## Radiological characterization of building materials produced in Spain for compliance with external gamma dose limits

## M. Pérez-Baeza,<sup>1,\*</sup> M. Sáez-Muñoz,<sup>1</sup> A. Sevilla,<sup>1</sup> Y. Pallás-Tamarit,<sup>1</sup> and, S. Martorell<sup>1</sup>

<sup>1</sup>Laboratorio de Radiactividad Ambiental. MEDASEGI research group. Universitat Politècnica de València, 46022, Valencia, Spain.

\* e-mail: mperbae@upvnet.upv.es corresponding/presenting author

The Directive 2013/59/EURATOM, transposed into Spanish law (RD 1029/2022), limits indoor external exposure due to gamma radiation emitted by building materials to 1 mSv/year. The aim of this work is the radiological characterization of the most used building materials in Spain, including concrete blocks, bricks, ceramic tiles, marble, and modern materials like synthetic stones and porcelain materials to see if they are compliant.

Fifty-six samples were analysed using gamma spectrometry. Activity concentrations of <sup>226</sup>Ra and <sup>232</sup>Th were estimated through their secular equilibrium descendants: <sup>214</sup>Pb (351.92 keV) and <sup>228</sup>Ac (911.07 keV), respectively. Activity concentration of <sup>40</sup>K was estimated through its peak (1460.75 keV). The European activity concentration index (I) was calculated and, for materials with I > 1, the annual external dose produced was also evaluated using a standard methodology (CEN/TR 17113:2017) that takes into account the density, thickness, and use of the material.

The results show significant variability in radionuclide content, even within the same material type. Those building materials with zirconium silicates and/or red clays in their composition showed higher activities. In terms of the European activity concentration index, marble, concrete, plaster, and terrazzo showed low indices (I < 0.4). Ceramic tiles presented indices below the limit (I = 0.6 - 0.9) and modern materials presented variable indices due to their different composition, sometimes exceeding the index limit (I > 1). Granite and brick presented indices very close to or above 1, sometimes reaching indices of 2. Materials studied that exceeded the activity index (I > 1) obtained dose values lower than 1 mSv/year, confirming compliance with the exposure limits. Therefore, all the materials tested could be used as building materials from a radiation protection point of view. However, for those materials exceeding the limit, a more detailed dose calculation should be performed to establish restrictions on use.

**Keywords:** Building materials, NORM, activity index, external dose.

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