INFORMATION

STRUCTURES AND MATERIALS PERFORMANCE

Structures and Materials Performance Laboratory

The Structures and Materials Performance Laboratory of the NRC Institute for Aerospace Research (NRC Aerospace) performs research and related to the design, strength, durability, structural integrity and performance of new and legacy aircraft structures and components. The Laboratory develops new design, analysis, and manufacturing technologies for structures and materials, as well as for noise and vibration control. It also investigates technologies to support existing aircraft fleet. Its facilities and expertise are available on a contract basis.

The SMPL management system has been registered to ISO 9001:2000

Engine structures

Research focuses on the design, properties and performance of engine components. This work is supported by microstructural analysis (SEM/EDX, STEM, OM and XRD) and high-temperature mechanical testing (including axial and thermomechanical fatigue, fatigue crack growth and creep). Two high velocity (Mach 0.8) burner rigs are used to simulate conditions in gas turbine engines to study oxidation, corrosion, erosion and thermal fatigue behaviour of high-temperature alloys and coating systems. Activities include:

- modelling of deformation behaviour and life prediction of high-temperature parts
- properties of superalloys, intermetallics and metal matrix composites
- durability and behaviour of coatings and superalloys
- thermal fatigue damage modelling.

Composite structures

Research activities focus on the structural performance of advanced composite structures with emphasis on the

effects of processing, impact damage, environmental degradation and multiaxial loading. Modelling capabilities have been developed to simulate the processing of composite structures and repairs. New composite processing technologies (such as electron-beam curing, vacuum-assisted resin transfer moulding, and smart tooling) and new materials (such as fibre-metal laminates and high-temperature resins) are investigated.

An autoclave (maximum 1.4 MPa, 370°C) is used for adhesive bonding and processing of composites. The chamber is 1.2 m in diameter and 1.8 m long. The Laboratory also has a wide range of standard and specialized servo-hydraulic and mechanical test equipment including a planar biaxial system. Custom tests can be designed for specific applications. Other facilities include:

- environmental test chambers (temperatures from -150 to +320°C, relative humidity from 20 to 90%)
- a drop tower for impact damage simulation, and
- electrical and optical strain measuring techniques.

Structural analysis

State-of-the-art computers and software are used for numerical analyses to make life predictions for airframe and engine structural components even those operating under adverse environmental conditions. Structural analysis capability extends to transient dynamic simulation including impact and bird or foreign object damage (FOD).

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Non-destructive evaluation (NDE)
Various NDE techniques, such as ultrasonic, eddy current, thermography, X-ray, enhanced optical, liquid penetrant, magnetic particle, and impedance analysis are used to detect manufacturing flaws and service-induced damage. Fully automated ultrasonic and eddy current C-scan systems are available for inspection of composite and metallic components as well as aerospace coatings. These techniques are supported by commercial and NRC Aerospace-developed signal and image processing methods as well as by multi-mode NDE analysis, data fusion and pattern recognition capabilities. Expertise is also available for inspection reliability assessments using probability of detection and confidence analysis.

Aeroacoustics and structural dynamics
The Laboratory invests in the research and development of active control systems involving adaptive or “smart” materials to control structural dynamics and vibration. Its facilities enable unique test configurations including mechanical, acoustic or aerodynamic loading. A 10,000 lbf electromechanical vibration system and various modal shakers are available to support work in modal analysis and structural durability.

An acoustics reverberant facility provides accurate, high-level noise testing (i.e. up to 165 dB) for Canada’s aerospace community. The facility includes two reverberant chambers of 80 and 536 m^3, and a 0.3 m x 1.2 m progressive wave-tube. The noise environment is accurately controlled with an automatic spectrum control system capable of maintaining tight tolerances on noise levels over the frequency range of 25 to 20,000 Hz. The reverberant chamber and high-bay preparation area have a Class 100,000 clean-room capability, with required humidity and temperature control for testing of spacecraft and spacecraft components, acoustic fatigue studies on aircraft components, and research on noise generation concepts and associated consulting.

Large-scale multi-channel testing
Research in this area is directed toward modelling the complete structural test system, including both the test system and specimen, in order to increase testing speeds. The primary focus, however, is on fatigue and static testing of full-scale aerospace structures. A large test bay is equipped with several multi-channel digital test controllers, with a maximum capacity of 64 actuators on a single test, integrated data acquisition for up to 700 strain gauges, and a large selection of hydraulic loading devices complete with protection devices. The facility is unique in its flexibility and its accuracy of applied loading.

Resident expertise in all aspects of structural testing (from conception to load spectrum derivation to application) has been built up over many years through more than 40 full-scale aircraft tests. A major test program for the CF-18 is in its final stages.

Other major facilities
The Laboratory also operates:
- a hot isostatic press (2000°C, 210 MPa) for metals and ceramics
- a calibration service for force measuring instruments and accelerometers
- a vacuum heat treatment furnace up to 2000°C with option of 5 bar gas pressure quenching.

CONTACT:
Dr. Prakash Patnaik, Director
Structures & Materials Performance Laboratory
NRC Institute for Aerospace Research
Ottawa, Ontario, Canada K1A 0R6
Tel: (613) 991-6915 Fax: (613) 990-7444
E-mail: prakash.patnaik@nrc.gc.ca

Mr. Jeff Mackwood
Marketing and Contracts Office
NRC Institute for Aerospace Research
Ottawa, Ontario, Canada K1A 0R6
Tel: (613) 990-0765 Fax: (613) 952-7214
E mail: jeff.mackwood@nrc.gc.ca

Or visit our Web site at: www.nrcaerospace.com

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