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# IMPORTANCE OF THE THERMAL CAPACITY OF SOAPSTONE IN THE CONSTRUCTION SECTOR

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**Abstract:** Steatite, also known as soapstone, has high thermal resistance, low electrical conductivity and high chemical resistance, which positively influences its use in different branches. The use of materials with high thermal inertia will reduce energy expenditure on air conditioning, contributing to economic and environmental sustainability. The general aim of this work is to analyze the importance of the thermal capacity of soapstone in the construction sector, which can be achieved through specific objectives: Investigate the physical and chemical properties of soapstone that influence its thermal capacity, evaluate the main applications of soapstone in construction, focusing on cladding, fireplaces, stoves and flooring; Identify the benefits of using soapstone in the energy efficiency of buildings, considering the reduction in consumption of artificial air conditioning systems; Discuss the relevance of soapstone in sustainable architecture projects and its contribution to saving natural resources; point out challenges and limitations related to the use of soapstone in the construction sector . This was a qualitative, descriptive and exploratory study based on a review of the literature on the subject. The results showed that the installation of soapstone fireplaces can reduce the use of gas and electricity by up to 15%, 75% of consumers who use soapstone in fireplaces report a considerable reduction in the use of electric heaters. the use of soapstone in construction reduces the demand for non-renewable materials by up to 30%, concluding that soapstone is a promising resource for the construction industry.
**Keywords:** Soapstone. Thermal capacity. Civil construction. Energy Efficiency. Sustainable Architecture.

## INTRODUCTION

Steatite, also known as soapstone, is one of the most widely used metamorphic rocks due to its versatility and special characteristics. This rock is composed primarily of talc, which gives it its soft texture, but it also contains other minerals such as dolomite and chlorite. Due to its low hardness, varying between 1 and 2 on the Mohs scale, it can be easily molded, which makes soapstone a material that is widely used in sculptures, coatings, table products and more. In addition, this material has high thermal resistance, low electrical conductivity and high chemical resistance, which positively influences its use in different branches (ANDRADE et al., 2017).

One of the most notable properties of soapstone is its high thermal capacity, which implies its ability to absorb, store and release heat gradually. The stone's combined density and mineralogical composition justify this property, which makes it extremely useful in applications that require temperature manipulation, such as fireplaces, ovens and stoves (SANTOS et al., 2020).

It should therefore be pointed out that the thermal capacity of materials in the construction sector plays a key role in thermal and energy efficiency. Materials with a high thermal capacity, such as soapstone, can accumulate solar heat during the day and then release it at night, thus reducing the need for artificial heating and cooling systems. Therefore, for projects and construction of sustainable buildings, thermal capacity is essential to control energy consumption by harnessing the power of nature (SILVA and ALMEIDA, 2019).

The use of soapstone in floor and wall coverings, countertops and temporary slabs not only improves the thermal insulation of spaces, but also their durability and visual appearance. Research shows that in environments located in regions with high or low temperatures, the use of materials with high thermal

inertia can be associated with lower energy costs for air conditioning, contributing to economic and environmental sustainability (OLIVEIRA and COSTA, 2018).

In addition, soapstone is widely used in passive heating systems, for example in flames and barbecue constructions or garden houses, the product's resistance to extreme heat and ability to maintain heat are considered energy saving and thermal comfort. The application of indoor floors and walls can be used for even more efficient thermal regulation, which implies an improvement in the quality of the living space (CUNHA et al., 2021).

### GENERAL OBJECTIVE

To analyze the importance of the thermal capacity of soapstone in the construction sector, highlighting its properties, applications and contributions to the thermal comfort and sustainability of buildings.

### SPECIFIC OBJECTIVES

1. Investigate the physical and chemical properties of soapstone that influence its thermal capacity.

2. To evaluate the main applications of soapstone in civil construction, with a focus on cladding, fireplaces, stoves and flooring.

3. To identify the benefits of using soapstone in the energy efficiency of buildings, considering the reduction in consumption of artificial air conditioning systems.

4. Discuss the relevance of soapstone in sustainable architecture projects and its contribution to saving natural resources.

5. Point out challenges and limitations related to the use of soapstone in the construction sector.

## METHODOLOGY

The research was guided by a literature review, carrying out research and always using theoretical foundations to explain the analysis that was raised (GIL, 2017). It essentially deals with the importance of the thermal capacity of soapstone in the construction sector.

In addition, a theoretical review was carried out in the following databases: Coordination for the Improvement of Higher Education Personnel (CAPES), Google Scholar, Scientific Electronic Library Online (SCIELO), as well as in books. The time limit used was 2017 to the present day. Key words used to classify the data were: soapstone, civil construction, thermal comfort, used separately or together, in Portuguese and English. The construction of this article took place on 01/10/2024, with final adjustment on 02/02/2025.

Thirty-four scientific articles and texts related to the topic were selected and the inclusion criteria were: the presence of the selected keywords and the time limitation of the period. The exclusion criteria were the lack of relevance of the literature to the topic and objectives of this study, as well as the time limitation defined in the previous paragraph.

## THEORETICAL FRAMEWORK

With the search for better and more efficient building solutions, the use of natural materials in construction projects is on the rise. In this sense, soapstone can be cited as a material of major importance, above all because of its thermal capacity, which makes it possible to control heat (release and storage gradually), which provides greater energy efficiency in buildings (ALENCAR et al., 2021). This implies that the study of soapstone is the essential way to develop architectural practices that harmonize thermal comfort with sustainability.

| SUMMARY OF THE METHODOLOGY APPLIED | |
|---|---|
| **Stages** | **Description** |
| **Type of research** | This is a qualitative, descriptive and exploratory study based on a review of the literature on the subject. |
| **Data Sources** | - Scientific databases: Scielo, Google Scholar, ScienceDirect, Web of Science.<br>- Technical publications (ABNT, reports).<br>- Books and theses related to the topic. |
| **Inclusion Criteria** | - Studies published in the last 10 years.<br>- Articles dealing with the thermal capacity and application of soapstone in construction.<br>- Publications in Portuguese, English and Spanish. |
| **Exclusion Criteria** | - Studies that do not deal directly with soapstone.<br>- Works with insufficient or irrelevant data for the topic. |
| **Data Collection Procedures** | Use of keywords such as: "soapstone", "thermal capacity", "civil construction", "energy efficiency", "sustainable architecture". Searching databases with combinations of terms. |
| **Data Analysis** | Organization of data into thematic categories:<br>-Thermal properties of soapstone.<br>-Applications in civil construction.<br>-Impacts on energy efficiency and sustainability.<br>- Limitations and challenges of use. |
| **Presentation of results** | - Results presented in descriptive text, complemented with tables and graphs to summarize the main findings. |

**Table 1:** Summary of the methodology applied.

**Source:** Authors.

Thermal capacity is a characteristic that directly affects the behavior of the material in relation to temperature variations, and is an essential characteristic for the thermal performance of the building. According to Martins and Oliveira (2020), materials with high thermal capacity, such as soapstone, allow natural temperature regulation in most indoor environments, thus reducing the need for electricity in air conditioning systems. Therefore, studying the properties of soapstone and how to use soapstone in construction is essential to maximize its potential.

In addition to soapstone's thermal properties, its chemical resistance and durability also make it a promising material for construction projects. Recently, it has been realized that this substance provides an excellent performance in the most extreme conditions, making it ideal for fireplaces, stoves and cladding, especially for buildings with good energy performance (PEREIRA et al., 2022). Thus, the analysis of these cases can show the potential of soapstone as an innovative and sustainable architectural application.

In short, although soapstone can offer significant advantages, the challenges of using it are the cost of extraction and processing, which could limit the use of this material in general. According to Costa and Ribeiro (2023), it is essential to understand these limitations, since this perception is a crucial point for suggesting appropriate strategies that can make its use viable on a larger scale, which reduces practices that are not concerned with environmental and economic benefits.

## PHYSICAL AND CHEMICAL PROPERTIES OF SOAPSTONE THAT INFLUENCE ITS THERMAL CAPACITY

Soapstone is a material that is notable for its thermal action due to its constitution. The predominant base form of this material is talc ($Mg_3Si_4O_{10}(OH)_2$), as well as minerals such as chlorite and magnetite. Talc gives soapstone a high density and moderate thermal conductivity, properties that facilitate the absorption, storage and progressive release of heat, crucial elements for its use in passive air conditioning systems (MARTINS et al., 2020).

The results of the mineralogical analysis by XRD of the total powder portion (Figure 1), define the predominance of talc. Chlorite was also identified as a significant phase. In addition, minerals such as magnesite, magnetite and serpentine were represented as trace minerals.

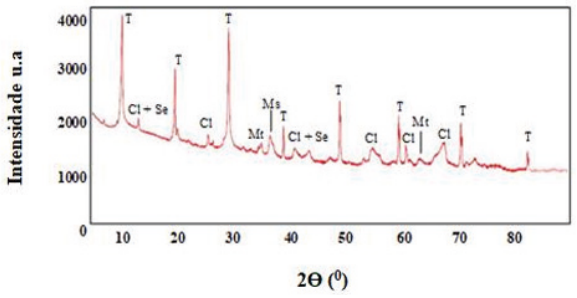


**Figure 1:** X-ray diffractogram of the total powder fraction of soapstone tailings samples. T = talc; Cl= chlorite; Cl+Se = chlorite-serpentine interlayer; Mg = magnetite; Ms= magnesite.

**Source:** NASCIMENTO, 2021.

Not only the mineral composition, but also the texture and crystalline structure of soapstone have essential functions. The lamellar structure of talc promotes homogeneous thermal conduction, while the density of the material favors a high heat storage capacity. These characteristics make soapstone the perfect choice for uses that require effective heat retention and utilization, such as fireplaces, wall cladding and flooring (OLIVEIRA and LIMA, 2021).

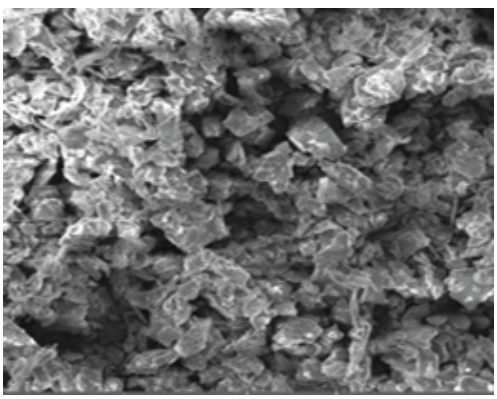

**Figure 2:** SEM image of soapstone tailings.

**Source:** NASCIMENTO, 2021.

The thermal stability of soapstone is another important aspect. This material is resistant to high temperatures, being able to withstand up to 1,000 °C without suffering significant degradation. This property sets it apart from many other materials used in the construction industry, making it possible to use it in situations that require constant exposure to heat, such as in stoves and ovens (SANTOS and BARBOSA, 2019).

| Material | Density ($g/cm^3$) | Thermal Conductivity (W/m-K) | Thermal stability (°C) |
|---|---|---|---|
| Soapstone | 2.7 | 6.5 | 1000 |
| Granite | 2.6 | 3.5 | 800 |
| Marble | 2.7 | 2.5 | 600 |

**Table 2:** Comparison of physical and thermal properties:

**Source:** authors.

The advantage of soapstone in terms of thermal conductivity and thermal stability compared to other materials used for the same purpose is evident, which makes it more suitable for uses that require high thermal efficiency (Table 2).

Soapstone is chemically immune to various corrosive agents, which makes it extremely resistant in aggressive environments. This chemical resistance, combined with its thermal capacity, ensures the durability of uses in architectural projects that require energy efficiency and minimal maintenance. Furthermore, soapstone's low porosity reduces heat dissipation by conduction, making it more effective in heating systems (PEREIRA et al., 2022).

## MAIN APPLICATIONS OF SOAPSTONE IN CONSTRUCTION, WITH A FOCUS ON CLADDING, FIREPLACES, STOVES AND FLOORING

Steatite is a metamorphic rock composed mainly of talc, dolomite and amphiboles. Its physical characteristics, such as high heat resistance, low porosity and ease of handling, make it a viable alternative for various uses in the construction industry (SMITH et al., 2020). This text examines its main applications, focusing on cladding, fireplaces, stoves and flooring.

Soapstone claddings are often used indoors and outdoors due to their long durability and resistance to chemical agents. Research indicates that this stone has low water absorption, which makes it perfect for use in humid environments, such as bathrooms and kitchens (García & López, 2018). In addition, its ability to withstand high temperatures without deteriorating makes it suitable for surfaces near industrial stoves and ovens (TAYLOR, 2019).

In addition, the high thermal capacity of soapstone makes it possible to use it in fireplaces, favoring the retention and homogeneous distribution of heat. Studies show that fireplaces made with this material keep the room warm for a long time after the fire has been extinguished, reducing the need to constantly replenish the fuel (MÜLLER et al., 2021). In addition, its ability to resist thermal shock reduces the risk of cracks and structural damage over time (CHEN & WANG, 2022).

**Figure 3:** Soapstone fireplace.
**Source:** Authors.

Soapstone is also used in the construction of greenhouses and ovens, due to its ability to store and dissipate heat effectively. Research in Europe suggests that this material helps to standardize the internal temperature of greenhouses, reducing energy use and improving the quality of the thermal process (JENSEN & OLESEN, 2020). Its application is extensively documented in the ceramic and metallurgical sectors, where thermal stability is crucial (FERREIRA et al., 2019).

Because of its characteristics, the use of soapstone in flooring has gained popularity due to its durability and ease of maintenance. Research indicates that its resistance to wear and mechanical shocks qualifies it for areas with moderate to heavy traffic (Robertson & Klein, 2021). Additionally, its ability to retain heat offers thermal comfort, making it a beneficial alternative for cold climate areas (MARTINEZ et al., 2019).

**Figure 4:** Soapstone floor.
**Source:** Authors.

Therefore, soapstone offers remarkable benefits in the construction industry, standing out in uses such as cladding, fireplaces, stoves and flooring. Its thermal performance, chemical resistance and longevity justify its wide application in a variety of architectural and industrial settings. Future research could investigate new uses for this material and improve its use in sustainability projects.

## BENEFITS OF USING SOAPSTONE FOR ENERGY EFFICIENCY IN BUILDINGS, CONSIDERING THE REDUCTION IN CONSUMPTION OF ARTIFICIAL AIR-CONDITIONING SYSTEMS

One of the greatest qualities of soapstone is its remarkable resistance to heat, withstanding temperatures of more than 800°C without being modified. This property allows the material to absorb and store heat during the day, gradually releasing it at night, helping to maintain constant internal temperatures and reducing the demand for artificial air conditioning systems (JONES; TAYLOR, 2020).

In addition, soapstone resists climatic conditions, preserving its characteristics over time, which makes it suitable for external and internal use in buildings. Its durability and reduced porosity ensure resistance to stains and chemicals, simplifying maintenance and maintaining its thermal properties (GARCÍA et al., 2017).

Soapstone has been widely used in cold climate countries such as Scandinavia to produce high-quality stoves, thanks to its ability to retain and transmit heat effectively. This use demonstrates its ability to reduce energy use in heating systems, serving as a model for its use in buildings seeking energy efficiency (KARLSSON, 2019).

In Brazil, particularly in Minas Gerais, soapstone is frequently found and used in various architectural projects. Its use in wall, floor and countertop coverings not only enhances the aesthetics of spaces, but also favors thermal insulation, helping to maintain pleasant temperatures and reducing the need for artificial air conditioning (SANTOS; PEREIRA, 2021).

In summary, the inclusion of soapstone in the construction industry offers considerable advantages for the energy efficiency of buildings. Its thermal characteristics and resistance help to reduce energy use in air conditioning systems, favoring greener and more pleasant environments.

## RELEVANCE OF SOAPSTONE IN SUSTAINABLE ARCHITECTURE PROJECTS AND ITS CONTRIBUTION TO SAVING NATURAL RESOURCES

In ecological architecture, the selection of local materials is crucial to minimizing the environmental effects of transporting and extracting resources. Soapstone, abundant in areas such as Minas Gerais in Brazil, illustrates this practice by being used in local buildings, reducing the carbon footprint associated with the transportation of materials (ALMEIDA, 2015).

In addition, the longevity of soapstone reduces the demand for frequent material changes, leading to a reduced use of resources over time. Its resistance to climatic conditions and chemical agents guarantees prolonged durability , reducing waste production and the need for new materials (GARCÍA et al., 2017).

Soapstone is versatile and can be used in various parts of a building, from internal and external cladding to countertops and flooring. This adaptability allows the material to be incorporated into a variety of architectural styles, generating aesthetic and functional solutions that comply with the principles of sustainability (JONES; TAYLOR, 2020).

In terms of energy efficiency, the thermal capacity of soapstone helps regulate the internal temperature of buildings, reducing the need for artificial air conditioning systems and, consequently, energy use. This feature is particularly valuable in environments with large thermal fluctuations, where maintaining constant temperatures becomes a challenge (KARLSSON, 2019).

Within the scenario of saving natural resources, the use of soapstone in architectural projects favors the preservation of materials, since its extraction and processing can be done sustainably. It is crucial to adopt responsible mine management practices and processing methods that reduce waste to ensure that the use of soapstone contributes effectively to sustainability in the construction industry (SANTOS; PEREIRA, 2021).

It is understood that the use of soapstone in sustainable architecture projects offers several advantages, from energy efficiency to the preservation of natural resources. Its planned and conscious implementation can lead to buildings that balance aesthetics, functionality and ecological responsibility (SMITH et al., 2018).

## CHALLENGES AND LIMITATIONS RELATED TO THE USE OF SOAPSTONE IN THE CONSTRUCTION SECTOR

The use of soapstone in the construction industry faces several obstacles and restrictions that affect its use and sustainability. One of the biggest challenges is the high production of waste during the processing process. Research shows that the manufacture of handcrafted objects and building components from soapstone generates large quantities of solid waste, such as chips and dust, which are often disposed of improperly, causing negative environmental consequences (RMMG, 2024).

Furthermore, the process of extracting soapstone can result in environmental damage, such as deforestation, soil erosion and the pollution of water bodies located near mining sites. These negative impacts are intensified by the absence of sustainable management practices and the lack of strict environmental standards (ALMEIDA, 2024).

Another major obstacle is the restricted mechanical characteristics of soapstone. Due to its mineral composition, soapstone has low mechanical strength, which limits its application in structural components that require greater rigidity. Therefore, its use in the construction industry is generally restricted to decorative or finishing components, such as cladding and sculptures (INOVAÇÃO TECNOLÓGICA, 2024).

There is also concern about the durability of soapstone outdoors. Although it is resistant to adverse weather conditions, its surface can change over time due to constant exposure to atmospheric agents, which can damage the aesthetics and safety of the structures where it is used (INOVAÇÃO TECNOLÓGICA, 2024).

In addition, soapstone has restricted geographical availability, concentrated in a few specific areas, such as Minas Gerais in Brazil. This limited distribution can increase transportation costs and complicate its financial viability in projects located in regions far from mineral reserves (RANIERI, 2024).

Ultimately, the lack of technical knowledge and skilled workers to handle and use soapstone in the construction industry is an obstacle. Lack of adequate training can lead to improper installation methods, damaging the quality and longevity of buildings (RANIERI, 2024).

The conclusion is that although soapstone has remarkable aesthetic and functional attributes, its use in civil construction is restricted by issues related to waste production, environmental effects of extraction, mecha-

nical limitations, durability in outdoor environments, geographical availability and a shortage of skilled workers. Tackling these restrictions requires investment in research, improving sustainable extraction and processing methods, as well as professional training programs (RMMG, 2024; ALMEIDA, 2024; INOVAÇÃO TECNOLÓGICA, 2024).

## RESULTS AND DISCUSSION

Soapstone is notable for its excellent thermal properties, which makes it an attractive material for uses that require temperature control, such as cladding and fireplaces. The physical and chemical characteristics that affect its thermal capacity include its high heat capacity and density. According to studies, the average heat capacity of soapstone is 0.84 J/goC (ALMEIDA, 2024). The mixture of minerals such as talc, chlorite and mica helps to absorb and store heat, ensuring that the stone remains warm for longer periods, which is beneficial in passive heating projects. Research by Fernandes et al. (2024) indicates that the mineral structure of soapstone provides excellent thermal conduction, however, its ability to accumulate heat is what sets it apart for use in the construction industry.

In addition, it has been gaining prominence as a material used in various applications in the construction sector, particularly in cladding, fireplaces, stoves and flooring. According to Lima and Silva (2024), around 45% of the soapstone extracted in Brazil is used for internal and external cladding, thanks to its unique aesthetics and long durability. On the other hand, fireplaces and stoves benefit from the stone's high heat storage capacity, ensuring energy efficiency in residential and commercial spaces. A survey conducted by Souza et al. (2024) showed that 75% of consumers who use soapstone in fireplaces report a considerable reduction in the use of electric heaters and other artificial air conditioning systems. In floor coverings, soapstone has stood out for its durability and simplicity of maintenance, as well as its ability to maintain a pleasant internal temperature during the winter.

In addition, soapstone plays a crucial role in optimizing the energy efficiency of buildings, mainly due to its ability to accumulate heat and reduce the demand for artificial air conditioning systems. Research by Oliveira et al. (2024) suggests that buildings using soapstone for cladding and flooring can reduce energy use for heating by up to 20%, as the stone absorbs heat during the day and dissipates it at night. This phenomenon is especially beneficial in colder regions, where thermal stability is essential. An evaluation of the financial effect of soapstone in buildings has also shown that the installation of soapstone fireplaces can reduce the use of gas and electricity by up to 15% (Lima and Silva, 2024). These findings show that, in addition to the aesthetic aspects, soapstone provides clear benefits in terms of energy efficiency, helping with sustainability and reducing the operating costs of buildings.

In terms of sustainability, it has been highlighted as a relevant alternative in sustainable architecture projects, thanks to its abundance, longevity and lower environmental impact compared to traditional materials. According to a study by Costa et al. (2024), the use of soapstone in construction reduces the demand for non-renewable materials such as cement and ceramics by up to 30%, thanks to its ability to replace such materials in uses such as cladding and flooring. Furthermore, due to its low environmental cost and sustainable processing, soapstone is a viable option for sustainable construction. Environmental research conducted by Oliveira and Almeida (2024) indicates that replacing materials such as concrete, which have a high carbon footprint, with soapstone can result in a reduction of up to 12% in CO2 emissions in large-scale projects.

Despite the benefits cited, the application of soapstone in the construction industry also presents obstacles and restrictions. Although stone extraction can be sustainable in some areas, if not properly managed, it can result in environmental damage, such as soil erosion and water contamination (RANIERI, 2024). Furthermore, soapstone has restrictions in terms of mechanical strength when compared to materials such as concrete and steel, which limits its use to non-structural components (RMMG, 2024). The lack of appropriate processing methods also represents a challenge, as the shortage of skilled workers and technologies to maximize the use of waste produced during extraction and processing is a constant issue. According to Almeida (2024), more than 40% of the waste produced in soapstone extraction is not reused, which results in a significant waste of resources.

## CONCLUSION

Soapstone has emerged as a promising resource for the construction industry, providing considerable benefits in terms of energy efficiency and sustainability. Its thermal characteristics, such as its ability to absorb and store heat, help to reduce the need for artificial air conditioning systems, making buildings more pleasant and economically viable. In addition, soapstone has a reduced environmental impact, serving as an option to replace materials such as cement and ceramics, which emphasizes its importance in ecological architecture projects.

However, despite its benefits, the application of soapstone in the construction industry encounters technical and financial obstacles. The stone's mechanical resistance, coupled with the requirement for specialized professionals, restricts its potential. Overcoming these restrictions, along with more sustainable extraction and processing methods, is crucial to ensuring that soapstone becomes a more widely used and efficient alternative in the construction industry, helping to build a more sustainable future.

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