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An Organizational and Technological Model for Construction Waste Management in Dense Urban Development

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Abstract

Introduction. The research is devoted to developing effective methods for managing construction waste on residential sites in dense urban areas. Innovative approaches to waste management are set forth, including separate collection, digitalization of processes and modern primary treatment technologies in compliance with the requirements of ecology and resource conservation.

Materials and Methods. The study was conducted using the method of aggregated calculations of waste volume using the example of an actual housing construction facility with an area of 20,000 m^2. The assessment was performed based on the distribution of waste by categories and stages of production (excavation, monolith, installation, engineering networks, finishing, landscaping). The average coefficients of waste generation and material density were used in oder to calculate the total mass of each fraction. A comparative analysis of two logistics scenarios was carried out: a traditional one (collecting all waste together and sending it to the landfill) and an innovative one (separate collection, on-site pre-treatment, recycling priority and digital accounting).

Research Results. The significant economic and environmental effect of the introduction of an innovative approach to construction waste management is indicated. Compared to the basic scenario ("mixed collection → landfill"), the innovative scheme ("separate collection + on-site processing + recycling priority + digital registration") provides a 51% reduction in landfill volumes and a 50% reduction in traffic. The major success parameter is the volume of soil reuse, which reduces the mass of recyclable waste and the number of dump truck trips by almost a half. The financial benefit is complemented by the possibility of commercial sales of secondary resources and introducing digital control tools. The results are presented in tables displaying the monthly dynamics of waste generation. Recommendations on containerization and assessment of the impact of the assumptions on the final indicators are provided.

Discussion and Conclusion. A construction waste management methodology has been developed that reduces the volume of disposal, transport load and provides savings by optimizing on-site recycling. An increase in the level of secondary use and effective primary waste treatment has been ensured.

Keywords: construction waste, waste management, waste sorting, recycling, digital platforms, mobile sorting complexes

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Оригинальное эмпирическое исследование

Организационно-технологическая модель управления строительными отходами в условиях плотной городской застройки

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Аннотация
Введение. Исследование посвящено разработке эффективных методик управления строительными отходами на площадках жилой застройки в условиях плотной городской застройки. Предложены инновационные подходы к обращению с отходами, включающие раздельный сбор, цифровизацию процессов и современные технологии первичной обработки, соответствующие требованиям экологии и ресурсосбережения.
Материалы и методы. Исследование проведено методом укрупнённых расчётов объёма отходов на примере реального объекта жилищного строительства площадью 20 тыс. м². Оценка проведена на основе распределения отходов по категориям и стадиям производства (земляные работы, монолит, монтаж, инженерные сети, отделка, благоустройство). Использованы усреднённые коэффициенты образования отходов и плотности материалов, позволяющие рассчитать итоговую массу каждой фракции. Проведен сравнительный анализ двух сценариев логистики: традиционного (сбор всех отходов вместе и отправка на полигон) и инновационного (раздельный сбор, предобработка на площадке, приоритет переработки и цифровой учёт).
Результаты исследования. Показан существенный экономический и экологический эффект от внедрения инновационного подхода к управлению строительными отходами. По сравнению с базовым сценарием («смешанный сбор → полигон»), инновационная схема («раздельный сбор + обработка на площадке + приоритет переработки + цифровая регистрация») обеспечивает снижение объемов захоронения на 51 %, уменьшение транспортного трафика на 50 %. Ключевым параметром успеха являются объемы повторного использования грунта, что снижает массу перерабатываемых отходов и количество рейсов самосвалов почти вдвое. Финансовая выгода дополняется возможностью коммерческой реализации вторичных ресурсов и внедрением цифровых инструментов контроля. Результаты представлены в таблицах, демонстрирующих помесячную динамику образования отходов. Даны рекомендации по контейнированию и оценке влияния допущений на итоговые показатели.
Обсуждение и заключение. Разработана методика управления строительными отходами, сокращающая объём захоронения, транспортную нагрузку и обеспечивающая экономию за счёт оптимизации переработки на месте. Обеспечено повышение уровня вторичного использования и эффективной первичной обработки отходов.

Ключевые слова*:* строительные отходы, управление отходами, сортировка отходов, переработка, цифровые платформы, мобильные сортировочные комплексы

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Introduction. The relevance of the research is due to the scope of the problem of a significant amount of construction waste typical of modern urban construction, particularly in limited urban construction areas. The high intensity of construction activity generates a large volume of construction debris, creating a considerable burden on the environment and urban infrastructure. Modern cities are faced with the urgent need of addressing issues of rational waste management due to the lack of temporary waste storage, increased requirements for environmental protection and sustainable development [4, 5].

Modern urban planning policy is aimed at developing a closed-loop economy, which provides for a significant increase in the level of recycling of building materials (up to 40% by 2030) [4, 11]. This poses major challenges for new approaches to waste management to be developed, including introducing innovative technologies and practices [5, 12].

Thus, this study addresses the problem of developing a comprehensive strategy for construction waste management aimed at reducing the environmental burden, increasing resource conservation and improving organizational as well as technological approaches to waste management in construction sites [2–4].

The object of the study is waste management organization in a construction site of a multi-storey residential building in dense urban environment. The subject of the study are innovative methods of collection, classification, processing and subsequent disposal of construction waste in specific construction sites.

The aim of the study is to justify and develop efficient solutions for optimizing construction waste management in construction of multi-storey residential buildings in dense urban environments, including modern sorting and recycling technologies in compliance with the environmental standards and restrictions of an urban environment.

To this end, the following research tasks were formulated:

1. Investigating the laws and regulations governing waste management in urban construction sites.
2. Analyzing the types and volumes of waste generated at each stage of residential building construction.
3. Studying modern methods of collecting, sorting and recycling construction waste, including digital management and mobile primary processing.
4. Developing practical recommendations for improving waste disposal during housing construction in dense urban environments.

Urban development is characterized by a significant amount of construction waste generated in cramped conditions, with strict restrictions on noise and traffic levels, as well as the lack of opportunities for their disposal [5, 8]. The traditional method of removing unsorted garbage leads to increased transportation costs, environmental risks, and downtime in construction sites [5].

The main types of construction waste include:

– dismantling waste (brick, concrete, structural fragments);
– excavation waste (excess soil, sand-gravel mixtures);
– construction waste (concrete crumbs, pieces of reinforcement, packaging);
– finishing waste (tile clippings, drywall, paint and varnish remnants).

Managing these flows is complicated by the peculiarities of urban development: lack of space, strict transportation rules and restrictions on the mode of work [5, 8]. In order to comply with the established standards, clear regulations for cleaning, separate collection and prompt disposal of waste are needed to minimize the negative impact on the urban environment and reducing the developer’s costs [2].

The digital waste accounting system helps automate monitoring and increase transparency of waste management [5, 12]. The example of the Moscow AIS OSSiG (Automated Information System Waste of Construction, Demolition and Soil) demonstrates the effectiveness of automatic tracking of dump truck flights using GPS sensors and electronic document management [8]. The system records movement of goods and the point of delivery, preventing illegal dumping of garbage and ensuring compliance with the environmental standards.

Commercial solutions expand functionality by offering IoT technologies (container occupancy sensors, weight sensors of equipment), increasing the accuracy of route planning and reducing logistics costs [10, 12]. Electronic marketplaces enable exchange of recyclable materials between objects reducing the total amount of waste [11].

The environmental significance of the issue is emphasized by the statistics: construction waste accounts for roughly 30% of the total municipal solid waste, which indicates the importance of accounting for such a volume of garbage. Large-scale urban reconstruction and new housing stock annually require solving the problem of recycling thousands of tons of building materials [1, 4]. At the same time, recycled construction waste is a valuable source of recyclable materials needed by industry [2, 9].

The increased state requirements are stipulated by Federal Law No. 89-FZ dated 24/06/1998 "On Production and Consumption Waste" that provides for waste management standards, including control over movement of construction debris. Regional authorities are actively introducing a system for monitoring movement of waste from the site to landfills, combating illegal dumping and unauthorized landfills [5, 8].

Thus, creating a construction waste management model combining separate collection, on-site pretreatment and efficient logistics becomes a prerequisite for compliance with modern environmental standards, reducing the burden on landfills and saving natural resources [2, 5, 9].

The research focuses on analyzing the compositions and volumes of construction waste at different stages of residential building construction in dense urban environments [3, 5]. Basic and improved waste management schemes are being considered, organizational and technical procedures (containerization schedules, RACI responsibility allocation, key KPIs) are being developed, and a feasibility study of each option is being conducted [2, 7, 12].

The practical value is a possibility of applying the developed model to similar projects of mass urban development [5, 8].

Materials and Methods. The calculations for the object were performed on a large scale due to the lack of detailed logs of mass volumes of work. The volume of waste is estimated based on the specific area of the object (20,000 m^2) and types of work (monolith, finishing, etc.) followed by categorization (inert, metal, wood, polymers, mixed material, waste of hazard class III) [3, 5]. Logistics is organized taking into account limitations of a site (one-way entrance, wheel washing complex, temporary entry windows for heavy equipment) [5, 8].

The basic option is the traditional mixed collection of all types of construction debris followed by shipment to landfills. An innovative alternative involves introducing a separate waste collection system in a construction site, pretreatment and priority transfer of suitable materials for recycling by means of digital technologies for controlling traffic flows and waste mass accounting [12].

The calculations were carried out for a specific object (Building 5 at 11 Kantemirovskaya Str., Saint Petersburg) using common initial values of V_i differing only in the organization of the waste stream and proportion of their subsequent reuse.

The calculation method is universal: each type of work corresponds to its own specific waste generation index (coefficient k_i), which makes it possible to identify the total mass of waste:

$$Q_i = k_i \times V_i$$

that is further distributed into the main fractions (inert materials, metals, wood, polymers, a mixture of finishing materials, hazardous waste).

The assumptions in the calculations are as follows:

– the excess soil makes up 25% of the total excavation (density 1.6 t/m³);
– residual concrete — 0.6 % of the volume to be poured (2.4 t/m³);
– rebar scrap — 1.5 % of the total weight;
– packaging of enclosing structures — 0.6 kg/m²;
– the excess of engineering supplies: packaging — 1.5%, technological trimmings — 2% by weight,
– finishing works: a mixed group — 3.5 kg/m², hazardous waste (containers of paints and polishes) — 0.12 kg/m²;
– landscaping: other waste — 0.8 kg/m².

The volume of work on the site: excavation — 12,000 m^3, monolithic concrete — 10,000 m^3, reinforcement — 1,500 tons, facade fences — 14,000 m^2, engineering networks — 300 tons, finishing works — 22,000 m^2, landscaping — 5,000 m^2 (Table 1).

Table 1

Calculation of waste generation by stages and fractions

Stage → fraction	Unit (V_i)	Initial data / coefficient	Mass (Q_i), t
Ground → excess soil	m³	12,000 × 25 % × 1.6 t/m³	4,800.00
Monolith → inert (remnants of concrete/mortar)	m³	10,000 × 0.6 % × 2.4 t/m³	144
Monolith → metal (rebar scrap)	t	1,500 × 1.5%	22.5
Enclosing/mounting → packaging	m²	14,000 × 0.6 kg/m²	8.4
Engineering systems → packaging	t	300 × 1.5 %	4.5
Engineering systems → technological trimmings	t	300 × 2.0 %	6
Finishing → mixed	m²	22,000 × 3.5 kg/m²	77
Finishing → hazardous (LKM packaging, class III)	m²	22,000 × 0.12 kg/m²	2.64
Landscaping → other	m²	5,000 × 0.8 kg/m²	4
Total			5,069.04

The bulk of construction waste is made up of soils formed during excavation. The total volume of extracted soil reaches 5,069.04 tons, which corresponds to 253 kg per 1 m^2 of a building. The significant specific gravity of soils is crucial to the strategy of their disposal and transportation, having a major impact on the key project performance indicators (KPIs). An analysis of the accumulation dynamics shows an intensive increase in the volume of waste in the initial months due to excavation work ("the ground peak") followed by a smooth increase in volumes due to monolithic work, facade operations and interior decoration of an object (Table 2). This determines the need for accurate planning of loading and unloading operations and timely release of the site for further construction and installation.

In order to make it possible to reproduce the calculations and verify the validity of the accepted assumptions, the coefficients and densities used in a separate table are summarized (Table 3).

The transition from waste mass calculations to logistics issues clearly illustrates the need for vehicles with the required body volume and number of flights (Table 4). As for the light fractions (such as packaging and mixed waste), the key factor is not their mass rather the volume occupied. The use of presses to seal cartons, films, and other lightweight materials significantly reduces container turnover, efficiently saving transportation resources and reducing the number of trips required.

Table 2

Monthly waste generation by stages (t/month)

Month	Ground	Monolith (inert + rebar)	Enclosing/ assembly	Engineering	Finishing	Landscaping	Total
1	1,600	0	0	0	0	0	1,600.00
2	1,600	0	0	0	0	0	1,600.00
3	1,600	16.65	0	0	0	0	1,616.65
4	0	16.65	0	0	0	0	16.65
5	0	16.65	0	0	0	0	16.65
6	0	16.65	0	0	0	0	16.65
7	0	16.65	0	0	0	0	16.65
8	0	16.65	0	0	0	0	16.65
9	0	16.65	1.05	0	0	0	17.70
10	0	16.65	1.05	0.95	0	0	18.65
11	0	16.65	1.05	0.95	0	0	18.65
12	0	16.65	1.05	0.95	7.24	0	25.89
13	0	0	1.05	0.95	7.24	0	9.24
14	0	0	1.05	0.95	7.24	0	9.24
15	0	0	1.05	0.95	7.24	0	9.24
16	0	0	1.05	0.95	7.24	0	9.24
17	0	0	0	0.95	7.24	0	8.19
18	0	0	0	0.95	7.24	0	8.19
19	0	0	0	0.95	7.24	0	8.19
20	0	0	0	1	7.24	0	8.24
21	0	0	0	0	7.24	0	7.24
22	0	0	0	0	7.24	1.33	8.57
23	0	0	0	0	0	1.33	1.33
24	0	0	0	0	0	1.34	1.34
Итого	4,800.00	166.5	8.4	10.5	79.64	4	5,069.04

Table 3

Accepted coefficients and densities

Parameter	Accepted value	Commentary
Excess soil	25 % from the excavation; ρ = 1.6 t/m³	Only the exported volume is considered
Landscaping – other	0.8 kg/m²	Cutting/packaging

Table 4

Calculation of the number of trips for removing soil

Fraction	Mass, t	Estimated density (bulk)	Volume, m³	Bunkers of 20 m³ (total)	Dump truck trips
Soil	4 800,0	–	–	–	≈ 423 (12 t/trip)

The excess soil is removed from the site exclusively by road — directly by dump trucks to specialized landfills. However, in order to make informed management decisions, it is critical to understand which assumptions have the greatest impact on the outcome of the calculations. Thus a brief sensitivity analysis is carried out below, revealing the most significant factor influencing the outcome of the study (Table 5).

Table 5

Sensitivity of the result to the major assumptions

Assumption change	Previous	New	Δ mass, t	Impact
Excess soil proportion ± 5 units	25 %	20–30 %	± 960	Critical (± 19 % of the total)

The operational readiness of the construction site ensures a clear definition of the hazard classes of waste and the types of containers in use (see Table 6 for an example). Such a measure is necessary for proper implementation of separate collection and further coordination of contract-based waste transfer procedures to specialized organizations. A proper classification and labeling of waste helps to avoid violations of sanitary and environmental standards, minimize the risks of fines and litigation, and contribute to improving waste management quality and compliance with the requirements of the state-run inspection bodies.

Table 6

Fractions, hazard classes and recommended packaging

Fraction	Class	Recommended packaging / area
Soil (non-polluted)	V	Direct export; temporary buffer ≤ 1–2 days

These data provide a reliable basis for comparing the considered scenarios. The main source of uncertainty is the level of reuse of excess soil. To take into account possible scenarios, the calculation is performed according to three reuse scenarios: zero use (0%), partial use (25%) and moderate use (50%) (Table 7). This approach makes it possible to identify the dependence of the volume of soil deposited, the number of trips and costs on the actual constraints existing in an urban space (quality of the extracted soil, availability of reception points, allowed time of export).

Table 7

Distribution of flows by fractions (reuse / recycling and burial), t (option: 50% reuse of the soil)

Fraction	Total mass	Base: reuse / recycling	Base: burial	Innovations: reuse / recycling	Innovations: burial
Soil (excess)	4,800.00	0	4,800.00	2,400.00	2,400.00

The final structure of waste streams heavily depends on the selected level of soil reuse. The indicators in Table 7 are calculated according to an optimistic scenario with a reuse rate of 50%. This case reflects a situation where there is a proven infrastructure for receiving soil, and favorable conditions for its use are provided.

However, in order to develop sustainable management solutions, it is suggested that an intermediate option with an equity participation of 25% is considered, which seems more realistic for most urban sites. On top of that, a conservative scenario with a complete absence of soil reuse (0%) is being considered.

Research Results. The results should be interpreted taking into account the above three levels: full utilization (0%), partial utilization (25%) [6] and optimal utilization (50%). The specific numerical values will depend on the clarifying calculations (Table 8).

The major criteria for evaluating scenarios are presented in a concise form of a table-map reflecting the four key indicators: proportion of waste involved in reuse, volume of disposal, logistical costs and unit costs per unit of the recycled area.

Table 8

Integral indicators (mass, logistics, specific ones)

Index	Base	Innovations	Effect
Reuse / recycling, t	36.02	2,593.70	2,557.68
Recycling proportion, %	0.71	51.2	50.5
Burial, t	5,033.02	2,475.34	–2,557.68 (–50.8 %)
Mass for export, t	5,069.04	2,553.84	–2,515.20 (–49.6 %)
Dump truck trips (12 t/trip), items	≈ 423	≈ 213	–210 (–49.6 %)
Specific burial, t/m²	0.252	0.124	–0.128
Specific reuse / recycling, kg/m²	1.8	129.7	127.9

For a fuller picture a cost comparison based on approximate tariffs is provided: transport — 9,000 rubles/trip (12 tons), soil placement — 900 rubles/ton (Table 9).

Table 9

Direct cost scenarios (a design example)

Expense item	Unit	Tariff, rub	Base (volume)	Base, rub	Innovations (volume)	Innovations, rub
Transport (dump trucks, 12 t)	trip	9,000	≈ 423	3,807,000	≈ 213	1,917,000
Soil placement	t	900	4,800	4,320,000	2 400	2,160,000
Total direct costs				8,127,000		4,077,000

The financial result ranges from 8.13 million to 4.08 million rubles (approximately a 50% reduction), depending on the proportion of soil reuse (0, 25 or 50%). The example is focused on an optimistic level of 50%; for a basic urban practice (25%) and a conservative scenario (0%), the cost is additionally adjusted using sensitivity analysis (see below for more information) [7]. The actual operating results should be considered in the specified range, rather than relying on a single value.

Operational advantages (non-financial ones):

– reduction in the number of car trips by almost a half (about 210 trips fewer), which facilitates the traffic situation and unloading of departure "slots";

– reduction in peak waste accumulations on site, thereby improving sanitary and hygienic conditions;

– increased transparency of operations: electronic transportation accounting, simplified control, and electronic reporting reduce the likelihood of administrative sanctions and penalties;

– effective handling of pollution (dust, noise) due to short cycles of pre-crushing and pressing of waste.

The sensitivity of the final result. The soil management strategy has the most significant impact on the overall project economy: a change in the share of reuse by only 5 percentage points (e.g., from 25 to 30%) involves those in the order of 960 tons of cargo and about 1 million rubles in savings. The other coefficients (concrete residues, rate of formation of finishing waste) have a less pronounced effect [7].

Thus while clarifying the initial data, it is recommended that the exact amount of excavation and the actual proportion of returned soil is recorded, availability of a mobile crusher is assessed and tariffs for waste transportation and reception at landfills are inspected [8].

The advantages of an innovative scenario. The implementation of an innovative strategy in an urban environment yields significant benefits:

– reduction in the burial volumes by 51 %;

– reduction in the traffic load by almost a half (–50% of trips);

– direct financial savings amount to almost a half of the initial cost of waste management.

Additional measures to enhance the effect include commercial sales of secondary resources (metal, secondary crushed stone) and mandatory digitalization of reporting, which contributes to transparency and reduces risks of errors [9].

The aim of the innovation scenario. In the construction site, it is necessary to organize the online work (Table 10) in such a way that:

– to maintain cleanliness and environmental friendliness: carry out regular cleaning of contaminated areas, cover bunkers and wash wheels at departure;

– to organize the weighing of goods at departure (if there is a weighing unit) or calculate the mass by volume and density with mandatory documentation (photo fixation);

– to carry out logistics planning between peak hours or at night, taking into account the established time "slots";

– to create a margin of flexibility in the departure schedule (+15% trip reserve);

– to use machinery: dump trucks with a lifting capacity of 12 tons for soil and bunkering trucks with a capacity of 20 m^3 for the remaining waste fractions.

Table 10

Weekly operation cycle (an example)

Day	07:00–11:00	11:00–15:00	15:00–19:00	22:00–06:00
Mon	Collection / fraction replacement	Packaging pressing	Loading the inert materials	Soil export (slots)
Tue	Crushing the inert materials	Screen / magnet	Loading of secondary limestone	Mix waste export

The main driver of positive changes is effective management of the largest mass of waste — of land and inert materials. Their local reuse has a direct impact on the total mass of waste and the amount of required transport. The accepted proportion of soil reuse (0, 25 or 50%) determines the extent of the positive effect: with an increase in the percentage of reuse, the volume of burial decreases and that of transported material decreases (Table 11).

Table 11

Total KPIs according to the scenarios (mass, logistics, specific ones)

Index	Base	Innovations	Effect
Accumulated waste mass, t	5,069	5,069	–
Reuse / recycling, t	36	2,593.7	2 557.7 t
Proportion of reuse / recycling, %	0.71	51.2	50.5 units
Burial, t	5,033	2 475.3	–2 557.7 t (–50.8 %)
Mass for export, t	5,069	2 553.8	–2 515.2 t (–49.6 %)
Dump truck trips (12 t/trip), items	≈ 423	≈ 213	–210 trips (–49.6 %)
Specific burial, t/m²	0.252	0.124	–0.128 t/m²
Specific reuse / recycling, kg/m²	1.8	129.7	127.9 kg/m²

E.g., with a 50% reuse rate, approximately 2.5 thousand tons of recycled soil and recycled crushed stone remain on site [6], whereas as the proportion drops, this positive effect naturally subsides.

Economic assessment. The estimated tariffs have been accepted (replaced by the actual ones): transportation — 9,000 rubles/trip (12 tons), soil placement — 900 rubles/ton, trip (Table 12).

Table 12

Direct costs according to the scenarios (a design example)

Expense item	Unit	Tariff, rub	Base (volume)	Base, rub	Innovations (volume)	Innovations, rub
Transport (dump trucks, 12 t)	trip	9,000	≈ 423	3,807,000	≈ 213	1,917,000
Soil placement	t	900	4,800	4,320,000	2,400	2,160,000

Discussion and Conclusion. As a result of the study, an effective construction waste management technique has been set forth that makes it possible to reduce the volume of landfills by 51% as well as the transport impact on the urban environment by 50% and achieve an economic effect: the total savings of about 4.1–4.2 million rubles (≈ 50% of the base), or ≈ 200–210 rub/m^2 of the total area, i.e. 50% relative to the traditional waste management model.

The resulting savings are achieved due to the three main factors:

– reducing the number of trips by almost a half due to localization of some of the processing directly in the construction site;

– reducing the fees for waste disposal at specialized landfills by increasing the share of reuse of raw materials;

– effectiveness of low-cost pre-treatment operations (crushing, pressing) providing additional benefits within the framework of an integrated approach.

At the same time, separate waste collection, mobile primary processing and digitalization of logistics have a major role to play [13]. The factor of reuse of excess soil turned out to be particularly significant: changing its proportion by only 5% can yield additional millions of rubles in savings. The implementation of the suggested concept provides for development of an integrated action program combining environmentally friendly methods, digital registration and competent logistics. The results will enable the construction of residential facilities with less damage to nature and significant savings in financial resources.

References

1. Kolodyazhny SA, Zolotukhin SN, Abramenko AA, Artemova EA Destruction of Buildings and Use of Materials from Renovated Urban Territories. *Vestnik MGSU*. 2020. 15(2), 271–293. (In Russ.) https://doi.org/10.22227/1997-0935.2020.2.271-293

2. Khmelevskoi NA Efficiency of Construction Waste Recycling. *Integral: International Journal of Applied Sciences and Technology*. 2020;3:19. (In Russ.) URL: https://elibrary.ru/item.asp?id=43086681 (accessed: 25.03.2026)

3. Paramonova ON, Yydina NV Construction Waste from Perspective of the Disperse Systems Stabilisation Theory. *Construction Materials and Products.* 2024;3(1):48–56. (In Russ.) https://doi.org/10.23947/2949-1835-2024-3-1-48-56

4. Yakovenko KA, Iskrin VA State of Construction Waste Management Abroad. *Proceeding of the Donbas National Academy of Civil Engineering and Architecture.* 2024;5(169):58–65. (In Russ.) https://doi.org/10.71536/vd.2024.5c169.7

5. Rozina VE, Dagbaeva YuB Managing a System for Processing Construction Waste. *Universum: Technical Sciences.* 2019;6(63). (In Russ.) URL: https://7universum.com/ru/tech/archive/item/7430 (accessed: 25.03.2026)

6. Dement'eva ME, Mazurin DM Organization of Construction Waste Processes Using “Smart Demolition” Technology. *Construction and Architecture*. 2023;4:10. (In Russ.) https://doi.org/10.29039/2308-0191-2023-11-4-10-10

7. Fedorov MI *Financial Aspects of Building a Recycling System in Construction.* Master’s Thesis. Siberian Federal University, Krasnoyarsk. 2019. 145 p. (In Russ.) URL: https://elib.sfu-kras.ru/handle/2311/112514 (accessed: 25.03.2026)

8. Akhmedova GT Logistics of Collection, Processing and Reuse of Construction Waste. *Author’s Abstract of Cand. (Econ) Thesis.* RSUE, Rostov-on-Don; 2022. 27 p. (In Russ.) URL: https://goo.su/Q9796o (accessed: 25.03.2026)

9. Makul N, Fediuk R, Amran M, Zeyad AM, Murali G, Vatin N et al. Use of Recycled Concrete Aggregates in Production of Green Cement-Based Concrete Composites: A Review. *Crystals.* 2021;11(3):232. https://doi.org/10.3390/cryst11030232

10. Dodampegama S, Hou L, Asadi E, Zhang G, Setunge S Revolutionizing Construction and Demolition Waste Sorting: Insights from Artificial Intelligence and Robotic Applications. *Resources, Conservation & Recycling.* 2024;202:107375. https://doi.org/10.1016/j.resconrec.2023.107375

11. Bao Z Developing Circularity of Construction Waste for a Sustainable Built Environment in Emerging Economies: New Insights from China. *Developments in the Built Environment.* 2023;13:100107. https://doi.org/10.1016/j.dibe.2022.100107

12. Han D, Kalantari M, Rajabifard A BIM for Construction and Demolition Waste Management in Australia: A Research Agenda. *Sustainability.* 2021;13(23):12983. https://doi.org/10.3390/su132312983

13. Kaewunruen S, Lin YH, Guo Y BIM-Driven Digital Twin for Demolition Waste Management. *Scientific Reports.* 2025;15:28989. https://doi.org/10.1038/s41598-025-13938-9

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