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РЕСПУБЛИКИ КАЗАХСТАН»

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THE USE OF SIMULATION MODELING IN CALCULATING THE PRODUCTIVITY OF THE TECHNOLOGICAL SYSTEM FOR THE PRODUCTION OF BUILDING PRODUCTS WITH FILLERS FROM MAN-MADE WASTE

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Abstract. Currently in Kazakhstan, the use of digital technologies to solve both applied and practical problems is quite active. One of the priority areas in scientific research is the methodology of simulation modeling. тThis is primarily due to the fact that simulation models are maximally adapted to real systems and adequate results are obtained in simulation. The advantages of simulation modeling include the performance of calculations by users who do not have practical experience in the construction industry. Quite often in production, when working with various types of technogenic raw materials (metallurgical slag, bauxite sludge), it is not always clear how these concrete mix fillers will affect the productivity of building products, which ultimately affects production efficiency. Therefore, the purpose of this article is to study the parameters of the system time, depending on the type of technogenic waste (metallurgical slag, bauxite sludge) used as fillers for concrete mixture and its impact on the performance of the technological system of building products production. The author's program was used as a software tool in the study. The results of the study can be used in real production.
Keywords: technogenic waste, productivity of the technological production system, simulation model, system time, modeling

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ҚҰРЫЛЫС БҰЙЫМДАРЫН ӨНДІРУДІҢ ТЕХНОЛОГИЯЛЫҚ ЖҮЙЕСІНІҢ ӨНІМДІЛІГІНЕ ТЕХНОГЕНДІК ШИКІЗАТТЫҢ ӘСЕРІН БАҒАЛАУ ҮШІН ИМИТАЦИЯЛЫҚ МОДЕЛЬДЕУДІ ҚОЛДАНУ

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Аннотация. Қазіргі уақытта Қазақстанда қолданбалы және практикалық мәселелерді шешу үшін цифрлық технологияларды қолдану белсенді түрде қолға алынды. Ғылыми зерттеулердегі басым бағыттардың бірі имитациялық модельдеу әдіснамасы болып табылады. Бұл, ең алдымен, модельдеу модельдерінің нақты жүйелерге максималды бейімделуімен және модельдеу кезінде адекватты нәтижелер алуымен байланысты. Имитациялық модельдеудің артықшылықтары құрылыс индустриясында практикалық тәжірибесі жоқ пайдаланушылардың есептеулерді орындауын қамтиды. Көбінесе өндірісте техногендік шикізаттың әртүрлі түрлерімен (металлургиялық шлак, боксит шламы) жұмыс істегенде, бұл бетон қоспасының толтырғыштары құрылыс өнімдерінің өнімділігіне қалай әсер ететіні әрқашан анық емес, бұл түптеп келгенде өндіріс тиімділігіне әсер етеді. Осыған байланысты, осы мақаланың мақсаты бетон қоспасын толтырғыш ретінде қолданылатын техногендік қалдықтардың (металлургиялық шлак, боксит шламы) түріне байланысты жүйе уақытының параметрлерін және олардың құрылыс өнімдерін өндіруге арналған технологиялық жүйенің өнімділігіне әсерін зерттеу болып табылады. Зерттеуде бағдарламалық құрал ретінде авторлық бағдарлама пайдаланылды. Алынған зерттеу нәтижелерін нақты өндірісте пайдалануға болады.

Түйін сөздер: техногендік шикізат, өндірістің технологиялық жүйесінің өнімділігі, имитациялық модель, жүйелік уақыт, модельдеу

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ИСПОЛЬЗОВАНИЕ ИМИТАЦИОННОГО МОДЕЛИРОВАНИЯ ПРИ РАСЧЕТАХ ПРОИЗВОДИТЕЛЬНОСТИ ТЕХНОЛОГИЧЕСКОЙ СИСТЕМЫ ПРОИЗВОДСТВА СТРОИТЕЛЬНЫХ ИЗДЕЛИЙ С НАПОЛНИТЕЛЯМИ ИЗ ТЕХНОГЕННЫХ ОТХОДОВ

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Аннотация. В настоящее время в Казахстане достаточно активно начато использование цифровых технологий для решения как прикладных, так и практических задач. Одним из приоритетных направлений при проведении научных исследований является методология имитационного моделирования. Это связано, прежде всего, с тем, что имитационные модели максимально адаптированы к реальным системам и при моделировании получаются адекватные результаты. К достоинствам имитационного моделирования можно отнести и выполнение расчетов пользователями, не имеющими практического опыта в строительной отрасли. Достаточно часто на производстве при работе с различными видами техногенного сырья (металлургический шлак, бокситовый шлам) не всегда ясно, как повлияют данные наполнители бетонных смесей на производительность производства строительных изделий, что в конечном итоге влияет на эффективность производства. В этой связи целью представляемой статьи является исследование параметров системного времени в зависимости от вида техногенных отходов (металлургический шлак, бокситовый шлам), используемых в качестве наполнителей бетонной смеси и влияния их на производительность технологической системы производства строительных изделий. В качестве программного средства в исследовании использована авторская программа. Полученные результаты исследования могут быть использованы в реальном производстве.

Ключевые слова: техногенное сырье, производительность технологической системы производства, имитационная модель, системное время, моделирование

Introduction

Within the grant project №APR-SSG-17/0290P «Innovative technologies of using solid industrial waste from thermal power and metallurgy plants of Pavlodar region in the production of building materials» funded by the «Stimulating Productive Innovation» Project, supported by the World Bank and the Government of Kazakhstan, studies of industrial waste (bauxite slime, metallurgical slag) of industrial enterprises of Pavlodar region were carried out.

For the production of alumina, the Pavlodar Aluminum Plant (PAP) uses bauxite ore from the Krasnooktyabrsky deposit.

From 1 ton of Krasnooktyabrsky ore, 200 kg of alumina is obtained, the rest is bauxite sludge. The estimated amount of bauxite sludge at the technogenic PAP deposit is presented in Table 1.

Table 1 – Estimated amount of bauxite sludge stored at the at the technogenic fields of PAP

Enterprise name	The year of the enterprise's opening	The amount of alumina produced, thousand/ton	Amount of bauxite sludge, thousand/ton
Pavlodar Aluminum Plant	1964	60000	240000

The chemical composition of bauxite sludge is shown in Figure 1. Bauxite sludge is a red-brown loose mass, granulometric analysis shows that during sieving, minimal particles can be sieved through a sieve with 0.05 cells (See Fig. 2).

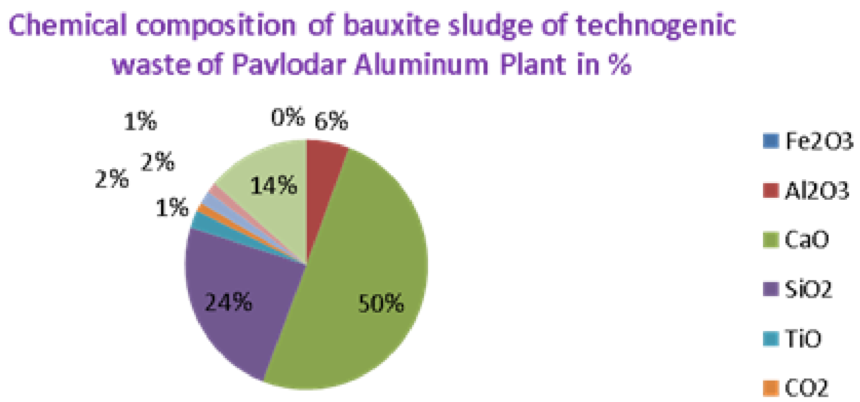

Figure 1 – Chemical composition of bauxite sludge

Figure 2 – Granulometric analysis of bauxite sludge

The study of bauxite sludge, chemical, strength characteristics allowed us to develop a sufficiently large number of concrete mixtures. Laboratory and field tests allowed us to obtain real statistical results that allow us to use the developed concrete mixtures based on man-made waste (bauxite sludge) for the production of construction products (Akishev, 2021).

Metallurgical slag of enterprises of the Pavlodar region is gray waste, of various sizes, formed during the smelting of steel from scrap metal Figure 3. The chemical composition of metallurgical slag is shown in Figure 4.

Figure 3 – Metallurgical slag of Pavlodar enterprises

According to open sources, the amount of metallurgical slag in the man-made deposits of Pavlodar region is 6000 thousand/ton. The data are shown based on the calculation that for the production of 1 ton of steel 4.7 tons of scrap is needed, the waste is 0.4 tons (Akishev, 2021).

Figure 5 shows the estimated amount of technogenic waste produced by enterprises of the Pavlodar region for 2019 (Akishev, 2021).

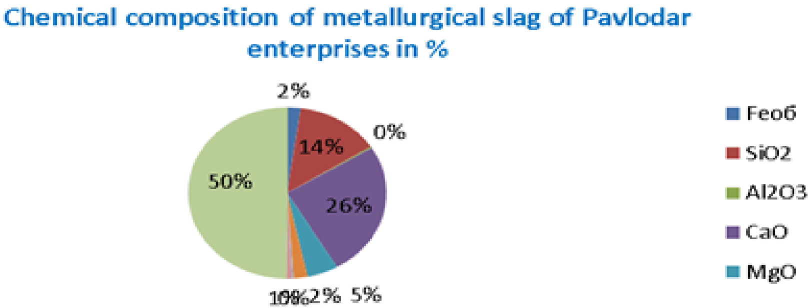

Figure 4 – Average chemical composition of metallurgical slag of Pavlodar

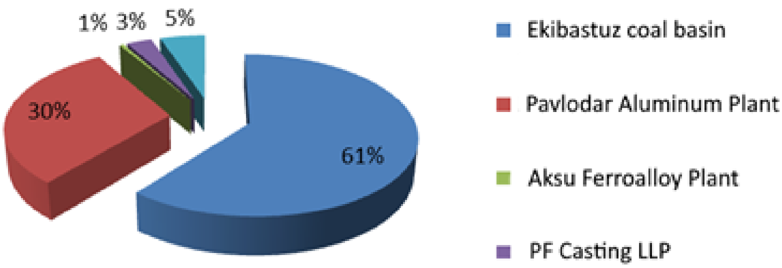

Figure 5 – Estimated amount of technogenic waste 2019

The amount of technogenic waste allows us to talk about the possibility of a serious raw material base for the production of construction products.

Experiments. We use technogenic waste (bauxite sludge, metallurgical slag) with various chemical properties and physical characteristics as fillers of concrete mixtures. Accordingly, we need to take this into account when organizing the production of construction products.

To assess the impact of various parameters, including technogenic raw materials, on the performance of the technological system for the production of construction products, the following methods were used in our simulation model:

1. «The principle of special states and the principle of Δt»;

For each type of technogenic raw materials, the task is to determine the system (model) time T, where T is taken as the interval of «real machine time», from the beginning of modeling and at the same time, «calendar time t_r», in the simulated system. The relationship between them can be represented by the ratio:

$$t_r = M * T \tag{1}$$

where M – is the scale factor.

In the process of modeling composite systems, the concept of *«modeling interval»* is adopted - a period of «real calendar time Δt_m», for which the behavior of a complex system is studied. It can be any period of a year or more. The simulation time can only depend on the capabilities of the computer technology, the developed simulation algorithm and a given «*simulation accuracy*».

As a rule, during the simulation process with the help of modern computer systems, the system time changes intermittently (discretely), and the real time is continuous (Rizhikov, 2004; Pichitlamken and Nelson, 2002; Karpov, 2017; Banks et al., 2003; Usupov and Sokolov, 2008; Preston, 2016; O'Sullivan, 2017; Ostauch, 2009; Ivaev, 2011).

For the *«principle Δt»*, a «discrete step of the system time ΔT_d» is set at the beginning, while the system time is determined by the expression:

$$T = T + \Delta T\, d, \tag{2}$$

where T=T(0)to start the simulation.

Calculation by formula 2, allows you to view all events in the interval ΔT_d with subsequent changes in the system. But for this principle, there is a problem that for events occurring «close in time to each other», the value of ΔT_d is assumed to be less (usually $\Delta T_d << \Delta t_m$), while the time of the modeling process increases, which does not ensure high efficiency (Ivaev, 2011; Каменev, 2011; Akishev et al., 2022).

2. Theory of state graphs.

As in real production, the simulation model used for research (Akishev, 2021) consists of objects, each of which ensures the functioning of the technological system for the production of construction products. Z_0, Z_1, Z_2 objects of the simulation model work according to the theory of graphs or graphs of states, taking into account the «principle of special states» discussed earlier. Let's take a closer look at how each object works.

For Z_0 we accept:

// OA_0 – object class Z_0

// 0 –it is free and can form a dry mixture

// 1 – the formation of a dry mixture without cement has been completed

// and the dry mixture can be transferred toZ_1, transfer time ordered

// 2 – simple, transfer is impossible, Z_1 is busy mixing the mixture, feeding cement, lime, plasticizer

// 3 –simple, out of any component.

Figure 6 shows the graph of states of the object Z_0. In states 0 and 1, the object is included in the event list. In other states, the object is excluded from the list of events. In state 3, the model stops working, because there is no procedure for adding components. The transition <1, 0> is carried out if the dry mixture is transferred to the object Z_1.The transition <1, 2> is carried out if the dry mixture has not been transferred to object Z1 due to its occupancy. The transition <2, 0> is carried out by a signal from object Z_1, at the time when it goes to state 0, that is, it is released.

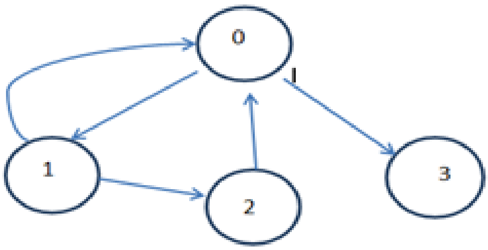

Figure 6 – Object state graph Z_0

For Z_1 we accept:

// OA_1 – object class Z_1

// 0 – free and can take a dry mixture

// 1 – the dry mixture is passed to the Z_1 object, the transfer end time has been ordered,

// 2 – the device is busy mixing, adding cement, water, plasticizer and mixing, the end time of mixing is ordered,

// 3 – the time of transfer of the mixture to the matrix has been ordered,

// 4 – simple, failed to transfer the mixture to the matrix, Z_2 is busy.

Figure 7 shows the graph of states of object Z_1. In the state 0,1,2,3, the object is included in the list of events. In state 4, the object is excluded from the list of events. The transition < 0, 1> is carried out if the dry mixture has been transferred to object Z_1 and the transfer end time has been ordered. The transition <1, 2> is carried out if the dry mixture is transferred to object Z_1. The transition <2, 3> is carried out if the object Z_1 is busy mixing the mixture and adding cement, water and plasticizer and the end time of this process is determined. The transition <4, 1>> is carried out by a signal from object Z_2, at the time when it goes to state 0, that is, it is released.

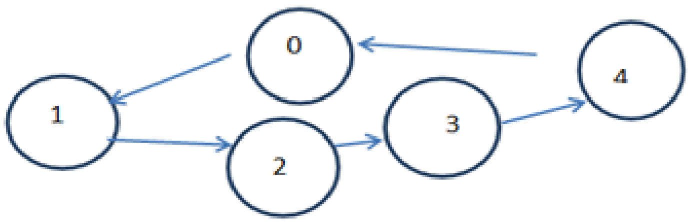

Figure 7 – Object state graph Z_1

For Z_2 we accept:
// OA2 – object class Z_2
// 0–he is free and can take ready- made mixtures,
// 1 –engaged in the transfer of finished concrete mix, from production waste
// 2 –accepted the mixture, ordered the end time of the transfer of finished products.
The graph of states of object Z_2 is shown in Figure 8.

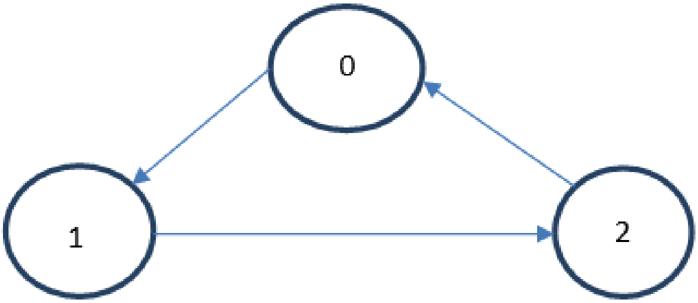

Figure 8. Object state graph Z_2

The Z_2 object in state 0 is disabled from the list of events. The transition <0, 1> is carried out by a signal from object Z_1. The transition <0, 1> is carried out if there is a mixture in the object Z_1 for transfer to the forming matrix. In this case, the end time of the transfer of the mixture to the matrix is ordered. The transition <1, 2> is carried out at the end of the transfer of the mixture to the forming matrix. In state 2, the time of transfer of the finished product is ordered. At this moment, the transition to state 0 is performed and the object Z_2 is excluded from the list of events.

Therefore, in the simulation model, four scenarios are defined, stored in an array of events:

// ST[4]– array of events:

// ST[0] – release of block Z_0: the end of the formation of the mixture by the Z_0 apparatus and transfer to mixing;

// ST[1] – release of block Z_1: the end of mixing the mixture, pouring water, transferring the wet mixture to the vibrating press and molding matrix,

// ST[2] – release of block Z2: finishing and forming, release of finished products Z_2

// ST[3] – end of the simulation interval

// T_t– system time, in minutes.

The principle of special events (states) is as follows: The system time is adjusted each time to the nearest event. After processing this event, the system is adjusted to the next nearest event, and so on. The formula for setting the system time is as follows (3):

$$T_i = minMS(i) \quad (3)$$

Usually, in addition to events that change the state of the system, the number of events includes reaching the value of system time, corresponding to a given simulation interval $\Delta\ t_p$ (Каменev, 2011; Akishev et.al., 2022). Since all special events are bound to the active blocks, the number of events Ns in the simulation system can be determined by the formula (4):

$$N_s = N_a + 1, \quad (4)$$

Results and discussion

Figure 9 shows a simulation model (developed in Russian (Akishev, 2021) used to assess the impact of technogenic waste on the performance of the technological system for the production of construction products.

The technological parameters introduced to calculate the productivity for technogenic raw materials are obtained by calculation.

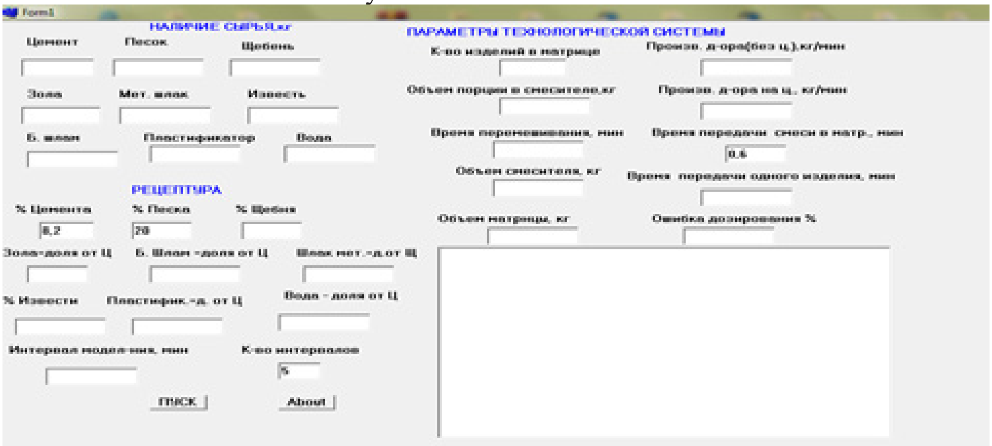

Figure 9 – Simulation model for assessing the impact of man-made raw materials on the performance of the TS

Let's calculate the productivity of the technological system for the production of construction products using bauxite as a filler, see Figure 10.

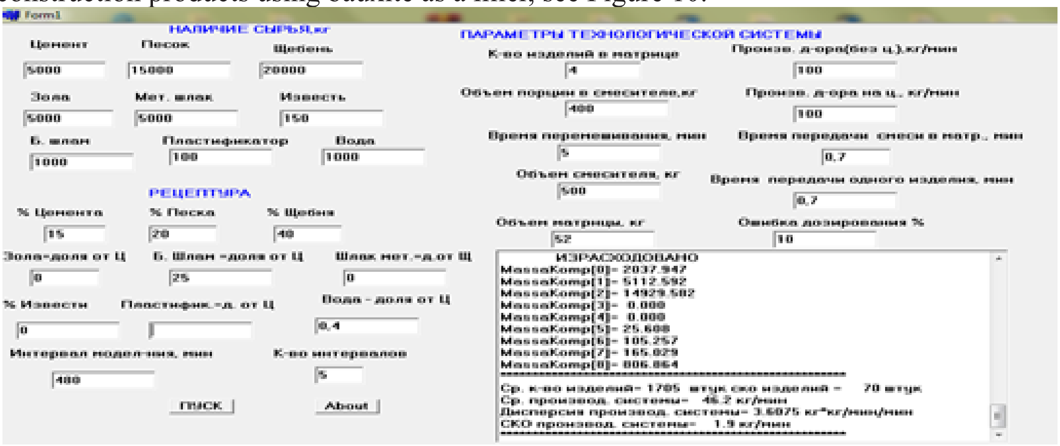

Figure 10 – Productivity modeling for a filler made of bauxite sludge

Let's calculate the productivity of the TS for the production of construction products using metallurgical slag as a filler, see Figure 11.

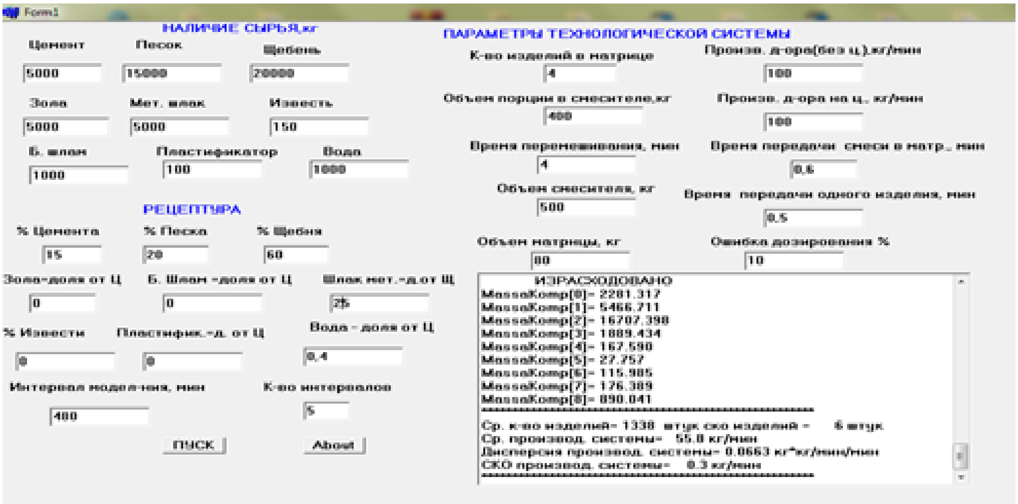

Figure 11 – Performance modeling for metallurgical slag filler

Conclusions

As can be seen from Figure 10, the productivity of the technological system for the production of construction products with filler from bauxite sludge is 1705 pieces of products with a modeling interval of 480 minutes, despite the longer system time of the technological process, and the productivity of the production of construction products with filler from metallurgical slag was 1338 pieces of products, the modeling interval is 480 minutes with a lower value of the system time, see Figure 11. In Figure11 shows the dependence of the productivity of the technological production system on the type of technogenic waste.

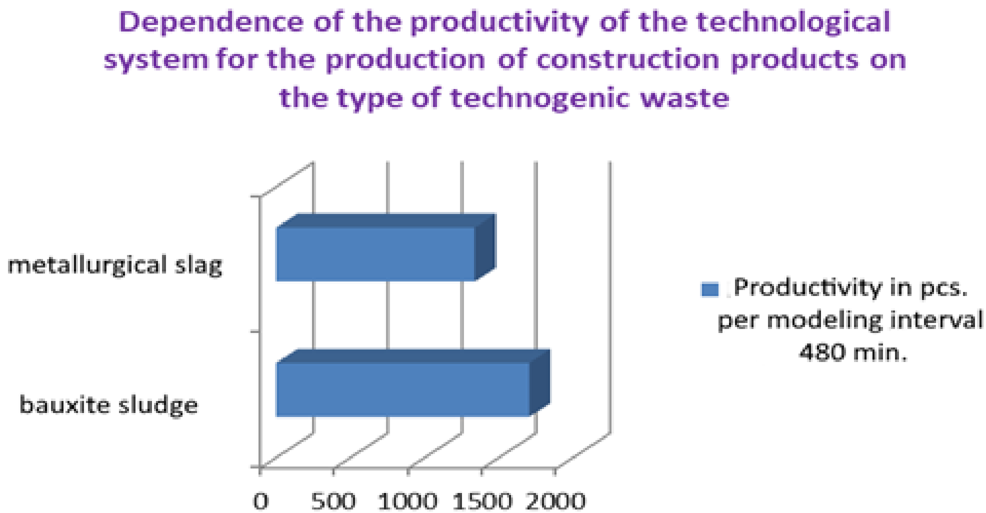

Figure 12 – Dependence of the technological line productivity on the type of technogenic waste

This is primarily due to the lower density of the concrete mixture with a filler made of bauxite sludge, physical parameters, plasticity, viscosity, which makes it possible to obtain lighter construction products, in larger quantities, with sufficiently good strength characteristics.

The use of concrete mixes with fillers from bauxite sludge allows to increase the efficiency of production of construction products, reduce production costs, reduce the percentage of traditional fillers, with a standard working shift duration (Akishev, 2021).

The simulation model (Akishev et al., 2022) opens up to users the possibility of calculating the performance of the technological system, when modeling changes in various parameters, factors related to the production of construction products.

REFERENCES

Akishev K.M. (2021). *Models and methods of analysis of technological systems for the production of construction products using man-made waste* [Akishev K.M. Modeli i metody analiza tekhnologicheskih sistem proizvodstva stroitel'nyh izdelij s ispol'zovaniem tekhnogennyh othodov]. Abstract of the dissertation for the degree of Candidate of Technical Sciences, specialty 05.13.06-automation of technological processes and production (by industry). — Bishkek, (**2021**). — 23 p. (in Russ.). https://vak.kg/wp-content/uploads/2021/06/Avtoreferat-Akishev-K-rus.pdf

Akishev K.M and other. (2022). Mathematical formulation and the problem solution of clastering recipes of concrete using technogenic waste and slags of metallurgic enterprises. Металлургия, (**2022**). — 61(1)213–216. (in Russ.). https://www.scopus.com/authid/detail.uri?authorId=57267522000

Banks J., Hugan J.C., Lendermann P., McLean C., Page E.H., Pegden C.D., Ulgen O., Wilson J.R. (2003). The future of the simulation industry // Proceedings of the 2003 Winter Simulation Conference (**2003**). — Pp. 2033–2043. (in Eng.).

Ivaev O.O. (2011). Automation of cyclic connected dosing processes using flow integrator dispensers in the industrial production of concrete mixtures [Ivaev O.O. Avtomatizaciya processov ciklicheskogo svyaznogo dozirovaniya s ispol'zovaniem dozatorov-integratorov raskhoda pri promyshlennom proizvodstve betonnyh smesej]. Autoref.for the degree of Candidate of Technical Sciences. — Moscow, (**2011**). — 135 p. (in Russ.).

Karpov V.I. (2017). Simulation modeling. [Karpov V.I. Imitacionnoe modelirovanie]. Electronic textbook. Ed. «MGTU im.Bauman». — Moscow. (**2017).** — P. 68 (in Russ.).

Каменev V.V. (2011). Automation of discrete dosing processes in the industrial production of cement-concrete mixtures / [Каменev V.V. Avtomatizaciya processov diskretnogo dozirovaniya pri promyshlennom proizvodstve cementnyh smesej]. Autoref. for the degree of Candidate of Technical Sciences. — Moscow (**2011**). — 168 p. (in Russ.).

Ostauch A.V. (2009). Automation and modeling of the work of enterprises for the construction of industrial facilities [Ostauch A.V. Avtomatizaciya i modelirovanie raboty predpriyatij po stroitel'stvu promyshlennyh ob"ektov]. Autoreferat for the degree of Doctor of Technical Sciences. —Moscow (**2009**). — 356 p. (in Russ.).

Pichitlamken P., Nelson B.L. (2002). Optimization via simulation: A combined procedure for optimization via simulation. Proceedings of the 2002 Winter Simulation Conference **(2002).** — Pp. 292–300. (in Eng.).

K. Preston W.Jr. (2016). The basics of simulation/ W.Jr K.Preston// Proceedings of the 2016 Winter Simulation Conference. — Pp. 38–48. — 978-1-5090-4486-3/16 (**2016).** IEEE. (in Eng.).

Rizhikov U.I. (2004). Simulation modeling. [Rizhikov U.I. Imitacionnoe modelirovanie]. Theory and Technology, St. Petersburg: Crown print;m.: Altex. — A (**2004**). — With 384. (in Russ.).

M.O'Sullivan (2017). Towards aconceptual modeling framework for construction simulation// Proceedings of the 2017 Winter Simulation Conference. — Pp. 2372–2382. — 978-1-5386-3428-8/17 (**2017).** IEEE. (in Eng.).

Usupov P.M., Sokolov B.V. (2008). Simulation modeling and its application in science and technology. [Usupov P.M., Sokolov B.V. Imitacionnoe modelirovanie i ego primenenie v nauke i tekhnike].// *Bulletin of the Russian Academy of Sciences*. (**2008**). — Vol.78. — No. 3. — from 471. (in Russ.).

CONTENT

A.E. Abetov, A.A. Auyesbek
GEOLOGICAL-GEOPHYSICAL CRITERIA OF THE JEZKAZGAN ORE DISTRICT IN CENTRAL KAZAKHSTAN...6

K. Akishev, K. Aryngazin, A. Tleulessov, L. Bulyga, V. Stanevich
THE USE OF SIMULATION MODELING IN CALCULATING THE PRODUCTIVITY OF THE TECHNOLOGICAL SYSTEM FOR THE PRODUCTION OF BUILDING PRODUCTS WITH FILLERS FROM MAN-MADE WASTE.................22

V.V. Gerasidi, R.G. Dubrovin, V.V. Kukartsev, T.A. Panfilova, G.V. Stas
BOOST SYSTEM DIAGNOSTIC PARAMETERS OF COHERENT GAS PISTON INSTALLATIONS OF MINING ENTERPRISES...33

E.M. Elekeev, B.P. Stepanov
TO THE ISSUE OF EFFICIENCY OF APPLICATION OF THE SAFETY CONTROL PROGRAM AT NUCLEAR FACILITIES...48

A.I. Epikhin, A.A. Stupina, I.A. Panfilov, V.V. Bukhtoyarov, N.A. Shepeta
DETERMINANTS FOR ASSESSING THE ENERGY EFFICIENCY OF A COAL MINING ENTERPRISE...61

E.A. Efremenkov, E.S. Chavrov, E.P. Khaleyeva, V.V. Tynchenko
EVALUATION OF TECHNIQUES FOR DETERMINING THE LOADING OF A CYCLOIDAL SATELLITE ROLLING BEARING..72

Zh.A. Zhanabayeva, K.T. Narbayeva, G.K. Ismailova, M.S. Ospanova, J. Rodrigo-Ilarri
ASSESSMENT OF THE RESERVOIRS IMPACT ON THE MAXIMUM RUNOFF OF THE SYRDARYA RIVER...85

M.K. Jexenov, Zh.K. Tukhfatov, E.K. Bektay, R.Sh. Abdinov, G.S. Turysbekova
STRUCTURAL-TECHTONIC AND MINERALOGICAL STRUCTURE OF INDER LIFTING FIELD, MINING AND CHEMICAL RAW MATERIALS IN ATYRAU REGION...96

G.M. Iskaliyeva[1,2*], N.K. Sydyk[1], A.K. Kalybayeva[1,3], M.S. Sagat[1], A. Samat
USE OF WATER INDICES FOR WATERBODIES IN THE ESIL WATER MANAGEMENT BASIN...117

Z.M. Kerimbekova, A.A. Tashimova, G.I. Issayev, E.K. Ibragimova, M.Zh. Makhambetov
CALCULATION OF ENVIRONMENTAL AND ECONOMIC DAMAGE CAUSED BY CURRENT SYSTEMS OF SOLID WASTE MOVEMENT IN OIL PRODUCTION..131

M.Zh. Makhambetov, R. Izimova, G.I. Issayev, N.A. Akhmetov, E.K. Ibragimova
ECOLOGICAL-GEOLOGICAL ASSESSMENT OF TECHNOGENICALLY DISTURBED TERRITORIES OF OIL FIELDS OF THE ATYRAU REGION...........143

A.D. Mekhtiyev, V.V. Yugay, Y.G. Neshina, N.B. Kaliaskarov, P. Madi
FIBER-OPTIC SYSTEM FOR CONTROLLING OPEN PIT SIDE ROCK DISPLACEMENT.. 157

A.S. Mussina, G.U. Baitasheva, B.S. Zakirov, Ye.P. Gorbulicheva
CONDITIONS FOR PREPARING THE SURFACE OF CONTACT PARTS FOR WETTIBILITY WITH MERCURY...168

A.N. Muta, R.B. Baimakhan, G.I. Salgarayeva, N. Kurmanbekkyzy, A. Tileikhan
STUDY OF THE STRENGTH PROPERTIES OF SOILS COMPOSING THE GEOLOGICAL STRUCTURE OF THE KOK TOBE MOUNTAIN..............................185

B. Mukhambetov, B. Nasiyev, Zh. Kadasheva, R. Abdinov, R. Meranzova
ADAPTABILITY OF KOCHIA PROSTRATA (L.) SCHRAD AND CAMPHOROSMA MONSPELIACA AGRICULTURAL ECOSYSTEMS ON SALINE LANDS OF THE NORTHERN CASPIAN DESERT................................197

M. Nurpeisova, G. Dzhangulova, O. Kurmanbaev, Z. Sarsembekova, A. Ormanbekova, Y.Kh. Kakimzhanov
CREATION OF GEODETIC REFERENCE NETWORK FOR MONITORING TRANSPORT INTERCHANGES IN SEISMIC AREAS...209

B.T. Ratov, V.L. Khomenko, A.E. Kuttybayev, K.S. Togizov, Z.G. Utepov
INNOVATIVE DRILL BIT TO IMPROVE THE EFFICIENCY OF DRILLING OPERATIONS AT URANIUM DEPOSITS IN KAZAKHSTAN..................................224

A.A.Tashimova, G.I. Issayev, Z.M. Kerimbekova, E.K. Ibragimova, A.M. Bostanova
ANALYSIS OF THE RESOURCE POTENTIAL OF SOLID OIL PRODUCTION WASTE...237

M.K. Tynykulov, O.D. Shoykin, S.O. Kosanov, M.B. Khusainov, Zh.G. Ibraybekov
BIOREMEDIATION OF ZONAL SOILS IN AYIRTAY DISTRICT OF NORTH KAZAKHSTAN REGION..246

A.S. Urazaliyev, D.A. Shoganbekova, R. Shults, M.S. Kozhakhmetov, G.M. Iskaliyeva
INVESTIGATION OF LSMSA APPROACH IN LOCAL GEOID MODELING..........261

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