Carbon Dioxide Emissions from Cement Industry

K. Elsayed and C. Vipulanandan[1], PhD., P.E.

[1]Texas Hurricane Center for Innovative Technology (THC-IT)
Department of Civil and Environmental Engineering
University of Houston, Houston, Texas 77204-4003
E-mail: keelsaye@cougarnet.uh.edu and CVipulanandan@uh.edu; Phone (713)743-4278

Abstract

In this study, the annual carbon dioxide (CO_2) emissions produced by the cement industry in each continent were investigated from 1928 to 2020. There are many factors that influence the production of cement including the population size and the growth of the economy. Based on the analyses, it was found that Asia is the largest continental population and Gross Domestic Product (GDP) in the world, and therefore the largest cement production of 1.32 billion tons in 2020.

1. Introduction

. Global greenhouse gas emissions continue to rise, at a time when they need to be rapidly falling (Lamb et al., 2022). The world emits around 50 billion tonnes of greenhouse gases each year [measured in carbon dioxide equivalents (CO_2eq)] (Hannah et al., 2020). To prevent severe climate change, it is needed to rapidly reduce global greenhouse gas emissions. Prior to the Industrial Revolution, CO_2 emissions were very low and the growth in emissions was still relatively slow until the mid-20th century. In 1950, the world emitted 6 billion tonnes of CO_2 (Hannah et al., 2020). With the growth of industrial activities and population around the world, carbon dioxide emission has increased rapidly.

Cement is the largest manufactured material around the world and in recent years over 4 billion tons are being manufactured annually to support all the construction, maintenance, and storage facilities onshore and offshore (Belaïd, 2022). Recent studies have shown that carbon dioxide associated with the cement industry can significantly impact global climate change (Rehan et al., 2005: Sanjuán et al., 2020). The historical database of cement emissions by continents can be considered as a metric way in order to know the sources and the ways to reduce the emissions

2. Objective:

The overall objective was to explore the CO_2 emissions across the world from the cement industry. The specific objectives of this study are the following:

a) Investigate the CO_2 emissions produced from the cement industry in each continent from 1928 to 2020.

b) Determining the main factors that affect cement production in each continent.

c) Explore the ways that may help in reducing CO_2 emissions worldwide.

3. Annual CO_2 emissions from the cement industry:

Six continents in the world were investigated: Africa, Asia, Australia, Europe, North America, and South America. Asia is the world's largest continental both by population and by land, while Australia is the smallest one. The CO_2 emissions were collected from the Our World in Data (https://ourworldindata.org/) and analyzed to determine the correlation between the CO_2 emissions with

time. Additionally, The main factors that affect the cement industry were collected from the statistics times website (https://statisticstimes.com/economy/continents-by-gdp.php).

Figure 1 shows the CO_2 emissions from the cement industry in each continent from 1928 to 2020 (Log scale). Results show that Europe was the highest producer of CO_2 emissions during the early 1900. Today, Asia is the largest CO_2 emissions produced by the cement industry with about 1.32 billion tons followed by Europe with 110.1 million tons of cement. Overall patterns across Africa and North America are similar with CO_2 emissions of about 77 million tons in 2020. South Africa also has notable emissions from cement with 43 million tons. However, Australia is the smallest continent in producing CO_2 emissions in 2020.

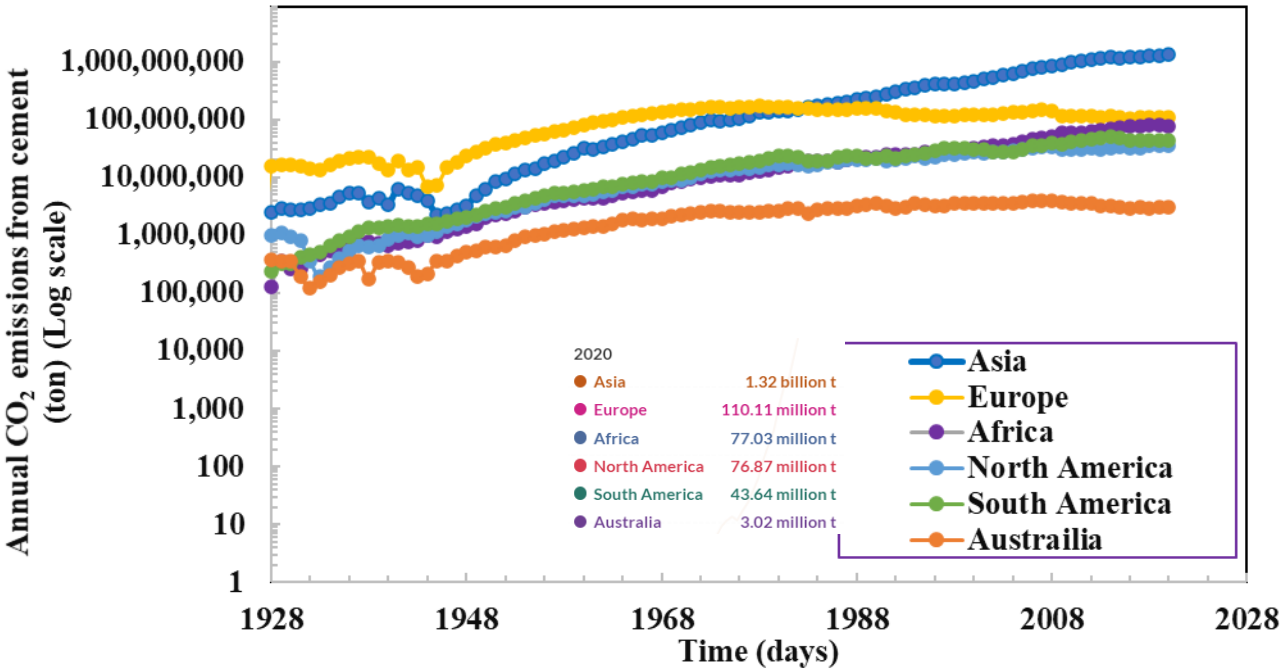
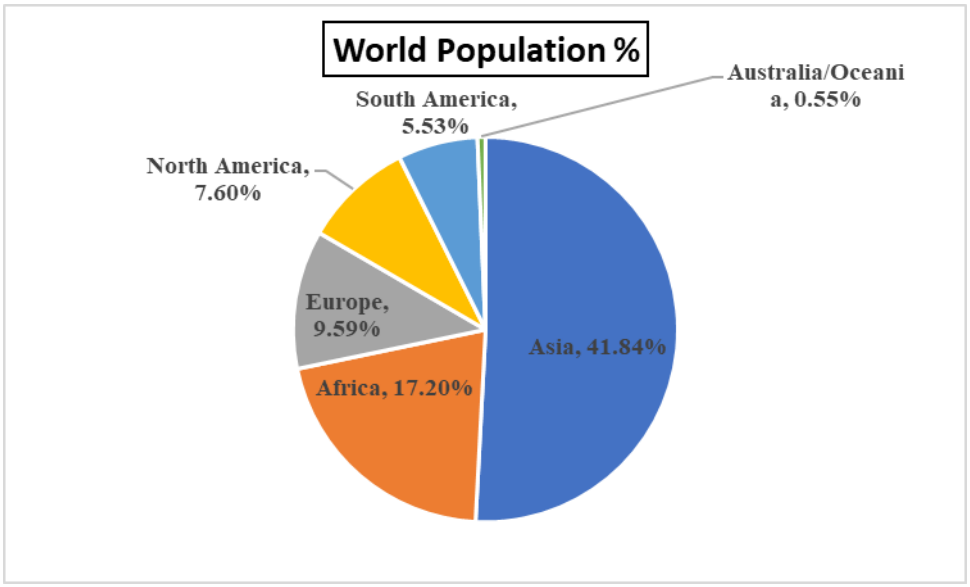
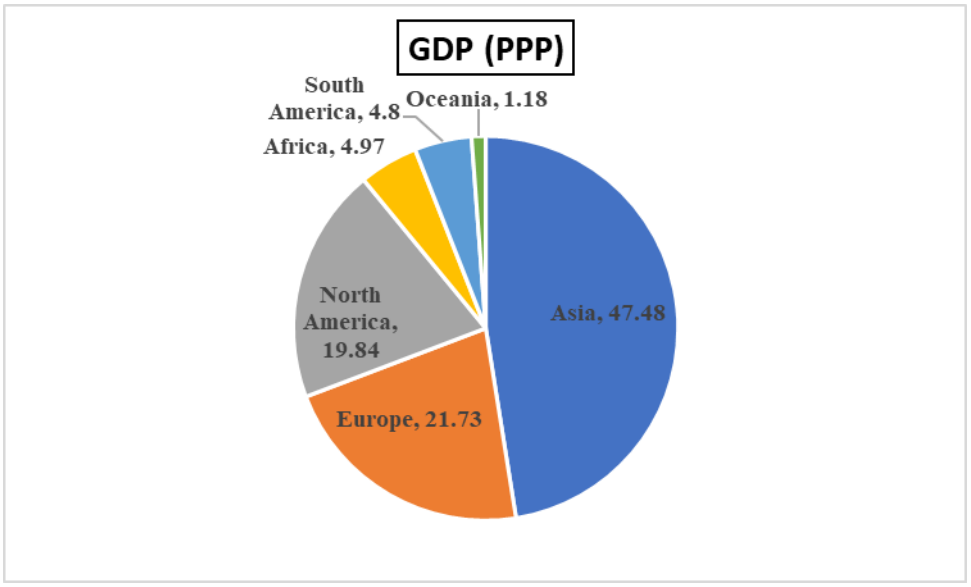


Figure 1 CO_2 emissions from the cement industry in each continent from 1928 to 2020 (Log scale).

Figure 2 presents the main factors that influence the production of cement including the population size and the growth of the economy. There is a strong relationship between population size and cement production. Asia represents around 42% of the world population and 48% of the gross domestic product (GDP) using purchasing power parity rates (PPP), Hence, is considered the highest CO_2 emissions. Europe represents about 22% of the total GDP, which is the second highest producer while Africa is the third with around 20% GDP. This is followed by the CO_2 emissions produced from North America and then South America due to the same two factors. Finally, Australia is the lowest continent in producing CO_2 emissions due to its lowest population size and GDP of about 0.55% and 1.18%, respectively.



(a)



(b)

Figure 2: Main factors that influence cement production: (a) population size and (b) GDP.

4. Conclusions

There are certain factors that influence the cement industry and are positively linked to cement production growth such as population size and GDP. The cement industry is also affected by technological advances, transportation advantages, and power sources. Based on the analyses, it has been found that Asia is the largest continent in producing CO_2 emissions from the cement industry due to its highest population size and GDP which represent 42% and 48% respectively.

5. Acknowledgment

This study was supported by the Texas Hurricane Center for Innovative Technology (THC-IT) and the Center for Innovative Grouting Materials and Technology (CIGMAT) at the University of Houston, Houston, Texas.

6. References

1. Belaïd, F. (2022). How does concrete and cement industry transformation contribute to mitigating climate change challenges?. Resources, Conservation & Recycling Advances, 15, 200084.

2. Hannah Ritchie, Max Roser, and Pablo Rosado (2020) - "CO_2 and Greenhouse Gas Emissions". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions' [Online Resource].

3. Lamb, W. F., Grubb, M., Diluiso, F., & Minx, J. C. (2022). Countries with sustained greenhouse gas emissions reductions: an analysis of trends and progress by sector. Climate Policy, 22(1), 1-17.

4. Rehan, R., & Nehdi, M. (2005). Carbon dioxide emissions and climate change: policy implications for the cement industry. Environmental Science & Policy, 8(2), 105-114.

5. Sanjuán, M. A., Argiz, C., Mora, P., & Zaragoza, A. (2020). Carbon dioxide uptake in the roadmap 2050 of the Spanish cement industry. Energies, 13(13), 3452.