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ORGANIZATIONAL ASPECT OF MANAGING THE CONSTRUCTION OF HIGH-RISE BUILDINGS

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Summary

This paper presents a detailed planning process for the construction of the residential-commercial building "Lamela B1" in Banovići, with a structure consisting of a basement, ground floor, and five upper floors. The planned construction period for this project is a total of sixteen months.Within the study, an assessment of the average monthly workforce requirements has been conducted, along with an analysis of the diagram depicting the average daily workforce needs for each month. Additionally, a static material plan has been developed, correlating with dynamic construction schedules created using network planning methods and Gantt charts.The duration of individual construction operations has been determined based on applicable norms and standards in the construction industry. Special attention has been given to the gradual introduction of machinery and labor, as well as the procurement of necessary materials. This planning approach ensures the continuous operation of essential machinery and workforce while also securing the periodic procurement of required construction materials. During the development of the network plan, Gantt chart, and static material plan, careful consideration was given to the logical sequence of operations, ensuring that the necessary conditions for starting a specific operation were met, as well as identifying opportunities for parallel execution of multiple operations.Based on the developed dynamic schedules and workforce requirements, a diagram representing the average monthly workforce demand has been constructed. This study contributes to a better understanding of construction planning methods and resource optimization in the context of project dynamics and time management.
Keywords: building, planning, execution, workforce, network planning, work dynamics

1. INTRODUCTION

Project management is a set of processes in which knowledge, skills, tools and techniques are applied with the aim of realizing project goals. During the creation of this work, the project solution of a business-residential building built in Banovići, with floor plan dimensions of 35.00 × 15.00 m, called "Lamela B1" was used as a basis.
The building consists of: basement, ground floor and five floors. The location of the object is characterized by the following elements:
- The building is located along a section of the city street
- Connections to all installations are provided on the plot.

All the walls around the reserved space for shelter are made of reinforced concrete: outer thickness d=25 cm, and inner d=20 cm, reinforced with mesh on both sides. The ceilings above

all floors are monolithic ab ceilings with a thickness of d=18.00 cm, reinforced according to the reinforcement drawings.
In the basement of the building, five business spaces with wet rooms have been designed.
Nine residential units were designed on the ground floor and upper floors of the building. Each residential unit consists of rooms: kitchen, living room, hallway, bathroom with toilet, and different number of bedrooms depending on the size of the apartment.
The external and internal load-bearing walls of the ground floor are a combination of ab walls and giter blocks or siporex d=25 cm, and partitions made of siporex d=10 cm. The outer walls in the basement are made of reinforced concrete. At the junction between the base plate and the walls, waterproofing from sika mortar is provided.
The other walls are made of giter blocks or siporex d=25 cm and d=20 cm, and the partitions are made of siporex blocks d=10 cm. All load-bearing walls in the basement are based on the AB base plate, which is placed on a cement glaze that protects the horizontal waterproofing.
Finishing of the floors and interior walls was carried out according to the project documentation.
Facade walls are lined with styrofoam d=8.00 cm with other shops and finished with a facade.
The roof structure is a multi-gable roof made of Class I fir, and it is attached to an AB cerclage and a plate with steel anchors, which have a thread on the tops, on which metal plates with fastening nuts are placed. The roof covering is a metal sheet placed on a wooden base over which terpaper is placed.
The facility has an elevator for 6 people, which consists of an elevator shaft and a house according to the manufacturer's instructions, while the elevator project will be the responsibility of the manufacturer.
The building's foundation is made on a 50 cm thick reinforced concrete slab placed on a cement glaze.
A 40 cm thick buffer layer is projected under the concrete base, which is compacted to a compressibility modulus of M 80.
The depth of the foundation and the bearing capacity of the terrain was determined based on the Elaborate on geomechanical testing of the soil for the needs of the construction of a residential and commercial building.[2]

2. CALCULATION OF AVERAGE WORKFORCE REQUIREMENTS PER MONTH

The calculation of the average labor needs per month was done in such a way that the expected term for the construction of a residential and commercial building is 16 months, taking into account the norms and all the positions of the works from the bill of quantities and estimate of the works, which is an integral part of the project documentation.

The basis for this budget is the dynamic work execution plan, average norms and standards, and a diagram of the average labor needs per month for the total execution period of 16 months has also been drawn up.

Table 1. Average labor needs by month

Month	Number of workers	Number of working days	Average number of workers
April	184	23	8
May	260	22	12
June	310	21	15
July	333	22	15
August	425	22	19
September	528	22	24
October	332	22	15
November	316	21	15
December	330	22	15
January	318	21	15
February	340	22	15
March	575	22	26
April	575	22	26
May	572	22	26
June	546	21	26
July	260	22	12

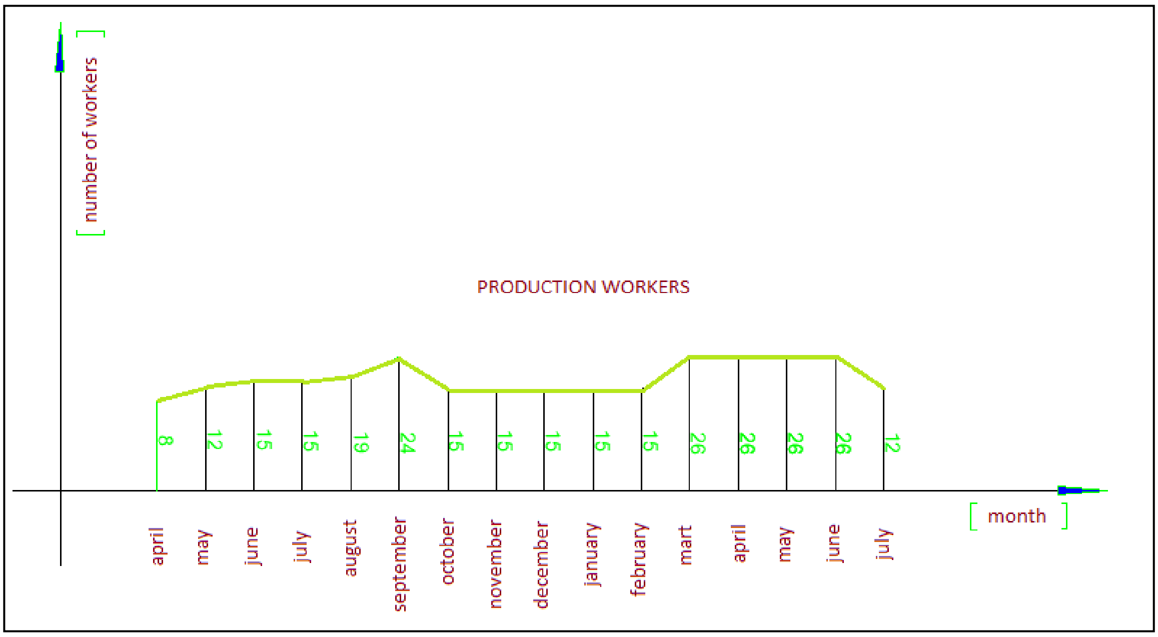

Figure 1. Diagram of average daily labor needs during the month

3. DYNAMIC WORK EXECUTION PLAN

The creation of a dynamic work execution plan is the determination of the order of execution of operations with the calculation of the time duration of the activity, which is determined on the basis of work norms and the amount of work on a certain activity and is calculated according to the form [1] [4]:

$$T= Q \times 1,2 \times N_{č} / n \times m \qquad (1)$$

Where is:
T-time of an activity

Q-quantity of work on an activity
1,2 -factor of increase of activity time by 20% due to unforeseen delays in construction (annual, vacations, sick days, absences)
$N_č$-norm hour for the unit of measure from the bill of quantities of works Q
(taken from norms and standards in construction)
n-number of workers
m-number of working hours [5] [6].

Since it is a building with four characteristic floors, the duration of activities for the execution of all earthworks is defined; the duration of activities required for the construction of the basement, ground floor and first floor is defined, and the duration of activities for the construction of the second, third and fourth floors and the need for labor are identical to the duration of activities for the need for labor on the first floor due to their repetition. [7]

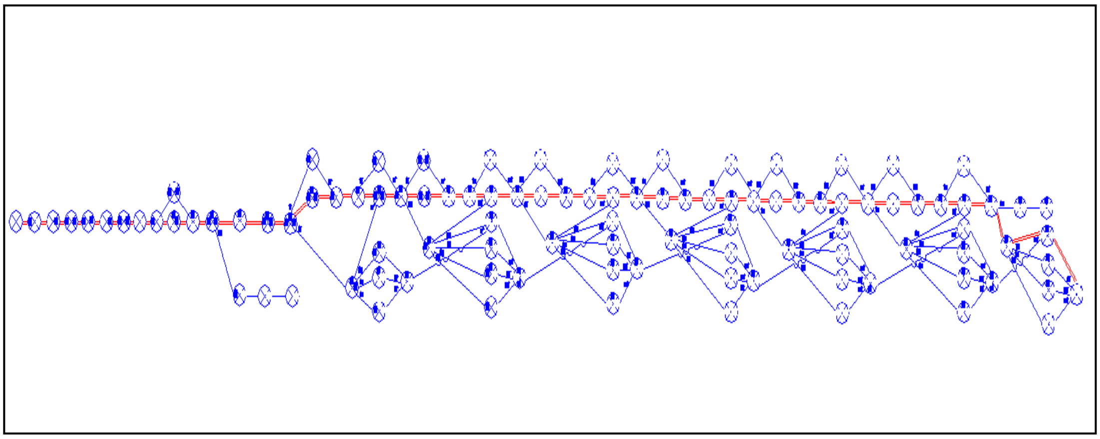

Figure 2. Network plan

This paper describes in detail the dynamics of work execution with a network plan and a Gantt chart, which enables:

- ➢ Graphical way of displaying the technological process via the network and gives a good visibility of the progress of the works;
- ➢ Marking the so-called "critical works", i.e. those that do not contain any time reserve and on which the execution deadline depends;
- ➢ Determining the optimal sequence of works.

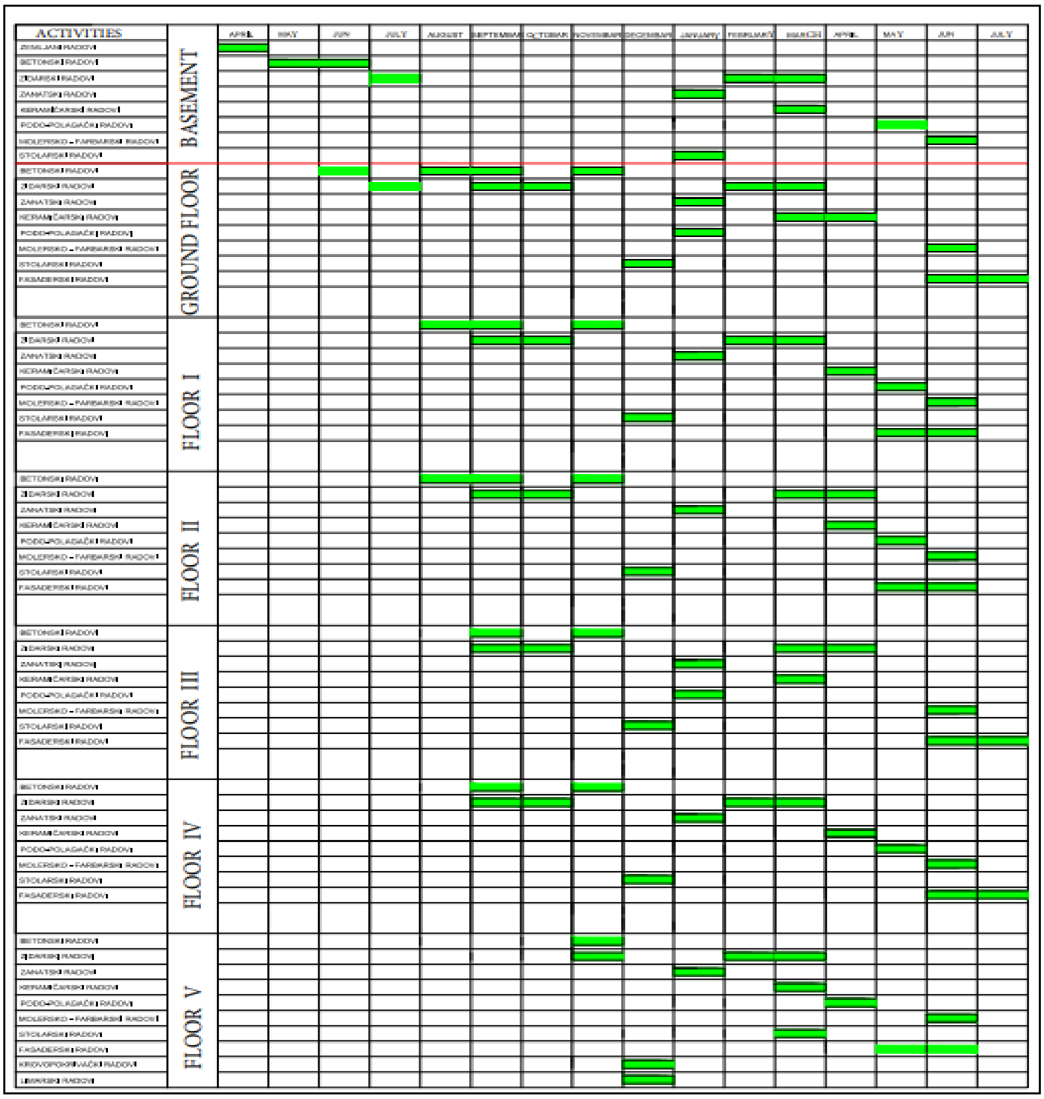

Figure 3. Gantt chart

Creating a network plan includes three phases:

- Which activities can start immediately after some observed activity;
- Which activities can take place in parallel with the observed activity;
- Which activities must be completed in order for the observed activity to start. [3]

In this paper, a network plan was created using circles, where activities are represented with one circle in which:

- No - Serial number (or some other activity mark)
- Rz - Early completion of works
- Kz - Late completion of works
- t_i - Activity duration

- The calculation of early terminations Rz is determined by the "forward" procedure and was calculated according to the form;

$$R_{zi}=max\ [R_z(p_a) + t_i \qquad (2)$$

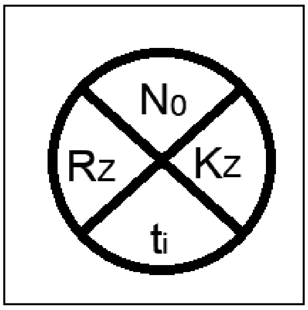

Figure 4. Activities in the network plan

- The calculation of late terminations Kz is determined by the "backward" procedure and was calculated according to the form;

$$K_{zi}=min\ [\ K_z(n_a) - t(n_a)\ ] \qquad (3)$$

Where is:
i – observed activity
n_a – the next activity
p_a – previous activity

- The mark *max* means that when determining the earliest completion time for a subsequent activity, we take the highest value of the sum of the earliest completion time of the previous activity with the duration of the observed activity.
- The mark *min* means that when determining the time of late completion, the smallest value that results when its duration is subtracted from each of the following activities is taken.

When the calculation is "back" to the initial activity, the process is complete and the critical path is drawn.
The critical path consists of a series of activities for which the time reserve is Tu=0, which means a series of activities with the same values for R_z and K_z.

4. STATIC PLAN OF MATERIALS

For each project, although it may seem similar to another project, a separate time plan should be developed to avoid exceeding the deadline, because no project is actually the same and no project is repeated twice. Without a good plan, monitoring and control of the execution of construction works, it is difficult to run a successful business and it follows that planning is always useful, although it does not guarantee the success of the project, since, in addition to the plan being developed in detail, it must also be implemented consistently.
For the consistent application of dynamic plans that describe the production of items on the project over a period of time, it is also necessary to develop a static material plan that provides visibility and the needs of a certain type of material in the same time interval in which the production of certain items is planned.

Specifically, for the project that was used as a basis for the development of this work, a static material plan was developed, presented in figure 5.

MATERIAL		unit of meas.	quantity	OIL (kg)		NATUR GRAVEL (m^3)		CEMENT (kg)		AGGREGATE (m^3)		WATER (m^3)		SANDS (m^3)		ARMATURE (kg)		LIME (m^3)	
No	DESCRIPTION			unit	total	unit	total	unit	total	unit	total	unit	total	unit	total	unit	total	unit	total
1.	CATEGORY III EARTH EXCAVATION	m^3	2029,95	0,278	564,33														
2.	FILLING THE TAMPON UNDER THE FOUNDATION PLATE	m^2	494,9			0,2	99,0												
3.	FILLING GRAVEL AROUND THE BUILDING	m^3	209,66			1,0	209,66												
4.	MAKING A LEVELING BOARD d-10 cm	m^3	49,49					300	14847	1,282	63,45	0,18	8,90						
5.	CONSTRUCTION OF WATERPROOFING PROTECTION UNDER THE FOUNDATION SLAB [illegible]	m^2	494,9					470x0,04	9304,1			0,35x0,04	6,92	1,01x0,04	20,0				
6.	concreting of the foundation slab d-50 cm MB30	m^3	242,6					350	84910	1,25	303,25	0,20	48,52			60,0	14556		
7.	concreting of columns with MB30 concrete	m^3	347,48					350	121618	1,25	434,35	0,20	69,49			60,0	20848,8		
8.	concreting of beams with concrete MB30	m^3	100,63					350	35220,5	1,25	125,79	0,20	20,13			60,0	6037,8		
9.	concreting of slabs with MB30 concrete	m^3	583,63					350	204270,5	1,25	729,54	0,20	116,73			60,0	35017,8		
10.	concreting of the cerclage with concrete MB30	m^3	69,08					350	24179,4	1,25	86,36	0,20	13,82			60,0	4145,04		
11.	concreting of stairs with concrete MB30	m^3	15,74					350	5509,0	1,25	19,68	0,20	3,15			60,0	944,4		

Figure 5. Excerpt from the static material plan

5. CONCLUSION

Based on the research conducted, it was concluded that dynamic planning is one of the key phases in the execution of construction works, as it allows for the optimal use of labor in a certain period of time. The research results show that with proper and detailed planning, the planned works can be completed within the given deadline. When creating the network plan and Gantt chart, special attention was paid to the sequence of operations - dependencies between activities were clearly defined, i.e. which operations must be completed before the start of the next, as well as those that can be performed in parallel. All operations during the execution of the works were accompanied by a static material plan, i.e. the calculated amount of material required to produce a certain position. Also, care was taken to gradually introduce the workforce and its continuous work, which is shown through diagrams of average daily labor needs on a monthly basis, as well as within individual months. This work can serve as a good basis for further research and improvements in the field of planning and execution of works in building construction.

LITERATURE

[1] Galamić A., Graduation thesis, Faculty of Mining, Geology and Civil Engineering, Tuzla, 2009.
[2] The Main project of the residential and commercial building "LAMELA B1" Banovići, Besting d.o.o.Tuzla, 2019
[3] Klepac J., CONSTRUCTION ORGANIZATION Construction site organization, Civil Engineering Institute, Faculty of Civil Engineering, Zagreb, 1982.
[4] NORMS AND STANDARDS OF WORK IN CONSTRUCTION 1 – HIGH-RISE CONSTRUCTION, IRO Construction Book, Belgrade, 1987;

[5] NORMS AND STANDARDS OF WORK IN CONSTRUCTION 2 - HIGH-RISE CONSTRUCTION, IRO Građevićna Knjiga, Belgrade, 1987;
[6] NORMS AND STANDARDS OF WORK IN CONSTRUCTION 3 - HIGH-RISE CONSTRUCTION, IRO Građevićna Knjiga, Belgrade, 1987;
[7] Trbojević B., ORGANIZATION OF CONSTRUCTION WORKS, Scientific book, Belgrade, 1979