



BAR1/15  
15<sup>th</sup> July 2015

### **BAR GUIDANCE NOTE 1/15: Welding of reinforcing steel containing boron**

The British Association of Reinforcement (BAR) is aware that some of the reinforcement imports that have entered the UK market may contain boron as a micro-alloying element. Boron is not specifically referred to in BS 4449 as it is not normally added to reinforcement bar, but even small additions of boron can affect the hardenability of a steel<sup>1</sup> and hence its welding characteristics. This may affect the quality of welds and the potential for weld defects if the welding process is not properly specified and controlled.

The effect of boron on the hardenability of steels is a well-documented phenomenon<sup>2</sup> and it is specifically added to some engineering grades of steel to take advantage of this aspect, but it has not been traditionally added to reinforcing steel. BAR is not aware of any detrimental effect of boron on the mechanical properties of reinforcement bar as traditional cut and bent.

However, for some arc welding processes the boron can significantly increase the hardness of the weld area thereby making it more susceptible to cracking, particularly in the heat affected zone<sup>3</sup>. This cracking can occur on cooling but also can occur up to 72 hours after welding when the defect is called 'delayed-cracking'. There is a potential safety issue if welds containing cracks are a part of the lifting points in pre-assembled welded fabrications. To date, there have been no reported health and safety problems containing added boron after being welded.

TWI Limited has advised that, in combination with the other elements in steel, boron can increase the risk of having crack-susceptible microstructures<sup>4</sup>. As such, additional precautions, such as slower welding, high heat input and additional controls on consumable hydrogen levels may need to be taken when welding boron-containing reinforcing steel. It is recommended that



weld procedures are assessed to determine their suitability for welding the boron-containing steel. For guidance on weld procedure contact TWI at [www.twi-global.com](http://www.twi-global.com)

As boron is not mentioned in BS 4449 its presence may not be displayed on the manufacturer's test certificates unless you use a CARES approved manufacturer. Since June 2015, CARES approved manufacturers have been required to report intentionally added micro-alloying or alloying elements in reinforcing steel that are not currently included in BS 4449. This includes the addition of boron. It is understood that UK Steel has requested that the BSI national technical committee makes an amendment to BS 4449 to ensure that steel manufacturers report intentionally added micro-alloying or alloying elements in reinforcing steel that are not currently included in BS 4449.

In the interim, we would advise a precautionary approach to the use of any welded steels that may potentially include boron by checking the full analysis back to the producing mill or have full sample tests taken.

#### References

1. Yuroka N, Okkumura M, Kasuya T, & Cotton H J U, (1987): 'Prediction of HAZ hardness of transformable steels' Metal Construction, April 1987, Vol.19 No.4, pp217R-223R.
2. Simcoe C R, Elsea A R, & Manning G K, (1955): 'Study of the effect of Boron on the decomposition of Austenite' Trans AIME Journal of Metals, January 1955, pp193-200.
3. Coe F, Bailey N et al, (1993): 'Welding steels without hydrogen cracking', Woodhead Publishing, revised 2nd edition (2004).
4. Devletian J H, (1976): 'Borocarbide precipitation in the HAZ of Boron steel welds', Welding Journal, January 1976, pp5s-12s.

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