Limestone Calcined Clay Cement

LC3

A VIABLE AND SUSTAINABLE ALTERNATIVE TO EXISTING CEMENT VARIETIES

LOW CARBON

LOW COST

LOW CAPITAL

HIGH PERFORMANCE

WHAT IS LC^3 ?

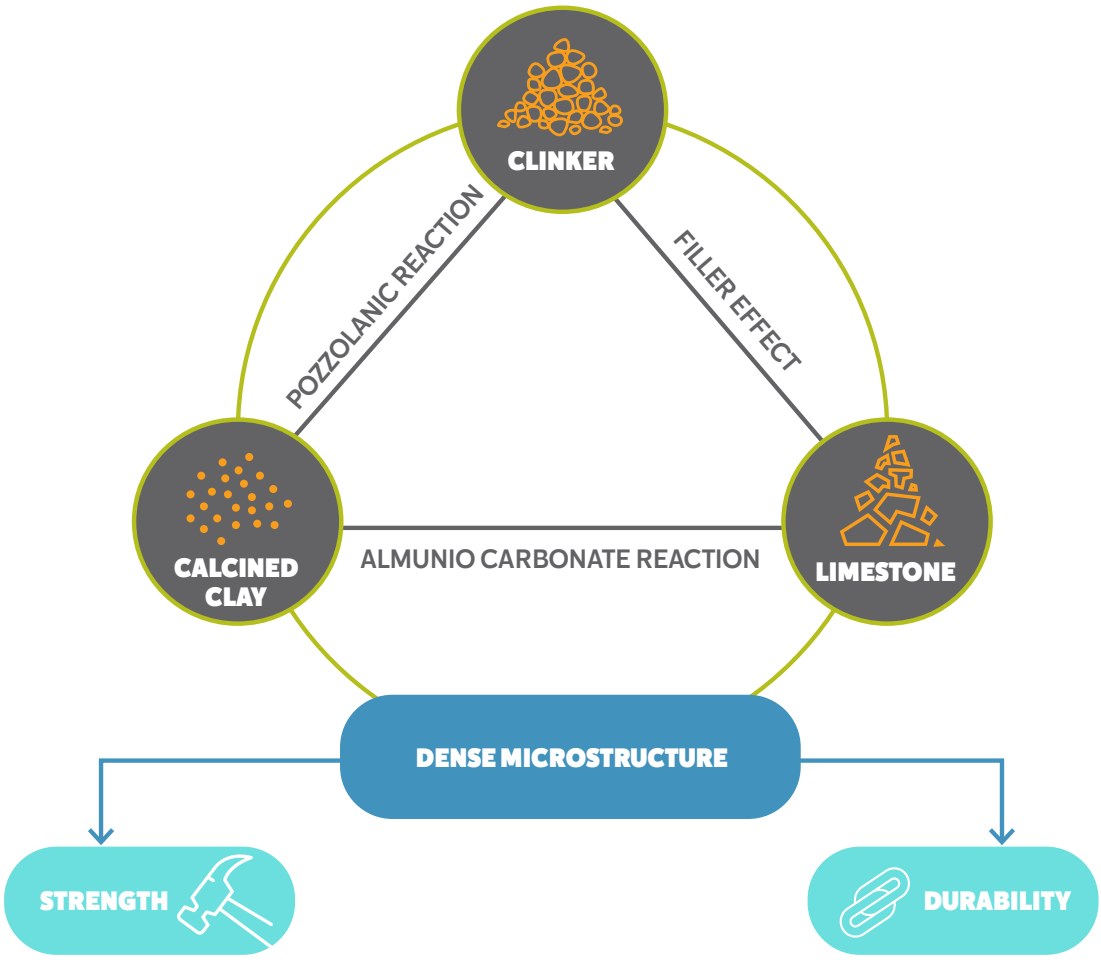
LC^3 or Limestone Calcined Clay Cement is a family of composite cements containing Portland clinker, calcined clay and limestone. The LC^3 technology promises a sustainable growth of economies around the world by reducing upto 40% CO_2 emission compared to Ordinary Portland cement at lower investment and production costs. LC^3 uses raw materials and technologies that are already used by the cement industries. The production process is similar to the way of producing normal cements. Thus they provide a practically viable solution to improve sustainability in the cement industry.

40% Less CO_2 Emissions

ADVANTAGES OF LC³ TECHNOLOGY

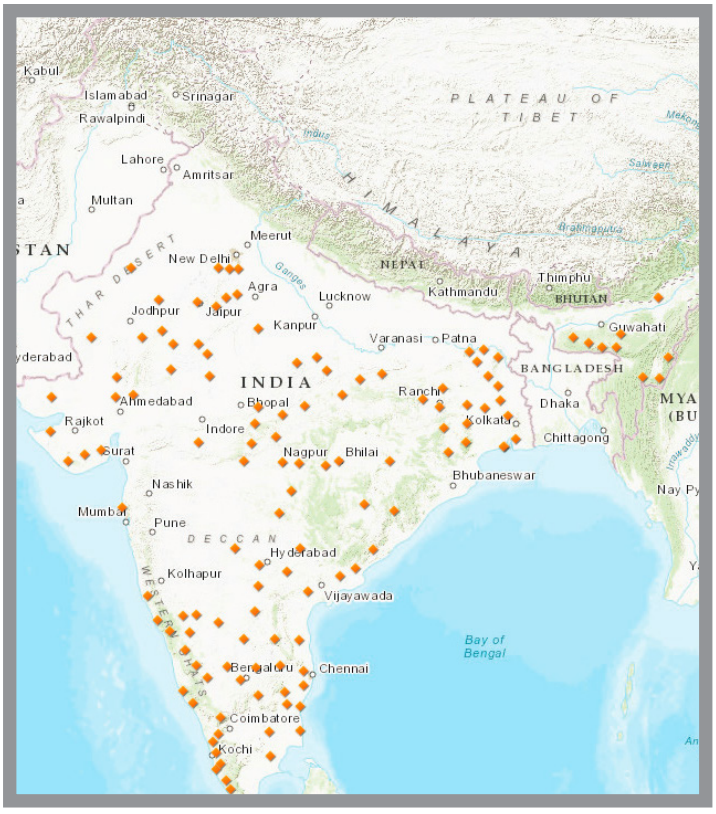
SYNERGY WITHIN LC^3

LC^3 works on the synergy between clinker, calcined clay and limestone phases. Calcined clay reacts with hydration products of clinker and limestone reacts with calcined clay, giving phases that make the microstructure denser. Calcined clays have been long used as pozzolanic materials in cements and limestone is an established semi-reactive filler in cements. The added synergy from the reaction of calcined clays with limestone producing carboaluminate phases improves the strength and durability of the cement.

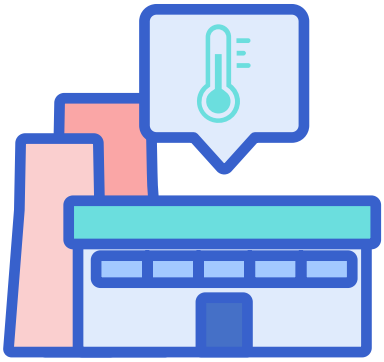


RAW MATERIALS FOR LC^3

The main raw material in LC^3 is kaolinitic clay. Clays containing 40% to 60% kaolinite are ideal for the production of LC^3. Even reddish clays with high iron content are suitable. Such clays are abundantly available as waste in mines where higher grade white clays are used for high value applications. The clays are calcined between 700° C to 800° C to make them reactive. Calcination requires almost half the energy required for clinker production. Kaolinite and alumina content in a clay are not to be directly correlated, since alumina can be present in other clay minerals in the form of gibbsite, muscovite etc. In LC^3 limestone with as little as 65% carbonate content can be used. Such low grade limestones are often rejected in cement plant mines. Limestone with impurities such as quartz and dolomite can also be used in LC^3 production. No calcination of the limestone is required. Apart from calcined clay and limestone, Ordinary Portland clinker is used in the production of LC^3.



CLAYS ARE CALCINED BETWEEN 700°C TO 800°C



COMPARED TO CLINKERIZATION TEMPERATURE OF 1450°C FOR CLINKER PRODUCTION

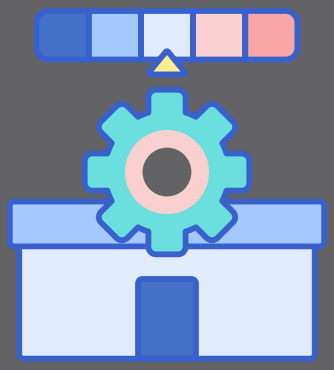
UTILISATION OF LOWER GRADE LIMESTONES WITHOUT EVEN CALCINING IT

COMPOSITION AND PRODUCTION OF LC3

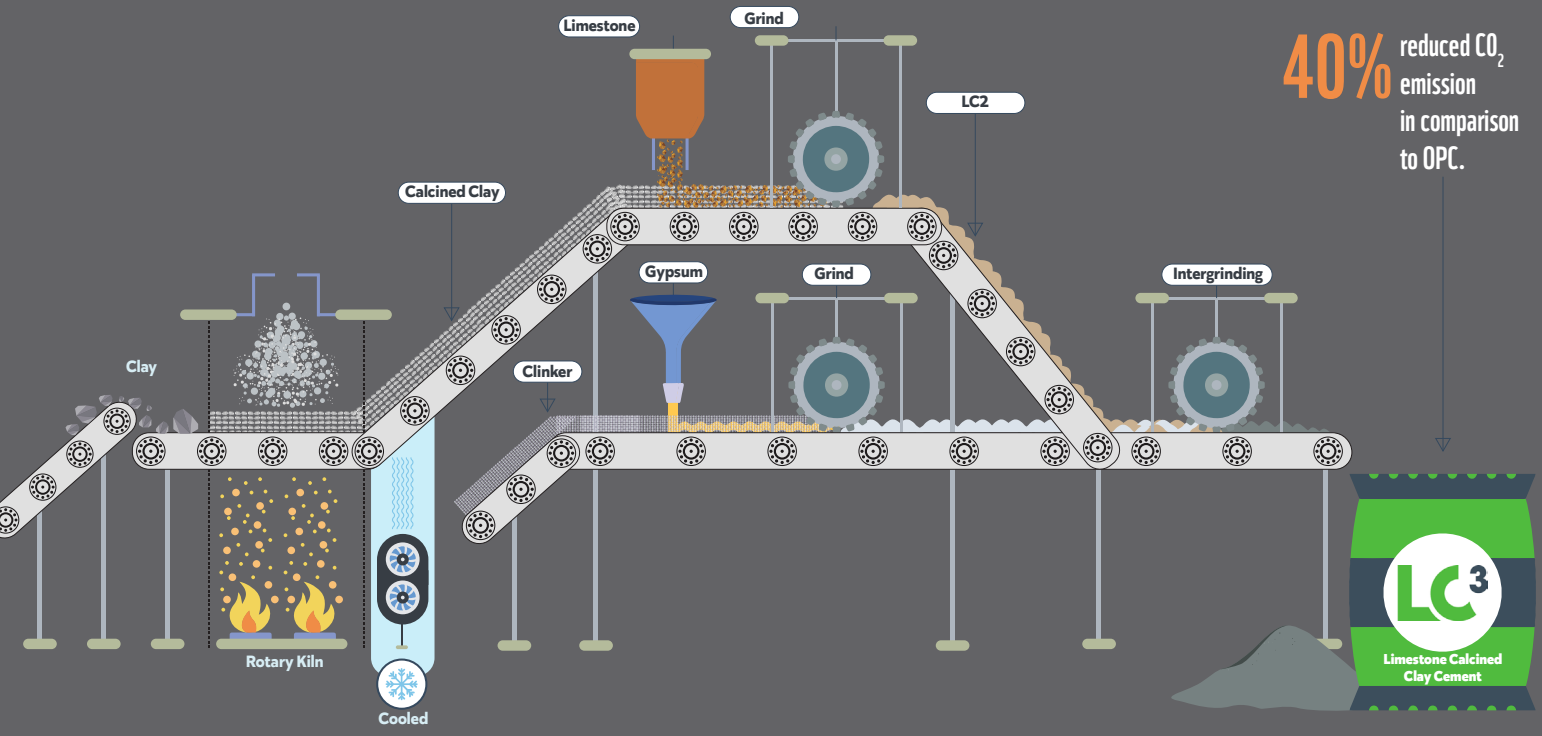
For calcination of clays, normal rotary kilns are best suited. Due to lower temperatures and lower energy, the capital investment required for these rotary kilns is likely to be less than that of cement kilns of the same capacity. Flash calcination and fluidized bed reactor technologies can also be used for the calcination of clays. The choice depends on productivity, capex, familiarity and ease of operation.

LC^3 can be produced in a similar manner as OPC and PPC by intergrinding or blending. The softer nature of the materials considerably reduces grinding energy, although, as is the case with many composite cements, separate grinding may be desirable. Ball mills or vertical roller mills can be used for grinding.

Easier to Grind



THE SOFTER NATURE OF THE MATERIALS CONSIDERABLY REDUCES GRINDING ENERGY



40% reduced CO_2 emission in comparison to OPC.

CHARACTERIZATION OF RAW MATERIALS AND LC^3

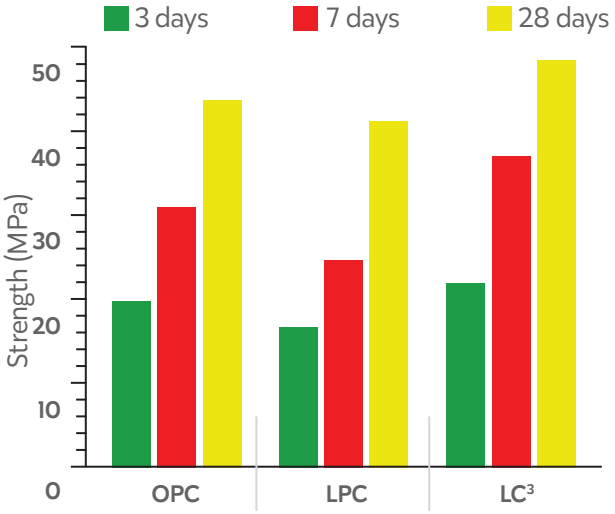
The suitability of clays and limestones required for the production of LC^3 can be easily characterized using loss on ignition, thermogravimetric analysis, X-ray fluorescence or X-ray diffraction techniques. These techniques are available in most cement plants and are routinely used to characterize cements and other raw materials. Existing standard test methods can also be used to identify suitable combinations of clays and limestones. The reactivity of calcined clay is measured through isothermal calorimetry or the simple lime reactivity methods.

Once produced, quality control of LC^3 can be easily carried out by measuring strength and other methods commonly used for OPC and PPC.

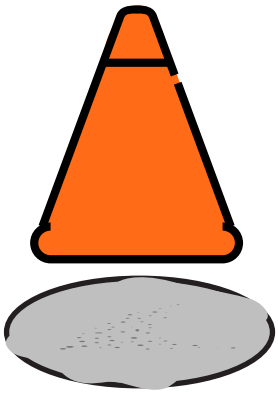
MECHANICAL AND OTHER PHYSICAL PROPERTIES OF LC^3

LC^3 has been seen to develop ultimate strengths comparable to OPCs produced using the same clinker. Strength development in LC^3 has generally been observed to be faster than OPC and PPC. LC^3 is expected to satisfy all the other requirements of physical characteristics laid down in most of the country standards. Additionally, calcined clay and limestone improves cohesion of fresh concrete which prevents segregation and bleeding.

A COMPARISON OF OPC, PPC AND LC3 PRODUCED USING THE SAME CLINKER AND THE SAME PROCESS



PREVENTS SEGREGATION AND BLEEDING IN CONCRETES



DURABILITY OF LC^3

Under most severe conditions e.g. marine, desert and extreme cold climates, the performance of LC^3 is better than or at par with OPC and PPC. LC^3 has a high chloride penetration resistance and produces a dense microstructure with high resistivity making it ideal for harsh conditions like in marine or desert environment. LC^3 is also highly suitable for use with reactive aggregates.

HIGH CHLORIDE RESISTANT

+

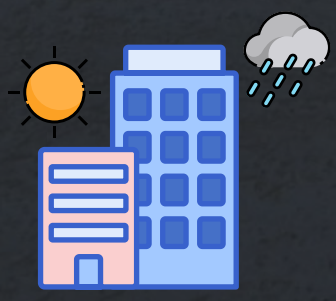
DENSE MICROSTRUCTURE

+

HIGH RESISTIVITY

=

IDEAL FOR HARSH CONDITIONS



ECONOMY OF LC^3

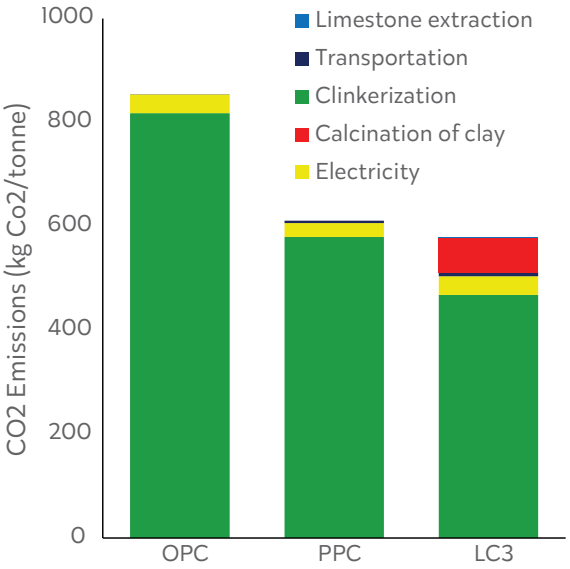
Due to the lower calcination energy requirements, LC^3 is more economical to produce than OPC for similar performance. Especially at locations with shortage of high quality fly ash, low limestone quality or excess reserves of waste limestone, LC^3 is more economical to produce than PPC.

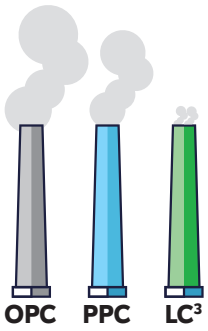
LC^3 is also suitable for production where clinker is being imported or the production costs are not competitive. Due to its lower clinker content and lower capital investment required for calcination of clays, LC^3 allows higher returns on capital investments. Also, clay and limestone which are otherwise discarded by cement plants can be utilized in LC^3 which leads to low raw material cost.

LC^3 IS MORE ECONOMICAL TO PRODUCE THAN OPC FOR SIMILAR PERFORMANCE.

EMISSIONS AND RESOURCE EFFICIENCY FROM LC³

The production of LC³ emits as much as 40% less CO_2 than OPC and 11% less CO_2 than PPC. The energy consumed in producing LC³ is also significantly lower than OPC and even lower than PPC in many scenarios. LC³ also offers an interesting solution for the utilization of low grade mine rejects widely available with the cement industry. Thus while it reduces GHG emissions from the cement industry, it also helps in utilization of waste materials, thereby promoting resource efficiency of materials.





THE ENERGY CONSUMED IN PRODUCING LC³ IS ALSO SIGNIFICANTLY LOWER THAN OPC AND EVEN LOWER THAN PPC IN MANY SCENARIOS.

FIELD AND LABORATORY EXPERIENCE WITH LC^3

Almost 2000 tonnes of LC^3 has been produced in India and worldwide under pilot scale. These has been used in various manual and high end automated applications. Pilot construction projects have been executed to obtain field data on the performance of LC^3 as a general use cement. In all the cases, the performance of the LC^3 has been found to be better than normal OPC and PPC. Presently LC^3 is commercially produced and distrubuted in Columbia by Argos Cementos under the brand name of Cemento Verde.

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LC³ TECHNOLOGY RESOURCE CENTRE

The LC³ Technology Resource Centre in India and Cuba has been set up with access to state of the art knowledge on LC³ and related products from a network of global research institutions; EPFL, IIT Delhi, IIT Madras, TARA and CIDEM-Cuba. The Centres provides testing and consultancy services for adoption of LC³ technology globally. It also provides LC³ based certified materials to research institutions. The Centres are equipped with modern equipments, testing facilities and scientific personnel and is ready to provide its services related to LC³ in India, Cuba and globally.

CIDEM
CENTRO DE INVESTIGACIÓN Y DESARROLLO DE ESTRUCTURAS Y MATERIALES

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
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Swiss Agency for Development and Cooperation SDC

TARA

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