
# Spraying Emulsions, Formulation Challenges In The UK

Swedish Tank Group UK Visit

May 2012

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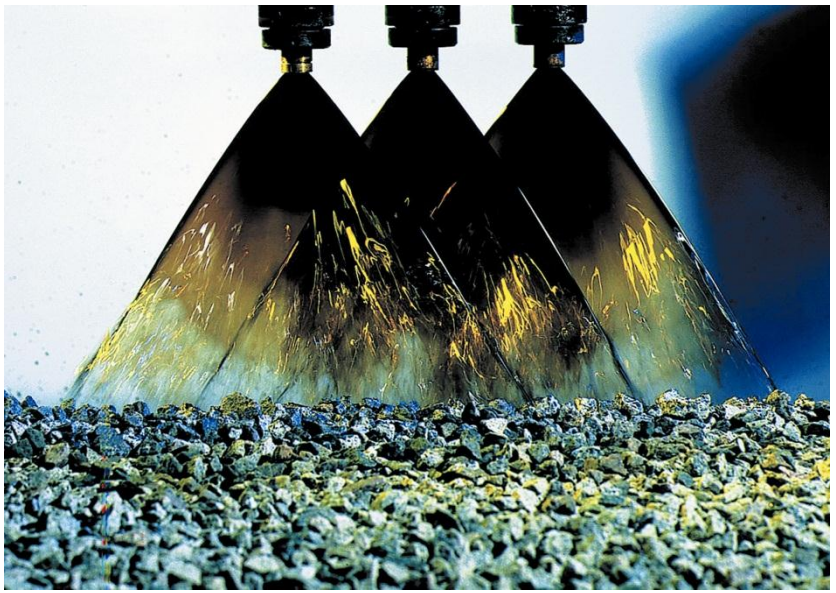
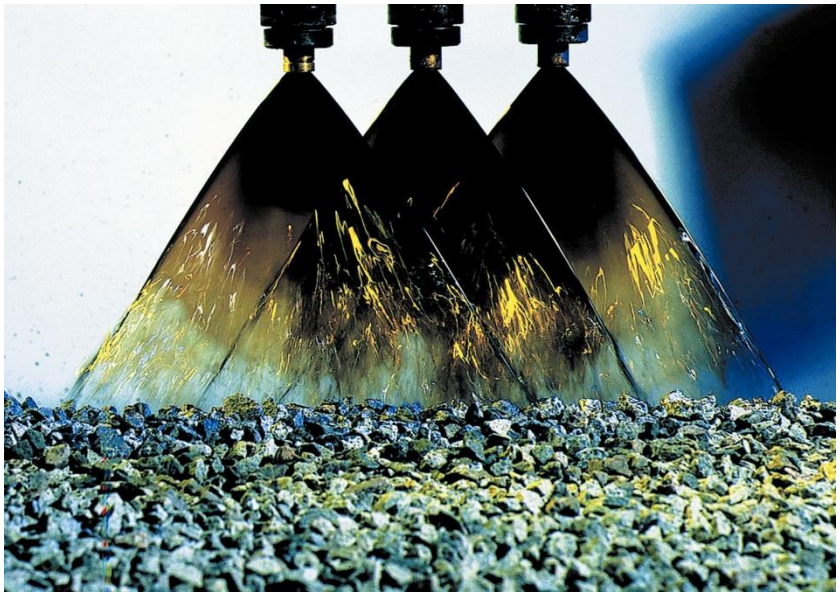
# What Is The Challenge?

- 1) Emulsion must meet requirements for storage and application.
- 2) Emulsion break characteristics and cohesion development must be sufficient to allow early trafficking or loading.
- 3) Cured binder within system must cope with loading and environmental conditions.



# Exploring The Challenge



- Emulsion Design.
- Binder Evaluation
- Performance Testing

# Emulsion Design

- What are the mechanisms involved during
  - Production
  - Storage
  - Transportation
  - Application
    - Specifications
  - Loading
    - Performance requirements

## Production

- Is it a batch or continuous plant
- Is heating available for water and/or emulsifier
- What are the key physical requirements
- Have I got control
- Don’t forget the water

## Storage

- Do I need emulsion Hot or cold
- Will emulsion deteriorate if stored at a certain temperature
- How long do I need to store; Do I need stirring?
- Do I need to stabilise against shear from  stirring
- Are there any compatibility issues
- What are the shear effects of my pumping system

## Transportation

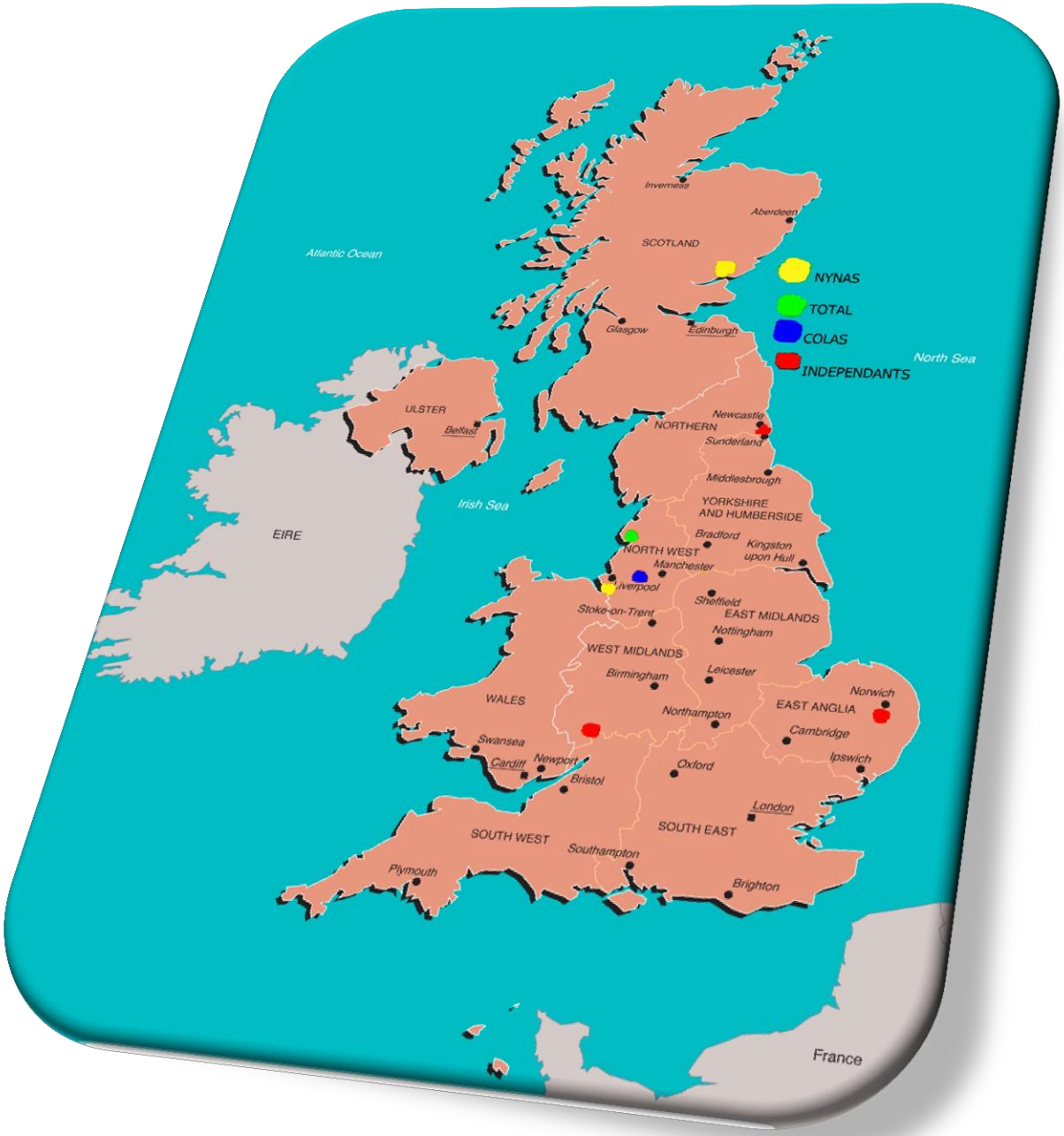
- How long will the material be transported for
- What is the transportation method
- What are the shear effects of the transfer pumps

## Application

- What is the application method and temperature
- Does the spray nozzle configuration affect  sprayability
- How soon do I want to apply traffic
- How soon can I sweep a surface dressing
- Do I need special plant for applying

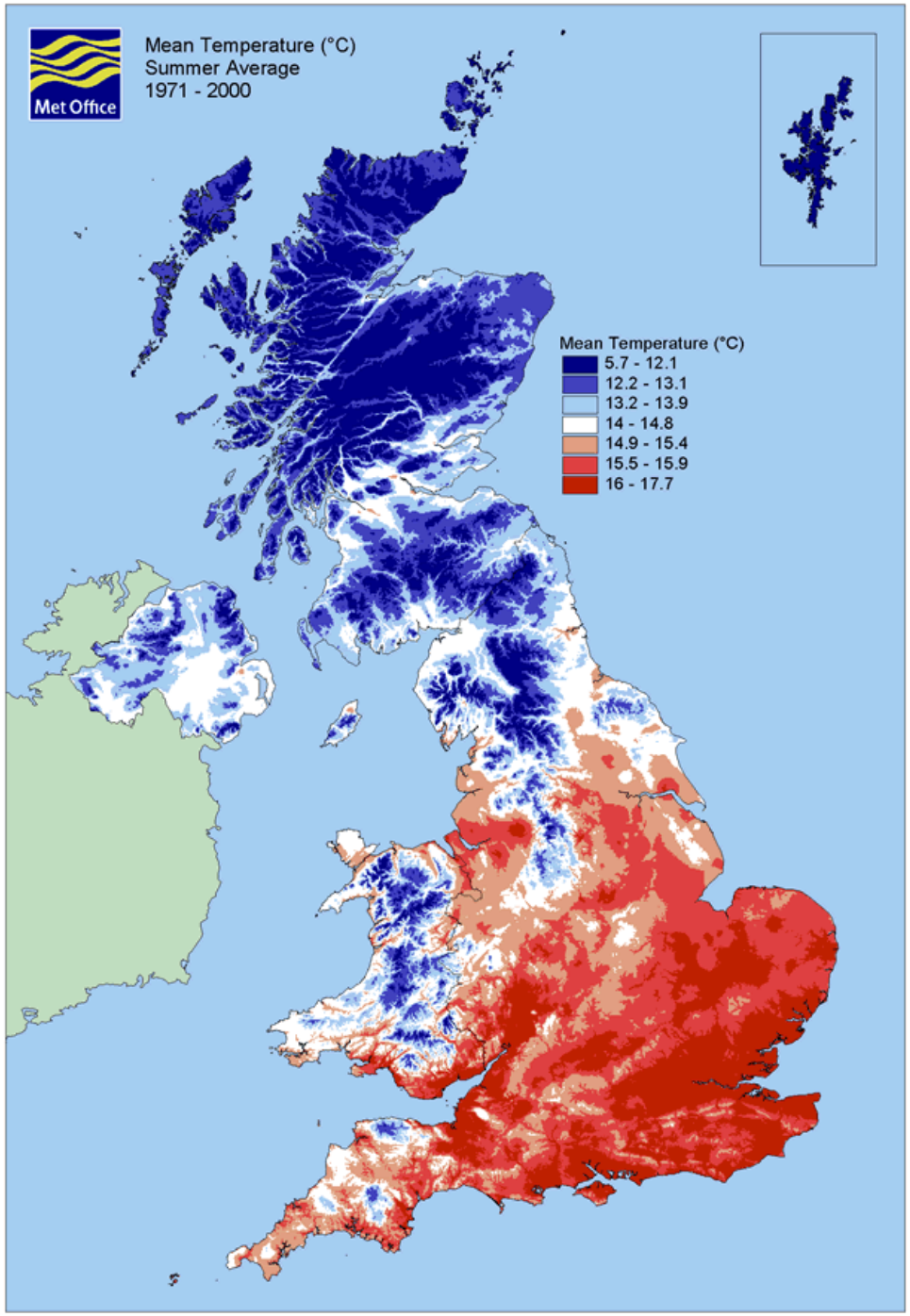
# Loading

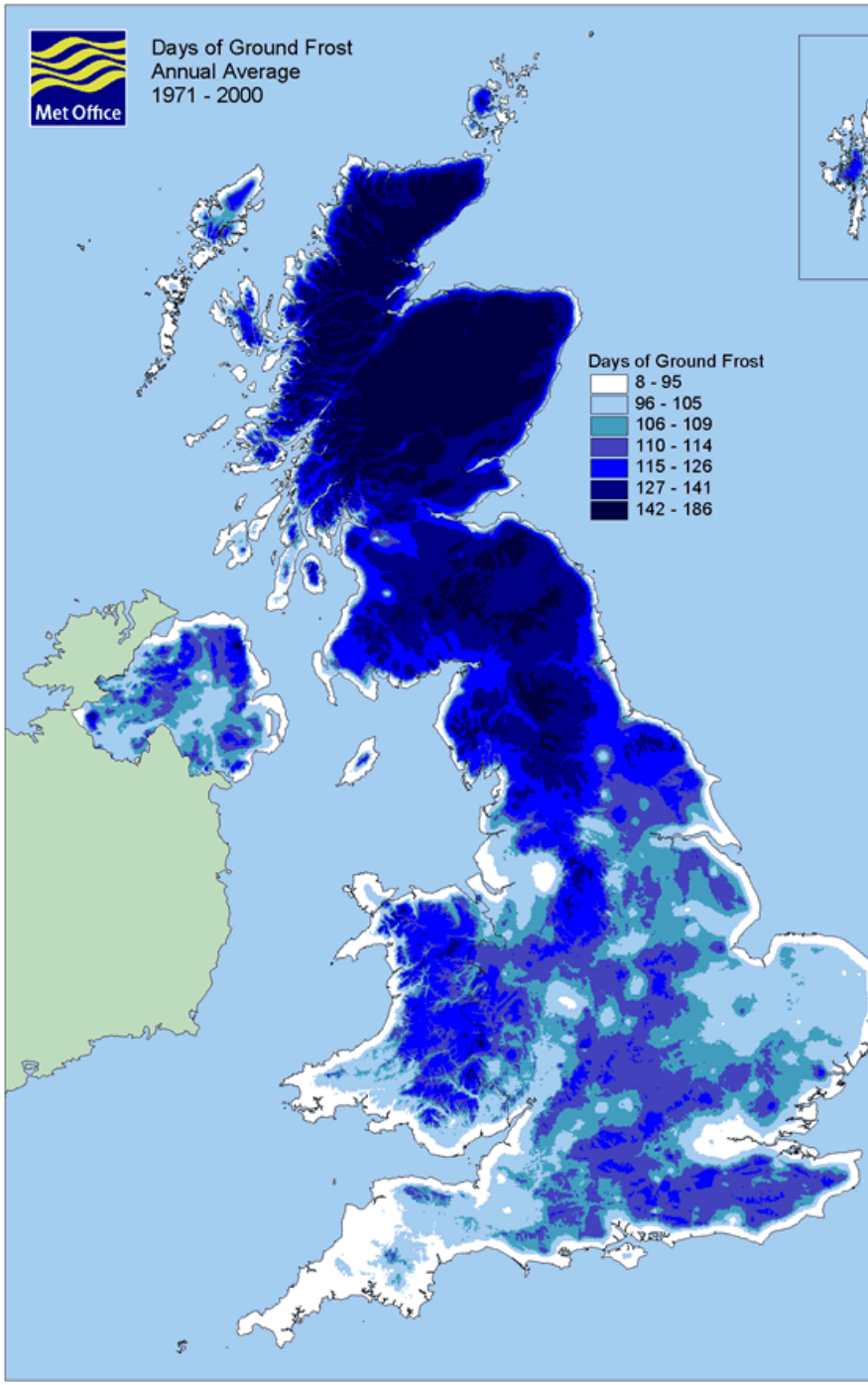
- What traffic level for surface dressing.
- Resistance to pick up by  traffic..
- What are the type of stresses that are occurring.
  - Approaches to Junctions
  - Approaches to pedestrian crossings
  - Bends


Atlantic Ocean
Inverness
Aberdeen
SCOTLAND
NYNAS
TOTAL
COLAS
INDEPENDANTS
Glasgow
Edinburgh
North Sea
ULSTER
Belfast
NORTHERN
Newcastle
Sunderland
Middlesbrough
Irish Sea
YORKSHIRE
AND HUMBERSIDE
EIRE
Bradford
Kingston
upon Hull
NORTH WEST
Manchester
Liverpool
Sheffield
Stoke-on-Trent
EAST MIDLANDS
Nottingham
WEST MIDLANDS
Birmingham
Leicester
WALES
Norwich
EAST ANGLIA
Northampton
Cambridge
Swansea
Cardiff
Newport
Oxford
Ipswich
Bristol
London
SOUTH EAST
SOUTH WEST
Southampton
Plymouth
Brighton
France

# Binder Evaluation


- What are the job requirements.
  - Traffic Loading.
  - Polymer or not.
  - Climatic Variations.
  - Bond Strength.
  - Adhesion.


Met Office
Mean Temperature (°C)
Summer Average
1971 - 2000
Mean Temperature (°C)
5.7 - 12.1
12.2 - 13.1
13.2 - 13.9
14 - 14.8
14.9 - 15.4
15.5 - 15.9
16 - 17.7


Met Office
Days of Ground Frost
Annual Average
1971 - 2000
Days of Ground Frost
8 - 95
96 - 105
106 - 109
110 - 114
115 - 126
127 - 141
142 - 186

# Performance Testing

- **Emulsion**
  - Reactivity
  - Cohesion development,
  - Viscosity
- **Binder**
  - Cohesive Strength using vialit pendulum .
  - Rheology using Dynamic shear Rheometer.
  - Adhesion using water sensitivity test.
  - Durability by ageing test.

# Surface Dressing Challenge

- Traditionally had 2 gangs one to apply and one for traffic management.
- Culture and market change requires 1 gang and rapid opening to traffic.
- Challenge to keep emulsion stable but have excellent early chip retention.

- 4 stages to surface dressing process
  - Stability & Viscosity control.
  - Reactivity with aggregate.
  - Cohesion Development.
  - Restructuring of polymer matrix.

# UK Emulsion Specifications

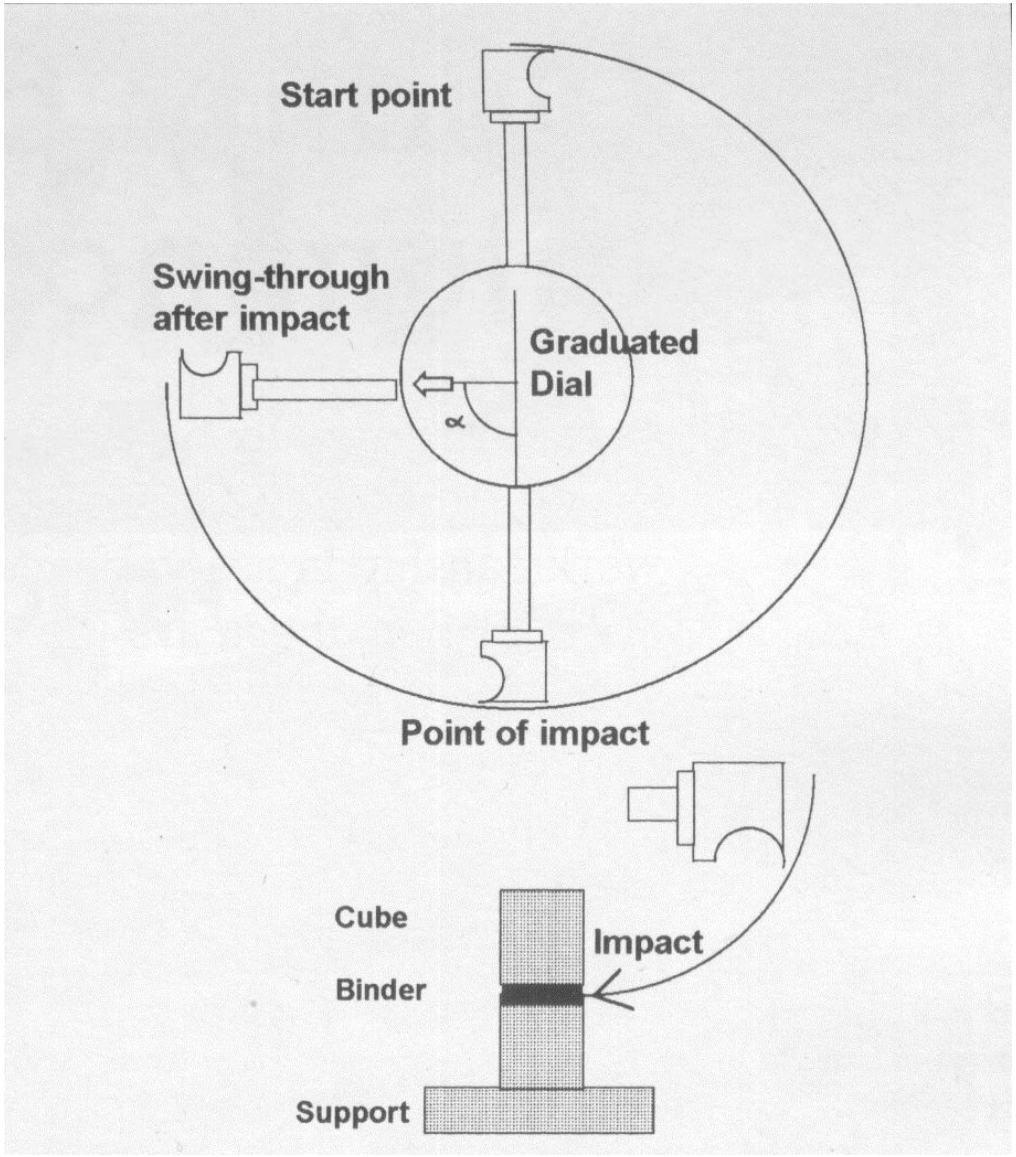
- Viscosity
  - Old BS434 =Redwood 2 @85$^{o}$C
  - En13808 = No specification
    - Some use Brookfield others use STV
- Bitumen Content
  - Old BS434 = 67% minimum
  - En 13808 = No specification but needs to be 67% minimum
- Spraying Temperature
  - Old BS434 = 85$^{o}$C
  - En13808 = No requirement

# UK Binder Specifications

- Nearly all has to be polymer Modified.
- Cohesion specification based on Vilalit Pendulum
  - Unmodified = class 3
  - Intermediate =class 4
  - Premium = Class 5
  - Super premium = class 6
- Rheology has to be reported.
- Properties of binder after recovery from emulsion and after ageing.

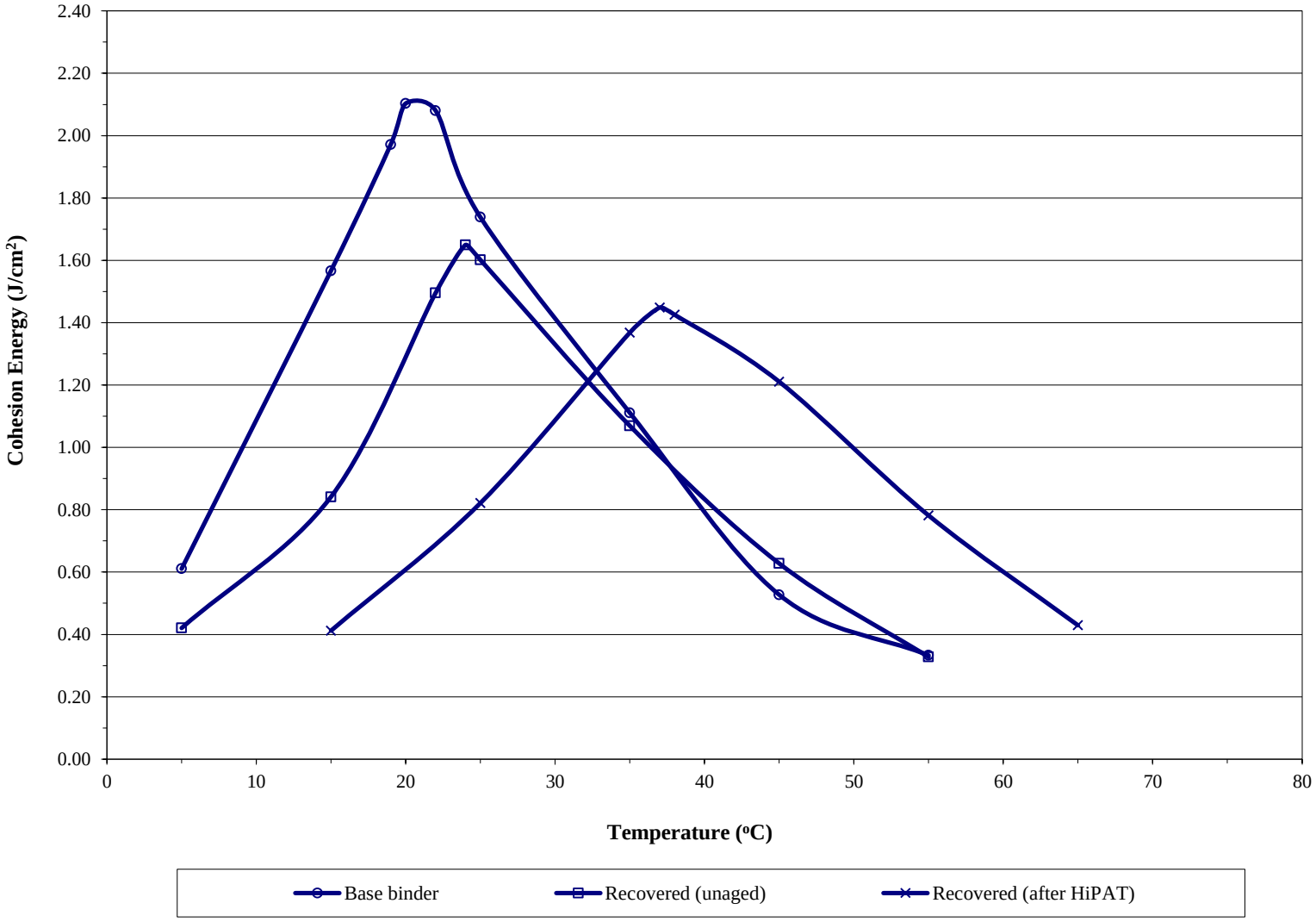
# Stability and Viscosity control

- Emulsifier choice.
- Production parameters.
- Particle size distribution.
- Modifiers and stabilisers


Start point
Swing-through
after impact
Graduated
Dial
α
Point of impact
Cube
Binder
Impact
Support

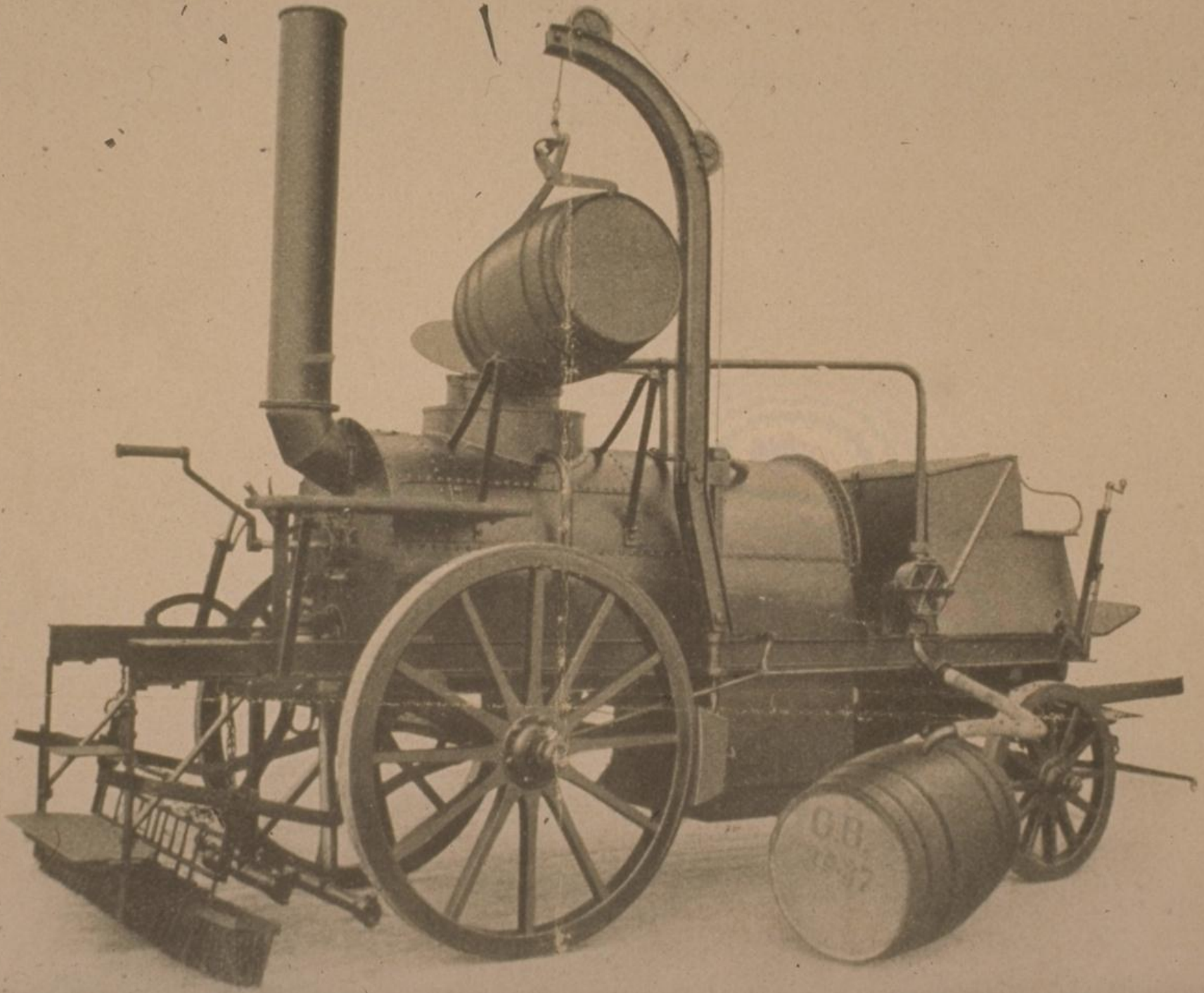
# Cohesion – Vialit Pendulum

- 1mm binder film
- Pendulum arc 0.5m
- Mass 1.8kg
- ~ 40kmh$^{-1}$ at point of impact
- Binder can:
  - resist
  - shatter
  - delaminate
- Temperature effects

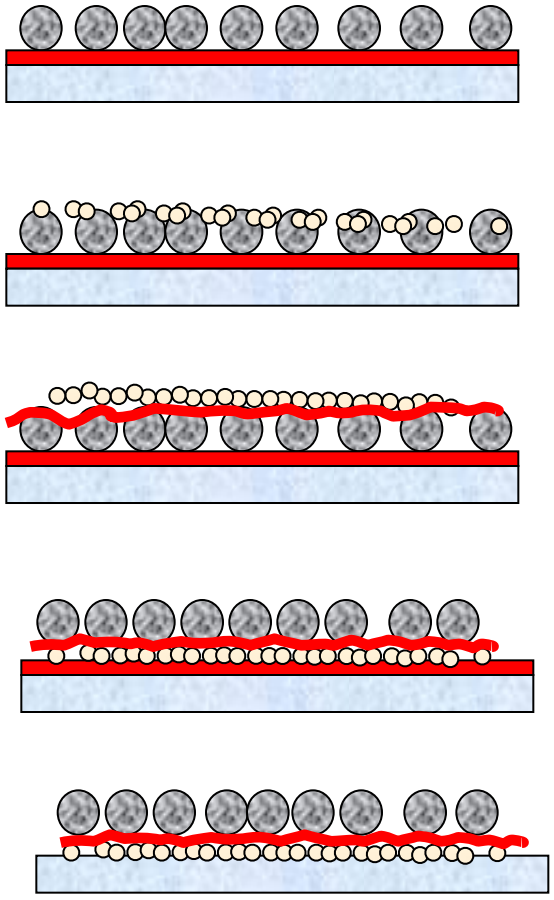

Cohesion Energy (J/cm²)
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
10
20
30
40
50
60
70
80
Temperature (°C)
Base binder
Recovered (unaged)
Recovered (after HiPAT)

# Further UK specifications based on DSR measurements

- Further UK specifications based on DSR measurements.
  - Ageing index $G^*_{aged}/G^*_{unaged}$.
  - Temperature where G* =2Kpa.(analogous but not equal to S.pt)
  - Temperature where G* = 2Mpa.
  - Temperature value of  T2Mpa-T2Kpa.( Indicator for temperature susceptibility)
  - Low delta high temp indicates good rutting resistance.
  - High delta low temp indicates good healing properties.



# Types of Surface Dressing



Single Dressing

Uses least amount of material, limited tolerance to stresses

Racked-in Dressing

Mainly used where traffic is heavy or fast

Double Dressing

More robust than racked in and used on binder lean surfaces

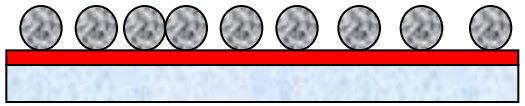
Inverted Double Dressing

Used on roads of uneven hardness or surfaces that are very hard

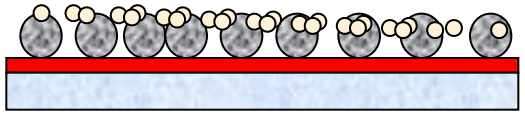
Sandwich Dressing

Used on Binder rich surfacing

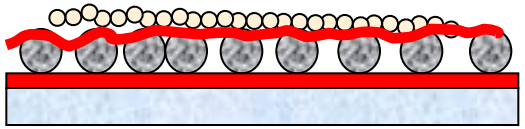
# Types of Surface Dressing



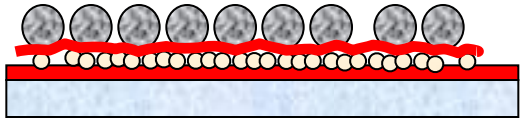
Single Dressing



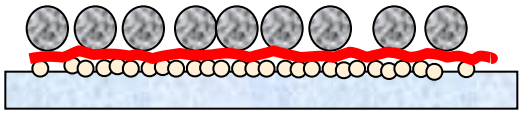
Racked-in Dressing



Double Dressing



Inverted Double Dressing



Sandwich Dressing

# Site variables

- Climate
- Exposed or shaded
- Flat or hilly
- Dry or humid
- Underlying surface properties
- Traffic levels
- Public safety

# August 2006


Air temperature 36.5°C
Road temperature 53°C

# June 2007

140mm of rain (Hull, Sheffield)
70mm of rain in <12h
Roads under water for several days

# January 2010

Air temperature -15°C
Prolonged zero/ sub-zero temperature

# Bitumen Behaviour - *Thermoplastic*

Hot

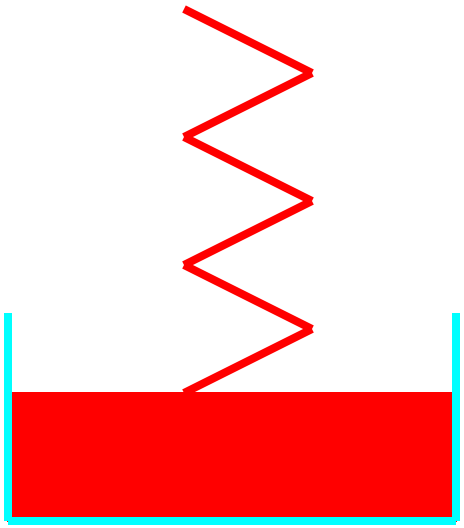
Soft
*Fatting up*

Cold

Brittle
*Fretting*

Difference between
softening point and brittle point
should be as great as possible

# Bitumen Behaviour – *Visco-elastic*



Spring

*Elastic (rigid)*

High Speed

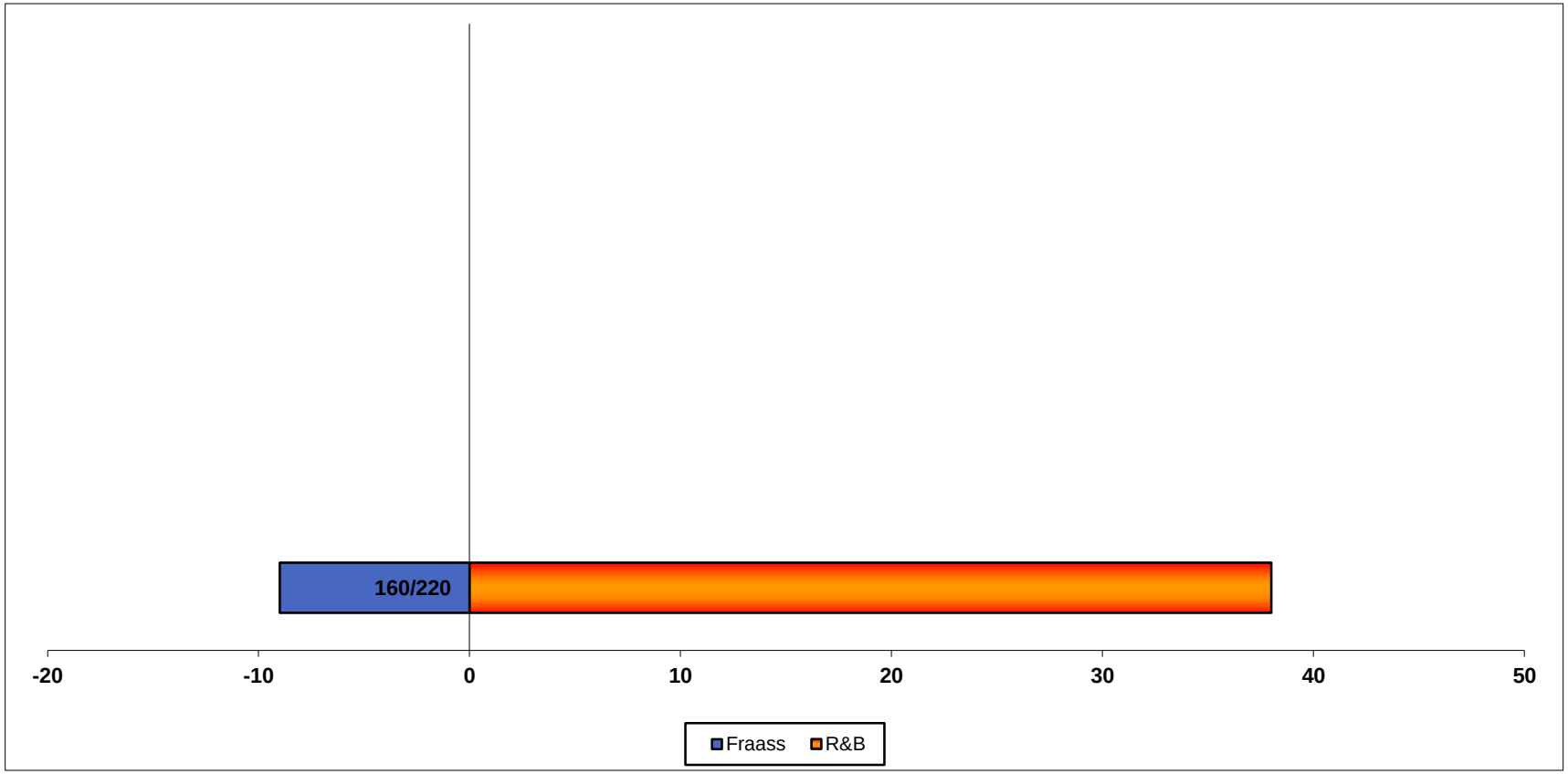
Dashpot

*Viscous (Soft)*

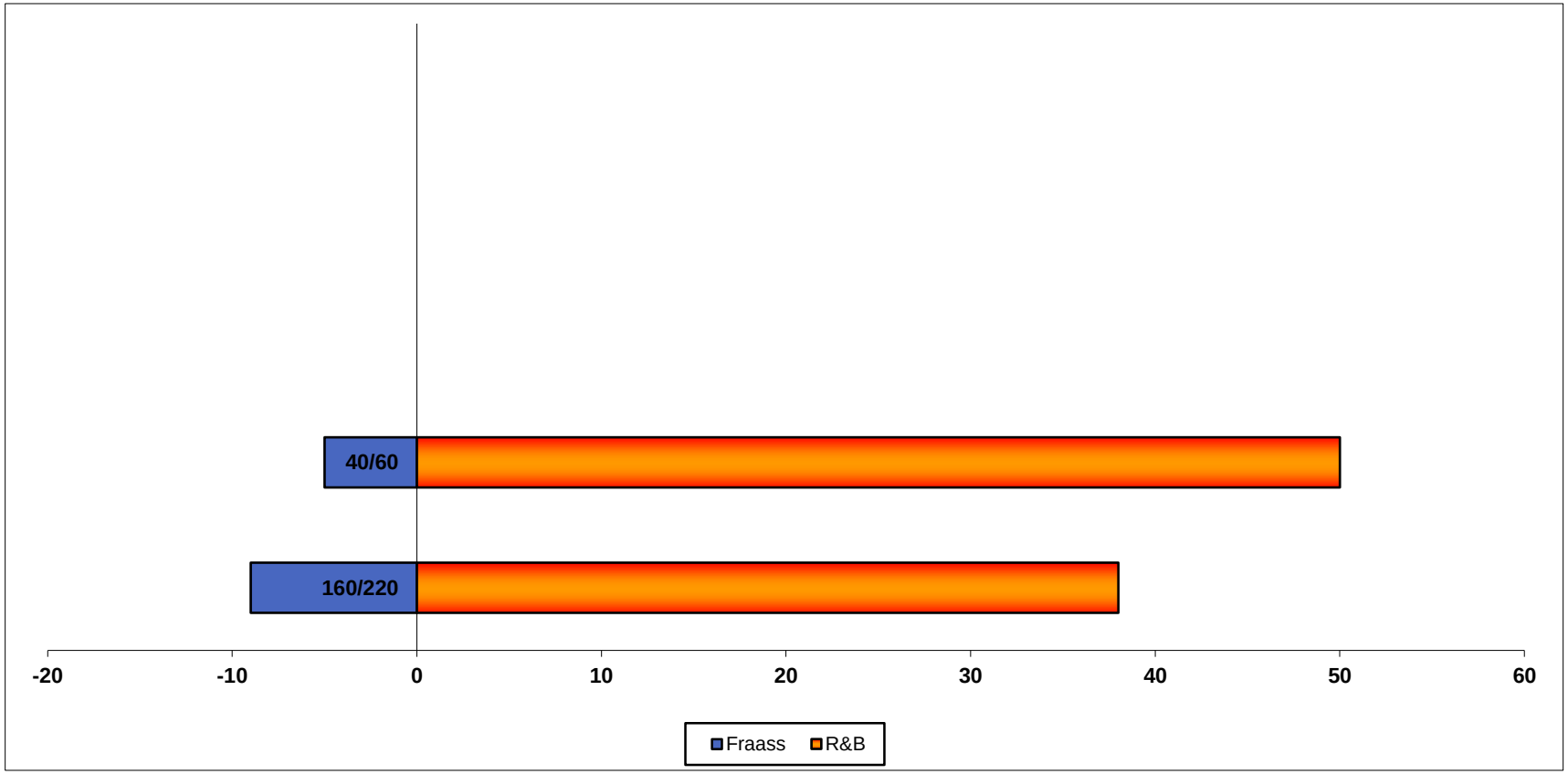
Low Speed

Elastic behaviour is preferable

# Plasticity Range – 160/220 Pen Bitumen



# Plasticity Range Improvement



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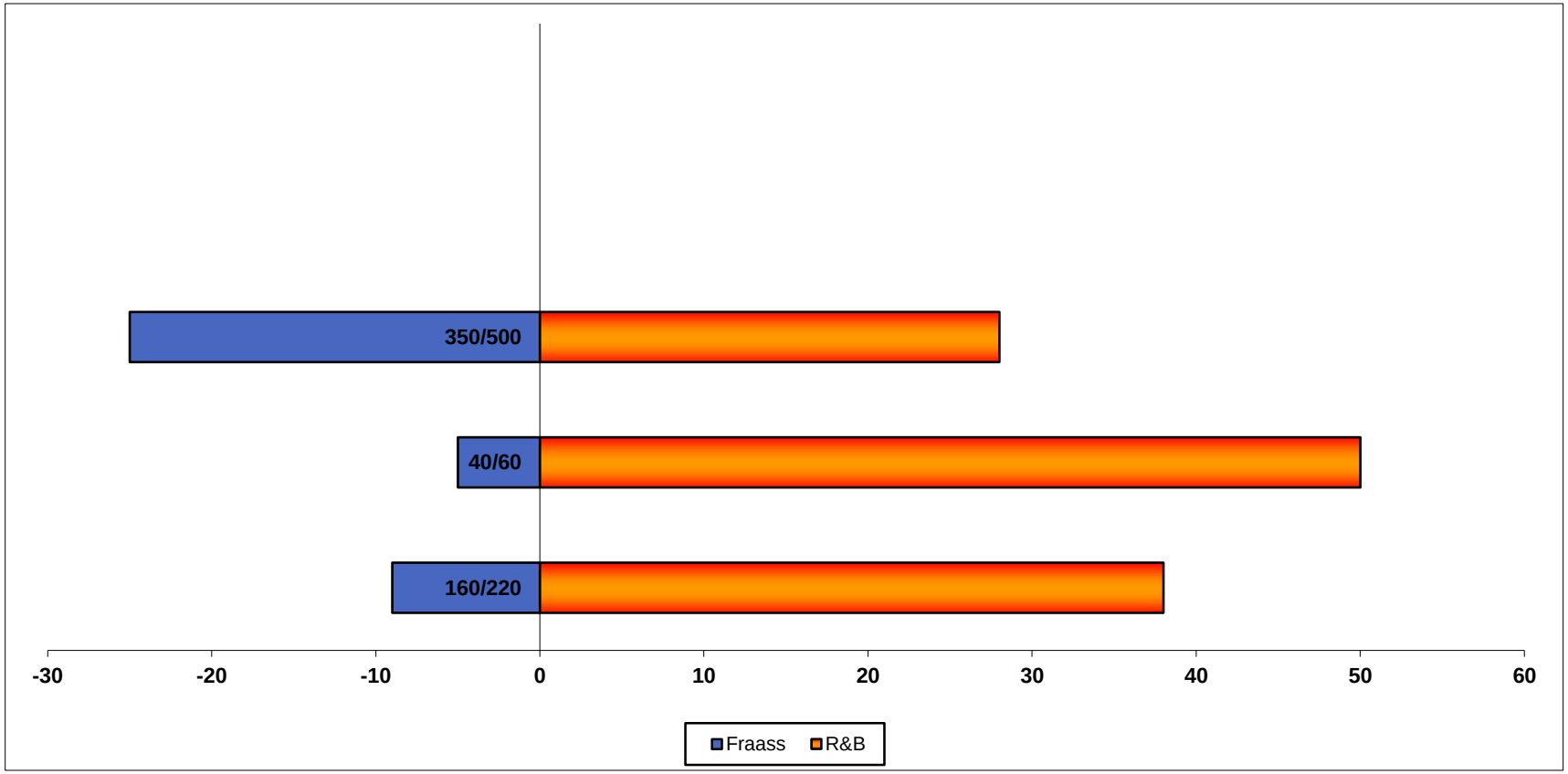

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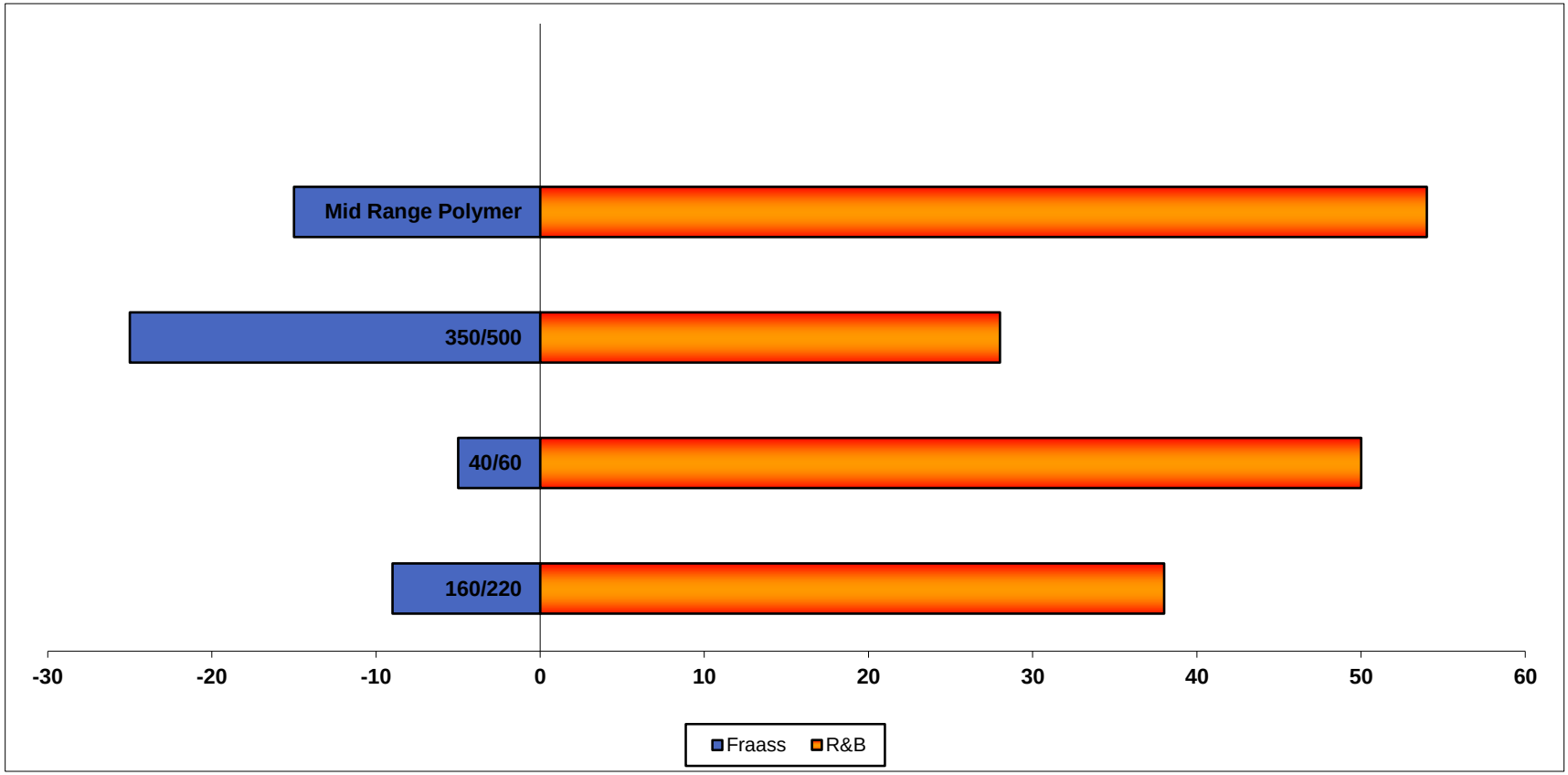
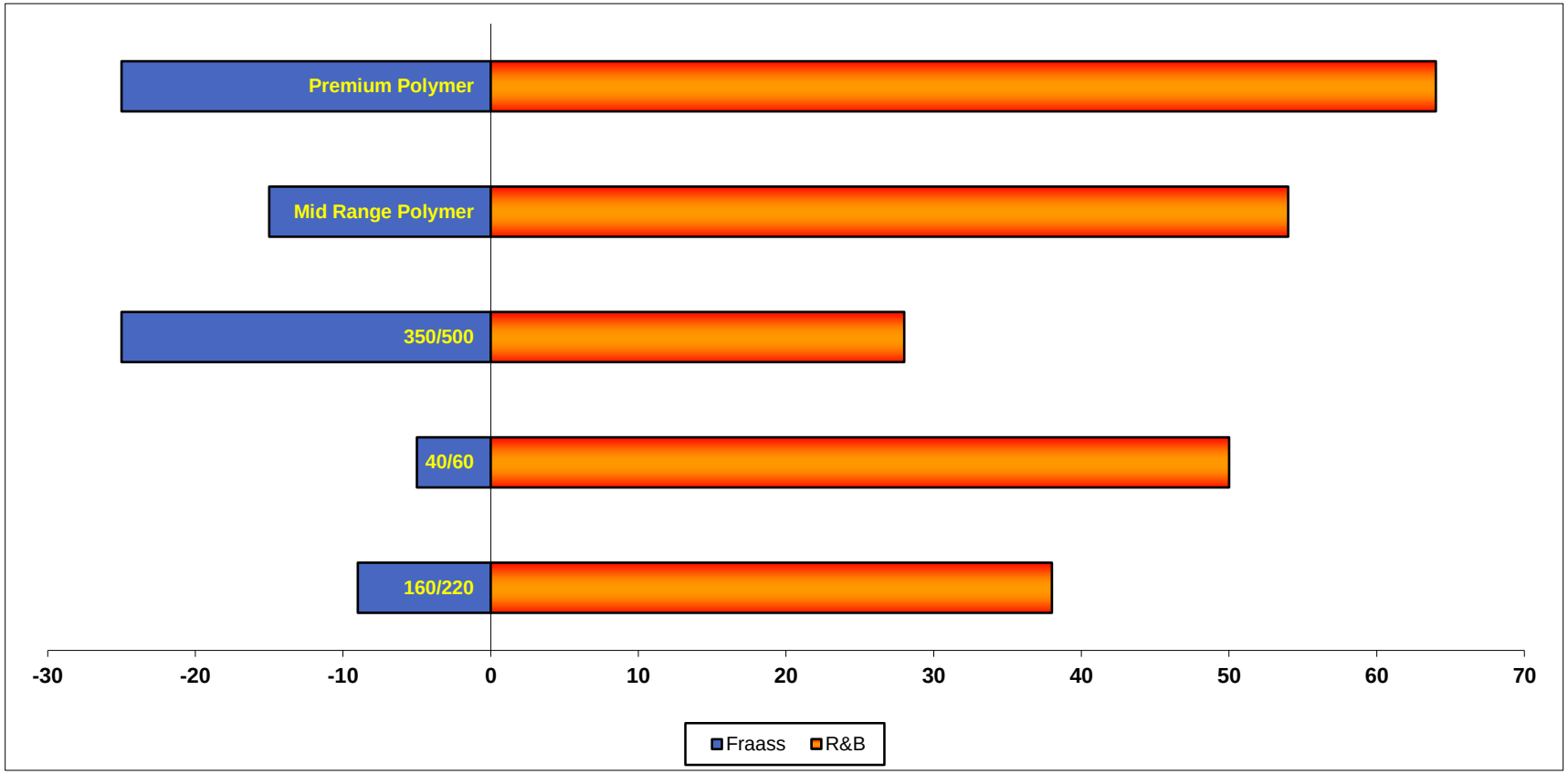


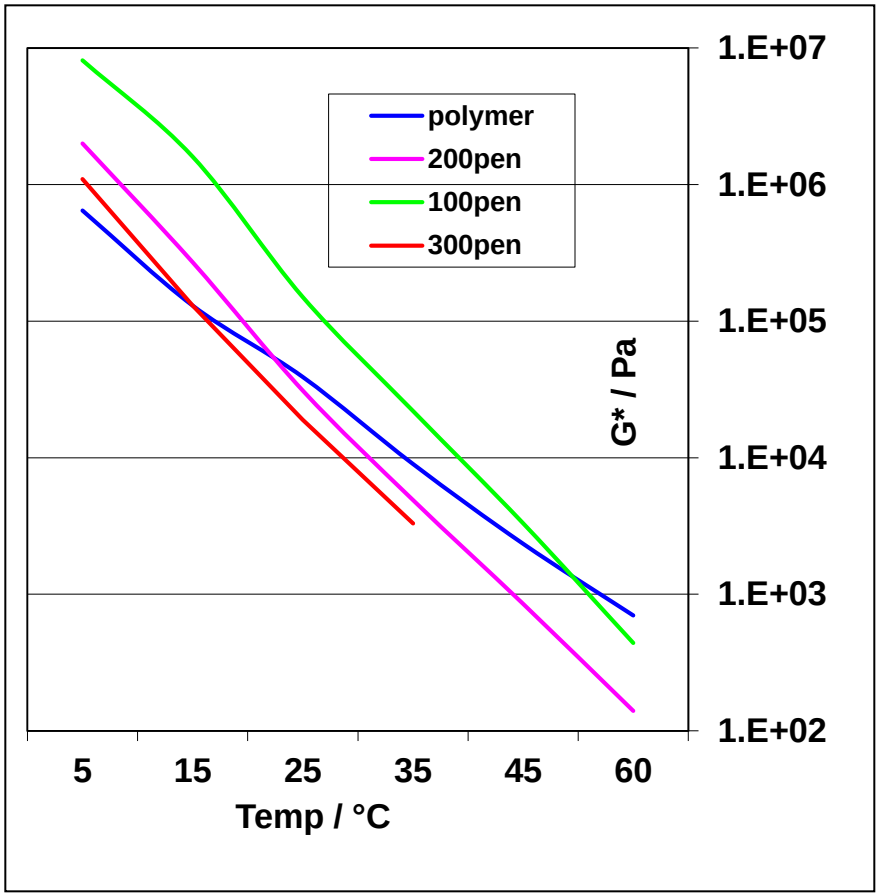
# Plasticity Range Improvement



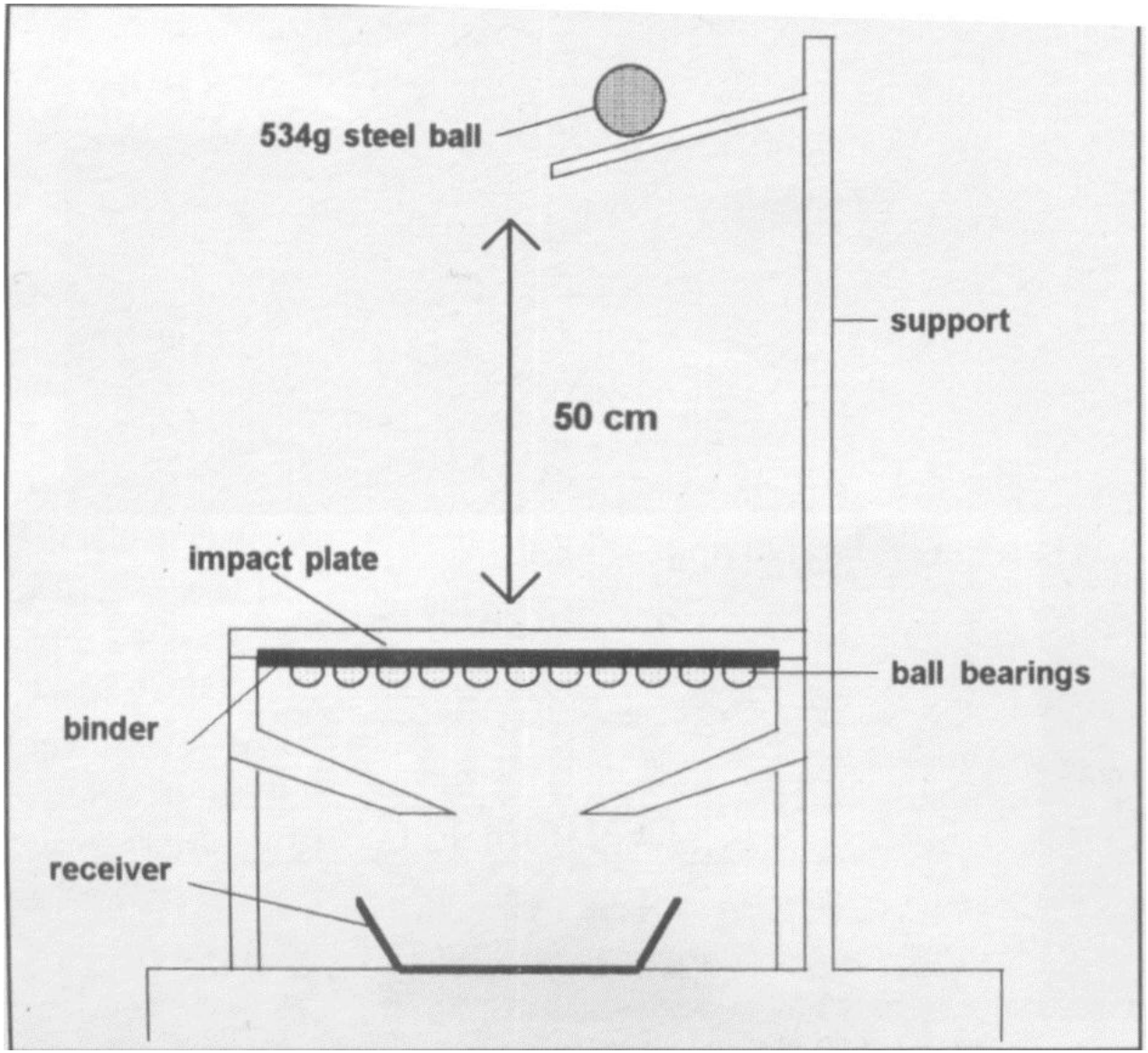
# Service Range

| | 195pen | 50pen | 450pen | Polymer Modified |
|---|---|---|---|---|
| Softening Point | 39 | 50 | 28 | 76 |
| Brittle Point | -20 | -10 | -30 | -25 |
| Range | 59 | 60 | 58 | 101 |

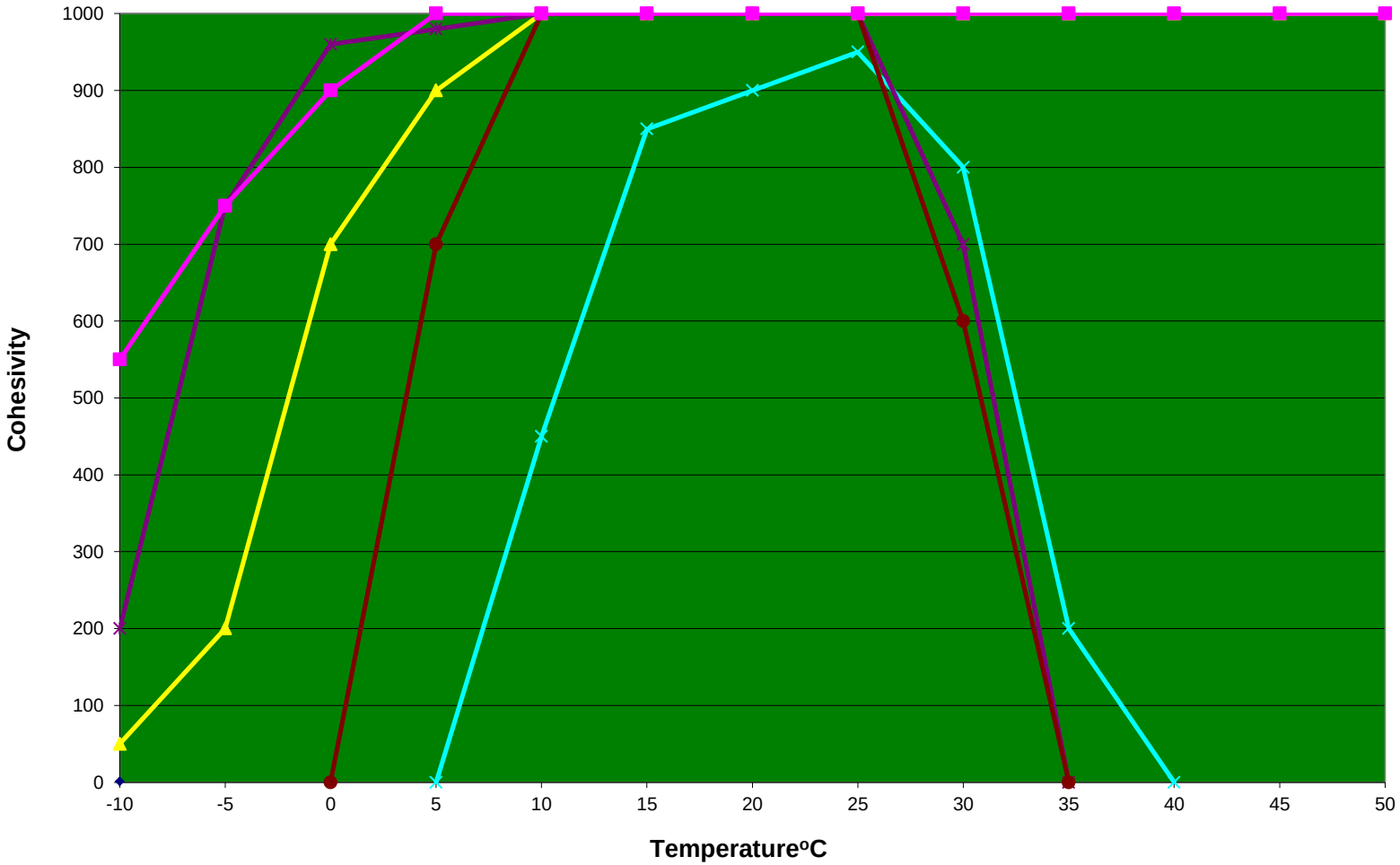
# Rheological Performance Improvement




- High Stiffness at high temp ≡ 100pen
- Low Stiffness at low temp ≡ 300pen
- Rate of change reduced


534g steel ball
support
50 cm
impact plate
ball bearings
binder
receiver

## Cohesivity Of Surface Dressing Binders




ACCORD


PHOENIX
DX06 NZU
PHOENIX
ACCORD

# Conclusion

- Formulating Emulsion presents challenges on
  - Identifying best solution for optimum stability for emulsion.
  - Optimising curing performance per end application.
  - Developing bitumen binder to cope with an ever changing climate.

# Some useful links

- http://www.rsta-uk.org/

- http://www.rsta-uk.org/publications.htm

Thank you for your attention.