RECYCLING FINE PARTICLES FROM CONSTRUCTION AND DEMOLITION WASTES: CHARACTERIZATION AND EFFECTS ON CONCRETE PERFROMANCES

Luc Courard[a], Mohamed El Karim Bouarroudj[a,b,d], Charlotte Colman[a,b], Adèle Grellier[a,b], Zengfeng Zhao[a,c], Frédéric Michel[a], Julien Hubert[a,], David Bulteel[b], Sébastien Remond[b,d]

[a] Urban and Environmental Engineering, GeMME Building Materials
University of Liège
Allée de la découverte, 9 – 4000 Liège, Belgium
e-mail: Luc.Courard@uliege.be

[b] Laboratoire de Génie Civil et géoEnvironnement LGCgE - EA 4515 – Département Génie Civil & Environnemental
IMT Lille Douai, Université de Lille
F-59000 Lille, France

[c] Research Group for Recycled Concrete Structures and Construction
Department of Structural Engineering
College of Civil Engineering
Tongji University
1239 Siping Road, Shanghai 200092
China

[d] Laboratoire LaMé – Polytech Orléans
8 rue Léonard de Vinci, 45072 Orléans
France

1. Background/ Objectives and Goals

Recycling construction and demolition wastes induce the production of coarse aggregates,

quite easily valorized in road foundations and concretes but also fine and very fine particles which are characterized by high water absorption level. The fine particles are very often rejected as they are containing polluting materials or because of their fineness and shape. This paper tends to show different ways of using Recycled Fine Aggregates (RFA).

2. Methods

A first material that has been investigated is gypsum residue. Sulfate attack is a deteriorating process for concrete, where the formation of expansive minerals such as ettringite causes the swelling of a material. The sulfates necessary for this reaction can come from an external (such as sea- or groundwater) or an internal (such as cement or aggregates) source. A specific situation within this problematic is the contamination of recycled aggregates with gypsum from the demolition site. To assess the extent of the damage that this gypsum contamination can cause, the length of cementitious mixes that incorporated recycled aggregates needs to be monitored. The challenge exists in finding the right testing protocol to follow the development of sulfate attack. Being a slow reaction which can take several months, accelerating procedures could be necessary. Different methods are described, but do not seem to be applicable in this specific context of gypsum contamination. Fine recycled aggregates contaminated with different levels of gypsum have been subjected to a set of various storage conditions and/or aging cycles.

A second material that has been analyzed is concrete fine particles. Research work focuses on the study of the behavior of self-compacting concrete produced from recycled sand and crushed recycled sand. The first step consists of a physico-chemical and mineralogical characterization (density, water absorption, sulphate content, chemical composition, etc.) of recycled concrete sand. In a second step, a study of the rheological and mechanical properties is carried out on mortars in order to reduce the quantity of natural materials used. The composition of the reference mortar is derived from a typical design of self-compacting concrete previously verified on the basis of various conventional criteria (spreading cone, t500, air content, ... etc).

Finally, investigations are performed on recycled fine bricks materials. The aim of this study is to analyze the recycling of the bricks in the production of self-compacting mortar (SCM). The investigation were performed on mortars produced with different replacement's percentage on the limestone filler, in one case, and on the limestone sand, in the other. The bricks were prepared and treated to achieve the similar physical properties of the filler and sand of limestone. Then the materials were characterized in order to make a comparison with the limestone fractions and to design the mix for the mortar. Several tests were performed to highlight the influence of the substitution's grade by this unusual material in the traditional mix of the most common product in the building industry: the concrete. The analysis is performed on mortars' sample due to the similar trends of the results coming from the

concrete material. Moreover, for this specific case, the use of superplasticizers was avoided for enhancing the behavior of the bricks fraction and its influence on the mixture. The study on the compressive and flexural strength show how much the substitution can affect or improve the main properties of the hard mortar. Another way of valorization of this material is studied: it consists of an incorporation of the bricks in the cements as an alternative binder.

3. Expected Results/ Conclusion/ Contribution

The results show that existing protocols, set up specifically for internal sulfate attack, do not provide the acceleration or aggravation of the reaction as might have been shown before. A definitive testing protocol, to be used in this specific situation, is proposed. It is also shown that limitation as required in EN206 standard may be too strict. Moreover, porosity of the fine particles seems to be a discriminant parameter for limiting potential swelling effects.

Replacing limestone filler with crushed recycled sand and natural sand with recycled sand are studied for designing self-compacting mortars. The results show a drop in workability as well as a decrease in mechanical strength at 7 days with the increase of the calcareous filler substitution rate by crushed recycled sand. On the other hand, taking into account the water absorption of the sand, an improvement of the workability with the increase of the substitution of the natural sand by recycled sand. The influence of the particle size on the workability was also studied, by means of a grain size recomposition of the recycled sand sieving curve similar to that of the natural sand: a better workability is observed compared to the reference composition.

Brick fines seem to have different pozzolanic properties. In mixtures with a substitution rate of 10% and 20% of the cementitious part by the reference brick fines, the mechanical strengths are equivalent to or even greater than for the cement alone. The substitution of the sand and the filler fraction inside the self-compacting concrete by the bricks' fractions is possible. The water absorption of the recycled material plays a fundamental role in the design mix of the mortars. The parameter has to be taken into account during the choice of the composition, especially for the amount of water to add. In the case of the limestone filler replacement by the bricks' filler, the workability showed not so important variations. Moreover, the mechanical properties of the mortars showed negligible changes by the reference mortar. Concerning the sand replacement by bricks, the workability of the mortars, even with increasing bricks sand content, don't decrease at a considerable level. The low changes between the reference mix and the other samples, for the compressive strength and the flexural strength, show a low influence by the brick's sand on the final mechanical properties.

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Biography (up to 100 words):

Luc COURARD is Professor of Building Materials at the Department of Architecture, Geology, Environment and Constructions, University of Liege, Belgium, where he received his Ph.D, 1998. His research interests include durability of concrete, repair materials and techniques and use of by-products and recycled materials in concrete technology. He is a member of the ACI and the RILEM. He is the author of more than 360 papers and chapters in books, magazine and conference proceedings.

Presenting author details that will be used for Certificates and Id cards
Full name: COURARD
Organization/Institute/ Company: University of Liège
Country: Belgium
Email 1(Work): Luc.Courard@uliege.be
Mobile (Whats app/WeChat): +32.472.74.12.95
Office Tel: +32.4.366.93.50
Please mention your ORCID iD (if any): https://orcid.org/0000-0001-6573-6631
Linked In id: Luc Courard