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data was used to assess the heat extraction at each step during cooling and compared with 2D heat transfer model.

A central part of the wedge mould sample (cross-section as shown in Figure 4) was cut up for the microscopy analysis. In addition, slab samples from conventional and thin slab casting, with comparable chemical composition to the wedge mould samples, were chosen for the analysis to validate the microstructure results.

Fig.3 - Example of the steel sample solidified in the wedge mould.

All samples were polished and etched using a Bechet-Beaujard (BB) etching solution to reveal the dendritic microstructure.

The samples were then analysed under optical microscope to measure the primary and secondary dendrite arm spacing across the full sample width. The example of dendrites at the edge of the sample can be found in Figure 5. It also schematically shows how to find the primary and secondary dendrites arm spacing. Cooling rate for each step of the wedge mould samples was then calculated based on the dendrite arm spacing and compared with the cooling rates based on the thermocouple measurements and 2D heat exchange model.

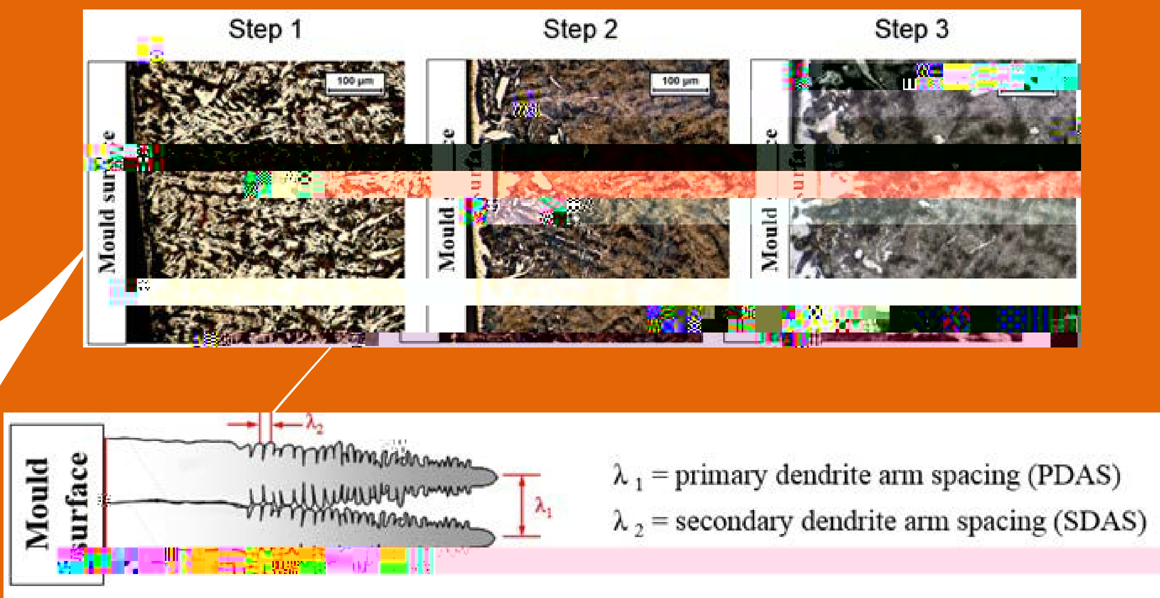

Fig.4 - Example of primary and secondary dendrites found at the surface of solidified wedge mould sample at steps 1, 2 and 3.

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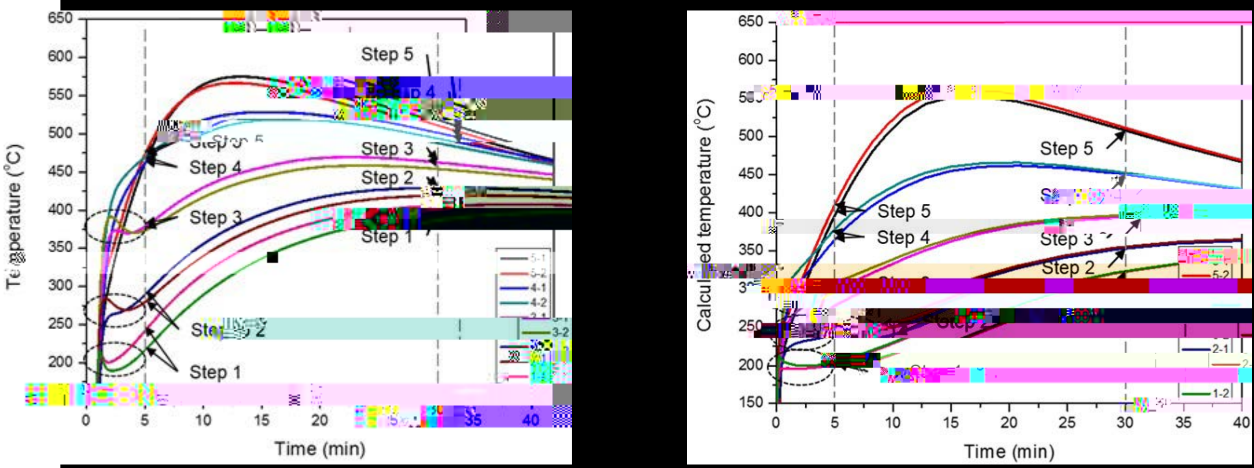

Fig.5 - [redacted]

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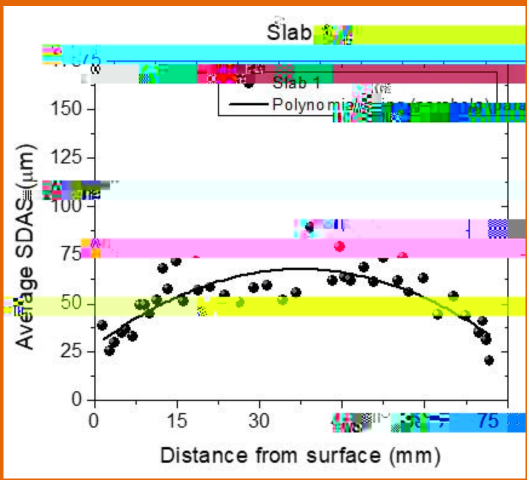

These results show that step 3 of the wedge mould can be used as an indication for future research of the dendritic microstructure (and micro segregation) during solidification at a thin slab caster. However, depending on the aim of potential research projects, the thickness of the step 3 of Wedge 1 sample should be taken into account. It is 25 mm thick compared to 72 mm of the thin slab caster sample.

Figure 7 shows the SDAS for the conventional slab sample. Assuming that the microstructure of the slab sample is symmetrical across the slab thickness only half of the conventional slab sample was measured (116 mm out of 225 mm). The second half of SDAS was mirrored for the purpose of plotting the polynomial curve. The average measured SDAS for the Slab 2 sample varies between 25 μm at the steel shell to 240 μm in the centre. In this case, step 5 of the Wedge 2 sample corresponds well with the measured SDAS of the conventional slab sample.

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of cooling rate ([4] and [5]) and solidification time [6] is based on available experimental and theoretical analysis ([5] and [6]). Considering SDAS dependence on carbon content, the secondary dendrites arm spacing λ_2 (μm) was calculated by El-Bealy and Thomas [7] as a function of cooling rate for steels containing less than 0.53 wt pct C as shown in Eq. (2):

$$_{2}= \ _{1}(\quad)^{-} \quad (2)$$

where (°C/s) is cooling rate. The parameters $_1$=148 and n=0.38 were calculated by fitting the experimental data in References [5] and [6] to the Eq. (2).

The third option of exterminating the cooling rate was done by Won and Thomas [8] using the SDAS data. In this case, the SDAS results were derived from various sources, (including Suzuki et al. [5]) at different cooling rates and steel carbon contents

By finding a best fit of the results, the empirical relationship was obtained by Won and Thomas [8] for the secondary dendrite arm spacing :

$$(\quad)=143.9\cdot \quad ^{-0.3616}\cdot \quad (0.5501^{-1.996} \quad) \qquad \text{for} \quad >0.15 \quad (3)$$
$$=(169.1-720.9\cdot \quad)\cdot \quad ^{-0.4935} \qquad \text{for } 0< \quad \leq 0.15$$

where is the cooling rate (°C/s) and is the carbon content (wt pct C)

All three equations described above were used to calculate a cooling rate. The results are illustrated in

Fig. 8, where the black, blue and red dots (and corresponding colour of polynomial fit) are referred to the Eq. (1), Eq. (2) and Eq. (3) respectively.

The highest cooling rate was obtained based on Eq. (1) - the model developed and validated using billet samples 01El0 Tw (-senkilpi .)0.5 [3]. Fe s by Womidd0 hpart. Fe s etween130 01El0/s) an0.5 mpiridgehe resules middo hpart. All tIlingn) arm car.5 mpirng rate was oe resules

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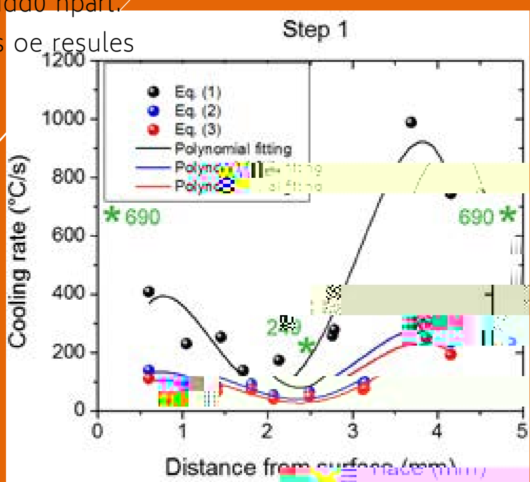

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