Global Cement and Concrete Association

India

STUDY ON CARBON UPTAKE BY CONCRETE IN INDIA

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This report has been jointly prepared by GCCA India and National Council of Cement and Building Materials (NCB).

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Message from Director General, National Council of Cement and Building Materials

Hon'ble Prime Minister has committed to achieve Net Zero target in India by 2070, at COP 21 in Glasgow. The Indian cement industry contributes around 6.3% of the overall CO_2 emissions and is proactively making efforts to reduce its carbon footprint. Recently, GCCA India in partnership with TERI released the Decarbonization Roadmap for the Indian Cement Sector: Net-Zero CO_2 by 2070 highlighting the levers for potential reduction, wherein carbon uptake has been one of the levers for CO_2 reduction.

This report, prepared by NCB and GCCA India, represents a significant step in understanding and quantifying the carbon uptake by concrete in India. Concrete, a cornerstone of modern construction, has the unique ability to sequester CO_2 through carbon uptake, partially offsetting emissions generated during cement production. This study builds on global research, tailoring methodologies to the Indian context, and provides a comprehensive analysis of CO_2 uptake by concrete structures and mortar, across the country. By exploring the carbon uptake process, this report highlights an often underestimated decarbonization lever for mitigating the CO_2 emissions arising from the cement production.

Ministry of Environment, Forest and Climate Change (MoEF&CC) submits Biennial Update Reports (BURs) to the United Nations Framework Convention on Climate Change (UNFCCC), detailing India's greenhouse gas (GHG) emissions, including CO_2, as part of its climate commitments. Presently, BUR does not quantify carbon uptake by concrete.

This report on carbon uptake by concrete (prepared by NCB and GCCA India) quantifies CO_2 sequestration through carbon uptake by concrete structures and mortar, partially offsetting cement-related CO_2 emissions. I am confident that the insights presented here will guide future strategies, formulate policy frameworks, and inspire continued progress toward a low-carbon future for the Indian cement industry.

Dr L P Singh
Director General
National Council for Cement and Building Materials

Acronyms

BIS	Bureau of Indian Standards
BUR	Biennial Update Report
CC	Composite Cement
CMA	Cement Manufacturers' Association
CO_2	Carbon Dioxide
COP	Conference of Parties
CSI	Cement Sustainability Initiative
DPIIT	Department for Promotion of Industry and Internal Trade
EF	Emission Factor
GCCA India	Global Cement and Concrete Association, India
GHG	GreenHouse Gas
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land Use, Land-Use Change, and Forestry
MoEF&CC	Ministry of Environment, Forest and Climate Change
MPA	Mineral Product Association
MR	Mortar Ratio
Mt	Million Tonnes
MTPA	Million Tonnes Per Annum
NATCO	National Communications
NCB	National Council for Cement and Building Materials
OPC	Ordinary Portland Cement
OWC	Oil Well Cement
PI	Performance Improver
PPC	Portland Pozzolana Cement
PSC	Portland Slag Cement
SCM	Supplementary Cementitious Materials
SRPC	Sulphate Resisted Portland Cement
t	Tonne
TERI	The Energy and Resources Institute
TIFAC	Technology Information Forecasting and Assessment Council
UNFCCC	United Nations Framework Convention on Climate Change
WBCSD	World Business Council for Sustainable Development

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1.0 Introduction

India has emerged as the fourth largest (PIB, 2025) economy in the world and is predicted to become the third largest economy by FY28, overtaking both Japan and Germany. Amongst the eight core industries of India, cement industry plays a vital role in the growth and economic development of our country because of its strong linkage to other sectors such as infrastructure, construction, housing, transportation, coal, power etc.

India is the second largest cement producer (10.4% of total cement production of 4.1 billion tonnes) in the world after China (as shown in Fig. 1.1) and is one of the most energy efficient in the world. The Indian cement industry excels in quality control and environmental improvement. It is also a significant contributor to employment, fiscal revenue, and community development while achieving manufacturing and technological excellence.

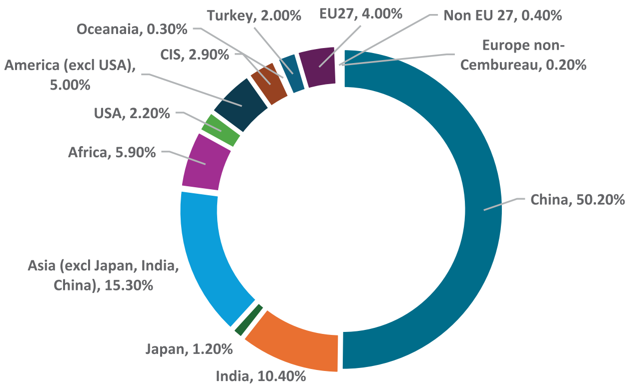

Fig 1.1: World Cement Production (Source: Cembureau)

The installed capacity of cement industry in India in 2024–25 is 690 million tonnes (Mt) with cement production of around 453 Mt (DPIIT, 2024). Total cement plants are 357 nos. in India comprising of 160 integrated large cement plants, 130 grinding units, 62 mini cement plants and 5 clinkerization units (NCB, 2024). Cement consumption in India is around 290 kg per capita against global average of 540 kg per capita, which shows significant potential for the growth of industry (NCB, 2024).

The cement production in India in business-as-usual (BAU) scenario is projected to increase to 1440 Mt in 2047 and 2278 Mt by the year 2070 as shown in Fig. 1.2 from 453 Mt in 2024–25. The cement production in India in decarbonization scenario is projected to increase to 944 Mt in 2047 and 1546 Mt by the year 2070 as shown in Fig. 1.2. (GCCA India- TERI (2025)).

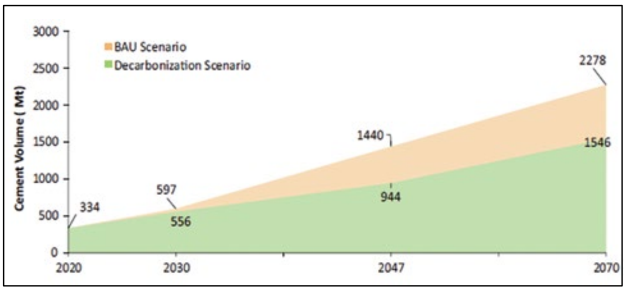

Fig 1.2: Growth in cement production

1.1 India's BUR to UNFCCC

India, as a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) since 1994, is obligated to submit Biennial Update Reports (BURs) to document its progress in addressing climate change. These reports update India's National Communications and provide detailed insights into GreenHouse Gas (GHG) inventories, mitigation efforts, and needs for finance, technology, and capacity building. Below is a summary of India's BUR submissions, with a focus on key achievements and data from the latest reports.

India has submitted four BURs to the UNFCCC:

- **First BUR:** Submitted on January 22, 2016, covering the GHG inventory for 2010.
- **Second BUR:** Submitted on December 31, 2018, updating the 2014 inventory and mitigation actions.
- **Third BUR:** Submitted on February 20, 2021, updating the 2018 inventory and mitigation actions.
- **Fourth BUR:** Submitted on December 30, 2024. providing the 2020 GHG inventory and showcasing significant climate progress.

Each BUR builds on prior National Communications (submitted in 2004, 2012, and later) and adheres to UNFCCC guidelines, incorporating inputs from governmental, academic, and private institutions.

India's BURs demonstrate its commitment to transparency and accountability in global climate efforts. The 36% reduction in emission intensity between 2005 to 2020 highlights the significant expansion of renewable energy underscoring India's leadership in sustainable development ((Government of India (BUR), 2024)

1.2 Status of CO_2 emissions from the Indian Cement Industry

Globally, cement sector contributes about 7% of the total anthropogenic CO_2 emissions (Global Cement and Concrete Association, 2021). As per India's Biennial Update Report (BUR), cement industry contributes 6.3% to the total CO_2 emissions from India as shown in Fig. 1.3.

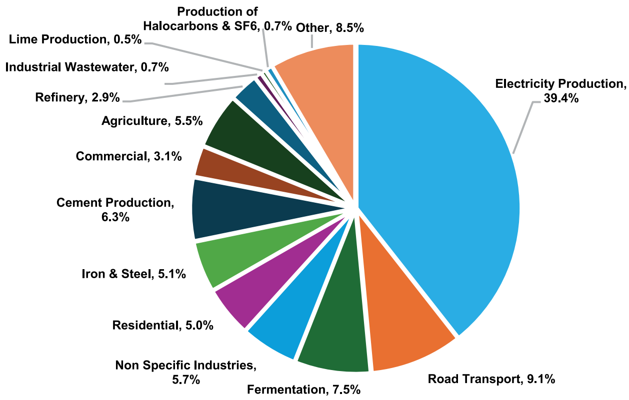

Fig 1.3: Breakup of India's BUR to UNFCCC

Indian cement industry has been working on decarbonizing the cement sector and has brought down the CO_2 emission factor from 1.12 t of CO_2/t of cement in 1996 to 0.719 t of CO_2/t of cement in 2010. Moreover, the CO_2 emission factor has reduced further to 0.670 t of CO_2/t of cement in 2020. CO_2 emissions are targeted to be further reduced to 0.51 t CO_2/t of cement by 2047 and to zero by 2070 as estimated in the roadmap.

1.3 Decarbonization Roadmap for the Indian Cement Sector: Net-Zero CO_2 by 2070

It was prepared by the GCCA India in collaboration with The Energy and Resources Institute (TERI) in March 2025, outlines a strategic pathway for India's cement sector to achieve net-zero CO_2 emissions by 2070, with an interim target for 2047 aligned with the vision of 'Viksit Bharat.' As the world's second-largest cement producer, contributing 8% of global capacity and approximately 7% of India's CO_2 emissions, the sector is critical to India's infrastructure and economic growth. With per capita cement consumption at 290 kg/capita far below the global average of 540 kg/capita the industry has significant growth potential, necessitating sustainable practices.

Developed with input from industry leaders, research institutions, academia, and sectoral experts, the roadmap leverages the European Cement Research Academy (ECRA) tool to quantify decarbonization levers.

Key strategies include reducing clinker content, enhancing energy efficiency, increasing alternative fuel use, new binders, adopting carbon capture, utilization, and storage (CCUS), and CO_2 uptake or carbon uptake through concrete as shown in Fig. 1.4.

The roadmap aligns with India's Net Zero Emissions 2070 target and Nationally Determined Contributions (NDCs), emphasizing the need for robust policy support and financial incentives to accelerate decarbonization. The roadmap envisages reduction of 91 million tonnes of CO_2 in 2070 by CO_2 uptake in concrete.

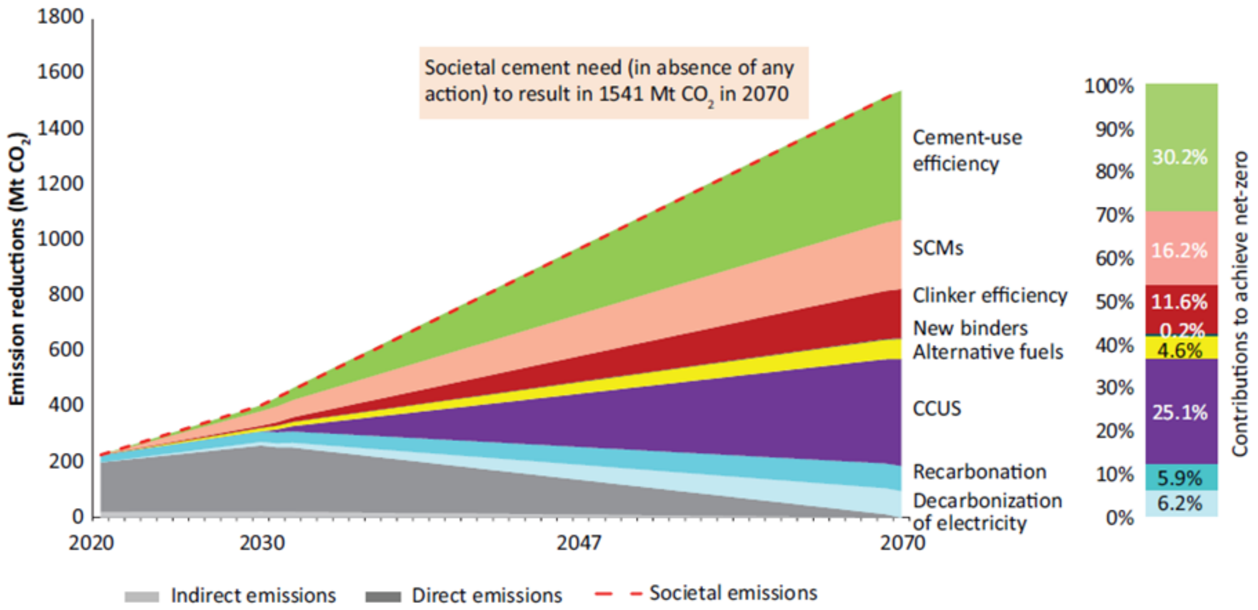

Fig 1.4 Decarbonization levers from the Indian cement sectors Net Zero CO_2 roadmap

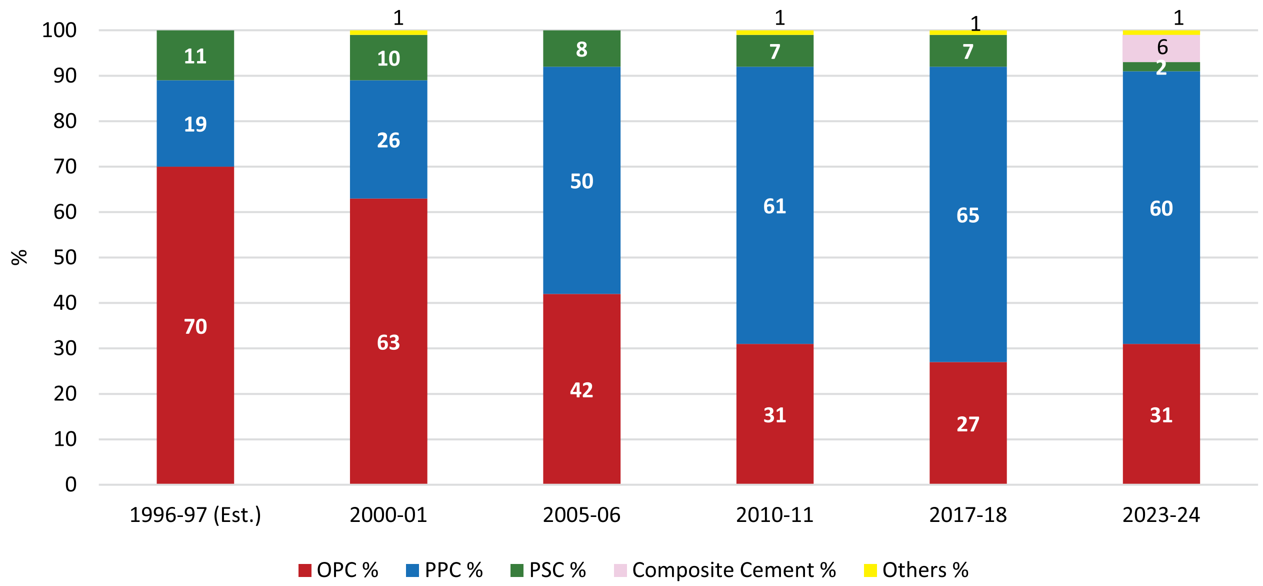

Fig 1.5 Cement Mix of India

1.4 Types of cements produced in India

Bureau of Indian standard in India have specified 16 types of cements as shown in Table 1.1. These cements include OPC, PPC, PSC, composite cements, LC3 and other special purpose cements as listed in Table 1.1. Among all these, three most common cement types produced in India are Ordinary Portland Cement (OPC), Portland Pozzolana Cement (PPC) and Portland Slag Cement (PSC). OPC is produced in three grades – 33, 43 and 53 grade OPC. OPC-43 and OPC-53 grades are higher strength cements and used for general constructions as well as to meet special requirements like pre-stressed concrete and pre-cast products. 43S & 53S grades of OPC are used in production of railway sleepers.

The share of blended cement in the total quantity of cement manufactured in India in 1996–97 was 30% which increased to 68% in 2010 and 69% in 2024 as shown in Fig 1.5 (Source: NCB). This is largely due to the market's growing acceptance of blended cement, emerging awareness of sustainability concepts, the availability of fly ash from thermal power plants and the use of advanced technology. The production of Pozzolana Portland cement (PPC) grew from 19% in 1996 to 60% in 2023. The share of Portland Slag Cement (PSC) in cement production has reduced from 11% in 1995 to 2% in 2023. The share of composite cement is continuous increasing with present share of 6% in 2023–24.

The percentage of Ordinary Portland cement (OPC) use has remained between 27% to 31% in the last ten years in India (data in Annexure II).

1.5 Study on CO_2 uptake by concrete

NCB in collaboration with GCCA India has undertaken the study on CO_2 uptake in concrete in India. In this report, the CO_2 uptake in concrete in India is calculated using Tier I methodology of IVL Swedish Environment Research Institute. This study is carried out based on default factors using available data and highlighted in subsequent chapters. The report will be submitted to Ministry of Environment, Forest and Climate Change (MoEF & CC), Govt. of India.

The forecast of 91 million tonnes of CO_2 uptake in the year 2070 as envisaged in the Decarbonisation Roadmap for the Indian cement sector is conservative; the more detailed carbon uptake values are presented in this report.

- **Table 1.1: Cements standardised by BIS**

S. No.	Indian Standard	Specification for
1	IS 269:2015	**Ordinary Portland Cement- OPC-33 grade (Sixth Revision)**
		Ordinary Portland Cement – OPC-43 grade (Sixth Revision)
		Ordinary Portland Cement – OPC-53 grade (Sixth Revision)
		Ordinary Portland Cement – OPC-43S grade (Sixth Revision)
		Ordinary Portland Cement -OPC-53S grade (Sixth Revision)
2	IS 455:2015	Portland Slag Cement (Fifth Revision)
3	IS 1489 (Part 1):2015	Portland Pozzolana Cement: Part 1 Fly ash based (4th Revision)
4	IS 1489 (Part 2):2015	Portland Pozzolana Cement: Part 2 Calcined clay based (4th Revision)
5	IS 3466:1988	Masonry Cement
6	IS 6452:1989	**High Alumina Cement for structural use**
7	IS 6909:1990	Super sulphated cement
8	IS 8041:1990	Rapid Hardening Portland Cement
9	IS 8042:2015	White Portland Cement (Third Revision)
10	IS 8043:1991	Hydrophobic Portland Cement
11	IS 8229:1986	**Oil-Well Cement**
12	IS 12330:1988	Sulphate Resisting Portland Cement
13	IS 12600:1989	Specification for Low Heat Portland Cement
14	IS 16415:2015	Specification for Composite Cement
15	IS 16993: 2018	Microfine Ordinary Portland Cement-Specification
16	IS 18189:2023	Limestone Calcined Clay Cement

2.0 Carbon Uptake by Concrete (Recarbonation)

Concrete reabsorbs a significant amount of CO_2 over its lifetime in a natural process known as carbon uptake or recarbonation. Decarbonization Roadmap for the Indian Cement Sector prepared by GCCA India and TERI has used Tier-1 of IVL methodology which permits 20% of theoretical maximum carbon uptake value of clinker for Carbon uptake.

Carbon uptake primarily involves the reaction of CO_2 with calcium hydroxide ($Ca(OH)_2$), a byproduct of cement hydration, in the presence of water within the concrete's porous structure. In addition to calcium hydroxide, CO_2 can react with other calcium-bearing phases in cement paste, such as calcium silicate hydrates (C-S-H), which are the primary binding agents in concrete. The resulting calcium carbonate is a stable, insoluble compound that permanently locks CO_2 within the concrete matrix. The formation of carbonates in these chemical reactions leads to a permanent sequestration of this CO_2.

Atmospheric CO_2 diffuses through the porous network of concrete. The rate of diffusion depends on the concrete's porosity, permeability, climate, cement composition, geometry and exposure condition of the structure, and the CO_2 concentration in the surrounding environment. The rate of carbonization is more at the initial stage and as the time passes the carbon uptake rate reduces. The efficiency and rate of CO_2 uptake in concrete are governed by several factors as shown in Fig 2.1.

Fig 2.1: Factors affecting rate of CO_2 uptake

CO_2 Concentration

Higher atmospheric CO_2 levels, such as in urban or industrial areas, accelerate carbon uptake.

Concrete Porosity

More porous concrete allows greater CO_2 diffusion but may compromise strength.

Moisture Content

Optimal carbon uptake occurs at relative humidity of 60–80% (IVL Swedish Environmental Research Institute, n.d.). Excessively dry concrete limits water availability for dissolution,while saturated concrete restricts CO_2 diffusion.

Temperature

Higher temperatures increasereaction rates, though extreme heat may dry out pore water.

Cement Composition

The availability of calcium compounds directly affects carbon uptake potential. Supplementary cementitious materials (e.g., fly ash, slag) may slow carbon uptake.

Surface Exposure

Exposed surfaces, such as external walls or crushed concrete, experience faster carbon uptake due to greater contact with atmospheric CO_2.

Time

Carbon uptake progresses slowly, with the depth of the carbon uptake front advancing proportionally to the square root of time. The rate of carbonization decreases with time.

Carbon uptake permanently sequesters CO_2, contributing to the mitigation of GreenHouse Gas emissions. The carbon uptake mechanism in concrete transforms atmospheric CO_2 into stable calcium carbonate through diffusion, dissolution, and chemical reaction. Governed by environmental and material factors, this process enables concrete to act as a carbon sink, offering a passive strategy to offset emissions in the construction sector.


CO2

3.0 Insights from other countries

Calculating carbon uptake by concrete requires assessing absorption across the lifecycle of cement-based materials, including in-use structures, mortar, construction waste. Concrete carbon uptake is scientifically well established and has been recognised by the Intergovernmental Panel on Climate Change (IPCC) as an important carbon emissions sink (AR6, WG11, Chapter 5).

3.1 Key methodologies

3.1.1 IVL Methodology (Tier 1–3 Models)

This methodology is developed by the IVL (Swedish Environmental Research Institute), provides simplified to advanced models for estimating carbon uptake by concrete. To align with the IPCC requirements for GHG reporting, the IVL methodology proposes three tiers of increasing complexity, where higher tier calculations require more detailed knowledge of actual concrete use. The Tier 1 model offers a simplified approach for national estimates, while Tier 2 and 3 models use detailed data for higher accuracy.

The IVL methodology provides a structured approach to estimate annual CO_2 uptake in concrete at a national level, divided into three tiers:

- **Tier 1 (Simplified):**
  The IVL Tier 1 methodology is based on annual CO_2 emissions due to cement calcination and is recommended for use where concrete production statistics are limited or not available. The estimate, based on an international literature review, is that each year 23% of the raw material calcination (CO_2) emitted during cement production is reabsorbed: 20% by concrete in its primary use (based on current construction levels) and 3% by demolished and recycled concrete (based on much lower historic construction levels, typical global demolition practices and low recycling rates). The calcination CO_2 emissions should be calculated on a consumption basis, i.e. from the annual national cement consumption, including both domestic cement production and cement imports but excluding cement exports. Although the uncertainty in calcination emissions is very low, the uncertainty in the Tier 1 calculation is relatively high, due to the assumptions made in the methodology.

- **Tier 2:**
  For a Tier 2 model, IVL recommends that, to be representative of national circumstances, data in the primary use stage should cover at least one year, five or more cement or concrete use applications – such as bridges, residential buildings, office buildings or mortar and at least 65% of national cement consumption. The remaining 35% of cement consumption is either distributed across the top five or more primary use applications or assigned to specific applications. For each primary use application, annual data on concrete volumes

(or cement consumption) is required, as is data on typical cement/clinker content in the concrete mix, and the concrete quality, exposure and surface area. For Tier 2, the methodology assumes that the national annual CO_2 uptake for all concrete in primary use in the built environment can be estimated from new-build construction during the reporting year. Instead of calculating the annual increment in CO_2 uptake for all existing concrete, the method calculates the CO_2 uptake of new-build concrete over its whole service life and treats this as an instantaneous carbon sink. Although this will introduce some uncertainty into the model, it is a reasonable approximation in countries with a mature market, where concrete production and construction have been relatively constant in recent decades.

- **Tier 3:**
  For a Tier 3 model, IVL proposes advanced user-developed software models to include at least 50 years of cement consumption data and detailed concrete use data covering at least three different years. Furthermore, the CO_2 uptake calculation should not be based solely on the cement clinker content, but incorporate carbon uptake of SCMs, such as fly ash and GGBS. Ideally, a Tier 3 model should also include historic CO_2 emissions data for cement calcination and SCMs.

3.1.2 EN 16757:2022 (British Standard)

The British Standard EN 16757:2022 provides a standard method to calculate the CO_2 uptake from concrete carbon uptake. It includes detailed worked examples applying the method to the primary use phase of concrete structures. However, the method can be used to calculate the carbon emissions sink due to carbon uptake in any stage of the concrete life cycle. EN 16757 gives values for the rate at which carbon uptake progresses through the concrete and the proportion of CO_2 absorbed, for a range of concrete strengths and exposures. The rate of progression of carbon uptake is highest for concrete exposed to indoor environments. However, the proportion of CO_2 absorbed, or degree of carbon uptake, is only 40% of the corresponding cement calcination emissions, whereas it is 75–85% in outdoor environments or in the ground. In lower carbon concretes containing SCMs or additions, (such as Fly Ash and GGBS), carbon uptake progresses more quickly than in a CEM I mix of the same strength, but the potential total CO_2 uptake is lower – due to the lower upfront embodied carbon. EN 16757 allows for the use of 'national provisions' for carbon uptake of end-of-life and secondary use concrete in the form of scenarios that are representative of typical practice and thus provide a unified calculation method.

3.2 Country-Specific Approaches

3.2.1 Sweden

Sweden has included Swedish CO_2 uptake in Concrete in Annex 8.5 of the National Inventory Report 2024 submitted to UNFCCC. The CO_2 uptake is calculated using IVL Tier 1 methodology for the use phase. The CO_2 uptake in concrete is, in the order of magnitude, below 1% of the total national Swedish CO_2 emissions and also of the CO_2 uptake in the LULUCF sector.

3.2.2 United Kingdom

In 2021, the Mineral Products Association (MPA), leading a consortium including UK's GHG inventory agency and other experts, were commissioned to develop a UK-specific model, at IVL Tier 2 (or above), to calculate the UK emissions sink from carbon uptake of concrete for consideration by the Department of Energy Security and Net Zero (formerly BEIS) for inclusion in the UK National Inventory Report (NIR). MPA commissioned an independent literature review, which concluded that, the IVL Tier 2 methodology, based on the British Standard EN 16757, would provide a robust method for calculating the CO_2 uptake due to carbon uptake of concrete and mortar during their primary use service life. However, it was also highlighted that CO_2 uptake values for end-of-life and secondary use of concrete suggested by IVL are not suitable for a national GHG inventory calculation and a UK-specific end-of-life carbon uptake model was developed. For concrete carbon uptake in the UK in 2020, the estimated total emissions sink, and overall uncertainty is 1.548 Mt CO_2 ±34% or 0.4% of the UK's total GHG emissions. Concrete in primary use absorbed 0.862Mt CO_2; end-of-life and secondary use concrete 0.686Mt CO_2. For 1990–2020, the estimated CO_2 sink from concrete in primary use varies between 14% and 20% of the annual UK cement calcination emissions (on a consumption basis). This is consistent with IVL's Tier 1 estimate, that the annual primary use sink equals 20% of calcination emissions. For end of life and secondary use concrete, the sink varies between 9% and 16% of calcination emissions (on a consumption basis) – higher than the IVL Tier 1 value of 3%, but lower than the maximum 110kg CO_2/m^3 concrete suggested by IVL.

3.2.3 China

China, the world's largest cement producer (2,100 Mt/year), has significant carbon uptake potential due to its vast concrete stock. Chinese Academy of Sciences presented a comprehensive analytical model of cement carbon uptake from China, revealing a substantial increase in carbon uptake from 1930 to 2021, peaking at 426.77 Mt CO_2 in 2021. The uptake accounts for 8.10% to 45.40% of China's annual land sink and 2.51% to 4.54% of the global land sink. The cumulative carbon uptake by cement or concrete is approximately 7.06 Gt CO_2 during this period, offsetting 50.7% of the total emissions from the cement industry. The study also estimated that cement mortar contributed to most absorption (65.64%). From a life cycle perspective, the service stage of cement materials is the period where the largest CO_2 sink is formed, accounting for 90.03% of the total. The CO_2 uptake by concrete is not yet included in China's BUR submitted to UNFCCC.

3.2.4 Spain

Technical University of Madrid estimated carbon dioxide uptake by cement-based materials in Spain. The study recommended that the natural carbon uptake should be added up to the carbon accounting. Therefore, natural carbon uptake should be included in the IPCC Guidelines for National Greenhouse Gas Inventories, and such accounting information should be made available promptly to the national regulatory authorities. The study estimated carbon dioxide uptake by Spanish cement-based materials from 1990 to 2020 by using an easy method of estimating the net carbon dioxide emissions (simplified method) considering the carbon dioxide released by the calcination during clinker production (process emissions). The outcome of this study reveals that there was 9.36 million tons of carbon dioxide uptake by the mortar and concrete manufactured in Spain from 1990 to 2020.

3.2.5 Japan

University of Tokyo estimated CO_2 uptake during the cement lifecycle in Japan by incorporating dynamic material stock-flow analysis into the model. Concrete stock-flow and CO_2 uptake from 1870 to 2070 are estimated by reflecting country-specific characteristics such as concrete mix design, surface-to-volume ratio of buildings, presence or absence of coating resins and/or covering materials, and exposure climate. Annual CO_2 uptake in the cement lifecycle was estimated to be 2.6 million tonnes/year in 2020, corresponding to 13.9% of CO_2 emissions from calcination during cement production. Annual CO_2 uptake by in-use concrete accounted for 86.8% of the total in 2020, whereas that by end-of-life concrete was relatively small throughout the estimation period. CO_2 uptake is expected to increase slightly in the late 2020s, then decrease to 2.3 to 2.4 million tonnes/year by 2070.

4.0 CO_2 Uptake Calculation & Methodology for India

For assessing the carbon uptake by concrete in India, the tier 1 model of IVL is used in this study.

Tier 1 is a simplified calculation method for estimating the annual uptake of CO_2 in existing concrete structures on a national basis. However, the uncertainty is relatively high for Tier 1 as this is a simplified calculation method based on the cement production data. The Tier 1 model is used primarily as a first estimate.

The national annual CO_2 uptake in concrete; in the use stage (existing structures), in end-of-life stage (demolition, crushing, stockpiling), and in secondary use, can be estimated according to this simplified method. The uptake values are related to the reported calcination emissions from the consumed clinker (produced – export + import) in India.

The annual uptake in the use stage can be estimated as 20% of the calcination emission (process emissions) during clinker manufacturing as per IVL Tier I methodology. If the mortar for rendering applications, in total, amount to more than 10% but less than 30% of the cement consumption, the annual uptake factor in the use stage can be estimated at 0.20 + 0.0115(MR – 10), where MR is the mortar percentage for rendering of the clinker use. If MR is below 10% use MR=10 and if MR is above 30% use MR=30.

In this study, the CO_2 uptake is calculated for the use stage using Tier 1 only. Further, the estimates are intentionally kept conservative. The end-of-life stage and secondary use are not included in the scope of the study.

In future, a detailed study will be carried out for development of the India-specific Tier 2 model.

5.0 Data for preparation of inventory of Carbon Uptake

The steps followed for calculation of CO_2 uptake potential in India are as follows:

1. Collection of cement production data from 1996 onwards
2. Collection of cement mix (% of various types of cements produced in India)
3. Estimation of clinker content in various types of cement produced in India from 1996 onwards
4. Collection of cement import data
5. Collection of cement export data
6. Estimation of clinker content in cements imported and exported from India
7. Calculation of net clinker content (clinker produced + clinker imported – clinker exported)
8. Calculation of CO_2 uptake potential based on clinker content and mortar %.

Based on the steps above the input data required for calculation of CO_2 uptake potential are discussed in this chapter.

5.1 Cement production data

The data of cement production is available from 1996 onwards as shown in Annexure I. The data of cement production is taken from various sources like planning commission reports, CMA data book, NCB compendium and DPIIT.

5.2 Cement mix of India

The cement mix data of production % of various types of cements is available for intermittent years only. This data is based on the published reports for intermittent years. Therefore, the production % data of all the years from 1996 to 2024 is calculated individual by interpolating the data.

5.3 Cement production Data

The production data of various cement types from the year 1996 onwards as shown in **Annexure III**, is calculated by multiplying the total cement production as shown in **Annexure I** with the production % of various types of cements as shown in **Annexure II**. Earlier, only OPC, PPC and PSC were produced in India. After 2018-19, production of composite cement in India picked up.

5.4 Clinker factor for different types of cement

The clinker factor for various types of cement produced in India as highlighted in Table 5.1 is calculated based on BIS standards and market scenario. The values of clinker factor for various cements are based on data from literature, industry average and BIS standards.

Table 5.1 Clinker for different types of cement

Type of Cement	Year of Application	Max. SCM%/PI% allowed	Avg. Clinker Substitution achieved	Clinker Factor
OPC	Before 2015	-	5%	**95%**
	After 2015	5%	10%	**90%**
PPC	Before 2015	25%	26%	**74%**
	After 2015	35%	30%	**70%**
	After 2020	35%	36%	**64%**
PSC	Before 2015	65%	57%	**43%**
	After 2015	70%	62%	**38%**
Composite Cement	After 2015	50%	55%	**45%**
Other Cements (White Cement, SRPC, OWC etc.)	-	-	-	**95%**

5.5 Clinker production data

The annual clinker production in India is estimated by multiplying the clinker factor shown in Table 5.1 with the annual production data of respective types of cement given in Annexure III. The cumulative absolute clinker production in India is shown in **Annexure IV**. The data of cement and clinker imported in India and exported from India is collected from Import – Export Portal of Ministry of Commerce, Govt. of India. The cement & clinker import data from the year 1996 onwards is shown at **Annexure V** and the data on cement & clinker export from the year 1996 onwards is shown at **Annexure VI**.

The net clinker production in India from the year 1996 onwards as shown in **Annexure VII**, is calculated by adding the absolute cumulative clinker production data as shown in **Annexure IV** and cement import data as shown in **Annexure V** and subtracting the cement/ clinker export data as shown in **Annexure VI**.

5.6 Mortar percentage in India

The cement usage for mortar applications in India is about 15% of the total cement production (GCCA India & RMCMA).

6.0 Conclusion

Using the IVL Tier 1 methodology discussed in chapter 4.0 and based on the data highlighted in the previous chapter 5.0, the CO_2 uptake potential by concrete in India is calculated for the year 1996–97 onwards till 2024–25 for the use stage considering 15% of cement usage for mortar applications. The end of life (demolition) stage is not included in this study.

The cement production in India from the year 1996 onwards and the corresponding CO_2 uptake by concrete in India is shown in Figure 6.1. The growth of calcination related CO_2 emissions vs CO_2 uptake by concrete in India is highlighted in Figure 6.2.
The detailed data is given at **Annexure VIII**.

Tier 1 CO_2 uptake factor, use stage fraction = 0.20 + 0.0115(MR – 10), where MR=15

Tier 1 CO_2 uptake = 0.20+0.0115*(15–10))* calcination related CO_2 emissions from clinker production

Summary of the findings
1. Between 1996 and 2024, the average carbon uptake is 22.45 million tonnes of CO_2.
2. The carbon uptake in the year 2024–25 is 40.68 million tonnes of CO_2 for 321.37 tonnes of Clinker (167.11 Million tonne of CO_2)

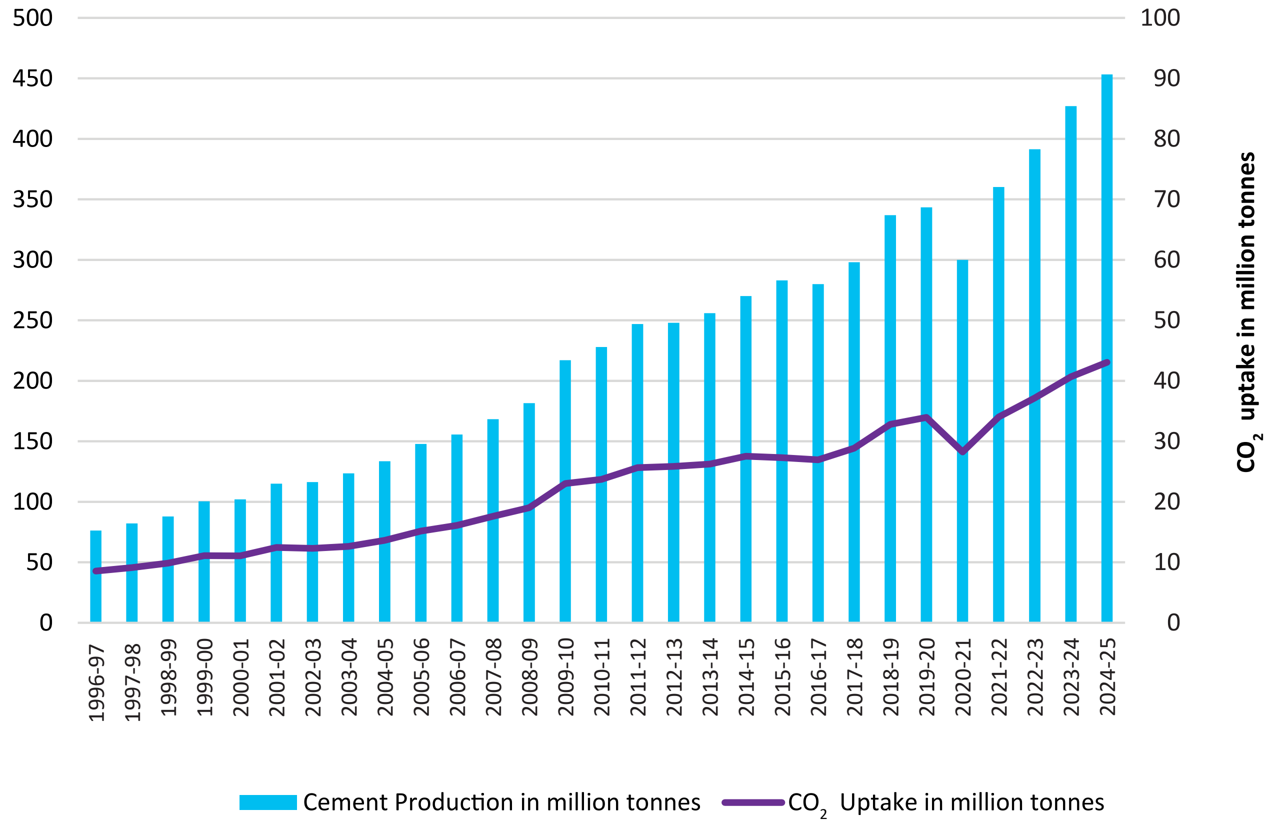

Fig 6.1: Cement production vs CO_2 uptake in India

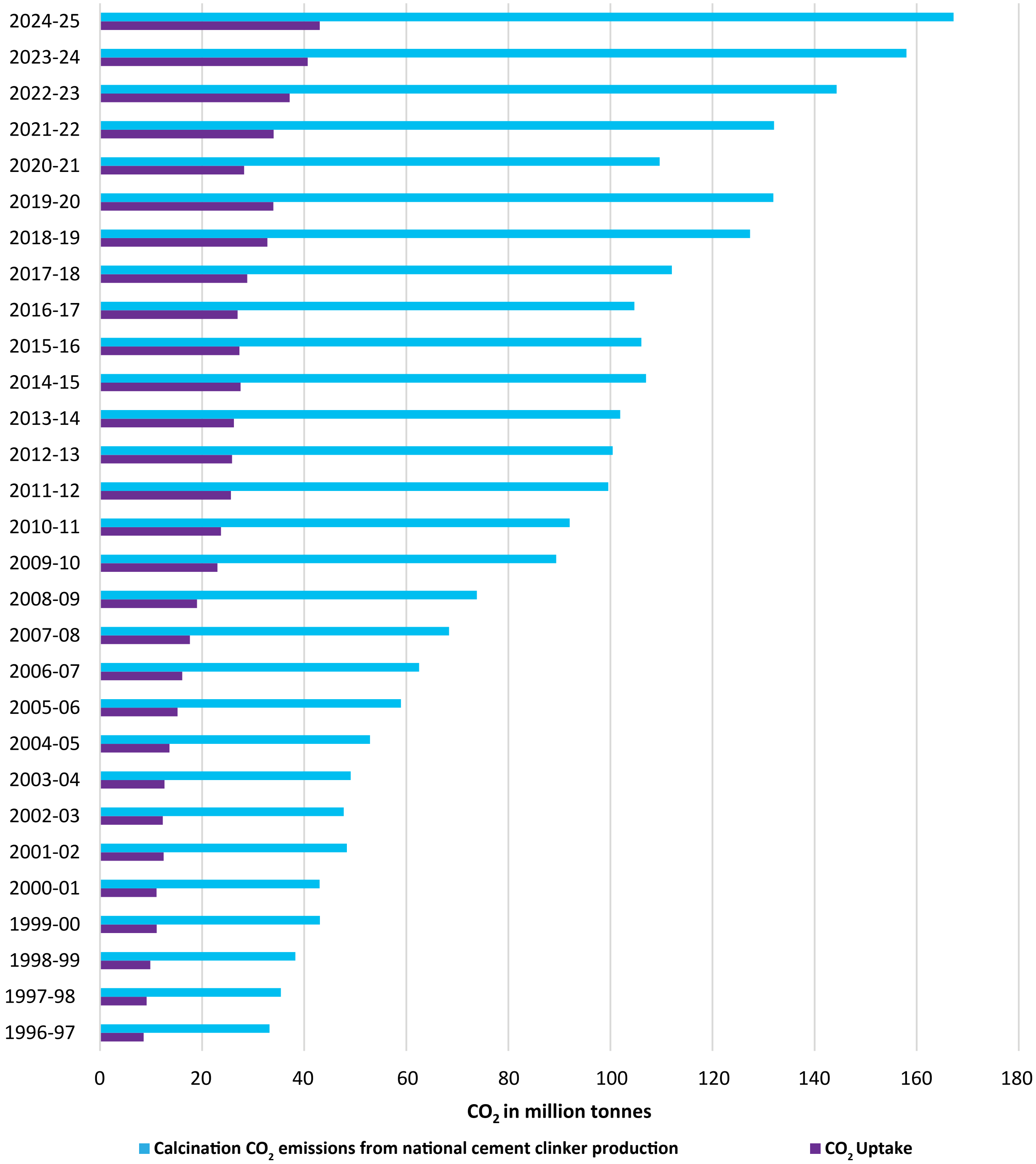

Fig 6.2: Calcination related CO_2 emissions vs CO_2 uptake in India

7.0 Way Forward

The report of carbon uptake by concrete in India using tier 1 of IVL methodology will be submitted to MoEF&CC to include the data in India's BUR submitted to UNFCCC. In the second phase, the detailed calculation of CO_2 uptake based on Tier 2 IVL methodology, a more advanced calculation method will be undertaken by NCB under the aegis of GCCA India covering following elements:

- Identification of appropriate annual activity data (AD) to input into the model for primary, end-of-life and secondary use of concrete
    - Annual Construction Output (Building types, infrastructure etc.)
    - Annual Cement Production
    - Annual Mortar Production
    - C&D waste recovered
- Identification of an appropriate choice of primary use concrete applications to satisfy the IVL Tier 2 model criteria
- Emission Factor (EF) calculated for each of the identified primary applications for concrete use
- EF calculated for concrete in the end-of-life and secondary life stages
- The cement production in India from the year 1996 onwards and the corresponding CO_2 uptake by concrete in India is shown in Figure 6.1. The growth of calcination related CO_2 emissions vs CO_2 uptake by concrete in India is highlighted in Figure 6.2. The detailed data is given at Annexure VIII.

$$CO_2\text{-uptake} = \left(\sum (k_i \times DOC_i \times A_i)\right)\left(\sqrt{t}/1000\right) \times U_{tcc} \times C$$

Units: kg CO_2 mm/√year m² √year kg CO_2/kg clinker kg clinker/m³ concrete

where,

i. ki is a constant factor for the rate of carbon uptake for surface i in mm/√(t)

ii. DOCi is the degree of carbon uptake for surface/volume i

iii. Ai is the area of carbon uptake surface i in m^2

iv. t is the number of years from start of carbon uptake

v. Utcc is the maximum theoretical uptake in kg CO_2/kg clinker. A default value for clinker can be 0.538

vi. C is clinker content in kg clinker/m^3 of concrete

The results from the Tier 2 CO_2 uptake study will also be presented to MoEF&CC and a methodology will be developed to report it on an annual basis for inclusion in the national Green House Gas Inventory of India.

- Report the carbon uptake potential (Tier-1) in India and reporting the carbon sinks to UNFCCC through MoEF&CC
- Development of methodology to measure the carbon uptake on an annual basis, submit the report to MoEF&CC for consideration of carbon uptake in reporting Inventory of Green House Gases (GHGs) in the form of periodic National Communications (NATCOM) to UNFCCC

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Annexures

Annexure I: Annual cement production in India

Fig No.	Year	Cement Production (in million tonnes)	Source
1	1996–97	76.2	
2	1997–98	82.1	
3	1998–99	88.0	
4	1999–00	100.0	
5	2000–01	102.0	Tenth Five-year plan 2002–07 Volume II, Planning Commission, Government of India, New Delhi
6	2001–02	115	Estimated
7	2002–03	116.35	
8	2003–04	123.5	
9	2004–05	133.6	
10	2005–06	147.8	Eleventh Five-year plan 2007–12 Volume III, Planning Commission, Government of India, New Delhi
11	2006–07	155.6	
12	2007–08	168.3	
13	2008–09	181.6	12^{th} Five-year plan 2012–17 working group report, DPIIT, Government of India
14	2009–10	217	
15	2010–11	228	
16	2011–12	247	
17	2012–13	248	
18	2013–14	256	
19	2014–15	270	
20	2015–16	283	
21	2016–17	280	
22	2017–18	298	
23	2018–19	337	NCB Compendium
24	2019–20	343.4	
25	2020–21	299.9	
26	2021–22	360.2	
27	2022–23	391.4	
28	2023–24	427	
29	2024–25	453.3	DPIIT

Annexure II: Cement mix of India

S.No.	Year	%OPC	%PPC	%PSC	% Composite Cement	% Others
1	1996–97	**70.00**	**19.00**	**11.00**	**0.0**	**0.0**
2	1997–98	68.25	20.75	10.75	0.00	0.25
3	1998–99	66.50	22.50	10.50	0.00	0.50
4	1999–00	64.75	24.25	10.25	0.00	0.75
5	2000–01	**63.00**	**26.00**	**10.00**	**0.00**	**1.00**
6	2001–02	58.80	30.80	9.60	0.00	0.80
7	2002–03	54.60	35.60	9.20	0.00	0.60
8	2003–04	50.40	40.40	8.80	0.00	0.40
9	2004–05	46.20	45.20	8.40	0.00	0.20
10	2005–06	**42.00**	**50.00**	**8.00**	**0.00**	**0.00**
11	2006–07	39.80	52.20	7.80	0.00	0.20
12	2007–08	37.60	54.40	7.60	0.00	0.40
13	2008–09	35.40	56.60	7.40	0.00	0.60
14	2009–10	33.20	58.80	7.20	0.00	0.80
15	2010–11	**31.00**	**61.00**	**7.00**	**0.00**	**1.00**
16	2011–12	30.43	61.57	7.00	0.00	1.00
17	2012–13	29.86	62.14	7.00	0.00	1.00
18	2013–14	29.29	62.71	7.00	0.00	1.00
19	2014–15	28.71	63.29	7.00	0.00	1.00
20	2015–16	28.14	63.86	7.00	0.00	1.00
21	2016–17	27.57	64.43	7.00	0.00	1.00
22	2017–18	**27.00**	**65.00**	**7.00**	**0.00**	**1.00**
23	2018–19	27.57	64.29	6.29	0.86	1.00
24	2019–20	28.14	63.57	5.57	1.71	1.00
25	2020–21	28.71	62.86	4.86	2.57	1.00
26	2021–22	29.29	62.14	4.14	3.43	1.00
27	2022–23	29.86	61.43	3.43	4.29	1.00
28	2023–24	30.43	60.71	2.71	5.14	1.00
29	2024–25	**31.00**	**60.00**	**2.00**	**6.00**	**1.00**

Annexure III: Production of various types of cement in India

Year	Total Cement Production (Mt)	OPC (Mt)	%PPC (Mt)	%PSC (Mt)	% Composite Cement (Mt)	% Others (Mt)
1996–97	76.2	53.3	14.5	8.4	0.0	0.0
1997–98	82.1	56.0	17.0	8.8	0.0	0.2
1998–99	88	58.5	19.8	9.2	0.0	0.4
1999–00	100	65.0	24.4	10.3	0.0	0.8
2000–01	102	64.3	26.5	10.2	0.0	1.0
2001–02	115	67.6	35.4	11.0	0.0	0.9
2002–03	116.35	63.5	41.4	10.7	0.0	0.7
2003–04	123.5	62.2	49.9	10.9	0.0	0.5
2004–05	133.6	61.7	60.4	11.2	0.0	0.3
2005–06	147.8	62.1	73.9	11.8	0.0	0.0
2006–07	155.6	61.9	81.2	12.1	0.0	0.3
2007–08	168.3	63.3	91.6	12.8	0.0	0.7
2008–09	181.6	64.3	102.8	13.4	0.0	1.1
2009–10	217	72.0	127.6	15.6	0.0	1.7
2010–11	228	70.7	139.1	16.0	0.0	2.3
2011–12	247	75.2	152.1	17.3	0.0	2.5
2012–13	248	74.0	154.1	17.4	0.0	2.5
2013–14	256	75.0	160.5	17.9	0.0	2.6
2014–15	270	77.5	170.9	18.9	0.0	2.7
2015–16	283	79.6	180.7	19.8	0.0	2.8
2016–17	280	77.2	180.4	19.6	0.0	2.8
2017–18	298	80.5	193.7	20.9	0.0	3.0
2018–19	337	92.9	216.6	21.2	2.9	3.4
2019–20	343.4	96.6	218.3	19.1	5.9	3.4
2020–21	299.9	86.1	188.5	14.6	7.7	3.0
2021–22	360.2	105.5	223.8	14.9	12.3	3.6
2022–23	391.4	116.9	240.4	13.4	16.8	3.9
2023–24	427	129.9	259.3	11.6	22.0	4.3
2024–25	453.3	140.5	272.0	9.1	27.2	4.5
2020–21	299.9	86.1	188.5	14.6	7.7	3.0
2021–22	360.2	105.5	223.8	14.9	12.3	3.6
2022–23	391.4	116.9	240.4	13.4	16.8	3.9
2023–24	427	129.9	259.3	11.6	22.0	4.3
2024–25	453.3	140.5	272.0	9.1	27.2	4.5

Annexure IV: Clinker production based on different types of cements

Year	OPC (Mt)	PPC (Mt)	PSC (Mt)	Composite Cement (Mt)	Others (Mt)	Absolute Clinker Production (Mt)
1996–97	50.7	10.7	3.6	0.0	0.0	**65.0**
1997–98	53.2	12.6	3.8	0.0	0.2	**69.8**
1998–99	55.5	14.6	4.0	0.0	0.4	**74.6**
1999–00	61.8	18.0	4.4	0.0	0.7	**85.0**
2000–01	61.0	19.6	4.4	0.0	1.0	**86.0**
2001–02	64.2	26.2	4.7	0.0	0.9	**96.1**
2002–03	60.4	30.7	4.6	0.0	0.7	**96.3**
2003–04	59.1	36.9	4.7	0.0	0.5	**101.2**
2004–05	58.6	44.7	4.8	0.0	0.3	**108.4**
2005–06	59.0	54.7	5.1	0.0	0.0	**118.7**
2006–07	58.8	60.1	5.2	0.0	0.3	**124.5**
2007–08	60.1	67.8	5.5	0.0	0.6	**134.0**
2008–09	61.1	76.1	5.8	0.0	1.0	**143.9**
2009–10	68.4	94.4	6.7	0.0	1.6	**171.2**
2010–11	67.1	102.9	6.9	0.0	2.2	**179.1**
2011–12	71.4	112.5	7.4	0.0	2.3	**193.7**
2012–13	70.3	114.0	7.5	0.0	2.4	**194.2**
2013–14	71.2	118.8	7.7	0.0	2.4	**200.2**
2014–15	73.7	126.4	8.1	0.0	2.6	**210.8**
2015–16	71.7	126.5	7.5	0.0	2.7	**208.4**
2016–17	69.5	126.3	7.4	0.0	2.7	**205.9**
2017–18	72.4	135.6	7.9	0.0	2.8	**218.8**
2018–19	83.6	151.7	8.0	1.3	3.2	**247.8**
2019–20	87.0	152.8	7.3	2.6	3.3	**253.0**
2020–21	77.5	120.6	5.5	3.5	2.8	**210.0**
2021–22	94.9	143.3	5.7	5.6	3.4	**252.8**
2022–23	105.2	153.9	5.1	7.5	3.7	**275.4**
2023–24	116.9	165.9	4.4	9.9	4.1	**301.2**
2024–25	126.5	174.1	3.4	12.2	4.3	**320.5**

Annexure V: Cement import in India (in tonnes)

Year	Cement Clinker	White Cement	Ordinary Portland Cement	PPC	PSC	Colored Portland Cement
1996–97	48	2262	0	0	0	144
1997–98	154	3998	0	0	0	42
1998–99	137	5284	0	0	0	86
1999–00	25	9424	0	0	0	255
2000–01	967	11944	0	0	0	51
2001–02	58864	80	0	0	0	32
2002–03	2332	121	0	0	0	49
2003–04	2259	80	12462	0	0	0
2004–05	2402	1774	5873	1505	0	0
2005–06	4537	291	6692	2576	0	0
2006–07	182030	995	10354	11558	0	0
2007–08	174014	2678	381586	9723	0	0
2008–09	170602	6861	792429	12400	275	0
2009–10	1257105	19371	726409	54622	7625	0

Year	Cement Clinker	White Cement	Ordinary Portland Cement	PPC	PSC	Colored Portland Cement
2010–11	184033	7911	780180	43868	13680	0
2011–12	145896	9612	746029	62975	22198	0
2012–13	556867	16193	552733	114451	23980	0
2013–14	80164	16598	542311	91103	23359	0
2014–15	48551	13187	865082	133702	14453	0
2015–16	235592	12597	950287	113172	26535	0
2016–17	324813	11413	1552088	90722	23651	0
2017–18	849321	72149	1390672	169677	31000	0
2018–19	776413	62643	1195645	151082	9856	0
2019–20	1462999	148099	372431	151232	11235	0
2020–21	1491411	174242	393659	191877	10583	0
2021–22	1211789	187662	345549	238596	8916	0
2022–23	1165980	212205	196614	212000	881	0
2023–24	1377010	273401	343908	352016	8	0
2024–25	578615	70674	125980	108903	30	0

Coloured OPC	Grey Portland Cement	Other Portland Cement	Aluminous Cement	Other Hydraulic Cement	High Alumina Refractory Cement	Other Hydraulic Cement NES
0	27	0	247	214	0	0
0	33	0	291	0	0	0
0	67	0	293	0	0	0
0	1	0	274	0	0	0
0	784	0	453	0	0	0
0	369	0	750	0	0	0
0	1938	0	833	0	0	0
2473	0	147	926	0	232	3529
0	0	338	695	0	1010	182
0	0	3681	1860	0	741	460
0	0	1544	3113	0	915	1261
0	0	45422	3063	0	1048	2234
115	0	39198	2858	0	575	519
512	0	33293	10465	0	1279	1318

Coloured OPC	Grey Portland Cement	Other Portland Cement	Aluminous Cement	Other Hydraulic Cement	High Alumina Refractory Cement	Other Hydraulic Cement NES
102	0	51678	5501	0	1035	7613
100	0	11057	5434	0	4583	3180
0	0	4102	4302	0	6739	2274
0	0	6022	4542	0	6277	7946
788	0	7991	6355	0	5038	4858
0	0	8231	4096	0	6409	1942
420	0	22429	4022	0	7080	938
0	0	90828	4079	0	9342	982
0	0	52353	4500	0	8790	309
66	0	46060	6706	0	7005	8646
0	0	36842	4500	0	4501	42829
0	0	10250	4437	0	5343	15640
1495	0	700	1545	0	5573	1284
949	0	668	1726	0	4679	22
0	0	268	569	0	1310	1

Annexure VI: Cement export from India (in tonnes)

Year	Cement Clinker	White Cement	Ordinary Portland Cement	PPC	PSC	Colored Portland Cement
1996–97	394451	113641	0	0	0	17718
1997–98	533851	42439	0	0	0	740
1998–99	396620	34426	0	0	0	1186
1999–00	1343193	15051	0	0	0	3856
2000–01	1592067	96293	0	0	0	74211
2001–02	1318029	191543	0	0	0	177973
2002–03	1942275	222560	0	0	0	2624
2003–04	4124505	186353	2332440	2262	11015	0
2004–05	3893853	246957	1999325	6727	15860	0
2005–06	1510956	165709	3581351	64466	3774	0
2006–07	628144	143013	3960772	38182	85	0
2007–08	427632	147527	2797357	22855	906	0
2008–09	817861	71371	2254218	66564	3281	0
2009–10	1012735	83241	1478108	55340	9784	0
2010–11	1088821	148189	2153706	33162	1160	0
2011–12	1267167	81470	1957071	22378	4483	0

Year	Cement Clinker	White Cement	Ordinary Portland Cement	PPC	PSC	Colored Portland Cement
2012–13	783254	87805	1889826	32242	3600	0
2013–14	2425903	80732	1987115	173784	1931	0
2014–15	3973986	71245	1553248	169659	1579	0
2015–16	2849120	34350	2276302	639133	1	0
2016–17	3988562	33179	2563121	166407	20	0
2017–18	4092125	23639	2276162	156459	52	0
2018–19	3570550	29181	2014673	141639	0	0
2019–20	800077	18166	1892278	107946	780	0
2020–21	1094051	18385	1528081	144764	3130	0
2021–22	734860	18284	995557	18727	3987	0
2022–23	4019	14594	455037	15842	1463	0
2023–24	12189	9353	463436	15501	0	0
2024–25	10050	4610	137777	2130	44	0

Coloured OPC	Grey Portland Cement	Other Portland Cement	Aluminous Cement	Other Hydraulic Cement	Pozzolona Cement	High Alumina Refractory Cement	Other Hydraulic Cement NES
0	621215	0	117	6371	0	0	0
0	1196572	0	0	0	5227	0	0
0	562647	0	0	0	15874	0	0
0	816334	0	90	0	0	0	0
0	1654101	0	51	0	2	0	0
0	1565446	0	10	0	950	0	0
0	2436154	0	7	0	1612	0	0
109039	0	175294	5	0	0	2	361
286820	0	409788	547	0	0	27	4568
1676	0	302268	31	0	0	373	7321
2953	0	41884	0	0	0	185	738
1469	0	13662	0	0	0	61	1759
1434	0	42738	60	0	0	872	1742
17173	0	28838	296	0	0	40	3693
3041	0	51759	513	0	0	1969	12528
6123	0	56253	2198	0	0	346	1037

Coloured OPC	Grey Portland Cement	Other Portland Cement	Aluminous Cement	Other Hydraulic Cement	Pozzolona Cement	High Alumina Refractory Cement	Other Hydraulic Cement NES
75099	0	41038	2224	0	0	399	3611
395007	0	72467	1740	0	0	372	1626
427905	0	87094	1632	0	0	635	598
212620	0	208383	1436	0	0	311	701
55403	0	42065	1429	0	0	220	398
69372	0	37970	1702	0	0	548	1052
26826	0	38758	840	0	0	468	1367
0	0	18452	474	0	0	733	1378
587	0	8468	510	0	0	3171	5731
0	0	3704	502	0	0	1538	123916
55	0	21479	1924	0	0	1101	155022
400	0	9309	4491	0	0	642	302228
31	0	6976	2041	0	0	194	146372

Annexure VII: Net clinker production in India

Year	Cumulative Absolute Clinker Production (Mt)	Cumulative Clinker Imported (Mt)	Cumulative Clinker Exported (Mt)	Net Clinker Qty (Production+ Imported- Exported) Mt
1996–97	65.0	0.003	1.1	63.9
1997–98	69.8	0.004	1.7	68.1
1998–99	74.6	0.009	1.0	73.6
1999–00	85.0	0.010	2.1	82.8
2000–01	86.0	0.014	3.3	82.7
2001–02	96.1	0.116	3.2	93.0
2002–03	96.3	0.007	4.5	91.8
2003–04	101.2	0.023	6.8	94.4
2004–05	108.4	0.015	6.7	101.7
2005–06	118.7	0.024	5.4	113.4
2006–07	124.5	0.381	4.6	120.2
2007–08	134.0	0.761	3.3	131.5
2008–09	143.9	1.142	3.1	142.0
2009–10	171.2	3.248	2.6	171.9
2010–11	179.1	1.209	3.4	176.9
2011–12	193.7	1.082	3.3	191.5
2012–13	194.2	1.738	2.8	193.1
2013–14	200.2	0.788	5.0	196.0
2014–15	210.8	1.058	6.1	205.7
2015–16	208.4	1.422	5.9	204.0
2016–17	205.9	2.128	6.7	201.3
2017–18	218.8	3.156	6.5	215.4
2018–19	247.8	2.777	5.7	244.9
2019–20	253.0	3.420	2.7	253.7
2020–21	210.0	3.551	2.7	210.9
2021–22	252.8	2.970	1.8	254.0
2022–23	275.4	2.729	0.6	277.5
2023–24	301.2	3.404	0.8	303.8
2024–25	320.5	1.348	0.3	321.6

Annexure VIII: CO_2 uptake factor for India

Year	Net Clinker Qty (Production +Imported-Exported)	Calcination CO_2 emissions (Mt)	Tier 1 CO_2 uptake factor, use stage, fraction (Mt)	Tier 1 CO_2 uptake factor, use stage, fraction (k. Tonne)
1996–97	63.9	33.2	8.553	8553.300
1997–98	68.1	35.4	9.121	9120.903
1998–99	73.6	38.3	9.854	9854.256
1999–00	82.8	43.1	11.091	11091.050
2000–01	82.7	43.0	11.076	11075.641
2001–02	93.0	48.4	12.457	12456.722
2002–03	91.8	47.7	12.293	12292.509
2003–04	94.4	49.1	12.644	12643.510
2004–05	101.7	52.9	13.619	13619.264
2005–06	113.4	58.9	15.178	15177.942
2006–07	120.2	62.5	16.100	16099.574
2007–08	131.5	68.4	17.609	17609.213
2008–09	142.0	73.8	19.010	19009.752
2009–10	171.9	89.4	23.016	23016.329
2010–11	176.9	92.0	23.692	23691.848
2011–12	191.5	99.6	25.644	25644.489
2012–13	193.1	100.4	25.862	25862.028
2013–14	196.0	101.9	26.244	26243.624
2014–15	205.7	107.0	27.546	27545.680
2015–16	204.0	106.1	27.311	27310.743
2016–17	201.3	104.7	26.959	26959.439
2017–18	215.4	112.0	28.847	28846.761
2018–19	244.9	127.4	32.797	32796.633
2019–20	253.7	131.9	33.969	33968.896
2020–21	210.9	109.7	28.237	28236.789
2021–22	254.0	132.1	34.008	34008.023
2022–23	277.5	144.3	37.159	37159.176
2023–24	303.8	158.0	40.683	40683.059
2024–25	321.6	167.2	43.060	43059.816
Total	**4881.5**	**2538.4**	**653.637**	**653636.969**

GCCA INDIA MEMBER COMPANIES

ACC
Ambuja Cement
Aditya Birla UltraTech
Dalmia cement
HeidelbergCement India
India Cements
The India Cements Limited (A subsidiary of UltraTech Cement Limited)
JSW Cement Start Strong. Grow Stronger. World's #1 eco-friendly cement company
JKcement
JK Lakshmi Cement Ltd.
Kamal Cement
MP Birla Group
Maha Cement Build it strong
Nuvoco Shaping a new world
The Ramco Cements Limited RAMCO
Sagar Cement

BlackCoffeeCreatives/GCCA/2512

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