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25 March 1978  
English

**CENTRE FOR THE  
DEVELOPMENT OF  
THE FURNITURE  
AND JOINERY  
INDUSTRIES,  
SARAJEVO**

DP/YUG/78/006

**YUGOSLAVIA .  
(Republic of Bosnia  
and Herzegovina)**

Technical report:  
**DESIGN OF THREE-DIMENSIONAL  
PREFABRICATED REGULAR WOODEN HOUSES**

Request for the Government of Yugoslavia by the  
United Nations Centre for Human Settlements,  
concerning the  
United Nations Development Programme

United Nations Development Programme

CENTRE FOR THE DEVELOPMENT OF THE FURNITURE AND  
JOINERY INDUSTRIES, SARAJEVO

DP/YUG/73/006

YUGOSLAVIA (Republic of Bosnia and Hercegovina)

Technical report: Design of three-dimensional  
prefabricated modular wooden houses

Prepared for the Government of Yugoslavia  
by the United Nations Industrial Development Organization,  
executing agency for the United Nations Development Programme

Based on the work of Lothar Schroeder, expert in the  
design of prefabricated wooden houses

United Nations Industrial Development Organization  
Vienna, 1976

### Explanatory notes

References to dollars (\$) are to United States dollars, unless otherwise stated.

The monetary unit in Yugoslavia is the dinar (Din). During the period covered by the report, the value of the dinar in relation to the United States dollar was \$US 1 = Din 17.80.

The following abbreviations are used in this report:

BiH	Republic of Bosnia and Hercegovina
OOUR	Osnovna Organizacija Udruženog Rada (A self-managed unit of an enterprise)
ZOOUR	Zajednica Osnovnih Organizacija Udruženog Rada (A co-operative of self-managed units)

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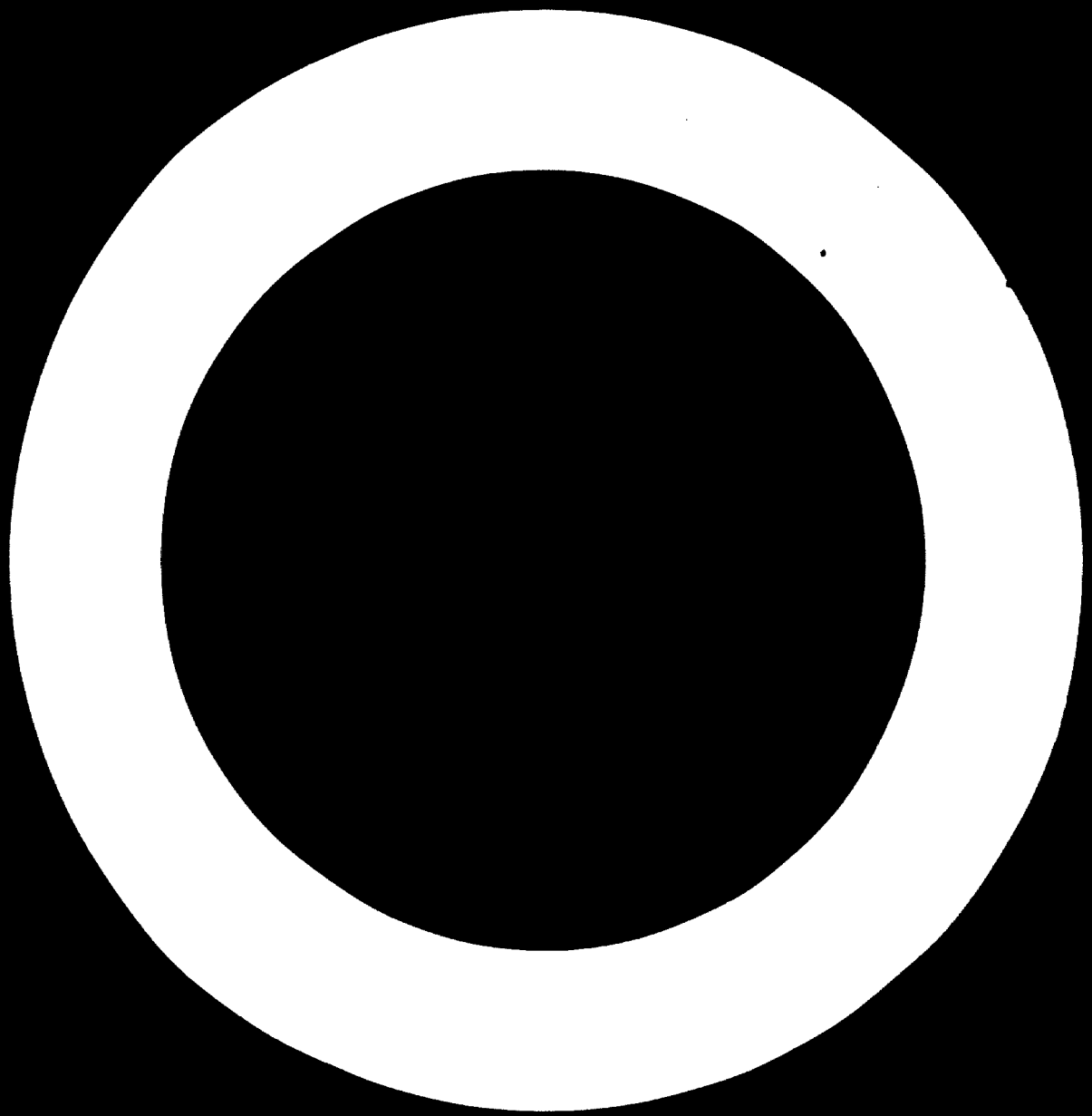
Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO).

ABSTRACT

The consultant, an expert in the design of prefabricated wooden houses, spent two months in Yugoslavia, arriving at the beginning of October 1975. His mission formed part of the parent project "Centre for the Development of the Furniture and Joinery Industries, Sarajevo" (DP/YUG/73/006). This project was submitted by the Government of Yugoslavia in December 1973 and approved by the United Nations Development Programme (UNDP) and the executing agency, the United Nations Industrial Development Organization (UNIDO), in August 1974. It was scheduled to start on 1 September 1974 and to last approximately four years. The UNDP contribution was \$555,000 and the contribution of the Government of Yugoslavia was Din 19,247,900.

During the expert's stay in Yugoslavia, he was assigned to the Design Centre of ŠIPAD, a Forest Industry Enterprise, at Sarajevo. His mission was to help ŠIPAD improve the design and construction of prefabricated wooden houses. This included analysis of existing construction methods, assessment of the standard and quality of factory and transportation equipment, and the costing of the production of existing factories. A prototype house, using a modular three-dimensional system, was produced at the OOUR Janj plant at Donji Vakuf during the mission and was erected on a site near the factory.

The expert's principal recommendation was that a new factory be established for the production of prefabricated wooden houses as the existing two factories cannot ensure production either for the local or export market.



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## INTRODUCTION

The expert's mission was part of the larger project "Centre for the Development of the Furniture and Joinery Industries, Sarajevo" (DP/YUG/73/006). The project was submitted by the Government of Yugoslavia in December 1973 and approved by the United Nations Development Programme (UNDP) and the executing agency, the United Nations Industrial Development Organization (UNIDO), in August 1974. It was scheduled to start on 1 September 1974 and to last for three years and four months. The UNDP contribution was \$555,000 and the contribution of the Government of Yugoslavia was Din 19,247,900.

The long-range objectives, as set forth in the project document, were to enable the furniture and joinery industries (which includes the wooden house industry), initially in the Republic of Bosnia and Hercegovina (BiH) and later in all of Yugoslavia, to make a greater contribution to the economy of the country and to increase their participation in domestic and foreign markets. Immediate objectives were to help the industries to increase the value of their products, to improve quality, to reduce costs of production, to design new products and to forecast market requirements and adapt production accordingly.

During his two-month stay in Yugoslavia, from the beginning of October 1975, the expert was assigned to the ŠIPAD Design Centre, at Sarajevo. ŠIPAD, the counterpart agency, is an integrated corporation of wood-working industries with more than 120 factories in BiH, employing some 55,000 persons, and covering the complete range of wood-processing industries from forestry: sawmills, pulp and paper production, wood-based panels (plywood, particle board, fibreboard), joinery and prefabricated houses, furniture etc.

The principal aim of BiH in the development of this sector is to double the production of furniture and to treble that of joinery within five years, increasing the work force from 6,000 to 9,000 persons in the furniture industry and trebling it to 4,500 persons in the joinery industry. At present ŠIPAD accounts for 80 per cent of the total forest in the Republic and produces 85 per cent of the manufactured ("finished") wood products. The supply of raw materials is adequate since one third of the country's total forest re-



sources are located within BiH and the forest will remain as one of the principal sources of raw material. Two thirds of the total are broad-leaved species, mainly beech, and one third are conifers with firs, pines and spruce predominating.

The consultant was recruited by UNIDO as an expert in the design of pre-fabricated wooden houses. The job description (annex I) was only a guideline and during a pre-mission briefing in Vienna the expert was instructed to change, if necessary, the duties outlined therein after obtaining the approval of the National Project Director.

The expert was assigned to the ŠIPAD Design Centre and during the first two weeks of October he visited the two factories - Bosnia Ilijas near Sarajevo and Janj at Donji Vakuf - that presently produce modular wooden houses (annex II). His task was to assist the ŠIPAD Design Centre to become a self-supporting unit for developing the joinery and wooden house industries for local and export markets. ŠIPAD would contribute to this development by providing advisors in the fields of technology, quality control, construction, design, production, marketing, documentation, and training. ŠIPAD covers all the various needs of the industries and its services will be needed in the future. The problem of under-employment can be solved by developing a labour-intensive industry such as the joinery industry.

From 15 October 1975 to 10 November 1975 the consultant worked at the Design Centre whose staff (annex III), had already started work on the design of a three-dimensional prefabricated modular wooden house. Paying due regard to Yugoslav regulations, he assisted in drawing up a list of services and personnel (annex IV), and of materials required for construction, for sewage disposal, and for electrical, kitchen and bathroom equipment. Production of the pilot house was started in the moulding factory of the Janj plant at Donji Vakuf on 12 November 1975 and the house was erected by 7 December 1975 (annex V). During this period the expert acted as de facto team leader for production and erection of the house. Although it was produced in a new factory without full resources, the house is suitable for industrial production. Drawings for the house are given in annex VI.

## I. FINDINGS

At the start of the expert's mission, the two factories of ŠIPAD that produce prefabricated wooden houses had only a small production of wooden elements for the simpler types of wooden houses. Previously, they produced wooden elements for exterior and interior walls and for roofs. Construction of the elements was based on actual European standards. Prospects were not good because cost analyses indicated that wooden elements cannot be produced at a price that is competitive with elements made from other building materials. Furthermore, the fact that the factories are not geared for modern production is not promising for the future. The two factories are lacking good machinery, equipment, storage room for raw material and space for the efficient processing of wooden elements on a modern line. No quality control measurement devices are installed for the production of elements.

The ŠIPAD Design Centre has developed several methods of construction for elements for prefabricated wooden houses for the local market but these proposals have not been implemented by the factories.

During the visit of the expert both factories were producing elements for the Arab market. The designs for these elements were done by consultants employed by the buyers and not by the ŠIPAD Design Centre. The quality of these elements was poor and these designs cannot be used as a basis for the development of ŠIPAD wooden-house factories. Modern designs for production of prefabricated summer houses in Bosna and Hercegovina have been developed by the ŠIPAD Design Centre, but mass production of these types of houses has not been started by the factories.

It is necessary that the ŠIPAD Design Centre should clarify and finalize the construction drawings of the prototype house made at the Janj plant for mass production of prefabricated wooden houses for the local market.

The designs should be of four basic types of wooden houses each having two floors, and be based on the proposal for three-dimensional modular wooden houses. The classic construction of a modular unit is up to 2.70 m wide, up to 6 m long and 2.70 m high based on the regulations for the transportation of containers by railway and motor trucks. The necessary wooden elements are manufactured using solid wood and wood-based panels, as well as insulating material and gypsum board for cladding for the interior walls. For the exterior walls it is usual to use wooden panels of moulded and impregnated sawnwood.

Several design plans for three or four sections for the ground floor have to be developed based on an area of up to 16 m<sup>2</sup> for each section. It is necessary that these plans should include details on all installations for water supply, sewage disposal and electrical equipment.

The designs have to be based on plans from the expert's work done for the first prototype house which means a classic construction of solid beams and plywood for ground floor exterior walls, interior walls and roofing elements. These plans have to be controlled for static loading with the existing regulations in Yugoslavia.

ŠIPAD sawmills produce very good materials for production of wooden elements. The beams have to be dried down to 14% to 16% moisture content and moulded to exact dimensions. Normal panels for load-bearing elements are made of plywood of thicknesses of 5, 7, 9, 10 and 12 mm. For external use this plywood has to be glued with phenol-based adhesives. For flooring and roofing elements blockboard can also be used. Plywood and solid wood can be joined with nails or screws.

Production can be of small elements of up to 120 cm wide and 250 cm long, or large elements of up to 250 cm wide and 600 cm long. These elements can be joined together to make modular sections either at the factory or at the erection site.

However, it is necessary for ŠIPAD to erect modern factories for the production of wooden elements. Such factories are usually connected to a sawmill which produces the basic raw material needed and they have modern moulding equipment. The factory has to be warm and dry and should include storage space for all raw material.

An economic production capacity for a wooden-house factory is usually one house per day each having a floor area of 100 m<sup>2</sup>. The factory must include storage for completed elements under its roof as open-air storage of wooden elements may result in damage.

If ŠIPAD enters the local market for wooden houses it is clear that it will have to compete with standardized elements of high quality selling at a low price. At the same time, ŠIPAD needs a realistic marketing plan for both the local and export markets as the several types of wooden houses developed

by the Centre are unknown. The modular house erected at the Janj plant could be used as a model to demonstrate the achievements of ŠIPAD in this field, then this and other types of modular wooden houses should be erected on sites in Bosnia or Serbia in order to assess their acceptability by the public. The population of Yugoslavia is large and future housing requirements will be high and if these requirements are to be fulfilled with wooden houses, these must be of good quality and priced realistically.

A practical marketing plan would be 500 houses a year for the next three years made by a new factory erected for this purpose.

Several countries have local building regulations and architectural design restrictions that militate against wooden houses. It would, therefore, be advisable for ŠIPAD to concentrate on the local market and learn to handle all problems related to the production of wooden houses before broaching the export market. This would mean that such questions as production planning, dimensional accuracy, packaging and transportation of elements and their erection on site could then be based on long-term experience. In the meantime, the personnel at the ŠIPAD Design Centre could already begin studying the regulations, design and construction methods used in developed countries.

## II. RECOMMENDATIONS

1. The work of the Design Centre should be clearly outlined to the OOURs so that any problems the latter may have may be submitted to the Design Centre now for eventual solution. This should lead to a growing demand for the future services of ŠIPAD and serve as a guideline for planning. Work should be started immediately in the form of discussions with marketing personnel and OOUR leaders based on the existing drawings and proposals for different types of housing.

2. Acceptance of the plans for the prototype prefabricated modular wooden house is the best way to solve the problem of production of wooden houses. The personnel at the ŠIPAD Design Centre should finalize these drawings for mass production in a modern factory. They should include a list of materials for each element and detailed drawings for the joints and joining material.

3. The drawings for the first modular project at the Janj plant contain all the necessary information on types of material used for the construction of prefabricated wooden houses. Construction should be based on solid wood of small dimensions for beams and panels, as well as plywood, blockboard and gypsum board. The static loading measurements will indicate the dimensions of the material to be used. All construction plans should be based on a module of 30 cm each for width, height, and length.

4. The experience gained in the production of the prototype prefabricated modular wooden house shows that ŠIPAD must erect a modern factory for such production. Detailed plans for this factory can be worked out by a UNIDO expert during a future assignment after discussion with national staff and the leaders of the OOURs concerned. At that time a list could also be made of equipment required for production, storage and transportation. Several ŠIPAD OOURs already have the buildings, trained staff, dried sawnwood and plywood necessary to form a basis for the establishment of a modern factory. However, the best site would be near a large market, for example, in the vicinity of Sarajevo, in order to facilitate transportation of the elements produced.

5. The most important matters to be dealt with after the establishment of a new factory are the training of workers and staff, the introduction of quality control, and the dimensions of the elements. The foremen will handle modifications of drawings, ordering of materials, production planning

and control, and the scheduling of the transportation of elements to erection sites. The erection staff must be informed of the construction and agree to work according to a time schedule. All material included in a house such as windows, doors, stairs, water and electric conduits must be ordered according to a time schedule and be transported to the erection site together with the wooden elements.

Transportation of all materials from the factory to the erection site must be done by motor trucks.

The regulations governing transportation will determine the maximum dimensions of the biggest elements.

The erection problems depend to a great extent on the type of house and the site. Usually, a crane must be used for lifting the elements in as short a time as possible. The roof must be fixed over the wall elements immediately after they are erected.

6. The ŠIPAD Design Centre should plan a marketing programme based on studies, surveys, and statistics compiled by a marketing service department on the proposed product and other new types of houses. Initially, the studies should be of the market around Sarajevo. Later, studies should be made to cover Bosnia, then throughout Yugoslavia, and finally of the export market. These marketing reports together with plans for the COURs should form the basis of plans to develop a new prefabricated wooden house factory by ŠIPAD.

7. Discussions held between the expert and counterpart staff and the deputy director of ŠIPAD led the expert to believe that technical assistance would be required for the establishment of the proposed factory.

Although existing factories are capable of producing sophisticated elements, a new factory will be required and advice needed on selection of machinery, internal and external transportation systems, storage, and erection of modules on the building site.

New designs must be checked and exact price calculations made for each type of wooden house. The expert will have to establish the static measurements for the new constructions with local civil engineers or experts in this field. He should also make a study of all the products of the ŠIPAD factories such as

windows, doors, wood-based panels etc. to ensure a high standard of housing. If requested, assistance should also be provided to ŠIPAD by UNDP/UNIDO experts during the erection of the first modern factory and during its running-in period.

8. ŠIPAD presently produces: sawn and moulded solid wood, plywood, blockboard, gypsum board, wood-based panels, insulating material, windows, doors, roof trusses; pipes for water, electricity and sewage; paints, wall-papers etc.

These materials have to be analysed and their dimensions or construction methods modified for use in prefabricated wooden houses. The expert believes that these products do not always meet local standards for wooden houses.

The ŠIPAD Design Centre needs assistance for the development of these products which should be concurrent with the design of new types of housing.

9. For mass production of prefabricated wooden houses the ŠIPAD factories need:

- (a) Glued laminated timber;
- (b) Wood-panelled doors for exterior use;
- (c) Wooden stairs for two-storey houses.

(a) Glued laminated timber

Designs of two-storey wooden houses in developed countries traditionally include glued laminated timber beams. Other timber constructions such as gymnasiums, schools, and factory storage halls can be built economically by using glued laminated timber.

No ŠIPAD factory is presently producing glued laminated timber. During the expert's stay in Sarajevo, he proposed that a group from the ŠIPAD factories and Design Centre should study modern production and erection methods in other countries, for example, the Federal Republic of Germany. Afterwards a UNIDO expert could work with the Design Centre on designs and production plans and costs for this product.

Once ŠIPAD factories start producing glued laminated timber the production of prefabricated wooden houses will become more flexible and economical.

(b) Wood-panelled doors

Modern wooden houses with insulated exterior walls require wood-panelled doors. One ŠIPAD factory produces these using a simple construction design

copied from one used in the Federal Republic of Germany. However, it is not suitable for modern wooden houses and it would be advisable for ŠIPAD to study Scandinavian designs and standards.

The expert has already helped to produce a door of sufficiently high standard for the prototype house made at the Janj plant. Based on this prototype, the ŠIPAD Design Centre will have to work out exact drawings for this product. The existing joinery factory at Janj has the necessary resources to produce such doors.

(c) Wooden stairs

ŠIPAD needs wooden stairs of a high standard for two-storey wooden houses. The best woods for this purpose are oak, beech, and fir and the raw materials available are very good.

ŠIPAD should start producing stairs immediately, not only for the local market and its own production of prefabricated wooden houses but also for a large export market. Assistance could be provided to ŠIPAD to develop the necessary standard designs and to plan factory equipment.



Annex I

JOB DESCRIPTION

DP/YUG/73/006/11-03/H/03 Rev. 1 <sup>a/</sup>

- POST TITLE: Expert in the design of prefabricated wooden houses.
- DURATION: Two months.
- DATE REQUIRED: As soon as possible.
- DUTY STATION: Sarajevo with travel in the Republic of Bosnia and Hercegovina.
- PURPOSE OF PROJECT: To create a centre for the development of the furniture and joinery industries in Sarajevo. This centre will cater for these industrial sectors of the Republic of Bosnia and Hercegovina in particular.
- DUTIES: The expert will be attached to the Centre for the Development of the Furniture and Joinery Industries which is being created with UNDP/UNIDO assistance. He will be responsible to the Centre's Director, and will, in collaboration with the Centre's Yugoslav staff, plan and start the activities of the Centre's design department in this field. Specifically, the expert will be expected to:
1. Supply information on world achievements in the field of designing, production and erection of prefabricated wooden houses using the panel system.
  2. Supply information on the development of the modular three-dimensional system for prefabricated houses solely of wood or combined with other materials. Particular emphasis should be placed on:
    - (a) Modular three-dimensional system of prefabricated houses for urban centres;
    - (b) Modular three-dimensional system for high-rise buildings;
    - (c) Problems of transporting three-dimensional units and means of transport available;
    - (d) Regulations and standards on biggest dimensions of three-dimensional modules used in wooden prefabricated houses;
    - (e) Comparison of investment requirements and costs of wooden prefabricated houses using the modular three-dimensional system with those using the panel system.

<sup>a/</sup> The revision of this Job Description, previously distributed on 21 March 1975, is being issued due to changes in the text.

3. Supply information to the counterparts on large constructions based on wooden glued laminated beams (sport halls, industrial halls, public buildings etc.).
4. Compile information on centres where these subjects are studied and executed, and on the literature and other information on where these systems were applied.
5. Study the building code of Yugoslavia, compare it with that of other countries where wood is used more intensively in housing and recommend changes which would allow a greater use of wood in housing and construction.

**QUALIFICATIONS:** Wood technologist, civil engineer or architect with considerable experience in timber engineering and the design of low-cost, factory-produced wooden housing.

**LANGUAGE:** English, French acceptable, German an asset.

**BACKGROUND INFORMATION:** The furniture and joinery industries of Bosnia and Hercegovina contribute about 3% to the Republic's gross national product, and represent over 4% of its exports. An ambitious 5-year development plan is being implemented to double the production of furniture to attain Din 2,000 million and increase the work force from 6,000 to 9,000 persons. This plan calls for an investment of Din 800 million. Joinery production will increase from Din 200 million to Din 650 million and the work force will treble to total 4,500 persons. Investments of Din 950 million are foreseen for joinery plants. (\$US 1 = Din 15.5). SIPAD, a co-operative integrated forest industry organization, consists of 126 factories employing 55,000 persons, and accounts for 65% of saw milling and 85% of the final products of the wood industries of Bosnia and Hercegovina. The Government of Bosnia and Hercegovina and the SIPAD organization have decided to create a Centre for the Development of the Furniture and Joinery Industries to cater for the 38 existing furniture and joinery plants within the organization and requested UNDP/UNIDO assistance in establishing this Centre. It is to have the following departments: technology and quality control, production and organization, design, marketing, documentation.

Annex II

REPORT ON VISITS TO THE JANJ PLANT AT DONJI VAKUF AND TO THE  
SIPAD FACTORY OF ZOOUR BOSNIA AT ILIJAS, NEAR SARAJEVO

The Janj plant

On 17 October 1975, the expert met with the assistant director of the Design Centre, and with the director of furniture manufacture and the director of manufacture and erection of houses of OOUR Janj at Donji Vakuf.

The expert visited the sawmill which has very good equipment to saw and process timber.

The joinery factory produces window frames in different standard sizes to be transported directly to erection sites. They also, when requested by the architects, make special sizes that do not conform to Yugoslav national standards. This is also the case for door frames. The factory buys door faces which are then used in the production of doors. Door faces are made from second quality material and the factory has started to produce its own as this is more economical than buying them. The surface coating and quality of both door frames and faces is very good and the production is of a high standard.

The only criticism made by the expert is of the transport equipment and that the handling of stock and of the material in the production line could be done more efficiently.

However, the machinery for, and handling of, blockboard production should not be changed as this product is not a modern one and factories everywhere find it expensive to produce.

The wooden-house industry is presently installed in an old factory but it has good machinery and equipment. It is producing exterior and interior walls and roof trusses for simple types of buildings such as barracks and semi-detached houses. It also produces gypsum panelling and steel frames (these production lines were not visited by the expert) and houses are often made of a combination of these three products: wooden elements, gypsum panelling and steel frames.

At the time of the visit plans for a two-storey wooden house had not been developed and the staff believed that such a product would be expensive and that customers would not have faith in it.

A new hall of 12 by 60 m had been built and new machinery was to be installed and production was due to begin at the beginning of November. Glued elements are not presently produced but could be if such production would be economical.

The staff at the plant are well informed about modern types of wooden housing but they are at the mercy of the customers who have no idea of modern wooden building methods and products. Another point is that wooden buildings are often more expensive for rural dwellers so production is usually limited to offices, motels, schools and hospitals. Wood used for these buildings is treated with a fire retardant. The staff are informed on three-dimensional modular wooden buildings but at the time of the visit had not produced this type of house. However, they were delivering to the Arab market prefabricated wooden elements.

In summation, the Janj plant is well sited, has good raw material and machinery; production halls are clean and in good condition; the engineers are well informed on exportation of joinery and wooden houses. The expert believed that this was the best factory to produce a prototype of a three-dimensional modular wooden house. Its economic resources are good and the staff are willing to spend time, effort and money to develop this type of house for public homes, schools, hospitals and offices.

#### ŠIPAD factory of ZOOOR Bosnia

On 13 and 14 October 1975 the expert visited the ŠIPAD factory of ZOOOR Bosnia at Ilijas, near Sarajevo, and met with the Director, Velemir Bajić.

The factory comprises a sawmill, a joinery workshop, a blockboard factory and a factory for prefabricated wooden elements.

Sawwood for joinery and wooden elements is not well dried because the capacity of the kiln is insufficient.

Not all products from the joinery workshop are standard as designs are specified by customers.

Joinery and prefabricated wooden elements are always produced according to the order received and not for stock. At the time of the visit, the workshop was producing special windows and doors for an export order to Iraq.

The wooden-house factory produces elements for about 400 houses a year. The only type of production which has been developed is for exterior and interior walls and roof trusses. A type of flooring element is now being produced to fulfil an order from Iraq but the features of this element are simple.

The machinery and equipment of the factory is old and not in good condition, and its capacity is insufficient for production. A proposal to purchase new factory equipment has been made by the engineers and this machinery would be installed in an old factory hall where production would be more efficient. However, it is unlikely that this plan can be successfully realized in the existing hall. The production halls for prefabricated wooden elements are not suitable for good quality products. The factory's development plan does not foresee a new factory for such production, nevertheless, one is absolutely necessary if production of wooden houses is to develop.

In summation, the staff have many good ideas on how to solve production problems but in fact, this factory is primitive. If these ideas can be realized, the factory could, in future, be a good producer of prefabricated wooden houses.

Annex III

COUNTERPART AND NATIONAL STAFF

<u>Name</u>	<u>Function</u>
Vaso Solaja	National director of the project
D. Praskač	Director, ŠIPAD Design Centre
Olga Kisić Janja Stanisić	Secretary and interpreters (English/Serbo-Croatian)
Dušan Rakojević	Chief architect of the ŠIPAD Design Centre
Spaso Učelač Zvonko Minalić Zlatan Bajić Franjo Tomić	Designers

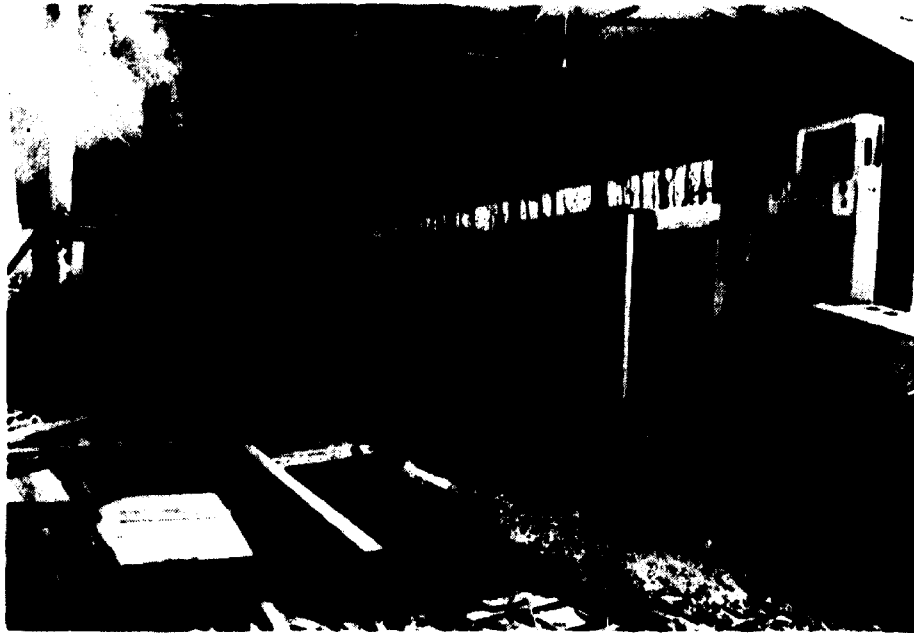
Annex IV

SERVICES AND PERSONNEL REQUIRED TO BUILD THE  
PROTOTYPE WOODEN HOUSE  
(Eight sections totalling 89 m<sup>2</sup>)

1. The expert assisted the team from the ŠIPAD Design Centre and factory led by D. Rakojević during a two-month period beginning in October 1975. Their work included: construction drawings, factory production drawings, erection drawings, calculation of factory costs, list of materials, advice on factory equipment for production of a prototype and advice to erection workers.
2. The factory had to supply the following:
  - 1 engineer to advise the workers;
  - 1 electrician (skilled labour) for the installation - 3 weeks;
  - 1 plumber (skilled labour) for the installation - 2 weeks;
  - 2 painters to paint exterior and interior walls - 4 weeks;
  - 10-12 labourers per shift (two shifts) - 5 weeks.
3. Equipment required:
  - Space (about 300 m<sup>2</sup>) at the plywood factory in Ilijas;
  - Dried, moulded timber of exact dimensions;
  - Three tables for the production of elements;
  - Various items for nailing and gluing timber and wood sheets;
  - 1 fork-lift truck for transporting material to the factory - 2 h/shift;
  - 1 flat-bed truck for transporting sections.
4. The expert had to commute between the factory and the ŠIPAD Design Centre and therefore transportation had to be available at short notice during the entire two-month period.

ANNEX V

PHOTOGRAPHS OF THE PROTOTYPE WOODEN HOUSE  
AT THE JANJ PLANT AT DONJI VAKUF



1. Prefabricated modular wooden sections before transportation to the erection site



2. Transportation by motor truck to the erection site





3. Foundation for the modular wooden house



4. Erection by crane of the second storey of the prefabricated modular wooden house



5. Prefabricated modular wooden house erected on 7 December 1975



6. Fully erected prefabricated modular wooden house

Annex VI

**PLANS FOR THE PROTOTYPE WOODEN HOUSE**

The house is a two-storey detached unit with a floor area of 89 m<sup>2</sup>. It is composed of eight three-dimensional modules, four for the ground floor and four for the first floor. The modules are factory fabricated and are placed on foundations prepared on site.

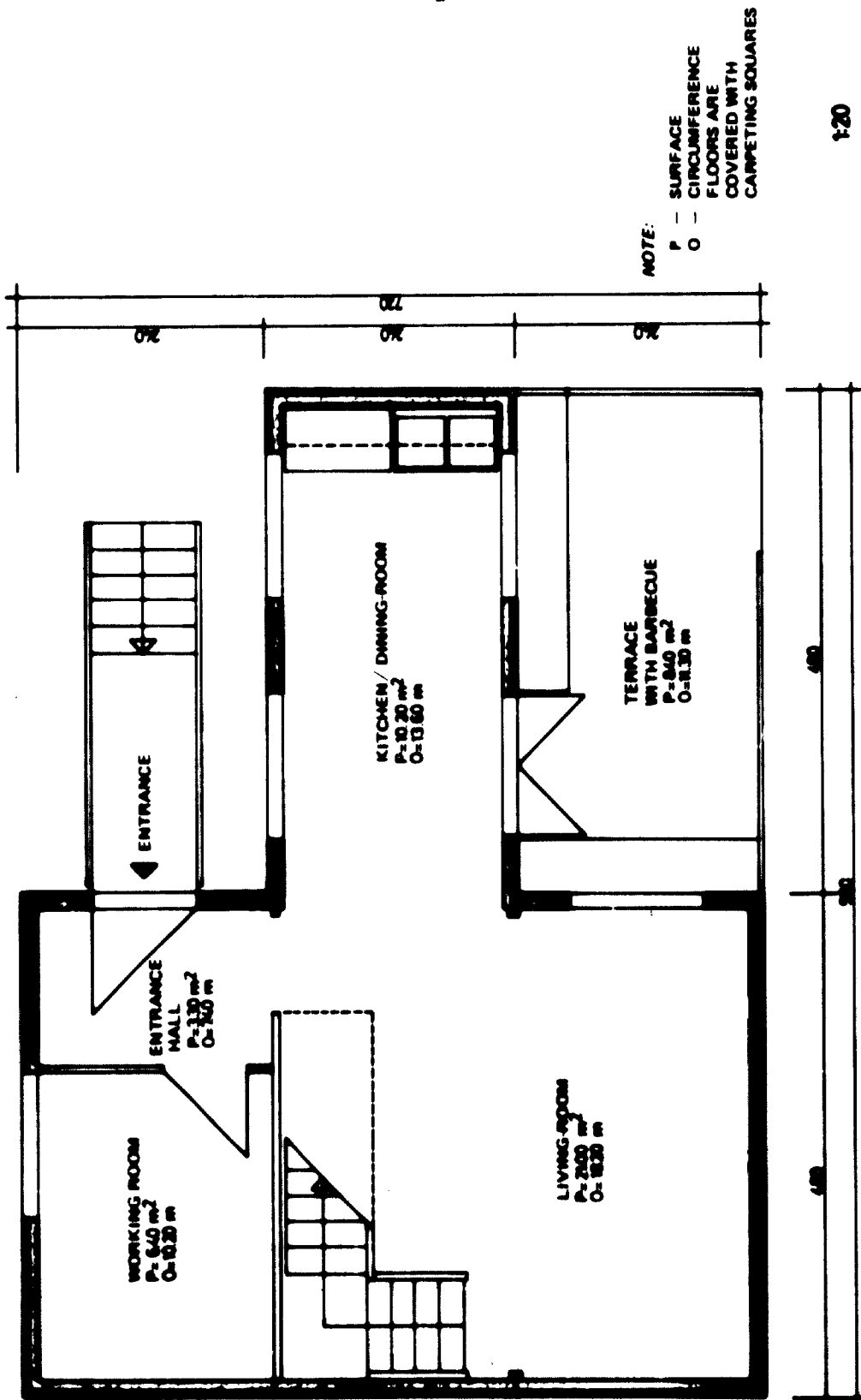
In the following drawings the elements for the ground floor have the prefix A and those for the first floor the prefix B. The roofing elements have the prefix C and the drawings for the terrace have the prefix D. Each level is composed of four modular three-dimensional elements, referred to as 1, 2, 3 and 4. The components of these elements have the following designations: floor - 01, ceiling - 02, walls - 03 and so on. Not given are the drawings for the doors and for the following elements: B 106 and B 204 (these elements are mirror images of each other), B 203, B 403 and C 401. The external staircase should be designed according to the terrain on which the house will be erected. Drawings have been reduced and are not to scale.

List of drawings

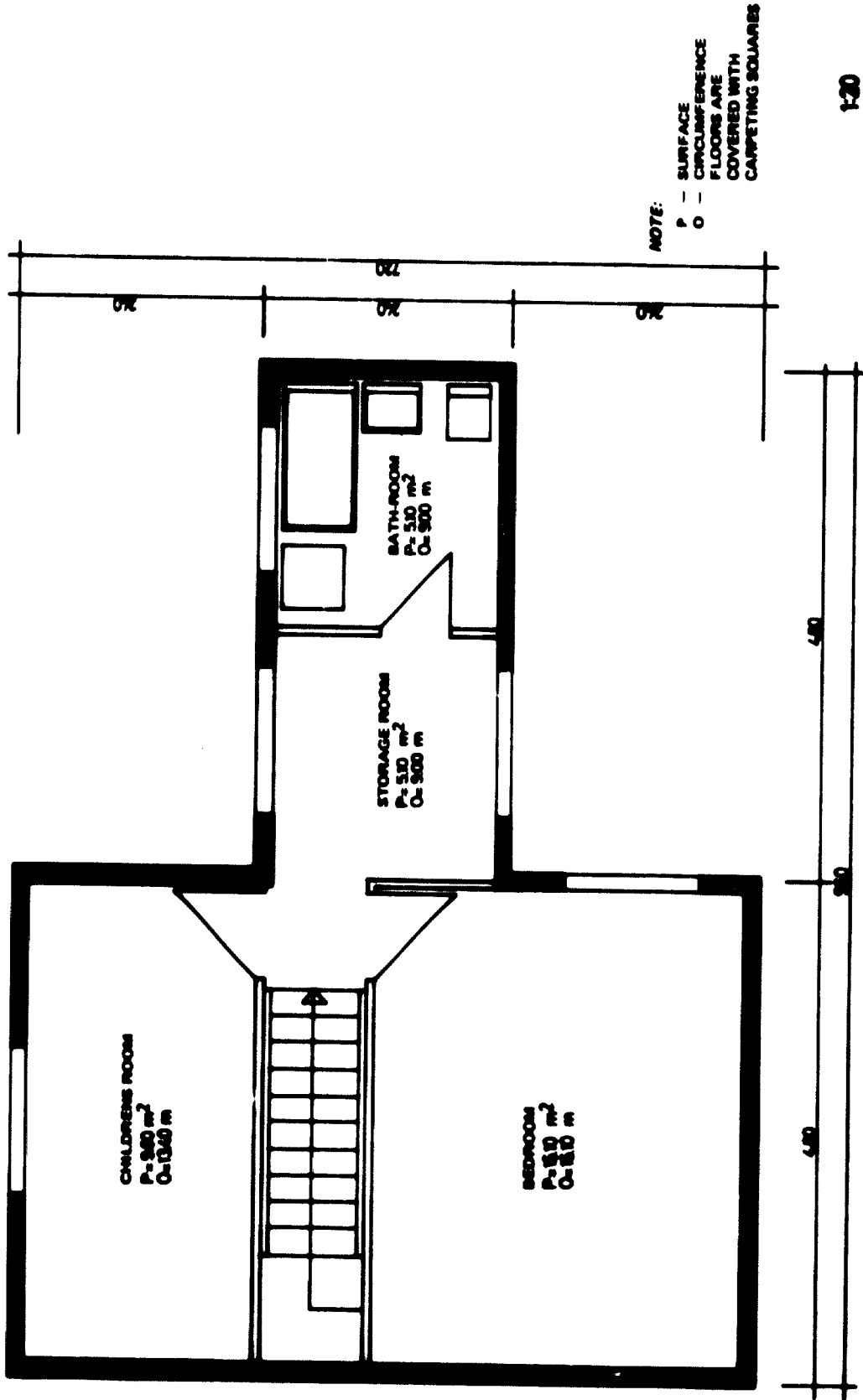
1. Ground floor plan
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26. External side wall elements - A 304 and B 304
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38. Terrace floor element - D 101
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40. Balustrade element - D 102
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48. Details of assembly of modules A 2 to A 3
49. Details of assembly of module A 2 to A 1 or A 3
50. Details of assembly of module A 2 to A 4

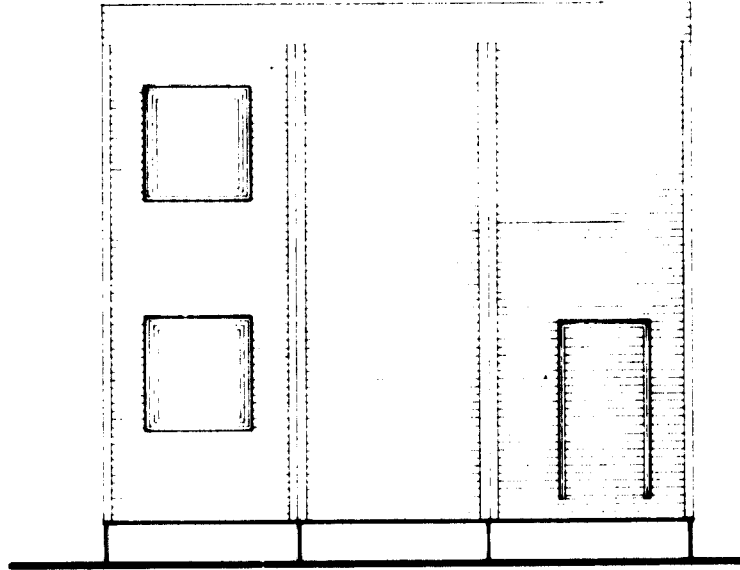
51. Details of assembly of modules A 2, A 3 and A 4
52. Details of assembly of modules B on modules A
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57. Details of assembly of modules B 2 and B 4 to A 2 and A 4 (with extra spacing)
58. Details of external corner joints
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60. Details of joints of floors to walls
61. Plan of bathroom and kitchen showing piping layout
62. Layout and dimensions of water piping installations
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64. Inside staircase



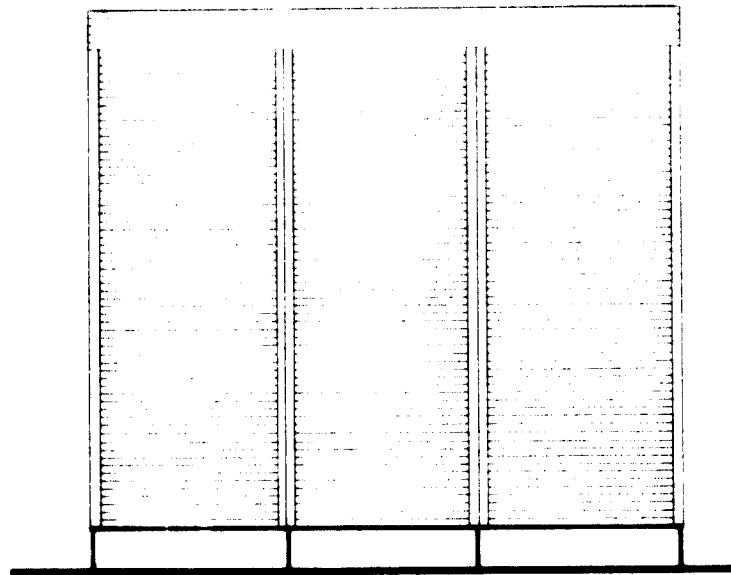
1. Ground floor plan



2. First floor plan

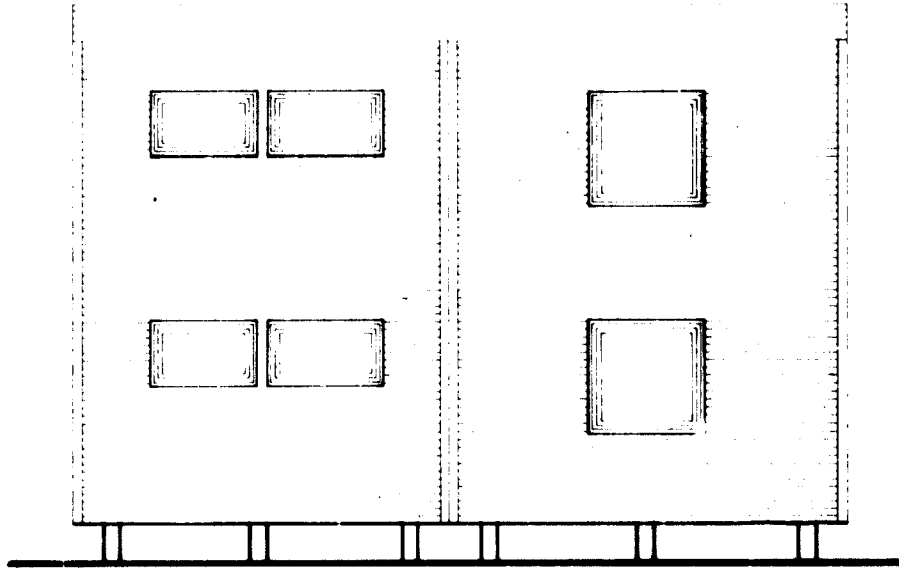


3. Front elevation

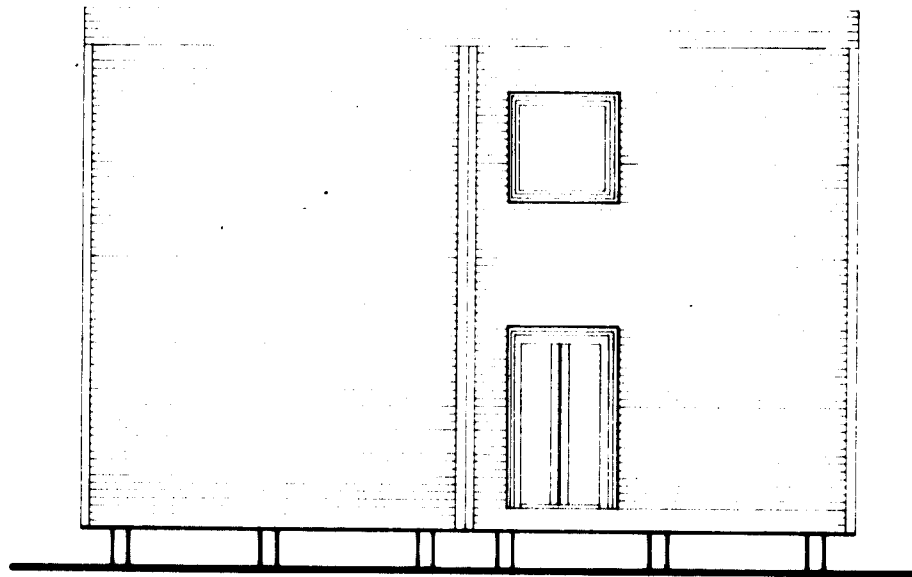


4. Back elevation

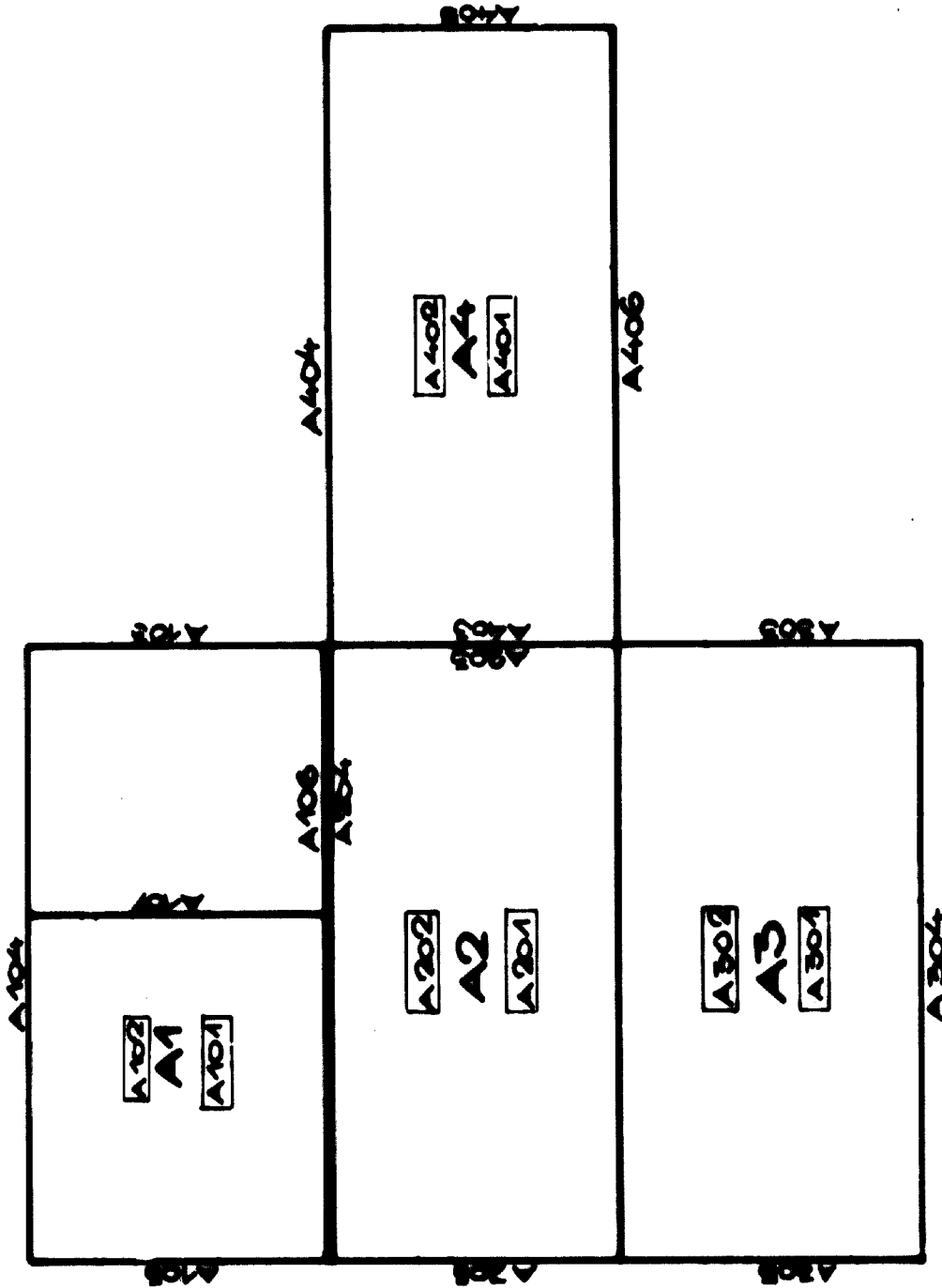




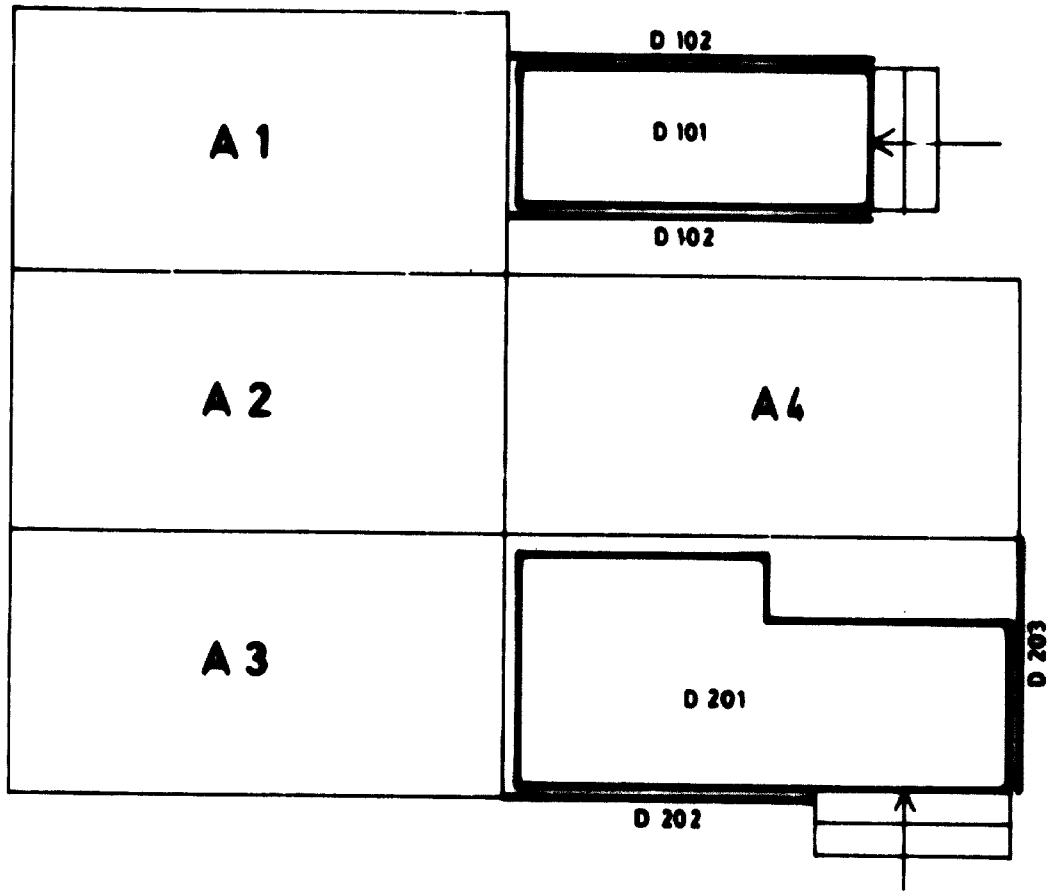
5. Side elevation (entrance side)



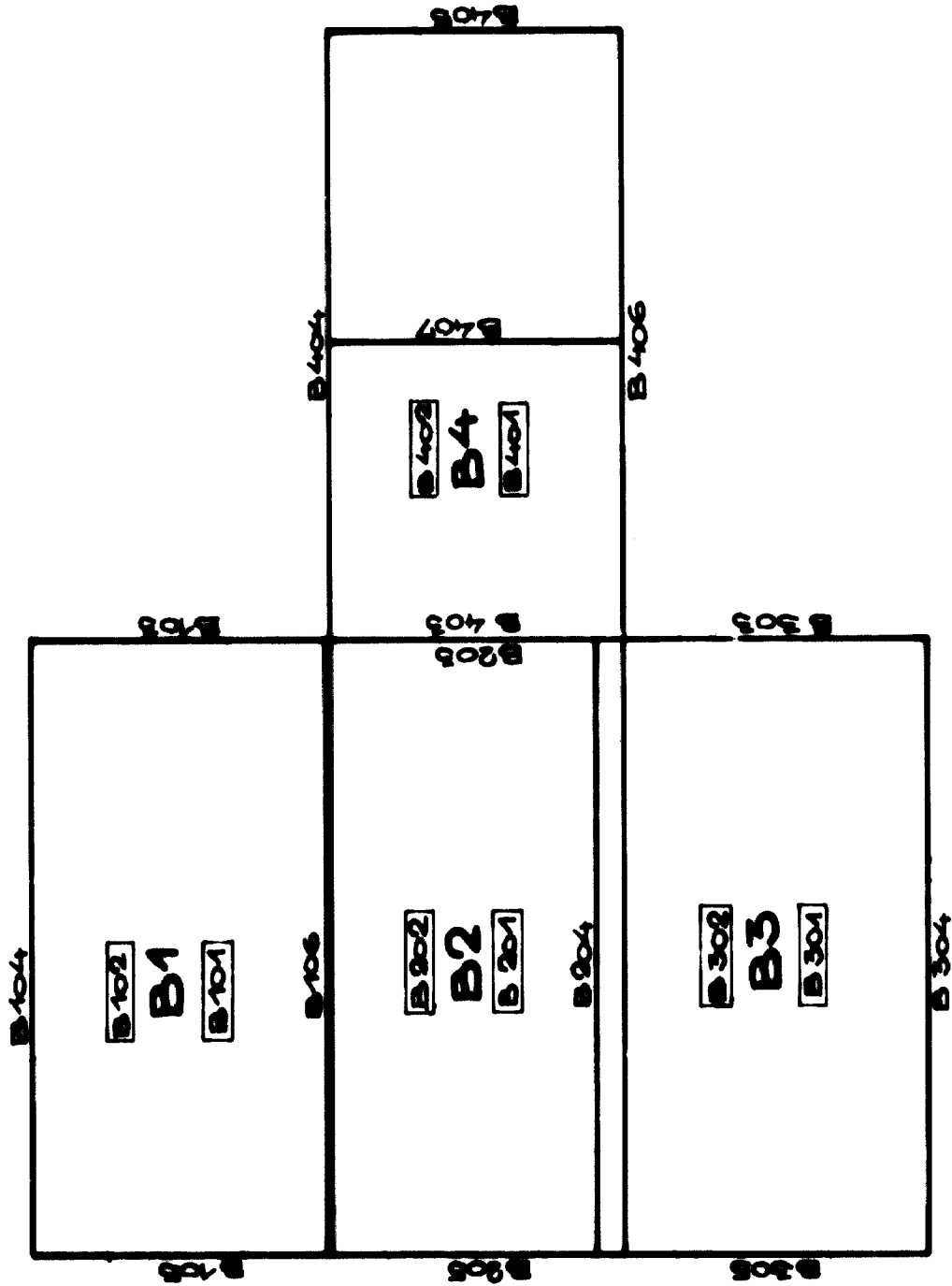
6. Side elevation (terrace side)



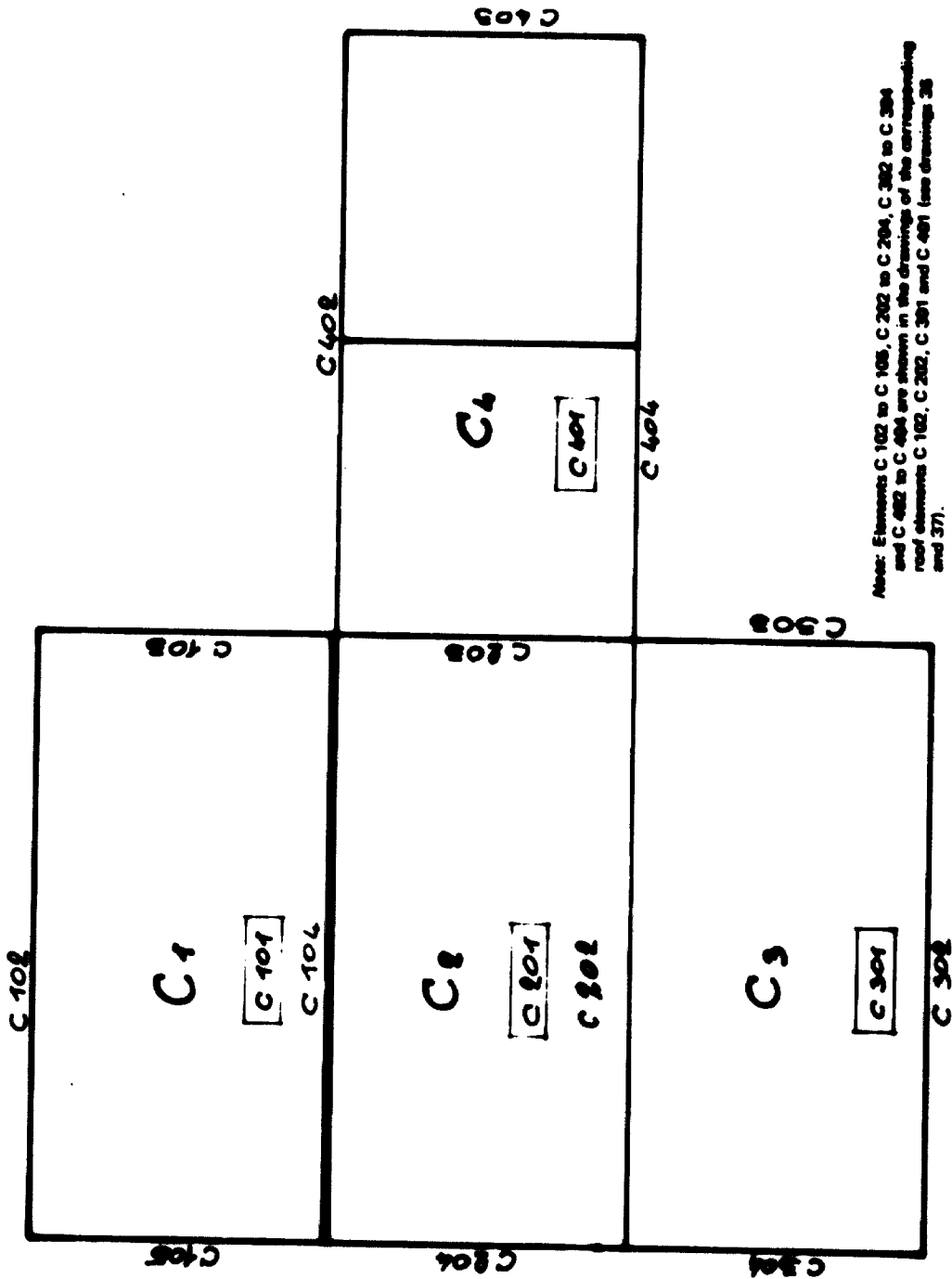
7. Assembly plan - level A (ground floor)



8. Assembly plan - level A (terraces)



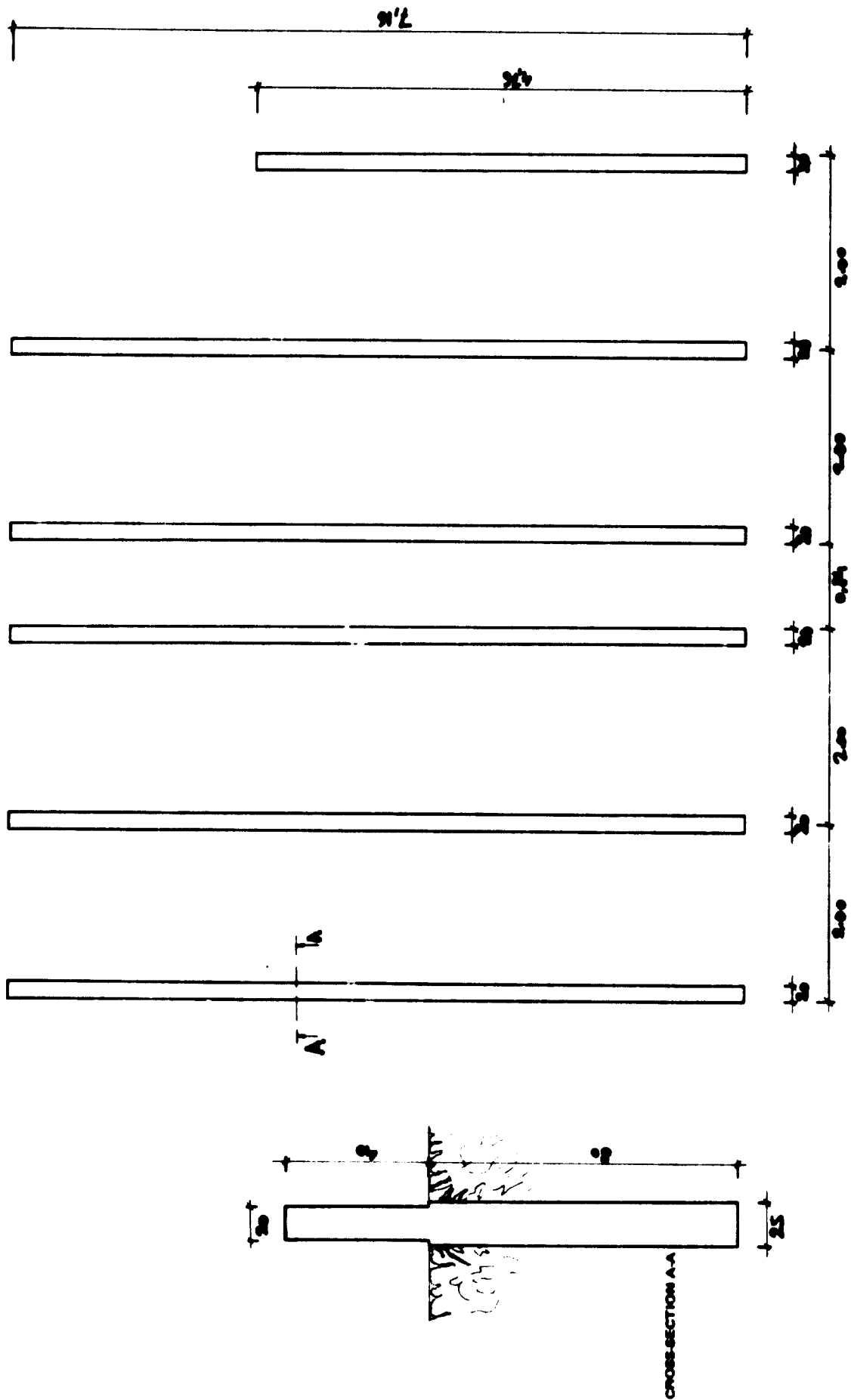
9. Assembly plan - level B (first floor)



Note: Elements C 102 to C 105, C 202 to C 204, C 302 to C 304 and C 402 to C 404 are shown in the drawings of the corresponding roof elements C 102, C 202, C 302, C 304 and C 402 (see drawings 35 and 37).

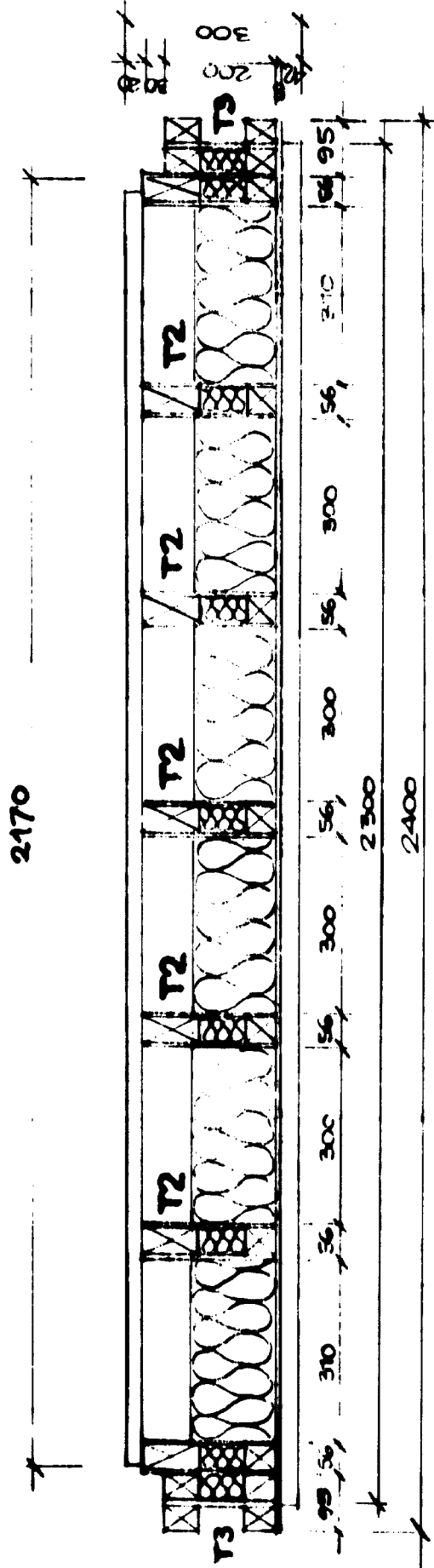
10. Assembly plan - level C (roof)





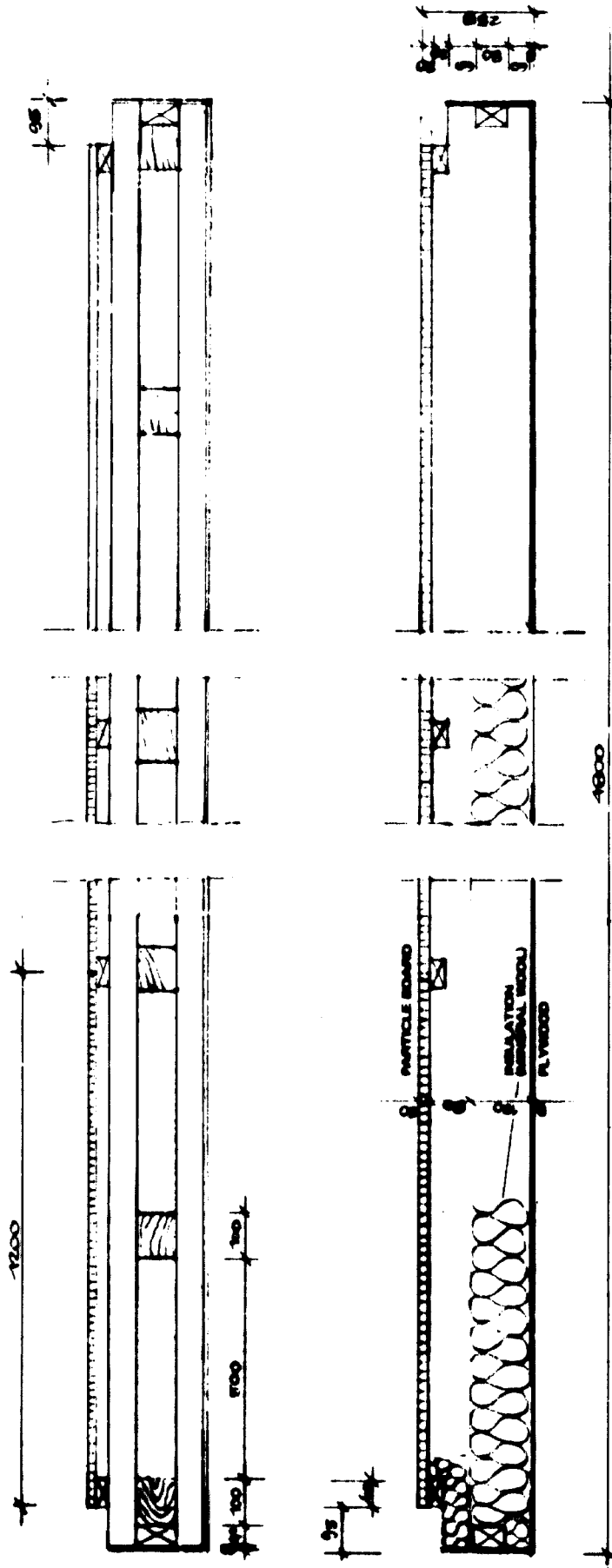
12. Foundation layout

M = 1:5



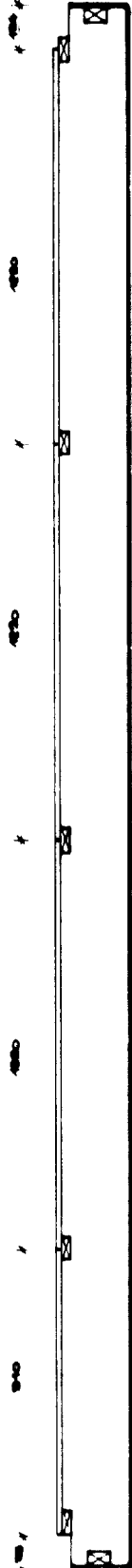
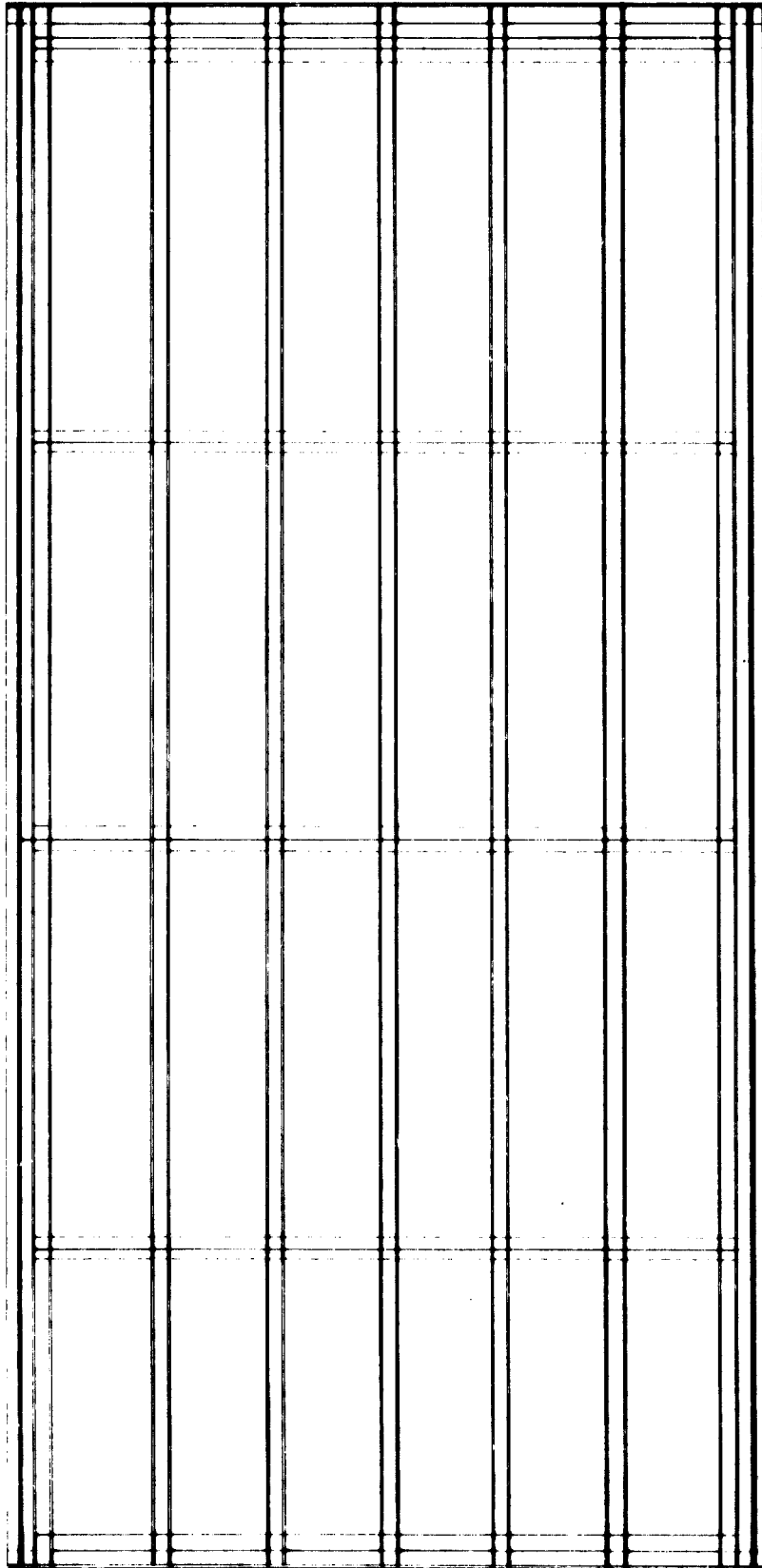
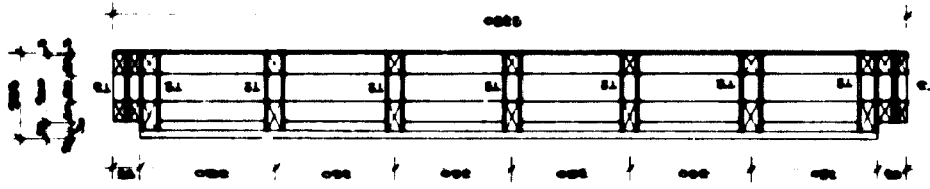
13. Floor element - transversal cross-section





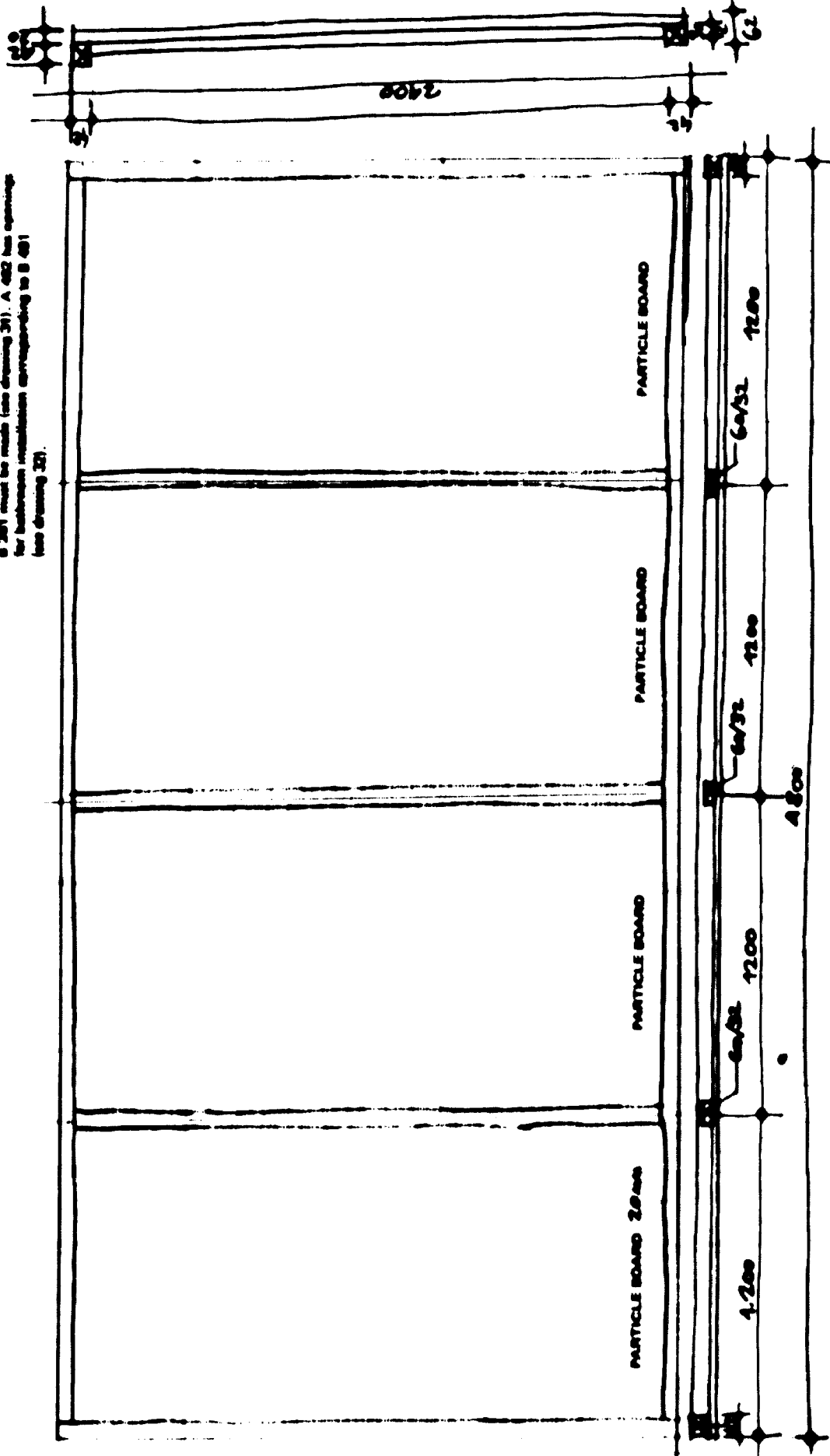
M=1/5

14. Floor element - longitudinal cross-section

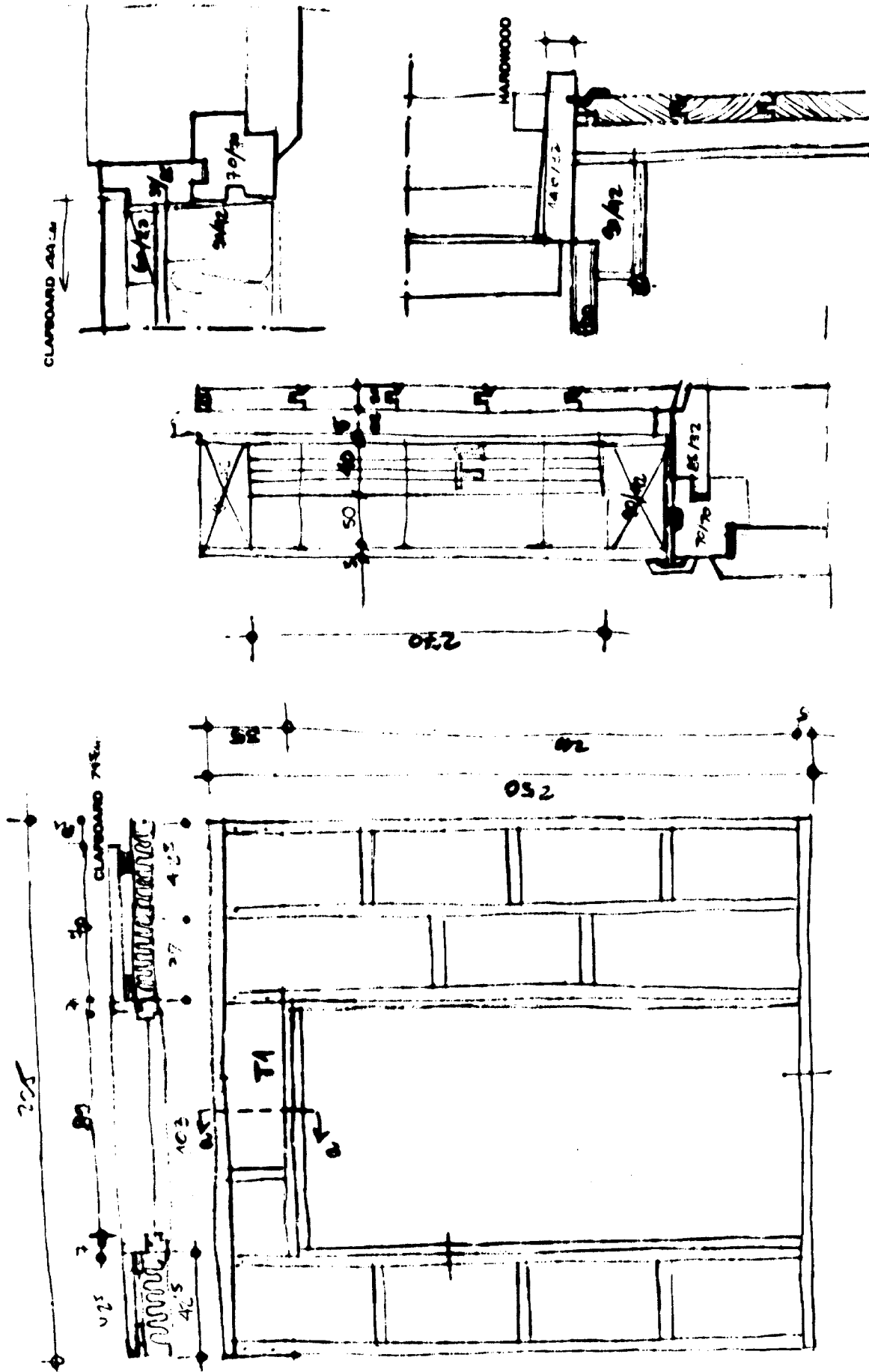


15. Floor elements - A 101, A 201, A 301, B 101 and B 301

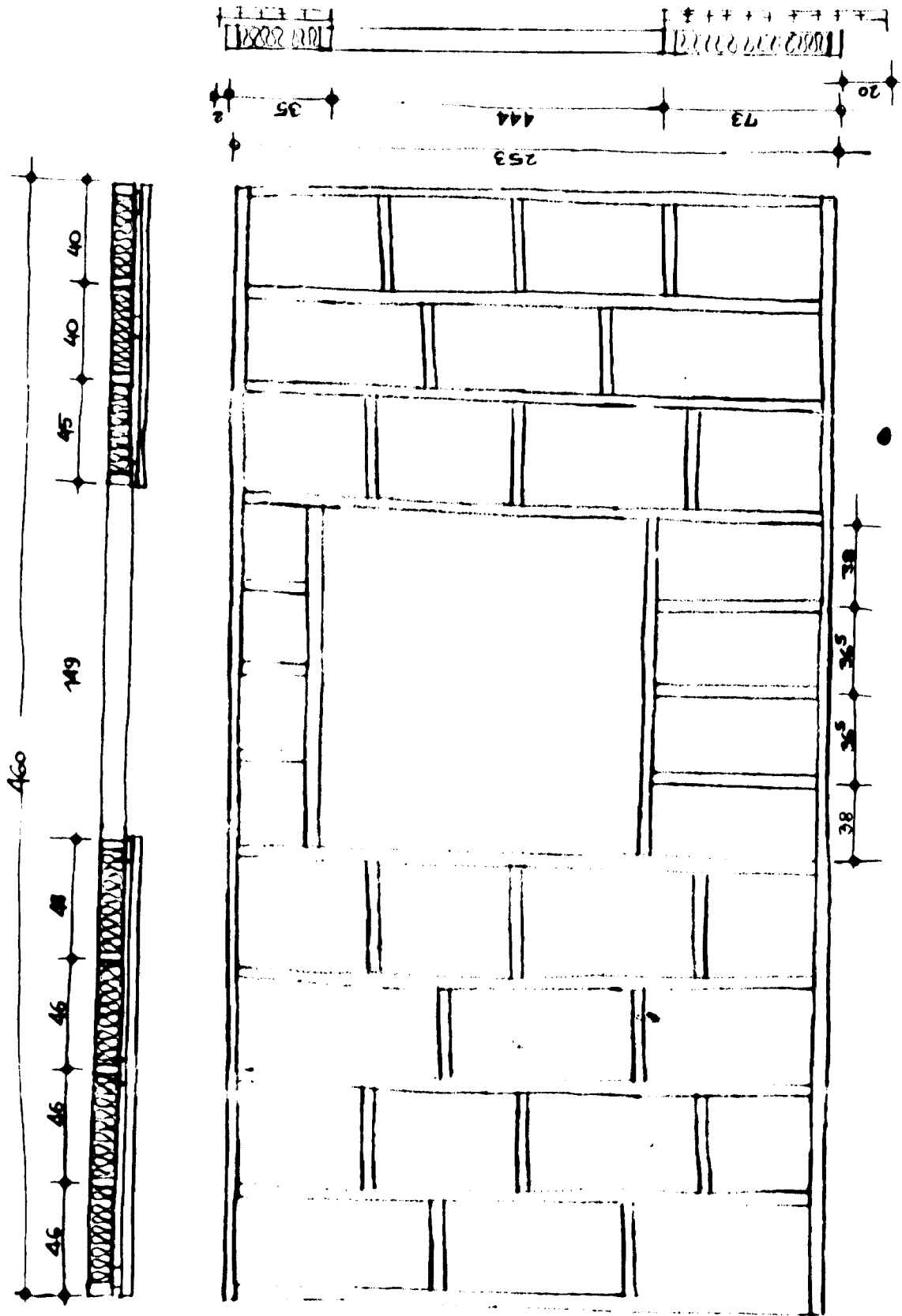
Note: A 202 has the same over-all dimensions as 402 but an opening of 3,000 X 600 mm that corresponds to B 201 must be made (see drawing 31). A 402 has opening for bathroom installation corresponding to B 401 (see drawing 31).



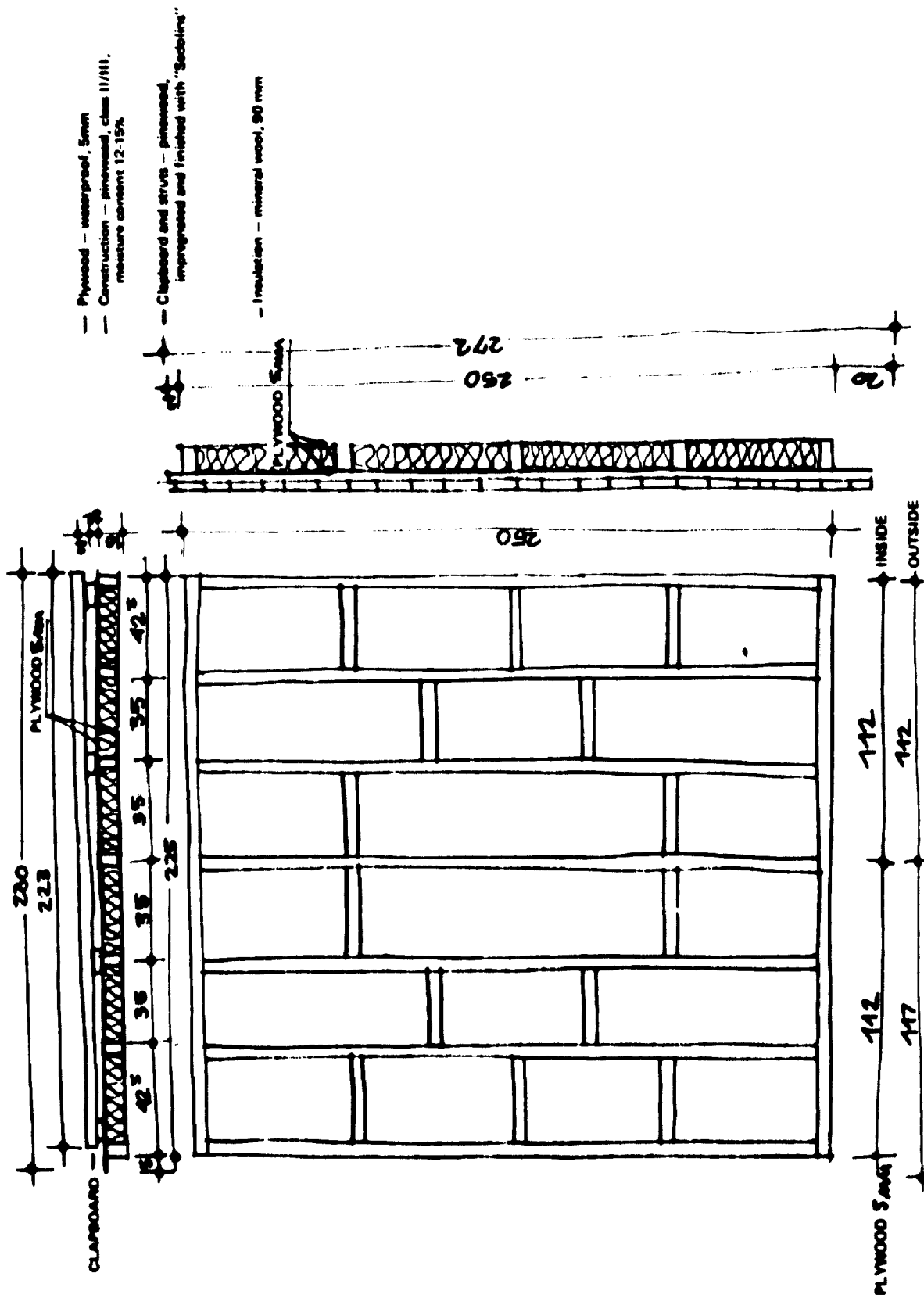
16. Ceiling elements - A 102, A 302, A 402, B 102, B 202, B 302 and B 402



17. External front wall element - A 103

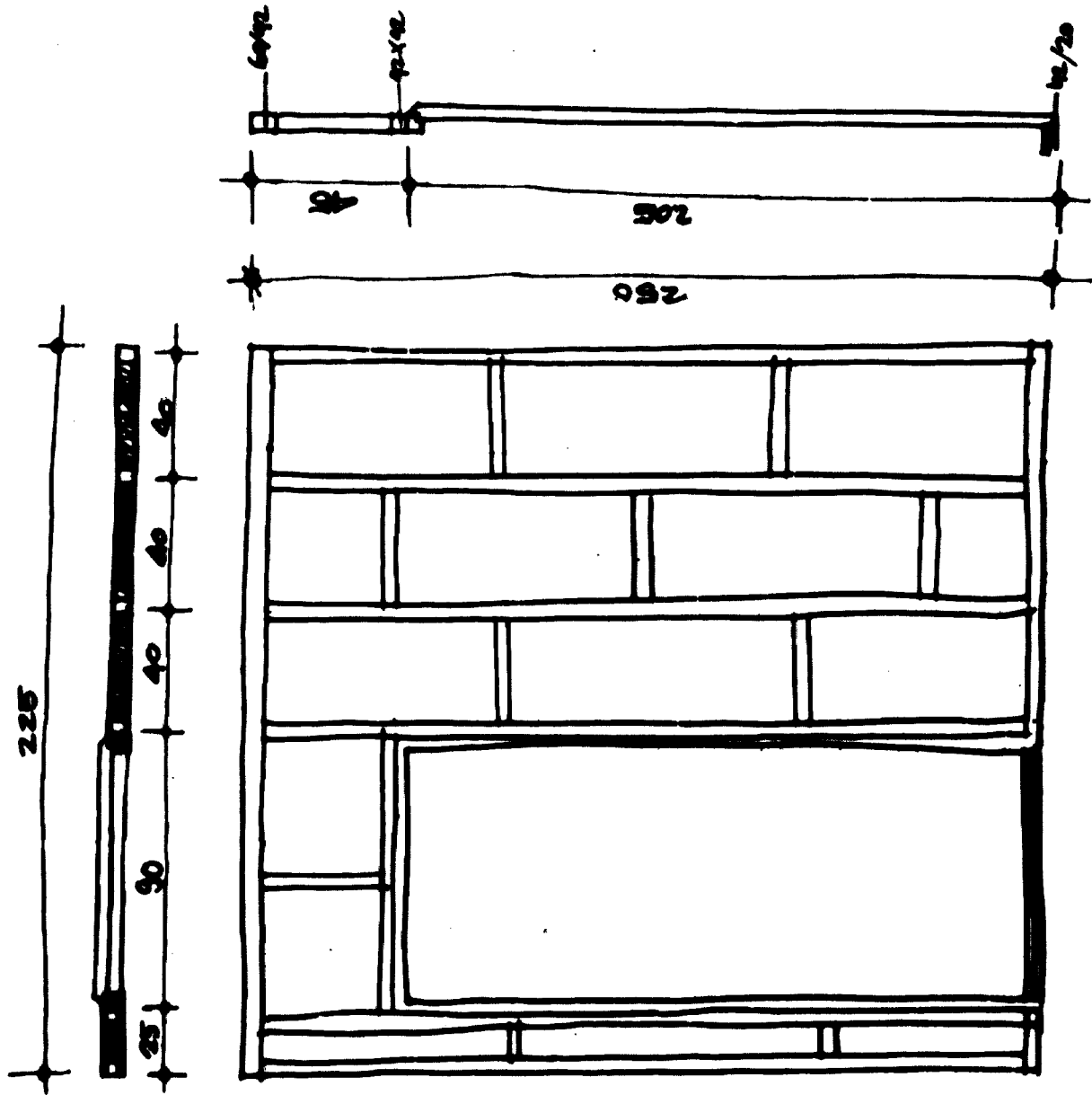


18. External side wall elements - A 104 and B 104



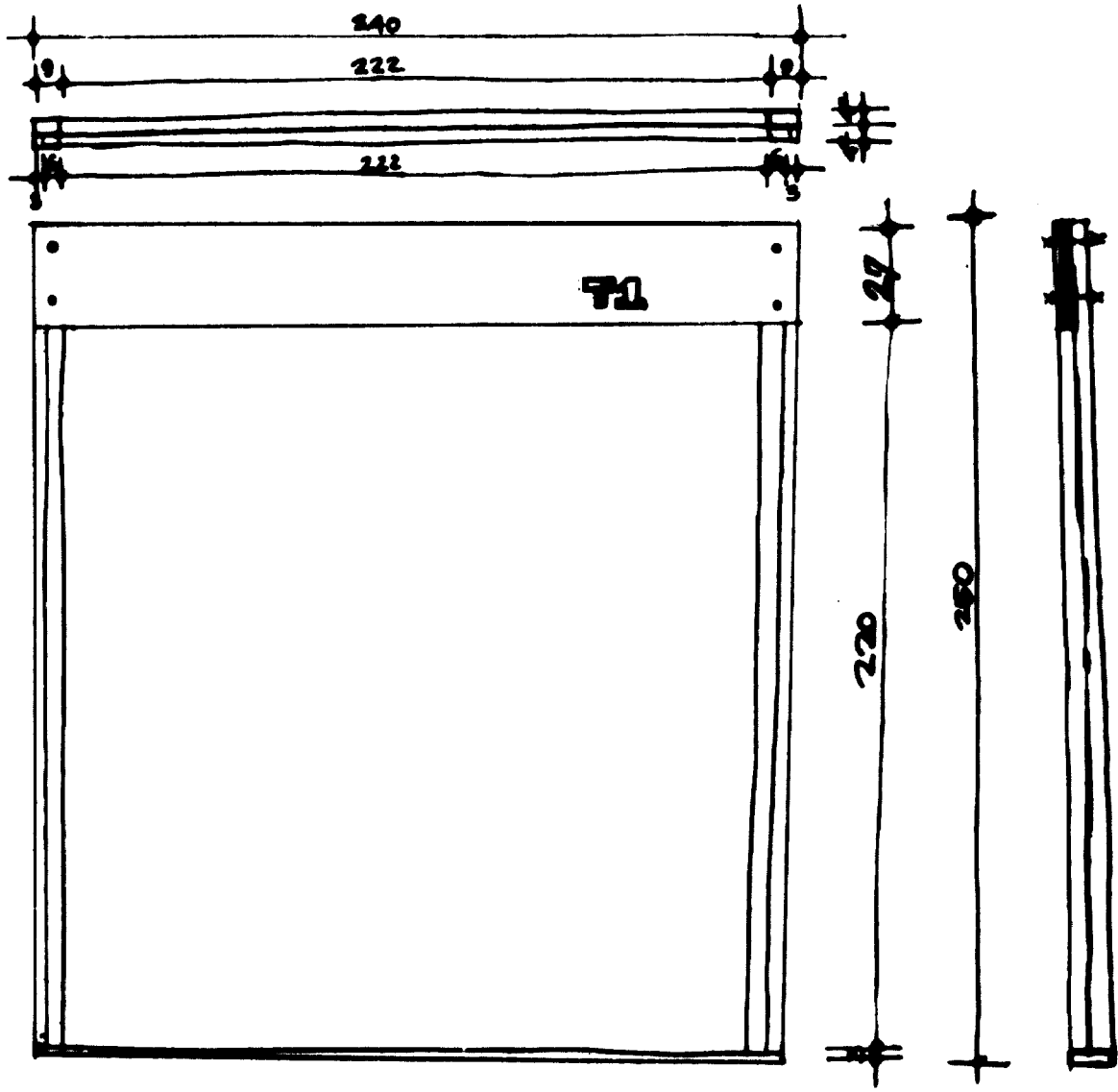
19. External back wall elements - A 105, B 103 and B 105



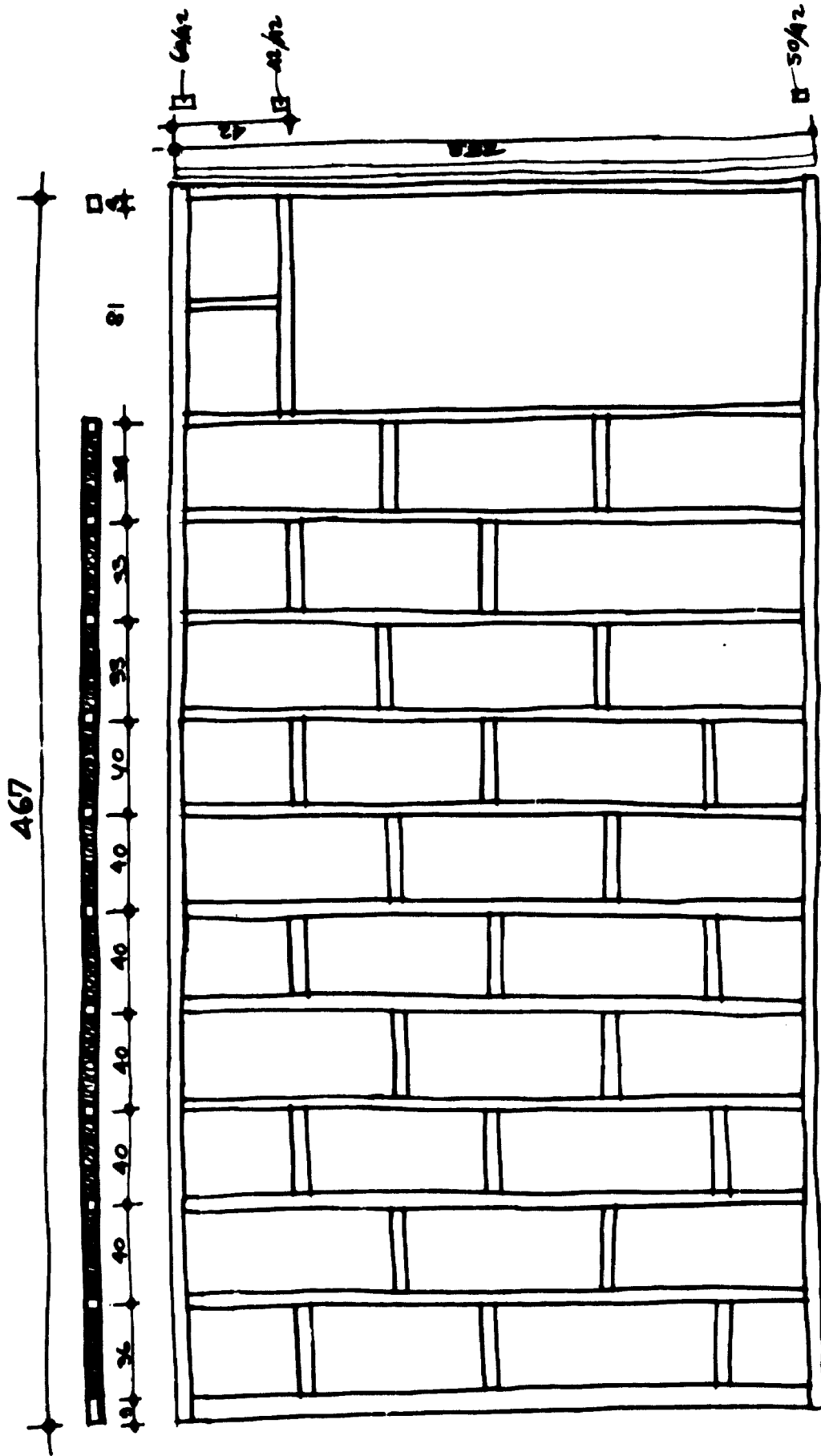


21. Internal partition - A 107

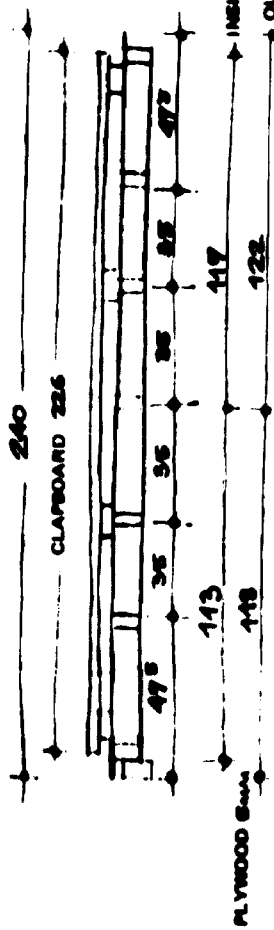
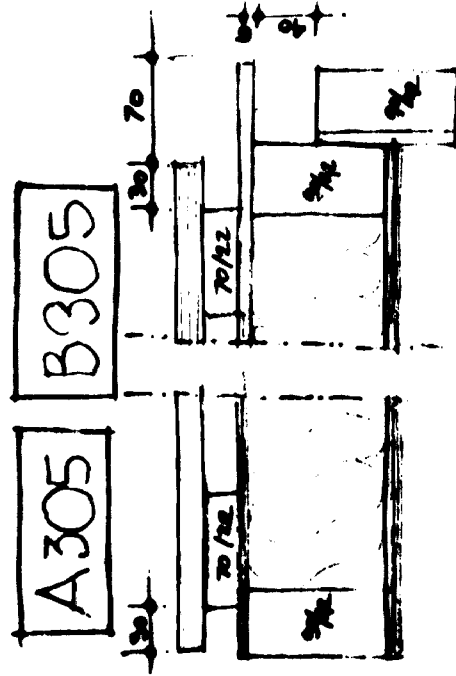
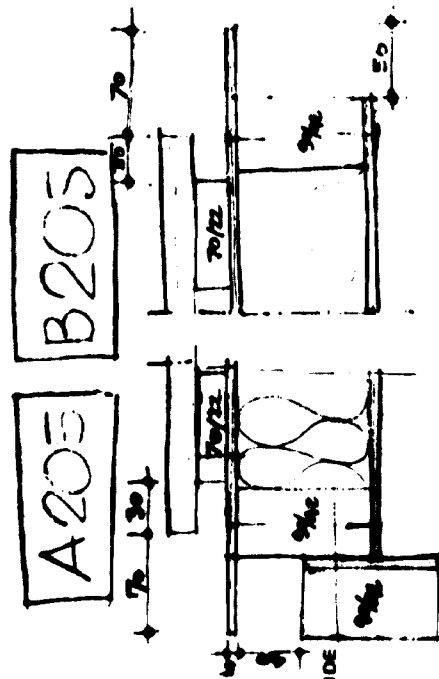




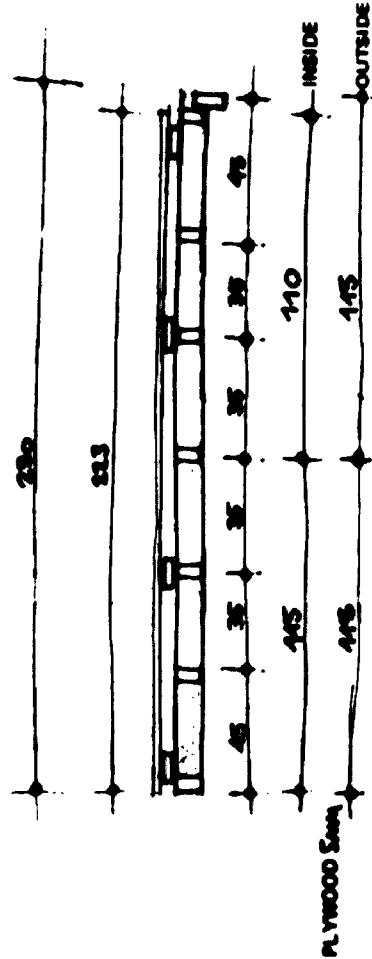
22. Internal partitions - A 203 and A 403



23. Internal partition - A 204

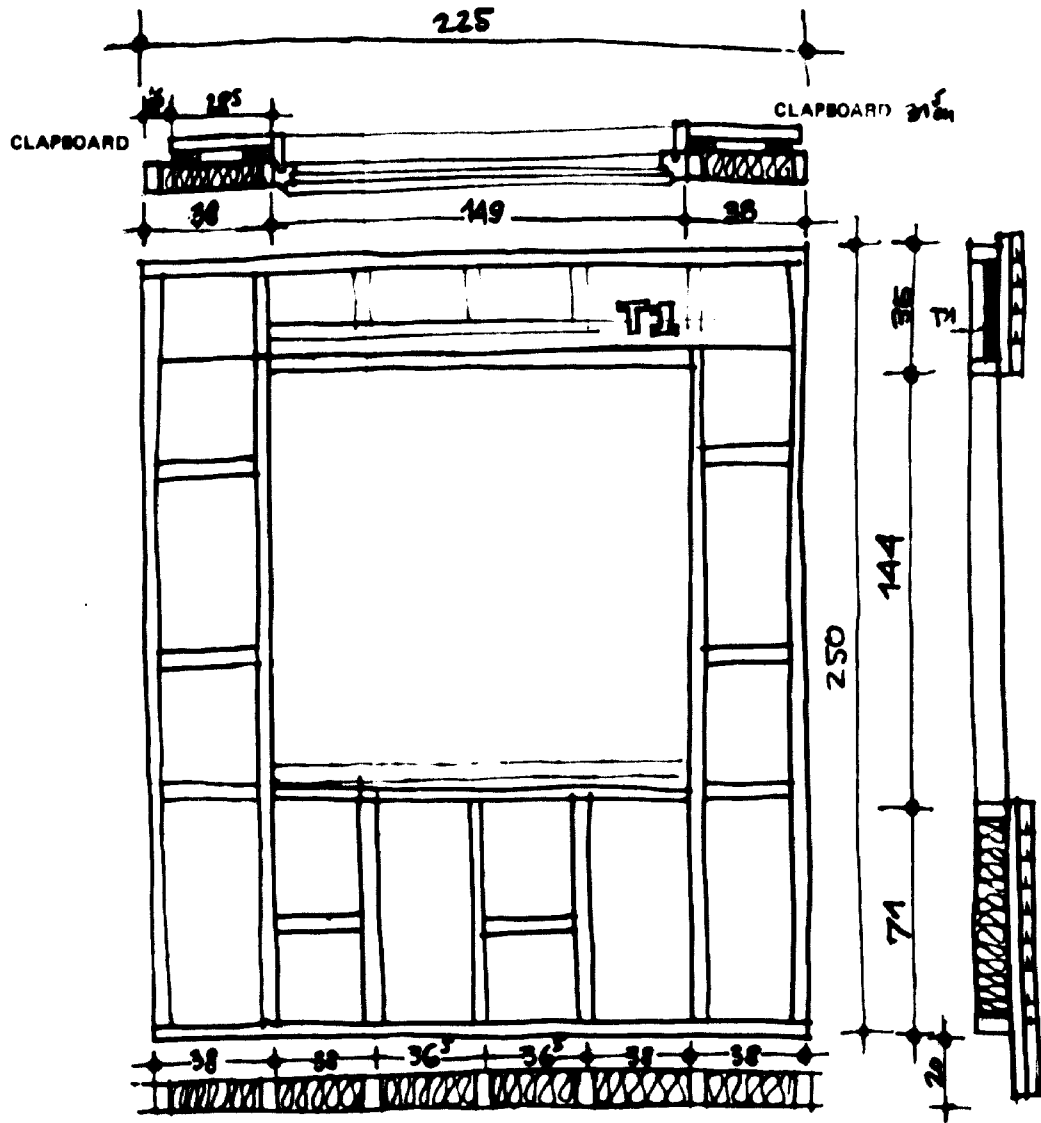


VERTICAL CROSS-SECTION SAME AS **A105**



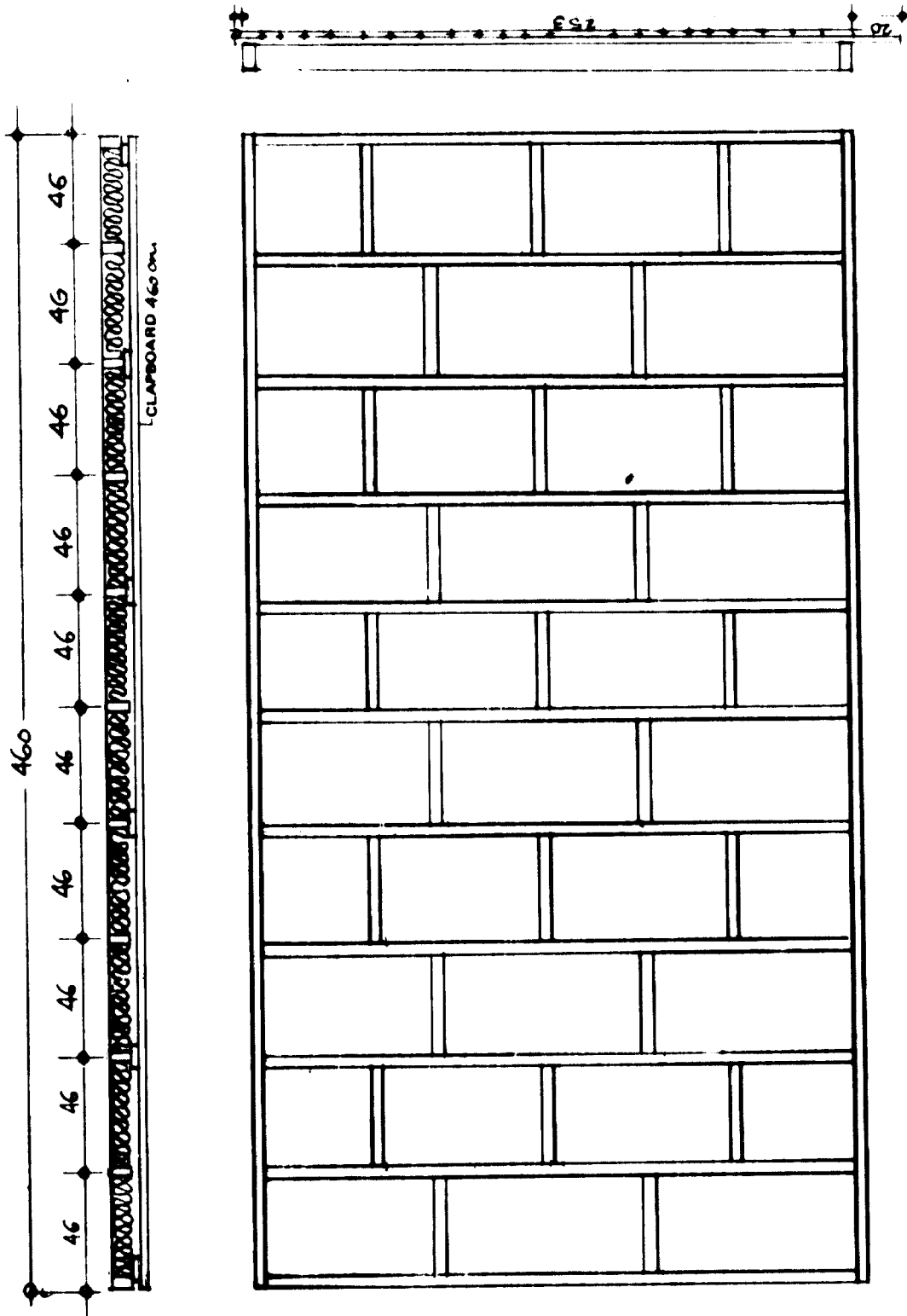
VERTICAL CROSS-SECTION SAME AS **A105**

24. External back wall elements - A 205, A 305, B 205 and B 305

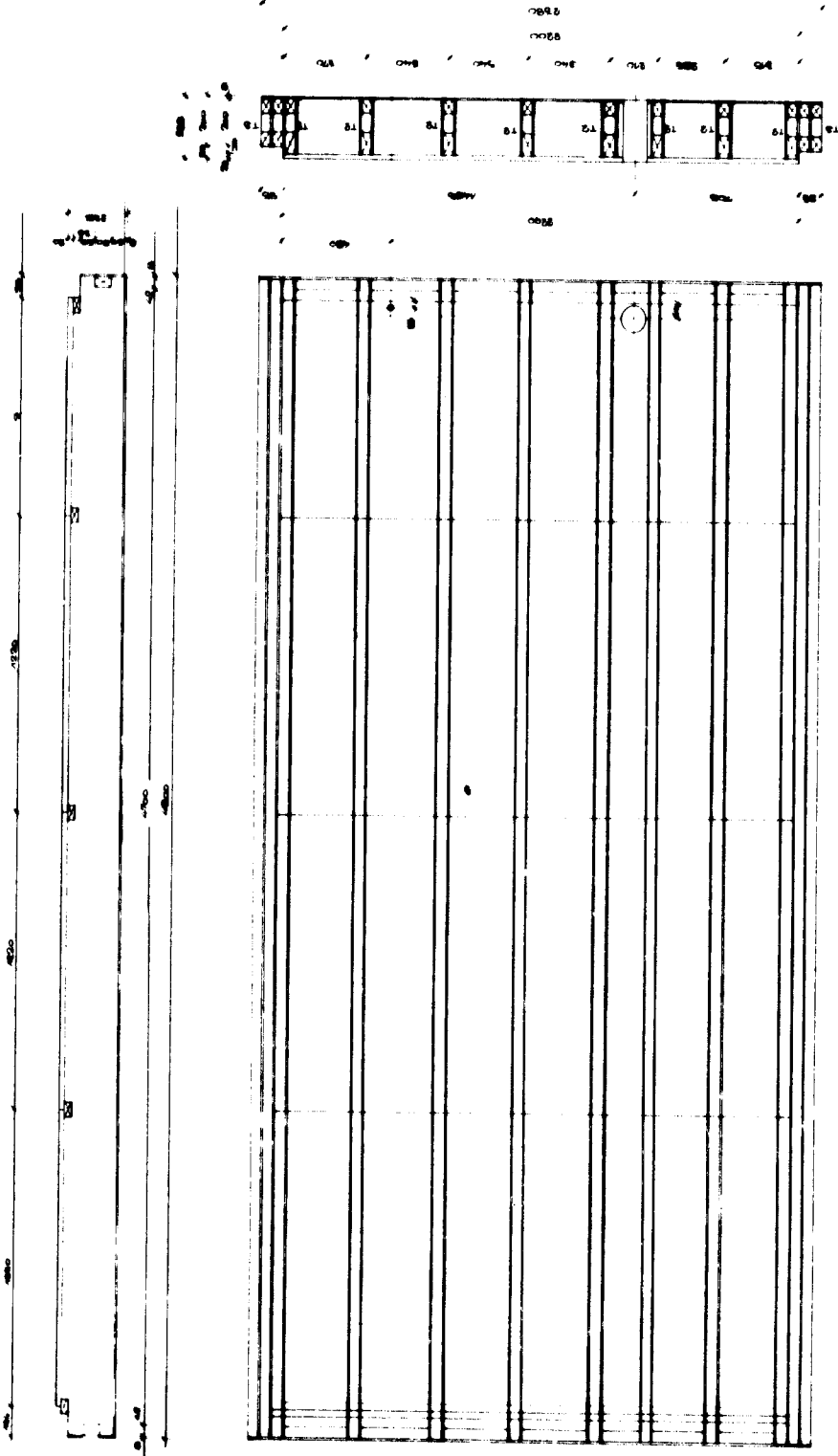


WINDOW 135X143

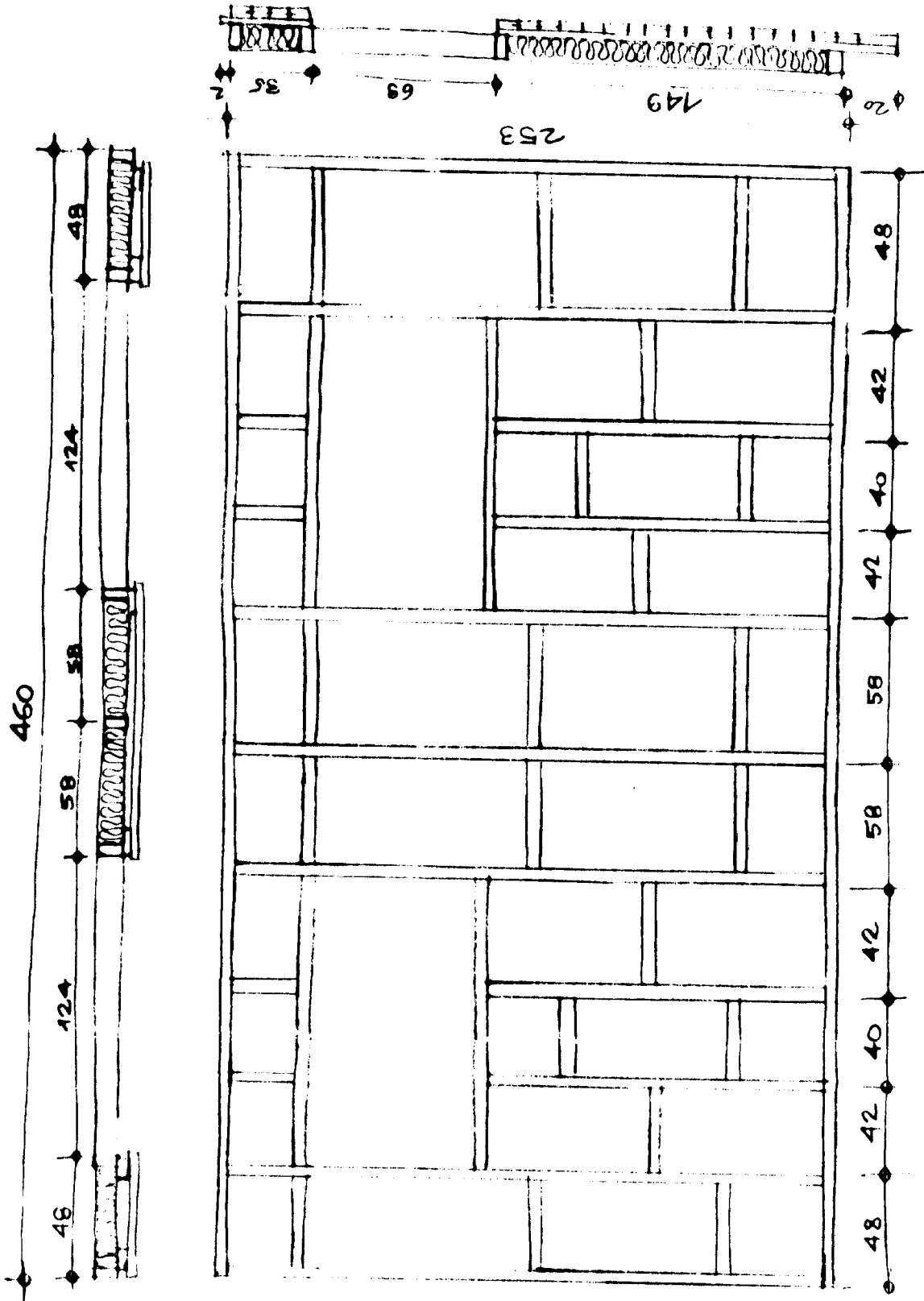
25. External front wall elements - A 303 and B 303



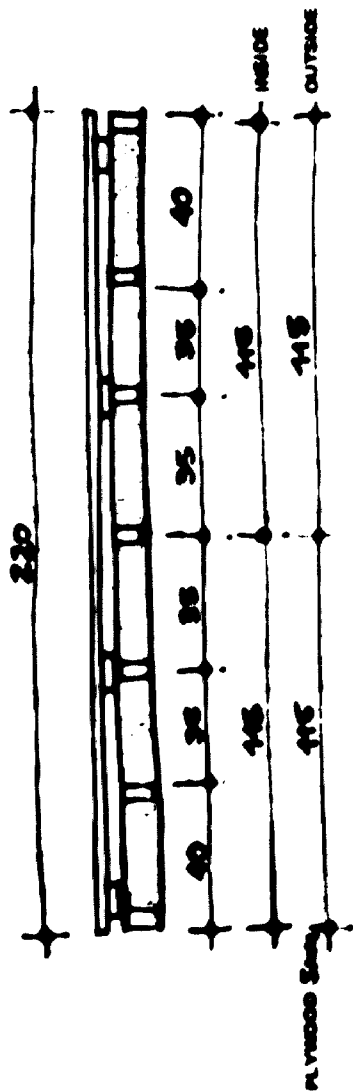
26. External side wall elements - A 304 and B 304



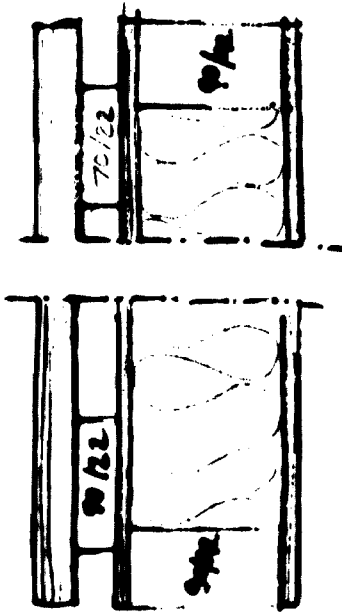
27. Floor element - A 401



28. External side wall elements - A 404 and B 404



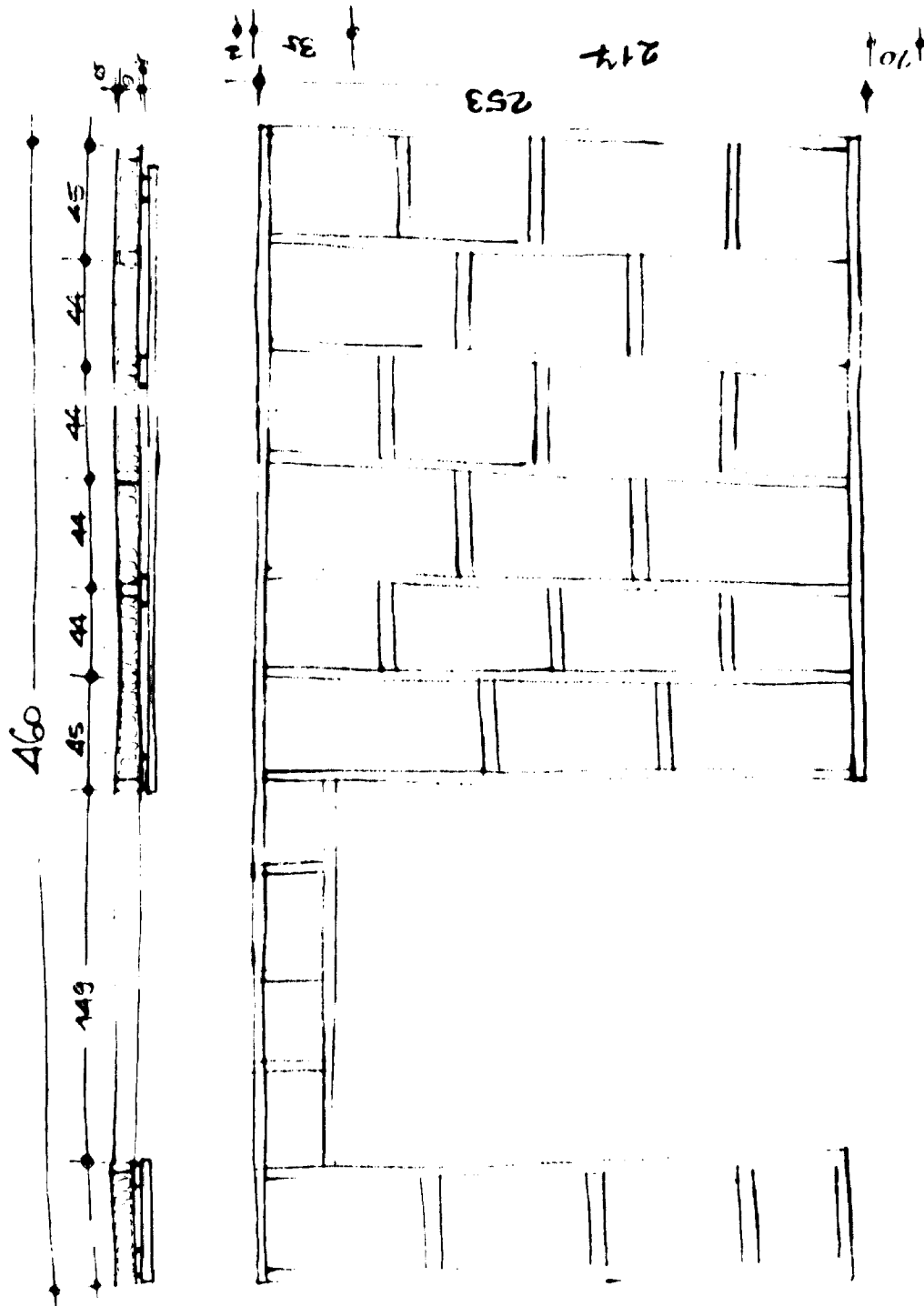
VERTICAL CROSS-SECTION SAME AS **A128**



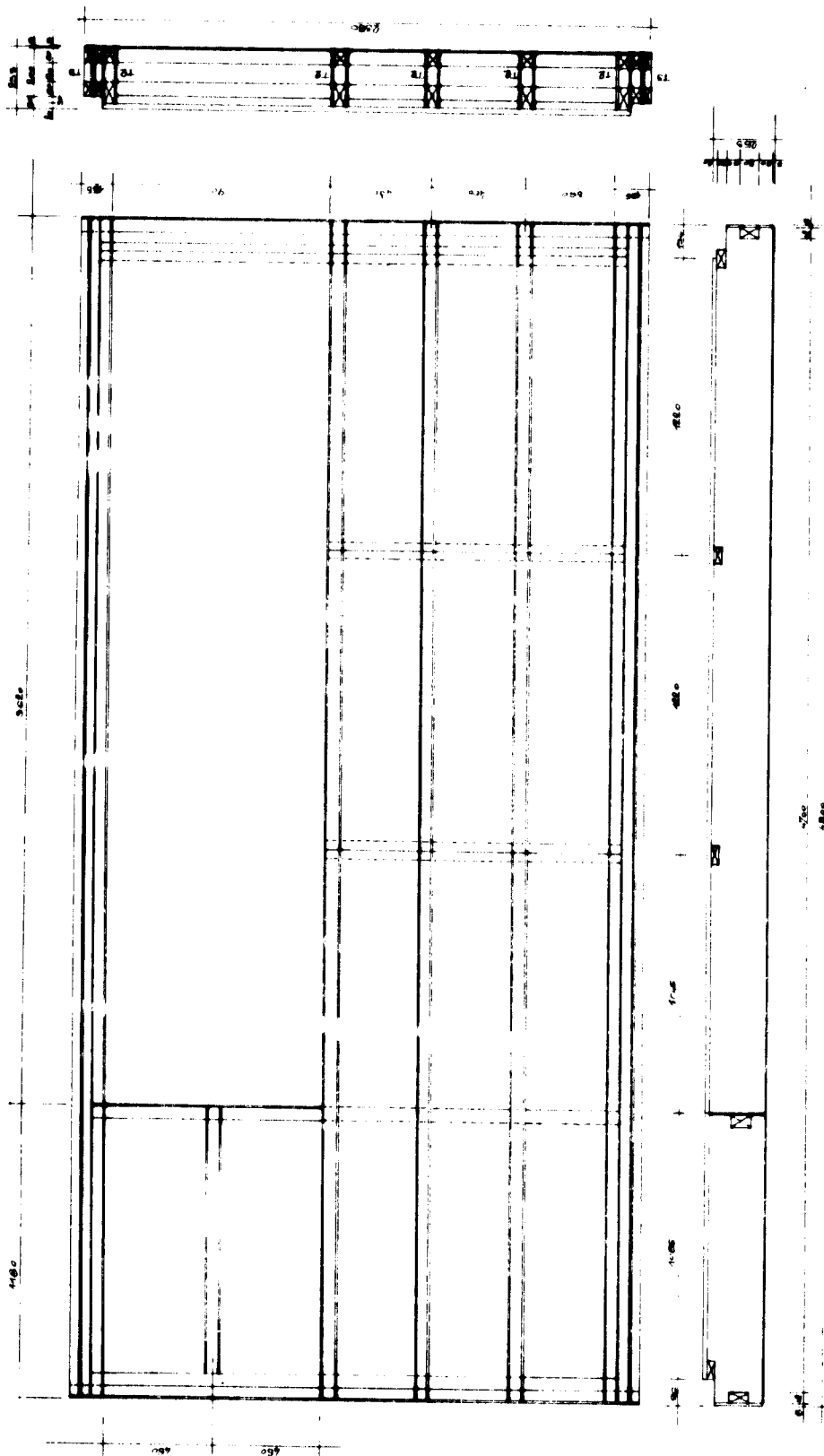
29. External front wall element - A 405



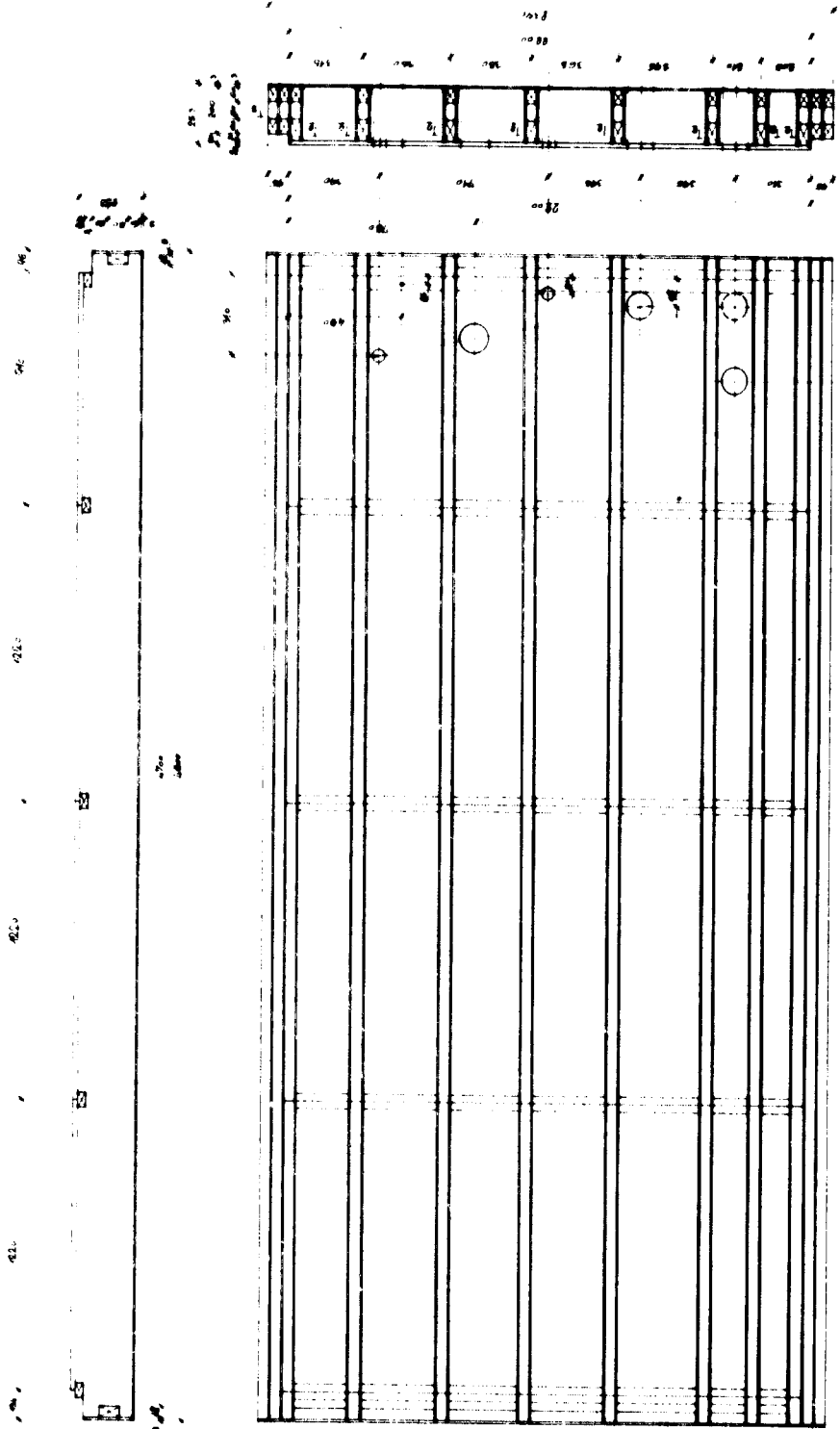




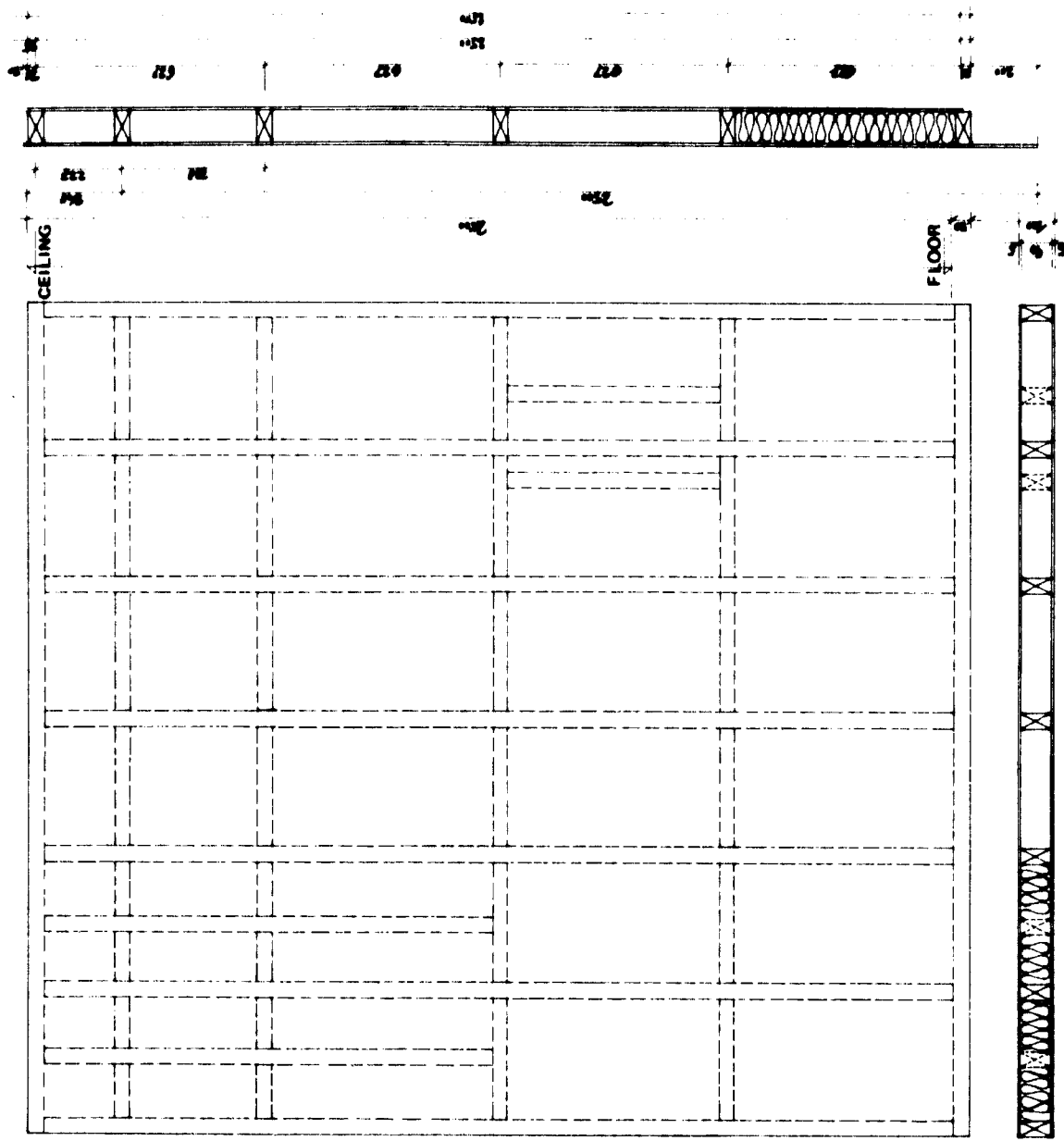
30. External side wall element - A 406



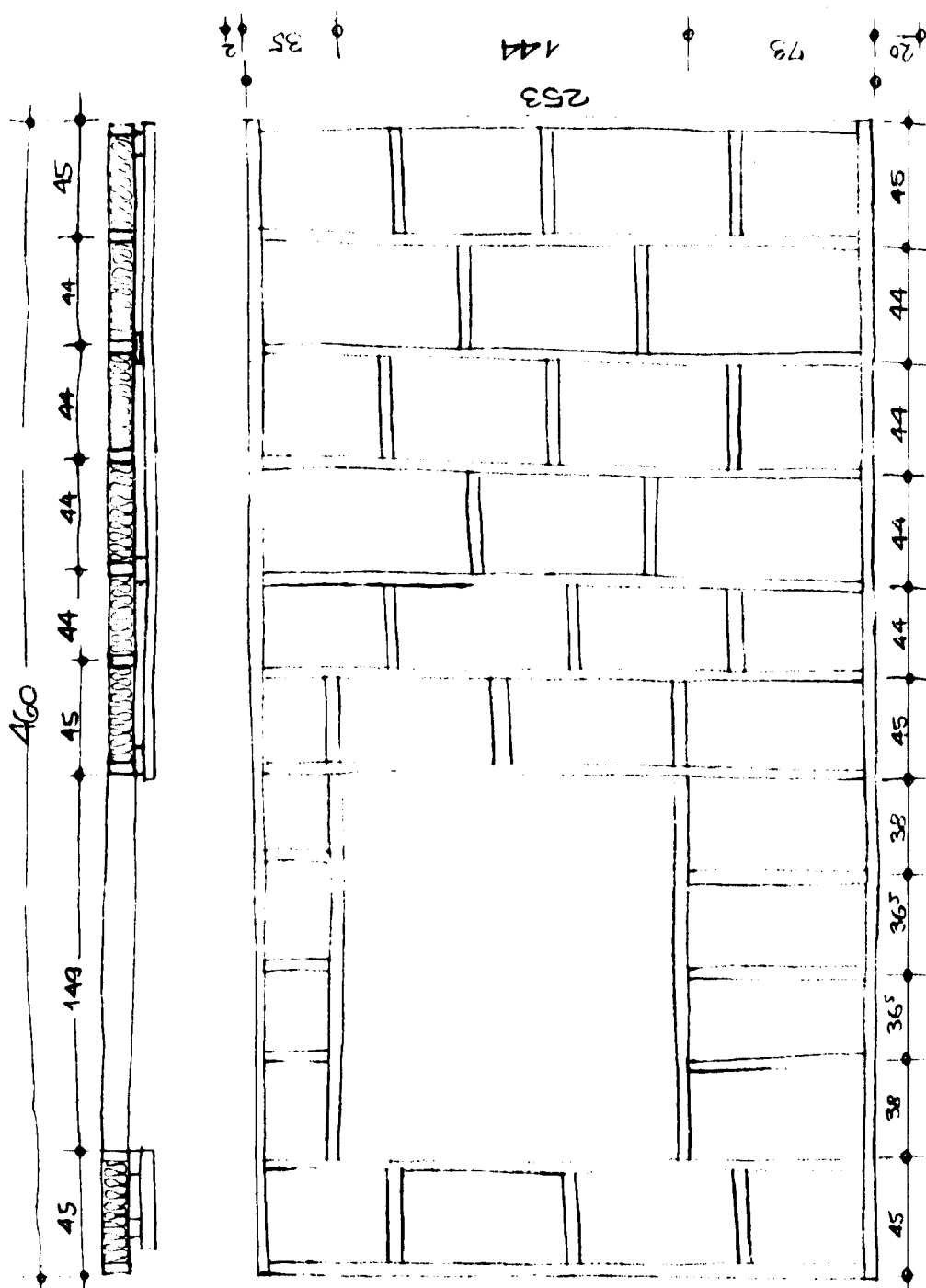
31. Floor element - B 201



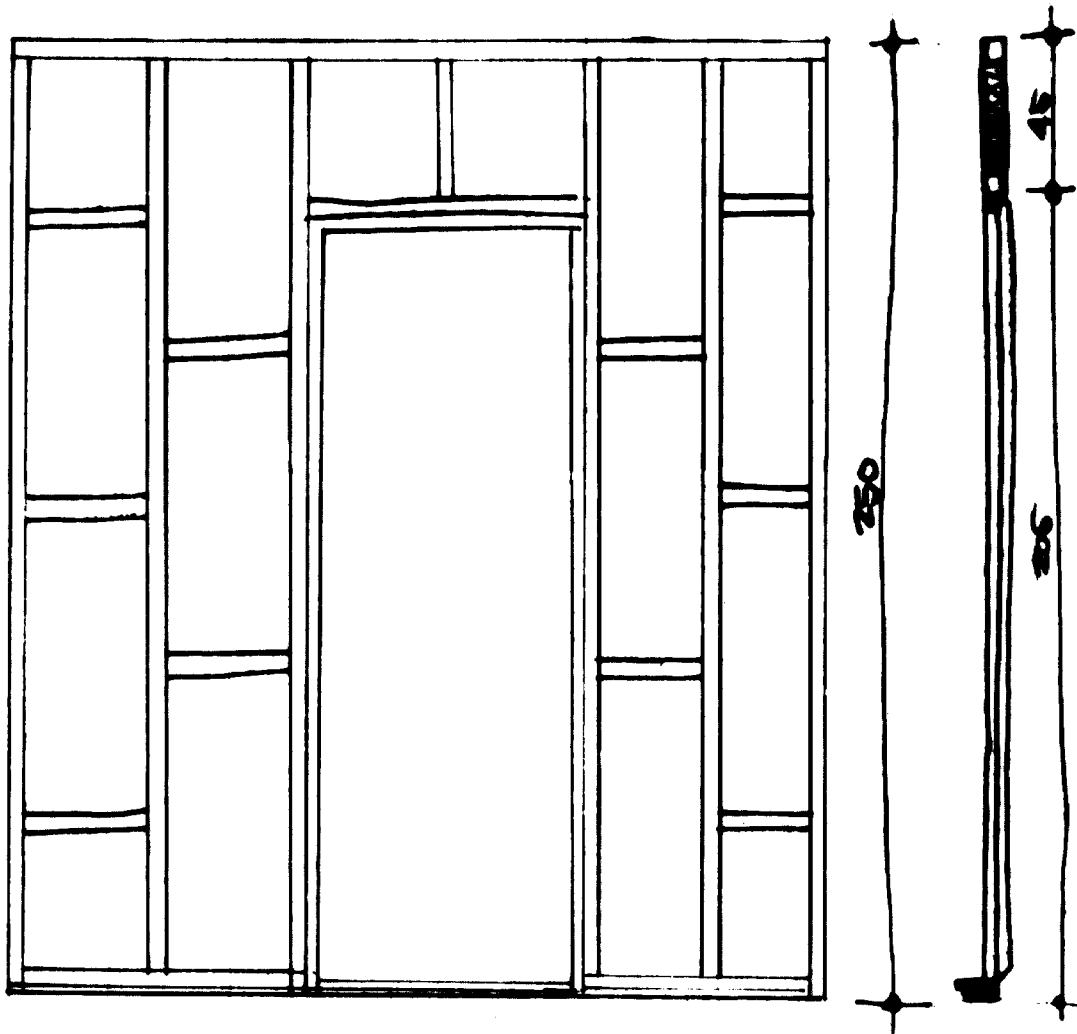
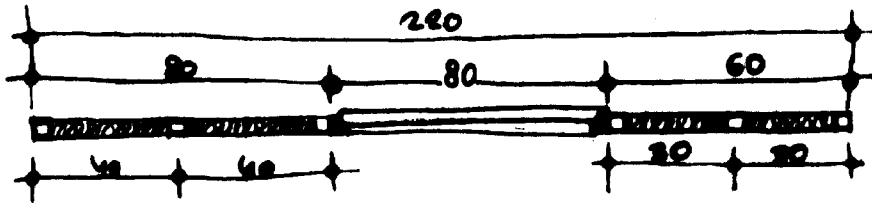
32. Floor element - B 401



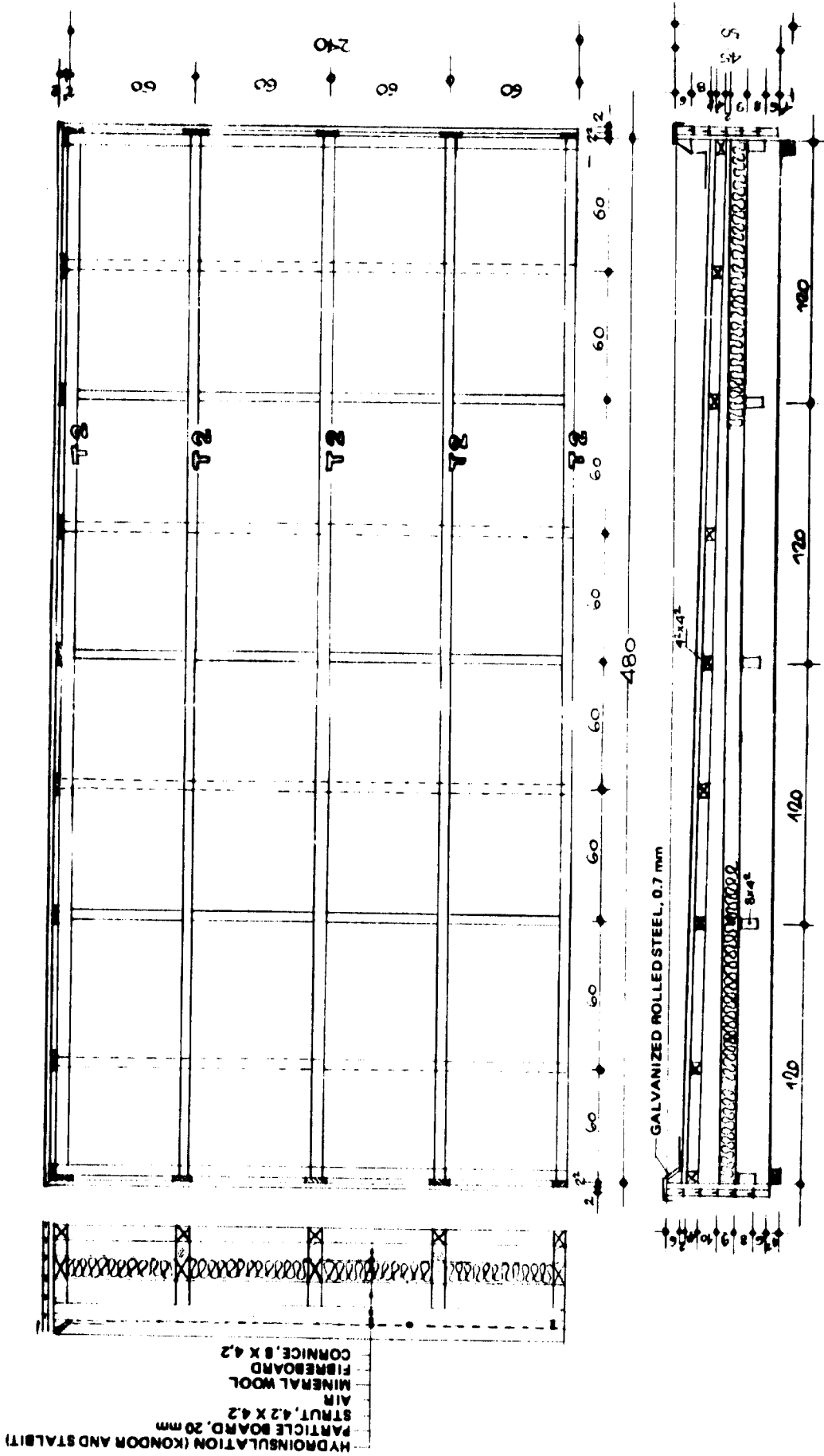
33. External front wall element - B 405



34. External side wall element - B 406

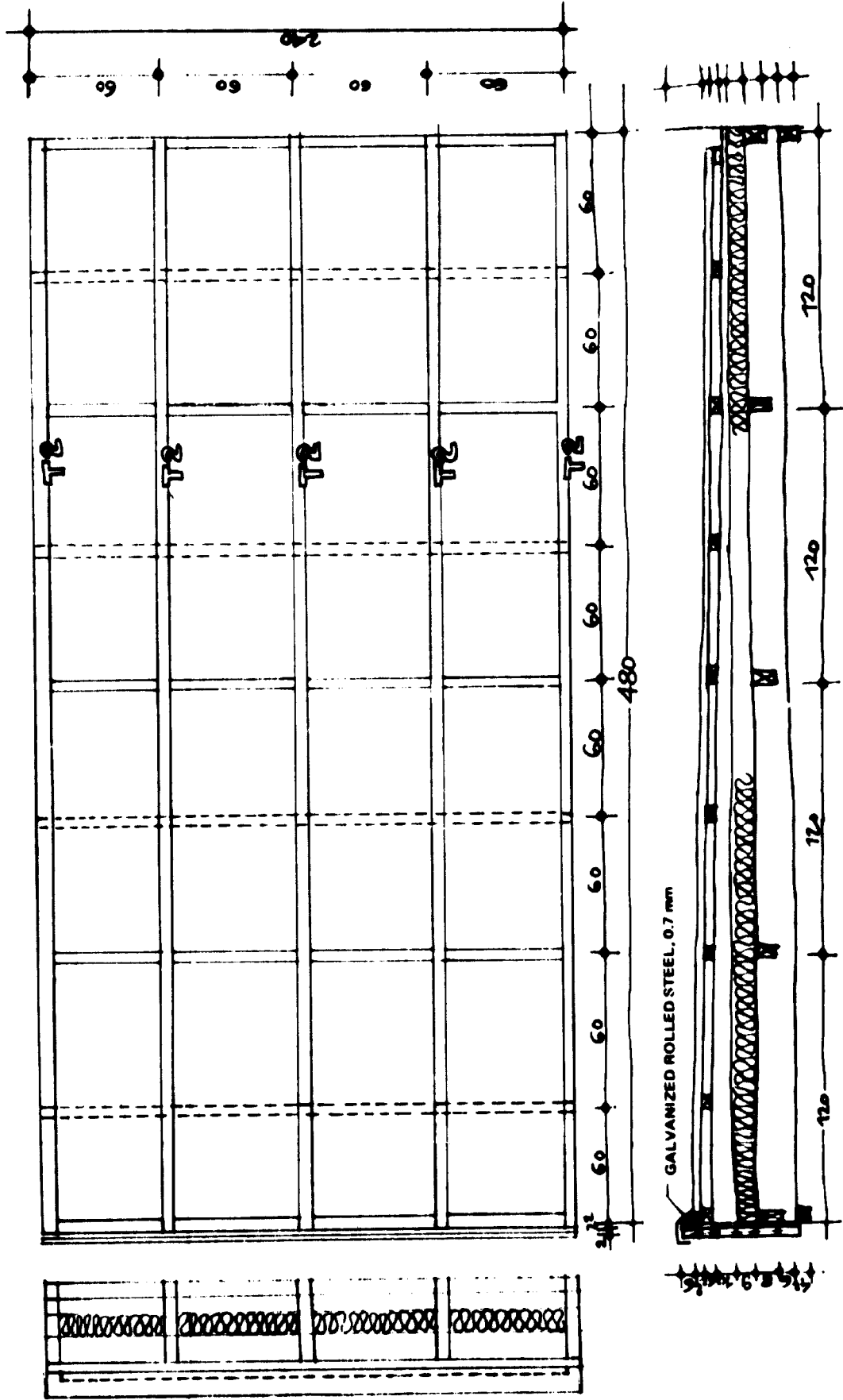


35. Internal partition - B 407



Note: The element C 301 is a mirror image of the element C 101.

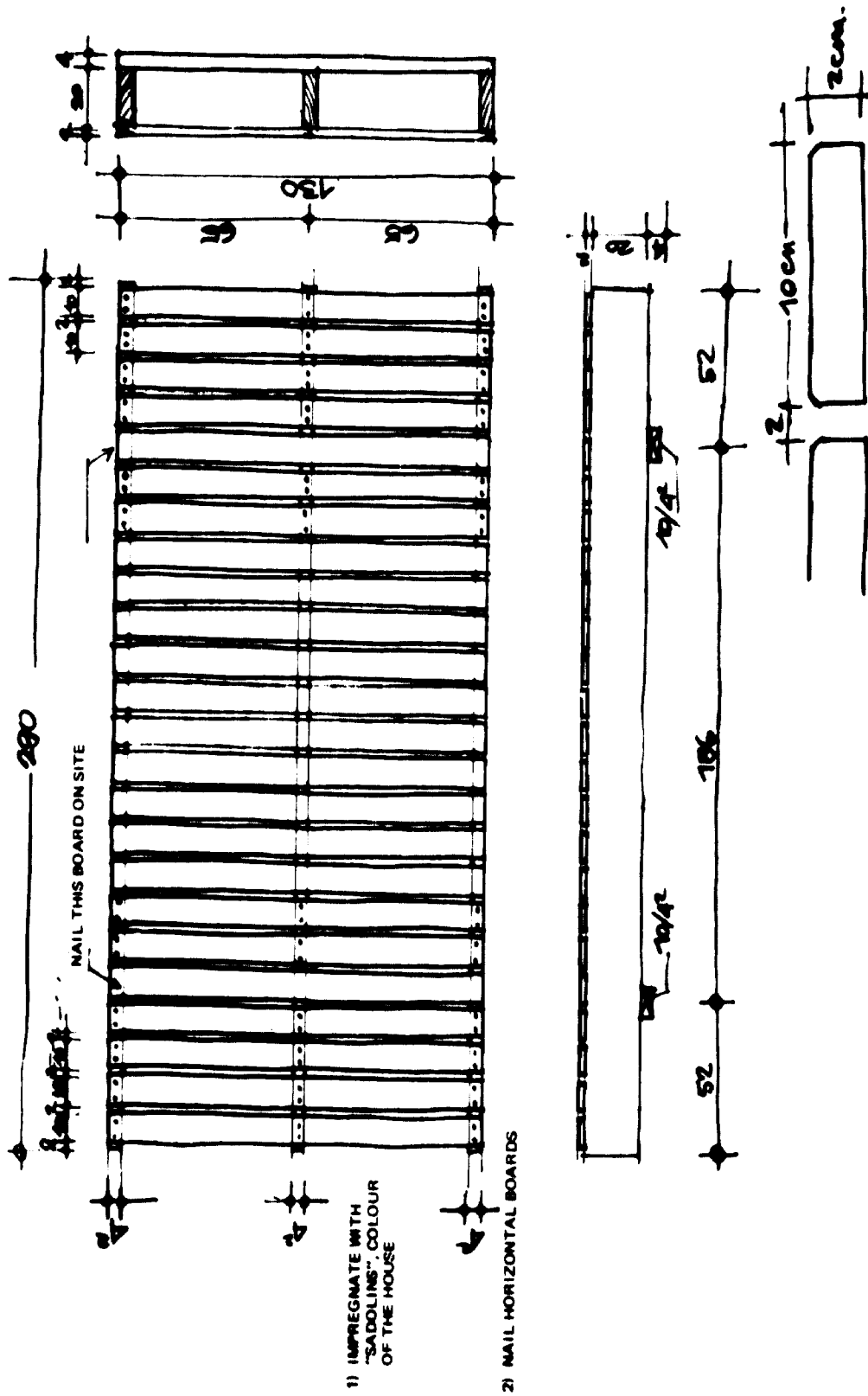
36. Roof elements - C 101 and C 301 with cornices



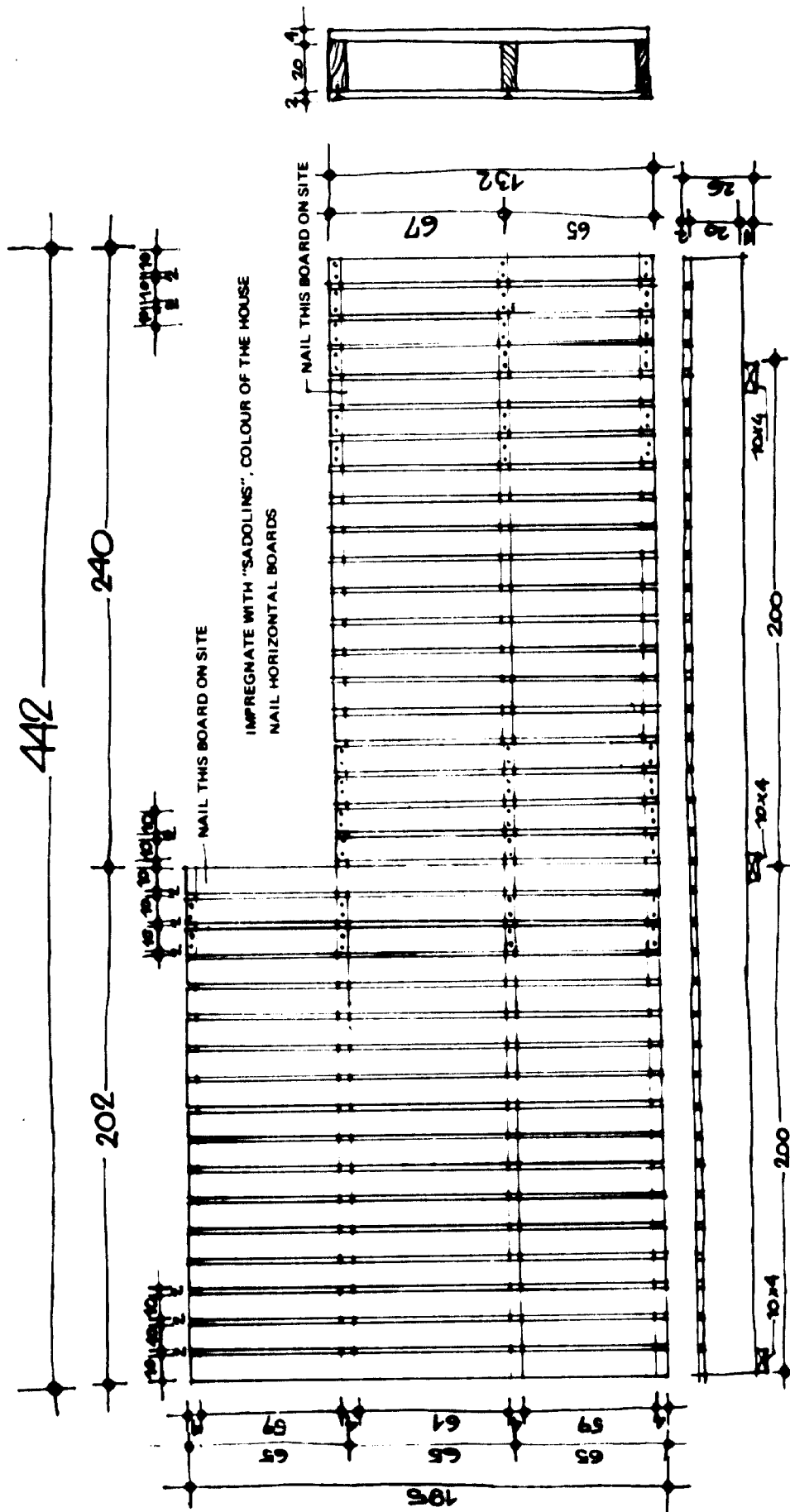
Note: The element C 401 is similar to the element C 201 but its cornice is fitted on three sides (two long and one short side) using the system shown for the elements C 101 and C 301.

37. Roof elements - C 201 and C 401 with cornices

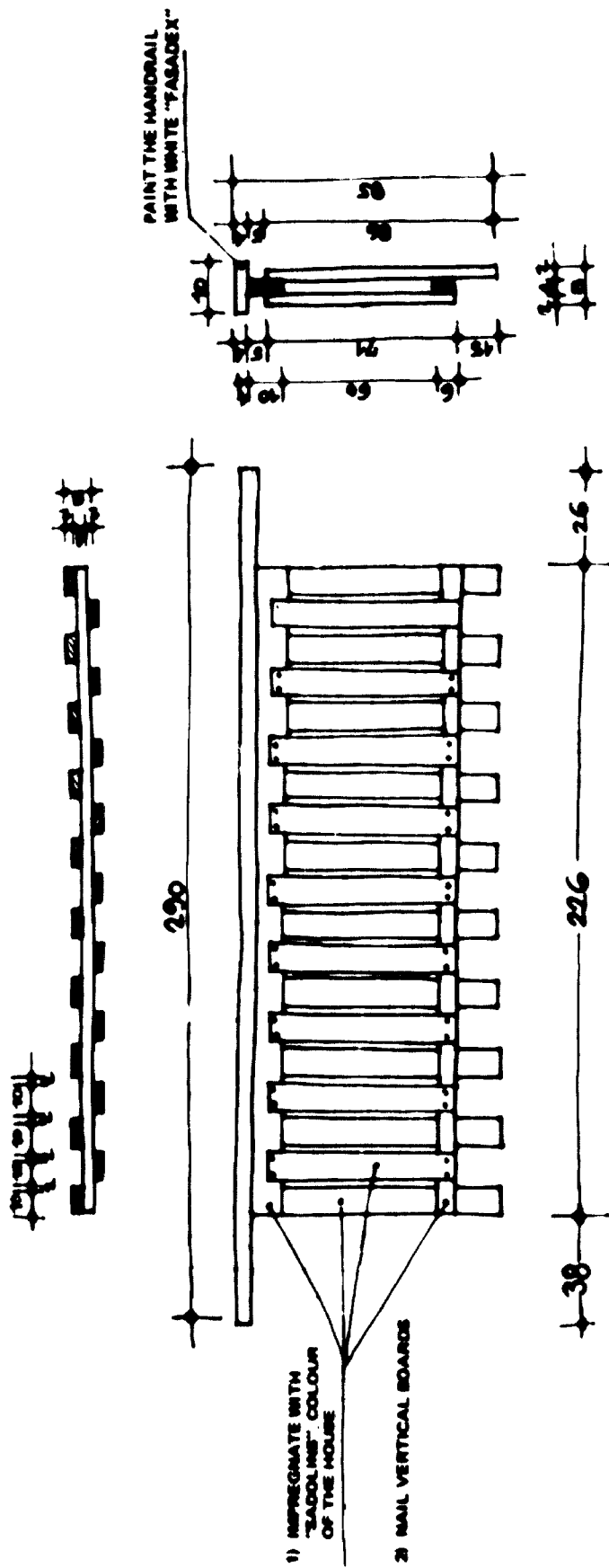




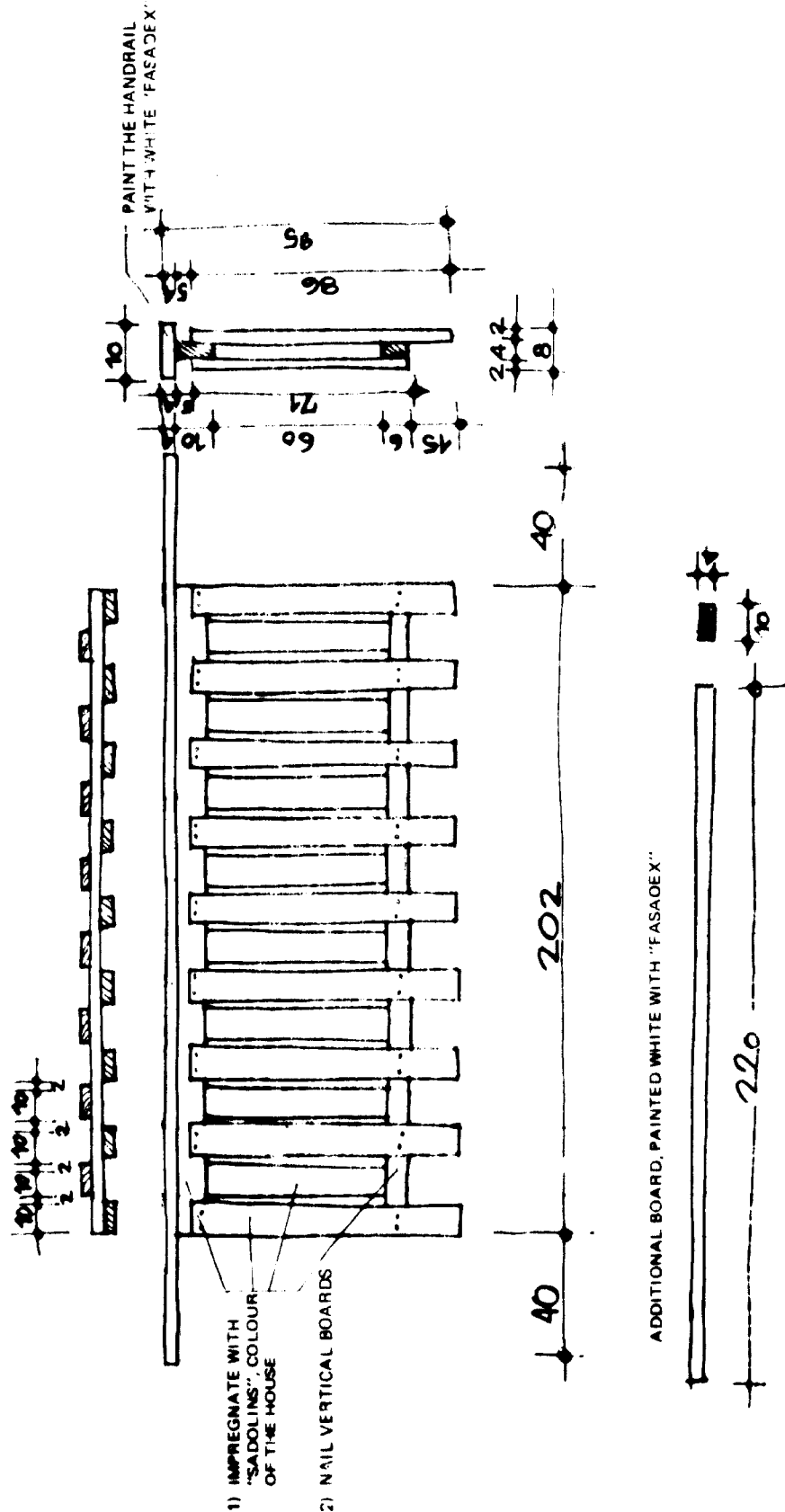
38. terrace floor element - D 101



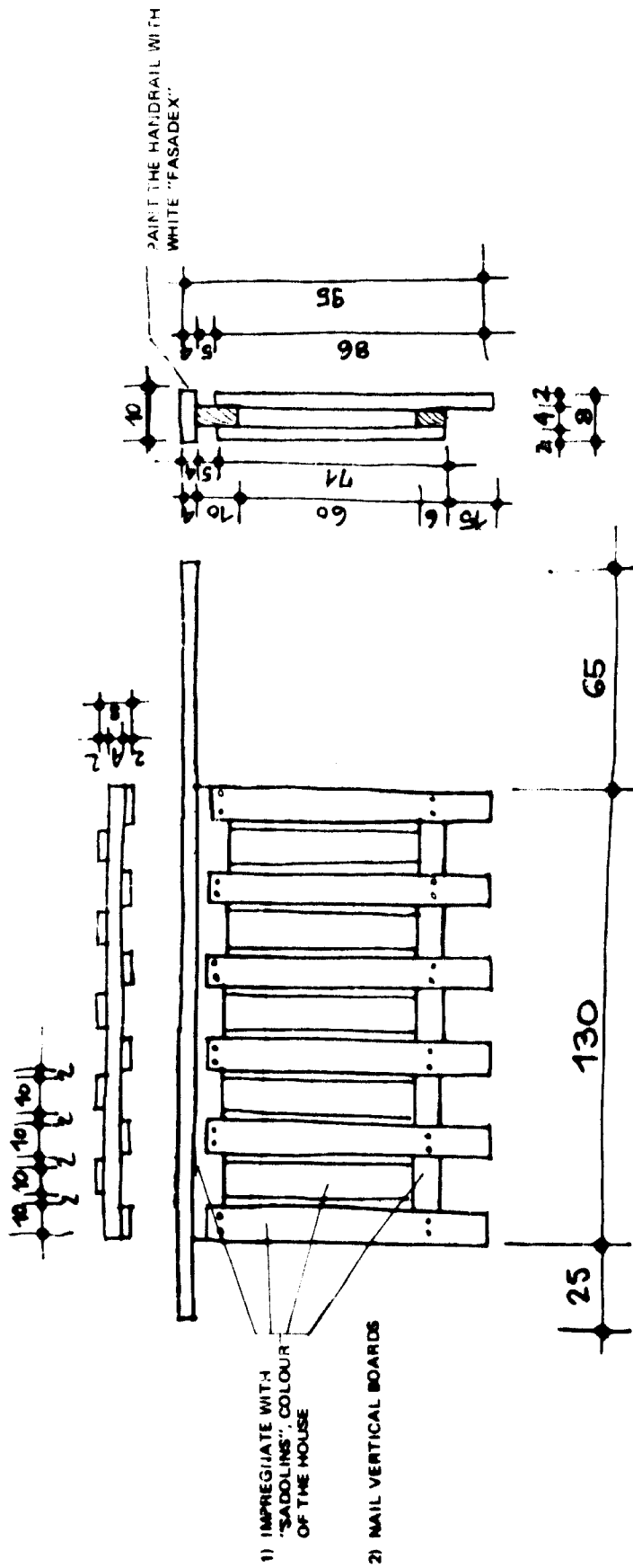
39. Terrace floor element - D 201



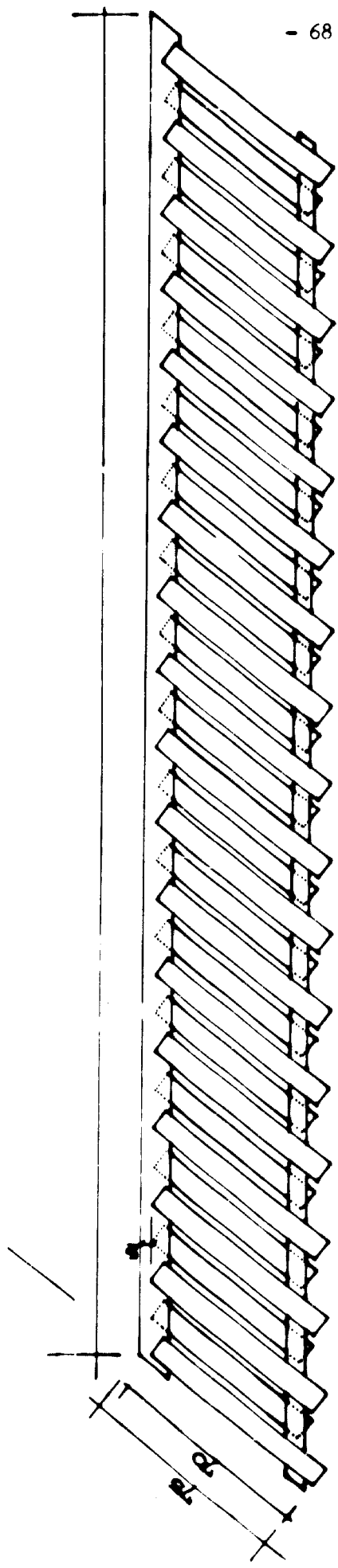
40. Balustrade element - D 102



41. Fajlustrada element - D 202

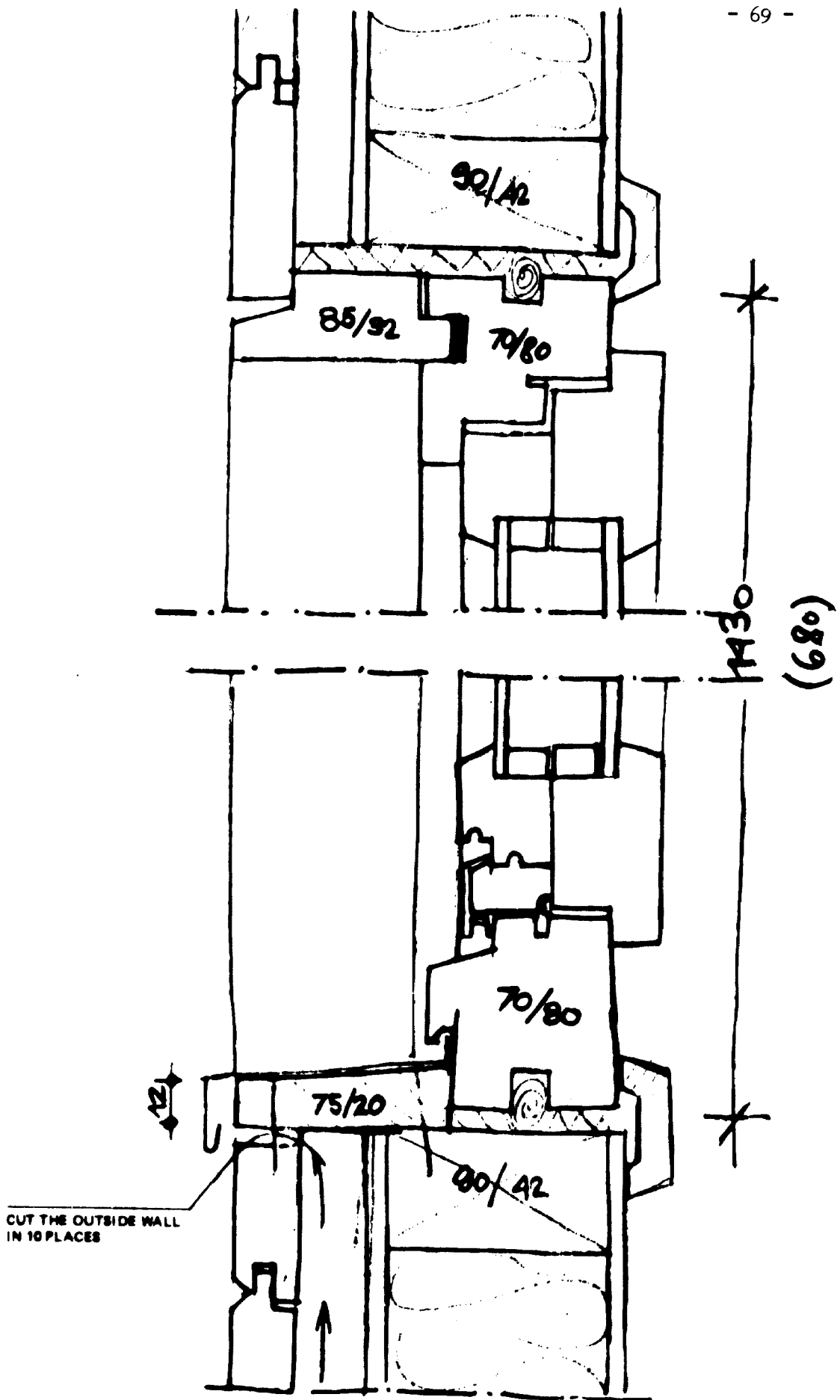


42. Balustrade element - D 203

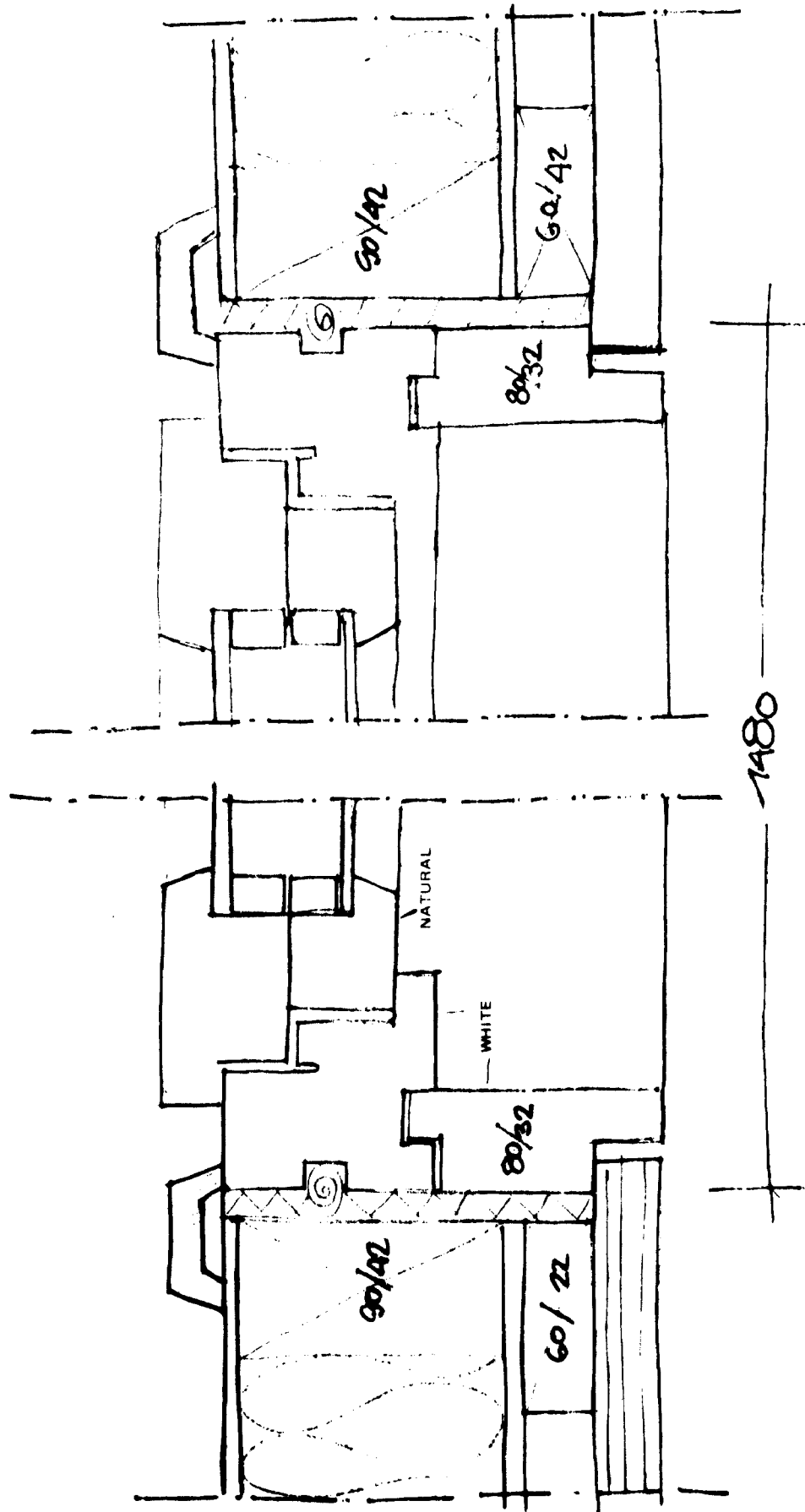


43. Balustrade for entrance stairs



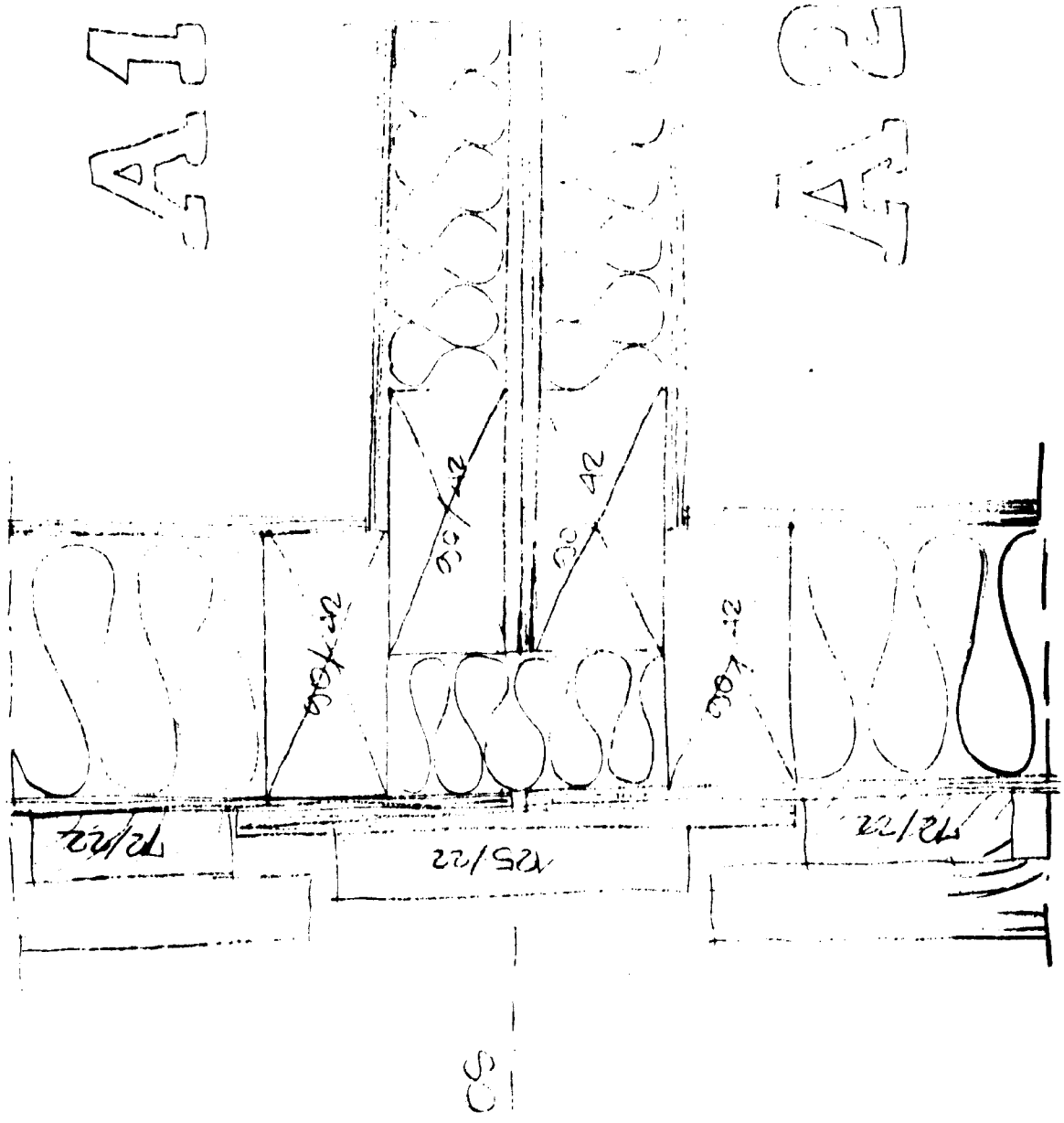


44. Vertical cross-section of the windows

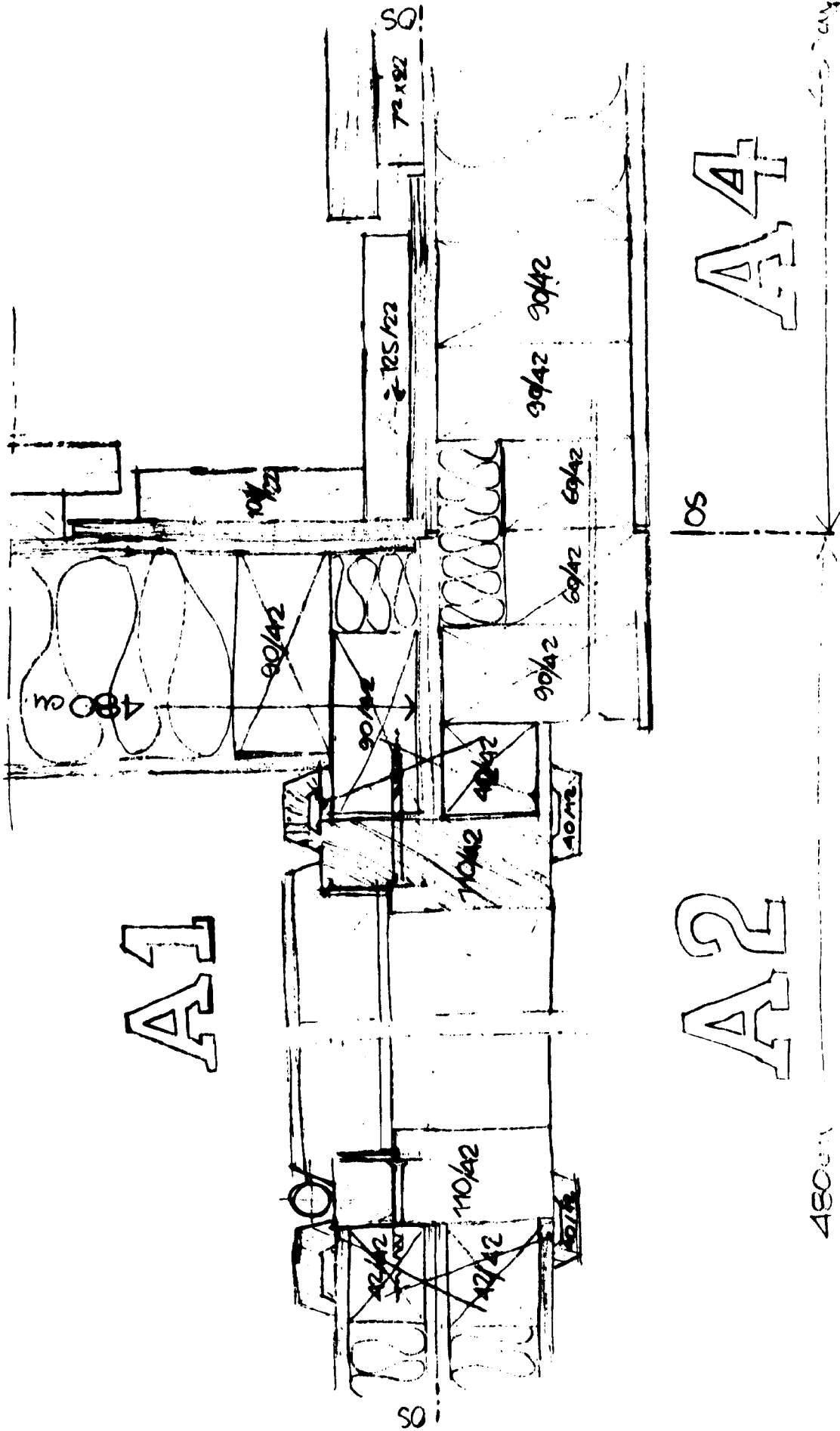


45. Horizontal cross-section of the structure

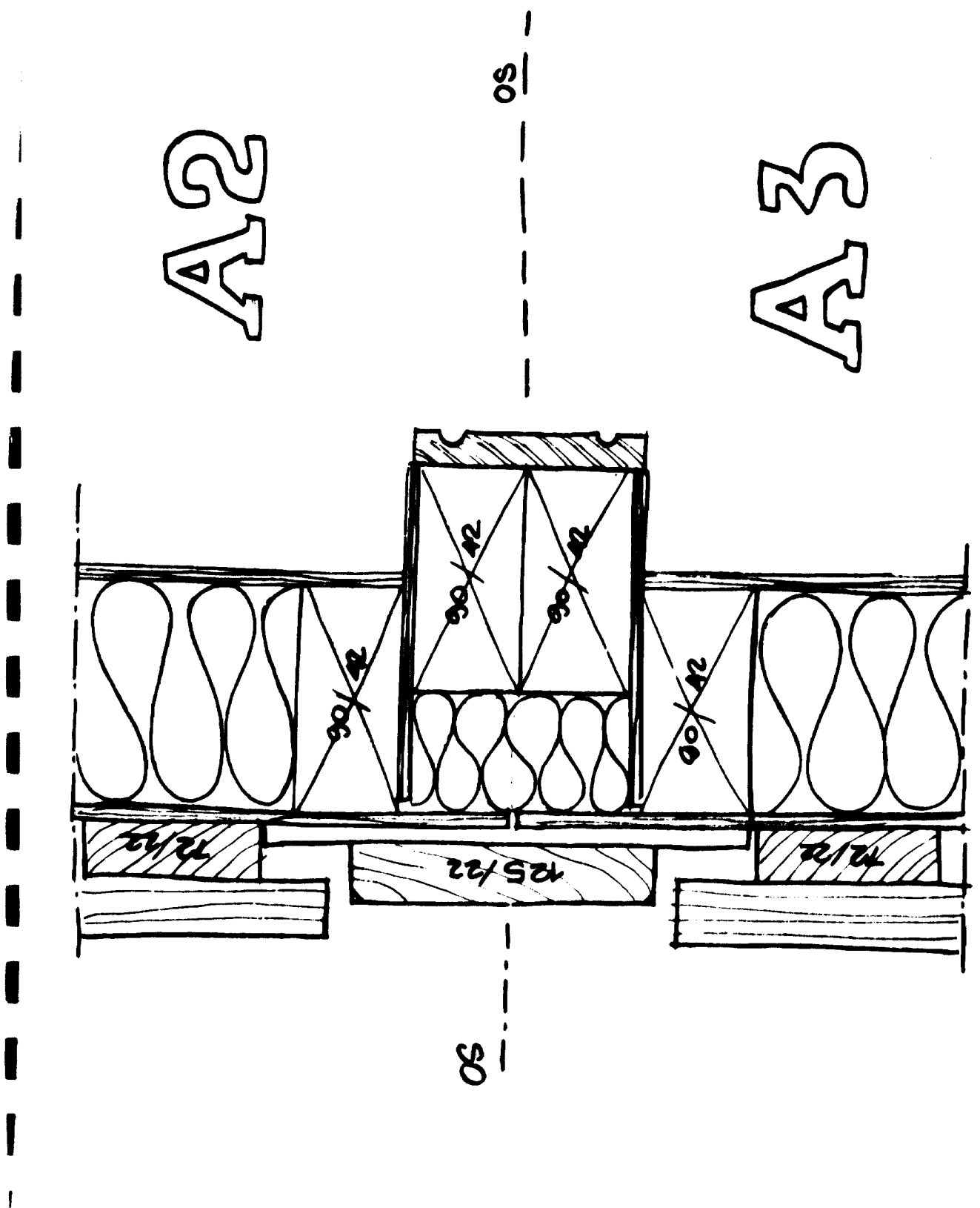




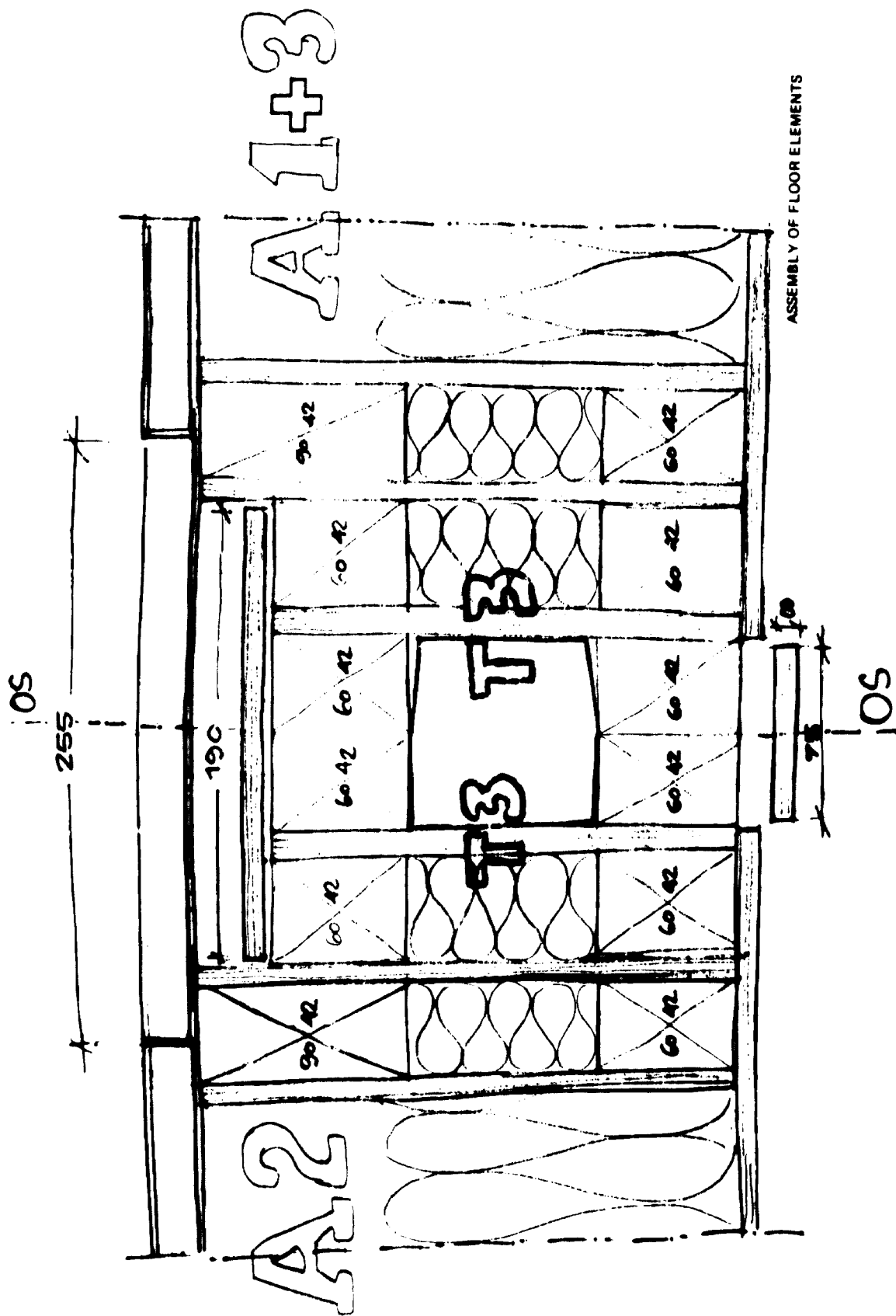
4. Details of assembly of modules A 1 to A 2



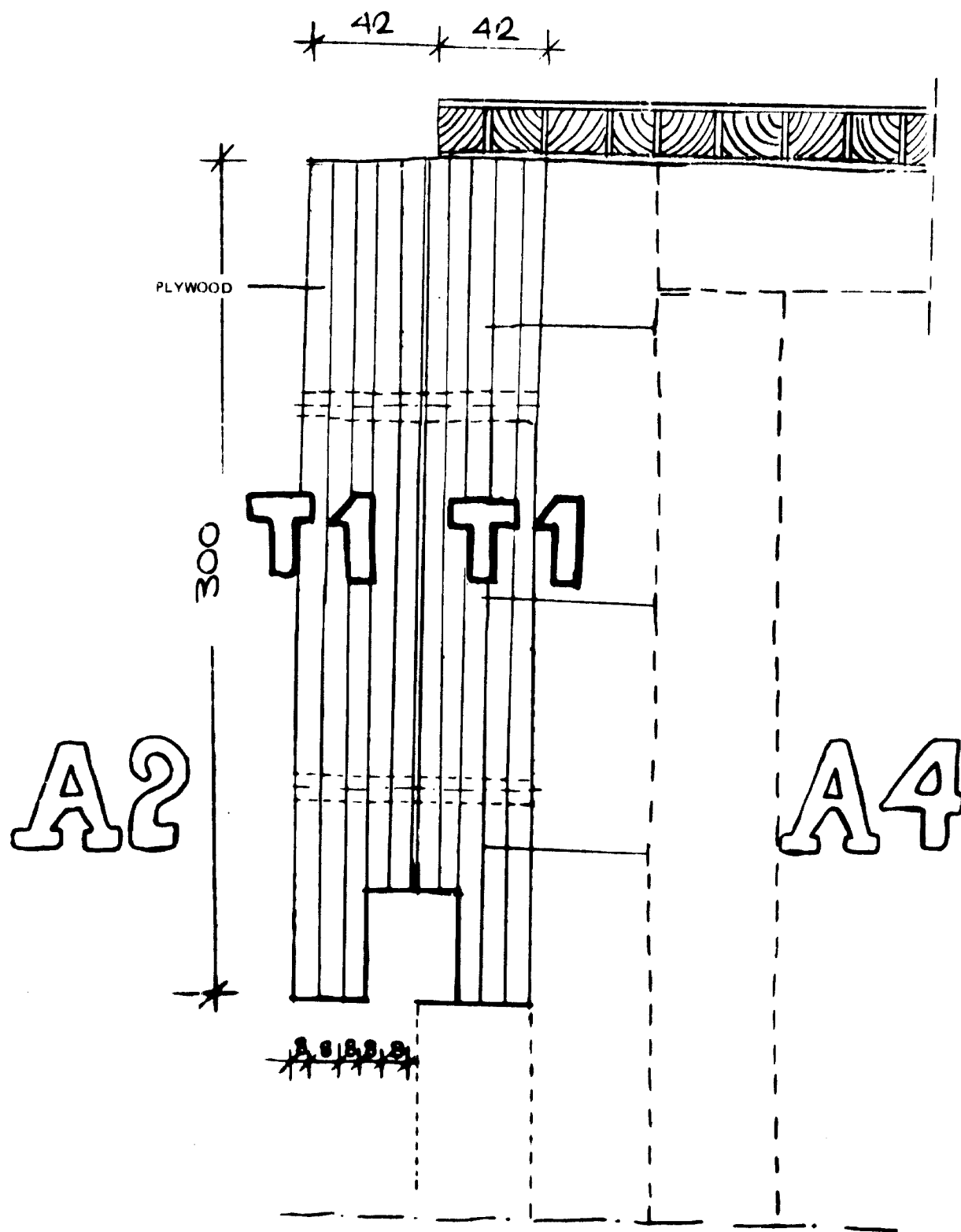
47. Details of assembly of modules A 1, A 2 and A 4



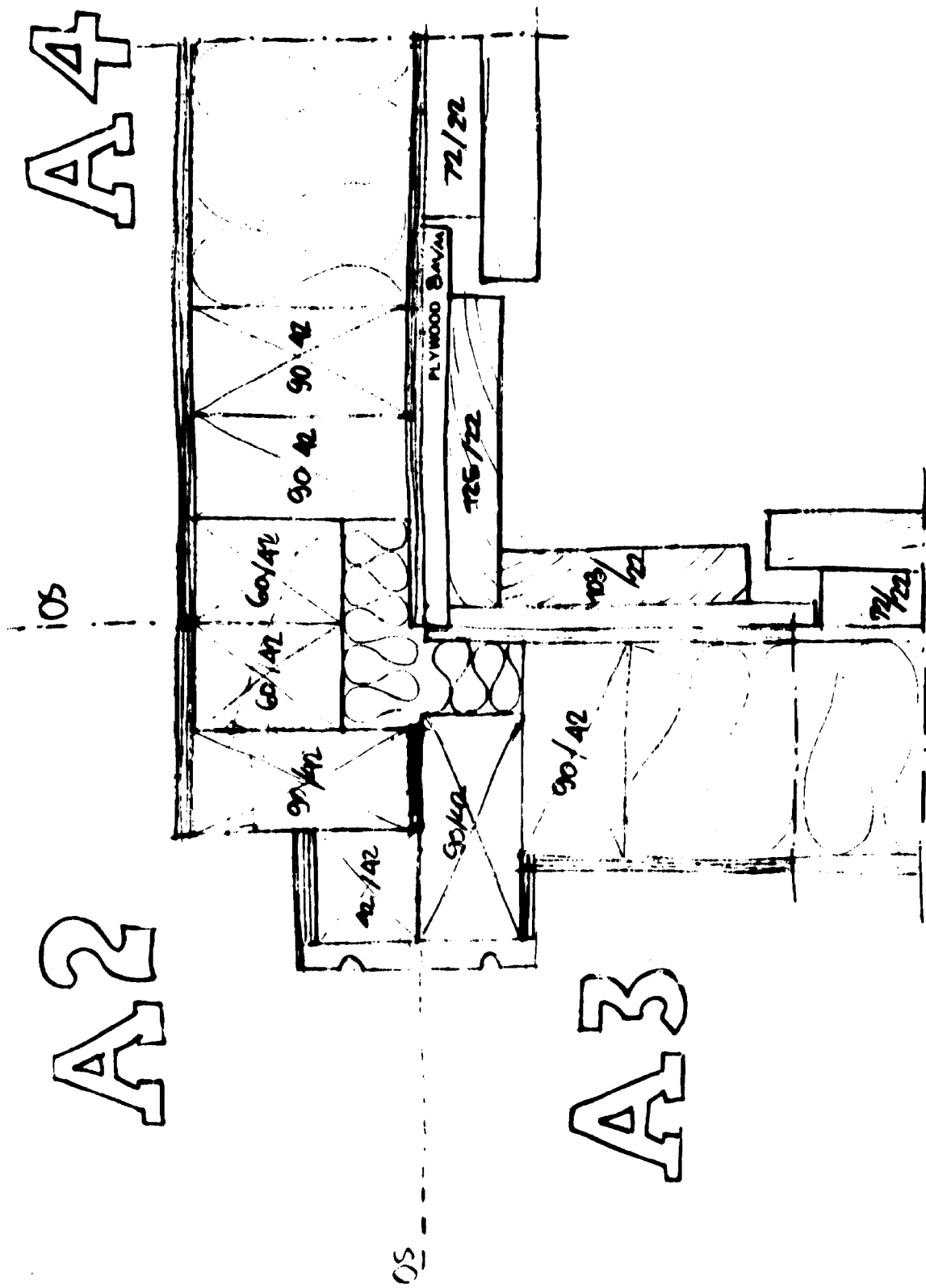
48. Details of assembly of modules A 2 to A 3



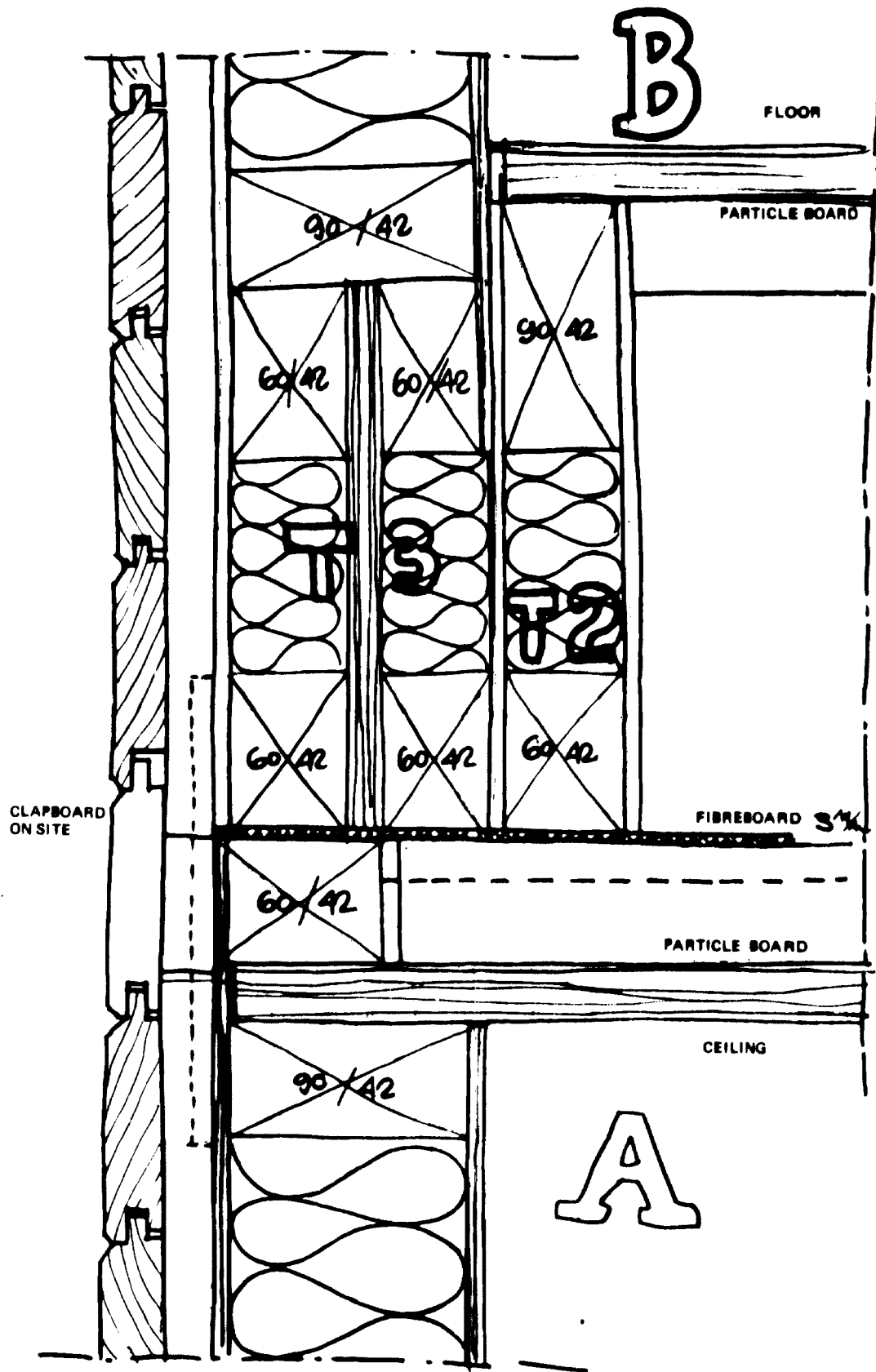
49. Details of assembly of module A 2 to A 1 or A 3



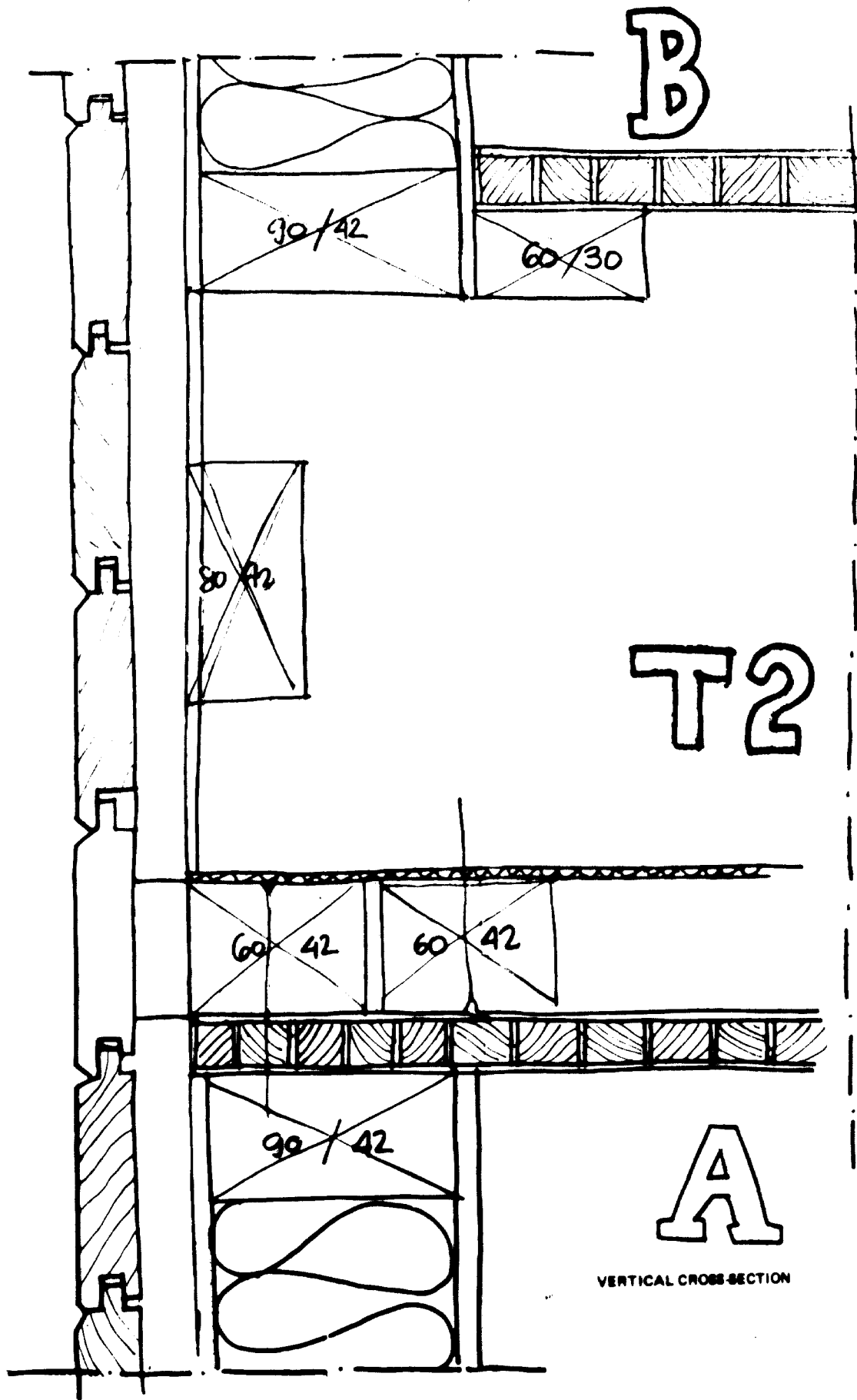
50. Details of assembly of module A 2 to A 4



51. Details of assembly of modules A 2, A 3 and A 4



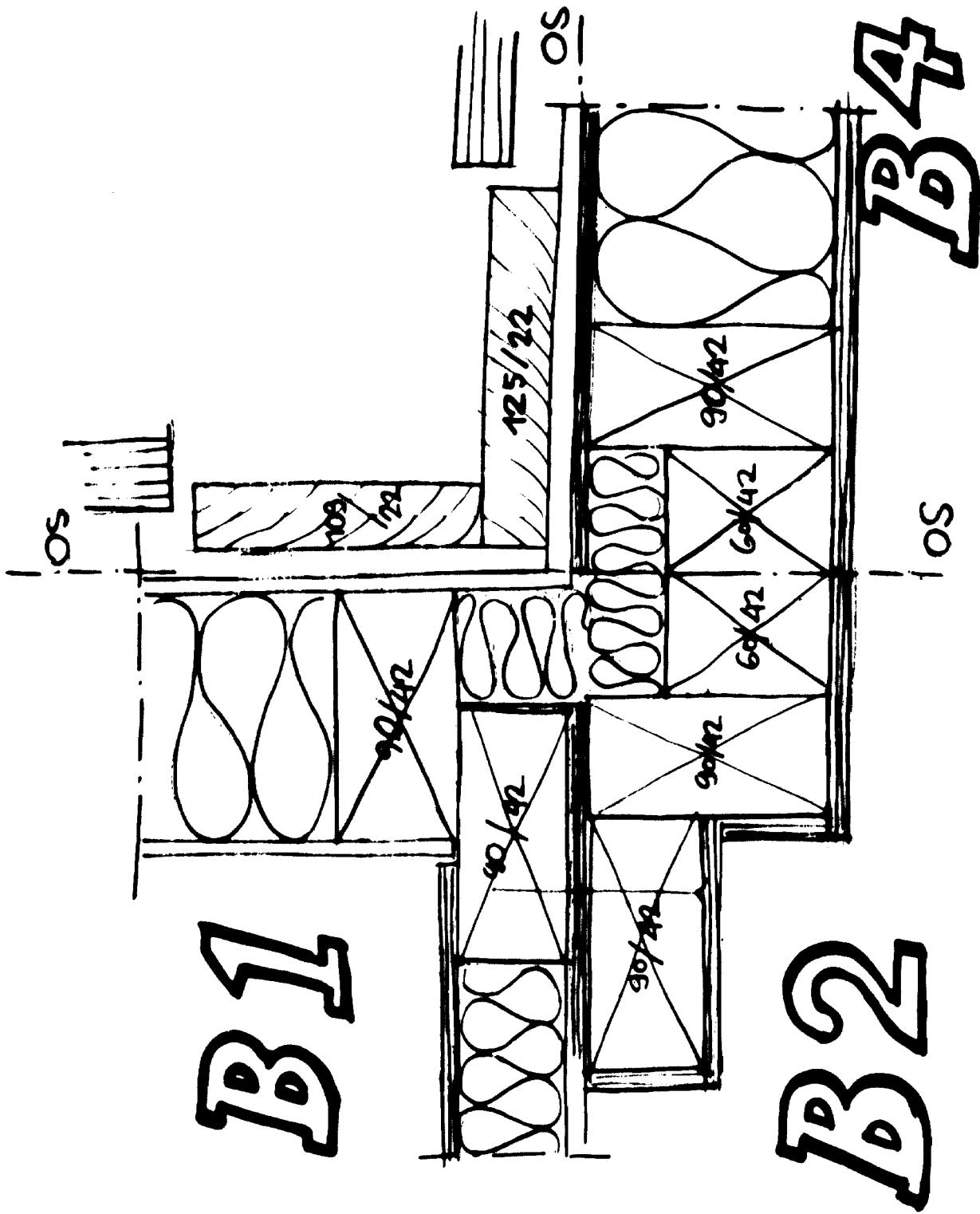
52. Details of assembly of modules B on modules A



53. Details of assembly of modules B on modules A (with extra spacing)

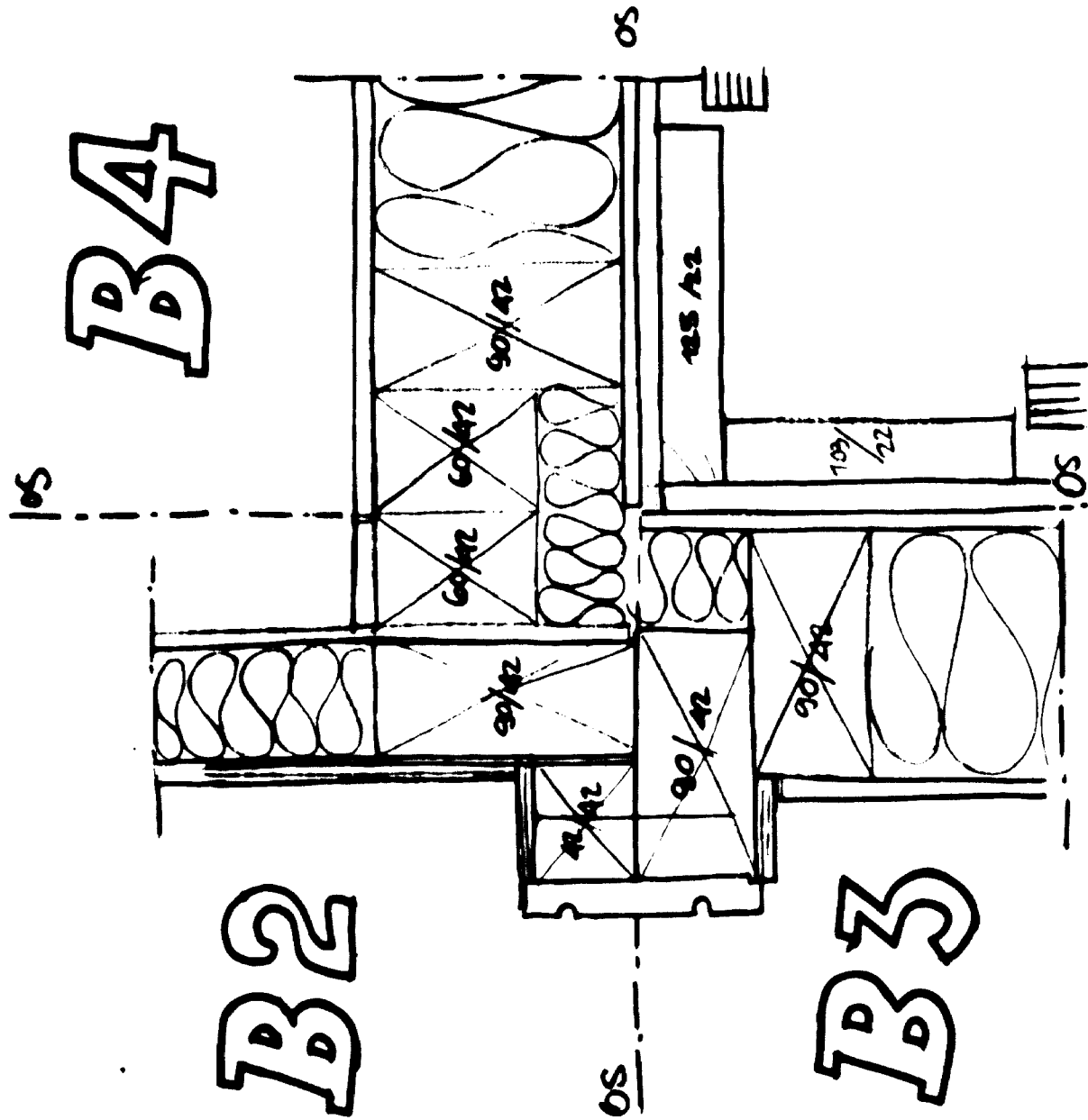




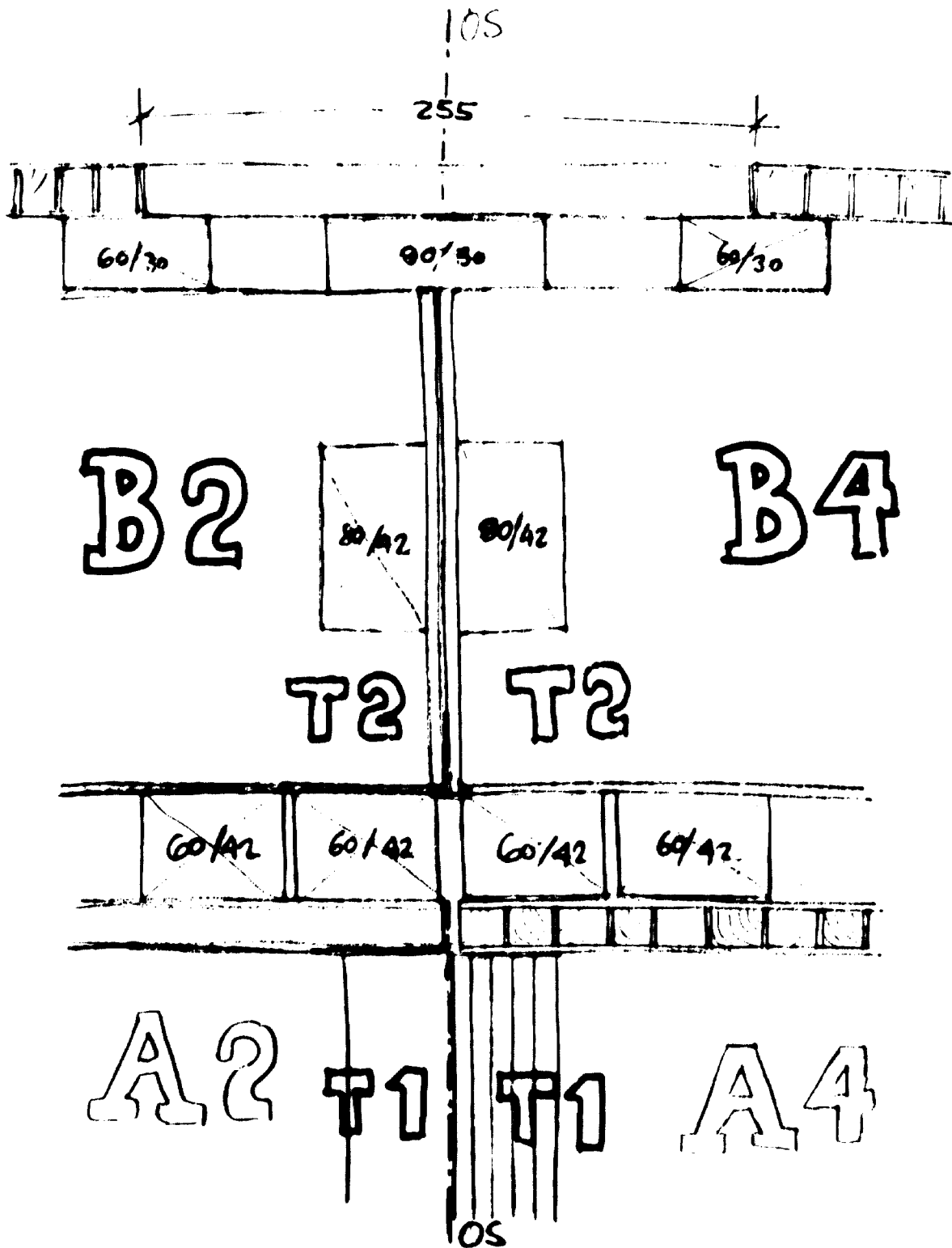


55. Details of assembly of modules B 1, B 2 and B 4



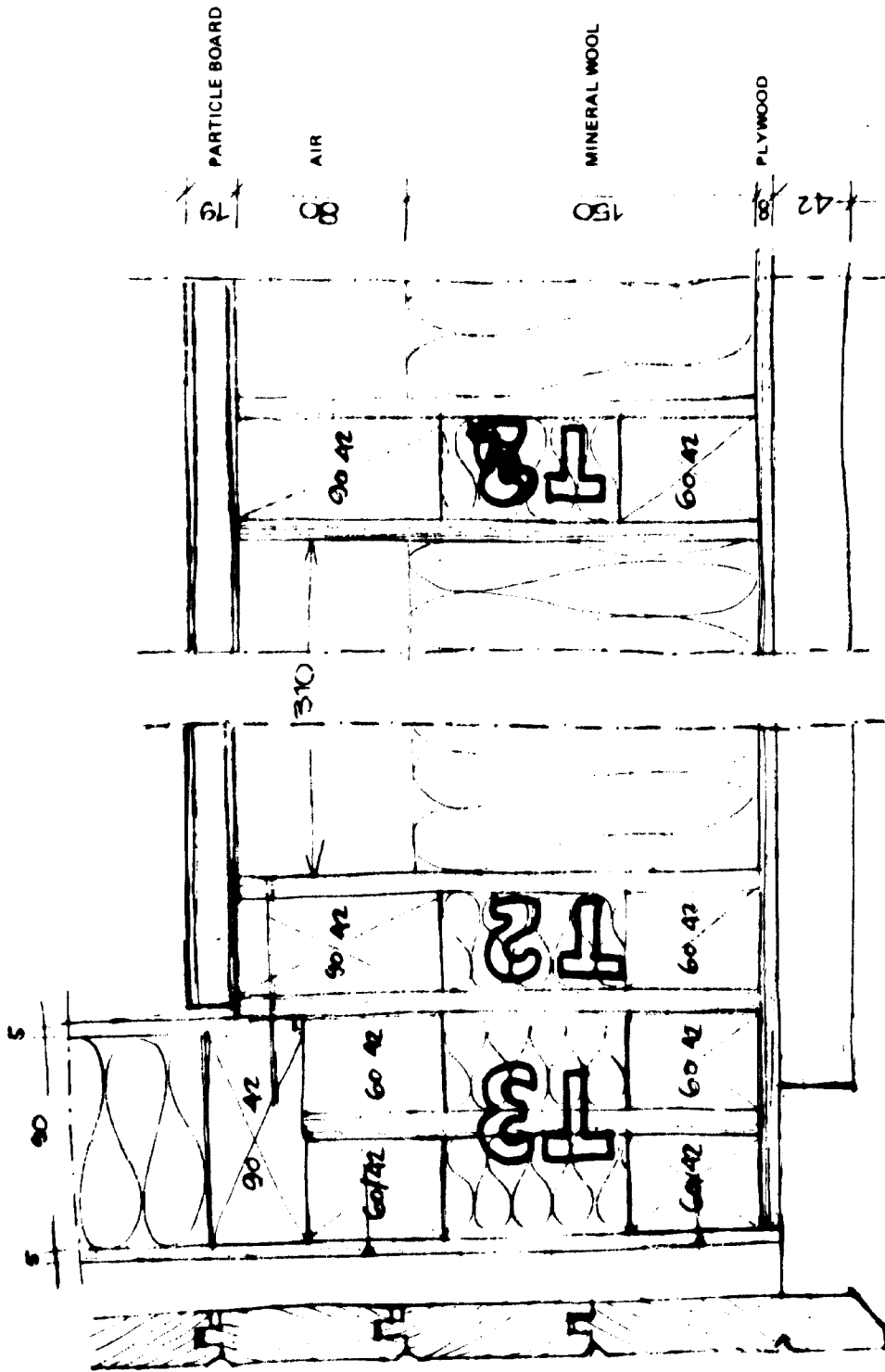


56. Details of assembly of modules B 2, B 3 and B 4

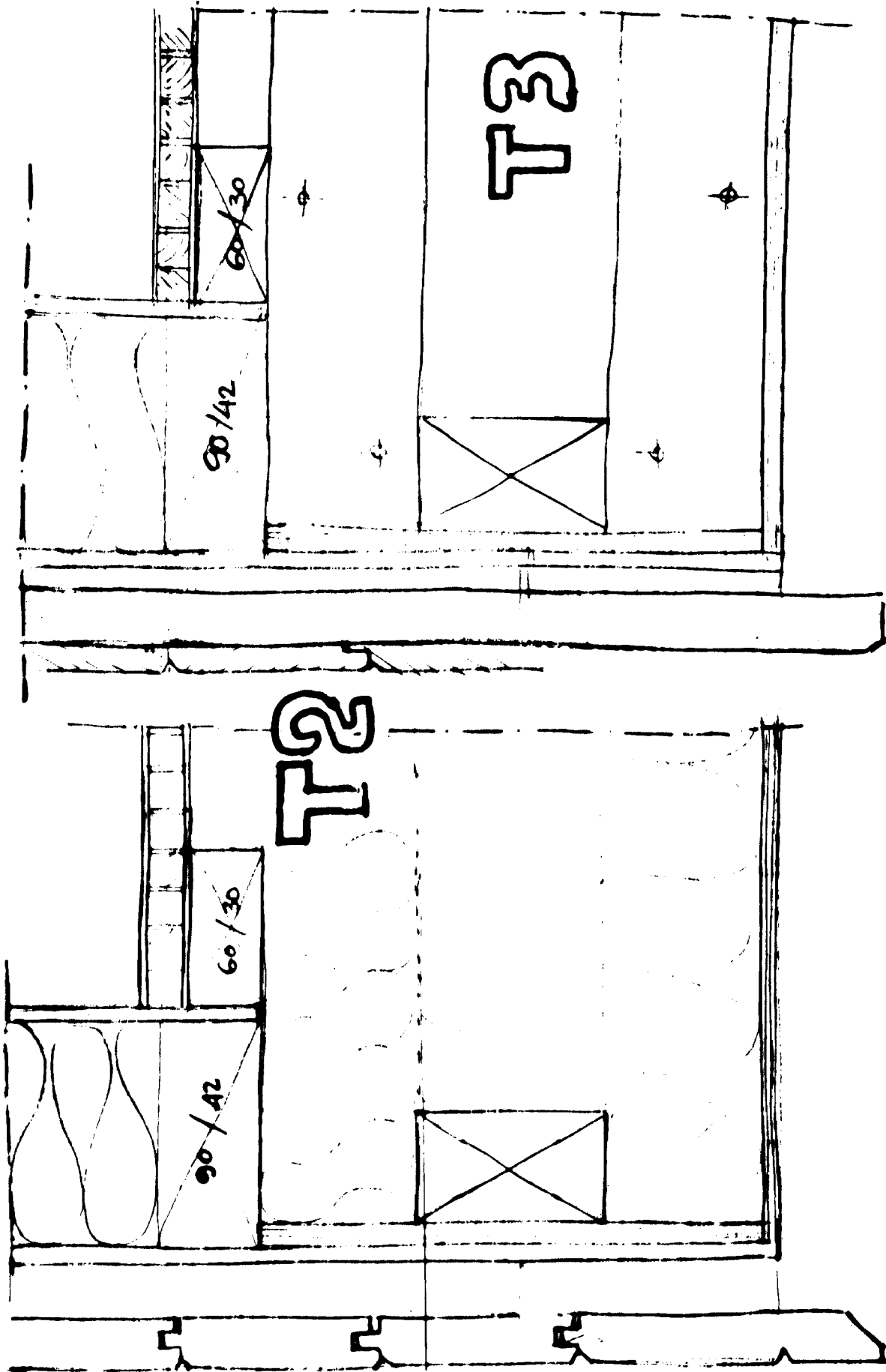


17. Details of assembly of modules B 2 and B 4 to A 2 and A 4 (with extra spacing)

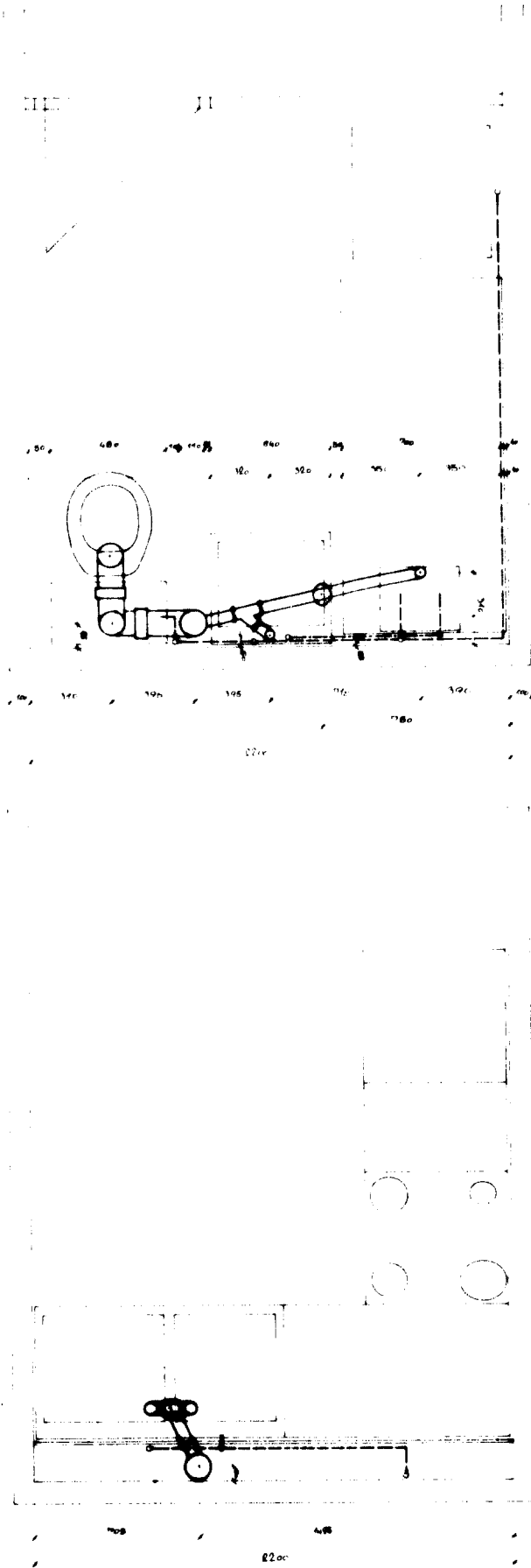




37. Details of joints of floors to walls

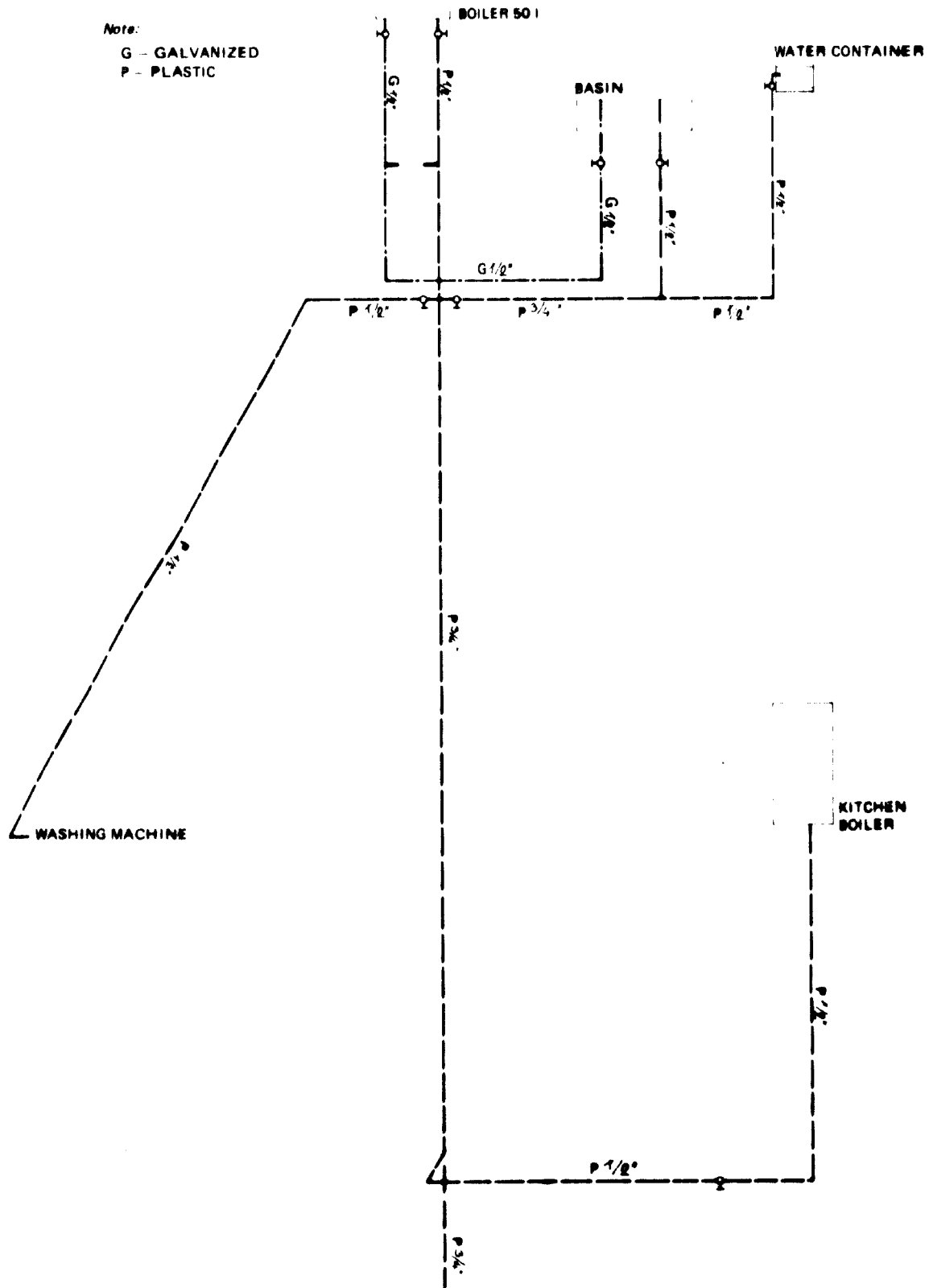


17. Details of joints of floors to walls

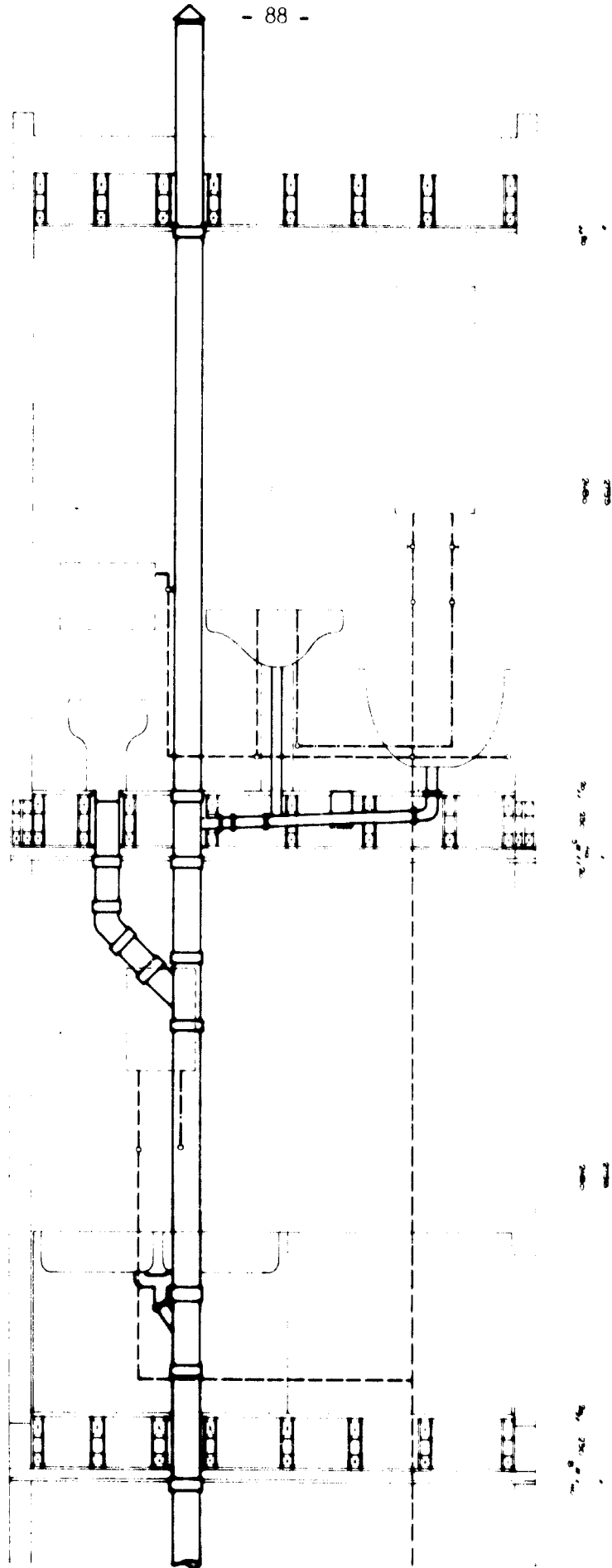


61. Plan of bathroom and kitchen showing piping layout

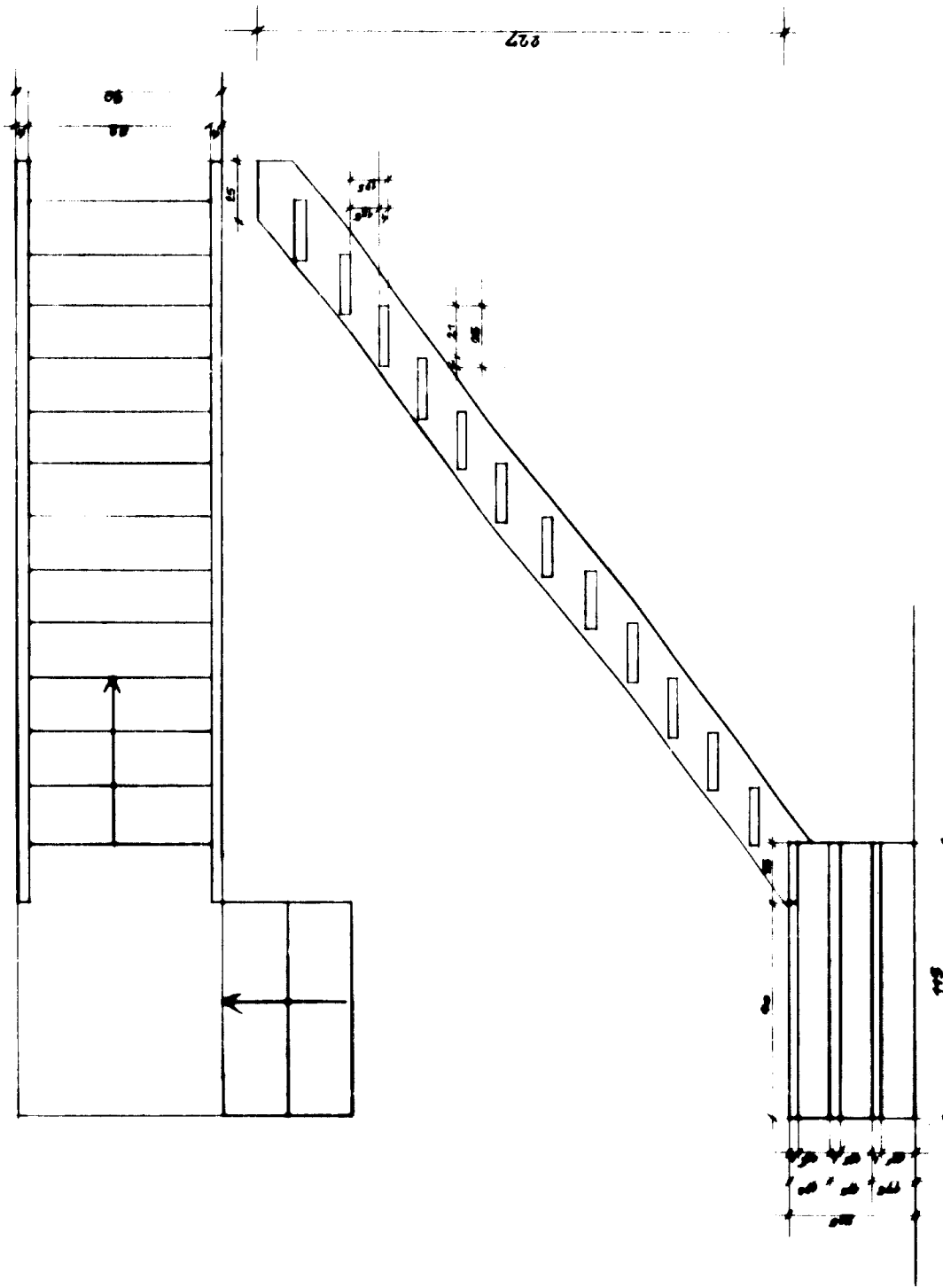




62. Layout and dimensions of water piping installations



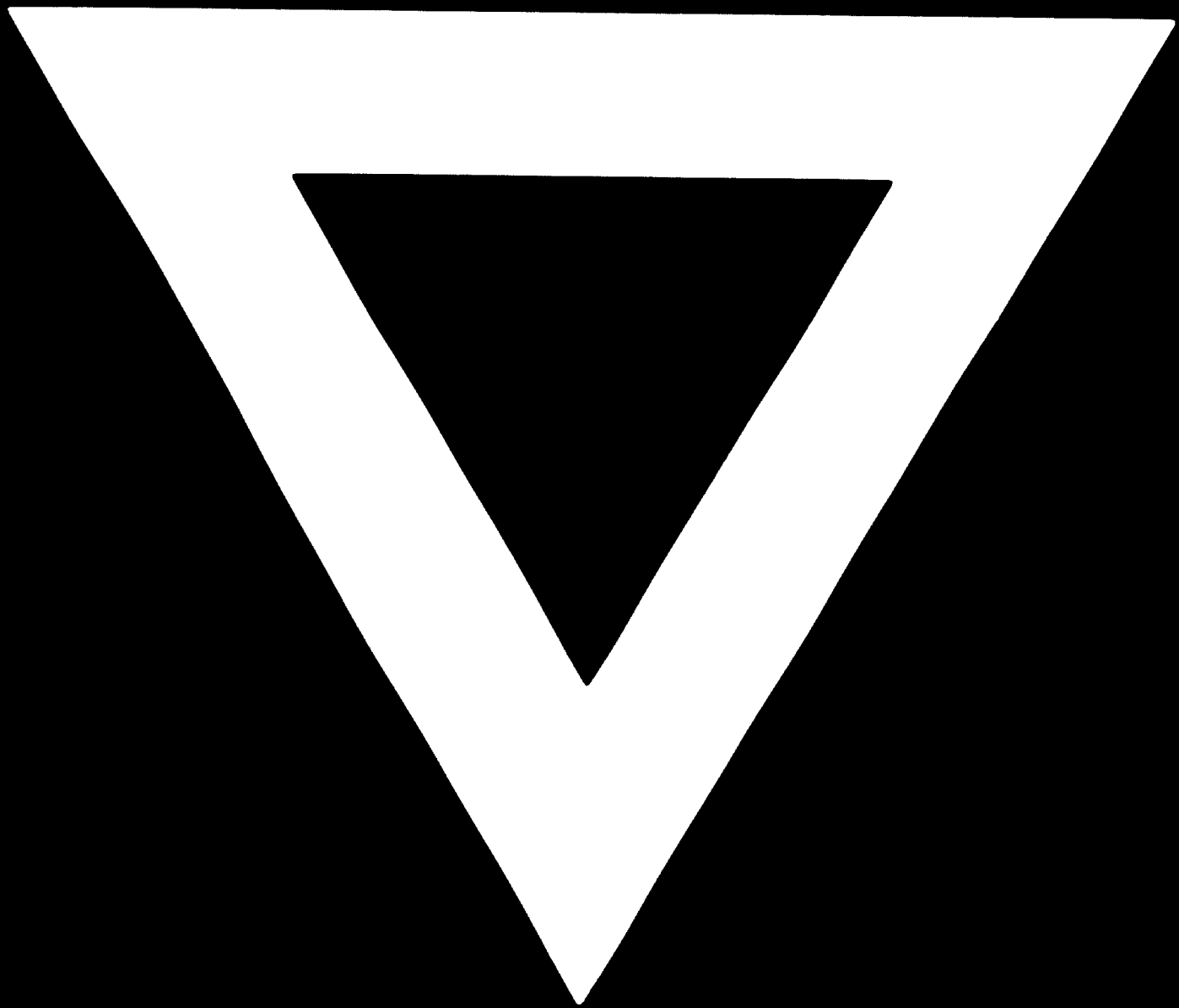
63. Cross-section of sewage installations



64. Inside staircase



**C-273**



**77 .07.05**