

Extended Pavement Life

RPA P8

Presented to: REDAC Subcommittee on Airports

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Federal Aviation
Administration



RPA P8 – Extended Pavement Life

Need

Longer design periods for airport pavements, up to double the current standard of 20 years, will provide cost savings to the AIP by reducing lifecycle costs. Extended airport pavement life also provides many green benefits, and minimizes down time at the nation's busiest airports.

Research Goals

- Link PA40 database to historical traffic data sources in AS AIS by FY17.
- Develop performance data models (Age-DL and Traffic-DL) by FY18.
- Next-generation FAARFIELD program incorporating new 40-year life design procedures by FY22.

FY 2017-8 Accomplishments

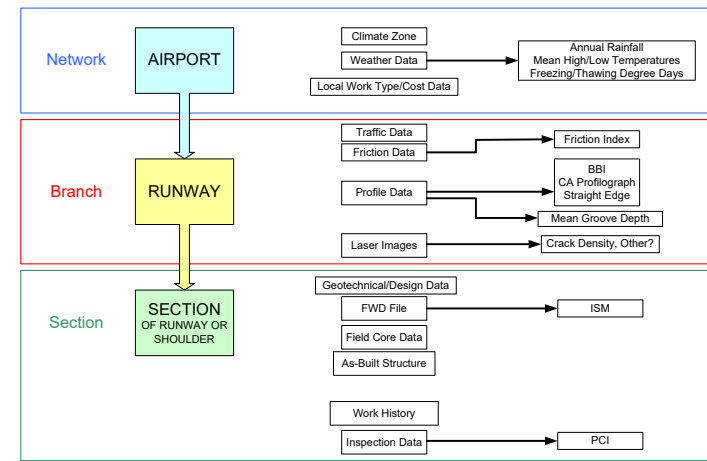
- Collect field data at DFW 18L-36R.
- Update PA40 to PAVEAIR 3.0 standard with active traffic link.
- Preliminary performance data analysis report 12/2017.

Funding Requirements

	FY 2018	FY 2019	FY 2020
Funding Target (\$000)			

Pavement Life Extension

- **Runway data collection.**
 - 4-year project complete.
 - Construction and performance data on medium- and large-hub runway pavements.
 - Field data collection.
 - Current efforts focus on filling known gaps in data.
- **FAA PAVEAIR database development (PA40).**
- **Pavement life model development.**



Updated Runway List

Airport Code	Airport Name	Runway	Pavement / Age	Field Testing	Subcontractor	Comments
Asphalt Runways, >20 years						
CMH	Port Columbus International	10L-28R	Flexible / >20	PCI / FWD / Inertial Profiler & SurPro	ARA	
BOS	General Edward Lawrence Logan Intl.	04L-22R	Flexible / >20	PCI / FWD / Inertial Profiler	Gemini	
BWI	Baltimore–Washington International	10-28	Flexible / >20	PCI / FWD / Inertial Profiler & SurPro	ARA	
TUS	Tucson International	11L-29R	Flexible / >20	Yes	Gemini/ARA	Field Work Completed 12/2015
SFO	San Francisco International	10L & 10R	Flexible / >50	No	ARA	
DCA	Ronald Reagan Washington National	04-22	Flexible / 40	No	Gemini	
LGA	New York - LaGuardia	42482	Flexible / >20	No	ARA	
SLC	Salt Lake City International	16L-34R	Flexible / >20	PCI / FWD / Inertial Profiler & SurPro	ARA	Field Work completed 11/2014
MCI	Kansas City International	09-27	Flexible / >30	Yes	ARA	Field Work Completed 4/2016
Concrete Runways, >20 years						
IAD	Washington Dulles International	01R-19L	Rigid / >20	PCI / FWD / Inertial Profiler	Gemini	
IND	Indianapolis International	5R-23L	Rigid / 23	PCI / FWD / Inertial Profiler & SurPro	Gemini	
SEA	Seattle-Tacoma International	16C-34C	Rigid / >20	No	ARA	
LAX	Los Angeles International	6R-24L	Rigid / 26	No	Gemini	
MCO	Orlando International	17R-35L	Rigid / 24	No	ARA	
SLC	Salt Lake City International	16R-34L	Rigid / 29	PCI / FWD / Inertial Profiler & SurPro	ARA	Field Work completed 11/2014
DEN	Denver International	17L-35R	Rigid / 19	No	ARA	
ATL	Hartsfield–Jackson Atlanta Intl.	9L-27R	Rigid / >20	YES	ARA	Field work completed 2/23/17
DFW	Dallas/Fort Worth International	18L-36R	Rigid / 40	YES	ARA	Field work completed 3/10/18
Asphalt Runways, <3 years						
CMH	Port Columbus International	10R-28L	Flexible / <3	Inertial Profiler	ARA	
GSO	Piedmont Triad International	5L-23R	Flexible / 3	PCI / FWD / Inertial Profiler & SurPro	ARA	Small Hub
TUS	Tucson International	03-21	Flexible / <3	Yes	Gemini/ARA	Field Work Completed 12/2015
MIA	Miami International	12-30	Flexible / <1	PCI / FWD / Inertial Profiler & SurPro	ARA	Field work Completed 2/2015. Material samples not obtained.
Concrete Runways, <3 years						
SEA	Seattle-Tacoma International	16R-34L	Rigid / <3	PCI / FWD / Inertial Profiler	ARA	
ORD						
IAD	Washington Dulles	01C-19C	Rigid / <3	No	Gemini	
IAH	George Bush Intercontinental	09-27	Rigid / <3	No	ARA	
FLL	Fort Lauderdale–Hollywood Intl.	10R-28L	Rigid / <1	PCI / FWD / Inertial Profiler & SurPro	ARA	Field work Completed 2/2015

Field Data Collection – DFW

- **LAX 6R-24L field data collection cancelled.**
- **DFW 18L-36R field data collection:**
 - Dec. 4-14, 2017 (PCI & profile data collection)
 - March 5-8, 2018 (HWD)

- Wet-No Freeze Climate Zone
- Original construction 1972 (>45 years).
- Old PCC runway exhibiting distresses including: joint seal damage, small patching, joint spalling, popouts.
- Fills gaps in PCI, HWD & profile data for old PCC runways.
- Coordinated site visit with DFW Operations.



PA40 Status – August 2017

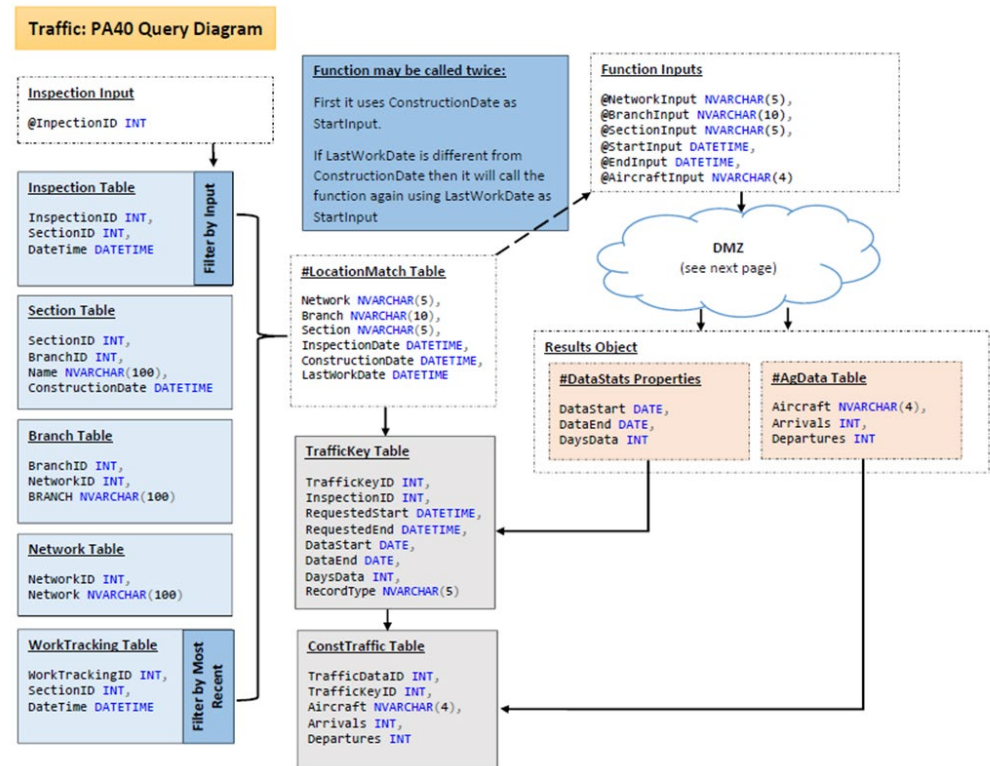
General		PA40 Database Status, March 1, 2018							
		Inventory	Work	PCI	Extended Life				
Airport	Runway				Design Traffic	FWD	Lab Test	Grooving	Profile
ATL	9L-27R	X	X	X	-	X	-	X	X
BOS	4L-22R	X	X	X	-	X	-	X	X
BWI	10-28	X	X	X	X	X	X	X	X
CMH	10L-28R	X	X	X	X	X	X	X	X
CMH	10R-28L	X	X	X	X	X	-	-	X
DCA	1-19	X	X	X*	X	-	-	-	-
DEN	17L-35R	X	X	X	-	-	-	-	-
DFW	18L-36R	X	X	X	-	-	-	X	X
FLL	10R-28L	X	X	X	X	X	X	X	X
GSO	5L-23R	X	X	X	-	X	X	X	X
IAD	1R-19L	X	X	X*	-	X	X	X	X
IAD	1C-19C	X	X	X*	X*	-	-	-	-
IAH	9-27	X	X	X	X	X	-	-	-
IND	5R-23L	X	X	X*	X	X	X	X	X
LAX	6R-24L	X	X	X*	-	-	-	-	-
LGA	4-22	X	X	X	-	-	-	-	-
MCI	9-27	X	X	X	X	X	X	X	X
MCO	17R-35L	X	X	X	X	-	-	-	-
MIA	12-30	X	X	X	-	X	-	X	X
ORD	10C-28C	X	X	X*	X	X	X	X	X
SEA	16R-34L	X	X	X	X	X	-	X	X
SEA	16C-34C	X	X	X	-	-	X	-	-
SFO	10L-28R	X	X	X	-	-	-	-	-
SFO	10R-28L	X	X	X	-	-	-	-	-
SLC	16L-34R	X	X	X	X	X	-	X	X
SLC	16R-34L	X	X	X	X	X	-	X	X
TUS	11L-29R	X	X	X	-	X	X	X	X
TUS	3-21	X*	X	X*	-	-	-	-	-

Legend				
X	Data			
-	No Data			
	Information is missing or incorrect in PA40			
	Some information is missing or incorrect in PA40			
	Data is present in PA40, but not yet checked for accuracy against the source data			
	Information is uploaded (where appropriate) & checked/spot-checked against source file w/ source file back-up where applicable			
	Import files have been prepared for future batch upload			
	Delete from PA40			

*Missing complete source file for upload, check or correction

PA40 Traffic Data Integration

- **Search runway usage data by:**
 - Aircraft type.
 - Runway end.
 - Arrival or departure event.
- **Designed to return runway traffic since:**
 - Construction or major work date.
 - Previous inspection date.
- **Access threaded track data (TTD) via NPN shared services.**



PA40 Updates

- **PA40 deployed in PAVEAIR 3.0 code base.**
- **January 2018 updates:**
 - Added traffic link filters, SQL command information, and examples to the traffic link.
 - Added units added to the header rows of the lab data tables.
 - Updated BWI section names to be consistent with the BWI database.
 - Updated FWD offset information.
 - Added DFW data (PCI, profile, groove).
- **Additional updates in March 2018:**
 - Add DFW data (HWD) & SLC lab test.
 - Code base update.

PA40 Updates – Traffic Link

Sample query returns all arrivals and departures of B787-8 aircraft on DFW RWY 18L-36R during July 2016.

The screenshot shows the PA40 Traffic Link web application interface. The browser address bar displays 'pa40.faa.gov/Traffic.aspx'. The page has a blue header with navigation links: Home, Inventory, Work, PCI, Prediction Modeling, Condition Analysis, M&R, Reports, Maps, Tools, Extended Life, Logout, Member Area, and Help. Below the header, the 'Current Database: DFW' section contains the following fields:

- Network: DFW (dropdown menu)
- Branch: RW18L-36R (dropdown menu)
- Start Date: 7/1/2016 (text input, with a note: 'The earliest date that data is available is 6/1/2014')
- End Date: 7/31/2016 (text input, with a note: 'The latest date that data is available is 8/28/2016')
- Aircraft: 'B788' (text input, with a 'Filter' button next to it)
- 'Show Help' button
- 'Run Query' button
- Radio buttons for 'Both', '18L', and '36R' (all are unselected)

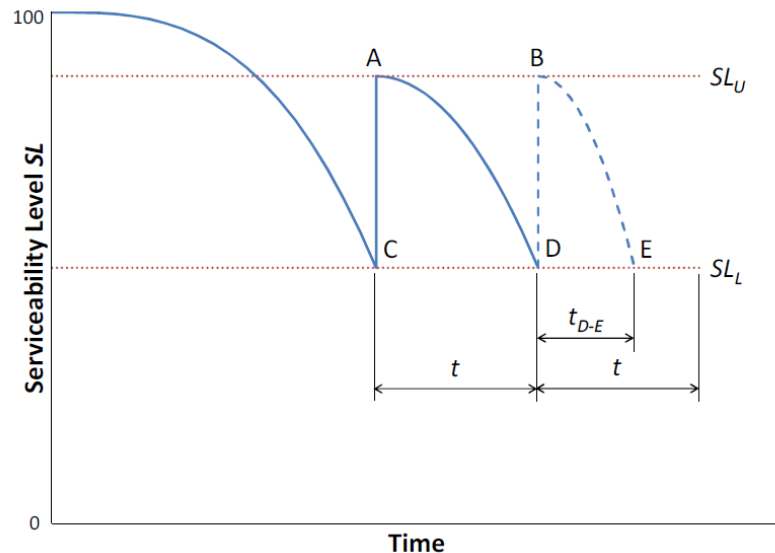
Below the form, a table displays the query results:

Aircraft	Arrivals	Departures
B788	28	77

At the bottom of the table, a note states: 'Data shown represents 31 days of data between 7/1/2016 and 7/31/2016 (100.0% complete between requested dates 7/1/2016 and 7/31/2016).'

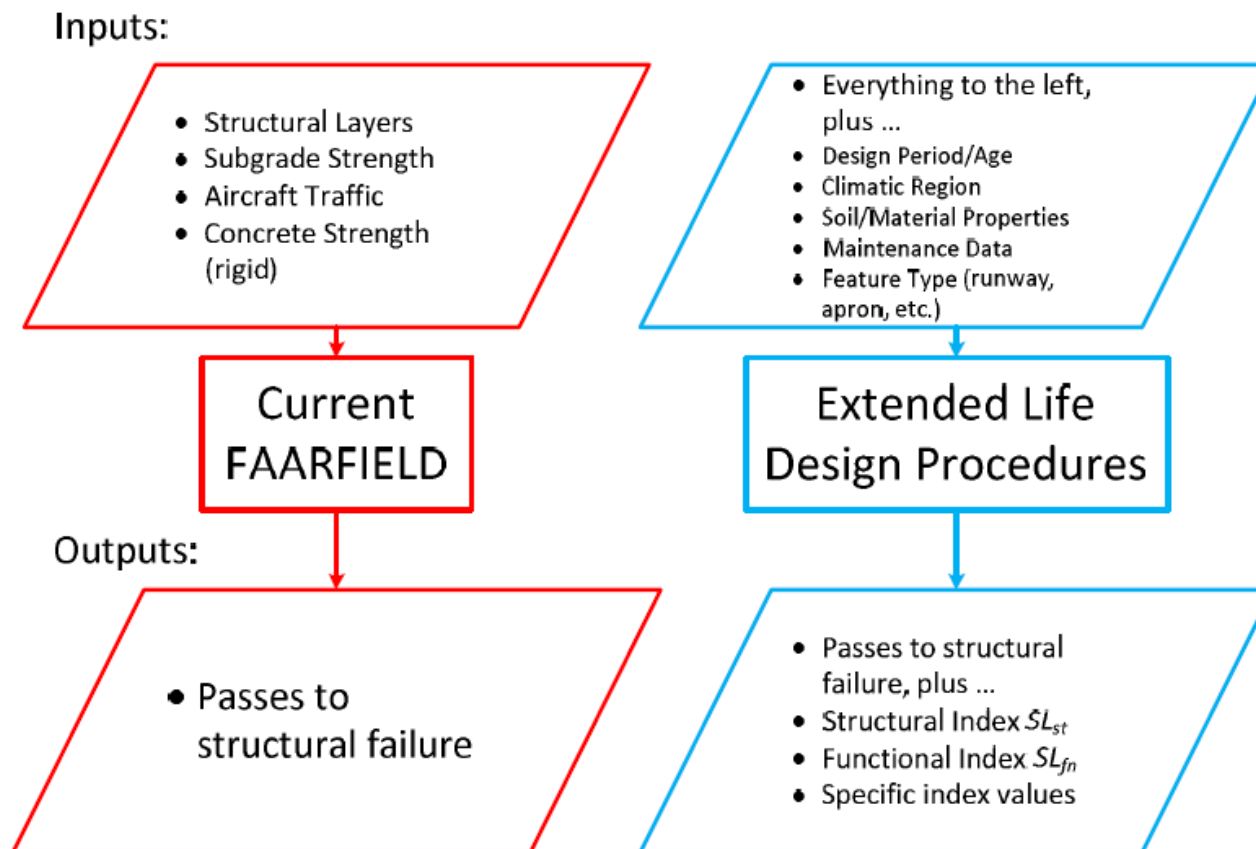
A red arrow points from the text on the left to the 'Run Query' button.

Serviceability Level Concept



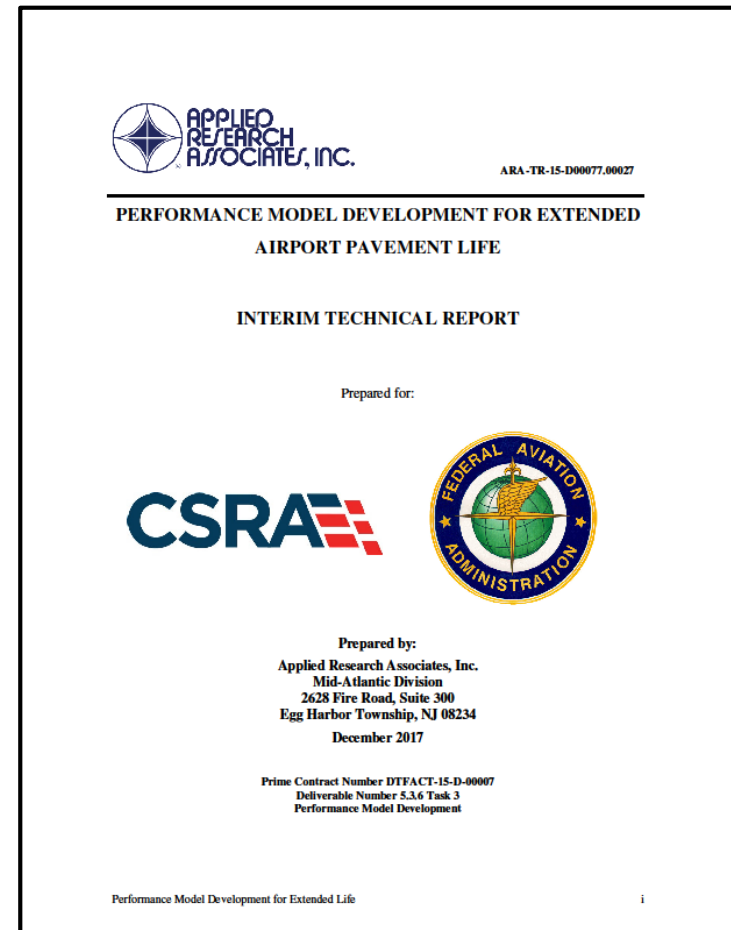
- Points A and B represent rehabilitations to restore serviceability.
- Points C and D represent “end of serviceability.”
- Point D also represents “end of life” if:
$$\Pr(t_{D-E} > t) < p$$
- Goal: find components of SL , and parameters SL_L , p such that “end of life” agrees with LCCA-based decision to reconstruct.

Schematic for Generalizing Design Procedures



Performance Modeling Framework

- **Interim Report:**
Performance Model Development for Extended Airport Pavement Life,
December 2017.
- Establish analytical framework for model development.
- Analyze data from 28 runways in PA40.



7-Step Analytic Procedure for Performance Model Development

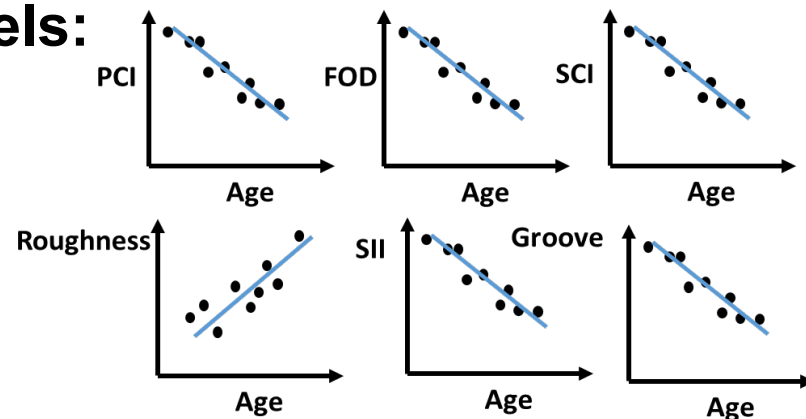
1. Identify dates of major rehabilitation or reconstruction.

- Assume pavement undergoing major rehabilitation is at or below the lower serviceability threshold SL_L .

2. Calculate functional age for section.

- Defined as the age counted from either the construction date or date of last major rehabilitation.
- Assume that any major rehab resets to “perfect” condition.

3. Create regression models:



7-Step Analytic Procedure for Performance Model Development (cont.)

4. Estimate missing condition indexes.

- Estimate condition of pavement at time of rehabilitation using condition analysis tools in PAVEAIR.
- Estimate any missing condition indexes.

5. Create pavement condition matrixes from PA40 database.

- Records associated with estimated conditions at time of rehab are assigned “**unserviceable**” value.
- Others assigned “**serviceable.**”

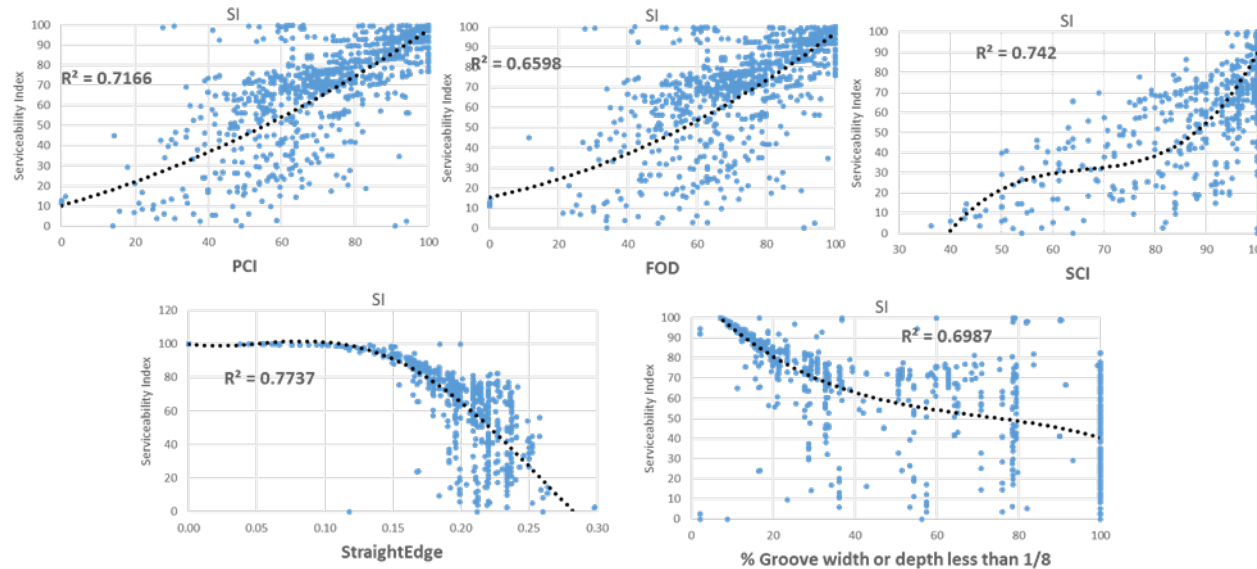
6. Develop serviceability level (SL) index.

- Based on a binary logistic regression model (“logit”).
- Find probability of section being unserviceable given condition indexes.

7. Establish SL thresholds for unserviceable pavements.

- Identify the threshold value that maximizes correct classification.

Initial Performance Model Development Based on PA40 Data (Flexible)

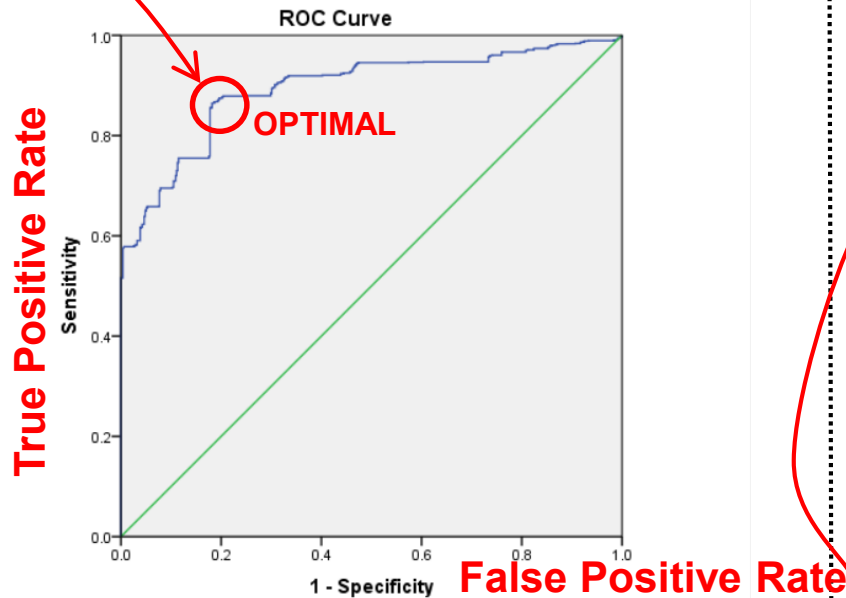


Component Index	Asphalt Trigger	Correct Classification of Unserviceable Pavements	Correct Classification of in-service Pavements
PCI	65	82%	64%
FOD	65	83%	63%
SCI	85	91%	42%
Straightedge	0.2 in	80%	71%
Grooves	40% < 1/8	69%	79%



Logit Model Analysis

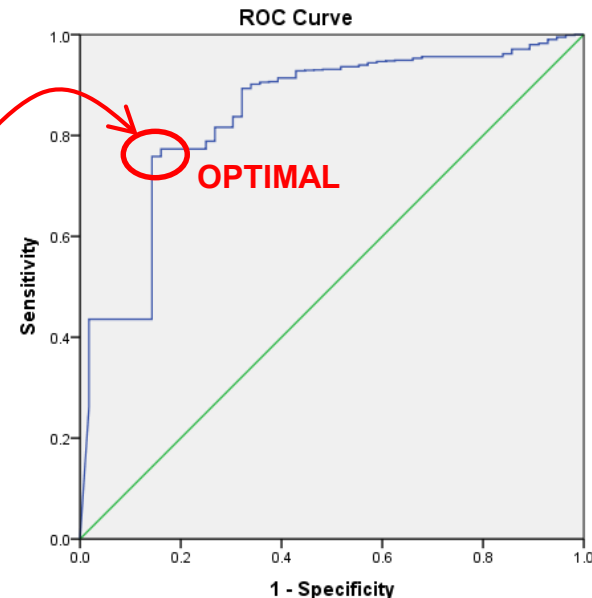
FLEXIBLE



$SL_L = 65$ gives the optimal separation between serviceable and non-serviceable pavements.

SL _L = 65 gives the optimal separation between serviceable and non-serviceable pavements.			Predicted		
			Serviceable?		Percent Correct
			Yes	No	
Observed	Serviceable?	Yes	1236	175	87.6
		No	100	395	79.8
Overall Percentage					85.6

RIGID



$SL_L = 95$ gives the optimal separation between serviceable and non-serviceable pavements.

SL _L = 95 gives the optimal separation between serviceable and non-serviceable pavements.			Predicted		
			Serviceable?		Percent Correct
			Yes	No	
Observed	Serviceable?	Yes	1182	374	76
		No	9	47	83.9
Overall Percentage					76.2

Planned Work

- **Extend regression models to include traffic history and climate cycles as independent variables (in addition to functional age).**
- **Incorporate new FAA airport roughness index.**
- **Re-evaluate alternate structural indexes (based on HWD) with additional data.**