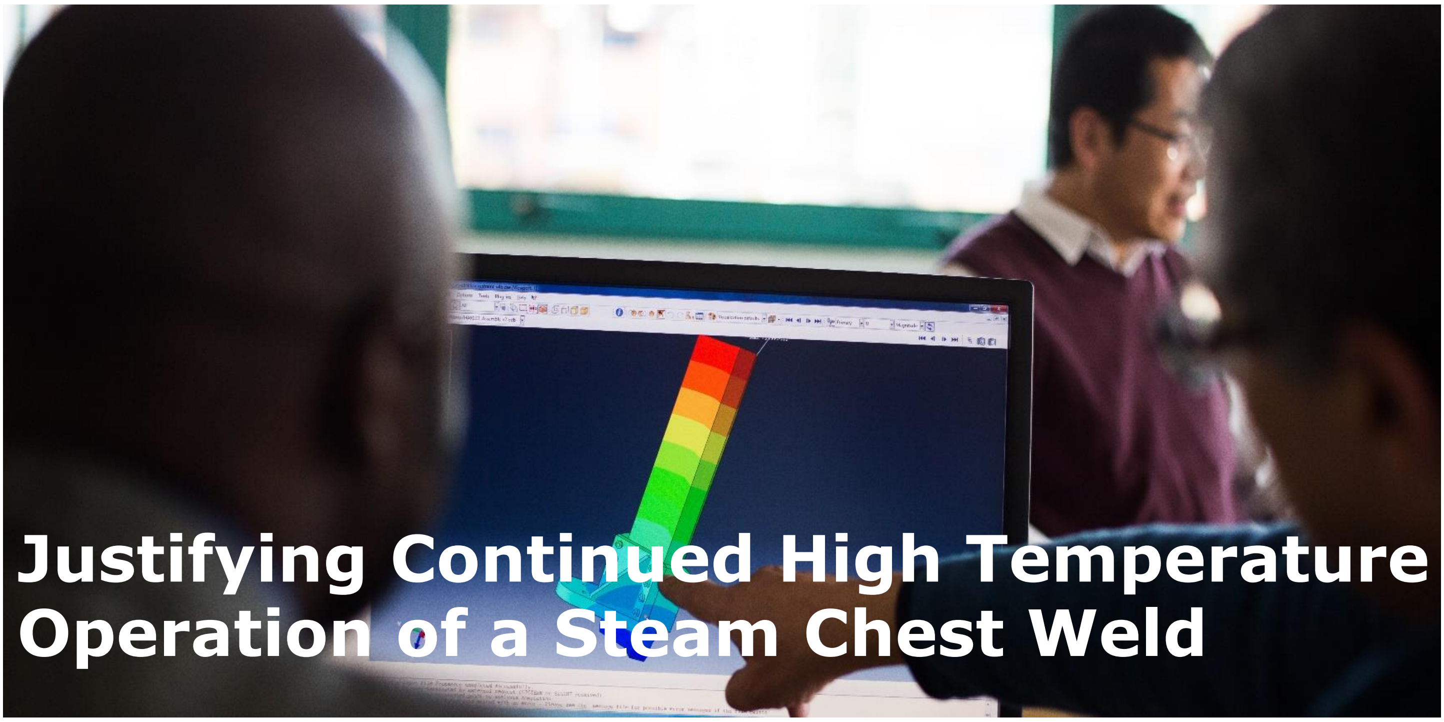


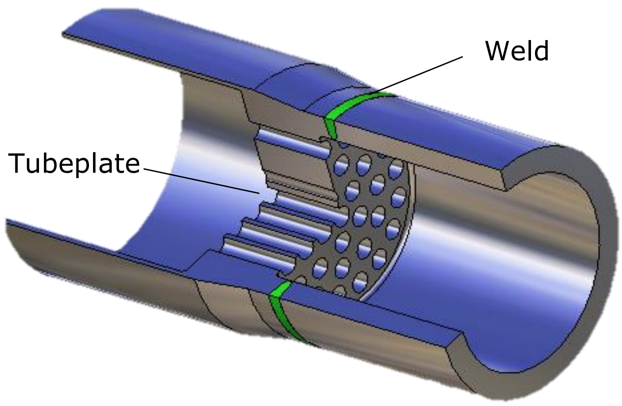
Justifying Continued High Temperature Operation of a Steam Chest Weld

Case study

During routine inspection of a steam header a defect was observed at the weld between the steam chest and the tubeplate. The defect was repaired by removing the original weld material and re-welding. The location of the weld meant that it was not possible to fully heat treat the weld. Whilst it was possible to reduce the welding residual stresses there are still significant welding residual stresses present. This has consequences for the re-initiation of potential defects.

The integrity of this weld forms an important part of the plant safety case. However, the location of the weld means that inspection of this weld is particularly time consuming and expensive. The client approached EASL to help generate a safety case for continued operation of the plant. The client already used us as an established supplier and had worked closely with us in the past. The results were used to underwrite continued operation of the plant.

The solution



During normal operation the plant operates at high temperature, around 530°C. In addition there are a number of thermal transients that result in cycling thermal stresses. This means that defect initiation due to creep and/ or fatigue is possible.

An assessment of defect initiation was carried out for the lifetime of the plant using the high temperature assessment code R5.

Finite element modelling, using ABAQUS, was used to determine the stress state in the region of the weld during normal operation. This model was used with the steam flow characteristics to calculate the temperature distribution for a series of thermal transients. From these temperature distributions the stress range variation during the transients was calculated.

The stress ranges during the thermal transients were then combined with the stress state during steady state operation to construct a load cycle.

From the load cycle, the stress ranges due to normal operation and infrequent thermal transients were determined.

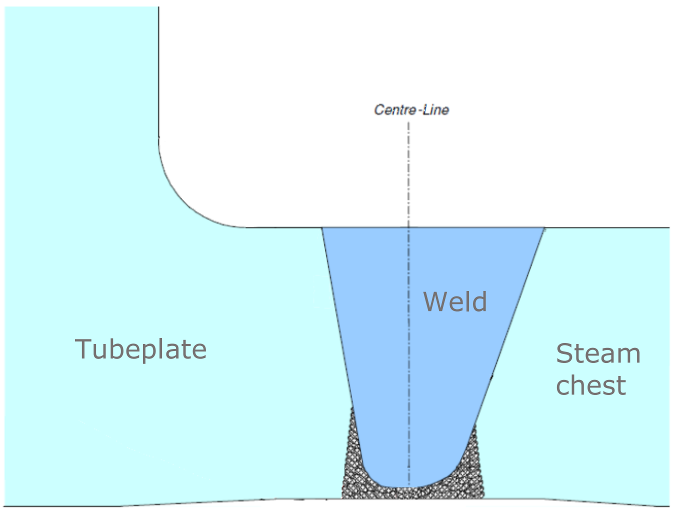
From these stress ranges, the associated strain ranges for each transient were calculated, taking account of plastic deformation where appropriate.

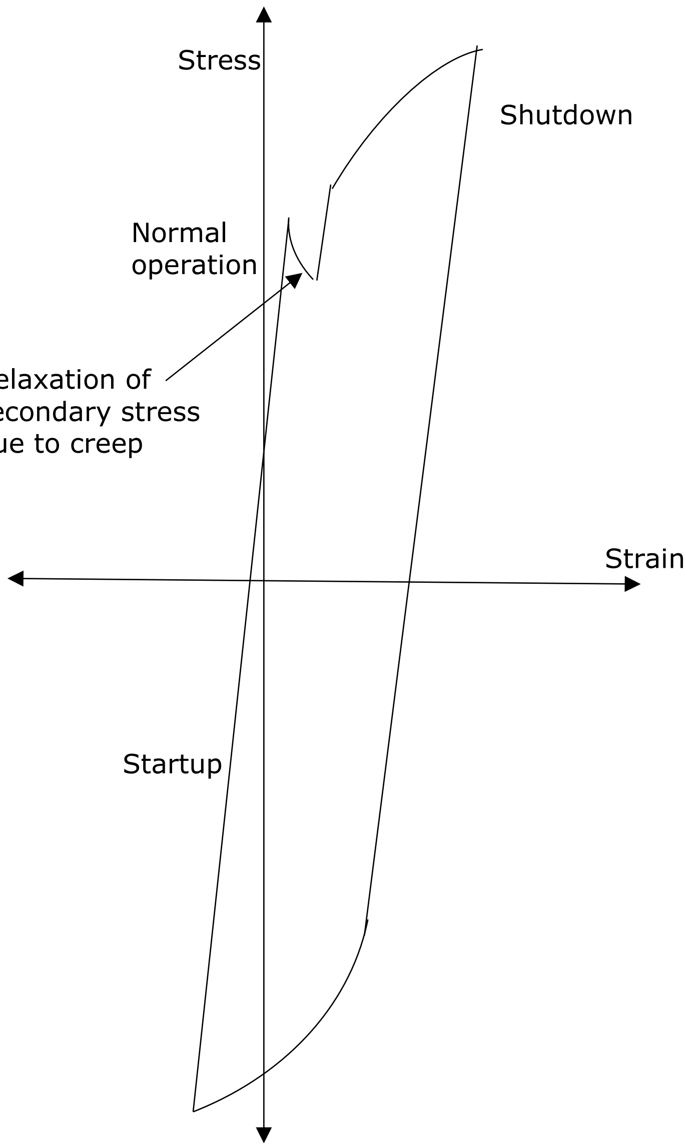
Using these strain ranges, the number of predicted cycles to the end of life and the strain range dependent fatigue endurance data, the fatigue life fraction at the end of life was determined.

To determine the creep life fraction during operation, a steady state reference stress was determined from the load cycle. The determination of this steady state reference stress took into account perturbation due to plasticity during the cycle. It also took into account the presence and relaxation of the welding residual stress during the operating life.

The steady state reference stress was used together with the creep properties of the weld and constituent materials to determine the creep life fraction of the weld at the end of life.

The creep and fatigue life fractions were then combined to determine the total life fraction and to assess the likelihood of a defect initiating.





The outcome

It was shown that, during the proposed life of the plant, the total creep and fatigue life fraction of the tubeplate to steam chest weld would remain well below a level likely to result in defect initiation weld.

This information was used as part of a safety case to underwrite the continued operation of the plant.

Other applications

This study was used in a safety case to justify continued high temperature plant operation.

Why not see if EASL can help you. Give us a call.

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