HEXAGON

Case study

Optimisation of casing buckling and deformation responses in shale gas wells

Robert Gordon University – Aberdeen, Scotland

ODYSSEE CAE reduces chance of failure in shale gas wells.

Robert Gordon University was founded as a university in 1992 with 18th and 19th century origins in medicine and engineering. This top modern university has grown to include over 6000 postgraduate students and over 600 academic staff.

Robert Gordon University is the top modern university in Scotland. The university focuses on providing a high-quality student experience through providing relevant education and collaboration with employers and industries. The university is producing impactful research in the fields of sustainable transport, industrial biotechnology, pharmacological practices, and artificial intelligence with smart data. Robert Gordon University is known for its research partnerships and close engagement with industry organisations, governments, and other educational institutions to stimulate innovation and economic development.

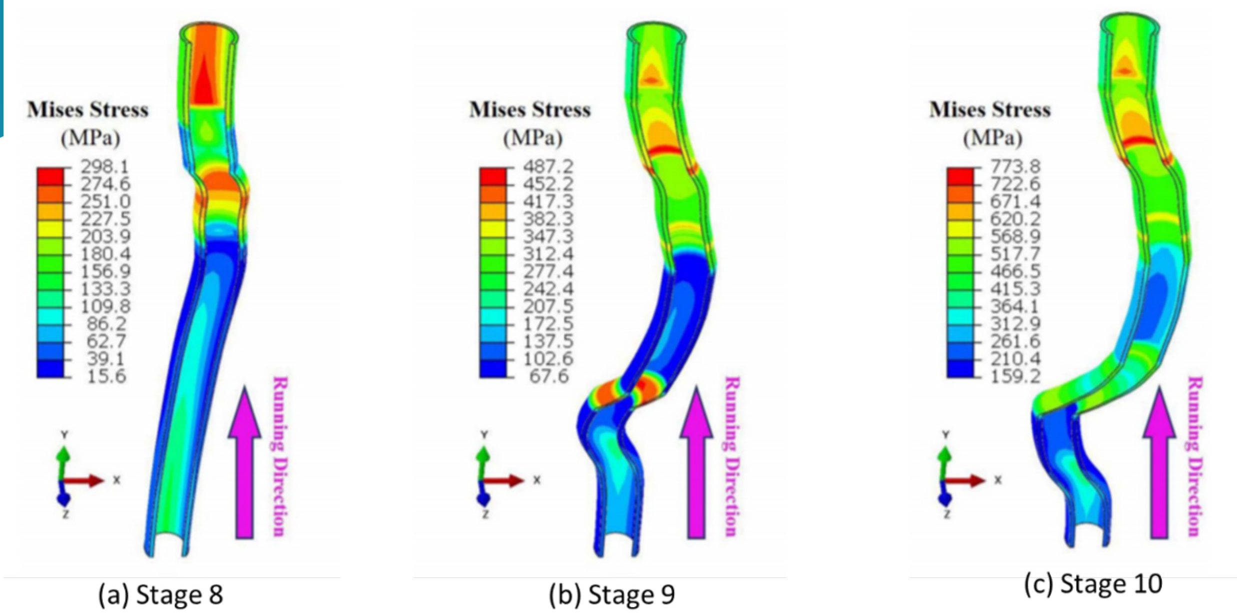

Fig 1: Different stages of buckling for a gas well, from structural instability to buckling and collapse.

Challenge

In the 1980s, a report has shown that as many as 45% of gas wells have casing failures. Globally in 2014, another report shows approximately one in fourteen gas wells have at least one form of integrity failure. In 2018, between 15 and 30% of gas wells have casing failures. The costs associated with repairing a failed gas well or rerouting a new gas well around the failed casing is approximately $20 million. The large costs and the increased time delay to the well usage are incentives to design better well casings. Mounting sensors onto the horizontal gas well's casing to measure the stress and deformation is an expensive endeavour with an estimated $1 million per well. The measurements achieved can be used to optimise the horizontal casing to withstand the expected stresses. The difficulty is in optimising the 12 different design parameters which requires a significant amount of FEA simulations to achieve. Robert Gordon University is endeavoring to reduce the occurrence of integrity failures in gas wells.

Solution

Robert Gordon University is reducing the failures through improving the structural stability with optimised parameters. The process to improve the gas well casing begins with creating a digital model of the system. FEA was used to model the gas well and the environment to the data gathered from previous wells. The model had 12 input parameters, which included cement properties, environmental properties, case dimensions, and the shale rock properties. ODYSSEE CAE was able to learn from 517 FEA simulations to produce an accurate reduced order model of the simulation. The reduced order model was then utilised to perform a parameter sensitivity study to determine which inputs had the greatest effect on the performance of the well. Optimisation with the parameter sensitivity knowledge took 21 iterations with ODYSSEE CAE to find the optimal casing parameters. Knowing the effect of the design parameters on the gas well's performance, Robert Gordon University is able to design better gas well casings.

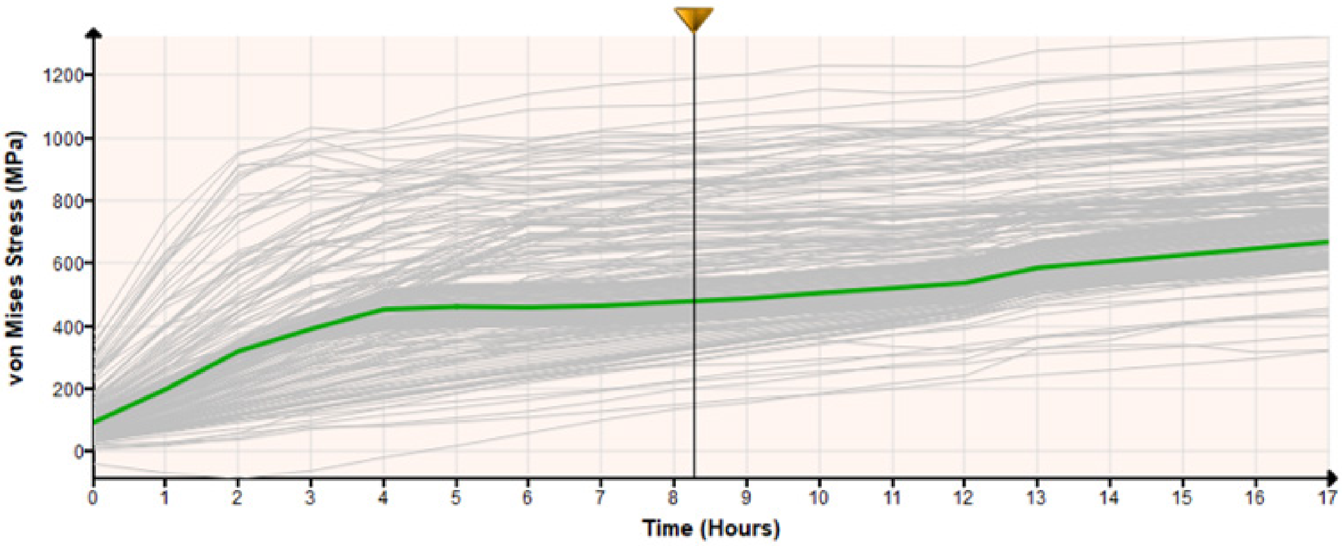

Fig 2: The effect of changing casing inner diameter on stress. The best scenario is shown in green; the grey lines represent other scenarios.

Results

Robert Gordon University used a novel approach to study casing structural integrity through the use of machine learning. The reduced order model developed through ODYSSEE CAE machine learning techniques was able to determine the effect of combined loading on multiple design parameters. The model was also able to establish the effect of those design parameters on stress, displacement, and the safety factor. The optimization of the gas well casing was performed with ODYSSEE CAE with spectacular results. The optimization process for the casing design had 21 iterations with near-zero computation time. Compared to the initial well casing design, ODYSSEE CAE optimized design had an 87% decrease in stress and an 89% reduction in total deformation. The optimized case improved the safety factor from 0.8 to 3.3 (over 300%). Robert Gordon University uses ODYSSEE CAE to improve shale gas wells and reduce the chance of casing failure.

Key highlights
Product: ODYSSEE CAE
Industry: Oil and Gas
Benefits: • ODYSSEE CAE reduces chance of failure in shale gas wells

> **The approach in this study is unique, as it can capture the pertinent parameters influencing the casing buckling and the evaluation of the magnitude of each."**

James Njuguna
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