

Brick prefab elements – the future of bricks

1. Introduction

Bricks have been used for thousands of years. Due to their manifold properties bricks are the most popular building material for residential construction. The brick industry - especially in Central Europe - has continuously developed its product to meet the ever-increasing demands placed on modern building materials.

In recent years, however, there has been a trend towards prefabricated construction, driven in particular by an acute shortage of skilled workers, poor workmanship and the associated complaints. Construction companies, as customers of the brick industry, are increasingly confronted with these problems and challenges.

The advantages of industrial prefabrication are obvious: consistent quality, weather-independent production and precisely calculable costs.

Industries such as manufacturers of prefabricated concrete parts, timber construction or lightweight timber construction have long ago been confronted with the challenge of prefabrication and have developed corresponding systems. Despite this, the construction industry is according to McKinsey's report "Reinventing Construction" from February 2017 in terms of productivity far behind all other industries and has a productivity increase potential of up to 100%.

2. Basics for the development of the Redbloc prefab system

In order to meet this potential for increased productivity more than 10 years ago, a prefabrication system based on grinded bricks was developed in Austria under the name Redbloc System, which combines the advantages of grinded brick technology with those of modern bonding technologies. An absolute novelty was the use of a two-component adhesive, as it has been used for decades in timber construction or in the automotive and aircraft industries. This adhesive has been specially developed by one of the world's leading manufacturers for this particular application.

The Redbloc system combines the massive advantages of brick construction in terms of living quality, sustainability, thermal and sound insulation and other physical building properties with the increase in efficiency of the prefab construction method.

2.1 Standards, approvals, norms for masonry

In Europe, masonry and its connecting elements are subject to structural regulations which are usually regulated in standards and approvals. By using a non-cementitious it was necessary to prove the suitability of this adhesive by extensive tests and tests based on European standards as a basis for university assessments. These certificates were carried out by the University of Graz for the OIB and subsequently - for the system approval in Germany by the DiBt - by the RWTH Aachen University.

These expert opinions and approvals were subsequently the basis for further system approvals in Russia, Belgium, the Netherlands, Italy, Switzerland, etc.

The following areas in particular were examined and evaluated intensively:

- thermal insulation
- sound insulation
- fire protection
- statics
- bond strength
- longevity (this study was ended after an equivalent of 80 years).

The result is a prefabrication system for solid building materials, which fulfills all requirements aliquot to conventional brickwork.

In the approval procedure, consideration was given to adopting the systematics and calculation principles of Eurocode 6. On the basis of the EC 6, a design aid was created which contains the necessary additions and extensions.

The Redbloc system meets even the most stringent sustainability requirements for the public construction of eco-bau and MINERGIE-ECO with regard to ecological and health requirements in Switzerland. It corresponds to the first priority ECO-BKP and is therefore very well suited for MINERGIE-ECO projects.

The advantage of the system is that no reinforcement steel or grouting mortar or similar is necessary for the production of elements. In contrast to mortar-laminated wall elements, the wall elements produced according to the Redbloc system are ready for transport within one hour after production. This makes "just-in-time" production possible and avoids expensive and logistically complex warehousing. The wall elements are delivered to the construction site absolutely dry.

The lifting of the walls was also intelligently solved by using reusable lifting irons. This means that no iron remains in the wall after assembly. The Redbloc system does not require any casting anchors, no bearing joint reinforcement, no supporting or lifting beams which have to be fixed to the respective element with expensive steel strapping bands.

A further objective was - everything that can be produced on site by hand must also be possible in industrial production. In order to meet this requirement, Redbloccsystems has developed special cutting processes for finished wall panels. Depending on the requirements and concept, 2 different systems are used.

Even the types of buildings to be manufactured have no limits. From single-family houses to residential, commercial and high-rise buildings - everything is possible (pictures 1-3).



Image 1 - Single Family homes



Image 2 - high rise buildings



Image 3 - Apartments

Redblocsystems has meanwhile developed 3 system configurations for different applications.

- Redbloc Semi-automatic
- Redbloc Economic
- Redbloc Advanced

The following system limits apply to these three types of systems:

- wall lengths up to 8 m
- wall heights up to 3.5 m
- wall thickness 11,5-51 cm
- lintel lengths of 1.0-2.5 m in automatic production, lengths of up to 3.5 m are possible on site.

3. Basics of technological solutions

The Semiautomatic and Economic systems require half and full formats for the respective wall thickness. In addition, holes with a diameter of approx. 4 cm in the half or third center point must be provided for the insertion of the reusable lifting rods. The Semiautomatic system is designed in such a way that an upgrade to Economic is possible at any time.

The system type Advanced has been specially developed for the use of filled brick material. In this system, beginners and fitting pieces are cut exactly to size so no open cuts occur at the wall ends or in the case of window soffits. With this type of system, the leverage holes are also drilled fully automatically, depending on the automatically calculated centre of gravity. Due to the design, this type does not require half formats.

The 2-component adhesive developed especially for Redblocsystems is used for all 3 types of systems.

3.1 Technical equipment - software

The basis for the production of the wall elements are the drawings of the customers, which are automatically imported by the CAD software. The CAD software has been specially configured by Precast Software Engineering (Nemetschek) to meet the requirements of Redblocsystems, ensuring worldwide support. The software then elements the building to be constructed into individual elements, taking into account parameters such as wall weight or location and crane type on the construction site. Necessary cut-outs, electrical or water plumbing ducts as well as sloping roofs or purlin supports are taken over (Figs. 4-5).

The contours of the individual wall elements of a construction project are transferred to the plant via a data interface. All detailed information (storey, recesses, type of building material etc.) is already taken from the building plan and transferred to the software for calculating the wall elements (MBS).

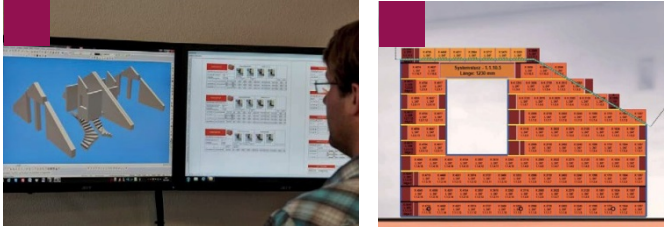


Image 4-5 • Software processing is used for production planning

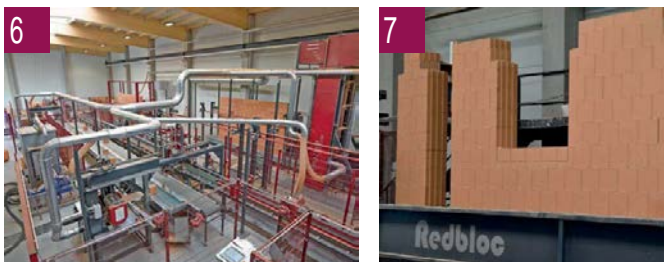


Image 6-7 • Insights into the production hall of the wall elements



Image 8-9 • Required bevels are cut in the production hall with special cutting processes.

The masonry calculation software (MBS) checks all wall elements and calculates the stone division within the walls. The data thus determined are transferred to a Simatic S 7 controller.

4. Production

The brick pallets are placed on conveyor belts by means of forklifts and the bricks are unloaded by means of robots and fed to the plant. If there are no flat ground bricks available, a grinding machine can be integrated. The bricks are then grouped into layers in the correct order. The two-component adhesive is applied to each individual layer in a computer-controlled process and the layers are placed on circulating pallets by a layer gripper. In the setting area there is a lifting platform which lowers by exactly one share height after each layer. When a wall element is finished, the pallet change occurs and the next element is manufactured.

Due to the short curing time of the adhesive, the wall can be further processed after approx. 40 minutes by the cutting machines or placed in containers after 1 hour for transport.

Fully automatic Redbloc systems produce up to 400 m² of wall elements per 8 hours shift with a very low space and personnel expenditure. In production, 4-5 employees are employed, work preparation and CAD preparation is carried out by another employee. The transport to the construction site (Fig. 10) can be carried out with containers or with an internal loader. The relocation on the construction site (Figs. 11-14) is ideally carried out using a tower crane or a mobile crane. A lot of 3 assemblers can easily move about 300 m² in one day.



Image 10 • Transport of the finished wall elements to the construction site



Image 11 • Setting a wall element



Image 12 • Mortar bed

In the meantime, the Redbloc system, for which licences are awarded with territorial protection, has been successfully implemented in Austria, Belgium, the Netherlands, France, Slovakia, Germany, Italy, Russia and Switzerland. Further licenses were granted for Saudi Arabia, China and Algeria.