

CM05 Breeze Block Manual



ARCH
BY UNIQUE

CMAA 



Photography by Brock Beasley

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Introduction

Decorative breeze blocks, distinct from traditional concrete masonry units, are characterised by their open patterns and geometric designs. These blocks are used to create visually striking walls, partitions and façades that combine privacy with natural light and ventilation. Their unique patterns make them an ideal choice for both residential and commercial applications, where style and functionality converge.

The purpose of this manual is to provide an in-depth exploration of decorative breeze blocks. It covers key topics such as material properties, design considerations, installation techniques and maintenance practices. This manual is designed to equip architects, engineers, builders and designers with the knowledge and skills necessary to effectively incorporate breeze blocks into any project, enhancing both aesthetics and utility.

It is recommended that construction undertaken using breeze blocks is done so through a structural engineer or experienced block layer and/or licensed contractor familiar with the product. Restrictions apply for non-loadbearing concrete masonry walls, so relevant codes and permits should be attained before construction. As breeze blocks are not explicitly included in AS 3700 *Masonry Structures*¹, additional design considerations (included in this manual) must be made. The manufacturer may be able to assist in specific state or territory requirements when using their products.

Due to the high porosity of breeze blocks, their compressive strength is significantly less than that of traditional concrete masonry units. It is for this reason that they should not be used in structural applications such as in loadbearing walls.

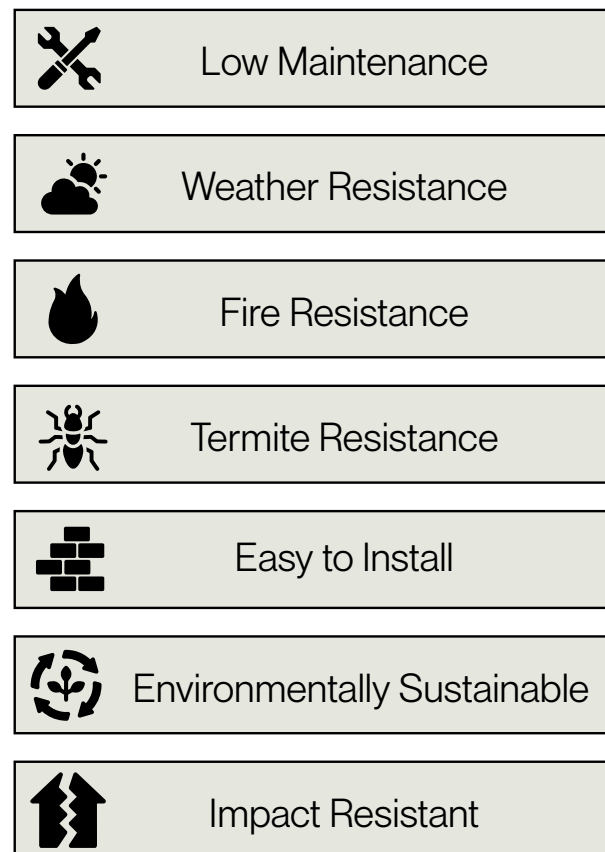


Figure 1: Benefits of Breeze Block Walls

History



Breeze blocks have played an enduring role in Australian architecture. They first emerged in the mid-20th century when they gained global popularity as a versatile building material. After being introduced into Australia during the post-war period, particularly in the 1950s and 1960s, they became iconic elements of modernist and mid-century architectural designs². Their distinctive geometric patterns allowed for unique façades that provided privacy and ventilation while allowing natural light to filter through. Australian architects widely embraced breeze blocks for their aesthetic appeal and functional benefits, incorporating them into residential homes, commercial buildings, and public spaces.

Eventually, as architectural styles evolved later in the 20th century, breeze blocks gradually fell out of favour. However, a resurgence in contemporary Australian architecture in the early 21st century renewed interest in breeze blocks, which can be attributed to a growing appreciation for mid-century modern design and a desire to incorporate retro elements into modern spaces. The rediscovery of the unique charm and versatility of breeze blocks has reintroduced them into contemporary projects where they are combined with other materials to create visually striking façades.

In residential architecture, breeze blocks are now being used to craft stylish privacy screens, decorative partitions, and sunshades, adorning outdoor areas, balconies and interiors. Their open patterns create dynamic visual effects through the play of light and shadows, adding depth and interest to modern living spaces. Commercial buildings and public spaces are also embracing the comeback of breeze blocks, utilising them to craft visually appealing façades that draw attention and establish unique identities. Restaurants, cafés, and retail spaces use them to enhance their architectural appeal, while public parks and urban landscapes incorporate them as decorative elements in sculptural installations or functional seating arrangements.

This resurgence reflects a broader trend of blending the old with the new, merging contemporary aesthetics with elements of the past. It demonstrates the timeless appeal of breeze blocks and their ability to infuse spaces with nostalgia while embracing modern design sensibilities. As architects and designers continue to explore the creative possibilities offered by breeze blocks, these iconic building elements are poised to shape and enrich the architectural landscape of Australia well into the future.

The history of patterned concrete blocks can be traced back to innovations by architects like Frank Lloyd Wright, who developed a precast concrete “textile block” system inspired by Mayan temple ornamentation. While Wright’s designs were more like wall systems, breeze blocks in Australia and elsewhere serve as sun baffles, providing shade and ventilation in various architectural applications.

The renewed popularity of breeze blocks can be seen in recent architectural projects such as Sunday by Architecture architecture that uses Austral Masonry’s GB Breeze Blocks to demarcate the various zones of the house while enabling natural light, quality airflow and glimpse views to enliven all the living areas, and Garden Tower by Studio Bright where sunlight filters in while outward views are glimpsed through the myriad holes of the block pattern. Both projects received high commendations in the 2023 Think Brick Awards.

The resurgence of breeze blocks coincides with a broader revival of postwar design, particularly the mid-century modern movement, which has spread beyond furniture and houses to include materials³. This highlights the unique qualities of breeze blocks, such as their durability, patterned design, and ability to create permeable, aesthetically pleasing walls that offer privacy, security, and sun shading.

The renewed interest in breeze blocks is part of a larger movement in contemporary architecture that explores surface and material ornamentation. The return of the breeze block underscores a growing appreciation for pattern, geometry, and adornment, enriching the architectural landscape and reaffirming the value of ornamentation in modern design. Thus, the breeze block has been redeemed, continuing to inspire architects and designers in Australia and beyond.

Breeze Block Products

3

3.1 Shapes & Sizes

There are two main shape types of breeze block products which are the rectangular and square (or 'cubic') blocks. These come in standard thicknesses of 90 mm and 140 mm, with some deviations and exceptions depending on the manufacturer. Height and length dimensions for these products may vary, but typically the rectangular breeze blocks are 390 mm x 190 mm, and the square breeze blocks are 290 mm x 290 mm.

Some examples of breeze block shapes and sizes available in Australia are shown in Figure 2. Standard concrete blocks may also be laid on their side to create a 190 mm thick concrete breeze block wall.

While there is not much flexibility with orientation and pattern for square breeze blocks due to their biaxial dimensional symmetry (and often similarly in patterns), rectangular breeze blocks may be placed horizontally or vertically depending on the desired wall finish. These orientations may be arranged to create more unique and interesting designs as seen in Figure 3.

Stack bonded masonry with bed joint reinforcement is restricted to be no more than 5 metres in length and must be constrained and fixed on both sides by an adequate structural member such as a concrete, masonry or steel columns. Anything exceeding this should have an expansion joint and so will require support regardless. The capacity of supporting members adjacent to the breeze block wall (as well as the connection details or walls greater than 5 m long) should be designed or checked by a qualified structural engineer.

3.2 Material Properties

All products are well suited for external and internal applications as non-structural elements. Due to the composition, orientation and core shape of the blocks they are not suitable for carrying structural loads.

It is important to consider the material properties of breeze blocks prior to their use. Key properties include:

- Durability class
- Core volume (%)
- Dimensions (length, height and width)
- Minimum shell thickness
- Unit Weight
- Characteristic compressive strength (f'_{uc})
- Characteristic flexural tensile strength (f'_{mt})
- Characteristic lateral modulus of rupture (f'_{ut})
- Critical failure plane

These properties are specific to the material and design of each breeze block product. These values should be provided by the manufacturer.

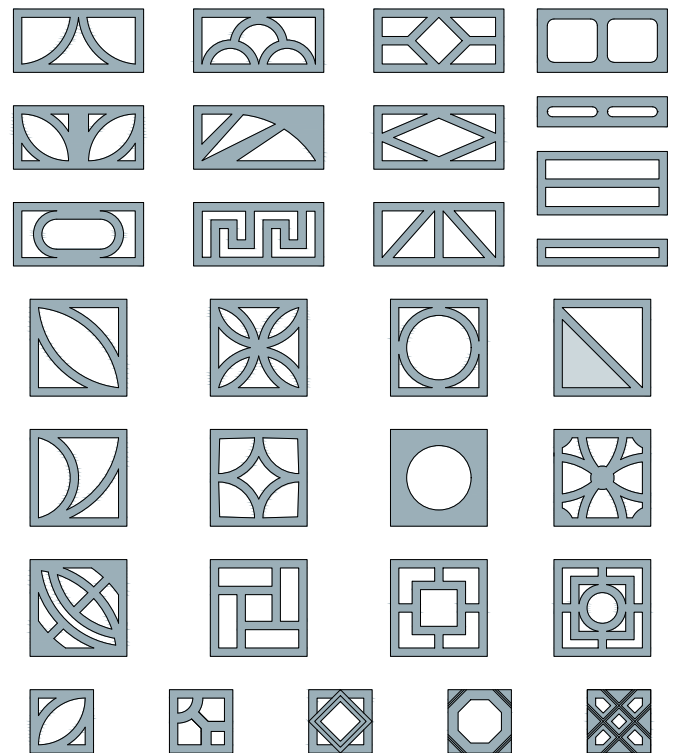
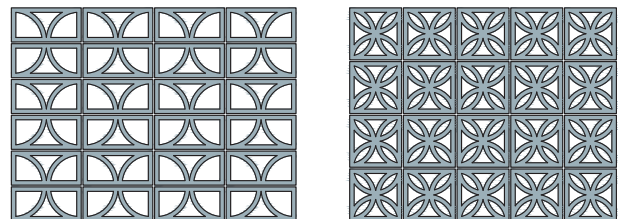
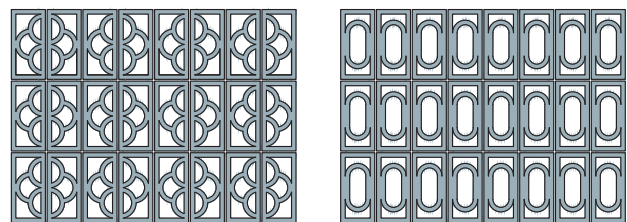


Figure 2: Breeze Block Shapes & Sizes

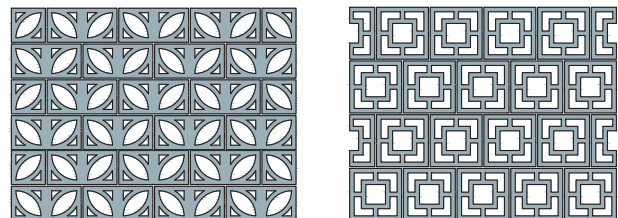
TRADITIONAL (HORIZONTAL) STACK BOND



VERTICAL STACK BOND



HORIZONTAL STRETCHER (RUNNING) BOND



VERTICAL STRETCHER (RUNNING) BOND

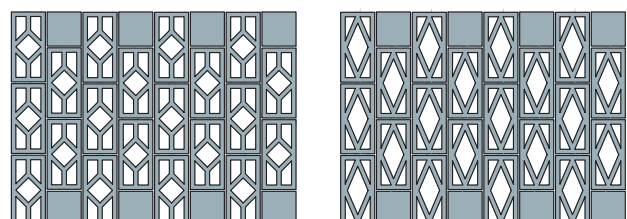


Figure 3: Breeze Block Bond Patterns

15.03 Block (or similar)

Design Considerations

4

4.1 Mortar Selection

The performance of mortar is dependent on its composition. As breeze blocks have a relatively low compressive strength, it is recommended to use a minimum mortar class of M3 to allow the wall to perform adequately. The various deemed-to-conform compositions of class M3 and M4 mortar are set out in Table 1 (as per AS 3700 Table 11.1).

Table 1: Deemed-to-Conform Mortar Composition

Mortar Class	Cement (GB/GP)	Building Lime	Sand	Water Thickener ³
M3	1	1	6	Optional Yes
	1	0	5	
M4	1	0.5	4.5	Optional Yes
	1	0	4	
	1	0 - 0.25	3	Optional

1. Mortar mixes are designated by the proportions of their ingredients following an initial letter, the chief cementing agent being given as unity (e.g. C1:L0.5:S4.5).
2. Volumes refer to materials in the dense-packed condition.
3. The water thickener referred to in this Table is cellulose based. The particular cellulose-based product used shall be suitable for this application and used in accordance with the manufacturer's or supplier's instructions.

Sands should be free of impurities including organic matter and salts. The resultant mortar should have no free water on its surface and be able to form peaks that are stiff enough to hold their shape. Adding more water to increase workability will reduce the strength and increase the shrinkage of the mortar. This will result in cracking due to shrinkage. For adequate mortar workability, the addition of hydrated lime and proper mixing is all that is needed, however additives (such as cellulose-based water thickeners) can be added for additional rheological benefits. The CMAA *Mortar Workability*⁴ factsheet for more information.

The appropriate mix used needs to be compliant with the AS 3700 durability requirements for grout and mortar as per Table 4.1. This requires M4 mortar when:

- within 100 m of a non-surf coast,
- within 1 km of a surf coast, and
- within 1 km of major industrial complexes producing significant acidic pollution.

Proprietary pre-bagged mortars are available that comply to certain mortar class compositions.

Powdered or liquid pigments may also be added to the mortar when a different colour is desired. It is generally best practice to colour match the mortar to the breeze blocks to reduce the risk of visible mortar stains. Refer to the CMAA *Mortar Colour Variation*⁵ factsheet for more information.

Care should be taken with mortar selection to reduce the likelihood of efflorescence occurring. This can occur due to salts present in the sand used in the mortar mix. See the CMAA *Efflorescence*⁶ factsheet on how to minimise the potential for efflorescence.

4.2 Mortar Joints

The primary function of the mortar joint is to bond the breeze blocks together, allowing them to effectively resist lateral loads from wind and earthquakes.

Properly filled and tooled/ironed joints improve the durability and weather resistance of breeze block walls. For durability in a salt atmosphere (for example, near the coast) a tooled, flush or near-flush joint is best.

The standard thickness for a mortar joint is 10 mm. However, AS 3700 Table 12.1 allows a ± 3 mm deviation from the specified bed joint thickness. The minimum thickness of the perpend joints is 5 mm, while the allowable deviation from the specified thickness is ± 10 mm from the average (i.e. maximum 20 mm thickness) and the maximum difference in perpend thickness in any wall is 8 mm.

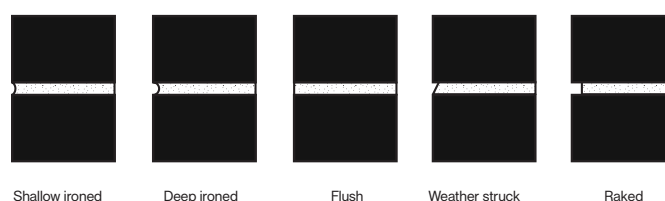


Figure 4: Common Mortar Joint Finishes



4.3 Control Joints

Concrete masonry units shrink as the concrete cures. This applies to breeze blocks, so units should be properly cured before delivery to the site. Saturated units should not be laid as they could be subject to subsequent drying shrinkage. If mortars with a particularly high cement content are used, their shrinkage could also provide sufficient tensile force to crack the breeze block wall.

Control Joints in breeze block walls are to act as:

- **Contraction Joints:** Opening joints to cater for the shrinkage of the breeze blocks within the wall.
- **Expansion Joints:** Closing joints (usually built into clay masonry to cater for brick growth) which are applicable to breeze blocks when there is the possibility of high thermal movement, and
- **Articulation Joints:** both opening and closing joints that cater for the movement of footings or supports.

All design and detailing shall comply with the requirements of AS 3700 Section 4.8. It is the designer's responsibility to allow for the effects of control joints, chases, openings, strength and stiffness of ties and connectors, and strength and stiffness of supports, in addition to normal considerations of loads and masonry properties.

Due to the high porosity of breeze blocks, they should be detailed as though they have openings in accordance with AS 3700. This requires a maximum allowable joint spacing of 5 m under AS 3700 Clause 4.8.2.1(f). The thickness of the control joints should be designed so that it does not exceed 10 mm more than the design joint thickness or become less than 5 mm wide (see Figure 5).

Control joints are considered to be a free edge, and so they may require additional support to maintain stability. These free edges can be supported by installing additional columns or steel posts adjacent to the vertical control joint, or installing appropriately adapted wall ties (see [Section 6.5](#)). All structural supports and reinforcements are not to bridge control joints.

All joints should be straight (not toothed), free of mortar and should extend to the full height or length of the masonry.

Flexible sealants are required at all control joints which are to be installed. This is to seal the joints while still allowing movement due to concrete shrinkage and thermal expansion of breeze blocks. This should be a proprietary silicone or butyl-based sealant. Sealants with the highest expansion and compression abilities are the most effective for use in movement joints. Check with the sealant manufacturer prior to using the product to check its suitability. They should, at minimum, be able to expand and contract by $\pm 25\%$.

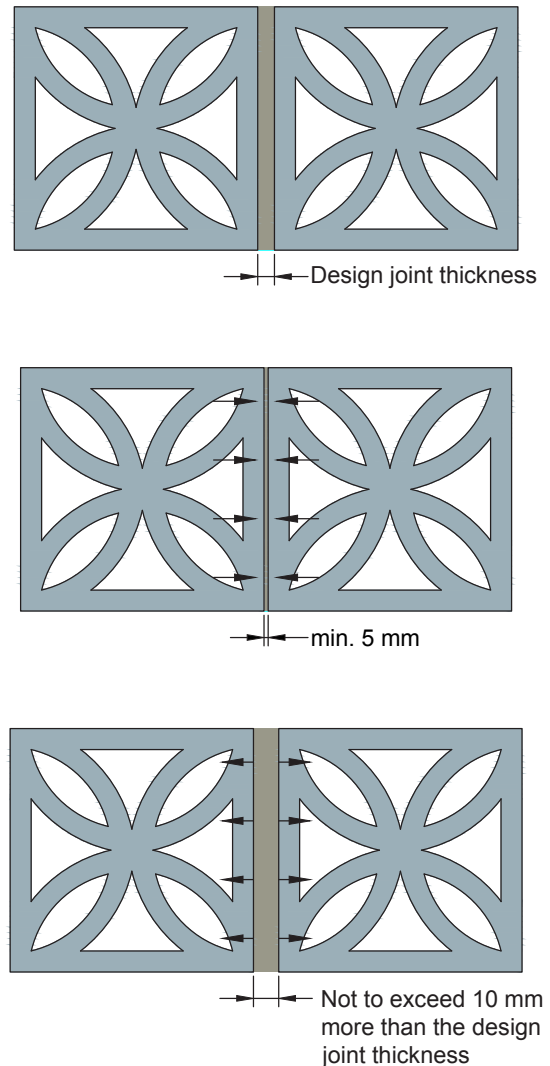


Figure 5: Allowable Control Joints



Garden Tower House by Studio Bright
Photography by Rory Gardiner

4.4 Stack Bonded Walls

Unlike stretcher bonded masonry, unreinforced stack bonded masonry has a comparatively low horizontal bending strength and is deemed to have zero horizontal bending capacity (M_{ch}) when calculated in accordance with AS 3700 Section 7.4.3. This is because the stack bonded pattern provides no unit overlap, meaning the perpend spacing factor (k_p) is set to zero.

However, testing showed that although the horizontal bending capacity of a stack bonded wall is less than a stretcher bonded wall, it does provide some degree of bending resistance. This is because its horizontal bending capacity is similar to its vertical bending capacity where, in both cases, the failure mode runs along the perpend and bedding joints respectively. AS 3700 provides detailing requirements and a structural design methodology that accounts for the true structural strength of stack bonded masonry walls.

Stack bonded breeze block walls require continuous bed joint reinforcement spaced vertically at centres no more than six times the thickness of the breeze block wall in accordance with [Section 5.5](#). Vertical columns or engaged piers may be required for additional wall strength and stability. The spacing of these columns varies depending on the height of the wall and the breeze block product used. These columns can be designed using reinforced concrete masonry blocks or steel posts (or the like). Horizontal reinforcement should be cast into or fastened to the vertical columns to ensure composite load actions are achieved.

4.5 Bed Joint Reinforcement

All reinforcement embedded in mortar joints is to comply with AS 3700 Section 5.9.3. This requires the reinforcement to be no more than two thirds the design thickness of the mortar joint in diameter ($D \leq \frac{2}{3}t_j$) with at least 15 mm cover to any exposed surface of the mortar joint.

This reinforcement should be at least $0.00035 \times A_v$ – where A_v is the vertical cross-sectional area of the wall ($h \times t$) and should be placed as per Figure 6 in:

- the first bed joint above or below an unrestrained horizontal edge of the masonry,
- at least one bed joint within 300 mm above and below any horizontal lines of lateral support, and
- vertical centre-to-centre spacings not exceeding six times the thickness of the breeze blocks ($6t$).

Some manufacturers may reduce these spacings to as low as every course to increase bending capacity. If necessary, the bed joint reinforcement should be lapped by at least 225 mm (with at least one cross wire for ladder reinforcement). These laps can be achieved by either stacking lengths or positioning the ends side by side. The position of laps should also be staggered throughout the breeze block wall.

The reinforcement should be suitably protected to provide the durability class required by Table 2. Reinforcement deemed to meet these durability requirements are:

- For durability classes R1 to R3, steel wire or bar with a galvanised coating mass of at least 470 g/m².
- For durability class R4, stainless steel reinforcement to BS 6744 *Stainless steel bars*¹⁵.

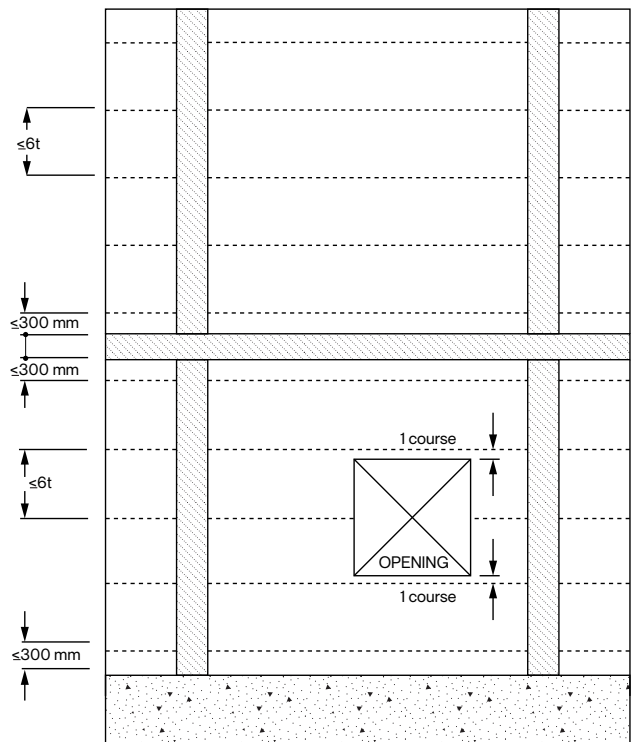


Figure 6: Reinforcement Placement for Stack Bonded Masonry



Table 2: Reinforced Durability Requirements

Location	Exposure Class	Durability Class
External Walls	Within 1 km of a surf coast or industrial area, or within 100 m of a non-surf coast	R4
	Between 1 km and 10 km of a surf coast, or between 100 m and 1 km from a non-surf coast	R3
	Areas considered to be mild-tropical as per AS 3700 Figure 5.1	R2
	All other areas	R1
Internal Walls		R1

These design requirements should take precedence over the requirements of reinforced masonry in bending as per AS 3700 Section 8.6, but this section may be used for designing for horizontal and two-way bending. For compression, shear and vertical bending, the members should be designed as unreinforced masonry in accordance with AS 3700 Section 7.

For ladder-type bed joint mesh, it should be at least 30 mm less than the width of the breeze block to allow for at least 15 mm of cover either side. Typical bed joint reinforcement includes the Leviat AMR Masonry Reinforcement¹⁶ which comes in 60 mm, 100 mm and 150 mm widths (as shown in Figure 7) to suit 90 mm, 140 mm and 190 mm thick breeze blocks respectively. These have been used in the design charts in Section 7. To continue bed joint reinforcement around a corner, the inner wire may be cut to allow the outer wire to be bent to fit.

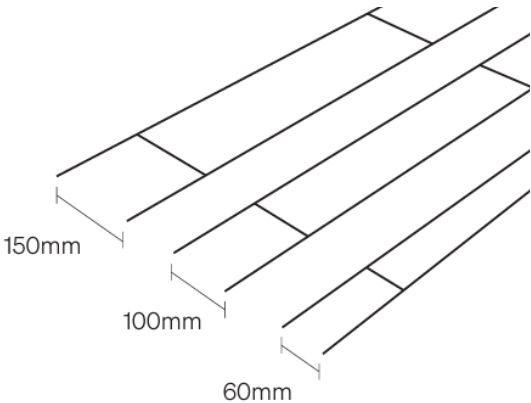


Figure 7: Leviat AMR Masonry Reinforcement Widths



Point 6 Development, Hope Island
Photography by Coastpark Creative

4.6 Vertical Reinforcement

Depending on the required wind loads and dimensions of the breeze block wall, vertical reinforcement may be required. This is to be installed as per AS 3700 Section 8.10 which requires that, for vertical bending, vertical reinforcement should:

- be located symmetrically in the cross-section of the wall,
- include a cross-sectional area of at least 100 mm^2 within 300 mm of a free end, and
- be spaced at centres no more than 2000 mm.

These vertical reinforcements may be in the form of external framework (made of steel, timber or concrete), manufactured or proprietary steel posts (either flat and concealed in the perpend joints, in-plane with the breeze blocks, or externally attached), or concrete masonry columns.

Some breeze block products contain grooved edges to allow vertical reinforcement to be slotted into the block without disrupting the perpend joint spacing. This is usually for the allowance of steel rebar that is mortared to the blocks during construction.

For flat plates concealed within the wall, recommended as the most suitable for seamless breeze block wall design with large centre-to-centre spacings, Leviat 8 mm thick flat steel wind posts (WP4)¹⁶ that can be slotted into the perpend joints. These connect to the top and bottom supports and are compatible with Leviat's AMR 'Ladder Type' Masonry Reinforcement and specially designed wind post ties to allow the masonry to connect with the vertical reinforcement. These posts are available in Grades 304 and 316 steel. The top connection on the Leviat WP4 allows for shrinkage or vertical movement of the frame to take place. The type of fixing will depend on the nature of the frame, where expansion bolts are typically supplied for concrete frames and set screws for steel frames.

The depth of the wind post should be chosen to be at least 20 mm less than the thickness of the breeze blocks and placed centrally to provide 10 mm cover at either face. Wind posts thicker than 8 mm can be made available to increase the capacity of the wall, however this will also increase the perpend joint thickness. Wind posts over 3 m in height will require welded joints between lengths. If the wind posts are of adequate durability and the full width is required, the wind posts may be left exposed. For more information or alternatives, contact Leviat Technical Services. Custom steel supports designed by a qualified structural engineer may also be used.

Engineering Design



5.1 Wind Loads

As breeze blocks are designed to be non-loadbearing, their main loads that need to be considered are wind and earthquake actions. For Australia, only wind actions need to be considered, and as they are considerably more porous than traditional concrete blocks it is recommended to design to AS/NZS 1170.2 *Structural design actions, Part 2: Wind actions*⁷. Due to the simplification of the pressure coefficient in AS 4055 Wind loads for housing⁸, it should not be used when designing for breeze block walls.

To determine the expected maximum wind actions on breeze block walls, the ultimate wind action (W_u) is used. This is determined using a regional wind speed appropriate to the annual probability of exceedance (P) specified for ultimate limit states as given in AS/NZS 1170.0 *Structural design actions, Part 0: General principles*⁹ or the *National Construction Code (NCC)*¹⁰. The method for determining the wind actions on a breeze block wall is to:

1. Determine the site wind speed (as per AS 1170.2 Clause 2.2)
2. Determine the design wind speed ($V_{des,\theta}$) from the site wind speeds (as per AS 1170.2 Clause 2.3)
3. Determine the design wind pressure (p) and distributed forces (as per AS/NZS 1170.2 Clause 2.4)
4. Calculate the ultimate wind action (as per AS 1170.2 Clause 2.5)

The final design wind pressure (p) is calculated using:

$$p = (0.5\rho_{air})[V_{des,\theta}]^2 C_{shp} C_{dyn}$$

Where:

ρ_{air} = density of air (usually taken as 1.2 kg/m³)

$V_{des,\theta}$ = building orthogonal design wind speed (to be taken at $\theta = 0^\circ$)

C_{shp} = aerodynamic shape factor

C_{dyn} = dynamic response factor (to be taken as 1.0)

This pressure is to be applied to the total area of the wall ($b \times c$ as per Figure 8) with the wind speed ($V_{des,\theta}$) calculated from the top of the wall (at height h as per Figure 8). For ultimate limit states design (W_u), $V_{des,\theta}$ is not to be less than 30 m/s as per AS 1170.2 Section 2.3.

The aerodynamic shape factor (C_{shp}) is designed to account for the effects of the geometry of the structure on surface pressure due to wind. This includes the absence of direct wind on the openings within a breeze block pattern and the total frictional drag forces derived from face frictional forces on the inner surfaces of the blocks. For rectangular freestanding walls with a wind pressure normal to the surface (as per AS/NZS 1170.2 Appendix B 2.1):

$$C_{shp} = C_{p,n} K_p$$

Where:

$C_{p,n}$ = net pressure coefficient acting normal to the surface

K_p = porous cladding reduction factor

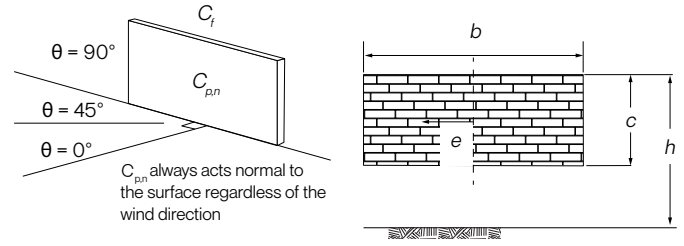


Figure 8: Freestanding Wall Notations

The resultant force of the pressure is to be taken to act at half the height of the wall ($h - c/2$) with a horizontal eccentricity (e). For wind loads normal to the wall, this eccentricity value is equal to zero ($e = 0$).

The net pressure coefficient ($C_{p,n}$) varies depending on the dimensions and height of the wall;

- For walls where $c/h > 0.2$;

→ For short walls ($b/c < 5$):

$$C_{p,n} = 1.3 + 0.5 \left[0.3 + \log_{10} \left(\frac{b}{c} \right) \right] \left(0.8 - \frac{c}{h} \right)$$

→ For long walls ($b/c > 5$):

$$C_{p,n} = 1.7 - 0.5 \frac{c}{h}$$

- For walls elevated by more than four times its height ($h > 5c$):

$$C_{p,n} = 1.4 + 0.3 \log_{10} \left(\frac{b}{c} \right)$$

As breeze blocks contain openings, and these are different for each product shape and pattern, the applied wind actions for each product varies. This is accounted for using the net porosity factor (K_p) as per AS/NZS 1170.2 Appendix B 1.4. This is calculated using:

$$K_p = 1 - (1 - \delta)^2$$

Where δ is the solidity ratio (or core percentage) of the unit, calculated as the ratio of solid area to total area of the face of the breeze block.

The permeability cladding reduction factor uses the same notation in AS/NZS 1170.2 but should not be used for breeze block wall calculations unless designing for an enclosed structure with a breeze block wall running parallel to the wind direction.

Once all factors are considered, the ultimate wind action (W_u) can be determined as:

$$\begin{aligned} W_u &= pA \\ &= (0.5\rho_{air})[V_{des,\theta}]^2 C_{shp} A \\ &= (0.5\rho_{air})[V_{des,\theta}]^2 C_{p,n} K_p A \end{aligned}$$

This is the ultimate wind load that should be used to determine the breeze block wall dimensions according to the design charts given in Section 7 or by the manufacturer, where A is the area upon which the pressure acts.

A frictional component of the wind action on the internal surface area of the breeze blocks may be considered as per AS/NZS 1170.2 Section 2.4.2. However, the aerodynamic shape factor for this component is equal to the frictional drag coefficient (C_f) as per AS/NZS 1170.2 Section 5.2 (Equation 5.2(5)) which equals 0.01 as per AS/NZS 1170.2 Table B.3 (and so is considered to be negligible).



5.2 Stability

The stability moment of a solid wall in which the centre line is also the centre of gravity can be calculated using the expression:

$$M_r = 0.9mt_w^2H$$

Where:

M_r = the stability moment capacity of the wall

m = force due to mass of a material (different per breeze block)

t_w = overall thickness of the wall

H = height of wall above bottom support

If the breeze block wall does not have a stability moment capacity greater than the overturning moment due to wind pressure, additional lateral support must be provided in the form of piers or posts, or by wall configuration. The economy and efficiency of the wall depends upon the designer balancing the requirements of the wall, the lateral support system and the footings design.

5.3 Robustness

Masonry members not subjected to loads (for example a partition wall in non-loadbearing construction) must satisfy the robustness requirements of AS 3700. These effectively limit the height and length of walls of a given thickness according to the support conditions. This should be designed such that the wall is proportioned to resist an ultimate distributed out-of-plane load of 0.5 kPa. For the case of breeze block walls, this means that they should be designed to withstand the greater of p (from [Section 5.1](#)) or 0.5 kPa.

When designing for bending, stretcher bonded breeze block walls differ from stack bonded walls as the bed joint reinforcement required for stack bonded masonry assists the members in resisting the lateral loads. For this reason, only stretcher bonded breeze block walls should be designed as an unreinforced wall in accordance with AS 3700 Section 7.

5.4 Bending of Stretcher Bond Walls

For lateral out-of-plane loading, whether it arises from wind or earthquake, the response of the structural element is usually calculated by considering the load as an equivalent static uniform pressure. Although there is a fundamental difference in the type of load caused by wind and earthquake, there is no difference in design procedure between the two in most cases.

Masonry elements subjected to out-of-plane loading resist the load by flexural action. The load capacity of unreinforced breeze block walls depends upon the dimensions and support conditions, the level of compressive stress in the wall, and the tensile strength of the masonry. The presence of door and window openings also has a strong influence on the behaviour.

The design charts given in [Section 7.1](#) give design lengths and heights for walls with a range of support conditions, for various wind pressures.

Usually, masonry walls crack in particular patterns under face loading depending on the support conditions and the dimensions. However, due to the high porosity of breeze blocks, these failure patterns are more prone to act through the block compared to typical solid masonry. Figure 9 shows the idealised cracking patterns that occur for various wall configurations, with edge supports indicated by dark lines. The crack lines shown, together with cracks along continuous or restrained edges, allow a mechanism to form, at which point the wall is considered to have failed. There are three types of failure lines:

- **Horizontal Failure Lines** will occur when the vertical bending capacity (influenced by bond strength, section modulus and compressive load) is exceeded. If a wall is relatively long compared to its height and the top edge is supported, a horizontal crack may appear in mortar joints near the mid-height. This is usually the first crack to appear, is often not noticeable and does not constitute a structural failure. A horizontal failure must also develop at or near the base of the wall before collapse can occur. It is normal to assume that the wall is rotationally unrestrained (due to lack of bond strength).
- **Vertical Failure Lines** occur when the horizontal bending capacity (influenced by bond strength and section modulus of perpendicular joints and the lateral modulus of rupture of units) is exceeded. A vertical failure may manifest either as a zig-zag pattern around the line of the joints, or as a vertical crack passing alternately through the perpend joint and breeze block. If a wall is relatively high compared to its length, a vertical failure line will appear first. If a wall is continuous past a vertical support, a vertical failure line will develop before collapse occurs.
- **Diagonal Failure Lines** radiate out from any corner where both vertical and horizontal edges are supported and forms as the units rotate relative to the adjacent units. For structural collapse to occur, these diagonal failure lines must cause a mechanism. The slope of the diagonal failure lines is governed by length-to-height proportions of the masonry units. A diagonal failure line will occur when the diagonal bending capacity (influenced by equivalent characteristic torsional strength, related to bond strength, and the equivalent torsional section modulus) is exceeded.

Wall edges can be free of any support or subjected to two types of edge restraint, namely lateral restraint and full rotational restraint. The latter can be referred to as a fixed edge. These two types of restraint are defined as follows:

- Lateral restraint occurs when the edge of the masonry wall has only restraint in the lateral (out-of-plane) direction and there is no capacity to transmit a moment across the edge. Control joints or isolation joints where the masonry is tied to a support provide such a case and the bed joint at the base of a wall is also considered to be of this type.
- Edge fixity occurs when the edge of the wall is restrained against both lateral movement and rotation. This condition can occur when a wall extends continuously past a support for a sufficient distance or where a wall returns for a sufficient distance around a corner. AS 3700 does not give any guidance as to what return distance around a corner to the edge of the nearest opening or end of the wall is sufficient for this purpose. In the absence of other guidance, a distance of at least ten times the wall thickness can be considered a reasonable minimum. Commonly, where there is some degree of rotational restraint, but it cannot be considered as full restraint, a rotational restraint factor of 0.5 or some other value between 0 (no restraint) and 1 (full restraint) is used. It should be noted that it is difficult to achieve full rotational restraint by building the edge of a wall up to a supporting member and incorporating metal ties. Such a condition should usually be considered as providing lateral restraint only.

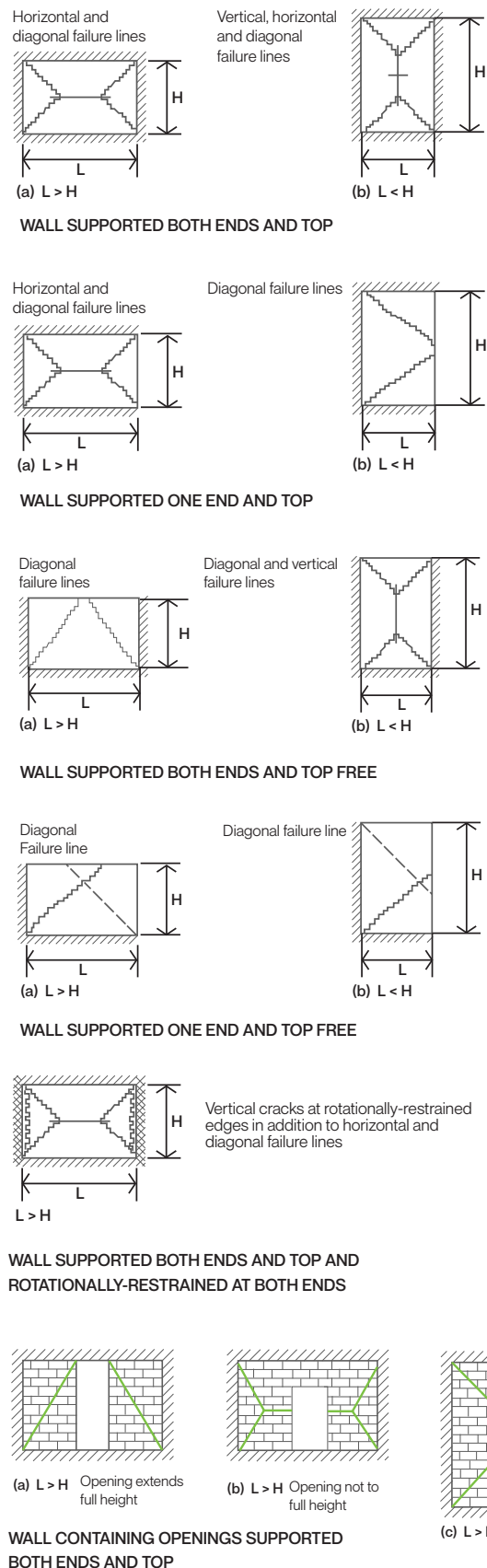


Figure 9: Theorised Crack Patterns for Various Wall Configurations

For breeze block walls, it is recommended that the top edge should have a lateral restraint. The base of a wall is considered to have lateral restraint as well.

5.4.1 One Way Vertical Bending

The simplest and most common form of one-way bending is simple vertical bending. In this mode, the wall panel acts as a simple beam between top and bottom supports, with the main flexural stresses acting across the bed joints. This is a simple mechanism and results in a brittle failure. When a bed joint crack occurs in masonry acting in this way, the joint is assumed to have no further resistance to the applied moment. Figure 10 shows an example of one-way vertical bending. Due to the high porosity of breeze blocks, they may fail at the bed joint (as shown in red) or through the block (as shown in blue) depending on the bond strength and breeze block pattern.

Vertical bending occurs predominantly when both vertical edges are unsupported. This is not common for breeze block walls but may be used in specific applications such as car ports or verandahs (covered areas with openings either side). Breeze block walls with both vertical edges unsupported have not been included in the design charts in this manual, however the following design procedure applies.

Resistance to vertical bending is only provided by the flexural tensile strength of the masonry, although it is enhanced by any superimposed vertical load on the wall. This superimposed load (if any) is taken into account in the design procedure by considering the resulting compressive stress as acting uniformly on the bed joint and partially relieving the tensile stress due to bending. Because a wall under pure vertical bending fails in a brittle manner and the flexural tensile strength of masonry is usually quite low, there are few cases where one-way spanning walls can be justified. Wherever possible, walls should be provided with additional support along one or both of the vertical edges or, if this is not practical, the use of reinforced elements should be considered.

The vertical bending capacity of a masonry wall subject to vertical bending (in Nmm per metre length of the wall) is given in AS 3700 Section 7.4.2 to be the least of:

$$M_{cv} = \phi f'_{mt} Z_d + f_d Z_d$$

(representing a combination of flexural bond strength and compression),

$$M_{cv} = 3.0 \phi f'_{mt} Z_d$$

(representing an upper bound on flexural bond strength and compression), and

$$M_{cv} = f_d Z_d$$

(representing the compression where $f'_{mt} = 0$).

Where:

ϕ = capacity reduction factor

f'_{mt} = characteristic flexural tensile strength of masonry

f_d = minimum design compressive stress on the bed joint under consideration

Z_d = section modulus of bedded area

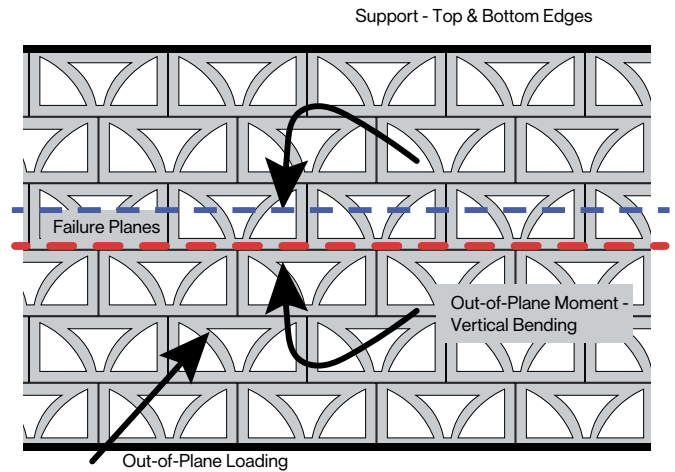


Figure 10: Breeze Block Wall Under Vertical Bending

5.4.2 One Way Horizontal Bending

As it is strongly recommended for breeze block walls to have both top and bottom lateral restraints, one-way horizontal bending is not expected to occur on its own, however it is an aspect used when calculating the two-way bending of any masonry wall. Due to the high porosity of breeze blocks, the failure plane is more likely to be straight, vertical, and at the most porous plane of the breeze blocks. Depending on the pattern of the blocks, some staggering of the failure plane may occur.

The horizontal bending capacity of breeze blocks can be calculated through the equations set out in AS 3700. Within the clause, it states that the horizontal bending moment capacity (in Nmm per metre length of the wall) is given by the least of:

$$M_{ch} = 2.0 \phi k_p \sqrt{f'_{mt}} \left(1 + \frac{f_d}{f'_{mt}} \right) Z_d$$

(representing a zigzag failure around the mortar joints with a combination of torsional bond strength and compression),

$$M_{ch} = 4.0 \phi k_p \sqrt{f'_{mt}} Z_d$$

(representing an upper bound on the zigzag failure with torsional bond strength and compression), and

$$M_{ch} = \phi (0.44 f'_{ut} Z_u + 0.56 f'_{mt} Z_u)$$

(representing a straight vertical failure alternating through masonry unit and mortar).

Where:

ϕ = capacity reduction factor

k_p = perpend spacing factor

f'_{mt} = characteristic flexural tensile strength of masonry

f_d = minimum design compressive stress on the bed joint under consideration

f'_{ut} = characteristic lateral modulus of rupture of the masonry units

Z_d = perpend spacing factor

Z_u = lateral section modulus of the masonry units (per metre length)

Z_p = lateral section modulus of mortar contact area of the perpend joints (per metre length)

5.4.3 Two Way Bending

Breeze block walls with support on at least two adjacent sides undergo a combination of vertical and horizontal bending. This action provides more opportunity for load sharing between various parts of the wall as cracks develop and leads to a less brittle behaviour. It is therefore more desirable than one-way vertical bending.

Observations of cracking in numerous tests on typical (more solid) masonry units have led to the identification of characteristic patterns that depend on the wall support conditions. Each of these cracking patterns divides the wall panel into a number of subplates, which can be considered as being joined by hinges at their edges. While the exact distribution of moment along these crack lines is unknown, the total residual moment capacity of a crack line has been shown to relate to the shape of the units and the basic bond strength f'_{mt} .

The collection of sub-plates in cracked walls forms a mechanism that allows the wall to deflect, at almost constant load, until the total deflection is sufficient to cause collapse. This pseudo-ductile behaviour is the basis of the virtual work method of analysis adopted in the AS 3700 design provisions. The moment capacities of these potential crack lines are derived from the vertical and horizontal moment capacities considered in one-way bending, along with consideration of the diagonal bending capacity.

The idealised cracking patterns are shown in Figure 9. The cracking pattern is always consistent with the shape of the breeze blocks and boundary conditions wall. As it is recommended that the top of a breeze block wall should be supported, or for long walls, the first crack to develop is usually a horizontal crack at approximately the mid-height of the wall. However, if the adjacent vertical and horizontal edges are supported, diagonal crack lines form and radiate out from at or near the corners. Typically, these cracks form in the bed and perpendicular joints and their angle is therefore governed by the length-to-height dimensions of the breeze blocks. Cracks can also propagate through the breeze blocks themselves if there are sufficient openings in their patterns.

When a breeze block wall is high (compared to its length) a vertical crack is more likely to develop at approximately the mid-length. This failure line extends to the diagonal failure lines at both top and bottom. When vertical edges have rotational restraint (for example because of continuity) they will crack either before, or at the same time as, the diagonal cracks develop.

The presence of vertical load applied simultaneously with the lateral load can enhance the strength of the panel and this will be reflected in a higher value of M_{ch} . When the load becomes substantial, such as where in-plane arching develops due to the wall edges bearing against the structural frame as the wall deflects, the wall strength can be substantially increased. However, there is no reliable design method for this action.

The lateral load design method used in AS 3700 is based on the virtual work approach for masonry units. This semi-empirical method relies on the identification of a particular cracking pattern (as outlined above) and certain assumptions about the material properties. This includes consideration of failure through the masonry units which, although breeze blocks are not explicitly included under AS 3700, still allows for the increased likelihood of unit failure to be considered.

The assumed behaviour of the three types of crack lines is as follows:

- Horizontal crack line in a bed joint – assumed to have no residual moment of resistance after cracking. This type of crack has virtually no influence on the overall strength.
- Vertical crack line – results from failure through masonry units and perpend or from the stepped shearing failure alternating between the mortar joints and perpend. The moment capacity is influenced by the lateral modulus of rupture of the masonry units and the flexural tensile strength of the masonry and is expressed by M_{ch} .
- Diagonal crack line propagating from a corner – results from torsional shearing action in the mortar bed joints and perpend. The geometry of the masonry units determines the slope of the line and the tensile strength of the masonry determines the flexural strength along the crack, expressed as the diagonal bending capacity M_{cd} . This type of crack has the greatest effect of the three in determining the overall strength.

The predicted load capacity depends on geometrical factors for the wall and the material properties, which are expressed as the horizontal moment capacity M_{ch} (see Section 5.4.2) and the diagonal moment capacity M_{cd} . The diagonal bending moment capacity is given in AS 3700 as:

$$M_{cd} = \phi f'_t Z_t$$

Where:

ϕ = capacity reduction factor

$f'_t = 2.25\sqrt{f'_{mt}}$ = equivalent characteristic torsional strength

Z_t = equivalent torsional section modulus (see AS 3700 Clause 7.4.4.3)

Once M_{ch} and M_{cd} have been determined, the two-way bending formula can be applied to the masonry wall being designed, given as:

$$w_d \leq \frac{2a_f}{L_d^2} (k_1 M_{ch} + k_2 M_{cd})$$

Where:

w_d = design wind, or other lateral pressure acting on the wall

a_f = aspect factor (as per AS 3700 Table 7.5)

L_d = the design length –

- When only one vertical edge is laterally supported – the actual length to the unsupported free edge;
- When both vertical edges are laterally supported – half the actual length of the wall between supports; or
- When an opening is present – the distance from the laterally supported end of the wall to the nearest edge of the opening.

k_1, k_2 = coefficients based on restraint, slope factor and aspect factor in AS 3700 Table 7.5

M_{ch} = the horizontal bending capacity of the wall (given in Section 5.4.2)

M_{cd} = the diagonal bending capacity (given above)

For the design charts in Section 8.1, it has been assumed for conservatism that there is no rotational restraint on any edges of the wall (such that R_{t1} and R_{t2} in AS 3700 Table 7.5 are zero). The capacity may be increased by engineering additional rotational stability.

5.5 Bending of Stack Bonded Walls

Stack bonded breeze block walls are not explicitly included in the scope of AS 3700. For this reason, applicable elements of the masonry standard have been taken in conjunction with engineering principles present in AS 3600 *Concrete structures*¹¹ for bending. This requires the breeze blocks to act as a series of reinforced concrete beams under wind load, with their face shell, bed joint mortar and horizontal reinforcement creating a composite beam.

The first structural check to be made is that the wall is acting in equilibrium with the forces acting within it. This is expressed as the sum of the tensile and compressive forces equating to zero:

$$\sum F_x = C_s + C_c - T_s = 0 \rightarrow C_s + C_c = T_s$$

$T_s = A_{st}f_{sy}$ = the tensile force on the bed joint reinforcement

$C_s = A_{sc}f_{sc}$ = the compressive force on the bed joint reinforcement

$C_c = \gamma d_n b \times \alpha_2 f'_c$ = the compressive force on the masonry

Due to the typical behaviour of concrete, the breeze blocks are assumed to have zero tensile strength as per AS 3700 Section 8.3(e), and so the tensile force is assumed to be exerted on the steel only. This gives the final equation to be:

$$A_{sc}f_{sc} + \gamma d_n b (\alpha_2 f'_c) = A_{st}f_{sy}$$

Where:

A_{sc}, A_{st} = the area of steel reinforcement in compression and tension respectively

f_{sy} = yield strength of steel (assumed to be 500 MPa in the design charts)

f_{sc} = stress of steel under compression = $\frac{E\varepsilon(d_n - c)}{d_n}$

$f'_c = (1.3)f'_m$ = stress of steel under compression

E = Young's Modulus of steel (assumed to be 200 GPa)

ε = the compressive strain limit = 0.0035

c = the cover of the steel reinforcement under compression

This equilibrium is made to determine the axis of the masonry not under stress. This is also known as the neutral axis, and its position is indicated by d_n , which is the distance from the inside (compressed) end to the neutral axis (see Figure 11).

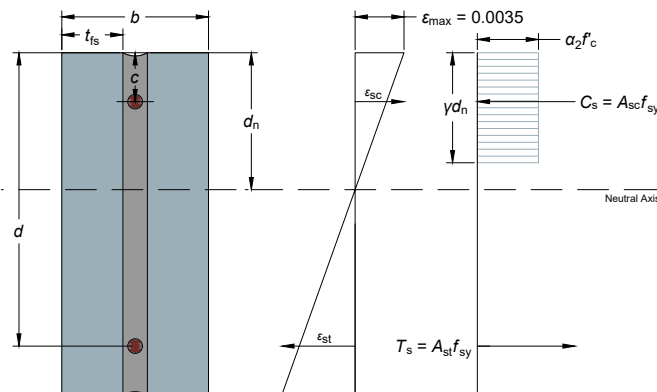


Figure 11: Stress and Strains Distributions on Bed Joint Reinforcement

While it is most likely that the compressive stress block at ultimate is parabolic, similar to that for reinforced concrete, it is idealised as a rectangular stress block whose depth from the extreme fibre is taken as 0.85 times the depth to the neutral axis ($\gamma = 0.85$) as per AS 3700 Supplement 1 C8.3(d).

It is also assumed that, as per AS 3700 Section 8.3(d), this uniform compressive stress acting on the area is equal to $(0.85)(1.3)f'_m$, such that $\alpha_2 = 0.85$ and $f'_c = (1.3)f'_m$. This '1.3' value is to convert from the unconfined compressive strength of masonry to an equivalent confined cylinder strength normally used for reinforced concrete as described in AS 3700 Suppl. 1 C8.3(d). This gives a typical equilibrium of:

$$A_{sc}E\varepsilon\left(\frac{d_n - c}{d_n}\right) + (0.85)d_n b (0.85)(1.3)f'_m = A_{st}f_{sy}$$

This is to be solved for d_n such that it does not exceed 0.4d (40% of distance to the tensile reinforcement) as per AS 3700 Section 8.3(c). This allows for the moment about the neutral axis to be calculated so the moment capacity of the specific breeze block bed joint can be determined. This is given by:

$$\begin{aligned} M_b &= \sum M_x = [M_{Cc} + M_{Cs} + M_{Ts}] \\ &= C_s(d_n - c) + C_c\left(d_n - \frac{(0.85)d_n}{2}\right) + T_s(d - d_n) \\ &= A_{sc}E\varepsilon_0\left(\frac{d_n - c}{d_n}\right) + (0.85)d_n b (0.85)(1.3)f'_m\left(d_n - \frac{(0.85)d_n}{2}\right) + A_{st}f_{sy}(d - d_n) \end{aligned}$$

As this gives the moment capacity of each bed joint acting as a composite beam, the bending moment capacity for the wall can be calculated by:

$$M_{c,h} = \frac{\phi M_b}{h_o}$$

Where $\phi = 0.75$ (capacity reduction factor for reinforced masonry as per AS 3700 Table 4.1) and h_o is the centre-to-centre distance between bed joint reinforcement.

The ultimate wind load for a given length (L) of breeze block wall can then be calculated using the maximum bending moment equation for a simply supported beam (a wall supported top and bottom):

$$M_{c,h} = \frac{w_u L^2}{8} \rightarrow w_u = \frac{8M_{c,h}}{L^2}$$

Where w_u is the ultimate wind load of the wall.

Alternatively, AS 3700 Section 8.6 can be applied such that:

$$\phi f_{sy} A_{sd} d \left[1 - \frac{0.6 f_{sy} A_{sd}}{(1.3 f'_m) b d} \right]$$

Where:

M_d = the design bending moment acting on the cross-section of the member as per AS 3700 Section 8.6

ϕ = the capacity reduction factor = 0.75 for reinforced masonry (as per AS 3700 Table 4.1)

f_{sy} = the design yield strength of reinforcement

A_{sd} = the proportion of cross-sectional area of the main tensile reinforcement, taken as the lesser of $0.377 f'_m b d / f_{sy}$

f'_m = the characteristic compressive strength of the breeze block

b = the width of the masonry member

d = the effective depth of the reinforced masonry member

5.6 Bending of Vertically Reinforced Walls

To determine the maximum dimensions of a stack bonded breeze block wall with vertical reinforcement, three checks need to be made. These checks are for:

1. deflection (Δ),
2. horizontal bending, and
3. vertical bending.

According to AS 3700 Section 2.5.2, a masonry structure is deemed to meet the deflection requirements under serviceability (ability to remain fit for purpose). This means that the serviceability wind load is to be used for deflection (rather than the ultimate wind load). It is assumed that the vertical steel reinforcement is acting to resist the deflection.

The maximum allowable deflection under the serviceability limit state criteria set out in AS/NZS 1170.0 Table C1 for masonry walls under face loads (worst wind load case) is span/400. This also requires a factored serviceability wind load (w_s) to be used. This factor accounts for the importance level of a building as per the NCC Volume One B1D3(c) which is used to determine the annual probability of exceedance for wind loads. For the design charts in [Section 7](#), this value has been assumed to be 0.75, such that:

$$w_s = \delta w_u (= 0.75 w_u)$$

Where δ is the value of the serviceability factor determined on the basis of the design actions in AS/NZS 1170.0 (a qualified engineer may adjust this value if necessary).

$$\frac{\Delta_{\max}}{L} = \frac{H/400}{L} = \frac{5}{384} \frac{w_s H^4}{EI} \quad \rightarrow \quad L_{\max, \Delta} = \frac{24}{125} \frac{EI}{w_s H^3}$$

Where E = elastic modulus (Young's Modulus) and I is the effective second moment of area of the vertical reinforcement. These values vary depending on the type of vertical reinforcement used. For concrete block columns, the method and formulae are slightly different due to the composite actions between concrete, grout and steel.

The second check that needs to be made is for horizontal bending. This maximum length can be determined based on [Section 5.5](#) such that:

$$w_u = \frac{8M_{c,h}}{L^2} \quad \rightarrow \quad L_{\max, h} = \sqrt{\frac{w_u}{8M_{c,h}}}$$

The third and final check is for vertical bending. This is based on the bending moment capacity of the vertical reinforcement specific to the design of the wall. This manual covers the design methods for steel posts and concrete block columns.

5.6.1 Vertical Steel Reinforcement

When using vertical steel reinforcement, Young's Modulus is assumed to be 200,000 MPa. For this reinforcement type, the bending moment capacity of the masonry does not usually govern for any given dimension due to the resistance to loads of the steel reinforcement and so AS 4100 *Steel structures*¹² should be used. This bending capacity can be calculated as per AS 4100 Section 5.2 such that:

$$M_u \leq \phi M_s = \phi f_{sy} Z_e$$

Where $\phi = 0.90$ (the capacity reduction factor for a steel member subject to bending as per AS 4100 Table 3.4) and $Z_e = \min(S, 1.5Z)$ (the effective section modulus of the steel post).

It is assumed that the steel reinforcement has a section slenderness (λ_s) less than or equal to 30. This is the value given for a 170 mm deep, 8 mm thick flat steel reinforcing plate (largest recommended for a 190 mm thick wall) with a 500 MPa yield stress as per AS 4100 Clause 5.2.2.

The maximum allowable distance between vertical steel reinforcement can then be calculated using the maximum moment capacity equation for a simply supported beam (or vertical column restrained at the top and bottom) such that:

$$\frac{M_{u,v}}{L} = \frac{wH^2}{8} \quad \rightarrow \quad L_{\max, v} = \frac{8M_{u,v}}{wH^2}$$

These relationships have been expressed in the design charts in [Section 7.3](#).



Point 6 Development, Hope Island
Photography by Coastpark Creative

5.6.2 Concrete Block Columns

For concrete block columns within a breeze block wall, the steel is assumed to be central and only acts in tension. The elastic modulus for concrete masonry units is given in AS 3700 as $E_m = 1000f'_m$ for concrete units with density greater than 1800 kg/m³.

This elastic modulus is given for the concrete only. The steel reinforcement is weighted based on the elastic moduli of the two materials using a factor known as the effective modular ratio (n_e). This is given by:

$$n_e = (1 + \varphi_{cc}) \frac{E_s}{E_c} = (1 + 0) \frac{200000 \text{ MPa}}{1000f'_m} = \frac{200 \text{ MPa}}{f'_m}$$

Where φ_{cc} is the creep coefficient associated with the time interval after cracking, determined in accordance with AS 3600 Clause 3.1.7. This has been assumed to be zero for the design charts in [Section 7.4](#).

While not explicitly referenced in AS 3700, deflection of the concrete block columns should be checked under serviceability. Knowledge of masonry deflection calculations is essential to understanding the behaviour of a concrete block column so that the deflection differential between the steel and concrete components can be appropriately incorporated into the design. This is why the deflection calculations below are based on established principles used in reinforced concrete such as those from the US Masonry Standards Joint Committee's *Building Code Requirements and Specification for Masonry Structures* MSJC (TMS 402/ACI 530/ASCE 5 and TMS 602/ACI 530.1/ASCE 6)¹³.

$$\frac{M_{u,v}}{L} = \frac{wH^2}{8} \quad \rightarrow \quad L_{\max,v} = \frac{8M_{u,v}}{wH^2}$$

The MSJC redefines the deflection formulae to account for cracking by adding a second component if $M_s > M_{cr}$ such that:

$$\Delta_{s \leq cr} = \frac{5}{48} \frac{M_s H^2}{E_m I_g}$$

$$\Delta_{s \geq cr} = \frac{5}{48} \left(\frac{M_s H^2}{E_m I_g} + \frac{(M_s - M_{cr}) H^2}{E_m I_{cr}} \right)$$

Where:

H = the clear height of the wall (for conservatism)

M_{cr} = the ultimate cracking moment capacity

M_s = the serviceability moment

I_g = the gross (uncracked) moment of inertia

I_{cr} = the cracked moment of inertia

It should be noted that this deflection formula does not use the effective moment of inertia I_{ef} from AS 3600, which involves Branson's Formula which is deemed to be less appropriate for concrete masonry (usually applies to concrete beams and slabs)¹⁴.

It is possible that cracking has occurred due to shrinkage when the concrete or grout is cured, so this should be checked in order to determine the deflection. The cracking moment capacity calculation can be written from AS 3600 as:

$$M_{cr} = \frac{(f'_{mt} - \sigma_{cs}) I_g}{y_b} = \frac{(f'_{mt} - \sigma_{cs}) I_g}{(D - d_n)}$$

Where:

f'_{mt} = tensile bond strength of masonry

σ_{cs} = maximum shrinkage-induced tensile stress

$y_b = D - d_n$ depth of crack area (depth below the neutral axis)

According to AS 3700 Clause 3.3.3, $f'_{mt} = 0.2 \text{ MPa}$. This can be quite conservative for reinforced masonry as the tensile strength of the grout is not accounted for. For academic purposes, it is suggested to use $f'_{mt} = 1.0 \text{ MPa}$ (as used in the design charts in [Section 7.4](#)) where no testing is available.

In the absence of more refined calculation, the value of maximum shrinkage-induced tensile stress (σ_{cs}) that accounts for the restraint provided by the steel reinforcement may be calculated using AS 3600 Clause 8.5.3.1 to be:

$$\sigma_{cs} = \frac{2.5p_w - 0.8p_{cw}}{1 + 50p_w} E_s \epsilon_{cs}^*$$

Where:

$p_w = A_{st}/bd$ = web reinforcement ratio for tensile reinforcement

$p_{cw} = A_{sc}/bd$ = web reinforcement ratio for compressive reinforcement

= 0 (for centrally placed vertical reinforcement)

ϵ_{cs}^* = final design shrinkage strain of concrete

The shrinkage strain of the concrete is given in Table 3 (based on AS 3600 Table 3.1.7.2). This is based on the environment, compressive strength (f'_c) of the concrete and the hypothetical thickness (t_h) given to be equal to the thickness of the wall:

$$t_h = \frac{2A_g}{u_e} = \frac{2A_g}{(P_g + \frac{P_v}{2})} = \frac{2A_g}{(2b + 0)} = \frac{A_g}{b} = t_w$$

Where:

A_g = gross cross-sectional area of the masonry column

$P_g = 2b$ = exposed perimeter of the masonry column

P_v = perimeter of any closed voids within the masonry column

= 0 for grouted (reinforced) masonry columns

Table 3: Typical Final Design Shrinkage Strains

Final design shrinkage ϵ_{cs}^* (x10 ⁻⁶)								
f' _c (MPa)	Arid Environment		Interior Environment		Temperate Inland Environment		Tropical, Near-Coastal & Coastal Environments	
	Wall Thickness (mm)							
	100	200	100	200	100	200	100	200
25	720	590	670	550	630	520	530	440
32	720	590	670	560	630	520	540	450
40	710	590	670	560	620	530	540	460
50	700	590	660	560	620	530	540	470
65	700	600	660	570	630	550	560	490

Note: $f'_c = (1.3)f'_m$ = maximum compressive stress of concrete masonry as per AS 3700 Suppl. 1 C8.3(d).

$$\sum Q_x = Q_c - Q_t = A_c y_c - A_t y_t = 0 \rightarrow A_c y_c = A_t y_t$$

Where:

$A_c = bd_n$ = area of concrete under compression

$y_c = d_n/2$ = the ultimate cracking moment capacity

$A_t = n_e A_{st}$ = weighted area of steel under tension

$y_t = d - d_n$ = distance of tensile force to the neutral axis

Substituting these values allows for the distance to the neutral axis (as seen in Figure 12) to be calculated by:

$$bd_n \left(\frac{d_n}{2} \right) = n_e A_{st} (d - d_n) \rightarrow d_n = \frac{n_e A_{st}}{b} \left(-1 + \sqrt{1 + \frac{2bd}{n_e A_{st}}} \right)$$

Where:

b = tensile bond strength of masonry

$A_{st} = n(\pi d^2/4)$ = maximum shrinkage-induced tensile stress

$n_e = E_s/E_c$ = depth of crack area (depth below the neutral axis)

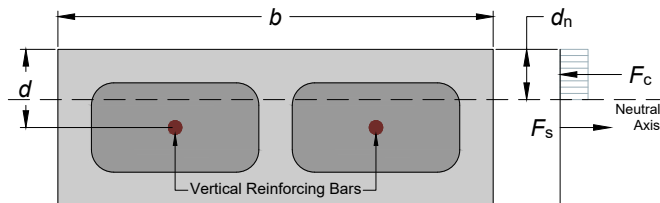


Figure 12: Force and Moment Areas of Concrete Block Column

This value for d_n can then be used to calculate the moment of inertia for the cracked column using:

$$I_{cr} = \frac{bd_n^3}{12} + bd_n \left(\frac{d_n}{2} \right)^2 + n_e A_{st} (d - d_n)^2 = \frac{bd_n^3}{3} + n_e A_{st} (d - d_n)^2$$

The gross moment of inertia (I_g) can then be calculated as the sum of second moment of area of the concrete (rectangular) and steel (circular) such that:

$$I_g = \sum I_x = I_c + I_s = \frac{bD^3}{12} + n_e A_{st} \left(\frac{d_{st}}{4} \right)^2$$

Where d_{st} is the diameter of the steel reinforcement (N10 bars assumed for the design charts in Section 7.4).

The serviceability wind load (w_s) can then be applied to calculate the serviceability moment (M_s) such that:

$$M_s = \frac{w_s H^2}{8} = \frac{\delta w_u H^2}{8} \quad (\text{in kNm/m})$$

To calculate this for the entire effective width of the wall (in kNm):

$$M_s^* = M_s (L + b_w)$$

Where L is the full length of the breeze block wall and b_w is the width of the supporting columns.

This can all be substituted into the deflection equation and solved for the maximum allowable deflection. As previously stated, under the serviceability limit state criteria set out in AS/NZS 1170.0 Table C1 for masonry walls under face loads (worst wind load case) is span/400.

If $M_s^* \leq M_{cr}$:

$$\frac{\Delta_{max}}{L} = \frac{H/400}{L} = \frac{5}{48} \frac{(M_s(L + b_w))H^2}{E_m I_g}$$

If $M_s^* > M_{cr}$:

$$\frac{\Delta_{max}}{L} = \frac{H/400}{L} = \frac{5}{48} \left(\frac{M_s(L + b_w)H^2}{E_m I_g} + \frac{(M_s(L + b_w) - M_{cr})H^2}{E_m I_{cr}} \right)$$

Solving for length (L) and height (H) gives the maximum dimensions as seen in the design charts in Section 7.4.

The deemed-to-satisfy requirements for reinforced masonry members subjected to bending must also be checked in accordance with AS 3700 Clause 8.6 such that:

$$M_d \leq \phi f_{sy} A_{sd} d \left[1 - \frac{0.6 f_{sy} A_{sd}}{(1.3 f'_m) b d} \right]$$

Where:

M_d = the design bending moment of the column

$\phi = 0.75$ = the capacity reduction factor for reinforced masonry (as per AS 3700 Table 4.1)

A_{sd} = the area of steel under tension used for design

$$= \min \left(\frac{(0.29) 1.3 f'_d b d}{f_{sy}}, A_{st} \right)$$

Construction

6

6.1 In-Plane Steel Structure

The simplest assembly of a breeze block wall with vertical reinforcement from a constructability perspective is to use steel posts (with the appropriate durability rating). These posts can be thin enough to fit within the perpendicular joints to hide them behind pointed mortar (such as Leviat's WP4 Windposts seen in Figure 14 and Figure 15) or slotted into grooved edges of blocks where available. However, larger wind posts (such as a 90 x 90 mm steel post seen in Figure 16) or those with angles can be used to more effectively increase the resistance of the wall to lateral loads, thereby increasing its length and/or height limitations. This assembly allows the wall to have the same appearance on both sides.

The horizontal bed joint mesh should be adequately tied to the steel posts to ensure the breeze blocks act compositely with the steel to resist lateral loads. This can be achieved by using masonry wall ties for steel frames or specialised systems such as those made by Leviat, as shown in Figure 13.



Figure 13: Leviat Specialised Steel Wind Post System with Wall Tie

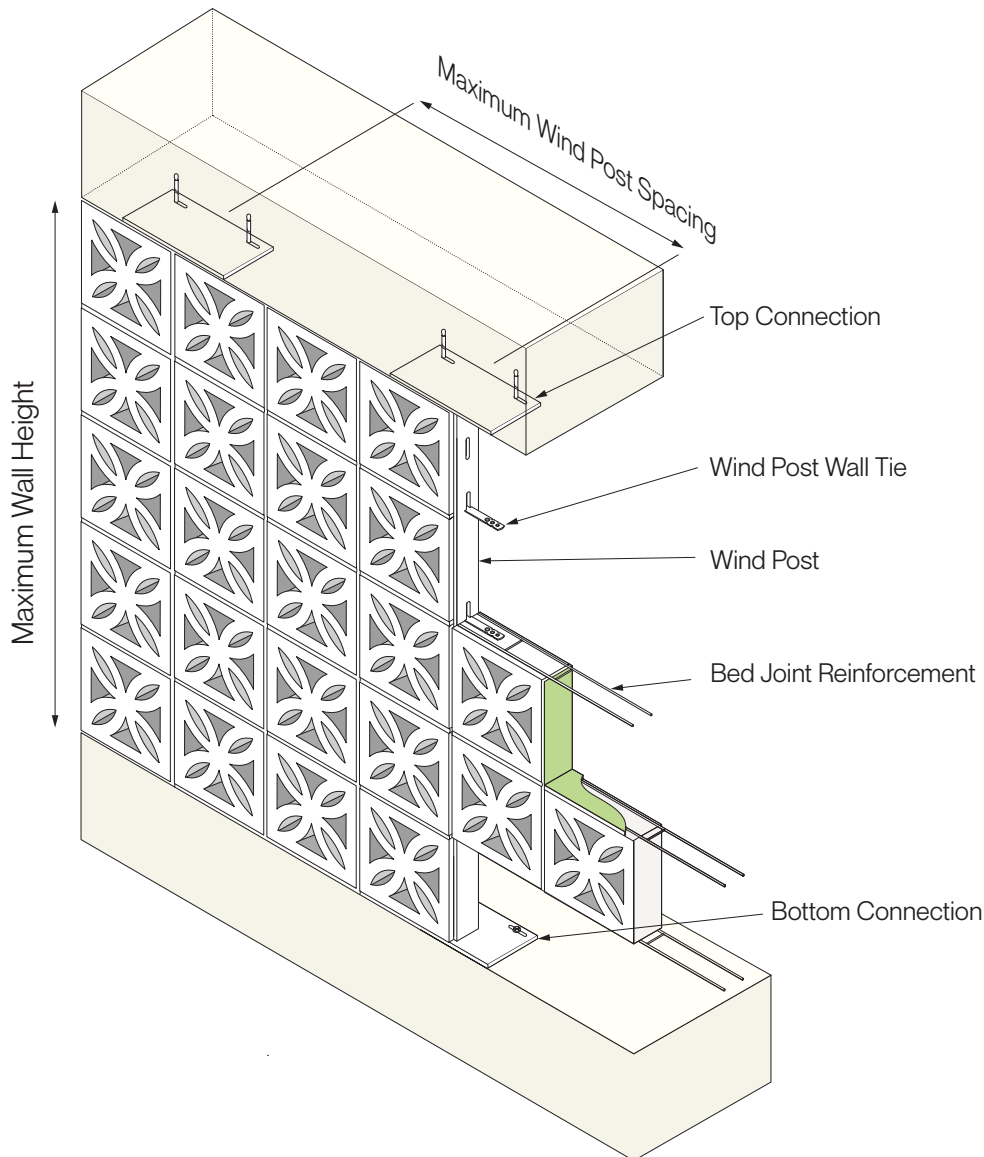


Figure 14: Concealed Leviat Wind Post Assembly Detail from Austral Masonry Breeze Block Manual

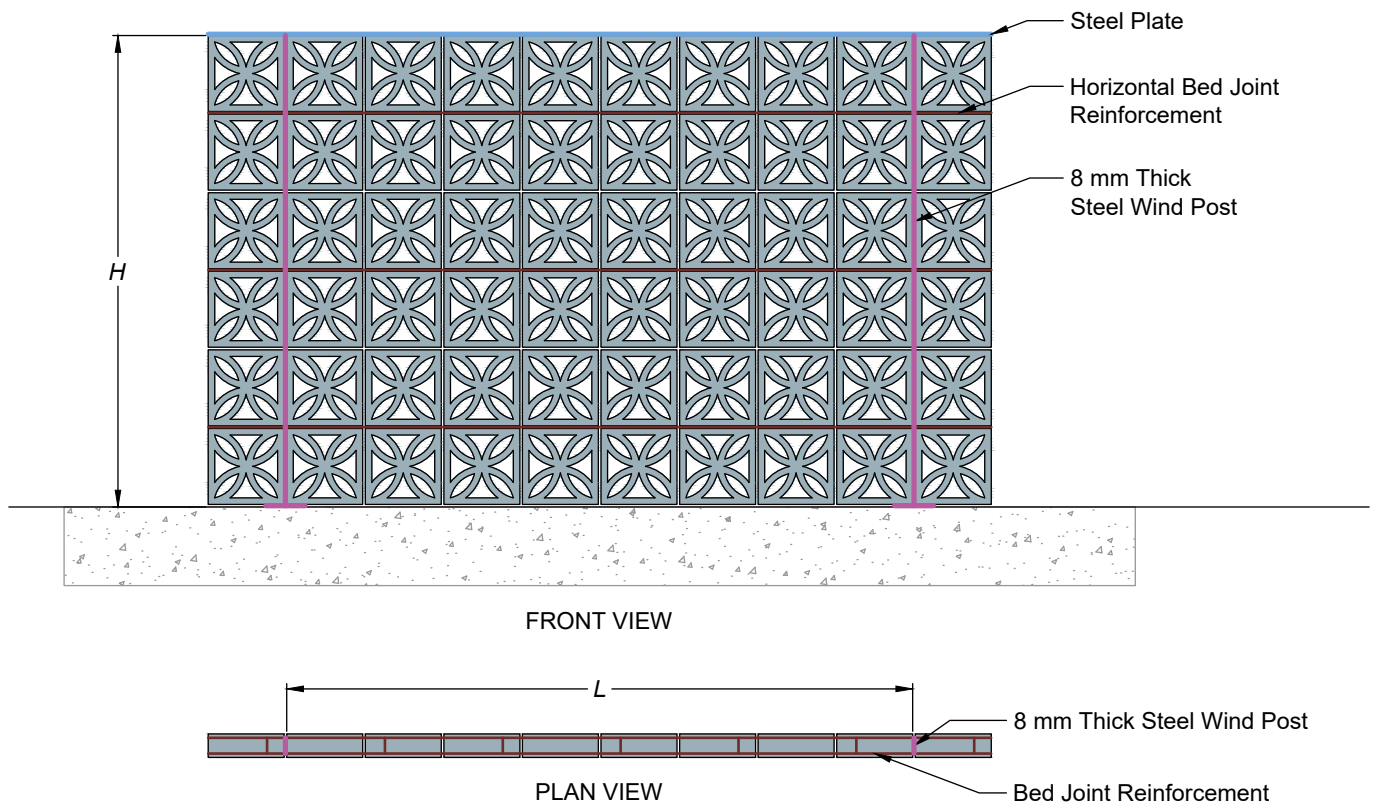


Figure 15: Concealed 8 mm Thick Steel Wind Post Breeze Block Assembly Detail

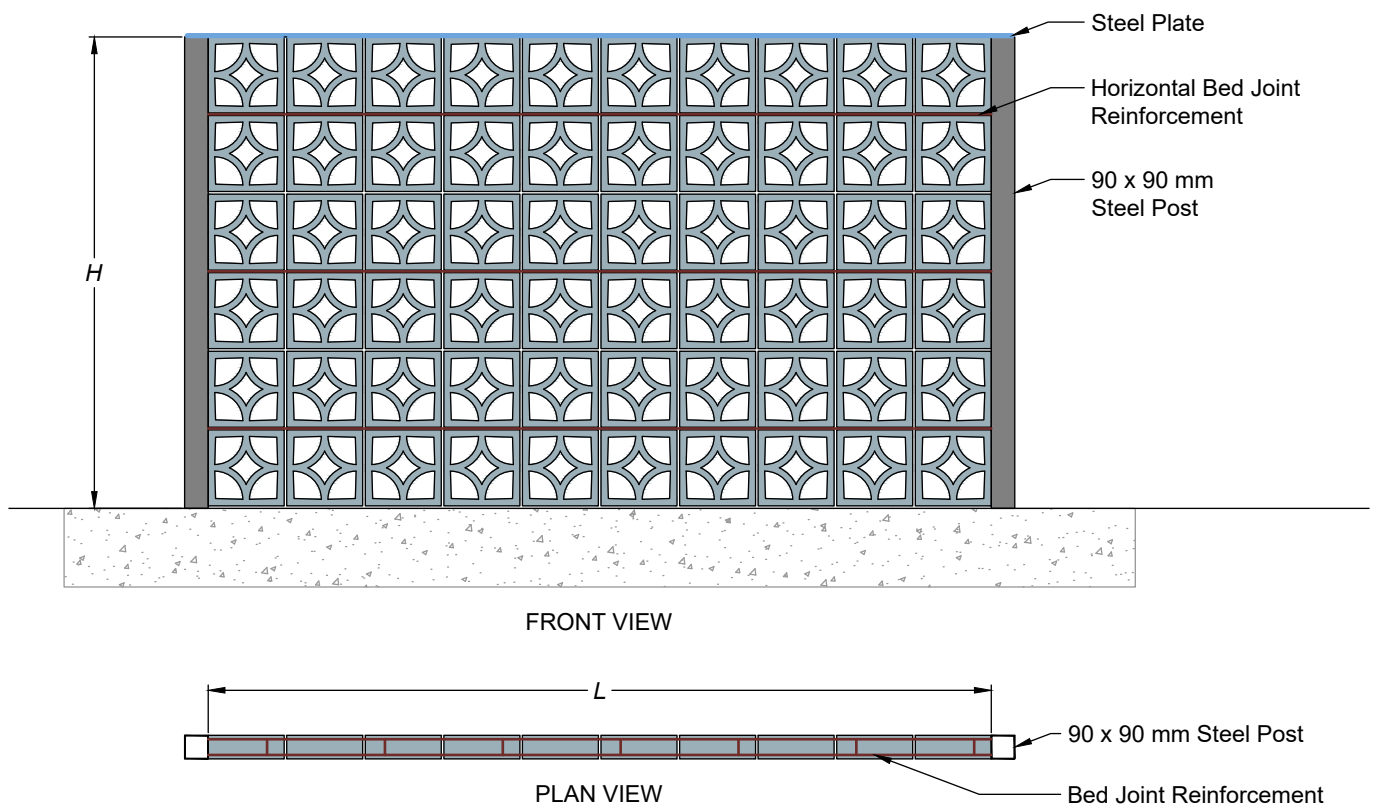


Figure 16: Exposed 90 x 90 mm Steel Post Breeze Block Assembly Detail

6.2 Offset Steel Structure

For steel vertically reinforced breeze block walls that require wind posts thicker than the perpend joints but still require a continuous façade, a steel frame can be used behind the wall. Depending on the required thickness of the vertical steel posts and the shell thickness of the breeze blocks, the steel can be concealed behind the solid elements of the breeze blocks. To achieve this, the posts should not exceed:

$$T \leq 2t_f + t_j$$

Where:

T = steel post thickness

t_f = face shell thickness

t_j = perpend joint thickness

This assembly required the steel posts or columns behind the wall to be adequately tied to the breeze blocks with either brick ties (see Figure 17) or steel tabs welded to the columns and inserted into breeze block wall joints. Some systems may use vertical steel tabs that have openings to allow the horizontal reinforcement to continue past the connection. An example of this can be seen in Figure 18.

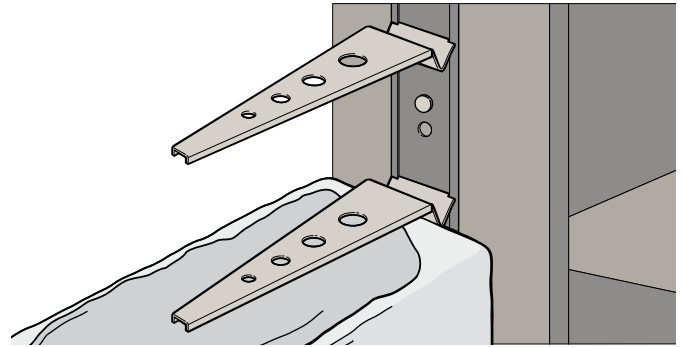


Figure 17: Wall Tie Connection to Steel Frame

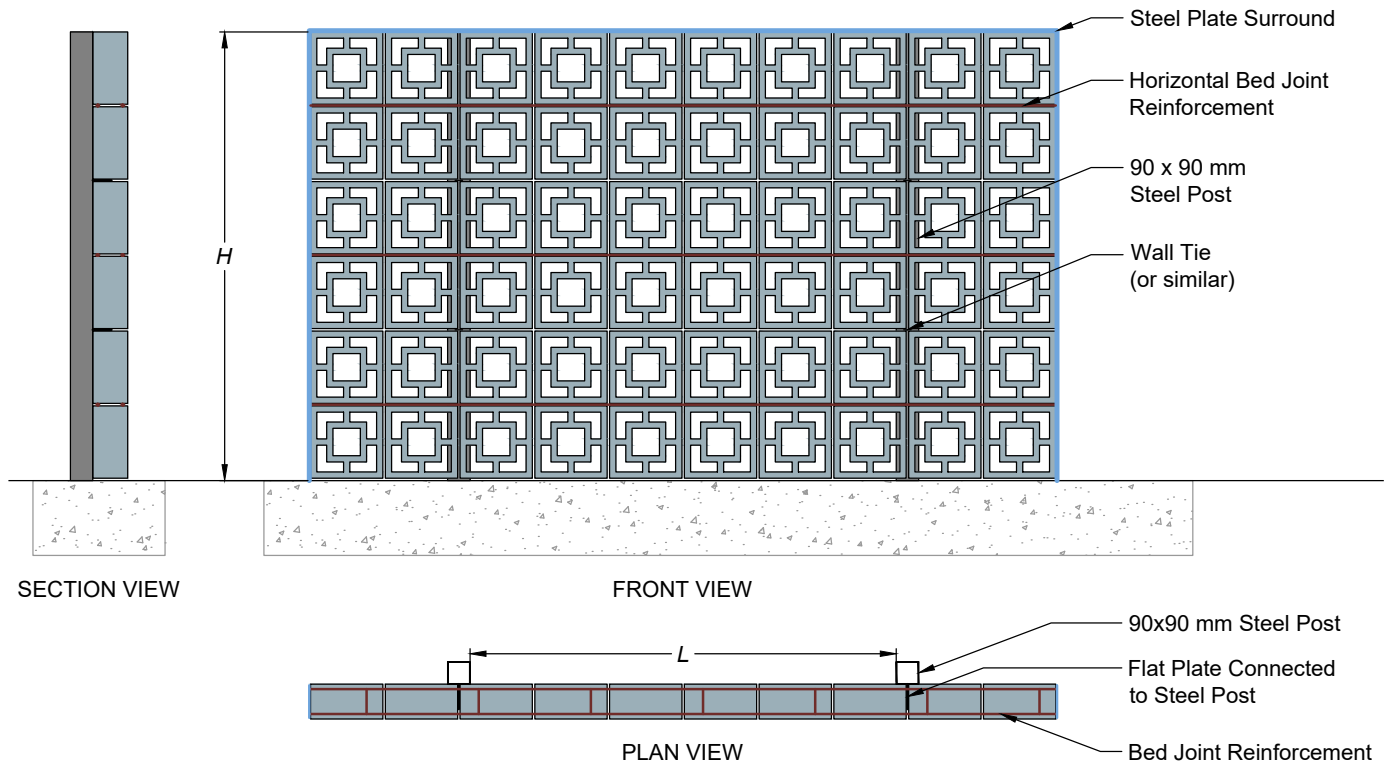


Figure 18: Concealed 90 x 90 mm Steel Post Breeze Block Assembly Detail

6.3 In-Plane Blockwork Structure

A common installation method for breeze block walls is to surround it with a blockwork pier. Often this acts as the vertical reinforcement for the wall to improve its wind load capacity (and ultimately permit longer lengths or heights) calculated as per [Section 5.6.2](#). These blockwork piers can be flush with the wall on either side or protrude as an engaged pier depending on the thickness of the wall and piers required for lateral load resistance. This assembly also allows the wall to have the same appearance on both sides depending on the thickness of the blockwork pier.

Where possible, the bed joint reinforcement should extend into the piers. Otherwise the breeze blocks should be adequately tied to the piers as shown in Figure 19. As standard blocks generally come in 190 mm heights, some breeze blocks require a set number of courses to achieve this assembly effectively. An example of misaligned blockwork to breeze blocks is seen in Figure 20, where the square (290 mm high) breeze blocks require 3 block courses to every 2 courses of breeze blocks. The bed joint reinforcement should extend into the piers, or the breeze blocks should be adequately tied to the piers.

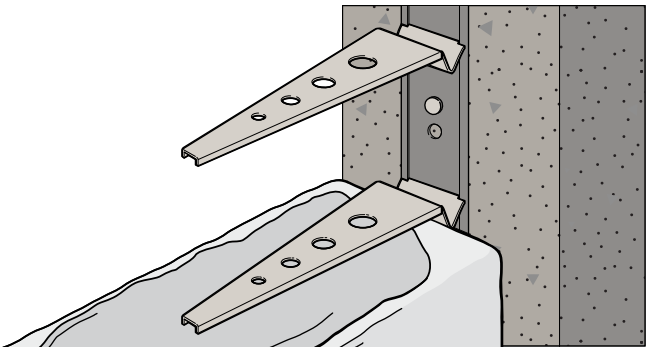


Figure 19: Wall Tie Connection to Concrete Blockwork

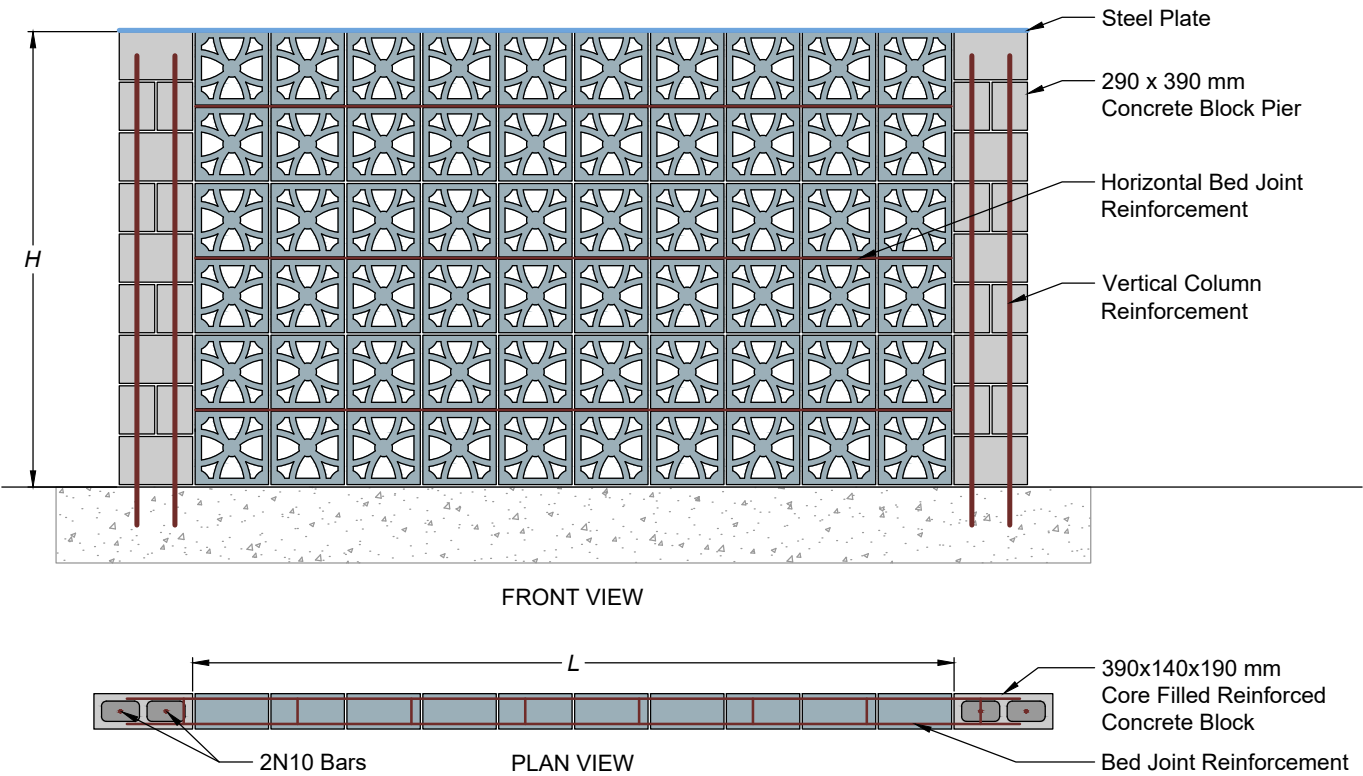


Figure 20: Exposed Concrete Block Pier Breeze Block Assembly Detail

6.4 Offset Blockwork Structure

When only one face of the breeze block wall is required to have visual appeal or there are intersecting block walls behind the breeze blocks, concrete piers may be installed behind the wall and hidden behind the breeze blocks. This also allows the ends of the wall to be exposed if required for additional aesthetic benefit and concrete continuity. This involves using concrete blocks built up in conjunction with the breeze block wall and connected at a series of points with wall ties. It is recommended that the concrete piers be reinforced and filled with grout to provide adequate stiffness to support the breeze block wall.

To tie the whole assembly together as a free-standing element, the top and side flanks of the installation can be surrounded with a flat plate connected to the vertical piers as shown in Figure 21. This is an additional benefit of the concrete block piers not being connected to the ends of the walls.

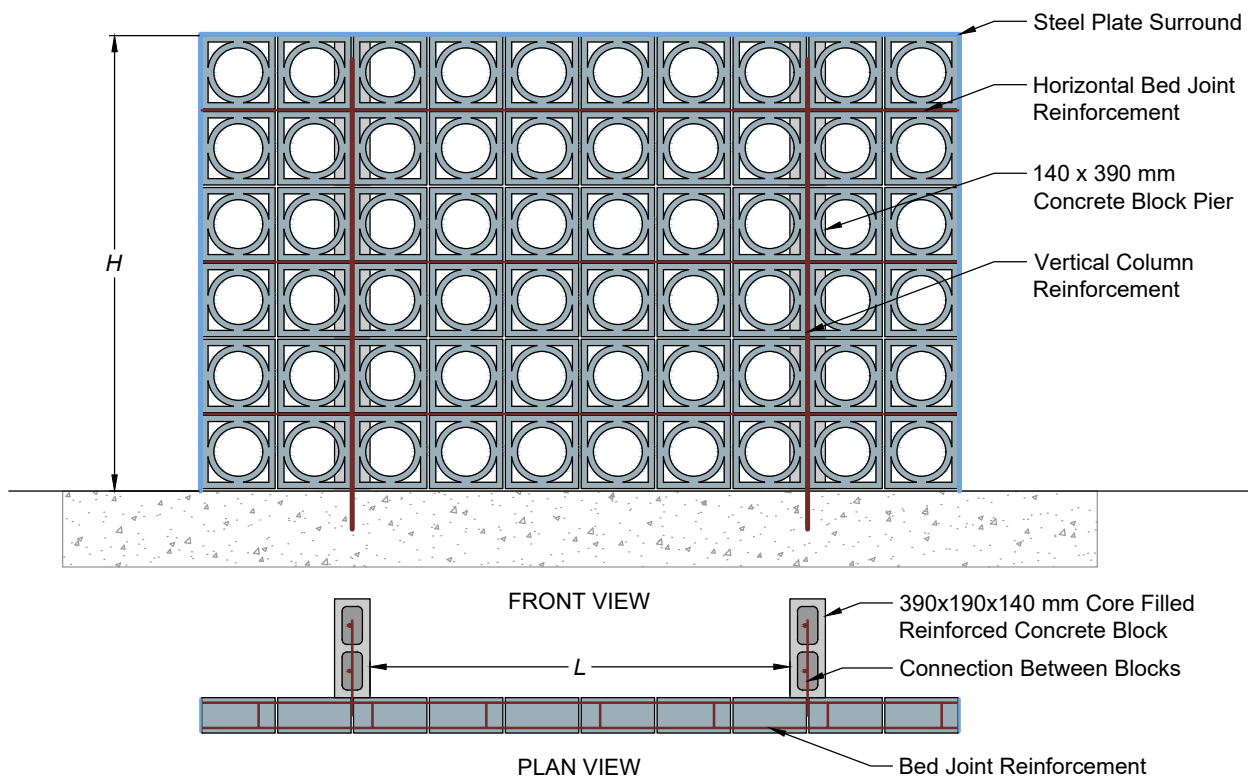


Figure 21: Concealed Concrete Block Pier Breeze Block Assembly Detail

6.5 Wall Ties

Where the breeze block wall has a free edge (at openings or control joints), it is recommended to install additional vertical reinforcements adjacent to the free edge. An example of this can be seen in Figure 22 using the Leviat WP4 that is referenced in [Section 6.1](#).

For bridging control joints, flexible masonry anchors may be installed to transmit shear forces imposed by lateral loads across the joint, while still allowing the two wall sections to move independently, to increase the wind post spacing around the joint (see Figure 23). Examples of suitable wall expansion ties are shown in Figure 24. Alternatively, debonding sleeves are effective when using specialised wind post systems (such as those made by Leviat¹⁶ as in [Section 6.1](#)). These can be installed onto one side of the wall tie to act as a slip plane, accommodating the movement of the two wall sections. Debonding sleeves should be installed with a 10 mm gap at the end to allow for expansion of the masonry¹⁷, as shown in Figure 25.

For connections to timber, steel or concrete block framework, Abey Alligator Ties are also a common option (see Figure 26). These also allow for movement of control joints, preventing issues such as cracking from occurring due to differential movement between materials.

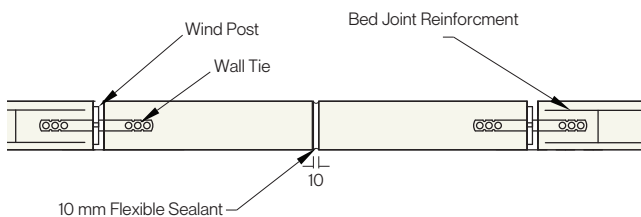


Figure 22: Wind Post Ties One Block Adjacent to Control Joint

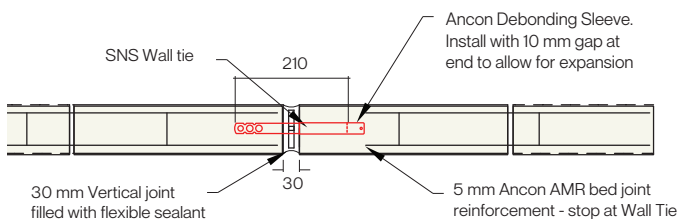


Figure 23: Debonding Sleeve on Wall Tie Bridging Control Joint

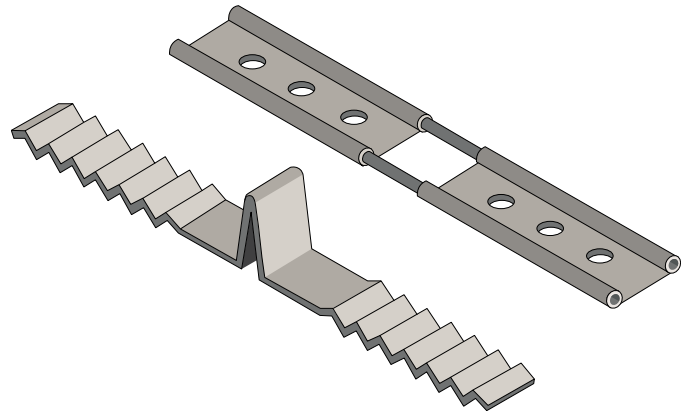


Figure 24: Wall Expansion Tie Examples

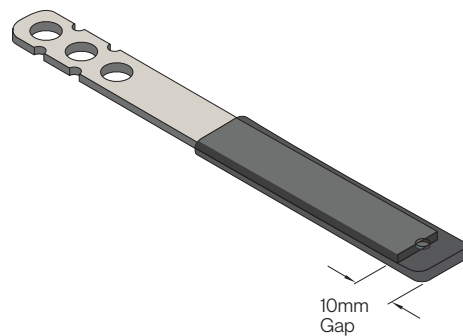


Figure 25: Debonding Sleeve Example for Wall Ties

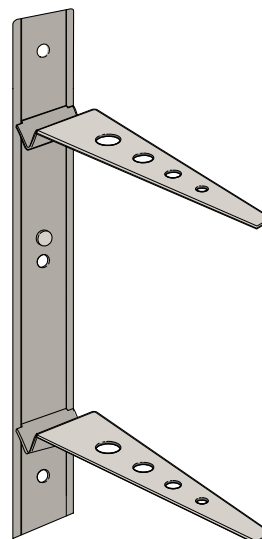


Figure 26: Abey Alligator Wall Tie

Design Charts

The following design charts show the limiting heights and lengths of breeze block walls under a given design wind load. The breeze block material properties for all properties have been assumed to be as those in based on values provided by GB Masonry¹⁸. These have been assumed close to (or equal to) the most conservative values.

Table 4: Breeze Block Material Property Assumptions

Breeze Block Property		Value	UoM
Design Joint Thickness	t_j	10	mm
Face Shell Thickness	t_f	25	mm
Core Percentage		48	%
Characteristic Lateral Modulus of Rupture	f_{ut}	0.48	MPa
Characteristic Unconfined Compressive Strength	f_{uc}	3.00	MPa

7.1 Stretcher Bond Walls

7.1.1 SQUARE (90 MM THICK) BREEZE BLOCKS

Chart 1 — 90 mm Thick 90 mm Thick Square Breeze Blocks with All Sides Supported

Chart 2 — 90 mm Thick Square Breeze Blocks with Top Edge Free

Chart 3 — 90 mm Thick Square Breeze Blocks with One Side Free

7.1.2 RECTANGULAR (90 MM THICK) BREEZE BLOCKS

Chart 4 — 90 mm Thick Horizontal Breeze Blocks with All Sides Supported

Chart 5 — 90 mm Thick Horizontal Breeze Blocks with Top Edge Free

Chart 6 — 90 mm Thick Horizontal Breeze Blocks with One Side Free

7.1.3 RECTANGULAR (140 MM THICK) BREEZE BLOCKS

Chart 7 — 140 mm Thick Horizontal Breeze Blocks with All Sides Supported

Chart 8 — 140 mm Thick Horizontal Breeze Blocks with Top Edge Free

Chart 9 — 140 mm Thick Horizontal Breeze Blocks with One Side Free

7.1.4 STANDARD 100 SERIES (10.01) BLOCKS

Chart 10 — Standard 10.01 Concrete Blocks with All Sides Supported

Chart 11 — Standard 10.01 Concrete Blocks with Top Edge Free

Chart 12 — Standard 10.01 Concrete Blocks with One Side Free

7.1.5 STANDARD 150 SERIES (15.01) BLOCKS

Chart 13 — Standard 15.01 Concrete Blocks with All Sides Supported

Chart 14 — Standard 15.01 Concrete Blocks with Top Edge Free

Chart 15 — Standard 15.01 Concrete Blocks with One Side Free

7.1.6 STANDARD 200 SERIES (20.01) BLOCKS

Chart 16 — Standard 20.01 Concrete Blocks with All Sides Supported

Chart 17 — Standard 20.01 Concrete Blocks with Top Edge Free

Chart 18 — Standard 20.01 Concrete Blocks with One Side Free

7.2 Horizontally Reinforced Stack Bond Walls

7.2.1 SQUARE (90 MM THICK) BREEZE BLOCKS

Chart 19 — 90 mm Thick Square Breeze Blocks with Horizontal Reinforcement

7.2.2 RECTANGULAR BREEZE BLOCKS

Chart 20 — 90 mm Thick Horizontal Breeze Blocks with Horizontal Reinforcement

Chart 21 — 140 mm Thick Horizontal Breeze Blocks with Horizontal Reinforcement

Chart 22 — 90 mm Thick Vertical Breeze Blocks with Horizontal Reinforcement

Chart 23 — 140 mm Thick Vertical Breeze Blocks with Horizontal Reinforcement

7.2.3 STANDARD HOLLOW CONCRETE BLOCKS

Chart 24 — Horizontal Standard 10.01 Concrete Blocks with Horizontal Reinforcement

Chart 25 — Horizontal Standard 15.01 Concrete Blocks with Horizontal Reinforcement

Chart 26 — Horizontal Standard 20.01 Concrete Blocks with Horizontal Reinforcement

Chart 27 — Vertical Standard Hollow Concrete Blocks with Horizontal Reinforcement

7.3 Windpost Reinforced Stack Bond Walls

7.3.1 SQUARE (90 MM THICK) BREEZE BLOCKS

Chart 28 — 90 mm Thick Square Breeze Blocks with Wind Posts

7.3.2 RECTANGULAR BREEZE BLOCKS

Chart 29 — 90 mm Thick Horizontal Breeze Blocks with Wind Posts

Chart 30 — 140 mm Thick Horizontal Breeze Blocks with Wind Posts

Chart 31 — 90 mm Thick Vertical Breeze Blocks with Wind Posts

Chart 32 — 140 mm Thick Vertical Breeze Blocks with Wind Posts

7.3.3 STANDARD HOLLOW CONCRETE BLOCKS

Chart 33 — Horizontal Standard 10.01 Concrete Blocks with Wind Posts

Chart 34 — Horizontal Standard 15.01 Concrete Blocks with Wind Posts

Chart 35 — Horizontal Standard 20.01 Concrete Blocks with Wind Posts

Chart 36 — Vertical Standard Concrete Blocks with Wind Posts

7.4 Concrete Block Reinforced Column Stack Bond Walls

7.4.1 RECTANGULAR (140 MM THICK) BREEZE BLOCKS

Chart 37 — 140 mm Thick Horizontal Breeze Blocks with Single Reinforced Block Column

Chart 38 — 140 mm Thick Horizontal Breeze Blocks with Double Reinforced Block Column

Chart 39 — 140 mm Thick Vertical Breeze Blocks with Single Reinforced Block Column

Chart 40 — 140 mm Thick Vertical Breeze Blocks with Double Reinforced Block Column

7.4.2 STANDARD HOLLOW CONCRETE BLOCKS

Chart 41 — Horizontal Standard 10.01 Concrete Blocks with Single Reinforced Block Column

Chart 42 — Horizontal Standard 10.01 Concrete Blocks with Double Reinforced Block Column

Chart 43 — Horizontal Standard 15.01 Concrete Blocks with Single Reinforced Block Column

Chart 44 — Horizontal Standard 15.01 Concrete Blocks with Double Reinforced Block Column

Chart 45 — Horizontal Standard 20.01 Concrete Blocks with Single Reinforced Block Column

Chart 46 — Horizontal Standard 20.01 Concrete Blocks with Double Reinforced Block Column

Chart 47 — Vertical Standard Hollow Concrete Blocks with Single Reinforced Block Column

Chart 48 — Vertical Standard Hollow Concrete Blocks with Double Reinforced Block Column



The Ash by Daleki Design
Photography by Dion Robeson

7.1 Stretcher Bond Walls

The following charts are for stretcher bond breeze block walls subject to lateral wind loads and associated two-way bending. These are designed with respect to [Section 5.4](#) with an assumed characteristic flexural tensile strength (f'_{mt}) equal to 0.07 MPa.

The support conditions of each stretcher bond wall assembly is indicated by an icon with each chart. Where the icon shows hatching along an edge, the corresponding edge of the wall is laterally supported. Openings and control joints are to be assumed as unsupported edges when using these charts. It has been assumed that there is no rotational restraint on any edges of the wall (such that R_{f1} and R_{f2} in AS 3700 Table 7.5 are zero).

7.1.1 SQUARE (90 MM THICK) BREEZE BLOCKS

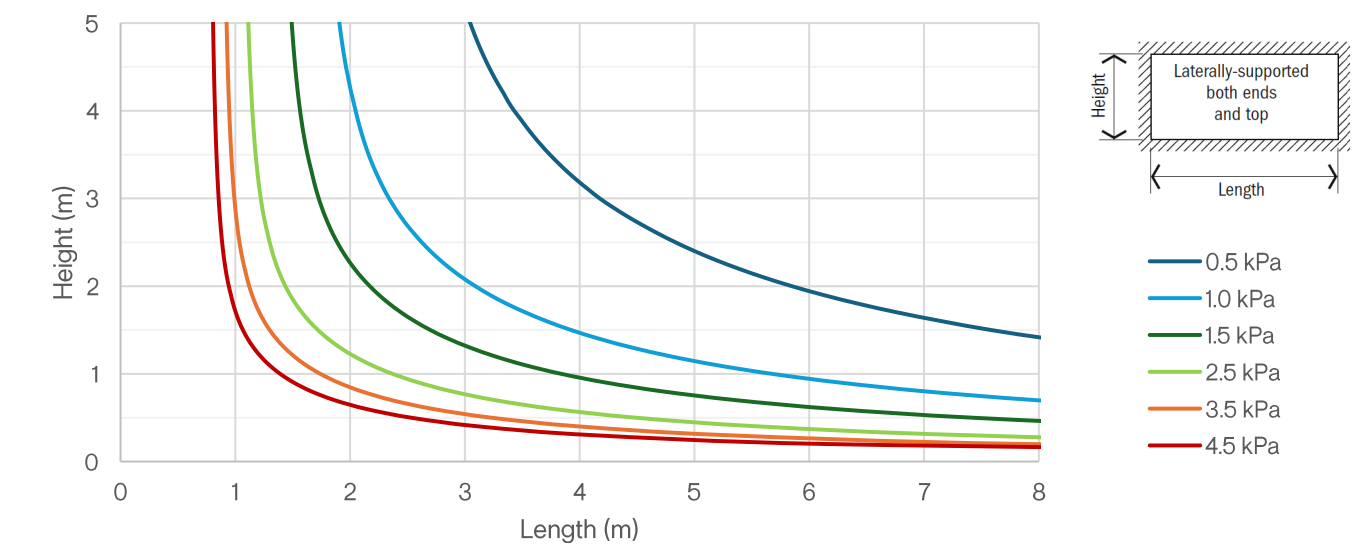


Chart 1: 90 mm Thick Square Breeze Blocks with All Sides Supported (Stretcher Bond)

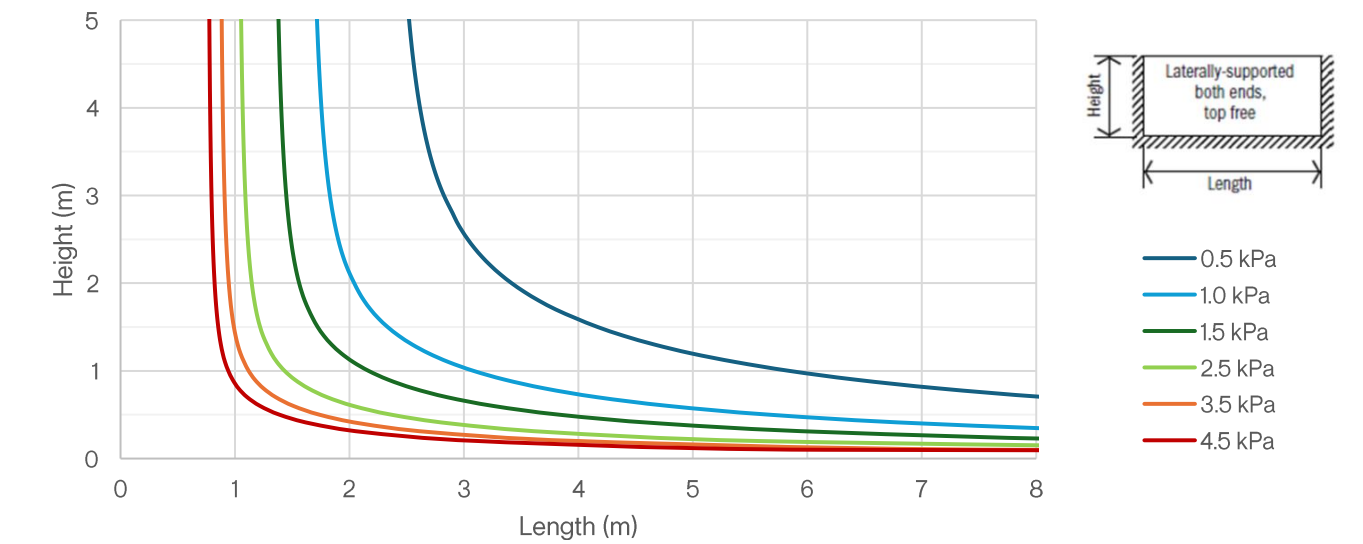


Chart 2: 90 mm Thick Square Breeze Blocks with Top Edge Free (Stretcher Bond)

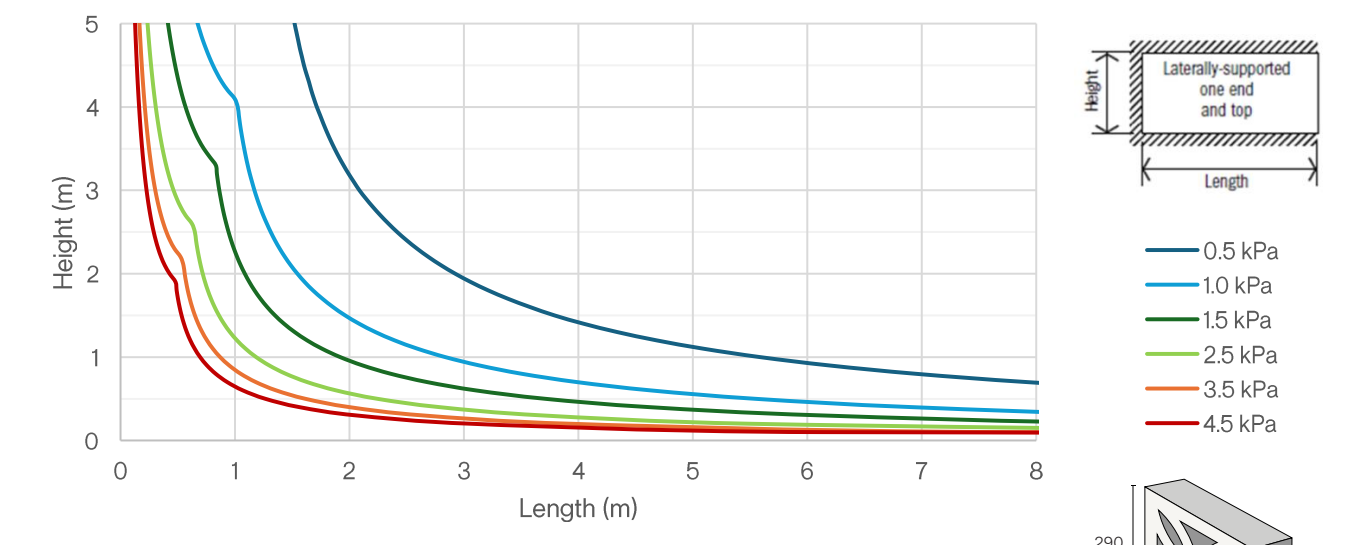


Chart 3: 90 mm Thick Square Breeze Blocks with One Side Free (Stretcher Bond)

7.1.2 RECTANGULAR (90 MM THICK) BREEZE BLOCKS

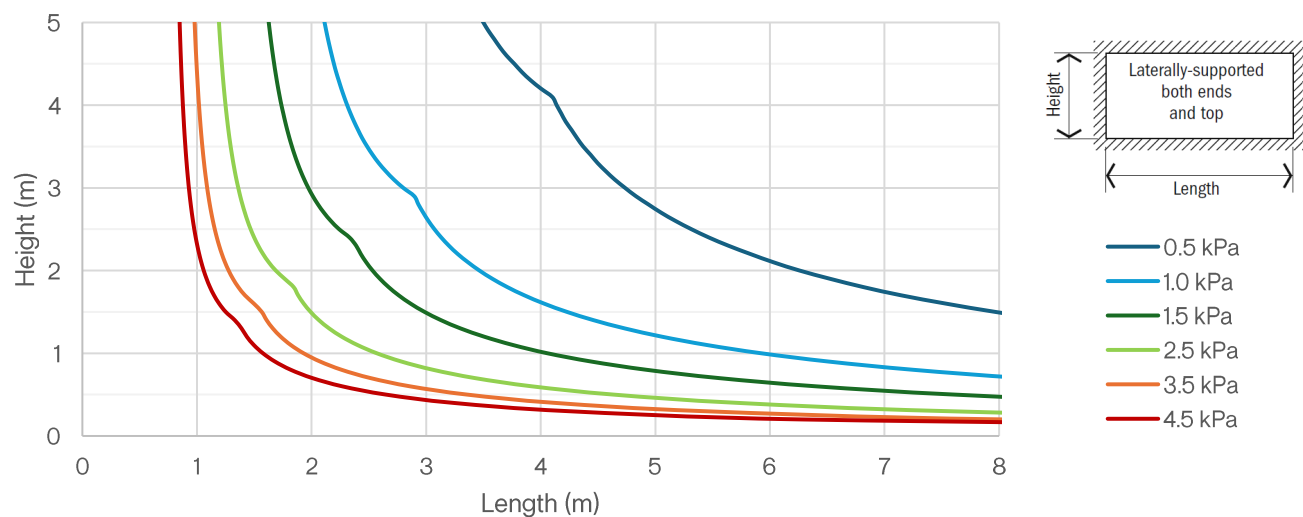


Chart 4: 90 mm Thick Horizontal Breeze Blocks with All Sides Supported (Stretcher Bond)

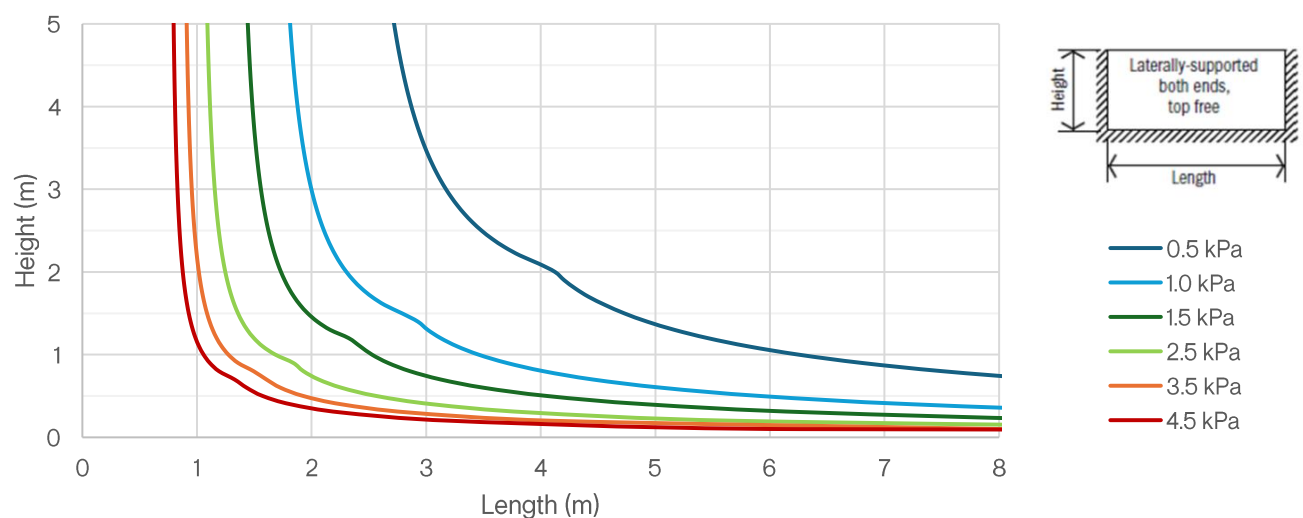


Chart 5: 90 mm Thick Horizontal Breeze Blocks with Top Edge Free (Stretcher Bond)

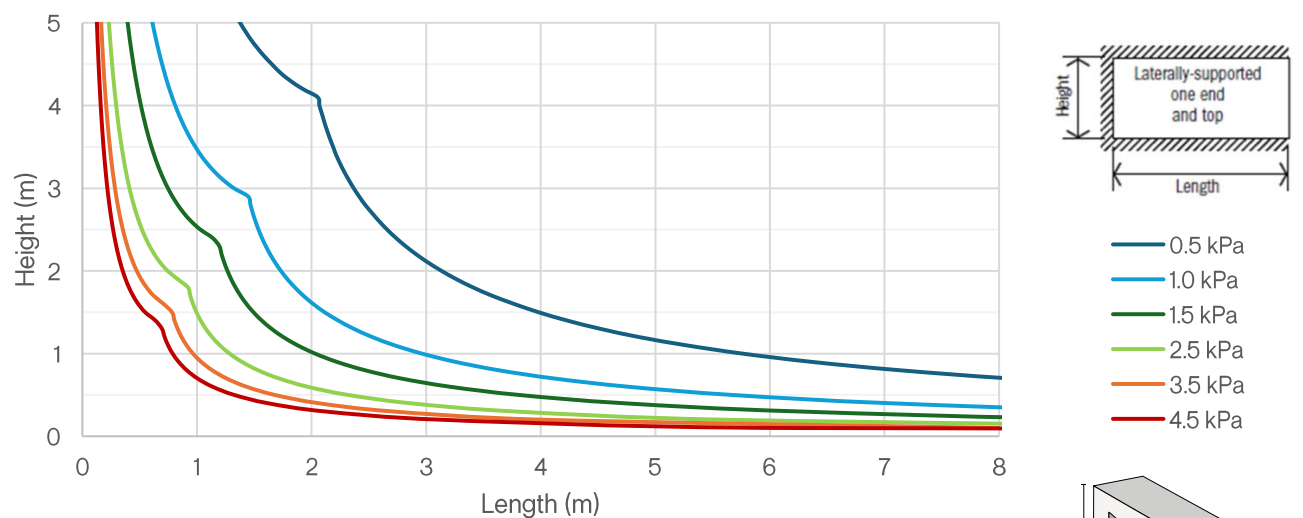


Chart 6: 90 mm Thick Horizontal Breeze Block with One Side Free (Stretcher Bond)

7.1.3 RECTANGULAR (140 MM THICK) BREEZE BLOCKS

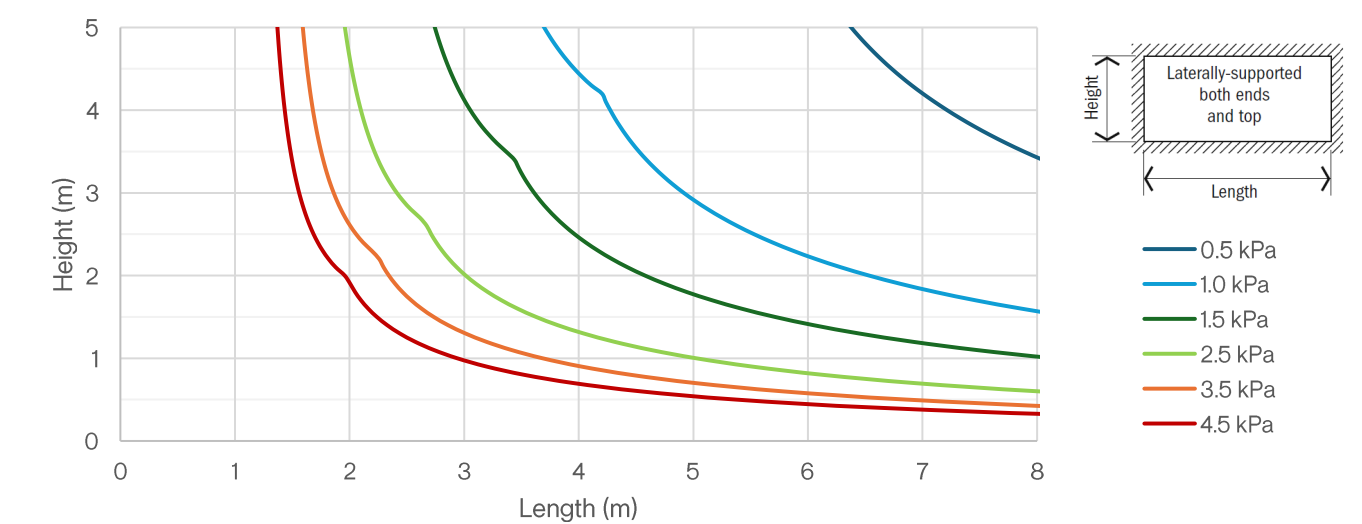


Chart 7: 140 mm Thick Horizontal Breeze Blocks with All Sides Supported (Stretcher Bond)

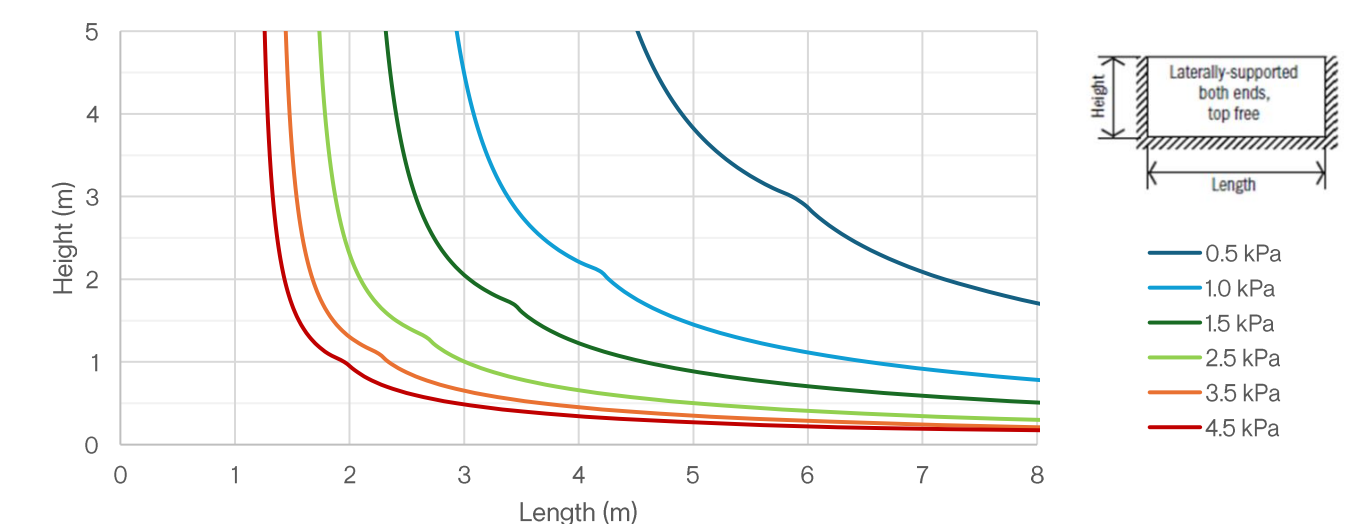


Chart 8: 140 mm Thick Horizontal Breeze Blocks with Top Edge Free (Stretcher Bond)

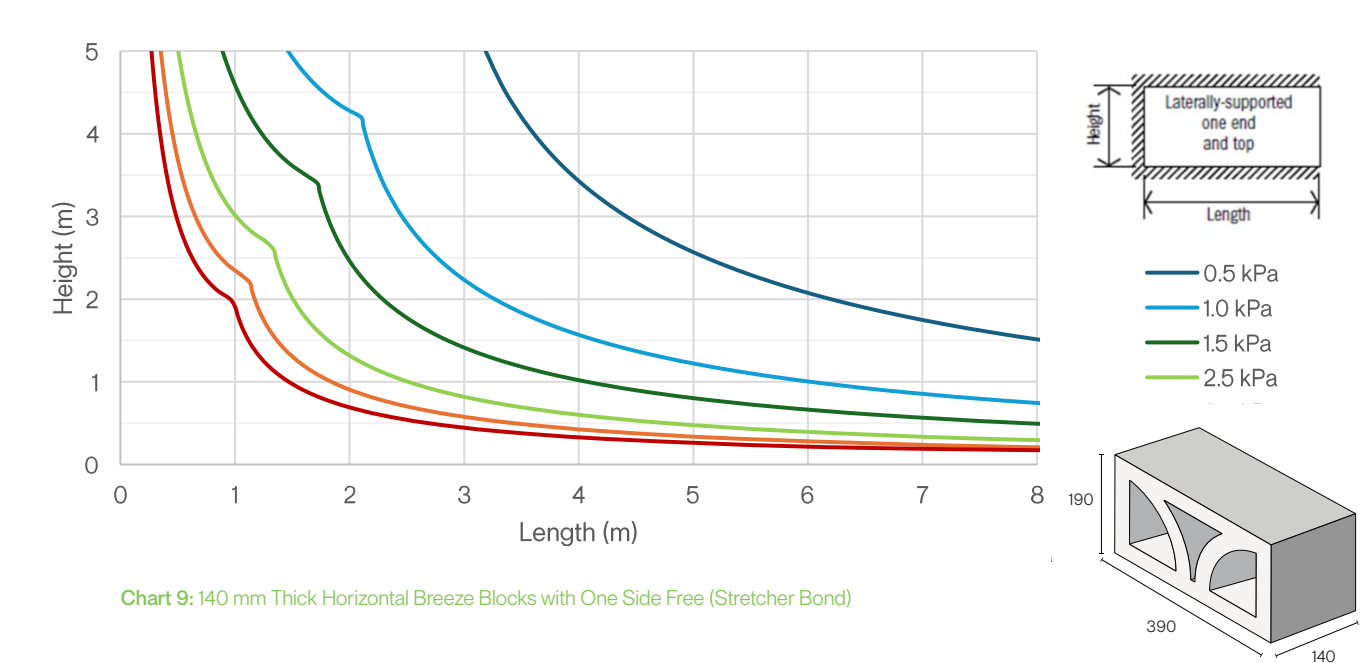


Chart 9: 140 mm Thick Horizontal Breeze Blocks with One Side Free (Stretcher Bond)

7.1.4 STANDARD 100 SERIES (10.01) BLOCKS

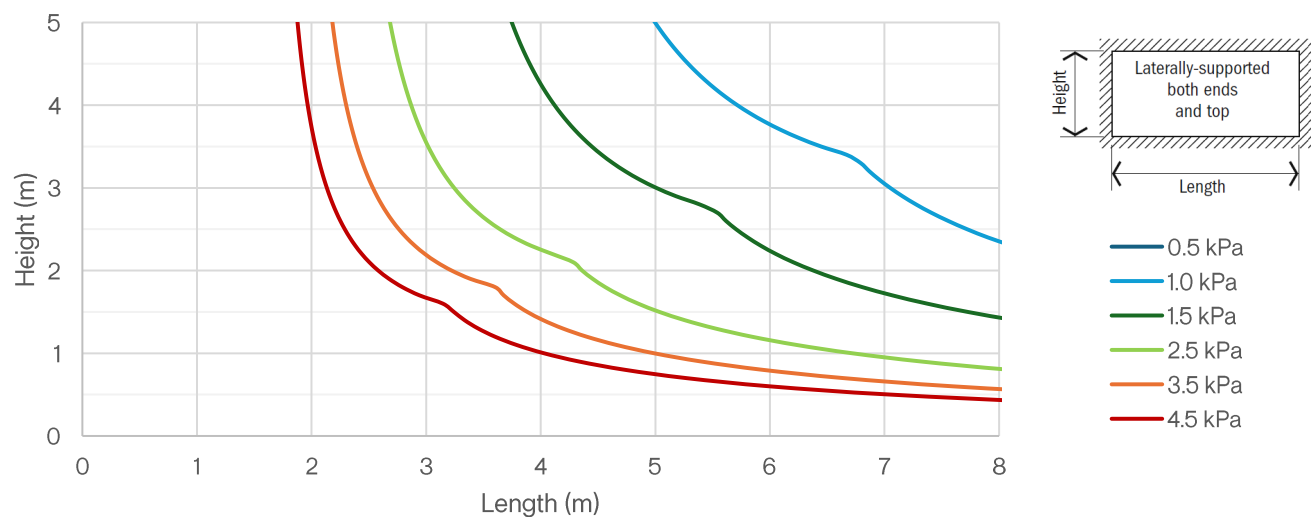


Chart 10: Standard 10.01 Concrete Thick Horizontal Breeze Blocks with All Sides Supported (Stretcher Bond)

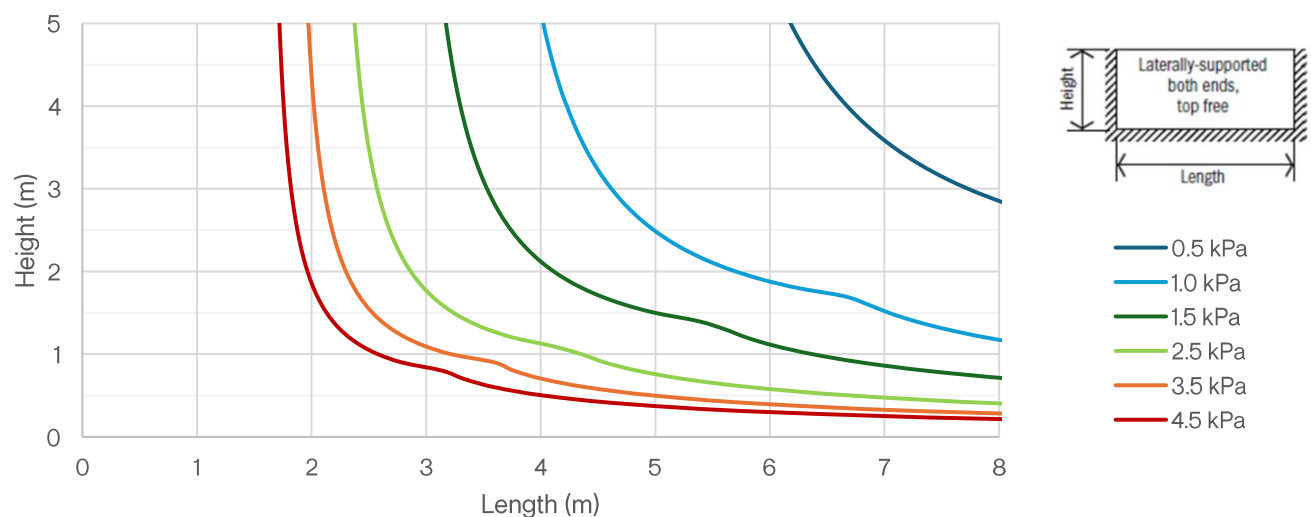


Chart 11: Standard 10.01 Concrete Blocks with Top Edge Free (Stretcher Bond)

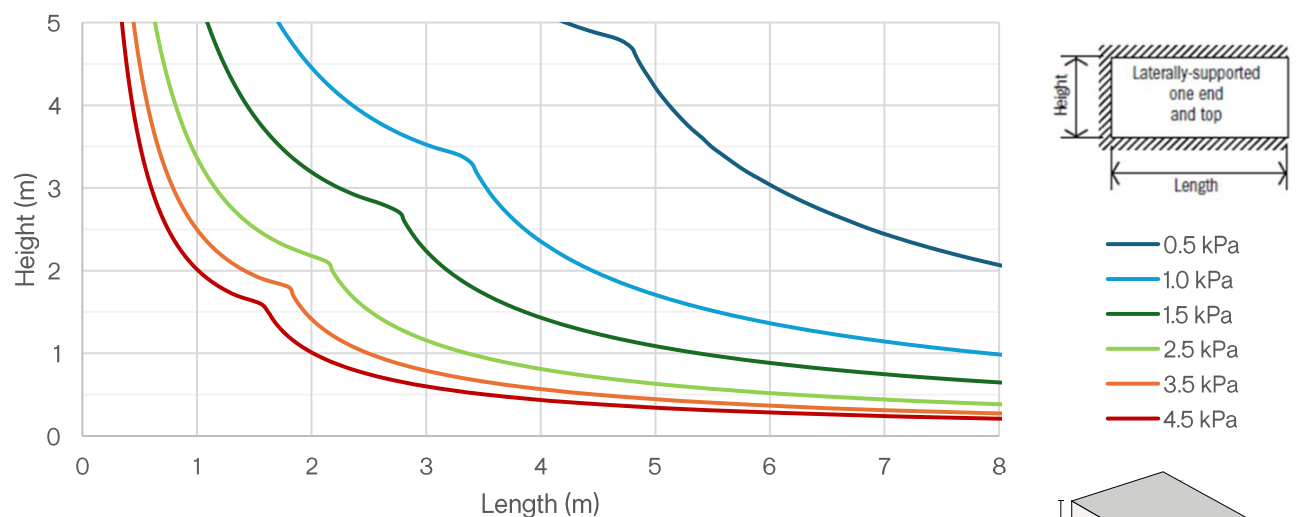


Chart 12: Standard 10.01 Concrete Blocks with One Side Free (Stretcher Bond)

7.1.5 STANDARD 150 SERIES (15.01) BLOCKS

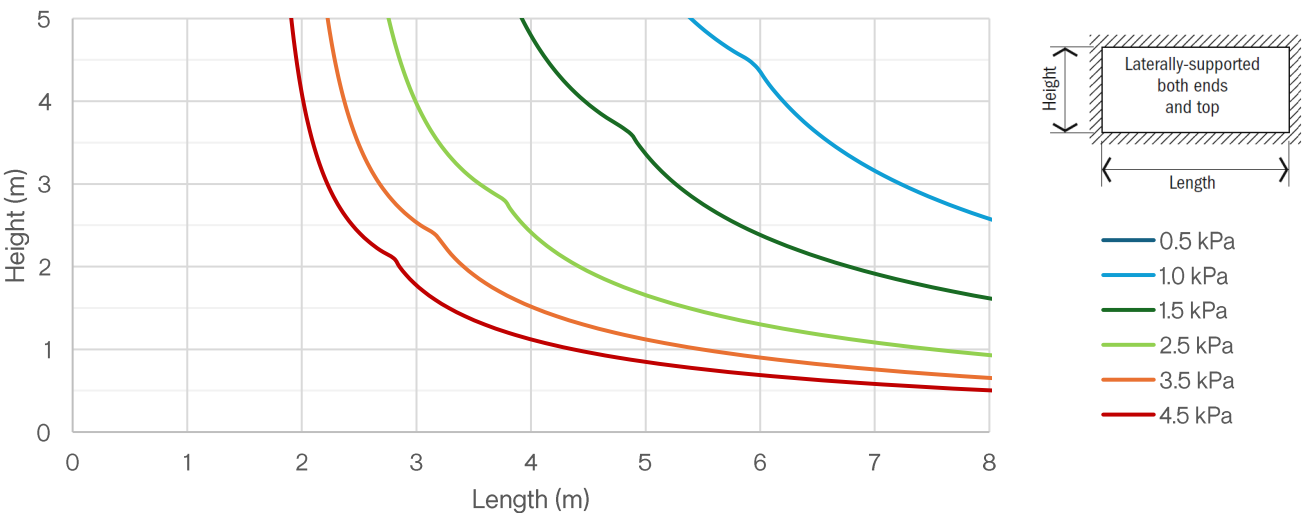


Chart 13: Standard 15.01 Concrete Blocks with All Sides Supported (Stretcher Bond)

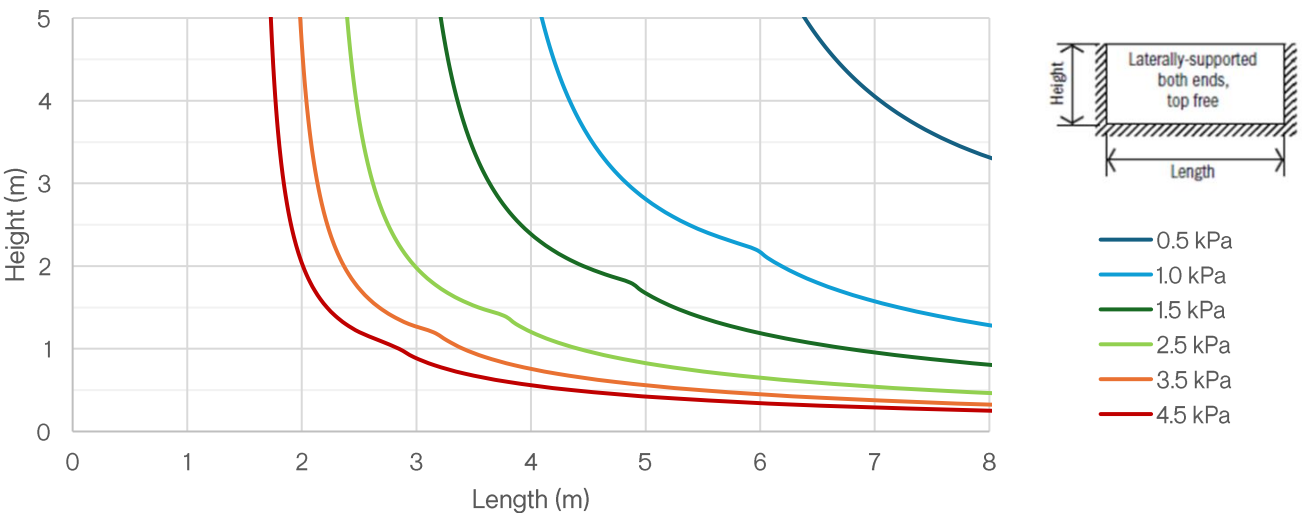


Chart 14: Standard 15.01 Concrete Blocks with Top Edge Free (Stretcher Bond)

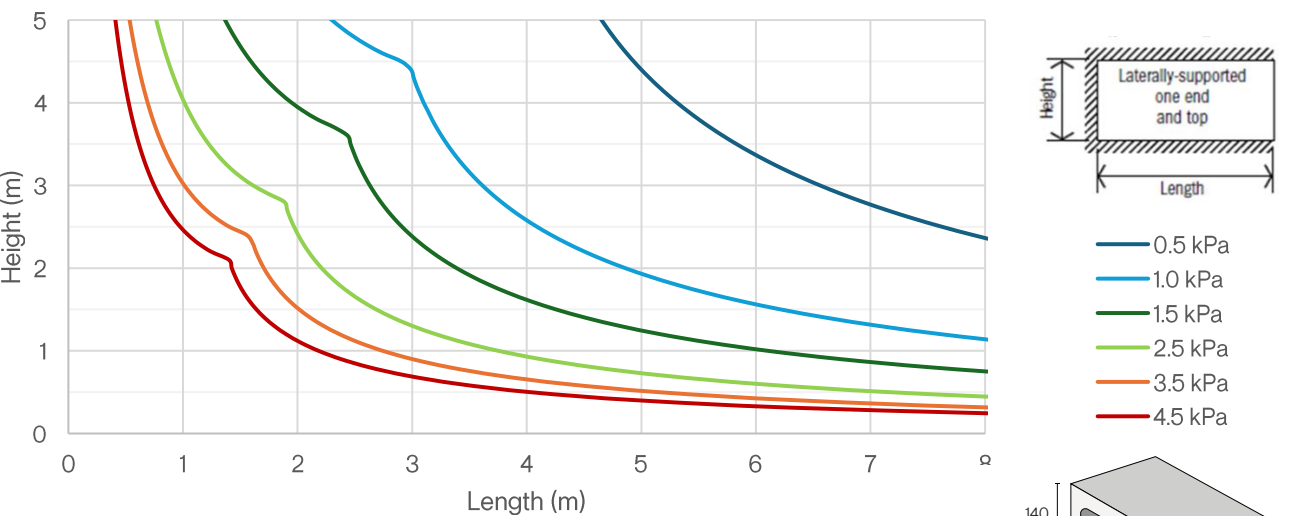


Chart 15: Standard 15.01 Concrete Blocks with One Side Free (Stretcher Bond)

7.1.6 STANDARD 200 SERIES (20.01) BLOCKS

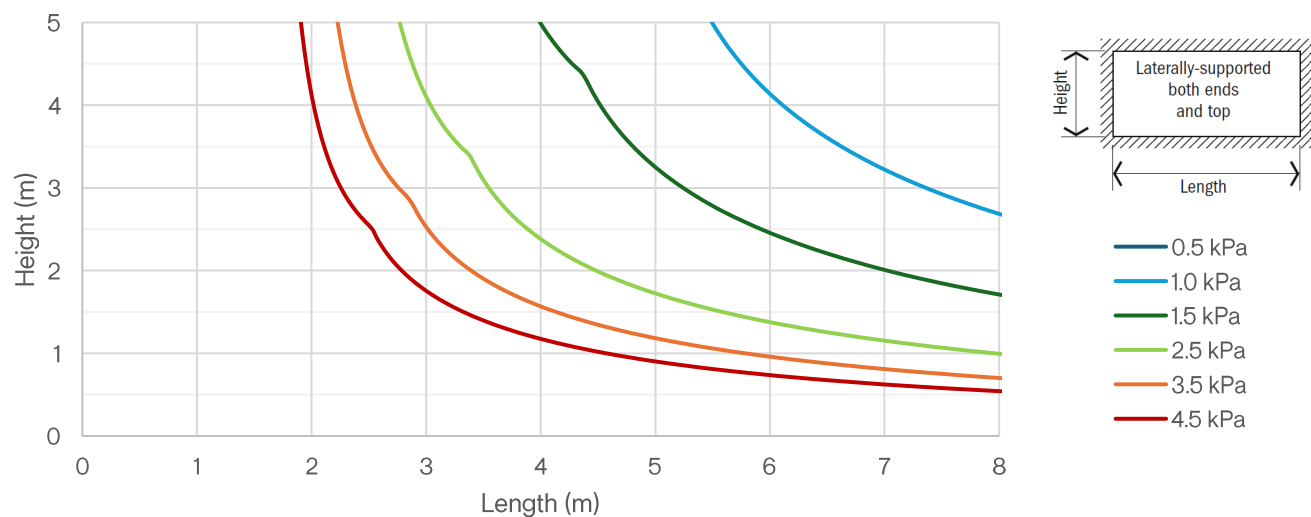


Chart 16: Standard 20.01 Concrete Blocks with All Sides Supported (Stretcher Bond)

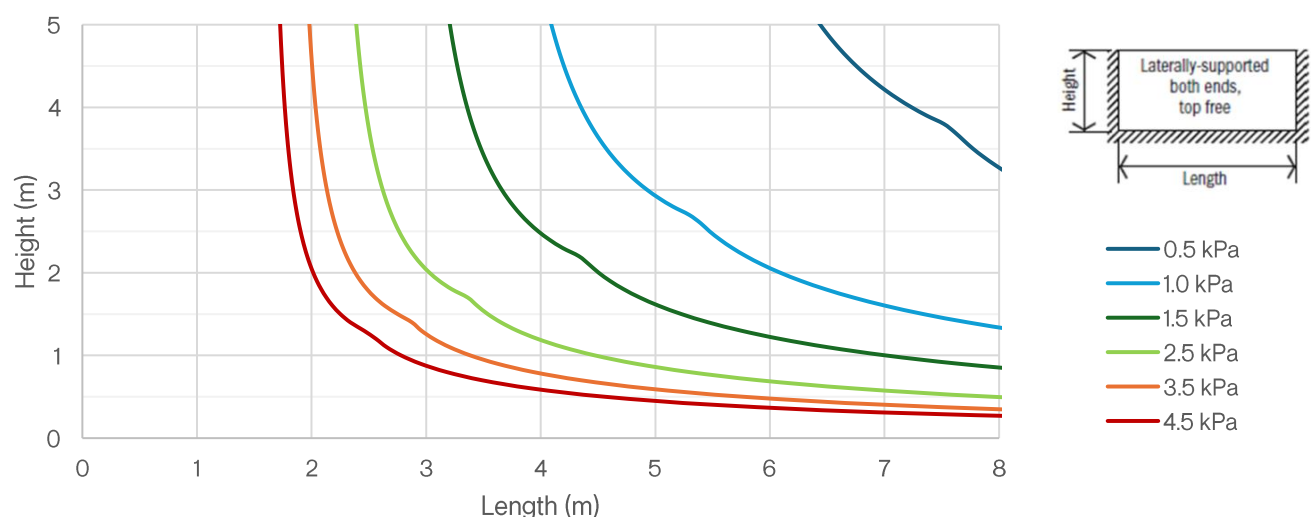


Chart 17: Standard 20.01 Concrete Blocks with Top Edge Free (Stretcher Bond)

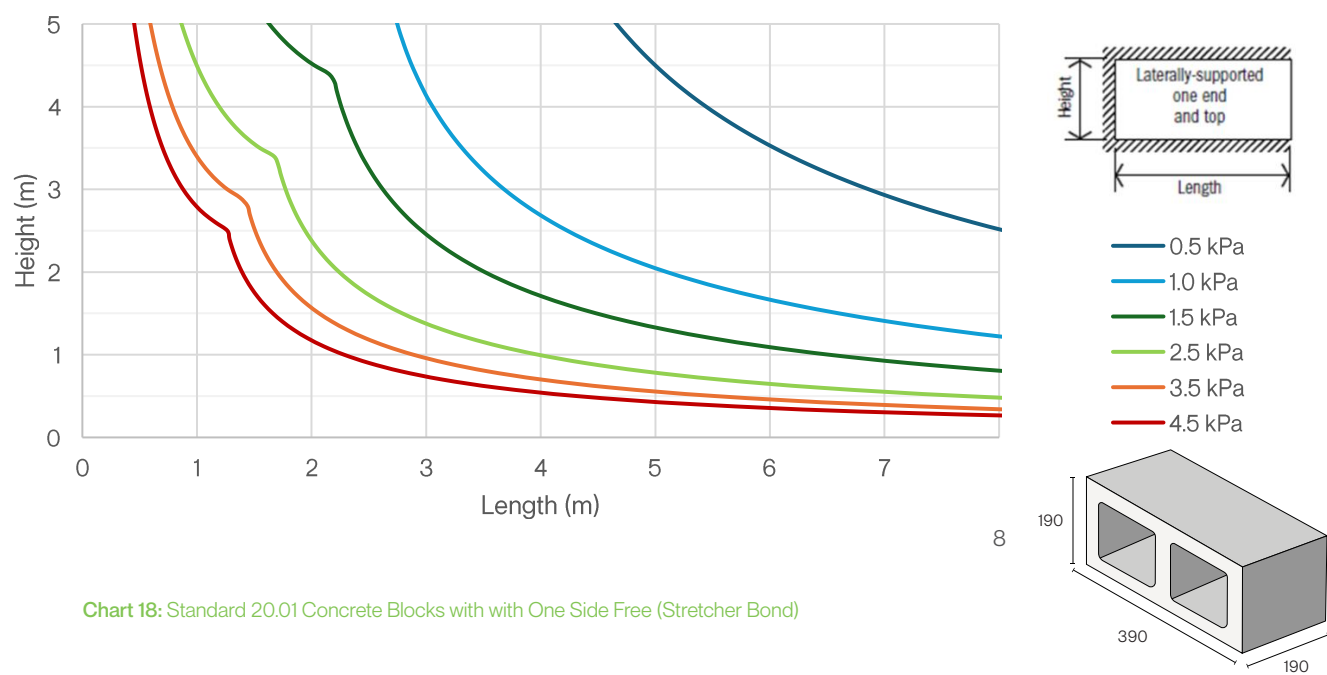


Chart 18: Standard 20.01 Concrete Blocks with with One Side Free (Stretcher Bond)

7.2 Horizontally Reinforced Stack Bond Walls

The following charts have been generated in accordance with Section 5.5 with the horizontal reinforcement assumed to be the Leviat AMR Masonry Reinforcement. The longitudinal wire diameters (indicated in the legend for each chart set) are given to be 3.0, 4.0 and 5.0 mm, however stainless steel reinforcement is also available in 3.5 and 4.5 mm diameters.

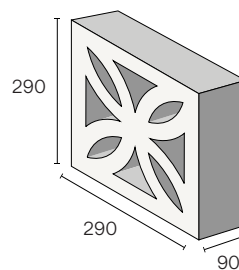
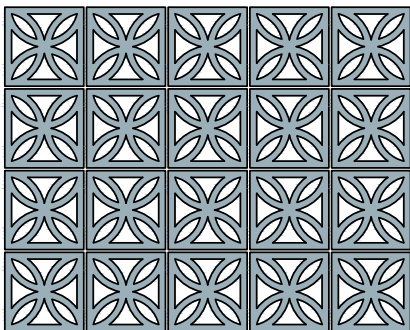
The most appropriate wire widths were chosen based on the thicknesses of the blocks as seen in Table 5. The longitudinal wires in the Leviat AMR Masonry Reinforcement have a minimum characteristic yield strength (f_{sy}) of 500 MPa.

Table 5: Breeze Block and AMR Widths

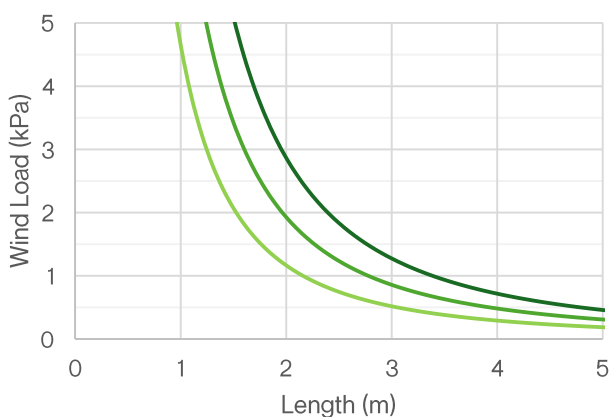
Block Thickness (mm)	AMR Width (mm)
90	60
140	100
190	150

All reinforcement embedded in mortar joints is to comply with AS 3700 Section 5.9.3. This requires the reinforcement to be no more than two thirds the design thickness of the joints.

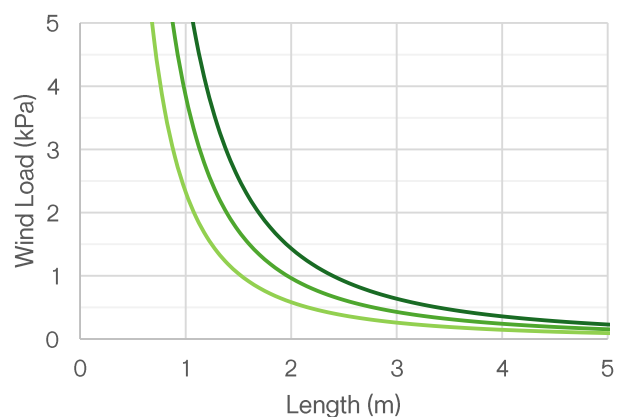
7.2.1 SQUARE (90 MM THICK) BREEZE BLOCKS



Bed Joint Reinforcement Every Course



Bed Joint Reinforcement Every Second Course



5 mm Reinforcement

4 mm Reinforcement

3 mm Reinforcement

Chart 19: 90 mm Thick Square Breeze Blocks with Horizontal Reinforcement (Stack Bond)

7.2.2 RECTANGULAR BREEZE BLOCKS

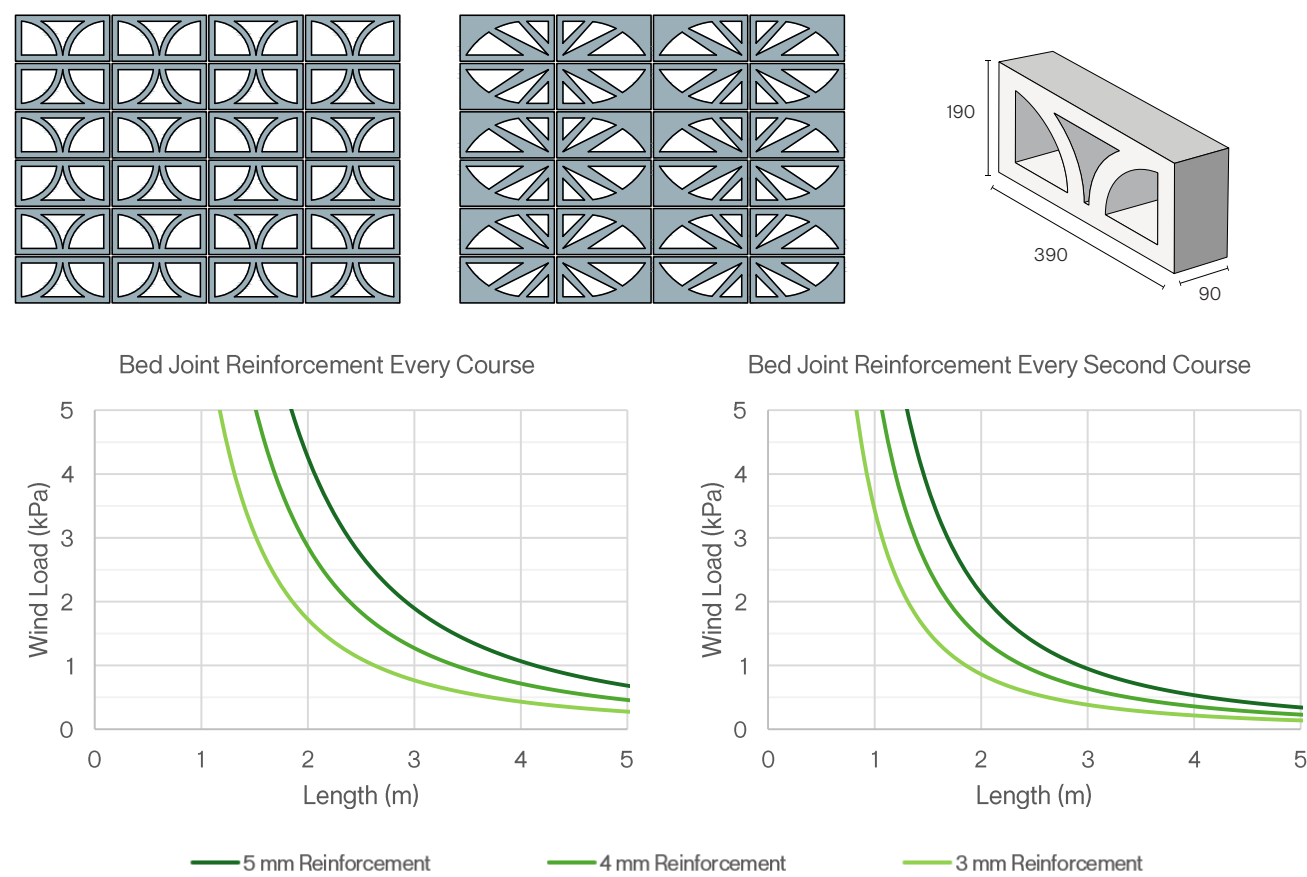


Chart 20: 90 mm Thick Horizontal Breeze Blocks with Horizontal Reinforcement (Stack Bond)

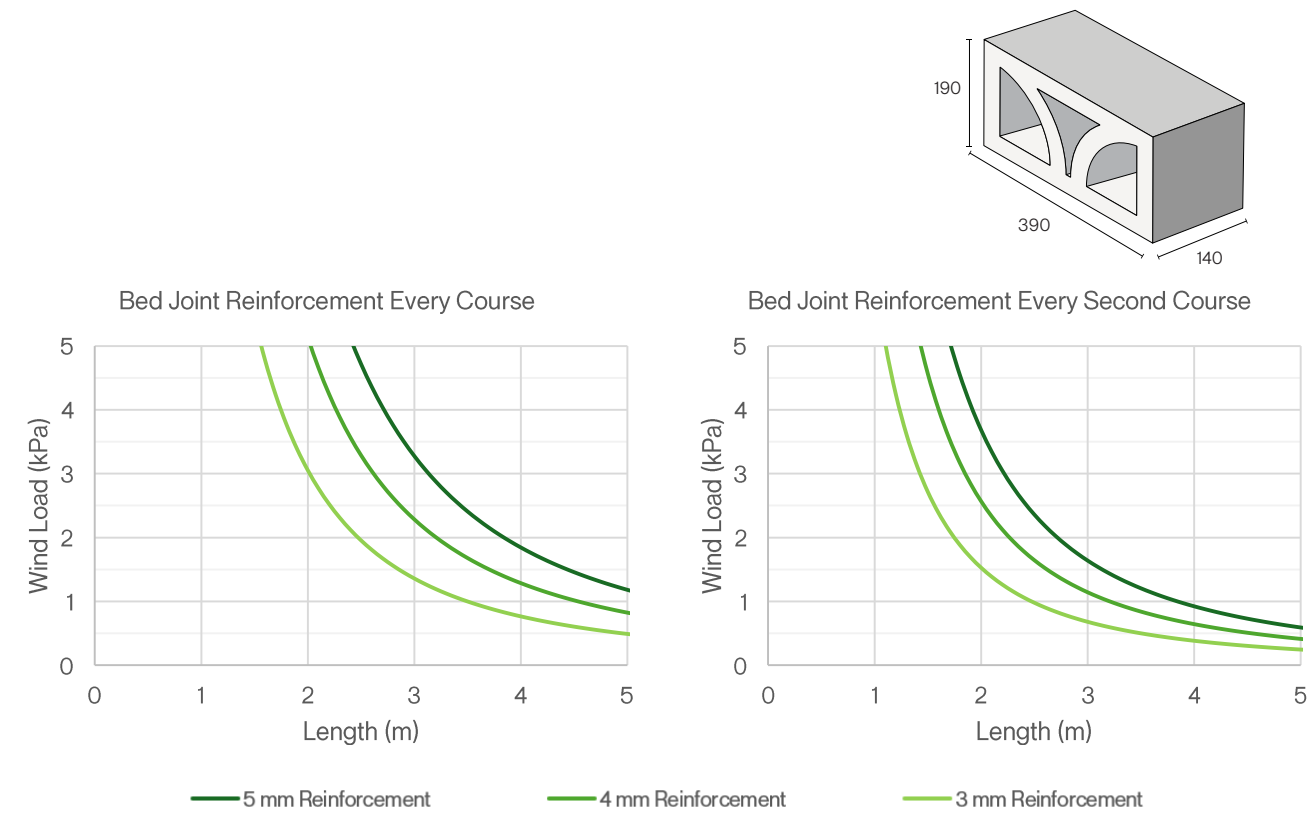
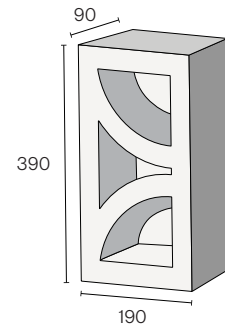
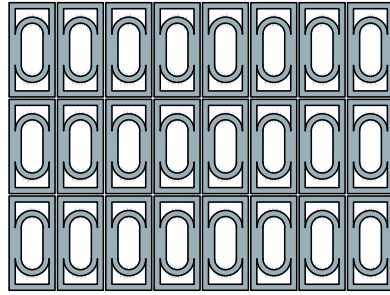
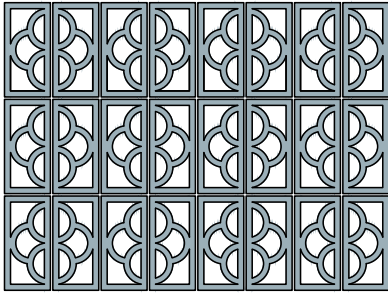
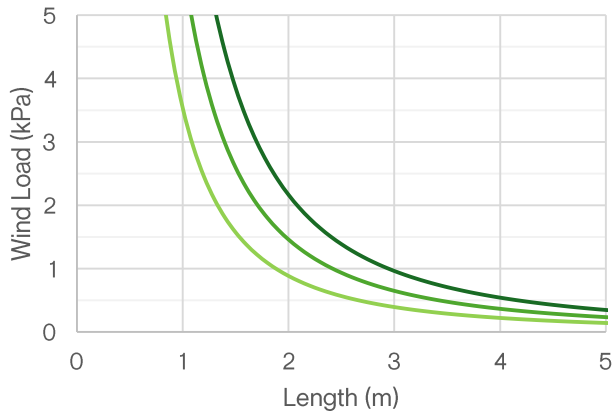


Chart 21: 140 mm Thick Horizontal Breeze Blocks with Horizontal Reinforcement (Stack Bond)

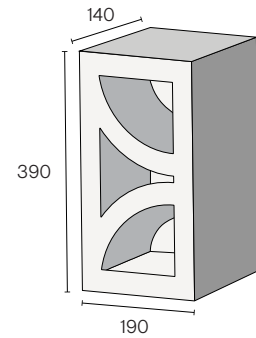


Bed Joint Reinforcement Every Course

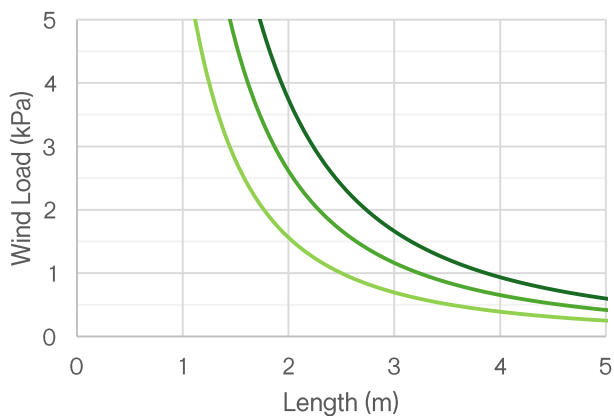


5 mm Reinforcement 4 mm Reinforcement 3 mm Reinforcement

Chart 22: 90 mm Thick Vertical Breeze Blocks with Horizontal Reinforcement (Stack Bond)



Bed Joint Reinforcement Every Course



5 mm Reinforcement 4 mm Reinforcement 3 mm Reinforcement

Bed Joint Reinforcement Every Second Course

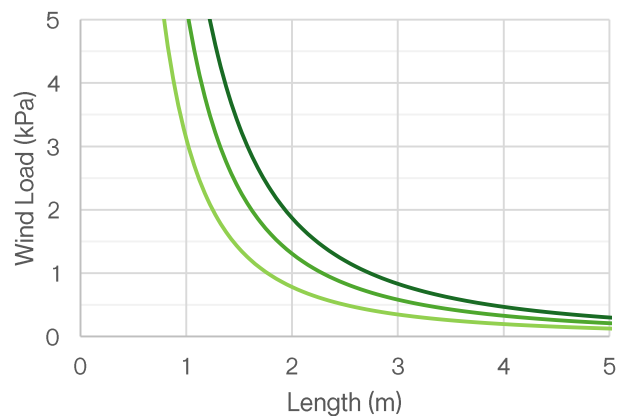


Chart 23: 140 mm Thick Vertical Breeze Blocks with Horizontal Reinforcement (Stack Bond)

7.2.3 STANDARD HOLLOW CONCRETE BLOCKS

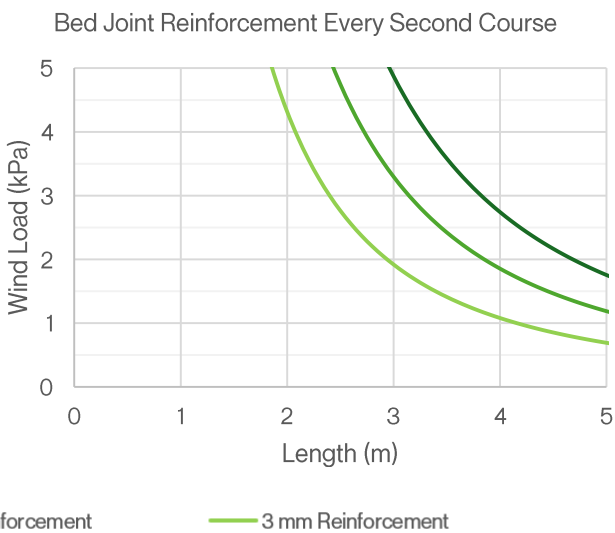
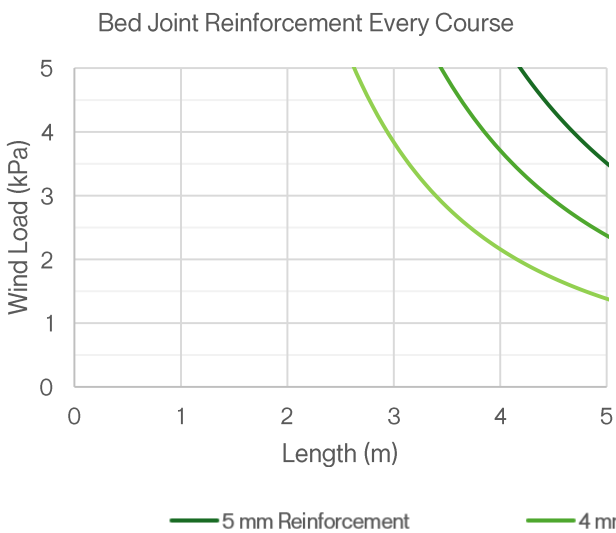
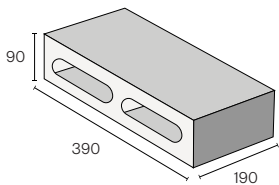
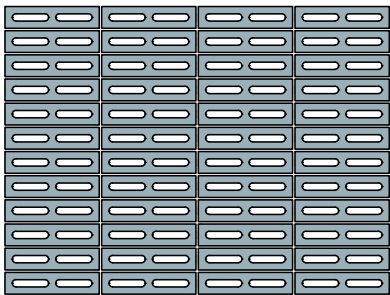


Chart 24: Horizontal Standard 10.01 Concrete Blocks with Horizontal Reinforcement (Stack Bond)

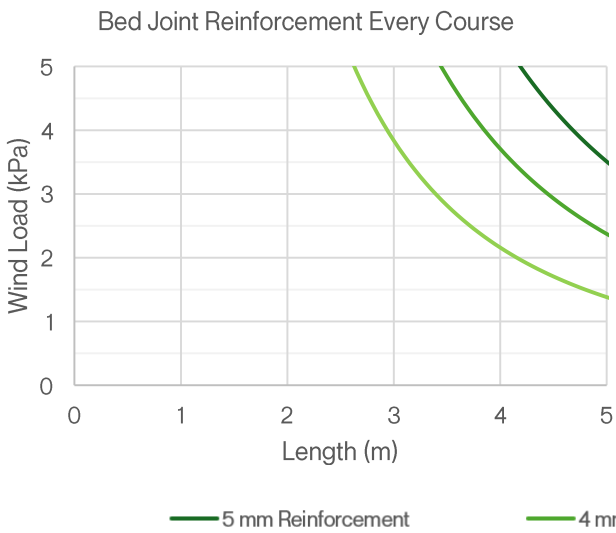
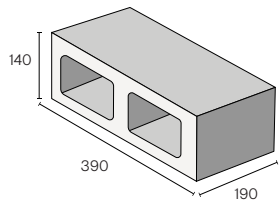
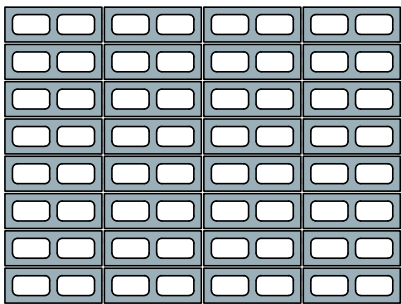


Chart 25: Horizontal Standard 15.01 Concrete Blocks with Horizontal Reinforcement (Stack Bond)

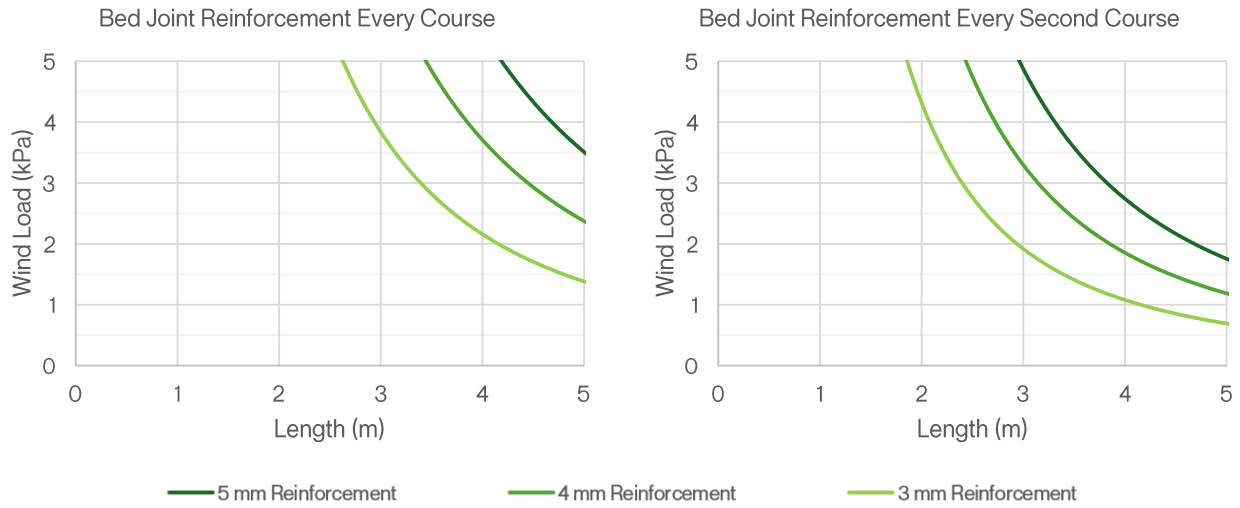
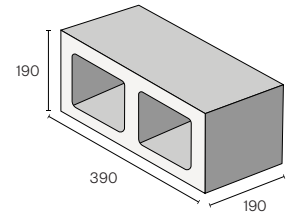
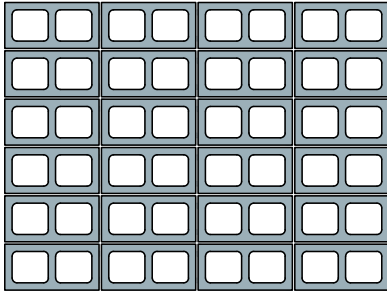


Chart 26: Horizontal Standard 20.01 Concrete Blocks with Horizontal Reinforcement (Stack Bond)

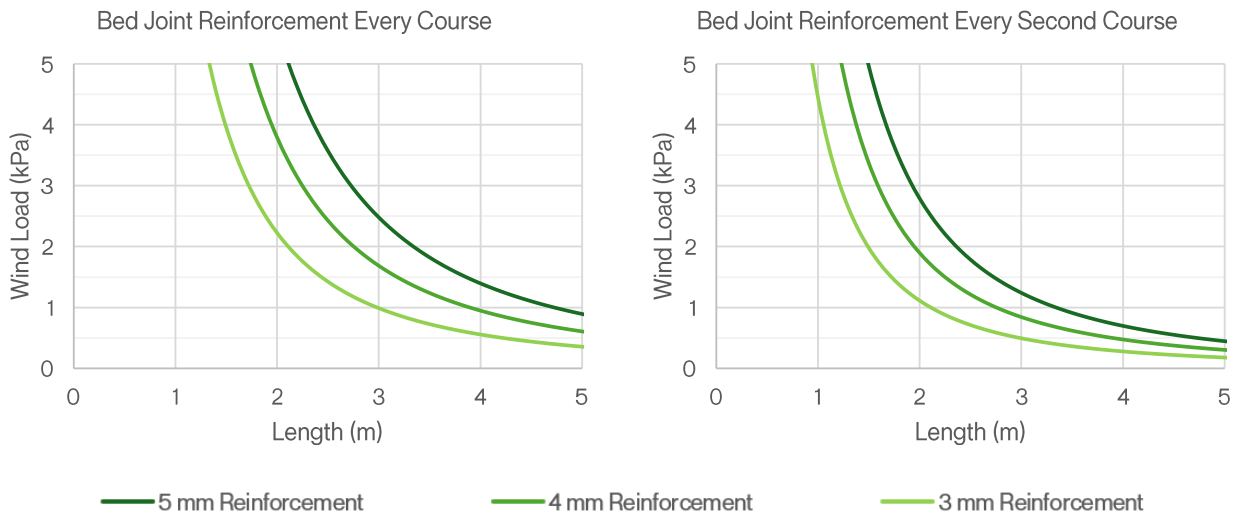
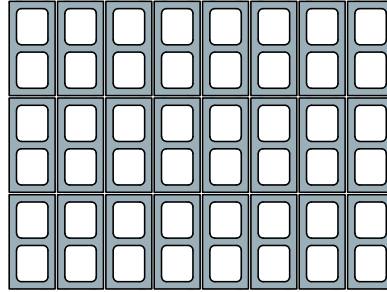
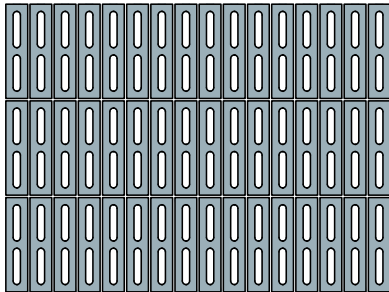


Chart 27: Vertical Standard Concrete Blocks with Horizontal Reinforcement (Stack Bond)

7.3 Windpost Reinforced Stack Bond Walls

The following charts have been generated in accordance with Section 5.6.1 with vertical reinforcement assumed to be the Leviat WP4 Windposts¹⁶. These are made to be 8 mm thick and with the appropriate wire widths chosen based on the thicknesses of the blocks as seen in Table 6. The standard block walls (190 mm thick) have been limited to 120 mm in wind post width for conservatism, but wider wind posts may result in an increase in spacing limits.

Table 6: Breeze Block and Wind Post Widths

Block Thickness (mm)	WP4 Width (mm)
90	70
140	120
190	120

These wind posts have been assumed to have a minimum characteristic yield strength (f_{sy}) of 500 MPa. The horizontal reinforcement used for these charts is the 5 mm thick Leviat AMR Masonry Reinforcement.

Note: It has been assumed that the bed joint mesh is laid in every course, but limits for walls with bed joint reinforcement every second course are shown as dashed lines (where applicable).

7.3.1 SQUARE (90 MM THICK) BREEZE BLOCKS

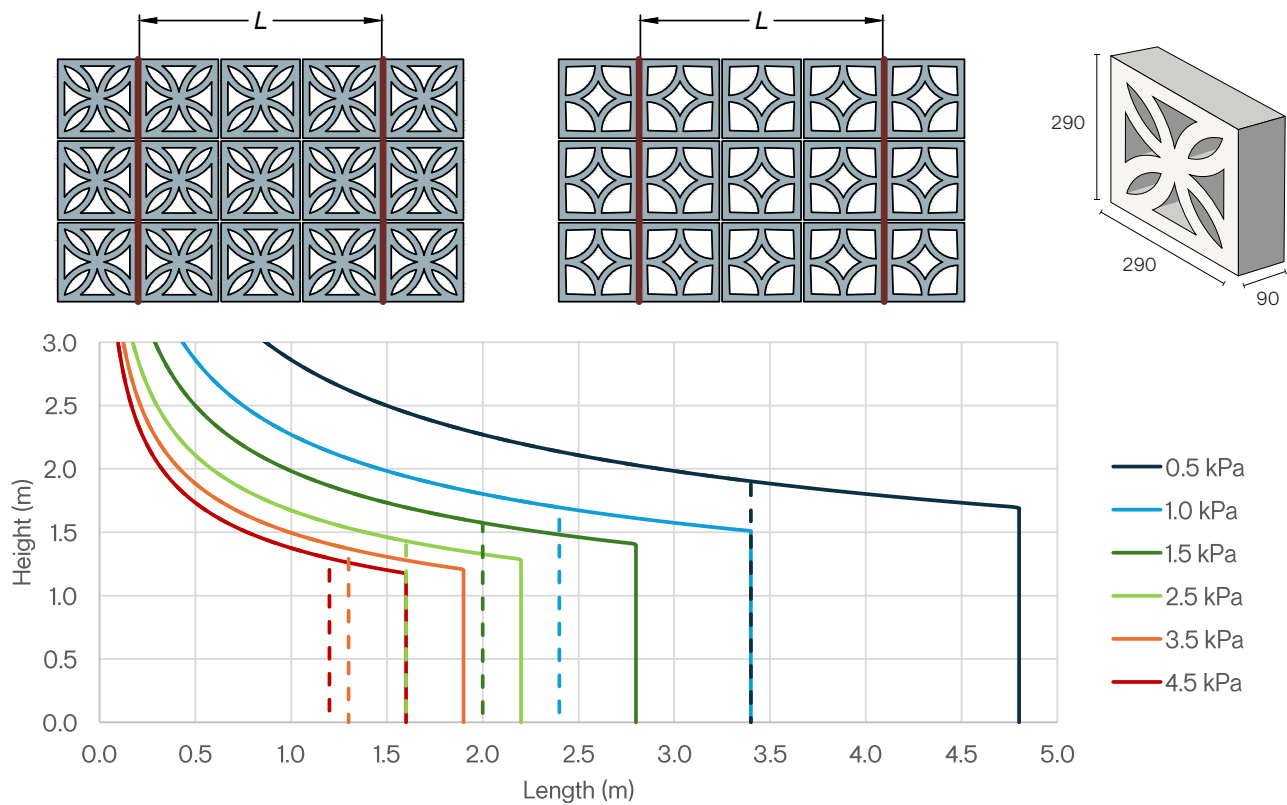


Chart 28: 90 mm Thick Square Breeze Blocks with Wind Posts (Stack Bond)

7.3.2 RECTANGULAR BREEZE BLOCKS

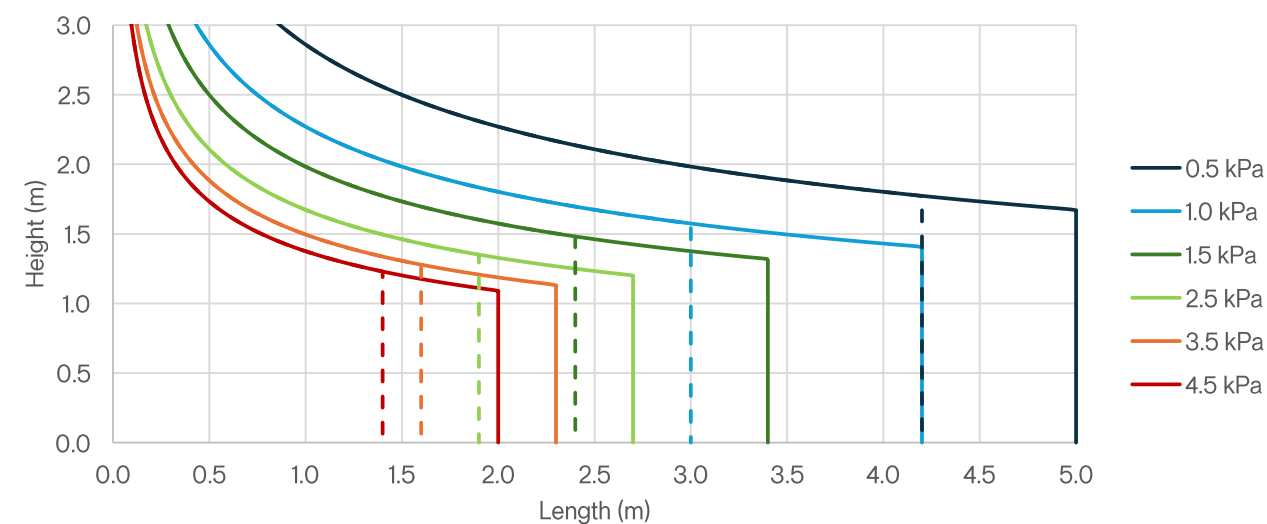
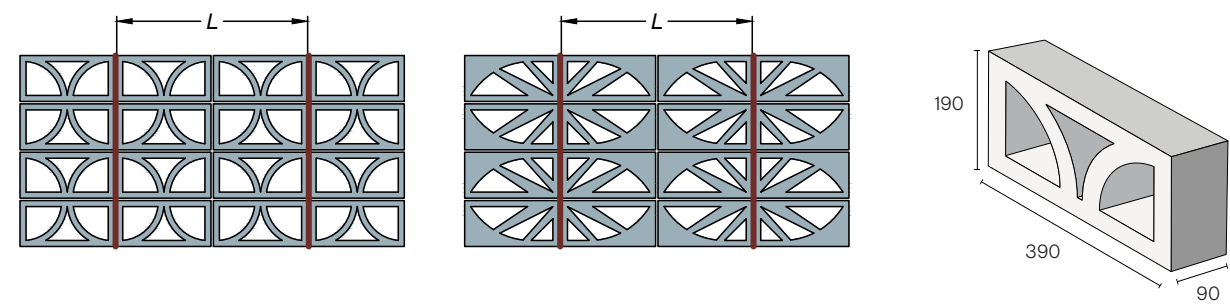


Chart 29: 90 mm Thick Horizontal Breeze Blocks with Wind Posts (Stack Bond)

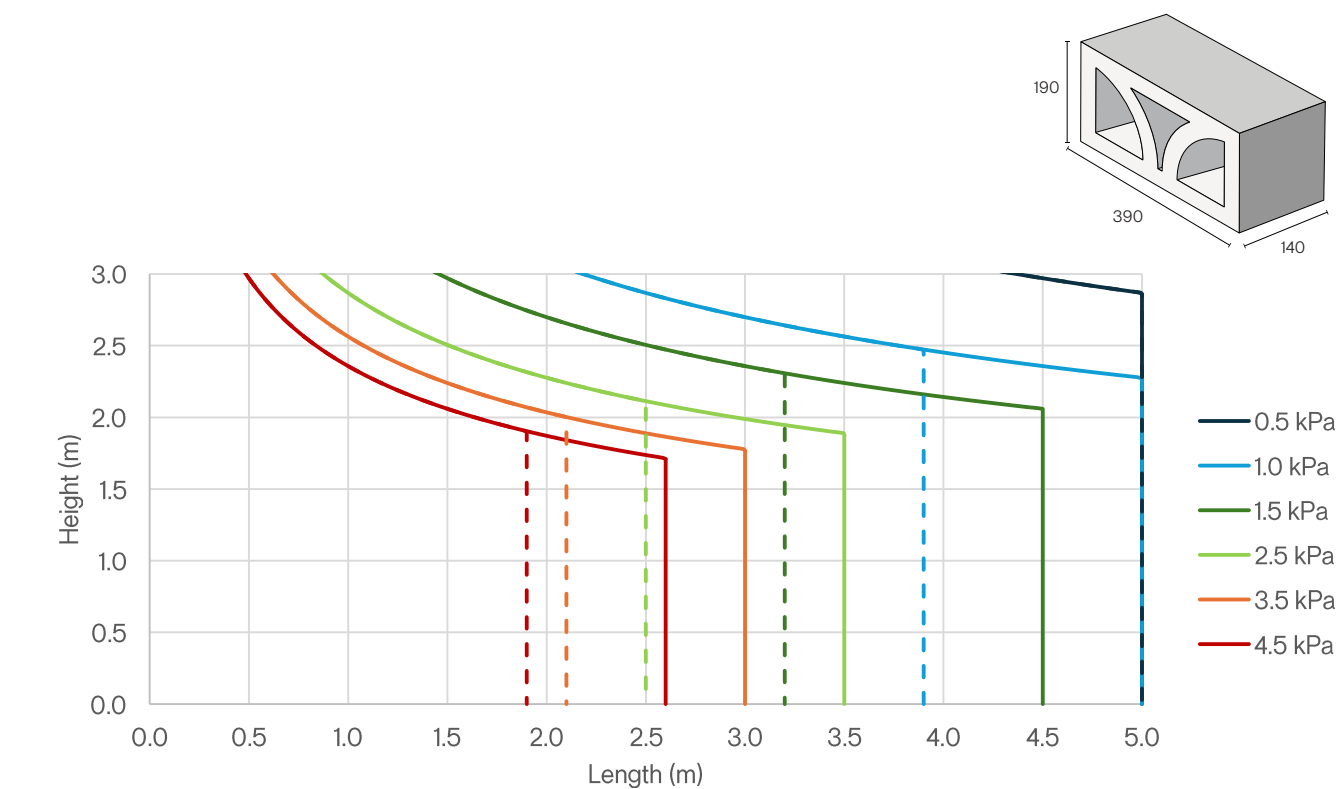


Chart 30: 140 mm Thick Horizontal Breeze Blocks with Wind Posts (Stack Bond)

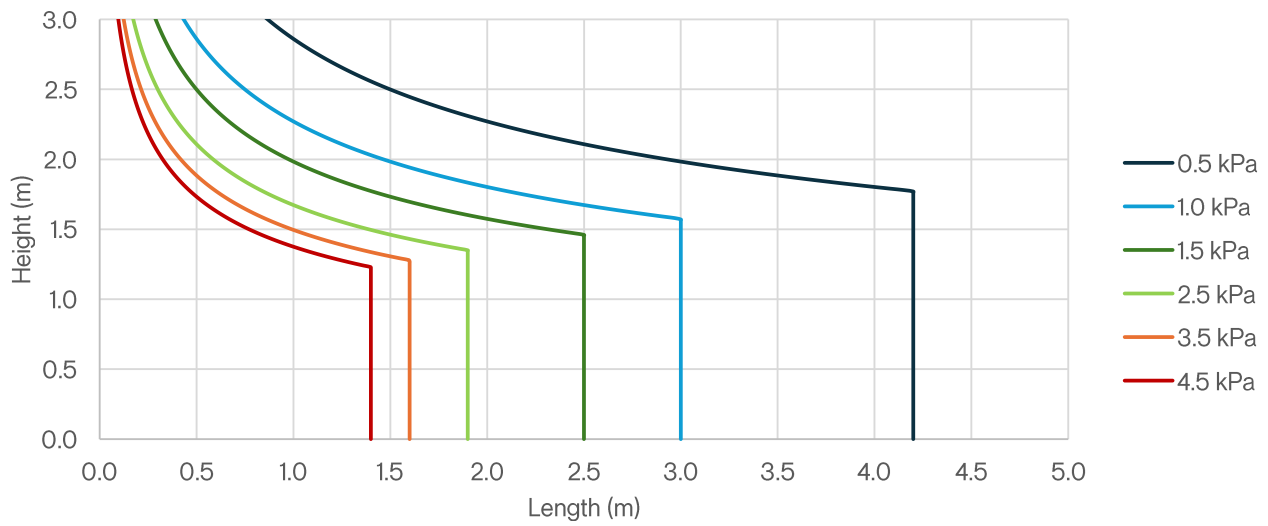
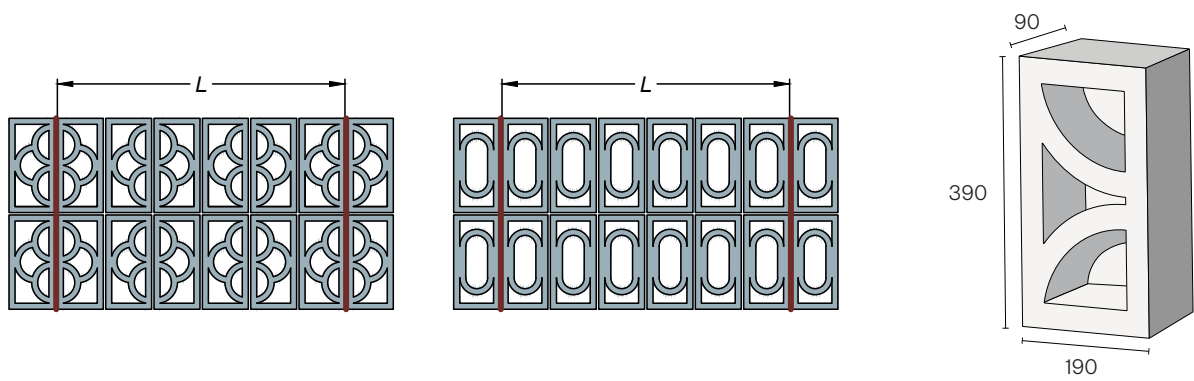


Chart 31: 90 mm Thick Vertical Breeze Blocks with Wind Posts (Stack Bond)

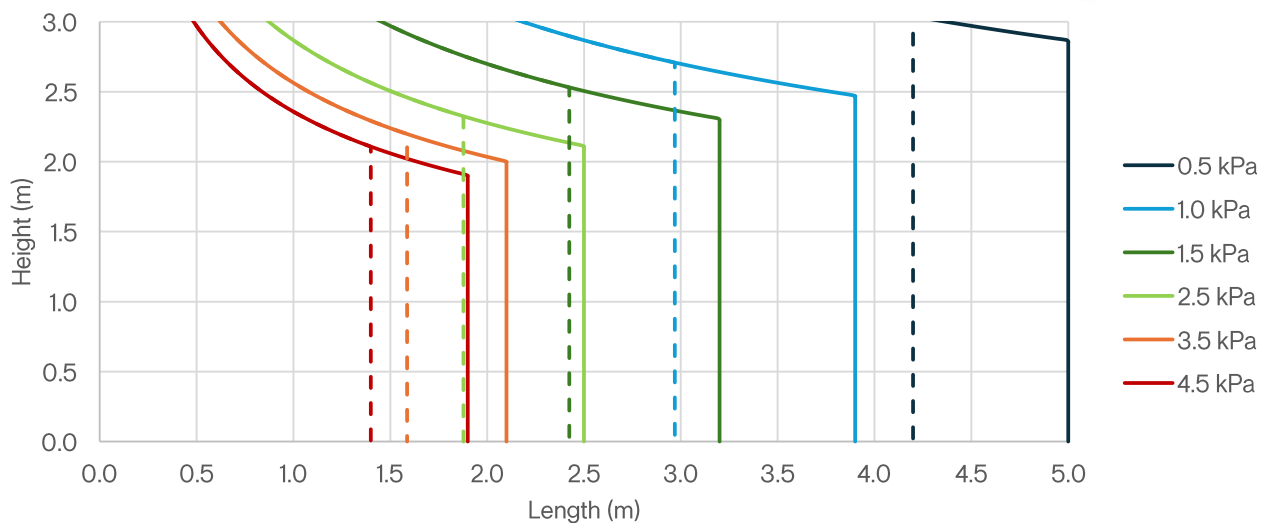
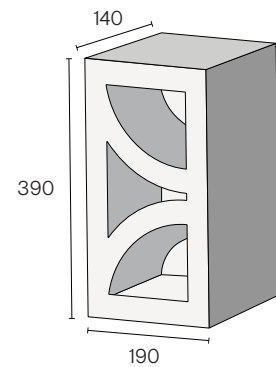


Chart 32: 140 mm Thick Vertical Breeze Blocks with Wind Posts (Stack Bond)

7.3.3 STANDARD HOLLOW CONCRETE BLOCKS

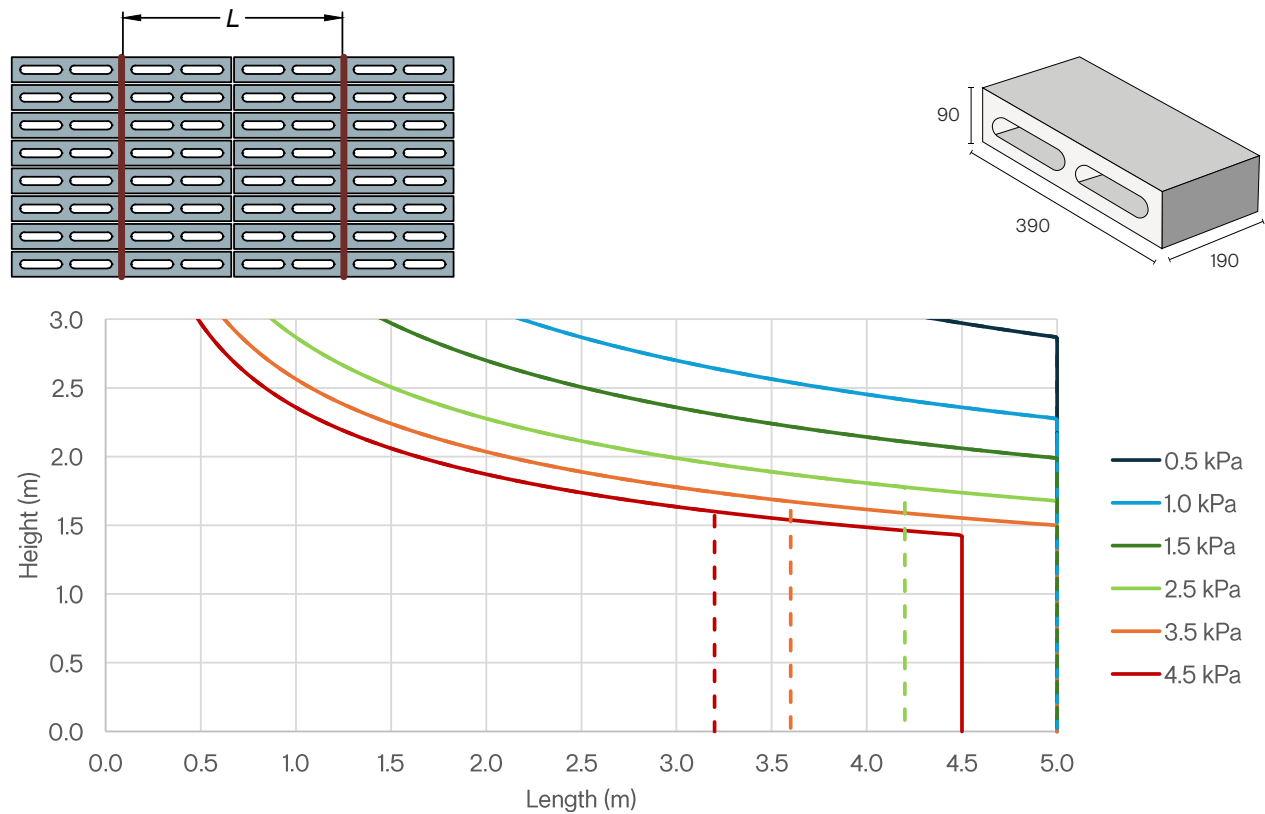


Chart 33: Horizontal Standard 10.01 Concrete Blocks with Wind Posts (Stack Bond)

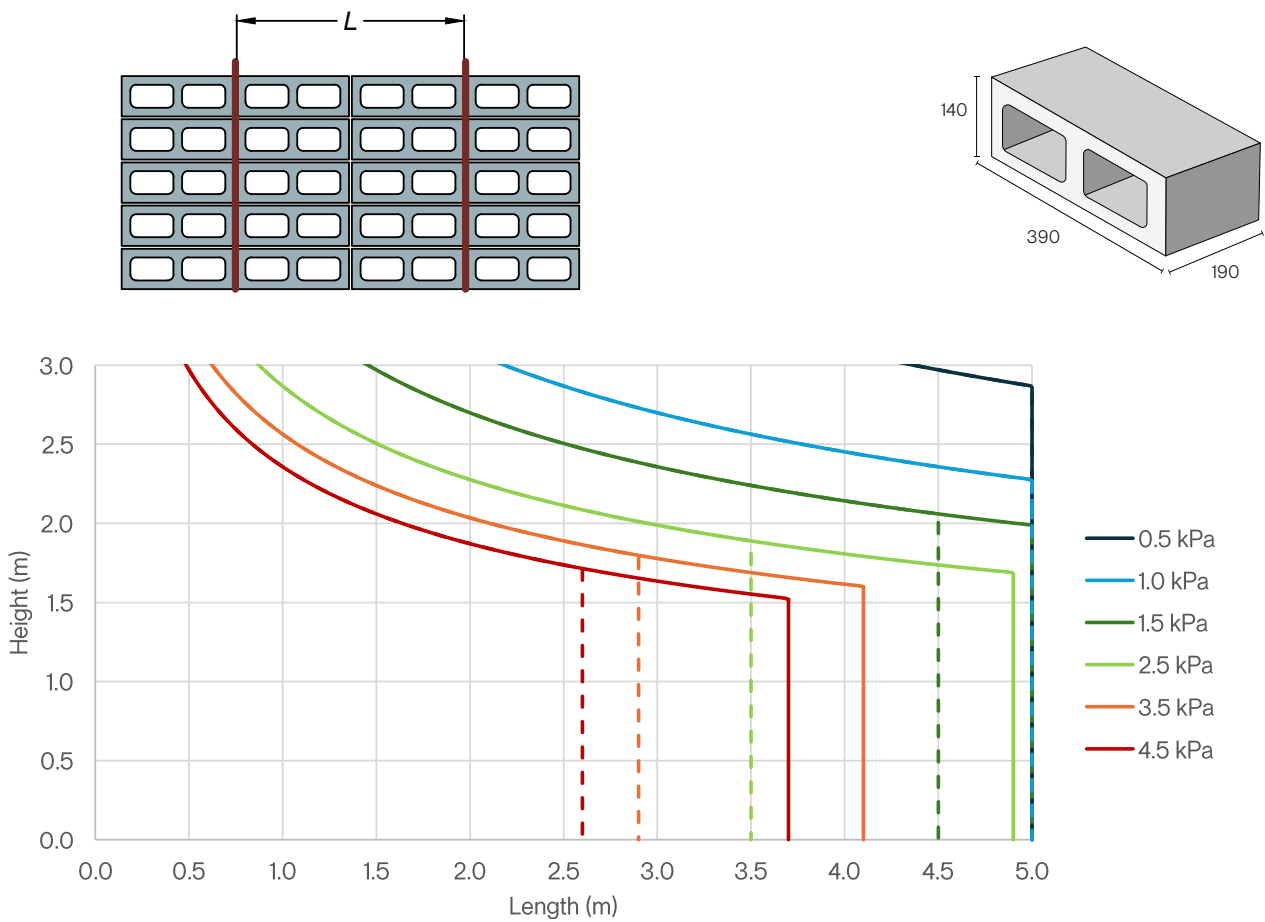


Chart 34: Horizontal Standard 15.01 Concrete Blocks with Wind Posts (Stack Bond)

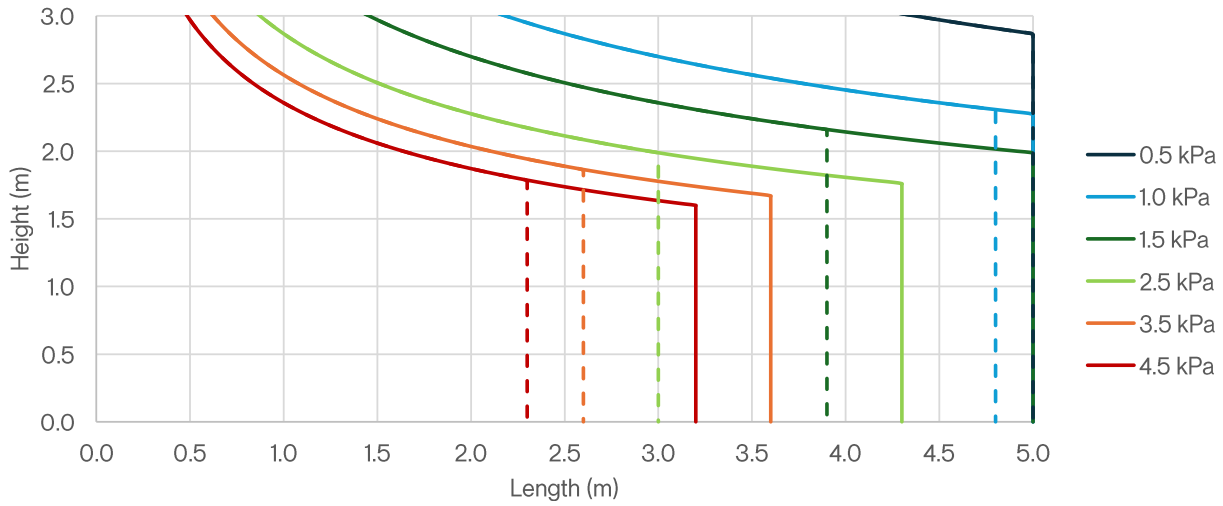
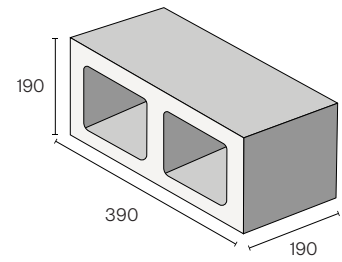
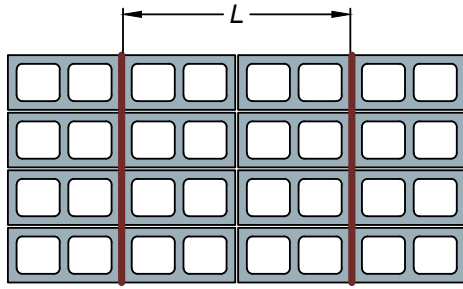


Chart 35: Horizontal Standard 20.01 Concrete Blocks with Wind Posts (Stack Bond)

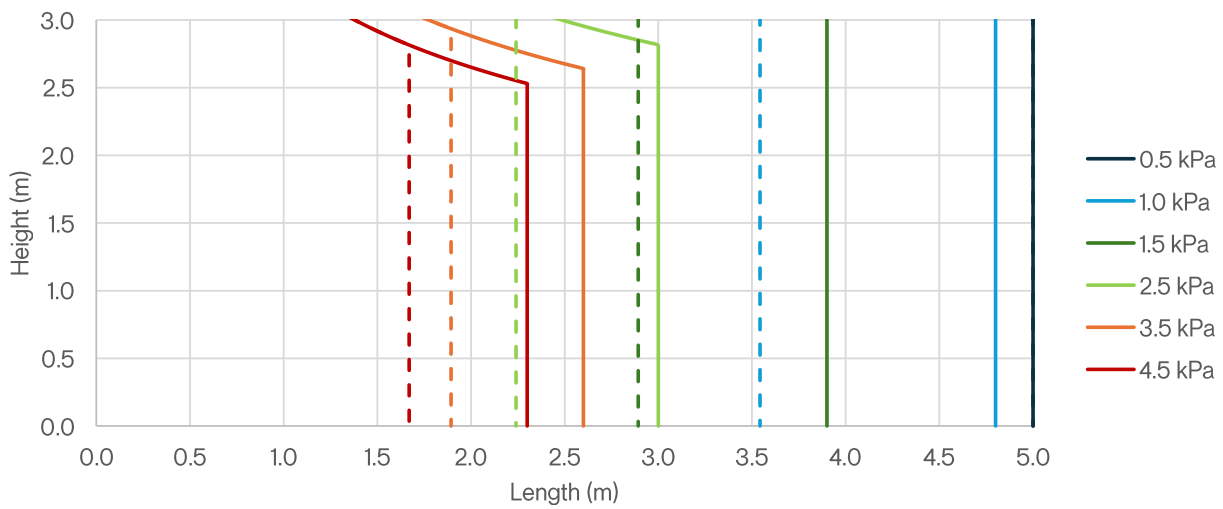
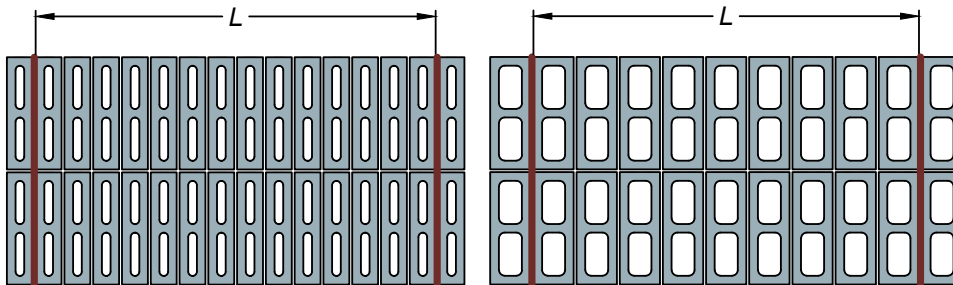


Chart 36: Vertical Standard Concrete Blocks with Wind Posts (Stack Bond)



Wabi Sabi by Stuart Holmes Architect
Photography by Derek Swalwell

7.4 Concrete Block Reinforced Column Stack Bond Walls

The following design charts are for breeze block walls vertically reinforced by grouted concrete blockwork piers. It has been assumed that these piers are equal in thickness to the breeze blocks (15.01 blocks for rectangular 140 mm thick breeze blocks and 20.01 blocks for standard hollow concrete blocks), reinforced with 2N10 vertical bars per block that have a minimum characteristic yield strength (f_{sy}) of 500 MPa. It has also been assumed that this results in a tensile strength (f'_{mt}) of 1.0 MPa (see [Section 5.6.2](#)).

The horizontal reinforcement used for these charts is the 5 mm thick Leviat AMR Masonry Reinforcement¹⁶.

7.4.1 RECTANGULAR (140 MM THICK) BREEZE BLOCKS

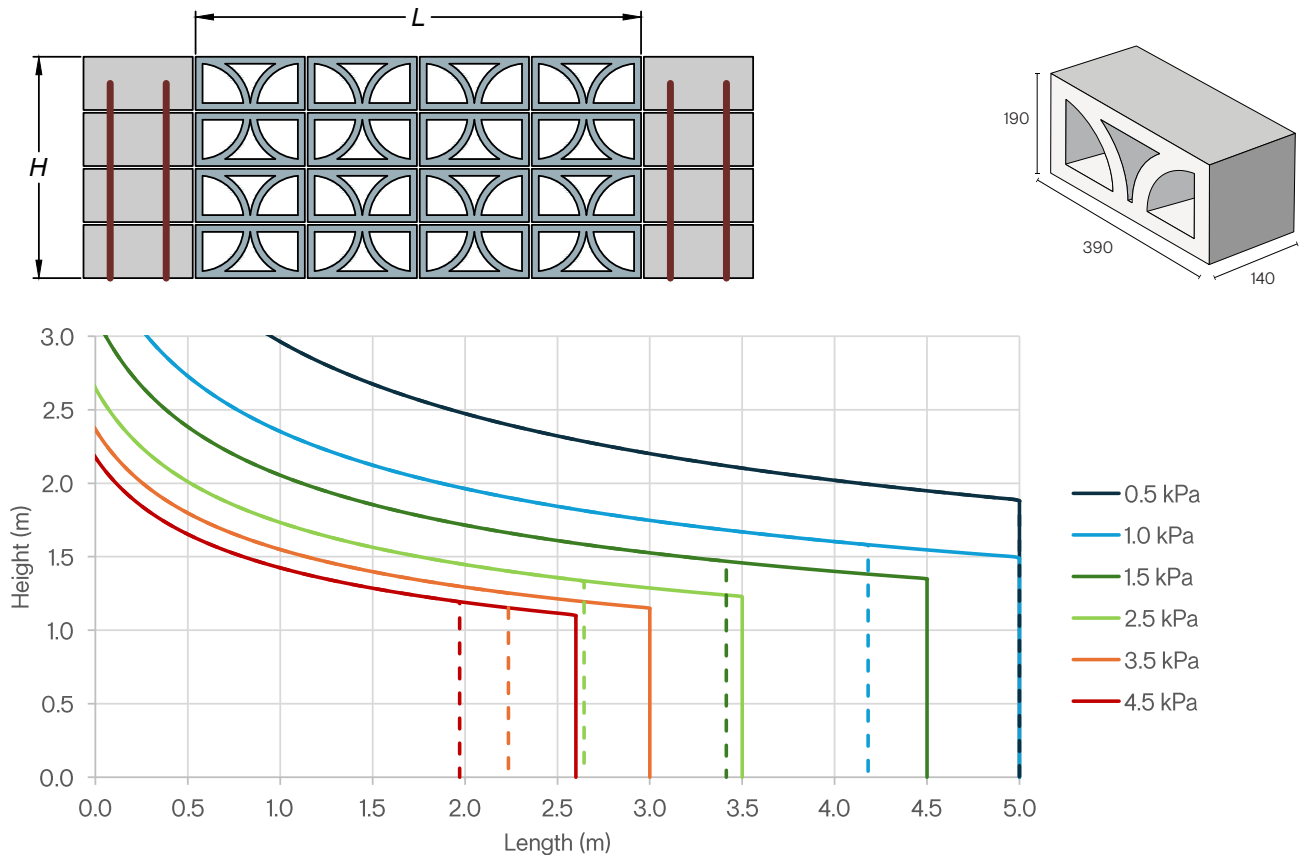


Chart 37: 140 mm Thick Horizontal Breeze Blocks with Single Reinforced Block Column (Stack Bond)

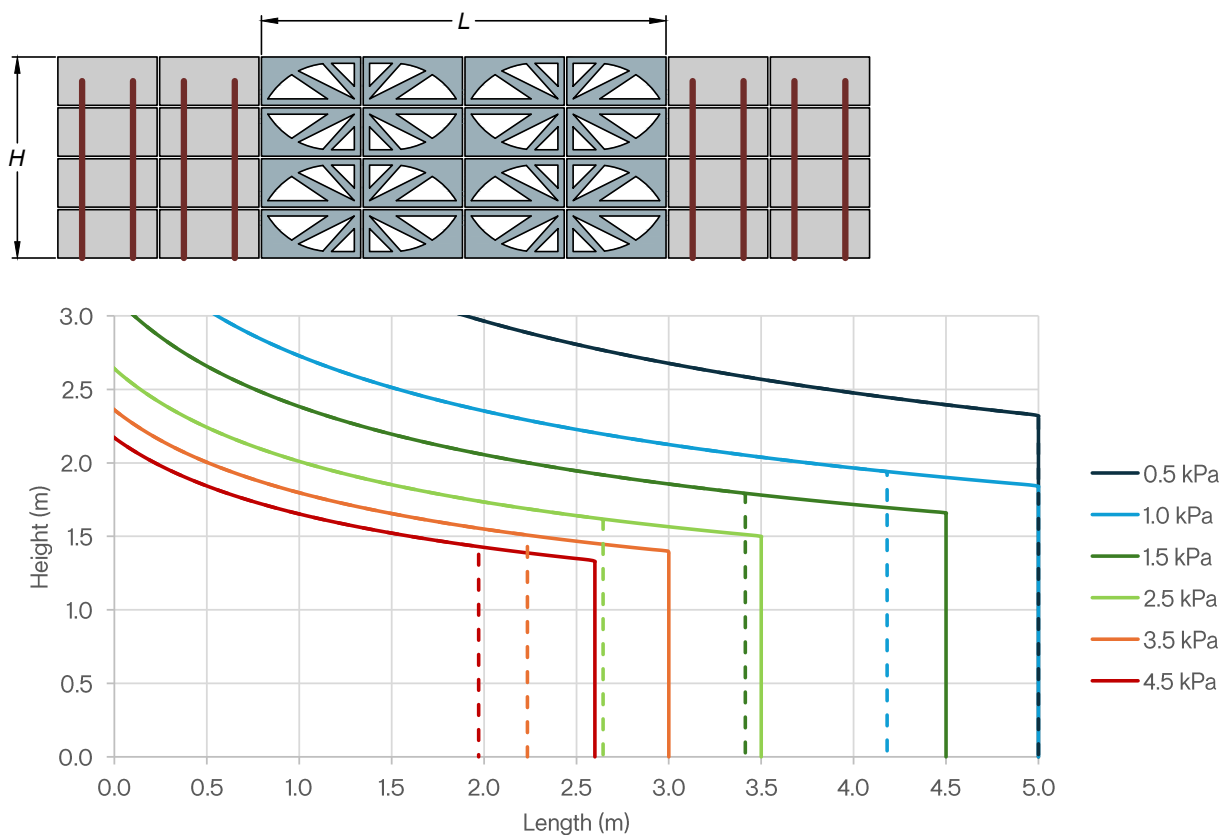


Chart 38: 140 mm Thick Horizontal Breeze Blocks with Double Reinforced Block Column (Stack Bond)

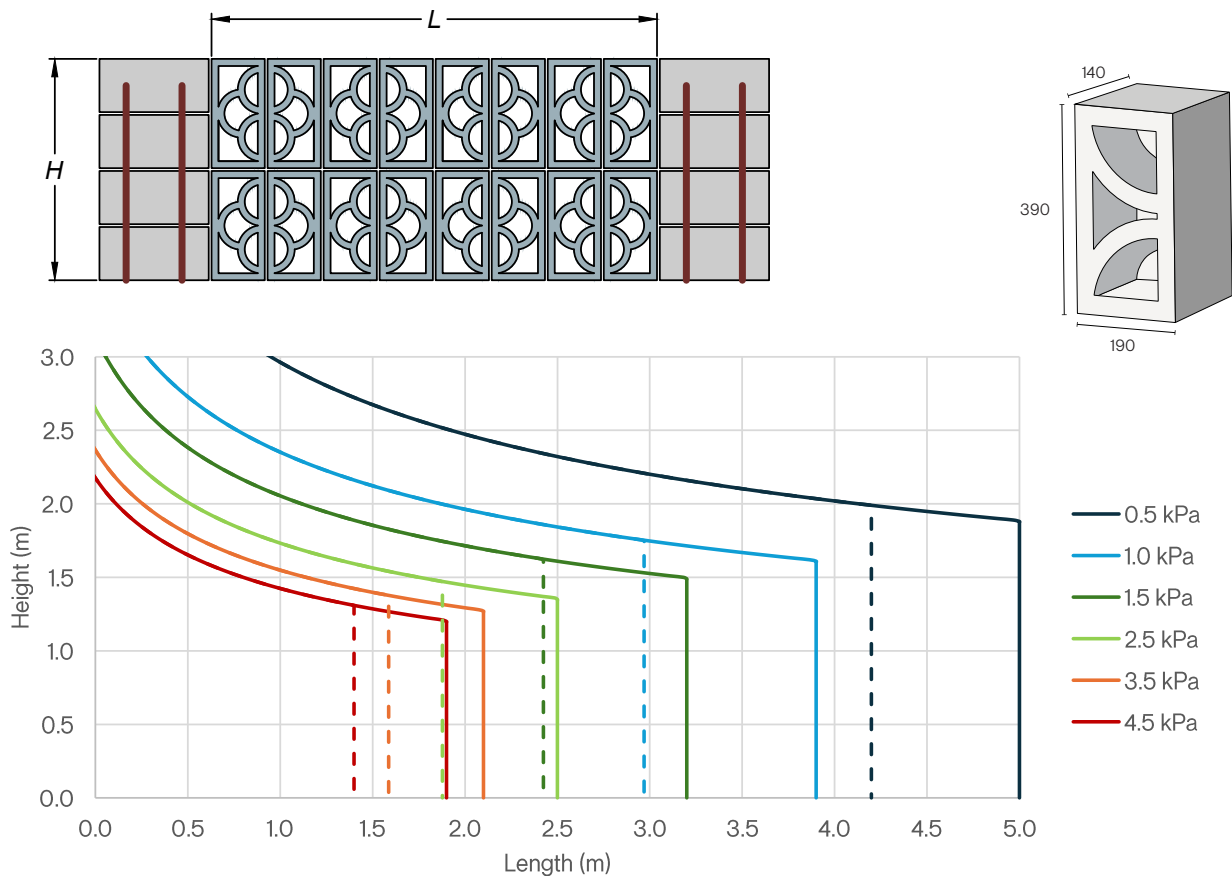


Chart 39: 140 mm Thick Vertical Breeze Blocks with Single Reinforced Block Column (Stack Bond)

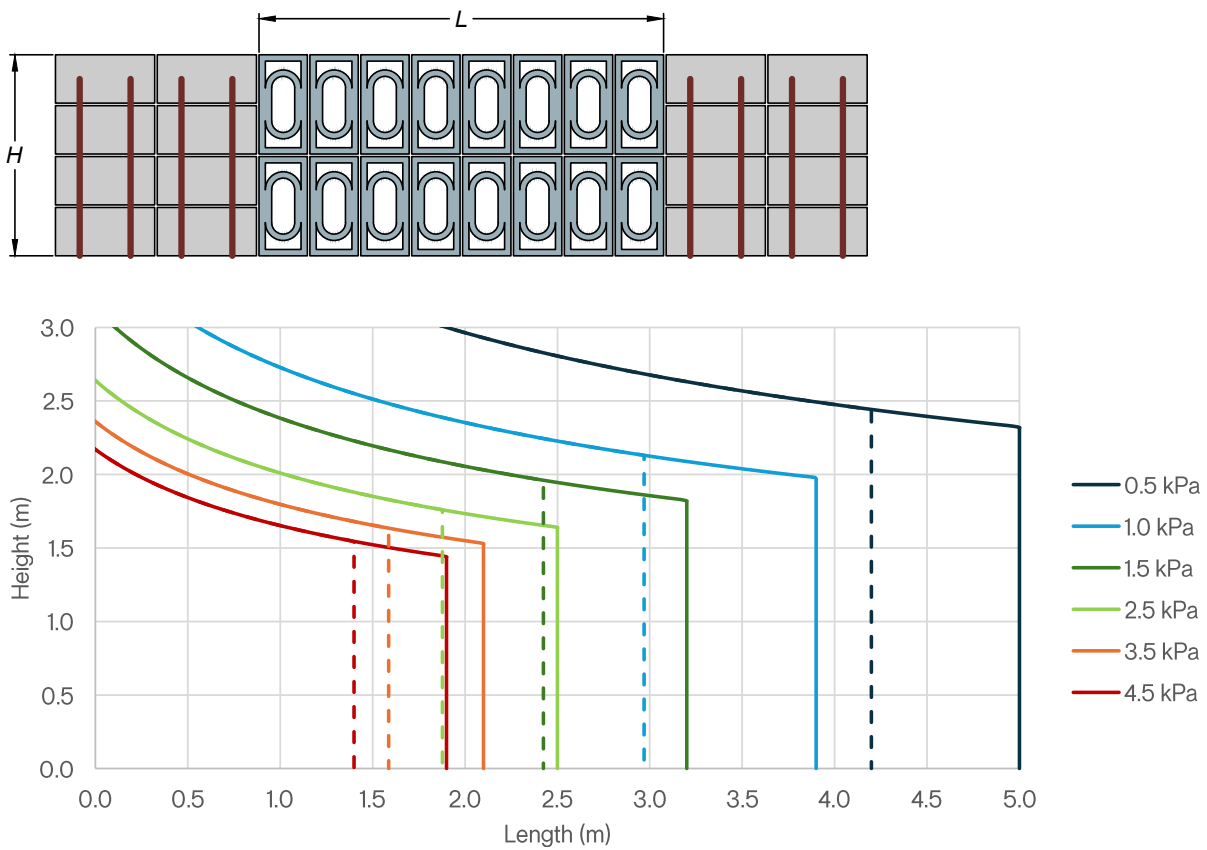


Chart 40: 140 mm Thick Vertical Breeze Blocks with Double Reinforced Block Column (Stack Bond)

8.4.2 STANDARD HOLLOW CONCRETE BLOCKS

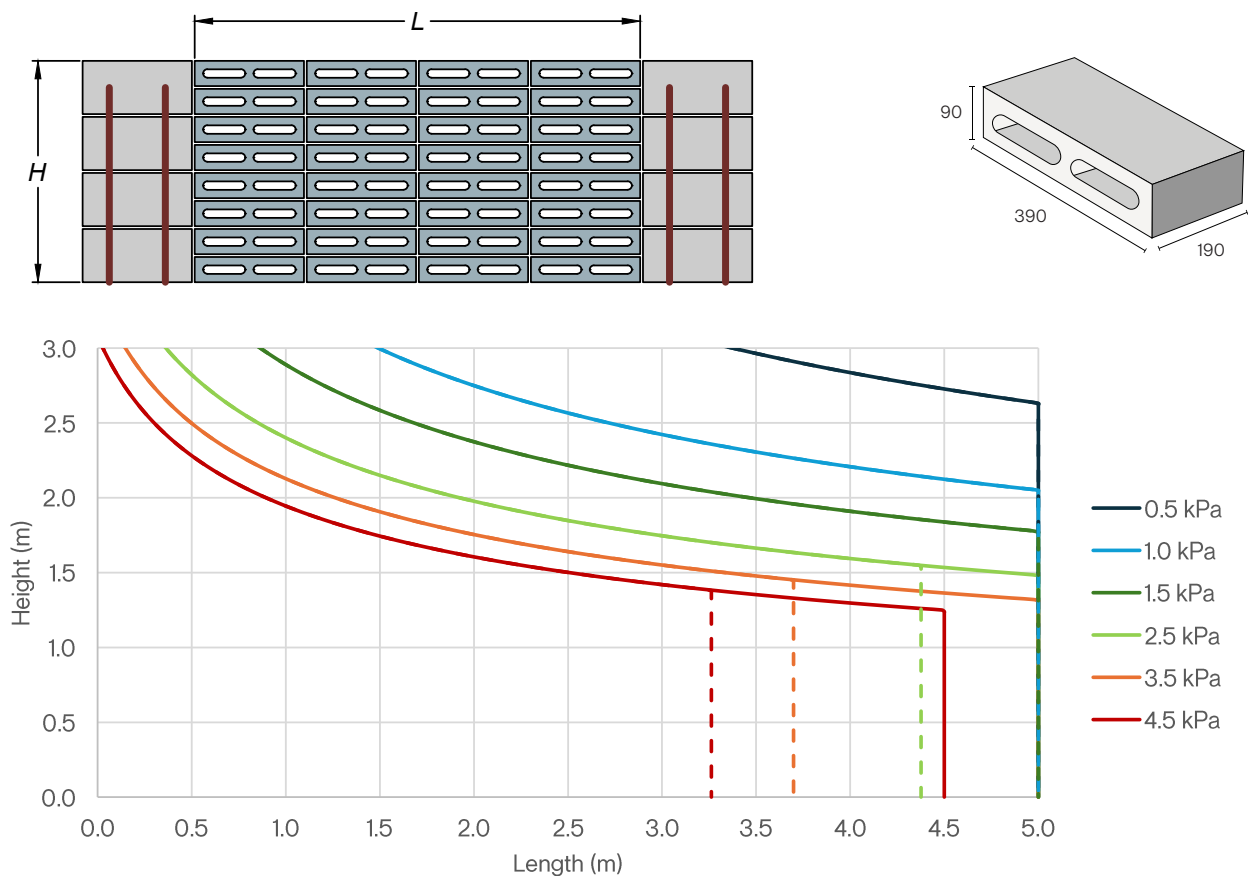


Chart 41: Horizontal Standard 10.01 Concrete Blocks with Single Reinforced Block Column (Stack Bond)

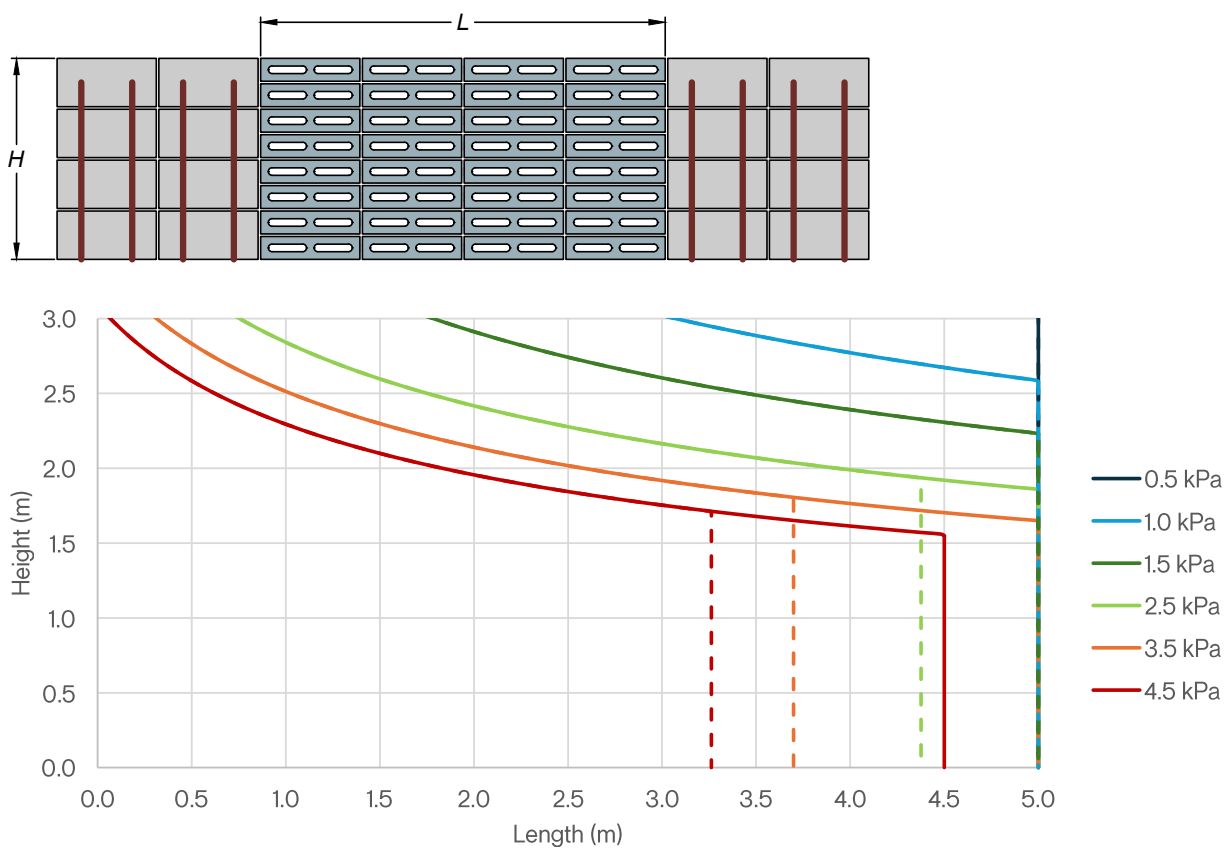


Chart 42: Horizontal Standard 10.01 Concrete Blocks with Double Reinforced Block Column (Stack Bond)

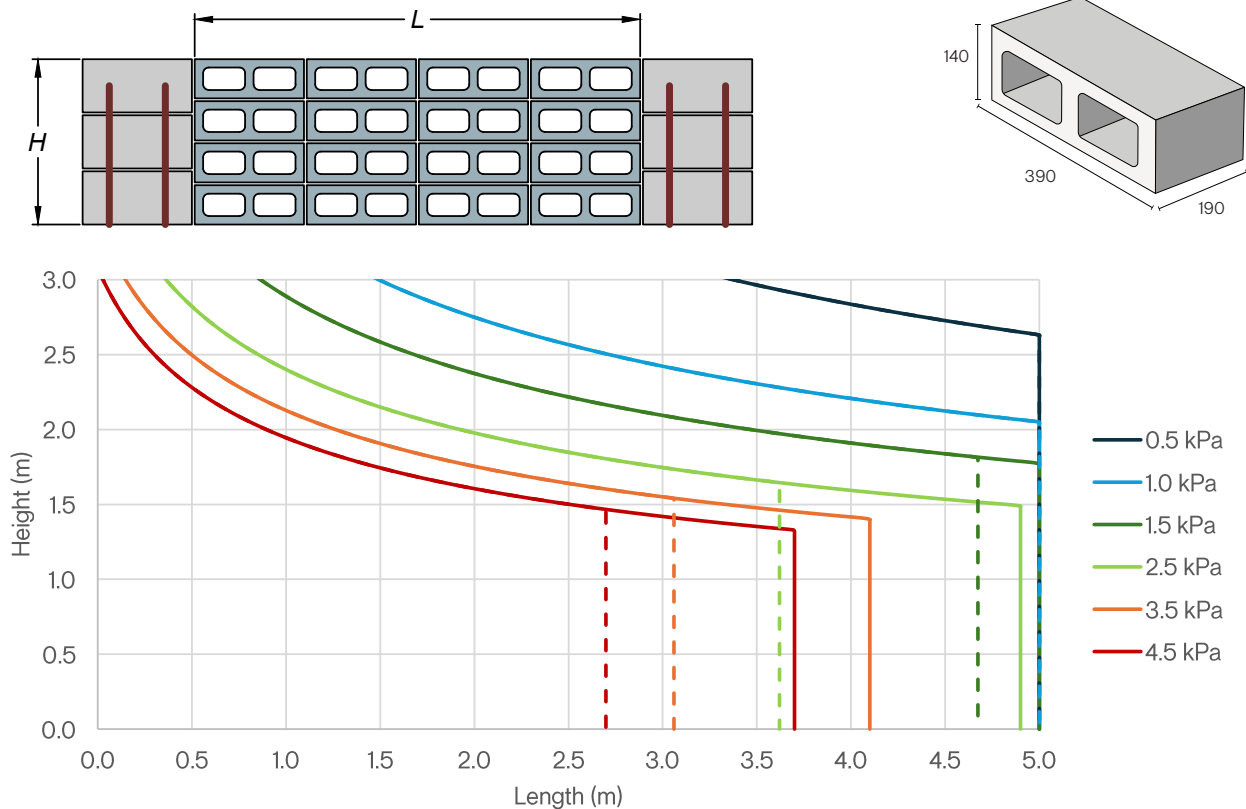


Chart 43: Horizontal Standard 15.01 Concrete Blocks with Single Reinforced Block Column (Stack Bond)

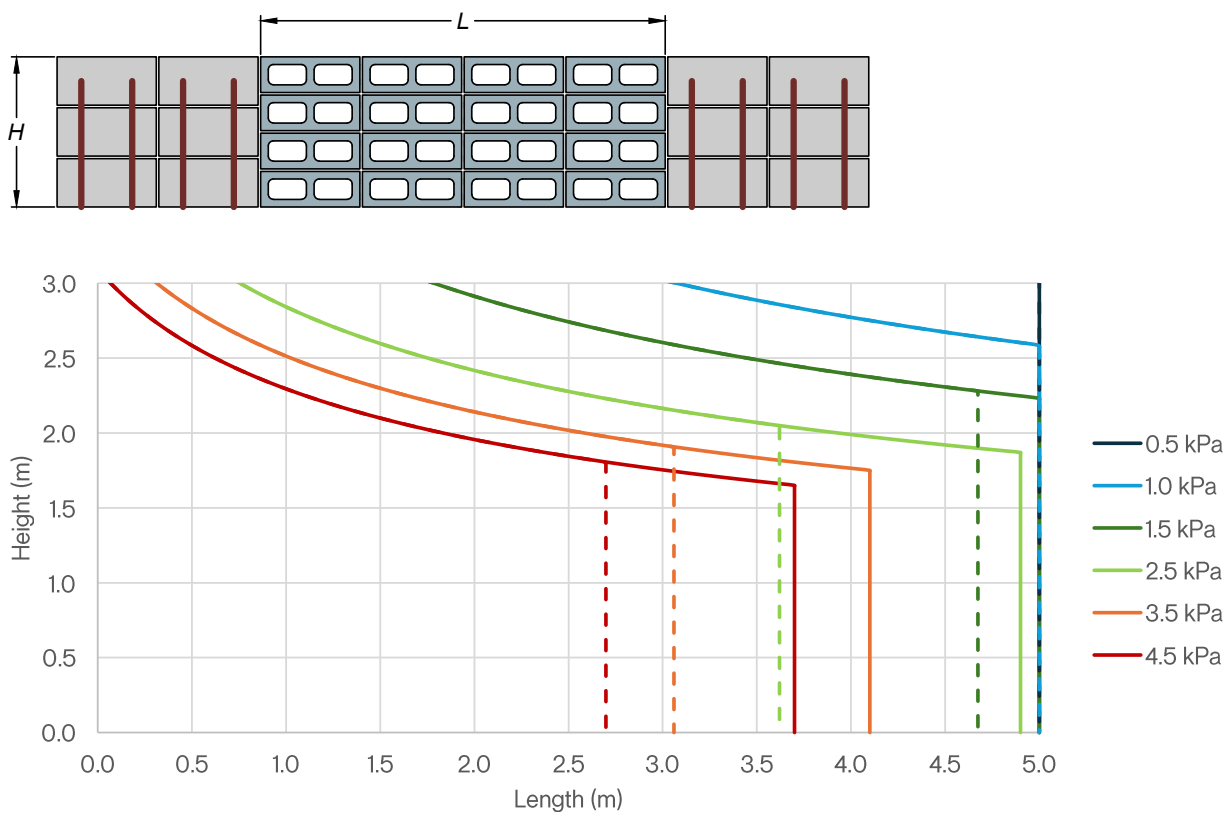


Chart 44: Horizontal Standard 15.01 Concrete Blocks with Double Reinforced Block Column (Stack Bond)

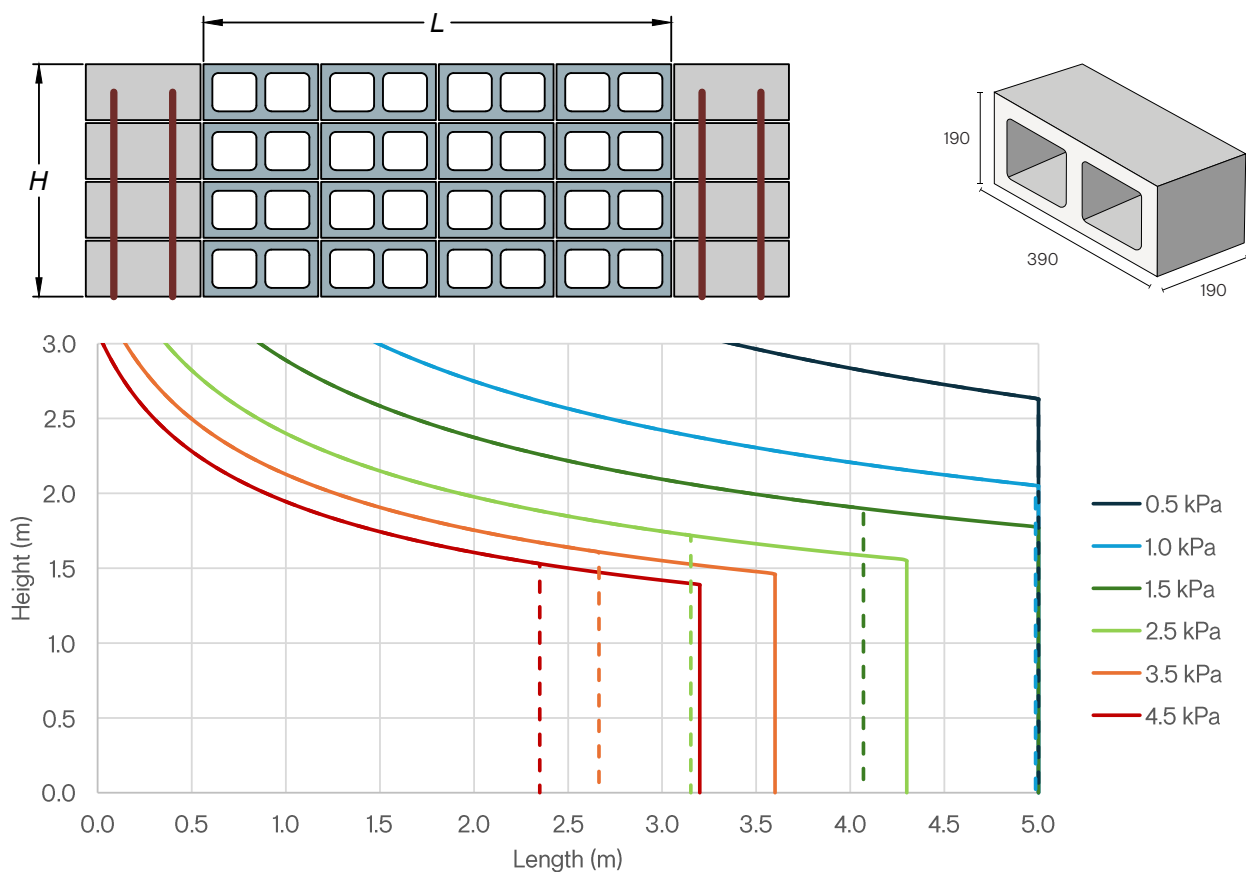


Chart 45: Horizontal Standard 20.01 Concrete Blocks with Single Reinforced Block Column (Stack Bond)

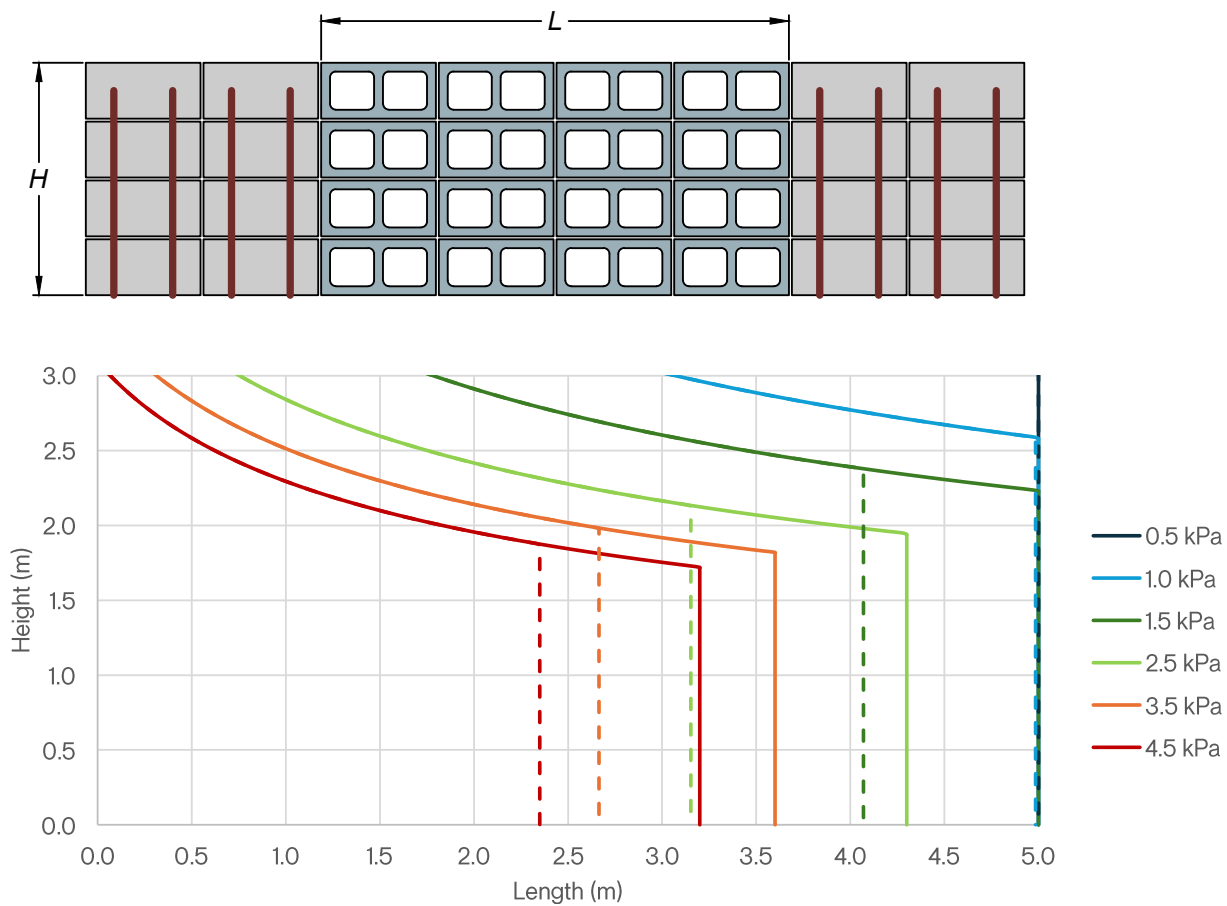


Chart 46: Horizontal Standard 20.01 Concrete Blocks with Double Reinforced Block Column (Stack Bond)

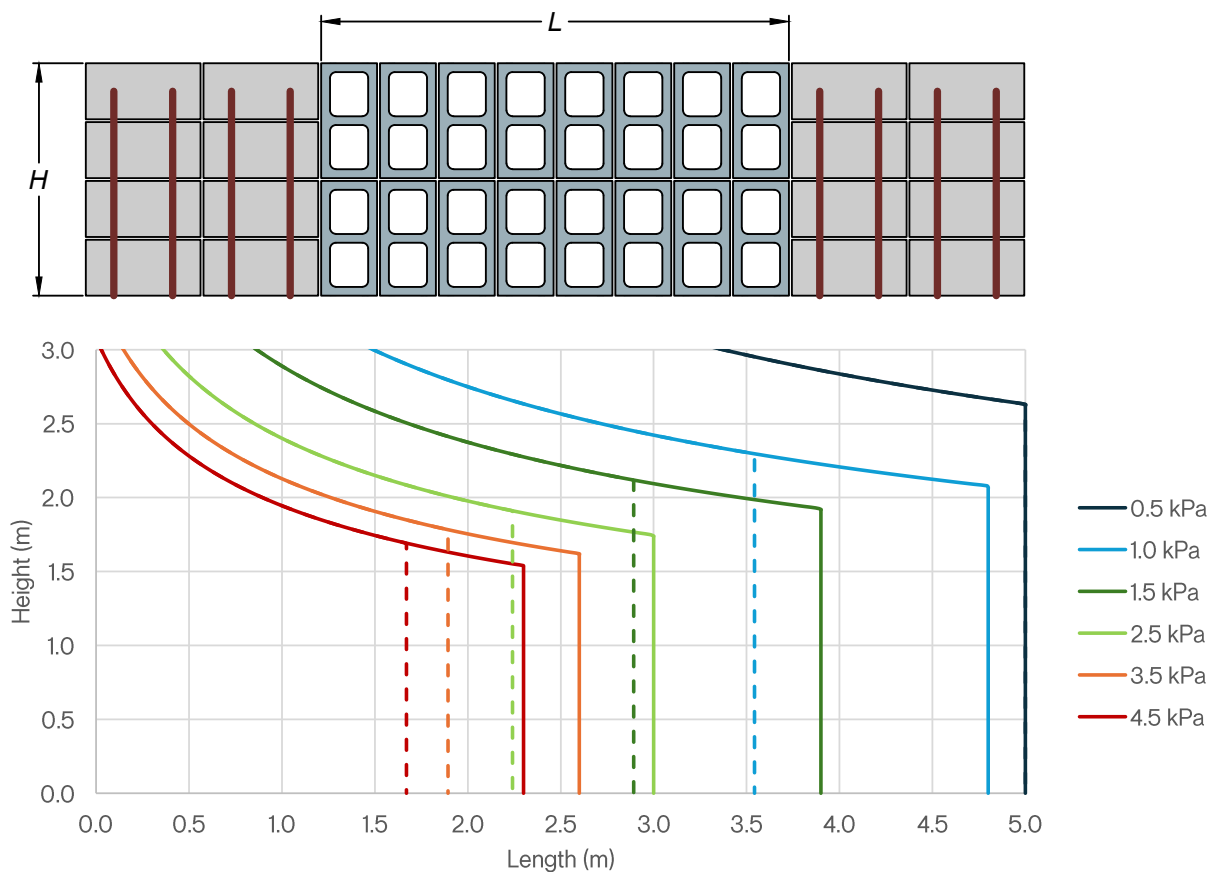


Chart 47: Vertical Standard Concrete Blocks with Single Reinforced Block Column (Stack Bond)

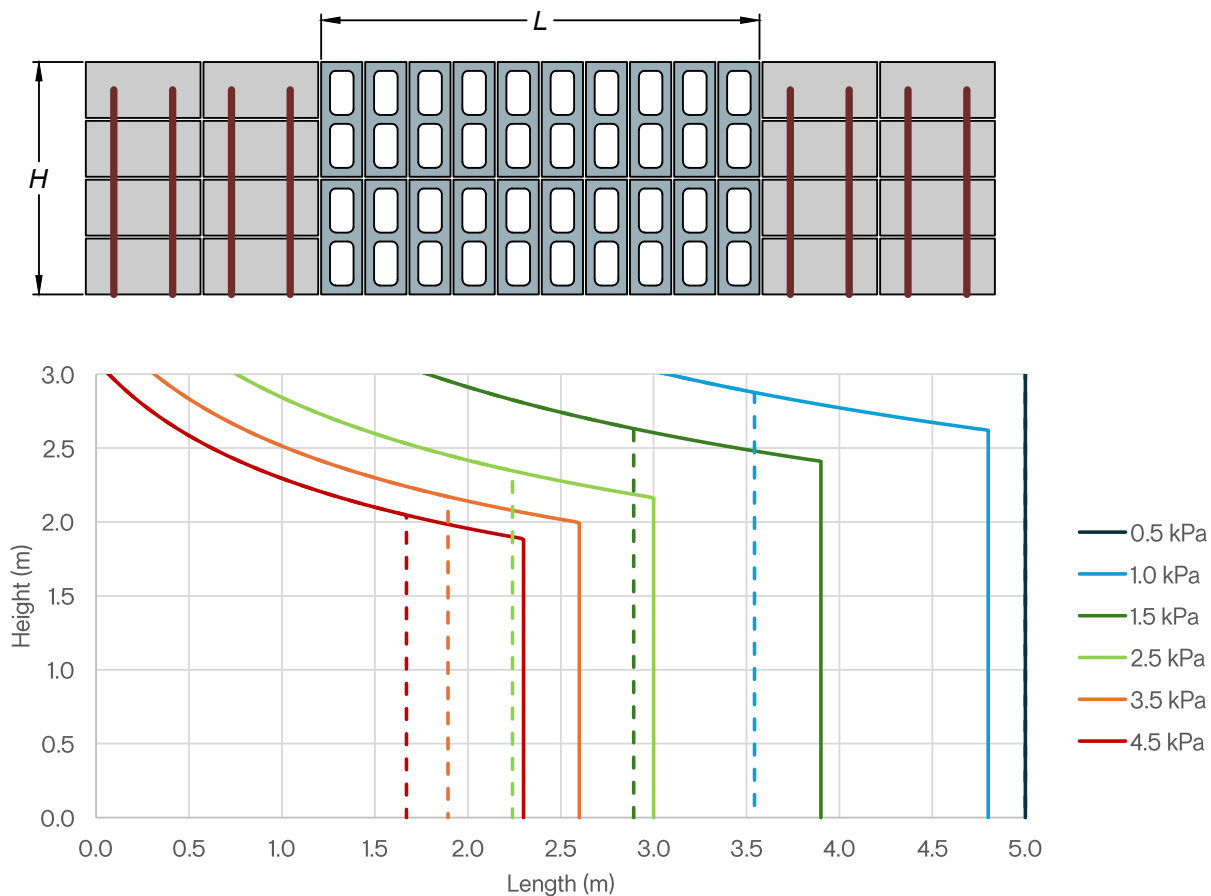


Chart 48: Vertical Standard Concrete Blocks with Double Reinforced Block Column (Stack Bond)

Maintenance

Once the construction of the breeze block wall is complete, it is recommended to soak the wall with water every day for a week to promote strong curing of the mortar and/or grout. If staining appears during this process, wait until the wall is dry before cleaning to check if it disappears on its own.

Before sealing the breeze block wall (if necessary), the mortar and/or grout should be allowed to cure for at least 28 days, and the surface of the breeze blocks should be clean, free of dirt, stains or mortar droppings, and completely dry. If stains are present, clean the masonry in accordance with CMAA's *CM03 Concrete Masonry Cleaning Manual*⁹. Or refer to the manufacturer's instructions.

8

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