MIXTURE OPTIMIZATION OF AN ALKALI-ACTIVATED STEEL SLAG TO MAXIMIZE BINDER STRENGTH USING OPTIMAL DESIGN OF EXPERIMENTS

Pavel Leonardo Lopez Gonzalez, KU Leuven, Department of Materials Engineering, , Belgium
Pavelleonardo.lopezgonzalez@kuleuven.be
Yiannis Pontikes, KU Leuven, Department of Materials Engineering, Belgium

Key Words: Alkali-activated, binder, BOF-slag, optimization, optimal design of experiments

The diversity of precursors suitable for alkali activation demands a flexible methodology to study the properties of alkali-activated binders. Optimal design of experiments (ODOE) [1] allows a systematic and efficient exploration of effects and interactions among mix components and processing conditions, a situation commonly found during proportioning studies. Moreover, the ODOE algorithms provide sets of experiments of an optimized size that consider all the factors studied at the same time, a key feature to detect absolute maximums (or minimums) of a response. In this case, the strength-optimized proportioning for basic-oxygen-furnace (BOF) slag specimens activated with NaOH solutions was determined. The impact of solution molarity ranging from 0M (only water) to 0.5M and the additions of gypsum (2 to 6 wt%), Portland cement (0 to 10 wt%) and 0.2 wt% of a commercial plasticizer (polycarboxylate-based dispersant) were mapped. Proportions tested were

selected running ODOE software using an I-optimality criteria algorithm, which minimizes the average variance of model prediction. A response surface model (RSM) for 28-day strength was defined. Paste and mortar specimens were produced with the predicted proportioning of highest strength and its binding matrix was characterized and compared with low-strength samples using X-ray diffraction (XRD), secondary electron microscopy (SEM) and infrared spectrometry (FTIR). The results obtained confirm that the methodology generates a model able to predict mechanical response, detecting general trends, high impact factors and interactions. More important, the optimal experimental design can be used to effectively study changes in the binding matrices and link them to the binder's mechanical performance.

[1] Goos P, Jones B. Optimal Design of Experiments: A Case Study Approach. Wiley; 2011.

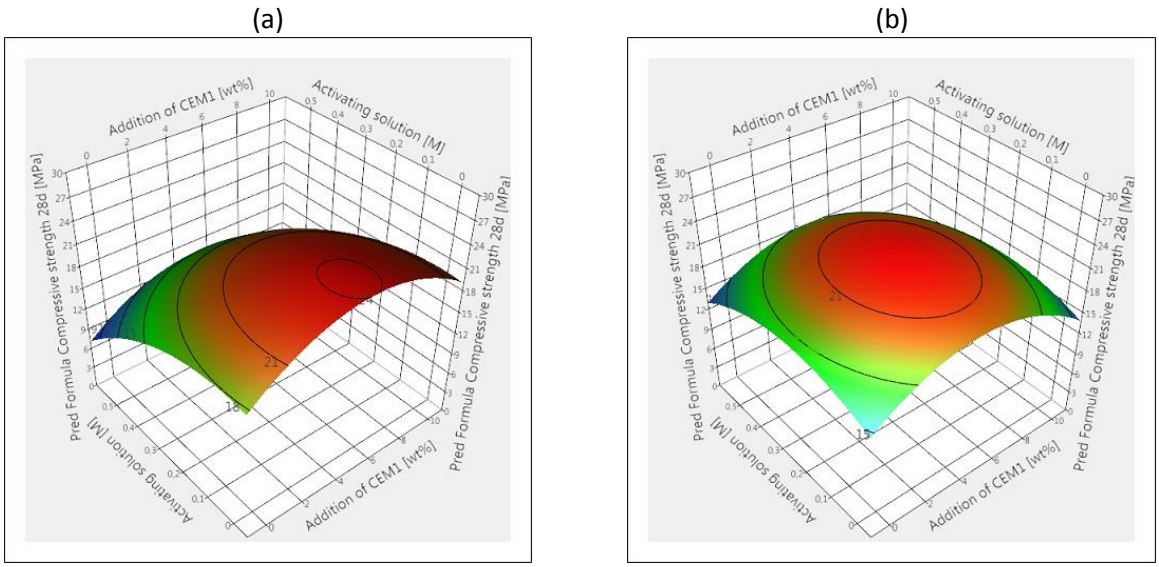

Figure 1. RSM model for 28-day compressive strength of paste specimens produced with BOF slag as precursor, (a) behavior with 6wt% addition of gypsum, and (b) behavior once plasticizer is included and 2wt% gypsum is added.