Autoclaved aerated concrete, or AAC, is concrete that has been manufactured to contain lots of closed air pockets. Lightweight and fairly energy efficient, it is produced by adding a foaming agent to concrete in a mould, then wire-cutting blocks or panels from the resulting ‘cake’ and ‘cooking’ them with steam (autoclaving).

The popularity of AAC in Australia has grown since its introduction here 20 years ago, although the market remains dominated by one manufacturer, Hebel. In Europe AAC has a long history of development, having been in use for more than 70 years. It has a moderate embodied energy content and performs well as thermal and sound insulation, due to the aerated structure of the material and its unique combination of thermal insulation and thermal mass. It 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 including woodworking tools.

**Performance summary**

**Appearance**

Autoclaved aerated concrete is light coloured. It contains many small voids (similar to those in aerated chocolate bars) that can be clearly seen when looked at closely. The gas used to ‘foam’ the concrete during manufacture is hydrogen formed from the reaction of aluminium paste with alkaline elements in the cement. These air pockets contribute to the material’s insulating properties. Unlike masonry, there is no direct path for water to pass through the material; however, it can wick up moisture and an appropriate coating is required to prevent water penetration.
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**Thermal mass**

The thermal mass performance of AAC is dependent on the climate in which it is used. With its mixture of concrete and air pockets, AAC has a moderate overall level of thermal mass performance. Its use for internal walls and flooring can provide significant thermal mass. The temperature moderating thermal mass is most useful in climates with high cooling needs. (see *Thermal mass*).

**Insulation**

AAC has very good thermal insulation qualities relative to other masonry but generally needs additional insulation to comply with Building Code of Australia (BCA) requirements.

A 200mm thick AAC wall gives an R-value rating of 1.43 with 5% moisture content by weight. With a 2–3mm texture coating and 10mm plasterboard internal lining it achieves an R rating of 1.75 (a cavity brick wall achieves 0.82). The BCA requires that external walls in most climate zones must achieve a minimum total R-value of 2.8.

*To comply with building code provisions for thermal performance, a 200mm AAC blockwork wall requires additional insulation.*

**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 gives a wall excellent sound insulation properties. (see *Noise control*)

**Fire and vermin resistance**

AAC is inorganic, incombustible and does not explode; it is thus well suited for fire-rated applications. Depending on the application and the thickness of the blocks or panels, fire ratings up to four 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 does not degrade under normal atmospheric conditions. The level of maintenance required by the material varies with the type of finish applied.
The porous nature of AAC can allow moisture to penetrate to a depth but appropriate design (damp proof course layers and appropriate coating systems) prevents this happening. AAC does not easily degrade structurally when exposed to moisture, but its thermal performance may suffer.

A number of proprietary finishes (including acrylic polymer based texture coatings) give durable and water resistant coatings to AAC blockwork and panels. They need to be treated in a similar fashion with acrylic polymer based coatings before tiling in wet areas such as showers. The manufacturer can advise on the appropriate coating system, surface preparation and installation instructions to give good water repellent properties.

Plasticised, thin coat finishes are common, but here a non-plasticised thick coat render (10mm approximately) was used. Some variation in the amount of show-through of the blockwork pattern can be seen in this example, which also illustrates the use of glass blocks as well as more conventional windows.

Toxicity and breathability
The aerated nature of AAC facilitates breathability. There are no toxic substances and no odour in the final product. However, AAC is a concrete product and calls for precautions similar to those for handling and cutting concrete products. It is advisable to wear personal protective equipment such as gloves, eye wear and respiratory masks during cutting, due to the fine dust 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.

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

Environmental impacts
Weight for weight, AAC has manufacturing, embodied energy and greenhouse gas 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 square metre than a concrete alternative. In addition, AAC’s 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)

Offcuts from construction can be returned to the manufacturer for recycling, or be sent out as concrete waste for reuse in aggregates; alternatively, the odd pieces can be used directly for making, for example, garden walls or landscape features.

The clear difference between the lower and higher course of blockwork in the loadbearing AAC walls of an apartment building under construction shows the difference in quality that can be achieved with the same material by differently skilled tradespeople.
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Buildability, availability and cost
Although AAC is relatively easy to work, it is one-fifth the weight of concrete, comes in a variety of sizes and is easily carved, cut and sculpted, it nevertheless requires careful and accurate placement: skilled trades and good supervision are essential. Competent bricklayers or carpenters can work successfully with AAC but dimensional tolerances are very small when blockwork is laid with thin-bed mortar. Thick-bed mortar is more forgiving but is uncommon and not the industry preferred option. 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 produces little waste as blockwork offcuts can be reused in wall construction. Good design that responds to the regime of standardised panel sizes encourages low-waste, resource-efficient AAC panel construction.

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 by a qualified engineer. Qualified professionals, architects and designers bring years of experience and access to intellectual property that has the potential to save house builders time and money, and help achieve environmental performance objectives. All masonry construction has to comply with the BCA and relevant Australian Standards, e.g. all masonry walls are required to have movement or 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 such as bricks: they can be applied as a veneer in timber frame or serve 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. AAC panels can be used as a veneer cladding over timber or steel-framed construction. (see Lightweight framing)

The AAC manufacturer provides 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 the manufacturer’s guidelines for further information.

Footings
AAC block construction requires level footings designed for full or articulated masonry in accordance with AS 2870–2011, Residential slabs and footings. Stiff footings are preferred because the wall structure of thin-bed mortar AAC acts as if it were a continuous material and cracking tends not to follow the mortar beds and joints the way it does in traditional masonry walling. Thick-bed mortar AAC walls 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 blockwork around steel frames but embedding reinforcement rods can be costly and difficult.
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Joints and connections
The AAC manufacturer provides proprietary mortar mixes. Although more conventional thick-bed mortar (approximately 10mm) can be used with AAC, the manufacturer’s approved option is a proprietary thin-bed mortar. With this method, the procedure of laying the blocks is more like gluing than conventional brickwork construction. This is why many traditionally trained bricklayers may need some time to adjust to this 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 than laying masonry units, an AAC block is equivalent to five or six standard bricks.

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

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. Proprietary fasteners 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 picture hook. A number of proprietary fixings for AAC come with extensive guidance in product literature. If you are not sure, 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, corners can be chamfered or curved for visual effect and you can easily make channels for pipes and wires with an electric router. Use appropriate dust reduction strategies with all carving and cutting, and wear appropriate personal protection equipment at all times.

Finishes
AAC blockwork and panels can accept cement render, but the manufacturer recommends 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.

References and further reading

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