Statement of Purpose

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Most of the buildings I have assessed over the past two years will have to come down, and their concrete will become rubble. Crushed and screened, much of it could become aggregate for new concrete. Whether it can go into beams and columns, rather than only into roads and fill, depends on one question: how to predict and control the quality of recycled aggregate when the rubble it comes from is mixed and of unknown origin. That is the question I want to study in a PhD.

My MSc thesis at the Islamic University of Gaza asked a narrower version of it. I cast 96 concrete cubes with 0, 25, 50 and 100% of the coarse aggregate replaced by crushed rubble, and tested their compressive strength and water absorption at 7, 28 and 90 days. At 25% replacement the concrete kept 94% of the reference strength; at 100% it lost more than a third. What the averages hid was the spread: cubes made from different batches of the same rubble varied more than cubes with different replacement levels. When I presented these results at a conference in 2023, someone in the audience asked the question I could not answer: how would a contractor know, before casting, which batch they had?

Two further results pointed the same way. When I measured the sulfate content of 12 rubble samples, three were above the usual limit for concrete aggregate, most likely because of gypsum plaster that crushing had not removed. And when I fitted a simple regression in R, the water absorption of the aggregate alone explained about 70% of the variation in 28-day strength across my 96 cubes ($R^2 = 0.71$). In other words, a quick test on the aggregate already told me much of what a month of curing did.

Since then my work has moved from the laboratory to the field. After three years as a site engineer with a building contractor, I spent 2024 to 2026 as a field engineer in a shelter programme, assessing about 600 damaged buildings and deciding which could be repaired safely. The work gave me a practical sense of what rubble actually contains: plaster, steel, tiles, plastics, and concrete of very different ages and strengths. In the laboratory I am at home with aggregate testing and mix design, and I analyse my results in R. For two semesters, from 2022 to 2023, I was also a teaching assistant in the concrete technology laboratory.

KU Leuven's research on concrete with recycled aggregates and on durability testing is where I could turn this practical knowledge into method. I would like to begin by testing whether quick measurements on the aggregate itself, such as water absorption and density, can predict the strength and durability of the concrete made from it well enough to grade rubble at the crushing site. That is a first step rather than a full proposal, and I would expect to shape it with my supervisor.

After the PhD I want to lead materials testing for reconstruction at home and to teach at a university, so that the engineers who rebuild Gaza can treat rubble as a material with known properties rather than as waste.

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