FY04 Technical Program Summary

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Vehicle Technology Directorate -
Langley Site
US Army Research Laboratory
at
NASA Langley Research Center
Hampton, VA 23681-0001

The ARL Vehicle Technology Directorate at the Langley Research Center conducts research in two business areas:

Structural Mechanics and
Loads & Dynamics

Program areas funded under these technical competencies include basic (6.1) and applied (6.2) research in Aviation Technology and Ground Vehicle Technology. The following "Table of Contents" outlines the organization of the work packages and individual research projects within this document.

Aviation Structural Mechanics Research - 6.1 - 61102 / AH66 / VS1011

VS1011.CA03	Development of Lightweight, Low-Cost Advanced Aircraft Structural Concepts
VS1011.CA04	Computational Methods for Deployment Analysis of Lightweight Structures
VS1011.IF01	Delamination Characterization
VS1011.IF02	Composite Low-Velocity Impact Analysis and Testing
VS1011.IF03	Small Crack-Growth Effects in Metallic Materials
VS1011.IF07	Tension-Bending Behavior of Tapered Composite Laminates
VS1011.IM01	Threshold Fatigue Crack Growth of Metallic Materials
VS1011.IN01	Damage Initiation and Growth in Composite Structures

Aviation Loads & Dynamics Research - 6.1 - 61102 / AH66 / VS1015

VS1015.AL05	Aeroelastic Modeling of Advanced Rotor Configurations
VS1015.AL06	High Performance Piezoelectric Actuator Development
VS1015.AL07	Lightweight Multifunctional Structural Components Development
VS1015.AL08	Fuselage Dynamics and Tail Buffet
VS1015.AR01	Structural and Material Characteristics of Biological Morphologies
VS1015.DC01	Crashworthiness of Composite Frames and Floor Sections
VS1015.DR14	Modeling of Thin Membrane Structures

Ground Vehicle Loads & Dynamics Research - 6.1 - 61102 / AH42 / VS1016

VS1016.DC02	Nonlinear Mechanics of Elastomeric and Composite Structures

Aviation Structural Mechanics Technology - 6.2 - 62211 / A47B / VS2011

VS2011.CA02	SARAP Crash Safety Research Program
VS2011.CD01	Damage Initation and Growth Studies in Tailored Laminates
VS2011.IC02	Skin/Stiffener Debonding Analysis Methods
VS2011.IC03	Exploratory Research on Adaptive Sensors for Composite Rotorcraft
VS2011.IC04	Failure of Rigid Foams
VS2011.IF04	Z-pin Reinforcement Analysis
VS2011.IF08	Fatigue Life Methodology of Metallic Rotorcraft Dynamic Components
VS2011.IF11	Impact Damage Resistance & Tolerance of Thin Skin Composite Sandwich Structure
VS2011.IF12	Reliability-Based Design Methods
VS2011.IN01	Composite Thermal Nondestructive Evaluation
VS2011.IN07	SARAP NDE/Reparability Program

Ground Vehicle Structural Mechanics Technology - 6.2 - 62105 / AH84 / VS2012

VS2012.CA01	Research on Ground Combat Vehicles
VS2012.CA02	Buckling - Vibration Interaction
VS2012.CA03	Analysis of Structural Joints for Ground Vehicles
VS2012.CA04	Inflatable Structures
VS2012.CD01	Selective Reinforcement of Aluminum Structures
VS2012.CD02	Multi-Functional Structures
VS2012.IN07	NDE of Composite Structures Using Laser Ultrasonics
VS2012.IN12	NDE of Electrical Wire Insulation Using Ultrasonics

Aviation Loads & Dynamics Technology - 6.2 - 62211 / A47B / VS2015

VS2015.AA02	High-Speed Aeroelastic Research Models
VS2015.AE03	High-Voltage Electrical Systems
VS2015.AL04	Experimental Investigation of Active Twist Rotor Concepts for Vibratory Load Reductio
VS2015.AL05	Analysis and Design of Active Twist Rotor Blades
VS2015.DC08	Innovative Composite Fuselage Design for Improved Crashworthiness
VS2015.DC09	Soft Soil - Water Impact
VS2015.DC11	Crash Simulation of an ATR42 Aircraft
VS2015.DT01	Applications of Structural Tailoring Concepts

Ground Vehicle Loads & Dynamics Technology - 6.2 - 62105 / AH84 / VS2016

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BUSINESS SUBAREA: 6.2 STRUCTURAL MECHANICS

PE/PRJ/WP#/WP: 62211 A47B VS2011 Aviation Structural Mechanics Technology

DIRECTORATE/DIVISION ARL Vehicle Technology Directorate Structural Mechanics

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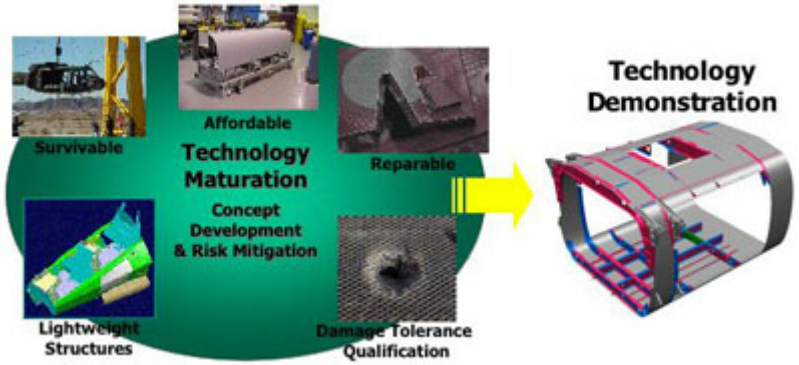
THRUST:

Applied and exploratory structural mechanics research to develop and validate damage tolerance, fatigue durability, nondestructive inspection, and advanced structural analysis design methods for metallic and composite rotorcraft dynamic components and airframe structures.

New concepts and advanced structural analysis methods for composite/hybrid structures that provide design tools for lighter, safer, more reliable and more affordable manned and unmanned Army rotorcraft.

OBJECTIVES:

* Apply advanced structural analysis methods to composite/hybrid structures and validate design tools for accurate loads and stress analysis.
* Incorporate composite delamination failure criteria for strength and fatigue predictions to extend static/fatigue limits of flight critical dyn components.
* Apply advanced NDE methods for field inspection of composite/hybrid structures to reduce MLH/FH and manufacturing costs.
* Test and validate advanced design methods to reduce EW/GW ratio and to increase structural efficiency.



PROGRAM SCHEDULE:

RESEARCH STUDIES	2003	2004	2005	2006	2007
SARAP Crash Safety Research Program		▪▪▪▪	▪▪▪▪	▪▪▪▪	
Damage Initation/Growth Studies in Tailored Laminates	▪▪▪▪	▪▪▪▪	▪▪▪▪		
Skin/Stiffener Debonding Analysis Methods	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Exploratory Research on Adaptive Sensors for Compos		▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Failure of Rigid Foams		▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Z-pin Reinforcement Analysis		▪▪▪▪	▪▪▪▪	▪▪▪▪	
Fatigue Life Methodology of Metallic Rotorcraft Dynamic	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Impact Damage Resistance/Tolerance of Composites	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Reliability-Based Design Methods	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	
Composite Thermal Nondestructive Evaluation	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
SARAP NDE/Reparability Program	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪

FY04 KEY DELIVERABLES:

* Conduct damage initiation and growth studies for tailored composites in support of NASA ITS project.
* Design and fabricate test fixture for compression testing of anisotropic laminates.
* Design composite flexbeam test specimens with embedded sensors.
* Relate strength values of laminates with z-pins to the corresponding strength values of the laminates without z-pins.
* Continue development on both the kink-band propagation and indentation growth strength analyses.
* Validate the strength analyses by conducting new tests and using existing data. Develop compact compression test.
* Incorporate reliability into strength and fatigue models and compare to Factor of Safety approach.
* Improve inspection depths using technologies such as synchronous heating and repeated flash.
* Investigate in-plane measurement technologies such as ultrasonic lamb wave measurements for large area noncontact NDE of SARAP structural concepts.

This chart covers Fiscal Year 2004

Business SUBAREA:	6.2		STRUCTURAL MECHANICS	
PE/PRJ/WP#/WP:	62211	A47B	VS2011	Aviation Structural Mechanics Technology

Workyears	2003	2004	2005	2006	2007
ARMY	4.45	5.65	5.45	4.6	3.2
NASA	.1	.6	.6	.3	.3
OTHER	4.25	6.3	5.3	4.4	2.7

STRUCTURAL MECHANICS

OBJECTIVE

Support the AMCOM Survivable, Affordable Reparable Airframe Program (SARAP) STO by working directly with the rotorcraft companies in durability and damage tolerance, crashworthiness, and NDE. In addition, this Workpackage supports Rotary Wing Vehicle (RWV) structures technical objectives. The benefits of VTDs structural mechanics research will help in fulfilling the requirements for future manned and unmanned rotorcraft vehicles to attain the low weight, low cost, and high reliability goals set forth in the RWV TDA.To develop and validate structural integrity technologies for metallic and composite structures. The current focus is on the development of design criteria for life extension methodologies and reliable inspection methods for field applications.

APPROACH

The S&T being worked in this Workpackage focuses on AMRDEC Structures Tech Effort Objectives as defined in the DoD Rotary Wing Vehicle (RWV) Technology Development Approach. In particular, specific VTD tasks directly support the AMCOM Survivable, Affordable, Reparable Airframe Program (SARAP) STO. The RWV TDA has a requirement for improving structural efficiency and affordability relative to 1994 baseline technology. Key technical barriers that are being addressed include: (1) the lack of physics of failure characterization models to eliminate conservative design penalties; (2) computationally intensive and non-robust structural analysis methods; (3) invalidated crash dynamics models for rotorcraft fuselage structures; and (4) inadequate inspection methodologies to assess damage and structural integrity. The approach for overcoming these barriers include developing: (1) efficient crash impact technologies for advanced composite/hybrid fuselage structures; (2) technologies for rapid damage assessment and repair; (3) new structural analysis methods to evaluate reliability and improve structural design; and (4) physics-based models of flaws and damage to predict durability and damage tolerance in advanced composite structures. A significant portion of this research is conducted jointly with the US helicopter industry through Cooperative Research and Development Agrements (CRDAs).

SIGNIFICANCE

The benefits to Army aviation will be validated design tools along with reliable and quantitative inspection methods for aviation metallic and composite structures. Payoffs will also included needed life extension technology for the current fleet as well as reliability and durability enhancements for future Army rotorcraft. The results of this joint ARL/NASA support will help to ensure the ability of US defense contractors to build lightweight, reliable, durable, and low-cost rotorcraft structures essential to the Army Objective Force and future vehicles like the FCS and FTR. More importantly, this technology will provide the Army with needed maintenance and inspection procedures for operating and supporting the fleet. The technical accomplishments of this Workpackage directly support RWV goals and payoffs.