

Rockzero Design Guide



| | | | | | |
|----------|---------------------------------------|-----------|-----------|--|-----------|
| 1 | Rockzero in a nutshell | 3 | 7 | Project process | 23 |
| | | | 7.1 | Design | 23 |
| | | | 7.2 | Cost calculation | 23 |
| | | | 7.3 | Tender | 23 |
| | | | 7.4 | Rockzero review | 23 |
| | | | 7.5 | Execution | 23 |
| 2 | ROCKWOOL Insulation | 5 | 8 | Standard details for lightweight cladding | 24 |
| 3 | Limitless freedom of design | 7 | 8.1 | External wall (standard cross-section) | 24 |
| 4 | Design specifications | 10 | 8.2 | Foundation | 25 |
| 4.1 | Our responsibility, your security | 10 | 8.3 | External corner | 25 |
| 4.2 | Modular concept | 11 | 8.4 | Internal corner | 25 |
| 4.3 | Dimensions | 12 | 8.5 | Windows and doors | 26 |
| 4.4 | Dead load | 13 | 8.6 | Intermediate floor | 27 |
| 4.5 | Foundation | 13 | 8.7 | Roof | 27 |
| 4.6 | Columns and corners | 14 | 9 | Standard details for brick walls | 28 |
| 4.7 | Windows and doors | 14 | 9.1 | External wall (standard cross-section) | 28 |
| 4.8 | OSB4 lining and service void | 15 | 9.2 | Foundation | 29 |
| 4.9 | External cladding | 15 | 9.3 | External corner | 29 |
| 4.10 | Interior walls | 16 | 9.4 | Internal corner | 29 |
| 4.11 | Intermediate floors and second storey | 16 | 9.5 | Windows and doors | 30 |
| 4.12 | Roofs and gables | 17 | 9.6 | Intermediate floor | 31 |
| 4.13 | Maintenance and repair | 17 | 9.7 | Roof | 31 |
| 5 | Component specifications | 18 | 10 | Standard details for party walls | 32 |
| 6 | System performance | 19 | | | |
| 6.1 | Statics | 19 | | | |
| 6.2 | Thermal | 20 | | | |
| 6.3 | Acoustics | 21 | | | |
| 6.4 | Airtightness | 21 | | | |
| 6.5 | Fire | 21 | | | |
| 6.6 | Moisture | 22 | | | |



1 Rockzero in a nutshell

Rockzero is an innovative system for constructing the load-bearing walls of low-rise buildings. The Rockzero wall system is a unique, innovative and patented modular system which meets and exceeds the requirements of the future for minimal energy loss and efficient construction processes – today.

The Rockzero wall system combines the requirements for sustainable lightweight constructions with optimal energy performance, efficient installation processes, technical support and end user benefits. In other words, the Rockzero wall system is the ideal all-in-one construction system.

The Rockzero wall system is the load-bearing core of the outer wall. A service void is installed on its interior face and a wide range of finishes can be installed as the exterior façade.

The Rockzero wall system is a unique combination of thermal bridge-free load-bearing columns, dense ROCKWOOL stone wool insulation and interior OSB4 lining. This unique combination results in a pioneering low energy wall system comprising few components and a slim solution.

The modular design decreases the risk of making mistakes on the building site. For all interfaces between the Rockzero wall system and other building solutions, a standard detail with minimised thermal bridges has been created. Due to the modularity of the system, very few adjustments are needed between different building designs. As a result, many of the standard details can be reused.

The system comprises very few components, which essentially can be assembled with just a power drill on-site. Rockzero is quick and easy for installers to learn and understand. Actual installation is quick and simple versus other building solutions, meaning improved build times and less mistakes on-site.

The Rockzero solution is delivered on-site to fit the specific house design. As only minor modifications are necessary on-site, the time spent on this and material waste is minimal.



1 Rockzero in a nutshell

Inherent advantages of the Rockzero wall system:

- Rockzero can be specified to meet the standard for nearly zero-energy buildings (nZEB).
- U-values can be optimised by altering the thickness of insulation (infill outer) in the exterior face of the Rockzero wall.
- Free of thermal bridges within the fabric itself – and minimised thermal bridges for interfaces to other building elements.
- No risk of moisture: its open structure allows water vapour to pass through the stone wool, without condensing.
- Built-in airtightness.
- Suitable for standard construction components (doors, windows, roofs, etc).
- Freedom with regard to architectural design: wide choice for the external façade.
- Efficient construction process: logical and rapid modular construction, which minimises assembly time and reduces mistakes and defects.
- Bespoke deliveries produced for each project. This minimises both adaption at the construction site and waste.

With the Rockzero wall system, you are always guaranteed:

- Project engineering assistance (descriptions, calculations and delivery specifications).
- Start-up assistance at the construction site.
- Advice and checks in connection to installation.
- After-sales service.

The construction of a building is cost-intensive, right from planning and design through construction, until the building is ready for use. It is therefore important to optimise each individual phase, so that all unnecessary costs are eliminated, errors are avoided and the overall construction process takes place as smoothly as possible.

A carefully considered system combined with a rational construction process results in faster construction and a total cost which is lower than with most traditional construction methods.

In general, waste and disposal costs are considerably greater with a traditional solution than with a Rockzero solution. The Rockzero wall system is basically supplied as a complete, customised system, delivered for each individual building. This results in only minimal adaptation and waste in the construction process itself.



2 ROCKWOOL Insulation

The Rockzero wall system is the construction method of the future. The development, production, implementation and support of the system is by the ROCKWOOL group, the world's largest manufacturer of stone wool. This guarantees you quality, performance, functionality and a smooth construction process.

Today, choosing the right insulation product is more important than ever because of the stricter requirements for energy efficient and sustainable buildings. Using ROCKWOOL

stone wool will guarantee you both efficient thermal insulation and a better technical solution. The product's inherent qualities give extra performance compared with other types of insulation.

ROCKWOOL is shown by independent assessments to be amongst the most sustainable insulation products available anywhere, leading to an unrivalled combination of environmental savings, energy reduction, sound insulation and fire safety. These are advantages which you get 'free' for your project.



2 ROCKWOOL Insulation



Fire safety

ROCKWOOL stone wool withstands temperatures up to 1000° C, and is rated best-in-class with regards to fire-resistance: it is an A1, non-flammable material. This resistance can slow a fire's progress and buy precious time for rescue operations while helping to protect the structure of a building from unnecessary damage. While heat and flames are bad enough in a fire, smoke is also a serious danger. It can suffocate occupants, and it can incapacitate people who might otherwise have been able to escape. ROCKWOOL stone wool insulation keeps toxic smoke to a minimum for even greater safety.



Moisture repellence

ROCKWOOL stone wool is moisture repellent. If the insulation is exposed to rain, only the outermost few millimetres will get wet. This moisture will evaporate when the rain stops. ROCKWOOL stone wool is also breathable and allows water vapour to pass through the wool – without condensing.



Comfort and indoor climate

A well-insulated home combined with controlled ventilation is the best and most economical way to ensure a good indoor climate. Insulation that provides an airtight building envelope guarantees a pleasant and constant temperature all year round. ROCKWOOL stone wool meets the strictest European requirements in relation to indoor climate, and is certified in the Finnish M1 emission class for construction materials.



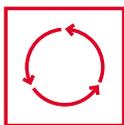
Sound and noise reduction

Buildings are noisier than many people think. Traffic outside, ventilation systems, music, talking, doors opening and closing: many sounds contribute to the typical acoustic environment of a room. We sometimes do not even register them consciously – but we are affected by them. Environments with a high noise level can be stressful and make it hard both to concentrate and relax. ROCKWOOL stone wool insulation and acoustic ceiling panels dampen noise, regulate sound and improve acoustics to improve comfort and quality of life both at home and at work.



Durability

Our products are built to perform over the long-term. ROCKWOOL stone wool insulation and cladding remain stable over time, and they do not allow thermal bridges to form. But it is not just our products that are 'rock solid' – so is our time-honoured name, and our reputation for delivering documented benefits and providing expert advice to architects, designers, contractors and building owners.



Sustainability

ROCKWOOL stone wool insulation is one of the most practical, cost-effective and environmentally efficient means of reducing energy consumption in a building. It reduces the need to burn fossil fuels, reduces CO2 released into the environment and contributes to a better climate.

The Rockzero wall system has been tried and tested at construction sites and is certified through independent laboratory tests. This guarantees the quality of every component in the system and ensures that it works well in practice at the construction site and in the finished building. This provides a safe, fast and efficient construction method, which gives planners, contractors, installers and homeowners maximum security throughout its lifetime.

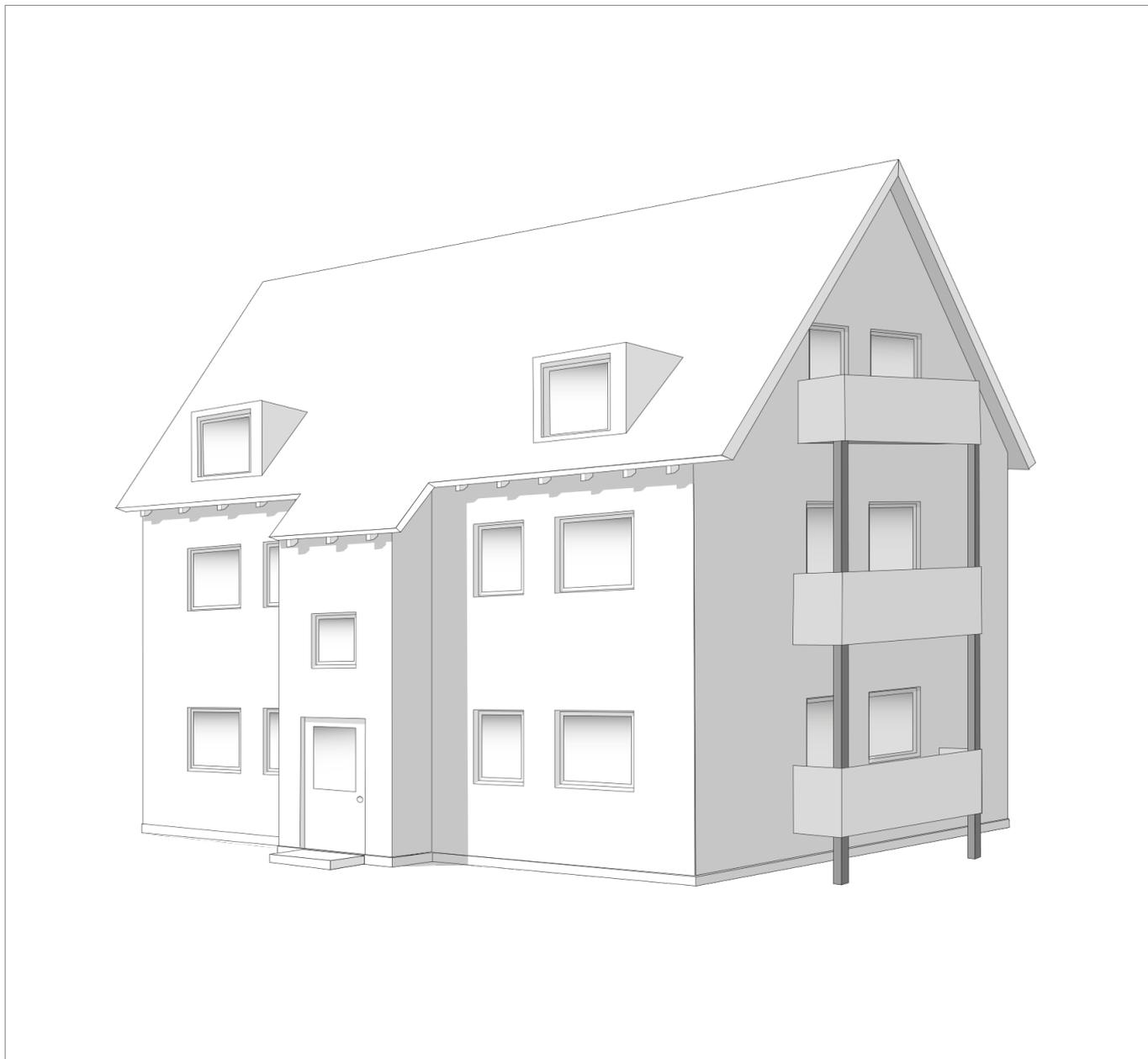
The ROCKWOOL Group gives you comprehensive project support during all phases of the construction from the initial building design through to construction. Ensuring completion of the project without compromising end user benefits such as energy performance, sustainability, indoor climate or building quality.

The Rockzero wall system's inherent characteristics help to make the system a complete solution for low energy buildings of the future.

3 Limitless freedom of design

Working with modular building systems does not have to restrict the architect's freedom to design and construct attractive buildings.

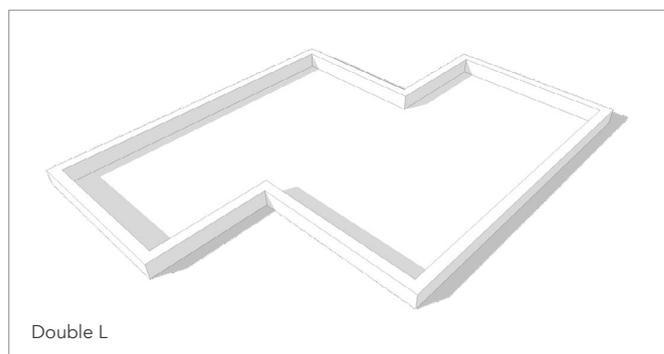
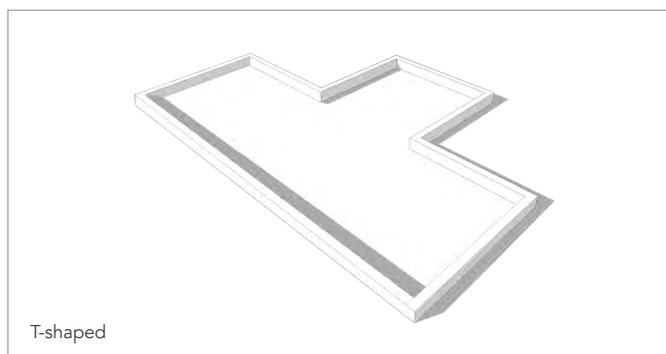
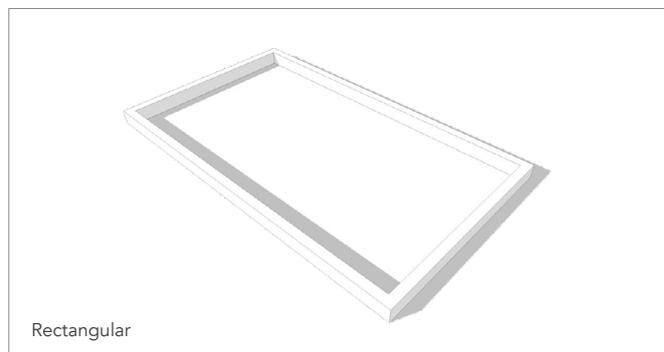
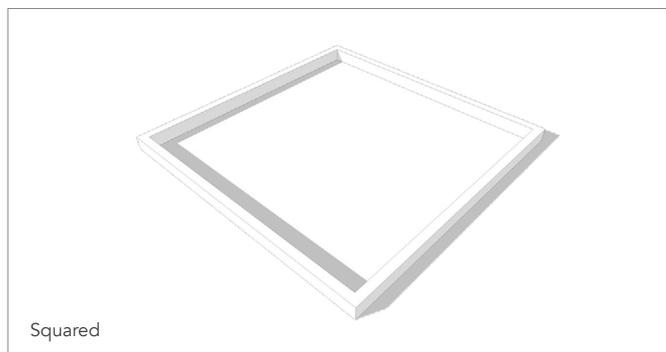
The variety of applications extend from single-family homes to terraced houses, schools and office buildings. Rockzero modules can also be easily exchanged next to doors or windows, making designs adaptable to future needs.



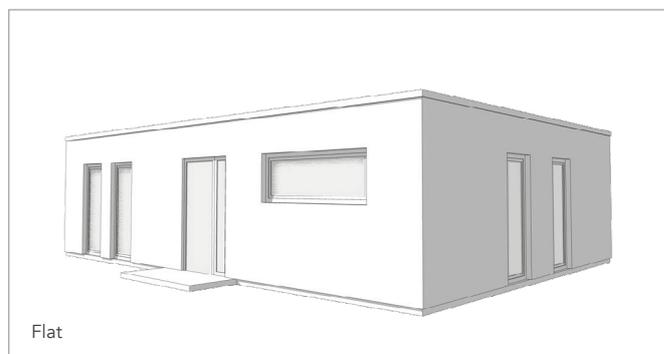
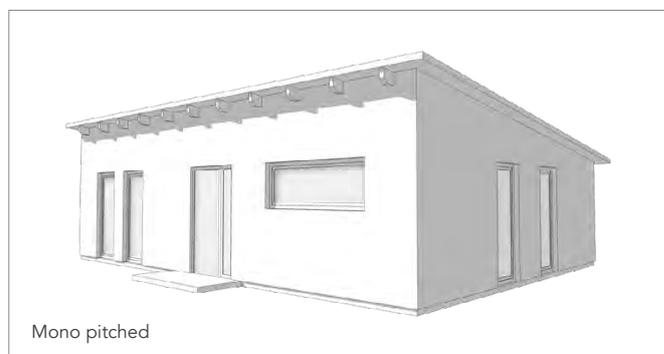
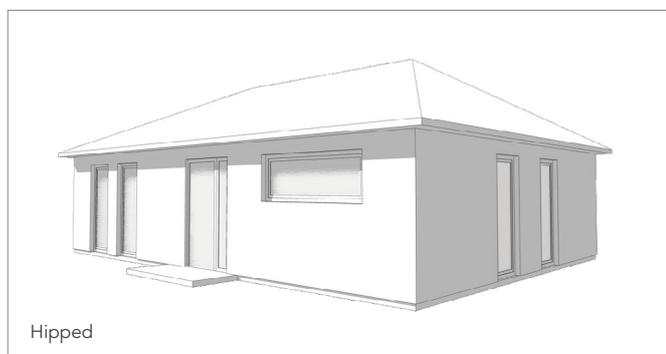
Up to 3 storeys incl. occupied attic

3 Limitless freedom of design

Rockzero allows combinations of various shapes of footprints, interior layouts, roof shapes and diverse façade expressions such as bricks, Rockpanel or wood cladding – a huge range of possibilities.



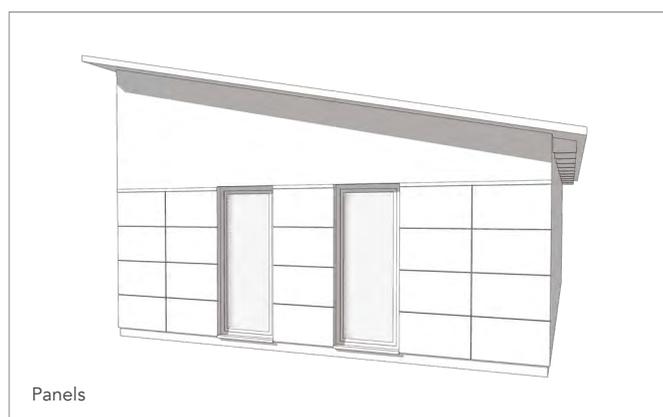
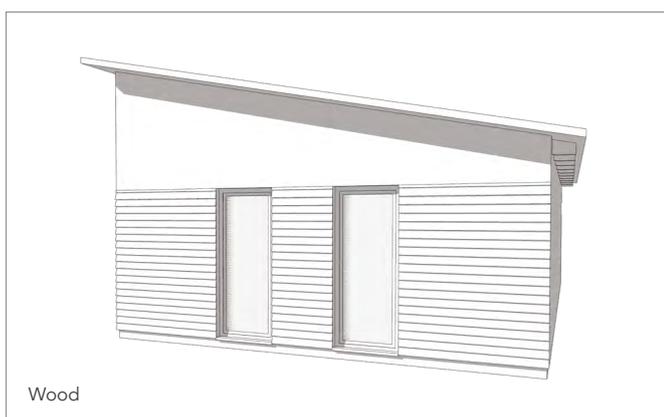
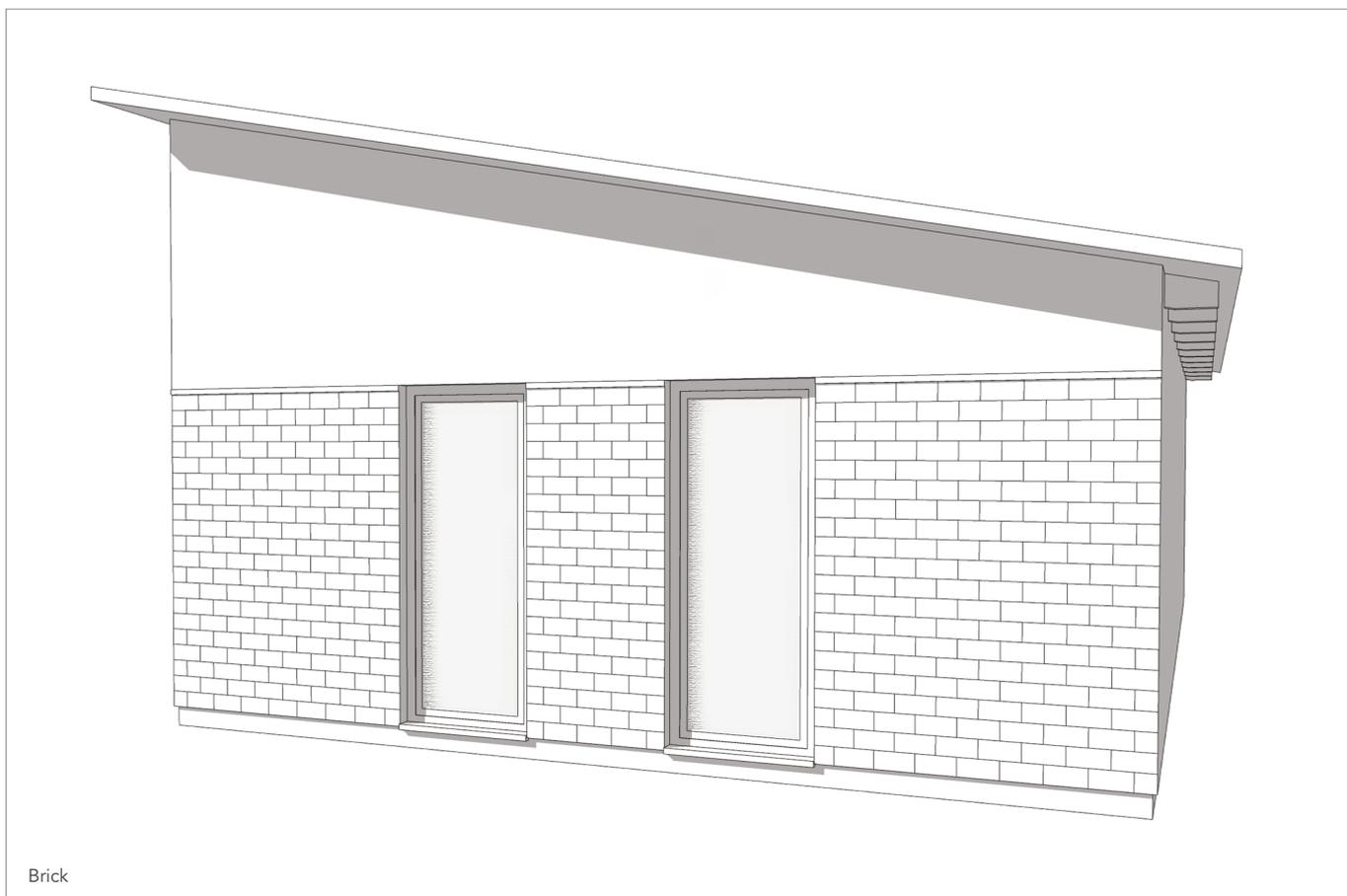
Footprint



Roof shape

3 Limitless freedom of design

The Rockzero wall system has been designed to accommodate a variety of external finishes, such as wood cladding, panel systems or bricks.



Cladding style

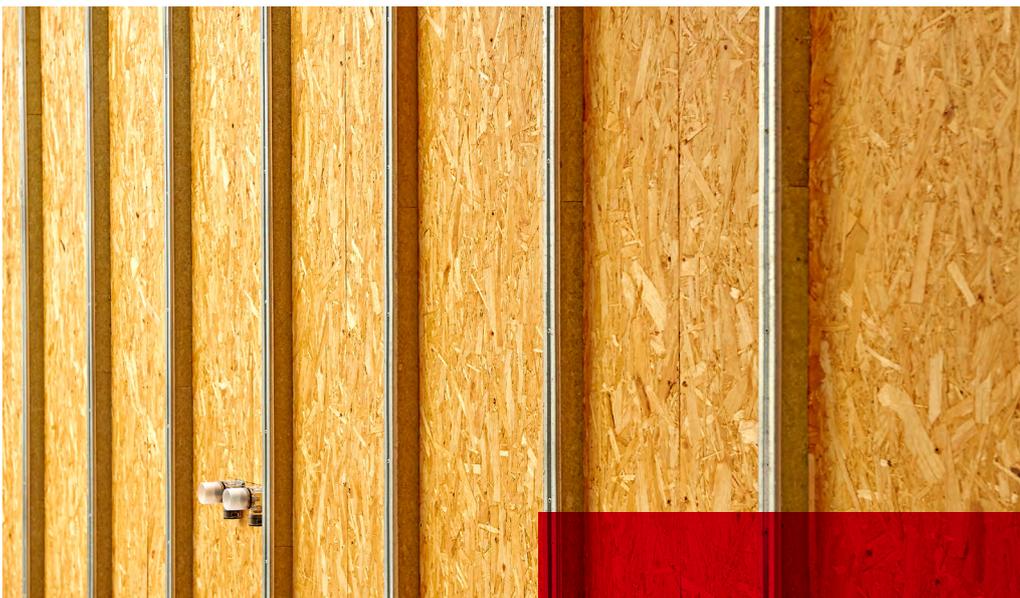
4 Design specifications

4.1 Our responsibility, your security

The Rockzero wall system is designed to deliver on all of its promises.

It interfaces with most standard building components such as roofs, windows and doors, as well as a variety of external finishes. The modular system is pre-fabricated to a high degree, using a minimum number of components. This simple design allows for efficient construction and decreases the risk of mistakes being made on the building site. Suggested standard details are available for interfaces between the Rockzero wall system and other building components; all designed to minimise thermal bridges. The modular design of the system means that only a few adjustments are required between different house designs.

- To ensure problem-free installation and a high level of quality, the ROCKWOOL Group offers training courses for installers.
- At the ROCKWOOL factory, all aspects of the manufacture of Rockzero components are controlled and documented to meet our high-quality specifications and accuracy of materials according to the specification of the system.
- The delivery of components for a bespoke project will be in accordance with the agreed build date and time.
- Key elements of the Rockzero wall system must never be removed, exchanged or substituted without approval of a ROCKWOOL consultant.
- System capabilities are predefined; however, all projects must be assessed and approved by local engineers.
- All major system components can be cut to size on-site, except load-bearing columns. They are delivered pre-cut (pre-made).
- The built-in airtightness of the system must not be compromised. The airtight layer is established between the steel construction and OSB4 boards.
- Rockzero is a system with racking strength, which means stabilising wall sections start with a stringer column and end with a stringer column. A stringer section is a continuous full height wall section, for example between a corner and opening or an opening and another opening.
- Heavy deck or roof constructions can be used together with the Rockzero wall system. A local engineer must approve the combination of such constructions, and the Rockzero system.
- Delivered items are inspected on arrival at the site, to ensure the correct number of components and to check for damage in transit. Any shortages or damage must be notified immediately.
- Installation inspections should be carried out periodically throughout the building process.



4 Design specifications

4.2 Modular concept

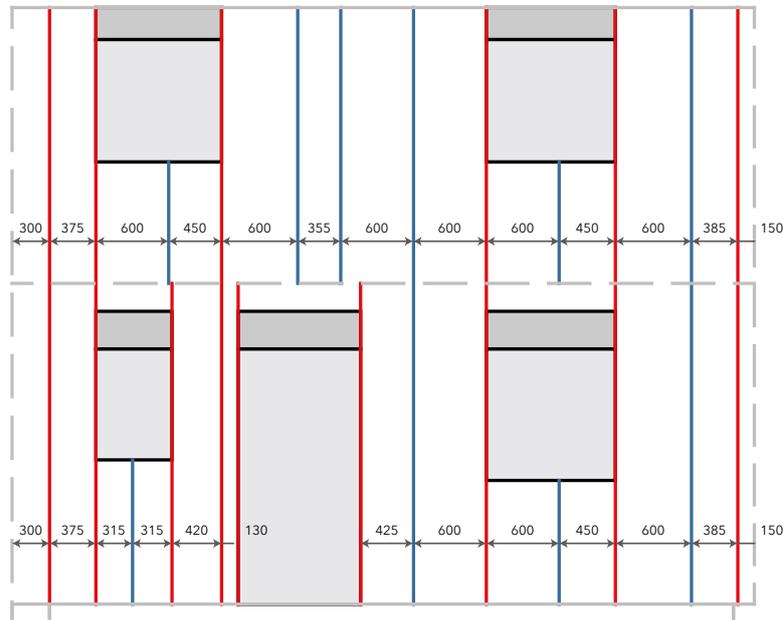
The Rockzero wall system is a modular system with a standard module size of 600 mm. The modules are framed by vertical bearing members, shaped as I-profiles (the Rockzero column), with a central axis which represents the module axis.

Preferred modular steps are 60 mm to match typical brick measures. The minimum distance between Rockzero columns is 180 mm.

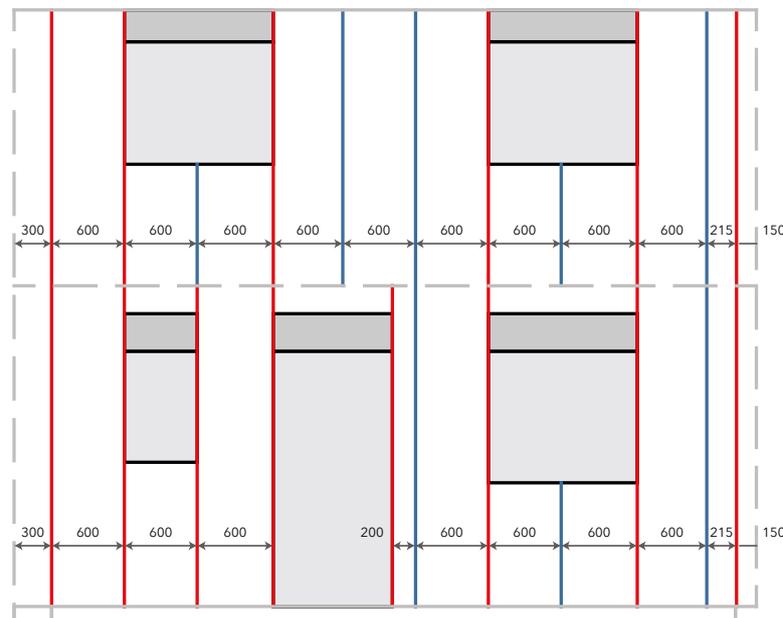
In multi-storey buildings, the modular grid should match that of other storeys to optimise the transfer of loads between

different storeys. It is also helpful to place windows (or doors) of the same size between the same vertical module line, on top of each other. A stringer column implies a higher vertical load at this module line and requires another stringer column at the same module line in the floor below.

Additionally, it is recommended to design as many standard modules as possible, to keep costs low and efficiency high. Ideally, at least 80% of the modules should be like this. Non-standard sizes can cause higher costs in production and mounting.



Original layout of a façade with an unfavourable module grid.



Modified module grid: optimised for a high share of standard modules.

4 Design specifications

4.3 Dimensions

Wall thickness

The thickness of walls built with the Rockzero wall system are given in the table below:

| Type of rain screen | U-value [W/(m ² ·K)] | |
|--|---------------------------------|-----------|
| | 0,10 | 0,12 |
| Brick (spacer 170/110 mm) | 352 mm * | 292 mm * |
| Lightweight cladding (spacer 195/150 mm) | 377 mm ** | 327 mm ** |

* Thickness of brick and air gap not included, 15 mm interior dry lining

** Thickness of cladding not included, 15 mm interior dry lining

Centre frame line

The centre frame line of the system is placed at the centre of a Rockzero column, i.e. the distance from the Rockzero centre frame to the inner side of the wall is 131 mm (incl. 15 mm interior dry lining). This is important to consider when designing corners at a building where brick is used (brick size).

Height

The maximum height of a Rockzero column is 3000 mm. If higher walls need to be built, a wall section is separated in height by a wall plate and a second wall section is built on top. Be aware that the wall plate needs to be anchored backwards at a suitable distance to avoid a hinged connection between the two wall sections.

Wall plate

The standard wooden wall plate is sized 45 x 170 mm. It can withstand a maximum vertical load of 12 kN/m (quality C24), e.g. being used as a rafter centred between two Rockzero columns. Other lesser loads can of course be accommodated (see chapter 6.1 for further information).



4 Design specifications

4.4 Dead load

The maximum dead load below is for a wall of 3 m high, module size 600 mm, U-value 0.10 W/(m²·K). Brick and external cladding are not included.

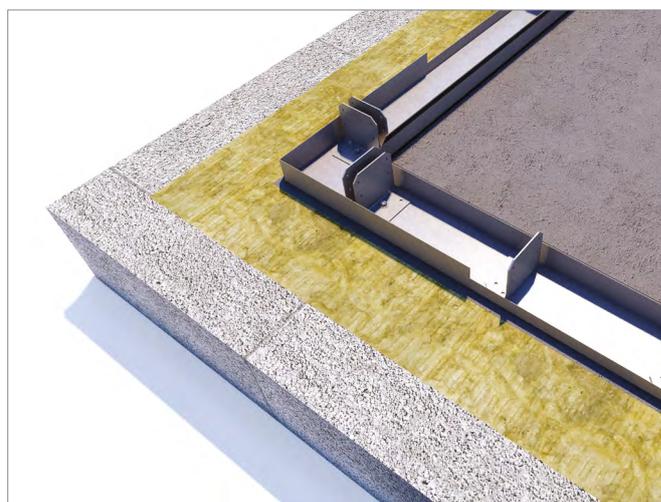
| Member | Brick | | | Lightweight cladding | | |
|---------------------------|-------------|---------------------------|--------------------------|----------------------|---------------------------|--------------------------|
| | Thickness m | Density kg/m ³ | Weight kg/m ² | Thickness m | Density kg/m ³ | Weight kg/m ² |
| Rockzero column | | | 10,92 | | | 13,26 |
| U-profiles | 0,001 | 7850 | 0,96 | 0,001 | 7850 | 0,96 |
| Wall plate | 0,045 | 420 | 1,07 | 0,045 | 420 | 1,07 |
| Brackets | | 7850 | 0,26 | | 7850 | 0,26 |
| Insulation (core) | 0,10 | 70 | 6,72 | 0,10 | 70 | 6,72 |
| Insulation (Infill outer) | 0,17 | 43 | 6,53 | 0,17 | 43 | 6,53 |
| Insulation (Infill inner) | 0,05 | 43 | 2,02 | 0,05 | 43 | 2,02 |
| OSB4 | 0,012 | 620 | 6,81 | 0,012 | 620 | 6,81 |
| Fibre gypsum board | 0,015 | 1150 | 17,25 | 0,015 | 1150 | 17,25 |
| Screws | | | 0,30 | | | 0,30 |
| | | | 52,84 | | | 55,18 |

4.5 Foundation

As the base for the Rockzero wall system, the foundation is especially important. Careful attention needs to be paid to the design and precise construction of the foundation to ensure a faultless wall system is created.

The foundation must be constructed of concrete with a quality of at least C20/25. The use of lightweight concrete blocks, a layer of mortar or similar material on top of the foundation is to be avoided, as this increases the risk of substrate failure due to high point loads acting on the substrate.

Concrete foundations underneath a Rockzero bottom U-profile must be a minimum of 130 mm wide (edge distance of concrete bolts 65 mm, from centre bottom U-profile = centre frame line). To ensure proper setting of concrete bolts, reinforcement bars should not be placed underneath the centre of the bottom U-profile.



4 Design specifications

4.6 Columns and corners

The major load-bearing part of the Rockzero wall system consists of Rockzero columns that are designed as I-shaped profiles, consisting of two steel flanges and an insulating core. This bearing member is placed vertically between two Rockzero insulation (core) elements. It serves as a support structure for fixing both the exterior finish and OSB4 lining on the inside.

Load-bearing Rockzero columns are delivered to site in the length required, usually equal to the height of a storey.

Corners always consist of two adjacent Rockzero columns ('stringer columns') to ensure a stable corner solution.

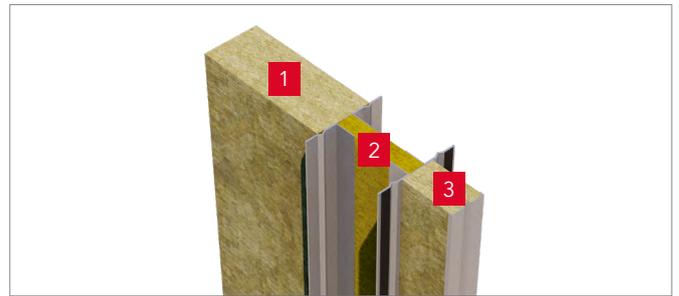
4.7 Windows and doors

Openings for windows and doors are vertically framed by Rockzero columns (stringer columns), with an inset wooden stud and a standard size of 53 x 90 mm on both sides. On top of these, a wooden lintel is used to bridge loads from above and lead them into the foundation.

It is advisable to align openings for windows and doors to the modular grid of the Rockzero wall system. However, it is of course possible to use elements that do not fit to the modular system grid.

Parapets of windows are not considered to be load-bearing, though its top U-profile can carry the load of a window temporarily before this is fastened to the columns on both sides.

The distance from the centre of a Rockzero column to a window/door frame is 96 mm when a Rockzero window board is used to hold the window/door (including 10 mm installation tolerance around the board). This can be important when designing a brick project – the 96 mm gives space for a full brick.



The column contains 3 zones;

1. Main insulation zone
2. A structural zone
3. Zone for running services

Thus, the minimum width of a Rockzero column between two adjacent openings is 192 mm, measured from frame to frame.

Using a standard wooden stud in an opening, the free width of openings is 128 mm smaller than the c/c distance of adjacent Rockzero columns, i.e. a Rockzero column fills 64 mm from its centre to the inside surface of a standard wooden stud.

The standard size of wooden members for lintels is 45 x 220 mm (C24). For a vertical line load up to 12 kN/m, a single lintel (1x 45 mm) is sufficient for opening sizes up to 2,4 m. A double lintel (2x 45 mm) is suitable for up to 3,4 m wide openings at this load. Other combinations of geometry and load can be accommodated (see chapter 6.1 for further information).

Lintels are placed directly below the top U-profile of the Rockzero system and carried by wooden studs placed in-between the flanges of Rockzero columns. The standard size of these wooden studs is 53 x 90 mm.



4 Design specifications

4.8 OSB4 lining and service void

The OSB4 boards on the internal side of the core construction serve 3 purposes:

1. Stability

Shear and racking strength of the system are primarily secured by OSB4 boards screwed to Rockzero columns. It is essential for the stability of a building that the distance between OSB4 screws is defined properly depending on the external loads and the layout of the building.

2. Airtightness

To secure sufficient airtightness of the external wall, OSB4 boards with certified tightness performance are used. If the OSB4 lining needs to be penetrated, e.g. by services running to the outside of the building, the breach is to be sealed by proper means such as a sealing tape collar.

3. Vapour retarding layer

The entire Rockzero wall construction consists of stone wool which is a vapour-open insulation material. To be able to suit a wide range of climates, both indoor and outdoor, OSB4 lining is used as a vapour retarding layer.

The service void is an integral part of the Rockzero wall system. It is established by 'inner spacers', creating an insulated void of 53 mm between the OSB4 boards to

the internal dry lining. Within this void, all services can be installed without penetrating the airtight layer of the system (OSB4). Cables and pipes can easily be inserted through the insulation (Infill inner) of the inner spacers.

Of course, the primary purpose of the service void is to meet the service needs of the building. However, the service void is also essential to achieve the system performance stated in chapter 6.



4.9 External cladding

The Rockzero wall system has been designed to accommodate a variety of external finishes, such as wood cladding, panel systems or bricks to protect the system from external influences. These finishes need to be designed and specified separately since they are not part of a Rockzero delivery.

For the Rockzero system, external cladding can be divided into two categories, depending on the way they are fastened to the system:

1. Brick

Wall ties are used to connect bricks and the Rockzero wall system.

2. Lightweight cladding

A front spacer channel can receive all types of cladding that can be screwed to a substrate. For this category, the specific weight of the cladding must not exceed 50 kg/m².



4 Design specifications

4.10 Interior walls

Separating walls

The construction of interior walls is not part of the Rockzero wall system. Interior walls can be designed independently from the Rockzero wall system, e.g. as dry-lined wood/metal stud walls, as heavy brick or as aerated concrete walls. In some circumstances the interior walls can be a vital contributor to the structural stability of the building. This will be determined when performing structural calculations for the individual project and location, based on the external loads.

Party walls

Following on from the structural concept of Rockzero, a system for party walls has been developed which can be easily combined with an external wall construction.

In general, the design of a party wall does not strictly depend on using the Rockzero system for the external wall. However, the Rockzero party wall offers a range of advantages for builder and buyer:

- Follows the innovative building concept of Rockzero
- Consists of the same standard parts as the Rockzero external wall

- Delivery together with external wall kit
- Structurally effective (load-bearing, stabilising)
- Easy to connect to the external wall
- Thin structure (minimum 260 mm)
- Airtight
- Insulating
- High sound reduction
- High fire-resistance

The mounting process of a Rockzero party wall is similar to that of the Rockzero external wall. The party wall design consists of the core of the external wall, physically separated by inner spacers to avoid a transfer of sound. To reach the documented sound and fire properties, the wall needs to be cladded with 2 x 15 mm fibre gypsum boards on one side and 1 x 15 mm fibre gypsum boards on the other.

The Rockzero party wall will be delivered together with the external wall kit. This guarantees a fast and continuous building process that gives little room for mistakes, as is the case with the Rockzero external wall.

4.11 Intermediate floors and second storey

The top of each storey is completed by a 45 mm thick wooden wall plate fastened to the top U-profile and column brackets. This member is always the base for the next storey or the roof.

The Rockzero wall system performs best in combination with lightweight intermediate floors, consisting of structural steel or wooden elements. All issues concerning structural capacities and other technical properties of the intermediate floor should be provided by the supplier of the intermediate floor.

Rockzero provides a junction detail that has been developed alongside the wall system. This ensures a cost-effective way to join the two components and help to ensure that the

intermediate floor meets its structural capacities, and fire and acoustics requirements.

The junction of an intermediate floor system to the Rockzero wall system must be designed to be airtight. This can best be achieved by sealing the intermediate floor fabric to the top U-profile of the Rockzero wall underneath (the wooden wall plate) and the bottom U-profile on top.

Structurally, consideration needs to be given to floors below attics which can be stressed by horizontal forces from the roof construction. In addition, intermediate floors may require shear panels to stiffen the building against wind loads. Thus, the joint between the floor and wall has to be subject to proper structural considerations.

4 Design specifications

4.12 Roofs and gables

The roof construction is not part of the Rockzero wall system, however it can be designed independently of Rockzero.

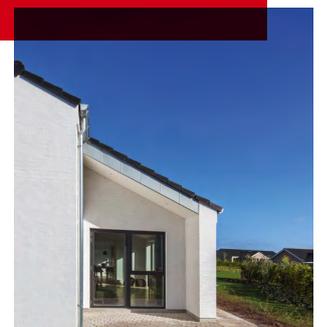
Horizontal forces from the roof, perpendicular to the wall plane, need to be retained at the top of the Rockzero wall system, either by the joists of intermediate floors or by the bottom chords of the roof construction.

The principles of constructing a gable wall correspond to those of a regular Rockzero wall. There are several options available regarding the height and pitch of the roof design. In the case of a gable triangle with a height of more than 3 m, a horizontal intersection of the gable wall may become necessary. The construction of this is similar to the intersection at the bottom of the gable triangle.

4.13 Maintenance and repair

Maintenance requirements for the Rockzero wall system are minimal. Excluding internal and external finishes, which may need to be painted or treated periodically (as well as elastic joints around building components like windows or doors), the Rockzero wall system itself is free of maintenance.

If repair work becomes necessary, it can be performed as with any other light-frame wall system.



5 Component specifications

Rockzero core components (always delivered by ROCKWOOL):

- Rockzero column for lightweight cladding*
 - Rockzero column for brick*
 - Insulation (core)
 - Infill (inner)
 - Infill (outer)
 - Spacer (inner)*
 - Corner U-profile*
 - Bottom U-profile, top U-profile*
 - Rockzero board*
 - Connector sheet
 - Rubber tape
 - Wooden stud (glulam, grade GL24c or higher)
 - Column bracket wedge
 - Wall tie
 - Column bracket
 - Concrete bolt 10 x 75 | 10 x 60
 - Self-tapping screw 4,1 x 49 (OSB4)
 - Self-tapping screw 5,5 x 45 | 5,5 x 100
 - Self-tapping screw 4,8 x 90 | 4,8 x 210
 - Insulation dowel
 - Shear washer
 - Push-pull prop
- * Always delivered by ROCKWOOL, and also for turn-key builders

Optional components (the customer can choose to have these provided individually):

- OSB4 boards
- Wood (lintel/wall plate, grade C24 or higher)
- Butyl sealant
- Bituminous felt
- Damp-proof course (DPC)
- Airtight tape
- PE membrane
- Wood screw 5 x 70 | 6 x 60 | 6 x 80
- Connector screw 5 x 40
- Self-tapping screw 4,2 x 19
- Joist hanger
- Nail plug



6 System performance

6.1 Statics

The structural load-bearing capacity of the Rockzero wall system has been verified both by full-scale tests and by calculations. From the calculations and tests performed, which include all relevant elements, the Rockzero wall system has been shown to possess the necessary strength and specifications to meet the requirements for the intended structures.

Rockzero column

Full-scale tests have been performed on a representative number of standard Rockzero elements by the Technical University of Denmark. Test results were obtained for the standard I-shaped Rockzero column (design values stated below). Values are valid for both external walls and party walls.

| | Design value |
|----------------------------|--|
| Axial compression strength | $N_{R,d} = 54 \text{ kN} \times (2,4 / H)^2$ |
| Shear strength | $V_{R,d} = 5,8 \text{ kN}$ |
| Bending strength | $M_{R,d} = 4,7 \text{ kNm}$ |
| Stiffness | $E \cdot I = 150 \times 10^9 \text{ Nmm}^2$ |
| Combined action | $N_d / N_{R,d} + M_d / M_{R,d} \leq 1$ |

Appropriate calculations on other relevant components have been carried out by independent consultants employed by Rambøll, Denmark. Nevertheless, structural calculations should be performed individually for each project by local engineers.

Stability (racking strength)

The global stability of the Rockzero structure is highly dependent on the geographical conditions of the location (i.e. wind loads) and on the individual building structure. Therefore, the stability must be investigated by the responsible designer or structural engineer for each specific structure and location.

The stability of a building is provided by construction elements like external and internal walls, floors and/or the roof. In Rockzero walls, the stone wool between the columns and the OSB4 boards contributes to the stability of the system, supporting the integrity of the building to a certain degree.

For minor projects, this integrity can be provided by the stiffening properties of the Rockzero wall system. There may be other cases where additional stabilising elements such as internal walls or floors need to be utilised.

Rockzero walls need to be strut-braced during construction using appropriate techniques. Having ensured the stability of the building as intended in the structural plans, the temporary strut-bracing may then be removed.

Screw connections

| Type of connection | Design strength | Comment |
|-----------------------------|-----------------|---|
| Foundation, stringer column | 13,7 kN | Joint of concrete bolts, column brackets and column |
| Wall plate (wood) | 8,0 kN | Pull out strength |
| Wall plate (steel) | 11,1 kN | Pull out strength |
| OSB4 | 0,59 kN | Shear capacity per screw |

6 System performance

6.1 Statics

Wall plate (grade C24)

| | | | | | |
|------------------------------|----------|----------|----------|----------|----------|
| Line load from roof [kN/m] | ≤ 8 | ≤ 10 | ≤ 12 | ≤ 14 | ≤ 16 |
| Dimension of wall plate [mm] | 45 x 120 | 45 x 145 | 45 x 170 | 45 x 195 | 45 x 220 |

Lintel (grade C24)

Size 45 x 220 mm (single member)

| | | | | | |
|----------------------------|--------|--------|--------|--------|--------|
| Line load from roof [kN/m] | ≤ 8 | ≤ 10 | ≤ 12 | ≤ 14 | ≤ 16 |
| Width of opening [mm] | ≤ 2900 | ≤ 2600 | ≤ 2400 | ≤ 2200 | ≤ 2100 |

Size 90 x 220 mm (double member)

| | | | | | |
|----------------------------|--------|--------|--------|--------|--------|
| Line load from roof [kN/m] | ≤ 8 | ≤ 10 | ≤ 12 | ≤ 14 | ≤ 16 |
| Width of opening [mm] | ≤ 4200 | ≤ 3700 | ≤ 3400 | ≤ 3100 | ≤ 2900 |

Size 90 x 295 mm (double member)

| | | | | | |
|----------------------------|--------|--------|--------|--------|--------|
| Line load from roof [kN/m] | ≤ 8 | ≤ 10 | ≤ 12 | ≤ 14 | ≤ 16 |
| Width of opening [mm] | ≤ 5500 | ≤ 5000 | ≤ 4600 | ≤ 4200 | ≤ 3900 |

Lightweight façade cladding

The specific weight of cladding mounted on a front spacer channel must not exceed 50 kg/m².

6.2 Thermal

Thermal transmission coefficients (U-value) of the Rockzero wall system have been calculated by the consultancy company Belenos according to EN ISO 10211-1, using the program 'Physibel Trisco'. The calculations included standard components of the Rockzero wall system, e.g. CE-marked ROCKWOOL stone wool insulation with thermal conductivities of 0,033 and 0,034 W/(m·K). U-values are provided in the table below with the corresponding thicknesses of external insulation (Infill outer).

Calculations have also shown that the heat capacity of the Rockzero wall system is up to 20 Wh/(m²·K) for a standard construction with a U-value of 0,1 W/(m²·K) and a thickness of 352 mm, without any external finish (Brick, lightweight cladding). As lightweight claddings are rear-ventilated, their thermal capacity cannot be included. For non-ventilated brick such as rain screen (108 mm, 1800 kg/m²) this value increases considerably to just above 95 Wh/(m²·K).

| Type of rain screen | U-value [W/(m ² ·K)] | |
|----------------------|---------------------------------|--------|
| | 0,10 | 0,12 |
| Brick | 170 mm | 120 mm |
| Lightweight cladding | 170 mm | 120 mm |

6 System performance

6.3 Acoustics

The sound reduction properties of a standard Rockzero party wall system have been tested at the consultancy company Delta in Denmark according to EN ISO 140-3 (see also chapter 4.10).

$$R_w (C; C_w) = 60 (-2; -8) \text{ dB}$$

6.4 Airtightness

Airtightness

The airtightness of the Rockzero wall system is provided by the interior OSB4 lining. The OSB4 boards are sealed at interfaces with other building components. To ensure the correct performance it is recommended to carry out an individual blower-door test for each building project. Although OSB4 boards are not entirely airtight, tests have shown that the permeability of a building can reach values below $n50 = 0.5 \text{ h}^{-1}$ as long as joints and penetrations are sealed properly.

Wind tightness

The Rockzero wall system offers sufficient wind tightness to minimise unwanted heat losses from inside the construction. There are three major reasons for this:

- On the exterior face, cladding products such as brick or façade boards leave only a small ventilated air layer between cladding and insulation, taking wind pressure from the insulation.
- The structure of stone wool insulation reduces air movement inside this material considerably.
- Behind the insulation, a wind and airtight layer of OSB4 boards is mounted, giving additional security against wind induced heat losses from the construction.

6.5 Fire

External wall

The standard Rockzero system comprising an internal service void with one layer of fibre gypsum board (15 mm) has been tested for fire-resistance according to EN 1365-1 at the Danish Institute of Fire and Security (DBI). Tests have been conducted, simulating fire loads both from the outside and from the inside.

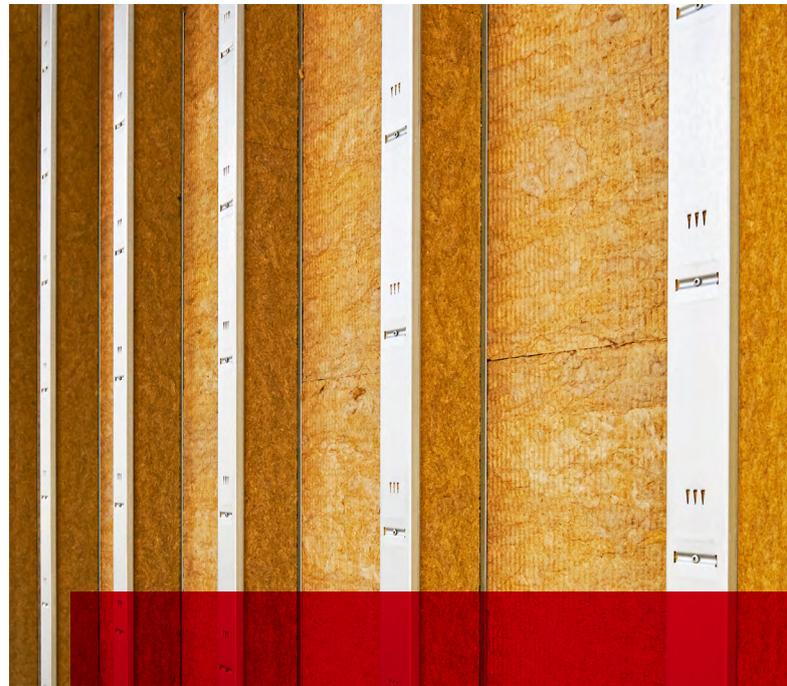
Fire from inside: REI 60

Fire from outside: REI 30 (without rain screen)

Party wall

The Rockzero party wall has been tested for fire-resistance according to EN 1365-1 at the Danish Institute of Fire and Security (DBI), with a solution comprising of two layers of fibre gypsum boards (15 mm) on one side of the load-bearing core of the construction, and one layer on the side of the OSB4 lining.

Fire from either side: REI 60



6 System performance

6.6 Moisture

Interstitial condensation

Interstitial condensation in the Rockzero wall system has been evaluated by the consultancy company Belenos.

The Rockzero construction shows no sign of relative humidity above 75% under standard climate conditions, which is the threshold value where growth of mould is normally initiated. The system therefore does not suffer from moisture-related problems due to interstitial condensation.

Capillary moisture suction

Stone wool is not a capillary active material. In addition, stone wool fibres have a surface treatment to make them water-repellent. Should the material come into contact with moisture in a liquid state, there is no immediate risk of penetration of the stone wool by the moisture without externally applied pressure.

Moisture during the building phase

The Rockzero wall system is designed to avoid 'built-in' moisture caused, for example, by temporary rain covers. Due to the water-repellent properties of stone wool, should moisture accumulate during the building phase, moist areas will dry fast due to the open cell characteristics of the fibrous stone wool.

Mould

The calculations for interstitial condensation show that the growth of mould in the Rockzero wall system is unlikely in any part of the Rockzero system. Retained moisture cannot affect the growth of mould as the moisture normally dries out faster than mould can establish.

Corrosion

Corrosion characteristics of major steel components have been evaluated by Force Technology, Denmark. Based on calculations made by the consultancy company, Belenos, the metal components in the wall construction are generally exposed to a dry environment where the relative air humidity for shorter periods only rises to 70-75%. Therefore, the coating thickness of the metal parts will provide good protection against corrosion under these conditions. Screws either have a minimum zinc coating thickness of 15 µm or are made of stainless steel.

It is expected by our experts that the metal parts in the Rockzero wall system will remain durable for at least 50 years. This evaluation requires that the wall construction remains closed to avoid air leakage and furthermore that the profiles do not have contact with water absorbent materials or are otherwise exposed to water or humidity over a longer period.



7 Project process

7.1 Design

In the pre-planning phase of a potential Rockzero project this information needs to be provided:

- Architectural sketch of the building envelope
- Performance of the external wall in terms of thermal, fire and acoustics
- Type of external cladding suitable for the building
- Dimensions (length, size) of walls, windows and doors
- Line loads from roof and deck acting on wall tops

Please always follow the Rockzero design specifications as described in chapter 4.

A project can be drawn in any architectural software that can export plans and sections to an Autodesk AutoCAD or Autodesk Revit environment. If drawn in Autodesk Revit, standard Rockzero wall types for brick and lightweight cladding can be downloaded from the local ROCKWOOL homepage.

It is possible to provide project drawings in both 2-D and 3-D software. For 2-D drawings, Autodesk AutoCAD is recommended. For 3-D drawings the Rockzero team uses Autodesk Revit. If projects are drawn in other software, 2-D models must be exported to AutoCAD format and 3-D models as an IFC-model.

7.2 Cost calculation

An online cost calculator is available on the local ROCKWOOL homepage. It provides an overview of the Rockzero related material prices for a project. Labour costs are not included. Explanations of how to use this calculator are given online. Though the customer is solely responsible for providing correct input for cost calculations, assistance can be provided to check a project and the input data for consistency.

7.3 Tender

Tender documents and details can be downloaded from the local ROCKWOOL homepage. The Rockzero team can assist with downloading the right documents and brief interested contractors on the system if needed.

7.4 Rockzero review

After the tender process, the Rockzero team will review the project, based on the architectural drawings and structural information provided by the project engineer. Construction details are reviewed to fit the Rockzero system, a bill of materials is created and, finally, Rockzero components are produced and prepared for delivery.

7.5 Execution

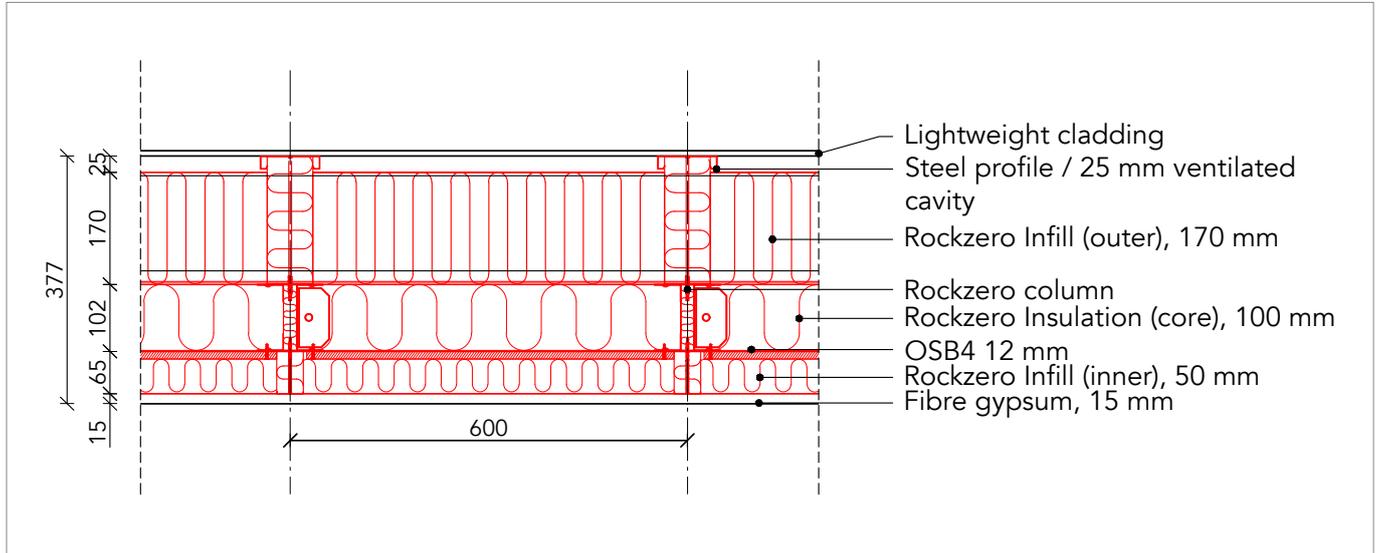
The Rockzero team offers contractor training to ensure a smooth building process and a satisfying project result. In special cases, it might be necessary to offer support on-site which can also be provided when agreed beforehand.



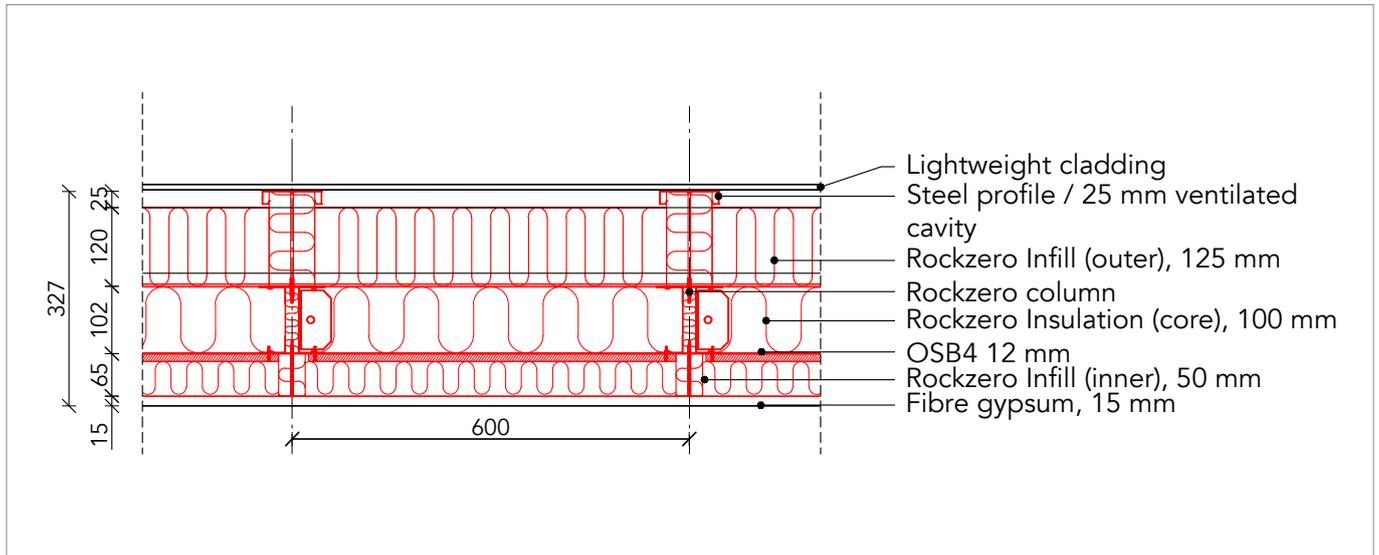
8 Standard details for lightweight cladding

8.1 External wall (standard cross-section)

Lightweight cladding, $U = 0,10$

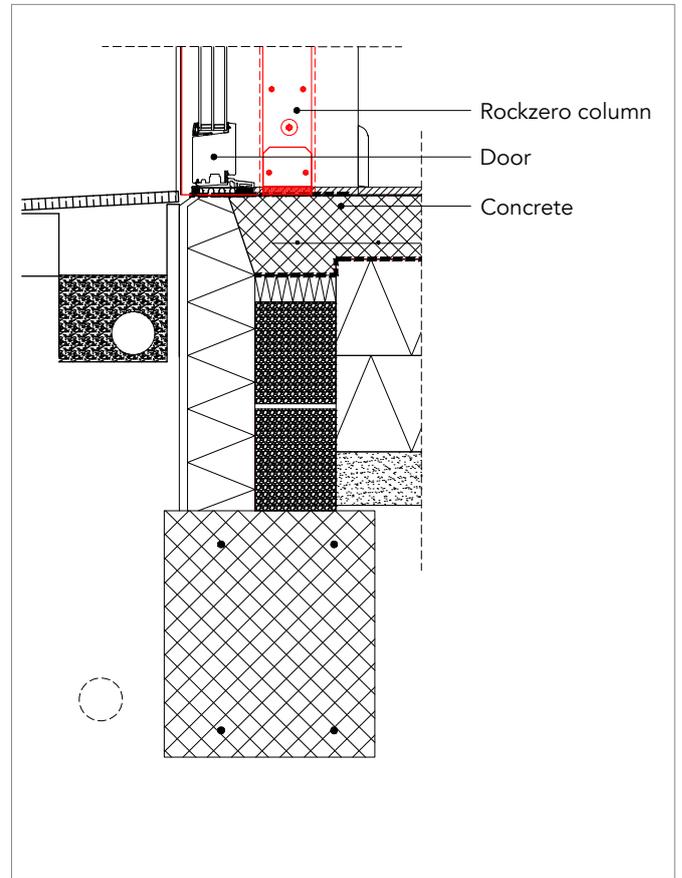
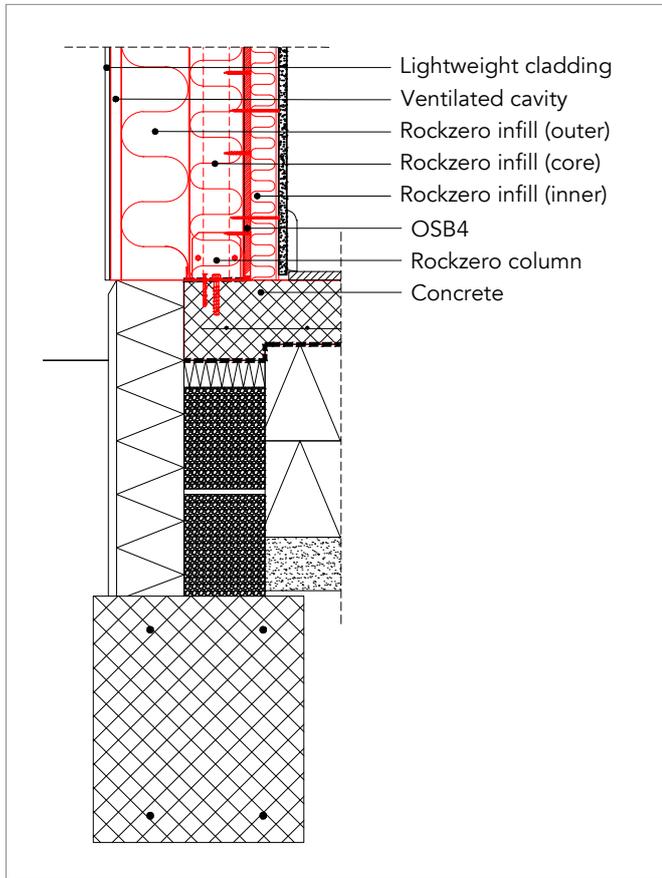


Lightweight cladding, $U = 0,12$

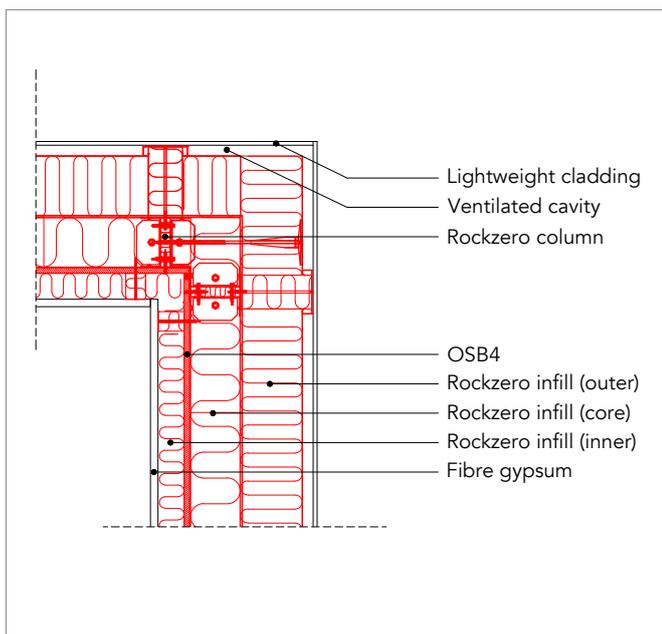


8 Standard details for lightweight cladding

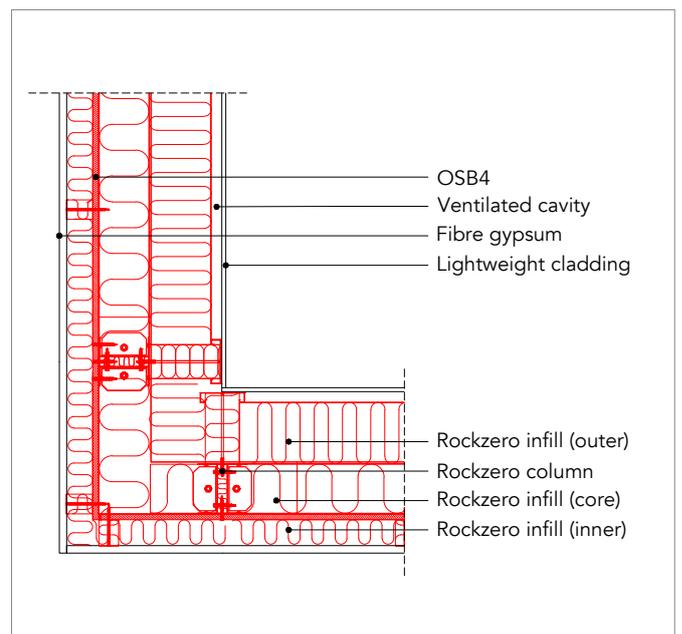
8.2 Foundation



8.3 External corner



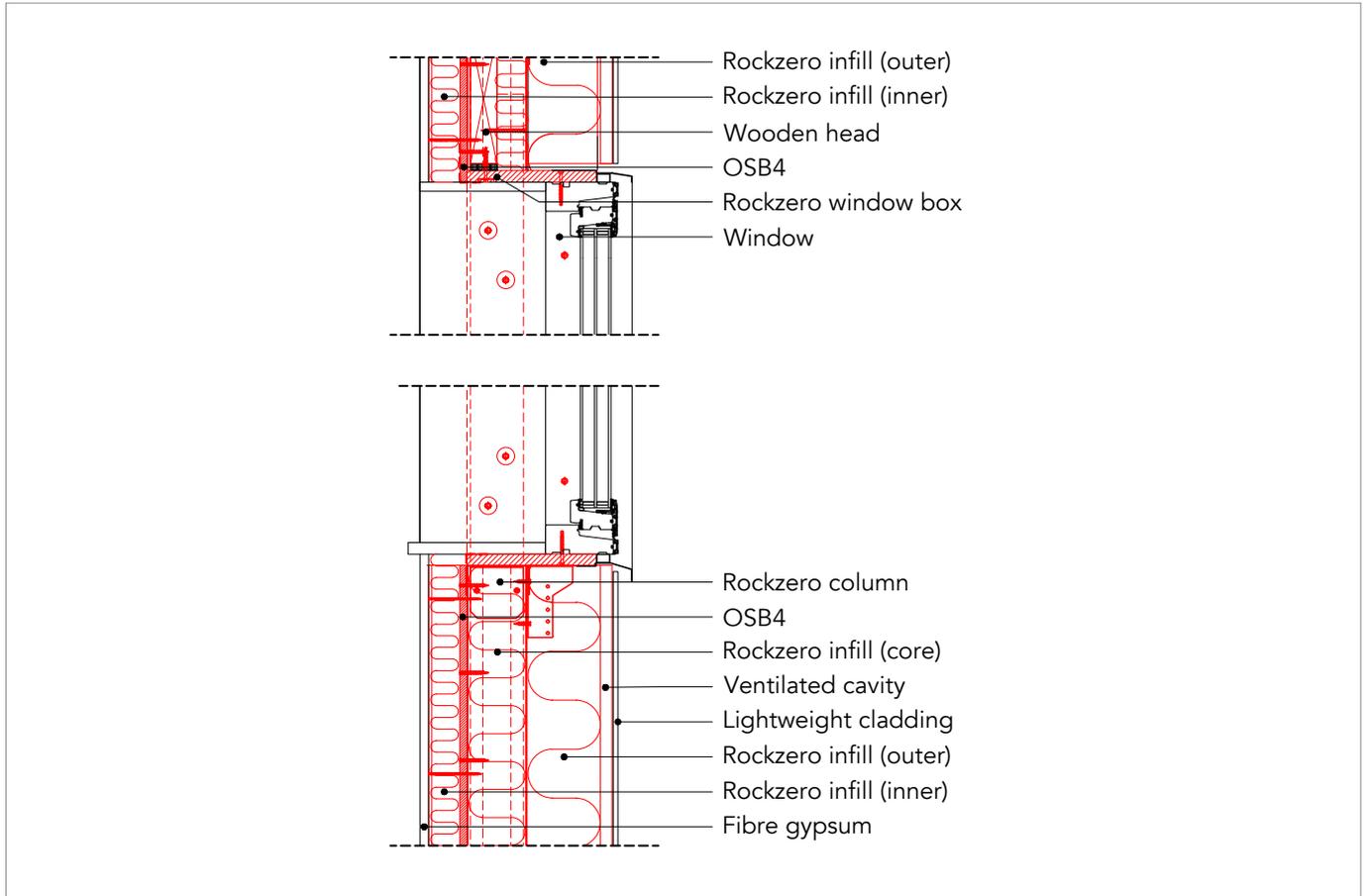
8.4 Internal corner



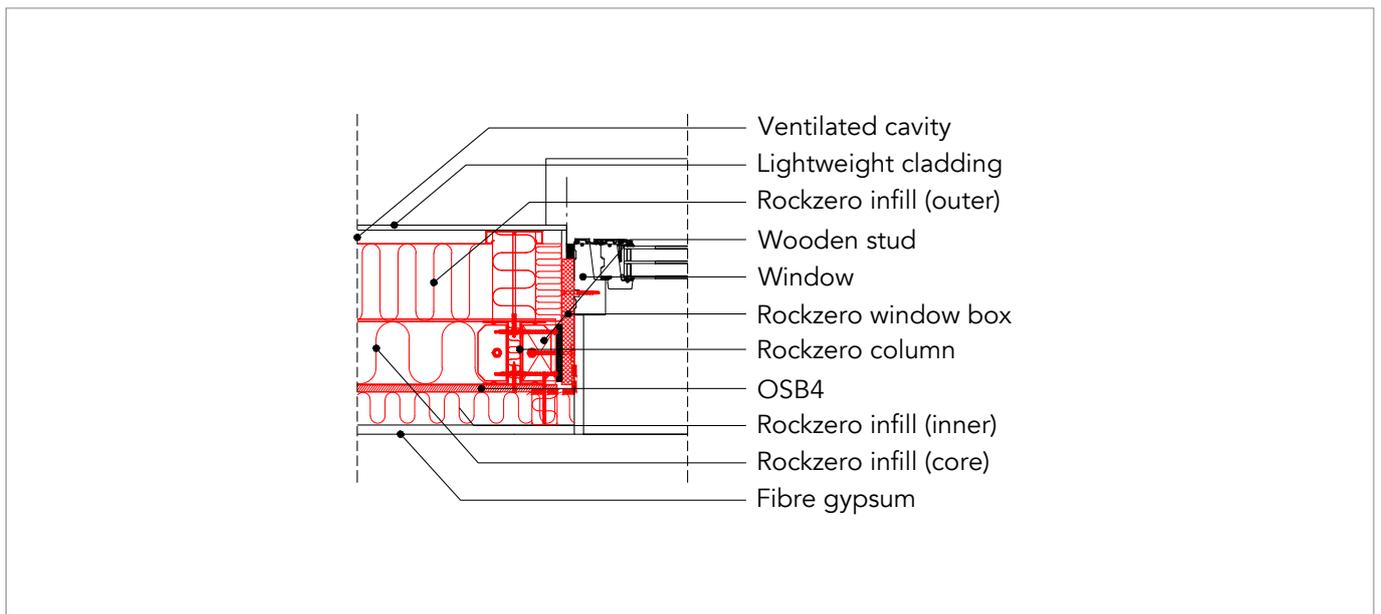
8 Standard details for lightweight cladding

8.5 Windows and doors

Vertical cross-section

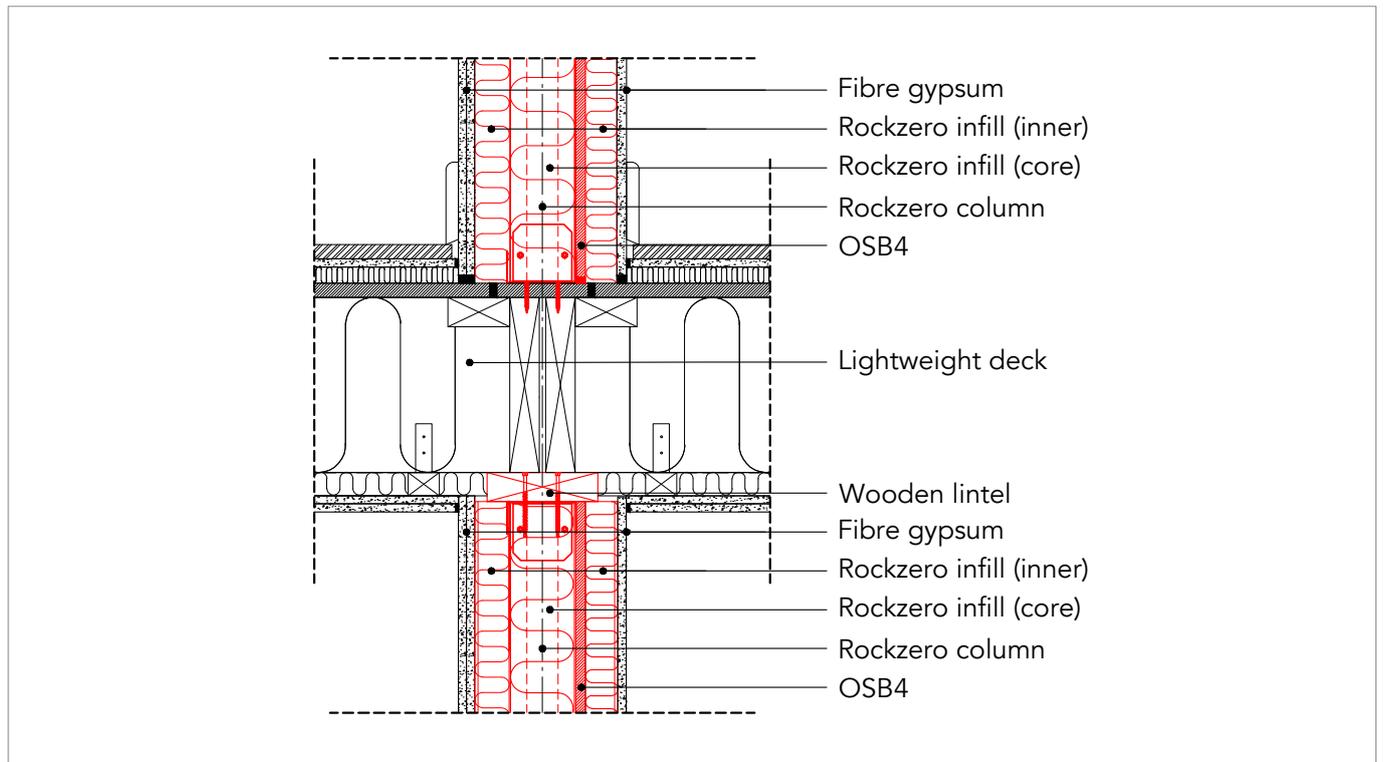


Horizontal cross-section

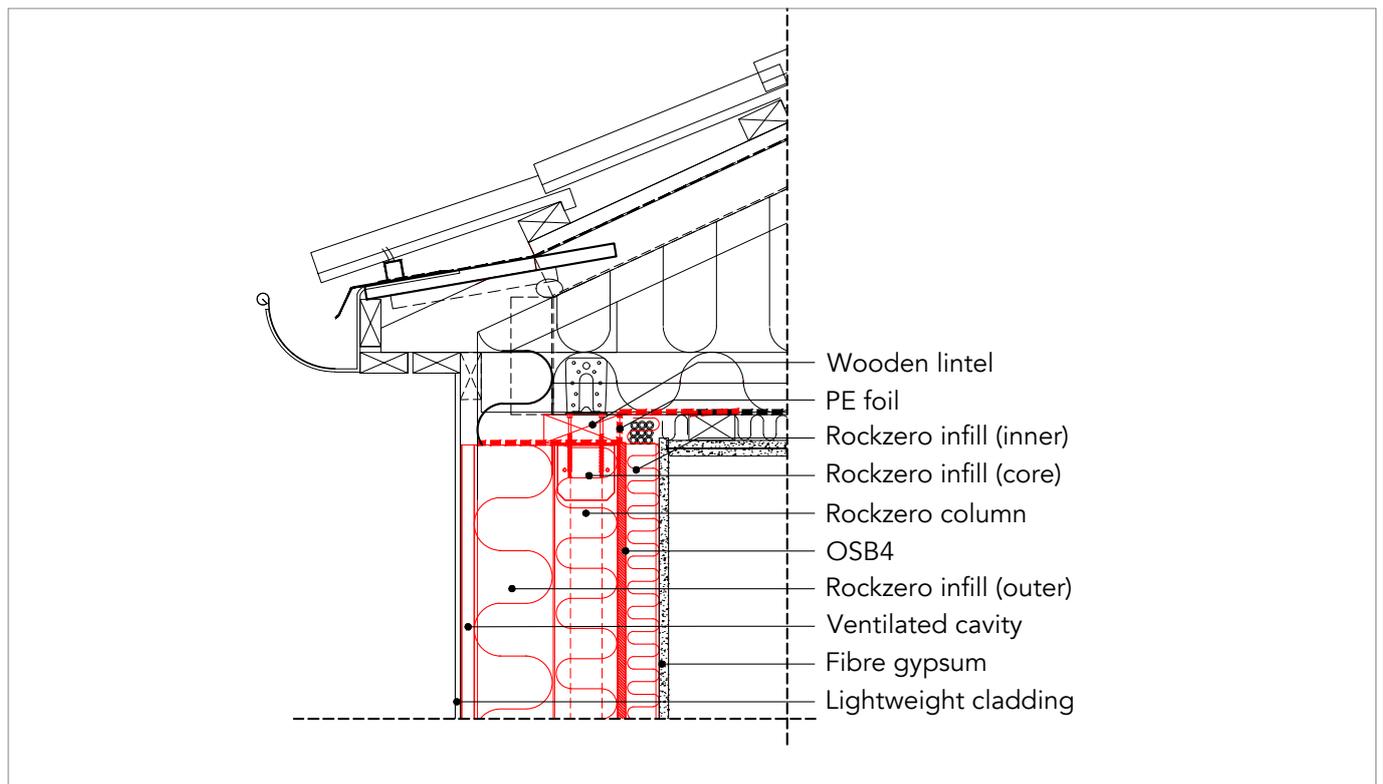


8 Standard details for lightweight cladding

8.6 Intermediate floor



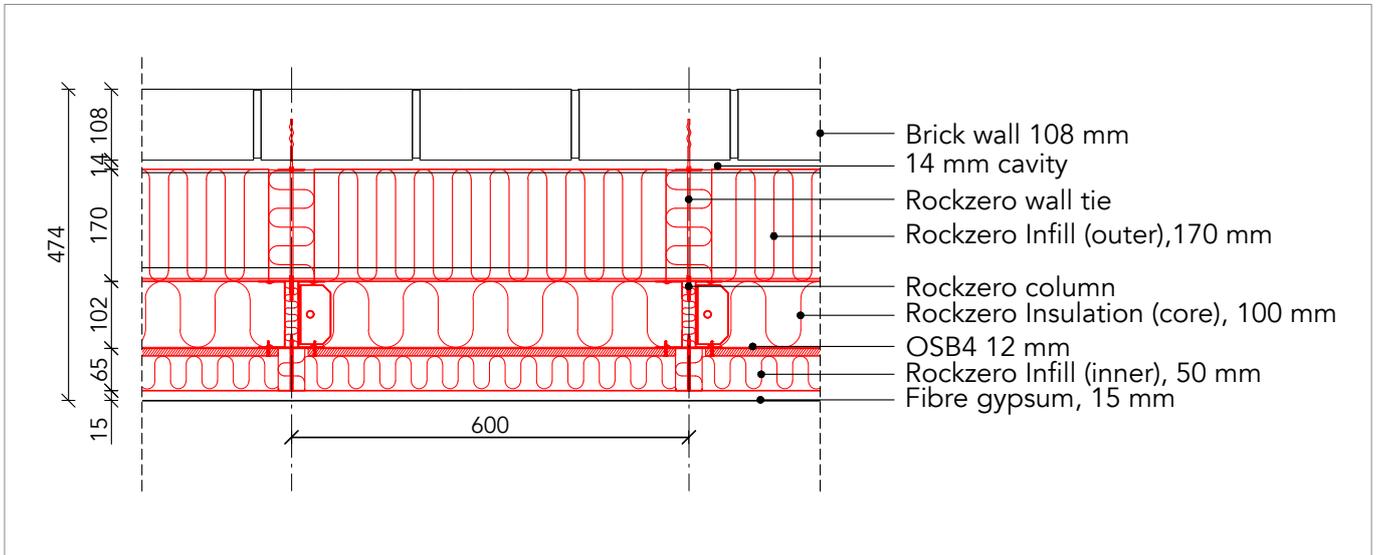
8.7 Roof



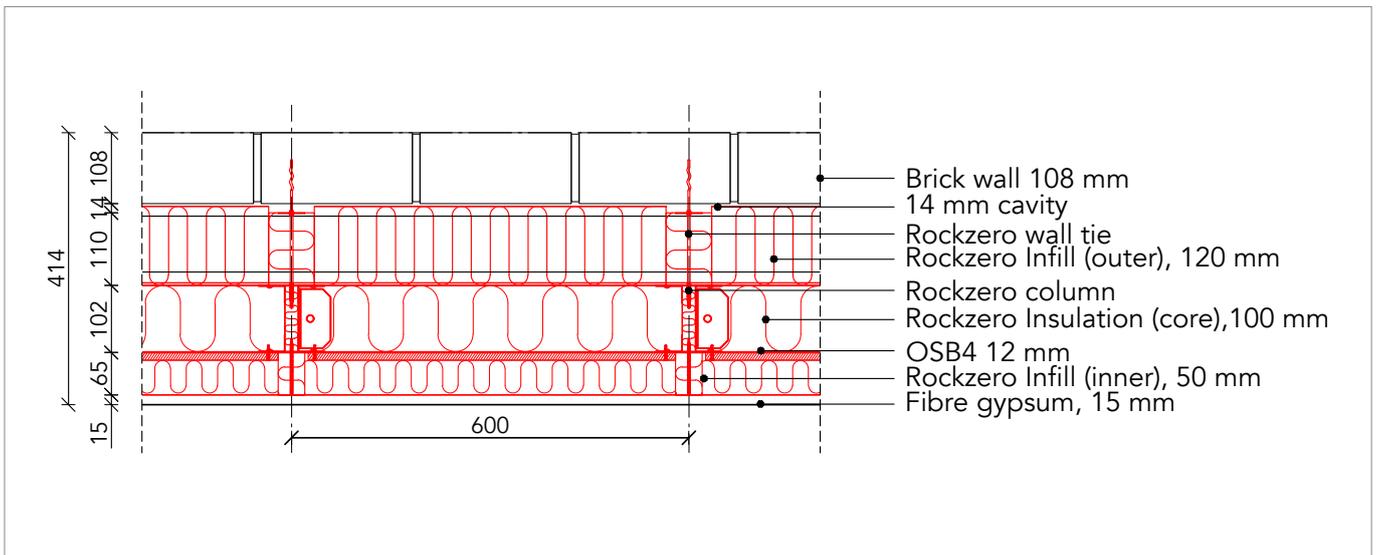
9 Standard details for brick walls

9.1 External wall (standard cross-section)

Brick wall, $U = 0,10$

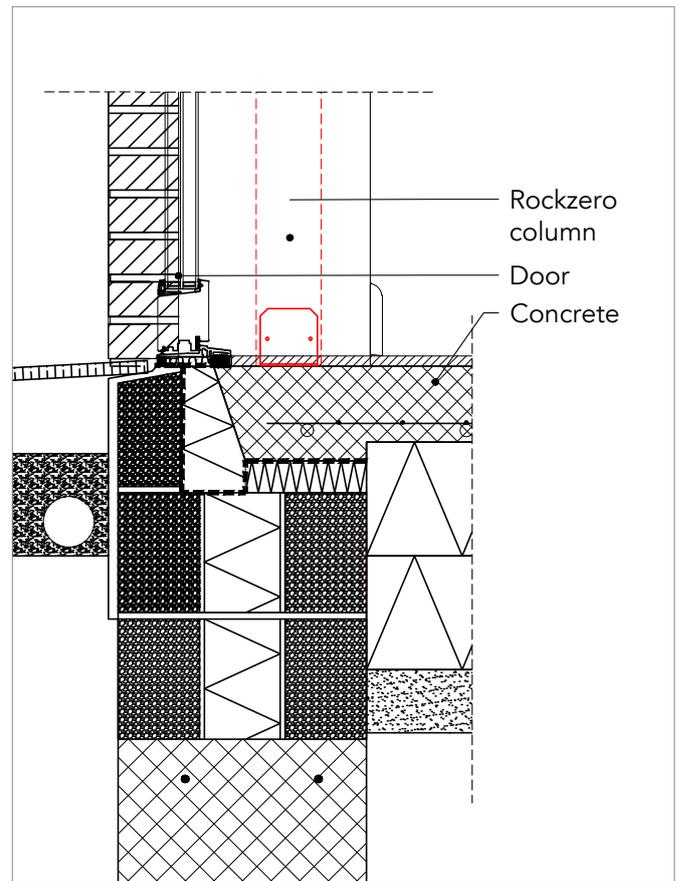
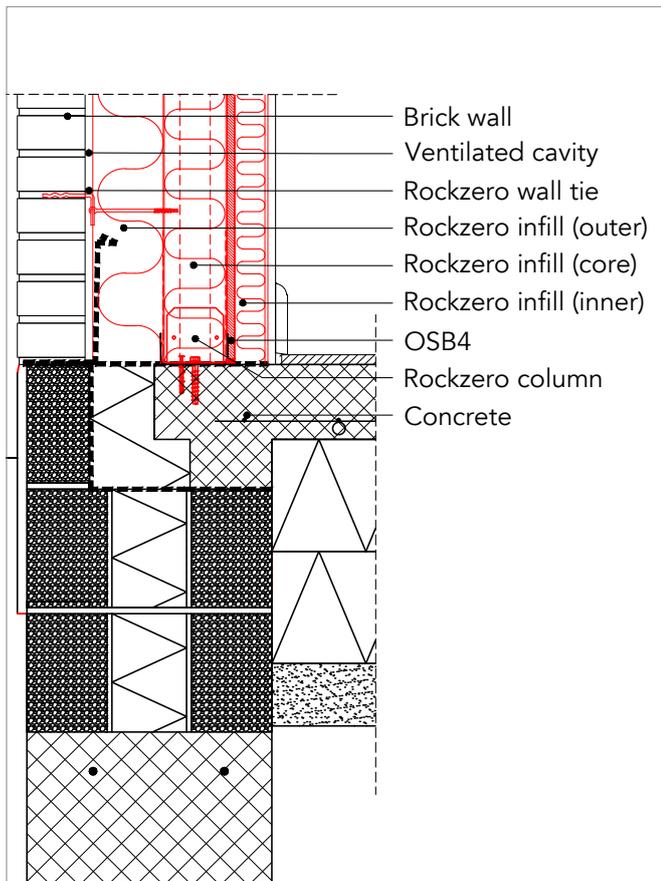


Brick wall, $U = 0,12$

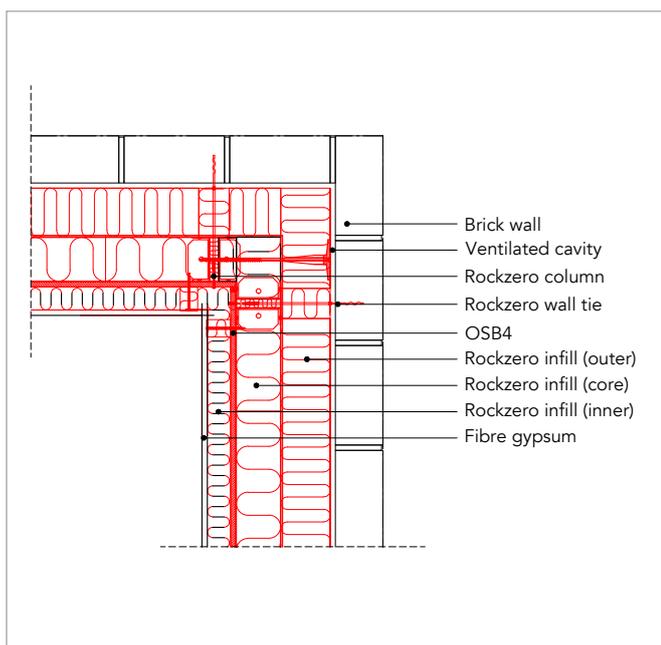


9 Standard details for brick walls

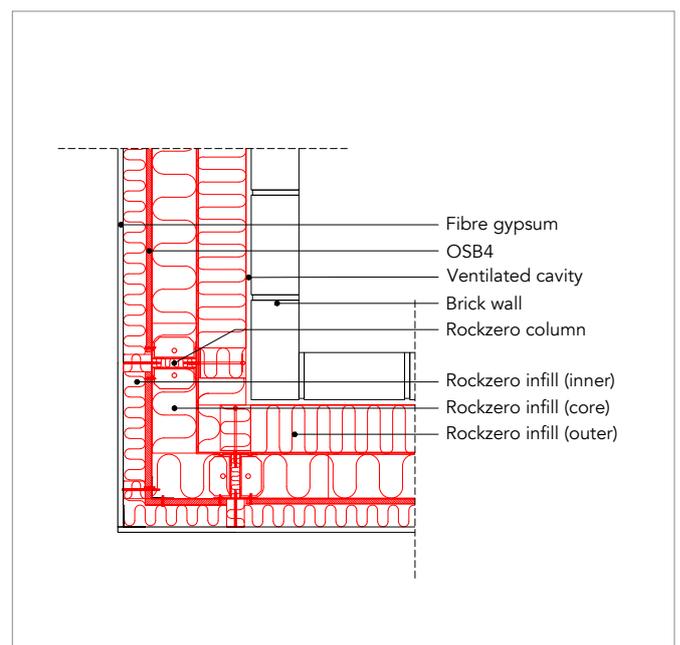
9.2 Foundation



9.3 External corner

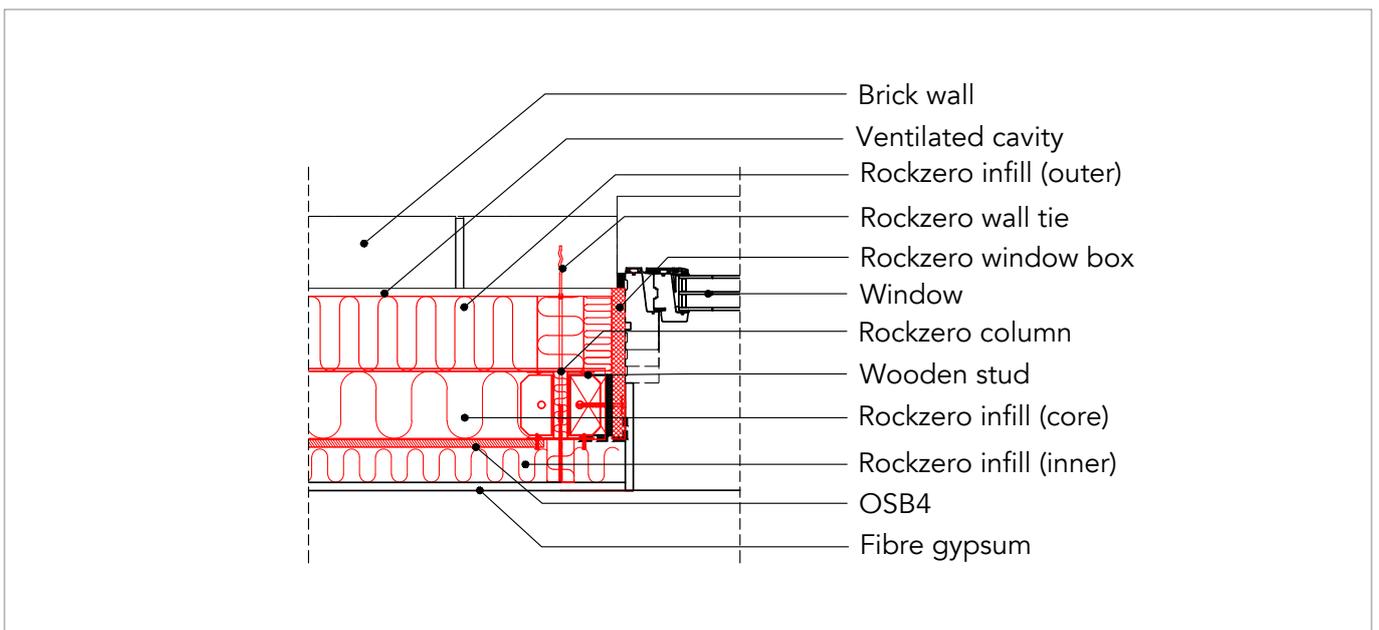
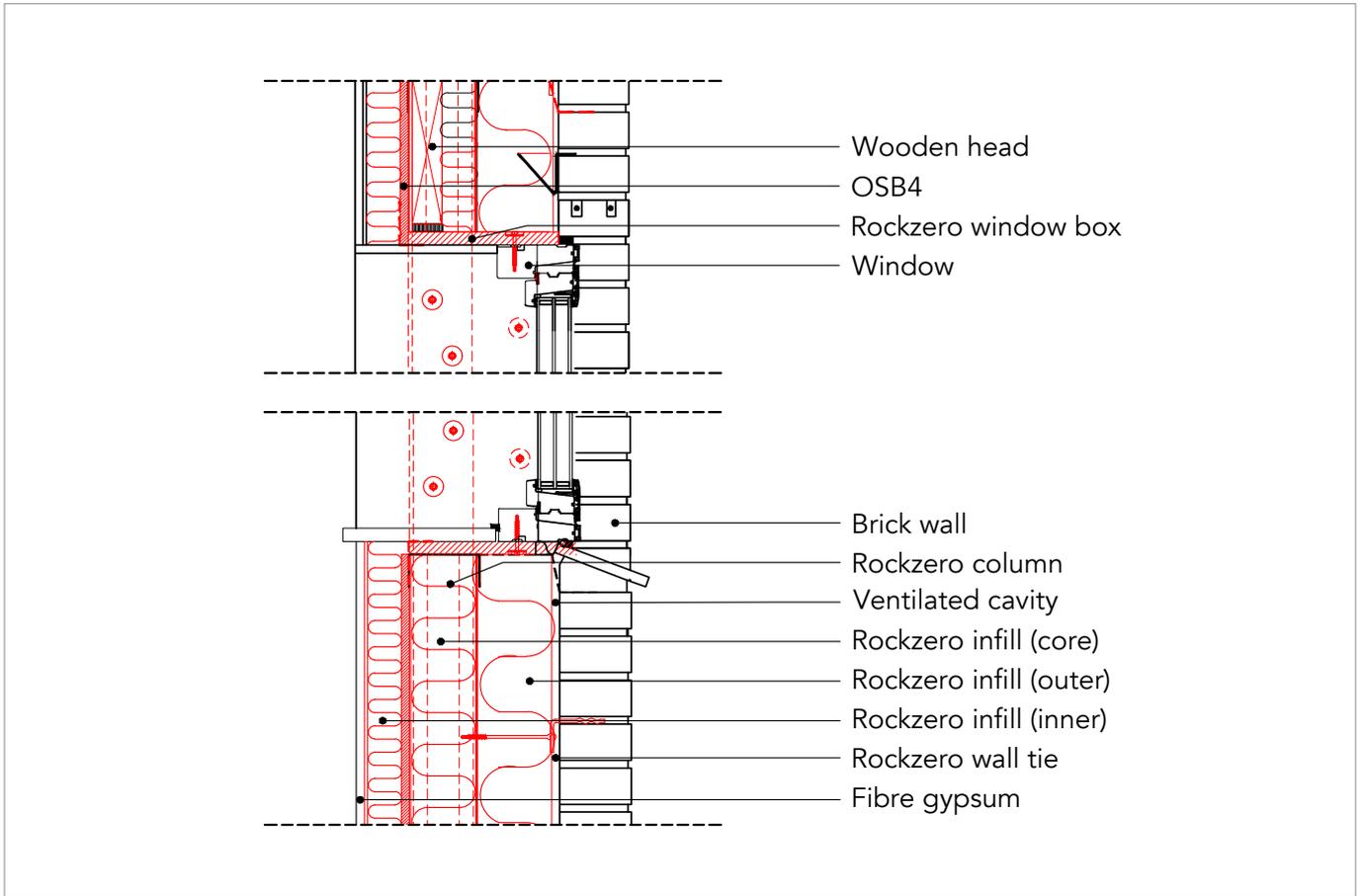


9.4 Internal corner



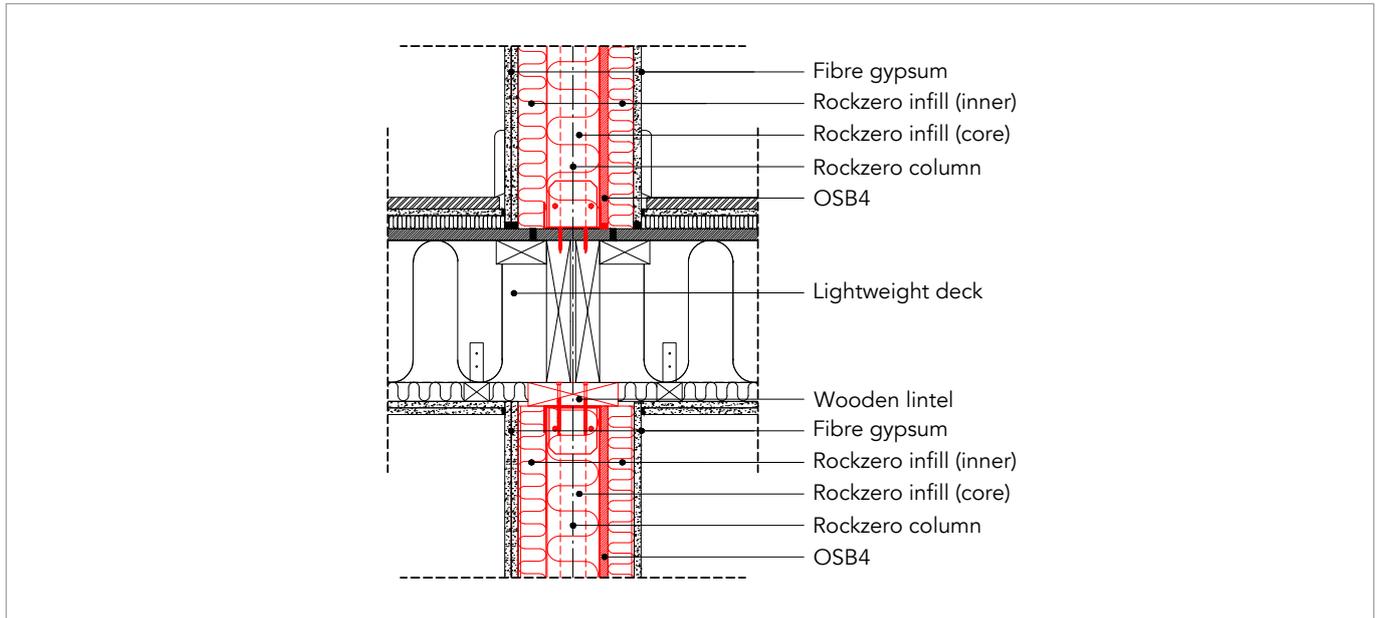
9 Standard details for brick walls

9.5 Windows and doors

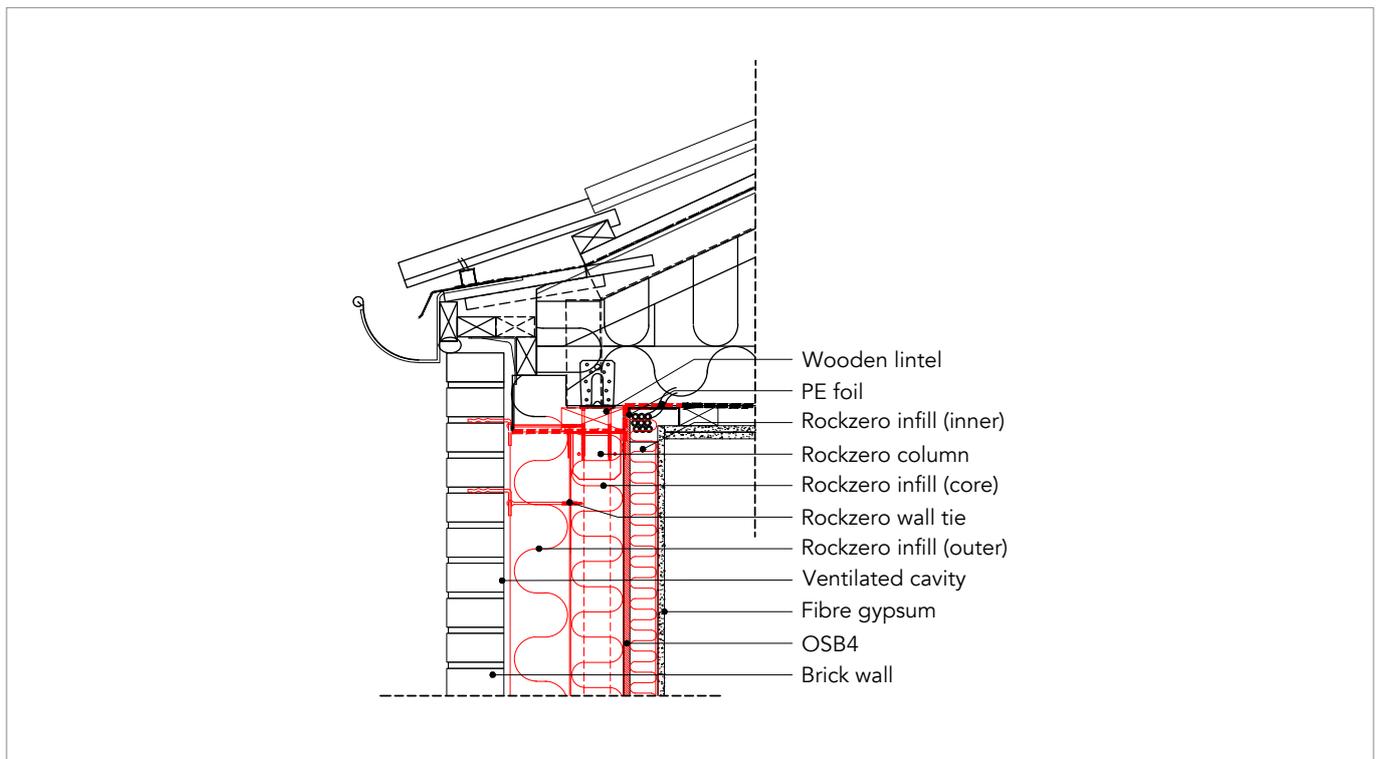


9 Standard details for brick walls

9.6 Intermediate floor

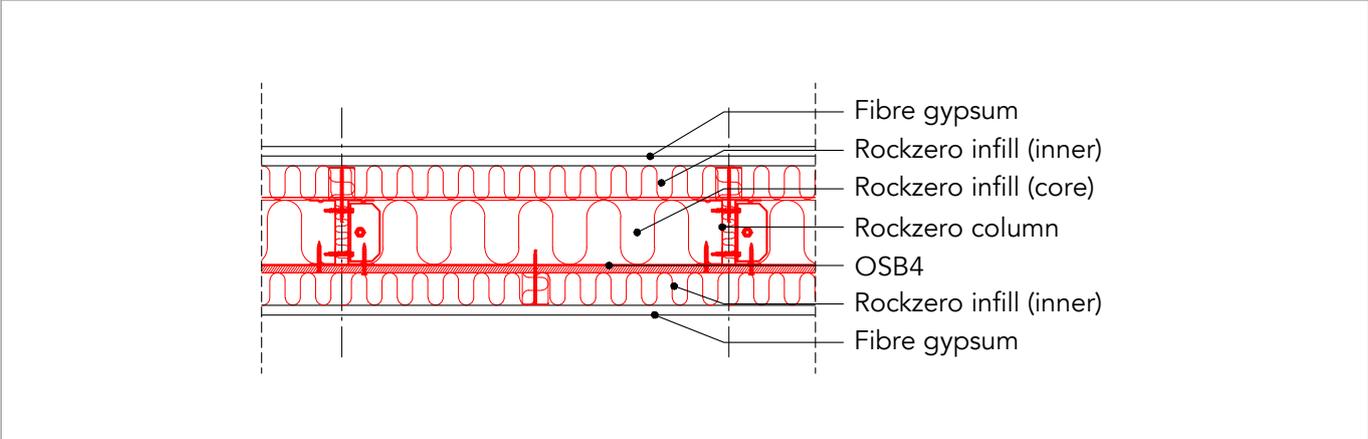


9.7 Roof

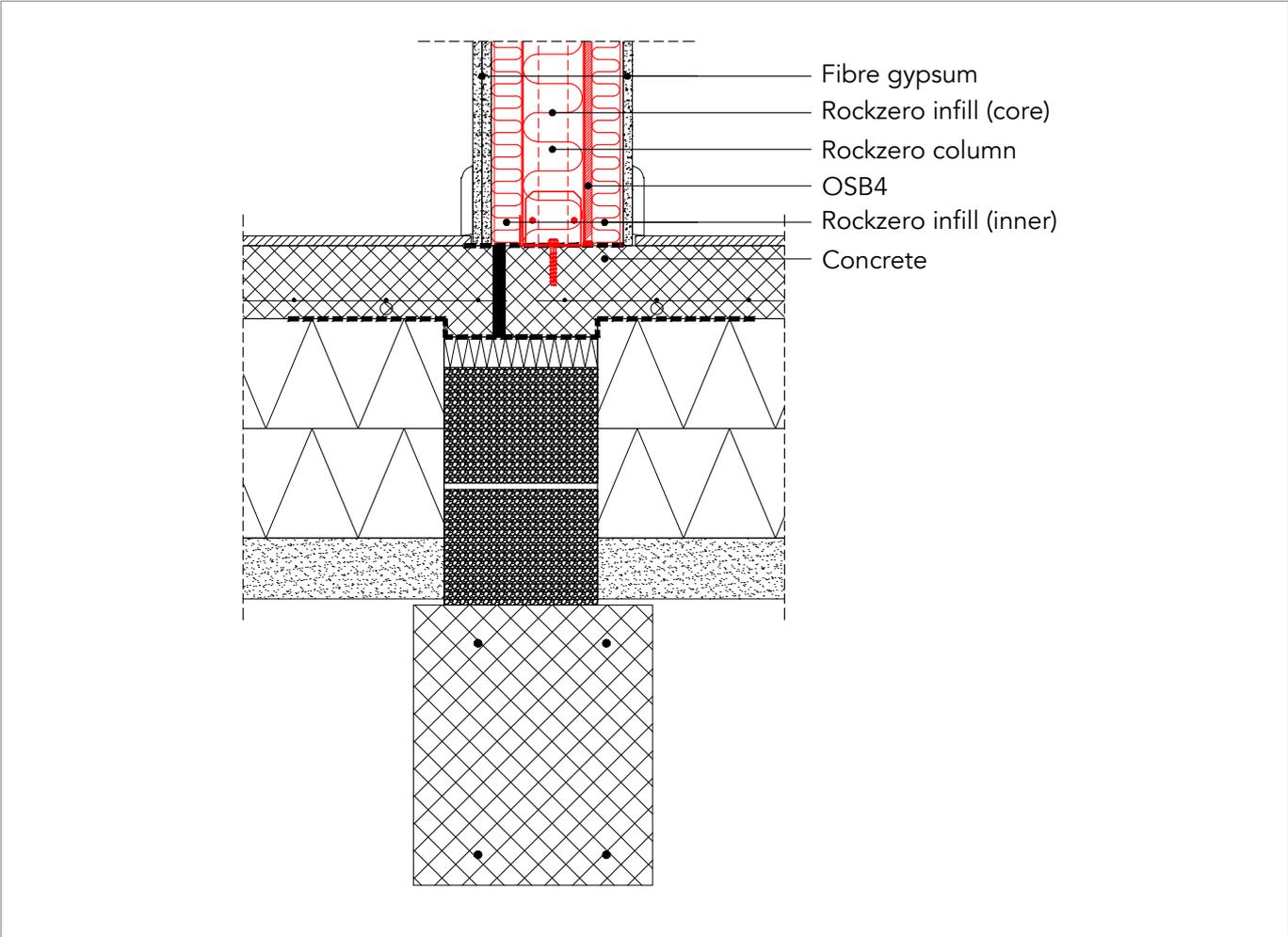


10 Standard details for party walls

Horizontal cross-section



Vertical cross-section



Notes

Notes

Notes



ROCKWOOL INTERNATIONAL A/S

DK-2640 Hedehusene
T: + 4546560300
www.rockwoolgroup.com