India's blended initiatives

One of the key measures being adopted by cement companies to reduce CO_2 emissions is the production of blended cements. With the use of SCMs forming part of Dalmia Cement's CO_2 reduction framework, the company discusses blended cement initiatives in India, and the advantages in terms of quality and environmental performance.

■ by **Dr Abinash Mishra,** *Dalmia Cement (Bharat) Ltd, India*

India intends to reduce the carbon emission intensity of its GDP by 33-35 per cent by 2030 from the 2005 level. The cement industry, being one of the major contributors of CO_2 emissions (accounting for around 27 per cent of the country's total energy and process CO_2 emissions), has a crucial role to play in supporting the country's Intended Nationally Determined Contributions (INDCs) of reducing the carbon emission intensity.

In view of the rise in population coupled with infrastructural requirements, global cement production is projected to reach around 4.8bnta by 2030 and 6.0bnta by 2050 (ie, a 12-23 per cent rise) from the current production level of more than 4.2bnta. In 1995 total global cement production amounted to 1.39bnta, which indicates the extent to which the construction industry has grown since then.

Most of the increase in cement demand in the coming decades is projected to be in emerging and developing countries, which already make up over 80 per cent of global production. Some regions, such as China and the Middle East, have excess cement capacity with cement production per capita levels well above the global average. Other regions, such as India and Africa, are set to increase their domestic cement capacity to fulfil their infrastructure development needs.

Today, India is the second-largest cement producer in the world after China and has evolved to become one of the best in terms of energy efficiency, quality control and environmental improvements. The Indian cement sector has also been a strong contributor to employment, fiscal revenue and community development while achieving manufacturing and technological advancement.

Indian initiatives

The Bureau of Indian Standards (BIS) has approved blended cements with either fly ash-based cement (Portland pozzolana cement – PPC, IS:1489, Part-1, 2015), slag-based cement (Portland slag cement – PSC, IS:415 ,2015) and composite cement (conforming to IS: 16415, 2015), a blend of both fly ash and slag together with clinker.

Production and the use of blended cements is helpful in enhancing the sustainability of the cement industry. In general, concrete made with blended cement using supplementary cementitious materials (SCMs) is more durable than concrete made with ordinary Portland cement (OPC) at the same water-to-binder ratio. The main reason is the formation of a denser microstructure due to both improved particle packing initially and more calcium silicate hydrates (CSH or CASH) formed from the conversion of calcium hydroxide (CH) due to the pozzolanic reaction. Improvements in the interfacial transition zone (ITZ), which is usually regarded as a major feature governing the permeability of concrete, are seen to improve the durability and strength of concrete. The fine particles of the SCMs and the formation of the C-S-H gel from the pozzolanic reaction play an important role in the improvement of the ITZ.

India has been working hard to lower its greenhouse gas emissions by championing the use of blended cements

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Composition

According to the BIS, the material proportions shown in Table 1 are specified for producing different types of blended cement.

Table 1: material proportions for producing blended cement

Material	Proportion (% by weight)		
	Portland pozzolana cement (IS:1489, Part-1, 2015) (%)	Portland slag cement (IS:455, 2015) (%)	Composite cement (IS:16415, 2015) (%)
Portland cement clinker	30-65	25-65	35-65
Fly ash	15-35	-	15-35
Granulated Slag	–	25-70	20-50

Source: Bureau of Indian Standards (BIS). Note: the above percentage with the necessary gypsum addition to create a cement that complies with the BIS while preserving the specified proportion.

Table 2: blended cement concrete compared to OPC

Properties	Performance of cement			
	OPC	PPC	PSC	Composite cement
Heat of hydration	High	Lesser	Lesser	Lower
Shrinkage	High	Lesser	Lesser	Lesser
Permeability	High	Lesser	Lesser	Lesser
Long-term strength	Normal	Higher	Higher	Higher
Durability	Low	Higher	Higher	Higher
Alkali aggregate reaction	Less resistance	High resistance	High resistance	High resistance
Sulphate attack	Less resistance	High resistance	Significantly high resistance	High resistance
Chloride attack	Less resistance	High resistance	High resistance	High resistance

Advantages

Advantages of using blended cement include:

- As slag and fly ash are added in a graduated manner, it reduces bleeding and segregation in the fresh condition, which lowers the permeability and impermeability of concrete compared to OPC and other variants.
- The development of thermal cracks in the hardened state is prevented because of the optimal use of SCMs, which lowers the temperature of hydration.
- Concrete made with composite cement exhibits excellent corrosion resistance due to lower surface resistivity, helping it stand by corrosion durability points as well.
- Concrete manufactured with composite cement is more durable than concrete made with spherical micro-built fly ash because it provides a natural glide to the concrete mix and optimal adsorption with slag for moisture added.
- The use of composite cement benefits structures where concrete is exposed to severe environments, such as wastewater treatment,

irrigation, refinery industry and marine applications.

Energy and carbon emissions reduction

Combining composite cement with SCMs such as fly ash and granulated slag is particularly advantageous in terms of reducing CO_2 emissions. The production of PPC results in a reduction in CO_2 emissions intensity of 27 per cent, 39 per cent for PSC and 58 per cent for composite cements.

The thermal energy cost to produce 1Mta of composite cement is 52 per cent lower than OPC production. The thermal energy cost to produce PPC and PSC is 27 and 35 per cent lower compared to OPC production, respectively.

Production of composite cement requires 34 per cent less power compared to OPC, and the production of PPC and PSC requires 20 and 23 per cent less power, respectively, compared to OPC.

Limestone conservation

The preservation of natural resources, notably limestone, has been made possible by the use of SCMs. It is highly resourceful to use less natural resources, such as limestone, in the making of composite cement, which reduces the clinker factor to 45 per cent.

For example, a 1Mta cement plant producing OPC, PPC and PSC requires nearly 1.5-1.6Mta, 1.0-1.1Mta and 0.8-0.9Mta of limestone, respectively. Whereas the production of same quantity of composite cement requires 0.6-0.7Mt of limestone, thus resulting in a reduction of limestone consumption.

Beneficiation of flyash

The beneficiation of fly ash involves various techniques to modify the chemical composition and physical properties of fly ash. Fly ash as an SCM offers several benefits, including improved workability, increased strength, reduced permeability and enhanced durability of cementitious products. However, the utilisation of raw or untreated fly ash in cement production can be limited due to its specific characteristics, such as high carbon content, variability in composition, and potential for alkali-silica reaction.

By employing beneficiation techniques, the quality of fly ash can be enhanced, making it more suitable for cement production. The beneficiation processes can involve methods such as classification, gravity separation, froth flotation, magnetic separation and thermal treatment. These techniques help in reducing the carbon content, controlling the particle size distribution, improving fineness and modifying the mineralogy of fly ash.

Overall, the beneficiation of fly ash can be effectively used in the cement sector in India to enhance the quality and suitability of fly ash for cement production, promoting sustainable practices and resource conservation.

Dalmia Cement's initiatives

Dalmia Cement (Bharat) Ltd is actively taking several measures to reduce its CO_2 emissions and reach its 2030 target. The company has set ambitious sustainability goals and is implementing various strategies and initiatives to achieve them. Some of the key measures undertaken by Dalmia Cement are described below.

Increasing the use of AFs and ARMs

Dalmia Cement is focussed on substituting fossil fuels with alternative fuels (AFs) such as biomass, industrial waste and agricultural residues. By replacing a portion of coal or petcoke with these alternative fuels, the company can reduce its CO_2 emissions.

Similarly, the use of alternative raw materials (ARMs), such as industrial by-products or waste materials, helps reduce the environmental impact associated with traditional raw materials.

Exploring the use of alternative binders, such as geopolymers, and incorporating SCMs to reduce the clinker content in cement are among some of the measures that Dalmia Cement is taking to reduce its CO_2 emissions and achieve its 2030 target

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Enhancing energy efficiency

The company is continuously investing in energy-efficient technologies and practices. This includes the adoption of advanced equipment, process optimisation and the implementation of waste heat recovery systems.

Utilising renewable energy sources

Dalmia Cement is actively exploring and investing in renewable energy sources to power its operations. This includes the installation of solar power plants, wind turbines and biomass-based power generation facilities. By transitioning to renewable energy, the company can significantly reduce its carbon footprint.

Implementing CCUS technologies

Dalmia Cement is also exploring and deploying carbon capture, utilisation and storage (CCUS) technologies.

Collaborations

The company actively engages in partnerships with research institutions, technology providers and other stakeholders to develop and implement innovative solutions for CO_2 emissions reduction. By leveraging collective expertise and resources, it can accelerate progress towards its sustainability goals.

Focussing on product innovation

Dalmia Cement is working on developing and promoting innovative cement and concrete products that have lower CO_2 emissions throughout their lifecycle. This includes exploring the use of alternative binders, such as geopolymers, and incorporating SCMs to reduce the clinker content in cement.

Conclusion

Construction will become greener and more sustainable as a result of blended cement. It provides a greener option to conventional OPC by considerably lowering carbon emissions and employing additional cementitious ingredients. It is a suitable option for building projects all around the world due to its improved performance, toughness and adaptability. A low-carbon economy and a healthier environment for future generations are two ways that blended cement has the power to change for the better in the building materials industry. ■

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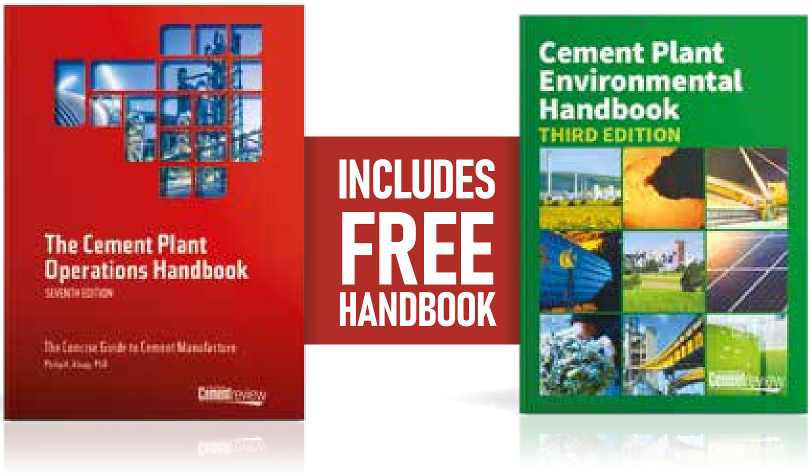

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