Precast Autoclaved Aerated Concrete

William V. Abbate
Hebel USA
2408 Mount Vernon Road
Atlanta, Georgia 30338
tel: 770-394-5546
date: 770-394-5564
e-mail: HebelAAC@AOL.com

Abstract

Precast autoclaved aerated concrete is a building material which consists of various sized elements that form a complete building system. In most cases, every portion of the structural and insulation requirements of a building are satisfied with the one material. The elimination of a number of other materials, and the fact that PAAC is an inherently "green" building system, results in a "healthier" building. Low energy required in production, low raw material consumption, ease of use in construction, high energy efficiency, better indoor air quality, and recyclability add up to make PAAC a very environmentally friendly building material and system.

Introduction

Precast autoclaved aerated concrete (PAAC) was developed in Europe in 1923. Commercial production of the material began in 1930. In 1995, more than 31 million cubic meters were produced by over 250 factories worldwide. PAAC is used in a wide range of building construction with residential, commercial and industrial buildings being common applications. The system consists of small masonry like units, larger "jumbo" units, panels, and a variety of specially manufactured shapes and pre-assembled wall sections.

Several important factors contribute to PAAC's worldwide acceptance. It is a versatile, easy to use, durable, and energy efficient system. PAAC is the only viable, single component structural insulation system available. The walls, floors and the roof of a building can be constructed with the system. Using one material to build the entire structural and insulation part of a building offers many advantages, allowing excellent design flexibility, quick construction and reduced waste.

PAAC is well known as an environmentally friendly construction material. Compared to the energy consumed in production of many other basic building materials, only a fraction is required to produce PAAC. Raw material consumption is very low for the amount of finished product produced. In the manufacturing process, no pollutants or toxic byproducts are produced. PAAC is also completely recyclable.

Due to PAAC's excellent insulation qualities, energy consumption for the heating and cooling of buildings is greatly reduced compared to most conventional wall and roof systems. In the finished structure, no pollutants or toxic substances are released that could affect indoor air quality, even in the event of fire.

Raw Materials

PAAC consists of basic materials that are widely available. These include sand, cement, lime, gypsum, water, and an expansion agent. Silica sand, the raw material used in the greatest volume in PAAC, is one of the world's most abundant natural resources. The finished product is up to five times the volume of the raw materials used, with an air content of between 70% to 80%
Due to this large increase in volume, PAAC is very resource efficient. The following chart demonstrates the volumes obtainable from one cubic meter of raw materials for PAAC and various other common building materials.

Production

The ingredients of PAAC are mixed to form a slurry that is poured into large metal molds. The reaction between the expansion agent and other components used in PAAC causes the slurry to expand (rise) in the mold and form a "cake." After several hours, the mold is stripped away and the "cake" is wire-cut into aerated concrete elements of high dimensional accuracy. These elements are then put into an autoclave (a vessel in which they are steam cured under pressure.) After autoclaving, PAAC can be shipped and used immediately.

The production process emits no pollutants and creates no toxic waste products. All waste produced during manufacturing is reused. Production of PAAC requires relatively little energy for the volume of material produced. The following chart compares production energy consumption for PAAC to some other common building materials.

Use in Construction

Ease of use of a building material is important in many ways. Construction time, manpower, waste, and energy consumed by equipment used during construction are affected. Large, precisely dimensioned elements of PAAC allow rapid construction. Their greater dimensional accuracy requires less on-site adjustment. The combination of large size and dimensional accuracy allows greatly increased productivity. Due to the light weight of PAAC, reduced equipment demands are realized. This allows a reduction of pollutants by emissions and power usage.
of equipment during construction. As an example, the structure of a recently constructed seven-story hotel in Atlanta was completed more than two months quicker than normal, with much less equipment, manpower, and waste.

Construction waste continues to be a serious problem for builders. Before completion of a building project, waste is either burned, buried, recycled, or shipped to a landfill. Many areas do not allow burying or burning due to the environmental problems created. A very small amount of recycling is currently possible due to the lack of infrastructure to support it. Landfills are becoming the more common method of disposal, which presents other environmental problems. Two features of PAAC help to greatly reduce waste. First, since it is both a structural and an insulation material, it simplifies construction, eliminating a number of different materials and their associated waste. Second, due to the ease of workability, and dimensional accuracy, very little waste occurs during construction. The woodworking properties of PAAC allows even cut pieces to typically be reused.

The Finished Building

In the US, it is estimated that 80 to 90 percent of the average person's time is spent indoors; at home, work and in other buildings. A number of issues must be addressed concerning these buildings and their environmental friendliness. Indoor air quality, safety, comfort, energy consumption and waste, noise, and in general how "healthy" a building is, are some of the more important issues.

It is widely known that some of the poorest quality air we breathe is in our homes and the buildings we work in. Many materials used in construction contain toxic substances and off-gas. It is not unusual for construction materials to pollute indoor air with formaldehyde, benzene, arsenics, and other chemicals that are classified as hazardous to human health. Even fiberglass insulation, a commonly used material, is classified as a carcinogen by the US Government. PAAC is an inorganic material that contains no toxic substances. It does not slowly decompose and off-gas. Since PAAC is both a structural and insulation material, it allows the elimination of other materials that can contribute to poor indoor air quality. With the mineral based plaster coatings commonly used on the interior of PAAC, complete elimination of toxic materials from the walls is possible.

A danger of many conventional materials is that of toxic fumes produced when they burn. PAAC is an inorganic material that does not burn. The melting point of PAAC is over 2900°F (1600°C), more than twice the typical temperature in a building fire of 1200°F (650°C). An 8" (20cm) PAAC exterior wall easily exceeds a four hour ASTM E-119 fire rating, while a typical PAAC floor system or 4" (10cm) interior wall easily exceeds a two hour rating.

High energy efficiency in a building is desirable for many reasons. By reducing heating and cooling requirements, lower operating costs and equipment sizes are achieved. Better temperature and humidity control will provide greater comfort for the building occupants. The reduced energy requirement of a building also helps conserve natural resources such as oil, coal, natural gas, etc., thereby reducing emission of pollutants into the atmosphere. Both the reduction in energy usage and pollutants should be considered over the total useful life of the building.

It is widely recognized that PAAC buildings are very energy efficient. This efficiency is due to a combination of high R-value, thermal mass and air-tightness. PAAC is the only product currently available that meets Germany's stringent energy codes without added insulation. It is well documented that the R-value of a mass product need not be as high as that of light frame construction, to perform thermally efficient. A recent study in the US shows that an 8" (20cm)
PAAC wall performs much better than a conventional wood stud wall system with R-30 insulation.

To demonstrate how the combination of R-value, thermal mass and air-tightness work together, PAAC was tested at the Fraunhofer Institute for Architectural Physics in Germany. The test measured surface temperatures of a 10" (25cm) PAAC wall over a 24 hour period. An exterior wall that received maximum sun exposure was used, with the exterior surface painted black. While the outside temperature fluctuated by over 126°F (50°C), the inside wall temperature maintained a comfortable 68°F (20°C) with only a +/-2°F (+/-1°C) fluctuation. The following chart shows the result of this test.

In addition to greatly moderating the interior temperature, there is a significant delay (lag time), about eight hours, from the exterior peak temperature to the interior peak temperature. This lag time allows energy consumption to be shifted to off-peak hours, a benefit to power companies.

PAAC is an inorganic, insect resistant, solid wall construction material. Since the walls are solid, it is not possible for insects to inhabit and breed in them as in most wall systems. Without concern of termites and other insects damaging or inhabiting the PAAC portion of the structure, chemical treatments can be reduced or eliminated. This prevents the need of putting these chemicals into the ground, or the indoor air, with their associated environmental and health threats.

A commonly overlooked environmental problem in residential construction is that of environmental noise pollution. The solid wall construction of a building made of PAAC provides excellent sound abatement, greatly reducing outside noise, providing a quieter, more comfortable interior for the occupants.

Durability, and its environmental impact, is an important factor when considering use of a building material. A structure that does not need major repairs and renovation every twenty years or so, as many wood products require, can save money, inconvenience, energy and other resources. This is of tremendous advantage to the building owner, creating a better investment and value up-front and long-term. PAAC has proven to be a very durable material. There are numerous structures worldwide, many over 50 years old, in excellent condition. PAAC will not rot, warp, rust, corrode, or otherwise decompose. PAAC provides a very low maintenance building, saving considerable time and money in upkeep over the life of the building. Although damage to a PAAC wall is unlikely, repair is simple using a PAAC repair mortar.

The durability of finishes, both exterior and interior, plays an important role environmentally. With PAAC, any number of interior and exterior coatings or applications are possible. More common coatings, such as a stucco type finish, along with interior plaster, aid in creating a more
environmentally friendly structure. The stucco type finish used on PAAC is very durable and requires little maintenance. These finishes can be integrally colored with mineral pigments, eliminating the need for frequent painting. Interior plaster applied to PAAC is durable, yet easy to repair. Veneered plaster can be left unpainted, providing a pleasing appearance.

A PAAC building can be very cost effective. In the US, first costs are generally only 1% to 5% higher. Operating cost savings for the building owner prove to be substantial, with life cycle break-even within a relatively short period of time. The PAAC building owner sees a significant reduction of maintenance, insurance and energy (heating and cooling) costs, as well as an increase in overall comfort and safety.

Conclusion

As a construction system, PAAC provides significant environmental and other benefits for the builder and the building owner. The short- and long-term effect of using PAAC compared to many other materials results in lower energy consumption, reduced operating costs, greater safety and comfort, and a healthier and more trouble-free building. These features provide a better investment for the building owner, and for our environment.