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## RESEARCH ON WORKING TIME IN THE CONSTRUCTION SECTOR

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### BADANIE CZASU PRACY W BUDOWNICTWIE

#### Abstract

The article describes the nature and the significance of research on working time of workers in the construction sector for the improvement of technology and organization of works. The author refers to the basic research methods and discusses the factors contributing to the performance of various works in the construction sector. Then, the research done on one of the construction sites in Warsaw, consisting of terrazzo tiling in stairways is discussed and the possible ways of interpreting the collected results is specified. The summary describes the benefits of proper observation and interpretation of research regarding working time of construction workers.

*Keywords: working time, efficiency*

#### Streszczenie

Artykuł opisuje istotę i znaczenie badania czasu pracy pracowników budowlanych dla doskonalenia technologii i organizacji robót budowlanych. Autor odnosi się do podstawowych metod badawczych czasu pracy oraz omawia czynniki składające się na wykonywanie poszczególnych robót w budownictwie. Następnie omówione zostały badania wykonane przez autora na jednej z warszawskich budów podczas wykonywania okładzin lastrykowych na klatkach schodowych wraz z określeniem możliwości interpretacji zebranych wyników. W podsumowaniu zostały opisane korzyści wynikające z prawidłowej obserwacji i interpretacji badań dnia roboczego pracownika budowlanego.

*Słowa kluczowe: czas pracy, wydajność*

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## 1. Introduction

The continuous development of the construction forces the participants of the construction process to constant improvement of technologies and organizational solutions during different works. An essential element of the construction industry is the physical work of people performing different works. Due to the high organizational and executive complexity and plurality of the attendant factors, the situation needs to be constantly monitored in order to draw proper conclusions that contribute to the optimization of the process.

Work measurement is one of the methodological concepts of work study that allows to measure the time required to perform the analyzed activities and to measure the level of disturbance in the factors accompanying the execution, necessary to determine the amount of time needed to effectively perform a task and determine the basis of the technical standards of time [1]. Determining the correct standards which take into account all the key factors affecting the working time allows for a reliable assessment of the construction being led. The conclusions drawn from the observation of working time are needed for the proper scheduling of works.

## 2. The Components of executed work research

For proper research of working time, it is necessary to isolate different aspects. Most general division of work distinguishes the three main research areas of work: quality of work, quantity of work and work organization (Fig. 1).

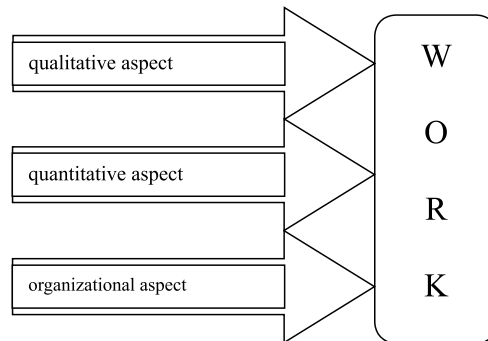


Fig. 1. Areas of work research (own description)

The proper and complete assessment of working time of construction workers should include possibly the largest number of factors affecting the performance of tasks on the site. The difficulty lies not in recording all components, but in their investigation. In order to analyze the work, the following factors need to be measured: physical and psychological effort, worker's qualifications, work ergonomics, existing legislation (eg. labor law), the wage system, macro and microeconomic situation, day of the week, distance from the date of completion of the works. Each of the factors mentioned above has a significant impact

on work, but it can't be examined with the same method of analysis. In order to accurately analyze the work of construction workers, interdisciplinary knowledge from the humanities (psychology), across economics (wage rate and the economic situation), finally, to the mathematical models (i.a.: quantitative aspect) should be used. Due to the complexity of the argument, it is necessary to perform research using practically all methodologies, since none of them in separation gives the feasibility of collecting the full amount of data for a complete description of the problem.

At present, working time in the construction sector is analyzed in several aspects. Very great importance is attached to an appropriate balance between work and time spent at home (work-life balance) [2]. Balance maintained in this aspect increases productivity and employee satisfaction, which is beneficial for the investment. Besides, the influence of temperature and humidity on work of the construction workers is thoroughly investigated. As a result, China has developed a model [3] that takes into account the weather conditions. The effects of calculations can be used directly to correct the construction schedules. Currently, from the group of psychophysical factors, the effect of stress and diseases is being analyzed [4, 5].

In the qualitative aspect of the research on work, it is necessary to analyze all the factors related to the work evaluation. Work evaluation is a process that aims at an accurate assessment of the factors affecting the difficulty and complexity of individual work components execution in the whole work. Within this area, it is essential to extract two types of research methods:

- summary (statistical, estimating, comparative),
- analytical (computational, investigative, simplified).

The study of the organizational aspect of work is based on one of the following methodologies:

- standard predetermined time,
- timing,
- sampling method,

or uses complementary methods such as photography of a working day or analytical estimation technique [6].

### 3. Completed research

The research on working time of the construction workers was performed on one of the sites in Warsaw during the realization of a part of the Eco-Park settlement at Chodkiewicza street. The whole observation concerned terrazzo tiling. The construction owner of the whole development was Sobiesław Zasada JSC Group, while the general executor was Krakow Re-Bau LLC.

That part is a set of five residential buildings connected by an underground garage. The height of each building is five floors above ground and one underground level. The buildings are each composed of two staircases. On the ground floor, a retail- service surface is located, while floors 1–4 are dedicated for living.

With the purpose of executing research, the observation of terrazzo lining in the staircases was carried out. The stairwells were stacked with prefabricated measured stairs consisting of treads and risers in a single element. The dimensions of every element were: length – 140–145 cm, width – 34 cm, height – 17 cm, thickness – 4 cm. The stairwells were made

Summary of execution times for each activity Zestawienie czasów trwania poszczególnych czynności

Number of staircase	Auxiliary and preparatory works	Execution of lining	Preparation of landings and corridors	Terrazzo lining on landings and in the corridors	Installation of stair plinths	Installation of plinths on landings and in the corridors	Grouting	Silicone application
	[h]	[h]	[h]	[h]	[h]	[h]	[h]	[h]
A1	71.77	233.1	86.85	131.15	22.73	26.98	44.3	24.28
A2	69.93	152.72	73.51	112.1	23.5	24.47	38.01	22.92
B1	41.4	131.06	52.23	95.27	24.18	25.34	37.91	22.83
B2	44.1	112.97	51.65	78.83	23.31	22.73	35.5	21.57
C1	61.9	113.45	64.71	100.98	30.18	26.4	30.37	23.41
C2	66.83	127.86	71.48	101.36	26.21	23.41	39.75	23.02
D1	48.65	108.13	62.58	79.41	24.18	24.28	35.21	23.7
D2	58.52	112.68	62.96	85.69	23.5	23.5	44.1	28.05
E1	52.13	133.76	64.9	92.37	22.63	28.53	36.56	21.28
E2	56.77	136.18	78.05	100.78	24.28	25.63	38.2	24.18

with the traditional method by using semi-dry cement mortar. Landings of staircases and corridors were laid with terrazzo tiles measuring 30 cm × 30 cm and with thickness of 2.8 cm, with the adhesive mortar, after having aligned the ground with a cementitious surface filler. After cleaning and preparing the ground for tiling, workers started to prepare semi-dry cement mortar. Ready, prefabricated steps, immediately after transportation to the place of incorporation, have been incorporated. When the stairwells were ready, workers started to align the ground of the landings and corridors in order to prepare it for terrazzo tiling. Once flat surfaces were ready, the workers tiled the plinths in the staircases, corridors and landings and they performed final termination activities, such as grouting and silicone application.

To conduct the research, the timing method was used [7]. Cards of daily worker observation were prepared, in which, to the nearest one minute, individual activities related to the execution of lining were described. The unit adopted for the presentation of the data was an hour, with the decimal expansion to second digit after decimal point.

The following components, performed by the workers were separated: auxiliary and preparatory works, execution of lining, preparation of landings and corridors, terrazzo lining on landings and in the corridors, installation of stair plinths, installation of plinths on landings and in the corridors, grouting and silicone application. Activities performed by workers were each time classified in an appropriate group, which allowed the researchers to extract the exact time for processes execution in every single staircase. Table 1 presents the results.

Using the timing method, the degree of influence of the workers' habituation to the new working conditions (new building) on the efficiency of works can be determined. Over the course of time, construction workers perform various tasks and, consequently, the whole job faster, more efficiently and effectively. For the realization of a single element they need less time, as it is presented in Fig. 2.

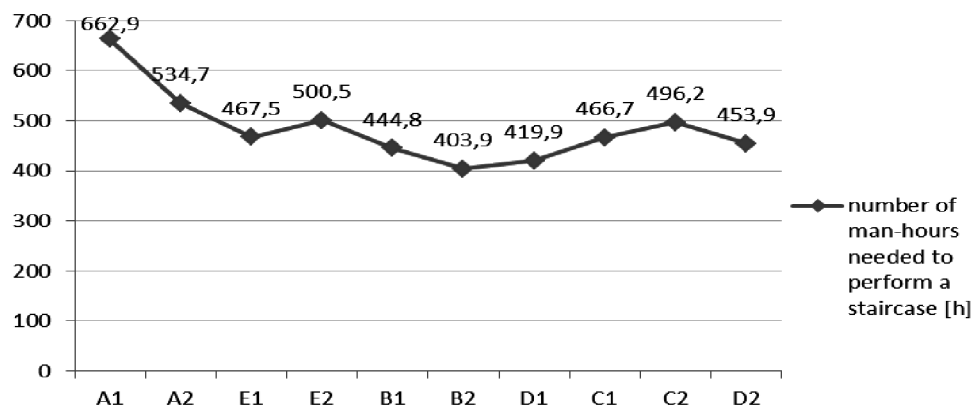


Fig. 2. Number of man-hours needed to perform a staircase

Basing on the timing method, the influence of days of the week on effectiveness of the construction workers can also be specified (Table 2). After analyzing the collected material, two variants of work on Friday were calculated:

- before working Saturday (Friday\*),
- not before working Saturday (Friday\*\*).

Employees achieve the greatest performance in the middle of the week, while the weakest at the beginning and at the end of the working week.

Table 2

**Performance of workers on each day of the week Wydajność pracowników  
w poszczególnych dniach tygodnia**

	Monday	Tuesday	Wednesday	Thursday	Friday*	Friday**	Saturday
Stairs installation [m/h]	1.09	1.24	1.24	1.25	1.09	1.01	0.91
Preparation of landings [m <sup>2</sup> /h]	1.25	1.7	1.76	1.58	1.92	1.72	1.28
Formation of landings [m <sup>2</sup> /h]	1.19	1.17	1.24	1.23	1.19	0.87	1.07

The studies presented above are an introduction to the analysis of working time of construction workers. Their objective is the determination of the impact of several factors on time and efficiency of construction workers. After analyzing all the factors and aspects that affect working time, it is possible to build a mathematical model of working time of construction workers. The presented results are only the beginning of a thesis and will be continued.

#### 4. A comprehensive study of working time

In order to realize the full research, that would present the widest image of working time of a construction worker and impact of each factor on its effectiveness, a multidisciplinary research using most of described research methods should be performed. Only a focus on the aspect of quantity, quality and organization analyzed together allows for an objective assessment.

Continuous development of the construction sector, implementation of new technologies and increasingly sophisticated mechanization of works impose the need for a constant monitoring of workers and the drawing of correct conclusions. Modern construction should not be based on old, outdated standards as, in any type of work, equipment manufacturers and materials suppliers aim to facilitate people's work. It increases the productivity and efficiency of every single worker. Keeping constant observation ended with the right conclusions increases optimization of the whole process, expense redundancy and faster turnaround time.

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