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Calcined Clay in Concrete: Facts and FAQs

Calcined Clay as a Supplementary Cementitious Material

Calcined clay, a new supplementary cementitious material (SCM), is now available in Victoria in commercial quantities. It is classified as a manufactured pozzolan and, as with the introduction of any new, key concrete ingredient, there are numerous questions that spring to mind about its use. The following information has been put together to address questions that have been raised to date. Further information about calcined clay as an SCM, progress in Victoria and guidance for its use on projects is provided after the FAQs.

Frequently Asked Questions

Standards, specifications and approvals

Are calcined clay and metakaolin the same?

Metakaolin generally refers to a calcined material that is predominantly derived from kaolinite rich clay. Calcined clay, however, can be produced from a variety of clay minerals. For example, a clay may contain kaolinite, illite, smectite, montmorillonite, other aluminosilicate minerals. After calcination, the resulting material can have very different pozzolanic reactivity.

What standards govern the use of calcined clay in concrete?

Three standards govern the use of calcined clay in concrete:

- AS 1379:2026 is the primary Australian Standard for the specification and supply of concrete. It sets minimum rules for materials, plant equipment, and mixing uniformity.
- AS 3582.4 Manufactured pozzolans is included in the latest publication of AS1379. All the manufactured pozzolans including calcined clay that meet the requirements of AS3582.4 can be used in supplied concrete. AS3582.4 covers their chemical, physical, and performance properties in cementitious system. This underpins the minimum requirements that any source of clay must meet to be considered acceptable for use in concrete.
- DTP Specification 610 governs the minimum quality control requirements regarding the supply and placement of concretes on major projects in Victoria. Noting that Department of Transport and Planning (DTP) is currently undertaking a thorough review and update of 610 given the significant advancements in cement and concrete technologies over the past 10 years and the need to decarbonise this important construction material.

AS 1379 now allows calcined clay (manufactured pozzolans), is DTP allowing calcined clay in VicRoads mixes now? If not, what is the pathway/ progress regarding VicRoads mix registration with calcined clay?

As of September 2026, in accordance with DTP/ VicRoads standard, structural concrete mixes with calcined clay are required to go through Technical Review Panel (TRP) / specific approval process by DTP. VIDA is optimistic that calcined clay will be accepted within the DTP/ VicRoads framework given that the focus is more on performance metrics rather than prescriptive requirements.

VICTORIAN INFRASTRUCTURE DELIVERY AUTHORITY

VICTORIA State Government

A DTP-led Low Carbon Concrete Working Group (LCCWG) has been established involving DTP, VIDA and SRLA. The group is investigating ways to make approvals more efficient while maintaining appropriate risk controls.

How can I find out which low carbon mixes have already been approved?

The DTP LCCWG is working to improve the visibility of approved low-carbon mixes through the development of a shared register/database of approved concrete mixes. Having a register of approved low-carbon concrete mixes will make it easier for projects to identify and specify suitable mixes without each project having to independently undertake the same approval investigations.

It is expected that all the major concrete suppliers will have approved calcined clay mixes in the coming months.

Performance and durability

I've heard concerns that combining calcined clay with fly ash may affect long-term stability and performance as calcined clay could render the fly ash inert, which can then negatively affect the binding performance of the cementitious component?

Calcined clay and fly ash both react with the same by-product of cement hydration (portlandite). As calcined clay is more reactive it reacts before the slower-reacting fly ash. When both calcined clay and fly ash have good pozzolanic reactivity and are used in the right proportions, they can work well together, calcined clay boosting early strength and fly ash contributing to later-age strength development and workability. Noting that the accelerating uncertainty around the supply of fly ash into the Victorian concrete supply market is the key reason that VIDA is keen to see a local supplier of calcined clay become established in this state.

Does the use of calcined clay lead to the concrete mix having a lower pH overall and in the event of thermal cracking and then with water ingress could that lead to an accelerated corrosive effect?

No, using calcined clay concrete won't have an accelerated corrosive effect under the conditions outlined above compared to any concrete using SCMs.

The reduction in pH associated with SCM use should be considered alongside the significant durability benefits these materials provide. SCM-based concretes, including those containing calcined clay, typically develop a denser and less permeable concrete. In addition, calcined clay mixes often exhibit lower heat generation during hydration, reducing the risk of thermal cracking. The resulting lower porosity, reduced pore connectivity and lower permeability slow the ingress of water, oxygen, chlorides and other aggressive agents that are required to initiate and sustain corrosion. Consequently, even if cracking or carbonation occurs, the overall durability performance of these concretes is often improved rather than diminished.

There are many research reports and guidance notes being produced on SCM concrete mixes with and without calcined clay that summarise the current durability consensus. The *RILEM Technical Letter on Corrosion of steel in carbonated concrete* provides a good overview of why the durability impacts of concrete carbonation are often overstated particularly when building large civil and structural infrastructure. Please reach out for more information on accessing these.

Are calcined clay concretes more susceptible to cracking and therefore potentially going to result in less durable infrastructure?

No, calcined clay mixes are not more susceptible to cracking. Similar to fly ash or slag, calcined clay concrete acts like other SCM mixes and results in more durable infrastructure. Given what has been reported overseas and what we are rapidly learning from the local research and field trials conducted to-date in Victoria, binary system calcined clay cement or ternary with calcined clay and slag or calcined clay with GL that we are focusing on to produce very low carbon mixes will not only be more durable than current mixes, but for the same total cementitious content, they have much lower thermal characteristics so heat of hydration issues for very large pours will be far more manageable by site crews and the need for detailed thermal modelling and control measures may well become redundant. In addition, the early indications are that shrinkage properties are also better/ lower, so there is a very real prospect that once we have sufficient data on these 'new'

concrete mixes that designers should be able to reduce the additional steel required to control thermal and shrinkage cracking and get our steel quantities down and make placement/ compaction/ finishes better.

Will high SCM mixes with calcined clay be more susceptible to alkali aggregate reactivity (AAR) problems?

No, since the widespread adoption of the first SCMs (slag and fly ash) over 40 years ago, it has been common practice to control the risk of AAR when aggregates are deemed susceptible by substituting a proportion of the GP cement with either fly ash or slag, with the fly ash substitution typically being a minimum of 25%. Calcined clay is generally more effective than fly ash at mitigating alkali-silica reaction (ASR). Research and international practice indicate that replacement levels above 10% calcined clay are typically sufficient to control ASR, making it a highly efficient supplementary cementitious material for ASR mitigation. As we move to very low carbon mixes where the GP cement component of the overall binder is 25% or less, then there is a high likelihood that more AAR susceptible aggregates will be able to be used in concrete production.

Durability concerns – how can designers undertake service-life modelling given the limited published guidance for calcined clay in concrete?

Current durability models for carbonation and chloride ingress rely primarily on two key performance indicators: chloride diffusion and carbonation resistance, which are measured using established standard test methods. During the design phase, service-life predictions are typically based on existing test data and datasets available in standards and industry guidance for conventional SCMs. The same standard durability tests can be readily applied to calcined clay mixes to generate project-specific performance data and verify compliance with durability requirements.

There is also growing evidence and industry consensus that adequate concrete cover and low permeability are the most critical factors in achieving long-term durability. These characteristics significantly reduce the rate of moisture and oxygen at the reinforcement, thereby delaying or preventing the initiation of corrosion.

Calcined clay concrete is not a new technology. It has been researched and used in Europe for decades. In Europe, the standard for cement, EN 197-1 allows cement producers to make a range of cements with up to 55% of the Portland cement clinker replaced by calcined clay. Calcined clays that conform to the requirements of BS 8615 may also be used in concretes conforming to BS 8500 Concrete.

In Australia, ongoing testing programs are continuing to expand the available performance database on locally supplied clays. Early findings indicate that calcined clay concrete can achieve very low permeability, reduced chloride ingress, and strong overall durability performance.

Therefore, durability is not regarded as a barrier to wider calcined clay adoption.

Considering TS 199:2023 (Design of geopolymer and alkali-activated binder concrete structures), is there any issue with creep given the limitations of AS 3600 for mixes with higher activator contents?

Long-term creep testing is currently being undertaken by researchers at the University of Melbourne on Australian calcined clay, with early results showing promising performance. Much international research demonstrated that calcined clay-based concrete reduces the creep coefficient. As outlined in TS 199, the basic creep model requires two measurement points for assessment. For preliminary evaluations, measurements may be taken at 14 and 56 days after loading, while data collected at 28 and 180 days provides greater confidence in the predicted long-term creep behaviour.

Applications and constructability

What are the main workability challenges being seen on site?

On-site feedback has been mixed, ranging from crews not noticing any difference compared to conventional concrete to others describing the mix as slightly "heavier" or "stickier". Overall, the concrete has been successfully placed using standard construction practices. VIDA recommends having a concrete technologist on site to avoid any workability issues, like with any new material, industry needs to get familiar with handling it.

Calcined clay concrete tends to retain water and produce little bleeding, depending on the dosage the type of calcined clay and the admixtures used, which can make finishing operations more difficult. Finishers may find the concrete "stickier" than conventional mixes. Similar challenges have been observed with slag mixes. The challenges can be managed through planning, placing trials, technical support and experience.

Note that several issues encountered during trials were related to batching and mixing sequences rather than the clay itself. Many workability issues can be addressed through admixture optimisation and appropriate batching practices. Successful implementation requires close collaboration between batch plant operators, concrete technologists, admixture suppliers, researchers and site crews.

As more of this type of concrete is being placed the one key measure is the early application of aliphatic alcohol during the placement phase, this prevents early ‘crusting’ of the fresh surface that might occur due to very low rate of bleed. The timing of final finishing and saw cutting (where required) is proving to be very similar to ‘standard’ concretes, with weather conditions being the primary factor rather than the mix constituents.

Are the concrete mixes currently being developed in Victoria binary or ternary cement blends?

While calcined clay can be used in a binary blend with GP or GL cement to achieve as much carbon reduction as possible, the emphasis is on ternary blends.

Can calcined clay be used in precast concrete elements or structural applications?

Yes, it has already been successfully trialled in Australia and at a much larger scale across Europe and the Americas. Precast products incorporating calcined clay are manufactured and installed on a daily basis in these regions, and the use of calcined clay in structural concrete continues to grow globally. Early precast trials have been undertaken using triple blend mixes containing 20% calcined clay and 20% slag, demonstrating promising early-age strength performance. Additional heat-curing trials are being performed to provide confidence that precast production, prestressed and rapid build situations with very high early strength gains requirements can be met.

Is calcined clay concrete being considered for structural components and / or elements?

VIDA Rail's structural testing program undertaken in collaboration with the Australian Calcined Clay Advancement Network (ACCAN) is specifically aimed at demonstrating the suitability of calcined clay concrete for structural components and / or elements, including precast and prestressed bridges and associated structures. The program's focus extends beyond non-structural applications such as shared user paths, maintenance strips, kerbs and channels, etc. The long-term objective is to support the approval and adoption of calcined clay concrete in precast, prestressed and in-situ structural applications.

Carbon benefits

What are the carbon benefits?

Calcined clay itself typically has a 60 to 80% lower embodied carbon than GP cement, depending on the calcination process and energy source. Research and field trials indicate that calcined clay concretes can achieve 75% or greater GP cement replacement, particularly when combined with slag and other SCMs. Current VR400/40 concrete mixes with published EPDs range from 150 to 450 kg CO_2-e/m³. Targeting high-SCM concrete with 80% cement replacement, using blends of clay and other SCMs, can potentially reduce concrete GWP below 100 kg CO_2-e/m³ in many applications.

Approximate comparison:

Concrete Type	Indicative GWP
VR400/40 concrete mixes with published EPDs	~150-450 kg CO_2-e/m³
Target low carbon concrete mixes, blends of calcined clay and other SCMs (above 80% SCM)	<100 kg CO_2-e/m³

Supply and scalability

What is the progress on scalability of calcined clay? Can the wider industry access calcined clay, and is supply sufficient?

Victoria has abundant, high-quality clay resources, and quarry investigations have confirmed a substantial resource base. Supply of raw clay is not considered a constraint. The main challenge is creating sufficient long-term market demand to support investment in larger-scale production, rather than securing access to suitable clay resources.

Victorian operation currently has capacity for approximately 30,000 tonnes annually, which is sufficient to support a significant volume of concrete production when used as a partial cement replacement. Expansion plans are being investigated, which could increase production to around 250,000 tonnes per year through a larger calcination facility, if market demand justifies investment.

All major concrete producers have access to calcined clay sources. Some smaller and independent suppliers also have access and capabilities to supply calcined clay concrete.

Who are the calcined clay suppliers in Australia?

Suvo / Green360 (VIC) and Auspozz / Zeotech (QLD) are currently known by VIDA as suppliers in Australia.

Is Australia likely to import calcined clay?

No. Domestic clay resources are significant not only across Victoria but Australia generally and are considered sufficient to support long-term industry growth. In the future, Australia could potentially become an exporter rather than an importer of calcined clay products.

About Calcined Clay

Concrete consists of a cementitious binder, aggregates (e.g. sand, gravel and crushed stone) and water. Although the cementitious binder typically represents only a small proportion of the concrete volume, it accounts for around 90% of its embodied carbon. Consequently, the large volumes of concrete used in infrastructure and building projects make it a significant contributor to VIDA's carbon footprint. In Australia the emissions due to the manufacture of General-Purpose Portland cement (GP cement) are our primary concern. GP manufacture involves the direct release of CO_2 and the input of a lot of energy to achieve the conversion temperatures (1400 –1500^{o}C). As this is the main component of GP cement the decarbonisation focus for concrete over the next 5-10 years is to minimize the amount of GP cement in every concrete mix used on every project.

Currently, the most widely used alternatives to GP cement are fly ash (sourced from combustion of coal) and slag (a by-product of steel making) collectively referred to as supplementary cementitious materials (SCMs), which are reducing in availability and have direct impact on project costs. Concrete suppliers in Victoria have already been advised that current volumes of fly ash from Queensland can no longer be guaranteed. So, it is vital that alternative low carbon SCMs are identified and they are brought online in commercial quantities as quickly as possible.

Victoria is fortunate to have access to a high-quality local clay resource, with bulk calcined clay production commencing in March 2026. Since then, all three major concrete suppliers, together with several other industry stakeholders, have assessed its performance as a supplementary cementitious material and successfully developed and deployed calcined clay concrete mixes. This demonstrates both the technical viability of the material and the industry's readiness to adopt it at scale.

Calcined clay is produced by heating suitable clay at between (650 to 850^{o}C) which transforms the clay and gives it cementing properties. There are no carbon dioxide by-products as per GP and the lower temperatures required to calcine means that the use of renewable energy is realistic for the manufacturing process. It is therefore a highly viable lower carbon alternative to traditional SCMs like fly ash and slag, which face long-term availability risks and are the by-products of fossil fuel industry whereas the quantities of suitable clay available in Victoria are conservatively estimated to be ~500 years.

Probably the most exciting thing about this first source of calcined clay in Victoria is that it is proving to be a very high-quality cementitious binder with performance characteristics that are superior to fly ash, slag and

even GP, so it can facilitate the use of much higher SCM contents in concrete mixes for applications which were problematic e.g. precast, prestressed and rapid build situations where very high early strength gains are required.

Progress in Victoria

Over 3,500 m³ of calcined clay concrete has already been placed on Victorian infrastructure projects, demonstrating successful uptake beyond laboratory trials, including triple blend mixes incorporating slag and calcined clay or limestone and calcined clay with up to 65% cement replacement, providing evidence of strong early-age and long-term strength development.

Using Calcined Clay on Projects

Pathway forward

Projects are encouraged to collaborate with suppliers, concrete experts, designers, asset owners and universities to bring forward innovative trials and accelerate adoption.

Optimise Mix Design: Develop tailored blends to meet diverse performance targets— workability, strength, durability, time dependent, constructability —while maximising carbon reductions. Collaboration between admixture suppliers and concrete suppliers for optimisation of mixes.

Triple Blend: Trial hybrid mixes of cement, calcined clay, and slag to make calcined clay concrete competitive with current low-carbon mixes in Victoria. Potential for trial of GL cement in lieu of GP cement to further reduce embodied carbon of mixes.

Temperature Matched Curing (TMC): Conduct early strength gain assessment/measurement trials on the lowest embodied carbon mixes which exhibit the best handling, placement, compaction and finishing characteristics. Sufficient TMC data can provide the necessary level of evidence in a relatively short period of time so that precasters and constructors planning very tight build programs can confidently adopt these mixes.

What needs to happen now to achieve VIDA's 2027 35% emissions reduction target?

A key priority is to reduce GP cement content quickly, with the longer-term aim of using concrete mixes containing more than 75-80% supplementary cementitious materials across all applications. Calcined clay is the opportunity to achieve these targets. Large-element trials and temperature-matched curing studies will be important to demonstrate performance under real project conditions. Designers and contractors should engage suppliers early and seek pre-approval for suitable low-carbon mixes before construction begins.

This needs to be supported by faster approval and broader uptake of calcined clay in mainstream infrastructure projects, alongside continued expansion of Australian production capability. Achieving this will require strong collaboration between industry, suppliers, designers, contractors, researchers and government.

Upcoming structural trials

Many VIDA Project Offices and SRLA have structural pours planned in the near future. Please reach out for more information as this is a fast-evolving space.

What should my project do if it wants to trial or use calcined clay concrete?

Consult with VIDA or SRLA Sustainability & Engineering Teams (if a VIDA or SRLA project) or reach out to Ecologiq who can connect you with the right people to support.

- Engage early during trial planning. Respective Project Office Technical Advisors or Ecologiq team can assist with the testing and inspection plans, long-term performance monitoring (e.g. shrinkage, creep, strength), data to be provided at completion of trial.

DTP/NTRO mix approvals

- DTP Low Carbon Concrete Working Group team can liaise with DTP/ NTRO for approval of mixes. For temporary or non-structural applications, calcined clay concrete can be used and no DTP/ Vic Roads registered mix is required.

Stakeholder Engagement

- Engage asset owners early to align expectations for asset handover.

Supplier Coordination

- Current calcined clay suppliers: Green360 (Suvo)(VIC) and Zeotech (AusPozz) (QLD).
- Current concrete suppliers known by VIDA with ability to incorporate calcined clay: Heidelberg Materials, Holcim, Boral and Eifers Concrete. Other independent suppliers may also be able to supply.

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