Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan:

24 September 2015, week4.

Personal information	
Name	Lavinia Spruit
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Studio	
Name / Theme	Architectural Engineering - Seismic Studio
Teachers / tutors	Job Schroën (architecture tutor) & Martijn Stellingwerff (research tutor)
Argumentation of choice of the studio	The studio of *Architectural Engineering* offers the opportunity to focus on a personal technical fascination combining it in the process with a personal architectural interest. It allows to develop a better knowledge in a specific field of technological innovation in architecture. It is, in fact, my personal interest and aim to combine architecture and technology in order to develop an integrated design. More in detail, the choice of the *Seismic Studio* emerged from several considerations. It is important for me to address a current and real problem (one in which at the moment several parties are deeply involved) which is not only related to the Netherlands but can be viewed as a world-wide issue. Till 2011 I lived in the south of Italy where earthquakes are a tangible danger which arouses much fear and trouble. Nevertheless, excepted engineering solutions for concrete made buildings, the technological innovations in terms of materials in this field are rather poor. Much more interesting are the traditional building methods with massive tuff stone walls. Holland, on the contrary, does not have a building tradition that fits this new emergency. Earthquakes are a new problem for this country, and they require compelling architectural and technical solutions. Choosing this studio gives me the opportunity to focus on structural and material studies improving not only my knowledge in building technology but also in architectural solutions for urgent technical issues. As earthquakes represent a world-wide phenomenon my hope is that the knowledge I will acquire after this year will allow me to think critically about anti-seismic architectural design not only in the Netherlands, but all over the world.

Graduation project	
Title of the graduation project	Use of lightweight materials (Wood or Bamboo or Cardboard) for seismic areas / for a new Dutch antiseismic architectural design approach (at P1) --- Seismic proof laminated bamboo structures: an architectural and socio-economical restart in the Groningen area (at P2)
Goal	
Location:	North East Groningen
Problem statement:	Groningen has one of the largest gas fields in Europe. From December 1963 it provided gas for decades without creating serious problems. Since December 1991 earthquakes have become an increasingly frequent phenomenon in this area. Only in 1993 the relation between earthquakes and gas production was officially admitted by the local Dutch gas company NAM. While in general earthquakes are a natural geological phenomenon, the earthquakes in Groningen, by contrast, are induced and caused by the extraction of natural gas, causing a gradual subsidence of the ground level. Dutch economy and government finances rely to a large extent on natural gas winning. Since the 1960s it has generated a profit of more than 265 billion of euros, while over1200 billion m^3 of gas remain to be extracted. A research from the national bank ING shows that a 30% decrease in the natural gas winning will immediately cause a shrink of 5% in the economy, affecting that of Groningen in particular. However, these economical interests are causing major damages to the buildings of the area which are not built to withstand earthquakes. Researchers state that earthquakes will keep going on in the years to come. That is why an active approach is required to make sure that this area will not suffer an unavoidable shrink and to assure a good liveability for the inhabitants of north-east Groningen. Since this is a new problem for the Netherlands, until the present day, there was no building code available with directions for an anti-seismic building design. A new version of the building code, known as NPR, is now available and will be finalized at the end of 2015. Apart from those with a historic value a lot of buildings in this area have been demolished and more are going to be demolished in the future. This is due to the fact that in most of the cases the damage is too extensive and the value of restauration equals the value of demolition. Demolition is seen by various real estate companies as the tool to stop shrinkage and to increase the liveability of the area by increasing the quality of the new building stock. While some opinions say that the population in Groningen is shrinking and that there is nothing to do about that, a lot of people do not want to leave

	the area which is actually largely appreciated, among other things, for its typical landscape. This is why large-scale antiseismic solutions are required. Since 2012 a lot of damages have been reported to the NAM. While damage compensation and fixing is one way to operate, NAM is also encouraging and supporting new building projects with technical and financial support. While some inhabitants, collocated in temporary housing solutions, will return to their houses after renovation, for others alternative and permanent solutions are required. It is a call for architects, and not only for engineers, to develop a suitable approach and response to a similar situation. As said before, while earthquakes are very common in many countries around the world, it is a relatively new problem for the Netherlands. Although the seismic behaviour of the area is site specific, anti-seismic technologies and building methods are not a new topic worldwide in the architectural engineering field. Thus, looking at existing techniques might help to find a suitable approach for Groningen. However, the particular nature of the earthquakes in Groningen does not permit to merely copy those techniques. Most of the buildings in Groningen are built with unreinforced mansonry which cannot absorb the horizontal and vertical forces caused by an earthquake. Now, it is a well-known fact that the forces generated by an earthquake and affecting a building are directly proportional to its mass. The higher the mass value of a building the higher the possible damage that an earthquake can cause. Finding an alternative construction method, bearing in mind this main physic law provides an important clue for the development of a situation specific approach for the area.
Research questions:	**Thematic research question** • How to develop a new **antiseismic** design **approach** for **the Netherlands** using **lightweight** materials? • In order to answer this question several sub-questions have to be answered, to develop a better view on the situation. **Antiseismic** ○ Why and how can lightweight materials be a response for seismic areas? Newton formula (mass and accelleration) Vibration (seismic principle) Sustainability (less use of materials, reciclable, local…etc) Lowrise buildings vs Highrise … ○ How can lightweight materials be integrated with seismic resistant structure approaches?

	Shear walls and braces (which materials could be used for those?) Moment frames (which materials could be used for those?) Diaphrams (which materials could be used for those?) … **Approach** ○ What could be our toolbox for lightweight materials? Weight and massa Details Properties Thermal qualities … ○ Which are extreme (lightweight) solutions for earthquake resistant constructions? Bamboo, wood, cardboard constructions (architectonical qualities – different response to climate issues) ○ Which are the construction methods of the area and which are the requirements? Unreinforced masonry Thermal insulation Wind resistance Climate Netherlands … **The Netherlands** ○ How can we develop a methodology for an anti-seismic construction approach for NL? Developing a design strategy Demand and target group (housing and/or farms?) New architectural language … **Lightweight** ○ Which lightweight materials could be used and which of those performs better? *Bamboo* Wood Cardboard Steel ○ Which are the local materials of the area and which of those can we make local? Local and sustainable materials Vlas, agriculture Groningen, cardboard, textiel twente, ecoboard, rieten daken etc … ○ Which could be the connection methods and joints between those materials? Research by design **Overall design question** • How can an **antiseismic design** improve the **liveability** in North East Groningen and what could be the new model of designing buildings in the Netherlands?

	In order to answer this question, several sub-questions have to be answered **Antiseismic design** ○ What is antiseismic design? Review basic principles Configuration horizontal and vertical Capacity design … **Liveability** ○ What is the demographic situation? Shrink Young and old Investing in youth … ○ What kind of dwellings would be necessary? Housing and farms Needs and demand of people Qualities of the area (nature, space, landscape…etc) … ○ What kind of facilities would be necessary in the area? Needs and demands of the people … ○ How can the liveability be improved and which are the opportunities to carry that out? Ecological base and public estate (net positive design theory) Safety Uncertainity ○ How can a new design approach contribute to human confidence restauration in Groningen? Positive development ○ Why a net-positive design for Groningen? A relative rich area (golden mines of NL) Being better off ○ How does the architecture look like at the moment in Groningen? ○ How can antiseismic design be applied to the Netherlands? New solutions … ○ How does the NAM promote the new building designs in Groningen? New rules and financial support … ○ What will be the strategy? Research for further design
Objective:	The objective is to gain more knowledge about anti-seismic design approaches and find a way to apply those to the specific Dutch situation. Structural, material and architectural issues are here implied and therefore a good opportunity for technological building

	innovation, in particular for the area of Groningen. There is a need for an integrated, technical and architectural, solution for this area that may lead to a new way of designing buildings in this area of the Netherlands. In particular, looking at light-weight materials, as technical research field, can establish a new design approach for the area. Attempting to solve this technical and architectural issue will improve the liveability of the area in general and eventually be the key for a human confidence restauration.

Process

Method description

- Literature research
- Analysy of reference projects
- Analysis of specific material connections (wood, cardboard and bamboo… after the choice of the main material)
- Research by design
- Interview experts
- Interview inhabitants

Literature and general practical preference

Books

Arnold, C. (1982) Building configuration and seismic design. New York: John Wiley & Sons.

Ban, S. (2014). Humanitarian architecture. Aspen: Aspen Art Press.

Boer, M.d. (2014) Ontwerpen van gebouwen onder aardbeving belasting. Groningen: NEN.

Charleson, A. (2008). Seismic design for architects. Oxford: Elsevier.

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Eekhout, M. (2008). Cardboard architecture. Amsterdam: IOS Press.

Harris, T. a. (2001, January 16). How earthquakes work. Retrieved September 22, 2015, from

Kuma, K. (2009). Recent projects. Tokyo: Ada edita.

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Shahnoori, S. (2013). Sustainable reconstruction of houses in seismic areas. Delft: TU Delft.

Sumiyoshi, T. (1989). Wood joints in japanese architecture. Japan: Kajima Institute Publishing Co.

United Nations (1975). Low cost constructions resistant to earthquakes and hurricanes. New York:

United Nations.

Zwerger, K. (2011)Wood and wood joints. Basel: Birkhauser.

Internet sources

HowStuffWorks.com: http://science.howstuffworks.com/nature/natural-disasters/earthquake.htm

NAM platform feiten en cijfers: http://feitenencijfers.namplatform.nl

NAM platform Aardbevingen in Groningen: http://www.namplatform.nl/categorie/aardbevingen

NAM platform Aardbevingen door gaswinning: http://www.namplatform.nl/aardbevingen/ervaren-van-aardbevingen.html

Associations

Rijksoverheid: https://www.rijksoverheid.nl/onderwerpen/aardbevingen-in-groningen/inhoud/onderzoeken-aardbevingen-groningen

NAM: Nederlandse Aardbeving Maatschappij

Ontwerp consultatie Groningen: http://ontwerpconsultatiegroningen.nl

Reflection

Relevance

Anti seismic design approaches are a new topic in the Netherlands. By consequence, it is a new field of scientific research and technical innovation. There is a need to develop a new construction and design method for the area of north-east Groningen.

Studying light weight material connections may lead to sustainable technical innovative solutions for seismic design that could be also potentially translated to other applications or environments.

Focusing on the shrinking area of Groningen means dealing with an economical problem that causes material -and unmaterial- damage to the local population and requires a compelling architectural response.

Time planning