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Recycled gypsum in ternary mortars: high-temperature performance

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Introduction

The search for alternative binders (AB) is a challenge, not only to minimize the use of Portland cement (PC), but also to obtain a material with performance suitable for its intended purpose (Nuruddim et al., 2010). AB can be used in various applications, such as pastes, grouts, and renderings, masonry blocks; in restoration work; and in fire protection elements (Morsy et al., 2017). They can be used in binary mixtures, as well as in ternary mixtures and are capable of hardening and forming stable compounds with good performance (Cachim et al., 2014).

Objetives

This study evaluated the performance of ternary mortars produced with hydrated lime (HL), metakaolin (MK), and gypsum (commercial – CG or recycled – RG) when subjected to high temperatures.

Materials and methods

Materials: hydrated lime (HL), metakaolin (MK), gypsum (commercial – CG or recycled – RG), admixture (superplaticizer), and river sand. Table 1 shows the mortars mix design.

Mortars		Materials HL (%)	Materials MK (%)	Additions CG (%)	Additions RG (%)	Binder/ sand ratio	Water/ binder ratio
Reference	R1090	10	90	0	0	1:1.5	0.65
CG addition	GC1090	10	90	10	0		
RG addition	GR1090	10	90	0	10		

Methods: heating in muffle furnace (temperatures ranging from 50 °C to 1000 °C), measuring flexural strength, compressive strength, and mass loss.
Tests were made is specimens after curing in air at the ages of 30, 60 and 90 days.

Results and Discussion

Figure1 show the specimens before and after heating at 1000 °C. Figures 2, 3 and 4 show, respectively, the results of flexural strength, compressive strength, and relative mass loss after the heating process (1000 °C).

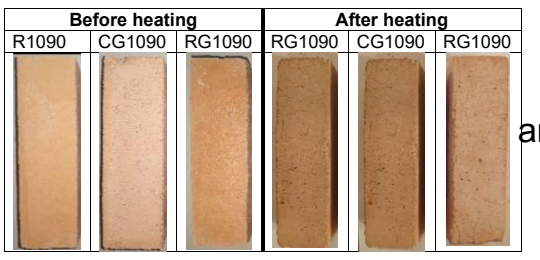


Figure 1. Mortars before and after heating at 1000 °C

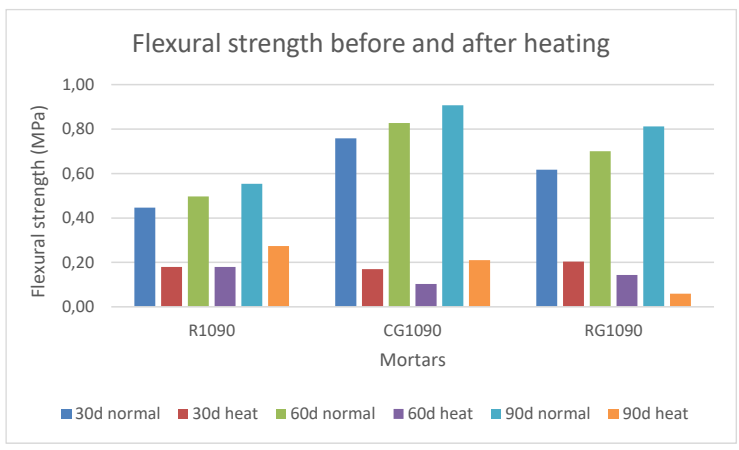


Figure 2. Mortars flexural strength

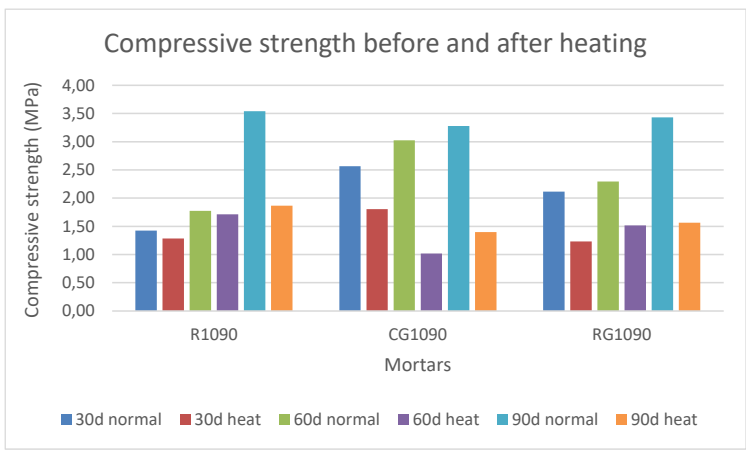


Figure 3. Mortars compressive strength

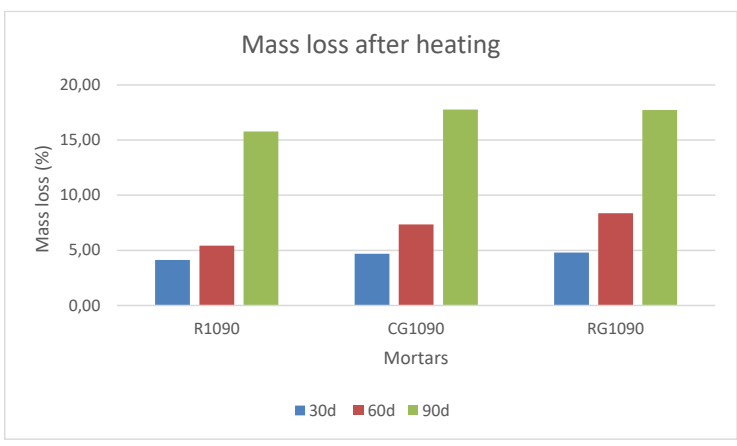


Figure 4. Mortars relative mass loss after heating at 1000 °C

The presence of gypsum (CG or RG) improved the mechanical performance of ternary mortars. The mass loss was similar to all mortars. To diminish the environmental impact, the use of RG is indicated to make these mortars.

Conclusion

Ternary mortars containing CG or RG exhibited results similar to those of the reference binary mortars (HL+MK) at 90 days. The ternary mortars of HL, MK, and CG or RG proved be suitable for application in situations requiring exposure to high temperatures, as their residual mechanical strengths after exposure to high temperatures were higher and demonstrate their potential for use in civil engineering.

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