Autoclaved aerated concrete

Autoclaved Aerated Concrete (often shortened to 'AAC') is effectively concrete with lots of closed air pockets in it. It is lightweight and energy efficient, and is produced by adding a foaming agent to concrete in a mould, then wire cutting blocks or panels from the resulting 'cake', and 'cooking' it with steam (autoclaving).

The use of AAC in Australia is not yet widespread but autoclaved aerated concrete blocks have been used in Europe for more than 50 years. AAC has a moderate embodied energy content and performs very well as thermal and sound insulation, due to the aerated structure of the material and the unique combination of thermal insulation and thermal mass properties. AAC is light, does not burn, is an excellent fire barrier, and is able to support quite large loads. It is relatively easy to work with and can be cut and shaped with hand tools. Blocks are made to very exacting dimensions and are usually laid in thin-bed mortar that is applied with a toothed trowel, although more conventional thick-bed mortar can be used. AAC has a long life and does not produce toxic gases after it has been put in place.

PERFORMANCE SUMMARY

Appearance

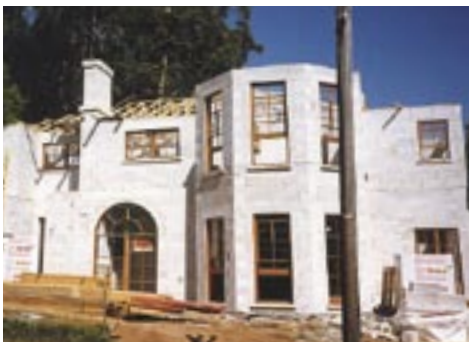
Autoclaved Aerated Concrete is very light coloured. It contains many small voids (similar to those in aerated chocolate bars) that can be clearly seen when looked at closely. The closed air pockets contribute to the material's insulating properties and also its aerated nature. Although there is no direct path for water to pass through the material, an appropriate coating is required to prevent water penetrating into the AAC material.

AAC can be sculpted with wood working tools, but its softness means that it is rarely used as an exposed finish owing to its need for surface protection.

Veneer construction

Structural Capability

The compressive strength of AAC is very good and load-bearing structures up to 3 storeys high can be safely erected. Entire building structures can be made in AAC from walls to floors and roofing with reinforced lintels, blocks and floor, wall and roofing panels available from the manufacturers. The Masonry Structures code AS 3700—2001 now includes provisions for AAC block design. AAC panels and lintels contain integral steel reinforcement to ensure structural adequacy during installation and design life. [See: Construction Systems Overview]



Block construction showing two storey house

Thermal mass

The thermal performance of AAC, as for other high-mass materials, is dependent on the climate in which it is used. With its mixture of lightweight concrete and air pockets, AAC has a moderate overall level of thermal mass performance. The temperature moderating thermal mass is most useful in climates with high cooling needs. [See: Thermal Mass]

Insulation

AAC has reasonably good insulation qualities. In most Australian climates the need for supplementary insulation can be avoided. A 200mm thick AAC wall gives an R-Value rating of 1.43 for AAC with 5% moisture content by weight. The Building Code of Australia provides an AAC masonry Deemed to Comply building solution consisting of a 200mm thick AAC wall and finishes, which requires no additional R-Value insulation in most Climatic Zones around Australia. Although the R-Value is lower than a well insulated, timber-framed structure, the combination of thermal mass and thermal insulation properties can deliver savings in heating and cooling costs through the life of a home. [See: Insulation Overview]

Load-bearing, insulating and capable of being 'sculpted', AAC has enormous potential as an environmentally responsible building material choice.

Sound insulation

With its closed air pockets, AAC can provide very good sound insulation. As with all masonry construction, care must be taken to avoid gaps and unfilled joints that can allow unwanted sound transmission. Combining the AAC wall with an insulated asymmetric cavity system will provide a wall with excellent sound insulation properties. [See: Noise Control]

Fire and vermin resistance

AAC is inorganic and incombustible and is thus especially suited for fire-rated applications. Depending on the application and the thickness of the blocks or panels, fire ratings up to 4 hours can be achieved. AAC does not harbour or encourage vermin.

Durability and moisture resistance

The purposely lightweight nature of AAC makes it prone to impact damage. With the surface protected to resist moisture penetration it is not affected by harsh climatic conditions and will not degrade under normal atmospheric conditions. The level of maintenance required by the material varies with type of finish applied.

The porous nature of the material can allow moisture to penetrate the material to a depth but appropriate design (damp proof coarse layers and appropriate coating systems) prevents this happening. AAC will not easily degrade structurally when exposed to moisture, but its thermal performance may suffer.

There are a number of proprietary finishes available (acrylic polymer based) which when applied over a sand and cement render provide a very durable and water resistant coating system to AAC blockwork. They need to be treated in a similar fashion with acrylic polymer based coatings prior to tiling in areas such as showers. The manufacturer can advise on the appropriate coating system, surface preparation and installation instructions to give good water repellent properties prior to tiling in wet areas.

Plasticised, thin coat finishes are common, but here a non-plasticised thick coat (10mm approximately) render was used for environmental reasons. Some variation in the amount of 'show-through' of the blockwork pattern can be seen in this example that also illustrates the use of glass blocks, as well as more conventional windows. The external plumbing was a choice made to reduce loss of internal space, avoid potential problems with wall cavities, and express the decision to avoid the use of PVC plastic in the construction.

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Toxicity and Breathability

The aerated nature of the material facilitates breathability. There are no toxic substances and no odour in the final product. However, AAC is a concrete product, and similar precautions should be taken as when handling and cutting concrete products. Personal protective equipment (such as gloves, eye wear, respiratory masks) is required during cutting due to the fine dust that is produced by concrete products. If low-toxic, vapour permeable coatings are used on the walls and care is taken not to trap moisture where it can condense, AAC may be an ideal material for homes for the chemically sensitive. [See: Indoor Air Quality]

Autoclaved Aerated Concrete is about one-fifth the density of normal concrete blocks.

Sustainability (environmental impacts)

Weight for weight, AAC has manufacturing, embodied energy and GH emission impacts similar to those of concrete, but can be up to one quarter to one fifth that of concrete based on volume. AAC products or building solutions may have lower embodied energy per m2 than a concrete alternative. Its much higher insulation value reduces heating and cooling energy consumption. AAC has some significant environmental advantages over conventional construction materials addressing longevity, insulation and structural demands in one material. As an energy and material investment it can often be justified for buildings intended to have a long life. [See: Material Use Introduction]

Off-cuts from construction can be returned to the manufacturer for recycling, or be sent out as concrete waste for re-use in aggregates, or the odd pieces can be used directly for making other walling, eg. Garden walls or landscape features. In this illustration there is a clear difference between the lower course and higher course of blockwork in the AAC apartment building under construction – this shows the kind of difference in quality that can be derived from the same material by differently skilled tradespeople.

Buildability, availability and cost

Blocks are one-fifth of the weight of concrete and are produced in a variety of sizes, but although AAC is relatively easy to work, is light and easily carved, cut and sculpted, it generally requires careful and accurate placement so that skilled trades and good supervision are essential. Competent bricklayers or carpenters can work successfully with AAC. Very large block sizes may require two-handed lifting and be awkward to handle but can result in fewer joints and more rapid construction.

The construction process with AAC products results in a low waste component, as the offcuts can be re-used in the construction of the wall.

In this illustration there is a clear difference between the lower course and higher course of blockwork in the AAC apartment building under construction – this shows the kind of difference in quality that can be derived from the same material by differently skilled tradespeople.

The cost of AAC is moderate to high. In Australia, AAC is competitive with other masonry construction but more expensive than timber frame. Lack of competition in the marketplace makes consumers highly dependent on one manufacturer.

TYPICAL DOMESTIC CONSTRUCTION

Construction process

All structural design should be prepared by a competent person, and may require preparation and approval of a qualified engineer. Qualified professionals, architects and designers provide years of experience and access to intellectual property that has the potential to save house builders time and money as well as help ensure environmental performance. All masonry construction has to comply with the Building Code of Australia and relevant Australian Standards, eg. all masonry walls are required to have movement/expansion joints at specified intervals.

The standard block size is 200mm high by 600mm long. Block thickness can range from 50mm to 300mm but for residential construction the most common block widths used are 100mm, 150mm and 200mm. AAC blocks can be used in a similar manner to traditional masonry units like bricks and be used as a veneer in timber frame and as one or both skins in cavity wall construction.

The standard panel size is 600mm wide by 75mm thick with lengths ranging from 1200mm to 3000mm. Typically, these AAC panels are used as a veneer cladding over a timber-framed construction.

AAC manufacturers provide a wealth of detailed technical advice that, if followed, should help to ensure successful use of the product.

Movement joints

Movement joints must be provided at 6m horizontal centres maximum (measured continuously around rigid corners). Refer to manufacturer's guidelines for further information.

Footings

AAC block construction requires level footings designed for full or articulated masonry in accordance with AS 2870. Stiff footings are preferred because the wall structure of thin-bed AAC acts as if it were a continuous material and cracking tends not to follow the mortar beds and joints like it does in traditional masonry walling. Thick-bed mortar AAC walls do act more like traditional masonry but are not the preferred method for AAC.

Frames

Frames may be required for various structural reasons. Earthquake provisions tend to require multi-storey AAC structures to have a frame of steel or reinforcement to withstand potential earthquake loads that may induce strong, sharp horizontal forces. It is a relatively simple matter to build AAC block work around steel frames but embedding reinforcement rods can be costly and difficult.

Load bearing walls

AAC is available in blocks of various sizes and in larger reinforced panels. These are sold as part of a complete building system that includes floor and roof panels in addition to interior and exterior walls.

Joints & connections

AAC manufacturers provide proprietary mortar mixes. Although more conventional thick-bed (10mm approx.) mortar can be used with AAC, the manufacturer's approved option is a proprietary 'thin-bed' mortar. Using thin-bed mortar, the procedure of laying the blocks is more like gluing than conventional brickwork construction. This is why many traditionally trained bricklayers may experience a need for a period of adjustment to a different method of working. In addition, brickies are used to lifting bricks with a single hand and AAC blocks often require two-handed manipulation. Although this may appear a slower construction process to lay masonry units, an AAC block is equivalent to 5 to 6 standard bricks.

Fixings

AAC has low compression strength. The use of mechanical fasteners is not recommended, as repeated loading of the fastener can result in local crushing of the AAC and loosening of the fastener. There are proprietary fasteners that are specifically designed to accommodate the nature of the material by spreading the forces created by any given load, whether it is a beam, shelf or a picture hook. There are a number of proprietary fixings for AAC with extensive guidance available in product literature. In the event of uncertainty regarding the appropriateness of a fixing, consult the project engineer or fastener manufacturer for guidance.

Openings

AAC is soft enough to be cut with hand tools. Niches can be carved into thicker walls and corners can be chamfered or curved for visual effect. Channels for pipes and wires are easily made with an electric router but with all carving and cutting care must be taken to use appropriate dust reduction strategies and appropriate personal protection equipment should be worn at all times.

This dry-lined interior shows how AAC can be exploited to make niches and unusual openings.

Finishes

AAC blockwork and panels can accept cement render, but the manufacturers recommend using a proprietary render mix compatible with the AAC material substrate. Site mixed cement renders have to be compatible with the AAC substrate, with the render having a lower strength than conventional renders. All renders should be vapour permeable (but water-resistant) to achieve a healthy breathable construction. All external coating finishes should provide good UV resistance, be vapour permeable and be proven suitable for AAC. Consult the manufacturer's literature for further information on coatings.

ADDITIONAL KEY REFERENCES

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Principal Author:
Paul Downton, Ecopolis Architects Pty Ltd