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CONDITIONS FOR THE DEVELOPMENT OF THE CRUSHED STONE PRODUCTION IN UKRAINE AND COMPETITION ON THE TRANSPORT MARKET

The article describes the production and use of crushed stone in Ukraine. The price factor of production and sale of crushed stone in the foreign countries is given and the comparative analysis with the Ukrainian producers is carried out. The dynamics of capacity and production of crushed stone products in Ukraine taking into account export and import components is given. It is established that the most capacious market is located in Zhytomyr region. It is noted that the share of crushed stone production of the enterprises located on the territory of the Regional Branch "South-Western Railway" is 44. It was found that only fruitful cooperation between two parties will get positive results, which will certainly increase railway traffic.

Keywords: *crushed stone, production technology, crushed stone fraction, price factor, market capacity, market segmentation, transport component, and competition.*

Introduction. The modern market of transport services is characterized by increased competition between the enterprises of different modes of transport. This problem is especially acute in the field of freight transport. In order to withstand this competition and ensure the effective development of the industry, the railway transport companies are faced with the task – to prevent the outflow of goods to other modes of transport, including motor transport.

The low rate of renewal of the main means of production of the domestic railway transport in the field of innovation and investment activities, led to the fact that the operation is almost 78%. And as a result, the railway transport carries out transportation by means of obsolete and imperfect rolling stock, which is repaired by technological equipment that does not ensure the safety of trains.

The evolution of the needs of the Ukrainian economy and the changing role of road, air and river transport require qualitative changes in the company by defining a development strategy in the medium term.

The purpose of adopting a new strategy for the development of the Joint-Stock Company "Ukrainian Railways" for 2019-2023 (hereinafter - the Strategy) is to define the corporate goals of the Company, which will be understood and accepted by the stakeholders, to focus efforts on achieving them through strategic initiatives.

The Company's development strategy envisages the achievement of the following main goals:

meeting the needs of Ukraine in railway transportation and logistics in accordance with the plans of economic development of the country and population mobility;

achieving and maintaining a strong financial position of the company, including by intensifying the necessary investments in the main activities of UZ;

ensuring the safety of the railway transport for the customers, employees and third parties;

increasing the company's attractiveness to consumers and employees; and

introduction of the modern and effective management practices and principles.

And most important, to review the attitude of carriers to their partners – shippers and to direct the vector of the operational and commercial activities in a customer-oriented direction.

The analysis of the recent research and problem statement. Ukraine has a high potential for the production and export of crushed stone. Subject to the further state and international support for the road construction and repair, the crushed stone market will continue to develop more intensively.

It should be noted that the transport component in the total volume of marketable products of the manufacturer of the construction goods has a significant share, which is about 10 - 50%. Therefore, such factors as the tariff for transportation of 1 ton and term of delivery of cargo that creates preconditions of the transport market with the corresponding competition have essential value for the manufacturer.

Five years ago, the proportion of crushed stone was 20% to 80% in favour of the railway. Every year road transport increases by 3-5%.

If effective measures are not urgently introduced to improve the conditions of transportation by railway, the volume of transportation of crushed stone by railway and road will be adequate.

Among domestic scientists, the solution of the specified problems is devoted to the scientific researches and publications: G.M. Kirpa, Yu. F. Kulaeva, G.D. Eitutis, V.K. Myronenko, V.V. Chornyi, V.I. Pasichnyk, O.V. Sobkevych, L.V. Kushnir and others.

In the works of these authors, the presented materials require further research in the current conditions of the railways, which are constantly changing, the issues of freight transportation need a new research.

The purpose and objectives of the research. The purpose of the article is to cover the problems of production and transportation of crushed stone by different modes of transport, which requires increasing the efficiency of industrial enterprises and carriers and creating a competitive environment in the field of logistics services.

Materials and methods of the research. Crushed stone is the most popular product, its output is usually 85-95 percent of the total marketable products of the enterprise. Crushed stone is produced divided into fractions (mm): 5 (3) –10; 10–20; 20–40; 40–70 (70–140). In recent years, due to the use of the Western technologies in road and housing construction, crushed stone companies produce up to 11 fractions. Crushed stone is used: as the main filler of (heavy) concrete in all concrete and reinforced concrete building structures; as a large filler of asphalt (and cement) concrete and ballast layer of pavements of roads and airfields; for the upper embankment of the railway tracks; for all kinds of dumping, paving, and planning works [1].

For lightweight concrete, crushed stone obtained from porous rocks is used, as well as artificial porous fillers, especially vermiculite and perlite, which are the best material for sound and heat insulation.

Today, the vast majority of domestic crushed stone plants do not use optimal technologies, their equipment is not only physically worn out, but also morally obsolete. Many companies

have exhausted the allocated reserves of raw materials. The industry is on the verge of reconstruction and restructuring. This requires new approaches to the evaluation of raw materials, technologies and equipment of plants, so as not to repeat their own mistakes in the organization of production of non-metallic building materials [2,3].

The technological scheme of the enterprise should be optimal according to two criteria:

maximum output of cubic crushed stone;

flexible technology that allows you to respond quickly to changes in demand and avoid overstocking with one or more fractions;

layout of the technological equipment, which allows to minimize the amount of transport equipment (crushers over screens, roars over bunkers, etc.);

use of specialized equipment;

unification of the equipment (use of conveyors with one belt width, but with different speed, etc.);

uniformity of loading of the equipment and stability of characteristics of initial material; and high efficiency of working time, etc.

Technological schemes developed taking into account these rules are not only highly efficient, but also the simplest [4].

Currently, the work is underway to improve the crushing equipment. Taking into account the physics of the solid body and the theory of oscillations, vibrating buccal and conical crushers were created. However, the scope of their application is limited by the physical and mechanical properties of rocks, high yields (up to 25-30 percent?) significant wear of working equipment. Additional tests are required to determine the rational scope of the crushers of this design.

The introduction of new technologies for the production of crushed stone requires an increase in the cost of its production. The cost of producing cubic crushed stone is 15-20% higher than usual. Up to 40% of screenings are formed. Therefore, the main task is the scientific and economic justification of the need for crushed stone in quantitative and qualitative terms. The analysis shows that the selling price of crushed stone in the United States, Europe and Russia is almost the same and averages about \$ 5 per ton.

Although in general the transportation of construction cargo occupies about 10 - 50% in the total volume of marketable products [5,6].

The ratio between the prices of production and consumption on average in Ukraine is estimated as two to one, which is due to transport, supply – marketing, tax and other costs. At the same time, consumption prices differ significantly in some regions.

The increasing demand for crushed stone leads to an intensive increase in its production. In 2015, there was a significant reduction in the production of crushed stone, but since 2016 the demand for crushed stone began to increase, which is due to the development of the construction industry in Ukraine and the need for crushed stone as a filler. In 2018, the production of crushed stone amounted to 81.9 million tons, which is 9.2% more than in 2014 [7].

Today in Ukraine there are many companies that produce crushed stone products. After the crisis in the country, which was observed in 2014-2016, enterprises for the production (extraction) of crushed stone are gradually updating the technological equipment, increasing the quality of crushed stone (cubic). In recent years, the construction market is growing. The largest growth of the building market is observed in Kyiv and Kyiv region, as well as in Lviv and Odessa regions; the construction of commercial buildings decreased in the market of non-residential buildings. The construction market is a significant consumer of crushed stone products, which makes it possible to increase the volume of crushed stone production and, accordingly, increase the company's revenues [7].

The greatest demand in the market of Ukraine and neighbouring countries is crushed stone fractions of 5-20 mm, less often – 5-10 mm, which is used for the production of asphalt, concrete and reinforced concrete structures. Crushed stone of granite fractions 20–40 mm, 40–70 mm is also in stable demand and is used in construction and repair of railway embankments, tramlines, foundations of highways, when laying foundations of buildings and structures, as well as for crushing into smaller fractions of crushed stone [8].

Ukraine has a high potential for the production and export of crushed stone. Subject to the further state and international support for road construction and repair, the crushed stone market will continue to develop. Crushed stone production and prices are constantly increasing, which indicates the prospects for the development of this market.

The crushed stone market in Ukraine is characterized by a high degree of saturation due to sufficient stocks of raw materials, which makes it possible to export products at competitive prices (from 120 to 220 UAH per ton). The competition in this segment is also regional in nature, because, due to the slight difference in geological composition and "factional" crushed stone, a key competition is observed in the field of logistics costs and the ability to deliver products in different batches and modes of transport [9]. Insignificant imports are characterized by the presence of own stocks, existing purchases are only local periodic in nature and are associated with a specific demand (Table 1).

Table 1. Crushed stone market capacity in Ukraine, 2014–2018

Indicators	2014	2015	2016	2017	2018
Production, million tons	74.0	62.4	64.0	75.7	80.9
Import, million tons	0.1	0.1	0.1	0.1	0.2
Export, million tons	23.4	12.0	6.7	8.5	6.4
Capacity, million tons	50.8	50.5	57.4	67.3	74.7
Growth rate, %		-0.5	13.6	17.3	11.0

Source: data of the State Statistics Service of Ukraine, market operators, Pro-consulting assessment [7,10,11]

In general, the crushed stone market is experiencing an increase in capacity, which is associated with the level of consumption and demand for road construction, construction of residential and non-residential buildings. Raw materials are also used in other areas – construction of drainage systems and others. At the moment, there is a positive trend in the growth of construction in general (Fig. 1).



Fig. 1. Dynamics of crushed stone market capacity, 2014–2018, million tons

Source: data of the State Statistics Service of Ukraine, market operators, Pro-consulting assessment [7, 10, 11].

Segmentation of the crushed stone market by regions of Ukraine in 2014-2018 shows that the most capacious market is located in Zhytomyr region. The share of crushed stone production of enterprises located in the Regional Branch "South-Western Railway" is 44% (Table 2).

Table 2. Crushed stone market capacity in Ukraine, 2014–2018, million tons

Indicators	2014	2015	2016	2017	2018
Capacity across Ukraine	50.8	50.5	57.4	67.3	74.7
Capacity in RB "South-Western Railway", including by areas	25.3	25.3	28.7	28.9	32.8
Zhytomyr	15.7	15.3	17.4	18.5	18.2
Kyiv	4.7	4.8	5.4	3.8	5.9
Khmelnysky	1.7	2.3	2.6	3.4	4.5
Vinnytsia	3.2	2.9	3.3	3.2	4.2

Source: data of the State Statistics Service of Ukraine, market operators, Pro-consulting assessment[7,10,11].

The most popular fraction in all industries is crushed stone 5–20 mm. This granite crushed stone is very often used in the construction of foundations, as well as for the manufacture of high quality concrete and structures that are created from it. The same material was used and continues to be used in the filling of airfield pavements, pavements and similar structures.

The dynamics of crushed stone production in physical terms in recent years shows a tendency to increase. In 2015, there was a significant reduction in the production of crushed stone, which was due to economic instability and the loss of a number of large economic regions. The average value of crushed stone production for the period 2014–2018 was 71.4 million tons, and the average growth rate was 9.2% (Fig. 2).



Fig. 2. Dynamics of crushed stone production in Ukraine, 2014–2018, million tons

Source: data of the State Statistics Service of Ukraine, market operators, Pro-consulting assessment [7,10,11].

Thus, by 2014, all cargo was sent to the Regional Branch “South-Western Railway” 38473 thousand tons, including construction cargo 20733 thousand tons or 54% of the total shipment to the branches, in 2018 all shipments were sent to the branch in volume 38467 thousand tons, of which 15548 thousand tons of building materials, which is 40% of the total shipment. It

should be noted that in 2019 the percentage of shipments of construction goods to the total shipment was 33% (table 3).

Table 3. Shipment of goods on the Regional Branch "South-Western Railway", 2014-2019

Name of cargo	Shipment of goods, tons						
	2013	2014	2015	2016	2017	2018	2019
Total	37 715 075	38 473 238	37 081 104	36 889 021	40 780 721	38 467 165	35 124 283
Coal	3 965	3 548	3 362	9 962	21 337	14 481	17 342
Oil cargoes	1,375,744	249 635	111 504	732 577	1 047 352	1 034 211	665 567
Ferrous metals	43 116	26 952	7 855	11 849	4 570	4 097	2 508
Forest cargoes	2 533 529	2,725,385	2,852,830	2,609,929	1,712,376	1 468 320	632 434
Cement	1,279,724	1 222 520	1 204 952	1 351 112	1 139 314	1,050,059	1 039 106
Chemical and mineral fertilizers	331 021	377 382	466 151	522 003	489 325	268 434	103 294
Bread cargoes	6,265,386	7 531 784	8 291 603	9 004 861	10 932 105	11 158 377	13,750,793
Ferrous scrap	884 967	904 426	734 371	627 366	752 629	753 916	642 792
Construction cargo	20,733,497	20 930 804	17 777 018	15 056 621	17 309 968	15 548 849	11 567 363
incl. stones, natural construction products	17 695 353	18 822 775	15,794,336	13 084 123	15 365 118	13 889 109	10 399 760
Refractories	891 010	889 392	779 766	671 971	730 568	757 891	549 078

Source: Reporting data of the Regional Branch "South-Western Railway" [12].

The main reason for the decline in the transport of crushed stone by railway, it should be said openly, is the fact that the vector of logistics of the railway transport was directed only in favour of the railways, without taking into account the interests of the shippers.

Consider this problem on the example of the Unigran Company.

Unigran is one of the largest manufacturers of the construction products in Ukraine. The main products are crushed stone, sand, screenings and paving slabs. In favourable periods of economic growth large-scale road construction was carried out. They produced and sold six million tons of crushed stone a year, and most transported it on their own. Since 2014, there has been a decline in the production and transportation of crushed stone, in 2017-2018 there was a rise, and in 2019-2020 - again a decline.

What problems, in the opinion of Unigran, have affected its production and economic activities?

The main problem today is the insufficient number of available electric freight and diesel locomotives. For example, at the station of gravity of the company - Penzyevychy there was always a locomotive, which carried out shunting works and formed routes to departure. Today, in addition to this station, the neighbouring ones are served: Irsha, Malyn, Chopovychy, and the number of locomotives and crews has not increased [13].

The second problem is routing. Today Ukrzaliznytsia relies on the scheduled shipments. However, in practice there is also a need to deliver goods in batches of cars and the company is forced to carry out this transportation by road. And the railway naturally loses these volumes of transportations. So a few years ago, automotive logistics worked only at a distance

of up to 100 km, if more - was considered inefficient. Today, such transportation is already carried out at a distance of 200-250 km.

Another problem is the lack of sites for the repair of freight cars, for this reason, dozens of scarce freight cars are idle without repair for two - three months. In addition, prices for repairs in recent years have risen significantly, that is, the cost of using your own car is constantly growing. It is advisable to open this market to private repair companies so that there is competition.

It is impossible not to agree with the specified problem questions of the company, which, first of all have to be solved operatively by railway people. It is hard to deny that reforming the operational vertical has impaired operational management. The newly created structures have centralized transportation management, which is still inefficient today, including the development of tariff policy. At the same time, the regional branches today do not have the appropriate levers to manage and resolve all issues of operational and commercial work, and require approval from Ukrzaliznytsia.

Thus, after the introduction of changes in the rates of payment for the use of own cars in accordance with paragraph 3.4.2 of the Agreement on the provision of services for the transportation of goods by railway, which changes came into force on October 1, 2020, the fee for the use of cars has increased significantly during the first three day, as an example, the cost of the service for the use of a universal semi-car on the first day increased 9 times (from UAH 88.3 to UAH 800.0).

It should be noted that the additional financial burden on the car component (usage fee) will lead to an increase in the cost of transportation logistics in the carrier's cars. At the same time, the difficult situation for JSC "Ukrzaliznytsia" with the volume of traffic in the carrier's cars may worsen.

The reorientation of loading of separate nomenclature groups of freights in private cars is possible in the conditions of surplus of private cars, after increase in cost for use of the carrier's car.

The management of the Regional Branch "South-Western Railway" proposed to reduce or cancel the fee for the use of the carrier's own cars within 48 hours, which will allow cargo owners and JSC "Ukrzaliznytsia" to use most CTL cars, which currently have worse technical condition than private cars.

There are a number of other issues that need to be addressed by both railways and freight owners. Only fruitful cooperation between the two sides will allow to obtain positive results, which will certainly increase the volume of the railway transport.

Conclusions. The research identified the main prerequisites for the development of crushed stone production in Ukraine and competition in the transportation market.

It is known that the crushed stone market of Ukraine is characterized by a high degree of saturation due to sufficient stocks of raw materials, which makes it possible to export products at competitive prices (from 120 to 220 UAH per ton). Competition in this segment is mainly observed in the field of logistics costs and the ability to deliver products in different batches and modes of transport.

At the same time, many enterprises have exhausted the allocated reserves of raw materials, their equipment and technology are physically worn out and obsolete [14].

The introduction of new technologies for the production of crushed stone requires an increase in the cost of its production [15].

The analysis shows that the selling price of crushed stone in the United States, Europe and Russia is almost the same and averages about \$ 5 per ton. Although in general, the

transportation of construction goods account for about 10-50% of the total volume of marketable products.

The ratio between production and consumption prices in Ukraine is estimated as two to one, which is due to transport, supply, sales, tax, and other costs. At the same time, consumption prices differ significantly in some regions [16].

If we take the data from 2014, then the proportion was 20% to 80% in favour of the railway. Every year road transport grows by 3-5%. And in the coming years, if the specified growth of traffic, road transport will reach the level of the railway transport [17].

On the example of Unigran Company, the main problems, which concern it at the present stage as both the producer of crushed stone, and the carrier, are considered:

Insufficient number of freight electric locomotives and diesel locomotives for shunting and export works;

negative impact of scheduled shipments organized by the railway on the timely departure of certain groups of freight cars;

lack of sites for repair of freight cars, for this reason dozens of scarce freight cars are idle without repair for two or three months.

It is impossible not to agree with the specified problematic questions of the company, which first of all, have to be solved operatively by railway people. At the level of the regional branch, appropriate measures are being implemented to improve operational and commercial work, but unfortunately there are problems, mainly of a regulatory nature, such as the introduction of changes in rates for own cars in accordance with paragraph 3.4.2 of the Service Agreement on the organization of cargo transportation by railway, the changes to which came into force on October 1, 2020.

The reorientation of loading of separate nomenclature groups of freights in private cars is possible in the conditions of surplus of private cars, after increase in cost for use of the carrier's car.

The management of the regional branch of the South-Western Railway proposed to reduce or cancel the fee for the use of the carrier's own cars within 48 hours, which will allow cargo owners and JSC "Ukrzaliznytsia" to use most CTL cars, which currently have worse technical condition than private cars.

There are many other issues that need to be addressed by both railways and freight owners, but only a fruitful cooperation between the two sides can achieve positive results, i.e. increase production and transportation.

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ПЕРЕДУМОВИ РОЗВИТКУ ВИРОБНИЦТВА ЩЕБЕНЮ В УКРАЇНІ ТА КОНКУРЕНЦІЇ НА РИНКУ ПЕРЕВЕЗЕНЬ

У статті охарактеризовані виробництво і застосування щебню на території України. Наведено цінові фактори виробництва і реалізації щебню в зарубіжних країнах і здійснено порівняльний аналіз з українськими виробниками. Наведено динаміку ємності і виробництва щебеневої продукції в Україні з урахуванням експортної та імпоротної складових. Встановлено, що найбільш ємний ринок розташований в Житомирській області. Відзначено, що питома вага виробництва щебню підприємств, розташованих на території регіонального філіалу "Південно-Західна залізниця" становить 44%. З'ясовано, що тільки плідна взаємодія обох сторін дозволить отримати позитивні результати, що, безумовно, вплине на збільшення обсягів перевезень залізничним транспортом.

Ключові слова: щебінь, технологія виробництва, фракція щебню, ціновий фактор, ємність ринку, сегментація ринку, транспортна складова, конкуренція.