Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: All tracks

The graduation plan consists of at least the following data/segments:

Personal information	
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Studio	
Name / Theme	Building Technology, Façade & Climate design
Teachers / tutors	Fred Veer (design) & Regina Bokel (research)
Argumentation of choice of the studio	I chose the building technology track because it is a combination between architecture and (sustainable) engineering and especially the (sustainable) engineering part was for which I was interested.

Graduation project	
Title of the graduation project	Fire resistance in a sun shading element, as a substitute for fire retardant glazing.
Goal	
Location:	Public buildings in Holland.
The posed problem:	Lack of integration of fire safety and design in architecture and the high costs of fire retardant glazing. But also the problems which occur when fire retardant glazing needs to be placed into the older frames of monumental buildings.
Research question:	How can sun shading be used as a fire retardant element, such that it will be a substitute for fire retardant glazing in public buildings in Holland?
Design assignment in which these result:	A sun shading element which also functions as a substitute for fire safety glass.

Sub questions:

- What are the criteria and specifications of the fire retardant element?
  - What are the current rules in Holland regarding fire resistance of windows?
  - What are the current criteria for fire retardant glazing and how does it work?
  - What criteria should the fire retardant sun shading element meet?
  - What is the influence of the distance between the element and the window?
  - What is the critical time in which the system has to close in order to prevent the window from breaking?
  - How to ensure that the system will close automatically in case of fire?
- Which materials will be used?
  - What kind of materials are best to use for the sun shading?
  - What kind of materials are best to use for the fire resistance?
  - What will be the influence of UV over time?
- What will be the durability of the element?
  - How is the price in relation to current fire retardant glazing and sun shading?
  - How to prevent malfunction, possible damage and wearing?

- What will be the performance of the sun shading element in relation to thermal comfort?

Process

Method description

To get to know the current relevant fire safety problems the Dutch Institute of Physical Safety and the fire department of The Hague are contacted to get insights in the current fire safety problems. Then a literature study will be done in order to get the basic knowledge about fire, fire development, fire safety and the current rules and regulations regarding fire safety in public buildings in Holland. Then a research will be done concerning current fire retardant glazing and other fire retardant products. For sun shading products also this study will be done. In these studies the materials, properties, the mechanism and the advantages and disadvantages are being discussed and used as reference. Also the lectures of the Civil Engineering course Fire Safety Design (CIE5131) will be studied and with this course a visit will be made to the Efectis Fire Laboratory in Bleiswijk and an official fire test will be attended.

After the research fire simulations in a small room (3.6 x 3.6 x 3.6 meters) and a large room (7.2 x 7.2 x 3.6 meters) are made in order to determine the optimal distance between the fire retardant shading element and the window. This optimal distance is important for the functionality of the element and to reduce the loss of space in the room. For this simulation the program Thermal Radiation Analysis (TRA) is used for simulating the heat radiation. The conduction and convection of the heat is simulated in the program TRISCO. Also a variation on the 4-16-4 milimeter glass is simulated in order to determine the effect of the thicker glass panes (6-16-6 milimeter) on the window and to determine the criteria of the glass for the program of requirements. If it is necessary also an internal heat simulation in the program Design Builder is made in order to determine the effect of the shading device on the room. The results of these simulations will be used in order to supplement the program of requirements.

When this is done, so after the P2, the design of the fire retardant shading element is further developed, in combination with a material study for the element and the mechanism. Also this mechanism for the shading element is developed and made into a prototype to see if it is working properly. Possible tests are done with (parts of a) prototype in a furnace in order to determine the temperature rise in the element and in the window over time, with the use of thermocouples. Also the mechanism of the element can be tested with the use of this furnace. Then a complete prototype of the whole element is made, and possibly tested and evaluated.

Literature and general practical preference

- Contact the Dutch Institute of Physical Safety to get to know the relevant and current fire safety problems.
- Contact the Fire Department of The Hague to get to know the relevant and current fire safety problems.
- Review the lectures of the Civil Engineering Course CIE5131
- Visit the Efectis fire laboratory and attend an official fire test with the CIE5131 course and U-base.
- General practice about:
  - Rules and regulations in Holland concerning fire safety design
  - Fire development
  - Fire safety
  - In general get to know more about fire safety in public buildings
- Literature study:
  - Fire retardant glazing, their materials, design, price and working
  - Other fire retardant products, their materials, design, price and working
  - Material study
  - Sun shading products, their materials, design and working
- Design research:
  - Simulation of the heat transfer of the fire by radiation on the fire retardant shading

element and the window in order to determine the optimal distance between the element and the window with the use of the computer program TRA.
- Simulation of the heat transfer of the fire by conduction and convection on the fire retardant shading element and the window in order to determine the optimal distance between the element and the window with the use of the computer program TRISCO.
- Simulation with variations on the glass in order to determine the effect of thicker glass panes.
- An internal heat simulation in the program Design Builder in order to determine the effect of the shading device on the room.
- Mechanism study in order to determine the best way to let the element close automatically (but not electrically) in case of fire.

Reflection

Relevance

To get to know the current problems on fire safety in buildings the research has to begin at the people who know most of fire safety and fire prevention, namely the fire department, the people who give training for firefighters and also the fire consultancies. Therefore the Dutch Institute of Physical Safety (de Witte, L) and the fire department of The Hague (Schotanus, W.) were contacted to get to know the current problems of fire safety in buildings. The result was an unequivocal answer; the difference between what is said on paper and thus in the theory of fire safety, and what is happening in reality. Also the smoke expansion through the construction and, in particular for architects, the lack of integration of fire safety and design are current big problems in fire safety in buildings. That is where the question about fire safety in sun shading has arisen. Architects are designing more and more with glass (façades). Because of all the glass sun shading is, besides the specifications of the glass, becoming more important to keep the indoor environment comfortable. With glass surfaces also the risk of flashover of fire via the outside will be higher. That is where the fire retardant glazing is playing an important role. The government as well wants more fire safety glass in public buildings like schools, daycare, hospitals and also in governmental buildings. Architects are looking for a substitute for fire safety glass, because this glass is relatively expensive in comparison to normal double or HR++ glass and not always wanted, especially in monuments where it will not always fit into the current frames.

Time planning

See the scheme on the 6th page.

References

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Time planning

Task / Week	P1 - Subject			P2 - Literature									P3 - Research & design									P4 - Design & prototype							P5 - Prototype & evaluate						
	44	45	46	47	48	49	50	51	52	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Searching subject																																			
Main fire problem																																			
Background																																			
Rules																																			
P1			10th																																
Fire safety																																			
Fire retardant glass																																			
Sun shading																																			
Simulation programs																																			
Simulation shading																																			
Simulation fire																																			
Efectis fire lab											5th																								
Course CIE5131																																			
Text report																																			
Reseach mechanism																																			
P2													22nd																						
Concept design																																			
Design mechanism																																			
Design element																																			
Material study																																			
P3																																			
Refine design																																			
Prototype																																			
Material order																																			
Build prototype																																			
Test prototype																																			
Evaluate prototype																																			
P4																																			
Refine research																																			
Refine design																																			
New prototype?																																			
P5																																			
Notes						sick			holiday																										

Table 1: time planning P1 – P5