



FISHWALL

Fire and Seismic performances of Hybrid fire WALLs in case of single-storey industrial and commercial steel buildings



UNIVERSITY
OF TRENTO

SESSION: ... Experimental campaign – Results and exploitation of fire tests

- **Material tests on aluminium bolts**
- František WALD | Meganatha VIJAYAKUMAR.
- CVUT in Prague

Introduction

➤ Separation of the structures during fire

- Fusible link
- Special device
- Aluminium bolts

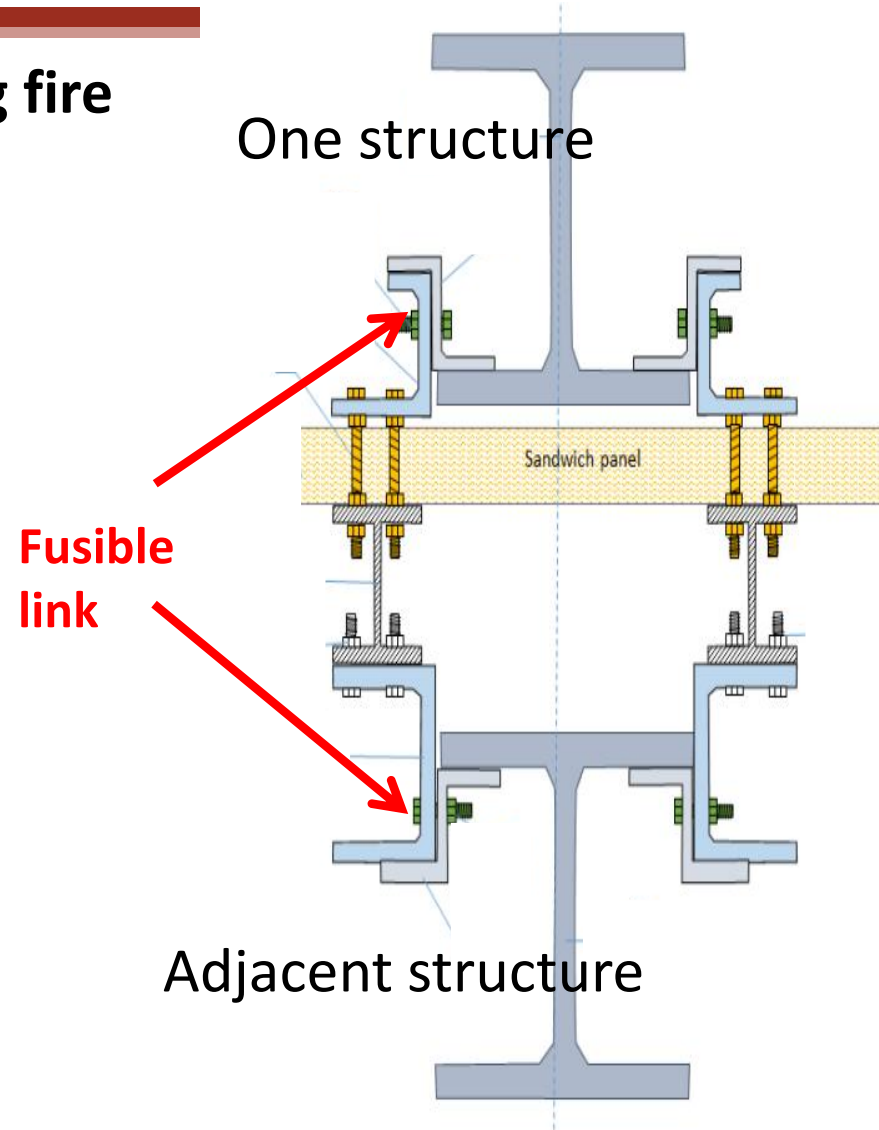
➤ Experiments

- Bolts
- Wall

➤ Numerical simulation

- Geometry
- Load path
- Volume Model

Investigated Fusible system



List of contents

- Experiments in tension
- Experiments in shear
- Degradation of stress-strain relationship
- Numerical simulation in fusible link
- Bolt spring models

Failure modes in tension



Test setup



Heating by
ceramic pads



100°C



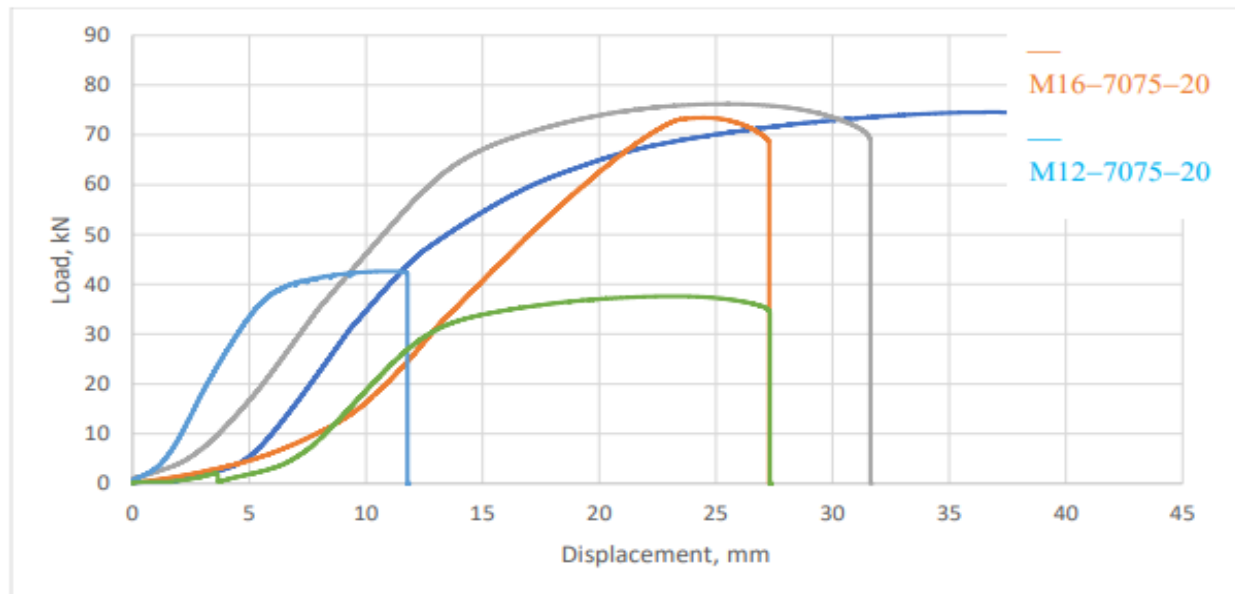
200°C



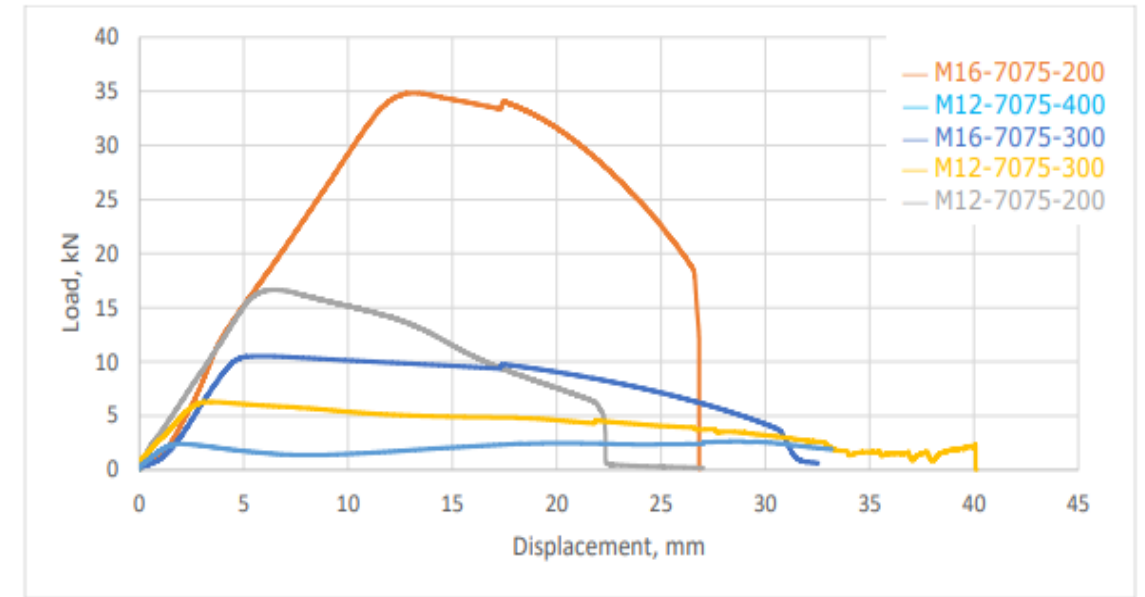
300°C

Load displacement curves in tension

➤ At 20 °C

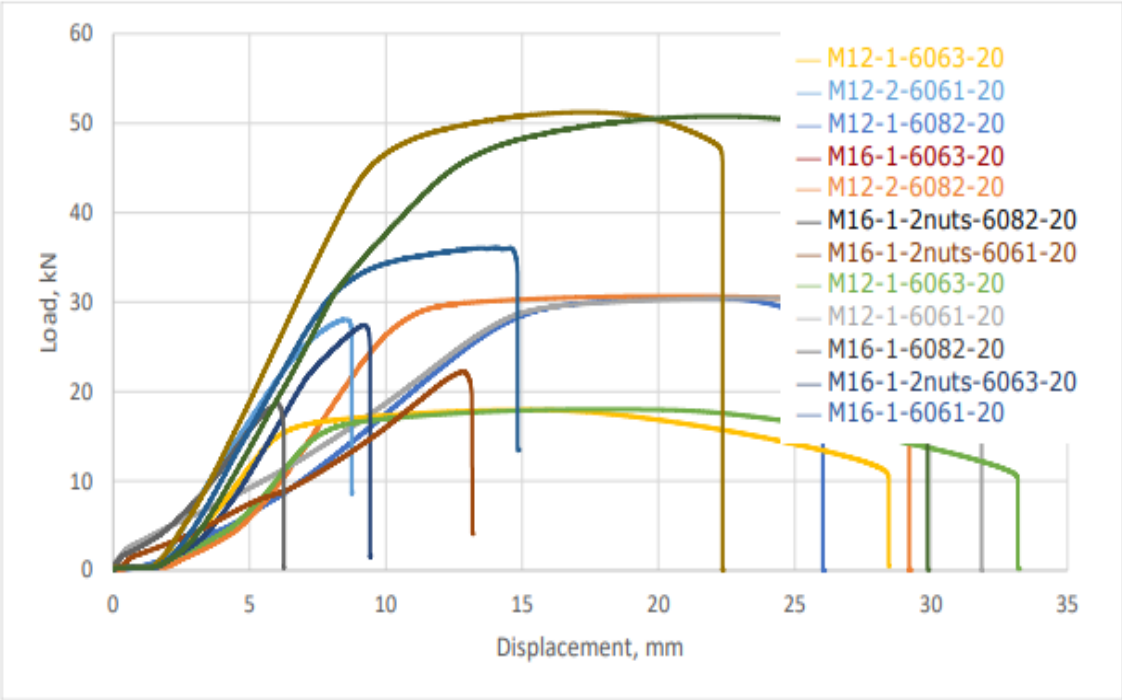


➤ At 200 °C – 400 °C

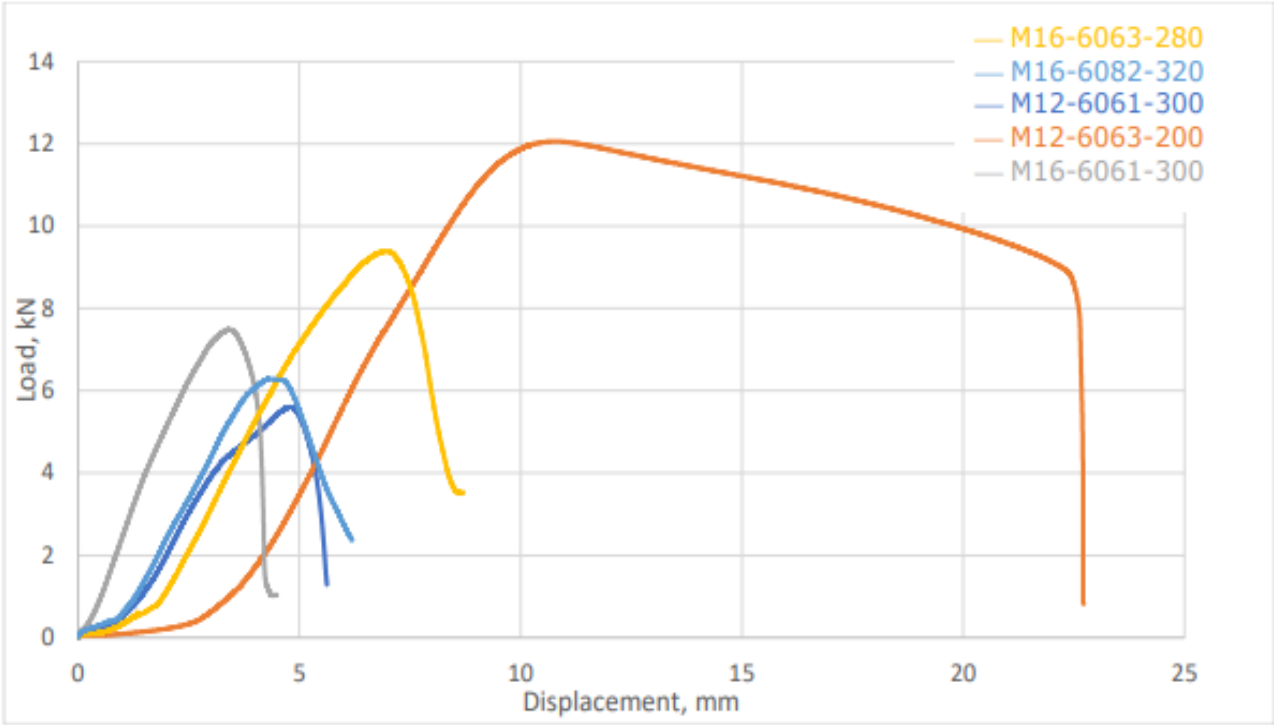


Different alloys in tension AL6XXX

➤ At 20°C

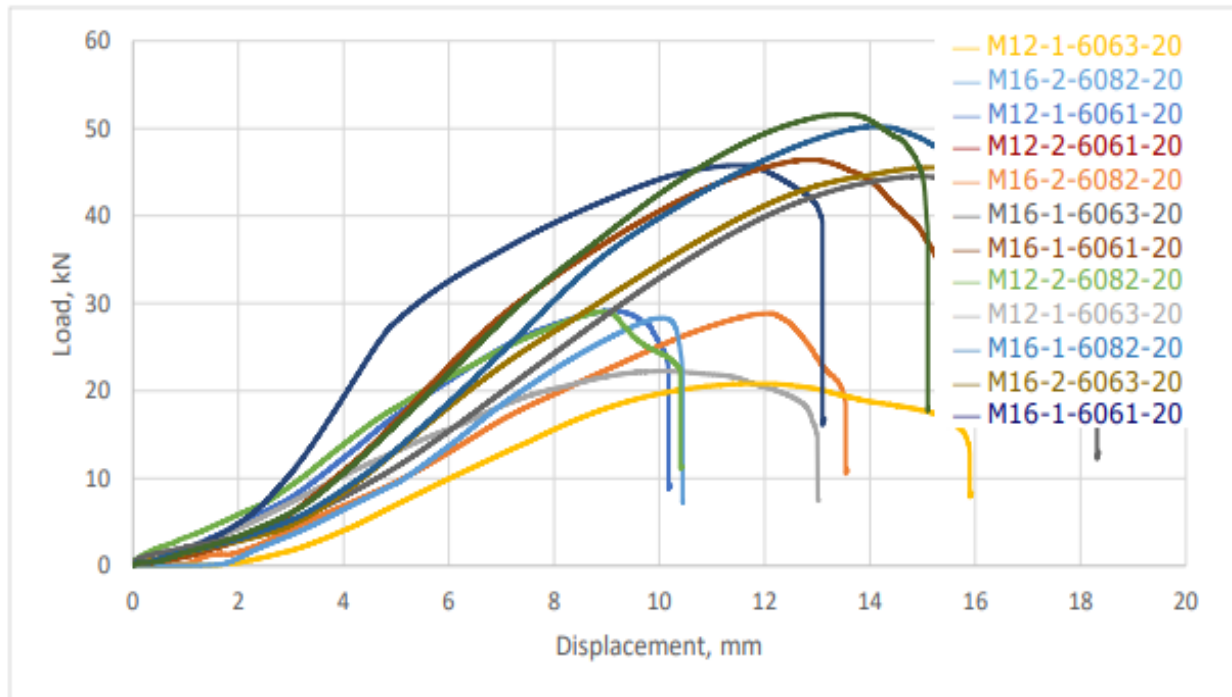


➤ At 200°C - 320°C

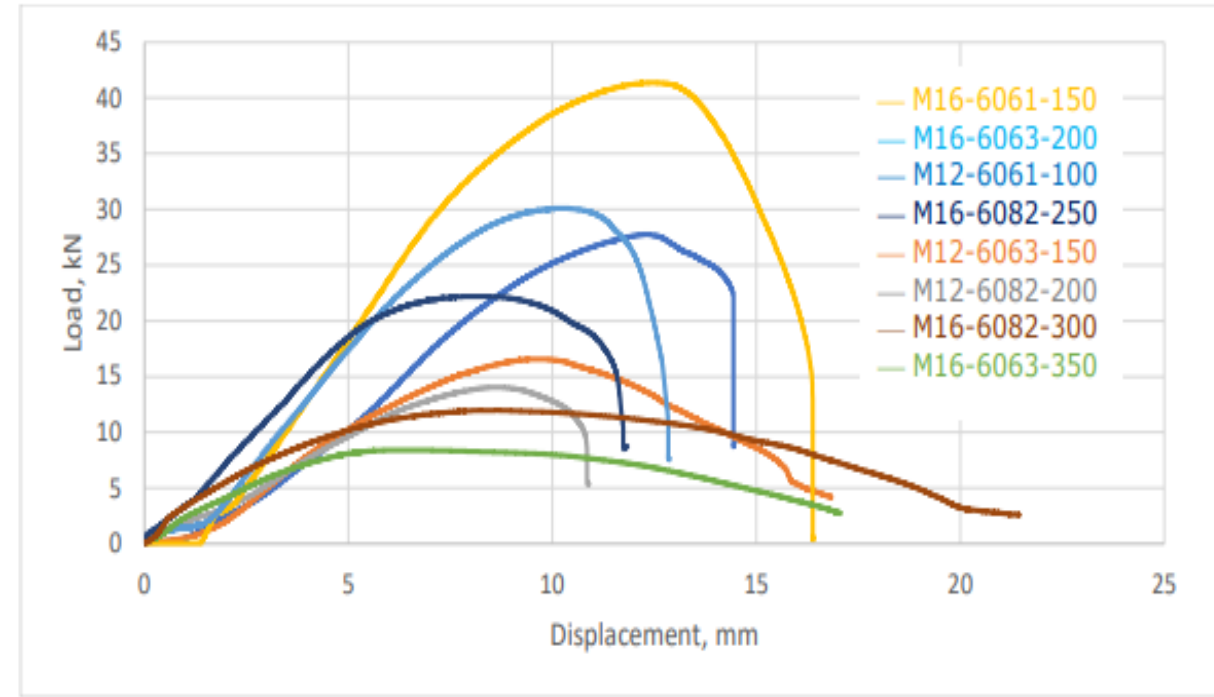


Tension AA6XXX

➤ At 20°C



➤ At 200°C - 350°C



Failure modes in shear



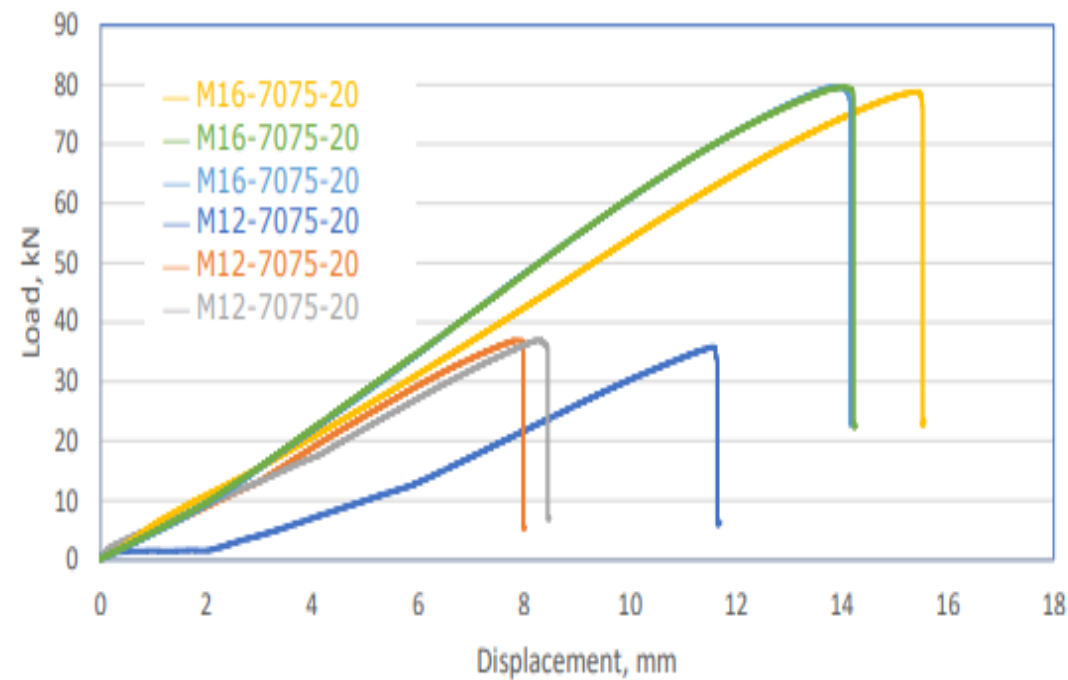
Bolts at 20 °C & 350 °C
AL 6XXX series



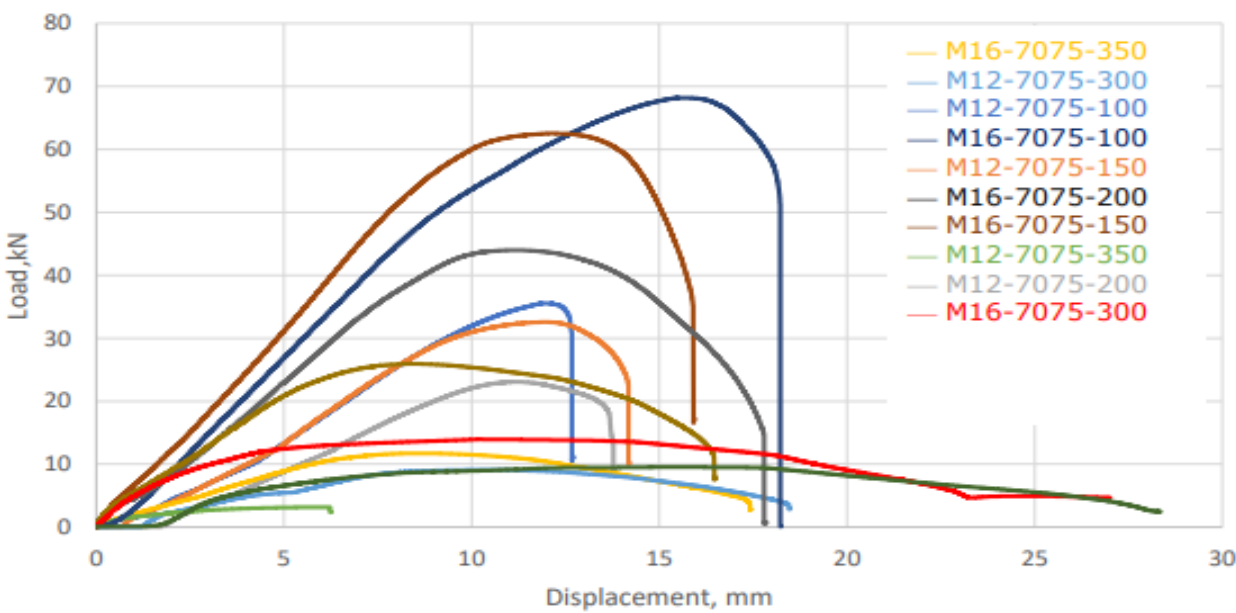
Bolts at 100 °C – 350 °C)
(AL7075)

In shear AL7075

➤ At 20°C



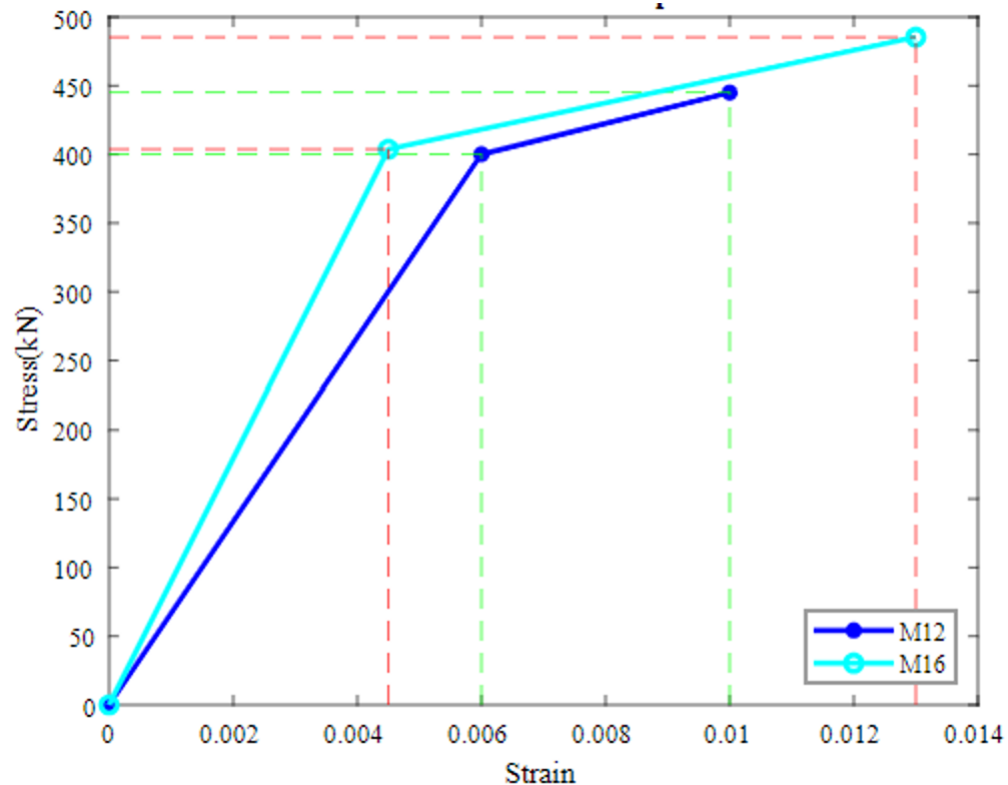
➤ At 200°C - 350°C



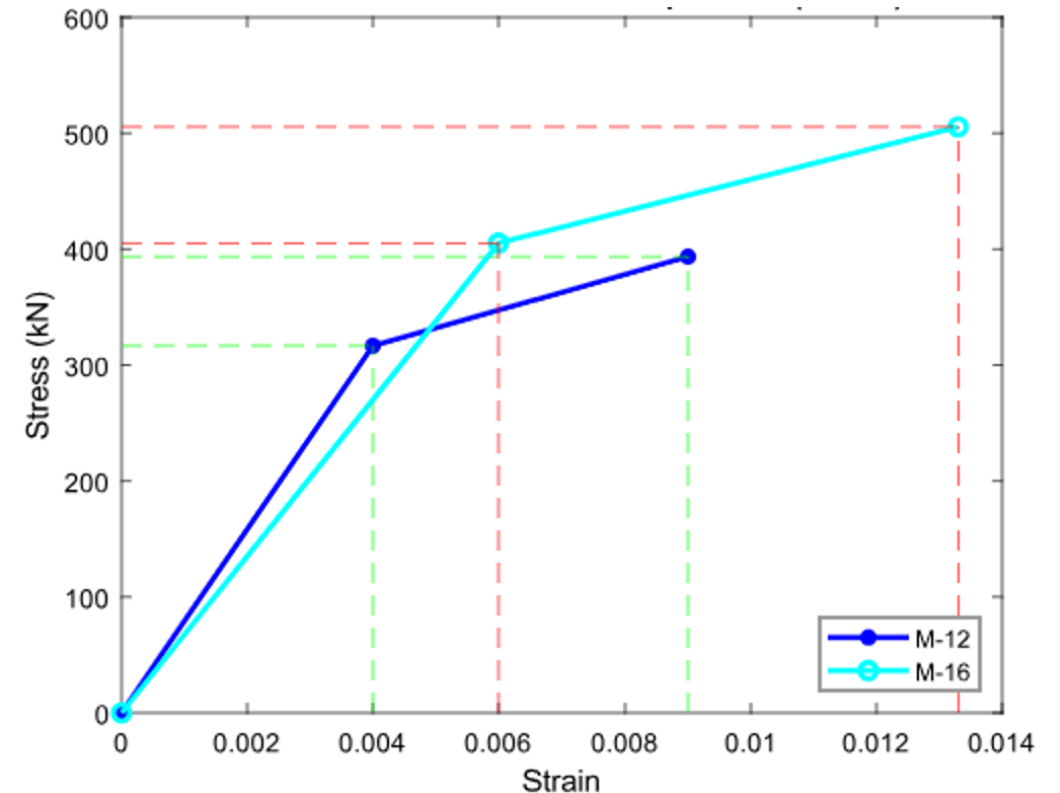
Numerical model

➤ Bilinear material models based on the bolt experiments

➤ Ambient temperature

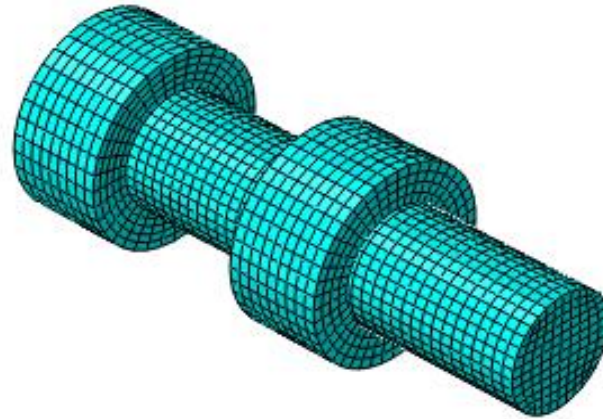


➤ Elevated temperature



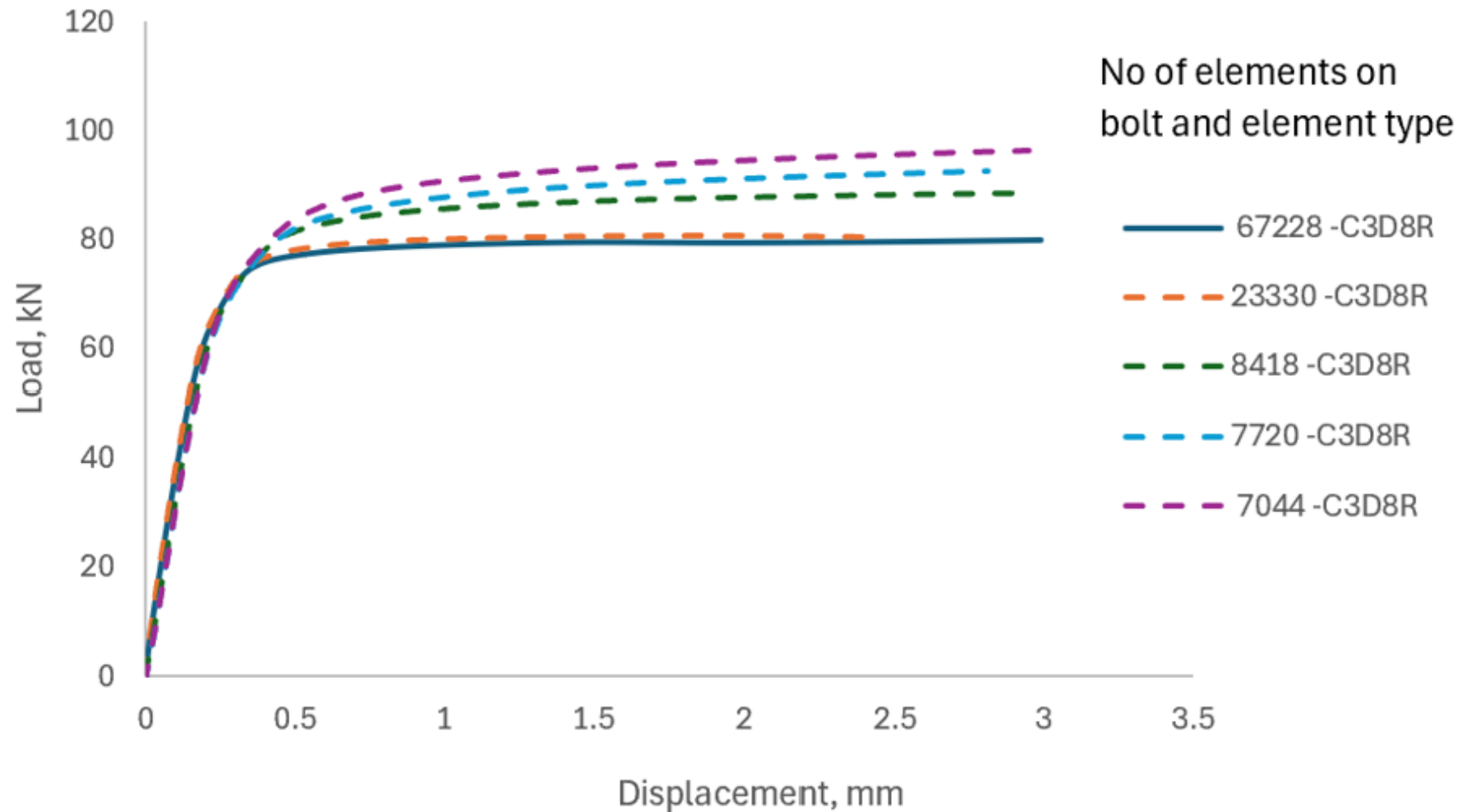
Numerical model

- Volume elements C3D8R
- Fine mesh
- ABAQUS v6.14



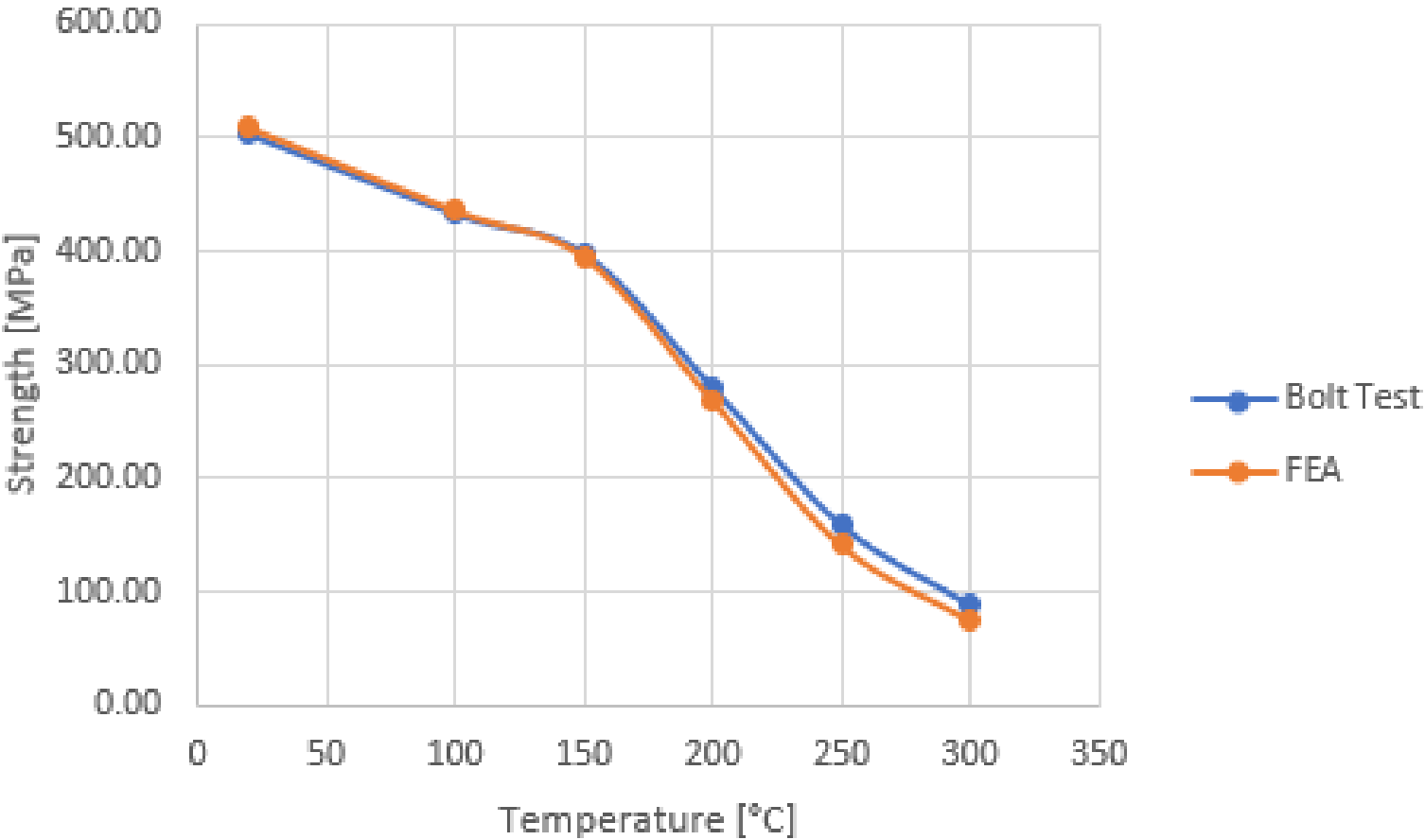
Numerical Model

➤ Mesh Sensitivity Study



Numerical model

➤ Validation of bolt numerical model loaded in tension at elevated temperature

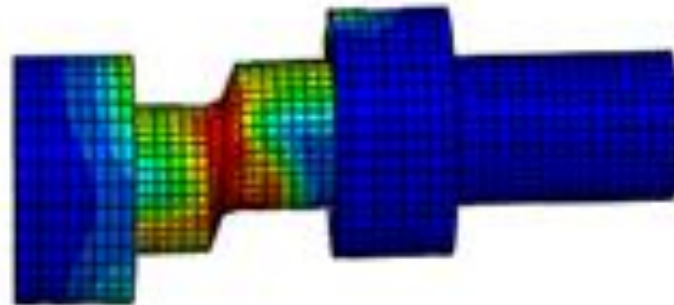
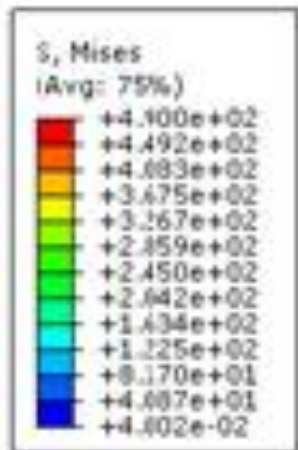


Material	Temperature	Strength		Test/FEA
		Bolt	FEA	
				[-]
AA-7075	20	503	509	0.98
AA-7075	100	433	436	0.99
AA-7075	150	398	395	1.0
AA-7075	200	280	268	1.0
AA-7075	250	159	141	1.12
AA-7075	300	89	75	1.18

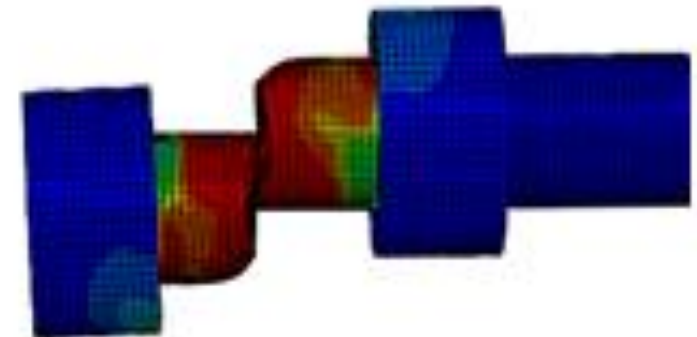
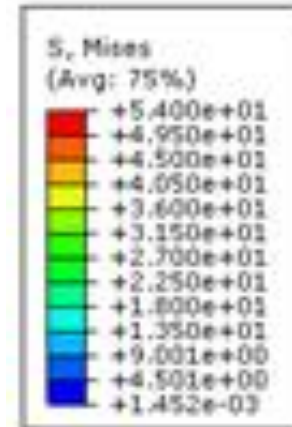
Numerical Model

- Loading in shear
- Von Mises stress distribution in the deformed bolts

➤ at 20°C

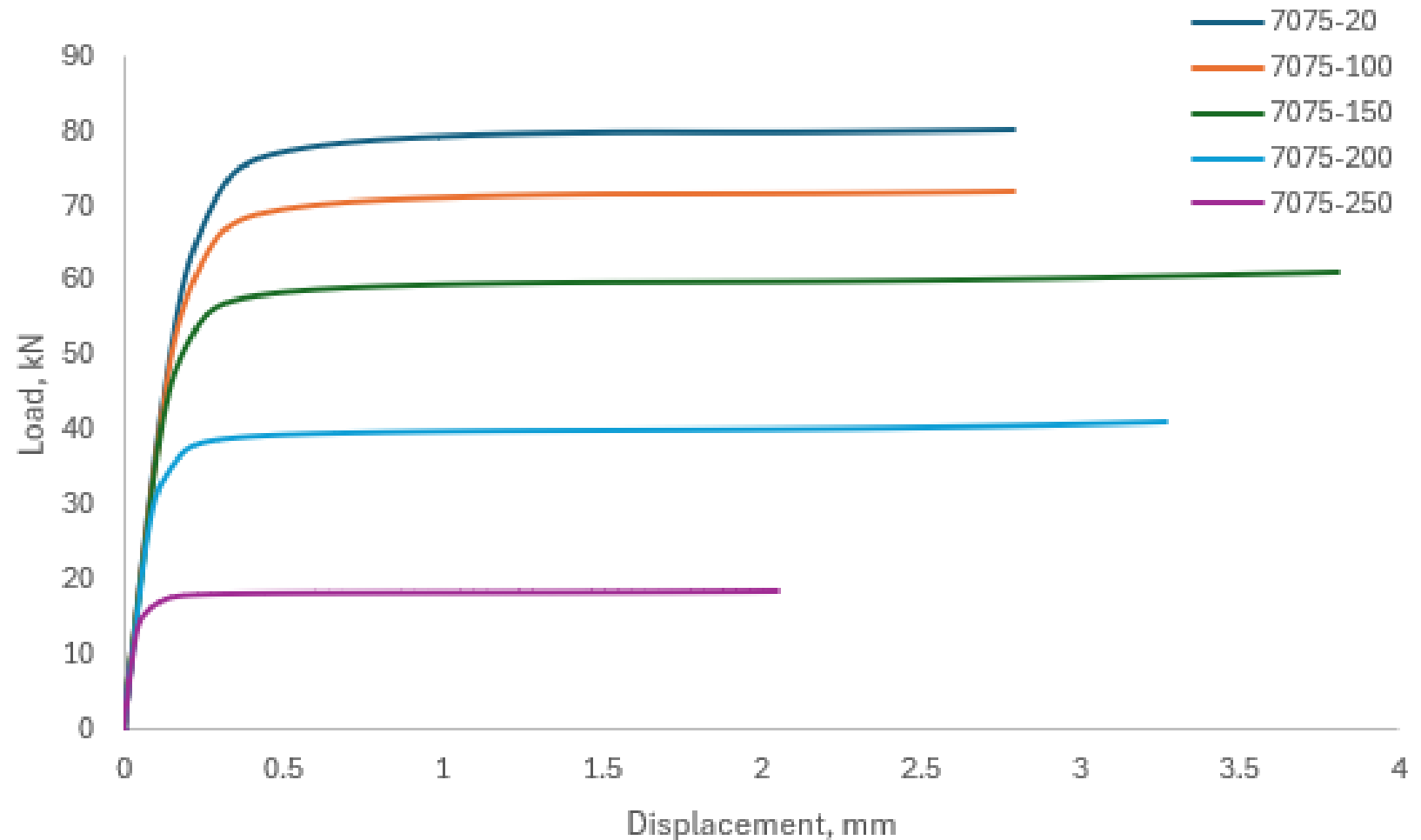


➤ at 300°C



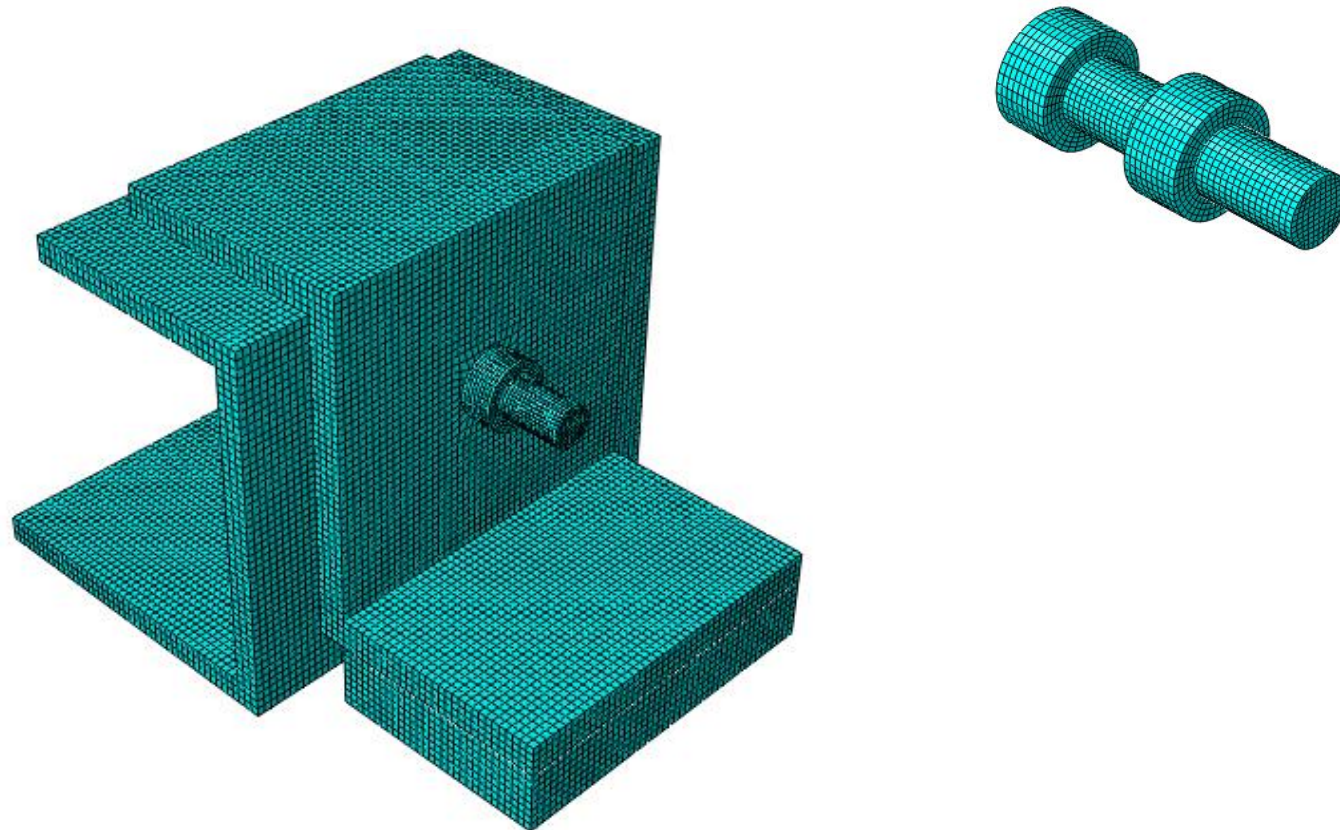
Numerical model

➤ Degradation of aluminium bolt at elevated temperature



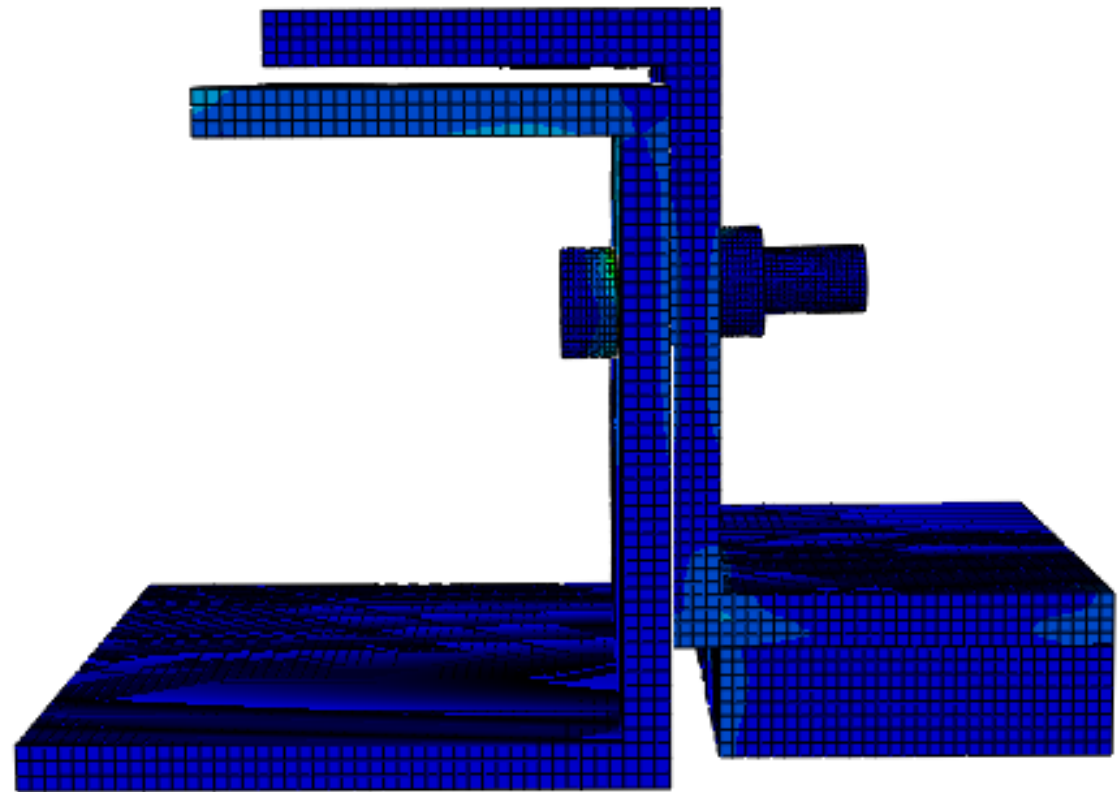
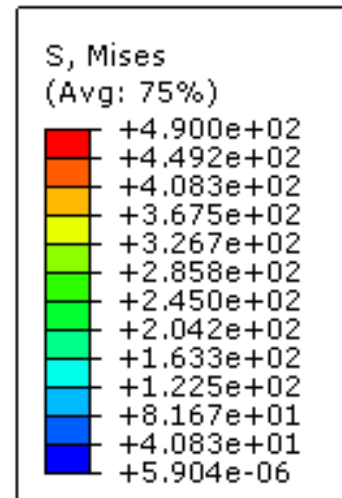
Numerical model

➤ Model of fusible link



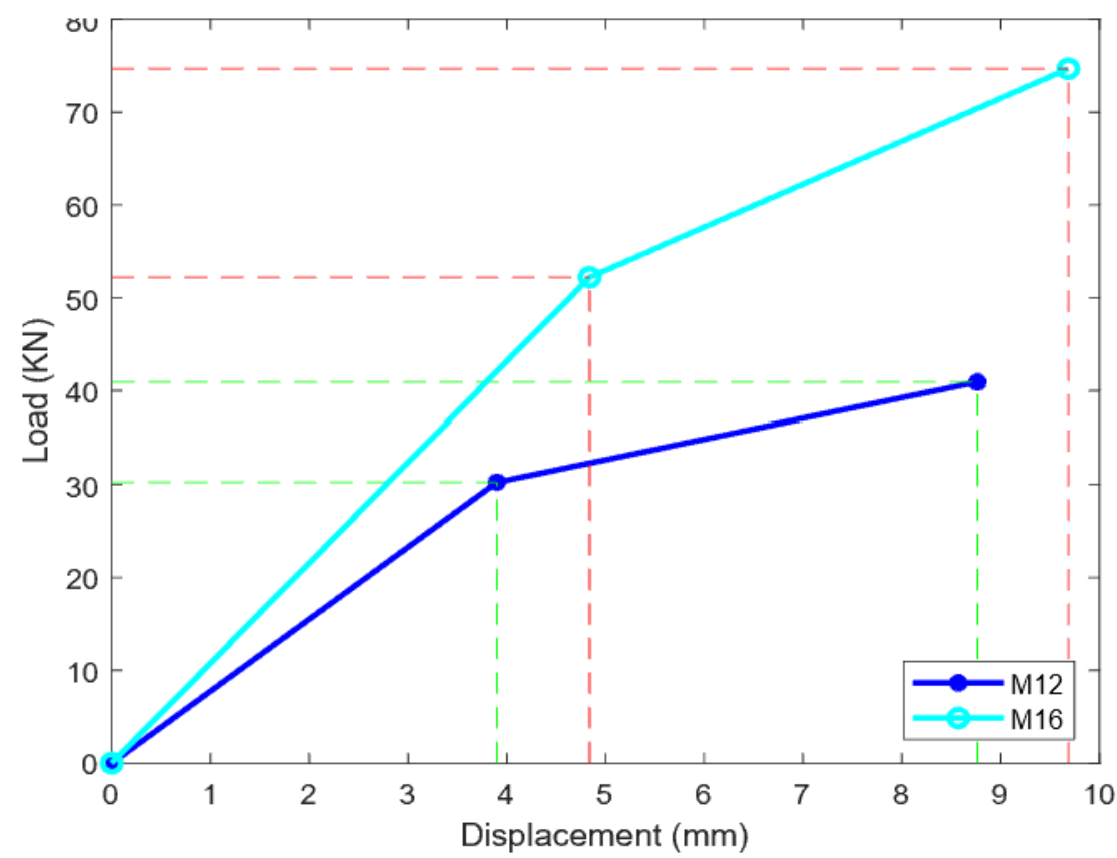
Numerical model

➤ Deformed shape

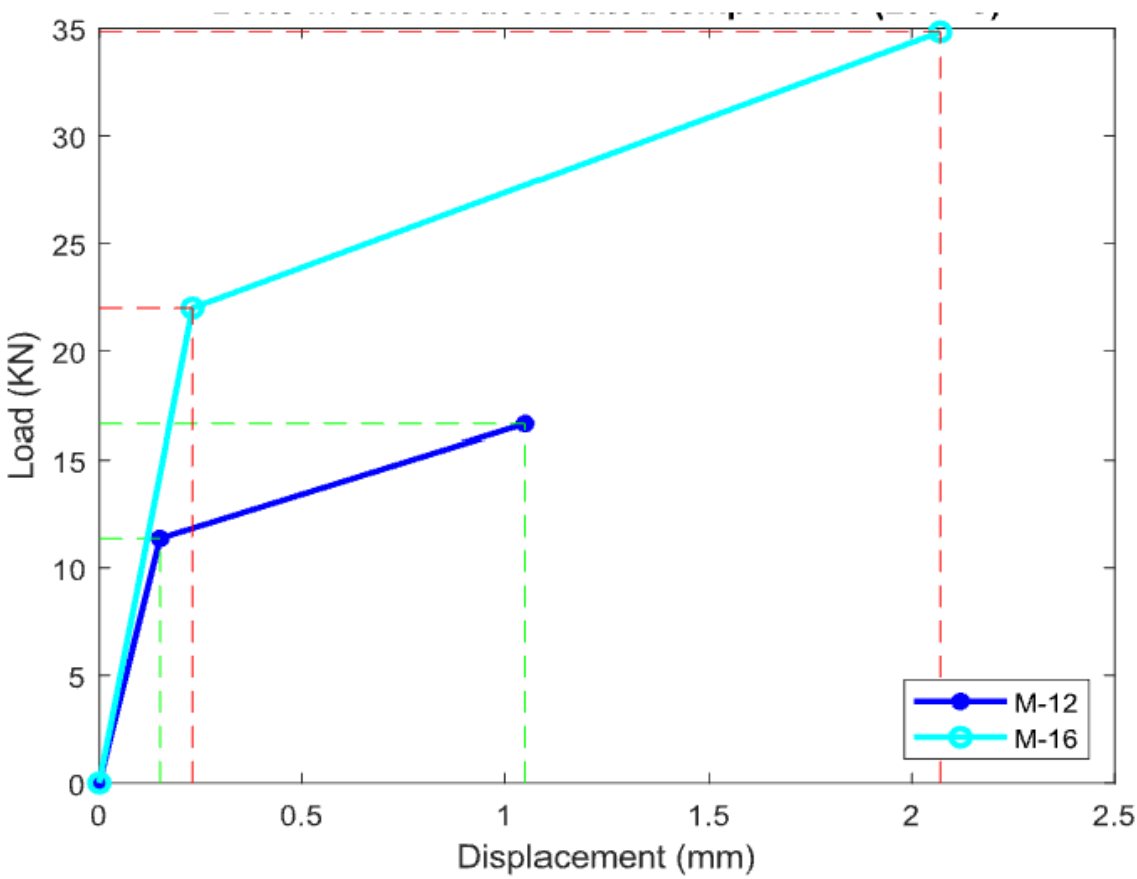


Bolt spring model in tension

➤ Ambient Temperature

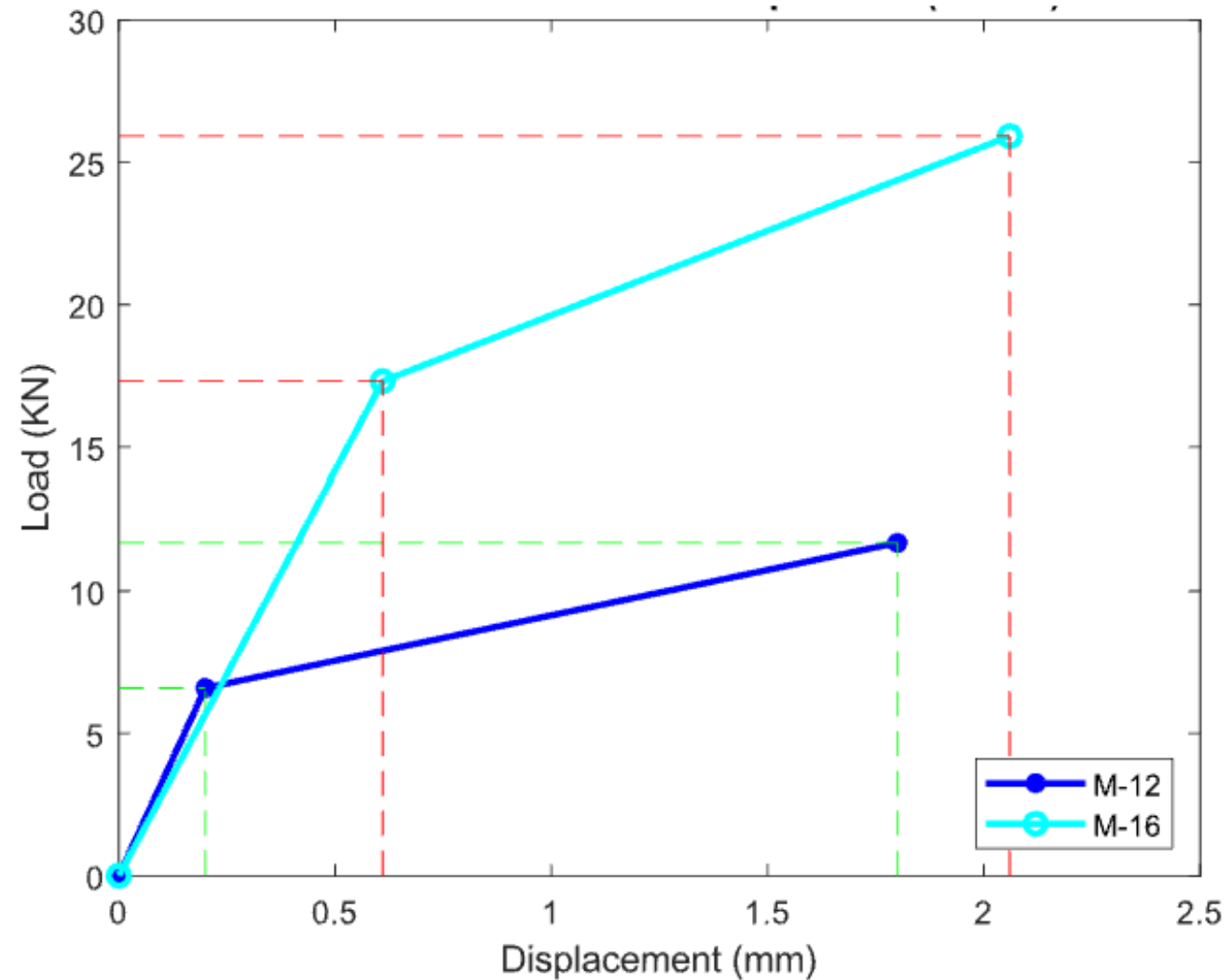


➤ Elevated Temperature



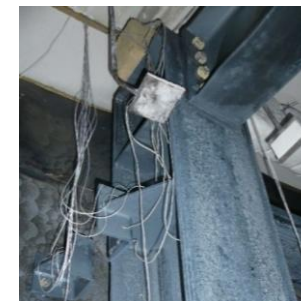
Bolt spring model in shear

➤ Elevated temperature



Summary

- 200 °C aluminium bolts 60 % of the strength
- 300 °C aluminium bolts 20 % of the strength
- Numerical results close to the experimental ones
- Aluminium bolts are predictable and suitable for fusion link system
 - As temperature dependent springs
 - Based on material degradation in EN1999-1-2:2006



Thank you for your attention!

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