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EXILVA, A YIELD STRESS ENHANCEMENT ADDITIVE FOR CONCRETE

APPLICATION BULLETIN

Concrete mix-designs use many different chemical and mineral admixtures to achieve the desired properties. For example, self-compacting concretes (SCCs) will need the right mix of superplasticisers (SPs), viscosity modifying admixtures (VMAs) and other additives to obtain the correct flow properties, reduce the propensity for segregation and bleeding as well as the right setting-time.

One method to determine the right type and dosage of an additive in concrete, such as a VMA, is to analyze the rheology of the corresponding cement paste. Yield stress (the minimum pressure needed for complete deformation of a cement paste) is an important parameter in assessing whether the addition of admixtures has a detrimental effect on the cement paste. For example, adding the right type and correct dosage of VMA into a cement paste will often increase the yield stress, making the concrete more stable and cohesive. However, adding the wrong type or incorrect dosage of a VMA will give undesirable properties, such as poor workability and retardation effects on the setting-time.

Cellulose ethers, which are semi-synthetic biopolymers, are often used as VMAs in the mortar/concrete industry as they enhance the quality of cement-based materials by improving water retention, workability and open-time as well as reducing sagging[1]. However, they can have a negative impact, such as retarding effects and high air-entrainment, which can reduce the yield stress values, leading to poor quality mortars/concretes[2].

In this study, we show a comparison of Exilva P 01-L versus a high viscosity methyl ethyl hydroxyethyl cellulose ether (MEHEC) that is commonly used in the cement-industry. Both Exilva P 01-L and the MEHEC are tested at the same active content liquids by weight of cement (lbwc) (%) in the cement paste. A reference cement paste, containing no VMAs, was also tested. All the mix-designs tested can be seen in Table 1 below.

All cement pastes tested had a water/cement ratio (w/c) of 0.5. The dosages used for the Exilva P 01-L cement pastes were 0.25% and 0.5% (as delivered) lbwc. The dosages for the MEHEC cement pastes, were 0.005% and 0.01% (as delivered) lbwc. No SP was used for any cement paste.

TABLE 1. Cement Paste Mix-Designs

COMPONENT	Reference	Exilva P 01-L	Exilva P 01-L	MEHEC	MEHEC
W/C	0.5	0.5	0.5	0.5	0.5
Water (g)	500	498.75	497.5	499.975	499.95
Cement (g)	500	500	500	500	500
Exilva P 01-L (g)[a]	–	1.25	2.5	–	–
MEHEC (g)[b]	–	–	–	0.025	0.05
Total (g)	1 000	1 000		1 000	1 000
Active dosage lbwc (%)	–	0.25	0.5	0.005	0.01
Additive active dosage lbwc (%)	–	*0.005*	*0.01*	*0.005*	*0.01*

[a] Exilva P 01-L contains 2% of active solids,

[b] MEHEC contains 100% of active solids.

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The rheology of each cement paste was measured for yield stress with a rheometer, using the parameters set out in Mukhopadhyay, A. K., et al.[3]. The results for each cement pastes' yield stress values are shown in Figure 1 below, based on additive active content lbwc (%).

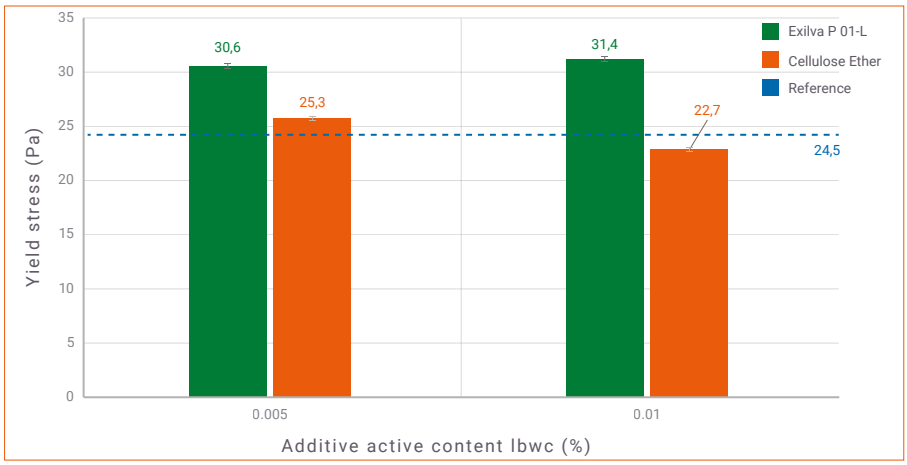

FIGURE 1. Yield Stress Values for the Cement Pastes Tested.

Addition of Exilva P 01-L into the cement paste, at 0.005% and 0.01% active content lbwc, leads to an increase in the yield stress compared to the reference paste. The yield stress values also increase as the active content lbwc increases form 0.005% to 0.01%. This indicates that addition of Exilva P 01-L will lead to a more stable and cohesive cement-matrix in the corresponding mortar/concrete, as seen in our previous bulletins [4, 5].

Comparing the MEHEC and Exilva P 01-L pastes at the same active content lbwc, Exilva P 01-L has a higher yield stress at both the 0.005% and 0.01% active dosages. In fact, the yield stress values for the MEHEC pastes decrease at increasing additive dosage. At 0.01% MEHEC lbwc has a lower yield stress than the reference paste. This loss in yield stress, at increasing dosage of MEHEC, shows that the corresponding mortar/concrete will have less stability, which will give an increasing propensity for bleeding/segregation as well as sagging. This decrease in yield stress could also signify a retardation of the setting-time, again this is not ideal for a concrete[2].

Based on these cement paste results, addition of Exilva P 01-L gives higher yield stress values compared to the MEHEC at the same additive active content lbwc. These increased yield stress values in the cement paste, with Exilva P 01-L, will lead to a corresponding concrete that has reduced segregation/bleeding and a more uniform and stable matrix in mortars that are more resistant to sagging effects.

KEY POINTS

- Addition of Exilva P 01-L into cement paste gives an increase in yield stress at increasing dosages (0.25% - 0.5% additive dosage lbwc).
- Effectiveness of Exilva P 01-L – gives higher yield stress values compared with the reference paste and the cellulose ether pastes at the same active content lbwc (%).
- Increasing yield stress values – reduces the propensity for segregation and bleeding of concretes and sagging in mortars.
- Exilva is 100% natural and infinitely sustainable.

[1] Brumaud, C., Baumann, R., Schmitz, M., Radler, M., Roussel, N. Cellulose ethers and yield stress of cement pastes. (2014) Cement and Concrete Research 55 14-21. http://dx.doi.org/10.1016/j.cemconres.2013.06.013

[2] Nguyen, D. D., Devlin, L. P., Koshy, P., Sorrell, C. C. Impact of water-soluble cellulose ethers on polymer-modified mortars. (2014) J. Mater. Sci. 49 923-951. 10.1007/s10853-013-7732-8

[3] Mukhopadhyay, A., & Jang, S. Using Cement Paste Rheology to Predict Concrete Mix. (2008) Texas Transportation Institute. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.626.9096&rep=rep1&type=pdf

[4] *Exilva in Self-Compacting Concrete*

[5] *Exilva: A Multifunctional Concrete Additive*

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