(177) Continuous Straightening: Results of FEM-Analysis and of Plant Experience (Development of the "Low Strain" Slab Caster - IV)

CONCAST SERVICE UNION AG, Zurich
A. Vaterlaus
o Dr. M. Wolf

1. Introduction: During slab straightening with liquid core, formation of internal cracks must be avoided. Therefore, the "continuous" straightening process was conceived which follows the ideal unbending curve and eliminates shear stresses in the unbending zone by the application of self-aligning support rollers (1). In order to demonstrate this benefical behaviour, it is attempted in the present investigation to provide corresponding evidence by mathematical modeling as well as by plant trials.

2. Investigation Procedure: The investigation by Finite Element Method (FEM)-analysis, previously carried out for the case of one-point straightening (2), was extended for the present case of continuous straightening using the same calculation conditions as already described i.e. 250 mm thickness of slab and 82 mm of shell. Four floating roller pairs are applied to the unbending zone of 2 m length.

Concurrently, plant trials were performed on a two-strand slab caster with 10.75 m radius by modifying one strand from one-point into continuous straightening. Thereby, three roller pairs of the module-type straightener were transformed into floating position giving an unbending zone of 1.7 m length. This required a lowering of the ideal passline by about 11 mm and a corresponding upward inclination of the subsequent roller table. The slab thickness was 190 mm, and shell thickness during straightening estimated to be 82 mm at 1.6 m/min casting speed.

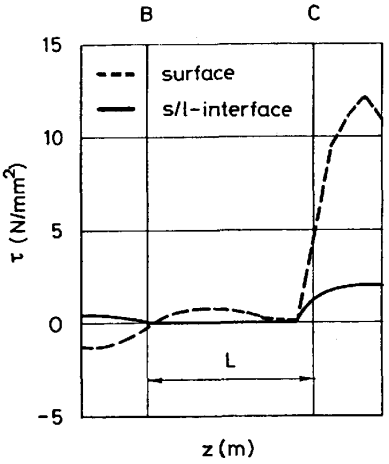

Fig. 1 Shear stress distribution along the strand axis in FEM-analysis

3. Results: The calculation of shear stress distribution along the strand axis by FEM-analysis in Fig. 1 shows, in good agreement with the analytically predicted behaviour, that shear stresses are virtually eliminated in the unbending zone.

Regarding plant trial results, the measured position of the floating roller pairs in Fig. 2 indicates a passline only slightly below the one calculated by FEM (curve 3). The small deviation from the theoretical position is attributed to the weight of floating modules which was not counterbalanced for these trials. Casting speed was increased up to 1.6 m/min without occurrence of inner cracks whereas on the parallel strand with one-point straightening, the limit was 1.3 m/min due to inner crack formation.

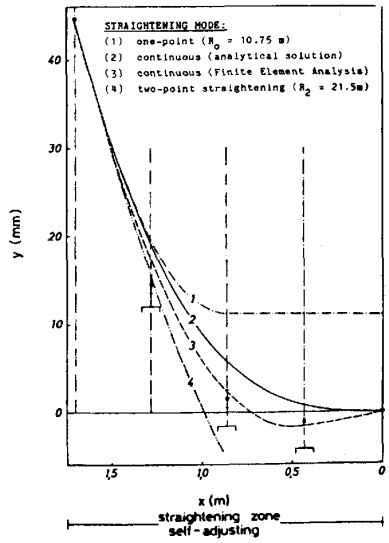

Fig. 2 Measured roller position and comparison with theoretical ones

4. Discussion and Conclusion: The results of the FEM-analysis have shown that shear stresses, being a critical factor in the formation of inner cracks (3), are virtually eliminated in the unbending zone by the continuous straightening process with floating rollers.

Measurements of floating roller position in actual plant trials have confirmed that the ideal unbending curve is closely approached, and that continuous straightening allows unbending of slab strands with liquid core without formation of inner cracks.

References:

(1) M. Poran, A. Vaterlaus, M.Wolf: Tetsu-to-Hagané 68 (1982) S988/S989

(2) A. Vaterlaus: Tetsu-to-Hagané 69 (1983) S170

(3) T. Matsumiya, Y. Nakamura: Tetsu-to-Hagané 67 (1981) S277