CONFERENCE 16TH EDITION EXHIBITION

CONFERENCE OMAINTEC 2018 EXHIBITION

INTERNATIONAL OPERATIONS & MAINTENANCE CONFERENCE
IN THE ARAB COUNTRIES

UNDER THE THEME
"MANAGING MAINTENANCE WITHIN INDUSTRY 4.0"
CONICIDE WITH THE 16TH ARAB MAINTENANCE EXHIBITION

AIRPORTS AND HIGHWAYS PAVEMENT PERFORMANCE EVALUATION FOR MAINTENANCE NEED- CASE STUDY

Dr. Ibrahim Asi & Eng. Aya Al-Asi

ACES Core Services

1 Site Investigation

2 Material Testing

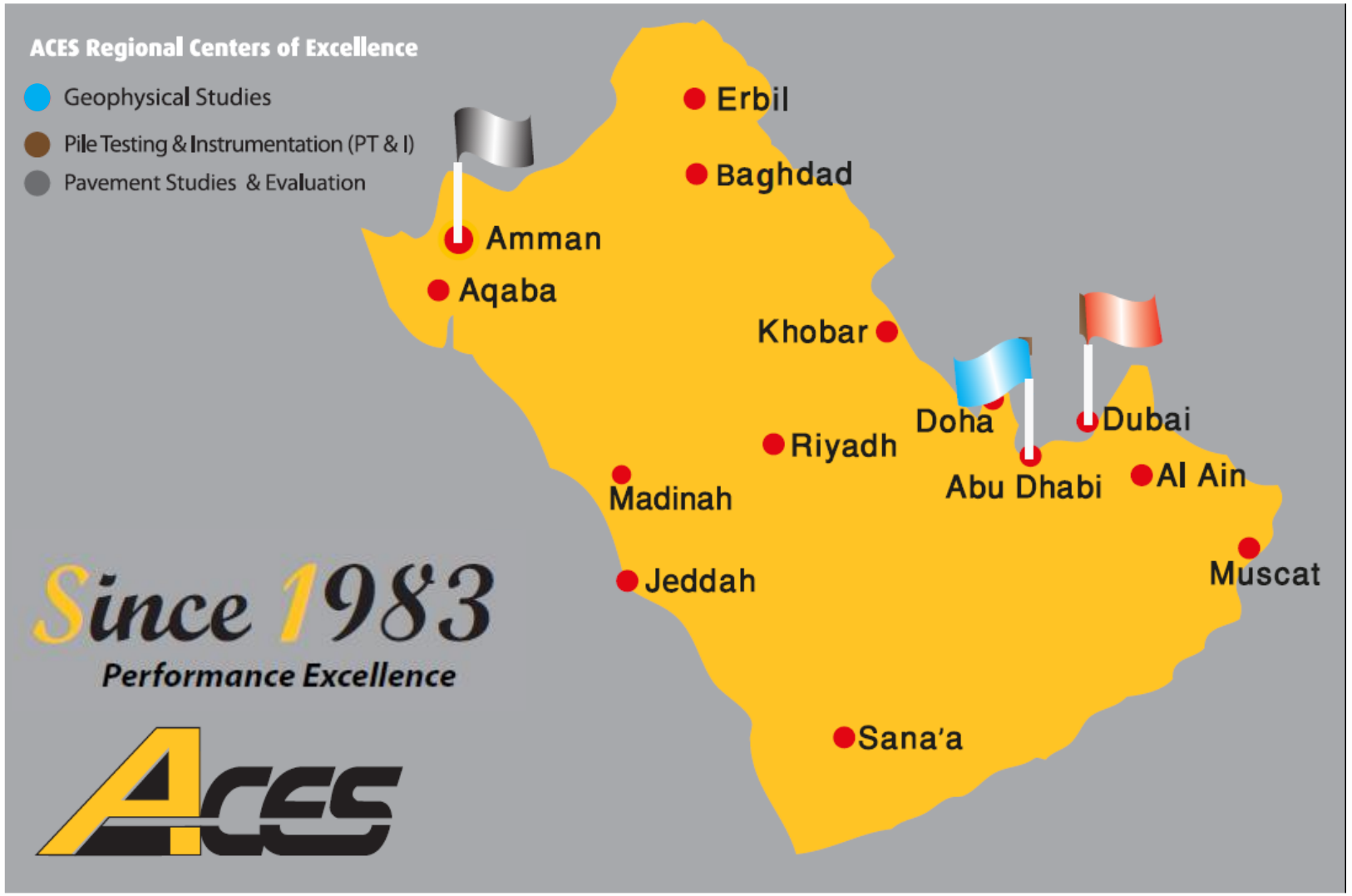
3 Quality Control

4 Special Projects

5 Environmental Testing

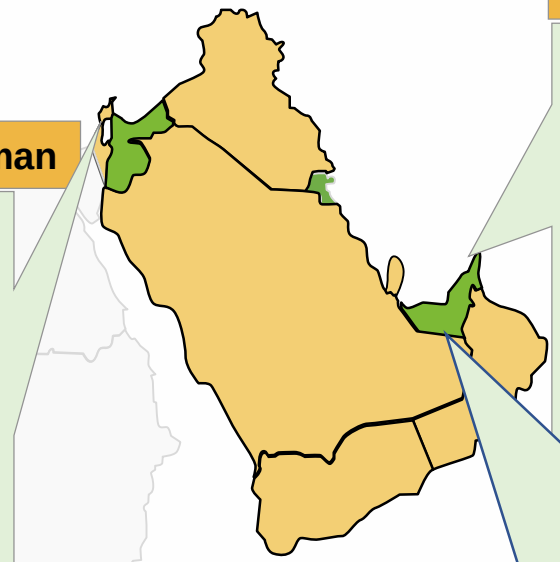
6 Land & Marine Surveying

ACES Network



Regional Centers of Excellence

ACES RCE Services and Locations



Pavement Studies & Evaluation - Amman

Focuses on functional and structural evaluation of roads and airport pavement sections. Services include:

- Structural Evaluation of Pavement
- Pavement Roughness Evaluation
- Road Safety Evaluation
- Pavement Condition Evaluation
- Pavement Material Testing

Pile Testing & Instrumentation –Dubai

This RCE carries out pile quality control and testing. Service include:

- Pile Integrity Testing
- High Strain Dynamic Testing
- Caliper Logging Testing
- Instrumented Static Pile Load Testing
- Instrumentation of Driven Piles
- Bi-Directional Static Load Cell Testing

Geophysical Studies & Testing – Abu Dhabi

This RCE offers an integrated suite of onshore and nearshore geophysical services, including:

- Surface Seismic Survey
- Borehole Seismic Survey
- Electrical Survey
- Borehole Logging
- Marine Geophysics (Marine ERT, Sub-Bottom Profiler, Side Scan Sonar and Marine Magnetic)

ACES Locations ***RCE Locations***

Experience in Airports Evaluation

- Dubai International Airport - UAE

Experience in Airports Evaluation

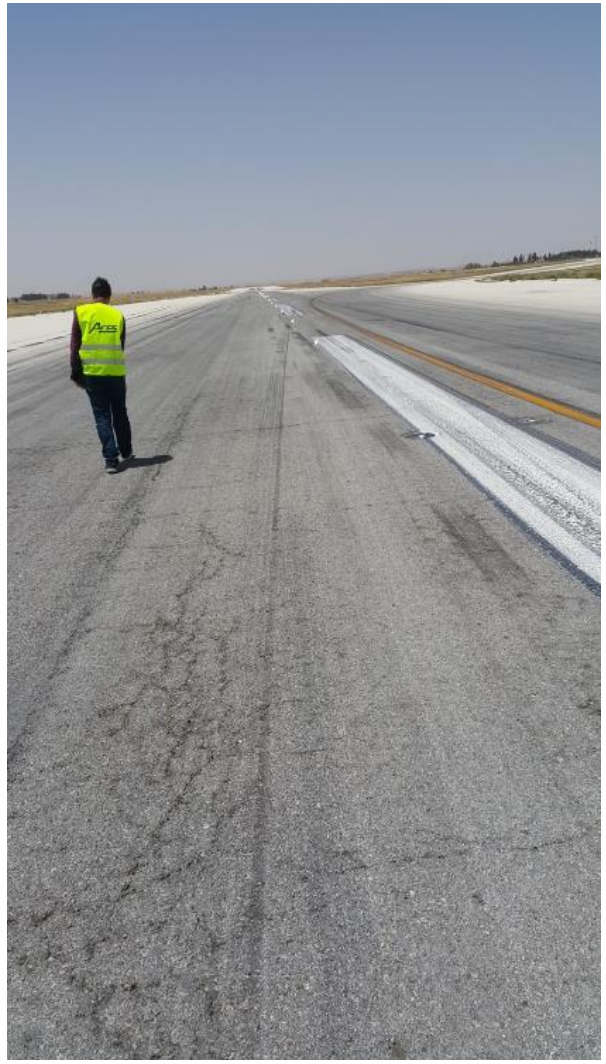
- Al-Maktoum International Airport - UAE

Experience in Airports Evaluation

- Muscat & Salalah International Airports - Oman

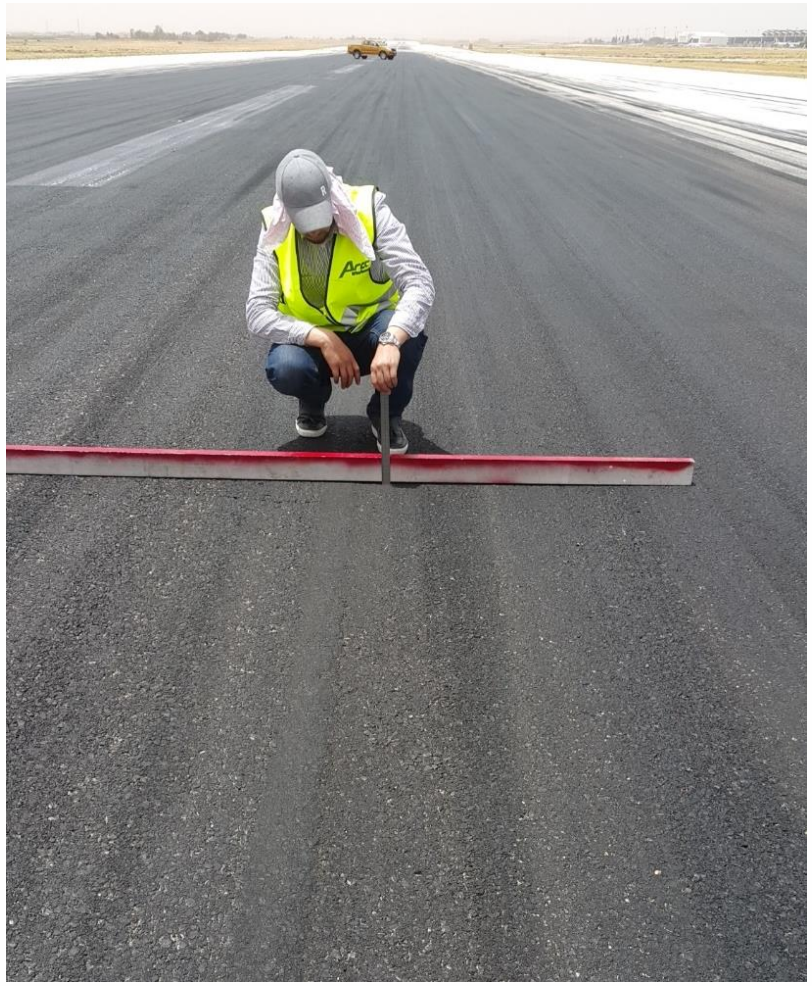
Experience in Airports Evaluation

- Queen Alia International Airport - Jordan



Experience in Airports Evaluation

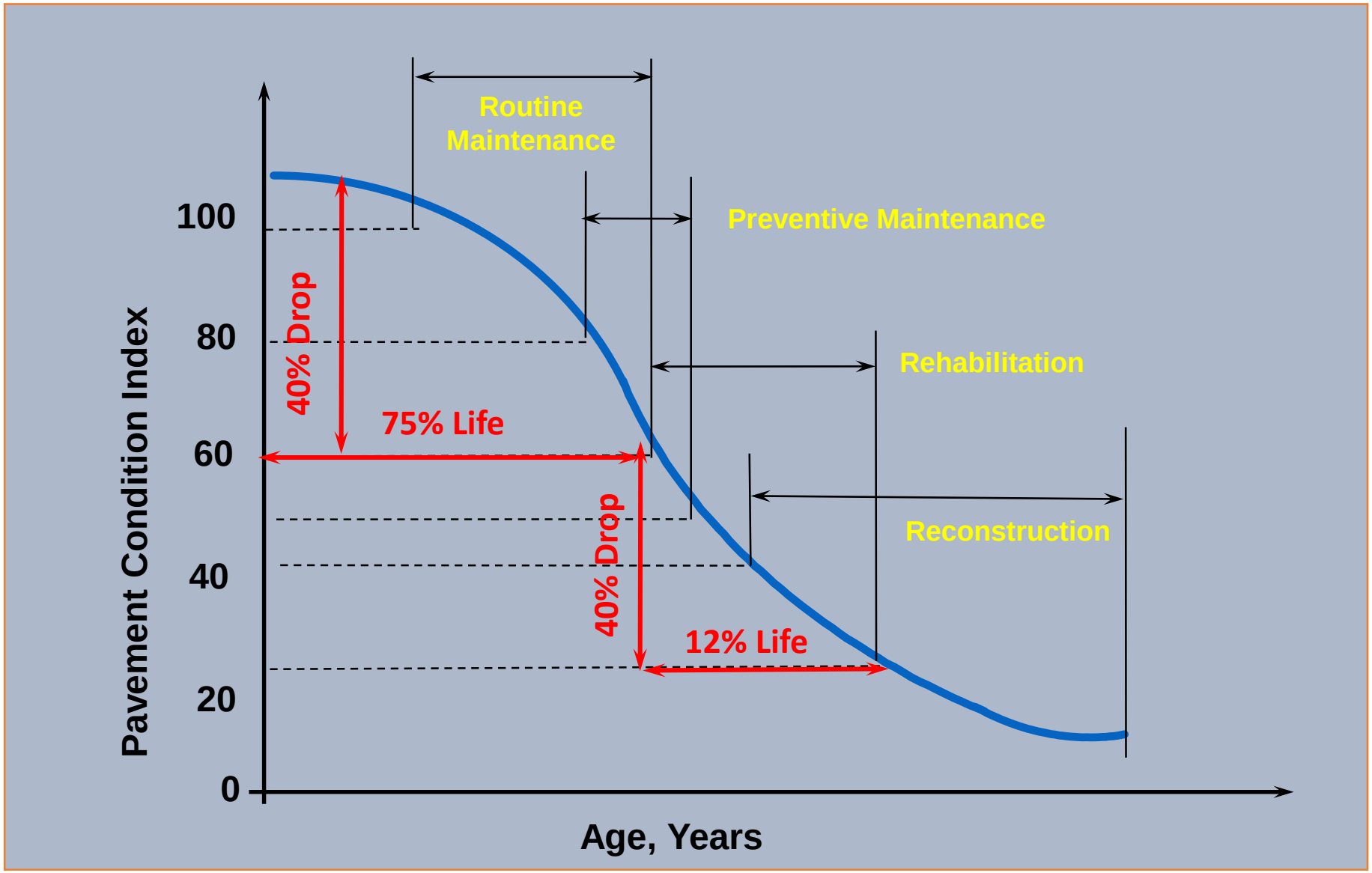
- Songwe Airport Runway - Tanzania



INTRODUCTION

- Pavements in Highways & Airports
- Pavements deteriorate
- Rate of pavement deterioration depends on:
  - used construction materials
  - construction and maintenance history
  - rate of loading, and rate of environmental conditions

PAVEMENT LIFE CYCLE



PAVEMENT PERFORMANCE EVALUATION

- Subjective
  - visual inspection
  - evaluator experience
- Objective
  - standardized evaluation procedures and equipment

OBJECTIVE EVALUATION

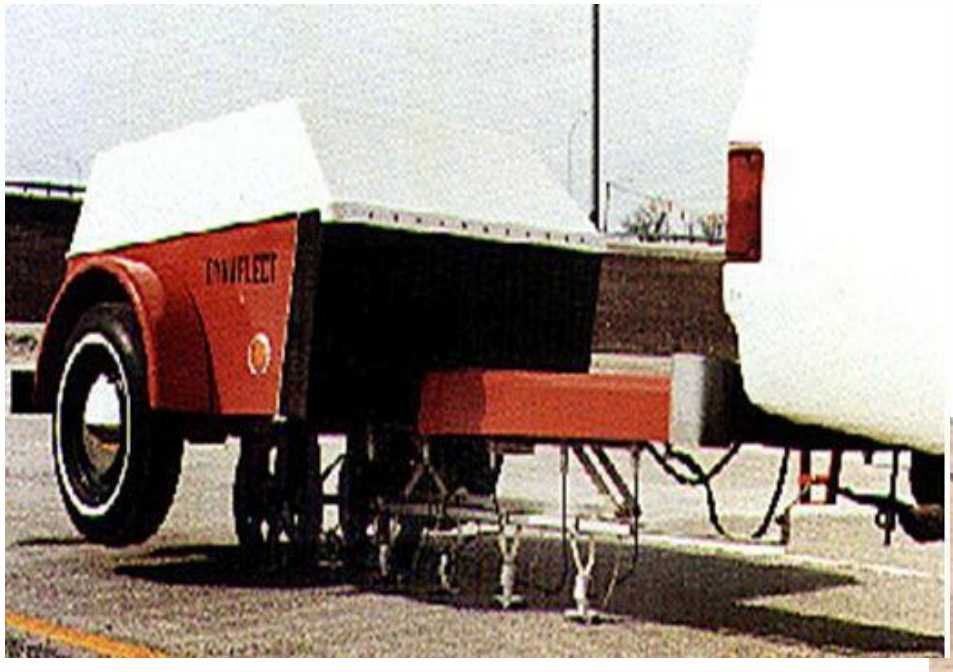
1. Structural Evaluation - Pavement deflection, cores and test pits
2. Functional Evaluation - Pavement roughness (rideability)
3. Surface Condition Evaluation - Pavement distresses
4. Safety Evaluation - Skid resistance

1- Structural Evaluation

- Obtain load-bearing capacity
- Evaluate the need for maintenance and rehabilitation,
- Assist pavement condition evaluation
- Construction quality control

1.1- Non - Destructive Evaluation

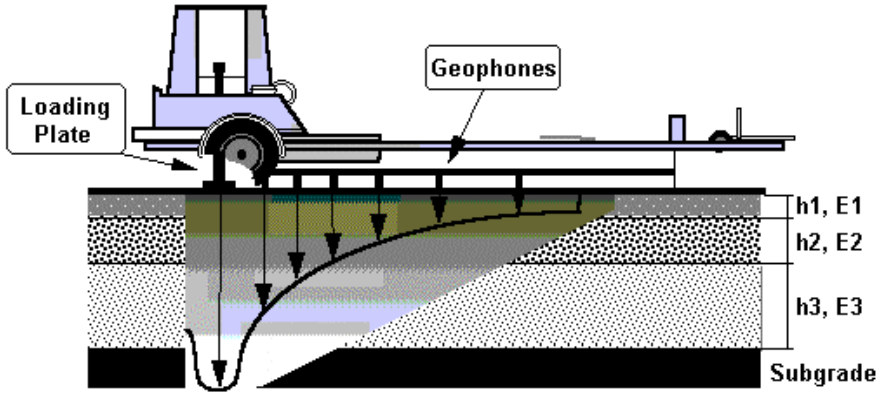
1.1- Non - Destructive Evaluation (Cont.)



1.1- Non - Destructive Evaluation (Cont.)

1.1- Non - Destructive Evaluation (Cont.)

- FWD applies a load to the pavement
- Deflections are measured directly under the load and at set distances from the load
- Deflections are back analyzed
  - Modulus of each pavement layer
  - Required overlay



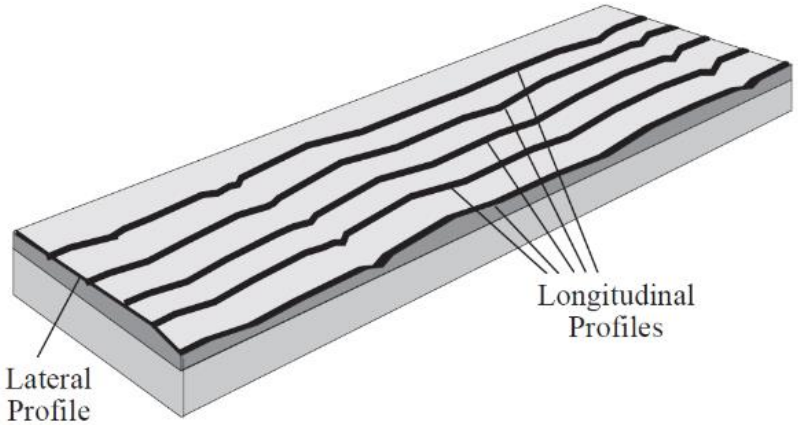
1.2- Destructive Evaluation

2- Functional Evaluation

2- Functional Evaluation

PAVEMENT ROUGHNESS:

Defined as an expression of irregularities in the longitudinal profile of the pavement surface that adversely affect the ride quality of the airplane (and thus the users)



3- Pavement CONDITION evaluation

- Refers to the condition of the pavement surface in terms of its general appearance
- A perfect pavement is leveled and has a continuous and unbroken surface
- A distressed pavement may be fractured, distorted, or disintegrated

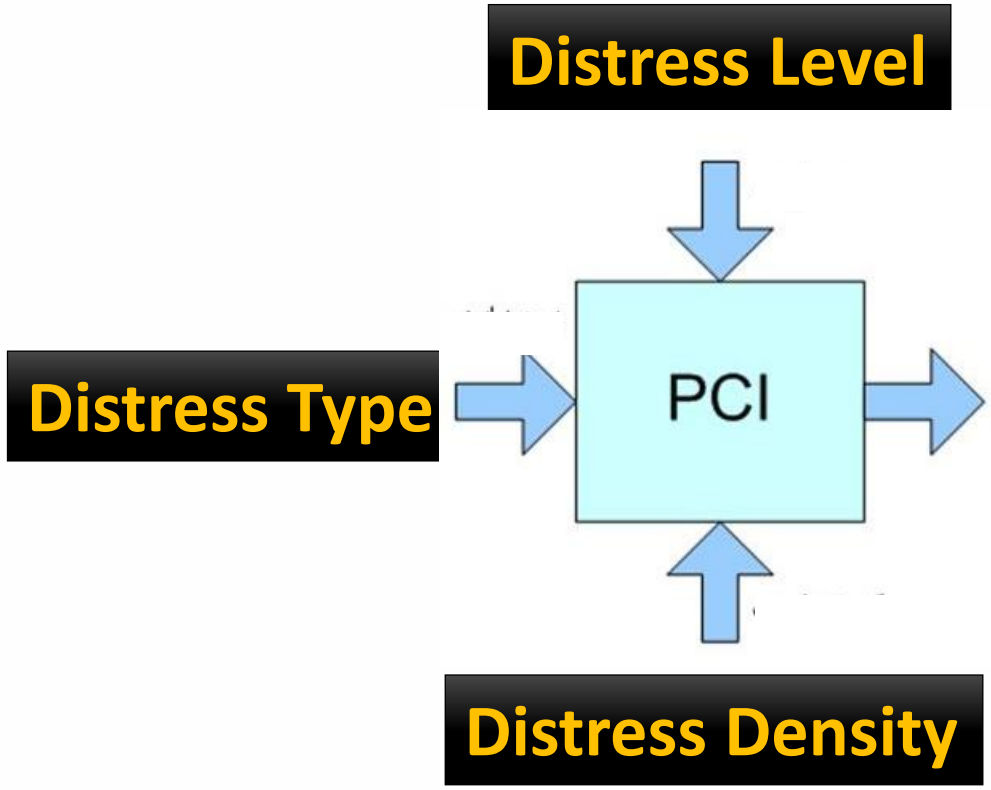
3- Pavement CONDITION evaluation METHOD

- Unbiased
- Repeatable
- Easily understood
- Relatively simple to perform in the field

PAVEMENT CONDITION INDEX (PCI)

- ASTM D5340-12 “Standard Test Method for Airport Pavement Condition Index Surveys”.
- ASTM D6433-18 “Standard Test Methods for Roads and Parking Lots Pavement Condition Index Surveys”.
- ASTM E2840 − 11 (2015) “Standard Test Methods for Pavement Condition Index Surveys for Interlocking Concrete Roads and Parking Lots”.

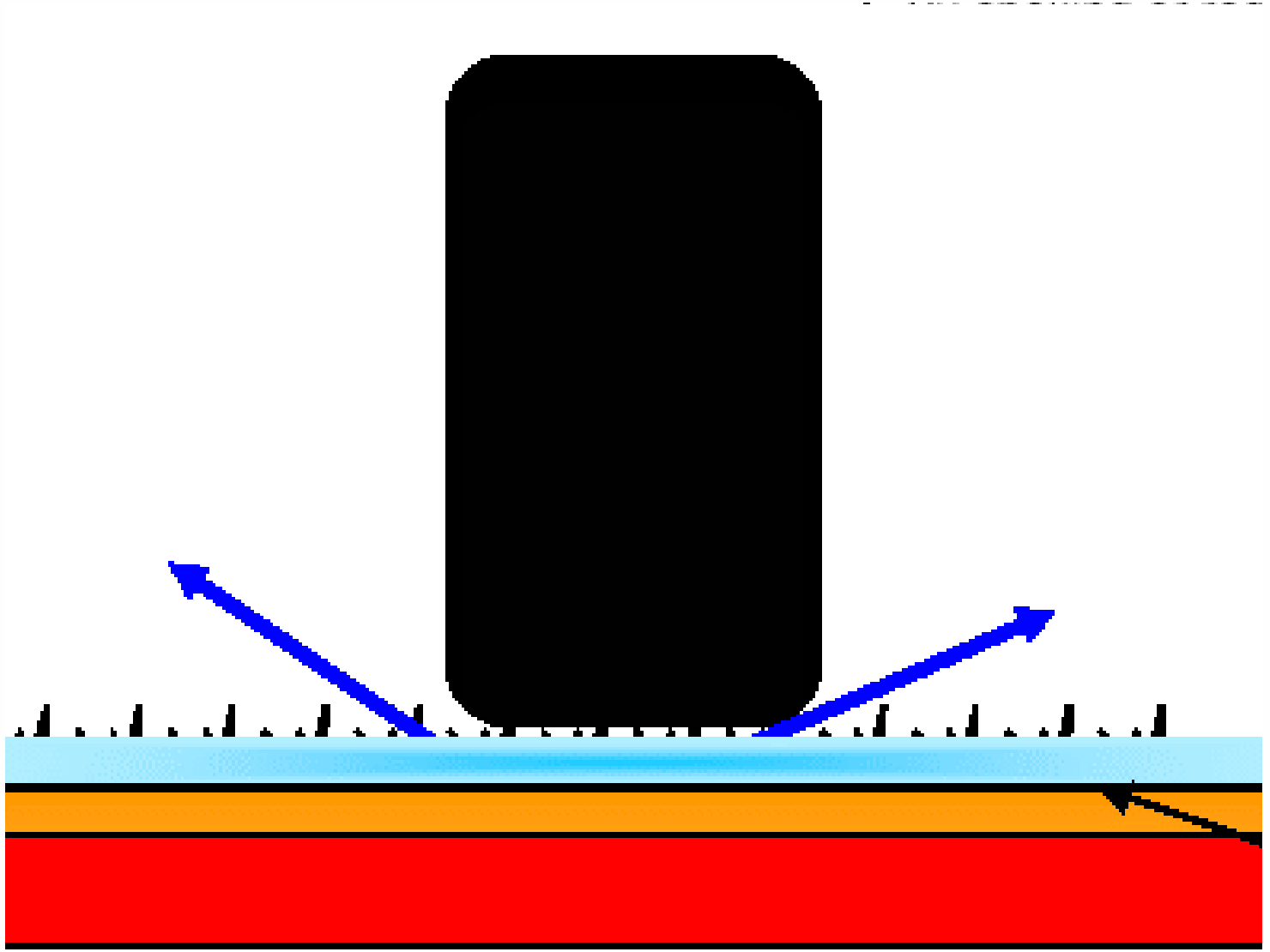
PAVEMENT CONDITION INDEX (PCI)



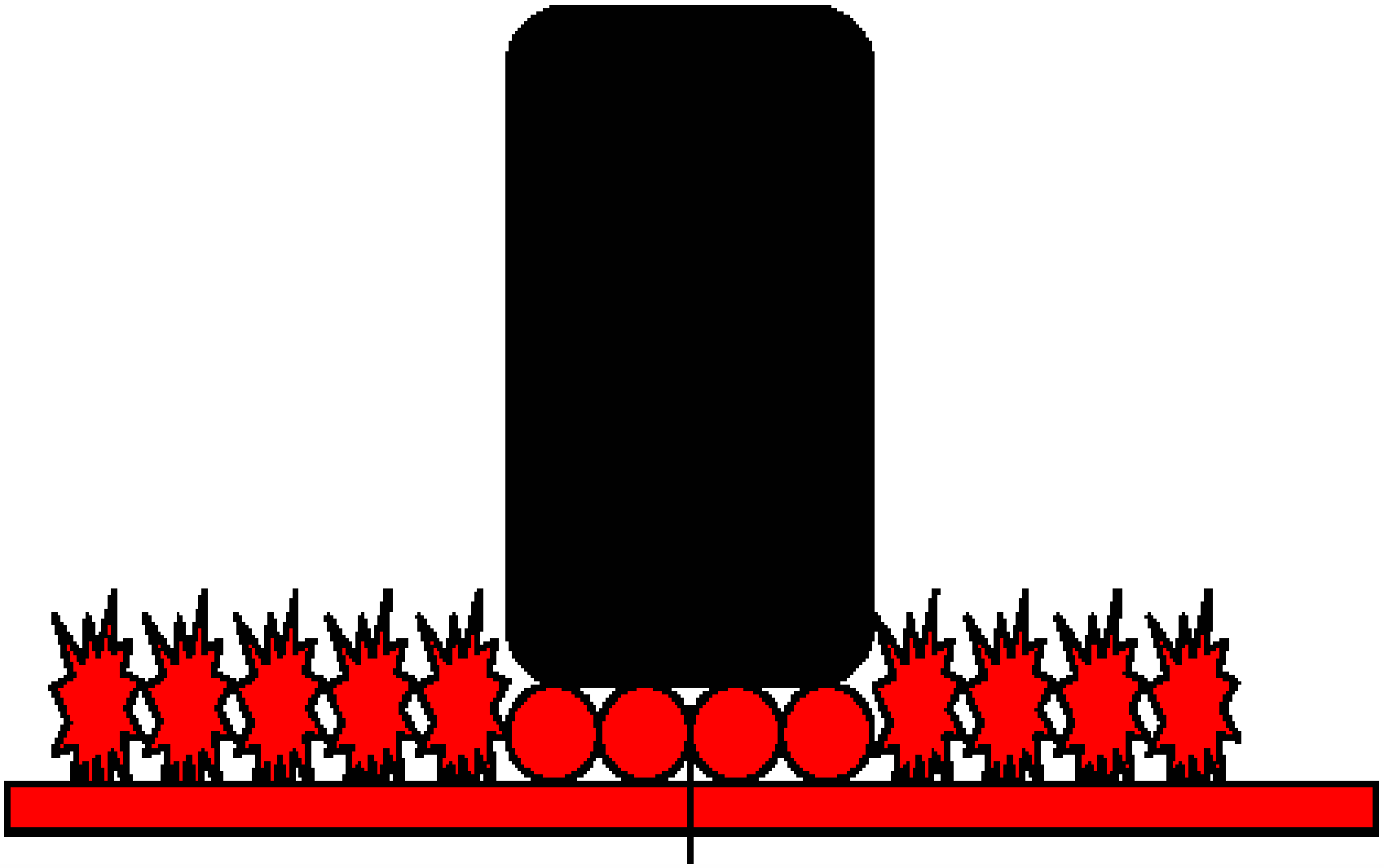
4- Safety Evaluation - Skid resistance

- Considered a type of safety characteristics of the pavement surface layers
- It is a measure of the resistance of pavement surface to sliding or skidding of the aircraft
- It is a relationship between the vertical force and the horizontal force developed as a tire slides along the pavement surface

ASPHALT SURFACE MACRO-TEXTURE



POLISHING OF AGGREGATE



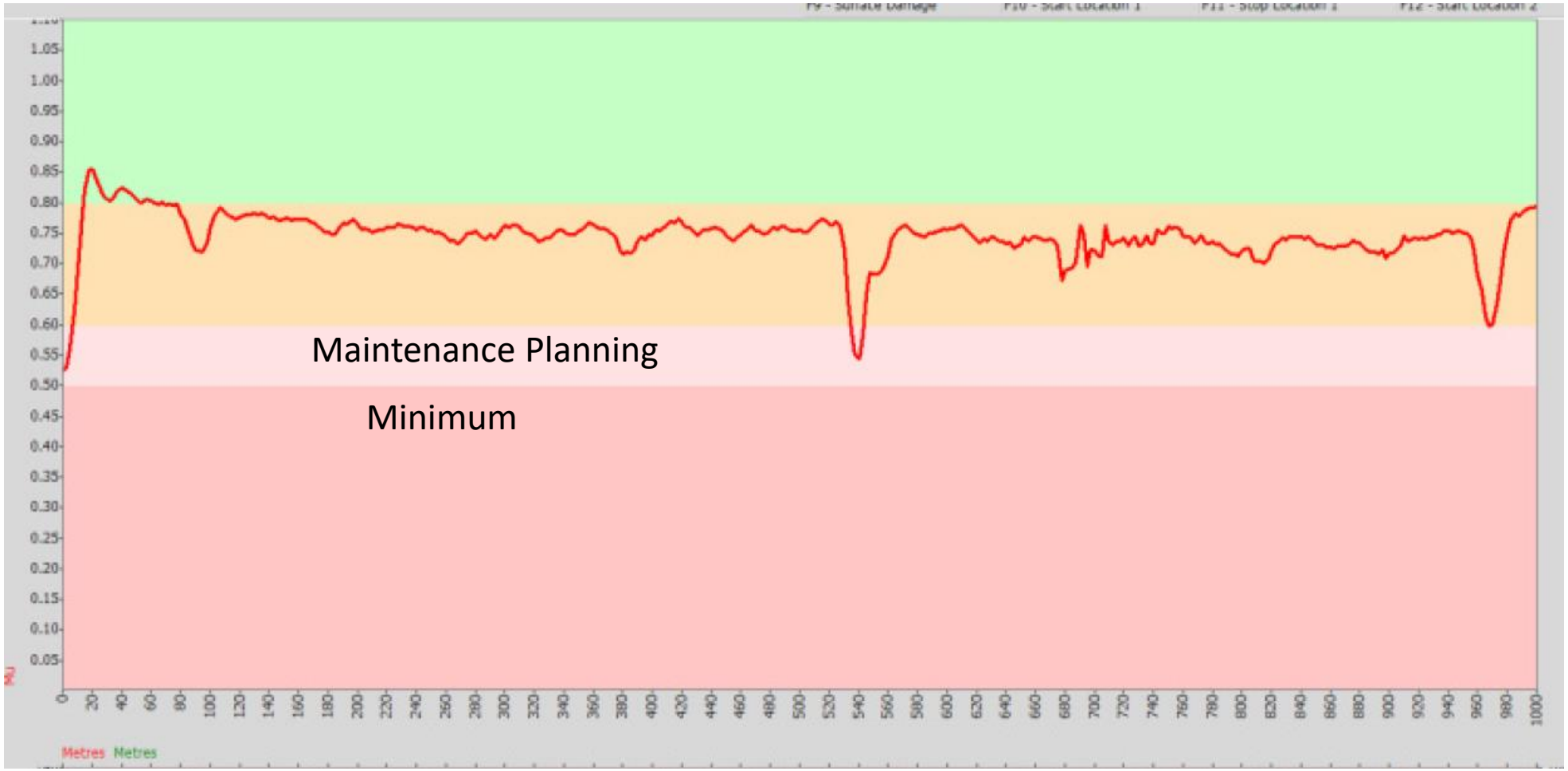
Frequency of Skid resistance evaluation

- Every runway for jet aircraft should be evaluated at least once each year.

NUMBER OF DAILY MINIMUM TURBOJET AIRCRAFT LANDINGS PER RUNWAY END	MINIMUM FRICTION SURVEY FREQUENCY
LESS THAN 15	1 YEAR
16 TO 30	6 MONTHS
31 TO 90	3 MONTHS
91 TO 150	1 MONTH
151 TO 210	2 WEEKS
GREATER THAN 210	1 WEEK

PAVEMENT CFME FRICTION TESTER

VARIATION OF FRICTION COEFFICIENT



CASE STUDIES OF PERFORMED PERFORMANCE TESTS

1- STRUCTURAL EVALUATION

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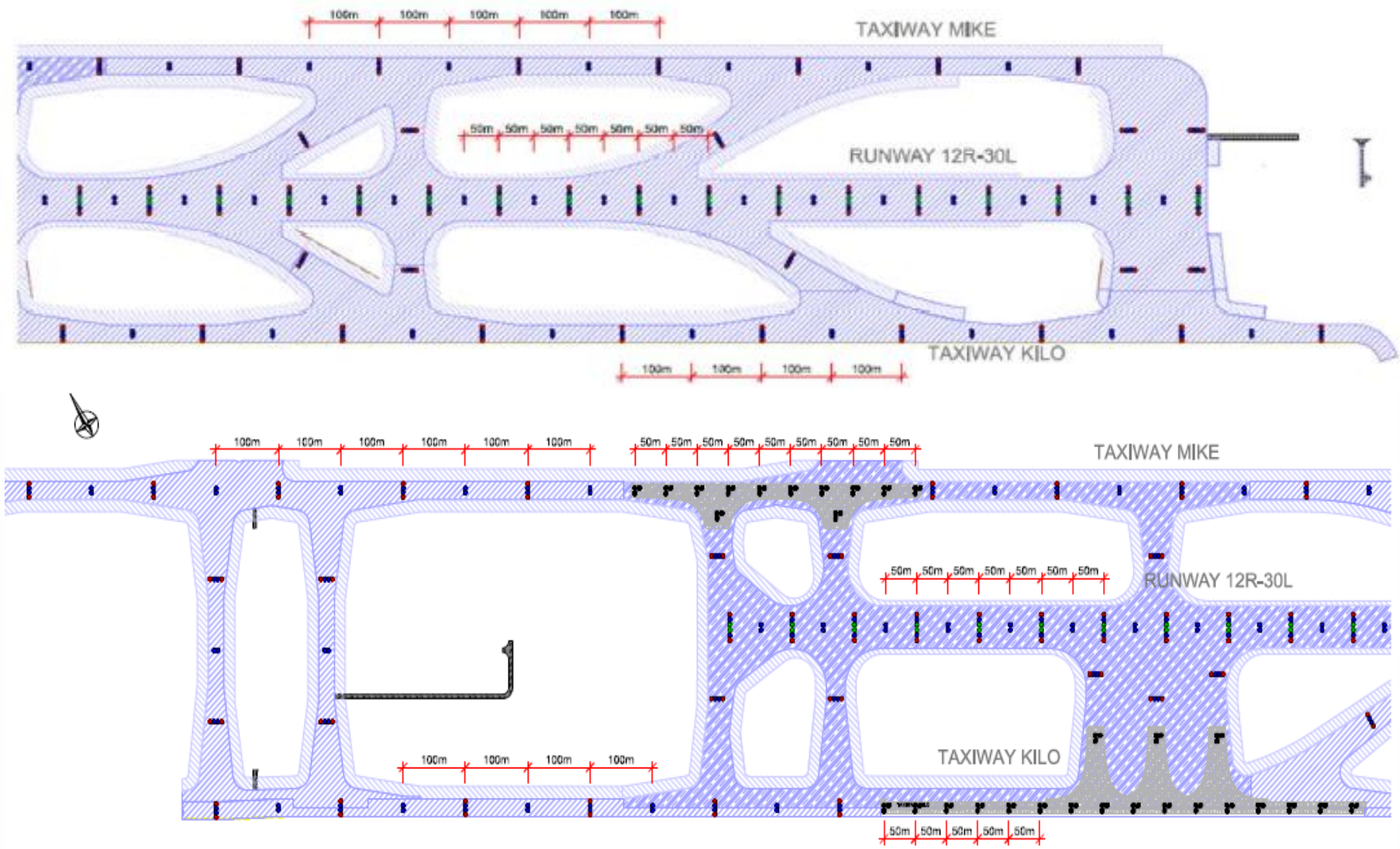
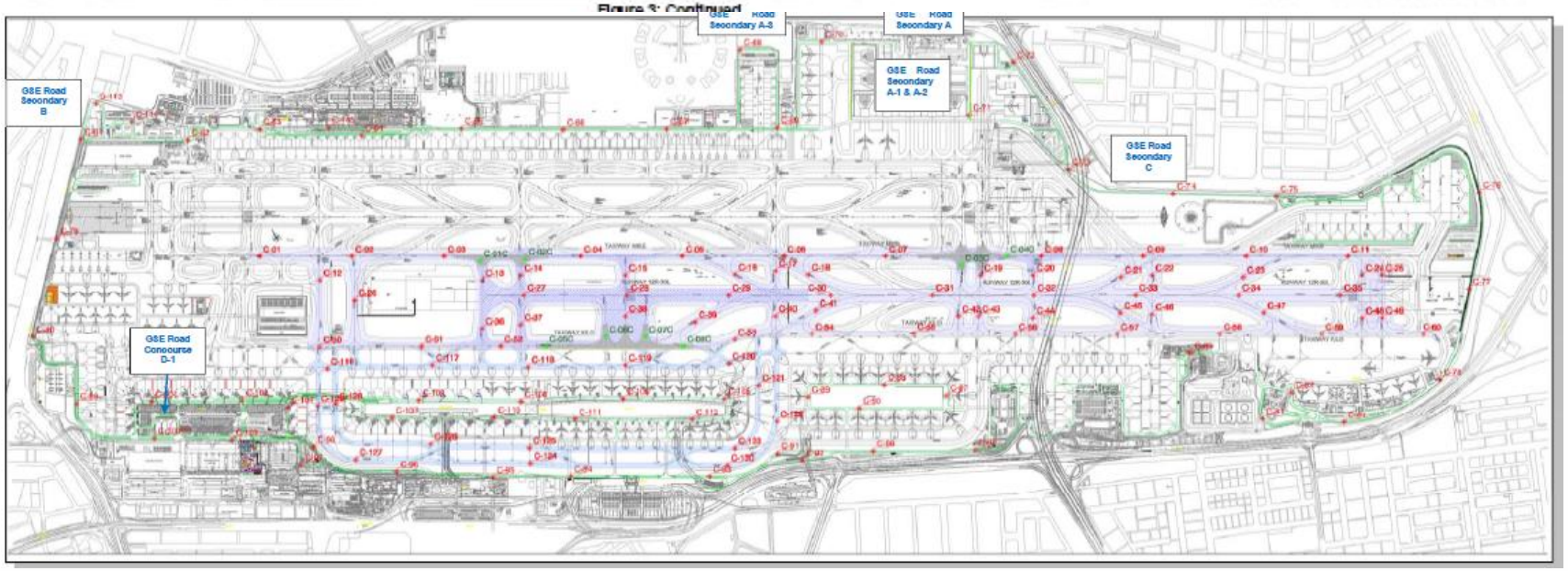


1- STRUCTURAL EVALUATION

Figure 3: Continued



GENERATED REPORTS

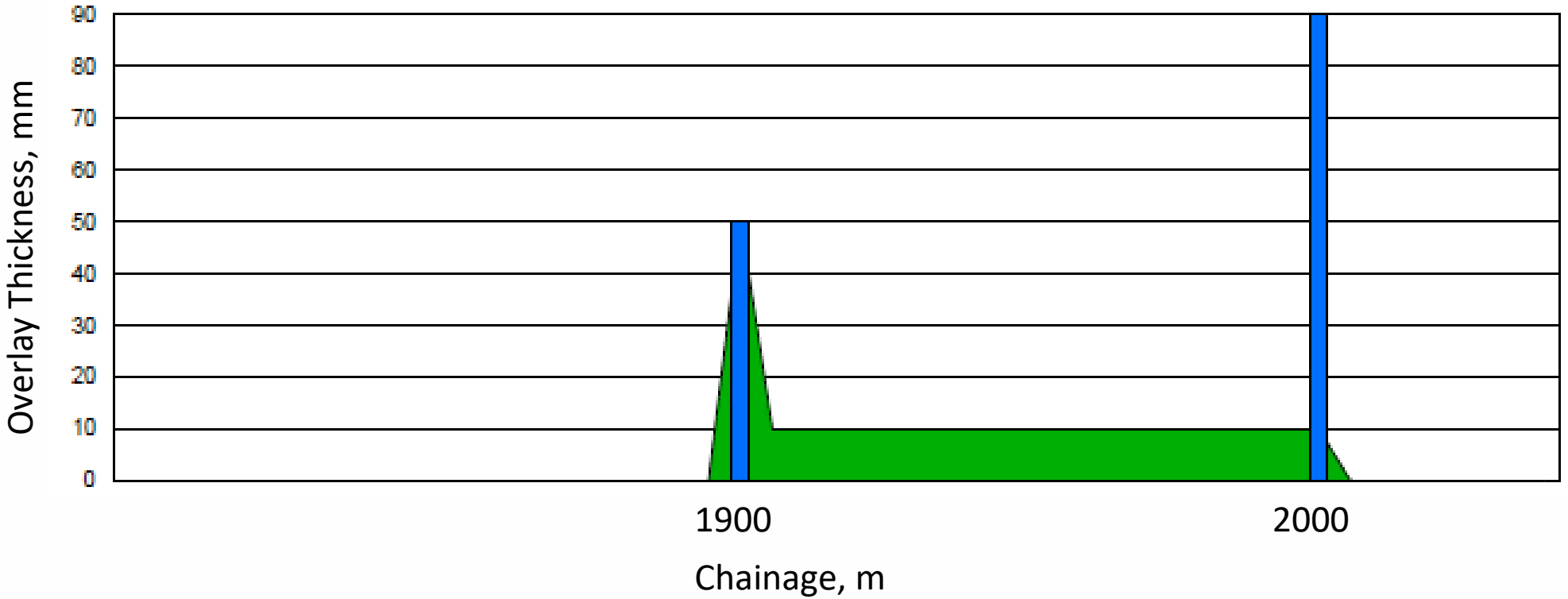
AIRPORT EVALUATION REPORT

Date 13-08-2017

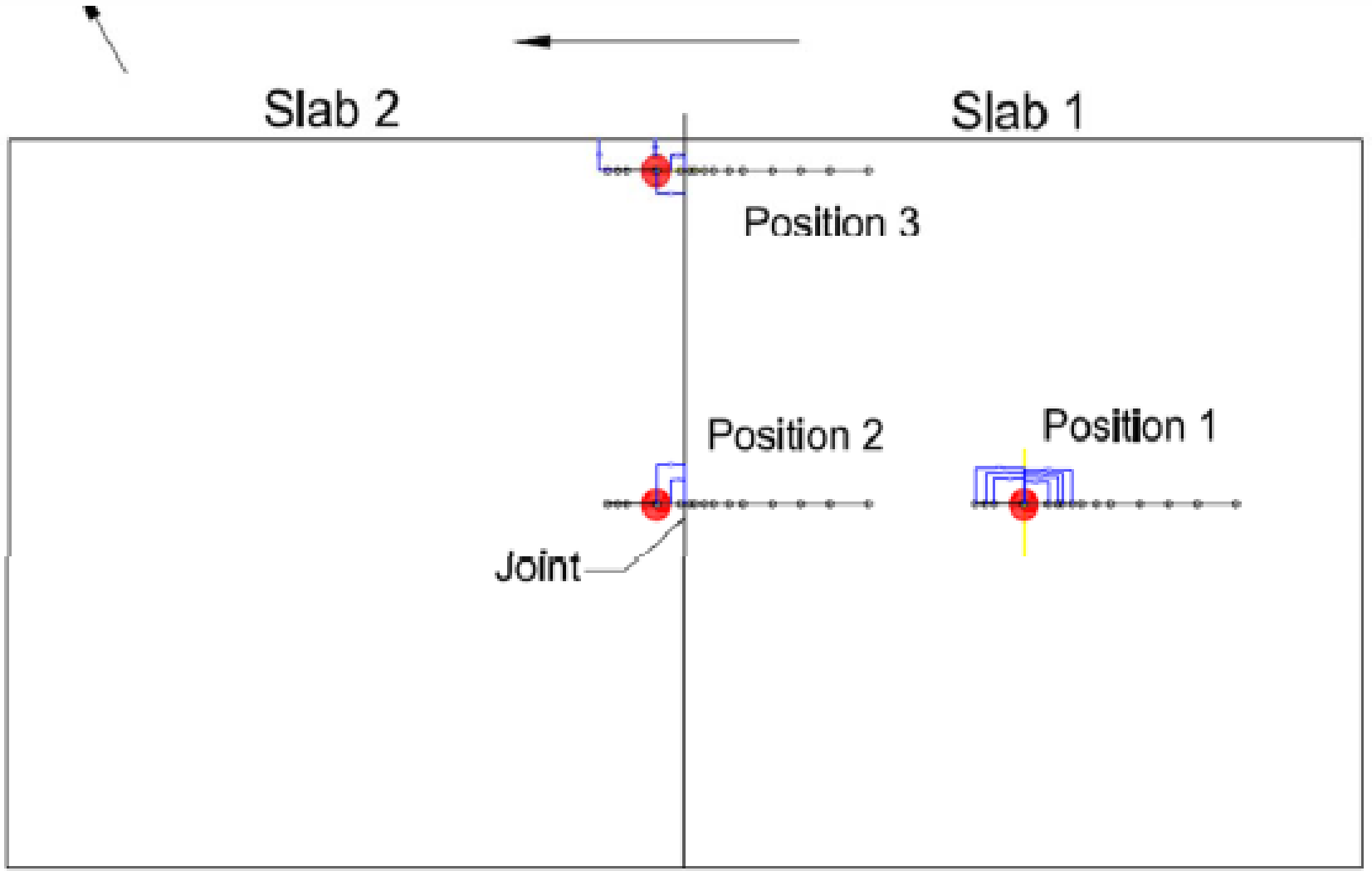
District	Road Number	Name	Chainage0	Lane	Lane chainage	Measuring date
Runway	1	South	0+000	Lane: 1	0 to 4,450 m	03/22/2017

Sect:	Chainage:	E1 [MPa]	E2 [MPa]	E3 [MPa]	E4 [MPa]	Crit. layer	H1 [mm]	H2 [mm]	H3 [mm]	Remark	Calc. type	PCN current	PCN new	Res. life [years]	Reinf. [mm]	ACN
1	0/R	5.982	2.718	3.728	735	1	399	150	150		ASPH	139	139	10	0	64.000
1	100/R	10.139	2.889	4.667	725	1	399	150	150		ASPH	139	139	10	0	64.000
1	199/R	13.668	4.034	5.248	1.001	1	399	150	150		ASPH	139	139	10	0	64.000
1	300/R	8.685	4.941	16.108	1.005	1	399	150	150		ASPH	139	139	10	0	64.000
1	404/R	11.973	3.453	3.219	893	1	399	150	150		ASPH	139	139	10	0	64.000
1	501/R	4.523	3.124	8.903	905	1	424	150	150		ASPH	139	139	10	0	64.000
1	603/R	7.965	5.210	8.474	1.227	1	424	150	150		ASPH	139	139	10	0	64.000
1	700/R	7.139	2.532	4.210	725	1	424	150	150		ASPH	139	139	10	0	64.000
1	800/R	8.183	851	455	609	1	424	150	150		ASPH	139	139	10	0	64.000
1	898/R	5.542	807	381	542	1	424	150	150		ASPH	139	139	10	0	64.000
1	1,001/R	7.446	1.213	656	450	1	395	150	150		ASPH	139	139	10	0	64.000
1	1,100/R	7.159	527	4.520	589	1	395	150	150		ASPH	139	139	10	0	64.000
1	1,200/R	7.764	1.076	1.435	774	1	395	150	150		ASPH	139	139	10	0	64.000
1	1,301/R	11.079	594	254	711	1	395	150	150		ASPH	139	139	10	0	64.000
1	1,400/R	6.427	1.085	531	558	1	395	150	150		ASPH	139	139	10	0	64.000
1	1,501/R	7.904	794	782	518	1	370	150	150		ASPH	139	139	10	0	64.000
1	1,601/R	4.294	1.499	1.179	464	1	370	150	150		ASPH	139	139	10	0	64.000
1	1,700/R	3.004	1.072	782	477	1	370	150	150		ASPH	139	139	10	0	64.000
1	1,802/R	3.958	1.412	1.176	503	1	370	150	150		ASPH	139	139	10	0	64.000
2	1,900/R	4.717	730	334	486	3	370	150	150		ASPH	139	139	6	50	64.000
3	1,998/R	3.954	1.434	857	531	1	370	150	150		ASPH	139	139	10	0	64.000
3	2,100/R	3.633	573	1.084	462	1	407	150	150		ASPH	139	139	10	0	64.000
3	2,199/R	2.118	861	10.982	455	1	407	150	150		ASPH	139	139	10	0	64.000
3	2,302/R	6.831	1.140	511	558	1	407	150	150		ASPH	139	139	10	0	64.000
3	2,399/R	6.084	1.070	541	556	1	407	150	150		ASPH	139	139	10	0	64.000
3	2,500/R	4.814	787	0	575	1	406	400	0		ASPH	139	139	10	0	64.000

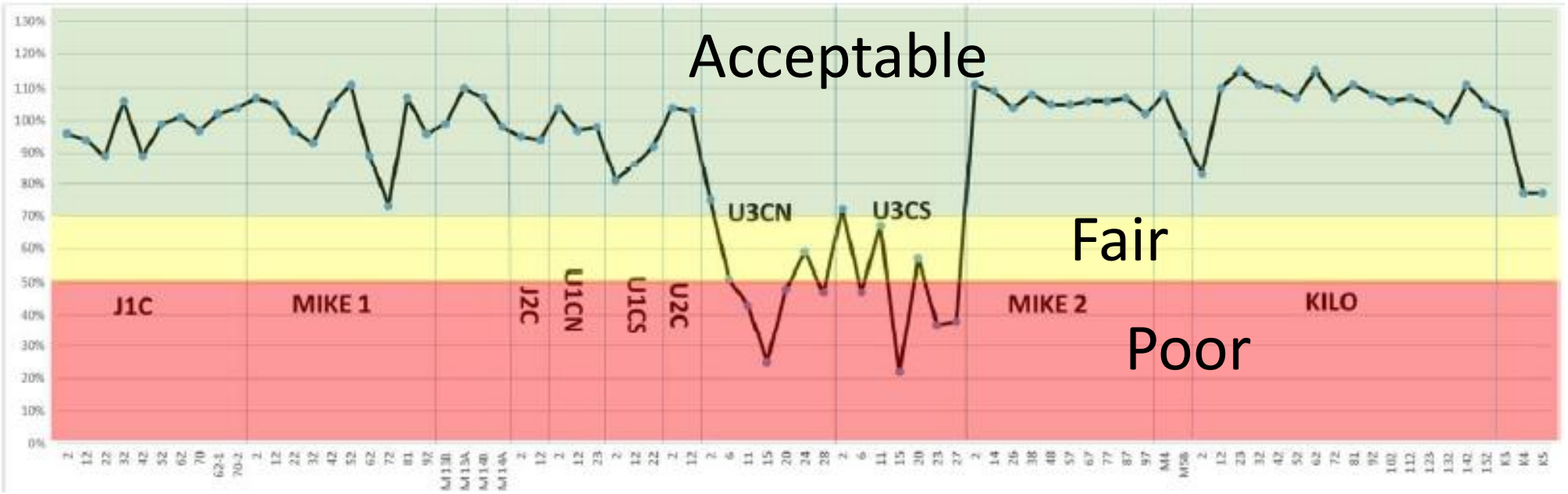
REQUIRED OVERLAY



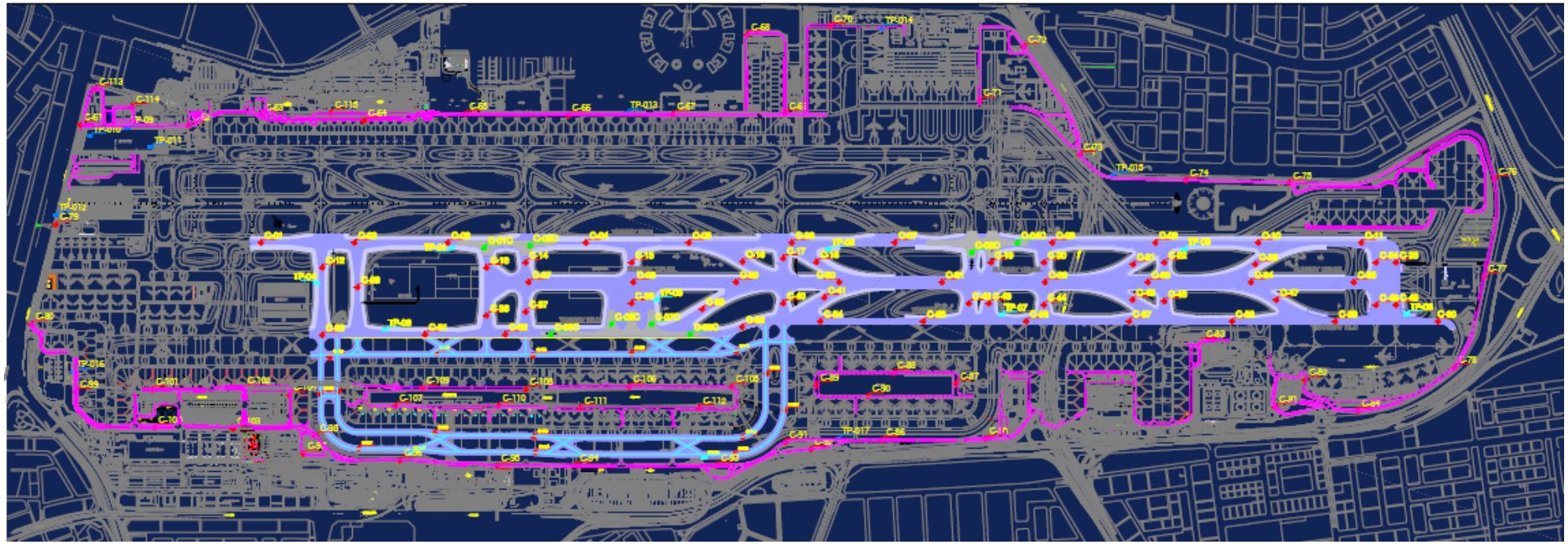
STRUCTURAL EVALUATION OF RIGID PAVEMENT



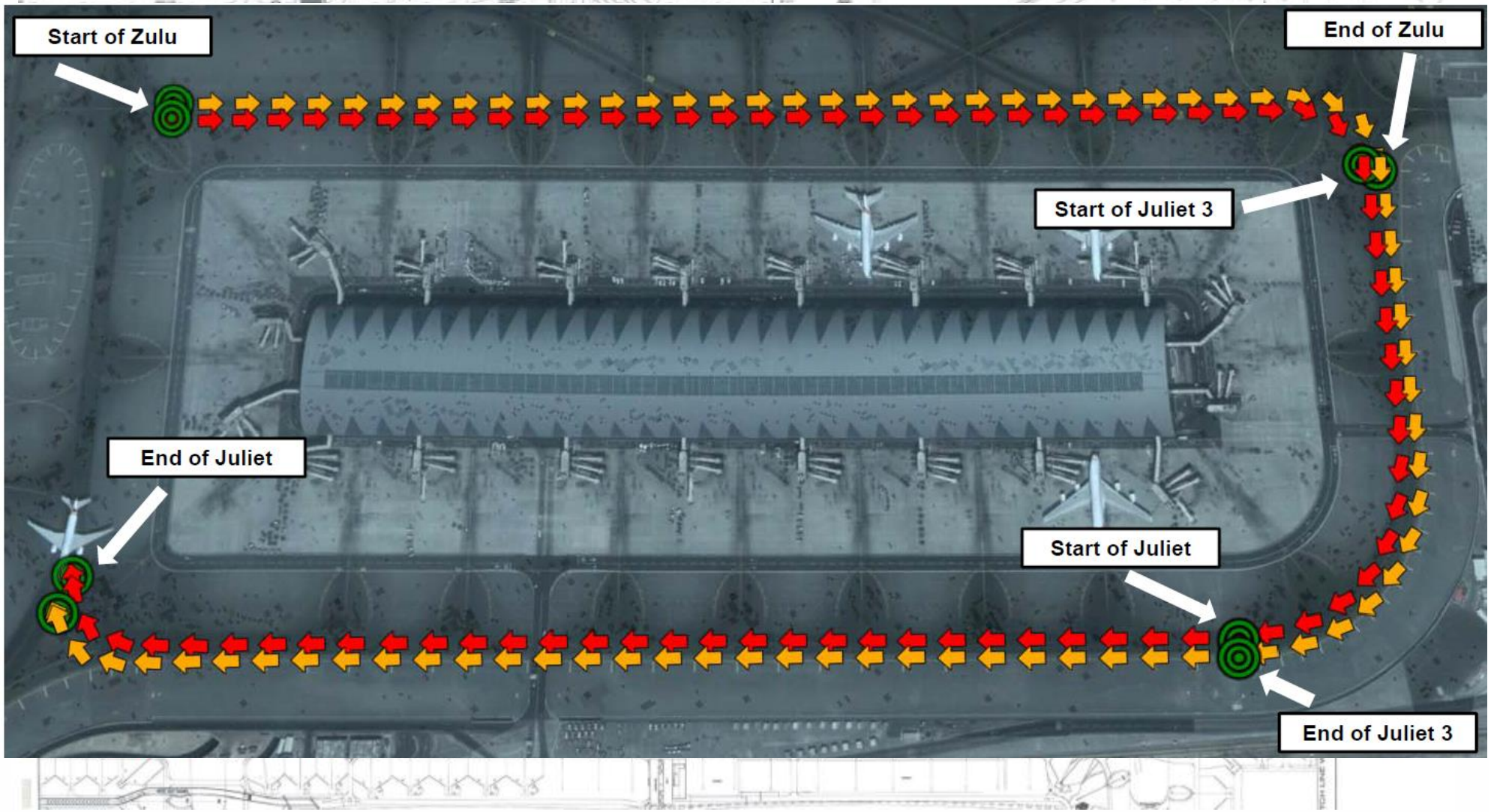
VARIATION OF LOAD TRANSFER EFFICIENCY (LTE)



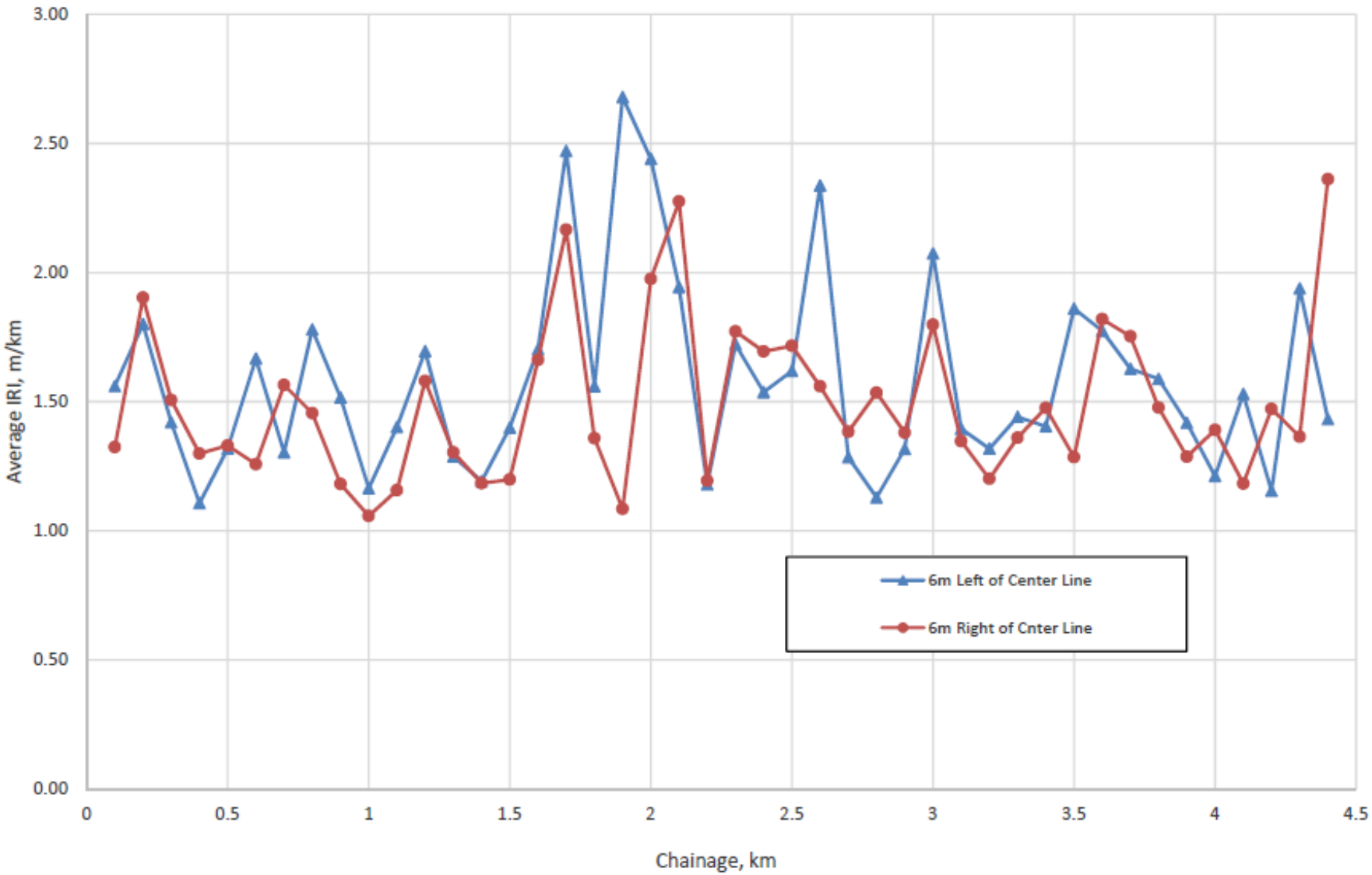
EXTRACTED CORES & EXCAVATED TESTS PITS



2- Functional Evaluation



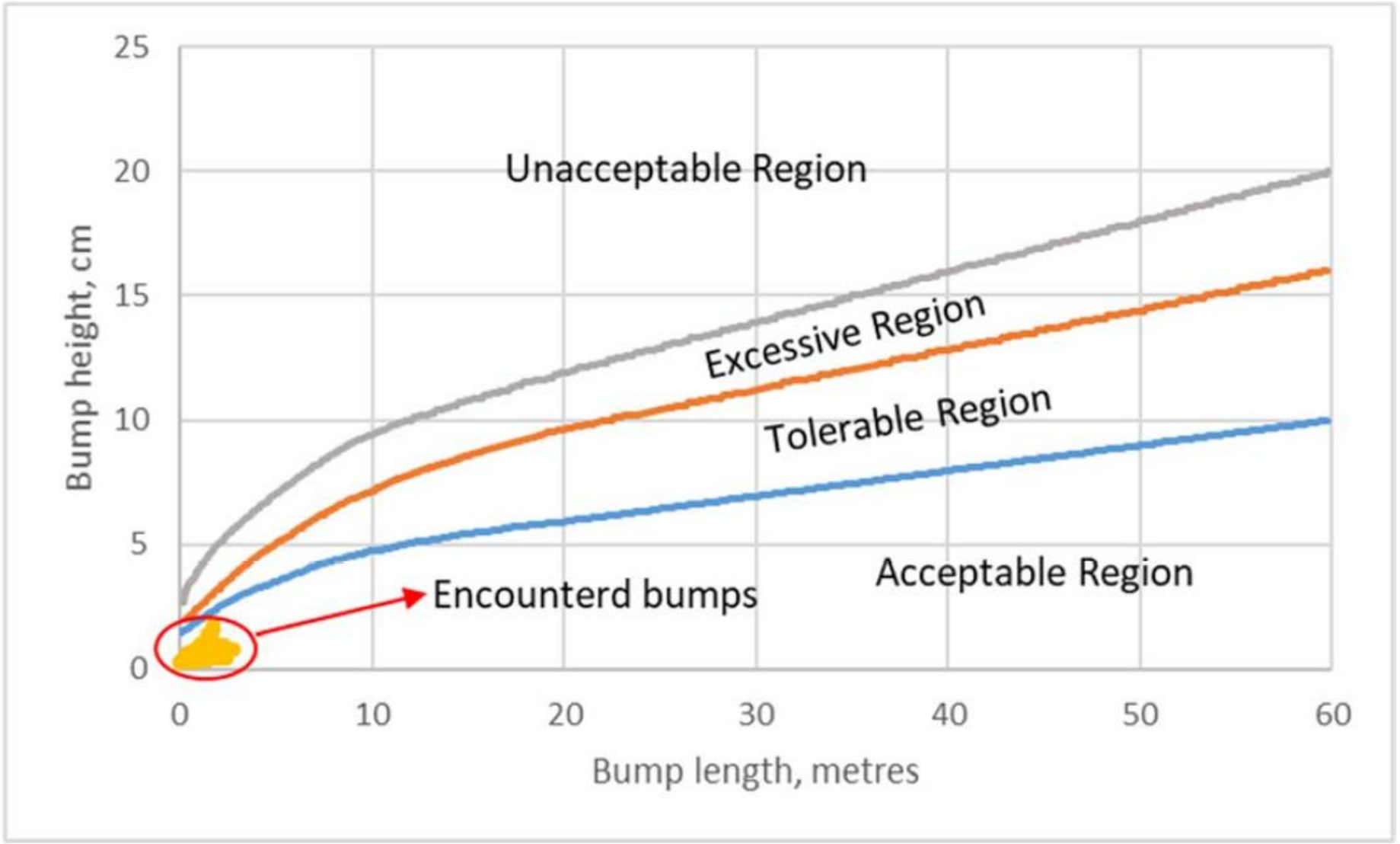
Variation of IRI Values



ROLLING STRAIGHT EDGE ANALYSIS

Right Profile				Left Profile			
Start Distance (m)	Stop Distance (m)	Bump Length (m)	Deviation (mm)	Start Distance (m)	Stop Distance (m)	Bump Length (m)	Deviation (mm)
8.4	9.1	0.6	-4.34	8.5	9.1	0.7	-4.20
20.6	20.8	0.1	3.08	10.5	10.8	0.3	3.29
84.0	84.9	0.8	3.79	84.6	85.1	0.5	3.24
95.3	96.0	0.7	4.24	107.0	107.2	0.2	3.03
106.4	106.8	0.4	3.27	202.3	202.6	0.3	3.27
138.7	139.3	0.5	3.93	203.7	205.1	1.4	-6.00
163.3	164.5	1.2	-5.25	219.2	220.2	1.0	-3.77
165.3	166.1	0.9	3.55	221.3	221.5	0.2	3.08
167.5	168.5	1.0	-3.70	306.1	306.4	0.4	3.22
294.9	295.0	0.1	-3.02	312.4	313.8	1.4	5.55
311.6	312.8	1.2	4.84	317.3	317.5	0.2	-3.14
315.6	316.9	1.3	-3.84	318.9	319.5	0.6	3.69
328.5	329.1	0.6	-4.13	325.6	327.2	1.7	4.45

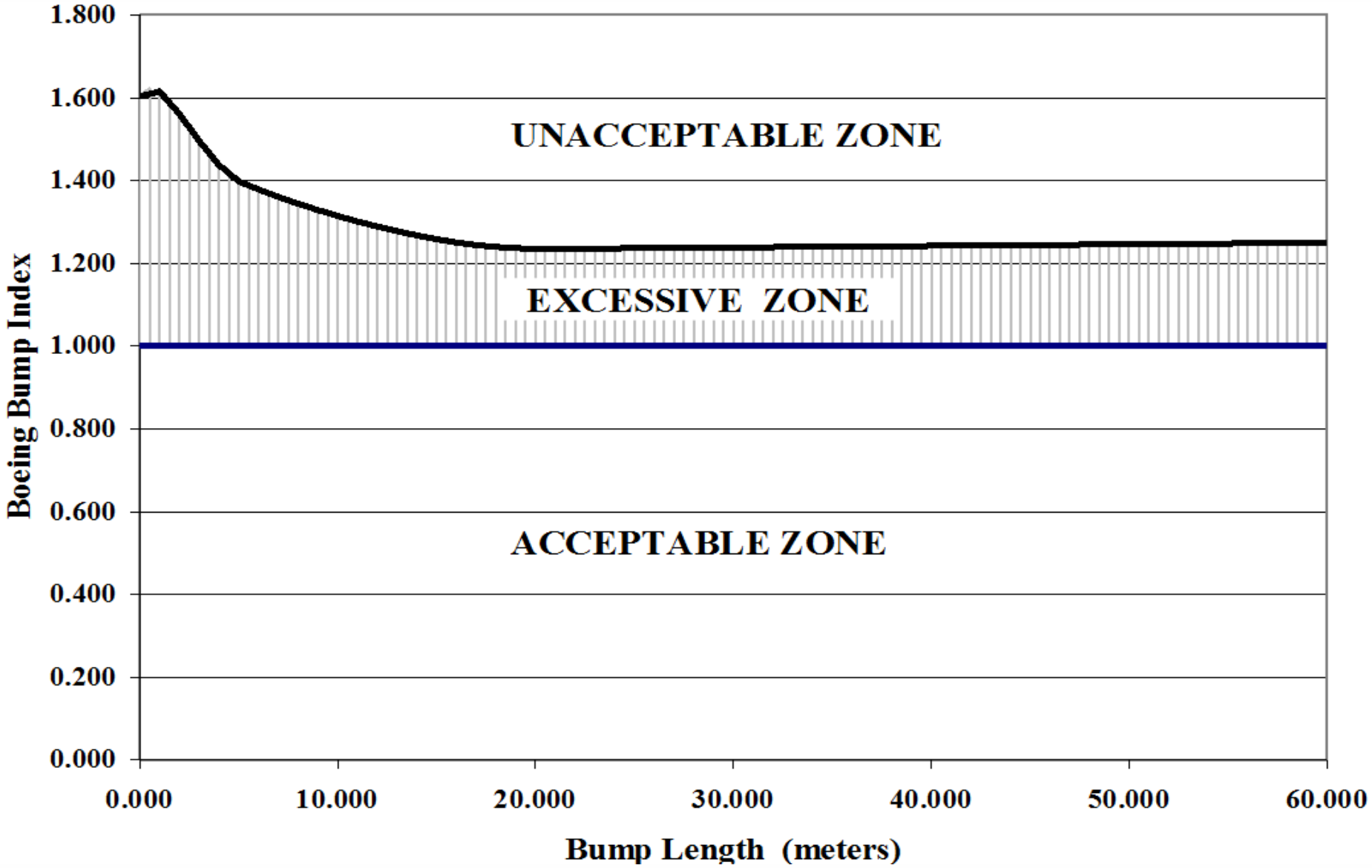
RSE ICAO ROUGHNESS CRITERIA



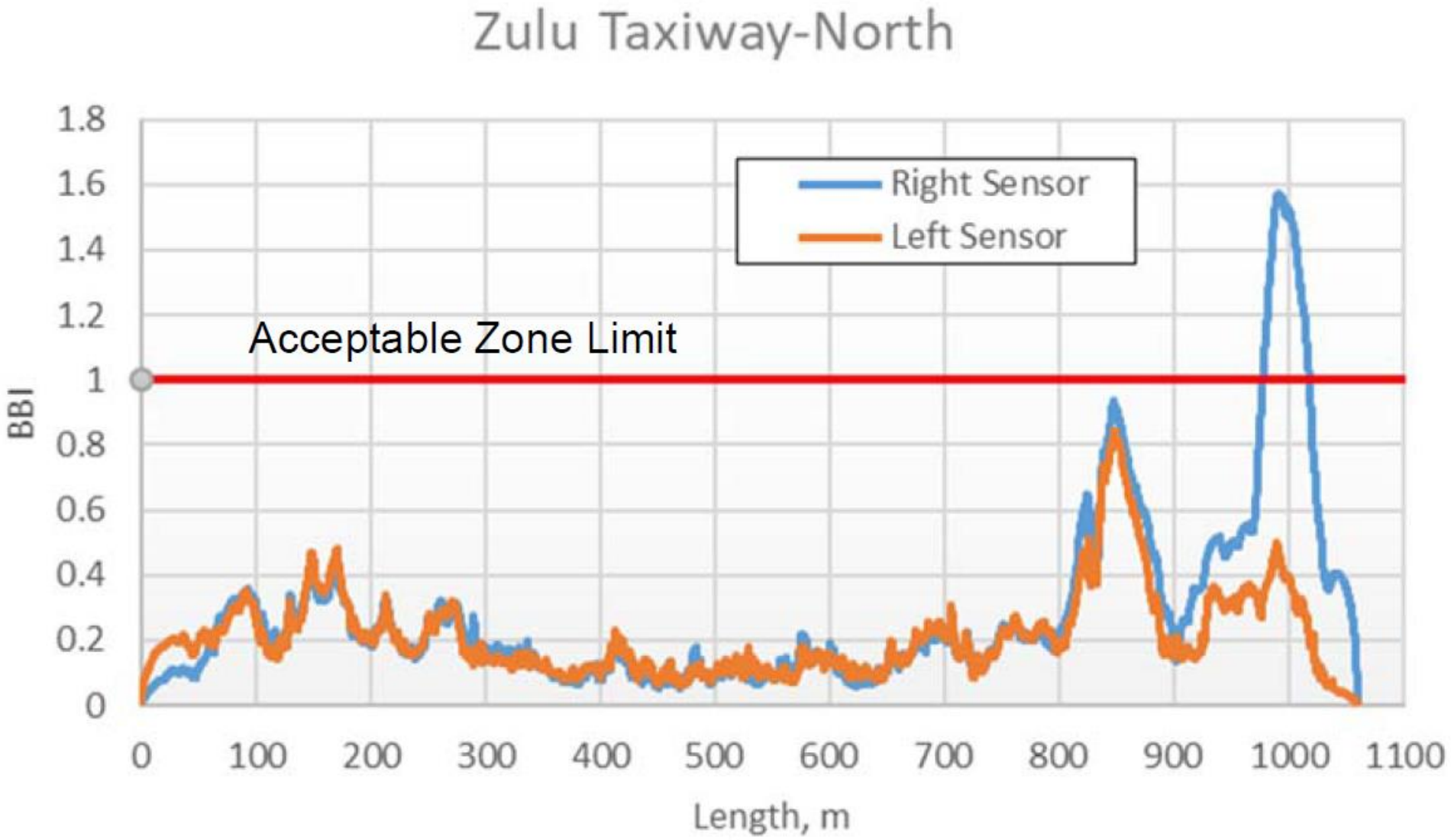
BOEING BUMP INDEX (BBI)

- **Single Event Bump:** are isolated events where changes in pavement elevation occur over a relatively short distance of 100 meters or less.

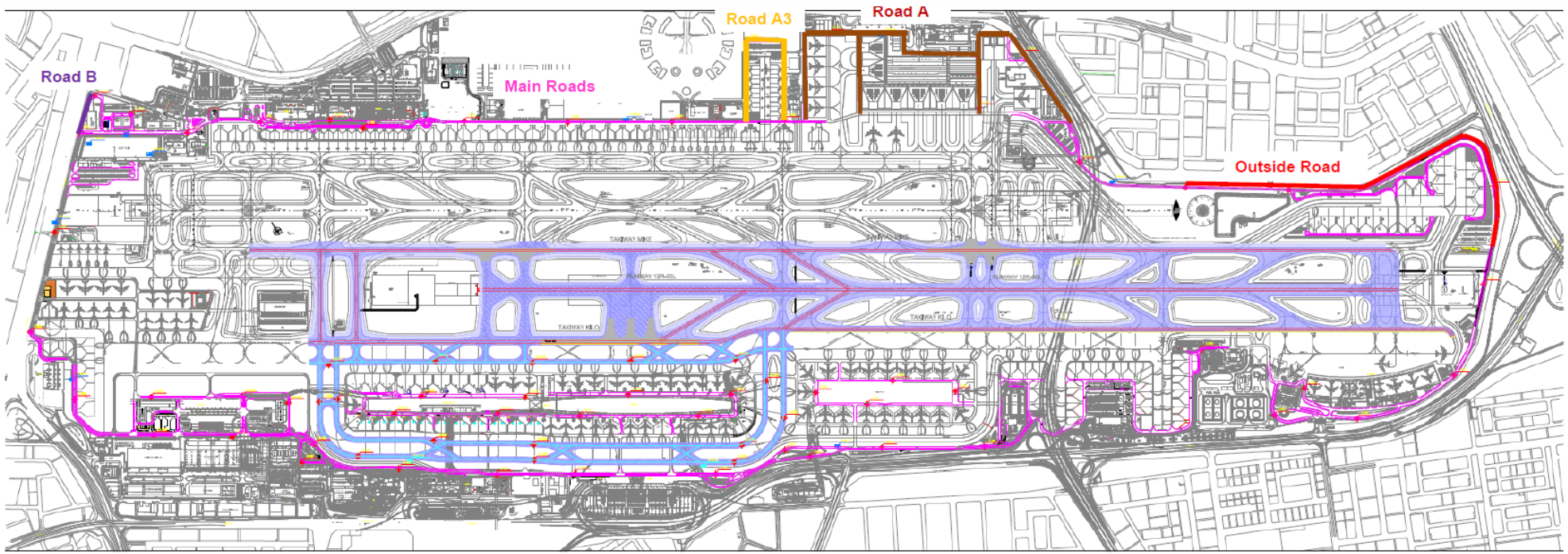
BBI – FAA Acceptance Criteria



VARIATION OF BBI VALUES

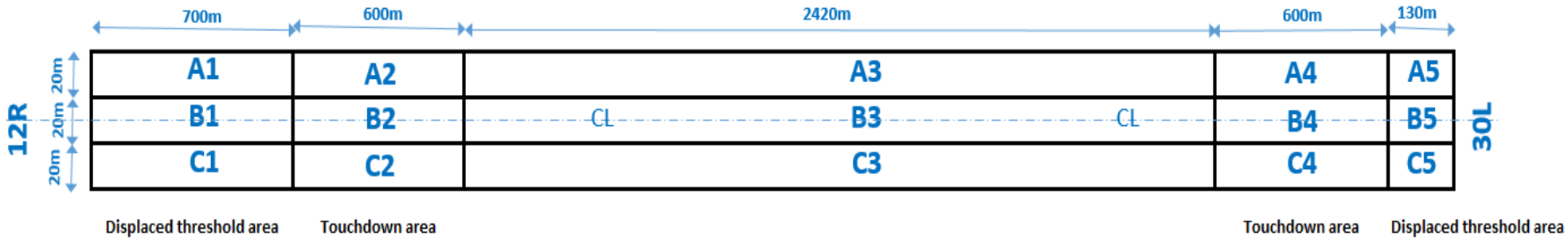


3- PAVEMENT CONDITION EVALUATION



SECTIONING OF PAVEMENTS

Runway



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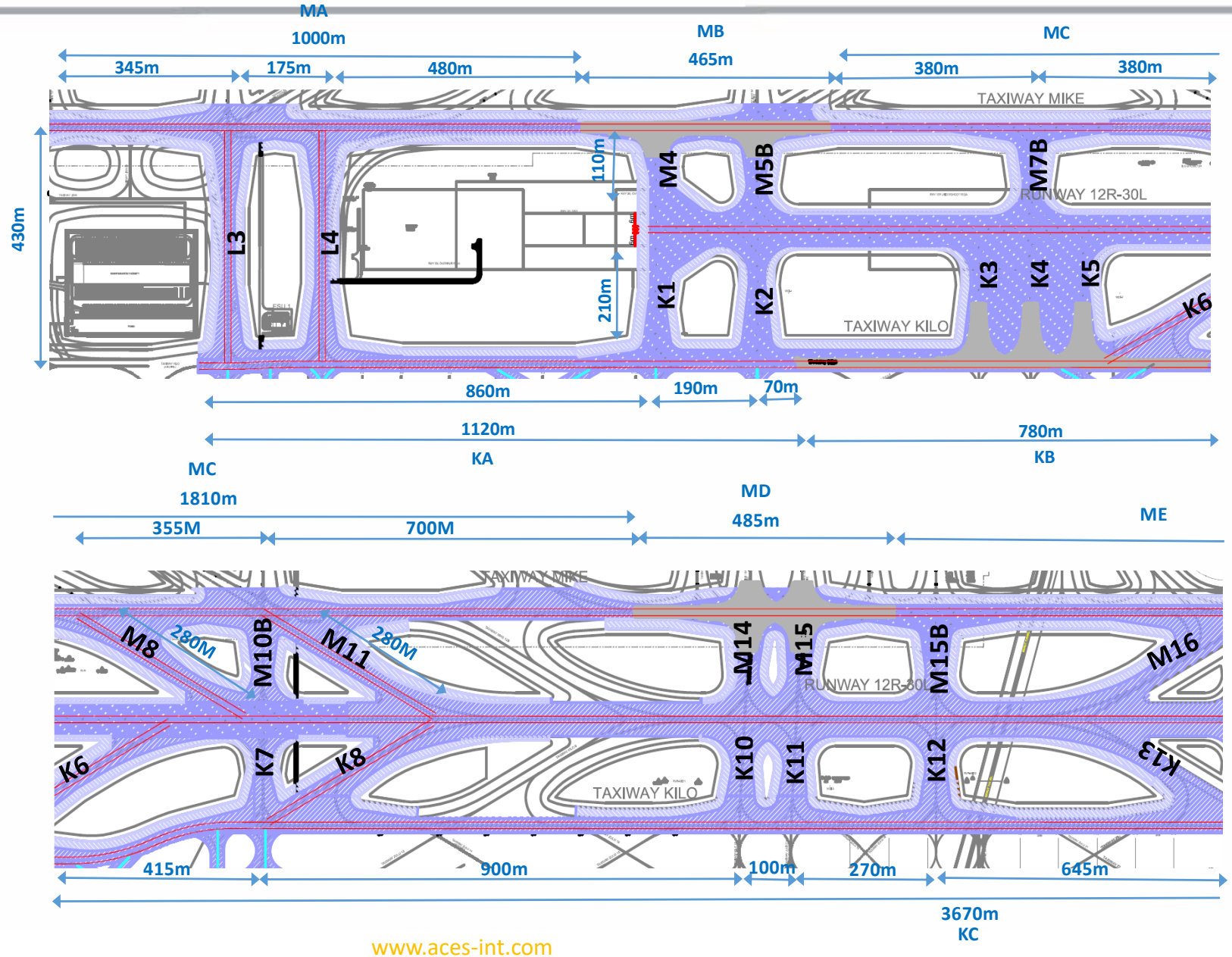
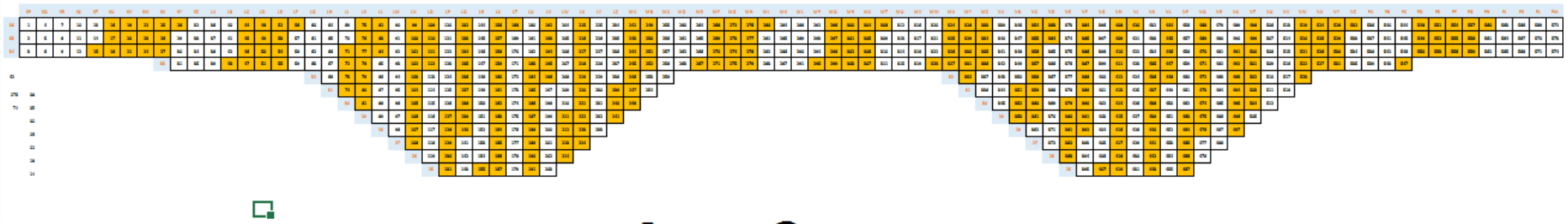
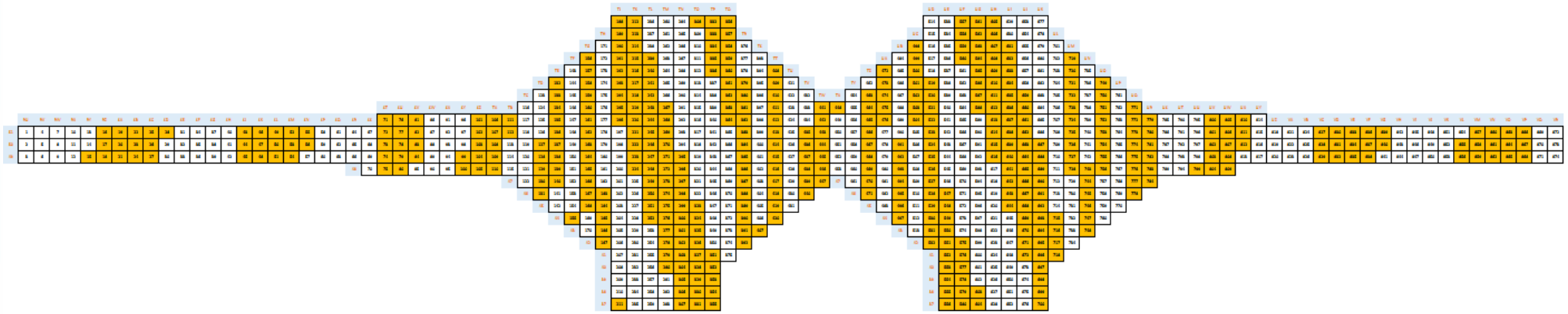


SECTIONING OF PAVEMENTS



Area 3

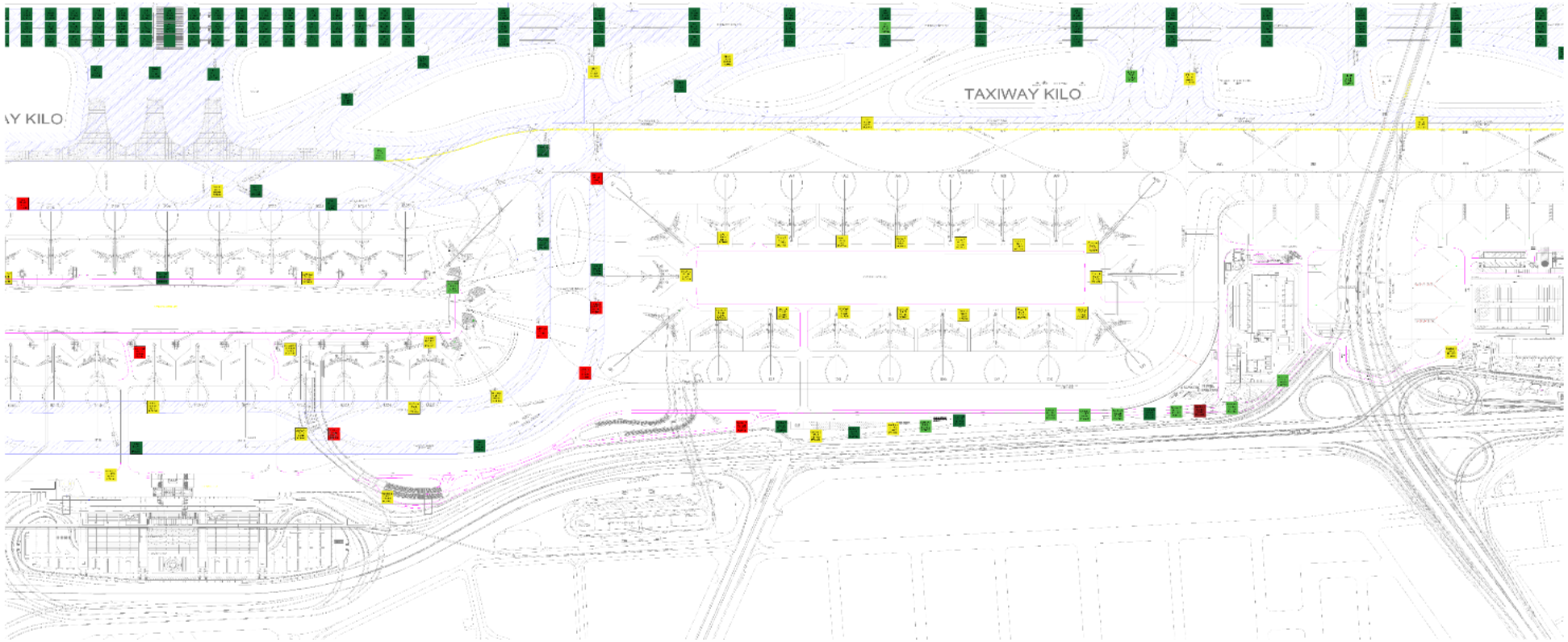


Area 1

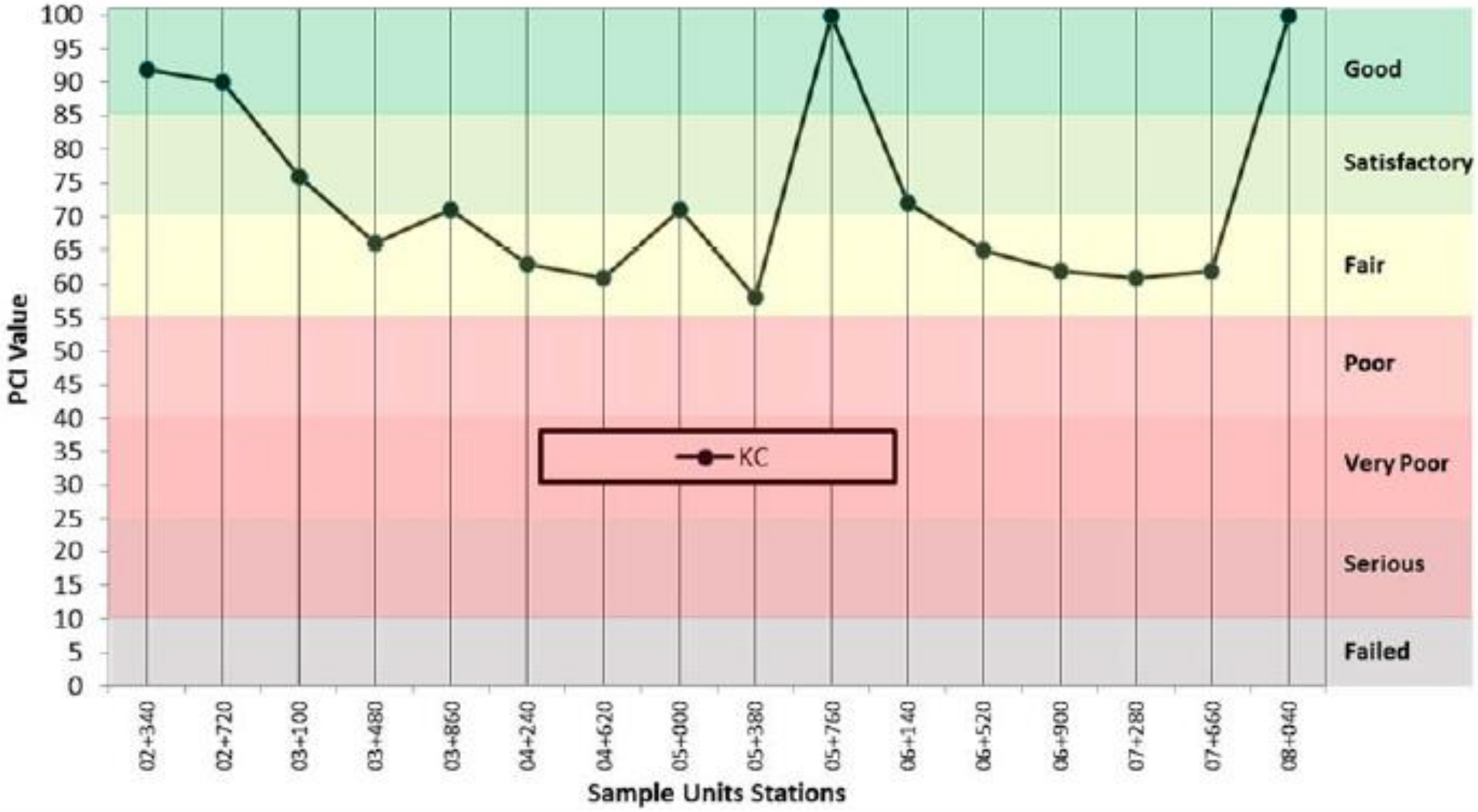
OBTAINED PCI RATINGS

Section ID	Sample Number	Station	PCI	Avg. PCI	Section ID	Sample Number	Station	PCI	Avg. PCI	Section ID	Sample Number	Station	PCI	Avg. PCI
MA	2	00+020	90*	85	MC	2	02+345	88	62	ME	2	05+705	96	94
	8	00+140	77			11	02+525	61			11	05+885	96	
	14	00+260	93			20	02+705	63			20	06+065	100	
	20	00+380	97			29	02+885	59			29	06+245	94	
	26	00+500	55			38	03+065	58			38	06+425	56	
	32	00+620	54			47	03+245	58			47	06+605	95	
	38	00+740	90			56	03+425	59			56	06+785	88	
	44	00+860	56			65	03+605	60			65	06+965	96	
	50	00+980	93			74	03+785	60			74	07+145	100	
	56	01+100	93			83	03+965	60			83	07+325	96	
	62	01+220	95			92	04+145	63			92	07+505	100	
	68	01+340	89			101	04+325	60			101	07+685	95	
	74	01+460	96			110	04+505	61			110	07+865	100	
	80	01+580	96			119	04+685	64			119	08+045	95	
	86	01+700	96			128	04+865	60			128	08+225	100	
	92	01+820	94			137	05+045	56			137	08+405	96	
											146	08+585	96	
KA	2	00+020	96	60	KC	2	02+340	92	73	O	2	00+020	100	72
	7	00+0120	71			21	02+720	90			34	00+660	56	
	12	00+0220	86			40	03+100	76			66	01+300	59	
	17	00+0320	52			59	03+480	66			98	01+940	93	
	22	00+0420	28			78	03+860	71			130	02+580	60	
	27	00+0520	55			97	04+240	63			162	03+220	86	
	32	00+0620	55			116	04+620	61			194 - Extra	03+560	29	
	37	00+0720	47			135	05+000	71			194	03+860	92	
	42	00+0820	44			154	05+380	58			226	04+500	34	
	47	00+0920	56			173	05+760	100			258	05+140	82	
	52	01+020	68			192	06+140	72			290	05+780	59	
	57	01+120	51			211	06+520	65			322	06+420	98	
	62	01+220	52			230	06+900	62			354	07+060	96	
	67	01+320	51			249	07+280	61			386	07+700	60	
	72	01+420	59			268	07+660	62			418	08+340	50	
	77	01+520	89			287	08+040	100			450	08+980	60	
											482	09+620	87	
											514	10+260	89	

DISTRIBUTION OF PCI RATINGS



DISTRIBUTION OF PCI RATINGS



DISTRESSES QUANTITIES

Section ID	Sample Number	PCI	Description	Severity	Quantity	Unit
A1	2	91	LONGITUDINAL & TRANSVERSE CRACKING	L	30	Meter
			WEATHERING	L	5	Square Meter
	4	96	LONGITUDINAL & TRANSVERSE CRACKING	M	2	Meter
	6	91	LONGITUDINAL & TRANSVERSE CRACKING	L	15	Meter
			WEATHERING	M	24	Square Meter
	8	91	LONGITUDINAL & TRANSVERSE CRACKING	L	20	Meter
			WEATHERING	M	18	Square Meter
	10	95	LONGITUDINAL & TRANSVERSE CRACKING	L	7	Meter
			WEATHERING	L	4	Square Meter
	12	93	LONGITUDINAL & TRANSVERSE CRACKING	L	15	Meter
			WEATHERING	M	2	Square Meter
	14	96	LONGITUDINAL & TRANSVERSE CRACKING	L	9	Meter
	16	92	LONGITUDINAL & TRANSVERSE CRACKING	L	10	Meter
			WEATHERING	H	1	Square Meter
	18	93	LONGITUDINAL & TRANSVERSE CRACKING	L	25	Meter

BRANCHES/SECTIONS PCI RATINGS

Network ID	Branch ID	Section ID	Surveying Date	Surface Type	Average PCI	PCI Categ
One (Runway)	One (Southern Runway)	A1	19/04/2017	Asphalt	96	Good
		A2	19/04/2017	Asphalt	99	Good
		A3	25/04/2017	Asphalt	98	Good
		A4	18/04/2017	Asphalt	99	Good
		A5	18/04/2017	Asphalt	98	Good
		B1	19/04/2017	Asphalt	95	Good
		B2	19/04/2017	Asphalt	100	Good
		B3	25/04/2017	Asphalt	91	Good
		B4	18/04/2017	Asphalt	70	Satisfacto
		B5	18/04/2017	Asphalt	99	Good
		C1	19/04/2017	Asphalt	95	Good
		C2	19/04/2017	Asphalt	98	Good
		C3	25/04/2017	Asphalt	97	Good
		C4	18/04/2017	Asphalt	99	Good
		C5	18/04/2017	Asphalt	99	Good
	Two (Runway-Taxiways)	MA	20/04/2017	Asphalt	86	Good
		MB	20/04/2017	Concrete	92	Good
		MC	20/04/2017	Asphalt	60	Fair
		MD	30/5/2017	Concrete	89	Good
		ME	20/04/2017	Asphalt	88	Good
		KA	18/04/2017	Asphalt	60	Fair
		KB	24/04/2017	Concrete	94	Good
		KC	19/04/2017	Asphalt	66	Fair
	Three (Runways Taxi Links)	Kilo 1	18/04/2017	Asphalt	56	Fair
		Kilo 2	18/04/2017	Asphalt	51	Poor
		K3b	19/04/2017	Asphalt	92	Good
		K4b	19/04/2017	Asphalt	89	Good
		K5b	19/04/2017	Asphalt	96	Good
		Kilo 7	19/04/2017	Asphalt	58	Fair
		Kilo 10	19/04/2017	Asphalt	71	Satisfacto
		Kilo 11	19/04/2017	Asphalt	61	Fair
		Kilo 12	19/04/2017	Asphalt	71	Satisfacto
		Kilo 14	19/04/2017	Asphalt	72	Satisfacto
		Kilo 16	19/04/2017	Asphalt	62	Fair
		Kilo 17	19/04/2017	Asphalt	100	Good

Services that can be Offered by ACES

Services Offered by ACES

- Structural design of flexible and rigid pavements for highways and airports
- Development of pavement maintenance management systems
- Evaluation of asphalt concrete construction materials and required modification methods
- Conduct highly specialized training courses
- Conduct Pavement Performance Evaluations

Thank You

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