



Implementing An effective Airport Pavement Management System

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Content

- **What is Pavement Engineering**
- **Why Airports Pavement Management System**
- **Building Airports Pavement Management System**
- **Conclusion**



TODAY...



Pavement Engineering- pavement management

Pavement Materials	Classification, quality assurance testing (specifications), material design
Pavement Design	Design of Structural layers for New Pavements and Pavement Rehabilitation Assess in-situ pavement material properties and layer thickness
Pavement Construction	Construction practices of New Pavements and Pavement Rehabilitation including specification development and quality assurance
Pavement Management	Monitoring Post-construction condition, timing preventive preservation and rehabilitation treatments, and economic analysis of alternatives
Pavement Research	Research to improve all of the above

Why do we need to “Manage” our Pavements?

- **To preserve our infrastructure value**
 - ✓ Key component of the asset Management
- **To develop “optimum” pavement preservation and renewal programs**
 - ✓ Better Use of Available Resources
- **To provide a level of service that the user considers appropriate**
 - ✓ State of Good Repair



Pavement Maintenance Management Basic Questions

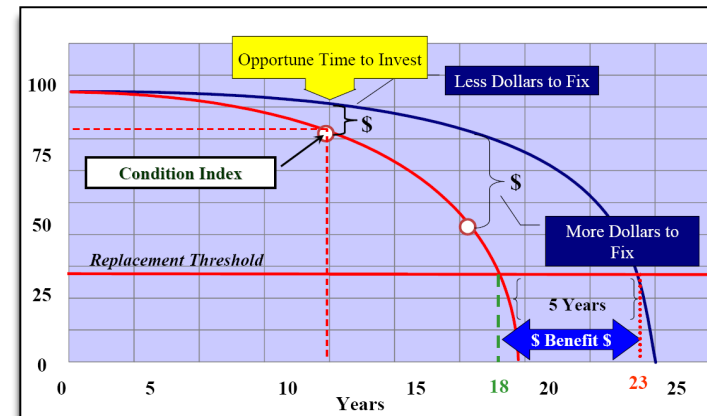
- Where ?

Where to maintain my pavement network



- When ?

When should be maintained



- How ?

How it should be maintained



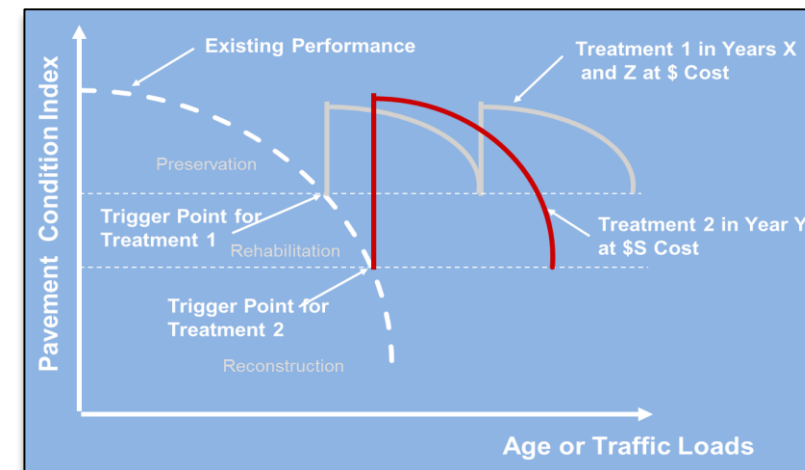
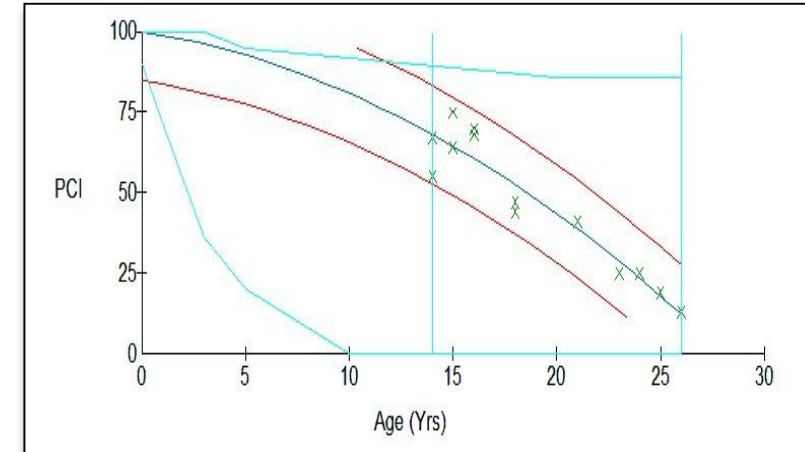
Airports Pavement Management System- Understanding

A Pavement Management System (PMS) is designed to *provide objective information* and *useful data for analysis* so that Airports Pavement managers can make more *consistent, cost-effective, and defensible decisions* related to the *preservation of Airport pavement*.



Airport Pavement Management System- Theory

- ❑ An airport's Pavement Management System (APMS) *not only evaluates the current condition* of the airfield pavements, but *also predicts its future condition*.
- ❑ By projecting the rate of deterioration, *a life cycle cost analysis can be made for various maintenance alternatives*.
- ❑ Determine the *optimal time for applying the best alternative*.



Airports Pavement Management - Subsystems

- **Goals & Policies**

- Performance measures
- Budget
- Guide analytical process
- City specific

- **Inventory / Data Collection**

- Network Definition.
- NDT and inspection
- Storage / retrieval
- Analysis (GIS, GPS)



- **Condition Assessment**

- Deterioration modeling
- Performance modeling

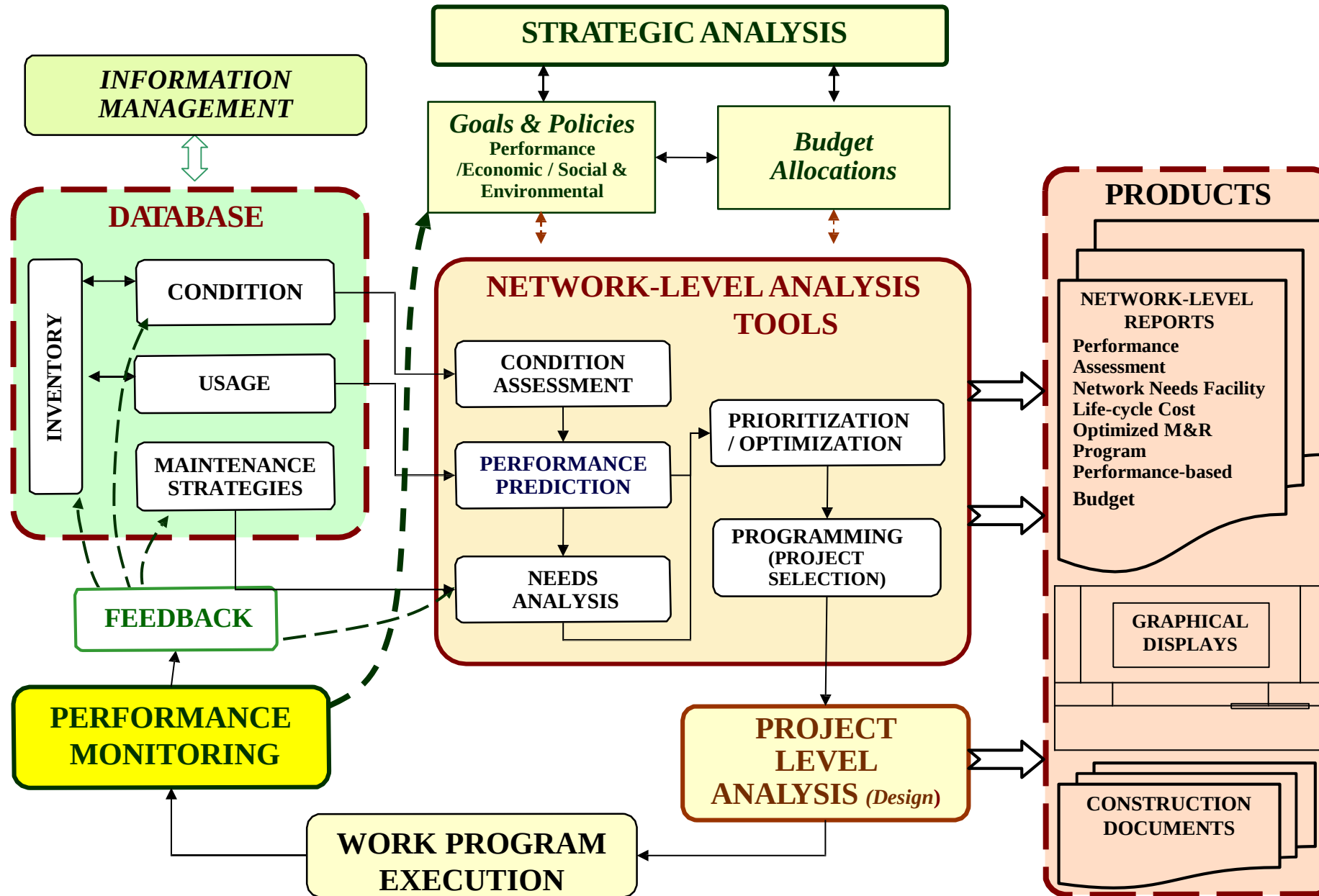
- **Alternative Evaluation**

- Trade-off analysis
- Cost/benefit analysis
- Life Cycle Cost
- Risk Analysis

- **Selection and implementation**

- **Monitoring / Feedback**

Pavement Management System – Business Process

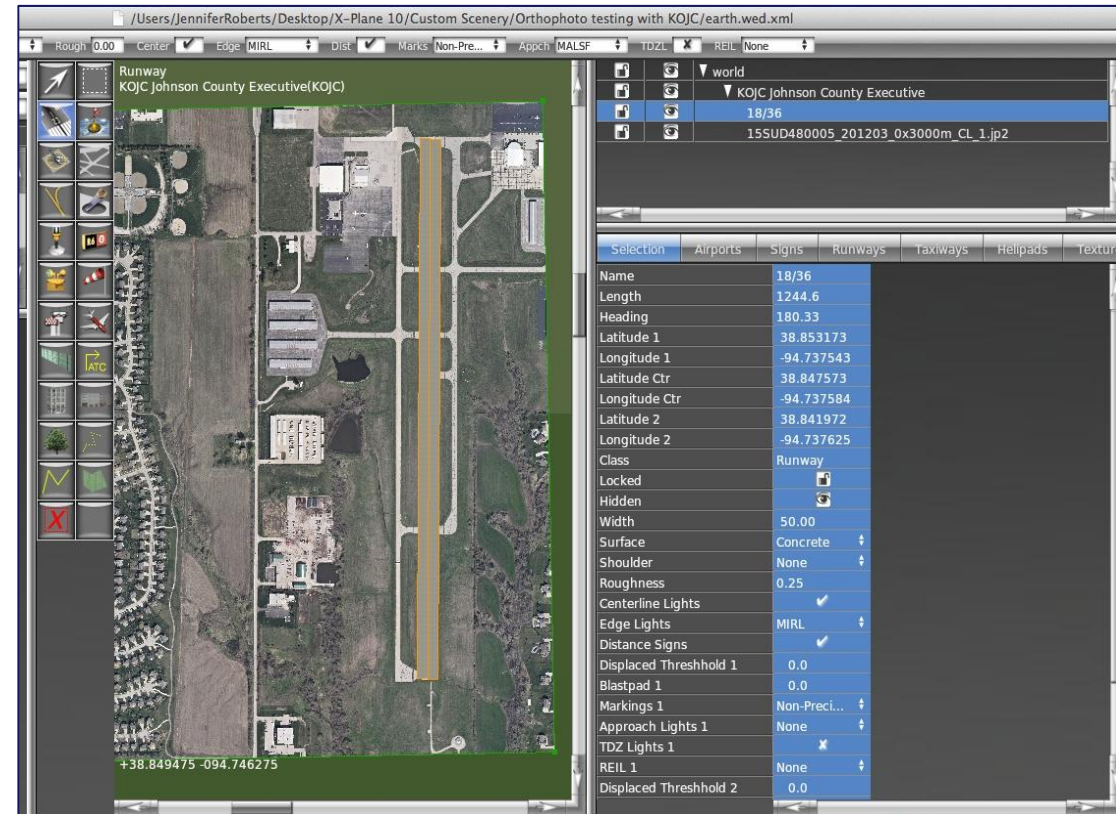


Pavement Definition and Inventory

❑ Create a database of all airfield pavement:

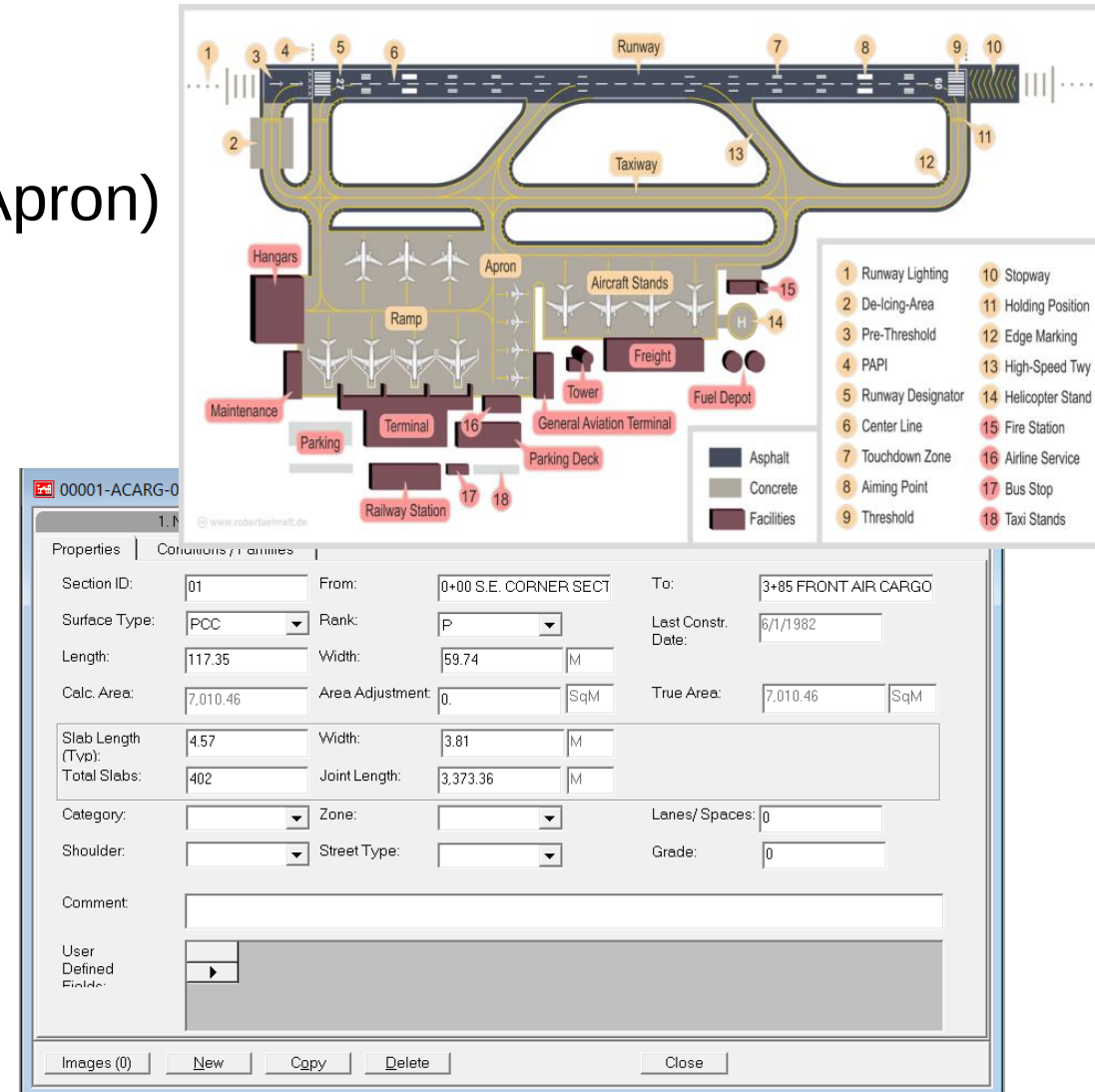
- Runway
- Taxiway,
- Apron
- other aircraft movement areas

❑ Provides a basis for budget development, and maintenance program.



Pavement Definition and Inventory – Pavement Inventory

- Airport Name
- Feature (Runway , Taxiway , Apron)
- Feature Identification Number
- Length and Width
- Pavement Type , Structure
- Shoulder Type and Width
- Marking



Pavement Definition and Inventory – Traffic History

- ❑ Number of daily operations and type of aircrafts using the pavement .
- ❑ necessary when analyzing probable causes of the deterioration and when to consider alternatives M&R procedures.

Aircraft Group	Aircraft Name [11]	Gross Taxi Weight (lbs)	Annual Departures	% Annual Growth
Generic	A320-100	150,796	600	0.00
Airbus	A340-600 std	805,128	1,000	0.00
Boeing	A340-600 std Belly	805,128	1,000	0.00
Other Commercial	A380-800	1,239,000	300	0.00
General Aviation	B737-800	174,700	2,000	0.00
Military	B747-400	877,000	400	0.00
External Library	B747-400ER	913,000	300	0.00
	B757-300	271,000	1,200	0.00
	B767-400 ER	451,000	800	0.00
	B777-300 ER	777,000	1,000	0.00

Library Aircraft	Float Aircraft
SWL-50	A320-100
Sngl Whl-3	A340-600 std
Sngl Whl-5	A340-600 std Belly
Sngl Whl-10	A380-800
Sngl Whl-12.5	B737-800
Sngl Whl-15	B747-400
Sngl Whl-20	B747-400ER
Sngl Whl-30	B757-300
Sngl Whl-45	B767-400 ER
Sngl Whl-60	B777-300 ER
Sngl Whl-75	
Dual Whl-10	
Dual Whl-20	
Dual Whl-30	
Dual Whl-45	
Dual Whl-50	
Dual Whl-60	
Dual Whl-75	

Buttons: Add, Remove, Save List, Clear List, Save to Float, Add Float, Gear



Pavement Definition and Inventory – Structural Inventory

- ❑ Mapping the airfield pavement structural composition (material and thickness), subsequent overlays, rehabilitation, etc.
- ❑ “As-built” records should provide this information; or coring of the pavement section



Pavement Definition and Inventory- maintenance history

- History of maintenance performed and its associated cost “ provide valuable information on the effectiveness of various maintenance procedure on the different airport pavements”.
- The cost of each maintenance project is necessary when performing lifecycle analysis.



Date:11/06/2016

Work History Report

1 of 21

Pavement Database:

Network: 00001	Branch ACARG	(APRON FOR AIR CARGO AREA)		Section: 01	Surface: PCC	
L.C.D.: 06/01/1982	Use: APRON	Rank: P	Length: 117.35 M	Width: 59.74 M	True Area: 7.010.46 SqM	
Work Date	Work Code	Work Description	Cost	Thickness (mm)	Major M&R	Comments
06/01/1982	UNKNOWN	UNKNOWN			True	

Network: 00001	Branch ACARG	(APRON FOR AIR CARGO AREA)		Section: 02	Surface: APC	
L.C.D.: 06/01/1974	Use: APRON	Rank: P	Length: 0.00 M	Width: 0.00 M	True Area: 6.693.94 SqM	
Work Date	Work Code	Work Description	Cost	Thickness (mm)	Major M&R	Comments
06/01/1974	UNKNOWN	UNKNOWN			True	

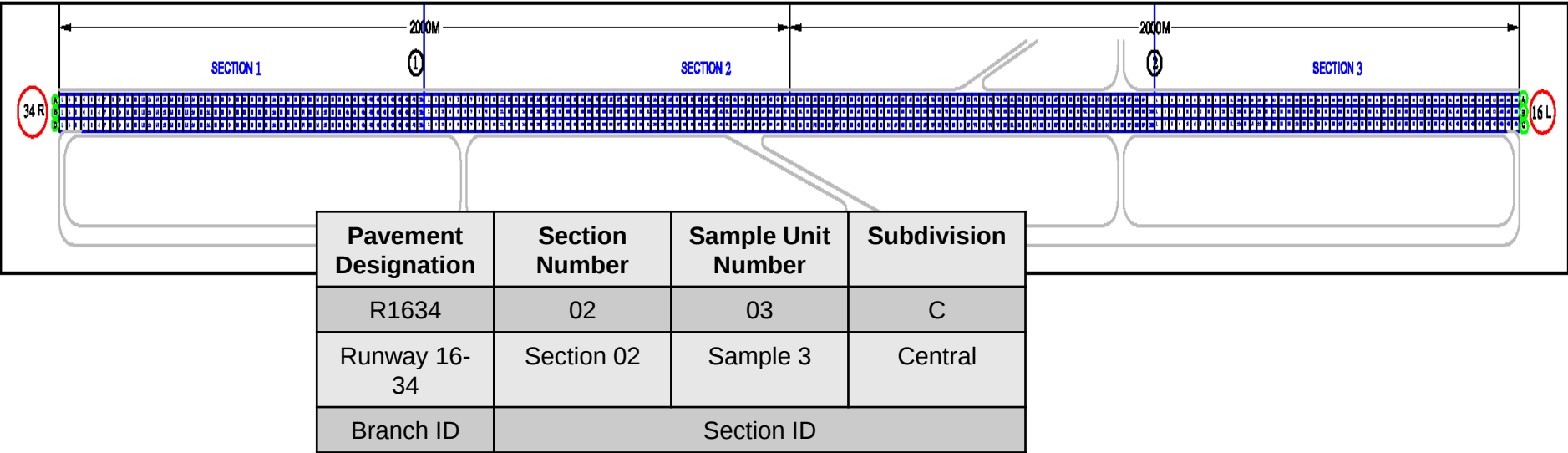
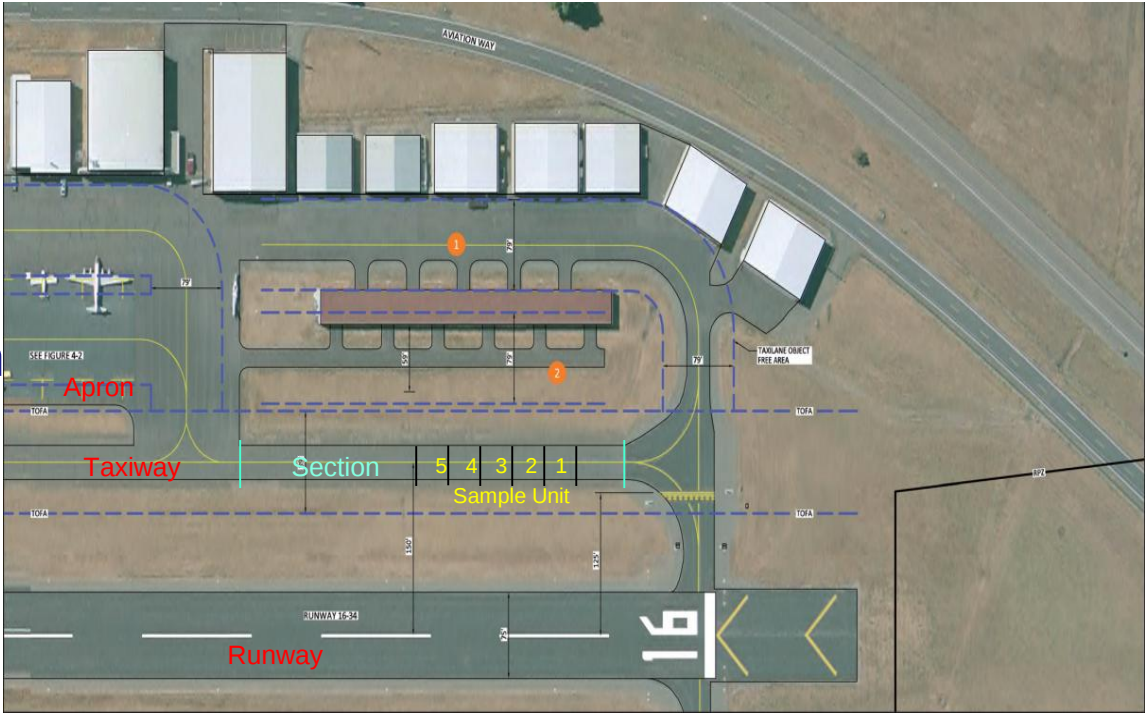
Network: 00001	Branch ACARG	(APRON FOR AIR CARGO AREA)		Section: 03	Surface: PCC	
L.C.D.: 06/01/1989	Use: APRON	Rank: P	Length: 0.00 M	Width: 0.00 M	True Area: 10.033.53 SqM	
Work Date	Work Code	Work Description	Cost	Thickness (mm)	Major M&R	Comments
06/01/1989	UNKNOWN	UNKNOWN			True	

Network: 00001	Branch APRON	(APRON FOR MAIN TERMINAL)		Section: C01	Surface: PCC	
L.C.D.: 06/01/1972	Use: APRON	Rank: P	Length: 138.07 M	Width: 74.68 M	True Area: 10.310.84 SqM	
Work Date	Work Code	Work Description	Cost	Thickness (mm)	Major M&R	Comments
06/01/1972	UNKNOWN	UNKNOWN			True	

Network: 00001	Branch APRON	(APRON FOR MAIN TERMINAL)		Section: C02	Surface: PCC
L.C.D.: 06/01/1972	Use: APRON	Rank: P	Length: 99.06 M	Width: 91.44 M	True Area: 9.058.05 SqM

Pavement Definition and Inventory- pavement definition

- ❑ Network (individual airport)
- ❑ Branches (Runway , Taxiway , Apron)
- ❑ Sections (Location , Construction type , Maintenance History, Traffic , condition)
- ❑ Sample Units (Inspection unit)



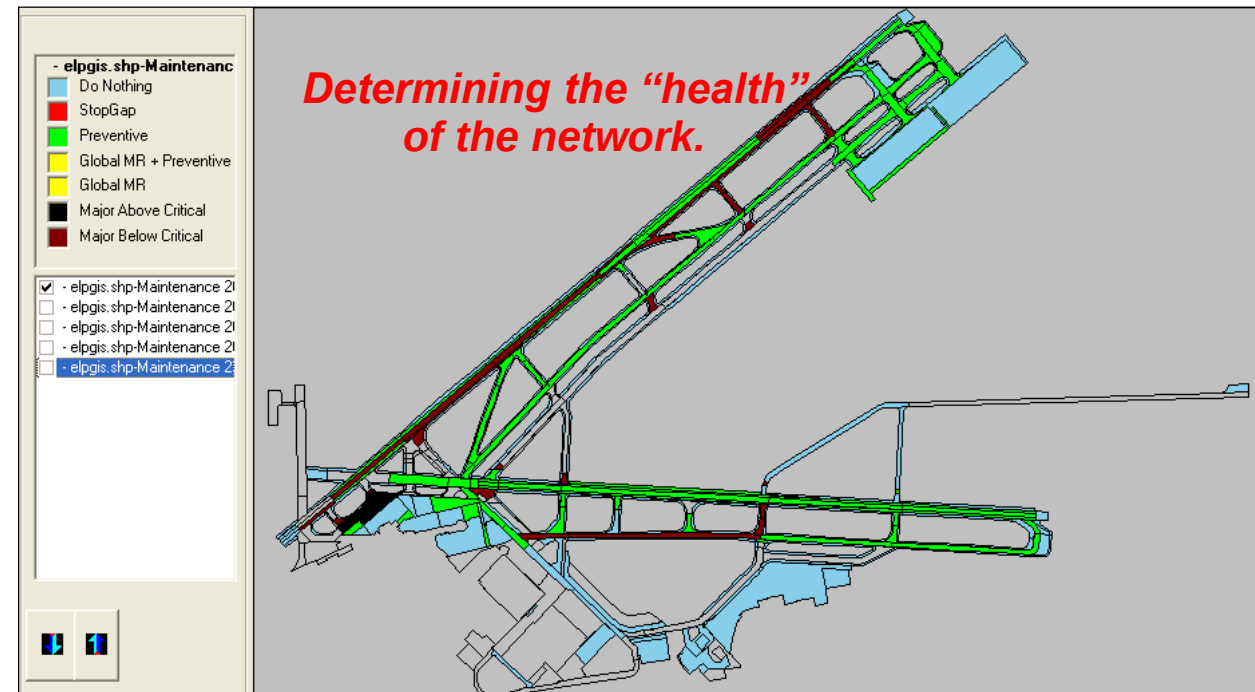
Pavement Definition and Inventory

The image displays three software interfaces used for pavement definition and inventory:

- KAIA - ArcMap:** A screenshot of the ArcMap interface showing a map of Saudi Arabia with a red dot marking the location of King Abdulaziz International Airport. The map is titled "KAIA - ArcMap" and includes a Table of Contents on the left.
- PAVR 5.0 - [RWY-16L/34R-3C]:** A screenshot of the PAVR 5.0 software interface. The main window shows a detailed map of the airport layout with various colored areas representing different pavement types. A red arrow points from the map to the "Section Properties" dialog box.
- Section Properties Dialog:** A screenshot of the "Section Properties" dialog box, which is used to define the properties of a specific pavement section. The dialog is divided into three tabs: "1. Network", "2. Branch", and "3. Section". The "3. Section" tab is active, showing fields for Section ID, Surface Type, Length, Calc. Area, From, Rank, Width, Area Adjustment, To, Last Constr. Date, True Area, and various other parameters.

Airport Pavement Condition Survey

- Assessing the current pavement condition of the Analysis Sections
- Basis for the performance and economic analysis.
- Maintenance Programs
- Assess the state of being, or readiness for use .



Pavement Condition “Quality measures and Performance Indicators”

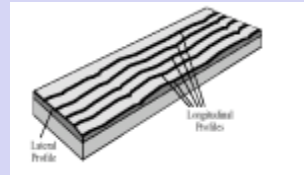
- **Physical Condition**



**Distress
(PCI)**



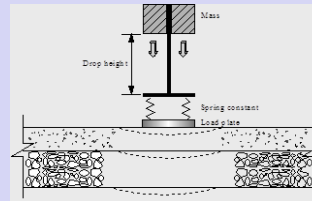
- **Service and User Perception**



**Roughness
(PSI, IRI)**



- **Structural Integrity
/ Load-Carrying Capacity**



**Deflection
(FWD)**



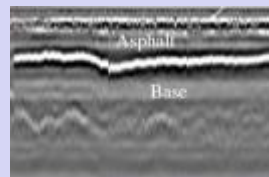
- **Safety and Sufficiency**



**Friction (FN)/
Macro texture**



- **Pavement Layer Structure**



**Pavement
Subsurface**

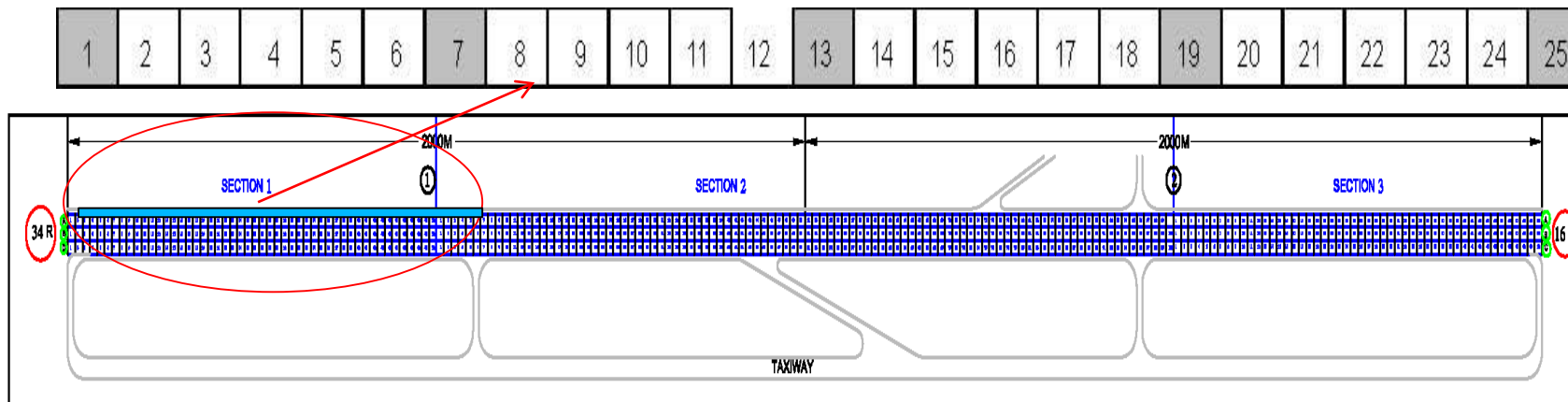
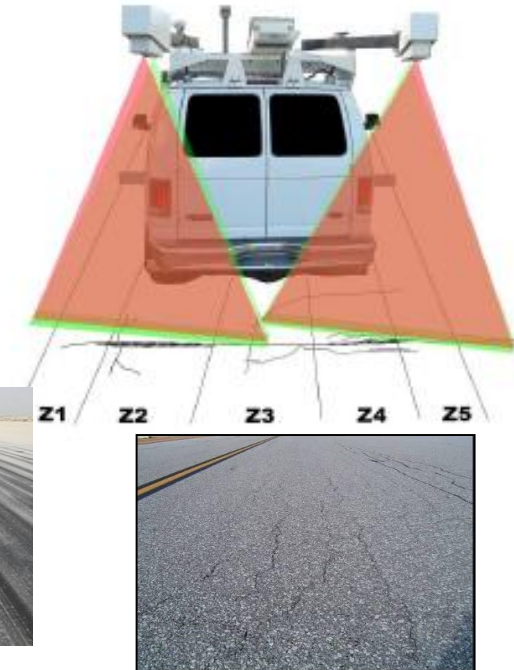


Pavement Condition Survey- pavement surface distresses

Surface of the pavement is evaluated manually, or automated equipment to identify:

- ☐ Type of distress
- ☐ Severity.
- ☐ Quantity or extent of distress present on the pavement surface.

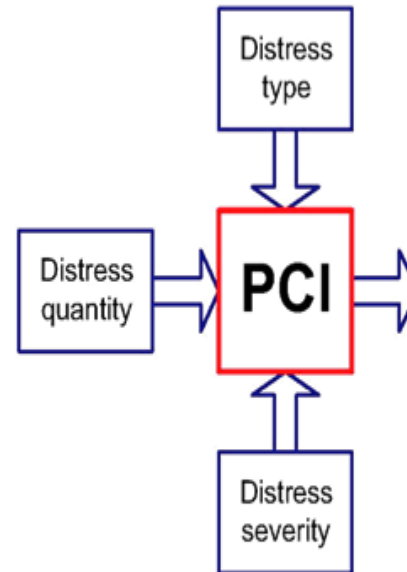
Flexible Pavement Pavement Condition Survey Data Sheet for Sample Unit			
Airport	Date	Section ID	
Job Number	Sample 100%	Part	Sample Unit
Surveyed by	JB	Area of sample	of
Distress Types		Sketch	
41 Alligator Cracking	50 Patching		
42 Bleeding	51 Polished Aggregate		
43 Block Cracking	52 Raveling/Weathering		
44 Corrosion	53 Rutting		
45 Depression	54 Shoving from PCC		
46 Jet Blast	55 Slippage Cracking		
47 Joint Reflection (PCC)	56 Swell		
48 Long & Transverse Cracking			
49 Oil Spillage			
Existing Distress Types			
Total		L	
Severity		M	
		H	
Comments			
Data entered into MC			
Entered by			



Pavement Condition Survey – Pavement Condition Index

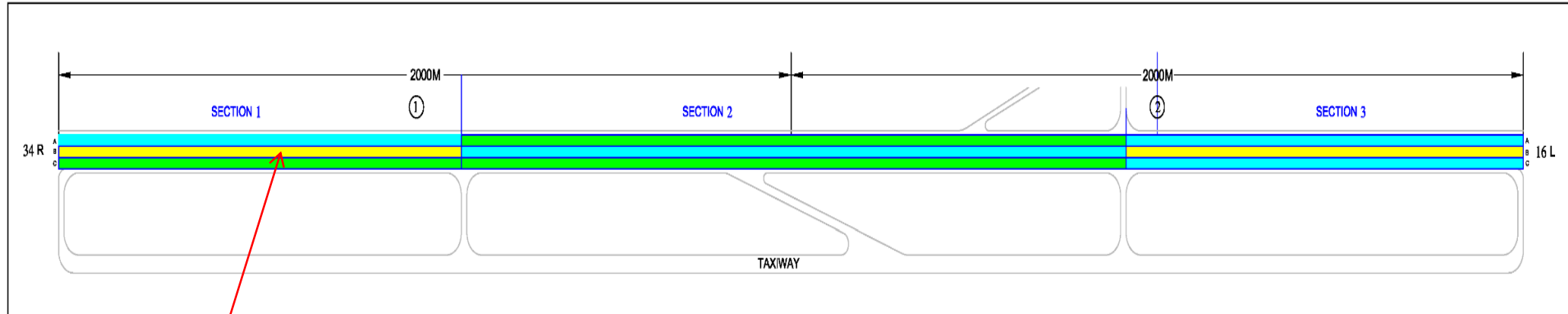
Standards:

- ❑ Federal Aviation Administration's (FAA's) Advisory Circular (AC) 150/5320 -6E, *Airport Pavement Design and Evaluation*
- ❑ *ASTM D5340 - 12: Standard Test Method for Airport Pavement Condition Index Surveys*

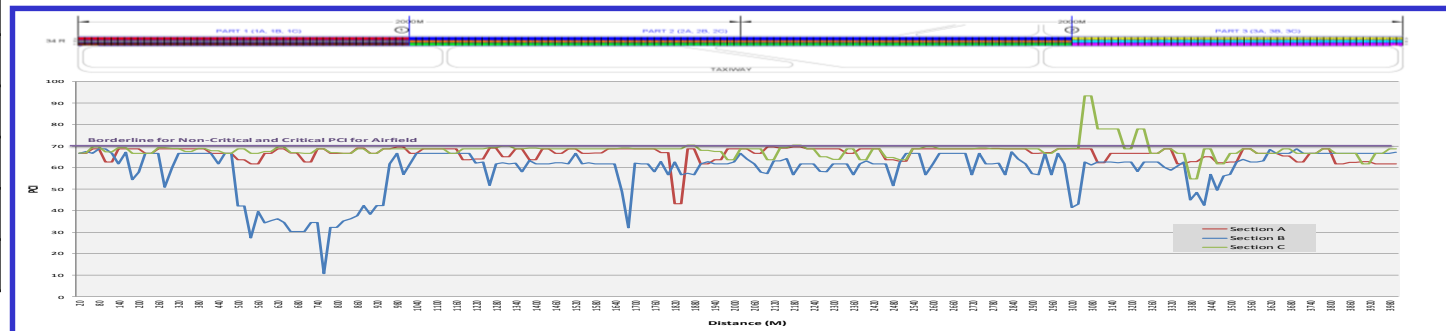
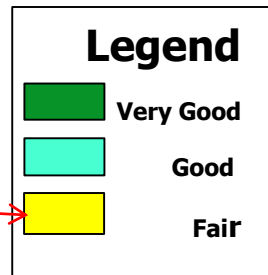


	Simplified PCI Color Legend	ASTM PCI Color Legend	PCI Range	PCI Ratings and Definition
GOOD	Green	Dark Blue	86-100	GOOD: Pavement has minor or no distresses and should require only routine maintenance.
		Light Green	71-85	SATISFACTORY: Pavement has scattered low-severity distresses that should require only routine maintenance.
FAIR	Yellow	Light Blue	55-70	FAIR: Pavement has a combination of generally low- and medium-severity distresses. Near-term maintenance and repair needs may range from routine to major.
POOR	Red	Yellow	41-55	POOR: Pavement has low-, medium-, and high-severity distresses that probably cause some operational problems. Near-term M&R needs range from routine to major.
		Purple	26-40	VERY POOR: Pavement has predominantly medium- and high-severity distresses that cause considerable maintenance & operational problems. Near-term M&R needs will be major.
		Red	11-25	SERIOUS: Pavement has mainly high-severity distresses that cause operational restrictions; immediate repairs are needed.
		Black	0-10	FAILED: Pavement deterioration has progressed to the point that safe aircraft operations are no longer possible; complete reconstruction is required.

Pavement Condition Survey – Pavement condition index

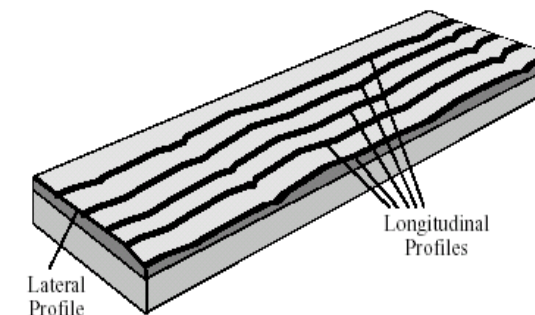
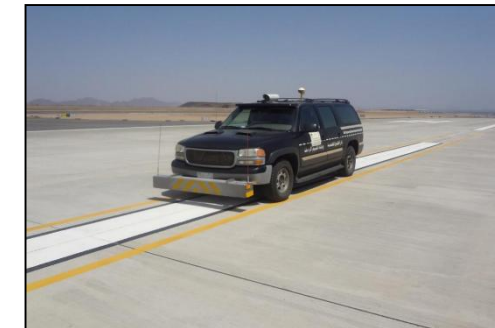
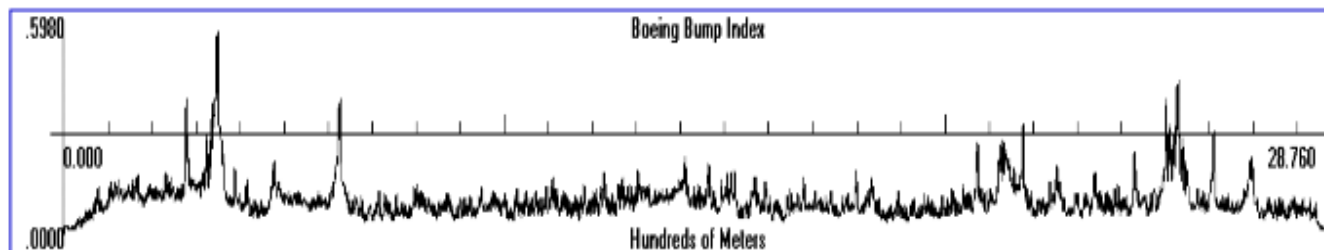
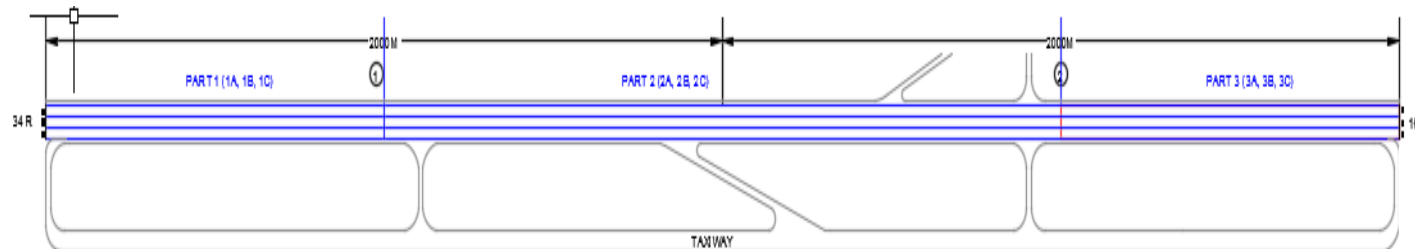
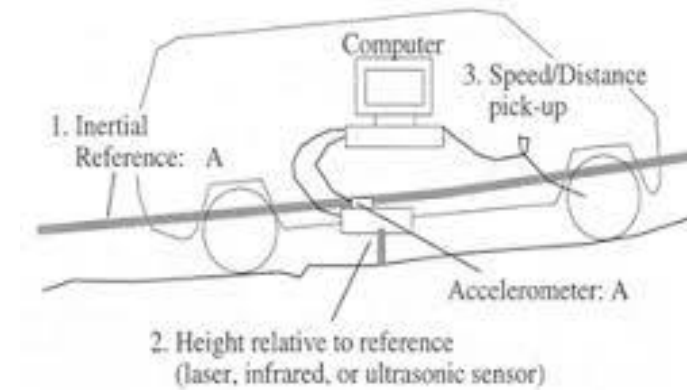


Pavement Condition Index (PCI) Runway: 16L/34R		
Section No.	PCI Index	Rating
1A	83	Very Good
1B	51	Fair
1C	68	Good
2A	75	Very Good
2B	62	Good
2C	72	Very Good
3A	61	Good
3B	50	Fair
3C	64	Good



Pavement Condition Survey - Pavement Roughness

- ❑ Runway roughness evaluation to be carried out in accordance to the guideline by the FAA Advisory AC no. 150/5380 – 9
 - International Roughness Index (IRI)
 - Boeing Bump Index (BBI)

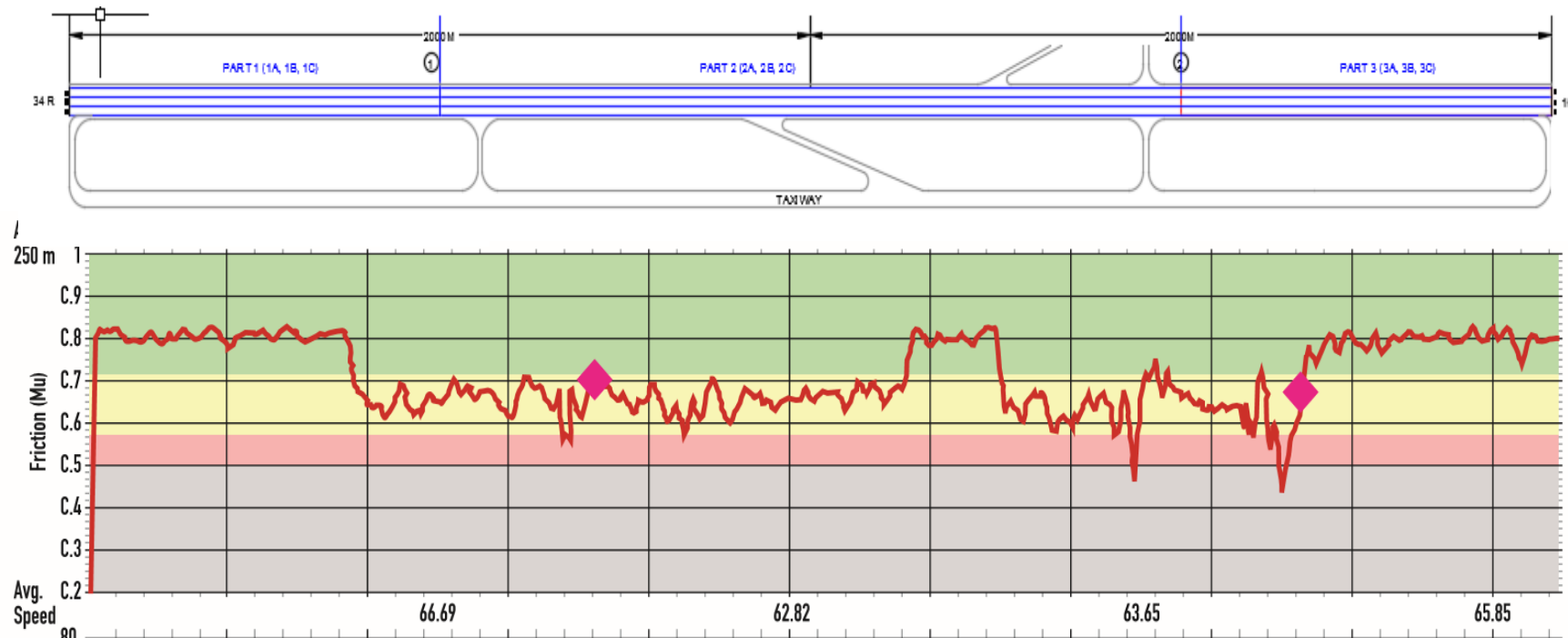


Pavement Condition Survey- Skid Resistance

- Assessment of the Coefficient of Friction of the wet Pavement Surface .

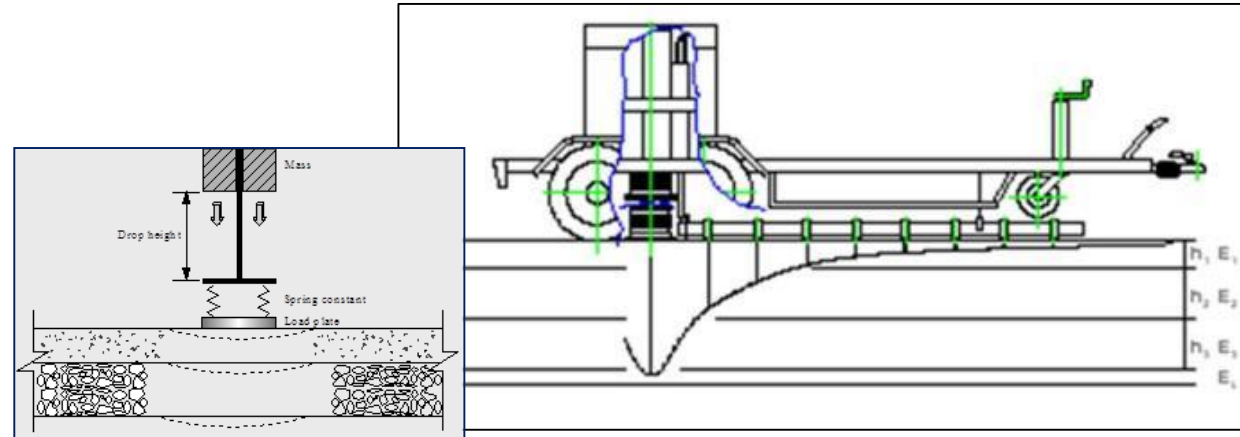


- Evaluations to be carried out in accordance with the FAA AC 150/5320-12

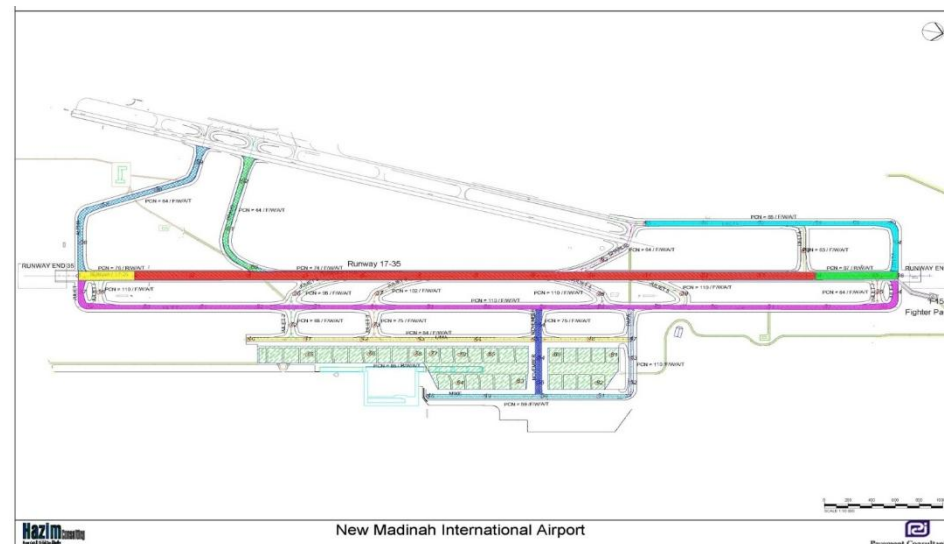


Pavement Condition Survey – Structural Capacity

- ❑ Falling Weight Deflectometer (FWD) , to measure the vertical deflection response of a surface to an impulse load.
- ❑ Calculate pavement properties :
 - ❑ Bearing Capacity
 - ❑ Layer Thickness
 - ❑ E Moduli
 - ❑ Expected Surface Life



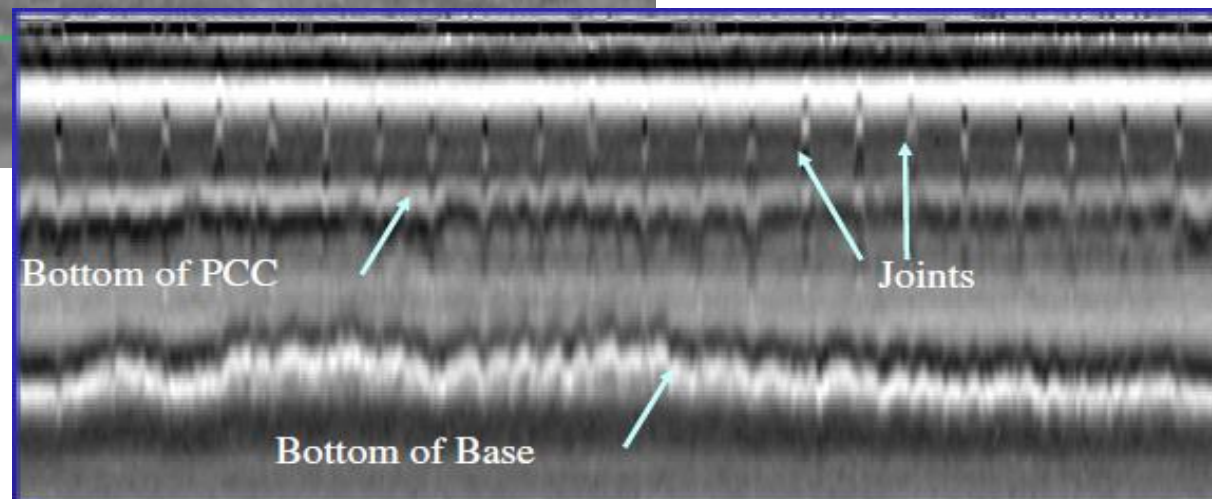
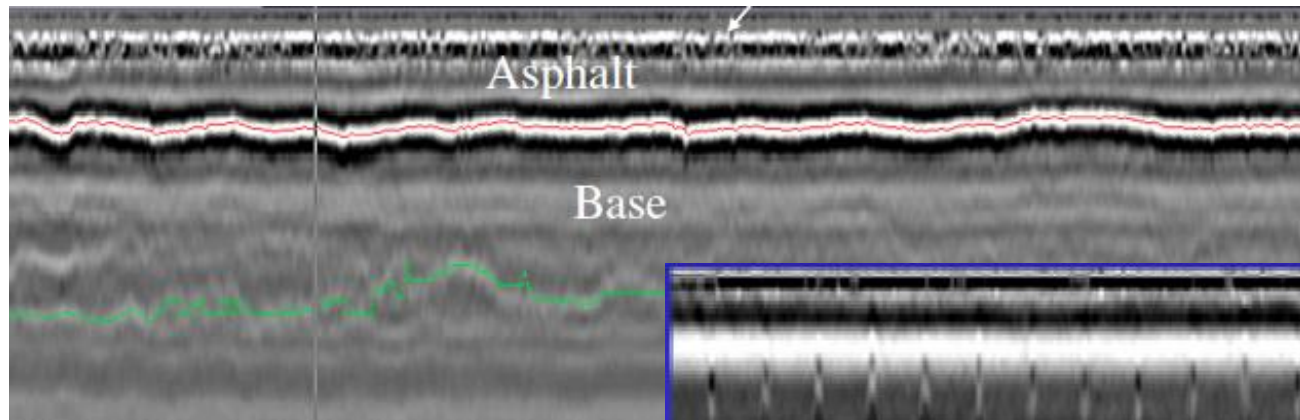
*ASTM D4694-03 Standard and
FAA Advisory circular 150/5370-
11A*



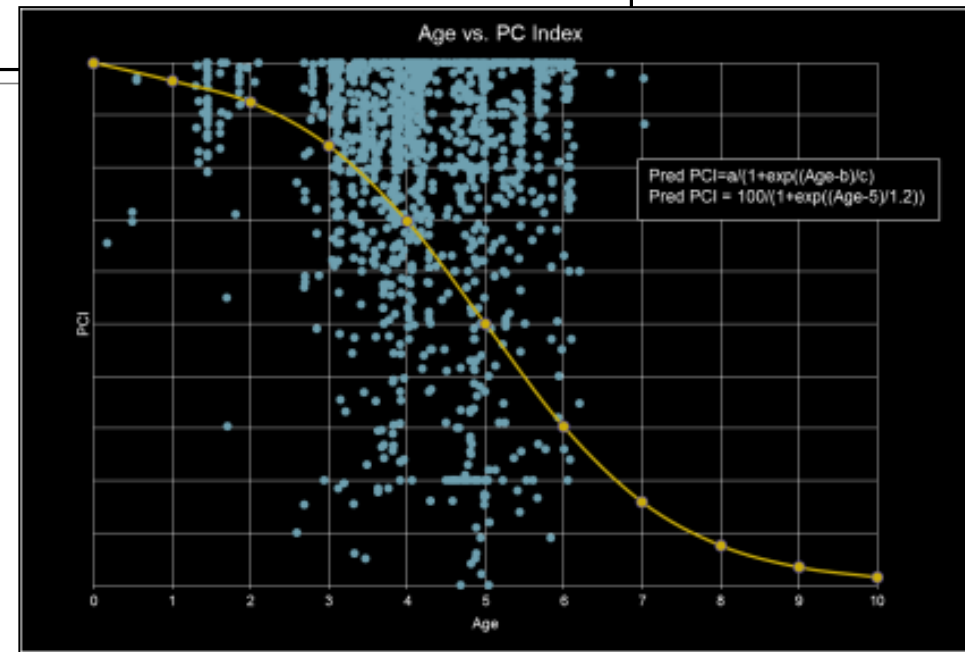
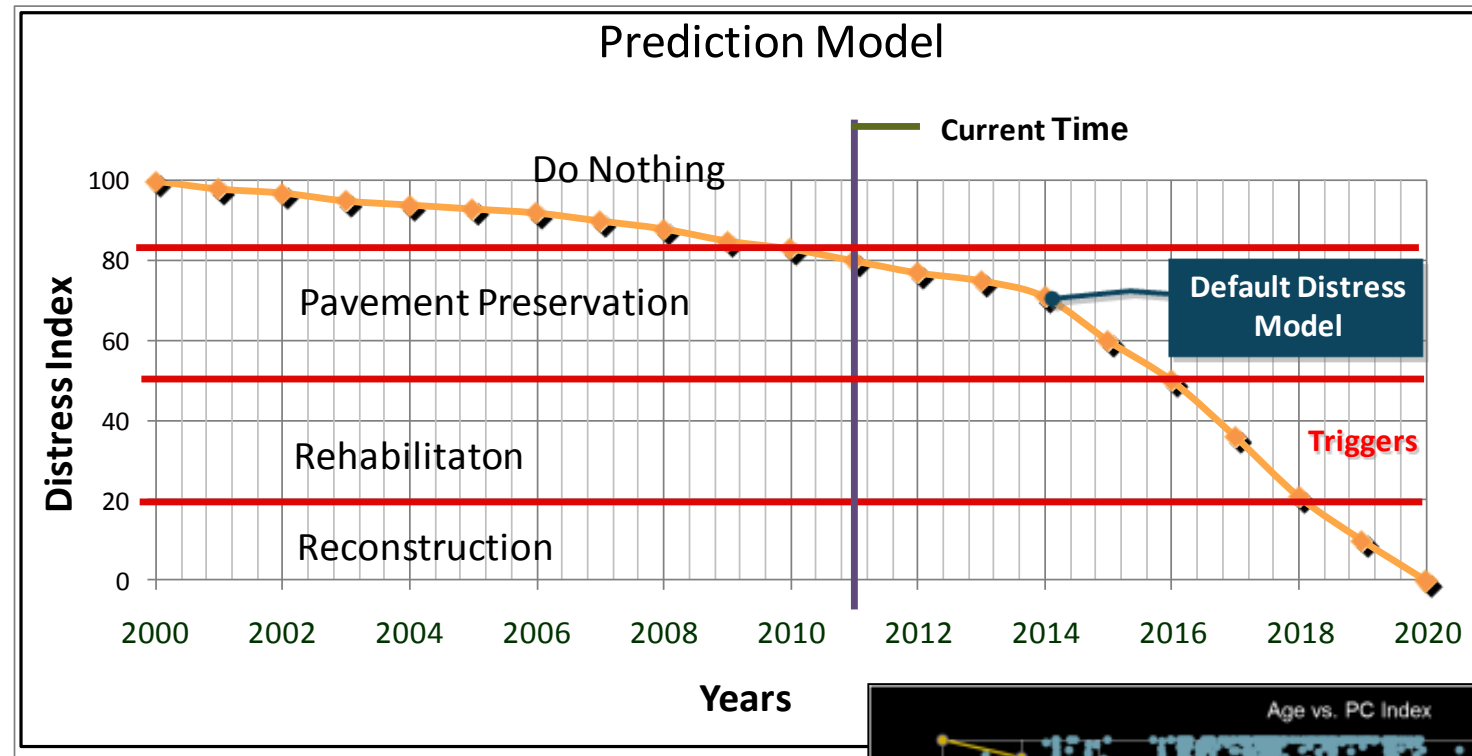
Pavement Condition Survey- Pavement layers

GPR in Airport Pavement Management System:

- ☐ Thickness of pavement layers
- ☐ Reinforcing steel
- ☐ Density variations
- ☐ Subsurface moisture
- ☐ Voids

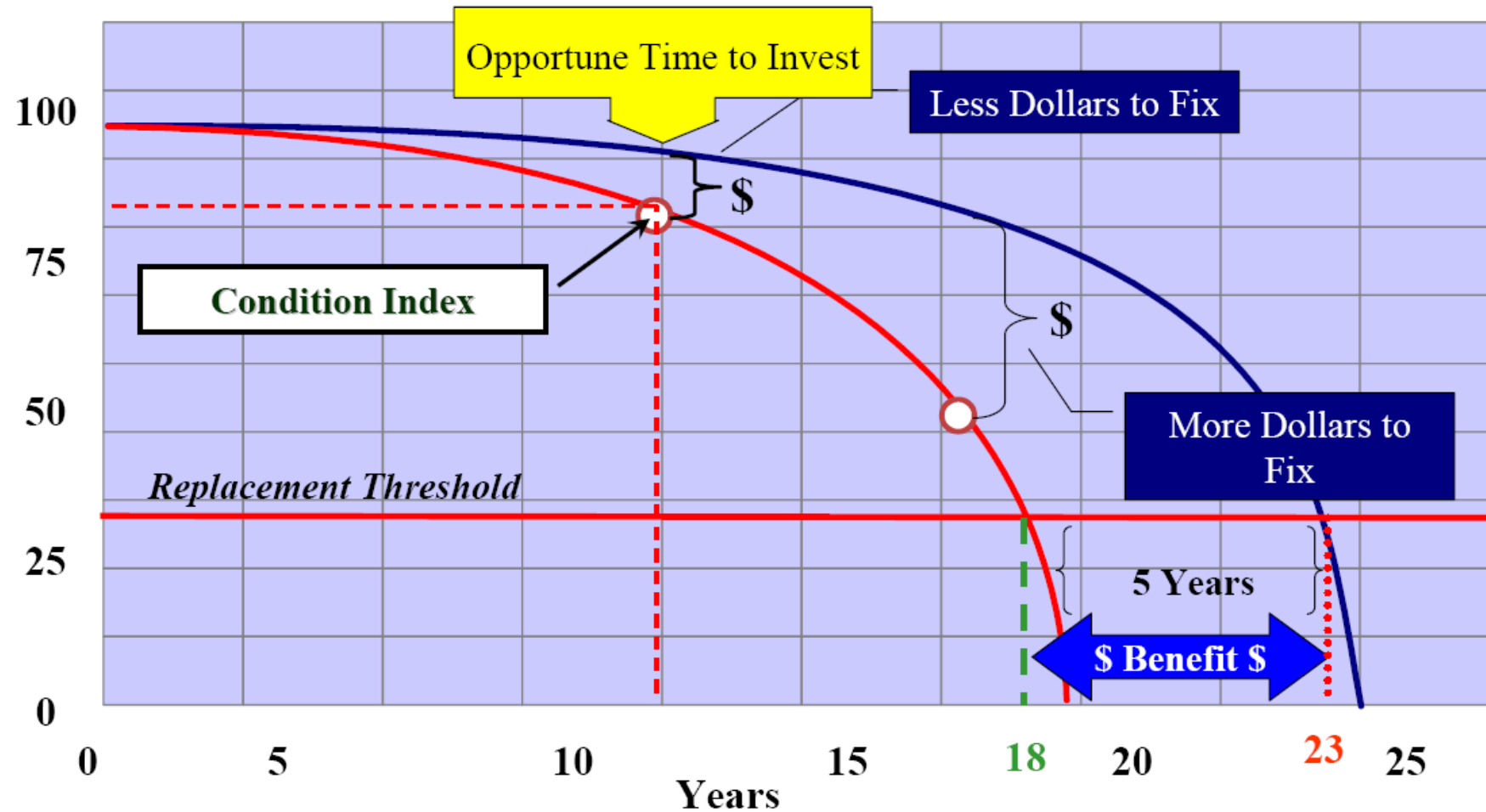


APMS Performance and Economic Analysis



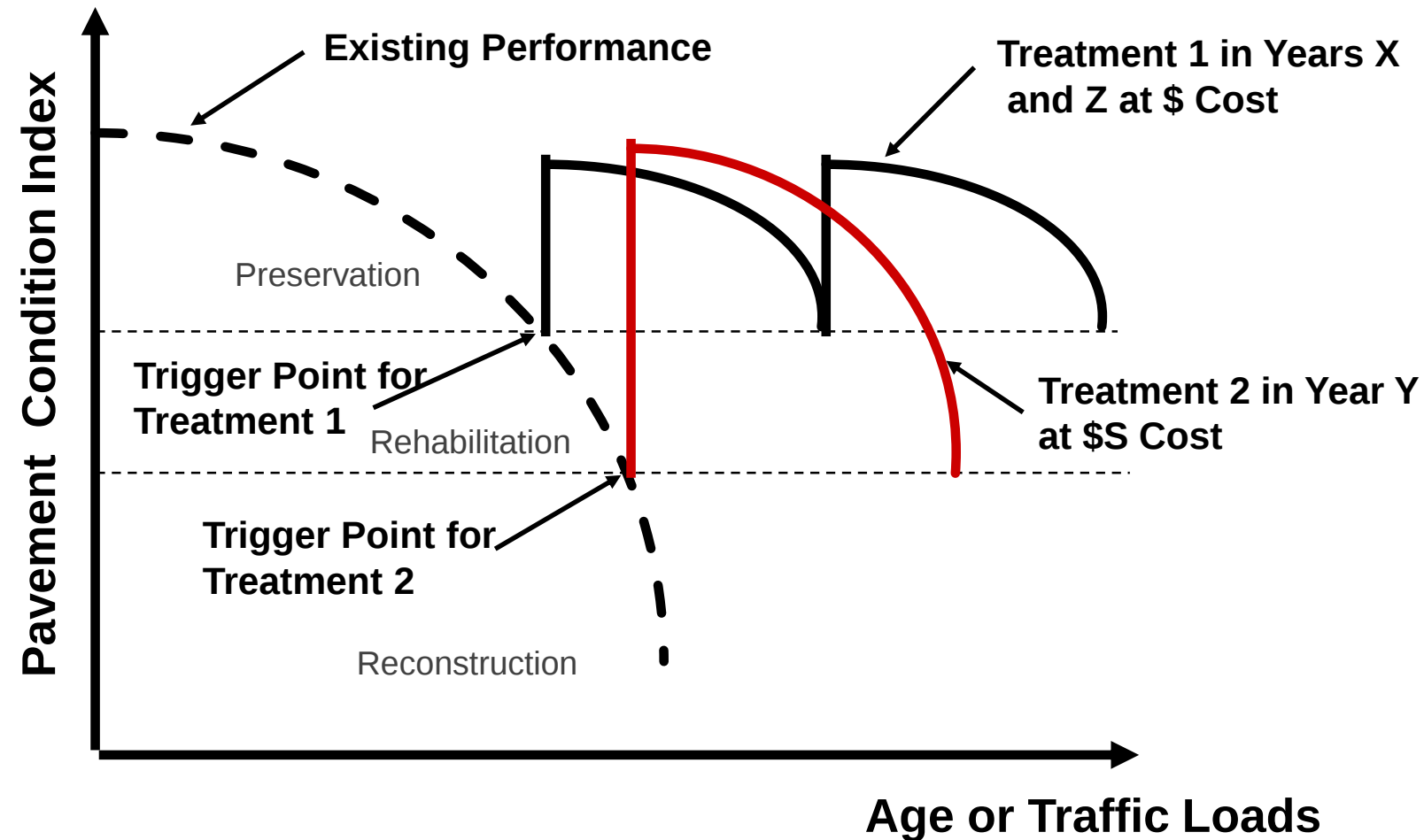
APMS Performance and Economic Analysis

Remaining Life Analysis



APMS Performance and Economic Analysis

Multi Year Treatment Choices and Prioritization



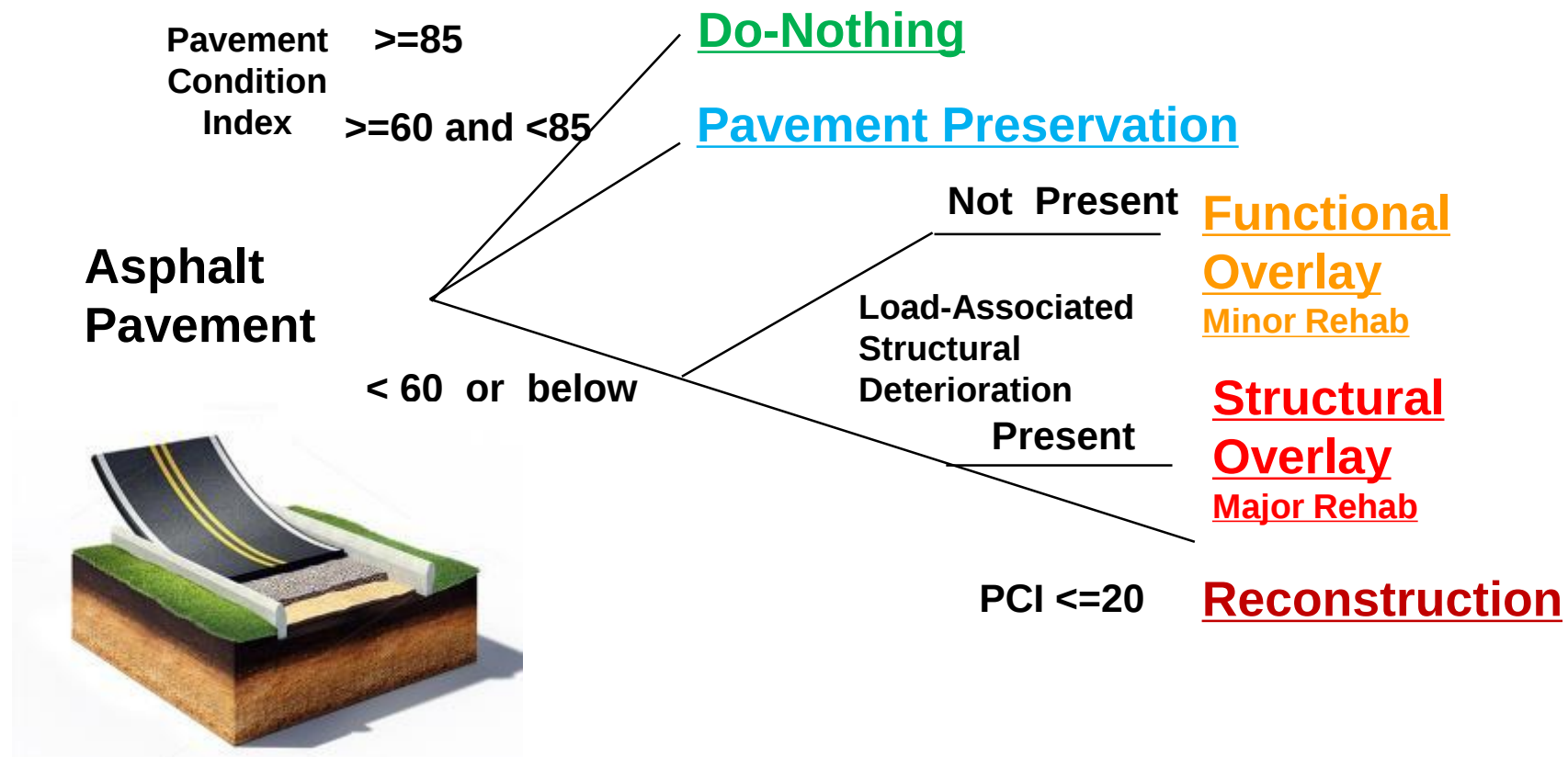
APMS Performance and Economic Analysis

Treatment Types and Costs

<i>Preservation Treatments</i>	<i>Cost Per L/ Km</i>
Slurry seals	\$14,080
Micro surfacing	\$17,600
High-performance thin overlays	\$45,760
<i>Rehabilitation Treatments</i>	<i>Cost Per L/ km</i>
Minor (functional): mill 2 in. and overlay 2 in.	\$107,430
Major (structural rehab): mill 2 in. and overlay >2 in.	\$154,106
<i>Reconstruction</i>	<i>Cost Per L/ Km</i>
Partial	\$422,400
Full	\$689,920

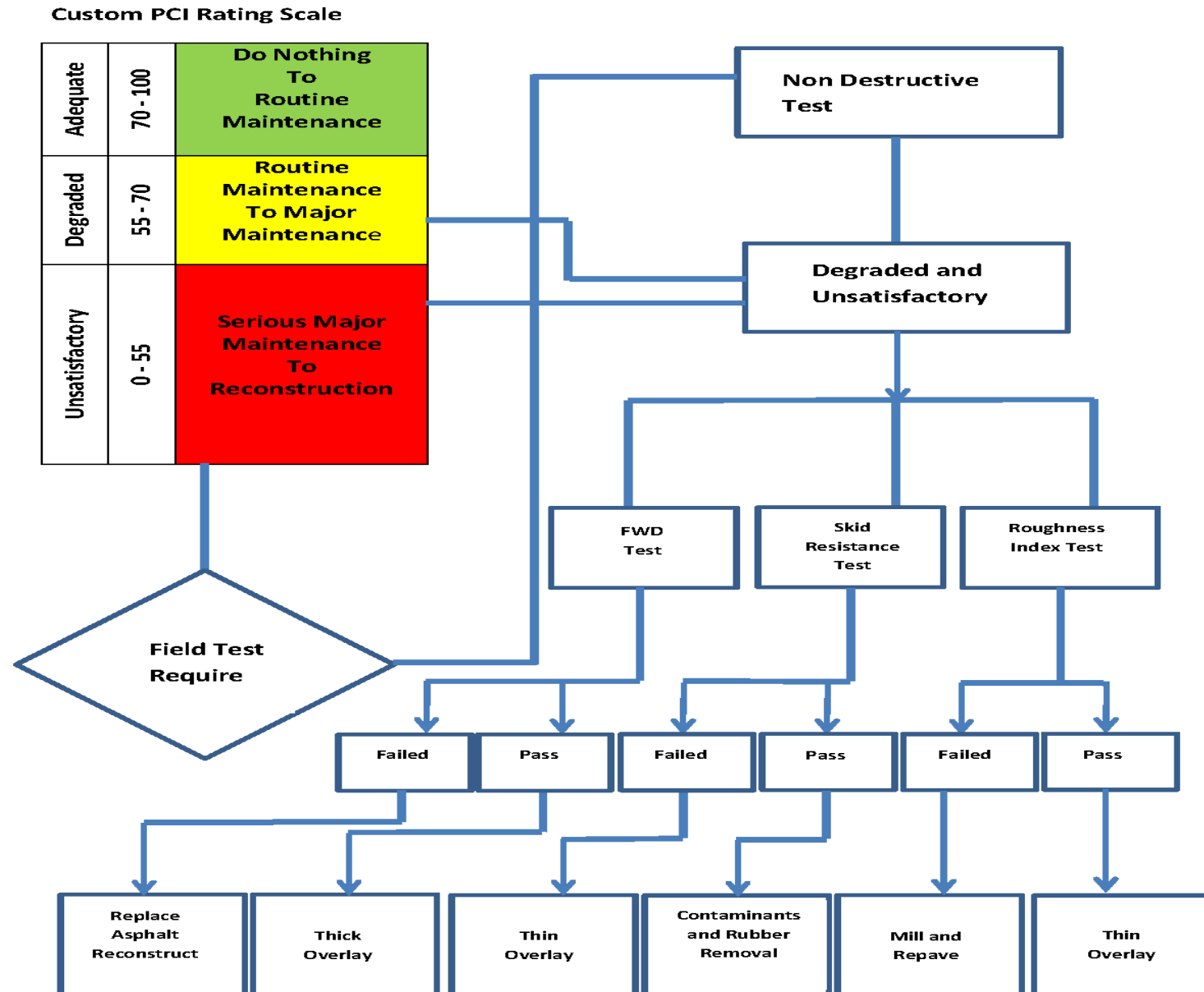
APMS Performance and Economic

Decision Trees/Treatment Rules



APMS Performance and Economic

Decision Trees/Treatment Rules



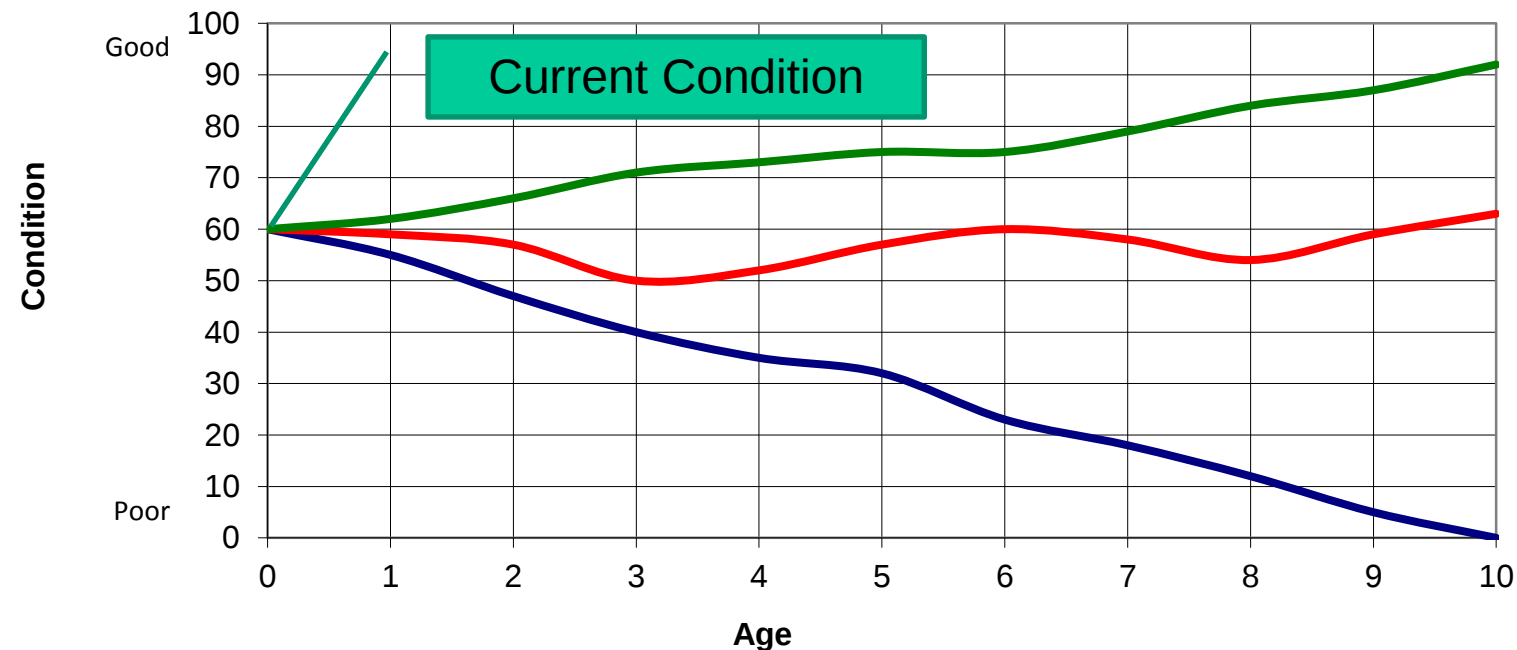
APMS Performance and Economic Analysis

Pavement Network Performance Scenario

Policy Decisions can be based on the average projected condition at given budget levels for a single asset or for the entire network

Network Performance Budget Scenarios

■ Do nothing ■ Spend \$1 million ■ Spend \$3 million



APMS Outcome

“The Most Effective Pavement Maintenance Program Through Pavement Life Cycle with the least possible cost ”

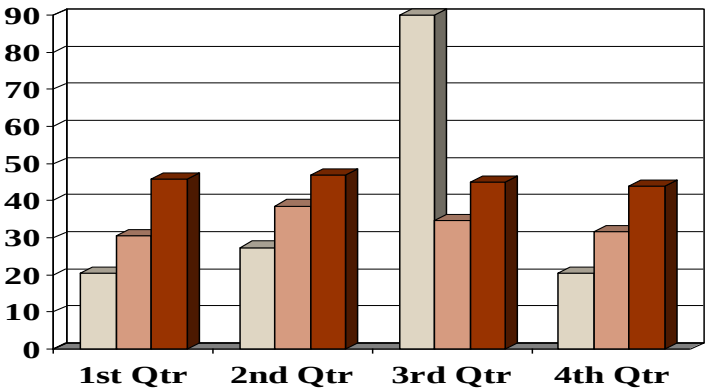
Budget

Section	Year	Cost
32	2016	\$100,000
47	2019	\$237,999

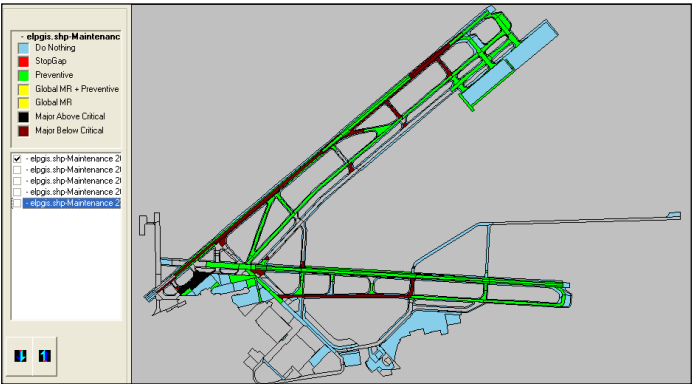
Current and predicted Airports Pavement Condition



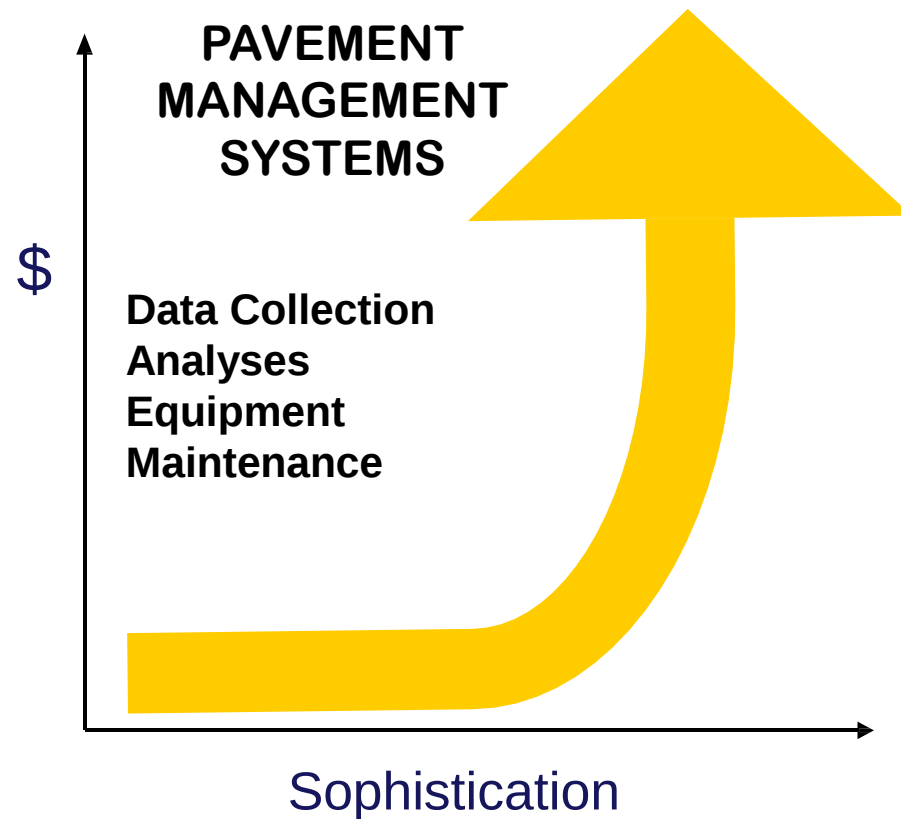
Planning and Statistics



Most cost effective Maintenance Programs



Which Pavement Management System to Select ?



Choosing What's Right for YOU



Conclusion

- ❑ There is a need to preserve our airfield pavement network assets
- ❑ Asset Management System is a tool for better assets preservation
- ❑ There is no system that can fit all, each organization should choose the system that meets its needs and challenges
- ❑ It is important to realize that it is not a software but a complete integrated system
- ❑ Feed back and continues improvement



Thank you