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Appendix A: ClinkaDETAIL

Chapters 5-8 ‘under construction’
clinka 10-star prototype house - Tasmania

- footingBLOK insulated footings
- clinkaFILL insulated slab
- isoBLOK external walls
- 150 clinkaBLOK internal walls
Private home - Victoria
• clinkaFILL insulated slab
• 250 isoBLOK single skin loadbearing external walls

Bendigo Bank - Gippsland, Victoria
clinkaFILL insulated slab and isoBLOK walls
1 General
1.1 Clinka Technical Handbook 2011

This guide is a tool for all professional users of *clinka* products, both designer and contractor. In addition to the manual refer to our website [www.clinka.com.au](http://www.clinka.com.au) for more information. The manual is handy as a reference and textbook. The website is perfect for what you want to access in electronic format, detailed drawings for download, and text for specifying *clinka* products. Technical changes occur and needs and requirements change, so new products and solutions will be offered to meet the needs of the market. Therefore, revision of product literature will always be important - and will be uploaded to our website [www.clinka.com.au](http://www.clinka.com.au) - please bookmark this page in your browser.

Good old-fashioned telephone support

We remind you that our technical helpline, m. 0411 588 603, is at your service if you have questions about how to best utilize our products.

Contents overview

- Chapter 1 provides information about Clinka the company and environmental information.

- Chapter 2 provides information about ClinkaBLOK products, manufacture and applications.

- In Chapter 3 you will find an introduction to the material properties, such as insulation, moisture, acoustics and fire.

- In Chapter 4 you will find information about design and execution of Clinka masonry, including tolerances, environmental classes, masonry and reinforcement, material transitions and surface treatment.
1.2 Clinka - a Scandinavian / Australian history

Clinka is a man-made lightweight clay aggregate that is used in its loose form as structural moisture resistant insulation, or bonded to make masonry products.

Natural lightweight aggregates have been used for centuries to create concrete that is lighter, easy to use and strong. Volcanic rocks like pumice has been used since the early Christian era. The vault of the Pantheon in Rome, from 2nd century A.D. was built with concrete made lighter with pumice. And natural lightweight rock such as scoria have been used in concrete in Australia for several decades.

The advantage of Clinka lightweight aggregate is that it has superior structural and thermal performance to natural lightweight aggregates as it is made using a controlled process to maximise its useful properties.

This roto-kiln process for making loose Clinka products has been continuously developed and industry-tested in Denmark for more than 50 years (and more recently in Norway and other countries around the world)

Clinka introduces these incredibly useful and tested products to Australia

Clinka 250 ISOBLOK
single skin loadbearing external masonry
R3.4 thermal rating
Environment
We work with natural materials. Clay, sand and lime. We collect our materials from nature. As an industry we have a clear environmental responsibility. In recent years, we and society in general have the necessary knowledge, will and technological opportunities to make up for old environmental sins. Today, the factory manufacturing expanded clay aggregate for Clinka products is among the cleanest and most energy efficient in Europe. And it is improving. The introduction of the international ISO 14001 environmental management standard has set clear targets, and requires continual improvements.

Product Features
Why is there so much expanded clay aggregate masonry in Scandinavian buildings? One main reason would be: flexibility. Both in practical applications and creative opportunities. Creatively speaking, Clinka is flexible because you can create many shapes and forms. Masonry is composed of small units: blocks and mortar. The blocks - available in different dimensions and also in curved formats - offer opportunities for exciting solutions. And it is a unique base for all types of surfaces; paint, plaster, or as a base for tiles, wallpaper or other cladding.

It could be for a large industrial building, sound insulating structures, or just to create a new partition wall. It could be a new building or an extension, or maybe an upper floor?

Clinka’s prime advantage is the combination of many good qualities. An important feature of Clinka is that you get so much all in one product. Use Clinka if you need very high fire protection, sound isolation, and low maintenance, and as a bonus you get a healthy indoor climate.

To this list you can also add: good load carrying capacity, low weight, low moisture absorption, frost resistance and good render & plaster adhesion. And not least, flexibility on the drawing board and on the construction site. We do not know your needs, but we know that the answer is often ‘clinka’.

Clinka requires minimal maintenance. Clinka is a robust material that requires very little maintenance and resists rot, fungus and pests. These characteristics are of course important to the building’s lifetime operating costs.

Clinka makes healthy buildings
The building you construct is someone's home or workplace. Therefore it is important to create a good indoor climate. Clinka is made of healthy and natural raw materials and emits no harmful gases or substances. Clinka buildings are therefore beneficial for people with asthma and allergies. Properly done, the Clinka walls are windproof, yet "breathable".

Clinka is a good insulator
Masonry is a "slow" material to absorb and store the temperature around it and also releases it back very slowly. Therefore, Clinka is cool and pleasant in summer, and warm when the winter weather gets colder. Using the correct Clinka solution in the outer wall, you get a simple and optimal wall with desired heat insulation. These properties can be utilized to reduce the heating or cooling needs in the building.

Clinka provides strong fire resistance
Clinka is a material with very good fire properties, most Clinka walls are rated at REI 240 (A240). Besides increased security against fire, Clinka masonry maintains most of its carrying capacity in the event of a fire - which is essential for safety.

Clinka walls provide good acoustic insulation.
Clinka walls are both sound absorbing and insulating. Solid walls of Clinka masonry have - because of their weight and internal damping - very good airborne sound insulation. The interior surfaces of ClinkaBLOK walls can be used as an absorbent surface to lower reverberation time.
1.3 Environmental information

Environmental considerations are a central part of Clinka philosophy. Our products must be environmentally efficient and all phases on the products lifecycle are assessed.

Environmental
All production facilities for Clinka are certified in accordance with quality and environmental management system ISO 9001:2000 / ISO 14001:1996.

Environmental Policy
The environmental management system ensures continuous environmental improvement and contribute to a sustainable society. Through the use of alternative and more environmentally friendly raw materials and energy types, employing modern and proven environmental technology and continuous improvement of production methods and products, the use of nonrenewable resources is reduced.

Life cycle
Our products are very eco-efficient throughout their life cycle. The life cycle of products includes all the phases of extraction of raw materials, production, construction, use, demolition and disposal.

Examples include:

• Production uses a growing proportion of bio and alternative fuels.

• Our products contain no health or hazardous substances and emit no harmful emissions.

• Our products are mineral, resistant to moisture, fungi and rot damage.

• Our products have very long life and require little maintenance.

• At the change of the building’s function, shape or size, it is easy to make changes to our products.

• After the end of life, our products are easy to extract and separate the individual parts. e.g. recycled ClinkaFILL can used as a lightweight fill or aggregates for new block products or highly sought after stable road-base for difficult sites.
2 ClinkaBLOK products

2.1 Manufacturing

The base material in ClinkaBLOK products are lightweight clinker balls (loose Clinka) made using natural deposits of clay. The Clinka balls are produced in large roto-kilns with a diameter of about 3 meters and length up to 60 meters.

Clay with additives is fed into one end and heat supplied to the other. The rotation, combined with the hot air flows, allows the clay to dry and expand to its final form at temperatures around 1100° C. The Clinka balls (or nuts) have now been given a porous structure surrounded by ceramic shell. The porous core consists of a variety of tiny air sacs where the internal air pockets occupy about 70 - 75% of the volume.

Clinka balls are easily transported to block factories where it is mixed with cement, sand and water. The mixture is compressed into steel forms in a fully automatic block machine. The block machines have interchangable forms, and can produce a large number of sizes. The mixture is cured with steam in the curing chamber before the blocks are stacked on pallets and put on outside storage. When the blocks have achieved 80 - 90% of its intended strength they are effectively movement stabilised.

The Clinka is graded into a size range of 4 to 10 mm for Clinka-BLOK and Clinka IsoBLOK formats, and 2 - 4mm for Clinka fineBLOK (which consequently, has a much finer texture and sharper edges). The density of Clinka lightweight concrete blocks varies between 600 and 1,300 kg/m³ depending on the product's intended use.

ClinkaBLOK products have a combination of advantageous properties: low weight; good load capacity; low moisture absorption; frost resistance and very good render adhesion, as well as good heat insulation, and sound attenuation ability.

ClinkaBLOK products are unreinforced and concrete grey in color with a coarse porous exterior.

2.2 Products

ClinkaBLOK’s are produced in different formats and types to meet different needs. Choice of block type and dimension will depend on the requirements for carrying capacity, heat insulation, sound insulation and absorption, fire resistance, aesthetics, surface structure, wall thickness, etc. A complete overview of clinkaBLOK products is shown in Table 2.1.

2.2.1 standard Clinka-BLOK & Clinka FineBLOK

These block types are produced in several dimensions, see table 2.1. Block types of 125 mm and larger are made with discontinuous cores, while the block types 100 and 75 mm are solid. The holes in the larger blocks can knocked-out and used for casting and vertical reinforcement of Clinka masonry walls.

Block strength of ClinkaBLOK is 2 or 3 MPa depending on block type, and most blocks have a net density of 770 kg/m³. 250ClinkaBLOK have a density of 650 kg/m³. Clinka fineBLOK have a density of 3 to 4 MPa where there is a need for greater carrying capacity. The density is the same as others, i.e 770kg/m³.

Standard ClinkaBLOK & Clinka fineBLOK have many applications, and can be used in both loadbearing and non-bearing external and internal walls.

2.2.2 Clinka U-BLOK

Clinka U-BLOK is used for casting of reinforced concrete to serve as lintel-beams over openings, and as ring-beams to bond brickwork together and distribute vertical loads. The blocks are provided with dimensions, strength and density as shown in Table 2.1. See appendix ‘clinkaDETAIL’ for U-BLOK span tables and lintel options.
2.2.3 Clinka IsoBLOK
Clinka IsoBLOK consists of two outer leaves of 82 mm clinkaBLOK bonded to an insulation layer of EPS foam. The block is also available as a cornerBLOK and U-BLOK in two thicknesses: 250 and 300 see Table 2.1. ISOclinkaBLOK is also available in curved format with internal diameter of 3.5 m.

Block strength is 4 MPa, and has a density of 900 kg/m$^3$. Polyurethane foam has a density of 37 kg/m$^3$. IsoBLOK is used for external masonry walls where there are requirements for very good thermal insulation and fire resistance. isoBLOK’s are laid with face shell mortar joints and generally with mortar joint reinforcing every 2nd course.

2.2.4 Special ClinkaBLOK’s
Clinka PartyBLOK is solid and has higher density than our other bloks. They are used where there is greater demand for sound-proofing and can be 175 mm and 250 mm thick. Clinka partyBLOK should always be laid with full mortar joints and rendered (or otherwise finished) on both sides to achieve its designed sound attenuating value.

Clinka constructionBLOK used where vertical and/or horizontal loads can not be absorbed by the standard blocks. The blocks have recesses of 150 x 150 mm for casting of reinforced concrete.

Clinka footingBLOK is used as an alternative to strip concrete footings for sustainable reasons (to minimise cement use). The block has a slot for reinforcement that is cast with 20MPa concrete. It can currently be used on class A and S sites and we plan to test its capabilities on Class M sites in the near future.

Clinka ColumnBLOK is used on decks and terraces, or for buildings that stand on stumps. The block has a core through the middle that can reinforced and cast, and can be laid either mortared or dry stacked. ColumnBLOK has vertical slots suitable for adding cladding between the pillars.

Other special block shapes sizes (adaptionBLOK’s and facadeBLOK’s) and densities are available on request - contact Clinka technical staff for details.
2.2.5 Overview of Clinka block products

Table 2.1 shows an overview of Clinka BLOK products and their attributes.

<table>
<thead>
<tr>
<th>Block Type</th>
<th>Strength / Density [MPa] [kg / m²]</th>
<th>Nominal Size [mm] W x H x L</th>
<th>Image</th>
<th>R-Value [Km²/W]</th>
<th>Sound [dB]</th>
<th>Fire Class</th>
<th>Weight [Kg / m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinka isoBLOK 300mm</td>
<td>3 / 600</td>
<td>300 x 250 x 500</td>
<td></td>
<td>4.55 (1)</td>
<td>41</td>
<td>REI 120</td>
<td>180</td>
</tr>
<tr>
<td>Clinka isoBLOK corner 300mm</td>
<td>3 / 600</td>
<td>300 x 250 x 500</td>
<td></td>
<td>3.44 (1)</td>
<td>40</td>
<td>60/120/120</td>
<td>130unfin. 150 fin.</td>
</tr>
<tr>
<td>Clinka iso U-BLOK 300mm</td>
<td>3 / 600 (2)</td>
<td>300 x 250 x 250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinka BLOK 300mm</td>
<td>2 / 600</td>
<td>300 x 250 x 500</td>
<td></td>
<td>1.54 (1)</td>
<td>47</td>
<td>&gt; REI 240</td>
<td>170</td>
</tr>
<tr>
<td>Clinka U-BLOK 300mm</td>
<td>4 / 900 (2)</td>
<td>300 x 250 x 250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinka BLOK 250mm</td>
<td>2 / 600 (3)</td>
<td>250 x 250 x 500</td>
<td></td>
<td>1.28 (1)</td>
<td>47</td>
<td>&gt; REI 240</td>
<td>160</td>
</tr>
<tr>
<td>Clinka U-BLOK 250mm</td>
<td>4 / 900 (2)</td>
<td>250 x 250 x 250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinka BLOK 200mm</td>
<td>3 / 770</td>
<td>200 x 250 x 500</td>
<td></td>
<td>1.11</td>
<td>46</td>
<td>&gt; REI 240</td>
<td>150</td>
</tr>
<tr>
<td>Clinka U-BLOK 200mm</td>
<td>3 / 770</td>
<td>200 x 250 x 250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinka BLOK 150mm</td>
<td>3 / 770</td>
<td>150 x 250 x 500</td>
<td></td>
<td>0.83</td>
<td>44</td>
<td>REI 240</td>
<td>120</td>
</tr>
<tr>
<td>Clinka BLOK 100mm</td>
<td>3 / 770</td>
<td>100 x 250 x 500</td>
<td></td>
<td>0.62</td>
<td>41</td>
<td>REI 120</td>
<td>90</td>
</tr>
<tr>
<td>Clinka BLOK 75mm</td>
<td>3 / 770</td>
<td>75 x 250 x 500</td>
<td></td>
<td>0.50</td>
<td></td>
<td></td>
<td>75</td>
</tr>
</tbody>
</table>

continued next page
2) U-BLOK and Iso U-BLOK 250 & 300 are produced in the same density. Iso U-BLOK insulated with 50 mm loose insulation board of EPS that is laid in the block & then grouted with 20MPa concrete.

3) 250 BLOK produced as standard in density of 650 kg/m², but can also delivered in density of 770. See the mark on the pallet.

4) R-values are calculated based on masonry panels with 10 courses. It is assumed the average moisture equilibrium in the wall is 4-6% by weight.

5) Wall with a U-block course (10% of wall area) and the use of 90 mm mortar insulation in the joints of the Clinka IsoBLOK.

6) deleted

7) Requires masonry with full mortar joints, and 10 mm render/plaster on one side. PartyBLOK must be rendered/finished on both sides. Estimated value of the residual airborne sound (in Rs 'uw') is 3 dB lower than the laboratory-measured values (Rw).

8) Requires skimcoat at least one side, except Fineblokk (which requires 2 sides.) IsoBLOK rendered on both sides, minimum thickness of 4 mm.

9) Self-Load specified for the finished raw brick wall, (Clinka BLOK/PartyBLOK 150 and smaller dimensions are bricked with full face horizontal mortar joints), without mortar in the perpendicular joints.

10) Self-Load specified for the finished raw brick wall, horizontal and perpendicular joints mortared.

---

**Block Type** | **Strength / Density [MPa] / [kg / m²]** | **Nominal Size [mm] W x H x L** | **Image** | **R-Value [Km²W] (K)** | **Sound [dB] (L)** | **Fire Class (R)** | **Weight [Kg / m²] (S)**
---|---|---|---|---|---|---|---
Clinka fineBLOK 250mm | 4 / 770 | 250 x 250 x 500 | ![Image] | 1.25 | 68 | > REI 240 | 180
Clinka fine U-BLOK 250mm | 4 / 770 | 250 x 250 x 250 | ![Image] | 1.11 | 46 | > REI 240 | 150
Clinka fineBLOK 200mm | 4 / 770 | 200 x 250 x 500 | ![Image] | 0.83 | 44 | REI 240 | 120
Clinka fine U-BLOK 200mm | 4 / 770 | 200 x 250 x 250 | ![Image] | 0.71 | 42 | REI 120 | 100
Clinka fineBLOK 150mm | 4 / 770 | 150 x 250 x 500 | ![Image] | 0.71 | 42 | REI 120 | 100
Clinka fine U-BLOK 150mm | 4 / 770 | 150 x 250 x 250 | ![Image] | - | - | - | -
Clinka fineBLOK 125mm | 4 / 770 | 125 x 190 x 490 | ![Image] | - | - | - | -
Clinka fine U-BLOK 125mm | 4 / 770 | 125 x 190 x 240 | ![Image] | - | - | - | -
Clinka fineBLOK 100mm | 4 / 770 | 100 x 250 x 500 | ![Image] | 0.63 | 47 | REI 120 | 90
Clinka adaptation fineBLOK | 4 / 770 | 100 x 200 x 500 | ![Image] | - | - | - | -
Clinka adaptation fineBLOK | 4 / 770 | 100 x 150 x 500 | ![Image] | - | - | - | -
Clinka partyBLOK | 8 / 1300 | 175 x 250 x 250 | ![Image] | - | 52 / 55 | > REI 240 | 240 / 350 (±20)
Clinka footingBLOK | 3 / 900 | 330 x 175 x 500 | ![Image] | - | - | - | -
2.3 Applications

ClinkaBLOK products can be used for several purposes. Common applications are basement walls, walls in subfloors and exterior walls.

Load-bearing walls inside and out, dividing walls, firewalls, sound isolating walls, wet walls, etc. can all be built with ClinkaBLOK’s.

Clinka houses have several advantages: excellent fire and acoustic characteristics, solidity, indoor air quality and insulation properties. But what has aroused the greatest interest in the market is the architectural opportunities Clinka provides, and not least the benefits of low maintenance. While a timber clad house has to repeatedly sanded, stained or painted, a Clinka-house manages nicely for 20 years with the bare minimum of maintenance.

2.4 Control and Quality Assurance

ClinkaBLOK production is certified according to ISO 9001 Quality management systems - and ISO 14001 Environmental management systems. Thorough Quality and Environmental control ensures satisfaction of public demands and orders, and Compliance with voluntary and legislated environmental controls. Dimensions, density and strength are CE marked for EN 771-3 /10/

Each pallet of ClinkaBLOK’s are marked with the production number, production location and strength grade / density.

2.5 Tolerances

ClinkaBLOK products are produced within the limits laid down in EN 771-3/10/

2.5.1 Tolerances for dimensions

According to EN 771-3/10/ dimensions of blocks (b x h x l), see Figure 2.8, each block dimension has a declared tolerance, ie the maximum permissible deviation from the declared basic goals. ClinkaBLOK’s are declared in the tolerance class D3 according to EN 771-3. Deviation from base objectives is maximum +1/-3 mm length and width and ± 1.5 mm in height.

2.5.2 Tolerances for density

For ClinkaBLOK’s the reported net density (dry) is given in kg/m³. The density is determined as a ratio of dry weight and its geometrical volume. Tolerance is ± 10% from the declared values.

Figure 2.8 Dimensions
### Table 3.1 Declared values for strength of Clinka masonry walls

<table>
<thead>
<tr>
<th>BLOK Type</th>
<th>Density [N/mm²] / [kg/m³]</th>
<th>Compressive Strength [MPa, N/mm²]</th>
<th>Flexural Strength [MPa, N/mm²]</th>
<th>Shear Force [MPa, N/mm²]</th>
<th>mortar joint type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Axial Pressure Vert. Hor. Hor.</td>
<td>Bending Moment Vert. Hor. Hor.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f'<em>{cny} f'</em>{cnx} f'_{vnx}</td>
<td>f'<em>{cnx} f</em>{tny} f_{tnx}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinka IsoBLOK 250 / 300mm</td>
<td>4/900</td>
<td>-</td>
<td>-</td>
<td>0.25</td>
<td>0.24</td>
</tr>
<tr>
<td>Clinka BLOK 300mm</td>
<td>2/600</td>
<td>1.35</td>
<td>1.00</td>
<td>1.10</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.05</td>
<td>1.00</td>
<td>1.10</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.05</td>
<td>1.05</td>
<td>1.15</td>
<td>0.17</td>
</tr>
<tr>
<td>Clinka BLOK 250mm</td>
<td>2/650</td>
<td>3/770</td>
<td>2.25</td>
<td>1.80</td>
<td>1.95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.75</td>
<td>1.80</td>
<td>1.95</td>
<td>0.20</td>
</tr>
<tr>
<td>Clinka BLOK 200mm</td>
<td>3/770</td>
<td>2.45</td>
<td>2.15</td>
<td>2.25</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.90</td>
<td>2.15</td>
<td>2.25</td>
<td>0.20</td>
</tr>
<tr>
<td>Clinka fineBLOK 250mm</td>
<td>4/770</td>
<td>2.70</td>
<td>2.15</td>
<td>2.30</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.00</td>
<td>2.15</td>
<td>2.30</td>
<td>0.22</td>
</tr>
<tr>
<td>Clinka fineBLOK 200mm</td>
<td>4/770</td>
<td>2.85</td>
<td>2.30</td>
<td>2.45</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.15</td>
<td>2.30</td>
<td>2.45</td>
<td>0.22</td>
</tr>
<tr>
<td>Clinka fineBLOK 150mm</td>
<td>4/770</td>
<td>3.05</td>
<td>2.65</td>
<td>2.75</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.30</td>
<td>2.65</td>
<td>2.75</td>
<td>0.22</td>
</tr>
<tr>
<td>Clinka fineBLOK 125mm</td>
<td>4/770</td>
<td>2.90</td>
<td>2.35</td>
<td>2.50</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.22</td>
</tr>
<tr>
<td>Clinka BLOK 150mm</td>
<td>3/770</td>
<td>2.45</td>
<td>2.15</td>
<td>2.25</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.90</td>
<td>2.15</td>
<td>2.25</td>
<td>0.20</td>
</tr>
<tr>
<td>Clinka fineBLOK 125 / 250mm</td>
<td>8/1300</td>
<td>4.95</td>
<td>4.95</td>
<td>4.95</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.95</td>
<td>4.95</td>
<td>4.95</td>
<td>0.25</td>
</tr>
</tbody>
</table>

- All values are based on mortar with a strength of 8 N/mm²
- The value of the flexural and shear strengths is for live loads
- Flexural strength f'_{cnx} (bending moment) values rely on perpendicular mortar joints. If not using perp mortar joints adopt f'_{cny} (axial pressure) values.
- Face shell values require the mortar bed to be minimum 2/3 of the block surface (125 fineBLOK & partyBLOK require full face mortar)

### Table 3.1.2 Illustration of the strength parameters

<table>
<thead>
<tr>
<th>Axial Pressure</th>
<th>Bending Moment</th>
<th>Flexural Strength</th>
<th>Shear Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>f'_{cny}</td>
<td>f'_{cnx}</td>
<td>f_{tny}</td>
<td>f_{vnx}</td>
</tr>
<tr>
<td>f_{vnm}</td>
<td></td>
<td></td>
<td>f'_{vnx}</td>
</tr>
</tbody>
</table>

1) the largest bending moment force in a reinforced section occurs at internal corners
3 Material Properties
3.1 General

The basic Materials in ClinkaBLOK’s are lightweight expanded clay and cement. Clinka expanded clay is a porous ceramic material. There are no fumes or aggressive substances and it is completely neutral. The material’s resistance to chemical attack is similar to hard-burnt brick and glass. Internal pore volume of the individual Clinka nuts is 70-75%. The pore system is closed, but the pores can be connected via micro cracks.

Lightweight Clinka aggregate - with cement as a binder - can produce expanded clay aggregate concrete with densities from 400 kg/m³ to up to ~2,300 kg/m³. Block products are manufactured primarily with densities of ~600 to 900 kg/m³, and for special acoustic partyBLOK’s up to 1,300 kg/m³. Different densities are used to create various properties in the blocks, such as load carrying capacity, acoustic or insulation.

3.2 Strength Properties
3.2.1 Compressive Strength

It is important to distinguish between the strength of a block unit and the strength of finished masonry. Block strength refers to the individual block type, while the masonry strength takes into account the masonry mortar quality, and the interaction between block and mortar. Normally the mortar strength is higher than block strength.

Block compressive strength depends on block density. Strength and density are two important variables in the characterization of ClinkaBLOK’s. The blocks are listed with these variables e.g ClinkaBLOK 3/770. These are blocks with characteristic compressive strength of 3 MPa calculated on the gross surface without deduction for any holes in blocks, and with the average density of dry Clinka concrete of 770 kg/m³. The relationship between block strength and net density of Clinka-BLOK are as indicated in the chart in Figure 3.1.

Higher density generally provides higher compressive strength.

Compressive strength is calculated according to EN 2-1/11/ that the relationship between fracture load and surface pressure without deduction for any holes (cores). For ClinkaBLOK 3/770 - compressive strength is measured on whole blocks, calculated on gross surface area, is 3 MPa.

Masonry compressive strength can be determined by standardized test method given in EN 1052-2/21/. Please note that the masonry has different compressive properties in the two directions in masonry plan (fרא and f oxy). The values of characteristic compressive strength of Clinka masonry are calculated according to formulas in NS 3475 is table 3.1.

3.2.2 Tensile strength

Generally the compressive strength is greater than the tensile strength. Normally tensile strength is 1/6 - 1/8 of compressive strength. For blocks with compressive strength 3 MPa, tensile strength is therefore 0.4 to 0.5 MPa.

3.2.3 Flexural Strength

Masonry flexural strength ftx can be determined by standardized test method given in EN 1052-2/21/. Bending tensile strength, in horizontal and vertical direction respectively is set as f rx and f oxy - see Figure 3.2

In the horizontal direction this means bending in the perpendicular joints, while the vertical direction bending strain is on the mortar bed joints. The values of characteristic flexural strength of Clinka masonry (Calculated by the expressions in NS 3475/6/) in the different axis directions are given in Chapter table 3.1.

Flexural strength testing on a single block is normally in the range 0.6 to 1.0N/mm² for a density of 770 kg/m³.

Figure 3.1 Correlation between density & compressive strength
3.2.4 Shear strength
Adhesion strength between the block and mortar can be indicated by their shear strengths determined by standardized test method given in EN 1052-3/22/. Horizontal shear failure in mortar joints and oblique shear failure of brickwork indicated respectively as $f_{vm}$ and $f_{vnm}$ see Figure 3.4. The values of characteristic shear strength of Clinka masonry is specified in Table 3.1.

3.2.5 Adhesion to concrete
Pure tensile testing of adhesive connection between concrete and ClinkaBLOK 3/770 provides failure by tensile strength at about 0.3MPa

3.3 Deformation properties

3.3.1 left intentionally blank

3.3.2 Modulus of Elasticity
The calculation of the deformation capacity of Clinka masonry is regarded as linear elastic. This means that the deformation increases proportionally with tension up to fracture. Proportionality factor is called the materials’ modulus of elasticity and stated in MPa.

Clinka masonry normally has a value of around 2.0. Modulus of elasticity of Clinka masonry work is relatively low, and varies with the amount of load, load direction, the load duration and masonry strength. To reduce any deformation under concentrated strain reinforced and cast U-BLOK courses are used for load distribution. See Section 4.6.3.5.

3.4 Thermal Engineering Properties

3.4.1 Thermal conductivity
A material’s ability to transport heat is expressed as thermal conductivity ($\lambda$).

This value is determined in the test apparatus according to standardized methods. The thermal conductivity (heat conductivity) of Clinka masonry varies with the block’s density, moisture content and joint design. Clinka masonry has higher thermal conductivity than blocks alone.

Calculations of masonry for heat resistance, therefore, are corrected by an allowance for the reduced capacity of the mortar joints. For example, ClinkaBLOK has a density of 770 kg/m$^3$ thermal conductivity: $\lambda = 0.23$ W/ mK. Face-shell mortar joints provide better insulation, i.e lower $\lambda$-value. To achieve the envisaged thermal insulation at least one wall requires a skimcoat of render - except for Clinka Fineblok that has a denser pore structure.

Thermal insulation and the calculation of U-values to Clinka masonry are discussed in Section 4.7.
3.4.2 Specific heat capacity = thermal mass capability

The material’s ability to accumulate or release warmth is expressed by the materials ‘specific heat capacity’ (c). For dry Clinka-BLOK the specific heat capacity:

\[ c = 900 \text{ W}/(\text{kgK}) \]

For moisture content is:

\[ c = 4.180 \text{ Ws}/(\text{kgK}) = 0.9 \text{ kJ/kgK} \]

Clinka masonry has a high heat capacity that has a beneficial impact on both indoor climate and economy as it can be exploited to reduce heating or cooling requirements in the building.

3.5 Moisture Technical properties

The technical properties of a material can be affected by moisture content. The amount of moisture in Clinka-BLOKs can affect: heat insulation, frost resistance, protection against moisture damage. As well as brick, plaster and mortar adhesion and curing. The moisture content of ClinkaBLOK is expressed as a percentage of the weight of dry material. Laying the block with high moisture content can cause problems due to high shrinkage. Because of this it is important to protect blocks stored on site and the completed masonry against increased moisture penetration before it is rendered or otherwise clad. For moisture protection of the Clinka masonry see chapter 4.8.

3.5.1 Porosity

The micro air-sacs within the individual Clinka nuts are referred to as the ‘internal pore volume’ and constitute 70 - 75% of the Clinka units volume. ClinkaBLOK’s also have an external pore system. The cement that binds the individual nuts together is thin and does not fill the cavity between the grains.

In addition, only a low proportion of sand is used in the blocks in order not to fill the pores. This composition achieves a rough and continuous porous surface between light Clinka grains.

The cavity between the grains is called the ‘external pore volume’. The external pore volume depends on the grain size and density. For example, ClinkaBLOK of quality 3/770 have approximately 30% external pore volume. The external pore system is interlocked, meaning that the blocks drain water and also ‘breathe’. This gives valuable properties such as to avoid the cracking effect of frost; and also sound absorption, but requires sealing with render or skim-coat on at least one side for heat and sound insulation, as well as fire wall structures. Without oversurface treatment of exterior Clinka walls - water can easily penetrate the wall.

3.5.2 Suction Ability

ClinkaBLOK’s have very low water suction. This is due to the coarse pore system which provides little opportunity for the capillary transportation of moisture. Based on low suction, both render and mortar have the excellent cure conditions when applied to ClinkaBLOK’s (even for the thin layers of mortar) as little water is transferred to the blocks - this prevents quick drying and increases bond strength. The rough surface of the blocks and cement component of the blocks also provides good adhesion between mortar and block.

3.5.3 Moisture Content

Unlike other masonry products ClinkaBLOK’s freely drain water because the ‘external pore volume’ is consistent throughout the block and there is no capillary suction, this is also helped by the sealed ‘internal pore volume’ of the individual Clinka nuts. This makes the blocks frost resistant. The blocks may hold small amounts moisture because of fines and cement content. Moisture Equilibrium in Clinka structures - which are protected from free water - varies with the relative humidity (RH) in air.

Risk of cracks due to temperature variation is countered by the use of mortar joint reinforcement and movement joints. This is discussed in Sections 4.6.4 and 4.6.5.

3.6 Dimensional Stability

3.6.1 Temperature Movement

Changes in temperature makes all building materials change size. Therefore, it is important to know the relative temperature expansion of materials within a structure to avoid damage due to relative movements.

Clinka masonry is a relatively stable material with low movements due to temperature. ClinkaBLOK masonry has a specific temperature expansion:

\[ \alpha = 8 \times 10^{-6}\text{mm/mmK} \]

\[ (0.008 \text{mm/mK}) \]

Temperature expansion co-efficient is affected by moisture content of masonry, but in the design context the coefficient as mentioned above applies for all moisture conditions.
3.6.2 Shrinkage and swelling

Most building materials change volume when moisture content changes. Higher moisture content gives increased volume (swelling), and when the material dries, the volume decreases (shrinkage).

Shrinkage of Clinka masonry can be divided into capillary shrinkage, chemical shrinkage and drying shrinkage. The biggest practical movement is caused by drying during and immediately after production in the factory. In practice approx. 70% of the shrinkage has occurred in the blocks on leaving the curing chamber.

During storing the shrinkage will continue and by the time blocks are used on site in masonry they will have undergone practically all shrinkage. On subsequent wetting of masonry shrinkage in generally regarded as reversible when the block dries.

Shrinkage of Clinka masonry will primarily depend on the relative humidity of the room in which the brickwork is in. Depending on this, free shrinkage in the exterior walls for ClinkaBLOK of quality 3/770 is in practice between 0.015 - 0.030%.

Shrinkage experiments by standardized testing method shows little difference between the newly cast and matured blocks when testing takes place from submerged (wetted) condition. In laboratory measurements performed at temperature 20 ± 2°C and relative humidity (RH) 43 ± 2% a typical shrinkage curve for ClinkaBLOK of quality 3/770 is shown in the diagram in Figure 3.9.

Shrinkage of masonry is a key reason for cracks of render and plaster. To reduce the risk of cracking, it is important that a wall which will be rendered is allowed to dry out well before finishing. It is recommended to use dry blocks when laying masonry and that the mortar is sufficiently hardened before render is applied. Wetting of masonry because of rain, for example, gives an expected rapid expansion of the brickwork. Drying takes much longer and leads to a much slower contraction than the growth from moisture expansion.

To ensure good drying masonry must be protected from precipitation and other moisture sources before the rendering. Proper use of joint reinforcement reduces harmful shrinkage to a controlled minimum. See Section 4.6.4.
3.7 Acoustic properties

3.7.1 Airborne sound insulation

Because of its relatively high density, coarse pore system and low-modulus, solid walls of Clinka-BLOK have very good acoustic insulation properties. To achieve the best airborne sound insulation walls must be tightly abutting adjacent structures.

Because of its open pore structure unfinished, raw Clinka walls provide modest airborne sound insulation. It is therefore necessary that the wall be finished with plaster or render on at least one surface. The best results are achieved with full mortar joints in both the perpendicular and face joints and plaster/render on both sides.

Terminations to adjacent walls, roofs or other structures must be completely sealed to prevent airborne sound penetration. Connection details to adjoining structures is crucial for good sound insulation solutions, and should be addressed at an early stage of a project.

For high acoustic attenuation requirements use Clinka Party-BLOK - it is specially made for this purpose. See also Chapter 5 that discusses, among other things, engineering of Clinka party walls.

3.7.2 Sound absorption

The structure of unfinished Clinka masonry gives a relatively high sound absorption. Absorption factor $\alpha$ is a measure of a material's sound absorption ability and defines the relationship between the sound energy absorbed by a surface and the total incident sound energy hitting the surface. Sound absorption depends on the construction solution and frequency range. Absorption factor $\alpha$ is relatively constant over the entire frequency and is equal to $\sim 0.4$. See Table 5.6.

Surface treatment with paint - by either spray, roller or brush - has little effect on the absorption when the surface pores are not filled by the applied paintwork. Use of a pore-sealant such render will mean the absorption capacity will be considerably reduced. While providing good attenuation, Clinka PartyBLOK has a tight structure and therefore provides little sound absorption.

Interior walls of Clinka blocks are often used as absorbent surface to lower the reverberation time (the time it takes from when a sound source is interrupted and the average sound level decreased by 60 dB). In practice, this means the elapsed time from when a sound is suddenly stopped and until it is not audible. Calculation of the reverberation time is shown in chapter 5.6.3.

3.8 Fire properties

Because of its porous structure and relatively low thermal conductivity, ClinkaBLOK masonry has excellent fire resistance and fire protective properties. As, the loose Clinka components in the block is a ceramic material that has already been burned at temperatures around 1100°C, these do not undergo any significant change in a fire.

Conversely, the cement will deteriorate into the blocks in step with the temperature increase. Cement disintegrates at approx. 570°C. Because of the Clinka nuts' heat insulating ability, this process is considerably slower than in normal concrete. i.e Clinka masonry is more fire resistant than concrete construction.

In a ‘normal’ fire event strength reduction will rarely go further into the block than 15 - 25 mm. Clinka masonry therefore maintains much of its carrying capacity during and after a fire, and in most cases is easily rehabilitated after the fire event, except perhaps for any odor problems.

To achieve the stated fire resistance ClinkaBLOK masonry must be rendered at least one face. Clinka FineBLOK can, however, (because of its tight pore structure) be either left untreated both sides provided that you have mortar in both horizontal and vertical joints. Clinka IsoBLOK requires rendering/plaster on both sides, minimum thickness 4 mm.

In the assessment of load-bearing capacity after a fire, several factors are taken into consideration, for example: reduced block and mortar strength, tears and cracks, spalling of plaster, etc. This is further described in chapter 6 that discusses the design of Clinka fire partitions.
4 Project Planning and execution of Clinka masonry

4.1 General

Design of Clinka structures should be done in accordance with the relevant Australian Standards, Building Code of Australia (BCA) and local building codes. The design shall, in addition to the structural design, also include the design with regard to fire safety, acoustics, energy and moisture protection.

This chapter provides general guidance for planning and practical execution of Clinka masonry, such as: masonry reinforcement, damp-proofing, etc. Furthermore, Section 5 discusses a number of important technical details, while Chapter 6 reviews the design of Clinka fire partitions. Dimensioning and calculation of Clinka masonry is described in Chapter 7.

Clinka masonry products are tested to the European equivalent of AS/NZS 4456, Masonry units and segmental pavers and flags Series.

Refer also to:

AS 3700-2001
Masonry structures

AS/NZS 2699.3:2002
Built-in components for masonry construction – Lintels and shelf angles (durability requirements).

Durability levels for mortars are described in AS 3700-2001 and AS 4773.1-2010

4.2 Control and responsibility

Planning and building legislation provide a clear definition of responsibilities and requirements for building design and documentation. Responsible designers must ensure that the project is in accordance with the BCA, Australian Standards, and local Regulations.

4.3 Tolerances

In addition to appropriate Australian Standard, the tolerance should be selected to be consistent with similar requirements for adjacent structural components. For certain masonry structures the tolerance should correspond with adjacent structural components, eg. beams, wall sections, trusses, etc. For thin fine plaster treatments, it must be consistent with the tolerance requirement masonry and plaster.
4.3 Tolerances

The following requirements for tolerances predict the quality of the finished product.

- Generally accepted construction site deviation of ± 15 mm. This means that all the targeted dimensions and distances should be within this requirement unless otherwise stated.

- Permissible deviation in thickness:
  - Single wall (a string) is the largest of ± 5 mm and ± 5% of wall thickness
  - Double wall (two strings) is ± 10 mm.
4.4 Environmental Stress

As with concrete structures, brick walls shall be designed in accordance with expected environmental stresses. Environmental stresses in this regard refer to the chemical and physical stresses on the structure and each constituent materials in the construction. Chemical stress may be due to the building’s use, aggressive environment etc, and physical stresses may be due to abrasion, and water ingress. Masonry constituent materials and accessories; ie render products, mortars, anchoring products, etc. shall have adequate durability to withstand the local environment stresses of the building’s expected life.

4.4.1 Protection of reinforcement

One must consider in each case how aggressive the environment is where the building is sited. Following requirements for corrosion protection of reinforcement:

- Reinforcement shall be corrosion resistant, or protected against corrosion due to environmental stresses.
- Requirements for the reinforcement and minimum protection of reinforcement should be used for the brickwork in the different exposure areas. The available reinforcing types are: untreated steel, surface-treated steel, stainless steel.
- When coated reinforcing steel is used, galvanising should re-coated after it is bent.
4.5 Requirements for materials

All materials used for Clinka masonry structures shall meet requirements of the relevant Australian Standards, and the requirements of the Building Code of Australia.

A wall is assembled from Clinka-BLOK, mortar and reinforcement, and any reinforcing and U-BLOK courses, with any movement joints, etc as required.

AS3700 & AS4456 give the most common materials of masonry and the demands they should satisfy. It requires, among other things, that:

- Concrete and lightweight concrete masonry (Clinka BLOK) must satisfy requirements of AS3700. & AS4773.2

- Factory made mortar and render shall meet the requirements of Part 14.8.1 Weather Resistant Coatings of AS 4773.1-2010 : Masonry in small buildings - Design. Any additives should used only after further consultation with the supplier.

- Materials that may be subject to corrosion must be protected.

- Joint reinforcement, reinforcing steel and masonry supplies shall meet the requirements to exposure category.

- Joint reinforcement shall meet requirements of AS3700.

- ClinkaFootingBLOK and Clinka U-BLOK reinforcing should be of stainless steel or other materials with similar strength and durability. Cross bars of steel should have a diameter of at least 4 mm unless otherwise noted.

- Render and other cladding types used over Clinka masonry work should be carried out using materials that can withstand the range of mechanical and climatic strains to which the building will be exposed.

- Movement joints should satisfy the requirements of AS4773.1 / NCC.

- Insulation materials shall meet requirements in AS4859.1 Insulation materials included in the exterior masonry shall be moisture resistant and water resistant, and have appropriate stiffness to resist the loads which they are subjected

- Timber attached externally to Clinka masonry that is subject to weathering, e.g cladding and battens should be of a class suitable to the exposure
4.6 Detailed design of Clinka masonry

4.6.1 Dimensions
Most ClinkaBLOK types have a nominal block height of 250 mm. Normal joint thickness is 8 - 12 mm, and it is assumed that the course heights are nominal joint thickness of 10 mm. This means that in the most cases target course height is 260 mm. The length of most ClinkaBLOK’s is 500 mm, adding 10 mm perpendicular joints, the module is 510 mm.

For Clinka Fineblokk 125mm thick the block height is 190 mm resulting in a course height of 200 mm. In the longitudinal direction the block is 490mm (500mm module with perpendicular joints).

For Clinka partyBLOK the block heights are either 250 or 175 mm depending on the selected wall thickness. This gives a course height respectively 260 and 185 mm. Length of module with perp. joints is the 260 mm.

While ClinkaBLOK are easy to customize. It is advantageous to take account of the standard formats, especially for height measurements. If seeking maximum material utilization a modular layout of blocks should be overlaid on elevations of all walls so that windows and doorways and floor heights matche the block modularity.

To achieve the desired levels, a course of 100 or 75 ClinkaBLOK laid on their side, see Figure 4.3. can modify modular height. Clinka blocks with cutouts (i.e standard blocks over 100mm thick) should not be laid on their side, as this can result in reduced loadbearing capacity. Adaptation of the module in the the longitudinal direction is performed simply by cutting with axe, Clinka Guillotine, angle grinder or by hand with a special Alligatorsaw.

Dimensions for all ClinkaBLOK products are shown in chapter 2.2, table 2.1.

4.6.2 Survey design and footings for walls
Footings for ClinkaBLOK masonry should be designed per AS2870 and should have at least the same resistance as for ‘articulated masonry veneer’ construction. If the site is Class ‘A’ or ‘S’ then the Clinka footingBLOK system (330 wide filled with reinforced concrete) can be used under exterior walls and loadbearing inner walls. Clinka footingBLOK can also be used on modified sites where the reactive soil is replaced locally with suitably compacted Fine Crushed Rock or bulk ClinkaFILL (subject to structural/geotechnical engineers approval).

To ensure stability the footingBLOK’s are placed on a continuous bed of moist 20MPa concrete. The groove in the footingBLOK is then cast with 20MPa concrete and reinforced with U-BLOK reinforcement in the middle of the cast concrete. When splicing of the reinforcement in the longitudinal direction, overlap at least 300 mm.

Figure 4.2 Clinka BLOK 10 mm course spacing

Figure 4.3 Example Clinka masonry wall with adaptation courses to create required height

Figure 4.4 Section through external ISOBLOK wall on ClinkaFOOTINGBLOK with infill slab on loose ClinkaFILL
For higher loads or in unstable soil, e.g. soft clay, the footing is dimensioned as per AS2870 or to a structural engineers design. In such case, a concrete strip footing or rebated edge reinforced concrete slab-on-ground is used. Appropriate slip-joints of thin plate acid-resistant, stainless or corrosion protected steel or 2 layers of suitable plastic film.

For Clinka isoBLOK walls, both side panels of each block should be supported by the footing or block below. The wall loads should never be only on one side panel of the isoBLOK. Inadequate support under the wall gives shear stress to the EPS foam insulation core of the block, even if one panel is not significantly overloaded. Self-load of one side panel of Clinka wall can be high enough to cause fracturing of the wall. Walls that have less thickness than Clinka IsoBLOK for example can be laid adjacent to a supporting structure see Figure 4.6.

### 4.6.3 Masonry of Clinka-BLOK

#### 4.6.3.1 Mortar for masonry
Clinka recommends masonry mortar of characteristic compressive strength $f_{cm}=8 \text{N/mm}^2$. Clinka can supply pre-mixed mortar in bags. It need only be mixed with water to be ready to use. Alternatively sand/cement mortar of ratio 4:1 will supply appropriate properties (confirm with your structural engineer).

#### 4.6.3.2 General masonry
Clinka masonry is laid with standard brick bond (½ overlap of blocks in the adjacent courses). The blocks shall be laid so as to ensure a good interaction between block and mortar. The blocks are tapped gently into place with a mallet or axe, but they should never be dislodged by tapping if they have sucked up some of the mortar’s water and the mortar has begun to harden. If they are dislodged or moved in this way then they should be relaid with new mortar. ClinkaBLOK’s draw little water out of the mortar. Therefore the mortar binds relatively slowly and will achieve high strength. This should be taken into consideration during laying, especially for thin walls. A quick bricking up too many courses high can cause the wall to move. When constructing in a windy location, temporary propping should be used when laying more than a few courses at a time.
Standard ClinkaBLOK (with hole cutouts) should be laid so that the sealed end of the holes is facing up. This avoids mortar falling down in the hole channels.

Clinka masonry walls should be finished (rendered) on at least one side. For masonry walls with render on one side and the application of a thin plaster treatment on the other hand, it is recommended that before the plaster is applied, any poorly filled gaps or holes are packed with mortar.

In load-bearing masonry to be rendered the mortar joints should be flush struck with the outside face on both sides and finished with a joint tool. Finished joint surface should not be deeper than 3 mm in from the block face unless this is specifically stated. Any grouting of the outside masonry shall be carried out simultaneously with the laying of masonry mortar. Grouting shall be performed in a manner and with such a tool that you get a minimum of mortar spills and good compression of mortar joint.

To increase speed of mortaring a Clinka Mortar Box can be supplied that will spread mortar in correct thickness of two parallel beds - Mortar Box’s are available for most block dimensions.

4.6.3.3 Ring-beam for Clinka walls

Clinka load bearing walls should always be terminated with a ringbeam on the top with a reinforced U-BLOK ring-beam course that ties the brickwork together. The ring-beam spreads loads and increases strength of upper wall. In corners one “leg” of U-BLOK is cut to create a continuous U-slot. U-BLOK reinforced with Clinka U-BLOK reinforcement, see Section 4.7. The U-slot is filled with 20MPa concrete and leveled on top.

Non-bearing walls do not need Clinka U-BLOK beam on top, but should be anchored to the overlying floors / ceiling effectively as necessary. See Section 4.6.6.4.

External U-BLOK courses should be insulated with the supplied insulation strip of polystyrene that is cast into with the grout.
4.6.3.4 Transitions between adjacent walls
For interior walls to be connected with adjacent walls: the joint should be staggered or anchored in some way to provide connection between walls. Where an extension to a building employs Clinka masonry it may be appropriate to anchor the new wall to the existing wall. Reinforcing steel (e.g. Ø6mm or Ø8mm) is drilled into the existing wall, and added into the mortar joints in the Clinka wall see Figure 4.9. These reinforcing rods should be used in every 2nd course and overlap the standard Clinka Joint Reinforcement / Bricktor. If there is a risk of differential movement between the adjacent walls, this must be taken into account in the design of foundations - or the walls kept separate with a movement control (construction) joint.

4.6.3.5 Concentrated loads
Clinka masonry has a relatively low modulus. Therefore, concentrated load should be absorbed and distributed so that the brickwork is not exposed to hazardous point loads. A grouted and reinforced U-BLOK course or Clinka lintelBEAM can be used, possibly in combination with load distribution plate of steel. Under a U-BLOK course or Clinka lintelBEAM there must always be joint reinforcement for a metre to each side of the load point. Calculation of capacity at the concentrated loads are discussed in Chapter 7.3.3.

If the point load is too large, one can strengthen the wall locally with a reinforced and grout-filled column Clinka constructionBLOK. This is possible as long as the blocks are laid allowing the cut-outs to form continuous vertical cores. For 250 mm thick masonry this can be done with Clinka constructionBLOK combined with ordinary ClinkBLOK, see Figure 4.11. Very large point loads may be absorbed by brick piers of Clinka ConstructionBLOK that are reinforced and grouted. Dimensions, reinforcement quantity, etc. must be calculated in each case - see chapter 7.3.

A column can also be formed by laying U-BLOK’s on edge and filled with reinforced concrete or used to encase a steel column.
4.6.4 Reinforcement of Clinka masonry
The following reinforcement variants are used on Clinka masonry:

- Clinka U-BLOK reinforcing
- Clinka Joint Reinforcement
- Clinka zigzag-reinforcement
- Clinka Thin Joint Reinforcement

4.6.4.1 Clinka U-BLOK reinforcing
Clinka U-BLOK reinforcing has characteristic yield strength $f_{sk} = 500 \text{ N/mm}^2$. The steel is cold rolled with ribs. The supplied length of a reinforcing ladder is 4m. Dimensions and technical data are shown in Figure 4.14.

Clinka U-BLOK reinforcing is used for reinforcement of the U-BLOK courses and Clinka footingBLOK. Clinka load bearing walls are always finished on top with a 20MPa grouted and reinforced U-BLOK course. Reinforcement is bent around corners and joined with at least 300 mm overlaps.

When a U-BLOK beam is used to support a perpendicular beam over an opening, the amount of reinforcing required is determined by the load from the beam and the shear force. This are described in chapter 7.6. For grouting of U-BLOK use 20MPa concrete or supplied premix bags from Clinka. Open spans of U-BLOK beams are temporarily supported so that the concrete will harden sufficiently before being loaded.

4.6.4.2 Clinka Joint Reinforcement
Clinka masonry is a cementitious material that will be exposed to temperature movements, as well as shrinkage and swelling, depending on the moisture level in the material. To counteract the harmful movement during curing and moisture-and-temperature dependent length changes, the Clinka masonry is reinforced horizontally with Clinka Joint Reinforcement. In addition, the reinforcement is used constructively for dispersing of horizontal loads, see Chapter 7.4.3.

Clinka Joint reinforcement has characteristic yield strength $f_{sk} = 680 \text{ N/mm}^2$. The supplied length of a reinforcing ladder is 4m. Dimensions and technical data is shown in Figure 4.16.

Movement and reinforcement of masonry are described in AS & NCC, but we recommend Clinka masonry is reinforced at least every 2nd course with joint reinforcement (Bricktor as minimum standard for cracking control and Clinka Joint Reinforcement for greater horizontal loads) regardless of wall type. Long walls should also be divided on the practical way with vertical movement joints, as per AS 4773.1-2010 Masonry in small buildings - Design.

Clinka Joint reinforcement shall be completely encased in the mortar so that it interacts with brickwork. For high horizontal load masonry mortar reinforcement can be used in each course. Walls with greater than 150 mm thickness shall always have two reinforcement runs in the reinforced joints (Double-reinforcement).

According to EN 3475 the distance between the reinforcement should be at least 20 mm. For wall thickness of 150 mm or less use simple central reinforcement only.

**Technical Data**

- longitudinal rod: 2 X 7mm diam.
- connecting rod: 5mm diam. at 150mm cts.
- longitudinal cross section $A_s = 2 \times 38.5 = 77 \text{mm}^2$
- characteristic strength $f_{sk} = 500 \text{ N/mm}^2$

![Figure 4.13 reinforcement of Clinka masonry](image)

![Figure 4.15 Insulated and reinforced Clinka U-BLOK course prior to grouting](image)

![Figure 4.14 Clinka U-BLOK reinforcing](image)
Reinforcement shall be fully embedded in the mortar and have a minimum of 15mm of cover.

Clinka Joint Reinforcement is always used in the first course at the base of a wall, and for 1.0m each side of any opening. For large openings, it is important that joint reinforcement placed correctly, see Figure 4.17.

At corners, cut the innermost rod of joint reinforcement and then bend reinforcement around the corner so that the outer rod is continuous.

When laying the next reinforcement - allow at least 300 mm overlap. Joints should be placed in known locations of least cracking in the structure. Distance between the centers of the overlaps should be at least 1 m. In the joints with double reinforcement the distance between the reinforcing overlaps should be at least 1 m. See Figure 4.19.

Technical Data
longitudinal rod: 2 X 4mm diam.
connecting rod: 3x4mm diam. at 95mm ctrs.
longitudinal cross section As = 2 x 12.5 = 25mm²
characteristic strength fₕ = 690 N/mm²

Figure 4.16 Clinka Joint Reinforcing

Figure 4.17 Horizontal Reinforcing in crack prone areas

Figure 4.18 Clinka Joint Reinforcement around a corner

Figure 4.19 Joining Clinka Joint Reinforcement in walls
4.6.4.3 Clinka zigzag reinforcement

Foundations of Clinka IsoBLOK 30 cm underground are reinforced with Clinka Zigzag reinforcement at least every 2 courses to ensure structural connection between the panels across the EPS insulation.

Clinka zigzag-reinforcement is a truss reinforcement with characteristic yield strength \( f_{yk} = 500 \text{ N/mm}^2 \). The surface is hot galvanized with at least 8 micron zinc coating and coated with at least 80 microns epoxy. Objectives and technical data are shown in Figure 4.20.

Overlap at least 300 mm at joints and around corners cut the reinforcement and bend as shown in Figure 4.21.

4.6.4.4 Clinka Thin Joint Reinforcement

Clinka Thin Joint Reinforcement is a truss reinforcement produced with a rectangular steel wire intended for masonry with thin joints. Used for interior walls of standard ClinkaBLOK and Clinka FineBLOK, with wall thickness 125, 150, 200 and 250 mm. There are three types of reinforcement: 90 mm, 140 mm and 190 mm.
4.7.2 Calculation of U-values

U-value coefficient \((W / m^2 K)\) is a standardized measure of how easily a building component heat passes through the material. The U-value indicates how much heating units, measured in watts \((W)\), can flow through a 1 m\(^2\) area at a constant temperature difference of 1K \((1°C)\) between the surroundings hot and cold side of the structure. A well insulated building has a low U-value.

U-value for a structure is either measured in the laboratory, simulated by using well-known heat flow program or calculated according to EN ISO 6946 Building components and elements - Thermal resistance Calculation 31. The U-value is dependent on the heat resistance of the building component \((R)\) and by heat transferance resistance - interior and exterior \((Rsi \text{ and } Rse)\).

U-value is then given by the formula:

\[
U = \frac{1}{R + Rsi + Rse + \Delta U}
\]

where \(\Delta U\) is possibly also due to the design, construction, etc.

The thermal resistance \((R)\) \((m\,K / W)\) to a building component tells how much it provides resistance to heat through time. The thermal resistance depends on thermal conductivity \((\lambda\text{-value})\) and thickness of the products of building component consists \((d)\), ie that for homogeneous materials layer is:

\[
R = \frac{d}{\lambda}.
\]

Typically, building components built up both of homogeneous layers and layers of that are composed of several materials. In a wall of Clinka IsoBLOK the inside and exterior render are homogeneous layers, while Clinka lightweight concrete and, polyurethane insulation, masonry mortar joints and possibly U-block courses form a composite layer. In such constructions the heat will not just flow right through (One-dimensional heat flow), but also lateral (two-or three-dimensional heat power). It is therefore difficult to make accurate calculations of thermal resistance for such structures without using special computer programs for multi-dimensional heat flow.

Thermal Conductivity \((\lambda\text{-value}, W / mK)\) is a material property that describes the ability a material has to conduct heat. Practical thermal conductivity for Clinka lightweight concrete in various applications can be considered for Table 4.5. Moisture content is in accordance with National Annex to EN ISO 10456/32/. Basic Values (dry values) are documented on our own Clinka lightweight concrete, and can be lower (better) than the corresponding values for light clinker contained in general reference works.

Heat transfer resistance (interior \(Rsi\) and exterior \(Rse\)) is an expression of the heat transfer resistance at the meeting respectively of the inner and outer surface \((m\,K / W)\).

<table>
<thead>
<tr>
<th>Clinka density light clinker concrete ([Kg / m^3])</th>
<th>The base value of (\lambda) ([W / mK])</th>
<th>(\lambda) - value Modified by moisture content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Interior</td>
<td>Exterior above ground</td>
</tr>
<tr>
<td>600</td>
<td>0.155</td>
<td>0.164</td>
</tr>
<tr>
<td>650</td>
<td>0.168</td>
<td>0.177</td>
</tr>
<tr>
<td>770</td>
<td>0.204</td>
<td>0.215</td>
</tr>
<tr>
<td>900</td>
<td>0.251</td>
<td>0.265</td>
</tr>
<tr>
<td>1300</td>
<td>0.476</td>
<td>0.502</td>
</tr>
</tbody>
</table>

Table 4.5 Thermal conductivity \((\lambda\text{-value})\) to Clinka light clinker concrete
Table 4.6 U-values for external walls of clinkaBLOK

<table>
<thead>
<tr>
<th>Masonry wall</th>
<th>Sketch</th>
<th>U-value $^1$ [W/m2K]</th>
<th>Masonry wall</th>
<th>Sketch</th>
<th>U-value $^1$ [W/m2K]</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 clinka-BLOK (2/650)</td>
<td><img src="image1" alt="Sketch" /></td>
<td>0.065</td>
<td>clinka 300 isoBLOK (4/900)</td>
<td><img src="image2" alt="Sketch" /></td>
<td>0.22 $^2$</td>
</tr>
<tr>
<td>250 clinka-BLOK (2/650)</td>
<td><img src="image3" alt="Sketch" /></td>
<td>0.78</td>
<td>clinka 250 isoBLOK (4/900)</td>
<td><img src="image4" alt="Sketch" /></td>
<td>0.29 $^2$</td>
</tr>
<tr>
<td>250 clinka-BLOK + 100mm insulation</td>
<td><img src="image5" alt="Sketch" /></td>
<td>0.25 $^3$</td>
<td>clinka 250 isoBLOK (4/900) + 50mm insulation</td>
<td><img src="image6" alt="Sketch" /></td>
<td>0.21 $^2,3$</td>
</tr>
</tbody>
</table>

1) U-values specified for wall panels with 10 courses incl. one U-block course (10% of the wall area). It is assumed standard masonry bond without mortar perp. joints with clinka mortar. Grouting of U-block course performed with 20 MPaConcrete. The wall is sealed on both sides or (if not sealed then mortar is used in perp joints).
2) Assumes the use of clinka supplied insulation strips of 90 mm in the bed joints between the face shell mortar.
3) Assumes mineral wool insulation, timber studs at 600 mm cts, vapour barrier and 13 mm plasterboard.
section through timber framed
floor fixed to clinka ISOBLOK wall
Retaining wall up to 2.4m high spans horizontally between perpendicular supports (stainless steel clinka 2-track joint reinforcing required)

Suggested detail - footings/size/fixings will depend on site classification/wind loading/project parameters; please consult with your structural engineer or relevant building surveyor.

www.clinka.com.au for more information
* render stopping bead used in the transition between acrylic render and sand/cement (-150 - 200mm above ground level).

**OPTIONAL:** insulated clinka U-BLOK used as horiz. services core, place in conduit & fill with 20MPa conc. & U-BLOK reinforcing.

- Flexible acrylic render to AS4773.2 Part 11.7.1
- Joint reinforcing - every second course
- Optional joint - insulation for max thermal performance (rockwool or similar)
- 3.1 sand/cement render
- Plastic drain matting
- Soil
- Geotextile
- Free draining backfill
- Ag. drain
- Geotextile
- Internal wall finish - render, paint or direct fix plaster
- Clinka ISOBLOK 250 or 300mm
- Kordon termite fabric as required
- Levelling screed
- Reinforced conc. infill slab
- Vapor barrier
- Clinka 10-20 bulk fill
- ClinkaFOOTINGBLOK with U-BLOK reinforcement
- ClinkaFOOTINGBLOK with U-BLOK reinforcement

---

**section through external isoBLOK wall on clinkaFOOTINGBLOK with infill slab on loose clinkaFILL**

Suggested detail - footings/size/fixings will depend on soil classification/wind loading/project parameters, please confirm with your structural engineer or relevant building surveyor.

www.clinka.com.au for more information
section: clinkaPANEL support on external isoBLOK wall

suggested detail - footings/sizes/fixtures will depend on soil classification/wind loading/project parameters; please confirm with your structural engineer or relevant building surveyor.

www.clinka.com.au for more information
*Design of roof anchor is dependent on fixing type and local wind loads

timber framed roof on
clinka ISOBLOK external walls
window: fixed with screws in reveal

NB: render reveals prior to installing window
### Technical Data

- **Logitudinal rod:** 2 × 7mm diam.
- **Connecting rod:** 5mm diam. at 150mm ctrs.
- Longitudinal course section: $A_s = 2 \times 38.5 = 77 \text{mm}^2$
- **Characteristic strength $f_{ck} = 500 \text{ N/mm}^2$**

### Clinka U-BLOK reinforcing methods

**A** - Clinka U-BLOK with steel reinforcing

**B** - Clinka U-BLOK with steel beam reinforcing

**C** - Clinka U-BLOK with steel reinforcing

**D** - Example of discontinued ring beam

---

**Table 1 - Clinka U-BLOK 250 and 300 - the necessary amount of reinforcement**

<table>
<thead>
<tr>
<th>Aperture in metres</th>
<th>Length reinforcement Exceeds</th>
<th>Number of U-BLOK courses (breaking load)</th>
<th>10 kN / m</th>
<th>20 kN / m</th>
<th>30 kN / m</th>
<th>40 kN / m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clinka Iso 250</td>
<td>Clinka Iso 300</td>
<td>Clinka Iso 250</td>
<td>Clinka Iso 300</td>
<td>Clinka Iso 250</td>
<td>Clinka Iso 300</td>
</tr>
<tr>
<td>0.75</td>
<td>1.25</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>1.5</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>1.25</td>
<td>1.75</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>1.5</td>
<td>2.0</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>1.75</td>
<td>2.25</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>DU</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>2.5</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>DU / St</td>
<td>DU / St</td>
</tr>
<tr>
<td>2.25</td>
<td>2.75</td>
<td>3</td>
<td>3</td>
<td>DU</td>
<td>DU / St</td>
<td>DU / St</td>
</tr>
<tr>
<td>2.5</td>
<td>3.0</td>
<td>3</td>
<td>3</td>
<td>DU</td>
<td>DU / St</td>
<td>DU / St</td>
</tr>
<tr>
<td>2.75</td>
<td>3.25</td>
<td>3</td>
<td>3</td>
<td>DU / St</td>
<td>DU / St</td>
<td></td>
</tr>
</tbody>
</table>

DU (double U-BLOK) (C) indicates two courses of Clinka U-BLOK with full mortar joints and reinforced with 3 ladders of Clinka reinforcing in each U-BLOK course (see below).

St (steel beam) (B) Alternative solution with embedded steel beam in the U-BLOK instead of reinforcement. This will be in the U-BLOK track and embedded with concrete.

**Clinka U-BLOK reinforcing**

(equivalent may be substituted with project engineers certification)