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Concrete

From Wikipedia, the free encyclopedia

Concrete is a composite construction material composed primarily of aggregate, cement and water. There are many formulations that have varied properties. The aggregate is generally a coarse gravel or crushed rocks such as limestone, or granite, along with a fine aggregate such as sand. The cement, commonly Portland cement, and other cementitious materials such as fly ash and slag cement, serve as a binder for the aggregate. Various chemical admixtures are also added to achieve varied properties. Water is then mixed with this dry composite which enables it to be shaped (typically poured) and then solidified and hardened into rock-hard strength through a chemical process known as hydration. The water reacts with the cement which bonds the other components together, eventually creating a robust stone-like material. Concrete has relatively high compressive strength, but much lower tensile strength. For this reason is usually reinforced with materials that are strong in tension (often steel). Concrete can be damaged by many processes, such as the freezing of trapped water.

Outer view of the Roman Pantheon, still the largest unreinforced solid concrete dome.[1]

Concrete is widely used for making architectural structures, foundations, brick/block walls, pavements, bridges/overpasses, motorways/roads, runways, parking structures, dams, pools/reservoirs, pipes, footings for gates, fences and poles and even boats. Famous concrete structures include the Burj Khalifa (world's tallest building), the Hoover Dam, the Panama Canal and the Roman Pantheon.

A modern building: Boston City Hall (completed 1968) is constructed largely of concrete, both precast and poured in place.

Concrete technology was known by the Ancient Romans and was widely used within its empire. After the Empire passed, use of concrete became scarce until the technology was re-pioneered in the mid-18th century.

The environmental impact of concrete is a complex mixture of not entirely negative effects; while concrete is a major contributor to greenhouse gas emissions, recycling of concrete is increasingly common in structures that have reached the end of their life. Structures made of concrete can have a long service life. As concrete has a high thermal mass and very low permeability, it can make for energy efficient housing.

Opus caementicium lying bare on a tomb near Rome. In contrast to modern concrete structures, the concrete walls of Roman buildings were covered, usually with brick or stone.

Contents

History

The word concrete comes from the Latin word "concretus" (meaning compact or condensed), the perfect passive participle of "concrescere", from "con-" (together) and "crescere" (to grow).

Concrete was used for construction in many ancient structures.[2]

During the Roman Empire, Roman concrete (or *opus caementicium*) was made from quicklime, pozzolana and an aggregate of pumice. Its widespread use in many Roman structures, a key event in the history of architecture termed the Roman Architectural Revolution, freed Roman construction from the restrictions of stone and brick material and allowed for revolutionary new designs in terms of both structural complexity and dimension.[3]

> Concrete, as the Romans knew it, was a new and revolutionary material. Laid in the shape of arches, vaults and domes, it quickly hardened into a rigid mass, free from many of the internal thrusts and strains that troubled the builders of similar structures in stone or brick.[4]

Hadrian's Pantheon in Rome is an example of Roman concrete construction.

Modern tests show that *opus caementicium* had as much compressive strength as modern Portland-cement concrete (ca. 200 kg/cm^2).[5] However, due to the absence of steel reinforcement, its tensile strength was far lower and its mode of application was also different:

> Modern structural concrete differs from Roman concrete in two important details. First, its mix consistency is fluid and homogeneous, allowing it to be poured into forms rather than requiring hand-layering together with the placement of aggregate,

which, in Roman practice, often consisted of rubble. Second, integral reinforcing steel gives modern concrete assemblies great strength in tension, whereas Roman concrete could depend only upon the strength of the concrete bonding to resist tension.[6]

The widespread use of concrete in many Roman structures has ensured that many survive to the present day. The Baths of Caracalla in Rome are just one example. Many Roman aqueducts and bridges have masonry cladding on a concrete core, as does the dome of the Pantheon.

Some have stated that the secret of concrete was lost for 13 centuries until 1756, when the British engineer John Smeaton pioneered the use of hydraulic lime in concrete, using pebbles and powdered brick as aggregate. However, the Canal du Midi was built using concrete in 1670.[7] Likewise there are concrete structures in Finland that date back to the 16th century.[citation needed] Portland cement was first used in concrete in the early 1840s.

Additives

Concrete additives have been used since Roman and Egyptian times, when it was discovered that adding volcanic ash to the mix allowed it to set under water. Similarly, the Romans knew that adding horse hair made concrete less liable to crack while it hardened and adding blood made it more frost-resistant.[8]

In modern times, researchers have experimented with the addition of other materials to create concrete with improved properties, such as higher strength or electrical conductivity.

Composition

There are many types of concrete available, created by varying the proportions of the main ingredients below. In this way or by substitution for the cemetitious and aggregate phases, the finished product can be tailored to its application with varying strength, density, or chemical and thermal resistance properties.

Recently the use of recycled materials as concrete ingredients has been gaining popularity because of increasingly stringent environmental legislation. The most conspicuous of these is fly ash, a by-product of coal-fired power plants. This use reduces the amount of quarrying and landfill space required as the ash acts as a cement replacement thus reducing the amount of cement required.

The *mix design* depends on the type of structure being built, how the concrete will be mixed and delivered and how it will be placed to form this structure.

Cement

Main article: Cement

Portland cement is the most common type of cement in general usage. It is a basic ingredient of concrete, mortar and plaster. English masonry worker Joseph Aspdin patented Portland cement in 1824; it was named because of its similarity in color to Portland limestone, quarried from the English Isle of Portland and used extensively in London architecture. It consists of a mixture of oxides of calcium, silicon and aluminium. Portland cement and similar materials are made by heating limestone (a source of calcium) with clay and grinding this product (called *clinker*) with a source of sulfate (most commonly gypsum).

In recent years, alternatives have been developed to help replace cement. Products such as PLC (Portland Limestone Cement),[9] which incorporate limestone into the mix, are being tested. This is due to cement production being one of the largest producers of global green house gas emissions.

Water

Combining water with a cementitious material forms a cement paste by the process of hydration. The cement paste glues the aggregate together, fills voids within it and allows it to flow more freely.

Less water in the cement paste will yield a stronger, more durable concrete; more water will give a freer-flowing concrete with a higher slump. Impure water used to make concrete can cause problems when setting or in causing premature failure of the structure.

Hydration involves many different reactions, often occurring at the same time. As the reactions proceed, the products of the cement hydration process gradually bond together the individual sand and gravel particles and other components of the concrete, to form a solid mass.

Reaction:

Cement chemist notation: $C_3S + H \rightarrow C\text{-}S\text{-}H + CH$
Standard notation: $Ca_3SiO_5 + H_2O \rightarrow (CaO)\cdot(SiO_2)\cdot(H_2O)(gel) + Ca(OH)_2$
Balanced: $2Ca_3SiO_5 + 7H_2O \rightarrow 3(CaO)\cdot 2(SiO_2)\cdot 4(H_2O)(gel) + 3Ca(OH)_2$

Aggregates

Main article: Construction aggregate

Fine and coarse aggregates make up the bulk of a concrete mixture. Sand, natural gravel and crushed stone are used mainly for this purpose. Recycled aggregates (from construction, demolition and excavation waste) are increasingly used as partial replacements of natural aggregates, while a number of manufactured aggregates, including air-cooled blast furnace slag and bottom ash are also permitted.

Decorative stones such as quartzite, small river stones or crushed glass are sometimes added to the surface of concrete for a decorative "exposed aggregate" finish, popular among landscape designers.

The presence of aggregate greatly increases the robustness of concrete above that of cement, which otherwise is a brittle material and thus concrete is a true composite material.

Redistribution of aggregates after compaction often creates inhomogeneity due to the influence of vibration. This can lead to strength gradients.[10]

Reinforcement

Main article: reinforced concrete

Concrete is strong in compression, as the aggregate efficiently carries the compression load. However, it is weak in tension as the cement holding the aggregate in place can crack, allowing the structure to fail. Reinforced concrete solves these problems by adding either steel reinforcing bars, steel fibers, glass fiber, or plastic fiber to carry tensile loads. Thereafter the concrete is reinforced to withstand the tensile loads upon it.


Installing rebar in a floor slab during a concrete pour.

Chemical admixtures

Chemical admixtures are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes. In normal use, admixture dosages are less than 5% by mass of cement and are added to the concrete at the time of batching/mixing.[11] The common types of admixtures[12] are as follows.

- Accelerators speed up the hydration (hardening) of the concrete. Typical materials used are $CaCl_2$, $Ca(NO_3)_2$ and $NaNO_3$. However, use of chlorides may cause corrosion in steel reinforcing and is prohibited in some countries, so that nitrates may be favored.
- Retarders slow the hydration of concrete and are used in large or difficult pours where partial setting before the pour is complete is undesirable. Typical polyol retarders are sugar, sucrose, sodium gluconate, glucose, citric acid, and tartaric acid.
- Air entrainments add and entrain tiny air bubbles in the concrete, which will reduce damage during freeze-thaw cycles, thereby increasing the concrete's durability. However, entrained air entails a trade off with strength, as each 1% of air may result in 5% decrease in compressive strength.
- Plasticizers increase the workability of plastic or "fresh" concrete, allowing it be placed more easily, with less consolidating effort. A typical plasticizer is lignosulfonate. Plasticizers can be used to reduce the water content of a concrete while maintaining workability and are sometimes called *water-reducers* due to this use. Such treatment improves its strength and durability characteristics. Superplasticizers (also called *high-range water-reducers*) are a class of plasticizers that have fewer deleterious effects and can be used to increase workability more than is practical with traditional plasticizers. Compounds used as superplasticizers include sulfonated naphthalene formaldehyde condensate, sulfonated melamine formaldehyde condensate, acetone formaldehyde condensate and polycarboxylate ethers.
- Pigments can be used to change the color of concrete, for aesthetics.
- Corrosion inhibitors are used to minimize the corrosion of steel and steel bars in concrete.
- Bonding agents are used to create a bond between old and new concrete (typically a type of polymer) .
- Pumping aids improve pumpability, thicken the paste and reduce separation and bleeding.

Mineral admixtures and blended cements

There are inorganic materials that also have pozzolanic or latent hydraulic properties. These very fine-grained materials are added to the concrete mix to improve the properties of concrete (mineral admixtures),[11] or as a replacement for Portland cement (blended cements).[13]

Blocks of concrete in Belo Horizonte, Brazil.

- Fly ash: A by-product of coal-fired electric generating plants, it is used to partially replace Portland cement (by up to 60% by mass). The properties of fly ash depend on the type of coal burnt. In general, siliceous fly ash is pozzolanic, while calcareous fly ash has latent hydraulic properties.[14]
- Ground granulated blast furnace slag (GGBFS or GGBS): A by-product of steel production is used to partially replace Portland cement (by up to 80% by mass). It has latent hydraulic properties.[15]
- Silica fume: A by-product of the production of silicon and ferrosilicon alloys. Silica fume is similar to fly ash, but has a particle size 100 times smaller. This results in a higher surface to volume ratio and a much faster pozzolanic reaction. Silica fume is used to increase strength and durability of concrete, but generally requires the use of superplasticizers for workability.[16]
- High reactivity Metakaolin (HRM): Metakaolin produces concrete with strength and durability similar to concrete made with silica fume. While silica fume is usually dark gray or black in color, high-

reactivity metakaolin is usually bright white in color, making it the preferred choice for architectural concrete where appearance is important.

Concrete production

The processes used vary dramatically, from hand tools to heavy industry, but result in the concrete being placed where it cures into a final form. Wide range of technological factors may occur during production of concrete elements and their influence to basic characteristics may vary.[17]

Concrete plant facility (background) with concrete delivery trucks.

When initially mixed together, Portland cement and water rapidly form a gel, formed of tangled chains of interlocking crystals. These continue to react over time, with the initially fluid gel often aiding in placement by improving workability. As the concrete sets, the chains of crystals join and form a rigid structure, gluing the aggregate particles in place. During curing, more of the cement reacts with the residual water (hydration).

This curing process develops physical and chemical properties. Among these qualities are mechanical strength, low moisture permeability and chemical and volumetric stability.

Mixing concrete

See also: Volumetric concrete mixer

Thorough mixing is essential for the production of uniform, high quality concrete. For this reason equipment and methods should be capable of effectively mixing concrete materials containing the largest specified aggregate to produce *uniform mixtures* of the lowest slump practical for the work.

Separate paste mixing has shown that the mixing of cement and water into a paste before combining these materials with aggregates can increase the compressive strength of the resulting concrete.[18] The paste is generally mixed in a *high-speed*, shear-type mixer at a w/cm (water to cement ratio) of 0.30 to 0.45 by mass. The cement paste premix may include admixtures such as accelerators or retarders, superplasticizers, pigments, or silica fume. The premixed paste is then blended with aggregates and any remaining batch water and final mixing is completed in conventional concrete mixing equipment.[19]

High-energy mixed (HEM) concrete is produced by means of high-speed mixing of cement, water and sand with net specific energy consumption of at least 5 kilojoules per kilogram of the mix. A plasticizer or a superplasticizer is then added to the activated mixture, which can later be mixed with aggregates in a conventional concrete mixer. In this process, sand provides dissipation of energy and creates high-shear conditions on the surface of cement particles. This results in the full volume of water interacting with cement. The liquid activated mixture can be used by itself or foamed (expanded) for lightweight concrete.[20] HEM concrete hardens in low and subzero temperature conditions and possesses an increased volume of gel, which drastically reduces capillarity in solid and porous materials.

Workability

Main article: Concrete slump test

Workability is the ability of a fresh (plastic) concrete mix to fill the form/mold properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, aggregate (shape and size distribution), cementitious content and age (level of hydration) and can be modified by adding chemical admixtures, like superplasticizer. Raising the water content or adding chemical admixtures will increase concrete workability. Excessive water will lead to increased bleeding (surface water) and/or segregation of aggregates (when the cement and aggregates start to separate), with the resulting concrete having reduced quality. The use of an aggregate with an undesirable gradation can result in a very harsh mix design with a very low slump, which cannot be readily made more workable by addition of reasonable amounts of water.


Pouring and smoothing out concrete at Palisades Park in Washington DC.

Workability can be measured by the concrete slump test, a simplistic measure of the plasticity of a fresh batch of concrete following the ASTM C 143 or EN 12350-2 test standards. Slump is normally measured by filling an "Abrams cone" with a sample from a fresh batch of concrete. The cone is placed with the wide end down onto a level, non-absorptive surface. It is then filled in three layers of equal volume, with each layer being tamped with a steel rod in order to consolidate the layer. When the cone is carefully lifted off, the enclosed material will slump a certain amount due to gravity. A relatively dry sample will slump very little, having a slump value of one or two inches (25 or 50 mm). A relatively wet concrete sample may slump as much as eight inches. Workability can also be measured by using the flow table test.

Slump can be increased by addition of chemical admixtures such as plasticizer or superplasticizer without changing the water-cement ratio[21]. Some other admixtures, especially air-entraining admixture, can increase the slump of a mix.

High-flow concrete, like self-consolidating concrete, is tested by other flow-measuring methods. One of these methods includes placing the cone on the narrow end and observing how the mix flows through the cone while it is gradually lifted.

After mixing, concrete is a fluid and can be pumped to the location where needed.

Curing

In all but the least critical applications, care needs to be taken to properly *cure* concrete, to achieve best strength and hardness. This happens after the concrete has been placed. Cement requires a moist, controlled environment to gain strength and harden fully. The cement paste hardens over time, initially setting and becoming rigid though very weak and gaining in strength in the weeks following. In around 3 weeks, typically over 90% of the final strength is reached, though strengthening may continue for decades.[22] The conversion of calcium hydroxide in the concrete into calcium carbonate from absorption of CO_2 over several decades further strengthen the concrete and making it more resilient to damage. However, this reaction, called carbonation, lowers the pH of the cement pore solution and can cause the reinforcement bars to corrode.


A concrete slab ponded while curing.

Hydration and hardening of concrete during the first three days is critical. Abnormally fast drying and shrinkage due to factors such as evaporation from wind during placement may lead to increased tensile stresses at a time when it has not yet gained sufficient strength, resulting in greater shrinkage cracking. The early strength of the concrete can be increased if it is kept damp during the curing process. Minimizing stress prior to curing minimizes cracking. High-early-strength concrete is designed to hydrate faster, often by increased use of cement that increases shrinkage and cracking. Strength of concrete changes (increases) up to three years. It depends on cross-section dimension of elements and conditions of structure exploitation.[23]

During this period concrete needs to be kept under controlled temperature and humid atmosphere. In practice, this is achieved by spraying or ponding the concrete surface with water, thereby protecting the concrete mass from ill effects of ambient conditions. The pictures to the right show two of many ways to achieve this, ponding – submerging setting concrete in water and wrapping in plastic to contain the water in the mix. Additional common curing methods include wet burlap and/or plastic sheeting covering the fresh concrete, or by spraying on a water-impermeable temporary curing membrane.

Properly curing concrete leads to increased strength and lower permeability and avoids cracking where the surface dries out prematurely. Care must also be taken to avoid freezing, or overheating due to the exothermic setting of cement. Improper curing can cause scaling, reduced strength, poor abrasion resistance and cracking.

Properties

Main article: Properties of concrete

Concrete has relatively high compressive strength, but much lower tensile strength. For this reason is usually reinforced with materials that are strong in tension (often steel). The elasticity of concrete is relatively constant at low stress levels but starts decreasing at higher stress levels as matrix cracking develops. Concrete has a very low coefficient of thermal expansion and shrinks as it matures. All concrete structures will crack to some extent, due to shrinkage and tension. Concrete that is subjected to long-duration forces is prone to creep.

Tests can be made to ensure the properties of concrete correspond to specifications for the application.

Concrete degradation

Main article: Concrete degradation


Concrete spalling caused by the corrosion of rebar

Concrete can be damaged by many processes, such as the expansion of corrosion products of the steel reinforcement bars, freezing of trapped water, fire or radiant heat, aggregate expansion, sea water effects, bacterial corrosion, leaching, erosion by fast-flowing water, physical damage and chemical damage (from carbonation, chlorides, sulfates and distillate water).[citation needed]

Environmental and health

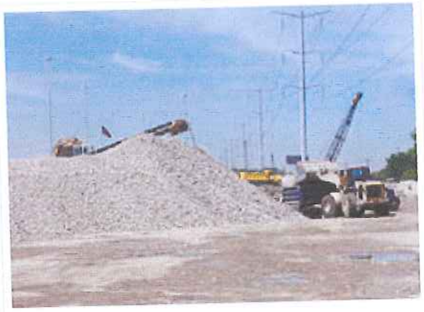
Main article: Environmental impact of concrete

The environmental impact of concrete is a complex mixture of not entirely negative effects. A major component of concrete is cement, which has its own its own environmental and social impacts.

The cement industry is one of two primary producers of carbon dioxide, a major greenhouse gas. Concrete is used to create hard surfaces which contribute to surface runoff, which can cause heavy soil erosion, water pollution and flooding. Concrete is a primary contributor to the urban heat island effect, but is less so than asphalt. Concrete dust released by building demolition and natural disasters can be a major source of dangerous air pollution. The presence of some substances in concrete, including useful and unwanted additives, can cause health concerns due to toxicidity and radioactivity. Wet concrete is highly alkaline and must be handled with proper protective equipment.

Concrete recycling

Main article: Concrete recycling



Recycled crushed concrete being loaded into a semi-dump truck to be used as granular fill.

Concrete recycling is an increasingly common method of disposing of concrete structures. Concrete debris was once routinely shipped to landfills for disposal, but recycling is increasing due to improved environmental awareness, governmental laws and economic benefits.

Concrete, which must be free of trash, wood, paper and other such materials, is collected from demolition sites and put through a crushing machine, often along with asphalt, bricks and rocks.

Reinforced concrete contains rebar and other metallic reinforcements, which are removed with magnets and recycled elsewhere. The remaining aggregate chunks are sorted by size. Larger chunks may go through the crusher again. Smaller pieces of concrete are used as gravel for new construction projects. Aggregate base gravel is laid down as the lowest layer in a road, with fresh concrete or asphalt placed over it. Crushed recycled concrete can sometimes be used as the dry aggregate for brand new concrete if it is free of contaminants, though the use of recycled concrete limits strength and is not allowed in many jurisdictions. On 3 March 1983, a government funded research team (the VIRL research.codep) approximated that almost 17% of worldwide landfill was by-products of concrete based waste.

Use of concrete in infrastructure

Mass concrete structures

These large structures typically include gravity dams, such as the Hoover Dam, the Itaipu Dam and the Three Gorges Dam, arch dams, navigation locks and large breakwaters. Such large structures, even though individually placed in formed horizontal blocks, generate excessive heat and associated expansion; to mitigate these effects post-cooling[24] is commonly provided in the design. An early example at Hoover Dam, installed a network of pipes between vertical concrete placements to circulate cooling water during the curing process to avoid damaging overheating. Similar systems are still used; depending on volume of the pour, the concrete mix used, and ambient air temperature, the cooling process may last for many months after the concrete is placed. Various methods also are used to pre-cool the concrete mix in mass concrete structures.[24]

Concrete that is poured all at once in one form (so that there are no weak points where the concrete is "welded" together) is used for tornado shelters.

Pre-stressed concrete structures

Main article: Pre-stressed concrete

Pre-stressed concrete is a form of reinforced concrete that builds in compressive stresses during construction to oppose those found when in use. This can greatly reduce the weight of beams or slabs, by better distributing the stresses in the structure to make optimal use of the reinforcement. For example a horizontal beam will tend to sag down. If the reinforcement along the bottom of the beam is pre-stressed, it can counteract this.

In pre-tensioned concrete, the pre-stressing is achieved by using steel or polymer tendons or bars that are subjected to a tensile force prior to casting, or for post-tensioned concrete, after casting.

Concrete textures

When one thinks of concrete, the image of a dull, gray concrete wall often comes to mind. With the use of form liner, concrete can be cast and molded into different textures and used for decorative concrete applications. Sound/retaining walls, bridges, office buildings and more serve as the optimal canvases for concrete art. For example, the Pima Freeway/Loop 101 retaining and sound walls in Scottsdale, Arizona, feature desert flora and fauna, a 67-foot (20 m) lizard and 40-foot (12 m) cacti along the 8-mile (13 km) stretch. The project, titled "The Path Most Traveled," is one example of how concrete can be shaped using elastomeric form liner.

40-foot cacti decorate a sound/retaining wall in Scottsdale, Arizona

Building with concrete

Concrete is one of the most durable building materials. It provides superior fire resistance, compared with wooden construction and can gain strength over time. Structures made of concrete can have a long service life. Concrete is the most widely used construction material in the world with annual consumption estimated at between 21 and 31 billion tonnes.[citation needed]

Concrete is used more than any other man-made material in the world.[25] As of 2006, about 7.5 billion cubic meters of concrete are made each year—more than one cubic meter for every person on Earth.[26]

Concrete powers a US$35 billion industry, employing more than two million workers in the United States alone.[citation needed] More than 55,000 miles (89,000 km) of highways in the United States are paved with this material. Reinforced concrete, prestressed concrete and precast concrete are the most widely used types of concrete functional extensions in modern days.

Energy efficiency

Energy requirements for transportation of concrete are low because it is produced locally from local resources, typically manufactured within 100 kilometers of the job site. Similarly, relatively little energy is used in producing and combining the raw materials (although large amounts of CO_2 are produced by the chemical reactions in cement manufacture). The overall embodied energy of concrete is therefore lower than for most structural materials other than wood.

Once in place, concrete offers significant energy efficiency over the lifetime of a building.[27] Concrete walls leak air far less than those made of wood-frames[citation needed]. Air leakage accounts for a large percentage of energy loss from a home. The thermal mass properties of concrete increase the efficiency of both residential and commercial buildings. By storing and releasing the energy needed for heating or cooling, concrete's thermal mass delivers year-round benefits by reducing temperature swings inside and minimizing heating and cooling costs[citation needed]. While insulation reduces energy loss through the building envelope, thermal mass uses walls to store and release energy. Modern concrete wall systems use both external insulation and thermal mass to create an energy-efficient building. Insulating Concrete Forms (ICFs) are hollow blocks or panels made of either insulating foam or rastra that are stacked to form the shape of the walls of a building and then filled with reinforced concrete to create the structure.

Fire safety

Concrete buildings are more resistant to fire than those constructed using wood or steel frames,[citation needed] since concrete does not burn. Concrete reduces the risk of structural collapse and is an effective fire shield, providing safe means of escape for occupants and protection for fire fighters.

Options for non-combustible construction include floors, ceilings and roofs made of cast-in-place and hollow-core precast concrete. For walls, concrete masonry technology and Insulating Concrete Forms (ICFs) are additional options. ICFs are hollow blocks or panels made of fire-proof insulating foam that are stacked to form the shape of the walls of a building and then filled with reinforced concrete to create the structure.

Concrete also provides the best resistance of any building material to high winds, hurricanes, tornadoes due to its lateral stiffness that results in minimal horizontal movement.[citation needed]

Earthquake safety

As discussed above, concrete is very strong in compression, but weak in tension. Larger earthquakes can generate very large shear loads on structures. These shear loads subject the structure to both tensional and compressional loads. Concrete structures without reinforcing, like other unreinforced masonry structures, can fail during severe earthquake shaking. Unreinforced masonry structures constitute one of the largest earthquake risks globally.[28] These risks can be reduced through seismic retrofitting of at-risk buildings, (e.g. School buildings in Istanbul, Turkey[29]).

World records

The world record for the largest concrete pour in a single project is the Three Gorges Dam in Hubei Province, China by the Three Gorges Corporation. The amount of concrete used in the construction of the dam is estimated at 16 million cubic meters over 17 years. The previous record was 12.3;million cubic meters held by Itaipu hydropower station in Brazil. [30][31][32][33]

The world record for concrete pumping was set on 7 August 2009 during the construction of the Parbati Hydroelectric Project, near the village of Suind, Himachal Pradesh, India, when the concrete mix was pumped through a vertical height of 715 m (2,346 ft).[34][35]

The world record for largest continuously poured concrete raft was achieved in August 2007 in Abu Dhabi by contracting firm Al Habtoor-CCC Joint Venture. The pour (a part of the foundation for the Abu Dhabi's Landmark Tower) was 16,000 cubic meters of concrete poured within a two day period.[36] The previous record (close to 10,500 cubic meters) was held by Dubai Contracting Company and achieved 23 March 2007.[37]

The world record for largest continuously poured concrete floor was completed 8 November 1997, in Louisville, Kentucky by design-build firm EXXCEL Project Management. The monolithic placement consisted of 225,000 square feet (20,900 m^2) of concrete placed within a 30 hour period, finished to a flatness tolerance of F_F 54.60 and a levelness tolerance of F_L 43.83. This surpassed the previous record by 50% in total volume and 7.5% in total area.[38][39]

The record for the largest continuously placed underwater concrete pour was completed 18 October 2010, in New Orleans, Louisiana by contractor C. J. Mahan Construction Company, LLC of Grove City, Ohio. The placement consisted of 10,224 cubic yards of concrete placed in a 58 hour period using two concrete pumps and two dedicated concrete batch plants. Upon curing, this placement will allow the 50,180-square-foot (4,662 m^2) cofferdam to be dewatered approximately 26 feet (7.9 m) below sea level to allow the construction of the IHNC GIWW Sill & Monolith Project to be completed in the dry.[citation needed]

See also

- Anthropic rock
- Biorock
- Brutalist architecture, encouraging visible concrete surfaces
- Bunding
- Cement
  - Geopolymers, a class of synthetic aluminosilicate materials
  - Hempcrete, a mixture with hemp hurds
  - Mudcrete, a soil-cement mixture
  - Papercrete, a paper-cement mixture
  - Portland cement, the classical concrete cement
- Cement accelerator
- Concrete canoe
- Concrete curing
- Concrete leveling
- Concrete mixer
- Concrete masonry unit
- Concrete moisture meter
- Concrete recycling
- Concrete step barrier
- Construction
- Diamond grinding of pavement
- Efflorescence
- Fireproofing
- Foam Index
- Form liner
- Formwork
  - Controlled permeability formwork
- High performance fiber reinforced cementitious composites
- High Reactivity Metakaolin
- International Grooving & Grinding Association
- LiTraCon
- Mortar
- Plasticizer
- Prefabrication
- Pykrete, a composite material of ice and cellulose
- Shallow foundation
- Silica fume
- Translucent concrete
- Whitetopping
- World of Concrete
- Types of concrete
  - Aerated autoclaved concrete
  - Asphalt concrete
  - Seacrete
  - Decorative concrete
  - ferrocement
  - Fiber reinforced concrete
  - Lunarcrete
  - Precast concrete
  - Prestressed concrete
  - Ready-mix concrete
  - Reinforced concrete
  - Roller-compacted concrete
  - Salt-concrete
  - Terrazzo

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Categories: Concrete | Building materials | Masonry | Pavements | Sculpture materials

Lime (material)

From Wikipedia, the free encyclopedia

Limestone quarry in Brønnøy, Norway.

Lime is a general term for calcium-containing inorganic materials, in which carbonates, oxides and hydroxides predominate. Strictly speaking, lime is calcium oxide or calcium hydroxide. It is also the name for a single mineral (native lime) of the CaO composition, occurring very rarely.[1] The word "lime" originates with its earliest use as building mortar and has the sense of "sticking or adhering."[2] Lime can also refer to a sticky substance (birdlime) smeared on branches to catch small birds.

These materials are still used in large quantities as building and engineering materials (including limestone products, concrete and mortar) and as chemical feedstocks, among other uses. Lime industries and the use of many of the resulting products date from prehistoric periods in both the Old World and the New World.

The rocks and minerals from which these materials are derived, typically limestone or chalk, are composed primarily of calcium carbonate. They may be cut, crushed or pulverized and chemically altered. "Burning" (calcination) converts them into the highly caustic material *quicklime* (calcium oxide, CaO) and, through subsequent addition of water, into the less caustic (but still strongly alkaline) *slaked lime* or *hydrated lime* (calcium hydroxide, $Ca(OH)_2$), the process of which is called *slaking of lime.*

When the term is encountered in an agricultural context, it probably refers to agricultural lime. Otherwise it most commonly means slaked lime, as the more dangerous form is usually described more specifically as quicklime or *burnt lime.*

Contents

Lime production process

- Limestone is extracted from quarries or mines.
- Part of the extracted stone, selected according to its chemical composition and granulometry, is calcinated at about 1000°C in different types of kiln, fired by such fuels as natural gas, coal, fuel oil, lignite, etc.

Quicklime is produced according to the reaction: $CaCO_3$ + heat → $CaO + CO_2$. Lime is used extensively for waste water treatment with ferrous sulphate.

- Quicklime can be hydrated, i.e., combined with water.

Hydrated lime, known as slaked lime, is produced according to the reaction: $CaO + H_2O \rightarrow Ca(OH)_2$

See also

- calcium oxide, the main component of dry mineral lime.
- calcium hydroxide, the hydrated form.
- gypsum: a similar mineral.
- sascab: a building and paving material (Central America).
- hydraulic lime
- Lime plaster
- Lime mortar
- Lime wash
- Plastering

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External links

- The National Lime Association (US & Canada) (http://www.lime.org)
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Categories: Building materials | Calcium minerals | Oxide minerals | Limestone | Alchemical substances | Plastering

Regional OpenSpace | Midpeninsula Regional Open Space District

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Mr. Rob Eastwood
Santa Clara County Planning Office
County Government Center
70 W. Hedding Street, 7th Floor, East Wing
San Jose, CA 95110

February 17, 2011

RE: The Lehigh Permanente Quarry Reclamation Plan Amendment Draft Environmental Impact Report (SCH#2010042063)

On behalf of Midpeninsula Regional Open Space District (District), I would like to provide the following comments on the Draft Environmental Impact Report (DEIR) for the Lehigh Permanente Quarry Reclamation Plan Amendment. The District has previously submitted numerous comment letters on various recent proposals related to the Permanente Quarry, as referenced in our May 17th, 2011 letter regarding the scoping of the subject DEIR.

East Materials Storage Area (EMSA)

The proposed EMSA remains extremely problematic. The District does not believe that Lehigh or the County have shown that this area is in fact a pre-existing use area associated with the quarry. We concur with the County Geologist's conclusion, as presented to the Board of Supervisor's for the public hearing related to existing non-conforming use (vested right), that the area proposed for mine waste at the EMSA was never a part of the quarry operations. It instead was developed and used for industrial manufacturing related to Kaiser's magnesium and aluminum plant operations. Many maps identify this location with the name "Permanente Metals" given to the magnesium and aluminum plant operations. In fact one natural gas source was shared by the metals manufacturing plants and the cement plant, as noted in the historic resources section of the DEIR, again testament to this location being a manufacturing plant facility, subject to a use permit, as opposed to an existing non-conforming quarry operation.

Quarry related overburden and waste dumped at the EMSA are in fact a very recent phenomenon, beginning in 2006, that correctly resulted in the County's 2008 Notice of Violation that this was not an allowed use. We believe that the record shows that the EMSA, until very recently, was never a part of quarry operations, and therefore cannot be "vested". Instead, development of the proposed EMSA area is clearly subject to a County use permit.

The addition of the EMSA as a "quarry operation" and inclusion in the Reclamation Plan Amendment is characterized in the DEIR as a "significant and unavoidable" visual impact. The proposed visual impacts related to the EMSA are simply staggering. The huge stepped waste pile proposed is vastly out of character with the surrounding topography, the hillside protection zone district, the County scenic ridge easement, valley view shed protection policies, and park protection policies. Within the historic context, the value of the visual resources at stake is well documented and recognized. This new unnatural waste pile will form the new background to the County scenic easement granted by Kaiser long ago in recognition of the visual importance of Permanente Ridge, and the strong community and County support behind its protection.

The 1985 Reclamation Plan stressed the importance of reclaiming a small pile of quarry waste at the time known as the east materials area (Area C). The scale of this pile is dwarfed by the proposed EMSA, but at the time was recognized as a visual impact to be immediately remedied. This allowed for quarrying to the west of this old waste pile, "while maintaining a knoll as a visual buffer between the quarried area and the Santa Clara Valley area". The 1985 Mitigated Negative Declaration (MND) for the 1985 Reclamation Plan states that "The existing ridgeline will be maintained by means of the (scenic) easement agreement and conditions of this reclamation plan to insure neither the quarry pit nor materials storage area will be visible towards the north and east." It further states that "The Permanente ridgeline and its easement dedication will insure no exposure of the quarry or its material area towards the north and northeast." One has to ask why the existing visual impact of the quarry is so much greater than the County initially envisioned. One also has to question the construction of the proposed EMSA which dwarfs this prior area of concern and also moves the huge pile of proposed quarry waste up to 5000' **closer** to the valley floor!

The DEIR project baseline is established as 2007, the year following Lehigh's initiation of dumping in the EMSA and one year prior to the County's Notice of Violation to Lehigh for unauthorized use of this area. Since Lehigh had initiated quarry waste disposal by 2007, the DEIR assumes the entire 6,500,000 tons of waste have been already piled in the proposed EMSA. This is clearly problematic, and inappropriate. The EMSA is in fact a new project, initiated in a new area, subject to a County Use Permit.

The DEIR concludes that alternatives which would not construct the EMSA (no project alternative) , or the removal of the EMSA at final reclamation (Alternative 1) are "least preferred" , since the lack of or lower height of the reclaimed EMSA would not provide visual screening for the existing Cement Plant site. This assumes the EMSA is built, it is not. The cement plant operates under a use permit issued and regulated by the County. This issue illuminates the overlap of the historic manufacturing plant facilities area (part of which is proposed to be buried by the EMSA waste) and the "quarry operations" proposed.

If the construction of a quarry waste dump is being done to screen the cement plant operations, isn't that more appropriately completed under a use permit amendment for the existing cement plant? It is also clear from a review of the cement plant site and the DEIR's supporting documents that substantial waste material is also being placed outside of the footprint of the proposed EMSA, in other areas around the cement plant. While also highly visible from the surrounding area, we assume that this ongoing operation is also intended to visually screen existing cement plant structures and features. Are these new fills a part of a use permit amendment for the plant? It is appropriate that all new fills proposed to visually screen the permitted cement plant, be reviewed and regulated under the cement plant use permit.

It is absurd for the DEIR to conclude that not building the new unprecedented visual impact associated with the proposed EMSA would result in a greater visual impact because the public will be able to then see the cement plant facility which already exists, and has been highly visible for decades. The County has had a history of failures with regard to scenic protection associated with the quarry and cement plant. This is an opportunity to finally get it right. The County should not be misled to use this Reclamation Plan Amendment process to mitigate past visual protection failures with a new much larger impact, the EMSA.

The visual analysis that is included in the DEIR also clearly shows that the proposed EMSA is far larger in extent and much higher than that necessary to visually screen a portion of the existing cement plant operations from the surrounding communities. The EMSA is proposed as a quarry waste dump to accommodate the substantial deepening of the existing quarry proposed under the Reclamation Plan Amendment. Any other characterization is simply disingenuous. The incredibly significant visual impact associated with the proposed EMSA cannot be understated.

Regarding the visual impacts associated with the proposed project, the no project alternative is clearly preferred since the EMSA would not be constructed. The DEIR is incorrect in the assumption that reclamation of the EMSA would have to wait 25 years to occur. The County could order this immediately to resolve the existing violation.

The visual simulation presented in the DEIR also appears to be overly optimistic, and paints a prettier, greener picture than what would actually likely exist. The proposed EMSA is a waste rock dump. Waste rock is a very difficult material to revegetate, the time involved in revegetation will likely be much longer than presented. The greening of the site as depicted is also misleading. Much of the initial growth will be grass. As is evident from the top of the WMSA visible from the valley floor, the grass is brown for over half of the year, a significant contrast to the surrounding evergreen hillsides and ridges. It would also likely have erosion rills and surficial slippage, exposing bare patches of ground. The look will be more like the look of any nearby garbage landfill, unnaturally stepped and brown for most of the year, with sparse woody vegetation, not exactly compatible with scenic hillside protection.

In addition to the visual impacts discussed above, the proposed EMSA is also a source of significant impact, related to air quality, requiring mitigation. As an immediate neighboring property, in public trust, we are opposed to the ongoing and proposed dust impacts associated with the EMSA construction. The air quality assessment presented in the DEIR attempts to characterize dust and associated known toxic substances related to the quarry waste disposal by assessing the existing operations in the EMSA. The existing operation is occurring further away from the park/open space properties, and at a smaller scale than the proposed full EMSA. This is not a fair representation or analysis. A detailed analysis for air quality impacts should be conducted at the shared property line to characterize potential impact to the recreating public and our nearby Foothill Field Office facility. Additionally, a long-term continuous air quality monitoring station should be established at this location. The PG&E Trail located within the Rancho San Antonio Open Space Preserve is often heavily impacted by dust generated by the quarry and cement plant operations, that leaves a layer of dust on vegetation. The quantification and analysis of air quality impact to the Open Space Preserve, including the Field Office located within is not well studied or characterized in the DEIR.

The EMSA is identified in the DEIR as a new source area for selenium, adding to the existing quarry related water quality impacts to Permanente Creek. Water quality and biological resources per the DEIR would incur significant and unavoidable environmental impacts associated with the proposed project. The DEIR discusses project alternatives and concludes the extended time frame to reclamation of the EMSA would increase water quality impacts.

An additional alternative should be analyzed in the DEIR, an alternative that allows no further placement of waste within the EMSA and the immediate removal of all material that has been recently placed there, and **immediate** site restoration. Further, the alternative overburden disposal should have been included in the DEIR. These alternatives would **avoid** the significant and "unavoidable" impacts identified in the DEIR related to the EMSA. The alternatives presented in the DEIR, including the Preferred Project, attempt to address the Project's significant impacts when Lehigh is finished making them, as opposed to avoidance of impacts or immediate mitigation of existing impacts. Per CEQA and the stated DEIR objectives, alternatives considered must be capable of eliminating or reducing significant environmental effects. The removal of the EMSA would eliminate and/or reduce the significant and unavoidable impacts identified in the DEIR. Per CEQA this alternative is also feasible, capable of being accomplished in a successful manner.

In fact, the County agreement with Lehigh to continue dumping in the EMSA, following the County's notice of violation states that there is no assurance that the quarry waste will remain if the quarry continues to place it under the agreement. In other words, Lehigh can continue dumping quarry waste at their own risk, knowing they may need to remove it. The alternatives noted above appear superior to the alternative presented in the DEIR since they would remove/ stop an additional source of water quality impact from an operation that is already out of compliance for water quality impacts, would not create additional dust impacts, and would not further substantially degrade visual resources.

Toxics/ Hazardous Materials

Section 4.9 of the DEIR states that "in some cases, past industrial or commercial activities on a site could have resulted in spills or leaks of hazardous materials to the ground, resulting in soil and/or groundwater contamination." It further states that "at sites where contamination is suspected or known to have occurred, the site owner is required to perform a site investigation and perform site remediation, if necessary."

The proposed EMSA is a significant concern regarding potential toxic substances associated with the old magnesium and aluminum plant locations. These obvious potential toxic concerns do not appear to have been investigated or evaluated in the DEIR. The quarry waste dumping proposed, particularly around the old graded metals manufacturing building pads and the down-slope edge of proposed EMSA waste is of most concern. Geotechnical fill placement details show that the former metals manufacturing area is proposed to have keyways excavated for the foundation support of the proposed EMSA waste pile. Given the magnesium and aluminum plants that existed in this location from 1941 through the 1990, it is necessary to investigate potential toxics within the existing soil. The potential health risk to mine workers, the surrounding community (including adjacent parkland), surface water, groundwater, and wildlife must be evaluated if toxics are encountered. We are surprised that quarry related disturbance has been allowed to take place, and continues to take place in this location, given the history of the site, without such an investigation. This issue was also raised by others during the DEIR scoping process.

EIR scope/ Baseline

We propose that the DEIR not use the artificial date (2007) to begin its analysis, but instead utilize the prior Reclamation Plan and associated maps and plans as the benchmark starting point. This may help explain why Lehigh at this late date has taken the exceptionally desperate and aggressive approach of beginning to place waste material right out in front of the surrounding communities and adjacent park/ open space preserve land. It's possible that Lehigh and their predecessors may have excavated a larger area than previously identified on the mining plans associated with the prior reclamation plan. Another possible indicator of this is that the WMSA, the only dumpsite identified in 1985, has also grown larger and taller that initially envisioned/proposed. The proposed EMSA appears to be the only convenient spot left to dump without filling the existing quarry pit, or hauling the waste material generated offsite. This bold desperate move by the Quarry has unfortunately been aided by past poor County oversight, as documented by the State Division of Mines and Geology, and the recent unsupported Board of Supervisor's "vested" determination.

The baseline utilized in the DEIR certainly should not grandfather the new use of the EMSA just because Lehigh chose to initiate dumping there, knowing full well that the Reclamation Plan Amendment was required. This simply doesn't pass the straight face test.

We have submitted numerous letters on the various iterations of reclamation plan amendments that have spun out of Lehigh and the County recently in an attempt to address quarry non-compliance issues. These issues are not uncommon for a quarry which has been operated intensively for 80 years. There are limitations on available resources and accessible product, and places to dump the waste generated. In fact, the DEIR states that "continued mining in the quarry is becoming infeasible from a geotechnical standpoint" and that regarding the status of the mineral designation, given 100 years of mining, "the reserves of limestone that feasibly can be extracted are approaching their limits." The recent proposal for a new south quarry pit also seems to substantiate this concern.

We have previously asked for an analysis of where quarry operations actually are in comparison with where the quarry operation was envisioned to be under the prior reclamation plan. This is essential at the quarry pit location, as well as for the proposed EMSA, and is necessary to understand existing conditions, cumulative, and future likely conditions/ impacts. It is particularly important with regard to the depth and area of the existing quarry pit versus the dimensions of record from the 1985 Reclamation Plan. This should clearly be shown.

The EMSA is also very confusing. The DEIR assumes its built, and even states in section 4.7 that "much of the stockpiling activity has already occurred," yet the visual analysis regarding the visual impact from the PG&E trail at Rancho San Antonio OSP states that that "although the existing overburden deposits are not a dominant feature in the landscape, the substantial increase in the height of the overburden deposit during construction could block views of the scenic mountains behind the EMSA." It appears through on-site review using the visual analysis presented in the DEIR that much more quarry waste is proposed to be dumped at the EMSA than currently exists. This needs to be rectified for an adequate environmental assessment of potential impacts. The DEIR should clearly detail what is on the ground now at the EMSA to give reviewers a better understanding of the levels of potential impacts being discussed.

This should include all contours and cross-sections at the quarry pit and EMSA as they currently exist, the 1985 reclamation plan final topography and cross-sections, and any proposed new changes in topography. While some contours and cross sections are presented in the DEIR they are often of differing, past dates (2007, 2009 etc.) and the original Reclamation Plan contours and cross-sections are not presented at all. It also appears that the quarry has undergone some substantial changes in the intervening years. The DIER should have an analysis of actual existing conditions compared with the conditions proposed under the former Reclamation Plan and proposed future conditions.

Water quality/ Biological Resource Impacts

The existing selenium-related impacts to Permanente Creek water quality are of serious concern. Permanente Creek exits the Lehigh property and flows through Rancho San Antonio County Park/ Open Space Preserve. The existing selenium related water quality impacts are thus transferred from their origin on the Lehigh property, to these public recreation facilities, then downstream through residential areas, and finally to the San Francisco Bay. Selenium levels that exceed water quality standards have been noted at both the Lehigh property and also in samples taken from downstream park/open space land.

Lehigh's proposal contained in the Reclamation Plan Amendment is to substantially deepen the existing quarry pit. There are significant problems associated with this related to water quality, particularly selenium. The main source of selenium identified in the Reclamation Water Quality assessment by SES is through groundwater inflow. The deepening of the quarry will substantially increase the volume of groundwater inflow into the quarry pit per the DEIR. To deepen the quarry groundwater will need to be pumped out, as currently occurs. The quarry currently does not have permits or regulatory approval to discharge the groundwater that is currently being intercepted, pumped, and discharged into Permanente Creek, with pollutants in excess of water quality standards. The DEIR proposes not only to allow the existing pollution to continue for another 20-plus years, but proposes to add additional volume, stating that water treatment costs would be too high, and treatment is therefore infeasible.

The quarry pit is a vested part of quarry operations and the operator has the right to quarry there. Fortunately, there is no vested right to pollute water, particularly when that water flows downstream to public resources. The quarry simply needs to stop polluting water as the cost of doing business. We question and strongly disagree with the DEIR assertion that water treatment is infeasible and that the significant and unavoidable water quality pollution impacts would instead simply be allowed to continue, and likely worsen, well into the future.

The two other main sources of selenium pollution identified in the DEIR are runoff from the quarry walls, and runoff from the WMSA. As proposed, the deepening of the quarry pit would extend and increase the quarry wall source, again increasing the source area for selenium. The WMSA is also identified as a significant source of selenium. One has to question the rationale of not only waiting to address the WMSA source of selenium pollution until phase III of the project, while at the same time proposing to build a new substantial source, the EMSA, during phase I. There is a significant ongoing impact that these proposed new changes will add to. This must be addressed within the cumulative impacts analysis in the DEIR.

While the long-term water quality mitigation proposed appears promising, as stated in the DEIR, it must be viewed as speculative until actual implementation and monitoring determine success or not. Avoiding new or expanded sources seems prudent, particularly when water quality standards are already being exceeded. There is no clear understanding of the existing level of impact since the water pollution findings have only recently been discovered. The trend of the selenium pollution is unclear (rising, stable, decreasing). Given the substantial area of recent disturbance, and assumed increase in groundwater pumping due to the quarry floor lowering, it is perhaps best to assume that it could get worse, even if everything were to stop today. There is no need to wait and see while pollution is occurring. Immediate water treatment, avoidance of new practices that could add to the ongoing pollution, and immediate reclamation/ mitigation of existing sources appears necessary. The Project as proposed in the DEIR does not meet the stated project objective of protecting water quality, and does not avoid or eliminate residual hazards to the environment.

Vegetated Buffer

We are in favor of the concept of maintaining a vegetated buffer as proposed within the DEIR. We are however, nervous with including this in the reclamation plan amendment. Our concern is that this reclamation plan amendment is necessary to account for disturbance areas that Lehigh and their predecessors have routinely disturbed well outside of the area approved. We want to be sure that this buffer area is somehow formally dedicated for no disturbance. Inclusion of the buffer into a reclamation plan could also be viewed as an approval to disturb (and then reclaim) consistent with the rest of the quarry operations. The County should be certain that this is not the case. Given the quarry history of disturbance out of bounds, there needs to be some formal assurance that this buffer area is actually an area where no disturbance will occur.

Recreation

We believe that impacts to recreation are substantially greater than identified in the DEIR, in particular the impact of the EMSA. The visual impact of the proposed project is determined to be significant and unavoidable, since it assumes the presence of the EMSA. The 2006 dawning of the EMSA began a significant period of recreational impact. Quarry operations that had until then been separated by a ridgeline from the main public recreation areas of the Rancho San Antonio County Park and adjacent Open Space Preserve, were compromised by new noise, dust, and visual impact. Ranch San Antonio is our most heavily utilized Preserve, with an annual visitation of approximately 500,000 recreationalists. The District has fielded many complaints from our visitors regarding the new quarry operations that have been undertaken immediately adjacent to the Park/Preserve. The EMSA quarry waste pile is immediately evident to visitors, as a new backdrop, upon entry into the Park/Preserve. The view from the PG&E Trail has been compromised by dumped quarry waste, and is projected to grow in height obscuring the scenic ridgeline views beyond. The current view from the scenic Anza Knoll within the County Park is simply staggering given the new quarry waste dump that has leapt up over the past few years. It is not possible to separate the recreational impact from the visual impact. The recreational impact of the Project has to also be characterized as significant and unavoidable. Again, as with many comments before, the EMSA is the reason for the significant impact. The Project rationale that since the EMSA was begun the year before the DEIR established baseline, it is assumed built, attempting to grandfather the impacts as "existing" and are therefore determined to be unavoidable. In reality the EMSA is not constructed, and the impacts or possible alternatives associated with its construction have never been reviewed or addressed under CEQA, by the County, or by the public. The potential impacts are in fact avoidable, if not built.

Flooding/ Hydrology

This section is simply unacceptable as presented in the DEIR. The Santa Clara Valley Water District has estimated that a 100-year flood on Permanente Creek would potentially inundate 3,170 parcels including homes, businesses, schools, public institutions, and road/ highway infrastructure, with an estimated $48,000,000 in damages for a single event. This is a huge potential impact if adequate detention through the Project is not feasible. The Lehigh property is quite large when compared to the detention facilities currently being investigated by the Water District. The Project must identify adequate flood water detention built into the reclamation plan.

Thank you for the opportunity to provide comments on the subject DEIR. Please feel free to contact me by email at mbaldzikowski@openspace.org or by phone at 650 691-1200 if you have any questions regarding this or any prior comment letters.

Sincerely,

Matt Baldzikowski

Matt Baldzikowski
Resource Planner III

Cc: District Board of Directors
Stephen E Abbors, District General Manager
Erin Garner, Chair, State Mining and Geology Board
Jim Pompy, Director, Office of Mine Reclamation
George Shirakawa, President, County of Santa Clara Board of Supervisors

STATE OF CALIFORNIA

GOVERNOR'S OFFICE *of* PLANNING AND RESEARCH

EDMUND G. BROWN JR.
GOVERNOR

KEN ALEX
DIRECTOR

February 22, 2012

Rob Eastwood
Santa Clara County Planning Office
70 W. Hedding Street
7th Floor, East Wing
San Jose, CA 95110

Subject: Lehigh Permanente Quarry Reclamation Plan Amendment
SCH#: 2010042063

Dear Rob Eastwood:

The State Clearinghouse submitted the above named Draft EIR to selected state agencies for review. The review period closed on February 21, 2012, and no state agencies submitted comments by that date. This letter acknowledges that you have complied with the State Clearinghouse review requirements for draft environmental documents, pursuant to the California Environmental Quality Act.

Please call the State Clearinghouse at (916) 445-0613 if you have any questions regarding the environmental review process. If you have a question about the above-named project, please refer to the ten-digit State Clearinghouse number when contacting this office.

Sincerely,

Scott Morgan
Director, State Clearinghouse

Document Details Report
State Clearinghouse Data Base

SCH#	**2010042063**
Project Title	Lehigh Permanente Quarry Reclamation Plan Amendment
Lead Agency	Santa Clara County

Type	**EIR** Draft EIR
Description	Note: Review per lead Amendment of the existing/approved 1985 Reclamation Plan for a 20 year period. Reclamation Plan area consists of 1,238.7 acres.

Lead Agency Contact

Name	Rob Eastwood		
Agency	Santa Clara County Planning Office		
Phone	408 299 5792	***Fax***	
email			
Address	70 W. Hedding Street 7th Floor, East Wing		
City	San Jose	***State*** CA	***Zip*** 95110

Project Location

County	Santa Clara		
City	Cupertino		
Region			
Lat / Long	37° 19' 12.15" N / 122° 6' 23.5" W		
Cross Streets	Stevens Creek Boulevard/Foothill Expressway		
Parcel No.	multiple		
Township	***Range***	***Section***	***Base***

Proximity to:

Highways	I-280
Airports	San Jose International
Railways	
Waterways	Permanente Creek
Schools	Lincoln ES
Land Use	

Project Issues	Aesthetic/Visual; Agricultural Land; Air Quality; Archaeologic-Historic; Biological Resources; Drainage/Absorption; Flood Plain/Flooding; Forest Land/Fire Hazard; Geologic/Seismic; Minerals; Noise; Population/Housing Balance; Public Services; Recreation/Parks; Soil Erosion/Compaction/Grading; Solid Waste; Toxic/Hazardous; Traffic/Circulation; Vegetation; Water Quality; Water Supply; Wetland/Riparian; Growth Inducing; Landuse; Cumulative Effects; Other Issues

Reviewing Agencies	Caltrans, Division of Aeronautics; Department of Conservation; Department of Fish and Game, Region 3; Office of Historic Preservation; Department of Parks and Recreation; Department of Water Resources; Resources, Recycling and Recovery; California Highway Patrol; Resources Agency; Caltrans, District 4; Regional Water Quality Control Board, Region 2; Air Resources Board, Major Industrial Projects; Department of Toxic Substances Control; Native American Heritage Commission

Date Received 12/23/2011 ***Start of Review*** 12/23/2011 ***End of Review*** 02/21/2012

Note: Blanks in data fields result from insufficient information provided by lead agency.