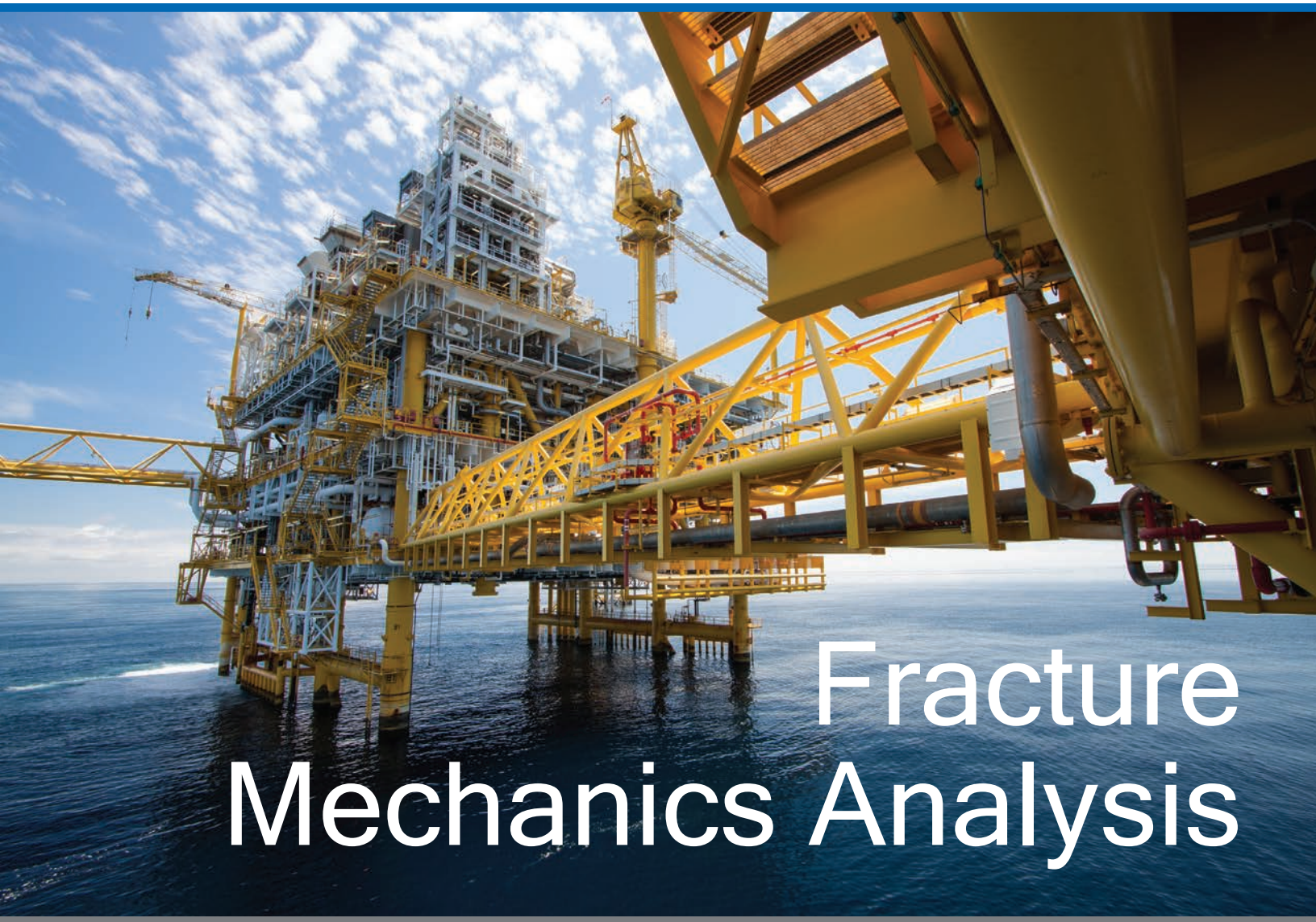
STRESS ENGINEERING SERVICES INC.
an employee-owned company

Upstream: Oil & Gas



Fracture Mechanics Analysis

Stress Engineering Services has extensive experience in conducting fracture mechanics analysis commonly referred to as engineering criticality assessment (ECA). Our experience covers both upstream and downstream oil and gas applications and follows the methodology of common industry standards such as BS7910 and API 579-1/ASME FFS-1

Target Applications

ECA can be applied to a wide variety of components in different industries, when the component under stress may nucleate a crack due to the presence of a notch, weld or other stress concentrator. It is important to evaluate the flaw tolerance of such components to guard against unexpected failures that may occur at loads much lower than the strength design loads of the component. Components under fatigue service are especially susceptible due to the tendency of nucleated cracks to grow over the life of the component until they become critical.

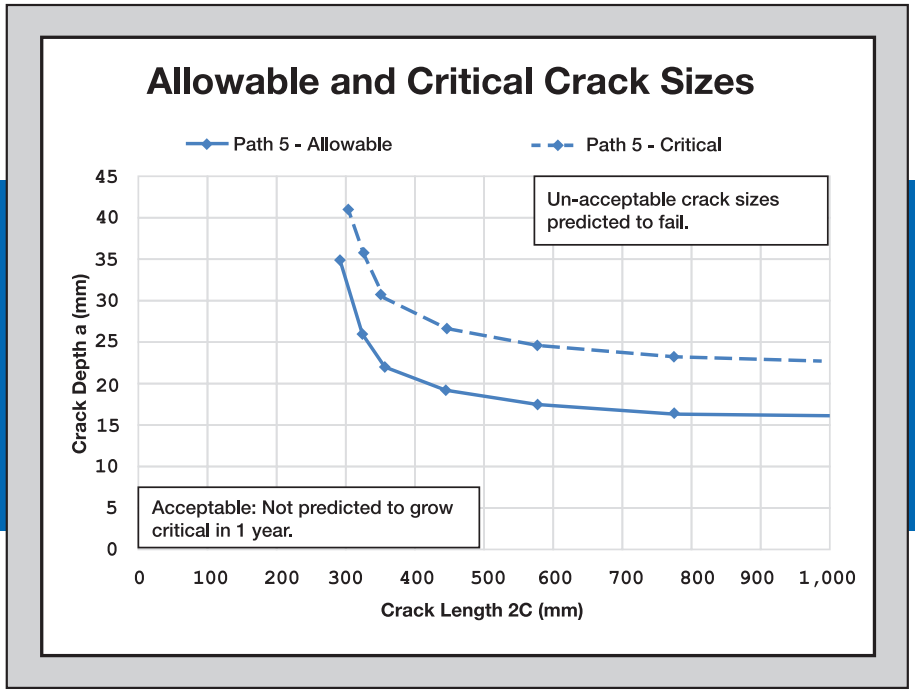
Stress Engineering performed ECA on Drilling Risers, Pipelines, Pressure Vessels, Mooring Chain and a wide variety of specialized components. In each application we provide our customers with clear insight as to the present condition of a flaw detected during an inspection or the required acceptance criterion for flaws detected during manufacturing quality evaluations.

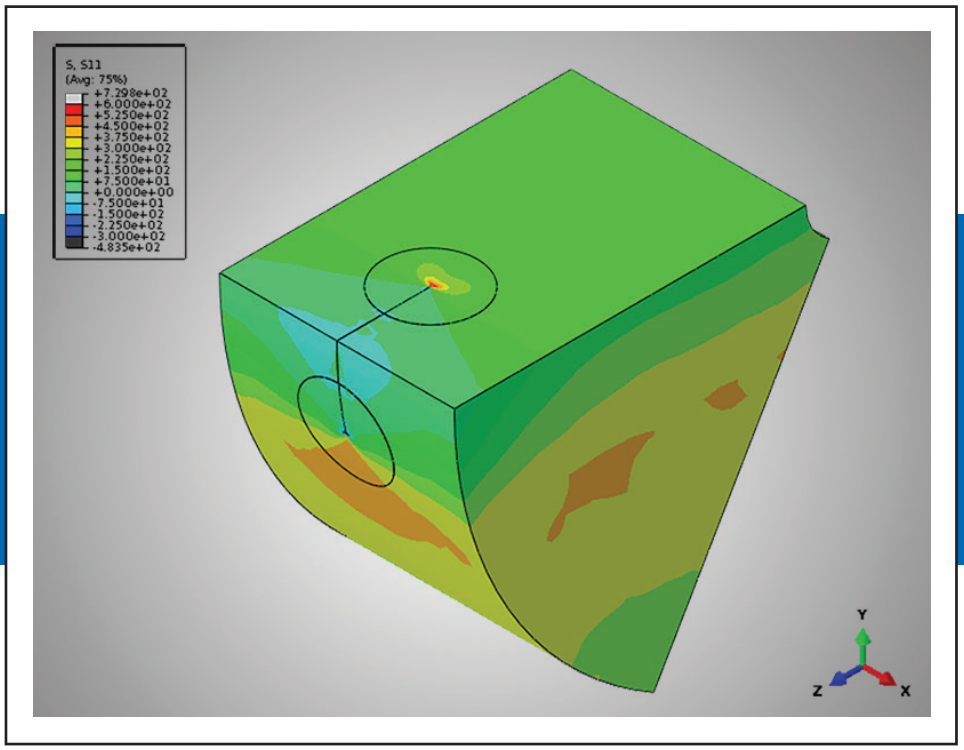
Critical Crack Size Analysis

Stress Engineering can perform studies to evaluate the critical crack size for a component under static or quasi-static load with surface or embedded cracks in a variety of common geometries.

For a Level 2 analysis the FAD diagram approach is used to assess the tendency of material failure due to both fracture and plastic collapse. Stress intensity solutions documented in the fracture mechanics standard are implemented in third party software that allow for efficient evaluation of the critical crack size.

Results can be used to evaluate the present condition of a detected crack during inspections, and set acceptance criteria for non-destructive evaluation of components during manufacturing quality checks and for fitness-for-service assessment of in-service components.





Crack Growth Analysis

Stress Engineering can perform crack growth assessments for components that operate under cyclic service conditions such as tapered stress joints at the top of production risers loaded by vessel motions, or a pressure vessel with frequent start-up and shut-down cycles.

The approach uses the Paris Law, which relates the crack growth rate, da/dN, to the range of the stress intensity factor, ΔK, for the material containing the flaw. The analysis is characterized by periodic FAD checks to determine when a growing crack becomes critical.

Results of such analysis can be used to evaluate the future condition of a present crack to establish acceptance criteria that prevent it from becoming critical over the life of the component or at least over an inspection interval.

ECA Modelling

Stress Engineering has extensive experience using the finite element approach for crack modelling.

FE analysis can be used to determine a more accurate stress distribution in components with stresses complicated by irregular geometric features. This can be fed into ECA programs that implement the K solutions to provide more accurate results.

In specialized cases requiring the highest degree of accuracy, Stress Engineering can model cracks explicitly in the finite element model. Such analysis, regarded as a Level 3 approach, provides the most accurate K solutions that take geometric irregularities into consideration and reduce the degree of conservatism inherent in Level 2 methods.

The FE modeling approach also allows for the evaluation of components with stresses in excess of

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yield, allowing for the calculation of J Integrals that provide an indication of the condition at the crack tip.

Business Synergies

Stress Engineering Services has a number of departments that complement our capability to provide effective solutions related to ECA.

Metallurgy

With one of the largest metallurgy groups in the industry Stress engineering can provide our clients a deeper insight to the characteristics of materials that cause them to be susceptible to premature fracture, crack growth and specialized fracture mechanisms related to hydrogen service. Our metallurgists also have extensive experience in failure analysis and root cause assessments.

Acoustic Emissions

Stress Engineering also has one of the most advanced Acoustic Emissions groups in the industry, providing services in a nondestructive evaluation (NDE) methodology that specializes in the detection of cracks over a large component area. They assist in narrowing the search scope for other NDE methods. Detected flaws are often suitable candidates for ECA.

Testing

Our test lab facility can conduct tests at scales ranging from a prolong sample material tests to a full scale component proof tests. Both quasi static and fatigue tests are commonly performed. The results of these tests can provide material property inputs to ECA. On the other hand ECA is often used to predict when failure is likely to occur.