

**AFRL-RX-TY-TP-2008-4535**

**POSTPRINT**



**AIR FORCE RESEARCH LABORATORY  
RESEARCH ON AUTONOMOUS AND NON-  
DESTRUCTIVE PAVEMENT SURFACE  
ASSESSMENT**

**Lt Andrew Kopeikin  
Air Force Research Laboratory**

**JULY 2007**

**Distribution Statement A:  
Approved for public release; distribution unlimited.**

**This briefing was presented at the US-Israel Air Force Project Agreement  
Conference held in Tel-Aviv, Israel from 27 July to 04 August 2007.**

**AIRBASE TECHNOLOGIES DIVISION  
MATERIALS AND MANUFACTURING DIRECTORATE  
AIR FORCE RESEARCH LABORATORY  
AIR FORCE MATERIEL COMMAND  
139 BARNES DRIVE, SUITE 2  
TYNDALL AIR FORCE BASE, FL 32403-5323**

**REPORT DOCUMENTATION PAGE**

*Form Approved  
OMB No. 0704-0188*

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

**PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

<b>1. REPORT DATE (DD-MM-YYYY)</b>	<b>2. REPORT TYPE</b>	<b>3. DATES COVERED (From - To)</b>
------------------------------------	-----------------------	-------------------------------------

<b>4. TITLE AND SUBTITLE</b>	<b>5a. CONTRACT NUMBER</b>
	<b>5b. GRANT NUMBER</b>
	<b>5c. PROGRAM ELEMENT NUMBER</b>

<b>6. AUTHOR(S)</b>	<b>5d. PROJECT NUMBER</b>
	<b>5e. TASK NUMBER</b>
	<b>5f. WORK UNIT NUMBER</b>

<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b>	<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>
---	---

<b>9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b>	<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>
	<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b>

**12. DISTRIBUTION/AVAILABILITY STATEMENT**

**13. SUPPLEMENTARY NOTES**

**14. ABSTRACT**

**15. SUBJECT TERMS**

<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>	<b>18. NUMBER OF PAGES</b>	<b>19a. NAME OF RESPONSIBLE PERSON</b>
<b>a. REPORT</b>	<b>b. ABSTRACT</b>	<b>c. THIS PAGE</b>			<b>19b. TELEPHONE NUMBER (Include area code)</b>



# **AFRL Research on Autonomous and Non-Destructive Pavement Surface Assessment**

**Lt. Andrew Kopeikin  
AFRL / RXQD**

**DISTRIBUTION A.** Approved for public release; distribution unlimited.



## *Overview*



- **Introduction**
- **Non-Destructive Airfield Evaluation**
  - **Non Contact System**
  - **Rolling Weight Deflectometer**
  - **Optical Correlation System**
- **Damage Assessment**
  - **Rapid Airfield Damage Assessment**
  - **Runway Roughness Studies**



# Introduction



- Problems with current Pavement Evaluation Methods
  - Pavement coring
    - Lengthy, tedious
    - Adds repair work to assessment



**Destructive**



**Discrete**

- Non-continuous information  
Pavement properties estimated between samples (cores, DCP)



# Introduction



**Bulky / Massive**

- Massive equipment  
The size of current assessment technologies is too large to implement on deployed airfields (HWD)

- Cost: Time and Money  
Current structural assessment techniques require many days and personnel (PCI). This adds to the cost and is inappropriate for front lines.



**Time Consuming - Cost**



# Introduction



- **Goal:**
  - Simplify assessment process
  - Avoid destructive procedures
  - Provide continuous measurements
  - Miniaturize survey tools
  - Expedite assessment methods
  - Increase accuracy



# *Structural Assessment*



- Structural Assessment Tools
  - Non Contact System
  - Rolling Weight Deflectometer
  - Optical Correlation System

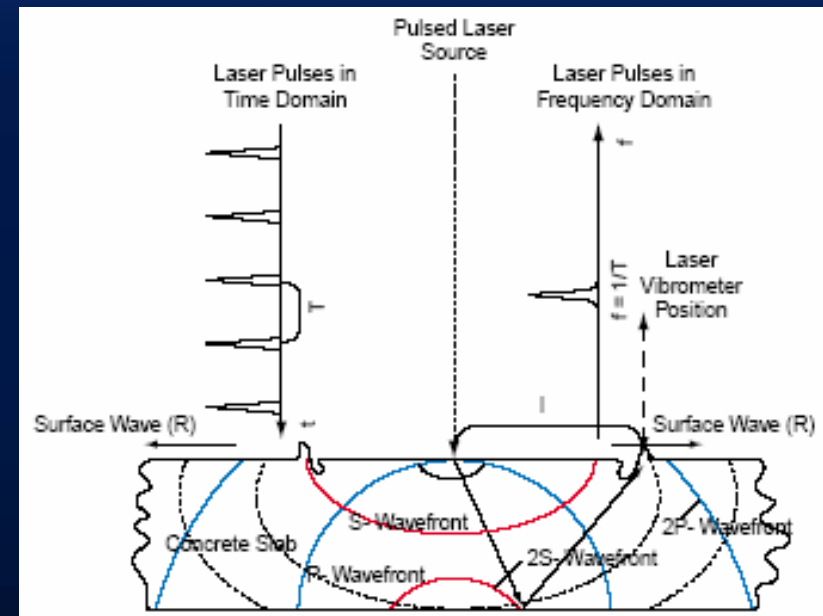
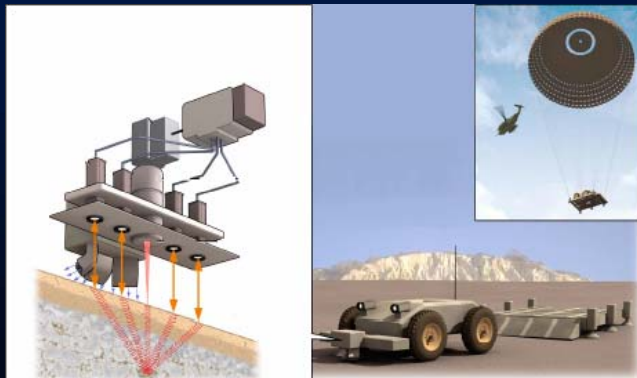


# Non Contact System



## • Laser Ultrasonic Non-contact Seismic System

- Laser Pulse Excites Pavement Surface
  - thermal strain
  - ablation recoil
- Laser Vibrometer analyzes seismic activity
- Provides multilayer thickness information
- Coupled with density gauge will provide Pavement Modulus information
- Potential Robotic Application



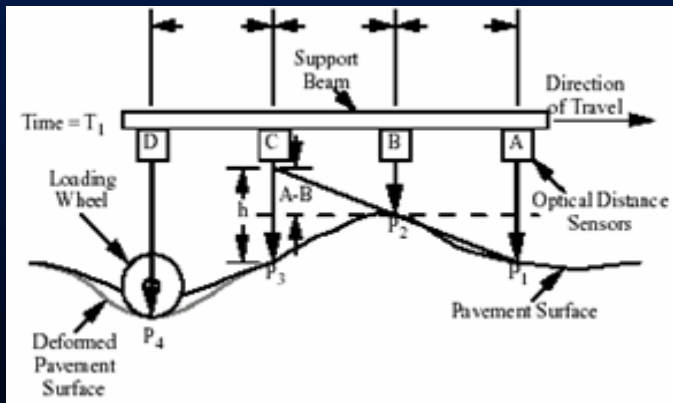
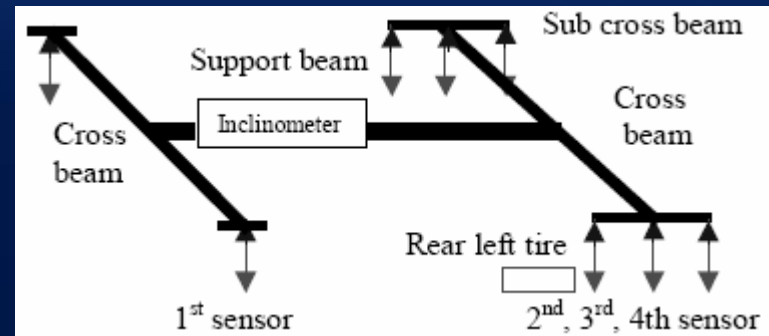


# Rolling Weight Deflectometer



- Miniaturize Rolling Weight Deflectometer

- Current RWD are too big
- Goal: Mount on a Dump Truck
- Challenges:
  - Provide enough mass for airfields
  - Stabilized sensor package
- Vary sensor location
- Study various laser ranging techniques

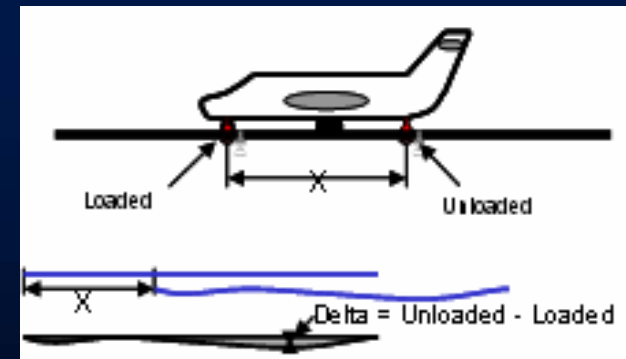




# Optical Correlation



- Optical Correlation Methodology
  - Deflection basin determined by cameras
  - Early stages of development



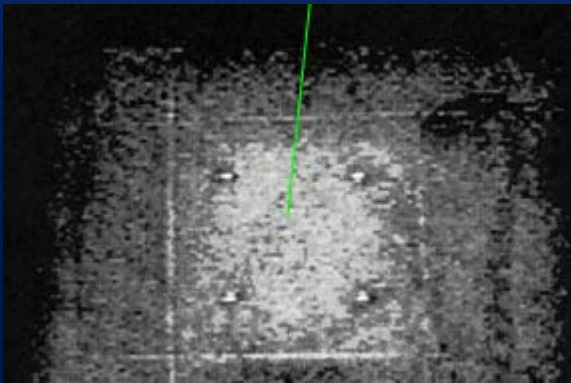


# Rolling Weight Deflectometer

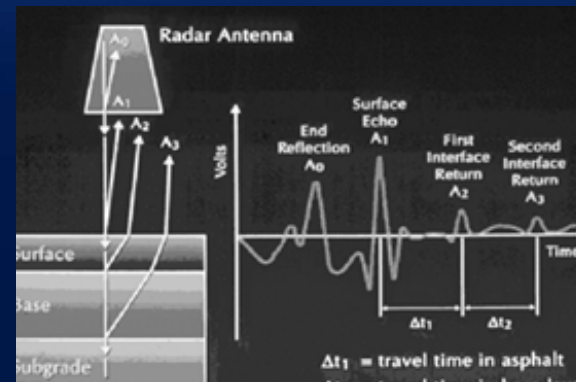
**AFRL**  
THE AIR FORCE RESEARCH LABORATORY  
LEAD | DISCOVER | DEVELOP | DELIVER



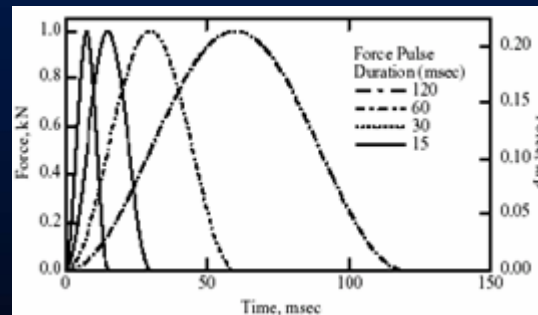
- Incorporating other assessment technologies



**IR Imaging**



**Ground Penetrating Radar**



**Falling Weight Deflectometer**



# *Damage Assessment*



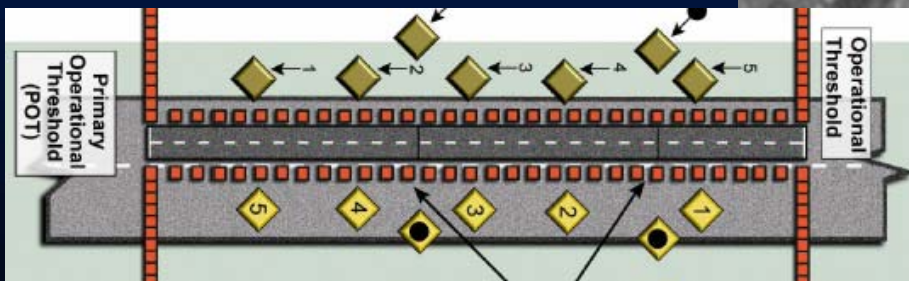
- Damage Assessment Methodologies
  - Rapid Airfield Damage Assessment
  - Pavement roughness assessment



# Airfield Damage Assessment



- Current Method
  - Airfield Damage Assessment Team is dispatched
  - Damage is surveyed (ie craters, spalls, bomblets) and manually plotted
  - Minimum Operating Strip is determined
- Shortfalls
  - Inaccurate and time consuming
  - Requires minimum of seven people

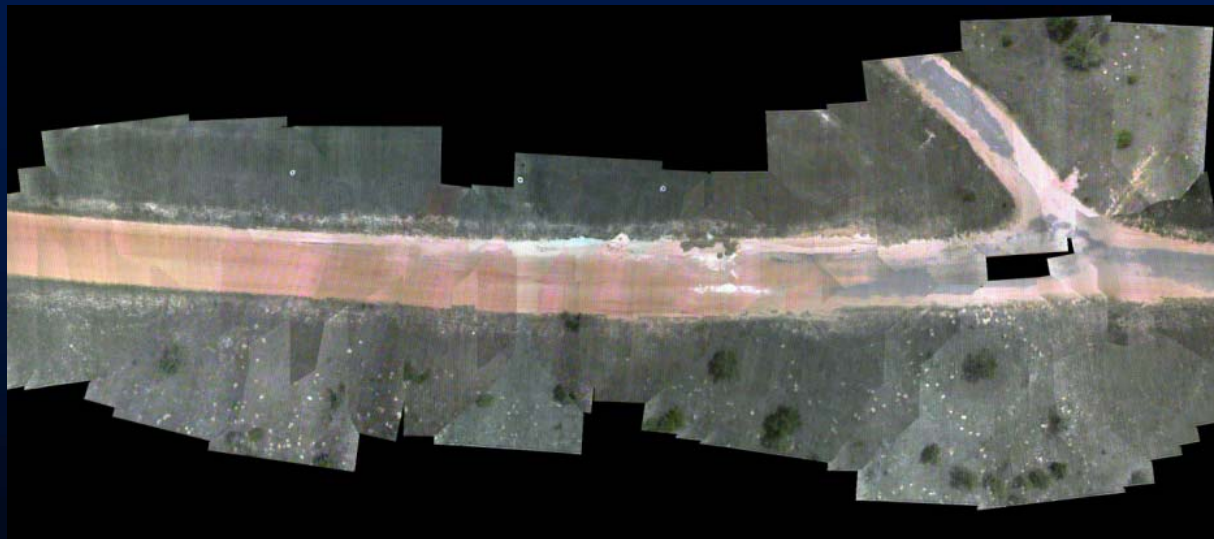
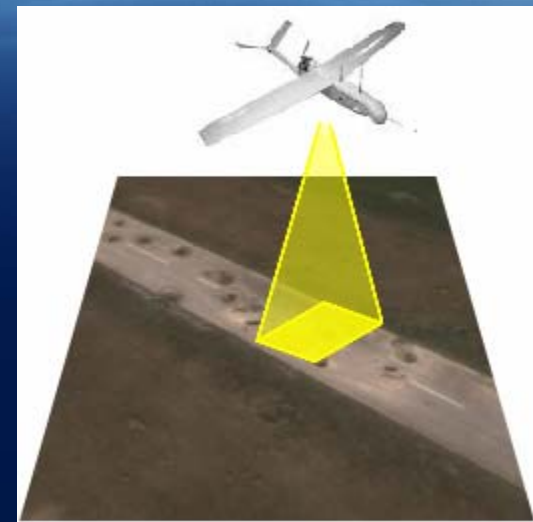




# Airfield Damage Assessment



- Solution:
  - Unmanned-Air-Vehicle assessment
  - Geo-referenced Imagery
  - Computerized Approach
  - Reduces necessary manpower
  - Decreases assessment time
  - Increases accuracy

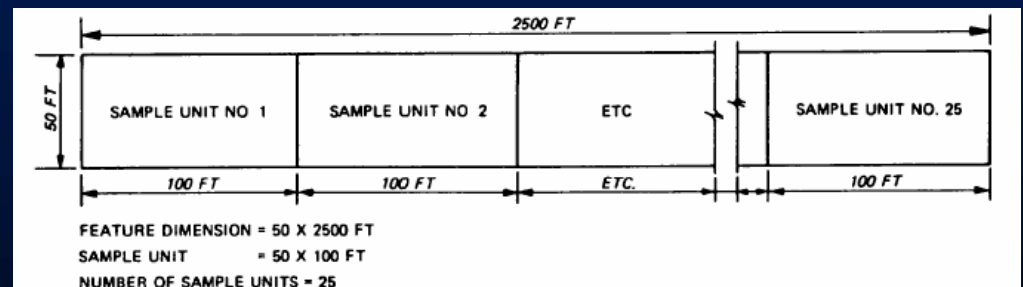




# Pavement Roughness



- Current assessment concerns
  - Too lengthy for deployed environment.
  - Focus on pavement structure, not aircraft
  - Does not provide adequate go / no go decision making criteria

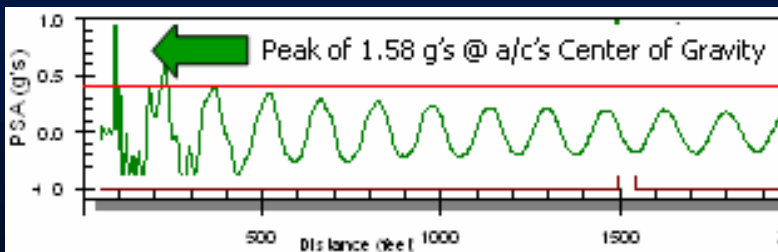




# Pavement Roughness



- Solution
  - Analyze aircraft interaction with surface roughness
  - Develop accurate numerical models to assess loads
  - Provide decision making tool for field assessment teams
- Needs
  - Validate models
  - Live aircraft testing





# *Summary*



- **Introduction**
- **Non-Destructive Airfield Evaluation**
  - **Non Contact System**
  - **Rolling Weight Deflectometer**
  - **Optical Correlation System**
- **Damage Assessment**
  - **Rapid Airfield Damage Assessment**
  - **Runway Roughness Studies**



# Aircraft Operating Surfaces



*Questions?*

