

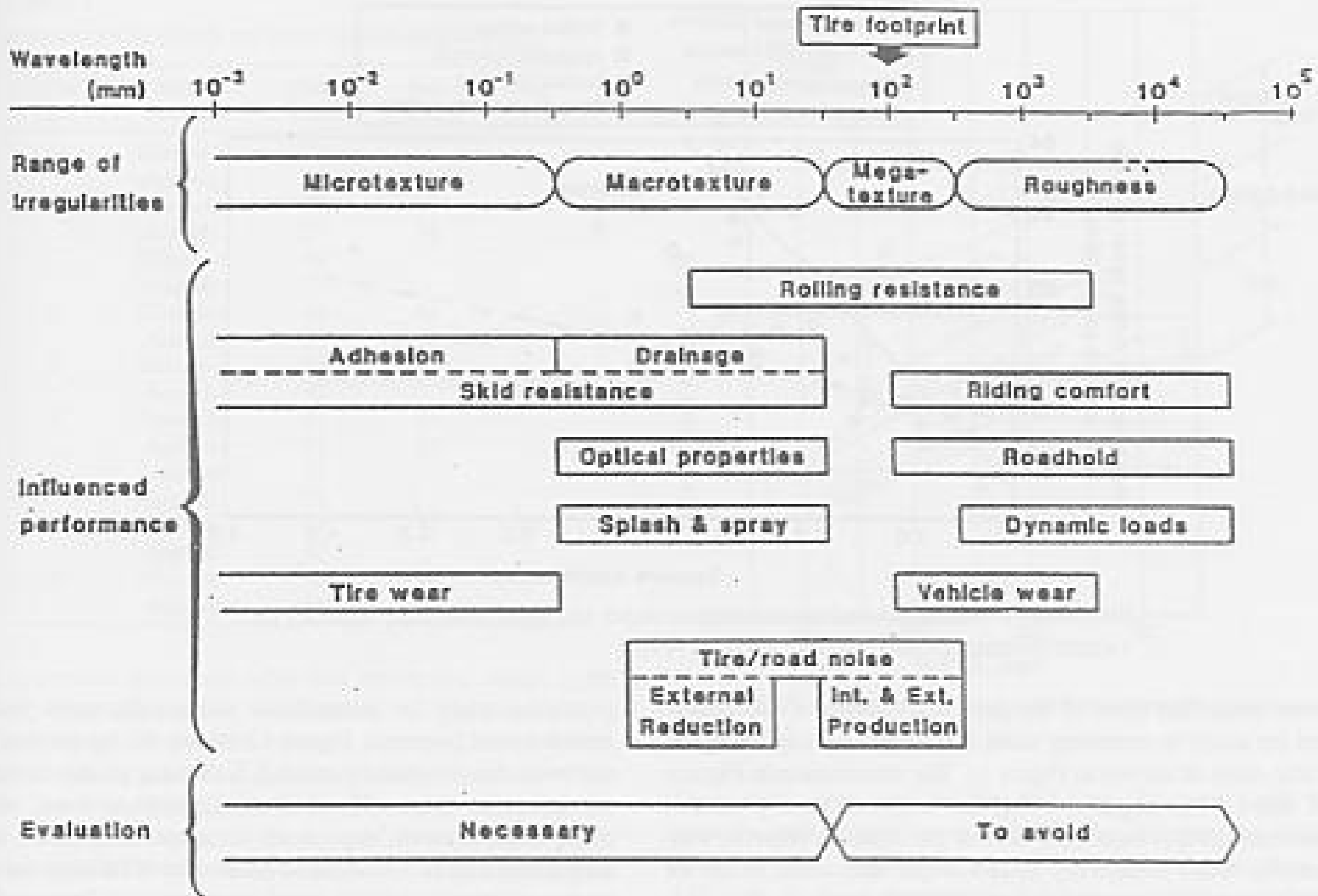
# Panel Discussion on (macro) Texture - a primer

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Ayton, 1991  
 Influence of  
 Surface  
 Characteristics  
 on Vehicle  
 Performance

### Texture Wavelength

$10^{-6}$     0.00001     $10^{-5}$     0.0001     $10^{-4}$     0.001     $10^{-3}$     0.01     $10^{-2}$     0.1     $10^{-1}$     1    10     $10^0$      $10^1$     100    ft  
m

Microtexture

Macrottexture

Megattexture

Roughness/Unevenness



Friction

Ext. Noise

Int. Noise

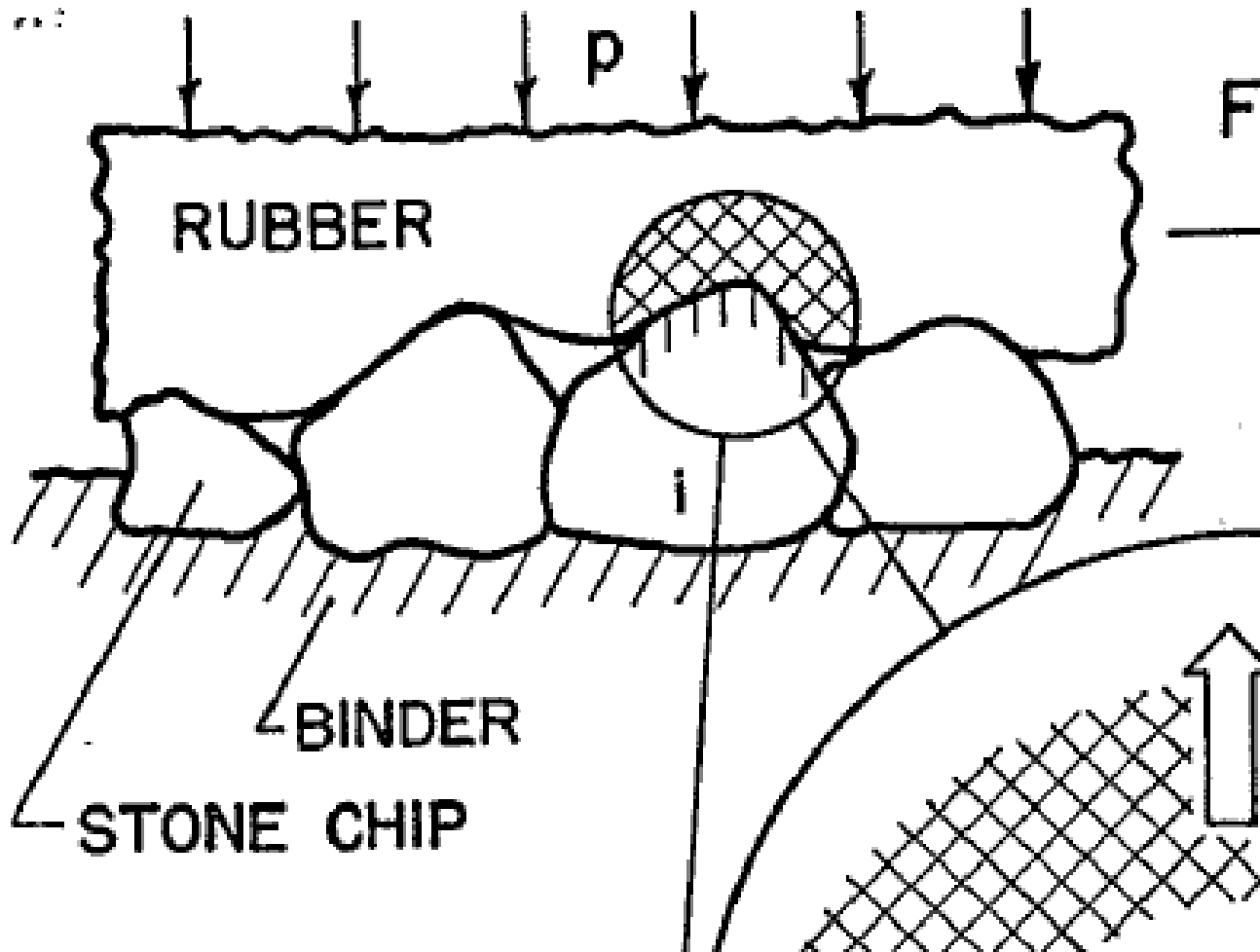
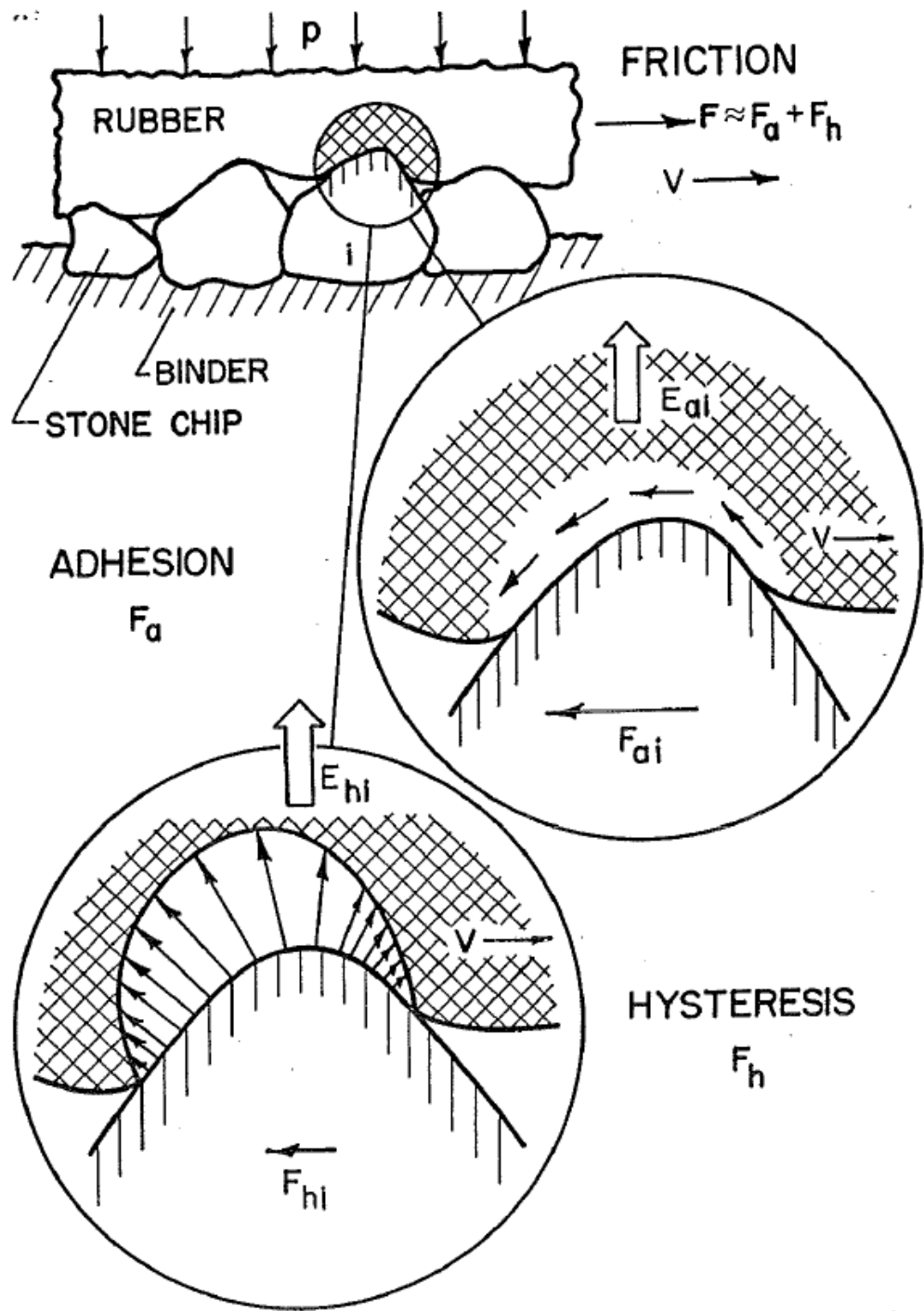
Splash/Spray

Rolling Resistance

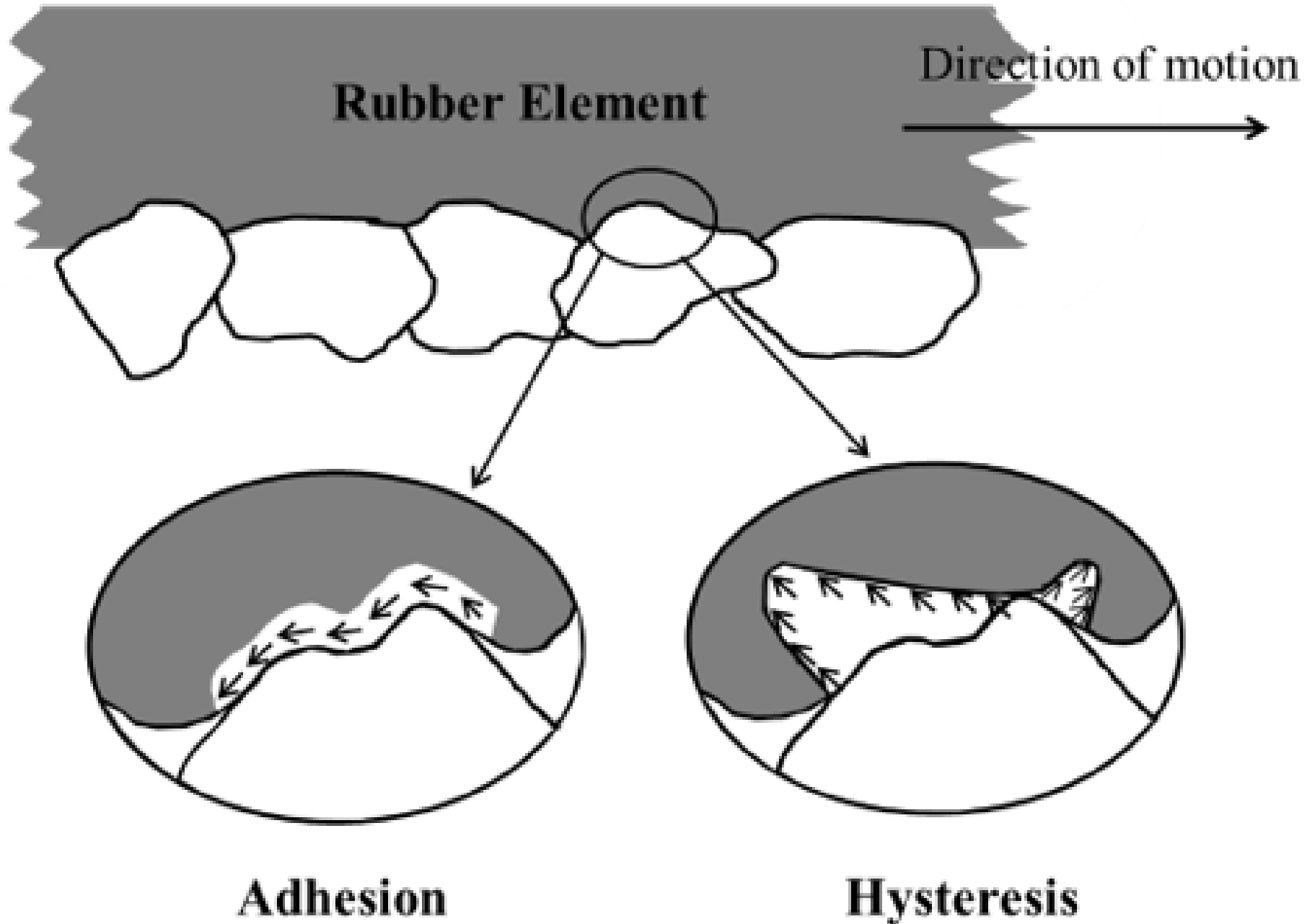
Tire Wear

Tire/Vehicle Damage

After Henry,  
2000  
Flintsch,  
Mcghee, Izeppi,  
Najafi 2012  
**The Little Book  
of Tire  
Pavement  
Friction**



Source: Hartwig Kummer, 1966 ERB 94 PSU  
 Unified Theory of Rubber And Tire Friction



(after Hall et al.  
2009)  
Flintsch, Mcghee,  
Izeppi, Najafi 2012  
**The Little Book of  
Tire Pavement  
Friction**

Macrotexture: plays significant role in:

1. **tire / pavement noise**
2. **splash and spray**
3. **friction / grip / skid resistance**
4. **hydroplaning potential**
5. **rolling resistance**
6. **ride quality – measurement issues resolved**

# Macrotexture: what it does:

- ▶ Contributes to voids between surface and tire to pump water or air
  - ▶ Wet friction, tire pavement noise, splash and spray
- ▶ Contributes to tire and tread block hysteresis (rubber deformation)
  - ▶ Wet and dry friction/grip, rolling resistance
  - ▶ How the tire/tread blocks conform to the surface
- ▶ Contributes to degree of “mechanical bite” of tire and tread blocks
- ▶ Could be more?

# Macrotexture Characterization

- ▶ **Depth or Average Depth** - MPD/ETD, result of sandpatch test
- ▶ **Degree of Positive vs. Negative Orientation** - Skew
- ▶ **Connectedness** - degree to which voids are connected and will contribute to evacuation channels with the tread pattern of a tire
- ▶ **Isotropic vs. Anisotropic** - is there a directional pattern to the texture
  - ▶ Isotropic = No - HMA, Chip Seal
  - ▶ Anisotropic = Yes - tine, diamond ground, diamond grooved
- ▶ **Shape** - Peaks and Valleys, sharp pointy vs. rounded
- ▶ **Surface Contact Area/Volume**
  - ▶ How far a tire penetrates or conforms to the surface
  - ▶ How much area/volume is left after tire conforms



# Macrotexture Characterization Proposal?

- ▶ Develop Advanced Macrotexture Parameters
  - ▶ Beyond Depth Alone
  - ▶ Objectively Measured & Quantified (standards?)
- ▶ Determine how each relates to Mechanisms of:
  - ▶ Tire/Pavement Noise
  - ▶ Tire/Pavement Friction
  - ▶ Hydroplaning
  - ▶ Rolling Resistance
  - ▶ Splash and Spray
- ▶ Accurately and Reliably Predict Response of Each

# Macrotexture Characterization

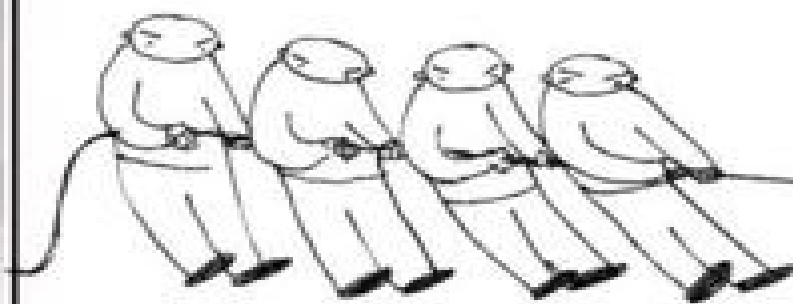
- ▶ **TRB 2015 Workshop on Texture** now TRB e-circular 216: International Experience and Perspectives of Pavement Texture Measurement and Evaluation
- ▶ **TRB 2016 paper (16-1834) *Enhancing Pavement Surface Macrotexture Characterization by Using the Effective Area for Water Evacuation*** by Mogrovejo, Flintsch, Katicha, de Leo'n Izeppi, and McGhee. **EAWE**
- ▶ **NCHRP 10-98 - Protocols for Network-Level Macrotexture Measurement - NCHRP Report 964**

Low Splash & Spray

Low Cost

Wet Friction

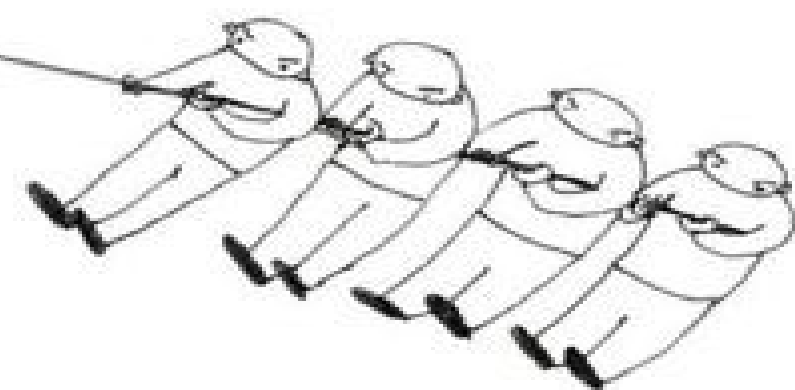
# Highway Surface



Low Rolling Resistance

Quiet

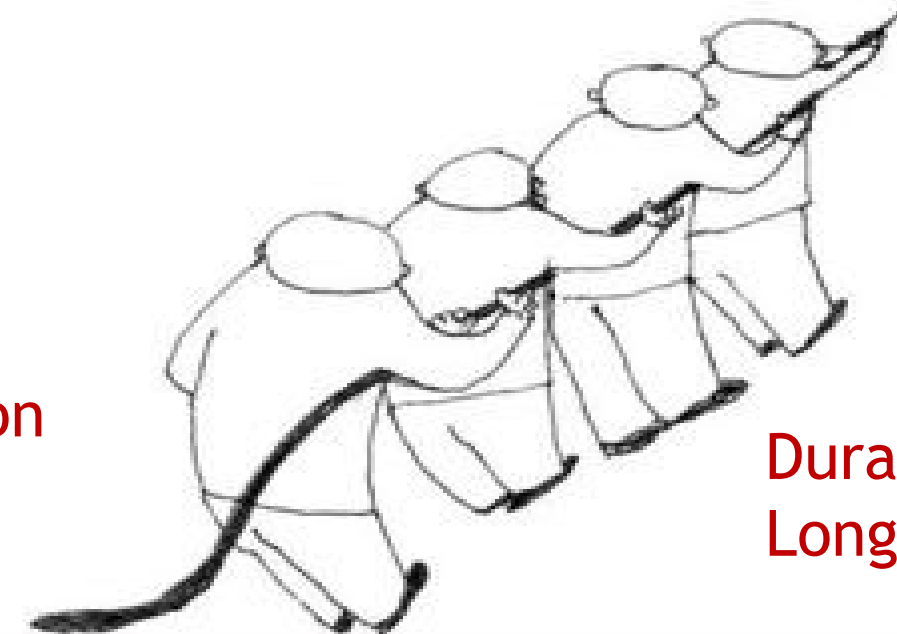
Smooth Ride



Support Repeated Loadings  
(Structurally Sound)

Dry Friction

Durable  
Long Life



Thank you  
now on with the panel  
discussion

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# How Aggregates Influence Friction

## Macrotexture of Asphalt Concrete surfaces

- ▶ a property of aggregate size
- ▶ a property of aggregate shape
- ▶ a property of aggregate gradation
- ▶ Influenced by binders
- ▶ Influenced by degree of segregation in the mix
- ▶ Influenced by other construction factors?
  - ▶ Compaction efforts for construction
  - ▶ Temperature of mat when opened to traffic

# How Aggregates Influence Friction

## Macrotexture of Portland Cement Concrete surfaces

- ▶ A direct result of mechanical texture or lack thereof imparted to the plastic concrete
  - ▶ Floats
  - ▶ Burlap drag
  - ▶ Turf drag
  - ▶ Tining
  - ▶ Diamond Grooving

# Can Texture Change Over Time?

## Microtexture

↓ Yes, propensity of aggregates to polish

## Macrotexture

↓ Yes, wear from traffic and plow blades

↓ Yes, “tightening” AC surface mixes

# Can Texture Change Over Time?

Raveling - loss of aggregate particles

Microtexture

↑ Yes, exposing new aggregate surfaces

Macrottexture

↑ Yes, creating more surface voids



# Mechanically Improving Texture

## Partial or Complete Exposure of underlying material

- ▶ Carbide Milling - Impact/Plucking Action: surface durability?
  - ▶ Micro Milling
  - ▶ Fine Milling
  - ▶ Conventional Coarse Milling
- ▶ Diamond Grinding - Abrasive Action - improves micro and macro
- ▶ Diamond Grooving - Abrasive Action - mainly improves macro
- ▶ Shot Blasting - Peening Action

# Mechanically Improving Texture



Conventional mill drum  
16mm cutterbit spacing

Micro mill drum  
5mm cutterbit spacing

Photo courtesy of  
Aidan McDonnell  
BOCA Construction Inc.

# Mechanically Improving Texture



Photo courtesy  
of John Roberts  
of the IGGA

# Conventional / Coarse Carbide Milling



8 10:43AM

# Carbide Micro Milling

Photo courtesy of  
Aidan McDonnell  
BOCA Construction Inc.



# Diamond Ground AC

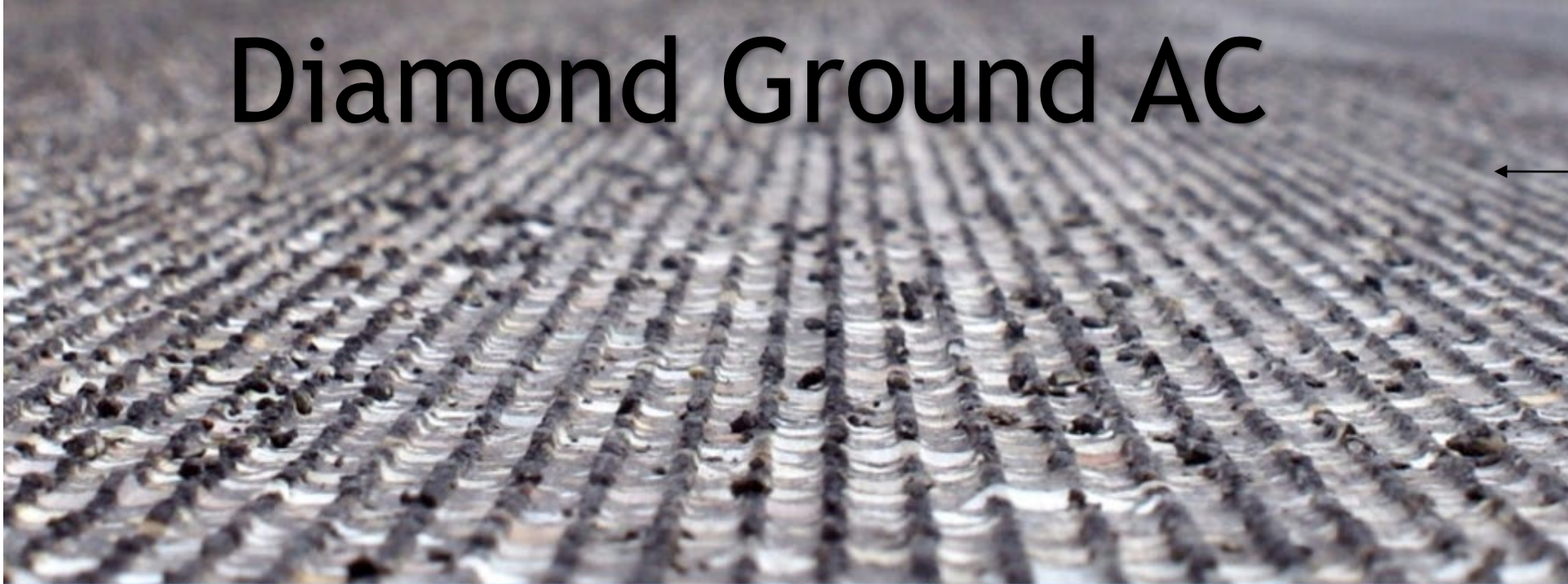


Photo courtesy of  
Aidan McDonnell  
BOCA Construction Inc.



Photo courtesy of  
Scott LeBlanc OH DOT  
District 7



# Diamond Grooved AC