DESIGN OF PASSIVE BUILDINGS WITH ENVIRONMENTALLY FRIENDLY MATERIALS

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Abstract: A passive house is an eco-house, the characteristic of which is the low consumption of energy from external sources (for example, heating with gas or other fuel that we are used to): instead, the system uses alternative sources of energy and is partially heated by the heat emitted by the living there and working devices in the house. A house with such technologies is a big plus for the ecological situation. The use of modern building materials and devices for measuring resources will significantly reduce both costs and energy losses. The passive house does not have to be heated in the usual ways - it uses alternative sources of energy.
Keywords: passive buildings, energy-efficient modules, eco-house, environmentally-friendly materials, green technologies

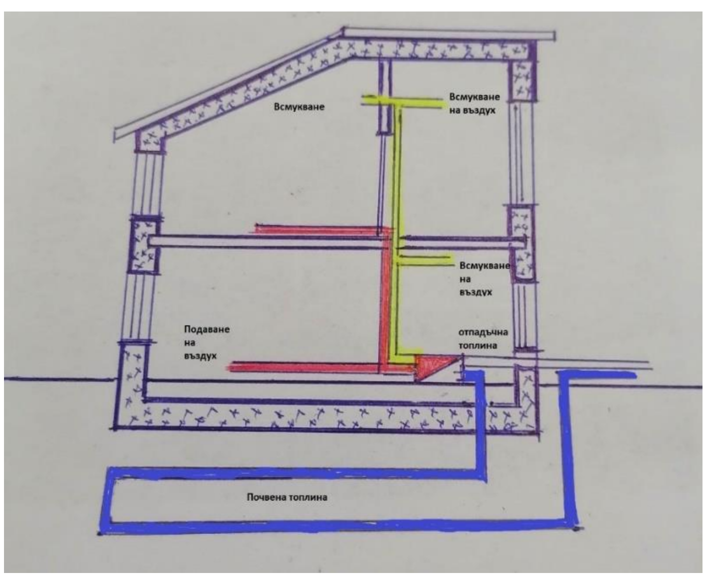
1. INTRODUCTION

Increasing awareness of energy efficiency and climate change issues has led to new developments in the construction industry, including the concept of low-carbon passive buildings and even zero-emission buildings. Low-carbon and zero-emission buildings serve to achieve common goals by applying all existing green design methods, strategies and technologies. Because of this broad definition, a building can be considered a low- or zero-carbon building by using renewable energy technologies within the building itself, or by using external renewable energy sources such as hydro or wind turbines. energy stations, etc. [1] On the other hand, the passive house concept focuses on the energy efficiency aspect of the building. The passive building takes the general principle of passive solar energy in building design as a starting point and combines it with airtight and well-insulated building facades to achieve a building with very low energy costs.

The heating demand of passive buildings is only *15kWh*/m2/year in Germany, compared to *250kWh*/m2/year for heating a typical apartment. A passive building is actually "a building in which a comfortable indoor climate can be maintained without active heating and cooling systems" [2]

A typical passive building.(Figure 1) is a well-insulated and airtight building with strict design and construction standards. It is heated primarily by passive solar heat and other internal heat sources and is equipped with an energy recovery system and a fan for a constant and balanced supply of fresh air.

Fig. 1: Passive house [3]



2. MAIN OPERATING CHARACTERISTICS

The passive design building uses all the available possibilities (e.g. landscape, sun, wind, rain, vegetation, etc.) and its interior is organized in such a way as to maximize energy savings and improve the quality of the internal environment. In addition, passive design buildings and technologies are based on the following principles:
Excellent insulation: The insulation standard is very strict to limit heat loss through conduction and radiation.
Hermetic construction: To enhance, not weaken, the effectiveness of insulation, airtight construction is essential to limit heat loss through direct airflow to/from the building.
Ventilation with waste heat recovery: Hermetic design does not use windows in the traditional sense of the word, as they have a high potential for heat loss. Fresh air for ventilation, instead of windows, comes from exhaust heat recovery fans, which transfer the heat energy of the exhaust air to the incoming fresh air to bring the incoming air temperature closer to the room temperature. To direct the incoming air through an underground duct, there is another possibility. The constant soil temperature, which is often warmer in the winter and cooler in the summer, helps to preheat/cool the incoming air. This process is also known as subsurface heat transfer. The preheated/cooled air is then subjected to the aforementioned waste heat recovery process [4].
Passive building design and technology are best suited to temperate climates such as in Europe and North America. Although the passive house concept has been expanded to include other climate regions, the principle of construction and hermetic super-insulated buildings is still debated, especially for warmer climates. The following key performance characteristics are discussed in terms of possible proven application in temperate climates, ie. where passive building design technologies were originally developed. To achieve its goals, a passive building must first of all use all design strategies to comply with the principles of climate design – [2] development of the Passive House Institute in Darmstadt, Germany. [Pasivhaus Passivhaus Institut-Darmstadt], ["ETAŽI JOURNAL" FS77- 78890]

3. MAIN PERFORMANCE CHARACTERISTICS OF THE MAIN PASSIVE HOUSE STANDARDS

Insulation: In addition to ensuring sufficient insulation in the building envelope, it is important to pay attention to the prevention of thermal bridges in poorly protected areas by using a triple-glazed system for windows, to carefully treat the construction joints between floor slabs and walls, walls and frames, the frames themselves, wall-to-ceiling connections and roof structures.
Airtight structures: Active windows and doors should be equipped with airtight structures, especially along the wall panels with doors and windows. Approximately air leakage through these unsealed studs should be *0.6* times the volume of the house per hour.
Air quality control measure: In an airtight building structure, indoor air quality becomes extremely important for the health of the occupants. Air quality control measures must therefore be taken during all stages of design and construction. The newly completed building must be completely open for continuous air circulation for the required period of time before use.
Ventilation system: exhaust air heat recovery using an air-to-air heat exchanger to achieve a recommended efficiency of *80%*. It is also important to determine the location of warm air ducts within the building envelope and cold air ducts outside (2). In warmer climates, however, the opposite is recommended.
Ongoing global climate changes and the inefficient conversion of energy from conventional energy carriers make it increasingly necessary to develop renewable energy systems of different energy, such as:
The energy of water is converted into electricity by installing hydroelectric plants.
Biofuel is obtained from wood waste, industrial and household waste, and high-yielding plants. Other technologies and ways to increase energy efficiency: In the construction of a passive eco-house, not only traditional materials (brick, wood, straw, rammed earth) are used, but also building blocks of recycled materials (for example, wood-cement) - in South-Eastern European countries, Germany, Denmark, etc.
An important aspect for the passive house is supply and exhaust ventilation with heat recovery. Air enters the house through an air duct equipped with a heat exchanger. In the winter, the cold air is heated and cooled in the summer, which allows you to maintain a comfortable temperature in the house throughout the year. Also, the passive eco-house includes saving electricity. Equipped with sensors and timers, such a house allows lighting to be controlled without human intervention. Such a system automatically turns off the light when it is not needed and turns it on when a person approaches. Building such a house will cost *10-15%* more than usual, but the cost of providing energy for such a house is *10* times lower.

4. MATERIALS FOR BUILDING ECOLOGICAL HOUSES

There are many different options for building modern eco-friendly houses.
Pressed straw:
Straw has a low price because it is not specially produced - it is a waste during the collection and processing of

crops. Due to the lightness of the walls, the shrinkage of the base is minimal or absent (depending on the type of soil). It is easy to breathe in a straw house.(Figure 2)
and due to the low thermal conductivity, heating will require about half as much energy as in a wooden one (for comparison: the thermal conductivity of straw is *0.050–0.065* W / (m/k), wood is *0.09–0, 18* W/(m/k)). (3) Reasonable price, low labor cost.

Fig. 2: warm, light and durable eco-house [3]

An adobe house:
An adobe house (Figure 3) is a cheap and easiest to build eco house. Only natural ingredients - straw and clay - are used for the production of adobe. When building such an eco-house, it is important to keep in mind that the height of the ceiling should be *20-30* cm more than that required for living quarters, since the walls of the adobe house will shrink over the years **[3]** It also requires treatment of blocks with lime-based plaster.

Fig. 3: An adobe house [3]

Nowadays, European countries have found that it provides better insulation than other materials.The basic construction principle is similar to that used centuries ago, with the supporting structure being wooden, and the walls made of compressed straw plastered with clay. Solar panels are installed on the roof, which provides hot water and electricity, and the insulation is so effective that heating is only needed during the coldest months.

A wooden house:

Houses built from wood are warm, durable and prefabricated. Wood is considered an environmentally friendly material if it is not treated with harmful impregnations. Wooden walls "breathe".

It is true that compared to adobe and straw, such a house will cost more. . [TISS; VELOX Werk Gesellschaft mbH, Austria; Austrian Research Promotion Agency FFG] Without treatment with a special composition, the tree will collapse, exposed to ultraviolet rays. In addition, due to its fire hazard, the material requires fire protection treatment, and due to its susceptibility to rotting and fungus formation, it also requires antiseptics.

The ecological wooden house has a presentable appearance, but the wood is picky in processing since not all impregnations are ecological.

Wooden-cement house:

A house made of wood-cement composites, also known as fibre-cement is easily erected, finished with almost any possible material (under stone or wood), and in terms of living comfort it is comparable to a wooden one.

Such a house retains heat if it is built of coniferous wood. Infrared panels or a "warm floor" system are often sufficient for heating.

Additional materials for insulation or sound are not needed.

Even without antiseptic treatments, insects do not breed, and the surface of the walls does not get moldy. [TISS; VELOX Werk Gesellschaft mbH, Austria; Austrian Research Promotion Agency FFG]

A house made of wood-cement:

does not burn for *1.5–3* hours.

When the foundation shrinks, the walls do not crack. . [TISS; VELOX Werk Gesellschaft mbH, Austria; Austrian Research Promotion Agency FFG]

Timber cement houses are suitable for northern areas, hot countries and seismic areas, and also perform well on weak and fragile soils. .(Figure 4-5)

Fig.5: Wooden-cement house [3]

Fig. 6 Wood-cement house: unfinished and lined on the inside so it looks like it's built of wood. [3]

House of rammed earth:

It is made from pressed wet earth in the form of blocks, which are laid with a simple brick dressing. An ecological house built using this technology will be strong, reliable, fireproof and durable. There is also an alternative technology for building from the ground - the use of canvas bags filled with soil without adding water.

Table 1: Ecological building materials advantages and disadvantages

Type of material	Advantages	Disadvantages
Pressed straw	low thermal conductivity; good vapor permeability; ease of processing; lightweight.	high moisture absorption; short service life; fire hazard; low strength
Straw	sufficient strength; low thermal conductivity; bending strength; Fire safety;vapor permeability.	high moisture absorption; prolonged shrinkage and drying of the walls.
Wood	rapid construction of houses; low thermal conductivity; high vapor permeability; high strength.	fire hazard;high moisture permeability;high price; susceptibility to rotting and fungus formation.
Wood-cement	low thermal conductivity; high vapor permeability; good sound insulation; biostability; high frost resistance; ease of processing	high moisture absorption.
A compacted earth mass	Fire safety; high strength; accessibility.	relatively high thermal conductivity;difficulty standing; unpresentable appearance without finishing works; high moisture permeability without finishing works; hygroscopicity.

5. CONCLUSION

To summarize from all of the ecological materials, wood-cement composites are the most optimal for the construction of eco houses, as they are with low thermal conductivity, durable, bio-resistant, and does not require costs for insect protection and fire resistance. A house built from wood-cement composites would be energy efficient and would not harm the health of the residents and the environment.

Everything that surrounds us comes from nature.

We mine raw materials, process them and build communities.

This connection with and dependence on the environment has always been vital to our existence.

However, there is a flip side to the intensity with which people are using resources. People are putting so much pressure on the environment today that they risk to undermine its ability to supply us in the future. Studies show that emissions from cement clinker production have contributed greatly to global warming and ecosystem damage:[https://www.intechopen.com/chapters/77062]

During the activities carried out, pollutants are released into the atmosphere, and plastics end up in the oceans. Ecosystems are changing faster than before, at an unnatural pace. Increased trade introduces new species that can invade entire ecosystems. Climate change is leading to changes in the pattern of rainfall. Yields become more uncertain, leading to higher food prices. We can clearly see that some regions and countries are more vulnerable. However, some environmental impacts, such as air pollution, affect everyone, albeit to varying degrees.

Current levels of consumption and production are already unsustainable with more than 7 billion people on the planet, and the population is expected to grow to about 9 billion by mid-century, billions of whom remain in poverty hoping for a higher standard of living.

The way we use resources degrades and reduces the natural capital that will be available to support the well-being of future generations. At best, this will mean that there will be less land and less fresh water per person to produce the food we need.

RECOMMENDATIONS

The economy must become more resource efficient. In practice, it will have to get more from less. It is needed to reduce the amount of resources, which are extracted and used.

It is important to really reduce the flow of new materials to production processes and make them more efficient, but this is only part of the whole job. We must also reduce the loss of materials and the waste generated in production and consumption.

It is possible to transform the economy, but it requires action and commitment over several decades. Europe has made significant progress in increasing resource efficiency, but much more needs to be done.

Various EU strategies and legislation, such as Europe 2020, the Resource Efficiency Europe initiative and the Waste Framework Directive or the Seventh Environment Action Program are already being implemented in an attempt to create sustainability in key activities of the economy in a long-term transition perspective.

Full implementation of these policies will offer numerous benefits. Fewer resources will be used per unit of output, and this will help protect and preserve the environment. At the same time, the economy will benefit from fundamental innovation and higher competitiveness for European businesses.

Can we really use end-of-life products (the "residues" of the production process) as inputs to another production process? Can we create a "circular economy" that generates as little waste as possible? Better waste management shows that the potential benefits, both for the economy and the environment, are enormous.

Greening the entire economy — the European, and ultimately the world — is a huge task. It involves implementing the sustainable use of resources in every aspect of life.

Eco-innovation projects, renewable energy sources and research in general all have a crucial role to play in developing better products and processes and reducing waste. Business communities in cooperation with public authorities and civil society can implement sustainable solutions until they become prevalent.

Naturally, in the absence of eco-innovations in our country, our agro-industrial production is at risk, since there is no way to ensure quality production with which to conquer markets outside Bulgaria.

At the moment, the question arises about the way in which the reconstruction and modernization of the existing buildings and premises will be carried out, with new construction materials and the design of new, in terms of properties and indicators, agro-industrial buildings.

They must be accessible to every farmer, thus bringing agricultural production up to the level of global trends. At this stage, in an economic and financial crisis, agro-industrial buildings with natural ventilation are suitable. The unification of their building blocks is a continuous process. The modules for the agrarian buildings are functionally intended only to enclose a certain space. The elements themselves have a massive construction, ensuring a passive exchange of mass and energy with the environment, hindering the creation of a natural and ecologically clean

environment for agro-industrial production. Buildings used as warehouses and fruit stores are purposefully designed and there is no modular connection between them.
There is no connection between the processes of energy and mass exchange with the enclosing elements and the use of energy from the environment.
It is a global trend to develop architectural energy-saving modules with new properties in agro-industrial production, providing a natural and ecologically clean environment.
Achieving the goals requires the development of architectural models with new energy-efficient materials to unify the modular elements, establish a single methodological basis, and provide an algorithm for automated design at the level of energy and mass exchange.

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