Abstract of Dissertation

Dual Water – Dissolution Method for Water House Model
(水の二重性 —建築設計における水の多様な展開と可能性について—)

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The aim of the thesis is to turn goals of sustainability to source of inspiration for planning, and explore a new method for integrated design, in which architectural and structural also environmental design considerations are merged into one building system. Dissolution method unites the various layers of design process by converting and calculating them to energy. Without expecting higher efficiency based on cooperation between various stakeholders, the decision makers are united on level of material use and building system instead: various elements, like space and planning, material use from manufacturing to waste management and demolishment, heating-cooling-ventilation and other operational demands all converted to energy and after accumulated in one objectively calculated value, used as an active reference system for whole decision making process.

The result of this approach is the Water House model: structure built by water, plastic and air layers only. The emphasis is on liquid constituents instead of solid components for both structural and environmental design. The defined system works similarly to planet Earth itself: main thermal mass is given by water volume and insulation is provided by additional air layers to assure well-tempered environment, and also capitalizes from the new surfaces effect on spatial relations and distribution.
Water House model reveals both the potential of Dissolution integrated design method and also the impact of water-plastic structural system on sustainable design. The method unites several functions and tasks into one material presence, and water becomes responsible for both construction mass, environmental management medium for conditioning and energy transfer inside the building.

This solution brings new assets for both structural and environmental design model. Water House system unites effectively the advantages of heavyweight structures and light building method: as main mass of the structure is water only, being available at site as well, manufacture also transportation or construction can count with the limited weight of the panel, while water is filled in the last stage of building process, transform it to heavy weight system during operation.
The structure defines a different thermodynamic model for sustainable building, as water properties (not only high heat mass but also conduction) modify the structure entirely. Perimeter skin inhabiting water is connected along the edges, water conduction and flow can thereby exchange heat gain and temperature differences rapidly. Combined with transparent insulation system, all areas of building

can capitalize of solar gain for instance, as the skin disperses the energy surplus along the water mass aiming constantly thermal equilibrium. The building becomes capable to exchange heat gains between east and west sides, also between north and south for example, while effective insulation avoids cooling towards outside. Heat energy gains thereby are used much more effectively than conventional cases, minimizing heating demands considerably.
The new thermodynamic model is also effective for hot climate as well. High thermal mass balances heated areas, and the heat exchange together with high heat accelerator capacity can keep the risk of overheating to minimum. This is an important asset compared to other transparent structures, which case radiant cooling during winters and rising temperatures for summers affect indoor thermal quality considerably. During nighttime the system can radiate heat gain back to outside and allow thermal storage capacity to be renewed for next day again. Heat transmission in water volume becomes crucial for this stage as well, as perimeter skin connected with internal mass cools not facades and roofs, but also the internal areas as well.

Heating, cooling and air-conditioning system also designed based on water presence in all structural elements: active radiating surfaces can be increased significantly, and permits to rely on renewable heating and cooling energy sources only, benefitting from the high coefficient of performance of such solutions, and lowering total energy consumption effectively. Fresh air-intake system is defined to utilize the same active radiating surfaces, and thereby conventional air-conditioning technologies are replaced by new solutions, sharing the energy supply with indoor heating and cooling surfaces. The new features are designed to be applicable for various climates, differences between cold, hot-dry and hot-humid conditions are explored and introduced in Case Study projects in detail.

In addition to energy consumption and structural design, challenges of recycling and manufacturing reveals another important advantage of Water House model. Dissolution method defines an ambiguous state of unity for water, air and plastic enclosure: constituents result structure altogether, but remain independent and able to be separated. Model of life cycle for the materials therefore show *Dual Loop* solution, which is the combination of biological (for water and air constituents) and industrial circulation (for plastic particles) targets both the energy-free recycling of the biological elements and the effective reuse of plastic parts simultaneously, by keeping both separated even during operation, embedded in one structure.

Furthermore, the four Case Study projects not only present the significance of water use for structural or environmental planning, but also on architectural design. Buildings' geometry and form or spatial distribution and all defined by Water House model design and by the influence of new water-plastic structural system. Design can take new direction and employ various surfaces and

structural possibilities, which are not only energy or cost-effective, but also reveal new esthetics especially on field of transparency.
The designed elements are not only based on architectural decisions, but also defined by calculations respecting heating or cooling and thermal mass demands at all cases, merging architectural, structural and environmental aspects effectively. Each Case Study is made for real site and program, and introduced in thesis not only with architectural concepts, but also structural and environmental decisions in detailed drawings with instructions including material use and assembly, maintenance and later disassembly.

Moreover thesis includes description of the new thermodynamic model, elaborated and tested with real laboratory measurements, presented with computer analysis and thermograph data. Detailed calculations not only affect details of structural elements, but also give comparison with reference buildings and show the impact of Water House model on total energy consumption in contrast with conventional structures or environmental technologies. This part also deals with the particular challenges of water use, like the risk of freezing, thermal compression and expansion or water proofing in detail.

Furthermore, the four Case Study projects represent a continuous development in structural design as well, while detailing and also overall design is affected by the change of climatic conditions. First system designed for mild weather introduces a simple prefabricated construction system, combined with conventional load-bearing framework. This solution is improved to Structure Insulated Panel system in the second case, when water mass fuses with a load-bearing net layer. The structural system contents four panel types, but with a particular linear system which is designed to form a surface where the panel boundaries disappear and repetition can not be perceived. This results a prefabricated surface with all benefits of cost effectiveness and punctuality, but with a randomized appearance projecting one united surface instead of sum of copied elements. In the third case the water presence is united with new cooling methods to meet the criteria of hot-dry climate, and water becomes responsible for additional tasks, increasing its contribution to architectural design. This is extended in the last house project, when water perimeter skin is capable to directly define form and geometry with interior light conditions simultaneously, thereby stepping forward as the main element for architectural space definition.

Main concerns of sustainability, like energy conservation or pollution and waste management simply has no preference of space or form, therefore affecting directly architectural design is difficult task. This is also retraceable in common methodology resulting buildings which design hardly differs of its contemporaries, except of sustainable gadgets added to the building itself. This increases the

contribution of structural and environmental practice in the whole planning process, while architectural designs significance is challenged because except of notable examples, the lack of capacity to find inspiration and specified answers in Sustainable Movement remains. Water House model therefore goes beyond the task of simply deal with challenges of new structural system: the thesis targets to reclaim integrated approach for architectural practice, unite the various tasks and constraints into one material, instead of uniting the stakeholders of decision making process only. By that Dissolution method not only solves effectively the problems of compromised elements between architectural design and green technology achieving higher efficiency and performance, but also aims the possibility to unite each layer as one for architectural design practice’s decision making process.