Presented to:  XI ALACPA Seminar on Airport Pavements and IX FAA Workshop, Santiago de Chile

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Federal Aviation Administration
Airport Technology R&D Program

- Research conducted at the FAA William J. Hughes Technical Center, Atlantic City, NJ, USA.
- Sponsor: FAA Office of Airport Safety and Standards (AAS-100), Washington, DC.
- Provide support for development of FAA pavement standards (Advisory Circulars).
Airport Technology R&D Branch, ANG-E26
Dr. Michel Hovan, Branch Manager

- **Airport Safety Section ANG-E261**
  - Jim Patterson, Manager
  - Visual Guidance
  - Runway Surface Technology
  - Aircraft Rescue and Firefighting (ARFF)
  - Wildlife Hazard Mitigation
  - Runway Incursion Reduction
  - Planning and Design for New Large Aircraft (NLA)

- **Airport Pavement Section ANG-E262**
  - Jeffrey Gagnon, Manager
  - Airport Pavement Design and Evaluation
  - Aircraft/Airport Compatibility
  - Advanced Pavement Materials Research
  - Airport Pavement Maintenance and Management
Federal Aviation Administration
Airport Pavement R&D Program

• R&D products are relied on worldwide by ICAO, aircraft industry & airport authorities.

• Four major R&D focal areas:
  1. Pavement thickness design.
  2. Aircraft/airport compatibility.
  3. Airport pavement maintenance & management.
National Airport Pavement Test Facility (NAPTF)

- Fully enclosed facility for accelerated traffic testing of airport pavements.
- Full-scale pavement structures and landing gear loads with programmed wander.
- Opened in 1999.
- Total construction contract was $21M.
  - $14M from FAA
  - $7M from Boeing Co. under FAA/Boeing CRDA.
Heavy Vehicle Simulator – Airport Version (HVS-A)

- Wheel loads - 10,000 to 100,000 lbs.
- Pavement temperatures up to 150°F
- Test speeds - 0.17 to 5 mph
- Single and Dual-Wheel configuration.
  - Single wheel is radial aircraft tires size 52x21.0R22
  - Dual wheel assembly is designed to accommodate smaller tires (B-737-800)
- Manufactured in USA by Dynatest.
## FAA Pavement Computer Programs

<table>
<thead>
<tr>
<th>Program</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAKFAA</td>
<td>Layered elastic back-calculation software for FWD</td>
</tr>
<tr>
<td>COMFAA 3.0</td>
<td>Pavement strength reporting (ACN-PCN)</td>
</tr>
<tr>
<td>FAA PAVEAIR</td>
<td>Web-based airport pavement management system</td>
</tr>
<tr>
<td>FAARFIELD 1.3</td>
<td>Pavement thickness design and evaluation</td>
</tr>
<tr>
<td>LEAF</td>
<td>Layered elastic analysis program (run from BAKFAA)</td>
</tr>
<tr>
<td>ProFAA</td>
<td>Airport pavement roughness and profile analysis</td>
</tr>
<tr>
<td>ProGROOVE</td>
<td>Groove analysis from longitudinal runway profile</td>
</tr>
</tbody>
</table>

- All programs are free to download, freely distributable, and available from: [www.airporttech.tc.faa.gov/naptf/download/](http://www.airporttech.tc.faa.gov/naptf/download/)
- FAA PAVEAIR web site: [https://faapaveair.faa.gov/](https://faapaveair.faa.gov/)
FAARFIELD 1.4

- Beta version now available.
- Plan to release with next change to AC 150/5320-6E.
- Many significant changes.
- Reduces excess design conservatism.
- New design-based compaction procedure.
- Incorporates results of full-scale tests at the National Airport Pavement Test Facility.

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FAARFIELD – What Is It?

FAARFIELD is the new FAA airport pavement thickness design program.

- FAARFIELD superseded LEDFAA 1.3 as the standard design procedure in FAA Advisory Circular (AC) 150/5320-6E.
- Current version is 1.305 (posted 1/18/11)
FAARFIELD 1.4 – What’s New?

FAARFIELD 1.4 has:

• Completely revised flexible and rigid failure models based on newest full-scale test data.
• Reduced excess stabilized base thickness requirement.
• Improved, more accurate 3D finite element model.
• Completely rewritten concrete overlay design procedure.
• Automated, software-based compaction criteria.
• Updated aircraft library aligned with COMFAA 3.0.
• Support for user-defined gear configurations.
• Advanced, energy-based asphalt fatigue models.
• All data files now stored in document directories.
Flexible Pavements

- New thickness designs are generally less conservative than FAARFIELD 1.305 designs for the same inputs.
- More compatible with COMFAA 1.3 (ACN-PCN method).

Conventional Flexible Pavement Comparison

Stabilized Flexible Pavement Comparison
Flexible Base Thickness

- The minimum stabilized base thickness is still 12.7 cm (5 inches).
- No additional stabilized base thickness requirement when improved subbase material (P-209) is used.
- Additional thickness requirement applies only if standard subbase (P-154) is used.
Rigid Pavements

- New thickness designs are generally less conservative than FAARFIELD 1.305 designs for the same inputs.
- New calibrations incorporate CC6 failure data.

Effect of Subgrade Modulus $E$

Rigid Design Example

New thickness designs are generally less conservative than FAARFIELD 1.305 designs for the same inputs. New calibrations incorporate CC6 failure data.
Improved Rigid Failure Model

- Sensitivity to factors such as concrete strength, traffic level and subgrade support is similar to current version.

**Effect of Concrete Flex Strength**

**Effect of Traffic**
Improved 3D Finite Element Mesh

• More accurate stress results.
• Improved infinite foundation model.
• Still one slab model with assumed 25% load transfer.

FAARFIELD 1.305

FAARFIELD 1.41
Rigid Overlay Design Procedure

- Completely rewrote overlay life program module.
- Eliminated gaps and illogical results, especially for overlays on new or undamaged PCC.
Automated Compaction Criteria

Computes compaction control points for rigid & flexible pavements.

<table>
<thead>
<tr>
<th>NonCohesive Soil</th>
<th>Depth of compaction from pavement surface (in)</th>
<th>Depth of compaction from top of subgrade (in)</th>
<th>Critical Airplane for Compaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Maximum Dry Density(%)</td>
<td>100</td>
<td>0 - 16</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>95</td>
<td>16 - 70</td>
<td>0 - 43</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>70 - 183</td>
<td>43 - 156</td>
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<td></td>
<td>90</td>
<td>16 - 28</td>
<td>0 - 1</td>
</tr>
<tr>
<td></td>
<td>85</td>
<td>28 - 96</td>
<td>1 - 69</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>96 - 178</td>
<td>69 - 151</td>
</tr>
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</table>
Aircraft Libraries

- Aligned the aircraft libraries in COMFAA and FAARFIELD to the extent possible.
- Used the most current data from manufacturers.
- Included new aircraft:
  - A350-900 (Preliminary)
  - B747-8
  - B787-9
  - Embraer Fleet
Changes to Design Guidance

• Deployment of FAARFIELD 1.4 in next AC will require changes to parts of AC 150/5320-6E.
• Partial list of recommended changes:
  – New guidance for applying automated compaction criteria.
  – Changes to HMA fatigue criteria (new RDEC energy model).
  – Revised shoulder design criteria.
  – Modify conversion from CBR to $k$-value.
  – Modified $k$-values for reduced subgrade strength (frost design).
  – Guidance for use of external aircraft library.
  – Modify Type A1 (reinforced isolation) joint detail.
  – Update all design examples.
# FAARFIELD 1.4

## System/Software Requirements

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<th>Recommended</th>
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<tr>
<td>• Windows XP or higher</td>
<td>• Windows 7 or higher*</td>
</tr>
<tr>
<td>• 2 GHz processor</td>
<td>• 3 GHz processor</td>
</tr>
<tr>
<td>• 2 GB RAM</td>
<td>• 4 GB RAM</td>
</tr>
<tr>
<td>• 200 MB of available space on hard drive.</td>
<td>• 64-bit operating system**</td>
</tr>
</tbody>
</table>

**Notes:**

*FAARFIELD 1.4 has not been fully tested on Windows 8.
**FAARFIELD 1.4 supports 32-bit or 64-bit Windows operating systems.
Changes in Data File Storage

• All data files are now stored in document directories by default.
  – Job files
  – External aircraft library files
  – Output files.
  – C:\Users\[User Name]\Documents\FAARFIELD

• Previously, data files (including job files) were stored in the program directory.
  – Required unrestricted read/write access for user.
  – Risk of data loss when changing/upgrading PC.
External Aircraft Library

- A new feature allows users to specify arbitrary gear geometries in the external library.
  - Coded as “X” in the external library.
  - Allows multiple wheel groups to be defined.
- Uses rewritten internal pass/coverage computation routine.
- New user guidance for the external library.

In this example, the externally defined A380 main gear gives the identical result as the internally stored airplane.
Future Developments

- **FAARFIELD 2.0 (Rigid)**
  - Multiple-slab mesh.
  - Variable joint spacing.
  - Shear load transfer.
  - Slab curling.
  - Top-down slab stress.

- **New rigid design considers:**
  - True slab size.
  - Design thermal gradient.
  - Critical position for full gear.
  - Maximum tensile stress on slab surface.

- **Currently in development.**
Thank You! ¡Muchas Gracias!

http://www.airporttech.tc.faa.gov/
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