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TECHNOLOGICAL SOLUTION OF SAWMILL CAPACITY FOR CONIFEROUS RAW MATERIAL PROCESSING

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ABSTRACT

The paper analyzes the technological solution of sawmill capacity for the coniferous raw material processing. It gives an overview of the necessary equipment (machines and transport means) which has the technological line, showing the phases in the process of making a technological layout, as well as the elaboration of the spatial layout of the equipment that is built for the projection of technological line coniferous raw material processing. The projected production capacity is from 8000 to 10000 (m^3) per year. The basic manufacturing process consists of four basic areas: net production surface, transportation surface, postponement surface and subsidiary surfaces. Net production area is 209,4 (m^2), transport surface 83,8 (m^2), postponement surface with a value of 52,4 (m^2) and subsidiary surfaces amounted to 41,9 (m^2). Total production surface for projecting technological line is 387,5 (m^2) or approximately 390,0 (m^2). Projection of the technological line includes machines from the primary and secondary processing.

Key words: technology, working machines, technology layout, coniferous raw material

1. INTRODUCTION

Not one final wood industry production (production of furniture, carpentry, etc...) can be imagined without the use of sawmill planks. It represents the basic raw material for products made of wood. Moreover, sawmill planks are often sold as semi finished products which are used in other industries. Sawmill assortments are often subject to sale and are one of the lucrative timber products in international trade in the Republic of Macedonia.

Sawmill planks which are obtained by processing of logs are distinguished by the wood type, quality, size, degree of processing, and so on.

As to processing the raw material, wood types vary, being white pine, black pine, fir, spruce, larch etc...

According to the class of quality, they can be: CHC, I, II, III, and IV.

According to the dimensions, the following commercial groups are present: very short sawmill planks, short sawmill planks and long sawmill planks.

According to the degree of processing, sawmill assortments can be in the form of : unedged planks, semi edged planks, edged planks, beams, small beams, slats, etc. (Стефановски, Рабациски 1994).

Based on the projected raw material processing, attention will be directed to the projection of technological line for processing logs of coniferous tree species defined with the necessary technological production elements (machinery, transport equipment, land jobs, etc.).

2. AIM OF RESEARCH

The purpose of this research is to project technological solution of sawmill capacity for processing raw material from coniferous tree species. Projected technological solution will depend on the projected wood type and planned production volume, i.e. which wood type will be processed and in which amount.

Main product of the technological line for processing logs of coniferous tree species will be planks. For this purpose from 8000 to 10000 (m3) sawmill planks will be processed annually. The logs are with length of 4,0 (m).

3. WORK METHOD

The work method is simple and practical and was derived from studied scientific and professional literature displays that we had available.

When the processed material is known, it gives us the right to offer a solution of mechanized processing technological line from coniferous raw material.

To perform the tasks, the equipment required for realization of the planned production is provided, as well as calculating the area under the working machinery and surfaces of the basic process of production.

4. RESEARCH RESULTS

Research was carried out in relation to:

- Technical characteristics of the working machines,
- Technical characteristics of transportation equipment,
- Calculation of the workplace surfaces, and
- Calculation of the surface of the basic process of production.

From these studies, particular attention will be paid to the calculation of the surfaces under working machines and surfaces of the basic process of production.

Concerning the design of the technological line for processing raw material from coniferous tree species, the following machines will be used:

- Automatic log band saw, AT - 1100
- Hydraulic cross cutting circular saw, HCP - 1
- Automatic cross cutting circular saw, AC - 3
- Precise circular saw, PCP - 450
- Band saw, TP - 9

For projecting the technological line, the following transportation equipment will be used: dosing pad, longitudinal chain conveyor, transverse heavy chain conveyor, transverse light chain conveyor, combined powered rollers conveyor, powered rollers conveyor, non-powered rollers conveyor and frontal forklift.

4.1 Calculation of the workplace surface

The surface under the working machine calculated by known length (l) and known width (š) of the machine is:

$$F_1 = l \times š$$

Based on the known size of the surface that the working machine takes (F_1), the size of the workplace surface will be calculated using a calculation factor (fr) according to the formula:

$$F_0 = F_1 \times f_r$$

The value of the calculation factor (f_r) depends on the size of the working machine surface (F_1). The value of the calculation factor (f_r), depending on the working machine surface (F_1), is given in Table 1 Šuletić, R. (1991).

Table 1. *Value of calculation factor (f_r)*

F_1 (m^2)	f_r
0,5-1,0	18
1,1-2,0	15
2,1-3,0	13,5
3,1-4,0	12
4,1-5,0	10
5,1-10	5
10,1-15,0	4,5
>15	4

Based on the calculated surface that the work machine takes (F_1), the workplace surface (F_0), for each working machine can be calculated. The calculated values are shown in Table 2.

Table 2 .*Working machine surface and workplace surface (in m^2)*

Working machines	Working machine surface $F_1 = l \times š$	Workplace surface $F_0 = F_1 \times f_r$
Automatic log band saw, AT - 1100	5,0	50,0
Hydraulic cross cutting circular saw, HCP - 1	3,0	40,5
Automatic cross cutting circular saw, AC - 3	5,5	27,3
Precise circular saw, PCP - 450	1,3	19,5
Band saw, TP - 9	1,1	15,8

The surface of the workplace with an automatic log band saw (F_{01}) is 50,0 (m^2), the surface of the workplace with a hydraulic cross cutting circular saw (F_{02}) is 40,5 (m^2), the surface of the workplace with an automatic cross cutting circular saw (F_{03}) is 27,3 (m^2), the surface of the workplace with a precise circular saw (F_{04}) is 19,5 (m^2) and the surface of the workplace with a band saw (F_{05}) is 15,8 (m^2).

4.2 Calculation of the surface of the basic production process

The surfaces of the basic production process can be divided into four basic parts: net production surface (F_n), transportation surface (F_t), postponement surface (F_{od}) and subsidiary surfaces (F_p) Šuletić, R. (1991).

The total production surface (F_u) is derived by to the expression:

$$F_u = F_n + F_t + F_{od} + F_p$$

4.2.1 Net production surface

Net production surface (F_n) represents the sum of the surfaces of all the workplaces that are covered in our technological line and it is calculated according to the formula:

$$F_n = \sum_{i=1}^{n} F_o$$

$$F_n = F_{01} + 2F_{02} + F_{03} + F_{04} + 2F_{05}$$

$$F_n = 50{,}00 + 2 \times 40{,}5 + 27{,}3 + 19{,}5 + 2 \times 15{,}8 = 209{,}4\ (m^2)$$

$$F_n = 209{,}4\ (m^2)$$

4.2.2 Transportation surface

For calculation of the transportation surface (Ft), we apply the following formula:

$$F_t = F_n \times f_t$$

the transportation factor (f_t) ranges between the limits of 0.3 to 0.6. The value taken in our case is f_t = 0,4.

$$F_t = 209{,}4 \times 0{,}4 = 83{,}8\ (m^2)$$

$$F_t = 83{,}8\ (m^2)$$

4.2.3 Postponement surface

For calculation of the postponement surface (F_{od}) we use the following formula:

$$F_{od} = F_n \times f_o$$

where the postponement factor (fo) varies between 0.2 to 0.5. In our case, we will use the value fo = 0,25.

$$F_{od} = 209{,}4 \times 0{,}25 = 52{,}4\ (m^2)$$

$$F_{od} = 52{,}4\ (m^2)$$

4.2.4 Subsidiary surfaces

For calculation of the subsidiary surfaces (F_p) the formula below is used:

$$F_p = F_n \times f_p$$

with subsidiary surfaces factor (f_p) ranging between 0.1 to 0.2, and in our case the value of f_p = 0,2 is taken.

$$F_p = 209{,}4 \times 0{,}2 = 41{,}9\ (m^2)$$

$$F_{op} = 41{,}9\ (m^2)$$

Based on previous calculations, the total production area (F_u), i.e. the surface of the basic production process for design of technological processing line for coniferous raw material will be:

$$F_u = F_n + F_t + F_{od} + F_p$$

$$F_u = 209{,}4 + 83{,}8 + 52{,}4 + 41{,}9 = 387{,}5\ (m^2)$$

$$F_u = 387{,}5\ (m^2)$$

In projecting the technological line for coniferous raw material, processing analyzes have been made in relation to:

- The spatial arrangement of the equipment (technology base - layout)
- Phases in the process of making the technological base - layout.

Technological basis - layout is the spatial distribution of workplaces, i.e. machines and transportation equipment. It is based on data obtained from the calculation of the total production surface needed for the basic production process. Our technological line requires surface of 387,5 (m2). Based on the required production surface we adopt the overall dimensions of the building. Selection and dimensions of the building depend on the adopted technological solution. The projection of the

technological basis - layout takes into account certain principles so that the technological process would be organized in space. We have to organize and arrange work operations in space so that they suit their execution time, the technological process to run smoothly without feedback and cross movements. Therefore attention has been paid to the length and width of the building depending on the duration of the technological process and the number of projected production lines etc. (Šuletić, 1991).

Development of the technological basis - layout is quite a complex process that consists of the following phases:

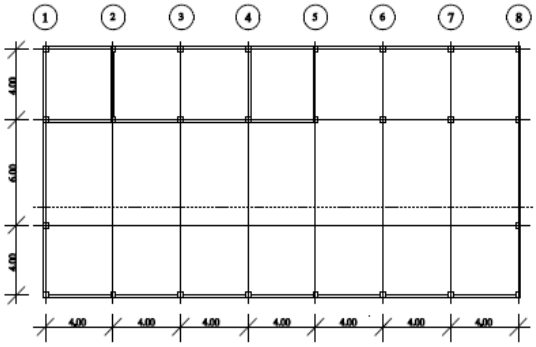

Figure 1. *Phase 1: Defining the base of the building*

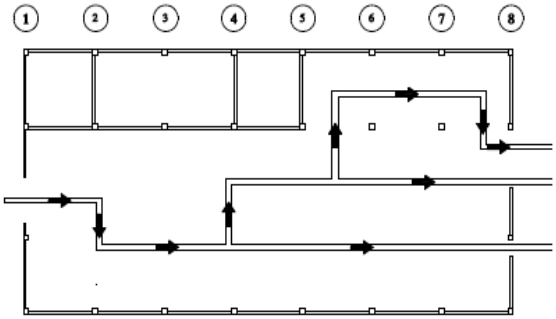

Figure 2. *Phase 2: Defining shape during production*

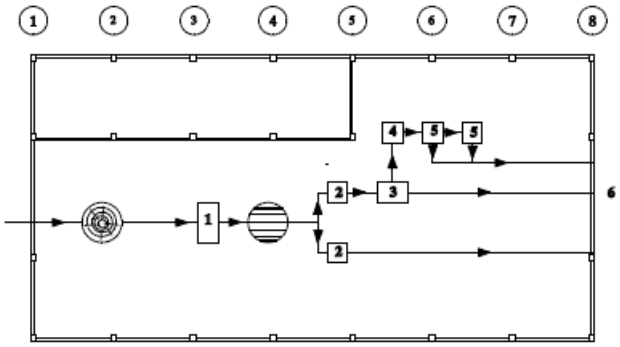

Figure 3. *Phase 2: Development of a scheme for the movement of material (diagram of the material)*

Legend:

1. Automatic log band saw, AT – 1100
2. Hydraulic cross cutting circular saw, HCP – 1
3. Automatic cross cutting circular saw, AC – 3
4. Precise circular saw, PCP – 450
5. Band saw, TP – 9
6. Sorting place

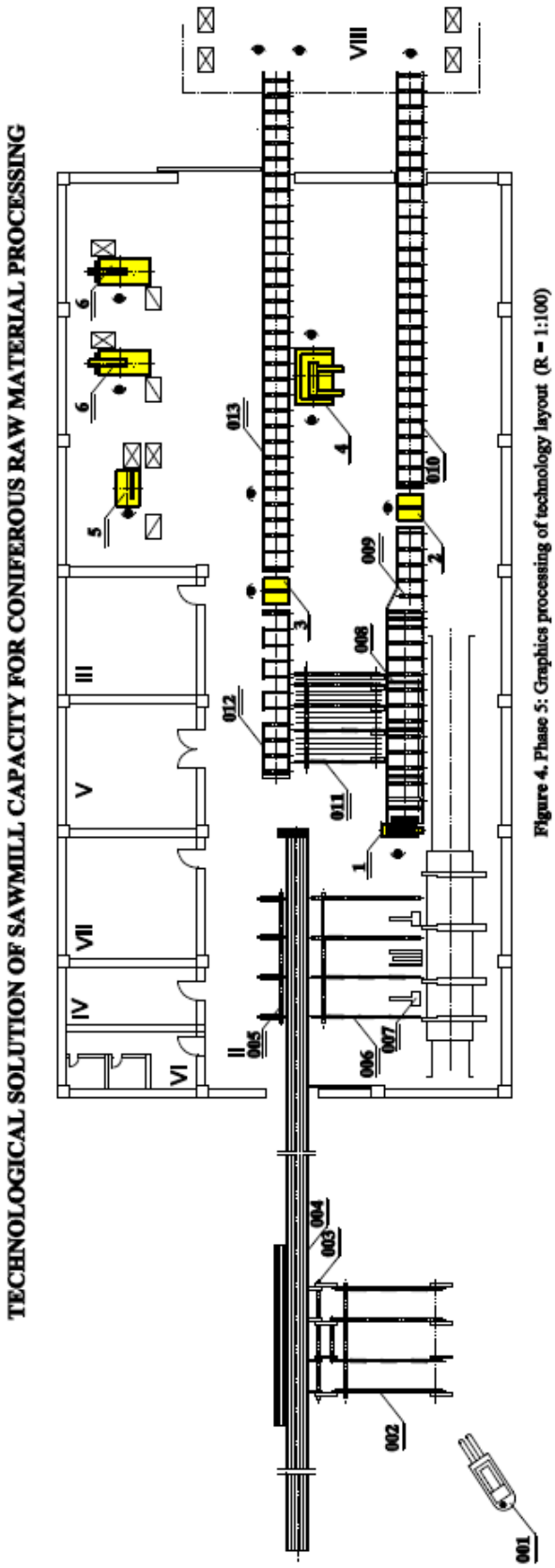

Figure 4. Phase 5: Graphics processing of technology layout (R = 1:100)

Phase 1: Defining the base of the building

At this stage is established the width of the building, which is 14,0 (m). Afterwards the module between the axes of the columns, which is 4,0 (m), shall be determined.. We also give the longitudinal axis of the building, constructed at a scale R 1:100 and shown in Figure 1.

Phase 2: Defining shape during production

At this phase we must determine the beginning and finish of the production process, then define the shape of the manufacturing process (which is straight), followed by determining the cross and longitudinal transport routes, as well as the main and side entrances. Phase 2 is shown in Figure 2.

Phase 3: Preparation scheme for the movement of material

At this stage we make material movement scheme and diagram for the material, both of which are shown in Figure 3.

Phase 4: Selection of the optimal solution

Based on previous research and the development of workplace space, machinery and transportation equipment, as well as previously processed stages, we can offer the optimal technological solutions which are identical to the last phase 5.

Phase 5: Graphic processing of the technological basis - layout

In the final phase of making the technological basis of sawmill capacity for coniferous raw material processing, marked as subsidiary facilities (warehouse, wardrobe, sanitary space, head space, space for preparation tool) the title, scale and legend are displayed. (Figure 4).

5. DISCUSSION AND CONCLUSIONS

Before starting the projection of the technological process. it is necessary to adopt the projected wood type and planned production volume. In addition, it is necessary to do research in the field of technical characteristics of the working machinery and transportation equipment. Basis for the design of technological line for the production of raw material from coniferous tree species is the calculation of the surface under working machines, from which one gets the basic production process, i.e. the overall dimensions of the building which will be located on the technological line.

From the above, the following important conclusions can be drawn:

1. The projected production capacity is ranges between 8000 to 10000 (m3) sawmill planks per year. Processing raw material (logs) is a coniferous tree species (pine, fir, spruce) with length of 4,0 (m).
2. In the technological process of processing raw material from coniferous tree species, the following machines were used: Automatic log band saw, AT - 1100, Hydraulic cross cutting circular saw, HCP - 1, Automatic cross cutting circular saw, AC - 3, Precise circular saw, PCP - 450, Band saw, TP - 9.
3. Working machines on warehouse logs and sawmill hall with related transport equipment: dosing pad, longitudinal chain conveyor, transverse heavy chain conveyor, transverse light chain conveyor, combined powered rollers conveyor, powered rollers conveyor, non-powered rollers conveyor and frontal forklift.
4. Based on the surface under machines, calculated surfaces of the basic production process for the design of technological line for coniferous raw material processing will be: net production surface F_n = 209,4 (m^2), transportation surface F_t = 83,8 (m^2), postponement surface F_{od} = 52,4 (m^2), subsidiary surface F_p = 41,9 (m^2).
5. The total production surface of the basic production process for the design of technological line is 387,5 (m2) or approximately 390 (m2), out of which net production surface covers 54.0 (%), transportation surface comprises 22.0 (%), postponement surface 14.0 (%) and subsidiary surfaces are represented with 10.0 (%).
6. Spatial layout of the equipment (working machines and means of transport) is shown with the technological basis. The technological basis defines the base of the building, where the width of the building is 14,0 (m), and the module between the axes of the columns is 4,0 (m); further was defined the shape of the production that is straight; was shown the scheme for movement of raw materials to be processed; was given the choice of the optimal solution, that gives technological solution for the projection of technological line for coniferous raw material processing.

7. Projected technological line for processing raw material from coniferous tree species will allow for continuous production without delays and other side effects during production.
8. Prospectively observed mechanized technological line of the sawmill capacity can be equipped additionally with machines for automatic measurement of the dimensions of the timber, for detection of foreign bodies and computer processing dispositions (ICs).

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