VMA for Concrete

Cellulose Ether as Viscosity Modifying Agent (VMA)
for the use in concrete

Dow Coatings & Construction

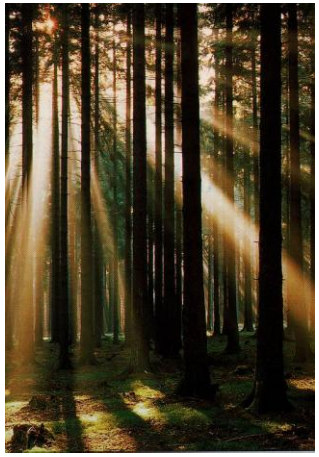
Heritage Rohm and Haas
+ Heritage Dow Wolff Cellulosics

= Dow Construction Chemicals

- Proven chemistry from combined know-how
- **A heritage of 40+ years** of development, formulation and application expertise

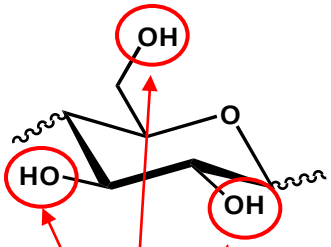
Chemistry of Cellulose Derivatives

Cellosize™ Products

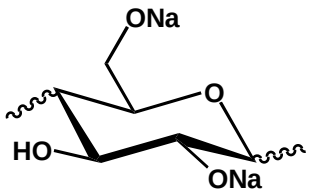


„Activating“

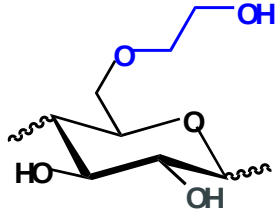
Cellulose → NaOH → **Alkali cellulose**



Could react

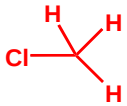


Ethylene oxide → **HEC**

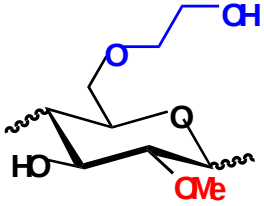


Walocel® M Products

Monochloromethane
Ethylene oxide → **HEMC**

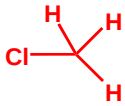


- NaCl

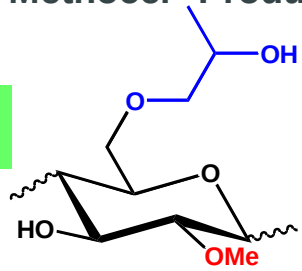


Walocel® M / Methocel® Products

Monochloromethane
Propylene oxide → **HPMC**

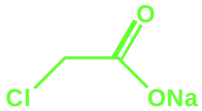


- NaCl

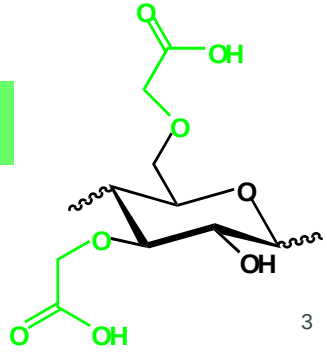


Walocel® C Products

Chloro acetic acid → **CMC**



- NaCl



Why the use of VMA becomes more important

Use of coarse aggregates will increase in future

– Leads to higher yield stress → more Plastiziser or higher w/c ratio

Increase of PCE acceptance as HRWR

CO2 footprint / eco concrete

– Less use or exchange of OPC / higher dosage of HRWR

Without Cellulose Ether as VMA

– No robustness against raw material variation (e.g. +/- 10l/m³ water)

– Segregation

– Bleeding

Main performance criteria which can be controled / influenced by a VMA

Rheological behavior
- Slump (Flow)
- V-funnel discharging time (for SCC)
- Mortar yield point
- Mortar viscosity
- Behaviour over time (0h, 1h, 2h)

Bleeding

Air entrainment
- Air void content
- Density

Cement hydration / Setting
- Ultrasonic

Investigation on CE chemistry for the use in concrete

A multi dimensional Design of Experiment (DoE) was made to define the desired Cellulose Ether chemistry

➢Substitution

- DS(M); MS(HE)
  - HEC, HEMC, MC
  - CMC and HPMC not part of this investigation

➢Molecular weight

- Viscosity in a 2% aqueous solution

➢Particle size

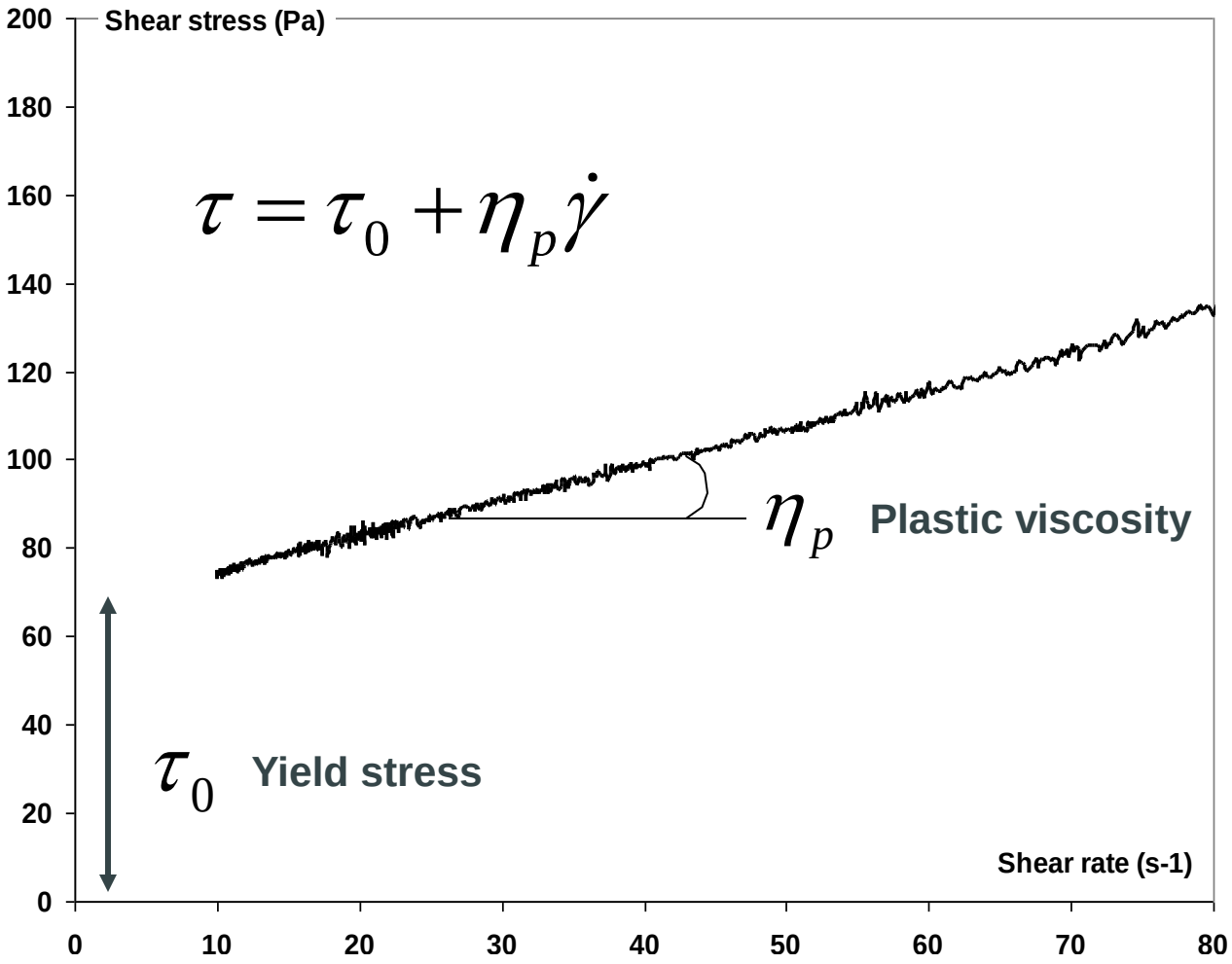
Summary Chemistry Findings

	Slump	V-funnel time	Bleeding	Static yield	Dynamic yield	Mortar viscosity	Air void content	Density	Setting time
DS(M)	↑↑	↑↓	*No bleeding observed*	↑↓	↑↓	–	–	–	↑↓
MS(HE)	↑↑	–		↑↓	↑↓	–	–	–	↑↓
V2	↑↓	↑↑		↑↑	↑↑	–	↑↑	↑↓	–
Particle size	↓↓	↓↑		↓↑	↓↑	↓↑	–	–	↓↑

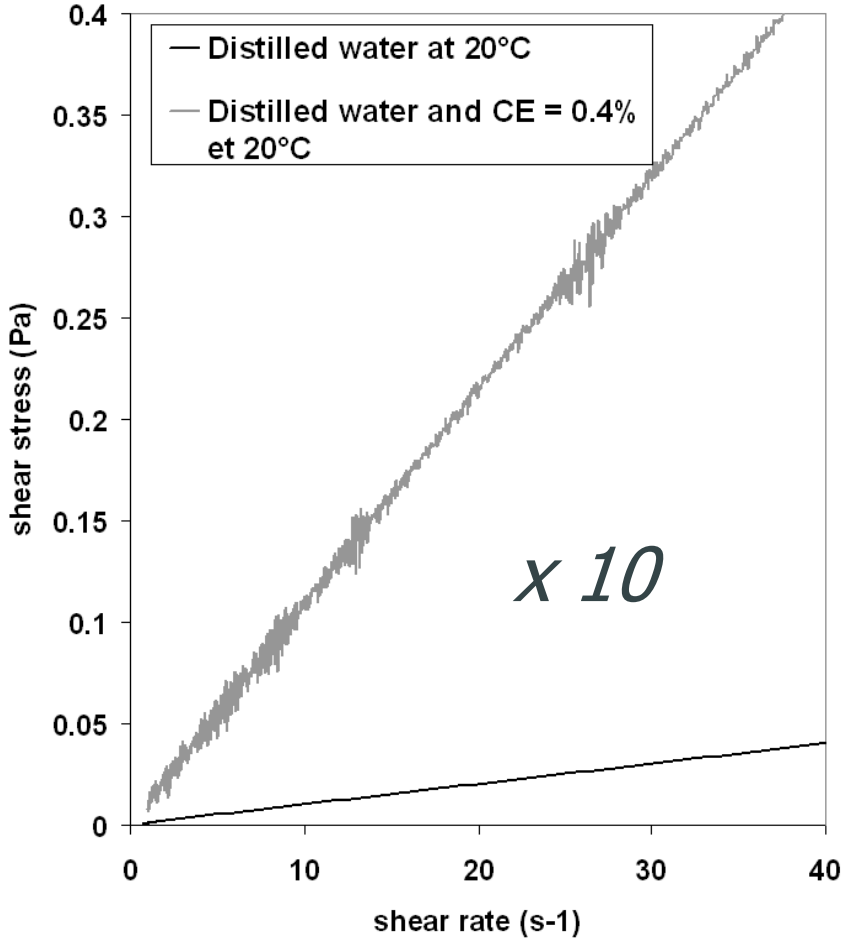
Potentially best performing HEMC:
- High DS – Highest impact regarding cement setting
- Low to medium MS
- Low to medium viscosity
- Fine powder

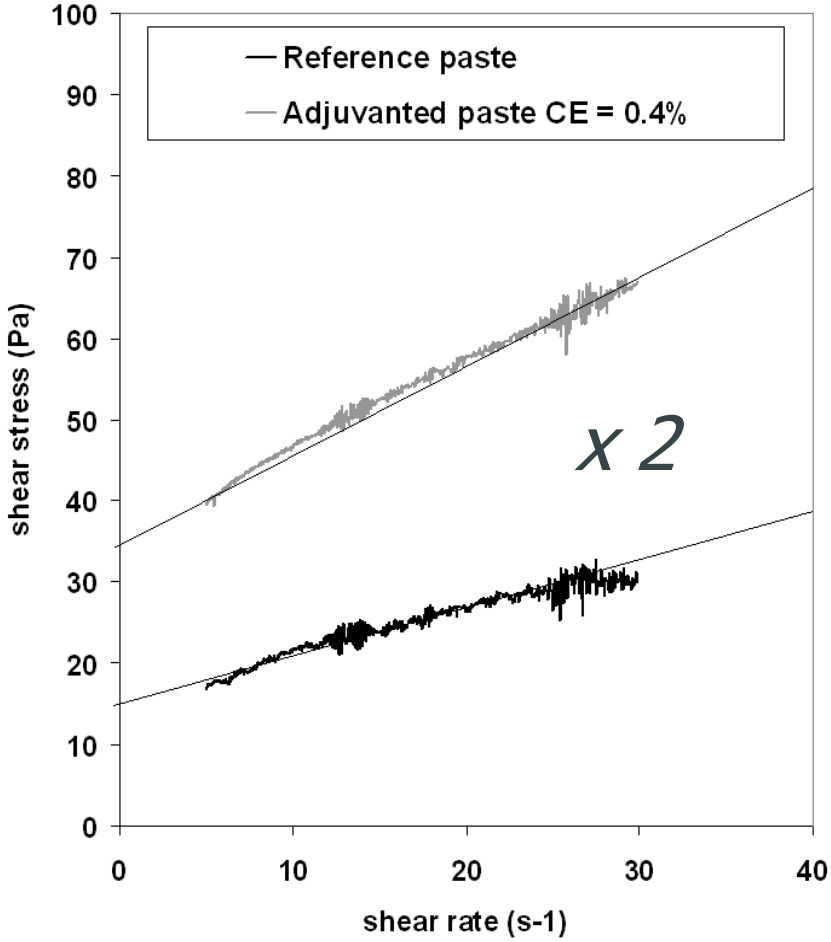
Structure parameters:
- DS(M): 1.65 – 2.20
- MS(HE): < 0.50
- Viscosity: < 30.000 mPas (2% aqueous solution)

Typical rheological behaviour of cement paste (Herchel-Bulkley)

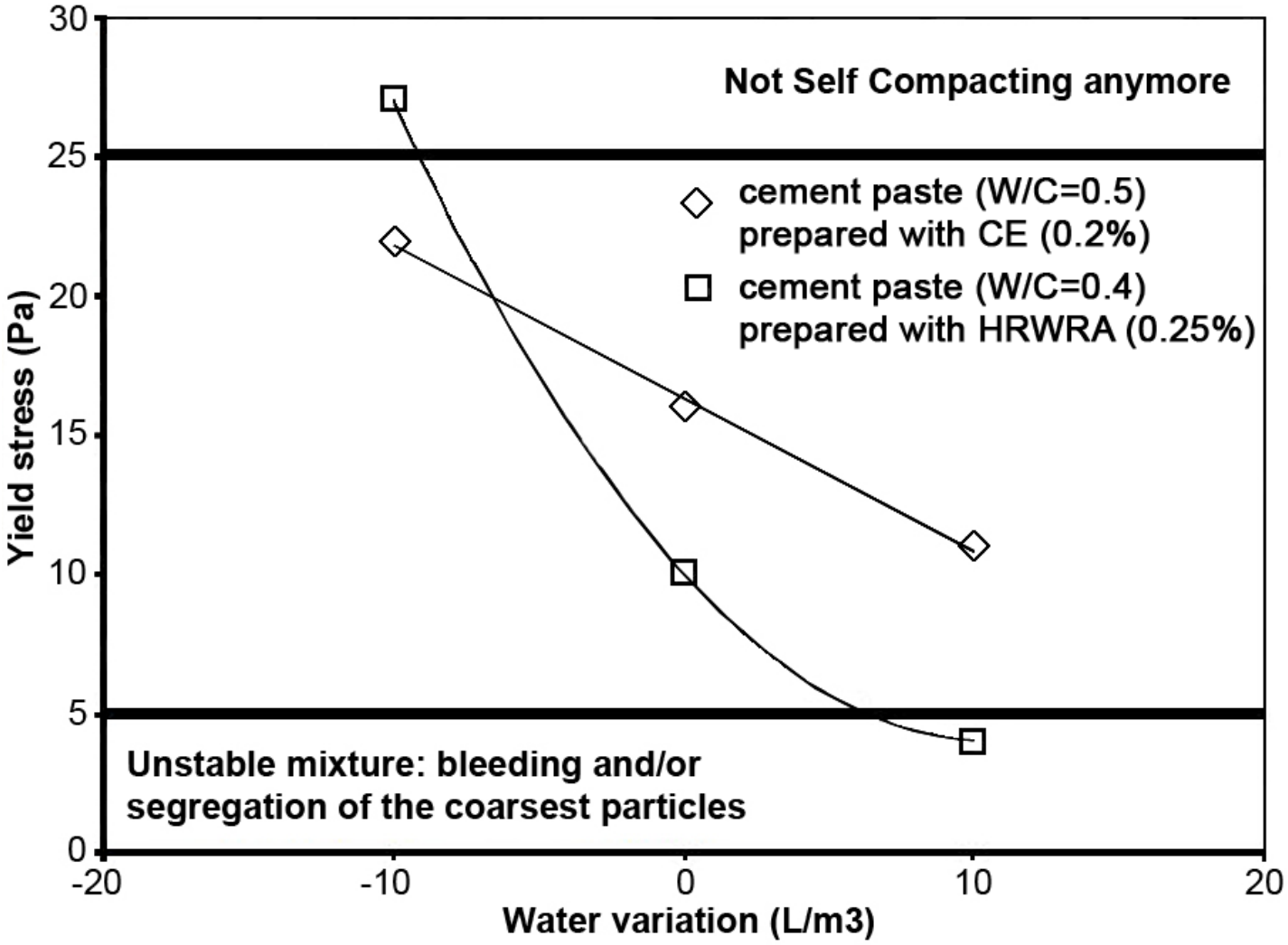


Viscosity increase by using CE in water and cement paste

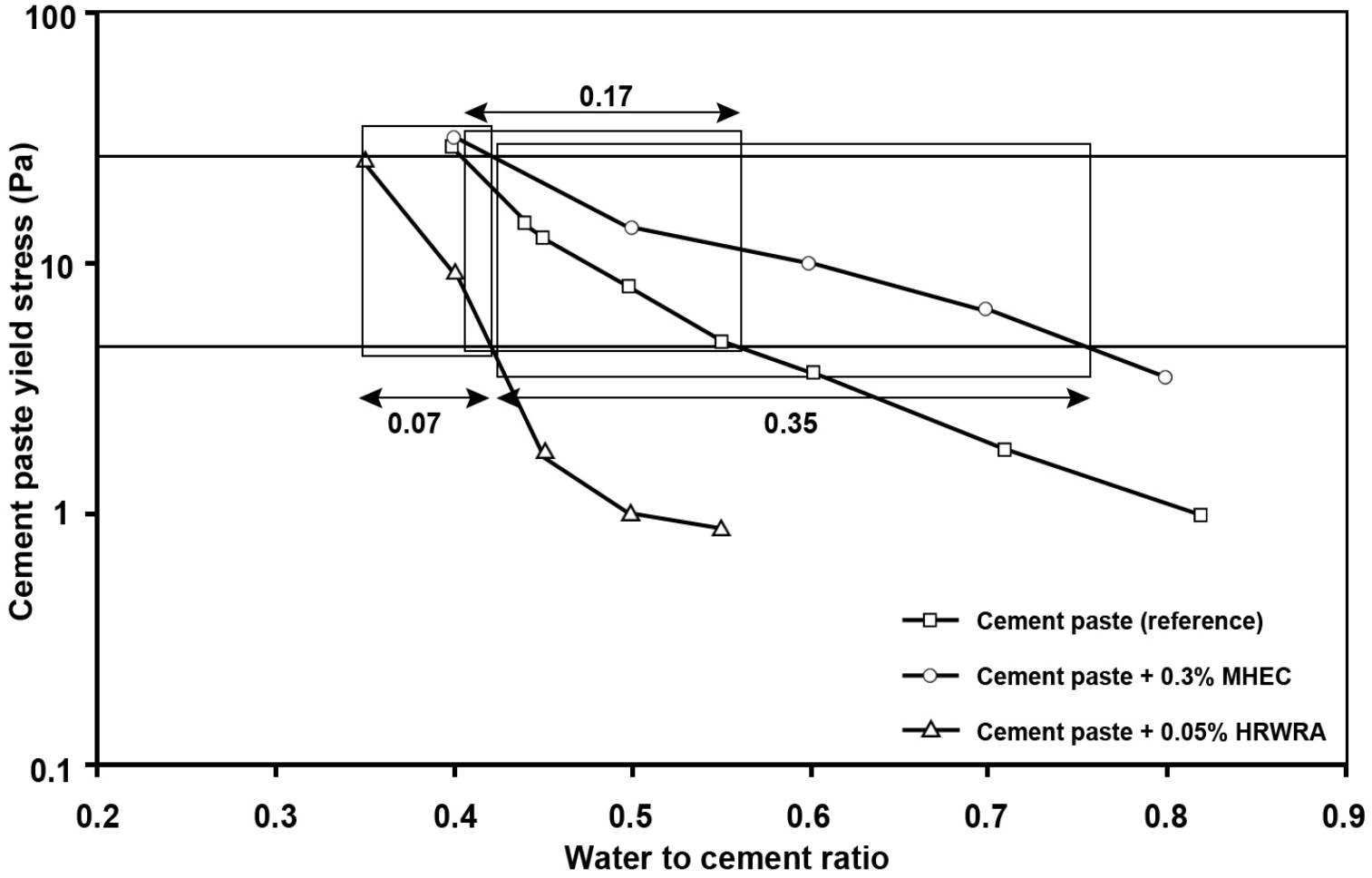




CE increases robustness of SCC



CE gives a wider range for w/c ratio



Summary

CE as VMA increases the yield point and the viscosity slightly and increase robustness against w/c ratio variation.

With a high subtitution degree no delay in hydration of cement

Use of CE prevents bleeding

Additional air entrainment could be reduced with the right mix of MS(HE) and molecular weight of the CE

Thank You

Dipl.-Ing. Marc Schmitz