The 4th International Online Conference on Materials (IOCM)
3–6 November 2025
Part of the International Online Conference on Materials series

Using Poultry Feather Waste as an Eco-Friendly Admixture in Cement Pastes and Mortars

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Abstract

Given that chicken is one of the most affordable and healthiest sources of protein, its daily consumption continues to rise globally. As a result, approximately 3 billion pounds of chicken feathers are produced worldwide each year, much of which is discarded as waste. These feathers contribute to soil and water pollution and serve as breeding grounds for harmful microorganisms. Consequently, feather waste poses a significant threat to ecosystems and has become a source of environmental pollution. With this in mind, the aim of this work is to develop and use poultry feather waste (PFW) in powdered form as an additive or auxiliary agent combined with a superplasticizer in cementitious materials such as cementitious pastes and cement mortars. An experimental study was carried out in two parts. In the first phase, PFW powder is incorporated into the superplasticizer, which is then added to cementitious pastes at varying dosages. A rheological analysis is conducted to evaluate the effect on flow behavior. In the second phase, the superplasticizer containing PFW powder is applied to cement mortars. This stage focuses on the physical–mechanical characterization of the modified mortars. The results indicate that PFW can be effectively used as a component of superplasticizer formulations in cement mortar systems, enhancing fluidity without compromising the mechanical performance of the material.

Keywords: poultry feathers, powder and admixture, cement and mortar, rheology, physical properties and mechanical properties

Experimental Study:

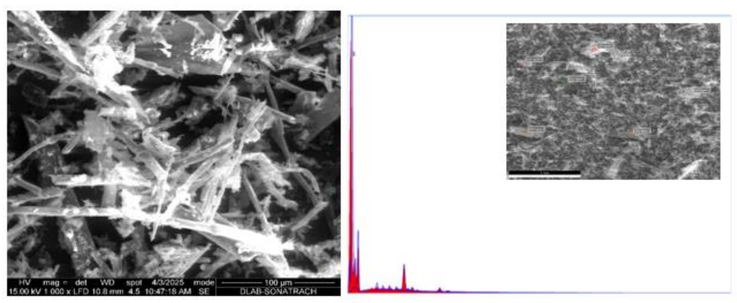
This section presents the experimental study conducted on cement pastes and mortars to assess the potential use of poultry waste powder as an additive or admixture in combination with a superplasticizer. The experimental program was carried out in two main phases.

Materials used:

An artificial superplasticizer was prepared in the teaching laboratory with the aim of replacing the conventional superplasticizer. Its formulation was based on the following materials:• Nano-silica (NS)• Poultry feather waste powder (PFW)• Superplasticizer (SP)• Water **Fig. 1**

Fig. 1 Poultry waste powder

Fig. 2 SEM and EDX images of poultry powder after preparation



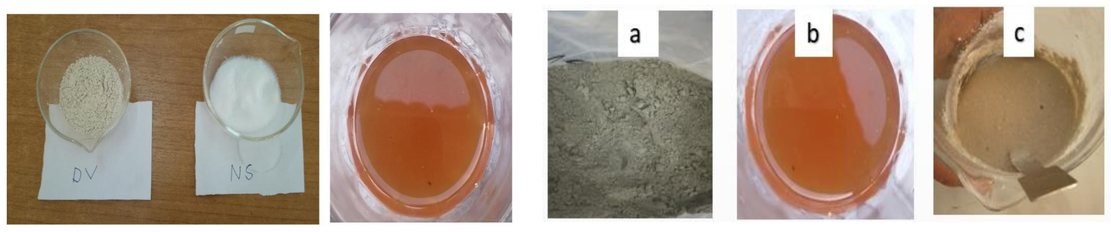


Fig. 3: Materials used:• Nano-silica (NS)• Poultry feather waste powder (PFW)• Superplasticizer (SP)• Water

Fig. 4: Cementitious pastes (a) Rheometer AR200- rheological tests (b)

Results and discussions

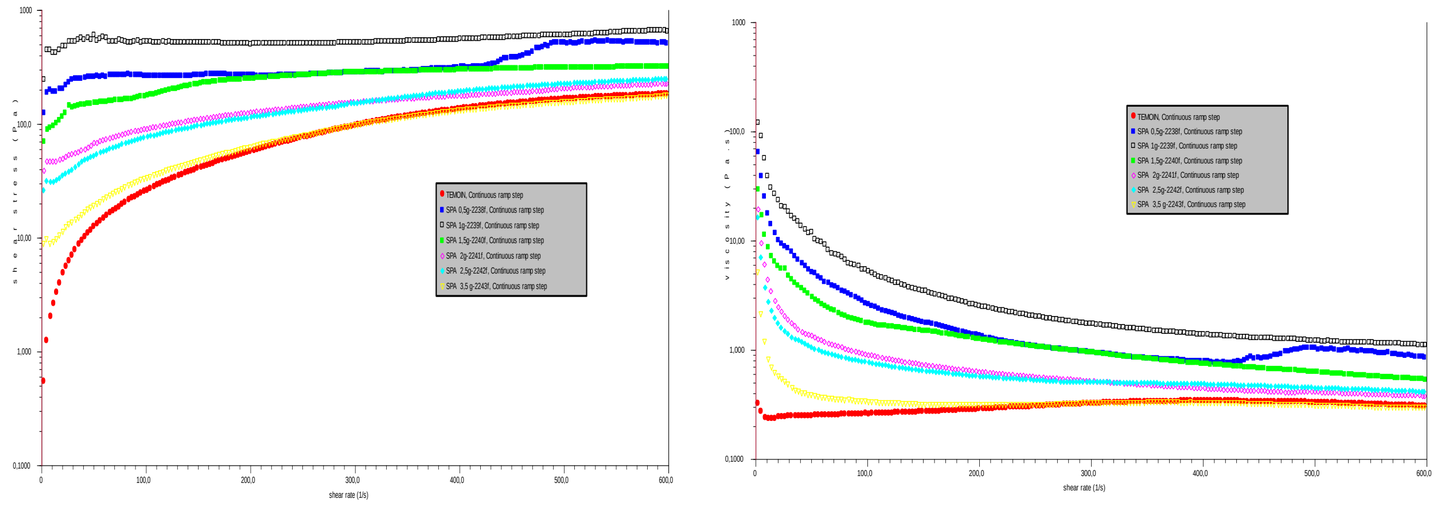


Fig. 5: Evolution of the shear stress and plastic viscosity of cement pastes

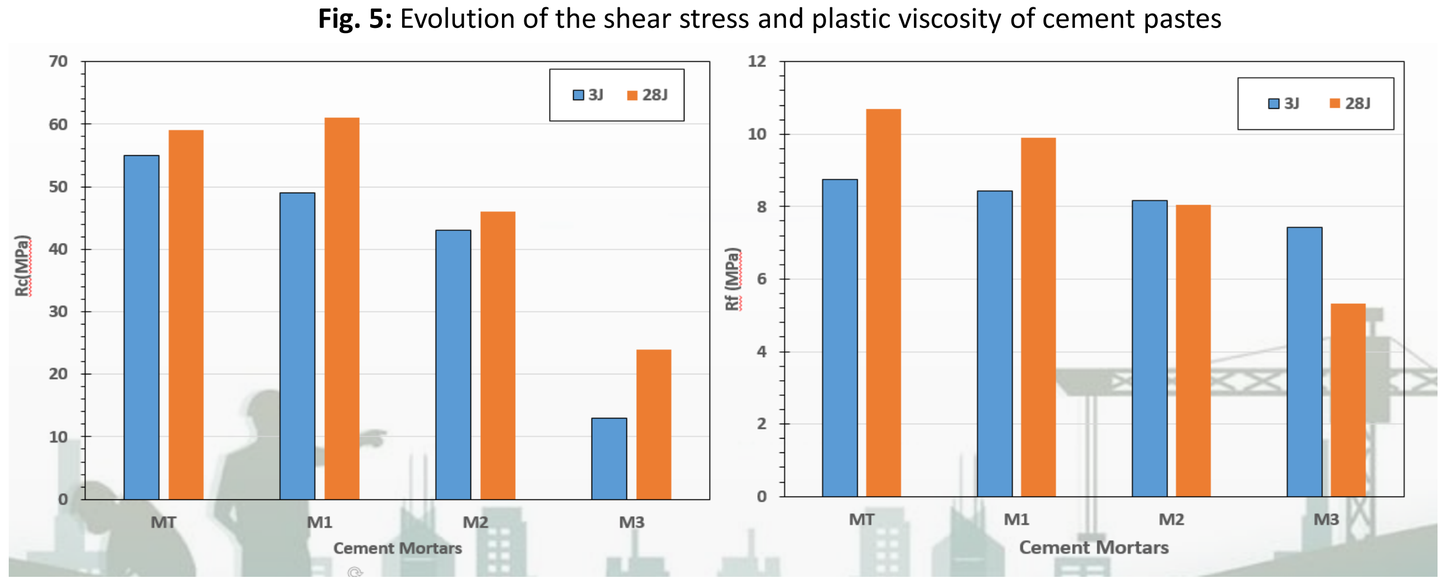


Fig. 6: Compressive and Flexural strength of EF self-compacting mortars (MPa)

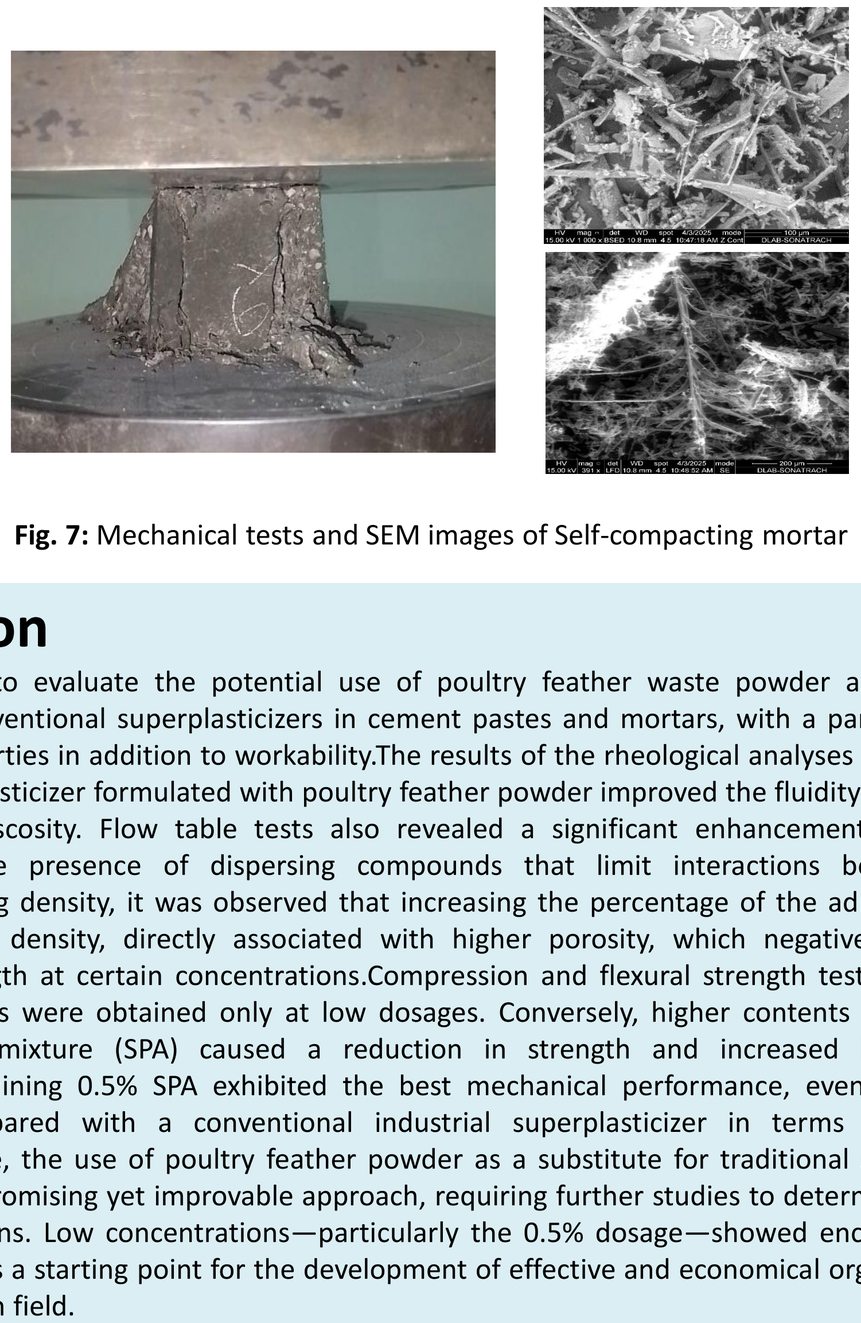


Fig. 7: Mechanical tests and SEM images of Self-compacting mortar

Conclusion

This study aims to evaluate the potential use of poultry feather waste powder as an alternative admixture to conventional superplasticizers in cement pastes and mortars, with a particular focus on mechanical properties in addition to workability.The results of the rheological analyses showed that the synthetic superplasticizer formulated with poultry feather powder improved the fluidity of the pastes by reducing their viscosity. Flow table tests also revealed a significant enhancement in workability, attributed to the presence of dispersing compounds that limit interactions between cement particles.Regarding density, it was observed that increasing the percentage of the admixture led to a decrease in bulk density, directly associated with higher porosity, which negatively affected the mechanical strength at certain concentrations.Compression and flexural strength tests indicated that satisfactory results were obtained only at low dosages. Conversely, higher contents of the synthetic poultry-based admixture (SPA) caused a reduction in strength and increased brittleness. The formulation containing 0.5% SPA exhibited the best mechanical performance, even surpassing the control mix prepared with a conventional industrial superplasticizer in terms of compressive strength.Therefore, the use of poultry feather powder as a substitute for traditional superplasticizers appears to be a promising yet improvable approach, requiring further studies to determine the optimal technical conditions. Low concentrations—particularly the 0.5% dosage—showed encouraging results and could serve as a starting point for the development of effective and economical organic admixtures in the construction field.

Brahim Safi currently is Professor at University M'Hamed Bougara - Boumerdes. He is Head of research team; Eco-Materials, Recycling and Recovery of Wastes in materials, at URMPE. He is Vice-Dean of PG, Scientific Research and External Relations. The scientific interests: Wastes recycling, Materials characterization. Construction and Building Materials, Mechanical behavior of Materials, Rheology of Fluids. Editor : Book of Proceedings – 3rd ISMSD2017 & 4th ISMSD2019 - J. Buil. Mat. Struct.