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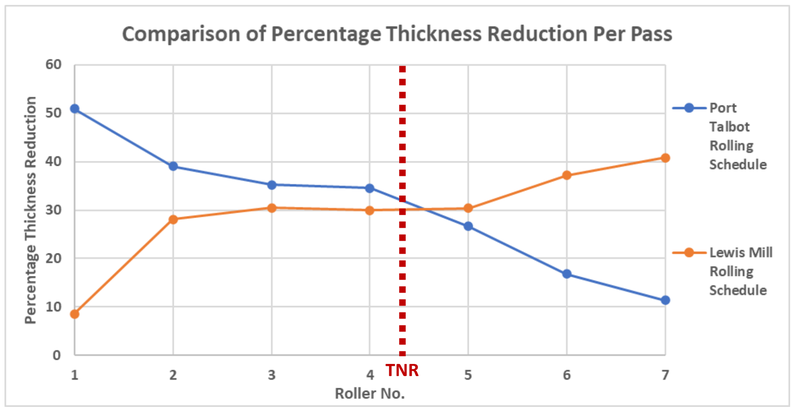
Sponsor Company:
Tata Steel

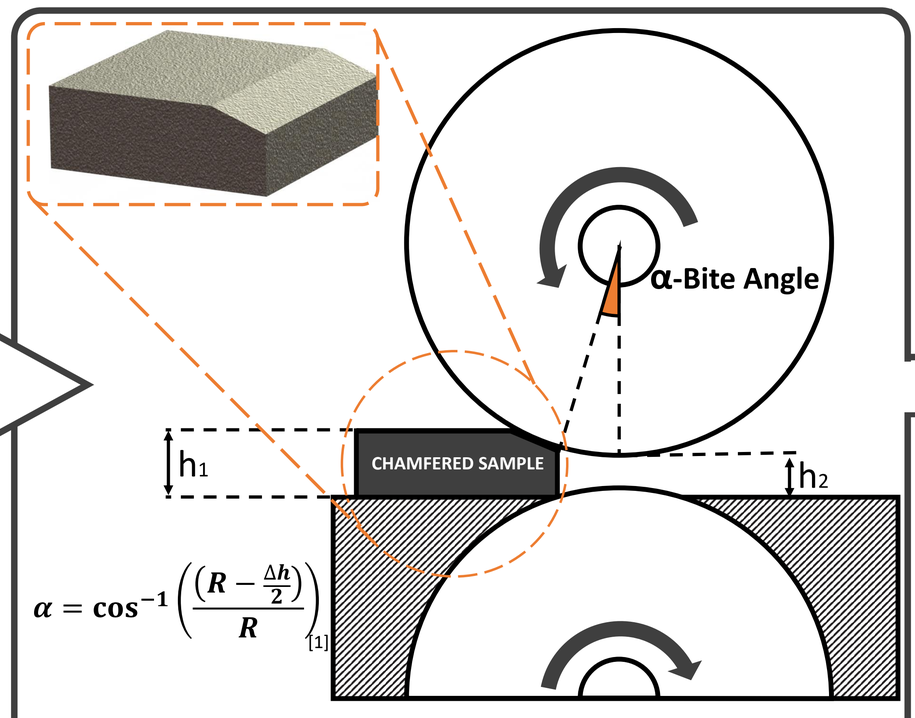
Investigating Formability of Future Steel Grades Using Rapid Alloy Prototyping

Swansea University Prifysgol Abertawe

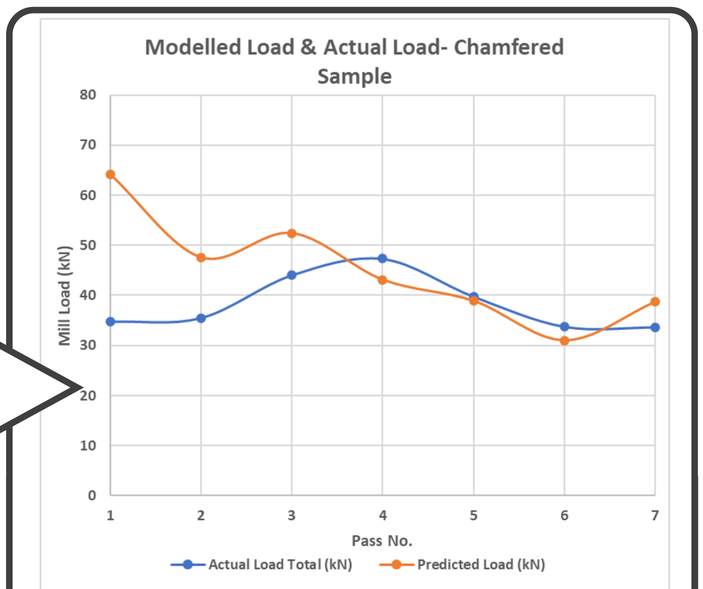
Lab-Scale Hot Rolling



- Existing experimental rolling schedule was not representative of plant production at Tata Steel Port Talbot.
- This resulted in larger strains being imparted below the T_{NR} resulting in inconsistencies in hot rolled grain structure.
- However the Port Talbot rolling schedule cannot be implemented due to **Bite Angle** limitations, as a result of a smaller roller radius.
- To overcome this a **Chamfered Sample** was created to satisfy the minimum **Bite Angle** criteria.



[1] L. Li, H. Yang, L. Guo, 5.19 - Hot Shape Rolling, Editor(s): Saleem Hashmi, Gilmar Ferreira Batalha, Chester J. Van Tyne, Bekir Yilbas, Comprehensive Materials Processing, Elsevier, 2014, Pages 393-439, ISBN 9780080965338, https://doi.org/10.1016/B978-0-08-096532-1.00528-8.

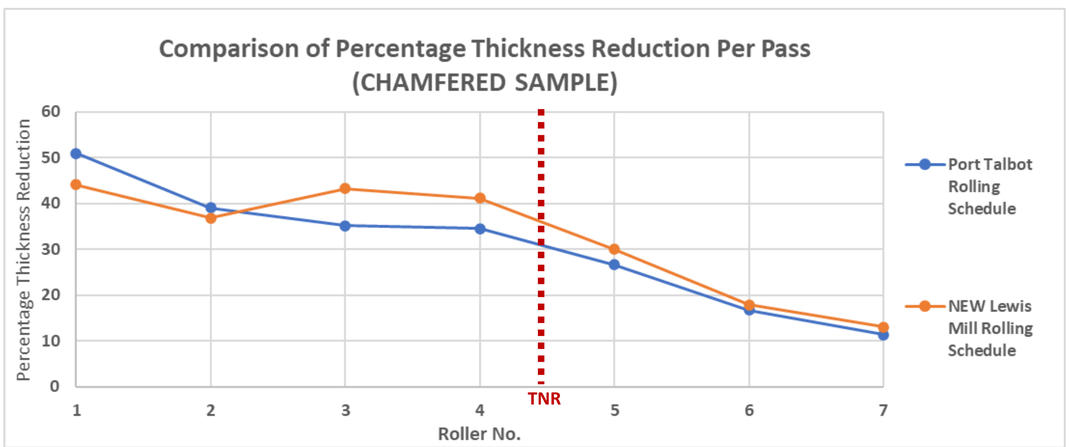


- Loads were predicted using the **Misaka Model**[2] for **Mean Flow Stress** and mill geometry, in order to protect the mill due to increased loads, as a result of larger strains being imparted on the material.

[2] Misaka Y and Yoshimoto T 1967 Formulation of mean resistance of deformation of plain carbon steel at elevated temperature J. of the Japan Society for Technology of Plasticity 8 414-22

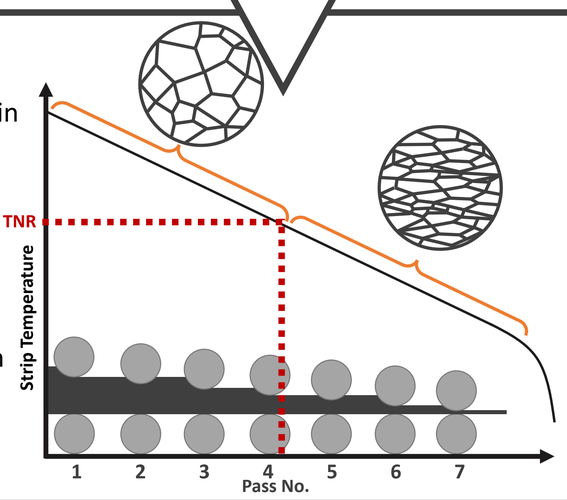
OUTCOMES

- Representative strain per roller pass was successfully achieved (Particularly below T_{NR}) whilst maintaining satisfactory **Mill Load, Mill Torque** and **Bite Angle.**
- This will allow more representative **Scale-UP of Novel RAP Produced Alloys** in the future.

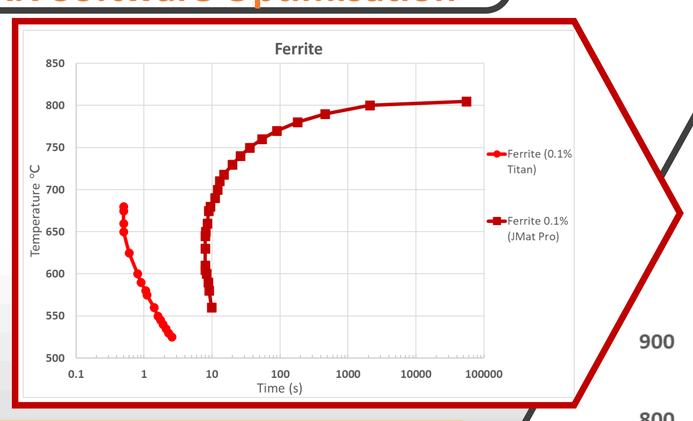


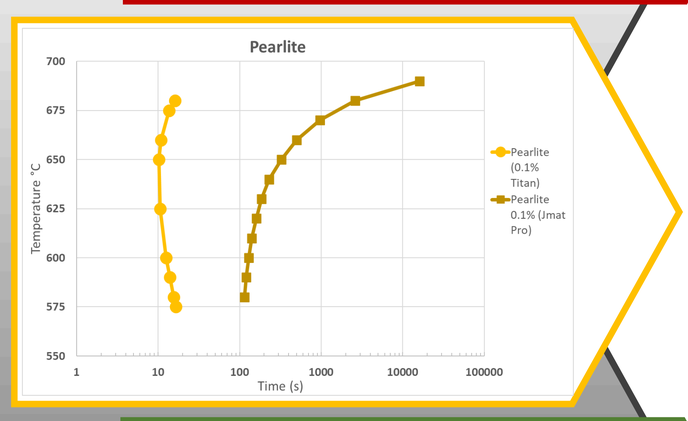
WHY IS THIS IMPORTANT?

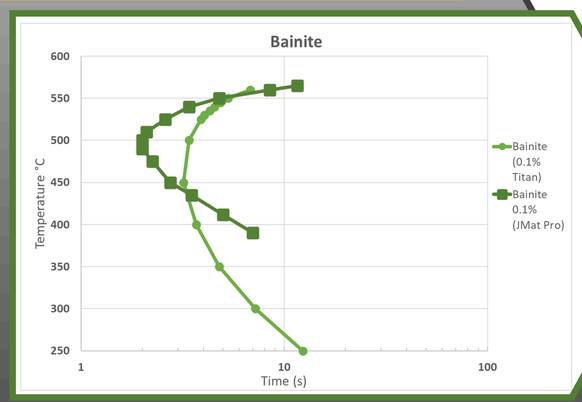
- Rolling above the T_{NR} allows the recrystallisation to occur, resulting in an **equiaxed grain structure**.
- Rolling below the T_{NR} results in pancaking of the grains, further refining the grain structure, in turn increasing the number of sites for **Ferrite Nucleation**.
- It is therefore critical that the strain experienced by the sample (especially below the T_{NR}) is representative of plant processes.



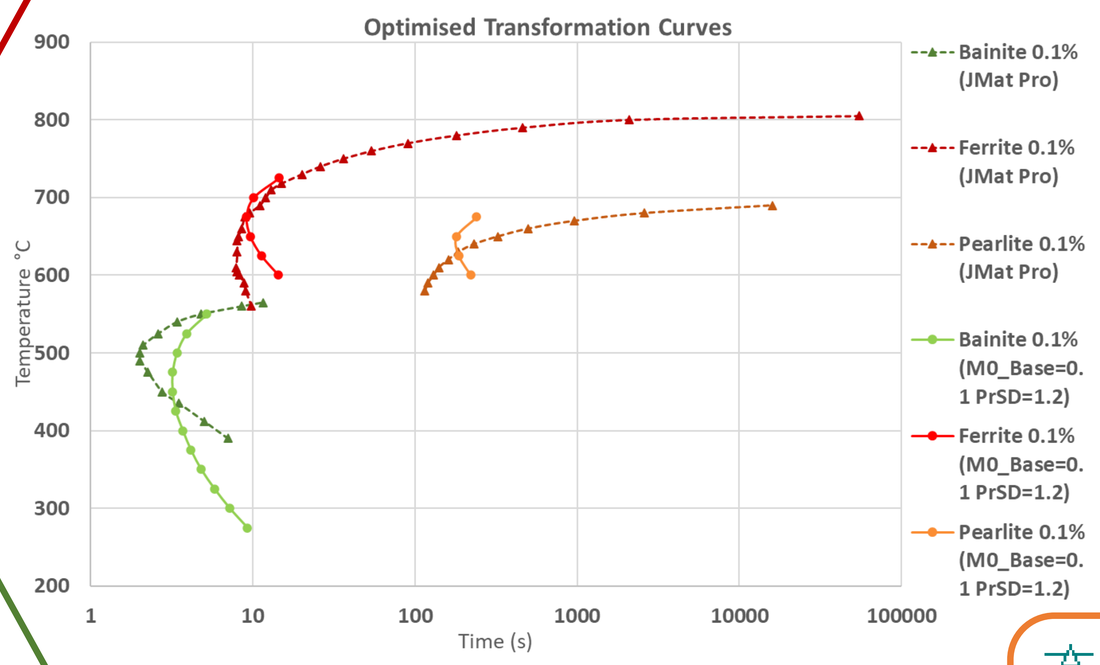
TITAN Software Optimisation



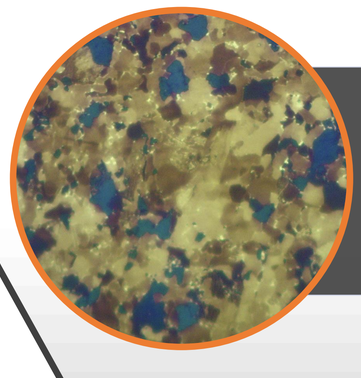




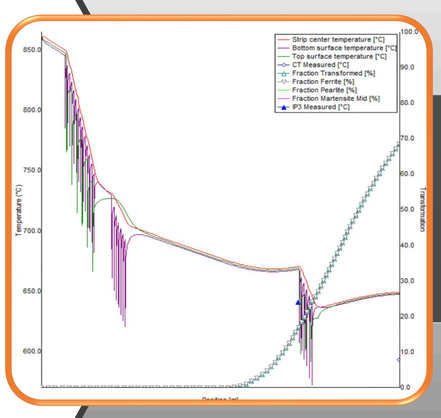
The **TITAN** software is a Tata produced tool that models **Run Out Table** transformations based on strip data, such as chemistry and cooling parameters.
Transformation curves for each phase were exported from the **TITAN** software and compared with those generated from **Jmat Pro**. A process of parameter optimisation was undertaken match the curves such that the transformation characteristics are representative of plant process.



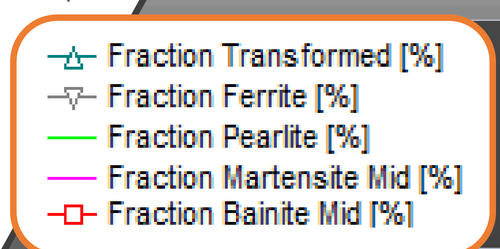
Optimisation of the small scale rolling process, as well as the **TITAN** model, will allow for experimental changes to be implemented in both the model and the laboratory setting. Both of which can be used to improve the thermomechanical treatment of existing grades or for novel **RAP produced alloys**.



Accurate reporting of grain size



Accurate modelling of strip temperature compared to pyrometer readings



Accurate modelling of phase volume fraction

MAIN IMPACTS OF CURRENT RESEARCH

DECREASED VEHICLE WEIGHT
Decreased vehicle weight results in a direct increase in the range of the vehicle which is one of the known drawbacks regarding electric vehicles. Which is chiefly achieved through the implementation of AHSSs.

INCREASED FORMABILITY
Increased formability allows more freedom for design engineers to create complex geometries improving performance.

RAPID ALLOY PROTOTYPING
All of the work carried out, especially regarding understanding megalographic samples at multiples scales, will feed into the work the Prosperity partnership is doing regarding Rapid Alloy Prototyping, allowing swift implementation of these novel alloys.

Rapid Alloy Prototyping
A PROSPERITY PARTNERSHIP

EPSRC
Engineering and Physical Sciences Research Council

TATA

Swansea University Prifysgol Abertawe

WARWICK
THE UNIVERSITY OF WARWICK