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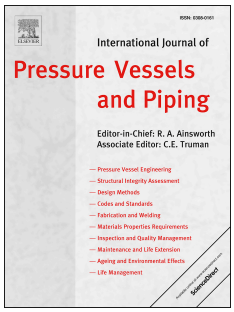

Fatigue crack growth assessment using BS 7910:2013 - Background and recommended developments

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Fatigue crack growth assessment using BS 7910:2013 - background and recommended developments

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ABSTRACT

The UK procedure for fracture mechanics-based assessment of flaws (BS 7910) was extensively updated in late 2013. This paper describes the changes made in the recent revision with respect to fatigue assessment. It also provides brief background information about the fatigue crack growth rate (FCGR) curves given in the standard and recommends future developments for fatigue assessment. A worked example is provided to highlight the importance of taking into account the profile of the weld root in the fatigue assessment of single-sided girth welds.

Key words: Fatigue crack growth rate; high strength steel; stress ratio; corrosive environments; residual stresses; stress intensity magnification factor.

1 INTRODUCTION

BS 7910 'Guide to methods for assessing the acceptability of flaws in metallic structures' (2013) is a procedure for the assessment of flaws in metallic structures, covering failure by fracture, plastic collapse, fatigue, corrosion and creep. With respect to fatigue assessment, it provides guidance for fatigue crack growth assessment based on fracture mechanics concepts and the crack growth parameters for steels in air and marine environment.

Combined with fracture/plastic collapse assessment, fatigue assessment can be used to determine the maximum tolerable initial flaw size in a structure with respect to the design life, make decisions on serviceability of safety-critical plant and structures, and also in failure investigation, life extension and design. It has been widely used in many industrial sectors such as oil and gas, nuclear, pressure vessels, petrochemical and power generation. BS 7910 has been in continuous use since 1999, when it superseded the earlier UK flaw assessment procedure PD 6493. The most recent edition of the procedure was published in 2013 and amended in 2015.

2 CHANGES IN FATIGUE ASSESSMENT IN BS 7910:2013

For fatigue assessment, the 2013 version is largely the same as the 2005 version, with only small changes as summarised below:

- Annex S "Approximate numerical integration methods for fatigue life estimation" and Section 8.4.7, which refers to Annex S, in the 2005 version were removed. Such methods are obsolete since most users now have access to a spreadsheet or other software.
- A new Annex "Worked examples in fatigue assessment using the quality category approach" has been added in Annex U. The examples highlight the main procedures and demonstrate the benefits of using this approach (S-N curve), especially when actual fatigue loading is unknown.
- BS 7910 uses a predominantly deterministic-based approach. In the new version, a probabilistic approach for fatigue crack growth assessment is also provided in Section K.3 in Annex K. This approach is very useful in some applications given that there are always many uncertainties in fatigue crack growth assessment such as initial and final flaw sizes, crack growth rates, threshold stress intensity factor ranges, etc.
- When producing Table 17 and Table 18 in the 2013 revision, some information from the corresponding Tables in the 2005 revision (Table 11 and Table 12, respectively) were removed in error (last column about Class W in Table 11 and footnote 2 below the table, and