Summary of the Research project

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During the past years, a strong collaboration between the University of Padova and the University of Cergy-Pontoise has been developed, aiming at developing sustainable heavy-weight concretes. Such materials may be efficiently used to design shields for radioprotection in strategic structures, such as reactor vessels, nuclear research facilities, hospitals, etc. However, for many applications, they can undergo high-temperature exposition, or even accidental fire. During a previous research work carried out at the University of Cergy-Pontoise, the behavior of three types of concrete have been analyzed, when exposed to increasing temperatures at two heating rates. The heavy-weight mixes were realized at the University of Padova, with barite (BAR) and Electric Arc Furnace (EAF) slag, this latter being a recycled aggregate, characterized by higher environmental sustainability than the former. Additionally, a normal-weight concrete was tested too, made with natural aggregates. Previous research works have already demonstrated the enhanced mechanical properties of EAF slag concrete, compared to natural ones; such improvement is considerably worth in respect with baritic concrete, which is characterized by high brittleness, this representing the main drawback of its application in structures. Concretes were exposed at 150 – 300 – 450°C at low rate of heating (1°C/minute), to study their behavior under high temperature; then, they were subject to 600°C with high rate of heating (10°C/minute), to assess potential spalling occurrence. After such exposition, specimens were analyzed in terms of mass loss, residual compressive strength, dynamic modulus of elasticity and porosity. Results demonstrate that it is possible to design heavy-weight concrete shields with similar (or even better) performances at high temperature than normal concrete. Particularly, EAF concrete displayed less strength reduction at increasing temperatures, and at the same time, it is characterized by high gamma-ray attenuation coefficient. During the research period at the University of Cergy-Pontoise, it is expected to develop some numeric analyses aimed at characterize the behavior of such kind of concretes, through a probabilistic approach, thus assessing the reliability of using recycled heavy-weight concrete in place of ordinary heavy-weight conglomerates, containing baritic aggregates only.