



CIRAN



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LECTURE 6 - ENVIRONMENTAL MITIGATION: A SWEDISH CASE

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Case study Environmental mitigation Cementsa Skövde

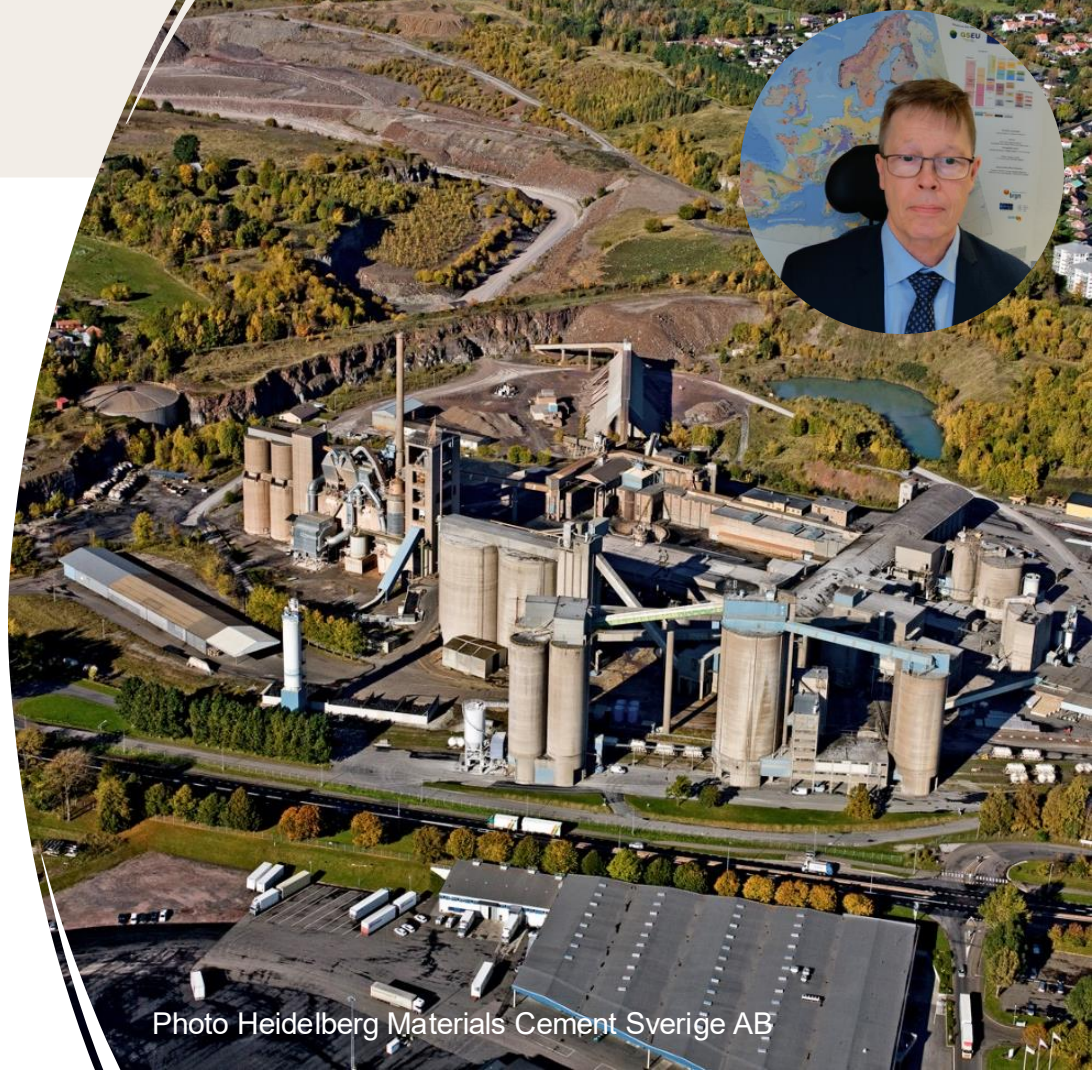
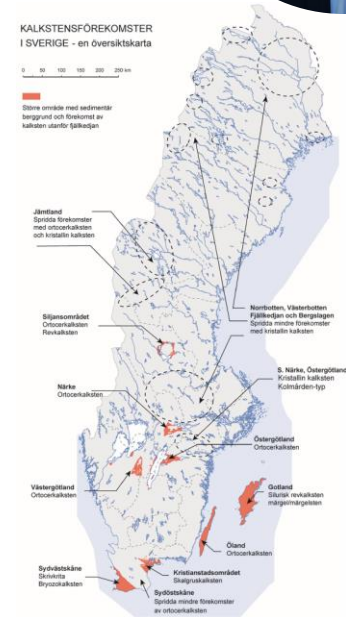


Photo Heidelberg Materials Cement Sverige AB

CIRAN Background



- Limestone mainly contains Calcium carbonate (CaCO_3), is a common industrial mineral with many applications and alkaline properties
- The society needs a large amount of cement for construction: e.g. building, infrastructure, communication purposes.
- Limestone bedrock has limited distribution in Sweden. Industry demands on quality (e.g. specific chemical and physical properties) and size of deposits (available tonnage) narrow the selection further.
- Due to the limited limestone distribution in Sweden, habitats of flora and fauna depending on calcareous soil are comparably rare and thus often contain protected species.
- Limestone bedrock often has implications for hydrological setting, groundwater availability etc. which in turn creates special habitats and challenges when it comes to mining operations.

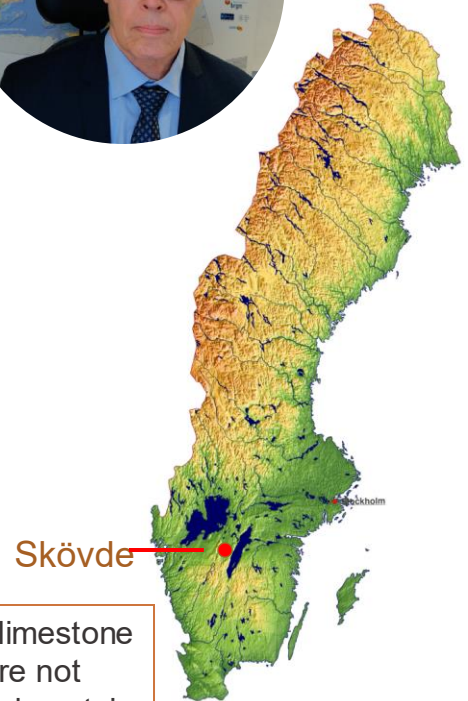


Coloured markings show limestone bedrock occurrence in Sweden. Map source: SGU report RR 2022:02, "Occurrence and access to limestone, cement klinker and cement in Sweden and exporting countries"

CIRAN The deposit

Key facts

- Limestone deposit of significant size
- Limestone quality suitable for cement production. It is not common in Sweden. Need short distance to consumer –otherwise very expensive to build.
- Long industrial operation on the site
- Strategic location on the Swedish mainland
- Quarry located next to protected nature areas and the town Skövde (~40 000 inhabitants)
- Production of ca. 2 000tonnes of cement / day
- Second and smallest cement producing plant in Sweden



In Sweden limestone areas are not common and contain rare habitats

The following factors are important to control for the surrounding and working environment

- Noise
- Vibration
- Dust
- Influence on local hydrology, groundwater, creeks
- Removal of sites & objects due to the extraction process:
 - Natural habitats and biotopes
 - Identified cultural and historic heritage objects (e.g. stone walls)
 - Regional hiking path
 - Creek (Hålldammsbäcken)



Photo Heidelberg Materials Cement Sverige AB.
Old tree trunks preserved in the new mining area.

CIRAN Mitigation of noise

Several aspects are important in order to construct the mine and minimize noise to acceptable levels

- Computer modelling of noise scenarios (sources, dispersion)
- Scheduling of soil stripping, drilling & blasting operations
- Scheduling of loading and hauling operations of rock material from the quarry
- Depending on topography use of noise protection embankments for noisy quarry operations (e.g. drilling, blasting) if required
- Encased crushing and milling equipment
- Scheduled transports of additional raw materials and ready-made products to and from the factory
- Regular control measurements and monitoring program

Permission constraints are expressed as guidance level of equivalent noise, measured outside adjacent residences: 50dB(A) daytime, 45dB(A) evening & weekends, 40dB(A) nighttime. Momentary noise level must not at any time exceed 55dB(A) at nighttime. Levels correspond with the guidelines from the Swedish environmental Protection Agency *Naturvårdsverket*.

Drilling and blasting are the largest sources for noise in cement quarry

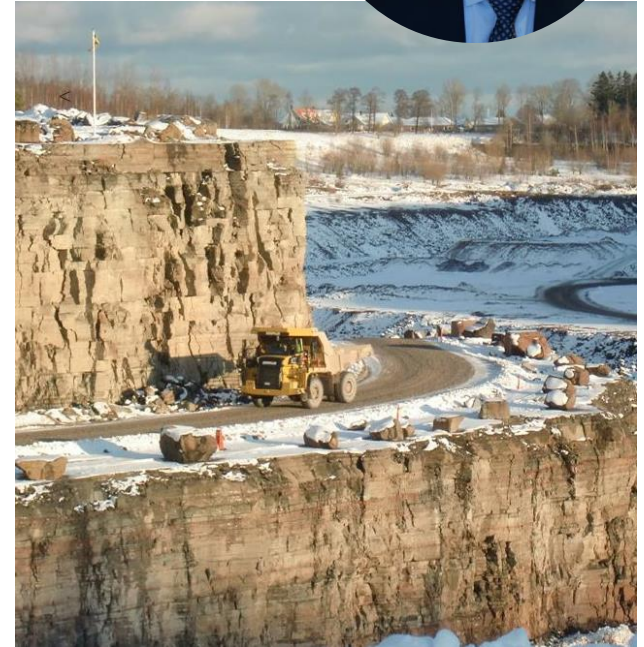


Photo Heidelberg Materials Cement Sverige AB

CIRAN Mitigation of dust

Dust has strict levels that must be kept and therefore several methods are being employed. This is connected both to the surrounding environment as well as health and safety.

- Reasonable dust control measures during summertime and frost-free winter conditions
- Sprinkling of blasted rock prior to loading and hauling, sprinkling of rock from primary crusher prior to transport to stockpile
- Sprinkling of quarry transport roads if necessary
- Quarry internal runoff water is collected and reused
- Quarry workflow shall consider and adapt to current wind situation to avoid unnecessary dusting.

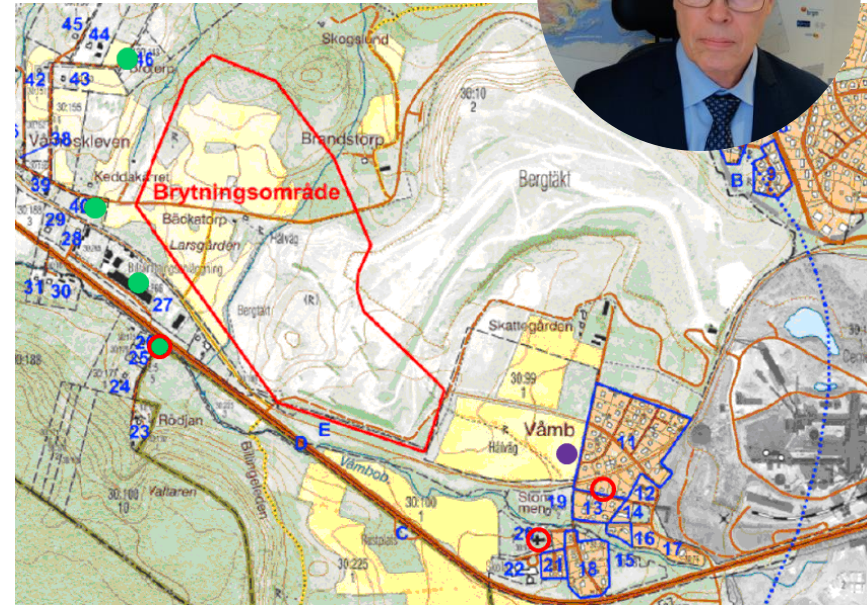


Wet water suppression is necessary for dust control. Water binds dust particles to the ground, e.g. sprinkling of blasted rock material, rock piles and transport roads

CIRAN Mitigation of vibration

- Mapping of adjacent building facades, documentation of existing damages (e.g. cracks) prior to operations.
- Computer modelling of ground vibration and blast airwave scenarios (sources, dispersion)
- Adapted quarry operation (e.g. recommendation on blast size depending on topography, distance and direction to adjacent housing)
- Use of protection embankments to milden impact of sound from blasting is required.
- Continued logging of ground wave and airwave vibration measurements at selected houses as part of the monitoring program. The moving of the quarry face will in time result in relocation of logging equipment to ensure relevant measurements.
- Airwave impact from quarry blasting is often perceived more than the ground wave but has little effect on physical objects.

Permit constraints: Ground vibration - 4mm/s (maximum vertical speed component of vibration oscillation) at housing; 6mm/s at industrial buildings. Airwave – 100 Pa (open air measurement).



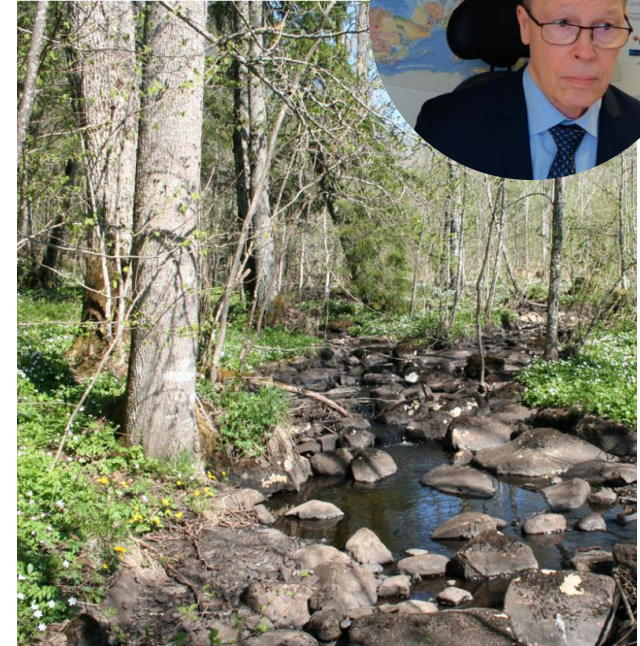
Red line: new mining area. **Circles:** current fixed logging equipment for measurements: red=ground vibration; lilac=airwave. **Dots:** adapted locations for the new mining area: Green=ground vibration; lilac=airwave. Map source: Heidelberg Materials Cement AB environmental impact assessment files

Airwave impact from rock blasting is commonly the most noticed vibration perceived by persons living near an operating quarry. Usually do not cause any damage.

CIRAN Mitigation - Hydrology, groundwater, creeks

Hydrological and hydrogeological modelling of groundwater flow and influence on groundwater table level to assure no unwanted impact occurs from mining

- Creek relocation including recreation of suitable aquatic biotopes and habitats. Monitoring of development.
- Monitoring of ground water level and quality in surrounding drinking water wells and in adjacent protected nature areas
- Runoff water handling in the quarry: sedimentation of suspended material, oil trap, artificial wetland Nitrogen reduction before release into recipient. Water quality is subject to regular sampling and analysis in the monitoring program.



Hålldammsbäcken creek. Photo source:
Heidelberg Materials Cement AB
environmental impact assessment files

Mitigation –Removal of sites & objects due to the extraction process

Identified measures (part of the Environmental Impact Study and permission process):

- Relocation of regional hiking path
- Relocation of creek Hålldammsbäcken
- Quarry remediation plan after closing of operations will create a rich environment including recreating lost habitats, biotopes & cultural heritage objects



CIRAN Quiz

- **Can any limestone be used for cement production?**
 - No. You need a limestone rock of specific physical and chemical properties, as well as a deposit of significant size to allow investing in a sustained production.
- **Why do limestone bedrock occurrences often coincide with rare or protected flora?**
 - Because limestone properties are unusual (alkaline) compared to most other Swedish rock types. Limestone creates specific environmental conditions e.g. influencing soil and topography when weathering.
- **What is the noisiest part in a quarry operation?**
 - Drilling and blasting
- **What do you normally use water for in a quarry?**
 - Mainly for dust control, e.g. sprinkling of blasted rock material, rock piles and transport roads to bind dust particles to the ground.
- **What is the aim of quarry remediation after mining has ceased?**
 - To create a variegated environment as a replacement for lost habitats, biotopes and cultural heritage objects
- **Which type of vibration is usually mostly noticed by people living nearby a quarry?**
 - Airwave impact from rock blasting is commonly the most noticed vibration perceived by persons living near an operating quarry.
- **Does airwave impact from rock blasting have a significant effect on physical objects nearby a quarry?**
 - The effect of an airwave impact is though often perceived as more severe by humans, normally completely harmless to physical objects, such as infrastructure or housing near a quarry.
- **What was the main components in obtaining the environmental permit apart from nature conservation/nature habitat issues?**
 - Noise, vibration & dust.

CIRAN Glossary

- **Sedimentary rock** Rock made by sedimentation of particles, building up layers, in time hardening to solid rock. Can be of biogenic origin (e.g. limestone) or clastic, created by sedimentation of mineral particles such as quartz sand, or clay (e.g. sandstone; mudstone).
- **Limestone** Rock made mainly of the mineral Calcium carbonate (CaCO_3), mostly of biogenic origin, often formed at an ocean floor by layers of fossils such as shells and corals.
- **Crystalline rock** Rock made by mineral crystals formed in a magma melt or by exposing a sedimentary rock to very high heat and pressure. May have similar chemical properties as sedimentary rock but physical properties, mineralogy and handling may be very different. E.g. marble, the crystalline counterpart of limestone.
- **Crushing** 1st step in production after blasting, usually a production line with several different crushers are needed to work rock material to a desired particle size suitable for further processing or direct use.
- **Milling** Fine grinding of coarser particles from the crusher, usually creating sand-size or sub-millimeter particles, in some cases down to micrometer scale particles depending on purpose of the milled product.
- **Habitat** Ecology term, describing an array of biotic and abiotic factors present in a defined area. Mostly used in describing suitable conditions beneficial for survival and reproduction of specific species, e.g. a plant, an insect or an animal.
- **Biotope** Ecology term, describing an area of uniform environmental conditions providing a living place for a specific assemblage of plants, insects and animals.
- **Decibel** Unit of measurement for noise, dB(A) with a logarithmic scale
- **Hauling** Transport of blasted rock, usually from the quarry to the crusher
- **Remediation** E.g. reclaiming and returning of land impacted or changed by anthropogenic activities, e.g. industrially used land. Often returning it to nature, environmental-, or other land use purposes. May include activities such as remodelling the topography, remove any potential dangers (e.g. fall risks), cleaning from harmful substances if present, removing any existing waste. Often remediation is made with the aim of improving or recreating lost habitats and biotopes, enhancing local biodiversity.
- **Runoff water** Surface runoff originating from precipitation
- **Groundwater inflow** Groundwater seeping through adjacent bedrock or soil into a quarry or a mine

Thank you





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