Reorganization of Waste Management Scheme for Construction and Demolition

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Abstract. The subject of the study is the organization of waste management of construction and demolition in the context of large-scale urban programs for new construction and renovation. This work is aimed at analyzing the principles of organizing the processing of construction waste and forming a proposal for the modernization of functional and planning schemes for handling construction and demolition waste in the context of large-scale urban programs for new construction and renovation. The following materials and methods were used: normative and technical documentation, construction organization projects, a list of environmental protection measures developed as part of the project documentation of implemented capital construction projects; additive scientometric analysis, generalization and presentation of aggregate experimental data on aspects of waste management of construction and demolition. The analysis of the principles of organization of processing of construction waste is performed. The functional and planning scheme of a stationary unit for processing construction and demolition waste and creating (producing) finished products with the integration of construction waste to create materials and products for new construction and renovation is proposed. The future use of the proposed functional and planning schemes is focused on making correct organizational and technological decisions when preparing organizational and technological documentation for capital construction projects. The development and implementation of economically and technologically sound management schemes for construction waste plays a relevant role in achieving responsible consumption and production, as well as in ensuring the transition to rational management models.

1. Introduction
The implementation of resource efficiency improvement and minimization of consumption and production waste is relevant in achieving a set of important socio-ecological and economic aspects of sustainable development.

The publications on the topic of waste management of construction and demolition, available in open access on the Internet, as well as in the following databases: e-library, Scopus (publishing house "Elsevier"), Google Scholar, Sci-hub, CyberLeninka were studied. The literature review demonstrates the significance and relevance of the subject for the domestic construction industry. A number of literature sources [1-13] describe and consider aspects of organization and management of construction and demolition waste management. For example, [9-12] describes methodological approaches to planning activities for the development of the waste management industry, as well as aspects of digitalization of waste management. At the same time, the reorganization measures
described and proposed by publicists concerning the subject under consideration do not take into account a number of factors that integrally affect the responsible management of construction and demolition waste, or do not focus on aspects of treatment that are of high practical significance, especially for the Moscow region.

This work is aimed at analyzing the principles of organizing the processing of construction waste and variably developing functional and planning schemes for the management of construction waste and demolition waste.

2. Methods
The work was carried out using normative and technical literature, as well as scientific databases. Data on the principles of waste management of construction and demolition (including their recovery) included in the organizational schemes of waste management of implemented capital construction projects are summarized and presented.

3. Results
Construction waste is generated at almost all stages of the life cycle of buildings and structures. As a rule, before the start of the zero cycle at the site of new construction is carried out preparation of the territory, which includes the dismantling and removal of existing buildings and structures. Almost all types of construction work are accompanied by the formation of tons of waste, which are often exported to unauthorized landfills, and with a responsible organization of waste management – to special complexes that process consumer and industrial waste, and landfills. [1-8]

According to the analysis of waste management highlighted two main principles of organization of recycling of construction and demolition waste management in the place of their formation, that is, directly on the construction site and waste treatment facilities (facilities for waste recovery, crushing and sorting complexes, points of reception of scrap metal, etc.). Table 1 contains the grouping of waste by category of objects where waste is exported.

| Category of the object to which waste is exported | Type of generated construction and demolition waste |
|--------------------------------------------------|--------------------------------------------------|
| Waste recovery complex                            | Construction rubble waste uncontaminated          |
|                                                  | Scrap brickwork from demolition and disassembly of buildings |
|                                                  | Construction brick scrap, unpolluted              |
|                                                  | Scrap concrete products, concrete waste in lump form |
|                                                  | Natural wood products that have lost their consumer properties and are not polluted |
|                                                  | Waste of thermal insulation materials based on mineral fiber |
|                                                  | Solidified plaster waste is not dangerous         |
|                                                  | Waste of roofing and waterproofing materials      |
| Crushing and sorting complex                      | Scrap of asphalt and asphalt concrete surfaces    |
|                                                  | Scrap of railway products, waste of railway products in lump form |
|                                                  | Scrap concrete products, concrete waste in lump form (from dismantling) |
| Point of reception of scrap metal                 | Scrap and waste containing non-polluted ferrous metals in the form of products, pieces unsorted |

Table 1. Grouping of waste by categories of objects to which it is exported.
The organization of processing directly on the construction site is accompanied by the following aspects: limited capacity of equipment, increased requirements for environmental protection of nearby residential buildings and structures. In turn, waste processing at special complexes entails additional transport costs, as well as the cost of implementing modern technologies for processing construction waste to create materials and products for new construction and renovation.

Based on the analysis of the project documentation of completed capital construction projects, it was found that the cost of transporting construction and demolition waste to recovery complexes on average varies within 50-70 km. This aspect directly affects the cost of construction, which is related to the cost of a square meter of housing. The organization of waste processing directly on the construction site is often limited to the area of the construction site. It is unprofitable to reduce transport costs by renting additional space to accommodate crushing and screening plants and other installations near the waste generation center.

In order to destabilize the projected growth in the cost per square meter due to the influence of the above aspects, it is proposed to reorganize the scheme for the management of construction and demolition waste. There are two schemes for organizing the management of construction and demolition waste: the first involves the organization of stationary nodes for processing construction and demolition waste and creating (releasing) finished products (with the integration of construction waste) with placement within the demolished area, including within the framework of the renovation program, buildings and structures, the second – organization of stationary nodes with the placement of demolished enterprises located on the territories of urban industrial zones located in close proximity to the territories of new construction and renovation, which are in an unused state and need redevelopment. Currently, the capital's redevelopment program includes more than 30 industrial zones. With the second possible treatment scheme, the service radius of a stationary node can be 5...10 km. With such a radius, it is possible to reduce the design capacity of future stationary nodes in comparison with the capacity of existing centers of treatment (including recovery) of the waste under consideration. A combined map of territories that are the dominant center of waste generation for construction and demolition, renovation, which involves the dismantling (demolition) of a number of buildings and structures, and a map of redevelopment of industrial zones in Moscow is shown in figure 1.
Figure 1. Combined map of renovation territories and redevelopment map of Moscow industrial zones.

The functional and planning scheme of a stationary node located in close proximity to the center for generating construction and demolition waste is shown in figure 2. The functional and planning scheme of a stationary node with waste generation centers located in the service area of construction and demolition, and objects of new construction and renovation, with the necessary explanations, is shown in figure 3.
Figure 2. Functional and planning scheme of a stationary node located in close proximity to the center for generating construction and demolition waste.

Figure 3. Functional and planning scheme of a stationary node with construction and demolition waste generation centers located in the service area and new construction and renovation facilities.

4. Discussion
The variability of the practical possibility of recycling construction and demolition waste leads to the need to develop comprehensive recommendations for the organization of stationary sites for processing these wastes and creating (releasing) finished products with their integration, as well as for the choice of technologies for processing construction waste to create materials and products for new construction and renovation.

5. Conclusions
The future use of the proposed functional planning schemes is focused on making correct organizational and technological decisions when preparing organizational and technological documentation for capital construction projects. The development and implementation of economically and technologically sound construction waste management schemes plays a relevant role
in achieving responsible consumption and production, as well as in ensuring the transition to rational management models.

6. References

[1] Kravtsova M, Vasiliev A, Kravtsov A 2015 Analysis of construction waste disposal methods with their subsequent involvement in secondary circulation Bulletin of the Samara Scientific Center of the Russian Academy of Sciences 4

[2] Berezovsky S 2011 Use of local raw materials and overburden for the production of building materials Bulletin of the Belarusian-Russian University 32

[3] Tskhovrebov E 2017 Modeling the ecological balance of the construction and demolition of buildings Construction: science and education 3 URL: https://cyberleninka.ru/article/n/modelirovanie-ekologicheskogo-balansa-obekta-stroitelstva-isnosna-zdaniy (accessed date: 10.03.2020)

[4] Gorbachevskii V 2019 Use of industrial waste in underground construction (M.: NRU MSUCE) 90 p

[5] Sinenko S, Miroshnikova I 2018 Introduction of the methodology for evaluating suppliers as one of the ways to reduce construction time System Technologies 2(27)

[6] Borovskih A, Gorbachevskii V, Pachomova L 2019 Account of the force resistance in the calculation of reinforced concrete structures Journal of Physics: Conference Series Vol 1425 012092

[7] Pakhomova L, Moiseeva S, Tereshina K 2018 Air pollution by construction vehicles IOP Conf. Ser.: Mater. Sci. Eng. Vol 463 042041

[8] Oleynik P, Brodsky V 2013 Organization of construction waste management Visnik PDABA 10(187) URL: https://cyberleninka.ru/article/n/organizatsiya-upravleniya-pererabotkoy-stroitelnykh-otvodov (accessed date: 10.03.2020)

[9] Tskhovrebov E 2018 Ecological and economic aspects of planning the location and design of industrial facilities for the treatment, recycling, disposal of waste Vestnik MGSU 11(122) URL: https://cyberleninka.ru/article/n/ekologo-ekonomicheskie-aspekty-planirovaniya-razmescheniya-i-proektirovaniya-promyshlennyy-obektov-po-obrabotke-utilizatsii (accessed date: 10.03.2020)

[10] Rozina V, Dagbaeva Yu 2019 Management of the system for processing construction waste Universum: technical sciences 6(63) URL: https://cyberleninka.ru/article/n/upravlienie-sistemoy-pererabotki-stroitelnykh-otvodov (accessed date: 10.03.2020)

[11] Oleinik S, Chulkov V 2016 Management of construction and demolition waste management Internet magazine "Waste and resources" Vol 3 1 URL: // resources.today/PDF/03RRO116.pdf (accessed date: 10.03.2020)

[12] Lunev G, Prokhotsky Yu 2019 Secondary construction resources: ecological and economic approach to classification Competence 7 URL: https://cyberleninka.ru/article/n/vtorichnye-stroitelnye-rersys-ekologo-ekonomicheskii-podhod-k-klassifikatsii (accessed date: 10.03.2020)

[13] Koklyugin A V 2015 Problems of the implementation of construction technologies for the use of waste during the dismantling of buildings in the Republic of Tatarstan News of KazGASU 4(34) URL: https://cyberleninka.ru/article/n/problemy-realizatsii-stroitelnyh-tehnologiy-ispolzovaniya-othodov-pri-razborke-zdaniy-v-respublike-tatarstan (accessed date: 10.03.2020).

[14] Skochikhina T 2015 The dynamics of the processing of construction waste generated on the territory of St. Petersburg Economics and Environmental Management 1 URL: https://cyberleninka.ru/article/n/dinamika-pererabotki-stroitelnyh-othodov-obrazuyuschisya-na-territorii-sankt-peterburga (accessed date: 10.03.2020)

[15] Stepanenko V 2012 On the development of regional regulation in the field of waste management Ecology of production (M.: Publishing House of Business Media) 5 104 p

[16] Fakhratov M A, Fayzullin D A 2018 Organizational problems of the use of industrial waste
Institute of Internal Affairs 3(50) URL: https://cyberleninka.ru/article/n/organizatsionnye-problemy-ispolzovaniya-promyshlennyh-othodov (accessed date: 10.03.2020)

[17] Oleynik S 2016 Construction waste during the reconstruction of buildings and structures Otkhody i resursy vol 3 2 http://resources.today/PDF/02RR0216

[18] Waste Awareness What's New in Eco-Materials Access mode: https://whatisnewinecomaterials.wordpress.com/2014/08/18/waste-awareness/ (accessed date: 10.03.2020)

[19] Lunev G 2019 Development of a methodology for the integrated use of secondary building resources (Moscow, Nauchtekhlitizdat) 284 p

[20] Lelikova O, Onishchenko O, Zhabalova G, Kamarova S 2018 Prospects for the use of waste of ArcelorMittal Temirtau JSC in construction Bulletin of science and education 5(41)

Acknowledgments
We express gratitude for the cooperation to the organizing committee of FEFU.