



(REVIEW ARTICLE)



The marble industry and its evolution since 1990 in Brazil: A bibliographic review

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World Journal of Advanced Research and Reviews, 2023, 19(01), 062–068

Publication history: Received on 25 May 2023; revised on 01 July 2023; accepted on 03 July 2023

Article DOI: <https://doi.org/10.30574/wjarr.2023.19.1.1318>

Abstract

The Brazilian stoneworking industry has undergone various structural, cultural, and technological changes since the 1990s. The introduction of multi-wire saws has made extracting harder rocks such as quartzites possible, increasing productivity. The arrival of modern cutting and finishing machinery has facilitated the production of slabs and met the demands of an increasingly demanding and selective market. The use of resin treatments for slabs has been a significant advance. This context has elevated Brazil as one of the largest exporters of slabs for the external market while also becoming one of the largest consumers of natural rocks. This study utilized a qualitative approach, with a literature review as the chosen research procedure. The results highlight that the rock market in Brazil, in general, primarily serves the construction industry, which is growing year after year. Nevertheless, stoneworking companies need to keep up with this growth to meet market demands.

Keywords: Rocks; Stoneworking Companies; Rock Market; Construction Industry

1. Introduction

In Brazil, since the 1990s, there has been significant growth in the natural stone sector, specifically in the field of marble workshops, which account for the majority of job creation, followed by sawmills and stone processing branches.

The chosen method for this study is characterized as a qualitative approach, and the selected procedure for conducting the research was a literature review.

The general objective of this study is to describe the behavior and evolution of marble workshops and the ornamental stone sector in Brazil since 1990. The specific objectives are as follows: to demonstrate the evolution of marble workshops and stone processors in Brazil and to present modern tools, techniques, and technologies that are continually raising the standards of quality in the stone sector.

This study is structured as follows: the first topic is the introduction, where the research objectives were explained. The second topic presents a theoretical framework divided into two subtopics. The first subtopic provides a historical overview of marble workshops in Brazil, while the second subtopic focuses on the evolution of marble workshops, exploring their prospects for progress. The third topic describes the methodology used to develop this scientific article, and finally, the last topic presents the concluding remarks.

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2. Material and methods

The chosen method for this study is characterized as a qualitative approach, aiming to present facts and research on the researched topic, seeking to delve into the historical evolutionary process of marble workshops and their future prospects.

According to Carlini (2022, p. 01): "The qualitative method guides research procedures on study objects that require non-numerical descriptions and analyses of a particular phenomenon [1]."

The selected procedure for conducting the research was a literature review, consisting of analyzing research sources classified into three categories: articles published in scientific journals, papers presented at scientific events, books, and documents from associations related to the researched topic.

According to Gil (2006, cited in Laureano, and Reis Filho, 2020, p.06), "bibliographic research is developed based on material that has already been elaborated, consisting of books and scientific articles [2]; [3]."

This article was elaborated based on the opinions of various authors, among which Mello, Lima, and Pereira (2017), Silva et al. (2018), Menezes and Silva (2019), Martins and Silveira (2020), and Revista Rochas (2021) stood out.

3. Literature Review

3.1. Historical Overview

Starting in the 1990s, Brazil witnessed a remarkable intensification of activities in all segments of the productive chain within the ornamental and cladding stone sector.

The main advancements were a result of increased exports, which demonstrated a significant qualitative and quantitative evolution. Qualitatively, the export profile was modified, with the growth of sales of semi-finished processed stones, particularly polished granite slabs, as well as finished products of slate and foliated quartzites.

Quantitatively, these exports increased from 900,000 tons in 1997 to 2.5 million tons in 2007, driven by sales of polished slabs to the United States and blocks to China [4].

Regarding processing works, in the early 1990s, they were conducted in a highly artisanal and rustic manner, which was time-consuming, resulted in raw material losses, and had low productivity. With the implementation of various machinery technologies, such as bridge saws, edge polishers, miter saws, and even waterjets, the processing process advanced significantly and continues to progress today.

According to Menezes et al. (2019, p. 2):

Brazil is one of the main producers and exporters of ornamental stones in the world, and the utilization of these materials has been increasingly enhanced in recent years. Brazilian ornamental stones are globally recognized for their chromatic diversity and durability, making them ideal for use in various construction and design projects. Additionally, the ornamental stone industry plays an important role in the Brazilian economy, generating employment and foreign exchange for the country [5].

The use of ornamental stones in Brazil has been significantly increasing each year, and it can be affirmed that Brazilian ornamental stones are increasingly being used due to their chromatic diversity and durability.

According to the Brazilian Association of Ornamental Stone Industry - ABIROCHAS (2021, p. 04):

From 1999 to 2020, Brazilian rock exports increased from \$200 million to \$1 billion, after declining from \$1 billion, which was first reached in 2006, to \$725 million in 2009, and then rising again to \$1.3 billion in 2013. Starting in 2014, our exports experienced continued decline until reaching the same level of \$1 billion in 2018, remaining at that level in 2019 and 2020. All negative fluctuations occurred as a result of economic or market events that affected, to a greater or lesser extent, all major players in the industry, including China itself [6].

With this scenario that positions the country as a global powerhouse in the export of processed slabs, whether of high-quality marble or granite, it is possible to perceive that currently, the largest share of these exports goes to the USA and Europe, resulting in the domestic market suffering from low-quality raw materials.

Revista Rochas (2022, p. 18) states:

The ornamental stone sector in Bahia originated in the 1950s when the extraction of Beige Bahia began in the Juazeiro region. According to the document 'Panorama of Ornamental Stones in Bahia' by CPRM, the rock was initially used as Portuguese stone for pavements. However, by the late 1950s, the rock started being extracted in blocks and split into slabs. Due to its pleasant aesthetic pattern and ease of combination with other architectural and decorative elements, Beige Bahia caught the attention of buyers and specifiers. Furthermore, its resemblance to Roman Travertine, imported from Italy, also contributed to its success in the Brazilian and international markets. Currently, Beige Bahia is widely used in various projects, both in internal areas such as floors, countertops, stairs, and decorative panels, and in external areas such as paving for leisure areas and pool edges [7].

The beige marble from the northern region of Bahia has been used in all regions of Brazil and also in a large part of the world. It is a material that brings significant wealth to that region of our country and is highly sought after for its natural beauty. Figure 01 shows an example of Beige Bahia marble.



Source: [8]

Figure 1 Photographic Record of a Sample of Beige Bahia Marble

Among the technological advancements observed in the past two decades, the use of resins and mesh in slabs stands out as innovations that have allowed the utilization of rocks with low mechanical strength and imperfections such as fissures or other flaws. Today, it is inconceivable to plan new projects without the availability of equipment that enables the use of these innovations.

The use of mesh and resins has been a solution for the commercialization of ornamental rocks with low mechanical strength or flaws that would not have been suitable for use in coatings before. These techniques allow for the use of these rocks, adding value to materials that would have been discarded previously [9].



Source: [7]

Figure 2 Slab being resin-coated

In the last decade, particularly with the extraction of quartzites, which are geologically composed of very hard material with numerous fissures and veins that confer a certain fragility during processing, the use of resins has corrected imperfections, and the use of mesh on the back of slabs has provided significant strength to these materials, as can be observed in Figure 02.

Martins and Silveira (2020, p. 863) assert that:

The most recent technological innovation for the resin application process is the manufacturing of equipment used for applying the epoxy system onto ornamental rock slabs. The most advanced equipment includes an applicator robot, where heated resin is applied and distributed over the surface of the slab by specific devices, without the need for human labor. It is worth noting that such equipment, such as the passage oven, the automatic resin application line, and the resin and hardener heater, have temperature control that can be adjusted by operators according to the mixture to be used and the rock to be processed. In the ornamental rock sector, when analyzing the best epoxy system to be used for rock enhancement, characteristics such as viscosity, catalysis and gel times, as well as the pre-polishing period, are taken into account. This new technology enables the treatment of rocks such as quartzites and dolomitic marbles that, in their geological formation, exhibit numerous fissures and cracks. In these cases, epoxy resins have added more quality to these types of rocks [10].

In Table 1, we will see the mixing proportions of this epoxy system.

Table 1 Proportion of Part B in epoxy systems

HARDENER	MIX
Hardener A	Mix at a ratio of 50% of the amount of Part A used in the mixture.
Hardener B	Mix at a ratio of 37% of the amount of Part A used in the mixture.
Hardener C	Mix at a ratio of 30% of the amount of Part A used in the mixture.
Hardener D	Mix at a ratio of 30% of the amount of Part A used in the mixture.

Source: [10]

In the treatment of rocks exhibiting fissures, the epoxy system mixture can play a significant role in stabilizing and consolidating these fissures. The epoxy system is a blend of two components: epoxy resin and hardener. When these two components are mixed, a chemical reaction occurs, resulting in the formation of a rigid and resistant polymer.

When applied to rock fissures, the epoxy system fills the empty spaces, firmly adheres to the walls of the fissure, and rapidly solidifies. This creates a stronger and more stable structure, preventing the propagation of the fissure and reducing the risk of rock collapse or failure [11].

Moreover, the epoxy system can also be utilized to fill voids on rock surfaces and secure loose or detached blocks, providing enhanced safety and stability to structures built on or with rocks.

3.2. Evolution of Marble Workshops - Perspectives of Progress

The production chain of ornamental rocks follows a similar process to any other production process, starting with the extraction of blocks from quarries, which are then transported to sawmills for processing, and finally to marble workshops.

In Brazil, the block processing sector has mainly been concentrated in the state of Espírito Santo, accounting for over 60% of the production. The blocks from quarries are transported to sawmills via road transportation. Initially, these blocks were cut using diamond blades. However, over time, with the increase in both domestic and international demand, the industry has evolved to using diamond wires, which offer higher productivity.

Silva et al. (2018, p. 03) assure that:

The production of ornamental rocks in Brazil has been driven by the rising demand, both domestically and internationally, in recent years. The blocks of rocks are extracted from quarries and transported by road to sawmills, where they are transformed into slabs and other finished products [12].

Initially, diamond blades were used for cutting the blocks, but with the advancement of technology and the need for greater productivity, sawmills started utilizing diamond wires for cutting the rocks. This technique has significantly increased productivity and efficiency in the transformation process of rocks into finished products. Once transformed into polished slabs or treated with other finishes such as brushed surfaces, these slabs are ready to be commercialized to marble workshops. Together with professionals like architects, marble workshops specify these slabs for various purposes, including ornamental and wall coverings, flooring, countertops, and even building facades.

According to Silva et al. (2019, p. 04),

Ornamental rocks are transformed into polished slabs or treated with other finishes, such as brushed surfaces, and are then commercialized to marble workshops. These materials are used for various purposes, including wall coverings, flooring, countertops, and even building facades, and are specified by architects and other professionals [13].

When the slabs arrive at the marble workshop, the production process begins. It starts with each client's specific demands, whether it is their own request or through another professional such as an architect. Once the demands are identified, the final measurements are taken on-site. The production then proceeds through the cutting, polishing, assembly, and dispatch stages, before finally being delivered to the client. The same process applies to buildings with ventilated facades, as well as flooring for shopping malls, airports, and other projects.

Marble workshops have made significant advancements with the introduction of synthetic materials, such as quartz, engineered stones, porcelain, and sintered slabs. These materials offer a higher added value compared to natural rocks, and their chromatic variety is superior. Additionally, they can perfectly mimic the appearance of natural rocks, which is a major advantage in the marble industry.

Today, it is evident that with new technologies and machinery advancements, the marble industry can offer exceptionally well-crafted finished materials to an increasingly demanding market. The market provides Computer Numerical Control (CNC) machines and waterjet cutting machines. Waterjet cutting has the capability to cut nearly all materials in various shapes and forms.



Source: Data from the Researchers

Figure 3 Automatic Machine

The automatic cutting machine has facilitated and provided precision in cuts when it executes precise cuts through software. One advantage is that the entire slab can be placed on the cutting table, and only one operator is required to operate the machine.

According to an article from A Voz da Indústria (2022, p. 01),

Waterjet cutting, also known as jet-cutting in the market, is one of the most cohesive cutting technologies, where a specific flow of water (ranging from 20 to 40 liters per minute) passes through a narrow diamond nozzle at an extremely high pressure - between 2,500 and 3,500 bar - to cut different materials.

This process falls under the category of hydrodemolition, which is similar to erosion found in the natural environment, but with the difference of adding more acceleration, precision, and concentration to achieve different results.



Figure 4 Waterjet Cutting Machine

Waterjet cutting machines offer numerous advantages, including the ability to make cuts at various angles and with different shapes. They allow for cuts of any size with great precision. However, the main disadvantage is that this machinery is still expensive, making it less accessible to small marble workshops. The initial price of these machines can reach up to R\$ 1,000,000.

With the advent of modern architecture and the utilization of these available technologies, various professionals in the construction industry, working together with marble workshops, have contributed to significant growth in the sector in the coming years.

4. Conclusion

At the end of this research, it is evident that the evolution of marble workshops in Brazil has been of great relevance to the sector of ornamental and synthetic rocks, as they serve as the link between slab-producing sawmills and the end consumer.

The research highlights that the rock market in Brazil, in general, primarily caters to the construction industry, which is growing year by year. Nevertheless, it is apparent that marble workshops need to keep up with this growth. The present research has shown that the growth of the rock market in Brazil is due to the emergence of modern machinery and techniques for the extraction and processing of slabs.

It has also revealed that with the introduction of synthetic materials into the market, such as synthetic stones, it becomes clear how much potential there is for further growth in the Brazilian marble industry.

Compliance with ethical standards

Acknowledgments

The authors would like to thank Ana Zuleika Mendes Bastos Tavares Education and Career Analyst II at Instituto Euvaldo Lodi - IEL/CE and Prof. Spec. Carlos Rubens Araújo Alencar Coordinator of the MBA Course in Use of Rocks in Civil Construction and also Professor M. Sc. Rosilda do Rocio do Vale Coordinator of the Graduate Courses at the Faculty of Industry and the Euvaldo Lodi Institute (IEL) for all the attention given.

Disclosure of conflict of interest

The authors assure that there is no conflict of interest with the publication of the manuscript or an institution or product mentioned in the manuscript and/or important for the result of the presented study.

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