



**HAL**  
open science

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

Alexandre Govin, Marie-Claude Bartholin, Barbara Biasotti, Max Giudici,  
Valentina Langella, Philippe Grosseau

► **To cite this version:**

Alexandre Govin, Marie-Claude Bartholin, Barbara Biasotti, Max Giudici, Valentina Langella, et al.. Impact of Guar Gum Derivatives on Properties of Freshly-Mixed Cement-Based Mortars. Caijun Shi; Yan Yao. 14th International Congress on the Chemistry of Cement (ICCC 2015), Oct 2015, Beijing, Italy. , The 14th International Congress on the Chemistry of Cement - ICCC Proceedings, 2015. emse-01250110

**HAL Id: emse-01250110**

**<https://hal-emse.ccsd.cnrs.fr/emse-01250110>**

Submitted on 4 Jan 2016

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

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

Alexandre Govin<sup>1</sup>, Marie-Claude Bartholin<sup>1</sup>, Barbara Biasotti<sup>2</sup>, Max Giudici<sup>2</sup>,  
Valentina Langella<sup>2</sup>, Philippe Grosseau<sup>1</sup>



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



Cement + Admixture + Sand = Mortar

**Water Retention Agent (polysaccharide)**  
Most widely used admixture: **Cellulose Ethers**  
~ 1/3 of raw materials cost for only **0,5 wt%**

### Water Retention

= Capacity of fresh mortar to keep its mixing water

With Water Retention Agent vs Without Water Retention Agent

**Desired Effect:** Mixing water stay into the fresh mortar → Good Mechanical and adhesive properties

**Without Agent:** Absorption of water by the substrate → Adhesion failure, Cracking

**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

Seed → Endosperm → Grinding → Native guar gum obtained without chemical treatment

Thermomechanical extraction

Irreversible nucleophilic substitution

CC(O)C1OC(O)C(O)C(O)O1

**HPG**

**HPG preparation**

**HPG Studied**

- A native Guar Gum (**GG**) + 3 HPGs + 2 hydrophobically modified HPGs
- Roughly the same molecular weight (≈ 2.10<sup>6</sup> Da)

| Sample | MS <sub>HP</sub> | Additional Substitution | DS <sub>AC</sub>  |
|--------|------------------|-------------------------|-------------------|
| HPG 1  | Low              | -                       | -                 |
| HPG 2  | Medium           | -                       | -                 |
| HPG 3  | High             | -                       | -                 |
| HPG 4  | High             | Short alkyl chain       | Higher than HPG 4 |
| HPG 5  | High             | Short alkyl chain       | -                 |
| GG     | -                | -                       | -                 |

### Mortar Formulation

| Component             | CEM II/B-LL 32.5R | Lime | CaCO <sub>3</sub> | CaMg(CO <sub>3</sub> ) <sub>2</sub> | 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<sub>HP</sub> → 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:  $WR(\%) = \frac{W_0 - W_1}{W_0} \times 100$

- Excepted **GG**, HPGs improve the WR capacity of mortars
- MS<sub>HP</sub> improves the WR capacity: MS<sub>HP</sub> HPG 1 < MS<sub>HP</sub> HPG 2 < MS<sub>HP</sub> HPG 3
- Thanks to ↓ Adsorption and thus ↑ [HPG] in pore solution
- Positive impact of the additional alkyl chain
- ↑ Adsorption compensated by ↓ in coil overlapping concentration
- DS<sub>AC</sub> slightly reduces the WR capacity: DS<sub>HP</sub> HPG 4 < DS<sub>HP</sub> HPG 5

## Rheological properties of mortars

**Herschel-Bulkley model:**  $\tau = \tau_0 + K\dot{\gamma}^n$

$\tau_0$ : yield stress,  $K$ : consistency coefficient,  $n$ : fluidity index

- τ<sub>0</sub> with HPGs 1, 2, 3
- Bridging flocculation
- MS<sub>HP</sub> ↓ adsorption ↓ bridging compensated by ↑ η<sub>0</sub> 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

### Water Retention

- HPGs are good water retention agents
- Huge impact of HPG chemical composition
- ↑ MS<sub>HP</sub> promotes WR by ↑ [HPG]
- Hydrophobic side chain promotes WR by ↓ C\*

### Rheological properties

- HPGs act as VEA
- "Classical" HPGs ↑ the stability of mortars by ↑ τ<sub>0</sub>
- Hydrophobically modified HPGs ↑ the resistance to the flow of admixed mortars by ↑ K

**Chemical composition of HPGs is a key parameter of mortar formulation**