

# ENVIRONMENTAL, SUSTAINABILITY AND ECOLOGICAL ASPECTS OF CORK PRODUCTS FOR BUILDING

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**ABSTRACT:** This paper summarizes the environmental and ecological aspects, sustainability aspects related to the production and utilization of cork products in the field of building. Cork based products still lack the desired level of information and diffusion within stakeholders in the design and selection of materials for construction, compared with other competing products. However, they potentially offer aspects of sustainability and energy efficiency are in the order of the day. Also considered are green building and sustainable materials which are concepts that are increasingly considered by engineers, architects and other technicians and even by consumers. This paper refers to cork materials for building and their relation with all these concepts.

**Keywords:** cork, building, environment, sustainability, ecology

**RESUMO:** Este artigo sumariza os aspectos ambientais e ecológicos, assim como os de sustentabilidade relacionados com a produção e a utilização de produtos de cortiça no domínio da construção civil. Os produtos de cortiça ainda não possuem o desejado nível de informação e de divulgação entre os técnicos envolvidos no projecto e selecção de materiais para a construção civil, comparativamente com outros produtos concorrentes. Para além disto, aspectos relacionados com a sustentabilidade e a eficiência energética estão na ordem do dia assim como conceitos como os da construção verde e dos materiais sustentáveis que de forma crescente estão a ser considerados por engenheiros, arquitectos e outros técnicos e mesmo pelos consumidores. Este artigo refere-se assim aos produtos de cortiça e à sua relação com todos estes conceitos.

**Palavras Chave:** cortiça, construção civil, ambiente, sustentabilidade, ecologia

## 1. INTRODUCTION

Cork is a natural material whose applications have been exploited since Antiquity, especially as a floating artifact and as stopper for beverages, whose market from the early twentieth century, has had a massive expansion, particularly due to the development of several cork based agglomerates.

The European Union is the largest producer of cork (>80%), particularly in the western Mediterranean countries, among which Portugal (>50%) is the world's largest producer and processor of cork. Cork oak forests, namely the "montados", usually with 50-150 trees/ha, are extremely well adapted to the regions of southern Europe and northern Africa, preventing desertification and providing habitat to many unique animal and plant species [1][2], with a world total area of about 2.3 million ha and an average annual production of about 300,000 tons of cork [2].

Cork is closely related to the maintenance of biodiversity (which is at the heart of sustainable development) and the reduction of emissions and sequestration of carbon dioxide (CO<sub>2</sub>), aspects that, in addition to the environmental importance, are also economically very important in some regions.

How much is a species worth? The answer is not easy but it is difficult to have doubts about its important value. In the fight against climate change and greenhouse gases, the parameter most commonly used is the ton of CO<sub>2</sub>, which has a market value (variable, but for example it worth in Europe about 14 euros in April 2010). The protection of protected species costs many millions of euros. Other services such as the formation of the landscape, soil protection, regulation of hydrological cycle, etc. also have a value difficult to quantify but clearly perceptible [3].

Sustainable materials are those that are durable and require little maintenance, which can be reused and/or recycled or recovered [4][5][6]. The selection of a sustainable material should take into account parameters such as durability, the fact that it must come from a fair production, a reasonable price, its possible rise in value, the fact that it is not contaminant, consumes low energy, has some cultural value, come from abundant and renewable sources and if it can incorporate recycled material [6][7]. This selection is made in order to aim at projects that reduce environmental impacts and increase social benefits within the limits of economic viability.

The environmental impact of building materials, includes five items related to health and the environment that are [4] [6]:

- energy consumption: one of the greatest indicators of sustainability is the use of energy efficient materials, throughout their life cycle and that promote energy efficiency;
- consumption of natural resources: one should opt for renewable materials so there is no risk of their disappearance and that are durable;
- impact on ecosystems: one should opt for materials that do not endanger sensitive ecosystems, or even that promote these ecosystems;
- emissions generated: one should opt for materials and installation systems that do not emit harmful substances to the environment and/or to human health (indoor air quality);
- behaviour as “waste”: after end their lifetime materials should not cause environmental problems and the reuse/recycling should be possible.

As discussed below, this is an area where the cork products for the construction industry have an important contribution and remarkable advantages. Indeed the Portuguese saying “*who cares about the grandchildren plant a cork tree*” or in another version “*my vineyards, olive trees from my parents, cork trees from my grandparents*”, already contains within itself the concept of sustainability related to cork, representing the cork oak one of the best examples of real sustainability through the economic, environmental and social functions within the various forest types, aspects currently placed on the agenda of world public opinion.

There is a European goal of reducing CO<sub>2</sub> emissions by 20% by 2020. Another European target is a 20% energy efficiency increase by 2020 in all Member States, and a major goal is to achieve the so-called “*Net Zero Energy Buildings*”, a requirement for new buildings for 2018. It is also foreseen a conversion of the existing buildings with a 50% reduction of energy consumption and 75% of CO<sub>2</sub> emissions by 2050 [8]. Currently, at a European level, the consumption of buildings accounts for 40% of primary energy consumption [9]. About half of the energy consumed by buildings is related to their insulation [10]. It is estimated that 70% of energy costs of operating a building during its lifetime is determined at conception, and maintenance/utilization costs can be reduced significantly choosing proper products and materials [11]. Significant reductions in emissions of greenhouse gases in this sector can be achieved through various measures for energy savings following European Directives, an area where cork derivatives can have a very important role, particularly regarding the thermal performance of buildings, but not only.

Energy efficiency in buildings is directly related to the rational use of energy and it is divided in household and service sectors. In the domestic sector 25% of the energy consumption is due to heating and cooling (area where cork products may be involved), and has a tendency to rapid growth [12] [13]. Moreover, energy efficiency is an indicator of a sustainable society and to some extent, these are interdependent concepts. For example, considering a functional unit of an insulating material in a lifecycle analysis for 1 m<sup>2</sup> of insulation material, for two thermal resistances  $R = 1 \text{ m}^2 \cdot \text{K/W}$  and  $R =$

$5 \text{ m}^2 \cdot \text{K/W}$ . Over 50 years the difference between the energy consumed and the energy saved were, respectively, from -450 MJ to -1335 MJ and from -4050 MJ to -9925 MJ [10]. Using these data one can estimate, for example, for the insulation corkboard, 50 mm thick (common) that has  $R = 1.25 \text{ m}^2 \cdot \text{K/W}$ , a value for this difference of about -2865 MJ.

## 2. ENVIRONMENTAL, ECOLOGICAL AND SUSTAINABILITY ASPECTS

At the end of the period of use, often imposed by the end of lifetime of the building, when it is feasible to remove the entire expanded corkboard pieces, these may come to be used in identical applications, since some sampling and testing of insulation corkboard used in buildings with 30-50 years showed that after this time the look and the essential properties of this insulation are unchanged [14][15].

When this is not possible (breaking of boards, contamination with other products) its grinding is promoted, obtaining a re-granulated material that like the clean re-granulate is destined for new applications in thermal insulation or to be used as inert material in the manufacture of light concrete and mortars [15], i.e. the expanded cork agglomerate is a completely recyclable product [16].

The cork granules (raw or boiled cork) when not mixed, can also be reused in the manufacture of fillers or agglomerates or mortar. If there is a process to obtain contaminated-free cork products (films, adhesives, mortars, etc.) from e.g. cork floor or wall coverings, these can be crushed and used or incorporated in technical products.

Composition cork products for construction can incorporate various types of waste from other cork products (e.g. used cork stoppers, wastes of cork agglomerates, etc.), contributing to the overall recyclability. In this field several initiatives can be mentioned [18] related to projects to collect and recycle cork stoppers around the world, which are largely for the production of products for building. Currently, for example, there is an initiative between Quercus (environmental NGO) and Amorim (world’s major producer of cork products, which has a licensed facility for this type of recycling) which in 2009 recycled over 20 million cork stoppers, although there are other initiatives and companies that contribute to this, in Portugal and in other countries [18]. The collection system, GREENCORK, aims at not only the transformation of used cork stoppers in other products as well as a reforestation fund and uses existing distribution channels [19] [20].

Linoleum (with cork) can be composted. When properly crushed into small pieces and in the presence of appropriate conditions with suitable minerals, linoleum decomposes through the action of microorganisms by creating a compound that can be used in gardening [21].

In addition to forest production and activities associated with the extraction of cork, other activities such as hunting, bee-keeping, livestock, harvesting of mushrooms and herbs (both with high gastronomic value) and medicinal plants, reflect

multifunctionality [2] and have a great social and economic importance in regions where the cork oak grows.

Cork oak forests (“*montados*”) are a habitat for many plant and animal species, some endangered, and some references claim that 42 species of birds that depend on this, as well as 140 species of plants and many other animals, being unique at a European level [22]. Other reference [23] states that in “*montados*” lives 24 species of reptiles and amphibians, 160 of birds and 37 of mammals. For example, the Iberian lynx, the most critically endangered feline in the world, uses cork oak forests as its preferred habitat [2]. In terms of flora over one hundred species has been recorded in plots of 0.1 hectares [2]. At a meeting of experts it was announced that the “*montado*” is integrated in one of the 34 “*hotspots*” of biodiversity worldwide, featuring a number of species per m<sup>2</sup> even higher than the Amazon rainforest [22]. The World Wildlife Fund (WWF) has identified and quantified geographically “Areas of High Conservation Value” in the “*montado*”, which are regions where values such as biodiversity, but also the carbon storage and regulation of the water cycle are of critical importance, areas designated by HABEaS [24]. Thus, the production and use of cork plays an important role in sustainable economic development, being a factor in preservation and survival of some species.

Ecosystems provide society with goods and services with direct value in the market (in this case, for example, cork, wood ...) but also give rise to environmental services that are essential and whose market value is difficult to estimate, and often nonexistent and indirectly determined. Within these services there is, for example, biodiversity conservation, regulation of hydrological cycle, soil protection, carbon sequestration [2]. Some experts divide the services of the “*montado*” ecosystem in services of supply (e.g. raw materials) of regulation (e.g. water cycle) and cultural (e.g. tourism) and mechanisms are being developed for the payment of these services in order to give rise to a conservation tool.

The decrease in the economic viability of the “*montado*” as a result of a decreased use of cork products, may lead to a lack of investment in its exploitation and abandonment, with a corresponding loss of biodiversity and environmental benefits and social imbalance, resulting in great loss of sustainability.

In terms of soil conservation the “*montados*” protect the surface layer of the soil, bringing the necessary nutrients, acting as a shield to surface erosion and promoting the introduction of water into the soil, thus constituting a barrier to desertification, and a habitat for rare, threatened or endemic species [2], forming an ecosystem that creates structural and functional conditions necessary to create good refuge areas as formerly noted.

In terms of cork products’ production and use, it is noted that the production of insulation corkboards uses only superheated steam, using steam generators fed with their own waste obtained in the grinding and finishing operations, not introducing any other products that are not exclusively cork, and the agglomeration is based on the resins in the cork itself, and so this is a 100% natural and ecological product, which is an advantage very difficult to match by competing materials.

A manufacturer of cork floor coverings has launched a new generation of products with an eco-binder based on water and in a study conducted by BASF a comparison of these products with alternative coverings (wood, vinyl) was carried out, which revealed the higher eco-efficiency of the cork floor coverings, stressing the lower consumption of resources (energy and raw materials), the reduction of heating costs for users, the best option in terms of greenhouse effect gases (emissions of CO<sub>2</sub> (g)/m<sup>2</sup>, because coverings based on wood emit 2.5 to 4 times more CO<sub>2</sub>-equivalents and vinyl coverings emit 6.5 to 11 times more) [18][23].

In cork processing operations for the production of cork products for building an important waste is produced, cork powder. This powder, the main waste of the cork industry, is estimated to reach over 30000 tons/year [25]. There are various types of cork powder with higher calorific values ranging from 4,000-7,000 Kcal/kg [26] and neutral with regard to CO<sub>2</sub>. This powder is commonly burned to produce steam and/or energy used in the factories themselves, given the high energy content of this material. In addition to this, all other industrial waste cork is reused or otherwise valued. As an example, a cork company of a large industrial group that produces cork products for construction, meets 60% of its energy needs using biomass (waste cork) [18].

In this context and in connection with the buildings, it can mentioned the possible heating of homes and/or other structures with cork powder briquettes through direct flame (fireplace) or boilers.

Many cork products can be recycled, as mentioned before, and the main advantage of this procedure is that this material incorporates carbon fixed by the cork tree that remains there during the lifetime of the products, thus increasing the delay of the emission of this carbon back to the atmosphere. Also noteworthy is that if there is no more use after their useful life, cork products can be used in energy production and when incinerated, having a high calorific value, the CO<sub>2</sub> produced is equivalent to the material being fixed in the material, what is commonly referred to as being “carbon neutral” [22].

The use of cork products is also ecologically very important because a renewable product is used in long life products, promoting the sequestration of CO<sub>2</sub>. In addition, the periodic extraction of cork oaks for cork production, produces between 250% and 400% more cork [25] than they would produce if it they were not harvested (when the bark is harvested the tree produces rapidly new bark for protection) increasing the fixation of CO<sub>2</sub>. Therefore, the consumption of cork products that leads to the exploitation of this material promotes the formation of more cork and thus more CO<sub>2</sub> is sequestered [27], beyond the fact that such products are long-life products retaining the carbon during their useful life and being “carbon neutral” at the time of decomposition or energy use [22]. Cork oak forests make a sequestration of about 5.7 ton CO<sub>2</sub>/ha/ano [2]. The 2.3 million ha of cork oak forests worldwide are seen as promoting the retention of about 14.4 million tonnes CO<sub>2</sub>/year [23]. It should be noted also that according to data from a supplier 0.379 kg of CO<sub>2</sub>/kg of cork are emitted but each kg of final product is responsible for fixing 1.833 kg of CO<sub>2</sub> [23].

Regarding CO<sub>2</sub> some interesting calculations can be carried out. For example, if we consider the value of 94,700 tons of Portuguese exportation (in 2007) of cork construction materials and knowing that the average carbon content of cork is 57.37% [27], this corresponds to a value of 54,330 tonnes of carbon per year in this cork which corresponds to 199,065 tons of CO<sub>2</sub> sequestered per year (CO<sub>2</sub>/C = 3.664 (w/w)). Considering the average annual mileage of a car of 17500 km and the average production of 146 g/km CO<sub>2</sub> (according to the JATO Report, September 2009, for the Top 25 brands of automobiles), in one year this vehicle produces 2.555 tonnes of CO<sub>2</sub>. Thus we conclude that this value corresponds to the pollution generated by approximately 78,000 cars per year.

Finally it should be noted that it was announced in 2010 that two Portuguese companies producing cork products for building joined the Iberian Network of the Global Forest & Trade Network (GFTN), a WWF alliance whose purpose is to improve the management of forest areas, halting deforestation and promoting forest conservation through the responsible consumption of forest products. This network supports member businesses, the adoption of enlightened and responsible policies for buying products such as cork, being an efficient tool that enhances competitiveness and corporate image of companies in order also to combat illegal logging and climate change. These companies agree to prioritize the purchase and distribution of cork products from socially and environmentally responsible sources certified by FSC (Forest Stewardship Council). In early 2010 there were about 25,000 ha of cork oak forests certified by FSC. This is important because it is needed that “*montados*” maintain a good ability to produce cork and provide the aforesaid services and so these need to be properly managed and certification is the mechanism that ensures sustainable management [28].

### 3. CONCLUSIONS

Several aspects related with the environment, sustainability and ecology not well known for cork products for building applications were discussed allowing the evidence of several advantages of these products. This article is based on a part of a book of the author [29].

### BIBLIOGRAPHY

- [1] Gil L., 2007, Manual Técnico: Cortiça como material de construção. Ed. APCOR, Stª Mª Lamas.
- [2] Pereira H., 2007, Cork: Biology, Production and Uses, Ed. Elsevier, Amsterdam.
- [3] <http://ecoesfera.publico.pt/noticia.aspx?id=1433434>
- [4] Froeschle L.M., 1999, The Construction Specifier, October, p. 53-57.
- [5] Rocheta, V.; Farinha, F, 2007, Congresso Construção 2007, Coimbra, s.p.
- [6] [http://www.construpedia.coam.org/Materiales\\_de\\_Construcion%C3%B3n\\_Sostenibles](http://www.construpedia.coam.org/Materiales_de_Construcion%C3%B3n_Sostenibles)
- [7] <http://www.csustentavel.com>
- [8] <http://greensavers.pt/2010/09/14/e2%80%9csustentabilidade-dos-materiais-de-construcao%e2%80%9d-ja-esta-livro/>
- [9] Guertler P.; Hamans C., 2009, Introduction to panel 7. Innovative building technologies, ECEEE 2009 Summer Study, p. 1465-1467, s.l.
- [10] Montoya L.M., 2007, II Congreso Internacional de Aislamiento Térmico y Acústico, s.l.
- [11] BCSD Portugal, s.d., *Procurement Sustentável*. Guia Prático de Implementação, s.l.
- [12] Isolani, P., 2008, Eficiência Energética nos Edifícios Residenciais, Ed. DECO, Lisboa.
- [13] <http://www.eficiencia-energetica.com/html/eee/eee>
- [14] Gil L., 1996, International Conference of Application of Life Cycle Assessment in Agricultural Food and non-Food Agro-Industry and Forestry, Bruxelles, s.p..
- [15] Gil L., 2002, World Renewable Energy Congress VII, Colónia, p. 705.
- [16] Sousa J.P.O.M., 2010, From digital to material: Re-thinking cork in architecture through the use of CAD/CAM technologies, PhD Thesis in Architecture, Instituto Superior Técnico, Lisbon.
- [17] Gil L., 2006, A Cortiça e o Vinho, Ed. INETI/CEDINTEC, Lisboa.
- [18] Borrego H., 2010, Seminário Materiais de Construção e Sustentabilidade, Coimbra.
- [19] <http://www.bcsdportugal.org/content/index.php?action=articlesDetailFo&rec=1035>
- [20] <http://www.ambienteonline.pt/noticias/detalhes.php?id=9033>
- [21] <http://earth911.com/construction/linoleum/tips-about-linoleum/>
- [22] Gil L., 2010, *Biologia & Sociedade*, N°10, p. 13-15.
- [23] Corticeira Amorim, 2008, Relatório de Sustentabilidade da Corticeira Amorim SGPS S.A. 2007, Ed. Corticeira Amorim, Mozelos.
- [24] <http://www.habeas.com.pt>
- [25] Gil L., 1998, Cortiça – Produção, Tecnologia e Aplicação, Ed INETI, Lisboa.
- [26] Gil L., Santos J.; Florêncio M.I., 1986, Bol. IPF-Cortiça, N° 575, p. 255-261.
- [27] Gil L., 2005, *Rev. Indústria & Ambiente*, N°38, p.10-11.
- [28] <http://www.wwf.pt>
- [29] Gil L., 2011, Cortiça na Construção Sustentável e Energeticamente Eficiente (in Portuguese), in printing.