PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

The Hot Ductility Behaviour of C-Mn-Nb-Al Steels and its Relation to Crack Propagation during the Straightening of Concast Strand

B. Mintz and J. M. Arrowsmith

Phil. Trans. R. Soc. Lond. A 1980 **295**, 124
doi: 10.1098/rsta.1980.0084

Phil. Trans. R. Soc. Lond. A **295**, 124 (1980)
Printed in Great Britain

The hot ductility behaviour of C–Mn–Nb–Al steels and its relation to crack propagation during the straightening of concast strand*

By B. Mintz and J. M. Arrowsmith

British Steel Corporation, Scottish Laboratory, Motherwell, U.K.

As most continuous casters used curved moulds, the as-cast strand must have sufficient hot ductility to survive the straightening operation without cracking.

The influence of composition on the tendency for surface crack propagation to occur on straightening of concast strand of a commercial C–Mn–Nb–Al grade of steel, has been examined and compared with the hot ductility behaviour as measured by Gleeble tensile tests.

Samples of steel with a nominal base composition of 0.15 % C, 1.4 % Mn, 0.03 % Nb, 0.005 % N but having soluble Al in the range < 0.01–0.07 % and P in the range 0.01–0.03 % have been solution treated to 1330 °C, cooled to test temperature and strained to fracture in the temperature range 1000–700 °C. The percentage reduction in area passed through a minimum in the temperature range 750–800 °C. Of the elements examined, soluble Al was found to be the most deleterious to ductility for test temperatures above 850 °C. The niobium addition tended to reduce hot ductility most significantly for temperatures below 850 °C. Phosphorus, surprisingly, was found to have a small beneficial effect on hot ductility.

Fractures were intergranular and NbCN was found to be precipitated at the γ grain boundaries. Ductility was worse when the precipitation of NbCN was fine (6–10 nm), and this, combined with other evidence presented, suggested that the intergranular failure mode was due to NbCN precipitating at the γ grain boundaries during deformation, preventing grain boundary sliding from occurring. Soluble aluminium appears to exert its detrimental effect on hot ductility by encouraging a finer dispersion of NbCN at the γ grain boundaries, causing them to be pinned more effectively. Niobium was also able to exert a major influence through the strengthening of the γ matrix which intensifies the stress on the grain boundaries. The reason for P improving hot ductility is not clear, but it has been tentatively suggested that because of its large atomic size factor it segregates to the γ grain boundaries, making it difficult for NbCN to precipitate out during deformation. Reasonably close agreement was found between the hot ductility behaviour as given by the Gleeble tests and the tendency for surface cracks to propagate during straightening of these steels at the exit from the continuous casting machine. Thus Gleeble test results can be used with a fair degree of confidence to predict the behaviour on straightening of other steel compositions made by the continuous casting process.

* Extended abstract; the full paper appears in *Metals Technol., Lond.* **6**, 24 (1979).