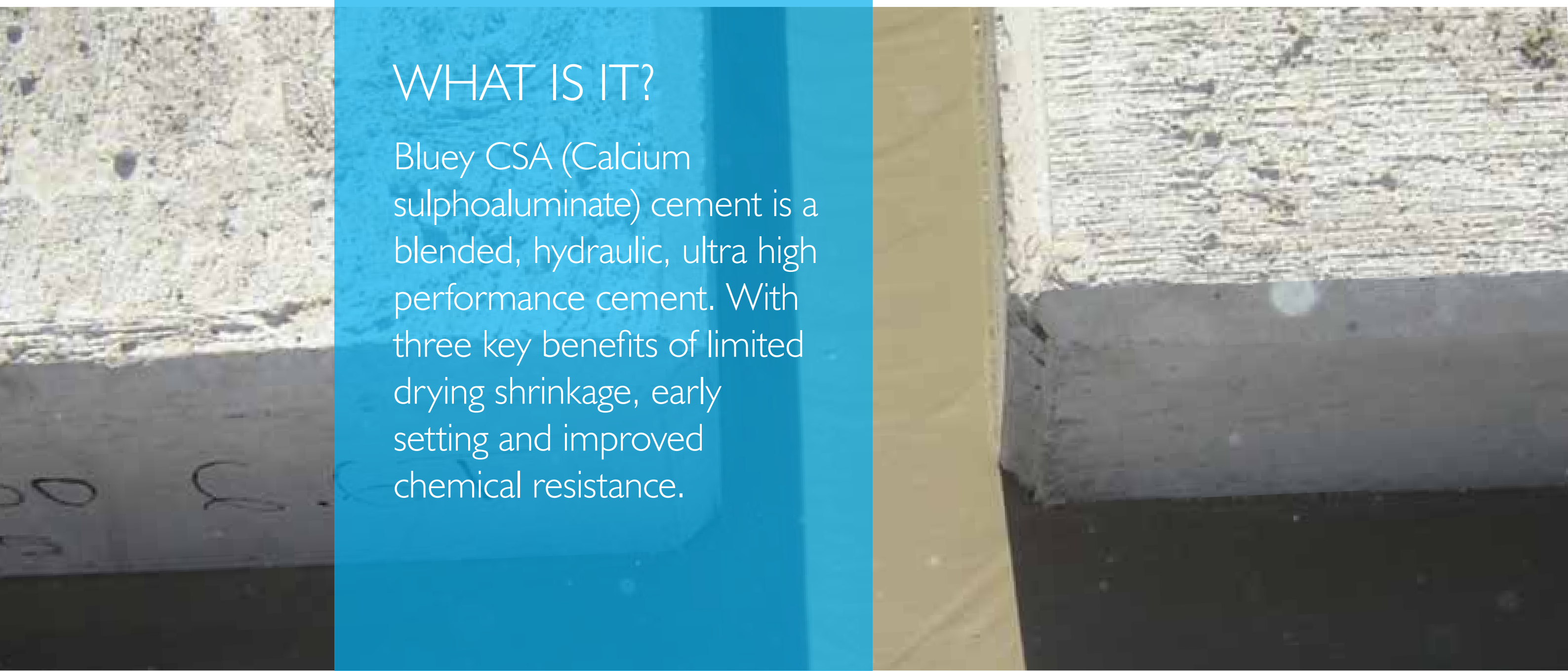
Bluey CSA Cement

PRODUCT INFORMATION

Bluey CSA Cement

ULTRA HIGH PERFORMANCE CEMENT



WHAT IS IT?

Bluey CSA (Calcium sulphoaluminate) cement is a blended, hydraulic, ultra high performance cement. With three key benefits of limited drying shrinkage, early setting and improved chemical resistance.

Bluey CSA Cement

PRODUCT APPLICATIONS

Bluey CSA cement is used for a range of concrete applications, from aggressive chemical environments to fast setting grouts.

PROJECTS WHERE RAPID STRENGTH GAIN IS IMPORTANT, SUCH AS:

Airport upgrades

Railway shutdowns

Tidal environments

Tunnel advancements

Ground support

Floor topping

PROJECTS WHERE CHEMICAL ATTACK OR AGGRESSIVE ENVIRONMENTS WOULD CAUSE CORROSION, SUCH AS:

Sewer refurbishment

Acid sulphate soils

Marine environments

Industrial process facilities

WHY BLUEY CSA CEMENT?

Calcium sulphoaluminate (CSA) cement is a blended, hydraulic, ultra-high-performance cement. Its main component is calcium sulphoaluminate cement crystals. Bluey use CSA as a source of calcium aluminate instead of the traditional high-alumina cement to react with calcium sulphate in the presence of lime to form ettringite, which is what CSA cement in its crystal form is widely known as. The construction industry has used ettringite for many years to impart controlled expansive properties to Ordinary Portland Cement (OPC) grouts in order to control shrinkage during drying.

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PRODUCT SUPPORT

RESEARCH, EXPERIENCE, PRODUCT, SUPPORT

Minova International manufacture products based on CSA systems exclusively for Bluey Technologies.

Minova's range of products includes resin capsules for rock bolting, high volume output grouts for strata support, ventilation control devices and specialised coatings including Tekflex.

Minova has over 1,200 employees worldwide, and 12 manufacturing sites in seven countries, with key facilities in the U.S. Germany, Poland, Australia and South Africa.

Construction-material supplier Bluey Technologies' partner for mining, Minova, has been producing and supplying ettringite-forming cement systems for more than 20 years. It has now developed a range of shotcrete and repair-mortar systems in conjunction with Bluey that aims to provide the three key benefits of limited drying shrinkage, early setting, and improved chemical resistance.

BACKED BY ORICA

Minova is part of the Orica Group (www.orica.com) which provides products and services to the mining, manufacturing and construction and consumer markets. Orica, with a market capitalisation of approximately AU$7 billion, is one of the top 50 companies listed on the Australian Stock Exchange, and has over 13,000 employees in approximately 50 countries and services customers in 98 different countries around the world.

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PRODUCT FEATURES

Practical examples throughout Australia include major airport upgrade works, major wharf repairs, seawall repairs, tunnel repairs, sewer protection and structural refurbishments.

Whilst new to the Australian building construction and civil-engineering industries, companies in the US and other parts of the world use such materials extensively for airport upgrades, bridge repairs, and road repairs, where the properties of reduced shrinkage, rapid strength development, and high chemical and abrasion resistance offer improved performance. Ettringite-based grout systems had been widely used since the 1940s.

Until recent years CSA cement has had limited availability in Australia despite its extensive use elsewhere. This limited availability has made the technology's development slower in Australia than in other parts of the world. In recent years, raw materials have become more readily available in Australia. Bluey Technologies has now supplied CSA cement grouts for nearly 10 years for many types of applications that require high early strength and long-term durability.

Australia now understands the benefits of CSA cements in full commercial use within the construction industry. In summary, their advantages include low shrinkage, low permeability, rapid strength gain, curing benefits, sulphate resistance, being chloride free, acid resistant, long-term durability, and having a low carbon footprint. Bluey Technologies' products Blu**Cem** RF20, HE80, HE80Ag HB50, HB60 contain it, and it is blended with OPC in the company's HB30 and HB40.

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PRODUCT FEATURES

LOW SHRINKAGE

CSA cements demonstrate considerably lower shrinkage characteristics than OPCs. This low shrinkage eliminates the need for secondary shrinkage-compensation systems that often rely on hydrogen or other gas formations to expand the grout during the gel phase. These gases can cause expansion that varies with the ambient temperatures and can also possibly lead to the hydrogen embrittlement of high-tensile reinforcing steel.

CSA-cement-based grouts require approximately 50% more water for proper hydration than do OPC grouts. The minimum recommended water-to-cement ratio is 0.35, whereas OPC's is approximately 0.22-0.25. Because of this higher water requirement, it consumes most of the mix water for hydration, making less excess water available to cause shrinkage. In ordinary Portland-cement-based systems the additional water in the cement matrix provides a greater chance for water loss due to evaporation. The higher rate of strength gain allows the cement matrix to overcome any tension stresses resulting from evaporation. This notably rapid strength gain can prevent shrinkage cracks because the concrete's strength increases more rapidly than its shrinkage stresses do, minimising or eliminating the formation of hair cracks in CSA cement matrices. This reduction of micro-shrinkage cracks results in CSA cement grouts having particularly low permeability. The formation of micro crystals that fill the concrete matrix's voids also provides a more dense final product with lower permeability.

RAPID STRENGTH GAIN AND CURING BENEFITS

Bluey Technologies' grouts and mortars containing CSA cement have strength gains in the order of 10MPa in one hour and up to 40MPa in 24 hours. Curing is indeed important with CSA, but its wet-curing durations are often hours rather than days or weeks. Those laying CSA concrete can achieve optimal hydration and stability by keeping it wet for at least three to four hours after casting. CSA concrete demands moisture during the initial hydration phase, and the rapid reaction generates significant heat. Plastic cracking is possible if it receives insufficient moisture during curing, but providing moisture through ponding or repeated wetting during the first few critical hours preserves and ensures long-term stability and strength. This early strength makes CSA-based grouts ideal for use in airport, roadway, and marine tidal applications. The reduced free water content and rapid curing also allow impermeable overlays such as membranes and coatings to be applied with 24-48 hours of curing.

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SULPHATE RESISTANCE AND CHLORIDE CONTENT

Sulphate attack in OPCs is a result of the calcium aluminate (C3A) phase of the cement-making process reacting with the sulphate solution to form ettringite, which is a CSA crystal. The late formation of ettringite causes disruptive expansion and a gradual deterioration of the POCconcrete. Sulphate-resisting OPC resists sulphate due to its reduction of the destructive reactions to its aluminium level, characterised by C3A content, in accordance with AS3972.

Sulphate attack does not occur in CSA cements because ettringite forms as part of their hydration process to form a stable mix. No late formation of ettringite occurs when placed in high sulphate solutions simply because the sulphate does not have any C3A with which to react.

The mix is also basically free of chloride ions, providing CSA cements with excellent resistance to chloride attack and also their low permeability. These features of CSA-based grouts make them ideal for use in marine environments.

ACID RESISTANCE

The main mineral components in CSA cements are anhydrous calcium sulfoaluminate ($4CaO{\cdot}3Al_2O_3{\cdot}CaSO_4$), dicalcium silicate ($2CaO{\cdot}SiO2$) and gypsum ($CaSO_4{\cdot}2H_2O$). The lime in CSA cement is bonded and therefore not free, making its alkali level lower, with a pH of only 10.5-11; the pH of OPC is approximately 13 due to the presence of free lime, which comes under attack in acidic environments. Their lack of free lime and low permeability make CSA cements ideal for use in water and such wastewater applications as sewer refurbishments.

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PRODUCT FEATURES

LONG-TERM DURABILITY

CSA cement should not be confused with high alumina cement (HAC), HAC is an unstable cement system and expands when in constant contact with water. Unlike HAC, CSA systems are extremely durable and completely stable. All of their C3A is completely bound into the reaction, leaving no C3A available for long-term reaction. OPC's only source of sulphate is its gypsum, which functions as set control. Higher percentages of gypsum affect the setting time and the soundness of the cement. In CSA cement the calcium sulphate is insoluble and is part of the cement's crystal matrix, which has an alternate function and behaves differently. CSA cement grouts are highly durable due to their low permeability and high sulphate and acid resistance. Their alkaline environment, lack of chloride ions, and ability to inhibit corrosion provide particularly long-term steel durability and excellent protection for embedded and reinforcing steel. They are able to provide this protection because their low permeability provides good protection against chemical attacks Their low chloride content, seven times less than the maximum allowable, minimises corrosion. Chloride ions are the principal reason for steel corrosion in concrete masses CSA crystals have the ability to react with the thin layer of iron dioxide rust on steel to form a protective layer of ettringites, which in turn increases the steel's passivity, consequently eliminating corrosion.

> “excellent protection for embedded and reinforcing steel”

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PRODUCT FEATURES

LOW CARBON FOOTPRINT

C3A is the compound responsible for early strength gain in OPC. The other compound, calcium disilicate (C2S), forms more slowly and is responsible for longer-term strength. C3S makes up approximately 50% to 60% of OPC's composition, while C2S makes up a smaller fraction, generally approximately 18% to 20%. The chemical conversion of limestone to calcium oxide contributes to approximately 48% of the CO_2 emissions generated in the production of OPC. Burning fossil fuels to achieve the high kiln temperatures accounts for an additional 42%. Combined, 90% of the CO_2 emissions are directly associated with the chemical conversion of limestone into cement.

The resulting CSA clinker is softer than Portland clinker and requires less energy to grind. Every 1,000kg of OPC results in 579kg of CO2 emissions, with every 1,000kg of CSA resulting in 216kg of such emissions, a 62% reduction in greenhouse gas emissions. CSA cements are significantly greener than OPC. (Green Cities Competition, "Green Cement: Finding a solution for a sustainable cement industry," Department of Civil and Environmental Engineering, University of California at Berkeley, 22 April 2007, John Anderson). The cement industry represents a small yet significant proportion of total global carbon dioxide emissions.

APPLICATION CONSIDERATIONS

The mixing of grouts with CSA cement is similar to mixing OPC based cements. The only consideration involved with its mixing and pumping is in regard to the fast initial set times. Pumps, mixers, and hoses must be cleared particularly quickly to prevent blockages.

CSA cement requires no curing and protection procedures in normal weather conditions. It is, however, advisable to protect the surface from moisture evaporation during the initial 60 minutes of curing. In such extreme conditions as hot or windy weather the moisture-evaporation protection should remain in

place for 24 hours. In marine tidal areas CSA cement grout may acceptably be submersed immediately in seawater without affecting the quality of the final product, as submersion in seawater actually improves its longterm strength. This is helpful for application to marine wharfs and seawalls, where work is completed at low tide.

Bluey CSA Cement
PRODUCT SUMMARY

SUMMARY

In conclusion, CSA cement is a blended, hydraulic, ultra-high-performance cement. Its main component is calcium sulfoaluminate cement crystals. It has most of OPC's constituents, with varying percentages and hydration mechanisms. The addition of pozzolan to OPC improves its sulphate resistance to some extent, but CSA cement is sulphate-resistant by itself without any addition, so it contains no pozzolan or fly ash. It is not high-alumina cement, even though its chemical analysis shows higher aluminate percentages than does OPC, and should be considered to be equivalent to SR cement type systems due to its low C3A content and inherent sulphate resistance.

CSA cements contain only non-soluble sulphate that forms an integral part of its crystal matrix and is bound into the reaction. The source of sulphur in OPC is gypsum, which functions to control initial set times. Higher percentages of free gypsum in OPC do effect its durability in certain environments. CSA cement, however, has no chlorides, its fast setting quality being related to a different hydration mechanism.

CSA cement products develop strengths of up to 35MPa in one hour and 80MPa in 28 days. Its grouts develop a wide range of strengths at different ages according to the mix design specifications for cement content, water-cement ratio, and aggregate qualities. Strengths of 10MPa in one hour are common with the Blu**Cem** range of CSA grouts. Their initial set times are approximately 30 to 45 minutes, with their final setting time being 1 to 2 hours. Some of the Bluey Technologies grouts use retarders to provide extended work life. The grout can also be submersed immediately in seawater without effecting the quality of the final product, submersion in seawater actually improving the concrete's long-term strength. Also, its setting time and seven-day strengths are within the acceptable range.

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CSA cements do not suffer from sulphate attack because ettringite is formed as part of their hydration process to form a stable mix. Late formation of ettringite cannot occur in high sulphate solutions because the sulphate has no free C3A with which to react.

CSA cement is non-shrink, non-expansive, and volume-stable. It achieves its low shrinkage from the binding of additional free water into its matrix and its high early strength gain, which resists evaporation tension. Its low shrinkage also contributes to its low permeability. In particular, however, its micro-crystals fill the voids in the concrete matrix and provide a more dense final product.

CSA cement needs no special curing and protection procedures, but it is advisable to protect the surface from moisture evaporation during the initial 60 minutes of curing. In extreme conditions such as hot or windy weather the moisture-evaporation protection should remain in place for 24 hours.

CSA cement's unique formula provides excellent protection for embedded and reinforcing steel due to its low permeability, particularly low chloride content, and the ability of its crystals to react with thin layers of iron dioxide rust to form a protective layer of ettringites, which in turn increases the steel's passivity, consequently eliminating corrosion.

CSA cement is beneficial for the environment as a substitute for OPC. The manufacturing of CSA Cement involves 62% lower emissions, including CO_2 emissions, than OPC. CSA Cement is sold and marketed at rates that are competitive with those of OPC grouts.

It is contained in Blu**Cem** RF20, HE80, HE80Ag HB50, HB60 and blended with OPC in HB30 and HB40.

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