

## **MATERIALS FOR SUSTAINABLE CONSTRUCTION**

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### **Abstract**

The Industry of Construction is an activity that generates large negative impacts on the environment; therefore it is necessary and urgent to insert it within the scope and principles of Sustainable Construction. It is considered that the choice of materials (and the application of technologies in this effort) is done in the direction of the Sustainability of the Construction Industry.

**Keywords:** Materials, sustainability, construction industry, sustainable construction.

### **INTRODUCTION**

The following communication relates to the importance of the choice and use of materials, based on a certain criterion, aiming to reduce the negative impacts on the environment in the construction industry, with the aim of entering it in the scope and principles of sustainable construction.

In this sense, alternative models of construction must be found, with more productive technologies, by using lower volume of raw materials and by increasing the use of renewable materials, thus reducing the negative impacts that result from the exploration and production of natural resources, such as reduction of waste, pollution and energy consumption. It is also important that the use of materials be recyclable and reusable, with the objective of increasing its durability after the end of the life cycle of buildings, which are incorporated and include the phase of deconstruction. The adoption of these measures by the industry of construction of buildings is fundamental to make the change to Sustainable Construction.

This communication presents, in the context of renewable materials, some examples of the application of cork (Portugal is one of the largest producers in the world of this material) used in thermal insulation, acoustic and in coatings of buildings.

### **AWARENESS OF SUSTAINABILITY**

The use of fossil fuels and pollutants as support of economic growth policies give rise to the production of carbon dioxide and other greenhouse gases, which contribute to global warming and climate change, the exploitation and excessive consumption of natural resources, the excessive production of waste, the decimation of forests, pollution of air and water, have all highlighted the need for an urgent amendment to a new type of development, "Sustainable Development".

The awareness of sustainability and its relationship with economic development, were heavily influenced in

the 1960s, by the book *Silent Spring* by Rachel Carlson. This book mentions, for the first time, dead flamingos killed by the ingestion of food contaminated by pesticides. However, it was through the book *Limits to Growth*, in 1972, written by Dennis and Donella Meadows, who coordinated a research group at MIT (Massachusetts Institute of Technology), that the world first awakened and became conscious of the serious problems at hand.

It was with this objective that the United Nations (UN) organized the conference in Stockholm in 1972, with the theme "Human Environment", to find answers to the problems of the Environment on a global level.

In this sequence, in 1984, the UN created, the "World Commission on Environment and Development" (WCED), entitled Brundtland Commission, which produced, in 1987, the report "Our Common Future", whose concept can be interpreted as allowing *"to satisfy the needs of the present without compromising the possibility of future generations to satisfy their own"*.

In 1992 the UN organized an international conference entitled the "Earth Summit", held in Rio de Janeiro, which produced a fundamental document "Agenda 21". The aim was to guide the future and the evolution of all the social activities around the world, including the Construction Industry.

The Agenda 21 defined an action plan for a shift in the direction of Sustainable Development", with objective financial and technological measures that will lead to an evolution in the use of resources that allow for a better quality of life, not only for the present generation but for future generations as well.

## **CONCEPTS OF SUSTAINABLE CONSTRUCTION**

The term Sustainable Construction was defined in a structured way by Charles Kibert (1994), (Coordinator of CIB, working group TG16, Center for Construction and Environment, in the School of Building Construction, at the College of Architecture, of the University of Florida), in November 1994, to refer to the responsibilities of the construction industry in relation to the concept and objectives of Sustainability. In this sense, Sustainable Construction can be understood" as that which allows for the creation and *maintenance of a responsible and healthy constructed environment, based on the exploitation, management and judicious use and efficient natural resources available and in respect for the environment and the ecology."*

According to Charles Kibert, the existing knowledge and the diagnosis of the construction industry in terms of environmental impacts, reveals the urgent need for a change in order to achieve the objectives of sustainability. Firstly, the characteristics of the construction industry should be analysed and compared with the criterion of sustainability of the construction materials, products and processes of construction.

## **CHARACTERISTICS OF THE CONSTRUCTION INDUSTRY**

The industry of building construction, under normal conditions, plays a major role in the national economy, though mobilized investment, by participation in the GDP, and contributing to the formation of gross fixed capital. It is also important in terms of employment rates that it creates and the role it plays in the inter-relation and influence on other industries (Reaes Pinto, 2001).

However, it can be easily concluded that the construction industry is both polluting and aggressive to the environment, and it is important to realize that the negative environmental impact that this industry produces (jointly with parallel industries), must be evaluated and can be substantially reduced.

In fact, the activity of building construction consumes approximately 50% of the natural resources available and produces approximately 40% of the total amount of solid waste. With respect to energy consumption, including the consumption for the operation of buildings, its total values reach above 40 %, which are at the base of the main emissions of gases that adversely affect the environment, and the buildings are responsible for approximately 30% of these emissions. The emission of carbon dioxide is especially relevant, in addition to other greenhouse gases, which give rise to global warming and climate change (Reaes Pinto, 2008).

It is, therefore, essential and urgent to reduce the negative impacts resulting from the activity of the Construction Industry, and hence the need to insert it in the framework and principles of Sustainable Construction.

## **MATERIALS FOR SUSTAINABLE CONSTRUCTION**

In order to minimize the negative impacts on the environment, it is fundamental to manage the exploitation of natural resources wisely, by knowing how to select and use the materials, technologies and equipment. It is

also important to increase the life cycle of these materials by choosing quality and durability, by aiming to reduce the amount of energy used, as well as minimizing their toxicity, and waste reduction. It is also important to consider the analysis and monitoring of the life cycle of their costs.

The choice of this materials will be important, after the end of the life cycle of buildings and their selective deconstruction. To this end, it is fundamental that they can be recycled and reused in the sense of reducing the negative impacts resulting from the operation.

Traditionally, with this choice prioritizes, in terms of practical requirements, its technical characteristics, in particular the durability, which can be defined as the capacity of the materials, during its life cycle and under certain conditions, to have a good performance mechanically, physically and chemically.

However, recently there has been a tendency toward change in the predominance of durability to sustainability, based on knowledge and awareness that we have the influence of materials and energy on the air, water and soil, and the consequences in the well being and health of living beings and the landscape.

On the other hand, durability and sustainability have a very close relationship and there are many connections between both concepts in terms of the properties of materials (Hendricks, 2000). In traditional construction, the developments in materials were very slow and empirical, with the predominant use of local materials.

After World War II, with industrialized construction, evolution has been ever more rapid, as a result of the need to fill the large gaps of buildings, of the research, as well as the professional diversification of teams that can include, for example, chemists, biologists, physicists, computer scientists.

The trends in sustainable construction include the use of natural materials, more renewable, with less primary energy incorporated, easily recyclable and reusable (raw earth, wood, natural stone, cork, the wool rugs of coconut fibers and hemp, etc.) and for the use of composite materials, (made or not made to order), resulting from the association of raw materials (with lower volume of use) with other materials. From this association, it is also intended to obtain greater versatility of functions of these materials, despite the difficulty of deconstruction to recycling, but easy to re-use. The use of reversible techniques are important, as well as mortars and adhesives, connections per slot, connections to dry components in industrialized, more lightweight and flexible, easily mountable and demountable.

We are witnessing the rationalization and industrialization of the association of two or more materials in the factory, traditionally constructed on the building site, thus reducing the labour and the production of waste in work fronts, thus obtaining a reflex economy resulting from the reduction of execution times.

With regard to renewable materials, there are several examples in buildings of use of cork, of which Portugal is one of the world's leading exporters. The panels of expanded cork have a natural resistance to fungi and decay and its resistance to compression make it a material with good characteristics for application in thermal insulation and acoustic and coatings in the construction of buildings.

Fundamentally, cork is used as a thermal insulation in exterior walls - double walls (Fig. 1), ventilated walls (Fig. 2), or on the walls of one assent (ETICS) (Fig. 3), and also covers (Fig. 4) (Fig. 5).

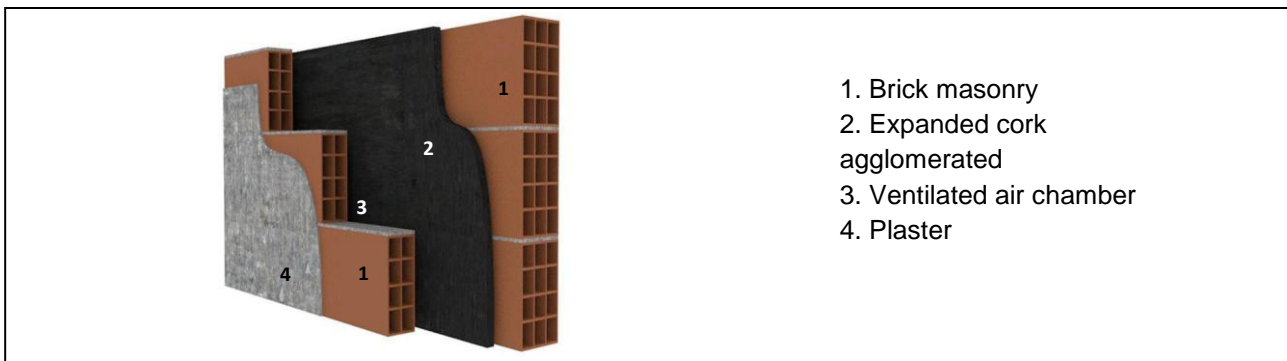


Fig. 1. Double wall (Reaes Pinto, 2015).

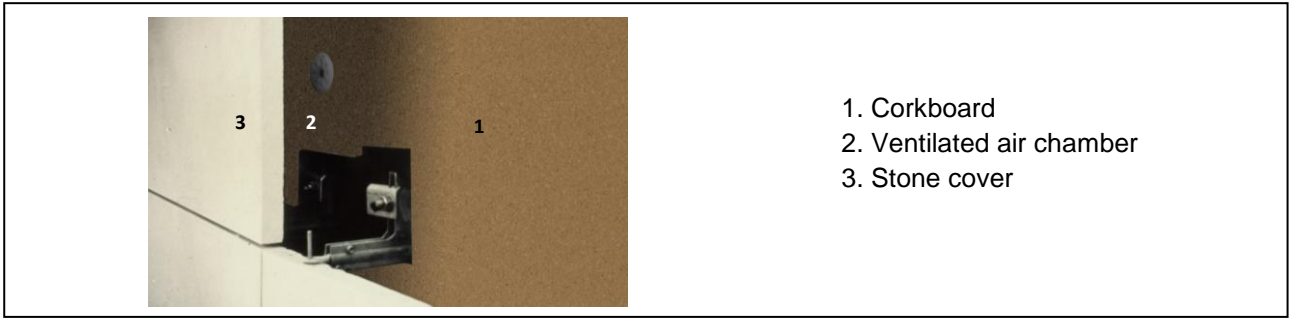


Fig. 2. Ventilated exterior wall (Reaes Pinto, 2015).

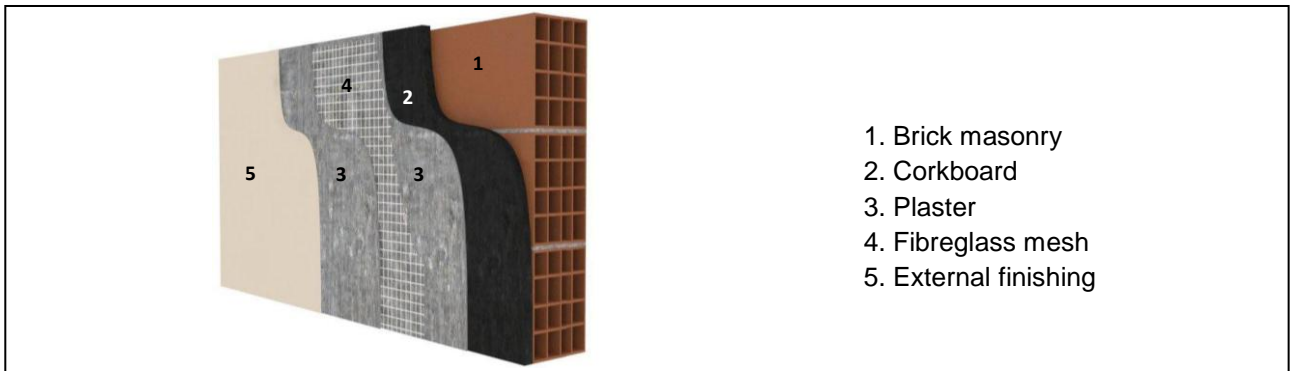


Fig. 3. ETICS (Reaes Pinto, 2015).

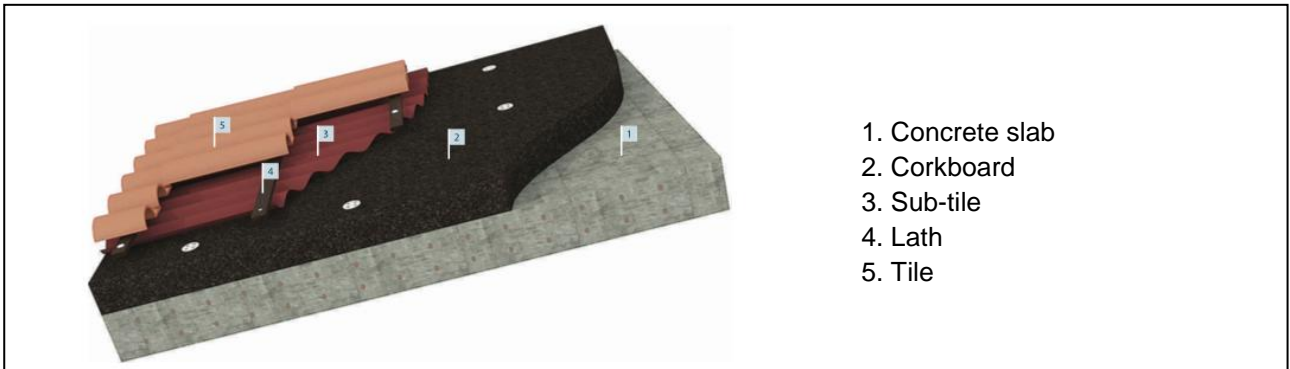


Fig. 4. Inclined roof (Sofalca, n.d.).

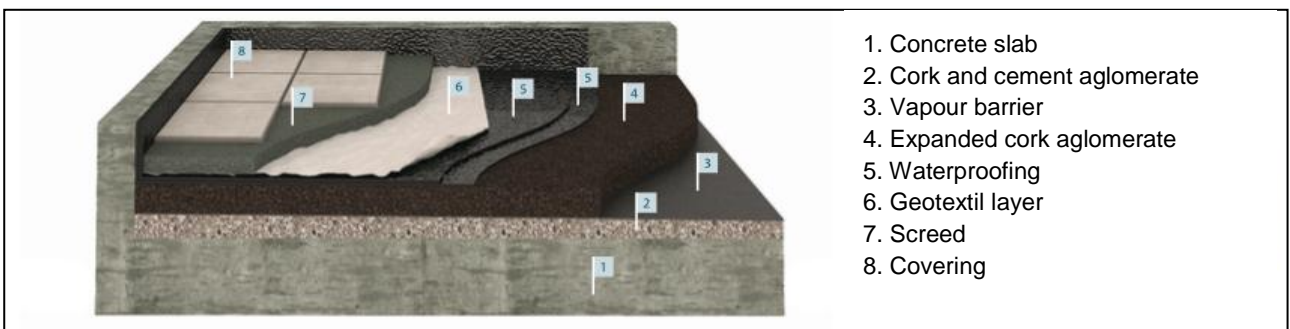


Fig. 5. Flat roof (Sofalca, n.d.).

It is also applied as acoustic insulation in floors (Fig. 6), interior walls (Fig. 6), and even as a coating of exterior walls (Fig. 7) (Fig. 8). Can also be used in granules.

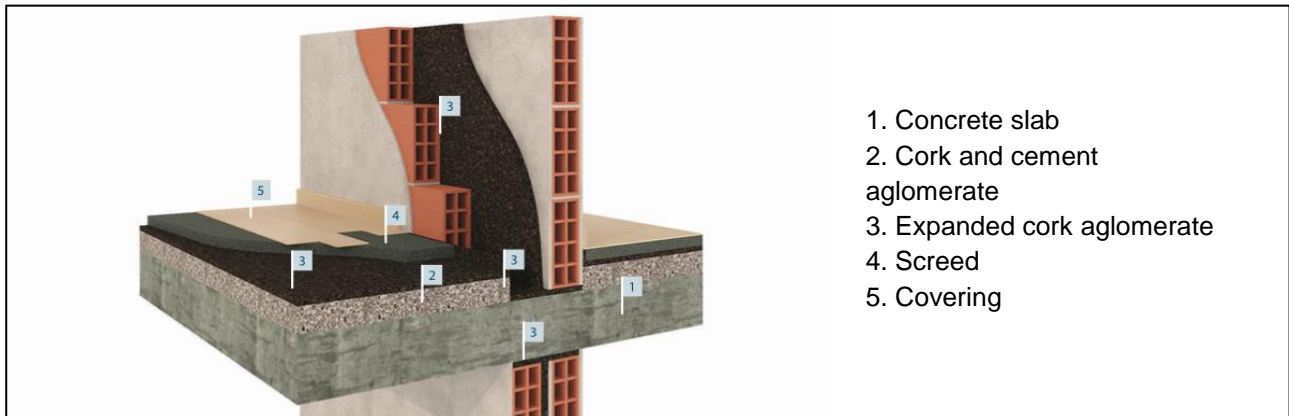


Fig. 6. Acoustic insulation in floors and interior walls (Sofalca, n.d.).



Fig. 7. ETICS (Reaes Pinto, 2015).

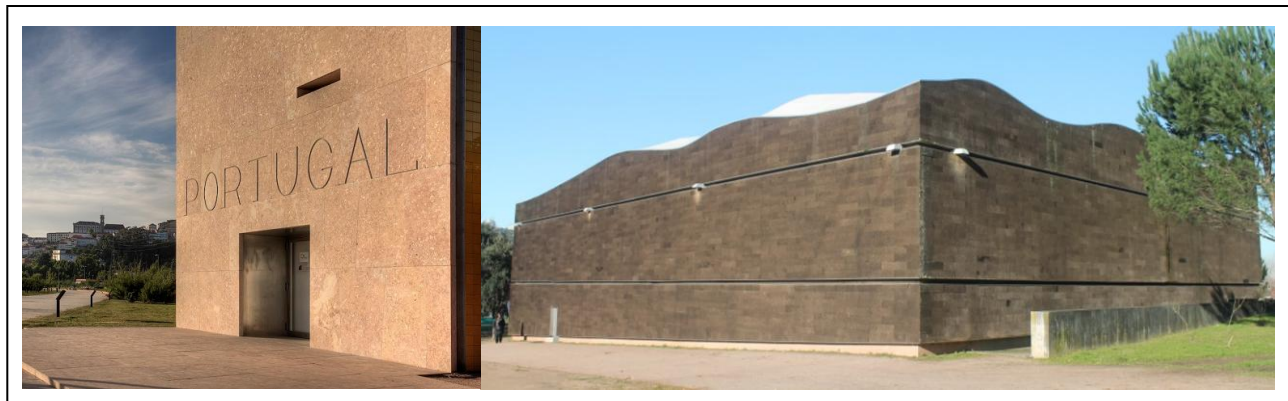


Fig. 8. Portugal pavilion for Hannover Expo 2000. Currently located in Coimbra (Reaes Pinto, 2015).

Cork (like webs of coconut fibre or hemp) is thus a renewable material, recyclable and reusable, with low energy costs, that replaces in a more sustainable way materials commonly used in the functions mentioned above. Cork is unlike the non-sustainable materials mentioned previously, which are generally derived from oil and are producers of gases (including carbon dioxide) that give rise to global warming and the climate change that we are witnessing today.

Cork can also be used in rehabilitation (Fig. 9) area of construction, where it may be applied as a natural material composite, e.g. associated with both plasterboard or other materials with functions of coating, rationalizing, and industrializing traditional operations, low productivity and high costs, referring them to the plant, thus reducing the labour and waste in work fronts and allowing better management of these operations, in the sense of better efficiency and the reduction of time.

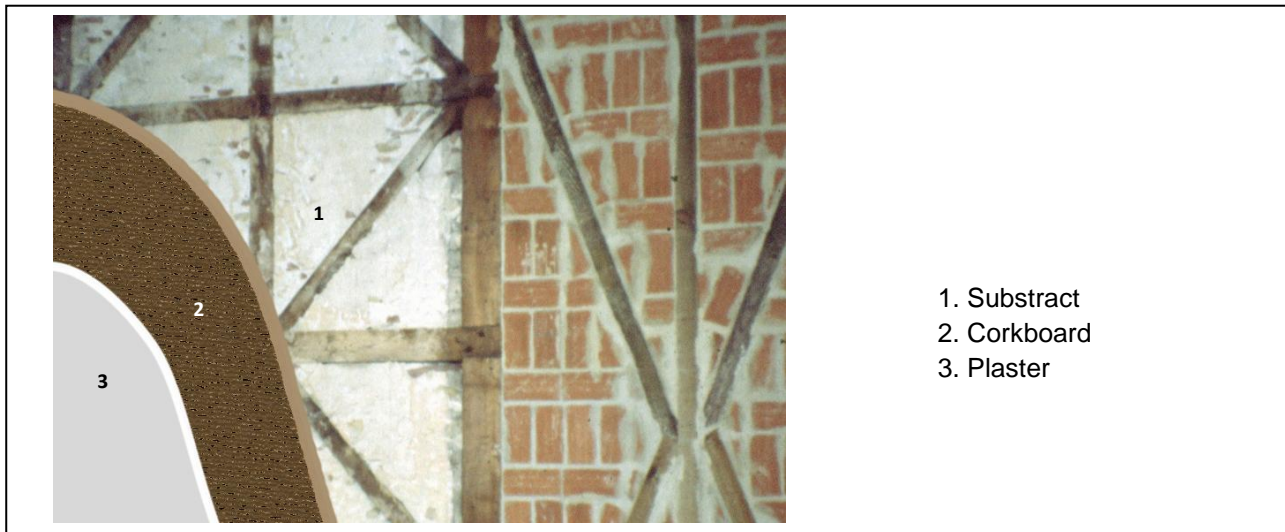


Fig. 9. Corkboard associated with plasterboard (Reaes Pinto, 2015).

## CONCLUSION

The choice and use of materials, within the framework of the principles of Sustainable Construction, is essential for the sustainability of the construction industry. This choice should be made with certain criterion in mind, with the aim of reducing the negative environmental impacts produced by this industry.

In this sense, we need to increase the use of renewable materials and materials with less built-in power and with less toxic emissions during its life cycle, which produce less waste, are recyclable and reusable after deconstruction and which include the process of selective dismantling of buildings where they are incorporated.

These changes and demands, which the Construction Sector must adopt and practice, are necessary for its reconciliation with Sustainable Development and Sustainable Construction. It is therefore vital to know how to manage the choice of materials and their technologies of application within the framework and principles of Sustainable Construction, aimed at minimising the negative impacts on the environment resulting from the activity of the Construction Industry. This shift requires a change of mind set and an integrated view of all actors involved in the process of construction and rehabilitation of buildings.

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