Quantitative Phase Analysis to predict engineering properties of concretes made with recycled construction and demolition waste

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Construction and demolition wastes (CDW) account for more than a third (37.1%) by weight of total waste generated in the EU (about 2.2 billion tonnes for EU-27 in 2020). With about 292 million tonnes, the non-hazardous mineral fraction constitutes more than 98% of the total CDW [1]. This fraction includes concretes, cements, mortars, bricks, hollow bricks, tiles, and natural stones. From a mineralogical point of view, CDW are mainly made up of mixtures of both natural silicate and/or carbonate phases, as extracted from quarries, and artificial ones present in industrial products used in construction, or newly formed from transformation processes of the original construction materials. Effective recycling (vs. downcycling) of CDW is one of the highest priorities of EC to comply with the paradigms of circular economy and sustainability of primary resources [2].

While the physical, mechanical, and engineering properties of new concretes prepared using recycled aggregates (RACs) have been widely investigated (e.g., [3]), very little attention has been paid so far to application of accurate quantitative phase analysis (QPA) by the Rietveld method to predict the performances of RACs. To fill this gap, we have performed Rietveld-QPA of recycled aggregates from earthquake-generated CDW and of RACs prepared from the same RAs in a previous study [4]. QPA results were used to calculate average pseudo-properties (density, hardness, and mass absorption coefficient) which were correlated to results of physical and mechanical tests. The correlations of “pseudo-density” to the compressive strength measured at 7 and 28 days are reported in Figure 1.

![Figure 1](https://example.com/figure1.png)

**Figure 1.** Correlation of mean “pseudo-density” calculated as a weighted average from Rietveld-QPA vs. the compressive strengths measured after aging at 7 and 28 days in mortars prepared with different proportion and types of recycled aggregates.

The good correlations found using Rietveld quantitative phase analyses allows to predict several physical and mechanical properties of concrete made from recycled CDW. The empirical relationships with calculated pseudo-properties can be used to select the type and amount of RA in order to achieve the designed performances. This will help in increasing the confidence on the use of recycled CDW in place of virgin materials from quarry, thus making the construction more circular and sustainable.