

Synthesis of Nano Calcium Carbonate from Egg Shell Wasteto Improve Paving Block Quality: A Literature Review and Bibliometric Analysis

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Abstract (English)

This research was conducted to determine (i) the growth in the number of scientific publications in the field of paving block materials with the addition of nano calcium carbonate, (ii) the top citations based on the number citations, and publisher, (iii) visualization of the most productive authors, and (iv) development map publications based on keywords. This research method is quantitative descriptive with bibliometric analysis using Publish or Perish software to obtain data and VOSviewer to visualize related research terms. Data collection was carried out by searching the Google Acholar database with the keywords “calcium carbonate” and “paving blocks” in the period 2011 to 2023. The research results show growth and paving blocks. The most researched subjects in nano calcium carbonate are “calcium carbonate”, “egg shells”, and “pavements”, which are based on overlay and density visualization. The relationships between topics are grouped into fifteen clusters with determine the topics to be researched and can also be a reference for further research.

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Key Words

Calcium carbonate, paving blocks, egg shells.

Abstrak (Indonesia)

Penelitian ini dilakukan untuk mengetahui (i) pertumbuhan jumlah publikasi ilmiah bidang material paving block dengan penambahan nano kalsium karbonat, (ii) sitasi teratas berdasarkan jumlah sitasi, dan penerbit, (iii) visualisasi penulis paling produktif, dan (iv) publikasi peta pengembangan berdasarkan kata kunci. Metode penelitian ini adalah deskriptif kuantitatif dengan analisis bibliometrik menggunakan software Publish or Perish untuk memperoleh data dan VOSviewer untuk memvisualisasikan istilah penelitian terkait. Pengumpulan data dilakukan dengan menelusuri database Google Acholar dengan kata kunci “kalsium karbonat” dan “paving block” pada periode tahun 2011 hingga 2023. Hasil penelitian menunjukkan pertumbuhan dan paving block. Subjek yang paling banyak diteliti dalam nano kalsium karbonat adalah “kalsium karbonat”, “cangkang telur”, dan “trotoar”, yang didasarkan pada visualisasi overlay dan kepadatan. Hubungan antar topik dikelompokkan menjadi lima belas cluster dengan menentukan topik yang akan diteliti dan juga dapat menjadi acuan untuk penelitian selanjutnya.

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Pendahuluan

Paving blocks are widely used in the construction sector and are an alternative choice for ground surface pavement. Ease of installation, relatively cheap maintenance and fulfilling aesthetic aspects make paving blocks more popular. Generally paving blocks are used for road pavement, pedestrians and sidewalks. Apart from that, it can also be used in special areas such as container port areas, parking lots, open areas and industrial

areas. The use of paving blocks really supports going green which has been promoted nationally/internationally, because the water absorption capacity through installing paving blocks can maintain ground water balance.(Fauna Adibroto, 2014)

Use in certain (special) areas requires the use of paving blocks of better quality than use on pedestrians or sidewalks. To function properly, paving blocks are needed that have high compressive strength, wear resistance and shock resistance. For this reason, through this research, efforts were made to obtain variations and types of additional material mixtures in making paving blocks so that they have quality, especially high compressive strength.(Fauna Adibroto, 2014)

The cement mixture is calcium carbonate in the form of limestone. Calcium carbonate is a chemical compound with the formula CaCO_3 which is a common ingredient found in rocks in all parts of the world, and is the main component of marine organisms, charcoal ball snails, pearls and egg shells. The properties of calcium carbonate or lime are that it hardens easily and provides binding strength. Making lime is widely used in the construction industry for several building materials, such as mortar, plaster, wire making, glass and ceramics.(Nugraha & Kadir, 2019)

Calcium carbonate is an inorganic mineral that is known to be available cheaply commercially. The physical properties of calcium carbonate such as morphology, phase, size and size distribution must be modified according to the field of application. The morphology and phase form of calcium carbonate (CaCO_3) are related to synthesis conditions such as reactant concentration, temperature, aging time and natural addictive substances (Kirboga and Oner, 2013). Calcite (CaCO_3) is the most stable phase and is widely used in industry. paint, paper, magnetic recording, textile, detergent, plastic and cosmetic industries (Lailiyah et al., 2012). Calcium carbonate is also used in the building industry, especially for resin and polymer materials, apart from that, calcium carbonate is used as an aid for pigmentation. (Manuel Subagio, Viktor 2022)

Chicken egg shells have a high potential to become waste because eggs are a source of protein for humans. So far, only egg yolks and whites have been used. At the same time, the shell is thrown away without further use. Even chicken egg coverings cannot be decomposed by soil microbes, resulting in increased environmental pollution (Gago, J., & Ngapa, YD 2021). From a chemical perspective, chicken egg shells consist of water (2%) and several protein fiber networks such as calcite phase calcium carbonate (94%), calcium phosphate (1%), magnesium carbonate (1%), and other organic substances (2%) (Waheed, M., Butt, et al 2019). The high levels of calcium in chicken egg shells provide a potential opportunity for chicken egg shells to replace the role of synthetic calcium and calcium from cow bones.

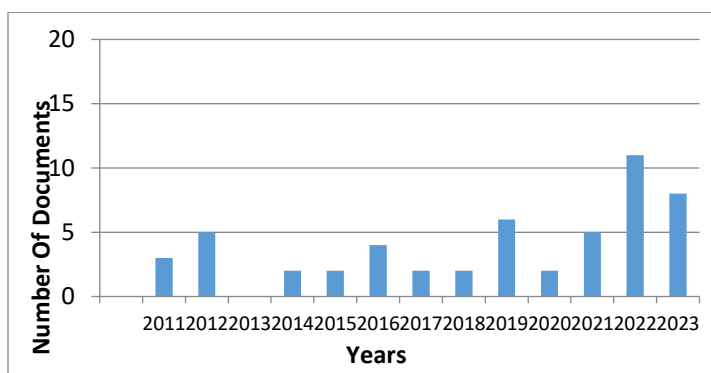
Metode Penelitian

This research aims to improve the quality of paving blocks by adding nano calcium carbonate (CaCO_3), which is not yet widely used, through research by exploring trends, theories, literature reviews and bibliometric analysis. We conducted a literature review and bibliometric analysis using VOSviewer covering twelve years of published research (2010-2023) on research to improve the quality of paving blocks. The formats entered into VOSviewer are Network Visualization, Overlay Visualization, and Density Visualization. By explaining Publication Trends, Top Article Documents by The Most Citation, and Publishers

Hasil dan Pembahasan

Publication Trends

These findings are based on the number of articles published in the Google Scholar database from 2011 to 2023. There are 53 articles related to calcium carbonate (CaCO₃) and paving blocks. Figure 1. illustrates the significant ups and downs in research growth over the last twelve years. The largest increase in publication growth occurred in 2022 with 11 publications (21.15%). Meanwhile, 2014, 2015, 2017, 2018, 2020 seems to have the lowest publication growth with 2 publications (3.85%). The number of publications about calcium carbonate (CaCO₃) and paving blocks in 2011 was 3 (5.77%), 2012 and 2021 was 5 (9.61%), 2013 was none (0%), 2016 was 4 (7.69 %), 2019 as many as 6 (11.54%), and 2023 as many as 8 (15.38%) publications.



Figures1The number of documents published for keywords “Calcium Carbonate” and “Paving Blocks”

- *Top Article Document by The Most Citation, and Publisher*

Article documents with more than 100 citations consist of 3 documents. The top 5 documents with the most citations are presented in detail in Table 1. The most frequently referenced article is “Microbially induced calcium carbonate precipitation: a widespread phenomenon in the biological world” written by M. Seifan, A. Berenjia. in 2019 with 152 citations. Then, the second is article entitled "Methode and Composition Using Calcium Carbonate" by BR Constantz, K. Farsad, C. Camire, I Chen. in 2019 with 144 citations.

N o	Cite s	Author	Title	Year	Journal Source	Publisher Source
1	152	M Seifan, A Berenjia n	Microbiall y induced calcium carbonate precipitati on: a widesprea d phenomen	2019	Applied microbiol ogy and biotechno logy	Springer

			on in the biological world			
2	144	BR Constant z, K Farsad, C Camire, I Chen	Methods and processes using calcium carbonate	2011	US Patent 7,922,809	Google Patents
3	107	BR Constant z, K Farsad, C Camire, I Chen, et al	Methods and processes using calcium carbonate	2012	US Patents...	Google Patents
4	66	BR Constant z, K Farsad, C Camire, J Patterson ...	Methods and processes using calcium carbonate	2012	US Patents...	Google Patents
5	61	J Li, S Yang, Y Liu, Y Muhammad, et al	Studies on the properties of modified heavy calcium	2019	Construction and Building ...	Elsevier

			carbonate and SBS composite modified asphalt			
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The number of citations is important because a large number of citations relates to the impact of the article on society. Indeed, it relates to the quality of the journal or publisher in selecting the best article. But, for some cases, it is important to note that while a high citation rate may indicate research impact, it is not the only measure of research quality. Other factors, such as the importance of the research question, the methodology used, and the contribution to the field, also play an important role in determining the impact of the paper. It has been mentioned previously that article documents with citations exceeding 100 citations consist of 3 articles that were identified from various publishers. The publisher with the highest number of citations is shown in Figure 2.

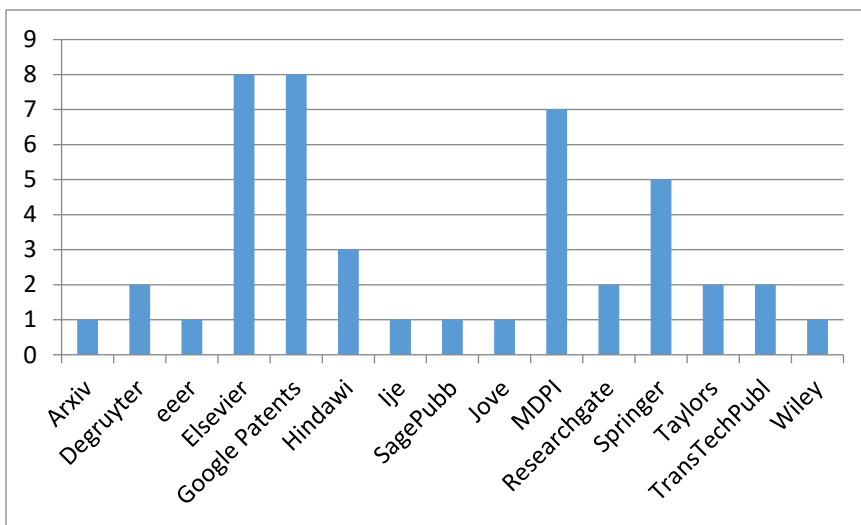


Figure 2 FTop 15 publisher sources with the highest number of citations

The number of citations of a person's scientific work will determine the level of professionalism in the academic world. In other words, the higher the number of citations a person has for a work, the more prestigious that person is in the academic world. The order of publishers that were most frequently satisfactorily based on this case was Elsevier > Taylors and Francis > Degruyter.com > Hindawi > Nature.

- *Co-authorship Analysis of Authors*

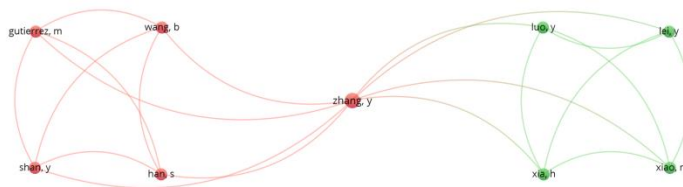


Figure 3 Co-authorship analysis of authors

A visualization of the most active authors in Calcium carbonate and Paving Block research is shown in Figure 3. A total of 135 authors participated in related research. There are different colors, representing different groups. Cluster 1 is filled with red circles, consisting of 5 authors, while cluster 2 consists of 4 authors, presented by green circles. The size of the circle represents the number of article documents. In other words, the more paper there is, the bigger the circle. As shown in the map, Zhang (green circle), Wang (orange circle), and Yu (purple circle) are considered the most productive authors in related research.

- *Visualization of Research Topic Area using VOSviewer*

Analysis of bibliometric data that is displayed visually through mapping tools is very extensively needed in this era of technological growth which is developing so rapidly as it is today (Nandiyanto et al., 2020a; Nandiyanto et al., 2020b). Mapping tools are used to get the results of the description and various information on the development of the field of science and the performance of research that has been carried out. One of the tools that can be used to perform bibliometric data analysis mapping and an example of mapping tools is VOSViewer (Gracia, 2020).

VOSViewer is very popularly used lately in analyzing the position of the research to be carried out and measuring the novelty of a study (Triwahyuningtyas et al., 2021). We can display a large bibliometric map in an easy way to interpret a relationship via the VOSViewer. VOSViewer has several characteristics, including being able to map various types of bibliometric analysis, supporting several major bibliographic databases, ignoring the time dimension, being limited to analyzing small to medium amounts of data, intended for text processing functions, using layout and cluster techniques, using overlay and density visualization features

Network Visualization

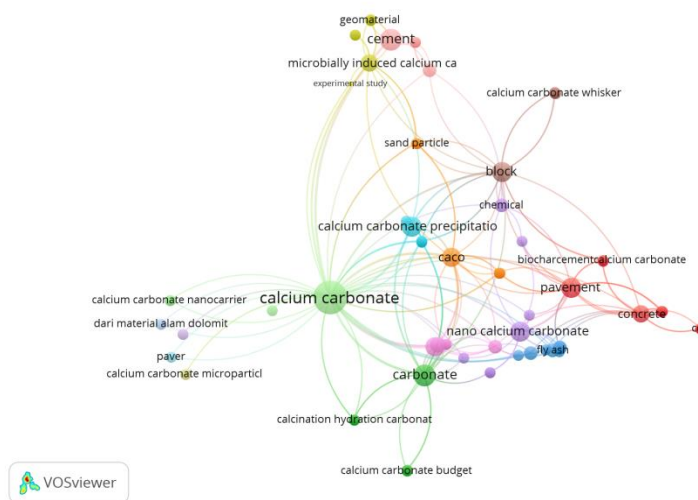


Figure 4 Network Visualization

Network visualization shows the network between visualized terms. Relationships in the network visualization are depicted as networks or lines from one term to another. Figure 4 shows the clusters for each research topic area. From the identification results it is known that there are 15 main clusters in the network, with a total link strength of 277 and 78 items with the main nodes "Pavement" in Cluster 1, "Carbonate" in Cluster 2, and "Fly Ash" in Cluster 3, "Microbially Induced Calcium Carbonate" in Cluster 4, "Nano Calcium Carbonate" in Cluster 5, "Calcium Carbonate Precipitation" in Cluster 6, "CaCO" in Cluster 7, "Block" in Cluster 8, "Syhntesis" in Cluster 9, "Cement" in Cluster 10, "Calcium Carbonate" in Cluster 11, "Dolomite Material" in Cluster 12, calcium carbonate nanocarrier, calcium carbonate nanocrystal, and innovative calcium carbonate reflected by the size of the largest circle the most often. The keywords that occurred the fewest were calcium carbonate microparticle, paved way, paver block, and dolomite material. This demonstrates that certain terms are rarely mentioned. As a result, these keywords can be researched and evaluated further in future studies. calcium carbonate nanocarrier, calcium carbonate nanocrystal, and innovative calcium carbonate reflected by the size of the largest circle the most often. The keywords that occurred the fewest were calcium carbonate microparticle, paved way, paver block, and dolomite material. This demonstrates that certain terms are rarely mentioned. As a result, these keywords can be researched and evaluated further in future studies.

- **Overlay Visualization**

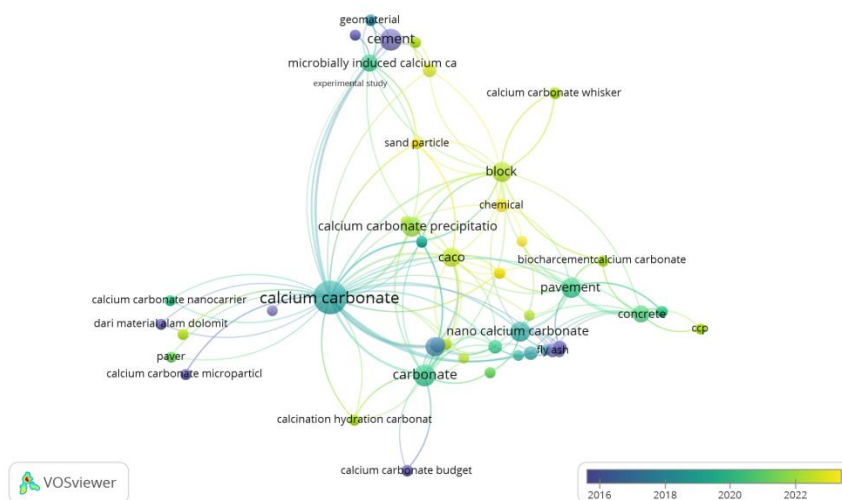


Figure 5 Visualization Overlay

Figure 5 illustrates a cluster analysis that uses keyword terms to find the most common and rare study subjects in research worldwide. An overlay network visualization is used to depict trending themes. Topics or keywords that contribute to the research are given in the overlay visualization network based on the year of publication. In 2022, the terms “Nano Calcium Carbonate”, "calcium carbonate precipitation", "egg shells", and "CaCO" with yellow nodes have not been studied intensively (see Figure 5)

- **Density Visualization**

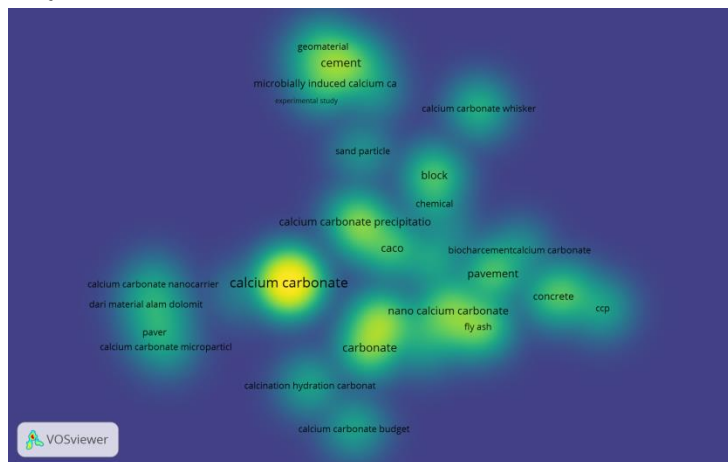


Figure 6 Density Visualization

Cluster density is the number of elements that have the same label as display items. Each dot has a different hue depending on the density of the object. This means that the color of a point on the graph is determined by the number of items associated with other objects. This section is very useful for understanding the basic layout of a bibliometric map by identifying which aspects are relevant to the study. Throughout this worksheet, you can identify terms that are frequently used in publications. A map depiction of the co-word

research growth density with the keyword's calcium carbonate and paving block is shown in Figure 6. Figure 6 illustrates that the calcium carbonate keywords have a fairly high density and are surrounded by many additional keywords that are close such as the keywords "carbonate", "nano calcium carbonate", and "pavement", and "calcium carbonate precipitation". Some dense keywords give rise to some research contact with the subject, indicating that the subject is still not fully investigated. Various thoughts that arise as a result of the expansion of transdisciplinary science can lead to new research gaps (Nandiyanto et al., 2023). This provides potential for future research in calcium carbonate in paving blocks.

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Kesimpulan

Based on the findings obtained, the development of calcium carbonate and paving block research, especially in Google Scholar-indexed journals is important. This is confirmed by the excellent number of publications in 2022 reaching a total of 11 publications (21.15%). The results of the top citation analysis show that 3 publications have excellent citations passing above 100 citations where the article is dominated by the publisher Elsevier and google patents. Author visualization analysis shows that the author named Zhang is the most prolific author in this topic area. The results of the network visualization analysis showed that the most frequent keyword is "calcium carbonate" and the rare keyword is "paver block". The most recent related research in 2023 focused on the terms "Chemical", "microstructural characteristics", "cement concrete pavement", and "sands particles". Furthermore, the results of the density analysis show that some keywords that have been studied in depth are "calcium carbonate", "carbonate", "nano calcium carbonate", and "calcium carbonate precipitation". Finally, this research is expected to assist researchers in determining the topics to be studied and can also be a reference for research related to calcium carbonate and paving blocks.

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