METHODS FOR FAILURE AVOIDANCE IN TRANSPORT INDUSTRIES

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Abstract

Avoidance of failure of engineering structures is of paramount importance since failure may harm human lives, environment and capital invested. Last but not least, failures can be very detrimental to the image of the company involved. Due to the serious consequences of technical failures, numerous standards and codes have been developed and are still under development, providing state-of-the-art procedures for safe design, material selection and operation. These methods are either application specific, e.g. pressure vessel codes, or "horizontal", which means they cover several areas of application. In Europe, for example, the SINTAP procedure is such a horizontal method. This method has been substantially extended by the method FITNET.

Structures used for transport are usually characterised by the requirement for low weight. This requirement is a consequence of the large amount of energy spent for the mobility of people and goods. Lower weight can be achieved by using material with higher strength or materials with lower density, introducing appropriate design principles and manufacture processes, and in particular by high exploitation of load bearing capacity and life. Such development calls for accurate methods for assessing the mechanical behaviour of a component or structure.

This presentation deals with some tools for assessing the load carrying capacity of light weight structures which are ingredients of the GKSS method SIAM (Structural Integrity Assessment Method). They include:

- The δ_5 crack extension resistance curve method,
- The ETM for assessing the crack driving force, including the treatment of mismatched welded joints,
- The cohesive model.
- The Gurson-Tvergaard-Needleman model.

The SIAM includes also methods for considering stress corrosion cracking and creep crack extension, which are, however, not presented here. A number of modules of the GKSS test and assessment procedures have made their way to international standards and codes.

The following examples in the wider area of transportation industries are presented:

- Recent accidents in railway transportation prompted deeper investigations on the assessment of the remaining lifetime of wheel sets. It is shown how initial cracks affect the behaviour of such components. The crack development depends on where at the axle the crack occurs.
- Aerospace structures are characterised by thin-walled, light-weight design. It is demonstrated how these structures can be assessed using either classical fracture mechanics or the cohesive model. Examples with increasing complexity are demonstrated: plane laboratory test pieces and stiffened curved panels, including a real aircraft structure.

The validation examples show the advantages and limitations of these models.