Airport Pavement Management: A Case Study of Applied Research

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CENTRE FOR PAVEMENT AND TRANSPORTATION TECHNOLOGY

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OUTLINE

- Introduction and Background
- Material Characterization
- Pavement Design
- Field Investigations
- Airport Asset Management
- Innovations and Future Opportunities

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CPATT Goals

1. CPATT's initiative involves an integrated program of field and laboratory research.
2. Focus on emerging and innovative technologies.
3. State-of-the-art research infrastructure.
4. Increase in the talent pool of HQP.
5. Sustained partnerships.
6. Provide national and international leadership.

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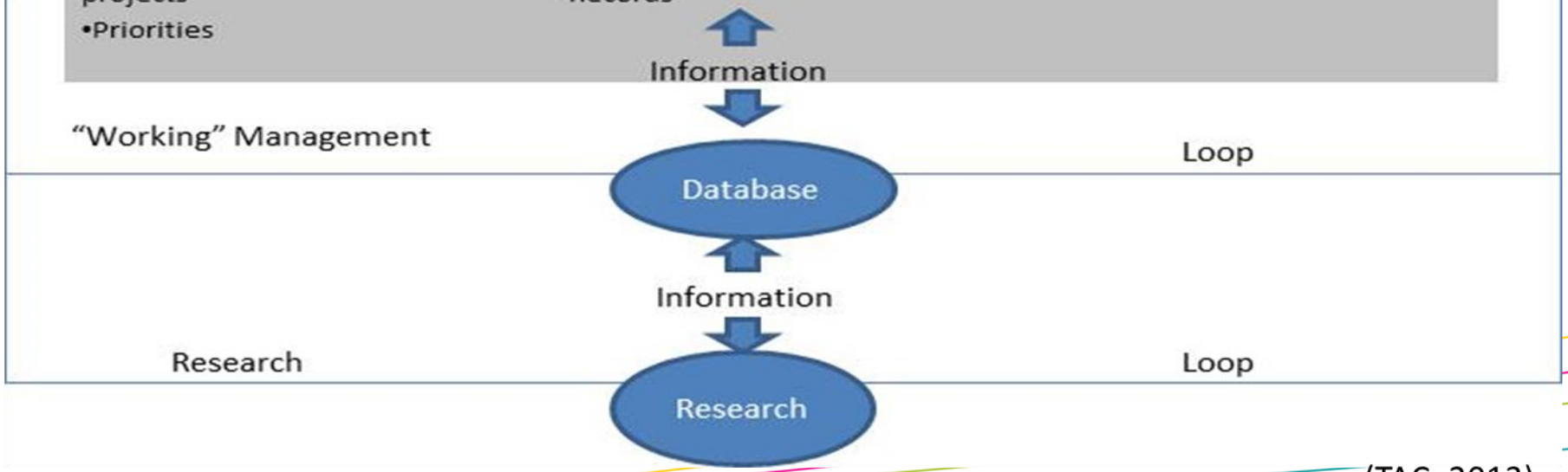
CPATT Values

1. Commitment to high quality research that advances theory and contributes to engineering practice or policy development.
2. Foster a community that promotes research and development of students, faculty and partners.
3. Support multidisciplinary and interdisciplinary research.
4. Facilitate commitment to making research findings and their implications available in formats that target the needs of different audiences.
5. Be responsive to research needs.

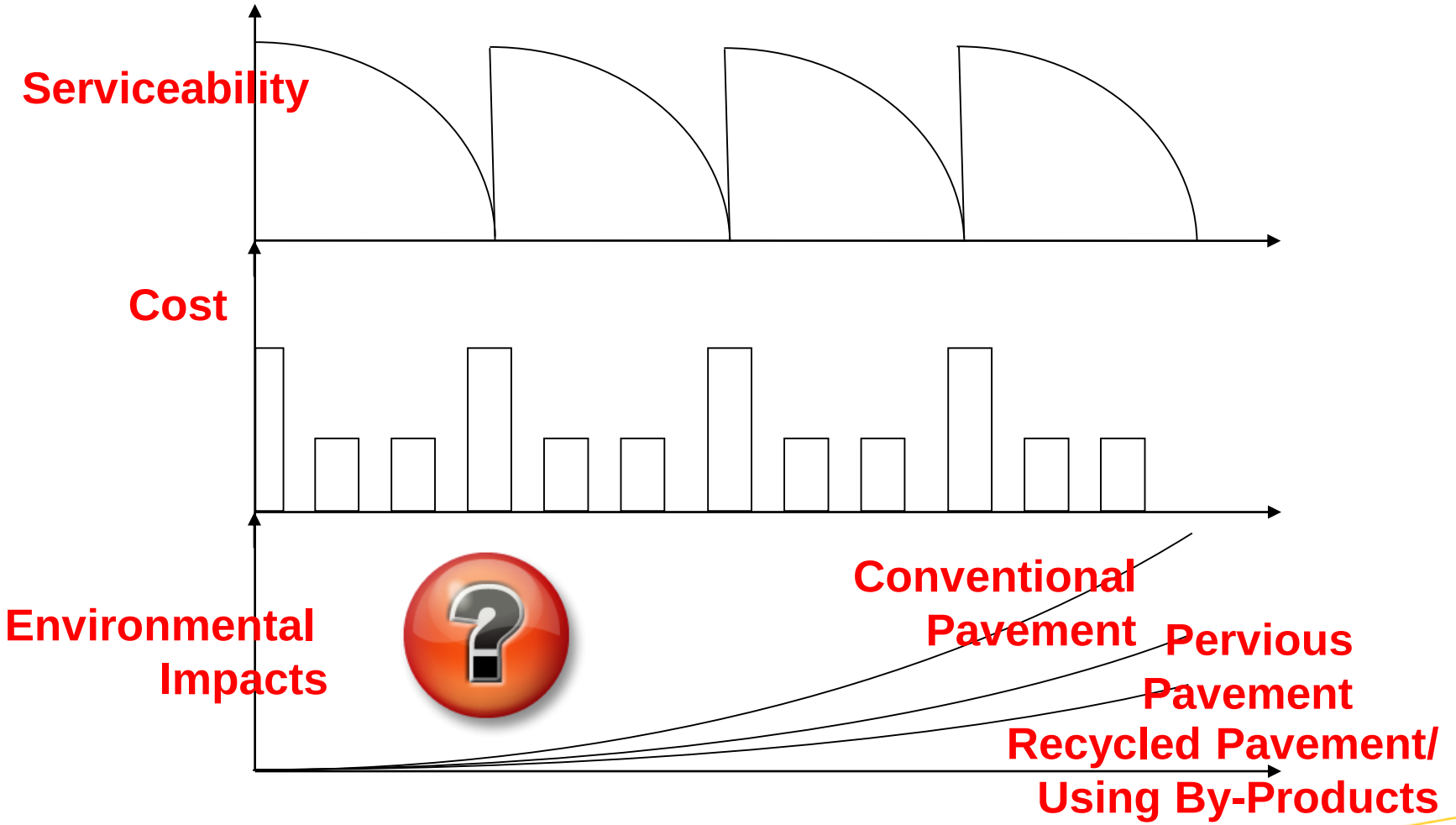
Key Theme Areas

- Climate Change Impacts on Infrastructure
- Sustainability Incorporated into Design, Construction, Maintenance, Management
- Investment balances: Preservation and Expansion
- Allocate Budgets: Satisfy Organization Needs, Customer Requirements, Meet Performance Expectations

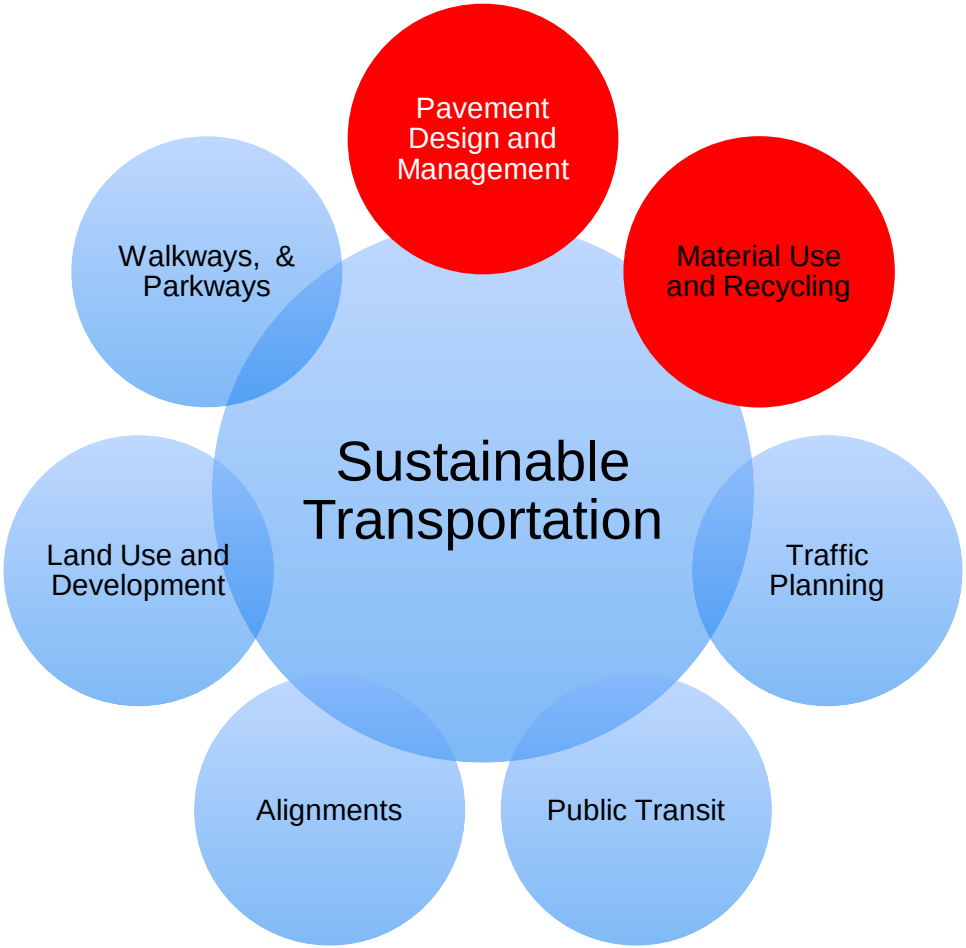
Planning and Programming	Design	Construction	Maintenance, Preservation and Rehabilitation	In-Service Evaluation	End of Service Life
•Traffic and Environmental data information •Assess network deficiencies •Budgets •Establish priorities •Schedule projects •Priorities	•Information on materials, traffic, costs, environment, etc. •Design alternatives •Analysis •Optimization •Sustainability •User costs	•Environment during construction •Specifications •Contracts •Schedules •Construction operations •Quality control/quality assurance •Records	•Standards •Treatments •Schedules •Operations •Budget control •Records •Impact on performance •User costs	•Periodic monitoring of structural adequacy, roughness, surface distress, and surface friction •Assess performance •Prioritize	•Recycling and reuse of materials for reconstruction •Salvage Value •Records •Restoration •Zero Waste Management



(TAC, 2013)


Serviceability
Cost
Environmental Impacts
Conventional Pavement
Pervious Pavement
Recycled Pavement/ Using By-Products

(Tighe, 2010)



Sustainable pavement is a subset of sustainable transportation

Main focus on Pavement Design and Management; and Material Use and Recycling

Material Characterization

- Critical shortage of high-quality aggregate
- Increasing amount of demolished concrete
- Produced concrete containing RCA with the desired 32+ MPa strength
- Possible applications in structural and non-structural concrete

Smith, Butler, Pickel

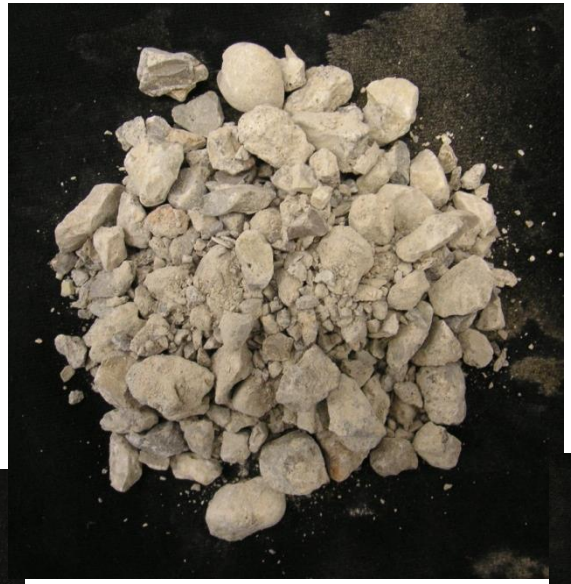
Material Characterization

Natural Aggregate Particle Shape

RCA Type 1 Surface Texture

Material Characterization

Natural Aggregate
ACV = 18.2

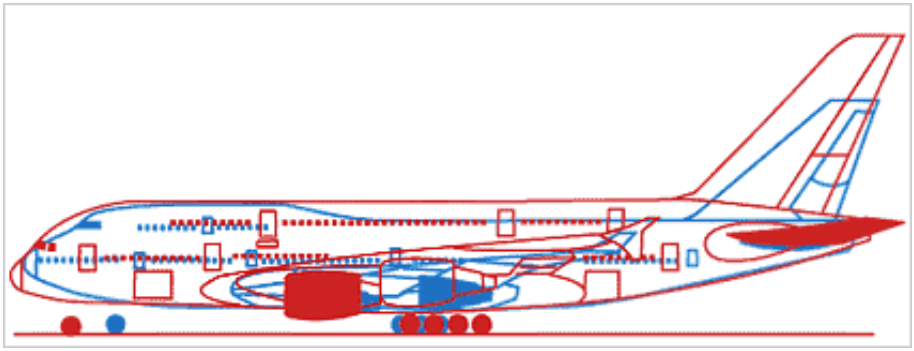


RCA-1
ACV = 23.1

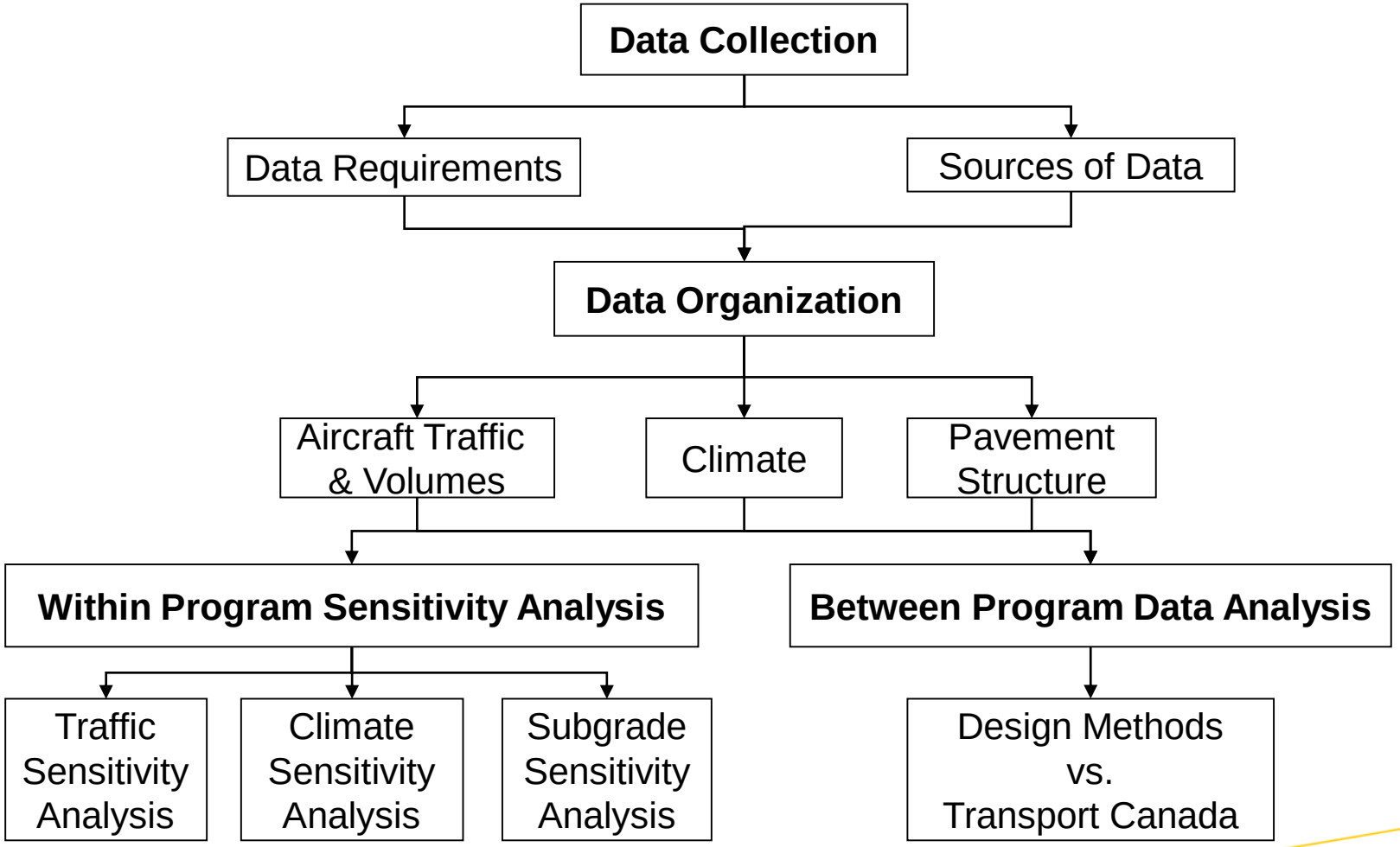
RCA-2
ACV = 26.0

Material Characterization

Heavy Aircrafts



Sensitivity of Design Parameters



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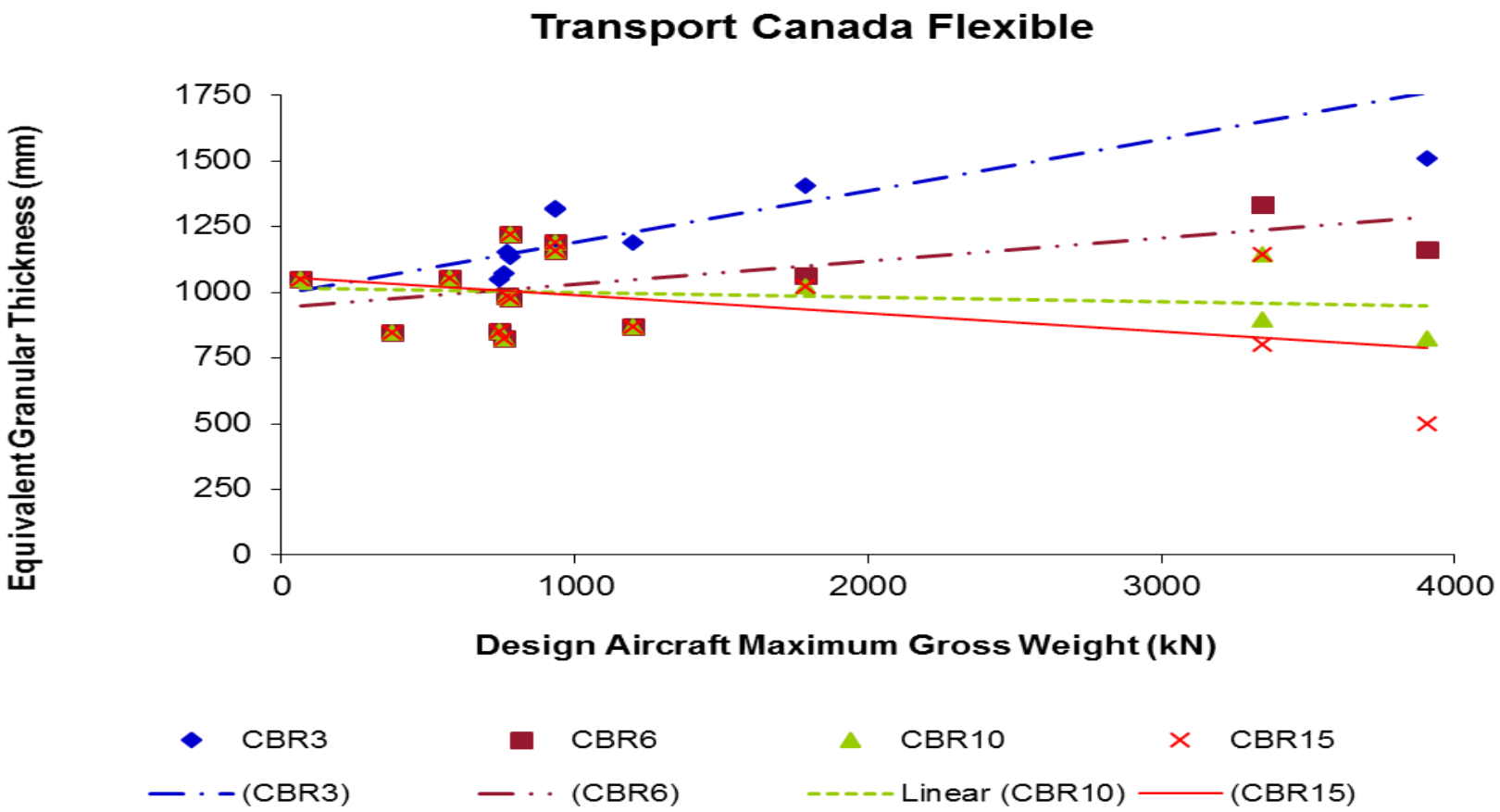

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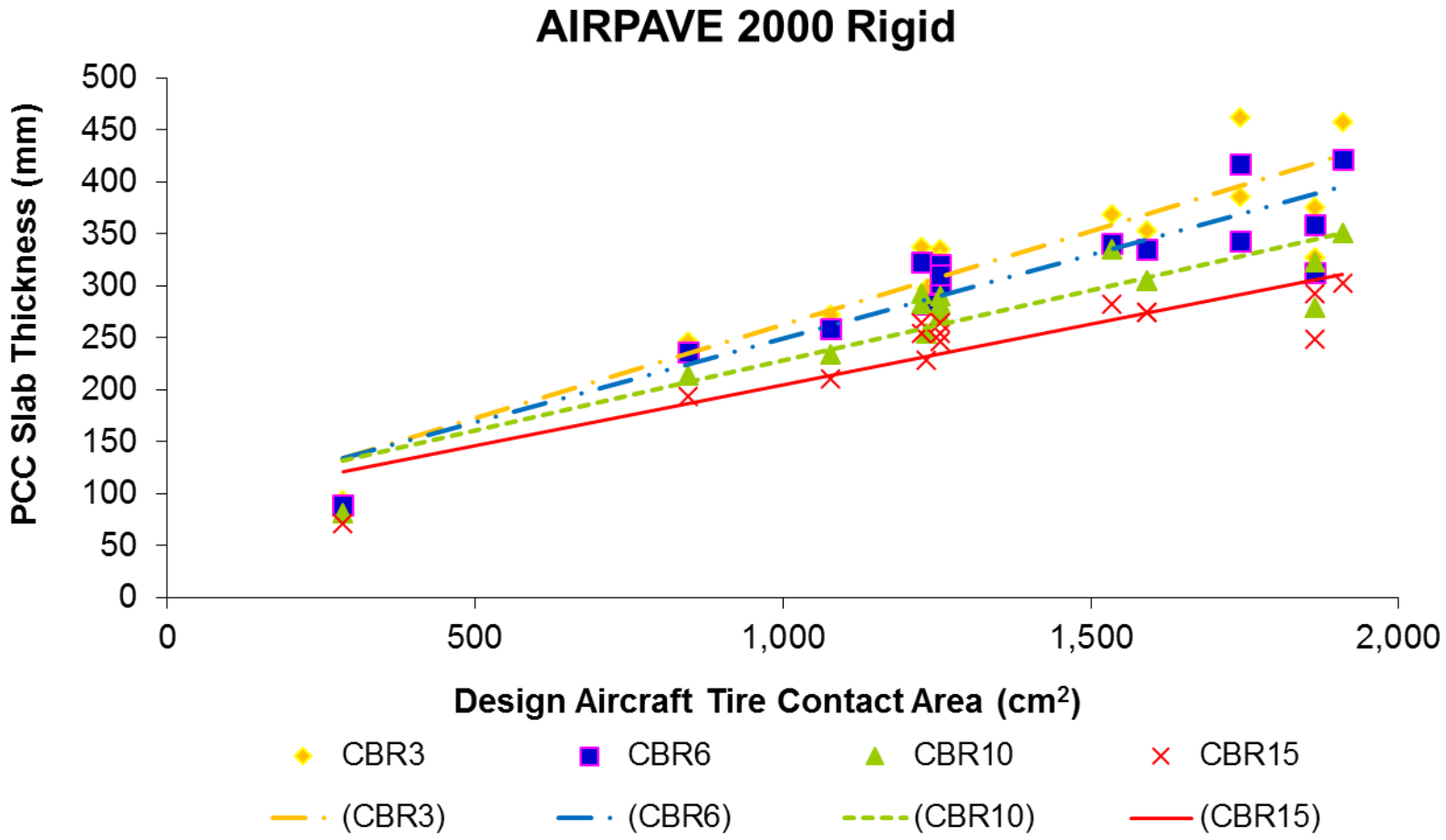

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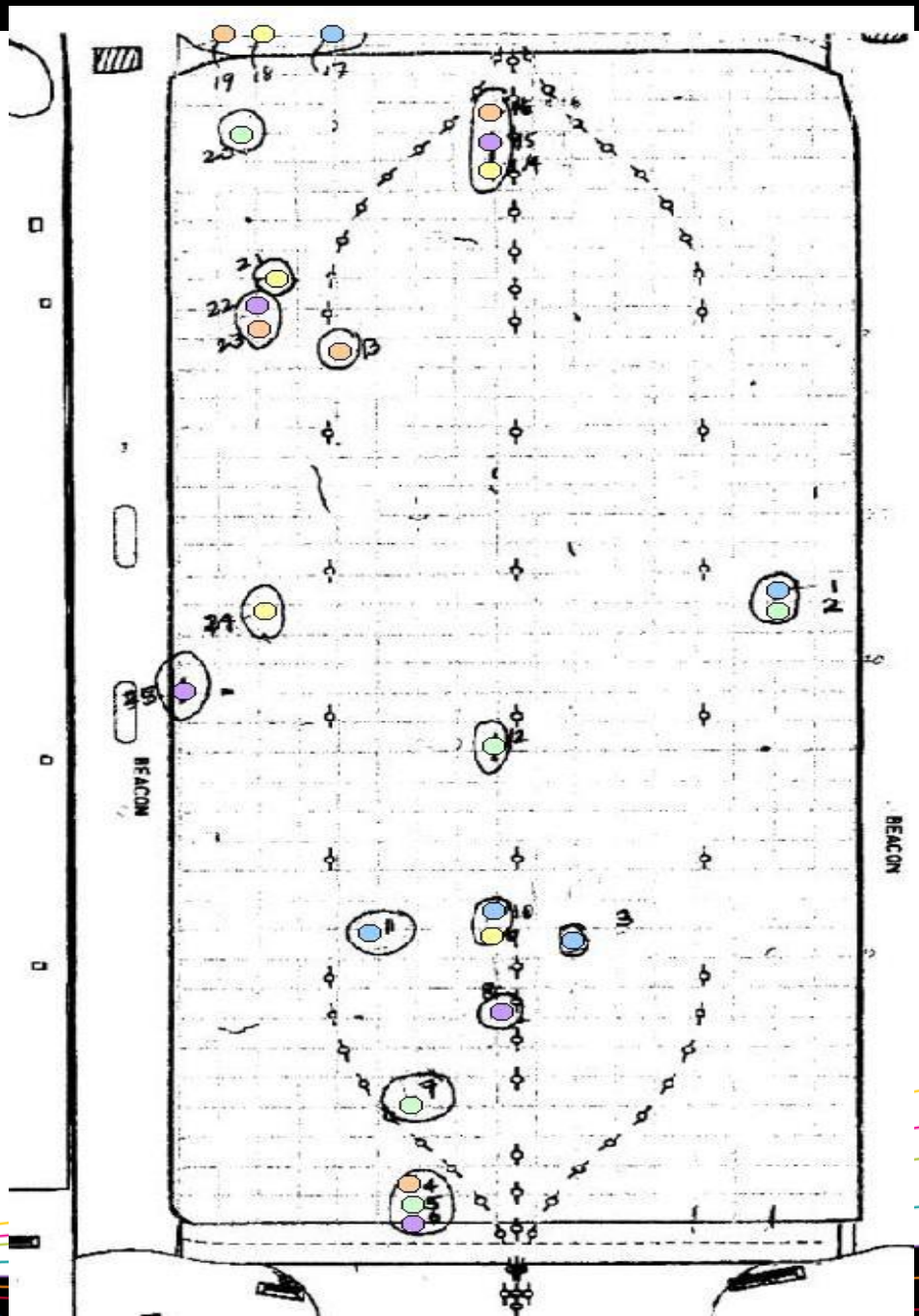
Sensitivity of Design Parameters

- Pavement thickness increases dramatically once the subgrade is reduced to a CBR of 6 (weak subgrade strength)
- LEDFAA, FEDFAA, SW-1, APSDS more sensitive to subgrade (vs. traffic)
- Complete review of design methods to ensure appropriate for Canadian airports

Fast Track Concrete Repairs

Smith

Fast Track Concrete Repairs



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1.0	**COMPANY NAME:**			
	1.1	COMPANY ADDRESS (Ontario?)		
	1.2	COMPANY WEBSITE		
	1.3	COMPANY CONTACT NAME		
	1.4	TELEPHONE		
	1.5	FAX		
	1.6	EMAIL		
2.0	**General Information**			**Check**
	2.1	Major market interest/Product line		
	2.2	Proposed research product		
	2.3	Proposed product performance/benefit		
	2.4	Distribution Method (within the province or use an agent?)		
3.0	**Airside Experience**			
	3.1	Number of years installing product airside		
	3.2	Number of airside projects completed		
	3.3	When were airside projects completed		
	3.4	Where were airside projects completed		
	3.5	Any airside safety related incidents		
4.0	**Project References (airport employee preferred)**			
	4.1	Airports where installed previously		
	4.2	Project name/type		
	4.3	Project Scope		
	4.4	Project Cost		
	4.5	Project Manager (airport employee or consultant)		
	4.6	Telephone/email		
	4.7	Airfield Maintenance Contact (airport employee)		
	4.8	Telephone/email		
5.0	**Technical Information**			
	5.1	Product Physical Properties:	a. compressive/flexural strength	
			b. bond strength	
			c. thermal expansion	
			d. freeze thaw resistance	
			e. scaling resistance	
			f. set time	
			g. abrasion resistance	
	5.2	Product technical drawings		
	5.3	Specification/installation/construction methods		
	5.4	Creditability of technology i.e. publications, reports, and awards		
	5.5	Research affiliations with other airports/organizations		

Fast Track Concrete Repairs

Fast Track Concrete Repairs Analysis

- Analytic Hierarchy Process (AHP)
- 15 characteristics identified with the help of the GTAA and weights assigned
- Three priority categories
- High (8-10)
- Medium (5-7)
- Low (1-4)
-

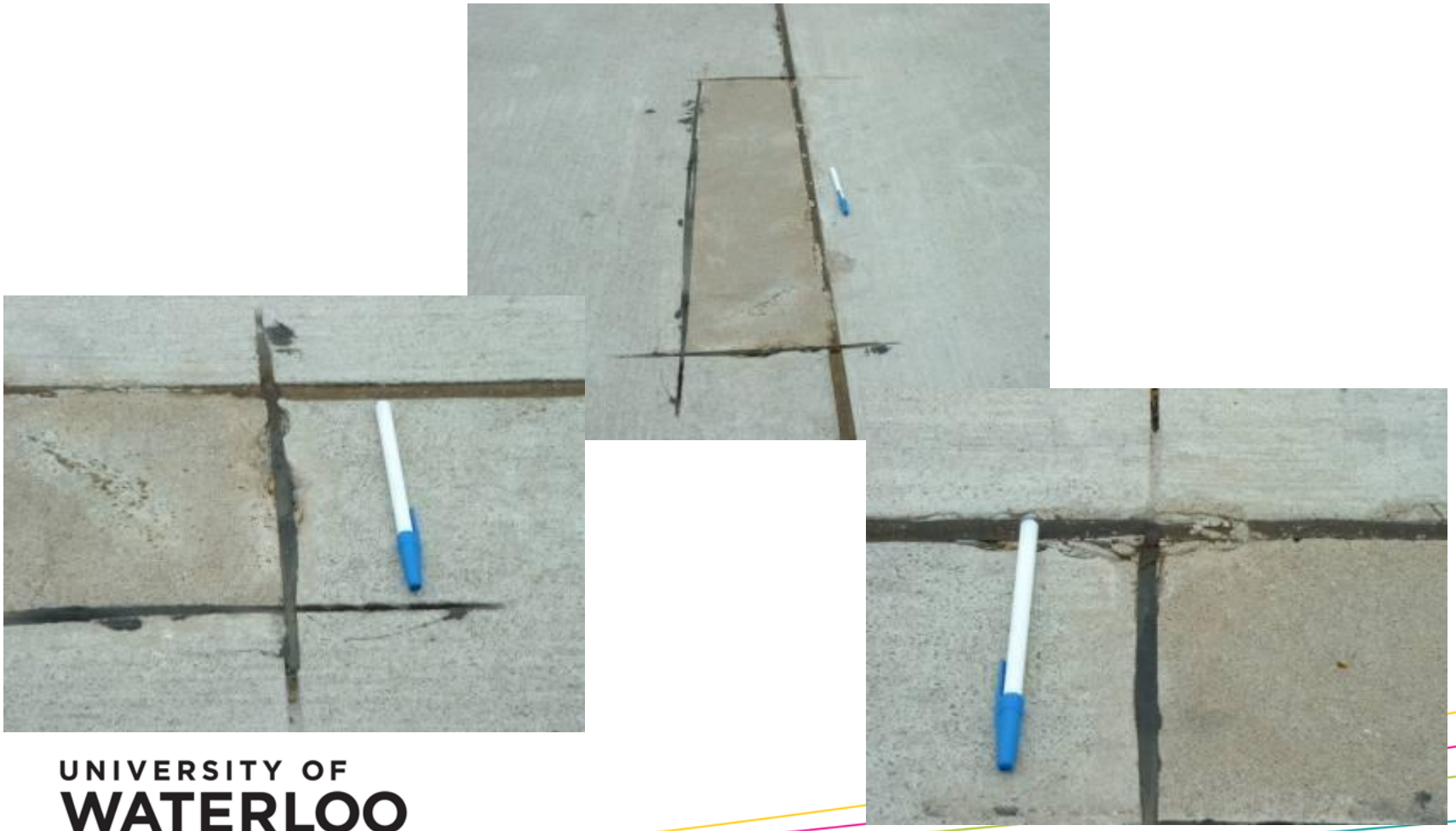
Priority	Criteria
High (8-10)	Mixing Time (10) Time Until Traffic (10) Temperature Range (9) Initial Set Time (9) Ease of Placement (9) Cost (9) Degree of Difficulty (8)
Medium (5-7)	Patch Preparation (6) Equipment Required (5) Crew Size (5)
Low (1-4)	Aggregate Extension (4) Required Finishing (3) Recyclabe Material (3) Aesthetics Scale (2) Technical Data (1)

Fast Track Repairs

Evaluation of 25 test sections

Fast Track Repairs

Evaluation of 25 test sections



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Summary of Fast Track Study

- Identify causes of the existing distress
- Manufacturer Evaluation Form is a useful first screening tool for product selection
- Examine technical/non-technical benefits of current products and compare to new products
- Field test proved products are appropriate for time sensitive partial depth concrete repairs

Effect of Rubber Build Up

Effect of Rubber Build Up

- Pavement texture and contaminant removal are crucial to safe aircraft landings/takeoffs.
- Cold climates: snow/ice decrease runway friction and braking effectiveness.
- Can create slippery conditions for aircrafts, impact pavement drainage, increasing the risk of aircrafts hydroplaning.

Effect of Rubber Build Up

- Chemical Removal
- Water blasting
- Shotblasting
- Mechanical Removal

Summary Rubber Build Up Treatment

- Location and access to equipment
- Cost of treatment
- Effectiveness could depend on weather
- Timing of treatment was important
- Different airports favored different treatments

Northern Canadian Airport

- Effects of Climate Change on the Runway 07-25
- Located above 58th parallel, southern limit of discontinuous permafrost distribution

Konarski

Northern Canadian Airport

Brooming Equipment

Field Site Visit 2012

Northern Canadian Airport

- Airport had safety concerns with runway surface friction and frequent amount of required winter maintenance
- Extensive friction/texture field testing program and analysis required to help in development of a cost effective friction restoration treatment

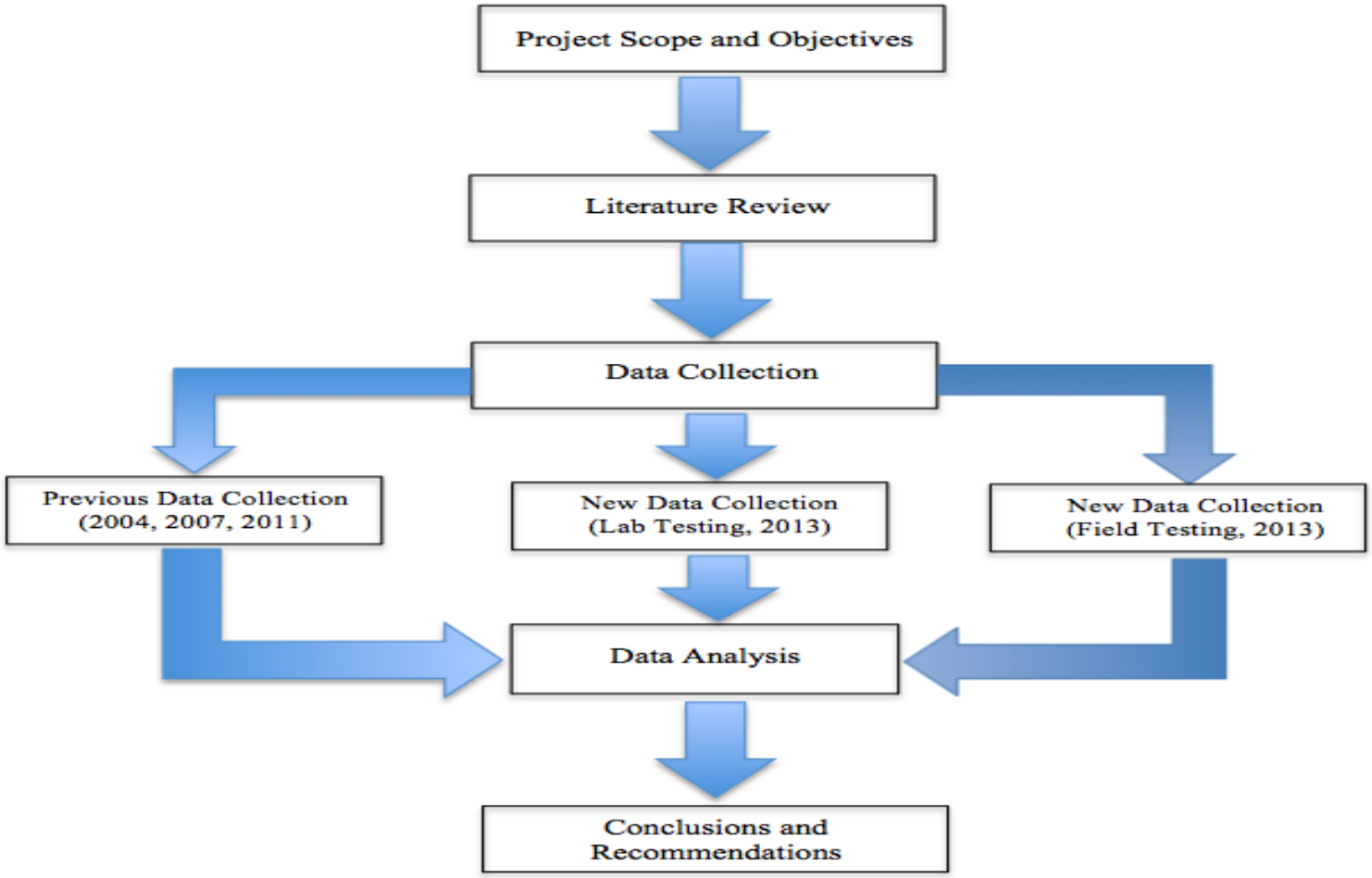
Northern Canadian Airport

- Fluctuations in ambient temperatures, Increased precipitation levels
- Ice cover diminishing on River, fog generation
- Fog condenses and freezes on runway
- Augmented requirement for winter maintenance activities (chemical and mechanical)

Northern Canadian Airport

- Increased winter maintenance (brooming) result in decreases in microtexture and friction, and increases in macrotexture
- Runway experiencing excessive bumps due to differential frost heave. The bumps were occurring as a result of non-uniformity in the frozen ground

Northern Canadian Airport



Northern Canadian Airport

- Laboratory Testing
  - Extraction and Gradation
  - Bulk Relative Density
  - Maximum Relative Density
  - Air Voids
  - Flow
  - Stability
  - Voids in Mineral Aggregate
  - In-situ Pavement Compaction Determination
  - PGAC Classification
  - British Pendulum Testing

Northern Canadian Airport

Field Testing Grip Tester

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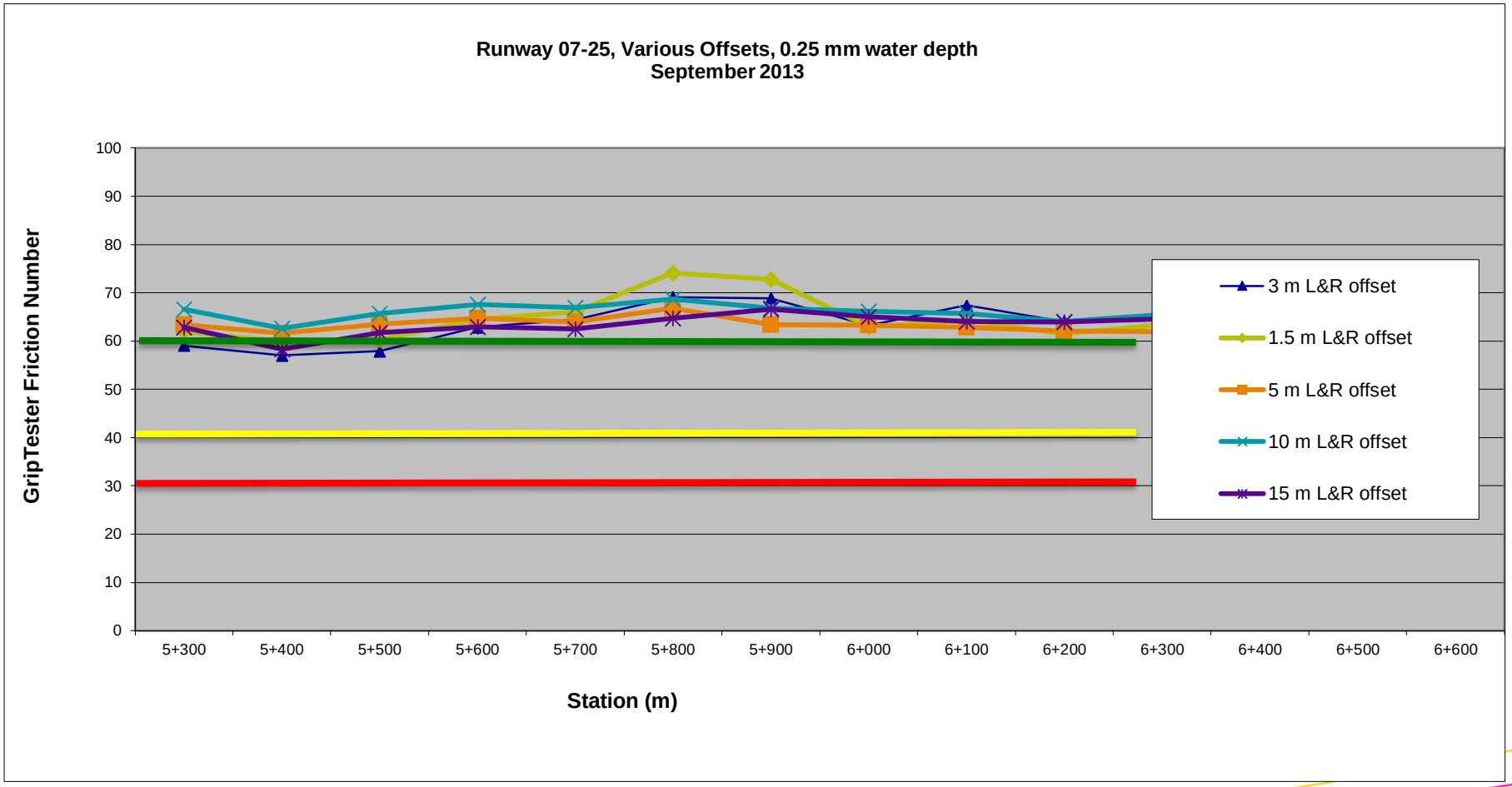
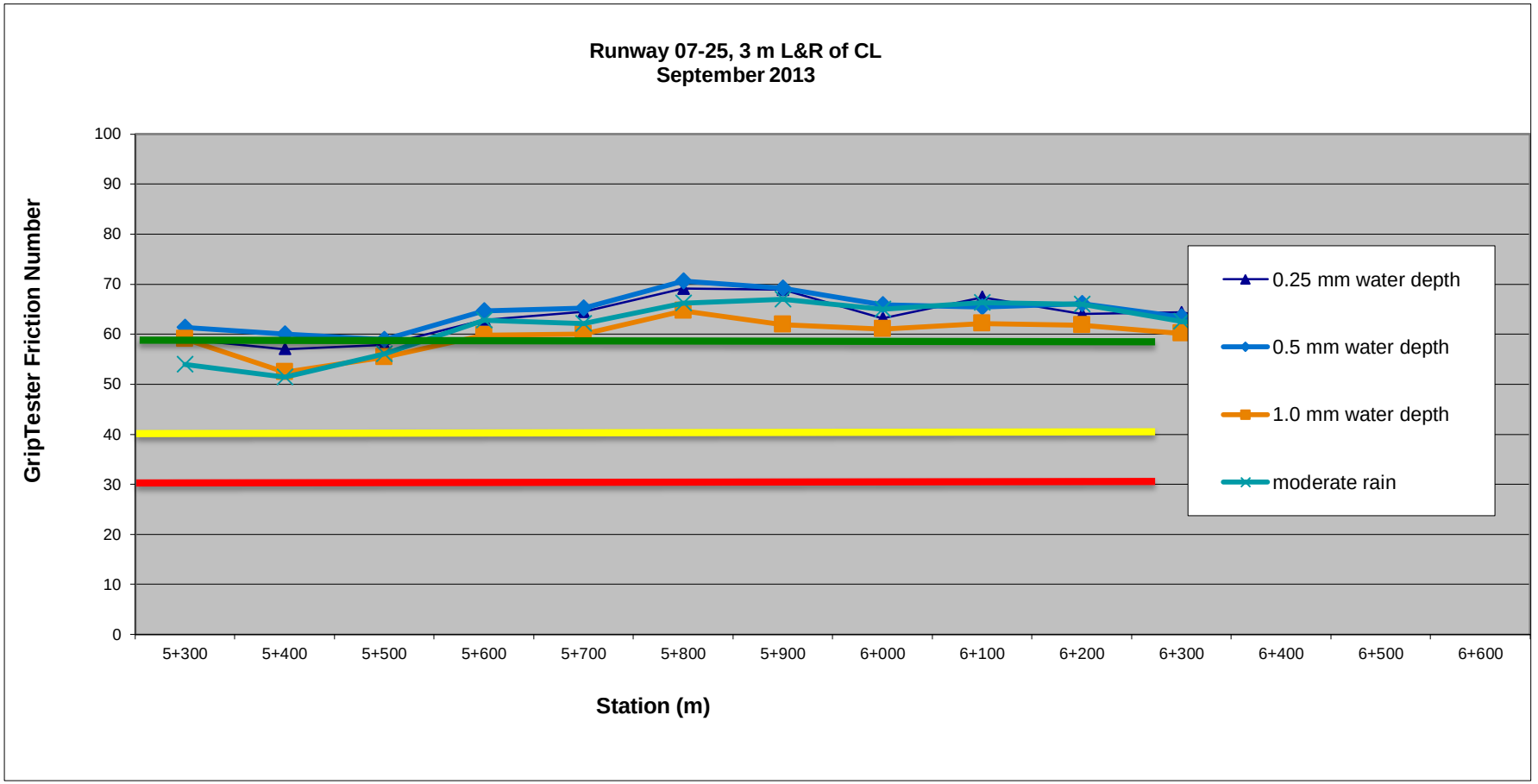
Northern Canadian Airport

- Previous testing data includes:
- Outflow Meter test (2004, 2007 and 2011) at centreline and at various offsets from centreline
- Friction testing (GripTester measurements from 2004, 2007 and 2011) at various offsets from centreline and varying water depths

Grip Tester Data



Grip Tester Results



3 m Left and Right Offsets from Centreline

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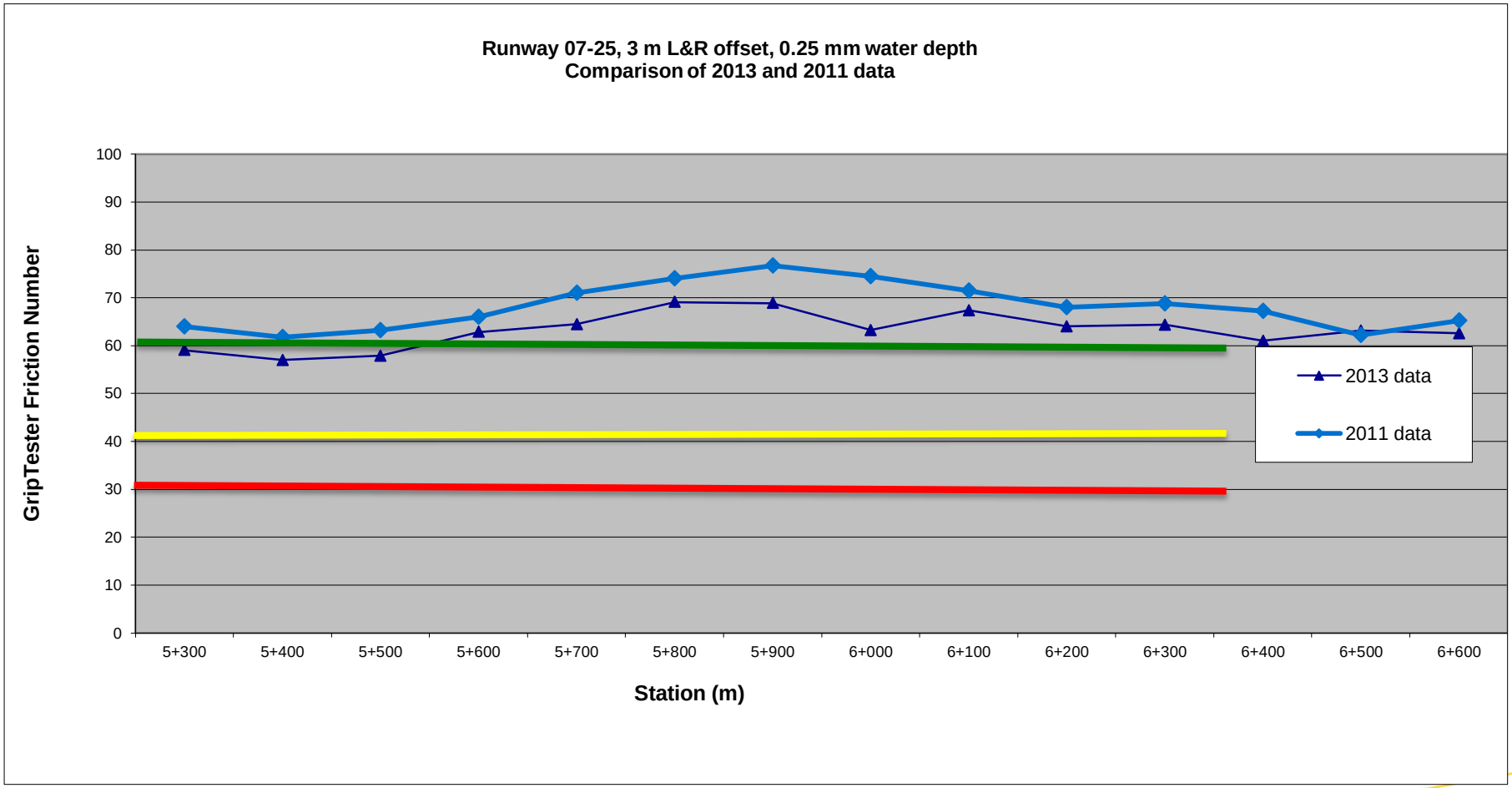
Grip Tester Changes Over Time



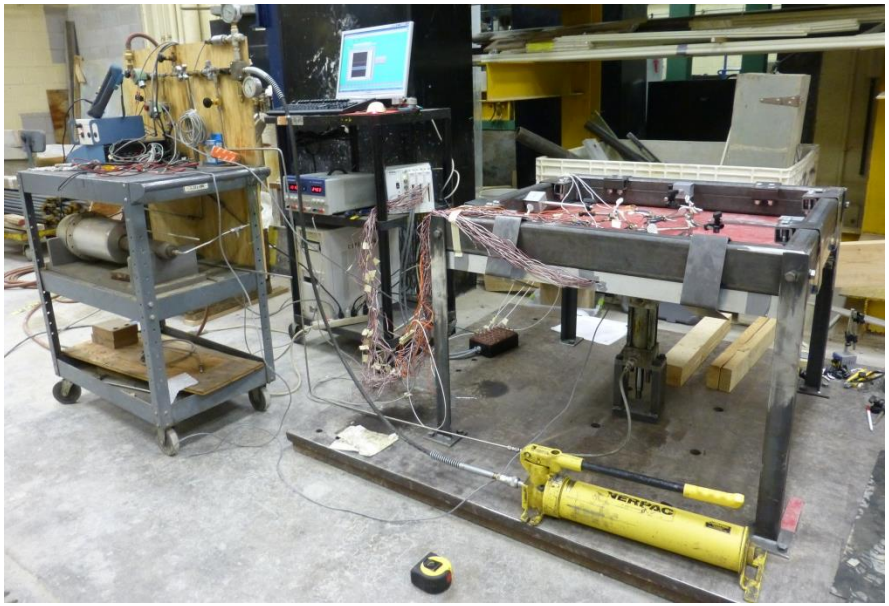
Solar Panels

- Offset Traditional Material Requirements
- Provide Additional Payback from Infrastructure
- Reduce CO_2 Footprint of Pavements

Solar Panels

Laboratory Investigation

- Structural Testing
- Panel Model Development
- Pavement Load Case Simulation



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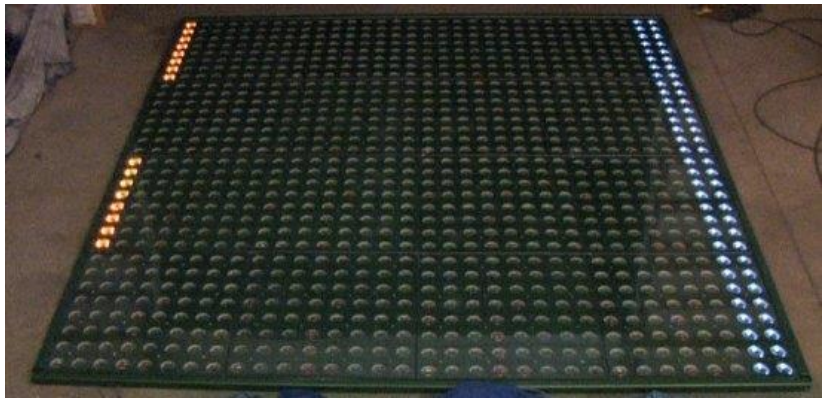

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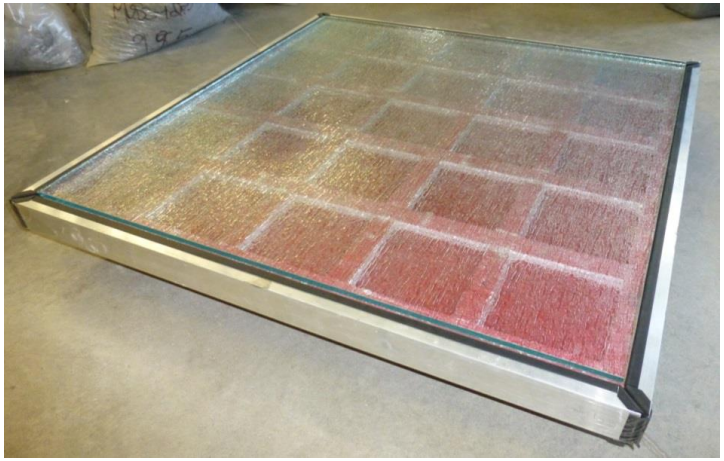
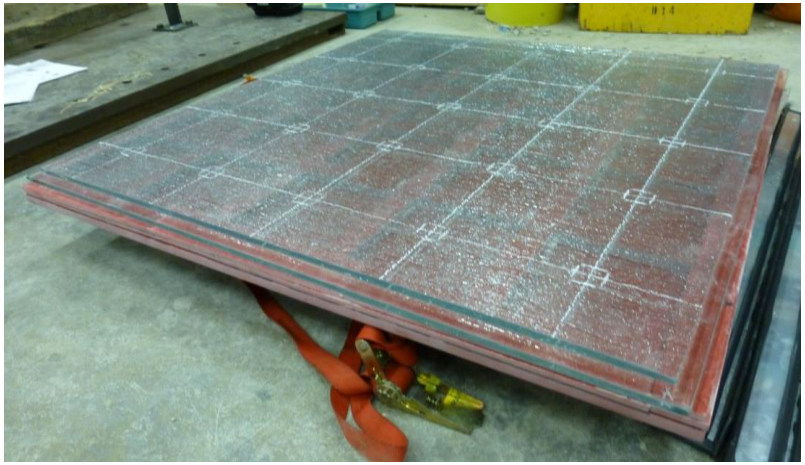
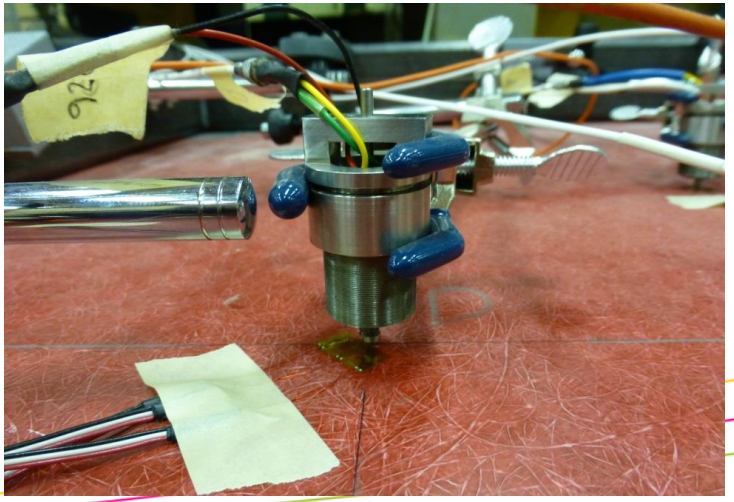
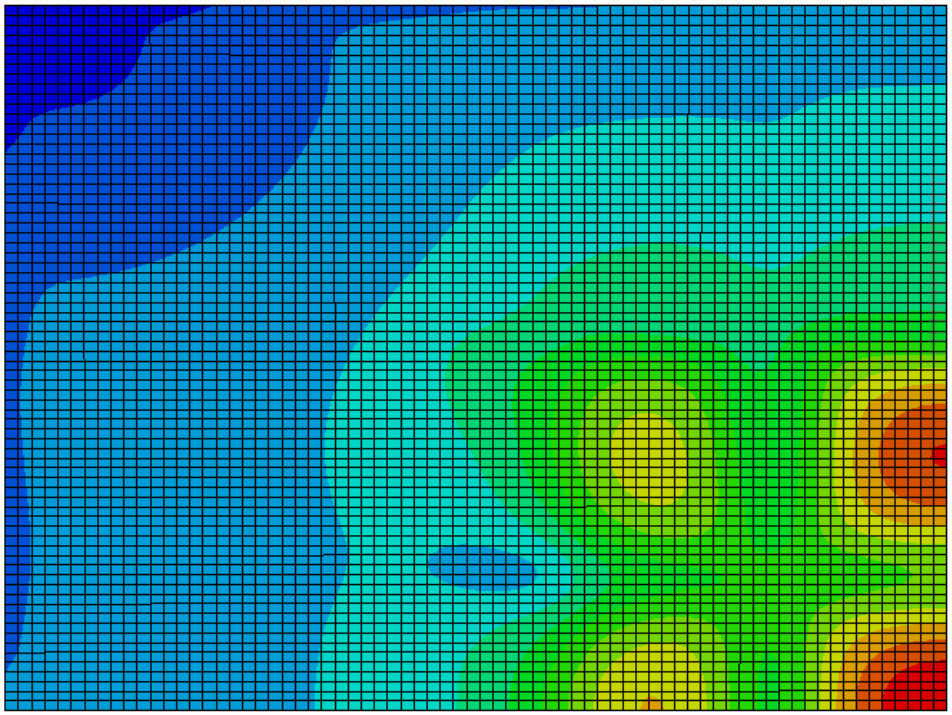
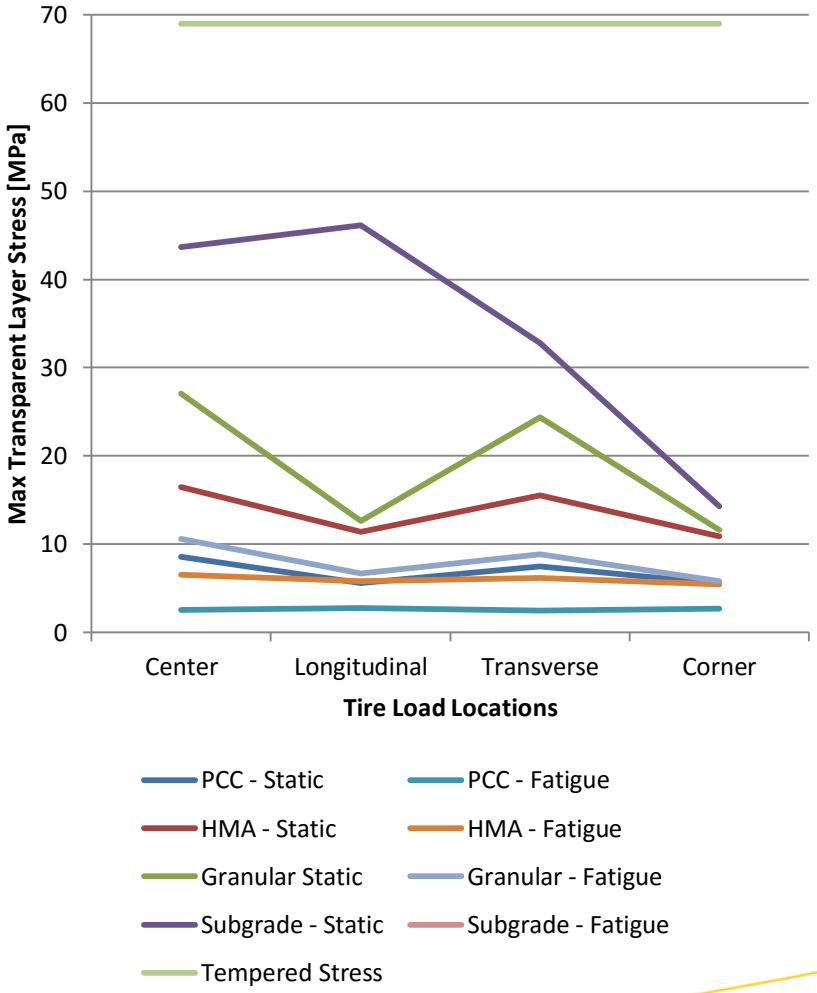






Solar Panels





Closing Thoughts

- Experimental Design in Airport Engineering Research Important
- Educating Future Leaders in Airport Engineering
- Tie Research into Management Applications
- Work with Industry to Facilitate Technology Transfer
- Examine Climate Change, Adoption of New Materials and Designs

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Ontario Hot Mix

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Questions?