



Impact of Guar Gum Derivatives on Properties of Freshly-Mixed Cement-Based Mortars

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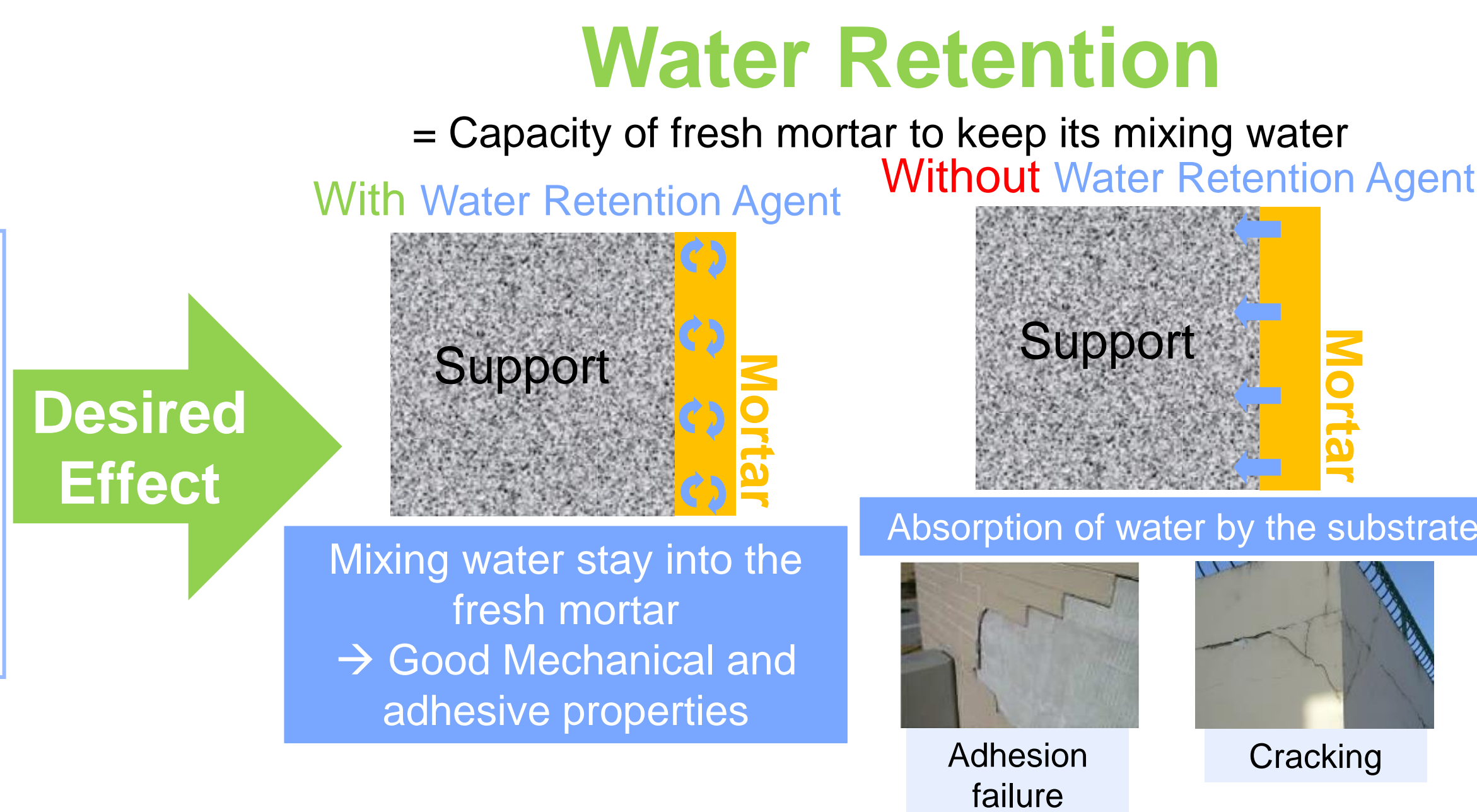
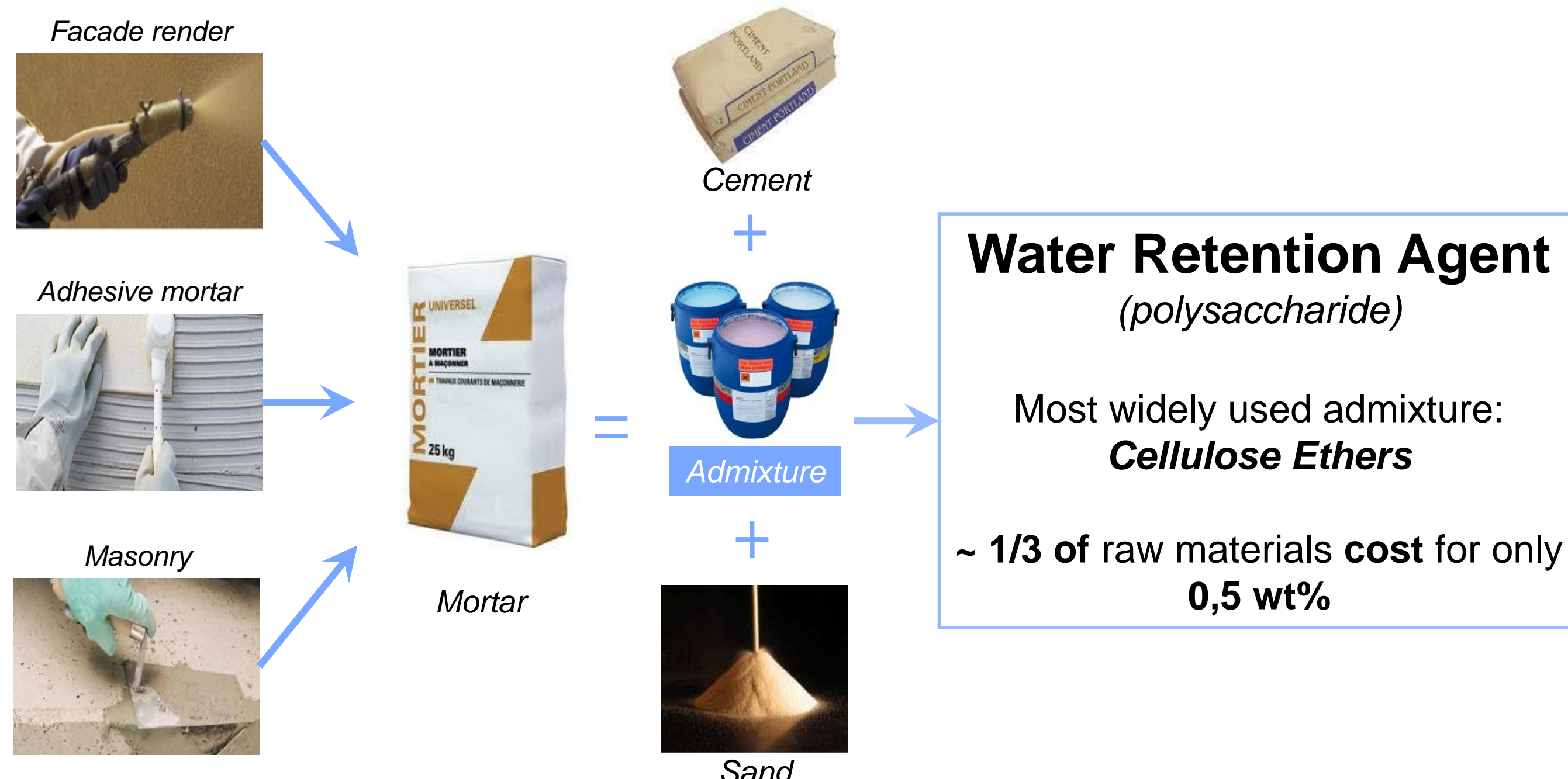
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Impact of Guar Gum Derivatives on Properties of Freshly-Mixed Cement-Based Mortars

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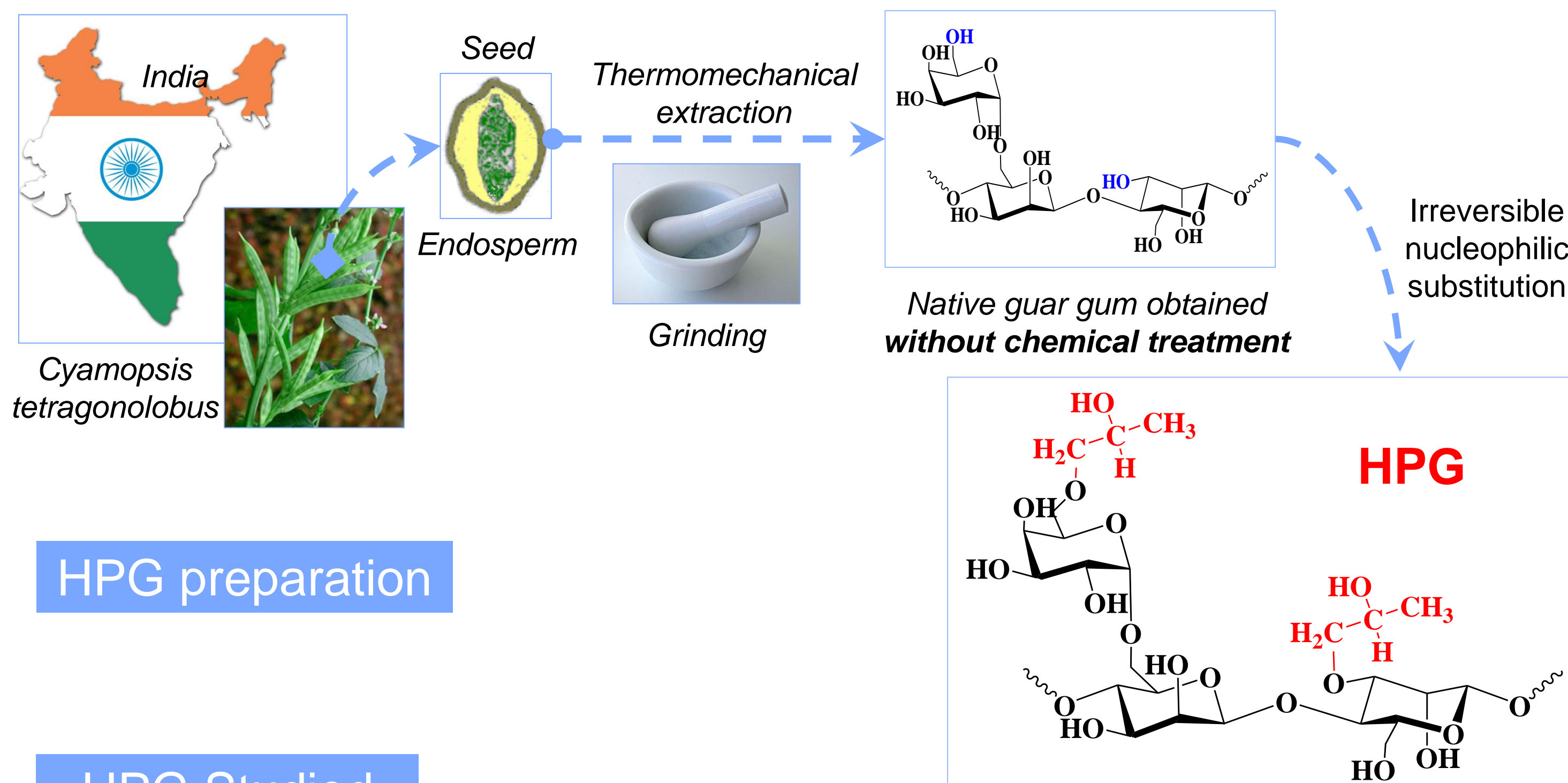
Polysaccharides are also expected to act as VEA

Major drawback: Cement hydration delay

Study of bio-based Water Retention and VEA admixture : Hydroxypropyl Guar (HPG)

Materials

HydroxyPropyl Guars



HPG preparation

HPG Studied

- A native Guar Gum (GG) + 3 HPGs + 2 hydrophobically modified HPGs
- Roughly the same molecular weight ($\approx 2.10^6$ Da)

Sample	MS _{HP}	Additional Substitution	DS _{AC}
HPG 1	Low	-	-
HPG 2	Medium	-	-
HPG 3	High	-	-
HPG 4	High	Short alkyl chain	-
HPG 5	High	Short alkyl chain	Higher than HPG 4
GG	-	-	-

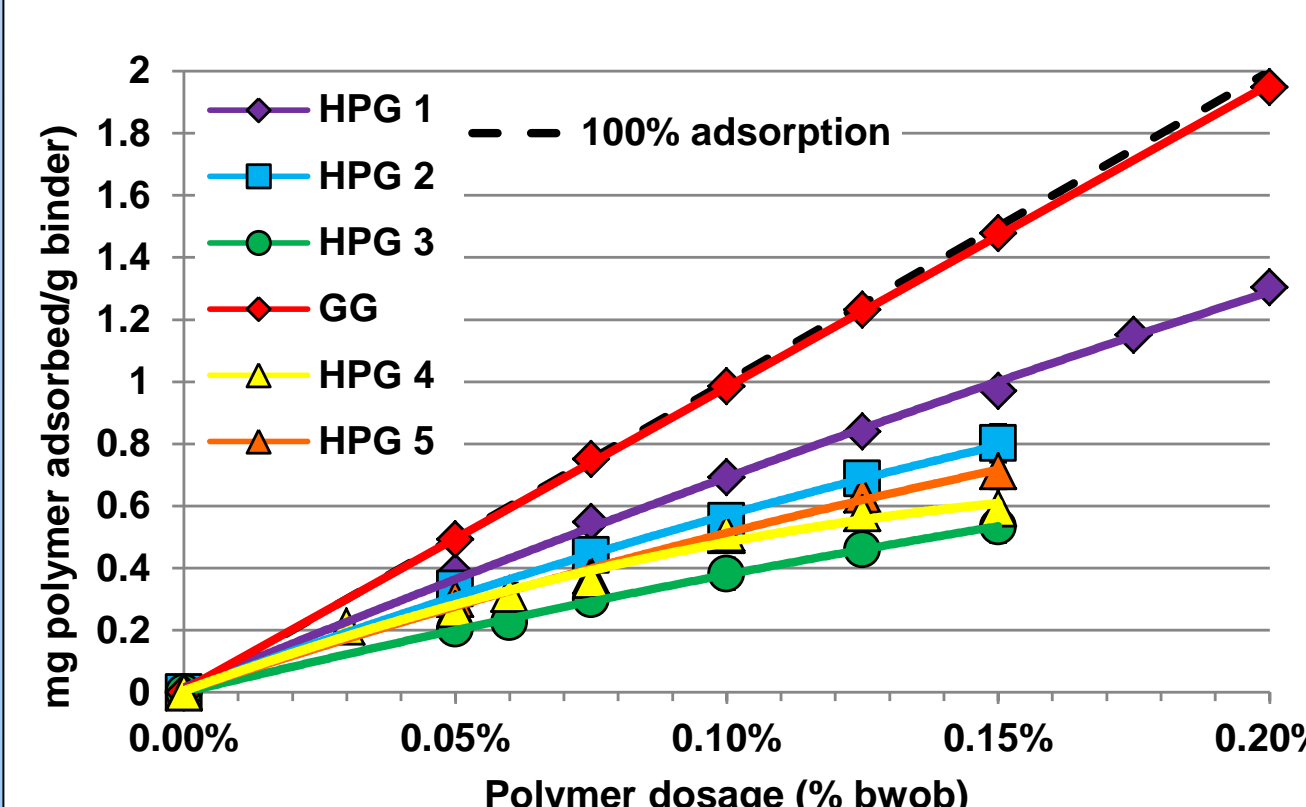
Mortar Formulation

Component	CEM II/B-LL 32.5R	Lime	CaCO ₃	CaMg(CO ₃) ₂	Water
% mass of dry mixture	12 %	3 %	18 %	67 %	22 %

- Water-to-Binder ratio: **W/B = 0.22**
- Admixtures in addition to the binder: **0.05% – 0.15% bwob**

Adsorption

TOC - Centrifugation - Depletion method

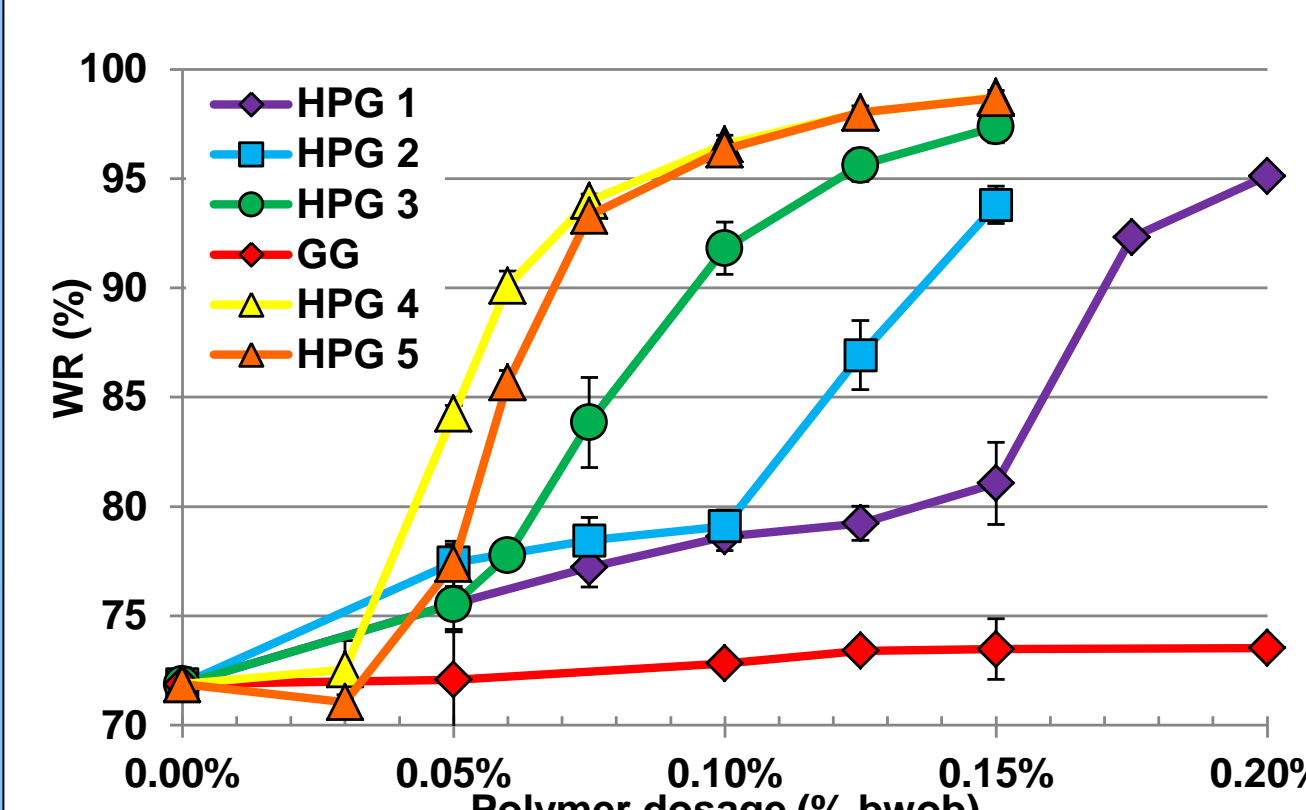


- ⚡ Low dissolution kinetics of GG
- ⚡ MS_{HP} : \downarrow Adsorption because of \downarrow free -OH and polarity
- ⚡ Hydrophobic alkyl chain: Low \uparrow Adsorption
- Change in conformation of HPG (Simon et al.)
- Alkyl chains inside the coils / Hydrophilic groups at the outskirts of the coils

Water Retention

Standard ASTM C 1506-09:

$$WR(\%) = \frac{W_0 - W_1}{W_0} \times 100$$



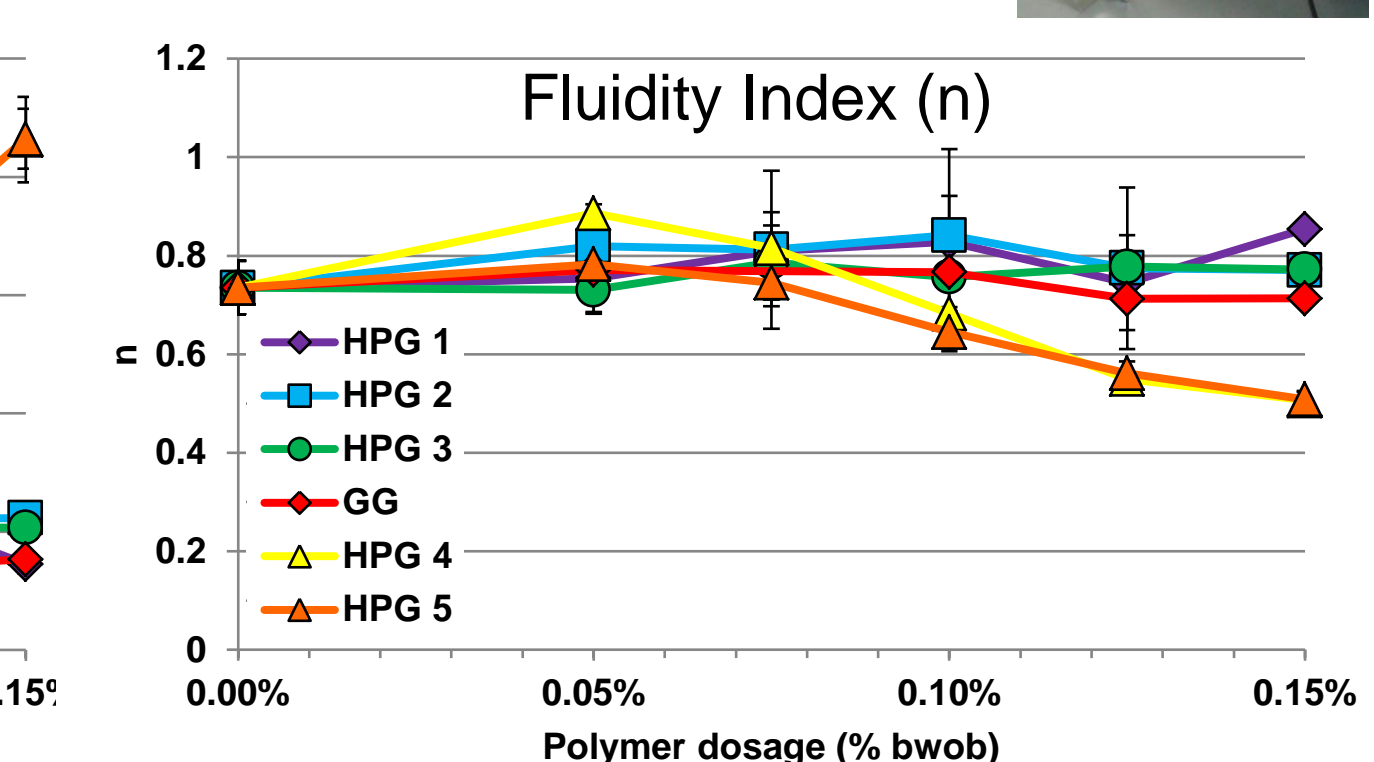
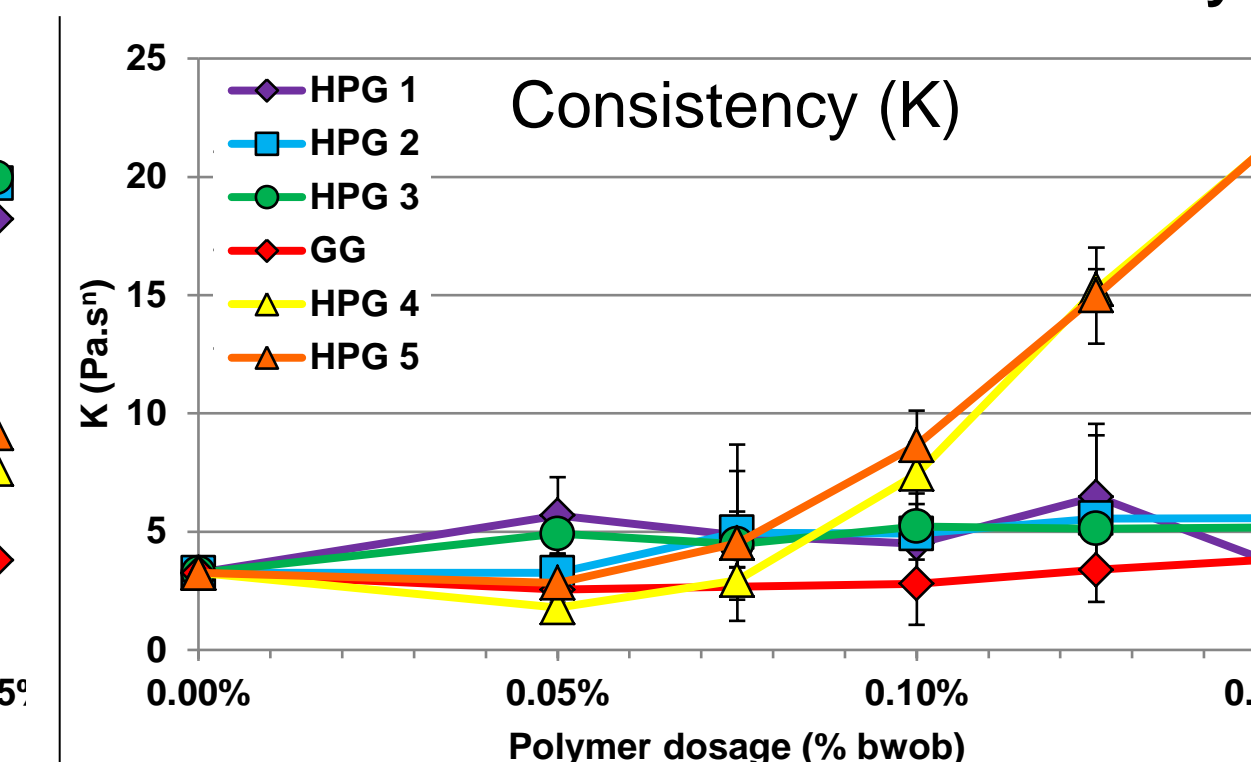
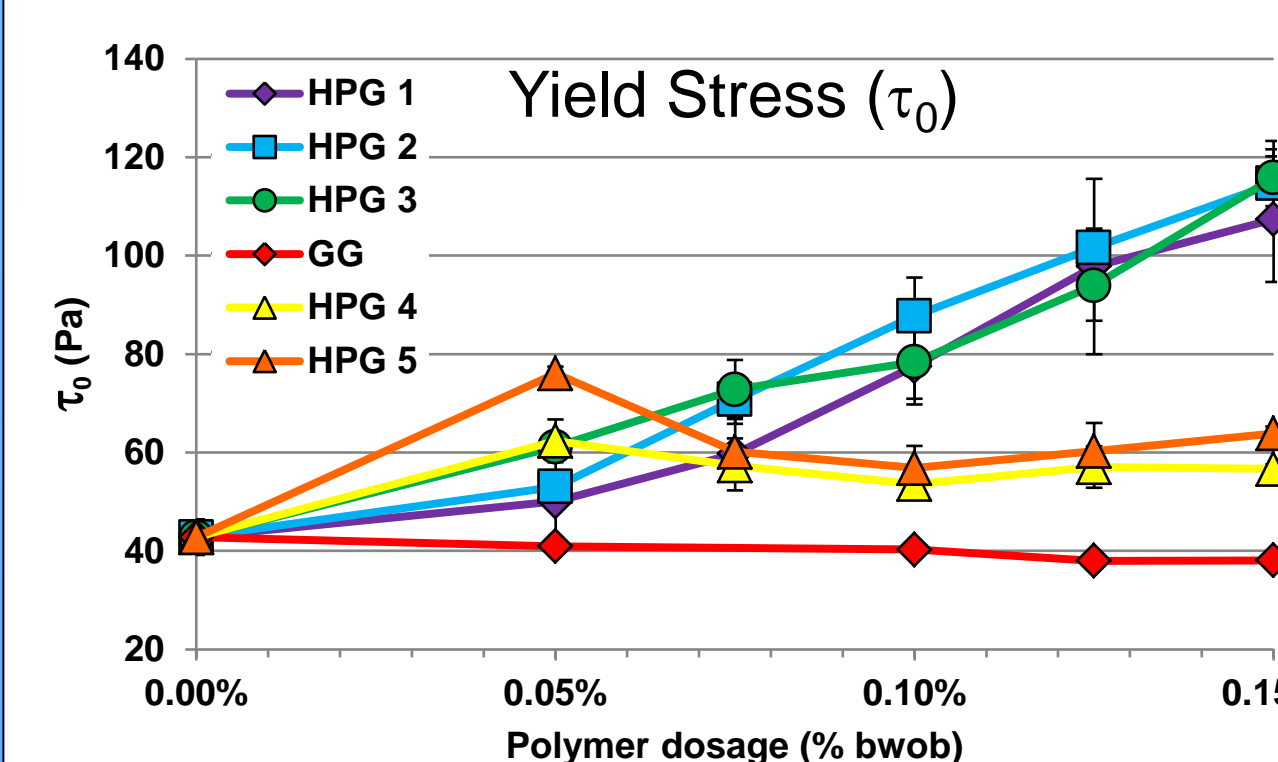
- ⚡ Excepted GG, HPGs improve the WR capacity of mortars
- ⚡ MS_{HP} improves the WR capacity $MS_{HP} HPG 1 < MS_{HP} HPG 2 < MS_{HP} HPG 3$
- Thanks to \downarrow Adsorption and thus \uparrow [HPG] in pore solution
- ⚡ Positive impact of the additional alkyl chain
- \uparrow Adsorption compensated by \downarrow in coil overlapping concentration
- ⚡ DS_{AC} slightly reduces the WR capacity $DS_{HP} HPG 4 < DS_{HP} HPG 5$

Rheological properties of mortars

Herschel-Bulkley model:

$$\tau = \tau_0 + K\dot{\gamma}^n$$

τ_0 : yield stress
 K : consistency coefficient
 n : fluidity index



- ⚡ τ_0 with HPGs 1, 2, 3
- Bridging flocculation
- ⚡ MS_{HP} \downarrow adsorption \downarrow bridging compensated by $\uparrow \eta_0$ and [HPG]

- ⚡ K and $\downarrow n$ with HPGs 4, 5

⚡ Rheological behavior of mortars imposed by the more and more shear thinning behavior of pore solution

Conclusions

Water Retention

- ⚡ HPGs are good water retention agents
- ⚡ Huge impact of HPG chemical composition
 - ➔ $\uparrow MS_{HP}$ promotes WR by \uparrow [HPG]
 - ➔ Hydrophobic side chain promotes WR by $\downarrow C^*$

Rheological properties

- ⚡ HPGs act as VEA
- ⚡ \rightarrow "Classical" HPGs \uparrow the stability of mortars by $\uparrow \tau_0$
- \rightarrow Hydrophobically modified HPGs \uparrow the resistance to the flow of admixed mortars by $\uparrow K$

Chemical composition of HPGs is a key parameter of mortar formulation