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CONSTRUCTIVE FINISHING AND PROTECTION SYSTEM
APPLIED TO THE PRODUCTION
OF WOOD-PREFABRICATED HOUSES IN ROMANIA^{1/}

by

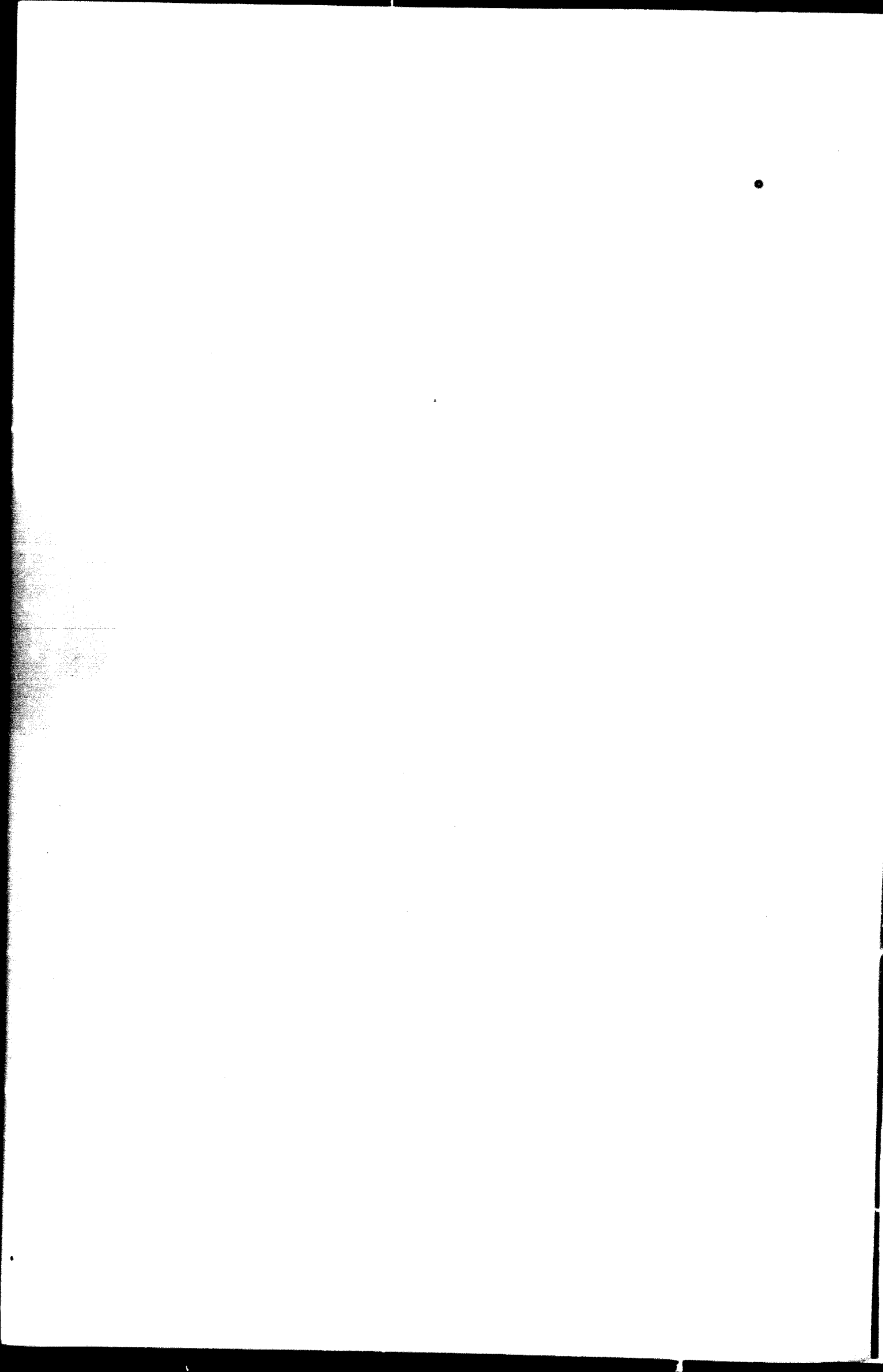
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Contemporary to the development of the industry of new materials made on the base of wood (particle boards, fibre boards, plywood) and the appearing of materials of another nature (plastics, insulating materials, minerals, etc.) the industry of prefabricated houses in wood materials arrived in Romania to a great development this last years.

On the basis of the experiences made by the Institute for research and technological projects for the woodworking industry in co-operation with the manufacturers producing prefabricated house elements were stated and checked materials to be utilized to the execution of prefabricated houses, constructive solutions, protection treatments etc.

At the same time technical solutions were elaborated too for electrical and sanitary plants.

A synthesis is exposed of the main technical aspects with respect to the production of prefabricated houses in Romania.

The constructive solutions that were elaborated and practically applied had as main characteristic the saving of sawn timber especially of the needlewood one and the extension in use of new materials in basis of wood.

Taking into account the requirements for internal consumption and for export, the house types as yet elaborated and executed, represent, depending on the destination these houses have, campings, vacation houses or permanent dwelling houses.

2/ Materials employed to the execution of the houses

The main materials employed to build these houses are:

- wood materials: particle boards, fibre boards, coniferous sawn timber;
- materials of another nature: minerals (mineral wadding, asbestos-concrete boards) metals, plastics and divers other finishing materials providing antiseptic, fire - and weather protection.

a) Particle boards

By producing prefabricated houses in wood materials generally are used normal pressed, 12 mm thick particle boards. Some foreign customers impose, in conformity with construction norms in use in their countries, the utilization of 18 mm thick boards for the external panel face. Outdoors and in bathroom, boards are utilized resistant to water and weather, employing in this scope as adhesive a phenol-formaldehyde glue. In some cases antiseptic treatment must be applied in manufacturing these boards.

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Indoors (except bathrooms) ureoformaldehyde resin-bonded wood particle boards are generally used.

b) Fibre boards

Assortments utilized by manufacturing prefabricated houses are insulation boards. These are used for heat insulation of panels.

c) Coniferous sawn timber

Sawn timber is utilized for the execution of the resistance framework.

d) Broadleaved sawn timber

Thin (24 mm) poplar or beech sawn timber is used of short lengths, to realize the resistance framework of the roof, in the case this is made from graded rafters.

e) Mineral wadding

This materials is employed for heat insulation.

Requirements of certain norms, impose to utilize 7-8 cm thick assortments, with a specific density of 60 kg/cub.m.

By manufacturing mineral wadding a synthetic un-combustible glue is used; mineral wadding products with a bituminous nature glue are not admitted.

f) Asbestos-cement boards

For some house types are used:

- 6-8 mm thin pressed flat boards for outdoor coatings of wall panels;
- waved 4-6 mm thick boards, for roof coverings;
- 4 mm thick pressed flat boards for roof coverings, having a form specific for these utilisations.

g) Metals

Generally a Ol. 38 - steel is utilized for jointing, in which scope divers profiles are needed (for the most part under the form of corner steel, U-steel, borders, bolts screws, nails etc.)

To avoid corrosion, all metal pieces, nails enclosed, are zinc-coated.

h) Plastics

From this materials group are utilized spongy insulating plastics e.g. the expanded polystyrene. Some plastics profiles are utilized too for the protection of joints between panels (polyvinyl chloride profiles) or shaped as waved roof sheets (glass fibre reinforced polyesters) and textile bands too of synthetic fibres of 0.1 mm as joint coverings, with the view of ulterior finishing by aspersing with a plastic plaster.

1) Finishing materials to increase the resistance to fungi and termites and to fire

From all the finishing materials as yet tested at the execution of house prototypes and of the numerous prefabricated houses produced in series, the panel faces being in particle boards, the best results were obtained by plastering with plastics (polyvinyl acetate) with mineral additives. This product has the property to impede water to contact particle boards, allowing nevertheless the migration of water steam from the interior to the exterior. The product has fire resistance properties and is very decorative, since it can be painted in any color. Houses, finished in this way have the same appearance as houses finished by common plaster.

For the weather protection other products were tested, namely: oil paints and enamels, alkydic, acrylic, perchlorevinyllic and epoxydic ones. The finishing of particle boards with these products rose a problem series, because of the requirement of a dry support, the multilayer application with intermediate drying times, the glossy aspect and the migration impedance of steam. Generally, these products are used only for the protection of solid wood

For the protection of solid wood parts are utilized unfilmily products with water resistance - and antiseptic properties as well as filmily products too.

- For indoors finishing of the dwelling rooms a semi-washable wallpaper with polyvinyl chloride is utilized.

- For antiseptic and fire protection of the wood materials, a product is utilized in whose composition copper, chrom- and bor salts are enclosed. The treatment occurs by brushing over particle boards and by immersion of insulation boards or of solid wood.

2. Constructive systems, structure of the panels and jointing proceedings

Taking into account the specific conditions of the woodworking industry in our country, where the utilization of new materials on the basis of wood and the reduction of the coniferous sawn timber are particularly emphasised, for the series production following construction systems were adopted:

- a) Bearing wall - and roof panels and flooring on concrete floor, or wood panels flooring;
- b) Bearing wall panels, rafters, roof boarding panels, ceiling panels, flooring on a concrete floor or wood panels flooring.

The first constructive system (with ceiling and roof panels) is applied in house types with a roof slope of almost 4%; the second system is applied in houses with a roof slope of more than 8%.

The panels are modulated at the 10 cm - standard - basis module.

The wall panels are 2.50 m high and have lengths between 1.20 m and 4.40 m. Great panels are generally utilized with the aim to have between the panels possible fewer joints (surface points of difficult finishing work and of rapid falling into disrepair).

Considering the existing materials and taking into account the need to realize panels having high mechanical resistances, adequate thermal insulation properties and being at the same time durable, the multilayer panel system was adopted. Some variants of outdoor wall panels that entered into the series production are further shown.

Outdoor wall panel (first variant)

Wall composition from the interior to the exterior

- particle boards glued with ureoformaldehyde resin 12 mm
- polyethylene sheet (barrier to steam) 0.25 mm
- mineral wadding 80 mm
- stagnant air layer 16 mm
- particle boards glued with phenol-formaldehyde resin 12 mm

Outdoor wall panel (second variant)

Wall composition from the interior to the exterior

- particle boards glued with ureoformaldehyde resin 12 mm
- polyethylene sheet 0.25 mm
- air layer 17 mm
- insulation boards 12.5 mm
- air damp 17 mm
- insulation boards 12.5 mm
- air layer 17 mm
- particle boards glued with ureoformaldehyde resin 12 mm

In both variants, the exterior layer of the panel formed by particle boards glued together with phenolformaldehyde resin can be substituted by following materials:

- particle boards glued together with ureoformaldehyde resin + asbestos-concrete boards;
- 20 mm - plant coating.

The joints between panels are executed by employing metal pieces and bolts or screws for wood.

3. Electrical, sanitary and heat plants

All electrical plants are included in the panels. From fabrication the panels are outfitted with plastic tubes in which are to be introduced, after building the house, the electric cable and boxes necessary to connection and fitting of electrical apparatus.

The sanitary plant is massed in a special panel named sanitary panel. This panel contains feed pipes and evacuation pipes; it contains some stiffness points for the outfitting of sanitary pieces (wash - hand - basin, WC, shower - and wash - hand - basin batteries, towel - and glass supports etc.)

The panel consists in a metal frame executed in zinc-coated steel profiles, with an aluminium or zinc sheet.

The panel can be otherwise made in a coniferous sawn timber frame coated with particle boards. In this case the wood material is treated.

Houses intended to permanent dwelling have a central heating plant. The heating aggregate is to be placed on the basement or on the ground floor; the heating elements can otherwise be connected to the thermo-power network. For the distribution of heat, heating elements are used.

Depending on the customer's preference, electrical heating can be supplied too by a special conductors network adequately sized.

Houses without heating plant are executed too.

3. The calculation basis

To dimension the compounding elements of the prefabricated houses, following calculations are made:

- static calculation
- thermo-technical calculation

The principles by which these calculations are made are shown further on.

Static calculation

Are dimensioned: rafters, wall panels and outpull of joints between roof and wall panels and between wall panels and foundations.

The calculation is carried out as follows:

a) for the rafters

- the exterior forces are determined, considering:
 - the own weight;
 - snow load $\approx 100 \text{ kp/m}^2$;
 - wind load = 500 kg/m^2 + the aerodynamic building coefficient;
 - the interior efforts in crossbeams are stated, generally using the Cremona - draught;
- the number of nails is to be stated taking into account the strength in crossbeams and the strength overtaken by a nail;
- the sections of the compounding elements of the rafters are dimensioned depending on the previously stated strengths.

b) For the wall panels

In dimensioning it is to observe the fact that only the sawn timber framework overtakes strengths.

The superior cross-beam girder of the panels is dimensioned depending on the loading given the roof and the voids.

The poles are dimensioned depending on loading of roof and wind pression.

c) The calculation on joint outpull between roof and wall panels and outpull between wall panels and foundations occurs taking into account the resultants of forces given by the pression and section of wind on roof and walls.

Thermotechnical calculation

As a rule two calculations are made, namely:

- the calculation of heat insulation;
- calculations related to diffusion of steam (condensed)

Thermical dimensioning is made on the principle of the resistance to thermal transmission, taking into account the different heat losses that occur in the panel's field (between the panel's solid wood elements) and on the framework.

The dimensioning to condensation is made taking into account the existing relations between temperature diminution in the building element interior, the resistance to permeability to steam of the compounding layers, the maximal pressures (saturation pressures) of water steam and

the partial pressures of water steam.

The calculations carried out, prototypes of building elements are executed and tested; follows the definitization of the execution scheme.

By the architectural conceiving of the house the function of the construction must be taken into account and an adequate architecture is aimed.

On the base of calculations and tests made on building elements, certificates are emitted, attesting: static and thermic calculation, behaviour to weather, antiseptical and fire protection.

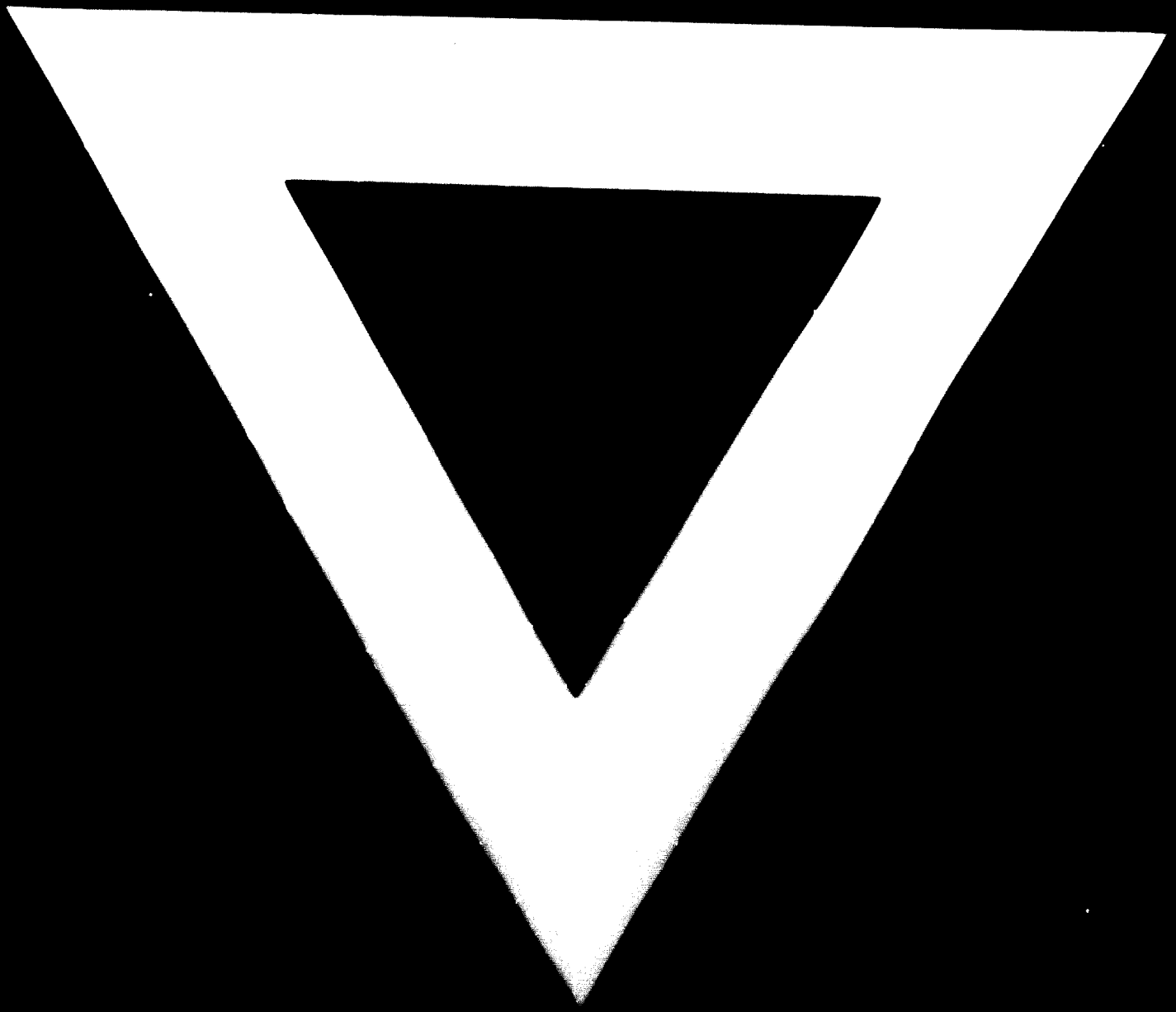
4. Conclusions and problems actually preoccupying the prefabricated house - production in Romania

Through scientific research work and the outworked designs, and taking into account the acquired experience in manufacturing prefabricated houses, the main knowledge were accumulated to allow further improvement of this product.

The wood materials producing industry and the other industries in Romania provide quality products proper to satisfy the internal and external requirements.

The main problems of present and future concern for scientific research and production of houses are following:

- Improvement of the physical - mechanical properties of the new materials on the basis of wood;
- Improvement of proceedings for antiseptical and fireproofing treatments;
- Elaboration of new products for protection and external aspect;
- Elaboration of new constructive solutions (extensions of the great panels principle etc.)



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