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TRENDS AND PERSPECTIVES IN THE RESEARCH OF CONCRETE WITH CERAMIC WASTE ADDITIONS: A BIBLIOMETRIC ANALYSIS

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Abstract: The increasing interest in the circular economy and the development of sustainable construction materials has led to intensified research on the use of ceramic waste in concrete composition. The aim of this study is to analyze the evolution and characteristics of scientific research in this field through a bibliometric analysis based on publications indexed in the Web of Science (WoS). Bibliographic data were processed and visualized using VOSviewer software, investigating publication trends, geographical distribution of research, most influential authors, representative journals, and relationships between keywords. The results show a significant increase in the number of publications starting from 2015, with a peak in the 2024–2025 period. Citation network analysis highlights influential authors such as Reig I., Borrachero M.V., and Paya J., while keyword analysis reveals the importance of concepts related to concrete, mechanical properties, cement, and the circular economy. Additionally, the journals Materials and Construction and Building Materials stand out as the main dissemination channels for research results. The study confirms the growing interest of the scientific community in the valorisation of ceramic waste in the construction industry and highlights current and future research directions in this field.

Keywords: bibliometric analysis, concrete, ceramic waste, Web of Science, VOSviewer, circular economy, sustainable construction materials

INTRODUCTION

The incorporation of ceramic waste into concrete represents an effective approach to improving resource efficiency and promoting sustainable construction practices [1]. This aligns with broader sustainability objectives, where integrated environmental risk assessment and performance evaluation are commonly applied within standardized frameworks such as ISO 14001 [2].

Bibliometric analysis is a quantitative method for evaluating and exploring scientific production, used to measure the impact, evolution, and structure of a research field [3]. It is based on the analysis of academic publications, citations, collaborations between authors and institutions, as well as the relationships between concepts and topics addressed in the scholarly literature.

Through bibliometric indicators such as the number of publications, number of citations, the Hirsch index (h-index), and co-authorship or co-citation networks, researchers can identify development trends within a field, the most influential authors and institutions, as well as the main emerging research directions [4,5].

In the last two decades, bibliometric analysis has become an essential tool for evaluating scientific performance and for conducting literature synthesis studies. The development of bibliographic databases and specialized software tools, such as VOSviewer and Bibliometrix, has facilitated the analysis and visualization of collaboration

networks, thematic structures, and research impact at a global level [6,7].

Therefore, bibliometric analysis provides an objective perspective on the dynamics of scientific knowledge, contributing to the identification of research trends, existing gaps in the literature, and opportunities for future academic investigations [4,8].

Despite the increasing number of studies in this field, there is still a lack of comprehensive bibliometric analyses that systematically map the evolution, influential contributors, and thematic structures specifically related to ceramic waste incorporation in concrete. This study addresses this gap by providing a structured bibliometric overview of the research domain.

MATERIALS AND METHODS

Bibliometric analysis provides useful information for researchers who aim to use it as an evaluation tool for scientific activity, as these analyses serve as a guide for ongoing research [9]. Bibliometric analysis consists of applying statistical methods in both qualitative and quantitative studies of a research topic, identifying trends within it [9,10]. The stages of conducting such a study are presented in Figure 1.

The data of this study are based on the Web of Science (WoS) database, using VOSviewer software to create a bibliometric map based on keywords. Web of Science (WoS) is considered one of the most prestigious, reliable, and comprehensive

bibliometric databases worldwide, being the oldest, most widely used, and most authoritative database of research publications and citations globally [11]. It provides multidisciplinary coverage, indexing over 22,000 academic journals (in the Core Collection) and more than 250 fields covering science, social sciences, arts, and humanities [12].

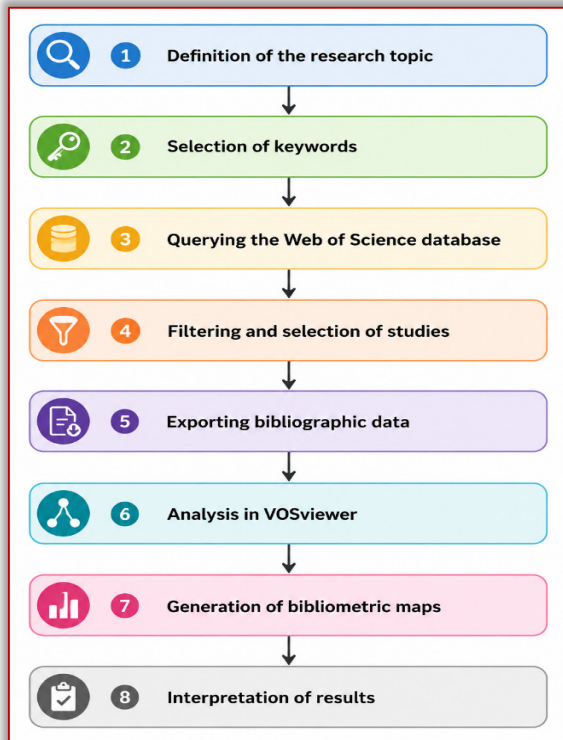


Figure 1. Methodological flow of bibliometric analysis

The literature search was conducted using the following keywords: ‘ceramic waste’, ‘waste ceramic’, ‘recycled ceramic in concrete’, and ‘ceramic aggregate concrete’. The search was limited to articles and reviews published between 2008 and present days, and only documents indexed in the Web of Science Core Collection were included. Duplicate records and non-relevant publications were excluded manually.

Figure 2, adapted from [7] and [5], presents the main types of bibliometric analyses performed using VOSviewer.

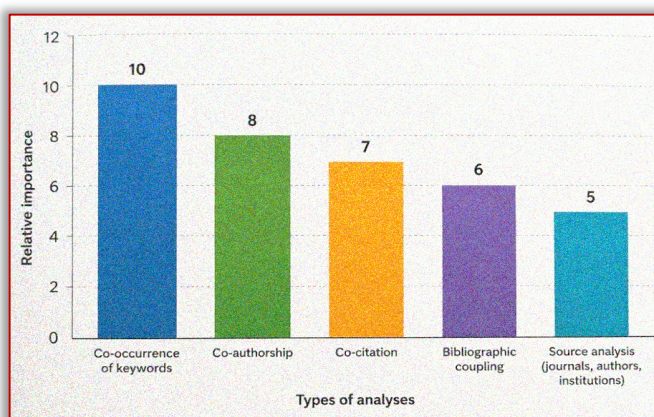


Figure 2. The main types of bibliometric analyses performed with VOSviewer.

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Co-occurrence and co-citation analyses were performed using full counting method with a minimum threshold of occurrence set at 5.

RESULTS AND DISCUSSION

Research on concrete containing ceramic materials was found in the Web of Science (WoS) database starting from 1991. Beginning in 2015, the number of published papers has steadily increased. This increasing trend reflects the growing global emphasis on circular economy principles and sustainable construction practices, particularly in response to environmental regulations and construction waste management policies.

The most productive years related to these keywords were 2024 and 2025, with 170 and 232 articles published in each year, respectively (Figure 3). This demonstrates the importance of current academic research focused on identifying new materials in the construction industry by integrating construction and demolition waste into its components [13].

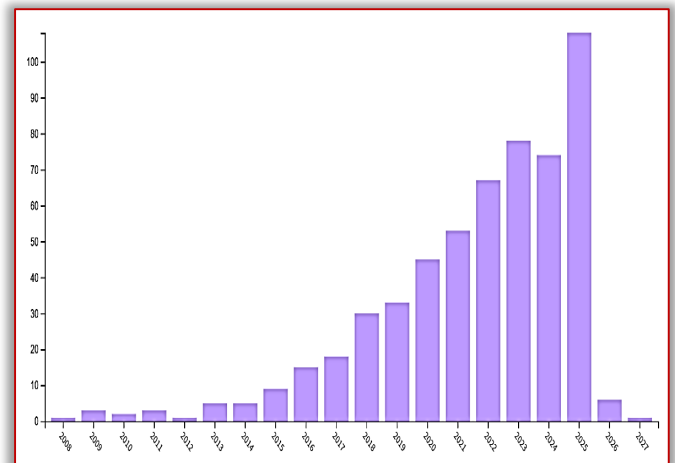


Figure 3. Yearly distribution of publications on concrete containing ceramic materials.

The bibliometric analysis of cited authors (Figure 4) in the studied documents shows that, among the analyzed authors, only 326 authors were selected, meeting the condition of at least one publication per author and at least 15 citations per document. According to the analysis, the most cited authors are Reig I., with 266 citations (in 4 documents), followed by Borrachero M.V. and Payá J., with 257 citations in 3 documents. The dominance of these authors indicates a strong research cluster in the field of alkali-activated materials and recycled

sustainable construction materials, indicating their central role in shaping research direction in this field.

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Figure 6. Map of the analysis of journals in which the articles are published.

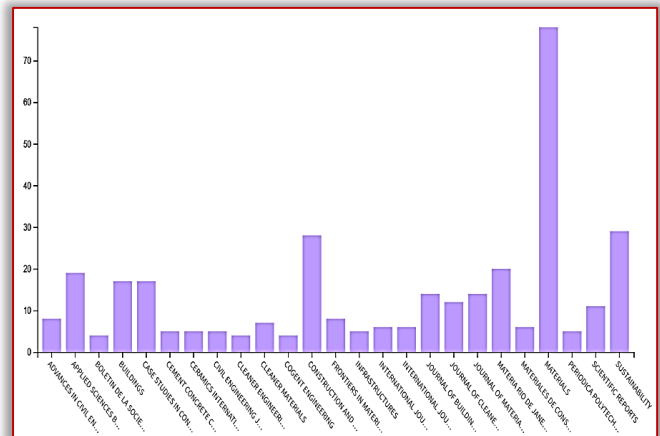


Figure 7. Graphical representation of the analysis of journals in which the articles are published.

From the countries where authors produce the most research on ceramic-containing concrete (Figure 8), Spain is the leading country, with 83 published documents, while Belgium has the lowest output, with only 9 documents.



From the analysis of the journals in which the articles are published (Figures 6 and 7), it can be observed that most of them are published in Materials and Construction and Building Materials, which provide an international forum for the dissemination of innovative and original research and development in the field of construction and building materials. These journals serve as key dissemination platforms for high-impact studies in

Figure 8. Graphical representation of the analysis of the number of studies on ceramic-containing concrete.

The leadership of Spain can be attributed to strong research groups in recycled construction materials and sustained funding in sustainability-oriented projects within European research frameworks.

CONCLUSIONS

This study shows the evolution of scientific research published in the Web of Science (WoS) database regarding concretes containing ceramic waste in various forms. The bibliometric analysis reveals a growing interest in recent years in this type of concrete. This trend is confirmed by the increasing number of articles in the field of construction, mainly driven by the search for alternative solutions to components derived from exhaustible resources used in concrete production, as well as the incorporation of construction and demolition waste into the manufacturing process.

The bibliometric analysis includes results on the number of publications per year, country productivity, authors, and journals, as well as an analysis of the most frequently used keywords and their relationships. Spain stands out in terms of affiliated authors, with universities from this country ranking in the top 5 with a total of 39 papers. The most productive author is Ghasan Fahim Huseien from the National University of Singapore, while journals from the United Kingdom have published the highest number of papers in the studied field.

The findings suggest that future research should focus on improving the long-term durability and mechanical performance of ceramic waste concrete, as well as standardizing methodologies for its evaluation across different studies. Additionally, future bibliometric studies could expand the analysis by integrating Scopus database data and applying advanced network clustering techniques to improve thematic mapping accuracy.

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