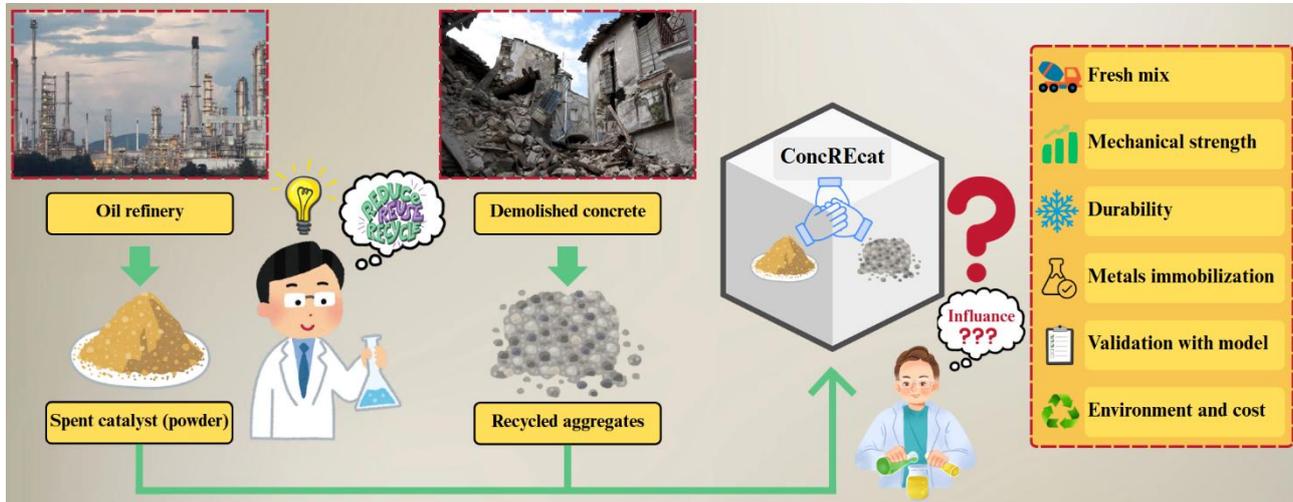


Experimental investigation of high-performance Concrete comprising REcycled materials - spent refinery catalyst and aggregates from demolished concrete structure (ConcREcat)

The scientific objective of the ConcREcat project is to develop a new sustainable high-performance Concrete (HPC) incorporating REcycled materials - spent refinery catalyst and recycled aggregates, through the experimental investigation of the influence and potential synergy they provide to concrete mixture and hardened concrete with the special emphasize on its durability and potential immobilization effect of oil impurities. The scope of the project has been graphically presented below.



The numerous research gaps appears in the scope of the effect of simultaneous incorporation of spent catalyst and recycled aggregates on the performances of HPC, especially on its durability. The scientific curiosity and desire to answering them presents the most vital motivation to carry out the proposed research. To accomplish this objective, the investigations were divided into three main phases (A, B and C) consisting of established experimental research tasks. The phase A (preliminary) consists of testing of selected physicochemical properties of the materials subjected for the research - cement, Silica Fume (SF), Spent Catalyst (SC), natural (NA) and recycled (RA) aggregates. The formulations of HPCs will be designed. The reference (plain cement) formulation will be modified by: (I) substituting 30% of NA by RA; (II) substituting 10% of cement by SF and SC; (III) incorporating SF and SC with simultaneous incorporation of RA. The phase B (main) consists of the preparation of HPC mixes followed by experimental evaluation of freshly mixed performances and hardened concrete samples (including strength, durability and toxicity aspects). Moreover, the evaluation of $\text{Ca}(\text{OH})_2$ consumption in its blends with SF and SC (which is a measure of pozzolanic activity of those additives) will be done to correlate the results with strength of concrete at different hydration periods. The phase C (final) consists of validation of the obtained results of mechanical tests with mathematical model and preparation of final environmental-economical-mechanical assessment of the utilization of SF, SC and RA in HPC concrete.

The research program was designed to answer the following research hypothesis and questions: (I) How the incorporation of SF and SC as a partial substitute of cement will affect the rheological performances of HPC mixes as well as mechanical performances of their hardened samples with respect to reference concrete? (II) Will the compressive strength performances of HPC prepared with addition of SF and SC be linearly correlated with the differences in $\text{Ca}(\text{OH})_2$ consumption in its blends with SF and SC at each hydration period as it is expected by Researchers? (III) Will compressive strengths of SF-HPCs match with predicted values obtained from the mathematical model? How it will look when the results of SC-HPCs will be uploaded to the model? (IV) What influence the addition of SF and SC will reveal regarding the durability of HPC in comparison to reference HPC, in case of resistance to carbonation, chlorides and freeze-thaw cycles? Will the densified microstructure of SF-HPC and SC-HPC (which is expected to be delivered when those additives are used) allows to counter the prognosed lower alkalinity of such concretes especially in carbonation test? (V) Which admixtures will be the most appropriate regarding the compatibility with SF and SC? (VI) What will be the parameters of RA in comparison with NA and how the substitution of NA with RA will affect fresh and hardened-state performances of HPC? The expected higher water absorption of RA might take crucial role in that scope. What impact RA will reveal in case of HPCs' durability? (VII) Will HPC ensure the immobilization of impurities potentially occurring in SC through quantification of heavy metals leached from SC-HPC? Will the presence of RA provide any variation in that scope?

The research will provide high scientific value to disciplines at the interface of materials and environmental science. It might be targeted that SC will deliver comparable or even higher pozzolanic activity to HPC than SF, which might enhances compressive strength for up to 25% and provide vital environmental benefits. The substitution of NA with RA is believed not to deteriorate HPC's performances.