Characteristics of hollow concrete blocks

Hollow concrete blocks are made from concrete, which uses Portland cement as a binder. The filler material used is generally a mixture of sand sieved with a fraction of 0-12 and crushed stone with a fraction of 2-6 and 6-12. Additionally, concrete admixtures can be used to improve the properties of the concrete mix.

Hollow concrete blocks are suitable for use both indoors and outdoors. The design must be based on the technical specifications of the masonry stones.

ARC hollow concrete block is a two-cavity building block made of concrete, suitable for use in most wall types. Blocks are available in widths of 90, 140, 190 and 240 mm. ARC hollow concrete blocks are 390 mm and 485 mm long and 190 mm high. There are four types of ARC hollow concrete blocks – row blocks, end blocks with smooth ends, end blocks with one smooth end and reinforcement blocks. In addition, the assortment includes a 190 mm diameter half block. The 240, 190 and 140mm row blocks have a combined locking system and end grooves found on the previous model, designed to make installation even more convenient - you can lay either a clean joint wall with an end joint or without an end joint, using only an end lock or mortise joint to connect the stones.

 row block 190 ARC199 190x190x390 1m² = 12.5 pcs	 190 row block (mix) ARC195 190x190x475/485 1m² = 10.1 pcs	 end block 190 ARC191 190x190x390 1m² = 12.5 pcs
 reinforcement block 190 ARC192 190x190x390 1m² = 12.5 pcs	 half-block ARC193 190x190x190 1m² = 25 pcs	 block 90 ARC090 90x90x390 1m² = 12.5 pcs
 140 row block (mix) ARC140 140x190x390 1m² = 12.5 pcs	 240 row block (mix) ARC245 240x190x485 1m² = 10.1 pcs	 reinforcement 240 ARC246 240x190x485 1m² = 10.1 pcs

ARC hollow concrete blocks are suitable for building various types of walls. The most common uses are as follows:

- load-bearing and non-load-bearing interior and exterior walls
- foundation and basement walls
- retaining walls, swimming pools, fences

A 240 mm wide block is particularly suitable for the construction of foundations and basement walls, but it is also possible to use a 190 mm block.

For the construction of load-bearing walls, a 190 mm wide block is most commonly used; depending on the load and other conditions, blocks with a width of 240 mm and 140 mm are also used.

For the construction of non-load-bearing partitions, blocks with widths of 90 mm and 140 mm are typically the optimal choice.

ARC hollow concrete block is an ideal choice for the construction of public buildings (schools, kindergartens) and industrial buildings, where painted clean-joint surfaces can be used as interior wall finishes. When laid with a clean joint and painted on the inside, walls made of ARC hollow concrete blocks are aesthetically pleasing and wear-resistant in addition to being inexpensive to build. In this case, there is also no need for time-consuming and costly plastering or wall coverings.

ARC hollow concrete blocks are also well suited for building walls in private homes, as they have good strength and sound insulation parameters compared to other small blocks, but are a more affordable solution. Another important advantage of hollow blocks is the ability to install the building's communication systems in the block's cavities, which eliminates the need for costly milling of cable and pipe channels.

Designing

ARC hollow concrete blocks are mostly used in a non-concreted form. For higher loads or higher walls, partial or complete concreting of the block cavities may be necessary. In general, full concreting should be considered when the gross compressive strength of the masonry is exceeded, when eccentric or lateral loads occur, as well as when constructing higher masonry (if the wall height h > 4 m). The most common concrete class for concreting block cavities is C 20/25. When building private houses, it is generally not necessary to fully concrete ARC blocks, as the previously mentioned aggravating circumstances usually do not occur in private houses.

This guide does not provide exhaustive information for the design of structures made of ARC hollow concrete blocks. Masonry design must be carried out by a specialist. The design must be based on the relevant design standards:

- EVS-EN 1996-2:2006+NA:2009 Eurocode 6: Design of masonry structures. Part 2: Design basics, selection of materials and execution of work
  (Eurocode 6 - Design of masonry structures - Part 2: Design considerations, selection of materials and execution of masonry)
- EVS-EN 1996-2:2005+NA:2008 Eurocode 6: Design of masonry structures. Part 1-1: General rules for the design of reinforced and unreinforced masonry structures

When planning the ground plan of a building, one needs to know the thickness of the masonry blocks used. This way, it is possible to make the lengths of the walls, the widths of the openings and the posts match the masonry dimensions already in the drawing. The masonry dimension is the sum of the masonry length and the thickness of the standing joint. When designing a structure, one needs to know the size of the masonry stones used and the thickness of the joints. In this way, all heights can be given as multiples of the thickness of the masonry layers. The thickness of the masonry layer here is understood as the sum of the height of the masonry stone and the thickness of the horizontal joint.

When constructing a building from ARC hollow concrete blocks, you will get better results and a faster construction pace if you have to cut as few blocks as possible. This is not possible everywhere, but if possible, the choice of masonry dimensions should be based on the modular pitch. The height of the block row including mortar is 200 mm. Therefore, to avoid large-scale cutting of blocks, the height of the building's floors should be selected based on a module pitch of 200 mm. The length of the block including mortar is 400 mm or 495 mm. Being based on the module in the longitudinal direction of the walls is generally more problematic. When dimensioning walls in the longitudinal direction, the recommended module is 1/2 the length of the block, i.e. 200 mm or 250 mm. The module should be taken into account for shorter window mullions and separate wall sections, and even more so for walls laid with unfinished or "clean joints".

Masonry stones should be laid in rows with overlaps at intervals so that the wall works as a unified structure. A good bond with a suitable mortar joins the individual masonry stones into a single structure and distributes the load across the entire structure. The bond also affects the overall appearance of the wall. If the masonry stones do not bond with each other and the load is not distributed, the strength of the wall will be low. If the masonry stones bond with each other and the load is distributed over a wide surface, the wall is strong. To ensure a secure bond, the blocks should be laid lengthwise with an overlap of at least 0.25 stone lengths. Hollow blocks should generally be laid so that the rows of blocks are offset by 1/2 a block.

At corners and junctions, the overlap of stones should be no less than the thickness of the element. To achieve the described connection, chopped stones or half blocks should be used in the end area of the wall. Hollow concrete blocks must be laid so that the cavities are aligned. It is not recommended to spread mortar under the first row of blocks for blocks that are completely filled with concrete, because the infill concrete must make contact with the foundation. A masonry structure needs a strong and immovable base that is straight and at the right height. The most common base material is concrete.

Reinforcement

Hollow concrete blocks are reinforced, either to ensure structural strength or to prevent cracks - to increase the spacing of expansion joints.

Horizontal reinforcement is installed in the joints between the rows of blocks after 3-4 rows or, in the case of fully concreted blocks, after partial removal of the partitions. The horizontal joint preceding or following the opening is reinforced below the openings and above the lintel, depending on the opening.

The reinforcement must be placed so that it works in cooperation with the masonry and cannot move in the masonry if cracks occur. The minimum amount of reinforcement to be installed must be at least as

large as is required according to the relevant calculation. In the case of hollow concrete block masonry, the height of an unreinforced wall could be 20 blocks wide, and in the case of reinforced hollow concrete block, 30 blocks wide. It is advisable to reinforce and concrete the lower and upper horizontal rows of a wall made of hollow concrete blocks.

A special "rebar ladder" with longitudinal reinforcement with a diameter of 4 mm is placed in the joints between the rows of hollow concrete blocks. There is a “rebar ladder" of different widths for each block width.

When reinforcing the cavities of hollow concrete blocks, the bottom of the row of blocks to be concreted must be covered with fine-meshed steel mesh or roofing felt to prevent the concrete from sinking. When continuing the reinforcement, the overlap of horizontal reinforcement is a minimum of 40 reinforcement diameters or 250 mm. When reinforcing vertically, the gap between the inner surface of the block wall and the reinforcement must be at least 10 mm. For vertical reinforcement, reinforcing bars (recommended as so-called ladders) can be placed in cavities after a maximum of approx. 1.6-2.0 m has been completed, taking into account the possibility of fully concreting the cavities. When continuing vertically, the overlap should be at least 2 block rows high, or 40 cm. Depending on the internal forces in the reinforcement, it may be necessary to increase the anchorage length.

The maximum diameter of the reinforcement must allow for its proper embedment in the mortar or concrete fill. The minimum total thickness of the reinforcing mesh in the embedment joint can be 1.5 mm for fine mortar and 4 mm for basic mortar and lightweight mortar. The minimum nominal diameter of individual bars is 6 mm. Sufficient anchorage length must be provided for the reinforcement so that the internal force of the bar is transferred to the masonry or infill concrete and longitudinal cracking or crumbling of the masonry is prevented. The spacing of the reinforcing bars must be large enough to allow for the placement and compaction of concrete fill or mortar. Reinforcing steel must be corrosion-resistant or adequately protected against the risk of corrosion arising from environmental conditions.

Intersecting load-bearing walls must be connected to each other in such a way that it is possible to transfer the resulting vertical and lateral loads. Opportunities must be created for the masonry to move in a way that would otherwise cause damage to the masonry. Vertical and horizontal expansion joints should be provided to allow for deformations caused by temperature and humidity, creep and deflection, and the possible consequences of internal stresses caused by vertical and lateral loads to occur without causing damage to the masonry.

Mortar and joints

Mortars must meet the requirements of EVS-EN 998-2. The mortar must have sufficient durability to meet the designed service life of the building and the specific conditions of use. The bond between the stones and mortar must correspond to the purpose of the masonry. It is recommended to use cement mortar with a grade of at least M2.5. In reinforced masonry, the cement mortar grade must be at least M5. You can use ready-made colored mixtures or add color pigments to the mixture. It is not recommended to use lime mortar. Plasticizers and when working below +3°C, anti-freeze additives can also be used in the mortar.

Hollow concrete blocks must be bonded together with mortar according to proven practice. The masonry should be laid vertically according to a level and with straight horizontal embedment joints, unless otherwise specified by the designer.

Mortar and aggregate must be mixed according to the prescribed composition. Mortar is applied to each edge of the hollow concrete block (except for the 190 mm row block with a combined locking system, which can be laid without leaving vertical joints if desired, locking the stones together), the joint thickness

should be approximately 10 mm. The hollow concrete block is picked up by hand horizontally, holding the masonry trowel in the other hand. The end of the block is turned upwards over the mortar container. To fill vertical joints, the blocks are first placed upright on their ends and two strips of mortar are applied to the edges, each up to 30 mm wide. The masonry trowel is filled with mortar and the mortar is laid out for the horizontal joint. When installing a block into a wall, a strip of mortar is pressed against the previously installed block and then leveled into place. The mortar squeezed out of the joint is immediately cut with a trowel. Different types of joints can be used: angle joint, smooth joint, round joint and V-joint.

After laying, all joints must be grouted to achieve the necessary weather resistance. It is not recommended to grout mortar that is too fresh, as water penetrating the outer surface of the joint will wash out the cement from the surface of the joint and the color of the joints will remain uneven. Grouting must take place while the mortar is still elastic.

Expansion joints are necessary for all masonry materials to relieve stresses resulting from volume changes in the masonry. Expansion joints can be divided into two: vertical sliding joints and longitudinal expansion joints.

Vertical sliding joints are made in places where there is a risk of various vertical deformations in the wall, the resulting stresses can lead to cracking of the wall.

Possible recommended locations for vertical sliding joints are:

- joints of intersecting walls
- joints between posts and pilasters
- places where the height of the walls changes
- above the openings

Longitudinal expansion joints are necessary to eliminate the effects of deformations caused by temperature changes and volume shrinkage in walls. The maximum spacing of expansion joints in unreinforced masonry is 6–7.5 m. The spacing and placement of expansion joints depend on the geometric shape of the wall, the locations of openings, columns, pilasters, intersecting walls in the walls, load concentrations, etc.

It is recommended that the designer determine the expansion joints in cooperation with the contractor. Expansion joints should be made at a distance of at least 1.0 m from the intersecting corners of the building and no further than max. 2.5 meters. When creating expansion joints, the load situations of the individual wall sections that arise must also be taken into account. Expansion joints must be made upwards from the corners of the lintels of openings: from one end of the lintel for openings up to 2.0 m and from both ends of the lintel for openings over 2.0 m. The spacing of expansion joints can be increased by reinforcing the masonry and concreting it.

The height of the wall laid in one day depends on the mortar, generally about 6-8 rows of blocks are laid. The height of masonry laid during the day should be limited to prevent deformation and overstressing of the fresh mortar. When determining a suitable height limit, the thickness of the wall, the type of mortar, the shape and bulk density of the masonry stones, and the influence of wind should be taken into account.

Infill concrete

The concrete used to fill the masonry must comply with EVS-EN 206. The workability of the infill concrete must be such that it completely fills all voids in the wall. If cavities are filled with dry mix, expanding

additives should be added to it to prevent cracking of the infill concrete due to volume shrinkage, which can be caused by water absorption by the masonry.

Filling hollow concrete blocks with concrete may be necessary to achieve greater strength of the masonry and to increase the soundproofing and fire resistance of the walls.

The masonry of concrete elements should be filled as soon as possible to reduce shrinkage cracks in the joints, however, premature concreting can cause the blocks to shift. Therefore, concreting is permitted after the mortar has reached sufficient strength. Before starting concreting, the mortar in the joints must have hardened for at least 24 hours.

Low concreting

It is recommended that up to 8 rows of blocks, or 1.6 m, can be concreted at a time. When leaving a concreting work joint, it must be at least 5 cm lower than the top edge of the block. In the case of reinforced walls, reinforcement overlaps must also be taken into account.

High concreting

This method is designed for structures whose openings, reinforcement, and element placement allow for free flow of the infill concrete. Concreting begins when the masonry has been filled to the design height and concreting is carried out in layers, with a maximum height of 1.6m. When concreting from a height, it is not recommended to make intermediate horizontal joints (connections) in the infill concrete. Concreting sections must be selected so that by the end of the working day, the final height of the masonry is reached. Compaction by vibration must begin no later than 10 minutes after placing the concrete layer. Each subsequent layer of concrete is pumped and compacted periodically after a minimum of 30 minutes and a maximum of 60 minutes (depending on the weather and concrete absorption). This time is necessary for the shrinkage of the installed infill concrete to stop and for excess water to be absorbed into the surrounding concrete element. The aforementioned waiting period also reduces the hydraulic pressure of the infill concrete and thus reduces the risk of blocks shifting. Each subsequent layer must be bonded to the previous layer by 30 cm during installation by vibrating.

When concreting vertical cavities, the pressure created by the concrete column in the cavity being poured and the complexity of compacting the infill concrete must be taken into account. The cavities next to the openings and the cavities where the bonds are anchored at the intersection of the walls must be filled with concrete.

Moisture insulation

Moisture is transferred through capillaries in the pores of hollow concrete blocks, therefore the increase in soil moisture through the foundation must be prevented with an adequate moisture barrier. In structural elements that may become saturated with water (e.g. basement walls and foundations), it is recommended to plaster the wall before waterproofing. Plastering and waterproofing are also necessary in other structural elements where water can damage the masonry.

Moisture insulation prevents water from passing through the wall. The durability of the moisture insulation should match the durability of the building. Insulation materials should be sufficiently strong against punctures and should not become wet on the opposite side under hydrostatic pressure.

Masonry in the soil must be such that it will not be damaged by soil conditions or it must be adequately protected. Masonry in contact with the soil should be protected from damage caused by moisture. If the

soil contains chemicals that may be hazardous to the masonry, the masonry must be laid with chemical-resistant materials or must be protected in such a way that chemicals or moisture cannot penetrate it.

Thermal insulation

Thermal insulation must be attached to the masonry of the exterior walls. Thermal insulation must not be installed on damp masonry.

The most common is insulation with expanded polystyrene boards and mineral wool. The polystyrene foam boards are glued and additionally mechanically fastened with dowels. When fastening, you must pay attention to the fact that the block wall is approximately 35 mm thick and choose the appropriate type of dowel.

In the case of a plastered facade, mineral wool boards are also attached with dowels. In the case of wooden facade cladding, wooden profile battens must be attached to the stone wall using metal angles. When attaching metal angles, also ensure that the dowels are suitable for the blocks.

Wall ties and lintels

Wall ties and their fastenings must ensure that they can withstand the loads intended for them, while also resisting the aggressive effects of the environment and the movement of wall layers between each other. The material of the wall ties must withstand possible deformations without loss of strength, elongation and corrosion protection. Prefabricated lintels must meet the requirements of EVS-EN 845-2. They must be corrosion-resistant in the conditions of use. The strength of reinforced and prestressed masonry and masonry diaphragms is determined by the mechanical properties of the stones, mortar and infill concrete used in the masonry in conjunction with the reinforcement.

The advantages of using concrete and steel together are:

- concrete and steel provide excellent resistance to compression and tensile forces and fractures
- the linear expansion coefficients of concrete and steel are close; concrete, mortar and steel adhere well to each other
- If the concrete layer is large enough, the concrete will prevent the steel from rusting

When supporting a reinforced concrete floor on walls made of ARC hollow concrete blocks, the block row under the panels or monolithic floor slab must be reinforced and filled with concrete (the intersecting walls of the hollow concrete blocks are partially removed) or a reinforced concrete belt of the required height for the site must be made (if the floor height does not match the block module. A reinforced concrete belt may also be structurally necessary).

When supporting larger spans, or in the case of higher loads, it may be necessary to center the support of the panel or reinforced concrete floor slab on the wall. To do this, an elastic filling material must be installed along the surface of the masonry - for example, expanded polystyrene, etc.

In the case of wooden floors, slots must be left in the masonry, and when supporting wood on a wall, it must be insulated and the ends of the beams must be treated with a moisture-resistant wood preservative.

To support roof beams, masonry lath for roof beams or rafters can be attached to a reinforced belt of blocks or a reinforced concrete belt.

When bridging openings, an expansion joint must generally be made from the end of the lintels upwards. For openings up to 2 m, this can be done at one end of the lintel. For openings over 2 m, a joint must be made at both ends of the lintel. The cavities of the blocks at the base of the lintel supports should generally be filled with concrete. It is recommended to place a thin metal sheet or roofing felt, etc., under one or both ends of the lintel, which allows the lintel to "move" better and reduces the possibility of cracks.

Other instructions

The handling and storage of materials used in masonry must be such that the materials do not become unfit for their intended purpose. Hollow concrete blocks should be carefully stacked on a suitable surface and protected from rain, snow, and mud and salt spray from passing vehicles. Hollow concrete blocks should not be stacked on a surface containing harmful chemicals, clinker or ash. Reinforcing bars and ready-made mesh for the embedment joint must be stored, bent and installed in such a way that they are not damaged and do not become unfit for their intended purpose.

The surface of the reinforcement must be checked before use. It must be free from substances harmful to steel, concrete and mortar or their adhesion. Reinforcement must be laid and bent in accordance with standards and the design, avoiding:

- mechanical damage
- tearing apart of welds of ready-made meshes of the embedment joint
- surface contamination that impairs adhesion properties
- the disappearance of markings

From the point of view of masonry work, winter conditions have arrived when the outside air temperature temporarily drops below 0_0C. The unbound water in the mortar freezes and its volume is approximately 10% larger than water. Ice melts unevenly in the masonry, causing various subsidences, tilting, cracking, etc.

In winter conditions, special care must be taken when carrying out masonry work, preserving and storing building materials, organizing work, and protecting the masonry.

Hollow concrete blocks must not be wet, icy or snowy. If necessary, they should be warmed up. The masonry mixture must not contain any ice cubes or frozen mixture particles. The heat of the masonry mix is obtained by using warm water or heated sand to prepare the mix, or by heating the finished mix. In winter conditions, masonry is carried out and the masonry is protected so that the temperature of the masonry mixture remains above 0_0C until the freezing of the water no longer threatens the hardening of the masonry mixture and the bond between the masonry mixture and the stones. A decrease in temperature causes the hardening of all cement-based products to slow down, due to a decrease in the reaction rate of the cement. When the temperature drops below 0_0C the water in the mixture begins to freeze. If the mixture has not reached the so-called freezing strength by then, the freezing water will destroy the bonds already formed in the mixture, as a result of which the masonry will not reach the designed strength. In addition, the joints will continue to crumble for several more years.

Fresh masonry should be protected from mechanical damage (such as impacts) and weather influences. The masonry must be protected from freezing for 48 hours. In case of rain, the top edge of the wall should be covered to prevent mortar from washing out of the joints, which leads to blistering and lime stains on the masonry, and to prevent damage to non-waterproof materials. Fresh masonry should not be allowed to dry too quickly. Necessary precautions should be taken to keep the masonry moist until the required strength is achieved, especially in adverse conditions such as low relative humidity, high temperature and/or strong air movement.

After the building is completed, masonry made of hollow concrete blocks does not require special care. The porosity of the surface and the fact that it is a breathable building material should be taken into account. Avoid damaging the masonry surface with pressure washing and mechanical cleaning. Continuous water flow along masonry surfaces should be avoided, as this can lead to salt leaching, or efflorescence, and the formation of lichens and algae on the surface. Efflorescence is greater during construction or immediately after construction is completed. The problem of efflorescence becomes more prominent in winter when the evaporation of salts from the masonry surface is slow. Efflorescence will not occur if the movement of water through the wall is blocked, there is no excess moisture, and there are no soluble salts. Generally, efflorescence can be removed by dry or wet brushing. Light sandblasting and pressure washing can also be used. If these measures do not work, the masonry surface should be washed with a hydrochloric acid solution (1-10% solution).

All work must be carried out by trained and experienced personnel. All occupational safety requirements must also be followed and the necessary personal protective equipment (protective gloves, safety shoes, respirator, etc.) must be used.