**Measuring and Predicting Composite Impact Damage**

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**Goal:** efficient and accurate predictive model for impact damage in laminated composites

**Method**
Large-scale test programme for: 1. material characterisation 2. model validation
Efficient phenomenological 3-stage multi-scale model
Virtual testing to complement experiments to obtain material parameters

**Experimental**

**Dynamic tension:** hydraulic actuation to 20 m/s

**Dynamic delamination** with drop-weight tower

**Drop-weight impact** and measuring damage

**Numerical**

**Operational sequence and analysis scales**

1. **Micro**
   - 1: Matrix dynamic tensile behaviour

2. **Meso**
   - 2: UD dynamic tensile behaviour

3. **Macro**
   - 3: Laminate dynamic in-plane behaviour

4. **4: Dynamic delamination behaviour**

5. **5: Impact behaviour**

**First results:** response subject to rate effects

1. **1. Pure matrix:**
   - **Design:** physical model
   - **Method:** explicit FE analysis, with 3D user material
   - **Two materials studied:**
     - Thermoset: epoxy
     - Thermoplastic: PA-6 (nylon)

2. **2. Fiber assembly in a strain-rate dependent matrix:**
   - **Components:** matrix + fibers + interface
   - **Periodic boundary conditions:**
   - **Loads:** longitudinal, transversal, shear
   - **Method:** explicit FE analysis with solid 3D elements
   - **Two fibre types studied:**
     - Carbon fibres
     - Glass fibres

**Conclusions**
Tracking lower delaminating arm delivers useful force and displacement values
Explicit periodic 3D analysis with debonding conceivable but CPU intensive

**Future tasks**
Removing inertia effects from dynamic results
Minimising test programme needed as model input

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