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SAINT-GOBAIN

Lightweight solutions for concrete

LWAC the solution for challenging structures

SAINT-GOBAIN

Long experience in

optimizing concrete structures

The spirit of engineering is always based on the optimization and improvement of projects. Leca has more than 30 years of experience in optimizing concrete structures such as bridges, floating platforms, buildings, etc.

Light weight aggregate concrete (LWAC) has been used for many centuries. The first known structure to use LWAC is more than 2000-year-old utilizing natural volcanic materials. Among several structures to use LWAC at that time are the well-known Coliseum and Pantheon in Rome.

Industrialized and commercial production of light weight aggregate (LWA) started early in the nineteenth century when the rotary kiln was invented. One of the earliest uses of reinforced LWAC was in the hulls of ships and barges from around 1918 in the USA. Today, LWAC is widely used across the world as a light weight and durable alternative to normal density concrete (NDC). Typical applications are bridges, slabs, floaters, balconies, high rise buildings and other constructions where low weight is advantageous.

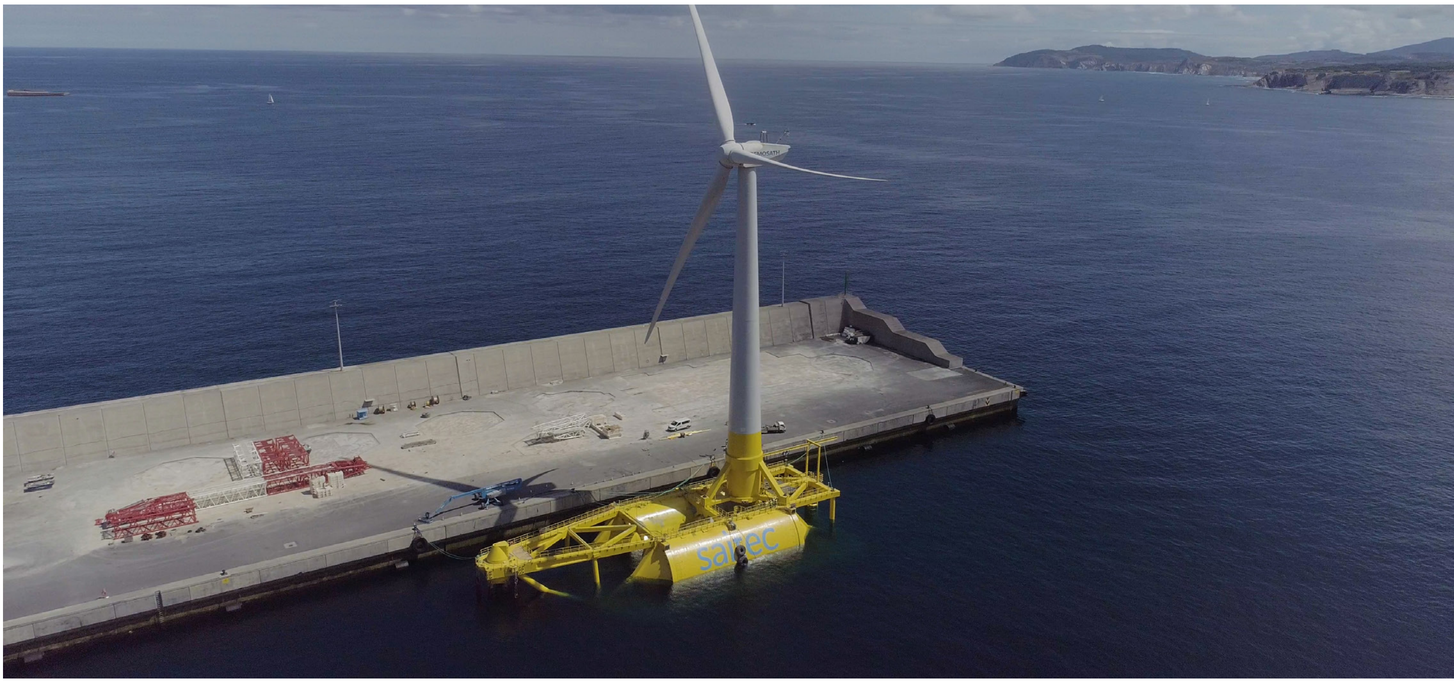
Leca® LWA is manufactured of dedicated well sorted clays carefully heated to around 1200° C for expansion in a rotary kiln, followed by sorting and sieving. Dry particle density in the range from 500 to 1.600 kg/m^3 and aggregate size from 1 to 20 mm can be “tailor-made” for specific applications. In addition to its low density, Leca LWA promote high durability and mechanical resistance, suitable for high performance concrete. Ready mix and precast LWAC can be produced with many densities and with characteristic compressive strength up to 70 MPa, or even higher.

Leca International is today manufacturing Leca LWA at seven plants and are commercially active in 13 European countries.

More than 30 years developing innovative projects

Leca International is a company group with an international profile that has been supplying innovative ideas to the construction market for more than 30 years that can be carried out with the products manufactured in its seven plants strategically located in Europe.

Saint-Gobain and Leca International are characterized by collaborating jointly with engineering and construction companies to develop differentiating and sustainable solutions that reduce construction costs compared to conventional solutions.



What are structural lightweight concretes?

Structural lightweight aggregate concretes have taken a leading role since the 1990s, being the chosen solution for the development of many bridges in Nordic countries, allowing geometries to be established that defy gravity. In simple words, light weight concrete can be made with high resistance and reduced weight, of typically 25 %. Combining design parameters, structural LWAC can fit in wide range of density classes, from 1000 to 2000 kg/m^3, and also wide range of strength classes, from 8 to 80 MPa.

Density classes	**1,0**	**1,2**	**1,4**	**1,6**	**1,8**	**2,0**
Dry density (kg/m^3)	801-1000	1001-1200	1201-1400	1401-1600	1601-1800	1801-2000

Table 1. Density classes according to EN 1992.

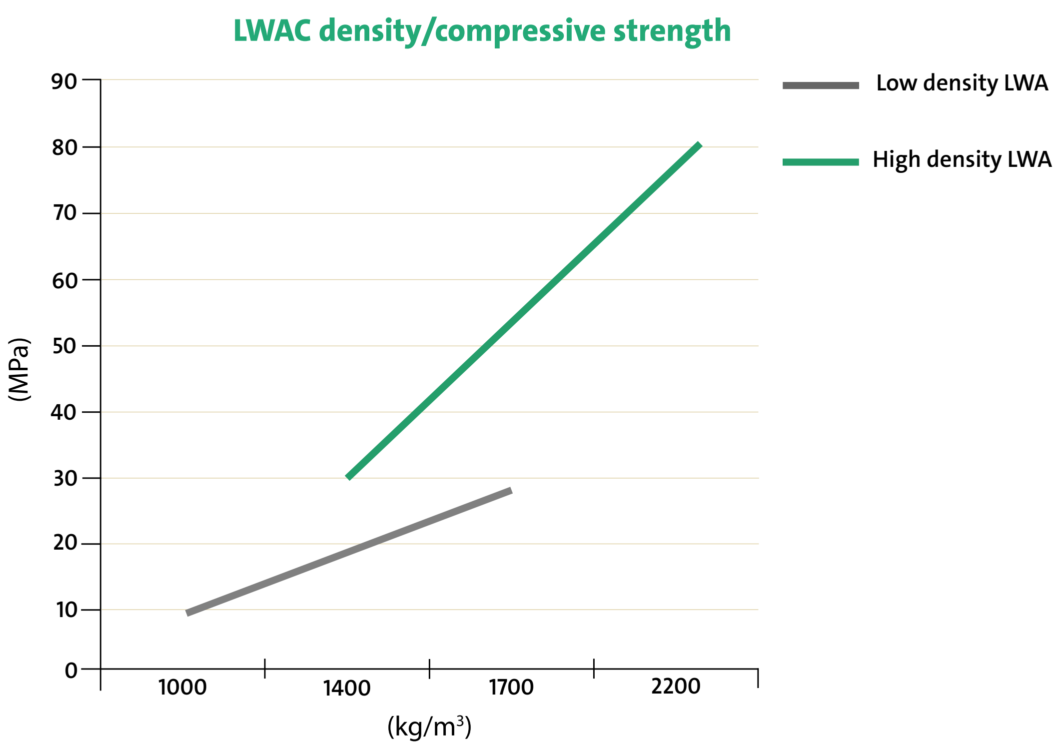
Note 1: The density classes are based on oven dry concrete.
Note 2: Fresh density is typically 150 kg/m^3 higher than dry density.

Better performance and the same way of manufacturing it anywhere in the world

One of the big questions is how and where to utilize the LWAC. LWAC can be used in the same structures as NDA, using traditional admixtures and local cements. The only difference is the use of high-performance Leca LWA that allows to reduce weight without significantly reducing the mechanical characteristics.

Compressive strength	LC 8/9	LC 12/13	LC 16/18	LC 20/22	LC 25/28	LC 30/33	LC 35/38	LC 40/44	LC 45/50	LC 50/55	LC 55/60	LC 60/66	LC 70/77	LC 80/88
Characteristic strength in cubes ($f_{ck,\ cube}$ in MPa)	9	13	18	22	28	33	38	44	50	55	60	66	77	88
Characteristic strength in cylinder ($f_{ck,\ cylinder}$ in MPa)	8	12	16	20	25	30	35	40	45	50	55	60	70	80

Table 2. Compressive strength classes according to EN 1992.



Graph 1. Typical LWAC strength - density ratio for low density and high density LWA.

WHY **LWAC?**

The possibilities offered by the design of lighter structures with the same mechanical performance is usually a dream for any structural engineer. Since LWAC is fully covered by EN 1992 and can be used wherever normal density concrete (NDC) is used, the reduced weight can be utilized for several applications to minimize construction costs, reduce volume of concrete, simplify structure and limit the total CO_2 emissions for the complete project. Some applications appear as more relevant than others for utilizing more efficiently the lower density.

Our experience in the Nordic region is that LWAC is 1,5-2 times costlier than NDC in the same concrete class. This is due to the LWA and the handling, but the benefits surpass the cost increase many times and reduce the total construction costs.

Long span structures

The main vertical load on most long span structures is the weight of the structure itself. Therefore, the reduction of concrete density is essential not only for the design of the span and the foundation, but also for the positioning distance between foundation elements. One example for efficient utilization of LWAC is the cantilever bridge.

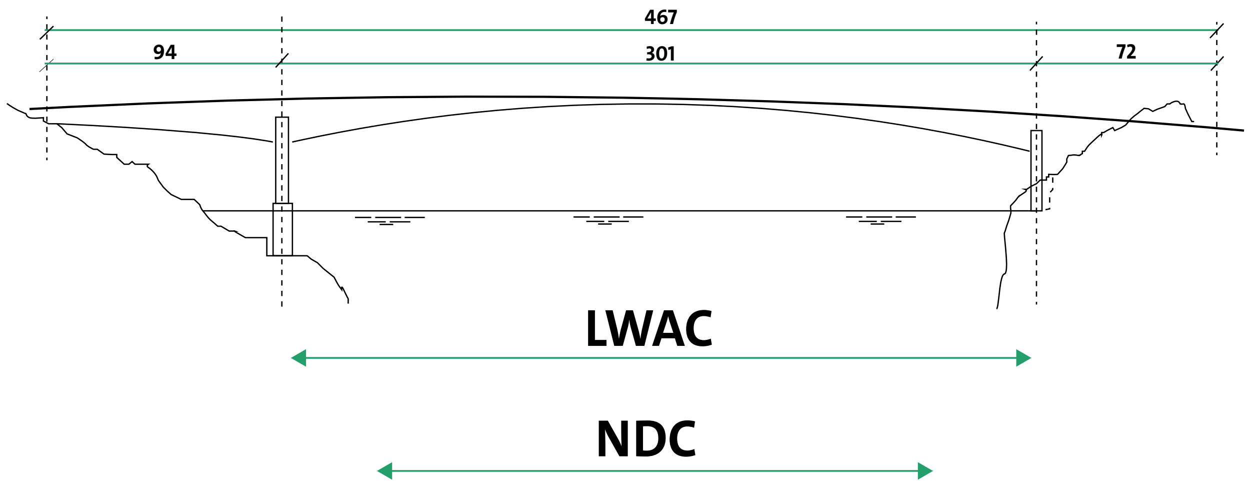


Figure 1. By using a lower density concrete longer span can be achieved. Thus, the positioning of the foundation are more flexible and large costs are saved.

One of the challenges for such construction is to position the towers at the optimum site. A smaller distance between the tower will reduce the main span and obviously reduce those costs, but that would mean positioning the towers in the sea. LWAC allows enhancing the length of the main span and therefore, considerably reduces the construction costs. Another issue is the balance of the bridge span growing in two directions from each tower.

LWAC makes it possible to easily balance the main span with the side span. The third reason for using LWAC is the reduced moment and force to be absorbed in the towers while cantilevering the span. A normal density concrete, due to its higher weight, will impact considerably higher moment which will increase the size of the cantilever box at the tower.

In general, the use of LWAC will create a slimmer and more cost-effective construction with lower amount of total use of concrete and therefore, also a greener construction.

Another method of strategic weight reduction is to use LWAC in the deck structure of cable-stayed bridges either as a fully LWAC structure or in composite solutions of LWAC/NDC/steel structure. In general, reduced construction costs are achieved due to lower need of concrete volume which can be proven during the design phase.

Reduced load on foundations

In addition to longer span and flexible positioning of foundation, reduced load on the foundation itself as well as on the ground is also strategically utilized in the design. One objective example of that advantage is submerged and semi-submerged structures, or even structures on soft soil. Another example is buildings constructed on existing basements, like the Colosseum Park building in Oslo. An additional floor was added to the structure and the economy of the project was improved with the use of a LC 45 with in-situ density of 1750 kg/m^3.

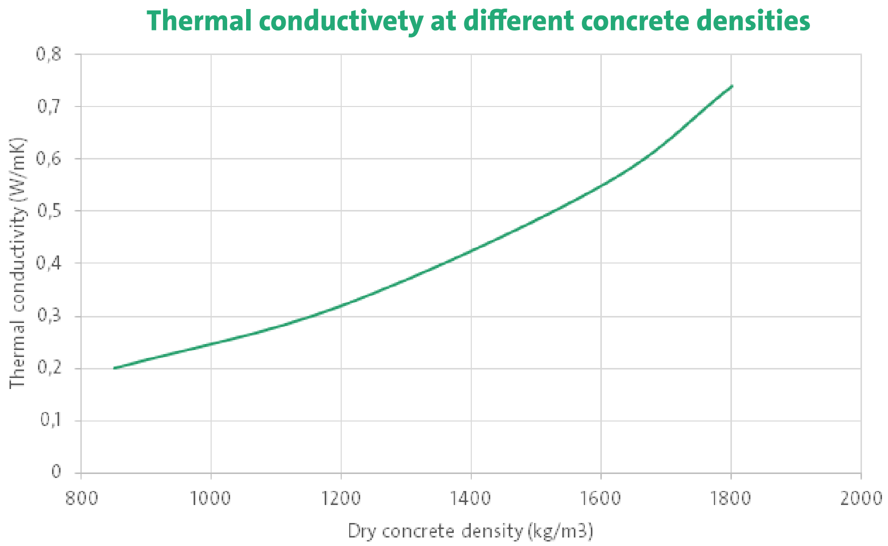
THE BUILDING HAD ADDED ONE MORE FLOOR DUE TO USE OF LIGHT WEIGHT CONCRETE.

Improved response to seismic action

The response to the seismic action is greatly advantageous when reinforced LWAC is used in constructions located in seismic regions, since not only the weight reduction but also the stiffness reduction allows to improve the response and to reduce the internal forces, promoting more eco-efficient design.

Improved insulation

Light weight is achieved by introducing micro air inside the light weight aggregate. Consequently, the LWA itself promote low thermal conductivity which can be utilized by several applications for LWAC.

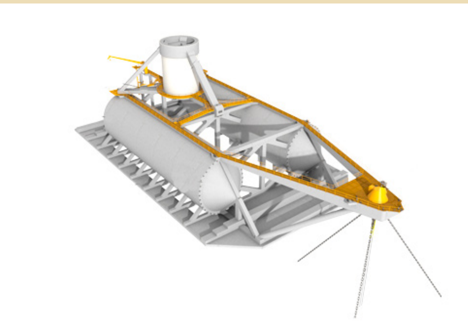


Graph 2. Light weight concrete achieves lower thermal conductivity due to the air porosity of the LWA.

The improved thermal conductivity can be utilized for reducing insulation in housing construction and improve frost resistance of tunnel covers.

Main advantages

- Better hydraulic performance.
- Reduction of floating platform dimension and CO_2 emissions.
- Reduction of use of steel in the platform.
- Lower costs in assembly and lifting cranes.
- Lighter elements imply less soil reinforcement in the ports where they are built.
- Requires minor port drafts.



DEMOSATH LWAC WINDMILL FLOATER

Floating structures

The most prominent use of LWAC is in floating structures like windmill, barges, floating fish farms, floating bridge foundations etc. The LWAC can be made with considerably lower density and keep much of the mechanical characteristics from NDC. LWAC service densities in the range of 1600-1950 kg/m^3 will result in characteristic compressive strength of 35-65 MPa and achieve considerably better structure buoyancy.

It is obvious that a floater with better buoyancy has advantages compared to the same structure based on NDC. The high buoyancy can be utilized in designing smaller floaters at lower costs and lower CO_2 emission for the complete project. LWAC has somewhat higher emission per m^3 of concrete, but lower volume of concrete, lower weight and less construction work may limit the total emissions in addition to reduce the costs. How well this turns out has to be calculated at design phase where the structure based on LWAC is designed with better buoyancy in mind.

Lower density will also allow better flexibility when constructing the floater, easier assembly and is more versatile when selecting the port for construction and the crains capacity. The total draft of the floater will be lower and the structure can handle more shallow waters during transport.

Another way of utilizing the better buoyancy is improved load carrying. A barge based on LWAC can carry more cargo than a similar barge of NDC, which can be utilized by building a smaller barge with the same load carrying performance. However, how large the benefit is can only be obtained by calculations during the design phase.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BUT MANY CLAY PELLETS CREATE A BETTER FUTURE

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