Control Stage Repair Services

Control stage repair services for AEG Kanis and ABB Nuremberg steam turbines

Reliability Improvement

An effective repair solution has been developed for the control stage of AEG Kanis turbines that helps to avoid failures of the damping wire due to thermal circumferential stresses.

By analysing the failure modes of the original wire and shroud configuration, GE has developed a repair solution that makes a significant improvement to the reliability of the stage. This protects both the control stage and the turbine as a whole and the applicable work can be done within the time period of a standard outage.

Background

During partial steam admission the control stage of a turbine is subjected to dynamic load changes that can cause blade vibration. A circumferential wire is fixed to the blade shroud in order to dampen or prevent these vibrations.

On inspection this damping lacing wire inlay is often found to be cracked (Fig. 1.). Any breakage will lead to ineffectual damping at low order vibrations. This can cause consequential damage to the control stage and even the entire turbine. A common solution is to replace the entire control stage blading and to employ a thicker damping wire.

GE has carefully looked into the failure mechanism with 3D surface scans of the wire, the fracture surface and the shroud groove. The shroud groove shows fretting wear marks, the wire surface is deformed (Fig. 2.) and the cracking is primarily found at the transition between blade shrouds. Wire cracking results from the high dynamic stresses exerted on the control stage, i.e. high cycle fatigue.

Calculations have been made for different wire types, dimensions and materials to simulate the thermal circumferential stresses experienced during start-up and shutdown. It was observed that the use of a larger wire, diameter does not extend their life.

Fig. 1: AEG Kanis G25 turbine control stage, damaged damping wire.

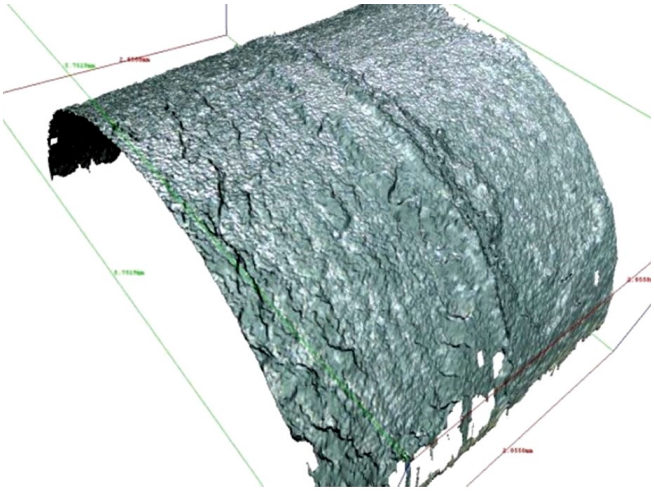


Fig. 2: 3D-scan of wire surface showing material deformation (and weakening) at a shroud intersection.

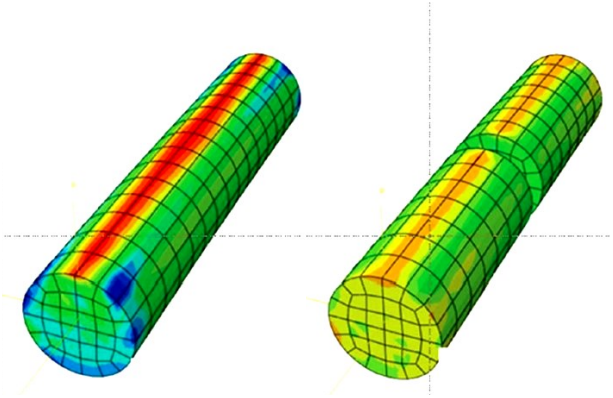
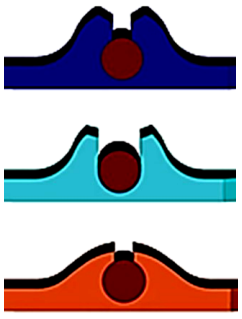


Fig. 3: Stress distribution comparison of the original wire (left) and the new segmented solution

Solution

Stress calculations (Fig. 3.) have been performed for a range of shroud and wire types using the thermal boundary conditions for turbine start-up and shutdown. These have enabled to develop a repair method using a wire that has good thermal expansion properties and is divided into sections to reduce hoop stress. The repair makes a significant improvement to the lifetime of the wire and is easy to implement within the timespan of a major turbine outage, using the nearest GE rotor workshop.

The work includes removing the affected wire, cutting a new shroud geometry and rolling the new wire with splits in appropriate positions around the circumference (Fig. 4 and Fig. 5). This repair should only be applied to a control stage which is otherwise in good condition (with no cracked blades and no deformation of the wheel). However, it is also suitable for cases where the stage has already been re-bladed.



Baseline shroud configuration

Repaired shroud configuration before rolling

Repaired shroud configuration after rolling (same wire diameter as baseline)

Fig. 4: Schematic of shroud and (broken) wire; cut shroud and new wire parts after rolling

Benefits

- Reliability Improvement

One of the main benefits of the control stage repair service is the improvement in turbine reliability that comes from using a failure-mode based approach. Additionally, the work can be completed within the timespan of a standard outage.

- Performance Improvement

Furthermore, it is possible to reduce the cost of electricity thanks to an improved turbine availability, repair and cost avoidance, increased flexibility and reliability as well as improved turbine reliability. The latter is the result of a more robust technical approach.

Applicability

The repair solution is applicable to all SST 200/300/400 AEG Kanis-models and ABB Nuremberg steam turbine models with damping wires.

References

GE 's repair solution is built on a vast engineering experience as original manufacturer of impulse-type steam turbines and on the related maintenance experience.

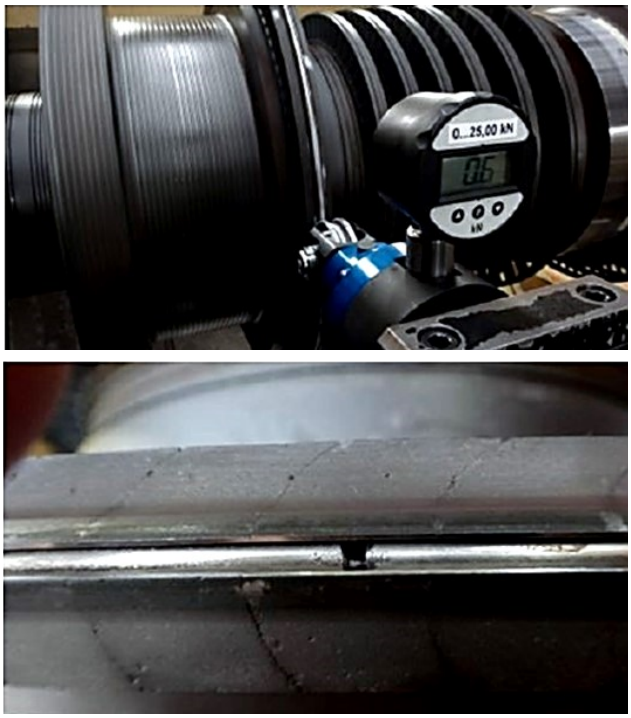


Fig. 5: Repair process: rolling-in the wire; quality check

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