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INNOVATIVE PRODUCTION TECHNOLOGIES AND APPLICATIONS IN THE FIELD OF WOOD CEMENT PRODUCTS

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ABSTRACT

This paper describes the further development of advanced production technologies for the manufacture of various types of Wood Cement Boards and the wide range of applications of these boards. Due to the increasing awareness for healthy (emission-free) and comfortable living conditions with reduced energy costs, the demand for various types of Wood Cement Boards has grown significantly over the last years. In Western Europe this growth is furthermore supported by the increasing need for "acoustic performance" and "comfort of living" in public buildings and private homes. As a result, the demand for automated production lines for these acoustic and energy-saving boards has also increased. Eltomation BV, The Netherlands, being a major player in the supply of turnkey Wood-Cement Board Plants for over 30 years, has further developed its advanced production technologies to meet this increasing demand. For the applications of these boards, various European Wood Wool Cement Board producers have made great steps in further improving the overall sustainability (incl. further reduction of CO2 footprint) and obtaining the highest levels of Cradle-to-Cradle certificates. This paper provides a general overview of the various Wood Cement Boards on the market and the new technologies being developed to meet the increasing demand for acoustic performance, thermal insulation, fire-resistance and sustainability.

KEYWORDS:

Wood Wool Cement Boards; Advanced Production Technologies; Energy Saving and Acoustics Applications.

INTRODUCTION

Eltomation BV of Barneveld, The Netherlands, is specialized in the development and supply of turn-key plants and equipment for the production of various Wood Cement Boards. The family-owned company, active in this specific field for over 60 years, is regarded as a specialist in the production technologies for these Wood-based Mineral Bonded Boards.

The main product produced in these plants is the so-called low-density Wood Wool Cement Board (WWCB). Other Wood Cement Products include the medium-density Wood Strand Cement Boards (WSCB - EltoBoard) and the Prefab Large WWC Wall Elements. Where the above listed products are based on using long wood wool strands (also called excelsior) as raw material, another product for which Eltomation has provided plant solutions is the so-called Cement Bonded Particle Board (CBPB), which high-density (fire-retardant) structural product is based on using small wood particles as raw material.

Eltomation's European clients include renowned producers such as Knauf Insulation (their WWCB products being well known under the brand name Heraklith) with multiple plants throughout Europe, Troldtekt A/S - Denmark (since 2022 under the umbrella of the Kingspan Group), Fibrolith Dämmstoffe GmbH - Germany (nowadays part of Soprema Group), Celenit S.p.A - Italy, Träullit AB - Sweden, Knauf Fibre - France, Cewood – Latvia, Dietrich Isol – Switzerland, Isolith Dämmstoffe – Austria, FRAGMAT H - Croatia and others. Annual production volume of WWCB is nowadays exceeding 20 million square meters, serving mainly the (fire-retardant) acoustic ceiling market. This demand is still steadily increasing.

During the last decade an increased interest for durable, environmentally friendly and energy-saving building materials has also come from the new Russian and Chinese markets. During these recent years a total of 7

additional Wood Wool Cement Board Plants have been supplied to clients in Russia and China, for serving the local markets with these fire-resistant, energy-saving products. In addition, these new Russian WWCB Plants also produce large quantities of fine-fibre acoustic ceiling panels for export to the large ready market in Western Europe (which has come to a full stop since early 2022 due to the current political situation and economic sanctions). The North American market for acoustic WWCB is also further developing, with increasing import of boards from several West-European producers. The recent sharp increased pricing for overseas container transports may justify the boards being produced locally instead.

OVERVIEW OF MAIN WOOD CEMENT PRODUCTS

In general, the following Wood Cement Boards (and Large Wall Elements) are considered to be the main Wood Cement Board products, which are on the market today:

1. Wood Wool Cement Board (WWCB).
2. Large WWC Wall Elements.
3. Wood Strand Cement Board (WSCB/EltoBoard).
4. Wood Residue Cement Board (WRCB).
5. Cement Bonded Particle Board (CBPB).

This paper will mainly deal with the production technology and applications of the first three mentioned product types. Each of these 3 product types requires small diameter logs (mostly soft wood species such as pine, spruce, poplar or aspen from forest thinning/plantations) as raw material, to enable the production of long and thin wood wool (in the USA referred to as “excelsior”) or wood strands. WRCB and CBPB are not made from wood wool but from wood chips, respectively small wood particles, thereby having different properties and applications.

PROPERTIES OF WOOD WOOL CEMENT BOARD

Of the above-described main Wood Cement Products, **Wood Wool Cement Board (WWCB)** is by far the most common product with a significant annual production volume. The fast-expanding market for (decorative) acoustic ceiling tiles, in (Western) Europe, creates a still increasing demand for some 20 million square meters per year.

To ensure its excellent properties in view of thermal insulation and sound absorption, WWCB is produced at a final density of only approx. 350-460 kg/m^3. These densities are subject to the board thickness and specific application.

The main features of WWCB are:

- Excellent acoustic performance
- High fire resistance (both as B1 and A2 class)
- Wet and dry rot resistance
- Freeze-thaw resistance
- Termite and vermin resistance
- High thermal insulation (energy-saving)

For increased thermal insulation (and/or further increased fire-resistance), WWCB can optionally be produced as a (2- or) 3-layer sandwich board with a core of Mineral Wool (or optionally EPS/Polystyrene or PU-foam). This product is referred to as “Composite WWCB”. A main application of such Composite WWCB panel is e.g. acoustic ceilings in open parking garages, where the design of the apartments or store above the parking house not only demands the required increased fire-safety, but also a high thermal insulation.

Figure 1 - Standard (white cement) WWC Board

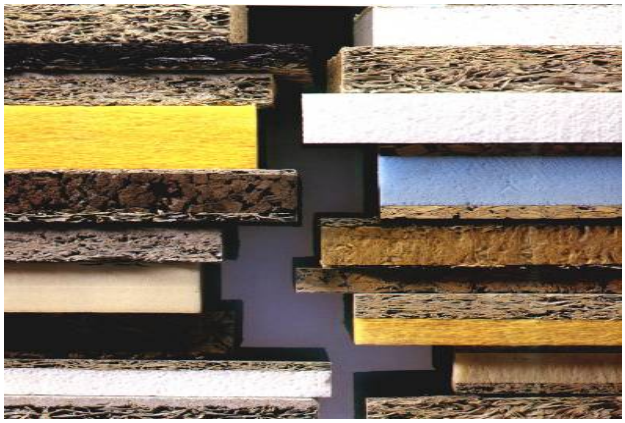


Figure 2 – Various types of Composite WWC Boards

APPLICATIONS OF WOOD WOOL CEMENT BOARD

Standard applications of WWCB include:

- Acoustic ceiling applications (being the vast majority of the market demand).
- Reinforced Roofing boards (mainly applied in Scandinavia, where heavy snow-loads apply).

In addition, specialty applications include:

- Insulation boards for external walls (and floors), referred to as “permanent shuttering” board.
- General boards for insulation / renovation / fire protection purposes.

Figure 3 - Acoustic ceiling panels in public building

Figure 4 - Reinforced Roofing Boards (Träullit, Sweden)

Figure 5 - Permanent Shuttering Boards

Figure 6 – WWCB for renovation projects

Although in certain regions WWCB is still used as construction board, most of the boards produced today are applied as **indoor acoustic and fire-resistant boards** in schools, offices, theatres, and sport facilities. While

the majority of applications are for acoustic ceilings, we are seeing a strong increase in the use of WWCB as wall covering to enhance the overall acoustic and visual properties of rooms.

Figure 7, 8 – Acoustic applications of WWCB in public buildings, such as in schools and restaurants (CEWOOD, Latvia)

Figure 9, 10, 11 – Acoustic applications of WWCB in various public buildings (Troldtekt, Denmark)

WWC Boards are also widely applied in the **Agricultural industry**, such as in stables for cows, pigs or chicken. Here the boards not only provide the required sound and thermal insulation and "comfort" for the animals, but in certain applications the WWCB ceiling also acts as "natural diffusion filter" for an even distribution of fresh air throughout the stables. Such Agro-WWCB panels are usually produced at a lower density, to ensure a certain amount of air flow through the panels.

Figure 12 – WWCB applied in the agriculture industry (Träullit, Sweden)

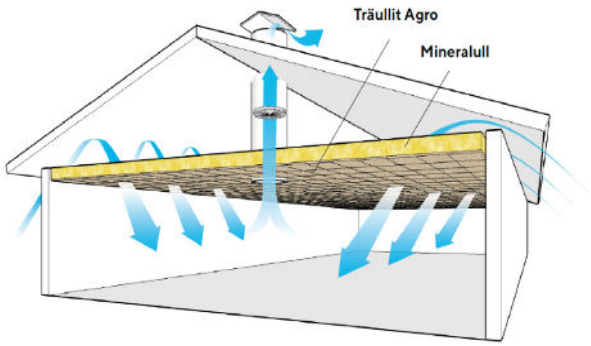


Figure 13, 14 – Special WWCB Agro-panel acting as diffusion filter for constant fresh air inlet in pig stables (Träullit, Sweden)

Nowadays there is a fast-growing application of WWCB as **Decorative & Acoustic Applications** on walls in offices, bars & restaurants, stores, theatres, etc., mainly due to the good acoustic performances and ecologic and modern appearance. These boards are typically applied in various decorative shapes or patterns and/or as a mix of various matching colours. Major players in this field are the companies BAUX/Träullit from Sweden, Troldtekt, Denmark and CEWOOD, Latvia. Other major WWCB producers have jumped onto this fast developing trend as well.

Figure 15 – Decorative WWCB (Troldtekt)

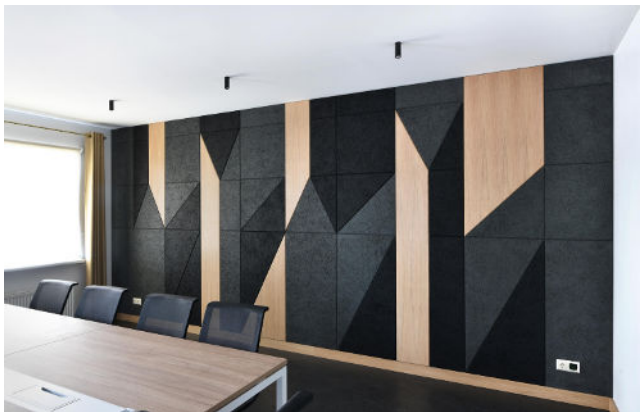
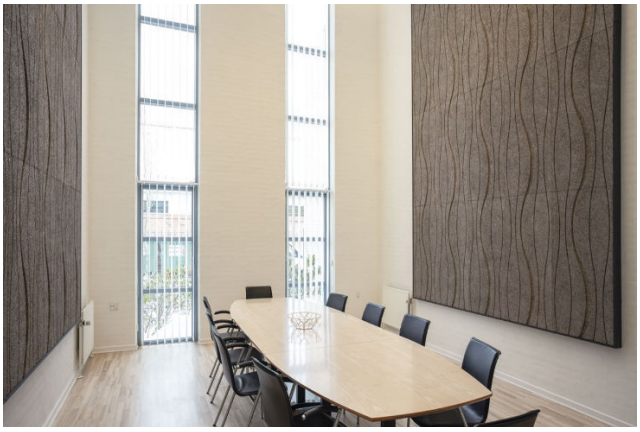


Figure 16 – Decorative WWCB (CEWOOD, Latvia)



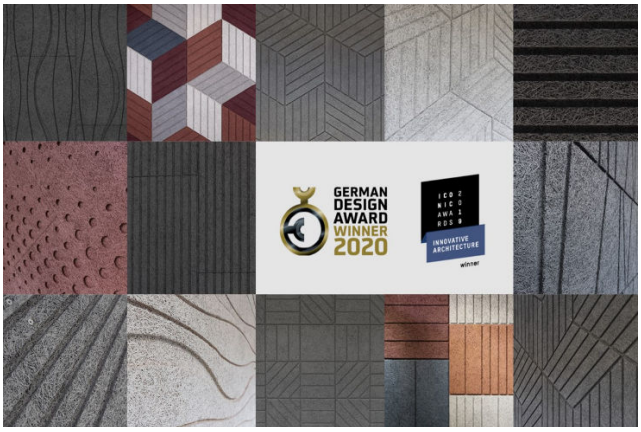


Figure 17, 18 – Endless combinations of shapes and patterns has led to various International Design Awards (Troldtekt).

Another fast-growing development is the application of **acoustic WWCB in private homes and apartments**. With the trending modern designs of hard floors, no curtains, etc. it is becoming increasingly difficult to meet the standards of "living comfort" in these houses, in view of sound absorption, low emissions, indoor air quality, etc. Adding WWCB as ceiling (and/or wall) boards resolves these architectural design hurdles. In this respect WWCB meets the most stringent norms per the Danish Indoor Climate Labeling (DIM) and has been awarded the M1 category by the Finnish Indoor Air Association. It is expected that this section of the market will quickly develop, to meet the increasing European norms on acoustics and "indoor living standards".

Figure 19, 20, 21 – Acoustic applications of WWCB in private homes and apartments (Troldtekt, Denmark)

A special outdoor application of WWCB can be found in **Sound Barriers** along railways, highways and along main roads near towns and homes. Previously such sound barriers were made of concrete or wood, modern regulations require these sound barriers to absorb the sound versus just bouncing it back. The open structure of WWCB meets these requirements of sound absorption, in addition to the board being resistant against the elements, such as rain and freeze-thaw cycles.

In other applications, WWCB is even being added between the rails to reduce the overall sound of passing trains. Such applications are known in railway tunnels in Austria. Also, in the city of Zoetermeer, The Netherlands, special WWCB elements were placed on both sides (and in between) the tracks to meet the high sound-restriction regulations of this light-rail system passing through the suburbs (see Figures 24, 25).

To provide a “natural look” of these sound barriers, a requirement may be to have the full surface be made “green” by having it be covered by ivy. The open structure of WWCB suits this application very well (see Figure 26).

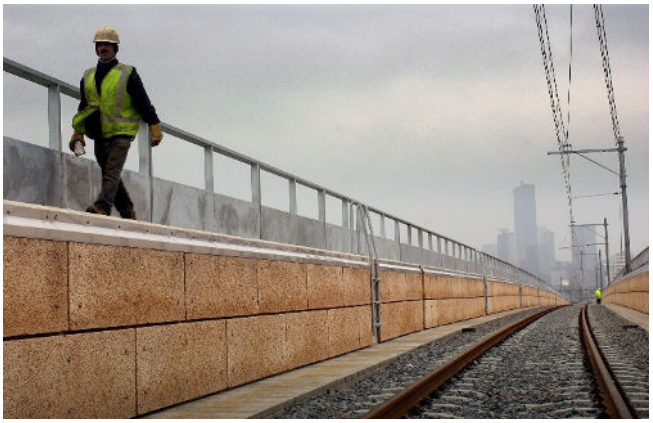


Figure 22 - Railway overpass in The Netherlands (Knauf Insulation)

Figure 23 – WWCB Barrier in Sweden (Träullit)

Figure 24, 25 – WWCB Elements placed between the tracks of a light-rail overpass

Figure 26 – WWCB Sound Barrier being covered by ivy for a natural look

PRODUCTION TECHNOLOGY FOR WWCB

The modern WWCB Plants supplied to the market nowadays combine the need for high-capacity production and minimal labour requirement with consistent high-quality boards. A high percentage of the output will find its way to the acoustic ceiling market. These boards require not only the needed fire-resistance (in either standard B1 or special non-combustible A2 Class) but also have a high standard for visible appearance. This has resulted in an increasing market for special “fine-fibre” ceiling panels, using white cement as binder and produced with fine wood wool of minimal width, such as 1,5 mm or only 1,0 mm in width (where standard WWCB is commonly produced with a wood wool width of 2,0 mm 2,5 mm or even 3,0 mm). Wood wool thickness (adjustable) is typically set between 0,2 and 0,25 mm.

The high-speed production of the fine-fibre wood wool is realized by means of a proprietary Rotating Wood Wool Machine (the so-called “Eltomatic CVS-16”). Such Eltomatic replaces a series of up to 8 of the previously known reciprocating crankshaft-driven wood wool shredding machines, which are no longer used in modern WWCB production plants due to safety and CE regulations. In the last decades close to 40 “Eltomatics” have been installed in WWCB plants worldwide, either as part of a new turn-key plant or replacing the old wood wool machines as part of a modernisation (in combination with safety-issues and labour savings).

Where the vast majority of the WWCB Plants use standard Portland Cement (OPC) as a binder (where increasingly white cement is replacing the previously common grey cement), a few production sites are based on using Magnesite as binder (where these boards are mainly applied indoors). To meet the changing market demand towards decorative applications, most of the acoustic board produced are cut to half-size length (typically 120 x 60 cm) and be profiled/bevelled and/or spray-painted in the desired colour. A certain (even increasing) percentage of the boards onto the market today, retain their “natural look” of the white cement

surface and for certain applications even the darker grey-cement look (preferred by architects for bars, clubs, restaurants etc., but also finding their way into modern apartments).

WWC-Boards are typically produced as 60 cm in width (optionally 2' / 61 cm for the North American market) and having a length of 200 or 240 cm (optionally up to 280 or even 300 cm). Thicknesses of solid WWCB range from 15 to 100 mm, where the majority will be in the 15-35 mm thickness range. For applications with a higher thermal insulation (or even further increased fire-resistance), the WWCB panel can be combined with a layer/core of insulating material, such as Mineral Wool (or EPS/XPS or PU-foam). These so-called (2- or 3-layer) Composite WWCB Panels are nowadays produced at a thickness of up to 250 mm, subject to application and required R-value. Previously the Composite (core) sheet was added to the fresh WWCB in the main production line, the modern procedure is completed by gluing the Composite Sheet to a ready WWCB Panel in the Finishing Area.

After forming of the fresh mixture, the boards are initially cured for typically 24 hours (up to 48 hours) in the stacked moulds, before being demoulded. The demoulded boards are automatically stacked onto pallets for further curing in the Second Setting Area for an additional 10-15 days. As a final step, all boards pass through an automatic Board Dryer to bring the moisture content of each board down to the desired approx. 12% (ATRO), which provides the required long-term stability of the board. As a final step each board may pass through a Board Thickness Calibrator and Final Trimming & Profiling Station, before (optionally) being spray-painted in the desired colour. For acoustic ceiling panels, boards (produced as 240/245 cm length) are usually cut into 120 cm length (standard for the European market) and may be provided with a 45 degrees bevel on all 4 sides (such as K-5 or K-11 design) or other profile. The standard in the USA is mainly based on 2' x 2' / 61 x 61 cm. WWCB is produced in accordance with EN 13168 (replacing the former DIN 1101).

The capacity of a modern WWCB Plant is up to 4.300 m^2 boards per shift (based on 25 mm board thickness) with a production line speed of the main line of up to 20 m/min. (resulting in average one board being produced each 7 seconds).

Each WWCB Producer determines whether the line to be operational on either a 1, 2 or even 3 shifts per day basis. Modern WWCB Plants can produce up to 3 million square meters of boards on an annual basis. With the integration of modern electronic control systems, the lines are not only more automated but also provide a more accurate formed board in view of even distribution, constant weight and density, and uniform visual appearance. Only a handful of supervisors are required to operate and supervise such line, supported when needed by direct on-line support from the Eltomation office in Barneveld, The Netherlands.

Figures 27, 28 - Eltomatic CVS-16 Wood Wool Machine

Figure 29 – Dosing and Mixing Group

Figure 30 – Main Forming Line

Figure 31 – Full moulds released from Stacking Press

Figures 32, 33, 34, 35 – Various operations of WWCB production, incl. Demoulding, Board Drying, Final Trimming & Profiling and Packaging.

WOOD STRAND CEMENT BOARD (WSCB – ELTOBOARD)

The production of **medium-density Wood Strand Cement Board** (WSCB – EltoBoard) is accomplished on a standard WWCB Plant to which a special hydraulic EltoBoard Press has been added at the end of the line. The Press will receive a full stack of filled moulds and will compress the fresh wood-cement mat to a much higher density. To ensure and maintain sufficient pressure during initial curing, the pressed stack of full moulds is secured in a so-called Press Package, consisting of a heavy-duty Top- and Bottom Frame, secured by 8 or 10 Tension Arms. The Package is secured under pressure during the initial 24 hours of curing, whereafter the Press Package is again opened in the same EltoBoard Press, to allow further processing, such as demoulding, further curing, final trimming, etc. This extra procedure results in a medium density board with structural strength (bending strength of up to approx. 20 MPa). Board dimensions are typically 60 cm wide and 240-300 cm long. Board thicknesses range from 8 to 25 mm. Producing these medium-density Wood Cement Boards on such WWCB Plant, provides a big advantage to the End-user, by now having the flexibility to produce both low-density WWCB and medium-density Wood Strand Cement Boards on one plant, allowing a wider range of

products from one plant location. Wood Strand Cement Boards are commercially being produced in Russia (OOO STIF) and Japan (Takemura Co.).

Figure 36 - WSCB Plant with EltoBoard Press

Figure 37 - WSCB applied in walls, floors and roof (Takemura, Japan)

LARGE WWC WALL ELEMENT BUILDING SYSTEM

During the last decade, a new revolutionary prefab building system has been developed by the company Träullit AB in Sweden, being one of Eltomation's long-term clients.

Utilising the excellent properties of WWCB in view of thermal insulation, weather-, fire, insect- and rot-resistance, the company decided to produce WWCB in much larger dimensions (referred to as "Large WWC Elements"), enabling fast and efficient prefab construction of homes, schools, offices, etc. These large wall elements are made out of uniform (although lightweight) WWC with dimensions of up to 6 m in length, 2,7 - 3 m in wall height and up to 40 -50 cm thickness, subject to the local climatic conditions.

In addition to the excellent thermal insulation (U = 0,16 W/m^2 ºC at 40 cm wall thickness, based on a lambda of 0,062), these elements also provide a high thermal storage capacity (250 kJ/m^2 ºC), which contributes to excellent living conditions in these homes.

Figure 38 – Collage of Large Element System: Production, Installation and a Finished Large Element House

CONSTRUCTION WITH LARGE WWC WALL ELEMENTS

Due to the low weight of the wall elements, a truck/trailer can be loaded with up to 18 Elements (subject to wall thickness), allowing for very efficient transport. The elements are loaded into open containers, or onto special drop-off frames, which are commonly used in the concrete element business, so the full load can be dropped-off at the building site (and when possible, the empty container/rack is picked- up for return to the plant).

Elements are lifted from the transport frame by a small crane (by making use of the two hoisting straps embedded in each Element). A small team of 3 workers can in this way place all Elements of a typical medium-size one-story house in less than one day.



Figures 39, 40, 41 - Ready Elements are efficiently placed on the ready concrete slab (Träullit, Sweden)

For one- and two-story housing, as commonly applied in Sweden, the Large Wall Element System receives its load-bearing properties by means of the reinforced concrete beams, which are freshly poured on-site, by filling up the U-shaped cavities between 2 Elements. In addition to these vertical “pillars”, each Element is provided with a horizontal running U-shaped groove (“Ring-beam”) at the crest of each Element. Both the vertical cavities and horizontal U-shaped groove are reinforced with steel bars and are cast on-site, spreading the load over the entire structure. The Large Element itself has a load carrying strength of 27 kN per running metre. The full load bearing of the outer wall construction is supported by the reinforced concrete ring beam (which is continuing above the window- and door openings) and the vertical pillars between the Elements.

Figure 42 - Open Ring-beam

Figure 43 - Pouring of concrete

Figure 44 - Anchors in ring beam for floor support

Some of the main technical properties of the Large WWC Wall Element are listed in the Table 1 below, based on the standard 40 cm wall thickness, as applied in most projects executed in Sweden.

Table 1 – Main Technical Specifications of the Large WWC Element (Träullit, Sweden).

Träullit Large Wall Element, Thickness 400 mm **Technical Data**	
U-value	0,16 – 0,19 W/m² K
Fire rating	REI 360 (6 hours)
Heat storage capacity	250 kJ/m² ºC
Critical RH (preliminary tests)	90 %
Air permeability	20 m³/mhPa
Load carrying strength	27 kN per running metre of wall
Density (adjustable, subject to application)	280-360 kg/m³

Although the listed thermal insulation range of U = 0,16 – 0,19 (R = 6,25 – 5,2 m^2K/W) is sufficient for most projects, such as houses, schools, etc. in Sweden, certain applications (such as a so-called "Passive Arctic House Project") may require an even higher thermal insulation. For such projects it will be possible to make the Elements of a thickness of 50 cm and even up to 60 cm. Such 60 cm thick wall will provide for an R-value of up to 10 (which equals US R = 57).

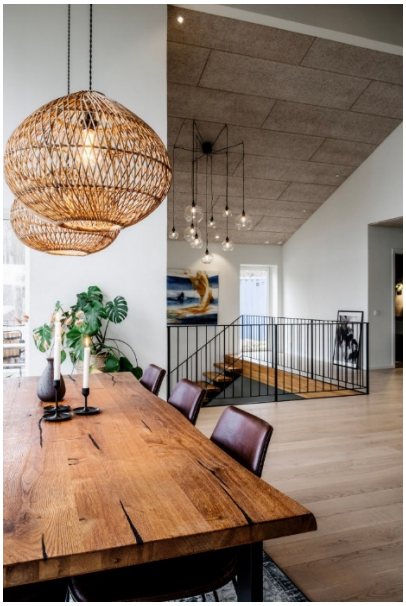
From the Table 1 above, one can see the excellent Heat Storage Capacity (250 kJ/m² ºC) of this material, which may be one of the most important features for a comfortable living condition in the house. The heat of the day is stored in the walls, to only gradually be released during the night. Another figure, which comes to mind is the very high fire-rating of REI 360. Extensive tests have been performed at the SP Technical Research Institute in Sweden, where a test Element was made subject to flames of 1200 degrees Celsius on one side during an extended period of 360 minutes (6 hours) under load. During this period the temperature on the other side of the element only came to 45 degrees Celsius and the overall Element remained intact. After the 6 hours testing period was successfully reached, the load was steadily increased up to 67 kN/m, which only caused initial cracks in the test element.

The various pictures displayed in this paper show the construction of houses, schools, etc. in Sweden, where the Elements are shipped to the building site as cut-to-size Element, however without any base stucco, which is applied only once all Elements are put in place. Also, openings for electrical fittings are afterwards milled into the wall. Eltomation's new fully automated Large Element Line is provided with a CNC Centre, which not only provides the proper sizing of each Element (including cut-outs for window openings, etc.), but will also provide all such openings for cables and piping in the plant, allowing certain components and fittings to be pre-mounted in the factory. As a final step the client may choose to already apply a base stucco in the plant and mount window-frames, where possible.

These additional steps will contribute to a higher efficiency in providing the Elements on full prefab basis, thereby further reducing labour on the building site and an overall quicker delivery of the finished house.




Figures 45, 46, 47, 48 - two-story villa under construction (Träullit, Sweden) ….

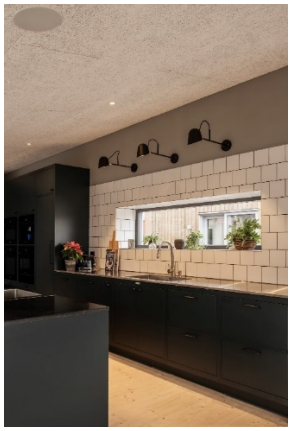



Figures 49, 50 – …. resulting in a comfortable (emission-free) and energy-saving living environment




Figures 51, 52, 53, 54 – Construction of a highly insulated day-care centre in Sweden, utilising Large Elements for the outer walls and Reinforced Roofing Boards for the roof (Träullit, Sweden)





Figures 55, 56, 57 – Construction of a modern villa in Torslanda, Sweden, utilising Large WWC Wall Elements



Figures 58, 59, 60 – Affordable & Sustainable Housing for Africa (and other regions worldwide)

PRODUCTION LINE FOR LARGE WWC WALL ELEMENTS

During the first years of production of the large WWC Wall Elements, Träullit, Sweden has further optimised its product using semi-automated production facilities for forming, demoulding, storage, cutting/finishing, etc. In order to meet the demand for a fully automated production of these Large Elements at considerably higher plant capacity, Eltomation has in recent years developed a production line for the fully automated production of such Large WWC Elements at high capacity and reduced labour requirements.

Figures 61, 62 - Impression fully automated Large WWC Element Line

The first such fully automated Large Element Line, was supplied to a client in Jiangsu Province, PR of China. Plant capacities of such Large Element Line are up to 24-30 Elements per shift (subject to wall thickness), allowing construction of up to 1500 housing units per year (subject to size and design).

Typical dimensions for these large elements are 6 m length x 2,8 m wall height. The wall thickness will standard be based on 30 - 50 cm, subject to the climatic conditions. Per each plant location and intended range of applications, the maximum wall thickness will be optimised (say up to 30 cm for a potential project in central Africa and up to 50 cm for a project in Northern Europe). Also, the maximum wall height will be optimised to the local market demand (typically ranging from 2,7 to 3,0 m). To secure a flexible production range, the Large Element Line can produce various wall thicknesses, which can be secured by laying in a dummy-bottom plate in the large form. For example, by adding a 15 cm dummy bottom in a 40 cm high form, also Elements of 25 cm thickness can be produced on the same line.

The fresh mat of material is formed continuously in the slow-moving large forms, which pass underneath the Double Forming Station in an uninterrupted flow. Each Element is formed in 2 subsequent layers (say of 20 cm thickness each), allowing the line to have hoisting straps or reinforcements to be inserted in between the 2 fresh layers of wood-cement mixture material. The continuous mat is hereafter cut into the desired (6 m) lengths by the separating saw, which moves at the same speed of the forms, while making the cut between 2 forms. The individual full forms are stacked for initial curing of the fresh mixture in the forms for approx. 48 hours. After this curing period the cured Element is released from the Form by means of a hydraulic Turning Table, where each empty form is returned to the Forming Line. The Element is transferred to a CNC Milling & Cutting Station to be processed to the proper dimensions, including creating openings for window frames, electrical conduits, etc. As a final step, the Producer may apply a base stucco/plaster to both sides of the ready Elements and may already insert the window frames. These steps contribute to an efficient Prefab Building technology, greatly reducing the on-site activities and virtually eliminating on-site construction waste. This results in a very fast construction time, which benefits not only the contractor but also the new homeowner.

Figure 63 - Finished Element from CNC operation

Figure 64 – Elements ready for shipment to the site

The capacity of the Large Wall Element Production Line is designed to be approx. 500 m^3 of finished product per day (based on a 3-shift production). For typical 40 cm thick Wall Elements, this results in a capacity of up to 23 Elements per shift (subject to complexity), allowing a capacity of Elements for up to 1500 housing units per year. For the market for Affordable & Sustainable Housing Units for countries in e.g. Africa, based on a typical 25-30 cm wall thickness and say 55-60 m^2 single story housing unit, such Large Element Line may have an output of Wall Elements for up to 2500 housing units per year. Such Large Element Line may be supported by a Wood Wool Cement Board (WWCB) Plant, to produce all partitioning walls (typically 100 mm thickness), Reinforced Roofing Boards (typically 75 mm thickness) and optional acoustic ceiling panels. When combined, a Large Element Line and WWCB Plant will allow all main building materials to come from one plant location, utilising the local available small diameter wood.

Other interesting markets for the prefab Large Elements are currently being developed, such as for Sound Barriers along highways and railroad tracks.

DURABILITY AND SUSTAINABILITY

WWCB, WSCB and Large WWC Elements are produced from only natural materials, such as FSC-certified small diameter Spruce (optionally Pine or Poplar), mixed with Portland Cement (OPC). To this mixture water and a small percentage of salt-solution is added for the proper binding. To reduce the cement content up to 20-30% of Limestone can be added.

Both scientific tests, initiated by customers of Eltomation, as well as open air application of WWCB have shown that WWCB is unaffected by over 70 years of open-air exposure to the elements (even in countries with a high number of freeze-thaw cycles, such as in Sweden). This property is further improved when the WWCB is stuccoed, as is customary done for external applications where the material is exposed to the elements.

At the end of its life cycle the WWC material can be fully recycled. The leading WWCB producer Troldtekt, Denmark has already obtained a Cradle-to-Cradle Gold Certificate for its WWCB production process. Recently a program has started to have all offcuts and trimming waste from production be ground to form basic ingredients, which are returned to the local cement producer. During incineration in the cement kiln, the wood content in the WWCB waste product replaces fossil fuels, while the cement acts as raw material. This process greatly reduces the CO_2 emissions. Another project which has recently started is to return the waste material to nature as composting material / soil improvement. Further developments on both the technical cycle and biological cycle will contribute to complete the full Cradle-to-Cradle concept.

In Denmark, the ongoing cooperation with the cement supplier has led to application of a new cement type (called “FUTURECEM”) with a 30 percent lower CO_2 footprint, which in combination with the CO_2 embedded in the wood wool, results in an overall “negative carbon footprint” during production of WWCB. This new development has been received very well onto the market, with high recognitions, such as the Green Product

Award 2022, the Danish Building Industry Climate Award 2022 and recently the Materialpreis 2022 (source Troldtekt, Denmark).

In general, WWCB meets the most stringent international environmental norms and certifications, supported by the certifications from renowned institutes, such as the Danish Indoor Climate Labelling, the Finnish M1 Low-Emission Classification, UK's 'Allergy Friendly Product Award', the German ‘Sustainable Building Council non-profit (DGNB)’, the German labelled ‘Blauer Engel’ and other certificates.

CONCLUSION

Although Wood Wool Cement Boards (WWCB) have been on the European market for some 100 years, it has seen a sharp increase in sales and applications over the last decade, with production volumes exceeding 20 million square meters annually. Supporting reasons for this re-birth of WWCB are the steadily increasing volumes for decorative acoustic ceiling panels with fine-fiber boards, produced with white cement. Leading countries in this field are Denmark, Germany, Sweden and The Netherlands. Another specific sector seeing an increased demand is the Agro-sector where special lightweight WWCB is applied in (pig) stables to act as a filter for the clean air flow through the ceiling in such stables. Producers in countries such as Austria and Germany also benefit from the market increase for fire-resistant applications in (indoor) parking garages, where new European fire-safety norms apply. In addition, new markets for fully automated WWCB Plants have in recent years been developed in countries such as Russia and China, where consumers, architects and builders have discovered the benefits of this sustainable and energy-saving product in a wide range of applications. As a result of the above, Eltomation BV, The Netherlands has further developed its range of semi-automatic and fully automatic plants for the production of various types of Wood Cement Products, to meet this market demand. In general, the Wood Cement Products described in this paper, although being a niche product in the huge building materials market, have a bright future ahead.

ACKNOWLEDGEMENT

The author wishes to express his gratitude to the management of Troldtekt A/S, Denmark, Träullit AB, Sweden and CEWOOD, Latvia for the technical data provided and the courtesy of making use of some of the pictures used in this paper. Additional pictures of WWCB applications are courtesy of Knauf Insulation, Celenit, Italy and Takemura, Japan. Additional information on applications as well as technical and environmental data (incl. Environmental Product Declarations – EPD’s) can be found on the websites of these WWCB producers.

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