

Computer Based Fatigue Analysis for Welded Joints



**PUBLISHABLE
SUMMARY**

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Background

The British Standards Institution standard BS 7608 (BSI, 1993) describes procedures for the assessment of the fatigue performance of steel structures. The fatigue properties of structural details are presented using plots of stress range (S) versus numbers of cycles to failure (N) or $S-N$ curves. The curves represent the results of many fatigue tests and are currently presented in terms of a nominal stress range (SN). This meant that engineers must estimate nominal stresses for their structures, and this was routinely done up to the end of the 1980s before the widespread introduction of computers.

Now, finite element analysis (FEA) is used to perform stress calculations. FEA results reveal the true distribution of stresses which are often complex, so it is difficult to assess a nominal stress. However, it is possible to deduce the linear equivalent of the real stress distribution at possible sites of fatigue cracking. The value of the linear distribution of stress at the location of possible fatigue cracking is called the structural stress (SS). Fatigue tends to initiate at the locations where the structural stress is highest. The structural stress at this location is called the hot spot stress (SH), and this project used this approach to propose updated design procedures.

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Objectives

The overall project objectives are summarised below:

- Investigate current procedures for obtaining the structural stress for fatigue assessment of welded structures to clarify modelling issues such as choice of element type and mesh sensitivity.
- Create SH-based design curves from available fatigue data.
- Recommend practical procedures for fatigue assessments of a wide range of structural details by the use of fewer fatigue design curves than at present.
- Encourage adoption of the new design procedure by Standards bodies.

Project Outcome

A large amount of FEA was done. The results from this investigation have provided the basis for an assessment of various methods of calculating the SS. The most reliable values of SS have been used to generate S-N curves in terms of SS versus the numbers of cycles to failure and it was found that many of the apparently lower strength weld details can be re-expressed as class D when plotted against SS instead of SN. However, in line with IIW recommendations, joints with load-carrying fillet welds were down-graded to class E.

The new S-N curves and a synthesis of the FEA results provided a basis for revision of BS7608, which was finally prepared for submission to the British Standards Institution.

Benefits

The project contributed to the significant reduction of effort and confusion associated with the use of FEA to perform fatigue assessments of welded joints. In consultation with Sponsors, TWI used its independent position within the welding community to swiftly propagate the new methods into national standards.

Participants

The Project Comprised:

- Dalmine SpA
- Howden UK
- UK Department of Trade and Industry (DTI)
- Jaguar Land Rover
- Corus Automotive
- Lloyd's Register

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Project Budget

The Project had a duration of two years and had a budget of £210,000. It was funded by Six Sponsors each making a contribution of £30,000. In addition to this the Project was supported with £30,000 of TWI internal funds. The project finished December 2008.

Further Information

For further information on how a Joint Industry Project (JIP) runs please visit:

<http://www.twi-global.com/services/research-and-consultancy/joint-industry-projects/>

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