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Simulation Studies on eVTOL Crashworthiness in the Conceptual and the Preliminary Design Phase

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Abstract

This conference paper presents two crash simulation studies on electric Vertical Take-Off and Landing (eVTOL) aircraft concepts; a conceptual as well as a preliminary design phase study.

Typical characteristics of eVTOL aircraft are the non-traditional vehicle designs and their deployment in the urban environment. Both novelties, vehicle configuration and flight mission, can have an impact on the design for crashworthiness and may require fundamental investigations on crash safety for the individual eVTOL design, from the very beginning of the vehicle development.

The presented conceptual and preliminary design phase studies consider generic eVTOL designs for air taxi missions carrying four passengers within a range of approx. 80 km. The investigated eVTOL designs are based on a lift+cruise concept with a fixed wing, eight propellers, battery energy storage and a carbon composite airframe structure. Crash simulations were performed in both studies using the explicit finite element solver LS-DYNA.

In the conceptual design study, a range of different eVTOL configurations was considered. A computational efficient modeling approach was selected with reasonable accuracy for the identification of crashworthiness trends. This first simulation study was used to assess the energy absorption management for vertical impacts up to v_z = 10 m/s (design load case: v_z = 8 m/s) and to identify the crash behavior of different eVTOL configurations under real-world impact conditions. The crash load cases considered variations in payload, impact speed, impact attitude and combined horizontal/vertical impact speed. The simulation study identified general crashworthiness trends for the different eVTOL configurations.

In the subsequent preliminary design study, the integrated safety design was further developed for one selected eVTOL aircraft configuration, using a more detailed modeling approach for the airframe structure, the seats and the occupants. First results from preliminary static sizing could be incorporated in the model design. Again, the selected crash load cases considered a range of different loading conditions including real-world crash scenarios to ensure a robust and safe crash design beyond the design load cases.

The conference presentation will discuss selected results from both, the conceptual and the preliminary design phase study.

Keywords: eVTOL · crashworthiness · conceptual design · preliminary design · finite element simulation

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