Dynamic Response of an Elastic Aircraft to Store Ejection

DEPARTMENT OF AEROSPACE ENGINEERING

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Background and Objectives

- Aircraft stores are typically released via a large ejection force that pushes them away from the aircraft and into a safe trajectory
- As modern aircraft structures become more flexible and stores become lighter, thus requiring larger ejection forces, store ejection might result in excessive loads acting on the aircraft's structure.
- The study aims at simulation of structural loads due to store ejection with a focus on:
  - Multiple store ejection (ripple ejection)
  - The role of nonlinear damping on the structural response

Governing Equations

The aeroelastic equation of motion:

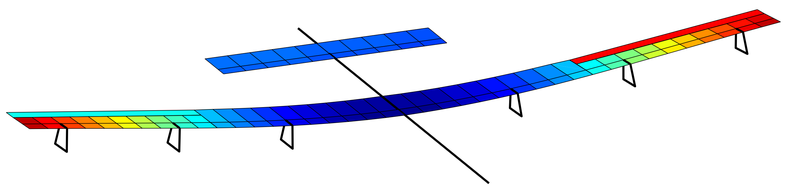
$$[M]\{\ddot{x}\}+[C]\{\dot{x}\}+[K]\{x\}=\{F\}$$

$$\{F\}=\{F_{aero}\}+\{F_{no\ store}\}+\{F_{ejection}\}$$

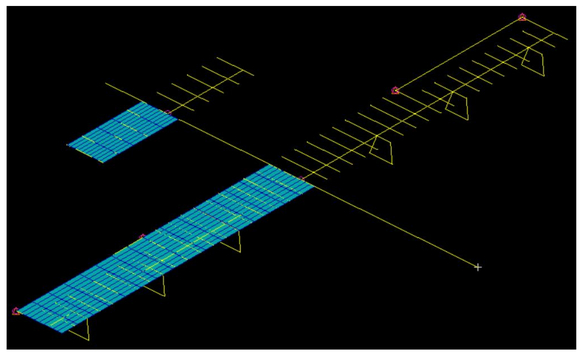
The Three Main Groups of Parameters

- Aircraft's Dynamic Characteristics
- Ejection Forces
- Flight Conditions

Test Case – Dynamic Model



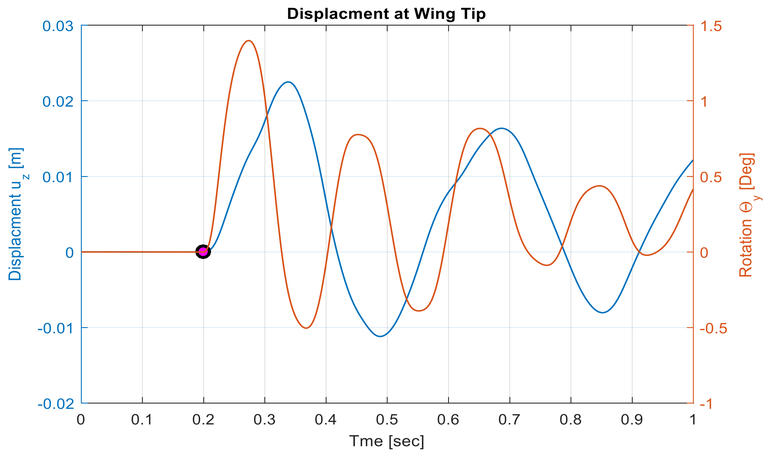
Test Case – Aerodynamic Model



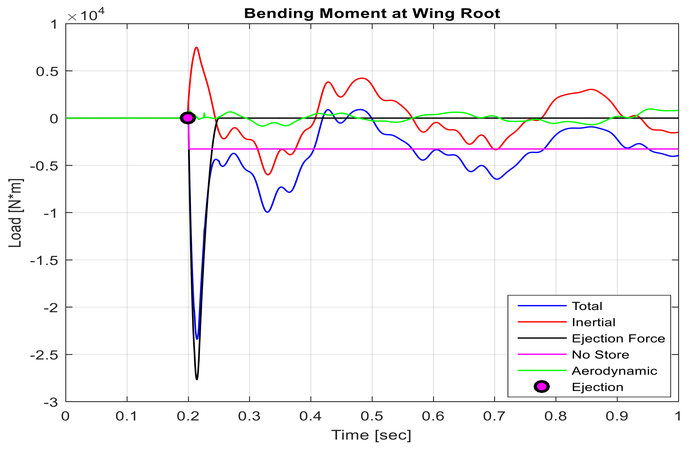
Test Case 1 – Single Store Ejection

Ejection of one store of 50 [kg] from the left wing
Ejection occurs at 10,000 [ft] 0.3M, 0.2 [sec],
straight & level flight

Wing Tip Motion



Root Bending Moment



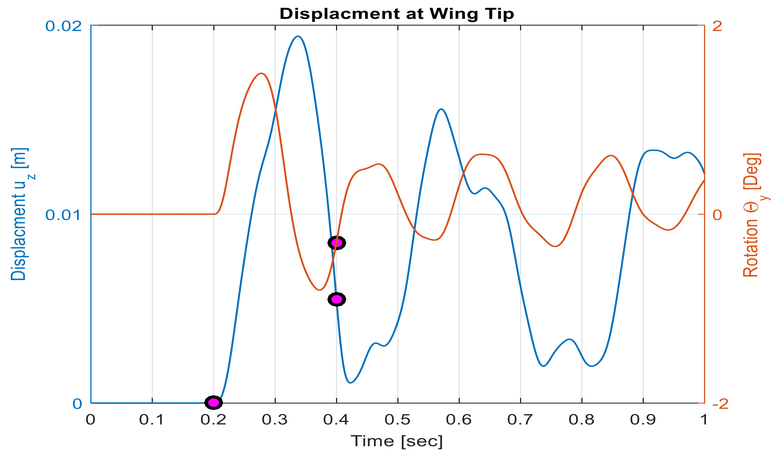
Summary

- Ejection force loads and inertial loads make the highest contribution to the total loads
- Aerodynamic loads make the lowest contribution to the total loads
- Ripple ejection creates larger dynamic loads compared with single ejection
- The modal damping value has a major influence on the loads

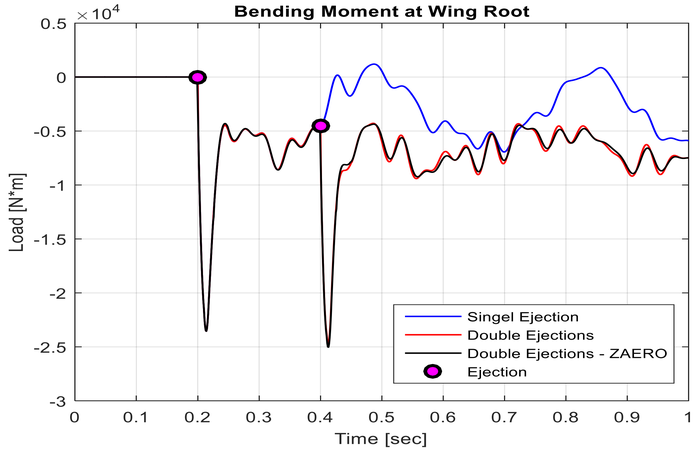
Test Case 2 – Double Store Ejection

Double ejection of 50 [kg] stores from the left wing
Ejections occur at 0.2 & 0.4 [sec] , straight & level flight.
No aerodynamic effect included

Wing Tip Motion



Root Bending Moment



Influence of Damping Coefficient