

## 22. Kolloquium und Workshop, Rheologische Messungen an mineralischen Baustoffen

# Effect of addition of superabsorbent polymers (SAP) on rheological properties of fresh cement-based mortars

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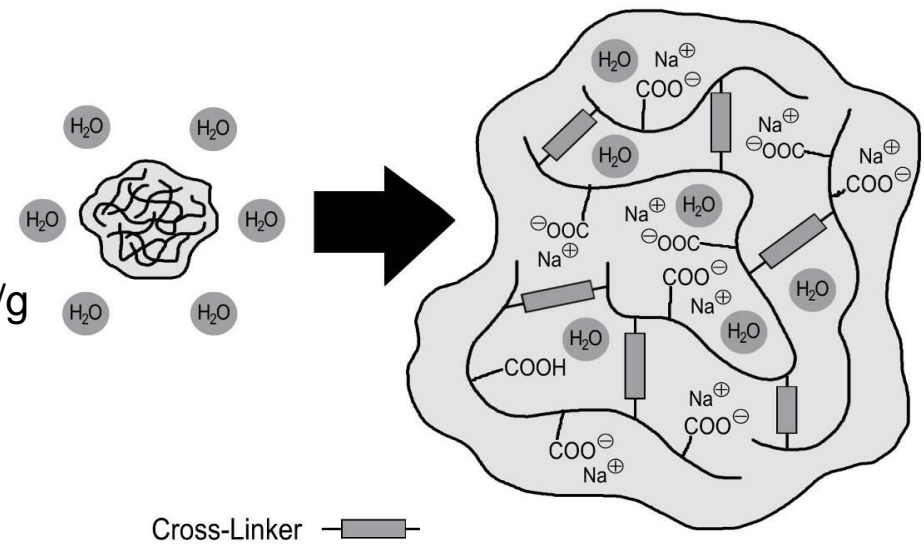
# Superabsorbent polymers (SAP)

## Superabsorbent Polymers as internal curing-agent

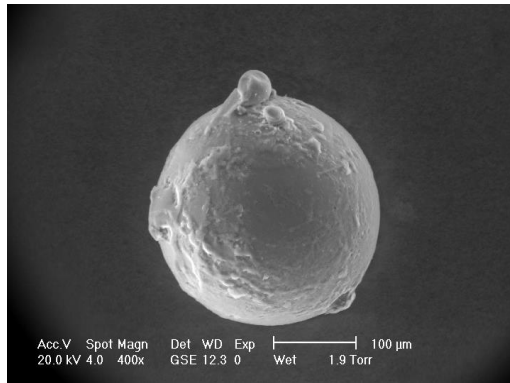
Mostly cross-linked polyelectrolytes

Water absorption:

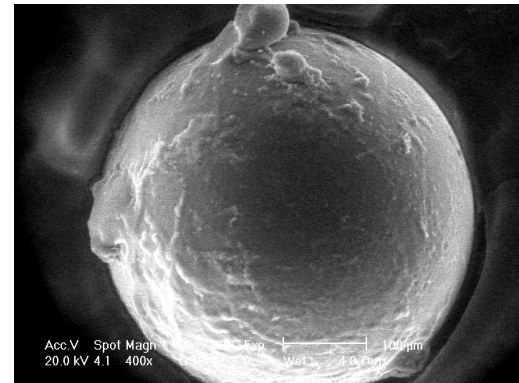
- max. water absorption ca. 1500 g/g
- commercial SAP ca. 50 – 300 g/g
- in high-ionic solutions mostly < 30 g/g



Raw SAP (particle ca. 200 μm)



SAP before water absorption



SAP after water absorption

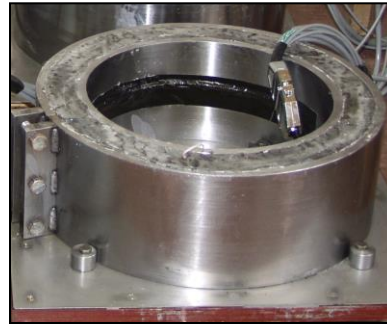


# Internal Curing of HPC

## Free and restrained autogenous shrinkage (AS) examination

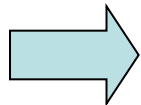


Corrugated tubes

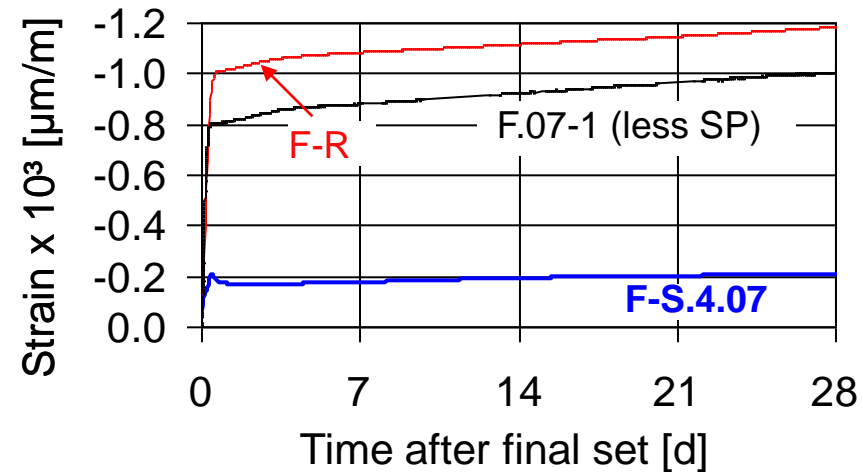


Instrumented ring test

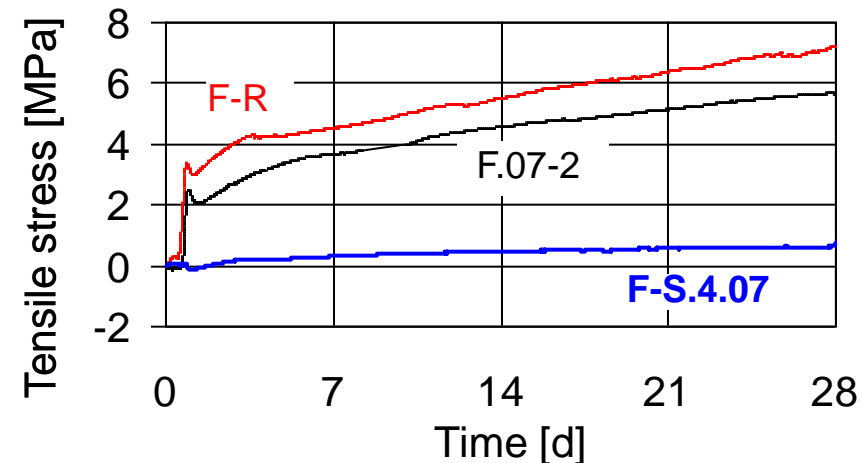
Additon of SAP and extra IC water mitigates susceptibility to cracking related to AS



## Free AS of UHPC

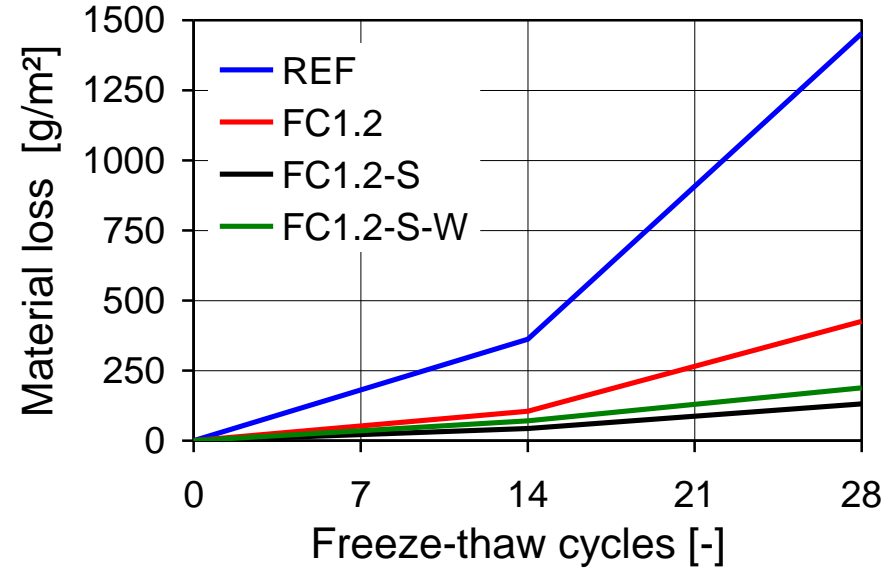
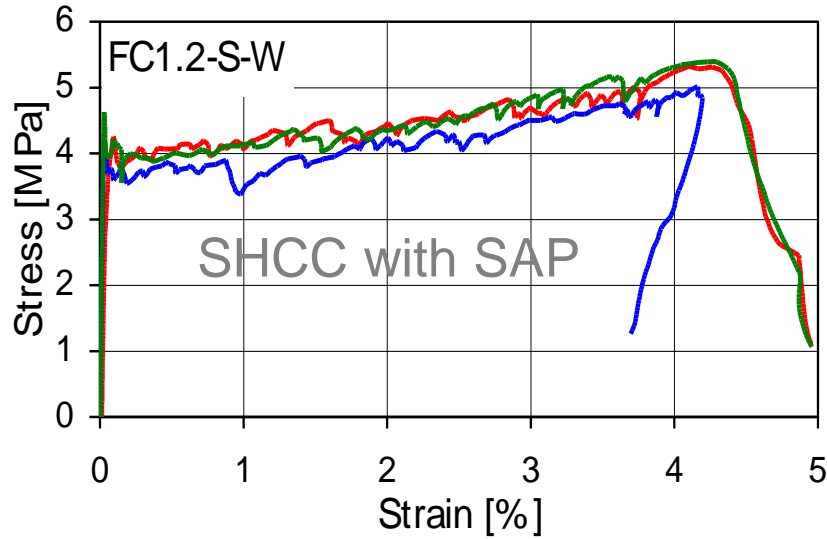


## Residual tensile stresses of UHPC





# Enhancing Frost Resistance and More



REF

FC1.2

FC1.2-S

FC1.2-S-W





# Superabsorbent polymers

## Two chemically distinct SAPs: SAP-B and SAP-D



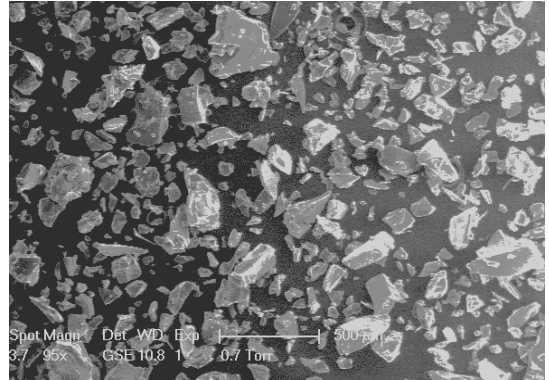
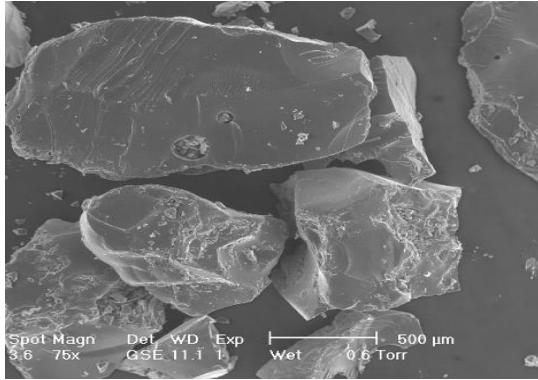
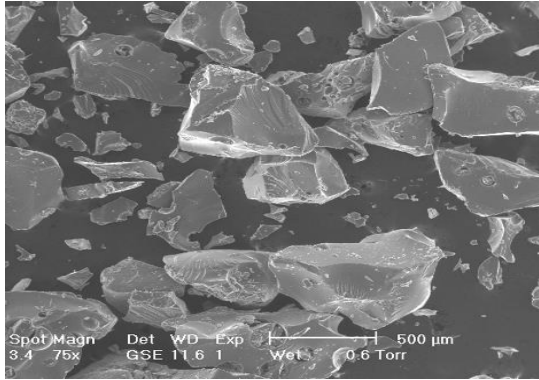
SAP-B



SAP-DC



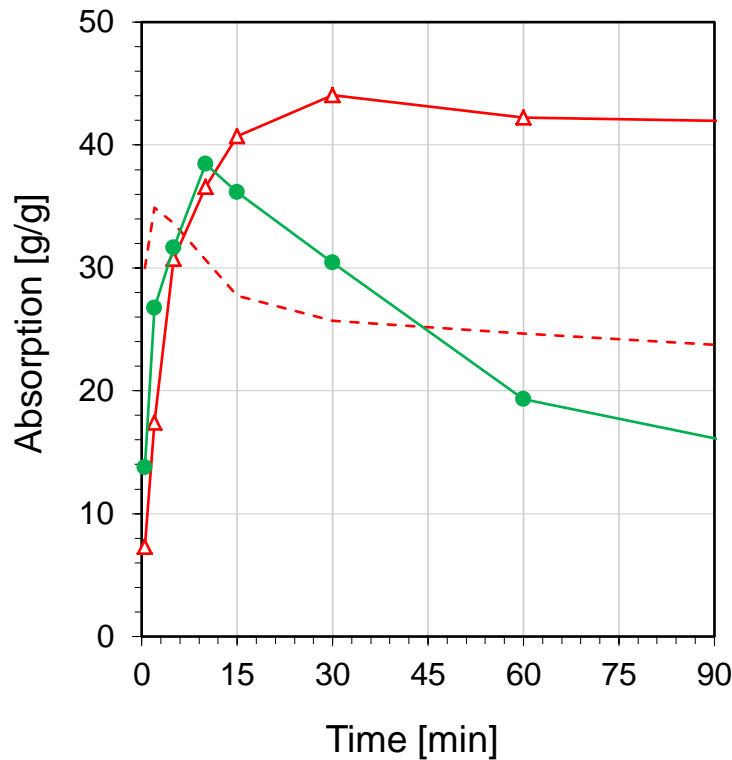
SAP-DF



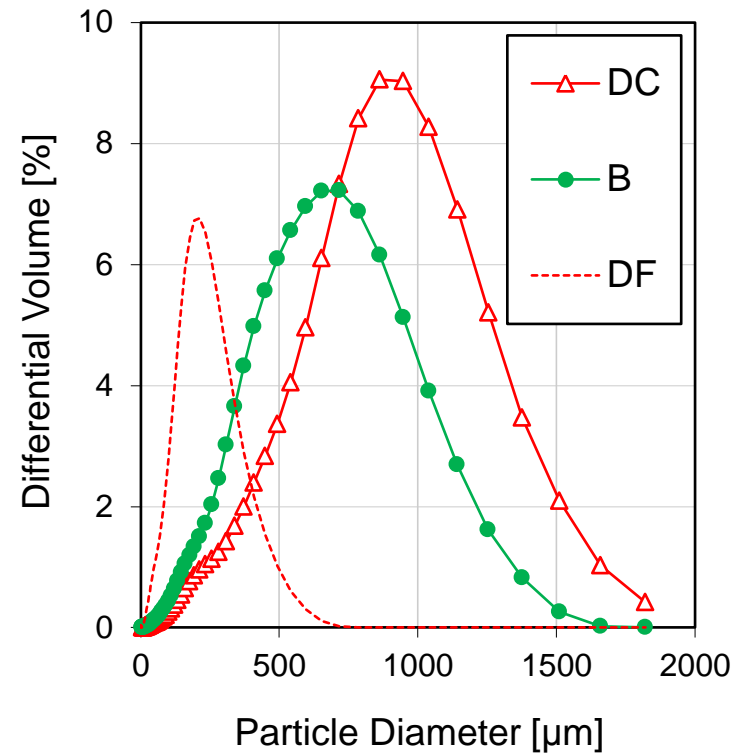


# Superabsorbent polymers

## SAP absorption behaviour in a synthetic pore fluid



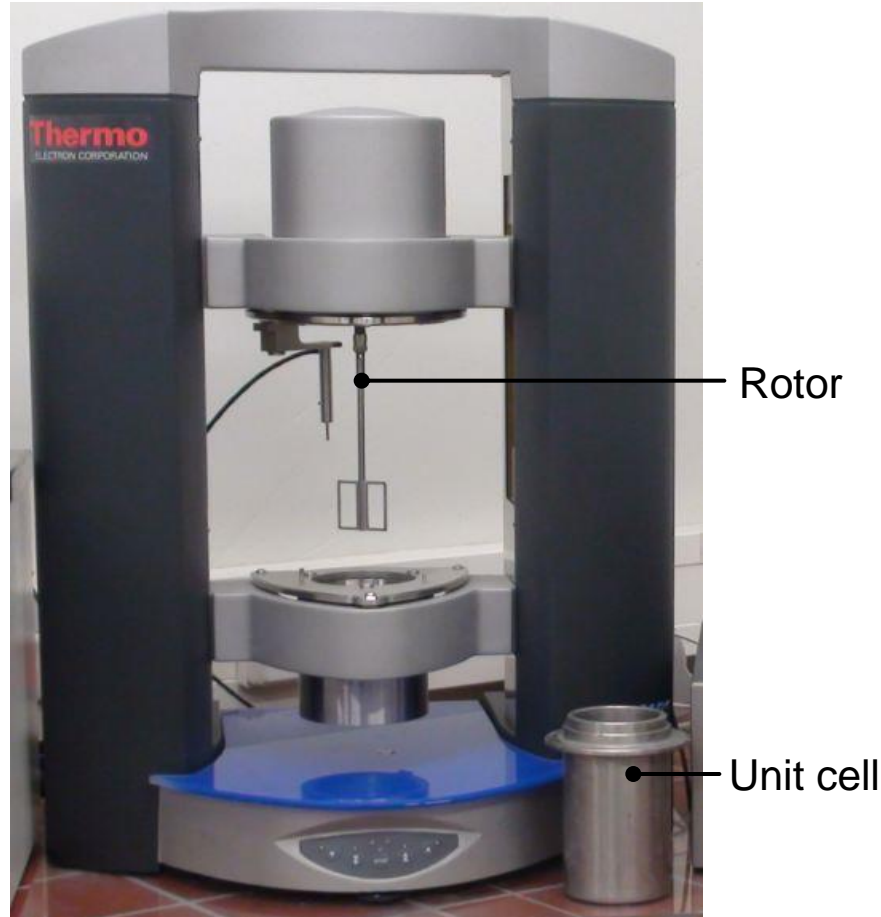
## Particle size distribution of different SAP samples



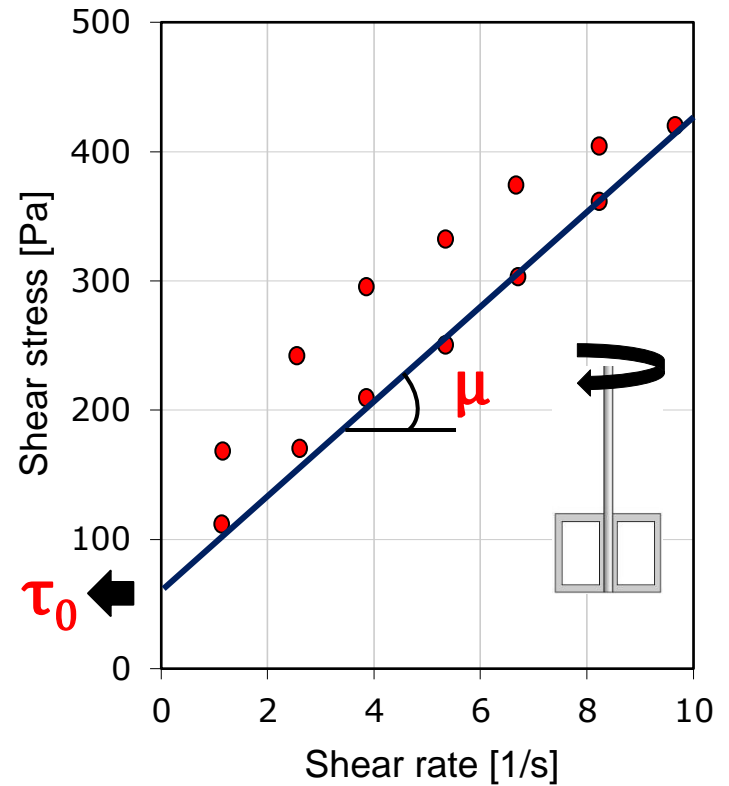


# Rheological equipment

## HAAKE MARS II rheometer



## Continuous shear rate test





# Testing procedure

## Measuring profile for the rheometer

Segment	Type	Time [s]	Further settings
0	Lift	5	Lift control: rotor to the measurement position
1	Osc-Time	30	Oscillation-time test, $\tau = 0$ Pa, $f = 1.0$ Hz
2	Osc-As	150	Oscillation amplitude test, $\tau = 1 \div 400$ Pa, $f = 1.0$ Hz, 40 steps
3	CS-RT	30	Controlled shear stress recovery test, $\tau = 0$ Pa, 30 steps
4	CR-RS	40	Controlled shear rate test, $\dot{\gamma} = 0.96 \div 9.6$ 1/s, 20 steps
5	CR-Time	30	Controlled shear rate test, $\dot{\gamma} = 9.6$ 1/s, 30 steps
6	CR-RS	40	Controlled shear rate test, $\dot{\gamma} = 9.6 \div 0.96$ 1/s, 20 steps





# Mortar mixes

## □ Group A

High SP content

A_RefMix_0.30	for 1 m <sup>3</sup> [kg]
Cement CEM I 42.5 R	776.0
Water	232.7
<b>Aggregate 0/2</b>	<b>1300.0</b>
SP <i>Glenium 51</i> 1.4 wt-% bwoc	10.9

## □ Group B

High SP content

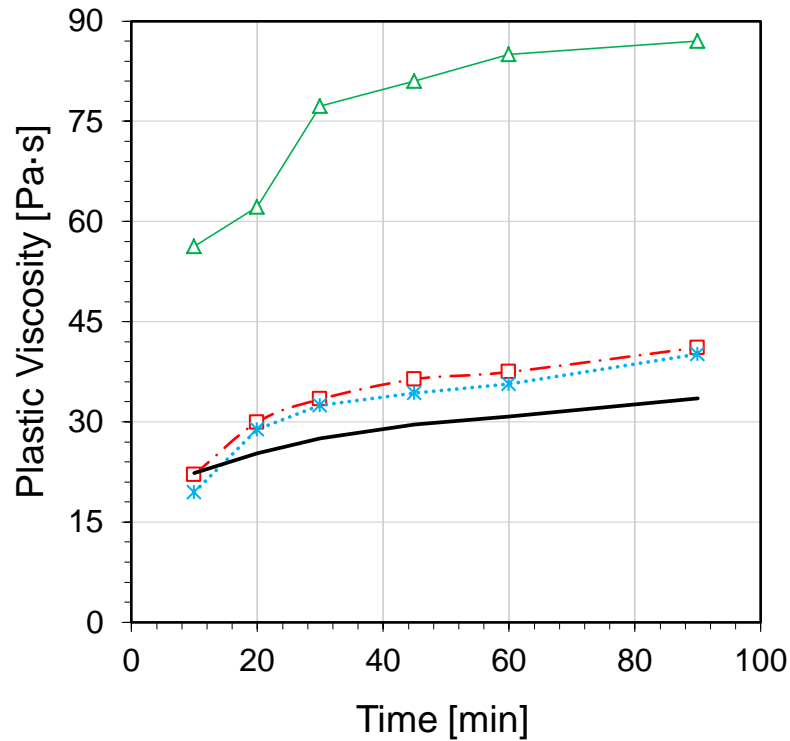
Silica fume

B_RefMix_0.30	for 1 m <sup>3</sup> [kg]
Cement CEM I 42.5	690.0
Silica fume <i>Elkem 971</i> 10 % bwoc	69.0
Water	227.5
<b>Aggregate 0/2</b>	<b>1300.0</b>
SP <i>Glenium 51</i> 2.0 wt-% bwoc	13.8

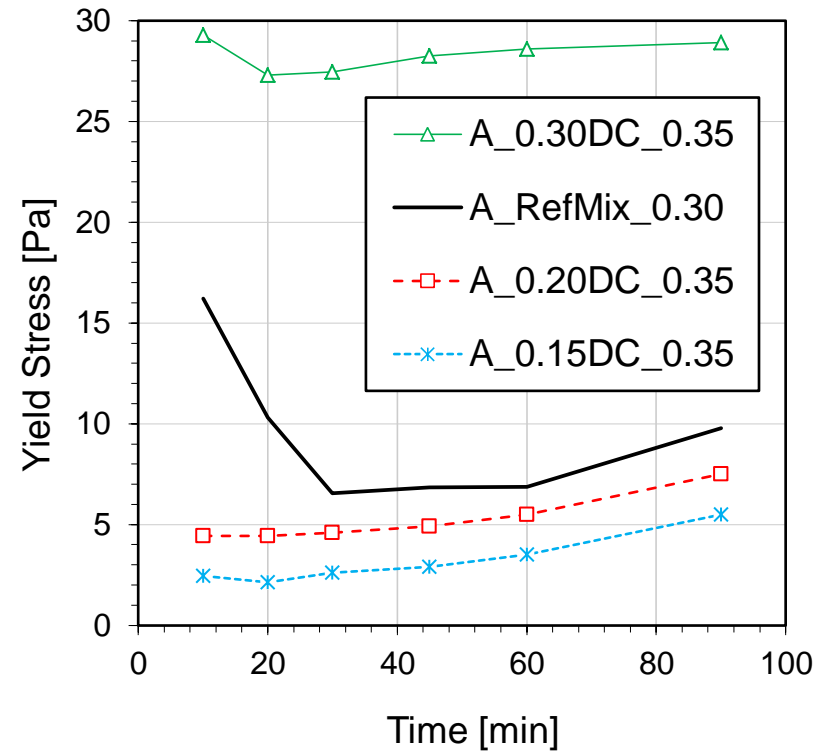


# Preliminary tests with SAP-DC

## Plastic viscosity



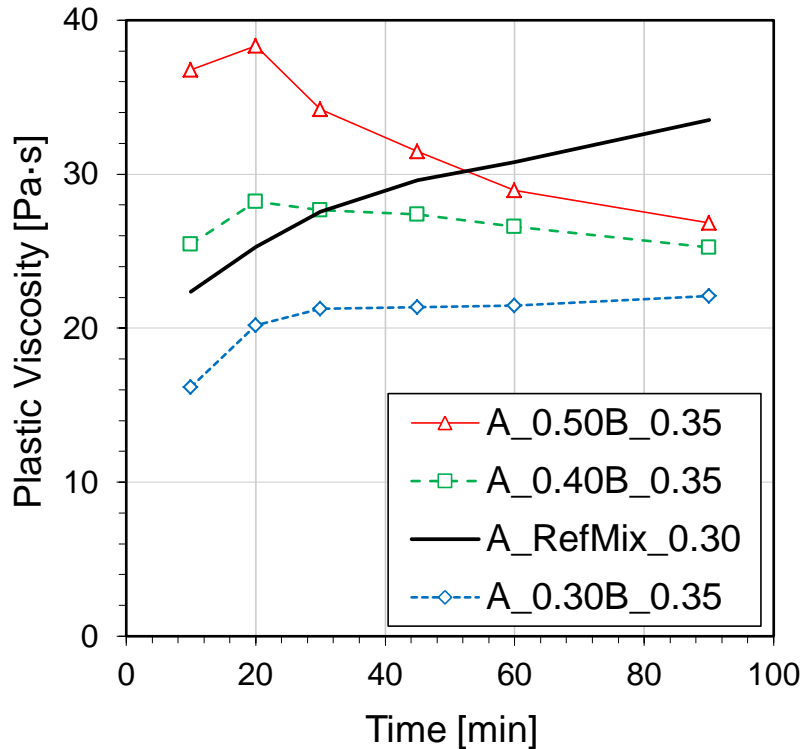
## Yield stress



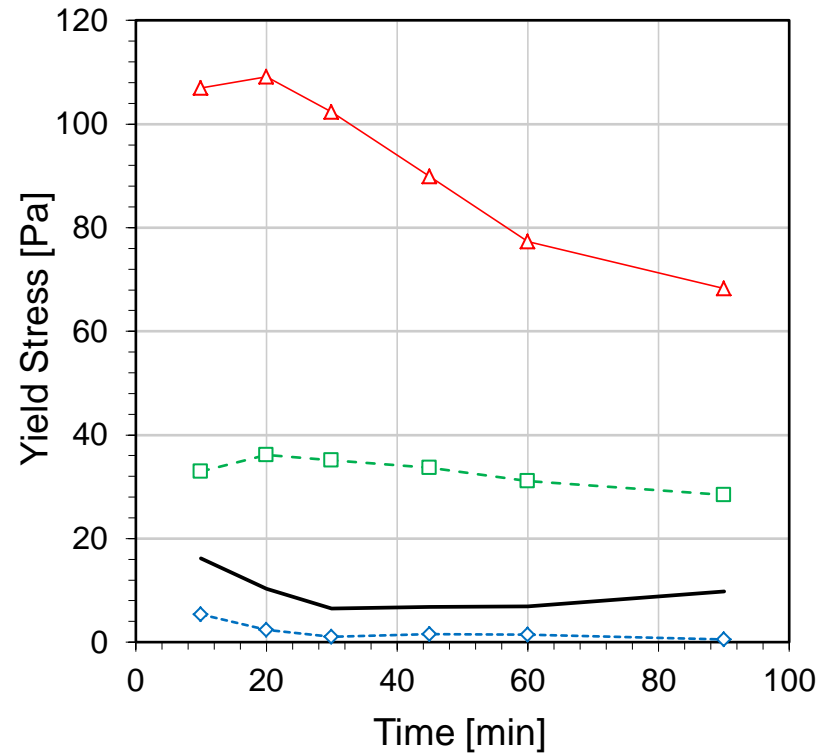


# Preliminary tests with SAP-B

## Plastic viscosity



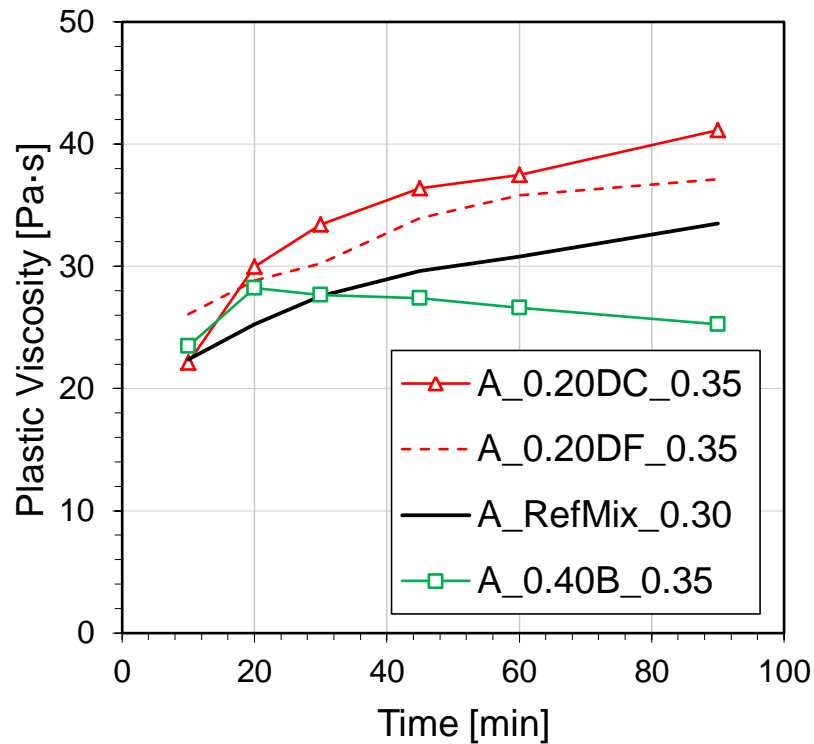
## Yield stress



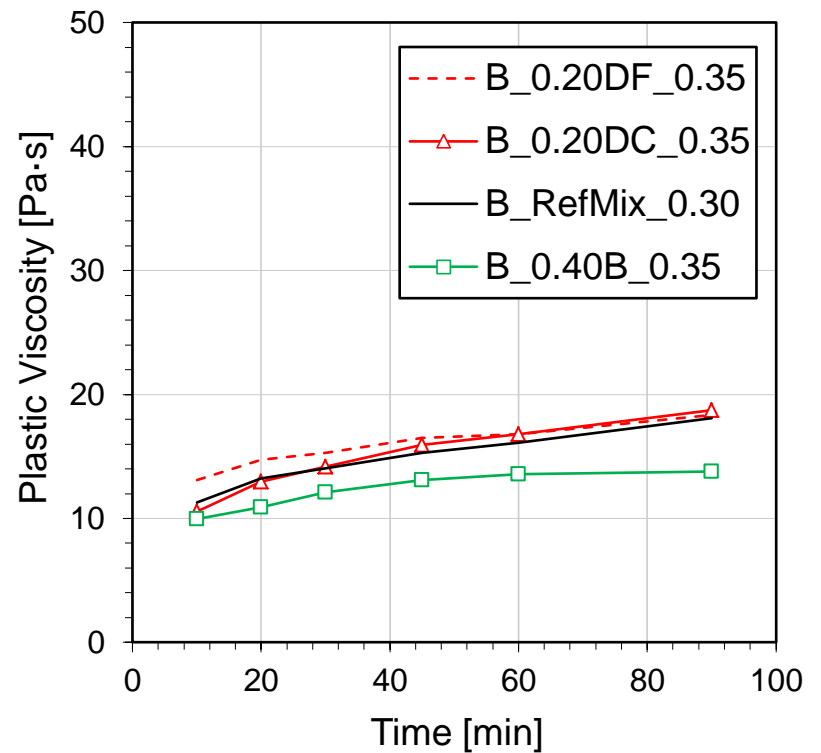


# Effect on plastic viscosity

## Group A mortars



## Group B mortars

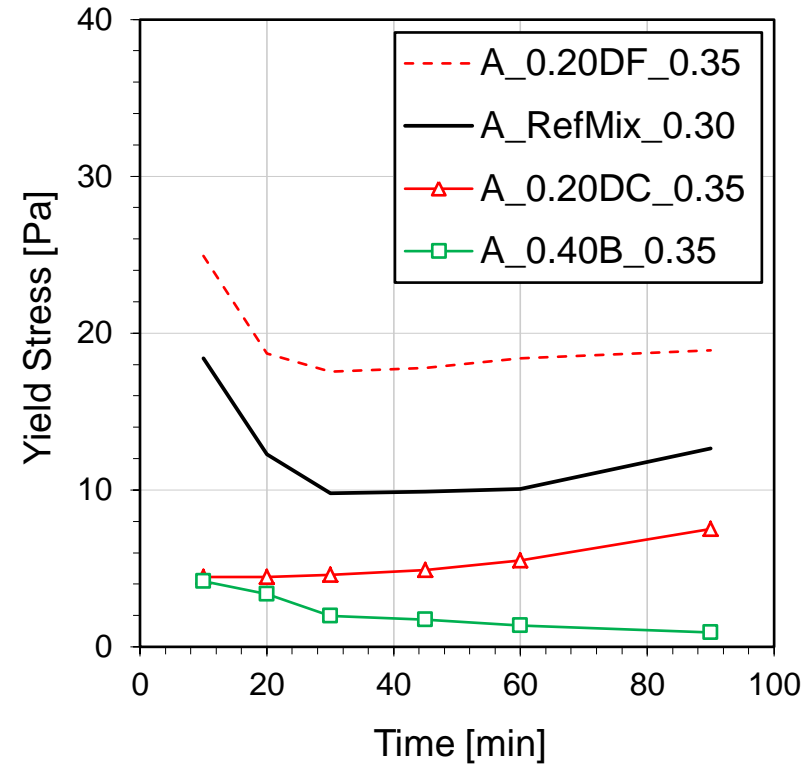


Changes in ref. to mix A:  
B: SP↑+silica fume

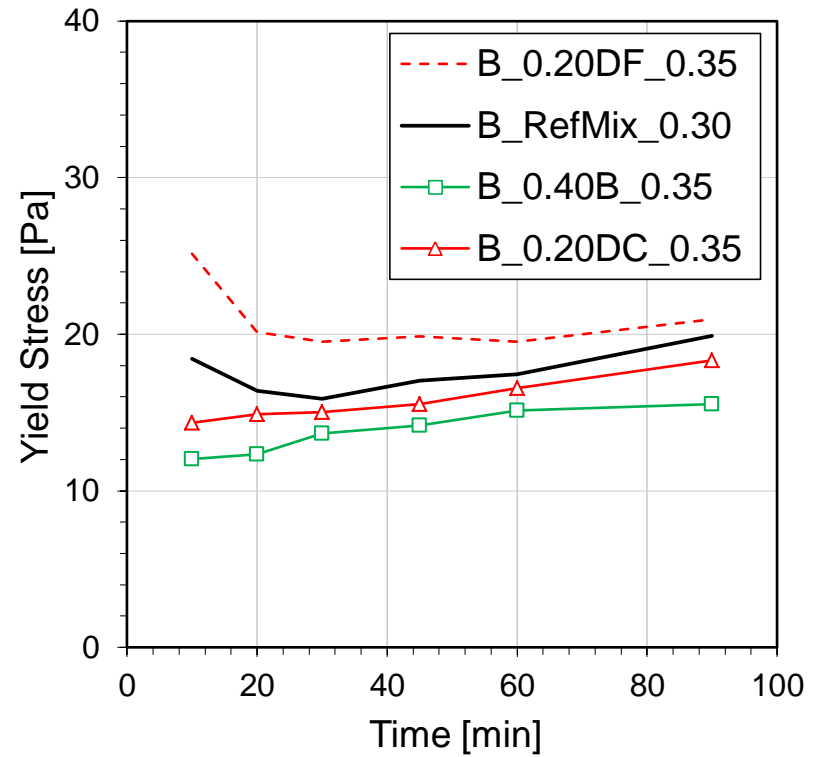


# Effect on yield stress

## Group A mortars



## Group B mortars



Changes in ref. to mix A:  
B: SP↑+silica fume



# Summary

- Prominent rheological effect of SAP**
- Distinct absorption-desorption behaviour of SAP-D and SAP-B**
- Influence of grain size distribution**



# Acknowledgements

Europa fördert Sachsen.



Europäischer Sozialfonds

