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Guidelines for Network Level Road Condition Measurements

Presented on behalf of the COTO Road Network Management Systems Committee

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RUBICON SOLUTIONS

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  - Concepts
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  - Planning a Survey
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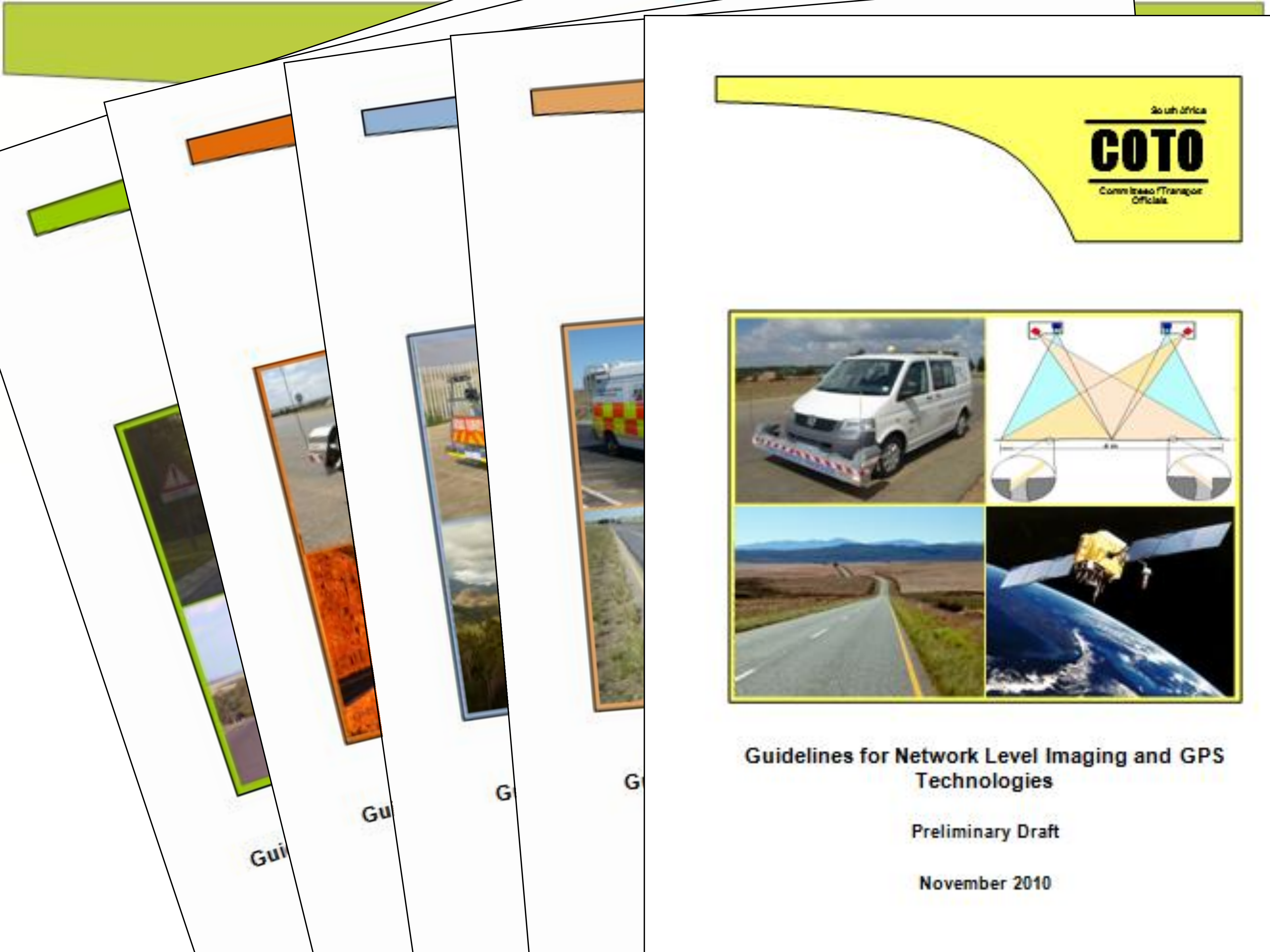
Background & Introduction

- Initiated & Funded by WCPG
- To introduce key concepts and methodologies
- To assist network management to plan, execute and control condition measurement
- Scope limited to roads and network level
- Roughness Guidelines in 2007 – Fritz Jooste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Guidelines for Network Level Imaging and GPS Technologies
Preliminary Draft
November 2010

systems, represent the expert knowledge, experience or judgement as data or rules within a software program. These systems capture the fragments of human know-how which is used to reason through a problem, compensating for the weaknesses of purely deterministic methods.

Knowledge-based systems may vary from simple checks and interventions to complex systems incorporating sophisticated inference procedures that make provision for uncertainty. As an example, the UK Highways Agency uses the TRRL relationships to interpret deflections measured with deflectograph devices. In recognition of the limitations of structural capacity/ residual life produced by this method, a "UKPMS Rule Set" was developed in consultation with practising maintenance engineers. In this way the residual life alone is constrained to generating a structural treatment within the pavement management system. A low residual life value requires coincident cracking in the wheel tracks and/or rutting from visual surveys to trigger a treatment using the national default rule set (UKPMS, 2005).

Summary of Concepts: Section 1

- Surface deflection is an instantaneous, non-destructive response of a pavement structure under the application of a vehicle wheel load. The instantaneous deformed surface takes on the shape of a bowl, known as a deflection bowl or deflection basin.
- Deflection bowl parameters describe the size and shape of the deflection bowl which reflect the load spreading ability of the pavement, or zones within the pavement structure, i.e. they are indicators of relative stiffness.
- The most common deflection bowl parameters and zones they represent within the pavement structure are listed below. The higher the magnitude of the deflection bowl parameter, the lower the relative stiffness of the zone it represents.
  - Maximum deflection (δMax): represents the total pavement structure;
  - Base Layer Index (BLI): represents the upper zone in the vicinity of base and surfacing;
  - Middle Layer Index (MLI): represents the middle zone in the vicinity of the subbase;
  - Lower Layer Index (LLI): represents the lower pavement layers such as the selected layer and upper subgrade.
- Measured deflections are primarily influenced by: (1) Load – magnitude and duration; (2) Climate – temperature and moisture, and (3) Pavement type and condition.
- The main objective of collecting deflection data is to provide and indication of the pavement structural condition, residual structural capacity or residual life. Several approaches have been developed to utilize deflections in this regard:
  - Deflection bowl parameters: Performance related directly to δMax, BLI, MLI, and LLI;
  - Pavement Strength Indices such as Structural Number (SN);
  - Mechanistic-based approaches including backcalculation of layer elastic moduli, and
  - Knowledge-based approaches.
- A holistic approach is recommended to obtain an overall picture of a pavement's condition, expected residual life, and remedial strategies. No single test – including deflections – or analysis method used alone can provide a complete description of the information needed to determine a pavement's structural condition with confidence.

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Document Structure

- Section 1: Concepts
- Section 2: Measurement/ Devices
- Section 3: Planning a Measurement Survey
- Section 4: Calibration and Validation
- Section 5: Operational and Quality Control
- Glossary
- Appendices

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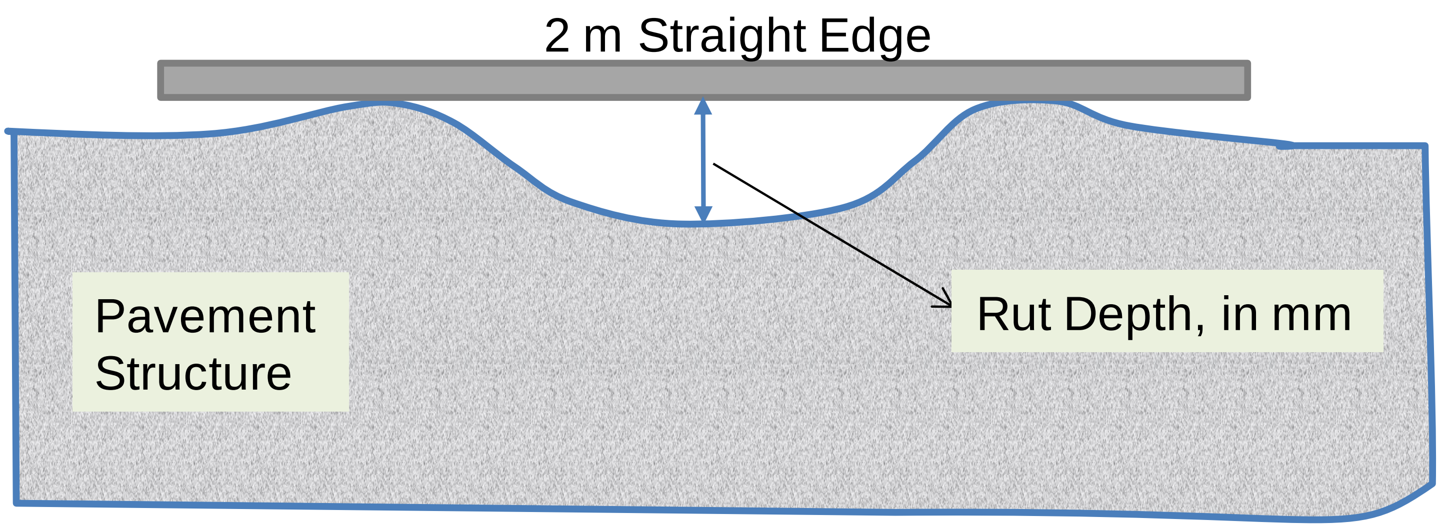
Section 1: Concepts Example - Rutting

- Definition
- Functional Significance
- Structural Significance and Causes
- Evaluation Criteria
- Characteristics of the Surface Transverse Profile

Section 1: Concepts Example - Rutting

Defining the condition parameter



Section 1: Concepts Example - Rutting

Functional Significance

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Risk Pond Classification

Risk	Depth (D, mm)	Length (L, m)
Low	D < 8	L < 8
Medium	8 ≤ D< 10 *or* D ≥ 8	L ≥ 8 *or* 8 ≤ D< 10
High	D ≥ 10	L ≥ 10

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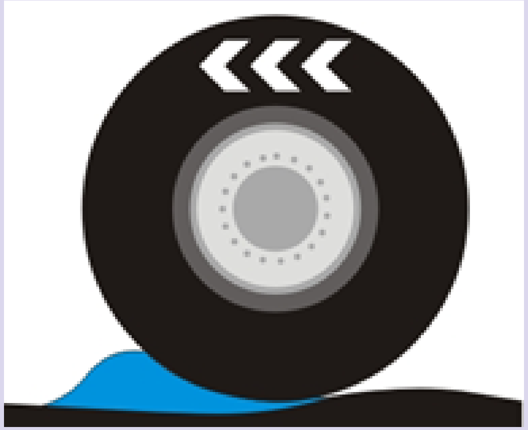
More about Aquaplaning

When a water wedge builds up between the surface and the tyre, friction between the tyre and surface diminishes and spin-down (reduction in wheel speed) occurs.



A more detailed discussion of aquaplaning, including the two types of aquaplaning, can be found in Austroads (2005).

Section 1: Concepts Example - Rutting

Functional Significance

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Section 1: Concepts Example - Rutting

Structural Significance & Causes

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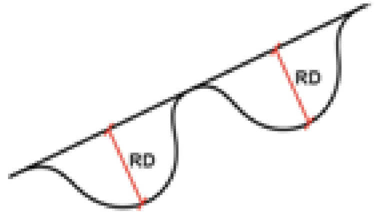
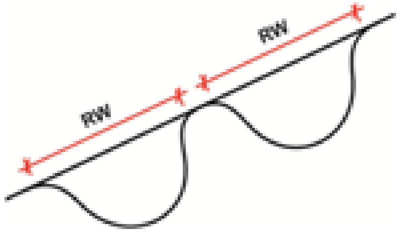
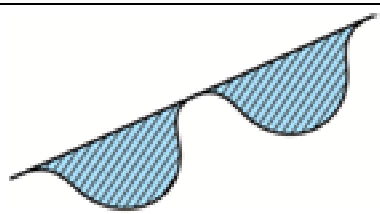
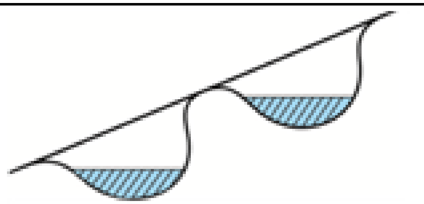
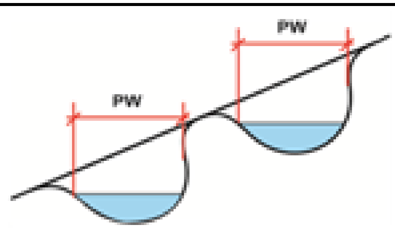
Rut Depth (RD)	
Rut Width (RW)	
Rut Area	
Pond Area	
Pond Width (PW)	

Section 1: Concepts Example - Rutting

Characteristics of the Surface Transverse Profile

Section 2: Devices Example - Skid & Texture

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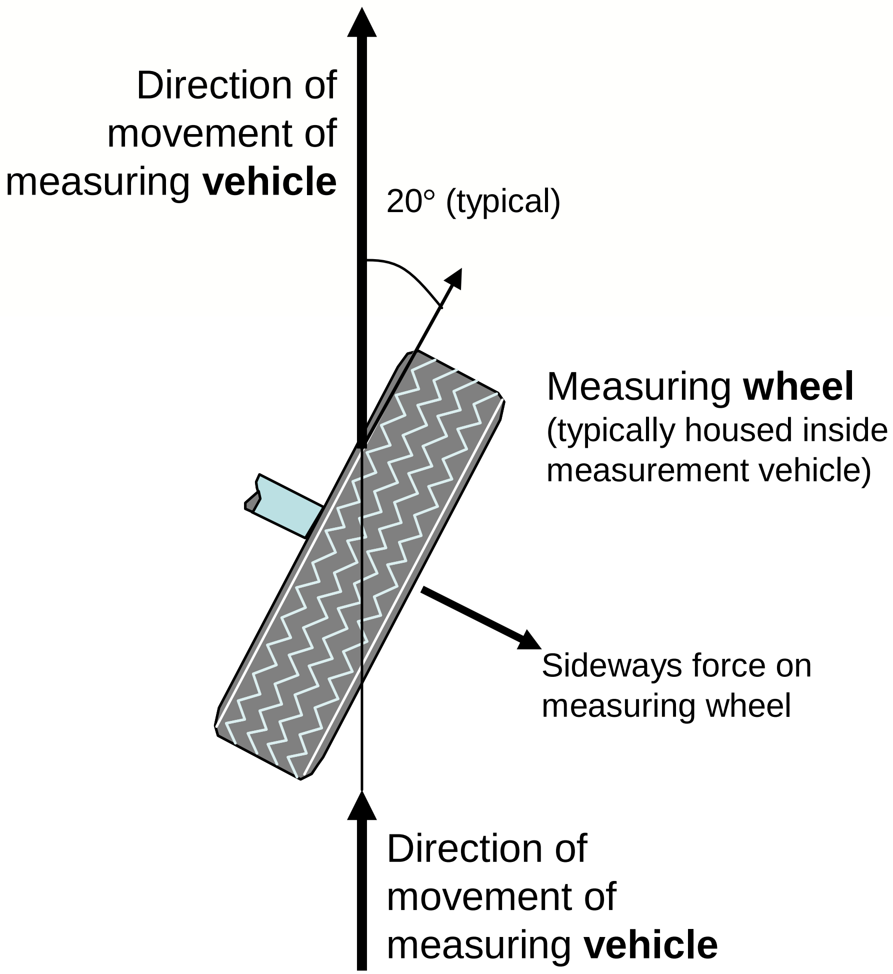
- Devices that Measure Skid Resistance
- Surface Texture Measurements
- Relative Interpretation of Friction Measurements

Principle of Measurement in Side Force Test Devices



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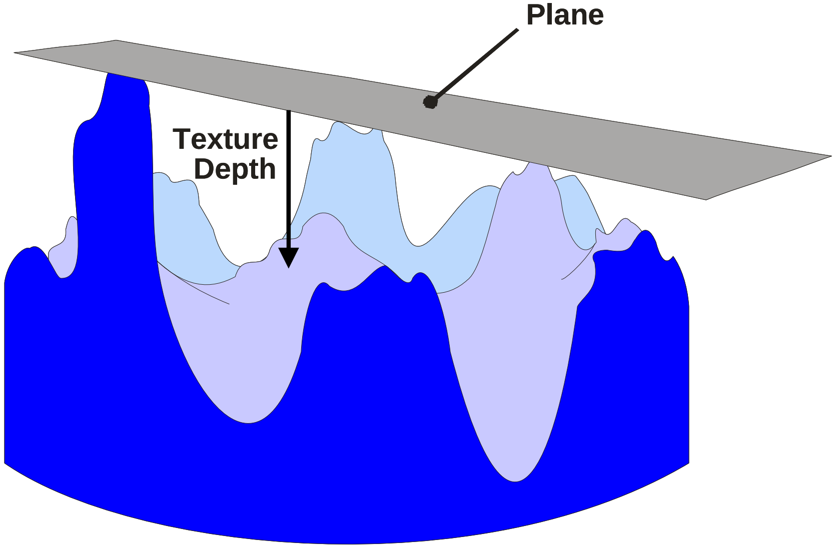
Section 2: Devices Skid & Texture

Devices that Measures Skid Resistance

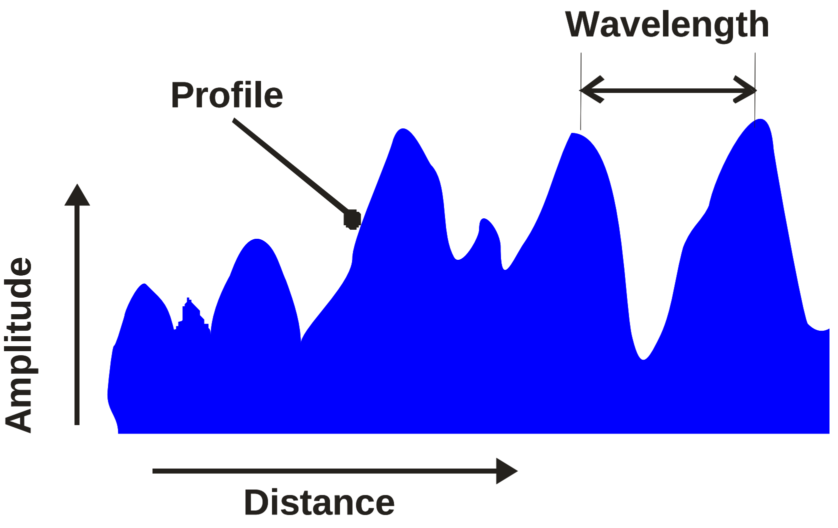
Section 2: Devices
Example - Skid & Texture

Surface Texture Measurements

Volumetric Patch: MTD



Texture Profiles: MPD



Section 2: Devices
Example - Skid & Texture

Calibrated wet friction at 60 km/h

F60 = f(device, Sp)

Speed constant, or speed number

Sp = f(device, TX)

Re … f Frict

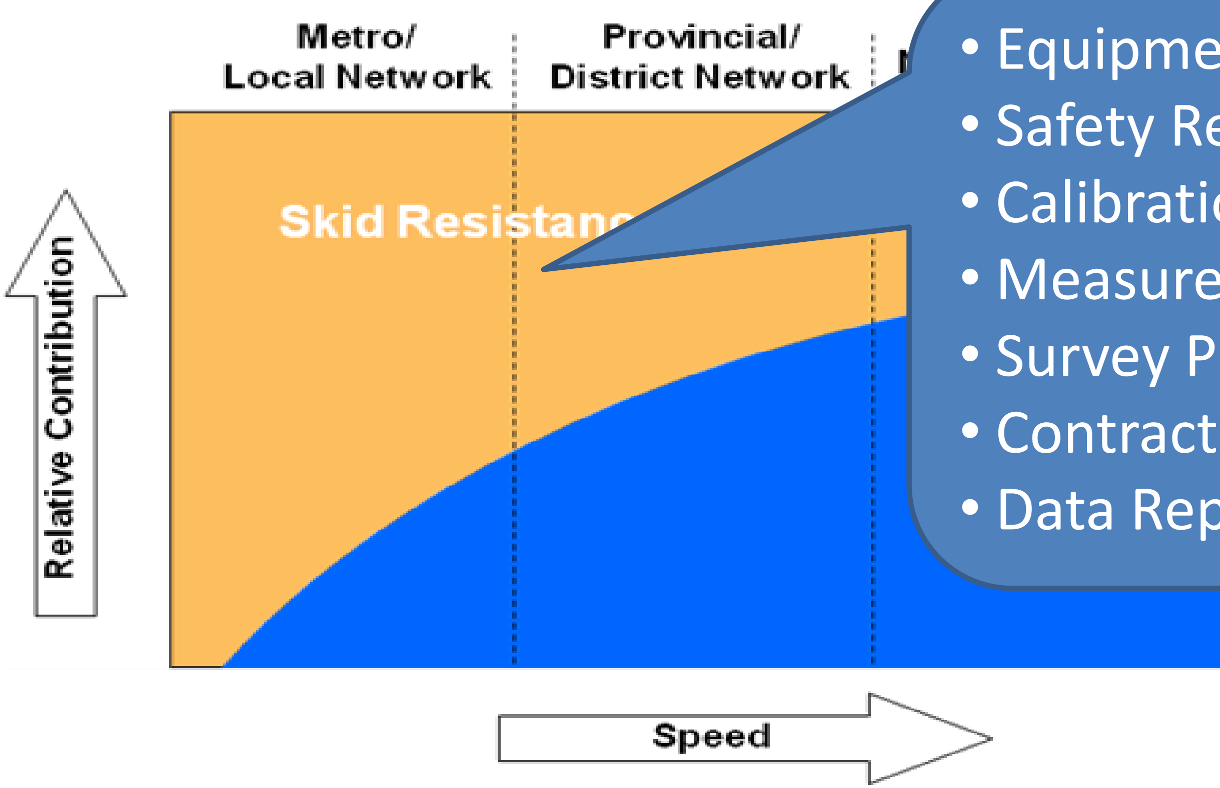
Inter … Index (I

IFI (F60, Sp)

Section 3:
Planning a Surv

- Manpower/ Budget Constraints
- Network Type
- Intended Use of the Data
- Timing

- Equipment Specification
- Safety Requirements
- Calibration & Validation
- Measurement Control
- Survey Procedures
- Contract Quality Plan
- Data Reporting Format



Section 4: Calibration & Validation

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Important!

During calibration, calibration factors (or gain factors) are determined to adjust the component or unit under consideration to conform to the required standards.

No adjustments of measurements are made based on the outcome of a validation exercise. If the device is not valid, it should be calibrated using appropriate protocols.

Section 4: Calibration & Validation - Deflectometers

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- Calibration:
  - Components
  - Calibration Frequency
  - User/ Calibration Station (or Manufacturer)
- Validation:
  - Reference Surveys and Devices
  - Validation Site Requirements
  - Validation Acceptance Criteria

Section 5: Operatio
Procedures - Defl

- Survey Requirements
- Safety
- Maintenance checks
- Calibration/ Verification Records
- Cleanliness
- Warm-up Time
- Load and Sensor checks

- Load Level
- Test Location
- Surface and Pavement Aspects
- Measurement Environment
- Seasonal Variation

- Operational Procedu
- Data Capture and R
- Data Checking
- Factors Affecting Deflection Measurements

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The Way Forward

TMH 13: A	**Guidelines for Measuring Road Roughness**
TMH 13: B	**Guidelines for Measuring Skid Resistance and Texture**
TMH 13: C	**Guidelines for Measuring Pavement Deflection**
TMH 13: D	**Guidelines for Measuring Rutting**
TMH 13: E	**Guidelines on GPS and Imaging Technologies**