COLLINS AEROSPACE SEAL TESTING SYSTEM PHASE II

SDSU

Collins Aerospace

PROBLEM DEFINITION

In Phase I, the ANSYS FEA model for nacelle seal stiffness was incomplete, leading to discrepancies with mechanical test data. Without an accurate model, reliable stiffness prediction was not possible. Phase II addresses this by generating an accurate, validated FEA model using material properties derived from the improved mechanical compression test rig.

BACKGROUND

Aircraft nacelle seals must maintain reliable sealing performance under large deformations, manufacturing tolerances, and operational loads. Our project combines physical compression testing with nonlinear FEA to better predict seal stiffness and contact behavior. Matching the simulation to the test data helps us refine the model faster and make sure it's behaving the way the real seal does.

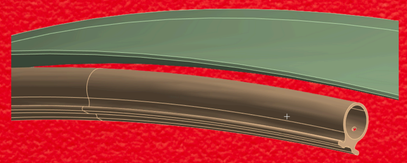
PHASE I OVERVIEW

Phase I was completed in Fall 2024 by a senior design team at SDSU. The project focused on designing and building a mechanical compression test rig to evaluate the stiffness of aircraft nacelle seals. The team developed a modular aluminum test system equipped with DC servo linear actuators, load cells, and 3D-printed curved interfaces that replicate realistic seal compression conditions. The rig enables stiffness measurement over longer seal sections than traditional equipment, providing more representative data on how geometry affects mechanical behavior.

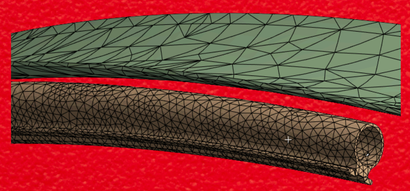
TEAM

William Sotelo, Kevin Lopez, Kaylee Tirado & Roy Foley

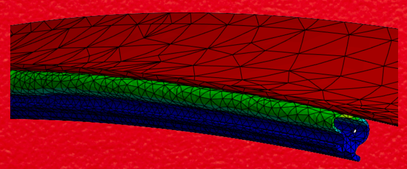
Collins Aerospace Nacelle System



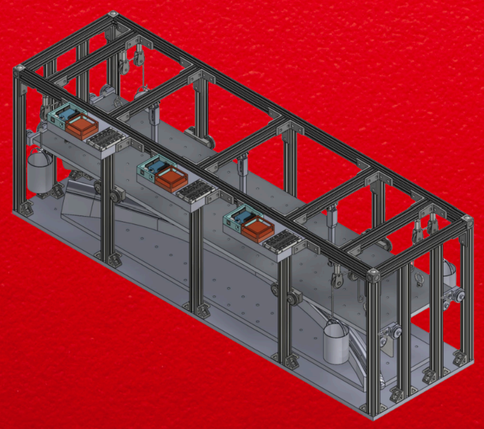
Seal CAD Geometry



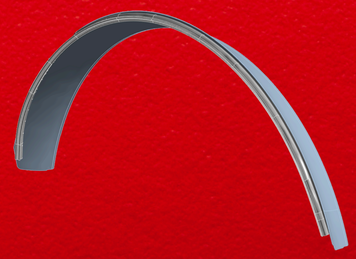
FEA Mesh Model



FEA Deformation Stress Map



Mechanical Compression Test Rig



Nacelle Seal Specimen

METHODOLOGY

A compression testing machine compresses seal samples in a controlled setup. The resultant data is processed into a function, which is the force as a function of displacement, also known as Young's Modulus. An ANSYS FEA model of the equivalent testing parameters is created, and material properties are changed until the Young's Modulus values converge with that of the empirical data. The ANSYS model extrapolates seal mechanical properties to a full length of seal representative of the actual nacelle application.

DELIVERABLES

- Upgraded Mechanical Compression Test Rig
  - Integrated into a single, simplified Arduino program for running tests and collecting data directly within the Arduino IDE.
- Excel Data Handling Tool
  - Automated links and formulas to generate stress–strain curves and calculate key performance metrics including specimen stiffness, maximum displacement, force at maximum displacement, and additional derived parameters.
- User Guide for Mechanical Compression Test Rig
  - Step-by-step instructions for system setup, operation, and data collection.
- ANSYS FEA Model of Nacelle Seal Geometries
  - Simulation environment representing various seal geometries under realistic compression and operating conditions.
- ANSYS FEA Model User Guide
  - Instructions for modifying geometry, running simulations, and interpreting FEA results.

SPONSOR

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Fall 2025