

Activation of supplementary cementitious materials in new environmentally friendly concrete

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1 Introduction

• Framework

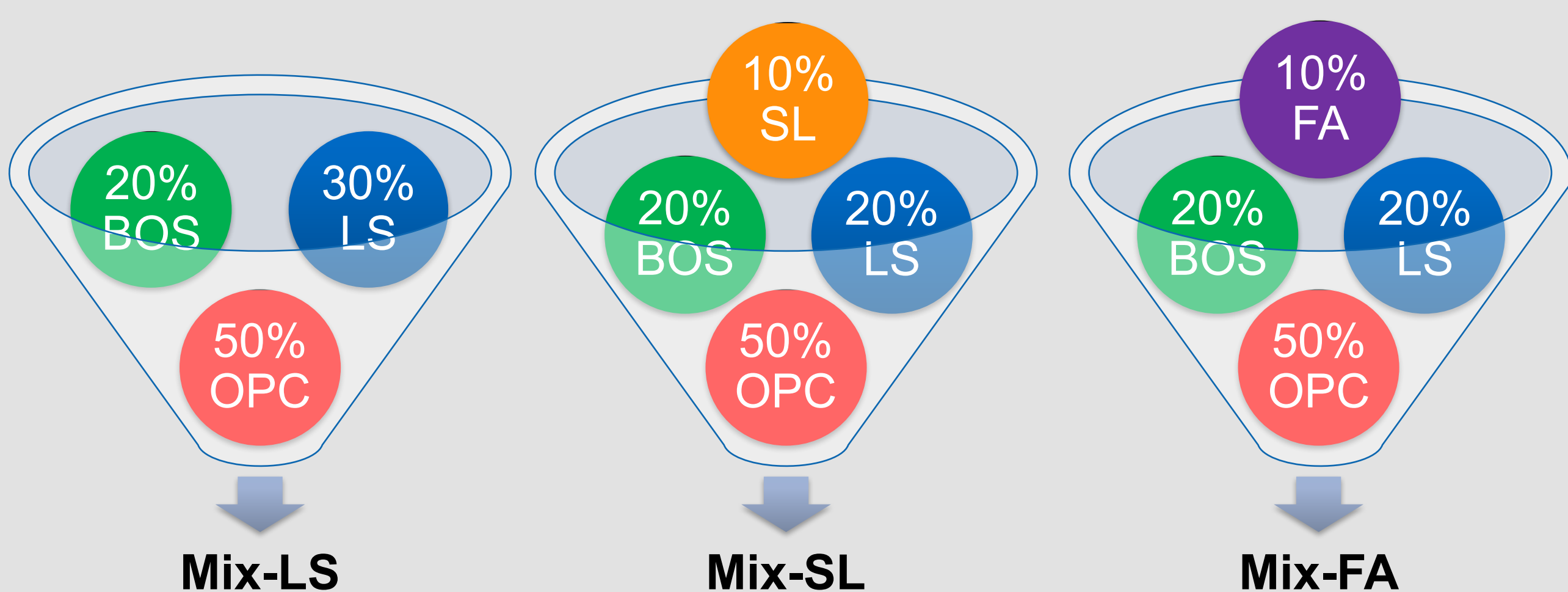
Concrete production accounts for 5-8% of man-made CO₂ emissions. One of the most effective strategies to decrease its environmental impact is clinker replacement with supplementary cementitious materials (SCMs). They are natural or by-product of industrial processes and they are selected based on their local availability and cost.

• Objective of the project

Development of a new generation of low clinker concrete that consider the local availability of raw materials in Switzerland. The main aim is to find synergies between activators and dispersants, necessary to improve the performance and avoid incompatibilities [1].

2 Materials

• Binders



OPC = Ordinary Portland Cement
BOS = Burnt Oil Shale
LS = Limestone
SL = Blast Furnace Slag
FA = Fly ash

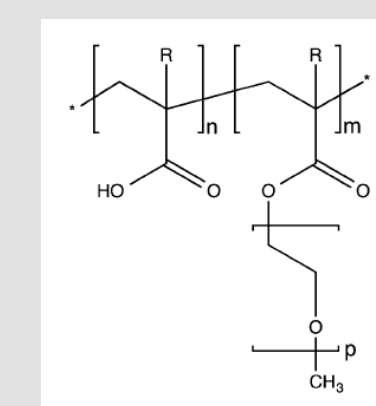
• Activators

- NaOH (0 – 1% bwb)
- Na₂SO₄ (0 – 1.75% bwb)
- Ca(NO₃)₂ (0 – 1% bwb)

• Dispersant

Comb-shaped superplasticizer

- PCE1 (0 – 0.4% bwb)



| | Molecular Structure | CIE | Backbone (g/mol) | Side chains (g/mol) | P | N | n | K _A |
|------|---------------------|-----|------------------|---------------------|----|-----|----|----------------|
| PCE1 | Methacrylic-based | 3.2 | 5250 | 1000 | 23 | 4.2 | 15 | 102 |

3 Results

- The addition of alkali solutions increases the reactivity of all the binders, being higher with NaOH as activator. The dosage of 0.4% PCE provides the best rheological properties in all the activated systems (Figure 1).
- The addition of activators and PCE truly enhances the mechanical performance up to 7 days (Figure 2).
- A relationship between the heat release and the compressive strength have been proved up to 7 days (Figure 3). The moderate amount of fly ash and blast furnace slag as SCMs seems to be not activated by the alkali solutions.

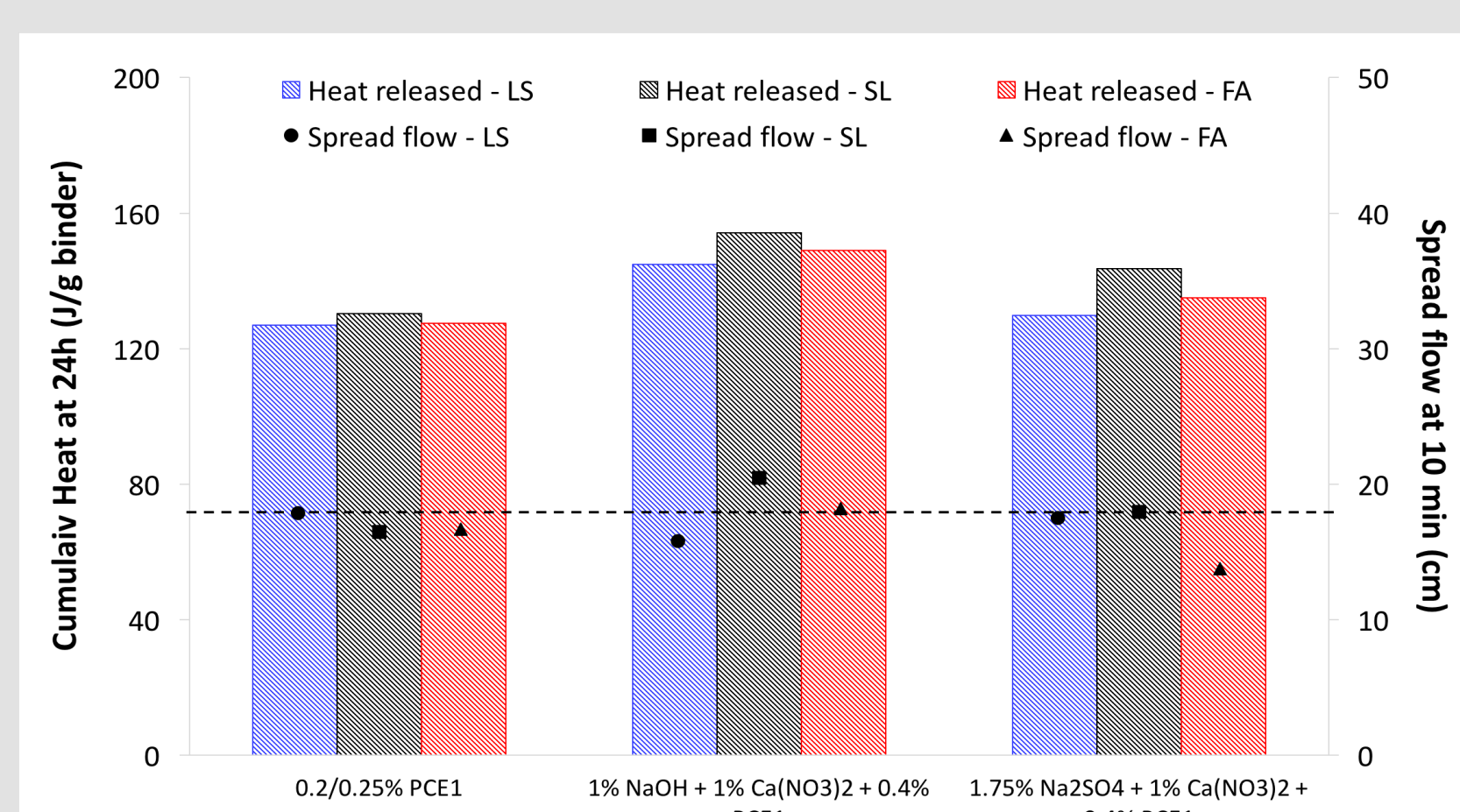


Figure 1. Influence of moderate alkali solutions on the heat release at 24h and the spread flow at 10 min.

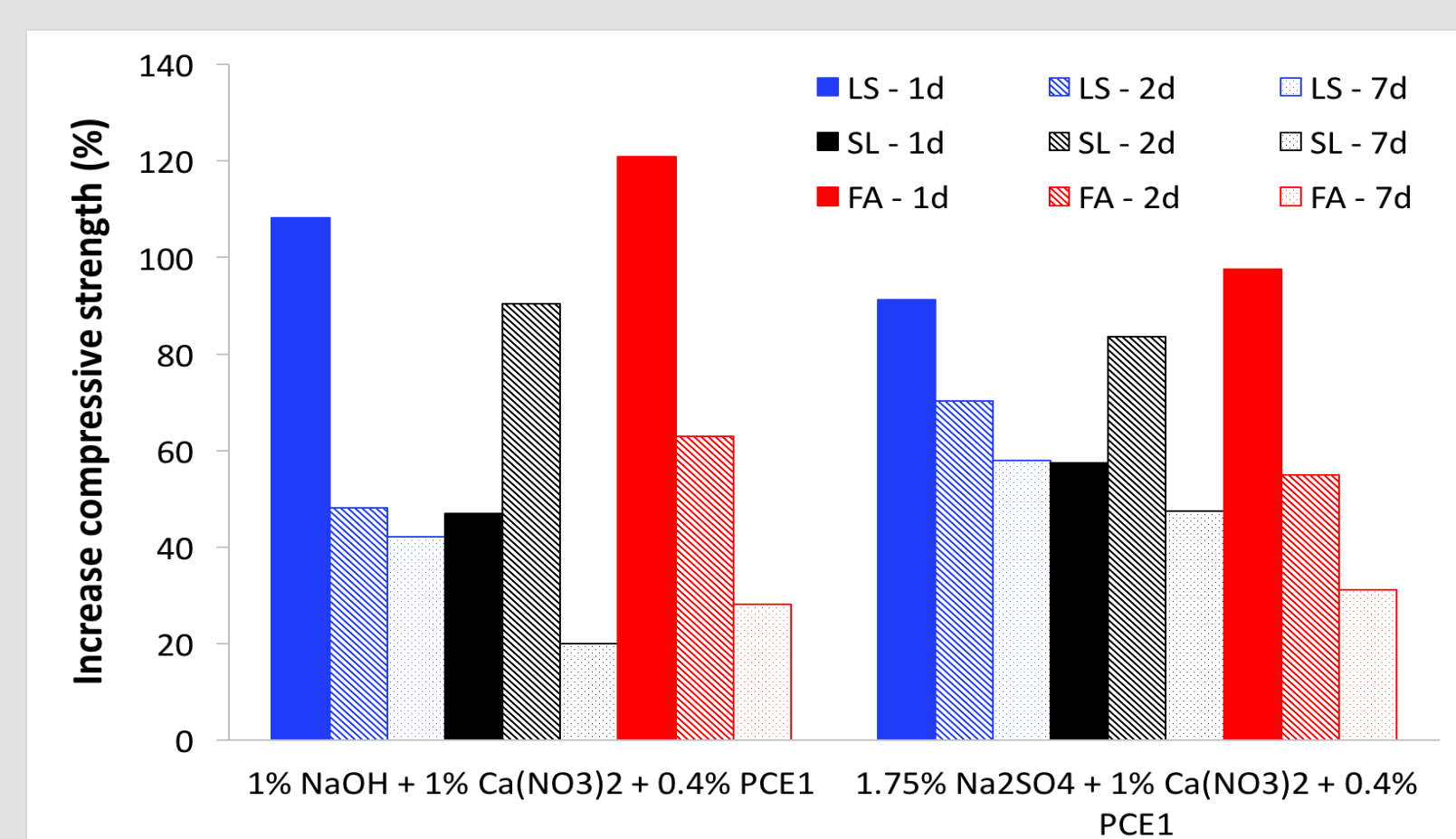


Figure 2. Increase of compressive strength of mortars measured at 1, 2 and 7 days of hydration.

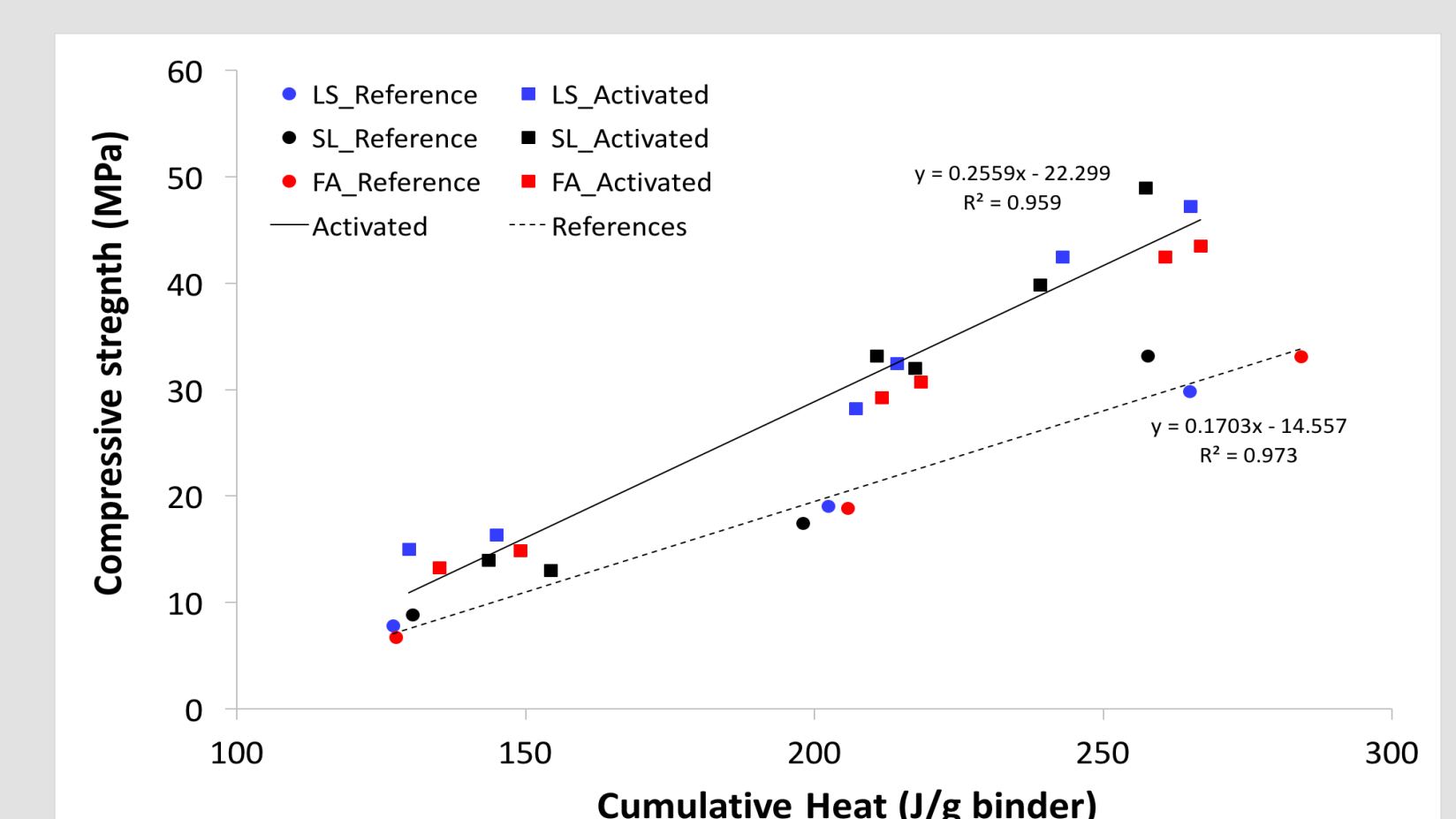


Figure 3. Relationship between the heat release and the compressive strength up to 7 days.

4 Conclusions

- Formulations for a new environmentally friendly cement for the Swiss mass market were developed
 - Field tests are being planned
 - Important but second order issues need to be fixed for market viability
 - Fluidity retention, corrosion risk

5 Acknowledgements

Research supported by the SNF project (no. 154062) titled "Formulation, use and durability of concrete with low clinker cements". H. Richner and A. Reusser are thanked for their help during the tests. Dr. Kruspan (LafargeHolcim) and Dr. Frunz (Sika) are thanked for providing the materials.

6 References

[1] D. Marchon et al., Soft. Matter 9, 10719-10728 (2013)