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(170) Finite Element Analysis for Slab Straightening with Liquid Core (Development of the "low strain" slab caster – III)

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1. Introduction: Bending calculations for steel slabs with liquid core as well as rubber slab bending simulations showed that the wide face plates bend around their own neutral axis and do not follow the displacement of the narrow face corners (1, 2). From experiments it was also shown that internal cracks are mainly initiated in the pinch roll zone (3). Hence, it is of great importance to know the bending behaviour of a cast strand in order to optimize the straightening unit in view of reducing strain and strain rate at the solid/liquid interface in the pinch roll zone.

2. Investigation Procedure: A finite element calculation programme was started to investigate the influence of the narrow face plate regarding the bending behaviour of the wide face plate. A continuously cast slab is modelled over a certain length which is considered reasonable to exclude artificial boundary effects. The face plates of the slab are represented by 8-node shell elements which are based on the Kirchhoff hypothesis and transmit membrane forces, bending moments and transverse shear forces. Thereby, the displacements in the nodes as well as the stresses and strains in the element integration points are obtained. These calculations were performed in cooperation with a local computer center.

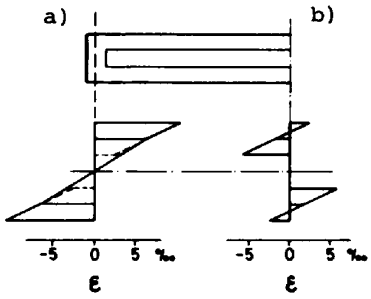

Fig. 1 Strain distribution near tangent point for a) narrow face plate and b) center of wide face plates

3. Results: A shear lag (deformation in casting direction) is clearly observed in the top plate, and the strain is calculated as illustrated in Fig. 1. A clear difference of the bending behaviour between the narrow slab and wide face plates is found. Fig. 2 shows the strain at different points of the slab section near the tangent point.

4. Discussion and Conclusions: From these results, it is obvious that both wide face plates behave like individual structural elements - at least around the center of the wide face plates. This confirms the new bending hypothesis of the "soft" box case for slab casting (1).

Hence, it is most important that bending strain and strain rate for slab sections (as well as big blooms) with liquid core are calculated according to the actual bending behaviour of a "soft" box. The "rigid" box bending is only applicable to billet and small bloom sections.

Based on the experience gained in the present investigation, this bending analysis will be extended further to get a complete understanding of the straightening process for slab sections with liquid core.

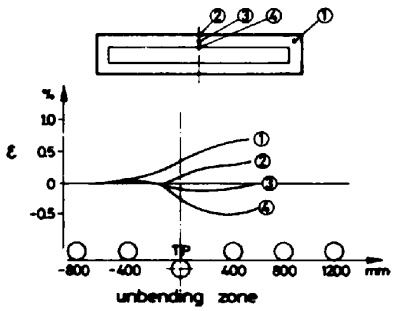

Fig. 2 Course of strain distribution in the straightening zone at various locations

References: (1) M. Poran, A. Vaterlaus, M. Wolf: Tetsu-to-Hagané 68 (1982) S 988
(2) H.G. Baumann: Stahlstrang-Giessanlagen, Verlag Stahleisen, Düsseldorf 1976
(3) M. Nakamura et al.: Tetsu-to-Hagané 68 (1982) A149-A152.