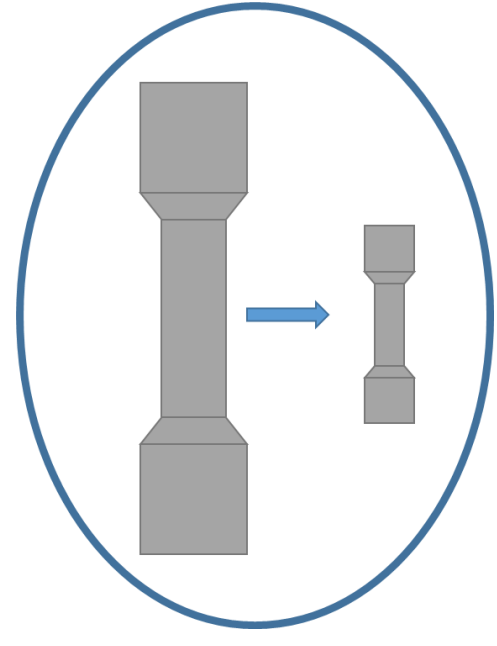
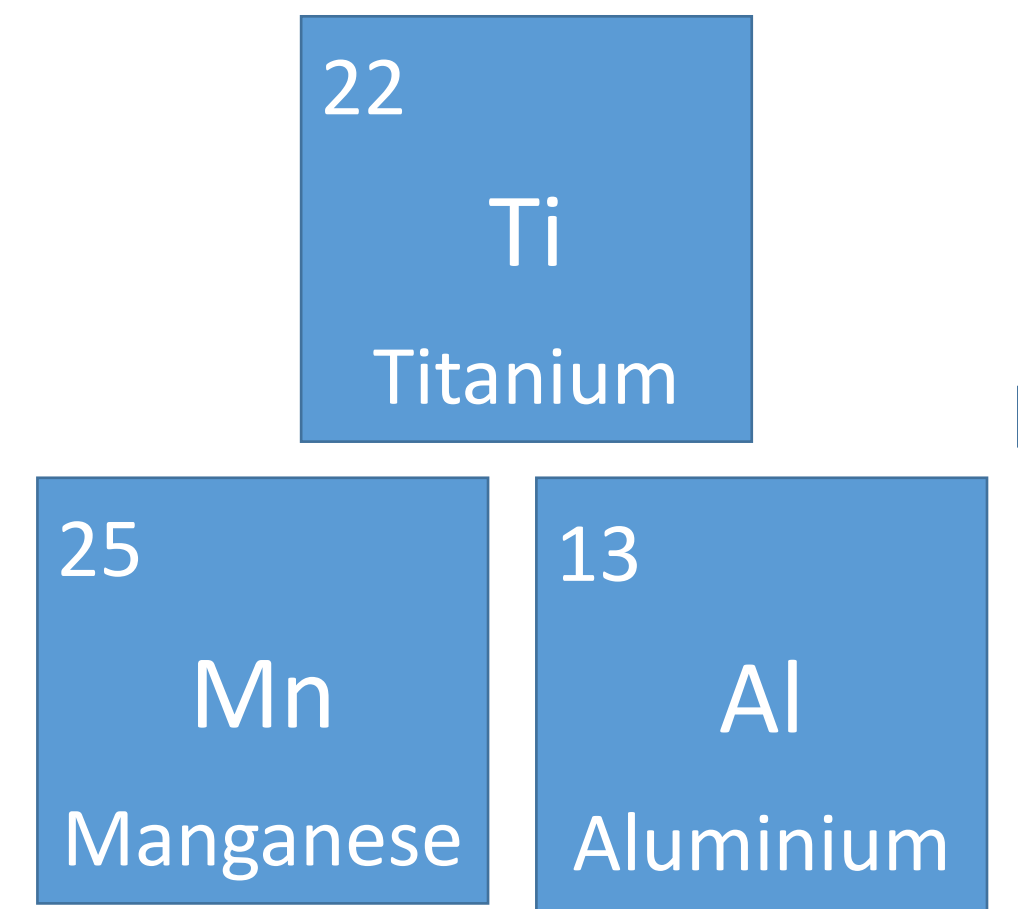


Rapid Alloy Prototyping (RAP) tensile testing



RAP route – testing miniaturised samples of DX57



Changing the composition of alloying elements in the DX57



Improve the formability of the material by increasing the elongation

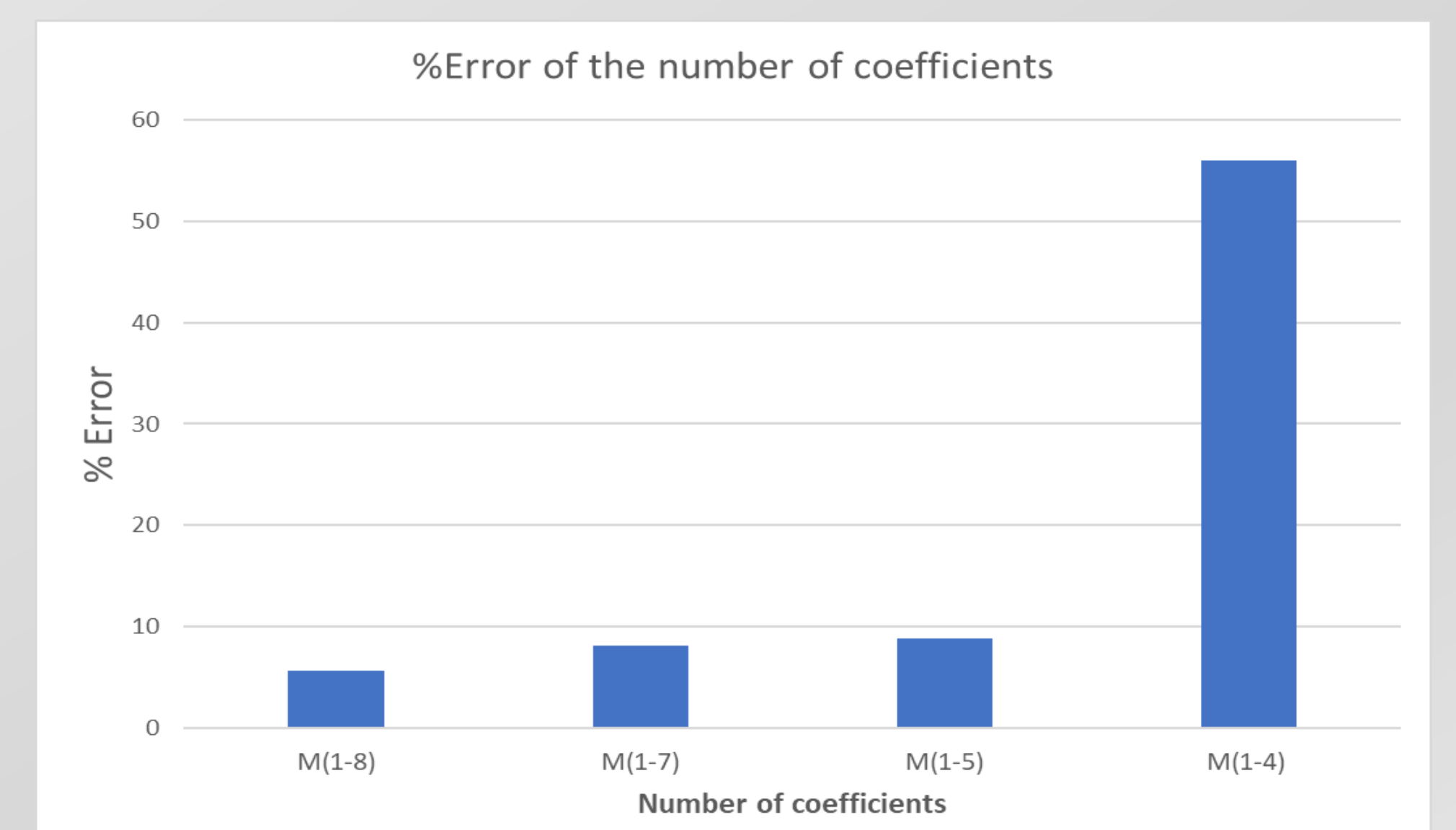
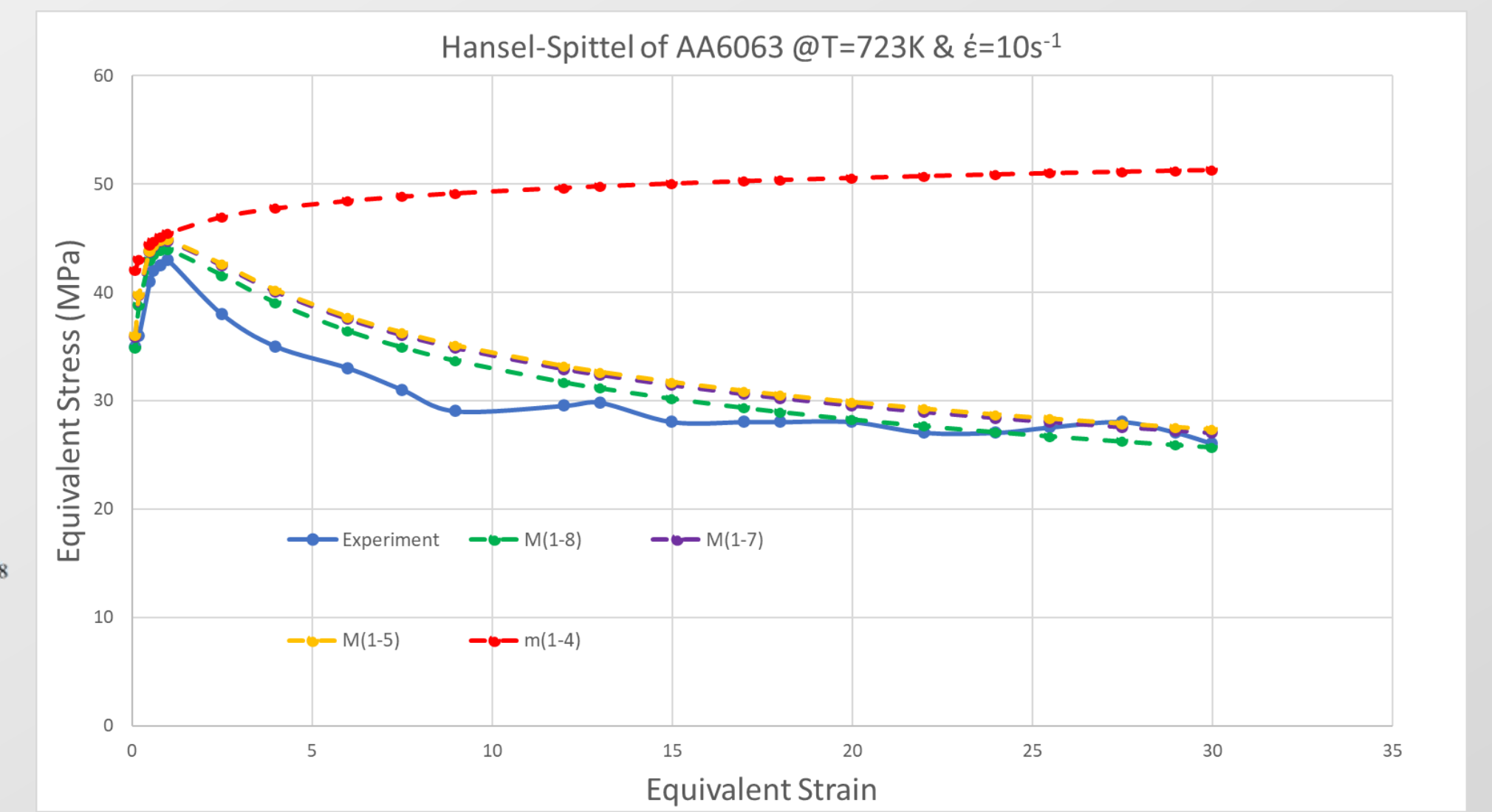
Hensel-Spittel

Hensel-Spittel is an expression used to represent the flow stress curve of a specimen subjected to thermo-compressive loading:

$$\sigma/MPa = A \exp(m_1 T) \dot{\epsilon}^{m_2} (\dot{\epsilon})^{m_3} \exp(m_4/\dot{\epsilon}) (1 + \dot{\epsilon})^{m_5 T} \exp(m_6 \dot{\epsilon}) (\dot{\epsilon})^{m_7 T} (T)^{m_8}$$

Data of AA6063 was used to attempt to implement the expression. The graphs below shows how the number of coefficient affect the %error of hansen-spittel graphs in comparison to the experimental data.

It shows that using all eight coefficients (M₁₋₈) yielded an **error of 6%**, which is the most optimal result.



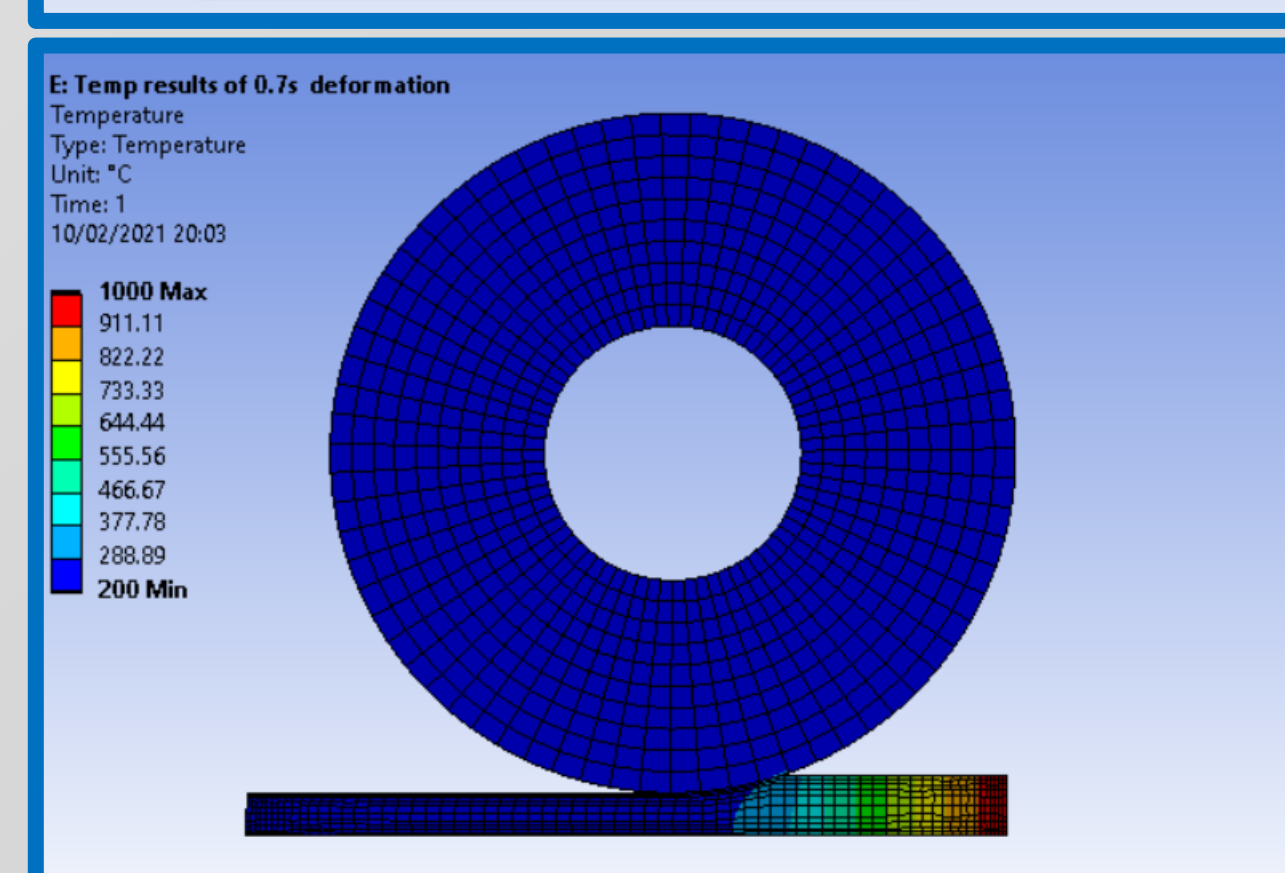
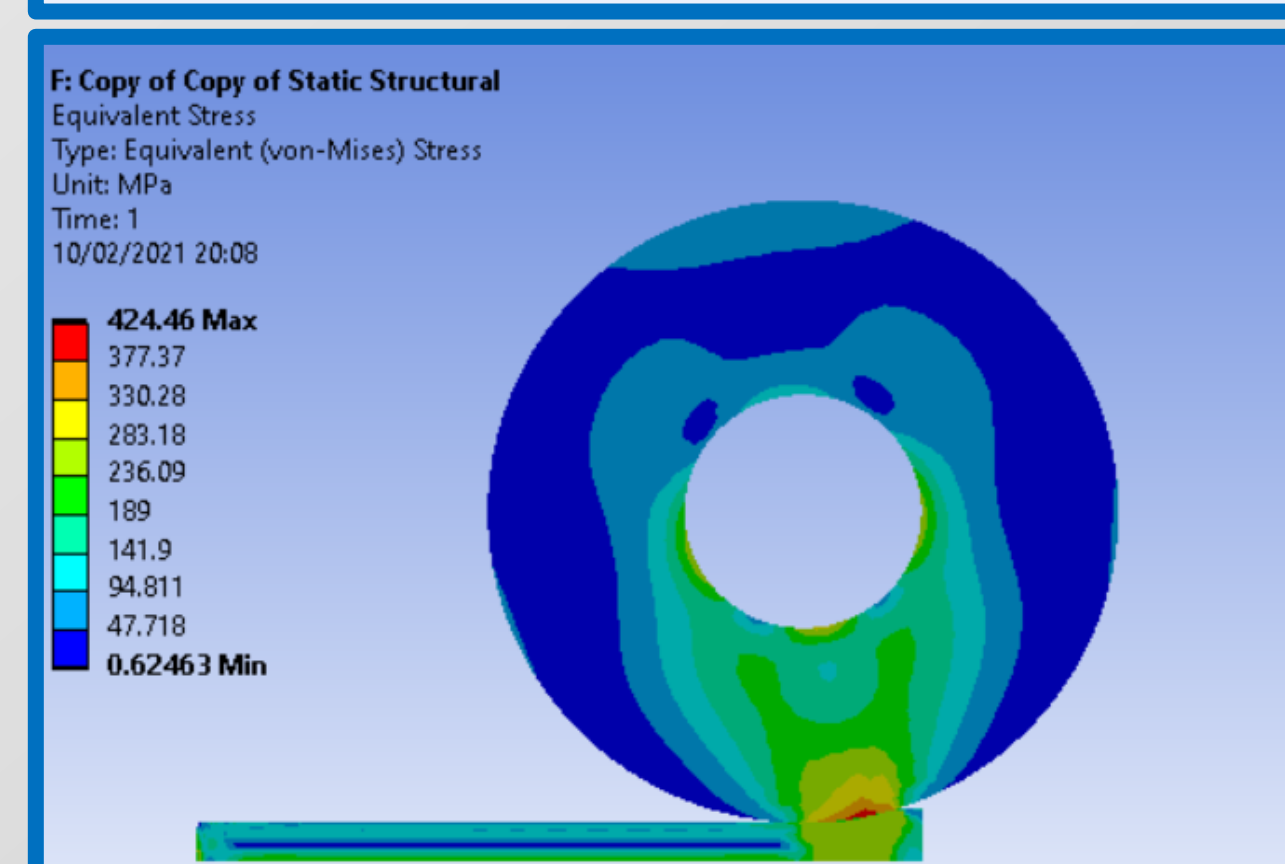
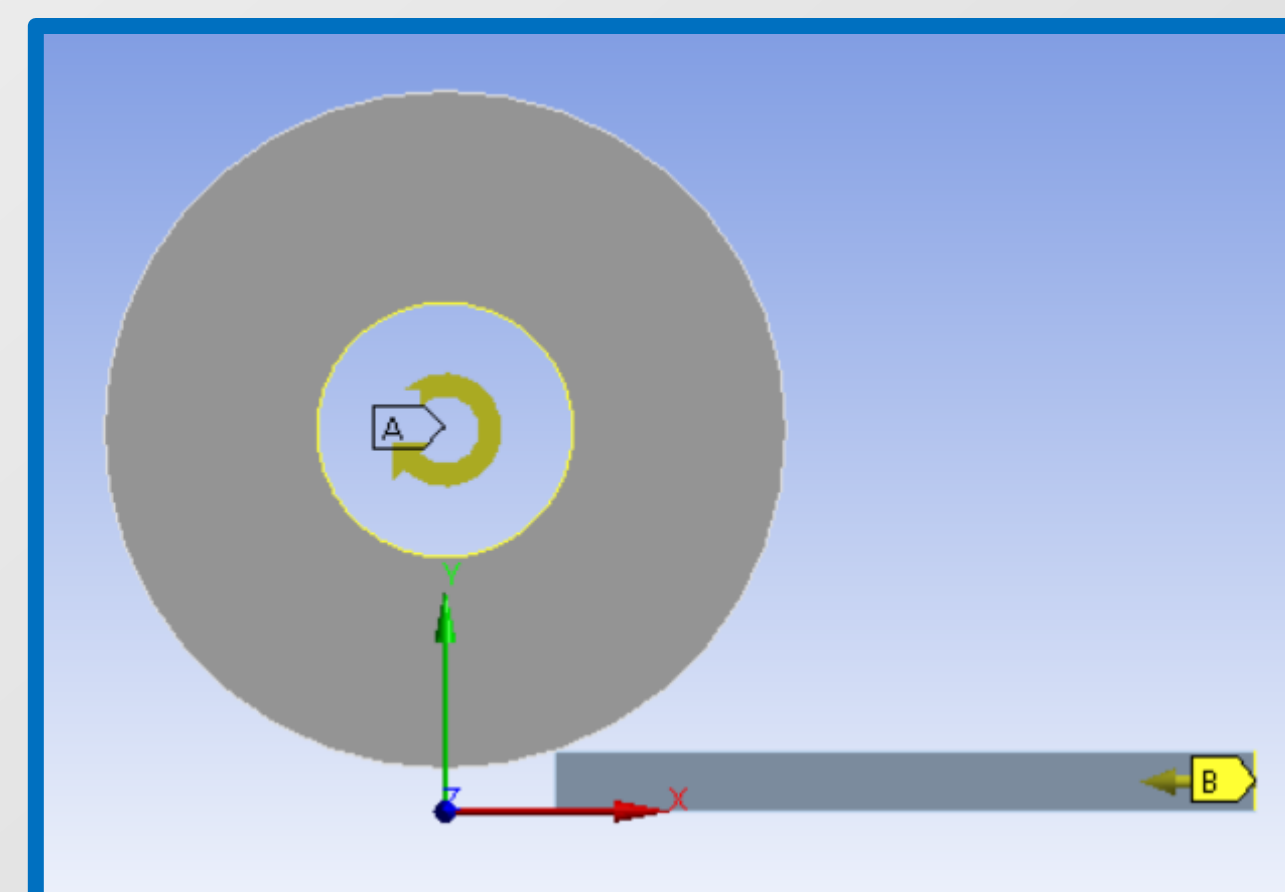
Objectives

- Develop a **2D hot rolling simulation** on Ansys, where thermal and structural conditions are applied
- Utilise the Hensel-Spittel expression to **approximate the flow stress** curves of a material
- Extract **R-value of DX57** through RAP tensile testing
- Improve the formability of the material by **manipulating its chemical composition**
- Apply the method on to an AHSS grade

Development of improved formability of Advanced High Strength Steels

Prototype Ansys 2D Hot rolling Mill simulation

- Geometry was created with a symmetry acting on the bottom surface of the sheet
- Rotational speed and velocity was applied to the rolling mill and the tail end of the sheet
- Structural steel was applied to the roller
- Von mises stress recorded on the right
- Temperature distribution recorded on the right
- The roller was set to 200°C and the sheet to 1000°C



Introduction

Improving the formability of advanced high strength steels is the project's aim and rapid alloy prototyping (RAP) is an effective way of tackling this endeavour. Miniaturised test samples of DX57 will be subjected to tensile testing with intentions of being able to extract the R-value. Manipulating the chemistry of Manganese, Titanium and aluminium will be assessed for any promising notable effects on the steel's mechanical properties. The rolling mill is also key to improving the mechanical properties of a material, and so a 2D rolling mill simulation (on Ansys) is being developed. The simulation is built with a thermal-structural study. The Hensel-Spittel expression will be used to help determine the material's flow stress curves and improves the defined material's property in the simulation.

Further Work

- Subject the DX57 samples to thermo-compressive loading using the Gleeble machine to extract several flow stress curves
- Incorporate the Hensel-spittle expression of the DX57 in to the Ansys simulation
- Extract R-value of the DX57 by performing tensile testing, via the RAP process
- Carry out hot rolling of the DX57 to validate the simulation
- Manipulate the chemical composition of the DX57, cast, roll and tensile test the cut specimens