FACT SHEET FS15

APRIL 2022

EFFECTIVE FULL PENETRATION BUTT WELD

In 2021, HERA published report R8-43 concerning the use of effective full penetration T-butts in welded moment connections. The report's findings and recommendations are discussed in this Q&A-based fact sheet.

Why use effective full penetration butt welds?

An effective full penetration butt weld (EFPBW) has a performance equivalent to that of the complete penetration butt weld (CPBW) and is significantly cheaper to fabricate. However, selection of the weld details should be discussed with the Fabricator to consider each specific production situation.

Where can EFPBWs be used?

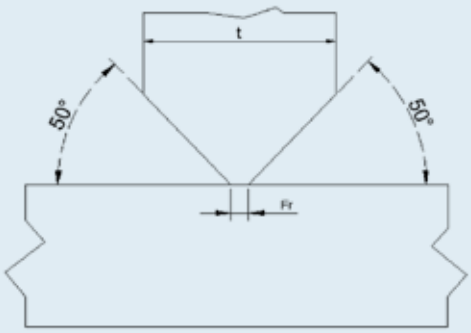
The EFPBW can be used in lieu of CPBWs in moment-resisting frames (MRFs) and other connections with a similar load path in the welds. HERA, together with the University of Auckland, is investigating the suitability of EFPBWs for eccentrically braced frame (EBF) connections and the results are expected later in 2022.

What is the basis for the EFPBW?

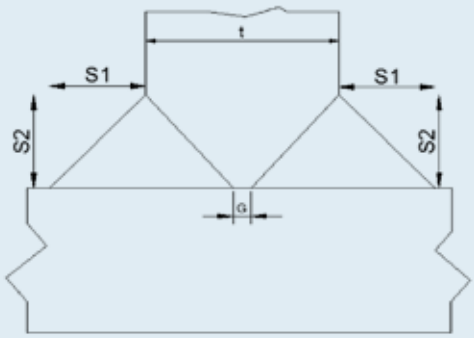
The recommendations are based on the seismic tests carried out at the University of Auckland, and the underlying modelling and ongoing research at HERA, and Auckland and Michigan (USA) universities. The EFPBW originated from the concept of the effective full penetration T-butt welds to EN 1993-1-8, which has been modified to suit seismic applications and the real production situation.

How are EFPBWs designed?

Selection of the equivalent EFPBW is based on the plate thickness. HERA report R8-43 provides an easy-to-use table that sets out the joint preparation required and the weld size. EFPBWs are applicable to the range of standard connections to Section 6.2 HERA R8-43, loading conditions (semi-static and seismic only) and steel elements of up to Grade 350 (i.e. nominal fy = 350MPa; fu = 480MPa).



Joint preparation



Weld sizing-After welding

Joint preparation and details of EFPBWs after welding

What are the Structural Steel Contractor's quality and inspection requirements?

Approval to use EFPBW connections should be limited to a Structural Steel Contractor that maintains a quality management system to AS/NZS 5131 CC3 or higher, and the Factory Production Control (FPC) for welding fabrication complies with AS/NZS ISO 3834.2 for Construction Category 3 (CC3) and CC4. In addition, it is recommended that the Structural Steel Contractor also complies with Section 7 of HERA report R8-43, and certifies by providing corresponding reports to the Engineer that all compliance items covered in Section 7 of HERA report R8-43 have been carried out in full. Furthermore, the extent of non-destruction examination should be in accordance with appendix I of AS/NZS 5131 for fillet welds. Ultrasonic testing is not recommended for EFPBW connections.

This figure from HERA report R8-43 illustrates the failure of a specimen following cyclic loading in the lab.

What steps should Design Engineers take?

1. Consider EFPBWs to HERA report R8-43 as complete penetration butt welds to Sections 9.7.2.1 and 9.7.2.2.2, NZS 3404.1.
2. Add a note to the project specification allowing the use of alternative EFPBWs according to HERA R8-43. See appendix E in HERA report R8-43 for a sample specification.
3. Design EFPBW to HERA report R8-43 (simple design based on plate thickness).
4. Approve EFPBW details as a part of the approval of the shop drawings.

What steps should Structural Steel Contractors take?

1. Identify butt weld details that can be executed as EFPBWs.
2. Request engineer's approval for the EFPBWs.
3. Designate EFPBWs on the shop drawings.
4. Qualify welders and Welding Procedure Specifications (WPSs) for the job to Section 7, HERA R8-43.
5. Implement fabrication QA to Section 7, HERA R8-43.

Need help? For welding enquiries, contact SCNZ or the HERA Welding Centre.

Acknowledgement
SCNZ would like to thank the HERA Welding Centre for its assistance in preparing this fact sheet.

References
HERA. (2021). The use of effective full penetration of T-butt welds in welded moment connections, HERA report R8-43. Heavy Engineering Research Association

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