Advancing Aeronautics: Collaborating for Smarter Wing Design

A consortium of industry beneficiaries and academic researchers is coming together with a common purpose – to achieve the following objectives:

Exploring Dynamic Wing Behavior: Launch an experimental campaign to uncover how modern airliner wings (200+ passengers) respond to dynamic loads while carrying fuel. The outcome database of measurements serves as a benchmark for the project's numerical and analytical methods.

Revolutionizing Numerical Techniques: State-of-the-art numerical techniques aiding the design of the experimental campaign and constructing a sophisticated digital twin of the setup.

Unveiling Efficient Models: Evaluate various reduced-order and analytical models, designed to simplify intricate numerical frameworks.

Integrating Disciplines for Optimal Design: Models generated are seamlessly integrated into a holistic design framework.

"Become a part of this visionary aviation initiative, where collective expertise shapes the next era of wing design."

SLOWD TEAM

Coordinator

AIRBUS

arianeGroup

AIRBUS DEFENCE & SPACE

easn Technology Innovation Services

University of Cape Town

University of BRISTOL

SAPIENZA UNIVERSITÀ DI ROMA

UKRI Science and Technology Facilities Council

Consiglio Nazionale delle Ricerche

https://slowd-project.eu

SLOWD

Sloshing Wing Dynamics

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 815044

SLOWD Results

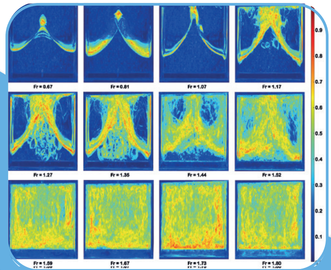
Vertical Sloshing in Flexible Structures: Experimental Testing and Achievements

WP2 Experimental Testing

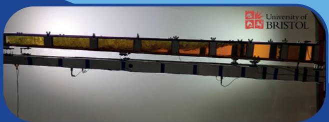
Developed various test rigs for exploring vertical sloshing.

Main Findings

- One DOF transient response rigs: Identified turbulent, lateral sloshing, and low-motion phases.
- One DOF harmonic rigs: Frequency and amplitude affect damping levels.
- Scaled (3m long) wing model: Realistic 3D multi-DOF test case for scaling.



Harmonic tests averaged motions



Scaled wing slosh testing

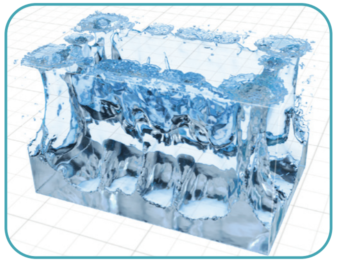
Advancing Aircraft Fuel Slosh Modeling

WP3 Fluid Dynamics

SLOWD advances aircraft fuel slosh modeling for improved design and safety

Main Achievements

- Use SPH models and VOF code for slosh-induced load simulation.
- Accurate modeling of 2D and 3D slosh cases.
- Develop scaling laws for aircraft design.



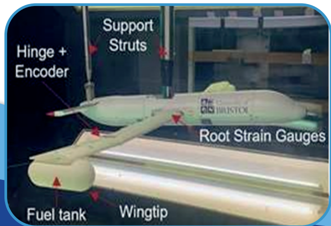
3D SPH free surface at impact

Advancing Structural Dynamics Modeling

WP4 Structural Dynamics

Main Achievements

- Enabled support for high and low fidelity FSI analyses.
- Shared MiniWoT FE model and experimental data with SLOWD partners.
- Gained insights and calibrated models for nonlinear damping in dry structures.
- Proposed ad hoc models to capture nonlinear effects in aerodynamics and dry damping.
- Described amplitude and frequency characteristics arising from geometric nonlinearity.
- Contributed to FSI coupling understanding and SPH/ROM model development.



Advancing Sloshing Simulation

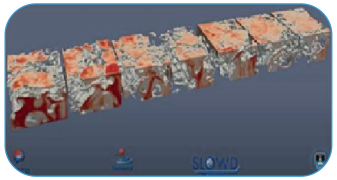
WP5 Fluid/Structure Coupling

Main Achievements

- Created new software capability for high-performance sloshing simulation.
- Studied fluid slosh effects at varying Froude numbers and baffle setups.

Key Findings

- Achieved coupled FSI simulation with commercial closed-source solutions.
- Importance of high-fidelity CFD for sloshing dynamics.
- Baffled regions' impact on damping behavior.
- SPH and VoF suitable for different sloshing scenarios.



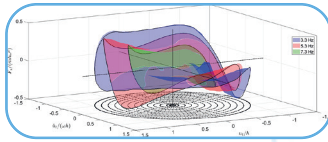
FSI simulation of Airbus ProtoSpace data using Elemental

Fuel Sloshing Reduced-Order Models (ROM)

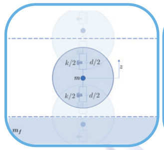
WP6 ROM and Analytical Models

Main Achievements

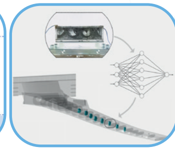
- Accurate sloshing behavior reproduction in diverse applications.
- Pressure ROM computes tank wall pressures precisely & faster than detailed CFD.
- LFD applied successfully to different tank shapes for small perturbations.
- Bouncing ball models, NN-based ROMs, and surrogate models predict sloshing-induced responses.
- Integrated ROMs demonstrate load alleviation in gust response analyses.



Surrogate model / Pressure ROM



Bouncing Ball



Neural network for sloshing aeroelastic wing modeling

Software Integration: Streamlining Success

WP7 Integration into Design

Main Achievements

- Comprehensive software managing project structure and configuration data.

Key Functions

- System coordination made easy.
- Flexible configuration options.
- Seamless communication with other work packages.
- Efficient simulation restart.
- Impressive results plotting.