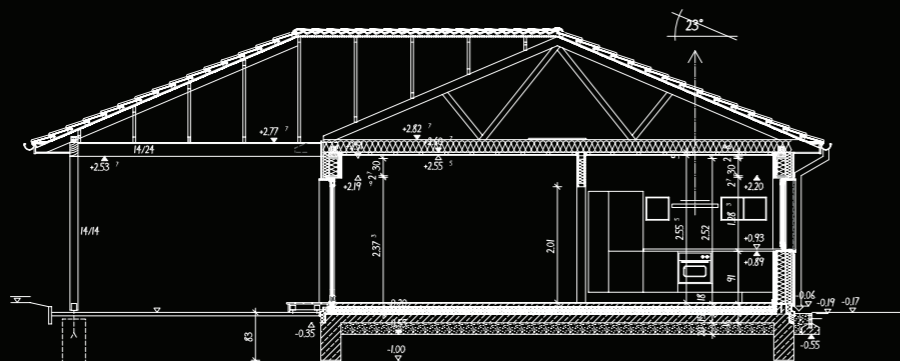


## 2. DESIGN SPECIFICATIONS

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## 2.1 Modular concept

The RockShell wall system is built up as a modular system with a module length of 600 mm. The modules are framed by vertical bearing members, basically shaped as I-profiles (RockShell column profile) which centre axes represent the module axes.

located at the flat side of the end columns. The outer module axes of a building are defined by the outer side of the OSB-boards, touching the RockShell columns. Wherever possible, all measurements should be adjusted to this modular grid.

When using RockShell end columns, e.g. at corners or windows, the module axis is

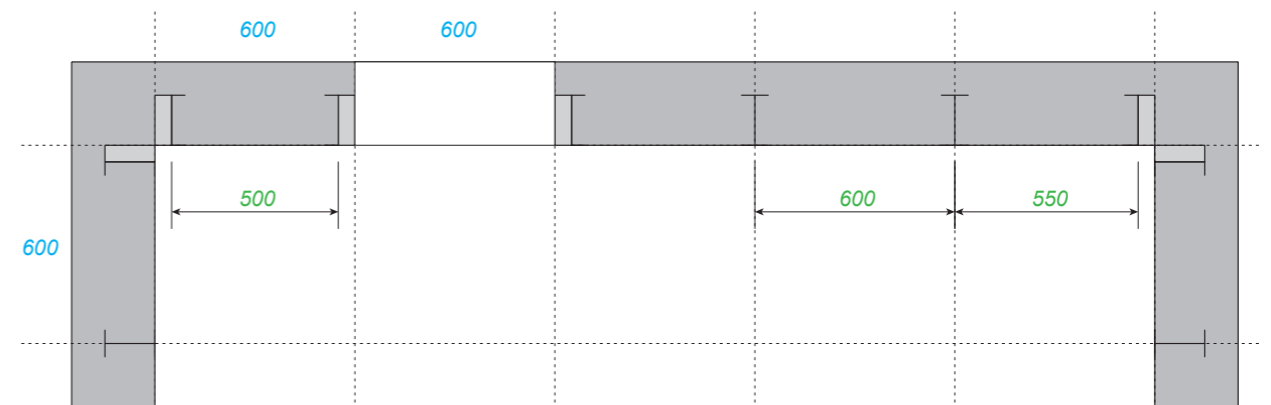


Figure 1:  
Modular grid setup of the RockShell wall system, including an opening.  
Numbers in blue typing: Length of system modules.  
Numbers in green typing: Widths of standard wool elements



## 2.2 Dimensions

In order to avoid mistakes in understanding, the names of the dimensions of a RockShell building are defined in figure 2.

### A Length

The length of the building is theoretically infinite. It is limited by the maximum wind load that can be applied to the building regarding global stability, especially in the gable walls and the tension forces in the fasteners to the foundation, preventing the construction from lifting off.

### B Width

The reference building has been limited to a width of 8 m which is equal to the span of the roof. In general, the width of the building depends on the maximum load on the RockShell wall system as well as on the maximum wind load that can be applied to the building (see chapter 3).

### C Height

The height of the RockShell wall system is limited to two storeys with a height of the bearing wall members (column profile, end profile) of a maximum of 2.7 m. The roof pitch can be chosen freely as long as the maximum loads are followed. Figure 3 shows an example of the geometry of a building with a roof pitch of 45°, which, at a maximum width of 8 m, results in a total maximum building height of 9.4 m.

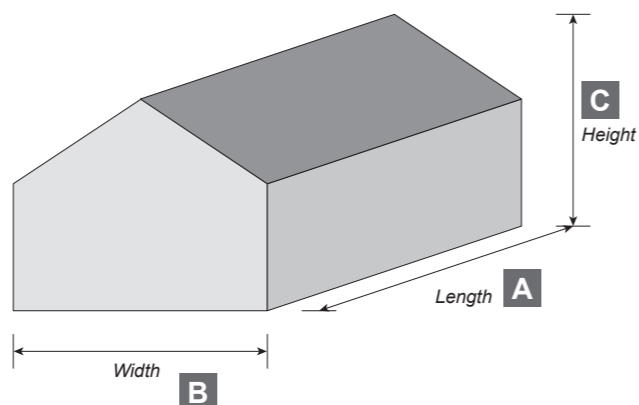


Figure 2: Names of dimensions of a RockShell building

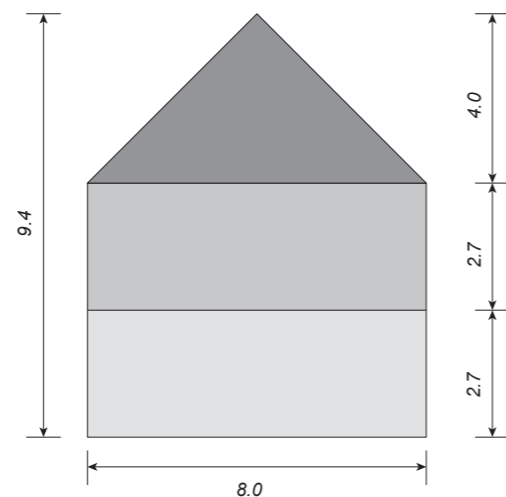


Figure 3: Maximum height of RockShell wall system

## 2.3 Loads

The loads on the RockShell wall system have been calculated according to EC 1991-1 for a predominant structure at a fictional but realistic location to show the possibilities of the system. Where necessary, British National Annexes of the Eurocode (EC) documents have been used to calculate the load resistance of bearing members of the RockShell wall system. A schematic overview of the load situation is given in figure 4.

Important: Loads, especially those for wind and snow, have to be calculated for each project in the specific location of use

### A Dead load

#### 1: RockShell wall system

The specific weight of the RockShell wall (including one gypsum plasterboard on the inside) has been calculated as 73,21 kg/m<sup>2</sup>. A value of 0,75 kN/m<sup>2</sup> is used in the calculations. Specific weights have been calculated with a module distance of 600 mm between the RockShell column profiles. The typical U-value of this setup is 0,15 W/(m<sup>2</sup>·K).

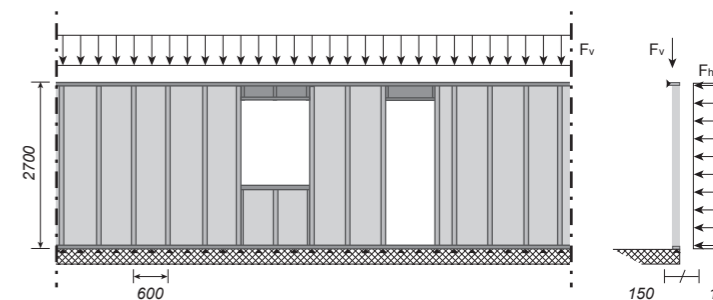


Figure 4 : Load situation and geometry of the RockShell wall system

#### Specific weight of RockShell wall system

Member	Thickness	Density	Weight	
	(mm)	(kg/m <sup>3</sup> )	(kg/m)	(kg/m <sup>2</sup> )
External plaster	8.0	1900		15.20
Plaster base sheeting	10.0	1110		11.10
Laminated veneer lumber, 98 mm	27.0	480	1.27	2.12
RockShell insulation, 2700 x 600 mm	250.0	70.00		17.50
Column profile, steel, 150 x 80 mm	1.0	7850	4.00	6.67
C profile top / bottom, steel, 152 x 50 mm	1	7850	1.98	1.47
Screws				0.50
OSB plate	12.5	600		7.50
Insulation in service wall	45.0	30		1.35
Internal Z profile, 45 x 30/30 mm	0.56	7850	0.58	0.97
Gypsum plasterboard	13.0	380		8.84
<b>Total, 2700 x 600 mm:</b>				<b>73.21</b>

Table 1

**2: Roof**

The specific weight of a typical roof with heavy roof tiles has been calculated as 88.15 kg/m<sup>2</sup>. Due to uncertainties regarding the materials actually used in roof construction, a value of 1.00 kN/m<sup>2</sup> is used in the calculations. See table 2.

**3: Intermediate floor**

The specific weight of a typical lightweight intermediate floor has been calculated as 68,65 kg/m<sup>2</sup>. Due to uncertainties regarding the materials actually used in floor construction, a value of 0,80 kN/m<sup>2</sup> is used in the calculations. See table 3.

**B Live load**

A value of 2,0 kN/m<sup>2</sup> is used in the calculation as the live load on intermediate floors. To take possible deviations in other countries into consideration, this value is higher than the value given in many national annexes of EC 1991-1.

**C Snow load**

Snow loads are calculated according to EC 1991-1-3. As mentioned before, snow loads need to be calculated for the specific location of each project.

**D Wind load**

Wind loads are calculated according to EC 1991-1-4. As mentioned before, wind loads need to be calculated for the specific location for each project.

**E Other**

Other possible parameters influencing the structure of the RockShell wall system such as temperature, accidental loads or seismic loads are not considered for structural calculations of the RockShell wall system.

**Specific weight of roof construction**

Member	Density (kg/m <sup>3</sup> )	Weight (kg/m <sup>2</sup> )
Roof tiles, 7.5 per m <sup>2</sup>	6 (kg)	45.00
Battens, 38 x 73 mm per 330 mm	600	5.00
Plastic underlay, 3.2 mm		3.00
Rafters, 60 x 250 mm per 600 mm	600	15.00
Insulation, 300 mm	32	8.64
Membrane, 0.2 mm		0.14
Lathing, 38 x 57 mm per 600 mm	600	2.17
Gypsum Plasterboard, 12.5 mm	736	9.20
<b>Total</b>		<b>88.15</b>

Table 2

**Specific weight of lightweight intermediate floor**

Member	Density (kg/m <sup>3</sup> )	Weight (kg/m <sup>2</sup> )
Wooden flooring, 20 mm	600	12.00
Gypsum plasterboard, 2 x 12.5 mm	736	18.40
Trapezoidal sheets, 1.25 mm	7850	10.00
C profile, steel, 200 x 30 x 1.5 mm per 600 mm		3.50
Insulation, 100 mm	32	3.20
Acoustic profile, 25 mm per 600 mm	7850	1.00
Gypsum plasterboard, 15.4 mm	736	11.35
Gypsum plasterboard, 12.5 mm	736	9.20
<b>Total</b>		<b>68.65</b>

Table 3

## 2.4 Foundation

As the basis for the RockShell wall system, the foundation is of special importance. Extra attention needs to be paid to proper design and a precise creation of the foundation to ensure the erection of a faultless wall system.

The foundation is to be made of concrete with a quality of at least C20/25. Using a layer of mortar, lightweight concrete blocks or similar material on top of the foundation increases the risk of substrate failures due to high point loads on the substrate.

The foundation has to be levelled to an accuracy of ±1 mm over 3000 mm. Beyond the difference in levelling of the foundation between two points, this requires in particular avoiding holes or recesses in the surface or gravel sticking out from the surface. It is recommended to set up the concrete shuttering rather accurately in the first place in order to use it as a stripping aid for the wet concrete.

The foundation must be 12 mm wider than the bottom profile to follow the requirements for the edge distance of the foundation bolts used for anchoring the RockShell wall system. This makes it at least 164 mm wide.



## 2.5 Column profiles

The major bearing part of the RockShell wall system consists of RockShell column profiles that are bent to an I-shape. This type of bearing member is to be placed vertically between two RockShell wool elements. It serves as a substrate for fixing both the outer cladding and OSB boards on the inside. It is delivered on site in the length required (mostly equal to the height of the storey).

Due to their geometry and bearing capacity, column profiles cannot be used at corners or as lateral members for openings in the outer wall towards doors or windows. Here, end columns are used.



## 2.6 End columns

End columns for the RockShell wall system are pre-assembled and delivered on site in the length required. The basis for all end columns is two C-shaped profiles that are screwed to each other in such a way that a closed box is formed. There are certain variations for the final setup of an end column concerning C-shaped profiles that might need to be fixed to the box-shaped end column, depending on the use of the end column

Four variations are possible:

- A** Corners, C-shaped profile attached to one side of the end column
- B** Corners, C-shaped profile attached to two sides of the end column
- C** Doors, C-shaped profile attached to one side of the end column (storey height) and partly on the second side (for a lintel)
- D** Windows, C-shaped profile attached to one side of the end column (storey height) and partly on the second side (for parapet insulation and a lintel)

For window and door sections, the second C-shaped profile is not foreseen to be placed on heights where windows or doors are to be mounted. It is recommended that some of the holes in the parts of the end column are pre-drilled.



## 2.7 Windows and doors

As shown in figure 1 and figure 4, windows and doors are vertically framed by RockShell end columns. On top, a lintel between the end columns is used to bridge loads from above and lead them into the end columns.

It is advisable to align openings for windows and doors to the modular grid of the RockShell wall system as a multiple of 60 cm; however, it is also possible to use elements that do not

fit the modular grid. In such a case, both the lintel and the RockShell standard wool need to be produced and delivered in a special length/width that fits the element's width.

Parapets of windows are not considered to be load bearing, though it is possible to load the top profile of a parapet temporarily with the load of an ordinary window before this is anchored to the end column on both sides.

## 2.8 Lintels

The RockShell wall system provides pre-assembled lintels to be used above openings for windows and doors. A lintel consists of at least four major parts: a top profile, a bottom profile and two side parts. These four parts form a box with two open ends, which is filled

with stone wool to avoid thermal bridges. It is recommended that some of the holes in the parts of the lintel are pre-drilled. Lintels that span over more than one module are stabilised by one interior partition per module made of sheet metal.

## 2.9 Bay windows

The dimensions of bay windows should follow the modular grid of the RockShell wall system to minimise variations in the size of the RockShell wool elements. Therefore, it is also recommended that bay windows are designed

with sides showing an angle of 45° to the main façade line. Other angles are possible but require special equipment for adoption of wool elements in the corners of the bay window.

## 2.10 Wool elements

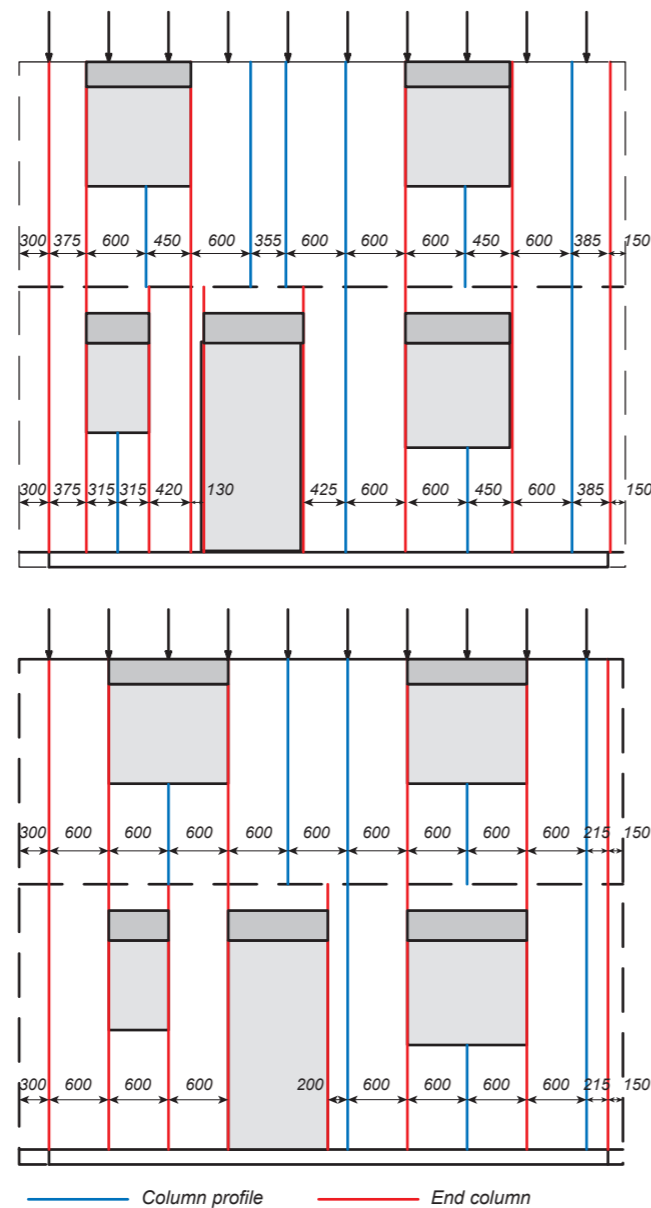
To ensure an efficient production process it is recommended that as many RockShell wool elements with a standard width are used as possible. Preferably, a share of 70 to 80% should be achieved compared to other sizes. Variations cause higher costs in production, confection and mounting.

Three widths are regarded as standard (see Figure 1 for more information):

- 600 mm, between two RockShell column profiles
- 550 mm, between one RockShell column profile and an end column
- 500 mm, between two end columns

Regular RockShell wool elements must be wider than 200 mm. Slimmer elements have a greater tendency to break during handling on site.

Figure 5: **Module grid ensuring a high share of standard wool elements**  
Top: original layout of a façade with disadvantageous position of openings.  
Bottom: modified module grid, optimised for a high share of standard wool elements.



## 2.11 External cladding

External claddings are not part of the RockShell wall system, but their choice is basically independent from the system. Wooden elements, panels, bricks, brick slips or render can be used to protect the RockShell wall system from external influences.

The base for external claddings is in most cases given by vertical laminated veneer lumber (LVL) boards mounted on the outside of joints between RockShell wool elements. The LVL boards are screwed through the outer part of the RockShell wool into the vertical bearing members (column profile, end column, lintel). Extended loads from the cladding might exceed the maximum frictional forces between LVL board and wool. This makes it necessary

to fasten the LVL boards at their top to the roof construction. In these cases, it is essential that the LVL boards are not disconnected at the height of the storey intersection.

Render based cladding types such as ETICS or brick slips need to be applied on a plaster-base sheeting board. To avoid cracks in the render layer, the length of such a sheeting board always has to cover the distance between the centres of two vertical LVL boards. Furthermore, non-bearing LVL boards, e.g. at parapets, need to be bridged completely by a sheeting board to transfer loads from the cladding to the bearing system. The same applies for panels and wooden elements.

## 2.12 Service walls

The service wall is not an integral part of the RockShell wall system. Structurally speaking, its design primarily has to fit the needs of the usage of the building.

However, it is recommended that a service wall is constructed as shown in this building manual to achieve characteristic values concerning thermal/energy, acoustic and fire related concerns mentioned in chapter 3.



## 2.13 Party walls

The design of party walls does not depend on the RockShell wall system, however, a thorough connection between the two walls should be ensured to address various construction aspects such as statics, fire and acoustic concerns. The OSB board layer on the inside of

the RockShell wall system may only be intercepted by the party wall construction if static calculations prove the global stability of the building and the air-tightness of the joint is given by adequate measures.

## 2.14 Inner walls

The construction of inner walls is not part of the RockShell wall system. Inner walls can be designed independently from the RockShell wall system, e.g., as light frame walls with steel or wooden elements and dry lining or as heavy masonry/concrete walls.

It can become vital for the RockShell wall system that the inner walls contribute to the global stability of the building. This is to be decided by calculations for every project regarding external loads given at a specific location.

## 2.15 Intermediate floors

The RockShell wall system is designed to be combined with light intermediated floors consisting of structural steel elements. All issues concerning statics of the intermediate floor are to be covered by the supplier of the intermediate floor.

Regarding the structural system, it must be taken into consideration that intermediate floors below occupied attics can be stressed by horizontal forces from the roof construction. Furthermore, intermediate floors might serve as a shear panels with regard to stiffening the building against wind loads. Thus, the joint between floor and wall is subject to proper structural considerations.

The intermediate floor is to be mounted to the RockShell wall system on the inner side of the OSB boards into C-shaped profiles, fastened to RockShell steel profiles placed behind the OSB boards. See also chapters 3 and 12 for more information about construction details.

## 2.16 Second storey

In buildings with two floors, the modular grids of the RockShell outer wall system should correspond to each other on the two storeys to optimise the transfer of loads between the two storeys. It is thus helpful to place windows (or doors) of the same size between the same vertical module line on top of each other.

An end column on the second floor implies higher vertical loads at this module line and requires another end column at the same module line in the floor below. Unnecessary end columns in one of the storeys could lead to an increased number of wool elements (i.e. various widths) and a longer mounting time and thus to higher costs.



Baggrund indsættes

## 2.17 Roofs

The roof construction is not part of the structural RockShell wall system. It can basically be designed independently from the RockShell wall system.

It is of course advantageous for rafters to be placed close to vertical bearing members of the RockShell wall system (column profiles or end columns), i.e., close to the module axes of the RockShell wall system. If that is not possible, a properly designed horizontal element – preferably made of wood – needs to be placed on top the RockShell wall system to take up loads from those rafters that come to be placed in between the RockShell column profiles. Special attention needs to be paid at openings for windows and doors.

Horizontal forces from the roof perpendicular to the wall plane need to be retained at the top of the RockShell wall system, either by joists of intermediate floors or by bottom chords of the roof construction. The feasibility of a design of jamb walls in RockShell style needs to be explicitly verified when required.



## 2.18 Gables

The principles of construction of a gable wall correspond to those of the ordinary RockShell wall. It is recommended to separate the triangular part of the gable wall from the storey part on the height of the eaves to provide a framing LVL board on the same level all around the building.

In case of a gable triangle with a height of more than 2.7 m, a horizontal intersection of the gable wall might become necessary. The construction is similar to this for the intersection at the bottom of the gable triangle.

## 2.19 Maintenance and repair

Maintenance efforts for the RockShell wall system are kept at a minimum. Not considering internal and external cladding, which potentially need to be painted periodically as well as elastic joints to adjacent building components

like windows or doors, the RockShell wall system itself is free of maintenance.

Repair work can be executed as for any other light frame wall system.