Pavement Design and Evaluation

RPA P5

Presented to: REDAC Subcommittee on Airports

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Date: March 21, 2018

RPA P5 – Pavement Design and Evaluation

Need

There is a need for advanced, computer-based pavement design & evaluation solutions to protect the FAA's investment in airport pavement. The FAARFIELD program provides confidence that pavements will meet the required service life. Savings to the AIP will result from reduced construction costs and fewer runway closures.

Research Goals

- Continue to update and modernize the FAARFIELD design software.
- New **ACR-PCR** system of reporting airport pavement strength in FY18.
- Incorporate top-down cracking mode in FAARFIELD rigid design by FY19.
- Fully integrate FAARFIELD thickness design with LCCA procedures by FY22.

FY 2017 Accomplishments

- Released FAARFIELD v. 1.4.
- Test new FAARFIELD-based ACN-PCN method.
- Tech Report: Flexible pavement new subgrade failure model.
- Prototype new FAARFIELD GUI.

AC 150/5320-6F & FAARFIELD 1.4

Released Nov. 10, 2016

U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Airport Pavement Design and Evaluation	**Date:** 11/10/2016 **Initiated by:** AAS-100	**AC No:** 150/5320-6F **Change:**

1. **Purpose.**
This advisory circular (AC) provides guidance to the public on the design and evaluation of pavements used by aircraft at civil airports. For reporting of pavement strength, see AC 150/5335-5C, *Standardized Method of Reporting Airport Pavement Strength – PCN.*

2. **Cancellation.**
This AC cancels AC 150/5320-6E, *Airport Pavement Design and Evaluation,* dated September 30, 2009.

FAARFIELD 1.4 – What's New?

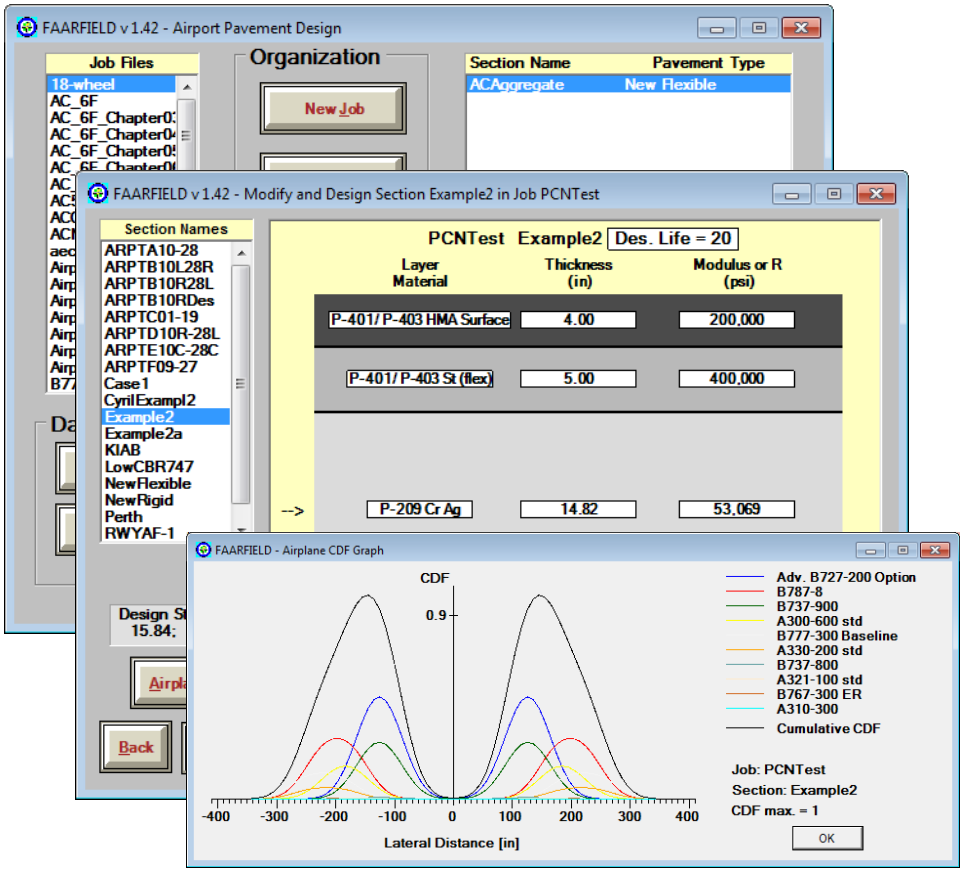
- Completely revised flexible and rigid failure models based on current NAPTF full-scale test data.
- Reduced excess stabilized base thickness requirement.
- Improved, more accurate 3D finite element model.
- Completely rewritten concrete overlay design procedure.
- Automatically generates PDF design report.
- Automated, software-based compaction criteria.
- Updated aircraft library aligned with COMFAA 3.0.
- Include non-airplane vehicles in library (ARFF vehicles, etc.)
- Support for user-defined gear configurations.
- Advanced, energy-based asphalt fatigue models.
- All data files now stored in document directories.

FAARFIELD 1.42

Posted Sept. 18, 2017

Main Updates:

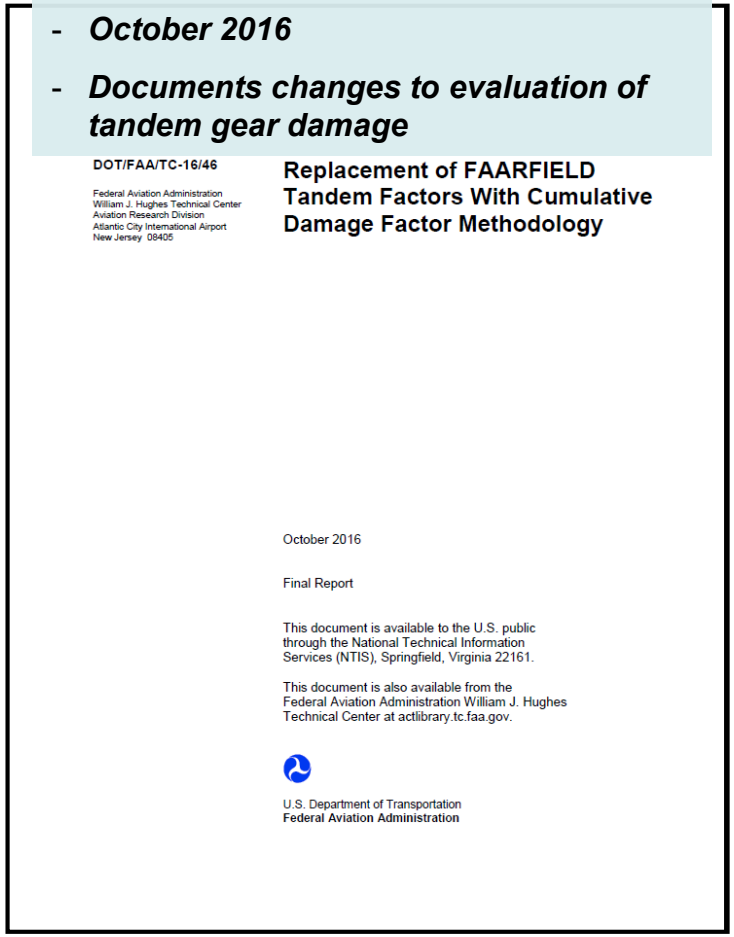
- **Changed the value of the interior slab stress for rigid pavement design from 100% to 95% of LEAF stress.**
  - Better represents the case of an aircraft gear loading the center of a finite-sized slab that is part of a system of jointed slabs (with nominal 20-ft. joint spacing).
  - Primarily affects traffic mixes dominated by B777.
- **Updated the internal formula for allocating aircraft weight to the wing and center gears of the A340 aircraft series based on current information from Airbus.**
- **Revised design examples in the Help file.**



Technical Reports

Replacement of FAARFIELD Tandem Factors with CDF Methodology

- ***October 2016***
- ***Documents changes to evaluation of tandem gear damage***



DOT/FAA/TC-16/46

Federal Aviation Administration
William J. Hughes Technical Center
Aviation Research Division
Atlantic City International Airport
New Jersey 08405

Replacement of FAARFIELD Tandem Factors With Cumulative Damage Factor Methodology

October 2016

Final Report

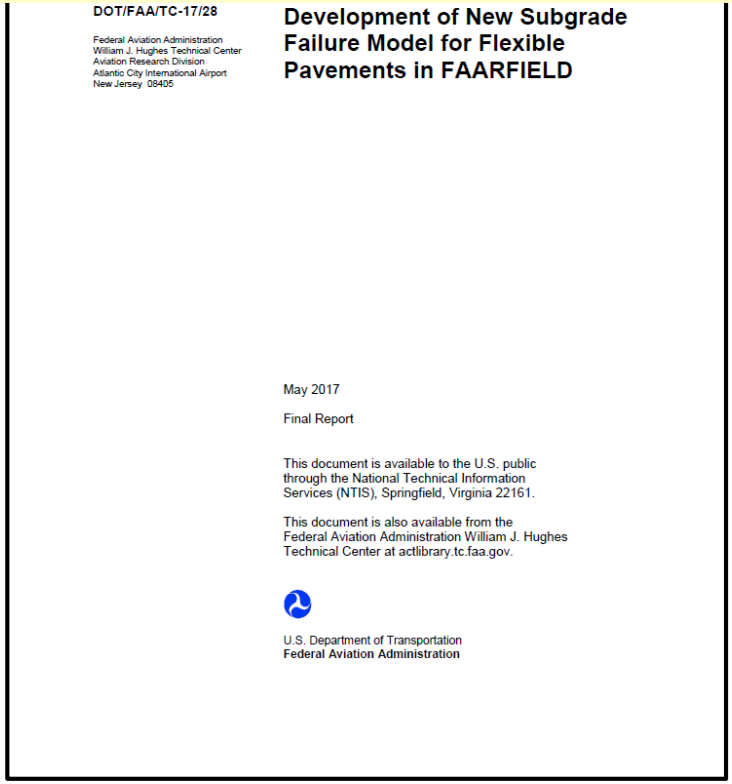
This document is available to the U.S. public through the National Technical Information Services (NTIS), Springfield, Virginia 22161.

This document is also available from the Federal Aviation Administration William J. Hughes Technical Center at actlibrary.tc.faa.gov.

U.S. Department of Transportation
Federal Aviation Administration

Development of New Subgrade Failure Model for Flexible Pavements in FAARFIELD

- ***May 2017***
- ***Documents new FAARFIELD 1.41 design models***



DOT/FAA/TC-17/28

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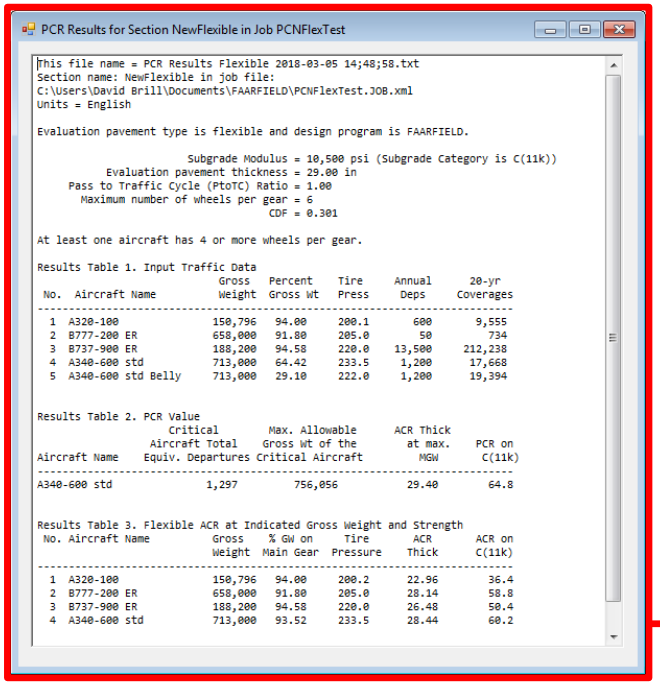
Upcoming Papers & Workshops

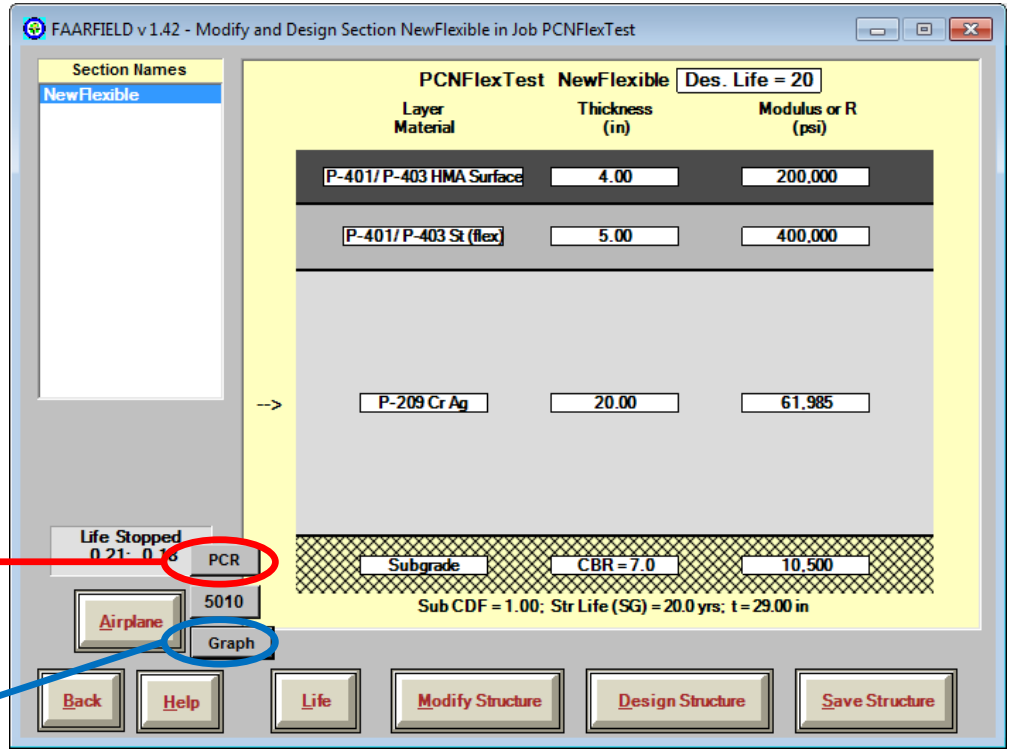
- **Papers & Presentations:**
  - *Full-Scale Traffic Test of PCC-on-Rigid Overlay With Existing Damage at FAA National Airport Pavement Test Facility*, 6th DUT-Workshop, Potsdam, Germany, June 17-18, 2018
  - *Full-Scale Tests of Aircraft Overloads on Airport Flexible Pavements*, ASCE T&DI Conference, Pittsburgh, PA, July 15-18, 2018
  - *Framework for Two-Dimensional Elastic Analysis of Reflective Cracking in Airport Pavement Asphalt Overlays*, EMI 2018, Cambridge, MA, May 29-June 1, 2018
- **Workshops:**
  - Dallas, TX, April 24-26 (Asphalt Institute)
  - Quito, Ecuador, May 30-31 (ALACPA)

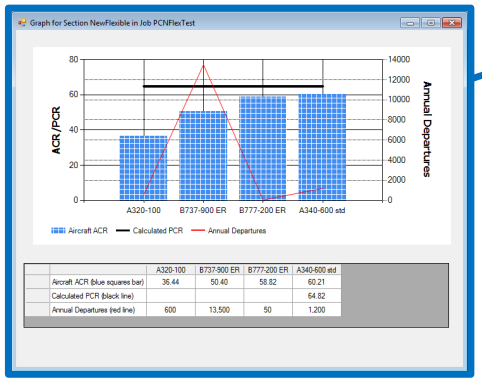
ACR-PCR Methodology

- **New ACR-PCR System**
  - Aircraft Classification Rating – Pavement Classification Rating
  - Rational, layered elastic based replacement for ACN-PCN.
  - Keeps the simplicity of the current ACN-PCN reporting system.
- **Advantages over existing system:**
  - Removes incompatibility between pavement thickness design and pavement strength reporting requirements.
  - Eliminates need to main two separate, mutually incompatible programs (FAARFIELD and COMFAA).
  - Directly enter the structure in FAARFIELD. No support spreadsheets, layer equivalency factors, equivalent *k*-value.
  - One uniform set of standard subgrade categories applies to rigid and flexible pavements.

FAARFIELD PCR Evaluation





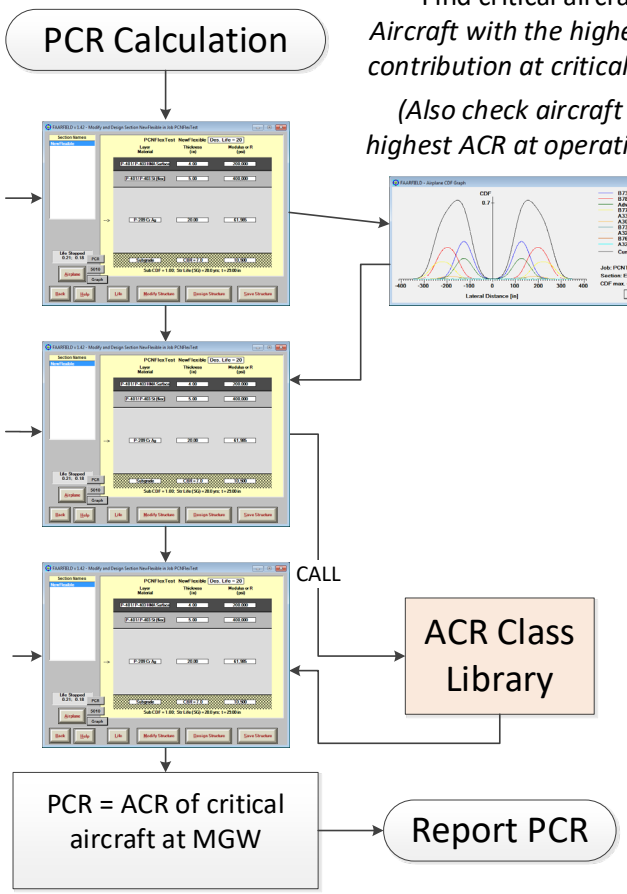


- **Directly uses FAARFIELD structure and traffic list.**
- **NO alpha factor, layer equivalency factors, top-of-base *k*, etc.**
- **Eventual replacement for COMFAA 3.0 & support spreadsheets.**

Flowchart of PCR Calculation

No more looping through all aircraft in the list!

1. Run FAARFIELD Life for the full aircraft traffic list
2. Run FAARFIELD Life for the critical aircraft only. *Equivalent passes = no. of passes giving same CDF as original traffic list.*
3. Run FAARFIELD Life for equivalent passes of the critical aircraft only. *MGW of critical aircraft = GW giving CDF = 1.0 for the design life.*



FAARFIELD-Based ACR/PCR

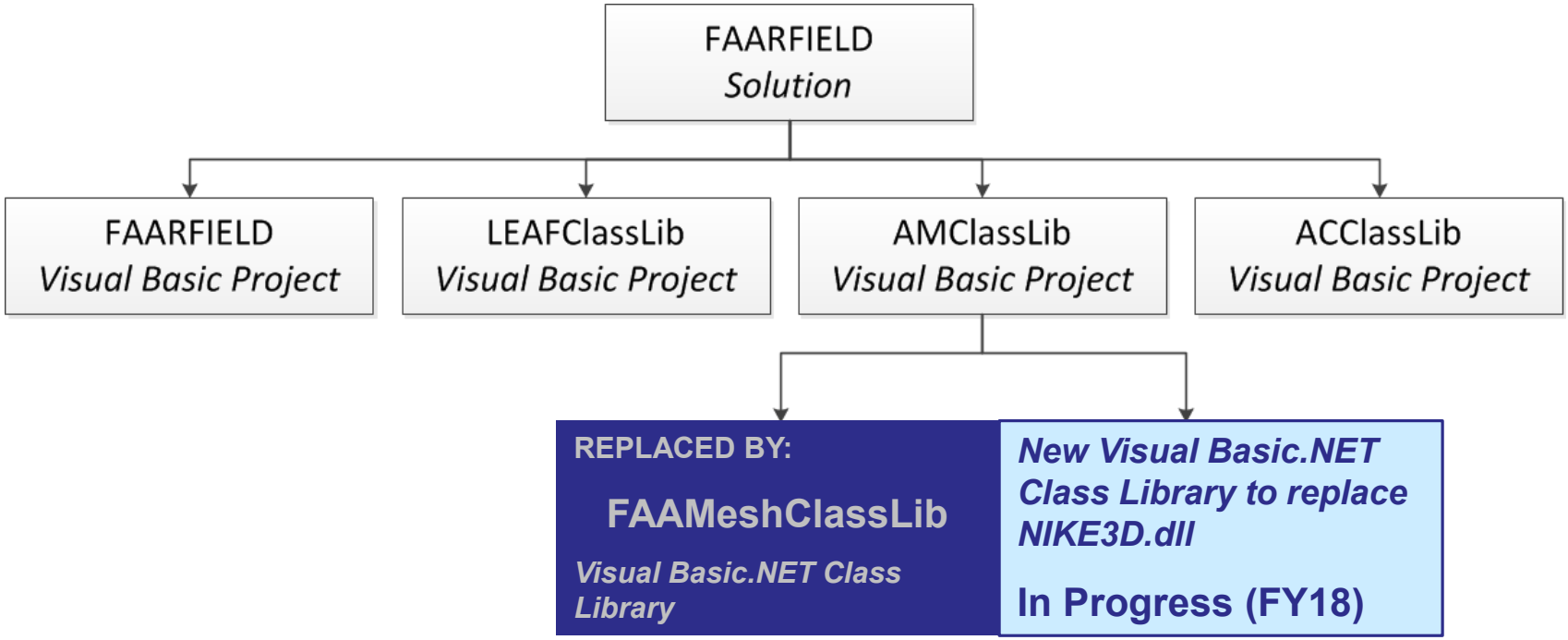
Accomplishments:

- **Created Visual Basic class library to compute layered elastic-based ACRs (rigid & flexible).**
  - Replacement for legacy ICAO ACN computer programs.
  - Open source library – supports linking to any PCR program.
  - Defined input & output protocols.
- **Implemented PCR calculation in FAARFIELD 1.42.**
  - New algorithm solves problem of computing PCR for mixed traffic (narrow bodies and LR aircraft) without unnecessary operating weight restrictions.
  - Seamlessly handles HMA overlays on flexible pavements.
- **On target for replacement ACR-PCR system with ICAO effective date in 2022.**

Legacy Fortran Libraries

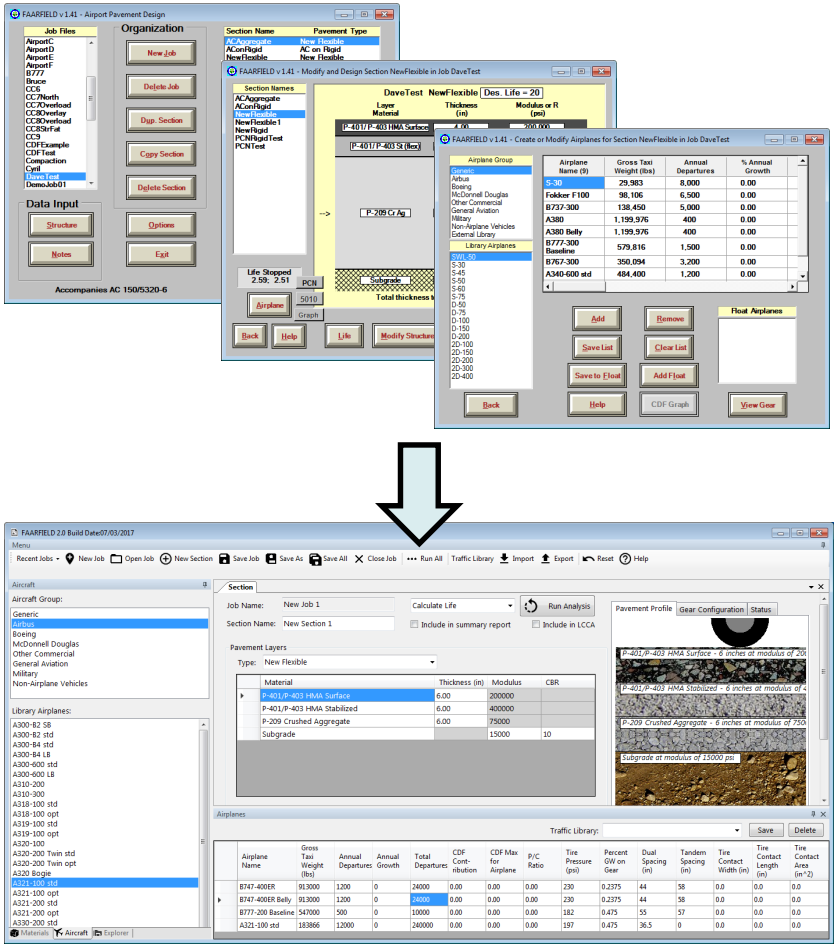
- **Existing Fortran libraries are modified from original 1995 programs.**
- **Still distributed by FAA under a software sharing agreement with Lawrence Livermore National Laboratory, the original NIKE3D developer.**
- **Very significant limitations for .NET programming.**
  - Unmanaged code.
  - Not under the control of .NET memory management services.
  - May lead to memory conflicts or crashes at runtime.
  - Obsolete data storage and retrieval methods.
  - Few young programmers have knowledge of Fortran.

FAARFIELD Calling Structure

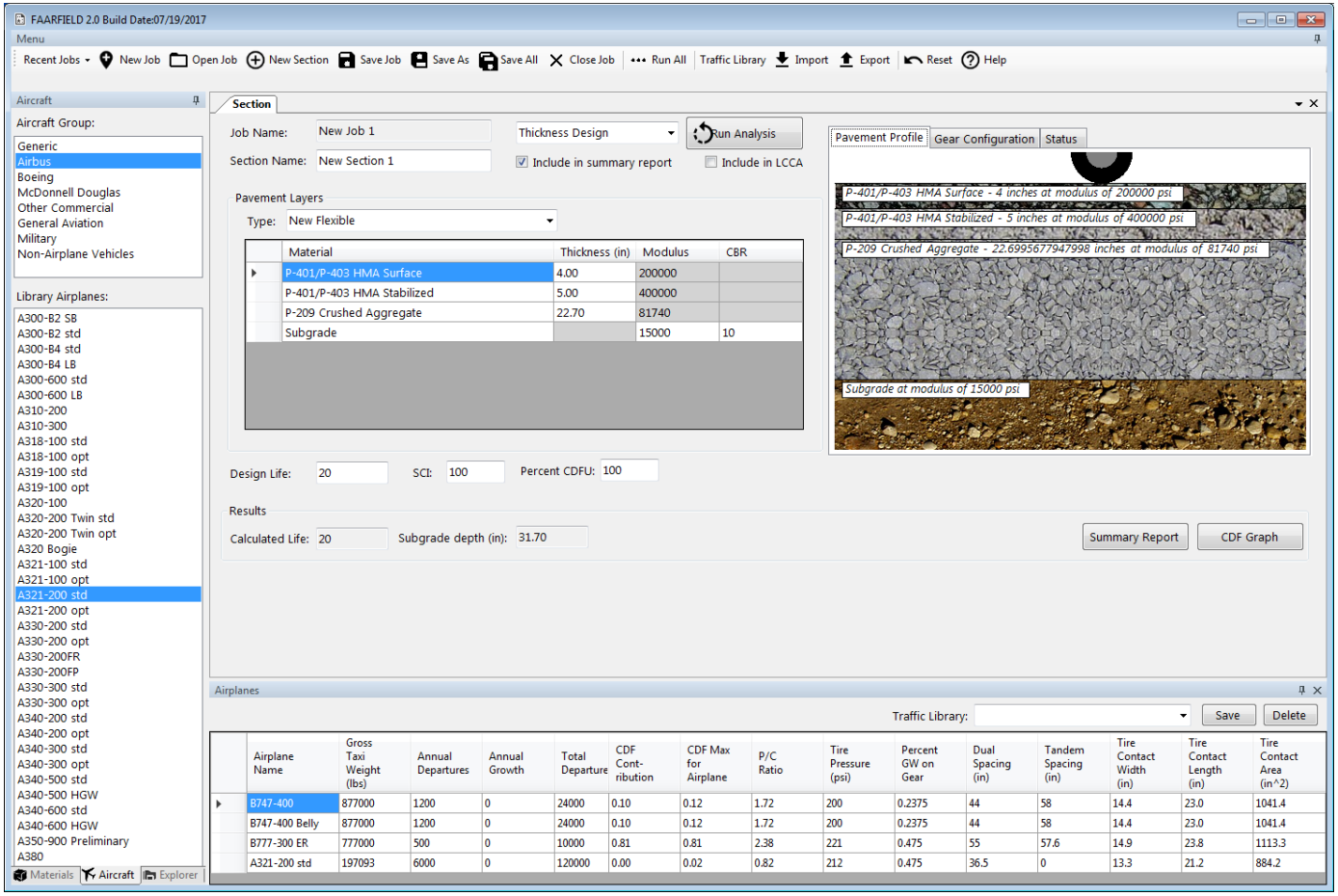


GUI Modernization

- **Modernize the FAARFIELD graphical user interface (GUI).**
  - Job and section entry.
  - Improved start-up screen.
  - Improved screen re-sizing and appearance.
  - Improved flow between screens.
  - Rationalize data file structure.
  - Remove program logic from GUI controls.
- **Working GUI prototype was demonstrated July 2017.**
- **FAARFIELD 2.0 beta – Target date July 2018.**



FAARFIELD 2.0 GUI Screenshot



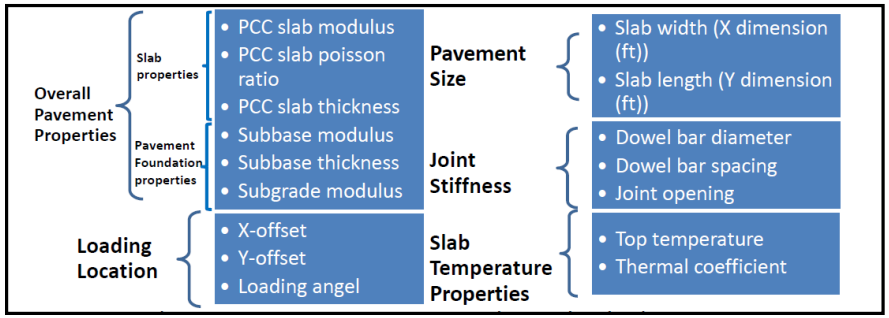
Features of Modernized GUI

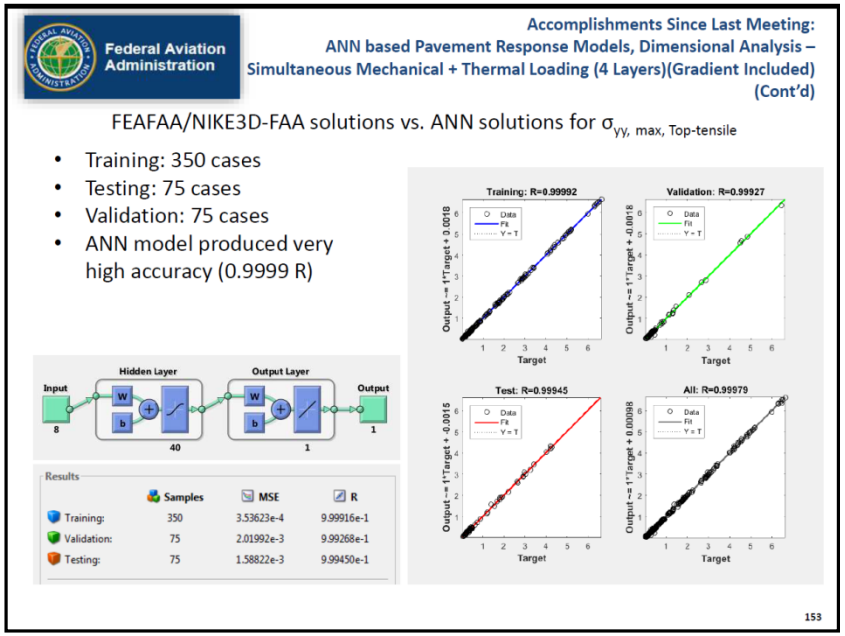
- **Multi-display interface.**
- **Highly configurable process flow.**
  - Consolidated data entry to single screen.
  - Open, resize, move, dock/undock, close screens independently.
  - Makes use of right-click context menus.
- **Resizable screens.**
- **Allows working with multiple jobs & sections.**
  - Switch between jobs/sections/pavement types with 1 click.
  - Cut and paste between jobs.
- **Standard Windows file management.**
  - Built-in Windows tools for saving/opening jobs.
  - Section and job names follow Windows standards.
- **Built-in standard pavement section library accessible from menu.**

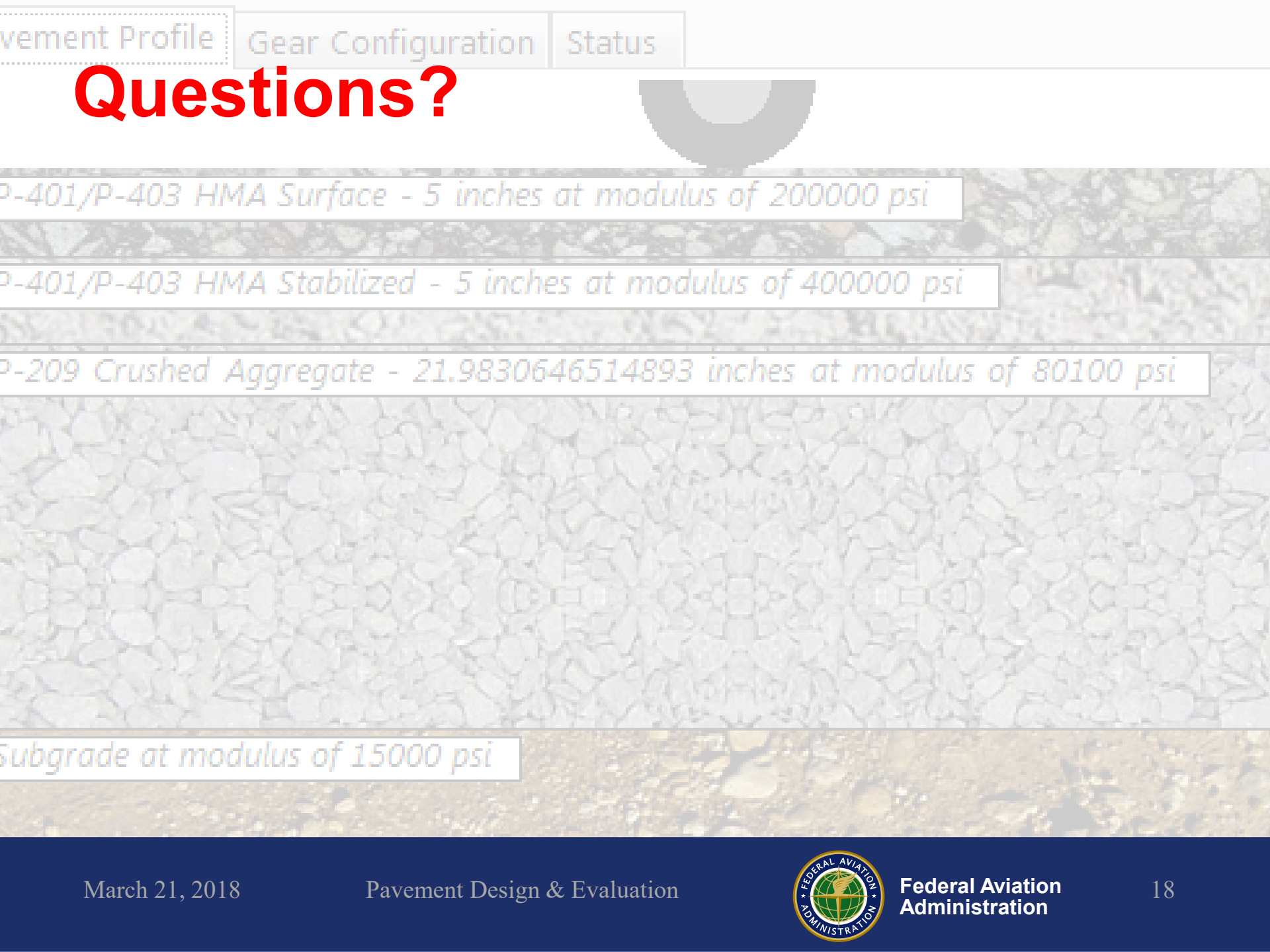
Top-Down Cracking Mode (Rigid)

- **Current efforts are focused on artificial neural networks (ANN) for multi-slab model with curling.**
- **Fast, accurate solutions within the defined problem space.**
- **Grant to Iowa State U.**
  - P.I. Dr. Halil Ceylan
  - 3rd year of 3-year project.
- **Paper at 2017 TRB:**
  - *Neural-Network Based Multiple-Slab Response Models for Top-Down Cracking Mode in Rigid Airport Pavements Subjected to Boeing B-777 Loading*

ANN Development: Input Parameters






vement Profile
Gear Configuration
Status
Questions?
P-401/P-403 HMA Surface - 5 inches at modulus of 200000 psi
P-401/P-403 HMA Stabilized - 5 inches at modulus of 400000 psi
P-209 Crushed Aggregate - 21.9830646514893 inches at modulus of 80100 psi
Subgrade at modulus of 15000 psi