BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi" din Iaşi
Tomul LIV (LVIII), Fasc. 4, 2011
Secția
CONSTRUCȚII. ARHITECTURĂ

ASSESSMENTS CRITERIA OF BUILDING MATERIALS FROM ECOLOGICAL POINT OF VIEW

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Received: November 1, 2011
Accepted for publication: November 22, 2011

Abstract. Environmental and health issues nowadays represent attracting increasing attention in our society. Understanding the importance of the quality of their surroundings, people are beginning to pay more attention towards their consumption patterns and the related potential impacts on the environment and their health, with concerns for the wellbeing of the current as well as future generation. Every material used for construction, insulation or finishing has different properties as well as advantages and disadvantages in comparison to others. Thus, before selecting one or another material for any type of building – single family, multi-storey residential house or administration building – the performance of careful assessment and analyses is preferable.

Key words: green materials; assessments criteria; sustainable principles.

1. Introductions

The concept of sustainable building incorporates and integrates a variety of strategies during the design, construction and operation of building projects. The use of green building materials and products represents an important strategy in the design of a building.

Green building materials offer specific benefits to the building owner and building occupants namely

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a) Reduced maintenance/replacement costs over the life of the building.
b) Energy conservation.
c) Improved occupant health and productivity.
d) Lower costs associated with changing space configurations.
e) Greater design flexibility.

Building and construction activities worldwide consume 3 billion tons of raw materials each year, or 40% of total global use. Using green building materials and products promotes conservation of dwindling nonrenewable resources internationally. In addition, integrating green building materials into building projects can help to reduce the environmental impacts associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of these building industry source materials.

Sustainable construction is based on the following principles:
a) Minimizing non-renewable resource consumption.
b) Enhancing the natural environment.
c) Eliminating the use of toxins.

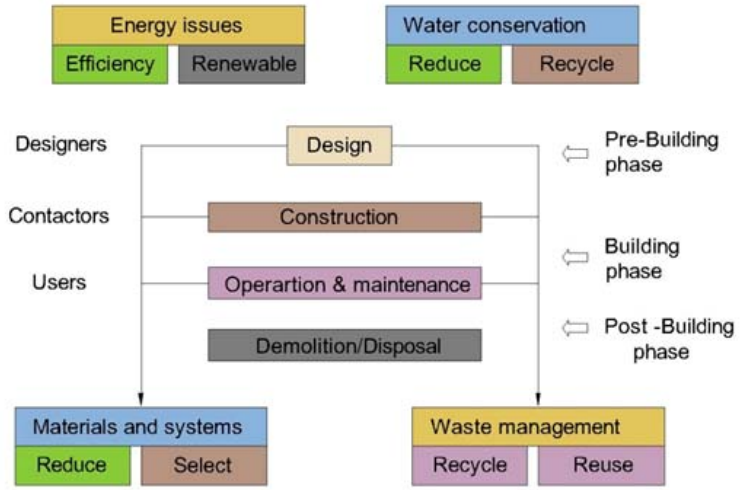

Fig. 1 – Sustainable construction principles.

2. The European Union – Recommendations for Sustainable Construction

In the European Union countries, the great efforts are made towards finding methods and procedures for environmental evaluation of building materials. Numerous working groups and committees work to create criteria and indicators for evaluation of ecological impact on environment, with the final goal to form a system of recommendations for designing ecologically acceptable buildings and to create software tools for evaluation of total impact of a building on environment. Some of these recommendations concern

a) reduction of the need for building materials (design rationalization);

b) maximization of use of environmentally friendly and healthy materials;

c) use of durable materials;

d) use of materials from renewable resources;

e) maximization of dismantling possibilities of buildings and its components;

f) maximization of re-use possibilities of buildings and its components;

g) designing with an idea for possible recycling;

h) application of recycled materials;

i) avoiding application of hazardous substances (PVC, solvents);

j) obligation to create a data base of expected effects.

It is obvious that the process of recognition of impacts and evaluation of environmental properties is ambiguous. Therefore at this moment it would be very difficult to set universal ways and evaluation tools which would, in all environments, give satisfactory results according to the mentioned levels. Nevertheless, with sublimation of certain methods and procedures, as well as their modification and extension according to the local needs, it is possible to achieve satisfactory level of environmental evaluation of building materials and products, with possibility to transfer the acquired results to the building level as a desired final product.

3. Evaluation Criteria for Green Materials

Due to phenomenal growth in the construction industry, there is tremendous pressure on depletable earth resources such as soil, sand, stones, wood, etc. Production of building materials leads to irreversible environmental impacts. Using environment–friendly building materials is the best way to build an eco-friendly building. Following criteria can be used to identify the green materials

a) Local availability of materials.

b) Embodied energy of materials.

c) Percentage of recycled/waste materials used.

d) Rapidly renewable materials.

e) Contribution in Energy Efficiency of buildings.

f) Recyclability of materials.

g) Durability.

h) Environmental Impact .

3.1. Local Availability of Materials

As far as possible locally available materials are to be preferred so as to minimize the energy spent in transportation of the building materials. Energy

consumed in transportation should be considered as total energy spent on transporting materials starting from the place of manufacturing.

Table 1
Energy Consumption in Transportation of Materials (Berge, 2010)

Transport mode	MJ/t/km
By air	33…36
By road (diesel)	0.8…2.2
By rail (diesel)	0.6…0.9
By rail (electric)	0.2…0.4
By sea	0.3…0.9

3.2. Embodied Energy of Materials

Embodied energy is an assessment of the energy required to manufacture any building material. This includes energy required to extract raw materials from nature, energy used to transport raw materials to manufacturing unit and the energy used in manufacturing activities to provide a finished

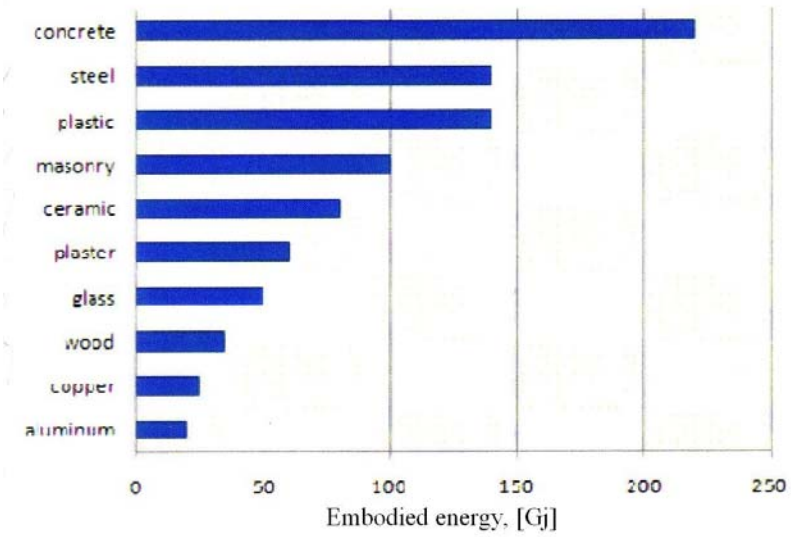

Fig. 2 – Embondied energy of some building materials.

product. Every building is a complex combination of many processed materials, each of which contributes to the building's total embodied energy. Embodied energy is a reasonable indicator of the overall environmental impact of building materials, assemblies or systems. Embodied energy of some building materials is represented in Fig. 2.

3.3. Percentage of Recycled/Waste Materials Used

Building materials can be manufactured using recycled materials or using waste materials. Use of recycled materials helps the environment and the economy in several ways. A significant effect is that of lessening the need for manufacture with virgin, non-renewable resources, which saves precious resources, energy and cost. Waste materials that would have ended in landfills after their useful life, instead can be re-processed for use in other products.

Table 2
Environmental Effects of Recycling

Material	Energy savings, [%]	Air pollution savings, [%]
Aluminium	95	95
Cardboard	24	–
Glass	5…30	20
Paper	40	73
Plastics	70	–
Steel	60	–

3.4. Use of Renewable Resources

Materials manufactured with resources that are renewable (*i.e*. wood or solar power) rather than non-renewable (*i.e*. fossil fuels) shall be preferred. Depletion of the earth's resources is occurring at an alarming rate. Entire ecosystem is affected due to continuous extraction of raw materials from the earth. As stock of fossil fuel is limited, it may get exhausted very soon. By utilizing renewable energies, such as wind, solar, tidal, as well as renewable materials, such as wood (certain certified species which are rapidly renewable), grasses or sand, impact on biodiversity and ecosystems can be lessen.

3.5. Contribution in Energy Efficiency of Buildings

With proper orientation of building regarding the solar radiation to receive maximum day lighting, operable windows for natural cross-ventilation, use of passive cooling techniques, (eliminating or lessening the need for air conditioning), walling unit with lower *U*-values, roof insulation, water-saving devices and more efficient appliances can all work to lessen energy needs

3.6. Recyclability of Materials

The building industry is, after food production, the largest consumer of raw materials in the world, today. Every material has a resource footprint and pollution footprint particularly during its production. Much of this can be

avoided buy recycling products rather than manufacturing from new raw materials. In order to protect natural resources as well as to reduce energy use and lower carbon emissions, buildings should be designed for deconstruction so that at the end of the buildings life, the materials can be reused or recycled thus reducing at least some of the energy used in extraction, manufacture and produced by waste. A product that can easily be recycled will normally be preferable to a product that is initially quite "green", but cannot be recycled (Berge, 2010; Yanchenko).

Some sustainable architecture (Fig. 3) incorporates the use of recycled or second hand materials, such as reclaimed lumber. The reduction in use of new materials creates a corresponding reduction in embodied energy (energy used in the production of materials). When new materials are employed, green designers look for materials that are rapidly replenished, such as bamboo, which can be harvested for commercial use after only six years of growth, sorghum or wheat straw, both of which are waste materials that can be pressed into panels, or cork oak, in which only the outer bark is removed for use, thus preserving the tree. When possible, building materials may be gleaned from the site itself; for example, if a new structure is being constructed in a wooded area, wood from the trees which were cut to make room for the building would be re-used as part of the building itself.

Fig. 3 – Big Dig House built with unused or recycled materials
from the Boston Big Dig project.

3.7. Durability & Interdependency

The durability of construction materials and construction systems depends on the building type, design, use, installation, and maintenance, thus being difficult to evaluate, assess and predict. Nevertheless, there are several aspects to consider as follows:

a) Disposal frequency – the anticipated shelf life of a system or product before it must be removed and replaced – estimation can be based on the manufacturer's warranty period.

b) Durability based on maintenance – some products may have a short life span if not maintained or may have a very long life if properly maintained (*e.g*. wood products).

c) Durability based on interdependency of systems – depends on the relationship between the various parts of a system to make the whole system function as designed.

Selecting durable materials besides cost savings to the building owners also reduces waste going to landfill, and reduces the raw materials and energy consumption needed for production of materials.

3.8. Environmental Impact

All materials used for construction of buildings must not harm the environment, pollute air or water, or cause damage to the earth, its inhabitants and its ecosystems during manufacturing process, and also during use or disposal after end of life. Material should be non-toxic and contribute to good indoor air quality. Worldwide industrial production uses billions of tons of raw materials every year. Pollution caused in excavation, manufacturing, use or disposal of a product, can have far reaching consequences on the Earth's ecosystem. Poor indoor air quality caused by VOC emission costs billions in medical bills and lost productivity to companies every year. The manufacturing, use and disposal of PVC pose substantial and unique environmental and human health hazards because of its uniquely wide and potential range of chemical emissions throughout its life cycle. It is virtually the only material that requires phthalate plasticizers, frequently includes heavy metals and emits large numbers of VOCs. In addition, during manufacture it is responsible for the production of a large number of highly toxic chemicals including dioxins (the most potential carcinogens measured by man), vinyl chloride, ethylene dichloride, etc. When burned at the end of life, whether in an incinerator, structural fire or landfill fire, it releases hydrochloric acid and more dioxins. Products made with PVC may be avoided as far as possible.

4. Conclusions

Eco-friendly construction has developed in response to the knowledge that buildings often have a negative impact upon our environment and natural resources as well as to human health (*e.g*., asbestos, toxic and lead containing paints and wood preservatives). Accordingly, the main criteria for evaluating building materials include the general categories of resources, performance and pollution. The resources required for a material can be consumed in extraction,

production, use or disposal. The same is true for pollution. Performance refers to the energy and resources it can save or squander during its use. For each category of material, performance means something quite different. For example, the performance of insulation must be judged mainly in terms of its thermal resistance, while a floor tile would be evaluated more for its durability.

Evaluation of materials from an ecological point of view is a challenging task. There is no common definition and criteria to follow, different experts evaluate materials from different perspectives. Some products in a certain category might be the greenest simply because the available alternatives are so destructive (for example, CCA-treated wood or PVC plastic).

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CRITERII DE EVALUARE ALE MATERIALELOR DE CONSTRUCȚII DIN PUNCT DE VEDERE ECOLOGIC

(Rezumat)

Fiecare material folosit pentru construcții, izolare sau finisaje are proprietăți diferite, precum şi avantaje şi dezavantaje în comparație cu altele. Astfel, înainte de a selecta un material sau un altul pentru orice tip de clădire (unifamilială, multietajată, rezidențială sau administrativă), evaluarea şi analiza atentă a performanțelor acestora este necesară. Construcțiile ecologice s-au dezvoltat ca răspuns la faptul binecunoscut că clădirile au adesea un impact negativ asupra mediului şi a resurselor naturale, precum şi pentru sănătatea umană (de exemplu, azbestul, vopselele toxice şi care conțin plumb

şi cele utilizate la conservarea lemnului). Prin urmare, principalele criterii de evaluare a materialelor de construcţii includ categorii generale de resurse, performanţă şi poluare.Utilizarea materialelor ecologice de construcţii reprezintă cea mai bună modalitate pentru a construi o clădire ”eco-friendly”. Criteriile care pot fi utilizate pentru a identifica materialele ecologice sunt: disponibilitatea locală a materialelor, energia înmagazinată de materiale, procentul din materiale reciclate/reziduuri folosite, materialele regenerabile rapid, contribuţia în eficienţa energetică a clădirii, capacitatea de reciclare a materialelor, durabilitatea, impactul asupra mediului.