



Installation involving plastic deformation

Non-linear Finite Element (FE) analysis is a core element of the service we offer. One area of our expertise is in the modelling of installation processes involving plastic deformation.

The challenge

There are a number of installation processes that involve significant plastic deformation of the flowline. Reeling is the most common but there are others, for example, the dual bending cycle of the GSP Falcon. The key concerns during these installation processes are local buckling of the flowline and girth weld fracture. Both of these concerns are driven by strain localisation.

When pipelines are plastically deformed, there is an inherent risk of strain localisation where there are changes in bending stiffness along the pipe string. The pipe bending stiffness is a function of its dimensions and the material strength/post yield behaviour.

Manufacturing tolerances for line-pipe mean that stiffness mismatches between individual pipe joints are to be expected; it is these mismatches that can lead to localisations. The severity of the localisation can also be driven by thick insulation coatings.

Modelling by finite element analysis

To evaluate strain localisation and local buckling the FE model must accurately represent the geometry of the lay vessel and the deformational response of the pipe.

Cron dall Energy has developed complete models of a number of lay vessels. The key bending structures are represented by contact surfaces to allow the pipe to take up the appropriate geometry.

The pipe is modelled using a combination of beam and shell elements. The beam elements are used to efficiently model the majority of the pipe string. In the vicinity of the girth weld, shell elements are employed to allow the local deformation to be accurately quantified.

The variation in material properties and pipe geometry across the weld allows the impact of strain localisation to be fully captured.

Software

Cron dall Energy uses the general-purpose FE program Abaqus for all non-linear analyses.

Benefit

Using this analysis Cron dall Energy is able to provide confidence that the flowline can be safely installed or define changes to specification that minimise the risk of failure.

“We have developed bespoke elastic-plastic models to optimise both installation and operation”