European Commission

HORIZON 2020

Dynamic aircraft MAterial property Database

Reporting

Project information

DeMAnD

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Closed project

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Coordinated by:
TECHNISCHE UNIVERSITAET MUENCHEN
Germany

Periodic Reporting for period 1 - DeMAnD (Dynamic aircraft MAterial property Database)

Reporting period: 2016-09-01 to 2018-03-31

Summary of the context and overall objectives of the project

The DeMAnD project has been set up to carry out a mechanical material characterization program to deliver a dynamic material property data base for typical aircraft materials, with a special focus on seat and crash absorbing structures of small aircraft. This dynamic material characterization will be carried out over a wide range of strain rates, ranging from quasi-static loading up to high strain rates of 500 s-1. For the various strain rate regimes, the best suitable test equipment has been identified and is available within the consortium. This will ensure the determination of high quality material data and complete stress-strain curves from static up to high strain rate loading, allowing the derivation of the strain rate dependent material behavior for all material properties needed for predictive crashworthiness simulations.

The DeMAnD project is carried out in context of the Transverse Activity (TA) “Small Air Transport (SAT)” and ITD Systems under Work Package WP 7.5 – Comfortable and safe cabin for small aircraft, more specifically: WP 7.5.2 – Advanced structural design of crashworthy configurable seats. As outlined in the CS2 work plan, “systems and equipment have to increase their intrinsic performance to meet new aircraft needs without a corresponding increase in weight and volume.” By understanding the material

behaviour of the structural materials used in aircraft seats and its respective crash absorbing structures from static to high strain rate loading up to strain rates of 500 s-1, and by providing the needed material data input for FE-simulations, the aircraft seat structure design can be optimised in the following sense:
- A better material data input enables a better prediction of the structural response under dynamic loading. In this way the design can be optimised via simulation and expensive and time consuming structural tests can be minimised.
- The materials used in the aircraft seat structure can be tailored to the applied dynamic load, resulting in a more efficient material selection and exploitation. Consequently in an improved safety for flight personal and likely in a reduction of structural weight. This in turn leads to significant fuel savings and thus a beneficial environmental impact. This project mainly contributes to reach the TA WP 7 high level objective: “Safety and Security”.

The overall and specific objectives of the DeMAnD project are as follows:
1. Determination of strain rate dependent material behaviour for typical structural aircraft seat and crash absorber materials (metal alloys, fiber-reinforced polymer composites, foams).
2. Efficient, yet complete coverage of strain rate regimes ranging from quasi-static loading up to strain rates of 500 s-1.
3. Development of new specimen geometries and methodologies, most suitable for the dynamic loading of the materials selected in the project.
4. Determination of the complete stress-strain response for the materials and strain rate regimes selected in the project.
5. Determination of strain rate trends for relevant material properties (e.g. modulus, strength and failure strain, if applicable).

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

"WP 1 - Project Management (entire project duration)

Task 1.1 - Coordination, reporting and documentation of all consortium activities.
Task 1.2 - Exploitation, dissemination and communication of the project outcomes.

WP 2 - Test Preparations (Project Month (PM) 1 to PM 4)

Task 2.1 - Materials review and selection with regard to typical materials used in aircraft seats and crash absorbing structures. A material selection defined among the project partners was presented and discussed with the topic manager.
Task 2.2 - Dynamic test methodology review of available and suitable dynamic testing methods and regulations on coupon level, including: a revision and summary of test methods, test equipment test specimen types and available standards and regulations.
Task 2.3 - Preparation of test specification, including design of test specimens with technical documentation.

WP 3 - Testing and Data Base (PM 5 to PM 19)

Task 3.1 & 3.2 - Manufacturing of specimens at project partner INEGI and TUM.
Specimen manufacturing was shared between consortium partners, but was mainly done at INEGI and TUM, with three exceptions as outlined in the ""Technical Report - Part B"" of this reporting period.
Task 3.3 3.4 & 3.5 - High strain rate testing at strain rate levels HR1 and HR2 at TUM, medium rate testing at DLR and quasi-static testing at INEGI and respective data reduction.
The work sharing between the different strain rate regimes was kept, with some exceptions as briefly explained in ""Technical Report - Part B"".
Task 3.6 - Final data reduction (comparison of experimental data for all strain rate levels and analysis of strain rate dependencies for relevant materials and test configurations) and summary of data into the dynamic material property database."

Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)

"Main results obtained in the project:

1. The size effect study (comparison of static tests with specimen geometries defined by respective ASTM standards and small specimen geometries required for the strain rate dependency study), showed that the reduced specimen geometries yielded a representative mechanical
response and are therefore applicable for further testing at higher strain rate level for all materials and test types.
2. No significant strain rate sensitivity was measured for the metal materials selected in the project (see Deliverable D3.2 for further details).
3. No significant strain rate sensitivity was measured for the Carbon SMC composite material.
4. Significant strain rate effects were measured for the carbon and glass fabric composite test series, with exception of 0° tensile loading of carbon fabric, where no strain rate effect was observed.
5. The crushing stress-strain response of the foam material exhibited an obvious strain rate effet. A quantative anaylysis of the strain rate effect was not possible, due to differences in the stress-strain response of the available foam material (test panels).

Exploitation and dissemination of results:

1. A selection of the experimental results available at this time, was presented at the renowned conference ICCS20 held in Paris, France, in Sept. 2017.
2. The experimental results obtained for the Carbon SMC composite material are novel and unique and a publication in an international journal is therefore planned (after official project end).
3. Results from all materials and expertise gathered in the dynamic test methods are used at all project partners to generate new research projects.
4. Experimental results and test methods will be used for the lecturing activities of all project partners.

5. Selected dynamic test methodologies will be carried into the working groups of the standardization organization DIN (after official project end).

Progress beyond the state of the art:

1. Despite the fact the no significant strain rate dependencies were observed for the metals, the results are unique, since they cover a wide range of metal alloys and were all done with the same setup (generally dynamic material properties need to be ""gathered"" from different publications, making a direct comparison difficult).
2. The results obtained for the Carbon SMC are new and unique and deserve publication in an international journal.
3. The completeness of results obtained for the fabric composites is unique and valuable (carbon and glass fibers, 0° and 90° tension and compression)."

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