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## Advanced Concrete Composites for Improved Performance: A Bibliometric Survey

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# Advanced Concrete Composites for Improved Performance: A Bibliometric Survey

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**Abstract:** Concrete is the core component of any civil engineering construction. Conventional concrete can be modified depending upon the needs and requirements of the construction. Such concrete is called advanced concrete and this report aims to study advanced concrete and its composites. The main objective of this report is to perform a bibliographic survey on the latest research literature available under the domain of advanced concrete composites for improved performance. Timespan considered for the survey is from the year 2015 to 2020. The bibliographic survey consists of literature from online platforms such as the Web of Science (WoS) and Scopus database. Both these platforms are remarkable and reliable sources. But in comparison, Scopus is considered to be the largest database with citations whereas WoS is more authoritative and has a unique search method for citations and references. It provides statistics of publications from journals, countries, authors, and citations to date. This analysis leads to significant findings showing need and scope for research in advance concrete domain.

**Keywords:** Concrete Composites, Advance Concrete, Construction.

## 1. INTRODUCTION

Construction is an important industry that contributes greatly to a nation's economic development. Concrete is the most important construction material and its consumption is increasing all around the world [1]. Just a few of the construction industry's classifications are homes, apartments, warehouses, offices, schools, roads, and bridges. The operations of this industry include the construction of new buildings, including the planning of sites, as well as maintenance and improvements to existing ones. Concrete is the most widely used material in construction. It also plays an important role in civil engineering. The annual production of concrete has surpassed 25 billion tones, which is >3.5 t for every person in the world [2]. In an attempt to achieve the objectives of the 2030 Sustainable Development Agenda, while at the same time reducing the use of non-renewable resources, more and more research focuses on the use of waste materials in construction goods[3]. Concrete has experienced a renewed degree of research and testing in the past few decades, resulting in the production of several new forms of concrete also known as advanced concretes[4]. New designs, models, and testing techniques have also been developed to advance the concrete envelope as a building[5]. Through using various composites, chemicals, manufacturing methods, there is now a high degree of control over the properties of particular concrete for a

wide variety of applications. Few advanced concrete which we came across in our literature were fiber reinforcement cementations concrete[6], basalt fiber concrete[7], polypropylene fiber concrete[8], carbon fiber enriched concrete[9], bacterial concrete[10], glass fiber concrete[10], fly ash concrete[10], polycarboxylate polymer concrete[10]. It has also developed new ideas, models and research techniques to advance the concrete envelope as a construction material.

Other construction materials such as steel and polymers are more expensive and less common than concrete materials. There are many drawbacks to plain cement concrete, such as poor tensile strength, brittleness, unstable crack prop-agation, and low fracture resistance[11]. On the other hand, the application of advanced concrete may have the ability to increase the performance of the building or construction from many prospective. For example, reducing construction time, building material, enhancing both structural stability and lifespan as well as reducing overall construction cost can be accomplished. Concrete composites are one of the most commonly used building infrastructure materials in the world due to their plentiful resources, mature manufacturing processes, and good adaptability. The concrete composites production, design, and implementation processes would have a significant effect on the Earth's wealth, electricity, and climate which is where we live. The use of new forms of advanced concrete composites represents a particularly significant opportunity for a safe and durable built environment towards the future.

### **1.1. Need of Study**

Bibliometry is a branch of scientific study that deals with systematic analysis of available literature from various aspects[12]. It is also possible to apply a bibliometric analysis to define general productivity in a given field. It can also be used to measure the productivity of individual researchers, journals, countries, or any other performance level, hence improving the research gaps. To highlight the amount of research done and the need for research in the field that is new to the community and forthcoming, it is important to compare the outcomes of two online databases. Based on applicable literature, the following sections define the survey series, information, and observations. Researchers have been committed to acquiring concrete of greater strength and improved efficiency since the advent of concrete[13]. Alternative binders need to be created to render concrete to counter the environmental consequences associated with Portland cement[14].

## **2. BIBLIOMETRIC SURVEY**

There are various online platforms to perform the bibliometric survey, such as WoS, Scopus, Google Scholar, Research gate, Science direct, etc. This survey is limited to the WoS and Scopus database, because of its ease of accessibility and wide range of published articles, journals, research papers, citations, etc. WoS was first launched in 1997, originally formed by the Institute for Scientific Information, and is currently maintained by Clarivate Analytics. WoS is known for its distinctive search methods and search by citations option. Whereas, Scopus was established by Elsevier in 2004. All the journals covered in Scopus's database, irrespective of the publisher, are reviewed each year to ensure that the high-quality standard is maintained. This study focuses on the bibliometric survey performed from the data

collected through the above-mentioned databases (WoS and Scopus) for the period of 5 years starting from the year 2015 to the year 2020. Following is the flow chart of the methodology adopted for carrying out this bibliometric survey.

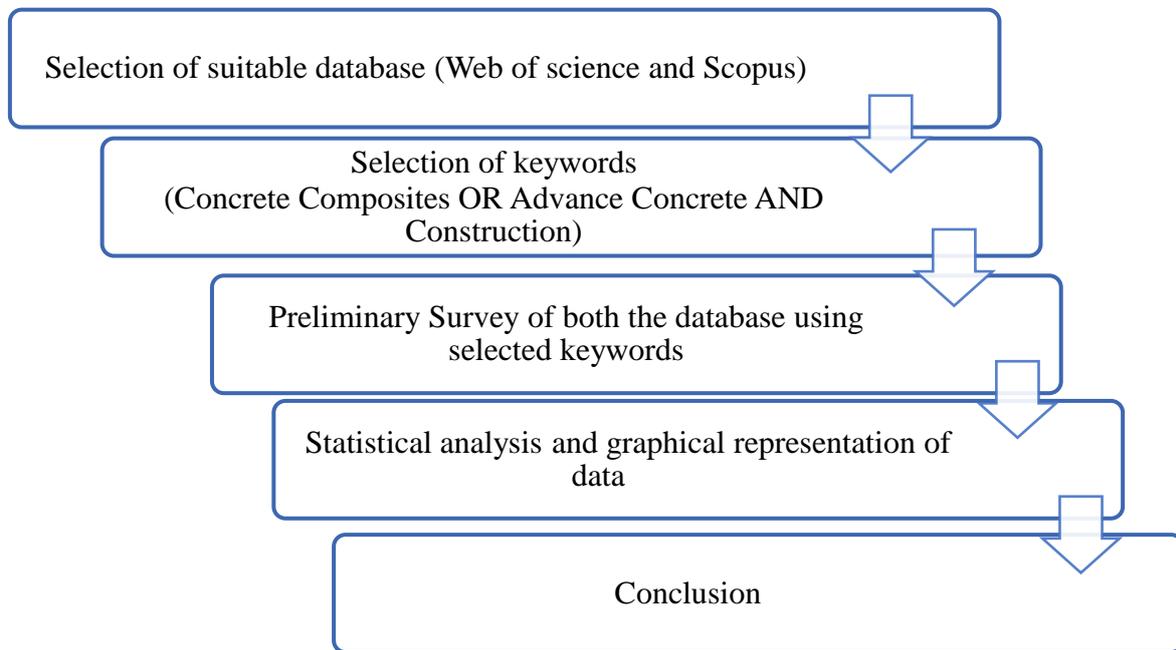


Figure 1: Flow chart of the bibliometric survey

The first step in the methodology to perform a bibliometric survey is to find a set of keywords relevant to the project domain and to find suitable databases for data collection. To follow the methodology of a bibliometric survey the selection of Keywords plays a very vital role. The next step is to select the subject from the Preliminary survey to perform statistical analysis and graphical representation. The area of subjects is Published year, Author, Countries / Region, Language of the documents published, Document types, etc. followed by the conclusion of analysis and results.

## 2.1 Selection of keywords

The selection of suitable keywords is the most important step in a bibliometric survey which further leads to the process of data collection. The use of the conjunctions "AND" and "OR" also varies with the use of keywords. According to the Scopus database, "AND" should be used when research is required to include all terms. "OR" conjunction should be used when the expected search results must include one or more terms, and as a result, any document with the fed term would be found. For this survey, the keywords “Concrete Composites OR Advance Concrete AND Construction” are selected.

## 2.2 A preliminary survey of the database using selected keywords

Input of selected keywords on the WoS platform revealed about 23,792 relevant documents

out of which 4,962 documents were open access. Whereas after using the keywords on the Scopus platform it revealed about 5,474 documents out of which 1,236 were open access. The results on both platforms were further classified into different subject areas such as publication years, document types, language, research domain, authors, countries / region. These classifications are made for the ease of accessibility and relevant publications, journals, articles, research papers, etc. under the subject domain

### 2.2.1 Documents by subject area

Subject area analysis is important to spread the need of certain aspects of certain subjects and also to educate anyone interested in a particular subject.

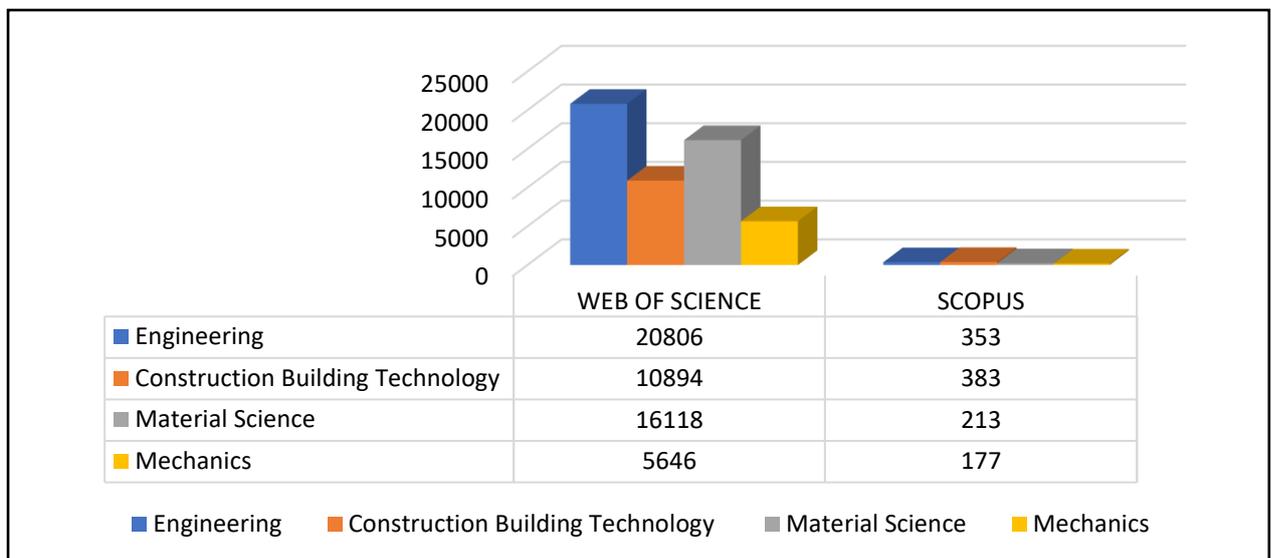


Figure 2: Bar chart showing documents by subject area

Figure 2 shows the bar chart of documents by subject area. The total number of documents can vary because some documents may get overlapped in two or more subject areas. Here it is observed that the highest number of documents using WoS is from the engineering sector whereas with Scopus highest number of documents are from the construction building technology subject area. And the least number of documents are from the mechanic's subject area in the case of both online databases i.e., WoS and Scopus.

### 3. STATISTICAL ANALYSIS AND GRAPHICAL REPRESENTATION

The systematic bibliographic research is performed to clarify the different types of sources, the new advances in the chosen area, and influential authors in advanced composites of concrete. This includes the sample's geographical focus, documents, published, author, papers, etc.

### 3.1 Year-wise publication details

The necessity of year-wise publication is so one can find the latest updates along with the evolutionary process of any particular field or topic.

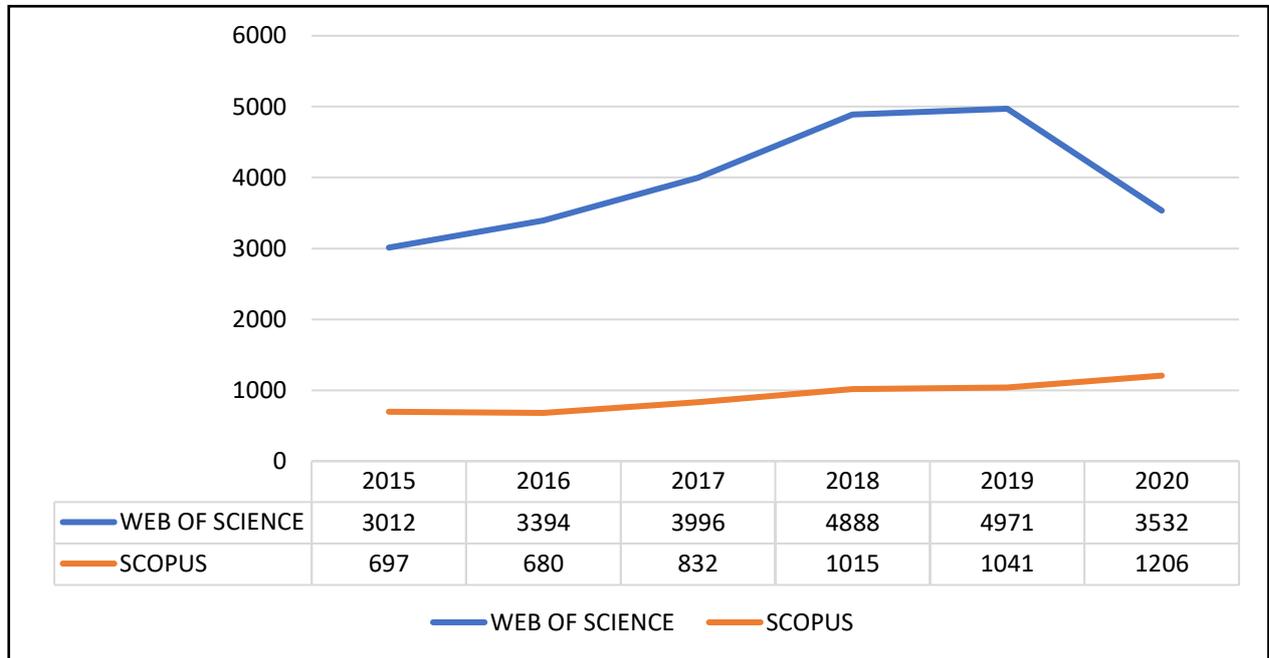


Figure 3: Year-wise number of publications

Figure 3 exhibits a line chart of two different databases. It displays the number of articles that are published by the different databases (WoS and Scopus) annually. The number of documents for the span of five years (2015 -2020) for Scopus is 5471 and for WoS is 23,792. For WoS the number of publications has risen from 12% in the year 2015 to 20% in the year 2019 and whereas for Scopus it has risen from 12.7% in the year 2015 to 22% in the year 2020. Since we see a rise in the publications for Scopus it is safe to predict a further hike in the same. Whereas with WoS, one has seen a decline in 2019-2020 there is a chance of the decrease in publications continuing forward but there also exists an equal probability of an increase in the publication number with the increasing awareness.

### 3.2 Document analysis based on author details

It is a common observation that there is a lack of Indian authors on both databases. And there must be more publications by Indian authors as every country has its concepts and prerequisites on every subject and for the viewing audience to find more relatable content this is a necessity in the future.

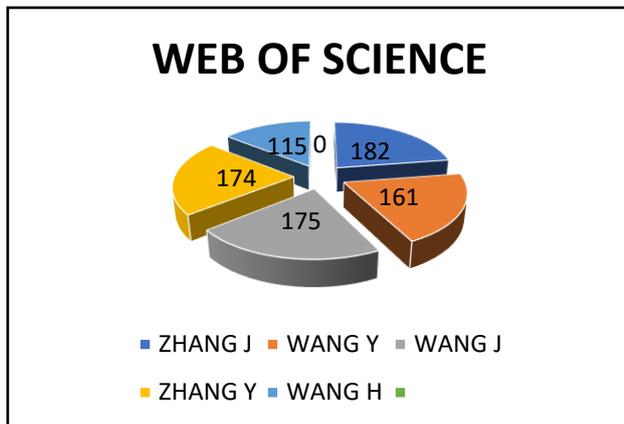


Figure 4: Author wise number of publications

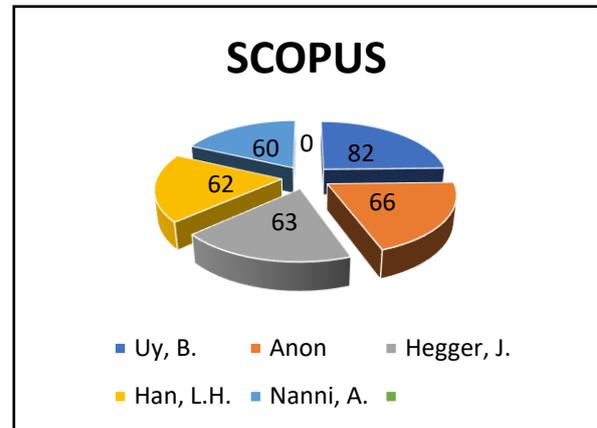


Figure 5: Author wise number of publications

Figure 4 displays a pie chart of the WoS database. It displays the various authors of the published articles by their quantity. The number of documents by all the authors (Zhang J, Wang Y, Wang J, Zhang Y, Wang H) is 807. The author with the maximum published articles is Zhang J with 182 articles. On the other hand, the author with the least number of published articles is Wang H with 115 articles. The range of published articles per author on average is around 161-162 articles.

Figure 5 displays a pie chart of the Scopus database. It displays the various authors of the published articles by their quantity. The number of documents by all the authors (Uy. B, Anon, Hegger. J, Han. L.H., Nanni. A) is 333. The author with the maximum published articles is Uy, B with 82 articles. On the other hand, the author with the least number of published articles is Nanni, A with 60 articles. The range of published articles per author on average is around 66-67 articles.

### 3.3 Document analysis based on Language

There is a variety of languages in which the documents have been published but the maximum documents in both databases are in English. This can be since English is the global communication language which is the common link to trade commerce and communication internationally.

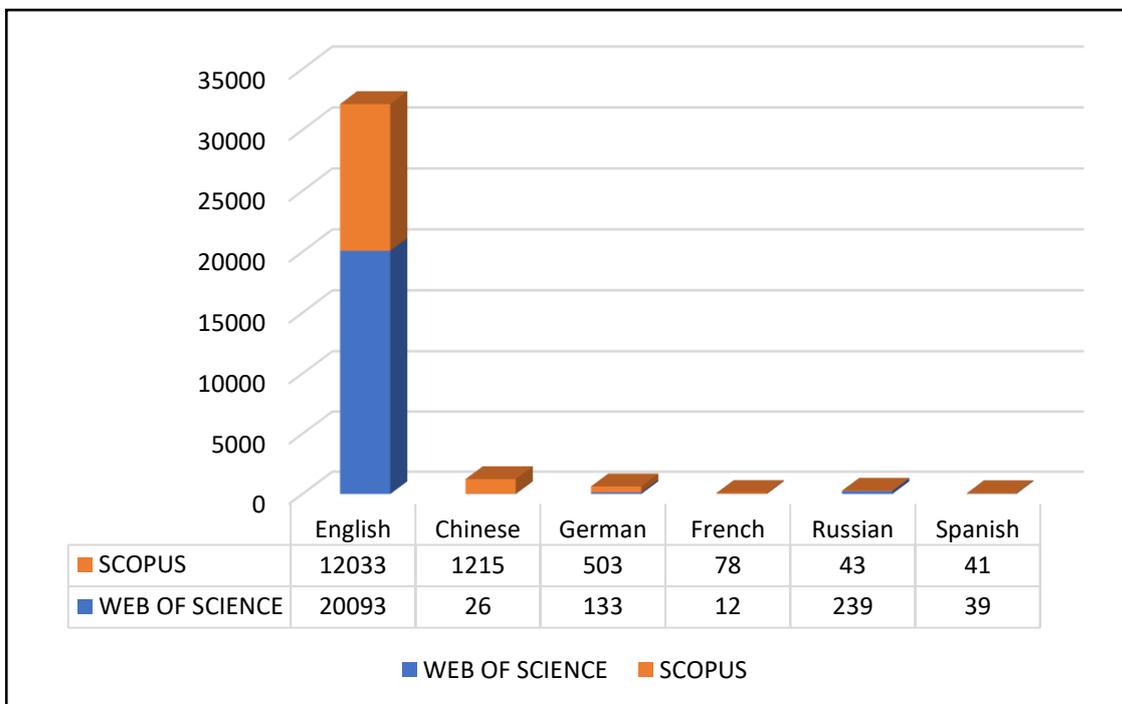


Figure 6: Number of publications as per Language

Figure 6 exhibits a bar graph of two different databases. It displays the number of documents published by the different databases (WoS and Scopus) language-wise.

The number of documents in all of the languages (English, Chinese, German, French, Russian, Spanish) for WoS is 20,542 and for Scopus is 13913. The most prevalent publishing language for both WoS and Scopus is English with 20,093 and 12,033 articles respectively. For WoS the least published language is French with a mere 12 articles whereas for Scopus it is Spanish at 41 articles.

### 3.4 Document analysis based on Country / Regions

Country-wise document segregation is necessary to find more relatable and suitable publications for reference as well as application. This also helps data collection and statistical documentation of information sources.

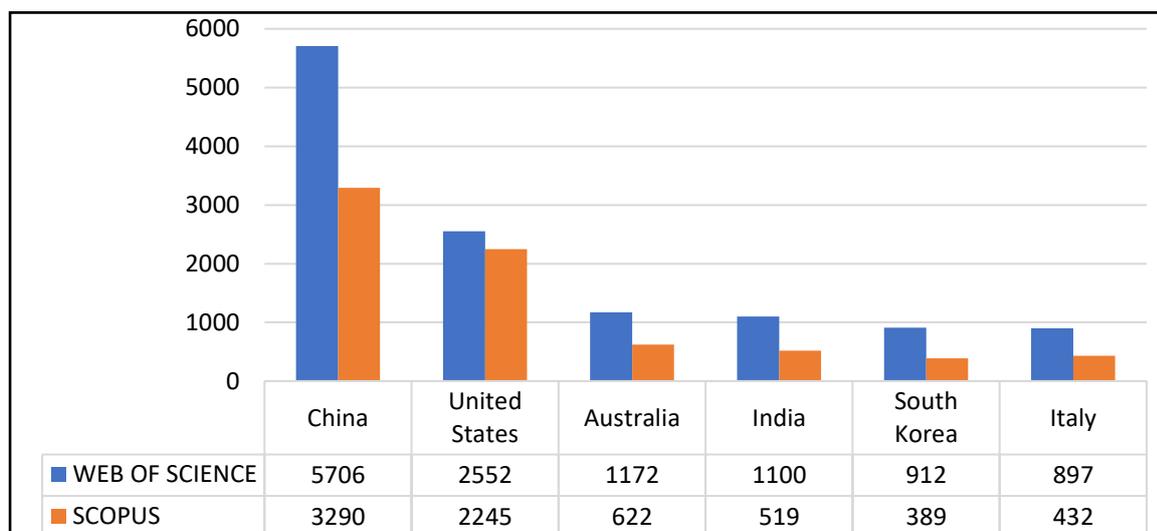


Figure 7: Number of publications based on Country/Region

Figure 7 exhibits a bar graph of two different databases. It displays the number of documents published by the different databases (WoS and Scopus) country-wise. The number of documents for all the countries (China, United States, Australia, India, South Korea, Italy) for WoS is 12,339 and for Scopus is 7,497. The number of documents published is maximum for both WoS and Scopus in China. For WoS the least published documents are in Italy whereas for Scopus it is in South Korea. In India, WoS published 1100 documents, however, Scopus only published about half of that number with 519 documents.

### 3.5 Document analysis based on Documents type

Analysis of document type is needed to help the finder find exactly what they require for their necessary task. It saves time, energy and helps in the sorting of various publications.

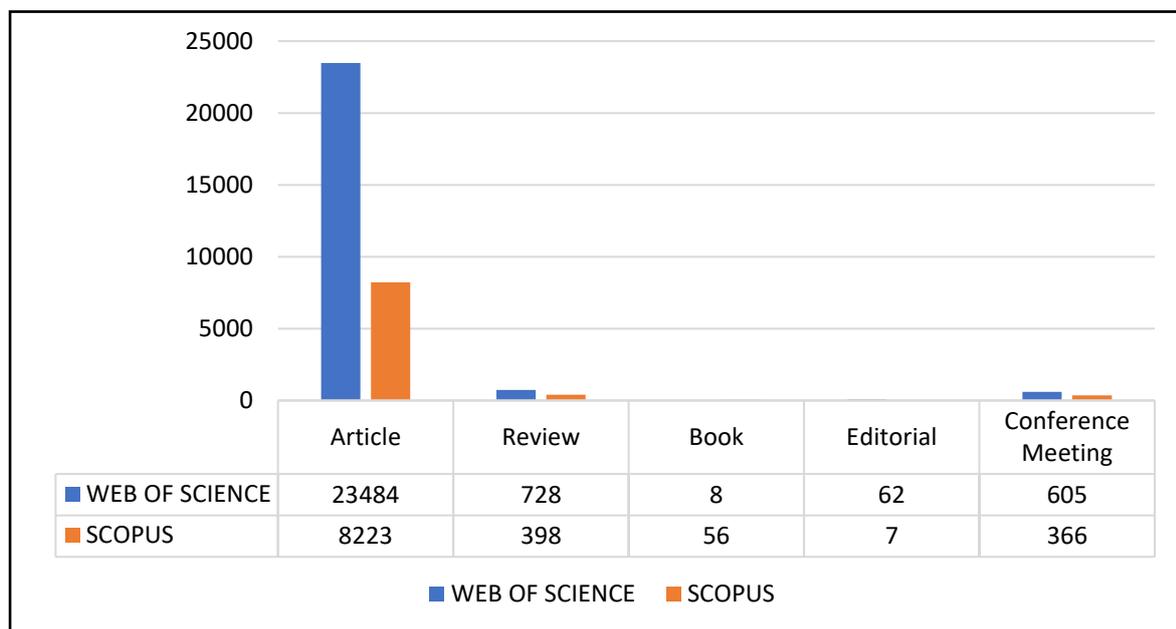


Figure 8: Number of publications based on Documents type

Figure 8 exhibits a bar graph of two different databases. It displays the various categories of published documents by two different databases (WoS and Scopus) by their quantity. The published documents vary by type based on size, format and content.

The number of published documents altogether (conference meeting, editorial, book, review, article) for WoS is 24,887 and for Scopus is 9,050. The categories have a range of up to 25000 copies. The number of articles published is maximum for both WoS and Scopus at 23484 and 8223 respectively. For WoS the least published documents are books whereas for Scopus it is the editorial.

### 3.6 Comparison of data from both the database

WoS and Scopus both have a large database to browse and research through. When compared with each other there are certain pros and cons to both them. WoS is favorable as it has a distinctive search engine whereas Scopus has a reputation for regular reviews of documents

to maintain standards. But on searching the required keywords, we found that the Scopus database has barely any articles related to our research. On the other hand, the WoS database has a considerable amount. Although the language of dominance for both databases is English the country of origin for the maximum documents published in China. But as an overall observation for both the databases, there is very limited publishing of documents by Indian authors.

#### **4. CONCLUSION**

The construction industry plays a vital role in boosting a nation's economy as well as the infrastructural aspects. Any construction project requires the use of cementitious concrete as the integral unit of the construction. Concrete is a homogeneous mixture of heterogeneous materials such as cement, sand, aggregate, and water. Like all the other mixtures and materials, concrete also has its undeniable limitations. Conventional concrete cannot withstand certain weathering effects, it lacks strength and durability and also cracks. By adding certain composites such as glass fibers, fly ash, carbon fiber, in the conventional concrete, we can improve its strength and durability while also enhancing several other factors. Such concrete is called Advance Concrete. This survey studies and explores the data available on the databases of WoS and Scopus, under the domain of the topic, Advance Concrete and its composites with the help of the following keywords: "Concrete composites OR Advance Concrete AND Construction".

By performing the survey, we can conclude that all the documents were divided into subdivisions such as Documents by subject area, year-wise publication details as per country/region. It was found that WoS had 23,553 documents and Scopus had 4,436 documents. Among the country's publication of such documents, the number of documents published in India under this domain is low as compared to the other countries. Whereas China has the highest number of publications. The period considered for this survey was of 6 years starting from 2015 to 2020, wherein 2018 highest number of documents published. Zhang J and Uy, B. are the leading researchers in the WoS and Scopus respectively with the highest number of documents published. However, we can conclude that the online database platform of Scopus had fewer published documents under the selected keywords as compared to the database of WoS. It is important to publish required documentation Journals that collect high citations and with easy access hit a maximum audience. Pointing to a clear research gap in the area of advanced concrete composites. There is a wide scope for Indian researchers to study research under consideration domain.

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