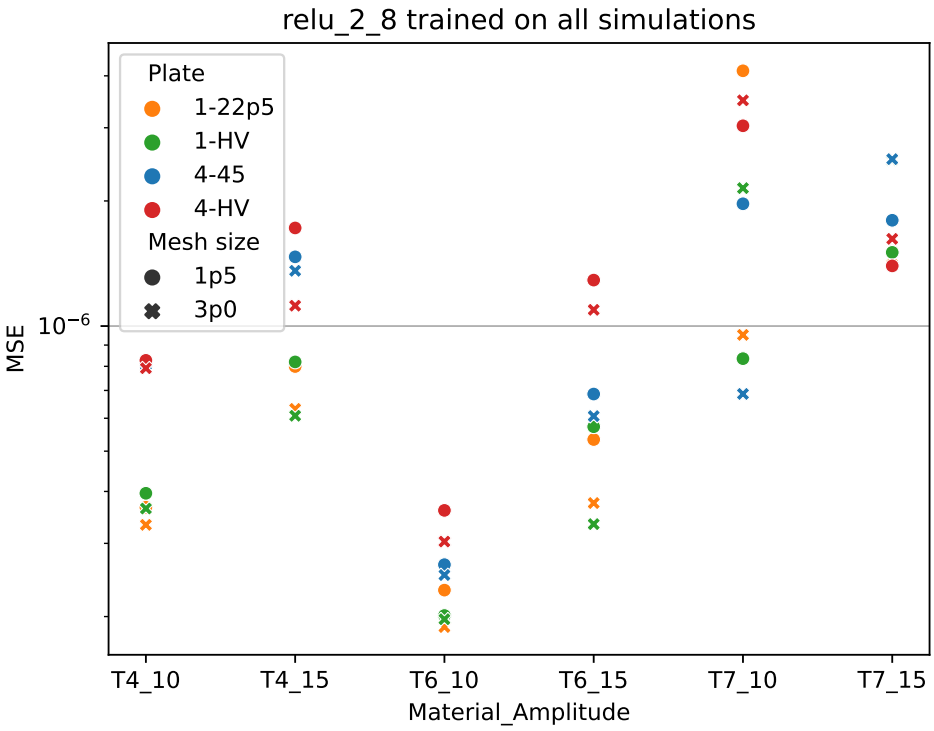


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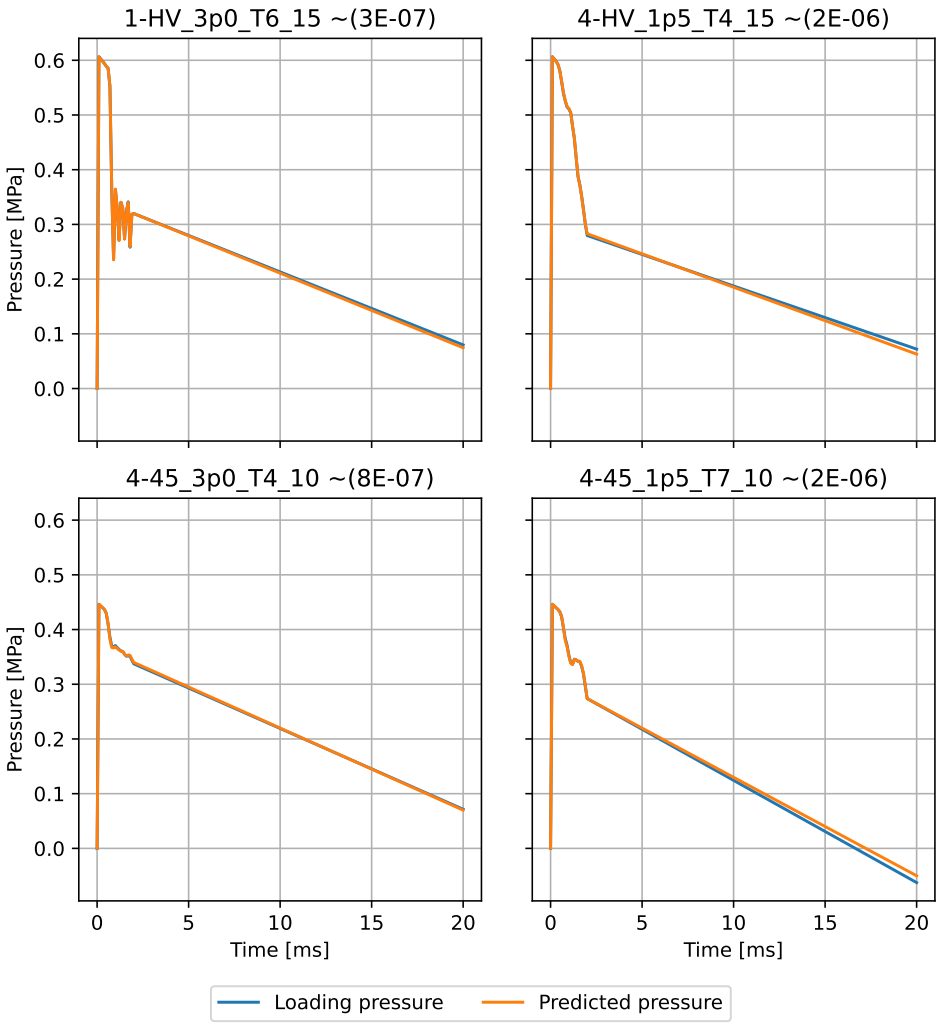


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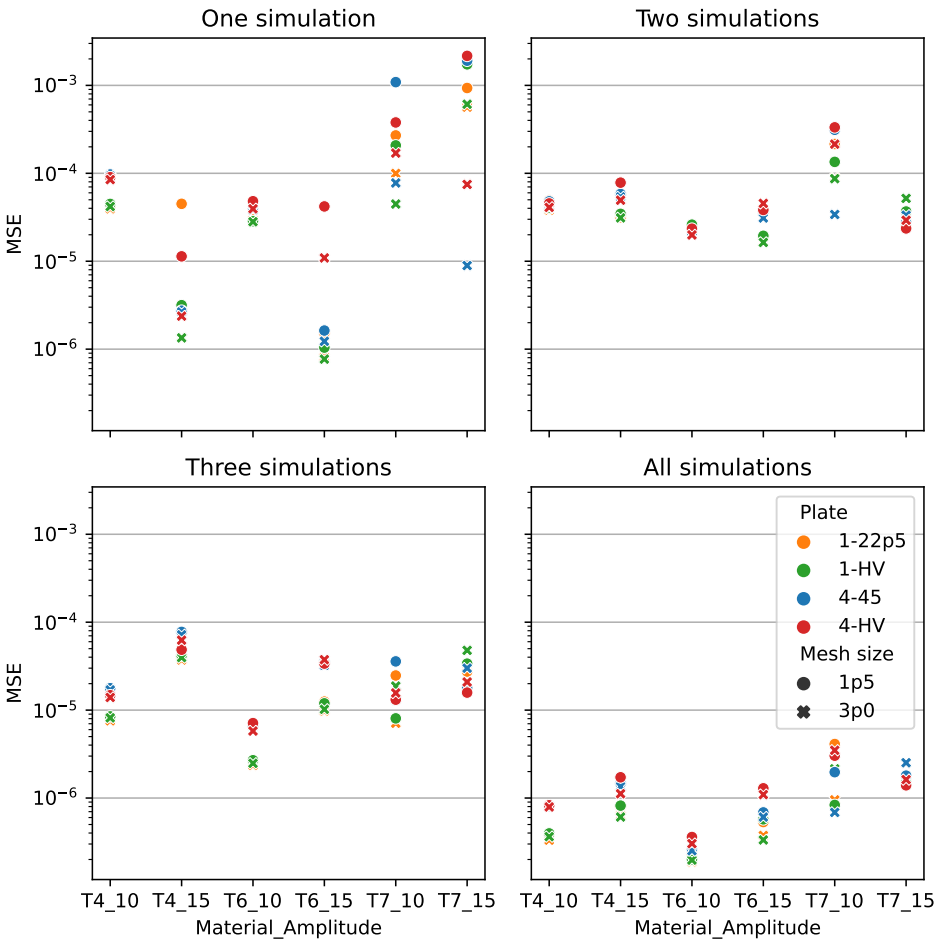


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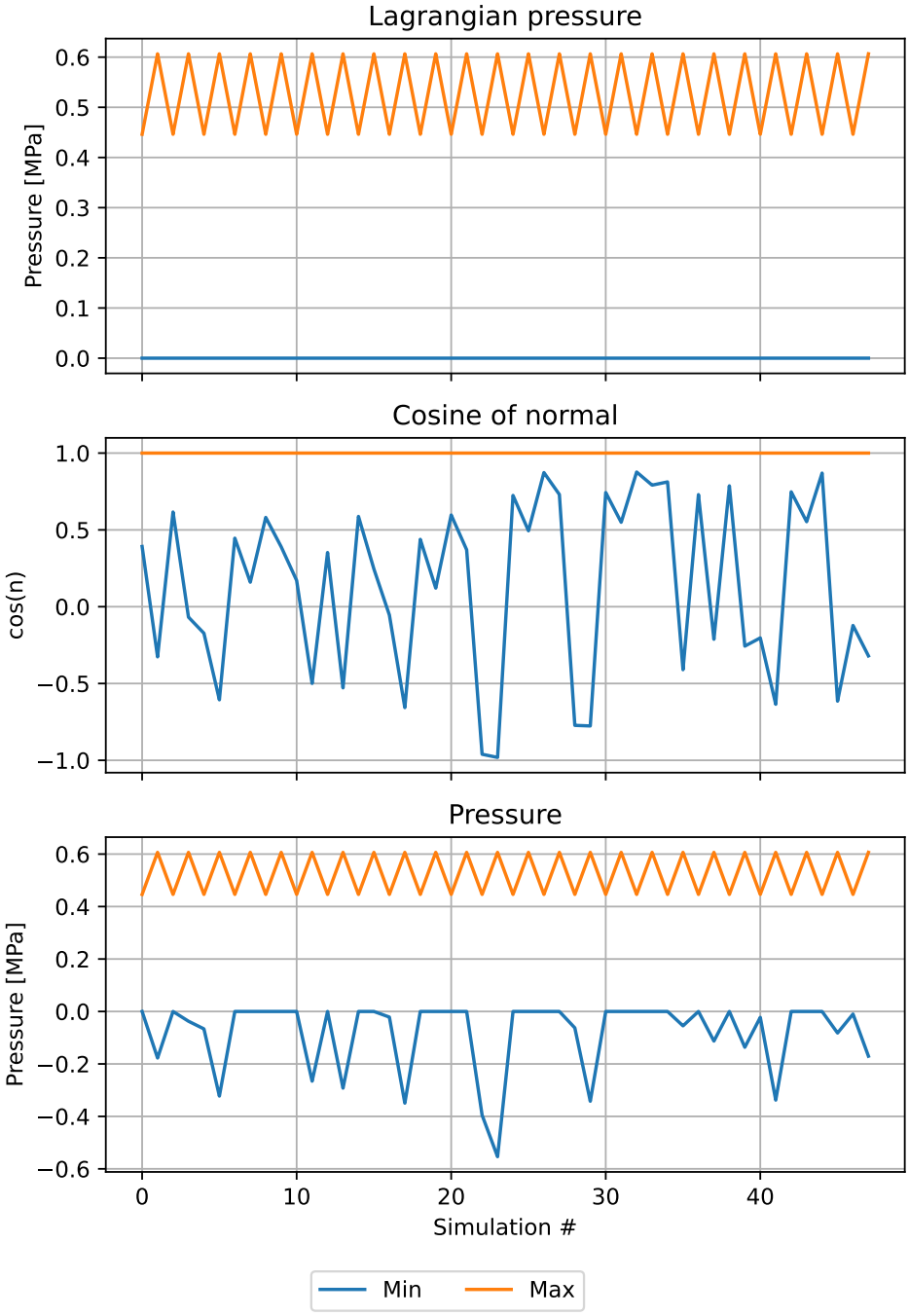


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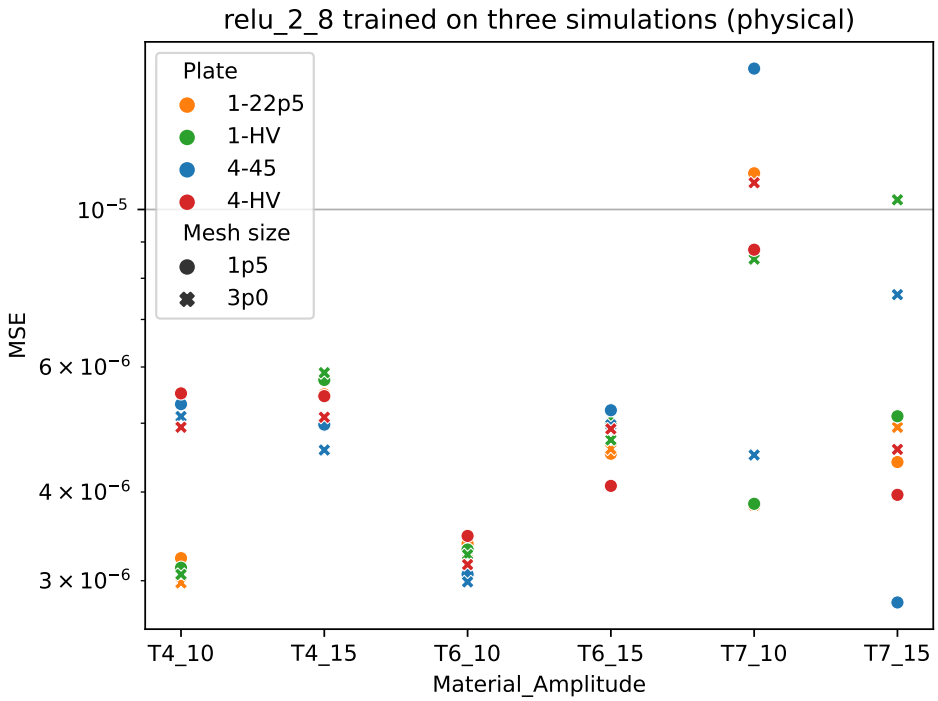


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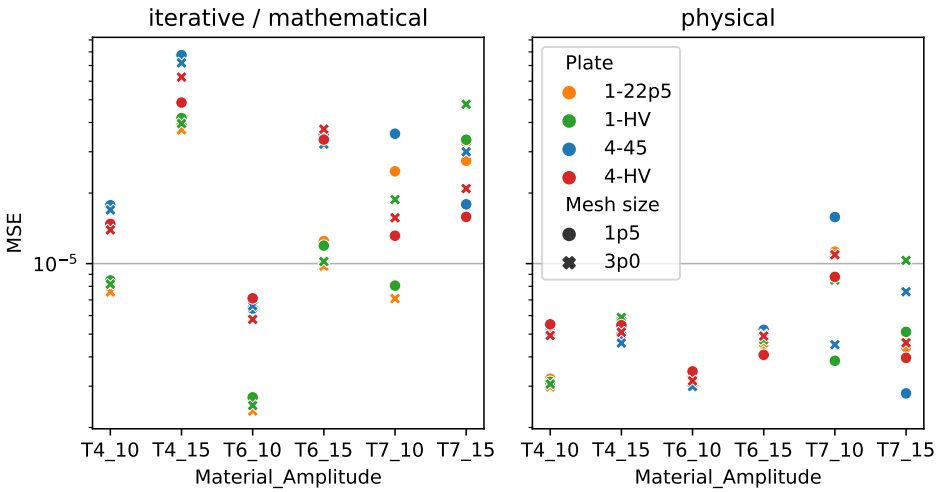


Figure 4.12: Bottom text

# Chapter 5

# Discussion

Discuss the results

# Chapter 6

# Conclusions

Conclusion, further work.

# Bibliography

[1] Vegard Aune. *Behaviour and Modelling of Flexible Structures Subjected to Blast Loading*. PhD thesis, Norwegian University of Science and Technology, 2017.

[2] H. Granum, D. Morin, T. Børvik, and O.S. Hopperstad. Simulation of blast-loaded aluminium plates with crack-like defects. *MekIT 19*, 2019.