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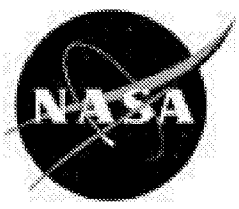
July 1999

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES



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Typical Report Citation and Abstract

❶ 19970001126 NASA Langley Research Center, Hampton, VA USA
❷ **Water Tunnel Flow Visualization Study Through Poststall of 12 Novel Planform Shapes**
❸ Gatlin, Gregory M., NASA Langley Research Center, USA Neuhart, Dan H., Lockheed Engineering and Sciences Co., USA; Mar. 1996; 130p; In English
Contract(s)/Grant(s): RTOP 505-68-70-04
❻ Report No(s): NASA-TM-4663; NAS 1.15:4663; L-17418; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche
❼ To determine the flow field characteristics of 12 planform geometries, a flow visualization investigation was conducted in the Langley 16- by 24-Inch Water Tunnel. Concepts studied included flat plate representations of diamond wings, twin bodies, double wings, cutout wing configurations, and serrated forebodies. The off-surface flow patterns were identified by injecting colored dyes from the model surface into the free-stream flow. These dyes generally were injected so that the localized vortical flow patterns were visualized. Photographs were obtained for angles of attack ranging from 10' to 50', and all investigations were conducted at a test section speed of 0.25 ft per sec. Results from the investigation indicate that the formation of strong vortices on highly swept forebodies can improve poststall lift characteristics; however, the asymmetric bursting of these vortices could produce substantial control problems. A wing cutout was found to significantly alter the position of the forebody vortex on the wing by shifting the vortex inboard. Serrated forebodies were found to effectively generate multiple vortices over the configuration. Vortices from 65' swept forebody serrations tended to roll together, while vortices from 40' swept serrations were more effective in generating additional lift caused by their more independent nature.
❽ Author
❾ *Water Tunnel Tests; Flow Visualization; Flow Distribution; Free Flow; Planforms; Wing Profiles; Aerodynamic Configurations*

Key

1. Document ID Number; Corporate Source
2. Title
3. Author(s) and Affiliation(s)
4. Publication Date
5. Contract/Grant Number(s)
6. Report Number(s); Availability and Price Codes
7. Abstract
8. Abstract Author
9. Subject Terms

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 405)

JULY, 1999

01
AERONAUTICS

19990047264 NASA Glenn Research Center, Cleveland, OH USA

Coupling of Low Speed Fan Stator Vane Unsteady Pressures to Duct Modes: Measured versus Predicted

Sutliff, Daniel L., AYT Corp., USA; Heidelberg, Laurence J., NASA Glenn Research Center, USA; Envia, Edmane, NASA Glenn Research Center, USA; May 1999; 44p; In English; Aeroacoustics, 10-12 May 1999, Seattle, WA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Contract(s)/Grant(s): RTOP 538-03-11

Report No.(s): NASA/TM-1999-209050; NAS 1.15:209050; E-11583; AIAA Paper 99-1864; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Uniform-flow annular-duct Green's functions are the essential elements of the classical acoustic analogy approach to the problem of computing the noise generated by rotor-stator interaction inside the fan duct. This paper investigates the accuracy of this class of Green's functions for predicting the duct noise levels when measured stator vane unsteady surface pressures are used as input to the theoretical formulation. The accuracy of the method is evaluated by comparing the predicted and measured acoustic power levels for the NASA 48 inch low speed Active Noise Control Fan. The unsteady surface pressures are measured,by an array of microphones imbedded in the suction and pressure sides of a single vane, while the duct mode levels are measured using a rotating rake system installed in the inlet and exhaust sections of the fan duct. The predicted levels are computed using properly weighted integrals of measured surface pressure distribution. The data-theory comparisons are generally quite good particularly when the mode cut-off criterion is carefully interpreted. This suggests that, at least for low speed fans, the uniform-flow annular-duct Green's function theory can be reliably used for prediction of duct mode levels if the cascade surface pressure distribution is accurately known.

Author

Green'S FUNCTIONS; Noise Intensity; Predictions; Pressure Distribution; Rotor Stator Interactions; Ducted Fans; Engine Noise; Aircraft Noise; Aeroacoustics

19990047443 Hampton Univ., VA USA

Study of the TRAC Airfoil Table Computational System

Hu, Hong, Hampton Univ., USA; May 1999; 44p; In English

Contract(s)/Grant(s): NAS1-19935; RTOP 538-07-14-10

Report No.(s): NASA/CR-1999-209323; NAS 1.26:209323; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The report documents the study of the application of the TRAC airfoil table computational package (TRACFOIL) to the prediction of 2D airfoil force and moment data over a wide range of angle of attack and Mach number. The TRACFOIL generates the standard C-81 airfoil table for input into rotorcraft comprehensive codes such as CAM- RAD. The existing TRACFOIL computer package is successfully modified to run on Digital alpha workstations and on Cray-C90 supercomputers. A step-by-step instruction for using the package on both computer platforms is provided. Application of the newer version of TRACFOIL is made for two airfoil sections. The C-81 data obtained using the TRACFOIL method are compared with those of wind-tunnel data and results are presented.

Author

Airfoils; Computational Fluid Dynamics; Noise Reduction; Aerodynamic Noise; Lift; Drag; Pitching Moments; Aerodynamic Coefficients; Navier-Stokes Equation; Computer Programs

19990047653 NASA Langley Research Center, Hampton,VA USA
Aeronautical Engineering: A Continuing Bibliography with Indexes, Supplement 403
Jun. 25, 1999; 43p; In English
Report No.(s): NASA/SP-1999-7037/SUPPL403; NAS 1.21:7037/SUPPL403; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This report lists reports, articles and other documents recently announced in the NASA STI Database.
Derived from text
Bibliographies; Data Bases; Aeronautical Engineering; Indexes (Documentation)

19990047898 Boeing Co., Mesa, AZ USA
Predicted Aerodynamic Characteristics of a NACA 0015 Airfoil Having a 25% Integral-Type Trailing Edge Flap
Hassan, Ahmed, Boeing Co., USA; May 1999; 168p; In English
Contract(s)/Grant(s): NAS1-20096; RTOP 538-07-14-10
Report No.(s): NASA/CR-1999-209328; NAS 1.26:209328; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

Using the two-dimensional ARC2D Navier-Stokes flow solver analyses were conducted to predict the sectional aerodynamic characteristics of the flapped NACA-0015 airfoil section. to facilitate the analyses and the generation of the computational grids, the airfoil with the deflected trailing edge flap was treated as a single element airfoil with no allowance for a gap between the flap's leading edge and the base of the forward portion of the airfoil. Generation of the O-type computational grids was accomplished using the HYGRID hyperbolic grid generation program. Results were obtained for a wide range of Mach numbers, angles of attack and flap deflections. The predicted sectional lift, drag and pitching moment values for the airfoil were then cast in tabular format (C81) to be used in lifting-line helicopter rotor aerodynamic performance calculations. Similar were also generated for the flap. Mathematical expressions providing the variation of the sectional lift and pitching moment coefficients for the airfoil and for the flap as a function of flap chord length and flap deflection angle were derived within the context of thin airfoil theory. The airfoil's sectional drag coefficient were derived using the ARC2D drag predictions for equivalent two dimensional flow conditions.
Author
Noise Reduction; Airfoils; Blade-Vortex Interaction; Navier-Stokes Equation; Trailing Edge Flaps; Aerodynamic Characteristics; Grid Generation (Mathematics); Computational Grids

19990052647 NASA Lewis Research Center, Cleveland, OH USA
Research and Technology, 1998
1999; 206p; In English
Report No.(s): NASA/TM-1999-208815; NAS 1.15:208815; No Copyright; Avail: CASI; A10, Hardcopy; A03, Microfiche

This report selectively summarizes the NASA Lewis Research Center's research and technology accomplishments for the fiscal year 1998. It comprises 134 short articles submitted by the staff scientists and engineers. The report is organized into five major sections: Aeronautics, Research and Technology, Space, Engineering and Technical Services, and Commercial Technology. A table of contents and an author index have been developed to assist readers in finding articles of special interest. This report is not intended to he a comprehensive summary of all the research and technology work done over the past fiscal year. Most of the work is reported in Lewis-published technical reports, journal articles, and presentations prepared by Lewis staff and contractors. In addition, university grants have enabled faculty members and graduate students to engage in sponsored research that is reported at technical meetings or in journal articles. For each article in this report, a Lewis contact person has been identified, and where possible, reference documents are listed so that additional information can be easily obtained. The diversity of topics attests to the breadth of research and technology being pursued and to the skill mix of the staff that makes it possible. At the time of publication, NASA Lewis was undergoing a name change to the NASA John H. Glenn Research Center at Lewis Field.
Author
Aeronautics; NASA Programs; Research and Development; Technology Utilization; Spaceborne Experiments

19990053351 NASA Langley Research Center, Hampton,VA USA
Aeronautical Engineering: A Continuing Bibliography With Indexes, Supplement 404
Jul. 09, 1999; 63p; In English
Report No.(s): NASA/SP-1999-7037/SUPPL404; NAS 1.21:7037/SUPPL404; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This supplemental issue of Aeronautical Engineering, A Continuing Bibliography with Indexes (NASA/SP-1999-7037) lists reports, articles, and other documents recently announced in the NASA STI Database. The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including

aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles. Each entry in the publication consists of a standard bibliographic citation accompanied, in most cases, by an abstract. Two indexes-subject and author are included after the abstract section.
CASI
Bibliographies; Aeronautical Engineering; Aerodynamics; Indexes (Documentation)

02
AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

19990047139 NASA Langley Research Center, Hampton, VA USA
A Parametric Study of Accelerations of an Airplane Due to a Wake Vortex System
Stewart, Eric C., NASA Langley Research Center, USA; May 1999; 40p; In English
Contract(s)/Grant(s): RTOP 538-04-11-12
Report No.(s): NASA/TM-1999-208745; NAS 1.15:208745; L-17831; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A study was conducted using strip theory to systematically investigate the effects of progressively more complete descriptions of the interaction of an airplane with a wake vortex system. The emphasis was in roll-dominant, parallel, vortex encounters. That is, the simulated airplane's longitudinal axis was nearly parallel to the rotation axis of the vortex system for most of the results presented. The study began with a drag-less rectangular wing in the flow field of a single vortex and progressed to a complete airplane with aerodynamic surfaces possessing taper, sweep, dihedral, and stalling and immersed in the flow field of a vortex pair in ground effect. The effects of the pitch, roll, and yaw attitudes of the airplane on the calculated accelerations were also investigated. The airplane had the nominal characteristics of a Boeing 757, and the vortex flow field had the nominal characteristics of the wake of a Boeing 767. The Bumham-Hallock model of a vortex flow field was used throughout the study. The data are presented mainly in terms of contours of equal acceleration in a two-dimensional area centered on the vortex pair and having dimensions of 300 feet by 300 feet.
Author
Aerodynamics; Flow Distribution; Rectangular Wings; Roll; Rotation; Vortices; Yaw; Aircraft Wakes; Mathematical Models

19990047705 Dayton Univ. Research Inst., Structural Integrity Div., OH USA
Statistical Loads Data for MD-82/83 Aircraft in Commercial Operations *Final Report*
Skinn, D.; Tipps, D. O.; Rustenburg, J.; Feb. 1999; 90p; In English
Contract(s)/Grant(s): FAA-96-G-020
Report No.(s): PB99-139594; UDR-TR-98-00077; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

The primary objective of this research is to support the FAA Airborne Data Monitoring Systems Research Program by developing new and improved methods and criteria for processing and presenting large commercial transport aircraft flight and ground loads usage data. The scope of activities performed involved (1) defining the service related factors which affect the operational life of commercial aircraft; (2) designing an efficient software system to reduce, store, and process large quantities of optical quick access recorder data; and (3) providing processed data in formats that will enable the FAA to reassess existing certification criteria. Equally important, these data will also enable the FAA, the aircraft manufacturers, and the airlines to better understand and control those factors which influence the structural integrity of commercial transport aircraft. Presented are analyses and statistical summaries of data collected from 3987 flights representing 7120 flight hours of six typical MD-82/83 aircraft during operational usage recorded by a single airline. The data include statistical information on accelerations, speeds, altitudes, flight duration and distance, gross weights, speed brake/spoiler cycles, thrust reverser usage, and gust velocities encountered.
NTIS
Statistical Analysis; Loads (Forces); Research; Prediction Analysis Techniques; Data Bases; Data Processing; Ground Tests

19990047711 NASA Dryden Flight Research Center, Edwards, CA USA
A Reassessment of Heavy-Duty Truck Aerodynamic Design Features and Priorities
Saltzman, Edwin J., Analytical Services and Materials, Inc., USA; Meyer, Robert R., Jr., NASA Dryden Flight Research Center, USA; June 1999; 36p; In English

Contract(s)/Grant(s): RTOP 251-10-01
Report No.(s): NASA/TP-1999-206574; H-2283; NAS 1.60:206574; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Between 1973 and 1982, the NASA Dryden Flight Research Center conducted "coast-down" tests demonstrating means for reducing the drag of trucks, buses, and motor homes. Numerous configurations were evaluated using a box-shaped test van, a two-axle truck, and a tractor-semitrailer combination. Results from three configurations of the test van are of interest now in view of a trucking industry goal of a 0.25 drag coefficient for tractor-semitrailer combinations. Two test van configurations with blunt-base geometry, similar to present day trucks (one configuration has square front comers and the other has rounded front comers), quantify the base drag increase associated with reduced forebody drag. Hoemer's equations predict this trend; however, test van results, reinforced by large-scale air vehicle data, indicate that Hoemer's formula greatly underestimates this dependence of base drag on forebody efficiency. The demonstrated increase in base drag associated with forebody refinement indicates that the goal of a 0.25 drag coefficient will not be achieved without also reducing afterbody drag. A third configuration of the test van had a truncated boattail to reduce afterbody drag and achieved a drag coefficient of 0.242. These results are included here and references are identified for other means of reducing afterbody drag.
Author
Aerodynamic Drag; Research; Experimentation; Drag Reduction; Trucks; Tractors

19990047889 NASA Langley Research Center, Hampton, VA USA
Aerodynamic and Aeroelastic Insights Using Eigenanalysis
Heeg, Jennifer, NASA Langley Research Center, USA; Dowell, Earl H., Duke Univ., USA; 1999; In English; Structures, Structural Dynamics, and Materials, 12-15 Apr. 1999, Saint Louis, MO, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Report No.(s): AIAA Paper 99-1473; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

This paper presents novel analytical results for eigenvalues and eigenvectors produced using discrete time aerodynamic and aeroelastic models. An unsteady, incompressible vortex lattice aerodynamic model is formulated in discrete time; the importance of several modeling parameters is examined A detailed study is made of the behavior of the aerodynamic eigenvalues both in discrete and continuous time. The aerodynamic model is then incorporated into aeroelastic equations of motion. Eigenanalyses of the coupled equations produce stability results and modal characteristics which are valid for critical and non-critical velocities. Insight into the modeling and physics associated with aeroelastic system behavior is gained by examining both the eigenvalues and the eigenvectors. Potential pitfalls in discrete time model construction and analysis are examined.
NASA
Aerodynamic Characteristics; Aeroelasticity; Eigenvalues; Eigenvectors; Mathematical Models; Vortices; Grid Generation (Mathematics); Computational Fluid Dynamics; Two Dimensional Flow; Aerodynamics

19990049398 NASA Dryden Flight Research Center, Edwards, CA USA
Design and Predictions for a High-Altitude (Low-Reynolds-Number) Aerodynamic Flight Experiment
Greer, Donald, NASA Dryden Flight Research Center, USA; Hamory, Phil, NASA Dryden Flight Research Center, USA; Krake, Keith, Sparta, Inc., USA; Drela, Mark, Massachusetts Inst. of Tech., USA; July 1999; 22p; In English; 17th Applied Aerodynamics, 28 Jun. - 1 Jul. 1999, Norfolk, VA, Norfolk, VA, USA, USA
Contract(s)/Grant(s): RTOP 529-10-04
Report No.(s): NASA/TM-1999-206579; NAS 1.15:206579; H-2340; AIAA Paper 99-3183; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A sailplane being developed at NASA Dryden Flight Research Center will support a high-altitude flight experiment. The experiment will measure the performance parameters of an airfoil at high altitudes (70,000 to 100,000 ft), low Reynolds numbers (200,000 to 700,000), and high subsonic Mach numbers (0.5 and 0.65). The airfoil section lift and drag are determined from pitot and static pressure measurements. The locations of the separation bubble, Tollmien-Schlichting boundary layer instability frequencies, and vortex shedding are measured from a hot-film strip. The details of the planned flight experiment are presented. Several predictions of the airfoil performance are also presented. Mark Drela from the Massachusetts Institute of Technology designed the APEX-16 airfoil, using the MSES code. Two-dimensional Navier-Stokes analyses were performed by Mahidhar Tatineni and Xiaolin Zhong from the University of California, Los Angeles, and by the authors at NASA Dryden.
Author
Airfoils; High Altitude; Low Reynolds Number; Navier-Stokes Equation; Aerodynamic Drag; Static Pressure; Subsonic Speed; Boundary Layer Stability; Flight Tests

19990050911 NASA Langley Research Center, Hampton, VA USA

CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999, Pt. 1

Woodrow Whitlow, Jr., Editor, NASA Glenn Research Center, USA; Todd, Emily N., Editor, Institute for Computer Applications in Science and Engineering, USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999; 437p; In English; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999, 22-25 Jun. 1999, Williamsburg, VA, USA; Sponsored by Confederation of European Aerospace Societies; See also 19990050912 through 19990050948

Contract(s)/Grant(s): RTOP 505-90-52-01

Report No.(s): NASA/CP-1999-209136/PT1; L-17863A; NAS 1.55:209136/PT1; No Copyright; Avail: CASI; A19, Hardcopy; A04, Microfiche

These proceedings represent a collection of the latest advances in aeroelasticity and structural dynamics from the world community. Research in the areas of unsteady aerodynamics and aeroelasticity, structural modeling and optimization, active control and adaptive structures, landing dynamics, certification and qualification, and validation testing are highlighted in the collection of papers. The wide range of results will lead to advances in the prediction and control of the structural response of aircraft and spacecraft.

Author

Conferences; Dynamic Structural Analysis; Unsteady Aerodynamics; Aeroelasticity; Flutter Analysis; Mathematical Models

19990050912 Research and Technology Organization, Neuilly-sur-Seine, France

A New Compendium of Unsteady Aerodynamic Test Cases for CFD: Summary of AVT WG-003 Activities

Ruiz–Calavera, Luis P., Instituto Nacional de Tecnica Aeroespacial, Spain; Bennett, Robert, NASA Langley Research Center, USA; Fox, John H., Sverdrup Technology, Inc., USA; Galbraith, Robert W., Glasgow Univ., UK; Geurts, Evert, National Aerospace Lab., Netherlands; Henshaw, Micahel J. deC., British Aerospace Aircraft Group, UK; Huang, XingZhong, Institute for Aerospace Research, Canada; Kaynes, Ian W., Defence Evaluation Research Agency, UK; Loeser, Thomas, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Naudin, Pierre, Office National d'Etudes et de Recherches Aerospatiales, France; Tamayama, Masato, National Aerospace Lab., Japan; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 1-12; In English; See also 19990050911; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

With the continuous progress in hardware and numerical schemes, Computational Unsteady Aerodynamics (CUA), that is, the application of Computational Fluid Dynamics (CFD) to unsteady flowfields, is slowly finding its way as a useful and reliable tool (turbulence and transition modeling permitting) in the aircraft, helicopter, engine and missile design and development process. Before a specific code may be used with confidence it is essential to validate its capability to describe the physics of the flow correctly, or at least to the level of approximation required, for which purpose a comparison with accurate experimental data is needed. Unsteady wind tunnel testing is difficult and expensive; two factors which dramatically limit the number of organizations with the capability and/or resources to perform it. Thus, unsteady experimental data is scarce, often classified and scattered in diverse documents. Additionally, access to the reports does not necessarily assure access to the data itself. The collaborative effort described in this paper was conceived with the aim of collecting into a single easily accessible document as much quality data as possible. The idea is not new. In the early 80's NATO's AGARD (Advisory Group for Aerospace Research & Development) Structures and Material Panel (SMP) produced AGARD Report No. 702 "Compendium of Unsteady Aerodynamic Measurements", which has found and continues to find extensive use within the CUA Community. In 1995 AGARD's Fluid Dynamics Panel (FDP) decided to update and expand the former database with new geometries and physical phenomena, and launched Working Group WG-22 on "Validation Data for Computational Unsteady Aerodynamic Codes". Shortly afterwards AGARD was reorganized as the RTO (Research and Technology Organization) and the WG was renamed as AVT (Applied Vehicle Technolology) WG-003. Contributions were received from AEDC, BAe, DLR, DERA, Glasgow University, IAR, NAL, NASA, NLR, and ONERA. The final publication with the results of the exercise is expected in the second part of 1999. The aim of the present paper is to announce and present the new database to the Aeroelasticity community. It is also intended to identify, together with one of the groups of end users it targets, deficiencies in the compendium that should be addressed by means of new wind tunnel tests or by obtaining access to additionally existing data.

Derived from text

Data Bases; Unsteady Aerodynamics; Wind Tunnel Tests; Data Management; Data Integration; Aerodynamic Configurations

19990050916 Pisa Univ., Dipt. di Ingegneria Aerospaziale, Italy

MDO of an Innovative Configuration: Aerodynamic Issues

Bernardini, G., Pisa Univ., Italy; Frediani, A., Pisa Univ., Italy; Morino, L., Rome III Univ., Italy; CEAS/AIAA/ICASE/NASA

Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 43-52; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A numerical methodology for the evaluation of aerodynamic loads acting on a complex lifting configuration is presented. The work is limited to the case of attached high-Reynolds number flows. A viscous/potential interaction technique is utilized to take into account the effects of the viscosity. For the potential-flow analysis, a boundary element formulation is used; for simplicity, only incompressible flows are examined; the wake geometry is either prescribed a priori or is determined as part of the solution (free-wake analysis). The theoretical basis of the present methodology is briefly described. Comparisons of present numerical results with analytical, numerical, and experimental results available in the literature are included.
Author

Aerodynamic Loads; Multidisciplinary Design Optimization; Potential Flow; Viscous Flow; Mathematical Models

19990050939 Aerospatiale, Airbus Division, Toulouse, France

A Reduced Basis Model for Aeroelastic Optimization

Grihon, S., Aerospatiale, France; Esquerre, J. P., Aerospatiale, France; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 325-332; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A method is proposed by which the computational efficiency of the aeroelastic sizing optimization process is improved. It uses a reduced basis model approach. This reduced basis model is first validated through flutter simulations under large structural modifications. The test case is a simplified model of a four engine aircraft wing . It is then applied to a flutter optimization study. The case studied is a full model of a large four engine aircraft. The flutter behavior of this model is controlled through an optimization of engine pylons. For a comparison purpose, two optimization methods are applied to this second case. The first one is the classical approach using exact modal and flutter reanalysis at each iteration, the second one uses the reduced basis model. Results are very close, but the optimization with the reduced basis model is considerably faster. It facilitates mode tracking during the optimization process as well as rapid evaluations of alternative optimization problem formulations.
Author

Aeroelasticity; Optimization; Flutter Analysis; Wings; Mathematical Models; Aircraft Models; Dynamic Models

19990050942 NASA Langley Research Center, Hampton, VA USA

Reduced Order Models Based on Linear and Nonlinear Aerodynamic Impulse Responses

Silva, Walter A., NASA Langley Research Center, USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 369-380; In English; See also 19990050911; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper discusses a method for the identification and application of reduced-order models based on linear and nonlinear aerodynamic impulse responses. The Volterra theory of nonlinear systems and an appropriate kernel identification technique are described. Insight into the nature of kernels is provided by applying the method to the nonlinear Riccati equation in a non-aerodynamic application. The method is then applied to a nonlinear aerodynamic model of an RAE 2822 supercritical airfoil undergoing plunge motions using the CFL3D Navier-Stokes flow solver with the Spalart-Allmaras turbulence model. Results demonstrate the computational efficiency of the technique.
Author

Turbulence Models; Mathematical Models; Dynamic Response; Volterra Equations; Nonlinear Systems; Navier-Stokes Equation; Kernel Functions; Dynamic Models; Computational Fluid Dynamics; Aeroelasticity

19990050946 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia

Influence of Nonplanar Supersonic Interference on Aeroelastic Characteristics

Kouzmin, V., Tsentralni Aerogidrodinamicheskii Inst., Russia; Kouzmina, S., Tsentralni Aerogidrodinamicheskii Inst., Russia; Mosounov, V., Tsentralni Aerogidrodinamicheskii Inst., Russia; Ishmuratov, F., Tsentralni Aerogidrodinamicheskii Inst., Russia; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 415-424; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A new version of supersonic panel method for computing the generalized aerodynamic forces on nonplanar lifting surfaces is described. Integral equation relating the velocity potential and a unit value of pressure distribution has been used. A flexible improved numerical procedure has been developed for the achievement of the high accuracy at different Mach numbers, reduced frequencies and panels dimensions. In practice proposed computer code has no restrictions for above mentioned parameters. Applied for the computational flutter investigations a software package KC-2 includes unified computer code for analysis in subsonic and supersonic flow because of the basic data organization is the same in both cases. Proposed method is illustrated by

the flutter and static aeroelastic characteristics calculations for modern aircraft. The influence of nonplanar supersonic interference on obtained results is analyzed.
Author
Flutter Analysis; Panel Method (Fluid Dynamics); Supersonic Flow; Aerodynamic Interference; Aeroelasticity; Aerodynamic Forces; Unsteady Aerodynamics

19990052585 Boeing Commercial Airplane Co., Advanced Development Aerodynamics, Seattle, WA USA
High Reynolds Number Hybrid Laminar Flow Control (HLFC) Flight Experiment, Report 4, Suction System Design and Manufacture, *Dec. 1987 - Aug. 1991*
April 1999; 110p; In English
Contract(s)/Grant(s): NAS1-18574; RTOP 522-32-31-01
Report No.(s): NASA/CR-1999-209326; NAS 1.26:209326; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche
This document describes the design of the leading edge suction system for flight demonstration of hybrid laminar flow control on the Boeing 757 airplane. The exterior pressures on the wing surface and the required suction quantity and distribution were determined in previous work. A system consisting of porous skin, sub-surface spanwise passages ("flutes"), pressure regulating screens and valves, collection fittings, ducts and a turbocompressor was defined to provide the required suction flow. Provisions were also made for flexible control of suction distribution and quantity for HLFC research purposes. Analysis methods for determining pressure drops and flow for transpiration heating for thermal anti-icing are defined. The control scheme used to observe and modulate suction distribution in flight is described.
Author
Laminar Boundary Layer; High Reynolds Number; Boundary Layer Control; Flight Tests; Suction

19990052586 Boeing Commercial Airplane Co., Advanced Development Aerodynamics, Seattle, WA USA
High Reynolds Number Hybrid Laminar Flow Control (HLFC) Flight Experiment, Report 2, Aerodynamic Design
April 1999; 170p; In English
Contract(s)/Grant(s): NAS1-18574; RTOP 522-32-31-01
Report No.(s): NASA/CR-1999-209324; NAS 1.26:209324; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche
This document describes the aerodynamic design of an experimental hybrid laminar flow control (HLFC) wing panel intended for use on a Boeing 757 airplane to provide a facility for flight research on high Reynolds number HLFC and to demonstrate practical HLFC operation on a full-scale commercial transport airplane. The design consists of revised wing leading edge contour designed to produce a pressure distribution favorable to laminar flow, definition of suction flow requirements to laminarize the boundary layer, provisions at the inboard end of the test panel to prevent attachment-line boundary layer transition, and a Krueger leading edge flap that serves both as a high lift device and as a shield to prevent insect accretion on the leading edge when the airplane is taking off or landing.
Author
Laminar Flow; Boundary Layer Control; Laminar Boundary Layer; High Reynolds Number; Boundary Layer Transition; Aerodynamics

19990052613 NASA Dryden Flight Research Center, Edwards,CA USA
Flight-Determined Subsonic Lift and Drag Characteristics of Seven Lifting-Body and Wing-Body Reentry Vehicle Configurations With Truncated Bases
Saltzman, Edwin J., Analytical Services and Materials, Inc., USA; Wang, K. Charles, Aerospace Corp., USA; Iliff, Kenneth W., NASA Dryden Flight Research Center, USA; Jan. 1999; 33p; In English; Aerospace Sciences, 11-14 Jan. 1999, Reno, NV, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): RTOP 529-50-04
Report No.(s): H-2287; AIAA Paper 99-0383; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
This paper examines flight-measured subsonic lift and drag characteristics of seven lifting-body and wing-body reentry vehicle configurations with truncated bases. The seven vehicles are the full-scale M2-F1, M2-F2, HL-10, X-24A, X-24B, and X-15 vehicles and the Space Shuttle prototype. Lift and drag data of the various vehicles are assembled under aerodynamic performance parameters and presented in several analytical and graphical formats. These formats unify the data and allow a greater understanding than studying the vehicles individually allows. Lift-curve slope data are studied with respect to aspect ratio and related to generic wind-tunnel model data and to theory for low-aspect-ratio planforms. The proper definition of reference area was critical for understanding and comparing the lift data. The drag components studied include minimum drag coefficient, lift-related drag, maximum lift-to-drag ratio, and, where available, base pressure coefficients. The effects of fineness ratio on

forebody drag were also considered. The influence of forebody drag on afterbody (base) drag at low lift is shown to be related to Hoerner's compilation for body, airfoil, nacelle, and canopy drag. These analyses are intended to provide a useful analytical framework with which to compare and evaluate new vehicle configurations of the same generic family.
Author
Lift; Reentry Vehicles; Aerodynamic Drag; Body-Wing Configurations; Subsonic Flow; Lifting Reentry Vehicles

19990052644 NASA Langley Research Center, Hampton, VA USA
Experimental and Computational Investigation of a Translating-Throat Single-Expansion-Ramp Nozzle
Deere, Karen A., NASA Langley Research Center, USA; Asbury, Scott C., NASA Langley Research Center, USA; May 1999; 51p; In English
Contract(s)/Grant(s): RTOP 522-21-51-04
Report No.(s): NASA/TP-1999-209138; NAS 1.60:209138; L-17708; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

An experimental and computational study was conducted on a high-speed, single-expansion-ramp nozzle (SERN) concept designed for efficient off-design performance. The translating-throat SERN concept adjusts the axial location of the throat to provide a variable expansion ratio and allow a more optimum jet exhaust expansion at various flight conditions in an effort to maximize nozzle performance. Three design points (throat locations) were investigated to simulate the operation of this concept at subsonic-transonic, low supersonic, and high supersonic flight conditions. The experimental study was conducted in the jet exit test facility at the Langley Research Center. Internal nozzle performance was obtained at nozzle pressure ratios (NPR's) up to 13 for six nozzles with design nozzle pressure ratios near 9, 42, and 102. Two expansion-ramp surfaces, one concave and one convex, were tested for each design point. Paint-oil flow and focusing schlieren flow visualization techniques were utilized to acquire additional flow data at selected NPR'S. The Navier-Stokes code, PAB3D, was used with a two-equation k-e turbulence model for the computational study. Nozzle performance characteristics were predicted at nozzle pressure ratios of 5, 9, and 13 for the concave ramp, low Mach number nozzle and at 10, 13, and 102 for the concave ramp, high Mach number nozzle.
Author
Navier-Stokes Equation; Throats; Exhaust Nozzles; Nozzle Design; Computational Fluid Dynamics; K-Epsilon Turbulence Model; Nozzle Efficiency

19990052669 Academy of Sciences (USSR), Inst. of Theoretical and Applied Mathematics, Novosibirsk, USSR
Supersonic Leading Edge Receptivity
Maslov, Anatoly A., Academy of Sciences (USSR), USSR; June 1998; 140p; In English
Contract(s)/Grant(s): NCC1-240; RTOP 282-10-01-01
Report No.(s): NASA/CR-1999-208445; NAS 1.26:208445; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

This paper describes experimental studies of leading edge boundary layer receptivity for imposed stream disturbances. Studies were conducted in the supersonic T-325 facility at ITAM and include data for both sharp and blunt leading edges. The data are in agreement with existing theory and should provide guidance for the development of more complete theories and numerical computations of this phenomena.
Author
Boundary Layer Transition; Viscous Flow; Sharp Leading Edges; Leading Edges

19990052671 Boeing Commercial Airplane Co., Advanced Development Aerodynamics, Seattle, WA USA
High Reynolds Number Hybrid Laminar Flow Control (HLFC) Flight Experiment, 3, Leading Edge Design, Fabrication, and Installation
April 1999; 92p; In English
Contract(s)/Grant(s): NAS1-18574; RTOP 522-32-31
Report No.(s): NASA/CR-1999-209325; NAS 1.26:209325; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

This document describes the design, fabrication, and installation of the suction panel and the required support structure, ducting, valving, and high-lift system (Krueger flaps) for flight demonstration of hybrid laminar flow control on the Boeing 757 airplane.
Author
Boundary Layer Control; Laminar Boundary Layer; Laminar Flow; Flight Tests; Suction

19990052675 NASA Langley Research Center, Hampton, VA USA

CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999, Pt. 2

Whitlow, Jr., Woodrow, Editor, NASA Glenn Research Center, USA; Todd, Emily N., Editor, Institute for Computer Applications in Science and Engineering, USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999; 419p; In English; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999, 22-25 Jun. 1999, Williamsburg, VA, USA; Sponsored by Confederation of European Aerospace Societies; See also 19990052676 through 19990052709

Contract(s)/Grant(s): RTOP 505-90-52-01

Report No.(s): NASA/CP-1999-209136/PT2; L-17863B; NAS 1.55:209136/PT2; No Copyright; Avail: CASI; A18, Hardcopy; A04, Microfiche

The proceedings of a workshop sponsored by the Confederation of European Aerospace Societies (CEAS), the American Institute of Aeronautics and Astronautics (AIAA), the National Aeronautics and Space Administration (NASA), Washington, D.C., and the Institute for Computer Applications in Science and Engineering (ICASE), Hampton, Virginia, and held in Williamsburg, Virginia June 22-25, 1999 represent a collection of the latest advances in aeroelasticity and structural dynamics from the world community. Research in the areas of unsteady aerodynamics and aeroelasticity, structural modeling and optimization, active control and adaptive structures, landing dynamics, certification and qualification, and validation testing are highlighted in the collection of papers. The wide range of results will lead to advances in the prediction and control of the structural response of aircraft and spacecraft.

Author

Conferences; Dynamic Structural Analysis; Unsteady Aerodynamics; Aeroelasticity; Flutter Analysis; Mathematical Models

19990052676 Virginia Polytechnic Inst. and State Univ., Center for Intelligent Materials, Systems, and Structures, Blacksburg, VA USA

Vortex-Lattice-Method to Analyze Aerodynamic Interference of Wing/Pylon/Store Configurations of an F16 Wing

Cattarius, J., Virginia Polytechnic Inst. and State Univ., USA; Preidikman, S., Virginia Polytechnic Inst. and State Univ., USA; Mook, D. T., Virginia Polytechnic Inst. and State Univ., USA; Inman, D. J., Virginia Polytechnic Inst. and State Univ., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 443-456; In English; See also 19990052675; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper will show initial results of a complete aeroelastic F16-like semi-span wing model, used to analyze the feasibility of piezoelectric stack actuation as a wing/store flutter suppression system. The model can identify the presence of aerodynamic interference between the store, pylon, and wing wakes and examine its significance with respect to the pressure and lift forces on the participating bodies. The wing and store data considered in this analysis, represent an F16 configuration that was identified to induce flutter in flight at subsonic speeds. The pylon is based on the concept of the decoupler pylon, introduced by Reed and Foughner in 1978 and flight tested in the early 1980's, and models both yaw and pitching motion of the store. The complete aeroelastic model is simulated in ABAQUS which has been augmented by the unsteady-vortex-lattice-method (UVLM) to calculate the aerodynamic loading. Both codes communicate through an iterative handshake procedure during which displacements and air loads are updated. For each increment in time the force/displacement equilibrium is found in this manner. At this point, the analysis is confined to a static analysis of the flexible structure. The wing is modeled as an elastic plate and pylon and store are rigid bodies. The store is connected to the pylon through an elastic joint possessing two degrees of freedom, pitch and yaw, respectively.

Author

Aerodynamic Interference; Aerodynamic Loads; Aeroelasticity; Flutter; Vibration Damping; Vortex Lattice Method; Wing-Fuselage Stores; Semispan Models; Body-Wing Configurations

19990052678 Technion - Israel Inst. of Tech., Faculty of Aerospace Engineering, Haifa, Israel

Structural Optimization Using Computational Aerodynamics

Raveh, Daniella E., Georgia Inst. of Tech., USA; Levy, Yuval, Technion - Israel Inst. of Tech., Israel; Karpel, Moti, Technion - Israel Inst. of Tech., Israel; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 469-482; In English; See also 19990052675; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A recently developed methodology for aircraft structural design, based on nonlinear airloads, is extended to include a modal-based optimization option, and an optional different computational aerodynamics code for loads analysis. Nonlinear maneuver loads are evaluated by a newly developed computational scheme that efficiently combines fluid dynamics iterations with iterations for elastic shape deformations and trim corrections. An efficient design process is obtained by performing several

optimization runs during one maneuver loads analysis, where each optimization is based on the interim non-converged airloads. This method was recently presented with structural optimization based on full-size, discrete-coordinate analyses. to allow the application of the method with large finite-element models and many constraints, the discrete-coordinates optimization is replaced by a modal-based optimization where a set of low-frequency vibration modes of the baseline structure is used to represent the structure throughout the optimization, both for response analysis and for sensitivity analysis. Comparative modal-based and discrete-coordinate design cases are shown to converge to the same optimal design variable values, even though they do not follow the same path. The current study also extends the loads analysis by replacing the flow computation with a newly developed code that handles complex geometries by using the Chimera overset grid method. This method greatly simplifies the process of grid generation and therefore allows for realistic complex configurations to be considered. Moreover, the method avoids the problem of mesh discontinuities due to elastic shape deformations and control surface deflections, as the displacements of each component only affect the component's mesh. The method is demonstrated with a wing-fuselage-elevator transport aircraft model performing symmetric and antisymmetric maneuvers at Mach 0.85.
Author
Aerodynamic Loads; Computational Fluid Dynamics; Aircraft Structures; Optimization; Elastic Deformation; Vibration Mode; Computational Grids; Structural Design; Applications Programs (Computers)

19990052703 Boeing Co., Loads and Dynamics, Long Beach, CA USA
Improving the Convergence of the Doublet-Lattice Method Through Tip Corrections
Baker, Myles L., Boeing Co., USA; Rodden, William P., Rodden (William P.), USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 763-776; In English; See also 19990052675; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

In 1973 Hough studied the slow convergence of the Vortex-Lattice Method (VLM) as the number of spanwise divisions (strips) is increased. Specifically, the lift curve slope of a lifting surface was shown to decrease significantly as the resolution of the lattice was increased, converging to the "true" value only with relatively fine spanwise divisions. Impressive improvements in the converged results were achieved when equally spaced divisions of the lifting surface were inset from the tip by a fraction of the strip width. Hough demonstrated the improvement via the tip inset on a number of wing planforms at a constant angle of attack. Hough's argument was based on an elliptical lift distribution which is a reasonable assumption in the steady, symmetric case. The present paper investigates also cases where elliptical lift distributions are not expected, specifically, the antisymmetric motion of rolling, elastic motions, and oscillatory motions with high reduced frequencies. The beneficial effect of the tip inset is observed in all cases investigated.
Author
Convergence; Correction; Unsteady Aerodynamics; Vortex Lattice Method; Wing Tips; Lift; Control Surfaces

19990052751 Washington Univ., Seattle, WA USA
Integrated Aeroservoelastic Optimization: Status and Direction
Livne, Eli, Washington Univ., USA; Journal of Aircraft; February 1999; Volume 36, No. 1, pp. 122-145; In English; Structures, Structural Dynamics, and Materials, 7-10 Apr. 1997, Kissimmee, FL, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): NAG2-723
Report No.(s): Paper-97-1409; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

The interactions of lightweight flexible airframe structures, steady and unsteady aerodynamics, and wide-bandwidth active controls on modern airplanes lead to considerable multidisciplinary design challenges. More than 25 years of mathematical and numerical methods' development, numerous basic research studies, simulations and wind-tunnel tests of simple models, wind-tunnel tests of complex models of real airplanes, as well as flight tests of actively controlled airplanes, have all contributed to the accumulation of a substantial body of knowledge in the area of aeroservoelasticity. A number of analysis codes, with the capabilities to model real airplane systems under the assumptions of linearity, have been developed. Many tests have been conducted, and results were correlated with analytical predictions. A selective sample of references covering aeroservoelastic testing programs from the 1960s to the early 1980s, as well as more recent wind-tunnel test programs of real or realistic configurations, are included in the References section of this paper. An examination of references 20-29 will reveal that in the course of development (or later modification), of almost every modern airplane with a high authority active control system, there arose a need to face aeroservoelastic problems and aeroservoelastic design challenges.
Derived from text
Aeroservoelasticity; Aircraft Structures; Active Control; Flight Tests; Numerical Analysis

19990053149 Office National d'Etudes et de Recherches Aerospatiales, Dept. Commande des Systemes et Dynamique de Vol, Paris, France

Aerodynamic Perturbations Encountered by a Helicopter Landing on a Ship: Effects on the Helicopter Flight Dynamics

Taghizad, A., Office National d'Etudes et de Recherches Aerospatiales, France; Verbeke, C., Institut de Mecanique des Fluides de Lille, France; Desopper, A., Office National d'Etudes et de Recherches Aerospatiales, France; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 6-1 - 6-16; In English; See also 19990053143; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper describes a French activity on helicopter ship landing operations simulation improvement. ONERA, under SPAe funding (Service des Programmes Aeronautiques), has developed an aerodynamic disturbance model around the landing deck of a frigate La Fayette, and has tested its effects on helicopter flight dynamics. Wind tunnel tests were carried out in ONERA-IMFL with a 1/50th scaled model of the La Fayette. Three dimensional measurements of the mean wind speed and velocity fluctuations were performed around the landing deck area. The La Fayette aerodynamic wake model includes a mean wake mode (1) to which a turbulence model adds velocity fluctuations measurements. The model was connected to the Eurocopter Helicopter Overall Simulation Tool (HOST). Simulations of flights above the deck with this model demonstrated important effects of the ship air-wake on the helicopter flight dynamics. This paper describes the test results obtained and the work performed in modelling the La Fayette wake and its influence on the helicopter flight dynamics.

Author

Perturbation; Aerodynamic Characteristics; Landing Simulation; Turbulence Models; Velocity Measurement; Wind Velocity; Ships

19990053161 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine

Hydrodynamical Characteristics of an Ekranoplane Wing Flying Near the Wavy Sea Surface

Byelinskyy, V. G., Academy of Sciences of the Ukraine, Ukraine; Zinchuk, P. I., Academy of Sciences of the Ukraine, Ukraine; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 18-1 - 18-12; In English; See also 19990053143; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Some results of experimental studies conducted at the Institute of Hydromechanics of Ukrainian National Academy of Sciences applicable to the problem of ekranoplane creating are presented in this paper. The aim of these research works was to determine the influence of proximity of the flat and wavy screen upon aerodynamics of the ekranoplane's wing. Experimental installation and procedure of the experiment are described. Instantaneous values of lift, drag and position of the center of pressure for a wing moving above the flat and wavy screen have been defined. It has been determined that influence of the angle of attack, the aspect ratio, the distance to a flat and wavy screen as well as the wave length and wave height of a wavy screen on the wing lift. The measurement results of forces and moments on the wing moving above the oblique waves are given.

Author

Aerodynamics; Hydromechanics; Hydrodynamics; Wings; Ground Effect Machines; Surface Effect Ships; Water Vehicles

19990053162 Marine Technical Univ., Saint Petersburg, Russia

Theoretical Analysis of Dynamics of a WIG Vehicle in Extreme Ground Effect

Rozhdestvensky, K. V., Marine Technical Univ., Russia; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 19-1 - 19-10; In English; See also 19990053143; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The paper discusses asymptotic form of the equations of longitudinal motion of ekranoplane in extreme ground effect, i.e. for very small relative ground clearances h. Derivation of "quartic" and "quintic" characteristic equations of unsteady perturbed motion is presented. One-dimensional unsteady non-linear theory of a simple flying wing with endplates, moving in close proximity to the ground, is used to determine derivatives of major aerodynamic coefficients with respect to perturbations of height and pitch as well as asymptotic behavior of these derivatives for vanishing h. Asymptotics of perturbed equations of motion is derived for distances of the order of the chord from the moment of perturbation. It is shown that in very close proximity to the ground parameters of stability and motion of the lifting system depend on ratios of design pitch angle and curvature of the lower side of the wing to relative ground clearance h as well as on a "reduced" density of the vehicle. The analysis also shows that at distances of the order of the chord from the moment of perturbation the vehicle performs corresponding induced motions in height and pitch, its speed remaining almost the same. At distances of the order of chord/h there takes place variation of speed mostly driven by height and pitch perturbations. At distances of the order of chord/h(exp 2) variation of speed of the craft is due to speed perturbation proper.

Author

Unsteady Aerodynamics; Asymptotic Properties; Equations of Motion; Ground Effect (Aerodynamics); Ground Effect Machines

19990053164 Saint Petersburg Inst. of Aerospace Instrumentation, Saint Petersburg, Russia
Aerodynamic Scheme of Ekranoplane Optimization with Reference to New Areas of Application
Nebylov, A. V., Saint Petersburg Inst. of Aerospace Instrumentation, Russia; Zhigalko, E. T., Saint Petersburg State Univ., Russia; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 21-1 - 21-8; In English; See also 19990053143
Contract(s)/Grant(s): RFBR-96-01-00010; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Opportunities of a choice of the expedient scheme of a large scale ekranoplane (LE) which would ensure the self-stabilization of an angle of attack and the controllability and would improve its properties required, for example, in using LE as a booster for an aerospace plane or as a sea rescue carrier are considered herein. The treated arrangement differs from known ones by utilizing less amount of aircraft elements which are not fully effective in flight of this type.
Author
Flight Optimization; Flight Mechanics; Air Transportation

19990053166 National Aerospace Lab., Amsterdam, Netherlands
Aerodynamic Analysis of a Surface Piercing Hydrofoil-Controlled Wing-In-Ground Effect Seabus Configuration *Progress Report*
vanBeek, C. M., National Aerospace Lab., Netherlands; Oskam, B., National Aerospace Lab., Netherlands; Fantacci, G., Intermarine S.p.A., Italy; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 23-1 - 23-18; In English; See also 19990053143; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Preliminary design investigations are presented for a Wing-In-Ground effect craft (SEABUS) in the framework of a European project on technology development for this type of vehicle. The concept of the craft features hydrodynamic control surfaces and a water jet propulsion system. A computational tool is developed and used to investigate the static equilibrium of lift, drag and pitching moment on the complete configuration over the entire speed range by taking the aerodynamic, hydrodynamic and propulsion contributions into account at the same time. Hydrodynamics turns out to be one of the key factors. At cruise speed the total drag of the presently proposed configuration is dominated by the hydrodynamic contributions of the submerged components. Limited effort has been spent on the design of the wing and the high lift system. Aerodynamic analysis of this design shows fair correspondence in terms of lift with the required lift values obtained from the preliminary design method. Ground effect trends on performance are correctly calculated. Optimization of the wing and high lift system has to be pursued.
Author
Piercing; Hydrofoils; Ground Effect (Aerodynamics); Design Analysis; Aircraft Design; Wings; Ground Effect Machines

19990053168 Joint Stock Co. Agency for Technologies and Transport, Nizhny Novgorod, Russia
A View of the Present State of Research in Aero- and Hydrodynamics of Ekranoplans
Maskalik, A. I., Joint Stock Co. Agency for Technologies and Transport, Russia; Rozhdestvensky, K. V., Marine Technical Univ., Russia; Sinitsyn, D. N., Joint Stock Co. Agency for Technologies and Transport, Russia; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 25-1 - 25-12; In English; See also 19990053143; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Ekranoplans as a novel very high-speed craft is one of the promising transportation alternatives of the next millennium. The paper presents a viewpoint upon present state of research relevant to development of ekranoplans with focus on Russian achievements in this field. Discussed are the problems of aerodynamics, hydrodynamics and dynamics of ekranoplans with particular attention to the matters related to use of power augmentation and peculiarities of static and dynamic stability.
Author
Air Transportation; Hydrodynamics; Static Stability; Dynamic Stability; Ground Effect Machines

19990053173 Fischer-Flugmechanik, Willich, Germany
The Hoverwing Technology: Bridge Between WIG and ACV
Fischer, Hanno, Fischer-Flugmechanik, Germany; Matjasic, Klaus, Fischer-Flugmechanik, Germany; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 30-1 - 30-8; In English; See also 19990053143; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Wingships (WIG, Wing in Ground) utilize water as runways to reach their lift-off speed, which is determined by the wing loading. High Wing loadings are desirable for high cruising speeds with inherent height and longitudinal stability. to build up the necessary dynamic air pressure under the wing, they need roughly 3 times more power to overcome the hydrodynamic hump-drag compared to the drag during ground effect flight. So it is necessary to develop suitable devices as lift-off-aids in order to reduce the recommended power. With support of the German Ministry for R and D (BMB+F) Fischer-Flugmechanik (FF) has developed

the "Hoverwing - Technology" in order to further reduce the necessary lift-off power. The principle of this technology, for which FF has patent rights, is the building up of static air pressure between the catamaran float. After lift-off the dynamic pressure will replace the static pressure and the craft operates as a WIG with high lift to drag ratios. FF is developing the "Hoverwing 80", with the target to transport 80 passengers at 100 kts. Some tests results with a scaled down two Seater will be demonstrated by video extracts.
Author
Ground Effect (Aerodynamics); Aircraft Design; Ground Effect Machines

19990053326 Air Force Flight Test Center, Edwards AFB, CA USA
Results of Attempts to Prevent Departure and/or Pilot-Induced Oscillations (PIO) Due to Actuator Rate Limiting in Highly-Augmented Fighter Flight Control Systems (HAVE FILTER), *1 - 18 Sep. 1998*
Chapa, Michael; Flick, Eric; Kraabel, Darren; Letourneau, Matthew; Parker, Terry; Mar. 1999; 76p; In English
Report No.(s): AD-A362947; AFFTC-TR-98-26; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

The objective of this effort was to evaluate the effects of software rate limiting the pilot command with and without a software pre-filter on a highly-augmented fighter aircraft flight control system. The software rate limiter and software pre-filter were designed to provide protection from departure and/or pilot-induced oscillation (PIO). In statically unstable aircraft stabilized with feedback, elevator/stabilator actuator rate limiting may lead to PIOs and/or departure during aggressive maneuvers. This project examined the use of a software rate limiter (SWRL) on the pilot command and compared the results with those for the unprotected airframe. Additionally, a nonlinear rate limiter pre-filter (RLPF) was used in conjunction with the SWRL. Previous attempts to suppress PIO and/or departure tendencies using similar technologies have encountered difficulty with noise-in-the-loop and out-of-trim bias development during filter operation. This project attempted to improve previous designs using a different algorithm for the RLPF. The SWRL was found to help prevent PIO and/or departure. The RLPF plus SWRL was generally found to be more helpful than the SWRL alone at preventing PIO and/or departure. However, handling qualities deficiencies arose when using low SWRL settings and worsened with low SWRL settings used in conjunction with the RLPF.
DTIC
Pilot Induced Oscillation; Actuators; Flight Control

19990053471 Innovative Scientific Solutions, Inc., Beavercreek, OH USA
Development and Application of an Advanced Optical Based Pressure Instrument for Low-Speed Flows *Final Report, 7 Aug. 1997 - 7 Feb. 1998*
Jordan, Jeff D.; Goss, Larry P.; Feb. 07, 1998; 47p; In English
Contract(s)/Grant(s): F33615-97-C-3005
Report No.(s): AD-A362829; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The STTR Phase I program targeted the development and application of advanced optical based systems the determination of surface-pressure distributions on test models in the Subsonic Aerodynamic Research Laboratory (SARL) at Wright Laboratory. The low-speed flows (0.1 less than or equal M less than or equal 0.5) encountered in the SARL facility effect relatively small changes in surface pressure, typically 1-2 psi about ambient (14.7 psia). As a result, quantitative surface-pressure determination in this environment remained contingent on the development of innovative pressure-sensitive paint (PSP)-coating and optical-measurement technology possessing the requisite sensitivity characteristics. The technical effort encompasses three primary objectives-the development of advanced PSP systems, data-acquisition instrumentation and measurement techniques, and post-processing software. In the Phase I effort, we have coupled the tools of sol-gel-processing technology and inorganic synthetic chemistry for the development of stable PSP's exhibiting tunable performance characteristics. Phase I research has produced sol-gel-based PSP's exhibiting significant improvements in sensitivity about ambient pressure, reduced temperature sensitivity (80%), and fast (>1 kHz) temporal response. Non-intrusive, optical-based measurement techniques capable of accurate pressure measurements in low-speed wind tunnels will find immediate application in commercial- and military-aircraft, automotive, and architectural industries in the USA.
DTIC
Pressure Measurement; Optical Measurement; Nonintrusive Measurement; Inorganic Chemistry; Data Acquisition; Commercial Aircraft; Aerodynamics

19990053472 Dayton Univ., Structural Integrity Div., OH USA

An Evaluation of Methods to Separate Maneuver and Gust Load Factors From Measured Acceleration Time Histories *Final Report*

Rustenburg, John W., Dayton Univ., USA; Skinn, Donald, Dayton Univ., USA; Tipps, Daniel O., Dayton Univ., USA; Apr. 1999; 34p; In English

Contract(s)/Grant(s): RTOP 437-25-14

Report No.(s): AD-A363333; URD-TM-1998-00011; DOT/FAA/AR-99/14; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The University of Dayton is supporting Federal Aviation Administration (FAA) research on the structural integrity requirements for the U.S. commercial transport airplane fleet. The primary objective of this research is to support the FAA Airborne Data Monitoring Systems program by developing new and improved methods and criteria for processing and presenting large commercial transport airplane flight and ground loads usage data. The accelerations recorded in flight result from maneuver inputs initiated by the pilot and atmospheric turbulence. to determine the gust and maneuver load factor spectra from the recorded flight loads data, it is necessary to separate the gust and maneuver load factors. Various means to separate the accelerations due to pilot maneuvers and turbulence from measured acceleration time histories have been used. This report presents the results of a study to evaluate the validity and operational processing efficiency of three different methods for the separation of maneuvers and gusts from measured acceleration data obtained from Optical Quick Access Recorder (OQAR)-equipped commercial aircraft. Conclusions and recommendations for the use of a maneuver-gust separation method are also provided.

DTIC

Gust Loads; Flight Operations; Aircraft Maintenance; Operational Problems; Airline Operations; Structural Design Criteria; Design Analysis

19990053497 Air Force Research Lab., Air Vehicles Directorate, Wright-Patterson AFB, OH USA

Innovative Control Effectors (Configuration 101) Dynamic Wind Tunnel Test Report. Rotary Balance and Forced Oscillation Tests *Final Report, 11 Mar. - 24 Apr. 1998*

Gillard, William J.; Jul. 1998; 205p; In English

Contract(s)/Grant(s): Proj-2403

Report No.(s): AD-A362903; AFRL-VA-WP-TR-1998-3043; No Copyright; Avail: CASI; A10, Hardcopy; A03, Microfiche

This report describes the technical effort investigating the dynamic characteristics of the Innovative Control Effectors Configuration 101 tailless aircraft concept. A series of static, rotary balance, and forced oscillation tests were conducted to acquire more information on the aerodynamic properties associated with this 65 degree, delta wing concept. Results show the vehicle to be well damped in pitch and roll motions and neutrally damped in yaw motions. Significant oscillating frequency effects were identified during forced oscillation testing with the impact most notable in the 15 is less than AOA is less than 45 degree region.

DTIC

Wind Tunnel Tests; Tailless Aircraft; Rotary Stability; Oscillations; Dynamic Characteristics; Aircraft Design

03
AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

19990047439 Federal Aviation Administration, Aviation Security Research and Development Div., Atlantic City, NJ USA

Test and Evaluation Plan for Integrating X-ray Screener Assist Technology and Nuclear Quadrupole Resonance

Monichetti, S. B.; Barrientos, J. M.; Fobes, J. L.; Neiderman, E. C.; Fabry, D.; Feb. 1999; 38p; In English

Report No.(s): PB99-140899; DOT/FAA/AR-99/16; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This Test and Evaluation Plan describes the evaluation of Nuclear Quadrupole Resonance Technology working in conjunction with Screener Assist Technology. The test will evaluate equipment detection and screener alarm resolution. Machine and system performance measures on detection and alarm resolution will be recorded, analyzed, and evaluated, with results to follow in a Test and Evaluation Report.

NTIS

Nuclear Quadrupole Resonance; X Rays; Warning Systems; Safety

19990047471 Army Simulation Training and Instrumentation Command, Orlando, FL USA
Automated Aeronautical Mission Planning Systems: Implications for Trainers
Gentner, Frank C.; Kettel, Michael S.; Crissey, Mona J.; Jan. 1998; 8p; In English; Prepared in collaboration with Univeristy of Dayton Research Institute, Dayton, OH.
Report No.(s): AD-A362204; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

To accomplish Department of Defense (DoD) missions, training must include all aspects of the mission, including mission planning. This planning can occur over different time scales depending on the amount of time available prior to the actual mission. Planning can involve any of the following: development of the scenarios expected to be followed; preparation and generation of products, such as the operations orders, maps and overlays, execution matrices, and administrative orders; coordination of all elements anticipated to be on the battlefield; consideration of available information from a variety of sources; establishing parameters for best meeting the challenges presented; and preparing initialization data both for the equipment to be used and the simulation battlefield, if applicable. Planning and preparation for aviation missions require that essential mission information be input into the cockpit prior to mission start. This information may include route plans, communications data, waypoint designations, friendly and threat situations, and weather information. Planning in a simulation environment requires that system initialization data be input to include initial placement of friendly and opposing forces, battlefield and environmental conditions, and network communications. All US Services now have available automated mission planning systems (MPSs) for aeronautical systems. Not only can these systems aid in mission planning speed, accuracy, and coordination, but also they can assist with creating total battlespace awareness, and have great potential for Joint Service planning and mission rehearsal training. Since use of automated MPTs is an essential part of today's missions, it is critical that trainers understand the capabilities offered by various automated MPSs so that they can develop training concepts and plans to best capitalize on the opportunities presented by these systems.
DTIC
Training Devices; Simulation; Mission Planning; Management Planning; Aerodynamics

19990047631 European Organization for the Safety of Air Navigation, Bretigny-sur-Orge France
Potential Applications of Collaborative Planning and Decision Making *Final Report*
Martin, P.; Hudgell, A.; Vial, S.; Bouge, N.; Dubois, N.; Sep. 1998; 148p
Report No.(s): PB99-136145; EEC/NOTE-19/98; Copyright; Avail: National Technical Information Service (NTIS), Microfiche

This document report on a potential set of applications of Collaborative Decision Making within Air Transport, based on an analysis of the recognized gate-to-gate phases of a flight. The applications are particularly concerned with improved information distribution and management, but also identify many potential new processes. Applications are described in terms of their context, objectives and benefits, collaborative aspects, actors, information flows, interfaces, relationship to ATM2000+ timescale, areas of cost, metrics, dependencies and further issues to be studied.
NTIS
Air Traffic Control; Decision Making; Airline Operations; Air Transportation

19990047716 Ohio State Univ., Cognitive Systems Engineering Lab., Columbus, OH USA
Preliminary Findings: Issues in Surface Movement
Smith, Philip J., Ohio State Univ., USA; Denning, Rebecca, Ohio State Univ., USA; Obradovich, Jodi, Ohio State Univ., USA; Billings, Charles, Ohio State Univ., USA; Woods, David, Ohio State Univ., USA; [1999]; 28p; In English
Contract(s)/Grant(s): NAG2-1156; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The final report for the grant is presented. The recent goals for this project have been: (1) to identify common surface movement challenges which affect the airlines and Air Traffic Control; (2) to map out possible solutions to these challenges; (3) to start generalizing about the information we are receiving so that major, abstract categories of challenges and potential solutions will begin to emerge. In particular, there are several areas of opportunity which are beginning to emerge from the data, dealing with the need for: (1) Tools to support information exchange regarding priorities (both within an individual airline and between the ATC tower and airlines). Such priorities include both concerns affecting departure throughput as well as the ordering of departures to accommodate other airline considerations; (2) Planning tools to help ATC and airline Ramp staff deal with information about priorities; (3) Implementation of strategies to enable greater flexibility in queueing flights for departures; (4) Tools to provide better coordination and situation awareness during taxiing (within an airline as well as between airlines and between the airlines); (5) Tools to support planning and to deal with the interactions between departures and arrivals. Thus far, the initial interviews and observations at three airlines and two ATC facilities have been completed.
Derived from text
Air Traffic Control; Airline Operations; Taxiing; Civil Aviation; Air Transportation; Operational Problems; Aircraft Guidance; Airfield Surface Movements; Airports

19990047757 National Transportation Safety Board, Washington, DC USA
National Transportation Safety Board Transportation Initial Decisions and Orders and Board Opinions and Orders Adopted and Issued during the Month of February 1999
Feb. 1999; 133p
Report No.(s): PB99-916702; NTSB/IDBOO-99/02; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche
This publication contains all Judges Initial Decisions and Board Opinions and Orders in Safety and Seaman Enforcement Cases February 1999.
NTIS
Accident Prevention; Air Transportation; Safety Management

19990047961 General Accounting Office, Resources, Community and Economic Development Div., Washington, DC USA
Aviation Security: FAA's Deployments of Equipment to Detect Traces of Explosives
Nov. 13, 1998; 12p; In English
Report No.(s): PB99-145864; GAO/RCED-99-32R; B-281440; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
You asked us to provide updated information on the status of FAA's deployments of trace detection equipment at the nation's busiest airports. Specifically, this report provides information on (1) the current status of FAA's deployments of the trace detection equipment, including whether all of the 19 category X or 60 category 1 airports are supplied with this equipment and, if not, why; (2) FAA's plans for deploying any remaining trace equipment; and (3) any problems that could affect the future deployments or operation of this equipment. In addition, the report describes the process FAA follows in deploying trace equipment.
NTIS
Airport Security; Explosives Detection; Congressional Reports

19990049250 Westar Corp., Saint Louis, MO USA
Risk Management of a Helicopter Fleet Containing Flight Safety Parts of Unknown Fatigue Strength
Arden, Robert W., Westar Corp., USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 11-20; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche
This paper describes the development and implementation of a risk management plan for critical helicopter components. It presents a brief overview of the fatigue methodology used in the original airworthiness qualification of the systems along with the analytical and test procedures required by the alternate vendor qualification program. The basis for the various methods used to derive the appropriate levels of risk is provided. Application of this risk management process to a specific aircraft system shows the calculation of component and system level risks. A comparison between the risk assessment based strength/life and the component test results ultimately achieved is presented. The overall approach is shown to be an effective tool in the assessment and management of fleet risk.
Author
Helicopters; Risk; Flight Safety; Residual Strength; Structural Reliability; Aircraft Structures; Fatigue (Materials)

19990052747 Federal Aviation Administration, Washington, DC USA
Notices to Airmen, Domestic/International, April 22, 1999
Apr. 22, 1999; 244p; In English
Report No.(s): PB99-147373; No Copyright; Avail: CASI; A11, Hardcopy; A03, Microfiche
Contents include the following: Airway Notams; Airports, Facilities, and Procedural Notams; General FDC Notams; Part 94 Revisions to Minimum En Route IFR Altitudes and Changeover Points; International Notices to Airmen; and Graphic Notices.
NTIS
National Airspace System; National Airspace Utilization System; Air Traffic Control; Air Navigation; Navigation Aids; Flight Paths

19990052842 Federal Aviation Administration, Fire Safety Section, Atlantic City, NJ USA
Effectiveness of Flight Attendants Attempting to Extinguish Fires in an Accessible Cargo Compartment
Blake, D.; Apr. 1999; 18p; In English
Report No.(s): PB99-150096; DOT/FAA/AR-TN99/29; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
This technical note documents the results of a project to evaluate the ability of flight attendants to extinguish cargo fires in small Class B cargo compartments. Thirteen fire tests were conducted in a modified Shorts 330 airplane in which flight attendants attempted to extinguish cargo fires. Some of the selected test variables included the cargo compartment size, the width of the access door, the size and type of fire extinguishers available, the presence and absence of an unobstructed center aisle in the cargo

compartment, the type of Protective Breathing Equipment (PBE), and the delay between the smoke detector alarm and the start of the firefighting efforts. The results of the testing indicated that in most cases the flight attendants were unable to successfully extinguish these fires.
NTIS
Flight Crews; Fire Extinguishers; Crew Procedures (Inflight); Fire Fighting; Fire Prevention

19990052846 National Transportation Safety Board, Washington, DC USA
Annual Review of Aircraft Accident Data: U.S. General Aviation, Calendar Year 1995
Sep. 1998; 76p; In English
Report No.(s): PB98-172463; NTSB/ARG-98/01; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche
A total of 2,078 U.S. registered general aviation aircraft were involved in 2,054 accidents during calendar year 1995. of these 2,054 accidents, 411 accidents (involving 419 aircraft) resulted in fatal injuries. This report presents a statistical review of these accidents, all involving U.S. registered aircraft that were not conducting air carrier revenue operations under Title 14 Code of Federal Regulations (14 CFR) Part 121 or 135. The accident data on which this review is based were extracted from the Safety Board's automated Aviation Accident Data System.
NTIS
Aircraft Accidents; General Aviation Aircraft; Data Systems; Air Transportation

19990052847 National Transportation Safety Board, Washington, DC USA
National Transportation Safety Board Safety Recommendations Adopted during the Month of March, 1999
Mar. 1999; 16p
Report No.(s): PB99-916603; NTSB/REC-99/03; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
This publication contains safety recommendations in aviation (only) mode of transportation adopted by the National Transportation Safety Board during the month of March, 1999.
NTIS
Safety; Accident Prevention; Safety Management

19990052850 Civil Aeromedical Inst., Oklahoma City, OK USA
The Role of Shift Work and Fatigue in Air Traffic Control Operational Errors and Incidents
DellaRocco, P. S.; SPIE; Jan. 1999; Volume 3334, pp. 470-479; In English
Contract(s)/Grant(s): F19628-95-C-0002
Report No.(s): AD-A360731; MS-12899; DOT/FAA/AM-99/2; No Copyright; Avail: Issuing Activity (Defense Technical Information Center (DTIC)), Microfiche
This report was developed from a collaborative effort between the FAA Civil Aeromedical Institute's (CAMI's) Shift Work and Fatigue Research Program and the National Aeronautics and Space Administration (NASA) Ames Research Center's Fatigue Countermeasures Program. The purpose of this report was to examine existing databases to assess the extent to which shift work and fatigue might be factors associated with incidents and errors in air traffic control (ATC) operations.
DTIC
Air Traffic Control; Air Traffic Controllers (Personnel); Fatigue (Biology); Errors; Aerospace Medicine

19990052944 LB and M Associates, Inc., Oklahoma City, OK USA
Analysis of Ditching and Water Survival Training Programs of Major Airframe Manufacturers and Airlines *Final Report*
Cosper, D. K.; McLean, G. A.; Jul. 1998; 40p; In English
Report No.(s): PB99-146839; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
Current transport category aircrew training programs related to ditching and water survival are reviewed for content and attention to detail. This activity resulted from industry and regulatory inquiries about the state-of-the-art in ditching and water survival operations, especially with regard to the increasing number of aircraft operations, and associated opportunities for emergency water landing events, that the future will bring. The information on water landing events was gathered from published reports related to these issues.
NTIS
Flight Crews; Water Landing; Ditching (Landing); Evacuating (Transportation)

19990052977 Civil Aeromedical Inst., Oklahoma City, OK USA

Comparison of Buckle Release Timing for Push-Button and Lift-Latch Belt Buckles

Gowdy, V.; George, M.; McLean, G. A.; Feb. 1999; 11p; In English

Report No.(s): AD-A360725; DOT/FAA/AM-99/5; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Small aircraft passenger restraint systems most commonly use lift-latch type buckle release mechanisms. Push-button buckle release mechanisms, similar to those used in contemporary automobiles, have rarely been used on passenger restraints. Although push-button buckles are not explicitly prohibited by Federal Aviation Administration (FAA) regulations, the human factors aspects of introducing push-button buckles in an aircraft environment are important considerations from the standpoint of safety. A test program was conducted by the FAA Civil Aeromedical Institute (CAMI) with volunteer human subjects to measure and compare the times it takes a passenger to release a push-button buckle on a 3-point restraint, a common lift-latch buckle on a 3-point restraint, and a lift-latch buckle on a common lap belt. Sixty subjects were tested in a repeated-measures counterbalanced test protocol, which included instrumentation to measure the response times to release the buckle. Response time for the subjects to exit the seat and press a remote button was also acquired. This report includes the physical profiles of the subjects, the test protocol, and a statistical summary of the results. Based on the data acquired in this project, there was no major difference in the response times of the human subjects to release or egress from a 3-point restraint with a push-button buckle, compared with a lift-latch buckle on a 3- point or a common lap belt restraint. This study was intended to address factors associated with the use of push-button buckles restraint systems in small airplanes. Any consideration of the use of push-button buckles on commercial transport aircraft passenger seats should include data on a broader range of human factors.

DTIC

Seat Belts; Transport Aircraft; Mechanical Devices

19990053243 Air Force Inst. of Tech., Wright-Patterson AFB, OH USA

Bird Strike Risk Assessment for USA Air Force Airfields and Aircraft

Tedrow, Christine A.; Apr. 21, 1999; 165p; In English

Report No.(s): AD-A363170; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

Analysis of strike data is critical to determine the true economic costs of bird strikes, determine the magnitude of safety issues, and develop preventive measures. Analysis of USAF bird-strike data identified trends and indicated suggested relationships among factors contributing to damaging strikes. From FY 1988 through FY 1997, the annual mean was 2,668 bird strikes with peaks evident in fall and spring. Daylight and dusk were hazardous for bird strikes. More bird strikes occurred during airfield operations - aircraft are at low altitudes and soaring birds are more numerous. Aircraft speed, phase of flight, taxonomic group, bird mass and aircraft group were the strongest predictors of damaging bird strikes. Bird strike rates were calculated for USAF aircraft and selected USAF airfields. Bomber aircraft had the highest strike rate; these aircraft frequently fly long missions at low altitudes where they are likely to encounter birds. Logistic regression analyses estimated odds of occurrence for damaging bird strikes during airfield operations General statistics, odds for a damaging airfield strike, and airfield strike rates, were used to identify USAF airfields with higher bird strike risks. Howard AFB, Panama, had a higher number and rate of bird strikes, and greater odds for a damaging bird strike than other airfields analyzed.

DTIC

Bird-Aircraft Collisions; Predictions; Costs; Airspeed; Regression Analysis

19990053303 Electro Magnetic Applications, Inc., Denver, CO USA

Statistical Study of the Closest Approach of Aircraft to Ground-Based Emitters: Results for Seattle and Comparison with Denver *Final Report*

Elliott, James R., Electro Magnetic Applications, Inc., USA; Perala, Rodney A., Electro Magnetic Applications, Inc., USA; Mar. 1999; 46p; In English

Contract(s)/Grant(s): DTFA03-97-P-00158

Report No.(s): AD-A363147; EMA-97-R-011; DOT/FAA/AR-99/5; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A Technical Program was initiated by the Federal Aviation Administration (FAA) William J. Hughes Technical Center to measure the distances that aircraft fly within high-intensity radiation emitters. This program was launched as the FAA and the High-Intensity Radiated Fields (HIRF) advisory committees were defining HIRF regulatory rulemaking requirements. This study was a follow-on of the work conducted at the Denver International Airport to determine the actual distances that aircraft flew within emitters. This study focused on a similar effort at Seattle International Airport. This program presented the data gathered from the Seattle Airport along with a detailed comparison of the data between the two airports. Any observable patterns and similarities between the two airports were recorded. Information on emitter location, frequency, power, etc., was obtained from

the Government Master File. Aircraft flight information was obtained from the System Analysis Recordings (SAR) tapes at the Seattle En Route Center. This program was used in conjunction with a research effort which located all high-powered emitters in the U.S. and Europe and established the actual HIRF environment.
DTIC
Electromagnetic Shielding; Radiation Shielding; Aircraft Safety; Flight Safety; Air Traffic Control; Beacon Collision Avoidance System

04
AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

19990047547 Civil Aeromedical Inst., Oklahoma City, OK USA
A Usability Survey of GPS Avionics Equipment: Some Preliminary Findings *Final Report*
Joseph, Kurt M.; Jahns, Dieter W.; Nendick, Michael D.; St.George, Ross; Mar. 1999; 10p; In English; Prepared in collaboration with Syner Tech Associates, Bellingham, WA and University of Newcastle, Callaghan, Australia.
Report No.(s): AD-A362193; DOT/FAA/AM-99/9; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

The rapid introduction of Global Positioning System (GPS) receivers for airborne navigation has outpaced the capacity of international aviation authorities to resolve human factors issues that concern safe and efficient use of such devices. Current certification technical standards appear to have had little influence on standardizing receiver architectures, interfaces, and operating manuals-despite evidence from research simulation and flight tests that lack of standardization may undermine safety. The present research used factor-analytic techniques to reduce 308 pilots' ratings from a 163-item survey to 24 factors. These factors are suitable for identifying human factors issues related to GPS receiver displays and controls, operating procedures, navigation performance, training, and other topical areas. Multivariate analysis of variance revealed that GPS experience and receiver type influenced pilot ratings for several of these factors. The results of this limited survey are consistent with previous research, and their application to certification procedures and standards is discussed.
DTIC
Human Factors Engineering; Global Positioning System; General Aviation Aircraft; Surveys; Multivariate Statistical Analysis; Flight Simulation; Aviation Psychology

19990047572 Naval Surface Warfare Center, Dahlgren Div., Dahlgren, VA USA
Performance Evaluation of Precise Absolute Navigation (PAN) Solutions Over Four Test Courses *Final Report*
Hermann, Bruce R.; Jan. 1999; 68p; In English
Report No.(s): AD-A362526; NSWCDD/TR-98/61; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This report describes a method where the Global Positioning System (GPS) Precise Positioning Service (PPS) solutions recorded in the field can be reprocessed at a later time with the precise ephemerides without requiring that the observations be saved. The reprocessing with the precise ephemerides improves the quality of the navigation solutions compared with the solutions obtained when the real-time broadcast ephemerides are used. This report continues the investigation of the Precise Absolute Navigation (PAN) technique by exploring its accuracy under highway conditions. Ellipsoid height solutions from survey vehicles traveling at highway speeds have the potential to map terrain heights in a fast, efficient manner. The absolute terrain heights, determined from GPS ellipsoid height solutions, can be used to calibrate remote sensing devices, such as Synthetic Aperture Radar (SAR) images. The performance of PAN is compared with PPS solutions, range-corrected Standard Position Service (SPS) solutions, and relative solutions using smoothed pseudorange. The relative merits of each are discussed.
DTIC
Global Positioning System; Precision; Ephemerides; Navigation; Radar Imagery

19990052721 Norwegian Defence Research Establishment, Kjeller, Norway
Evaluation of GPS Attitude Determining System *Evaluering av Retningsbestemmende GPS*
Dyva, Ronnie Roger, Norwegian Defence Research Establishment, Norway; Dec. 14, 1998; 19p; In Norwegian; Original contains color illustrations
Contract(s)/Grant(s): FFIE Proj. 69702/134
Report No.(s): FFI/Rapport-98/06383; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This document discusses availability of attitude information from a Global Positioning System (GPS) Attitude Determining System (ADS) receiver. The intention was to find out what influence different types of terrain had on availability of heading information.
Author
Attitude (Inclination); Global Positioning System

19990053474 Civil Aeromedical Inst., Civil Aeromedical Inst., Oklahoma City, OK USA
GPS User-Interface Design Problems *Final Report*
Williams, Kevin W., Civil Aeromedical Inst., USA; Apr. 1999; 11p; In English
Report No.(s): AD-A363331; DOT/FAA/AM-99/13; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
This paper is a review of human factors problems associated with the user-interface design of a set of Global Positioning System (GPS) receivers, certified for use in aircraft for instrument non-precision approaches. The paper focuses on design problems associated with the interfaces and specific inconsistencies across the set of interfaces that could cause confusion or errors during operation. Some specific problems addressed involve the layout and design of knobs and buttons; control labeling inconsistencies across units; the placement and use of warnings; feedback, or the lack thereof; and the integration of specific flying tasks while using the receivers. Recommendations for solving some of the problems are provided, as well as suggestions to the FAA, GPS manufacturers, and pilots regarding the future development and use of these products.
DTIC
Global Positioning System; Design Analysis

19990053485 Smiths Industries Aerospace and Defense Systems, Inc., Grand Rapids Div., Grand Rapids, MI USA
Navy AV-8B Crash Survivable Flight Incident Recorder (CSFIR)
May 03, 1999; 33p; In English
Contract(s)/Grant(s): N00019-98-F-0016; GS-24F-3027G
Report No.(s): AD-A363122; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
Navy AV-8B Crash Survivable Flight Incident Recorder (CSFIR) meeting minutes of the program on April 28, 1999 are presented.
DTIC
Flight Recorders; Crashes; Harrier Aircraft

19990053486 Smiths Industries Aerospace and Defense Systems, Inc., Grand Rapids Div., Grand Rapids, MI USA
Navy F/A-18 Crash Survivable Flight Incident Recorder (CSFIR)
May 06, 1999; 26p; In English
Contract(s)/Grant(s): N00019-99-F-0680; GS-24F-3027G
Report No.(s): AD-A363120; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche
On 28 April, 1999 representatives from the Navy, Boeing and Smiths Industries (SI) met at the Naval Air Weapons Development Center, China Lake, CA for a Coordination I Kick Off Meeting in support of the F/A- 18 Crash Survivable Flight Incident Recorder System (CSFIR) integration program. Smiths Industries is enhancing the software currently under development for its Voice and Data Recorder (VADR) under this contract. This enhancement will allow the uploading of software updates and version verifications of the F/A-18 flight software via a MIL-STD-1553 multiplex data bus. This will be accomplished using the Memory Loader I Verifier Set (MLVS).
DTIC
Attack Aircraft; Flight Recorders; Weapons Development; Channels (Data Transmission); Data Recorders; Applications Programs (Computers)

05
AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

19990047095 NASA Langley Research Center, Hampton, VA USA
An Overview of Landing Gear Dynamics
Pritchard, Jocelyn I., Army Research Lab., USA; May 1999; 20p; In English
Contract(s)/Grant(s): RTOP 522-18-11-04

Report No.(s): NASA/TM-1999-209143; NAS 1.15:209143; ARL-TR-1976; L-17840; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

One of the problems facing the aircraft community is landing gear dynamics, especially shimmy and brake-induced vibration. Shimmy and brake-induced vibrations can lead to accidents due to excessive wear and shortened life of gear parts and contribute to pilot and passenger discomfort. To increase understanding of these problems, a literature survey was performed. The major focus is on work from the last ten years. Some older publications are included to understand the longevity of the problem and the background from earlier researchers. The literature survey includes analyses, testing, modeling, and simulation of aircraft landing gear; and experimental validation and characterization of shimmy and brake-induced vibration of aircraft landing gear. The paper presents an overview of the problem, background information, and a history of landing gear dynamics problems and solutions. Based on the survey an assessment and recommendations of the most critically needed enhancements to the state of the art will be presented. The status of Langley work contributing to this activity will be given.

NASA

Aircraft Landing; Landing Gear; Surveys; Structural Vibration; Aircraft Brakes; Dynamic Characteristics

19990047358 Naval Postgraduate School, Monterey, CA USA

Simulation Validation and Flight Prediction of UH-60A Black Hawk Helicopter/Slung Load Characteristics

Tyson, Peter H.; Mar. 1999; 303p; In English

Report No.(s): AD-A362524; No Copyright; Avail: CASI; A14, Hardcopy; A03, Microfiche

Helicopter/slung load systems are two body systems in which the slung load adds its rigid body dynamics, aerodynamics, and sling stretching dynamics to the helicopter. The slung load can degrade helicopter handling qualities and reduce the flight envelope of the helicopter. Confirmation of system stability parameters and envelope is desired, but flight test evaluation is time consuming and costly. A simulation model validated for handling quality assessments would significantly reduce resources expended in flight testing while increasing efficiency, productivity, and safety by aiding researchers, designers, and pilots to understand factors affecting helicopter-slung load handling qualities. This thesis describes a comprehensive dynamics and aerodynamics model for slung load simulation, obtained by integrating the NASA Ames Gen Hel UH-60A simulation with slung load equations of motion. Frequency domain analysis is used to compare simulation to flight test frequency responses and key system stability parameters. Results are given for no load, a 4K lb Block, and a 4K lb CONEX load. Handling quality parameters, stability margins, and load pendulum motion roots for cases without load aerodynamics and with static wind tunnel data were compared. Results illustrated state-of-the-art simulation modeling of helicopter/slung load dynamics and its accuracy in predicting key dynamic parameters of interest.

DTIC

Helicopters; Aerodynamics; Flight Simulation; Helicopter Control; Helicopter Performance; Proving

19990047474 Naval Air Warfare Center, Aircraft Div., Patuxent River, MD USA

Aircraft Depainting Technology

Kozol, Joseph; Conrad, Dayle; Hartle, Steven; Neumeister, Gary; Spadafora, Stephen; Mar. 18, 1999; 37p; In English

Report No.(s): AD-A362188; NAWCADPAX--98-236-TR; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Chemical paint strippers historically used for aircraft contained toxic and hazardous components; aircraft depainting operations are a major source of hazardous waste generation in DOD. Federal and state agencies have begun to restrict using these hazardous materials and Government directives require significant reductions in hazardous waste generation. The Naval Air Systems Team has partnered with the Air Force at WR-ALC in investigating mature, advanced paint removal technologies and has taken a multiprocess approach to meeting the requirements of aircraft and component stripping at various levels of maintenance. Under this program, the Navy pursued development of non-HAP chemical paint strippers as alternatives for methylene chloride based strippers. In addition, the Navy has selected the xenon flashlamp/CO2 (Flashjet(R)) process for materials testing and developed a prototype semiautomatic manipulator system incorporating the Flashjet(R) process for depainting large aircraft. As a result of extensive materials testing, NAVAIRSYSCOM authorized using the Flashjet(R) paint removal process on metallic fixed-wing aircraft surfaces. The approval process for using Flashjet(R) on fixed-wing organic composite aircraft surfaces is nearly complete. Relative life cycle costs per square foot of comparable aircraft surface were found to be favorable for Flashjet(R) paint removal compared to methylene chloride chemical stripping or plastic media blasting.

DTIC

Aircraft Maintenance; Hazardous Materials; Fixed Wings; Paint Removal; Aircraft Configurations

19990047576 Drexel Univ., Dept. of Materials Engineering, Philadelphia, PA USA

Boundary Correction Factors for Elliptic Surface Cracks Emanating from Countersunk Rivet Holes Under Tension, Bending, and Wedge Loading Conditions *Final Report*

Rahman, Anisur, Drexel Univ., USA; Bakuckas, John, Federal Aviation Administration, USA; Bigelow, Catherine, Federal Aviation Administration, USA; Tan, Paul, Federal Aviation Administration, USA; Mar. 1999; 79p; In English

Report No.(s): AD-A362544; DOT/FAA/AR-98/37; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

To predict crack growth and residual strengths of riveted joints subjected to widespread fatigue damage (WFD), accurate stress and fracture analyses of corner and surface cracks at a rivet hole are needed. The results presented in this report focus on the calculation of stress-intensity factor (SIF) solutions for cracks at countersunk rivet holes for tension, bending, and wedge load conditions. A wide range of configuration parameters were varied including the crack size, crack shape, and crack location as well as the length of the straight-shank hole. A finite element based global-intermediate-local (GIL) hierarchical approach was used in this study. The results are expressed as boundary correction factors (BCF), which is a nondimensional representation of the SIF. The boundary correction factors were determined along the crack front in terms of the physical angle, which was measured from the inner surface of the plate to a point on the hole boundary or the outer surface of the plate. In general, the values of boundary correction factors increased as one move along the crack front from the inner surface of the plate towards the hole boundary or the outer surface. The values of the boundary correction factor were highest for the crack fronts closest to the hole boundary. The trends in the solutions were the same for the three loading conditions.

DTIC

Bending; Crack Propagation; Airframes; Wedges; Riveted Joints; Surface Cracks; Stress Intensity Factors; Fatigue (Materials); Loads (Forces)

19990047783 Federal Aviation Administration, Airport and Aircraft Safety Research and Development, Atlantic City, NJ USA

Boundary Correction Factors for Elliptic Surface Cracks Emanating from Countersunk Rivet Holes under Tension, Bending, and Wedge Loading Conditions *Final Report*

Rahman, A.; Bakuckas, J.; Bigelow, C.; Tan, P.; Mar. 1999; 86p; In English

Report No.(s): PB99-143984; DOT/FAA/AR-98/37; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

To predict crack growth and residual strengths of riveted joints subjected to widespread fatigue damage (WFD), accurate stress and fracture analyses of corner and surface cracks at a rivet hole are needed. The results present in this report focus on the calculation of stress-intensity factor (SIF) solutions for cracks at countersunk rivet holes for tension, bending, and wedge load conditions. A wide range of configuration parameters were varied including the crack size, crack shape, and crack location as well as the length of the straight-shank hole. A finite element based global-intermediate-local (GIL) hierarchical approach was used in this study. The results are expressed as boundary correction factors (BCF), which is a nondimensional representation of the SIF. The boundary correction factors were determined along the crack front in terms of the physical angle, which was measured from the inner surface of the plate to a point on the hole boundary or the outer surface of the plate. In general, the values of boundary correction factors increased as one move along the crack front from the inner surface of the plate. In general, the values of boundary correction factors increased as one move along the crack front from the inner surface of the plate towards the hole boundary or the outer surface. The values of the boundary or the outer surface. The values of the boundary correction factor were highest for the crack fronts closes to the hole boundary. The trends in the solutions were the same for the three loading conditions.

NTIS

Surface Cracks; Crack Opening Displacement; Ellipsoids; Holes (Mechanics); Riveted Joints; Stress Concentration; Aircraft

19990049249 Coast Guard, Aircraft Repair and Supply Center, Elizabeth City, NC USA

Coast Guard Efforts to Deal With Aging Aircraft

Connor, D. C., Coast Guard, USA; Devoe, K. W., Coast Guard, USA; Mihelic, J. E., Coast Guard, USA; Butt, M. E., Coast Guard, USA; Carmel, M. S., Coast Guard, USA; Baker, J. T., Coast Guard, USA; Dwyer, P. J., Coast Guard, USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 1-10; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Coast Guard operates approximately 200 aircraft which include HC-130 transports, HU-25 Falcon Jets, HH-65 Dolphin and HH-60 Jayhawk helicopters all of which operate low level over salt water and in the case of the helicopters, hover in salt spray and deploy for extended periods on ships. Over time, we have developed both a maintenance philosophy and an engineering program to deal with these harsh conditions. In addition, the current and future projected budget climates will necessitate that we continue to operate our current fleet of aircraft well into the next century. This combination of operating in a severely corrosive environment and budgeting in an austere fiscal climate has induced us to develop an aggressive Aging Aircraft program. This paper will discuss our corrosion control program, two prototype sensor projects to monitor corrosion and structural loads on

operational aircraft, plans to upgrade avionics equipment, our mature reliability centered maintenance program and service life extension plans which have been formulated for all of our aircraft. These individual projects make up our Aging Aircraft program. We are convinced that they will enable us to meet the immediate challenges and will position us for those that lie ahead.
Author
Aircraft Maintenance; Corrosion Prevention; Aircraft Reliability; Service Life

19990049254 British Aerospace Defence Ltd., Military Aircraft and Aerostructures, Preston, UK
Eurofighter 2000 Structural Health and Usage Monitoring: An Integrated Approach
Hunt, Stephen R., British Aerospace Defence Ltd., UK; Hebden, Iain G., British Aerospace Defence Ltd., UK; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 46-55; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper outlines the Structural Health Monitoring system being developed for Eurofighter 2000. The system is designed as an integral part of the avionics system, both on and off-aircraft, enabling the customer to perform fleet-wide monitoring of fatigue life and significant structural loading events.
Author
Systems Health Monitoring; Fighter Aircraft; Pilot Support Systems; Fatigue (Materials); Aircraft Structures

19990049255 Air Logistics Center, C/KC-135 Systems Program Office, Tinker AFB, OK USA
FSIP: The C/KC-135 Functional Systems Integrity Program
Pappas, Jim, Air Logistics Center, USA; Ward, Ralph, Boeing Information, Space and Defense Systems, USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 56-62; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

After several C/KC- 135 mishaps in the early 1990's that resulted from system failures or malfunctions, the -135 System Program Director (SPD) recognized that a logical, organized, and disciplined approach to ensure or monitor the safety and durability of aircraft functional systems did not exist. This was true even though system failures or anomalies have caused most mishaps within the last five years involving USAF large body transport type aircraft. At this same time, HQ AMC/CC tasked the SPD's managing the aircraft within their command to develop a Functional Systems Integrity Program (FSIP) to ensure the safety and durability of aircraft systems much like the Aircraft Structural Integrity Program ensures the safety of aircraft structures. Since a generic FSIP process did not exist, the -135 SPD volunteered to develop a FSIP process which would be adaptable to all aircraft based on recent experience with analysis and problem resolution of -135 fuel systems. The requirement for a generic FSIP process was subsequently cancelled. However, the -135 Board of Directors decided that any -135 sustainment program must include a thorough and pro-active evaluation of system integrity especially in the light of the aging problems, changing aircraft roles and missions, subtle system degradations that may have been induced during years of system sustainment, etc. Accordingly, the SPD tasked Coral Reach, the C/KC-135 Aging Aircraft Integrated Production Team (IPT), to develop and execute a FSIP process. Coral Reach then expanded their Integrated Product Team (IPT) with the -135 OEM to accomplish this effort. This paper presents the -135 FSIP process, and the activity and progress made to date.
Author
System Failures; Systems Health Monitoring; Malfunctions; Aircraft Safety

19990049259 Dayton Univ. Research Inst., OH USA
Aging of Aircraft Transparencies
Bouchard, Michael P., Dayton Univ. Research Inst., USA; Bowman, Daniel R., Dayton Univ. Research Inst., USA; Whitney, Thomas J., Dayton Univ. Research Inst., USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 91-100; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Aircraft transparencies (windshields, canopies, and windows) are structural components that must withstand flight and ground loads. This paper seeks to demonstrate that transparencies, like metal airframe components, are subject to aging with attendant reductions in structural capability, and therefore transparency aging must be adequately considered when addressing aircraft structural integrity. Typical transparency construction and aging mechanisms are described, and case histories demonstrating the impact of aging on structural life and safety are presented. Approaches for managing transparency aging, including design, removal for cause, inspection, and life extension, are described. The discussion is based on experience with military aircraft transparency system design, development, research, and problem solving.
Author
Aircraft Structures; Windshields; Transparence; Aging (Materials); Canopies; Structural Analysis; Structural Failure

19990049265 Israel Aircraft Industries Ltd., Engineering Div., Ben-Gurion Airport, Israel

Composite Repair of Aging Metallic Structure P-Version 3D Finite Element Approach

Nathan, Arnold, Israel Aircraft Industries Ltd., Israel; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 153-162; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A quick, easy and relatively accurate method to calculate the effect of composite material repairs bonded to metallic structure is addressed in this paper. P-version, three dimensional, parametric, finite element analysis is used to calculate load transfer to the repair as well as stress intensity factors for cracks in the parent metallic structure. Cracks by cutouts under composite patches are also analyzed. The parametric nature of the model allows simple changes in geometry or crack size.

Author

Composite Materials; Structural Analysis; Stress Intensity Factors; Load Distribution (Forces); Finite Element Method; Cracks; Maintenance; Mathematical Models

19990049267 Naval Air Warfare Center, Structures Engineering, Patuxent River, MD USA

Repair Development for Fatigue Cracks in the F-5E Vertical Stabilizer

Elmore, Jennifer S., Naval Air Warfare Center, USA; Rosenzweig, Edwin L., Naval Air Warfare Center, USA; Ulander, Penelope, Naval Aviation Depot, USA; Perl, Douglas, Naval Aviation Depot, USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 173-182; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper describes the experience gained by the Navy in the development of composite patch repair techniques for the F-5E vertical stabilizer. The F-5E is used by the Navy as an aggressor aircraft in the Dissimilar Air Combat Training (DACT) program. In this role, the aircraft has sustained different and more severe fatigue loading than originally designed. Fatigue cracking was discovered at the termination of the integral blade stiffeners in the aft section of the vertical stabilizer. These fatigue cracks occur randomly at five different vertical stabilizer stations (VSS). Bulges due to plastic deformation were also found in the skins at some repair stations. Due to the long lead times and costs associated with the manufacturing of new stabilizers, the decision was made to engineer and apply a bonded composite repair concept. This paper outlines the approach followed in the planning, development, certification and application of repairs to arrest or retard crack growth thereby restoring original structural life and elaborates on critical stages in the process and important lessons learned. A grit blast/silane surface preparation technique developed by the U. S. Air Force was selected. A double vacuum debulk and staging process was developed for Textron 5521 Boron/epoxy to improve patch quality, inspectability and formability over the plastically deformed bulges in the skin. The overall engineering, and certification methodology also required extensive design and analysis efforts to properly size, shape and locate the patch on the post-buckled structure. Also, limited coupon testing was performed to verify critical processes, certify personnel, and establish material design allowables. Subcomponent design and fatigue testing were required to replicate skin loads, demonstrate crack initiation, and validate the repair design and crack growth retardation predictions. Finally, NDI methods were developed to monitor crack growth rate and detect possible failures. Initially, the repaired stabilizers will be inspected using eddy current, the patch bondline by thermography. As confidence in the repair process grows, the inspection intervals will be lengthened to account for the beneficial effects of the repair on structural integrity and durability.

Author

Aircraft Structures; Stabilizers (Fluid Dynamics); Fatigue (Materials); Aircraft Maintenance; Composite Materials; Crack Arrest; Cracking (Fracturing)

19990049281 Boeing Phantom Works, Seattle, WA USA

Bonded Repair Techniques using Sol-Gel Surface Preparations

Blohowiak, Kay Y., Boeing Phantom Works, USA; Krienke, Kenneth A., Boeing Phantom Works, USA; Osborne, Joseph H., Boeing Phantom Works, USA; Mazza, James J., Air Force Research Lab., USA; Gaskin, Georgette B., Naval Aviation Systems Team, USA; Arnold, Jonahira R., Naval Aviation Systems Team, USA; DePiero, William S., Army Armament Research, Development and Engineering Center, USA; Brescia, Joseph, Army Armament Research, Development and Engineering Center, USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 313-320; In English; See also 19990049248

Contract(s)/Grant(s): SERDP Proj. PP-1113; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This joint development program is a concerted SERDP-funded Tri-Service effort to develop sol-gel surface treatments for adhesive bonding on aluminum, titanium, and steel surfaces. Sol-gel formulations and processes applicable to epoxy adhesive systems were developed. These nonchromated, water-based sol-gel coating systems are comprised of environmentally-acceptable materials and can be applied on the substrate by spraying, brushing, or swabbing for various repair applications. The joint R&D project focuses on development, optimization, and implementation of these sol-gel processes for repair and remanufacture of

aircraft structures. The goals of this program are to design a process that 1) increases durability, 2) improves process robustness, 3) decreases repair time, 4) uses simple equipment and processes, 4) uses environmentally-friendly materials, and through all of these 5) increases affordability. Depot sites, including NADEP-North Island, NADEP-Cherry Point, Warner Robins ALC, and Corpus Christi Army Depot are involved in the requirements generation and testing cycle to ensure end-user needs are being met and technology transition issues are assessed. Current and potential applications of this technology on aerospace hardware and manufacturing and repair criteria are discussed.
Author
Sol-Gel Processes; Adhesive Bonding; Aircraft Maintenance; Surface Treatment; Metal Surfaces; Performance Tests; Aircraft Structures

19990049283 Defence Science and Technology Organisation, Airframes and Engines Div., Fishermens Bend, Australia
A Smart Patch Approach for Bonded Composite Repair/Reinforcement of Primary Airframe Structures
Baker, Alan A., Defence Science and Technology Organisation, Australia; Galea, Stephen C., Defence Science and Technology Organisation, Australia; Powlesland, Ian G., Defence Science and Technology Organisation, Australia; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 328-338; In English; See also 19990049248; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The application of bonded composite patches to repair or reinforce defective metallic structures is becoming recognised as a very effective versatile remedial procedure for many types of problems. Immediate applications of bonded patches are in the fields of repair of cracking, localised reinforcement after removal of corrosion damage and for reduction of fatigue strain. The application of bonded composite patches or reinforcements to repair or restore properties of defective secondary structures has become routine in the Royal Australian Air Force (RAAF). However, bonded repairs to critical damage in primary components are generally limited due to certification concerns and are generally acceptable only on the basis that a margin on design limit-load (DLL) capability is retained in the loss (total absence) of the repair. to certify such repairs substantial analysis and testing programs are required, as well as a stringent inspection program during service to ensure structural integrity is not compromised. For certification and management of critical repairs for very high cost components, the "Smart Patch" approach may be an acceptable solution from the airworthiness perspective and be cost effective for the operator and may even allow some relaxation of the certification requirements. Assuming patch disbonding due to bond environmental degradation is not a concern and that the static requirements are satisfied, then full credit for the patch in slowing crack growth could be justified by a continuous safety-by-inspection approach based on self-assessment of the patch system integrity using a "smart patch" approach. In the most basic form of the "Smart Patch", in-situ sensors can be used as the nerve system to monitor in-service the structural condition (health or well-being) of the patch system and the status of the remaining damage in the parent structure. This application would also allow the operator to move away from current costly time-based maintenance procedures toward real-time health condition monitoring of the bonded repair and the repaired structure. These systems would allow timely decisions on preventative and scheduled maintenance before failure of the repair or repaired structure. to this end a 'stand-alone' patch health monitoring device which is in close proximity to sensors on a repair is being developed. More specifically this paper describes a laboratory demonstration on bonded doublers of an F-111 skin doubler specimen. The instrumentation will measure, process and store sensor measurements during flight and then allow this data to be down loaded, after the flight, onto a PC, via remote (wireless) data access.
Author
Aircraft Structures; Systems Health Monitoring; Aircraft Maintenance; Composite Materials; Bonded Joints; Fault Detection

19990049306 Air Force Inst. of Tech., Wright-Patterson AFB, OH USA
Incorporating Scene Mosaics as Visual Indexes Into UAV Video Imagery Databases
Page, Timothy I.; Mar. 1999; 61p; In English
Report No.(s): AD-A361624; AFIT/GCS/ENG/99M-16; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

The rise of large digital video archives has strengthened the need for more efficient ways of indexing video files an accessing the information contained in them. Reconnaissance platforms, such as the Predator UAV, are contributing thousands of hours of video footage that require analysis, storage, and retrieval. A process is proposed for converting a video stream into a series of mosaic and selected still images that provide complete coverage of the original video. The video mosaic images can be utilized as visual indexes into a video database. in addition, mosaic images contain information from an entire sequence of video frames to provide "at a glance" analysis capabilities. Actual reconnaissance video footage is converted to still-image representation using the proposed process and the results are discussed. Further, a web-based browse and search capability was developed to

demonstrate the benefits of using the proposed process. Further, the Predator Unmanned Aerial Vehicle (UAV) system configuration is described with recommendations for placement of the video mosaic building process proposed in this research. DTIC

Data Bases; Video Signals; Visual Aids; Data Storage

19990050915 La Sapienza Univ., Dipt. Aerospaziale, Rome, Italy

Aeroelastic Contraints in MDO

Mastroddi, F., La Sapienza Univ., Italy; Ciancaleoni, E., La Sapienza Univ., Italy; Morino, L., Rome III Univ., Italy; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 33-42; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A Multidisciplinary Design Optimization (MDO) study for a transport configuration with emphasis on the integrated aerodynamic and structural design of the wing is presented. The novelty is in the use of aeroelastic constraints for flutter as well as gust response (both deterministic and stochastic).

Author

Aeroelasticity; Dynamic Response; Multidisciplinary Design Optimization; Structural Design; Wing Planforms

19990050924 Rome III Univ., Dept. of Mechanical and Industrial Engineering, Rome, Italy

Analysis of Fuselage Vibrations Induced by the Proprotor in a Tiltrotor Aircraft

Gennaretti, M., Rome III Univ., Italy; Iemma, U., Rome III Univ., Italy; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 139-148; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The aim of the present paper is the analysis of the aerodynamically induced fuselage vibrations for proprotor-fuselage configurations which are of interest in tiltrotor aircraft. As widely known, the development of technology concerning tiltrotor aircraft is of primary interest in modern aeronautical research. This type of vehicle combines advantageous takeoff and landing procedures (similar to those needed by helicopters), with cruise performances that are analogous to those of currently used propeller-driven airplanes. Noting such flexibility in flight operations, it may be anticipated a large impact of this kind of aircraft on the aeronautical transport field in the near future. Here, we consider different proprotor-fuselage configurations which include those related to vertical takeoff and landing (horizontal proprotor disk), and cruise conditions (vertical proprotor disk). In the fuselage vibration analysis, the elastic displacements are expressed in terms of series expansions on a complete set of orthogonal functions. The forcing terms in the structural dynamics equations, which depend on the exterior pressure field, are obtained from the analysis of the interactional aerodynamics of the fuselage-proprotor system. This will be accomplished by a boundary element method for compressible potential flows, based on a boundary integral equation for the velocity potential. The application of the Bernoulli theorem yields the pressure distribution and hence the aerodynamic loads acting on the fuselage. The formulation presented has been applied to a simple, but realistic, fuselage configuration. Numerical results are presented for external pressure fields generated by a proprotor in three different flight conditions, corresponding to the takeoff and landing phase (horizontal rotor disk), cruise (vertical rotor disk), and the conversion phase (45 degrees angle between the rotor axis and the fuselage axis). In order to validate the methodology on a simple test case, the results obtained for an external pulsating point source are also included. Author

Interactional Aerodynamics; Fuselages; Forced Vibration; Aircraft Configurations; Orthogonal Functions; Rotor Aerodynamics; Tilt Rotor Aircraft; Mathematical Models; Dynamic Structural Analysis; Propellers; Rotors

19990050947 Boeing Co., Stability, Control and Flying Qualities, Long Beach, CA USA

An Application of the P-Transform Method for Transient Maneuvering Analysis

Dykman, John R., Boeing Co., USA; Rodden, William P., Rodden (William P.), USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 425-432; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The P-Transform method provides an alternative to the Rational Function Approximation (RFA) methods for representing oscillatory aerodynamics in the time domain. It is based on the flutter eigenvalues and eigenvectors obtained for each mode at a given velocity from a PK-flutter analysis. As such it avoids the curve fitting errors of the RFA and assures exact agreement with flutter predictions. Furthermore, it makes no assumptions regarding the transient aerodynamic lagging mechanism and is therefore equally valid at subsonic and supersonic speeds. An application is presented to a forward-swept wing aircraft configuration that

has been the subject of earlier maneuvering studies by quasisteady methods. The differences between the responses using quasisteady aerodynamic loads and general unsteady loads are illustrated in this example.
Author
Flutter Analysis; Aeroelasticity; Prediction Analysis Techniques; Transient Response; Unsteady Aerodynamics; Aerodynamic Loads

19990051022 California Univ., Dept. of Mechanical and Aeronautical Engineering, Davis, CA USA
Airfoil Design Using a Coupled Euler and Integral Boundary Layer Method with Adjoint Based Sensitivities
Edwards, S., California Univ., USA; Reuther, J., California Univ., USA; Chattot, J. J., California Univ., USA; [1997]; In English
Contract(s)/Grant(s): NCC2-5201; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

The objective of this paper is to present a control theory approach for the design of airfoils in the presence of viscous compressible flows. A coupled system of the integral boundary layer and the Euler equations is solved to provide rapid flow simulations. An adjunct approach consistent with the complete coupled state equations is employed to obtain the sensitivities needed to drive a numerical optimization algorithm. Design to target pressure distribution is demonstrated on an RAE 2822 airfoil at transonic speed.
Author
Airfoils; Equations of State; Boundary Layers; Control Theory; Pressure Distribution; Viscous Flow

19990051024 Washington Univ., Dept. of Aeronautics and Astronautics, Seattle, WA USA
Equivalent Plate Structural Modeling for Wing Shape Optimization Including Transverse Shear
Livne, Eli, Washington Univ., USA; AIAA Journal; June 1994; Volume 32, No. 6, pp. 1278-1288; In English
Contract(s)/Grant(s): NAG2-723; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

A new technique for structural modeling of airplane wings is presented taking transverse shear effects into account. The kinematic assumptions of first-order shear deformation plate theory In combination with numerical analysis, where simple polynomials are used to define geometry, construction, and displacement approximations, lead to analytical expressions for elements of the stiffness and mass matrices and load vector. Contributions from the cover skins, spar and rib caps, and spar and rib webs are included as well as concentrated springs and concentrated masses. Limitations of wing modeling techniques based on classical plate theory are discussed, and the Improved accuracy of the new equivalent plate technique is demonstrated through comparison with finite element analysis and test results. Expressions for analytical derivatives of stiffness, mass, and load terms with respect to wing shape are given. Based on these, it is possible to obtain analytic sensitivities of displacements, stresses, and natural frequencies with respect to planform shape and depth distribution. This makes the new capability an effective structural tool for wing shape optimization.
Author
Shear Stress; Transverse Loads; Wings; Finite Element Method; Loads (Forces); Numerical Analysis; Deformation; Kinematics

19990051025 Washington Univ., Dept. of Aeronautics and Astronautics, Seattle, WA USA
Analytic Sensitivities for Shape Optimization in Equivalent Plate Structural Wing Models
Livne, Eli, Washington Univ., USA; Journal of Aircraft; August 1994; Volume 31, No. 4, pp. 961-969; In English
Contract(s)/Grant(s): NAG2-723; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

Equivalent plate modeling techniques based on Ritz analysis with simple polynomials prove to be efficient tools for structural modeling of wings in the preliminary design stage. Accuracy problems are encountered, however, when these models are used to obtain finite difference behavior sensitivities with respect to planform shape. The accuracy problems are associated with the poor numerical conditioning of static and eigenvalue equations. As higher-order polynomials are being used to Improve the analysis itself, the more sensitive is the finite difference derivative to the step size used. This article describes a formulation of wing equivalent plate modeling in which it is simple to obtain analytic, explicit expressions for stiffness and mass matrix elements without the need to perform numerical integration. This formulation leads naturally to analytic expressions for the derivatives of displacements, stresses, and natural frequencies with respect to shape design variables. This article examines the accuracy of finite difference derivatives compared with the analytic derivatives, and shows that In some cases it is impossible to obtain any information of value by finite differences. Analytic sensitivities, in this case, are still sufficiently accurate for design optimization.
Author
Design Analysis; Numerical Integration; Stiffness Matrix; Finite Difference Theory; Optimization; Planforms; Shapes

19990052602 Mississippi State Univ., Computational Fluid Dynamics Lab., Mississippi State, MS USA
Aerodynamics and Maneuvering of Tiltrotor Aircraft *Final Report*
Whitfield, David L., Mississippi State Univ., USA; Briley, W. Roger, Mississippi State Univ., USA; 1999; In English
Contract(s)/Grant(s): NAG2-114; Copyright; Avail: Issuing Activity (Mississippi State Univ., P.O. Box 9627, Mississippi State, MS 39762-9627), Hardcopy, Microfiche

A physics based capability is being developed for flow simulations and maneuvering predictions for tiltrotor aircraft, including treatments of the rotors both as actual rotating blades and as body force (actuator disk) models. Simulations of relevance to tiltrotor aircraft include isolated rotors, quasisteady airframes with actuator disk rotors, and full configurations with rotating blades. Flow regimes of interest include hover, cruise and transition or conversion conditions. Body force models of rotors that include radial distributions of thrust and torque have significant advantages in reducing grid size, grid complexity and runtimes, and in excluding high Mach number tip regions. A time step that is larger than that needed to resolve detailed unsteady rotor physics can be used, and hence fewer time steps are required. However, this model does not adequately predict details of unsteady rotor flows such as blade/vortex and rotor wake/airframe interactions of interest during transition, and for noise reduction. This type of flow problem can introduce variable Mach number effects due to large regions of low velocity flow during hover, and possible transonic rotor tip effects (flutter, increased drag, and aerodynamic interference) during high speed cruise. Accordingly, there is a need for variable Mach number algorithms and simulations, and this capability is also being developed and applied in this study. Icing effects on both airframe and rotor are also of interest in connection with maneuverability and stability. Simulations for isolated rotors and airframe/disk/rotor combinations are all of interest. This study will explore influences of icing by including existing icing models in flow simulations, through collaboration with Tennessee State University.
Derived from text
Tilt Rotor Aircraft; Aerodynamic Characteristics; Maneuverability; Unsteady Flow; Hovering

19990052617 Arizona State Univ., Tempe, AZ USA
Multidisciplinary Optimization of Tilt Rotor Blades Using Comprehensive Composite Modeling Technique
Chattopadhyay, Aditi, Arizona State Univ., USA; McCarthy, Thomas R., Arizona State Univ., USA; Rajadas, John N., Arizona State Univ., USA; 1997; In English, 29 Apr. - 1 May 1997, Virginia Beach, VA, USA; Sponsored by American Helicopter Society, Inc., USA
Contract(s)/Grant(s): NAG2-1046; NAG2-771; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

An optimization procedure is developed for addressing the design of composite tilt rotor blades. A comprehensive technique, based on a higher-order laminate theory, is developed for the analysis of the thick composite load-carrying sections, modeled as box beams, in the blade. The theory, which is based on a refined displacement field, is a three-dimensional model which approximates the elasticity solution so that the beam cross-sectional properties are not reduced to one-dimensional beam parameters. Both inplane and out-of-plane warping are included automatically in the formulation. The model can accurately capture the transverse shear stresses through the thickness of each wall while satisfying stress free boundary conditions on the inner and outer surfaces of the beam. The aerodynamic loads on the blade are calculated using the classical blade element momentum theory. Analytical expressions for the lift and drag are obtained based on the blade planform with corrections for the high lift capability of rotor blades. The aerodynamic analysis is coupled with the structural model to formulate the complete coupled equations of motion for aeroelastic analyses. Finally, a multidisciplinary optimization procedure is developed to improve the aerodynamic, structural and aeroelastic performance of the tilt rotor aircraft. The objective functions include the figure of merit in hover and the high speed cruise propulsive efficiency. Structural, aerodynamic and aeroelastic stability criteria are imposed as constraints on the problem. The Kreisselmeier-Steinhauser function is used to formulate the multiobjective function problem. The search direction is determined by the Broyden-Fletcher-Goldfarb-Shanno algorithm. The optimum results are compared with the baseline values and show significant improvements in the overall performance of the tilt rotor blade.
Author
Rotor Blades (Turbomachinery); Algorithms; Design Analysis; Equations of Motion; Three Dimensional Models; Tilt Rotor Aircraft

19990052618 Washington Univ., Dept. of Aeronautics and Astronautics, Seattle, WA USA
Automated Finite Element Modeling of Wing Structures for Shape Optimization
Harvey, Michael Stephen, Washington Univ., USA; Nov. 12, 1993; 183p; In English
Contract(s)/Grant(s): NAG2-723; No Copyright; Avail: CASI; A09, Hardcopy; A02, Microfiche

The displacement formulation of the finite element method is the most general and most widely used technique for structural analysis of airplane configurations. Modem structural synthesis techniques based on the finite element method have reached a certain maturity in recent years, and large airplane structures can now be optimized with respect to sizing type design variables

for many load cases subject to a rich variety of constraints including stress, buckling, frequency, stiffness and aeroelastic constraints (Refs. 1-3). These structural synthesis capabilities use gradient based nonlinear programming techniques to search for improved designs. For these techniques to be practical a major improvement was required in computational cost of finite element analyses (needed repeatedly in the optimization process). Thus, associated with the progress in structural optimization, a new perspective of structural analysis has emerged, namely, structural analysis specialized for design optimization application, or.what is known as "design oriented structural analysis" (Ref. 4). This discipline includes approximation concepts and methods for obtaining behavior sensitivity information (Ref. 1), all needed to make the optimization of large structural systems (modeled by thousands of degrees of freedom and thousands of design variables) practical and cost effective.
Derived from text
Finite Element Method; Structural Analysis; Aircraft Structures; Aeroelasticity; Cost Effectiveness; Optimization; Stiffness; Design Analysis

19990052681 Georgia Inst. of Tech., School of Aerospace Engineering, Atlanta, GA USA
Characterizing the Effects of Geometrical Nonlinearities on Aeroelastic Behavior of High-Aspect-Ratio Wings
Patil, Mayuresh J., Georgia Inst. of Tech., USA; Hodges, Dewey H., Georgia Inst. of Tech., USA; Cesnik, Carlos E. S., Massachusetts Inst. of Tech., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 501-510; In English; See also 19990052675
Contract(s)/Grant(s): F49620-98-1-0032; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper presents the results of nonlinear aeroelastic analysis of a representative large-aspect-ratio wing. The effects of steady-state lift and drag are characterized and quantified. Certain simplifications for obtaining nonlinear results are given and a way of avoiding deleterious nonlinear effects is presented.
Author
Nonlinearity; Aeroelasticity; High Aspect Ratio; Mathematical Models; Dynamic Response; Dynamic Structural Analysis; Slender Wings

19990052682 Northrop Grumman Corp., Integrated Systems and Aerostructures, Pico Rivera, CA USA
Simulation of Non-Linear Transonic Aeroelastic Behavior on the B-2
Dreim, D. R., Northrop Grumman Corp., USA; Jacobson, S. B., Northrop Grumman Corp., USA; Britt, R. T., Northrop Grumman Corp., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 511-522; In English; See also 19990052675
Contract(s)/Grant(s): NAS1-19347; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

At high subsonic flight speeds, large flexible aircraft begin to encounter unsteady airloads which are not predicted by most currently available aerodynamic analysis and design methods. With increasing speed and the development of transonic flow and shocks, viscous effects quickly become very important, and flow separation can occur. The Northrop Grumman USAF B-2 Bomber encountered a nonlinear aeroelastic Residual Pitch Oscillation (RPO) under these conditions. Simulation studies were performed with the Computational Aeroelasticity Program-Transonic Small Disturbance, Viscous (CAPTSDv) computer program to evaluate its ability to predict these nonlinear aeroelastic responses. Open and closed loop simulations were performed to assess the participation of the flight control system. Control, system actuator hysteresis characteristics were modeled and found to be a significant participant in the RPO phenomenon. Simulations were also performed for varying Mach numbers and altitudes to establish the stability boundaries and compare with flight test data. These CAPTSDv simulations compared well with flight data and revealed many potential further modeling enhancements.
Author
Aeroelasticity; Nonlinearity; Subsonic Speed; Wing Oscillations; Unsteady Aerodynamics; Applications Programs (Computers); Viscous Flow; B-2 Aircraft

19990052694 NASA Langley Research Center, Hampton, VA USA
An Overview of Landing Gear Dynamics
Pritchard, Jocelyn, NASA Langley Research Center, USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 649-664; In English; See also 19990052675; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

One of the problems facing the aircraft community is landing gear dynamics, especially shimmy and brake-induced vibration. Although neither shimmy nor brake-induced vibrations are usually catastrophic, they can lead to accidents due to excessive wear and shortened life of gear parts and contribute to pilot and passenger discomfort. Recently, NASA has initiated an effort to increase the safety of air travel by reducing the number of accidents by a factor of five in ten years. This safety initiative has spurred an

increased interest in improving landing gear design to minimize shimmy and brake-induced vibration that are still largely misunderstood phenomena. In order to increase the understanding of these problems, a literature survey was performed. The major focus of the paper is to summarize work documented from the last ten years to highlight the latest efforts in solving these vibration problems. Older publications are included to understand the longevity of the problem and the findings from earlier researchers. The literature survey revealed a variety of analyses, testing, modeling, and simulation of aircraft landing gear. Experimental validation and characterization of shimmy and brake-induced vibration of aircraft landing gear are also reported. This paper presents an overview of the problem documented in the references together with a history of landing gear dynamic problems and solutions. Based on the assessment of this survey, recommendations of the most critically needed enhancements to the state of the art are given.
Author
Structural Vibration; Landing Gear; Aircraft Landing; Wheel Brakes; Aircraft Brakes; Aircraft Safety; General Overviews

19990052695 NASA Langley Research Center, Hampton, VA USA
Actively Controlled Landing Gear for Aircraft Vibration Reduction
Horta, Lucas G., NASA Langley Research Center, USA; Daugherty, Robert H., NASA Langley Research Center, USA; Martinson, Veloria J., NASA Langley Research Center, USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 665-678; In English; See also 19990052675; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Concepts for long-range air travel are characterized by airframe designs with long, slender, relatively flexible fuselages. One aspect often overlooked is ground induced vibration of these aircraft. This paper presents an analytical and experimental study of reducing ground-induced aircraft vibration loads using actively controlled landing gears. A facility has been developed to test various active landing gear control concepts and their performance. The facility uses a NAVY A6-intruder landing gear fitted with an auxiliary hydraulic supply electronically controlled by servo valves. An analytical model of the gear is presented including modifications to actuate the gear externally and test data is used to validate the model. The control design is described and closed-loop test and analysis comparisons are presented.
Author
Active Control; Feedback Control; Landing Gear; Mathematical Models; Vibration Damping; Equations of Motion; Control Systems Design

19990052697 Kyushu Univ., Dept. of Aeronautics and Astronautics, Fukuoka, Japan
Application of Direct Search Method to Aeroelastic Tailoring of an Arrow Wing Configuration
Isogai, Koji, Kyushu Univ., Japan; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 691-698; In English; See also 19990052675; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A computer code for aeroelastic tailoring of an arrow wing supersonic cruise configuration is developed. A direct search method is employed to find the optimum fiber orientation angles and thickness distributions of the upper and lower skin panels of the wing box for the minimum weight design under multiple constraints. The static strength symmetric and antisymmetric flutter velocities are taken into account at the same time as the thickness constraints. The code is applied to a typical arrow wing configuration to demonstrate its capabilities.
Author
Aeroelasticity; Arrow Wings; Aerodynamic Configurations; Applications Programs (Computers); Optimization; Design Analysis; Supersonic Airfoils

19990052699 DaimlerChrysler Aerospace Airbus G.m.b.H., Hamburg, Germany
Influence of Aeroelastic Tailoring in the Multidisciplinary Design of a New Aircraft
Kelm, Roland, DaimlerChrysler Aerospace Airbus G.m.b.H., Germany; Dugas, Michael, Technische Hochschule, Germany; Voit–Nitschmann, Rudolf, Technische Hochschule, Germany; Grabietz, Michael, Ingenieurbuero Michael Grabietz, Germany; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 709-718; In English; See also 19990052675; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper discusses ways of determining the effects of aeroelastic tailoring in the predevelopment phase of wings. At DaimlerChrysler Aerospace Airbus, the program system FAME (Fast and Advanced Multidisciplinary Engineering) has been developed. The part FAME-w deals with the mass prognosis of wings. In order to achieve reliable data within a short period of time, it is imperative to take into account the elastic properties of the structure for the determination of the aerodynamic loads and for the preliminary dimensioning. Only by regarding these effects, the FAME-w program has been successful in providing reliable

prognoses of wing mass and, of course, of the occurring loads and deformation. This report describes the extensions carried out so far which make it possible to investigate the effects and possibilities of composite wings, as well, using FAME-w.
Author
Aeroelasticity; Multidisciplinary Design Optimization; Wings; Applications Programs (Computers); Aerodynamic Loads; Aircraft Design

19990052704 California Univ., Mechanical and Aerospace Engineering Dept., Los Angeles, CA USA
Aeroelastic Analysis of a Trimmed Generic Hypersonic Vehicle
Nydick, I., California Univ., USA; Friedmann, P. P., California Univ., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 777-809; In English; See also 19990052675
Contract(s)/Grant(s): NCC2-374; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The aeroelastic equations of motion governing a hypersonic vehicle in free flight are derived. The equations of motion for a translating and rotating flexible body using Lagrange's equations in terms of quasi-coordinates are presented. These equations are simplified for the case of a vehicle with pitch and plunge rigid body degrees of freedom and small elastic displacements. The displacements are approximated by a truncated series of the unrestrained mode shapes, which are obtained using equivalent plate theory. Subsequently, the nonlinear equations of motion are linearized about the trim state, which is obtained using a rigid body trim model and steady hypersonic aerodynamics. The appropriate flutter derivatives are calculated from piston theory. Results describing mode shapes, trim behavior, and aeroelastic stability of a generic hypersonic vehicle are presented.
Author
Aerodynamic Stability; Aeroelasticity; Equations of Motion; Hypersonic Vehicles; Flexible Spacecraft; Aerodynamic Balance; Hypersonics; Flutter

19990052727 Washington Univ., Seattle, WA USA
Conceptual Design Oriented Wing Structural Analysis and Optimization
Lau, May Yuen, Washington Univ., USA; Dec. 11, 1996; 80p; In English
Contract(s)/Grant(s): NAG2-723; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

Airplane optimization has always been the goal of airplane designers. In the conceptual design phase, a designer's goal could be tradeoffs between maximum structural integrity, minimum aerodynamic drag, or maximum stability and control, many times achieved separately. Bringing all of these factors into an iterative preliminary design procedure was time consuming, tedious, and not always accurate. For example, the final weight estimate would often be based upon statistical data from past airplanes. The new design would be classified based on gross characteristics, such as number of engines, wingspan, etc., to see which airplanes of the past most closely resembled the new design. This procedure works well for conventional airplane designs, but not very well for new innovative designs. With the computing power of today, new methods are emerging for the conceptual design phase of airplanes. Using finite element methods, computational fluid dynamics, and other computer techniques, designers can make very accurate disciplinary-analyses of an airplane design. These tools are computationally intensive, and when used repeatedly, they consume a great deal of computing time. In order to reduce the time required to analyze a design and still bring together all of the disciplines (such as structures, aerodynamics, and controls) into the analysis, simplified design computer analyses are linked together into one computer program. These design codes are very efficient for conceptual design. The work in this thesis is focused on a finite element based conceptual design oriented structural synthesis capability (CDOSS) tailored to be linked into ACSYNT.
Derived from text
Design Analysis; Wing Profiles; Structural Failure; Optimization; Aircraft Design

19990052755 Old Dominion Coll., Dept. of Aerospace Engineering, Norfolk, VA USA
Control Design Strategies to Enhance Long-Term Aircraft Structural Integrity *Final Report, Period ending 11 Jan. 1999*
Newman, Brett A., Old Dominion Coll., USA; June 1999; 31p; In English
Contract(s)/Grant(s): NCC1-273
Report No.(s): ODURF-181210; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Over the operational lifetime of both military and civil aircraft, structural components are exposed to hundreds of thousands of low-stress repetitive load cycles and less frequent but higher-stress transient loads originating from maneuvering flight and atmospheric gusts. Micro-material imperfections in the structure, such as cracks and debonded laminates, expand and grow in this environment, reducing the structural integrity and shortening the life of the airframe. Extreme costs associated with refurbishment of critical load-bearing structural components in a large fleet, or altogether reinventoring the fleet with newer models, indicate alternative solutions for life extension of the airframe structure are highly desirable. Increased levels of operational safety and reliability are also important factors influencing the desirability of such solutions. One area having significant potential for

impacting crack growth/fatigue damage reduction and structural life extension is flight control. to modify the airframe response dynamics arising from command inputs and gust disturbances, feedback loops are routinely applied to vehicles. A dexterous flight control system architecture senses key vehicle motions and generates critical forces/moments at multiple points distributed throughout the airframe to elicit the desired motion characteristics. In principle, these same control loops can be utilized to influence the level of exposure to harmful loads during flight on structural components. Project objectives are to investigate and/or assess the leverage control has on reducing fatigue damage and enhancing long-term structural integrity, without degrading attitude control and trajectory guidance performance levels. In particular, efforts have focused on the effects inner loop control parameters and architectures have on fatigue damage rate. to complete this research, an actively controlled flexible aircraft model and a new state space modeling procedure for crack growth have been utilized. Analysis of the analytical state space model for crack growth revealed the critical mathematical factors, and hence the physical mechanism they represent, that influenced high rates of airframe crack growth. The crack model was then exercised with simple load inputs to uncover and expose key crack growth behavior. to characterize crack growth behavior, both "short-term" laboratory specimen test type inputs and "long-term" operational flight type inputs were considered. Harmonic loading with a single overload revealed typical exponential crack growth behavior until the overload application, after which time the crack growth was retarded for a period of time depending on the overload strength. An optimum overload strength was identified which leads to maximum retardation of crack growth. Harmonic loading with a repeated overload of varying strength and frequency again revealed an optimum overload trait for maximizing growth retardation. The optimum overload strength ratio lies near the range of 2 to 3 with dependency on frequency. Experimental data was found to correlate well with the analytical predictions.
Derived from text

Aircraft Structures; Structural Design; Prediction Analysis Techniques; Control Systems Design; Active Control; Crack Propagation; Fatigue (Materials); Aircraft Models

19990052759 NASA Lewis Research Center, Cleveland, OH USA

Probabilistic Evaluation of Fuselage-Type Composite Structures

Shiao, Michael C., Sverdrup Technology, Inc., USA; Chamis, Christos C., NASA Lewis Research Center, USA; Probabilistic Engineering Mechanics; 1998; ISSN 0266-8920; Volume 14, pp. 179-187; In English; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

A methodology is developed to simulate computationally the uncertain behavior of composite structures. The uncertain behavior includes buckling loads, natural frequencies, displacements, stress/strain, etc., which are the consequences of the random variation (scatter) of the primitive (independent random) variables in the constituent, plv. laminate and structural levels. This methodology is implemented in a computer code integrated probabilistic assessment of composite structures (IPACS). A fuselage-type composite structure is analyzed to demonstrate the code's capability . The probability distribution functions of the buckling loads, natural frequency, displacement, strain and stress are computed. The sensitivity of each primitive (independent random) variable to a given structural response is also identified from the analyses.
Author

Composite Structures; Computer Programs; Fuselages; Probability Distribution Functions; Finite Element Method; Structural Reliability

19990052866 NASA Langley Research Center, Hampton,VA USA

Aircraft and Ground Vehicle Winter Runway Friction Assessment

Yager, Thomas J., NASA Langley Research Center, USA; May 1999; 16p; In English; International Forum on Aeroelasticity and Structural Dynamics, 22-25 Jun. 1999, Williamsburg, VA, USA

Contract(s)/Grant(s): RTOP 522-18-11-04

Report No.(s): NASA/TM-1999-209142; L-17852; NAS 1.15:209142; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Some background information is given together with the scope and objectives of a 5-year, Joint Winter Runway Friction Measurement Program between the National Aeronautics & Space Administration (NASA), Transport Canada (TC), and the Federal Aviation Administration (FAA). The primary objective of this effort is to perform instrumented aircraft and ground vehicle tests aimed at identifying a common number that all the different ground vehicle devices would report. This number, denoted the International Runway Friction Index (IRFI), will be related to all types of aircraft stopping performance. The range of test equipment, the test sites, test results and accomplishments, the extent of the substantial friction database compiled, and future test

plans will be described. Several related studies have also been implemented including the effects of contaminant type on aircraft impingement drag, and the effectiveness of various runway and aircraft de-icing chemical types, and application rates. Author

Friction Measurement; Runway Conditions; Ground Tests; Contaminants; Ground Handling; Airfield Surface Movements

19990052997 Naval Air Warfare Center, Aircraft Div., Patuxent River, MD USA

High Intensity Radiated Field External Environments for Civil Aircraft Operating in the USA of America

Heather, Frederick W.; Dec. 1998; 138p; In English

Report No.(s): AD-A359458; NAWCADPAX-98-156-TM; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

NAWCAD Patuxent River, Maryland, was tasked by the FAA to determine the High Intensity Radiated Field (HIRF) levels for civil aircraft operating in the U.S. The electromagnetic field survey will apply to civil aircraft seeking FAA certification under Federal Aviation Regulations (FAR's) Parts 23, 25, 27, and 29. The HIRF survey determined the Rotorcraft Severe, Fixed Wing Severe, Certification, and Normal Environments that civil aircraft may be exposed to while operating in the continental U.S. and its territories. The HIRF survey was accomplished by accessing EME data bases, technical manuals, and phone contact with emitter operators to determine the HIRF drivers, analyze the severity, and provide a U.S. composite environment. These HIRF environments were subsequently provided to the EEHWG for harmonization with the European HIRF environment. The harmonized environment is known as the International HIRF environments that are planned to be used in the FAR advisory material and other supporting documents. The International HIRF environments are also shown in this report for completeness. DTIC

Electromagnetic Fields; Fixed Wings; Rotary Wing Aircraft

19990053144 Pennsylvania State Univ., Dept. of Aerospace Engineering, University Park, PA USA

Recent Development in the Analytical Investigation of Shipboard Rotorcraft Engage and Disengage Operations

Smith, Edward C., Pennsylvania State Univ., USA; Keller, Jonathan A., Pennsylvania State Univ., USA; Kang, Hao, Pennsylvania State Univ., USA; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 1-1 - 1-18; In English; See also 19990053143; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper presents an overview of recent developments in an effort to predict transient aeroelastic rotor response during shipboard engage and disengage sequences. The blade is modeled as an elastic beam undergoing in flap, lag, extension and torsion. The blade equations of motion are formulated using Hamilton's principle and they are spatially discretized using the finite element method. The discretized blade equations of motion are integrated for a specified rotor speed run-up or run-down profile. Blade element theory is used to calculate quasi-steady or unsteady aerodynamic loads in linear and nonlinear regimes. The analysis is capable of simulating both articulated, hingeless, and gimballed rotor systems. Validation of the rotor code is discussed, including correlation with droop stop impact tests and wind tunnel experiments. Predictions of safe engagement and disengagement envelopes, limited by excessive blade tip deflections or hub moments, are presented. Future directions of study are also discussed. Author

Aeroelasticity; Finite Element Method; Equations of Motion; Unsteady Aerodynamics; Transient Response; Rotors

19990053165 Krylov Shipbuilding Research Inst., Saint Petersburg, Russia

Conceptual Bases of WIG Craft Building: Ideas, Reality and Outlooks

Aframeev, E. A., Krylov Shipbuilding Research Inst., Russia; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 22-1 - 22-18; In English; See also 19990053143; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Wing-in-Ground (WIG) craft (ekranoplans) building has sufficiently long history but till now there is not any established view on their technical appearance and place in the system of transport means. It was assumed that technical and economical characteristics of WIG craft wittingly exceeded those of competitive transport means: aircraft (and hydroaeroplanes) because of the high lift-to-drag ratio value (aerodynamic efficiency). However in reality they don't a priori provide the superiority over the aircraft (hydroaeroplanes). Now it is necessary to revise the conceptual base of WIG craft building. The idea of creation of second generation ekranoplans on the base of a the A-conception, suggested by the author in 1977, assumes that they are created as marine transport means with high ship features when sailing (air transport means, including hydroaeroplanes, doesn't possess such features), i.e. as two-mode vehicles. Realization of this conception puts the ekranoplans out of competition as compare with other classes of engineering in the cases when it is necessary to stay at sea for a long time. At the same time such ekranoplans have the incomparably high level of safety when using for the transportation of passengers and cargo. In the near-term future the sphere of WIG craft application can be significantly expanded and include not only the transportation but such important missions as the creation of global sea rescue system or sea launch of space vehicles. In the more remote future it may be possible to realize

the trans-ocean transportation, however this mission requires the creation of superheavy ekranoplans what in turn requires the solution of some complicated technical problems.
Author
Air Transportation; Transport Aircraft; Aerospace Planes; Aerospace Engineering; Aircraft Design; Design Analysis; Ground Effect (Aerodynamics); Ground Effect Machines

19990053167 Joint Stock Co. Agency for Technologies and Transport, Nizhny Novgorod, Russia
The First Commercial Ekranoplan "Amphistar" and Prospects for the Development of Passenger Ekranoplans
Sinitsyn, D. N., Joint Stock Co. Agency for Technologies and Transport, Russia; Maskalik, A. I., Joint Stock Co. Agency for Technologies and Transport, Russia; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 24-1 - 24-18; In English; See also 19990053143; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The background and evolution of ekranoplan development in Russia is described in the paper. The data are given on the developed ekranoplans including the first civilian ekranoplans "Amphistar". The whole range of marine passenger ekranoplans (MPE) developed by the Russian "Technologies and Transport" JSC is shown. The description of the Marine Passenger Ekranoplan MPE-200 is presented together with conclusions concerning prospects for the development of passenger ekranoplans.
Author
Commercial Aircraft; Air Transportation; Aircraft Design; Ground Effect Machines

19990053219 Georgia Inst. of Tech., Atlanta, GA USA
Integrated Diagnostics, *1 Jun. 1998 - 31 May 1999*
Cowan, Richard S.; Winer, Ward O.; May 31, 1999; 192p; In English
Contract(s)/Grant(s): N00014-95-1-0539
Report No.(s): AD-A363343; No Copyright; Avail: CASI; A09, Hardcopy; A02, Microfiche

This document summarizes activity concerning the performance of basic research being conducted in the area of Integrated Diagnostics, a term associated with the technologies and methodologies used to determine how mechanical failures occur, and how they can be detected, predicted, and diagnosed in real time. Objectives, set forth through a Department of Defense Multidisciplinary Research Program of the University Research Initiative (M-URI), are being addressed by faculty and staff from the Georgia Institute of Technology, Northwestern University, and the University of Minnesota. Fourth year accomplishments and plans are reported upon. During this reporting period, experiments based on material, load, and vibration information from critical rotorcraft components continued so as to collect data of relevance in understanding the mechanisms of small crack growth for use in developing fatigue failure models. Such models serve as a guide in the selection and development of sensors to detect faults and pending failures. Effort has been placed on sensor development, and achieving the means to analyze and correlate reliable sensor output for operator use. Organizationally, this activity is being accomplished through (11) projects, categorized by the thrust areas of (1) Mechanical System Health Monitoring, including microsensor development and the condition monitoring of rotordynamic elements; (2) Nondestructive Examination Technology; and (3) Material Failure Characterization and Prediction Methodology.
DTIC
Rotary Wing Aircraft; Prediction Analysis Techniques; Failure Analysis; Vibration; Failure

19990053230 Mitre Corp., Jason Program Office, McLean, VA USA
Nondestructive Evaluation and Self-Monitoring Materials
Williams, Ellen; Lewis, Nate; Abarbanel, Henry; Eardley, Doug; Happer, Will; Apr. 1999; 55p; In English
Report No.(s): AD-A363256; JSR-98-145; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This report is a response to a request from DARPA for a JASON study to evaluate existing and novel approaches to condition-based maintenance. Our guidance was to avoid the area of "smart materials", which is by itself an active area of research with which DARPA is quite familiar. In addition, the JASON study was narrowed to exclude the research area devoted to developing self-healing materials, i.e., materials that not only detect a change and produce a signal when the change occurs, but which also deform or reorganize structurally at either the macroscopic or microscopic level to counteract any harmful operational effects due to such changes. Instead, the JASON study focused primarily on methods through which condition-based maintenance could be facilitated, improved, and/or enhanced.
DTIC
Aircraft Maintenance; Rotary Wings

19990053475 Electro Magnetic Applications, Inc., Denver, CO USA
Statistical Study of the Distance of Closest Approach of Aircraft to Ground-Based Emitters *Final Report*
Elliott, James R., Electro Magnetic Applications, Inc., USA; Perala, Rodney A., Electro Magnetic Applications, Inc., USA; Apr. 1999; 36p; In English
Contract(s)/Grant(s): DTFA03-96-00036
Report No.(s): AD-A363263; EMA-97-R-007; DOT/FAA/AR-98/75; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A Technical Program was initiated by the Federal Aviation Administration (FAA) William J. Hughes Technical Center to determine the closest distances that aircraft fly to high-intensity radiation emitters. This program was launched as the FAA and the High-Intensity Radiated Fields (HIRF) advisory committees were defining HIRF regulatory rulemaking requirements. This study was conducted at the Denver International Airport to determine the actual closest distances that aircraft fly in proximity to high-intensity radiation emitters. Information on emitter location, frequency, power, etc., was obtained from the Government Master File. Aircraft flight information was obtained from the SAR (System Analysis Recordings) tapes at the Denver En Route Center. This program was used in conjunction with a research effort which located all high-powered emitters in the U.S. and Europe and established the actual HIRF environment.
DTIC
Electromagnetic Fields; Electromagnetic Radiation; Aircraft Safety; Air Traffic Control; Flight Safety; Beacon Collision Avoidance System; Flight Paths

07
AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.

19990047389 NASA Dryden Flight Research Center, Edwards, CA USA
The Use of a Lidar Forward-Looking Turbulence Sensor for Mixed-Compression Inlet Unstart Avoidance and Gross Weight Reduction on a High Speed Civil Transport
Soreide, David, Boeing Defense and Space Group, USA; Bogue, Rodney K., NASA Dryden Flight Research Center, USA; Ehernberger, L. J., NASA Dryden Flight Research Center, USA; Ehernberger, L. J., NASA Dryden Flight Research Center, USA; Seidel, Jonathan, NASA Lewis Research Center, USA; July 1997; 18p; In English; Joint Propulsion, 6-9 Jul. 1997, Seattle, WA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): RTOP 529-50-24
Report No.(s): NASA/TM-1999-104332; NAS 1.15:104332; H-2186; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Inlet unstart causes a disturbance akin to severe turbulence for a supersonic commercial airplane. Consequently, the current goal for the frequency of unstarts is a few times per fleet lifetime. For a mixed-compression inlet, there is a tradeoff between propulsion system efficiency and unstart margin. As the unstart margin decreases, propulsion system efficiency increases, but so does the unstart rate. This paper intends to first, quantify that tradeoff for the High Speed Civil Transport (HSCT) and second, to examine the benefits of using a sensor to detect turbulence ahead of the airplane. When the presence of turbulence is known with sufficient lead time to allow the propulsion system to adjust the unstart margin, then inlet unstarts can be minimized while overall efficiency is maximized. The NASA Airborne Coherent Lidar for Advanced In-Flight Measurements program is developing a lidar system to serve as a prototype of the forward-looking sensor. This paper reports on the progress of this development program and its application to the prevention of inlet unstart in a mixed-compression supersonic inlet. Quantified benefits include significantly reduced takeoff gross weight (TOGW), which could increase payload, reduce direct operating costs, or increase range for the HSCT.
Author
Airborne Equipment; Commercial Aircraft; Optical Radar; Supersonic Transports; Flight Instruments; Supersonic Inlets; Atmospheric Turbulence; Warning Systems

19990047460 NASA Glenn Research Center, Cleveland, OH USA
Small Engine Technology (SET) - Task 14 Axisymmetric Engine Simulation Environment *Final Report*
Miller, Max J., NASA Glenn Research Center, USA; May 1999; 22p; In English
Contract(s)/Grant(s): NAS3-27483; RTOP 509-10-11

Report No.(s): NASA/CR-1999-208673; NAS 1.26:208673; E-11401; Rept-21-10296; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

As part of the NPSS (Numerical Propulsion Simulation System) project, NASA Lewis has a goal of developing an U.S. industry standard for an axisymmetric engine simulation environment. In this program, AlliedSignal Engines (AE) contributed to this goal by evaluating the ENG20 software and developing support tools. ENG20 is a NASA developed axisymmetric engine simulation tool. The project was divided into six subtasks which are summarized below: Evaluate the capabilities of the ENG20 code using an existing test case to see how this procedure can capture the component interactions for a full engine. Link AE's compressor and turbine axisymmetric streamline curvature codes (UD0300M and TAPS) with ENG20, which will provide the necessary boundary conditions for an ENG20 engine simulation. Evaluate GE's Global Data System (GDS), attempt to use GDS to do the linking of codes described in Subtask 2 above. Use a turbofan engine test case to evaluate various aspects of the system, including the linkage of UD0300M and TAPS with ENG20 and the GE data storage system. Also, compare the solution results with cycle deck results, axisymmetric solutions (UD0300M and TAPS), and test data to determine the accuracy of the solution. Evaluate the order of accuracy and the convergence time for the solution. Provide a monthly status report and a final formal report documenting AE's evaluation of ENG20. Provide the developed interfaces that link UD0300M and TAPS with ENG20, to NASA. The interface that links UD0300M with ENG20 will be compatible with the industr,, version of UD0300M.

Author

Standardization; Boundary Conditions; Data Systems; Engine Tests; Turbofan Engines; Evaluation

19990047461 NASA Glenn Research Center, Cleveland, OH USA

Parametric Studies of the Ejector Process within a Turbine-Based Combined-Cycle Propulsion System

Georgiadis, Nicholas J., NASA Glenn Research Center, USA; Walker, James F., NASA Glenn Research Center, USA; Trefny, Charles J., NASA Glenn Research Center, USA; May 1999; 14p; Aerospace Sciences, 12-15 Jan. 1998, Reno, NV, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Contract(s)/Grant(s): RTOP 523-61-23

Report No.(s): NASA/TM-1999-209172; NAS 1.15:209172; AIAA Paper 98-0936; E-11679; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Performance characteristics of the ejector process within a turbine-based combined-cycle (TBCC) propulsion system are investigated using the NPARC Navier-Stokes code. The TBCC concept integrates a turbine engine with a ramjet into a single propulsion system that may efficiently operate from takeoff to high Mach number cruise. At the operating point considered, corresponding to a flight Mach number of 2.0, an ejector serves to mix flow from the ramjet duct with flow from the turbine engine. The combined flow then passes through a diffuser where it is mixed with hydrogen fuel and burned. Three sets of fully turbulent Navier-Stokes calculations are compared with predictions from a cycle code developed specifically for the TBCC propulsion system. A baseline ejector system is investigated first. The Navier-Stokes calculations indicate that the flow leaving the ejector is not completely mixed, which may adversely affect the overall system performance. Two additional sets of calculations are presented; one set that investigated a longer ejector region (to enhance mixing) and a second set which also utilized the longer ejector but replaced the no-slip surfaces of the ejector with slip (inviscid) walls in order to resolve discrepancies with the cycle code. The three sets of Navier-Stokes calculations and the TBCC cycle code predictions are compared to determine the validity of each of the modeling approaches.

Author

Ejectors; Navier-Stokes Equation; Propulsion System Performance; Ramjet Engines; Computational Fluid Dynamics; Propulsion System Configurations; Aircraft Configurations; Supersonic Combustion Ramjet Engines; Two Dimensional Flow; K-Epsilon Turbulence Model; Multigrid Methods; Turbulent Mixing

19990047548 Advanced Structures Technology, Inc., Phoenix, AZ USA

Assessment of an Advanced Containment System *Final Report*

Presley, Kenneth L.; Feb. 1999; 22p; In English

Contract(s)/Grant(s): DTRS-57-90-C-00026

Report No.(s): AD-A362197; AST-R8008-1; DOT/FAA/AR-97/82; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

An advanced turbine engine fan blade containment system using ceramic tiles on a polymer fiber backing ring is proposed. The proposed ceramic/polymer-fiber system has proven more weight effective than monolithic metallic or polymer materials for stopping penetration of ballistic munitions projectiles. It was expected that this technology, originally developed for aircraft armor systems, could decrease containment system weights while still providing the same degree of protection as existing systems. This technology would allow for the design of higher thrust-to-weight engines and be used either for new designs or for retrofit

application for existing engines. This program concluded that ceramic liners do not improve the performance of metal or composite containment structures for turbine engine uncontainment when evaluated in terms of contained energy per unit weight. DTIC

Rotary Wing Aircraft; Fan Blades; Turbine Engines; Containment; Composite Structures

19990047784 Naval Air Warfare Center, Weapons Div., China Lake, CA USA

Small-Engine Uncontained Debris Analysis *Final Report*

Frankenberger, C. E.; Feb. 1999; 24p; In English

Contract(s)/Grant(s): DTFA03-95-X-90019

Report No.(s): PB99-143976; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The Naval Air Warfare Center has conducted an analysis to define the characteristics of small civil turbine engine uncontained debris. The objective of the analysis was to define the debris size, weight, exit velocity, and trajectory that can be used to update AC 20-128A. The effort was conducted by gathering historical data from uncontained engine failures. These data included, when available, phase of flight, engine operating condition, the failed engine component, aircraft damage location, and damage size. With this basic information, debris size was correlated to damage size. A methodology developed in the 'Large-Engine Uncontained Debris Analysis' report number DOT/FAA/AR-99/11 was used to estimate debris exit velocity. Representative engine cases and cowls were defined, and existing ballistic penetration equations were used to calculate exit velocity. This analysis was conducted for disk and blade failures on fan, compressor and turbine components. Results of the analysis provided some interesting insight into these events.

NTIS

Fragments; Fan Blades; Turbine Engines; Penetration; Damage Assessment; Engine Design; Debris; Terminal Ballistics

19990047909 Allison Engine Co., Pratt and Whitney, Indianapolis, IN USA

TADS--A CFD-Based Turbomachinery Analysis and Design System with GUI: User's Manual, 2.0 *Final Report*

Koiro, M. J., Allison Engine Co., USA; Myers, R. A., Allison Engine Co., USA; Delaney, R. A., Allison Engine Co., USA; May 1999; 96p; In English

Contract(s)/Grant(s): NAS3-27394; RTOP 538-03-11

Report No.(s): NASA/CR-1999-206604; NAS 1.26:206604; E-11117; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

The primary objective of this study was the development of a Computational Fluid Dynamics (CFD) based turbomachinery airfoil analysis and design system, controlled by a Graphical User Interface (GUI). The computer codes resulting from this effort are referred to as TADS (Turbomachinery Analysis and Design System). This document is intended to serve as a User's Manual for the computer programs which comprise the TADS system, developed under Task 18 of NASA Contract NAS3-27350, ADPAC System Coupling to Blade Analysis & Design System GUI and Task 10 of NASA Contract NAS3-27394, ADPAC System Coupling to Blade Analysis & Design System GUI, Phase II-Loss, Design and, Multi-stage Analysis. TADS couples a throughflow solver (ADPAC) with a quasi-3D blade-to-blade solver (RVCQ3D) in an interactive package. Throughflow analysis and design capability was developed in ADPAC through the addition of blade force and blockage terms to the governing equations. A GUI was developed to simplify user input and automate the many tasks required to perform turbomachinery analysis and design. The coupling of the various programs was done in such a way that alternative solvers or grid generators could be easily incorporated into the TADS framework. Results of aerodynamic calculations using the TADS system are presented for a highly loaded fan, a compressor stator, a low speed turbine blade and a transonic turbine vane.

Author

Turbomachinery; User Manuals (Computer Programs); Computational Fluid Dynamics; Graphical User Interface; Computer Programs; Design Analysis

19990050999 Allison Engine Co., Indianapolis, IN USA

TADS: A CFD-Based Turbomachinery Analysis and Design System with GUI: Methods and Results, 2.0 *Final Report, Feb. 1996 - Sep. 1998*

Koiro, M. J., Allison Engine Co., USA; Myers, R. A., Allison Engine Co., USA; Delaney, R. A., Allison Engine Co., USA; May 1999; 160p; In English

Contract(s)/Grant(s): NAS3-27394; RTOP 538-03-11

Report No.(s): NASA/CR-1999-206603; E-11116; NAS 1.26:206603; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

The primary objective of this study was the development of a Computational Fluid Dynamics (CFD) based turbomachinery airfoil analysis and design system, controlled by a Graphical User Interface (GUI). The computer codes resulting from this effort are referred to as TADS (Turbomachinery Analysis and Design System). This document is the Final Report describing the theoretical basis and analytical results from the TADS system developed under Task 10 of NASA Contract NAS3-27394, ADPAC System Coupling to Blade Analysis & Design System GUI, Phase II-Loss, Design and. Multi-stage Analysis. TADS couples a throughflow solver (ADPAC) with a quasi-3D blade-to-blade solver (RVCQ3D) or a 3-D solver with slip condition on the end walls (B2BADPAC) in an interactive package. Throughflow analysis and design capability was developed in ADPAC through the addition of blade force and blockage terms to the governing equations. A GUI was developed to simplify user input and automate the many tasks required to perform turbomachinery analysis and design. The coupling of the various programs was done in such a way that alternative solvers or grid generators could be easily incorporated into the TADS framework. Results of aerodynamic calculations using the TADS system are presented for a multistage compressor, a multistage turbine, two highly loaded fans, and several single stage compressor and turbine example cases.
Author
Computational Fluid Dynamics; Turbomachinery; Graphical User Interface; Systems Analysis; Airfoils; Design Analysis

19990052582 NASA Glenn Research Center, Cleveland, OH USA
A Three-Dimensional Coupled Internal/External Simulation of a Film-Cooled Turbine Vane
Heidmann, James D., NASA Glenn Research Center, USA; Rigby, David L., DYNACS Engineering Co., Inc., USA; Ameri, Ali A., AYT Corp., USA; April 1999; 20p; In English; Gas Turbine and Aeroengine Congress, Exposition and Users' Symposium, 7-10 Jun. 1999, Indianapolis, IN, USA; Sponsored by American Society of Mechanical Engineers, USA
Contract(s)/Grant(s): NAS3-98008; NAS3-27571; RTOP 523-26-13
Report No.(s): NASA/TM-1999-209078; NAS 1.15:209078; E-11638; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A three-dimensional Navier-Stokes simulation has been performed for a realistic film-cooled turbine vane using the LeRC-HT code. The simulation includes the flow regions inside the coolant plena and film cooling holes in addition to the external flow. The vane is the subject of an upcoming NASA Glenn Research Center experiment and has both circular cross-section and shaped film cooling holes. This complex geometry is modeled using a multi-block grid which accurately discretizes the actual vane geometry including shaped holes. The simulation matches operating conditions for the planned experiment and assumes periodicity in the spanwise direction on the scale of one pitch of the film cooling hole pattern. Two computations were performed for different isothermal wall temperatures, allowing independent determination of heat transfer coefficients and film effectiveness values. The results indicate separate localized regions of high heat transfer coefficient values, while the shaped holes provide a reduction in heat flux through both parameters. Hole exit data indicate rather simple skewed profiles for the round holes, but complex profiles for the shaped holes with mass fluxes skewed strongly toward their leading edges.
Author
Three Dimensional Models; Turbines; Simulation; Navier-Stokes Equation; Vanes

19990052638 Advanced Structures Technology, Inc., Phoenix, AZ USA
Assessment of an Advanced Containment System *Final Report*
Presley, K. L.; Feb. 1999; 30p; In English
Report No.(s): PB99-143968; AST-R8008-1; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The objective of this program was to evaluate the potential benefit of adding ceramic liners to turbine containment structures. Military ballistic programs have shown that ceramics can alter the ballistic projectile and increase the effect of impact area to provide significant benefit. Turbine engine failures generate slower moving, odd-shaped debris. This effort added ceramic liners to metal and composite containment rings to evaluate the energy absorbed as a function of component weight.
NTIS
Containment; Turbines; Linings

19990052939 Naval Air Warfare Center, Weapons Div., China Lake, CA USA
Small-Engine Uncontained Debris Analysis *Final Report*
Frankenberger, C. E., III; Feb. 1999; 18p; In English
Contract(s)/Grant(s): DTFA03-95-X-90019
Report No.(s): AD-A362579; DOT/FAA/AR-99/7; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Under Contract to the Federal Aviation Administration, the Naval Air Warfare Center has conducted an analysis to define the characteristics of small civil turbine engine uncontained debris. The objective of the analysis was to define the debris size,

weight, exit velocity, and trajectory that can be used to update AC20-128A. The effort was conducted by gathering historical data from uncontained engine failures. These data included, when available, phase of flight, engine operating condition, the failed engine component, aircraft damage location, and damage size. With this basic information, debris size was correlated to damage size. A methodology developed in the "Large-Engine Uncontained Debris Analysis" report number DOT/FAA/AR-99/11 was used to estimate debris exit velocity. Representative engine cases and cowls were defined, and existing ballistic penetration equations were used to calculate debris exit velocity. This analysis was conducted for disk and blade failures on fan, compressor and turbine components. Results of the analysis provided some interesting insight to these events. Looking at the debris trajectories, the analysis shows that the trajectories defined in AC20-128A are comparable to those seen in field events. Also the analysis highlights the fact that small engines produce fewer uncontained fragments than large engines (1 per event versus 11 per event on the average for large engines).
DTIC
Engine Design; Debris; Trajectory Analysis; Aircraft Engines

19990052943 General Electric Co., Aircraft Engines, Cincinnati, OH USA
Crack Growth-Based Predictive Methodology for the Maintenance of the Structural Integrity of Repaired and Nonrepaired Aging Engine Stationary Components *Final Report*
Barron, M. L.; Apr. 1999; 112p; In English
Report No.(s): PB99-147381; No Copyright; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche
This report contains the description and results of work conducted by General Electric Aircraft Engines(GEAE) between October 1994 and April 1997 under the Federal Aviation Administration (FAA) contract to study aging engine issues relative to stationary components. GEAE's project in support of this goal was to study specific components, combustion castings, and compressor rear frames in service on older GEAE engines to determine if periodic inspections are warranted and to develop the tools necessary to conduct effective inspections should the data support a proactive need. A detail description of the planned work scope along with results for that portion of the work that was completed are reported.
NTIS
Crack Propagation; Cracking (Fracturing); Structural Failure; Aircraft Engines; Engine Parts; Maintenance

19990053005 NASA Glenn Research Center, Cleveland, OH USA
NASA Glenn Research Center's Hypersonic Propulsion Program
Palac, Donald T., NASA Glenn Research Center, USA; May 1999; 10p; In English; Airbreathing Engines, 5-10 Sep. 1999, Florence, Italy; Sponsored by American Inst. of Aeronautics and Astronautics, USA; Meeting sponsored by AAF and ATI
Contract(s)/Grant(s): RTOP 523-61-13
Report No.(s): NASA/TM-1999-209185; E-11696; NAS 1.15:209185; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche
NASA Glenn Research Center (GRC), as NASA's lead center for aeropropulsion, is responding to the challenge of reducing the cost of space transportation through the integration of air-breathing propulsion into launch vehicles. Air- breathing launch vehicle (ABLV) propulsion requires a marked departure from traditional propulsion applications. and stretches the technology of both rocket and air-breathing propulsion. In addition, the demands of the space launch mission require an unprecedented level of integration of propulsion and vehicle systems. GRC is responding with a program with rocket-based combined cycle (RBCC) propulsion technology as its main focus. RBCC offers the potential for simplicity, robustness, and performance that may enable low-cost single-stage-to-orbit (SSTO) transportation. Other technologies, notably turbine-based combined cycle (TBCC) propulsion, offer benefits such as increased robustness and greater mission flexibility, and are being advanced, at a slower pace, as part of GRC's program in hypersonics.
Author
Air Breathing Boosters; Air Breathing Engines; Launch Vehicles; Spacecraft Launching

08
AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

19990047878 California Polytechnic State Univ., San Luis Obispo, CA USA
Multicriteria Gain Tuning for Rotorcraft Flight Controls (also entitled The Development of the Conduit Advanced Control System Design and Evaluation Interface with a Case Study Application Fly by Wire Helicopter Design) *Final Report, 1 Oct. 1995 - 30 Sep. 1997*
Biezad, Daniel, California Polytechnic State Univ., USA; 1997; 101p; In English
Contract(s)/Grant(s): NAG2-1024; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

Handling qualities analysis and control law design would seem to be naturally complimenting components of aircraft flight control system design, however these two closely coupled disciplines are often not well integrated in practice. Handling qualities engineers and control system engineers may work in separate groups within an aircraft company. Flight control system engineers and handling quality specialists may come from different backgrounds and schooling and are often not aware of the other group's research. Thus while the handling qualities specifications represent desired aircraft response characteristics, these are rarely incorporated directly in the control system design process. Instead modem control system design techniques are based on servo-loop robustness specifications, and simple representations of the desired control response. Comprehensive handling qualities analysis is often left until the end of the design cycle and performed as a check of the completed design for satisfactory performance. This can lead to costly redesign or less than satisfactory aircraft handling qualities when the flight testing phase is reached. The desire to integrate the fields of handling qualities and flight,control systems led to the development of the CONDUIT system. This tool facilitates control system designs that achieve desired handling quality requirements and servo-loop specifications in a single design process. With CONDUIT, the control system engineer is now able to directly design and control systems to meet the complete handling specifications. CONDUIT allows the designer to retain a preferred control law structure, but then tunes the system parameters to meet the handling quality requirements.
Author
Control Systems Design; Design Analysis; Fly by Wire Control; Aircraft Control; Control Theory; Flight Control

19990049309 Colorado Univ., Dept. of Aerospace Engineering, Boulder, CO USA
Real Time Predictive Flutter Analysis and Continuous Parameter Identification of Accelerating Aircraft *Final Report, 1 Nov. 1997 - 30 Sep. 1998*
Farhat, Charles; Sep. 30, 1998; 8p; In English
Contract(s)/Grant(s): F49620-98-1-0112; AF Proj. 2304
Report No.(s): AD-A361695; AFRL-SR-BL-TR-99-0106; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

This is a four-part final report on the research supported by the Air Force Office of Scientific Research Center under Grant F49620-98-1-0112, Real Time Predictive Flutter Analysis and Continuous Parameter Identification of Accelerating Aircraft. Flutter clearance, which is part of any new aircraft or fighter weapon system development, is a lengthy and tedious process from both computational and flight testing viewpoints. An automated approach to flutter clearance that increases flight safety and reduces flight hours requires as a stepping stone the development of a real time flutter prediction capability. Such a fast analysis tool can be designed if the coupled fluid/structure aeroelastic system is represented by a simplified mathematical model that can be quickly adapted to changes in flight atmospheric conditions, aircraft mass distribution (weapon systems), fuel loading, and Mach number, and if the current parallel processing technology is exploited.
DTIC
Real Time Operation; Prediction Analysis Techniques; Flutter Analysis; Acceleration (Physics); Fighter Aircraft; Parameter Identification

19990050914 NASA Dryden Flight Research Center, Edwards, CA USA
An H-Infinity Approach to Control Synthesis with Load Minimization for the F/A-18 Active Aeroelastic Wing
Lind, Rick, NASA Dryden Flight Research Center, USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 23-32; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The F/A-18 Active Aeroelastic Wing research aircraft will demonstrate technologies related to aeroservoelastic effects such as wing twist and load minimization. This program presents several challenges for control design that are often not considered for traditional aircraft. This paper presents a control design based on H-infinity synthesis that simultaneously considers the

multiple objectives associated with handling qualities, actuator limitations, and loads. A point design is presented to demonstrate a controller and the resulting closed-loop properties.
Author
Aeroservoelasticity; Controllability; Feedback Control; H-Infinity Control; Wing Loading; Controllers

19990050917 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Aeroelasticity, Goettingen, Germany
Simulation of Nonlinear Airfoil/Control-Surface Flutter at Subsonic Speeds using Classical Unsteady Aerodynamics and an Euler Method
Schulze, Silvio, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 53-70; In English; See also 19990050911; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A flutter simulation method for aeroelastic systems with discrete structural nonlinearities is presented and applied. The computational approach is based on the coupling of the discretized fluid and structural equations which are solved in the time domain. Embedded in an effective procedure to compute complete flutter boundaries (bifurcation diagrams), the method is employed to investigate the flutter stability of an airfoil/control-surface system for hardening and softening stiffness characteristics in the control mechanism. The aerodynamic forces are predicted under the assumption of subsonic inviscid flow by the classical linear airfoil theory as a basis of comparison and by a Euler method. The typical flutter behavior of the system is described and explained by comparing it with the flutter properties of a predefined linear reference model. The results presented here demonstrate the practicability of the method and provide a deeper insight into the nonlinear airfoil/control-surface flutter mechanisms.
Author
Unsteady Aerodynamics; Aeroelasticity; Flutter; Mathematical Models; Control Surfaces; Aerodynamic Stability; Euler Equations of Motion; Structural Analysis; Predictor-Corrector Methods; Finite Difference Time Domain Method

19990050922 National Aerospace Lab., Structures Div., Tokyo, Japan
Wind Tunnel Tests and Analysis on Flutter of Spacecraft Including Pitching Effects in its Launching Configuration
Kanda, Atsushi, National Aerospace Lab., Japan; Ueda, Tetsuhiko, National Aerospace Lab., Japan; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 115-120; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A project of experimental reentry winged space vehicle "HOPE-X" is proceeding in Japan. An elastically supported pitching mode may be involved in the dynamic characteristics of this vehicle since it is attached to the H-II rocket in the launching configuration. It is of importance to take these kind of modes into consideration for flutter analysis because the flutter affected with this mode can be critical at the launching phase. A sting support system with controllable pitching rigidity was innovated and tested in a transonic wind tunnel. As the result, the flutter related to the pitching mode was observed. This type of flutter was also confirmed in the analysis using DPM (Doublet Point Method). Further, it was found that a different type of flutter occurred in anti-symmetric mode at relatively low dynamic pressure.
Author
Wind Tunnel Tests; Flutter Analysis; Dynamic Characteristics; Launch Vehicle Configurations; Vibration Tests; Pitch (Inclination); Transonic Flutter

19990050923 NASA Langley Research Center, Hampton, VA USA
Aeroelastic Tailoring for Stability Augmentation and Performance Enhancements of Tiltrotor Aircraft
Nixon, Mark W., Army Vehicle Technology Center, USA; Piatak, David J., NASA Langley Research Center, USA; Corso, Lawrence M., Bell Helicopter Co., USA; Popelka, David A., Bell Helicopter Co., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 121-138; In English; See also 19990050911; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The requirements for increased speed and productivity for tiltrotors has spawned several investigations associated with proprotor aeroelastic stability augmentation and aerodynamic performance enhancements. Included among these investigations is a focus on passive aeroelastic tailoring concepts which exploit the anisotropic capabilities of fiber composite materials. Researchers at Langley Research Center and Bell Helicopter have devoted considerable effort to assess the potential for using these materials to obtain aeroelastic responses which are beneficial to the important stability and performance considerations of tiltrotors. Both experimental and analytical studies have been completed to examine aeroelastic tailoring concepts for the tiltrotor,

applied either to the wing or to the rotor blades. This paper reviews some of the results obtained in these aeroelastic tailoring investigations and discusses the relative merits associated with these approaches.
Author
Tilt Rotor Aircraft; Aeroelasticity; Stability Augmentation; Aerodynamic Characteristics; Rotor Aerodynamics

19990050925 Politecnico di Milano, Dept. of Aerospace Engineering, Milan, Italy
Multi-Body Analysis of an Active Control for a Tiltrotor
Ghiringhelli, G. L., Politecnico di Milano, Italy; Masarati, P., Politecnico di Milano, Italy; Mantegazza, P., Politecnico di Milano, Italy; Nixon, M. W., Army Research Lab., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 149-158; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The design of advanced rotorcrafts requires the ability to analyse sophisticated, interdisciplinary systems to a degree of refinement that only recently has become achievable at a low price, thanks to the improvements in computer power. Multi-body analysis allows the detailed modeling of the kinematics as well as of the structural properties of rather sophisticated mechanical systems, such as helicopter rotors. When integrated with aeroservoelastic analysis, it represents a powerful tool for both the analysis and the design of aircraft, with particular regard to rotorcrafts. An original multi-body formulation is presented, based on the direct writing of a system of differential-algebraic equations (DAE) that describe the equilibrium and the kinematic constraints of a structural system. The finite rotations, during the time-step integration of the initial value problem, are handled in an efficient manner by means of a technique called "Updated-Updated Rotations", an Updated Lagrangian approach that uses as reference the predicted configuration of the system. This allows to neglect the rotation perturbations in the computation of the Jacobian matrix with considerable computational savings, while preserving the accuracy by consistently computing the residual. Control equations and the related unknowns are added, to model the control system to the desired level of refinement, from idealised control input/output signals, to each servosystem component. The numerical analysis of a tiltrotor configuration is proposed, based on an analytical model of the WRATS wind tunnel model. This is a 1/5 scale model of the V-22 tiltrotor aircraft, currently tested in the Transonic Dynamic Tunnel (TDT) at NASA Langley. The control strategy is based on the Generalized Predictive Control (GPC) technique, with a Recursive Least Mean Squares (RLMS) on-line identification of an equivalent discrete linear system, that is used to design the adaptive controller. The rotor pitch controls are used as actuators. Different combinations of strain gages and accelerometers are used as sensor devices.
Author
Active Control; Tilt Rotor Aircraft; Kinematics; Servomechanisms; Aeroservoelasticity; Adaptive Control; Mathematical Models; Recursive Functions

19990050927 Old Dominion Univ., Dept. of Aerospace Engineering, Norfolk, VA USA
Review of Nonlinear Panel Flutter at Supersonic and Hypersonic Speeds
Mei, Chuh, Old Dominion Univ., USA; Abdel–Motagaly, K., Old Dominion Univ., USA; Chen, R., Old Dominion Univ., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 171-188; In English; See also 19990050911; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A review of various analytical methods and experimental results of supersonic and hypersonic panel flutter is presented. The analytical methods are categorized into two main methods. The first category is the classical methods, which include Galerkin in conjunction with numerical integration, harmonic balance and perturbation methods. The second category is the finite element methods in either the frequency domain (eigen solution) or the time domain (numerical integration). A review of the experimental literature is given. The effects of different parameters on the flutter behavior are described. The parameters considered include inplane forces, thermal loading, flow direction, and initial curvature. Active control of composite panels at supersonic speeds and elevated temperatures is also presented.
Author
Panel Flutter; Nonlinearity; Supersonic Speed; Hypersonic Speed; Aeroelasticity; Supersonic Flutter; Temperature Effects

19990050932 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
An Unsteady Aerodynamics Identification Procedure for Flutter Prediction
Prudhomme, S., Office National d'Etudes et de Recherches Aerospatiales, France; Blondeau, C., Office National d'Etudes et de Recherches Aerospatiales, France; Humbert, M., Aerospatiale, France; Bucharles, A., Office National d'Etudes et de Recherches Aerospatiales, France; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 235-244; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This article introduces an identification procedure from flight-data, in the perspective of quasi real time flutter prediction models upgrading. Parameters are introduced to model uncertainties on the unsteady aerodynamics. While tests are performed for increasing velocity, identification algorithms use flight data to update the parameters and make flutter prediction more accurate for investigation towards higher velocity. Performance of identification is evaluated in terms of accuracy for unsteady aerodynamics estimation, and of flutter prediction capability, with and without turbulence.
Author
Flutter Analysis; Prediction Analysis Techniques; Unsteady Aerodynamics; Mathematical Models; Parameter Identification

19990050933 Alberta Univ., Dept. of Mathematical Sciences, Edmonton, Alberta Canada
Parameter Estimation in Flutter Analysis by Wavelet and Neural Network
Wong, Y. S., Alberta Univ., Canada; Lee, B. H. K., Institute for Aerospace Research, Canada; Wong, T. K. S., Alberta Univ., Canada; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 245-254; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Despite rapid advances in the development of computational aerodynamics and wind tunnel testing techniques, flight tests are still required to determine flutter boundaries of aircraft. Normally, modal frequencies and damping values are measured, but these quantities can be difficult to determine accurately when noise is present or when modal frequencies are close to each other. Various methods have been considered for parameter estimation in flutter tests, and these include curve fitting based on non-linear least squares, maximum likelihood estimation, Kalman filters and filter error method, to name but a few. Some of these techniques require considerable amount of computations, and hence real time evaluation of frequency and damping values may require efficient algorithms. Wavelet theory for signal processing has made great progress in recent years. Also, artificial neural networks capable of modeling complex characteristics in nonlinear systems have contributed to the development of more advanced methods in analyzing aeroelastic response signals. Unlike conventional methods, these approaches do not require explicit mathematical manipulations. Furthermore, the required parameters can be estimated in real time once the neural network has been properly trained. to achieve optimal computational efficiency, the required parameters can be determined by a group of neural networks using a parallel algorithm. This study is an extension of the approach suggested by Lee and Wong where only one neural network was used to analyze a one-degree-of-freedom time signal represented by an exponentially decaying sine wave corrupted with noise.
Derived from text
Parameter Identification; Aeroelasticity; Flutter Analysis; Wavelet Analysis; Neural Nets; Mathematical Models

19990050934 Manchester Univ., Manchester School of Engineering, UK
Flutter Speed Prediction During Flight Flutter Testing Using Neural Networks
Cooper, J. E., Manchester Univ., UK; Crowther, W. J., Manchester Univ., UK; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 255-264; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Flight flutter testing is a crucial part in the certification of a prototype aircraft. The flight envelope must be expanded safely, however, there is always the pressure to complete the tests as quickly as possible. Although there will be an aeroelastic model of the system for comparison, the decision to proceed to the next test point is usually based upon the modal parameters estimated from the flutter test data. A number of different methods have been proposed to determine the speed at which flutter occurs, however, the most commonly used approach is simply to extrapolate the estimated damping ratios. In this paper, a method for the prediction of flutter speed from flutter test data is proposed based upon the use of Neural Networks. The method is demonstrated upon a simulated aeroelastic model.
Author
Flutter Analysis; Prediction Analysis Techniques; Neural Nets; Aeroelasticity; Dynamic Response; Flight Tests

19990050935 Northwestern Polytechnical Univ., Data Processing Center, Xian, China
Overview of Recent Flutter Boundary Prediction Techniques Based on Testing Data Analysis
Chengming, Pei, Northwestern Polytechnical Univ., China; Zhihua, Qiu, Northwestern Polytechnical Univ., China; Kun, Zhai, Northwestern Polytechnical Univ., China; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 265-274; In English; See also 19990050911; Sponsored in part by the K. C. Wong Education Foundation, Hong Kong, Chengdu Aircraft Industry Corp., and Xi'an Aircraft Industry Corp.; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

FBP (Flutter Boundary Prediction) due to subcritical signal analysis is becoming a significant research subject in the field of flutter testing. In this paper, traditional modal damping and modern system stability analysis are reviewed. The principle and

specifics of the methods are also briefly discussed. Especially, a new hybrid prediction method based on NNES (Neural Network Expert System) is proposed and integrated into current FBP techniques and human experiences from experts.
Author
Flutter Analysis; Prediction Analysis Techniques; Expert Systems; Neural Nets; Vibration Damping

19990050937 California Univ., Mechanical and Aerospace Engineering Dept., Los Angeles, CA USA
Active Control of Flutter in Compressible Flow and its Aeroelastic Scaling
Presente, E., California Univ., USA; Friedman, P. P., California Univ., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 287-310; In English; See also 19990050911
Contract(s)/Grant(s): F49260-94-1-0400; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Active flutter suppression of a two dimensional wing section in subsonic flow is studied. Pitch and plunge dynamics, combined with a trailing-edge control surface is considered. Aerodynamic loads are expressed in time-domain using Roger's approximation. Augmented aerodynamic states are reconstructed using a Kalman filter, and linear optimal control is used to design a full-state feedback regulator for flutter suppression. Constraints on actuator deflection and rate limit the flutter envelope expansion. A new two-pronged approach to developing aeroelastic and aeroservoelastic scaling laws is presented and applied to a typical example. Flutter suppression for a typical cross-section with a conventional trailing edge control surface is compared with that obtained with piezoelectric actuation utilizing bend/twist coupling on a finite span composite wing. Power consumption and its scaling for these two cases is compared.
Author
Aeroelasticity; Aeroservoelasticity; Compressible Flow; Active Control; Subsonic Flutter; Vibration Damping; Scaling Laws; Aeroelastic Research Wings

19990050938 Naples Univ., Dept. of Aeronautical Engineering, Italy
New Experimental Stall Flutter Active Control of a Bridge Section
Lecce, L., Naples Univ., Italy; Selvaggi, E., Naples Univ., Italy; Nicolosi, F., Naples Univ., Italy; Baruffo, M., Naples Univ., Italy; Abate, A., Naples Univ., Italy; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 311-324; In English; See also 19990050911; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

In this paper experimental activities on stall flutter phenomenon will be presented. Tests have been performed in the low speed wind tunnel at the Department of Aeronautical Engineering (DPA) of the University of Naples on a model using a typical single deck box girder bridge section. In the first part of the work, the stall flutter has been controlled using a leading edge (l.e.) movable surface (tab) deflecting downward. Application of a new active control system has been performed using the previous movable surface. The stall flutter in dynamic conditions has been controlled using an active system which automatically changes the tab position (from 0 to 10 deg) and is able to suppress the stall phenomenon. The control system consists of a mixed digital-analogue feedback circuit with an accelerometer as error sensor and two electromagnetic actuators to control the tab rotation. In the second part a new approach has been tested. The new methodology consists of a rotating cylinder placed at the section leading edge. Through the cylinder rotation it is possible to change the section aerodynamic behaviour and then to increase stall flutter critical speed up to 60% at certain angles of attack.
Author
Flutter Analysis; Aerodynamic Stalling; Tabs (Control Surfaces); Active Control; Bridges (Structures); Aerodynamic Stability

19990050943 NASA Langley Research Center, Hampton, VA USA
Transonic Flutter Suppression Control Law Design, Analysis and Wind Tunnel Results
Mukhopadhyay, Vivek, NASA Langley Research Center, USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 381-392; In English; See also 19990050911; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The benchmark active controls technology and wind tunnel test program at NASA Langley Research Center was started with the objective to investigate the nonlinear, unsteady aerodynamics and active flutter suppression of wings in transonic flow. The paper will present the flutter suppression control law design process, numerical nonlinear simulation and wind tunnel test results for the NACA 0012 benchmark active control wing model. The flutter suppression control law design processes using (1) classical, (2) linear quadratic Gaussian (LQG), and (3) minimax techniques are described. A unified general formulation and solution for the LQG and minimax approaches, based on the steady state differential game theory is presented. Design considerations for improving the control law robustness and digital implementation are outlined. It was shown that simple control laws when properly designed based on physical principles, can suppress flutter with limited control power even in the presence

of transonic shocks and flow separation. In wind tunnel tests in air and heavy gas medium, the closed-loop flutter dynamic pressure was increased to the tunnel upper limit of 200 psf The control law robustness and performance predictions were verified in highly nonlinear flow conditions, gain and phase perturbations, and spoiler deployment. A non-design plunge instability condition was also successfully suppressed.
Author
Transonic Flutter; Vibration Damping; Control Theory; Flutter Analysis; Wind Tunnel Tests; Unsteady Aerodynamics; Active Control; Nonlinearity; Computerized Simulation; Aeroelasticity

19990050944 NASA Dryden Flight Research Center, Edwards, CA USA
Wavelet Applications for Flight Flutter Testing
Lind, Rick, NASA Dryden Flight Research Center, USA; Brenner, Marty, NASA Dryden Flight Research Center, USA; Freudinger, Lawrence C., NASA Dryden Flight Research Center, USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 393-402; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Wavelets present a method for signal processing that may be useful for analyzing responses of dynamical systems. This paper describes several wavelet-based tools that have been developed to improve the efficiency of flight flutter testing. One of the tools uses correlation filtering to identify properties of several modes throughout a flight test for envelope expansion. Another tool uses features in time-frequency representations of responses to characterize nonlinearities in the system dynamics. A third tool uses modulus and phase information from a wavelet transform to estimate modal parameters that can be used to update a linear model and reduce conservatism in robust stability margins.
Author
Flight Tests; Flutter Analysis; Wavelet Analysis; Dynamical Systems; Signal Processing; Flight Envelopes; Aeroelasticity

19990050948 ZONA Technology, Inc., Scottsdale, AZ USA
A Damping Perturbation Method for Flutter Solution: The g-Method
Chen, P. C., ZONA Technology, Inc., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 433-441; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

By utilizing a damping perturbation method the present g-method includes a first order damping term in the flutter equation that is rigorously derived from the Laplace-domain aerodynamics. The g-method generalizes the K-method and the P-K method for reliable damping prediction. It is valid in the entire reduced frequency domain and up to the first order of damping. The present work also provides a theoretical foundation for the g-method that can be used to estimate the truncation error for large values of damping. The solution algorithm of the g-method is proven to be robust and can obtain an unlimited number of aerodynamic lag roots; as demonstrated by the results of the selected test cases.
Author
Perturbation Theory; Vibration Damping; Flutter Analysis; Aeroelasticity; Frequency Domain Analysis

19990051006 Army Aviation and Missile Command, Aeroflightdynamics Directorate, Moffett Field, CA USA
The Development of the CONDUIT Advanced Control System Design and Evaluation Interface with a Case Study Application to an Advanced Fly by Wire Helicopter Design
Colbourne, Jason, California Polytechnic State Univ., USA; March 1999; 66p; In English
Contract(s)/Grant(s): NCC2-983; RTOP 581-30-22
Report No.(s): NASA/TM-1999-208763; NAS 1.15:208763; AFDD/TR-99-A-005; A-99V-001; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This report details the development and use of CONDUIT (Control Designer's Unified Interface). CONDUIT is a design tool created at Ames Research Center for the purpose of evaluating and optimizing aircraft control systems against handling qualities. Three detailed design problems addressing the RASCAL UH-60A Black Hawk are included in this report to show the application of CONDUIT to helicopter control system design.
Author
Aircraft Control; Control Systems Design; Design Analysis; Computer Programs

19990052677 Alenia Marconi Systems, Missile Systems Div., Rome, Italy
Flutter Stability of Movable Control Surfaces for Aircraft Stores
Ponzi, Claudio, Alenia Marconi Systems, Italy; Schweiger, Johannes, DaimlerChrysler Aerospace A.G., Germany;

CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 457-468; In English; See also 19990052675; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Flutter stability of movable control surfaces for aircraft stores is a rather complex topic because a large variety of different store system conditions, aircraft configurations, store to aircraft functional conditions, aircraft maneuver and environmental conditions have to be covered by analysis as well as by ground and flight tests. For this purpose, the most critical or most sensitive flutter parameters of the stores must be known and covered by analysis and tests. For stores with only fixed aerodynamic stabilizers, the verification of their flutter stability is usually quite simple because these surfaces are small and stiff. For them, it is usually sufficient to include only their mass properties and attachment stiffnesses in the aircraft flutter analysis, where the store is considered only by its rigid body motions. Only in some cases it is required to include also effects from rigid aerodynamic surfaces on the store. But as soon as a surface is used to provide control forces, it usually needs to be larger and thus gets also more flexible. Additional flexibility is added by the drive system, and, in some cases by a free floating attachment mode for captive flight conditions. Detailed flutter investigations for the store itself are usually performed by the store manufacturer. On this side however, possible impacts from the different types of aircraft are not known and could also not be covered in their multitude during the development of a new store. For example, the aerodynamic flow field in the vicinity of the aircraft, especially under the fuselage, can be completely different from free flight conditions. This paper explains how to handle these aspects and depicts major advantages and drawbacks of the state of the art analysis and testing techniques. The different specifications for the development and certifications of aircraft and stores are also addressed briefly. Finally an approach will be described how the flutter stability of control surfaces can be enhanced by means of formal mathematical optimization methods.

Author

Aeroelasticity; Flutter; Flutter Analysis; Wing-Fuselage Stores; Unsteady Aerodynamics; Optimization; Body-Wing Configurations

19990052683 La Sapienza Univ., Dipt. Aerospaziale, Rome, Italy

Singular Perturbation Technique for Nonlinear Aeroelastic Analysis

Dessi, D., La Sapienza Univ., Italy; Mastroddi, F., La Sapienza Univ., Italy; Morino, L., Rome III Univ., Italy; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 523-532; In English; See also 19990052675; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

In this paper we consider an aeroelastic section with cubic free-play nonlinearities, approximating Wagner's function in the expression of aerodynamic forces with exponentials in the time domain. The mathematical model is then recast in the standard first order ordinary differential form, with x the global state-space vector, to which nonlinear analysis tools apply. An extensive numerical study has been performed to show the dependence of Hopf bifurcation characteristics from the structural and geometric properties of the wing section. Bifurcation and frequency vs. dynamic pressure plots are presented. In such cases the onset of flutter might happen before the linear flutter speed for certain initial conditions.

Author

Flutter Analysis; Nonlinearity; Aeroelasticity; Mathematical Models; Dynamic Structural Analysis; Unsteady Aerodynamics

19990052685 Old Dominion Univ., Aerospace Engineering Dept., Norfolk, VA USA

Flutter Suppression and Vibration Control of Plate-Wing Structures using Self-Sensing Active Constrained Layer Damping

Ro, Jeng–Jong, Old Dominion Univ., USA; Elsaadawy, Ehab, Old Dominion Univ., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 543-552; In English; See also 19990052675

Contract(s)/Grant(s): DAAH-04-96-1-0317; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Active Constrained Layer Damping (ACLD) treatment has been used successfully for controlling the vibration of various flexible structures. The treatment provides an effective means for augmenting the simplicity and reliability of passive damping with the low weight and high efficiency of active controls to attain high damping characteristics over broad frequency bands. In this study, a self-sensing configuration of the ACLD treatment is utilized to simultaneously suppress the bending and torsional vibrations of plates and flutter control of a plate-wing structure. The treatment considered ensures collocation of the sensor/actuator pairs in order to guarantee stable operation. First part of this study, a three-layer network of the Self-sensing Active Constrained Layer Damping (SACLD) treatment is used to control multi-modes of vibration of a flexible aluminum plate (0.264m x 0.127m x 4.826E-4m) which is mounted in a cantilevered arrangement. Two ACLD patches (0.264m x 0.0635m) with self-sensing polyvinylidine fluoride (PVDF) actuators oriented by (14 deg/-14 deg) configuration are treated on one side of plate. The theoretical characteristics of the multi-layer treatment are presented in this paper and compared with the experimental performance. Secondly, the concept of vibration control using SACLD/plate is implemented to perform the flutter suppression

experimentally. The experimental demonstration of flutter control of the SACLD/plate-wing structure is performed in the Low Speed wind Tunnel (LST) at Aerospace Department at ODU. Simple linear control with self-sensing strain and strain rate feedback is utilized to study the performance of the SACLD/plate in flutter control.
Author
Active Control; Flutter; Vibration Damping; Wings; Mathematical Models; Actuation; Piezoelectricity; Dynamic Characteristics; Rectangular Plates

19990052686 NASA Langley Research Center, Hampton, VA USA
An Examination of Applying Shunted Piezoelectrics to Reduce Aeroelastic Response
McGowan, Anna–Maria Rivas, NASA Langley Research Center, USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 553-572; In English; See also 19990052675; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Several analytical and experimental studies clearly demonstrate that piezoelectric materials (piezoelectrics) can be used as actuators to actively control vibratory response, including aeroelastic response. However, two important issues in using piezoelectrics as actuators for active control are: 1) the potentially large amount of power required to operate the actuators, and 2) the complexities involved with active control (added hardware, control law design, and implementation). Active or passive damping augmentation using shunted piezoelectrics may provide a viable alternative. This approach requires only simple electrical circuitry and very little or no electrical power. The current study examines the feasibility of using shunted piezoelectrics to reduce aeroelastic response using a typical-section representation of a wing and piezoelectrics shunted with a parallel resistor and inductor. The aeroelastic analysis shows that shunted piezoelectrics can effectively reduce aeroelastic response below flutter and may provide a simple, low-power method of subcritical aeroelastic control.
Author
Piezoelectricity; Bypasses; Circuits; Dynamic Response; Aeroelasticity; Active Control; Smart Structures; Vibration Damping

19990052687 Old Dominion Univ., Dept. of Aerospace Engineering, Norfolk, VA USA
A Comparison Study of the Performance of a Saturation Absorber and Classical Vibration Control Methods
Omar, Hanafy M., Old Dominion Univ., USA; Kunz, Donald, Old Dominion Univ., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 573-584; In English; See also 19990052675; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The saturation absorber is an application of the saturation phenomenon as a vibration suppression device. The saturation phenomenon occurs in autoparametric, multi-degree-of- freedom systems, if the natural frequencies of the absorbers and the plants are commensurable (omega(sub p) = 2(omega(sub c)),3(omega(sub c)),...). to control the vibratory response of a plant with a single degree of freedom, a second-order absorber is introduced and coupled to the plant with quadratically nonlinear terms. When the plant is forced at its resonant frequency and the magnitude of the response reaches its saturation level, the nonlinear coupling forms an energy bridge between the plant and the absorber. The objective of the research described in this paper is to quantify the performance of the saturation control (response, the required control authority, robustness to the plant parameter variation), as compared with the performance of classical controllers, such as velocity feedback, and nonlinear controllers like the Fuzzy Logic Controller (FLC). This comparison will serve to identify the advantages and the disadvantages of saturation control, especially regarding the control authority required to suppress the response of a vibrating system. In addition, a parametric study of the nonlinear coupling parameters will result in guidelines for obtaining the desired absorber performance is also given.
Derived from text
Vibration Damping; Controllers; Fuzzy Systems; Active Control

19990052689 National Inst. for Research and Development of Turbomachinery, Bucharest, Romania
Effects of Transient Hypersonic Flow Conditions on Failure Prediction of Panels
Udrescu, Radu, National Inst. for Research and Development of Turbomachinery, Romania; Surace, Giuseppe, Politecnico di Torino, Italy; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 595-604; In English; See also 19990052675; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A new approach of the transient flow conditions (simultaneous transitory behaviour of thermal load and fluid velocity) is proposed in the nonlinear panel flutter analysis. Applying proper aeroelastic theories (von Karman elasticity, piston aerodynamic theory) and fatigue life estimation (Heywood's approach) the results confirm differences in failure prediction compared with the classical approach (case of constant flow and kinetic heating parameters). This study demonstrates the sensitivity of the aerothermoelastic system to the transitory hypersonic flow conditions: the pattern of the motion changes in amplitude even when

modifying the increasing slope of the thermal and flow parameters that govern the motion, but maintaining the same steady state values. The panel behaves like a chaotic system and needs to be carefully investigated for a reliable design.
Author
Hypersonic Flow; Transient Loads; Failure Analysis; Panel Flutter; Flutter Analysis; Aeroelasticity; Aerothermoelasticity; Finite Element Method; Dynamic Response

19990052690 Military Univ. of Technology, Warsaw, Poland
Nonlinear Regular and Chaotic Flutter of an Airfoil with a Trailing Edge Flap in Supersonic Flow
Dzygadlo, Z., Military Univ. of Technology, Poland; Nowotarski, I., Military Univ. of Technology, Poland; Olejnik, A., Military Univ. of Technology, Poland; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 605-614; In English; See also 19990052675; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

An airfoil in supersonic flow, having deformable nonlinear supports, is an aeroelastic system for which various types of instability, bifurcations and regular or chaotic motions can appear. The airfoil has three degrees of freedom - that is, plunge displacement, angle of pitch and angle of flap deflection. The stiffness force and moments for all those motions are assumed to be nonlinear ones. The airfoil is subjected to the pressure difference produced by its motion in supersonic flow. Stability and bifurcations occurring in the system, limit cycles of self-excited vibrations and regions of regular or chaotic motions have been investigated. The effect of some parameters of the system on the course of linear and nonlinear vibrations has been studied.
Author
Aeroelasticity; Linear Vibration; Nonlinearity; Supersonic Flow; Trailing Edge Flaps; Random Vibration; Flutter Analysis; Aerodynamic Stability; Supersonic Airfoils

19990052691 NASA Langley Research Center, Hampton, VA USA
Correlation of Fin Buffet Pressures on an F/A-18 with Scaled Wind-Tunnel Measurements
Moses, Robert W., NASA Langley Research Center, USA; Shah, Gautam H., NASA Langley Research Center, USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 615-626; In English; See also 19990052675; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Buffeting is an aeroelastic phenomenon occurring at high angles of attack that plagues high performance aircraft, especially those with twin vertical tails. Previous wind-tunnel and flight tests were conducted to characterize the buffet loads on the vertical tails by measuring surface pressures, bending moments, and accelerations. Following these tests, buffeting responses were computed using the measured buffet pressures and compared to the measured buffeting responses. The calculated results did not match the measured data because the assumed spatial correlation of the buffet pressures was not correct. A better understanding of the partial (spatial) correlation of the differential buffet pressures on the tail was necessary to improve the buffeting predictions. Several wind-tunnel investigations were conducted for this purpose. When compared, the results of these tests show that the partial correlation scales with flight conditions. One of the remaining questions is whether the wind-tunnel data is consistent with flight data. Presented herein, cross-spectra and coherence functions calculated from pressures that were measured on the High Alpha Research Vehicle indicate that the partial correlation of the buffet pressures in flight agrees with the partial correlation observed in the wind tunnel.
Author
Buffeting; Fins; Pressure Measurement; Wind Tunnel Tests; Aerodynamic Stability; F-18 Aircraft; Aeroelasticity; Dynamic Response; Vortices

19990052692 CFD Research Corp., Huntsville, AL USA
Twin-Tail Buffet Simulation using a Multi-Disciplinary Computing Environment (MDICE)
Sheta, Essam F., CFD Research Corp., USA; Siegel, John M., Jr., CFD Research Corp., USA; Golos, Freddy N., CFD Research Corp., USA; Harrand, Vincent J., CFD Research Corp., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 627-638; In English; See also 19990052675; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The current paper presents a state-of-the-art approach for performing efficient multi-disciplinary simulations. A Multi-Disciplinary Computing Environment (MDICE) is presented and validated with a twin-tail buffet simulation of a generic fighter aircraft. MDICE is an object-oriented computing environment which allows several analysis modules to run and communicate with each other over a distributed network of computers. In a buffet condition, the leading edge vortices of a delta wing break down producing an unsteady turbulent flow which empennages on the surfaces of the tails, causing severe premature structural fatigue. The application of MDICE to the twin-tail buffet problem involves four types of modular functionality: a

fluid-dynamics module, a fluid-structure interfacing technique, a structural dynamics module, and grid motion technique. The configuration model is pitched at a wide range of angles of attack at Mach and Reynolds numbers of 0.4 and 1.25 million, respectively. The computational results are in very good agreement with the experimental data.
Author
Dynamic Structural Analysis; Multidisciplinary Design Optimization; Buffeting; Flight Simulation; Vortex Breakdown; Applications Programs (Computers); Dynamic Response; Computerized Simulation

19990052693 Old Dominion Univ., Aerospace Engineering Dept., Norfolk, VA USA
Adaptive Suction and Blowing for Twin-Tail Buffet Control
Kandil, Osama A., Old Dominion Univ., USA; Yang, Zhi, Old Dominion Univ., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 639-648; In English; See also 19990052675
Contract(s)/Grant(s): NAG1-648; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Adaptive active flow control for twin-tail buffet alleviation is investigated. The concept behind this technique is to place control ports on the tail outer and inner surfaces with flow suction or blowing applied through these ports in order to minimize the pressure difference across the tail. The suction or blowing volume flow rate from each port is proportional to the pressure difference across the tail at this location. A parametric study of the effects of the number and location of these ports on the buffet response is carried out. The computational model consists of a sharp-edged delta wing of aspect ratio one and swept-back flexible twin tail with taper ratio of 0.23. This complex multidisciplinary problem is solved sequentially using three sets of equations for the fluid flow, aeroelastic response and grid deformation, using a dynamic multi-block grid structure. The computational model is pitched at 30 deg angle of attack. The freestream Mach number and Reynolds number are 0.3 and 1.25 million, respectively. The model is investigated for the inboard position of the twin tails, which corresponds to a separation distance between the twin tails of 33% of the wing span. Comparison of the time history and power spectral density responses of the tails for various distributions of the control ports are presented and discussed.
Author
Adaptive Control; Aeroelasticity; Buffeting; Flow Velocity; Tail Surfaces; Active Control; Delta Wings; Fluid Flow; Vortex Breakdown; Multiblock Grids

19990052700 Virginia Polytechnic Inst. and State Univ., Blacksburg, VA USA
Synergistic Interaction of Aeroelastic Tailoring and Boundary Moment Control on Aircraft Wing Flutter
Gern, Frank H., Virginia Polytechnic Inst. and State Univ., USA; Librescu, Liviu, Virginia Polytechnic Inst. and State Univ., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 719-734; In English; See also 19990052675; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The implications of active feedback control and aeroelastic tailoring on the flutter instability of straight/swept aircraft wings carrying external stores are discussed. The stabilizing feedback control is generated by a bending moment acting at the wing tip. Relating this bending moment with adequately selected kinematic response quantities, a complex eigenvalue problem is obtained. Its solution yields the closed-loop flutter speed and frequency of flutter. The beneficial interaction of active feedback control in conjunction with aeroelastic tailoring upon the flutter boundary of aircraft wings made-up from advanced composite materials is emphasized. In addition, the prospects of an extension of the operational envelope of flight vehicles carrying external stores without weight penalties are revealed.
Author
Active Control; Aeroelasticity; Bending Moments; Feedback Control; Flutter; Rectangular Wings; Wing Oscillations; Mathematical Models; Computerized Simulation; Wing Tips; Optimization

19990052752 Washington Univ., Dept. of Aeronautics and Astronautics, Seattle, WA USA
Panel Flutter Constraints: Analytic Sensitivities and Approximations Including Planform Shape Design Variables
Livne, Eli, Washington Univ., USA; Mineau, David, Washington Univ., USA; Journal of Aircraft; August 1997; Volume 34, No. 4, pp. 558-568; In English
Contract(s)/Grant(s): NAG2-723; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

Analytical sensitivities of panel flutter constraints with respect to panel shape as well as thickness and material properties are derived and numerically tested. Cases of fixed in-plane loads and cases in which in-plane loads are variable (depending on panel and overall wing shape as well as material and sizing design variables) are considered. Accuracy of approximations and

range of move limits required are studied in preparation for integration with nonlinear programming/approximation concept aeroelastic design synthesis methodology.
Author
Aeroelasticity; Nonlinear Programming; Planforms; Panel Flutter; Design Analysis

19990053154 Office National d'Etudes et de Recherches Aerospatiales, Dept. Commande des Syst mes et Dynamique, Toulouse, France
Piloting of a VTOL-UAV to Shipboard Recovery
Reboulet, C., Office National d'Etudes et de Recherches Aerospatiales, France; Mouyon, P., Office National d'Etudes et de Recherches Aerospatiales, France; deFerrier, Bernard, Bombardier Services Corp., USA; Langlois, Bernard, Bombardier, Inc., Canada; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 11-1 - 11-6; In English; See also 19990053143; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A system of guidance and control ensuring the safe recovery of a VTOL type unmanned air vehicle is described. The key ideas of the proposed approach are the estimation of the velocity/position with respect to the ship in a quasi-inertial coordinate frame and the guidance/control of the air vehicle to a virtual target (predicted position of the landing grid). The advantage of this guidance and control approach is the complete decoupling of the UAV from ship motions. The various methods used in each module of the whole recovery system are presented, including: tracking, filtering, and landing deck position prediction. Model performances based on test results are discussed. Strategy chosen in the development of the whole automated recovery system is described. Finally, an assessment of the proposed concept obtained by simulation is provided. These results show that this approach is more robust than conventional motion sensitive techniques. The system promises to dramatically increase UAV operational limits and recovery efficiency. This activity is sponsored by the Delegation Generale de l'Armement (DGA France) and was accomplished with the framework of a Franco- Canadian collaborative project between ONERA-DCSD and Bombardier, Inc (Canadair).
Author
Pilotless Aircraft; Remotely Piloted Vehicles; Vertical Takeoff Aircraft; Vatol Aircraft; Autonomous Navigation; Automatic Flight Control; Aircraft Control

19990053157 Delegation Generale de l'Armement, Surface Ship Dept., Paris, France
Heel Compensation for the Charles de Gaulle Aircraft Carrier: Principles and Control Structure
Kummer, S., Delegation Generale de l'Armement, France; Hardier, G., Office National d'Etudes et de Recherches Aerospatiales, France; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 14-1 - 14-10; In English; See also 19990053143; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

To improve the sea keeping performances of the french nuclear aircraft carrier Charles de Gaulle, with respect to its predecessors Clemenceau and Foch, DCN has developed a platform motion control system, called SATRAP, which reduced the ship motions while ensuring navigation capability. This system involves a centralized computer which controls three subsystems: two pairs of stabilizing fins, a set of rudders and a moving-mass system (athwart ship) for heel compensation, the Cogite system. Originally conceived for situations where the stabilizing fins would be otherwise saturated (steady heel from wind or heavy weights displacements). Cogite has evolved into a system which also improves the operational capability of the ship by limiting the heel during sharp turns, permitting non-stop handling and preparation of aircrafts. This paper presents the results of the studies which led to the development of a performing mode of operation for SATRAP, where the helmsman has full control of the rudders while the fins and Cogite system automatically reduce the ship motions. The following points are discussed in this paper: operational requirements in terms of performances, SATRAP system architecture and principles chosen for the control laws (task allocation for the actuators, feedforward-feedback controllers).
Author
Aircraft Carriers; Control Theory; Control Systems Design; Feedback Control; Feedforward Control; Stabilization

19990053163 Academy of Sciences of the Ukraine, Inst. of Hydromechanics, Kiev, Ukraine
Longitudinal Stability of Ekranoplans and Hydrofoils Ships
Korolyov, V. I., Academy of Sciences of the Ukraine, Ukraine; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 20-1 - 20-8; In English; See also 19990053143; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Longitudinal stability of ekranoplans and hydrofoil ships, that have two carrying hydrofoils separated by some distance along the length of hull, "tandem" system, is considered in the paper. Longitudinal stability is characterized by the value of metacentric height, which is used in the practice of ship-building. An expression is given for the definition of this value depending on the main geometric and aerodynamic parameters. A link is determined between the metacentric height and frequency of the free angular

movements of ekranoplans. A parameter investigation is fulfilled and recommendations are obtained for the choice of combinations of the carrying system basic elements.
Author
Hydrofoils; Hydrofoil Craft; Hydroplanes (Vehicles); Longitudinal Stability; Hydrodynamics

19990053348 NASA Dryden Flight Research Center, Edwards, CA USA
An H-infinity Approach to Control Synthesis with Load Minimization for the F/A-18 Active Aeroelastic Wing
Lind, Rick, NASA Dryden Flight Research Center, USA; 1999; In English; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

The F/A-18 Active Aeroelastic Wing research aircraft will demonstrate technologies related to aeroservoelastic effects such as wing twist and load minimization. This program presents several challenges for control design that are often not considered for traditional aircraft. This paper presents a control design based on H(sub infinity) synthesis that simultaneously considers the multiple objectives associated with handling qualities, actuator limitations, and loads. A point design is presented to demonstrate a controller and the resulting closed-loop properties.
Author
Aeroelasticity; Wings; H-Infinity Control; F-18 Aircraft; Feedback Control; Actuators

09
RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

19990047272 Defence Science and Technology Organisation, Aeronautical and Maritime Research Lab., Melbourne, Australia
MicroVAX/Bus Communication Testing Software for the Low Speed Wind Tunnel Data Acquisition System
Edwards, Craig D., Defence Science and Technology Organisation, Australia; February 1999; In English
Report No.(s): DSTO-TN-0189; DODA-AR-010-843; Copyright; Avail: Issuing Activity (DSTO, Aeronautical and Maritime Research Lab., PO Box 4331, Melbourne, Victoria 3001, Australia), Hardcopy, Microfiche

Software has been developed to test the communication between the MicroVAX computer and the bi-directional parallel data bus in the Low Speed Wind Tunnel (LSWT) data acquisition system. It enables reading any combination of data parameters from the bus for a user-defined number of iterations. An output file is created which contains the final values, average bus communication times associated with the read process and a statistical analysis of the recorded data. This report describes the operation of the software and presents results of tests performed on the existing data acquisition configuration.
Author
Channels (Data Transmission); Computer Systems Programs; Data Acquisition; Low Speed Wind Tunnels; Source Programs; Data Transmission; Systems Analysis

19990047776 DYNACS Engineering Co., Inc., Brook Park, OH USA
Five-Hole Flow Angle Probe Calibration for the NASA Glenn Icing Research Tunnel
Gonsalez, Jose C., DYNACS Engineering Co., Inc., USA; Arrington, E. Allen, DYNACS Engineering Co., Inc., USA; May 1999; 26p; In English; Advanced Measurement and Ground Testing Technology, 17-20 Jun. 1996, New Orleans, LA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): NAS3-27186; RTOP 523-91-13
Report No.(s): NASA/CR-1999-202330; E-10677; NAS 1.26:202330; AIAA Paper 96-2201; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A spring 1997 test section calibration program is scheduled for the NASA Glenn Research Center Icing Research Tunnel following the installation of new water injecting spray bars. A set of new five-hole flow angle pressure probes was fabricated to properly calibrate the test section for total pressure, static pressure, and flow angle. The probes have nine pressure ports: five total pressure ports on a hemispherical head and four static pressure ports located 14.7 diameters downstream of the head. The probes were calibrated in the NASA Glenn 3.5-in.-diameter free-jet calibration facility. After completing calibration data acquisition for two probes, two data prediction models were evaluated. Prediction errors from a linear discrete model proved to be no worse than those from a full third-order multiple regression model. The linear discrete model only required calibration data acquisition according to an abridged test matrix, thus saving considerable time and financial resources over the multiple regression model that required calibration data acquisition according to a more extensive test matrix. Uncertainties in calibration coefficients and

predicted values of flow angle, total pressure, static pressure. Mach number. and velocity were examined. These uncertainties consider the instrumentation that will be available in the Icing Research Tunnel for future test section calibration testing.
Author
Calibrating; Data Acquisition; Free Jets; Ice Formation; Regression Analysis; Flow Measurement

19990050926 Micro Craft, Inc., Hampton, VA USA
Rotary Wing Test Stand Capability for the Republic of Korea
Breaks, Jeffrey, Micro Craft, Inc., USA; Cooper, Michael, Micro Craft, Inc., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 159-170; In English; See also 19990050911; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Two agencies in the Republic of Korea have commissioned the design and fabrication of rotor test stands to provide performance and dynamic testing capability for helicopter rotor systems in newly constructed wind tunnel facilities near Taejon, Korea. These test stands, based on the proven design of the 2 Meter Rotor Test Stand (2MRTS) that has been operating in the NASA Langley Research Center, 14 x 22-Foot Low Speed Tunnel for some time, incorporate significant improvements in the drive power and in the control and instrumentation subsystems. Both rotor test systems are robust and utilize many off-the-shelf components for durability and ease of maintenance.
Author
Test Stands; Dynamic Tests; Rotary Wings; Low Speed Stability; Aerodynamic Stability

19990052696 NASA Langley Research Center, Hampton, VA USA
Aircraft and Ground Vehicle Winter Runway Friction Assessment
Yager, Thomas J., NASA Langley Research Center, USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 679-690; In English; See also 19990052675; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Some background information is given together with the scope and objectives of a 5-year, Joint Winter Runway Friction Measurement Program between the National Aeronautics & Space Administration (NASA), Transport Canada (TC), and the Federal Aviation Administration (FAA). Participants recently completed the fourth winter season of testing. The primary objective of this effort is to perform instrumented aircraft and ground vehicle tests aimed at identifying a common number that all the different ground vehicle devices would report. This number, denoted the International Runway Friction Index (IRFI) will be related to all types of aircraft stopping performance. The range of test equipment, the test sites, test results and accomplishments, the extent of the substantial friction database compiled, and future test plans will be described. Several related studies have also been implemented including the effects of contaminant type on aircraft impingement drag and the effectiveness of various runway and aircraft de-icing chemical types and application rates. New equipment and techniques to measure surface frictional properties are also described. The status of an international friction index calibration device for use in ensuring accuracy of ground vehicle friction measurements will also be discussed. NASA considers the success of this joint program critical in terms of ensuring adequate ground handling capability in adverse weather conditions for future aircraft being designed and developed as well as improving the safety of current aircraft ground operations.
Author
Friction Measurement; Ground Handling; Runways; Winter; Ground Tests; Surface Properties; Runway Conditions; Airfield Surface Movements; Ice

19990052964 Defence Science and Technology Organisation, Melbourne, Australia
MicroVAX/Bus Communication Testing Software for the Low Speed Wind Tunnel Data Acquisition System
Edwards, Craig D.; Feb. 1999; 37p; In English
Report No.(s): AD-A362582; DSTO-TN-0189; DODA-AR-010-843; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Software has been developed to test the communication between the MicroVAX computer and the bi-directional parallel data bus in the Low Speed Wind Tunnel (LSWT) data acquisition system. It enables reading any combination of data parameters from the bus for a user-defined number of iterations. An output file is created which contains the final values, average bus communication times associated with the read process and a statistical analysis of the recorded data. This report describes the operation of the software and presents results of tests performed on the existing data acquisition configuration.
DTIC
Wind Tunnel Tests; Software Engineering; Data Acquisition

19990053242 General Accounting Office, Resources, Community and Economic Development Div., Washington, DC USA
General Aviation Airports: Unauthorized Land Use Highlights Need for Improved Oversight and Enforcement
May 1999; 30p; In English; Report to Congressional Requesters.
Report No.(s): AD-A363173; GAO/RCED-99-109; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

To increase the capacity of the nation's airport facilities and maintain the aviation infrastructure, the federal government has made financial grants or transferred federal land to about 2,000 of the almost 18,000 general aviation airports in the USA Since 1982, the Federal Aviation Administration (FAA) has provided about $4.7 billion in financial grants to general aviation airports. About 350 such airports have received land that is surplus to federal needs, while about 100 have received land that was not considered surplus but was transferred to support the airports' needs. to receive this federal assistance, airports must agree to abide by a number of requirements designed to ensure that the public interest is served. Among other things, airports must obtain approval from FAA before altering the use or ownership of airport land and must use airport revenues only for their operation, maintenance, or development FAA is responsible for monitoring airports' compliance with these requirements and, when requirements are not met, for enforcement. As requested in the House Transportation and Infrastructure Committee Report on the Airport Improvement Program Reauthorization Act of 1998 this report evaluates (1) FAA'S monitoring of general aviation airports' compliance with federal land-use requirements and (2) FAA's use of enforcement tools to resolve cases of noncompliance. to obtain information on FAA'S oversight of land at general aviation airports, we visited 14 and surveyed the remaining 9 FAA field offices responsible for overseeing airports' compliance.
DTIC
Land Use; Airports; General Aviation Aircraft

19990053469 Air Force Research Lab., Human Effectiveness Directorate, Brooks AFB, TX USA
Transfer of Training Effectiveness in Flight Simulation: 1986 - 1997 *Final Report, Jan. - Dec. 1997*
Carretta, Thomas R., Air Force Research Lab., USA; Dunlap, Ronald D., Air Force Research Lab., USA; Sep. 1998; 16p; In English
Contract(s)/Grant(s): AF Proj-1123
Report No.(s): AD-A362818; AFRL-HE-AZ-TR-1998-0078; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The purpose of this report was to review recent studies regarding the effectiveness of flight simulators as augmentation for "hands-on" flying training. Simulation-based training has been proposed to reduce costs, extend aircraft life, maintain flying proficiency, and provide more effective training, especially in areas difficult to train in operational aircraft. A review of the literature from 1986 to 1997 identified 67 articles, conference papers, and technical reports regarding simulator flying training and transfer. of these, only 13 were related directly to transfer of training from the simulator to the aircraft. Studies of simulator effectiveness for training landing skills constituted a majority of the transfer studies, although a few examined other flying skills such as radial bombing accuracy and instrument and flight control. Results indicate that simulators are useful for training landing skills, bombing accuracy, and instrument and flight control. Generally, as the number of simulated sorties increases, performance improves, but this gain levels off after approximately 25 missions. Further, several studies indicate that successful transfer may not require high-fidelity simulators or whole-task training, thus reducing simulator development costs. Evaluation of this literature is difficult for many reasons. Typically, researchers fail to report sufficient detail regarding research methods, training characteristics, and simulator fidelity. In addition to these methodological concerns, there is a lack of true simulator-to-aircraft transfer studies involving complex pilot skills. This may be due to problems such as inadequate simulator design, cost, and availability, and access to simulators in operational flying units. Future directions in simulator transfer of training are discussed.
DTIC
Flight Simulators; Transfer of Training; Control Simulation; Flight Control; Motion Simulators; Education; Pilot Training; Computerized Simulation

10
ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications, spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

19990047600 NASA Langley Research Center, Hampton, VA USA
Aerodynamic Characteristics and Development of the Aerodynamic Database of the X-34 Reusable Launch Vehicle
Pamadi , Bandu N., NASA Langley Research Center, USA; Brauckmann, Gregory J., NASA Langley Research Center, USA;

1999; In English; Atmospheric Reentry Vehicles and Systems, 16-18 Mar. 1999, Arcachon, France; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

An overview of the aerodynamic characteristics and the process of developing the preflight aerodynamic database of the NASA/ Orbital X-34 reusable launch vehicle is presented in this paper. Wind tunnel tests from subsonic to hypersonic Mach numbers including ground effect tests at low subsonic speeds were conducted in various facilities at the NASA Langley Research Center. The APAS (Aerodynamic Preliminary Analysis System) code was used for engineering level analysis and to fill the gaps in the wind tunnel test data. This aerodynamic database covers the range of Mach numbers, angles of attack, sideslip and control surface deflections anticipated in the complete flight envelope.

Author

Aerodynamic Characteristics; Data Bases; Ground Effect (Aerodynamics); Flight Envelopes; X-34 Reusable Launch Vehicle

19990047853 NASA Glenn Research Center, Cleveland, OH USA

An Air-Breathing Launch Vehicle Concept for Single-Stage-to-Orbit

Trefny, Charles J., NASA Glenn Research Center, USA; May 1999; 16p; In English; Propulsion, 20-23 Jun. 1999, Los Angeles, CA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Contract(s)/Grant(s): RTOP 523-61-23

Report No.(s): NASA/TM-1999-209089; E-11674; NAS 1.15:209089; AIAA Paper 99-2730; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The "Trailblazer" is a 300-lb payload, single-stage-to-orbit launch vehicle concept that uses air-breathing propulsion to reduce the required propellant fraction. The integration of air-breathing propulsion is done considering performance, structural and volumetric efficiency, complexity, and design risk. The resulting configuration is intended to be viable using near-term materials and structures. The aeropropulsion performance goal for the Trailblazer launch vehicle is an equivalent effective specific impulse (I*) of 500 sec. Preliminary analysis shows that this requires flight in the atmosphere to about Mach 10, and that the gross lift-off weight is 130,000 lb. The Trailblazer configuration and proposed propulsion system operating modes are described. Preliminary performance results are presented, and key technical issues are highlighted. An overview of the proposed program plan is given.

Author

Air Breathing Engines; Aircraft Engines; Performance Prediction; Design Analysis; Volumetric Efficiency

19990050929 Centro Tecnico Aerospacial, Inst. de Aeronautica e Espaco, San Jose dos Campos, Brazil

Panel Flutter Analyses for the First Brazilian Satellite Launcher

Damilano, J. G., Centro Tecnico Aerospacial, Brazil; Said, Jamil C., Centro Tecnico Aerospacial, Brazil; Azevedo, Joao L. F., Centro Tecnico Aerospacial, Brazil; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 201-210; In English; See also 19990050911

Contract(s)/Grant(s): CNPq-522413/96-0; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The paper describes panel flutter analyses performed in the context of the development of the first Brazilian satellite launcher (VLS). The development of the structural-dynamic and aerodynamic formulations are presented, together with their coupling to obtain the aeroelastic equations. Two different approaches were used to describe the aerodynamic loading, namely formulations based on the quasi-steady, linearized, small perturbation potential equation and on 1st-order piston theory. Results are presented for the VLS main aerodynamic fairing panels, both at zero incidence and at angle of attack. The effect of the inclusion of the unsteady aerodynamic terms in the aeroelastic results was also investigated. The overall conclusion of the study indicates that the VLS payload shroud would be free from panel flutter even with a considerable reduction in the fairing panel thickness.

Author

Panel Flutter; Flutter Analysis; Unsteady Aerodynamics; Aeroelasticity; Aerodynamic Loads; Shrouds; Fairings

19990052705 Aerospace Corp., Los Angeles, CA USA

Stiffness and Damping Effects of Launch Vehicle Aeroelastic Coupling

Dotson, K. W., Aerospace Corp., USA; Baker, R. L., Aerospace Corp., USA; Sako, B. H., Aerospace Corp., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 811-820; In English; See also 19990052675; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The self-sustained coupling of structural responses with transonic flow state transitions at the nose of launch vehicle payload fairings can be analyzed by solving the nonlinear system equation of motion based on the force response relationship and the periodicity condition. The traditional analysis approach for this phenomenon, however, linearizes the equation of motion by converting the alternating flow forces into an aerodynamic damping term and defines a stability criterion as the response amplitude

that yields zero net system damping. This work clarifies the relationship between the new and traditional methods, and compares results and conclusions. The feasibility of modifying a launch vehicle buffet analysis (of random fluctuations caused by turbulent flow) to include aeroelastic coupling effects is also explored. The aerodynamic stiffness and damping terms formulated are consistent with trends observed in wind tunnel test data. It is shown, however, that the modified buffet analysis approach can be inaccurate, particularly when the aeroelastic coupling contribution does not dominate the system response.
Author
Aeroelasticity; Buffeting; Equations of Motion; Stiffness; Dynamic Structural Analysis; Vibration Damping; Launch Vehicles; Structural Stability

19990052764 NASA Goddard Space Flight Center, Greenbelt, MD USA
Autonomous Attitude Sensor Calibration (ASCAL)
Peterson, Chariya, Computer Sciences Corp., USA; Rowe, John, Computer Sciences Corp., USA; Mueller, Karl, NASA Goddard Space Flight Center, USA; Ziyad, Nigel, NASA Goddard Space Flight Center, USA; Dec. 10, 1998; In English; Flight Mechanics, 18-19 May 1999, Greenbelt, MD, USA
Contract(s)/Grant(s): NAS9-98100; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

In this paper, an approach to increase the degree of autonomy of flight software is proposed. We describe an enhancement of the Attitude Determination and Control System by augmenting it with self-calibration capability. Conventional attitude estimation and control algorithms are combined with higher level decision making and machine learning algorithms in order to deal with the uncertainty and complexity of the problem.
Author
Calibrating; Applications Programs (Computers); Attitude (Inclination); Flight Control; Autonomy; Augmentation

11
CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; propellants and fuels; and materials processing.

19990049258 Naval Air Systems Command, Patuxent , MD USA
Support of Composite Structures on Naval Aircraft
Mehrkam, Paul A., Naval Air Systems Command, USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 79-90; In English; See also 19990049248; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Since the first composite structures on navy aircraft were introduced in the early 1970's, the Navy has developed extensive composite repair experience for maintaining the fleet which includes current, emerging, and aging aircraft. To be presented will be composite repair experiences and developments for F-14, F-5, F/A-18A/B/C/D, AV-8B, CH-46, F/A-18E/F, and V-22. This will include solutions to specific repair problems such as ambient storable repair materials, reduced temperature vacuum bag cure of repair materials, support equipment for composite repair, and rapid composite repair procedures, This repair experience and technology was developed through teaming between Naval Air Systems Command (NAVAIR), Naval Air Warfare Center Aircraft Divisions (NAWCAD), Naval Aviation Depots (NADEP), Air Force agencies, international organizations, and aircraft manufacturers.
Author
Military Aircraft; Composite Structures; Aircraft Maintenance; Aging (Materials)

19990049270 Warner Robins Air Logistics Center, Robins AFB, GA USA
Expansion of the WR-ALC Fatigue-Arrest Composite Repair Capability
Adams, Steven F., Warner Robins Air Logistics Center, USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 201-223; In English; See also 19990049248; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Warner Robins Air Logistics Center (WR-ALC) has been performing fatigue-arrest boron-epoxy repairs for over four years and has designed and installed almost 500 repairs of primary structure on various U.S. Air Force and Foreign Military Sales (FMS) aircraft. All of these repairs, however, have been designed to survive a similar environment of cyclic fatigue typical of primary wing or fuselage structure, and they have been almost exclusively boron-epoxy patches of similar stiffness ratio on aluminum alloy substrate. WR-ALC has a great deal of research data quantifying the design requirements and performance of this type of repair as well as the fleet-wide statistical base of the in-service C-141 repairs, but opportunities exist within the Air Force for fatigue arrest repairs for which the existing repair methodology or knowledge base may not be satisfactory. This paper will focus on three

in-house engineering efforts that have been geared towards establishing the effectiveness of this type of bonded crack-arrest technology outside this existing repair envelope - areas where potential workload exists or where limitations of the existing repair methodology currently limit its applicability. These efforts are: A) Low-stiffness ratio repairs for thin structure or fatigue-critical areas, B) Non-aluminum substrate fatigue repair such as titanium, high-strength steel, etc., and C) High cycle fatigue applications, such as structure subjected to turbulent flow or acoustically-excited thin structure. These efforts were intended to assess concept feasibility prior to a full-scale repair development and therefore are not exhaustive engineering studies, but rather cursory first looks attempting to identify a potential Achilles' heel prior to a full repair development effort being undertaken.
Author
Aircraft Maintenance; Fatigue (Materials); Aircraft Structures; Structural Analysis; Cracking (Fracturing)

19990052698 Bath Univ., Dept. of Mechanical Engineering, Bath, UK
Ply Angle Optimization of Non-Uniform Composite Beams Subject to Aeroelastic Constraints
Evrard, T., Bath Univ., UK; Butler, R., Bath Univ., UK; Hughes, S. W., Bath Univ., UK; Banerjee, J. R., City Univ., UK; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 699-708; In English; See also 19990052675; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper investigates the effect that varying the orientation alpha of a [90+alpha/O+alpha/+45+alpha/-45+alpha](sub s) lay-up has on the flutter and divergence behaviour of a uniform flat composite beam, in both swept and unswept configurations. Minimum-mass optimization of non-uniform flat composite beams, with varying orientation of the same lay-up, is also presented. Results show a reduction in mass of 23% for optimum alpha compared to the baseline alpha = 0 case. It is also found that the lay-up orientation giving maximum permissible airspeed for a uniform beam corresponds to the optimum orientation for a non-uniform beam. Hence, the wing designer may quickly and accurately determine the optimal lay-up orientation by performing flutter and divergence analyses at a range of values of alpha between +90 deg and -90 deg. The current limitations of the technique, concerning strength requirements and manufacturing considerations, are recognized. Furthermore, some of the designs are shown to be highly imperfection-sensitive.
Author
Aeroelasticity; Ply Orientation; Optimization; Beams (Supports); Composite Structures; Flutter Analysis; Free Vibration

19990052702 Virginia Polytechnic Inst. and State Univ., Blacksburg, VA USA
Divergence and Flutter of Adaptive Laminated Composite Aircraft Wings Featuring Damaged Bonding Interfaces
Librescu, L., Virginia Polytechnic Inst. and State Univ., USA; Icardi, U., Politecnico di Torino, Italy; DiSciuva, M., Politecnico di Torino, Italy; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 747-762; ffa; In English; See also 19990052675
Contract(s)/Grant(s): CTB97.00589.CT11; CTB97.00459.CT11; CRG960118; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A study of the aeroelastic divergence and flutter of swept-aircraft wings made-up from laminated composite materials featuring nonrigidly bonded interfaces is presented. Among the goals to be reached, those of capturing and revealing the effects played by interlaminar bonding imperfections on static and dynamic aeroelastic instabilities, and that of the incorporation of a feedback control methodology are investigated. Implementation of a feedback control methodology enabling one: a) to counteract the detrimental effects of bonding imperfections, and b) to enhance the overall aeroelastic response behavior, is also considered. In order to obtain results emphasizing the implications of bonding imperfections, the aeroelastic problem will be considered in a restricted sense, i.e. for the case when only the bending degree of freedom is involved. In this context, results addressing the problem of the influence of interfacial bonding imperfection, and feedback control on static and dynamic aeroelastic instabilities of swept-aircraft wings are presented, and pertinent conclusions are outlined.
Author
Divergence; Flutter; Swept Wings; Laminates; Composite Materials; Aerodynamic Stability; Dynamic Response; Aeroelasticity

19990047462 NASA Glenn Research Center, Cleveland, OH USA
Titanium Aluminide Applications in the High Speed Civil Transport
Bartolotta, Paul A., NASA Glenn Research Center, USA; Krause, David L., NASA Glenn Research Center, USA; March 1999; 12p; In English; Gamma Titanium Aluminides, 28 Feb. - 4 Mar. 1999, San Diego, CA, USA; Sponsored by Minerals, Metals and Materials Society, USA
Contract(s)/Grant(s): RTOP 537-04-23
Report No.(s): NASA/TM-1999-209071; NAS 1.15:209071; E-11627; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

It is projected that within the next two decades, overseas air travel will increase to over 600,000 passengers per day. The High Speed Civil Transport (HSCT) is a second-generation supersonic commercial aircraft proposed to meet this demand. The expected fleet of 500 to 1500 aircraft is required to meet EPA environmental goals; the HSCT propulsion system requires advanced technologies to reduce exhaust and noise pollution. A part of the resultant strategy for noise attenuation is the use of an extremely large exhaust nozzle. In the nozzle, several critical components are fabricated from titanium aluminide: the divergent nap uses wrought gamma; the nozzle sidewall is a hybrid fabrication of both wrought gamma face sheet and cast gamma substructure. This paper describes the HSCT program and the use of titanium aluminide for its components.
Author
Exhaust Nozzles; Noise Reduction; Titanium Aluminides; Supersonic Commercial Air Transport; Weight Reduction

19990049252 Boeing Commercial Airplane Co., Seattle, WA USA
Influence of Undetected Hidden Corrosion on Structural Airworthiness of Aging Jet Transports
Akdeniz, Aydin, Boeing Commercial Airplane Co., USA; Das, Girindra K., Boeing Commercial Airplane Co., USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 29-38; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

In this paper the implications of combined hidden corrosion and fatigue on structural integrity of aging jet transports are presented. The primary concern, the corrosion between the fay surface of the Principal Structural elements (PSE), is discussed. Examples of hidden corrosion that were found in older airplanes in the Boeing fleet are shown. Current maintenance programs for structural integrity of aging commercial fleets are discussed. Commercially available detection methods for hidden corrosion are described. Finally, recommendations to address hidden corrosion in older airplanes are proposed by supplementing existing visual inspections with subsurface nondestructive evaluation (NDE).
Author
Aircraft Reliability; Structural Analysis; Corrosion; Fatigue (Materials); Transport Aircraft

19990053500 Naval Surface Warfare Center, Carderock Div., Bethesda, MD USA
Heat Treatment of Al 7075 for Ejection Seat Shear Wire
Wong, Catherine R.; Mastroianni, Lee S.; Mar. 1999; 15p; In English
Report No.(s): AD-A362873; NSWCCD-61-TR-1999/04; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Shear pins in ejection seats are required to have double shear breaking load values in the range of 46-51 lbs. over the life of the equipment. Aluminum 6061-T6 that was cold worked to increase the shear strength was initially used and performed well for many years. Current lots of Al 6061 could not duplicate the double shear breaking load values and so it was attempted to achieve the required double shear breaking load in the Al 7075 alloy with a stable microstructure. A variety of heat treatments were performed and tested for hardness and double shear breaking load. This report presents the resulting heat treatment curves and the correlation between hardness and double shear breaking load. The proper heat treatment for this application is identified as a solution treatment between 870 and 900 deg F for 32 hours, aging at 225 deg F for 8 hours and then further aging at 350 deg F for 144 hours. This heat treatment was found to produce a double shear breaking load in the required range that is stable over time.
DTIC
Aluminum Alloys; Ejection Seats; Shear Strength; Microstructure

19990049260 Battelle Columbus Labs., OH USA
Effects of Corrosion Inhibiting Lubricants on Avionics Reliability
Abbott, W. H., Battelle Columbus Labs., USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 101-115; In English; See also 19990049248; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Studies were conducted on the effects of corrosion inhibiting lubricants on the electrical performance of gold plated connectors. The basis for the work was the premise that a significant number of typical No Defect (ND), Can Not Duplicate (CND), and Retest OK (RTOK) maintenance actions may be due to environmental corrosion of connector surfaces. This may include typical gold plated I/0 connectors as well as ground connections. The objectives of the work which was conducted in several phases were as follows. First, field and laboratory studies were conducted to evaluate the electrical performance and potential risk versus benefits associated with the use of Commercial Off The Shelf (COTS) materials conforming to MIL-L-87177A and MIL-C-81309E. Materials from 12 vendors were evaluated. Second, it was planned that if satisfactory results were obtained in Phase I, a field study would be conducted in which selected lubricants would be applied to the I/0 connectors on specific Line Replaceable Units (LRUs) of operational aircraft. This was, in fact, initiated with the F-16 aircraft as the test vehicle. to date, flights tests have involved nearly 150 aircraft spread over 10 bases in CONUS. The Phase I studies produced several important

conclusions. Among the lubricants which were evaluated there was a wide range of performance. One unique material was identified which actually appeared to degrade performance. A number of materials showed little benefit compared to the unlubricated state, and only several showed an excellent combination of corrosion inhibition in severe environments and good electrical performance under a wide range of environmental extremes. These results indicate that a few lubricants can be used in such applications with no identified engineering risk, but lubricants must be thoroughly qualified to a far greater extent than is required in existing specifications. The Phase II studies have yielded positive results. Most important is the confirmation that such materials can be routinely applied in the field with no identified or perceived risk to the aircraft systems or with any objections from maintenance personnel. Beyond this, the results from several years worth of flight tests have produced variable results/benefits among different LRUs as might be expected. However, on specific LRUs there have been significant reductions in ND and NR values as well as Maintenance Man Hours/Flight Hour. Results comparing maintenance actions for aircraft with lubrication against comparable data for the entire fleet of aircraft within the same command have been favorable. While these results have been positive, there is one overriding conclusion which must be stressed. Lubricants for such applications cannot be selected in an arbitrary manner. Thorough qualification data must support these decisions. Such data do not appear to be available from historical qualification requirements.
Author
Aircraft Reliability; Corrosion Prevention; Lubricants; Electrical Properties; Performance Tests; Electric Connectors

19990049288 Australian Defence Force Academy, School of Aerospace and Mechanical Engineering, Canberra, Australia
Effect of Aircraft Washing on the Life of Corrosion Prevention Compounds
Shankar, Krishnakumar, Australian Defence Force Academy, Australia; Tindall, Natasha, Royal Australian Navy, Australia; Hinton, Bruce, Defence Science and Technology Organisation, Australia; Salagaras, Maria, Defence Science and Technology Organisation, Australia; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 378-386; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Corrosion Prevention Compounds (CPCs) are now commonly employed to combat corrosion in aircraft structures, particularly for controlling crevice corrosion in airframe skin splice joints. On the other hand, for fixed and rotary wing aircraft operating in severe corrosive conditions as in the marine environment, frequent washing with fresh water is also employed to remove salt deposits and inhibit the onset of corrosion. Unfortunately, while both these remedies are independently effective, it has been found that aircraft washing tends to reduce the effectiveness of the corrosion prevention compounds. This paper describes the results of an experimental program aimed at determining the effect of frequent washing on the effective life of CPCs in crevice joints. The tests were conducted on crevice washer specimens treated with three different kinds of commercially available Water Displacing Corrosion Preventive (WDCP) compounds and exposed to continuous salt spray testing as per ASTM Standard B-117. After thirty days of exposure, specimens treated with CPCs but not subjected to washing had developed less than twenty percent of corrosion compared to unwashed specimens without any CPCs, whereas corrosion in untreated specimens subjected to frequent washing was about half of that in untreated unwashed specimens. After thirty days of exposure to salt fog and frequent washing, the specimens treated with CPCs had developed the same amount of corrosion as the untreated specimens. A comparison of the performance of the different CPCs studied showed while some of them may remain effective up to a period of about two weeks, in most cases frequent washing causes corrosion to develop over a significant part of the crevice in a matter of six to seven days, highlighting the necessity of reapplication of the CPCs every time the aircraft is washed.
Author
Aircraft Maintenance; Washing; Corrosion Tests; Cavitation Corrosion; Corrosion Prevention

19990052881 Search for Extraterrestrial Intelligence Inst., Mountain View, CA USA
Synthesis and Development of Porous Polymeric Column Packing and Microchip Detectors for GC Analysis of Extraterrestrial Atmospheres *Final Report, 1 Oct. 1989 - 30 Sep. 1998*
Shen, Thomas C., Search for Extraterrestrial Intelligence Inst., USA; Apr. 30, 1999; 72p; In English
Contract(s)/Grant(s): NCC2-650; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This report summarizes the last nine years research accomplishments under Cooperative Agreement NCC2-650 between NASA, Ames Research Center and SETI Institute. Four Major research tasks are conducted: 1. Gas chromatography column development. 2. Pyrosensor development. 3. Micro-machining gas chromatography instrument development. 4. Amino acid analysis and high molecular weight polyamino acid synthesis under prebiotic conditions. The following describes these results.
Derived from text
Synthesis (Chemistry); Product Development; Amino Acids; Chips (Electronics); Polymers; Detection; Research; Molecular Weight; Flight Instruments

19990047549 Defense Logistics Agency, Defense Energy Support Center, Fort Belvoir, VA USA
Survey of Jet Fuels Procured by the Defense Energy Support Center
Jun. 09, 1998; 77p; In English
Report No.(s): AD-A362331; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

This first report is a compilation of data which are representative of the quality of jet fuels (JP4, JP5, and JP8) purchased by the Defense Energy Support Center (DESC) worldwide. This information was obtained from our Petroleum Quality Information System (PQIS), an automated system which contains product quality history. This database contains over 6000 records of aviation fuel deliveries, which represents 8.5 billion gallons of product. The data contained in this report are summarized to provide statistical information on average, minimum and maximum values of selected test properties for use by our customers in researching specification or quality issues. Although this report covers seven years of quality history, future reports will be published on an annual basis.
DTIC
Fuels; Data Bases; Jet Engine Fuels; Surveys; Crude Oil

19990047550 Defense Logistics Agency, Defense Energy Support Center, Fort Belvoir, VA USA
Petroleum Quality Information System Jet Fuels Data
Dec. 30, 1998; 49p; In English
Report No.(s): AD-A362332; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This is the second report, summarizing test results of aviation fuels received in calendar year 199? with comparison statistics from calendar year 1995 and 1996. Data is stored in our Petroleum Quality Information System (PQlS) Database which currently contains 4,385 records, representing just under 6.8 billion gallons of product, starting from January 1, 1995. Many DESC personnel contributed to its development, maintenance and data entry functions. Special thanks go to the field offices of DCMD and DCMDl for their response in providing information for shipments that were missing from the database. The result of this effort was an increase by almost 1/2 billion gallons of jet fuel represented in the report. The JP4 representation increased to 100% for both 1996 and 1997. For 1996, JP5 representation increased from 24% in the 1990-1996 Report, to 87% in this Report. JP8 representation also increased from 57% to 81% for calendar year 1996
DTIC
Testes; Jet Engine Fuels; Data Acquisition; Information Systems

19990047707 Baylor Univ., Dept. of Aviation Sciences, Waco, TX USA
Proceedings of the Second International Conference on Alternative Aviation Fuels ***Final Report***
Knopp, K. J., Editor; Mar. 1999; 366p; In English; Alternative Aviation Fuels, 6-8 Nov. 1997, Waco, TX, USA
Report No.(s): PB99-139487; No Copyright; Avail: CASI; A16, Hardcopy; A03, Microfiche

This publication contains 50 technical presentations presented at the Second International Conference on Alternative Aviation Fuels. Baylor University, in Waco, Texas, hosted the conference on November 6-8, 1997. Topics covered in the papers and panel discussions included: Environmental impact of alternative aviation fuels; Cost-effectiveness and characteristics of alternative fuels; Alternative aviation fuel case studies; Fuel suppliers' and manufactures' responses to alternative fuels; and Barriers to commercialization.
NTIS
Conferences; Aviation Meteorology; Energy Policy; Aircraft Fuels

19990049212 Baylor Univ., Waco, TX USA
Proceedings of the Second International Conference on Alternative Aviation Fuels ***Final Report***
Mar. 1999; 329p; In English; Alternative Aviation Fuels, 6-8 Nov. 1997, Waco, TX, USA
Report No.(s): AD-A362182; DOT/FAA/AR-98/73; No Copyright; Avail: CASI; A15, Hardcopy; A03, Microfiche

Baylor University, in conjunction with the Federal Aviation Administration (FAA), U.S. Department of Energy, Texas State Technical College, and Environment Canada, presented the Second International Conference on Alternative Aviation Fuels to introduce members of the industry to the promise and applications of alternative fuels in aviation. This publication contains 50 technical presentations presented at the Second International Conference on Alternative Aviation Fuels. Baylor University, in Waco, Texas, hosted the conference on November 6-8, 1997. Topics covered in the papers and panel discussions included: Environmental impact of alternative aviation fuels; Cost-effectiveness and characteristics of alternative fuels; Alternative aviation fuel case studies; Fuel suppliers' and manufactures' responses to alternative fuels; and Barriers to commercialization.
DTIC
Aircraft Fuels; Conferences

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ENGINEERING

Includes engineering (general); communications and radar; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

19990047928 National Inst. of Standards and Technology, Fire Safety Engineering Div., Gaithersburg, MD USA
Prediction Based Design of Fire Detection for Buildings with Ceiling Heights between 9m and 18m
Davis, W. D., National Inst. of Standards and Technology, USA; Notarianni, K. A., National Inst. of Standards and Technology, USA; Jul. 1998; 54p; In English
Report No.(s): PB98-148158; NISTIR-6199; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

The purpose of this paper is to provide the experimental and theoretical background necessary to extend guidelines to ceiling heights between 9 m and 18 m. Based on the results of experiments conducted in 15 m and 22 m high hangars, detector activation thresholds and detector spacing are analyzed for both smoke and heat detectors. Only ceiling mounted detection devices are analyzed in this paper. In addition to the detector threshold study, the predictive capabilities of computer fire model simulations were compared with experimental results. This comparison, which is based on 12 fire tests, resulted in the development of a new ceiling jet algorithm to model phenomena which had not been included in previous algorithms. The improved algorithm provides a better representation of the development of the ceiling jet temperature to a growing hot layer and a better estimation of plume centerline temperature. Guidelines are examined, based on the experimental results, for fire detector spacing, placement, and sensitivity. Recommendations concerning the use of computer fire models at these heights are made as a function of fire size and hot layer development. The role of draft curtains is discussed and their impact on detector activation is demonstrated.
NTIS
Fires; Hangars; Smoke Detectors; Fire Prevention; Safety Devices; Fail-Safe Systems; Algorithms; Computerized Simulation

19990053143 Research and Technology Organization, Applied Vehicle Technology Panel, Neuilly-sur-Seine, France
Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface ***Problemes de Dynamique des Fluides des Vehicules Evoluant dans ou Pres de l'Interface Air-Mer***
Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999; 380p; In English, 5-8 Oct. 1998, Amsterdam, Netherlands; Sponsored by Research and Technology Organization, France; See also 19990053144 through 19990053173; Original contains color illustrations
Report No.(s): RTO-MP-15; AC/323(AVT)TP/9; ISBN 92-837-0004-X; Copyright Waived; Avail: CASI; A17, Hardcopy; A03, Microfiche

The papers prepared for the RTO Applied Vehicle Technology (AVT) Symposium on "Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface" which was held 5-8 October 1998 in Amsterdam, The Netherlands, are contained in this report. In addition, a Technical Evaluator's Report aimed at assessing the success of the Symposium in meeting its objectives, and an edited transcript of the General Discussion held at the end of the Symposium are also included. In addition to presentations from the NATO Countries, this Symposium included several presentations by Russian and Ukrainian authors. In total, 30 papers were presented during sessions on the following subjects: (1) Aerodynamics and Flight Dynamics around Ships; (2) Stabilization and Control Techniques for Ships; and (3) Non-Classical Aircraft Flying Near the Air-Sea Interface.
Author
Fluid Dynamics; Aerodynamics; Ships; Air Water Interactions; Conferences

19990053158 Delegation Generale de l'Armement, Saint-Cloud, France
New Advances in Sailing Hydrofoils
Lefaudeux, Francois, Delegation Generale de l'Armement, France; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 15-1 - 15-14; In English; See also 19990053143; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Two sailing hydrofoils projects are currently in progress in France. The objective of the first one, Techniques Avancees, is to establish a new all categories world speed record (now belonging to Yellow Pages Endeavour with more than 46 knots). The objective of the second, L'Hydroptere, is even more ambitious; it is a new record for the eastward crossing of the Atlantic Ocean. The two boats have been built and they sail regularly, a lot have been learn from those experiments and they are quite successful. Techniques Avancees holds the world speed record in its size category, L'Hydroptere sails regularly at 35-37 knots and it has been recorded at 39 knots. This paper presents, first, a brief history of hydrofoil sailing, starting with Monitor, a very successful project dating from the end of the fifties. After this introduction to hydrofoil sailing, it concentrates on the two main design advances

which explain the success of those two ships. The first deals with the lateral stability of hydrofoils sailing ships which have to counter the strong lateral force and heeling moment due to the action of the wind on the sails. The second deals with the problem of the general longitudinal stability of an ocean-going first generation hydrofoil in strong seas: how to avoid the dangers of fast changes in the flow angle of incidence on the main foils with the risks of negative lift and subsequent "hard landing".
Author
Hydrofoils; Hydrofoil Craft; Hydroplanes (Vehicles); Ships; Structural Design; Gas Turbine Engines; Engine Design

19990052709 La Sapienza Univ., Aerospace Dept., Rome, Italy
Nonlinear Aeroelastic System Identification Via Wavelet Analysis in the Neighbourhood of a Limit Cycle
Mastroddi, F., La Sapienza Univ., Italy; Bettoli, A., La Sapienza Univ., Italy; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 857-866; In English; See also 19990052675; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A wavelet analysis on the output signal of a nonlinear system in the neighbourhood.of a Hopf bifurcation (i.e., a limit-cycle oscillation) has been performed to point out the linear and nonlinear signatures of the system. Indeed, this kind of nonlinear behaviour is characterised not only by a simple harmonic oscillation in developed steady-state condition, but also by an initial transitory phase with a complex time evolution of the spectral signal content. Both of issues could be described in an analytical way via a singular perturbation analysis but they could be also directly analyzed by a signal-processing tool via wavelet analysis (Continuous Wavelet Transform, CWT): this is obtained using the wavelet capability in describing efficiently the time evolution of the spectrum of the signal (i.e., a nonlinear "signature" of a Hopf bifurcation). The novelty of the paper consists of applying the wavelet theoretical tool in the behavior description of a wing experiencing a limit cycle.
Author
Aeroelasticity; Nonlinear Systems; Oscillations; Signal Processing; System Identification; Wavelet Analysis; Wings

19990047366 Office of Naval Research, Arlington, VA USA
Proceedings of the International Symposium on Seawater Drag Reduction, 22-23 July 1998 Newport, Rhode Island
Jul. 1998; 453p; In English
Report No.(s): AD-A362573; No Copyright; Avail: CASI; A20, Hardcopy; A04, Microfiche

The International Symposium on Seawater Drag Reduction (ISSDR), held in Newport, RI, on 22-23 July 1998, focused on drag reduction methods applicable primarily in the seawater environment. The symposium was jointly sponsored by the Office of Naval Research (including ONR's European Office), the Naval Sea Systems Command, the Defense Advanced Research Projects Agency, the Naval Surface Warfare Center Carderock Division, the American Society of Mechanical Engineers and the Naval Undersea Warfare Center Newport Division. The call for ISSDR papers resulted in an overwhelming response from around the world. Accepted papers represent authors from 11 different countries and include contributions from the government sector, private industry, and academia. The resulting proceedings volume offers a comprehensive collection of the latest thinking on seawater drag reduction from leaders of the international drag reduction community. Papers are grouped in this volume in the following categories: * drag reduction - historical overview, * wall turbulence physics, * drag reduction physics * seawater physics * turbulent drag reduction methods including compliant coating, spanwise fluid motion and wall motion, polymer, microbubble, electromagnetic, and biology based methods. One of the fundamental advances in the study of turbulence over the last five decades has been the discovery that turbulence production and self-sustainment in a boundary layer are organized phenomena and not entirely random processes. A principal objective of this symposium and proceedings was to promote a closer coupling of these wall turbulence physics fundamentals to drag reduction methodologies, while also seeking to increase awareness of the challenges unique to seawater drag reduction, and encouraging wider and more extensive discussion in the drag reduction community of the potential applicability to seawater vehicles.
DTIC
Aerodynamic Drag; Fluid Dynamics; Turbulent Flow; Elastic Properties

19990050936 Office National d'Etudes et de Recherches Aerospatiales, Paris, France
Aeroelasticity Simulations in Turbulent Flows
Grisval, Jean–Pierre, Office National d'Etudes et de Recherches Aerospatiales, France; Liauzin, Cedric, Office National d'Etudes et de Recherches Aerospatiales, France; Zdenek, Johan, Centric Engineering Systems, Inc., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 275-286; In English; See also 19990050911; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Unsteady turbulent flow calculations involving moving boundaries and fluid-structure interaction problems are solved using a finite element method and Spalart-Allmaras and k-epsilon turbulence models. These models are tested on buffeting problems

with 2D airfoils. Wall functions have been implemented for both turbulence models in order to perform 3D simulations with the Dyvas wing.
Author
Aeroelasticity; Airfoils; Buffeting; Finite Element Method; Turbulence Models; Turbulent Flow; Mathematical Models; Computerized Simulation

19990052701 Air Force Research Lab., Aeronautical Sciences Div., Wright-Patterson AFB, OH USA
Non-Linear Fluid and Structures Interaction Simulation
Melville, Reid B., Air Force Research Lab., USA; Gordnier, Raymond E., Air Force Research Lab., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 735-746; In English; See also 19990052675; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A dynamic aeroelastic solver is used to simulate several fluid-structure interactions with highly non-linear flowfields. A Beam-Warming, approximate factored algorithm, coupled with a linear, second-order structural model via subiteration, becomes a fully implicit, second-order accurate aeroelastic solver. Key issues for accurate aeroelastic simulation are discussed and highlighted by examples. These include geometric conservation, temporal synchronization of the fluid and structural state, full coupling and feedback between the solvers, and non-linear flow features that drive aeroelastic stability and require high levels of spatial discretization.
Author
Aeroelasticity; Dynamic Structural Analysis; Fluid-Solid Interactions; Mathematical Models; Computerized Simulation

19990053145 Southampton Univ., UK
CFD Predictions of the Influence of External Airflow on Helicopter Operations When Operating From Ship Flight Decks
Wakefield, N. H., Southampton Univ., UK; Newman, S. J., Southampton Univ., UK; Wilson, P. A., Southampton Univ., UK; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 2-1 - 2-10; In English; See also 19990053143; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A CFD model of a hovering helicopter main rotor is developed to examine airflow in the presence of ship structures and side winds. The rotor is modelled by modifying the governing Navier-Stokes equations in the region of the disc. The extra terms added to the governing equations apply a downforce to the fluid; these forces are independent of the flow around the rotor and equal to the helicopter weight. The boundaries of the computational domain are also modified in order to generate a physically correct solution. Flow solutions in both two and three dimensions are achieved using the commercial flow solver CFX 4.1. The flow solutions exhibit very good correlation with established momentum and power principles. In order to model helicopter operations from a ship's flight deck, typically a frigate, the rotor is modelled at several positions above a ship profile. Cross winds are applied to the computational domain. The thrust of the rotor is held constant and the resulting flow solutions are calculated. The power exerted at the rotor is obtained and compared to the ideal hover condition and computational flow solution. The flow solutions show that the airflow accelerates over the flight deck and a helicopter operating in this region encounters large cross winds and velocity gradients. The results also show that the helicopter control margins are more likely to limit the safe operating limit than the power margin. Using the modified boundary conditions, this method demonstrates the viability of CFD for predicting the ship airwake and the reduced power margins a helicopter experiences whilst operating in the vicinity of the ship. This study has been exploratory and limited by computing resources, but future models will include helicopter fuselage, tail rotor, time dependent boundary conditions and dynamic flight.
Author
Helicopter Control; Computational Fluid Dynamics; Navier-Stokes Equation; Mathematical Models; Loads (Forces); Boundary Conditions; Predictions; Rotary Wings

19990053148 Defence Evaluation Research Agency, Aero/Structures Dept., Farnborough, UK
Prediction of Ship Air Wakes Over Flight Decks Using CFD
Tattersall, P., Defence Evaluation Research Agency, UK; Albone, C. M., Defence Evaluation Research Agency, UK; Soliman, M. M., Defence Evaluation Research Agency, UK; Allen, C. B., Bristol Univ., UK; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 5-1 - 5-12; In English; See also 19990053143; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A Computational Fluid Dynamics (CFD) method is presented for calculating the airflow over a ship superstructure, with emphasis on the flow over aft-located helicopter decks on conventional naval ships. The non-aligned grid generation and flow solution methods are described, including discussion of the modelling of time-accuracy and rotor downwash effects. Work on the

coupling of the CFD results with a rotor performance code (CRFM) is also described. Example solutions are shown to illustrate the current capabilities of the method.
Author
Computational Fluid Dynamics; Ships; Wakes; Air Flow; Rotors

19990053150 Institute for Aerospace Research, Aerodynamics Lab., Ottawa, Ontario Canada
Analysis of Patrol Frigate Air Wakes
Zan, S. J., Institute for Aerospace Research, Canada; Syms, G. F., Institute for Aerospace Research, Canada; Cheney, B. T., Institute for Aerospace Research, Canada; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 7-1 - 7-14; In English; See also 19990053143; Original contains color illustrations; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The operation of helicopters from a ship-based platform is a challenging procedure from a pilot's perspective. In addition to maneuvering near a moving platform, the pilot must respond to the complex, unsteady flow field which exists over the flight deck. The flow over the ship superstructure generates an air wake which contains significant spatial gradients in the mean wind velocities as well as increased turbulence levels; both may significantly alter the performance of an immersed helicopter rotor. to address this issue completely, one must deal with a fully-coupled problem including both the helicopter rotor and the ship air wake. However, as a first step, the ship air wake can be mapped out to estimate what inflow the rotor might experience. A program is under way in the National Research Council of Canada Aerodynamics Laboratory (NRC/AL) to analyze the air wake formed behind the Halifax-Class Patrol Frigate (CPF). It contains an experimental component and a computational one. Using hot-film anemometers and the AL 5m Vertical Wind Tunnel, the experimental element maps out the flow field (14x13x16 matrix) in the vicinity of the flight deck of a 1:50 scale CPF model at 0 deg yaw and 12 deg yaw. The region measured included the boundaries of the recirculation zone that exists behind the hangar. An atmospheric boundary layer profile was created by placing a set of horizontal rods upstream of the model, which generated a properly scaled variation of mean velocity with height. to complement this work the flow field around a modified CPF was computed using a Navier-Stokes flow solver. This modification exists for these experiments only. No such modifications exists on the real ships. In order to facilitate grid generation, simplifications were made to the bridge and several of the smaller structures around the flight deck were removed. A structured, multi-block, pressure-based Navier-Stokes flow solver was used to compute the steady-state flow field. The atmospheric boundary layer was included in the numerical simulation. This modified ship geometry was also placed in the wind tunnel for validation of the numerical solutions. The results of the wind tunnel experiments show the recirculating zone behind the hangar as well as the asymmetries in the flow field caused by a 20 mm Phalanx CIWS found on the starboard roof of the hangar. The numerical results agree favourably with the modified CPF experimental results and give further details of the air wake.
Author
Wakes; Numerical Analysis; Flow Distribution; Steady State; Unsteady Flow; Atmospheric Boundary Layer; Navier-Stokes Equation; Rotary Wings; Wind Velocity

19990053151 Defence Evaluation Research Agency, Flight Management and Control Dept., Bedford, UK
Modelling and Simulation of Ship Air Wakes for Helicopter Operations: A Collaborative Venture
Wilkinson, C. H., Defence Evaluation Research Agency, UK; Zan, S. J., Institute for Aerospace Research, Canada; Gilbert, N. E., Defence Science and Technology Organisation, Australia; Funk, J. D., Naval Air Warfare Center, USA; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 8-1 - 8-12; In English; See also 19990053143; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The development of simulation for application to the helicopter-ship dynamic interface has been an activity under an international collaborative panel of The Technical Co-operation Programme since 1990. Modelling the ship air wake and its effect on the helicopter behaviour is regarded by the panel as one of the most significant technical challenges. Increasing the fidelity in this area can enhance the effectiveness of simulation in research, qualification and training, and open up opportunities to predict and correct for 'troublespots' in the design of new ships. A number of approaches are being pursued concurrently aimed at applying Computational Fluid Dynamics and other, more empirical, analyses to achieve a modelling capability. All participants in the collaboration are also actively involved with conducting full- and model-scale testing to gain an improved understanding of the key features of the air wake topology and to develop a validation database. This paper details the collaborative efforts being pursued by the member nations, under the coordination of the authors. It summarises the work being conducted and draws together the various research aspects and validation tests. The aim is to present a comprehensive and co-ordinated approach to modelling and simulation of the air wake problem at the dynamic interface, putting into an operational context the more technical aspects

to be discussed elsewhere in the Symposium. The paper demonstrates the application of air wake prediction in ship and aircraft design, and the value of air wake simulation in research and training.
Author
Computational Fluid Dynamics; Wakes; Ships; Aircraft Design; Computerized Simulation

19990053152 Tsentralni Aerogidrodinamicheskii Inst., Moscow, USSR
The Experience of Aerodynamic Disturbances Research Behind an Aircraft-Carrier Ship with Elements for Safe Operation of Ship-Based Aircraft
Maslov, L. A., Tsentralni Aerogidrodinamicheskii Inst., USSR; Valuev, N. O., Tsentralni Aerogidrodinamicheskii Inst., USSR; Zharinov, A. V., Tsentralni Aerogidrodinamicheskii Inst., USSR; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 9-1 - 9-6; In English; See also 19990053143; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A opinion about some reasons of relatively late appearance of the first aircraft carrier in the Soviet Navy is expressed. TsAGI's works for provision of aerodynamic compatibility of ship-based aircraft and carrier are described. The works were directed on development of methodology of estimation of wind flow disturbances over flight deck and behind carrier by model experiment in wind tunnel. Its aim was design and realization of measures of reduction of these disturbances and its gradients up to level required for takeoff landing operation safety. Numerous model tests of different ship architecture variants allowed to study the mechanism of flow formation and to estimate the effects of motion ship kinematic parameters relative to wind and of some features of ship architecture on the flow structure. Some recommendations were developed and created on aircraft-carrier cruiser "Minsk" for deck flow leveling. The range of relative wind angles was determined for safe landing on carrier "Admiral Kuznetsov".
Author
Aircraft Carriers; Aerodynamics; Takeoff; Ships; Kinematics

19990053153 Bombardier Services Corp., Dynamics Interface Program, Arlington, VA USA
Simulation Tools in the Calculation of Aircraft-Ship Interface Operational Limits ***Application des Outils de Simulation pour le Calcul des Limites Operationnelles de l'Interface Dynamique Aeronef-Navire***
deFerrier, Bernard, Bombardier Services Corp., USA; Langlois, Bernard, Bombardier, Inc., Canada; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 10-1 - 10-12; In English; See also 19990053143; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Helicopters operating from small ships are limited in the maritime environment by high winds and rough seas. In addition, man-made obstacles, such as, hangar wall generated turbulence, ship stack hot gas motor ingestion, inappropriate deck lighting and markings limit helicopters. Dynamic Interface (DI) is defined as the study of the relationship between an air vehicle and a moving platform. It is performed to reduce risks and maximize operational flexibility. Countries with a large number of platforms conduct DI testing as a matter of necessity. An analytic approach to helicopter/ship dynamic interface testing is presented. A brief synopsis of the theory and calculation of the ship motion simulation program is presented. The Ship Motion Simulation (SMS) model is derived from the relationship between the wave and ship motion spectrum. It incorporates seakeeping philosophy and applies various definitions of seaway spectral formulation. SMS defines a seaway, computes the hydrodynamic and hydrostatic forces imposed on a ship (defined as the product of its transfer function and the seaway) and calculates a resulting ship time history. The simulation is an extensive treatment of a floating object's response to the dynamic loads on its structure. The application of ship motion simulation as a developmental operational tool is introduced. The primary application of the SMS is in operational simulation such as aircraft launch and recovery; deck handling; and flight readiness or availability. The Aircraft/Ship Interface Simulation (DI) is a mathematical description of conditions limiting the availability of an air vehicle. Factors affecting an air vehicle on a moving platform are primarily ship motion; wind-over-deck; ship airwake turbulence; and deck conditions (wet, dry, oily obstructed, etc). Sample helicopter/ship interface operational limits or envelopes are discussed. Spin-off projects into other field of growth, such as visual aids, are developed.
Author
Computerized Simulation; Motion Simulation; Helicopters; Ships; Operational Problems; Wind Velocity; Sea Roughness

19990053155 Technische Univ., Ship Hydromechanics Lab., Delft, Netherlands
Motions and Added Resistance due to Waves of Surface Effect Ships
Moulijn, Joost C., Technische Univ., Netherlands; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 12-1 - 12-10; In English; See also 19990053143; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper presents a computational method for motions and added resistance due to waves of Surface Effect Ships. The computed added resistance only includes the added resistance of the air cushion. This added resistance component was believed to be the largest. The results of the computational method are compared to experimental results of MARIN and to results of new experiments which are carried out at the Ship Hydrodynamics Laboratory of Delft University of Technology. The computed motions and cushion excess pressures agree well with the MARIN results. The computed added resistance is however much smaller than the added resistance that was measured by MARIN. This discrepancy was the major reason for the new experiments. The aim of the new experiments is to get insight into the magnitude and origin of added resistance of SESs. The new experiments are still in progress at the time this paper had to be delivered. This paper presents therefore only some first results of these experiments. The new experiments show that the added resistance of the air cushion is not large. The new results for added resistance are reasonable agreement with the computational results.
Author
Surface Effect Ships; Ground Effect Machines; Computation; Experiment Design

19990053160 Academy of Sciences of the Ukraine, Inst. of Mathematics, Machines and Systems Problems, Kiev, Ukraine
Hydrodynamic Characteristics of Rudders Operating in Air-Sea Interface
Savchenko, V. T., Academy of Sciences of the Ukraine, Ukraine; Fluid Dynamics Problems of Vehicles Operating Near or in the Air-Sea Interface; February 1999, pp. 17-1 - 17-10; In English; See also 19990053143; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Results of experiments with a series of rectangular and triangular (in plane) foils are described. These foils have a wedge profile and function nearly as a solid body. Three conditions of flow around the foil were being guaranteed: a continuous, a cavitating and continuous with a gas-liquid layer (Gll) at the body. The research permitted us to find some effects and to design a special foil operating effectively at the body with a gas layer.
Author
Hydrodynamics; Cavitation Flow; Unsteady Flow; Hydrodynamic Coefficients; Aerodynamic Characteristics

19990052760 NASA Glenn Research Center, Cleveland, OH USA
A New Method to Measure Temperature and Burner Pattern Factor Sensing for Active Engine Control
Ng, Daniel, NASA Glenn Research Center, USA; May 1999; 10p; In English
Contract(s)/Grant(s): RTOP 274-00-00
Report No.(s): NASA/TM-1999-209090; E-11675; NAS 1.15:209090; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

The determination of the temperatures of extended surfaces which exhibit non-uniform temperature variation is very important for a number of applications including the "Burner Pattern Factor" (BPF) of turbine engines. Exploratory work has shown that use of BPF to control engine functions can result in many benefits, among them reduction in engine weight, reduction in operating cost, increase in engine life, while attaining maximum engine efficiency. Advanced engines are expected to operate at very high temperature to achieve high efficiency. Brief exposure of engine components to higher than design temperatures due to non-uniformity in engine burner pattern can reduce engine life. The engine BPF is a measure of engine temperature uniformity. Attainment of maximum temperature uniformity and high temperatures is key to maximum efficiency and long life. A new approach to determine through the measurement of just one radiation spectrum by a multiwavelength pyrometer is possible. This paper discusses a new temperature sensing approach and its application to determine the BPF.
Author
Temperature Measurement; Procedures; Turbine Engines; Temperature Sensors; Detection; Active Control

19990050930 DaimlerChrysler Aerospace A.G., Military Aircraft, Munich, Germany
Self-Induced Brake Torque Oscillations of Landing Gear as an Interaction of Non-Linear Tyre with Brake Control System
Luber, Wolfgang G., DaimlerChrysler Aerospace A.G., Germany; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 211-224; In English; See also 19990050911; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The paper describes Brake Torque Oscillations at Brake Initiation as a quasi self-induced oscillation due to the interaction of non-linear tyre circumferential force characteristics with the brake control system. Usual means to suppress oscillation (dampers or modification of landing gear geometry) are ineffective in this case. This case demonstrates that not only unsuitable combinations of structural stiffness, damping, and pneumatic tyre characteristics may lead to unexpected vibration problems on landing gears. Rather, an unlucky combination of brake system design with the peculiarities of circumferential force development by a tyre can also produce a serious vibration problem. In a series of development rig tests for a fighter aircraft brake system, some

tests were scheduled to demonstrate the fastest possible brake force rise at high speed. A fast brake force rise was considered to yield, at least in theory, the shortest possible landing ground run distance.
Author
Dynamic Structural Analysis; Landing Gear; Aircraft Brakes; Wheel Brakes; Braking; Oscillations

19990050931 Allied-Signal Aerospace Co., Aircraft Landing Systems, South Bend, IN USA
Nonlinear Transient Whirl Vibration Analysis of Aircraft Brake Systems
Chang, Craig F., Allied-Signal Aerospace Co., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 225-234; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The objective of this paper is to present a nonlinear transient analysis method for understanding and solving aircraft brake whirl vibration problems. Mathematical modeling and derivations of the brake mechanism, which include the hydraulic interaction between the brake and the fluid, will be discussed. The factors that influence whirl will be presented. Potential methods for resolving whirl vibration will also be discussed.
Author
Aircraft Brakes; Wheel Brakes; Aircraft Hydraulic Systems; Rotary Stability; Mathematical Models; Nonlinearity; Dynamic Structural Analysis; Rotation; Vibration

19990049272 Southwest Research Inst., San Antonio, TX USA
Reliability Study of Magneto-Optic (MOI) Imaging Inspection of C-5 Aircraft Fuselage
Fisher, Jay L., Southwest Research Inst., USA; Burkhardt, Gary L., Southwest Research Inst., USA; Stolte, Jeffrey S., Southwest Research Inst., USA; Buckingham, Janet P., Southwest Research Inst., USA; McKeighan, Peter C., Southwest Research Inst., USA; Fitzgerald, Jack, Southwest Research Inst., USA; Burkhardt, George, San Antonio Air Logistics Center, USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 230-239; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A program was recently conducted for the San Antonio Air Logistics Center (SA-ALC) at Kelly Air Force Base (AFB) to quantify the reliability of the magneto-optic eddy current imaging (MOI) inspection system developed by PRI Instrumentation for detecting defects in the skin of the C-5 aircraft fuselage. The primary emphasis was determination of probability of detection (POD) of first-layer cracks extending radially past the edge of the fastener head. Secondary goals were to make limited assessment of the capabilities of the MOI technique for detecting corrosion and second-layer cracks. In order to provide realistic POD estimates, experiments were conducted to identify significant variables-the range of test conditions and conditions found in aircraft that adversely affect the performance of the MOI system. Variables found to be significant included flaw orientation (parallel or perpendicular to the first layer edge), fastener-to-edge spacing, fastener-to-fastener spacing, fastener head height, paint thickness, skin curvature, and MOI excitation frequency and power level. Variables found to be not significant for first-layer flaws were fastener diameter, first- and second-layer thicknesses, and second-layer geometry. A statistically designed experimental program was developed to determine POD in aircraft conditions as determined from measurements taken on an aircraft. Specimens containing fatigue cracks were fabricated according to this experimental design. Procedures were written, and Kelly AFB inspectors were trained in the use of the MOI equipment and procedures. Four of the trained inspectors were given blind tests using the specimens. Separate tests were conducted with aluminum, titanium, and steel fasteners. The results were tabulated separately for each of the three different fastener types, and also separately for cracks that are connecting (i.e., that link two fasteners or a fastener and an edge) and nonconnecting. The Air Force criterion for acceptable performance was a POD of 90 percent with a 95-percent lower confidence bound for first-layer fatigue cracks 0.17 inch (4.3 mm) or more in radial length from the edge of the fastener head. The results were that this criterion could be met with aluminum and titanium fasteners for cracks which are nonconnecting. For connecting cracks, the criteria were almost met for aluminum and titanium fasteners. For steel fasteners, the criterion was not met in either case. As a result of this work, PRI Instrumentation has made improvements to the MOI system to address the difficulties found, and the POD tests will be repeated in the near future.
Author
Magneto-Optics; Imaging Techniques; Cracks; Fault Detection; C-5 Aircraft; Fuselages; Structural Analysis

19990049273 Northwestern Univ., Evanston, IL USA
Quantitative Investigation of Surface and Subsurface Cracks Near Rivets in Riveted Joints Using Acoustic, Electron and Optical Microscopy
Connor, Z. M., Northwestern Univ., USA; Fine, M. E., Northwestern Univ., USA; Achenbach, J. D., Northwestern Univ., USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 240-243h; In English; See also

19990049248; Sponsored in part by an Amelia Earhart fellowship from Zonta International; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The scanning acoustic microscope was previously shown to be useful for quantitatively investigating subsurface fatigue cracks at and near countersunk rivets in riveted lap joint specimens. Such cracks initially form on inner surfaces and are not visible on the outside surface. When combined with optical and electron microscopic examination of the surface and with fractography of fractured specimens, the formation and growth of subsurface cracks near rivets may be characterized in detail. A detailed study of crack formation and microcrack growth near rivets is presented. Observations were made on specimens fabricated from two pieces of Alclad 2024-T3 sheets riveted with 2017-T4 aluminum alloy flathead chamfered rivets. Specimens were fatigued in tension with an R ratio of 0.1. The interior crack lengths and crack growth rates as shown by the acoustic microscope are compared to the crack lengths and crack growth rates after the cracks broke the surface as shown by the light microscope. Plots of subsurface crack length vs. cycle number show slow almost linear growth vs. time. However, when the crack breaks through the outer surface, i.e., becoming a through the thickness crack, the crack growth rate increased rapidly. The length of the crack on the back surface of the countersunk panel remains longer than the length of the crack on the front surface of the specimen even with cracks several mm long; the growth rate along the crack front is constant. Fractographic examination of a specimen which was fatigued until a crack was just barely visible in the acoustic microscope but not seen on the surface reveals multiple cracks on each side of the rivet hole. The cracks in these specimens appears to be qualitatively identical to some cracks very close to single rivet cracks in full scale fuselage testing. FASTRAN II analysis, developed by Dr. James C. Newman, Jr. was performed, and the predictions of crack length vs. cycles from this analysis are compared to the results obtained in these experiments.

Author

Structural Analysis; Aircraft Structures; Cracks; Riveted Joints; Lap Joints; Crack Propagation; Crack Initiation; Microcracks; Microscopy; Applications Programs (Computers)

19990049274 Johns Hopkins Univ., Center for Nondestructive Evaluation, Baltimore, MD USA

Non-Contact Ultrasonic NDE Systems for Aging Aircraft

Green, Robert E., Jr., Johns Hopkins Univ., USA; Djordjevic, B. Boro, Johns Hopkins Univ., USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 244-251; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper will describe the advantages of non-contact ultrasonic systems under development for the early detection of fatigue and corrosion damage in aging aircraft.

Author

Ultrasonics; Fault Detection; Structural Analysis; Aircraft Structures; Systems Engineering

19990049275 NASA Langley Research Center, Hampton, VA USA

Evaluation of the Self-Nulling Rotating Eddy Current Probe System

Hagemaier, Don, Boeing Co., USA; Rengel, Kent, Boeing Co., USA; Wincheski, Buzz, NASA Langley Research Center, USA; Namkung, Min, NASA Langley Research Center, USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 252-264; In English; See also 19990049248; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

In order to detect multi-site fatigue cracks located under flush-head rivets, automated eddy current equipment is required. to assure a reliable system, the eddy current probe must be centered easily over the installed rivets. to meet these requirements, the NDE Group at NASA LaRC developed the Self-Nulling Rotating Eddy Current Probe System (SNRECPS) which will be referred to as RPS in this document. The system was evaluated at the FAA, NDI Validation Center, in Albuquerque, New Mexico. The system was capable of detecting a 0.032 inch long crack with a 90/95% PoD. Further evaluations were conducted at Boeing in Long Beach, California. These evaluations included fatigue cracks and notches in a range from 0.025 to 0.100 inch long under flush-head aluminum rivets, and titanium or steel flush-head fasteners. The results of these tests are reported herein. Subsequently, the system was loaned to the USAF Structures Laboratory for the purpose of detecting and measuring short cracks under flush-head rivets in a variety of fatigue test specimens. The inspection task was to detect and plot crack growth from numbered fasteners in lettered rows. In January, 1998, the system was taken to Northwest Airlines Maintenance Base, in Atlanta, to inspect a DC-9, for multi-site cracks in three circumferential splices. The aircraft had 83,000 cycles. The inspection was conducted at 30 kHz from longeron 5 left to longeron 5 right. The system was calibrated using a 0,030 EDM first layer notch. The instrument gain was set to 19 mV from the notch. The reject level was set at 10 mV and the unflawed fasteners yielded a signal amplitude of 2 to 3 mV. Only one fastener location, out of about 2,500 tested, yielded a signal of 58 mV. The rivet was removed and visually evaluated. It appeared to be a slight gouge in the counter-sink zone. No fatigue cracks were detected. The same fastener locations

were also inspected using the Boeing MAUS system at 60 kHz. No cracks were detected. Thus far, the rotating probe eddy current system has been found to be very user friendly and capable of detecting first layer cracks on the order of 0.030 inch long or longer. Author

Fault Detection; Cracks; Eddy Currents; Structural Analysis; Airframes; Riveted Joints

19990049276 Wayne State Univ., Inst. for Manufacturing Research, Detroit, MI USA

Thermal Wave NDI of Disbonds and Corrosion in Aircraft

Han, Xiao–Yan, Wayne State Univ., USA; Favro, L. D., Wayne State Univ., USA; Thomas, R. L., Wayne State Univ., USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 265-274; In English; See also 19990049248

Contract(s)/Grant(s): DTFA03-98-D-00008; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

We describe advances in the application of thermal wave imaging to NDI of disbonds and corrosion in aging aircraft. This technique uses an infrared (IR) video camera to image the surface of the aircraft after the application of a short pulse of heat. The heat is applied by high-power xenon flash lamps. The camera and flashlamps are connected to the control computer by a 50-ft cable. This design makes it highly portable, as well as suitable for robotic manipulation. The computer is used to process the digital video data stream from the IR camera, as well as to display the resulting images. The imaging requires only a few seconds per square foot of aircraft surface. The system is capable of detecting and measuring as little as 1% metal material loss. Disbonded metal-to-metal doublers are readily detected, and disbonds and delaminations in graphite and boron fiber composite structures can be imaged and their depths measured. Examples of disbonds as deep as 36 plies under a boron patch are presented, along with an example of discrimination of impact damage on a ply-by-ply basis in a carbon fiber composite.
Author

Aircraft Structures; Structural Analysis; Infrared Imagery; Imaging Techniques; Fault Detection; Delaminating; Debonding (Materials); Thermal Mapping; Corrosion

19990049277 Lehigh Univ., Dept. of Mechanical Engineering and Mechanics, Bethlehem, PA USA

Aging of Airframe Materials: Probability of Occurrence Versus Probability of Detection

Harlow, D. Gary, Lehigh Univ., USA; Wei, Robert P., Lehigh Univ., USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 275-283; In English; See also 19990049248

Contract(s)/Grant(s): F49620-96-1-0245; F49620-98-1-0198; FAA-92-G-0006; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The reliability of airworthiness assessment and the management of aging fleets of aircraft depend critically on the quality of tools for predicting damage nucleation and accumulation and its detection, i.e., on the interrelationship between the probabilities of occurrence and detection. To illustrate these interrelationships, a mechanistically based probability approach for one plausible scenario involving localized pitting corrosion and subsequent fatigue crack nucleation and growth is presented. A probability of detection based on typical non-destructive evaluation data is used for comparison and probabilistic assessment. The results suggest that the probability of detection using the state-of-the-art techniques is inadequate, and damage size should be quantitatively characterized as a part of an effective airworthiness assurance methodology. An appropriate nondestructive inspection target for damage sizes of about 0.10 mm with a probability of detection and a confidence level of sizing of at least 90% is suggested, versus the current capability of detection of 1.27 mm with a probability of detection of only 50%.
Author

Aging (Materials); Airframe Materials; Aircraft Reliability; Cumulative Damage; Fault Detection; Damage Assessment; Probability Theory

19990049278 Ogden Air Logistics Center, Hill AFB, UT USA

Crack Detection and Monitoring of Aging Airframes

Phelps, Neal, Ogden Air Logistics Center, USA; May, Scott, Department of the Air Force, USA; Haugse, Eric, Boeing Phantom Works, USA; Leeks, Tamara, Boeing Phantom Works, USA; Johnson, Pat, Boeing Phantom Works, USA; Ziola, Steve, Digital Wave Corp., USA; Dorighi, John, Digital Wave Corp., USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 284-293; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Reducing structural operation and support (O&S) costs is a primary objective for those responsible for system operation and sustainment. Flying aircraft longer and harder than originally expected, as we do today, makes this objective difficult to achieve. One way to reverse this trend and lower O&S costs of aging aircraft, is to perform automated inspections of the airframe. Present day computer technologies make it possible to install a small, autonomous computer and sensor system on an aircraft to monitor

difficult and costly to inspect structural locations. The health of the monitored location could be determined by the end user through normal operations (Standard Flight Data Recorder download) providing a significant reduction in scheduled maintenance. This paper will provide an overview of an approach that will autonomously detect and monitor crack growth in aircraft structures. The overview will discuss the final results developed under the AFRL F-16 Crack Monitoring System Proof of Concept Program, provide background on system requirements and summarize the preliminary design of the electronics and software necessary for on-aircraft crack monitoring.
Author
Aging (Materials); Airframes; Fault Detection; Crack Propagation; Systems Health Monitoring; Computer Techniques; Acoustic Emission

19990049280 Acoustic Emission Monitoring Services, Inc., Kingston, Ontario Canada
Use of Acoustic Emission Monitoring to Detect, Locate and Measure Multiple Site Damage (MSD) Fatigue Crack Growth Underneath Rivet Heads
McBride, Stuart L., Acoustic Emission Monitoring Services, Inc., Canada; Scott, Jason P., Carleton Univ., Canada; Eastaugh, Graeme F., Institute for Aerospace Research, Canada; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 303-312; In English; See also 19990049248
Contract(s)/Grant(s): DND-3GB12W7711-7-7370; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This presentation describes an investigation into the feasibility of using acoustic emission monitoring (AEM) for the detection and measurement of multiple site damage (MSD) fatigue cracks underneath the rivet heads of a fuselage skin splice during laboratory fatigue testing. There are currently no other known laboratory or in-service methods for the measurement of cracks under rivet heads. Furthermore, the only technique available for constructing crack growth curves for such situations is that of counting microscopic fatigue striations. A special MSD test specimen was used to simulate a fuselage splice. The specimen was manufactured from aluminum alloy 2024-T3 and was roughly representative of the skin splices in some pressurized transport aircraft fuselages. Constant amplitude fatigue loading was used to simulate fuselage pressurization cycles, and cracks were allowed to nucleate naturally, i.e., without the use of artificial notches. The four central rivet holes in the critical rivet row of the specimen were monitored using two pairs of piezo-electric sensors placed in a line 3.8 cm from the critical rivet row. The fatigue test was terminated shortly after "visual initiation" - the appearance of the first crack beyond a rivet head. Post-test analysis was performed using standard AEMS Inc. interactive software, except for some new algorithms that were developed to remove fretting and rubbing noise at each rivet location. Crack growth curves showing crack face area vs. cycles were constructed for the period of crack growth underneath the rivet heads. For these curves, the relationship between acoustic events and crack growth increments was obtained by a separate calibration test on a coupon specimen containing a single countersunk open hole. The AEM results were compared with fractographic measurements. The investigation indicated that the AEM techniques used could detect small hidden cracks under rivet heads and that it might be possible to obtain useful crack growth curves showing crack face area vs. cycles from AEM data alone. Individual crack growth curves could be obtained when there was only one crack on one side of a rivet hole. Otherwise, there was ambiguity in the time-of-flight data and only curves showing aggregate crack area could be constructed. Acoustic events translated into clearly defined crack growth curves at all the monitored holes. Such curves initiated at all holes at between 60% and 70% of the visual initiation period of the specimen, indicating that hidden MSD had developed long before the first crack was detected visually. The crack face areas associated with these AEM detection points were estimated to be about 0.1 sq. mm - i.e., about 10% of the area of a visibly detectable crack. Additional tests are planned to confirm the results, determine the consistency and accuracy with which crack growth curves can be constructed, and develop routine test and analysis procedures for application by trained (NDE) technicians.
Author
Acoustic Emission; Fault Detection; Damage; Fatigue (Materials); Crack Propagation; Riveted Joints; Fuselages; Lap Joints; Structural Analysis

19990049284 Sandia National Labs., Airworthiness Assurance NDI Validation Center, Albuquerque, NM USA
Evaluation of Commercial Thermography Systems for Quantitative Composite Inspection Applications
Valley, Michael T., Sandia National Labs., USA; Roach, Dennis P., Sandia National Labs., USA; Dorrell, Larry R., Sandia National Labs., USA; Ashbaugh, Dennis M., Science Applications International Corp., USA; Mullis, Roy T., Warner Robins Air Logistics Center, USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 339-348; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The expanded use of composite structures and the development of new composite repair techniques on U.S. Air Force (USAF) aircraft has created the need for improved portable, quantitative NDI methods and systems that can be used by field-level USAF NDI personnel. Recent advancements in thermal imaging technologies offer new inspection capabilities that can reliably meet

this need. As part of a multi-phase program to field this technology, commercially available thermography systems are being assessed in structured experiments and on-aircraft field evaluations. The recently completed structured experiments evaluated quantitative inspection capabilities for bonded composite repair doublers and composite honeycomb structures and repairs. Specifically, test specimens included real and simulated C-130 underwing doubler repairs, C-141 underwing and plank riser doublers, C-141 engine cowlings, and F-15 rudders. Specimen flaws included disbonds, delaminations, and water and hydraulic fluid ingress in both repaired and unrepaired structures. This paper discusses test specimen design, experiment results, and the suitability of thermography for each composite inspection task under consideration.
Author
Aircraft Structures; Thermography; Nondestructive Tests; Thermal Mapping; Fault Detection; Test Equipment

19990051020 Pennsylvania State Univ., Applied Research Lab., State College, PA USA
Condition Monitoring of Large-Scale Facilities
Hall, David L., Pennsylvania State Univ., USA; March 1999; 78p; In English; Original contains color illustrations
Contract(s)/Grant(s): NAG2-1182; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

This document provides a summary of the research conducted for the NASA Ames Research Center under grant NAG2-1182 (Condition-Based Monitoring of Large-Scale Facilities). The information includes copies of view graphs presented at NASA Ames in the final Workshop (held during December of 1998), as well as a copy of a technical report provided to the COTR (Dr. Anne Patterson-Hine) subsequent to the workshop. The material describes the experimental design, collection of data, and analysis results associated with monitoring the health of large-scale facilities. In addition to this material, a copy of the Pennsylvania State University Applied Research Laboratory data fusion visual programming tool kit was also provided to NASA Ames researchers.
Derived from text
Data Acquisition; Multisensor Fusion; Experiment Design; Feasibility; Aerodynamics; Fan Blades

19990047738 NASA Langley Research Center, Hampton, VA USA
Vibro-Acoustics Modal Testing at NASA Langley Research Center
Pappa, Richard S., NASA Langley Research Center, USA; Pritchard, Jocelyn I., Army Research Lab., USA; Buehrle, Ralph D., NASA Langley Research Center, USA; May 1999; 16p; In English; Aeroelasticity and Structural Dynamics, 22-25 Jun. 1999, Williamsburg, VA, USA; Sponsored by National Oceanic and Atmospheric Administration, USA
Contract(s)/Grant(s): RTOP 632-10-14-04
Report No.(s): NASA/TM-1999-209319; L-17851; NAS 1.15:209319; ARL-TR-1980; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This paper summarizes on-going modal testing activities at the NASA Langley Research Center for two aircraft fuselage structures: a generic "aluminum testbed cylinder" (ATC) and a Beechcraft Starship fuselage (BSF). Subsequent acoustic tests will measure the interior noise field created by exterior mechanical and acoustic sources. These test results will provide validation databases for interior noise prediction codes on realistic aircraft fuselage structures. The ATC is a 12-ft-long, all-aluminum, scale model assembly. The BSF is a 40-ft-long, all-composite, complete aircraft fuselage. To date, two of seven test configurations of the ATC and all three test configurations of the BSF have been completed. The paper briefly describes the various test configurations, testing procedure, and typical results for frequencies up to 250 Hz.
Author
Vibrational Stress; Acoustics; Fuselages; Noise Prediction (Aircraft); Aircraft Structures

19990049248 NASA Langley Research Center, Hampton, VA USA
The Second Joint NASA/FAA/DOD Conference on Aging Aircraft, Pt. 1
Harris, Charles E., Editor, NASA Langley Research Center, USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999; 422p; In English; Aging Aircraft, 31 Aug. - 3 Sep. 1998, Williamsburg, VA, USA; Sponsored by NASA Langley Research Center, USA; See also 19990049249 through 19990049288
Contract(s)/Grant(s): RTOP 538-10-00
Report No.(s): NASA/CP-1999-208982/PT1; L-17819A; NAS 1.55:208982/PT1; No Copyright; Avail: CASI; A18, Hardcopy; A04, Microfiche

The purpose of the Conference was to bring together world leaders in aviation safety research, aircraft design and manufacturing, fleet operation and aviation maintenance to disseminate information on current practices and advanced technologies that will assure the continued airworthiness of the aging aircraft in the military and commercial fleets. The Conference included reviews of current industry practices, assessments of future technology requirements, and status of aviation

safety research. The Conference provided an opportunity for interactions among the key personnel in the research and technology development community, the original equipment manufacturers, commercial airline operators, military fleet operators, aviation maintenance, and aircraft certification and regulatory authorities. Conference participation was unrestricted and open to the international aviation community.
Author
Aircraft Maintenance; Aging (Materials); Fatigue (Materials); Structural Reliability; Cumulative Damage; Aircraft Structures; Aircraft Reliability; Conferences

19990049256 Naval Aviation Depot, Office of Research and Engineering, San Diego, CA USA
An Application of Fracture Mechanics Principles in Determining a Service Life Enhancement Interval for the US Navy's C-2 Outer Wing
Hocson, Alex R., Naval Aviation Depot, USA; White, Tommy N., Naval Aviation Depot, USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 63-69; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Navy's C-2 aircraft have suffered unaccounted fatigue damage from a phenomenon not considered a likely source during the original design and determination of their service life. This phenomenon, the addition of spectral loading caused by thermal expansion of the outer wing panels (OWP's) in a stowed condition when exposed to turbine engine exhaust, produced compressive field stresses in the wing's lower skin. These compressive stress magnitudes were as much as 30 to 40 percent of the lower skin field stresses experienced from maximum service loads. As such, this unaccounted condition has diminished the projected useable life of the affected structure. Structural enhancements to extend the wing's fatigue life are being developed and tested to establish an extended service life. This effort requires a corrected useable life for the original design so as to establish a suitable life interval for enhancement incorporation. Since fleet requirements preclude the time necessary to accomplish an additional fatigue test incorporating the thermal loading, a tear down examination of several relatively high service time outer wing panels was elected as a representative and conservative sample of fleet assets. The tear down revealed small embedded cracks, less in size than what is normally accepted as an initial flaw size for damage tolerance philosophy. Because safe life predictions incorporating thermal expansion effects were considerably less than the tear down specimen lives, a life to a removable flaw size, was desired for establishing an enhancement life. to accomplish this, a modified damage tolerance approach was adopted. to obtain the required life, crack growth data from thermally adjusted spectrum tested coupons was used. The life for a flaw equivalent to the tear down findings to grow to a removable, thus repairable flaw size, was determined and combined with the thermally adjusted life of the full scale fatigue test (FSFT) article. This combined life was then factored with the appropriate scatter factors, as dictated by Navy safe life policy, to obtain a life interval needed to define the enhancement schedule.
Author
C-2 Aircraft; Fracture Mechanics; Service Life; Crack Propagation; Wing Panels; Structural Analysis; Fatigue (Materials)

19990049257 Fatigue Technology, Inc., Seattle, WA USA
Determining and Attaining Realistic Inspection Thresholds to Meet Durability and Damage Tolerance Requirements
Reid, Len, Fatigue Technology, Inc., USA; Restis, Jude, Fatigue Technology, Inc., USA; Swift, Tom, Fatigue Technology, Inc., USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 70-78; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A recent revision to the regulations governing fatigue and damage tolerance for commercial aircraft (FAR 25.571 amdt. 96) requires inspection thresholds for certain types of structure based on crack growth from likely initial defects. The industry challenge is how to economically achieve these requirements in new design. For certain situations, the USAF currently allows the damage tolerance analysis to take credit for fatigue enhancement fastening systems and cold expanded holes by assuming a smaller initial flaw size. Testing and in-service experience has shown this method to be conservative. More quantitative means of accounting for the benefits of these fatigue-enhancing processes is needed. A method of determining a "modified" stress intensity factor for fastener holes that have been processed to be fatigue resistant, using split sleeve cold expansion, was developed by Boeing Wichita. This paper compares the smaller initial flaw size concept and the Boeing method for predicting crack growth life with hole cold expansion to determine inspection thresholds.
Author
Commercial Aircraft; Aircraft Structures; Crack Propagation; Holes (Mechanics); Tolerances (Mechanics); Structural Analysis; Fatigue (Materials)

19990049262 Aerospatiale Aeronautique, Dept. A/BTE/CC/CM, Toulouse, France

An Engineering Approach to the Assessment of Widespread Fatigue Damage in Aircraft Structures

Balzano, Marc, Aerospatiale Aeronautique, France; Beaufils, Jean–Yves, Aerospatiale Aeronautique, France; Santgerma, Alain, Aerospatiale Aeronautique, France; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 124-131; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

According to the recommendations of Advisory Circular AC91-56A, a full structural evaluation for Widespread Fatigue Damage (WFD) will be completed at Aerospatiale as part of the Airbus A300 extended service life activities. The approach followed in this evaluation is based on a specific calculation method, supported by experimental results provided by tear-down and analysis on a full-scale fatigue test and representative component tests. Research activities on the WFD phenomenon were done at Aerospatiale a few years ago in the framework of a thesis conducted concurrently with European research program on the same subject. Based on the Finite Element Method and Monte-Carlo simulations, an overall prediction method has been developed to automatically simulate multiple crack development in a structure in a realistic way. The two main particularities of this phenomenon, scatter at crack initiation and interaction effects, are taken into account. The same process allows different ranges of analysis to be completed, depending on the required objective. Calculation results have been successfully compared with tests performed on simple open hole and lap joint structures. This approach is now applied to the A300 aircraft structure.
Author

Damage Assessment; Aircraft Structures; Structural Analysis; Crack Initiation; Crack Propagation; Fatigue (Materials)

19990049263 Battelle Memorial Inst., Columbus, OH USA

Transport Risk Assessment Containing Widespread Fatigue Damage: TRACWFD Analyses of Longitudinal and Circumferential Splice Joints to Determine the Onset of Widespread Fatigue Damage and its Probability of Occurrence

Kurth, Robert E., Battelle Memorial Inst., USA; Bigelow, Catherine A., Federal Aviation Administration, USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 132-144; In English; See also 19990049248; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A probabilistic analysis tool has been developed over the last two years to assess the damage progression in aging aircraft and such damage's impact on the onset of widespread fatigue damage, the residual strength, and maintenance and inspections. The analysis tool combines the results of previous Federal Aviation Administration, US Air Force, and National Aeronautics and Space Administration developments into a fast, efficient mechanics model for the aging aircraft fleet. Studies have been concluded examining a narrow-body jet longitudinal lap splice, wing, and circumferential lap and butt splices. Several predictions of the time-dependent probability of the onset of widespread fatigue damage and the loss of residual strength have been made. More importantly, the minimum crack sizes that must be able to be detected to maintain a risk level have been predicted. Times between inspections, the impact of wall thinning due to corrosion, and initiation predictions can be studied with this tool. This paper will present an overall description of the model and some of the results generated to date.
Author

Damage Assessment; Fatigue (Materials); Aircraft Structures; Structural Analysis; Residual Strength; Crack Initiation; Crack Propagation; Cracking (Fracturing); Lap Joints

19990049266 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia

Ensuring Damage Tolerance of Aging Aircraft Structures

Nesterenko, Grigory I., Tsentralni Aerogidrodinamicheskii Inst., Russia; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 163-172; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The principles of ensuring damage tolerance in Russian aging aircraft structures are outlined. The test scopes are presented for fatigue and damage tolerance tests of full-scale structures for various new and long-operated aircraft. The residual strength study results are generalized for full-scale wing and fuselage structures of various aircraft types affected by widespread fatigue damages (WFD). Test values of crack resistance for the specimens cut out of new materials are compared with those taken from long-operated aircraft wing and fuselage skins. Test data in fatigue and damage tolerance of new and long-operated structures are presented. The results are given of determining corrosion damage growth time by measurement of corrosion in high-time structures using probabilistic methods. The examples are presented of operating the aging aircraft structures with cracks.
Author

Aircraft Structures; Tolerances (Mechanics); Fatigue Tests; Fatigue (Materials); Cumulative Damage; Residual Strength; Structural Analysis

19990050913 Manchester Univ., Dynamics and Aeroelasticity Research Group, UK

A Combined Modal/Finite Element Analysis Technique for Nonlinear Beam Dynamic Response Under Harmonic Excitation

McEwan, Matthew I., Manchester Univ., UK; Wright, Jan R., Manchester Univ., UK; Cooper, Jonathan E., Manchester Univ., UK; Leung, Andrew Y. T., Manchester Univ., UK; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 13-22; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A method is proposed for modelling multi-mode large deflection beam response. Significant savings in computational time can be obtained compared with the direct integration nonlinear finite element method. The deflections from a number of static nonlinear finite element test cases are transformed into modal co-ordinates using the modes of the underlying linear system. Regression analysis is then used to find the unknown nonlinear modal stiffness coefficients. The governing nonlinear equations of motion are completed by including finite element derived modal mass, and an arbitrary damping model. The response of the beam to excitation of an arbitrary nature may then be found using time domain numerical integration. The work presented here extends upon the work of previous researchers to include non-coupled multi-modal response, and the effect of buckling due to axial loads. The proposed method is applied to the case of a homogeneous isotropic beam, which is simply supported and axially constrained at both ends. For the case of steady state harmonic excitation, results are compared with the direct integration nonlinear finite element method.

Author

Modal Response; Finite Element Method; Dynamic Response; Harmonic Excitation; Aeroelasticity; Dynamic Structural Analysis; Beams (Supports); Thermal Buckling

19990050928 Old Dominion Univ., Dept. of Aerospace Engineering, Norfolk, VA USA

Nonlinear Response of Composite Panels Under Combined Acoustic Excitation and Aerodynamic Pressure

Abdel–Motagaly, K., Old Dominion Univ., USA; Duan, B., Old Dominion Univ., USA; Mei, C., Old Dominion Univ., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 189-200; In English; See also 19990050911

Contract(s)/Grant(s): NAG1-2150; F33615-91-C-3205; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A finite element formulation is presented for the analysis of large deflection response of composite panels subjected to aerodynamic pressure- at supersonic flow and high acoustic excitation. The first-order shear deformation theory is considered for laminated composite plates, and the von Karman nonlinear strain-displacement relations are employed for the analysis of large deflection panel response. The first-order piston theory aerodynamics and the simulated Gaussian white noise are employed for the aerodynamic and acoustic loads, respectively. The nonlinear equations of motion for an arbitrarily laminated composite panel subjected to a combined aerodynamic and acoustic pressures are formulated first in structure node degrees-of-freedom. The system equations are then transformed and reduced to a set of coupled nonlinear equations in modal coordinates. Modal participation is defined and the in-vacuo modes to be retained in the analysis are based on the modal participation values. Numerical results include root mean square values of maximum deflections, deflection and strain response time histories, probability distributions, and power spectrum densities. Results showed that combined acoustic and aerodynamic loads have to be considered for panel analysis and design at high dynamic pressure values.

Author

Acoustic Excitation; Composite Structures; Deflection; Finite Element Method; Dynamic Response; Aerodynamic Loads; Aeroelasticity; Dynamic Pressure; Panel Flutter; Modal Response; Rectangular Plates; Time Domain Analysis

19990051026 Washington Univ., Dept. of Aeronautics and Astronautics, Seattle, WA USA

Analytic Sensitivity and Approximation of Skin Buckling Constraints in Wing-Shape Synthesis

Livne, Eli, Washington Univ., USA; Milosavljevic, Radomir, Washington Univ., USA; Journal of Aircraft; October 1995; Volume 32, No. 5, pp. 1102-1113; In English

Contract(s)/Grant(s): NAG2-723; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

Explicit expressions for terms of the stiffness and geometric stiffness matrices are derived for the buckling analysis of trapezoidal fiber composite wing skin panels. The formulation is based on Ritz analysis using simple polynomials, and leads to explicit expressions for the analytic sensitivities of the stiffness and geometric stiffness matrices with respect to layer thickness, fiber directions, and panel shape. Integration with wing box analysis using either the equivalent plate approach or the finite element method, makes it possible to obtain sensitivities of panel buckling constraints with respect to wing planform shape or locations

of internal ribs and spars. The analytic sensitivities are used to construct approximations of panel buckling constraints for integrated wing/panel design synthesis.
Author
Stiffness Matrix; Buckling; Composite Structures; Fiber Composites; Wing Planforms; Finite Element Method; Sensitivity

19990052679 Japan Atomic Energy Research Inst., Center for Promotion of Computational Science and Engineering, Tokyo, Japan
Multidisciplinary Aero-Structural Modeling on Parallel Computers
Onishi, Ryoichi, Japan Atomic Energy Research Inst., Japan; Kimura, Toshiya, Japan Atomic Energy Research Inst., Japan; Guo, Zhigong, Institute of Physical and Chemical Research, Japan; Iwamiya, Toshiyuki, National Aerospace Lab., Japan; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 483-490; In English; See also 19990052675; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The system for coupled aero-structural analysis has been implemented on a distributed-parallel processing environment at Japan Atomic Energy Research Institute(JAERI). The system is based on loose coupling of CFD(Computational Fluid Dynamics) and CSD(Computational Structural Dynamics), solves fluid and structural equations concurrently exchanging each solution data, and has been applied to the dynamic aeroelastics problem of a high aspect-ratio swept-back wing. The analytical model of skin, spar, and rib construction of a wing box structure was created and used for aero-structural computations. Parallel and distributed approaches employed in the system is efficient for multidisciplinary applications.
Author
Aeroelasticity; Dynamic Structural Analysis; Multidisciplinary Design Optimization; Parallel Processing (Computers); Dynamic Response; Structural Design

19990052680 Oklahoma Univ., Norman, OK USA
Astros*: Seamless Integration of Astros with a Unified Aerodynamic Module: Applications Benchmarking and Testing
Striz, A. G., Oklahoma Univ., USA; Jung, S. Y., Oklahoma Univ., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 491-500; In English; See also 19990052675
Contract(s)/Grant(s): F33615-96-C-3217; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This paper reports application cases to benchmark and test the analysis capabilities of the seamless integration of the Automated STRuctural Optimization System (ASTROS) with a unified steady/unsteady aerodynamics module (ZAERO) called ASTROS*. With these unified aerodynamics, ASTROS* can now perform analysis and design optimization for realistic wing-body configurations throughout the linear subsonic/supersonic and the nonlinear transonic/hypersonic flight regimes. Three fully-built up wing/fuselage models were used to validate ASTROS* and to show its applicability in all Mach number ranges.
Author
Unsteady Aerodynamics; Body-Wing Configurations; Optimization; Applications Programs (Computers); Dynamic Structural Analysis; Aeroelasticity; Flutter Analysis

19990052684 Alberta Univ., Dept. of Mathematical Sciences, Edmonton, Alberta Canada
Application of the Centre Manifold Theory in Nonlinear Aeroelasticity
Liu, L., Alberta Univ., Canada; Wong, Y. S., Alberta Univ., Canada; Lee, B. H. K., National Research Council of Canada, Canada; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 533-542; In English; See also 19990052675; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

In dynamic response investigations of aircraft structures, classical theories assume linear aerodynamics and linear structures, so that the aeroelastic equations can be reduced to a set of linear equations that can be readily solved. However, in many instances, linear aerodynamics give insufficiently accurate results. For example, when the airspeed approaches transonic Mach numbers, linear theory fails to detect the transonic dip and other phenomena associated with the presence of shock waves. Aircraft structures also can have nonlinearities that affect not only the flutter speed, but also the characteristics of the dynamical response. Hence, to obtain a better understanding of the physical and mathematical aspect of non-linear aeroelasticity, recent research has been directed towards the study of these two types of nonlinearities. Lee et. al. studied a two-degree-of-freedom aeroelastic system with a structural nonlinearity represented by a cubic restoring spring force. When the system is subject to an external forcing term with driving frequency w, Lee et. al. derived analytical formulae that provide amplitude-frequency relationships for the pitch and plunge motion, respectively. However, for a self-excited system (i.e. in the absence of external forcing term), the reference frequency w is not known, and the motion can not be determined from the amplitude-frequency relationships they derived. Several procedures were discussed to estimate the frequency value w for the self-excited system, but the results were not satisfactory except when the velocity U* is very close to the linear flutter speed U*(sub L). to overcome this limitation in Lee et. al. analysis,

we apply the centre manifold theory of Carr and the principal of normal form, to derive a frequency relation for self-excited motion of a two-degree-of-freedom nonlinear system. Using the frequency equation and the amplitude- frequency relationships, limit cycle oscillation (LCO) for self-excited system can be predicted analytically.
Derived from text
Aeroelasticity; Dynamic Response; Flutter; Nonlinear Systems; Aircraft Structures; Mathematical Models; Airfoil Oscillations

19990052688 Defence Science and Technology Organisation, Aereonautical and Maritime Research Lab., Airframes and Engines Div., Melbourne, Australia
Creation of a Finite Element Model for F/A-18 Structural Dynamic Analyses Based on Ground Vibration Test Data
Dunn, S. A., Defence Science and Technology Organisation, Australia; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 2, pp. 585-594; In English; See also 19990052675; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

In this paper, a technique for creating structural dynamic models directly from experimental data is proposed. The method is based on having a finite element model with prescribed geometry for nodes and beams and using the artificial intelligence optimisation tool of genetic algorithms. The aim is then to create an optimal model by selecting mass and stiffness properties such that the resulting model gives the best approximation to the real data. Such a process has been the subject of a number of earlier papers by the author and in this paper, results are presented for the creation of a complete aircraft model with symmetric boundary conditions based on actual ground vibration test data.
Author
Dynamic Models; Genetic Algorithms; Mathematical Models; Optimization; Aircraft Models; Finite Element Method; Dynamic Structural Analysis

14
LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.

19990047594 Georgia Inst. of Tech., School of Literature, Communications and Culture, Atlanta, GA USA
Cultural Variability in Crew Discourse
Fischer, Ute, Georgia Inst. of Tech., USA; [1999]; 41p; In English
Contract(s)/Grant(s): NCC2-933; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Four studies were conducted to determine features of effective crew communication in response to errors during flight. Study One examined whether US captains and first officers use different communication strategies to correct errors and problems on the flight deck, and whether their communications are affected by the two situation variables, level of risk and degree of face-threat involved in challenging an error. Study Two was the cross-cultural extension of Study One and involved pilots from three European countries. Study Three compared communication strategies of female and male air carrier pilots who were matched in terms of years and type of aircraft experience. The final study assessed the effectiveness of the communication strategies observed in Study One.
Author
Culture (Social Sciences); Flight Crews; Aircraft Pilots; Anthropology; Communication

15
MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

19990050940 NASA Langley Research Center, Hampton, VA USA
A Survey of Shape Parameterization Techniques
Samareh, Jamshid A., NASA Langley Research Center, USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 333-344; In English; See also 19990050911; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper provides a survey of shape parameterization techniques for multidisciplinary optimization and highlights some emerging ideas. The survey focuses on the suitability of available techniques for complex configurations, with suitability criteria

based on the efficiency, effectiveness, ease of implementation, and availability of analytical sensitivities for geometry and grids. The paper also contains a section on field grid regeneration, grid deformation, and sensitivity analysis techniques.
Author
Parameterization; Multidisciplinary Design Optimization; Mathematical Models; Shape Functions; Aircraft Design

19990049251 Ogden Air Logistics Center, Hill AFB, UT USA
Tracking Aircraft Structural Repairs From a Fleet Risk Management and Economic Standpoint
Giese, Robert D., Ogden Air Logistics Center, USA; Herring, Grant D., Ogden Air Logistics Center, USA; Bockman, James F., Ogden Air Logistics Center, USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 21-28; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The F-4 Structures Group at Hill AFB, UT has developed an Aircraft Structural Integrity Program (ASIP) management and engineering support software system. This software, called FLEETLIFE, includes analytical, fatigue tracking, individual aircraft tracking, configuration management, repair tracking, and other modules. These modules are designed to support the ASIP engineer and fleet manager in assuring the structural integrity of a fleet of aircraft. This paper will detail the risk management and economic aspects of the repair tracking module. In the repair tracking module all data concerning the details of structural repairs are cataloged. These details include the deficiency necessitating the repair, the action taken, and all archiving data. Several enhancements are in work for the software. One of these enhancements is the incorporation of cost and economic information into the repair tracking module. This paper will describe the effort, the approach and working solution for this effort. It will detail the incorporation of economic data into the repair tracking module and database. Repair cost data fields have been added to the database structure. The query engine has been defined to include search and accumulation of cost data. The cost data can be searched by repair discrepancy type. In this fashion, for example, the repair costs for corrosion initiated repairs can be retrieved. The report feature has also been modified to provide repair and modification costs trends. The module has been modified to track engineering hours, repair installation hours and repair material costs. The report feature can total these costs, determine average repair costs and can total repair costs per tail number. This data, while certainly not complete will be necessary inputs for a fleet economic life model. The paper will detail the approach used to track the types of discrepancies and how these discrepancies were detected. The types of discrepancies are, for example, corrosion, corrosion fatigue, fatigue, overstress, impact damage, and others. Examples of how discrepancies were detected are, routine inspections, special inspections, heavy maintenance, other maintenance, and others. Data concerning the types and magnitudes of discrepancies are accumulated. In this fashion trends can be detected and fleet risk lowered. Also, data concerning how defects are found and therefore the most effective inspection methods will be accumulated. The paper also describes in detail the database structure, look of the user interface windows, and report features.
Author
Aircraft Maintenance; Structural Analysis; Documentation; Data Management; Economics

19990049420 NASA Glenn Research Center, Cleveland, OH USA
An Automated Code Generator for Three-Dimensional Acoustic Wave Propagation with Geometrically Complex Solid Wall Boundaries
Dyson, Rodger William, Jr., NASA Glenn Research Center, USA; June 1999; 354p; In English
Contract(s)/Grant(s): RTOP 538-03-11
Report No.(s): NASA/TM-1999-209182; E-11691; NAS 1.15:209182; No Copyright; Avail: CASI; A16, Hardcopy; A03, Microfiche

Finding the sources of noise generation in a turbofan propulsion system requires a computational tool that has sufficient fidelity to simulate steep gradients in the flow field and sufficient efficiency to run on today's computer systems. The goal of this dissertation was to develop an automated code generator for the creation of Software that numerically solves the linearized Euler equations on Cartesian grids in three dimensional spatial domains containing bodies with complex shapes. It is based upon the recently developed Modified Expansion Solution Approximation (MESA) series of explicit finite-difference schemes that provide spectral-like resolution with extraordinary efficiency. The accuracy of these methods can, in theory, be arbitrarily high in both space and time, without the significant inefficiencies of Runge-Kutta based schemes. The complexity of coding these schemes was, however. very high, resulting in code that could not compile or took so long to write in FORTRAN that they were rendered impractical. Therefore, a tool in Mathematica was developed that could automatically code the MESA schemes into FORTRAN and the MESA schemes themselves were reformulated into a very simple form, making them practical to use without automation or very powerful with it. A method for automatically creating the MESA propagation schemes and their FORTRAN code in two and three spatial dimensions, is shown with up to 29th order accuracy in space and time. Also, a method for treating solid wall boundaries in two dimensions is shown with up to 11th order accuracy on grid aligned boundaries and with up to 2nd

order accuracy on generalized boundaries. Finally, an automated method for parallelizing these approaches on large scale parallel computers with near perfect scalability is presented. All these methods are combined to form a turnkey code generation tool in Mathematica that once provided the CAD geometry file can automatically simulate the acoustical physics by replacing the traditionally labor intensive tasks of grid generation. algorithm development, FORTRAN coding, and wall boundary treatments with automated algorithmic procedures.
Author
Cartesian Coordinates; Finite Difference Theory; Applications Programs (Computers); Computer Aided Design; Wave Propagation; Computer Programming; Grid Generation (Mathematics); Aeroacoustics; Aerodynamic Noise; Software Development Tools; Euler Equations of Motion

19990052867 SRI International Corp., Menlo Park, CA USA
Partitioning in Avionics Architectures: Requirements, Mechanisms, and Assurance
Rushby, John, SRI International Corp., USA; June 1999; 75p; In English
Contract(s)/Grant(s): NAS1-20334; RTOP 519-51-11-01
Report No.(s): NASA/CR-1999-209347; NAS 1.26:209347; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

Automated aircraft control has traditionally been divided into distinct "functions" that are implemented separately (e.g., autopilot, autothrottle, flight management); each function has its own fault-tolerant computer system, and dependencies among different functions are generally limited to the exchange of sensor and control data. A by-product of this "federated" architecture is that faults are strongly contained within the computer system of the function where they occur and cannot readily propagate to affect the operation of other functions. More modern avionics architectures contemplate supporting multiple functions on a single, shared, fault-tolerant computer system where natural fault containment boundaries are less sharply defined. Partitioning uses appropriate hardware and software mechanisms to restore strong fault containment to such integrated architectures. This report examines the requirements for partitioning, mechanisms for their realization, and issues in providing assurance for partitioning. Because partitioning shares some concerns with computer security, security models are reviewed and compared with the concerns of partitioning.
Author
Automatic Flight Control; Avionics; Computer Information Security; Fault Tolerance; Distributed Processing; Architecture (Computers)

19990050918 Air Force Seek Eagle Office, Eglin AFB, FL USA
Limit Cycle Oscillation Prediction using Artificial Neural Networks
Denegri, Charles M., Jr., Air Force Seek Eagle Office, USA; Johnson, Michael R., Air Force Seek Eagle Office, USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 71-80; In English; See also 19990050911; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A static artificial neural network in the form of a multi-layer perceptron is investigated to determine its ability to predict linear and nonlinear flutter response characteristics. The network is developed and trained using linear flutter analysis and flight test results from a fighter test. Eleven external store carriage configurations are used as training data and three configurations are used as test cases. The network was successful in predicting the aeroelastic oscillation frequency and amplitude responses over a range of Mach numbers for two of the test cases. Predictions for the third test case were not as good. Several network sizes were investigated and it was found that small networks tended to over-generalize the training data and are not capable of accurate prediction beyond the sample space. Conversely, networks that were too large, or trained to error levels that were extreme, tended to memorize the training data, and are also unable to produce adequate predictions beyond the sample space. The results of this study indicate that relatively simple networks using small training sets can be used to predict both linear and nonlinear flutter response characteristics.
Author
Aeroelasticity; Flutter Analysis; Neural Nets; Dynamic Response; Wing Oscillations

19990050945 NASA Langley Research Center, Hampton, VA USA
Aerodynamic and Aeroelastic Insights using Eigenanalysis
Heeg, Jennifer, NASA Langley Research Center, USA; Dowell, Earl H., Duke Univ., USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 403-414; In English; See also 19990050911; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper presents novel analytical results for eigenvalues and eigenvectors produced using discrete time aerodynamic and aeroelastic models. An unsteady, incompressible vortex lattice aerodynamic model is formulated in discrete time; the importance

of several modeling parameters is examined. A detailed study is made of the behavior of the aerodynamic eigenvalues both in discrete and continuous time. The aerodynamic model is then incorporated into aeroelastic equations of motion. Eigenanalyses of the coupled equations produce stability results and modal characteristics which are valid for critical and non-critical velocities. Insight into the modeling and physics associated with aeroelastic system behavior is gained by examining both the eigenvalues and the eigenvectors. Potential pitfalls in discrete time model construction and analysis are examined.
Author
Eigenvalues; Eigenvectors; Unsteady Aerodynamics; Aeroelasticity; Dynamic Models; Equations of Motion; Dynamic Structural Analysis

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PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

19990047458 General Electric Co., Aircraft Engines, Cincinnati, OH USA
Acoustic Treatment Design Scaling Methods, Volume 1, Overview, Results, and Recommendations
Kraft, R. E., General Electric Co., USA; Yu, J., Rohr Industries, Inc., USA; April 1999; 26p; In English
Contract(s)/Grant(s): NAS3-26617; RTOP 538-03-12-02
Report No.(s): NASA/CR-1999-209120/VOL1; NAS 1.26:209120/VOL1; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Scale model fan rigs that simulate new generation ultra-high-bypass engines at about 1/5-scale are achieving increased importance as development vehicles for the design of low-noise aircraft engines. Testing at small scale allows the tests to be performed in existing anechoic wind tunnels, which provides an accurate simulation of the important effects of aircraft forward motion on the noise generation. The ability to design, build, and test miniaturized acoustic treatment panels on scale model fan rigs representative of the fullscale engine provides not only a cost-savings, but an opportunity to optimize the treatment by allowing tests of different designs. The primary objective of this study was to develop methods that will allow scale model fan rigs to be successfully used as acoustic treatment design tools. The study focuses on finding methods to extend the upper limit of the frequency range of impedance prediction models and acoustic impedance measurement methods for subscale treatment liner designs, and confirm the predictions by correlation with measured data. This phase of the program had as a goal doubling the upper limit of impedance measurement from 6 kHz to 12 kHz. The program utilizes combined analytical and experimental methods to achieve the objectives.
Author
Acoustic Properties; Aircraft Engines; Frequency Ranges; Impedance Measurement; Mathematical Models; Scale Models

19990047903 Boeing Co., Mesa, AZ USA
Implementation of a Trailing-Edge Flap Analysis Model in the NASA Langley CAMRAD.MOD1/Hires Program
Charles, Bruce, Boeing Co., USA; May 1999; 82p; In English
Contract(s)/Grant(s): NAS1-20096; RTOP 538-07-14-10
Report No.(s): NASA/CR-1999-209327; NAS 1.26:209327; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

Continual advances in rotorcraft performance, vibration and acoustic characteristics are being sought by rotary-wing vehicle manufacturers to improve efficiency, handling qualities and community noise acceptance of their products. The rotor system aerodynamic and dynamic behavior are among the key factors which must be addressed to meet the desired goals. Rotor aerodynamicists study how airload redistribution impacts performance and noise, and seek ways to achieve better airload distribution through changes in local aerodynamic response characteristics. One method currently receiving attention is the use of trailing-edge flaps mounted on the rotor blades to provide direct control of a portion of the spanwise lift characteristics. The following work describes the incorporation of a trailing-edge flap model in the CAMRAD.Mod1/FHUS comprehensive rotorcraft analysis code. The CAM-RAD.Mod1/HIRES analysis consists of three separate executable codes. These include the comprehensive trim analysis, CAMRAD.Mod1, the Indicial Post-Processor, IPP, for high resolution airloads, and AIRFOIL, which produces the rotor airfoil tables from input airfoil section characteristics. The modifications made to these components permitting analysis of flapped rotor configurations are documented herein along with user instructions detailing the new input variables and operational notes.
Author
Aerodynamic Characteristics; Trailing Edge Flaps; Aerodynamic Loads; Dynamic Characteristics; Noise Pollution; Airfoils

19990047908 GTE Internetworking Services, Cambridge, MA USA

Active Control of Fan Noise by Vane Actuators *Final Report*

Curtis, Alan R. D., GTE Internetworking Services, USA; May 1999; 84p; In English

Contract(s)/Grant(s): NAS1-20101; RTOP 538-03-11

Report No.(s): NASA/CR-1999-209156; NAS 1.26:209156; E-11704; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

An active noise control system for ducted fan noise was built that uses actuators located in stator vanes. The actuators were piezoelectric benders manufactured using the THUNDER technology and were custom designed for the application. The active noise control system was installed in the NASA ANCF rig. Four actuator array with a total of 168 actuators in 28 stator vanes were used. Simultaneous reductions of acoustic power in both the inlet and exhaust duct were demonstrated for a fan disturbance that contained two radial mode orders in both inlet and exhaust. Total power levels in the target modes were reduced by up to 9 dB in the inlet and total tone levels by over 6 dB while exhaust power levels were reduced by up to 3 dB. Far field sound pressure level reductions of up to 17 dB were observed. A simpler control system, matched to the location of the disturbance with two radial actuator arrays, was demonstrated to control total acoustic power in four disturbance modes simultaneously in inlet and exhaust. The vane actuator met the requirements given for the ANCF, although in practice the performance of the system was limited by the constraints of the power amplifiers and the presence of control spillover. The vane actuators were robust. None of the 168 vane actuators failed during the tests.

Author

Active Control; Aerodynamic Noise; Noise Reduction; Piezoelectricity

19990050921 NASA Langley Research Center, Hampton, VA USA

Vibro-Acoustics Modal Testing at NASA Langley Research Center

Pappa, Richard S., NASA Langley Research Center, USA; Pritchard, Jocelyn I., NASA Langley Research Center, USA; Buehrle, Ralph D., NASA Langley Research Center, USA; CEAS/AIAA/ICASE/NASA Langley International Forum on Aeroelasticity and Structural Dynamics 1999; June 1999, Pt. 1, pp. 101-114; In English; See also 19990050911; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

This paper summarizes on-going modal testing activities at the NASA Langley Research Center for two aircraft fuselage structures: a generic "aluminum testbed cylinder" (ATC) and a Beechcraft Starship fuselage (BSF). Subsequent acoustic tests will measure the interior noise field created by exterior mechanical and acoustic sources. These test results will provide validation databases for interior noise prediction codes on realistic aircraft fuselage structures. The ATC is a 12-ft-long, all-aluminum, scale model assembly. The BSF is a 40-ft-long, all-composite, complete aircraft fuselage. To date, two of seven test configurations of the ATC and all three test configurations of the BSF have been completed. The paper briefly describes the various test configurations, testing procedure, and typical results for frequencies up to 250 Hz.

Author

Aircraft Noise; Modal Response; Noise Measurement; Acoustics; Vibration Mode; Frequency Response; Noise Prediction (Aircraft)

19990052630 General Electric Co., Aircraft Engines, Cincinnati, OH USA

Acoustic Treatment Design Scaling Methods, Volume 4, Numerical Simulation of the Nonlinear Acoustic Impedance of a Perforated Plate Single-Degree-of-Freedom Resonator Using a Time-Domain Finite Difference Method

Kraft, R. E., General Electric Co., USA; April 1999; 50p; In English

Contract(s)/Grant(s): NAS3-26617; RTOP 538-03-12-02

Report No.(s): NASA/CR-1999-209120/VOL4; NAS 1.26:209120/VOL4; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Single-degree-of-freedom resonators consisting of honeycomb cells covered by perforated facesheets are widely used as acoustic noise suppression liners in aircraft engine ducts. The acoustic resistance and mass reactance of such liners are known to vary with the intensity of the sound incident upon the panel. Since the pressure drop across a perforated liner facesheet increases quadratically with the flow velocity through the facesheet, this is known as the nonlinear resistance effect. In the past, two different empirical frequency domain models have been used to predict the Sound Pressure Level effect of the incident wave on the perforated liner impedance, one that uses the incident particle velocity in isolated narrowbands, and one that models the particle velocity as the overall velocity. In the absence of grazing flow, neither frequency domain model is entirely accurate in predicting the nonlinear effect that is measured for typical perforated sheets. The time domain model is developed in an attempt to understand and improve the model for the effect of spectral shape and amplitude of multi-frequency incident sound pressure on the liner

impedance. A computer code for the time-domain finite difference model is developed and predictions using the models are compared to current frequency-domain models.
Author
Degrees of Freedom; Noise Reduction; Pressure Effects; Sound Intensity; Honeycomb Structures; Aircraft Engines; Grazing Flow; Noise (Sound)

19990052642 NASA Langley Research Center, Hampton, VA USA
Effect of Directional Array Size on the Measurement of Airframe Noise Components
Books, Thomas F., NASA Langley Research Center, USA; Humphreys, William M., Jr., NASA Langley Research Center, USA; 1999; In English; Aeroacoustics, 10-12 May 1999, Bellevue, WA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Report No.(s): AIAA Paper 99-1958; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

A study was conducted to examine the effects of overall size of directional (or phased) arrays on the measurement of aeroacoustic components. An airframe model was mounted in the potential core of an open-jet wind tunnel, with the directional arrays located outside the flow in an anechoic environment. Two array systems were used; one with a solid measurement angle that encompasses 31.6 deg of source directivity and a smaller one that encompasses 7.2 deg. The arrays, and sub-arrays of various sizes, measured noise from a calibrator source and flap edge model setups. In these cases, noise was emitted from relatively small, but finite size source regions, with intense levels compared to other sources. Although the larger arrays revealed much more source region detail, the measured source levels were substantially reduced due to finer resolution compared to that of the sm0er arrays. to better understand the measurements quantitatively, an analytical model was used to define the basic relationships between array to source region sizes and measured output level. Also, the effect of noise scattering by shear layer turbulence was examined using the present data and those of previous studies. Taken together, the two effects were sufficient to explain spectral level differences between arrays of different sizes. An important result of this study is that total (integrated) noise source levels are retrievable and the levels are independent of the array size as long as certain experimental and processing criteria are met. The criteria for both open and closed tunnels are discussed.
Author
Airframes; Aeroacoustics; Noise Measurement; Acoustic Properties; Emittance; Noise Generators

19990052767 Rohr Industries, Inc., Chula Vista, CA USA
Acoustic Treatment Design Scaling Methods, Volume 5, Analytical and Experimental Data Correlation
Chien, W. E., Rohr Industries, Inc., USA; Kraft, R. E., General Electric Co., USA; Syed, A. A., General Electric Co., USA; April 1999; 80p; In English
Contract(s)/Grant(s): NAS3-26617; RTOP 538-03-12-02
Report No.(s): NASA/CR-1999-209120/VOL5; NAS 1.26:209120/VOL5; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

The primary purpose of the study presented in this volume is to present the results and data analysis of in-duct transmission loss measurements. Transmission loss testing was performed on full-scale, 1/2-scale, and 115-scale treatment panel samples. The objective of the study was to compare predicted and measured transmission loss for full-scale and subscale panels in an attempt to evaluate the variations in suppression between full- and subscale panels which were ostensibly of equivalent design. Generally, the results indicated an unsatisfactory agreement between measurement and prediction, even for full-scale. This was attributable to difficulties encountered in obtaining sufficiently accurate test results, even with extraordinary care in calibrating the instrumentation and performing the test. Test difficulties precluded the ability to make measurements at frequencies high enough to be representative of subscale liners. It is concluded that transmission loss measurements without ducts and data acquisition facilities specifically designed to operate with the precision and complexity required for high subscale frequency ranges are inadequate for evaluation of subscale treatment effects.
Author
Aircraft Noise; Acoustics; Frequency Ranges; Ducts; Noise Reduction

19990053133 NASA Langley Research Center, Hampton, VA USA
Acoustic Characteristics of a Model Isolated Tiltrotor in DNW
Booth, Earl R., Jr., NASA Langley Research Center, USA; McCluer, Megan, NASA Ames Research Center, USA; Tadghighi, Hormoz, Boeing Co., USA; 1999; In English; 55th, 25-27 May 1999, Montreal, Quebec, Canada; Sponsored by American Helicopter Society, Inc., USA; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

An aeroacoustic wind tunnel test was conducted using a scaled isolated tiltrotor model. Acoustic data were acquired using an in-flow microphone wing traversed beneath the model to map the directivity of the near-field acoustic radiation of the rotor for a parametric variation of rotor angle-of-attack, tunnel speed, and rotor thrust. Acoustic metric data were examined to show trends of impulsive noise for the parametric variations. BVISPL maximum noise levels were found to increase with mu for constant alpha and C(sub T), although the maximum BVI levels were found at much higher cc than for a typical helicopter. BVISPL levels were found to increase with mu for constant alpha and C(sub T). BVISPL was found to decrease with increasing C(sub T) for constant alpha and mu, although BVISPL increased with thrust for a constant wake geometry. Metric data were also scaled for M,i, to evaluate how well simple power law scaling could be used to correct metric data for M(sub tip) effects.
Author
Rotors; Acoustic Properties; Wind Tunnel Tests; Tilting Rotors; Sound Waves; Noise Intensity

19990053424 Rohr Industries, Inc., Chula Vista, CA USA
Acoustic Treatment Design Scaling Methods, Volume 3, Test Plans, Hardware, Results, and Evaluation
Yu, J., Rohr Industries, Inc., USA; Kwan, H. W., Rohr Industries, Inc., USA; Echternach, D. K., Rohr Industries, Inc., USA; Kraft, R. E., General Electric Co., USA; Syed, A. A., General Electric Co., USA; April 1999; 80p; In English
Contract(s)/Grant(s): NAS3-26617; RTOP 538-03-12-02
Report No.(s): NASA/CR-1999-209120/VOL3; NAS 1.26:209120/VOL3; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

The ability to design, build, and test miniaturized acoustic treatment panels on scale-model fan rigs representative of the full-scale engine provides not only a cost-savings, but an opportunity to optimize the treatment by allowing tests of different designs. to be able to use scale model treatment as a full-scale design tool, it is necessary that the designer be able to reliably translate the scale model design and performance to an equivalent full-scale design. The primary objective of the study presented in this volume of the final report was to conduct laboratory tests to evaluate liner acoustic properties and validate advanced treatment impedance models. These laboratory tests include DC flow resistance measurements, normal incidence impedance measurements, DC flow and impedance measurements in the presence of grazing flow, and in-duct liner attenuation as well as modal measurements. Test panels were fabricated at three different scale factors (i.e., full-scale, half-scale, and one-fifth scale) to support laboratory acoustic testing. The panel configurations include single-degree-of-freedom (SDOF) perforated sandwich panels, SDOF linear (wire mesh) liners, and double-degree-of-freedom (DDOF) linear acoustic panels.
Author
Aircraft Noise; Acoustic Properties; Scale Models; Cost Reduction; Flow Resistance; Grazing Flow

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.

19990049261 Tsentralni Aerogidrodinamicheskii Inst., Zhukovsky, Russia
Effective Method of Working Out an Optimum Inspection Schedule
Raikher, Veniamin L., Tsentralni Aerogidrodinamicheskii Inst., Russia; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 116-123; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Two durations from total Fatigue Life Depleting Process are taken into account: (1) the duration t up to reaching the critical damage size which characterizes the Limit State of the Structural Significant Item considered; (2) the duration v of crack growth between Maximal Undetectable Size (MUS), which is such a crack that can be missed (with small allowable probability) during the inspection, and the critical size. MUS depends sufficiently on the used inspection means and methods. Both durations are random values. Their joint probability characteristics are considered as a t-v System. An effective approach is described which gives an opportunity in a simple and uniform manner to calculate all necessary probability values for any probability characteristics of t-v System and for any inspection schedule. The method is based on the procedure of forming on a t-v Plane of some zones which correspond to possible properties of different structure copies if the individual t-v Point < hits into the corresponding zone. The main features of probability characteristics of the t-v System are investigated using the results of different type cyclic tests conducted in TsAGI during the 1960-70s. About 300 copies of the same Al-alloy D16 sheet coupon having a

central hole have been tested. The derived qualitative results may be considered apparently as typical features for many aircraft structures.
Author
Aircraft Structures; Fatigue Life; Inspection; Probability Theory; Schedules; Crack Propagation

19990049269 Federal Aviation Administration, William J. Hughes Technical Center, Atlantic City, NJ USA
Development of Novel Inspection Systems: Anticipating Operator Requirements
Smith, Christopher D., Federal Aviation Administration, USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 193-200; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The establishment of maintenance programs to support a fleet of transport aircraft is an extremely difficult task which often results in the application of inspection technologies and procedures that may seem primitive to the casual observer. A thorough review of the maintenance operation usually shows that the selection of inspection mode and technology is optimal or nearly optimal for the given organization at that time. This does not, however, mean that such operations will stay optimal or that technology solutions will stay adequate. The FAA's long-term investments in inspection research are selected based on anticipated changes in airline maintenance requirements. This paper will discuss four classes of inspection-related technologies being developed to address anticipated inspection needs. In particular it will discuss FAA- and government-sponsored initiatives in distributed damage assessment, large-area inspection, robotic inspection, and the application of emerging computational resources to aircraft inspection.
Author
Damage Assessment; Inspection; Aircraft Maintenance

19990049268 Air Force Research Lab., Robins AFB, GA USA
Air Force Cost of Corrosion Maintenance Study
Kinzie, Richard, Air Force Research Lab., USA; Cooke, Garth, NCI Information Systems, Inc., USA; The Second Joint NASA/FAA/DOD Conference on Aging Aircraft; January 1999, Pt. 1, pp. 183-192; In English; See also 19990049248; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

In 1990 the annual direct cost of corrosion maintenance was determined for USAF systems. This extensive database has been widely used and is the only one of its kind. A new study has now been completed using a 1997 base year. This new study not only provides updated cost figures but it also provides a snapshot in time for determining trends and changes in the costs of corrosion. These figures include all Air Force assets but exclude facilities, real property installed equipment, classified systems, and some indirect costs associated with corrosion. Corrosion costs the Air Force in excess of $795 million per year in direct maintenance expense. The results show that while the fleet size has decreased nearly 20% between the two studies, the costs of corrosion have gone from $720 Million in 1990 to $795 Million in 1997. Corrosion costs per aircraft have risen drastically for nearly all systems. This trend is equally important when it is realized that significant numbers of the retired assets were those requiring the most corrosion maintenance. In the 1990 study 53% of the corrosion costs involved the 5 aging weapon systems. Today 50% of those costs involve just 3 of the oldest systems (C-135, C-5, and C-141). This Cost of Corrosion database gives costs by command, location, and weapon system as well as field level vs. depot level expenditures. The field vs. depot corrosion cost distribution has remained almost constant between the two studies.
Derived from text
Aircraft Maintenance; Cost Analysis; Data Bases; Military Aircraft

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GENERAL

19990047114 NASA Dryden Flight Research Center, Edwards, CA USA
Fifty Years of Flight Research: An Annotated Bibliography of Technical Publications of NASA Dryden Flight Research Center, 1946-1996
Fisher, David F., NASA Dryden Flight Research Center, USA; May 1999; 522p; In English
Contract(s)/Grant(s): RTOP 953-36-00
Report No.(s): NASA/TP-1999-206568; H-2216; NAS 1.60:206568; No Copyright; Avail: CASI; A22, Hardcopy; A04, Microfiche

Titles, authors, report numbers, and abstracts are given for more than 2200 unclassified and unrestricted technical reports and papers published from September 1946 to December 1996 by NASA Dryden Flight Research Center and its predecessor organizations. These technical reports and papers describe and give the results of 50 years of flight research performed by the NACA and NASA, from the X-1 and other early X-airplanes, to the X-15, Space Shuttle, X-29 Forward Swept Wing, and X-31 aircraft. Some of the other research airplanes tested were the D-558, phase 1 and 2; M-2, HL-10 and X-24 lifting bodies; Digital Fly-By-Wire and Supercritical Wing F-8; XB-70; YF-12; AFTI F-111 TACT and MAW; F-15 HiDEC; F-18 High Alpha Research Vehicle, and F-18 Systems Research Aircraft. The citations of reports and papers are listed in chronological order, with author and aircraft indices. In addition, in the appendices, citations of 233 contractor reports, more than 200 UCLA Flight System Research Center reports and 25 video tapes are included.

Author

Bibliographies; Flight Test Vehicles; Aeronautical Engineering; Flight Tests; Research Vehicles; Research Facilities

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