Background
Adhesive bonding promises to allow the design of lighter weight structures. Before adhesive bonding can be more widely applied, more knowledge is required about its damage tolerance characteristics. One of the most important damage modes is disbonding, especially due to fatigue load cycles.

Aim
The goal of this project is to gain a better understanding of the mechanisms governing disbond growth, in order to develop more accurate prediction models.

Research questions
In order to understand the disbond growth behaviour, the following sub-questions will be addressed during this research:

- Are fatigue disbond growth and quasi-static failure driven by the same mechanism?
- Why does the growth rate vs strain energy release rate (SERR) behaviour deviate from log-linearity approaching the critical SERR value ($G_c$)?
- Is there both a mechanism that is dependent on the maximum SERR $G_{max}$ and a mechanism that is dependent on the SERR range $\Delta G$ or is there only one mechanism that depends on both?
- What is the effect of temperature on disbond growth?
- When subjected to variable amplitude loading is there a history or interaction effect?

Theory
It is known that the disbond growth rate is correlated with the strain energy release rate (SERR). In general:

$$\frac{dh}{dN} = C f(G)^n$$

Here $dh/dN$ is the disbond growth rate, and $C$ and $n$ are empirical parameters, generally determined by curve fitting.

Methodology
The SERR is a function of geometry and load and can be found by one of several finite element techniques. Physical specimens will be subjected to different loading conditions in order to attempt to isolate the various mechanisms thought to be involved in disbond growth. Fractography, using optical and scanning electron microscopy, will be employed to relate the SERR state to the observed mechanisms. Apart from the Paris relation, it appears there is also a relation between the disbond growth rate and the total strain energy released during a fatigue cycle:

$$\Gamma = \int_{N_i}^{N_{\infty}} G(b) \, db$$

$$\frac{dh}{dN} = f(\Gamma)$$

This idea will be investigated further.

Progress and Objectives
Achieved so far:
- Formulation of research questions.
- Completion of research plan.
- Completion of literature review (submitted for publication).

Highlights of the literature review:
- A historical overview of delamination growth methods is critically discussed.
- 4 classes are defined: stress/strain based, LEFM based, CZM based, XFEM based.
- It is shown most models are in essence phenomenological.
- It is argued a stronger connection with the physical mechanisms is needed.

Further objectives for the 1st year:
- Investigate fatigue vs quasi-static growth.
- Investigate $G_{max}$ vs $\Delta G$ behaviour.

Journal papers

Conference papers