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CEMENT BONDED PARTICLE BOARD (CBPB) AND WOOD STRAND CEMENT BOARD (ELTOBOARD): PRODUCTION, PROPERTIES AND APPLICATIONS

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ABSTRACT

This paper reports the production of 120-125 cm, respectively 4' wide Cement Bonded Particle Board (CBPB) and the new Wood Strand Cement Board (EltoBoard) on one combined Eltomation production plant.

Such a plant has two material preparation sections and two different distributing stations but uses the same steel cauls and all other available CBPB equipment for the production of both products. This enables the manufacturer to produce two complimentary products on one plant. The high dense CBPB (1250-1400 kg/m³) has a higher fire resistance and EltoBoard of approximately 1100 kg/m³ is better nailable and screwable and has a higher bending strength.

Major differences in the properties and typical applications of both products will be discussed. Also the production and advantages of boards for which combinations of the two raw materials are used, will be explained.

KEYWORDS:

Eltomation; EltoBoard; Wood Strand Cement Board; Cement Bonded Particle Board; CBPB-EltoBoard plant



Figure 1

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INTRODUCTION

Eltomation BV in Voorthuizen, The Netherlands, is specialized in the development and supply of turnkey plants and equipment for the production of various wood cement products such as Wood Wool Cement Board (WWCB), Wood Strand Cement Board (EltoBoard) and Cement Bonded Particle Board (CBPB).

The first Cement Bonded Particle Board was produced around 1970 by the Company Durisol in Switzerland. The boards were called Duripanel.

Soon after start-up of the first CBPB production plant approximately 40 more plants were built and put in production worldwide. About 50 % of them in the former Soviet Union. This rapid spread was partly caused by the market looking at that time for replacement sheet materials for asbestos boards. However, CBPB has not exactly the same characteristics as asbestos sheets and therefore the manufacturers had to find also other markets.

Some companies in Western Europe, the USA, Mexico and Russia, which did not find other markets in time, had to sell or close down their plants. But presently, after having found and developed such markets and also due to the improved economy, several of the remaining factories can hardly meet the high demand. Most of the European CBPB producers, and some in Russia, now run three or four shifts per day and some also during the weekends, but the European producers still cannot produce enough to maintain also their export to the USA. Therefore some do have to import a considerable amount of boards from Russia, which in turn causes a greater shortage of boards in that country.

PRODUCTION OF CEMENT BONDED PARTICLE BOARD (CBPB)

For the production of CBPB two in principle different systems are in use, which determine the build-up of the boards produced:

- I The Bison System produces three or four layer boards having two layers of fine particles at the surfaces and one or two thicker layers of course particles in between.
- II The Eltomation System produces boards with fine particles at the surface changing gradually to course particles in the middle and to again fine particles at the other surface.

This difference in systems has mainly an influence on the mixing and distributing processes. In Bison plants the two layers with fine particles for the two surfaces are distributed by means of air flows and the core by means of mechanical distribution.

Eltomation plants distribute, with two opposite to each other placed mechanical distributing machines, a mixture of fine and course particles but separates the particles during the distribution process into fine particles for the surfaces and gradually more course particles in the centre of the board. These differences have also an influence on the raw material preparation.

The Bison System uses two mixers for the preparation of two separate mixtures of fine and course particles and keeps them apart for the allocated distributing machines.

Eltomation uses only one large mixer, figure 3, in which determined portions of course and fine particles (and the cement, water and chemicals) are dosed and mixed.

To produce the fine and course particles there are a number of somewhat different systems in use. Some producers buy paper mill chips at the market and than refine and separate them with hammer mills or knife ring flakers, refiners and screens. Other board producers produce the chips themselves from wood logs, e.g. by using a drum flaker and refiners, etc.

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Eltomation Cement Bonded Particle Board Plant

Simplified Flow-chart

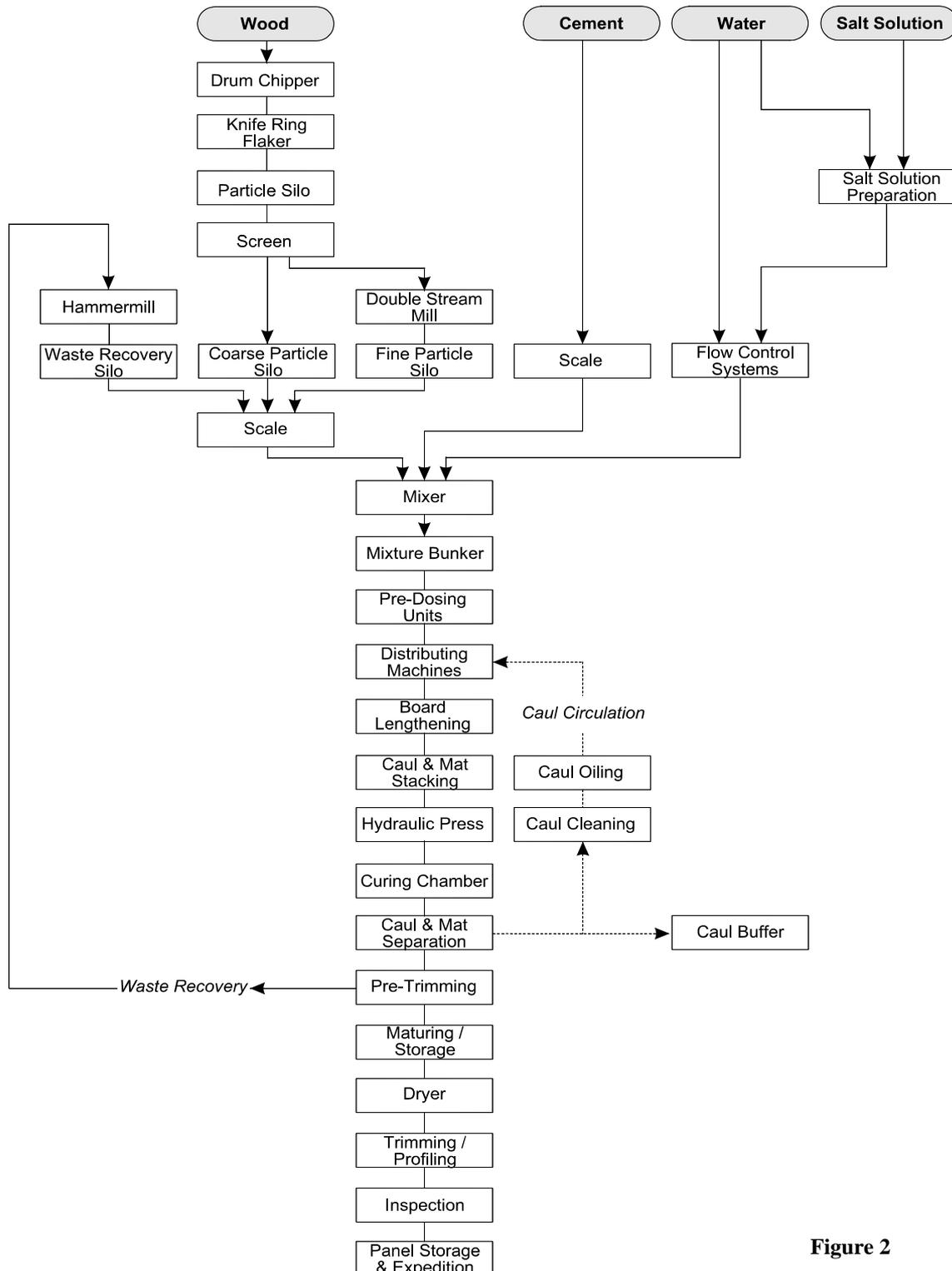


Figure 2

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As soon as a charge of mixture is ready in the mixer, figure 3, it is discharged in a bunker underneath shown in figure 4 from which it is dosed onto an inclined conveyor toward the distributing machines. At the top centre of figure 1 the end of the inclined conveyor is visible.



Figure 3



Figure 4



Figure 5

The Eltomation distributing machines are shown in figure 1 and the further process follows from a simplified Flow-chart, figure 2 and some pictures. By the first distributing machine (in the middle of picture 1 at the right hand side) first the very fines and gradually more coarse particles are distributed onto the cauls. The second identical distributing machine is placed in an opposite position by which also the top receives very fine particles. This assures the generally wanted smooth surfaces of the boards, see the cross section in figure 5. The fresh board separator in figure 6 removes some fresh material from both ends of the

steel caul into the hopper at the right, which fresh material is transported back to the mixing department. Than the caul with the fresh board passes through the fresh board lengthening machine shown in figure 7.



Figure 6



Figure 7

In case shorter boards have to be produced, the board lengthening machine takes a certain amount of fresh material from both ends of the caul which material is also transported back to the mixing department. Thereafter the caul with fresh boards moves over the electronic weighing station, figure 8, to check the weight of the fresh mat, (the weight of the caul which is put in the memory of the computer just before entering the distributing machine, is subtracted to exactly determine the weight of the fresh mat), compare it with the set value and moves on to the stacker and bundle press. This weight checking is important to prevent the production of any board out of weight tolerance e.g. during changing the thickness of the boards without interruption of the flows of materials and cauls.

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Figure 8

The material of such out of tolerance fresh boards is dumped in the hopper with a screw conveyor shown at the left beside the machine and is also reused again. All this returned fresh board material is collected in a hopper in the mixing department and in constant portions dosed into the mixer to maintain a constant mix. Since recently also all other waste of trimmings and cuttings and from tongue and grooving, etc. is reprocessed and in a controlled way blended with the fresh mix without having a measurable negative effect on the quality of the boards. This saves the very high costs for dumping at the city dump.

After the weight check the cauls with fresh boards move to the caul stacker which is visible in the middle of figure 9. In the centre of this picture the lower part of a new stack of cauls with fresh boards is already visible. As soon as the stack in the press is pressed and bundled between the heavy top- and bottom frames, it will be released and moved out onto the cross conveyor on the in-floor rails and moved into the curing chamber at the far left. A stack of cured boards coming out of the curing chamber is placed in the press for de-clamping. The heavy top with arms stays in the press to be used for the next stack and the heavy bottom with cured boards is placed onto the heavy roller conveyor at the right, moving the bottom plus stack to the stripping machine which is shown in figure 10.



Figure 9



Figure 10

The picture of the stripping machine on figure 10 is taken from the opposite side of picture 9. In this machine the cured boards are removed from the cauls, pre-trimmed and stacked on pallets for further curing during several days. Only thereafter they are dried in the drying tunnel. The empty steel cauls are cleaned and oiled and moved from the stripping machine to the distributing machines again. The unloading section of the drying tunnel and the final trimming department for the boards are shown at the right and in the centre of figure 11. On this picture at far left also the bundle press is visible.



Figure 11

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APPLICATIONS OF CEMENT BONDED PARTICLE BOARD

Successful new applications in Western Europe, different from that of asbestos boards, are amongst others:

- Flooring with tongue and grooved boards;
- Large size prefabricated elements for permanent shuttering of concrete walls and floors
- The production of complete prefabricated houses.

Depending on cultures and building codes, the developments in the market since 1970 for CBPB are very different in various countries, which is also depending on price and quality of the boards. Amroc in Magdeburg, Germany, which company has Eltomation mixing, dosing and distributing equipment for narrow thickness tolerances, recently reported the distribution of their high standard CBPB Class B1 and high fire resistant boards Class A2 in Western Europe as follows:

Approximate distribution for the following applications:

- 15% - (raised) Floors
- 20% - Office containers, influenced by new governmental fire and moisture regulations
- 15% - Supply to prefabricated house manufacturers
- 25% - Various supplies to the industry, amongst others for kitchens, bathrooms and furniture.
- 5% - Facades
- 20% - Various, including high fire resistant Class A2 boards.

A fast expanding application in Western Europe and Russia is for prefabrication of large elements for permanent shuttering of concrete walls as licenced by the company VST GROUP in Vienna, Austria. See reference (2). For the assembly of the elements VST uses spacers of steel, and for a similar system, the DUO-MASSIV system, spacers of strong plastic are used. In the factory the elements are already provided with all openings, reinforcing, tubing and piping. At the building site the wall and floor elements are filled with concrete of local ready mix suppliers. For the assembly of DUO-MASSIV elements, Eltomation supplies automatic equipment.



Figure 12



Figure 13

Figure 12 shows the installation of large size prefab wall elements and picture 13 shows the installation of prefabricated floor elements in Austria for very fast and efficient construction work. Of this building the three men shown installed and concreted a complete storey of that multi storey apartment building every week. The man at the far distance operated the crane by remote control with one hand and helped to position the wall and floor elements with the other hand. The concrete for the floors was poured on each Friday and the next wall started to be installed the next Monday. In the middle of the week the electricians and pipe fitters came along to take care of their work.

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Figure 14



Figure 15

In figure 14 nearly completed DUO-MASSIV apartment buildings are shown. At the apartment building at the front some of the Polystyrene sheets for insulation at the exterior of the wall can be seen. After installing the insulation, a thin layer of stucco will be sprayed on. Picture 15 shows a DUO-MASSIV luxury hotel near Munich in the south of Germany.



Figure 16



Figure 17

MAJOR APPLICATIONS IN JAPAN

Although the first CBPB products and the production plants have been developed in Western Europe, we must admit that with further developments and perfections of the boards, the Japanese producers are ahead with certain special products and applications. Specially in view of perfections of sophisticated embossed and painted CBPB for exterior cladding of homes and other buildings. Figure 16 shows one of the hundred thousands of houses built in Japan, cladded with in various colours painted embossed panels. Figure 17 shows a similar apartment with multi coloured embossed panels. This application for cladding was strongly supported by the new regulations of the Japanese government after the big fires following the earthquakes in large cities as Kobe, which fires were partly caused by the fierce burning of the former wooden claddings.

Also accidents on a much smaller scale such as the fires at the airports in Düsseldorf and the recent one at Schiphol Airport in Amsterdam, increased the demand for fire resistant CBPB. As an example for the new airport building in Zürich, Amroc of Germany supplied approximately 10.000 m² of their special fire resistant CBPB Class A2. These A2 boards are coloured red for the use in walls and doors and grey for the (raised) floors. Similar effects can be expected from tsunamies and hurricanes like Katrina, where the fire- and moisture resistance of CBPB open new markets. However in the generally conservative construction industry these changes toward fire- and moisture resistant building materials are slow and take years.

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PRODUCTION OF WOOD STRAND CEMENT BOARD – ELTOBOARD

For the production and applications of 2' wide EltoBoard in moulds of plywood on a WWCB-EltoBoard plant, I refer to reference (4). I will explain the production of 4' wide EltoBoard and CBPB on a combined 4' CBPB-EltoBoard plant, using cauls of steel. For densities above approximately 1100 kg/m³, as needed for the production of CBPB, the needed pressure goes up steeply. Therefore cauls of steel are needed which cauls in this case are also used for the production of EltoBoard.

Due to the use of long thin strands of wood, EltoBoard has a much higher bending strength and flexibility than CBPB. Already at a density of 1100 kg/m³ EltoBoard has double the bending strength of CBPB with a density of 1250-1400 kg/m³. Due to the fact that the wood strands are cut parallel to the grain of the wood and that the position of the strands in the boards are in nearly all cases parallel to the plane, also screws hold approximately 2 times better against pull out forces than screws in the denser CBPB with the particles in random positions. Further due to the lower density, EltoBoard can be produced at considerable lower costs and is better machinable, nailable and screwable than CBPB.

In view of 20% less raw materials needed for EltoBoard and the higher flexibility and higher strength, Eltomation decided to modify existing CBPB plants for the production of also 120-125 cm, respectively 4', wide EltoBoard. The required extra equipment will be limited to an Eltomatic CVS-16 Wood Wool / Wood Strand Shredding Machine, a continuous Wood Strand Cement Dosing and Mixing plant and an Eltomation Wood Strand Distributing Machine with the appropriate controls. Further for separation of the distributed and pre-pressed Wood Strand Cement mat, an Eltomation flying saw will be needed to "cut" the mat at the end of the cauls in stead of scraping off sideways the CBPB particles. Thereafter all other existing CBPB equipment can be used for the production of also EltoBoard.

In case of adapting existing CBPB plants for the production of also EltoBoard, the usually two sets of CBPB distributing machines will be split in two. Section 2 will mainly stay in position but section 1 will be placed several meters upstream to make room for a single or double Eltomation Wood Strand Distributing Machine. For the production of the strands and the preparation of the Wood Strand Cement mixture, see reference (4). After installation of the EltoBoard production equipment, the steel cauls move underneath respectively the following distribution machines:

- a. The first CBPB distributing machine
- b. The one or two Wood Strand Cement Board-EltoBoard distributing machines.
- c. The second CBPB distributing machine.

By having also counter embossed cauls of steel available, the producer has the option to produce the following types of boards:

- I: Standard CBPB, by not using the EltoBoard raw material preparation section and its distributing machines;
- II: Standard EltoBoard, by not using the CBPB raw material distributing stations;
- III: EltoBoard with or without one or two smooth surfaces of CBPB fine particles;
- IV: Various types of embossed CBPB with smooth surfaces.
- V. Various types of embossed EltoBoard with one or two smooth surfaces by applying one or two layers of CBPB consisting of only fine wood particles and cement.

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Figure 18



Figure 19

Figure 18 shows the flexibility and strength of EltoBoard and figure 19 an application of natural EltoBoard in the Philippines. For more examples of applications of EltoBoard I refer to reference (4).

Test results of Wood Strand Cement Board – EltoBoard

In 2005 EltoBoard has officially been tested at the Moscow State Forestry University in Russia. Since there are no test procedures established yet for testing the new EltoBoard, the tests were executed according to the procedures of the GOST Norms, see reference (5), for CBPB. These Norms in Russia are closely related to the testing procedures for the DIN and CEN norms for CBPB in Western Europe, see reference (6).

Table 1

	Parameter	GOST Norm	Norms for: CBPB1 and CBPB2	Tests of EltoBoard Average:
1	Density, kg/m ³	GOST 26816-86	1100 and 1400	1130
2	Humidity, %	GOST 26816-86	6-12	10,46
3	Bending strength, Mpa for 10 mm thickness, at least	GOST 26816-86	9.0 and 12.0	20.31
4	Hardness, Mpa	GOST 11843-76	45 and 65	42.6
5	Impact strength Dzh/m ²	GOST 11842-76	1800	1720
6	Screw pulling force N/m	GOST 10637-78	40 and 70	76.83
7	Therm. Conductivity W/(m*K)		0.26	0.21
8	Frost resistance (decrease of strength not more than ...%)	GOST 8747-88	10	1.7

Copies of the complete test reports are available upon request from Eltomation.

Remarks re the points:

2. A separate test at the IKOB Building Materials Institute in Holland confirmed a shrinkage in length and width directions of only 1.23 mm/m (1,23 ‰) from fully saturated condition to reconditioned in air of 85% RH at 20 °C.
3. The high elasticity and bending strength of up to 30 Mpa for EltoBoard are due to the use of long, wide and thin strands of wood and the orientation parallel to the plane of the board during distribution and pressing.

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General remarks:

- Due to the higher strength and the low swelling characteristic in longitudinal and width directions, it is expected that EltoBoard will replace CBPB in the near future mainly for flooring and permanent shuttering as well as for longer planks and embossed and larger painted panels for wall claddings.
- We quote Mr. Terry Brady, having a Master degree in Wood Science in Alaska (USA), re his practical tests on EltoBoard:

“The results were very impressive. The samples were virtually indestructible under ordinary severe environmental conditions (snow, rain, wind, freeze, solar UV, boiling, and exposure to flame). Only prolonged hot flame broke down the samples. Otherwise there was no dimensional change, no soaking up moisture, and no insect or fungal degradation.”

CONCLUSION

After a difficult time to develop the right applications and the markets for the product, CBPB is now produced on large scale in Western Europe, Russia and Japan. The later developed Wood Strand Cement Board (EltoBoard) of lower density than CBPB but of higher strength, can also be produced on these plants. For adaptation of an existing CBPB plant to a CBPB-EltoBoard plant only some extra equipment, at relatively low extra costs, has to be installed making it possible to produce two types of boards.

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- (6) EN-634 (-1 and -2) to be applied at quotes@bsi-sales.com or www.global.ihs.com.