Floating houses – chances and problems

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Abstract

Floating architecture could be a resolution in the future for current problems in many districts, cities and landscapes. Such problems can be seen particularly in the need for additional housing areas and construction grounds in some countries in Europe and Asia as a result of the growing population and/or the slowly rising sea level in context with the worldwide climate change. Another example for problems of current interest is the use of alternative energies. The water areas of channels and closed down harbours offer good opportunities to create new water landscapes with modern marinas consisting of floating houses and other floating architecture. As this paper will show, this is achieved in the same way that brownfields, such as the pits of former opencast lignite mines, are appropriated for such modern marinas after their transformation into post-mining lakes. Thereby, the possible use of water as an alternative energy source is demonstrated too.

On the other hand there are a lot of new problems with regard to the physical and chemical effects of water on the constructions of floating architecture. New materials and structures must be developed in order to withstand the attacks of waves, sea climate, salts and ph-values. The harmonisation between architecture and nature is to be discussed. Moreover, there are questions about energy and water supply, waste disposal and safety. Three years ago a new project was started with regard to these topics. The first results of the investigations supported by experiments and numerical simulations are presented in the paper.
Keywords: floating architecture, floating houses, post-mining lakes.

1 Introduction

Floating architecture is gaining significance in the wake of increasing public awareness for the new development of bank areas. Rehabilitation of brownfields,

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particularly those of former lignite mine pits, is an expensive undertaking and requires not only technical solutions, but also the generation and involvement of new ideas.

Floating architecture is a possibility for redevelopment after the closure of opencast lignite mines. It can give impulses for regional development instead of pure rehabilitation of a culture landscape. Moreover it offers opportunities for a renewable energy source: water.

Yet there are a lot of additional problems due to the special climate boundary conditions, including wind waves and chemical components of the water in the case of post-mining lakes. There is a need for studying and solving these problems to avoid damage in the future. The paper demonstrates the effect of the corrosion of steel concrete by an unusual environment. Direct attacks of the climate components solar radiation and wind, owing to a lack of neighbouring buildings or trees on the one side and modern glass architecture on the other side, cause an uncomfortable room climate in summertime. The management of energy and water supply and waste disposal must be resolved. The safety of children or animals is also to be discussed. In districts with a cold wintertime the attacks of ice on the pontoons and the safety of walking on footbridges must be considered.

2 History of floating architecture

The global history of floating houses is very complex [1]. The technique and architecture of these buildings all over the world depend on the climate boundary conditions, the culture and the raw materials that were available at the different local places. In Europe the historical situation is relatively simple: At the beginning there were houseboats, which in many cases were originally used as barges. Asia has a much longer history of floating architecture. Yet owing to

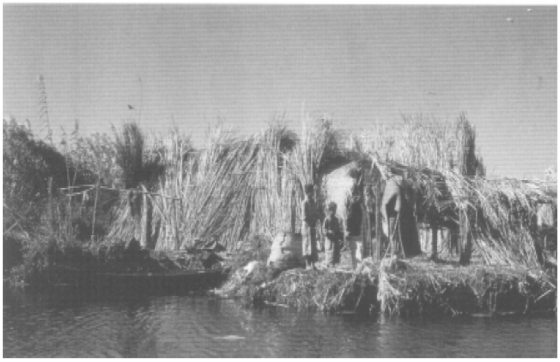

Figure 1: Floating houses and islands of the former “Madan – culture” using reed material.

the Asian mentality, the documentation is very meagre and the records are only rarely available. Figures 1 and 2 show examples of floating architecture from the past and present.

3 Chances

The development of life has taken place likely in the environment of water. There was and still is a fairly affection of human beings for water areas. Now it is possible – and in some cases it even seems to be a necessity – to return to the water places. Nowadays techniques are available to use the properties of water in our favour; this means to use the possibilities of the mobility of floating architecture and the energy resources of the surrounding water areas.

In the following some prospects in context with floating architecture are briefly presented.

3.1 Use of alternative energy resources

The surrounding water can be used for heating and cooling throughout the year. For this we can utilise the techniques of evaporation, heat pipes or running water through the building envelopes by using the buoyancy and minimized pumps that are available, see the sketch in figure 3.

Figure 2: Floating house erected in 2009 at a post-mining lake.

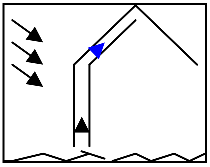

Figure 3: Moving water in the envelope parts of floating houses by means of the difference in density of water caused by the different solar radiation on the facades.

3.2 A new feeling

The direct experience with the natural environment of water is the base for an attractive property. Many people would like to spend their life in a floating house.

3.3 Additional construction ground

Floating architecture will be a resolution for the future lack of construction ground as a result of the growing and expanding population of the world. In addition, in context with the rising sea level, the marinas of floating houses could be an alternative construction ground, e.g. in The Netherlands and some countries in Asia.

3.4 New materials and innovative construction

The construction and materials of floating architecture are subjected to attacks of water and climate components, such as wind waves, salts, solar radiation, humidity and so on. In the sense of sustainability, new materials and composites of them with innovative properties are to be developed and tested.

3.5 Mobility

One advantage of floating architecture over usual buildings is its mobility in view of changing positions or local places. By this the owner can look for other places as desired and to his liking. Besides the subjective component, the mobility is an advantageous property with regard to supply and waste disposal and regarding the optimization of the solar energy inputs.

3.6 Revaluation of brownfields

The use of floating architecture in the areas of old docks and post-mining lakes revalue the cities and landscapes in numerous towns and districts all over the world. The flooding of a post-mining lake is a long-term and complicated process.

Figure 4: Marina animation of so-called gothic floating houses at the lake of Geierswalde in the Lusatian Lakeland near to the border of Poland, Germany.

Figure 5: Revaluation of former opencast mining landscapes in Lusatia, Germany: initiated by the international building exhibition IBA "Fürst Pückler Land".

(a) (b)

Figure 6: Floating bridges of the diving school on lake "Gräbendorfer See" during wintertime. German district Lusatia, near the border with Poland.

4 Problems and risks

On the other hand there are a lot of problems due to the special environment of water and its physical and chemical properties. Some problems of floating houses and their swimming bridges are given below.

4.1 Local climate

The construction is subjected to stronger external loadings due to the increased attacks of wind, wind waves, driving rain, ice and solar radiation. Floating houses should be reached safely in winter time too, figures 6, 7.

Figure 7: Frozen lake “Partwitzer See” in the German district Lusatia.

Figure 8: “Ar-che” design with a comprehensive glass architecture [2], animation of the floating house according to figure 2.

4.2 Indoor climate

There is no problem to improve the heat insulation in the cold season in case of strong winter climate e.g. by an increased intensity of wind. But during summertime innovative solutions are necessary in order to guarantee a moderate indoor climate. Users demand a comfortable atmosphere in spite of more and more glass architecture (figure 8), no plants and neighbouring buildings, reflected radiation and difficulties with use of blinds caused by more and intense wind.

4.3 Corrosion of materials

The additional attacks by chemical and physical components of salts, ph-values, ions etc. and the special components of the local outdoor climate effect an intense corrosion of materials. Figure 9 represents the damage at a concrete, which set in already two years after its installation at the lake “Partwitzer See”.

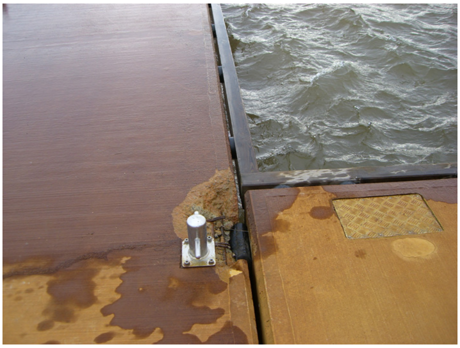

Figure 9: Concrete corrosion at the floating bridge of the floating house according to figure 14.

4.4 Algae determination

The microbiological growth of surfaces is a topic worldwide [3, 4]. Owing to the improved thermal insulation of envelope parts of buildings the external surfaces tend to a natural state. Currently and in context with the investigation of floating houses by the authors the systematic measurements of algae are underway.

4.5 Energy and drinking water supply, waste disposal

The supply of a floating house with drinking water and energy by electricity, gas or district heating as well as the disposal of the property are possible both by decentralized and by centralized systems (e.g. see table 1). They have to comply with the current environmental law and building guidelines.

5 Selected examples

5.1 Alternative energies

5.1.1 Use of the heat pipe principle

In different versions it is possible to use the phase change energy for the transfer of heat energy. For instance figure 10 demonstrates the heat pipe as a protector against attacks of ice loading in wintertime.

5.1.2 Envelopes with flowing water

With regard to the sketch in figure 3 the graphs in figure 11 show the difference of pressure caused by the difference of temperature between the facades.

5.2 Mobility of floating houses

The advantages of a mobile building have a subjective side (everybody can choose a place according to his desires, ideas and technical references) and an objective side (by means of the possible position changes a maximum input of

Table 1: Comparison of different sanitation options.

	catch basin onboard	**small absorption bed onboard**	wastewater treatment plant near the water at the bank (semi centralized connection)	**central connection**
technical requirements				
plant construction flexible connectors	-	-	●	●
weatherproof	-	-	●	●
antifreeze/ heating	-	-	●	●
anti-abrasion-material inside outside	●	●	● ●	● ●
UV- protection	-	-	●	●
heat resistant material	●	●	●	●
corrosion protected	-	-	●	●
leak warning system double-wall system	●	●	●	●
noise insulation	-	●	(●)	(●)
appendix connections outside the building	●	●	(●)	(●)
fail safe system	-	●	-	-
system level security	●	●	-	-
continuous operation necessary	-	●	-	-
multiple usage of the treated sewage	○	(●)	○	○
weight raising of the pontoon	●	●	○	○

Assessment:

● : yes
(●): yes, under certain preconditions or restrictions
○ : no
- : not necessary

Figure 10: Test stand for the dolphin model, constructed as a heat pipe.

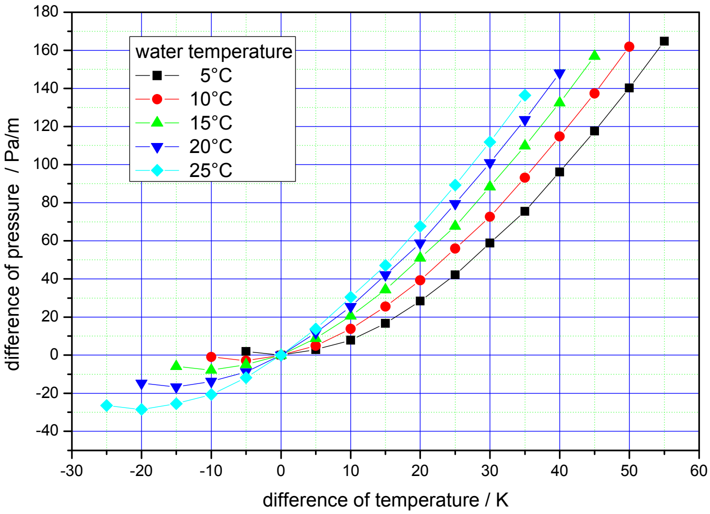

Figure 11: Differences of pressure between facades of one building with and without solar radiation.

solar energy can be reached). A concentration of the infrastructure on one centralized location in a large district of several lakes connected through so-called channels reduces the costs of supply and waste disposal [5].

5.3 Materials

5.3.1 Reinforced concrete pontoon

Figure 14 shows the attacks by wind-waves to a floating house on a post-mining lake flooded with water almost completely.

(a) (b)

Figure 12: Fitting of heat exchanger in the pontoons for cooling and heating of the floating house according to figure 2.

Figure 13: Map of connected lakes in the so-called Lusatian Lakeland.

Yet the dynamic loading of the concrete is not the only. reason for the damage. Above all things a low level of the ph-value causes a strong corrosion (see figure 16). Investigations for new concrete formulations and innovative composition of concrete are underway.

5.3.2 Steel pontoon

Steel pontoons must be overcoated with an additional surfacing of a high quality. Of course this is necessary if it is planned to put the pontoons into post-mining lakes with a ph-value measured according to figure 16.

Figure 14: Waves at the lake “Partwitzer See” – a former opencast lignite mine in the Lusatian Lakeland.

(a) (b)

Figure 15: Investigation of concrete samples subjected to different areas (water, air and fluctuating zone between water and air).

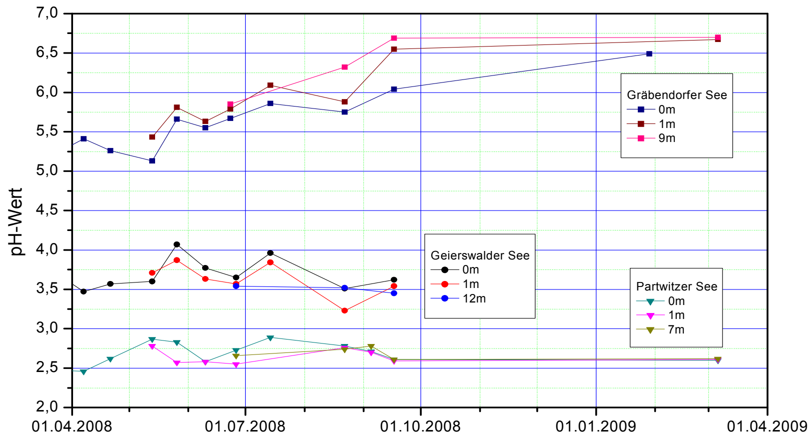

Figure 16: Course of the ph-value of different lakes in the Lusatian Lakeland.

5.4 Room climate in the warm season

Figure 17 shows the issue with regard to human thermal comfort [6].

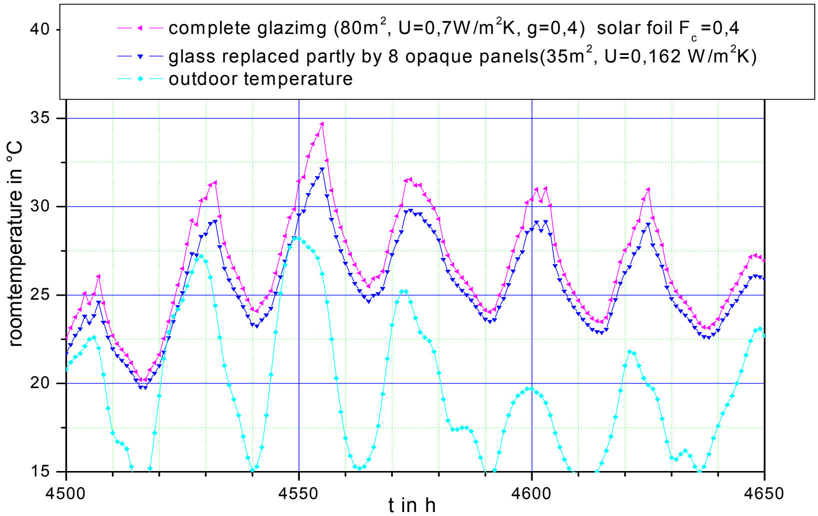

Figure 17: Course of the room temperature of a floating house according to figure 8.

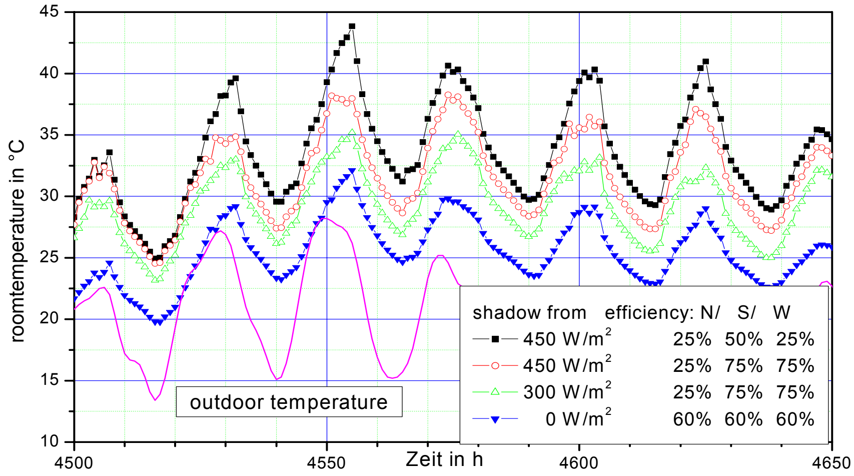

Figure 18: Floating house according to figure 8, glazing replaced partly by 8 opaque panels shaded by 25% bright curtain, 50% indoor blind, 75% outdoor blind and 60% solarfoil applied to the interior surface of the window glass.

References

[1] Giebler, S.: Master Thesis "Schwimmende Architektur: Bauweisen und Entwicklung", Brandenburgische Technische Universität, BTU 2007.

[2] Project: Wil/Design K. Wilde; concept: steeltec37 T. Wilde; manufacturer: Wilde Metallbau GmbH, Germany

[3] Stopp, H. Strangfeld, P. et al: Algen auf Fassaden, Bauphysikkalender, pp. 561-644, Verlag Ernst & Sohn, Berlin, Germany 2004.

[4] Stopp, H; Strangfeld, P.: Energy saving and the hygrothermal performance of buildings. Conference proceedings, III. Latin American Conference on Comfort and Energy Efficiency in Buildings, Curitiba, Brazil, November 2003.

[5] Floating Mobile Architecture, documentary of the international competition 2008, Internationale Bauausstellung (IBA) Fürst-Pückler-Land 2000-2010.

[6] Stopp, H; Strangfeld, P.: "The hygrothermal effects of external and internal wall surfaces", 4th IBPC, Istanbul, August 2008.