Airfield Pavement Management Program

ICAO Airfield Pavement Workshop

Presented by:

Harold Muniz
Airfield Pavement Engineer
FAA Headquarter, AAS-110

David R. Brill, P.E., Ph.D.
Program Manager – Airport Pavement Technology
FAA Airport Technology R&D Branch, ANG-E262

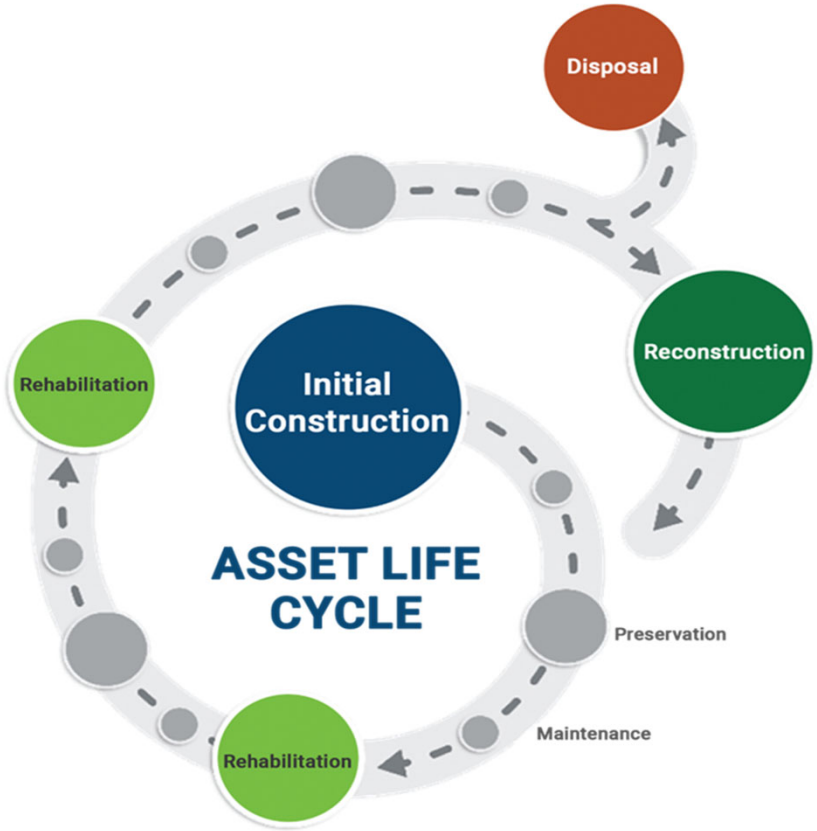
Overview

- **Pavement Management Fundamentals**
- **Benefits of Pavement Management Program**
- **Components of Pavement Management Program (PMP)**
  - Inventory
  - Management
  - Reporting
- **Benefits of Geospatial Information System (GIS)**
- **PMP and Sustainability**
- **FAA Guidance on PMP**

Pavement Management Program Fundamentals

- **Pavement Management** - A systematic process of maintaining, upgrading, and operating physical assets cost-effectively throughout its life-cycle

- **Pavement Management Plan**
  - Set of defined procedures for collecting, analyzing, maintaining, and reporting pavement data.
  - Assists airports in finding optimum strategies for maintaining pavements in a safe, serviceable condition over a given period for the least cost
  - Not just a condition inspection
    - maintenance procedures,
    - management of completed works
    - staff competence needs



Benefits- Pavement Management Program

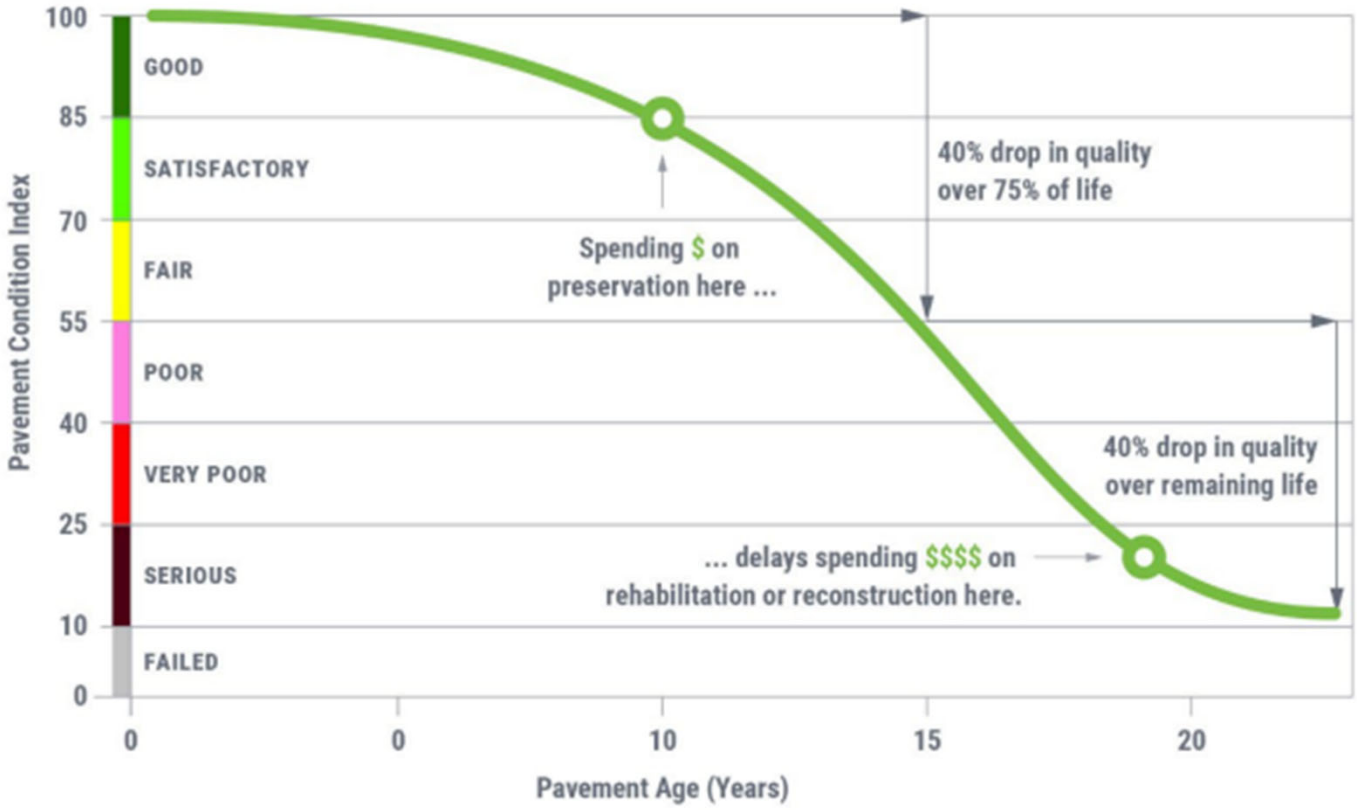
- An objective and consistent evaluation of the condition of a network of pavements.
- Increased pavement useful life.
- Reduced life-cycle cost.
- Life Cycle Cost Analysis for various M&R alternatives.
- Identification of budget requirements various service levels
- Documentation on the present and future condition of the pavements.
  - Support planning and development
- Identifying the impact on the pavement if no major repairs are performed

Benefits- Pavement Management Program

- Pavement management program evaluate the **current condition** of the inventory and allow users to predict future condition
  - Objective inspection criteria
  - Historic information
  - Condition Indicators
- **Predicted condition** allows life-cycle analysis of various M&R alternatives
  - Can maximize pavement life
  - Reduce overall M&R cost
  - Project prioritization
  - Determine optimal maintenance timing

Typical Pavement Life-Cycle

- Pavement is expected to maintain a good condition for the first several years
- Deterioration will accelerate at a certain point
- Preventative maintenance early in a pavement life is more cost effective than major rehabilitation later

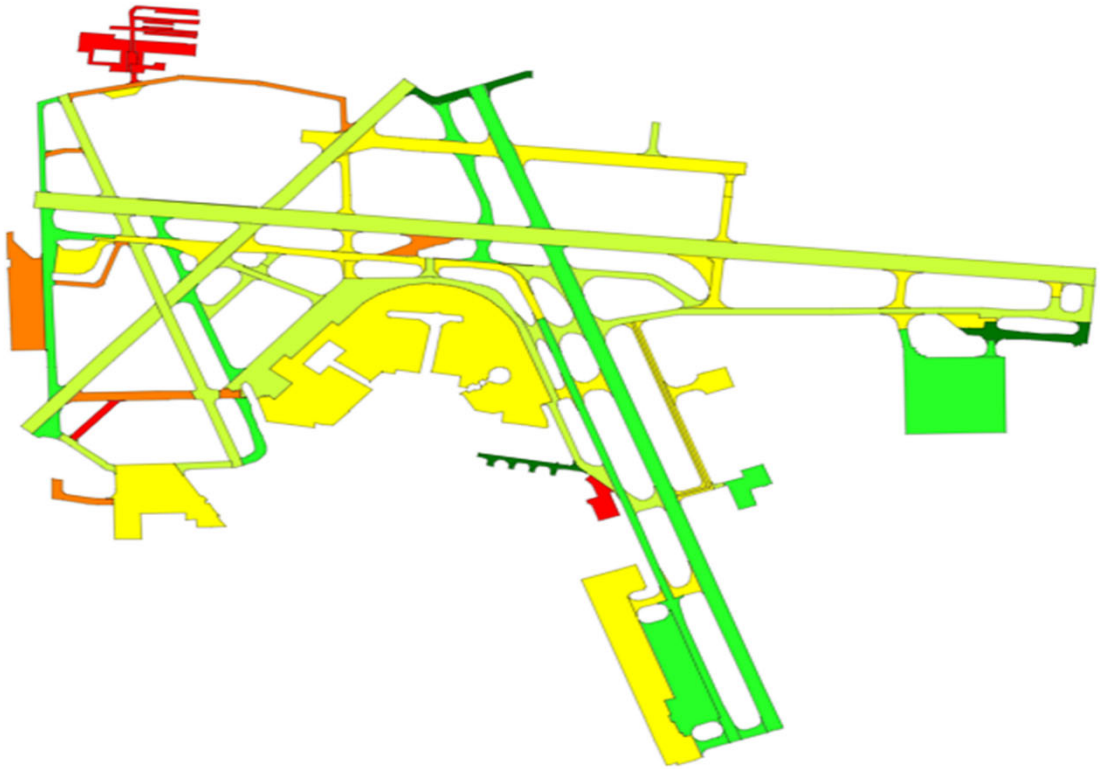


Benefits- Pavement Management Program

- **Predicted condition alone is not enough to effectively manage pavement**
  - Maintenance alternatives must be established(Preventative, Rehabilitation)
    - Should target the deficiency and improve pavement condition
    - Need estimates of unit cost for M&R to assess investment
  - Implementation Criteria
    - Maintenance Policies
    - Trigger Values
- **Enables assessment of multiple budget scenario***
  - Comparison with “Do nothing” scenario
  - Cost of maintaining a level of service

But how does a PMP benefit me…

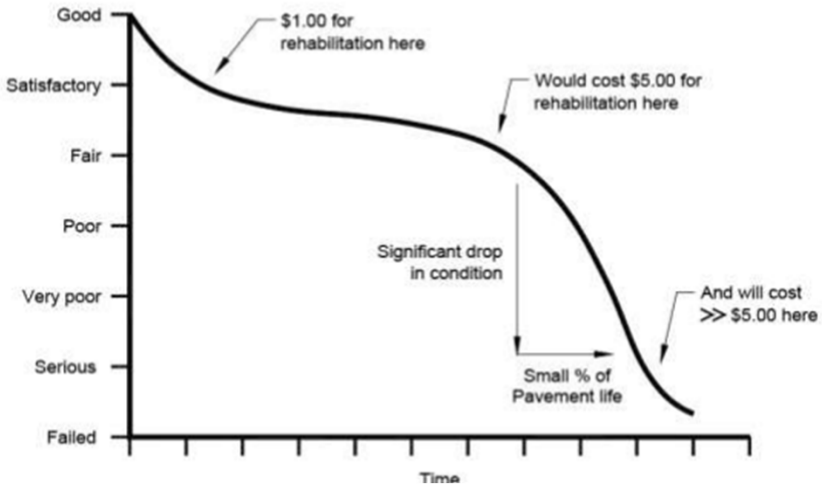
- **As the Engineer**
  - Identifies Inventory
  - Assesses Condition
  - Prioritizes M&R
  - M&R Cost
- **As the Airport Owner**
  - Operational Impact
  - Balance Requirements
  - Budgets
- **As an Agency**
  - Prioritize Funding
  - Health of Infrastructure
  - Maximize Investment



Pavement Management Approaches

- **Lack of PMP results in reactionary maintenance & repair- "worst first"**
  - More costly than preventive approach
  - Additional cost limits funds available for future work
  - Limited solutions available due to lack of planning

- **Moving away from "worst first" can be tough**
  - Requires a change in thinking at all levels
  - PMP help support an optimized approach prioritizing preservation



Historical Pavement Management

- **Concepts of Pavement Management started in the 1970's**
  - Development of pavement inspection procedures
  - Application of low-cost preventative treatments
  - Critically of timing
- **Didn't gain wide-spread adoption until the mid 1990's**
  - Implementation of PCI program
  - Publishing AC 150/5380-7B
    - Federally Obligated Airports must maintain a Pavement Management Program and update annually

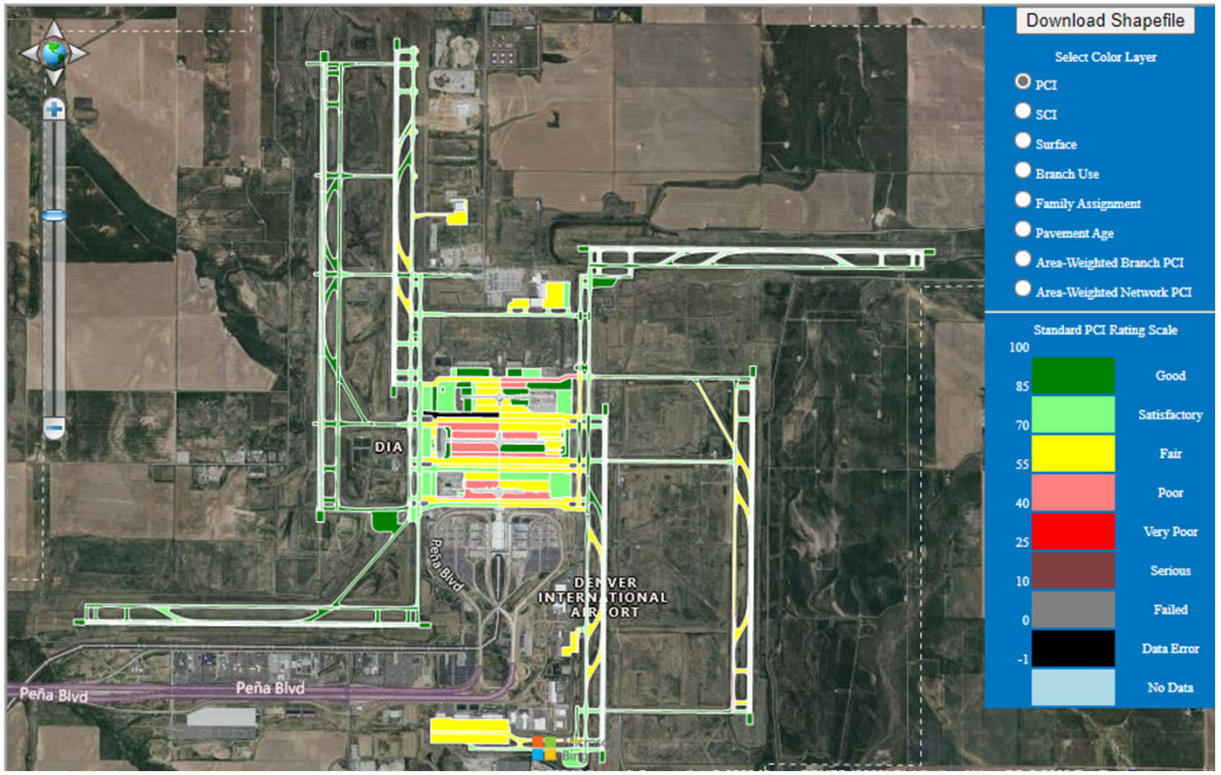
Pavement Management Levels

- **Network Level-** *A network level management approach focuses on routine assessments; planning be utilized to optimize funding and prioritize M&R requirements o decisions are made for the management of an entire pavement network.*
  - Assessments generally based on statistical sampling of pavement
  - Supports sponsor and agency long-term planning
  - Prioritizes funding needs
- **Project Level-** *In project-level management is primarily focused on determining the most cost-effective M&R alternative for the pavements identified in the network analysis. However, factors may change the optimum M&R strategy between the time of the last PMP and the actual development of a project.*
  - Assessments generally consist of 100% distress identification
  - Supports projects scope development & alternative analysis

Pavement Management Process

Pavement Management Software

- **Pavement Management**
  - PAVER (USACE)
  - PAVEAIR (FAA)
- **Structural Evaluation**
  - FAARFIELD
  - PCASE
  - ICAO-ACR
- **Roughness**
  - PROFAA



Components- Pavement Management Program

- **Inventory (Network, Branch, Section)**
  - Pavement Condition
  - Pavement Structure
  - Construction History
  - Traffic Data

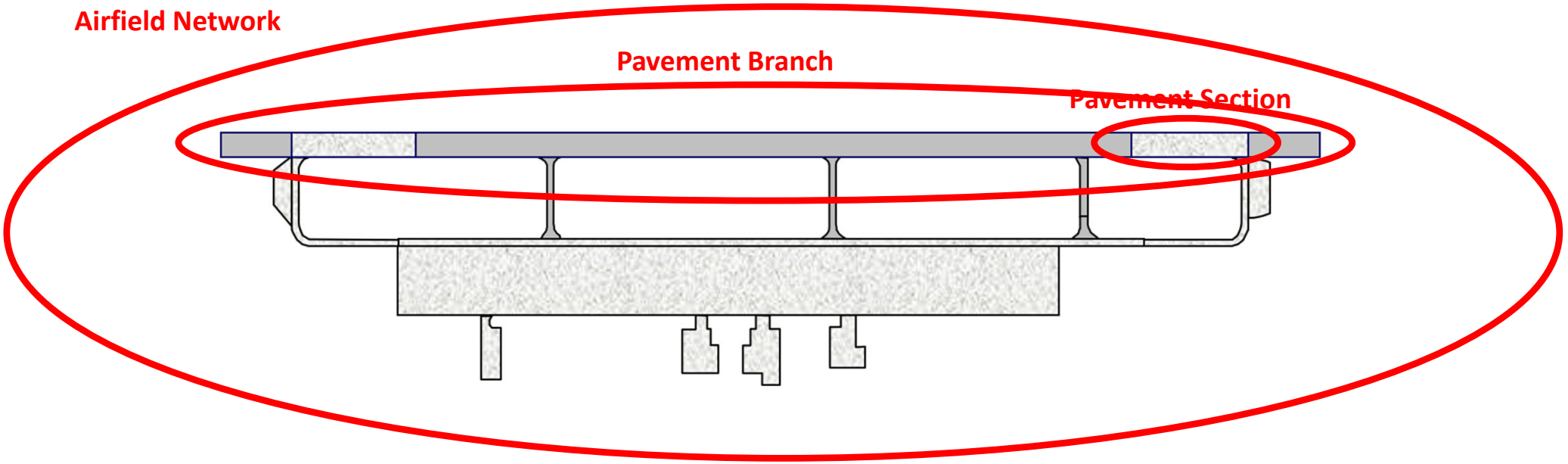
- **Management**
  - Deterioration Rates
    - Future Condition
  - Maintenance Polices
  - Budget Scenarios

- **Reporting**
  - Future Condition
  - Recommended M&R
    - LCCA

Pavement Inventory

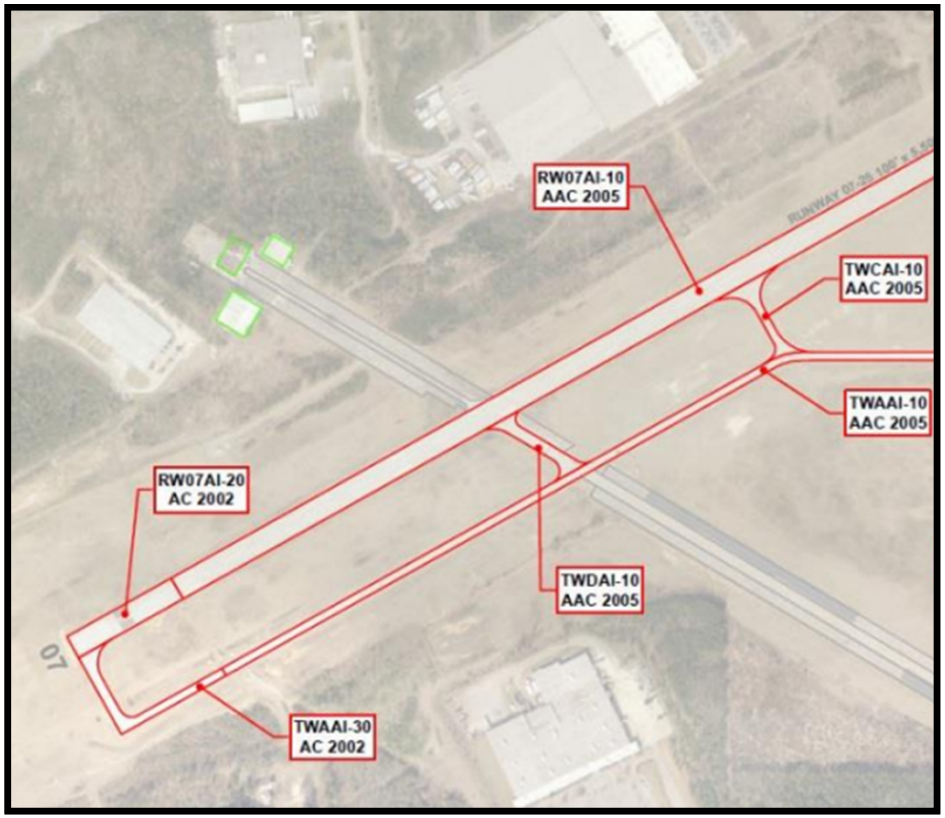
- **Pavement Network-** a logical unit for organizing pavements into a structure for the purpose of pavement management. A network will consist of one or more pavement branches. Highest level of the hierarchy.
  - Examples: DCA (Reagan) Airfield Pavement, DCA Landside Pavement
- **Pavement Branch -** a readily identifiable part of the pavement network with a distinct function.
  - Examples: Taxiway Kilo, Runway 15/33, GA Parking Apron
- **Pavement Section** - is a subset of a branch and is an area of pavement having a consistent or uniform pavement type, thickness, and condition, as well as the same pavement use.

Pavement Inventory



Pavement Inventory Data

- **Pavement Section Data**
  - Pavement Type
  - Pavement Use
  - Construction Date
  - Size
  - Location
  - Ranking
  - Distresses
  - Condition



Pavement Inspection

- Annual Inspection Required for PMP update
- Visual Inspection of Surface Condition
  - PCI Inspection (ASTM D5340)
    - Inspection valid for 3-year (FAA Standard)
    - Maintain pavements >70 PCI
  - PASER
  - Sponsor developed inspection
    - Objective and repeatable assessment
    - Ability model past and future conditions
    - Capable of being used to develop M&R program
- Routine inspection is needed to maximize benefit

PCI Rating

Condition	Rating	Definition
Good	86 - 100	Pavement has minor or no distresses and will require only routine maintenance.
Satisfactory	71 - 85	Pavement has scattered low-severity distresses that should need only routine maintenance.
Fair	56 - 70	Pavement has a combination of generally low- and medium-severity distresses. Maintenance and repair needs should be routine to major in the near term.
Poor	41 - 55	Pavement has low-, me cause some operationa should range from routi
Very Poor	26 - 40	Pavement has predomi causing considerable m maintenance and repai
Serious	11 - 25	Pavement has mainly h restrictions. Repair nee
Failed	0 - 10	Pavement deterioration operations are no longe

Rating 5 – Excellent
No maintenance required

Rating 4 – Good
Minor routine maintenance, crack sealing

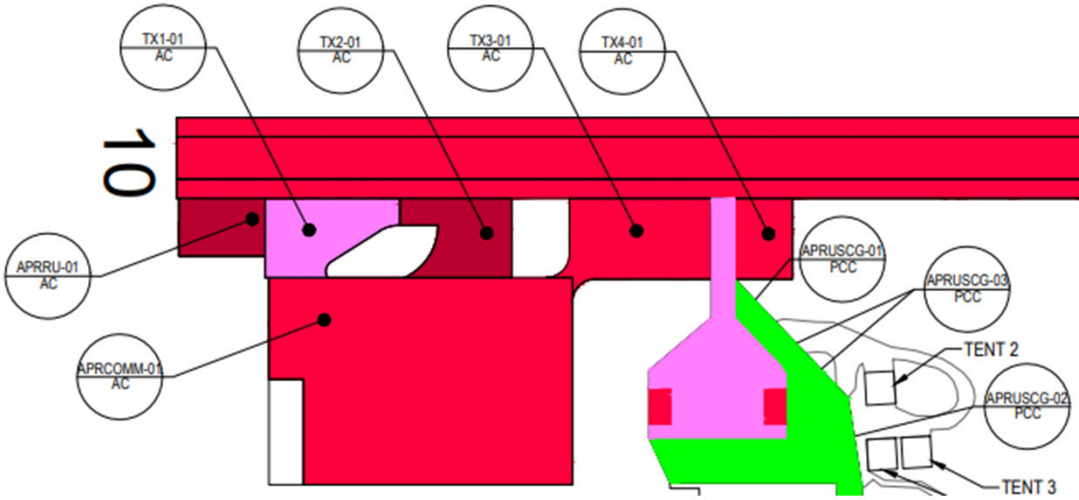
Rating 3 – Fair
Preservative treatments, crack sealing and surface treatment

Rating 2 – Poor
Structural improvement and leveling (patching then overlay)

Rating 1 – Failed
Reconstruction

PASER Rating

Airfield Pavement Inventory and Condition



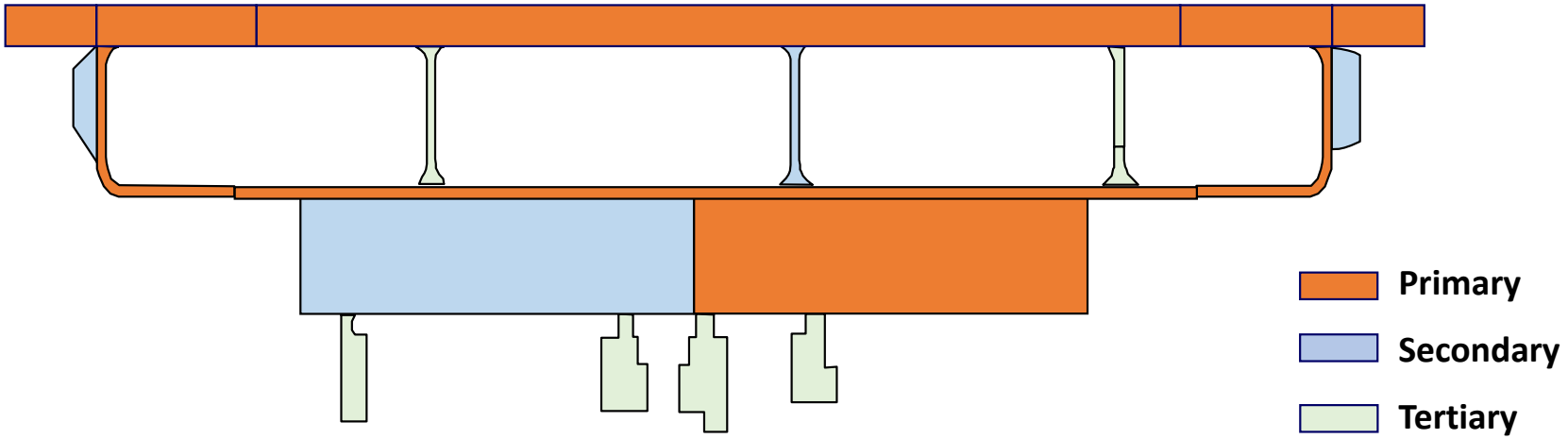
PAVEMENT CONDITION INDEX	
	GOOD (86-100)
	SATISFACTORY (71-85)
	FAIR (56-70)
	POOR (41-55)
	VERY POOR (26-40)
	SERIOUS (11-25)
	FAILED (0-11)

Airfield Pavement Ranking

- Consider establishing ranking criteria to between the relative importance of the pavement to operations.
  - Pavements of higher importance typically require additional funding to support maintenance and rehabilitation.
  - Could require different levels of service
  - Aids in M&R prioritization

- Classification approach; Primary, Secondary, and Tertiary pavements
  - **Primary-** Pavement critical to the daily operations
  - **Secondary-** Key pavement that offer some redundant capability
  - **Tertiary-** Non-critical pavement features

Airfield Pavement Ranking – Example

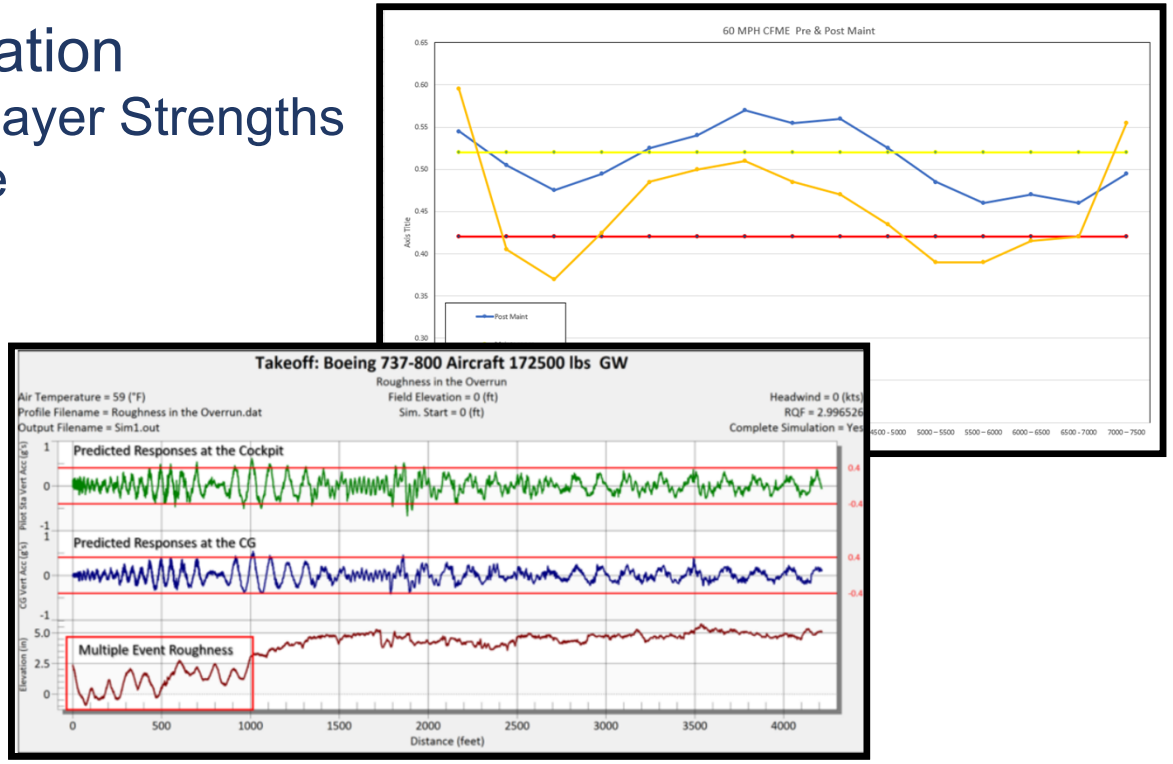


Pavement Construction History

- **Maintenance & rehabilitation data information provides essential information regarding the history of the pavement**
  - Construction Date
  - Extent of work accomplished
  - Project Cost
- **Historically hard to gather due to poor record keeping**
- **Can be collected within PMS or externally**
- **Aids in determining pavement performance**

But there is more a PMP…

- Structural Evaluation Information
  - Pavement Thicknesses and Layer Strengths
  - Destructive & Non-destructive
- Friction Information
- Pavement Strength (PCR)
- Roughness Data
- Reports
  - Condition
  - Budget Scenarios
  - Maintenance Alternatives



Projecting Pavement Condition

- Typical Airfield Pavement Deterioration;
  - Asphalt Pavement 2-3 PCI points per year
  - Concrete Pavement <1-2 PCI points per year
- Rate of deterioration is dependent on;
  - Age of pavement
  - Traffic
  - Environment
  - Construction
- PMS can be used to locally calibrate
  - Pavement grouped by families

Projecting Pavement Condition

Example Runway Condition Summary

Category	Airport	Runway ID	Runway Length	Runway Width	Runway PCI	5 Year RW PCI
General Aviation						
GA	2IS	RW 13-31	5,902	75	88	80
GA	APF	RW 14-32	5,001	100	86	77
GA	APF	RW 5-23	6,600	150	76	67
GA	AVO	RW 10-28	3,844	75	75	66
GA	AVO	RW 5-23	5,374	100	94	85
GA	BOW	RW 5-23	5,000	100	54	44
GA	BOW	RW 9L-27R	5,000	150	79	69
GA	BOW	RW 9R-27L	4,400	150	31	26
GA	CHN	RW 18-36	4,005	75	100	91
GA	GIF	RW 11-29	4,001	60	99	84
GA	GIF	RW 5-23	5,005	100	82	68
GA	IMM	RW 18-36	4,550	150	26	18

Critical Condition

- Critical condition is the point where a pavement will start to rapidly deteriorate, reducing the level of service provided
  - Dependent on the type of distresses (structural or environmental)
  - PMS help predict this based on detailed distress data
  - Can be estimated based on typical deterioration rates
- Agencies can establish critical condition values to support level of service and help project M&R needs
  - Examples
    - PCI 70 – Rehabilitation for Primary Pavement
    - PCI 55 – Reconstruction for Primary Pavement

Maintenance Policies

- Trigger values can also be used to type of work & policies
  - Preventative maintenance
  - Stop-gap maintenance
  - Rehabilitation
  - Reconstruction
- Maintenance Policies
  - Low-Severity Longitudinal Cracking- *Do nothing*
  - High-Severity Alligator Cracking- *Full-depth Path*

Maintenance & Rehab Policies

- **Identify values that will trigger some type of work & policies**
  - Preventative maintenance
  - Stop-gap maintenance
  - Rehabilitation
  - Reconstruction
- **Examples**
  - PCI 70 – Rehabilitation for Primary Pavement
  - PCI 55 – Reconstruction for Primary Pavement
- **Maintenance Policy**
  - Low-Severity Longitudinal Cracking- Do nothing
  - High-Severity Alligator Cracking- Full-depth Path
- See ACRP Report 159 for recommendation

Expected Maintenance & Rehab

Expected Maintenance Based on Condition

PCI		Rating	Pavement Treatment
100		Good	Routine maintenance only
85		Satisfactory	Preventative maintenance
70		Fair	Corrective maintenance and rehabilitation
55		Poor	Rehabilitation or reconstruction
40		Very poor	Rehabilitation or reconstruction
25		Serious	Immediate repairs and reconstruction
10		Failed	Reconstruction
0			

Source: Hajek et al. 2011.

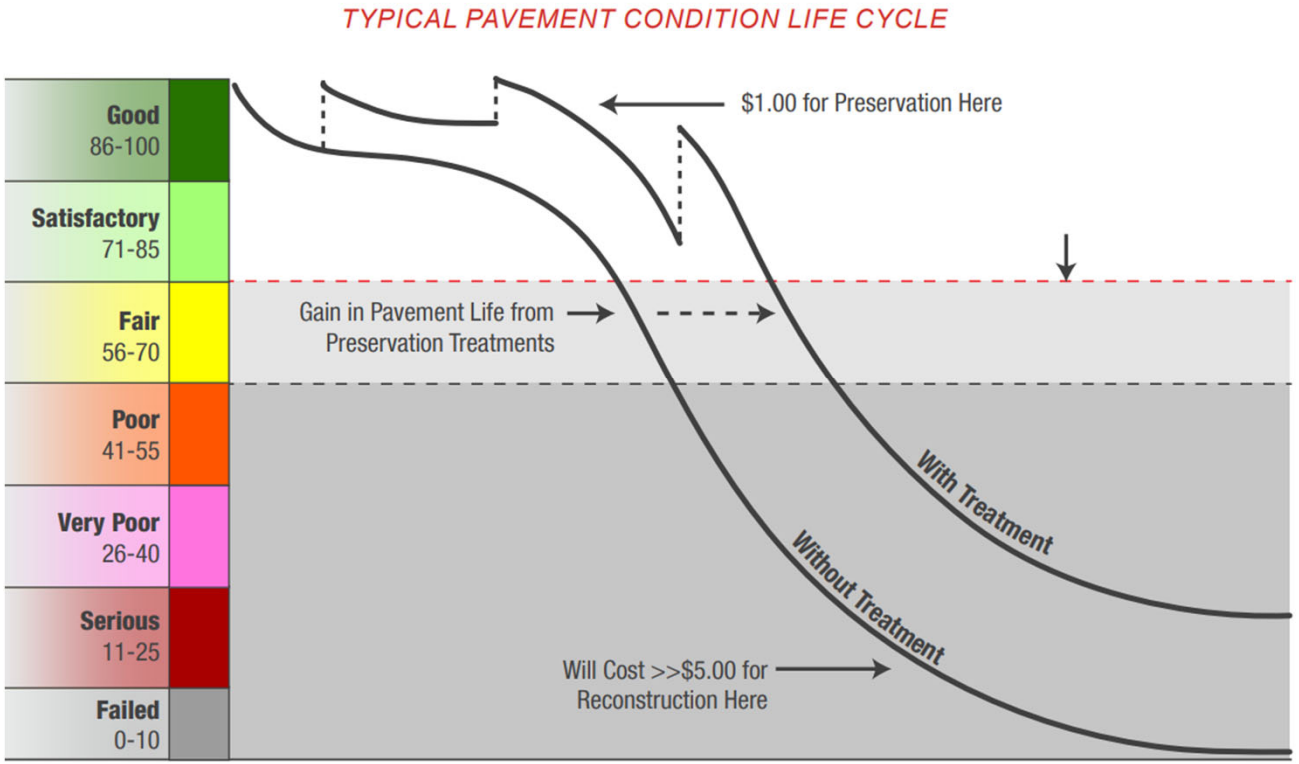
Pavement preservation, maintenance, and rehabilitation, options.

Asphalt Treatments	Concrete Treatments
Do nothing	Do nothing
Crack seal/fill	Crack/joint seal
Rejuvenator	Partial depth repair
Fog/coal tar seal	Full-depth repair (localized)
Slurry/micro	Cross-stitching/dowel-bar retrofit
Chip/cape seal	Slab stabilization/jacking/underseal
AC overlay/mill + overlay	Concrete/asphalt overlay
Patch/reconstruct area	Grinding/grooving
Too severe (rehab/reconstruct)	Too severe (rehab/reconstruct)

Note: AC = asphalt concrete.

ACRP Report 159

Maintenance & Rehab Policies



FDOT Airfield Pavement Evaluation Report , 2022

Maintenance Plans

- PMP should include report planned maintenance based on pavement condition and established policies
  - Preventative Maintenance
  - Minor Repair
  - Major Rehabilitation
  - Reconstruction
- Plans should include;
  - Work Type
  - Estimated Cost
  - Projected Condition

Example

YEAR 1 LOCALIZED MAINTENANCE BY WORK TYPE SUMMARY

Localized Maintenance Category	Localized Work Type	Rough Estimate of Work Quantity	Work Units	Planning Material Cost
Localized Preventive Maintenance (Total = $1,147,470)	AC Crack Sealing	2,708	LF	$10,860
	Surface Seal	645,710	SF	$484,550
	AC Full-Depth Patching	285	SF	$5,360
	PCC Joint Seal	137,599	LF	$584,840
	PCC Partial-Depth Patching	365	SF	$61,860
Localized Stopgap Maintenance (Total = $101,260)	AC Full-Depth Patching	5,399	SF	$101,260
			Total Localized Maintenance Needs =	$1,248,730

FDOT Airfield Pavement Evaluation Report , 2022

Budget Planning

- Budget planning allow agencies to determine funding requirements to maintain user defined level of service
- PMS does allow execution of different budget scenarios
  - Unrestricted to maintain a level of service
  - Constrained budget based on a projected amount

M&R FUNDING NEEDS BY YEAR (IN MILLIONS)

Category	Network ID	Inspection Year	Year 1*	Year 2	Year 3	Year 4	Year 5	Planning Total
PR	PGD	2022	$42.62	-	$0.59	$3.15	-	**$46.36**
	RSW	2022	$125.33	$25.81	$1.24	$14.49	$6.35	**$173.22**
	SRQ	2022	$31.95	$8.22	$16.70	$6.55	-	**$63.42**
PR Planning Total			**$199.90**	**$34.03**	**$18.53**	**$24.19**	**$6.35**	**$283.00**

FDOT Airfield Pavement Evaluation Report , 2022

Example of PMP Benefits

District	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
District 1	73	72	70	69	67	65	64	63	61	60
District 2	73	72	70	69	68	67	65	64	62	61
District 3	71	70	69	67	66	65	64	62	61	60
District 4	75	73	71	70	68	67	66	64	63	61
District 5	72	70	68	67	65	64	62	61	59	57
District 6	64	63	61	59	58	56	54	53	51	49
District 7	73	72	70	69	67	66	64	63	61	60
Statewide	**72**	**71**	**69**	**68**	**66**	**65**	**63**	**62**	**60**	**59**

- Project PCI is no work is accomplished

- Funding needed to maintain safe level of service

DISTRICT-LEVEL 10-YEAR MAJOR REHABILITATION NEEDS BY YEAR (COST IN MILLIONS)

District	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1	$100.7	$0.7	$277.5	$47.6	$31.5	$30.6	$21.5	$17.0	$15.5	$33.9	$18.0	$29.4
2	$86.8	$9.8	$106.8	$47.4	$5.5	$15.7	$26.8	$24.6	$24.1	$64.8	$16.1	$13.4
3	$139.8	$2.7	$110.8	$18.1	$10.2	$21.8	$7.6	$11.2	$14.2	$12.0	$6.2	$21.2
4	$55.8	$0.8	$371.9	$26.1	$11.0	$19.6	$19.1	$28.5	$24.4	$38.3	$23.1	$80.7
5	$23.4	$0.5	$418.3	$16.7	$12.5	$17.0	$24.8	$13.2	$18.7	$38.8	$35.5	$26.6
6	$35.9	$0.1	$211.9	$7.5	$9.7	$5.7	$1.8	$8.2	$3.2	$4.7	$12.3	$6.7
7	$54.7	$0.4	$69.4	$11.3	$1.0	$4.6	$9.5	$6.0	$2.7	$3.3	$3.6	$4.3
Statewide	**$497.1**	**$15.0**	**1.6 B**	**$174.7**	**$81.4**	**$115.0**	**$111.1**	**$108.7**	**$102.8**	**$195.8**	**$114.8**	**$182.3**

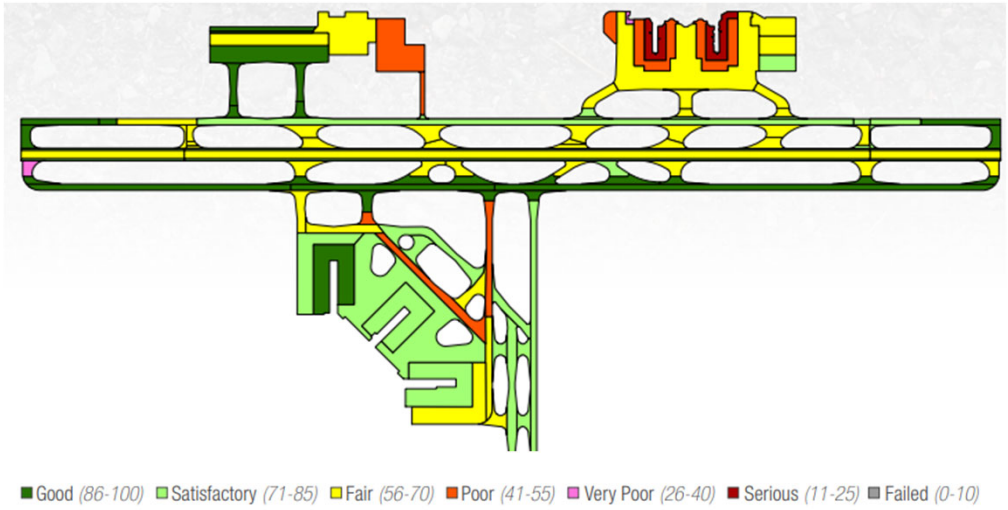
FDOT Airfield Pavement Evaluation Report , 2022

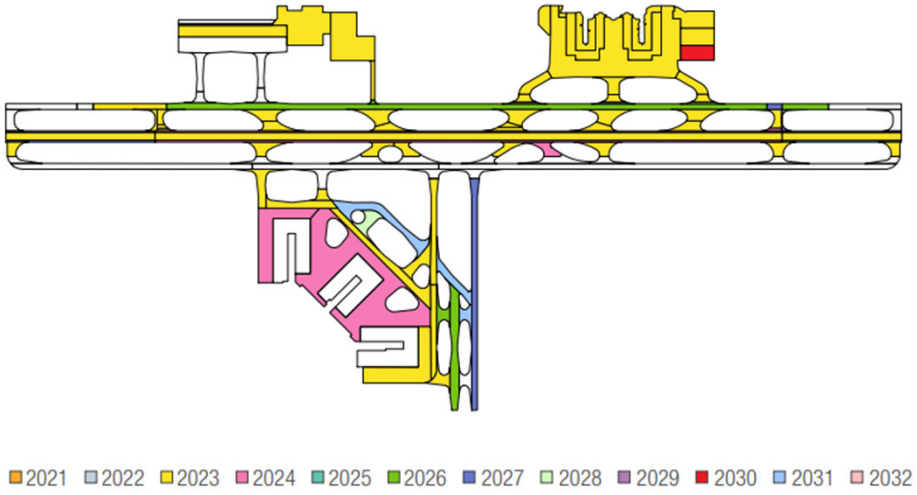
GIS for Pavement Management

- Geographical Information System integration can significantly increase the effective for your pavement management program
  - Visualize data elements
  - Support Spatial Analysis
  - Facilitate Project Planning and Reporting

- **One map is worth 100 pages!**

Examples of GIS Maps

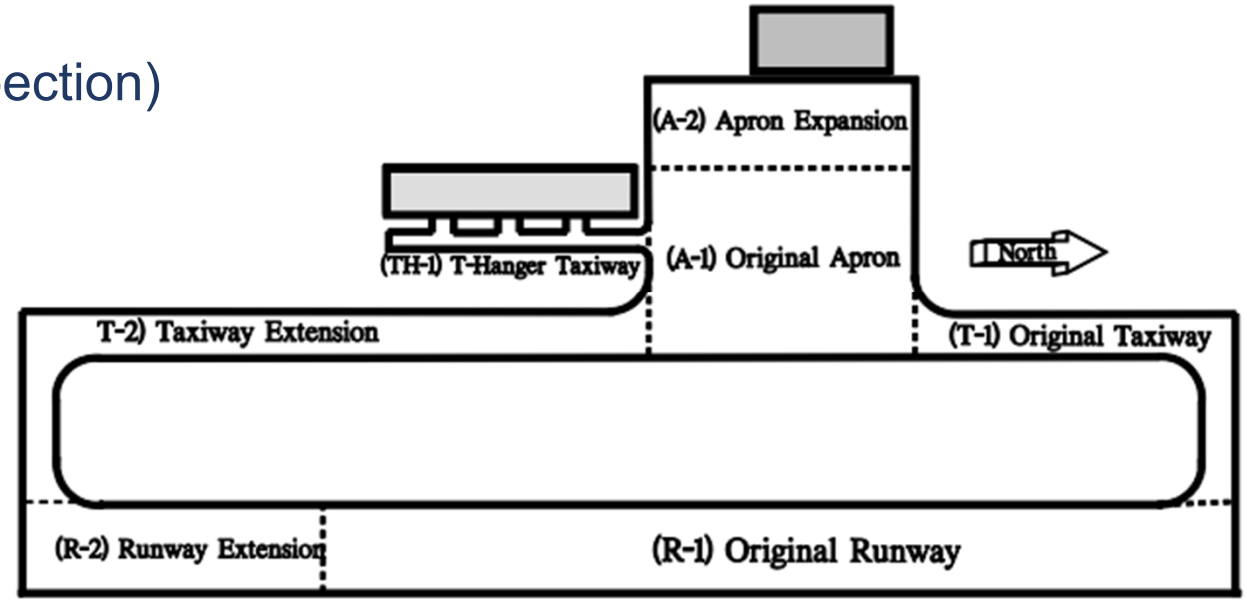




FDOT Airfield Pavement Evaluation Report , 2022

Getting Started

- PMP doesn't need to be complex
- Current information available is enough to get started
  - Collect Inventory
  - Establish condition (inspection)
  - Consider deterioration
  - Establish basic policy
  - Develop M&R Plan



PMP & Sustainability

- **Pavement Management Principles can be combined with Sustainability and Carbon reduction initiatives**
  - Effective pavement management practices can extend pavement life with lower-impact maintenance and rehabilitation to reduce life-cycle carbon footprint.
  - Combining Lifecycle Analysis (LCA) with Lifecycle Cost Analysis (LCCA) can balance carbon footprint with the life-cycle costs of a pavement section to promote a long-lasting, cost effective, lower carbon pavement.

- **The largest contributor to carbon in the life-cycle of a pavement is initial construction.**
  - Extending pavement life through effective management will help airports achieve their carbon reduction and carbon neutral initiatives

FAA Guidance

- **AC150/5380-7B** Airport Pavement Management Program (PMP)

  - Federally obligated airports must perform a detailed inspection of airfield pavements at least **once a year** for the PMP

    - If a pavement condition index (PCI) survey is performed IAW **ASTM D5340**, the frequency of the detailed inspections by PCI surveys may be extended **to three years**

- **Public Law 103-305**, section 107, amended Title 49, Section 47105
  - Sponsor must provide assurance to the FAA that they have implemented an effective pavement maintenance management program.

Overview - Pavement Management Program

- Pavement Management Program (PMP)
  - Required if have received AIP funds for pavement (since 1995)
- Responsibility of Airport/Owner
- PMP is more than Pavement Inspection
- FAA AC's
  - 150/5380-7B Airport Pavement Management Program (PMP)
  - 150/5380-6C Guidelines and Procedures for Maintenance of Airport Pavements

Review

- Pavement Management Fundamentals
- Benefits of Pavement Management Program
- Components of Pavement Management Program (PMP)
  - **Inventory**
  - **Management**
  - **Reporting**
- Benefits of Geospatial Information System (GIS)
- PMP and Sustainability
- FAA Guidance on PMP

QUESTIONS?

David R. Brill, P.E., Ph.D, Program Manager
david.brill@faa.gov
(609) 485-5198

Harold Muniz, Airfield Engineer
harold.muniz-ruiz@faa.gov
(202) 267-5190