Thesis Statements of
Ph.D. Dissertation

Gergely Dobszay:

Building Constructions of Cladded Roofs

Budapest University of Technology and Economics
Faculty of Architecture
Department of Building Constructions
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I. Choice of subject and the goals of the research

The subject of this dissertation are the building constructions of "cladded roofs", an entirely new type of roof constructions where the geometry, the roofing material and every visual detail of the roof is determined solely by the architectural design idea, often disregarding traditional constructional considerations. The well established rules and design methods for facades, roofs or even terrace roofs don't apply anymore. New materials appear on the roof which are unable to provide a durable protection against the effects of weather. One example for this is the cladding of roofs with the same materials used on the façade.

These roofs are a manifestation of a rapidly spreading architectural trend, which propagates the total artistic freedom of the architect as a value in its own. This movement doesn't consider the building in its archetypical sense, but rather as an object, or even a statue, carved out of a single block of stone. The chief design method these architect use is the "magnification" of models and other small scale objects. The result is a homogeneous building where the distinct boundary between façade and roof disappears. The slope of the roof is chosen according to the visual appearance. Buildings designed with this magnification method inevitably demonstrate unconventional details and materials. {15}{15}{16}

As a result the building constructions of such buildings significantly differ from traditional flat, terrace, low slope and conventional slope roofs and façade constructions. Therefore I created a new and unique typological group for these constructions and named them as "**cladded roofs**".

This dissertation aims:

a) to determine the constructions that fall in the group of "cladded roofs",
b) to make an inventory of the characteristics of building with these kind of constructions,
c) to systematize the specific effects and impacts that affect them,
d) to categorize, evaluate and further develop the possible constructional solutions and details of "cladded roofs",
e) to analyse their behaviour over their life-span,
f) to propose new design methods and rules for the planning of such constructions.

II. Methods of research

The main sources for the research were:

a) the basic rules in the discipline of building constructions,
b) built examples from Hungarian and international practice
c) personal design experience
d) professional literature and regulations
e) analogies from other fields of the building constructions
f) my experience as a teacher at the Faculty of Architecture

The professional literature is limited at best, and the regulations are incomplete. Many acknowledged journals published thematic essays and even whole issues about the constructions of "cladded roofs", but solely from an architectural viewpoint. The relevant technical publications only deal with certain aspects of the problem. According to my knowledge a work that tried to systematize the underlying building constructional problems has not been published jet.

The buildup of my dissertation mirrors the stages of the real-life design process of building constructions for such structures. The titles of the chapters, the design phase they represent, their expected result and the used methods and sources are summed up in the next chart.

	chapter	design phase, expected result	sources, methods
1	**Introduction**	the definition of "cladded roofs" and their archetypes	examples from the international architecture
2	**Characteristics**	the "parameter-list" of the building: all the architectural and geometrical questions and choices of materials that affect the constructional decisions	personal design experience, examples form the international architecture and academic design projects
3	**Grouping**	conceptual constructions, brainstorming, the accumulation of the possible biggest number of solutions; the development of the various ideas with the possibility of error	built examples, general knowledge of building constructions, analogical examples
4	**Effects**	problem-identification, unique impacts, cataloguisation of basic considerations	academic design projects, constructional alternatives, professional literature
5	**Behaviour**	understanding of certain processes, determination of failure mechanisms, schematic figures, determination of the links between the individual components	analogies, professional literature, conceptual detail,
6	**Feasibility**	presentation of real-life design projects, resolving of the inconsistencies, cooperation with and control by the specialist designers, the evaluation of the design alternatives	personal design works, consultation with specialist designers
7	**Design**	design algorithm, the state of regulations, requirements in the choice of building materials with regards to their interactions	parameter-list, priority order, regulations
8	**Summary**	summary of conclusions, suggestions for further research	-

Chart 1: The buildup of the dissertation and its main sources

The dissertation was developed based on the combination of effects, requirements and performance in the design methodology of building constructions, thus its resting on previous scientific works carried out at the Department of Building Constructions {12}{14}, and it aims to further develop their results.

III. The constructional definition of "cladded roofs"

"Cladded roofs" are not pointless constructional experiments; they're an adequate answer to a challenge raised by contemporary architecture. The name serves to distinguish them from ordinary roof coverings, because the primary function of the cladding material is purely aesthetic, while the protection against rain, snow and wind becomes secondary, or it's completely guaranteed by underlying layers. We can speak of a loose set of constructions whose members are identifiable by the properties that make them different from conventional sloped roofs, flat roofs, terrace roofs and façade claddings:

"Cladded roofs" are parts of the building envelope that fulfil at least two of the criterions listed in the next chart:

A	**„homogeneous use of materials"**
B	**„ inadequate roofing material"**
C	**„ inadequate joints between roofing elements"**
D	**„uncustomary pitch"**
E	**„extreme long distance between ridge and eaves "**
F	**„lacking eaves"**

Chart 2: The criterions of "cladded roofs"

In chapters 1 and 2 of the dissertation I defined each of these criterions. Having given the definition for "cladded roofs" I will omit the quotation marks from now on.

IV. Summary of the new scientific result of the dissertation

I recognised that the new tendencies in contemporary architecture are causing profound changes in the field of building constructions. I was the first to introduce and define the group of constructions I named as "cladded roofs" {1}{4}{6}. Despite the huge variety of such constructions I've been able to determine the technical properties they all share.

1. I recognised and proved that the constructions I defined as "cladded roofs" are a completely new group in the typology of building constructions (chapters 1 and 2). {1}{3}{4}{5}{7}{9}

a) I reached the conclusion that currently used concepts used to describe building constructions are insufficient to define the problems that arose in the planning of cladded roofs. I therefore introduced the concept of the "parameter-list", and created its first experimental form. This freely extendable list is capable of describing the most basic properties of such constructions.

b) Comparing them with traditional flat, terrace, low slope and conventional slope roofs I proved that the requirements for cladded roofs differ significantly from any of these constructions.

c) Analysing their hypothetical long-term behaviour, I determined that cladded roofs function differently than conventional constructions. Therefore present constructional rules and guidelines can't be used safely in their planning, or only with significant limitations and care. Therefore I introduced new concepts to better describe the behaviour of cladded, e.g. the "multi-layer drainage of water", the "joint-type index" and the "on and a half skin, semi-warm roof", and demonstrated the benefits of their use.

2. Through hypothetical and built examples I proved, that the group of "cladded roofs" is not an empty category. They can be built safely, with currently available building materials and technologies, to satisfy every conceivable architectural idea and fulfil all technical requirements (chapters 2, 3 and 6). {6}{8}{10}{11}

a) Based on my inventions and the development of analogue examples I created more than forty constructional alternatives that can serve as a basis for the planning of cladded roofs with all possible cladding materials. (I present ten of these constructional alternatives with stone claddings, the rest and their detailed evaluation is given in the annex.)

b) Through examples taken from 50 renowned architects from around the world and 20 Hungarian projects I proved, that the structural alternatives I presented answer to an existing architectural need, their realization is possible and necessary, and the choice of the research topic was justified.

c) I demonstrated, with the help of four real-life building project I participated in, that the realization of cladded roofs is possible despite the unusual architectural requirements and choices of roofing material. But the prerequisites of a near optimal, and often innovative, solution are the thorough cataloguisation of the project's special parameters, the correct quantification of the requirements and the creative cooperation between the architect and the constructional designer.

d) I made recommendations for the solution of some of the complicated problems that arise at the design of cladded roofs. These problems include: "extreme long distances between ridge and eaves", "cladding fastenings that enable the drying of the construction", "geometrically independent waterproofings", "the imperfect substrate of contact-claddings", "roofs without eaves and snow guards", "fastening of the cladding against sliding-down", "quasi-contact claddings" and the "thermal insulation and waterproofing of curved surfaces".

3. I proved that the system of requirements now used in the design of building constructions doesn't contain all the necessary elements for the optimal selection of every component in a cladded roof. I presented a proposal for the expansion and actualization of this system (chapters 3, 4, 5 and 7). {2}{5}{7}{9}

a) I created a problem identification chart by summing up the lessons learned from more than 30 academic design projects I participated in as a consultant at the Faculty of Architecture. By developing this chart further I composed a list of the most important effects, emphasizing those, that only ocure on cladded roofs. (These include the "periodical water pressure", the "dynamic effects of rainwater", the "limited drying of the construction", the "woodpecker-effect" and the "cladding damage due to bending stresses".)

b) Studying the professional literature I compiled a list of those requirements that aren't properly regulated, need special knowledge that isn't widely available, presently can't be properly quantified or can only be determined with experiments or are hard to simulate. (I also enclosed a chart summing up the standards and regulations currently available.)

c) I present a separate chart for each functional layer and for each constructional alternative I created giving the specific requirements in their planning. I define every requirement and briefly summarize its purpose. I came to the conclusion, that in most cases no universal value can be given for the required performance of these layers and constructions. The values must be determined individually in each case by the designer according the concept he developed for the long-term behaviour of the construction.

4. I concluded and demonstrated that the method known as "the programmed design of building constructions" can be used successfully in the unique planning process of cladded roofs as well, and it can greatly contribute to the finding of the near-optimal solution (chapters 6 and 7). {6}{8}{9}{10}{11}

a) I demonstrated that the programmed design of cladded roofs can encounter certain difficulties. The database of the effects and requirements for building constructions is incomplete, not always accessible or not properly regulated. The morphological matrix is not filled up with all the necessary data, the number of possibilities is increasing at a fare greater paste than its possible to fill it up. The development of architectural trends is much more intensive and motivated than the constructional research work. The propagation of the database is a general economic and scientific task, and the necessary determination to carry it out is missing.

b) I concluded and demonstrated that not only stereotypical thinking and "early constrictions" can hinder the free design work, but also the regularization (both over- and under-regularization). These can reduce the number of possible constructions, especially unique and innovative ones.

c) I created a new algorithm for the planning of cladded roofs. I demonstrated that the use of a well-revised priority order, composed by the ranking of the parameter-list, can help significantly to increase the effectivity of the concept-forming. The unordinary parameters can cause both the increase and decrease of the strains on the construction, which can give ground for the choice of a new and more adequate solution. This new algorithm enables the objective handling of "deviant" building, and it puts the intuitive part of the design in the proper phase of the process, therefore it can be used in the planning of other unique types of constructions as well.

V. Areas for the practical aplications of the thesis' findings and further research

I'm planning to publish the results of my research in a book. Primarily the behavioural schemes and constructional alternatives I described and the actualization of the system of requirements can be used to help the work designers. The list of effects is also usable in academic education

Finally I must restipulate that the emergence of cladded roofs and the research into their constructional principles was motivated by a rapidly evolving architectural trend. This trend has not yet run its course. The tendency is that the building constructions of these contemporary buildings grow more and more unique; they can't be planned just out of routine. These unique tasks can be solved with the careful use of the thesis' findings.

I make recomendations for the further research work necessary (chapter 8). The most important of these are in the fields of building physics, building chemistry and fire protection.

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VII. List of personal publications related to the thesis statements

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VIII. References in the summary

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