



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

Engl & Fran

09181

UNITED NATIONS INDUSTRIAL
DEVELOPMENT ORGANIZATION

Distr.
LIMITED
UNIDO/EX.56
23 October 1978
ENGLISH

LOW COST BUILDING SYSTEM^{a/}

POLSERVICE
Warsaw, Poland

001331

^{a/} This document has been reproduced without formal editing. The views expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO.

id. 78-7414

Our low-cost building system is particularly effective in areas where large distances, poor infrastructure and lack of construction equipment prevent introduction of industrial methods of large-scale building.

In all such cases our system is best suited, since not only does it not require any heavy machinery, but it can also make use of locally available building materials or even industrial wastes. The only equipment needed is a hollow blocks machine producing a whole line of elements, which can be assembled in various ways according to individual needs, and the hollow part is then filled with some material serving dual purpose: thermal insulation and stabilization of the structure.

The principal features of the system are:

- possibility to use cheap local materials and industrial wastes;
- limited use of expensive and sometimes hard-to-get materials such as steel and cement;
- simplified construction of buildings enabling erection with only a few types of elements and without any equipment;
- assembly of buildings can be done by their future inhabitants, since it requires no particular skills;
- fast assembly and extremely low costs.

Our system consists of two main types of elements, i.e. wall elements and ceiling (roofing) elements. Additionally, there are four types of wall elements and two ceiling (roofing) elements. These types enable construction of houses of practically any design and any size with rooms up to 5.40 m long. (The only limiting factor is the length of the ceiling elements. Handling of longer elements would require additional lifting equipment.)

Elements are produced in a simple plant equipped as follows:

- hard surfaced area for production and storage of ready elements;
- space for storage of gravel, sand, cement, lime, etc;
- forming equipment (hollow blocks machines and moulds);
- workshop, stores and office buildings;
- weather protection;
- reinforcement section;
- supply of water and power; access roads.

A diagram is attached to illustrate the technological process. Such a plant is actually working and turning out approximately 200 family houses a year. However the size of the plant and its equipment can be altered according to the intended production volume. Moreover, expansion of the plant can be done at any time with very low investment outlays.

As mentioned above, the basic equipment for elements production is the hollow blocks machine. The diagram attached shows a model produced by the Stalowa Wola Steel Works. It is mounted on a chassis, electrically powered and hydraulically steered, produces elements out of cheap and easily available materials such as sand, gravel crushed stones, rubble, tree bark or wood shavings mixed with cement slurry.

Concrete mix is prepared in a concrete mixing unit from where it is transported by electric carts to the hollow blocks machine. There moulds are filled with the mix, elements shaped, pressed out of moulds and deposited on the ground while the machine, at the rate of 6 meters a minute, proceeds to the next position, where the process is repeated.

Spaces left between ready elements in a row are 20 to 30 cm and between rows approx. 40 to 50 cm. The turning radius of the machine is 2 meters. It is operated by only one man provided a steady supply of concrete mix is assured.

With recent innovations introduced, it is possible to produce elements which require no plastering since wallpaper can be glued directly on them.

The most important feature of our system is its economy. Our houses are remarkably successful in terms of economy as compared to houses built traditionally. Thus, it was observed that our system saves about 40 to 45 per cent on labour, 25 to 30 per cent on transport costs, while the total construction period is shortened by 25 to 30 per cent. This is the result of efficient organization of planning, designing and of all construction stages.

On the whole, our houses are 40 to 60 per cent cheaper than the traditional method.

In each case, however, final economic results depend on proper implementation of all features of the system, listed at the outset of the article, which must be considered individually for each project.

And it is our task to assist our clients in deciding which solutions to adopt in relation to local conditions.

House Design

Thanks to the fact that elements needed for construction of walls are small (module 30 cm) buildings of any function and shape and up to three stories high can be erected. The only limiting factor is the weight of the ceiling prefabricate which in simple field conditions should be tackled by four persons. For this reason the ceiling element length ranges from 3.6 m to 5.4 m. Longer elements would require additional lifting equipment.

As a rule this range allows for vast possibilities design of various types of buildings - individual housing, social services buildings (dispensaries, kindergartens, schools, shops, etc.), small industrial plants, workshops, garages, etc. These examples show that the system provides for ample flexibility of form, function, height of buildings, individual tastes and cultural traditions.

Some of the sample designs are attached.

Production of Elements

Production of elements can, depending on the requirements of the client, be mechanized to a varying degree from the most simple machines to sophisticated equipment with high production capacity.

The basic principle of elements production is keeping investment costs for each element produced as low as possible. On the other hand the production should be easily and efficiently adaptable to changing needs and conditions.

Below we are giving a proposal of a plant organization producing from several dozens to several hundred houses per year:

- Space for production and storage of wall and ceiling elements;
- Hard floored raw materials store;
- Concrete department with silos for binding materials (cement, lime, etc.)
- Production equipment (hollow blocks machines PSH-2 or POZNAN, ceiling elements producing equipment);
- Stores, workshop and premises for personnel;
- Weather protection and equipment for reinforcements;
- Supply of water, electricity and access roads.

Attached is a lay-out of a plant producing from 50 to 200 single houses a year (200 working days and two shifts per day). Actual size of the plant and its equipment should be individually established according to foreseen output. However, which is important, the system allows for easy, unlimited expansion of the plant each time the demand grows.

Below we are giving suggested equipment according to production volume foreseen:

Houses per year	Hollow Blocks Machines	Carts	Concrete Mixing Unit	Cement Silos	Roof Elements Moulds
50	1	2	1	2	6
100	2	4	1	3	12
150	3	6	1	3	15
200	4	7	1	4	18

Hydraulic Hollow Blocks Machine

The machine is the basic component of any prefabricated elements plants. Designed and produced at the Stalowa Wola Steel Works it is simple and efficient in operation. It works in cycles lasting from 40 to 60 seconds each time turning out 5 to 12 elements depending on size and shape. Number of cycles, in turn, depends on a steady supply of concrete mix. Thus, during one day of fourteen working hours the machine can produce enough wall elements for one house. Diagram and pictures of the machine are attached.

Here are some technical data on the STALOWA WOLA hollow blocks machine (type PSH-2):

Height	1980 mm
width	2320 mm
length	2150 mm
maximum mould dimensions	980 x 750 mm
height of elements	240 mm
power	8 kW
total weight with accessories	2200 kg
weight of accessories (moulds, driving blocks)	600 kg

working speed	6 m per min.
turning radius	2 m
forming capacity during one cycle	0.12 to 0.15 cu.m.
duration of a cycle	40 to 60 sec.

Types and sizes of elements and their various possible combinations are shown in diagrams attached.

POZNAN Hand-Operated Hollow Blocks Machine

Produced especially for distant, far-flung locations. Its only requirement is a concrete floor about 5 inches (12 cm) thick. Total weight of the unit does not exceed 600 lbs (300 kg). It is simple to operate and easy to transport. In four days of eight working hours one person can produce wall elements for a house of 110 sq.m. of effective area. The only mechanical device needed is the electric vibrator (can also be run with a combustion engine).

The machine is shown in the pictures attached.

Construction Stage

Prefabricated elements, both for walls and ceilings (roofs), are palletized and transported to the building site. They can be assembled even by unskilled labourers given only essential instruction and supervised by one qualified technician who would continue training the labourers while the work is in progress. An ideal solution would be to organize the construction on an assembly-line basis. Such an arrangement would lead to considerable specialization.

Finishing

The walls have to be plastered on the outside. Plastering can be done with special equipment provided for the purpose. Inside, spaces between the elements have to be filled before plastering, if necessary. Metal frame windows and doors are fitted. In longer series of houses ducts for piping and electric wiring can also be prefabricated.

PILOT PLANT

for Production of Prefabricated Elements for Industrial Building and Low-cost Housing Construction

Background

An International Conference was organized by UNIDO in 1975 in Warsaw. Several prefabrication systems were presented to the participants. Out of these particular attention was attracted by the presentation of light construction elements enabling construction of workshop buildings, prefabricated housing settlements, etc.

For several years now Polish experts have been working on an economical simplified building system suitable both for housing and for small industrial plants. This is to be achieved by the introduction of various prefabrication systems such as would allow for:

- use of cheap local materials and industrial wastes;
- decrease in the use of costly materials such as steel and cement;
- mechanization of the elements production process to a point where they can be built from light elements with no need for any equipment;
- erection of buildings by their future inhabitants or unskilled labourers;
- fast and easy erection, keeping the costs as low as possible.

Production of elements can, depending on the requirements of the client, be mechanized to a varying degree from the most simple machines to sophisticated equipment with high production capacity.

The basic principle of elements production is keeping investment costs for each element produced as low as possible.

In order to promote large-scale application of this low-cost building system, establishment of a pilot plant is proposed in the country of its future users, both to prove the effectiveness of the system in local conditions and to train personnel necessary for future production.

Such a pilot plant would consist of the following elements, as shown in the technical process diagram:

A. Equipment

1. Two hollow blocks machines
2. Three carts with chutes for transport of concrete mix
3. One concrete mixing unit

4. One cement silo
5. Two trucks
6. Two fork lifts (if palletization is foreseen)

B. Facilities and Services

1. Concrete slab of approx. 50 x 100 m and 25 cm thick for the production area
2. Steady supply of cement, gravel, sand and steel
3. Supply of water and electric power
4. Amenities buildings (office, workshop, stores, etc.)
5. Weather protection

C. Personnel

1. Six specialists (from Poland) needed to run the plant and to train local personnel for a period of six months
2. Unskilled local labourers to be trained for production and maintenance of machinery.

Pilot Plant Organization

To organize a pilot plant it is indispensable to ensure the co-operation of UNIDO, Polservice (representing Polish companies) and the authorities of the country where the plant is going to be established.

UNIDO is expected to provide assistance and the necessary financial backing which, for the part concerning expenditures in Poland and purchase of Polish equipment, might be covered by voluntary contributions from the Polish Government to UNIDO and UNDP.

Thus, UNIDO will provide:

- expenditures connected with sending three experts for a period of two to three weeks on a preparatory mission to discuss conditions for establishment of a pilot plant and selection of a proper site;
- cost of machinery;
- cost to Polservice of sending 6 specialists needed to run the plant and train the local personnel for a period of six months;
- cost of transport of equipment and air travel for Polish personnel.

PolSERVICE, acting as co-ordinating agency on behalf of the Polish companies involved, will provide:

- Free-of-charge technology for the production of prefabricated elements;
- Supervise delivery of selected machines and equipment for the pilot plant;
- Provide on UNIDO's request experts and specialists for the establishment of the pilot plant;
- Provide training for local staff needed for proper operation and maintenance of the pilot plant.

The local counterpart organization is expected to provide:

- Approximate site for the installation of the pilot plant;
- Equipment needed to complete the pilot plant (concrete mixing unit, cement, silo, trucks, fork lift);
- Necessary number of unskilled workers to be trained by UNIDO experts;
- Supply of raw material (cement, gravel, sand and steel);
- Necessary office space, workshop, stores, etc.

Approximate cost calculation

Under this item approximate expenditure is given only for those elements which will be provided by UNIDO and the Polish institutions (PolSERVICE).

Machinery to be delivered from Poland

- Hollow blocks production machine PSH-2 (2 pcs)
- Carts with hoppers (3 pcs)
- Sets of moulds for blocks (4 pcs)
- Transport of equipment
- Salaries for Polish experts during their stay in the developing country for preparatory mission and running of the pilot plant

\$ 100,000

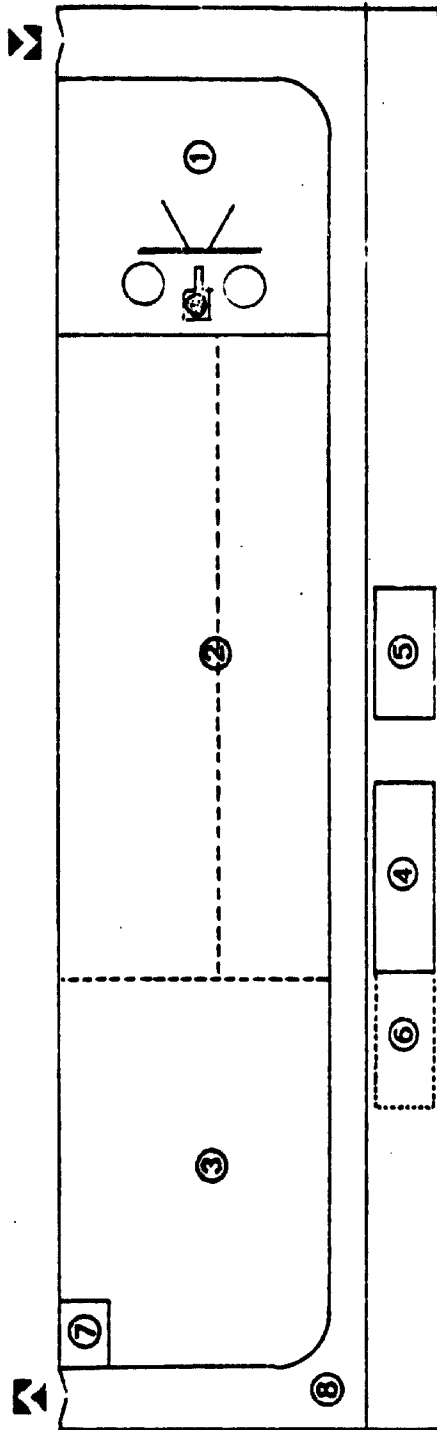
The cost of machinery and services mentioned above, amounting to US \$100,000, could be covered by Polish Zloty which are available through the Polish contribution to UNDP, or by any other currency available to UNDP and UNIDO.

Salaries of experts during their stay in the field

- Preparatory mission by 2 experts, 3 weeks each	US \$ 7,500.-
- Team of specialists for installation and running production of pilot plant for 6 months	US \$72,000.-
	<hr/>
Total:	US \$79,500.-

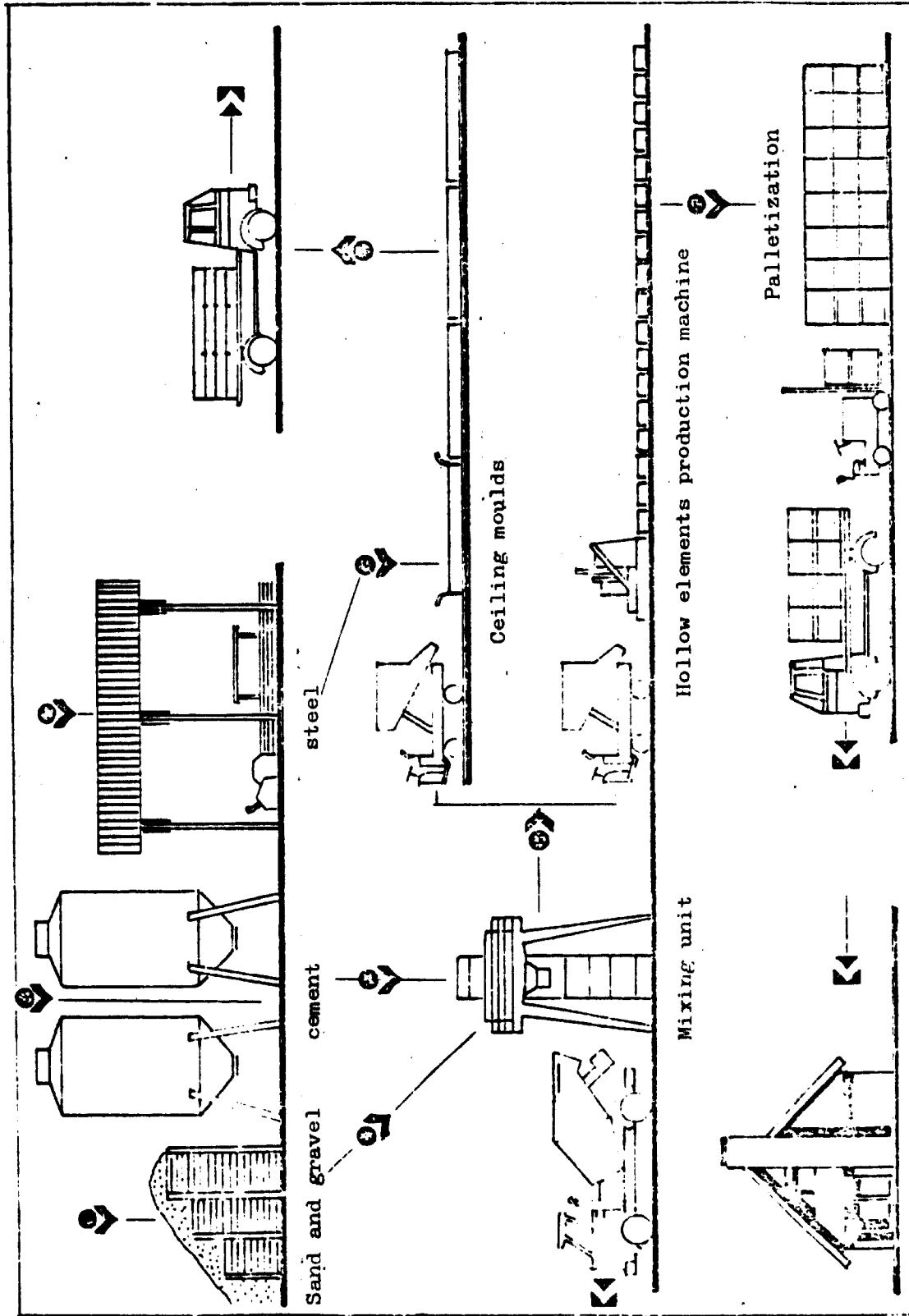
A more precise calculation of expenditures will be prepared by the preparatory mission in close collaboration with the appropriate counterpart organization in each country concerned.

PLANT LAY-OUT

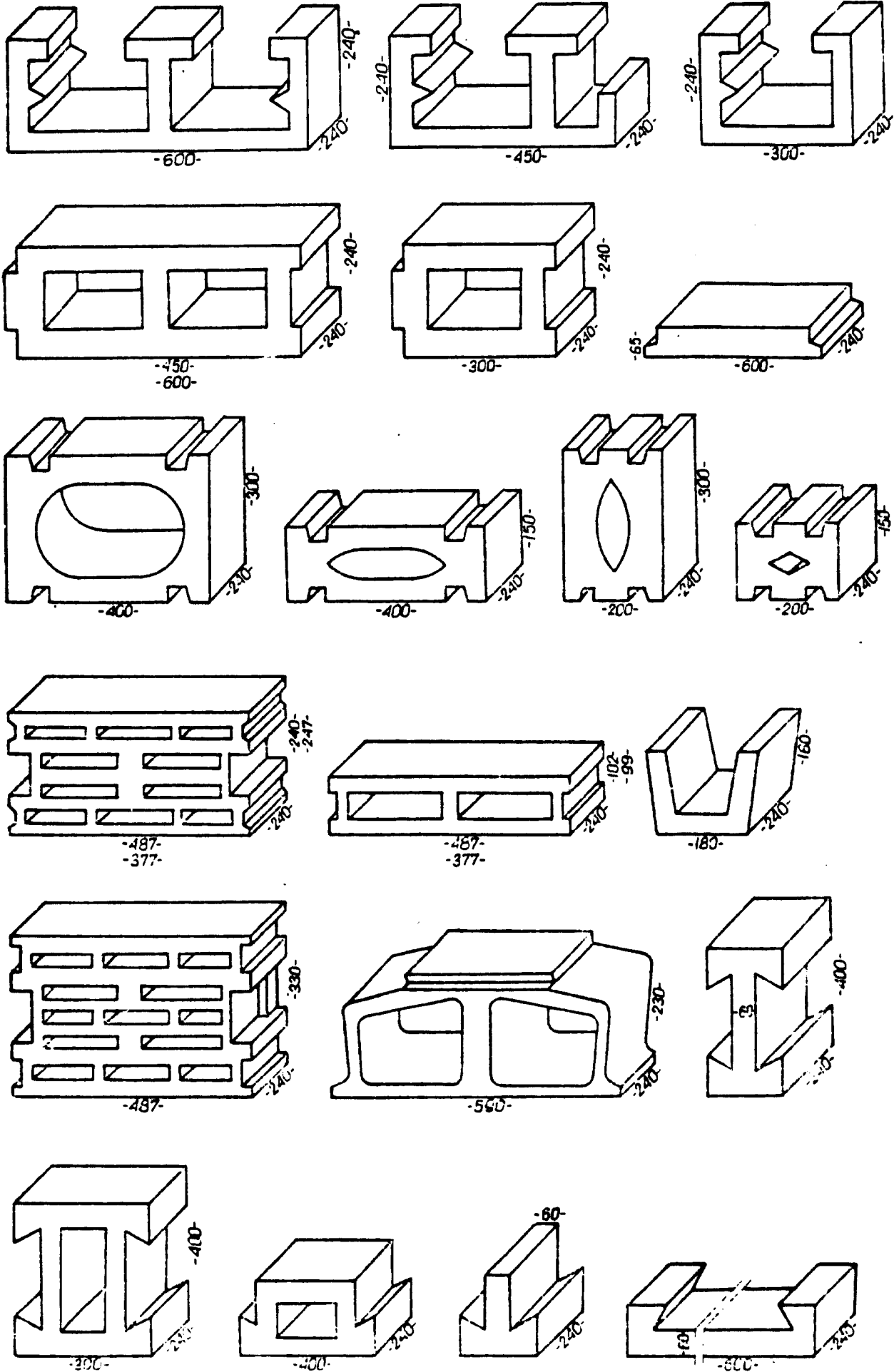


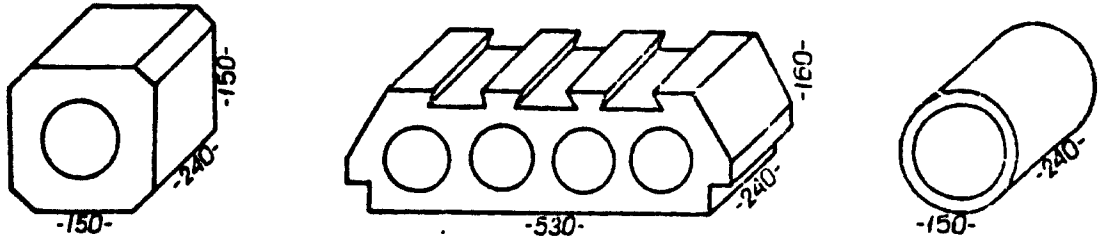
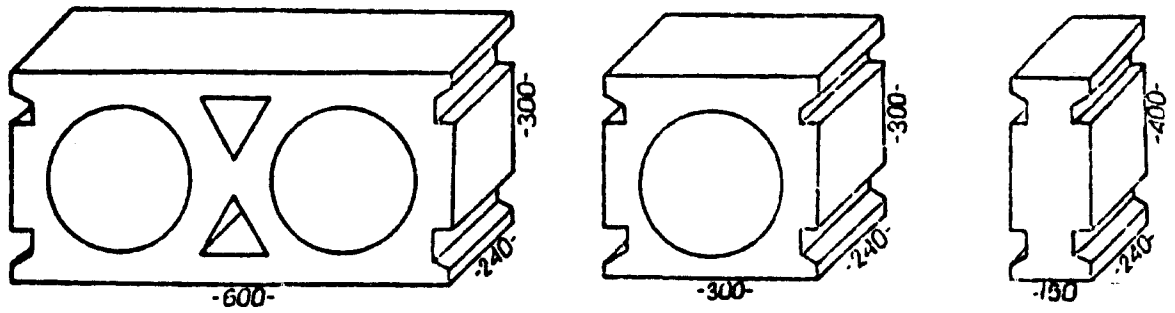
- 1. Sand and gravel store, cement silos, concrete mixing unit
- 2. Production area
- 3. Product storage space
- 4. Office building and workshop
- 5. Reinforcement department (workshop)
- 6. Covered area
- 7. Guard
- 8. Roads

Technological Flow-Line of Prefabricated Elements Production

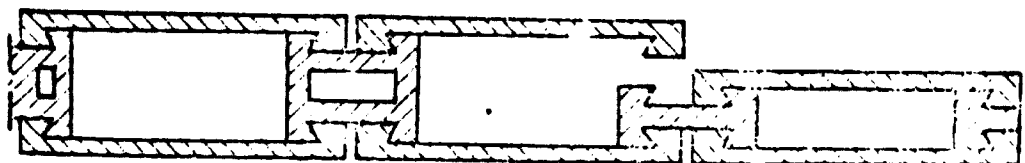
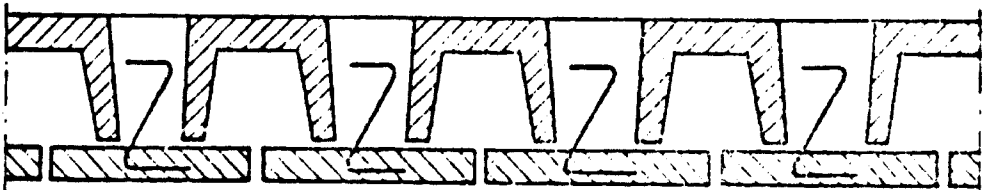
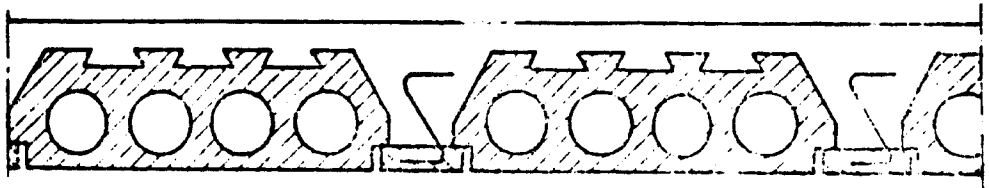
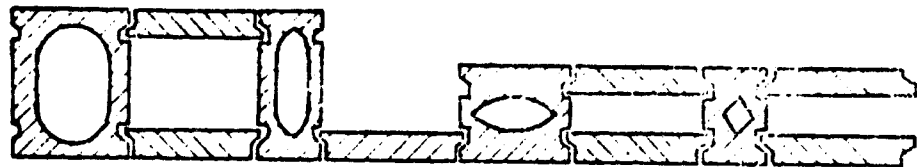


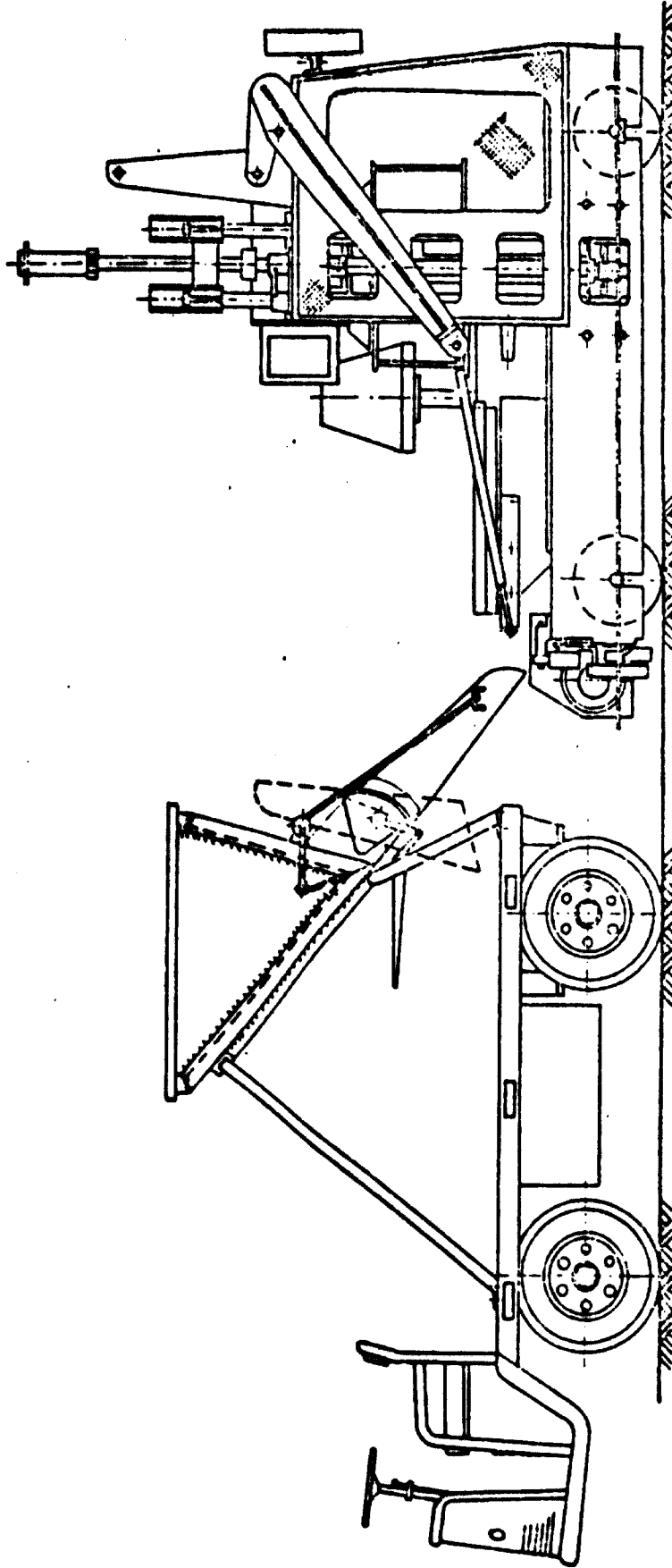
Wall Elements produced by PSH-2 Machine





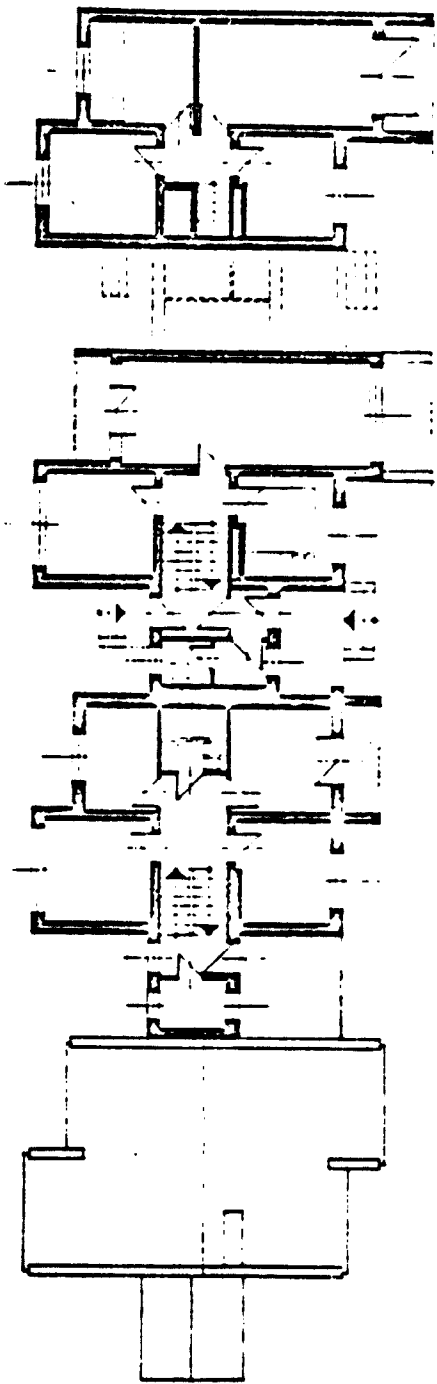
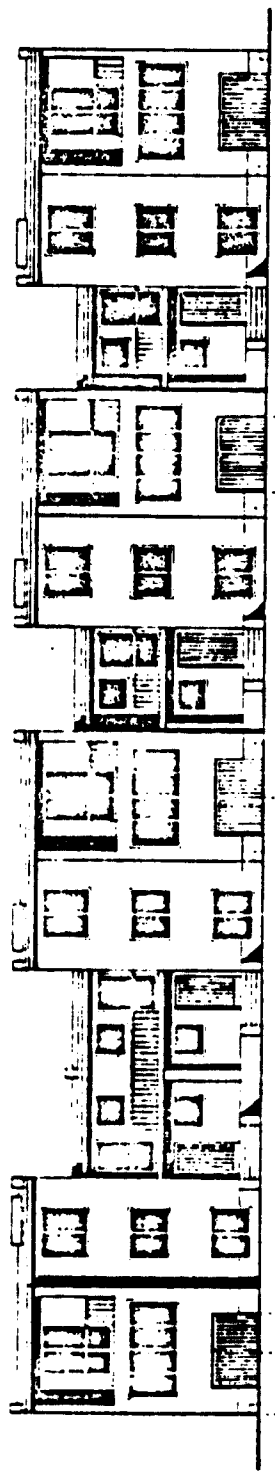
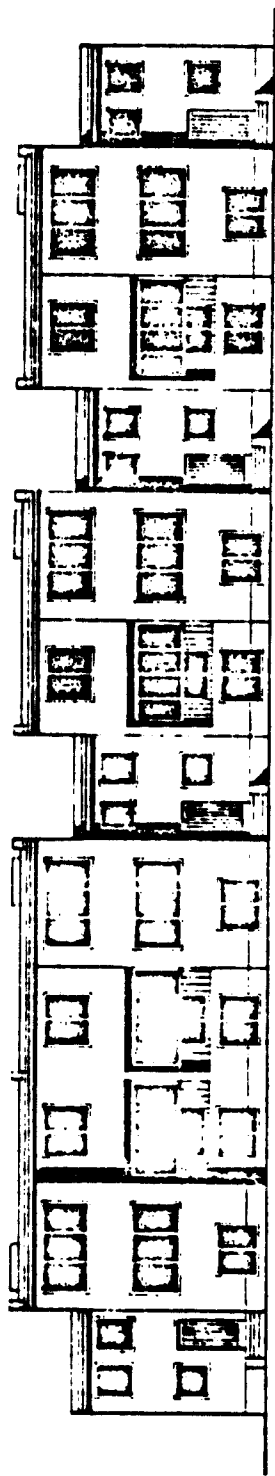
Arrangement of Elements

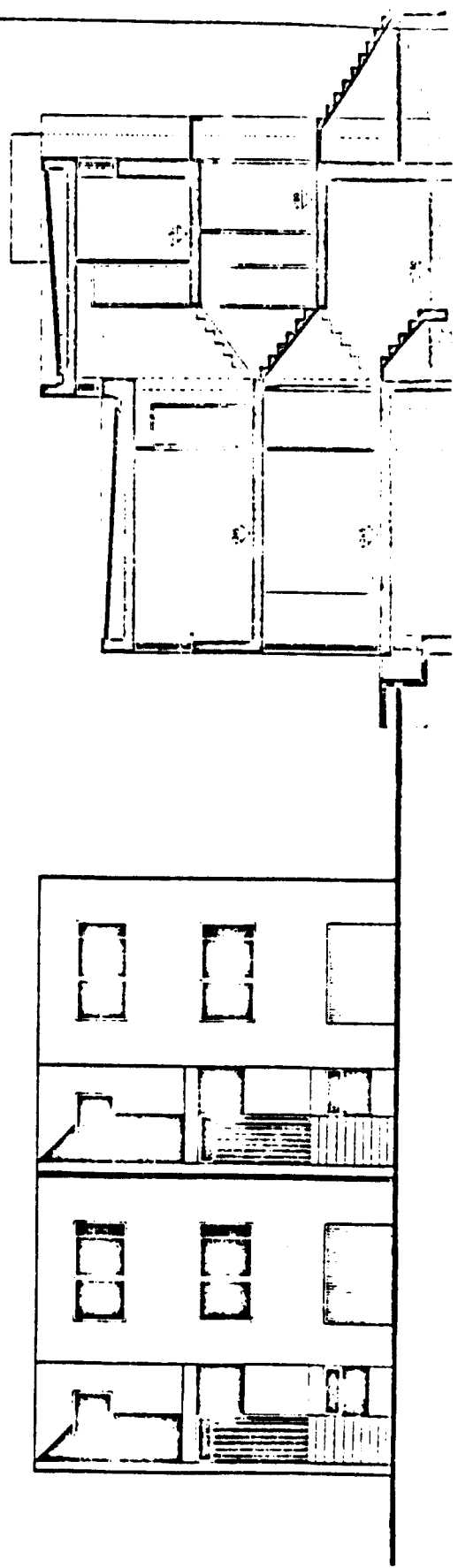
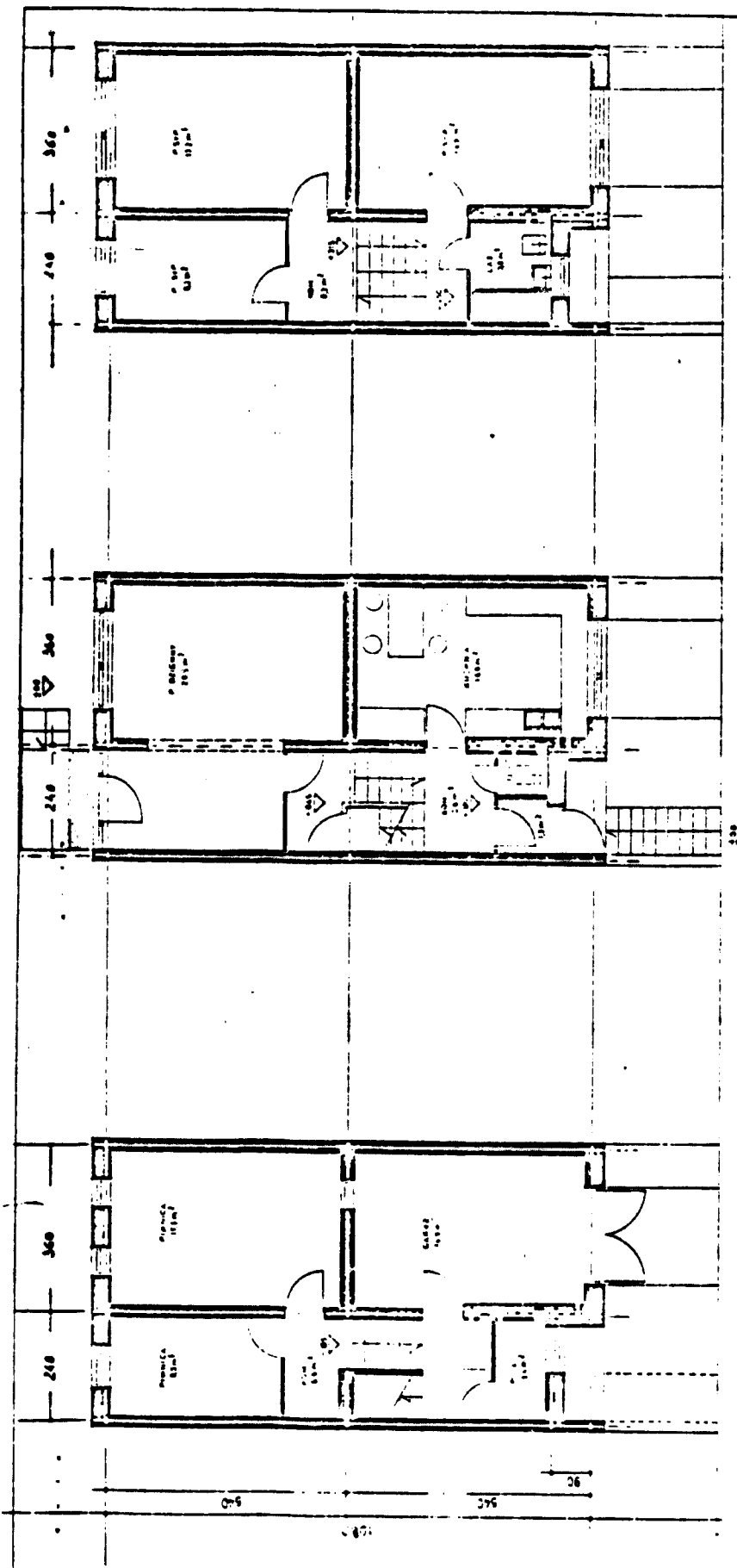


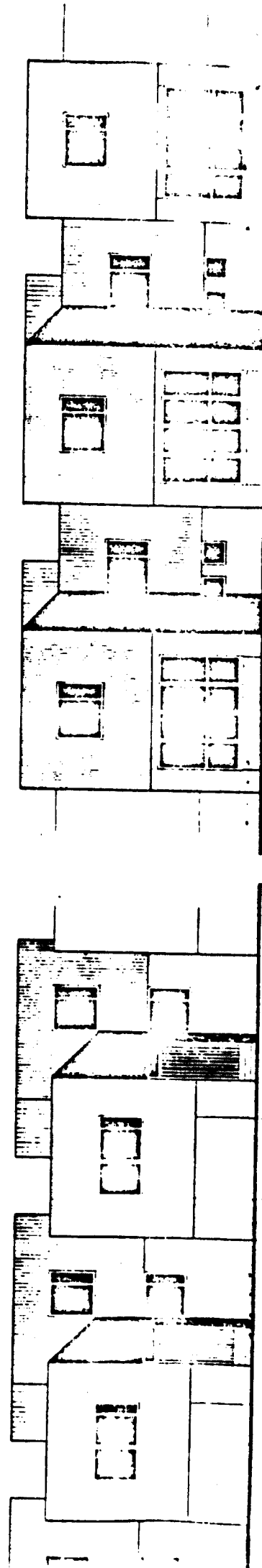
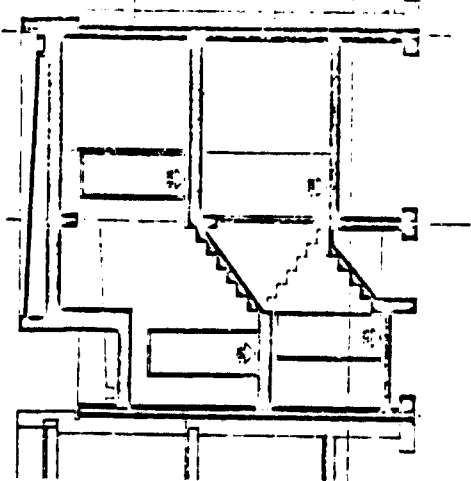
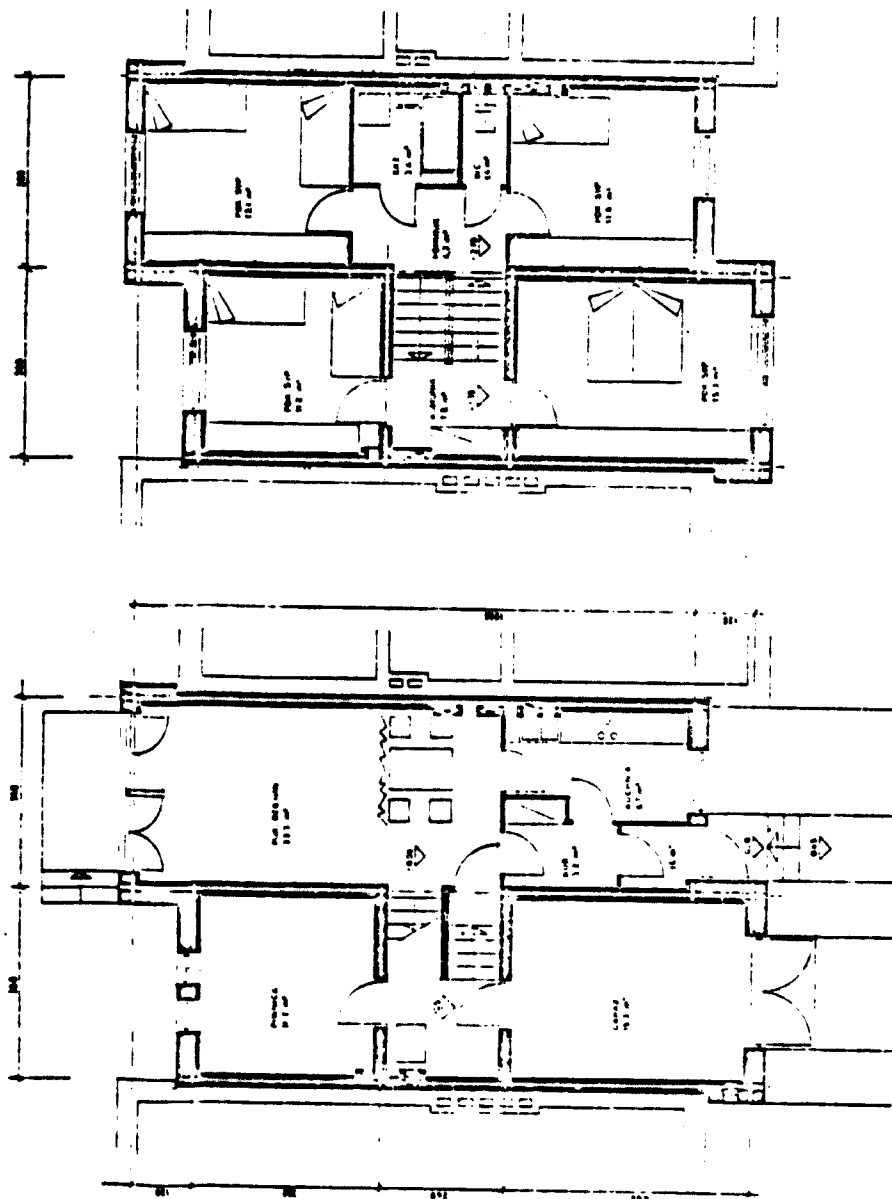


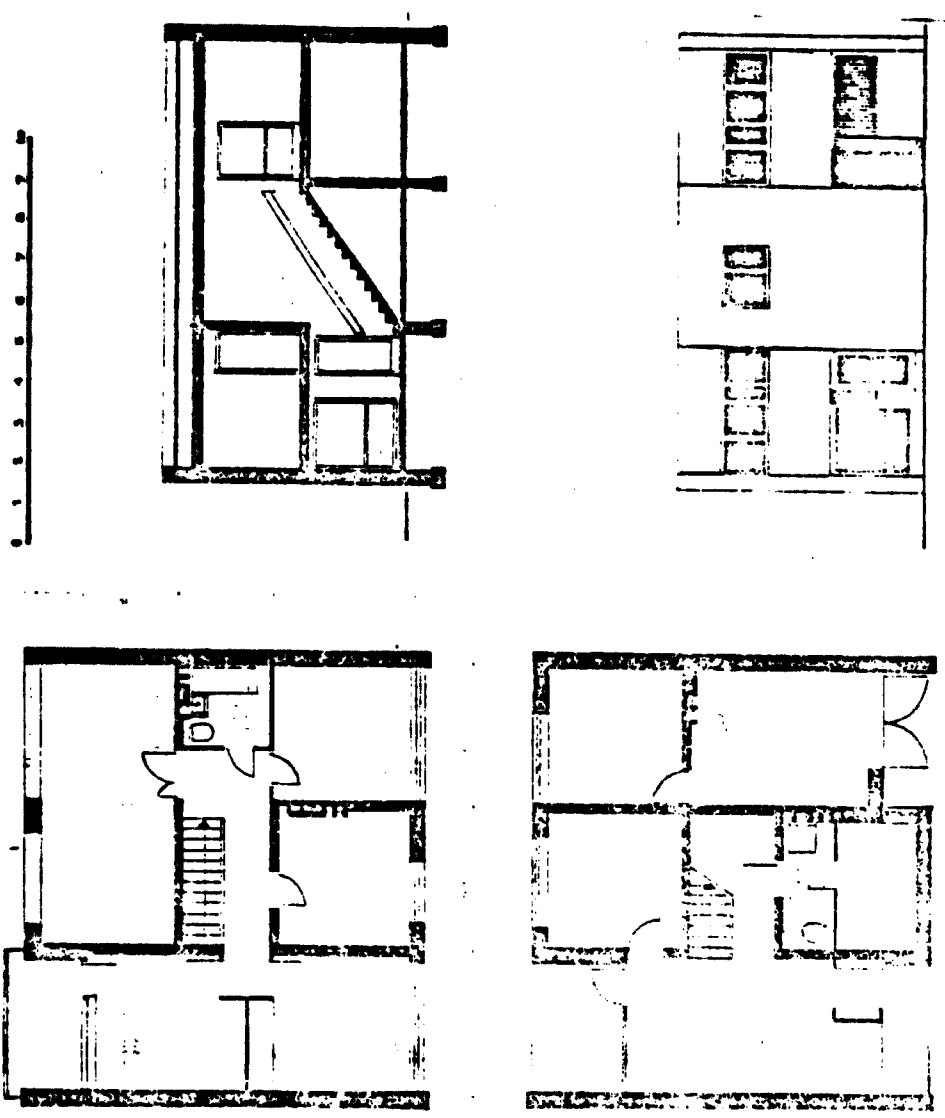
Hollow elements production machine FSH-2 with cart

Some examples of buildings which
can be constructed using the
Low-cost Building System









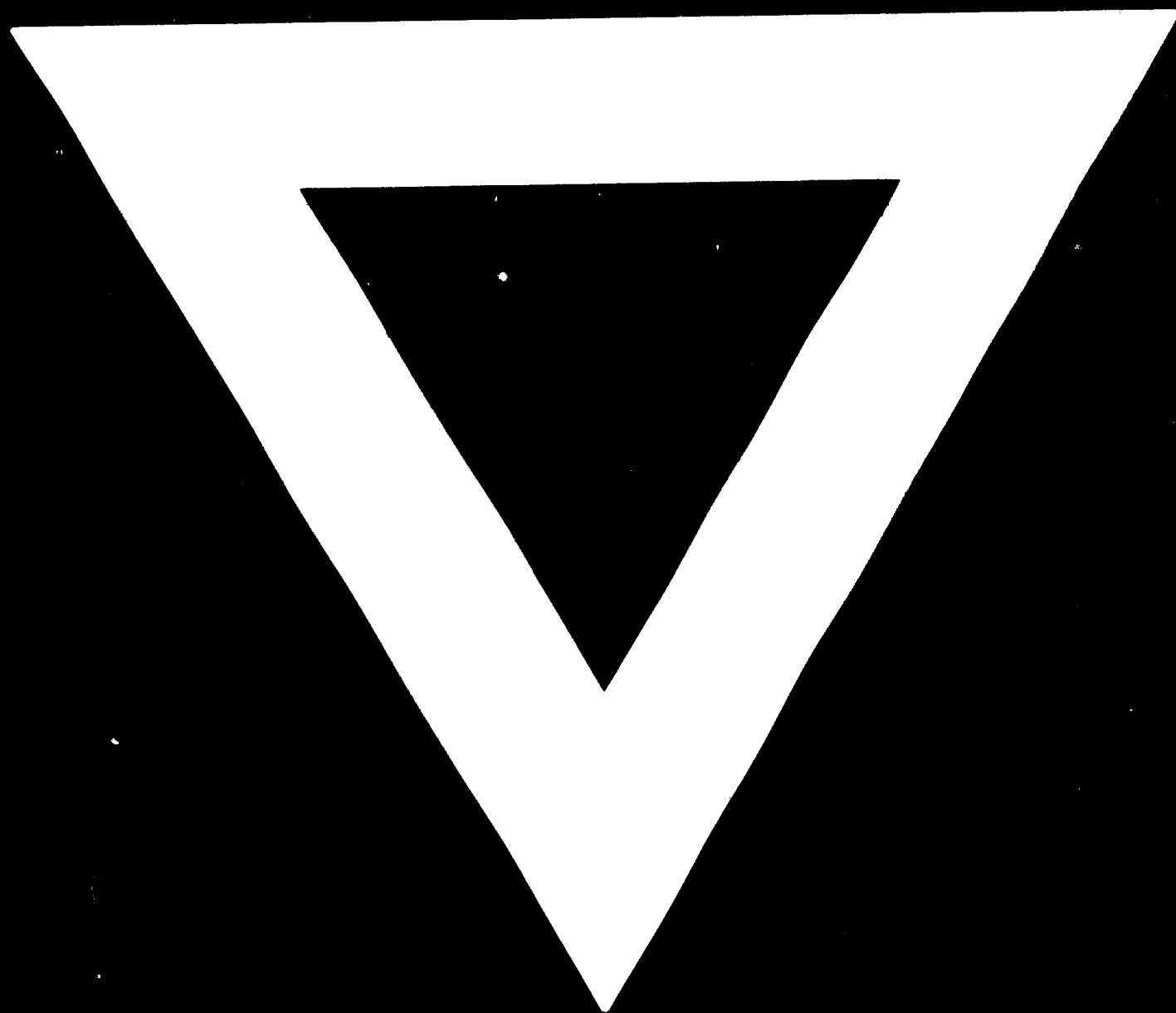
110 m²

iv.



We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

C-628



81.10.23