Improvement of Testing Methods for Composites at Intermediate Strain Rates

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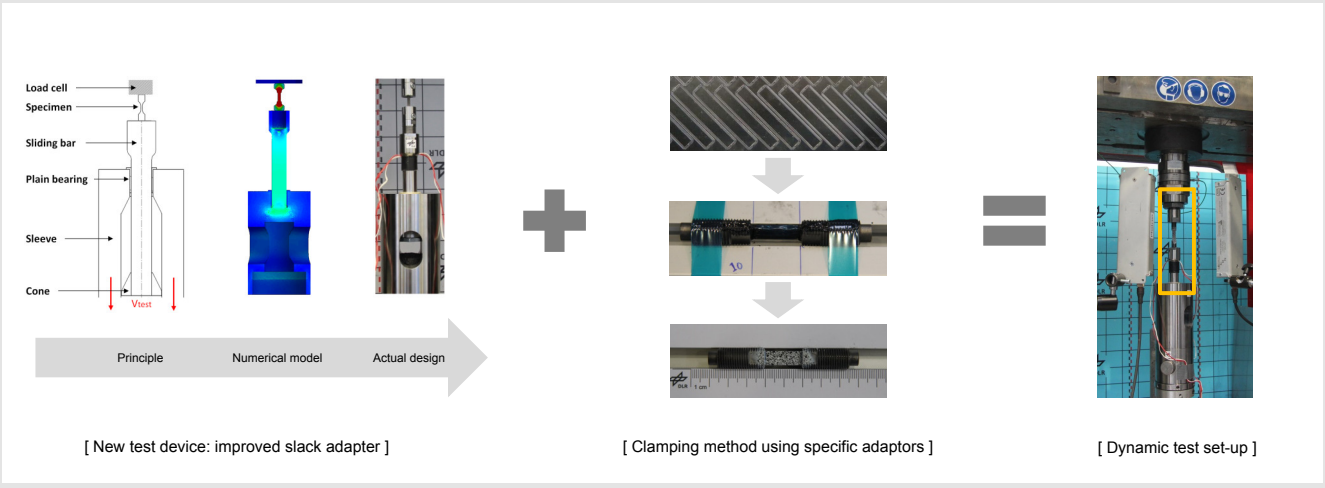


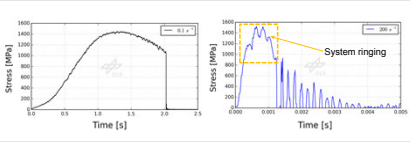
[New test device: improved slack adapter] [Clamping method using specific adaptors] [Dynamic test set-up]

New dynamic testing set-up

Introduction

Motivation

- Reliable material properties are essential to support simulations.
- Experimental challenge on dynamic testing: to suppress spurious signals due to system ringing induced by the inertial effect of involved experimental devices.



Dynamic stress-time data of a steel material at different strain rates of 0.1 and 200 s^{-1}.

Aim

- To develop new test procedures for the reliable and accurate material characterisation of Fibre Reinforced Plastics (FRP) composite at intermediate strain rate.

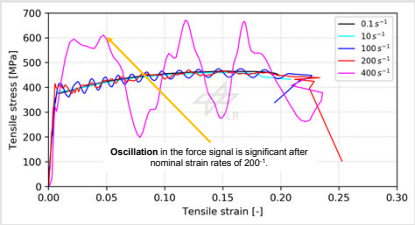
Working plan

- Analyse the dynamic interaction between test machine and test specimen.
- Develop a new test device with support of numerical simulations.
- Optimise test configuration and geometries of specimens.

Results

Evaluation of a new test device

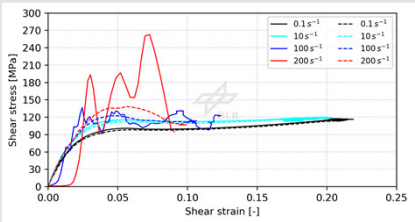
- Purpose: to investigate the capabilities of a newly developed slack adapter and assess the dynamic interactions.
- Aluminium alloy 2024 T-3, which is known as strain-rate insensitive at intermediate strain rates, is selected as material to evaluate the test method.
- Dynamic tensile testing was carried out at 5 strain rate levels up to 400 s^{-1}.



Dynamic stress-strain data of Aluminium alloy 2024 T-3 at different strain rates without damping materials.

Carbon/Epoxy composites

- Purpose: to evaluate a new test protocol for FRP composites incorporating a clamping method using specific adaptors and adhesives to reduce inertial effect-induced oscillations in measured force signals.
- To assess strain rate dependence of carbon/epoxy composites (Hexply® IM7/8552) at intermediate strain rates up to 200 s^{-1} with/without damping materials.



Dynamic stress-strain data of ± 45° specimens for in-plane shear properties at different strain rates without (solid lines '-') and with damping materials (dot lines '--').

Conclusions

- Test procedures are improved with the **newly developed slack adapter** and an **adhesive bond** clamping method.
- The use of damping material is crucial to obtain reliable dynamic properties.
- **Dynamic material properties** of carbon/epoxy composites at **intermediate strain rates** up to **200 s^{-1}** are available. The in-plane shear tests show a clear rate-dependent behaviour with increasing strain rates.

Potential Impact

- **Test protocol/standardised procedures** to perform the dynamic testing at intermediate strain rates.
- **Reliable mechanical material data** to support certification by simulations of crash events.
- **Cost-effective design process** through a combination of coupon level testing and simulation analysis at sub-component up to full-scale levels.

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