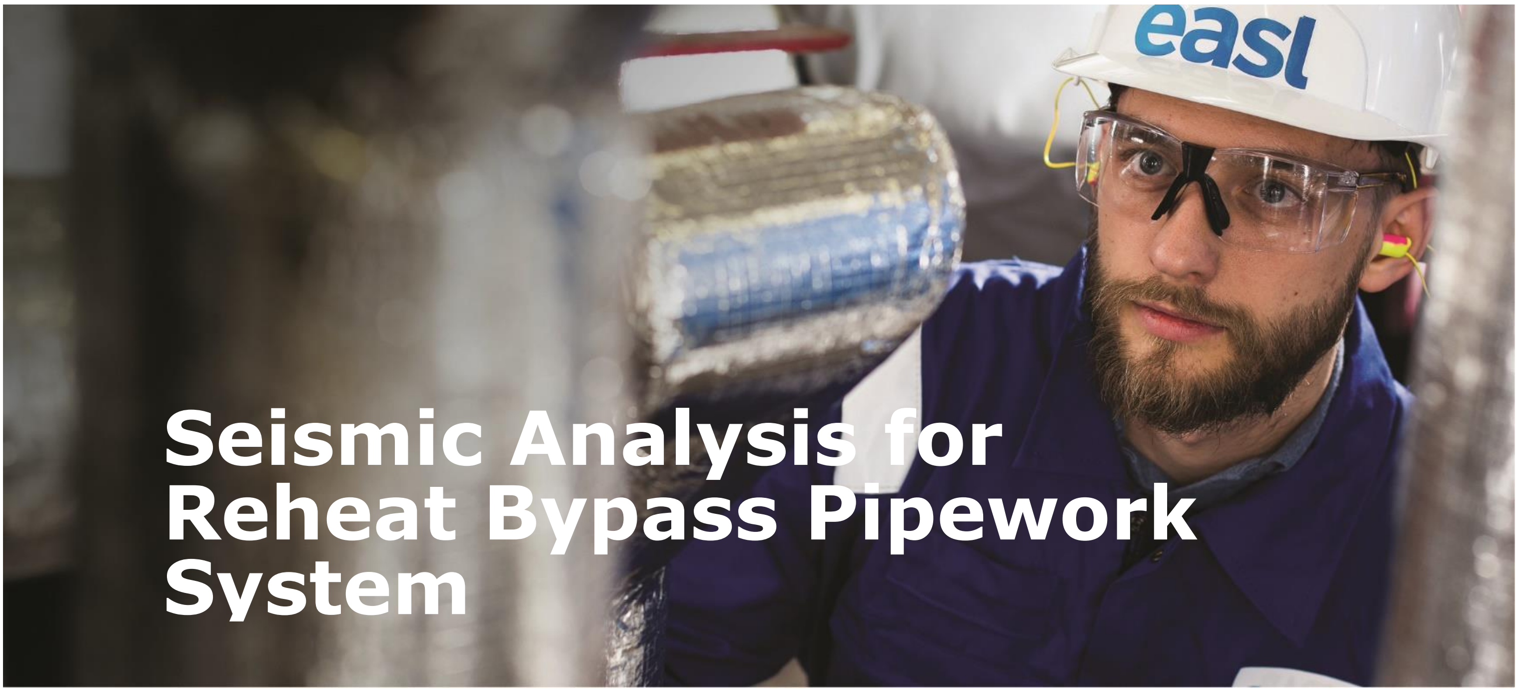

Seismic Analysis for Reheat Bypass Pipework System

Case study

We received a request to assess the reheat bypass pipework systems under seismic loading including the effects of seismic anchor motions (SAMs) of two of the UK's nuclear power station fleet. Our analysis considered the seismic qualification for the current snubber configuration and the snubber optimisation for the reheat bypass system pipework.

Snubber optimisation is the physical disconnection and removal of snubbers installed during construction which analysis can show are not necessary to maintain the seismic plus normal operation stresses below the allowable values. However, the analysis established that there were several locations with stress ratios significantly over unity with the current snubber configuration and that snubber removal would not improve the situation, but make it worse.

The reheat bypass pipework with the existing snubber arrangement has been assessed previously and shown to be over-stressed against allowable limits prescribed by BS806 enquiry case 3. The objective is to reduce the high stress ratios identified in a previous report, to as low as possible, preferably to below unity, with the minimum number of additional snubbers.

Our approach

An increase in the allowable stresses as a result of considering the normal operating temperature instead of the design temperatures is insufficient to overcome the high stress ratios identified in the existing snubber arrangement.

Figure 1 CRP3 in Quad 'A' showing no clear path from anchor point of column to line to CRP3

EASL explored different ways of reducing the high stress ratios predicted for the reheat bypass pipework by the introduction of additional snubbers. The results presented in the report are the culmination of a detailed optimisation study which considered numerous snubber configurations and locations to identify the minimum number and arrangement of snubbers required to reduce all stress ratios below unity. This solution also anchors the new snubbers off the main columns and, where possible, uses existing redundant snubber anchorage points. Appropriate locations were determined by site surveys at both nuclear power stations.

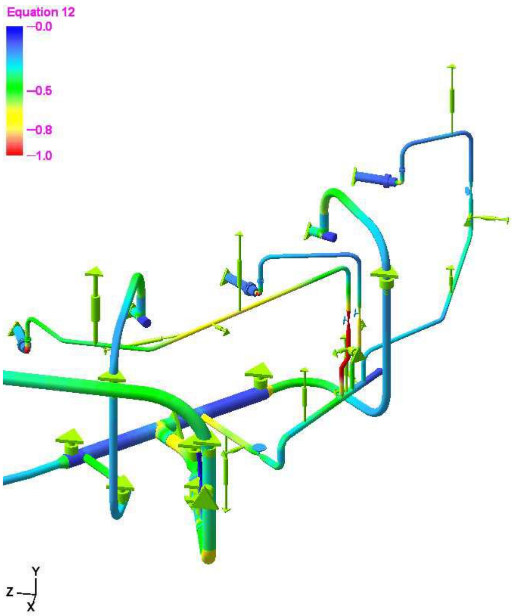

Figure 2 Location of maximum equation 12 stress ratios in Quadrant A bypass for current bypass snubber arrangement and 5% critical damping

An alternative solution which could be implemented relatively quickly as it made use of the existing redundant snubber anchorage points was also considered. Following the additional snubber assessments, the additional snubber arrangement was selected as the way forward.

A site visit to the site followed to check that the pipe layout was essentially the same as that at the other station before detailed design and final design analysis were undertaken.

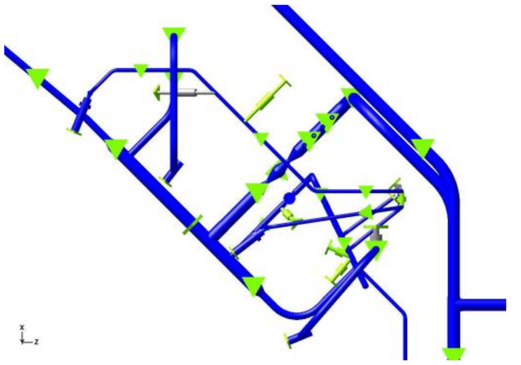

Figure 3 Plan of ADLPipe model of proposed additional single snubber location from anchorage point to CRP4 line in Quadrant 'A'

The results

A detailed optimisation study involving analysis work and site surveys at both stations was conducted which considered numerous snubber configurations and locations to identify the minimum number and arrangement of snubbers required to reduce all stress ratios below unity. A solution using additional snubbers was considered and was believed to be the optimum arrangement. Design calculations and drawings of the additional snubbers including modifications to the existing support frame were prepared.

Analysis of the final proposed arrangement was carried out. This showed that stresses are reduced to within tolerable limits. The loads on snubbers and supports and the displacements of spring supports are shown to be significantly lower than in the existing arrangement, however in some cases there is inadequate design information to justify the loads and displacement.

Our team identified an optimum solution reducing timings and cost significantly by carrying out detailed optimisation studies followed up by site visit.