

Improvement of the material and transport component of the system of construction waste management

Mikhail Kostyshak¹ and Mikhail Lunyakov¹

¹Moscow State University of Civil Engineering, Yaroslavskoe shosse, 26, Moscow, 129337, Russia

E-mail: 2338580@mail.ru

Abstract. Relevance of the topic of selected research is conditioned with the growth of construction operations and growth rates of construction and demolition wastes. This article considers modern approaches to the management of turnover of construction waste, sequence of reconstruction or demolition processes of the building, information flow of the complete cycle of turnover of construction and demolition waste, methods for improvement of the material and transport component of the construction waste management system. Performed analysis showed that mechanism of management of construction waste allows to increase efficiency and environmental safety of this branch and regions.

1. Introduction

Nowadays, urgency of the problem of management of construction and demolition waste is increasing in proportion to growth of the scale of construction at regional and municipal levels. Task of improvement of management of construction and demolition wastes in recent years has the same importance as protection of the life-support from pollution, issues of conservation of biological and land resources.

Reconstruction and demolition of buildings or structures is performed on the basis of reconstruction and demolition projects and corresponding projects. This is the responsibility of a specialized project organization which develops calendar plans for disassembling of the building, constructive master plans for the preparatory and main periods of work, schedules for necessity for machines, mechanisms, technological equipment, etc. It needs a whole package of information for it: Working documentation for demolished buildings, geological study, technical inspection conclusions, etc. Then further works are projected: schedules for the movement of workers and construction machines are planned, technological maps are developed for the performance of certain types of works, etc.

2. Materials and Methods

In case of necessity of reconstruction or demolition, buildings and structures are considered as a specific set of elements, which are transferred into the category of construction waste. Sequence of processes of reconstruction or demolition of a building consists of the technological processes shown in the Fig. 1



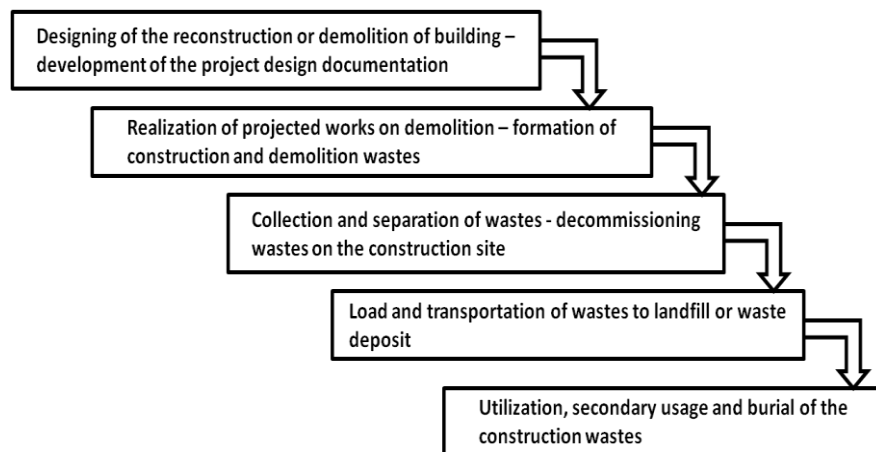


Figure 1. Sequence of reconstruction or demolition processes

Management of construction waste directly on the construction site includes the processes of organization of their collection and sorting, planning of their further processing, required transport, preparation for transportation to waste processing enterprises or landfills for disposal [1].

Analysis of these processes revealed that in many sites under construction and demolition all wastes are collected in one place in a mixed state, which considerably complicates any further actions on them. Separate waste collection, when already sorted disassembly materials are loaded into containers, and each type of material is loaded into each container with minimal content of impurities of foreign substances is not always organized on the site. On construction sites very often occurs situations when significant part of the building has already been dismantled, sorting of generated waste has been performed but as a result of someone's uncoordinated actions there are no garbage containers. This leads to accumulation of wastes in the area of the site of work, and if this area has a limited space, the breakage of the deadlines for the construction and installation works is possible because of lack of territory for sorting and storing newly generated wastes.

At performance of construction and demolition works in the central part of large cities, it is necessary to organize routes of transport along the streets loaded with cars and try to minimize losses from traffic jams in urban traffic jams. Development of urbanization processes, increase in the volume of waste generation, and tightening of environmental requirements lead to necessity of location of enterprises on burial and recycle of wastes at greater distances from the places of their formation, that leads to increase in transportation costs.

Lack of data connection and objective function between the stages of the waste cycle is the primary reason of occurrence of the listed above problems. Specialists involved in the process of building wastes movement at a certain stage (collection, transportation, processing, disposal) often do not have operational information about what happened to the wastes at the previous stage and whether the infrastructure of the next stage is capable to accept them [2].

Systematic approach allows to ensure the informational integrity and objective function of activity. From the point of view of the system approach, in our case, object of the study is the waste management system for construction and demolition, including territorial administrations which are responsible for waste management. Many elements of this system include waste producers; enterprises involved in their collection and transportation; waste-processing enterprises; landfills for waste disposal. Overall objective of the system is the organization of the process of effective usage of construction wastes.

3. Results

It is necessary to consider and analyze information on the full cycle of waste turnover, including data on volumes, species, locations and timing of waste generation at usage of the systemic approach for waste management; to systematize received information, and to process, actualize it and provide the necessary information upon request. Consequently, for improvement of waste management system, it is

necessary to create an informational flow of the full cycle of waste turnover which allow to provide a clear coordination of the activities of individual enterprises at each stage of waste movement (Picture 2).

A number of methodological principles is used at the development of the system.

Systematic approach is based on integrity, which assumes development of informational cooperation between regional authorities which are responsible for treatment of construction waste management and local structural components of the control system. It should be possible to promptly coordinate and mutually adjust actions of organizations involved in the collection and transportation of waste, waste processing plants and landfills for the disposal of construction waste products among themselves [3].

The most important principle in the development of system of construction and demolition waste management is the reliability (ability to maintain the values of the main parameters over time) to ensure safety of their transportation, availability of reserve mechanisms, equipment and communications for adjustment and, in case of necessity, direction of material flows (waste, secondary raw materials, documentation).

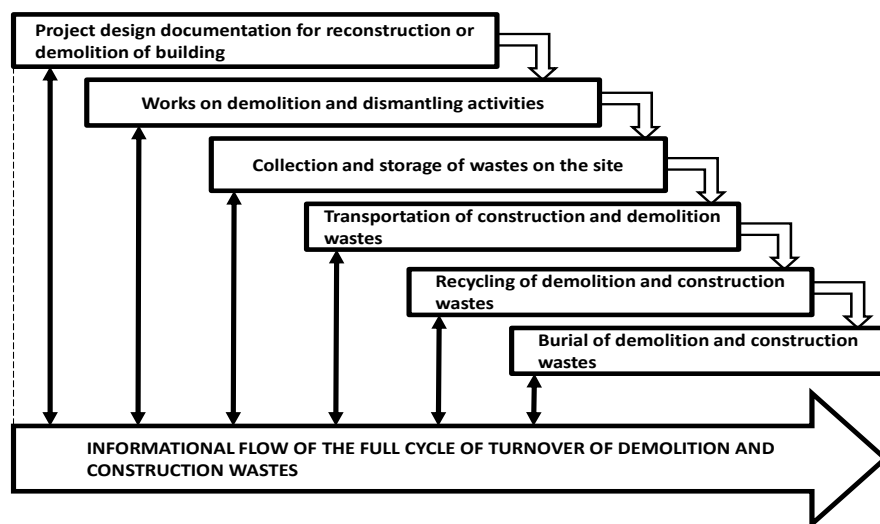


Figure 2. Information flow of the complete cycle of turnover of construction and demolition waste

Principle of alternatives is applied at choose of the most effective way of construction waste procession into the secondary materials. For example, analysis of conditions of the construction site allows to choose one of the schemes for organization of procession for reinforced concrete waste into crushed stone: to install crushing equipment on site or send a concrete breakage on the plant for production of recycled rubble.

In modern conditions, when the external environment of any system is rapidly changing under the influence of situational factors, the presence of properties of adaptability and stability of the system which is being developed is necessary. So, a significant factor in the sustainability of individual parties and the region as a whole becomes the ability of the waste management system to adapt to changing needs of the region and the environment.

As international experience shows, in conditions of the dynamics of market demand, variability of priorities and goals, large reserves of the management efficiency improvement are hidden in application of the modern process approach.

Process approach to the management of turnover of construction waste involves structuring of arising at that material and transport streams in the form of sequence of standardized processes. Today, material and transport component of any process requires a significant investment of assets, so the more rational process of transporting construction waste will be, the greater savings can be obtained.

For solution of existing problems of turnover of construction waste, usage of accumulated tools of logistic methods of organization of processes [4] and, first of all, optimization of their transportation and dispatching is perspective. This principle implies dispatching and monitoring, in other words constant control over the movement and change of movement of every transport which is carrying construction waste, and introduction of timely adjustments to these processes, including: clear coordination of supplies and export of containers with construction and demolition wastes, provision of specialized construction equipment, transportation of waste, readiness for wastes processing enterprises to change the volumes of incoming waste in accordance with seasonality (peak of construction falls on the warm season) and other factors. For that, modern navigation systems are currently used on transport which is carrying construction waste. Technical means of information gathering, called transport navigation systems, are established and based on the usage of navigation satellite systems such as GLONASS and GPS [5] are installed on the specialized transport.

Organizational concept "just in time" has become widespread in these days. Similar principle of "mounting from wheels" is used in domestic practice of construction. Application of this concept allows to ensure the availability of exact amount of required material resource of required quality in a certain place within agreed time with minimal costs. Usage of such concept in the waste management control system can be concluded, for example, in the delivery of the necessary amount of containers of certain capacity with certain characteristics for separate collection of waste at construction sites. "Just-in-time" concept is relevant for planning of the movement of waste from construction sites to waste-processing plants, when calculation of the optimal transportation route and determination of compliance of the waste volume with availability of free production facilities for their processing is necessary [6].

In the countries of European Union, special strategies for management of solid waste are developed. They assume unification of methods for handling them in the realization of procedure for the better real choice on for environment (VREO - Best Practicable Environmental Option). VREO includes development of unified documentation, standardization of characteristics of specialized transport for transportation of solid wastes, etc. Besides, concepts of solid waste management are based on the principles of "shortest distance", the main points of which are the delivery of waste from their places of origin to sites of disposal and processing along the optimal path, as well as prevention of movement of waste at unreasonably long distances [7]. Figure 3 presents an application of the process approach to the material and transport component of the waste management system in construction industry.

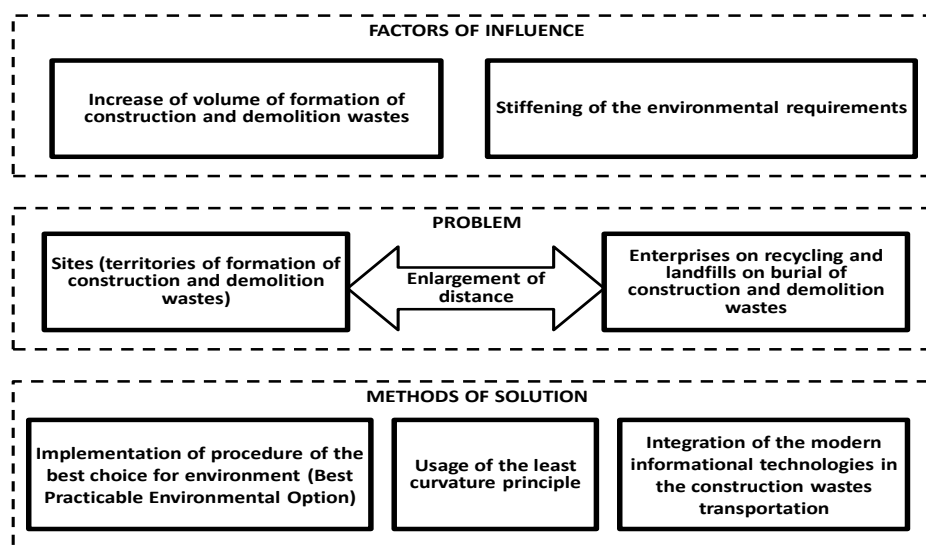


Figure 3. Improvement methods of the material and transport component of the system of construction waste management.

4. Conclusions

So, analysis of the turnover of construction waste problems revealed that management of this sphere should be based on systematic approach to information, which provides an information flow of the full turnover cycle of waste on the basis of modern information technologies and process approach to material transport flows which monitors and optimizes the transportation of wastes on the basis of logistical methods of the processes organization.

Performed analysis revealed that there has not been a single targeted approach for management of the collection, storage and processing of construction wastes and demolition of buildings at the regional and municipal levels to the present times. While the creation of construction wastes management mechanism allows to increase efficiency and environmental safety of the industry and regions.

In management of the processes of storage, utilization and processing of construction and demolition waste, perspective direction of scientific developments, both from the point of view of the regional economy and from the protection of the environment is the study of construction and demolition wastes potential and demolition as secondary raw materials and possibilities of modern technologies of application of wastes as a new sources of raw materials.

References

- [1] Baronin S 2009 *Real estate economy management* **1** pp. 58-62
- [2] Kardes I and Ozturk A and Cavusgil S and Cavusgil E 2013 *International Business Review* **22**, pp. 905-917
- [3] Duvanova I, Bubnova T and Romanovich M 2016 *Procedia Engineering*, **165**, pp. 1794 – 1800
- [4] Ulubeyli S and Kazaz A and Arslan V 2017 *Procedia Engineering* **172** 190-1197
- [5] Evangelista R Vezzan A 2010 A firm-level analysis **39** pp 1253-1263
- [6] Bucher R and Couch C 2013 *International Journal of Marine Energy* **2** pp. 28-42