



MagnaDense in civil engineering



LKAB Minerals

More weight, less volume

LKAB Minerals Who are we?

Since the start in 1890, north Sweden has been LKAB's home base. Our identity is rooted in Malmfälten ("the Ore Fields") - or, more specifically, in our mines in Kiruna and Gällivare. MagnaDense has been used since the early 60's in concrete mixes and is approved according to EN12620, the standard for concrete aggregates.



What we believe in

All our employees contribute with their special skills, characteristics, conditions and background to our LKAB. That's important. Through diversity and an inclusion, we can create more innovative solutions and better, climate-efficient products.

What we do

LKAB is an international mining and minerals group that offers sustainable iron ore, minerals and special products. We are committed to developing carbon-free processes and products by 2045, leading the transformation of the iron and steel industry. Since 1890 we have developed through unique innovations and technological solutions and are driven forward by more than 4,500 employees in 12 countries.

Our organisation

LKAB Minerals is the international industrial minerals division of LKAB, developing and delivering circular, critical and climate-efficient mineral products. We develop mineral solutions in partnership with our customers, supplying natural minerals engineered for functionality and usability.

MagnaDense.

More weight, less volume.

MagnaDense is a heavy aggregate produced from the mineral magnetite (Fe_3O_4). It is an environmentally friendly and inert material that comes from our own mines in the north of Sweden. This guarantees a sustainable source and consistent quality.



Thanks to its high density, MagnaDense is ideal as a loose ballast material and as an aggregate for high-density concrete.

This concrete is produced and poured with standard equipment. Applications for heavy concrete include counterweights, foundations, radiation protection, coastal protection elements, underwater concrete, anchors and pipe coating (negative buoyancy).

Installation of loose ballast

As a loose ballast material, MagnaDense is ideal for use as temporary ballast in construction pits and for stabilising wind turbines at sea.

MagnaDense is regularly classified as a class 1 building material via APO4 inspections. Installation of loose ballast material takes place via fall pipe barges or by pumping it as slurry with a centrifugal or positive displacement pump.

Different grades

MagnaDense is available in different grades. MagnaDense 2 (0 - 2mm), MagnaDense 8s (0 - 8mm) and MagnaDense 20s (4 - 16mm).

It is delivered via our own ports to various strategic storage locations worldwide.

MagnaDense is certified in accordance with EN 12620 (aggregates for concrete).



Technical information

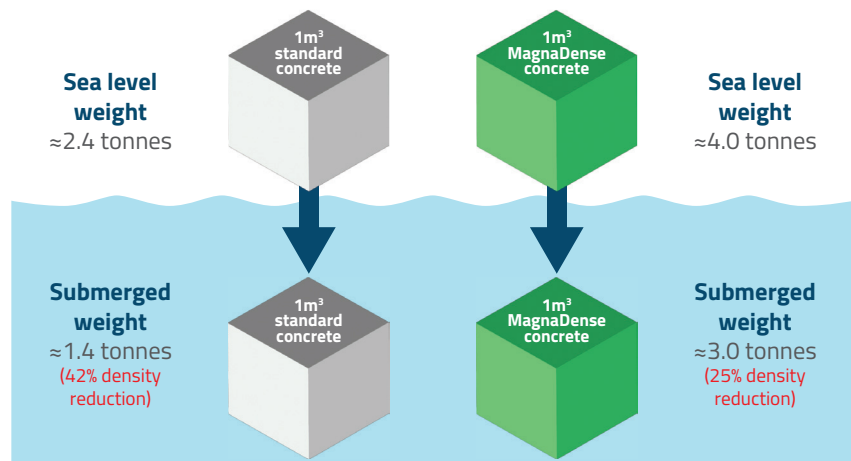
Special properties

The high density of MagnaDense provides more weight with less volume. With MagnaDense it is possible to produce concrete with a density of up to 4000kg/m³, about 60% heavier than normal concrete. The excellent product properties of MagnaDense make high-quality, high-strength concrete easy to produce.

MagnaDense has been used for a long time as loose-fill ballast material and as an aggregate for heavy concrete, both for the mortar and precast industries.

The high density of MagnaDense brings several advantages:

- Less volume = less excavation, transport, reinforcement and time
- More weight for a fixed volume
- Less heat of hydration
- High density under water
- Good radiation protective effect
- Space saving
- Reduction of noise and vibration
- Thermal energy storage

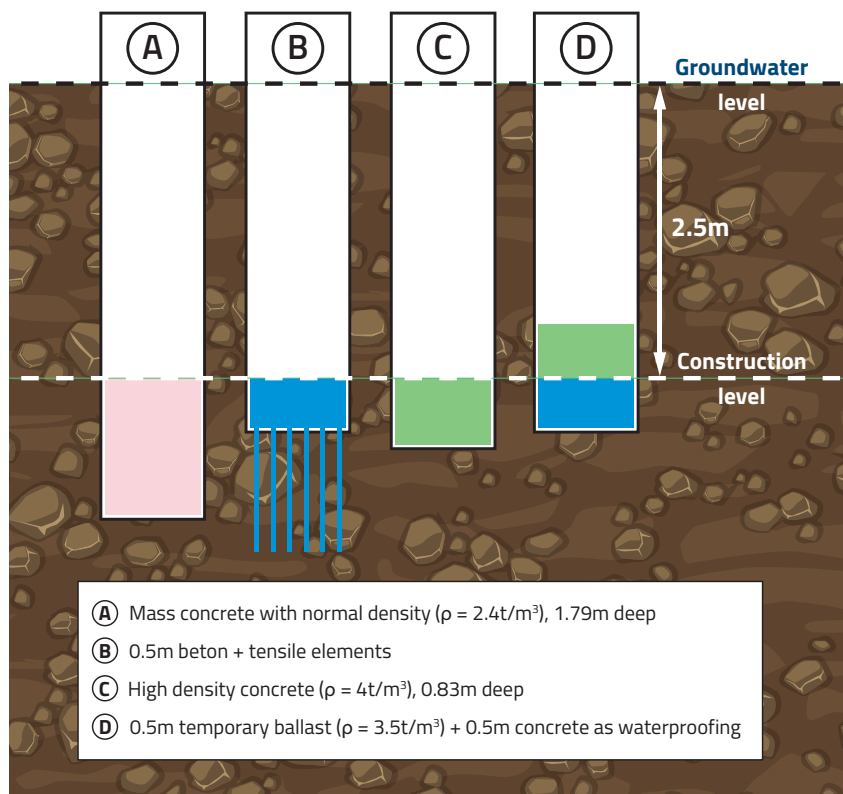


Physical characteristics

Particle density (t/m ³):	4.8 - 5.1
Hardness (Mohs):	5.5
Water absorption (%):	<0.3
Grain shape:	Angular
Colour:	Black

Archimedes' law - weight (ton) in air and water for 1m³ of concrete

An object - immersed in a liquid - loses an amount of weight equal to the weight of the displaced liquid. As a result, heavy concrete is extra attractive for underwater applications.



Vertical balance

MagnaDense can be used to achieve vertical balance in construction pits with a risk of floating. Both by making the underwater concrete in a higher density and also by applying loose ballast (possibly temporarily) on top of the underwater concrete, such as for the Maasdelta tunnel project. The high density here does not lead to more mass, but rather to less volume, which makes even more difference underwater.

Advantages:

- Less concrete and tension anchors
- Time saving
- Fewer transport movements
- Less excavation
- No lost construction
- Thinner sheet pile profile
- Reduction of thermal cracking
- Reduction of noise and vibrations

Heat development of concrete with MagnaDense

MagnaDense, when used as an aggregate in large pours of mass concrete, reduces the peak temperature. Usually because the required mass is achieved in less volume and therefore less cement is used, this results in less energy being released from hydration. However, if it is used to achieve more mass in the same volume, the same amount of energy is released, but it is distributed over much more mass, resulting in a lower temperature being reached.

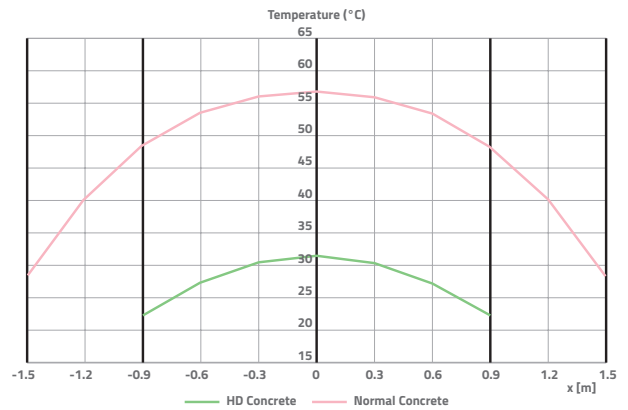
Graph 1, on the right, shows a cross-section of a wall with normal concrete and an equally heavy wall with high-density concrete and shows the temperature gradient from the centre to the side, measured after 124 hours.

Density of normal concrete: 2.4t/m³

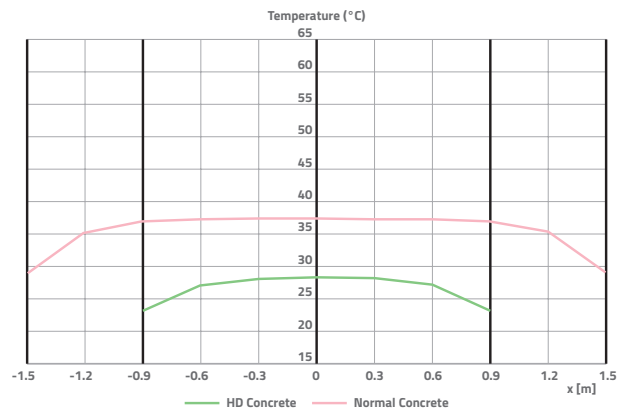
Concrete density with MagnaDense: 4.0t/m³

Reduced risk of crack formation

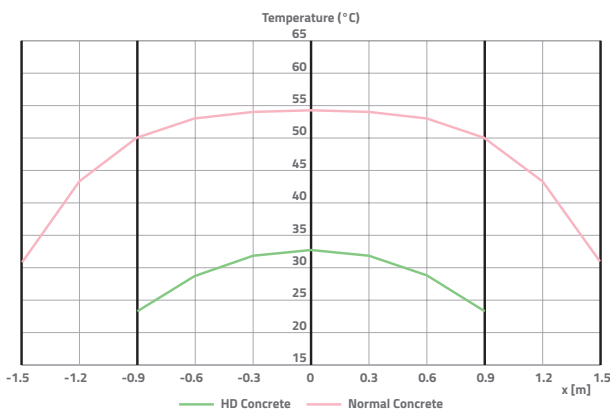
During the evaluation, various snapshots were analysed and displayed graphically. The graphs clearly show that the high-density concrete reaches a much lower peak temperature and that the temperature difference between core and side is much smaller than when using normal concrete. This results in a reduced risk of thermal cracking.



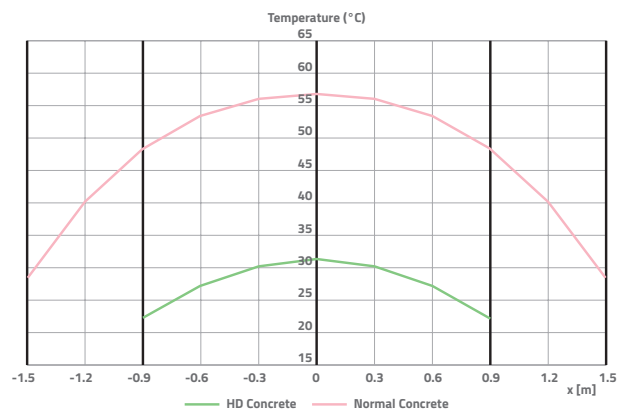
Graph 1: Cross-section of a plain concrete wall and an equally heavy high-density concrete wall. It shows the temperature gradient from the centre to the outside, measured after 124 hours.



Graph 2: Temperature after 24 hours.



Graph 3: Temperature after 70 hours, maximum temperature in the core of the high-density concrete.



Graph 4: Temperature after 124 hours, maximum temperature in the core of the normal concrete. Start and ambient temperature: 15°C.

Application Sleepers (HAS)

HAS (High Attenuation Sleepers) is a solution to reduce environmental noise. One of the crucial components is that **MagnaDense** is used to give the sleepers a higher concrete density, which limits vibrations.



Project Blankenburgverbinding

For the well-known infrastructure project in the Netherlands, the Blankenburg connection, we supplied MagnaDense to serve as temporary ballast in the tunnel box.

MagnaDense was used in the Maas Delta Tunnel as ballast material to compensate for groundwater pressure, creating vertical balance. By using temporary ballast material, less concrete and fewer tension anchors could be used. A sustainable saving! All the more so because once the tunnel was finished, the MagnaDense was removed and reused.

PROJECT FACTS:

Project owner: Dutch government through "Rijkswaterstaat"

Contractor: BAAK BV

MagnaDense delivery: June 2021

Expected reclaim date: Sep - Nov 2022

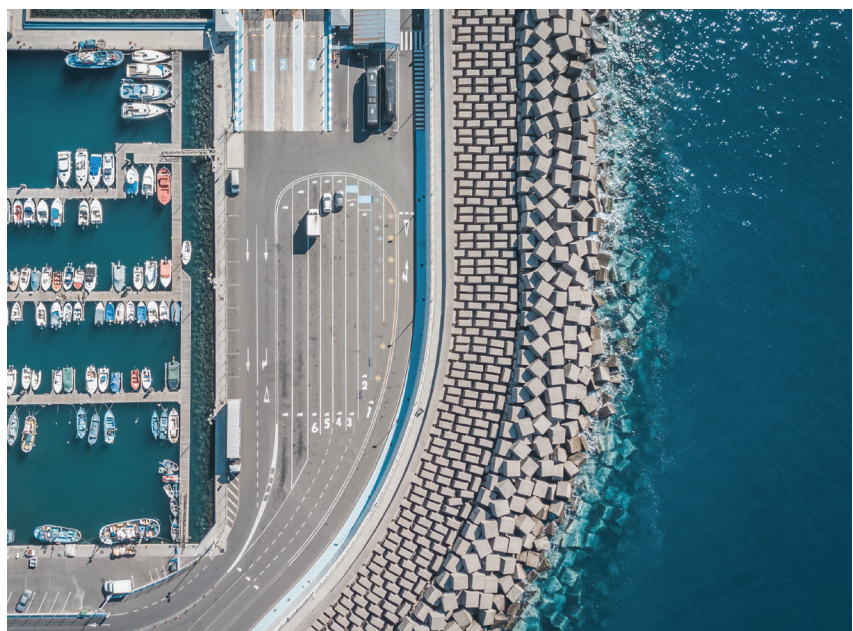
MagnaDense: 12,000 tonnes



Application Coastal protection

Less volume and more weight provide improved stability for coastal protection

- Increased density very efficient for coastal protection elements
- Increasing density leads to much fewer large blocks
- Particularly interesting for larger wave heights to keep dimensions and mass per unit manageable
- See short video about research in Delft hydraulics lab



learn more at
lkabminerals.com/magnadense

