DIN - DEPARTMENT OF INDUSTRIAL ENGINEERING

PhD Course in Mechanics and Advanced Engineering Sciences (DIMSAI)

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A STUDY OF FATIGUE IN ADHESIVELY BONDED JOINTS AND COMPOSITE STRUCTURES

Fatigued structures

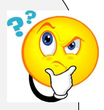
$99 bln Estimated yearly cost of fatigue failures in the USA, equal to 4.4% of the GNP.

1885 Number of aircraft accidents due to fatigue from 1927 to 1981 (7.8% of the total).

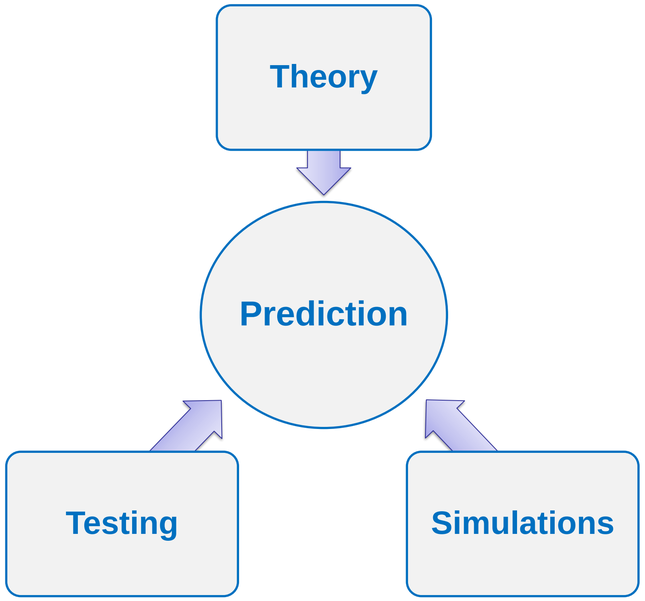
100 Average number of aircraft accidents per year caused by fatigue failures.

All structures suffer from fatigue. The presence of defects is unavoidable and so is the subsequent crack development. In the long run the fullfilment of the design requirements is spoilt by crack growth. Coping with fatigue is therefore a necessity for all those structures which must ensure integrity throughout their whole operational life.

Composites do not suffer fatigue



Composites are often said to be insensitive to fatigue. As a matter of facts fatigue failures can be observed in composite materials, even though their characteristic features are different from those found in metals. Crack growth in composites is usually associated to delamination or intralaminar damage mechanisms. Damage growth analysis and prediction in composite structures requires the development of sophisticated tools.

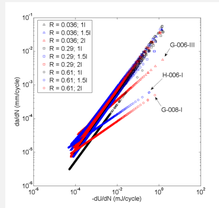


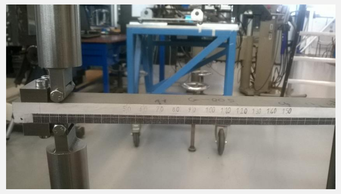
The future

Composite materials and adhesively bonded joints will predictably play a central role in future aircraft design. Considerable effort is to be put into the development of numerical models as an aid for crack growth prediction. Besides, the fracture mechanism of adhesive joints needs to be investigated further and several unclear points need to be clarified. Most importantly, a theoretical fundation on sound physical bases is required. Along with increasing computing capability, analytical models and experimental tests will pave the way to the understanding of fatigue.

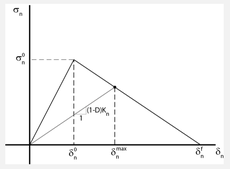
A close bond: understanding adhesive joints

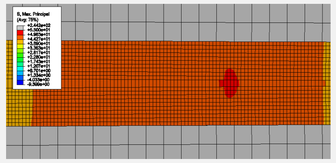
Adhesively bonded joints have been gaining increasing interest in aerospace applications owing to their good mechanical performances and light weight. The very nature of adhesive joints makes them prone to failure by disbonding, which may be triggered by fatigue. Several analytical models have been proposed to deal with disbonding propagation in adhesive joints. Experimental tests play at present a major role in studying the behaviour of adhesive joints and are fundamental for the validation of theoretical models.





Computations of stress and strain distribution at the crack tip are carried out by means of numerical simulations. Numerical models provide quantitative evaluations of the disbond growth as a complex phenomenon and, together with theoretical and experimental approaches, complete the triad available to the researcher.





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