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THE STRAWBALE HOUSES ENVIRONMENT AND ENERGY CONSCIOUS BUILDINGS

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ABSTRACT. About half of the energy used all over the world is generated during constructing and maintaining buildings. The energy rate of maintaining is much bigger than the energy rate of constructing in case of the houses of the recent decades. As the energetic features of today's buildings increase, the importance of the inbuilt energy increases as well. It is not enough to be energy conscious; we have to consider the environmental aspects too. The environmentally friendly house has got small ecological footprint like strawbale houses. The first strawbale houses were built in Nebraska in the end of the 19-th century. Since then thousands of them have been built worldwide, from which the oldest ones are more than 100 years old and are still inhabited. Nowadays more and more strawbale houses are being built all around the World. The importance of ecological buildings increases today, because most of the people have recognized that we have to do something against the climatic change. Houses, made of strawbales, are really environmentally friendly. It is very few energy needed to build and maintain them, because they are made of a cheap, natural material which has got excellent thermal insulation features. In Hungary there are only one or two dozens of them. The reason of it is very complex: obscurity, judiciary problems and lack of test results. During examinations we would like to review the inland situation, and find out what to do for the spread of this technology. We will especially focus on the tests and examinations, which are needed to get know much more information of these houses. We would like to compare the strawbale houses with conventional ones concentrating on ecological and sustainability questions beyond the standard technological and architectural aspects.

Keywords: strawbale house, sustainable architecture, environmentally friendly building

INTRODUCTION

The first strawbale houses were built at the end of the 19th century in Nebraska, after the baling machine had been invented. Among the sandy hills it was impossible to find proper materials to build from. Wood could be found only along rivers. At some places huts were built of turf, but suitable lawn could mot be found everywhere either, so got the idea into the mind of some settlers to put the strawbales into each other like bricks and build house of them. First it was built to be temporary, but they realized if the strawbale houses are plastered, it become really durable and comfortable. The first ones were built more than one hundred years ago, some of which are still inhabited (Lacinski et al., 2000).

After a while, the appearance of up-to-date building materials and the development of the mobilization, made these houses fall into oblivion, but later, at about the energy crisis of the 70's, they were rediscovered again. Since then hundreds of them have been built all over the world. Today's economical and environmental crisis makes more and more people recognize the importance of environment and energy conscious buildings, so the strawbale houses are facing a great future.

Fig. 1a Nebraska style (load-bearing) strawbale house during building

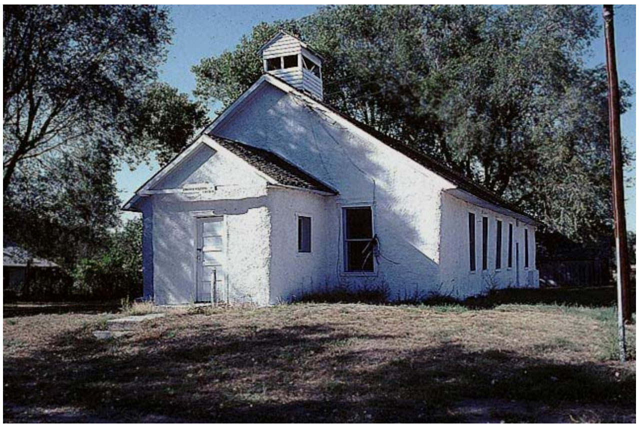

Fig. 1b Strawbale church from the USA (1927)

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STRAWBALE HOUSES IN EUROPE

Strawbale houses were built with different building technologies in several EU countries (e.g. United Kingdom, French, Germany, Denmark, Spanish, Austria…) The majority of the houses were built with traditional technology, but several example can be mentioned when strawbale houses were made of prefabricated blocks. The inbuilt energy of the buildings depends on the technology it was made by. It can be effected by the energy of mining, producing and transporting of the building materials. We have to add the energy of demolishing as well. All kind of strawbale technologies need significantly less energy than the conventional (brick, concrete) ones. The energy of operation is included into the life cycle either. Although it partly depends on the habits of the users, it is mainly determined by the features of the building. The majority of the energy is used for heating (Medgyasszay et al., 1999) and cooling (in some cases), so the minimalization of it is the most important thing in connection with an environment and energy conscious building. Passive houses, which are becoming more and more popular, fulfill the demands of energy consciousness, but I have to note that an energy conscious house is not definitely environment conscious too, because in the latter case it is not enough to use little energy during operation, additionally it is obligated not to put much pressure onto the environment during building (Medgyasszay, 2007). It can be clearly demonstrated through an Austrian study, which shows us the ecological footprint of a conventional passive house (made of concrete and polystyrene) and a passive strawbale house. According to the study the conventional one puts five times as much pressure on the environment as the strawbale house (Reinberg et al., 2007).

We can understand it better if we have a look at *figure 2.b*, which shows the overall CO_2 emissions (Corneliu, 2009.) by weight (kg) released by production of 1 kg of twenty-four common building materials. We can notice that in case of using natural organic building materials (straw, wood, cork) comparing to so called modern artificial ones (metals, synthetics, ceramics), we do not even increase the CO_2 contamination of the atmosphere, but reduce it. This makes it possible to get negative values instead of positive ones (like normally in case of artificial building materials) (Wihan, 2007).

Fig. 2a Outer view of the strawbale house in Tattendorf (near Wien)

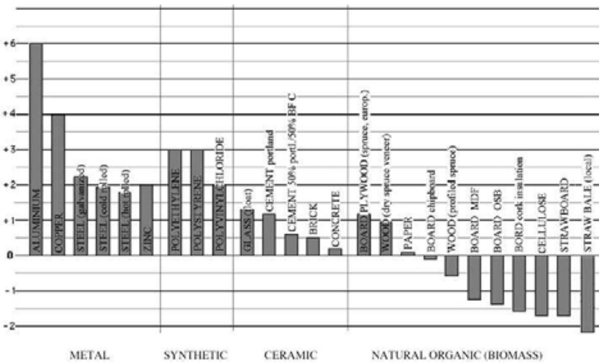

Fig. 2b Overall CO_2 emissions by weight (kg) released by production of 1 kg of twenty-four common building materials

Fig. 2c Inner view of the strawbale house in Tattendorf (near Wien)

Fig. 2d Strawbale house in Tattendorf made of prefabricated blocks

That is the main reason why strawbale houses are so environment friendly, while conventional passive houses are only energy conscious in terms of maintaining. In case of a normal house, which needs much energy for operation as well, the pressure onto the environment is even much more bigger. Considering the situation of the Hungarian buildings, we have to admit that it is even more disastrous than the western European ones.

THE HUNGARIAN SITUATION

Although we can hear more and more about passive houses and renewable energies here in Hungary as well, the break-through have not happened yet. The spread of environment friendly (and often cheaper) natural solutions are pulled back even by the legal environment. According to the **3. §** (1) point of the joint regulation of 3/2003 (I. 25.) BM-GKM-KvVM: Negotiation or incorporation of building materials are only allowed with Conformity Certificate. It practically means that natural and reused building materials are forbidden, which significantly reduces the palette of eco-architectural repertoire. According to the point **41. §** (1) of the 1997 LXXVIII law about the formation and protection of built environment: Materials and products for the aim of building can be negotiated and incorporated only with legally regulated Conformity Certificate. According to point (2): Conformity Certificate is a written confirmation of the suitability of the building material, which has to meet the requirements of

- *a)* localized harmonized European standard
- *b)* European Technical Approval (ETA)
- *c)* or a national technical specification (national standard or technical approval for construction)
- *d)* the specified requirements of the plans of the construction in case of unique (not serial) products

Although according to paragraph *d)* we have got the chance to build with unique (not serial) products, the content of the plans has not been specified by any law, so it is impossible to apply it. Due to the ambivalent laws, in spite of the increasing needs for eco-houses, natural materials like straw and adobe are pulled back.

Fig. 3a Fire test of plastered strawbale wall at the laboratory of ÉMI in Szentendre (2008)

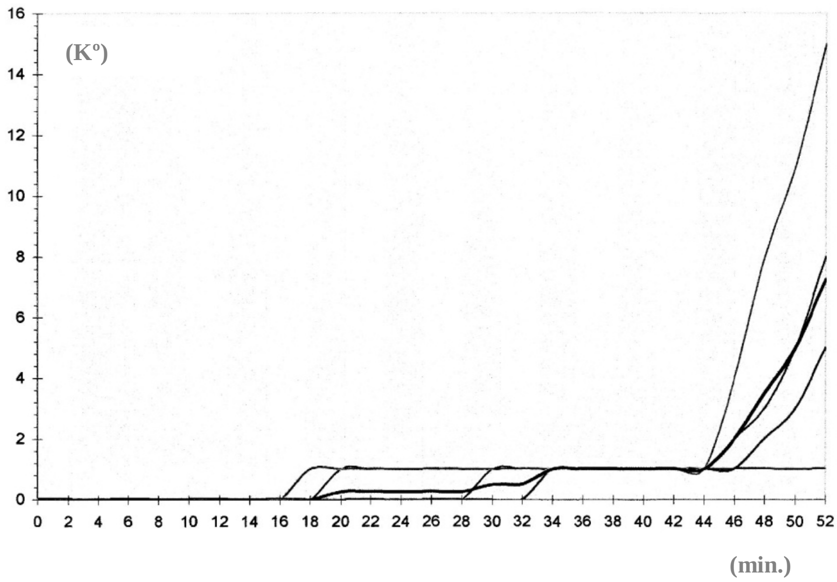

Fig. 3b Rising of the temperature on the cold side of the wall during the fire test

Recently, several attempts has happened to deal with the legal problems by professionals and civil people as well. A professional committee has formed within Hungarian Chamber of Architects trying to solve the problem mentioned above (Ertsey, 2009). In case of monument protection the situation is the same, they are struggling against the ambivalent laws as well. The Hungarian foundation called “Energia és Környezet Alapítvány” (Energy and Environment Foundation), whose main goal is to make the strawbale houses more popular, has financed an official fire test, which shows the fire resistance of such a wall (ÉMI). During the construction and the test method I was on the spot, so I could witness that the average increase of the temperature on the cold side of the wall was only 7°C during the test method in which the temperature increased up to 1000°C. This value is much lower than the permitted value of 140°C, furthermore the model could naturally preserve its load bearing ability, and hasn’t happened any break-through of flames or pass through of flammable gases (Takács, 2008). As a result of it some strawbale house could get the building permit, but in the majority of the cases, due to the lack of the full ÉME (technical approval for construction), the requests were refused. Since then a firm, using the results of the fire test and other tests, has got the full ÉME, which prove the conformity of the technology. In spite of this fact it has not spread in Hungary, because of the restrictions and high associated costs of building with that firm.

The Hungarian Strawbuilders Association has formed on June 5th in 2009, World Environment Day, to solve the problem mentioned above. The main goal of this non-profit association is to make this technology well known and spread. The Association, similarly to the Energy and Environment Foundation, is working to make such a technical documentation which is tended to be reachable free for everyone to help the spread of the strawbale houses. In Hungary only one or two dozen of them have been built legally, but we can add the privy ones with an unknown number. The legalization of the strawbale houses would be beneficial not only for the builders, but all people who would like to live in a better and healthier environment.

Fig. 4 Building of a strawbale hut in Mátraballa (2009)

HUNGARIAN EXAMPLES

On September of 2009 a „strawbale hut” has been made in Mátraballa. The construction was made by volunteers. The size and the functions were chosen so that we did not need any permission to build it from clay and straw. The hut was designed so that it was able to build it from local (and possibly natural) building materials. The load bearing structures were made of acacia. To protect the piles from humidity, the woods were shaved and saturated by recycled waste oil. The acacia beams and columns were shaved too and built in as roundwood. Structural connections were made as traditional carpentry joints. The local straw bales were put between the columns and plastered with 4-5 cm of clayplaster to protect the structures from the environmental and meteorological effects. The walls are protected by big overhanging green roof, which was planted with species of drought tolerant plants.

About a hundred of volunteers participated during the 3 days of the construction, and even more people watched it. Thankable for the volunteers and the natural materials the building was not only ecological, but economical too. The construction of the building cost only some hundreds of Euro instead of thousands, because the majority of the building materials were free or cheap and the volunteers didn’t need any fee, but food. Fortunately many people could experience that a construction can be an enjoyable free time activity while wallet-friendly too.

In case of another project I was only a consultant, not an organizer. An old adobe house was renovated and thermally insulated by straw bales from EU sources near to Nyíregyháza at the farm of E-misszió Nature and Environment Association. During the project we could reduce the original U value from 1,39 W/m^2K to 0,15 W/m^2K, which means almost tenfold improvement. Due to this improvement the amount of escaping energy through the walls reduced about one tenth of the original amount, which will have positive effect on energy bills.

CONCLUSIONS

These examples show reassuring initiatives here in Hungary, but for the spread of straw bale houses this technology has to be more accepted among users, authorities and architects. It is necessary to solve the problem of legality, to make more examinations and to publish it in order to make this environmentally friendly technology much more known.

Fig. 5. Strawbale thermal insulation of an old adobe house

Fig. 5a Building of the wooden structure of the strawbale insulation wall of the adobe house

Fig. 5b Compressing of the straw in the wall

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