TECHNOLOGIES AND DOLOMITE: HOW LOCAL RESOURCES RESHAPE GLOBAL BUSINESS

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Abstract. The integration of locally sourced raw materials into advanced technological processes is transforming the global construction materials industry. This study focuses on Lithuanian dolomite reserves, particularly those at the Petrašiūnai 2 and Petrašiūnai 3 quarries, and evaluates their potential to meet international infrastructure standards. Laboratory analysis confirms that Petrašiūnai dolomite possesses high magnesium oxide content and consistent mineral quality, making it suitable for demanding applications. Multi-stage crushing technologies significantly enhance the mechanical properties and geometric uniformity of dolomite aggregates, enabling them to compete with granite in road construction. Furthermore, the use of locally sourced dolomite supports sustainability goals by reducing energy consumption, lowering emissions, and strengthening supply chain resilience. These findings demonstrate that strategic utilization of regional mineral resources, combined with technological innovation, can promote sustainable development and improve global competitiveness in the construction sector.

Keywords: dolomite; Petrašiūnai quarries; local resources

INTRODUCTION

In the context of globalization, the efficient utilization of local raw materials is becoming increasingly important. Dolomite a carbonate rock widely distributed in Lithuania is one such resource that, when properly processed, can be effectively used in road construction. Its application reduces dependence on imported materials and contributes to the development of sustainable infrastructure.

Objective: To investigate dolomite extracted from the Petrašiūnai-2 and Petrašiūnai-3 quarries.

Tasks:

1. To evaluate the impact of multi-stage crushing technologies on the mechanical performance and geometric consistency of dolomite aggregates, and assess their competitiveness with granite in road construction.
2. To analyze the physical and chemical properties of dolomite extracted from Petrašiūnai 2 and Petrašiūnai 3 quarries, with a focus on magnesium oxide content and its suitability for high-performance infrastructure applications.
3. To investigate the environmental and logistical benefits of using locally sourced dolomite, including reduced energy consumption, lower emissions, improved supply chain resilience, and enhanced global market competitiveness.

AGGREGATE PRODUCTION TECHNOLOGIES

Aggregates constitute more than half of all materials used in the construction sector (Langer, 2016). They are produced by processing natural rocks such as granite, dolomite, basalt, quartz diorite, and others (Gupta et al., 2016; Wills & Finch, 2015). The primary stage of production is crushing, the method of which depends on the petrographic composition of the rock and the required properties of the aggregate (Balasubramanian, 2017).

Three-stage crushing technology enables the production of aggregates with various fractions suitable for asphalt and concrete applications (Gupta et al., 2016; Holmberg et al., 2017; Wills & Finch, 2015; see Fig. 1).

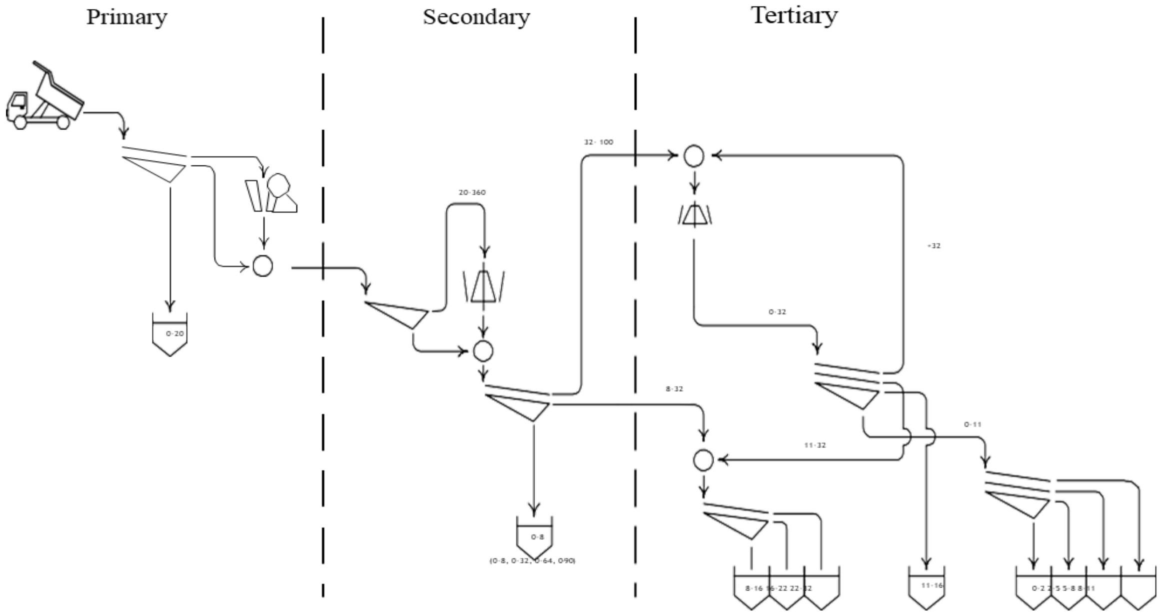

Figure 1. **Technological scheme of three-stage aggregate production (Gupta et al., 2016; Holmberg et al., 2017; Wills & Finch, 2015)**

Lithuanian researchers Deltuva and Vaitkevičius (2006) proposed a four-stage granite crushing scheme adapted to rocks of varying strength (Figure 2).

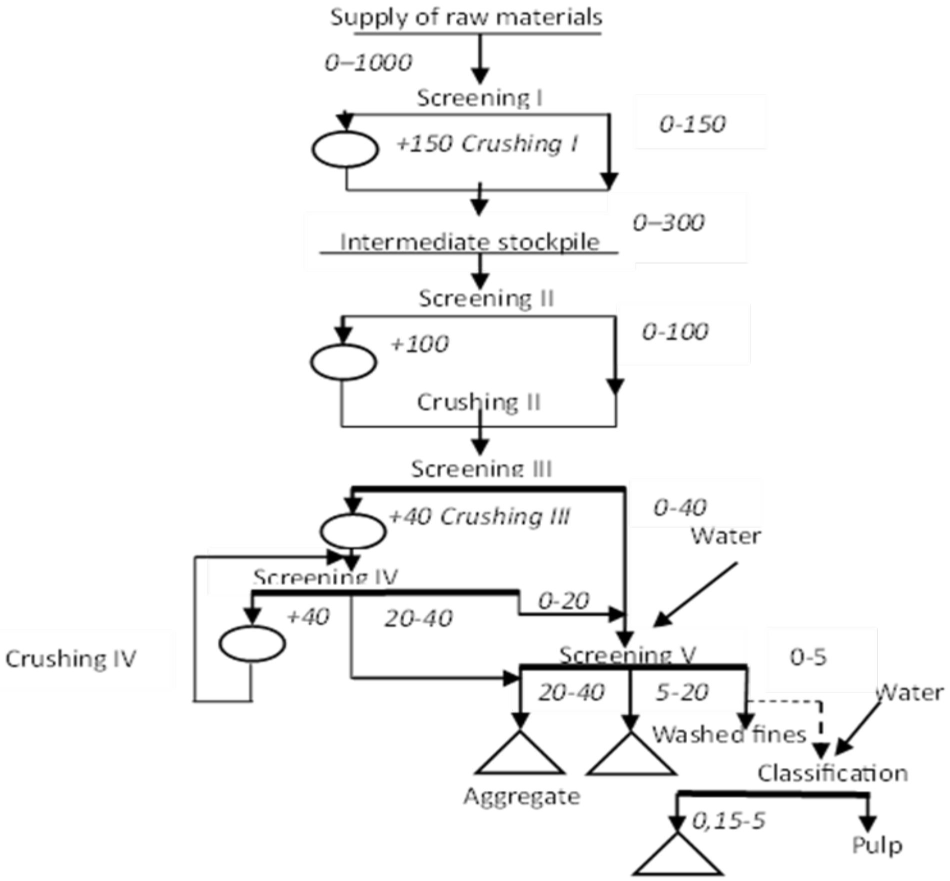

Figure 2. **Technological scheme of granite aggregate production (Deltuva ir Vaitkevičius, 2006)**

One of the dolomite aggregate producers in Northern Lithuania, operating at the Petrašiūnai 2 quarry, utilizes a multi-stage crushing technology specifically designed to produce dolomite aggregate suitable for the upper layer of asphalt pavement. The technological scheme incorporates four distinct crushing stages (Figure 3).

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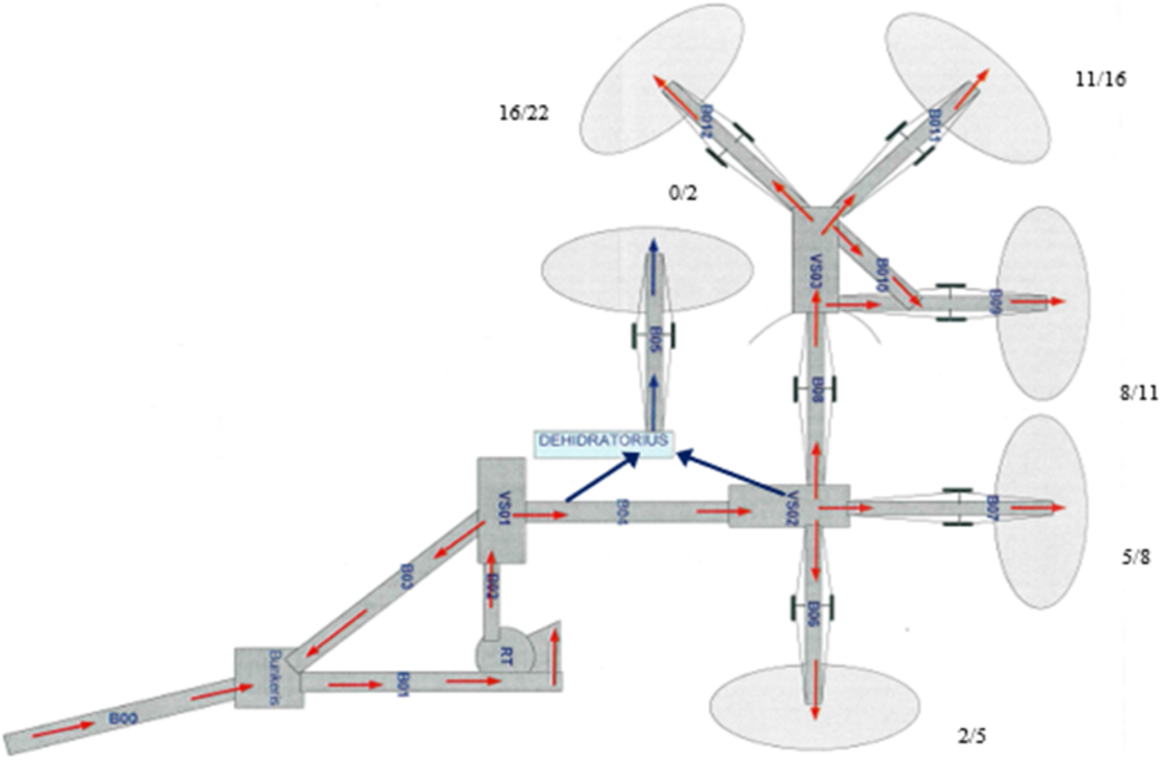

Figure 3. **Technological scheme of multi-stage dolomite aggregate crushing (Šneideraitienė, 2021)**

This advanced crushing process is characterized by the inclusion of a fourth stage, during which dolomite particles sized 16–45 mm with an initial impact resistance (SZ) value of ≤22% are further processed to achieve an enhanced impact resistance value of ≤18% (Šneideraitienė, 2021). This improvement in mechanical performance is particularly significant, as it ensures the suitability of the dolomite aggregate for high-performance asphalt applications, where durability and resistance to dynamic loads are critical.

PROPERTIES OF DOLOMITE AGGREGATES

Dolomite is a carbonate rock composed primarily of the mineral dolomite ($CaMg(CO_3)_2$), along with calcite, clay minerals, and other impurities (Andrzejuk et al., 2019). The name originates from the French geologist Dolomieu, who studied the Dolomite Alps (Bourrouilh-Le Jan, 2000). In Lithuania, dolomite deposits account for approximately 0.9% of all exploited mineral resources (Čygas et al., 2005; Skrinskas et al., 2010).

Four major deposits are distributed across different regions, and their depth of occurrence significantly influences economic viability (Gasiūnienė, 2007). The use of local resources can reduce transportation costs by up to 30% (Dagilienė & Mykolaitienė, 2012; Gulevitš et al., 2010).

Dolomite exhibits favorable mechanical properties, including high frost resistance and low water absorption, making it suitable for use in road surface mixtures. The properties of dolomite aggregate and filler—geometrical, physical, durability-related, and chemical—are defined in national technical standards (Table 1).

Table 1

Properties of Dolomite Aggregate Used in Road Construction

(Source: Šneideraitienė (2024), TRA AGGREGATES 19, Laboratory test data)

Property Category	**Parameter**	**Measured Value**	**Regulatory Limit / Benchmark**	**Notes**
Geometrical	Particle size (D/d), mm	-	Defined by gradation standards	Covers coarse and fine fractions
	Fines content (%)	<3%	≤5%	Especially relevant for D ≤ 8 mm
	Flakiness index	<15%	≤25%	Indicates particle shape uniformity
	Shape index / Flow coefficient	<15%	≤25%	Assessed via laboratory tests

Physical	Water absorption (24 h)	<1%	≤2%	Indicates low porosity
	Resistance to freezing and thawing	<0,5%	<1%	Ensures durability in cold climates
	Resistance in presence of NaCl	<1,5%	<5%	Important for winter road conditions
Durability	Magnesium sulfate resistance	<1,5%	<18%	Assesses long-term mechanical stability

Modernized dolomite crushing lines, combined with raw dolomite containing at least 19% magnesium oxide, enable the production of aggregates with geometric and physical characteristics comparable to those of granite (Table 2).

Table 2

Chemical Strength Indicators of Dolomite and Granite

(Source: Šneideraitienė (2021), Bourrouilh-Le Jan (2000))

Rock Type	**Key Chemical Component**	**Content (%)**	**Function**
Dolomite	Magnesium Oxide (MgO)	≥19	Enhances durability and impact resistance
Granite	Silicon Dioxide (SiO_2)	~65	Provides structural strength and hardness

LITHUANIA'S NON-METALIC MINERAL RESOURCES

Every year, the European Aggregates Association (UEPG) compiles data on the use of construction materials across Europe. In the Baltic States – Lithuania, Latvia, and Estonia – aggregates such as sand, gravel, and crushed rock are primarily extracted from quarries and pits (Table 3).

Table 3

Aggregate Production in the Baltic States

(Source: European Aggregates Association (UEPG), 2023)

Country	**Sand and Gravel (Mt)**	**Crushed Rock (Mt)**	**Extraction Sites**	**Companies**
Lithuania	13.6	9.3	220	70
Latvia	9.8	6.1	105	55
Estonia	8.8	4.4	290	193

Lithuania possesses approximately seventeen types of natural resources. Some of these are currently being exploited, others are under active geological investigation, and several remain classified as predicted reserves based on preliminary assessments. The distribution of extracted non-metallic mineral resources in Lithuania, based on 2023 data, is presented in Figure 5.

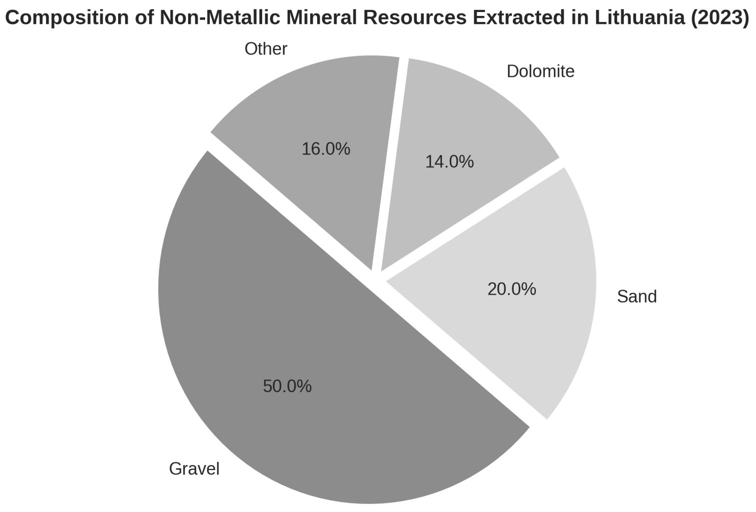

Figure 5. **Composition of non-metallic mineral resources extracted in Lithuania (2023)**

Approximately 50% of Lithuania's extracted mineral resources consist of gravel, while sand accounts for around 20%, and dolomite comprises approximately 14%.

Dolomite resources in Lithuania are primarily located in the northern part of the country, with notable deposits in Petrašiūnai, Klovainiai, and Skaistgirys. In most locations, dolomite lies directly beneath a thin surface layer, facilitating extraction. However, in the Petrašiūnai 2 and Petrašiūnai 3 quarries, the deposits are situated at greater depths, requiring more advanced mining techniques.

TECHNOLOGY AND DOLOMITE: HOW LOCAL RAW MATERIALS ARE TRANSFORMING GLOBAL BUSINESS

The integration of locally sourced raw materials, such as dolomite, into advanced production technologies is emerging as a key driver in the global construction materials market. Technological advancements not only enhance the quality of dolomite aggregates but also broaden their international application potential—particularly in infrastructure and road construction sectors. Recent geopolitical developments, including sanctions on Belarus and disruptions in global supply chains, have prompted Lithuania's construction industry to reconsider its reliance on imported resources.

One of the most promising alternatives is dolomite, which is widely distributed across the country. Utilizing domestic mineral resources significantly improves economic efficiency by reducing transportation costs, stabilizing supply chains, and strengthening regional economies. This shift also decreases dependency on foreign materials and fosters the growth of local industries.

Dolomite and Environmental Sustainability. Dolomite requires less energy for processing compared to synthetic alternatives, resulting in a lower carbon footprint. The use of local materials in construction minimizes waste generation and supports circular economy principles, contributing to broader sustainability goals.

Advanced Processing and Competitive Quality. Innovative multi-stage crushing technologies employed at the Petrašiūnai quarries enable the production of dolomite fillers that meet international standards for impact resistance. These high-performance materials serve as viable alternatives to granite in high-traffic road surfaces, enhancing both innovation and competitiveness within the construction sector.

Supporting Sustainable Infrastructure Development. The incorporation of dolomite into asphalt concrete mixtures improves mechanical performance and extends pavement durability. This not only reduces long-term maintenance costs but also mitigates environmental impact, aligning with sustainable infrastructure development objectives.

CONCLUSIONS

1. Multi-stage crushing significantly improves the mechanical performance and geometric consistency of dolomite aggregates, enabling them to compete effectively with granite in road construction applications.
2. Dolomite extracted from the Petrašiūnai-2 and Petrašiūnai-3 quarries demonstrates stable physical and chemical characteristics. Its elevated magnesium oxide content confirms suitability for high-performance infrastructure projects requiring durability and resilience.
3. Utilizing locally sourced dolomite reduces energy consumption and emissions, strengthens supply chain resilience, and enhances regional competitiveness in global markets, contributing to sustainable infrastructure development.

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