Field skid resistance and macrotexture performance: from early life to long-term relationship

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Outline

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• Methodology
• Results
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Background

Pavements serve society’s needs

That’s all folks guys...

NTUA Maria POMONI

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Background

Functionality
✓ Safety
✓ High Quality
In contact with the tire tread of the moving vehicles

Functional condition

Characteristics of the upper/antiskidding layer

Structural condition

Surface anti-slip layer

Asphalt Base

Base/Subbase

Subgrade
Macrotexture and Microtexture contribute to skid resistance properties of the surface layer.
Background

Design and Construction phase

In-service phase

Seasonal Variation

Long-term performance

In service pavement:

Year to year deterioration

- (Increasing) Traffic volume
- Site characteristics
Objective

- To present and assess the long-term field evolution of skid resistance based on the effect of seasonal variation.
- To illustrate the traffic effect on skid resistance and macrotexture long-term performance based on field data.
- To assess the relationship between skid resistance and macrotexture evolution.
Site characteristics

✓ In service - urban highway 14 years old, 11 consecutive years of monitoring
Surface layer: HMA, O-5 mix designation, ASTM D3515
✓ Differences in sections on traffic volume and geometric characteristics
Methodology

Data collection

Survey period

Skid Coefficient

Early Middle Late

Skid resistance data

- **Early dry period**: Approximately one week after rainfalls
- **Middle dry period**: Approximately two to three months after period 1
- **Late dry period**: Approximately four to six months after period 1

GripTester

Grip Number: GN

**Annual mean**: Mean of three periods

✓ *To characterize the annual performance*
Methodology

Data collection

- Traffic: AADT
- Mean Profile Depth (MPD) (mm)

Macrotexture data

Laser Profiler
ASTM E1845

Mean Profile Depth: MPD (mm)

Annual mean: Mean of three periods

- To characterize the annual performance

Cumulative traffic for each year of the total monitoring period
An indicative relationship between early and late GN measurements was balanced to be $\text{GN}_{\text{late}} = 65\% \text{GN}_{\text{early}}$.

Seasonal variation effect is gradually being less pronounced as skid resistance level reaches a low value.
Results

Year to year deterioration

Start point: Evidence of Inverse trend between MPD-GN

Traffic volume effect

No Correlation, $R^2 \approx 0$

Correlation $R^2 > 0.8$
Results

Before extensive polishing

Skid resistance

Finest aggregates → Microtexture

Coarse aggregates → Macrotexture

After extensive polishing

Skid resistance

Finest aggregates → Microtexture

Coarse aggregates → Macrotexture

Critical for the remainder of service life

*H: height of aggregates above surface

Macrotecture before polishing ($H_{before}$)

Macrotecture after polishing ($H_{after}$)
Indications that the inverse trend between macrotexture and skid resistance is related to the decreasing influence of seasonal variation.
Results

Extra sections investigated

✓ **Same asphalt** mixture properties

✓ **Later constructed**

✓ **Different weather conditions**, heavy rain during winter months and increased precipitation occurrence during summer months

✓ **Low traffic volume** (both light and heavy vehicles)
Results

Extra sections investigated

- Newly constructed pavement
- No traffic effect
- Indication of relationship between BPN and MTD measurements

BPN: British Pendulum Number
Testing device: British Pendulum
MTD: Mean Texture Depth (mm)
Testing method: Sand Patch
Results

Extra sections investigated

Early evidence of clear inverse trend between MPD-GN
**Results**

**Extra sections investigated**

Loose debris are cleansed away due to **heavy rainfalls**, acting against **fine dust formation**

Low traffic volume cannot efficiently roughen the aggregates, just polishing

- **Increasing macrotexture**
- **Decreasing skid resistance** (+ microtexture)
Research question

✓ Seasonal variation effect
✓ Traffic volume
✓ Initial levels
✓ ....

Lab-based Prediction Models
Field data / imaging techniques

Computational Simulation

Eliminate friction measurements (many measuring systems)

Estimate or Predict: Skid resistance

Macrotexture
Mainly used as an input

Can we finally link these characteristics?
It seems hard to find a safe relationship between field macrotexture and skid resistance

Albeit their proportional opposite trend, there is no equation to be used for estimating skid resistance through macrotexture measurements

Skid resistance and macrotexture should be considered together under pavement performance assessment but measured (monitored) separately
Conclusions

It is important to:

✓ Collect data and face the challenges of field conditions
  - Skid resistance and macrotexture measurements should be together with weather data (a few days before measurements)

✓ Data analysis and performance assessment should be strictly in relation to seasonal conditions of the area

✓ All the above to be considered under the limitations of the utilized measuring device / method
Conclusions

Key aspects
Continuous pavement monitoring

Assess field pavement performance considering the area of investigation
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Thank you!