

## **Development of robust, on-line, vibration-based damage detection techniques**

A lot of failures in mechanical components are caused by fatigue. It's very important to detect damage as early as possible in order to prevent a possible catastrophic failure. The purpose of this research is to develop robust on-line damage detection techniques that can detect and localize the damage in an early stage on a slat track that is fatigue tested on a test rig.

When aiming at the development of on-line damage detection techniques, several criteria like the sensitivity, the robustness, the applicability and the security, should be kept in mind. A study of through the whole frequency domain (from several Hz to several MHz) was performed in order to develop a robust and sensitive on-line damage detection technique.

In the low frequency domain (0-10 kHz) technique based on modal analysis were used. The basic principle of damage detection by modal techniques is very simple: the modal parameters of a mechanical structure depend on the physical parameters of that structure. Damage will change the physical properties of the structure, which will cause detectable changes in the modal parameters (eigenfrequency, mode shapes and damping). Also the influence of the temperature on the change of the modal parameters has been studied. From the results, it can be concluded that these techniques suffer (and will always suffer) from changing boundary and environmental conditions.

In the high frequency domain (1-10 MHz) the reflection and the transmission of surface (Rayleigh) acoustic waves is used for damage detection since in most cases the damage evolves from the surface. The transmission and the reflection of these kind of waves is influenced by the opening and closing of the crack. This variability will be used to detect the damage. Also the use of multisines is introduced to optimize the damage detection capabilities of the Rayleigh waves. An extension of the developed high frequency technique is made to plate-like structures. It was found that the high frequency techniques are very sensitive and robust. Nevertheless, it has to be noticed that these methods are local methods.

Finally a study in the mid frequency domain (10 kHz - 1 MHz) was made to cope with the drawbacks of the low and high frequency methods.