



OPTIMIZATION OF MATERIAL COSTS IN CONSTRUCTION ENTERPRISES

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Abstract: Material costs have the largest relative share of the cost of construction production. The present paper is pointed to some possible ways for optimizing the material costs. All actions aimed at achieving resource economy have to be interrelated with the aim of improving the quality of construction production. Material saving options may be planned both at the design and the construction stage. Economy of building materials can be planned still in the process of architectural, construction and technological design. In addition, concrete measures can be targeted for saving materials used at the various stages of construction works.

Keywords: construction production; material costs; opportunities for optimizing.

INTRODUCTION

Material costs have the largest relative share of the cost of construction production. Building materials are one of the main production factors in construction industry, which form the material nature of construction production. This also determines the need to continually seek opportunities for optimizing material costs. In general, the saving of material resources should be realized through increasing the level of their utilization, i.e. by reducing the actual costs of a production unit or type of construction works compared to the costs provided in the design documentation or to previous periods of similar construction works.

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At the planning stage and in the preparation of the documentation as a tool for optimizing the material costs, it is possible to use specification of the building materials. It determines the type and quantity of the basic materials necessary for the execution of the construction works. It can also serve as a means of controlling the expenses of building materials. In practice, the specifications of building materials are most often tabulated.

Still at the stage of planning the required basic building materials, such cost norms¹ should be provided which will fully match the technology and the specific features of the particular construction. These norms must be followed and optimized if possible in the process of execution of the construction works. The use of different methods for setting a material consumption norm, the right choice of measuring units, the availability of well-combined preliminary data enable the drawing up of optimal norms used for planning, organizing and controlling the material consumption, which in turn will help to reduce the cost of construction production.

¹ Norm in construction - this is the generally accepted expense of resources used for the production of a unit of quality construction product. Norms are not mandatory, but serve as a basis for negotiating, organizing and executing the construction process. A material consumption norm is defined as the maximum permissible material consumption per output unit.

Ways to cut down material costs can be found in the following main directions:

- reducing the amount of consumed materials;
- lowering the value of a unit of material;
- using new, more efficient materials.

To achieve these goals, a number of actions can be taken, some of which are:

- ✓ exploration of building material markets;
- ✓ control over the quantity and quality of the materials delivered;
- ✓ optimizing material transport, loading and unloading costs;
- ✓ optimizing the costs of material storing in storehouses;
- ✓ control over the material input;
- ✓ improving the means of dosing materials;
- ✓ repeated use of auxiliary materials;
- ✓ minimizing or, if possible, using the generated waste;
- ✓ searching for new more efficient materials with improved properties, etc.

Each construction company should provide a stock of materials ensuring the flow of the technological process. This means that there should always be such a quantity of materials (working stock) that would be sufficient for the normal performance of the construction work. On the other hand, the enterprise should seek to maintain and effectively manage the so-called guarantee stock needed to ensure a normal production process where there is a prerequisite for regular supply disturbances or technological process changes. Authors of specialized literature point to the following most important reasons for construction companies to have guarantee stock (Genov & Ilieva, 1994, p. 89):

- failure on the part of suppliers to meet their obligations for timely deliveries of materials;
- deliveries of lower quality materials;
- unplanned transport disturbances;
- change of the needs for material resources for objective reasons, etc.

The exact determination of the required stock of different construction materials is of fundamental importance for the organization and execution of construction works. For example, a shortage of materials can cause slowing of the process or, in the worst case scenario, interruption of construction works. On the other hand, the surplus of materials leads to an increase in storage and maintenance of warehouse costs. The stock of materials is determined by the construction schedule. Materials and quantities needed at a given time on the construction site are calculated according to the sequence of construction processes. The following formula can be applied to determine a particular stock of material – Q_{st} (Popov, 2008, p. 105.):

$$Q_{st} = \maxq_{aver} \times t_{st}, \quad (1)$$

where:

- \maxq_{aver} – maximum average daily expense of the material;
- t_{st} – stock norm (norm of storage).

The norm of storage depends on the type of building material and on a number of other factors, including:

- remoteness of the construction site from the production sites of the materials;
- type of vehicles used;
- climatic conditions in the construction works area;
- pace of construction works and material consumption for the construction process.

Each construction company, depending on the specifics of the site, must make an accurate assessment of the required materials. This means that the construction process must be secured with optimal quantities and quality of the materials to ensure its proper flow. For this purpose, the company should use the building materials specifications that have been compiled; mathematical models for calculating the stock; information on input materials for similar building sites, etc. In addition, the construction company should make a detailed research of different suppliers and their price offers in order to negotiate the lowest possible prices for the materials. The lower single delivery price is also one of the basic prerequisites for optimizing the cost of materials, which are a component of the total cost of the construction.

In order for a construction to be carried out within the stipulated time limit, it is advisable to monitor regularly the quantities of the delivered materials. For this purpose, the actual volumes of the delivered materials should be compared with those determined in the contracts concluded with the suppliers. The best case is when the two dimensions coincide. Reasons for any discrepancy could be either contractor's failure to comply with contractual obligations or irregular transportation and unjustified delay of resources along the way. The impact of the transport factor is determined by deducting from the quantities actually received those sent by the supplier. In addition, the quantities of the actually made deliveries must be compared to the quantities of the materials provided for the particular construction site. The equality between them means that the enterprise has secured the necessary materials for the actually executed construction works and there is no difference between the stock of materials at the end and the beginning of the respective period. If the volume of deliveries is greater than the needs of the construction works, the resource is dormant, and in the opposite case, the construction works are secured by the stock of materials available at the beginning of the period.

It can be concluded that the regular deliveries of the necessary building materials and their rational use have a direct impact on the execution of the construction and assembly works. Violation of regularity of deliveries can seriously hamper and reduce the efficiency of construction works. In practice, it is possible that the volumes of materials in stock increase excessively, hence the costs of their storage and the amount of the money invested. That is why for the most important material resources, it is advisable to schedule the deliveries in advance according to their consumption.

Construction companies have to look for ways of decreasing the cost of acquisition of the materials by reducing transport and loading costs. Transport costs in general are related to the movement of construction materials from the place of production to the construction site or to intermediate warehouses. In this sense, regarding construction enterprises, transport can be differentiated into external, internal and on-site. For example, the external is used to transport the materials from the production place to the site or to adjacent storehouses; the internal transports the materials between storehouses and from the intermediate storehouses to the construction site; the on-site transport distributes the materials within the site, to the place of their use.

Optimization of transport costs can be achieved by reducing transport distances, i.e. construction sites should be supplied with materials from the nearest possible sources. Moreover, when construction works allow, it is advisable to minimize the costs of internal and on-site transport of materials. Transport costs are also affected by the choice of appropriate means of transport and the type of vehicles. The choice of the latter depends on the type and quantity of the materials, the transport distances, the available transport network, the available company owned vehicles and others.

As an alternative to purchased construction materials, contractors can use their own manufactured building materials and products when possible. In order to choose the more economical of the two options, it is advisable to compare the cost of the purchased and the cost of the self-produced building materials.

A prerequisite for both material savings and the prevention of abuse is the organization of strict control over the storage and consumption of building materials in the process of construction works. In this regard, limit cards can be used as control means for the materials allocated to the sites and periodic inventories can be performed in the construction company's storehouses.

The degree of utilization should be determined for the different kinds of building materials. This analysis will contribute to the efficient management and optimization of the materials delivered and stored. For this purpose a utilization coefficient (*Cutil*) is calculated, which can be done in two ways (Mihaylov, 2013, p. 125). The first option expresses the ratio between the actual and the projected material expenses (*me*) per construction activity and the second between the projected and the finally reported expenses. Therefore, the formulas for the practical calculation of the utilization coefficient are as follows:

$$Cutil = me_1 / me_0 \quad (2)$$

$$Cutil = me_0 / me_1 \quad (3)$$

The obtained coefficient values give information on how rationally the materials have been used on the construction site. It can be calculated for both the total costs of materials, as well as for the costs of the different types of materials used in the construction process. In principle, the value of the coefficient should be

close to one. When the value is determined by the first of the formulas above and the result is bigger than one, it means that the actual costs are higher than the estimated costs and the trend is unfavorable. Higher material costs will also lead to an increase in the total construction costs. This necessitates a detailed examination of the reasons that have led to this increase, by dividing the costs of the different building materials by types. The reasons for the increased amount of actual costs can be as follows:

- using larger quantities of a building material compared to the projected;
- increase of the value of a unit of input material caused by higher than the estimated delivery price per unit;
- raising the building material cost norms, etc.

When the value of the calculated coefficient in the first formula is less than one, this means that the amount of the actually spent costs is less than that of the projected costs. The observed trend is favorable for the construction company. It has managed to optimize the costs of materials for the execution of the construction works, which will also lead to a decrease in the total costs.

When the utilization coefficient is calculated by the second formula and the result obtained is bigger than one, the trend is positive and vice versa when it is smaller, the trend is unfavorable.

CONCLUSION

In the process of carrying out construction works, enterprises should constantly strive for efficient use of the materials. For this purpose it is necessary to analyze in detail their use for each particular site, sub-site, stage and even for the specific technological operations. When possible, a saving scheme has to be introduced which will contribute to reducing the cost of construction works and improving its cost-effectiveness and competitiveness.

All actions aimed at achieving resource economy have to be interrelated with the aim of improving the quality of construction production. This means that the goal of construction enterprises in the building process should be to save materials while at the same time improving (keeping) the quality of the construction or the work done.

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