

Impact of increased CO₂ emission due to usage of cement and latest advancement in cement industry

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Abstract - Emerging new systems are now responsible for environmental materials which will soon be increasingly used on site of a construction project. There are also a lot of new construction materials which are very easy to use and by using the same, quality of the project is also increased at a certain cost. These materials are already used extensively around the world but there is a restricted use in our country particularly due to the lack of awareness. This paper explores the latest advancements in technology in Civil Engineering. It will also give information on the environment impact about the processes already in use and also the emerging construction materials. This paper will compare the environmental impact of currently used methods and materials to that of emerging materials that are not even heard of by many in India. It will give a reflection on how adverse effects on environment can be decreased by using these emerging trends. While, cost and time are important, quality shall not be compromised. It is important to note that quality and sustainability often go hand in hand. It is equally important to think about the environment and to use a suitable material which is optimum in quality and also environment friendly. This paper will also discuss about the the impact of the quality of construction by using latest these materials. With the restricted use and the major technological gap between small firms and MNCs, this paper will discuss the reasons behind the same and how that can be changed.

Key Words: Emerging Trends, Technological Gaps, Environment, Materials

1. INTRODUCTION

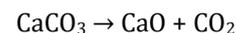
Infrastructure is the key for any tourist to judge a country. While India is one of the fastest growing economies in the world, there are still a lot of areas which need to be developed and focused upon in India for it be called as a developed country. One such key area is Infrastructure. With unprecedented amount of land still to be used in rural parts and mega construction projects like Mumbai metro or the bullet rail project, construction industry in India is definitely booming and the country requires more civil engineers for the same. However, there is still a major gap in terms of technology between small independent builders and MNCs in India and also around the world. Civil Engineering has undergone a lot of new technological advancements around the world but same cannot be said for India. For a project to be successful, cost and time along with quality are key factors. If the project is not overrun by cost and there is no substantial delay in duration, a project can be called successful. Emerging new trends and technology ensures the

same. Technology is the amalgamation of skills, process, methods, proficiency and expertise. With the advancement of technology in any field, the field itself undergoes a far-reaching shift. Civil Engineering is undergoing the same right now around the world. This has also resulted in increase in the quality of the project such that there is no adverse effect on environment.

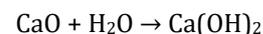
2. COMPOSITION OF CEMENT

Construction is the process of constructing a building or infrastructure. Construction industry is singularly responsible of 6-9 percent of Gross development product of developed countries. Cement is one of the major constituents of construction of a building. It is basically a binder substance, setting and hardening of which results in adhering to other materials, holds everything together. Type of cement used is generally lime or calcium silicate based, and can be put into the category of hydraulic or non-hydraulic based on its ability to set in water.

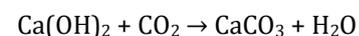
Non hydraulic cement generally reacts with Carbon Di oxide present in air. By calcination, calcium oxide is generated from calcium carbonate at temperatures above 825 degree Celsius. Reaction for the same is as follows:



Calcium oxide is the mixed with water for the formation of slaked lime.



Carbonation commences after the evaporation of excess water. This can also be termed as setting.



This is how a cement hardens and sets. Lot of heat is generated during this process.

3. SAFETY ISSUES IN USAGE OF CEMENT

Several hydration chemical reactions get under way once setting starts after mixing it with water. There are several safety warnings on the bags of cements. This is done because of the following reasons:

- 1) Alkalinity of the cement along with several exothermic reactions are the main reasons for it.
- 2) In fact, wet cement is so toxic that it causes severe burns on skin.

3) Breathing problems or irritations in eye can also be caused when dry cement powder comes in contact with mucous membranes.

4) Allergic dermatitis can also be caused due to presence or trace elements. Chromium is one such element. This happens due to impurities present in raw materials which are used to produce cement.

Labours that are in constant touch with cement need to be provided with gloves and protective clothing.

4. PRODUCTION OF CEMENT

The production of cement was 3,300 million tonnes in 2010. India was among the top 3 producers in the world with 220 million tonnes along with China (ranked first with 1800 million tonnes) and USA (ranked third with 63.5 million tonnes). This consumption further continued to climb with 3585 million tonnes and 3736 million tonnes in 2011 and 2012 respectively. As synonymous as it can get with cement consumption, China, USA and India are also world's three biggest contributor to global CO2 emissions with 24.2 %, 14.2% and 5.7% respectively. CO2 emissions have only increased in the three countries in recent years. Increased CO2 emissions is one the biggest reason for the global warming around the world. India being one of the most polluted countries around the world, steps have to be taken to reduce the same. With immense amount of land still available for industries and infrastructure development, out of the above three countries India is the most under developed country. One can only imagine that with increase in the use of the vacant land for development. Cement consumption is only going to increase in India. Population coupled with urbanization has led to increased levels of pollution especially in the capital city of Delhi. A daunting future awaits the citizens if steps are not taken to reduce global warming. This can start with construction industry itself because of the amount of cement consumed and the waste generally generated.

Rank	Country	share of global CO2 emissions
1	China	23.43 %
2	U.S.	14.69 %
3	India	5.70 %
4	Russian Federation	4.87 %
5	Brazil	4.17 %
6	Japan	3.61 %
7	Indonesia	2.31 %
8	Germany	2.23 %
9	Korea	1.75 %
10	Canada	1.57 %
11	Iran	1.57 %

Figure 1. Biggest Contributors To Global Warming In The World By Country for year 2017

2011 Total Emissions Country Rank	Country	2011 Total Carbon Dioxide Emissions from the Consumption of Energy (Million Metric Tons)
1.	China	8715.31
2.	United States	5490.63
3.	Russia	1788.14
4.	India	1725.76
5.	Japan	1180.62
6.	Germany	748.49
7.	Iran	624.86
8.	South Korea	610.95
9.	Canada	552.56
10.	Saudi Arabia	513.53
11.	United Kingdom	496.80
12.	Brazil	475.41
13.	Mexico	462.29
14.	South Africa	461.57
15.	Indonesia	426.79
16.	Italy	400.94
17.	Australia	392.29
18.	France	374.33
19.	Spain	318.64
20.	Poland	307.91

Figure 2. Each Country's Share of CO2 Emissions (data are for 2011)

We can clearly see from figure 1 and figure 2 that India has jumped from 4th position in 2011 to 3rd position in 2017 by pushing down Russia. So, in the last 7 years there has been an increase in the Carbon di oxide emissions in India and Cement consumption is one of the main reason for the same. It is thus very important to tackle this problem in order to preserve our environment.

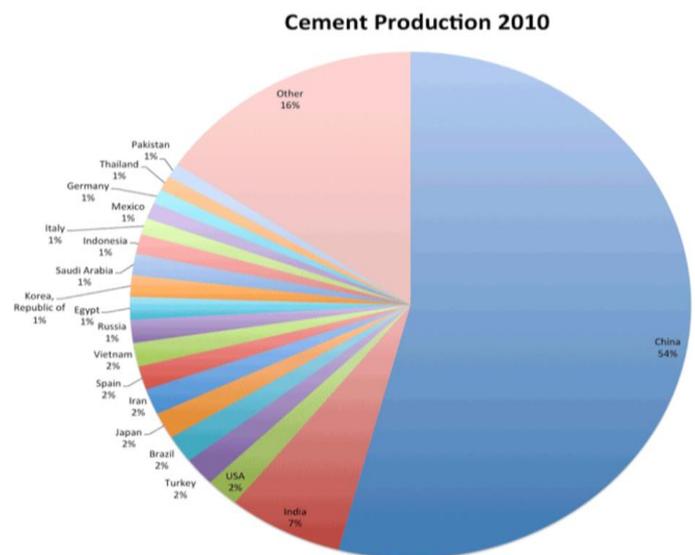


Figure 3. Cement Production in 2010

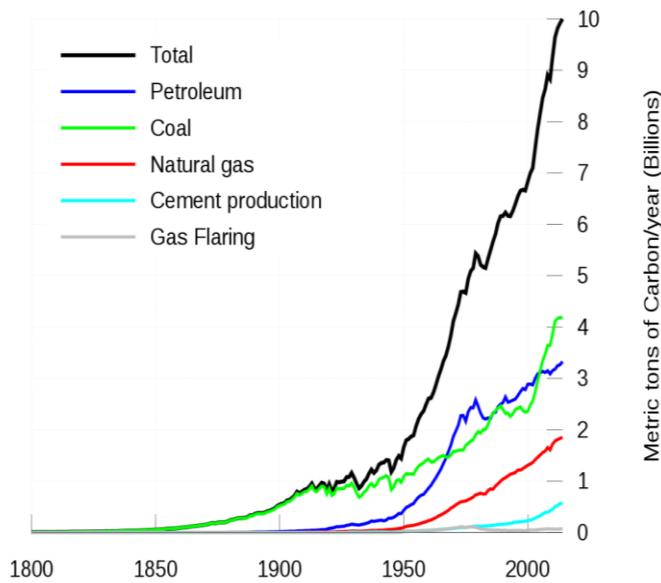


Figure 4. Global annual fossil fuel carbon dioxide emissions through year 2007

5. LATEST CEMENT PRODUCTS TO COUNTER THE INCREASE EMISSIONS OF CO₂

Increased emission of CO₂ has been a constant problem and this has to be tackled before its aggravated effect on environment. Following are the advancement in the cement producing industry which will counter the above mentioned problem with less impact on environment.

5.1. GREEN CEMENT:

Green cement is one of the most important and recent innovation that can change the world for its own good. Green cement is very similar to ordinary portland cement and generally meets or sometimes even surpass the capabilities of Ordinary portland cement. This has resulted in a reduced consumption of raw materials, water and also energy. This is a more sustainable option than Ordinary Portland cement. Below are examples of some companies using alternatives to produce "Green" cement.

1) Calera Corp. of USA is producing Calcium carbonate from sea water or brine mixed with CO₂ that may be used as a portland cement.

2) Super heated steam is now being used by an Australian company called Calix for modifying cement particles, as a result, making them reactive. CO₂ is successfully separated and captured during this process.

3) A new binder was developed by Solidia Technologies similar to raw materials in Ordinary Portland Cement which can be developed at lower temperatures in a rotary kiln and with a disparate chemical reaction that produces low amount of CO₂.

4) In 1970s, a calcium sulfoaluminate cement was produced in China as a type similar to rapid setting cement where the cement is set within 24 hours. Because of the kiln temperature of around 2250 Fahrenheit compared to that of 2600 Fahrenheit required for Ordinary Portland Cement, there is a reduced level of environment hazard.

One other alternative developed by researchers are producing the cement with a reduced amount of clinkers. Clinkers are produced in kilns and require a lot of energy, thus using less amount of clinkers will automatically contribute to less CO₂ emissions. This can also be termed as low carbon cement. Fly ash and slag are two products that are increasingly used now a days as substitute.

5.2. BIO CEMENT:

Recently, innovations and research is being done to produce a cement consisting of bacteria. One such innovation has been done by a student from University of Edinburgh where a bacterium *Sporosarcina pasteurii*, with binding qualities produced a cement with 70% strong as compared to general materials when combined with sand and urine.

There have also been many research and development on producing brick and cement primarily with bacteria as there are bacteria which are the sources of calcium carbonate. One such development is done by bioMASON, a company based in USA which is responsible for using a rod shaped bacillus bacteria that is found in limestones cave. This bacteria is then responsible for developing a microenvironment which is results in the formation of this calcium carbonate crystal. This is a revolutionary technique and can completely turn construction industry on its head.

6. RESTRICTED USAGE OF THESE MATERIALS

One reason for the restricted use of these materials is cost. Because of the unavailability of the product in India and the funds that go into the research and development of the product it is quite obvious that the above mentioned material will be of very high cost. So, independent contractors and small construction firms will be reluctant to use the product even if they are made aware about it. But, the question still remains about the general environment awareness and of the impact of the materials already in use. This can be changed by making it mandatory by the government. All the construction firms need to file a report on the usage of the Carbon di oxide producing materials and setting a limit on the usage of the same depending on the size of the project. While it will be unfair to blame the builders for the negligence in the use of the product, government should also be involved in bringing path breaking technologies like bio cement to India and making it an affordable material. The reduced cost will be paramount to convince the people in this industry to use the latest materials like bio cement and many more technological advancements and equipment that are common in the developed countries.

7. CONCLUSION

There are many new technologies and materials which have recently come to the fore and can be used for a sustainable construction. It is high time that construction firms which are big and small are made aware of all the technological advancements happening around the world. It is important for builders and contractors in the country to understand the impact of the ever increasing consumption of cement on environment and how that can be reduced by adopting the technologies and materials mentioned above. A healthy life is more important than a wealthy life and for that, we need to keep thinking and educating ourselves about ways to preserve our environment.

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