Optioneering for Re-design of Pipe Tee in Manufacturing Plant

Case study

Following in-service problems with their manufacturing plant, and a limited window of opportunity to remedy them, the client approached EASL to appraise alternative design proposals. Following an initial consultation, where the client outlined the problem and proposed solution, based on their extensive experience analysing and assessing pressurized components, EASL were able to pinpoint the relevant issues and provided a detailed specification of the work required. EASL were able to complete the work within the required timescales, and, in collaboration with the client and the insurance inspector, agree the design modification and demonstrate an appropriate fatigue life for the revised structure.

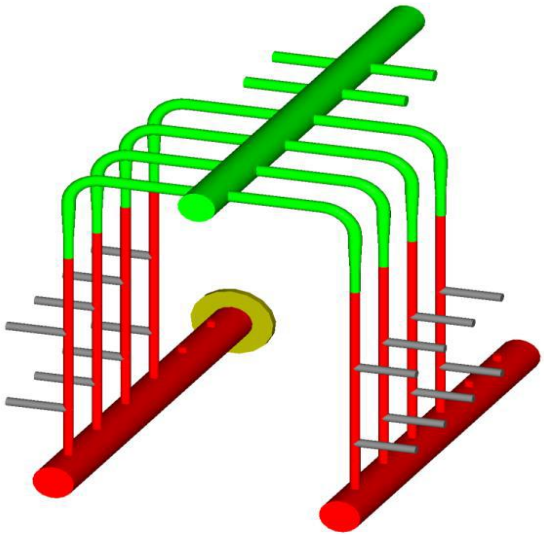
Protection against collapse failure

The client asked EASL to assess alternative design proposals for the tees attaching eight quick release legs to a manifold in pressurized system.

EASL have extensive experience of using UK and international standards to conduct design code assessment.

EASL initially used pipe stress analysis software to compare the loads and stresses predicted at the tees under pressure, temperature and dynamic loading for the current on-plant configuration and the two proposed alternative. Assessment against the ASME B31.3 design code was conducted for design and operational conditions.

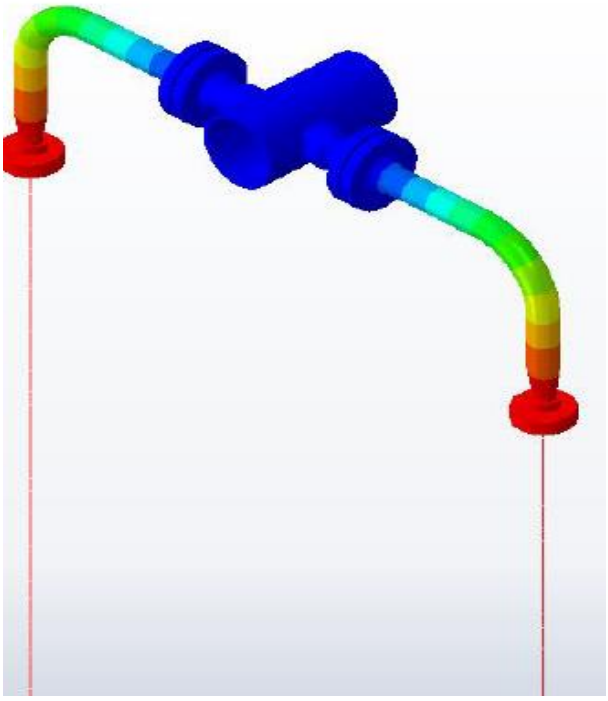
The proposed alternative identified to offer the greater improvement was then



analysed and assessed in more detail for the same loading conditions using finite element analysis.

Using non-linear finite element analysis to determine the limit analysis collapse load for the re-designed structure, EASL were able to demonstrate safe margins to plastic collapse.

EASL used BS EN 13480-3 to demonstrate that the eight tees were spaced a sufficient distance apart and hence do not interact. The finite element model was, therefore, reduced to include only one pair of the tees thereby reducing computational resources and improving project turnaround time.



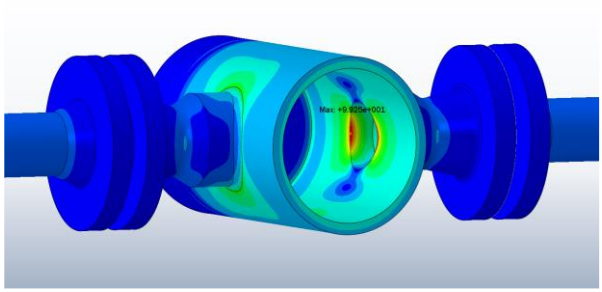
Protection against fatigue failure

In operation, the pipework is subjected to different pressure and temperature loading cycles and the client was seeking to underwrite a safe working life of 15 years.

To guard against fatigue failure, EASL conducted an endurance assessment, firstly, using limits prescribed by ASME III and, secondly, using proprietary data specific to the material used.

These approaches are only valid if the structure shakes down and achieves a substantially elastic response to cyclic loading within the first few cycles of loading.

Unfortunately strict shakedown could not be demonstrated according to the simple, elastic rules within ASME III.



Instead global shakedown was demonstrated using an elastic perfectly plastic FEA model.

Initially a short fatigue life was predicted using the pessimistic approach in ASME III. Repeating the assessment using best estimate proprietary data gave the required 15 year life.

Defect tolerance - leak before break

Use of best estimate data to provide the required life means that there remains a possibility that defects may initiate by fatigue within the 15 year life.

EASL showed that the structure would not suffer guillotine fracture even in the presence of a large, through-wall defect. EASL conducted a defect tolerance assessment in accordance with BS 7910 to determine the limiting defect size. This showed that, even if a defect initiated and grew through-wall, and the resulting gas leakage would enable the defect to be detected before complete guillotine failure of the pipework. The risks to plant and personnel were fully evaluated.

Safe operation

The complex technical challenges were met within the tight timescales specified. The manufacturing plant pipework has now been modified by the client using the design proposal recommended by EASL. If you would like to find out how EASL can help solve your manufacturing plant issue, please get in touch with our experts.

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