Engine Thrust Reverser Structural Analysis

Typical Thrust Reverser in deployed mode

Thrust reversal, also called reverse thrust, is the temporary diversion of an aircraft engine's exhaust so that the thrust produced is directed forward, rather than aft. This acts against the forward travel of the aircraft, providing deceleration.

Task Objectives

Jesmond Engineering was tasked by its customer with supplying a Finite Element Model (FEM) of a new Engine Thrust Reverser structure followed by static and fatigue stress analysis of some of the critical structural components.

The engineering challenges for Jesmond Engineering included the construction of a fully operational Thrust Reverser FEM, subjected to all critical flight and ground load conditions. These conditions included internal pressure, external pressure, thermal loading and inertial loading.

The FEM results were subsequently used as part of the Static and Fatigue check stress analysis. The FEM and stress calculations formed a crucial part of the Thrust Reverser's certification and airworthiness process.

Finite Element Modelling

The initial construction of the FEM, load application and post process analysis of results were carried out using MSC PATRAN. The thrust reverser was primarily modelled in 2D shell elements (CQUAD and CTRIA) and 1D beam elements (CBEAM and CBAR). Solid elements (CHEXA) were used to create a fine mesh in critical areas where greater accuracy of results was required.

Verification of the FEM was carried out by applying test load cases and comparing the resulting deflections and strains with those measured during physical testing. Some minor adjustments were made to the model to ensure that a good correlation was achieved with the test results.

Load cases represented the aircraft flight and ground conditions in the stowed and deployed configurations. In addition, special load cases covered scenarios such as bolt failure or engine fire.

The load cases were made up of a combination of inertial loading, thermal loading and aerodynamic internal and external pressures.

The full Quality Assurance Checking of the model completed the FEM task, prior to the results being submitted for Static and F&DT check stress.

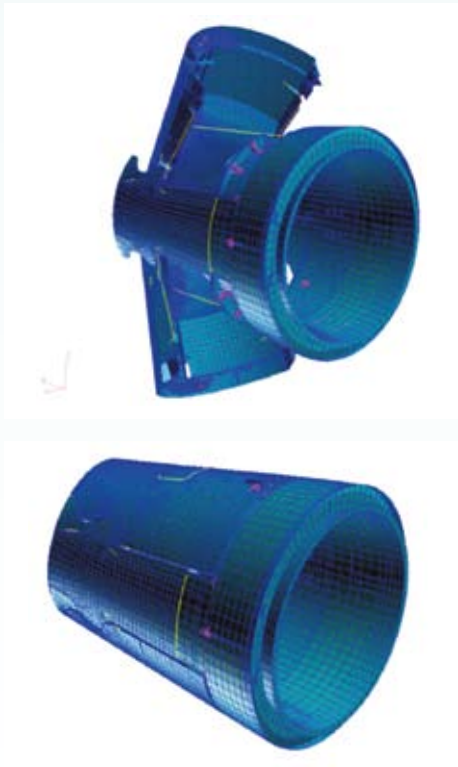

Figure 1 *The Thrust Reverser FEM with the doors deployed (top) and stowed (bottom)*

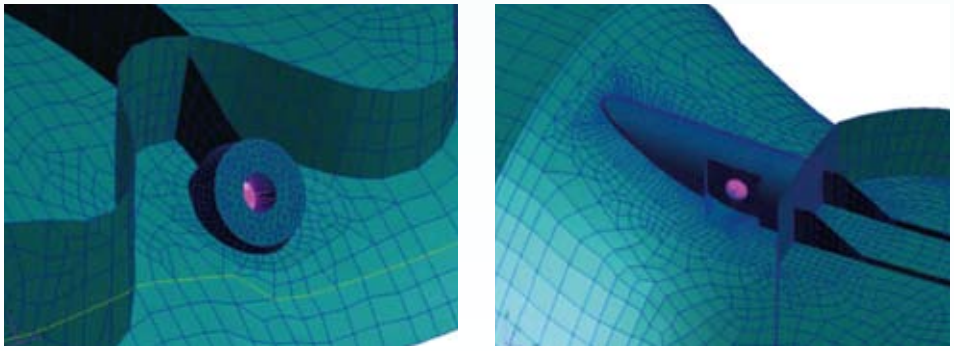

Figure 2 *Above: Critical 'fine mesh areas' modelled in detail.*

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Static And Fatigue Check Stress

A Static and Fatigue check stress analysis was carried out on some of the critical components. Stresses were calculated using a combination hand calculations and Finite Element results.

Static stress analysis methodology incorporated various approved reference sources such as Roark[1] and Bruhn[2]. Fatigue analysis followed Miner's 'cumulative damage' approach. Stress concentration factors were obtained via local FE models and published sources such as Peterson[3].

References:

1. Young WC, "Roarks Formulas for Stress & Strain", 6th Edition, McGraw-Hill, 1989.

2. Bruhn EF, "Analysis and Design of Flight Vehicle Structures", Jacobs Publishing Inc. 1973.

3. Peterson RE, "Stress Concentration Factors", JE Wiley & Sons 1974.

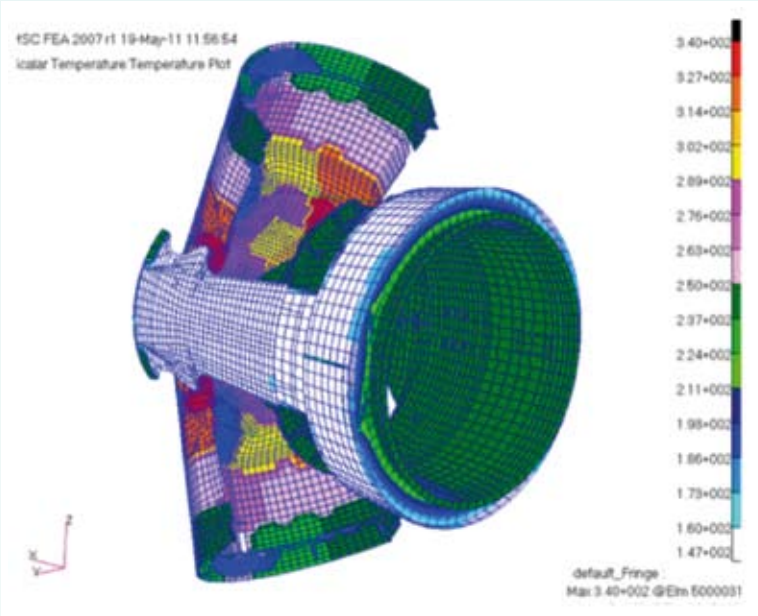

Figure 3 *Typical mapped temperature loading on the deployed Thrust Reverser FEM.*

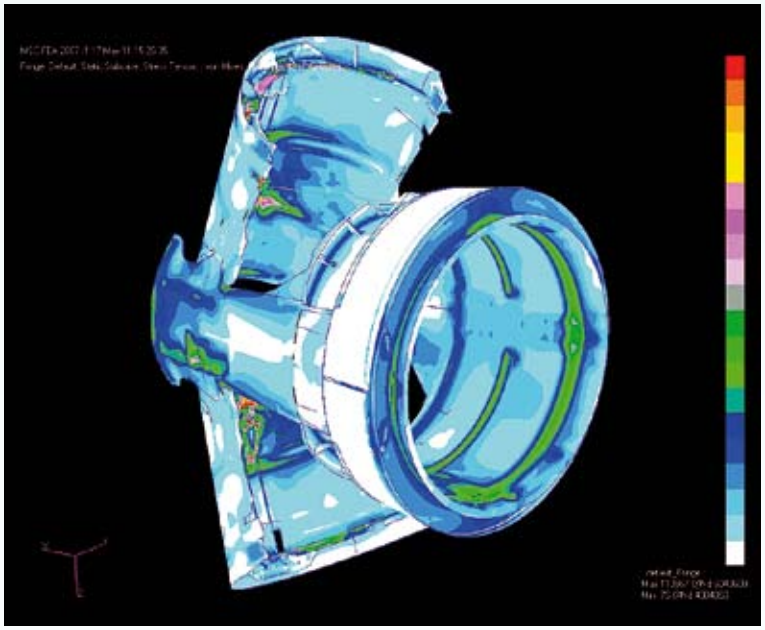

Figure 4 *Typical stress fringe plot.*

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