

# Autoclaved aerated concrete

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**Autoclaved aerated concrete** (AAC), also known as **autoclaved cellular concrete** (ACC), **autoclaved lightweight concrete** (ALC), **autoclaved concrete**, **cellular concrete**, **porous concrete**, **Aircrete**, **Hebel Block**, and **Ytong** is a lightweight, precast, foam concrete building material invented in the mid-1920s that simultaneously provides structure, insulation, and fire- and mold-resistance. AAC products include blocks, wall panels, floor and roof panels, cladding (facade) panels and lintels.<sup>[1]</sup>

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## History

AAC was perfected in the mid-1920s by the Swedish architect and inventor Dr. Johan Axel Eriksson,<sup>[2][3]</sup> working with Professor Henrik Kreüger at the Royal Institute of Technology.<sup>[2][3]</sup> The process was patented in 1924. In 1929, production started in Sweden at the city of Yxhult. From "Yxhults Anghärdade Gasbetong" later became the first registered building materials brand in the world: Ytong. Another brand "Siporex" was established in Sweden in 1939 and presently licenses and owns plants in 35 locations around the world. The second major international cellular concrete Hebel brand goes back to company founder and technicians Josef Hebel from Memmingen. In 1943, the first Hebel-plant was opened in Germany.

Originally Ytong autoclaved aerated concrete in Sweden was produced with alum shale, whose combustible carbon content was beneficial in the production process. Unfortunately, the slate deposits used for Ytong in Sweden also contain a very low level of natural uranium, which makes the material give off radioactive radon gas in the building. In 1972, the Swedish Radiation Safety Authority pointed out the unsuitability of a radon-emitting construction material, and the use of alum slate in the production of Ytong ceased in 1975. By using new formulations, containing only quartz sand, calcined gypsum, lime (mineral), cement, water and aluminum powder, Ytong produced a new type of aerated concrete which no longer contains alum slate and thus has eliminated the problem of radon exposure from this raw material. The production of this white autoclaved aerated concrete is now state of the art and similar formulations are used by all producers around the world.



Aerated autoclaved concrete - close-up view



Autoclaved aerated concrete tiles of various shapes and sizes



On the right, green AAC blocks are being fed into an autoclave to be rapidly cured under heat and pressure

Today aerated concrete is produced in many companies, particularly in Europe and Asia. There is some production in the Americas, and in Africa there is one plant in Egypt. AAC production in Europe has slowed down considerably, but the industry is growing rapidly in Asia due to strong demand in housing and commercial space. China is now the largest aircrete market in the world with several hundred factories. China, Central Asia, India, and the Middle-East are the biggest in terms of AAC manufacturing and consumption.<sup>[4]</sup>

The product aircrete is sold, like other masonry materials, under many different brand names. Ytong and Hebel are brands of the international operating company Xella headquartered in Duisburg. Other more internationally renowned brand names in Europe are H + H Celcon (Denmark), or Solbet (Poland).

## Uses

AAC is a highly thermally insulating concrete-based material used for both internal and external construction. Besides AAC's insulating capability, one of its advantages in construction is its quick and easy installation, because the material can be routed, sanded, or cut to size on site using standard carbon steel power tools.

AAC is well suited for urban areas with high rise buildings and those with high temperature variations. Due to its lower density, high rise buildings constructed using AAC require less steel and concrete for structural members. The requirement of mortar for laying of AAC blocks is reduced due to the lower number of joints. Similarly, the material required for rendering is also lower due to the dimensional accuracy of AAC. The increased thermal efficiency of AAC makes it suitable for use in areas with extreme temperatures, as it eliminates the need for separate materials for construction and insulation, leading to faster construction and cost savings.

Even though regular cement mortar can be used, most of the buildings erected with AAC materials use thin bed mortar in thicknesses around  $\frac{1}{8}$  inch, depending on the national building codes. AAC materials can be coated with a stucco or plaster compound to guard against the elements, or covered with siding materials such as brick or vinyl.

## Manufacturing

Unlike most other concrete applications, AAC is produced using no aggregate larger than sand. Quartz sand, calcined gypsum, lime (mineral) and/or cement and water are used as a binding agent. Aluminum powder is used at a rate of 0.05%–0.08% by volume (depending on the pre-specified density). In some countries, like India and China, fly ash generated from thermal power plants and having 50-65% silica content is used as an aggregate.

When AAC is mixed and cast in forms, several chemical reactions take place that give AAC its light weight (20% of the weight of concrete) and thermal properties. Aluminum powder reacts with calcium hydroxide and water to form hydrogen. The hydrogen gas foams and doubles the volume of the raw mix creating gas bubbles up to 3mm ( $\frac{1}{8}$  inch) in diameter. At the end of the foaming process, the hydrogen escapes into the atmosphere and is replaced by air.

When the forms are removed from the material, it is solid but still soft. It is then cut into either blocks or panels, and placed in an autoclave chamber for 12 hours. During this steam pressure hardening process, when the temperature reaches 190° Celsius (374° Fahrenheit) and the pressure reaches 8 to 12 bar, quartz sand reacts with calcium hydroxide to form calcium silicate hydrate, which gives AAC its high strength and other unique properties. Because of the relatively low temperature used AAC blocks are not considered fired brick but a lightweight concrete masonry unit. After the autoclaving process, the material is ready for immediate use on the construction site. Depending on its density, up to 80% of the volume of an AAC block is air. AAC's low density also accounts for its low structural compression strength. It can carry loads of up to 8 MPa (1,160 PSI), approximately 50% of the compressive strength of regular concrete.<sup>[5]</sup>

Since 1980, there has been a worldwide increase in the use of AAC materials. New production plants are being built in Australia, Bahrain, China, Eastern Europe, India, Israel, and the United States. AAC is increasingly used by developers, architects, and home builders worldwide.

## Advantages

AAC has been produced for more than 70 years, and it offers several significant advantages over other cement construction materials, one of the most important being its lower environmental impact.

- Improved thermal efficiency reduces the heating and cooling load in buildings.
- Porous structure allows for superior fire resistance.
- Workability allows accurate cutting, which minimizes the generation of solid waste during use.
- Resource efficiency gives it lower environmental impact in all phases of its life cycle, from processing of raw materials to the disposal of waste.
- Light weight saves cost & energy in transportation, labor expenses, and increases chances of survival during seismic activity.<sup>[6]</sup>
- Larger size blocks leads to faster masonry work.
- Reduces the cost of the project.
- Environmentally friendly: When used, it helps to reduce at least 30% of environmental waste as opposed to going with traditional concrete. There is a decrease of 50% of greenhouse gas emissions. When possible, using autoclaved aerated concrete is a better choice for the environment.
- Energy savings: It is an excellent property that makes it an excellent insulator and that means the interior environment is easier to maintain. When it is used, there is usually not a need for any supplementary insulation.
- Fire resistant: Just like with regular concrete, ACC is fire resistant. This material is completely inorganic and not combustible.
- Great ventilation: This material is very airy and allows for the diffusion of water. This will reduce the humidity within the building. ACC will absorb moisture and release humidity; this helps to prevent condensation and other problems that are related to mildew.
- Non-toxic: There are no toxic gases or other toxic substances in autoclaved aerated concrete. It does not attract rodents or other pests nor can it be damaged by such.
- Lightweight: Concrete blocks that are made out of ACC weigh about one-fifth of typical concrete. They are also produced in sizes that are easy to handle for quick construction.
- Accuracy: The panels and blocks made of autoclaved aerated concrete are produced to the exact sizes needed before they even leave the factory. There is less need for on-site trimming. Since the blocks and panels fit so well together, there is a reduced use of finishing materials such as mortar.
- Long lasting: The life of this material is extended because it is not affected by harsh climates or extreme changes in weather conditions. It will not degrade under normal climate changes either.
- Quick assembly: Since it is a lightweight material and easy to work with, the assembly is much quicker and smoother.

## Disadvantages

AAC has been produced for more than 70 years, however some disadvantages were found when it was introduced in the UK (where cavity wall with clay brick two-skin construction has been the norm).

- Installation during rainy weather: aircrete is known to crack after installation, which can be avoided by reducing the strength of the mortar and ensuring the blocks are dry during and after installation.
- Brittle nature: they need to be handled more carefully than clay bricks to avoid breakages.

- Fixings: the brittle nature of the blocks requires longer thinner screws when fitting cabinets and wall hangings and wood-suitable drill bits or hammering in. Special, large diameter wall plugs (*aircrete anchor*) are available, though at a higher cost than common wall plugs.<sup>[7]</sup>
- Insulation requirements in newer building codes of northern European countries would require very thick walls when using AAC alone. Thus many builders choose to return to traditional building methods installing an extra layer of insulation around the building as a whole.

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## External links

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