THE FERROCEMENT

CATALOGUE

WARSAW UNIVERSITY OF TECHNOLOGY
Institute of Technology and Organization of Building Production
FERROCEMENT RESEARCH LABORATORY
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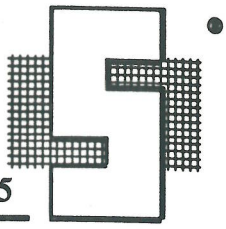


THE FERROCEMENT CATALOGUE

INTRODUCTION

The Ferrocement Catalogue serves as a guide book for compact information on ferrocement elements and constructions elaborated in the Ferrocement Research Laboratory of the Institute of Technology and Organization of Building Production of the Warsaw University of Technology.

The Catalogue is directed to those who wish to put ferrocement into practice. Designs presented in the Catalogue are sent in detailes on order. In many cases it is possible to be supplied with ferrocement elements or complete production devices directly by the Ferrocement Laboratory of the Warsaw University of Technology.

The Catalogue helps you become acquainted with practical possibilities of applying ferrocement and take opportunity of the Ferrocement Laboratory's research potential, so as to order a design like never before.

We're at your service!

Michał Sandowicz
Managing Director
Ferrocement Research Laboratory
Warsaw University of Technology

FERROCEMENT RESEARCH LABORATORY

General Information

Ferrocement research has an over 25 year tradition at the Warsaw University of Technology, first work having been done in 1967. A small group of enthusiasts has grown over the years into a team of several score experts conducted by Michał Sandowicz Sc. D., initiator of this work at the Ferrocement Research Laboratory.

Thanks to the support of the University's management and Ministry of Sciences and Higher Education, as well as institutions interested in ferrocement, during the years 1971-73 the Ferrocement Research Laboratory had been built, being the base for research and design work. The Laboratory's organizational structure enables the conduction of complex design-research work and its practical application.

The Laboratory employs 30 engineer, technical and administration workers who are grouped in teams of different speciality workshops, these being:

- the design workshop,
- the technology workshop,
- the mechanical workshop,
- the research-testing workshop,
- the prototype-assembly workshop.

Thanks to the above described structure there exists the possibility of putting into industrial practice ferrocement elements, constructions and technologies of production which are thoroughly checked and completely tested.

During the twenty five year period of the Ferrocement Research Laboratory's activity the research done for practical use has been concentrated on a few subjects of ferrocement application.

In the first phase of activity the team worked out a pipe construction and pipe technology production for the purpose of non-pressure and pressure pipelines used for water and industrial sewage disposal. At the same time investigations of ferrocement construction tanks were carried

out. The technology of producing prefabricated and monolithic tanks, and mixed construction, i.e. prefabricated-monolithic tanks has been worked out.

The next phase of activity was finding solutions to complex design problems and the manufacturing of light prefabricated elements for housing, rural and industrial building. In the course of this work an original system of building single family houses was developed, called the ELSA system.

During the last years the Laboratory worked mainly at research and design for the implementation of ferrocement elements and constructions in the Warsaw underground tube. Among others, ferrocement boarding for roofs in underground halls, pedestrian street brackets, light prefabricated elements for underslung ceilings, curtain walls with ceramic facing, multichannel cable culverts, prefabricated partition walls, acoustic shields, etc. had been designed, tested and put into operation.

First of all the basic research covers questions of ferrocement resistance and deformation in complex and laminar elements. The results of basic research are for the most part used in applied research and design work for industry.

CONTENTS

The Catalogue consists of a set of leaflets containing a brief technical summary of a design, data for practical use, a schematic diagram and a picture of the prefabricated product or building.

The Catalogue is divided into the following sections:

1 - Prefabricated elements

2 - Prefabricated constructions

3 - Prefabricated-monolithic constructions

4 - Monolithic constructions

5 - Building designs

6 - Production devices and process lines

7 - Patents

1. PREFABRICATED ELEMENTS

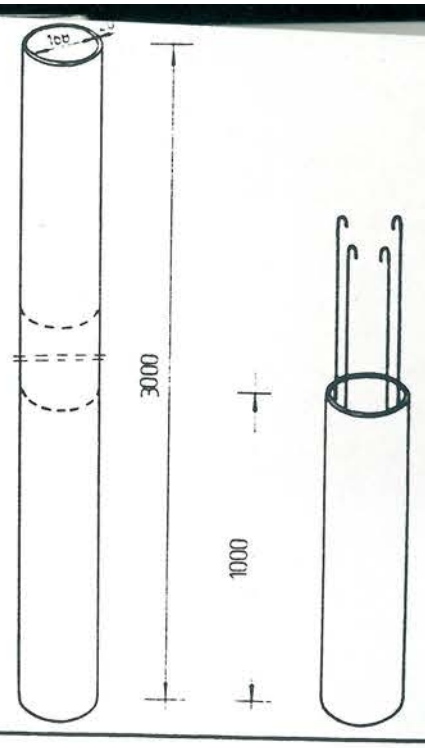
1. PREFABRICATED ELEMENTS

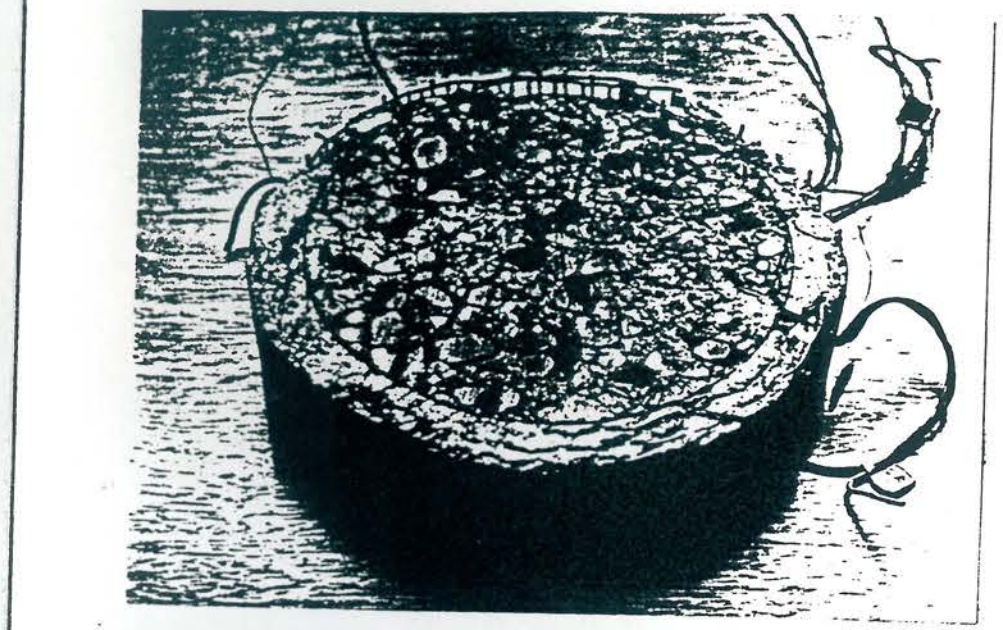
101

FERROCEMENT PIPES AS POST BOARDING

FERROCEMENT PIPES AS POST BOARDING

Ferrocement pipes used for post boarding are: 186 mm in inner diameter, 20 mm thick in wall, reinforced with 5 layers of mesh of 8x8 mm grid size. Posts made of ferrocement pipes filled with concrete have a better load-carrying ability, just like winded posts do. Additional use - in sewage systems and fine rain culverts.



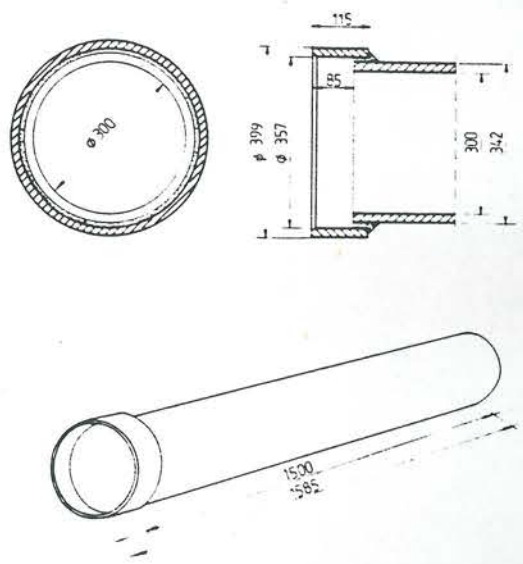


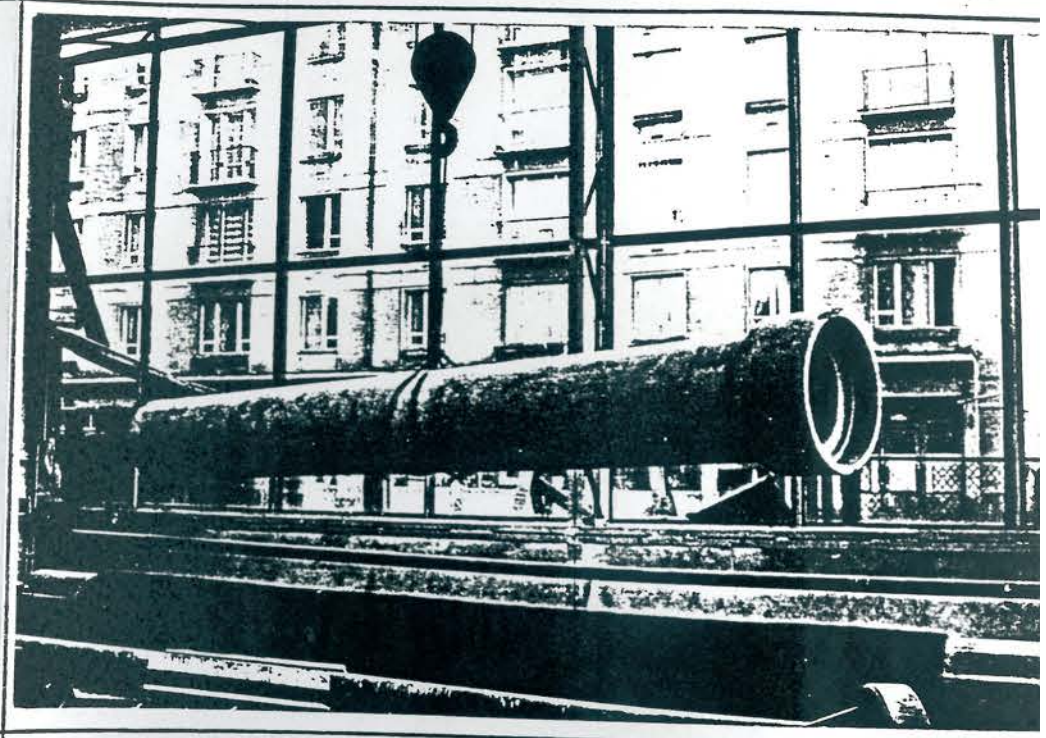
102

BELL-END SEWAGE PIPES 300 mm IN DIAMETER

BELL-END SEWAGE PIPES 300 mm IN DIAMETER

Bell sewage pipes produced in a vertical position have been used in Warsaw while building a pipeline for sewage disposal from an industrial car-wash. The bells are produced at separate work stands and then glued to bare ends of pipes. A polyurethane seal is used for gap filling.



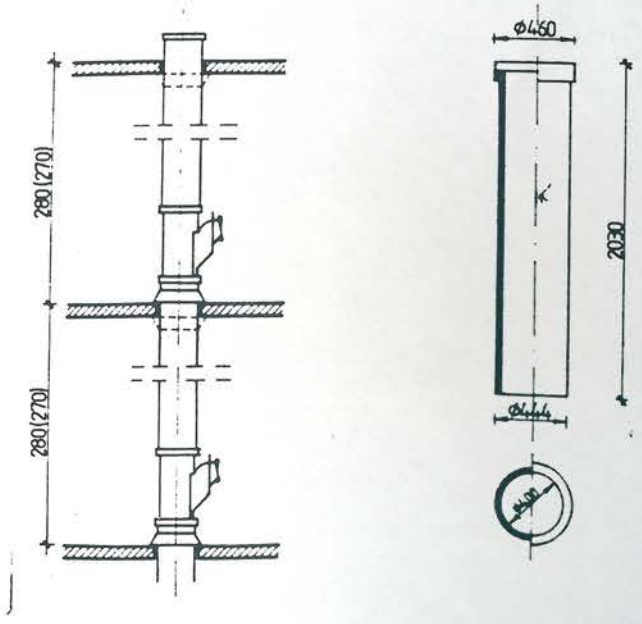


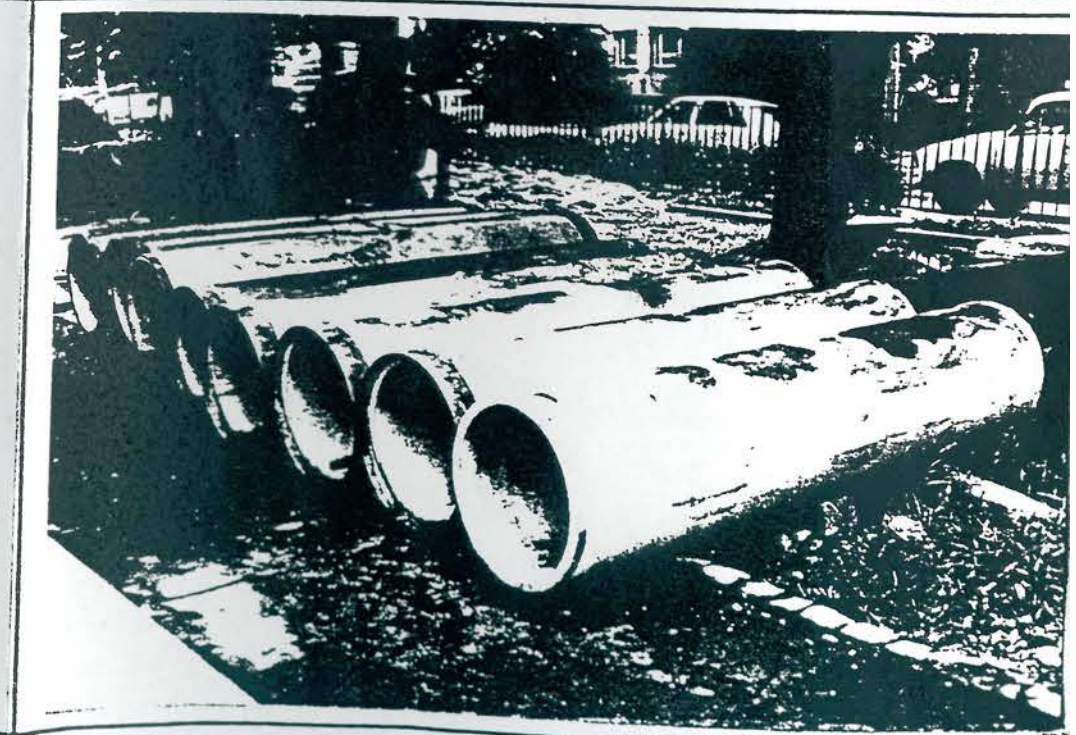
103

A FERROCEMENT RUBBISH CHUTE PIPE

A FERROCEMENT RUBBISH CHUTE PIPE

400 mm in diameter and 2 m long are pipes produced in a horizontal position. These pipes together with a segment of a steel pipe supplied with a rubbish tipper are a repeated element of the rubbish chute. In Poland they are commonly used in housing and municipal buildings instead of the withdrawn from use asbestos cement pipes.



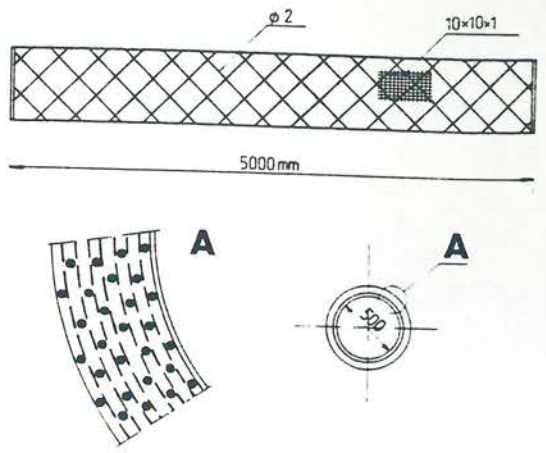


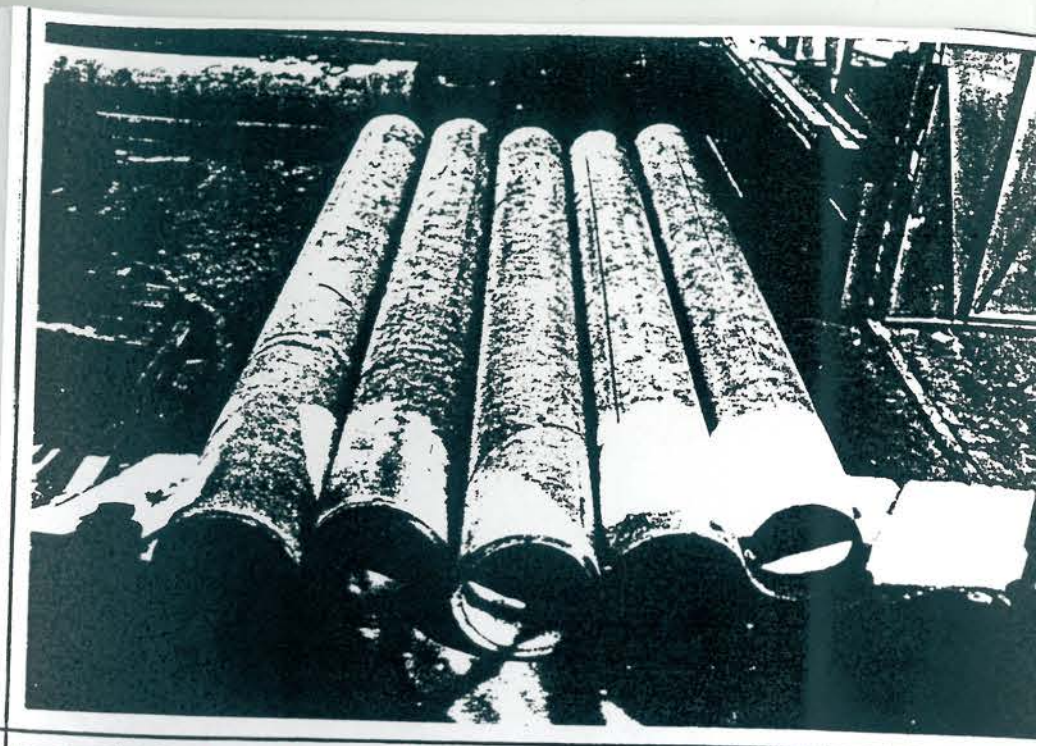
104

LOW-PRESSURE PIPES 500 mm IN DIAMETER

LOW-PRESSURE PIPES 500 mm IN DIAMETER

Low-pressure ferrocement pipes have been produced on an oryginal vertical aggregate which gives a 5 m long pipe within 20 min. and immediate demoulding. Pipes withstand pressure of 4 atm and can be used in water or industrial pipelines with the inner plastic liner.



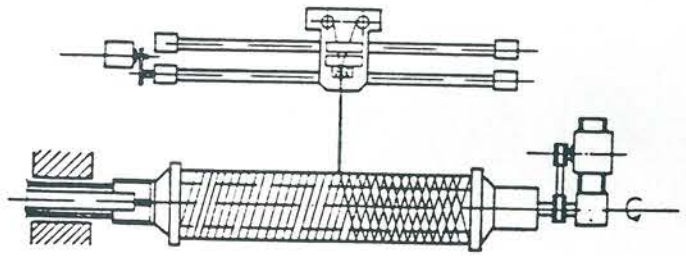


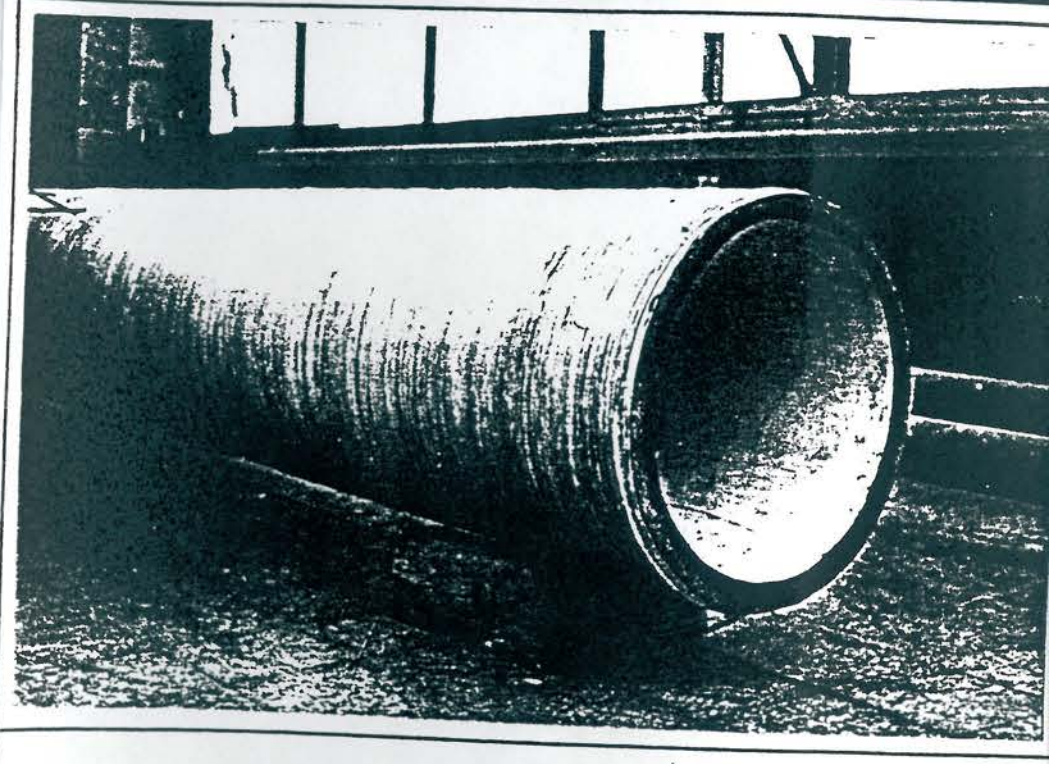
105

HIGH-PRESSURE PIPES 500 mm IN DIAMETER

HIGH-PRESSURE PIPES 500 mm IN DIAMETER

A high-pressure ferrocement pipe (10-12 atm) is received through placing an outer plait made of grooves filled with epoxide resins on the core of the low-pressure pipe.Lenght of the pipe - 5 m. Pipes are sleeve jointed.





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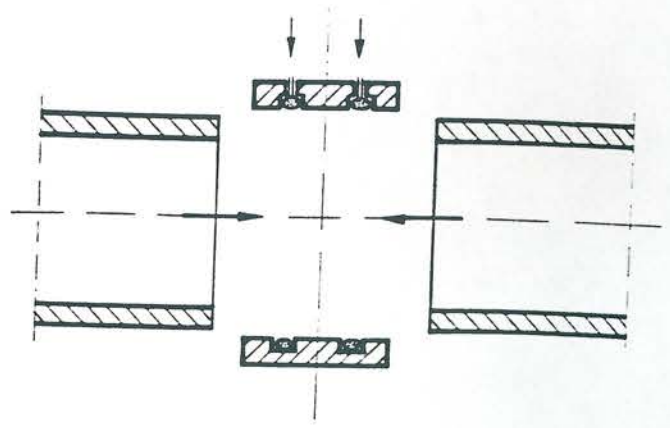
SLEEVE JOINTING OF FERROCEMENT PIPES

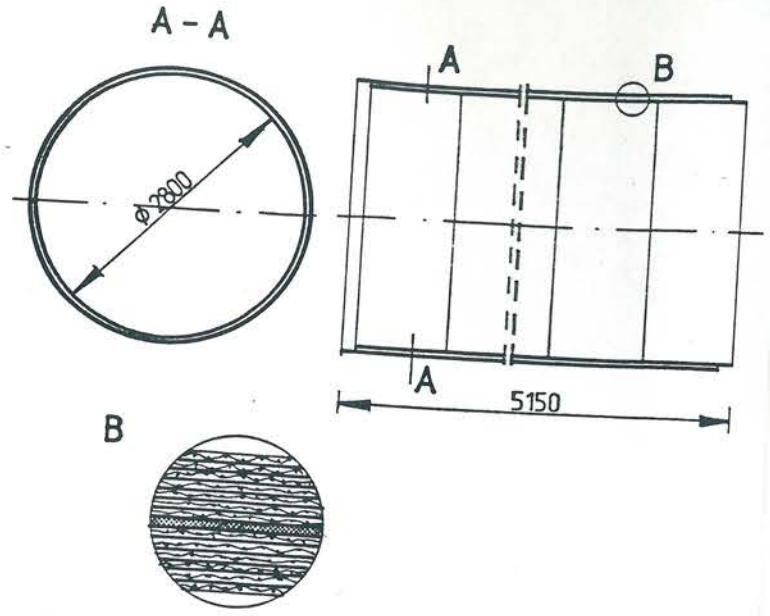
SLEEVE JOINTING OF FERROCEMENT PIPES

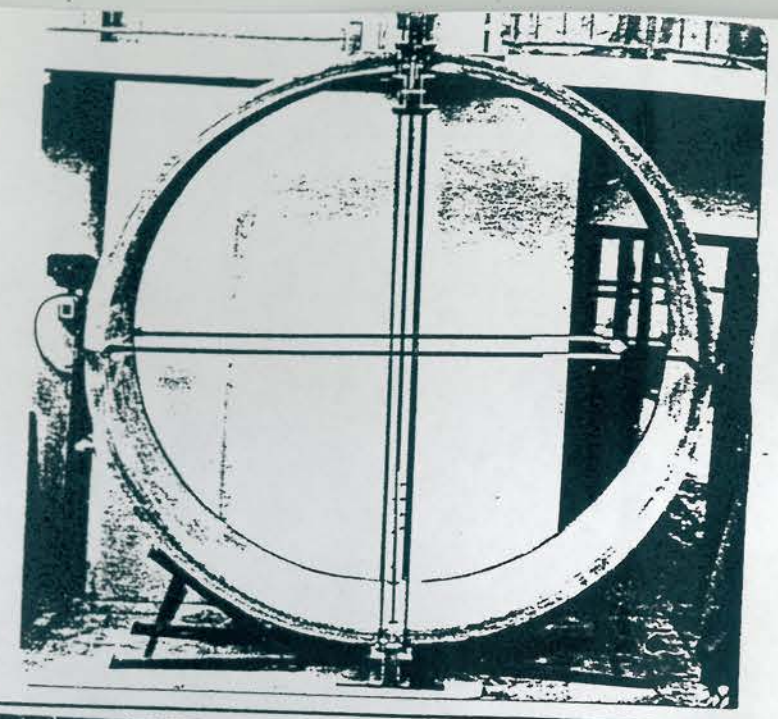
Sleeve jointing is characteristic for its tight rubber tube gashets which after inserting the two bare pipe ends are filled under pressure with an expansive material of permanent elasticity.



LAMINAR PIPE 2800 mm IN DIAMETER

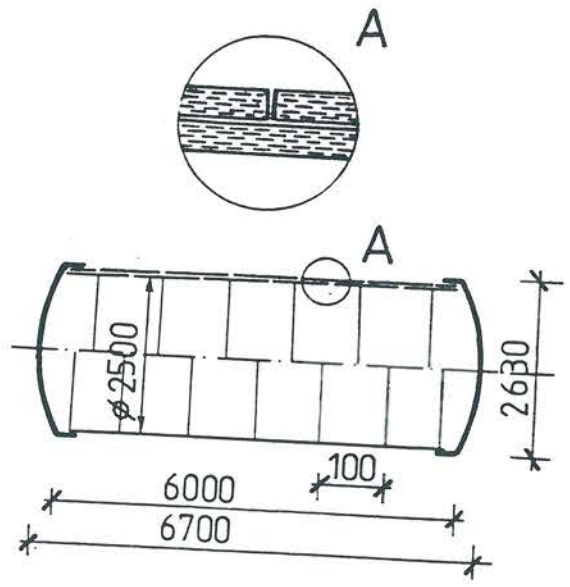
A laminar ferrocement pipe is made up of two ferrocement rings jointed by a layer of epoxide glue. Prototype pipes in this diameter were supposed to be used in far-reaching sewage disposal tubes.

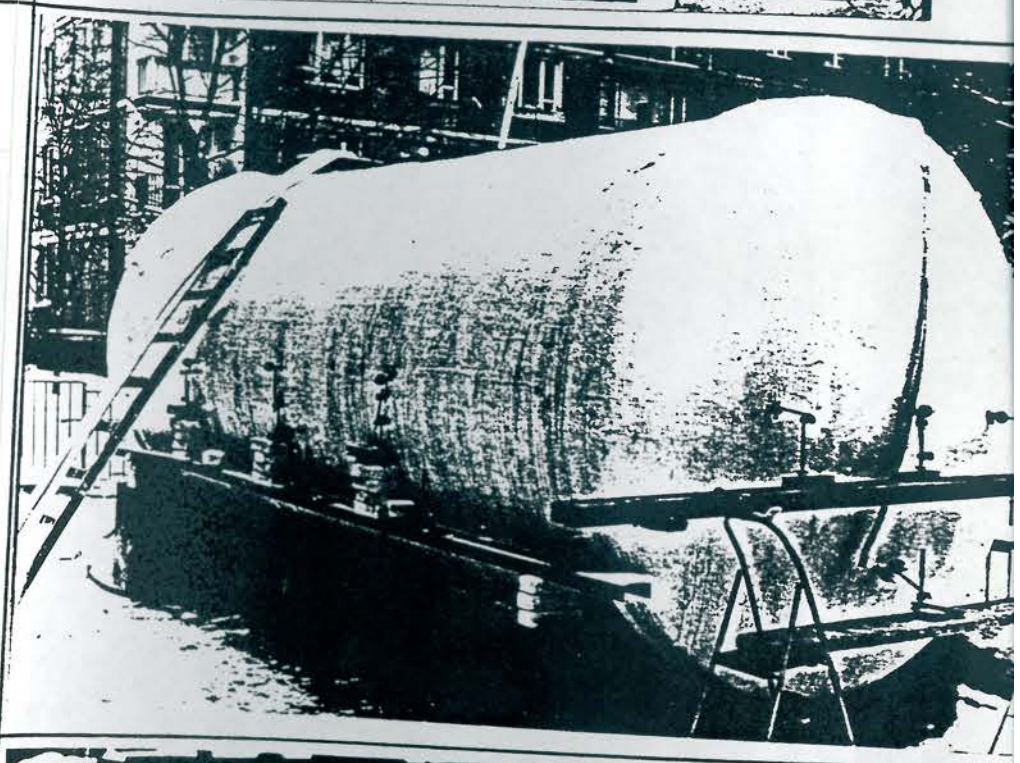




CYLINDRICAL TANK V = 25 m³

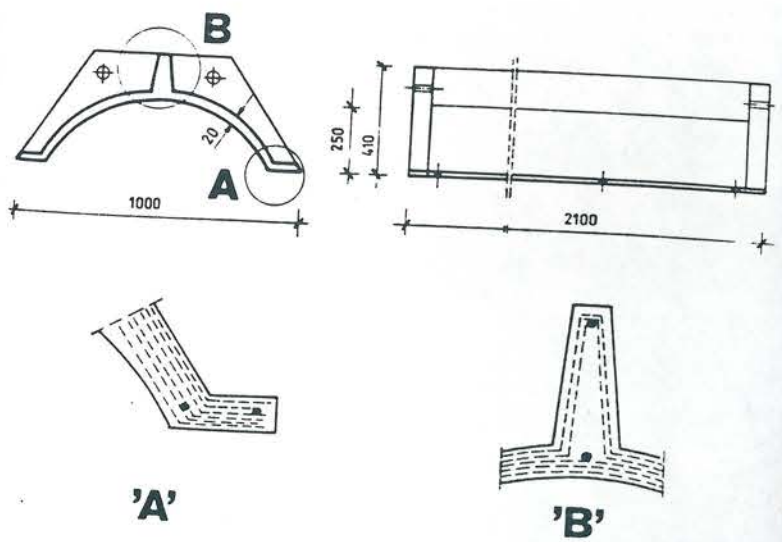
A cylindrical tank has a use capacity of 25 m³ and is used for an underground fuel reservoir at petrol stations. The tank wall is made of a ferrocement laminar glue construction with an inner antyelectrostatic lining. The prototype of this tank is used at the petrol station in Wołomin near Warsaw.

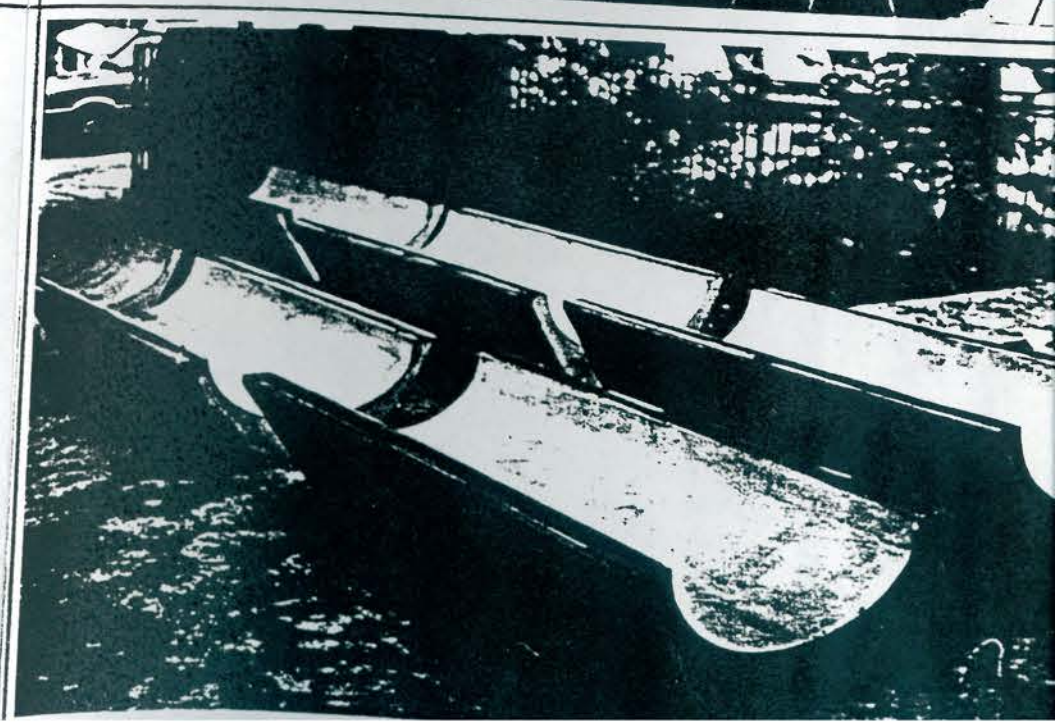




CASING OF CENTRAL HEATING PIPELINES

The casing of straight segment of a heating net is made of 2 symmetrical and same-size prefabricated coated elements which in cross section form an ellipse. The coat of the element is reinforced with 3 lengthwise ribs and crosswise ribs in the front. The lengthwise and crosswise screw joints ensure leak tightness of the casing and intractability of uneven settlements.



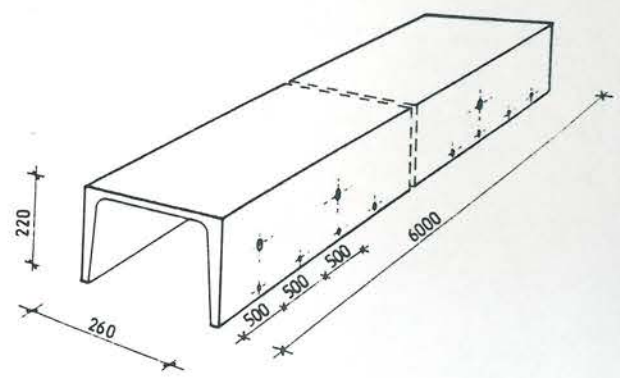


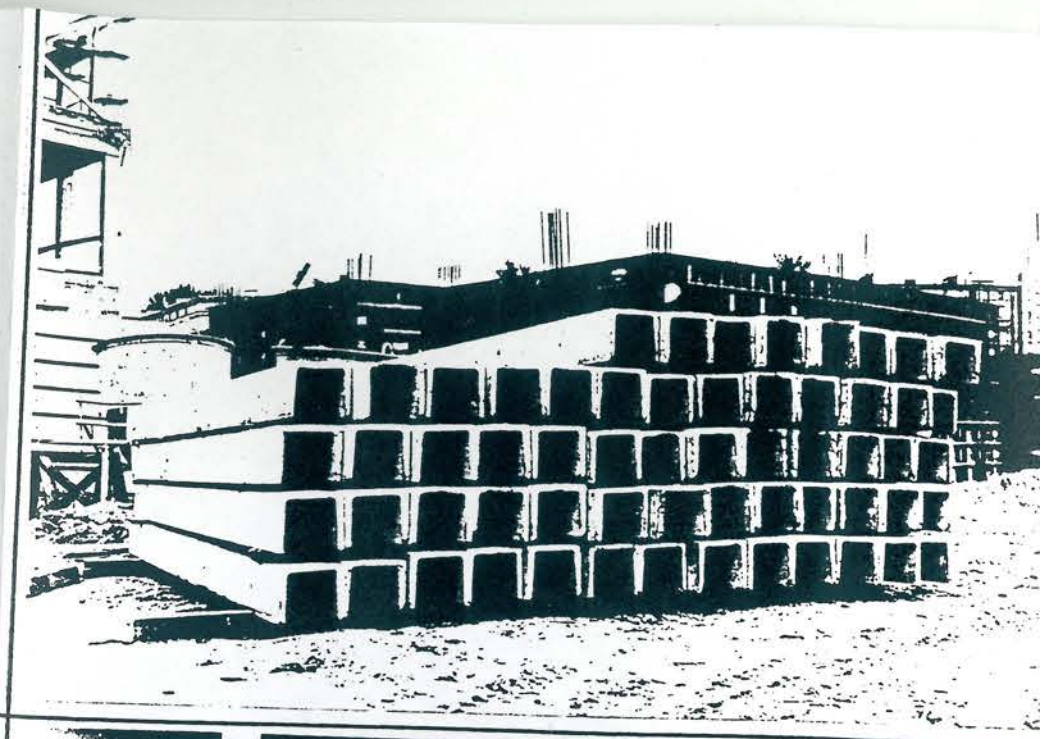
110

ELSA FERROCEMENT CHANNEL

ELSA FERROCEMENT CHANNEL

An ELSA channel is a universal construction element with a constant crosswise section but with variable length - max.6 m. 1 m of the element weights 31,5 kg. The maximal breaking moment -13 250 Nm. It is produced and in common use as an element of the roof, board, post, bolt as well as ventilation casing, gutter, etc.



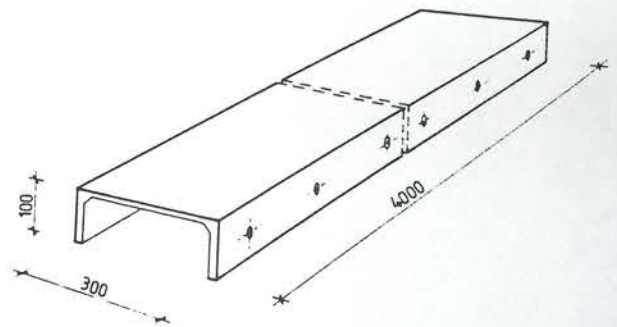


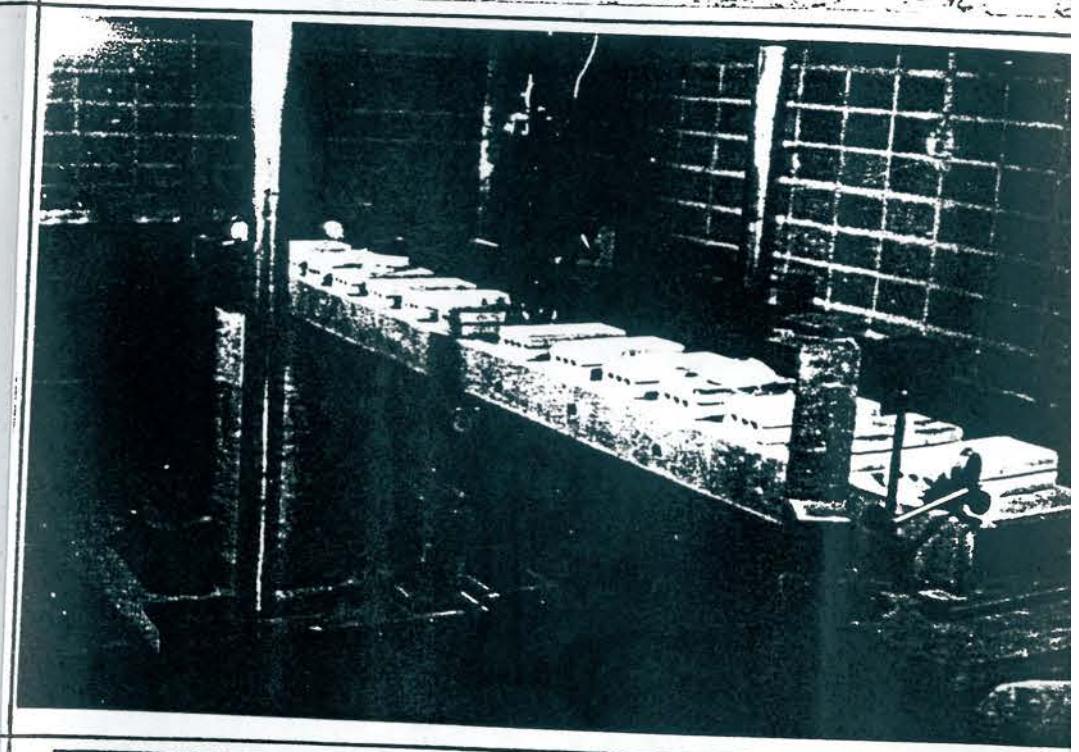
111

CeEs CHANNEL

CeEs CHANNEL

A ferrocement CeEs channel is a prefabricated element used individually or as a complementary element in the ELSA system. 1 m of the element weights 16 kg. Net reinforcement 10x15x1 mm - threelaminar in plate and twolaminar in ribs. Additional reinforcement - 6 mm or 8 mm in diameter. Calculative bending moment (ribs downward) is 1360 Nm, breaking moment 1770 Nm. Since ten years the CeEs channel is produced and applied in Poland.



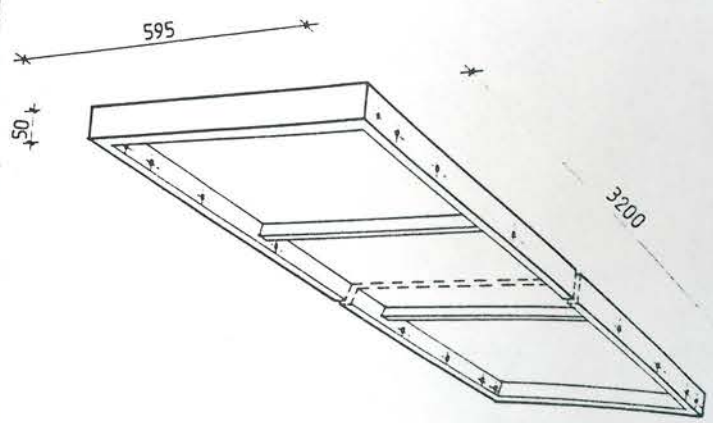


112

ELWO FACADE ELEMENT

ELWO FACADE ELEMENT

A prefabricated element used mainly in a vertical suspension on the building construction cage as a facade plate. A 3 m long element weights about 75 kg. Twolaminar net reinforcement and additional reinforcement in ribs. Calculative bending moment - 472 Nm, breaking moment - 2000 Nm. The ELWO element is produced and applied in several buildings of temporary use.

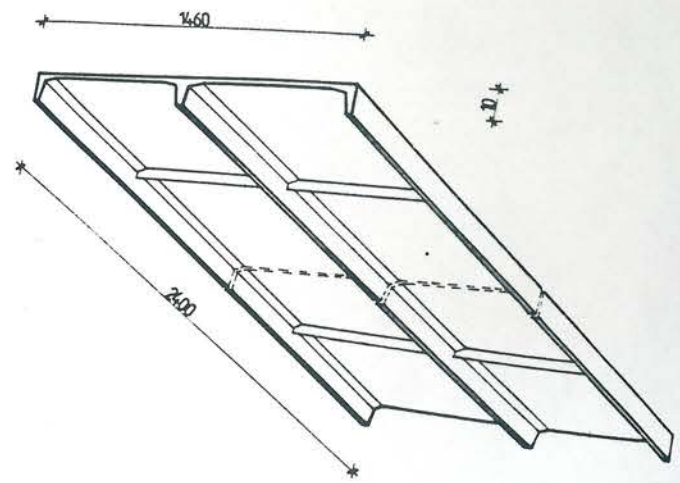


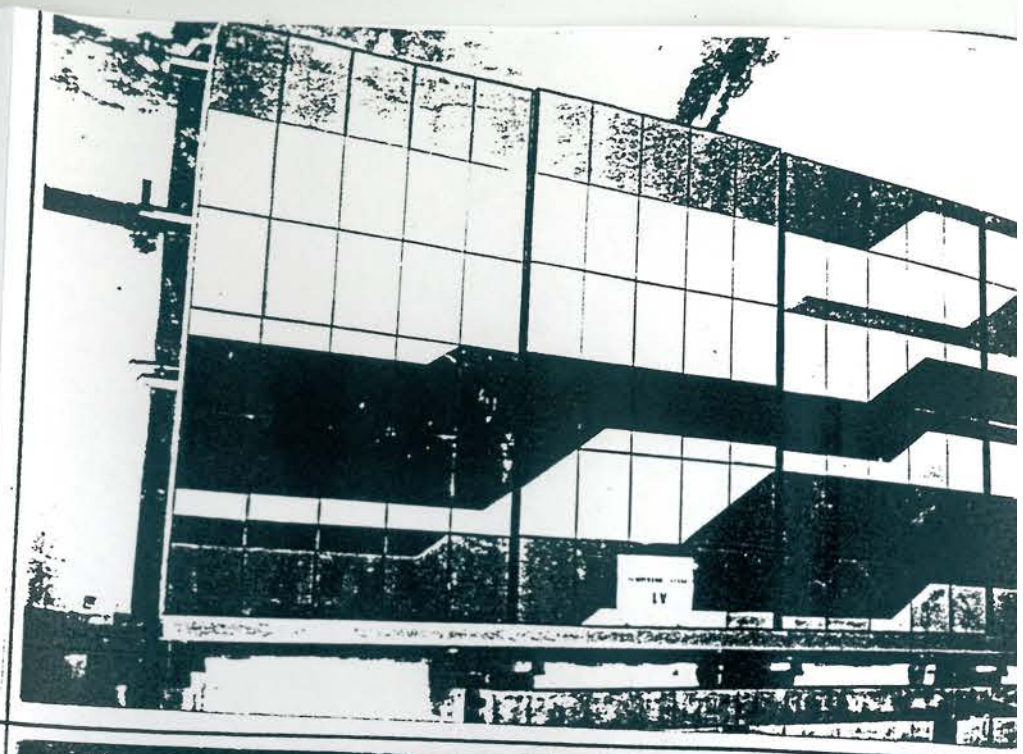
113

LEWAN CASING ELEMENT

LEWAN CASING ELEMENT

A light element used in overall building or as a casing element. Used in the Warsaw underground tube in the platform hall station with glued ceramic plates. The element's weight - 152 kg.



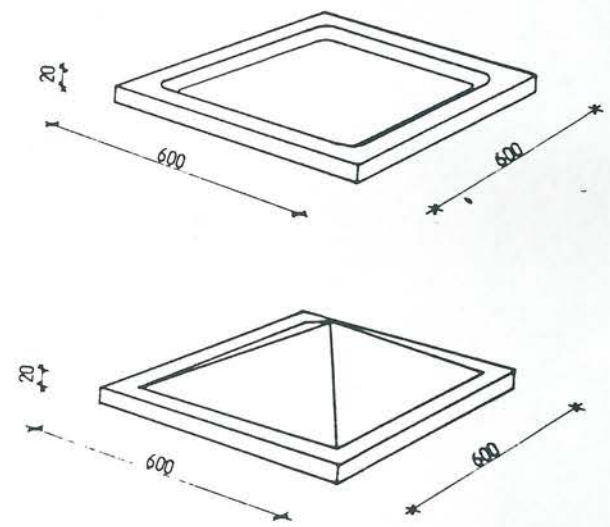


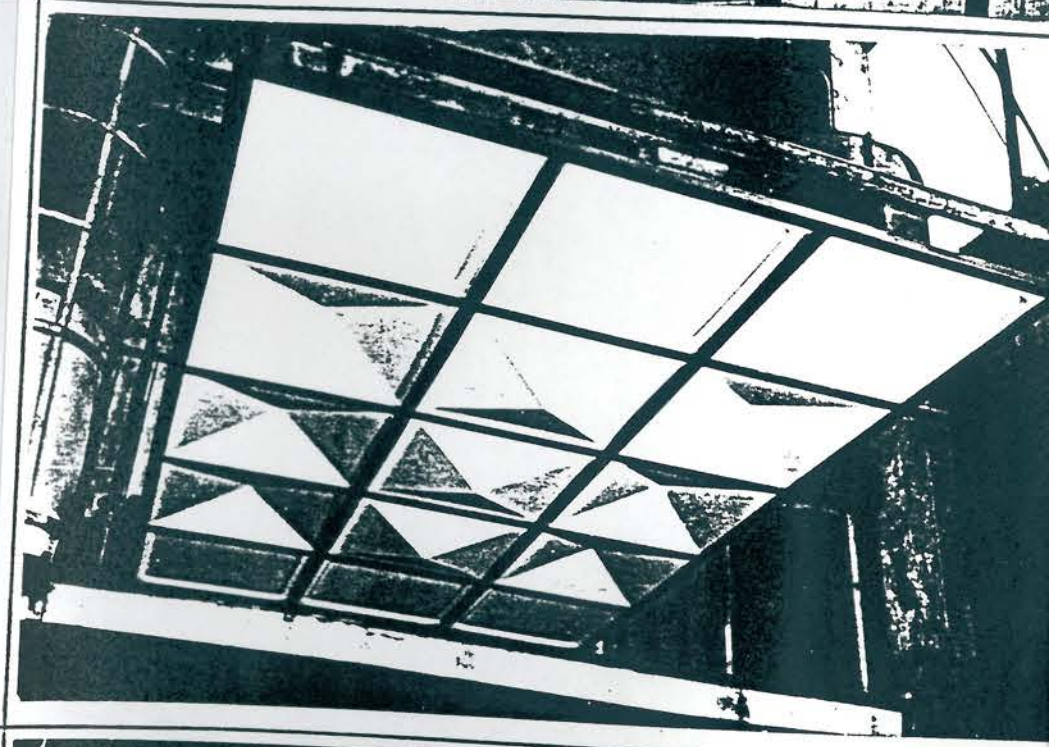
114

LACUNAR UNDERSLUNG CEILING

LACUNAR UNDERSLUNG CEILING

Lacunar prefabricated products with dimensions 60 x 60 cm and thickness 0,8 cm are the elements of the underslung ceilings. The plates are treated with special paints. The plate is put into a steel grate or suspended. They are used in the pedestrian underground passages of the Warsaw tube.





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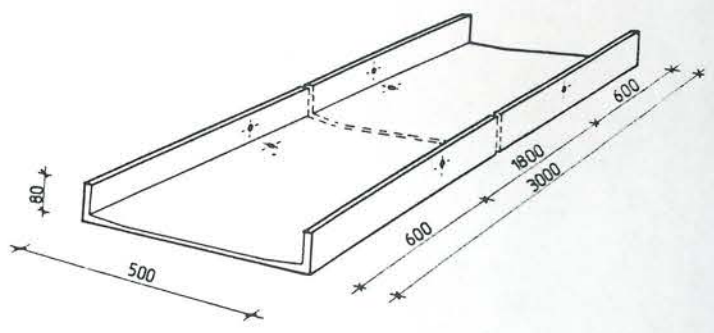
CHANNEL UNDERSLUNG CEILING

CHANNEL UNDERSLUNG CEILING

An element for making the underslung ceilings. Reinforcement - weaved net 10x15x1 mm and two bars 6 mm in diameter. The weight of the 3 m long element is 50 kg. Surface finish - emulsion paint, coloured micro plaster or chlorinated rubber paint. First use of these elements was made in the underslung ceiligs of the Warsaw tube.



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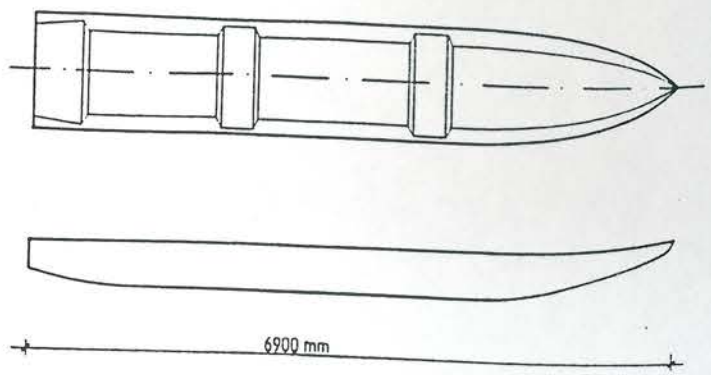
LABOUR WORKING BOAT SW 23

LABOR WORKING BOAT SW 23

This boat was designed as a work unit for water-way supervisors and fishermen. It has 3 float chambers filled with polystyrene foam. Propelled by oar (1 -2 pairs of oars in oarlocks) or outboard motor 2-10 ps power. Load capacity - 350 kg or 5 persons in 12 cm immersion. Lenght - 6,9 m; width - 1,2 m; freeboard - 0,4 m; dead weight - 250 kg.

„PROFER"



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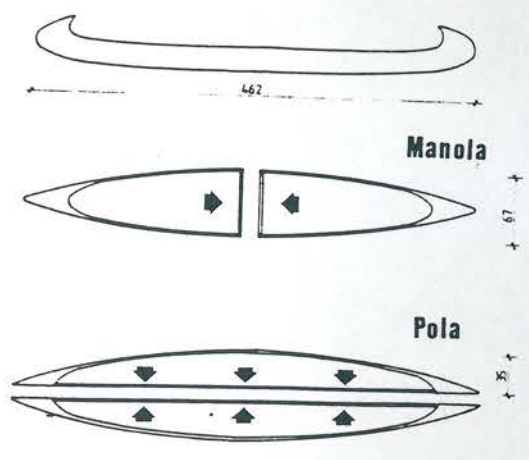
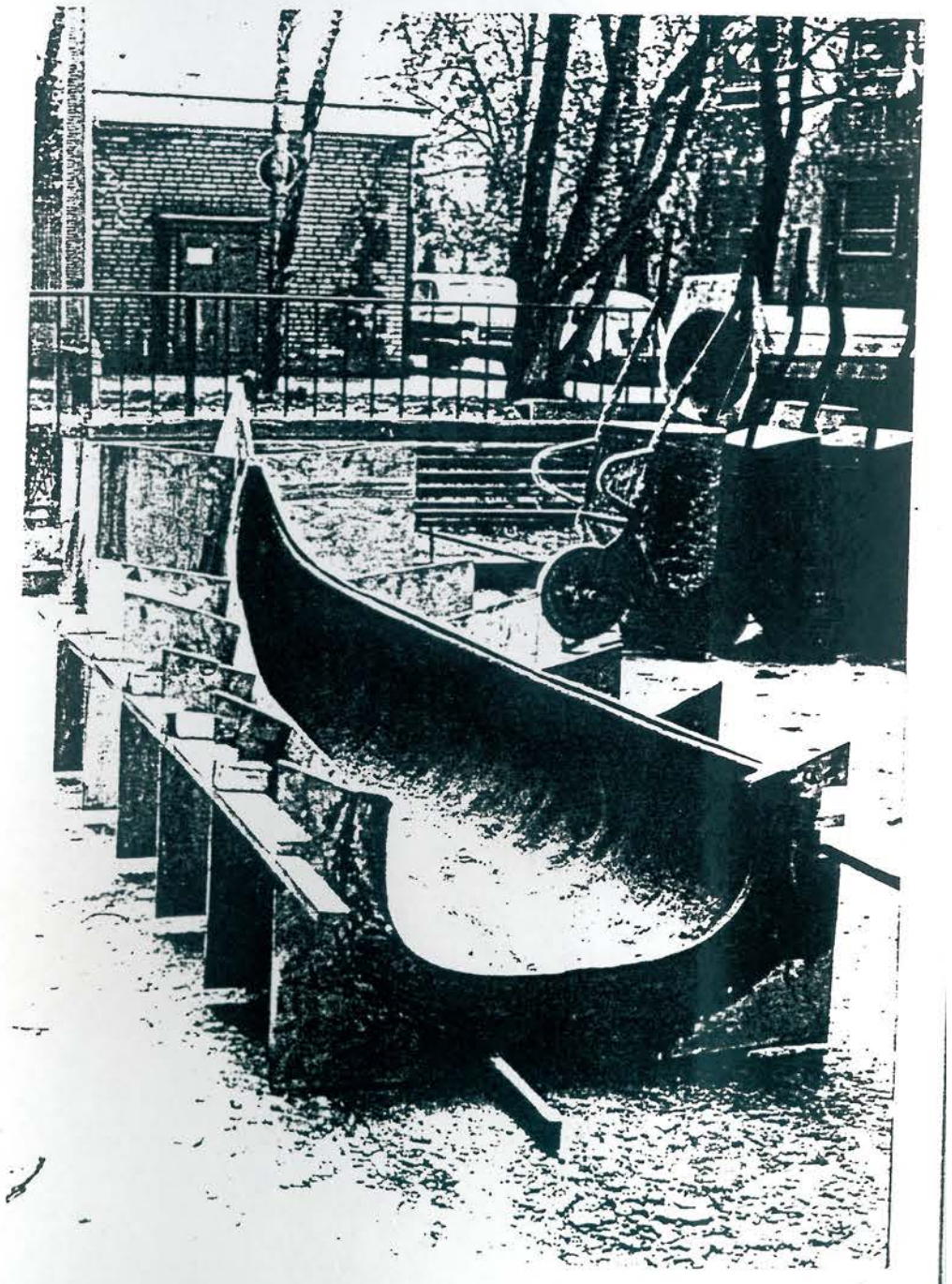
REGATTA BOATS "POLA" AND "MONOLA"

REGATTA BOATS "POLA" AND "MONOLA"

"POLA" and "MONOLA" are classic canoe-type boats, built at the Betokanorace in 1984 in Holland. Building technology: sectional outer forms. "Monola" is divided in crosswise length in the middle, "Pola" is divided lengthwise. Crew - 2 rowers per boat. Canadian style oars. "Pola": length - 4,9 m; width - 70 cm. "Monola": length - 4,62 m; width - 67 cm.

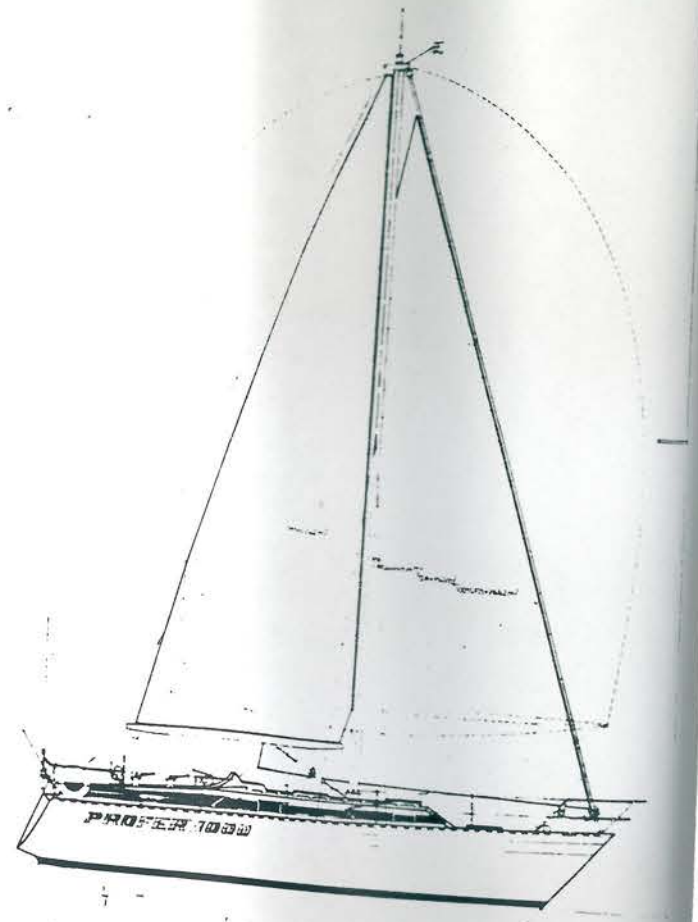


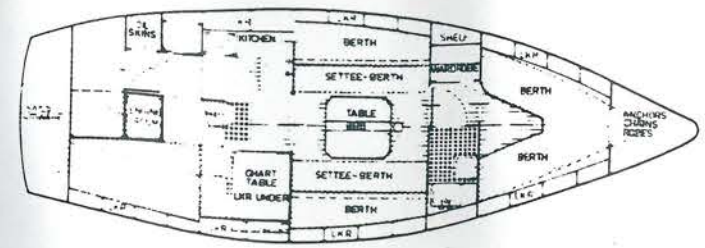


130

YACHT PROFER 1000

PROFER 1000 is a fast comfortable tourist-racing yacht, designed for serial production, having a ferrocement hull in one of 3 versions: ballast, dagger-ballast and dagger. Crew - 5-6 people. Emergency engine - diesel 25 ps, folding bolt. Length - 11,03 m; width - 3,38 m; immersion - 1,50 m; displacement - 7,5 t; surface of sails - 50 m².





YACHT PROFER 1000

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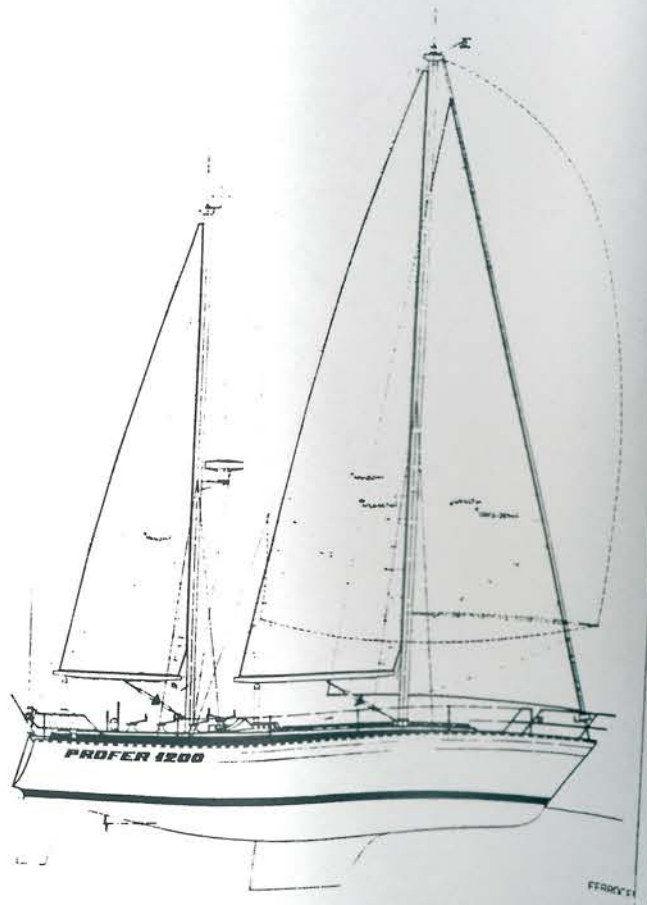
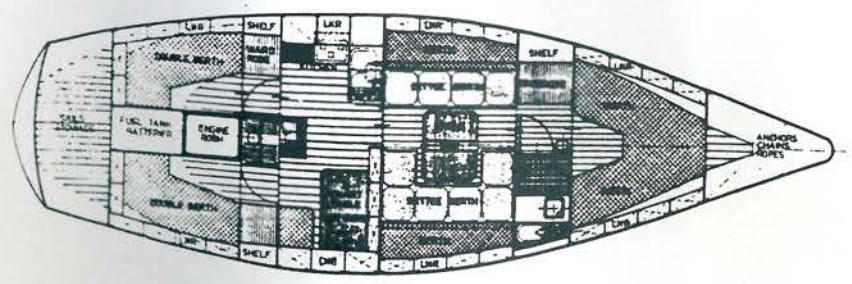
YACHT PROFER 1200

PROFER 1200 is a fast and comfortable tourist yacht, can participate in regattas even with one-man crew. The construction of the hull is designed as a ferrocement shell made in a mould under serial production conditions. Crew - 8-10 people. Diesel engine 40 ps; folding bolt. Ketch rig - surface 70 m²; 2 aluminium masts; length - 13,10 m; width - 3,96 m; displacement - 10,9 t; ballast - 4,25 t. Yacht can be offered in different stages of finish.





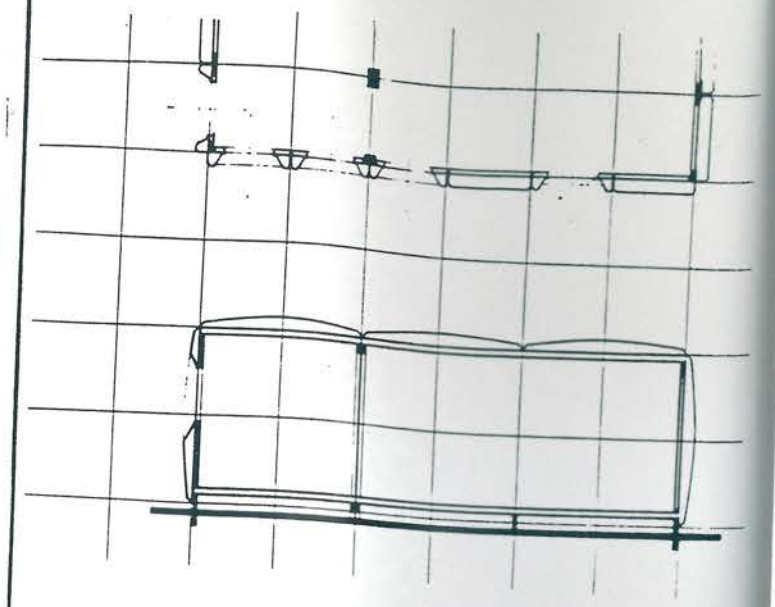
2. PREFABRICATED CONSTRUCTION

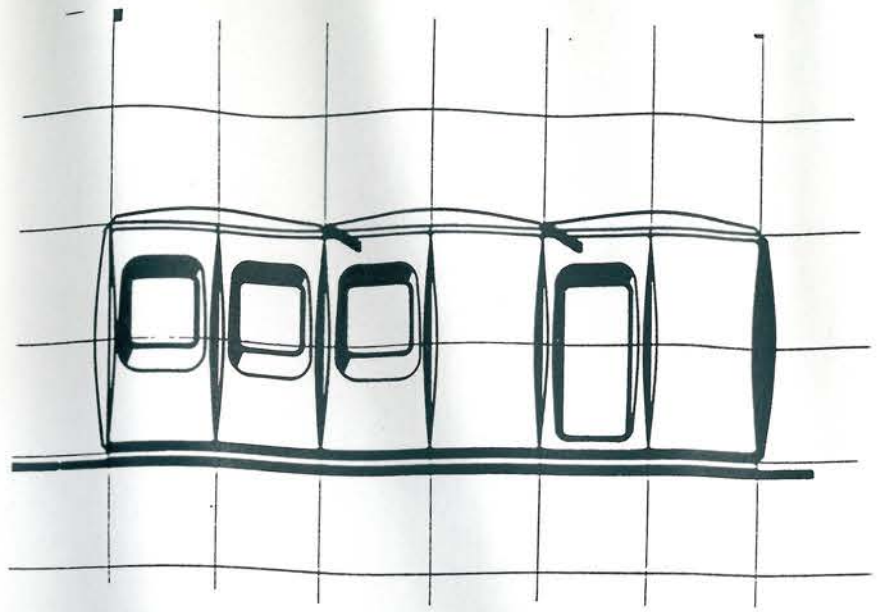
201

THE SUBUS SYSTEM

THE SUBUS SYSTEM

This system has been developed for ground floor, easy-to-assemble railway buildings - stops, watchman's booths, dispatch offices, store-rooms, lavatories etc. The construction system composes of: reinforced concrete framework, ferrocement channel plank, ferrocement coat and guard element and ferrocement fold element. Design idea not put into effect.





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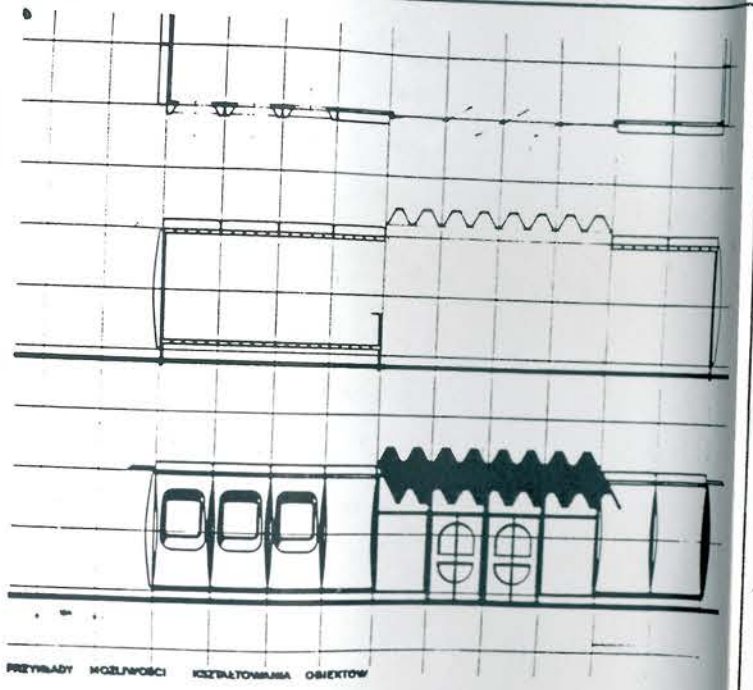
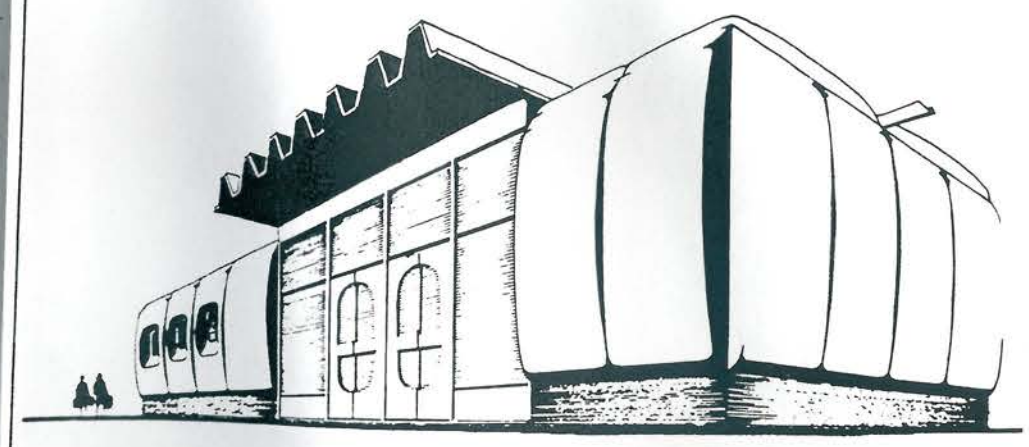
RAILWAY STATION

RAILWAY STATION

A station is an example of building forming of the SUBUS system. Traditional foundation. Construction situated on the ground consists of a skeleton put together from the casing frames coated from the outer side with facade elements. The cover of waiting-hall made from folded elements. The whole construction can be assembled with finish in two weeks. Prototype.



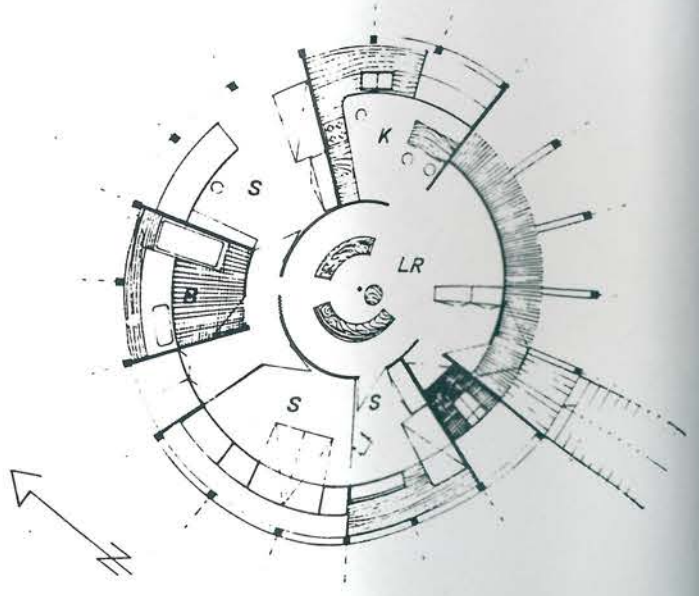


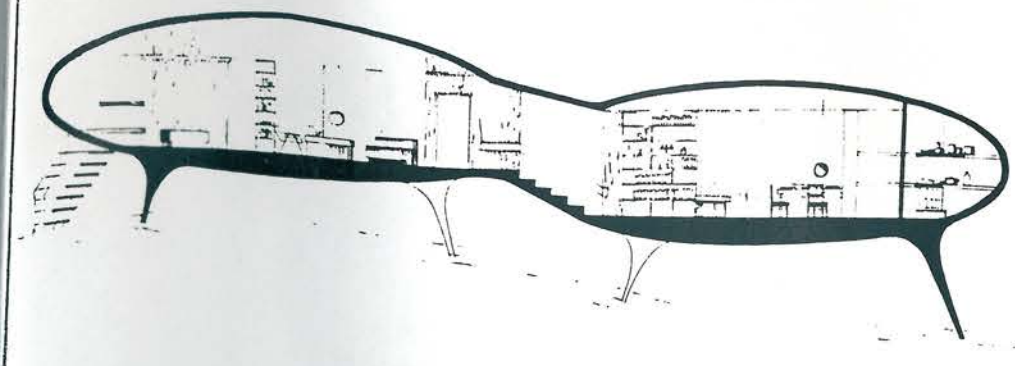
203

THE ALTA SYSTEM

THE ALTA SYSTEM

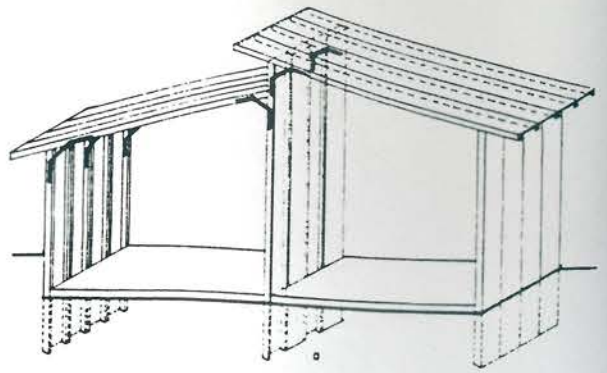
A system is an assembly of spatial construction or town planning complex from the ellipsoidal ferrocement coating. Forming of coating proceeds on the filled with air ellipsoidal ballons. Structure of coating wall - multilaminar, with insulation divider. Use - housing, hotels, summer houses.

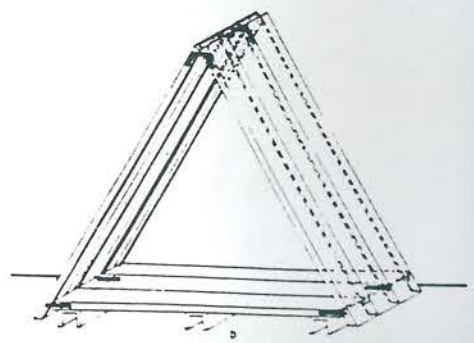


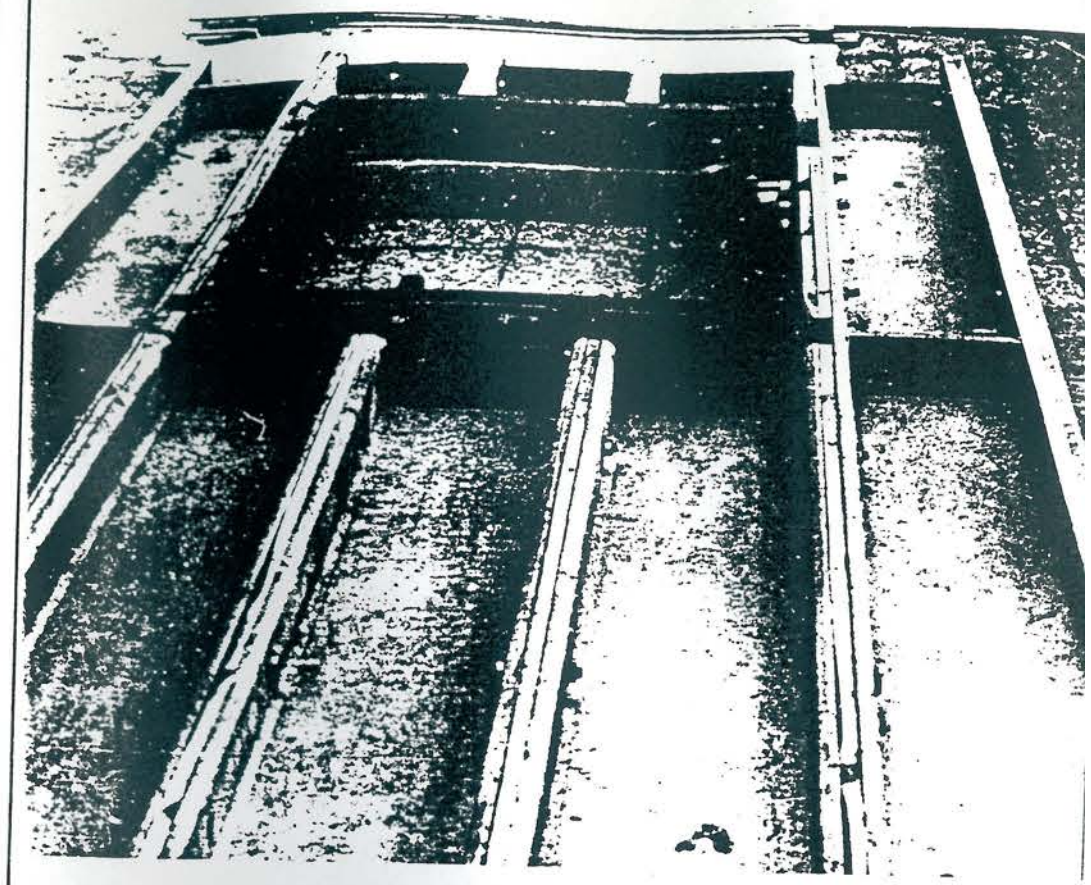


THE CeEs SYSTEM

A system is an assembly of construction made mainly from the prefabricated CeEs elements and joined with screws and steel corner elements. Foundation of buildings proceeds on the prefabricated concrete blocks with special furrow or through diging the lower element parts in the ground (hoarding wall). The system is suitable by erecting of provisional buildings for example: back-up facilities and farm animals buildings.

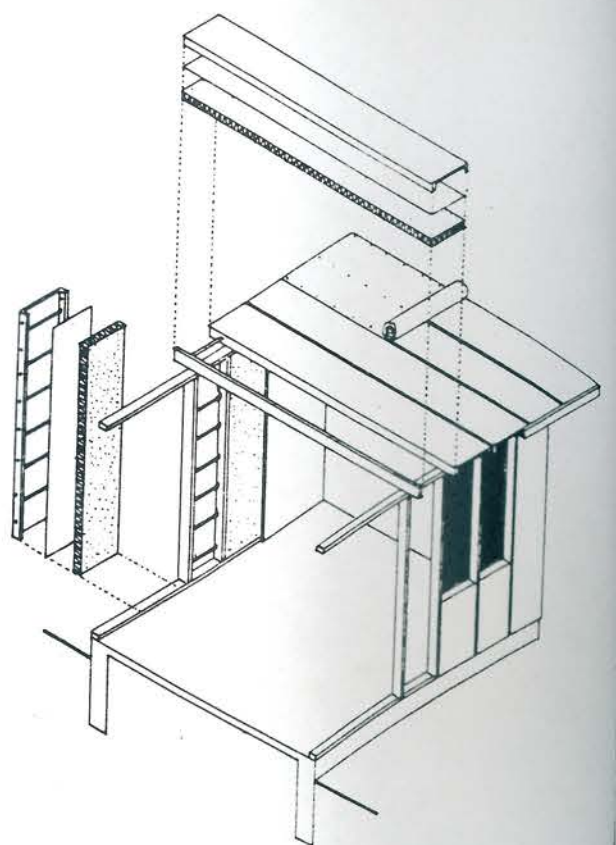


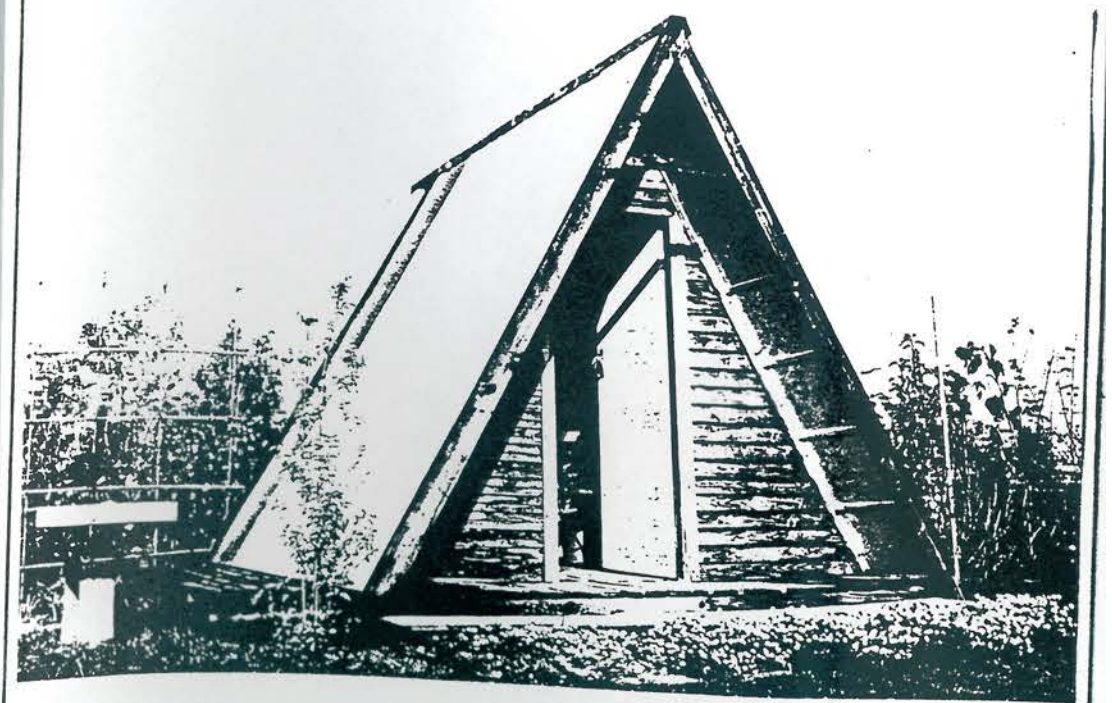




THE ELWO SYSTEM

A system is a join-construction of ferrocement ELWO elements and laths in vertical and horizontal ribs with steel corners used as a top and bottom wall framing. Traditional foundation. Use - weekend and summer houses.

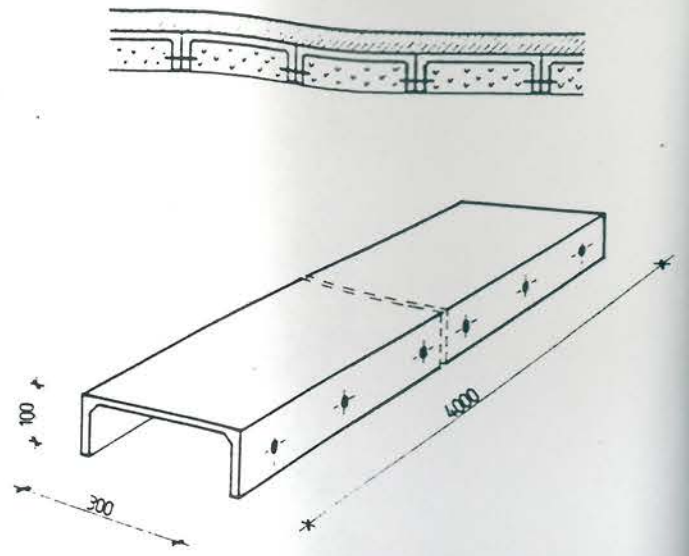


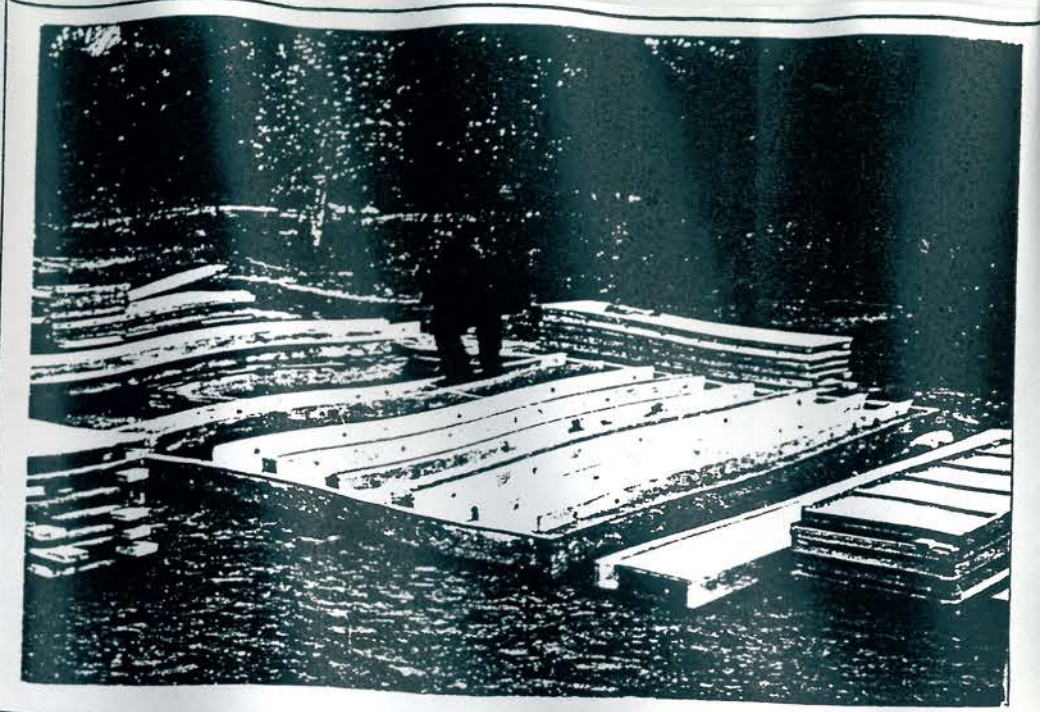


206 FERROCEMENT BEAM-FRAMED CeEs FLOOR

FERROCEMENT BEAM-FRAMED CeEs FLOOR

A floor consists of light ferrocement CeEs channels joined with screws. Is used for covering of garages, stores, provisional buildings, stations etc. In case of increasing a load capacity - over the prefabricated ferrocement elements is made on the building site additional light ferroconcrete slab. Maximal span - 4,2 m.

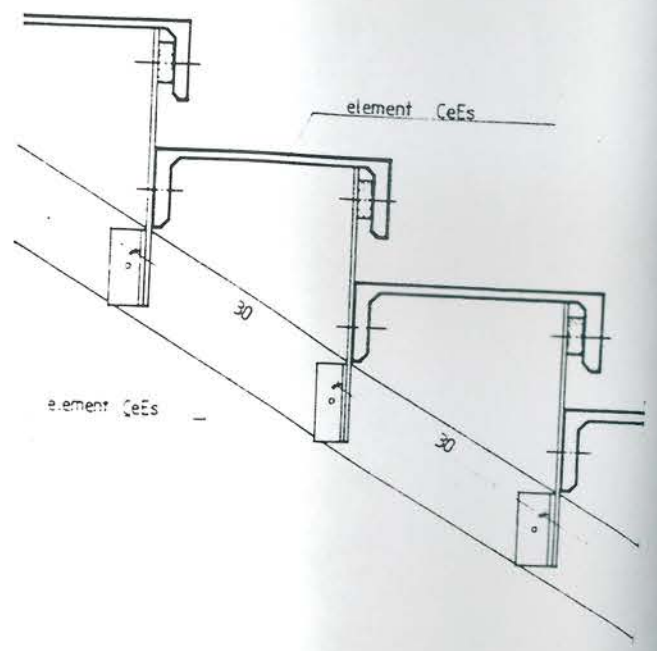


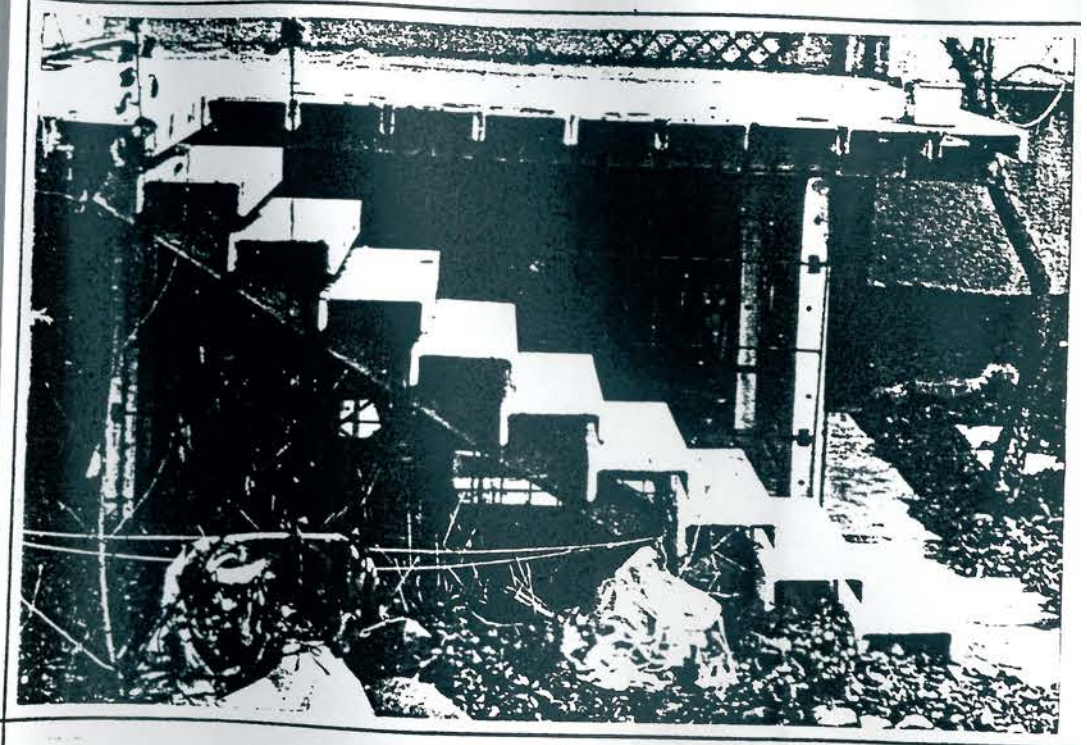


207 STAIRS

STAIRS

The stairs consist of prefabricated CeEs elements and steel connectors. For the bigger span of flight of stairs the CeEs element is filled with concrete. The stairs are treated with a resinous paint.

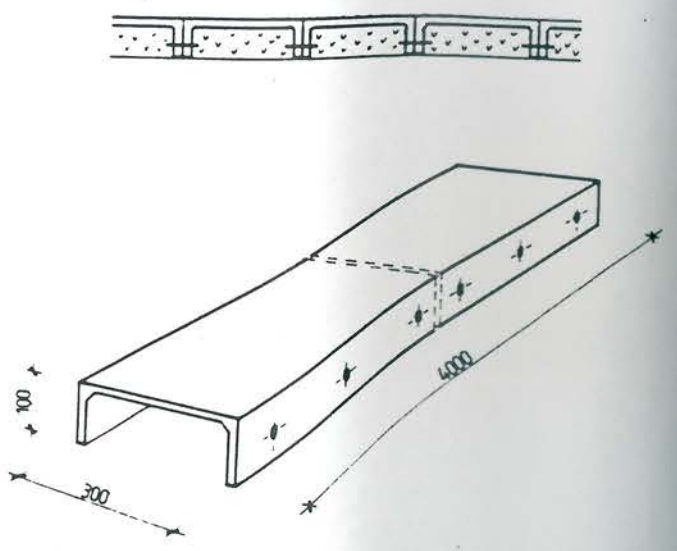


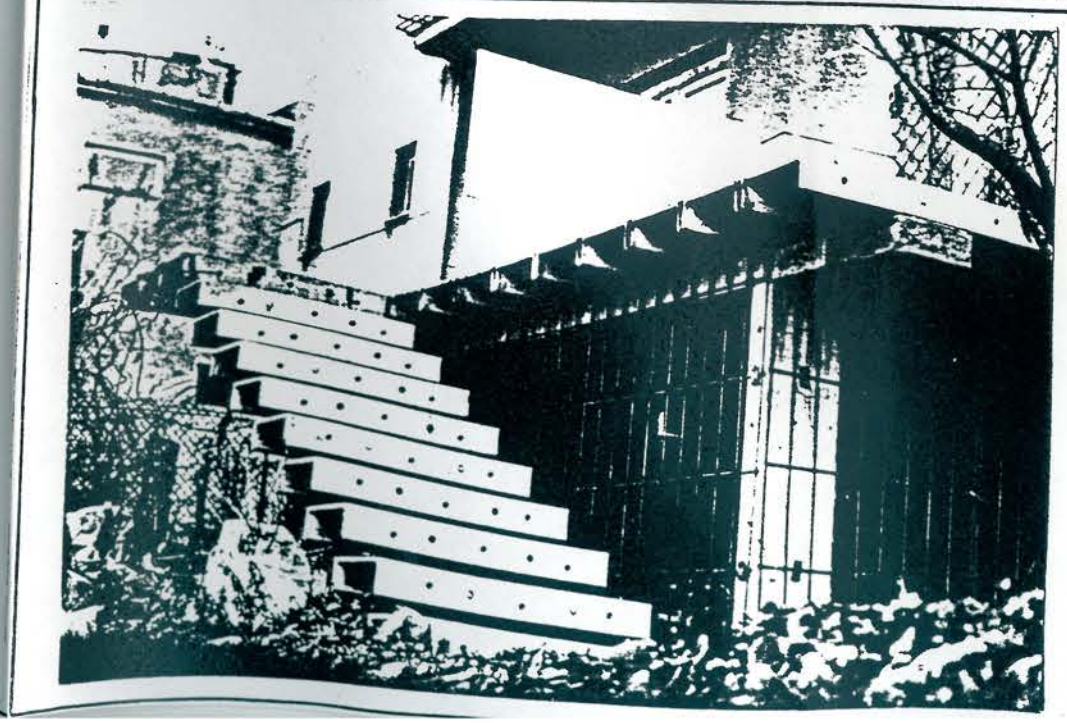


208 TERRACES

TERRACES

The ferrocement terraces are built mainly there, where the house is already existing and the user want easily and quickly to achive an additional space using a minimum workforce with the fresh concrete on the building site. An example of such terrace is shown on the picture. The beam-framed floor with CeEs elements joined with screws was used. The terrace is protected against atmosphere factors with a resinous paint.



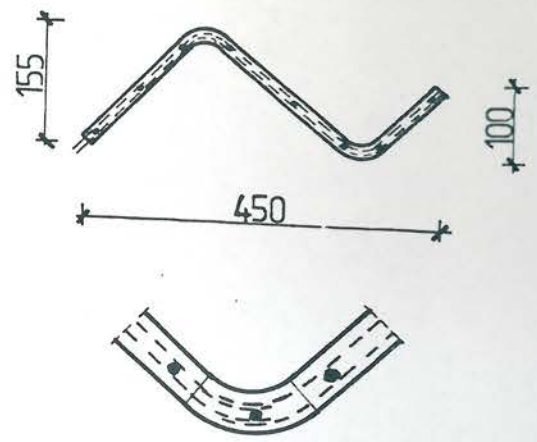


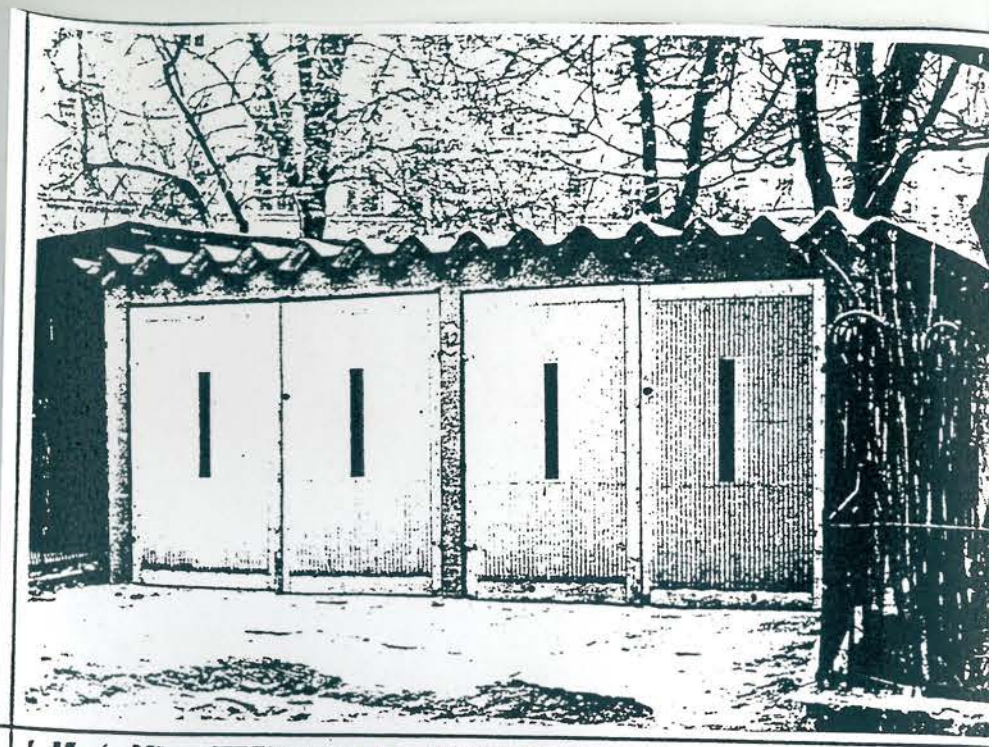
209

THE "TRYGON" GARAGE

THE "TRYGON" GARAGE

A garage is put together from eight prefabricated wall elements made "on flat" on the building site and with roof made from folded elements produced with "bending method". The connection of wall elements proceeds through embeding the corners in poured concrete.



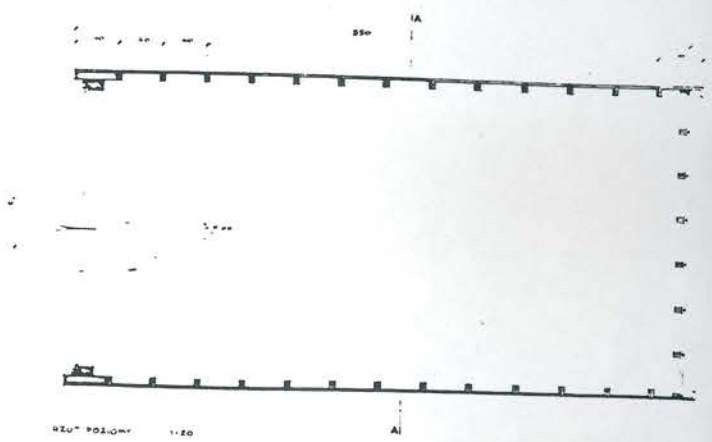


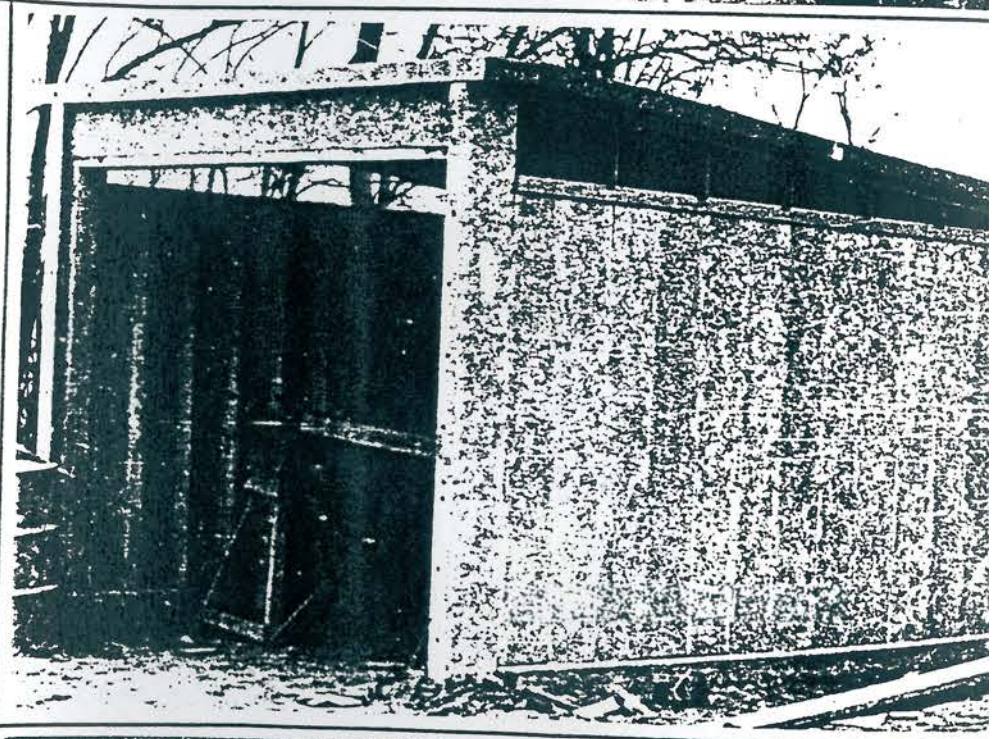
210

THE "AMIS" GARAGE

THE "AMIS" GARAGE

A garage is put together from CeEs channels and connected with screws. A monolithic frame around the gateway poured from concrete on the building site in boarding made from the same CeEs elements. Building time and assembly - 2 days.



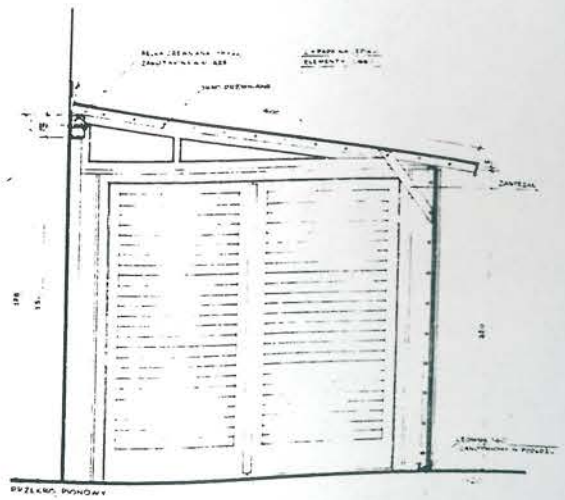


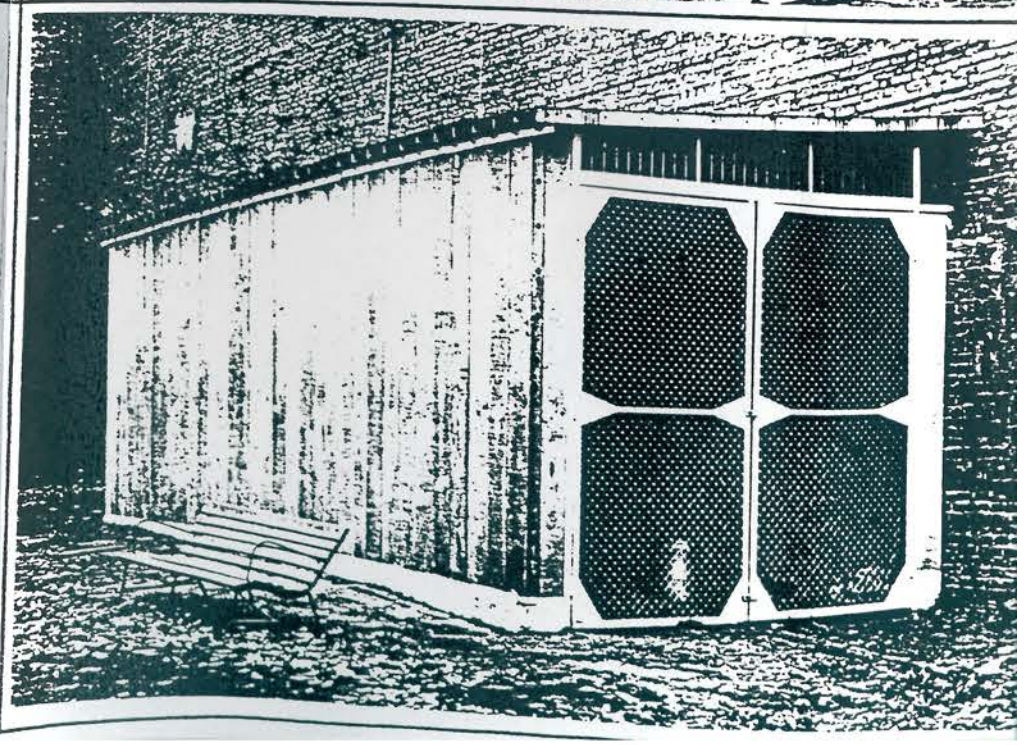
211

BUILDING WAREHOUSE

BUILDING WAREHOUSE

A warenhouse had been assembled from the ferrocement CeEs elements closed to the repaired theatre building in Warsaw. Construction twinned with screws, completely disassembled.



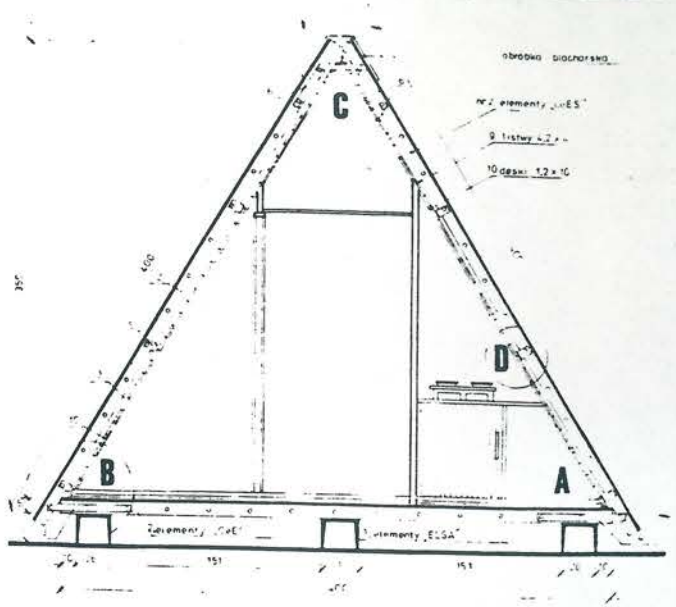


212

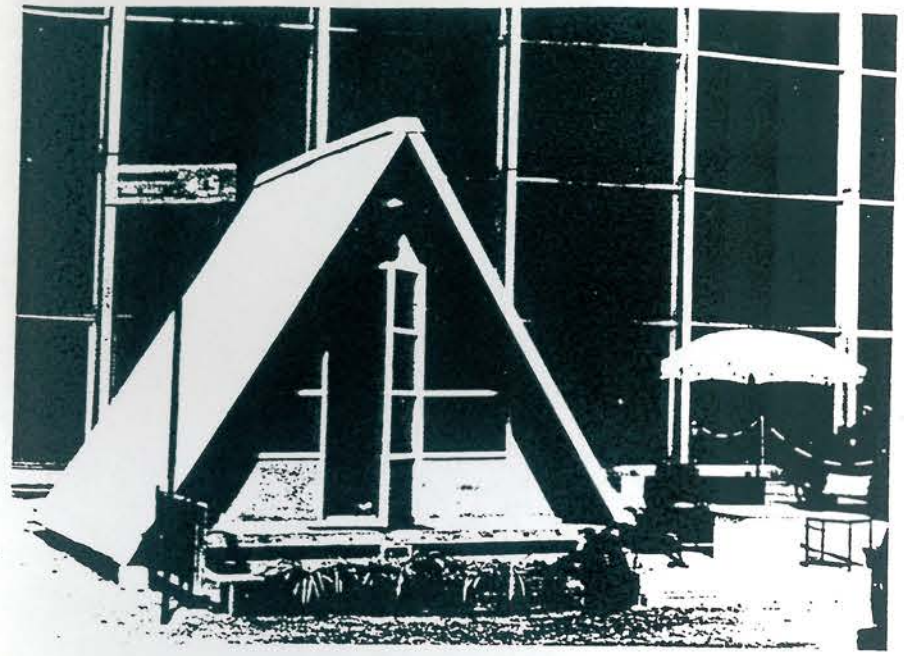
THE GARDEN HOUSE "BETKA 1"

THE GARDEN HOUSE "BETKA 1"

"Betka 1" is a summer garden house made from prefabricated ferrocement CeEs elements. Construction is simple, 4 persons can assembly the house in one day. Building area - 15,6 m^2, cubature - ca. 30 m^3.



Przekrój A—A 1:20

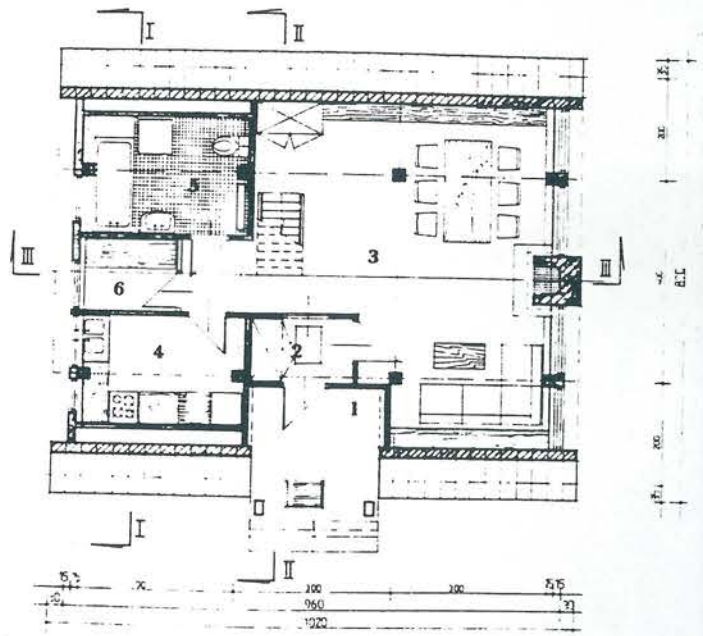


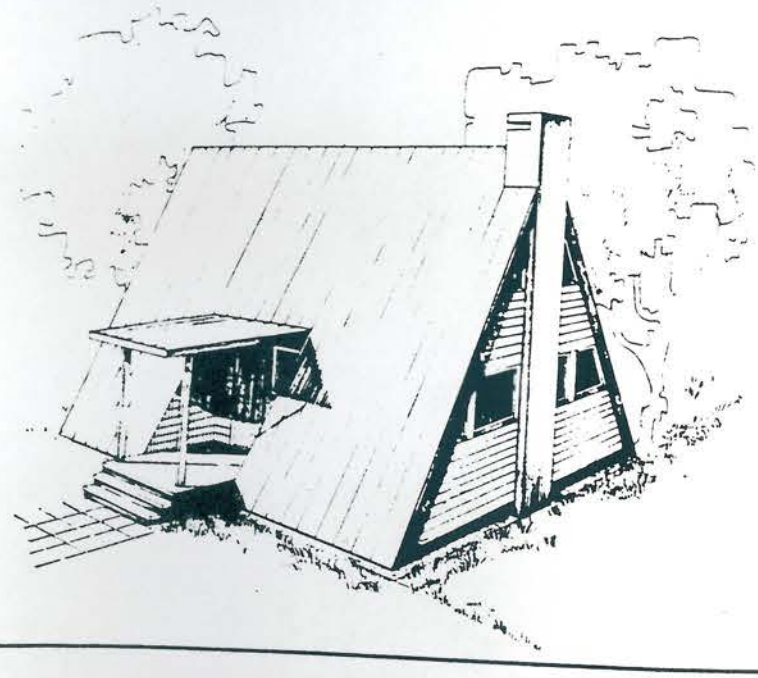
213

MULTIFUNCTIONAL HOUSE "BETKA 2"

MULTIFUNCTIONAL HOUSE "BETKA 2"

Multifunctional, free-standing, small house "Betka 2" can be used among other as a dwelling house, camping house, house for administration for quick assembly. One-floor, completely prefabricated with foundation, two bedrooms. Designs are offered in five different alternatives. Usable area - 70,1 m^2, cubature - 346 m^3.



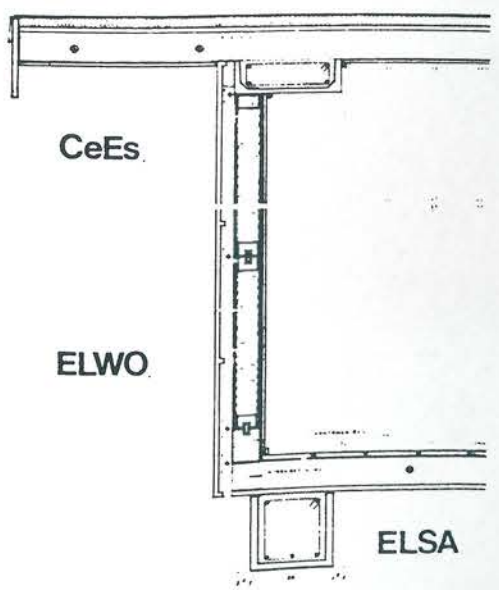


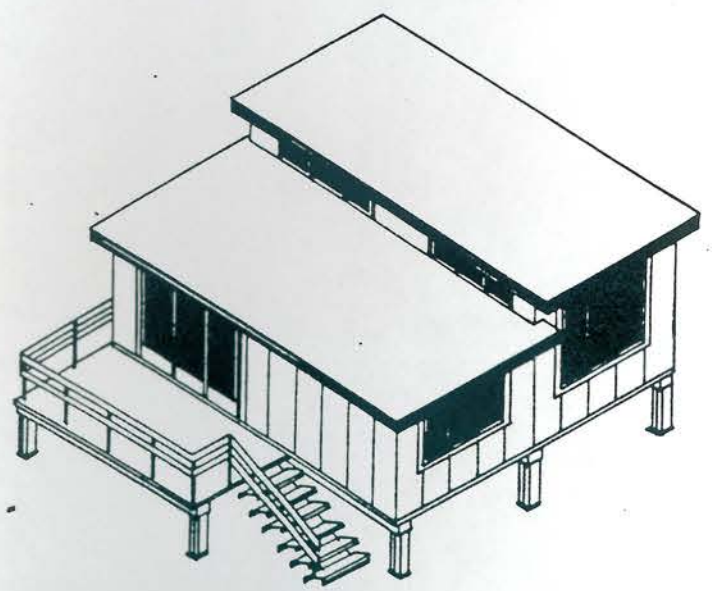
214

SUMMER HOUSE "ANIRA"

SUMMER HOUSE "ANIRA"

"Anira" is designed for building on recreation areas where periodical flooding may occur. That's why the house is set on posts. It's for four people and can be used year round. The construction consists of ELSA elements (posts and bolts), CeEs elements (ceiling and roof) and ELWO elements (laminar outer and inner walls). Technical documentation available. Never had been built.



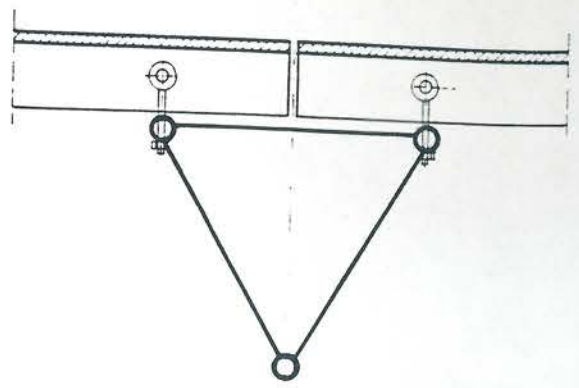


215

STORE-ROOM UMBRELLA ROOF

STORE-ROOM UMBRELLA ROOF

A store-room umbrella roof was built through the joining of light pipe steel girders with prefabricated CeEs elements. Reinforced concrete posts are made in the lost boarding from CeEs elements.

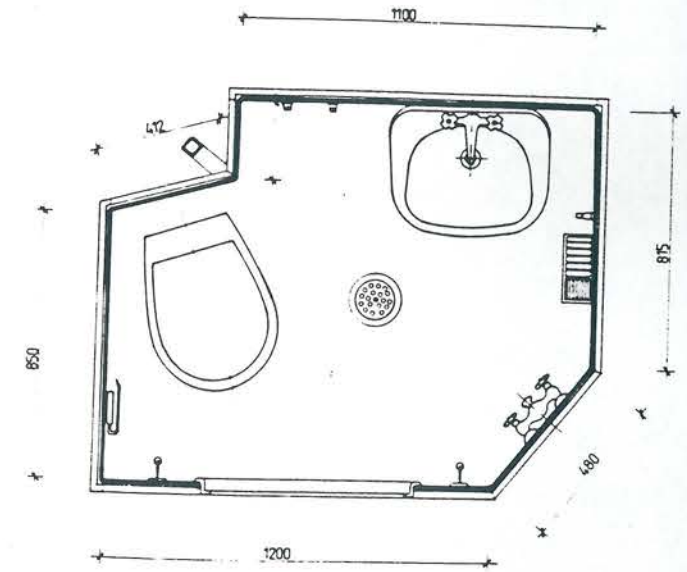


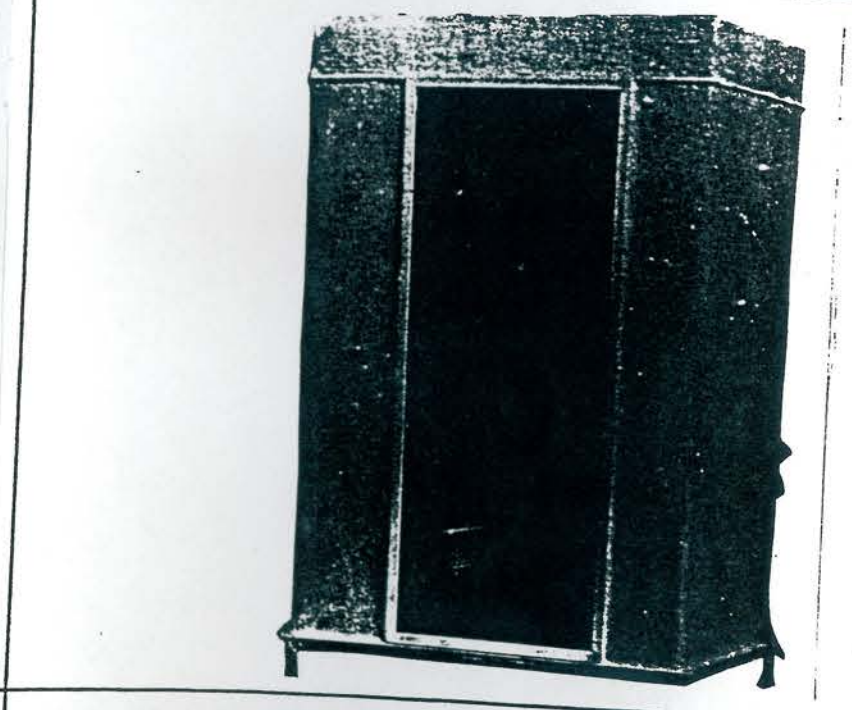
216

SANITARY CABINS

SANITARY CABINS

Light ferrocement sanitary cabins are designed as modular blocks for hotel fittings of sea ferries. The cabin is equipped with a shower, WC, wash-basin and weights 420 kg. Operating research was carried out on a Polish Ocean Lines ferry m/s Skoczów.



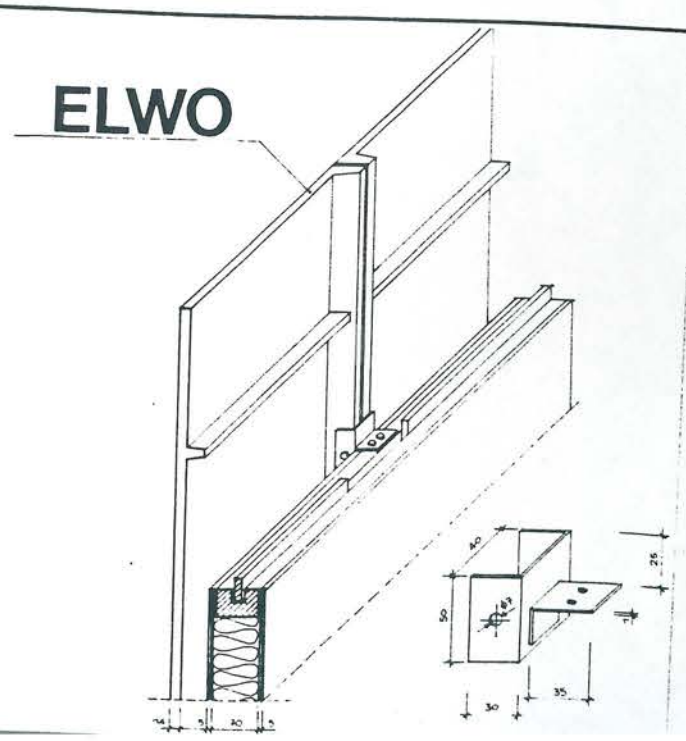


217

SUMMER HOUSE "FLORIS"

SUMMER HOUSE "FLORIS"

An example of a house made in the ELWO System. Traditional foundation. A prefabricated CeEs ceiling rests on the cellar walls. The house can be used from early Spring to late Autumn by three-people family. ELWO boards are treated with chlorinated paint. Assembly in 3 days.

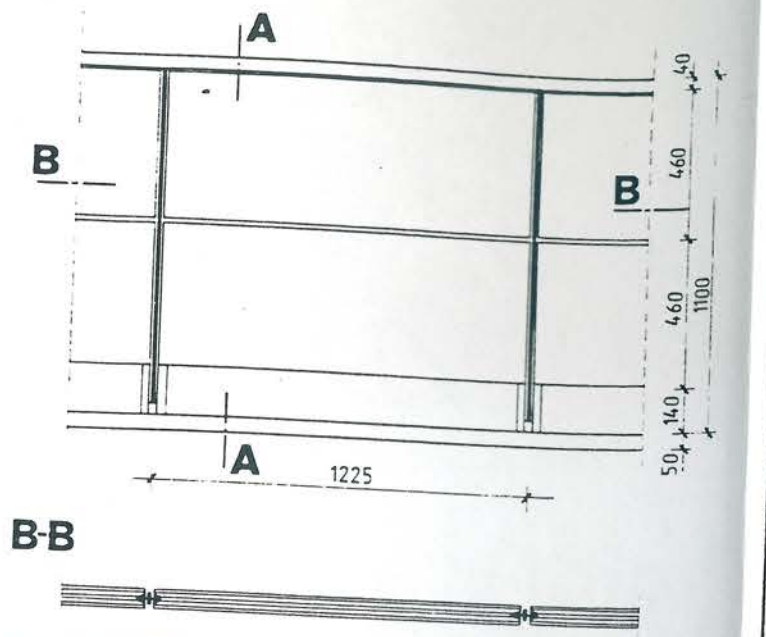


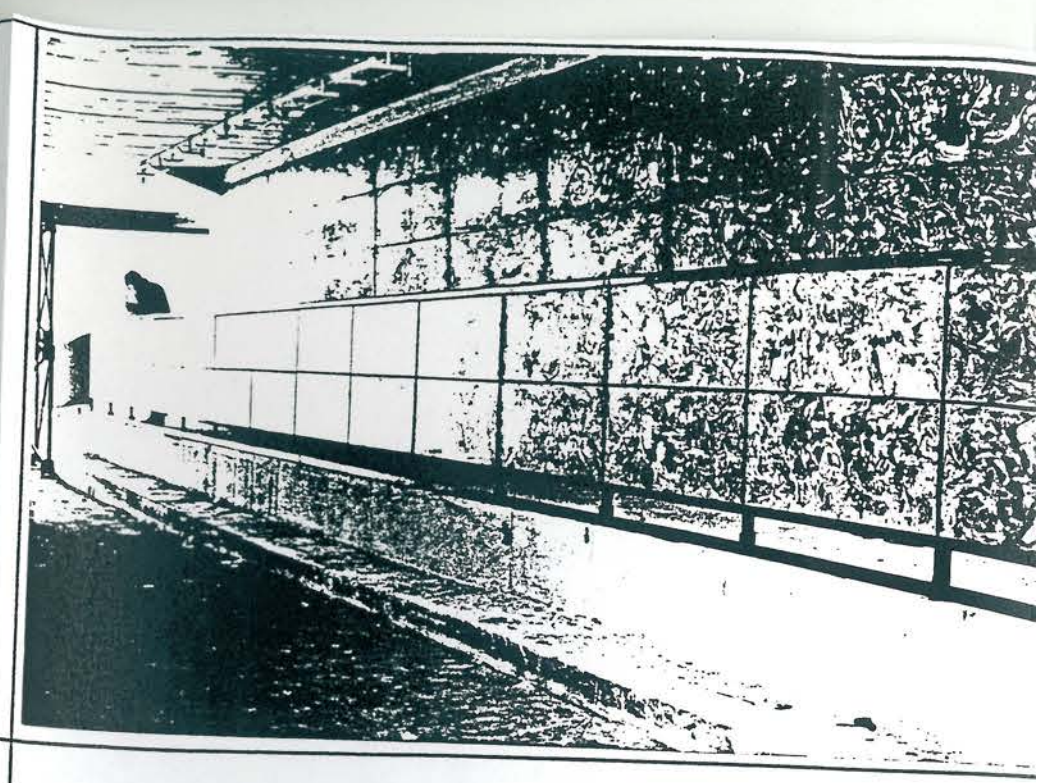
218

BARRIER WITH ARTIFICIAL MARBLE LINING

BARRIER WITH ARTIFICIAL MARBLE LINING

The barrier consists of flat thin-walled ferrocement boards in steel framing, to which artificial marble plates are glued. The barrier was built for protection of a pedestrian passage in a Warsaw tunnel.





219

220

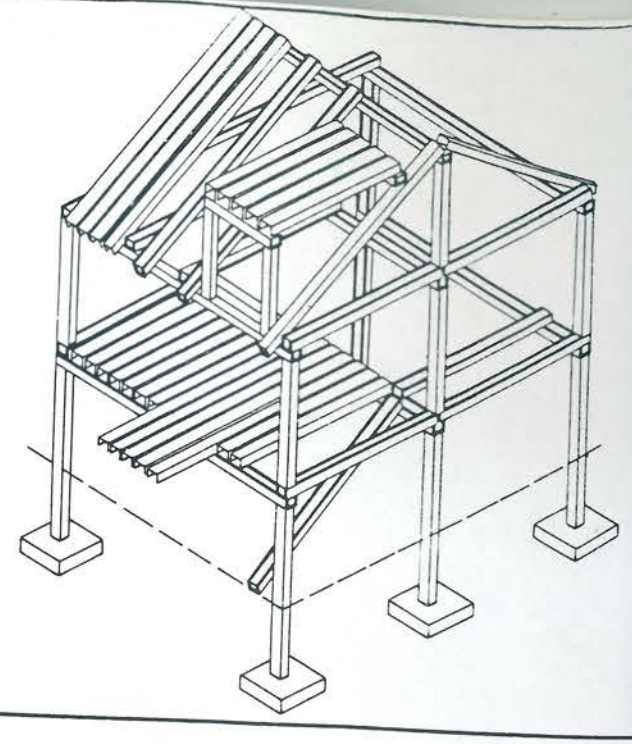
3. PREFABRICATED-MONOLITHIC CONSTRUCTION

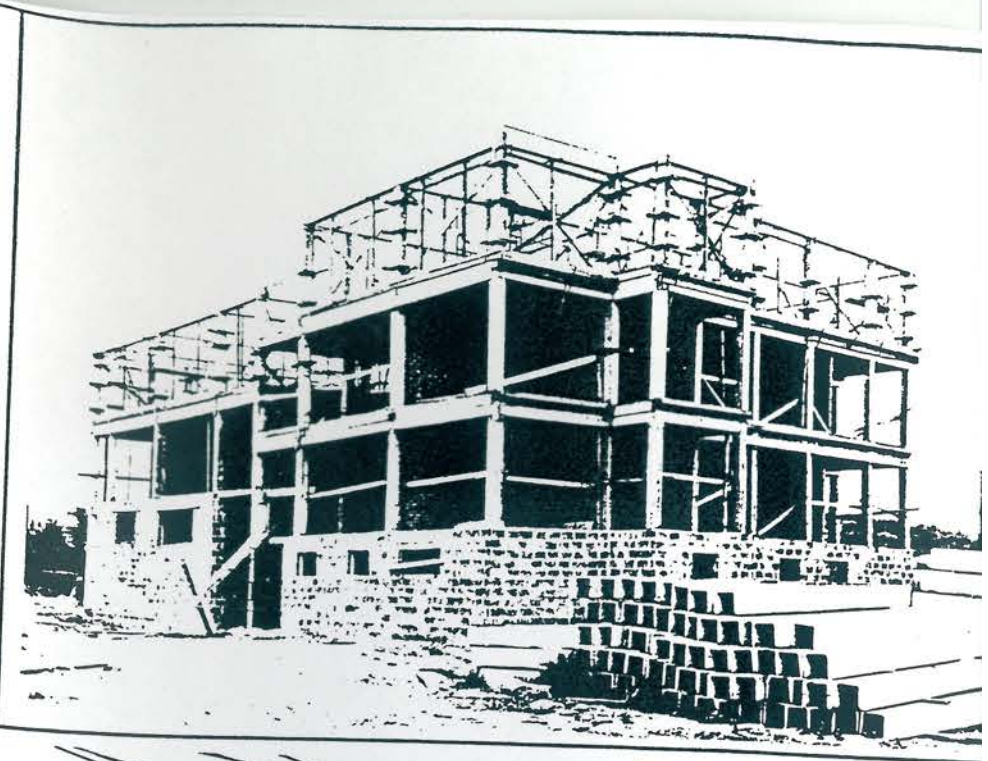
301

THE ELSA SYSTEM

THE ELSA SYSTEM

This system is based on an ELSA ferrocement element of a constant crosswise cut (22x26 cm) but of variable length (max. 6 m), which is the only and, at the same time, sufficiently universal prefabricated element of a frame construction. The ELSA element is used as lost boarding of a pillar, spandrel beam, curb-roof, etc., or is a self-supporting ceiling or roof element.
This system is applied in several single and multifamily buildings in Poland. Prize awarded in Holland.



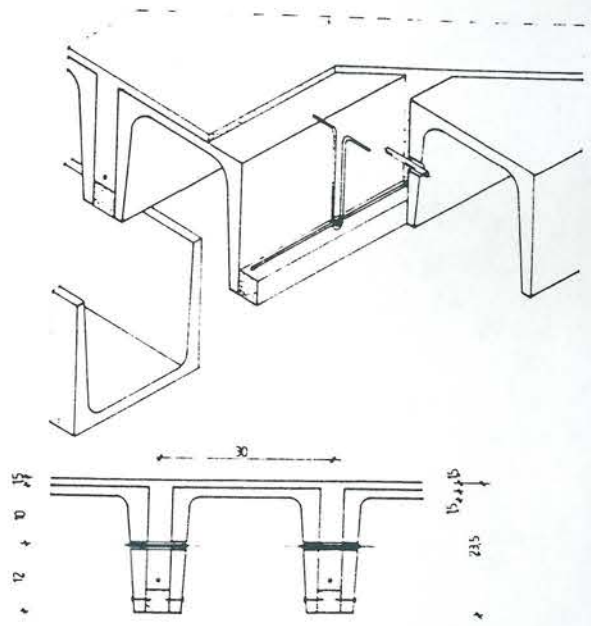


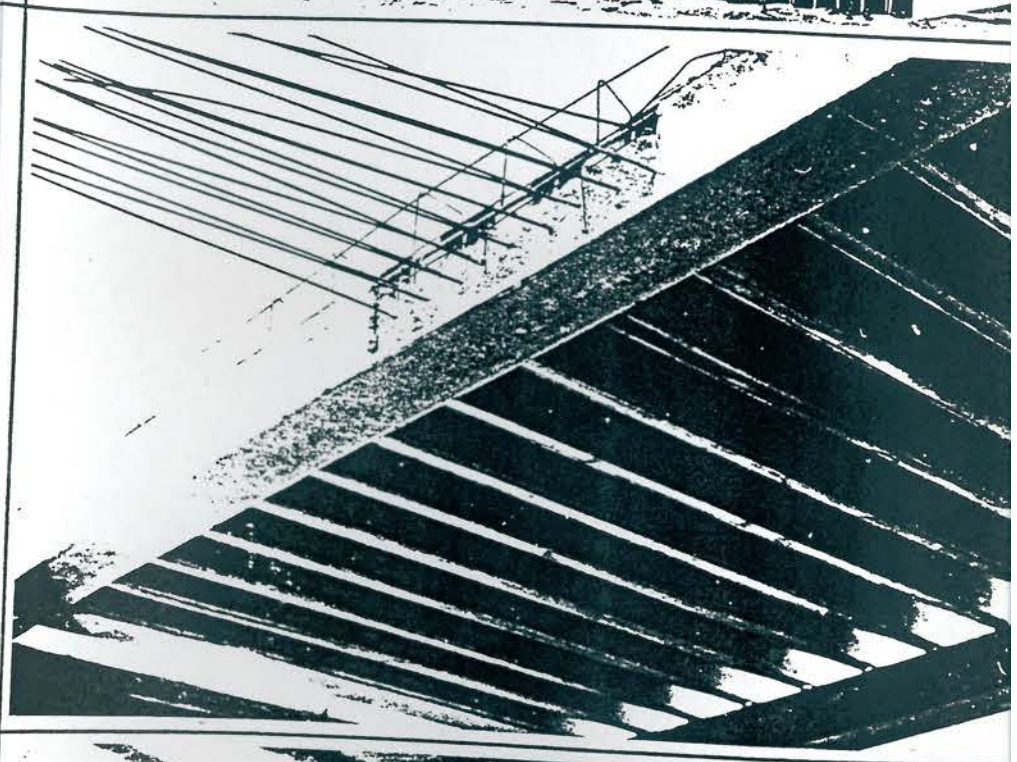
302

THE ELSA (FERROCEMENT) CEILING

THE ELSA (FERROCEMENT) CEILING

The ELSA ceiling is a light close-ribbed beam framed floor formed from ferrocement self-supporting ELSA channels and ferroconcrete ribs filled between elements at the building site. Rules placed on bottom ends of ribs are for the purpose of affixing the false ceiling made eg from gypsum card-board plates. Noise absorbing inserts are placed in empty spaces. Weight of ceiling - 170 kg/m². Maximal span - 6 m. Application - ceilings and ceiling-roofs in housing.



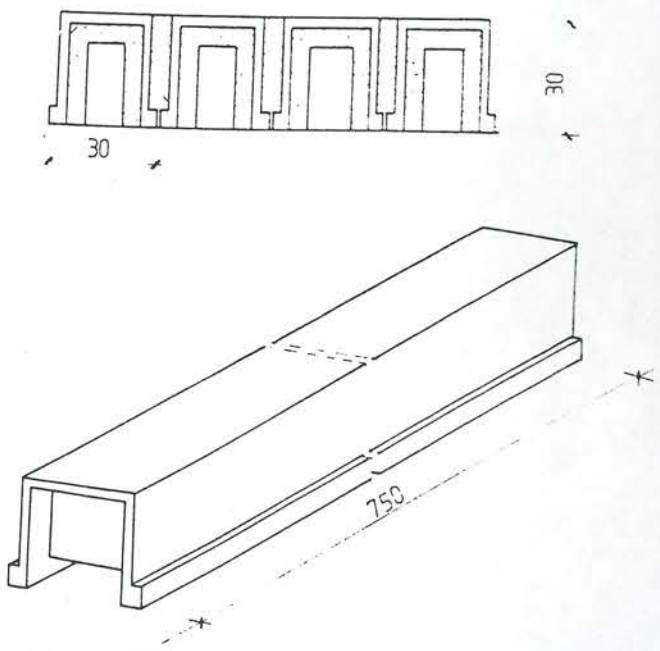


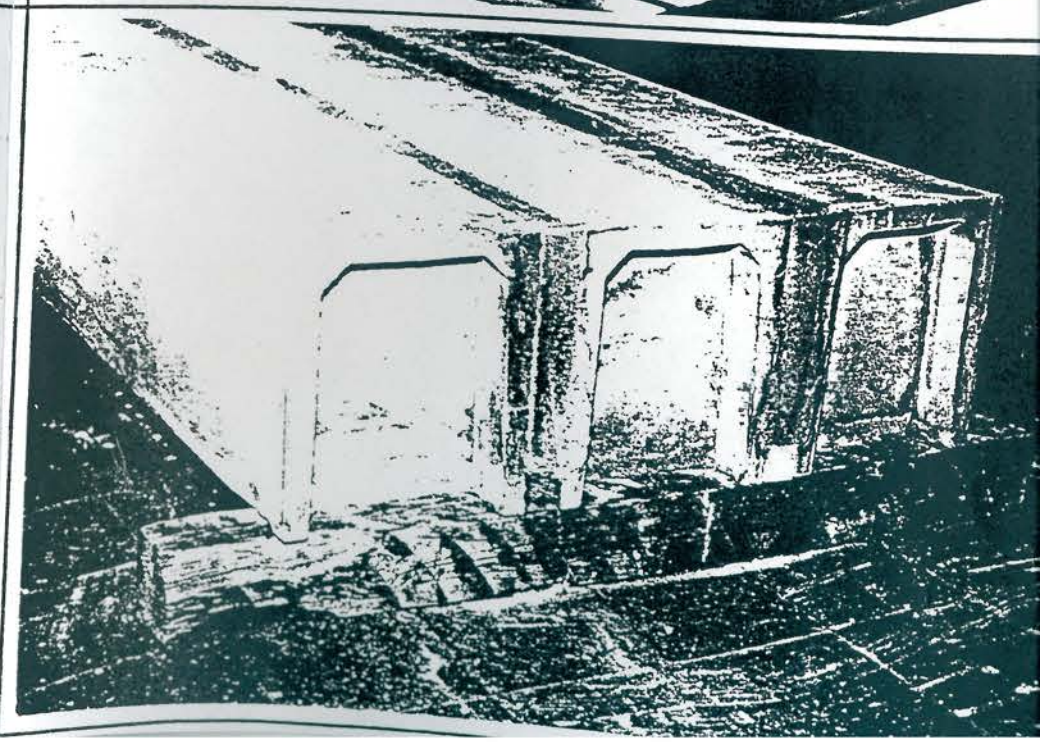
303

THE ELSA-S CEILING

THE ELSA-S CEILING

This ceiling is a variation ELSA ceiling intended for school buildings. Maximal ceiling span - 7,5 m. Ceiling height - 30 cm. Ceiling elements are formed on chip-concrete inserts being a heat and noise insulation. Different types of false ceilings are affixed to the chip-concrete elements. This material is being tested at the moment in an experimental building.

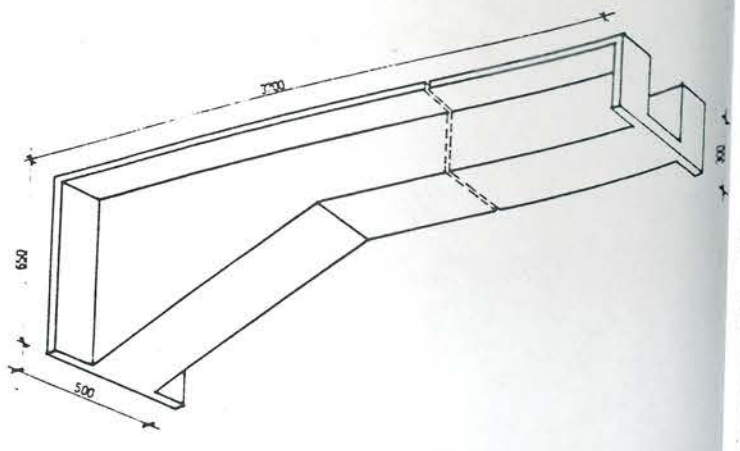


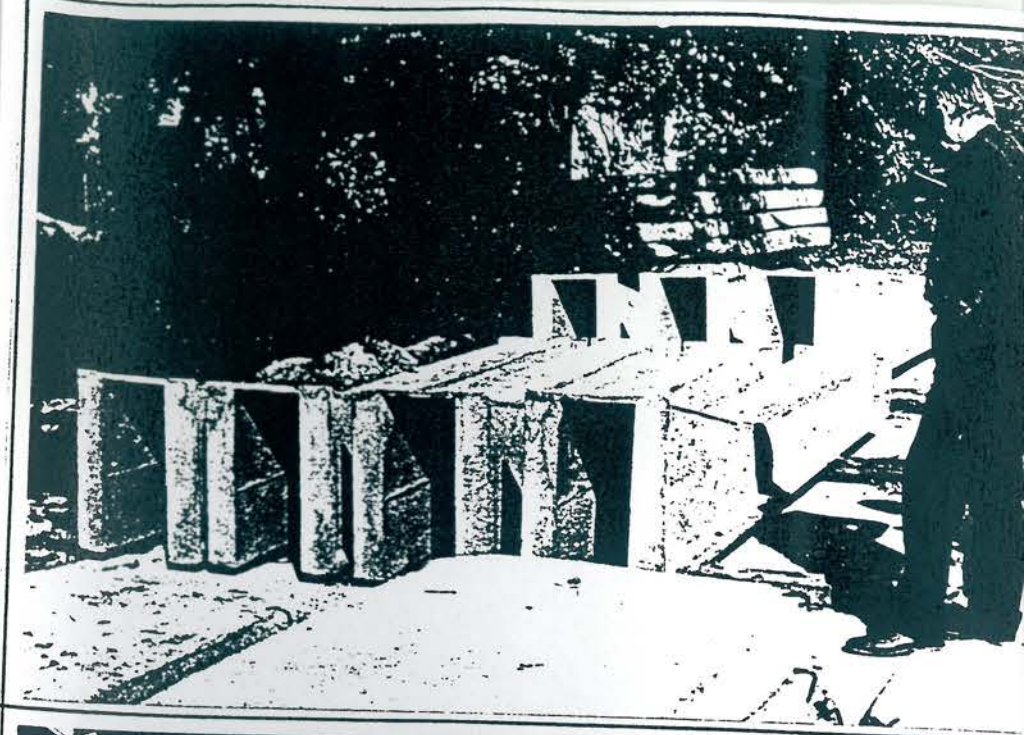


304 BRACKETING GALLERIES OF AN UNDERGROUND TUBE STATION

BRACKETING GALLERIES OF AN UNDERGROUND TUBE STATION

The galleries of the underground tube stations, being the pedestrian accesses to platforms, have been designed in the form of closeribbed brackets. Instead of wooden boarding ferrocement prefabricated products with channel section have been used at the building site. This accelerated considerably the building of the underground tube stations.

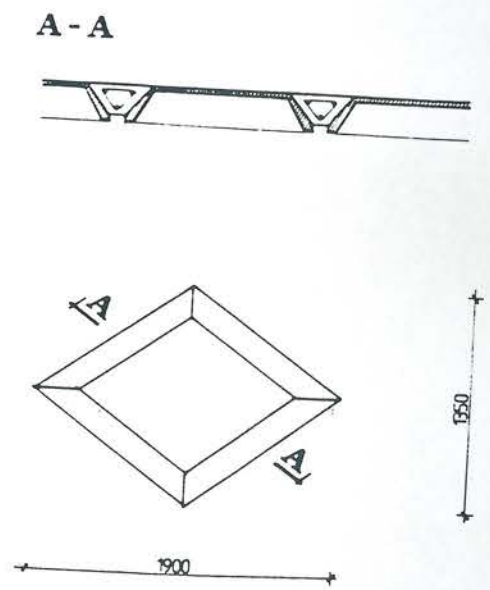


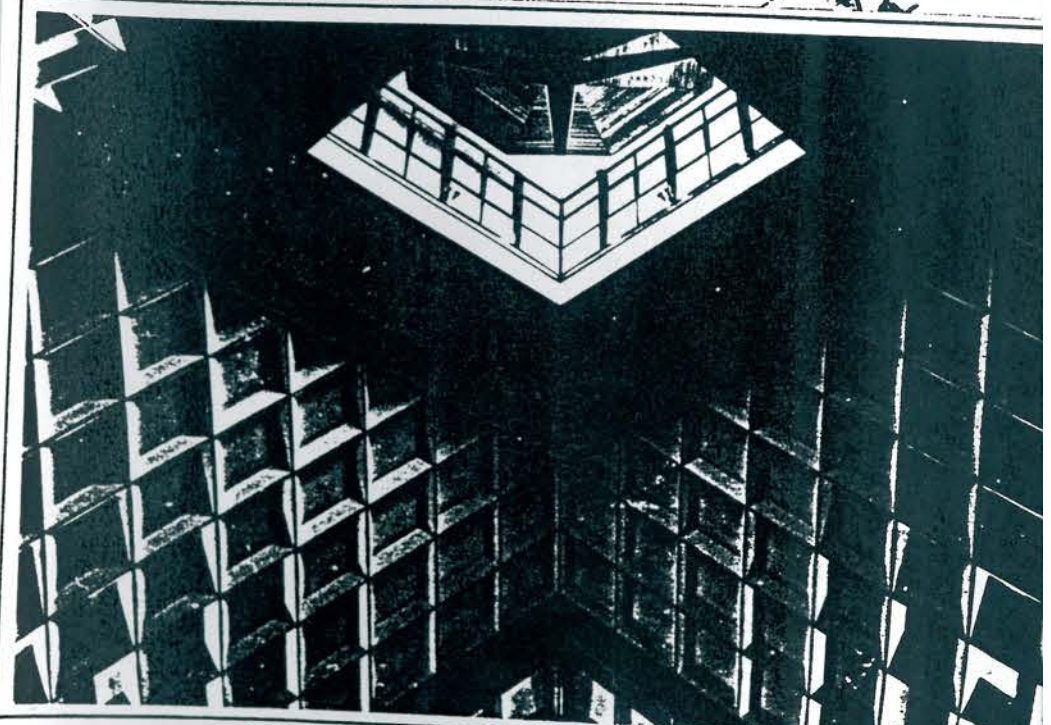


305 LACUNAR VAULT OF CHURCH

LACUNAR VAULT OF CHURCH

Light ferrocement prefabricated products in the form of lacunar vault lost boarding have been used in building of the Catholic Church in Otwock. These prefabricated elements replaced labour consuming, expensive, traditional wooden boarding of ceiling, accelerated its making and eliminated finishing work.

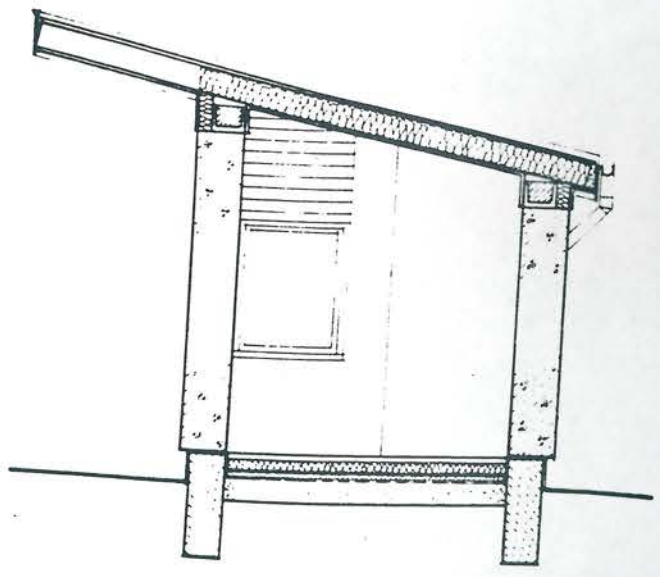




306 GATE-HOUSE OF TRANSPORTATION BASE

GATE-HOUSE OF TRANSPORTATION BASE

Near the entry to the parking lot of the Warsaw University of Technology a gate-house had been built. The construction consists of two reinforced concrete frames with ferrocement shuttering forms and an ELSA ceiling. The walls of the gate-house are made of concrete-chip elements.

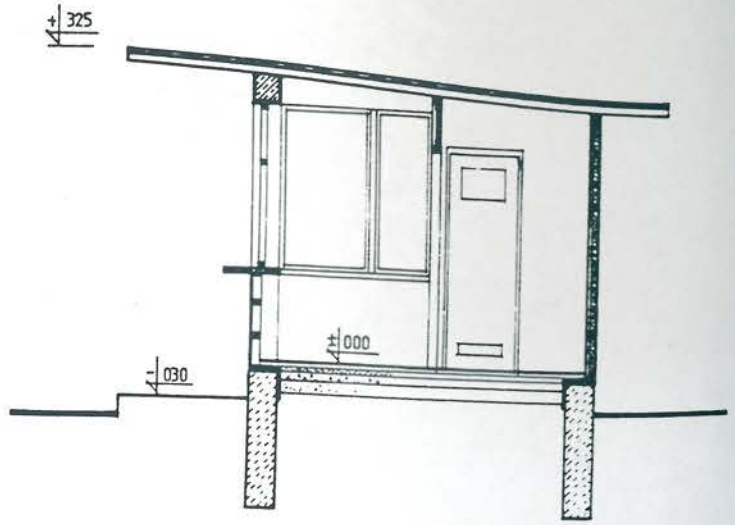


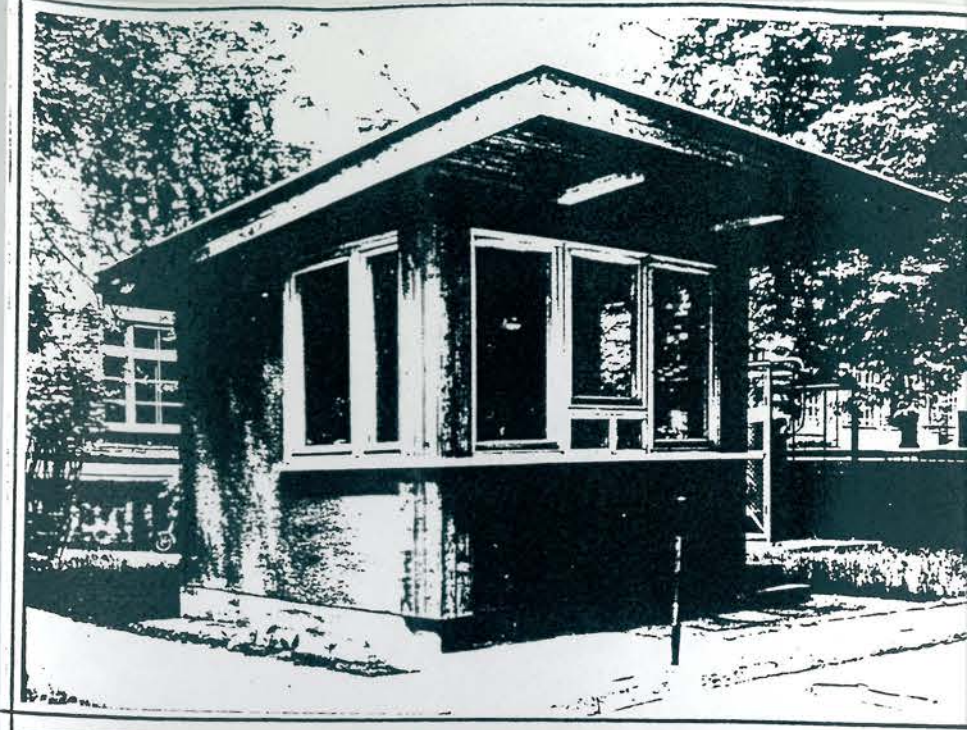
307

PLANT GATE-HOUSE

PLANT GATE-HOUSE

Built from light prefabricated ferrocement CeEs elements. Rigidity of the construction had been obtained through embeding in concrete the front frame using the same prefabricated products in the form of lost shuttering. The gate-house has its own sanitary cabin. Finish - impregnated wooden elements.



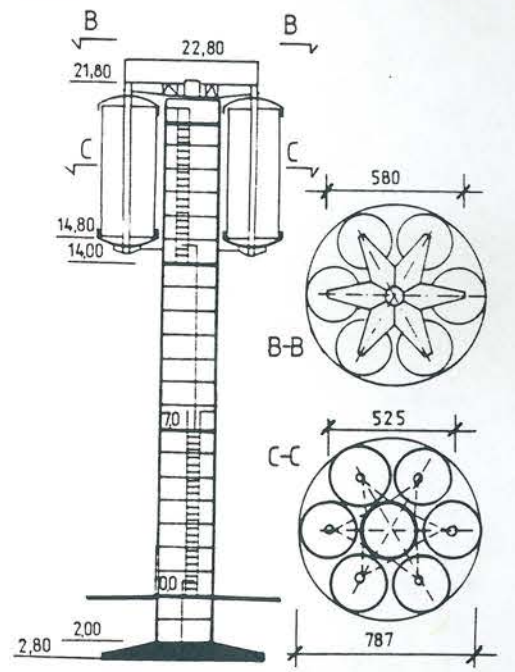


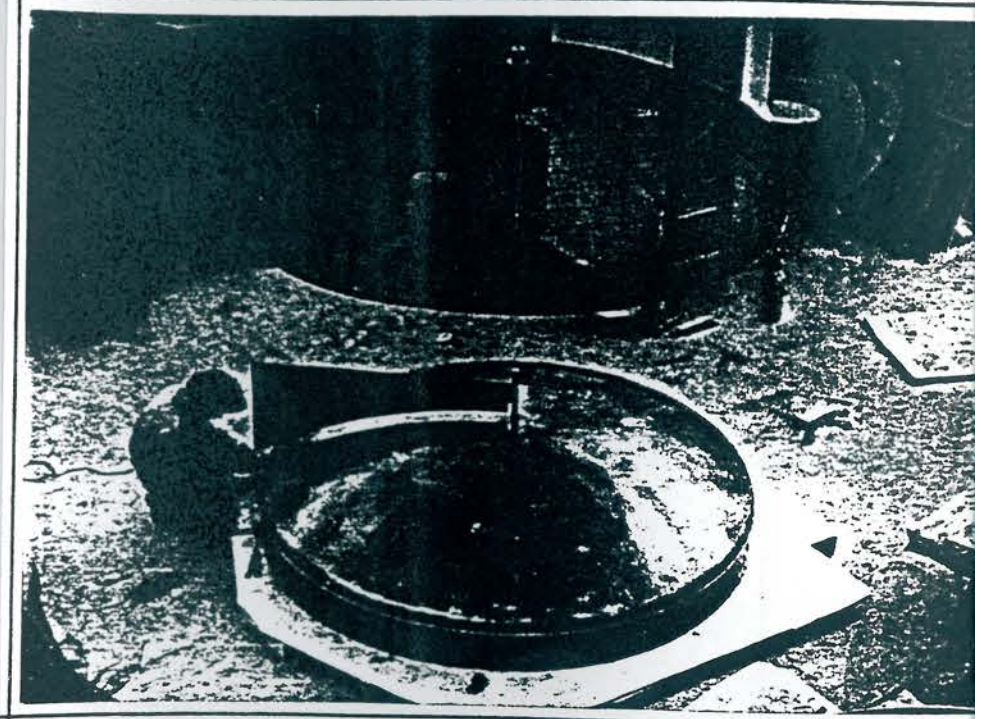
308

WATER TOWER V = 150 m³

WATER TOWER V = 150 m³

An elevated tank with a capacity of 150 m³ had been designed as a 6-chamber tank. The separate chambers in the form of cylinders with laminar ferrocement walls make a system of connected vessels. The tower's shaft had been designed as a monolithic prefabricated construction, i.e. the ferrocement rings with height of 1 m make the lost boarding for monolithic filling.



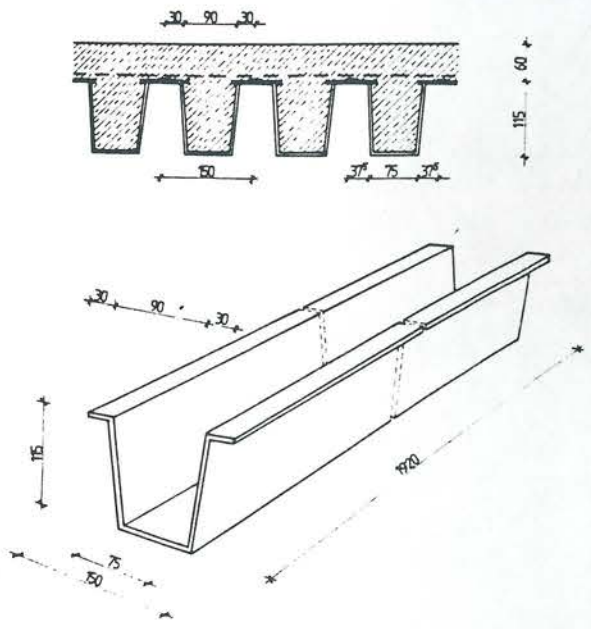


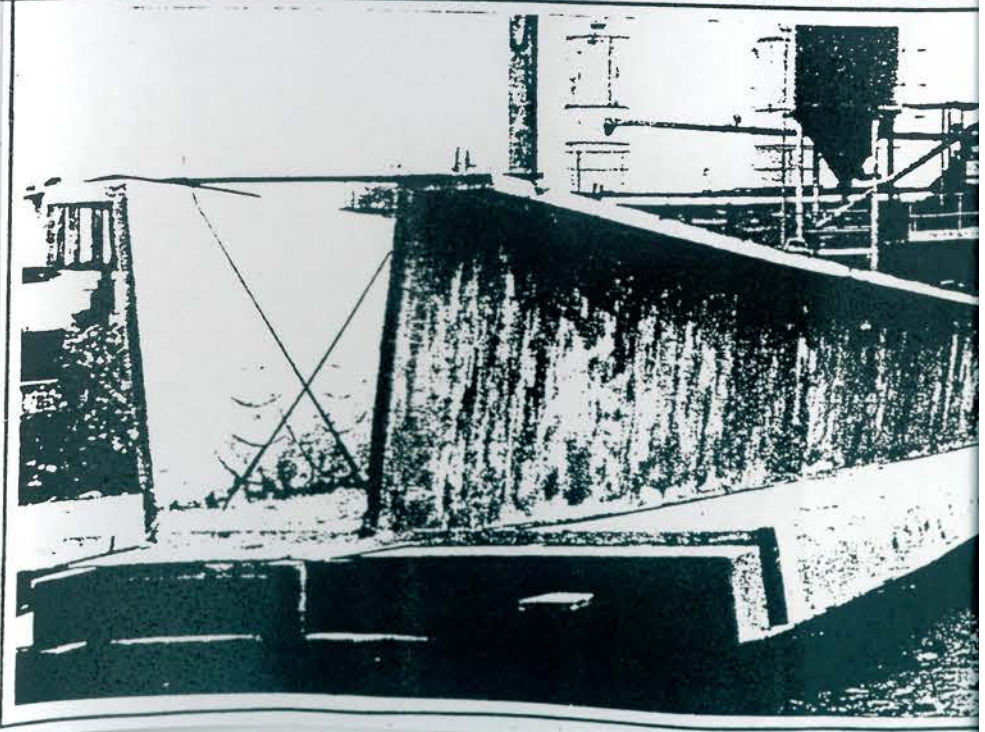
309

CEILING MADE FROM FOLDED FERROCEMENT GIRDERS FAES

CEILING MADE FROM FOLDED FERROCEMENT GIRDERS FAES

Folded ferrocement girders had been designed as a lost boarding of ferrocement ceiling of the Warsaw underground tube station. The girder has a 19,2 m span, height of 115 cm, thickness of plate walls and bottom - 5 cm. Thanks to the spatial work and a system of appropriate bracings the girder forms the self-supporting construction, which enables the carrying on of reinforcement work in troughs and the top plate without the necessity of its supporting. In the phase of putting concrete on the ceiling additional supporting construction is added. The FAES girders have an attestation of the Institute of Building Technics in Warsaw.





310

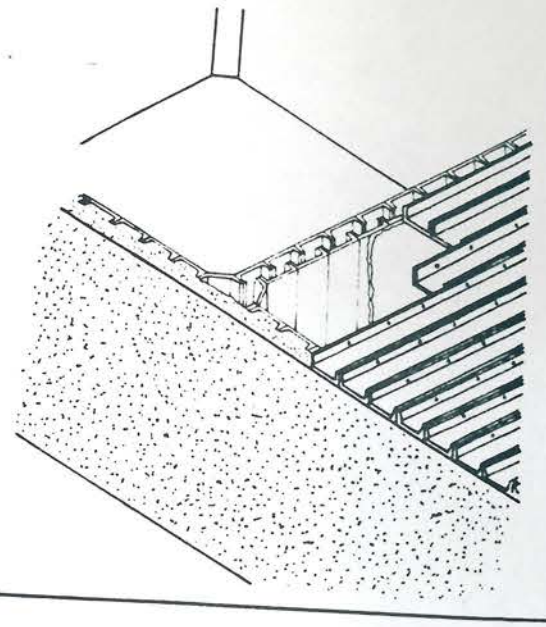
PREFABRICATED-MONOLITHIC TANK

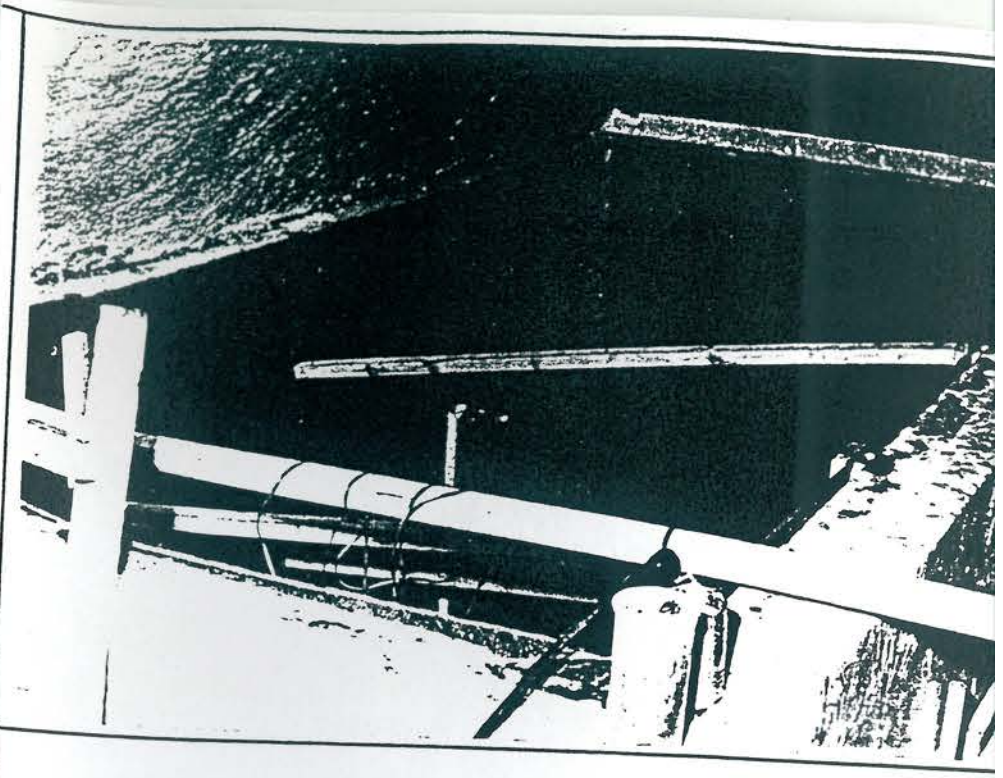
311

312

PREFABRICATED-MONOLITHIC TANK

The construction of tanks, rectangular in scheme, consists of ferrocement channel CeEs elements, which make a lost boarding for monolithic construction walls. The tank's bottom had been made in the form of a flat ferrocement slab, whereas the whole construction had been covered with light slabs made from channel CeEs elements. The pools with appropriate internal lining were intended for wine storage in the Warsaw Winery "Warsowin".





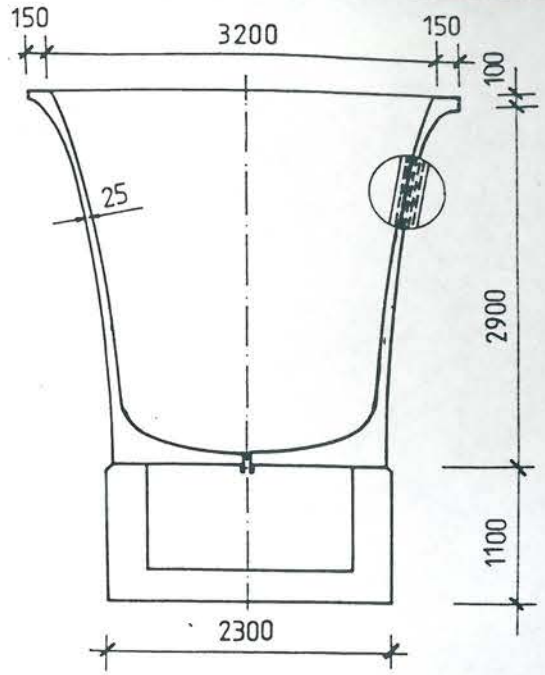
4. MONOLITHIC CONSTRUCTIONS

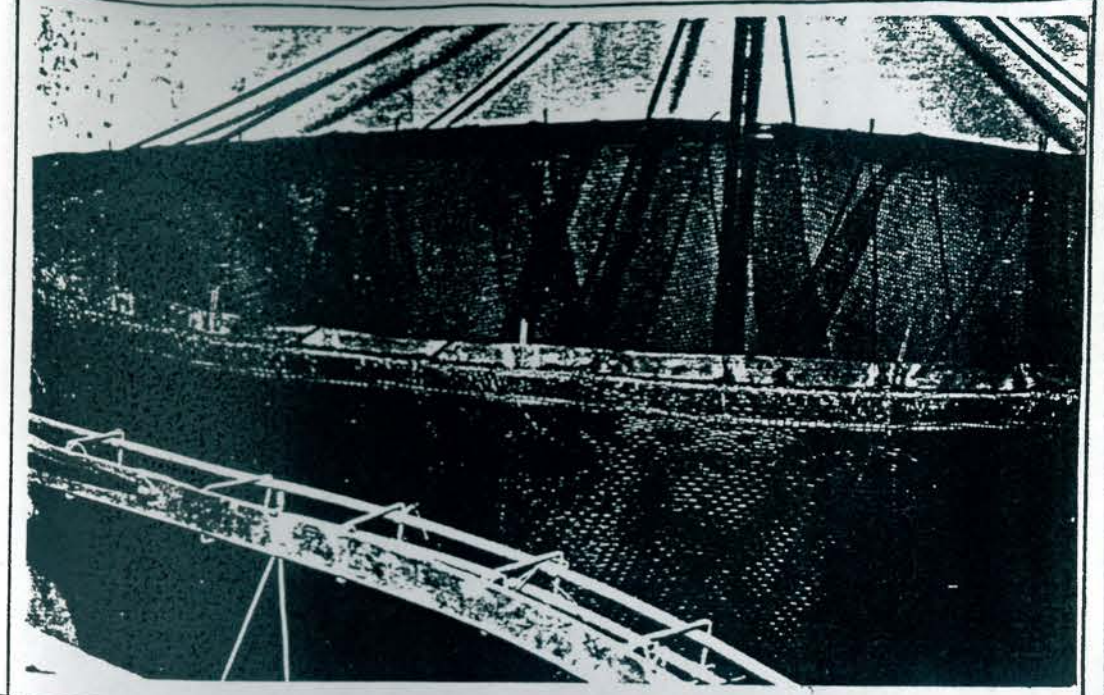
401

HYPERBOLOIDIC TANK V = 15 m³

HYPERBOLOIDIC TANK V = 15 m³

A tank of a capacity of 15 m³ is destined for a fermentation pool in the winemaking industry. A thin wall of the tank enables good drying of concrete before putting on an epoxide-glass laminate. The presented tanks are exploited since 20 years in the Warsaw Winery "Warsowin".



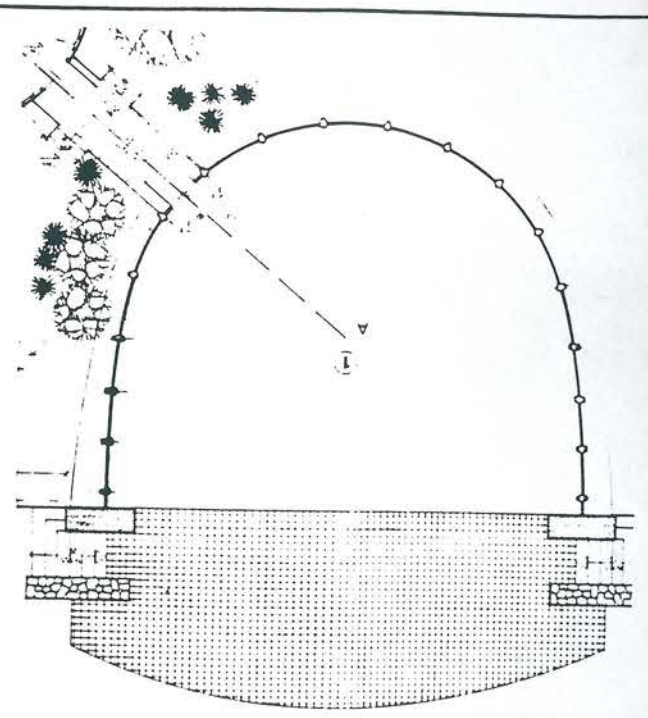


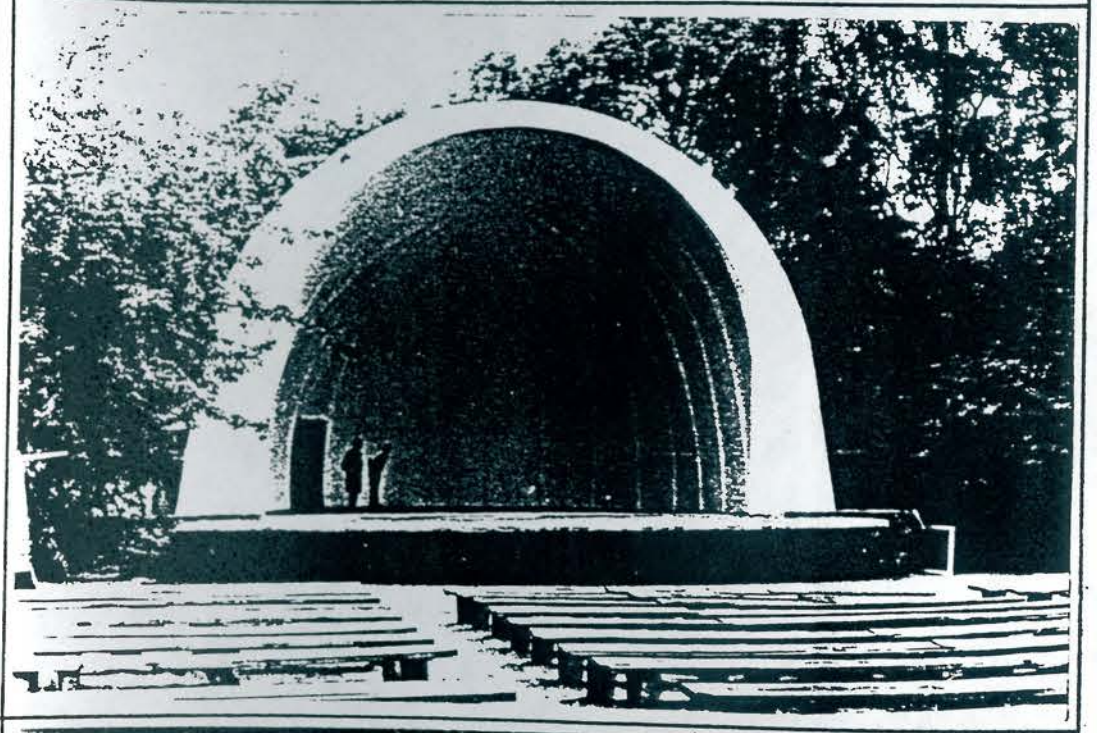
402

CONCERT CONCHA

CONCERT CONCHA

A concert concha was built in Warsaw, in the J.Paderewski Park. Maximal span - 22 m, arch elevation - 16 m, thickness of interrib coat - 3÷4 cm. Reinforcement - four layers of Rabitz net and traditional bar pads in ribs. The shell was made without boarding, only through manual floating of concrete mix on the reinforcing cage with unilateral slidable fibreboard screen.



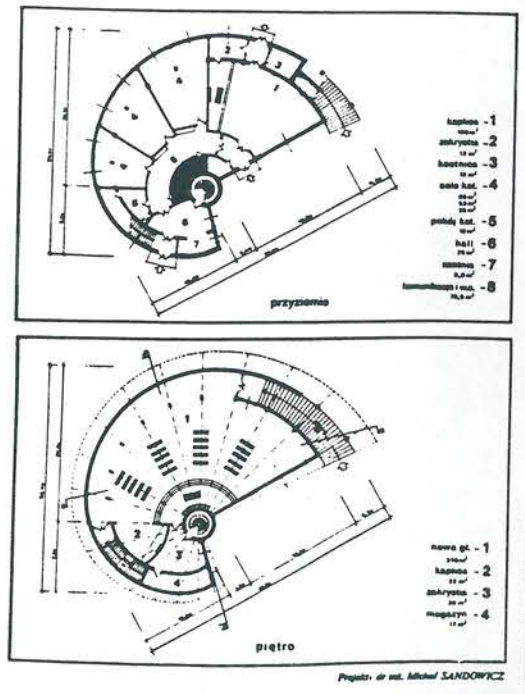


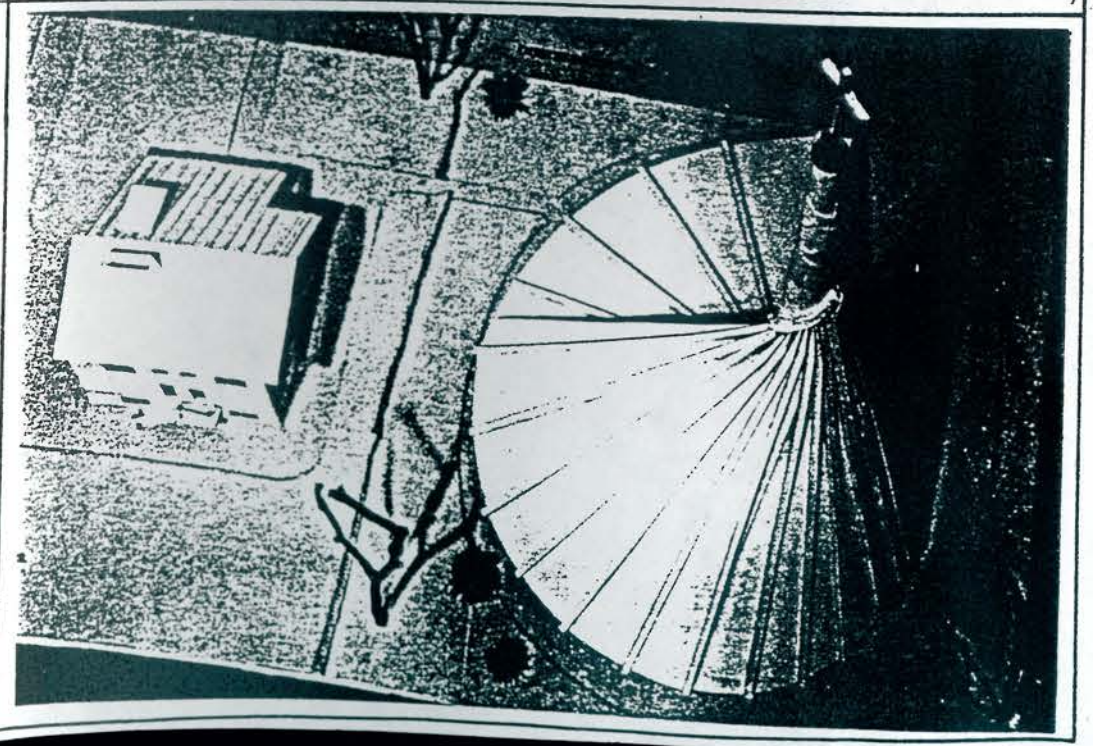
403

UNDERSLUNG CEILING OF A CHURCH

UNDERSLUNG CEILING OF A CHURCH

The Saint Georg Church in Zielonka near Warsaw has the shape of a spiral coiled roof underslunged to the conic tower. The steel construction of the roof is filled up from the bottom with a thin-walled ceiling coat made from ferrocement through shotcrete.



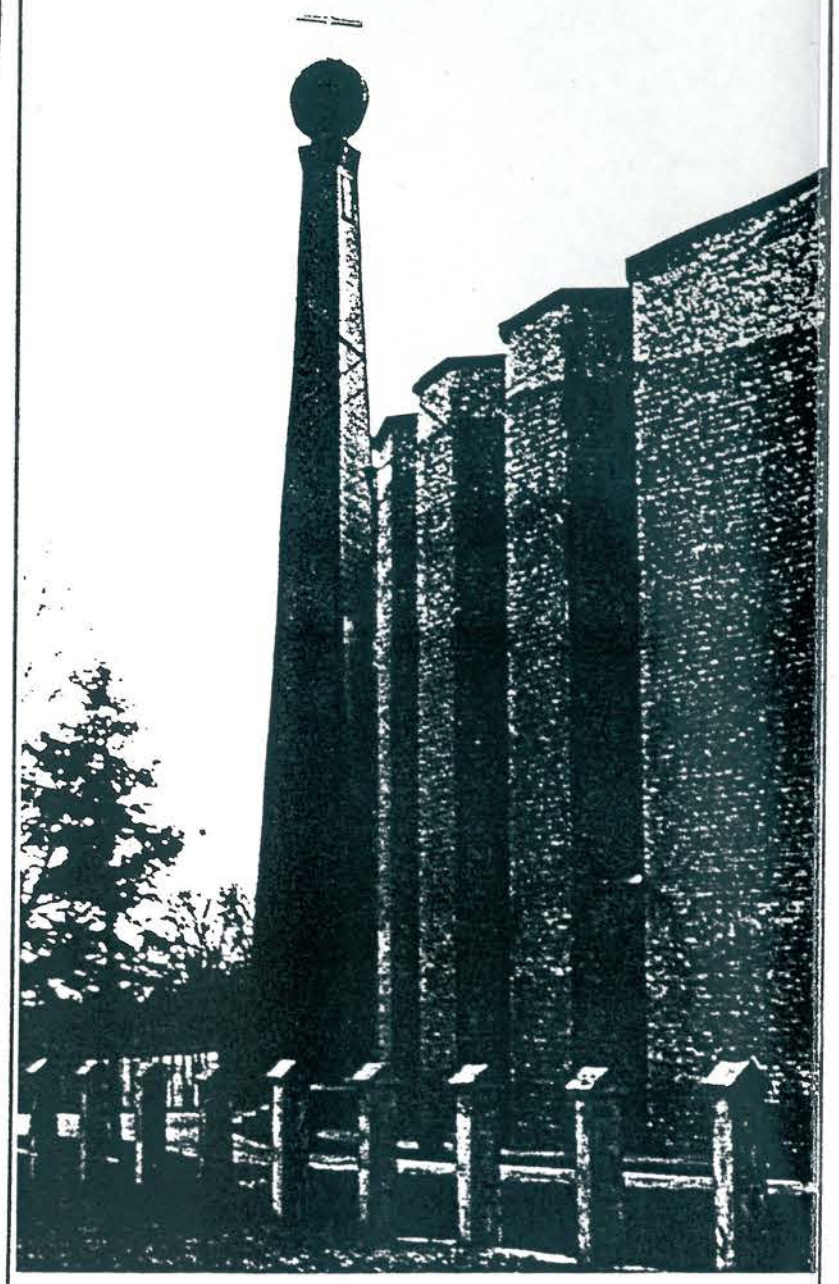


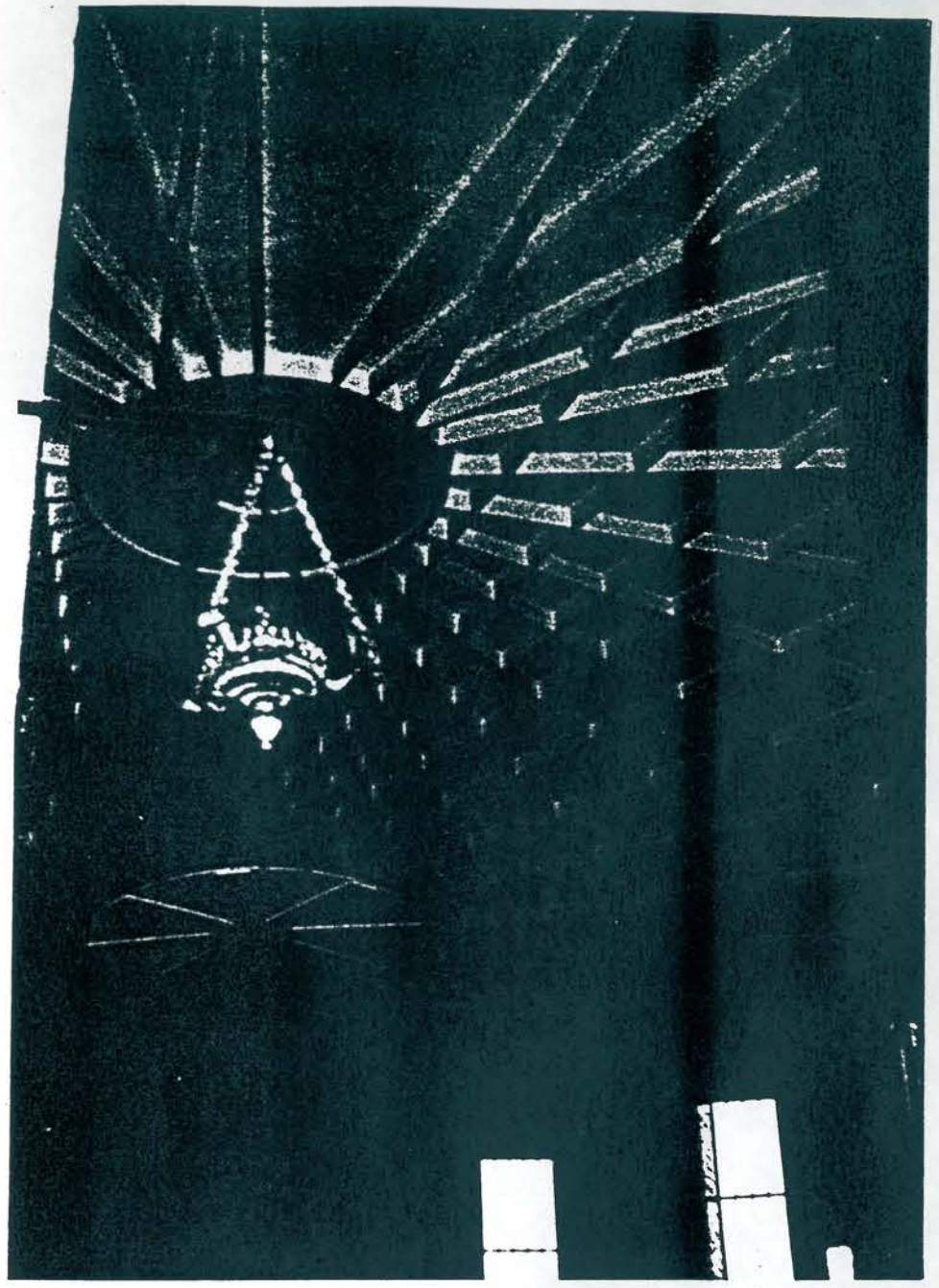
404

PLAFOND

PLAFOND

A ferrocement plafond in the shape of an ellipse with dimensions 22x30 m has been made in the Saint Teresa Church in Mrozy (Poland). The plafond is underslunged to the steel roof girders. Reinforcement - cut-drawn net and traditional reinforcement bars. The plafond was made on sheets underslunged from the top.





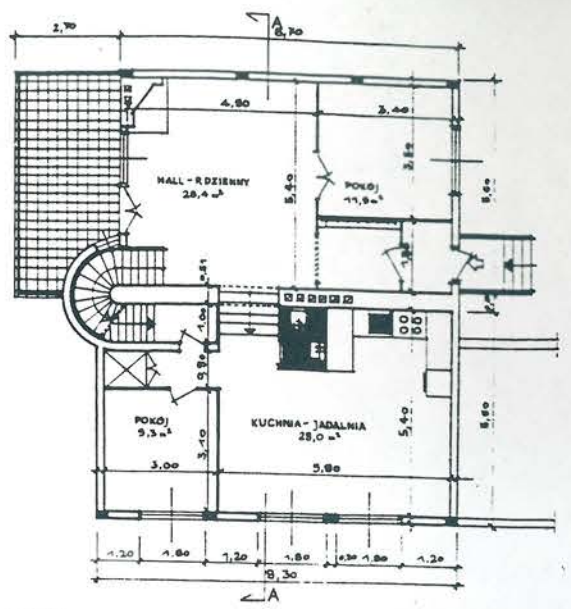
405

5. BUILDING DESIGNS

501 FREE-STANDING HOUSE WITH WORKROOM

FREE-STANDING HOUSE WITH WORKROOM

First house was designed in 1980 with the use of the ELSA prefabricated elements. It is a joined construction of traditional bricking system (middle wall) and skeleton structure. Cover and ceilings of ELSA type. The house is located on the slope in the Mokotów district in Warsaw.



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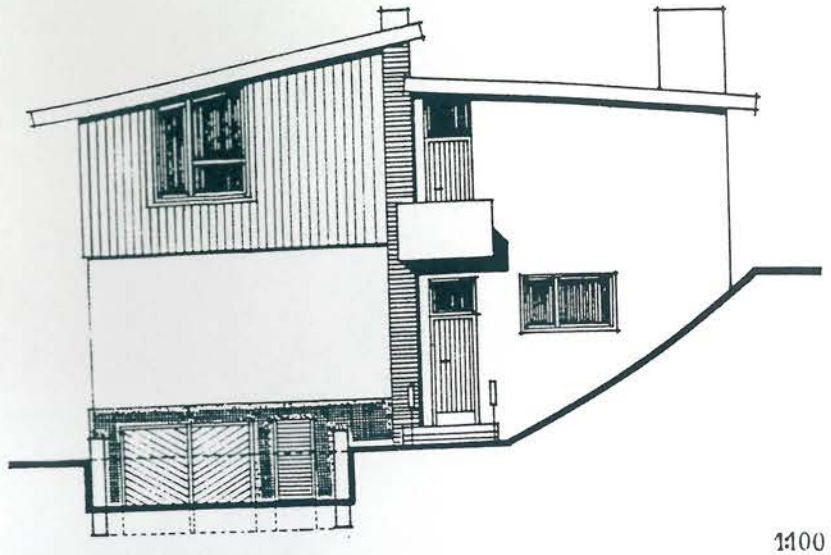
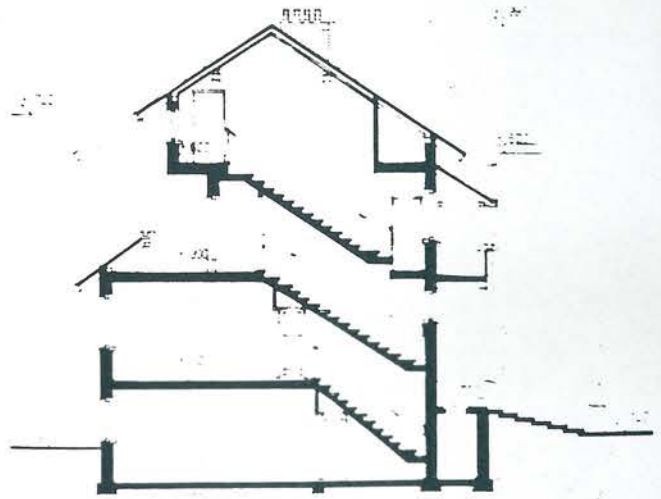


1:100

502 A COMPLEX OF SEGMENT HOUSES ELSA 1

A COMPLEX OF SEGMENT HOUSES ELSA 1

The segment houses ELSA 1 are the first built which put to test the ELSA system. Whole skeleton construction with walls filled with sawdust chip concrete. Additional wall casing is performed through ligno-cement boards with foamed polystyrene divider, which provides a coefficient c = 0,26 W/m²C. Gross area - 270 m². An alternative solution to inside surfaces.

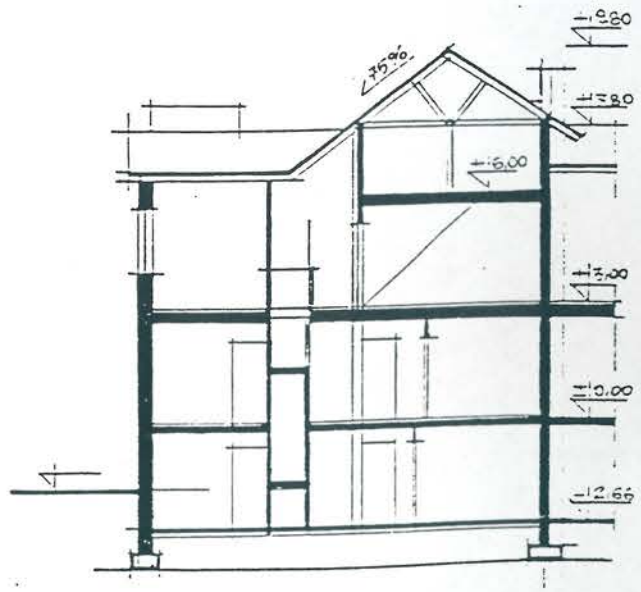


SCHNITT

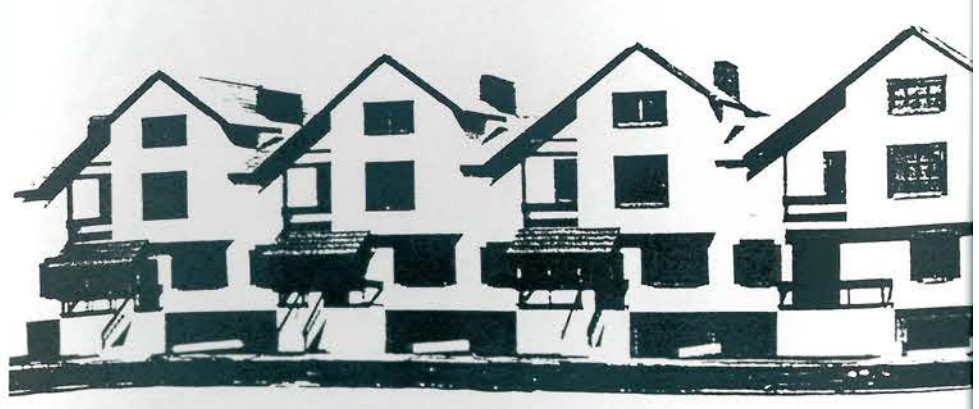
503 A COMPLEX OF SEGMENT HOUSES ELSA 3

A COMPLEX OF SEGMENT HOUSES ELSA 3

This is an alternative design to ELSA 1. By preserving similar functions of both solutions the outer form of the house was designed differently, and resembles old-town building. Construction system - ELSA skeleton combined with brick wall. The building was planned to be finished in 1990.



PRZEKRÓJ PODŁUŻNY 1:100

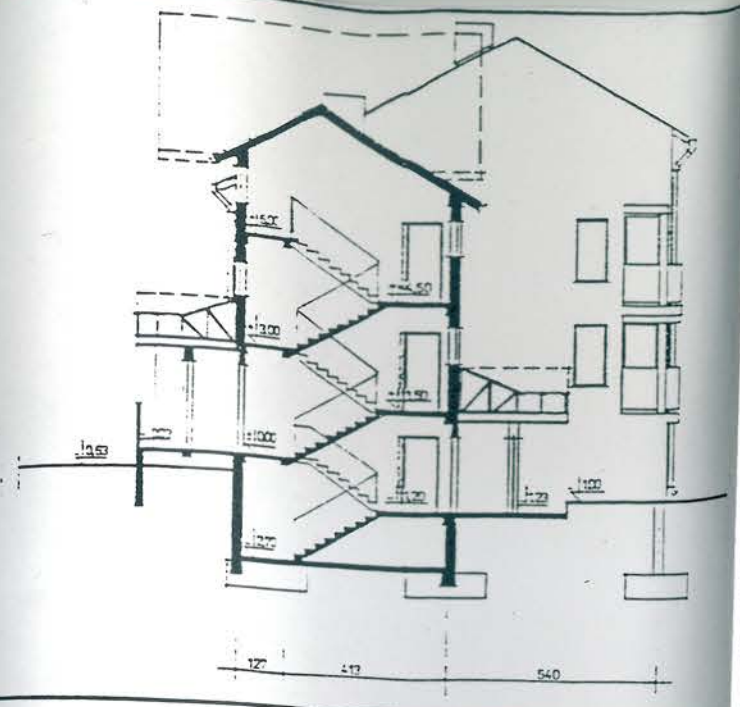


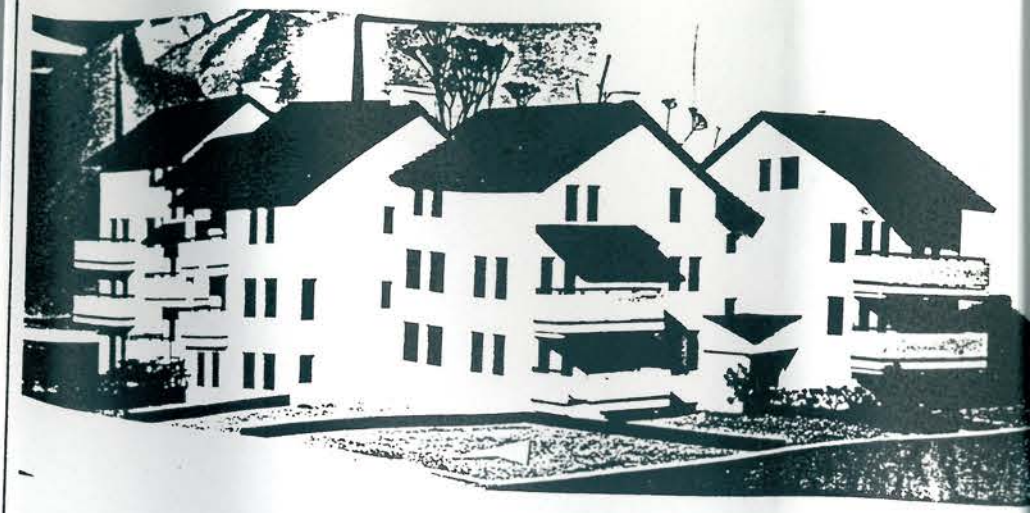
504

FREE-STANDING MULTIFAMILY HOUSE

FREE-STANDING MULTIFAMILY HOUSE

First multifamily house in Poland built in the ELSA system. The house consists of 12 apartments, 4 apartments in three separate parts of the building. On the first floor are bilevel apartments. The roof construction is made partially from wood and ELSA elements. The building had been erected in Warsaw by the Housing Cooperative "Elsam".



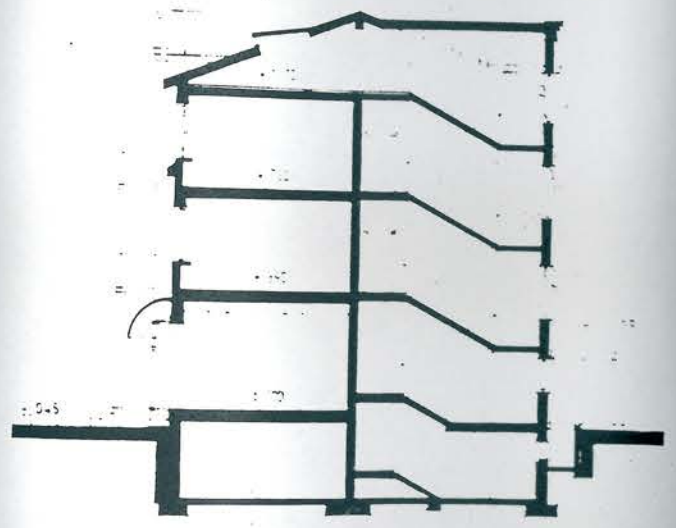


505

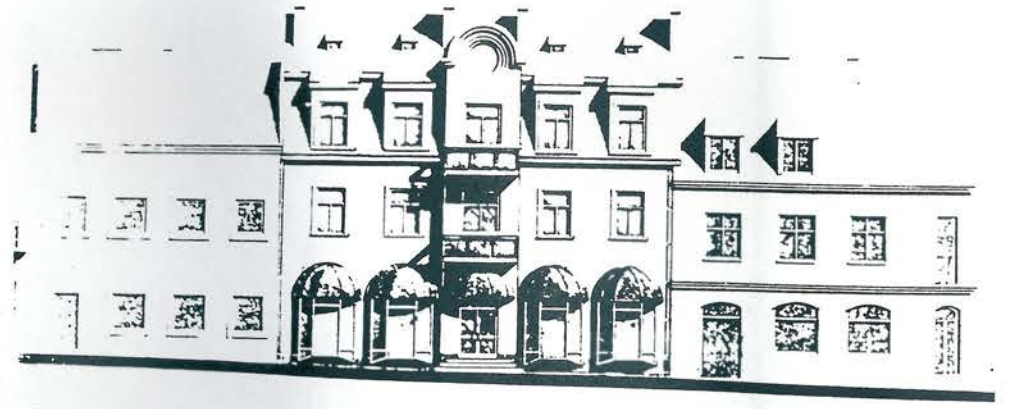
DWELLING HOUSE WITH A SERVICE GROUND FLOOR

DWELLING HOUSE WITH A SERVICE GROUND FLOOR

This is a design of a seal building, built in between 2 other houses located at an old tourist site in the centre of a small town. Skeleton construction in the ELSA system, wooden rafter framing of attic type. Completely subcellared. On the ground floor is a shop with back-up facility, on each higher storey two apartments. The outer wall made from chip concrete insulated with mineral wool. Usable area - 614 m^2, cubature - 2857 m^3. Length of building - 15,5 m.



PRZEKRÓJ I-I

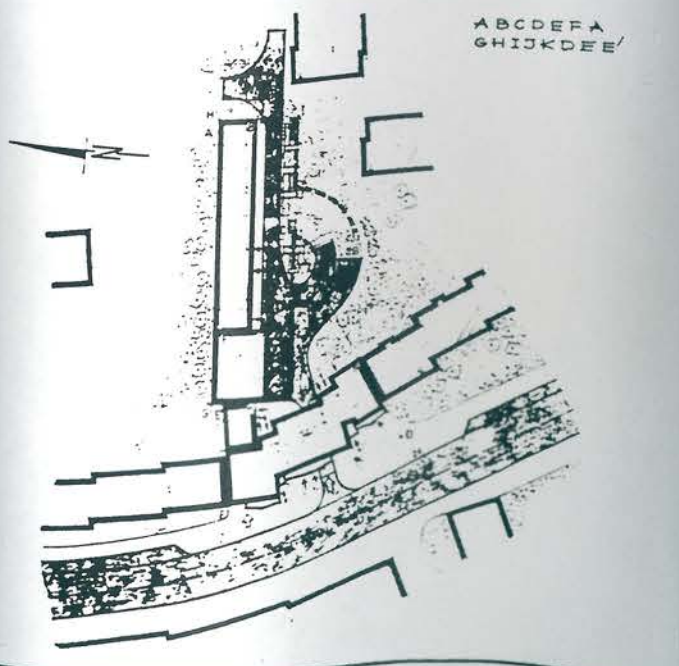


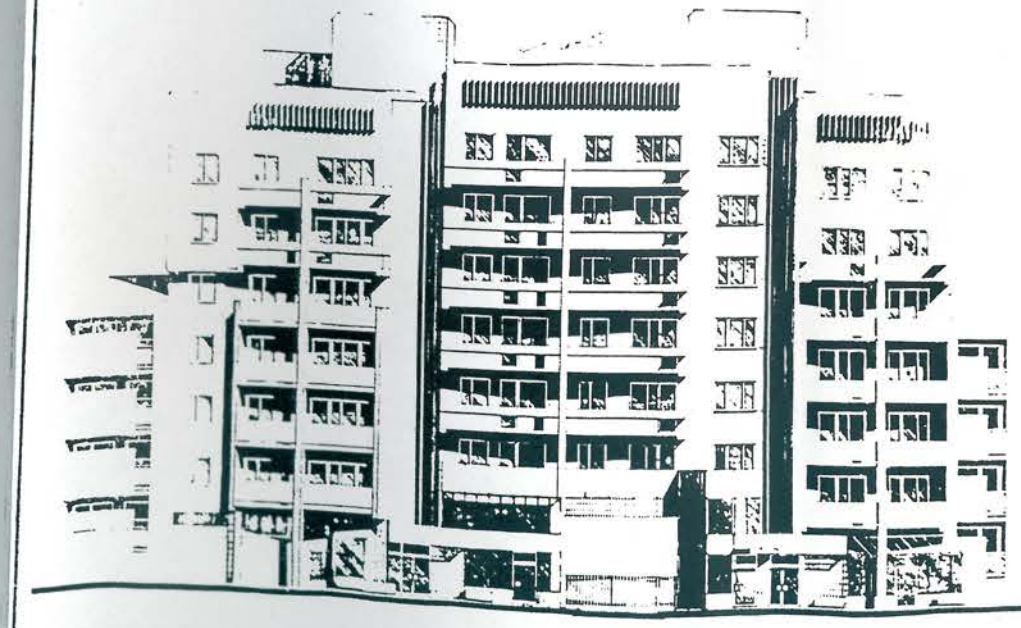
506

BIG CITY APARTMENT BUILDING

BIG CITY APARTMENT BUILDING

This is a big city apartment building of difficult location, designed between existing neighbouring houses. The eight-storey building accomodates: 23 big apartments (also bilevel), two services premises, a big pastry shop with own production, and underground parking - lot for 60 cars. ELSA system construction. Usable area - 6374 m^2. Total cubature - 22403 m^3.

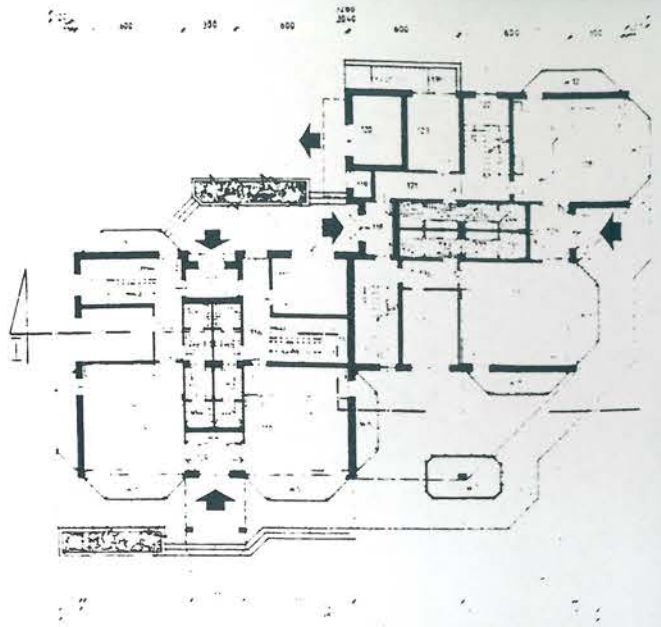


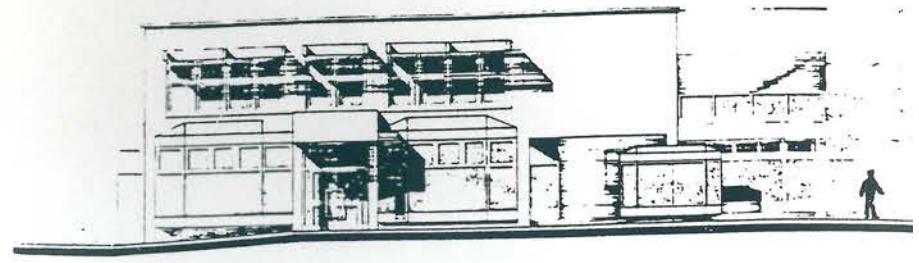


507 SHOPPING CENTRE

SHOPPING CENTRE

This shopping service has enough area for 4 production-trade or services businesses. The ground floor is planned for sales saloons, first floor - workrooms, in the cellar - practical store rooms. Skeleton construction - ELSA system, walls made from chip concrete blocks with insulation mineral wool coat. Usable area - 1017 m^2, cubature - 4301 m^3, one-floor building completely subcellared, suitable mainly for narrow building sites with corner location. Never built.

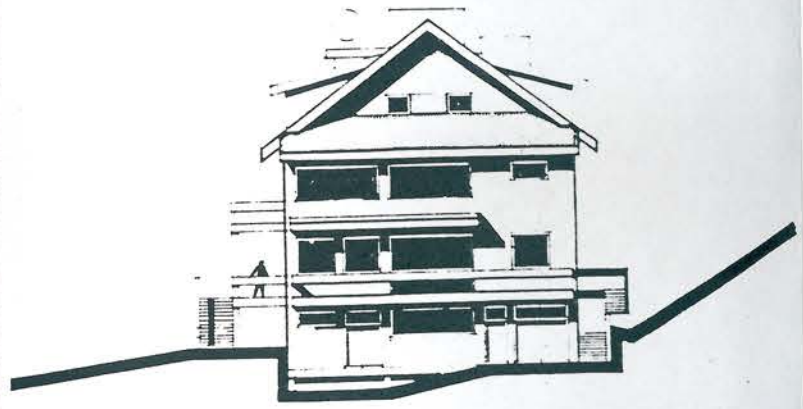


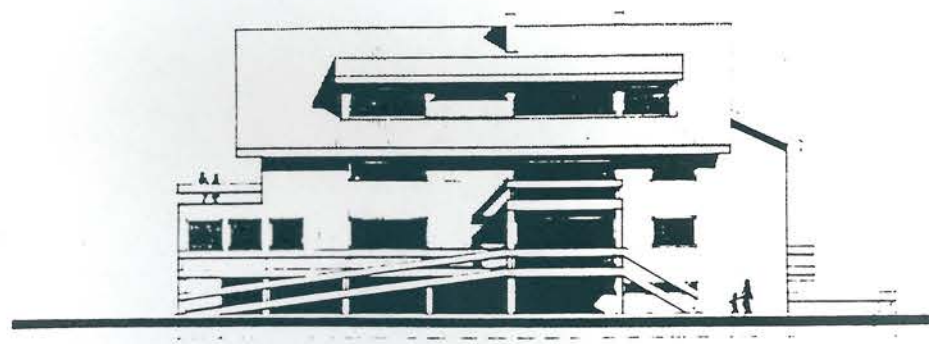


508 HARBOUR MASTER'S OFFICE

HARBOUR MASTER'S OFFICE

A service-administration building for a yacht club designed for the Polish Yacht Club in the ELSA system. The building accomodates: a restaurant for 80 people with a terrace, a cafe for 60 people, a practical master's office, lecture halls for yachting courses, official flats and guest rooms. ELSA system construction, walls made from chip concrete. Usable area - 1940 m^2, cubature - 5260 m^3. Planned for building in 1993-1994.

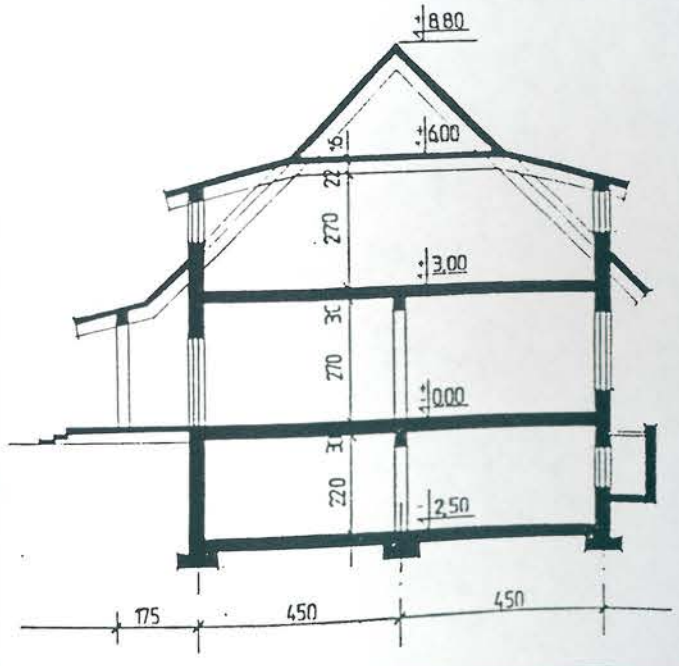




509 TWIN HOUSE "MICHAEL"

TWIN HOUSE "MICHAEL"

The twin house "Michael" is a adaptation of the "Michael" offered in Germany by the Nordhaus Company. Prefabricated-monolithic ELSA construction. It was necessary to make changes in the German design. The house has one floor, is subcellared and has an attic. Total use area - 191 m^2. Walls are made from light chip-sawdust blocks. The house can be built in various designs according to investor's needs.

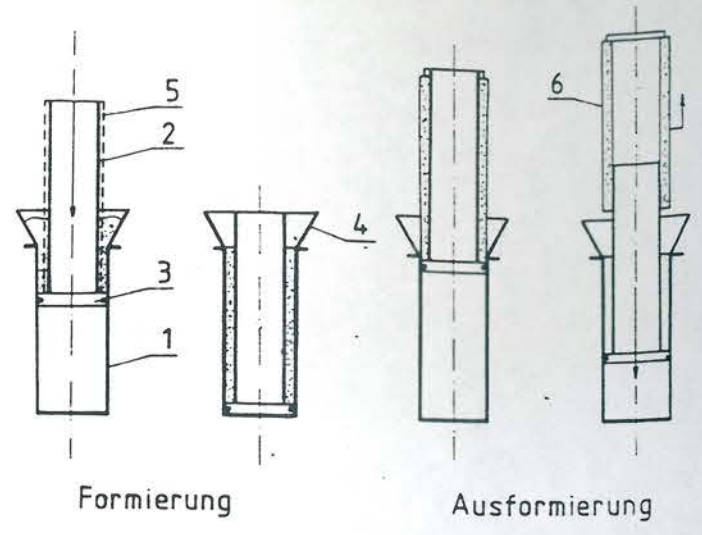


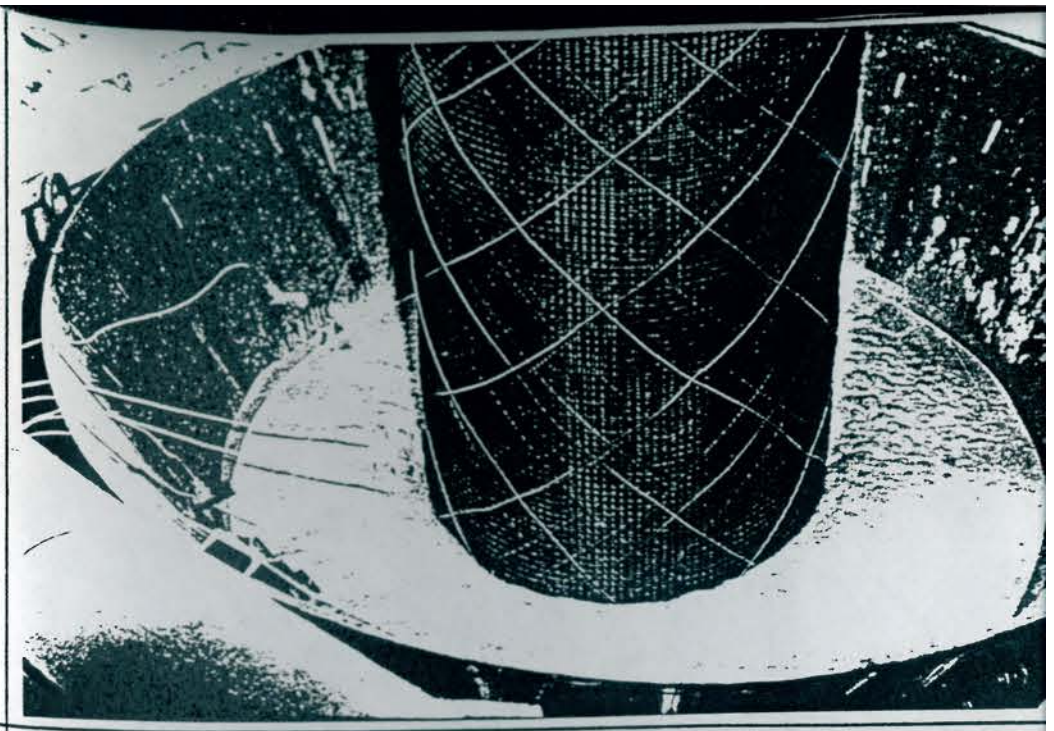
6. PRODUCTION DEVICES AND PROCESS LINES

601 FORMING OF PIPE ELEMENTS

FORMING OF PIPE ELEMENTS

Forming of a pipe element takes place in the space between the outer mould 2 ending with a funnel 4 and the core 2 with a piston 3 during the core motion 2 downward. The concrete mix is fluidizated through vibrators fixed to the outer mould funnel 4. Disforming proceeds immediately after forming.
The element 6 is lifted through the net reinforcement.

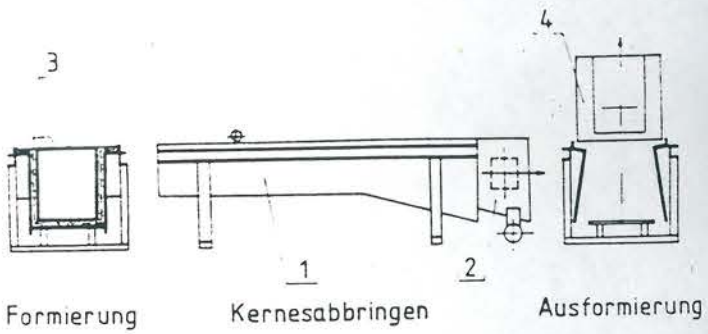


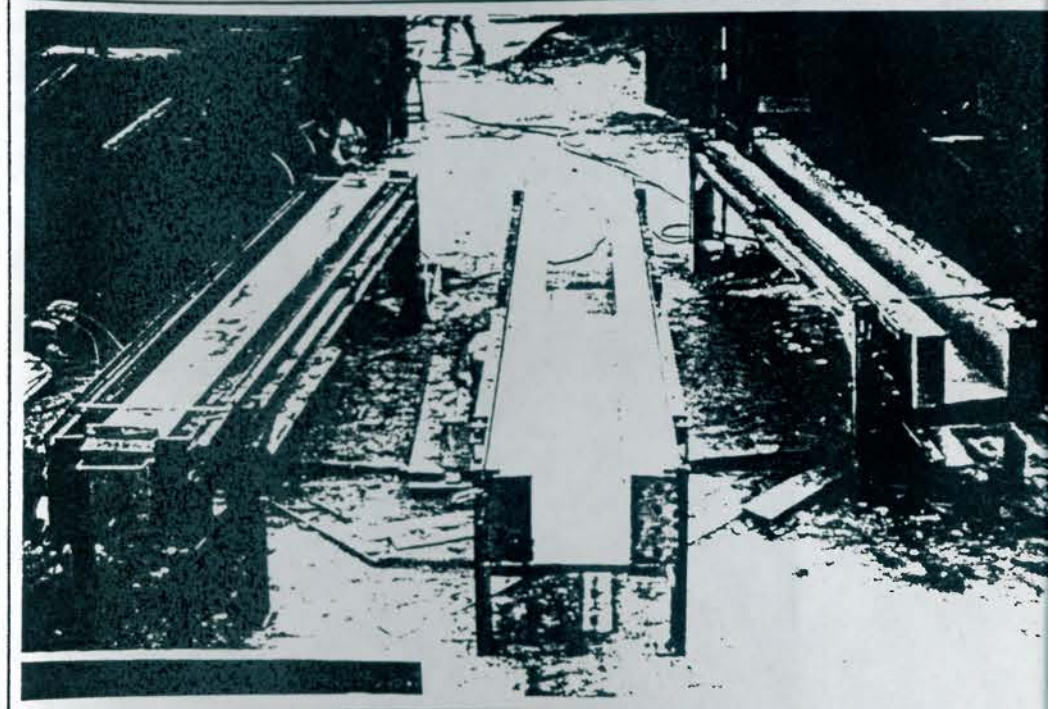


602 UNIVERSAL CHANNEL FORMING OF ELEMENTS

FORMING OF UNIVERSAL CHANNEL ELEMENTS

To the outer mould 1 the reinforcement is put in and then the core 2. The concrete mix is fluidizated through a vibrator fixed to the core 2. After finishing the forming process of the element 4, the core 2 is pushed out from the mould 1 and the element remains for hardening. Deforming proceeds through drawing aside the lateral walls of the mould 1 and removing the ready element of the mould 4.

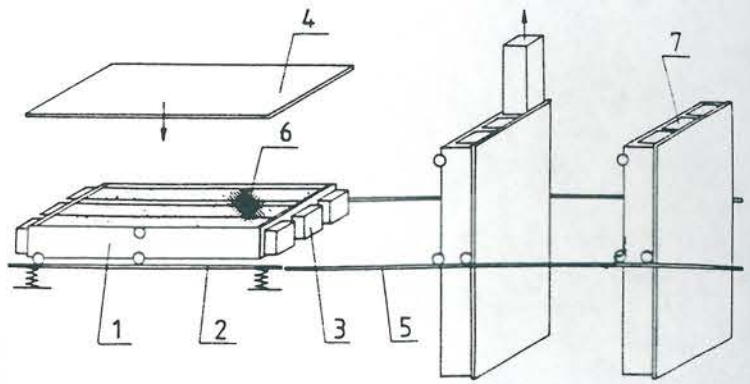


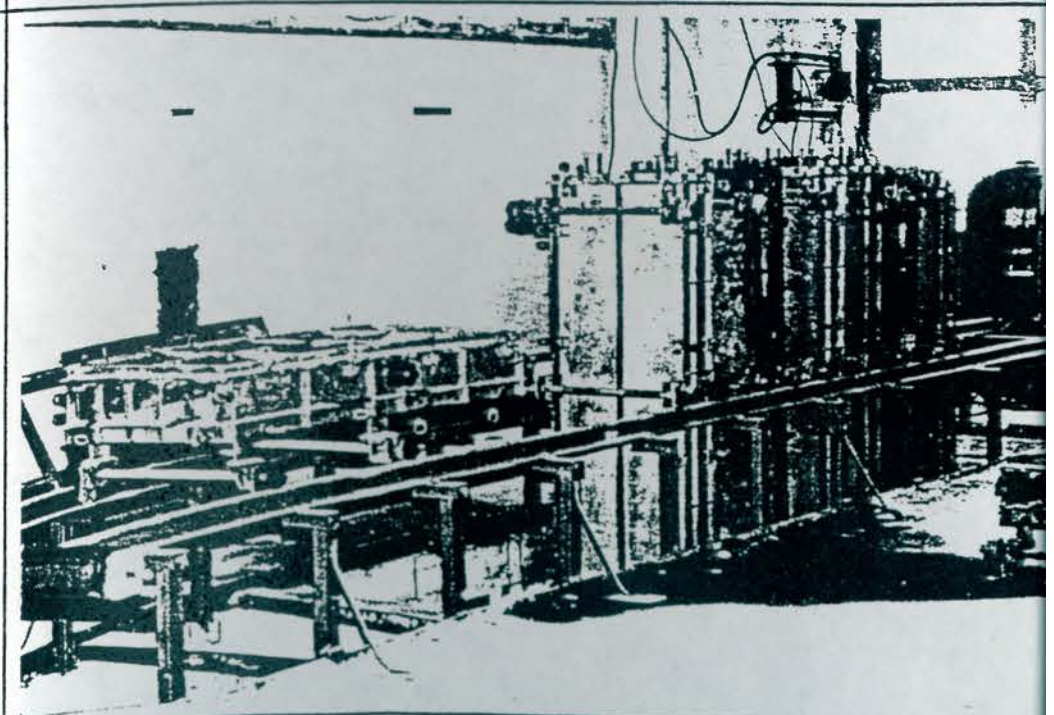


603 FORMING OF VENTILATING ELEMENTS AND CABLE DUCTS

FORMING OF VENTILATING ELEMENTS AND CABLE DUCTS

To the mould 1 set up on the raceway 2 segment reinforcement is put in 6 and then the cores 3 are inserted. After adding the concrete mix the whole structure is under vibration. When the forming is finished, the mould is inserted under the cover 4 and turned to the vertical position. In this position the cores are removed. Full deforming takes place in the horizontal position.





7. PATENTS

PATENTS

The Ferrocement Research Laboratory of the Warsaw University of Technology is an active research group in the field of protecting own designs in the Polish Patent Office. The below attached list of patents and reports gives only numbers and titles of the Polish Patent Office. Should you be interested in any detailes we shall send full xerox copies to you.

Patent Nº	Title
58 386	Production of ferrocement pipes
89 411	Production of a ferrocement hull of a vessel
93 627	Production of pipelines and tanks from concrete and reinforced concrete
104 222	Production and production device for pipe elements particularly from reinforced concrete
111 895	A forming device for ferrocement pipes
114 722	A ferrocement channel element
118 255	Production of high-pressure pipe elements
118 434	Production of volume elements particularly sanitary cabins and their production device
119 312	Multi layer wall element
120 718	A cubic samples mould
127 236	Production and production device for winding wire-mesh reinforcement on pipe elements
131 846	Production of heat insulated pipe elements
135 355	Production of a building element and a laminar building element
136 950	Cut lining
138 056	Railway road
138 551	Facade board
141 225	Building heat insulation
142 041	Casing of heat distribution network
146 068	Forming device for thin-walled ferrocement pipes
148 435	Rib-and-slab floor

Utility pattern Nº	Title
3 954	Ferrocement poling
44 828	Ferrocement hole element
46 784	Antidamping hollow insulator of building construction
46 852	Division wall element
46 853	Division wall element
25 244	Ellipsoidal apartment element
39 709	Forming device for ferrocement elements
44 592	Skeleton building construction
42 811	Prefabricated panel building
45 491	Thon-walled ferrocement pipe

Report №	
80 351	Production device for hole elements
80 352	Forming device for channel elements
82 264	Division wall
82 265	Division wall
82 241	Screen board
86 902	Combined mould for channel elements
261 869	Production of a facade board and facade board
267 569	Insulation of hearth plate hip and walls and a system of elements for protection of hearth plate hip