SCI Construction Materials Group AGM 2016

Bitumen Emulsion Spray for Road Pavements

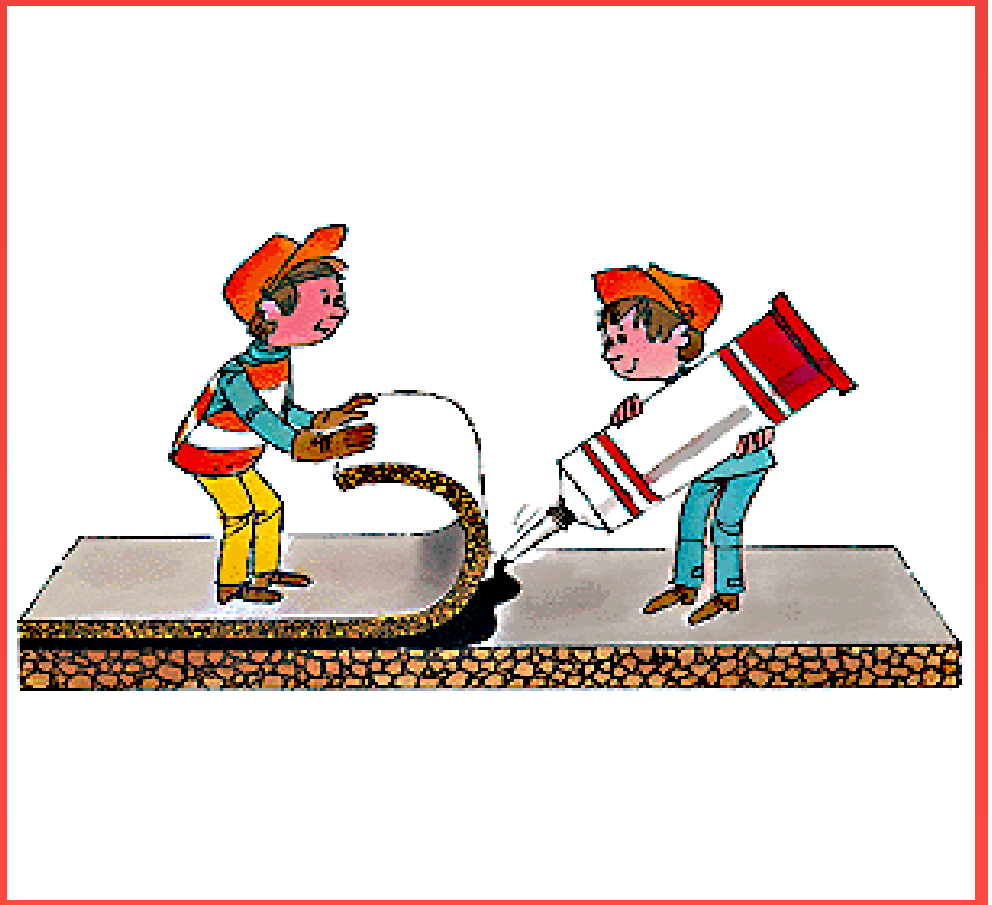
John Richardson

Date - 19/05/16

Colas | we go further

Bitumen Emulsion Spray for Road Pavements

- Bitumen emulsion
- Definitions
- Introduction of bond coat
- Testing
- Effect on pavement performance

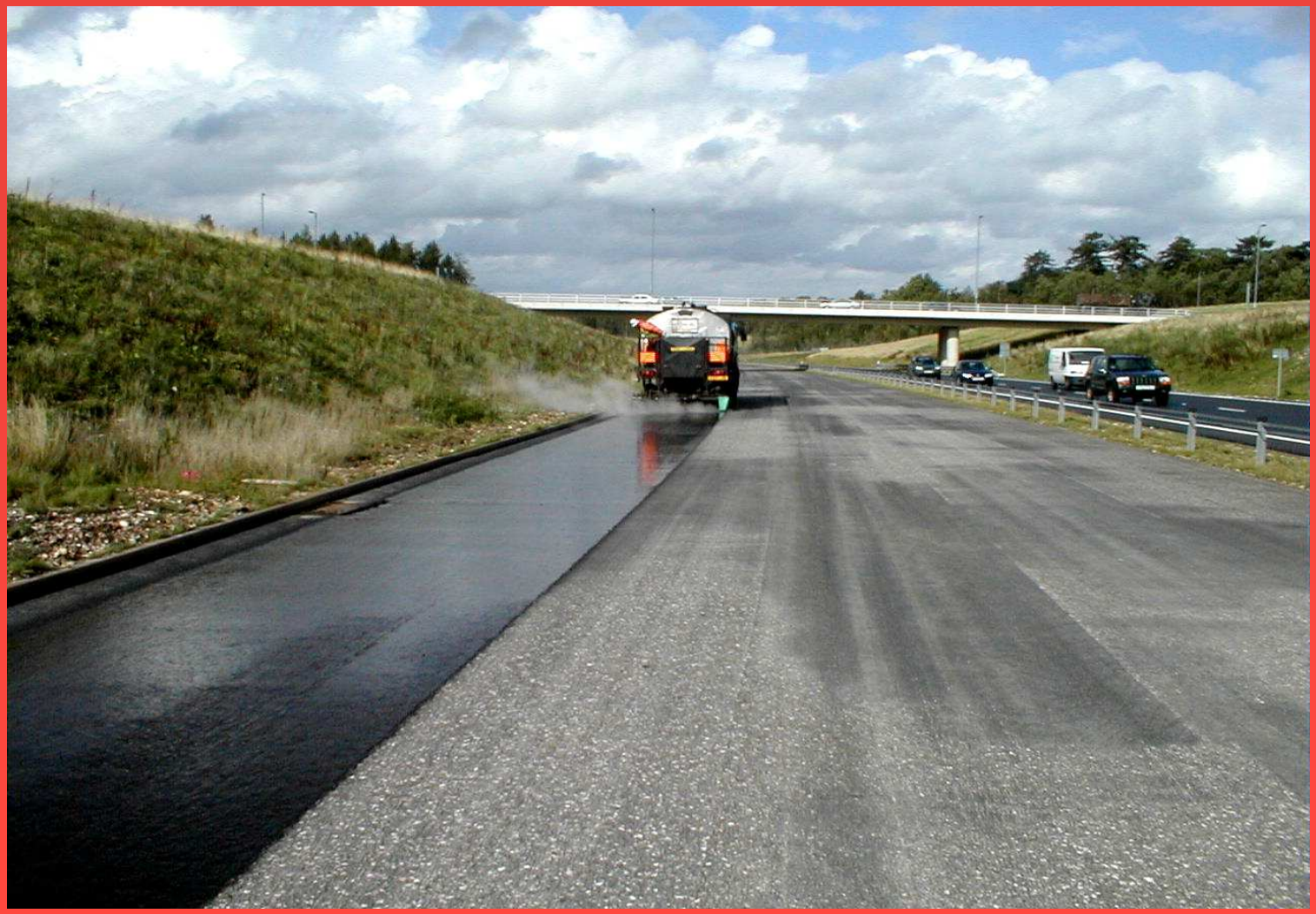


Bitumen Emulsion Sprays

Specialized Spraying Equipment

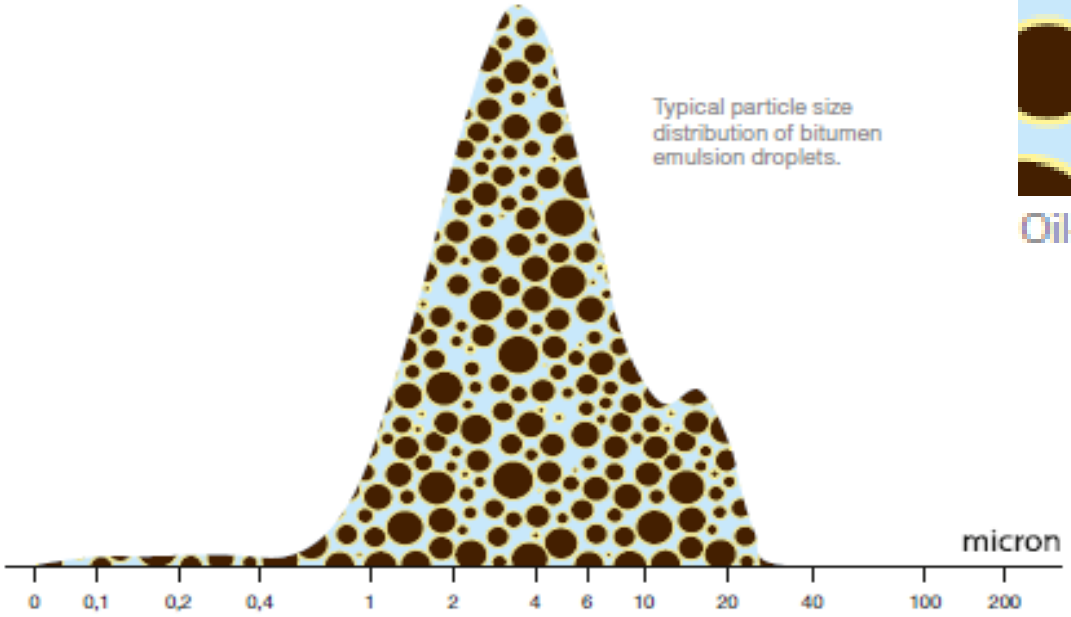
Tack Coat Emulsions

Motorized Emulsion Distributor

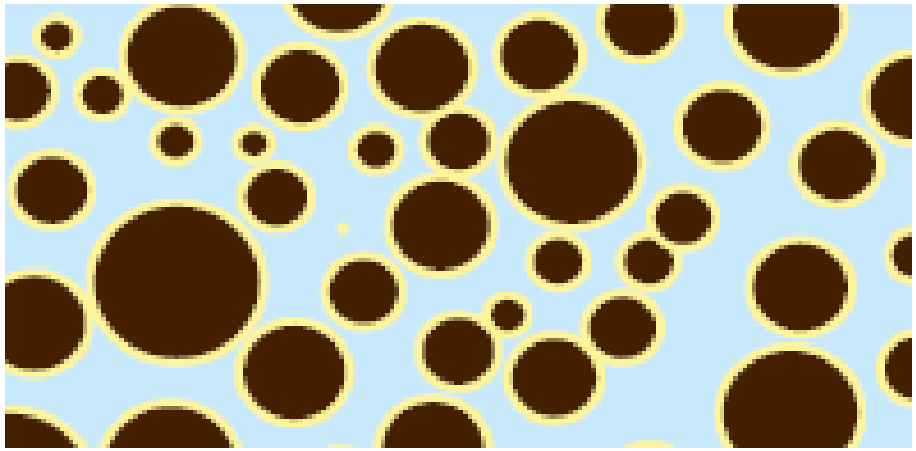


What is an emulsion?

An emulsion is a dispersion of small droplets of one liquid in another liquid.

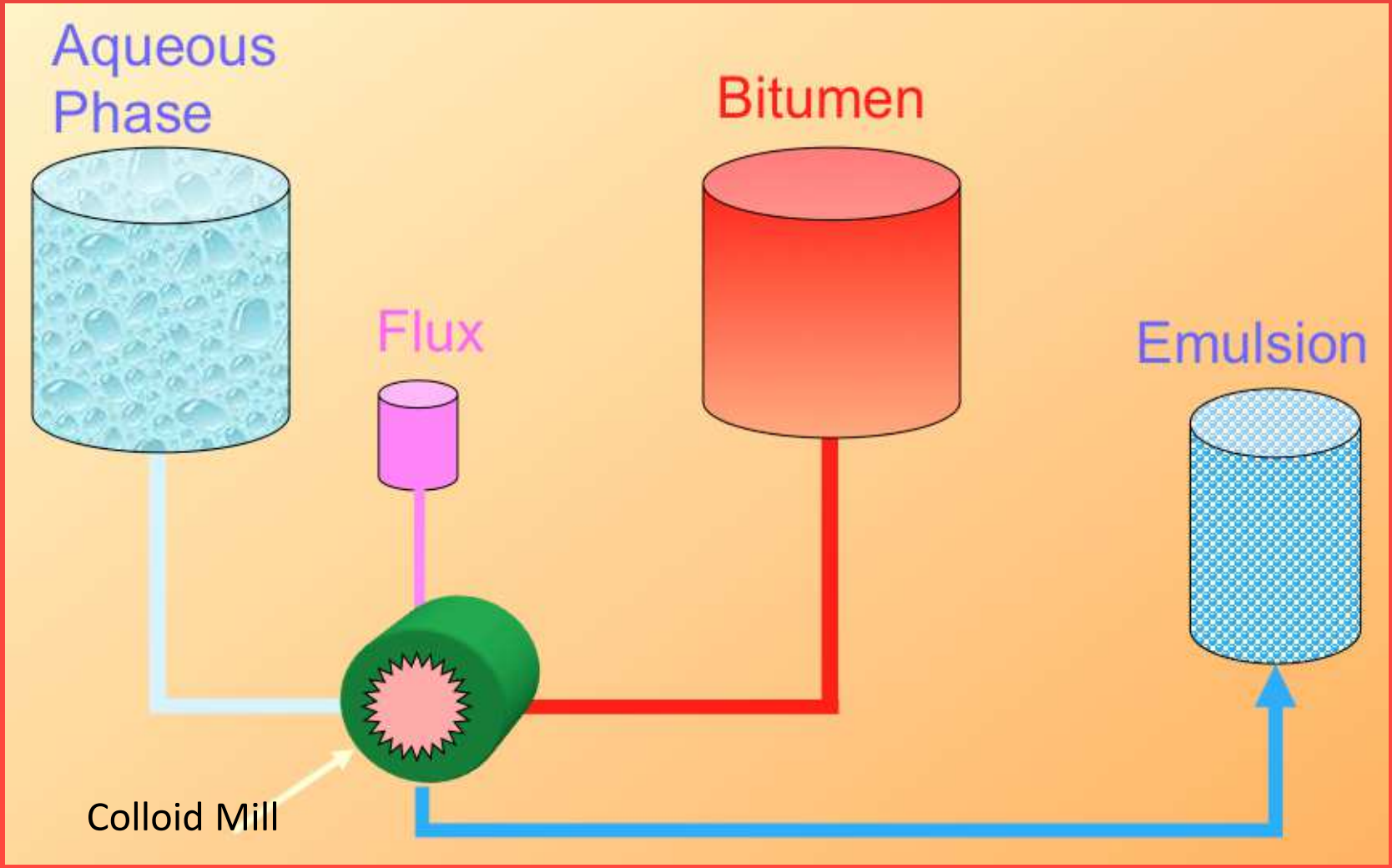


Typical particle size distribution of bitumen emulsion droplets.

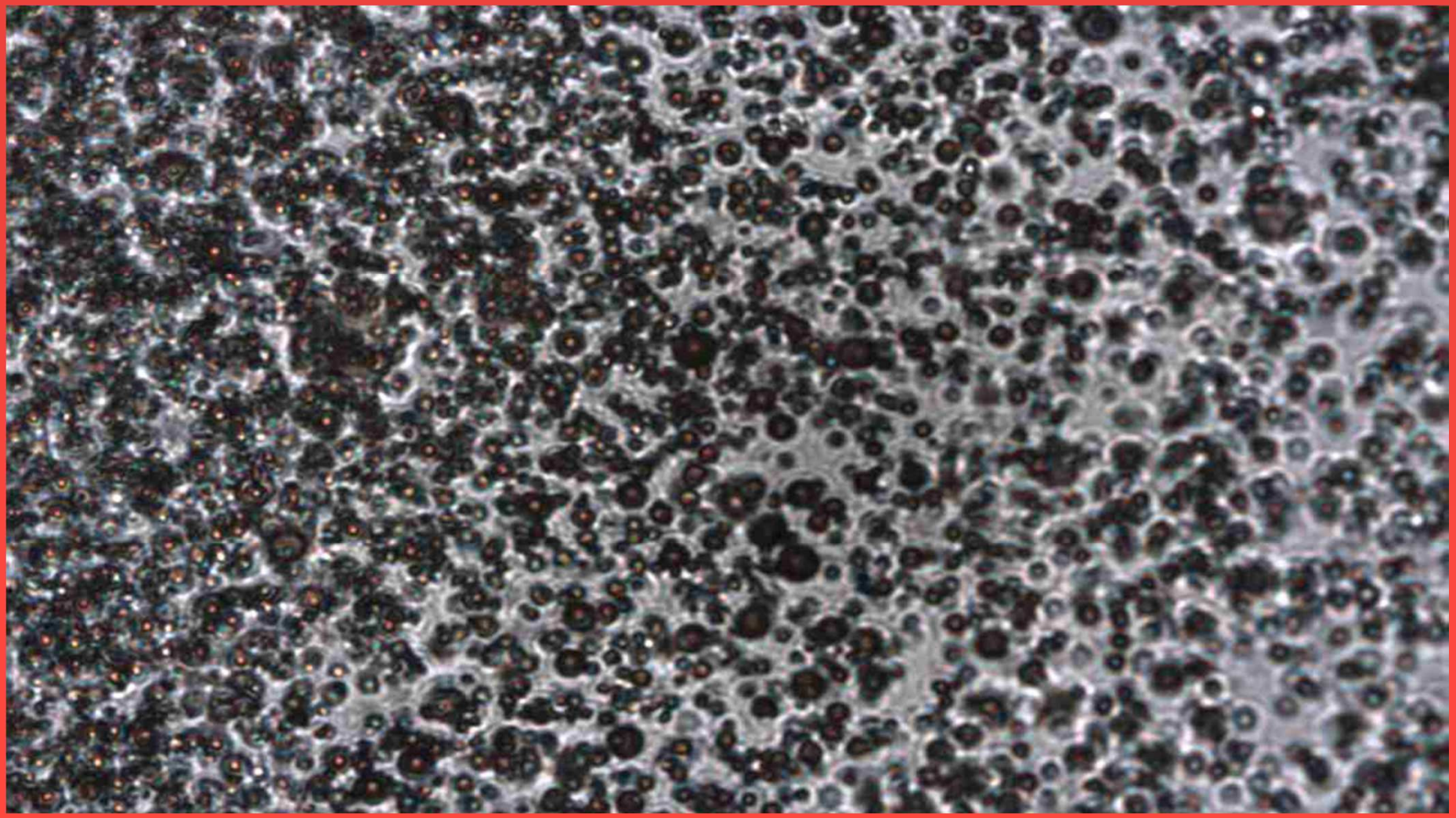


Oil-in-water emulsion

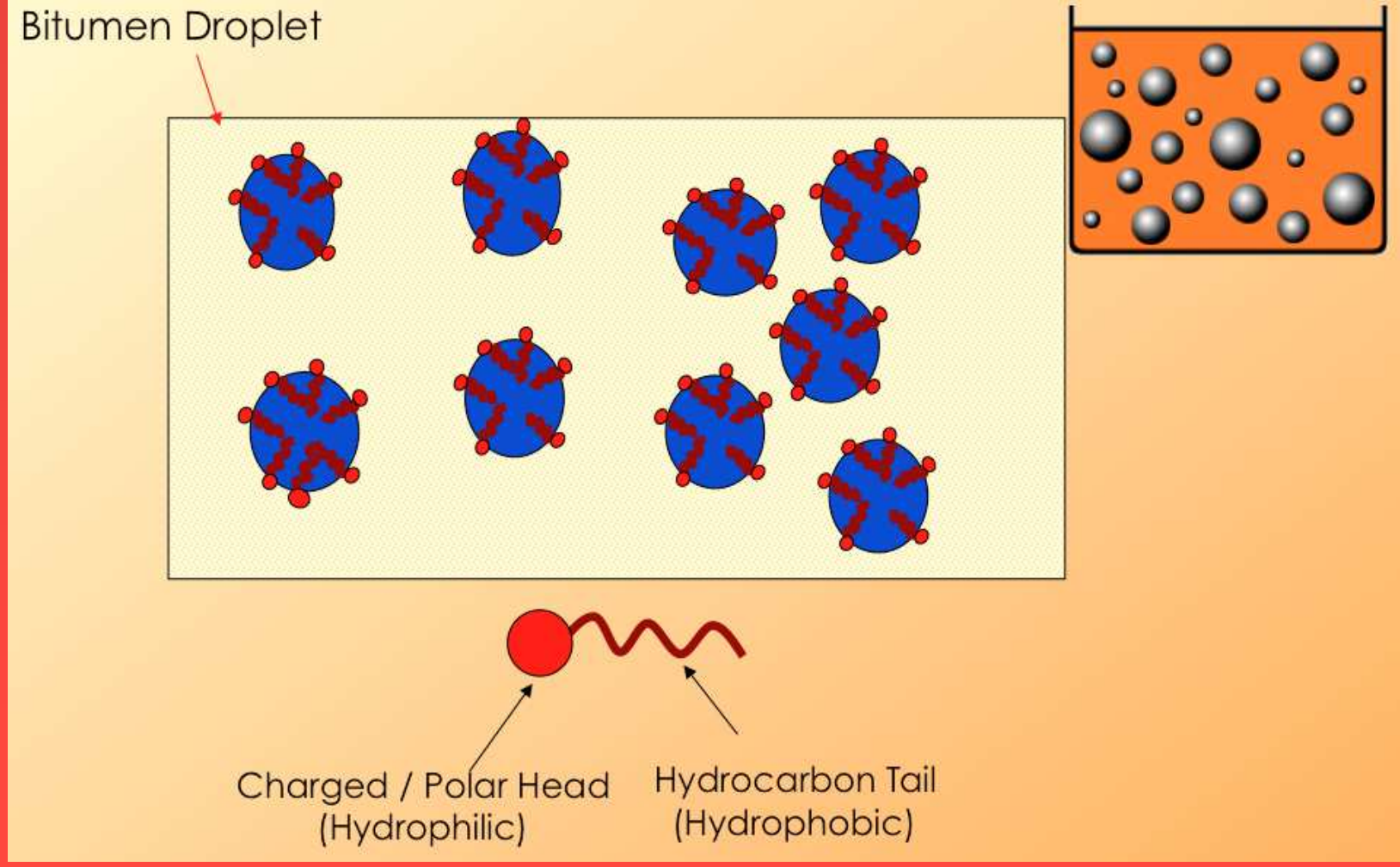
Emulsion production



Emulsion under a microscope



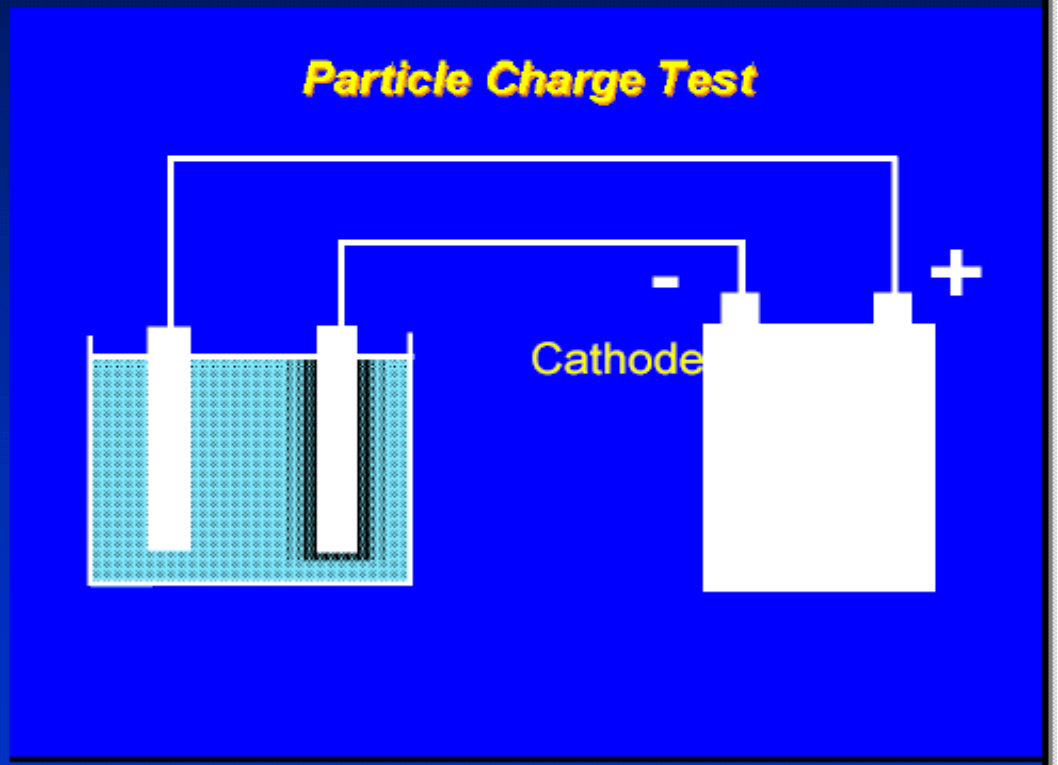
Additive Chemistry



Particle charge and emulsion types

- Positive - Cationic
- Negative - anionic
- No Charge
  - non-ionic

- Determined by emulsifier type



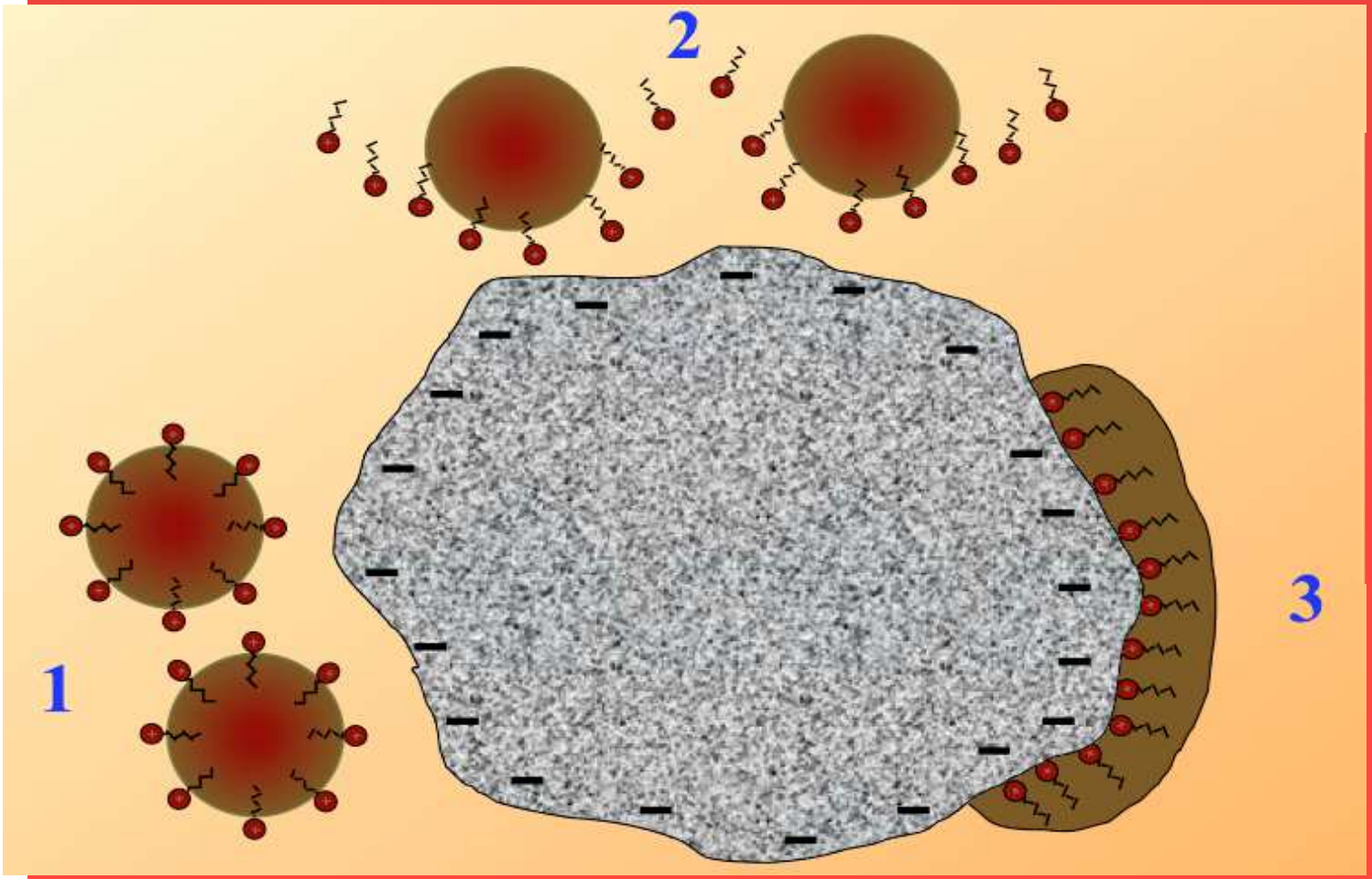
Cationic Emulsion

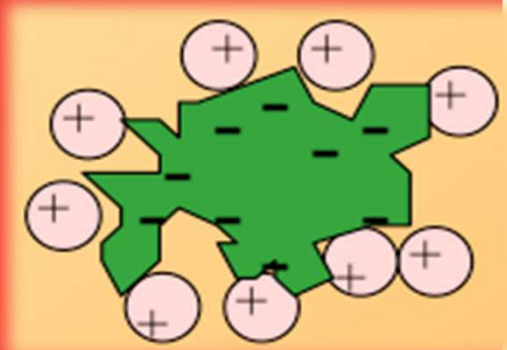
Simple MonoAmine Emulsifier

Amine Acid Alkyl-ammonium Chloride

Others: diamine, amidoamine, quarternary ammonium compound, alkoxylated amine

Emulsions form a chemical bond with aggregates



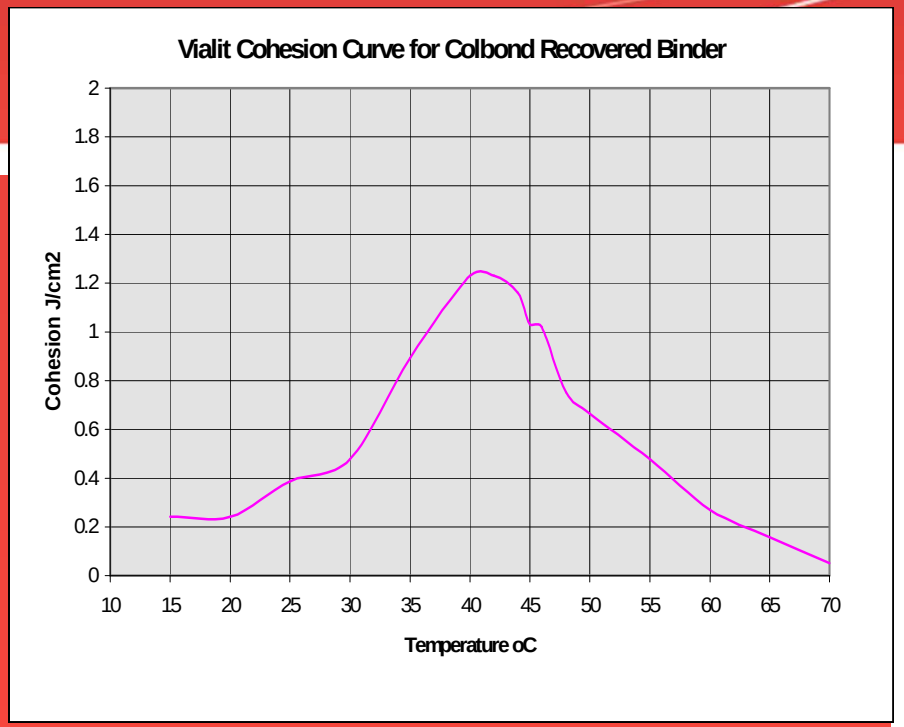


Bond Coats & Tack Coats

- Tack coat to BS 434
  - Cationic, rapid breaking, 40% unmodified binder – fluid emulsion for fine spray. Provides tacky surface to initiate adhesion.
- Bond coat (proprietary)
  - Highly cohesive binders applied hot at high rates to provide adhesion & waterproofing. Characterized by Vialit Pendulum Peak Binder Cohesion.

Vialit Pendulum

Peak Binder Cohesion



Application Rates

- Tack coat to BS 434
  - Typically 0.3-0.5 L/m^2 (0.1-0.2 kg/m^2 residual bitumen)
- Bond coat (proprietary)
  - Typically 0.5-1.0 L/m^2 (0.3-0.65 kg/m^2 residual binder)
- BS 594987 recommendations
  - Tack coat & bond coat at slightly higher rates, except when applied to newly laid asphalt

European Standards

EN Bitumen Emulsions

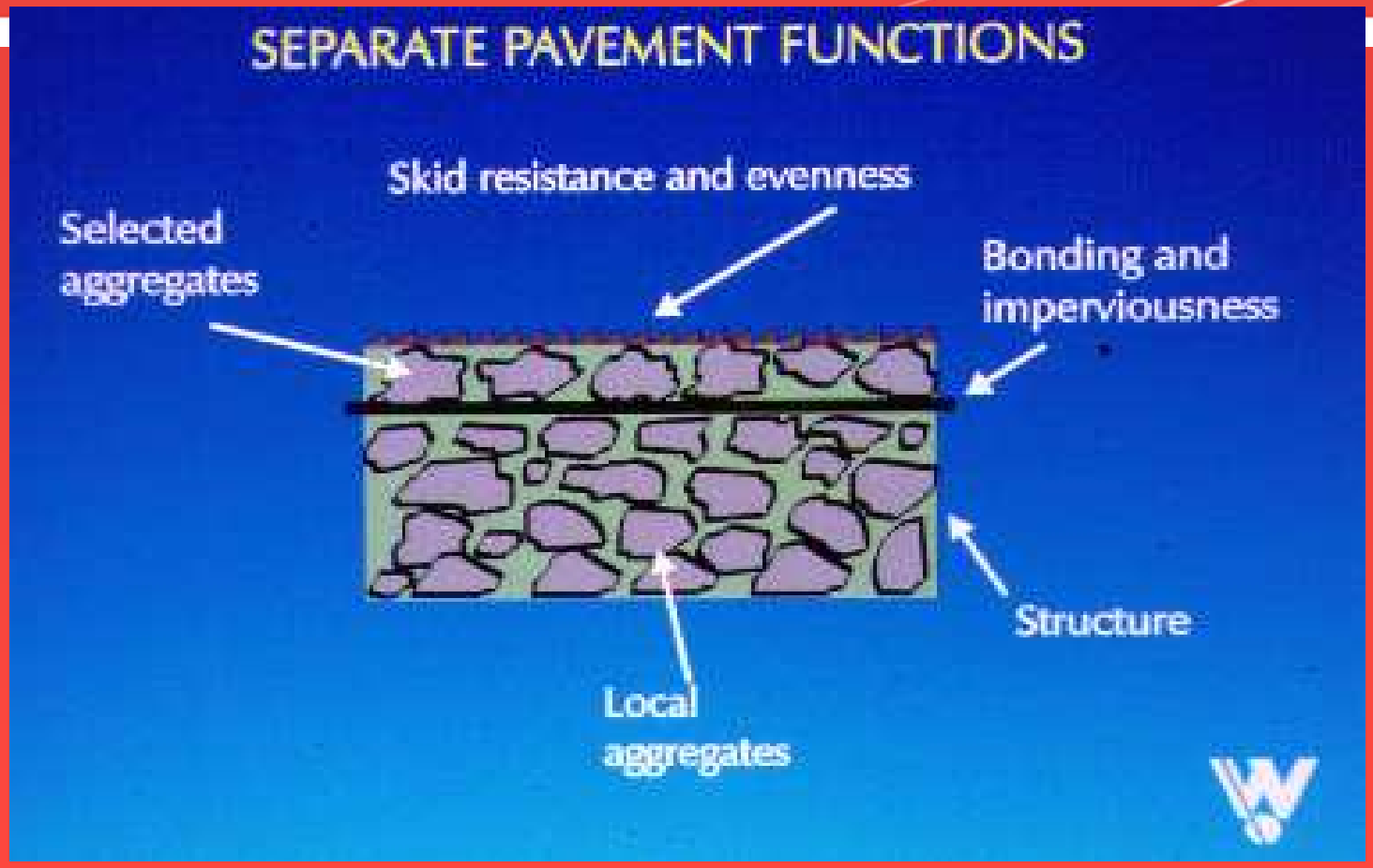
- BS EN 13808 (2005/2013)
  - Framework for specifying cationic bitumen emulsions
- Terminology
  - K1-40 (BS)
  - C40 B 4 or C40 BF 4 (EN)
- Properties
  - Emulsion, Recovered binder & Aged binder

Developments in France

French Directorate of Road's
HIGHWAY INNOVATION CHARTER
(1983)

Best innovative techniques, materials & processes in road construction

New philosophy of highway engineering design



- Adoption of very stiff bases
- Special surfacing with high specification constituents
- Reduced maintenance & road user costs

A13 Motorway in France

- 20 mm thick
- 6 mm stone
- 1 mm texture depth
- 10 years old development

Asphalt Thin Surfacing

- Flexible & resistant to cracking
  - thick binder film
- Resistant to shoving
  - good binder system
- Good adhesion to base
  - bond coat

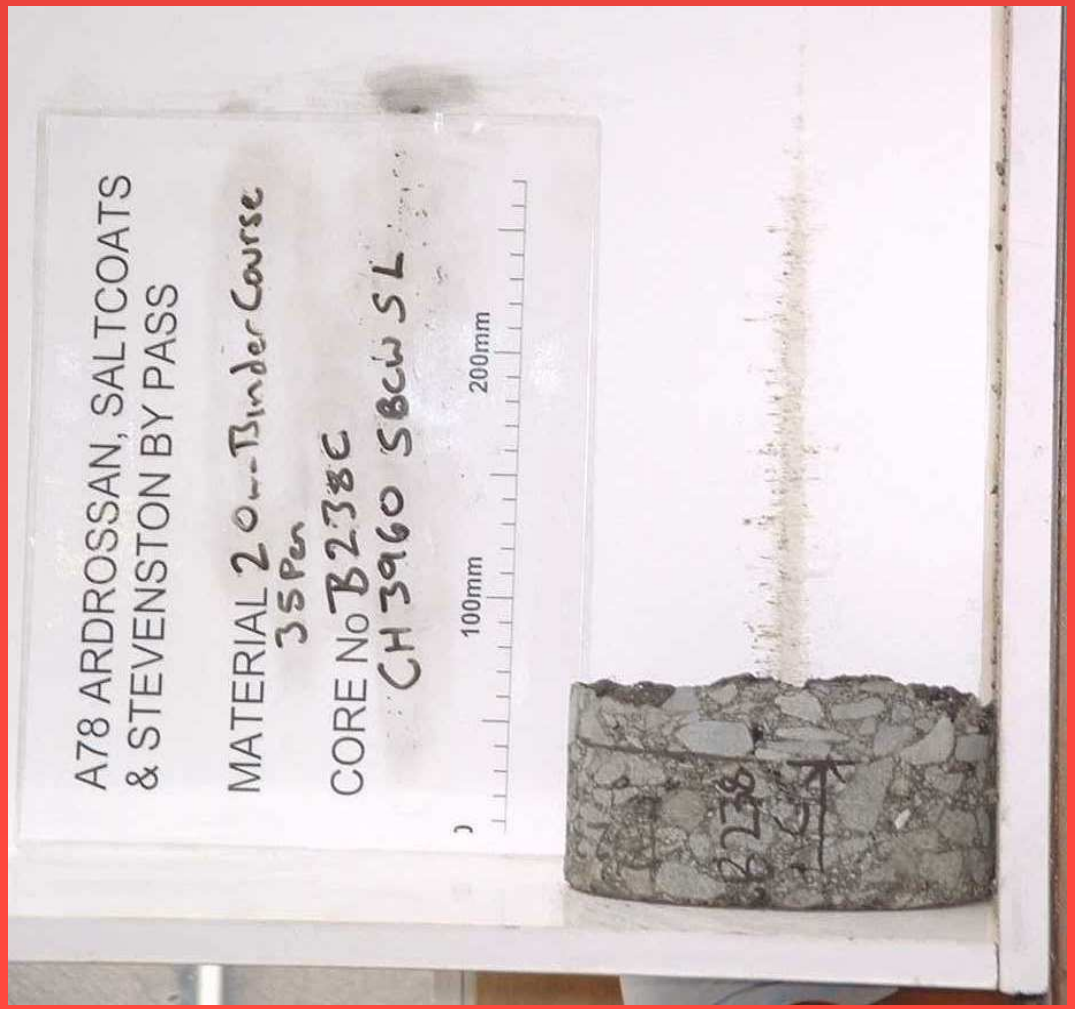
Bond Coat into the UK

- Safepave
  - Thin surfacing introduced in 1991 (originally SCREG Euroduit in France & Novachip elsewhere)
  - Only 15-20 mm thick & system relies heavily on thick bond coat
  - Pick-up on paver & truck tyres?
  - Paver integrated bond coat spraying device

Non pick-up Bond Coats

- Alternative to high cost & operational difficulties of paver integrated sprayer

Interlayer Bond Strength

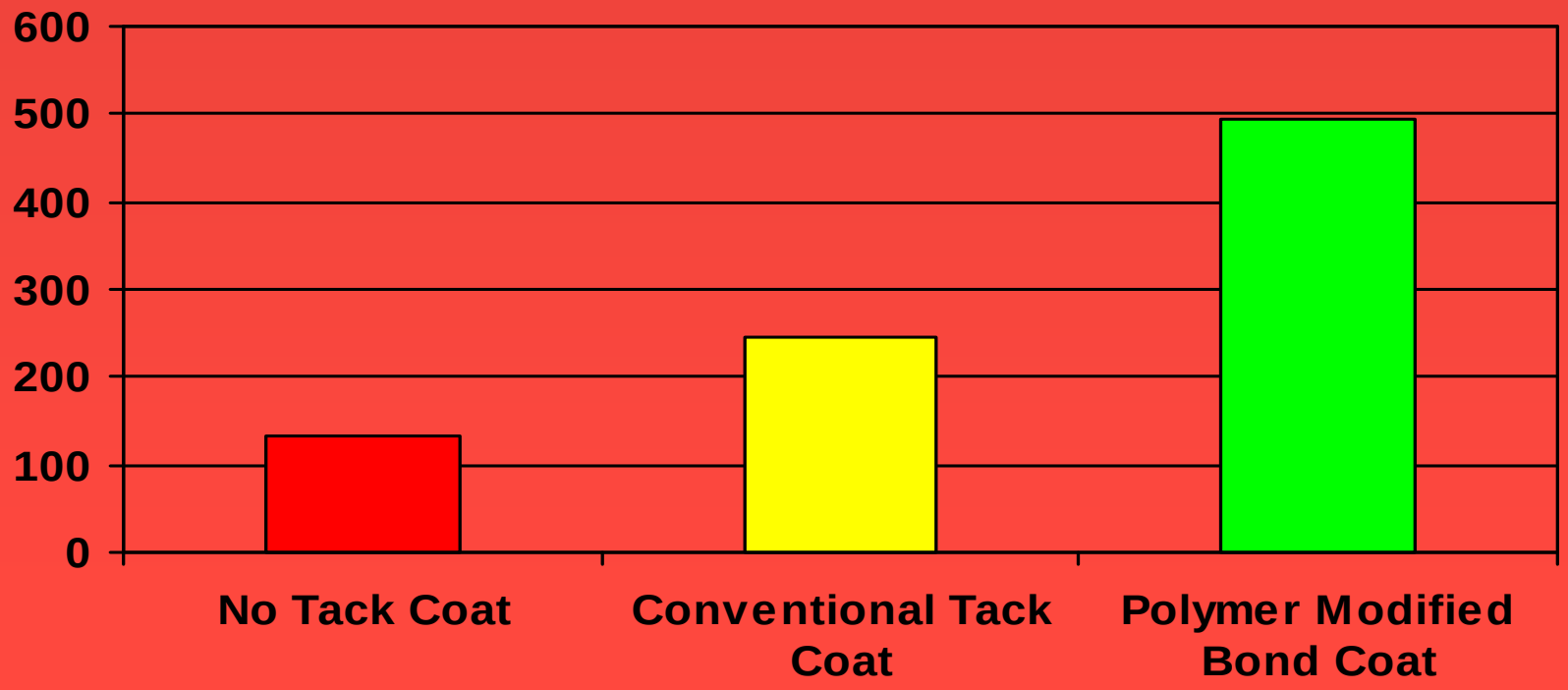


Interlayer Bond Strength

- Torque bond test
  - Simple method with hand held torque wrench
  - Torque applied to top of core induces twisting shear failure at interface
  - In-situ or laboratory
  - Adopted by HAPAS

Torque Bond Test Results

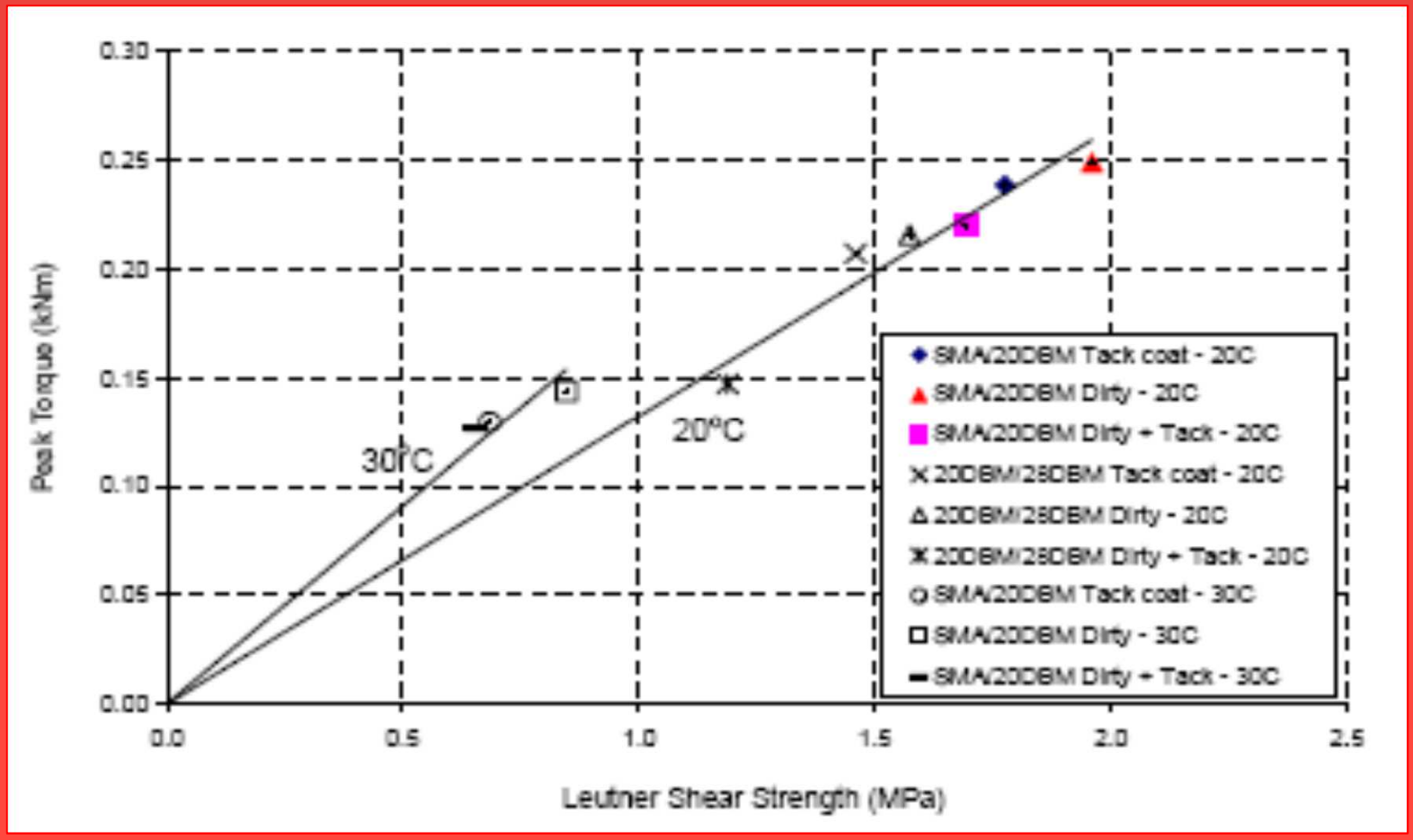
Inter-layer bond strength, kPa



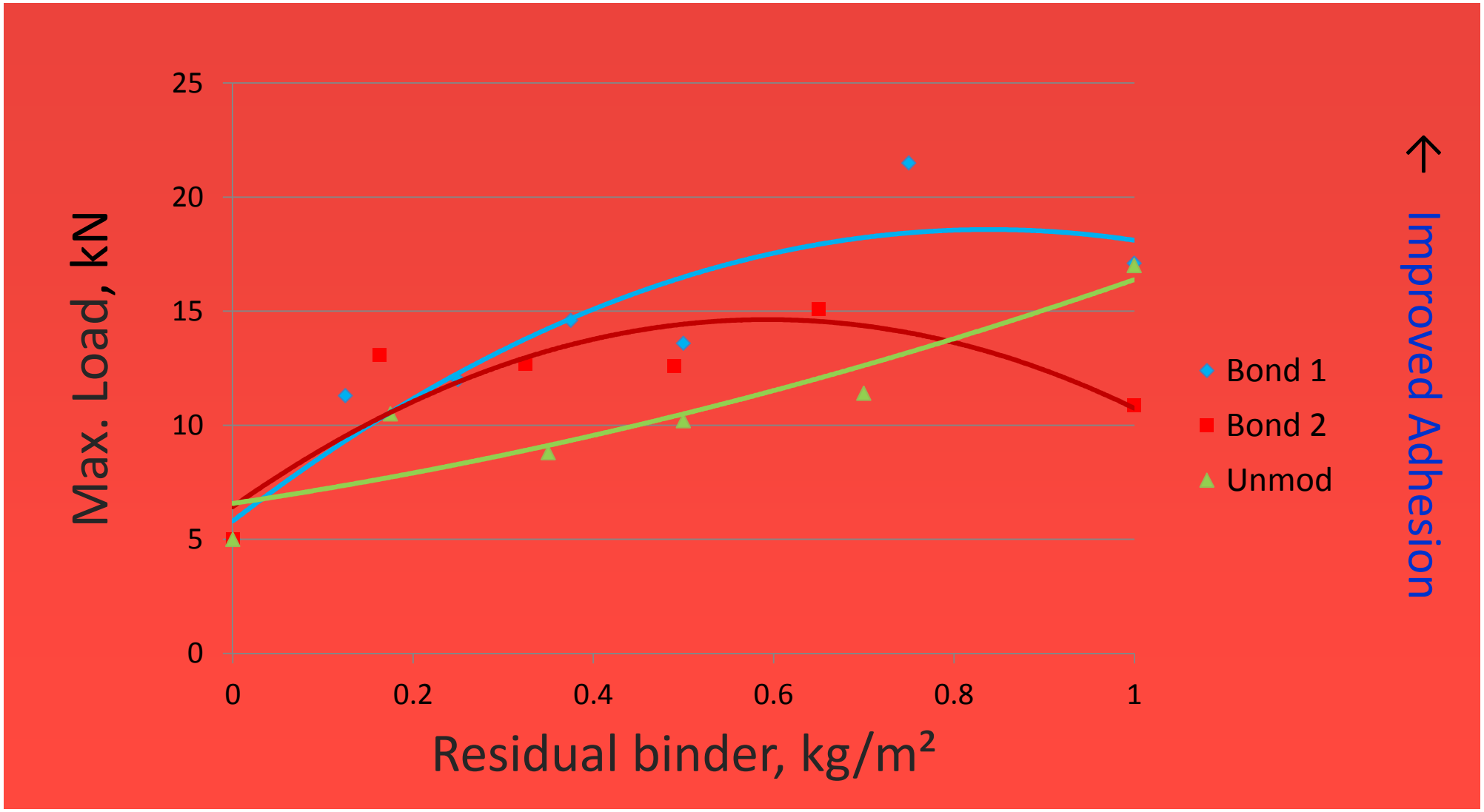
Interlayer Bond Strength

- Leutner shear test
  - German lab test
  - Simple means of direct shear test on bond between cores
  - Apply shear displacement rate & measure shear force

Correlation between Torque & Leutner test results



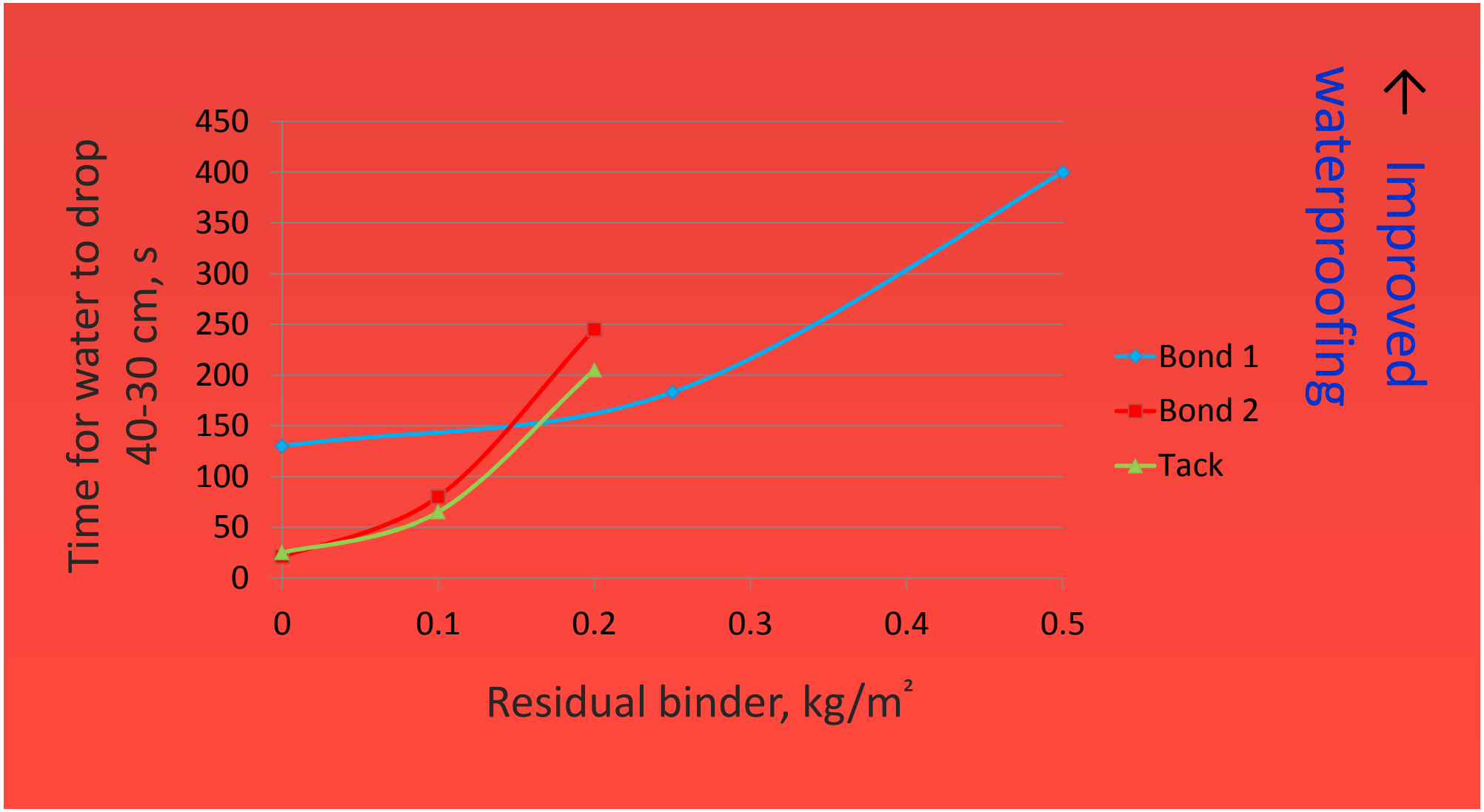
Leutner Shear Adhesion versus Spread Rate (asphalt on concrete)



Effect of bond coat on pavement performance

- Thick bond coat
  - waterproofing
- Full layer adhesion
  - improved bearing capacity

Ad Hoc Falling Head Permeability



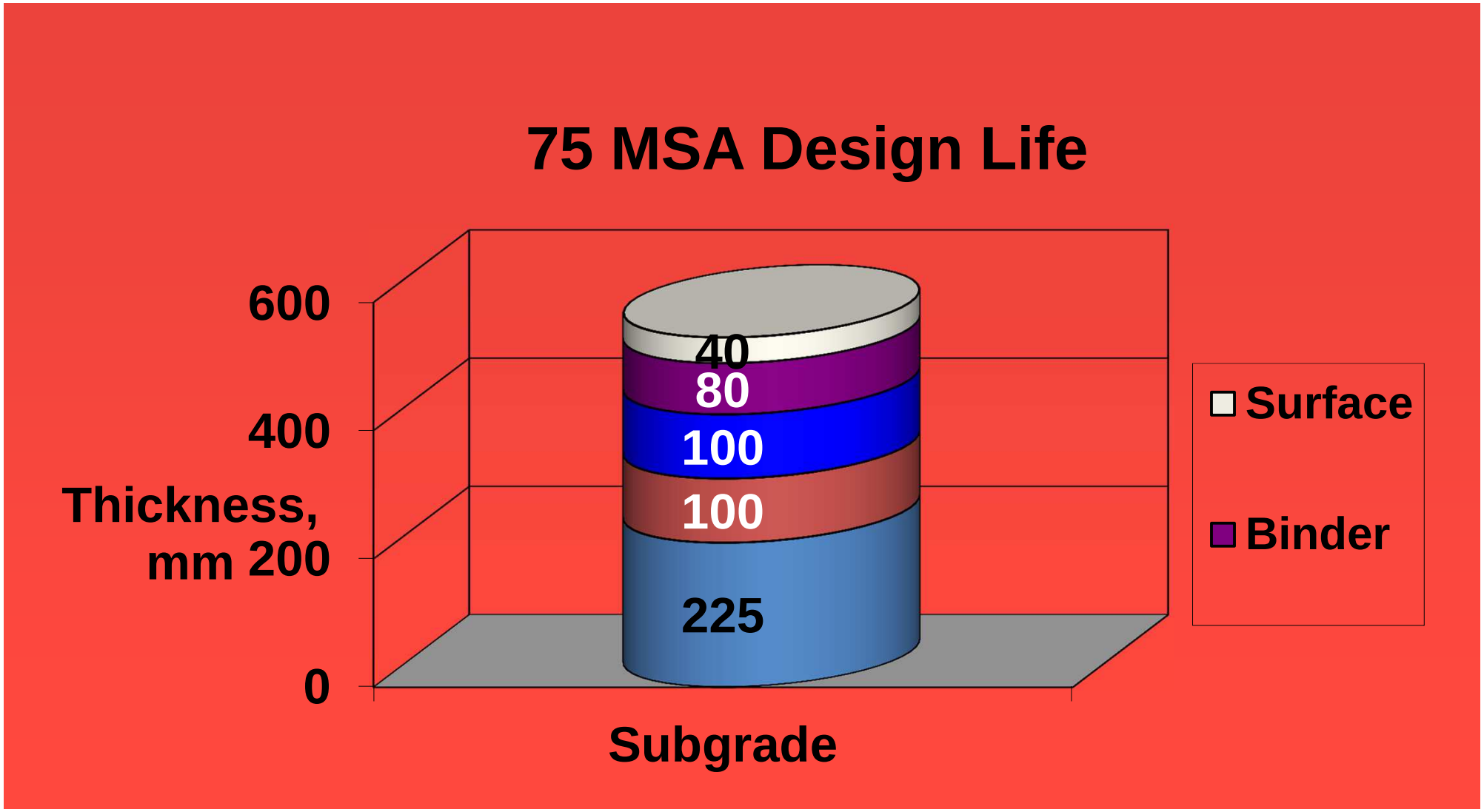
Effect of interlayer bond on pavement performance

- French Experience
  - 1980s study of French national roads concluded 5 % of roads failed at 10 years versus design life of 20 years due to inadequate bonding

British Study – examination of cores

Site	% de-bonding	Site	% de-bonding
1	82	6	100
2	86	7	87
3	36	8	73
4	85	9	73
5	90	10	100

Typical Flexible Pavement



Pavement Evaluation

Interlayer Bond Condition				% Life
Surface	Binder	Base	Base	
Full				100
Partial	Full			84
Poor	Full			69
Partial				64
Poor	Full			40
Poor				13

Conclusion

- Good seal is essential for protection of pavement against air and water
- Good bond between pavement layers is essential for structural performance
- Good bond coat can provide enhanced waterproofing & bond
- Pavement must be well constructed
  - i.e. bond coat isn't everything!

END

Image with caption