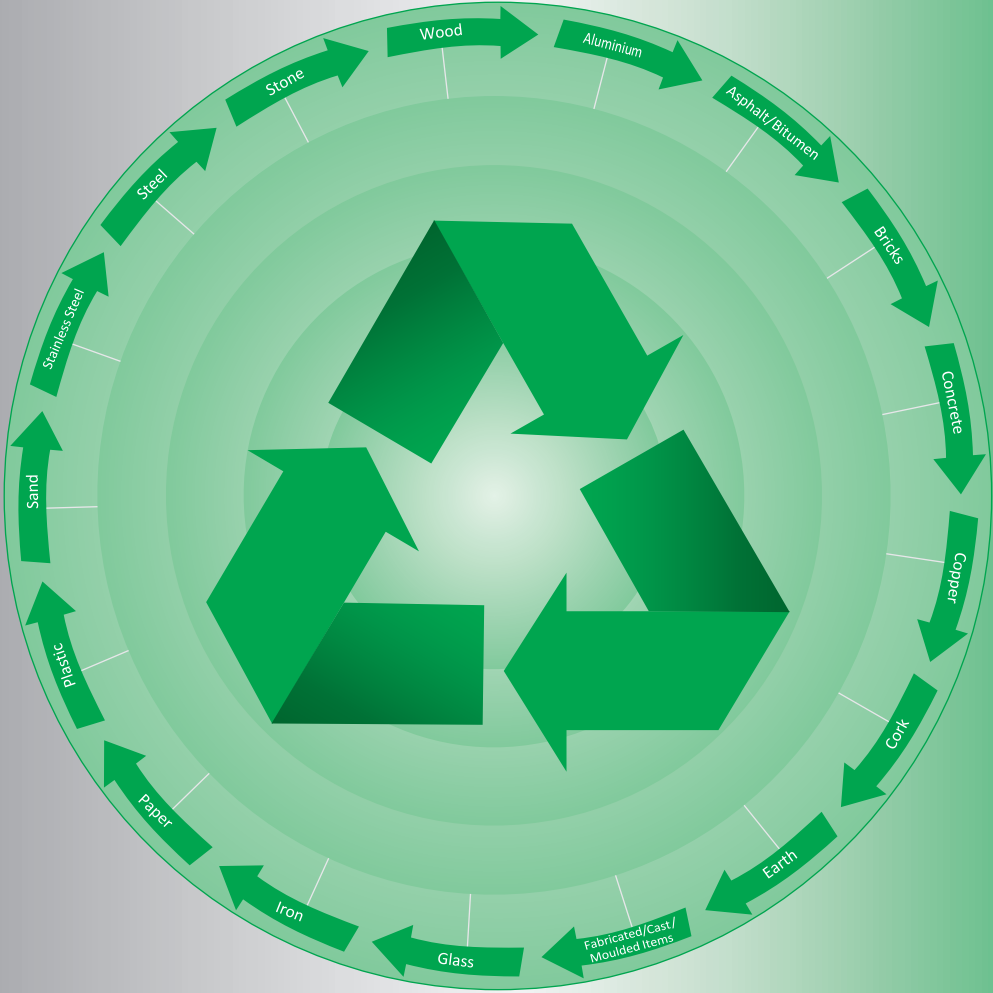


# VIEWPOINT

OFFICIAL QUARTERLY MAGAZINE OF CEAI

www.ceai.org.in

## Recycling & Reuse of Building Materials in the Construction Industry





*Take Off*  
*with*  
**INDIA**

# *Join CEAI*

*The Apex Body of Consulting Engineers*

*Over 60 YEARS*

*Of Service to the Profession*

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## **CEAI**

- *promotes the interest and works to enhance the status of the Consulting Engineering profession in India*
- *advocates global networking and co-operation*
- *helps to keep in touch with the latest professional updates – technical, regulatory, legal, financial, health & safety, environmental, etc.*
- *provides excellent opportunity to present papers in seminars and technical lectures organised from time to time*
- *aids in skill development through regular training programmes including training on FIDIC Conditions of Contract and sharing of the legal issues based on the Indian context*
- *takes-up various issues confronting the profession with government and other authorities from time to time with the objective of making the conditions of engagement on a fair and equitable basis so that Consulting Engineers can function in the best interest of the country*
- *promotes the cause of Women Engineers with a view to ensure rightful places for them in the engineering consultancy arena*
- *helps to develop Young Engineers to be the Future Leaders*

**JOIN Now & Grow**

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**Dear Members,  
Readers & Engineers**

**Wishing You  
A Bright, Prosperous  
&  
Happy New Year**

**May The New Year See You  
Soaring & Conquering New Frontiers**

**Preserving & Enriching  
The Earth  
&  
The Solar System**

**For Posterity  
Interacting Ethically –  
Be it Social or Professional  
With Integrity  
As the Criterion of Ones Conduct**

**Consulting Engineers Association of India**





# Message from President

Dear Colleagues, Friends and Members,

*Wishing All  
A Very Bright, Happy & Prosperous Year AHEAD*

2024 has gone by in a flash, full of activities and events organised by CEAI as it continued to propound Sustainable Development and activities for the betterment of the Nation.

CEAI has also been exhorting All Members to adopt and abide by CEAI's Code of Ethics to Plan and Make a Better Tomorrow.

It has been a rewarding year with training programmes, seminars, workshops, technical talks, webinars, etc. and increased activities by the Young Professionals.

CEAI Academy has been formed and have started functioning and holding training courses.

The meetings with officials and authorities have also been fruitful and positive.

Together with the Services Export Promotion Council (SEPC), set up by the Ministry of Commerce and Industry, Government of India, CEAI has improved the image of the professional consulting engineers abroad.

CEAI has partnered with WWF-India and ASCI.

The consulting engineering profession is digitalising at a good pace in which the young engineers are contributing with alacrity.

CEAI Foundation has done creditable work to help the masses.

CEAI once again beckons all professional engineers to be a Member of the association and be a part of the country's journey of development.

Let us all strive to make Indian consulting engineering a profession to look upto and be respected.

The term of the current Governing Council has drawn to a close and the next Governing Council will take up the baton. We thank all those who have helped and been a part of the endeavours to raise the level of the profession.

**Rama Shanker Sharma**



# Message from Chief Editor

*Dear Fellow Consulting Engineers & Readers,*

*Wishing Each and Every One A Bright, Happy & Prosperous New Year*

2024 has been a kaleidoscopic year with the general elections and the resulting environment that they entail. All the same, for the professional engineers the contractual performance still remains paramount. The goals need to be met and they inter alia include those of Sustainability and Net Zero objectives. The Budget 2024-2025 introduced the strategy for that but thereon it is up to the project owners/ developers and all concerned professionals to plan and execute so that the goals are met.

It is based on that aspect that the theme of this issue of ViewPoint is **“Recycling & Reuse of Building Materials in the Construction Industry”**. It is upto the consulting engineers to make that happen, especially in the transport and building sectors where recycling and reuse can be implemented on a good scale.

The ViewPoint issue of December 2022 was on **“Circular Economy towards Sustainability”** in which the moto proposed was *Use and Reuse with Design for Long Service Life what is Fit for Its Purpose with Due Regard to Personnel Safety*. That calls for judicious and purposeful usage to minimize if not eliminate wastage, recycle the material and also help nature to regenerate what is in nature’s sphere of regeneration. The current issue emphasizes those principles and dwells further into the practical application of those principles.

Development of infrastructure, habitats, work places and industries are all essential to making our Mother Earth a better place for human comfort. However, let’s pause to consider the implications of all that on the flora and fauna which are also equally, neigh more essential, for survival of humankind. As has been stressed in the past issues, **Air-Water-Food** are the three **Necessities** for all forms of life on Mother Earth to continue to be on it. Every form of life feeds on another life form, hence when that is the case, the concerns need to be for meeting the requirements of Air-Water-Food in a manner that does not lead to abnormal depletion and extinction of any life form which Nature in its infinite wisdom has created and sustained.

Moving on to the practicality of human living – the requirements of living can be fulfilled if the elements of over indulgence, opulence and one upmanship are controlled. However, that takes the engineers into a different realm, all the same the engineers can and should ensure optimum utilization of materials, raw or manufactured; their

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transformation into other combined materials and then their use for the purpose intended. The maintenance and reuse at the end of life should also be planned and executed.

It is imperative to plan each project in its entirety for India to achieve its SDG Goals, for a project, once the purpose and design service are predefined, the choice of materials to be used can be accessed and so also the mode and manner of execution, thereafter its maintenance and then the end-of-life reusability of the facility per se or of the constituent building elements or the materials. With digitalization and the advent of AI which are being increasingly employed and deployed, the sequence as delineated above can be done and shared with all – from the top to the lowest level workers so that all are in the know. Once everyone is aware and aligned to the project goals, the results will follow for then everyone feels that they are a part of the team and the chain must not be broken at any place or at any time.

The technical team of the project, once appointed, and takes charge must have a clear and unfettered mandate to execute the project. For that it is also essential that just like a Surgeon is given full freedom to take decisions albeit with responsibility and accountability so also the technical personnel must be given full freedom coupled with their proportionate responsibility and accountability.

For the above to be put into practice it is essential that there be legislation for the profession of engineering – a need which the Government of India, even after 75 years of Independence, still has to fulfill. The legislation for the profession of engineering would also boost the export of consulting engineering services to developed as well as developing countries.

*For Nation's Development*  
*Achieving Targets of SDGs*  
**Engineers Need To Drive**

*Wishing Everyone*  
*A Very Happy, Bright & Prosperous*  
*Year AHEAD*

*Happy Reading & Learning*



**A P Mull**

# About CEAI

Consulting Engineers Association of India (CEAI) is the apex body of consulting engineers in India having membership of organisations as well as individuals. The membership represents large, medium and small consultancy companies/ organisations both in the private and public sector and eminent individual consultants. EPC organisations are also members of CEAI since they have planning and design engineers, apart from construction management consultants.

CEAI is the Member Association, of the International Federation of Consulting Engineers, commonly known as FIDIC, the acronym for Fédération Internationale Des Ingénieurs-Conseils, representing the Consulting Engineering Fraternity in India. FIDIC has membership of more than 100 Member Association of various countries and is headquartered in Geneva.

CEAI was incorporated in 1996, with the merger of two leading national associations Association of Consulting Engineers (India) {ACE(I)}, incorporated in 1960 and National Association of Consulting Engineers {NACE}, incorporated in 1976. Thus, CEAI has, behind it six decades of accumulated knowledge and experience.

- CEAI promotes the interest and works to enhance the status of the consulting engineering profession in India
- CEAI advocates global networking and co-operation
- CEAI's activities include:
  - Quality development of Consultants.
  - Productivity enhancement.
  - Promotion of ethical practices.
  - Facilitation and interaction with government and other authorities/ bodies to streamline and improve the system of engagement of consultants.
- Regional Centres in Jaipur, Bengaluru, Kolkata and Mumbai to broad base activities.

## *Aims & Objectives*

- Promote the professional interest and establish the rights and privileges of the status of consulting engineering profession in India
- Represent the consulting engineering profession within India and abroad. Connect the members locally and globally.
- Disseminate among the members information on all matters pertaining to engineering, especially knowledge and information related to consulting engineering profession by way of holding Conferences, Seminars, Courses, Workshops, Field/ Site Visits, etc. and thus assist in Continuing Education for the Professional Development of Members.
- Act as the principal champion for consulting engineering profession through constantly informing and educating the public and lawmakers about key engineering issues and making it possible to have the voice of the profession heard by the policy makers.
- Promote adoption of equitable forms of contracts and other documents used in consulting engineering practice.

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## *Vision*

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- To represent, promote and enhance the status of consulting engineers in India as an honoured and dignified profession for nation building and propagate Indian engineering consultancy globally.

## *Mission*

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- Promote interests of the consulting engineering profession nationally and internationally.
- Promote sustainable, safe and sound engineering practices.
- Upgrade engineering knowledge and skill.
- Propagate code of professional ethics, safety, health and environment.

## *Values*

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- Commitment with tenacity to high ethical values, integrity, professionalism and achieving technical excellence and inclusive development.

## *Code OF Ethics*

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- CEAI has adopted a Code of Ethics, to which all members must abide. It is not just for the quality of the jobs they work on, but for the safety and well-being of the public at large.
- CEAI is the profession's most respected voice on the practice of ethical engineering.
- The code specifies the responsibilities of Consulting Engineers towards the society as well as the profession, to refrain from performing services unless competent to do so, to act in the legitimate interest of client, to be impartial, to maintain ethical relations with other consultants.

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**THE GAZETTE OF INDIA**  
**EXTRAORDINARY**  
**PART II—Section 3 -Sub-section (i)**  
**NEW DELHI, TUESDAY, JULY 30, 2024/ SHRAVANA 8, 1946**  
**MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE**  
**NOTIFICATION**

New Delhi, the 29th July, 2024

G.S.R. 458(E).— Whereas by notification vide G.S.R. 445(E), dated 29th March, 2016, the Central Government through the Ministry of Environment, Forests and Climate Change, Government of India had notified the Construction and Demolition Waste Management Rules, 2016 to provide a regulatory framework for management of construction and demolition waste in the country;

And whereas, the rules were notified to undertake environmental sound management of construction and demolition waste covering its segregation, collection, recycling, treatment and disposal, and to discourage unscientific disposal, promote scientific waste management, prevent loss of embedded recyclable value, and address air and water pollution related issues emanating from dumping of waste;

And whereas, the Ministry of Environment, Forest and Climate Change has noted through the implementation review that the existing regulation needs comprehensive revision and strengthening by incorporating specific measures for waste management, waste utilization and non-compliance, along with alignment with circular economy and resource efficiency approaches by introducing extended producer responsibility, environmental compensation, centralised interface based online monitoring and compliance assessment;

NOW, THEREFORE, in exercise of the powers conferred by sections 6, 8, and 25 of the Environment (Protection) Act, 1986 (29 of 1986) read with sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986, the Central Government hereby invites suggestions or comments, within a notice period of sixty (60) days, from the general public at [mishra.vp@gov.in](mailto:mishra.vp@gov.in) and [amit.vashishtha@nic.in](mailto:amit.vashishtha@nic.in) on the following draft notification, which supersedes the Construction and Demolition Waste Management Rules, 2016, namely-

**CHAPTER-I**  
**PRELIMINARY**

**1. Short title and commencement.**

- (1) These rules shall be called the Construction and Demolition Waste Management Rules, 2024.
- (2) They shall come into force with effect from **01st April 2025**.

**2. Application. -**

- (1) These rules shall apply to all activities of construction, demolition, remodelling, renovation and repair of any structure.
- (2) These rules shall not apply to the waste categories or streams covered under the following:
  - a. Solid Waste Management Rules, 2016, as amended;
  - b. Plastic Waste Management Rules, 2016, as amended;
  - c. Hazardous and Other Waste Management Rules, 2016, as amended;
  - d. Atomic Energy Act, 1962 (33 of 1962) and rules made thereunder;
  - e. Defence projects, and other projects of strategic nature; and
  - f. Waste streams covered under other extended producer responsibility frameworks.

---

## Time lines for implementation of Construction and Demolition Waste Management Rules 2024 are as given in the Schedules

### Schedule I

[See Rule 4(3)]

Targets for recycling of waste as per  
Extended Producer Responsibility framework

Year	Re-construction Projects	Demolition Projects
2025-26	50%	50%
2026-27 onwards	100%	100%

### Schedule II

[See Rule 8(5)]

Minimum targets for utilisation of waste in construction and re-construction activities  
as per Waste Utilisation Framework for building construction

Year	Waste Utilization Mandate
2026-27	5%
2027-28	10%
2028-29	15%
2029-30	20%
2030-31 and onwards	25%

Note:

#### 1. Direct produce of construction and demolition waste are

- i. Fine aggregates,
- ii. Recycled Concrete Aggregates (size 5-10 mm, 10-20 mm, 20-40 mm or as required);
- iii. Recycled Aggregates (5-10 mm, 10-20 mm, 20-40 mm or as required), and
- iv. Manufactured soil;

#### 2. Downstream products manufactured by using recycled C&D waste are

- i. Bricks, blocks, tiles, hollow bricks, wall tiles;
- ii. Pavers, kerb stones;
- iii. Park benches, drain covers, planters, compound wall, fence post, tree guards, tree pit covers, manhole covers, underground cable covers, pre-cast boundary wall panels and poles, etc.

---

### Schedule III

[See Rule 8(5)]

#### Minimum targets utilization of waste in road construction

Year	Waste Utilization Mandate
2026-27	5%
2027-28	5%
2028-29	10%
2029-30	10%
2030-31 and onwards	15%

Note:

- As per IRC:121-2017, Recycled aggregates and Recycled concrete aggregates derived from construction and demolition waste, after processing, can be used in road construction applications like:
  - embankments, including earthen embankments (as fill material);
  - flexible pavements (as granular sub-base, cement stabilised base, sub-base course); concrete pavements (in dry lean concrete, roller compacted concrete, plain cement concrete, and
  - paving blocks and kerb stones; and
- The powdered C&D waste, produced as a result of crushing during production of aggregates, can be utilised as sub-base material after cement stabilization to meet technical requirements like gradation, strength, water absorption, soundness etc.

[F. No. HSM-12/152/2022-HSM]  
NARESH PAL GANGWAR, Addl. Secy.

# 01

# Building Material Recycle and Reuse – a Step towards Sustainability in Construction Industry



**Manos Kumar De**  
Discipline Head – Civil  
TATA Consulting Engineers Limited

## Introduction

The building and construction industry has a substantial carbon footprint in the stages starting from construction to operation (use), till end-of-life processing of building materials. A major part of carbon emission is from the inherent carbon in the construction materials, and waste generation during construction and demolition. That includes the energy used in the manufacture of building materials like cement, steel, and aluminium, and later during building occupancy and use. About 6% emission is related to production of construction materials – cement, steel, and aluminium and another 8% is direct emission from the building construction. Reports predict that CO<sub>2</sub> emissions in 2035 may rise by 42.7% over the 2007 levels. 40% of this increase is expected to come from the construction sector with construction materials accounting for 10% to 20% from production to demolition.

The emission contribution of embodied carbon which stood at 25% of the building total emission is predicted to increase to 49% in 2050. With a properly defined framework for assessing the carbon footprint in a building's lifecycle, a mitigation plan with an alternate design, material use, and construction technology can be planned to reduce the emissions. Intergovernmental Panel

on Climate Change (IPCC) and International Energy Agency (IEA) recommend pathways for improvement in emission with expected annual reduction of about 2%.

Studies on building materials show that there is scope for reduction of embodied carbon footprint of construction materials with zero or low-cost premium towards the building cost. Optimisation of concrete mix can lead to 14-33% reduction, use of recycled rebars can achieve 4-10% reduction, low-carbon insulation materials can contribute to 16% reduction and use of low-carbon glass and finishes can result in 3 and 5% carbon reduction, respectively.

## The Impact of Materials in Building Carbon footprint

Embodied carbon in a building is classified under Scope 3 emissions since the materials are produced by other

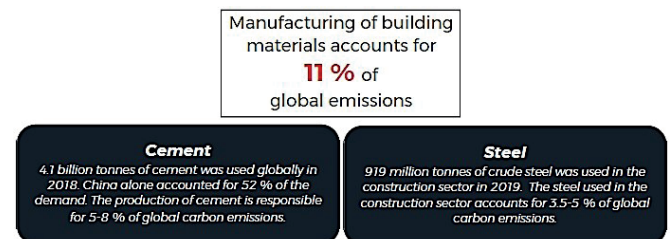


Figure 1: Carbon Emissions from Building Materials <sup>[1]</sup>

companies who report it under their Scope 1 or Scope 2 emissions. Data reported show that the manufacturing of building materials has a large, yet unaddressed share of carbon emissions as shown in Figure-1.<sup>[1]</sup>

The attention is now towards reducing upfront the carbon content and that is expected to result in more than 50 % reduction in carbon footprint of new construction from this decade till 2050 (global NZE target), the year identified as net zero target for the building sector (2070 for India). Population and urbanisation are both set to increase, creating positive demand for floor space and that makes it critical to reduce embodied carbon. The total number of human dwellers worldwide will reach 9.7 billion in 2050, and urban dwellers will comprise 68% of that population.

The percentage contribution to carbon footprint of various building materials is shown in Figure-2.<sup>[2]</sup>

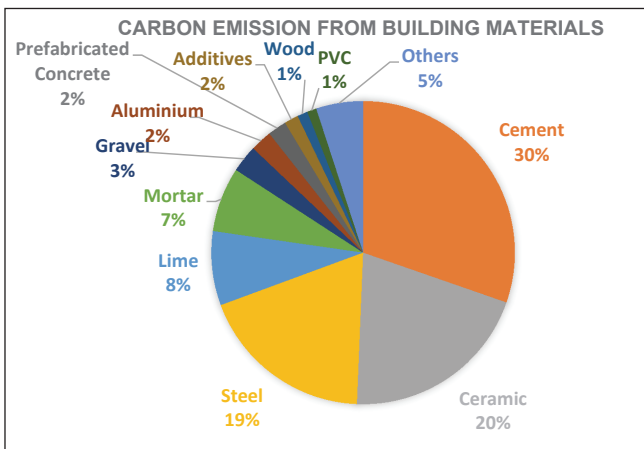


Figure-2: Carbon Emission from Building Materials <sup>[2]</sup>

## Role of Material Selection in Sustainable Design

### History of Construction materials

When human beings abandoned cave dwellings and started constructing shelters and later on buildings, the naturally available items like reeds (long grass), leaves, tree branches, bamboo, soil, stone, were the

first materials. Subsequently, to make the building more durable, the natural products were transformed through heating or chemical treatment, all of which consumed energy. Such processes include burning of clay to form bricks, extracting metals from ores, and use of lime and lime-based products inevitably leading to higher carbon emissions for product manufacturing. Additionally, use of non-local and exquisite materials from faraway sources increased the carbon footprint due to the transportation involved. The changing situation in use of building materials in terms of embodied energy/ carbon is presented in Table-1<sup>[3,1]</sup>

Table-1: Development of Building Materials and Energy Content<sup>[3]</sup>

Prior to 4000 BC	4000 BC – 1800 AD	1800 AD – to date
Soil, stones, reeds/ thatch, Sun dried bricks/ adobe, unprocessed timber	Burnt clay bricks, lime, cast iron products, lime-pozzolana cement	Aluminium, steel, glass, Portland cement, plastics, other smart materials, nanomaterials
Zero-energy materials	Medium-energy materials	High-energy materials

### Low Carbon Materials

The increasing awareness about sustainability and reducing carbon emissions and the urgent need to incorporate their requirements as a part of design and construction are forcing building engineers to look for technologies to maximise use of natural materials improvised through low energy conversion processes to improve durability and low carbon transport. Some alternative low-carbon materials and construction methodologies are presented in Table-2<sup>[3]</sup>.

Table-2: Alternative Low Carbon Materials and Construction Methodologies<sup>[3]</sup>

Low Carbon Materials	Construction Methodologies
Blended cements	Cements that contain high volume of complementary cementing materials (CCM), such as coal fly ash, granulated slag, calcined clay, silica fume and reactive rice-husk ash
Stabilised Mud Blocks (SMB)	SMB are solid compacted blocks of a mixture of soil, sand, stabiliser (cement/lime) and water, used after 28 days curing. Compressive strength of the block depends upon the soil composition, density of the block and percentage of stabiliser.
Compacted fly ash blocks	Made by compacting a mixture of lime, fly ash and stone dust at ambient temperature or accelerated by low temperature steam curing or using industrial waste of phosphor-gypsum.
Rammed earth walls	These are solid walls formed by compacting soil, sand and gravel in layers inside a form. Cement or lime may be added to stabilise.
Demolition and Industrial and mine solid wastes	Recycled materials like steel, stone, timber, broken bricks/ blocks, concrete, aggregates, mortar from demolished structures. Wastes like red-mud, coal ash, slag, fly ash, ore tailings (iron, copper, zinc).
Low carbon floor/ roof	Composite masonry jack-arch roof or floor system, RC filler slab, unreinforced masonry vaults

## Benefits of Construction Material Recycle-Reuse

There are two principal pathways for recycle-reuse of materials in building construction. Repurposing existing building and its components to extend the use or rebuild part of the structure with required strengthening provides opportunities for reducing cost and saving time and thus a considerable reduction of carbon footprint by avoiding new construction and disposal of demolition debris. Using recycled building materials in new construction and retrofit design is another method to achieve sustainability in construction by preventing use of new materials with associated costs and carbon footprint from mining to material processing and transport. Some of the benefits of such design and construction planning include:

- Reduction of cost of new materials
- Avoiding costs for demolition and end-of-life processing of materials
- Reducing carbon footprint of new material sourcing and processing

- Saving energy and associated emissions
- Preserving nature with less mining of resources
- Avoiding dumping and landfills of discarded construction materials
- Preserving natural habitats due to lowering of land use for environmentally harmful activities, and
- Reducing the impact on the environment.

## Data on Recycled Materials

### Using Waste Materials for Construction

Different types of waste materials can be gainfully used in the construction industry. They are commercial and industrial (C & I) waste, construction and demolition (C & D) waste, and Municipal Solid Waste (MSW). The possible uses of the various categories of waste materials in the construction industry are listed in Table-3<sup>[4]</sup>.

Table-3: Types of Waste Materials Used in Construction<sup>[4]</sup>

Material Type	Use
MSW	Paper mill sludge used in burnt brick making for high strength and durability
	Soft clay soil with seashells and eggshells used in road construction
	Palm bunch ashes recycled using nanotechnology as soil addition in lateritic soils
	Paper waste in developing lightweight components of higher strength and lower water retention for roofing and insulation
	Rice grain husk in earth mix for wall and ceiling cover
	Recycled paper mill sludge to improve tensile properties of asphalt mixtures made of granite and limestone aggregates
C & I	Foam-glass and polystyrene additives in building materials to improve mechanical properties
	60% recycled concrete aggregates in porous asphalt mix
	Recycled plastic waste in manufacture of non-traffic area paver blocks
	Fibres of polyethylene terephthalate rings to substitute synthetic fibres
	Textile waste for heat insulation by compression moulding
	Sisal fibres in clay bricks to enhance thermo-mechanical properties
	Plastic with bitumen to coat aggregates for road construction
C & D	Recovered filler to manufacture high performance concrete
	Recycled gypsum waste in brick manufacturing for better strength
	Metakaolin in concrete mix to produce geopolymer concrete
	Use as binding agents and aggregates with alkaline activation

Globally, around 2 billion tonnes of industrial wastes, more than 2 billion tonnes of municipal solid waste and 3.57 billion tonnes of construction and demolition waste are produced each year. Such a huge quantity of waste is a burden on the society since it requires large disposal areas and providing systems to prevent environmental pollution due to chemicals leaching into the soil, ground water and water bodies. With the population expected to reach about 9.8 billion in 2050 all these quantities will also increase in direct proportion if linear economy is continued to be adopted. Reuse of these materials in sectors where possible is thus of prime importance to ensure a sustainable green Mother Earth for the future generations.

### Properties of Recycled/ Reused Materials

Research into material properties using recycled aggregated from C&D waste in concrete mix have shown good compatibility for properties like compressive strength, split tensile strength and flexural strength when compared to concrete with natural aggregates. Porosity and absorption show some decline due to the recycled aggregates tending to absorb more water due to the impurities present. That results in a less dense concrete and more water is required for achieving the same workability that would be there if natural aggregates were used. The use of construction rubble in concrete mix however produces poorer concrete and is not advocated where strength, durability and robustness are necessary.

Other building materials like wood, bricks, earthen materials, metal components like steel/ aluminium/ iron/ copper can be recovered in almost intact pieces for reuse. However, where these have corroded excessively, they can be recycled back by processing for reforming the basic products <sup>[5], [6]</sup>.

The C&D waste amounts to about 30 to 40 percent of total global waste output. Concrete and asphalt concrete comprise the biggest chunk of ~80% and most of that is sent to landfill. Only about 20% of it gets recycled globally. According to the American Institute of Steel Construction (AISC), more than 1.0 billion tons (98%) of steel structure components are recycled leading to

saving CO<sub>2</sub> emission of ~1.4 billion tons, and 1.6 billion tons of iron ore production and ~280 million tons of coal.

The amount of C&D waste reused in the construction industry varies from country to country. The UK recycles about 90% of its C&D waste while data from the Environmental Protection Agency (EPA) shows that in the USA, 76% of the C&D waste is recycled or reused. According to data from the Centre for Science and Environment, India generates about 150 million tons of construction waste annually but recycles only about 1% of the waste produced [7].

## Case Studies on Recycle-Reuse of Buildings and Materials

Some case studies from different published articles demonstrate the concepts of reuse-recycle in respect of both whole building/ structure, part of the structure, or reuse of the materials from dismantled buildings.

### Retrofitting Steel Bridge in Norway [8]

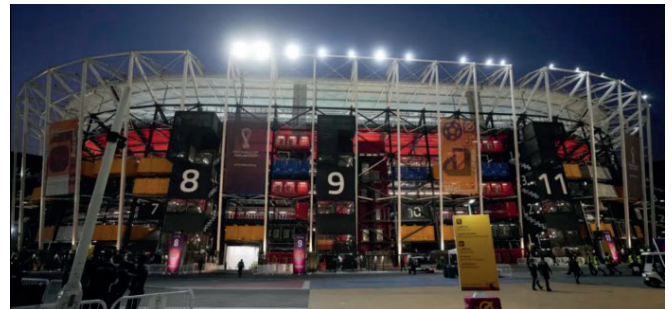
The Nisja truss bridge in Sunndal kommune, Møre og Romsdal in Norway was constructed in 1933. The authorities decided to restore the bridge for continued use. Structural engineering team of Aas-Jakobsen performed the task of detailed assessment of the structure including checking of members and connections using principles of conservation of heritage structure and modern techniques in structural engineering so that the retrofitted structure would meet the current safety standards.



*Nisja truss bridge in Sunndal kommune, Møre og Romsdal in Norway*

### Stadium 974 in Qatar for Soccer World Cup 2022 [9]

The organising committee of Soccer World Cup 2022 in Qatar embarked on a unique construction for a match venue at Stadium 974. It was aptly named based on the International Subscriber Dialling (ISD) code of Qatar. Built at a port-side location, the stadium seats 40,000 plus and is built from recycled shipping containers and steel. The structure used the concept of “Design for Disassembly” (DfD) that allows reuse of both the structure and the site occupied for other purposes in the true spirit of sustainable building design.



*Stadium 974, Qatar*

### Minka houses in Japan [10]

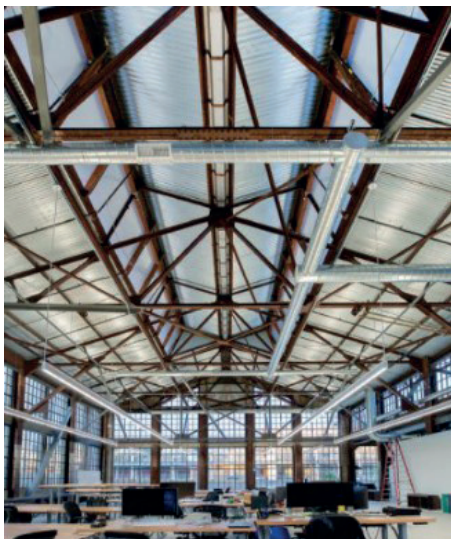
Minka house construction style in Japan uses a highly functional design, traditional architectural concepts, locally available material of wood, bamboo, reeds with few jointing materials in traditional hand-crafted construction techniques. The design and construction like an interlocking puzzle did not require use of screws or nails and the structure can later be completely disassembled and rebuilt at a different location without wasting the precious natural resources. Takumi Osawa, an architect, specialises in restoration projects to preserve the heritage of Japanese architecture.



*Minka House, Japan*

### Uber Advanced Technologies Group R&D Center, San Francisco <sup>[11]</sup>

The house of an advanced technology service of self-driven cars is constructed within Pier 70 in San Francisco. The architect team of Marcy Wong Donn Logan Architects, Berkeley, California and structural engineers from Nabih Youssef Associates, San Francisco adopted an approach to retain and repair the usable portion of the steel structure where feasible. Parts which needed replacement were substituted with components that were historically relevant and environment friendly. In addition to that, environmentally friendly functional/ operation design principles were adopted using skylights and windows to maximise the use of daylight and natural ventilation, radiant heating, and permeable concrete for external paving.



Uber Advanced Technologies Group R&D Center, San Francisco

### Foundation Reuse <sup>[12]</sup>

A sustainable design and construction technique that is gaining credibility is the reuse of foundations. The concept of decarbonisation of foundations requires assessment of existing foundations load capacity and structural health and the additional load to be catered to which can be met by retrofitting. Innovative designs based on this concept have been used in the following cases:

Port Reconstruction project for the South Carolina Port Authority, Charleston, SC, USA where 20 - 30-year-old, 18 in. and 24 in. square prestressed concrete pile foundations were reused after capacity estimation and dynamic testing. That resulted in cost savings of USD 9M and time saving of 6 months.



1. Milton Madison River Bridge Replacement Project, Madison, Indiana and Milton, Kentucky, USA (Ohio River Crossing) in which the existing



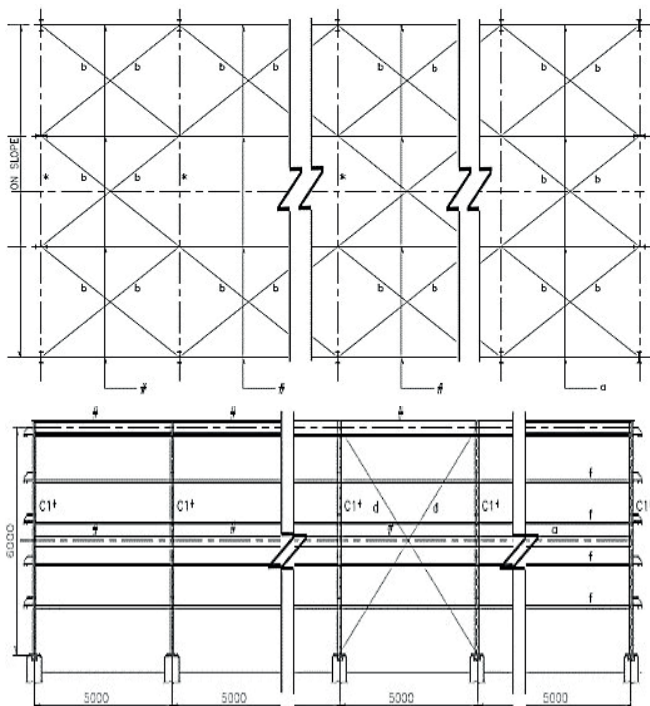
pneumatic caisson foundations were reused with minor retrofit after conducting various tests such as core test, sonic logging, petrography, chloride penetration and compressive strength. That resulted in saving of USD 50M, reduction in closure time from 5 years to 1 year and saved a detour of about 100 miles.

2. Saving the timber piles provided in 1950 for a two-span Bridge Foundation on Jackson Road (over Route 2), Devens, MA, USA. However, the superstructure was replaced. It involved carrying out engineering studies by back estimating pile capacities from pile driving logs and visual inspection and NDT on piles. The project resulted in cost savings of USD 1M and several months of time.



### Structure Relocation Design <sup>[13]</sup>

The project involved designing of site enabling works as part of installation of a new Coke Oven Plant at Tata Steel's Jamshedpur works. It required many existing facilities, which were in operating condition,



to be relocated to new locations at other places inside the plant area. For one such industrial shed, the entire steel structure was carefully dismantled from above the foundation level and the same structure was installed on new foundations and anchor bolts at a new location. The existing structure was subjected to health study - visual inspection and thickness measurements, to judge its suitability for reuse for its new function. Reuse of the steel structure of 36.0MT resulted in cost saving of INR 30 lakhs and time saving of 2 months which would have been required for procurement and fabrication of new steel.

### Repurposing Heritage Buildings <sup>[14]</sup>

The project was part of the Smart City Development program for Agartala city, the capital of the state of Tripura. The impressive Ujjayanta Palace is in the heart of the city and surrounding it are various annexe buildings. As part of the area redevelopment program, the structures were retained and repurposed after necessary retrofitting and strengthening to preserve the visual harmony of the area and save on cost and material consumption of new construction. The illustration shows the repurposed "Astabal" (stables) which was transformed into shops but preserved the traditional architectural forms as an example of sustainable design. The shops are to sell the ethnic handicrafts of Tripura and to promote local culture.



### Conclusions

The contribution from the construction industry to global Gross Domestic Product (GDP) is about 13%

and provides employment for close to a 100 million people. The industry is also expected to grow by about 70% by 2040. That dominance also translates to a huge impact on the environment in addition to the economy and society. While the latter two aspects have been the focus of great impetus in planning and policy framing, the environmental aspect had been pushed back. Environmental changes are slow in manifesting themselves as compared to economic and social changes, but they are more difficult to change or reverse from an incorrect direction. Construction for infrastructure development contributes to a whopping 79% of global carbon emissions, while investments to make the infrastructure climate change resilient consumes 88% of the climate change mitigation costs. In that scenario, the most pragmatic approach towards continuing with the required construction projects while mitigating climate change by reducing environmental impact would come through reuse/ recycling of waste products. Data shows that C&D waste has about 75% of material that can be recovered for reuse or secondary use.

Research into use of waste materials from industrial processes and structure demolition has shown that structural components that reuse waste products are not inferior in strength and durability from those built anew using natural products. Thus, circularity of materials instead of the current linear approach will relieve the stress on procurement of new materials with the associated energy use and emissions, prevent landfills and associated environmental impacts. All that will go a long way in ensuring a sustainable future for the generations to come<sup>[15]</sup>.

## Acknowledgements

The author is grateful to TATA Consulting Engineers Limited for giving permission to submit this article and to the client's Tata Steel Limited for having provided the opportunity to use dismantled structures for construction

of new facilities in their projects, and to Agartala Smart City Corporation for entrusting the city redevelopment project with heritage preservation.

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# Adopting Sustainable Construction and Demolition Waste Management - Key to Green Building Initiatives for a Sustainable Future

# 02



## Vasudevan Suresh

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## Background

The increasing urbanisation and population growth in India highlight the pressing need for sustainable construction and demolition (C&D) waste management. With India's urban population expected to double by 2030 and urban housing shortages reaching 20 million, integrating green practices into construction is paramount. It is absolutely essential that resource efficiency for all development be optimised, done efficiently with intensive use of all resources that are deployed

### Key Development Trends:

- By 2050, 88% of the world's population will reside in developing and lesser-developed countries.
- India's urban growth is accelerating at 8% annually, thereby adding 700-900 million sq. m of building space each year.
- Over 70% of the buildings required by 2030 are yet to be constructed, thus underlining the need for sustainable planning.

### IGBC: Pioneering the Green Building Movement

The Indian Green Building Council (IGBC), established

by CII in 2001, is at the forefront of promoting sustainable construction. IGBC envisions enabling a sustainable built environment for all, aiming to position India as a global leader by 2025.

### The Indian Construction Sector is going green:

- 15,000+ projects covering 13 billion sq. ft. of green building space.
- India has the second largest green building footprint in the world.
- 20 lakh green homes, 500+ green factories, and 3,000+ green offices.
- IGBC's 32 Green Ratings are aligned with the UN Sustainable Development Goals (SDGs).

### Transforming Waste to Wealth

Waste generation is unavoidable in all development contexts. It could be:

- Domestic Waste
- Municipal Waste
- Bio Medical Waste
- Electronic Waste
- Construction & Demolition Waste
- Industrial & Hazardous Waste
- Agricultural Produce Waste

It is necessary to have a holistic and integrated approach to waste minimisation [**reduce**] and **recycle** and **reuse** which will enshrine strategies and interventions for transforming:

**Waste to Wealth ⇔ Refuse to Resource ⇔ Trash to Treasure ⇔ Trash to Cash**

There are multiple regulatory regimes brought out by the Ministry of Environment Forests and Climate Change (MOEFCC) to deal with segregation, transportation, treatment, processes to convert all streams of waste into value added products in a scientific manner. The State Pollution Control Boards, the Central Pollution Control Board and the Local bodies deal with the enforcement of Waste Management regulations brought out by MOEFCC.

**Construction and Demolition Waste**

India generates 165 million tonnes of C&D waste annually, but the recycling capacity is limited to 2.3 million tonnes. Addressing this challenge is crucial to mitigate environmental degradation and reduce resource exploitation. IGBC is driving initiatives to promote net-zero waste by encouraging material reuse, recycling, and sustainable demolition practices.

**Key Strategies for Net-Zero Waste:**

- a) **Reduce by Design:** Emphasising modular construction and prefabricated modules to minimise waste generation.
- b) **Reuse Materials:** Encouraging reuse of demolition materials, such as repurposing railway sleepers.
- c) **Sustainable Demolition:** Maximising resource recovery through responsible demolition practices.
- d) **Segregation and Recycling:** Establishing dedicated teams for waste segregation and recycling to prevent landfill diversion.

**Ecosystem for Circular Economy**

To create an ecosystem that would encourage and promote Circular Economy, IGBC advocates:

- Increased recycling industry participation,

- Deployment of digital platforms for waste material exchanges, and
- Government and private sector investments in C&D waste management facilities.

**Utilisation of Industrial Waste**

Table-1 gives the ways in which some of the major industrial wastes could be utilised as building materials and thus reduce the adverse impacts that are created by their disposal.

Item	Source	Application in Building Material
Fly-ash	Thermal power stations	Portland pozzolana cement, bricks, lime pozzolana mixture, lightweight aggregate, cellular concrete
Phospho-gypsum	Hydro-fluoric/ phosphoric acid, Amm.Phosphate Fertiliser Plants	Gypsum plaster, fibrous gypsum boards and blocks, cement clinker, as a solid retarder and for making super sulfate cement
Red mud	Aluminium extraction plant	Building bricks and tiles, light-weight structural blocks, roofing sheets and as additive to concrete
Blast furnace slag	Steel plants	Portland blast furnace slag cement, super sulfate cement, as an aggregate in concrete, as substitute for sand, Light weight concrete
Limestone waste	Limestone quarry	Masonry cement and activated lime pozzolana mixture
Lime sludge	Sugar, ferti-lizer, calcium carbide paper, acetylene	Portland cement, masonry cement, sand lime bricks, building lime pozzolana mixture

*Table-1: Utilisation of Industrial Waste for Building Materials*

**Utilisation of Agricultural Waste**

Agricultural waste is another major item that needs to be addressed. The major agricultural waste items and their use in the construction industry is shown in Table-2.

Item	Source	Application in Building Material
Rice husk	Rice mills	As fuel and in production of rice husk binder, fibrous building panels, bricks
Bagasse	Sugar Industries	Manufacture of insulation boards, wall panels, etc
Banana leaves/ stalk	Banana plants	Building boards, fire resistant fibre board
Coconut husk	Coir fibre Industry	Building boards, roofing sheets, insulation boards, building panels, as a lightweight aggregate
Groundnut Shell	Groundnut oil mills	Building panels, building blocks, chip boards, roofing sheets, particle boards
Jute Stick	Jute Industry	Chip boards, roofing sheet
Cinder	Thermal power stations/ railways	Lime cinder mortar, concrete building blocks, bricks from black cotton soil

*Table-2: Utilisation of Agricultural Waste*

## IGBC Net Zero Waste: Pioneering the Future of Waste Management:

Achieving Net Zero Waste is a transformational approach. The Indian Green Building Council (IGBC) continues to lead the charge in advancing sustainable practices through the Net Zero Waste rating system. This initiative aims to revolutionise waste management by eliminating landfill contributions and fostering a circular economy for the building and infrastructure sectors.

IGBC's Net Zero Waste Rating System was launched in 2021. It offers a structured framework for organisations to eliminate landfill waste, contributing to resource efficiency and environmental sustainability.

**IGBC's Definition of Net Zero Waste:** A Net Zero Waste building or environment diverts all waste from landfills by emphasizing nature-centric design, minimising debris during construction, responsibly managing operational waste, and maximising reuse and recycling.

### Core Principles of Net Zero Waste

#### 1. Reduce by Design:

- Emphasise modular construction, prefabricated elements, and 3D printing to minimise waste generation.
- Target waste reduction within prescribed limits across materials such as cement, steel, bricks, and glass.

#### 2. Reuse of Materials:

- Promote the reuse of salvaged materials, such as railway sleepers and recycled PET bottles.
- Case Study: Decathlon recycles PET bottles into yarn for clothing.

#### 3. Green Procurement:

- Prioritise products that are eco-labelled, made from C&D waste, rapidly renewable, or salvaged.
- Encourage procurement of bio-based materials, including agri-waste and recycled paper.

#### 4. Sustainable Demolition:

- Maximise resource recovery during demolition by reusing materials in new constructions.

#### 5. Responsible Segregation:

- Establish dedicated teams to oversee segregation and ensure minimal contamination of recyclable materials.

#### 6. Construction Waste Management:

- Facilitate the reuse and recycling of construction waste through authorised recyclers, thereby reducing landfill contributions.

### The Ecosystem for Net Zero Waste

- **GreenPro Ecolabel:** Thousands of products certified, ensuring high environmental standards.
- **Policy and Investment:** Stronger government and private sector investments to build recycling infrastructure.
- **Technology Deployment:** Digital platforms connecting waste producers and recyclers, fostering transparency and efficiency.

### Benefits of Net Zero Waste Certification

- Compliance with national and international environmental standards.
- Increased resource efficiency and reduction in construction costs.
- Enhanced brand reputation and corporate social responsibility.
- Opportunities to convert waste into valuable products, contributing to a circular economy.

### IGBC's Net Zero Waste Movement

The IGBC Net Zero Waste certification provides a roadmap for sustainable development, transforming the way buildings and communities handle waste. All need to work towards a greener, waste-free future. Visit [www.IGBC.in](http://www.IGBC.in) to learn more about Net Zero Waste initiatives.

## The Road Ahead

Local bodies are encouraged to establish city-level C&D waste collection and processing facilities to support the green path. With over 320 organisations already taking the Net Zero Pledge, the decade ahead will be crucial in driving India's sustainable transformation.

Coordinated and cooperative working is essential to create a greener and more sustainable future.

## Driving Sustainability with Net Zero Waste Initiatives - Case Studies

As the call for sustainability intensifies, Indian businesses are making significant strides towards achieving Net Zero Waste. Pioneering projects like the Godrej C and D Waste Management Unit in Mumbai, Ascendas IT Park and Cyber Pearl Information Technology Park in Chennai are setting benchmarks in waste management, highlighting the importance of responsible waste ecosystems and green procurement.

### Project Highlights:

#### 1) Godrej Cand D waste Management Unit at Vikhroli, Mumbai

It is one of the pioneering and trend setting initiatives taken by the Godrej Group for collecting construction and demolition waste from different parts of construction sites in and around Mumbai and transforming to many value-added products in the recycling unit at Vikhroli. The products can be used in the construction industry.

#### 2) Ascendas IT Park, Taramani, Chennai

- Established a comprehensive waste management ecosystem onsite.
- Implemented systematic collection and segregation of waste.
- Organic waste is treated using an onsite Organic Waste Converter (OWC).
- The manure generated is distributed free of charge to tenants, promoting circularity.

#### 3) Cyber Pearl Information Technology Park, Chennai

- It is the second IT park in India to achieve IGBC Net Zero Waste - Platinum (Operations) certification.
- 57% of the operational products adhere to green procurement policies.
- Waste generation is reduced by 46.57% as compared to the baseline (0.05 kg/person/day vs. 0.1 kg/person/day).
- Onsite OWC facility with a capacity of 140-500 kg/day processes 100% of organic waste.
- As of April 2023, 99.95% of operational waste is diverted from landfills through the 3R strategy (Reduce, Reuse, Recycle).

#### 4) Municipal Waste Management innovations.

A large number of Municipal Corporations and Municipalities convert the biodegradable and other degradable wastes to value-added products like Compost, Refuse derived Fuel [fuel pellets] and Waste to Energy and recycling through downstream applicators.

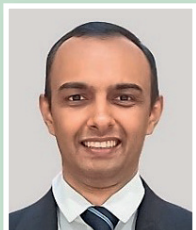
### Impact and Key Learnings:

- These projects exemplify how thoughtful waste management practices can significantly reduce landfill contributions.
- Emphasis on green procurement and waste reduction drives operational efficiency and environmental responsibility.
- Net Zero Waste certification not only enhances the sustainability profile of businesses and cities but also sets an industry precedent for future developments.

### Acknowledgement

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# Life Cycle Assessment of Recycled Materials in Nuclear Infrastructure



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## Summary

This article explores the Life Cycle Assessment (LCA) of recycled materials in nuclear infrastructure, focusing on the environmental, economic, and regulatory implications of integrating these materials into nuclear projects. The assessment evaluates various recycled materials, such as concrete aggregates, steel, and lead, highlighting their production, performance, and global warming potential. While the use of recycled materials presents significant environmental benefits - including reduced carbon emissions and resource conservation - it also faces challenges, including stringent regulatory requirements and public perception concerns. The article emphasizes the importance of rigorous testing and LCA to ensure the safety and performance of recycled materials in nuclear applications. Through case studies, it demonstrates the potential for recycled materials to contribute to sustainable practices in the nuclear sector, aligning with broader environmental goals. As the nuclear industry seeks to enhance sustainability, the integration of recycled materials offers a promising pathway toward reducing its environmental footprint while maintaining safety and efficiency.

## Keywords

Life Cycle Assessment (LCA), Recycled Materials, Nuclear Infrastructure, Decommissioning, Environmental Impact, Sustainability

## Introduction

Nuclear infrastructure, including power plants, storage facilities, and auxiliary structures, presents unique challenges in terms of material selection and sustainability. As the world increasingly moves toward sustainable practices, the role of recycled materials in the construction and decommissioning of nuclear infrastructure has become a point of interest. The LCA of these materials is a critical tool to evaluate their environmental impacts, energy use, waste generation, and overall sustainability throughout their life cycle, from extraction to disposal.

Recycled materials hold promise in reducing the carbon footprint of nuclear infrastructure projects, while also addressing the significant volumes of waste produced globally. However, the integration of recycled materials into nuclear projects must also consider the rigorous safety, regulatory, and performance standards that govern the nuclear industry. This article provides an in-depth life cycle assessment of recycled materials such as concrete aggregates, steel, and lead, used in nuclear infrastructure, highlighting the challenges, benefits, and pathways to their broader adoption in this highly regulated sector.

## Overview of Nuclear Infrastructure Materials

### Conventional Materials in Nuclear Infrastructure

Construction materials account for 12% of the capital

costs when expressed in terms of labour, goods, and materials <sup>[1]</sup>. Material usage in nuclear infrastructure is dominated by conventional materials like concrete (around 50-60%), steel (approximately 20-30%), and specialized materials such as lead (1-3%). These three key materials serve distinct and essential functions:

- **Concrete:** As the largest contributor to construction materials, concrete is vital for both structural support and radiation shielding. Its extensive use in containment buildings, storage facilities, and auxiliary structures highlights its versatility in nuclear construction.
- **Steel:** Steel represents a significant portion of the material requirements. It is primarily used in reinforced concrete structures, containment structures, framed structures, foundations and anchoring systems, and safety barriers. Its strength and durability make it suitable for the demanding operational conditions of a nuclear facility.
- **Lead:** While used in smaller quantities, lead plays a crucial role in radiation shielding. Applied in specific areas that require high levels of protection, it ensures the safety of both personnel and sensitive equipment by mitigating radiation exposure.

Each of these materials is selected for its proven ability to meet the rigorous standards of nuclear construction, including the need for strength, durability, robustness, and radiation shielding, all of which are critical to the facility's long-term safety and performance. However, the production and disposal of these materials have significant environmental impacts, including carbon emissions from cement production, energy-intensive steel manufacturing, and the mining of raw materials.

### Potential Recycled Materials for Nuclear Applications

The adoption of recycled materials into nuclear infrastructure can help reduce the environmental impact associated with traditional construction materials <sup>[2]</sup>. Potential candidates for recycling include:

- **Recycled concrete aggregates (RCA):** Derived from the demolition of old structures, RCA can replace virgin aggregate in concrete production. While both fine and coarse fractions are generated, coarse RCA is more commonly recycled due to its denser, less porous structure, which is less prone to contaminant absorption. This distinction is particularly significant in contexts like nuclear decommissioning, where the separation of coarse and fine aggregates is prioritized to limit contamination risks <sup>[2]</sup>.
- **Recycled steel:** Steel is highly recyclable and can be reused in structural applications with minimal loss in strength.
- **Recycled lead:** Lead can be reused in shielding applications, particularly in spent fuel storage and radiation protection systems.

The nuclear industry has additional layers of complexity due to the critical nature of safety and long-term durability. Therefore, the integration of recycled materials into nuclear projects must undergo a rigorous evaluation through life cycle assessment to ensure that these materials meet the sector's stringent requirements. However, their use in the non-critical nuclear facility structures ought not to be an issue.

## Life Cycle Assessment (LCA) Methodology

### Definition and Objectives of LCA

Life cycle assessment is a systematic method used to evaluate materials, processes, and products' environmental impacts throughout their life cycle (see Figure-1). In the context of nuclear infrastructure, an LCA aims to assess the sustainability of recycled materials by examining the environmental impact at each stage:

- **Raw material extraction** (for recycled materials, this would be waste collection and processing).
- **Production/manufacturing.**
- **Construction/installation.**
- **Operation** (including maintenance), and
- **Decommissioning** (including waste disposal or recycling).

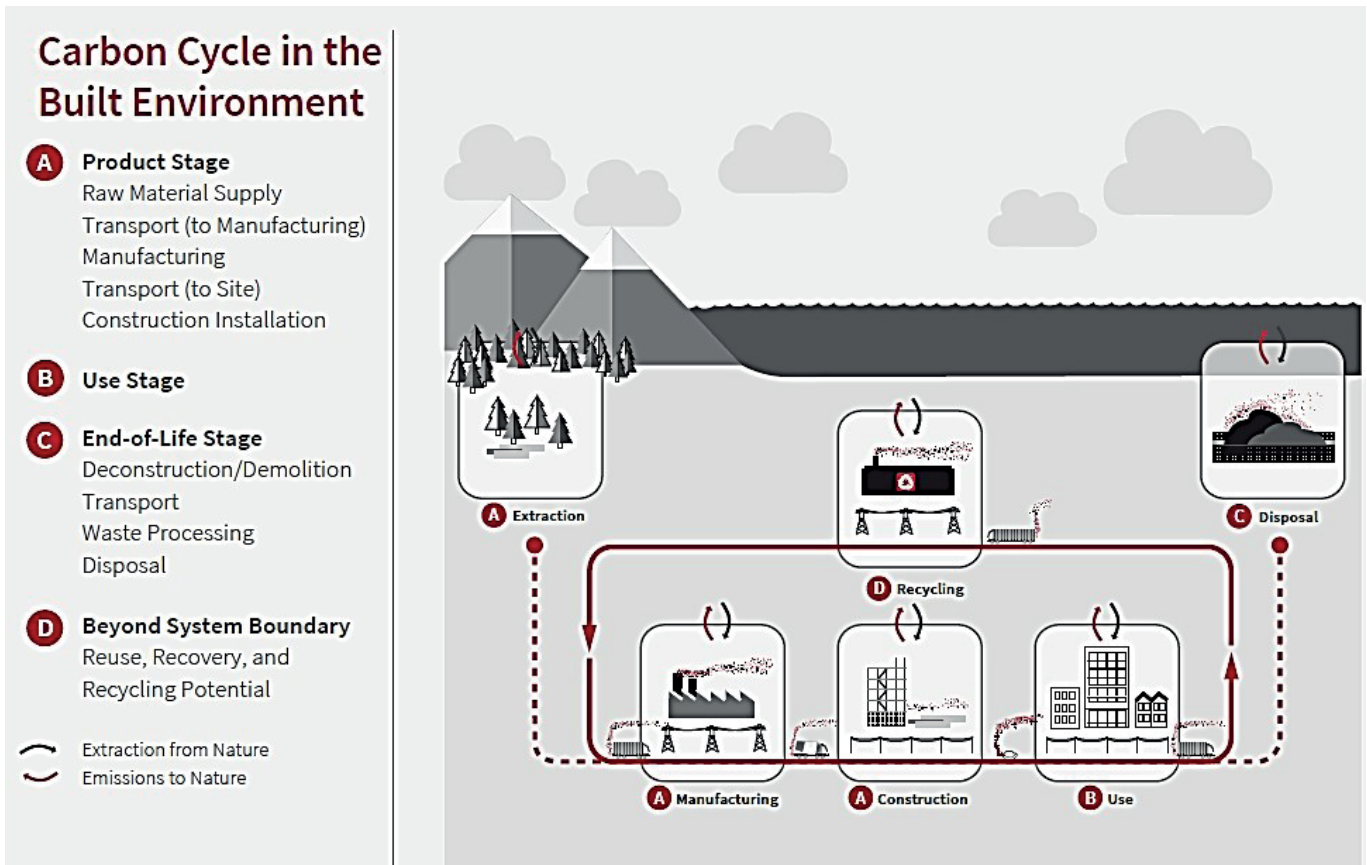


Figure-1: Life Cycle Stage Definitions <sup>[3]</sup>

The primary objective of conducting an LCA on recycled materials in nuclear infrastructure is to quantify the potential benefits and drawbacks compared to conventional materials. The LCA also examines energy consumption, emissions, resource depletion, and the generation of waste across the life cycle stages.

### Key Environmental Indicators

The Key Environmental Indicators used in LCA for nuclear infrastructure materials include <sup>[4]</sup>:

- **Global Warming Potential (GWP):** This measures the contribution of the materials to climate change, often expressed in kilograms of carbon dioxide equivalent (kg CO<sub>2</sub>-eq).
- **Energy consumption:** Total energy required across the life cycle, including both renewable and non-renewable sources often expressed in megajoules (MJ) or kilowatt-hours (kWh).
- **Material resource depletion:** The reduction in available natural resources due to the extraction of raw materials expressed in kilograms (kg) or tons (t).
- **Waste generation:** Amount of waste produced, both hazardous and non-hazardous, throughout the life cycle expressed in kilograms (kg) or tons (t).
- **Water consumption:** Total water used in the life cycle of materials expressed in cubic meters (m<sup>3</sup>) or liters (L).
- **Toxicity potential:** The potential release of hazardous substances that could impact human health or the environment expressed in comparative toxic units (CTUs).

### Boundaries of the LCA Study

In LCA studies for recycled materials in nuclear infrastructure, it is essential to define the scope and boundaries of the analysis. These typically include <sup>[3]</sup>:

- **Cradle-to-grave:** Analyzing the full life cycle from material extraction (or recycling) to disposal or recycling after decommissioning.
- **Cradle-to-gate:** Focusing on the life cycle from extraction to the point where the material leaves the factory gate, ready for use in construction.
- **Gate-to-gate:** Examining a specific segment of the life cycle, such as the construction or operational phases.

**Cradle? Gate? Grave?**

The beginning of the life cycle is also referred to as the “cradle,” while the exit point of the manufacturing facilities is known as the “gate,” and the end of the life cycle is known as the “grave.” Thus, terms such as “cradle-to-gate” and “cradle-to-grave” are used to refer to different ranges of the life cycle.  
Source: [3]

The **cradle-to-grave** approach is often preferred for nuclear infrastructure, given the need to assess materials from extraction through the extended operational and decommissioning phases of nuclear facilities.

**Life Cycle Assessment of Key Recycled Materials**

**Recycled Concrete Aggregates (RCA)**

**1. Extraction and Production**

Recycled concrete aggregates are derived from the demolition of existing structures, which are crushed and processed to remove contaminants like metals and glass. Using RCA can reduce the need for virgin aggregates, lower greenhouse gas emissions from quarrying, and minimize construction waste [5]. However, the crushing and processing stages require energy, which can offset some of the environmental gains.

**2. Performance in Nuclear Infrastructure**

Concrete used in nuclear facilities must meet strict specifications for durability, radiation shielding, and mechanical performance

[6]. Studies show that RCA, including that arising from the decommissioning of nuclear facilities, can be used in non-critical areas such as on-site construction and site remediation [2], but its use in critical structures like containment walls or reactor buildings may be limited due to concerns over long-term durability and leaching behaviour [7].

**3. Environmental Impact**

LCA studies indicate that using RCA in place of natural aggregate (NA) can reduce the GWP by approximately 30-60%, depending on transportation distances and the efficiency of the manufacturing process [8]. However, it is essential to ensure the quality of RCA is carefully managed to prevent potential structural degradation over time.

**Recycled Steel**

**1. Extraction and Production**

Steel is one of the most recyclable materials globally, and recycled steel maintains nearly identical properties to virgin steel. The production of recycled steel (see Figure-2) via the electric arc furnace (EAF) method uses significantly less energy than the traditional blast furnace-basic oxygen furnace (BF-BOF) method, reducing emissions by up to 60% [9].

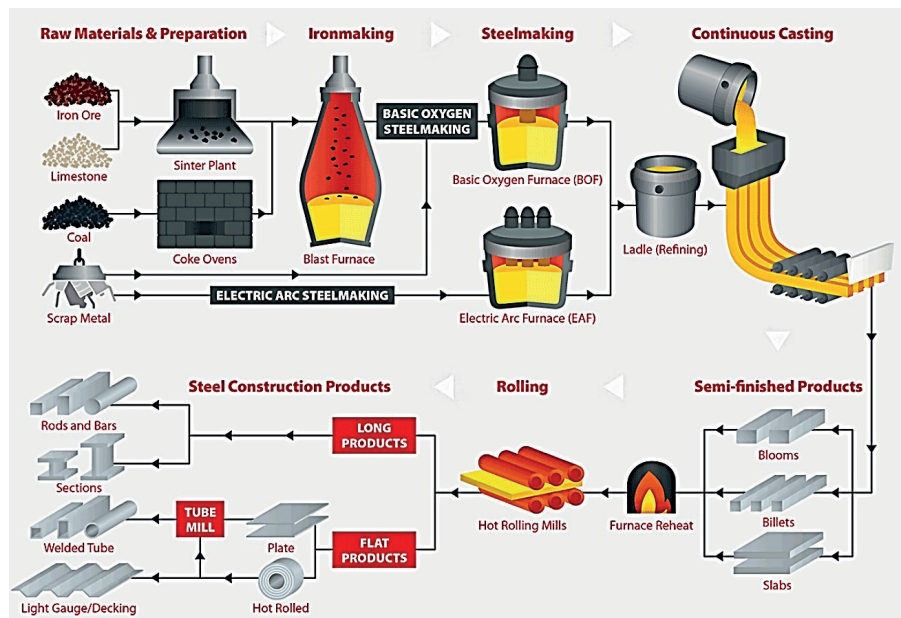


Figure-2: Steelmaking Process  
(Source: StockAxis Tata Steel Ltd Research Report)

## 2. Performance in Nuclear Infrastructure

Recycled steel can be used in all structural applications in nuclear infrastructure, provided it meets the necessary strength, toughness, and corrosion resistance standards. Recycled steel, including that arising from decommissioning nuclear facilities, has been successfully used in multiple nuclear projects worldwide [2].

## 3. Environmental Impact

Recycled steel production requires 2.5 times less energy as compared to virgin steel production, primarily due to the lower energy requirements of electric arc furnaces [9]. Recycled steel also reduces the demand for virgin iron ore, contributing to resource conservation.

## Recycled Lead

### 1. Extraction and Production

Recycling lead is a well-established process, primarily from batteries and other industrial waste. The recycling process is energy-efficient and significantly reduces the environmental impact of mining virgin lead, which is associated with high levels of pollution [10].

### 2. Performance in Nuclear Infrastructure

Lead is widely used in radiation shielding applications, including spent fuel storage and reactor shielding. Recycled lead, subject to regulatory clearance (when arising from decommissioning of nuclear facilities), performs identically to virgin lead in these applications and is a reliable option for reducing environmental impacts while maintaining critical safety functions. For example, at the BR3 nuclear power plant in Belgium, 34 tons of lead from removable shielding were recycled through an on-site melting process and repurposed for use in new hot cells [2].

### 3. Environmental Impact

Recycling lead is estimated to use 80% less energy than extracting virgin lead. Additionally, recycling lead reduces the environmental damage associated with mining and refining processes, which are often located in ecologically sensitive areas [11].

## Challenges in Adopting Recycled Materials in Nuclear Infrastructure

Several challenges must be addressed to integrate recycled materials into nuclear infrastructure, as highlighted in Figure-3. These challenges range from regulatory and safety concerns to public perception, cost, and supply chain issues. The following sections explore these obstacles in more detail:

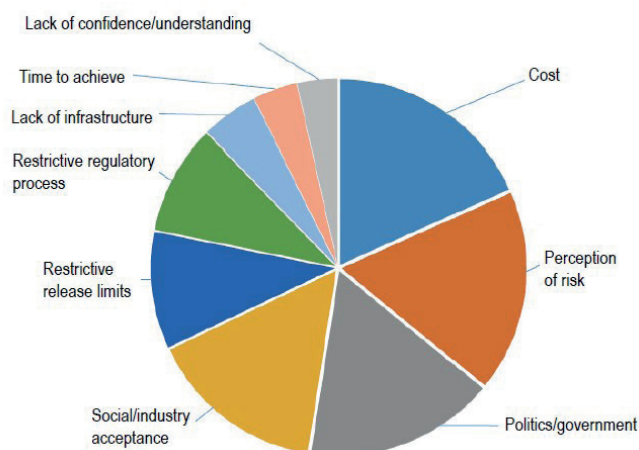


Figure-3: Challenges to the Recycle and Reuse of Materials [2]

### Regulatory and Safety Concerns

Strict regulatory requirements in the nuclear sector make it difficult to incorporate recycled materials, especially those exposed to radiation. Regulations around radiation protection and material integrity vary across countries, with some requiring dose limits stricter than the 10  $\mu\text{Sv}/\text{year}$  standard recommended by the International Commission on Radiological Protection (ICRP) [12]. Harmonizing international standards and ensuring extensive testing of recycled materials are vital to meeting these safety criteria.

### Long-Term Durability and Performance

Nuclear facilities demand materials that can endure extreme conditions over several decades—typically designed for 40 years, with extensions allowing operation up to 60 to 80 years [13]. Recycled materials must prove their durability under radiation, temperature fluctuations, and corrosive environments. Addressing concerns about their long-term performance, particularly in such high-risk settings, is essential for their broader acceptance.

### Public Perception and Acceptance

Public skepticism about the safety of recycled materials in nuclear applications remains a major barrier. Recycled materials especially from nuclear decommissioning are often viewed with suspicion, particularly following events like Fukushima, Chernobyl, and the Windscale fire. Gaining public trust will require transparent communication about the safety, testing, and certification processes involved.

### Supply Chain and Availability

The inconsistent availability and quality of recycled materials are significant challenges, especially for nuclear-grade applications. Many in the recycling industry are reluctant to process materials from the nuclear sector due to perceived risks, making it difficult to establish a stable supply chain. International collaboration is needed to ensure a reliable flow of high-quality materials that meet nuclear standards.

### Cost Considerations

Recycling in the nuclear sector can be more expensive than direct disposal, due to the additional costs of decontamination and certification. Although recycling can yield long-term savings, the upfront costs often deter decision-makers. Tools like cost-benefit analysis can help assess whether recycling is a financially viable option compared to disposal.

### Lack of Infrastructure

The infrastructure for handling recycled materials from nuclear facilities is limited, with many facilities unwilling or unable to process them. Expanding this infrastructure, supported by government intervention, is crucial to making recycling a feasible solution in the nuclear industry.

## Benefits of Recycled Materials in Nuclear Infrastructure <sup>[14]</sup>

### Environmental Benefits

The most significant benefit of using recycled materials in nuclear infrastructure is the reduction of environmental impacts. Recycling materials reduces the need for virgin resource extraction, lowers energy consump-

tion during production, and minimizes the generation of waste. This contributes to the overall sustainability goals of the nuclear sector, which seeks to provide low-carbon energy with minimal environmental impact.

### Cost Savings

In some cases, recycled materials can offer cost savings compared to virgin materials, especially when considering the disposal costs of construction and demolition waste and the environmental damage that they do. Reduced energy consumption during production also translates to lower operational costs for manufacturers.

### Resource Conservation

The use of recycled materials helps conserve natural resources, particularly non-renewable materials like metals and minerals. This aligns with the growing emphasis on circular economy principles, which aim to maximize the reuse and recycling of materials throughout their life cycle.

## Pathways for Broader Adoption of Recycled Materials in Nuclear Infrastructure

The adoption of recycled materials in nuclear infrastructure is gaining attention due to environmental and economic benefits. However, their use remains limited due to safety, regulatory, and technical challenges. Addressing these barriers through targeted strategies can pave the way for broader acceptance. The key pathways that can support this transition are:

### Enhanced Regulatory Frameworks

Governments and industry bodies can work together to establish specific standards for recycled materials in nuclear projects, ensuring they meet stringent safety and durability criteria to ensure robust structures that will be fit for the purpose intended. Regulatory approval processes should be streamlined to support innovation in material use.

### Research and Development

Continued R&D efforts can focus on testing recycled materials' long-term performance under nuclear-specific conditions, such as radiation, temperature fluctuations, structural loads/ forces, and fatigue. These studies will help develop a body of evidence to support broader usage.

### Public Engagement and Perception

Public trust is crucial in the nuclear sector. Proactive communication and education about the safety, reliability, and environmental benefits of recycled materials can address public concerns and encourage societal acceptance.

### Supply Chain Integration

Ensuring a consistent and reliable supply of high-quality recycled materials that meet nuclear-grade specifications is vital. This can be achieved through better coordination among suppliers, recyclers, and nuclear operators.

### International Collaboration

Global cooperation between nuclear regulatory bodies, research institutions, and industry can help share best practices and harmonize standards for recycled material use, facilitating cross-border adoption in nuclear infrastructure projects.

### Conclusions

The life cycle assessment of recycled materials in nuclear infrastructure presents both challenges and opportunities. While the nuclear industry is characterized by stringent safety and regulatory requirements, there is growing potential for the adoption of recycled materials in non-critical areas, auxiliary structures, and radiation shielding applications.

The environmental benefits of using recycled materials are clear, including reductions in greenhouse gas emissions, energy consumption, and resource depletion. However, these benefits must be carefully weighed against concerns related to long-term durability, safety, and public perception.

Moving forward, continued research and pilot projects are essential to refine the use of recycled materials in nuclear applications. As sustainability becomes an increasingly important consideration in the nuclear industry, recycled materials offer a pathway to reduce the environmental impact of nuclear infrastructure without compromising safety or performance. Through a rigorous life cycle assessment process, the nuclear sector can identify the most suitable applications for recycled materials, contributing to a more sustainable future for nuclear energy.

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# Need for Circularity in Concrete and the Road Map in the Context of Research and Innovations



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## Introduction

India is on the forefront of growing economies and aspires to be the third largest economy by 2030. India's growth coupled with population explosion and influx of people towards urban cities have given rise to rapid expansion of cities, construction of satellite towns (Tier II & III), increased demand of affordable housings and associated infrastructures. The growth of urban population is projected to be 600 million by 2030, up from 377 million in 2011<sup>[1]</sup>. The projection of housing demand by 2036 is 93 million units<sup>[2]</sup>. Concrete being a major component of construction materials, its demand is going to increase manifold, both in the short as well

as in the long run. The demand is poised to skyrocket once the growth in the infrastructure sector is also factored.

Cement consists of about 13% by weight of concrete and is an indicator of concrete production. Study shows that demand for cement in India is estimated to grow 116% by 2030 to 660 million metric tonnes at a CAGR of 6.6% (Figure-1).

The demand for cement globally is projected to reach 4,832.6 million metric tonnes by 2028 as compared to 3644.5 million metric tonnes in 2022, at a compound annual growth rate (CAGR) of 4.94% during 2023-2028<sup>[4]</sup>. It is seen that 40% of CO<sub>2</sub> emission for construction of a new building is due to concrete and cement contributes a whopping 70% of the total carbon emission for production of a unit volume of concrete (Figure-2).

Cement production is highly energy intensive and it has high embodied carbon. Given that one metric tonne of cement production emits approximately one metric tonne of CO<sub>2</sub>, the atmosphere is expected to be loaded with about 5000 million (5 billion) metric tonnes of CO<sub>2</sub> by 2028 due to production of cement alone. It may be noted that 1.6 billion metric tonnes of cement was produced in 2022 globally contributing 8% of the total CO<sub>2</sub> emission. That is an awful scenario given that cement production will increase three times within

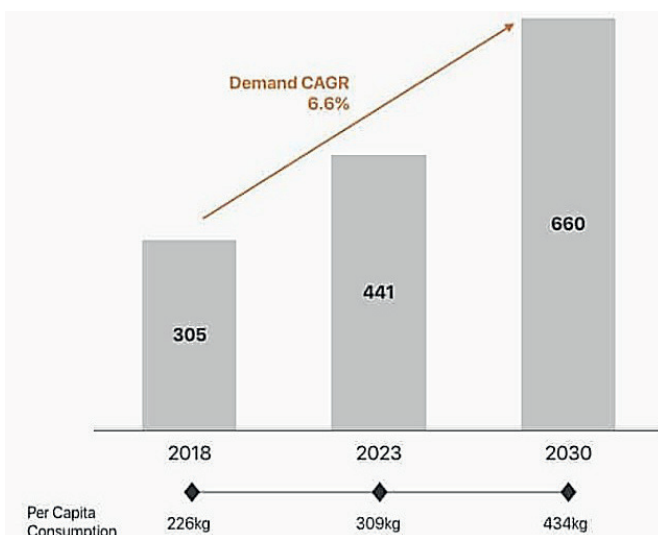
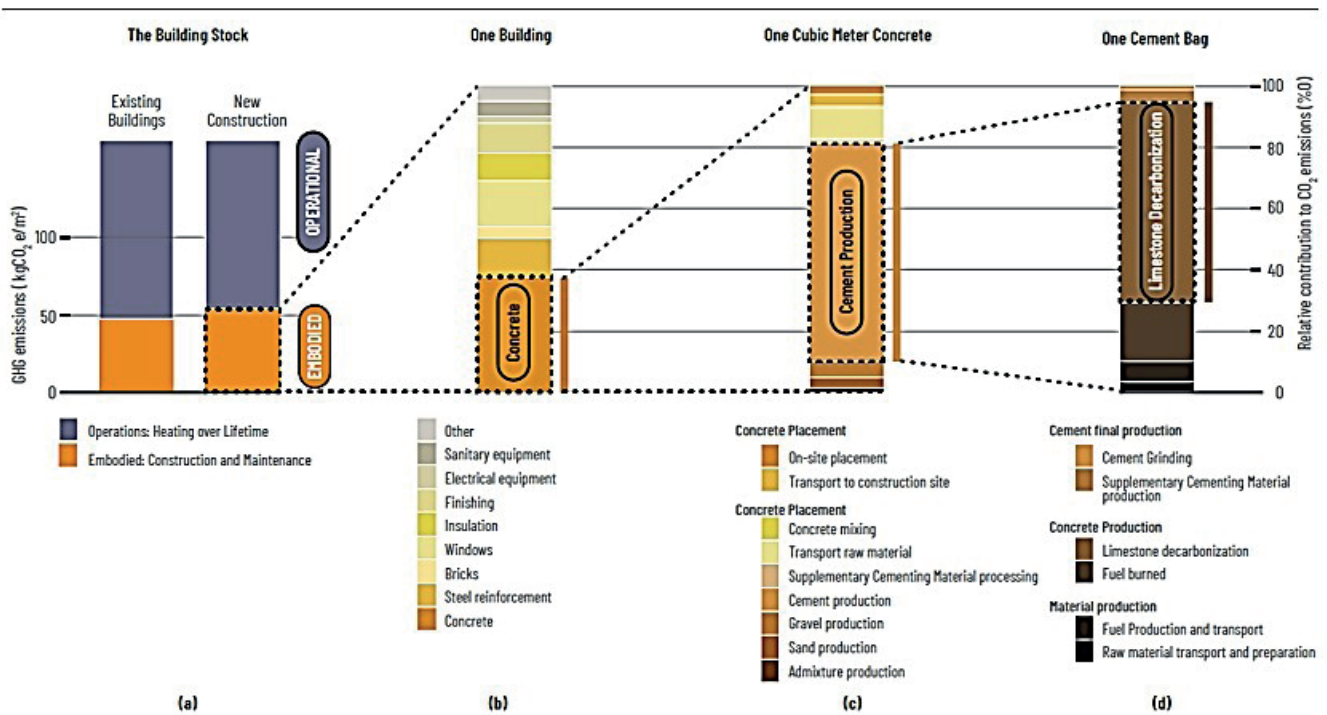


Figure- 1<sup>[3]</sup> – Demand for Cement in India



Within concrete production, the main emissions are from cement production, in particular limestone processing.

Note: Figure (a) compares the operational (heating/ventilation/cooling over lifetime) and embodied (construction and maintenance) greenhouse gas emissions from the existing global building stock versus new construction. Figure (b) shows that for new construction, the largest emissions from a typical multi-family concrete building come from concrete production. Figure (c) shows that within concrete production, the main emissions are from cement production, in particular limestone processing (d). Source: Habert et al. 2020.

Figure-2<sup>[5]</sup> - Dominance of Concrete and Cement in the embodied emissions of newly constructed buildings

a short period of 6 years infusing a huge quantity of CO<sub>2</sub> into the atmosphere and threatening the living population of the planet.

## Approach to Mitigation

It is obvious that a sustainable solution to mitigate the CO<sub>2</sub> emission arising out of cement production is one of the target areas to achieve an appreciable positive impact on the environment. The framework to decarbonize the materials as suggested by the United Nations Environment Programme (UNEP) is represented in Figure-3.


The framework suggests a major role for the manufacturers and designers (boxed in red in Figure-3). The essence of the approach is circularity of the materials. Under the context, construction and demolition (C&D) waste recycling and bringing the

same into the concrete making can play a significant role.

Construction and demolition (C&D) waste is the fall out of any construction/ demolition activity of built-up environments like buildings and infrastructures such as roads, bridges, fly over, subway, etc. It consists mostly of inert and non-biodegradable material such as concrete, steel, aluminum, mortar, metal, wood, plastics, etc.

About 10-12 million metric tonnes of waste is estimated to be generated annually by the construction industry. According to an estimate by the Technology Information, Forecasting and Assessment Council (TIFAC) in 2001, wastes generated per square meter of built-up area are 40-60 kg and 300-500 kg for new construction and demolition of old construction respectively in India. According to a Report by The

TABLE 0-2



## WHO DOES WHAT TO DECARBONISE MATERIALS?











	POLICY MAKERS 	FINANCIAL INVESTORS + DEVELOPERS 	MANUFACTURERS, BUILDERS + WASTE MANAGERS 	ARCHITECTS, ENGINEERS + OCCUPANTS 
 WORK OF THE GEO-BIOSPHERE	<ul style="list-style-type: none"> <li>&gt; Policies to reduce extraction of non-renewable materials</li> <li>&gt; Facilitate innovation in biodiverse, circular forestry and agriculture</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Use economic practices that value natural capital and biodiversity</li> <li>&gt; Commit to gender equity + fair labour across project life cycles</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Avoid unsustainable land-use patterns, soil degradation and forestry practices in sourcing both conventional and bio-based materials</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Consider the source and recovery rate of non-renewable and renewable materials when designing materials</li> </ul>
 DESIGN	<ul style="list-style-type: none"> <li>&gt; Enforce performance-based building codes</li> <li>&gt; Develop fair green certifications and transparent labelling</li> <li>&gt; Incentivize tools for data-driven design</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Invest in design of recycled, re-used and bio-based materials and components</li> <li>&gt; Invest in accessible data visualization frameworks</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Commit to the development of circular components</li> <li>&gt; Develop materials to optimize recyclability</li> <li>&gt; Develop bio-based alternatives</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Design for longer life</li> <li>&gt; Increase education in decarbonisation strategies</li> <li>&gt; Computation / design / optimization of local materials for re-use</li> </ul>
 PRODUCTION	<ul style="list-style-type: none"> <li>&gt; Electrify the grid</li> <li>&gt; Mandate recycling and best available technologies (BAT)</li> <li>&gt; Mandate forest and material management</li> <li>&gt; Improve certifications</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Invest in innovation for low-carbon materials and binders</li> <li>&gt; Invest in new low-carbon methods</li> <li>&gt; Invest in BAT equipment</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Upgrade plants</li> <li>&gt; Avoid primary materials</li> <li>&gt; Circular manufacturing and composites for re-use</li> <li>&gt; Commit to fair labour</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Work with producers to specify circular materials</li> <li>&gt; Design development of alternative bio-based materials and components</li> </ul>
 CONSTRUCTION	<ul style="list-style-type: none"> <li>&gt; Mandate green certifications</li> <li>&gt; Mandate third-party verification of site processes and emissions</li> <li>&gt; Incentivize off-site circular manufacturing</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Increase energy-efficient financing</li> <li>&gt; Improve financing for refurbishment and renovation of existing buildings and materials</li> <li>&gt; Commit to fair labour</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Trace material use</li> <li>&gt; Electrify all equipment with renewable energy</li> <li>&gt; Require energy efficiency</li> <li>&gt; Improve training</li> <li>&gt; Commit to fair labour</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Manage on-site waste through pre-fabrication</li> <li>&gt; Improve management of on-site construction with circular design</li> </ul>
 USE	<ul style="list-style-type: none"> <li>&gt; Adopt building energy codes that mandate materials supporting high-performance envelopes to reduce operational carbon</li> <li>&gt; Incentivize renovation over new construction</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Develop financial tools to incentivize low carbon material selection by reconizing energy and cost pay-back periods</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Support building owners and occupants to select low-carbon alternatives through supply chain development</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Increase material life with low-carbon maintenance practices</li> <li>&gt; Select materials that reduce operational carbon</li> </ul>
 END OF USE	<ul style="list-style-type: none"> <li>&gt; Certify pre-used components</li> <li>&gt; Building codes to mandate re-use</li> <li>&gt; Plan cities to incorporate transfer plants</li> <li>&gt; Regulate demolition</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Provide economic incentives to avoid demolition by refurbishing buildings, increasing re-use and recycling</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Improve recovery and on-site sorting of materials</li> <li>&gt; Standardize materials to improve recycling</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Design for disassembly and re-Use</li> <li>&gt; Increase continuing education for students and professionals in novel circular material strategies</li> </ul>

Figure-3<sup>[5]</sup>- Action framework for decarbonizing the materials

World Bank in 2018, approximately 50% of the solid waste may be considered as C&D waste and that amounts to about 1.05 billion metric tonnes of C&D waste per year globally.

Study reveals that India generates about 150 million metric tonnes of C&D waste annually with negligible recycling capacity of 1.3% only<sup>[6]</sup>. Therefore, large quantities of balance material pollute the waterbodies in the landfill area, block free movement of vehicles when dumped uncontrollably and most dangerously generate dust. Figure-4 identifies that concrete comprises about one third to one fourth of the total C&D waste generated in India.

Waste sub-streams	As per Technology Information Forecasting and Assessment Council (TIFAC), 2001 (India)	As per MCD survey, 2004 (Delhi)	As per survey by Infrastructure Leasing & Financial Services (IL&FS) Ecosmart, 2005 (Delhi)	As per study by University of Florida, 2009 (India)	As per Coimbatore City Municipal Corporation survey, 2015 (Coimbatore)
Soil/sand, gravel	36	43	31	35	49
Bitumen	2	0	0	2	0
Metals	5	0	0.4	5	4
Masonry/brick	31	15	59	30	19
Concrete	23	35	0	25	23
Wood	2	0	1.5	2	2
Others	1	7	7.6	1	3

Figure-4<sup>[7]</sup> Indian construction and demolition waste percentage composition

Given the projection of generation of a large quantity of C&D waste and the lion's share remaining unutilized, there is no other way but to recycle and reuse it for sustainability. Concrete being a major part of C&D waste, recycling it would reduce the waste, reduce quarrying of virgin natural resources for aggregates and reduce production of cement, thus resulting in lesser emission of CO<sub>2</sub>.

## Research and Innovation

Recycled concrete is being utilized mostly as Recycled Concrete Aggregate (RCA), and Manufactured Sand (M Sand), for granulated sub-base in road construction, paver blocks and concrete blocks. The International Standards including Indian Standard allow use of RCA and M Sand, but in a very restricted and limited manner. There are no specific recommendations for the upper

limits for use of RCA and Recycled Fine Aggregate (RFA) in the American Standard<sup>[8]</sup> but it very strictly lays the rules that the recycled aggregates must conform to strength and durability requirements, and testing and quality control systems must be in place throughout the project execution. The Indian Standard<sup>[9]</sup> is no less stringent in restricting the use in M25 grade for RCC construction only and that too a limit of 20%. It further disallows the use of RCA in prestressed concrete. Both the Standards are very cautious to point out directly/indirectly that RCA should be used from a single source. The major concern being the hydrated cement paste that remains adhered to the RCA leads to more porosity, lesser strength and durability.

It is obvious that the stipulations of the standards restrict large scale adoption of RCA and are not going to help circularity in any appreciable quantum. Therefore, research and innovation are essential to overcome the shortcomings and enable RCA to be more widely used in the future.

Scope of research and innovation for circularity of demolished concrete should be primarily concentrating on the ordinary portland cement (OPC) replacement and scalable adoption of RCA with suitable additives/treatment. The research should encompass not only the production process but the value chain of RCA as well as the integration of cutting-edge intelligent technologies like 3D printing, Artificial Intelligence (AI), Building Information Modelling (BIM), Big Data (BD), etc.

Bulk of the research is concentrated on RCA and RFA. Research on part substitution of cement with C&D waste needs to be geared up. The C&D waste in India has been found to have 5 to 20% of ultra-fines (less than 0.15 mm) during crushing and hence cannot be used as aggregates<sup>[10]</sup>. The brighter side is that it contains Silica, Lime, Aluminum and Ferrous thus there is a potential of its use for partial substitution of cement in concrete. Experiments show comparable strength and gain of strength with age to that of OPC when blended with 20% ultra-fines<sup>[10]</sup>. This research can further be advanced in experimenting with cementitious grouts

and other construction chemicals for scalable adoption in the industry. Exploration of using the crushed C&D waste in partial/ full replacement of cement grouting, cement/ lime stabilization of soil appears to be an attractive research and innovation area where success could be a game changer in the engineering field.

Additive manufacturing is being advocated nowadays in construction engineering. It is possible to achieve complex geometries with sharp precision and almost no wastage of materials leading to sustainability. Fines/ ultra-fines from demolished concrete appear to have good potential to be used as the printing material in this upcoming technology.

The conventional process of producing RCA and RFA is mechanical crushing and sieving. The fines in the RFA (<4mm) consists of sands and ultrafine hydrated cement pastes. Separation of hydrated cement pastes is necessary to get clean RFA for use in the concrete and mortar. This can be done either by mechanical crushing or thermal treatment. Research has developed technologically advanced smart crushers thus enabling improved separation of cement paste from the aggregate surface. Several laboratory scale technologies are underway like the Electric Pulse Discharge for selective fragmentation and microwave heating. Industry level

innovative technology currently reported is Advanced Dry Recovery (ADR) followed by Heating Air System (HAS)<sup>[11]</sup> to produce superior quality of RCA and RFA. The process cycle is shown in Figure-5. The equipment for the process is easily transportable and can be used at the demolition site itself, thus saving land, minimizing transportation, and improving logistics.

Researchers in India are also engaged and their breakthrough achievements are noteworthy. The Indian Institute of Technology, Madras researchers have demonstrated a Solar Thermal Technology to produce RCA and it is reportedly claimed to be superior to RCA produced by mechanical crushing<sup>[12]</sup>.

Classification and identification of the concrete in the debris after the demolition of a building is a complex and major task where reduction of CO<sub>2</sub> emission can be targeted by innovative solutions to increase the efficiency of the task. Proper site selection for establishing the manufacturing facility of the RCA by optimizing the transportation, reduction of dust generation is of vital importance. The advanced and intelligent technologies have an immense role to play in this field and researchers are already in the fray. Research articles reveal how technologies like AI, BIM, GIS, IoT, Remote Sensing, Big Data (BD), and

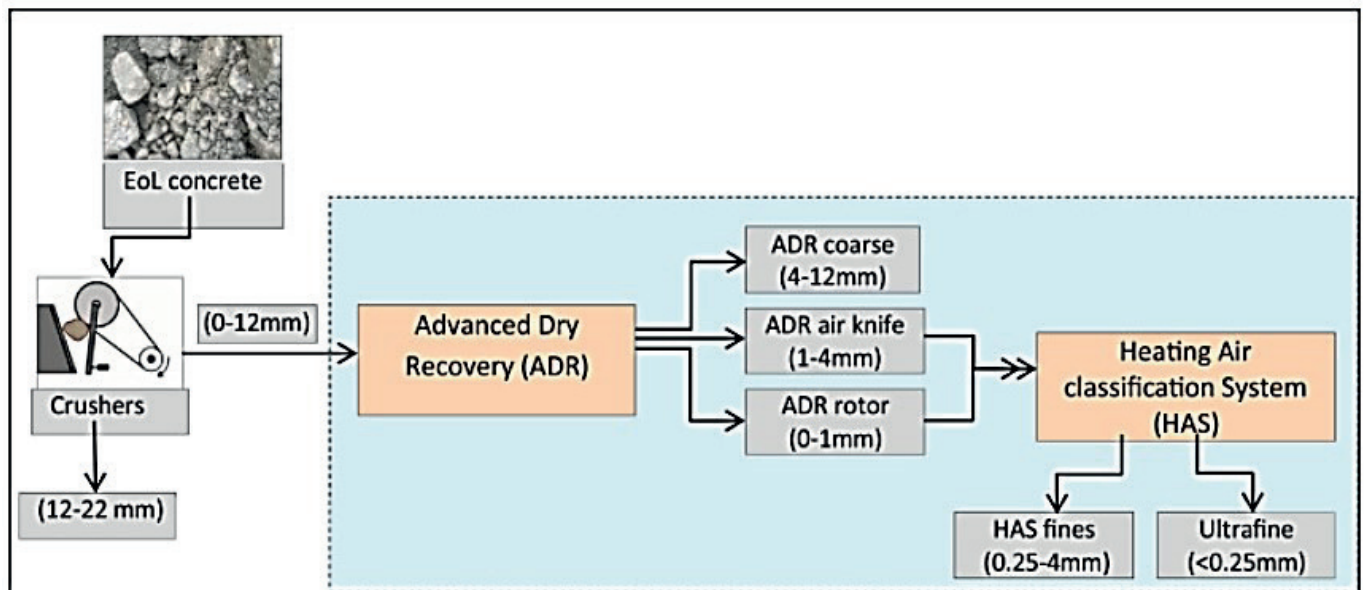


Figure-5<sup>[11]</sup> Schematic workflow using ADR and HAS technologies

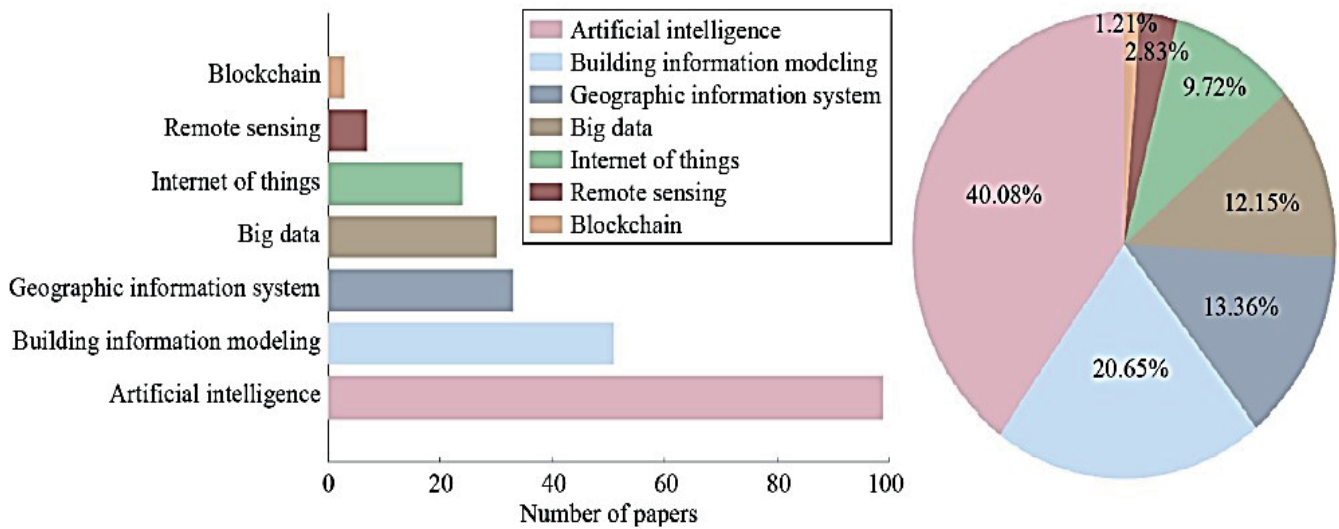


Figure – 5<sup>[13]</sup> Overview of major technology applications

Blockchain can be utilized to improve the efficiency of the value chain to reduce CO<sub>2</sub> emission and enhance sustainability. Taking the number of papers as an index, it is observed from a study (Figure-5) that most of the research during the last ten years ending 2023 had been focused on application of AI, followed by BIM and they together constituted about 60% of the research being done.

AI being researched for identification and classification of demolished concrete in the debris of demolished buildings constituting concrete, glass, steel reinforcements, bricks, aluminium, mortar, etc. To illustrate, a robot has been made with computer vision to classify and collect the C&D waste<sup>[13]</sup>. BIM technology is being utilized for efficient deconstruction methods with proper sequence eliminating errors and repetition, thus resulting in reduction of associated CO<sub>2</sub> emission, accurate estimation of quantities of waste, coordination of stakeholders to plan and reduction of waste. Models using GIS have been developed to identify potential locations of illegal dumping, selection of sites for waste facilities optimizing transportation and pollution. Big Data has been extensively utilized for prediction of waste generation and reduction of environmental impact.

## Conclusion

Population growth, growing urbanization, and influx of people to urban areas are responsible for the rising demand for housing and related infrastructures all over the world. That will result in a huge increase in the demand for concrete and consequentially of its major ingredients i.e. cement and natural aggregates. Cement production globally is estimated to increase three times within six years and lead to emission of 5 billion metric tonnes of CO<sub>2</sub> and besides there would be increased quarrying of natural stones for the aggregates. Under the circumstances, a circular economy for concrete is essential for a sustainable solution.

C&D waste is generated both during new construction and demolishing of old constructions. The quantum of C&D waste will also increase in the near future. In the Indian context, only 1.3% of C&D waste is recycled and most remains unutilized. Therefore, maximizing the recycling of waste products (RCA, RFA, M Sand), developing new processes for quality improvement during recycling, finding more application avenues for reuse/ recycling, and developing new products made from C&D waste should be the priorities. This need opens up a wide horizon for the research & development (R&D) and innovations. Research should be planned

based on a multipronged approach covering processes, materials, and value chain with the integration of advanced technologies to reap the benefit of synergy. It is encouraging to note that studies, experiments, and research are being done in these directions, globally and India is also not behind. Research is underway in leading Indian institutes and the successes are visible. The Building Materials & Technology Promotion Council (BMTPC), Ministry of Housing & Urban Affairs, Government of India, has been assigned to drive new and innovative building materials and construction technologies that are resource efficient and climate resilient. Despite the efforts, recycling, and reuse of C&D wastes, India lags considerably when compared to Netherlands, UK, Germany, Japan, USA, South Korea where more than 70% of the C&D wastes are recycled<sup>[14]</sup>. These countries have strict rules and regulations regarding generation, collection and mandatory recycling of C&D wastes and strict implementation. India also needs to follow the same path, increase awareness, introduce incentives, arrange investments for R&D to turn the waste to resources.

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# Recycling & Reuse of Construction & Demolition Waste in Construction Industry



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## Abstract

In view of the shortage of materials which are extracted from the earth and the resultant environmental issues, it is necessary that recycling and reuse of construction and demolition waste (C&D) be adopted on a large scale in the construction industry.

While using those materials, care must be taken regarding appropriate quality control. The latter is possible only if fresh material is mixed with the C&D waste and their proportion is determined after proper laboratory investigations. This paper discusses the recycling and reuse of C&D waste in the construction industry.

## Sources of C&D Waste Material

The principal source for generation of construction and demolition waste are building construction/renovation/demolition sites. However, no authenticated data is available about the quantum of C&D waste generation in India. The TIFAC report (2001)<sup>1</sup> states that the estimated waste generation during construction is about 40 to 60 kg/sqm of built-up area. Similarly, waste generation during renovation and repair work is estimated to be about 40 to 50 kg/sqm of the built-up area, and 300-500 kg/sqm for buildings that are demolished.

## Brief from International Specifications

Many countries around the world have incorporated several provisions to facilitate use of C&D waste for infrastructure building. Developed countries are leading in this regard.

**European (CEN) Practice** – EN 12620<sup>2</sup> – includes recycled aggregate in the EN Standard for aggregate used in concrete, according to which the aggregates can be of the following types:

- Natural aggregates from mineral resources,
- Manufactured aggregates of mineral origin, involving thermal or other modification, and
- Recycled aggregates, resulting from processing of inorganic material previously used in construction.

**UK-BS 8500-2:2023<sup>3</sup>** is the complementary British Standard to BS EN 206-1, refers to two types of recycled aggregate – Recycled Concrete Aggregate (RCA), and Recycled Aggregate (RA). RCA is obtained by crushing demolished concrete structures, discarded precast elements and unused hardened concrete. BS 8500 stipulates that RCA must be predominantly composed of coarse aggregates and masonry content should be less than 5%. Those aggregate can be used in structural concrete of cube strength upto 50 MPa. In case RCA contains a higher percentage of mortar, a

maximum of 20% replacement of coarse aggregate can be made in concrete which has a cube strength between 25 to 50 MPa. RA may contain masonry up to 100%.

**Germany** has elaborate regulations for recycling materials in order to utilise them and make them an alternative to fresh materials. Most of them are used in road construction. DIN 1045<sup>4</sup> permits up to 25% of

RCA in structural concrete of cube strength 37.5 MPa in dry or low humidity environments.

Similar practices are followed in many other countries. Worldwide trends with regard to provisions in specifications for using C&D waste aggregates (RCA as well as RA) in concrete are summarised in the Table-1<sup>5</sup>.

Country/ Organisation	C&D Type	Maximum Substitution Allowed	Maximum strength of Concrete that can be made using C&D	Other Restrictions
United Kingdom	RCA	20%	20 to 40 MPa	No Chloride Exposure, No Freeze thaw
	RA	Not Specified	16 MPa	Only Mild Exposure
Australia	RCA	30%	40 MPa	
	RA	100%	20 MPa	
RILEM	RA	100%	16 MPa	Masonry Aggregate
	RCA	100%	50 MPa	
Korea	RCA	30%	27 MPa	
Germany	RCA	35%	25 MPa	In dry or low humidity environments
		25%	30 MPa	
Portugal	RCA	25%	35 MPa	
		20%	40 MPa	
Hongkong	RCA	20%	35 MPa	
		100%	20 MPa (Non-Structural Concrete)	

Table-1: Provisions for Using C&D Waste in Concrete in Different Countries<sup>5</sup>

### Typical Properties of Processed C&D Waste

Table-2 gives the typical properties of processed C&D

waste aggregates as per a study conducted by the Haryana Public Works Department<sup>6</sup>.

Property	Recycled Aggregate (RCA)	Natural Mineral Aggregates (NMA)
Aggregate Impact Value (%)	29.9	24.7
Aggregate Crushing Value (%)	35.7	26.5
Los Angeles Abrasion Value (%)	50.2	32.3
Specific Gravity	2.45	2.63
Bulk Density (kN/m <sup>3</sup> )	15.00	15.70
Water Absorption after 24 hours (%)	4.7	0.4
Flakiness Index (%)	15.6	-
Elongation Index (%)	17.5	-

Note: RCA was from demolished concrete road near Ambala

Table-2: Comparison of Engineering Properties of RCA and NMA<sup>6</sup>

Table-3 gives the properties of Recycled Aggregates (RCA)

Property	Range
Water Absorption (%)	0.9 to 7.0
Bulk Density (kN/m <sup>3</sup> )	11.50 to 14.40
Specific Gravity	2.32 to 2.56
Aggregate Crushing Value (%)	17.77 to 36.30
Aggregate Impact Value (%)	9.66 to 38.0

Table-3: Typical Range of Engineering Properties of RCA<sup>7</sup>

### Effect of C&D Waste Usage in Cement Concrete

Cement concrete can be prepared using processed

C&D waste aggregates (RA) or by using Recycled Concrete Aggregate (RCA). Many of the studies report usage of RCA rather than RA in concrete. The most significant factor that influences properties of RCA is that it contains hydrated hardened cement paste sticking to natural mineral aggregates. That hardened paste reduces the specific gravity but increases the porosity thus leading to higher water absorption. Besides, a coat of weak mortar attached to the aggregates results in a weaker interfacial transition zone between the aggregate phase and the mortar, leading to reduction in strength of the concrete. Table-4 shows the effect of replacing Natural Mineral Aggregate (NMA) with RCA in a high strength concrete mix, having cement content of 500 kg/m<sup>3</sup> (PPC), silica fume and water/binder ratio of 0.243, on the physical characteristics of the concrete. The reference mix in Table-4 (without RCA) was designed for a target slump of 175 mm<sup>5</sup>.

High Strength Concrete Using RCA	Replacement by RCA (%)	Slump (mm)	Compressive Strength (MPa)	Flexural Strength (MPa)	Split Tensile Strength (MPa)
			at 28 days		
R-0	0	180	84.4	14.9	5.8
R-20	20	160	80.5	13.0	4.8
R-40	40	140	75.3	11.5	4.6
R-60	60	130	71.3	10.8	4.5
R-80	80	110	65.4	9.6	4.2
R-100	100	80	62.2	8.0	3.9

Table-4: Replacing Fresh Aggregate with RCA for High Strength Concrete<sup>5</sup>

The following conclusions can be drawn from Table-4.

- i). As the proportion of RCA replacing NMA is increased, workability (slump) decreases.
- ii). The strength of concrete (compressive, flexural, and split tensile strength) decreases with increase in RCA. The quantum of decrease for each type of strength varies.

- iii). Even with 100% replacement of NMA, compressive strength values of 60 MPa at 28 days with 80 mm slump were obtained.

Table-5 provides the comparative test results of concrete using Recycled Concrete Aggregates (RCA) vis-à-vis concrete using NMA as reported by Haryana PWD<sup>7</sup>.

Property	Concrete using NMA	Concrete using RCA
Compressive Strength, MPa	16.0 at 3 days	13.2 at 3 days
	26.9 at 28 days	24.5 at 28 days
	38.5 at 90 days	37.1 at 90 days
Flexural Strength, MPa	3.4	2.95
Tensile Strength, MPa	2.66	2.20
Bond Strength with steel, MPa	4.0	3.6
E value in compression, MPa	28000	20000
E value in tension, MPa	32000	27000
Shear Strength, MPa	1.95	2.30
Drying shrinkage (%)	0.04	0.067
Loss on abrasion (%)	0.13	0.16

Table-5: Comparative Test Results of Concrete with RCA and NMA<sup>6</sup>

## Innovative Technologies and Practices in Recycling and Reuse

- **3D Printing:** some 3D printers can use recycled concrete to build structures.
- **Advanced Sorting and Recycling Systems:** New automated technologies for sorting materials on-site (such as robots and AI-driven sorting systems) are improving the efficiency of recycling operations.
- **Modular Construction:** Modular construction encourages the reuse of materials and components since individual modules can be disassembled and reused for future projects.
- **Sustainable Cement:** New developments in alternative cement products, such as geopolymer concrete, use of industrial by-products like fly ash, slag, and silica fume reduce the need for traditional raw materials and contribute to sustainability.

- **Design for Disassembly (DfD):** In this system the buildings are designed with the end-of-life stage in mind. The materials used are easier to disassemble, sort, and reuse, thus minimizing waste generation at the demolition stage.

## Advantages and Limitations of Using Processed C&D Waste Products in Road Sector

Using processed C&D waste for road construction has the following advantages:

- Mitigates shortage of raw materials such as coarse aggregates, sand, etc., thus bridging the demand supply gap.
- C&D waste is usually available closer to the site, especially for construction within or near a city where C&D waste processing facilities can be set-up, resulting in saving transportation cost for the aggregates.
- Conservation of natural resources such as river sand, stone aggregates, etc., and
- Saving land required for dumping of C&D waste.

However, strength characteristics of processed C&D waste material may differ from natural mineral aggregates. This aspect should be kept in view for its proper use.

## Case Studies of Recycling and Reuse in Construction

### a) Foreign Countries

- **The Edge (Amsterdam, Netherlands):** The office building is a prime example of integrating sustainability into construction. It uses recycled materials throughout, in all the building elements, including reclaimed timber and recycled aluminum. The building's modular design allows for easy disassembly and reuse of components.

- **The Bullitt Center (Seattle, USA):** Known as the "greenest commercial building in the world," the structure uses reclaimed materials and a design that prioritizes resource efficiency. It also incorporates a rainwater harvesting system and a high level of energy efficiency.
- **Berlin's "Urban Mining" Projects:** The concept of urban mining, which involves reclaiming materials from existing buildings, is gaining traction in cities like Berlin. The city has successfully used salvaged bricks, timber, and other materials in new construction projects.
- **Industrialised countries** have systems in place for recycling of construction and demolition debris. Use of Construction and Demolition (C&D) waste aggregates in road works is a widely accepted practice in countries like Denmark, USA, UK, France, Japan, etc.
- **Germany:** In the German construction industry, a 'Closed loop recycling system' operates for the management of C&D wastes resulting in recycling of the order of more than 80% of the material. The closed loop system comprises steps for (a) avoiding construction wastes, (b) recycling methods to allow reuse, (c) reducing disposal of C&D wastes to the minimum possible extent, and, (d) avoiding the disposal of recyclable wastes.
- **Japan:** About 95% recycling of concrete rubble has been achieved in Japan and the emphasis has now shifted from 'quantity-oriented' to 'quality-oriented' recycling, to enable Recycled Concrete Aggregates (RCA) to be used in all types of constructions, including high strength concrete in new construction. Japanese Standards and Regulations have three classes of recycled aggregate: Class H, M and L denoting High, Medium, and Low quality. Special techniques have been developed using mechanical scrubbing using an eccentric tubular vertical mill and application of heat to remove mortar sticking to aggregate pieces for producing high quality recycled aggregates.

## b) India

C&D Waste Disposal and Utilisation Studies and Practices have been carried out by many Institutes/ PWDs in India to understand the nature of construction and demolition waste with a view to evolve avenues for utilisation of C&D waste in various construction activities related to buildings, roads, and other infrastructure. Some of the organizations are:

- CSIR-Central Road Research Institute (CRR), New Delhi
- National Council for Cement and Building Materials (NCCBM), Ballabhgarh
- Municipal Corporation of Delhi (MCD), presently trifurcated
- Public Works Department, Haryana (Haryana PWD)
- Karnataka Rural Roads Development Agency (KRRDA)
- IL&FS Environmental Infrastructure & Services Ltd. (IEISL)

The city of Delhi could be considered as a typical example for Indian cities with regards to handling of C&D waste. It is estimated that, on an average, the city of Delhi generates about 3000 tonnes per day (TPD) of C&D waste. The respective Municipal Corporations of Delhi (MCD – North, South and East) are responsible for the transportation and disposal of the unclaimed waste as per the Delhi Municipal Corporation Act, 1957, in their jurisdictional area. However, the total quantity of C&D waste collected and disposed of by MCD is estimated to be less than the quantity of C&D waste generated in the city. Moreover, C&D waste is generally disposed of without adequate processing and it gets intermixed with other wastes. In addition to the ad-hoc nature of this system, constraint of space for storage of the C&D waste is the main concern.

Being the first such project of organised management of C&D waste in the country, it has set an example, which can be replicated by other cities in India.



*Photo-1: C&D Processing Plant at Burari in Delhi*

### c) **Processed C&D Waste in Road Sector**

C&D waste to be used in road works requires to be processed (mainly crushing and grading) before it can be used.

The next step thereafter would be crushing the C&D waste in stone crushers (Jaw type crushers) of suitable capacity to convert the big chunks of debris to desired gradation (re-sizing). After processing the C&D waste can be used in road works for the following:

- Embankments,
- Flexible pavements – in granular sub-base layer, for bound/ cement stabilised base and sub-base course and for granular base courses,
- Concrete pavements – Dry lean concrete, Roller Compacted Concrete, Plain cement concrete pavement,
- Paving blocks and Kerb stones,
- Road side drainage systems, and
- Slope stabilisation

Several state governments as well as the Central government have taken up several initiatives to promote usage of C&D waste.

### **Future of Recycling and Reuse in Construction**

As the global construction industry continues to grow, the need for sustainable building practices will increase. Some potential future developments include:

- a) **Circular Economy Models:** More construction companies are embracing circular economy principles, focusing on minimizing waste and continuously recycling materials to create a closed-loop system.
- b) **Government Policies and Incentives:** Governments are likely to continue introducing stricter regulations and financial incentives to encourage recycling and reuse in construction, such as tax breaks or building code changes to accommodate reclaimed materials.

- c) **Collaboration and Standardisation:** The development of industry-wide standards for recycled building materials will help streamline processes, improve quality control, and encourage wider adoption of recycling practices.

## Conclusion

Recycling and reuse of C&D materials in the construction industry play a pivotal role in making the sector more sustainable and also help to reduce costs, especially where the new material has to be sourced from long distances. While challenges remain, the adoption of innovative technologies, stronger regulations, and an increasing awareness of environmental issues are driving the industry toward more sustainable practices. As the demand for sustainable building practices grows, recycling and reuse will continue to evolve, leading to greater resource efficiency, reduced environmental impact, and a more circular economy.

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# The Role of Environment Assessments to Ensure Nature Positive Infrastructure Development



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## Introduction

In the face of rapid urbanization and environmental degradation, the need for sustainable infrastructure development has become paramount. Environmental Assessments (EAs) play a crucial role in guiding infrastructure projects toward nature-positive outcomes. This paper explores the significance of EAs in promoting environmentally friendly practices, protecting biodiversity, and enhancing ecosystem services. By examining the methodologies, benefits, challenges, and future directions of EAs, the paper highlights their essential role in facilitating infrastructure that supports both human needs and ecological health.

## Infrastructure Development Aspects

Infrastructure development is a critical driver of economic growth and social progress. However, conventional infrastructure projects often lead to adverse environmental impacts, including habitat destruction, pollution, and loss of biodiversity. As a response to these challenges, the concept of nature-positive infrastructure has emerged, advocating for developments that not only minimize harm but actively contribute to the health of ecosystems. Environmental assessments are key tools in this endeavor, providing frameworks to evaluate the potential impacts of projects on the environment and guiding decision-makers toward sustainable practices.

## Understanding Environmental Assessments

### Definition and Types

Environmental Assessments encompass a range of processes designed to evaluate the environmental implications of proposed projects. The two primary types of EAs are:

1. **Environmental Impact Assessments (EIAs):** These are project-specific assessments conducted prior to the approval of major projects. EIAs identify potential environmental effects, propose mitigation measures, and ensure compliance with environmental regulations.
2. **Strategic Environmental Assessments (SEAs):** SEAs are broader evaluations applied at the policy or planning level. They assess the potential environmental impacts of proposed policies, plans, or programs, helping to integrate environmental considerations into early decision-making processes.

### Objectives of EAs

The primary objectives of EAs include:

- Identifying potential environmental impacts and risks.
- Proposing mitigation strategies to minimize negative effects.

- Enhancing public participation and stakeholder engagement.
- Informing decision-makers about sustainable alternatives.

## Benefits of Environmental Assessments

### Informed Decision-Making

EAs provide essential data and insights that inform policymakers, developers, and stakeholders. By assessing potential impacts early in the planning process, EAs enable informed decisions that align with sustainability goals.

### Sustainability

EAs encourage the adoption of sustainable practices and technologies, promoting developments that are environmentally responsible. By considering alternative approaches, EAs help identify solutions that minimize resource consumption and ecological footprints.

### Stakeholder Engagement

EAs facilitate meaningful engagement with communities and stakeholders. Through public consultations and participatory processes, EAs ensure that diverse perspectives are considered, fostering transparency and trust in the decision-making process.

## Role in Nature-Positive Development

### Biodiversity Protection

One of the critical roles of EAs is to safeguard biodiversity. By identifying and evaluating potential impacts on local ecosystems, EAs guide infrastructure projects away from sensitive habitats and encourage the implementation of measures that protect flora and fauna.

### Ecosystem Services Enhancement

Nature positive infrastructure is designed to enhance ecosystem services, such as flood control, air purification, and carbon sequestration. EAs play a vital role in identifying opportunities for integrating natural features

into infrastructure, promoting designs that contribute positively to the environment.

### Adaptive Management

EAs support adaptive management practices by incorporating monitoring and feedback mechanisms into infrastructure projects. This allows for adjustments based on observed impacts and changing environmental conditions, ensuring that projects remain aligned with sustainability objectives.

### Innovative Approaches in Environmental Assessments

To enhance the effectiveness of EAs in promoting nature-positive infrastructure, several innovative practices have emerged:

1. **Strategic Environmental Assessments (SEAs):** SEAs provide a broader framework for assessing the cumulative impacts of multiple projects within a region, rather than evaluating projects in isolation. This holistic approach encourages coordinated planning and helps identify areas where infrastructure development can coexist with conservation goals.
2. **Ecosystem-Based Approaches:** Integrating ecosystem-based management principles into EAs promotes the consideration of ecological integrity and resilience in decision-making. This approach emphasizes maintaining ecosystem functions and services, aligning infrastructure development with ecological health.
3. **Digital Tools and Technologies:** The use of digital platforms for data collection, analysis, and stakeholder engagement enhances the efficiency and transparency of EAs. Technologies such as drones for aerial surveys, AI for data analysis, and online platforms for community engagement can streamline the assessment process and improve outcomes.
4. **Nature-Based Solutions (NbS):** Incorporating NbS into infrastructure planning such as green roofs, urban forests, and wetlands can significantly mitigate

environmental impacts while enhancing urban resilience. EAs that prioritize NbS are instrumental in fostering nature-positive development.

## Case Examples

### Example 1: Green Infrastructure Projects

In urban areas, the implementation of green infrastructure—such as green roofs, permeable pavements, and urban forests—has been facilitated by EAs. These assessments have demonstrated how such projects can reduce storm water runoff, improve air quality, and enhance urban biodiversity.

### Example 2: Wildlife Corridors

EAs have been instrumental in the planning and design of wildlife corridors, which are critical for maintaining animal migration pathways. By assessing the potential impacts of infrastructure on wildlife, these assessments ensure that projects include measures to support ecological connectivity.

Several successful case studies illustrate the effective application of environmental assessments in achieving nature-positive outcomes:

- **The High Line, New York City:** This elevated urban park transformed an unused railway into a green space, enhancing urban biodiversity while providing recreational opportunities. An EA that considered ecological, aesthetic, and social factors was crucial in its planning and design.
- **Nature-Based Flood Management in the Netherlands:** The Dutch government has implemented various projects that utilize natural processes to manage flood risks. EAs have played a critical role in assessing the potential impacts of these initiatives on local ecosystems and communities.
- **Wildlife Corridors in Australia:** Infrastructure projects that incorporate wildlife corridors have been assessed through rigorous environmental evaluations. These corridors facilitate safe animal

movement across roadways and urban areas, reducing wildlife-vehicle collisions and enhancing habitat connectivity.

## Challenges and Limitations

Despite their benefits, EAs face several challenges:

### Compliance and Enforcement

The effectiveness of EAs often depends on compliance with their recommendations. Inconsistent enforcement of regulations can undermine the potential benefits of EAs.

### Funding and Resources

Comprehensive EAs require significant resources, which can be a barrier, particularly in developing regions. Limited funding may result in inadequate assessments and oversight.

### Stakeholder Conflicts

Balancing economic development with environmental protection can lead to conflicts among stakeholders. EAs must navigate these tensions to foster cooperative solutions.

## Future Directions

### Integration of Technology

Advancements in technology, such as Geographic Information Systems (GIS) and remote sensing, can enhance the effectiveness of EAs. These tools enable more precise assessments of environmental impacts and facilitate better planning.

### Strengthening Policies

There is a growing need for stronger regulations governing EAs. Policymakers must advocate for comprehensive and enforceable assessment frameworks that prioritize sustainability.

### Public Awareness and Education

Raising public awareness about the importance of EAs

in nature-positive development is crucial. Education initiatives can foster a culture of sustainability and encourage stakeholder participation in the assessment process.

## Conclusion

Environmental Assessments are vital in ensuring that infrastructure development aligns with nature-positive principles. By identifying potential impacts, promoting sustainability, and facilitating stakeholder engagement,

EAs contribute to the creation of infrastructure that benefits both human communities and the environment. As we face increasing environmental challenges, enhancing the role of EAs, EIAs to not merely meet requirements for getting statutory approvals but to also practically help protect the environment and mitigate impacts to help reduce pollution and global warming will be essential in guiding future development towards a more sustainable and harmonious coexistence with nature.

## Heidelberg Materials' first industrial concrete recycling facility in Poland uses award-winning FCB Rhodax technology

Published by Alfi e Lloyd-Perks (/team/alfi e-lloyd-Perks/), Editorial Assistant  
World Cement (<https://www.worldcement.com>)

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Heidelberg Materials, one of the world's leading manufacturers of building materials, recently commissioned Poland's first industrial concrete recycling plant. This innovative plant uses Fives' revolutionary FCB Rhodax technology, enabling 100% of demolition concrete to be recycled with optimum quality.

The FCB Rhodax® technology was awarded the French Marc Regnier Innovation-Recycling prize by the Société de l'Industrie Minérale, which recognises industrial projects with a significant impact on the circular economy and the reduction of CO2 emissions.

An advanced bed compression grinding technology to turn demolition concrete into new high-quality product

This material bed compression grinding technology transforms 100% of demolition concrete into high-quality aggregates, sand and cement paste, which can be reused as sustainable building materials.

Wolfgang DIENEMANN, Director Global Research & Development, stated that "After several pilot plant testing with the FCB Rhodax®, Fives see this as the best suited system to recover recycled cement paste from deconstruction concrete and get high-quality recycled aggregates and recycled sand."

A commitment to the sustainable development of building materials

This recycling unit represents a major milestone for Heidelberg Materials, illustrating its commitment to providing alternative, low-carbon building materials.

FCB Rhodax® technology opens up a new perspective for the circular economy, with 100% reuse of recycled fractions. High-quality recycled aggregates and sand can be used in new concrete, preserving natural resources and reducing energy consumption and CO2 emissions linked to quarry extraction. In addition, the extracted cement paste can be used as an additive in cement recipe, or fed into the raw process to produce low-carbon clinker.

To read the full press release, click here!

([https://webasset.fivesgroup.com/Cement\\_Minerals/Z.Download/Press%20Release\\_Heidelberg%20Gorazdze\\_Concrete%20recycling\\_FCB%20Rhodax\\_21-10-2024.pdf](https://webasset.fivesgroup.com/Cement_Minerals/Z.Download/Press%20Release_Heidelberg%20Gorazdze_Concrete%20recycling_FCB%20Rhodax_21-10-2024.pdf))

# British Standard BS 8524 - Essential for Fire Curtain Quality and Safety

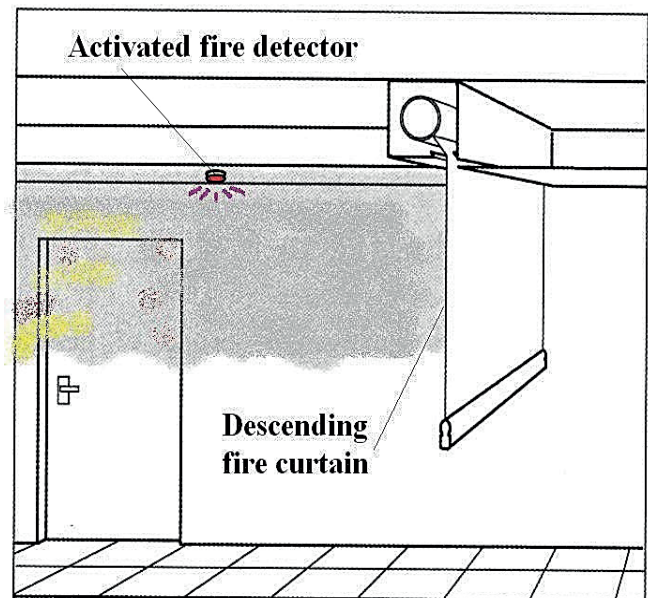
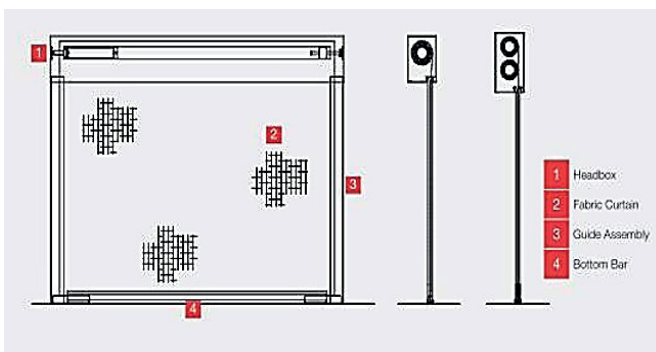


**Ray Kerry**  
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## Importance of Standards in Fire Safety

In fire safety, one concept stands above all: quality assurance. When lives and properties are at stake, rigorous standards ensure that fire protection products perform reliably in emergencies. Standards developed by industry experts provide clear performance and safety benchmarks that are crucial for the construction and safety industries.

In India, as buildings grow taller and more complex, fire safety becomes an ever-critical concern. Fire curtains, in particular, play a vital role in containing fire, controlling smoke, and allowing safe evacuation in buildings where traditional fire doors may be impractical. Adopting a globally recognized standard like BS 8524 which deals with Active fire curtain barrier assemblies, in India



can elevate fire safety standards, offering builders, architects, and safety engineers a reliable framework for specifying fire curtains that meet international quality and performance levels. The code comprises of BS 8524-1:2013 “Active fire curtain barrier assemblies – Specification” and BS 8524-2:2013 “Active fire curtain barrier assemblies - Code of practice for application, installation and maintenance”. Both are currently under review.

## Understanding BS 8524

The British Standard BS 8524 is specifically designed to test, assess, and validate the effectiveness of active fire curtains. Developed by a consortium of fire safety experts, the standard is one of the most comprehensive benchmarks available. It considers the full lifecycle of fire curtains, from design and testing to installation and maintenance, ensuring that fire curtains not only perform reliably under fire conditions but also remain durable over time. This paper breaks down the critical elements of BS 8524 and explores why they matter, especially in the Indian context



### Rigorous Fire Resistance Testing

At the heart of BS 8524 is fire resistance. Fire curtains must be able to withstand high temperatures for extended periods, protecting escape routes and compartmentalizing the fire to prevent it from spreading. The standard subjects fire curtains to stringent fire resistance tests, assessing both the fabric and the system components such as the motor, guides, and control panels. BS 8524 mandates that fire curtains be tested for fire integrity and insulation under challenging conditions.



For Indian construction projects, adopting BS 8524 would mean that fire curtains installed in high-rises, hospitals, shopping malls, and public facilities can be trusted to perform as intended, even in extreme fire conditions. That level of testing offers building owners and managers a higher degree of assurance that their fire safety measures are robust and effective.

### Mandatory Durability Testing: Prepared for Long-Term Use

In addition to fire resistance, durability is a key aspect

of BS 8524. Fire curtains are required to undergo hundreds of operational cycles to ensure that they can withstand regular usage over time. The standard includes testing for wear and tear, requiring fire curtains to be as dependable on their 500<sup>th</sup> cycle as they are on their first.

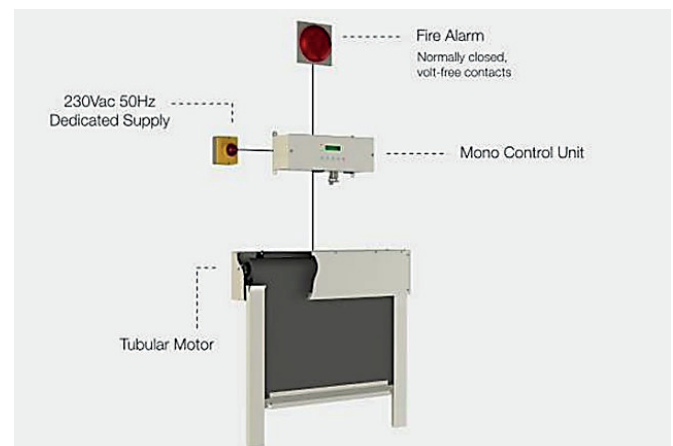


For Indian buildings, where high-traffic areas may demand frequent deployment of fire curtains, this durability testing ensures that fire curtains remain effective year after year. BS 8524 requires assurance that the curtains are built not just for emergencies, but for long-term reliability, even with frequent operational demands.

### Elevated Temperature Motor Testing: Ensuring Consistent Deployment

One unique requirement of BS 8524 is elevated temperature motor testing. During a fire, motors powering the fire curtain must continue to operate in intense heat to ensure deployment. BS 8524 mandates that these motors should still perform even when exposed to high temperatures, a critical factor for effective fire containment.

In India, that requirement is particularly relevant. BS 8524-compliant fire curtains offer added assurance that they will deploy reliably, even under heat stress, giving occupants and emergency responders more time to act in case of a fire.



### Emphasis on Maintenance and Safety Checks

BS 8524 not only governs the design and performance of fire curtains but also provides guidelines for maintenance and routine safety checks. Regular maintenance ensures that fire curtains deploy correctly when needed and that there are no obstructions or issues with components like side guides or self-closing mechanisms. The standard's maintenance requirements mean that fire curtains remain functional and ready for use throughout their service life.



For India's growing infrastructure sector, where fire safety is often overlooked in building maintenance, adopting BS 8524 could significantly improve ongoing fire safety practices. Scheduled checks as mandated by the standard will help ensure fire curtains are fully operational in case of an emergency, reducing the risk of system failure when it's needed the most.

### A Global Benchmark for Quality and Safety

BS 8524 has become the preferred standard in the UK and internationally for fire curtain specifications in life safety applications in respect of ISO. The standard is highly regarded for providing consistency in product quality and performance, offering a model for other countries aiming to enhance their fire safety practices.

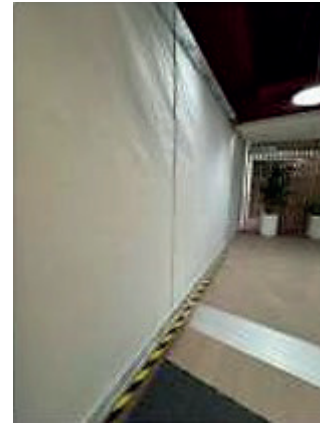
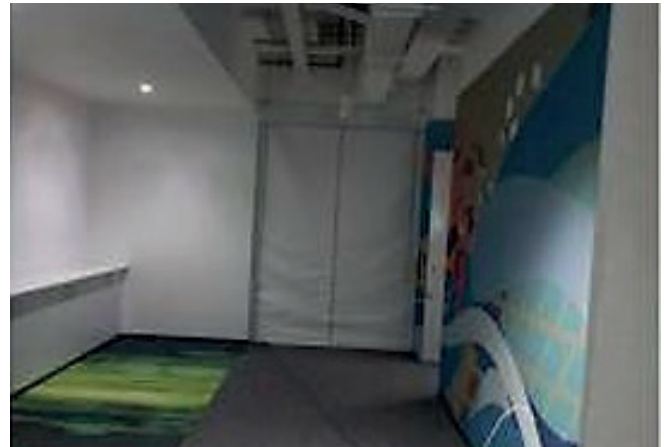
As India modernizes and urbanizes, adopting internationally recognized standards like BS 8524 can help Indian professionals align with global best practices in fire safety. Such alignment would especially be beneficial for high-profile projects, where developers and architects are increasingly expected to meet the highest safety standards. Adopting BS 8524 would allow



Indian companies to gain credibility in the global market, enhancing confidence among clients and stakeholders.

### The Benefits of BS 8524 for Fire Safety

For India, the adoption of BS 8524 presents a unique opportunity to set a new benchmark in fire safety. By embracing the British Standard, Indian architects, engineers, and safety officials can specify fire curtains that meet globally recognized standards for performance, durability, and reliability.



## Key Benefits of Adopting BS 8524



- **Increased Safety:** With reliable fire containment and deployment, BS 8524-compliant fire curtains can significantly improve building safety, particularly in high-rise structures and commercial facilities.



- **Reduced Maintenance Costs:** BS 8524 ensures product durability and provides clear guidelines for maintenance, which can reduce long-term maintenance costs and prevent costly repairs.



- **Enhanced International Credibility:** Meeting the British Standard for fire safety can improve the reputation of Indian construction projects, making them more competitive and attractive to global investors and clients.

## Achieving World-Class Fire Safety Standards in India

The adoption of BS 8524 in India could pave the way for a safer future. By setting fire curtains to a higher standard, architects, engineers, and contractors can aim to protect lives more effectively and align with global best practices. With BS 8524, Indian fire safety can advance, providing robust protection that's trusted worldwide.

Standards aren't just about compliance; they're about ensuring that a product performs as intended, every

single time. By adhering to BS 8524, Indian projects can demonstrate a commitment to safety, reliability, and quality that truly matters.



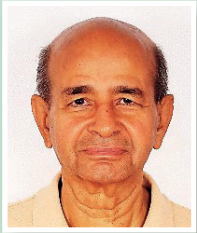
For India's rapidly expanding cities and infrastructure, BS 8524 offers a path toward world-class fire safety, safeguarding lives and properties while building trust and credibility on the global stage. Embracing this standard could become a defining step in India's journey toward enhanced fire protection, proving that high standards are essential not just in theory but in practice.

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## About the Author

Ray Kerry has served 24 years in the smoke and fire curtain industry, having designed and developed products that have set the benchmark for others going forward. He is a leading expert in the field of smoke and fire curtain systems representing BSI on committees for associated standards in the UK (BS), Europe (EN) and International Standards (ISO). Ray has worked on iconic projects such as the Louvre, Abu Dhabi, Battersea Power Station (UK), One Za'abeel (UAE), Museum of the Future (UAE) and Dubai International Airport (UAE) to name but a few.



## A P Mull

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Development and Growth are propelling the country on a fast track in all spheres of human activities. Engineers, Scientists and other Technical personnel are essential for both - development and growth, to translate the requirements into fit for purpose facilities, then operate and maintain them for their design service life. Thereafter what is made needs to be checked if it is fit for the same use further if required or whether it can be used for some other purpose or is to be demolished/ dismantled and disposed of by segregating the components. The full cycle of use and reuse needs to be predetermined.

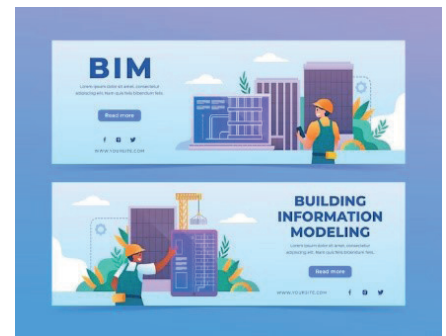
In providing all those services the Consulting Engineers are facing many challenges. CEAI through its workshops, seminars, lectures and its quarterly magazine 'ViewPoint' has been taking up various matters concerning consulting engineering – to bring the fraternity up to speed on the new developments, tools and techniques. CEAI has also been taking up and pursuing matters that concern the consulting engineering fraternity with the Government. Some of the major issues that impinge on a consulting engineer's repertoire are discussed hereinbelow.

## Roles, Responsibilities, Accountabilities, Contracts & Project Planning

Since ancient times, Vishwakarma, Kautilya, Ham-

murabi, and others prescribed the rules, codes, and laws for construction of buildings - the builder was accountable and responsible for any mishap. Then the number of professionals and trades involved were few, whereas today the number of professionals and trades involved in a project are many due to the size of the projects having become enormous and the complexity involved. The roles are many and the accountability and responsibility thus rests on a greater number of persons involved with the project starting with that of the project owner, the concerned authorities/ bodies, the professionals such as architects, engineers and scientists, the workmen, the facility users, the maintenance personnel, etc.

It is necessary that the role and responsibilities of each is defined so that one knows what one is accountable for. Very often the project owner shelves the responsibility, especially that of obtaining statutory clearances to one of the contracted person/ agencies, when, in reality, it



is the owner, in case of government projects, who is best placed to getting those clearances.

The spate of failures and accidents in the past few years itself clearly go to show how lightly some parties take their role, responsibility, and accountability to be. The professionals in the eagerness to be part of the project accept to do that which is really not to be in their ambit. That is a practice that needs to be put an end to.

The contract must be well balanced – be equitable and clearly define each party’s scope of work, the timelines for executing each activity, the consequent penalty and extension of time for delay by any of the parties concerned with the project, define the purpose, use and the period (design service life for the structures, plant & equipment, etc.) which the facility is to be provided for, how the facility will be maintained, how the project records of the facility will be maintained and their authorised updating, should any modifications be done during the design service life, plan for the end of life usage or disposal, etc. The planning must be holistic and fully coordinated with all requirements properly integrated.

The above calls for a relook at the project planning and the contracts, especially the obligations of each party on the project. These can be much better done and integrated with the help of AI, VR/AR, 3D, Digital Twin and other digitised working tools now available. Needless to add that all the parties concerned would need to be working on the same platform.

### Materials for the Project

Projects, especially the big ones require a large quantum of materials, most of which come from scarce and defined natural resources. These are available as a natural material only once. Hence it is imperative that they be used sparingly and with care in a manner that does not have adverse effects on nature. Materials that are recyclable or regeneratable should be the preferred ones. Needless to add that the necessary quality tests must be done for all materials. All this is no small task – it requires dedication and steadfast determination but must still be done within a specified time schedule.

### Manpower for the Project

Trained, skilled and experienced human resources is the main requirement for a project and covers all the



professionals and trades persons. Each must have a positive and ‘can do’ attitude, be ready to take up challenges, albeit with due preparation, and, are able to work in a team. There is also a need to look at project requirements in a holistic, integrated and coordinated manner and not discipline or trade wise. It is only then that there will be true unification in meeting the project requirements and the results will be astounding – completion of a classic project and innate self-satisfaction for each and every one on the project.



With the changing technological scenario and the requirements of the projects it is essential that each and every person continues to develop professionally.

Where a project requires cutting edge technological inputs, the team must innovate, carry out desk or laboratory or test house research, and be ready for the grind.

### Digitalisation

In the normal course a project takes a rather long time to get off the ground and an even longer time to translate into physical functional reality. However, the digital era has brought in its wake a plethora of digital solutions in the form of software,



hardware, instrumentation and gadgets that enable reduction in time for the project plus also provide comparable if not better solutions. They also enable better project management, faster and better controlled work execution, quality control, etc.

The dilemma that the consulting engineers, especially the senior ones, faced a few decades ago was whether to change from manual to digitalisation and then again should that transformation be done in part or in total. At that point of time stepwise adoption of digitalisation would have been feasible and then they could have kept pace with the developments and adapted to them as and when they were announced since then the clients – the project owners or developers were themselves way behind times. However, today, the scenario is different. The Project owners and developers have adopted and advanced into digitalisation of their work processes and systems. It is therefore imperative that the Consulting Engineers come upto speed and be a few steps ahead and truly function as a Consultant to their Client.

The Consulting Engineer thus needs to be abreast of the developments that would aid all the facets of a project right from concept, to design, to physical execution, to testing and certifying, the management of the facilities created and finally its end of design service life reuse or disposal.

AI is the in thing today and as it develops it will make many routine tasks easier and faster to perform plus provide a number of alternatives to choose from and even suggest as to which one would be the most suitable.

Whilst all that is most welcome the consulting engineer should not forget to apply his/ her own experience and knowledge.

One must not forget the adage - GIGO (Garbage In Garbage Out), for in the ultimate analysis it is the human mind that is the creator.



**It all Zero's down to Abiding by CEA's Code of Ethics and maintaining Professional Integrity.**

**Consulting Engineers**  
**Accept the Challenges**  
**Move Forward Boldly**  
**With Courage of Conviction**  
**Of Knowledge, Experience & Capabilities**

# CEAI NEWS

## CONFERENCE ON “RECENT DEVELOPMENT OF LAWS AND THEIR IMPACT IN CONSTRUCTION INDUSTRY”, 18<sup>th</sup> OCTOBER 2024, MUMBAI

The CEAI-Western Region Centre had organised a Conference on “*Recent Development Of Laws And Their Impact In Construction Industry*”, 18<sup>th</sup> October 2024, at the Taj President in Mumbai.



**Dr. Harshavardah Subbarao**, Member CEAI Governing Council and Chairman CEAI-WRC welcomed the Chief Guest, the Distinguished Guest, the speakers and the participants and gave a brief about CEAI and its functioning. He

then informed the gathering of the untimely demise of Mr. Jeffrey Nambiar who was the Hon. Secretary & Treasurer of CEAI-WRC and requested for a minute silence to pay respect to the departed soul.



Thereafter he invited the dignitaries to light the lamp after which the Chief Guest **Hon'ble Justice (Retd) R. Y Ganoo**, Former Judge Bombay High Court gave his address. He stressed on the need to

keep abreast of the laws as they develop so as not to be caught off guard. He also informed that a Circular had been issued by the Ministry of Finance, Government of India on the 3<sup>rd</sup> June 2024 on the subject of “*Guidelines for Arbitration and Mediation in Contracts of Domestic Public Procurement*” which limits arbitration to disputes with a value less than Rs. 10 crores. That he said would change the remediation scenario.



**Mr. Parimal K Shroff**, Proprietor, M/s. Parimal K Shroff, Advocates and Solicitors was the Distinguished Guest and while dwelling on the “*Scope and Future of Arbitration in Construction Contracts*” on account of the

increasing complexity and interdependence of various services for construction works he inter alia emphasised that design engineers must be conversant with contracts and the laws that govern them so that they know exactly what their responsibilities are and that they should keep those in mind while performing their job. The same applies to the engineers at the work sites He then reiterated that the MoF, GoI circular of 3<sup>rd</sup> June 2024 will affect arbitration in a big manner and was not really in keeping with what GOI had earlier desired that India be an International Arbitration hub like Singapore, etc. He added that the two would need to be reconciled.



**Dr. Milind Wankhede**, Legal Advisor, Construction Contracts & Arbitration Law, Adjunct Professor, IIT Bombay, Member Core Committee, CEAI-WRC spoke on the “*Types of Construction Disputes and the Best Practices*

*for an Effective Resolution*”. He dealt with the causes (facts) that lead to disputes, the types of disputes, the remedial measures to avoid some of the disputes, etc. He then covered the various stages of the dispute about the case of termination which arose between the Dehi Metro Rail Corporation and the Delhi Airport Metro Express Private Ltd.

**Ms. Shwetha Bidhuri**, Director & Head South Asia, Singapore International Arbitration Centre (SIAC) talked on “*Institutional Arbitration for Construction Disputes*”. She spoke of the current global, regional and



local growth areas and the sectors for growth in the construction industry; what distinguishes construction arbitration; common causes of construction disputes; why arbitration is the norm for construction disputes; the considerations for drafting arbitration clause; and why Institutional Arbitration is preferred. She went on to talk about SIAC's expertise and experience and the Emergency Arbitration and the SIAC procedure and its benefits.



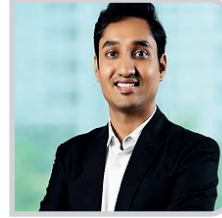
**Mr. Aditya Gupte**, Partner, Tuli & Co. dwelt on "*Recent Judgments on Loss of Profit - Government's Guidelines for Arbitrating High Value Disputes*". He set the context by explaining Sec 73:

Compensation for loss or damage caused by breach of contract and explained with reference to some cases. He then moved on to the formulae used for determining the compensation such as the Hudson Formula, the Emden Formula and the Eichleay Formula and explained with reference to a few cases. He went on to say that the solution lay in pleading and proving the claim. He then explained the Guidelines for Arbitration and Mediation in Contracts of Domestic Public Procurement issued by the Ministry of Finance, Government of India in June 2024.



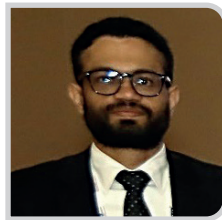
**Mr. Rohit S Mishra**, Senior Manager-Legal, TATA Consulting Engineers Limited covered "*Extension of Time, Prolongation Costs & Compensation*". He presented the data on the expected growth of the Indian construction industry primarily by Green Energy Projects, Road, Rail & Housing Projects. However, along with that there has been an increase in disputes due to delays in projects as per the data of the Ministry of Statics and Programme Implementation, Government of India. He then covered Extension of Time, Prolongation Cost, and the Claims & Compensation that arise on account of them.

He explained Extension of Time, Damages for Delay, Compensation issue as per the Indian Contract Act and showed some judicial interpretations of the recent past.



**Mr. Ayush Banka**, Senior Consultant, Osborne Partners expanded on "*Quantification of Claims and Damages - Proving Project Costs and Damages*" very succinctly explained what damages are as per English Law,

what can be claimed, the role of an expert in an arbitration, and that the assessment is to be reliable and persuasive. He recapitulated the distinctive features of the construction sector and explained the accounting process for costs and the sources available for working on that. He moved on to discuss as to how much evidentiary support is enough, how a company's structure and operations affect the working and thus the case. He also dealt with the three formulae for overhead allocation of cost and termination payment.



**Mr. Amrit Singh**, Partner, Tuli & Co. moderated the **Panel Discussion**. The Panel Members were Dr Milind Wankhede, Mr. Ayush Banka, Mr. Aditya Gupte and Mr. Rohit S Mishra. They summed up all that was discussed

by the various speakers and elaborated where the need arose.



**Mr. A P Mull**, Member CEAI Governing Council and Co-Chairman CEAI-WRC thanked the dignitaries, the speakers, the select audience, the vendors, and Taj President for enabling the conference.



*Welcome Address by  
Dr. Harshavardhan Subbarao, Chairman CEAI-WRC*



*On the dais: (L to R): Dr. Milind Wankhede,  
Mr. A P Mull, Hon'ble Justice (Retd) R. Y Ganoo,  
Mr. Rajat Taimni, and Mr. Parimal K Shroff*



*Chief Guest Hon'ble Justice (Retd) R. Y Ganoo Former  
Judge Bombay High Court addressing the Conference,*



*Distinguished Guest Mr. Parimal K Shroff  
Proprietor, M/s. Parimal K Shroff  
Advocates and Solicitors*



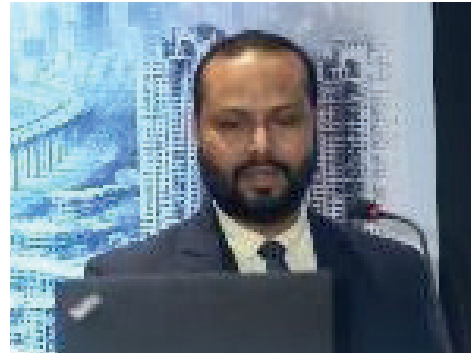
*Dr. Milind Wankhede  
Legal Advisor, Construction Contracts &  
Arbitration Law, Adjunct Professor, IIT Bombay, Member  
Core Committee, CEAI-WRC*



*Ms. Shwetha Bidhuri  
Director & Head South Asia, Singapore International  
Arbitration Centre*



*Mr. Aditya Gupte Partner, Tuli & Co.*



*Mr. Rohit Mishra, Senior Manager-Legal  
TATA Consulting Engineers Limited*



*Mr. Ayush Banka  
Senior Consultant, Osborne Partners*



*Panel Discussion Members:  
Mr. Amrit Singh, Mr. Rohit S Mishra, Mr. Ayush Banka,  
Dr Milind Wankhede, and Mr. Aditya Gupte.*



*L to R: Mr. Amrit Singh, Mr. Aditya Gupte, Ms. Shweta Bidhuri, Dr Harshavardhan Subbarao, Mr. A P Mull,  
Mr. Parimal K Shroff, Hon'ble Justice (Retd) R. Y Ganoo, Dr Milind Wankhede, and Mr. Rohit Mishra*



*View of the Audience*

## GLOBAL SERVICES EXPORT CONCLAVE ON “DESIGN, ENGINEERING, CONSTRUCTION, R&D AND ENVIRONMENT SERVICES”, 29<sup>th</sup> OCTOBER 2024, NEW DELHI

The conclave on 29<sup>th</sup> Oct 2024 at Le Meridien Hotel, New Delhi by SEPC and CEAI was with the objective to grow the potential of Indian players in export of services on a global platform. The conclave targeted to explore:

- Target Markets, Sectors & Services
- Current Opportunities and Future outlook
- Business Development efforts required
- Expected Government Support in expanding the footprint of Indian Players
- Emerging Global Business Opportunities for Indian companies in consultancy services funded by Multilateral funding Agencies (for Overseas Opportunities)
- India’s differentiated offering for Global markets
- Experiences, Issues and Challenges, Risks & Mitigation and Doing Business in Global Environment

The conclave was structured into four sessions in hybrid mode in which key officials from various Ministries, Indian Ambassadors to various countries, diplomates, representatives from The World Bank, Asian Development Bank, Industry Experts and Eminent Speakers participated.

### Inaugural Session



**Mr. R S Sharma**, President CEAI, extended his warm welcome to the Chief Guest, Dr. Senthil Nathan S, Director, Ministry of Commerce and Industry; Mr. Amit Sharma- Design & Engineering Services Head in SEPC and Managing Director, TATA Consulting Engineers Limited, Dr. Abhay Sinha, Director General, SEPC and Mr. J V L Narayana, Vice President CEAI. Mr. R S Sharma highlighted the collaborative efforts of CEAI and SEPC and emphasised the role of CEAI in creating quality and ethical values amongst the engineers. Mr. R S Sharma stressed the need and importance to work in the key areas emphasised by the Hon’ble Minister of Commerce & Industry.

Addressing the conclave in the inaugural session, the Chief Guest, **Mr. Senthil Nathan S**, Director, Ministry of Commerce and Industry highlighted that India’s services exports are set to overtake manufacturing ex-



ports by the end of the decade. That transformation, he added, was being fuelled by manufacturing itself becoming more service oriented with AI, IoT and 3D printing revolutionising production processes and enabling India to compete globally. Elaborating further on the strength of service exports, Mr. Nathan said that through the right efforts to skill and reskill, the Indian economy cannot only close skill gaps but also set a new benchmark in engineering efficiency. "It can help to drive India's exports and global standing. Our future is engineered, from the homes we live in to the roads we travel. These silent background minds make life happen, delivering ease of living, through invisible engineers." He is of the firm opinion that by building right synergies between government, industry, and educational institutions we can make our talent pipeline over one and a half million engineers annually – and building a workforce ready to shape the next wave of innovation.



In continuation of the views expressed by Mr. Nathan, **Mr. Amit Sharma** stated that India was witnessing a thriving services export economy driven by engineering services, which have generated an estimated \$34 billion, growing at 15%.

The consulting services are also expanding at an impressive 25%, showcasing expertise in energy transition and supply chain resilience. Lauding India's engineering and scientific achievements, Mr. Amit Sharma said that milestones such as the success of Chandrayaan 3 highlight the country's capabilities. Mr. Amit Sharma also added that India is well-positioned to align its strengths with global demand. The growth of the services sector and the dedication of our engineers and innovators promise a bright future where India continues to set new standards in engineering and innovation worldwide and he hoped we would continue having such gatherings to pave the way forward.

**Dr. Abhay Sinha**, Director General, SEPC added that India's services exports have shown remarkable



growth, rising from \$325 billion in 2022-23 to an estimated \$341 billion in 2023-24. Noting how the engineering services sector has made a vital contribution, increasing from \$31 billion to \$35 billion within the same period, he said the sector is projected to grow further, potentially reaching \$100 billion by 2030 if a CAGR of 18% is maintained. The focus on engineering, design, construction, and R&D will be crucial in harnessing those opportunities. He added that SEPC-CEAI are looking forward to the industry and the ministries coming together to focus on opportunities like expos that focus on capturing new emerging markets.



*Chief Guest, Dr. Senthil Nathan S, Director, Ministry of Commerce and Industry, Government of India lighting the lamp to inaugurate the event.*



*Dr. Abhay Sinha, Director General, SEPC and Mr. J V L Narayana, Vice President CEAI, lighting the lamp.*



*Dr. Abhay Sinha, Director General, SEPC set the context for the conclave.*



*Mr. Amit Sharma- Design & Engineering Services Head in SEPC and Managing Director TCE, gave the formal address and highlighted the country's capability and the expanding scope of the consultancy services.*



*Mr. R S Sharma President CEAI and Mr. Amit Sharma- Design & Engineering Services Head in SEPC and Managing Director TCE, lighting the lamp.*



*Dr. Senthil Nathan S, Director, Ministry of Commerce and Industry, addressed the conclave and highlighted that India's service exports are set to overtake manufacturing exports.*



*Mr. R S Sharma, President CEAI giving the Welcome Address.*



*Mr. Amit Sharma presenting a bouquet to Dr. Senthil Nathan S.*

### Session -1: Oceania & NEA region (focused countries: Australia; Japan; New Zealand)

The take-aways from this session included opportunities for Indian players in energy transition, carbon neutrality, growth of infrastructure, supply chain transition, opportunities to Indian players due to China and global dynamics. The panellist brought out the fact that SEPC-CEAI through the Ministry of Commerce and Industry, Government of India can help grow the footprint of Indian players by branding services in the region such as One India Pavilion, etc. and emphasising the capability and expertise of India players in Consulting engineering services. It was also emphasised that smaller countries in the region have Engineer's Bill whereas such a bill is non-existence in India and the session emphasised the immediate need to escalate to GOI such requirement. The World Bank is investing in the nations of pacific islands and there are ample opportunities for Indian players in design, engineering, project management activities in infrastructure development in the region which can be tapped by the Indian players by collaborating with local firms and governments.



*Panellists: Ms Sneha Redla, Vice President, Aarvee Associates, Mr. Biswajit Bhattacharya Business Head - Mining and Metal – TCE, Mr. Rajesh Rohatgi Infrastructure Program Leader - World Bank Asia Pacific  
In the backdrop: Mr. Manish Dabkara, Chairman & MD, EKI Energy Services Ltd. and Dr. Dhiraj Kumar Singh Managing Director, GRC India*



*Mr. Rajesh Rohatgi, Infrastructure Program Leader – The World Bank Asia Pacific, responding to a question raised by a participant.*

### Session-2: ASIA & CIS region (focused countries: Indonesia; Kazakhstan Philippines; Uzbekistan; Vietnam)

Vietnam and India have reinforced their bilateral relationship which has resulted in preference to Indian firms and big opportunities in Railways, Metro, High Speed Rail, Airport expansion, Deep Seaports, Roads, Industrial Parks and Smarts Cities. Vietnam is heavily investing on the infrastructure including improvising the water and wastewater facilities. With improved connectivity and the opportunities to India players have developed in the recent past. There is a great need to capture the market and SEPC-CEAI through the GOI can ensure the greater participation of Indian firms in the country. ADB has a huge investment plan for the infrastructure in the Philippines which include the expansion of Metro, Rail, Ports, Highways and Urban Development. The participation of Indian players was fewer earlier however has recently started increasing. The working environment is quite good for India players and efforts are to be made to brand Indian companies which are cost effective when compared to European or American companies. Uzbekistan being an Uranium rich country can help India in sustaining its nuclear power plant and help achieve its electrification targets. Uzbekistan is a prosperous destination for investment in areas of infrastructure for better regional connectivity

which can help India to increase its trade exports. Based on the recent bilateral treaties between both countries, areas of cooperation and opportunities for the Indian service sector in expansion of infrastructure are found to be good and sustainable. Post Covid, Indian exports of generic drugs to central Asia grew considerably. The expansion of the Indian pharmaceutical industry in the country looks promising. ABD presented the opportunities in the region which shows a promising growth platform for the Indian players.



*Panellists: Mr. Amit Sharma, MD, TCE, Dr. Madan Mohan Sethi, Consulate General of India, Ho Chi Minh City, Vietnam, Mr. Pankaj Gupta, Managing Partner, Roark Consulting Engineers LLP, Mr. Anil Prakash, Director General, Satcom Industry Association (SIA India), Mr. M. Shyam Sunder Mehndiratta, Senior Procurement Officer, ADB – India.*

*In the backdrop: Mr. Pavit Ramachandran, Country Director for Philippines, ADB – India*



*View of Audience in Session 2*

### Session-3: AFRICA & GCC Region

The Ambassador, Embassy of India, Riyadh, Saudi Arabia - H. E. Dr. Suhel Ajaz Khan in his video message highlighted the growing opportunities for Indian industry in the GCC Region. With the recent strengthening of the bilateral trade between the GCC countries and India, the opportunities in Oil, Gas, Refineries, Power, Infrastructure, and the Railways/ Metros sectors are showing promising growth opportunities for Indian firms in the region. While Africa continues to be an investment destination in infrastructure, health, water resources, drinking water



*Panellists: Mr. J V L Narayana, VP – CEAI, Mr. Shivank Garg Founder Director, Kaizen Steel Building Solutions Pvt. Ltd, Mr. Ram Sharma Assistant General Manager, Shapoorji Pallonji EPC, and Mr. S. K. Puri Executive Director, ICT*

*In the backdrop: Mr. Faizi Mohsini CEO & Managing Director, GEMS Gulf, UAE*

supply, sanitation and energy sectors, there is risk of securing projects, repatriation of funds, tax issues, etc. Indian firms should work as a group to secure projects and form a consortium to provide end to end services and construction in the region. Indian players should be able to identify bankable projects in the region and deliver the services in collaboration with local governments and local consultants to ensure complete project cycle in the region.

**Session 4: LAC, NAFTA & EU Region**

The sessions have brought out many opportunities for Indian players in Chile, Brazil, Argentina Peru and other LAC counties, which include mining, metals such as copper, food processing, infrastructure and medical facilities. Trade with LAC countries have considerably

increased in the recent past and LAC offers many opportunities which are untapped by Indian players as emphasised by H.E. Dinesh Bhatia, Ambassador, Embassy of India, Argentina and H.E. Ms. Abhilasha Joshi, Ambassador, Embassy of India, Santiago, Chile. The Ambassadors collectively emphasised and welcomed SEPC-CEAI initiatives and expressed their keen support to encourage and provide necessary assistance to increase the footprint of India players in the region. Space technology is another area which has growing demand for India players in Denmark and Indian firms in collaboration with Danish players can make a significant contribution to increase their exports. GOI support to MSME in space technology was clearly emphasized as one of the outcomes of the session.



*Panellists: Dr. Abhay Sinha, Director General-SEPC, Mr. Chandan Sinha, Associate Director & Planning Lead, AECOM India Private Limited, Mr. Sethu Saveda Suvanam, Founder and CEO, ReOrbit OY*

*In the backdrop: H.E. Manish Prabhat Ambassador, Embassy of India, Denmark and Mr. Naga Bharath Daka Co-Founder, Skyroot Aerospace*



*In the backdrop: H.E. Manish Prabhat Ambassador, Embassy of India, Denmark, Mr. Naga Bharath Daka Co-Founder, Skyroot Aerospace, and H.E. Ms. Abhilasha Joshi Ambassador, Embassy of India, Santiago, Chile*



*Mr. A. S. Brara, CEAI, GC Member alongwith the session panellists*



*Mr. J V L Narayana, Vice President – CEAI, sharing the takeaway from the conference.*

### Conclusion:

The event encompassed the differentiated value that India brings to the global stage, examining opportunities, challenges, and risks associated with international growth, alongside practical insights for expanding business footprints across diverse markets.

With the above take-aways SEPC-CEAI will prepare a roadmap on branding service industry and intend to organize a global conclave outside India to promote the service industry.

### ANNUAL CONFERENCE OF FIDIC ASIA PACIFIC (FAP) – 18<sup>th</sup> TO 20<sup>th</sup> NOVEMBER 2024, KATHMANDU, NEPAL

The FIDIC Asia Pacific Annual Conference 2024, held from 18<sup>th</sup> to 20<sup>th</sup> November 2024 in Kathmandu, Nepal, was hosted by the Society of Consulting Architectural and Engineering Firms (SCAEF), Nepal, a member association of FIDIC. The theme for this year's conference was *“Governance for Climate Shocks”*.

A good number of members of CEAI Attended the conference:

- Mr. R. S. Sharma, President CEAI
- Mr. Prashant Kapila, Member GC, CEAI & Member FIDIC Board
- Dr. Ajay Pradhan, Past President, CEAI
- Mr. Arvinder S Brara, Member GC, CEAI
- Mr. Gagan Anand, Member GC, CEAI
- Ms. Vandana Randhawa, Member CEAI
- Ms. Veera Biradar, Member CEAI
- Mr. Sachin Pant, Member CEAI
- Mr. Ajit Mishra, GM DFCC

With around 400 delegates attending, the conference was a grand success. FIDIC's President Ms. Catherine Karakatsanis also graced the conference. Many senior engineers from consultancy firms and government organisations were present throughout the event. Professionals from the industry and educational institutions also contributed to the discussions.

The Society of Consulting Architectural and Engineering Firms, Nepal (SCAEF) has signed memorandums of understanding (MoUs) with several universities and colleges to promote learning and collaboration. Around 30 volunteers from these colleges played a vital role in organising the event.

The FAP General Assembly Meeting (GAM), chaired by Mr. Sudhir Dhawan, covered several important agenda items. A special mention was made of the active participation of three engineers from the

Pakistan Consulting Association. Their enthusiasm and willingness to collaborate with India and other countries were appreciated by everyone.



*Mr. R. S. Sharma, President CEAI participating in the Conference*



*Ms. Catherine Karakatsanis  
President FIDIC delivering her address*



*Mr. S K Kaul, Group Director Holtec Consulting received  
the award from Ms. Catherine Karakatsanis*

Mr. Prashant Kapila and Mr. Sudhir Dhawan chaired a session and the Panel Discussion.



*Mr. Prashant Kapila*



*Dr. Ajay Pradhan*



*Mr. Prashant Kapila*



*Mr. Ajit Kumar Mishra*

There were 3 speakers from India:

- Mr. Arvinder S Brara
- Dr. Ajay Pradhan
- Mr. Ajit Kumar Mishra



*Mr. Arvinder S Brara*



*Mr. R S Sharma and Mr. Arvinder S Brara*

The FAP Awards were presented during the GAM event. M/s Holtec Consulting Pvt. Ltd. from India received an award for their outstanding project on the Waste Heat Recovery (WHR) designed to harness waste heat generated during cement production process installed at a cement plant in Karnataka.

CEAI President Mr. R. S. Sharma along with Mr. Sudhir Dhawan, held a meeting with Mr. Thakur Sharma President SCAEF-Nepal. During the discussion, various areas were identified where India and Nepal could arrange exchange programmes on a reciprocal basis to foster mutual benefits.



## CEAI-WWF Webinar

The fourth webinar in the series of Nat-Infra Dialogue series on Natural Resources Safeguards in Linear Infrastructure Development in India was held on 22<sup>nd</sup> November 2024. It focused on the use of GIS based tools for informed decision making in LI development. Mr. R. S. Sharma, President Consulting Engineers Association of India gave the introductory remarks. Dr. Areendran G., Director – Tech for Conservation, WWF-India presented the Rapid Infrastructure Impact Assessment Model (RIIAM) developed by WWF-India in collaboration with the Carnegie Mellon University under the support of AI for Social Good project by Google Inc.



Link to the webinar:

[https://www.wwf.org/about\\_wwf/asia\\_linear\\_infrastructure\\_safeguarding\\_nature/?27362/Nat-Infra-Dialogue-Use-of-GIS-in-LI-development](https://www.wwf.org/about_wwf/asia_linear_infrastructure_safeguarding_nature/?27362/Nat-Infra-Dialogue-Use-of-GIS-in-LI-development)

## FIDIC AWARDS 2024

FIDIC announced the winners of its annual FIDIC Member Association Excellence Awards at a gala dinner event held in Geneva on 10<sup>th</sup> September 2024, their fifth year, to highlight the achievements and successes of FIDIC's International Member Associations and their work representing the global engineering consulting industry. This year the judging panel chose winners across four categories – People and Culture, Advocacy, Inspiring the Next Generation and Showcasing Value.

Speaking at the awards ceremony in Geneva, the FIDIC President Ms. Catherine Karakatsanis said: *“These awards showcase the significant achievements and successes of FIDIC's brilliant global member*

*associations and the excellent work that they do in representing the global consulting engineering industry. Our members work day-in, day-out on behalf of their member firms and we are delighted to be able to pay tribute to this work through these awards. All the winning entries demonstrate how member associations address key issues facing their industry and platform them to a wider audience, helping to raise the profile of this crucial industry sector.”*

The winner of the **MA Excellence Award for Showcasing Value** was the **Consulting Engineers Association of India** for the **“CEAI Compendium”**; a campaign that showcased the spectacular engineering accomplishments made in India since it gained its independence nearly eight decades ago.

It also highlighted a roadmap for the consultancy of the future, demonstrating not only the progress made over that time, but also engendering a sense of pride to encourage the sector to strive to achieve even higher levels of excellence. The judges were impressed by an entry that promotes the significant value that engineers bring to society and an initiative which is dedicated to the spirit of the unsung Indian engineers who triumphed over formidable challenges.





Mr. R S Sharma, President, Consulting Engineers Association of India received the FIDIC Member Association Excellence Award, for “SHOWCASING VALUE”, from FIDIC President Ms. Catherine Karakatsanis

## WEBINAR ON CHALLENGES OF URBAN TUNNELING IN METRO CONSTRUCTION HELD ON 14TH DECEMBER 2024 AT 11:00 AM

President CEAI, Mr. R. S. Sharma extended a warm welcome to all participants at the webinar held on December 14, 2024 on the “*Challenges of Urban Tunnelling in Metro Construction*” which around 55 persons attended. It focused on the complex challenges associated with the construction of underground structures in metro rail projects, particularly in urban environments. It highlighted the technical difficulties faced during the Delhi Metro Project and emphasized the need for stringent settlement criteria and protection measures in densely populated areas, where construction often impacts the surrounding infrastructure.

### Key Topics Discussed:

#### 1. Tunnelling and Interaction with Existing Structures

A significant challenge discussed was the interaction between new tunnels and existing piles of the elevated metro lines since it could potentially have detrimental effects on the stability of the nearby structures. The presentations highlighted how thorough geotechnical studies were essential to understanding and mitigating the risks.

#### 2. Safety in Low-Cover Tunnelling Operations

Another challenge shared was related to tunnelling operations in areas with low cover, especially at the transition zone between cut-and-cover tunnels and Tunnel Boring Machine (TBM) driven sections. The safety considerations and strategies used to ensure stability and minimize risks to workers and adjacent structures were discussed.

### Presenters:

- **Mr. Ayan Kundu** – Geotechnical Expert with 16+ years of experience in deep excavation, foundation design, and tunnel geotechnical engineering. Ayan has worked on numerous metro rail, marine, power plant, refinery, and industrial projects globally.

He is currently serving as a Geotechnical Expert at Intercontinental Consultants & Technocrats Pvt Ltd, focusing on the underground metro projects of Delhi Metro (DC09), Mumbai Metro (UGC03), and Bhubaneswar Metro.

- **Dr. Jishnu R B** – Tunnelling Expert with 15+ years of experience in tunnel geotechnical engineering. He holds a Ph.D. from IIT Delhi and has worked on metro rail, highways, and railways projects across India. Jishnu is also a Tunnelling Geotechnical Expert at Intercontinental Consultants & Technocrats Pvt Ltd, with experience in the Delhi, Mumbai, Nagpur, Lucknow, and Chennai Metro projects.

The session provided a valuable opportunity for professionals to learn about the complexities of underground metro construction and the innovative solutions used to tackle the challenges.

## CEAI NATIONAL AWARDS 2024

CEAI received a total of 14 applications across various categories by the prescribed deadline. To select the awardees, CEAI constituted an External Jury comprising distinguished members:

1. Sh. K. N. Agrawal, Former Director General of CPWD, and Chairperson of the Jury
2. Dr. Prabhat Kumar, IRS (Retd.)
3. Mr. Nirmaljit Singh, Former Director General (Road Development) & Special Secretary, MoRTH

After evaluation, the Jury selected the following individuals and organizations as the recipients of the CEAI Awards 2024:

### A. INDIVIDUALS

- i). CATEGORY A: PROJECT ENGINEERING
  - ANAL NARESH SHAH
- ii). CATEGORY B: ENGINEERING INNOVATION
  - No application was received.

### B. ORGANISATIONS

- i) CATEGORY A: GROUP 1 UPTO RS 50 CRORES: PROJECT ENGG.
  - BARSYL
- ii) CATEGORY A: GROUP 2 ABOVE RS 50 CRORE: PROJECT ENGG.
  - WAPCOS LIMITED
- iii) CATEGORY B: GROUP 1 UPTO RS 50 CRORES: INNOVATION
  - Tech TANGENT Solutions Pvt. Ltd.
- iv) CATEGORY B: GROUP 2 ABOVE RS 50 CRORE: INNOVATION
  - Mott MacDonald Private Limited

## GC ELECTION RESULT FOR THE BLOCK YEARS 2025 – 2026

The GC election for the block years 2025 – 2026 were declared on 26<sup>th</sup> December 2024. The following are declared elected:

### A. Member (Individual)

For the 6 vacancies in the Members (Individual) category, the following individuals were declared elected:

1. Shri Alok Bhowmick
2. Shri V N Heggade
3. Shri Mihir Kumar Singha
4. Shri O P Goel
5. Shri Somenath Ghosh
6. Shri Aseem Kumar Prabhakar

### B. Young Professional Member (Individual)

For the 2 vacancies in the Young Professional member (Individual) category, 2 nominations were received. Since the number of nominations matched the number of vacancies, both the nominations were declared elected.

1. Shri Aseem Rastogi
2. Shri Merajuddin Ansari

### C. Member (Organisation)

For the 14 vacancies in the Member (Organisation) category, 14 nominations were received. Since the number of nominations received matched with the number of vacancies for the Member (Organization) category, all the 14 nominations were declared elected:

S. No	Member Organisation	Represented by	Designation
1	Aarvee Associates Architects Engineers & Consultants Pvt Ltd	Shri J Venkata Lakshmi Narayana	Regional Director (North)
2	AEON Integrated Building Design Consultants LLP	Shri Ashish Rakheja	Managing Partner
3	Almondz Global Infra-Consultant Limited	Shri Ajaya Behari Lal Srivastava	Chairman & Director
4	Balaji Railroad Systems Pvt Ltd	Shri. Sunil Srivastava	Managing Director
5	Civtech Consultants Pvt. Ltd.	Shri Rajender Kumar Bhola	Director
6	Construma Consultancy Pvt Ltd	Dr. Harshavardhan Subbarao	Chairman & Managing Director
7	Dhrumataru Consultants and Constructions	Shri K Rajkumar	Managing Partner
8	Holtec Consulting Private Limited	Umesh Shrivastava	Executive Chairman
9	Intercontinental Consultants and Technocrats Pvt. Ltd.	Shri Prashant Kapila	Managing Director
10	Lion Engineering Consultants Private Limited	Shri Navneet Sharma	CEO
11	Mantec Consultants Pvt Ltd.	Shri A S Brara	Chairman & Managing Director
12	Nippon Koei India Pvt. Ltd.	Dr. G Sampath Kumar	Director
13	Tata Consulting Engineers Limited	Shri K Ramesh	President and Advisor to MD
14	Theme Engineering Services Pvt. Ltd.	Shri Tarun Rawat	Managing Director

#### D) Affiliate Member (Organisation)

For the 1 vacancy in the Affiliate Member (Organisation) category, only 1 nomination was received. Since the number of nominations received matched with the vacancy for the Affiliate Member (Organization) category, the single nomination was declared elected:

1. Vandana Randhawa

## FORTHCOMING EVENTS OF CEAI

### 1. Construction Law Course

The construction law course has been rescheduled to February 2025. The new dates will be duly announced.

#### Key topics: - Engineering Law

- Contractual Problems of Project Execution
- Mechanism of Amicable Settlement of Differences
- Practical Application (including Moot Court)

#### Registration Details:

Participation Fee per delegate: CEAI Members: ₹32,000  
| Non-members: ₹36,000

*GST @ 18% to be added to the Participation Fee.*

A 7.5% discount will be given on the Participation Fee if there are 5+ registrations from the same organisation.

Registration Link: <https://forms.gle/NXbfFDYfZkFdyMft8>

## 2. The Annual General Meeting- 10<sup>th</sup> January 2025

The 28<sup>th</sup> Annual General Meeting of the Members of the Consulting Engineers Association of India will be held on Friday, 10<sup>th</sup> January 2025, at the India International Centre, 40, Max Mueller Marg, Lodhi Gardens, Lodhi Estate, New Delhi-110003

On the day of the AGM, all the Awardees will make Presentations about their projects and thereafter the awards will be given.

## Other News, Views, Notes

### Rehabilitation of Vidyasagar Setu, Kolkata

The Vidyasagar Setu was a creation by the famed designer late Dr. Jorg Schlaich. It is a high-level cable-stayed bridge across River Hooghly in Kolkata, which was opened to traffic in 1993, and while it was being designed, it was the longest Cable-stayed bridge in the world and is still acclaimed as a pioneer structure in terms of many of its design features.



*Frau Eve checking rivets with her hands*

*Mr. Ghoshal explaining the tower anchorage*



The rehabilitation work on the bridge to keep it fit for service was started in 2022. Mr. Amitabha Ghoshal, Past President CEAI is the Chairman of the Technical Advisory Group for the ongoing rehabilitation work of the bridge.

When Frau Eve Schlaich, the 88-year-old wife of the late Dr. Jorg Schlaich, desired to visit it recently, Mr. Ghoshal arranged to take Frau Eve to the bridge with help from GPT Infrastructure, the JV partners of the agency now engaged on the bridge.

Frau Eve, had earlier been to Kolkata multiple times along with Dr. Jorg, who used to spend long periods at the bridge design office and the site. This time she had come on a memory trip to pay tribute to her husband's passion in life.

Frau Eve with her younger son and daughter-in-law visited the bridge on 5<sup>th</sup> October 2024 and keenly inspected the bridge including the rivets by feeling them by hand to check whether they had loosened after 30 years of service.



*GPT Infrastructure personnel, Mr. Amitabha Ghoshal, Frau Eve and her son*



*Frau Eve, her son and daughter-in-law with Mr. & Mrs. Amitabha Ghoshal*

## VIEWPOINT

The themes for the quarterly issue of CEAI’s magazine “*ViewPoint*” for 2025-2026 will be decided by the Publication Committee 2025-2026.

The articles for an issue need to reach CEAI at least 3 weeks prior to the end of the month of the ViewPoint issue. The articles for an issue need to reach CEAI at least 3 weeks prior to the end of the month of the ViewPoint issue. Articles need to be in Times New Roman 12 with single line spacing with before and after 6 pt and normal margin, on A4 size. A recent clear and bright passport size photograph of the author(s) is to be sent along with the article. For details of formatting please refer to “*Format for Articles for CEAI Viewpoint*” on CEAI’s website, under ‘*Publications*’.

**We urge all Professionals to use CEAI’s ViewPoint to showcase the capabilities and achievements of the Engineers in India plus educate and guide new engineers.**

### Advertisement in ViewPoint

ViewPoint is circulated to all CEAI Members, FIDIC, Ministries of the Government of India, Public and private Sector Undertakings, Construction Firms, Contractors, Consultants, Foreign Missions and Funding Institutions in India and other organisations related to or dealing with the engineering profession. Thus, all stakeholders partnering development and progress are its readers.

**Catch the Customers Eye**  
**Get Wide Exposure** → **VIEWPOINT**  
**Improve Visibility**

Support from CEAI members and stakeholders are sought for increasing the number of advertisements so that ViewPoint gains in its stature as a unique Technical Publication for the fraternity and the public at large to spread information about how Consulting Engineers are helping society for improving the quality of life and doing so sustainably. The rates for advertisements in *VIEWPOINT* are given below:

Item	Rate Per issue* (Rs)	Discounted rate at 10% for 2 consecutive issues* (Rs)	Discounted rate at 20% for 4 consecutive issues* (Rs)
Back Cover	25,000.00	45,000.00	80,000.00
Inside Front Cover	18,000.00	32,400.00	57,600.00
Inside Back Cover	18,000.00	32,400.00	57,600.00
Full Page (Colour)	12,000.00	21,600.00	38,400.00
Full Page (Colour), if a specific page position is required	14,000.00	25,200.00	44,800.00
Full Page (B&W)	8,000.00	14,400.00	25,600.00

(such advertisements will be taken up for printing only when there are 4 or multiple of 4 advertisements for an issue)

Notes: \*GST @ 5% or as prescribed will be added to the above rates.

## Tech Quiz

1. Which is the most recyclable material?
  - a. Sand
  - b. Stone
  - c. Ferrous Metal
  - d. Wood
  - e. Plastic
2. How much energy is saved by recycling aluminium?
  - a. 50%
  - b. >90%
  - c. 40%
  - d. <80%
  - e. 70%
3. Are all types of glass material recyclable?
  - a. Yes
  - b. No
4. How energy efficient is it to recycle glass rather than create new glass?
  - a. Around 0 %
  - b. Around 20%
  - c. Around 50%
  - d. Around 30%
  - e. Around 60
5. Which country produces the maximum amount of plastic waste?
  - a. China
  - b. Nigeria
  - c. Indonesia
  - d. Pakistan
  - e. India
6. What is the total quantum of waste from the construction industry?
  - a. 12 to 15 mtpa
  - b. 4 to 7 mtpa
  - c. 8 to 10 mtpa
  - d. 1 to 5 mtpa
  - e. 6 to 12 mtpa
7. From which year is re-construction and demolition waste to be recycled in India?
  - a. 2015-2016
  - b. 2014-2015
  - c. 2022-2023
  - d. 2023-2024
  - e. 2025-2026
8. What percentage of construction and demolition waste is the producer responsible for?
  - a. 25%
  - b. 75%
  - c. 100%
  - d. 50%
  - e. 10%
9. Which of the activities are a part of construction project management?
  - a. Waste collection & storage
  - b. Waste dispatch for recycling
  - c. Training of personnel regarding sustainability requirements
  - d. None of above
  - e. All of a to c
10. Is it feasible to fully recycle demolition concrete and substitute virgin materials in concrete production?
  - a. Yes
  - b. No

The first person who mails the correct answers to CEAI [info@ceai.org.in](mailto:info@ceai.org.in) will get a congratulatory mail and will be acknowledged by publishing the persons photograph in the next issue.

Contributed by A P Mull

Answers to Tech Quiz September 2024 issue

1. (b), 2. (a), 3. (a), 4. (d), 5. (b), 6. (d), 7. (a), 8. (d), 9. (b), 10. (a)

## **FIDIC PUBLICATIONS**

1	FIDIC Contracts Guide (2 <sup>nd</sup> Ed. 2022)
2	EPC Turnkey Contract 2 <sup>nd</sup> Ed 2017 Silver Book Reprinted 2022 with amendments
3	Construction Contract 2 <sup>nd</sup> Ed 2017 Red Book, Reprinted 2022 with amendments
4	Plant & Design Build Contract 2 <sup>nd</sup> Ed 2017 Yellow Book, Reprinted 2022 with amendments
5	The Short Form of Contract (2 <sup>nd</sup> Edition, 2021)
6	Conditions of Contract for EPC Turnkey Projects (First Edition, 1999)
7	EPC/Turnkey Contract 2 <sup>nd</sup> Ed (2017 Silver Book)
8	Conditions of Contract for Construction (First Ed. 1999)
9	Construction Contract 2 <sup>nd</sup> Ed (2017 Red Book)
10	Conditions of Contract for Plant & Design-Build (First Ed, 1999)
11	Plant and design-build contract 2 <sup>nd</sup> Ed (2017 Yellow book)
12	Dredgers Contract 2 <sup>nd</sup> Ed (2016 Blue-Green Book)
13	Client/Consultant Model Services Agreement 5 <sup>th</sup> Ed (2017 White Book)
14	GUIDE to Conditions of Contract for Design, Build and Operate Projects (2008 GOLD BOOK) 1 <sup>st</sup> Ed 2011
15	Conditions of Contract for Works of Civil Engineering Construction (4 <sup>th</sup> Ed. 1987 Reprinted 2011)
16	Conditions of Contract for Design-Build and Turnkey First Edition 1995 Reprinted 2011
17	Conditions of Contract for Underground works (2019 Emerald Book)

## **WE OFFER**

# **FIDIC TRAINING COURSES**

- **Module I : Practical Use of FIDIC Conditions of Contract**
- **Module II : Management of Claims and Disputes Resolution**
- **Module IV : Contract Management and Administration**

The investment in infrastructure is growing and would continue to grow at an accelerated rate in the near and distant future across the Globe and especially in developing economy like India. The multilateral financial institutions are pouring in funds and want to be a part of the India growth story. These MDBs invariably use the FIDIC Conditions of Contract which are acclaimed as the Gold Standard of Conditions of Contract Globally.

The FIDIC Conditions of Contract are being used the world over where multi-lateral development banks provide the funding. And in large complex Government projects.

With a number of large and complex projects BOTH on-going and planned in the country, this training course will bring the participant the necessary detailed knowledge and insights as to the claim management and dispute resolution provisions under the FIDIC Conditions of Contract.

It covers the identification of project risks, their allocation, and the various causes of claim which can emerge over a construction contract and the way FIDIC addresses those. It details the way to handle claims - preparation, submission, assessment, determination under FIDIC Contracts, and how disputes are prevented or otherwise resolved.

### **Certificate**

After completion of the training a Certificate will be distributed to the participants.

***The comprehensive program on FIDIC Contracts led by accredited trainers***

**Contact for further query**

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