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

Alexandre Govin¹, Marie-Claude Bartholin¹, Barbara Biasotti², Max Giudici², Valentina Langella², Philippe Grosseau¹

¹ SPIN-EMSE, CNRS:UMR5307, LGF, École des Mines de Saint-Étienne, 42023 Saint-Étienne, France
² Lamberti SpA, 21041 Albizzate, Italy

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

Hydroxypropyl Guar

- A native Guar Gum (GG) + 3 HPGs + 2 hydrophobically modified HPGs
- Roughly the same molecular weight (= 2.10⁶ Da)

Water Retention

Water Retention Agent (polysaccharide)

Water Retention = Capacity of fresh mortar to keep its mixing water

Desired Effect

Mixing water stay into the fresh mortar → Good Mechanical and adhesive properties

Support

Absorption of water by the substrate

Adhesion failure

Cracking

Polysaccharides are also expected to act as VEA

Major drawback: Cement hydration delay

Materials

Hydroxypropyl Guar

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

Mortar Formulation

Water Retention

- HPGs are good water retention agents
- Huge impact of HPG chemical composition
  - MSHP promotes WR by [HPG]
  - Hydrophobic side chain promotes WR by C

Adsorption

TOC - Centrifugation - Depletion method

- Low dissolution kinetics of GG
- MSHP: Adsorption because of free -OH and polarity
- Hydrophobic alkyl chain: Low Adsorption Change in conformation of HPG (Simon et al.)
  - Alkyl chains inside the coils / Hydrophilic groups at the outskirt of the coils

Water Retention

Standard ASTM C 1506-09:

- Excepted GG, HPGs improve the WR capacity of mortars
- MSHP improves the WR capacity [MSHP] < [HPG] < [MSHP]
  - Thanks to Adsorption and thus [HPG] in pore solution
- Positive impact of the additional alkyl chain
- Adsorption compensated by in coil overlapping concentration
- DSAC slightly reduces the WR capacity DSAC < DSAC

Rheological properties of mortars

Herschel-Bulkley model:

- τ = τ₀ + Ky

- τ₀ with HPGs 1, 2, 3
- Bridging flocculation
- MSHP adsorption bridging compensated by η₀ and [HPG]

- K and n with HPGs 4, 5

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

Conclusions

- HPGs act as VEA
- “Classical” HPGs the stability of mortars by τ₀
- Hydrophobically modified HPGs the resistance to the flow of admixed mortars by K

Chemical composition of HPGs is a key parameter of mortar formulation