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PRODUCTION AND ERECTION OF AUTOCLAVED LIGHT-WEIGHT PANELS[1/]

by

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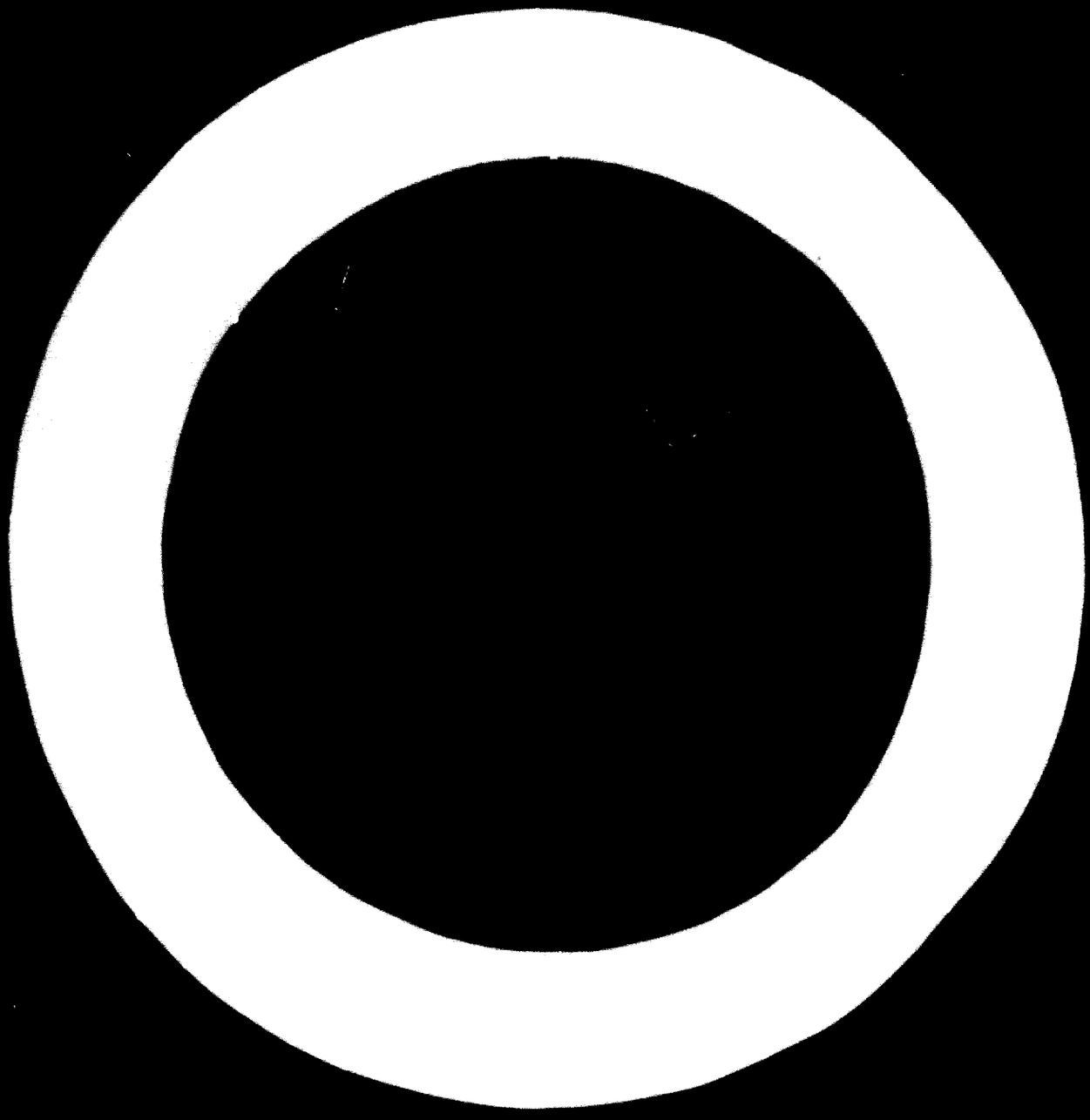


1. Generalities

The autoclaved cell concrete is a new material of our time with various utilization in construction works.

This material is an artificial stone with evenly distributed pores; it is prepared of an inorganic binding agent (cement, lime), a finely grounded material with a high content of silica (sand or ash), an expanding material (aluminium powder) water and eventually additives.

The autoclaved cell concrete is characterized by its low weight, its great compression strength in relation with the apparent density, great sound absorbing and heat insulating capacity and its minimal contraction.

The autoclaved cell concrete is four times lighter than the heavy concrete and three times lighter than the brick masonry; it is also lighter than water and because of this it floats on water surfaces.

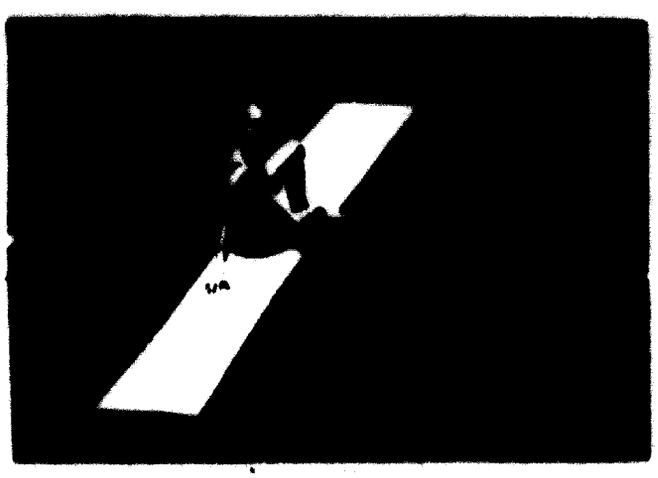


Fig. 1. The autoclaved cell concrete floats on the surface of water.

The autoclaved cell concrete is a very good heat insulating; in buildings constructed with autoclaved cell concrete elements the heating costs are in winter considerably lower, while in summer such buildings offer a cool shelter against excessive heat (Fig.2).

Fig.2. The autoclaved cell concrete is a very good heat insulator

The autoclaved cell concrete behaves very well at extreme temperatures and has a great resistance to abrupt changes of temperature: when heated at a very high temperature - above 2000°C - and sprayed with cold water it doesn't break. The autoclaved cell concrete precast elements can be utilized also as fire proof materials. (Fig.3).

Fig.3. The cell concrete is very resistant at extremely high temperatures

Due to its apparent low density and to its homogeneous structure, in which the minute pores are evenly distributed the autoclaved cell concrete can be processed as easy as timber, namely

- it can be perforated with a borer
- it can be cut with a saw
- it can be planed
- it can be carved with an ax.

Fig.4. Tools for processing cell concrete elements

In cell concrete nails can be driven in, grooves can be executed with aid of a plain chisel, metal or plastics dowels can be fixed in to take up screws and the surfaces can be smoothed with the aid of a mason's float on wich glazed paper has been fixed (Fig.4).

2. Physical and mechanical characterization

The autoclaved cell concrete had in its entire mass a fine porous structure, the pores of which are of approximately 3 mm. The variation of the apparent density between the upper and the lower portion of the material is no more than 10%.

The main characteristic of the autoclaved cell concrete is its low apparent density. Depending of the value of the apparent density in dry condition, the cell concrete can be currently produced in 400 ÷ 500 and 600 kg/m^3 assortments.

The apparent density is measured by using cubes with 100 mm sides or cylinder with 113 mm and 226 mm height, dried at 105-110°

until they reach a constant weight.

The compression strength of the autoclaved cell concrete hangs on the following factors: the apparent density, the moisture content the dimensions of the tested samples, the direction in which the load is applied in relation to the mass expanding direction etc.

The compression strength is one of the important characteristics of the autoclaved cell concrete, on which the strength calculation of the precast elements is based and which determines the concrete mark.

The compression strength is measured on similar samples as those utilized for measuring the apparent density.

The types of autoclaved cell concrete being now produced have the compression strengths and the apparent densities given in table I.

Table I

Type of concrete	Quality class	Apparent density kg/cm	Compression strength kgf/sq cm
400	GSB 25	450 ± 50	25
500	GSB 35	550 ± 50	35
600	GSB 50	650 ± 50	50

As the moisture content increases, the strengths of the autoclaved cell concrete diminish. At a moisture content of 10% of the mass, the compression strength is only 0,8 and at of the moisture content reaches 20% of the mass it diminishes to 0,7, tending towards a constant value of about 0,65 (Fig.5).

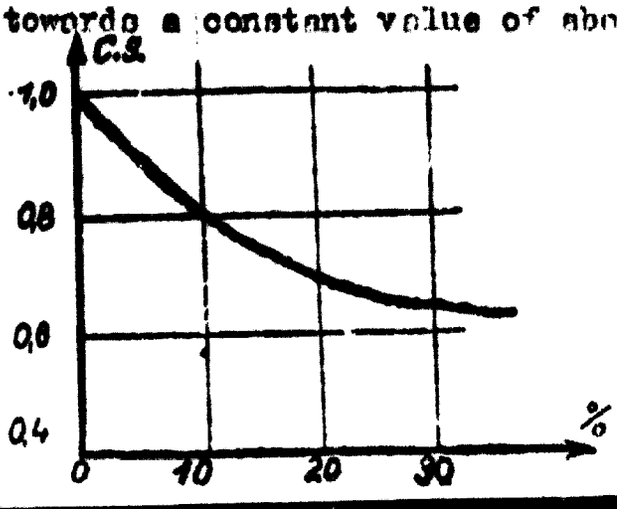


Fig.5. The variation of the compression strength in relation with the moisture content of the mass of the cell concrete

Another main characteristic of the cell concrete is its thermal conductivity. The thermal insulating capacity of the material is closely related to its apparent density, varying from a value of 0,08 kcal/mh°C for the 400 type to 0,15 kcal/mh°C for the 600 type (Fig.6).

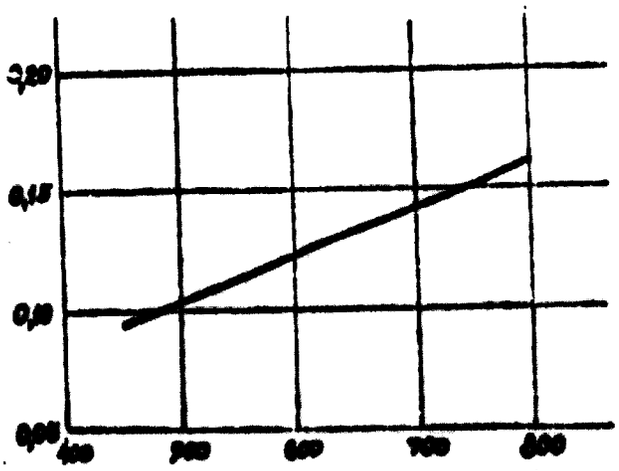


Fig.6. The variation of the thermal conductivity in relation with the apparent density.

The main characteristics of the autoclaved cell concrete are shown in table II.

Table II

Technical data	Concrete quality		
	CBCA 25	CBCA 35	CBCA 50
- Apparent density in dry condition kg/cm	450 ± 50	550 ± 50	650 ± 50
- Compression strength kgf/sq cm(minimum)	25	35	50
- Thermal conductivity at 20°C, kcal/m.h.°C	0,08-0,09	0,10-0,12	0,15-0,17
- Linear contraction mm/m (maximum)	0,5	0,5	0,5
- Cold resistance measured for 15 alternating freezing-thawing cycles:			
- mass loss % (maximum)	10	4	3
- diminshing of compression strength,% of volume (maximum)	-	15	10
- capillary rise, cm.(maximum)	13	13	13
- water absorbtion,% of volume (maximum)	40		

Observation_. With the exception of the linear contraction, all other technical characterization are measured on samples dried at 105-110°C, until they reach a constant weight.

3. Manufacturing technology

The autoclaved cell concrete is manufactured in modern industrial units, equiped with plain technological plants of high productivity.

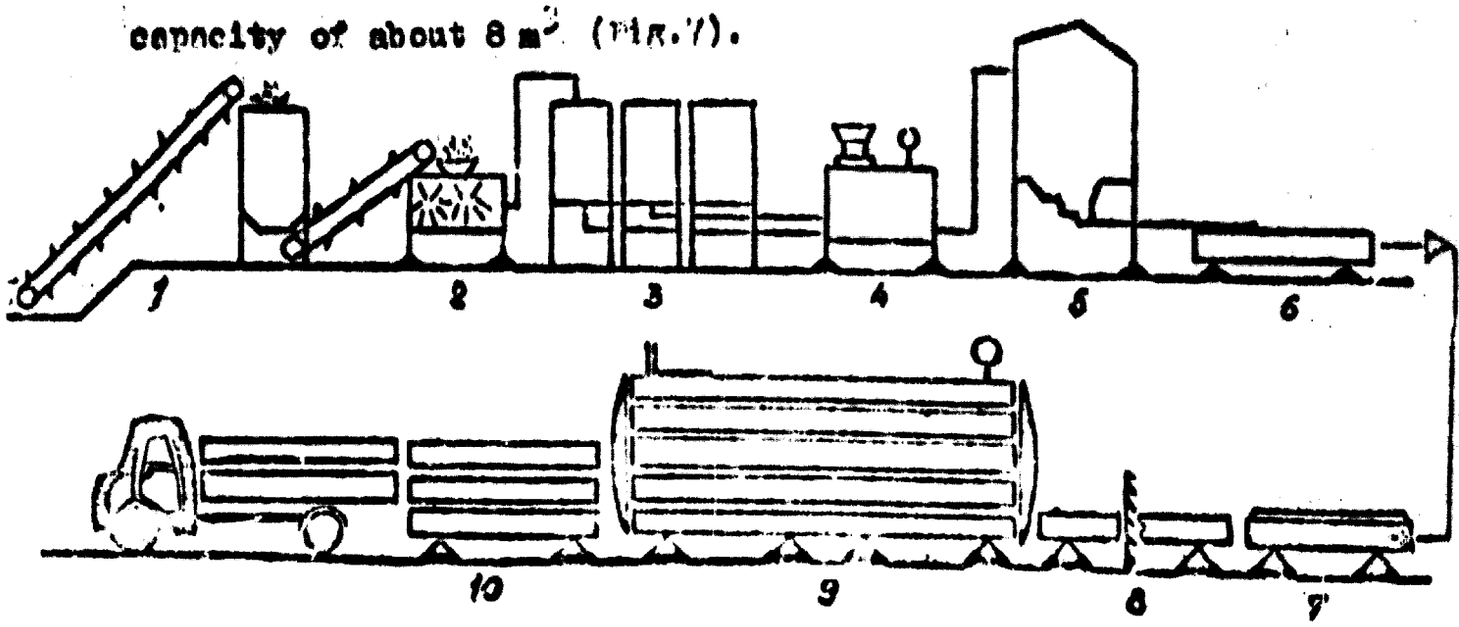
The cell concrete consists of about 70% sand/20% binding agent and lime and about 1% different additives.

The raw-materials utilized are ordinary pit sand or ash from thermal power stations, building lime intensely burnt and Portland cement.

In principle the technological sequence of apparition for the fabrication of autoclaved cell concrete is the following :

-The sand is first milled in tube mills, the obtained slurry being then stored in homogenizers (3).

-The dosage of the various components takes place in an automatic or semi-automatic plant (4) with the aid of which two different mixing formulae composed each of seven various components can be simultaneously, obtained. The concrete mixing is carried out in a stationary or in a mobile concrete mixing machine of a capacity of about 8 m^3 (Fig.7).



The fresh concrete is then cut in metal moulds of wich the dimensions are 6000 x 1200 x 600 mm.

About four hours after casting, when the cell concrete mass has sufficiently hardened (7), respectively when it has reached a minimal strength to be taken up and transported, the concrete blocks are transferred to the cutting station (8) where, after removing the calotte and the lateral sides, the cell concrete mass is cut to the desired dimensions and the necessary shapings on the outline are carried out.

After being cut and shaped, the concrete block is introduced in an autoclave and submitted to an about 12 hours lasting thermal in saturated vapours at 12 atm pressure and about 200°C temperature (Fig.8).

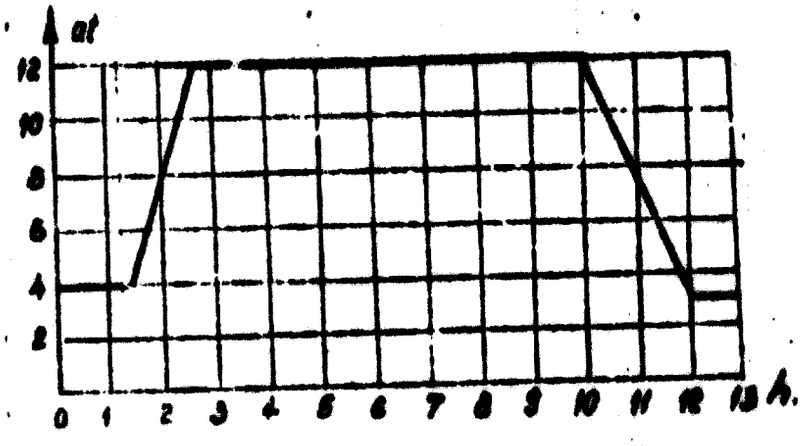


Fig.8. Diagram of the heat treatment in autoclaves.

The treatment is followed by the striking and by the eventual cuting and drilling out operations, after which the cell concrete is packed, marked and stored until it is delivered (1e-11).

4. Precast elements of autoclaved cell concrete

The autoclaved cell concrete precast elements most frequently used in constructions are small blocks, wall and insulating plates, wall strips, roof plates etc.

a) Elements of plain autoclaved cell concrete

1.1 Small blocks and wall plates(Fig.9):

- length 60 cm
- width 24 cm
- thickness 12,5-25 cm (can be varied from 25 to 25 mm)

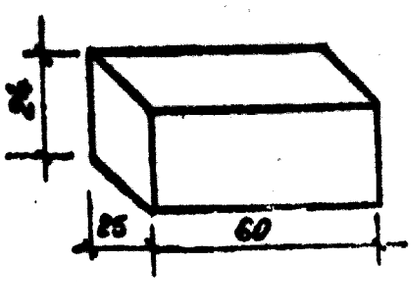
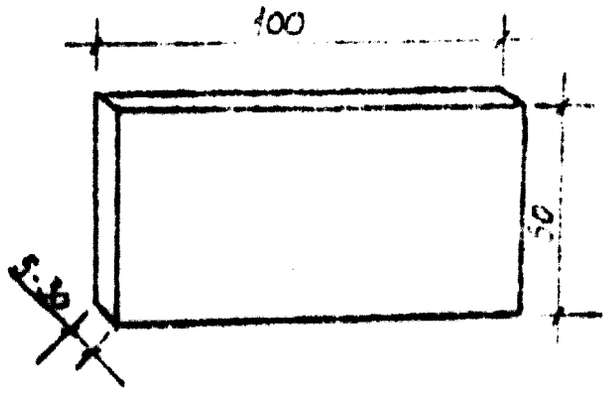


Fig.9. Small wall blocks.

4.2. Thermal insulating plates (Fig.1o).



- length 5o-1oo cm
- width 6o cm
- thickness 5-3o (can be varied from 25 to 25 mm).

Fig.1o. Thermal insulating plates.

b) Reinforced cell concrete elements

4.3. Strips for resistance and partition walls, internal and external :

- length 2oo-6oo cm
- width 6o cm
- thickness 7,5-3o cm (can be varied from 25 to 25 mm);

the wall strips can be executed with straight or shaped (groove and tongue) longitudinal sides (Fig.11).

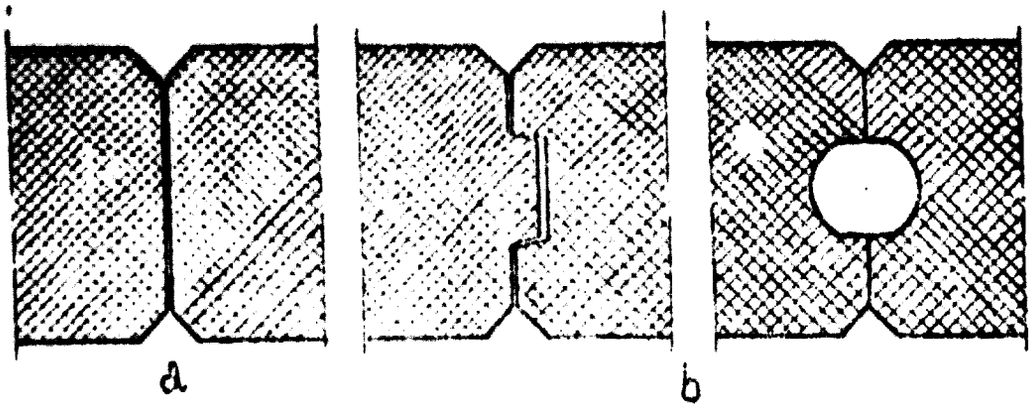
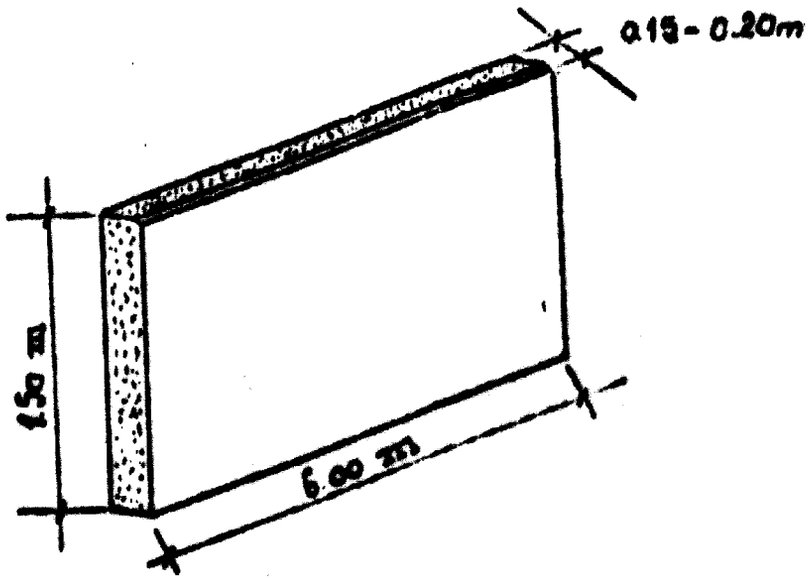


Fig.11. Internal and external wall strips:
a) with straight longitudinal sides
b) with shaped longitudinal sides.

4.4. External wall panels :

- length 200-600 cm
- width 60 cm
- thickness 15-30 cm (can be varied from 25 to 25 mm).

4.5 Large panels for external walls (Fig.12):



- length 600 cm
- width 60 cm
- thickness 15-20 cm.

Fig.12. Large panels for external walls.

4.6 Roof plates (Fig.13):

- length 200-600 cm
- width 60 cm
- thickness 12,5-25 cm (can be varied from 25 to 25 mm).

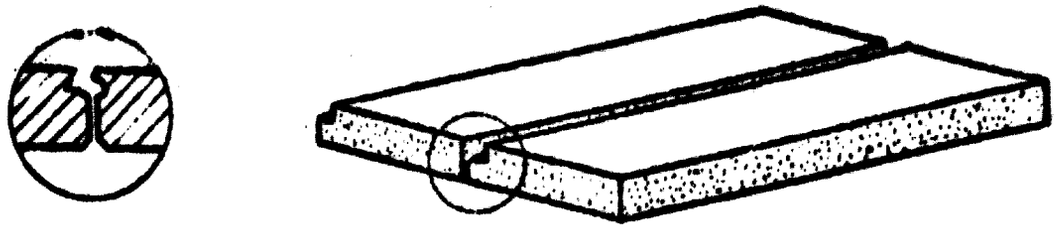


Fig.13. Roof plates.

4.7. Floor plates (Fig.14)

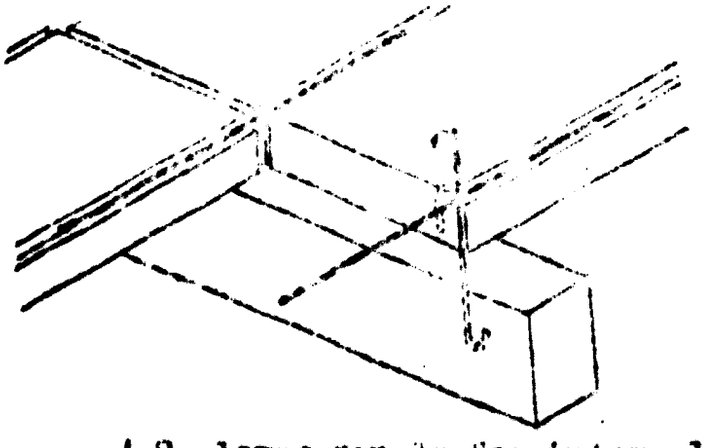


Fig.14. Floor plates.
- length 200-600
- width 60 cm
- thickness 15-30 cm.

4.8. large panels for internal and external walls obtained by assembling several wall strips (Fig.15):
- length max.600 cm
- width 250-300 cm
- thickness 15-25 cm

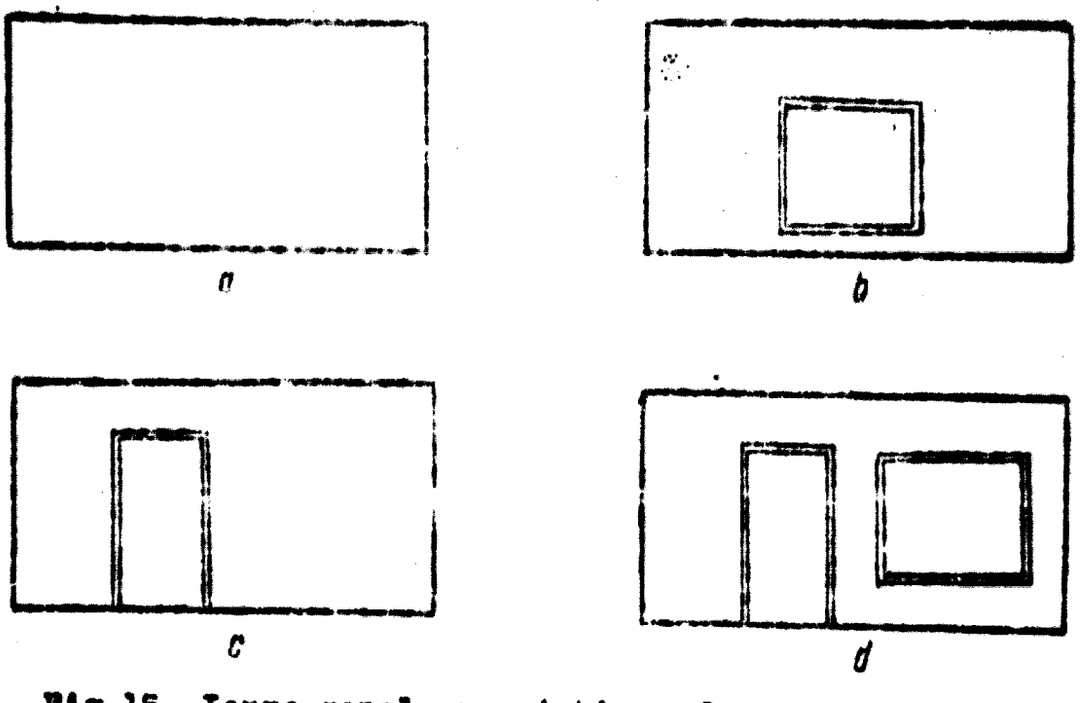


Fig.15. Large panels consisting of assembled strips:
a) full
b) with window recess
c) with door recess
d) with window and door recesses.

The cell concrete precast elements are characterized by the great precision of their dimensions (of the millimetre order of magnitude) with boundary angularities and plane and parallel surfaces. (Table III).

TABLE III

	Dimension deviations		
	Thickness	Width	Length
Reinforced elements	± 2 2	± 2 2	± 5 3
Plain elements	+ 1 - 2	+ 2 - 2	+ 2 - 2

The wall blocks and thermal insulating plates are delivered on wooden pallets protected by polyetylene sheets.

The reinforced cell concrete elements are delivered as bundled packages with the edges protected by corner cramps; the packages are covered with polyetylene sheets (Fig.16).

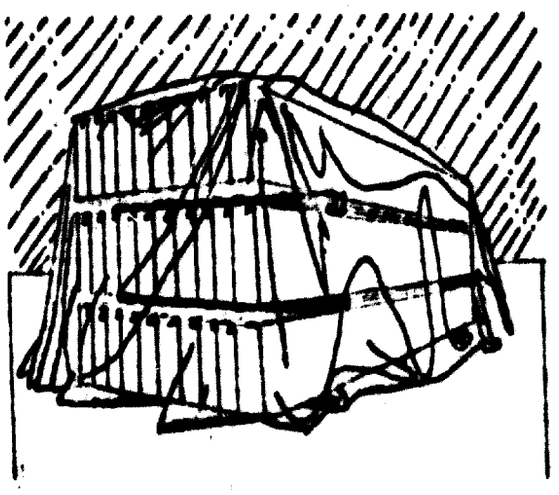


Fig.16. Bundled packages of reinforced cell concrete elements protected by polyetylene sheets.

The handling of the pallets and of the packages is carried out by usual fork-lift trucks or by autocranes equiped with similar lifting devices.

The products must be stored on plane surfaces; at the ends at distances of approximately 1/5 of their total length, they must be laid on supports of uniform thickness.

5. Utilization of the autoclaved cell concrete precast elements.

Due to the multiple advantages they offer the autoclaved cell concrete precast elements are utilized for all types of

constructions, as : residential and office buildings, motels, [illegible] palaces, prefabricated constructions etc.

5.1 The small blocks and the plates of autoclaved cell concrete (4.1) are used in the same way as the bricks, for the construction of external and internal resistence or of partition walls. The masonry is executed either from entire blocks or plates or from portions of such elements, after cutting them to the required dimensions with the aid of a saw; usual tools and utensils for the brick masonry and a common mortar prepared from cement and lime are used.

Due to the high precision of the shape and size of these blocks and plates, the masonry can be executed with narrow joints of 1-2 mm and with adhesive mortar. Masonries with such narrow joints need less mortar; at same time walls without thermal bridges with a smooth surface are obtained, on which transparent or opaque lacquer finishes various colours can be directly applied.

This way one of the main advantages of the utilization of cell concrete precast elements is demonstrated, namely the elimination of wet processes during the mounting and finishing operations (various stages which classical methods were carried out in wet state are carried out in this case in dry state). The consequence is a considerable shortening of the execution time and a corresponding increase in productivity.

In walls of cell concrete elements grooves for electric wiring can be readily executed and sanitary outfits can be fixed on vertical supports or on consoles anchorated in the masonry.

The door and window frames can be fixed with common nails while the conduits for indoor installations can be mounted either apparently or masked by cell concrete plates.

Walls executed from small cell concrete blocks can be let

incovered or various coloured coatings can be applied, such as water colour or oil paintings, washable wall papers, ceramic or faience plates etc.

The exposed masonry must be protected by a two layers lacquer film.

5.2 The thermal insulating plates manufactured from autoclaved cell concrete (4.2) can be utilized for the thermal insulating of external walls, of terraces and roofs, of basement floors as well of other constructive elements of materials looking thermal insulating proportion.

5.3 Wall strips (4.3) are utilized either for internal resistance and partition walls or for external walls.

By using wall precast elements a large range of residential building types can be realized, some structural systems of which are shortly described below :

- Structure with transversal resistance walls (Fig.17); no window recesses exist in the external transversal walls which form uninterrupted membranes. The internal walls have door recesses. The distance between the transversal walls is of 4-5 metres. The main advantage of this solution is the fact that only a small number of plate types for the roof are needed.

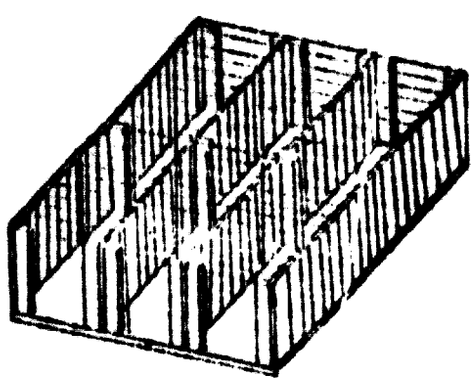


Fig.17. Constructive structure with resistance transversal walls.

Another structure with a more free solution consists of two longitudinal internal resistance walls, with other openings then the necessary window - and door recesses and of transversal walls perpendicular on the first ones to the stiffening of which they contribute (Fig.18).

If this solution is adopted the windows can be directed towards all cardinal points.

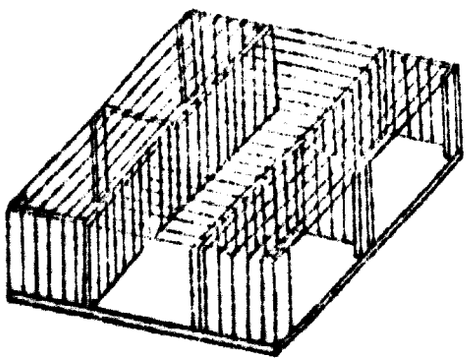


Fig.18. Constructive structure with longitudinal resistance walls.

Another type of used structures consists of four perpendicular crossing resistance walls. The building is usually square and needs a single length of roof plates. The square hollow space in the floor above the ground-floor is covered with a lighting cupola made of transparent plastics and provided with double walls so as to ensure the thermal insulating.(Fig.19).

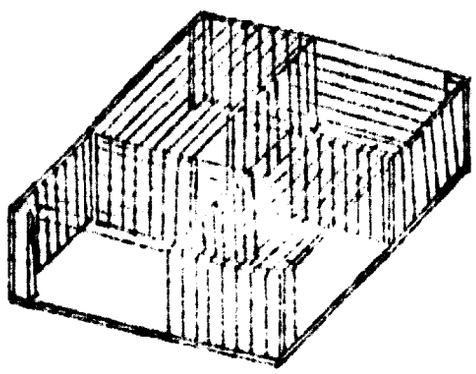


Fig.19. Constructive structure with four crossing

The thickness of the external walls is between 15 and 25 cm depending on the climatic conditions. For joining the strips are provided with filling spaces on the narrow-sides in which cement morter is cast after mounting. In the groove on the upper side a ϕ 12 mm rod of steel for reinforced concrete is embedded, while the binding between the wall and the floor is realized by steel rods which are curved at a 90^{0} angle or are provided with mounts which penetrate in the vertical joints between the wall strips and in the floor. (Fig.2o).

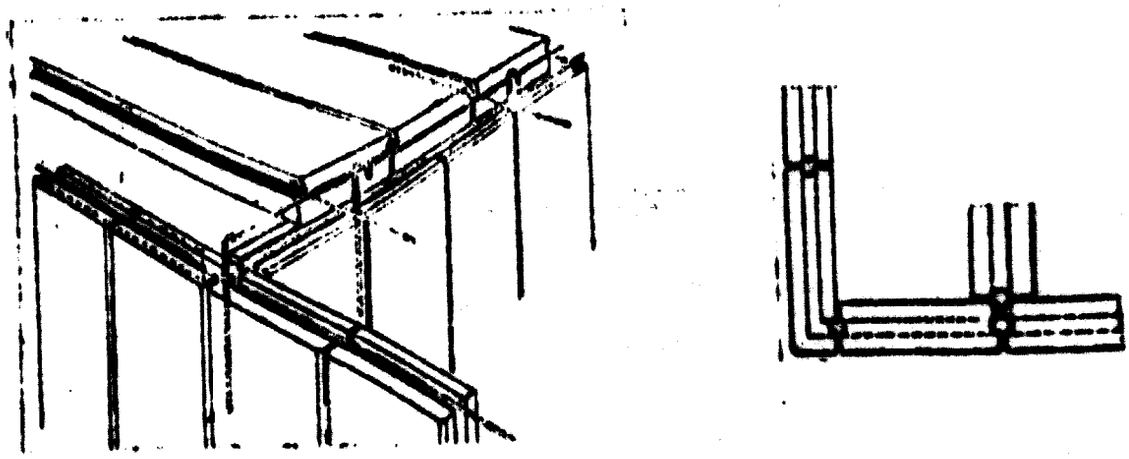


Fig.2o. Details of the joining between the wall strips and the floor plates.

The mointing operations for a ground-floor building constructed of vertical strips are carried out with the aid of an autocrane or of a carriage disposing of a plain device to catch the strips. Before mounting the outer edges of the strips must be beveled with a plane; this operation is most easily executed while the strips rest horizontally on the carriage.

Firstly the strips are laid on a bed of morter and afterwards they are fixed in the final vertical position with the aid of wooden wedges. After all strips of which a wall consists have been so mounted, the joints are filled with cement morter so as to obtain a monolith. The mounting of vertical strips is a highly productive operation. A three workers gang can mount more than

40 sq m per shift,

5.4 By assembling several strips large panels (4.8) are obtained wich can be utilized as resistence elements for ground-floor or for ground-floor + 1 storey buildings as well as closure elements for buildings with more levels.

5.5. The roof plates (4.6) can be easily and rapidly, the operation is highly productive manted; a 5-6 men gang being able to mount more than 400 sq m of roof daily. (Fig.21).

Fig.21. A roof of reinforced cell concrete plates.

If the buildings are erected in zones exposed to earthquake the joint action of the pl tes in taking over the horizontal forces in the roof plane is ensured by dowels and by continuity fittings placed in the joints. The dowels and the joints must be monolithized by filling with concrete.

5.6 The panels for external walls (4.4) can be utilized either horizontally or vertically for closing industrial houses. They are adequate for the various concrete or metal structures of such buildings and by their utilization a great diversity of façades can be obtained such as screened or glass façades, with solution or mixed windows.

The fixing systems between the panels and the structure of industrial houses are simple and they guarantee the take-offer

of the horizontak forces due to the wind or to seisms.

The joints between the panels can be filled with concrete or adhesive mortar, so as to form a monolith.

5.7. The buildings for which precast autoclaved cell concrete elements are used can be more rapidly and in a more simple way erected than the traditional ones: all wet internal and external plastings are eliminated and the productivity is raised more than 4 times. For walls consisting of autoclaved cell concrete elements a great variety of finishings of various colours can be choosen.

On the indoor surfaces water colour or oil colour paintings, paper tapestry, CERAROM plates or faience can be applied.

The outdoor surfaces can be finished by plainly applying paintings on synthetic resins base, either transparent or coloured.

The buildings of precast autoclaved cell concrete elements distinguish themselves by their attractive aspect; they perfectly fit in any architectural ensemble and offer best conditions of comfort.

The utilization of precast cell concrete elements for whole structures or as independent elements in the framework of structures of another type has obvious qualitative and economic advantages and accelerates the execution rhythm of constructions.

5.8. Through its specialized units the Industrial Central for Precast Concrete Elements develops multilateral activities most, various fields as research, design, production and mounting; all those units offer their technical assistence in problems refering to:

- Designing of various types of buildings and the utilization of precast autoclaved cell concrete elements for such buildings.

- The designing, construction and putting into service of process lines for the fabrication of cell concrete.

During its long activity the Industrial Central for Precast Concrete Elements has accumulated a vast experience in both fields of production and utilization of such elements; the good results obtained are a confirmation of this fact.

The Central has realized constructions of a great variety of types, such as rural and urban residential buildings, towrist villas, motels, bungalows, hotels, transformer stations, industrial and agro-zootechnical buildings etc.

In view of the many advantages offered by the cell concrete, our Central will continue to further develop in the future this branch, as well for internal use as for export.

Specialists belonging to the Central are ready to offer their technical assistance as well as any kind of information to all those interested in problems of research, design production and utilization of precast autoclaved cell concrete elements.

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