TRÄULLIT LARGE WALL ELEMENTS

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ABSTRACT

In the Construction Industry in Europe, Wood Wool Cement Boards (WWCB) are used for nearly one hundred years.
Träullit Large Wall Elements of WWCB are used for external walls with unique characteristics.
The Large Wall Element has been developed to offer the market a homogenious very high insulating exterior wall with a high thermal capacity to satisfy the growing demand for Insulation, Comfort and Industrialised Construction.
Thanks to the relative low weight and the simplicity to install the large Prefab - Elements one small crew with a crane can install all exterior walls for three houses per day. Besides the characteristics mentioned the Large Wall Elements are resistant to termite attack, mould and rot and pass with ease the highest demand for fire resistance with a very low TVOC (Total amount of Volatile Organic Compounds). An excursion is planned by IIBCC for Friday November 7th to Sweden to inspect the construction and various completed houses.

KEYWORDS

Wood Wool Cement, Prefabrication, Industrialised Construction.

INTRODUCTION

Träullit's large wall elements are very well suited for building a passivhaus. In an exam paper from lund's technical university from spring 2008, the results of the study show that a house built of träullit's large wall elements has an energy consumption that is 11% lower than a standard timber frame house with insulation of mineral wool. Träullit can also deliver a single homogeneous wall unit which increases the speed of construction compared to a timber frame wall that is usually delivered in two or three units.

BACKGROUND

Träullit's products have been used for more than 60 years in Sweden. During the 1940's and 1950's the products were generally used for interior and exterior insulation and insulation of the beam layout. Since the 1960's Träullit has produced mostly acoustic boards for ceilings and independent reinforced ceiling boards. In the beginning of the 1990's Bengt Rääf, the owner of Träullit AB, and I started a cooperation to continue the development of Träullit's products. The first product we developed was a construction block one could build a single-level house with. In 1995 we used this construction block to build an experimental house close to Lund in southern Sweden. Due to the single-level limitation of the

construction block and the relatively work-intense method to build the house it was difficult to get a breakthrough for the product in the Swedish market. However, we still took note of the fact that the walls of the house functioned as intended, and therefore continued our development work. Our aim was to cut down the working time at the building site and lower the static performance of the wall without losing any of its good qualities. In 2003 we cast a 40 centimetre thick wall element of 2,4 metres high and 2,4 metres wide. With these large wall elements we were able to mount the entire building in less than a day, while also opening up the possibility to increase the amount of levels.

MANUFACTURE OF LARGE WALL ELEMENTS

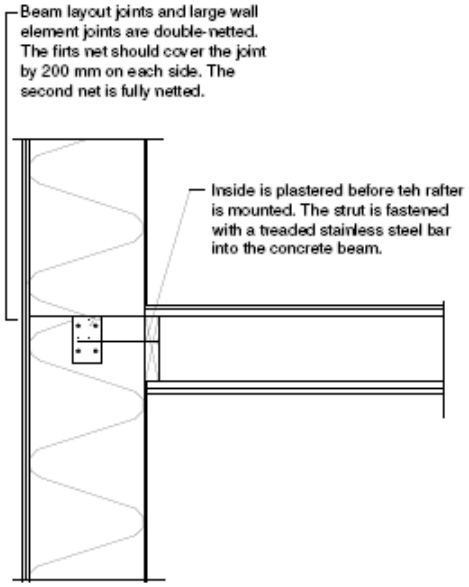
The mixing conditions for a large wall element differ from that of standard WoodWool- CementBoards due to the thickness of the wall. Under normal mixing conditions the cement-wood wool mix becomes too heavy and gives way which makes the density too high. Träullit's large wall elements are manufactured in large casting moulds according to the standard measure of 2,6 metres high, 6 metres wide and 40 centimetres thick. A 15 ton weight is laid on top of the casting moulds. On the crest of the large wall element a Ushaped groove is shaped out for the carrying ring beam and on the sides V-shaped slits are made for columns. Window openings are made according to possibility in the mould, while door openings are always situated between two elements. Above the door openings wood wool beams are fitted. These beams are made from standard wood wool cement boards with the same groove structure in the middle as the wall elements. Lifting tackles are cast into the crest of the large wall element to enable the handling of the elements with a crane. After one day the elements are removed from the mould and put to stand upright to harden for at least 28 days.

BUILDING WITH LARGE WALL ELEMENTS

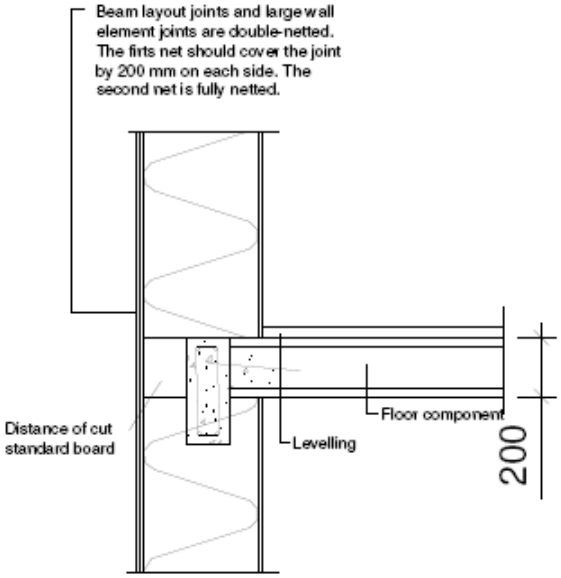
Due to the low weight of the wall elements one can transport up to 108 metres of large wall elements on a truck with a trailer. The elements are loaded into loose containers, one on the truck and two on the trailer. If space at the building site should be a problem, the trailer can be left where more convenient and the truck can drive up to the house foundation to unload the container and get the next one from the trailer. While the truck fetches the next container the construction of the building made of the large wall elements can start. The Träullit large wall elements system consists of a column/beam system of reinforced concrete cast on site after the elements have been mounted onto the foundation. In the joints between the large wall elements the vertical V-shaped slits now form a square cavity when the elements are mounted next to each other. At the crest of the large wall element the Ushaped groove forms the carrying (ring) beam that runs along the top of the element around the entire outer wall crest. The vertical and horizontal cavities and grooves are reinforced with steel bars and are cast on site when the elements have been stabilised with buttresses. During the mounting the corners can be stabilised with sharpened corner braces. These ensure stability for the casting process.

To get the correct cover layer of concrete around the reinforcement we use rafter fastening irons. This is an arrow-shaped, 3 millimetres thick piece of sheet metal that has punched holes for the reinforcement bars and the fastening of the rafters. It is struck into the U-shaped groove of the large wall element crest. Possible plays between the large wall elements are caulked and door openings are mounted with moulding boards before the casting is made. The walls are mounted with a mortar levelling on the foundation. A reinforcement bar in the joint between the large wall elements is anchored into the foundation and can be bound to the carrying (ring) beam. The load-bearing structures are the joint columns and the carrying (ring) beam. These are reinforced in order to be able to carry the appropriate loads. The large wall element itself has a compression resistance factor of 27kN per running metre and a strength of concrete in flexure factor of 27kPa. A possible benddown of the concrete beam is caught by the large wall element that works together with the concrete beam. Once the wall elements have been mounted and the beams and cavities have been cast on site the walls have to be air tightened so that no wood wool cement remains visible. This is particularly important around windows and the crest of the building where it will be impossible to plaster after the windows and the rafters have been mounted. Beams and struts that are placed in direct contact with the outside wall must also be plastered before they are mounted. The diffusion barrier on the inside of the roof is folded double and squeezed against the exterior wall with an L-shaped sheet metal profile. Between the wall and the diffusion barrier an EPDM-rubber is fitted.

The rafters are anchored to the large wall elements by the arrow-shaped sheet metal pieces that were cast into the carrying (ring) beam. The actual amount of nails/screws needed for the anchoring of the rafters is determined by the wind load on the roof. Under each rafter a moisture proofing sheet must be placed to ensure no moisture is carried to the wood rafters. The gable walls are anchored to the roofing with screws and plugs all the way to the concrete beam in the large wall element joints to ensure a tight fastening of the gable. If the building is more than one level, the large wall elements are placed on top of each other and the joint column runs all the way to the top of the upper carrying (ring) beam. The elements on the ground level must be mounted, reinforced and cast first before the large wall elements of the upper level can be mounted. Depending on the wind load the building must withstand (depending on location), the columns may have to be cast larger and be better reinforced to be able to ensure stability. The beam layout of a multilevel building can be made of wood or concrete. If wood is the chosen material, a strut with a cast-in threaded stainless steel bar is anchored onto the wall which the rafter can be hung into with an iron joist hanger. Concrete-based rafters can be made of lightweight concrete or similar. All rafters, regardless of material, are mounted onto the inner crest of the large wall elements. The exterior part is fitted with a piece of standard wood wool concrete board and the U-shaped groove together with the height of the beam layout is utilised up to the height of the carrying ring beam.



Detail: Fastening of wooden floor structure

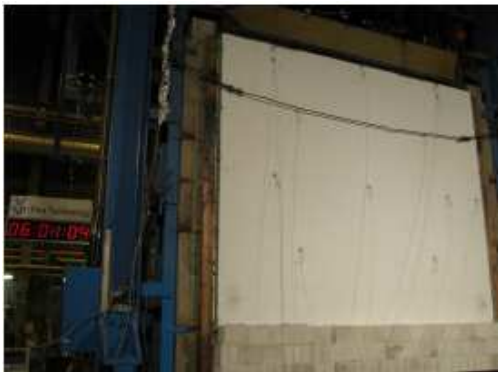


Detial: Fastening of concrete floor structure

The elements are always lifted and handled by a crane and two or three construction workers that fit the elements together, buttress them, and manage the concrete casting on site. Such a work team can manage to lift down 5-6 large wall elements from the truck, fit them, and buttress them in an hour. It takes about the same amount of time to mount a 6- metre element as a 2-metre element. A complete mounting with reinforcing, caulking the joints and casting on site naturally takes a longer time. On average one can complete a mounting of about two elements per hour.

Electricity fittings are simply milled into the wall since the large wall element is very easy to work with. When all the fittings are finished the milled fittings are plastered over. After that the entire surface of the interior wall can be plastered.

Fastenings for e.g. Kitchen cupboards and fittings are usually made with screws and plugs. The hole for the plug should be drilled a couple of millimetres smaller than what is recommended for the selected plugs. The drilling hole should be cleaned and air-proofed with e.g. mounting glue before the plug is mounted. After this the interior fittings can be mounted into place. A normal 10 millimetre plug has a vertical pulling load of 165 kilos per mounted screw. Stiffer plugs of the type that is used for lightweight concrete has a vertical pulling load of 300 kilos per mounted screw.



The Träullit large wall elements have obtained the highest fire-rating in Sweden. When tested the large wall element was subjected to a continuous fire during six hours. The temperature of the fire was 1200 degrees centigrade on the fire side of the wall, while the other side of the wall held a temperature of only 45 degrees centigrade.

Träullit Large Wall Element, Thickness 400 mm Technical data	
U-value	0,19 w/m² °C
Fire rating	REI360
Heat storage capacity	250 kJ/ m² °C
Critical RH (preliminary tests)	90 %
Air permeability	20 m³/mhPa
Bending Strength	27kPa
Compressive strength	27kN per running metre of wall
Density	280 kg/m³