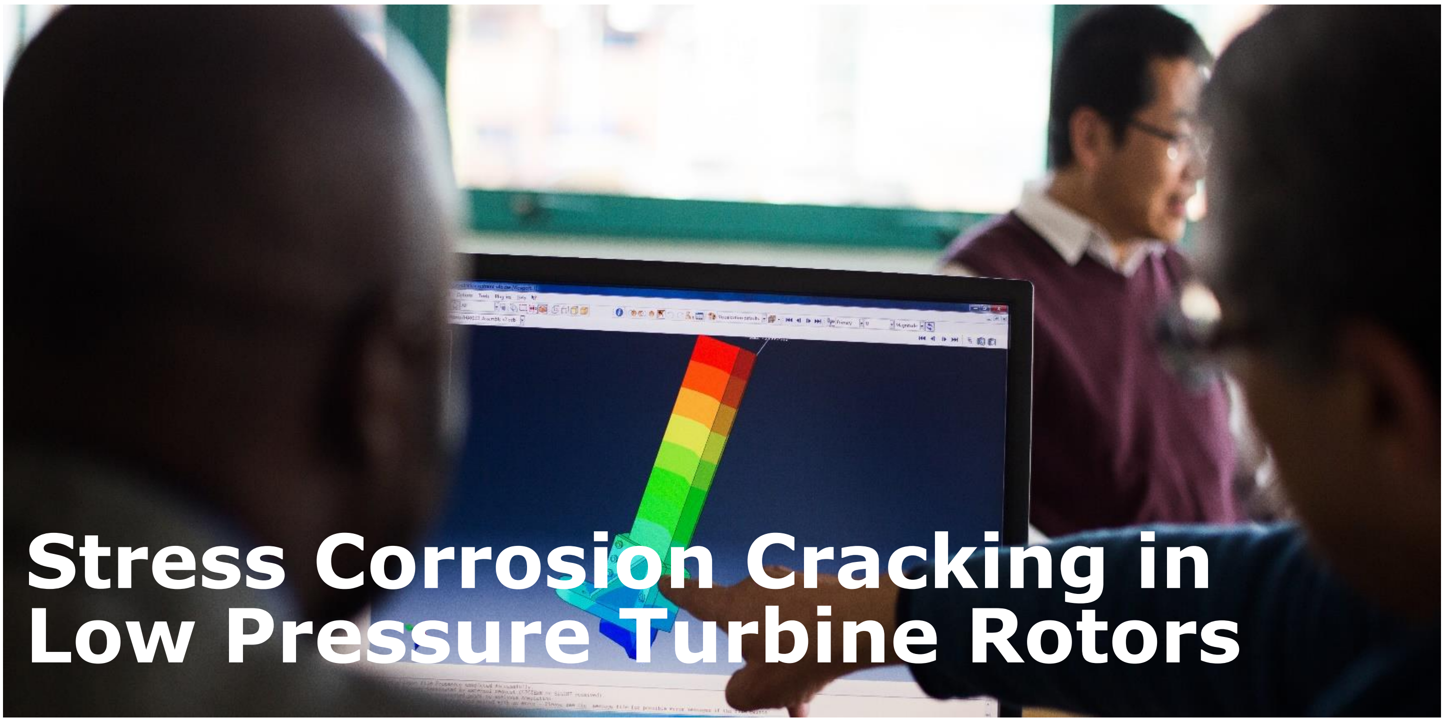


Stress Corrosion Cracking in Low Pressure Turbine Rotors

Case study

Power station steam turbines have a number of stages, which use steam of differing quality. Steam conditions within some of the low pressure stages can leave turbine blade fixings susceptible to stress corrosion cracking. The regions susceptible to stress corrosion cracking are difficult to access for inspection. If unrevealed, this could potentially cause the loss of a section of the rotor and associated blades, which could result in significant plant damage and resulting down time for repairs.

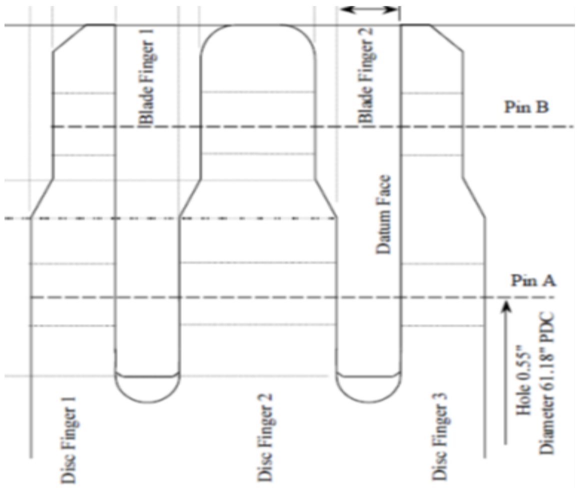
The client approached EASL to help reduce inspection intervals and thereby reduce outages. The client already used us as an established supplier and had worked closely with us in the past. The results generated by EASL were used to underwrite an inspection schedule for the turbines.

The solution

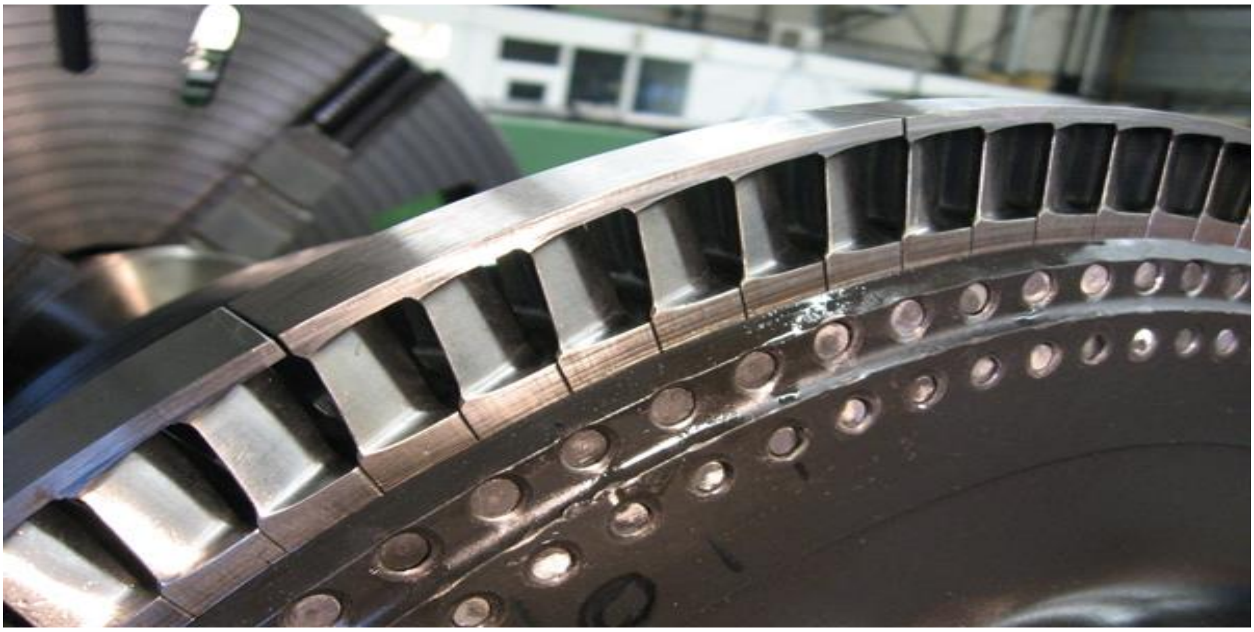
The low pressure (LP) turbine stage in question consists of a central shaft with a disc rotor to which the LP turbine blades are attached. The blades are attached using interlacing fingers.

Two different turbine stages were assessed, one with three fingers on the rotor and two on the turbine blade. The fingers on both the rotor and the turbine blade have holes drilled through them. Once the fingers of the rotor and blade are interlaced the holes on the blade align with those on the rotor and retaining pins are inserted.

There are 156 turbine blades attached to the rotor.



To determine the consequences of cracking of the rotor a series of scenarios were proposed. These included loss of a disc finger around the whole circumference



of the rotor, loss of all disc fingers over a limited circumference of the rotor and combinations of lost and intact ligaments between fingers.

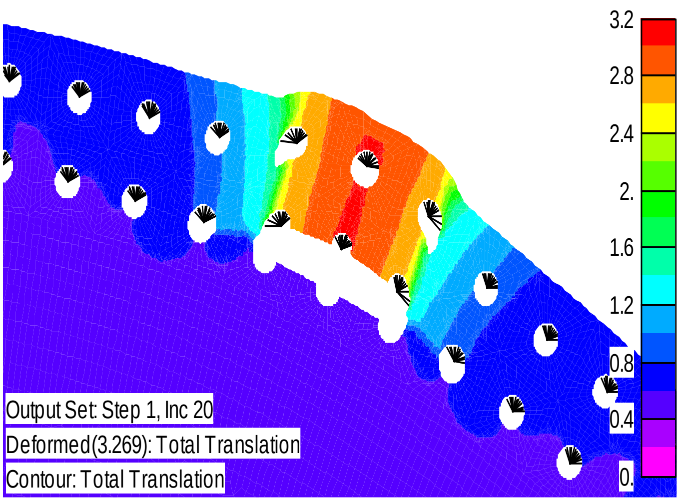
A finite element model of a sector of the rotor disc with the blades attached was constructed. The rotor disc was modelled in some detail while the turbine blades were only modelled in sufficient detail to ensure the correct loading was applied to the rotor.

The rotor was modelled using material properties that modelled both the elastic and plastic behaviour of the rotor material.

The outcome

For each of the scenarios a limit analysis collapse load assessment was performed to determine at what turbine speed a catastrophic loss of part of the rotor would occur. These failure speeds were then compared with speeds during normal operation and over-speed faults.

Significant margins of around 50% on turbine speed were seen for single finger failure around the whole circumference. It was also determined that multiple failures of fingers could be tolerated without catastrophic failure of the turbine blades or rotor.



Other applications

This study was used in the safety case to justify a reduced inspection frequency for the turbine rotors, thereby reducing outage time and costs.

The successful approach has been rolled out to turbines at other power stations.

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

engineering analysis services ltd.
2 Edward Court, George Richards Way, Altrincham, WA14 5GL
0161 923 0070 www.easl-stress.co.uk
easl