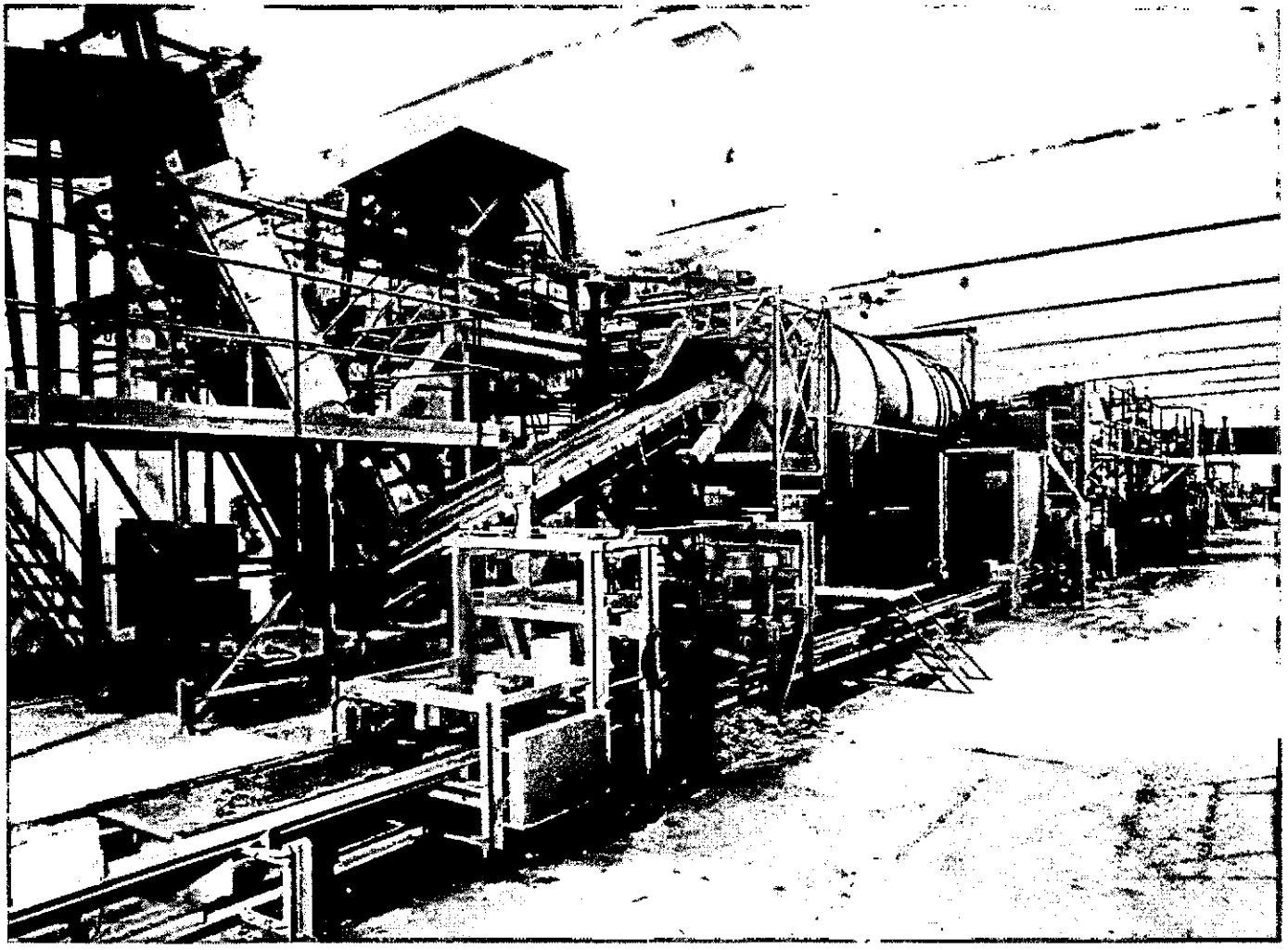
ELTEN PLANTS FOR MINERAL BONDED BUILDING BOARDS

ELTEN ANLAGEN FÜR MINERAL GEBUNDENE BAUPLATTEN



Automatic ELTEN production line for wood wool cement boards.

Automatische ELTEN-Produktionslinie für Leichtbauplatten.

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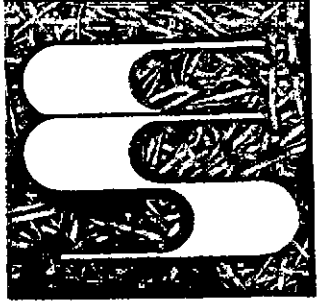


Complete plants available from manually operated till fully automatic, deliverable in capacities of 35 to 150 m^3 per shift.

Komplette Anlagen in Ausführungen von handbedient bis vollautomatisch, lieferbar in Leistungen von 35 bis 150 m^3 pro Schicht.

FURTHER PROGRAM

Apart from the plants for the production of wood wool building boards we can also supply:

PLANTS FOR THE PRODUCTION OF:

* cement bonded low density chip boards
* cement bonded high density particle boards
* cement/wood building elements including flooring, roofing and walling
* gypsum bonded particle boards

For further information on these special plants, please contact us.

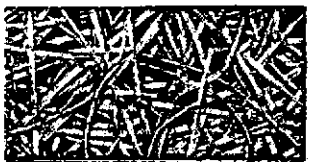
WEITERES PROGRAMM

Neben Anlagen zur Herstellung von cement zementgebundenen Holzwolle-Leichtbauplatten können wir auch liefern:

ANLAGEN ZUR HERSTELLUNG VON:

* zementgebundenen Holzspanplatten in Volumengewichte von 500 bis 1250 kg/m3
* Bauplatten aus Holz und Zement für Boden-, Dach- oder Wandkonstruktionen
* gipsgebundenen Holzspanplatten

Für weitere Informationen über diese Spezial-Anlagen, bitte Schreiben Sie uns.



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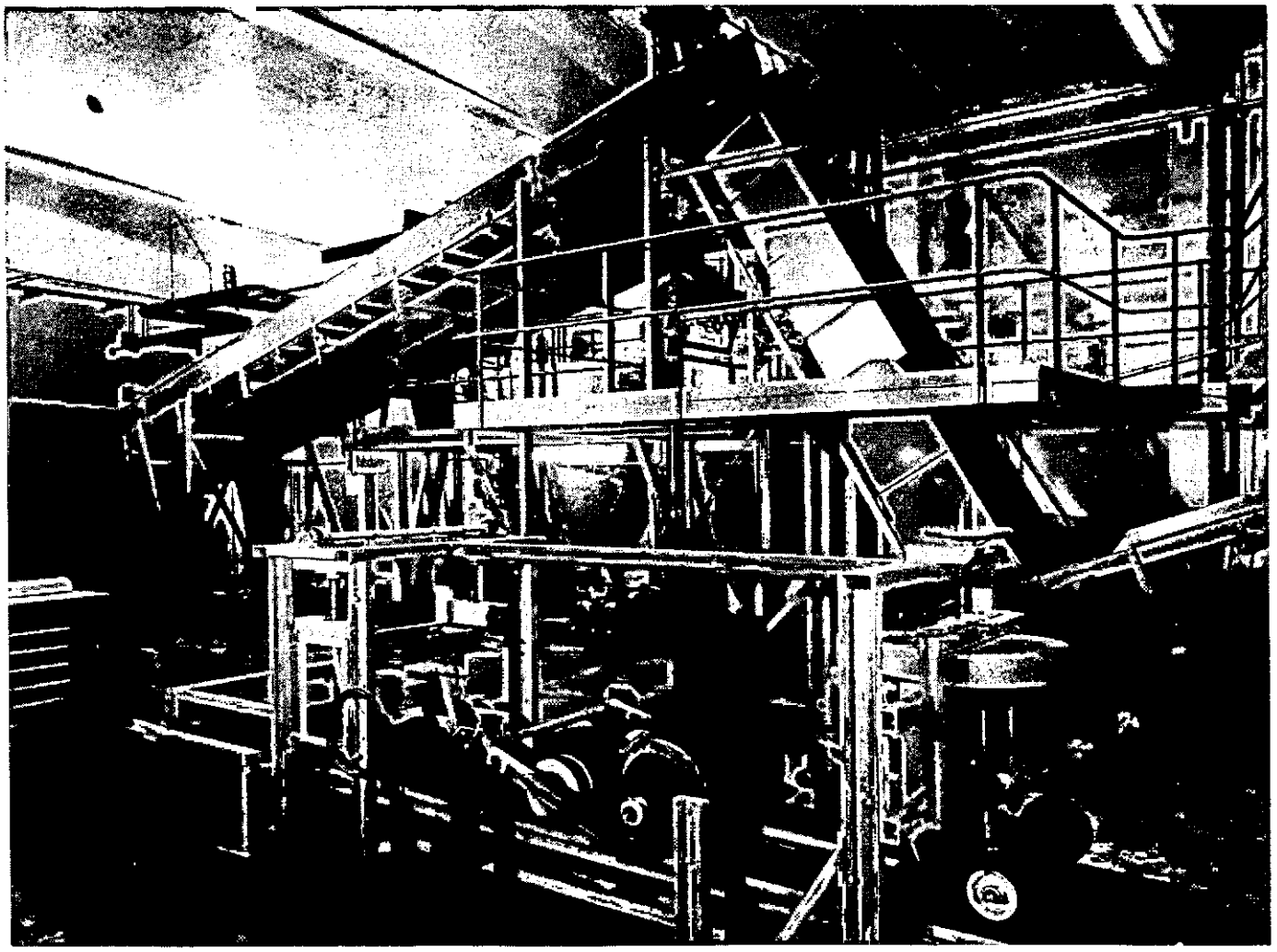
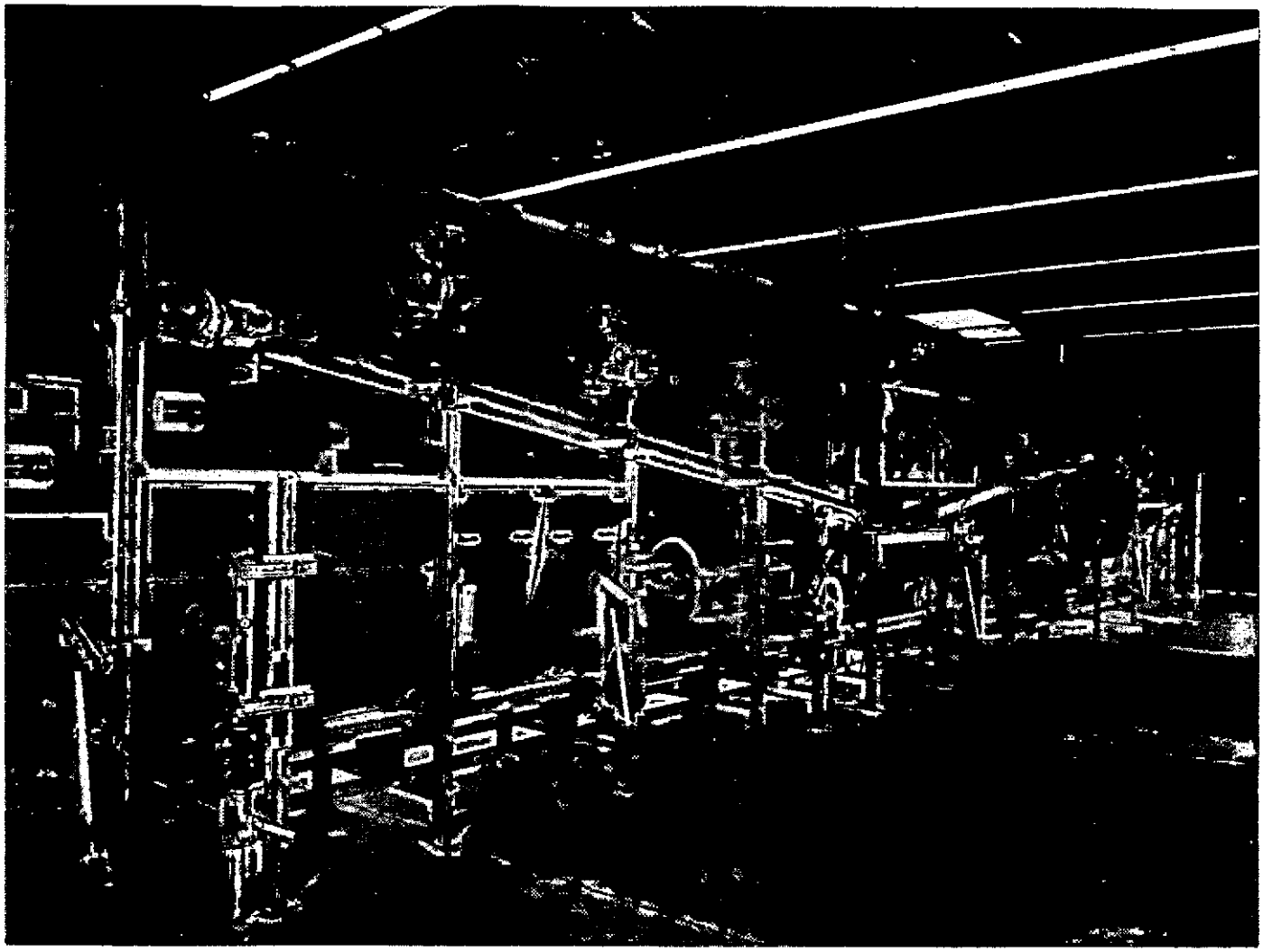
In background wood wool conveyor with wood wool batch weigher and chemical solution preparation unit; in front mould cleaning equipment.

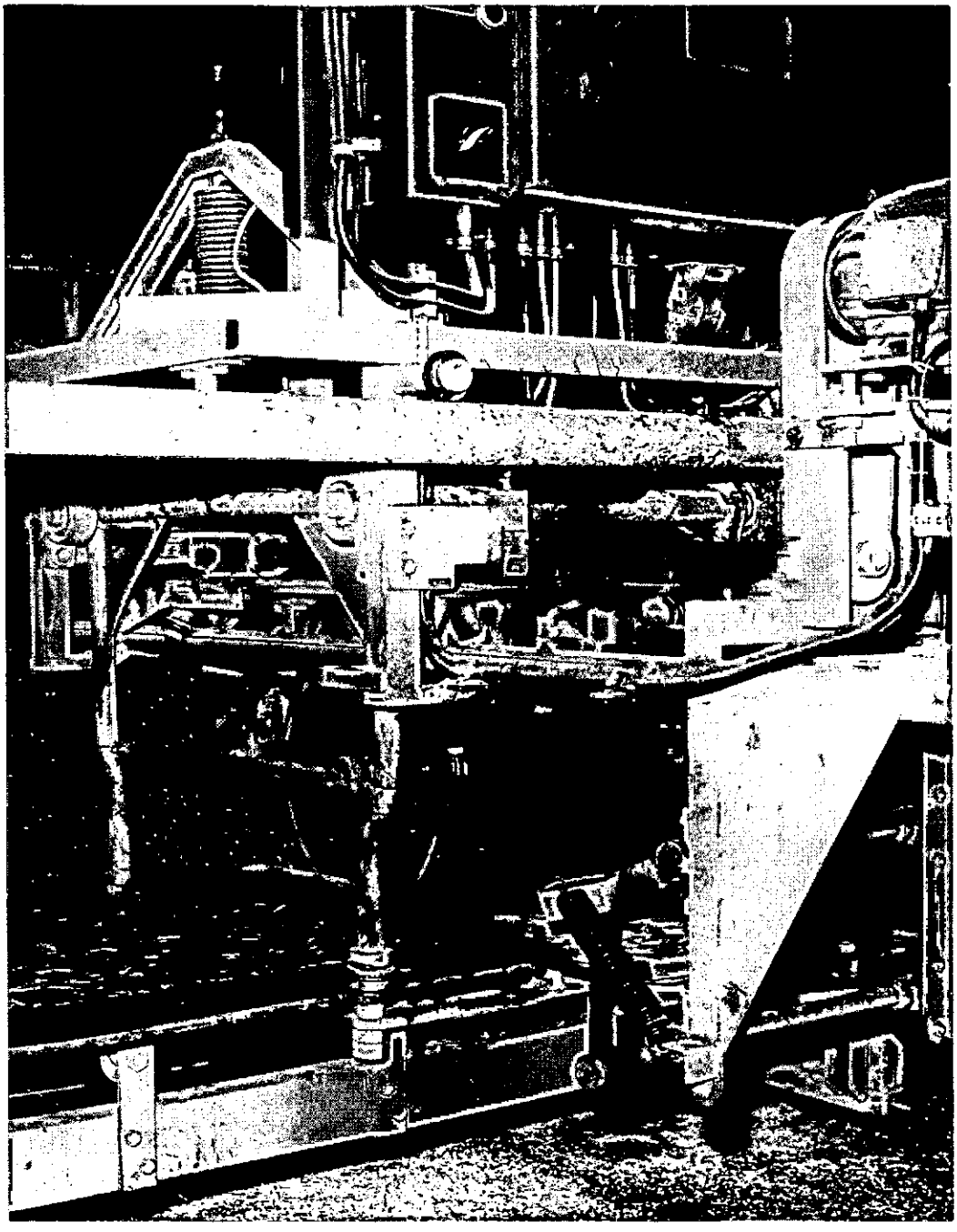


Im Hintergrund Holzwolleförderband mit Holzwollewaage und Salzaufbereitungsanlage; im Vordergrund Formenreinigungssystem mit Einölung.



View of the distribution machine with two spreading units for the manufacture of multi-layer sandwich boards.

Blick auf die Einlegemaschine mit zwei Einstreustationen für die Herstellung von Mehrschicht-Sandwichplatten.

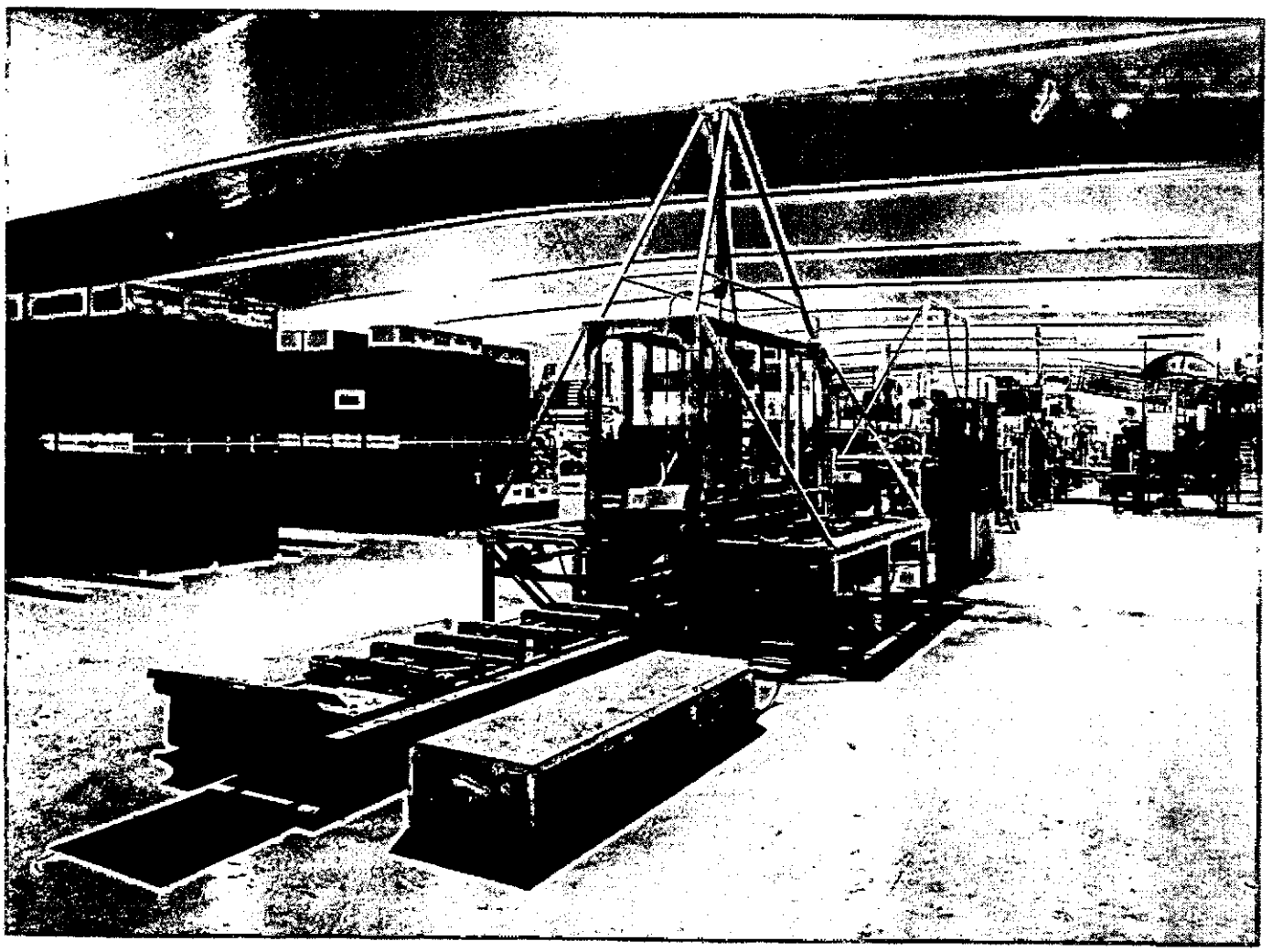


Cross-cutting separating saw with centering arms in the recesses of the moulds.

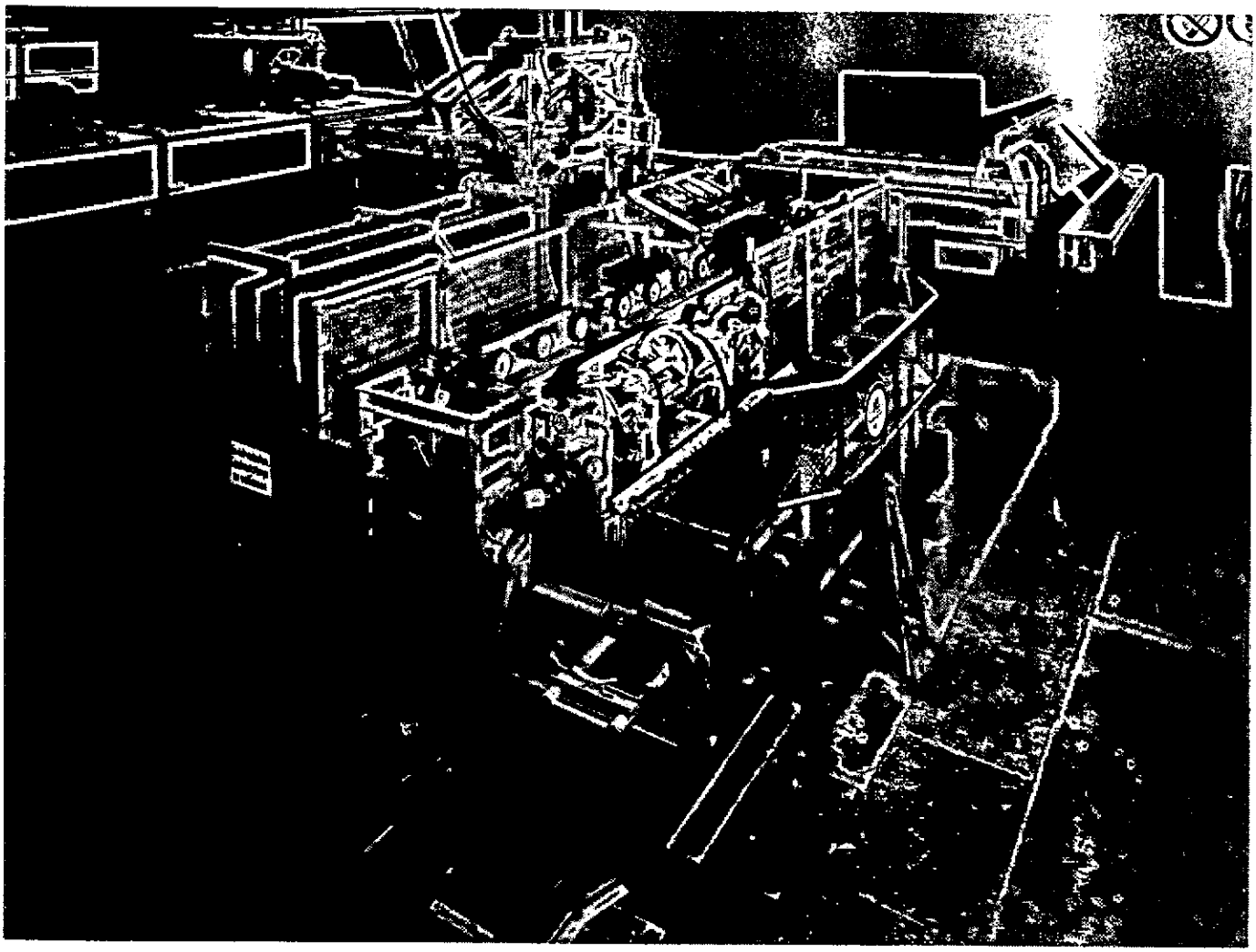
Mitlaufende Trennsäge mit Einrastarmen in den Aussparungen der Formen.

Automatic piling press;
on the left, first setting
area with concrete weights
on top of the piles.

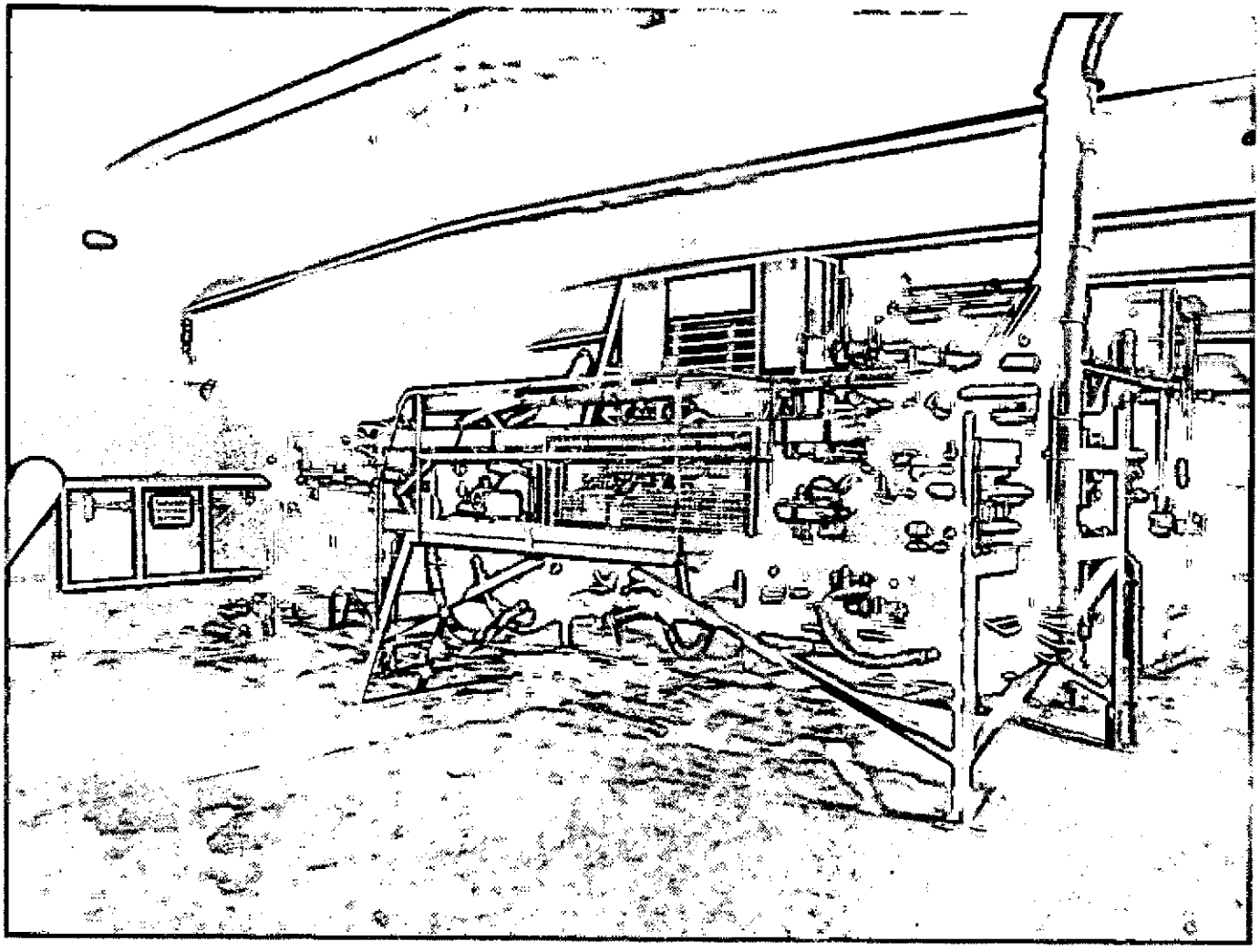
Automatische Stapelpresse;
links, erste Abbindungs-
platz mit Betongewichten
auf den Stapeln.



Automatic mould stripping machine with in front the mould supplier.



Automatische Formenausschalmaschine mit im Vordergrund die Formenabgabemaschine.

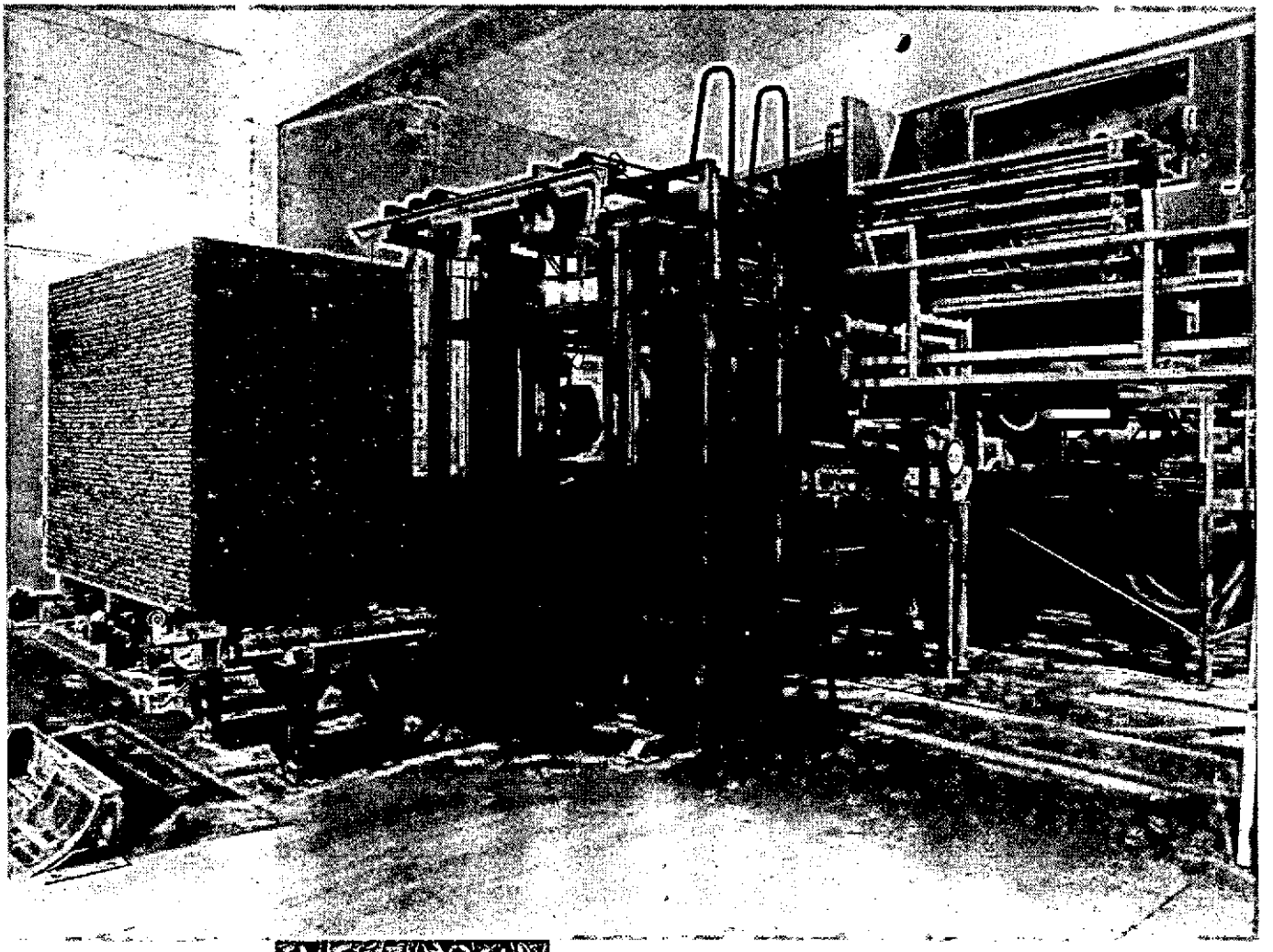


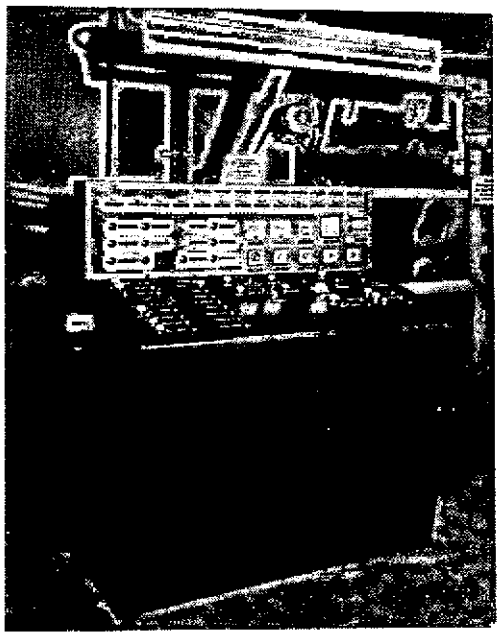
Edge dressing machine
with exhausting unit.

Besäumsäge mit
Absaugungsanlage.

Board piling machine with piles of ready boards on pallets;
top right, automatic pallet feeder.

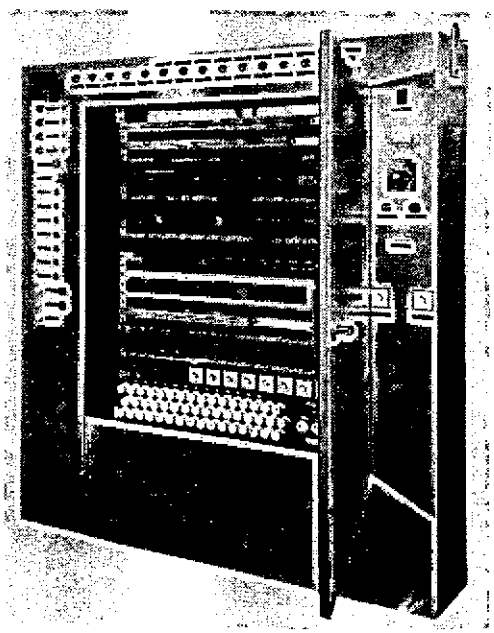
Plattenstapelautomat mit Stapeln fertigen Platten auf Paletten;
oben rechts, automatische Palettenabgabemaschine.





Control desk.

Schalt-pult.

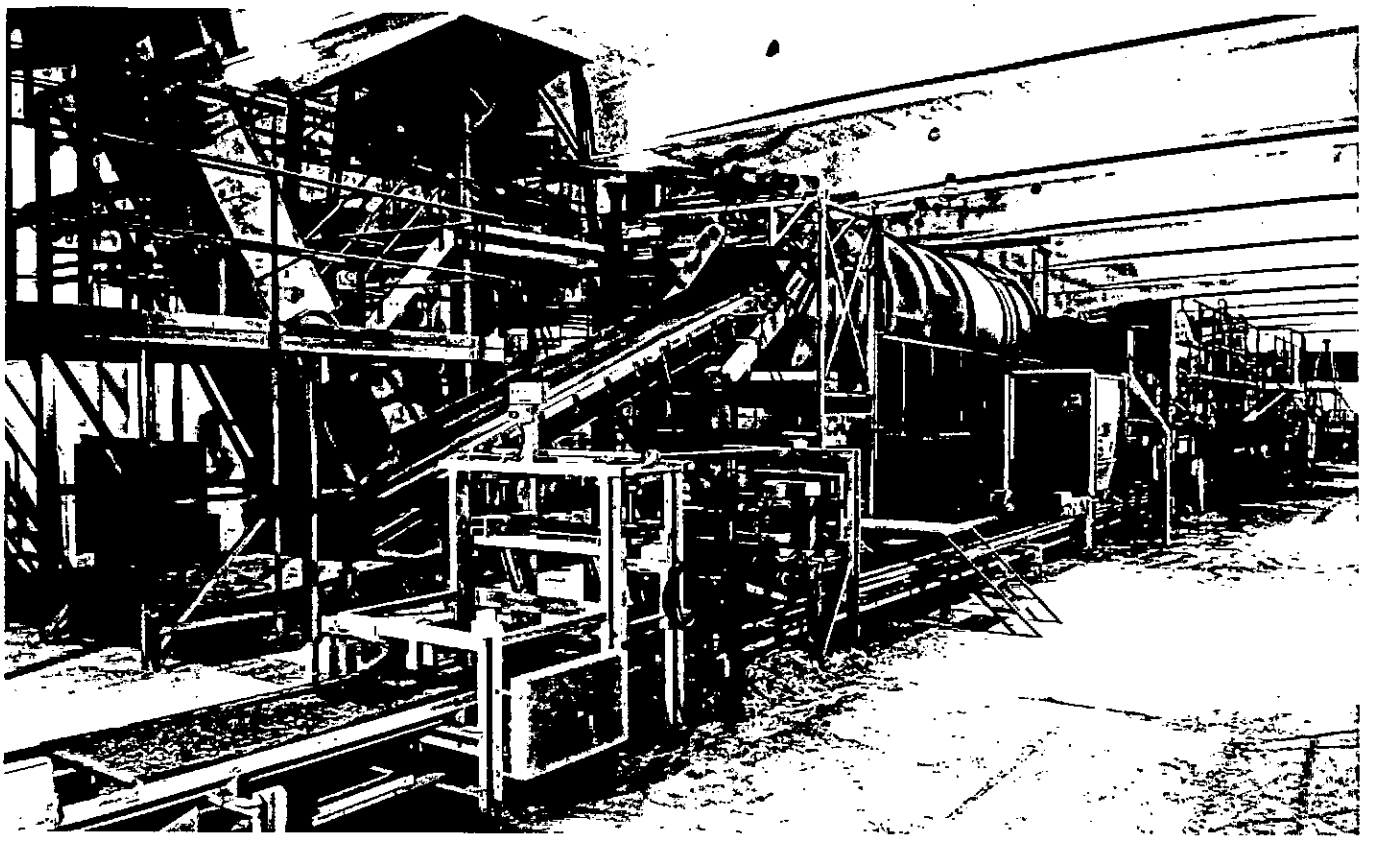


Main switch box.

Hauptschalt-schrank.

elten
systems
barneveld – holland

engineering & manufacturing Postbox 15 - 3770 AA Barneveld / Holland
Tel. (0)3420-12944 Fax (0)3420-14182 Tlx 47408



Automatic ELTEN production line for wood wool cement boards

FULLY AUTOMATIC ELTEN-PLANT Type 18 M

Board dimensions: Length : 200 cm
Width : 50 cm
Thickness : 1-10 cm

For other shapes and/or board dimensions please ask for additional information.

Mould speed : Variable up to 18 m/min.

Average capacity : 7 boards per minute.
Note: for board thicknesses from 5 to 10 cm the number of boards produced will be less, however the volume of material remains constant.

Moulds : Plywood bottoms with only 2 fixed longitudinal rims.

Labourers : In addition to labour for cutting timber and operation of the wood wool planing machines, the following labourers in the production hall are required:
1 plant operator for control and general supervision
1 fork lift truck driver
1 handy-man for supervision of mouldstripping machine and boardpiling machine as well as supply of pallets

Number of wood wool planing machines : Depending on timber diameter and quality as well as set board weight: the number of wood wool planing machines varies from 4 - 6.

The ELTEN plant is a carefully devised System, not merely a number of separate machines.
From the supply of raw materials up to and including the completed boards the production and quality as well as the weight of the boards is automatically controlled.
This ELTEN-SYSTEM is protected by patents in 29 countries throughout the world.

Description of the ELTEN-SYSTEM

Continuous fully automatic production.

Neither the raw materials wood wool (excelsior) and cement, nor the mixture or the manufactured fresh boards are touched by hand, whilst the quality of the boards is automatically controlled.

Production of wood wool and mixture

By means of conveyor belts or tubes the wood wool produced by the planing machines is supplied to the wood wool weighing machine without any intermediate storage (this eliminates fire danger entirely). In the weighing machine the wood wool is weighed to attain accurate cement dosing. If more wood wool comes from the planing machines, for instance caused by thicker wood logs, automatically more cement will be dosed. From the wood wool weigher, the wood wool is moistened in the submersion unit and after adjustable demoistening passed to a continuous mixer. At the same time an accurately measured quantity of cement is automatically added to the mixer from the cement dosing silo, by a dosing screw.
The cement dosing silo is automatically filled from the main silo. The quantities of wood wool and cement supplied to the mixer are thoroughly mixed there and continually supplied to the filling machine.
At the same time empty moulds are supplied by the automatic stripping machine via the mould-supplier and the mouldcleaning and oiling machine to the filling machine.

Distributing machine

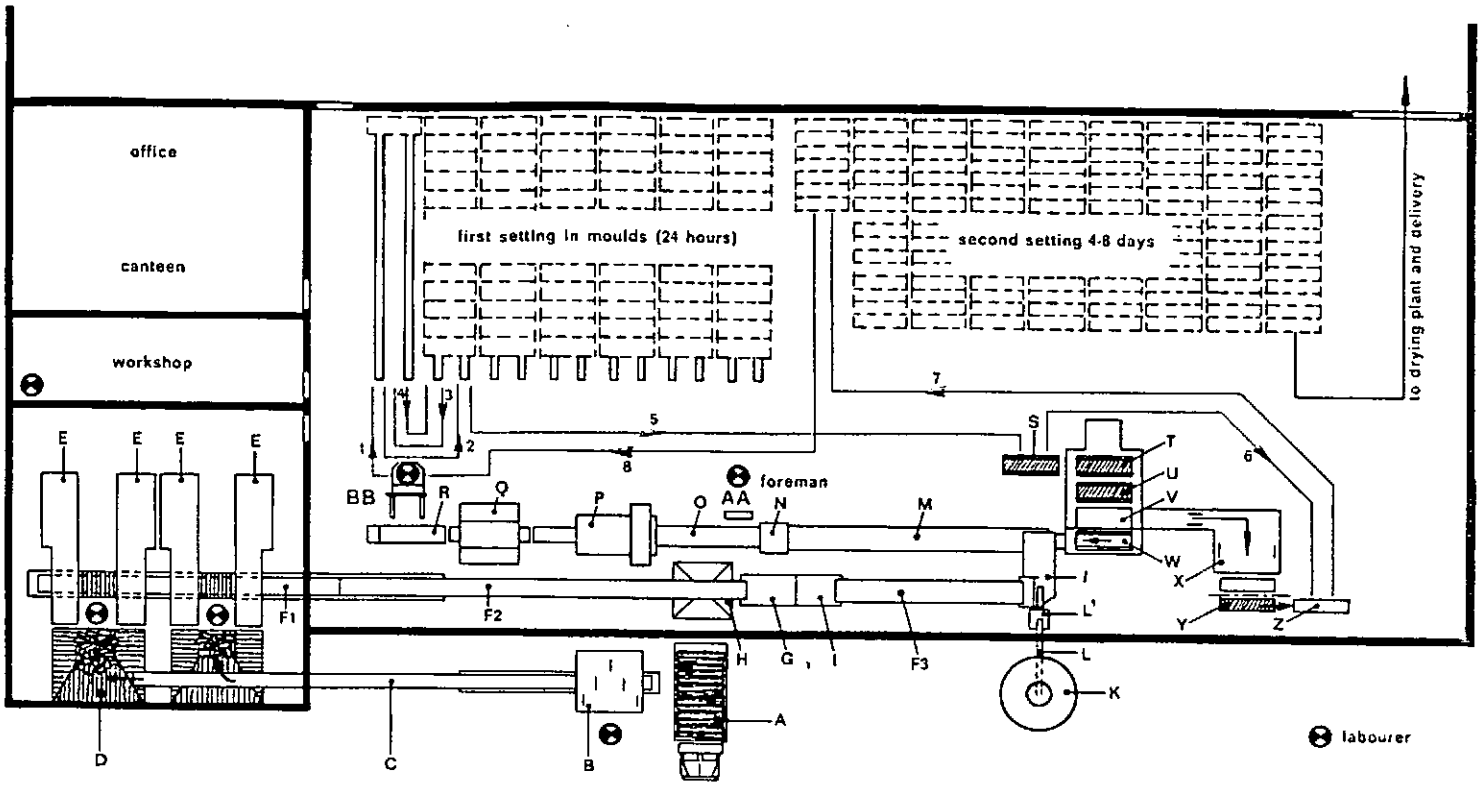
In the filling machine the mixture is further stirred up and distributed into the continuously moving moulds, after being dosed the required weight by means of a dosing belt weigher. This dosing belt weigher is equiped with an electronic equipment for the automatic control of the mouldspeed.
As the speed of the moulds is always in direct relation to the varying quantity of wood wool produced by the planing machines, the wood wool can continuously and immediately be worked up without any intermediate storage, whereas the weight of the boards produced remains constant.
The moulds containing the mixture pass through the following operations:
First the side pressing equipment, second the rollpress with electronically controlled maindrive for the mould transport and finally, before piling and pressing, the separating saw which runs along with the moulds and cuts accurately between mould ends.

Piling and Pressing

The individual moulds with material are supplied to the piling press, where they are automatically piled up under pressure to piles of e.g. 25, whilst at the same time by means of hydraulically operated steel plates, the usual forming of whiskers is prevented.
Without any interruption of the production rhythm the piling press automatically pushes the pile of boards on the roller conveyor behind the piling press, whence the pile is taken away by the fork lift truck.

Fork lift truck route

By means of the fork lift truck the pile of moulds with boards is taken away and moved along the way indicated by the red-arrowed line nr 1 (see drawing) and then put on the floor. In the floor recesses have been provided to accommodate the forks.
A special pallet having recesses at the top has been put on this pile beforehand by the fork lift truck operator, enabling him to put a second pile on the first one. Next he moves on (red arrow nr 2) taking off the concrete weight from a double pile of boards already hardened and by means of the truck putting this weight of concrete on the double pile of unhardened boards (see green arrowed line nr 3). This double pile of new boards remains under pressure for 24 hours. Next he moves again to the piles of hardened boards (green arrow nr 4) and takes away the top pile, taking it (red arrow nr 5) to the conveyor S near the automatic stripping machine and putting the pile down there.
He may drive on to the roller conveyor Z (red arrow nr 6), there taking up a pallet bearing a pile of finished boards and moving it (red arrow nr 7) to the second hardening place, where he puts it on the floor. Then the operator returns (red arrow nr 8) to the piling press for the next pile, etc.



Top view on the production hall of a board factory with an ELTEN plant type 18 M.

Explanation

A = truck with wood logs
B = automatic 5-blade ELTEN woodlogging saw
C = conveyor for 50 cm wood pieces
D = 2-3 wood log bunkers
E = 4-6 wood wool planing machines
F = 3 wood wool conveyors
G = wood wool weigher for control of wood wool cement proportion
H = container for chemical solution
I = submersion unit with rubber squeeze rolls
J = continuous mixer
K = cement silo
L = cement screw with dosing equipment L'
M = dosing and distributing machine with dosing belt weigher
N = continuous rollpress
O = side pressing device
P = separating saw
Q = piling press
R = taking-off roller table for mould piles
S = driven supplier roller table
T = mouldstripping machine
U = first turning table
V = second turning table with chain conveyor
W = mouldsupplier with mouldcleaning equipment
X = four-side trimming machine
Y = board piling machine
Z = taking-off roller table for board piles on pallets
AA = main switch box
BB = fork lift truck

For the route of the fork lift truck (red and green arrows) please see description of system.

Automatic stripping of the moulds

The pile of moulds with boards put down by the fork lift truck on conveyor Z is at the right moment automatically transported into the automatic stripping machine T where the pile is hydraulically lifted onto a stop. The topside mould is pushed sideways on table U and, by means of a hydraulically operated shaft with arms, turned 180° onto table V. Due to the impact, the wood wool cement board falls out of the mould onto the built-in chain conveyor and is moved in the direction of the edge dressing saw by means of this chain conveyor.
As soon as the board has been moved away the empty mould is taken by a second shaft with supporting arms and again turned 180° and laid down on the mouldsupplier W where the empty moulds are piled up for a small mould stock. The bottom mould of the mould pile is pushed automatically into the filling machine.

Trimming, printing and piling of the ready boards

The wood wool cement board, coming from table V is passed underneath a printing roll where the trademark is printed and then transported into the trimming machine X, where the longitudinal sides of the board are cleared of any projecting fibre.
Next the board automatically moves away in a transverse direction and is accurately trimmed to the required length up to a maximum of 600 cm. The finished boards are piled automatically in piles of e.g. 170 cm high by means of the automatic piling machine Y.

Production capacity

The speed of the moulds is electronically controlled by a dosing belt weigher, depending on the quantity of the mixture.
The main drive for the mould transport is automatically and infinitely variable from zero to maximum.
By this plant an average of 7 boards is produced per minute. The maximum rate is 9 boards a minute (= 18 m/min).

Quality of boards

The fibres of the board mixture are thoroughly twisted together during distribution by means of the automatic filling machine; a considerable part of the fibres are directed longitudinally.
During the after-distribution the last thin layer of fibres, which only consists of selected long fibres, is put onto the mixture, giving the surface a very fine appearance.
The weight desired for the boards to be produced can be adjusted to any figure by means of the dosing belt weigher. In this way a very consistent quality board is obtained together with high structural strength.
During tests in Belgium to determine the heat conducting capacity it has been shown that the insulation value has increased by 30 % as compared with the earlier manually moulded boards (owing to the regular distribution). Also the compression strength has increased due to the very regular distribution, e.g. at a factory in Western Germany by **417 %** of the DIN 1101 requirements. During official tests for the DIN-Test-Certificate, e.g. at another factory in Western Germany, it has been shown that the bending strength in average was **310 %** of the DIN 1101 requirements.
A board of 2,5 cm thickness has a thermal conductivity in 10°C average temperature of 0,0585 Kcal/mh°C. The bending strength of this board is 31 kg/cm² according to the tests made by a technical highschool.
Because of our special edge filling equipment and piling press it is possible in the simplest moulds with two fixed longitudinal ridges to produce boards of the highest quality and accurate size. The boards are of homogeneous structure throughout, including edges.

The wood wool weigher with the dosing belt weigher and the very homogeneous distribution of the fibres have together made possible a maximum saving in material. This alone is sufficient to make a substantial contribution towards the cost of the plant within a short time!

Technical details

Human influence on the quality and capacity has been completely eliminated. The production flow rate is automatically adapted proportionately to the amount of mixture being supplied, i.e. to the output of the planing machines.
The ball bearings are filled with special grease and where required provided with perfected sealings, so that no dust and cement can penetrate into the bearings. The construction of the machines is heavy and fully meets the severe requirements for plants of this kind.

The ideal to produce high grade wood wool cement boards with a minimum of labour and material has been realized by this plant.

General information

Basic board properties

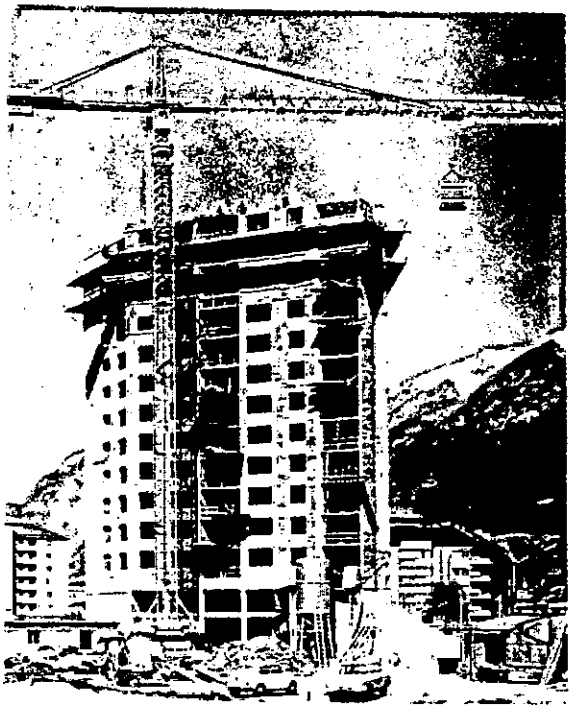
- insulating
- acoustical
- fire-proof
- structural
- nailable
- plasterable
- sawable
- termite-proof
- resistant against woodfungi
- paintable
- nice appearance
- cheap to manufacture

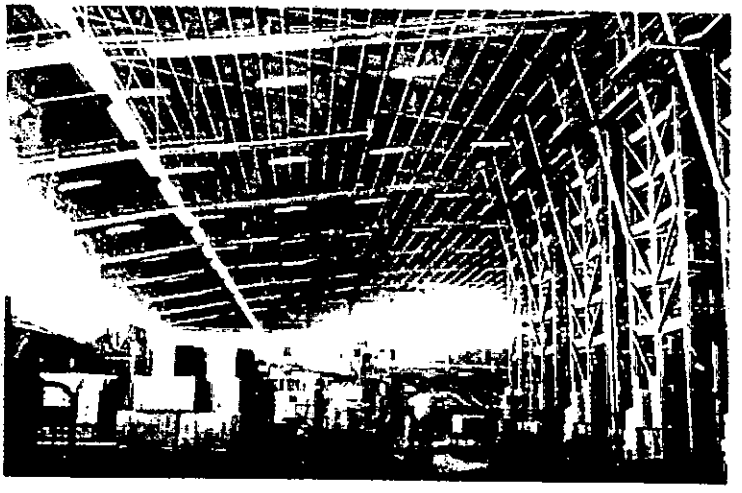
For insulating value and structural data of boards, manufactured on the ELTEN SYSTEM, we have available a certificate of tests executed by the "Technische Hochschule Hannover", Western Germany.

Application of the boards

Main applications are:

- roofing (non-reinforced, wood-reinforced, concrete reinforced and steel-channel reinforced roofpanels)
- insulation of constructions
- formboard for concrete walls (permanent shuttering as Thermoklith)
- formboard for concrete floors
- walls (in different ways)
- exposed ceilings
- acoustical boards





cargo-building Amsterdam Airport with 10.000 m²
5 cm wood wool boards in the roof.

13-storey-appartment building
under construction in Innsbruck (Austria).
Complete building with wood wool boards
according to the Thermoklith-system.

For further information please contact:

elten
systems
barneveld – holland

engineering & manufacturing Postbox 15 - 3770 AA Barneveld / Holland
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WOOD WOOL CEMENT BOARDS AND PANELS

General information

I. Board properties

- insulating
- acoustical
- fire resistant
- structural
- nailable
- plasterable
- sawable
- termite resistant
- fungi resistant
- paintable
- rot resistant
- inexpensive

For insulating value and structural data of boards, manufactured on the ELTEN SYSTEM, a certificate of tests issued by the 'Technische Hochschule Hannover', Western Germany, is available.

II. Board dimensions

The standard size of a Wood Wool Cement Board is:

Length	:		2000 mm		
Width	:		500 mm		according to DIN 1101
Thickness	:	15	-	100 mm	

Many plants however are delivered for other board dimensions in the following sizes:

Length	:	2000	-	3000 mm	(also up to 4000 mm)
Width	:	500	and/or	600 mm	(also up to 1000 mm)
Thickness	:	15	-	100 mm	(also up to 150 mm)

Subject to manufacturing limitations plants for different board dimensions can be designed and supplied.

Using and Elten 'Double Layer' plant it is possible to produce composite boards with Expanded Polystyrene or other core materials.

III. Plants operating in various countries

In Europe the use of Wood Wool Cement Boards has assumed enormous proportions because of their special qualities and low prices in comparison with other building materials. Since 1960 Elten plants have been installed throughout the world and the total has now reached over 120 plants in 30 different countries including:

- Western Germany	- Spain	- USSR	- Argentina
- Eastern Germany	- England	- Yugoslavia	- Belgium
- Netherlands	- Finland	- Greece	- Japan
- South Africa	- Sweden	- USA	- Indonesia
- France	- Norway	- Mexico	- Australia
- Switzerland	- Denmark	- Venezuela	- Honduras
- Austria	- Italy	- Brazil	- India

IV. Raw materials

a. CEMENT

Normal Portland Cement No. 350 or No. 450 (BS 12/DIN 1164).
In cold conditions the use of high early No. 550 may be necessary.

b. WOOD

To assist in the identification of suitable local timbers a list of 100 different species is available on application. These timbers have been tested by Prof. W. Sandermann, director of the 'Institut für Holzchemische Technologie', Hamburg, West Germany.

c. CHEMICAL SOLUTION

1. Calcium Chloride ($Cacl_2$) mostly used (2-3° Baumé solution)

2. Magnesium Chloride ($MgCl_2$)

3. Cilicate of Soda ($NaSio_3$)

The choice of the chemical is subject to availability in the respective country and Elten approval.

V. Raw material requirements

Based on the production of a standard density board size 2000 x 500 x 25 mm the following quantity of raw material is required.

Other sizes and thicknesses will require a quantity of raw material pro rata to the undermentioned figures.

The raw material requirement will vary with the density of the board.

Raw material

Wood wool	:	3,25 kg
Portland cement	:	6,50 kg
Salt solution (water + chemical)	:	3,25 kg

The volume weight (kg/m3) of Wood Wool Cement Boards is dependent upon the density of the boards. Assuming a standard density the figures are:-

Board Thickness in mm	Unit weight in kg wet	Unit weight in kg dry	Volume weight Kg/m3	Kcal/ mh°C
15	9,5 - 10	8,5	570	0,0543
25	12,8 - 13,5	11,5	460	0,0596
35	16 - 17	14,5	415	0,0544
50	21,5 - 23	19,5	390	0,0638
75	31 - 33	28	375	0,0635
100	40 - 42	36	360	0,0636

VI. Output

An Elten plant will produce 750.000 boards per year when operated on a 1 shift per day of 8 hours for approximately 250 days per year.
This output is based on the manufacture of boards 2000 x 500 x 25 mm. The total volume of output may vary in relation to thickness and density.
Plants may be operated on a 2 or 3 shift basis provided adequate time is allowed for cleaning and maintenance.

VII. Applications of the boards

Main applications are:

- roofing
- roof decks
- insulation (thermal)
- insulation (sound)
- formboard for concrete
- permanent shuttering
- ceiling panels
- walling
- acoustical boards
- partitions
- system building

Elten Systems can provide information related to low income group housing and the prefabrication of construction elements.

ELTEN SYSTEMS
BARNEVELD/HOLLAND

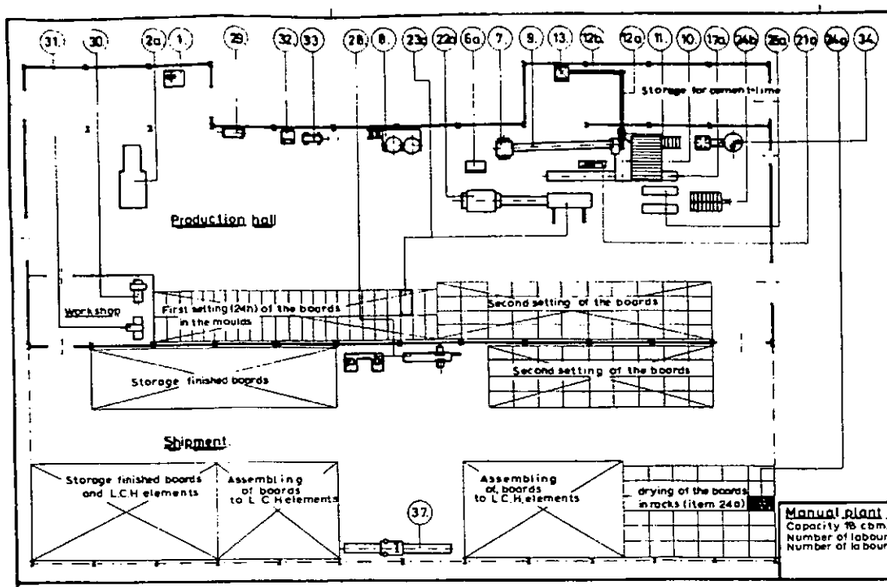
SUMMARY OF OUTPUT AND NUMBER OF OPERATIVES REQUIRED FOR DIFFERENT PLANTS TO PRODUCE WOOD WOOL CEMENT BOARDS

Type of plant	I SEMI-AUTOMATIC	II AUTOMATIC	III AUTOMATIC (extended)	IV FULLY AUTOMATIC
Maximum capacity per 8 hours production time in cubic metres	36	54	72	90
Operatives required for factory (excluding administrative & supervisory staff)	15	13	14	13
Required land in square metres	8.000	10.000	10.000	12.000
Required building area a. production hall b. roofed storage area	 60 X 18 40 X 18	 60 X 18 40 X 18	 60 X 18 40 X 18	 70 X 18 40 X 18

Remarks: - The lay-out of the plants are designed in such way that later modification to fully automatic operation can be effected easily and economically. (see drawing 0.220.0).

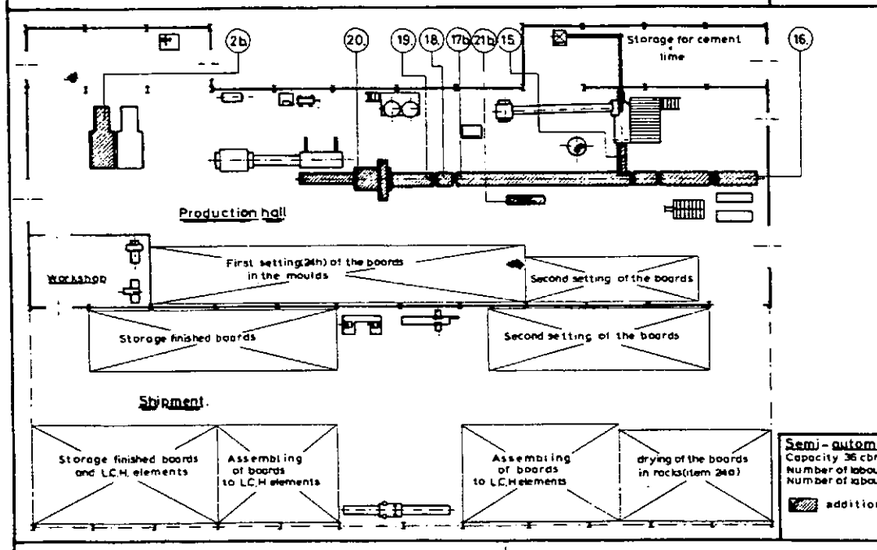
Extension from manual plant to fully automatic plant for the manufacture of woodwool cementboards and Low Cost House elements to the Elten system

Drawing 0-220-0



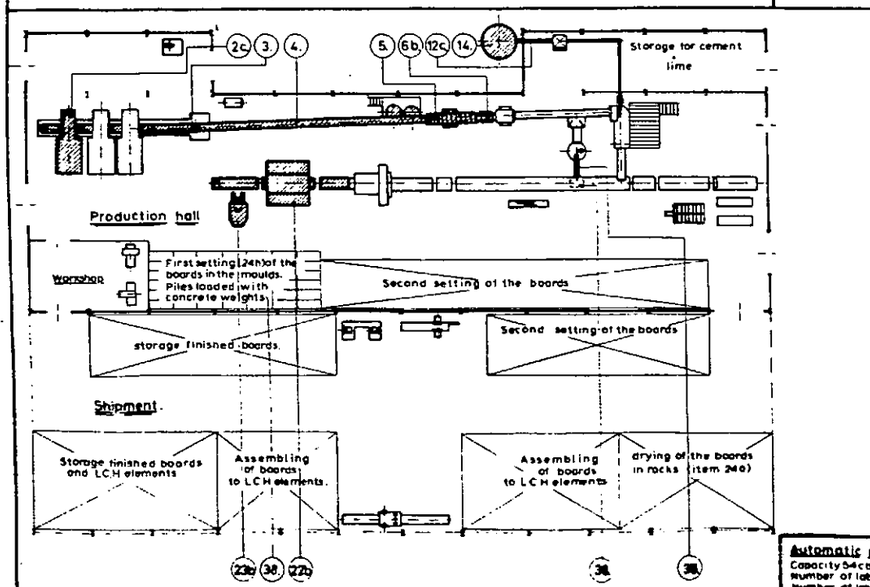
1	WOOD LOGGING SAW
2a	SLEDGE WW PLANING MACHINE
6a	WOOD WOOL BATCH WEIGHER
7	WOOD WOOL DIPPING MACHINE
8	SALT SOLUTION PREPARATION UNIT
9	CONVEYOR FOR WET WOOD WOOL
10	CONTINUOUS MIXER
11	CEMENT DOSING EQUIPMENT
12a	CEMENT SCREW CONVEYOR
12b	CEMENT SCREW WITH BIN
13	CEMENT SACK TIPPING UNIT
17a	DISTRIBUTION STATION
21a	MAIN SWITCH BOX
22a	BUNDLE PRESS
23a	TRANSPORT CART
24a	DRYING RACKS FOR BOARDS
24b	HAND PALLET TRUCK
25a	HAND STRIPPING TABLE
28a	EDGE DRESSING MACHINE
29	AIR COMPRESSOR
30	KNIFE GRINDING MACHINE
31	SAW BLADE GRINDING MACHINE
32	HAMMER MILL
33	TRANSPORT CART FOR WW WASTE
34	PADDLE MIXER
37	UNIVERSAL MILLING MACHINE

Manual plant type I (I)
Capacity 18 cbm/8h
Number of labourers for board production 14
Number of labourers for L.C.H. elements production 2



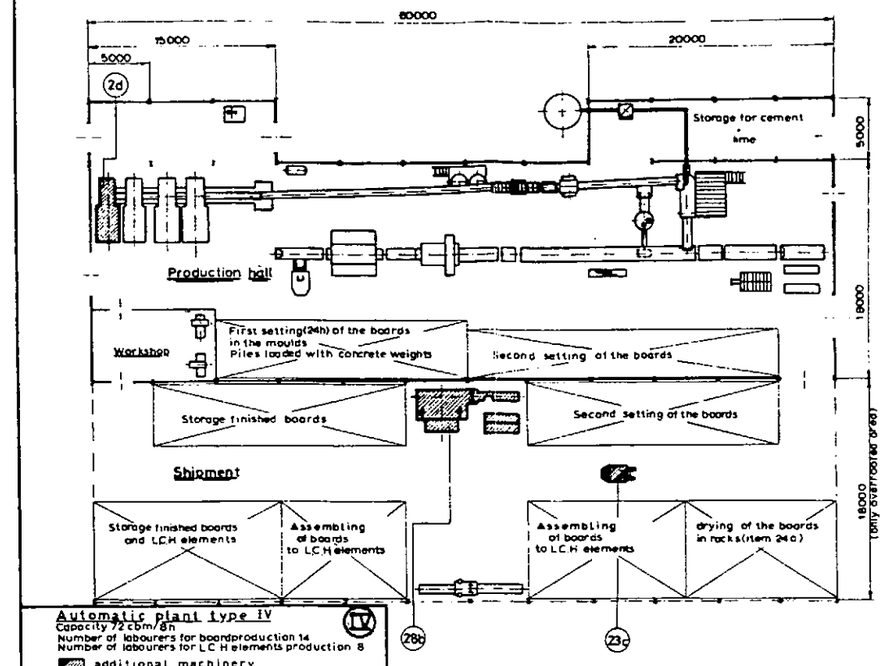
2b	SLEDGE WW PLANING MACHINE
15	CONVEYOR FOR MIXTURE
16	MOULD SUPPLIER
17b	AUTOM DISTRIBUTING MACHINE
18	CONTINUOUS ROLL PRESS
19	SIDE PRESSING DEVICE
20	SEPARATING SAW
21b	MAIN SWITCH BOX

Semi-automatic plant type II (II)
Capacity 36 cbm/8h
Number of labourers for board production 15
Number of labourers for L.C.H elements production 4
additional machinery

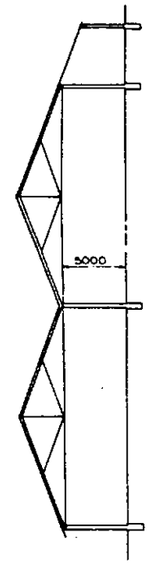


2c	SLEDGE WW PLANING MACHINE
3	CONVEYOR FOR DRY WOOD WOOL
4	CONVEYOR FOR DRY WOOD WOOL
5	WOOD WOOL SHAKER
6b	WOOD WOOL BATCH WEIGHER
12c	CEMENT SCREW CONVEYOR
14	CEMENT SILO
22b	PILING PRESS
23b	FORK LIFT TRUCK
35	SCREW CONVEYOR FOR SLURRY
36	DOSING EQUIPMENT FOR PLASTER
38	CONCRETE WEIGHTS AND INTERMEDIATE PALLETS

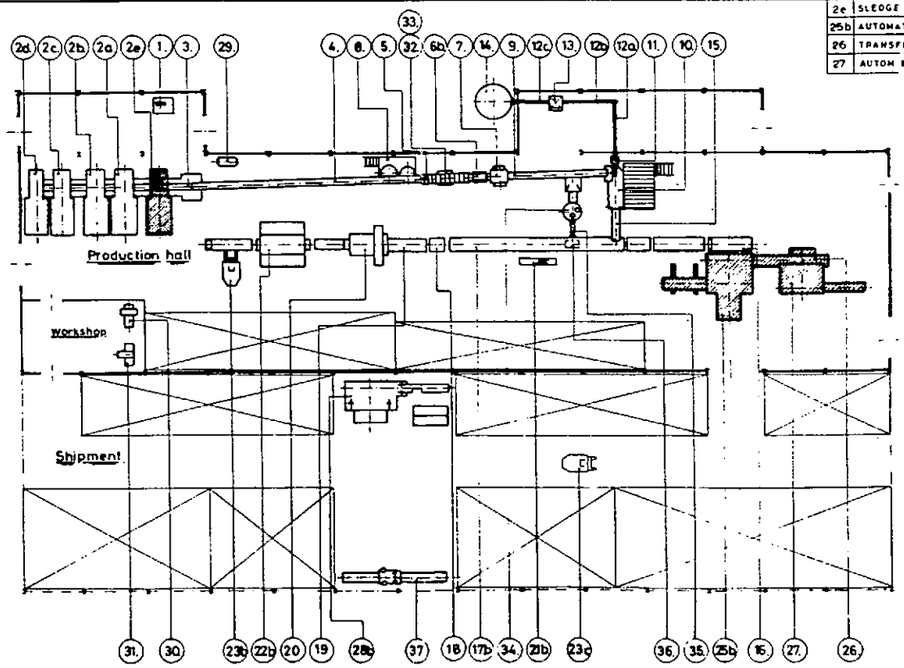
Automatic plant type III (III)
Capacity 54 cbm/8h
Number of labourers for board production 13
Number of labourers for L.C.H elements production 6
additional machinery



2d	SLEDGE WW PLANING MACHINE
23c	SECOND FORK LIFT TRUCK
28	EDGE DRESSING SAW



Automatic plant type IV (IV)
Capacity 72 cbm/8h
Number of labourers for board production 14
Number of labourers for L.C.H elements production 8
additional machinery



2e	SLEDGE WW PLANING MACHINE
25b	AUTOMATIC STRIPPING MACHINE
26	TRANSFER CONVEYOR
27	AUTOM BD.

Fully automatic plant type V (V)
Capacity 90 cbm/8h
Number of labourers for board production 13,14
Number of labourers for L.C.H elements production 10
additional machinery

Extension from manual plant to fully automatic plant for the manufacture of woodwool cement boards and Low Cost House elements to the Elten system

Date: 31-7-75
Name: H-K
Scale: 1:200
Drawing: 0-220-0

ELTEN ENGINEERING
ELTEN MACHINEFABRIEK N.V.
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WAEP

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INTERNATIONAL CONFERENCE ON THE USE OF PREFABRICATED BUILDING ELEMENTS

Constructions in developing countries
Hamburg, 19-22 september 1977

Prefab Elements from Wood Wool Cement for Economic and Low Cost Housing in Argentine, Brasil, Honduras, Malaysia, Mexico, Panama, Spain, Yugoslavia

by

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World Association for Element Building
and Prefabrication (W.A.E.P.)

'Prefab Elements from Wood Wool Cement for Economic and Low Cost Housing in Argentine, Brasil, Honduras, Malaysia, Mexico, Panama, Spain, Yugoslavia'

Prefab elements from wood wool cement are increasingly used for economic and low cost house building.

The main reasons for this increase are: the good properties (see Exhibit A), combined with relative low price, the simple technology to produce the product and the fact that in the majority of the countries the basic raw materials, wood and cement, are readily available.
Moreover, wood wool cement panels can be produced easily in the dimensions of the desired panels, so the architect can choose the dimensions of the panels.
The relative low price is possible due to the fact that wood wool is produced from second class wood, unsuitable for sawmills. In some cases even residues or rejects from sawmills are used for the wood wool board production.
In Europe several larger wood wool cement board plants are (or were) combined with sawmills, however most factories now use the so-called paper wood, which is still considerably cheaper than straight full size trunks.

Raw Materials

Simplified, expanding one cubic meter of soft wood to three cubic meter wood wool cement board, can be illustrated as follows:
1 cu. m.wood (solid, air dry) + 720 kg cement +
360 l water → 3 cu. m.wood wool board
(± 360 kg wood wool + 720 kg cement +
360 kg water = 1440 kg (wet))
After drying the boards weigh approximately: 420 kg per cu. m.

Principally soft woods such as pine, poplar and eucalyptus are used, these can be easily cut to long strands and bind usually well with the cement.

Properties of Wood Wool Cement

For low cost housing the important properties are: the high isulation value, low weight, easy handling and workability, as well as the resistance against fire, water, fungi and termites.

The low specific weight allows handling large panels without the use of cranes.
The high insulating value makes it specially valuable in countries with high and/or low temperatures.
A 5 cm thick wood wool cement board has an insulating value equal to 35 cm solid brick.

With respect to the workability, it is clear that it is a great advantage that no complicated tools or machines are needed to cut or to fix the boards and further for cheap finishing of low cost houses it is important that the boards have a surface which can easily be stuccoed with a cement screed.

Frames and Finish

If classified according to the type of frame to support the roof and to connect the panels, the houses could be divided into the following groups:

I. Houses with wooden frames
II. Houses with steel frames
III. Houses with concrete frames

Of course several variations and combinations do exist, e.g. panels with wooden frames are used in buildings with steel columns to support the roof. Also variations occur where and when the frames are installed.

Which combination is chosen depends partly on local prices for wood, steel or cement.

Sometimes the frame is incorporated in the panels, in other cases the frame is installed before the panels are attached to it, or is only formed after the panels are put together (see III-c, d, e).

Most manufacturers use vertical panels of 240 to 260 cm height, but sometimes the boards are nailed horizontally on wooden frames and then plastered or stuccoed (see III-a), or just put together and reinforced horizontally afterwards with mesh wire netting in the plaster (see I-d).
The width of the panels varies from 50 to 120 cm.
The thickness of the panels varies from 3,5 (low cost) to 14 cm (economy).

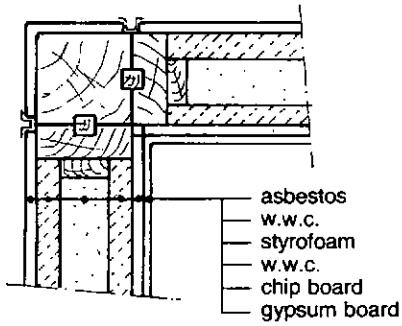
As will be shown in the following disclosures, also the degree of prefabrication varies considerably.
Some manufacturers supply only unfinished wood wool cement boards, but others have the wood wool cement incorporated in complete large panels, which are completed with internal tubing for electric wires and incorporating frames for windows, doors, etc.

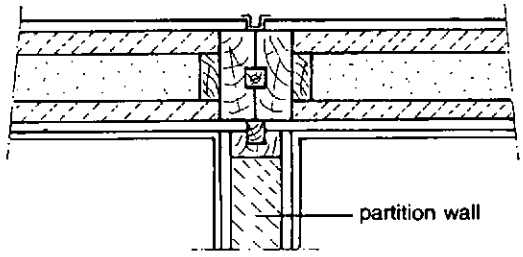
Which type of joint or finishing is chosen, depends on prices, availability of materials and on the acceptance of visible joints in the walls, as well as costs for labour.
The cheapest finish as far as material is concerned, will be a screed of stucco directly on the wood wool cement.
Sometimes on the inside of the house a gypsum plaster instead of stucco is put on.

The stuccoing can be done after the erection of the house on site, or on the panels in the factory by hand or mechanically.
The advantage of stuccoing after the erection, is that no joints will be visible and any damage of panels will disappear under the stucco.
The disadvantage however will be that more work has to be done on site.

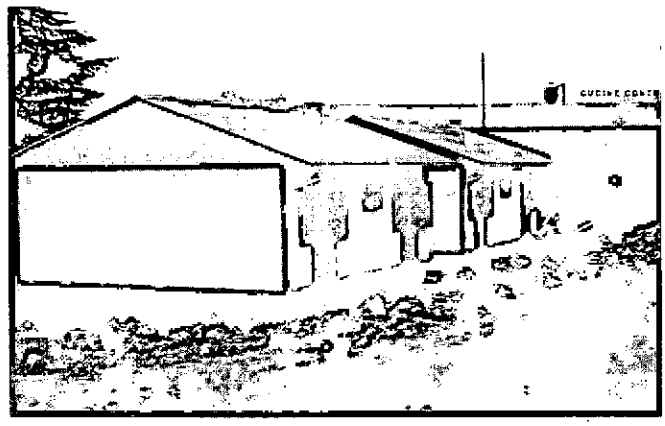
If asbestos sheets or a combination of asbestos (outside) and particle board or gypsum board (inside) are used, more rigid panels are obtained, the erection will go quicker, but some damage to the panels may occur during transport and handling or by rain (gypsum or particle board).

After these explanations, it will be clear that several different systems were developed, which will be described hereafter.



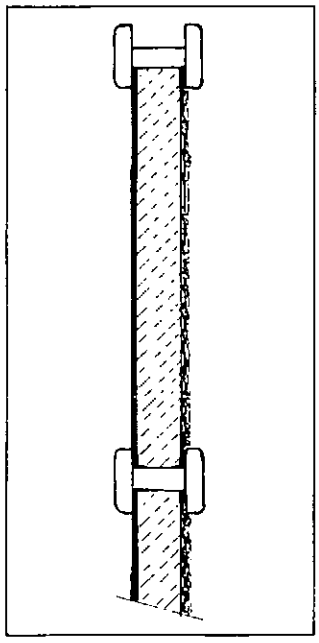


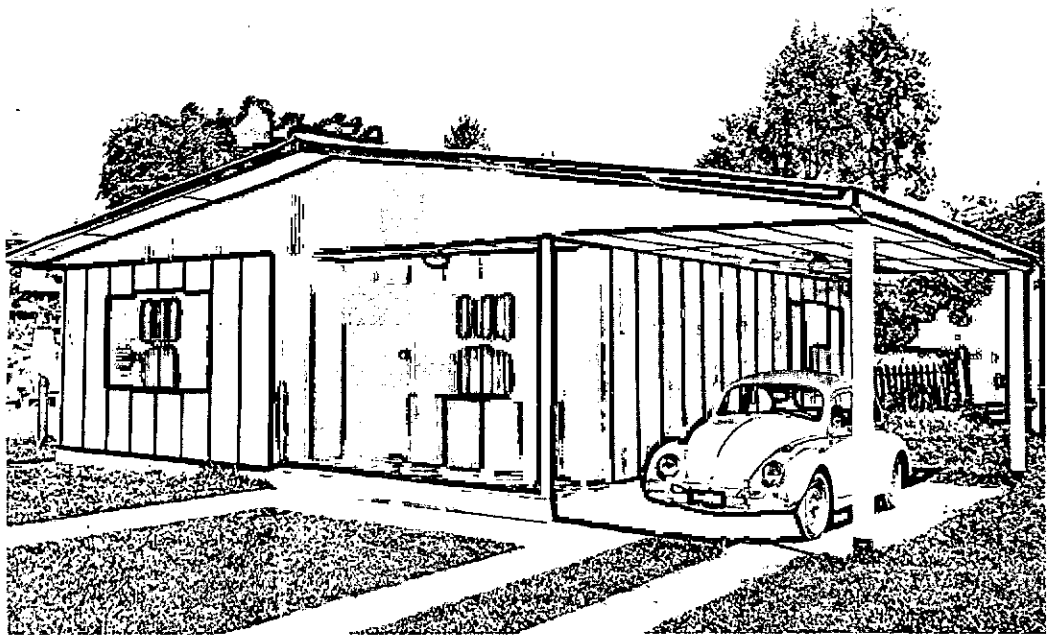
Krivaja - Weekend houses



Krivaja houses near Udine, Italy erected after the earthquakes.
Contract signed: November 1976
Erection started: December 10, 1976
Pictures taken: February 20, 1977
(1200 of 1350 houses were already overroofed)

One family house in Brasil





I. Houses with Wooden Frames

I-a.

The wood industry Krivaja, Zavidovići, Yugoslavia, delivers thousands of houses in the economic class.
For Yugoslavia itself and surrounding countries, the prefabricated panels have a wooden frame, which is covered with asbestos sheets on the outside and chip board or gypsum board on the inside.

A typical Krivaja economic house is one story high and has a saddle-type roof of corrugated asbestos.
50% of all wood framed houses in Yugoslavia are built according to the Krivaja system, using wood wool cement boards in wall panels and ceiling panels.

A standard Krivaja panel shows the following dimensions:
height : 250 cm
width : 120 cm
thickness : 13,8 cm (outside wall panel)

The composition of a panel is: (from outside to inside)
8 mm asbestos sheet (weather protection)
120 mm wooden frame with in between a 120 mm wood wool board or a sandwich board of wood wool cement with a core of styrofoam
10 mm chip board or gypsum board
138 mm

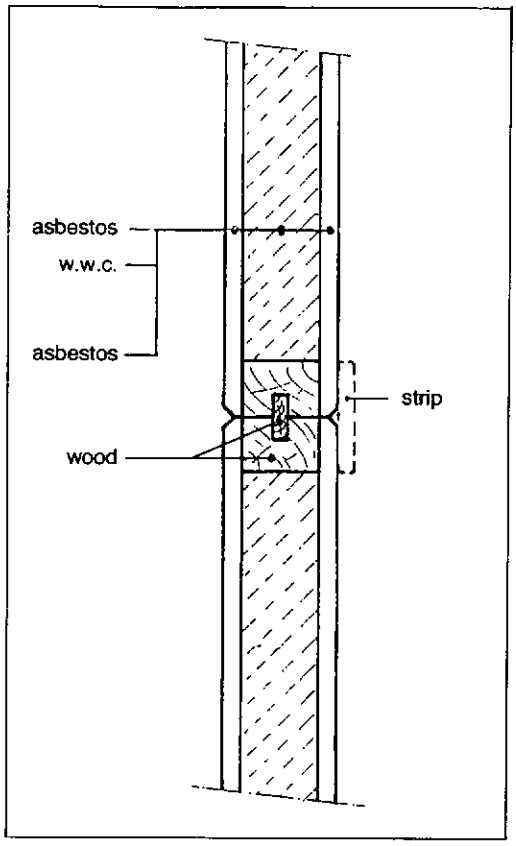
For use in climates with low temperatures, a vapour barrier is installed between the inner board and the wood framing and wood wool cement board, and in certain occasions on special request, after the erection of the house an extra gypsum board is attached to the chip board to cover all joints and obtain a smooth surface, e.g. to be painted or finished with wall paper.

Tests executed on Krivaja panels

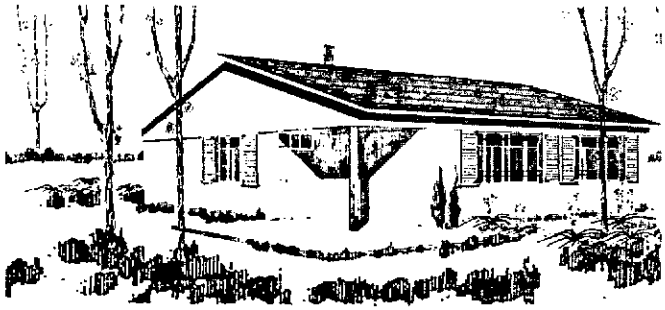
According to a published certificate re tests on these building elements, such elements allow a vertical load of 6200 kg each.
The panels were tested also at temperatures of 650° C, 800 ° C and 1000° C for the duration of 100 minutes with positive results.
Tested on wind load and accidental impact, it was proven that with a safety coëfficient of 3.6, the panels resist an accidental impact with a kinetic energy of 35 resp. 52 kgm; against wind load the panels did resist without any damage a wind load of 90 kgm of kinetic energy.
The tested panels further showed an insulating value of K = 0,48 Kcal/m²h°C, which equals a 130 cm solid wall of masonry brick.
Remark: the tested panels had sandwich boards inside. If filled with wood wool cement only, the K-value will be somewhat higher.
After erection the panels are coated with a white-greyish plastic coating of the make Chromacril, which is elastic and resistant to all common influence and climatic conditions.
As all parts of the wood frame are treated with a chemical, protecting it against fungi and insects, Krivaja guarantees durability of the prefabricated building system for 50 years with a minimum upkeep of single parts.

I-b.

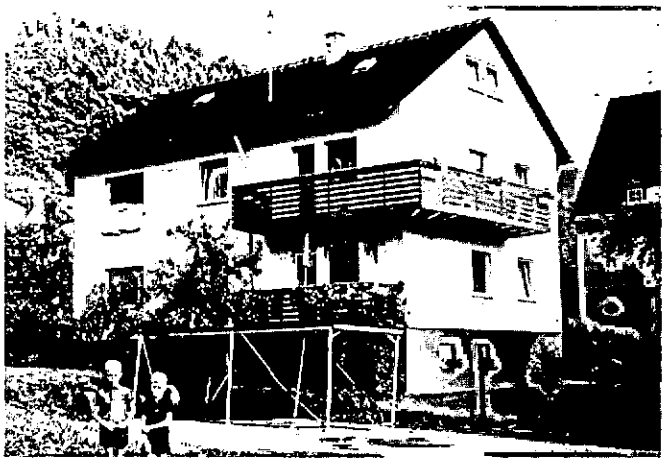
Companhia Industrial Madeireira, Caxias do Sul, Brasil, delivers 5 types of low cost houses: small, medium and large up to 4 bedrooms.
The walls consist of 3,5 cm thick wood wool cement boards, tightly fitted in between vertical wooden studs of H-shape.
The wooden studs support the roof and ceiling.



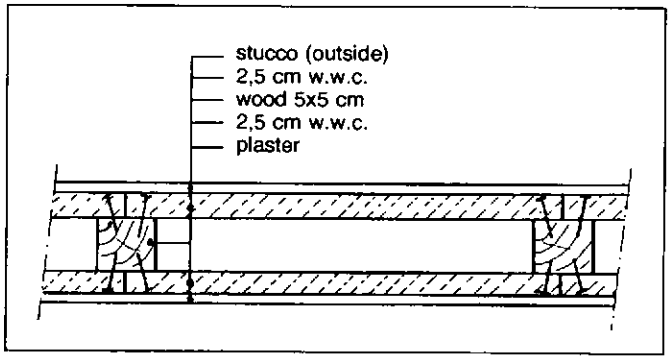
Burgo de las Naciones (Santiago de Compostela).
Accommodation for 2.000 pilgrims, with main building covering 7.500 sq.m. (Reception, livingroom, kitchen, diningrooms and facilities).
Completion time, including urbanization: 130 days.



Uniseco bungalow, 63 sq.m with 2 bedrooms, living and dining room, hall, kitchen, bathroom and terrace.



Outside: 2,5 w.w.c. (stuccoed)
Inside ; Gypsum boards



House in the Netherlands built in 1945, picture taken in 1974.

I. Houses with wooden frames (continued)

The insulation value of 3,5 cm wood wool cement board equals 24,5 cm brick. The boards are covered in the factory on the outside with a finish based on acryl and on the inside with plaster.
The finish on the outside has a rough structure, however as far as they fit in the wooden studs, the surface is smooth.
These houses are erected in southern Brasil for a price equal to US dollar 105/sq.m., complete with toilet, shower connection, basin, valves in kitchen and all electric switches and lamp connections.
Even the foundation (up to 70 cm max.) is included.
The ceiling consists of wood wool cement boards layed down on T-steel bars and the rain protection is obtained by corrugated asbestos sheets.

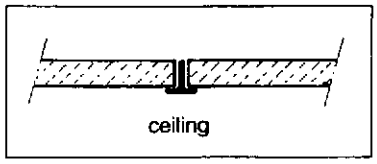
I-c.

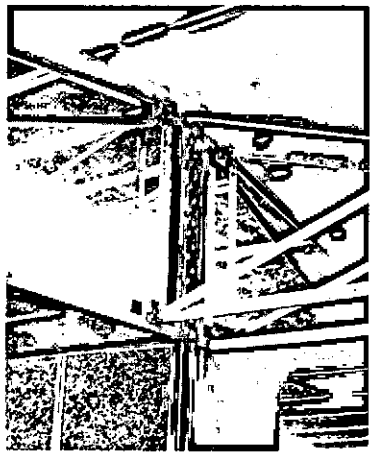
The company Uniseco, Madrid, Spain, which belongs to Agroman, one of Europe's biggest construction companies, delivers and erects complete houses, schools, offices, hospitals, laboratories, etc., according to a detachable construction system.
The elements consist of two 6 mm asbestos sheets with a 3,5 cm x 3,5 cm wooden framing and are filled with wood wool cement.
The wooden frame has a groove all around, so that with a small wooden lath a solid connection from panel to panel is obtained.
Sometimes an extra strip is nailed over the joints.

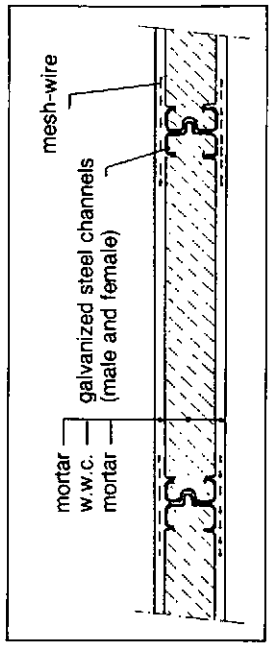
After erection the wall is painted on the outside with a suitable paint. The inside is also painted or is covered with wall paper.
Due to its light weight and solid construction, these panels are shipped all over Spain and are exported to African and Middle East countries. It is a very fast system to build with, but an extra advantage of this system is that buildings are completely removable and all components can be re-used.
In 1964 e.g. an accomodation was built for 2000 pilgrims in Santiago de Compostela in 130 days. The panels were produced locally in a removable plant rented from Elten Engineering in the Netherlands.
When the buildings were ready, the factory was removed.
The weight of the panel is 36 kg/sq.m.
The thermal insulation of the panels is 1.47 Kcal/m^2h^0C, which equals 26 cm solid brick.
The compressive strength is 3 tons per linear meter, so for many constructions the roof can rest on the panels and no extra structure is required.
Usually the roof consists of corrugated asbestos sheets with a suspended ceiling of wood wool cement board underneath.
These wood wool cement boards preferably are not plastered, but keep its open structure for acoustic reasons and can be painted in any desired colour by spray-painting.

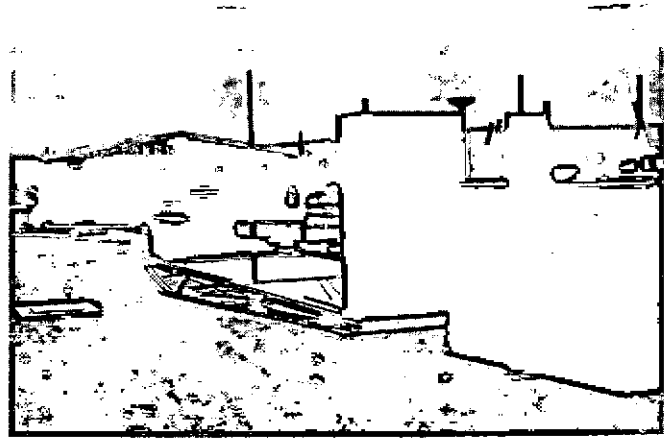
I-d.

In several countries in **Western Europe,** houses are built with a construction of wooden studs with wood wool cement boards nailed to it on both sides and then plastered.
In some cases at the outside a wood wool cement board and on the inside a gypsum board is nailed to the vertical wooden studs.



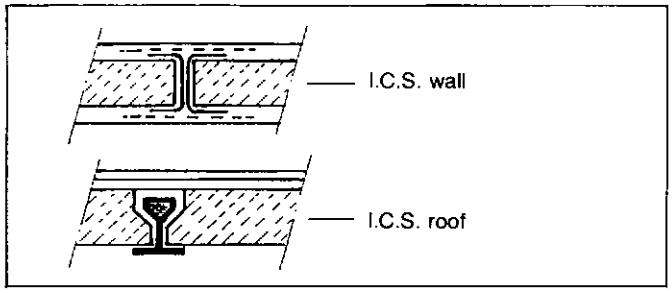


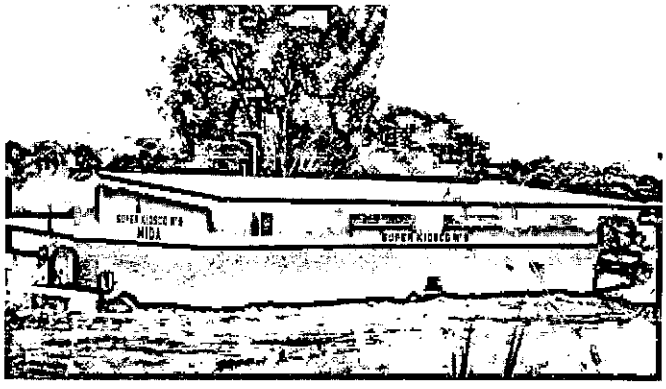


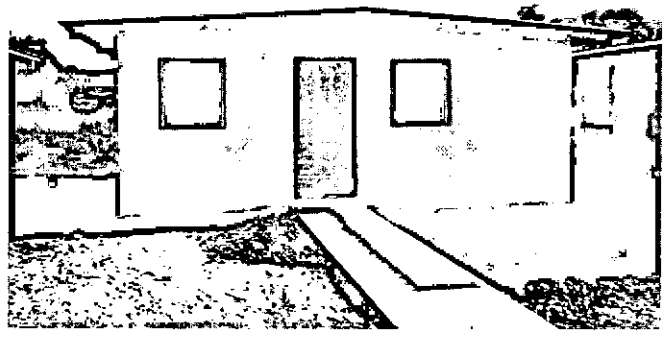


Construction of series of houses in Mexico (Pamacon System)

Krivaja house, steel framed, flat roof type





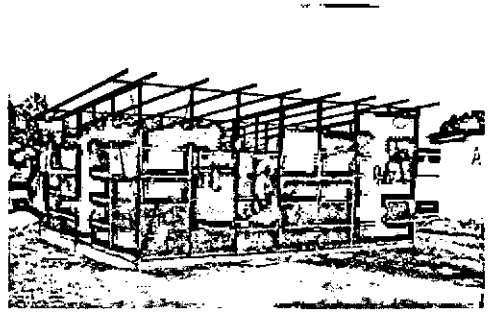


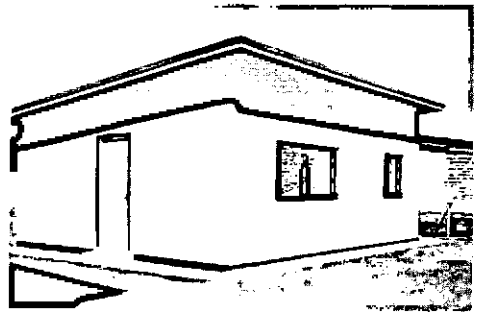
mini super market •

series of small houses in Honduras •

• built according to the ICS-System

Pictures illustrating the steelframed houses in Kenya





II. Houses with Steel Frame

II-a.

Grupo Intra in Mexico City, produces 60 cm wide Pamacon wood wool cement elements, reinforced on their longitudinal sides with male and female galvanized steel profiles.
The wall boards are 5 cm thick with a length of 250 cm and vertically installed.

For the saddly type roof of the houses the same type of element is used, however 65 mm thick, which is covered with normal or shingle like roofing paper.
A horizontal suspended ceiling of 2,5 cm wood wool cement boards is installed by placing the boards on the flanges of T-bars and spray paint them.

The windows are made out of aluminum profiles and the door frames of steel. The steel construction and prefabricated clips, windows, etc., allow the use of practically unskilled labourers to screw and clip the house together, which is stuccoed and plastered.

II-b.

For export to the Middle East and Africa, **Krivaja, Yugoslavia,** developed a flat roofed prefabricated house, for which steel framed panels are used. These steel profiles support the roof and no other studs are necessary. The dimensions, properties and compositions of the panels are, apart from the steel frame, about identical to the system described in I-a.

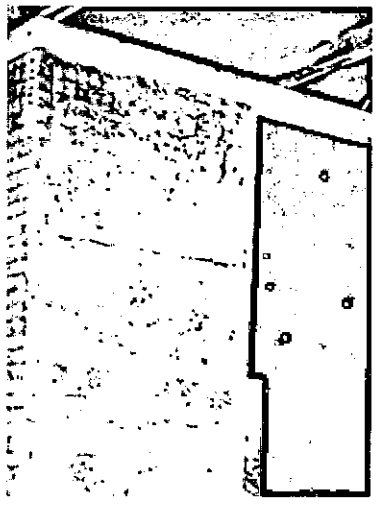
II-c.

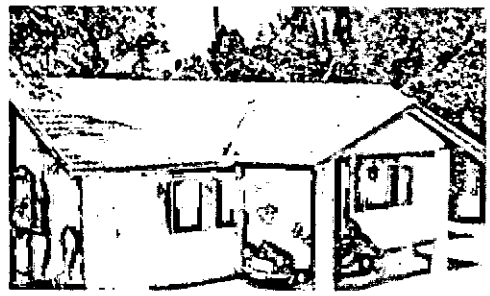
International Construction Systems (I.C.S.) in Panama City, erects low cost houses in Panama and abroad.
Soon a similar production line will be started in Honduras on a so-called Elten manual plant.

The wall elements are 100 cm wide, 250 cm high and have a thickness of 65 mm.
Each element is framed with a galvanized U-type steel channel all around and where needed incorporates door frame or window.
At the building site frames are welded together and to anchor plates embedded in the prepared concrete floor.
After erection 10 cm mesh wire strips are attached over all joints, then the walls are finished with a 1 cm elastic cement screed, and spray painted after being dry
The roof usually is a saddle type, however with a very slight slope and consists of 65 mm wood wool cement boards placed on the flanges of T-bulb bars.
The joints are filled with grout, so they cannot be lifted off by wind, finished with clay filled asphalt and painted with a heat and light reflecting acryl coat.
Houses according to this system are erected in Panama for a price of approximately $ 85/sq.m floor space and for considerably less in Honduras, due to lower wages.

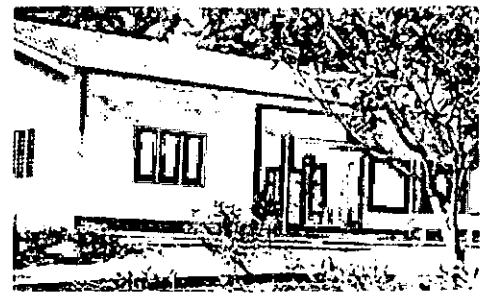
II-d.

Anglo American Timber Company built houses in **Kenya** according to a different system.
First vertical steel profiles were put together to complete house frames. Then horizontally wood wool cement boards were placed in between and connected together and into the steel profiles with mortar, after this the houses were stuccoed.



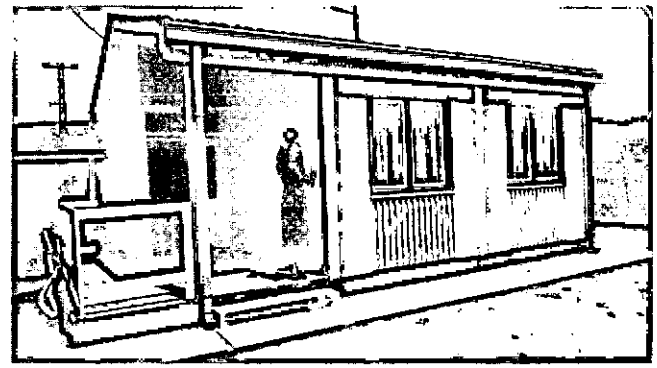


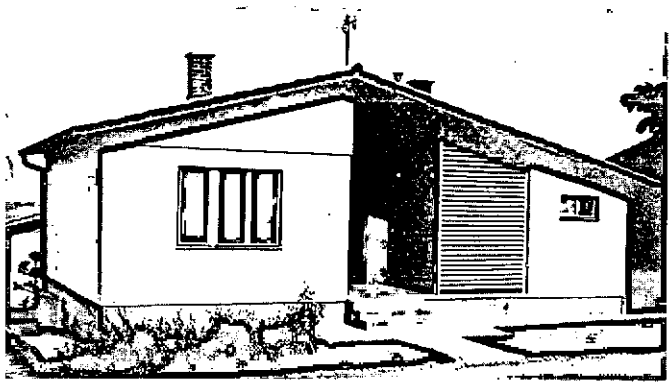
small 3 bedroom bungalow in Johore



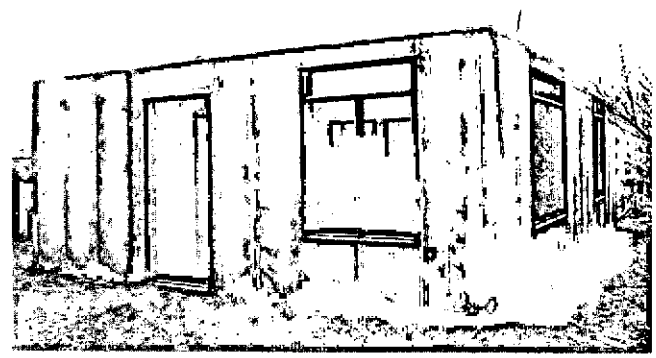
2 bedroom house in Singapore

Model of low cost house, built by Komgrap-Durisol Co. in Belgrade, Yugoslavia.

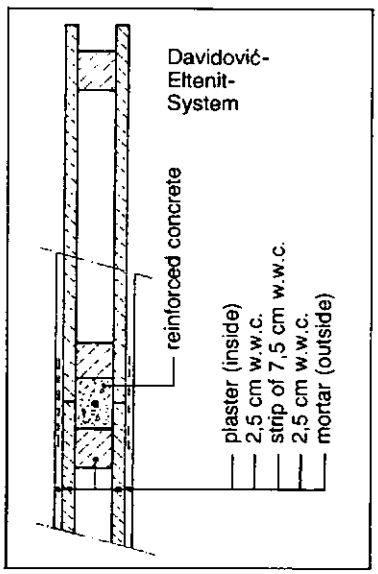


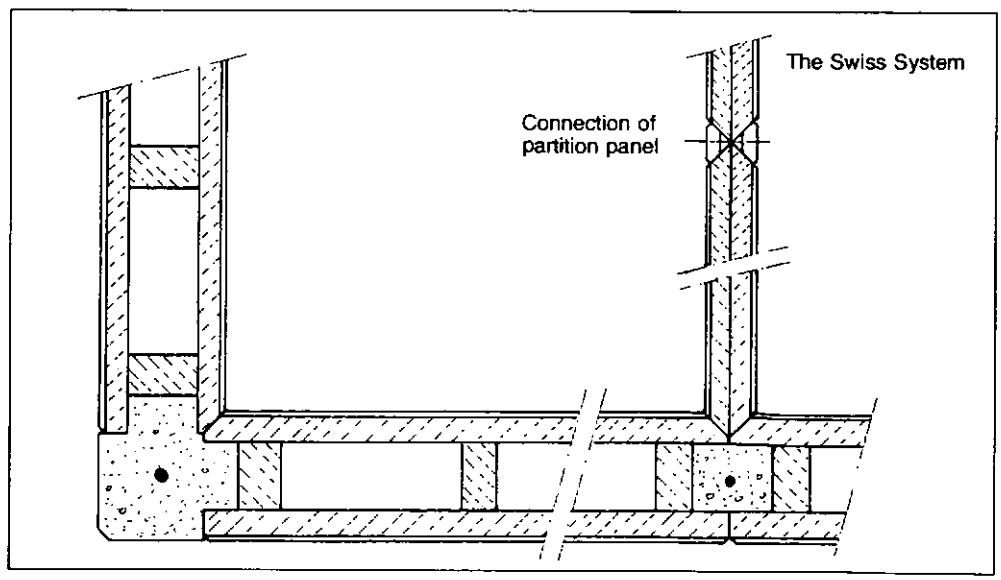


Small one family house built according to the „Davidović"-System.



Eltenit house before painting





III. Houses with Concrete Frames

III-a.

The company Insulations Malaya Ltd., in Jahore, Malaysia, developed a low cost house system according to which plain 5 cm thick wood wool cement boards are placed horizontally on each other.

All joints of the boards are filled with cement and lime mortar, well slushed in and covered with mesh wire on corners, above doors, etc.

These walls get stabilized by stuccoing and plastering.

The plastering is done in two operations and gets a total thickness of at least 13 mm.

For large and long walls extra studs of reinforced concrete are used to give the wall the necessary rigidity and to support the roof.

III-b.

The company Komgrap in Kijevo, Yugoslavia, developed a low cost house system made from wood chips cement boards, called Durisol or Eltosol. After erection, the house is finished with mortar with gravel at the surface, which gives the house a very nice and expensive looking appearance and minimizes upkeep.

To support the roof reinforced precasted concrete beams are used.

III-c.

One of the first manufacturers of wood wool cement products in the world, the late Mr. B. Davidović in Yugoslavia, developed the so-called „Davidović-System", in which two large plain boards by means of two wood wool cement strips near the long sides are glued together with a cement milk.

Placing these panels vertically side by side, at each junction of panels hollow encasements are formed, which are filled with concrete from the top. Also at the top a horizontal concrete beam is formed in the panels, which completes the very rigid frame of reinforced concrete embedded in the panels. A complex built in Belgrade around 1950 at the border of the Danube, was stuccoed in different colours, which created a pleasant atmosphere. The occupants are very pleased with their homes.

III-d.

The Eltenit company in Santa Rosa, Argentine, is installing an Elten plant with a capacity for 4000 low cost houses per year.

The 60 cm wide boards receive already a screed of cement when produced in the moulds.

By glueing two boards together as in the Davidović-System, complete prefabicated panels with a smooth surface are obtained, and can be finished by painting.

The concrete framing is suitable to support a second floor without extra studs.

III-e.

The consulting company L. C. Housing Corporation in Zug, Switzerland, designed low cost houses for an African company according to their system with detachable inside walls.

The panels are of the Eltenit/Davidović type, 120 cm wide and the 3,5 cm boards at the inside (of the outside wall) have 45° tapered sides which adapt at any junction, if wanted, partition panels.

The partition panels are tapered under 90°, so that they fit in the grooves of the outside walls.

The 5 cm thick partition panels are obtained by glueing two prefinished 2,5 cm boards together and are, after that, trimmed to get exact dimensions. By using triangle wooden laths, the partition panels can be screwed together to detachable walls.

Exhibit A

Specification of properties of mechanically manufactured wood wool cement boards.

Specific gravity:

light boards for insulation only:	360 kg/m³
denser boards for roofs and permanent shuttering:	450 kg/m³

Insulation value:

light boards for insulation only:	λ = 0,06 kcal/mh°
denser boards for roofs and permanent shuttering:	λ = 0,07 kcal/mh°

Bending strength: 20-30 kg/cm²

Sound absorption:

for a suspended ceiling of 2,5 cm boards

frequency:	250	500	1000	2000	4000	c/s
absorption coefficient:	0,67	0,48	0,44	0,72	0,73	

Sound transmission:

Resistance of a plastered wall of 5 cm w.w.c. boards:	36-40 dB
Resistance of a plastered double wall with air space in between:	53-57 dB
Resistance of a wall of permanent shuttering with a core of 12 cm concrete:	54-56 dB

Fire Resistance: (tests according to BS 476)

5 cm boards - 1 hour resistance
10 cm boards - 2 hours resistance

Water resistance:

emersed in water for 10 years : no deterioration
being in the ground for 30 years: no deterioration

Fungi resistance:

resistance against dry rot and fungal growth
and also impervious to all forms of vermin

Termite proof:

termites do not attack the product

Workability:

wood wool cement products may be sawn, nailed or
painted and can easily be plastered with mortar or gypsum

ELTEN SYSTEMS
BARNEVELD/HOLLAND

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Telephone (0)3420-12944
Telefax (0)3420-14182
Telex 47408

world consultation on wood based panels
consultation mondiale
sur les panneaux dérivés du bois
consulta mundial
sobre paneles a base de madera

New Delhi, India, 6-16/2/1975

FO/WCWBP/75

EVENING
LECTURE

WOOD WOOL CEMENT BOARDS USED FOR LOW COST HOUSES AND OTHER APPLICATIONS

by

G. J. van Elten
general manager
Elten Engineering
Barneveld / The Netherlands

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE
ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMEN TACION

wood wool cement boards used for low cost housing and other applications

Raw materials:

Wood wool cement boards are made from long woodfibres and Portland cement. The fibres are 1–5 mm wide and from 0,2–0,5 mm thick, depending on the application of the boards.
For acoustical and decorative purposes, the fibres are comparatively narrow but thick in section.
For insulation purposes the fibres are wider and thinner in section.

From one cubic meter of second class wood, three cubic meters of wood wool cement boards can be produced with a density of about 400 kg per cubic meter, however for certain purposes the boards are made denser and somewhat heavier.

Until recently it was believed that only a few kinds of wood, such as pine, poplar and eucalyptus, could be used, but now there is a development towards using also mostly all other kinds of soft wood, making use of a special treatment of the wood.

For a board of 2,5 cm thickness the following raw materials (per square meter) are used:

about	3 kg	wood wool
about	6 kg	Portland cement
about	3 kg	water (salt solution)
total:	12 kg	(wet)

After drying, this board will weigh about 10-11 kg.

Apart from cement, in some countries i.e. U.S.A., Fed. Rep. Germany, Austria and Italy, magnesite is also used as a binding agent.

Origin:

The material originates from Austria and before the last World War the product was already used on a large scale in Austria and Germany.

Expansion:

After the war, the use of the material spread over the whole world.

As an example I may mention that my company since 1960 delivered more than 80 plants to 28 countries all over the world.
With reference to the production increase I refer to the F.A.O.-paper No. 5.18, in which Professor Kollmann mentions the increase of the production in Fed. Rep. Germany from 1947–1961 from 11 million sq. metres to 39 million sq. metres.
I estimate the world production in 1974 at approximately 6 million cubic meter.

New applications:

With a few exceptions, until 1960 the product was quite poor in quality, due to its manual distribution in the moulds and lack of controlled means for dosing, etc.
After mechanical production became accepted, the number of different methods of applications increased, due to superior quality, simpler moulds and mass production allowing lower prices.
The increase in quality is proven by official tests certificates, indicating that for instance the bending strength of mechanically fabricated board reaches up to 5x the minimum requirements of DIN 1101.
Compression strength can reach up to 10x the minimum requirements of DIN 1101.

Because of the even distribution and constant quality, the boards are now increasingly used for decorative purposes and for acoustic absorption.
In this case the boards are not plastered, but spray-painted in many colours and have beveled edges.

Low cost housing:

In developing countries the material proves to be attractive for the production of pre-fabricated panels for low cost housing.
The reason seems to be that apart from the relative low price and its excellent properties, such as high insulation value, fire resistance, termite- and fungi-proof, it can be produced from locally available wood and cement, but also because it can easily be finished with mortar, or plastered or covered with other materials, such as asbestos-, aluminium-, or

plastic-sheets and roofing paper.
It can, due to its light weight, easily be man-handled, so no cranes are necessary.
Also it can be nailed or screwed onto frames of different materials, sawn and painted.
For low cost housing three principal construction methods are used:

1. The boards are nailed or screwed on both sides onto a timber or steel frame and after that finished with one of the materials mentioned before.

2. The boards are furnished with steel channels (see Exh. A-12). This steel also gives structural strength to the house.

3. Sometimes sandwich-panels are used, having a pre-screeded mortar finish on its surface and longitudinal channel-shaped openings on its sides to enable concrete-pouring for framing. This concrete can be reinforced with steel bars (see Exh. A-20-21-22).

The system to be chosen is dependent on the presence of termites and the availability and price of timber and steel, etc., but also on the climatic conditions.
The same applies for the choice of system for covering the walls.
Usually the walls are plastered with mortar on the outside and mortar or gypsum on the inside.

The roof can be constructed from steel channel reinforced wood wool cement boards, covered with roofing paper or shingles.
Another type of roof consists of a wood or steel construction covered with different materials, such as corrugated asbestos, corrugated steel-sheets, corrugated aluminium-sheets or tiles.
In this case the roof should be insulated for instance with wood wool cement boards, connected to the roof construction on the inside, or a suspended ceiling should be installed, especially if the roof is of a saddle-type.

Special applications:

In several countries special applications have been developed which differ very much from country to country.
It is very interesting to notice that products being very succesfully used in one country, will not be sold at all in another country, in which another special application is popular.
However, in many countries one observes a parallel development from plastered to *unplastered ceilings* for increased acoustic value, whereas in most countries *roofing* is very popular with all kinds of shapes, compositions and dimensions of boards.
Further, because of its insulation value in certain countries exists an increased interest to use it as *permanent shuttering* of concrete walls, mainly for high rise apartment buildings and cooled or heated factories, warehouses, etc.

For instance a 12 cm concrete wall poured in between two wood wool cement boards of 5 cm thickness each, after plastering or covering with sheet material, will have an insulation value equal to a 102 cm brick wall (see a.o. F.A.O.-paper No. 5.18)

Several systems for permanent shuttering have been developed.
Most of them make use of plain boards being assembled on site to form the shuttering using spacers of steel wire.
During assembling and concrete pouring the shuttering boards are supported by a provisional timber construction.
Other systems make use of a wood wool cement board on the outside and a gypsum board or a sandwich board from gypsum and wood wool cement on the inside for easier plastering.
According to the Thermoklith-system, elements of 25 cm high and 1 meter long, are pre-fabricated into rigid light-weight elements which can be placed upon each other without any support and then filled with concrete.

For finishing these walls, several systems exist, such as plastering with gypsum on the inside and mortar

on the outside, or covering the walls on the inside with gypsum boards and on the outside with Eternit boards (Glasal), aluminium-sheets, plastic-sheets, tiles, etc.

In some countries so called *sandwich boards*, consisting of a styrofoam core and two layers of wood wool cement, are increasingly popular, especially where high insulation values are necessary.
Also this type of board is used to give styrofoam boards a fire protection and more rigidity.

In some countries wood wool cement boards are reinforced on their longitudinal sides with male and female U-type steel channels to give them structural strength for a free span up to 6 meter or even more.

In other countries, because of their low price, low weight and acoustic property, wood reinforced roof boards are very popular.

In exhibit A, you can see several types and shapes of elements incorporating wood wool cement material for different applications.

On hand are several slides, made in different countries.
I will show buildings and explain construction details of low cost housing and other applications.
The slides will show in particular:

1. low cost houses
2. roofing
3. permanent shuttering
4. ceilings
5. decoration
6. acoustic purposes
7. fire protection

Often the purpose of application is a combination of requirements.
For instance a roof of wood wool cement boards is light in weight, economic in price, insulates against heat and cold and absorps noise.

Durability:

Because the wood wool is petrified by the cement, it has a very long life.
Boards produced 50 years ago are still in good condition.
A test house, built in the Netherlands in 1945, has been used as a house for a long time and is now being used as an office.
In exhibit B, the main properties of the material are listed.

Future prospect:

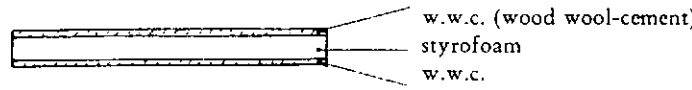
In view of increased demand for comfort and the existing and expected governmental instructions to reduce noise in schools, offices, etc., more and more wood wool cement boards will be used as suspended ceilings and as roofs on warehouses and factories.
Further it is expected that permanent shuttering will obtain a larger share of the market, because of its energy saving and added comfort and moreover because certain countries have already prescribed larger insulation values for buildings.
Finally, in view of the tremendous demand for low cost houses and the possibilities of producing durable panels at low cost from locally available raw materials, an increased application of wood wool cement products can be expected.

Ing. G. J. van Elten
Barneveld - Holland

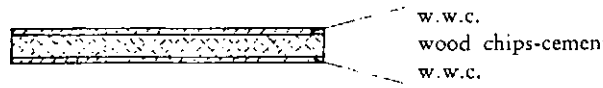
special products of wood wool cement

Exhibit A

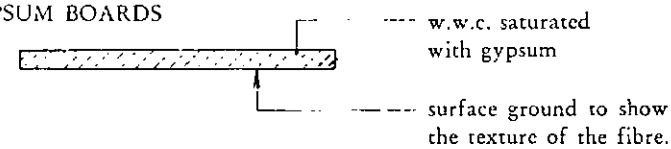
1 SANDWICH BOARDS
light weight with
increased insulation value



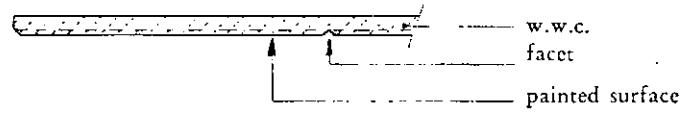
2 TRIPLO BOARDS
with a core of wood chips-
cement



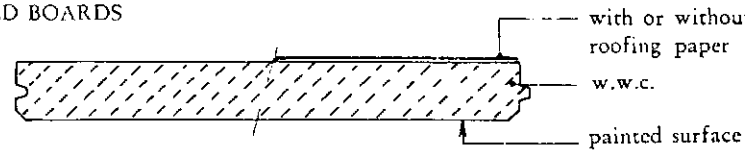
3 WOOD WOOL CEMENT - GYPSUM BOARDS



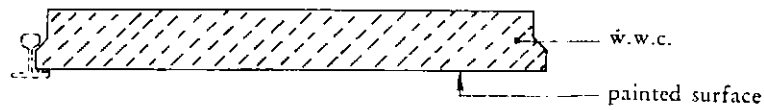
4 FACET BOARDS
facets dividing the boards
in 1, 2 or 4 faces



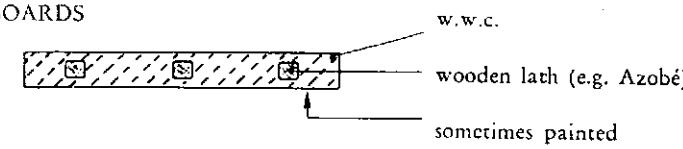
5 TONGUED AND GROOVED BOARDS
used as roof boards,
transversal on the
purlins



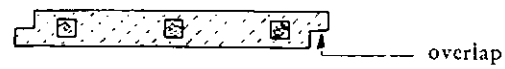
6 BULB T SYSTEM
roof boards
on bulb T profile
steel



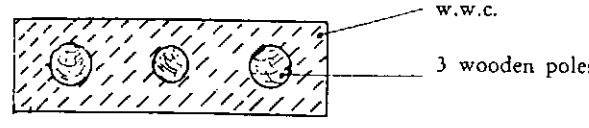
7 WOOD REINFORCED ROOF BOARDS
(1 m span)



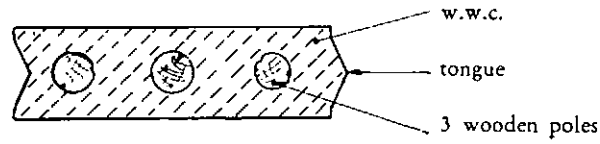
8 WOOD REINFORCED ROOF BOARDS



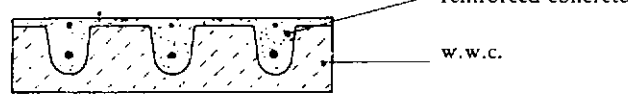
9 WOOD REINFORCED ROOF BOARDS
(2 m span)



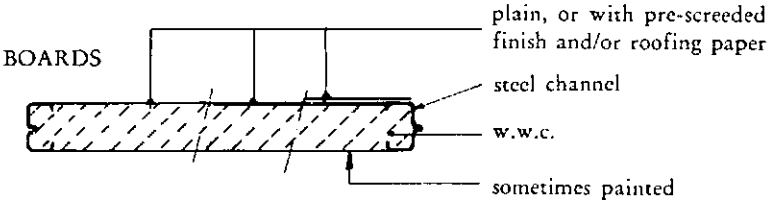
10 WOOD REINFORCED ROOF BOARDS
with tongue and groove



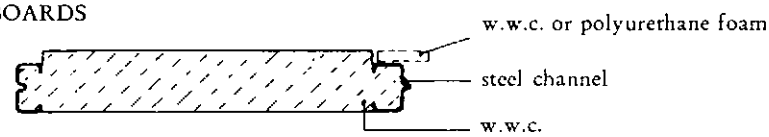
11 CONCRETE REINFORCED ROOF BOARDS
with mortar finish



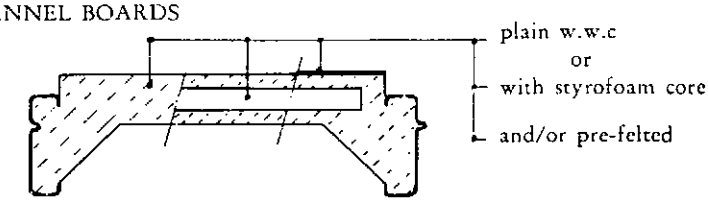
12 STEEL CHANNEL ROOF BOARDS
(2–4 m span)



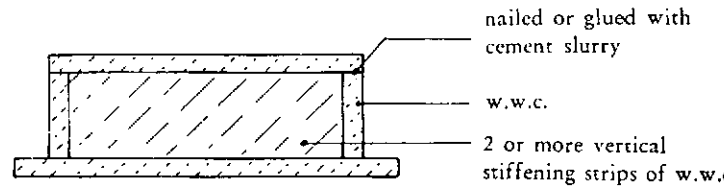
13 STEEL CHANNEL ROOF BOARDS
with rebate and infill
(for humid conditions)



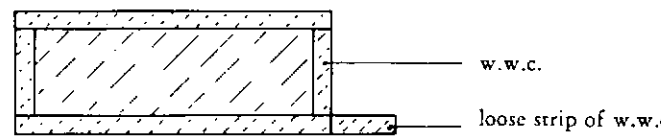
14 LONG SPAN STEEL CHANNEL BOARDS
(4–6 m span)



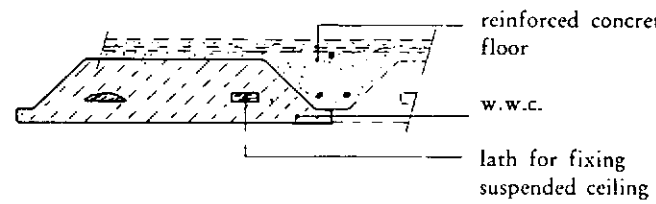
15 FLOOR UNITS
(assembled)



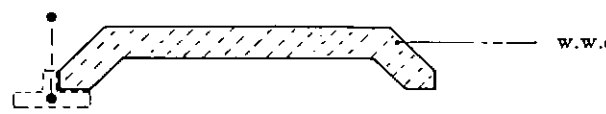
16 FLOOR UNITS
(assembled)



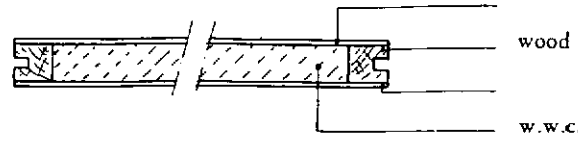
17 FLOOR UNITS



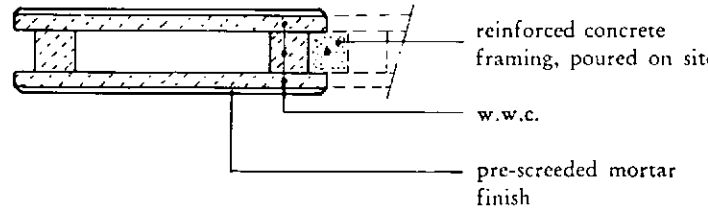
18 FLOOR UNITS



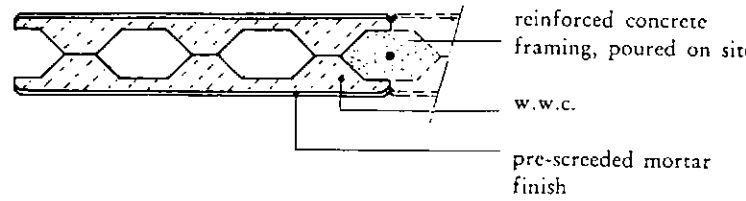
19 WALL PANELS



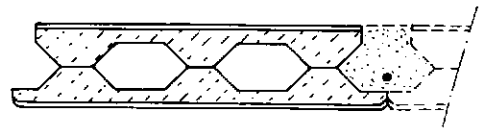
20 LOW COST HOUSE ELEMENTS DAVIDOVIĆ SYSTEM
(assembled) with pre-screeded finish of mortar



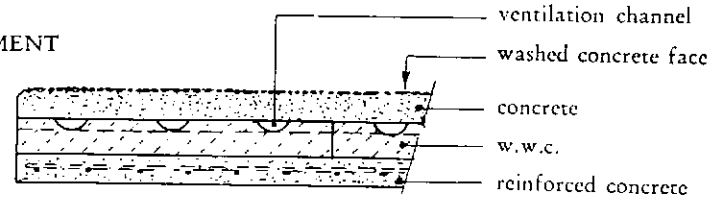
21 LOW COST HOUSE WALL ELEMENTS ELTENIT SYSTEM
with pre-screeded finish of mortar



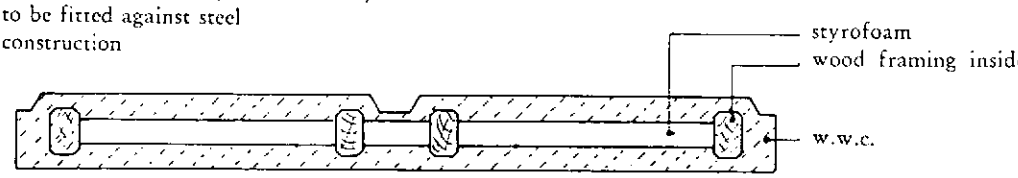
22 LOW COST HOUSE ROOF ELEMENTS



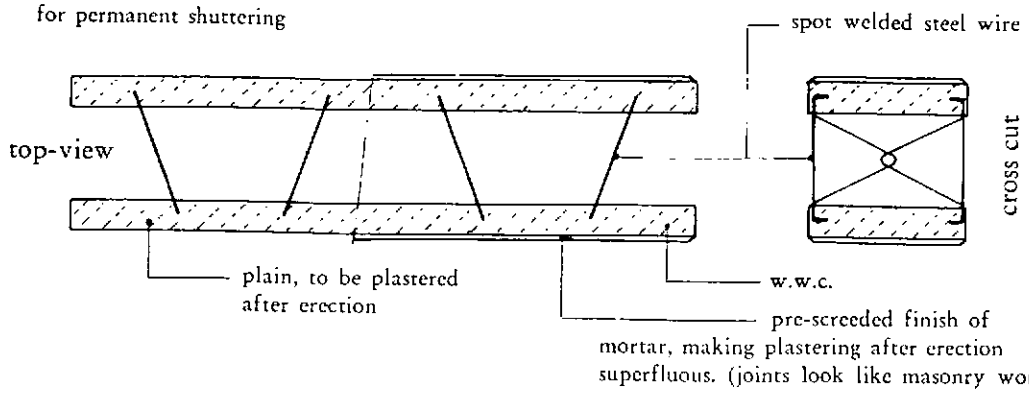
23 INSULATING FRONT ELEMENT
(ventilated)



24 WALL ELEMENTS (3-M SYSTEM)
to be fitted against steel construction



25 THERMOKLITH ELEMENTS
for permanent shuttering



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elten
systems
barneveld – holland

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