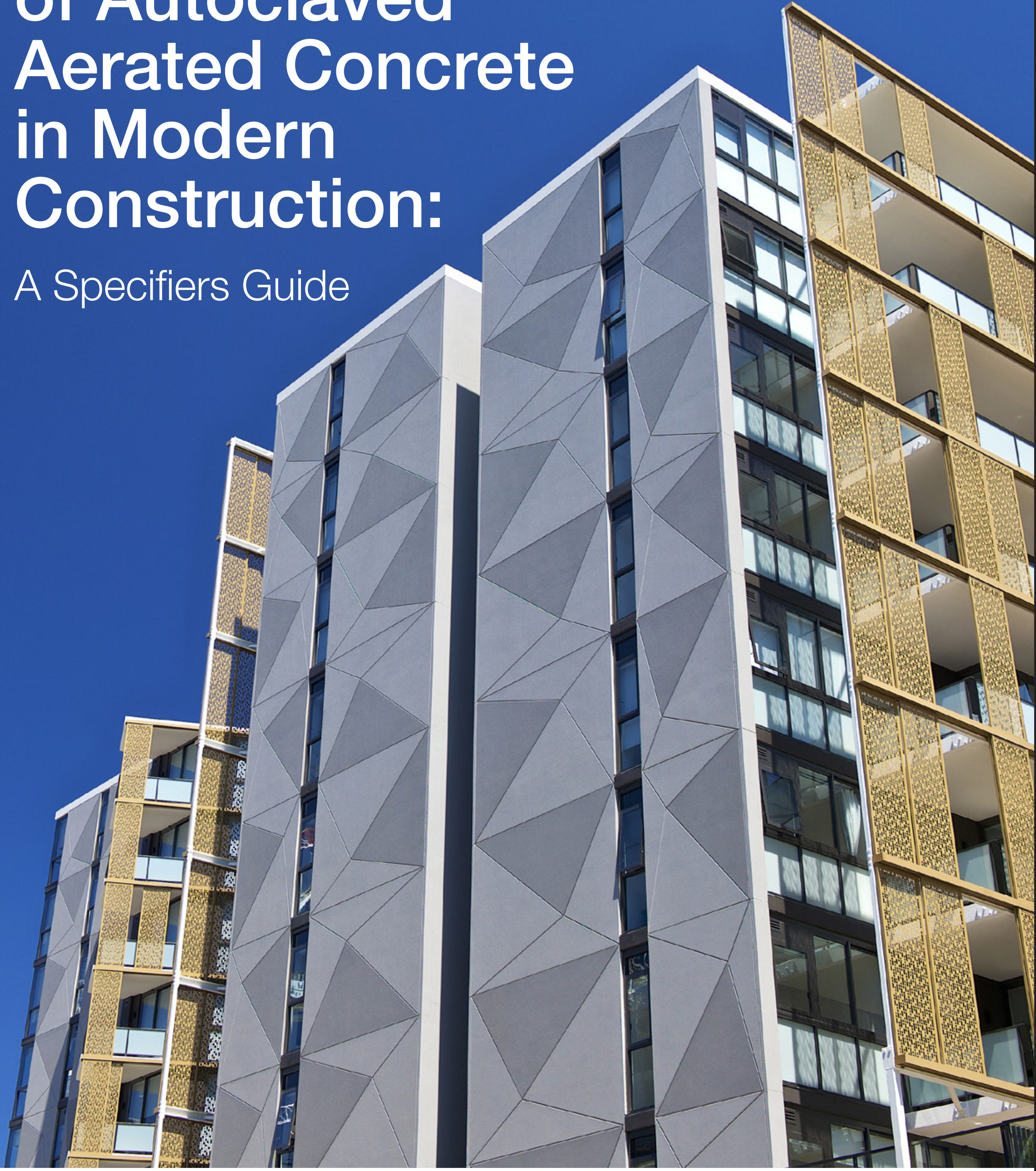
# The Benefits of Autoclaved Aerated Concrete in Modern Construction:

## A Specifiers Guide



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## INTRODUCTION

Across the country, the demand for sustainable buildings is growing in all sectors. Australia is one of the highest greenhouse gas emitting countries in the world on a per capita basis, with a large proportion of its emissions attributed to the built environment.[1] As the climate crisis escalates, so does the need for healthy, green and energy-efficient building materials and construction methods.

At the same time, the Australian regulatory landscape is becoming more challenging. Recent updates to the *National Construction Code* (NCC) established elevated energy efficiency targets for new Australian buildings. Stringent regulatory requirements for strength, durability, fire resistance, thermal efficiency and acoustic performance are also in place. Building standards and regulations are constantly changing, making compliance a top concern for industry professionals and property owners alike.

Design and construction professionals are seeking versatile building materials that enable a wide range of designs and greener ways of building. Autoclaved Aerated Concrete (AAC) – an aerated concrete-based product that is manufactured to contain many closed air voids (also referred to as macropores) and cured under high steam pressure in an autoclave – provides an answer. Due to its aerated structure, AAC is lighter than concrete and masonry yet offers exceptional structural capability, acoustic performance, thermal efficiency and fire resistance.

In this whitepaper, we introduce AAC, a sustainable alternative to traditional building materials – from its history and the manufacturing process to its performance profile and environmental credentials. We also discuss the benefits AAC offers to modern Australian construction, its application versatility and how it provides an efficient path to compliance with the NCC.

Hebel facade, Turner Architects

# WHAT IS AAC?

## HISTORY

From late 19th to early 20th century, several key developments in concrete technology occurred including innovations in steam curing and aerating.[2] In response to the wood shortage in Sweden caused by deforestation in the early 1900s, Swedish architect and inventor, Dr. John Axel Eriksson, sought to perfect the process to create a new aerated concrete-based material for use in construction.

In 1920, Dr. Eriksson patented methods of making an aerated mix of limestone and ground slate.[3] Three years later, Eriksson successfully applied pressurised steam to cure the foamed mass, which achieved fast hardening of the material and eliminated shrinkage.[4] The result was a strong yet lightweight, concrete-like material with many small, closed air voids that could be moulded or cut into precisely dimensioned units – AAC was born.

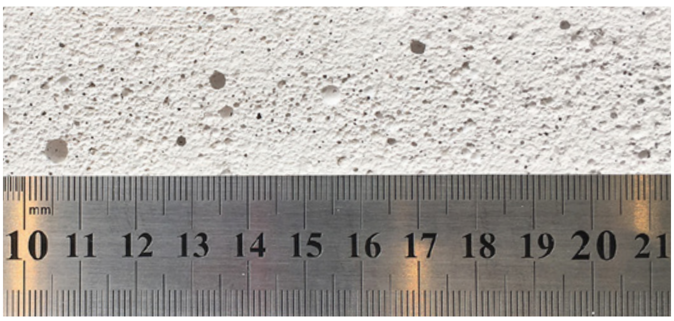
In 1945, German construction engineer Josef Hebel pioneered the manufacture of prefabricated AAC panels reinforced with steel, providing additional strength and structural reliability.[5] This new patented AAC panel product, named "Hebel", was instrumental in the rapid rebuild of German cities post-World War II.

Prized for its superior insulation properties and ease of installation, AAC spread across North America, Central and South America, Europe and the Middle East.[6] Since its introduction 20 years ago, the popularity of AAC in Australia has steadily grown,[7] with the AAC market currently dominated by one manufacturer – Hebel.[8]

## COMPOSITION

While ingredients may vary depending on manufacturer, AAC is generally made up of the following basic raw materials:[9]

- Portland cement;
- lime;
- water;
- sand or fly ash; and
- an expansion agent (e.g. aluminium powder).



Cross section of AAC, showing the voids.

## THE MANUFACTURING PROCESS

The process of manufacturing AAC begins with the pre-curing stage, starting with the blending of wet and dry ingredients – specifically, the cement, lime, water and finely ground sand – to create a slurry.[10] An expansion agent is added to the slurry (aluminium powder is commonly used) and the blended mixture is cast into a large billet or mould. In the case of reinforced AAC panels, steel reinforcing cages are secured within the mould.[11]

Adding the expansion agent to the slurry causes a chemical reaction in which hydrogen is formed within the mixture, making the slurry rise. The hydrogen gas dissipates leaving extremely small, finely dispersed air voids (also referred to as macropores) throughout the mixture. The aerated mixture is then set and the resulting "cake" (a solid, but still soft mix) is wire cut into precisely-sized blocks or panels.

The resulting blocks or panels from the pre-curing stage are steam cured under pressure in autoclaves, which are pressure vessels used to process materials requiring exposure to elevated pressure and temperatures.[12] Autoclaving is critical to achieving AAC's characteristic structural properties and dimensional stability.[13]

After being hardened and cured, AAC blocks and panels are inspected for quality then packaged and shipped.

Hebel testing laboratory

# BENEFITS OF AAC

## PERFORMANCE PROFILE

### Structural Capability

With its light weight yet high strength capability, AAC is more versatile than standard concrete.[14] AAC has one-quarter of the density of normal concrete. Due to its inherent strength, AAC blockwork can be used for loadbearing structures up to three storeys high.[15] AAC reinforced floor panels provide superior load-carrying capacity and excellent fire resistance.

Steel reinforcement adds further strength and stability to AAC blocks and panels, allowing such products to be used in a variety of structural applications. In Australia, AAC is increasingly being used as a cladding system.[16] Entire building structures can be made in AAC including walls, floors, and roof structures.[17]

### Thermal Performance

Due to its aerated structure, AAC is considered to have very good thermal insulation relative to concrete and masonry materials.[18] Air is a poor heat conductor, so the air bubbles in AAC prevent heat from being passed through it easily.[19] The thickness of AAC blocks and any additional layers contribute to the overall R-Value, which is the measure used to indicate a material's ability to resist the transfer of heat and provide thermal resistance.[20]

As it is a lightweight material, the R-Values for AAC has the effect of moderating indoor temperatures and reducing heating and cooling costs.[21] In addition, AAC also has inherent airtightness characteristics that allow designers to create airtight building envelopes that prevent heat escaping and energy loss.[22]

### Acoustic Performance

With its high surface mass and porous structure, AAC provides excellent sound insulation properties.[23] AAC is particularly effective in acoustically reflecting mid to low frequency sounds.

### Fire Resistance and Non-Combustibility

When compared to other building materials, AAC is one of the highest-rated fire resistant materials available. AAC is inorganic and does not explode nor combust, making it well suited for fire-rated applications, including construction in bushfire-prone areas, and building elements that are required to be non-combustible under the requirements of the NCC, such as components of external walls. Depending on the application and the thickness of the blocks or panels, some AAC products achieve a fire rating of up to four hours.

### Durability and Longevity

With a surface coating, AAC can resist moisture penetration, is less affected by harsh weather conditions and does not degrade under normal atmospheric conditions.[24] As a concrete-based material, AAC is resistant to rot and termite damage.[25]

## SUSTAINABILITY

Versatile materials such as AAC play an important role in reducing the environmental footprint of the built environment. With its high thermal efficiency and airtightness characteristics, AAC helps buildings meet energy efficiency targets under the NCC and State specific regulations. In addition, AAC's durability, fire resistance and acoustic properties contribute to healthy, cost-effective and long-lasting buildings. As it contains no volatile organic compounds (VOCs), AAC does not negatively impact indoor air quality.

The process of manufacturing AAC is eco-friendly when compared to other masonry products. The AAC manufacturing process uses naturally-available materials while minimising waste. During the manufacturing process of Hebel products, all green waste (pre-autoclaved) is returned into the green mix. Post manufacturing, AAC can be recycled and reused for other purposes such as clean fill and road base.

Over its lifecycle, AAC results in less embodied energy and emissions than regular concrete construction. Lightweight and easy-to-install, using AAC lowers transport costs, reduces construction waste and enables fast installation, all of which help reduce the total energy consumed during construction.

Incorporating AAC into new buildings can contribute to credits under sustainable building certification schemes such as GreenStar, LEED (Leadership in Energy and Environmental Design) and NABERS (National Australian Built Environment Rating System).

## VERSATILITY

Blocks and panels made from AAC can be manufactured in various sizes, thicknesses and edge profiles, with or without steel reinforcing. Its lightweight and inherent physical properties make AAC easy to use and install, giving architects, designers and specifiers a high degree of design and construction flexibility.

As AAC offers insulation, structural capabilities and fire resistance in one material, it can be used for a wide variety of applications. AAC is used for cladding, wall, floor and fencing systems across all sectors. It is suitable for fire wall applications in the industrial, utilities and infrastructure sector. Due to its sound and thermal insulation properties, AAC is also ideal for intertenancy and corridor walls, especially in multi-residential, commercial and educational settings.

AAC Autoclave

## CERTIFYING FOR COMPLIANCE MADE EASY

In today's changing regulatory landscape, AAC offers Australian architects, designers and builders a key advantage – easy-to-approve, code-compliant building systems. Two factors contribute to make compliance with AAC solutions easy and simple:

- AS 5146 Reinforced Autoclaved Aerated Concrete provides details on designing and constructing AAC systems to ensure code compliance and building certification; and
- leading AAC manufacturers such as Hebel offering CodeMark-accredited AAC systems that have been rigorously tested to the requirements of AS 5146 and with clear compliance pathways.

AS 5146 is referenced in the NCC giving the following reinforced AAC construction systems Deemed-to-Satisfy (DTS) status:

- Houses and Low Rise 75mm AAC External Walls;
- Low Rise 75mm AAC Intertenancy / Party Walls
- 75mm AAC Floors;
- 75mm AAC High Rise Facade Walls; and
- 150mm-250mm AAC Floors.

Builders and installers constructing a building using AAC and following the details provided in AS 5146 will find certification of the building easier. The NCC also refers to AAC in terms of what is acceptable construction to achieve compliance with various performance requirements including structural reliability, weatherproofness, fire resistance, sound insulation and energy efficiency.

When designing and specifying construction elements, a critical step is requesting documentation that the building product or system has been tested and proven to perform to the extent claimed by the manufacturer. In relation to AAC systems, ensure that the AAC product has been rigorously tested to meet the requirements under AS 5146 and the NCC. A CodeMark Certificate of Conformity ensures that the product is authorised in specified circumstances to facilitate compliance with the NCC.

## HEBEL

Hebel is Australia's only manufacturer of high performance AAC for residential, high rise, commercial, civil and infrastructure applications. Hebel has over 25 years of experience meaning you can be assured you are getting a high-quality product with the technical expertise to back it up. The company offers innovative building solutions available in AAC panels and blocks that are strong, versatile, resilient and sustainable.

Hebel manufactures AAC in Australia at a world class facility in Somersby, New South Wales.

## HEBEL POWERPANEL

Engineered to deliver high performing wall solutions for residential, multi-residential, high rise apartments and commercial and industrial buildings, Hebel PowerPanel is an AAC panel solution containing steel reinforcement for added strength with an anti-corrosion protection layer on the steel for maximum durability. PowerPanel is strong, solid and safe, and can be used can be used for a wide range of applications, including high rise facades, intertenancy walls, corridor walls, service walls and more.

Hebel PowerPanel

Installing PowerPanel systems for both internal walls and external facades is quick and cost-effective when compared to traditional masonry construction. PowerPanel can be made-to-length or made-to-order, meaning less wastage, fewer waste bins and less crane movements – leading to further cost savings.

PowerPanel delivers the benefits of AAC and more, including strength, versatility and design efficiency. Hebel also makes compliance easy – the performance properties of PowerPanel enable easy compliance with the fire, acoustic and thermal performance requirements under the NCC. PowerPanel is independently tested to meet AS 5146 and CodeMark-accredited for use as a non-load bearing external wall system.

PowerPanel systems are a sustainable and environmentally-friendly choice, with an estimated product lifetime of 50 years. Over a typical 50-year installed lifespan, maintenance and repair refurbishment are expected to be minimal, reducing operational costs and minimising environmental impact.

PowerPanel is available in a standard 75mm range square edge (nil profile) and tongue and groove models, caged and made-to-order. Hebel also recommends the use of acrylic coating systems and sealants to provide panel durability and wall system weathertightness performance.

Previous page: Solar Solution Designs
This page: Carter Grange

## REFERENCES


1 Martek, Igor and M Reza Hosseini, "Buildings produce 25% of Australia's emissions. What will it take to make them 'green' – and who'll pay?" The Conversation. https://theconversation.com/buildings-produce-25-of-australias-emissions-what-will-it-take-to-make-them-green-and-wholl-pay-105652 (accessed 14 May 2020).

2 Van Boggelen, Willem. "History of Autoclaved Aerated Concrete." Aircrete. https://www.aircrete.com/wp-content/uploads/2018/10/History-of-AAC.pdf (accessed 14 May 2020).

3 Fouad, Fouad H. "AAC in the USA – A second look." CE Papers Vol. 2, Issue 4 (2018): E1-E6.

4 Ibid.

5 Ibid.

6 Klingner, Richard E. "Using Autoclaved Aerated Concrete Correctly." Masonry Magazine. https://www.masonrymagazine.com/blog/2008/06/01/using-autoclaved-aerated-concrete-correctly/ (accessed 14 May 2020).

7 Australian Government. "Autoclaved aerated concrete." YourHome. https://www.yourhome.gov.au/materials/autoclaved-aerated-concrete (accessed 14 May 2020).

8 Ibid.

9 Zhang, Haimei (ed). Building Materials in Civil Engineering. Cambridge: Woodhead Publishing Limited and Science Press, 2011.

10 International Masonry Institute. "Autoclaved Aerated Concrete Masonry Units." IMI. https://imiweb.org/wp-content/uploads/2015/10/01.02-AAC-MASONRY-UNITS.pdf (accessed 14 May 2020).

11 Above n 6.

12 Above n 10.

13 Above n 6.

14 Above n 7.

15 Ibid.

16 Ibid.

17 Ibid.

18 Ibid.

19 Connection Magazines. "Autoclaved aerated concrete (AAC)." Build. https://build.com.au/autoclaved-aerated-concrete-aac (accessed 14 May 2020).

20 Ibid.

21 Above n 7.

22 Fudge, Cliff. "Designing with AAC to achieve sustainable houses." Cement, Wapno, Beton (2011): 116-120.

23 Above n 10.

24 Ibid.

25 Portland Cement Association. "Autoclaved Aerated Concrete." https://www.cement.org/cement-concrete-applications/paving/buildings-structures/concrete-homes/building-systems-for-every-need/autoclaved-aerated-concrete (accessed 14 May 2020).


All information provided correct as of June 2020