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Autor: Crosthwaite, C.D.

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Les aciers pour constructions soudées

Eigenschaften der Materialien für geschweisste Konstruktionen

Characteristics of materials for welded structures

C. D. CROSTHWAITE

A. C. G. I., B. Sc., M. I. C. E., London

In his paper on the "Characteristics of Materials for Welded Structures", M. Nihoul focusses attention on the disturbing phenomenon of brittle fracture. The further advance of welded structures, and their acceptance as being as reliable under service conditions as those of riveted construction, have been retarded by certain spectacular failures, notably those of the Belgian Bridges and American Liberty ships mentioned by M. Nihoul. These failures were catastrophic in their nature, and resulted in complete destruction and loss. Opponents of welding point out that similar disasters occur rarely if ever to rivetted structures.

It is now becoming generally accepted that the brittle fracture of welded structures is a phenomenon of notch sensitivity at working temperatures, and that it can be controlled by ensuring a sufficiently low transition temperature in the steel employed, and by attention to stress-raising design details and welding methods. The American Board of Investigation state that the Liberty Ship fractures were due to notch brittleness at the exceedingly low operating temperatures, and that locked up stresses did not contribute materially to failure. It may be pointed out that, owing to war conditions, many of the ship plates had a lower manganese content than usual. Deficiency of manganese has a marked effect on notch sensitivity.

The Belgian Bridge failures occurred in winter at low temperatures, in some instances as low as -20° C. It is difficult to resist the conclusion that here again is a phenomenon of notch sensitivity at working temperatures. A contributory cause may have been excess of nitrogen in the prewar Thomas steel. It is known that excess nitrogen has a notch embrittling effect, which is particularly noticeable on ageing after plastic deformation.

It may be asked why, if notch brittleness is the cause of the sudden

failures without deformation of welded structures, the same type of failure is not observed in rivetted structures, where stress-raisers of considerable magnitude occur. The answer would appear to be that brittle cracking of individual plates and sections does take place. Owing however to the discontinuous nature of rivetted construction, cracking generally terminates at a rivet hole or the edge of a plate, and may be undetected, whereas, in a welded structure, the crack may travel right across a member, and produce complete collapse.

It would appear therefore, that in welded structures notch brittleness may have a quite different order of importance to what it has in rivetted work. Moreover it has been established that the act of welding may raise the transition temperature by 20 or 30° C, and that even though the deformation zone be localized, the whole member may behave in a brittle manner. In the writer's opinion, a simple reliable test to establish adequate ductility and freedom from brittle fracture at working temperatures is still awaited. This test must give good correspondence with full scale tests, and should be incorporated in welding specifications. It is clear that the concept of "weldability" cannot be disassociated from notch sensitivity.

Résumé

La rupture brusque sans déformation de constructions soudées est une manifestation de la sensibilité à l'entaille du matériau aux températures de service. Cette sensibilité peut être contrôlée en abaissant les températures de transition et en accordant toute l'attention aux détails de conception et d'exécution. L'auteur exprime la nécessité d'établir une méthode de mesure simple pour la détermination de cette température de transition.

Zusammenfassung

Der plötzliche Bruch ohne Deformation von geschweissten Konstruktionen ist eine Erscheinung der Kerbempfindlichkeit des Materials bei den Betriebstemperaturen. Sie kann kontrolliert werden, indem die Uebergangstemperaturen niedrig gehalten werden und den Entwurfsdetails und der Schweissfolge die nötige Aufmerksamkeit geschenkt wird. Eine diesbezügliche einfache Prüfung der Uebergangstemperatur steht bevor.

Summary

The sudden failure without deformation of welded structures, is a phenomenon of notch sensitivity at working temperatures. It can be controlled by keeping down the transition temperature, and by attention to design details and welding methods. A consistent simple test for the transition temperature is awaited.