

Personal Reflection

Personal information

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Graduation Studio

Name/Theme: Building Technology Graduation Studio

Teachers: Ulrich Knaack, Regina Bokel

Argumentation of choice of the studio: Part of the Building Technology Track

Graduation Project

Title of the graduation project: Adaptive fabric façade for a high-rise in Paris

The relationship between Research and Design

The topic of this graduation project is the design of an adaptive fabric façade for a high-rise in Paris. More specifically, the main question is how an adaptive fabric façade can be designed, a façade that will be responsible for improving the indoor comfort in terms of thermal and acoustical insulation, as well as sun shading. Several sub-questions were immediately generated, concerning the main problems of high-rises that should be tackled, the suitable fabrics/textiles as a solution to these problems, the most effective design of a façade component that meets the requirements and lastly the desired adaptivity and the way it can be achieved. In order to answer to these questions, a sequence of steps had to be followed.

The first part of the project consists of a literature survey concerning various types of fabrics/textiles and more specifically their properties, the available necessary coatings, as well as some new technologies that are being integrated gradually to fabrics (photovoltaic films, PCMs). Subsequently, a comparison of fabrics was conducted depending on their advantages and disadvantages, so as to choose which one(s) among them should be used for the project. Also, a list of reference projects is presented, in which fabrics/textiles are used, either as roof -which concerns usually most of the cases- or as façade components, in order to understand how membranes can be integrated in the building sector.

Furthermore, a research is conducted concerning high-rise buildings, focusing on their main problems, along with several reference projects presenting the ways architects and engineers have dealt with the highlighted problems.

Moreover, the climate conditions of Paris are examined (diffuse and direct radiation, average min. and max. temperatures, wind direction and speed, humidity levels) and also the required indoor comfort is defined. In addition, the building regulations for the specific area are explored and the requirements for the façade element are defined as well (U-values, airborne sound insulation values, wind resistance etc.). Of course, a case study is selected, onto which the façade concepts would be applied.

Then, ten design concepts are presented -based mainly on façade principles- and are evaluated, so as to conclude to the four best. These are being developed further according to several factors (adaptivity, feasibility, thermal and acoustical insulation properties, transparency and shading possibilities, air and water tightness, reaction to fire and soiling behaviour), until one design concept is finally chosen. Physical models are also constructed in order to experiment with and define the façade's design (pattern, shape) and finally place the façade in the "real" context/building. At the same time, hand calculations are conducted concerning the thermal and acoustical performance, as well as computer simulations with THERM and Design Builder software examining various different versions, in order to validate the results of the hand calculations.

The relationship between the theme of the graduation lab and the subject/case study chosen by the student within this framework (location/object)

The sustainable graduation design studio of the Building Technology track deals with four research fields, which are Façade, Climate, Structural and Computational design. This graduation project focuses on two of them, those of Façade and Climate design. The goal of the project is to explore the possibilities of using membranes as the main envelope of a high-rise building, since in the realised examples they have been integrated mostly in roof structures or in the outer layer of a double façade system. In addition, the exploration of the possibilities of a pneumatic structure (inflated cushion) in combination with a vacuum system (deflated cushion) as a complete façade component is rather interesting and innovative. As the hand calculations and the computer simulations showed, a good thermal performance can be achieved when placing both systems together and a good acoustical performance, as well, thanks to the vacuum element as the lower air pressure increases the airborne sound insulation of the cavity.

In addition, designing an adaptive fabric/textile façade for a high-rise can have many advantages in terms of sustainability. Such façade components can be rather lightweight, which has an impact on the structural elements of the rest of the building that can be reduced and thus less material is used. Another aspect, which should be taken into account, is that of recycling. Nowadays, technology has been significantly developed towards this direction. For instance, the French company "Serge Ferrari" has developed a procedure named "Txyloop" that renders membranes recyclable and also it aims to create new materials, which can then be reintroduced into the membrane fabrication process. Furthermore, the properties of fabrics concerning their transparency, translucency, insulation and solar protection, as well as coatings, such as low-e coatings, applied onto them can be rather beneficial for creating low energy buildings. Consequently, such design solutions could be considered as an innovative sustainable idea in the building domain that will also be responsible for reducing construction costs.

The relationship between the methodical line of approach of the graduation lab and the method chosen by the student in this framework

The methodical line approach of the sustainable graduation design studio of the Building Technology track is either design by research or research by design. The method that was used in this graduation project followed both directions. At first a research (literature survey) was conducted in order to get familiar with the topic and gather all the necessary information to form a solid background of knowledge on the chosen topic. Then, the design phase started based on that research. Subsequently, several changes were applied to the design and various versions were explored in order to confirm

the research, but also the fact of conducting calculations and simulations and constructing physical models, thus making more changes in the design, had as a result new outputs that came into light, which enriched the initial research. Therefore, this second part could be described as research by design. Hence, there was a continuous relationship of validating and improving between the research, the design, the physical experiments and the simulations.

The relationship between the project and the wider social context

As already mentioned, the design of an adaptive fabric/textile façade for a high-rise can have many advantages in terms of sustainability. Membranes have a very low embodied energy per m², especially in comparison with glass, which renders them a rather interesting and competitive material for the façade industry. Also, such façade components can be rather lightweight, which can have a positive impact on the structural elements of the rest of the building that can be reduced and thus less material is used. In addition, the use of pneumatic structures (inflated and deflated cushions) constitutes a simple and cost-effective solution, which can lead to energy savings, as long as there is a careful and smart design for the necessary pipes too. Furthermore, the elements are pre-fabricated and only the pipes need to be connected to the cushions in situ for their inflation and deflation, which reduces remarkably the construction time. Moreover, the adaptivity of the integrated shading system, as well as the modularity and flexibility of the façade component itself, along with the customization of the transparent and translucent parts according to the needs and preferences of the users can be proven rather useful. Last but not least, the replacement strategy to be done entirely from the inside, in case damage on the membrane or a collapse of the inflation/deflation system occurs, constitutes an interesting idea for a high-rise.