Academic year 2016 - 2017 #2 | June

MOLLIER I UNIT BPS I STUDENTS I ACTIVITIES I MEMBERS

Study Association Building Physics and Services

MOLLIER

Study trip South Korea

Robust net-zero energy buildings: How to evaluate

R.R. (Rajesh) Kotireddy, MSc

ATTA

Design of the innovative bio-concrete using

J. (Jonathan) Ezechiëls, MSc

SICK BUILDING SYNDROME STILL DIFFICULT TO DIAGNOSE



Foreword

Hester Thoen



Dear readers,

I would like to present the second INSide Magazine of the year 2017. Last half year has been a busy time for Mollier members, with many activities like excursions, lunch lectures and social activities. Thanks to your enthusiasm, the magazine keeps increasing in volume, so keep going!

As always, this edition has published a hold of the researches and activities carried out by the BPS unit. The two winners of the last BPS student day were willing to write an article about their research project. In addition, many other studies have been published, both by students, graduates and PhD students. Two of our sponsors have written an article about energy efficiency, a hot topic at the moment, through both smart sensors and energy exchange.

Last month, a number of students from our unit went to South Korea. They learned about the special culture, the rich history the country has and the business life on the other side of the world. For this edition, they have bundled their special story and jealous photos to give us a glimpse into their travel adventure.

Unfortunately, also this year we are going to say goodbye to some of our committee members. I would like to thank these editors for their enthusiasm and devotion and I wish them good luck on their final stages of their graduation. But after rain comes sunshine, which makes us hope for a beautiful summer, and we are looking forward to welcoming new members in our committee! If you like to participate in the INSide commitee, don't hesitate to contact us.

Enjoy reading!

Hester Thoen



EDITOR IN CHIEF

Hester Thoen

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3 -

COLOPHON

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Sound propagation in urban environments

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Consulting housing corporations using the Cost Optimality

method

ir. R (Robin) van der Sande

Supervisors prof. dr. Ir. J.L.M. Henser, dr. ir. M. Hamdy dr. ir. J.I. Torrens ir. T.V.J. Pastoor

INTRODUCTION

Sweco is continuously seeking to improve their business opportunities towards the market segment of the housing corporations. By starting a partnership with the TU/e via a graduation project, Sweco aims to further develop their business advisory on a multi-disciplinary field. A literature study and interviews conducted earlier revealed a desire for a decision support method based on the EBPD cost optimality method.

With natural resources depleting, the awareness for a more sustainable way of living is wide spread. Governments have set themselves targets to decrease the energy use and increase the share of renewable energy. The Netherlands has committed itself in 2020 to consume 14% of its energy from renewable sources. In 2013 it consumed 4.5% of its energy from renewable sources [1].

The built environment has a great potential to reduce the energy demand and increase renewable energy. Housing associations have large stock portfolios (26 million homes, meaning 11% of existing dwellings in the EU) [2]. Due to its size, they play an important role in the ambitious Dutch commitment.

In the Netherlands a significant part of the housing stock (30 to 40%) is owned by housing associations. These housing associations have inherited a complex social task to make their housing stock with limited funds future-proof in a pleasant living and working environment. Many housing corporations struggle with the preservation of their existing dwellings to many and very diverse reasons of technical, financial, social / governance nature.

METHOD

A good understanding of the current developments in the housing sector is important, as decisions to upgrade are not only financial driven.

Sweco values a verification on the studied literature. Over twenty experts from Sweco, housing corporations, and research institutes are interviewed, giving practical insight and input for the decision support method.

indings from the literature study on the developments in the housing sector, opportunities and threats are assessed by the interviewees enabling them to verify and co-create the SWOT analysis.

Sweco values information that improves their market opportunities towards the market segment of the housing corporations. How Sweco can strengthen their advisory is based on the SWOT analysis. The findings of the field study are not documented in this article.

Developing the decision support method begins when the challenges in the sector are known. The method includes housing concepts from a range of energy efficiency, costs, and scenarios.

xcel acts as the starting point, where data from other sources are stored in. Building performance simulation software predicts the hourly heating demand for each combination of energy saving measures under different user Θ climate scenarios (electric consumption of appliances excluded).

The System Advisory Model predicts the energy production of renewable energy variants and their costs. This is again stored in Excel where variants of household appliances are added, and the heating demand is converted using the corresponding SCOP values of the heating systems. Finally, the costs are calculated and economic scenarios applied.

Tableau extracts the result from Excel and displays it in a user friendly environment. A custom user interface gives displays the result in a professional and attractive setting.

CASE STUDY

Design variants: the performance of the decision support method is investigated by a case study. The reference building is chosen with care to represent a large part of the building stock. Nevertheless, the performance of the design variants rely on case specific details and the outcome should be weighed accordingly [3]. The reference building used in this project is developed by the Dutch state



Figure I. Scenarios



organization RVO. Its purpose is, among others, to help assessing the impact of building concepts and scenarios. The building of choice is the terraced house, as it is the most common building type in the Netherlands [4].

he reference building is analyzed on three design variables [6]: Building envelope options (3), heating system options (2), and renewable energy systems options (4). This brings the total number of unique design combinations on 24.

cenarios: social housing Scenarios: social nousing corporations, Sweco's clients, strive for steady expenses for their tenants. The target group of social housing corporations exists primarily of more economic vulnerable tenants. Their financial reserves are often insufficient to absorb fluctuating energy costs. If the energy prices are included in the rent, the risk falls down to the housing corporations. Assessing the design variants on user & climate scenarios provides an estimation of the risk. This study includes user scenarios (4), climate scenarios (2), and economic scenarios (9).

ost calculation: this study aims to give an estimation of the costs. A more accurate representation of the construction and maintenance costs requires a higher level of details on the building elements. The cost estimations derive from a market-based analysis extracted from Sweco and other sources. Costs that are equal for all variants, such as the purchase of the land plot, are excluded.

his study differentiates 3 types of cost estimations that derive from an earlier extensive study on cost optimality [5]:

- Investment costs
- Global costs
- Life cycle costs

RESULTS & CONCLUSION

he case study in this paper served mainly to shape the decision support method. Nevertheless, the case study's result can provide helpful insight in cost optimal solutions. A selection of result is showcased that enables Sweco to advise housing corporations in new design variants. The performance of the

design solutions can be measured in multiple ways. Measuring it by analyzing the global cost is common for cost optimality studies [5]. Investigating the global cost for this study point out the lesser insulated building envelope (Low) as the most cost optimal design solution.

or most scenarios, the energy efficient design variants have slightly higher life cycle costs. Whether it outweighs the considerable energy efficiency is for the housing corporation to decide. The performance of energy efficient housing concepts relies heavily on the energy subscription (EPF), which on its turn relies on net-metering. The method includes multiple scenarios to determine the effect of a change in the

feed-in tariff. The economic scenarios affect the business model, in particular the variants that affect the EPF. The combination of high usage scenarios and a low energy price with even lower feed in tariff has a significant impact on the financial performance of energy efficient design variants.

uture work: The decision support method is designed to minimize the user effort. It is possible to further automate the process. The System Advisory Model - which predicts the performance of renewable systems can be further automated with a script. During this study the applicability of such a script has been tested on a small scale prototype.

0 m² PV

25 m² PV

ASHF

GSHP.

0 10 m2 PV









- [1] Algemene rekenkamer, "Stimulering van duurzame energieproductie (SDE +)," 2015.
- [2] Buildup, "OVERVIEW Energy Efficiency in Public, Cooperative and Social Housing within the context of the Energy Union.," 2015.
- [3] J. Rammerstorfer, "Implementing the cost-optimal methodology in EU countries Case study Austria," BPIE, 2012.
- [4] Centraal Bureau voor de Statistiek, "WoningOnderzoek Nederland (WoON)," Den Haag, 2013.
- [5] M. Hamdy and K. Sirén, "A Multi-Aid Optimization Scheme for Large-scale Investigation of Cost-optimality and Energy Performance of Buildings.," 2015.
- R. Kotireddy, P. Hoes, and J. L. M. Hensen, "Optimal balance between energy demand and onsite energy generation for robust net zero [6] energy buildings considering future scenarios", Rajesh Kotireddy , Pieter-Jan Hoes and Jan . L . M . Hensen Unit Building Physics and Services , Department of the Built E," Proc. IBPSA Conf., pp. 1970–1977, 2015.



Ice Breaker Kristing Mues

ello! My name is Kristina Mues. I'm 24 years old and live in Vaals. Vaals is located in the south of the Netherlands where the borders of Germany, Belgium and the Netherlands meet. I have lived here my whole life and love the landscape, because it is so different from the rest of the Netherlands. My native language is German. My parents moved to the Netherlands after my graduation from the RWTH Aachen. Due to the fact that I have lived in the Netherlands my whole life, I feel more like a Dutch person than a German.

urthermore, I have one older brother who is studying social work and is planning to move to Sweden after his graduation. We also own three dogs, one of which is mine. Because we always have had dogs, cats, birds and other pets I love animals and think it is too quiet when they are not around.

hen I was younger I regularly played The Sims and always enjoyed to build houses in this game. This was the start of my interest in the built environment. My high school time started at preparatory secondary vocational education (VMBO), where I graduated in 2008. After graduation I decided to get a higher education and I continued at the same high school with higher general secondary education (HAVO). After graduation in 2011 I was interested in art and interior architecture. So I decided to start at the Maastricht Academy of fine arts and design. Soon after starting I realized that this wasn't my thing. Because the subjects were very vague I realized I missed some exact subjects. After orientating and still being interested in interior architecture I decided to study building engineering at ZUYD university of applied sciences. Here I attended some lectures about building physics and services and immediately felt that this subject fitted me. So I did an internship at ARCADIS at the department of building physics and services where my interest in this discipline only got bigger. Because the study



Figure 2. My dog Daisy

building engineering had a wide scope I felt like I did not know enough about this specific discipline. So I decided to learn more and chose to start my premaster here at the TU/e.

really enjoy studying here and love the ambiance and people at the TU/e. I also joined the student dance association Footloose here in Eindhoven where I take Salsa and Zouk classes and participate in a lot of activities. Furthermore, I really love to go on hikes with my 8-year-old dog who is always there to brighten up my day. I also like to play online games in my leisure time. By gaming I met a lot of people and have made some really good friends around the world. For instance, one of my best friends lives in the United Kingdom and last summer I went to visit him with some friends.



Figure 1. Me together with my dog Daisy



Figure 3. Visiting one of my best friends in the UK



Deel je onze passie?

Wij hebben passie voor installatietechniek. Omdat klanten (zoals TBI, Engie en Unica) met onze design software prachtige 3D-modellen maken. Het resultaat: spraakmakende gebouwen in binnen- en buitenland. Als product manager, software engineer of BIM-consultant ben je meer dan een klein radertje in het grote geheel – je doet ertoe vanaf de eerste dag.

Meer weten over je mogelijkheden? Neem contact op met onze recruiters Tim Blok & Denise Pet (jobs@stabiplan.nl of 0172 65 02 65) of kijk op www.stabiplan.nl/jobs.

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Mollier Calendar Past events

BOWLING Bowling with Richard! In order to get to know each other, Mollier hired a whole bowling room for its members. A nice blend of old and new people were present to bowl and have some fun. In the end we finished with a beer in the city center.
SINTKERSTBORREL The classic SinterKerstDrink was held the 22nd of December! With the old an new faces of Mollier we had a great time, eating pepernoten, kerstkransjes and other candies.
LUNCH LECTURE #3: STABIPLAN & BAM The 13th of December Stabiplan and BAM joined us for the third lunch lecture of this academic year. The 30 people in the room made a great audience.
The first lecture began with Tim Blok, who explained the core business of Stabiplan. Stabiplan develops software for the services market, but in order to do that it also needs input from the market itself. This is where Roger Fuchs comes in. Roger Fuchs told a detailed story about his work as a product developer. Which is much more than only programming. He is the spider in the web of technology, the product and the client, which he has to manage all three in order to make the product future-proof. The second lecture was from BAM. First Matthias Weide talked about BAM as a company in general, which is much more than only a construction company. All facets of the building process are represented within the company. Eva van Enk continued the presentation, explaining her work with the department of Energy Systems. Projects she is working on are for example upgrading sustainable building concepts, smart grids and problem solving for clients.

DECEMBER

TVVL - JONG PROFESSIONALS VERENIGD BUSINESS FESTIVAL 2017

The morning started early as the festival kick-off was around 08:00. This kick-off keynote speech was held by Thomas Rau, who talked about the Universal Rights of Materials. An interesting story in which the use of materials in our current society was evaluated and the way this could/should change in the

future. Throughout the rest of the day, several other speakers talked about the implementation of big data (Strukton,) the use of virtual reality in the built environment, the future and challenges of social robots and many other interesting and thoughtful subjects.

Parallel to these presentations, there was also the possibility to drive in a F1 simulator, experience virtual reality with the Microsoft Hololens and the Oculus Rift, to



make your own electronical battery eater shaped like a doggie or just chatting with likeminded people.

The day ended with keynote speaker Martijn Aslander, stand-up philosopher and creative mind. A talk about using no money to get things done, avoiding bureaucracy and organizing things faster and more efficient. In the end, our own David went home with a signed copy of Thomas Rau's book for the best question asked.

FEBRUARY

MEET & GREET

Master students in all phases of the master attended the Meet & greet. This year, 16 of our partners were present, which is the largest number of companies ever present at our annual career event.

The event started with a pitch session. All company representatives introduced their company to the public in a pitch of 2,5 minutes. After half an hour the introduction was over and the Meet & Greet

could start. The first couple of minutes the students were a bit reluctant, but after the first daredevils introduced themselves to company representatives, many followed. In no time, lots of interaction was visible which lasted until the end of the afternoon.

The committee received lots of positive reactions. It was a useful, informative and sociable event. We are proud to call the event a success! Many thanks to all the participants, companies and of course the Committee!



BEERPONG BATTLE ROYALE

Winter finally came and the beerpong battle royale was held in the Skybar. Many brave members of KOers and Mollier have witnessed sights no ordinary man could withstand. Many glorious battles and brilliant duels were fought. Both sides have claimed righteous victory with great honour and suffered losses. Among the members it was Mollier who deemed ice cold ultimate victory and settled the score with 12-10.

The battle of the titans was fierce and exhilarating, it required extreme vigor and extraordinary endurance and tested the patience of both KOers and Mollier. This battle reached the ultimate climax when both sides remained still standing with one cup for twenty turns. However the fate was not on our side and the tide grievously turned to KOers which ultimately claimed this victory with their extreme tensile strength. A tradition is born.



EXCURSION DOORNROOSJE

Together with CHEOPS, Studievereniging Bouwkunde, Mollier organised a trip to one of Netherlands' most interesting music venues. One of the main goals of the trip to Doornroosje, Nijmegen, was to introduce bachelor students to the world of building physics in practice and show them where architecture meets our field of expertise. Within the 28 participants of the excursion there was a perfect blend of bachelor students and BPS master students.

The excursion started with a presentation from the architect, who explained the problem around the logistics of the place. Another presentation was given by Peutz, who were most of all involved in the acoustical part of the project. Many aspects needed to be taken into account like, for example, the vibrations from the trains driving by, vibrations from the pop podium towards the student housing and the large peak loads of ventilation during concerts. After the theoretical part, we had a tour through the building.



MARCH

LUNCH LECTURE #4: KUIJPERS / NELISSEN

The 7th of March Kuijpers and Nelissen joined us for the fourth lunch lecture of this academic year. The expectations were around 20 people, but eventually we had a room full with 30 people. The first lecture began with Rowan de Nijs, an alumnus of our study, who explained all about his position as tender

manager with Kuijpers. Within his role he coordinates different disciplines within the building engineering field and strives to win all tenders Kuijpers signed up for.

The second lecture was from Nelissen. Ivo de Visser, also an alumnus, talked about an interesting building physics project called 'het huis met de hoofden', freely translated: 'the house with the heads'. Interesting solutions were found for ventilation and the positioning of the technical room.



COCKTAILPARTY 4.0

our years in a row now. The cocktailparty is becoming a tradition! A lot of people showed up and we had a great time enjoying the lovely cocktails, the cake, pinatas and the candy.

CRASH COURSE VAN HOUT

A crash course was given by Van Hout explaining the benefits and use of the program RETScreen. RETScreen is a financial analysis program for the implementation of renewable energy technology in buildings. Koen van Heeswijk (Director at Van Hout) first gave a short introduction about the company, how they use RETScreen and implemented the program in their projects. After this introduction, Joop Neinders (Director of IBTH B.V.) gave an explanation of RETScreen and why this tool is such a valuable asset in the early stage of a project.



A fter all this theory about Net Present Value, Cashflow, Return On Investment and a lot of other financial parameters, we went hands-on with a case-study in RETScreen ourselves. A simple case of implementing PV panels on a dwelling appeared to be complex to get it financially viable. This simple case gave us an insight in what some financial parameters can do with the viability of a project.

LINKEDIN TRAINING

On tThe 30th of March Mollier organized the annual Job application training together with Voort. Deborah Dielis and Luuk Peeters took us on a trip of two hours, talking about the process of getting a job. Several issues were discussed with the participants: What are the right questions at the right moment? How can you ensure yourself of an invitation? And of course, tips and tricks for your LinkedIn account and CV. Hopefully we will see them again next year!

EXCURSIE PEUTZ

Thursday the 23th of March, Mollier is invited at Peutz to visit their laboratories in Molenhoek near the German border. After a train ride of one and a half hour, the group of 15 people found themselves at an abandoned train station in the middle of nowhere, a 5 minute walk from Peutz' experimental area. At arrival a luxurious tea table was waiting for the participants, which was arranged very well. The afternoon started with a short introduction of the director, Casper



Esmeijer, and three additional presentations about Peutz in general, the laboratory and work within the company. The first presentation was given by Albert Alders. The presentation took us along many projects within different disciplines. The last two presentations were about working within the company. One of these presentations was given by Manon Derks, an alumnus of Mollier. This last presentation was most interesting because of her insight in Peutz and the link with our master.

A fter the presentations we had a small break, which was followed by the visitation of the laboratories. We visited two climate chambers, three interconnected rooms for acoustical measurements, an anechoic chamber, the model room with different scale models for acoustical measurements, the pyrotechnic oven, the fire safety laboratory and the wind tunnel.



APRIL

LUNCH LECTURE #5: ENGIE

On the 4th of April ENGIE, one of our main sponsors, joined us for the fifth lunch lecture of this academic year. Around 35 people participated in this lecture. Elke Klaassen started with a short introduction of the company. After that she told an interesting story about smart grids, her part in this new concept and 'Energy navigator', a performance monitoring system for HVAC and other services in the build environment.

SCHOONE LEI SPRING ACTIVITY

Saturday 29th of April our alumni association held their yearly Spring Activity. Several Mollier members and a lot of just graduated students joined this activity. The day started with a canoe trip of 8 km over the Dommel. Luckily, none of the canoes flipped over and we all stayed dry, which was quite a achievement if you know that there was quite some competition along the way and some teams even finished backwards.

A round 18:00 we went to Scouting Angelo Roncalli to finish the day with a nice BBQ and a drink. Sitting next to an enormous fire pit, a lot of memories were exchanged and the new Schoone Leij members were announced (getting their official Schoone Leij pin). Somewhere late during the night (or early in the morning) the enjoyable day was ended.



MAY

STUDYTRIP 2017 - SOUTH KOREA

This year's study trip went to South Korea. A group of 20 members has done many different activities, both culture and study-related. For the full story see page 26 .



BEERTASTING 2.0

Mollier went beertasting again! We can look back at another amazing edition of the Beertasting activity. Our vedettes Jelle and Dennis have outdone themselves organising this event. The two special beer tours were refined and exquisite as one would expect of a Mollier beertour. Marissa's headquarter was packed with many Mollier faces who were put to the test literally. Their knowledge of Mollier was tested via an awesome Mollier Quiz, which was ultimately won by our former Treasurer. Congratulations Wies!



LUNCH LECTURE #6: VALSTAR SIMONIS & FELLOW FSE

The 23rd of May, Peter van Mierlo (Valstar Simonis) and Ricardo Weewer (Fellow FSE) joined us for the sixth lunch lecture of this academic year. The talks were interesting which was visible in the amount of questions the audience of around 30 students asked afterwards.

Peter van Mierlo, an alumnus of our master, prepared a lecture about the Atlas building (which is commonly known as the main building of the TU/e campus). Valstar Simonis was involved during the renovation, developing the installations of the building. This also included all sensor equipment and the smart facade of the building.

Ricardo Weewer, a lecturer at the national fire academy and former fire fighter, prepared a lecture about fire safety and the importance of research into this topic. Buildings are changing due to regulations and sustainability which means different fire fighter techniques need to be explored and examined. Ricardo mentioned interesting experiments on small and large scale.



Did you miss some of the events and/or are you interested in some more information about a company or any event we've organized so far? Than stop by at floor 5 of Vertigo (colloquium room side), the Mollier booth at the 2nd floor or ask the present board for more information.





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Five questions for Thomas Thunnissen, Heijmans

Author M. (Mandy) Snijders

BESENSE, THE DIGITAL GOLD

BeSense is a smart sensor system cooperation with cleaning company CSU and sensor manufacturer Clickey. The sensor collates data in buildings. An analysis of the data leads to better management, maintenance and comfort. A talk with Thomas Thunnissen, Project Manager Innovation at Heijmans, about digital gold. "The possibilities of BeSense are enormous."

1. Heijmans is deliberately pursuing the crossroads of construction, IT and hospitality management. Why?

An office building was once a collection of elements comprising facades, a roof, floors. Interior decorators furnished the building. Who the end-

users were or what they required of their workplace was irrelevant. Heijmans is turning this around, because it's all about people. We place people at the centre of what we do. The building may be beautiful but it is merely a shell. Our aim is to make a building as comfortable as possible for its occupants. A healthy, pleasant and clean environment increases productivity. Above all, it befits a good employer.

Through BeSense we collect relevant data about user behaviour without actually knowing the user. Anonymity is guaranteed. This information is the basis for sustainable building management, maintenance and hospitality management, but it also provides



insights and data that we can use for renovation or for new-build projects.

2. What data do you collate – and how?

We make use of sensors that we initially mount on desks. It is also possible to mount them on walls or ceilings. All sensors have a unique ID number. The sensors are connected wirelessly to a software system. They



Figure 1. Thomas Thunnissen, projectmanager Innovatie bij Heijmans



continually measure things that we find important: room occupation, temperature, CO2 levels, light intensity and humidity. Analysis of that data provides valuable insights. Examples? You discover that a room which is heated day and night is only occupied twelve per cent of the time. Or that there is a disturbingly high CO2 level in meeting room X, which undermines the concentration. Or that the east facade is by far the most favoured – and the reason why. This knowledge enables you to make strategic proposals to companies. That is pleasant for the building manager, the employer, the staff but certainly also the cleaners because they can then organise their work more efficiently.

3. What is the role of Heijmans in BeSense?

We are the initiator, connector and directing partner. Construction knowledge is indispensable, but we cross-link it with the Internet of Things (IoT). In other words: we enable buildings to exchange data with sensor networks and integrated IT systems. A pilot project of BeSense was started in June 2016 at the head office of Aegon in The Hague, which houses 2200 workplaces. We have already gathered substantial knowledge, but still continue to learn.

4. What knowledge have you already acquired?

ne of the most important insights: not only start-ups are flexible and innovative in their business model. It could also apply to two large organisations. It is about people being able work together, but emostly about sharing the same beliefs and commitment. The agreements that Heiimans and CSU have about BeSense do not cover more than a piece of A4-sized paper. Legal attachments are lacking. It all boils down to trust, whereby collegiality of everyone involved surpasses even the corporate boundaries. You see each other as colleagues, not as business partners who each have different interests. There is a shared will to win terrain together. That is how you also stand united at an exhibition.

A nother lesson: dare to say goodbye. We have already said goodbye to one party. They did not share our pace, resulting in a delay of the product development. That's when you then need to make decisions.

5. Big future?

n five years' time we will be one of the Top 5 platforms for integrating, reading and managing software. In short, yes, we expect that BeSense will become big. The time is ripe. The Internet of Things marks the start of the sixth Kondratiev wave - the Industrial Revolution at the end of the eighteenth century was the first wave. The IoT is already providing interesting applications, from speech and image recognition to intelligent climate control. Is data the new gold? No, the real gold is the interpretation. We have the knowledge to make good analyses. Heijmans and CSU are dreaming often and out loud about future developments. We share the belief in the IoT. If substantiated, belief is controlled freedom to do whatever is necessary to achieve success.



Werk jij met ons aan de volgende markthal?

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Ga jij de uitdaging aan om ontwerpvraagstukken over energiebesparing, duurzaamheid en een comfortabel binnenklimaat in gebouwen integraal aan te pakken? We zijn op zoek naar enthousiaste stagiairs, afstudeerders en nieuwe collega's die hierover met ons willen nadenken! Bij Techniplan Adviseurs lever je een bijdrage aan duurzame en innovatieve bouwprojecten en werk je integraal aan de advisering op het gebied van techniek in gebouwen en de gebouwde omgeving. Ook zijn er mogelijkheden voor een duaal traject, waardoor je al tijdens je studie praktijkervaring kan opdoen.

Geïnteresseerd? Neem dan contact op met Esther Gerritsen (tel: 010-4562311).

heijmans

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Sound propagation in urban environments

Author ng. W. (Wouter) Reijnders

Supervisors ir. P. (Pagán) Muñoz, MSc dr. ir. M.C.J. (Maarten) Hornikx

INTRODUCTION

n this research, an experiment has been conducted to obtain high quality acoustic impulse responses in a real urban scenario. The aim of this research is to investigate if the used experimental method is suitable for urban outdoor environments. The results also indicate that the engineering prediction methods used for calculating noise maps in European cities like the Nord2000 model, the Harmonoise model and national regulations (Reken- en meetvoorschrift geluid 2012) underestimate the noise levels in canyon-type streets when the main noise source is shielded.

METHOD

he excitation and recorded signals are not synchronized during the execution of the experiments. The impulse responses are measured at 19 positions along the streets, as shown in Figure 1. Each position consists of 16 microphones placed in the crosssection of the street, creating a slice of the street-canyon. The measurements were conducted in the city centre of Eindhoven at the corner of the Hooghuisstraat and Rechtestraat, where a typical European canyon-street-type configuration was found. The sound source was placed in Rechtestraat to have some shielded recording positions in Hooghuisstraat, as was intended.

RESULTS

igure 2 shows two impulse responses and two energy time curves from sound pressure recordings. The latter are obtained by normalizing the logarithm of the squared impulse response to its maximum value. The positions shown in Figure 2 correspond with a line and a non-line of sight source-receiver configuration, line 7 and 18, respectively. It is interesting to see the difference in shape between both impulse responses, the shape can be



Figure 1. Schematic measurement location and dimensions. The four circles in a row are measurement lines numbered from 1 to 19 (only 1, 7, 8, 18 and 19 are indicated in this figure). The source is located 20 m away from the corner and line 8 is located 2 m away from the corner. All distances are in mm.

seen as energy distribution. A closer look into the energy time curves shows how the main reflections arrive in the beginning of the distribution for the line of sight configuration, while in position 18 the main energy arrives at a later time. Therefore, if a prediction method only computes the first order reflections, the sound pressure level is systematically underestimated in non-line of sight configurations.

CONCLUSIONS

his research has shown that the used measurement method is suitable for measurements in urban environments, even for distances up to 90m (line 19). On the other hand, the results of this work probe that, in urban configurations with canyon-type streets, the main sound energy is not arriving in the first part of the impulse response in non-line of sight configurations. This means that the most significant reflections arrive at a later time and, therefore, the prediction methods that do not consider enough number of reflections underestimate the sound levels when calculating the noise maps.



Figure 2. Impulse responses and energy time curves from the octave band of 2 kHz. Upper: measurement line 7. Bottom: measurement line 18. Both measurement lines are numbered in Figure 1.

 Regeling van de Staatssecretaris van Infrastructuur en Milieu, van 12 juni 2012, nr. IENM/BSK-2012/37333, houdende vaststelling van regels voor het berekenen en meten van de geluidsbelasting en de geluidproductie ingevolge de Wet geluidhinder en de Wet milieubeheer

Sverige, vänaste land uppå jord

Author L. (Lenny) Menner

ej hej! Since January this year I'm studying for one semester at the Kungliga Tekniska Högskolan (KTH) in Stockholm. Everyone knows the typical image of Sweden: their outdoor life and magical nature, their awareness of fashion, their knäckebröd and of course Ikea, H&M, Spotify, and Volvo. Even before I went, I had high expectations of this country. Let's find out whether this is appropriate.

TH accommodation offered me a room somewhere in a village thirty minutes travelling from the city center of Stockholm. It's really hard to get housing in Stockholm on your own, so I was happy that at least I had a roof over my head. Eventually it turned out to be the best place I could ever dream of! We're with many international students living here, so there is always something going on. Soon I found out that the village, Tyresö, is very close to Tyresta national park. In my spare time I like to go running, and having a national park this close is every runner's dream! For me it's the perfect combination between city and nature. To experience nature in a way you don't find it at many places in the world, I went to Lapland with my friends from here. We did many amazing things (my advice if you ever want to go: leave the ice-fishing behind...) and we even saw the northern lights!



Figure 1. Northern lights in Kiruna!



Figure 2. Dog sledging

While I'm writing this, the days in Sweden are getting longer than in the Netherlands. And although the lakes are still frozen, the sun is shining a lot and there isn't much rain. They say that Dutch people always talk about the weather, but in my opinion it affects the Swedes even more. In January and February the sky was very grey and it seemed even darker than usual. In these days, there was no one in the streets. How does this happen while Stockholm is called the "party city" of Scandinavia? However, this differs as much as black and white when the sun starts to shine. People even greet you kindly with a small nod! No, they still don't say hi. But however they are cold from the outside, they are very warmhearted people.

Generalizing is not the most charming thing to do, but writing a book about every single one is not where my interests lie either. So generally I would say that Swedes are also proud people. It started with Carl Linnaeus, who thought that he could grow tea plantations in Sweden. And nowadays there is a Swedish flag in front of many houses (are you serious, we're in Sweden?). But of course their pride is in place, because it is a really good country to live in and they are all so well-dressed! I've also never seen a fight or something like that, only a small disagreement. They are actually so polite that they wait in line for the bus when it isn't even there yet!

Besides getting to know the Swedish culture, I also learn a lot from the people living with me. Out of the 45 students there are 22 different nationalities! On a regular basis we have theme dinners. Then we can taste food from all over the world, hear music from all over the world, and try every kind of alcohol. Going on an exchange certainly enriches your world and, I know they always say this, it is a priceless life experience!



Figure 3. Theme diner

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ENGIE bestaat in Nederland uit ENGIE Energie, ENGIE Services, ENGIE E&P, ENGIE Fabricom en ENGIE Laborelec. Wij zijn het bedrijf dat voorop loopt in de energietransitie en dat, dankzij innovatieve en duurzame energieoplossingen, de energietransitie ook echt waarmaakt. Wij geven richting aan deze verandering en helpen klanten (bedrijven, instellingen en consumenten) om de stap van een fossiele naar een 100% duurzame energiehuishouding, en tevens de beweging naar decentralisatie, zo snel en zo kostenefficiënt mogelijk te maken.

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Onze specialisten hebben een passie voor techniek en zitten vaak al in de conceptfase bij de klant aan tafel. Naast het ontwerp en het realiseren van de technische installaties, beheren en onderhouden we als geen ander de installaties van onze klanten: het totaalpakket is bij ENGIE in goede handen.

Markante projecten zijn hiervan het resultaat: de warmte/koudeopslag op het Oosterdokeiland in Amsterdam, de aanleg en het onderhoud van de installaties in de Beneluxtunnel, en de bekabeling van baggerschip Vos Maxima. Wij werken voor allerlei klanten zoals; Heineken, Schiphol, Shell en Rijkswaterstaat. Geen dag is hetzelfde – dat is typisch ENGIE. Samen werken we met plezier aan het eindresultaat en daarbij aan het behoud van onze klanten.

ENGIE. Ver vooruit in duurzame technologie



Robust net-zero energy buildings: How to evaluate robustness?

Author R.R. (Rajesh) Kotireddy

Supervisors prof. dr. ir. Jan Hensen dr. ir. Pieter-Jan Hoes

INTRODUCTION

ew buildings should be nearly zero energy from 2020 as per the recast of EU directive on the energy performance of buildings. To meet this target, the Netherlands set national targets to achieve 45-80% energy saving in the built environment and zero energy new buildings from 2020, i.e. an energy performance coefficient (EPC) of zero [1]. This is typically achieved by improving building insulation levels, using energy efficient technologies and integrating renewable energy systems in the built environment. Considering the great social and economic efforts required for the implementation of these measures in the built environment, it is important to ensure net-zero energy buildings (NZEB) delivers intended performance over the building life span.

WHY RUBUST DESIGNS?

In the current design practice, building performance is predicted considering fixed assumptions about building operation. For instance, in EPC assessment, fixed (average) assumptions regarding occupant behavior such as set point temperatures, internal heat gains etc. are considered for energy performance predictions to label the buildings. However, many uncertainties in building operation and external conditions such as occupant behavior, climate change etc. influence the building performance, which cause variations in energy use, operational costs and thermal comfort. The impact



Figure 1. Example of variation in predicted overheating and costs of a NZEB design due to uncertainties in building operation and external conditions compared to fixed (average) assumptions



Figure 2. Performance robustness assessment methodology considering multiple performance indicators and their corresponding robustness

of these uncertainties is very high in low-energy buildings [2] resulting in the so-called performance gap between predicted and actual performance [3]. For instance, it can be seen from below example (Figure 1) that uncertainties in building operation and climate change could lead to large variations in predicted overheating and net-present value (NPV) of costs of a NZEB design, compared to fixed assumptions based on average occupant behavior and reference NEN5060 weather data.

These uncertainties lead to higher risk of overheating of about 364h and incur additional costs of about 30K€ compared to average assumptions. To reduce the impact of these uncertainties, it is essential to assess the performance robustness of NZEB considering these uncertainties and should be included in the design phase to ensure intended performance in the future. The probabilities of occurrence of these uncertainties are usually unknown and hence scenarios are used for performance robustness assessment.

WHO IS INTERESTED?

Dolicymakers can use performance robustness to define energy performance requirements in future building regulations to safeguard intended policy targets. They can also define policies to support adaptations of current buildings to improve their performance and extend their life span. Similarly, performance robustness is a relevant concern for homeowners, to ensure their preferred building performance over the building's life span. Energy performance contractors can benefit from performance robustness assessment by reducing the performance gap between predicted and actual operation. Similarly, by considering performance robustness, building designers, contractors and component suppliers can design and deliver more robust buildings, thus guaranteeing the satisfaction of their customers.

Table 1. Different NZEB designs considered in this case study

Design variant	Design-1	Design-2	Design-3	Design-4	Design-5
Rc, m ² K/W (Floor/walls/roof)	3.5/4.5/6	6/7/7	5/7/8	6/8.5/10	10/10/10
Windows(U), W/m ² K	1.43	1.01	1.01	0.81	0.55
Infiltration, dm ³ /sm ²	0.625	0.4	0.4	0.15	0.10
	Ener	gy and storage	systems		
PV system, m ²	28.8	24	19.2	14.4	9.6
Solar DHW system, m ²	5	5	5	2.5	2.5
Battery, kWh	12	10	8	6	4
Investment cost VC	31	33	32	30	32

HOW TO EVALUATE ROBUSTNESS?

In this research, a computational methodology is developed for assessing the performance robustness assessment of net-zero energy buildings to identify robust designs [4]. The developed methodology comprises multi-criteria performance assessment and multi-criteria decision making considering multiple performance indicators and their corresponding robustness (Figure 2). This methodology consists of the following steps:

- Stepl: Identify decision-maker (DM) preferences and define the building design space, future scenarios and performance indicators based on DM preferences
- Step2: Set up building performance simulation model and simulate the performance, based on the defined performance indicators, of the design space for all future scenarios
- Step3: Carry out multi-criteria performance assessment considering multiple performance indicators and their corresponding robustness evaluated using a robustness assessment method. This multicriteria assessment enables different DM's to choose robust designs from a large design space based on their preferred performance indicators
- Step4: Select robust designs for DM by prioritizing the performance indicators based on DM preferences

he developed methodology is generic and can be used for performance robustness assessment in holistic approach for both new buildings and renovations and also for robustness assessment of individual systems such as HVAC, PV, Solar DHW systems etc. This methodology is very useful when different stakeholders are involved in a project with multiple performance requirements and it is also effective in identifying a robust design from large design space. In this article, due to space constraints, it is demonstrated how a designer can use this methodology to identify robust NZEB design among five design alternatives for a homeowner.

ROBUST NZEB: DEMONSTRATION FOR HOMEOWNER Step 1: Identify homeowner preferences and define design space, scenarios and performance

indicators. omeowners prefer a robust design that delivers a comfortable indoor environment with low operational and investment costs. Overheating hours based on adaptive temperature limits proposed by [5] is used for thermal comfort assessment and the total cost that include investment costs, replacement costs, operational costs and maintenance costs is used to assess financial implications of design. Fixed costs such as land, labor etc. are not considered in this study. These costs are calculated for a 30-year period and discounted to get net-present value (NPV) considering inflation rate and real interest rates.

The design space is defined based on the requirements of DM and the current and future building regulations such that the preferred design by a DM will also meet the criteria of building codes and regulations [6]. The design

Table 2. Future scenarios considered in this case study

space is defined, as shown in Table 1, by varying passive building design parameters such as insulation levels, airtightness, window type etc. These envelope properties meet requirements of Dutch current building standards (design-1), Dutch zero energy building standards (design-2 - design-4) and a passive house standard (design-5). Energy and storage systems such as PV, solar DHW systems and battery are added to these designs to make them NZEB. All these designs are equally good, for instance, a design can be a NZEB solution with very low energy demand and corresponding small energy generation system (design-1) as well as with relatively higher energy demand and larger onsite energy generation system (design-5). However, the optimal NZEB design can be selected based on the robustness of the design [4].

Scenarios need to be defined considering all uncertain parameters that can cause variations in the building performance over the lifespan. Hence, scenarios are formulated, as shown in Table 2, considering different household size (referred as occupant scenarios) and the wide range of the possible use of a building (referred as occupant behavior) over building lifespan, external conditions such as weather considering reference weather data and climate change (referred as climate scenarios) and policy changes (referred as net-metering scenarios). The combination of all these scenarios need to be used for performance robustness assessment as the likely occurrence of any scenario in the future is unknown. However, to reduce computational time, scenario sampling is carried out using uniform Latin hypercube sampling (ULH) method and a ULH sample of 100, the smallest sample that results in similar performance as all scenario combinations, is considered in this study.

Scenarios		Units	Min	Max
Occupant scenarios	Ť	[-]	1	4
	Ō	[-]	Working	Retired
	J	[°C]	18	22
	A	[L/day/p]	40	100
Occupant behavior	9	$[W/m^2]$	1	3
scenarios	Q	$[W/m^2]$	1	3
		$[W/m^2]$	200	350
	H	[ach]	1	5
		[ach]	0.9	1.5
Climate scenarios	0	[-]	NEN5060	W+
Policy changes (Net-metering)		[-]	Yes	No



Figure 3. Variation of overheating hours and corresponding regrets of designs for all scenarios

Step 2: Set up building performance simulation model.

A detailed building and energy systems simulation model, to predict thermal and energy performance of designs (Table I), is developed in TRNSYS and it is coupled with Mode Frontier to carry out assessment for multiple designs for considered scenarios.

Step 3: Multi-criteria performance assessment.

Performance of the design space is assessed with overheating, costs and their corresponding performance robustness, which is calculated using the minimax regret method. Performance regret is used as measure of robustness and is defined as the performance deviation of a design from that of best performing design for a certain scenario [7]. The design that has high performance and the least regret is the most robust.

1. Overheating

igure 3 shows variation of overheating hours and corresponding regrets of five NZEB designs across considered scenarios. Each box plot represents a design and the spread of the boxplot is due to considered scenarios. It can be observed that overheating risk increases with higher insulation levels and airtightness. The design-1 has lower overheating hours for all scenarios and least regrets compared to other designs. The designs with highly insulated and airtight building envelopes (design-5) are highly prone to overheating risks in the future. It is noteworthy that design-1 has maximum overheating of about 940 hours, which is caused by an extreme climate change scenario, however, regret of overheating of design-1 is close to zero indicating that design-1 is performing better than other designs even for that extreme scenario and thus, the most robust NZEB among available designs.

2. Costs

igure 4 shows variation of NPV of costs and corresponding regrets of five NZEB designs across considered scenarios. In contrast to overheating, designs with higher insulation levels and smaller PV systems have low NPV of costs and corresponding regrets. This is because, among other factors, operational costs are less dependent on the size of PV system (net-exported energy) in case of no net-metering scenario. Design-1, that is robust to overheating, has higher regrets of costs compared to other designs. This is attributed to higher energy demand of design-1 due to low insulation levels. In contrast, operational costs vary with the size of a PV system in case of netmetering scenario and thus resulting close to zero regrets of costs for design with larger PV system size (design-1) compared to that of design with smaller PV system size (design-5). Optimal balance between insulation levels and energy generation systems is important to achieve a cost optimal robust NZEB, which is design-4.



Figure 4. Variation of total costs and corresponding regrets of designs for all scenarios

Step 4: Multi-criteria decisionmaking.

f a homeowner prioritizes costs and accepts the risk of certain overheating hours, then design-4 is the preferred robust NZEB design. Similarly, if a homeowner prefers to reduce overheating, design-1 is more preferred. However, design-1 incurs an extra NPV of costs up to 8900€ as a trade-off to reduce overheating regrets of about 456h/a compared to design-4. To reach a compromise, design-3 is a more preferred robust design, as it has lower maximum regret of NPV of costs compared to design-1 and lower maximum regret of overheating compared to design-4. However, additional investment cost of design-3 is higher than design-1 and design-4.

SUMMARY

his methodology, as demonstrated, can be used by designers/ consultants to aid decision-makers in the design phase to identify robust NZEB designs that ensure intended performance in the future. Using this methodology, a decision-maker can prefer a robust design by prioritizing the performance indicator and can trade-off with the robustness of other performance indicators. This example shows that buildings with higher insulations are prone to overheating and optimal balance between insulation levels and energy system size is essential to achieve a cost optimal robust NZEB.

- A. Hermelink, S. Schimschar, T. Boermans, L. Pagliano, P. Zangheri, R. Armani, K. Voss, E. Musall, Towards nearly zero- energy buildings Definition of common principles under the EPBD, Final Rep. (2013) 467.
- [2] T. Maier, M. Krzaczek, J. Tejchman, Comparison of physical performances of the ventilation systems in low-energy residential houses, Energy Build. 41 (2009) 337–353.
- P. De Wilde, The gap between predicted and measured energy performance of buildings: A framework for investigation, Autom. Constr. 41 (2014) 40–49.
- [4] R. Kotireddy, P. Hoes, J. Hensen, Optimal balance between energy demand and onsite energy generation for robust net zero energy buildings considering future scenarios, Proc. IBPSA Conf. (2015).
- [5] L. Peeters, R. de Dear, J. Hensen, W. D'haeseleer, Thermal comfort in residential buildings: Comfort values and scales for building energy simulation, Appl. Energy. 86 (2009) 772–780.
- [6] RVO, BENG referentiegebouwen, (2016). http://www.rvo.nl/initiatieven/energiezuiniggebouwd/hoekwoning-m.
- [7] R. Kotireddy, P. Hoes, J. Hensen, Simulation-based comparison of robustness assessment methods to identify robust low energy building designs, Proc. IBPSA Conf. (2017).

HOE VERENIG JIJ DYNAMIEK EN DUURZAAMHEID IN DE STAD VAN 2050?

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Studytrip South Korea

DAY 1 AND 2

ednesday morning, half past nine, we all gathered in front of the Starbucks at Eindhoven Station. Almost everyone took the train to Schiphol. On the way, some of us tried to join the group (tried, since for some it was difficult to give good directions where to get on). At Schiphol, we gathered at the red and white meeting point (Figure 1) and we were complete: the trip could start for real now!

he security checks went well and with time to spare we arrived at our gate. Unfortunately the flight was delayed, resulting in a need to hurry to make it to our connecting flight in Frankfurt. For some, this was very stressful, but in the end it wasn't as bad as we thought and again with some time to spare we arrived at the gate to continue the journey. Sleeping was very difficult, but all in all we had a good flight and our luggage arrived as well.

n the airport in Seoul, the travel Cards were arranged and we could continue to our hostel. After settling in, we explored the neighbourhood, showered and played games before dinner started. We started off with a mad hatters party. The rule was to wear a crazy headpiece, or no beer for you! So, everyone had found something beautiful to wear during the Korean BBQ. This being our first dinner together in Korea meant of course that the Mollier anthem had to be sung with the appropriate Jägermeister shot.

fter the BBQ, everyone was Adedicated to head to bed early in order to get up for an exciting second day!

DAY 3

 Δ fter a lack of sleep at the first night in the hostel (the attempts of some for a good night rest were futile), today the first programmed day started! Today the Bukhansan hike was planned. The hike would be not that advanced, would take 2.5 hours in total and according to Stephen could be done on flip-flops.



Figure 1. The start of the study trip

Unfortunately, this wasn't really the case. After a small search for the bus station and the different busses, we began hiking up the mountain. After a half hour walk on a hardened and nice path, Mollier approached the real deal. A stone stairway followed and then the path continued in stones, stones and more stones. A nice climb followed, in which it appeared to be essential to have some good condition and some good climbing flip-flops. Wait, did we say flip-flops? We meant shoes.

fter too much sweat, some Aimpossible pathways and a lot of anxiety we reached the top of the mountain (Figure 2)! The view was amazing and the climb was definitely worth it. After the long way back, we ate Korean stew with the whole group, where the enormous pans of meat would be cooked by yourself. Eventually half of the group stranded in the garden and the evening became really cosy.

DAY 4

 Δ fter a surprising rough day and again a short night of sleep we went on a city trip. First stop: Changdeokgung palace and the Huwon secret garden, which was in-practice the back garden of the palace. The palace is mentioned in the UNESCO list for outstanding architecture.



Figure 2. On the top of the mountain (835 meters!)



Figure 3. Gyeonbokgung Palace built by the Joseaon dynasty (1395 Seoul)

A fter visiting the palace we went for lunch at a very large market hall, similar to a bazaar, enjoying the delicious native street food like noodles (hot and cold) and pork- or veggieomelettes.

The journey continued to the vantage point of Bukchon Hanok giving a great view over the traditional neighbourhood. This area shows the importance of proper roofing and the quality of the traditional building method, so in fact the importance of the master BPS.

The last stop was the kingdom's palace: Gyeongbukgung palace (Figure 3). Built in 1395, it is located in northern Seoul and the largest of the



Five Grand Palaces built by the Joseon dynasty. After walking about 13km through the city, we split up in order to get some typical Korean dinner. It turns out to be impossible to find a spot for 20 people on a Saturday night in Seoul. Finally, we enjoyed the evening in the hostel's garden.

DAY 5

Day 5 was the DMZ day, also known as the Demilitarized Zone between North and South Korea. A VIP tour bus picked us up. On the drive to the DMZ, they gave us a short history lesson about the division between North and South Korea and how it came to be.

he first stop was a park before we entered the actual DMZ. At the park a few historic items were displayed, like a train which was destroyed in the war, the Freedom Bell and a vantage point on the Bridge of Freedom (Figure 5). After a short stop we continued as "Michelle's Group", a name which our tour-guide called Michelle picked, to the next stop. This stop was at the 3rd infiltration tunnel, after a short propaganda-movie about the war between North and South Korea, a few incidents afterwards, the DMZ and the four discovered tunnels North Korea dug. Once the movie was finished we were allowed to enter the 3rd infiltration tunnel up until the first barricade. Which was after a 360 meters walk down at a depth of 73 meters underground. The blockade was a thick concrete wall with a heavy metal door.

The third stop was at a vantage point. This point showed the border between the North and the South and a few villages on the Northern side. The villages were mostly faux as they were only used by military forces. Once we nearly arrived at the last stop, Mohamed discovered he should duck before taking his seat, to prevent bumping his head each time he sat down. The last stop was a train station. This was only used by people visiting the DMZ. It was constructed with donations from citizens hoping the track will connect the North and the South.

DAY 6

fter (again) only a few hours of sleep, we had to wake up pretty early for a packed schedule. This definitely felt like a Monday morning. With the standard butter-and-jam-toast breakfast in our bellies, we left on our first trip of the day to our first company visit, LG. Finally! So far, we have perceived the Korean people to be very warm, polite and modest. We felt very welcome the moment we walked into the LG conference room. They gave us a presentation about the company, the current status and their products in the building service range. The presentation also included an interesting timeline of the development of South Korea. Next to LG, it was also Samsung and Hyundai that stimulated the economy after the



Figure 5. War Memorial of Korea

Figure 4. Cheonggyecheon Stream & Cheonggye Plaza



Figure 6. Tour around the campus of Seoul National University (SNU)

Korean War in 1953. The presentation was very insightful and it was great to see the Korean modesty here also and not just marketing talk.

A fter LG we had to hurry off to Seoul National University (SNU). SNU is regarded as the #1 university in South-Korea. Three students of the "SNU Student Ambassador" (SSA) of the International Student Office gave us a tour around the biggest campus in South Korea (Figure 6). It is as large as 600 football fields! During the tour they enlightened us with a lot information about student life in South Korea. Sidenote of the day: It was very refreshing meeting people that could speak proper English.

DAY 7

In the morning of the 7th day we went to The National Museum of Korea. When we came there we saw a grand building with all kinds of artefacts from Korea and Asia. From prehistoric digged-up artefacts and chinaware to calligraphy, furniture and Buddhist statues. It was interesting to see how this building was designed.

A fter the museum, we travelled with most of the group to Incheon. To the smart city district "Songdo". This district is built on reclaimed land of the Yellow Sea, according to smart principles where they use information technology to manage and control the city. We saw a few of the buildings and got a presentation of the history of the district in the Smart City Exhibition. It started raining when we were there, because of this instead of walking around through the smart city. We got a bus tour through the region. The last few days we had some trouble with yellow dust, which is small dust coming from the deserts of Mongolia and northern China. For which some of us had to use dusk masks. So this was actually quite pleasant. With this bus we discovered Incheon and had a good meal at a local place at the sinpo market.

nstead of going to the smart city, the acoustics group (Diyako, Jantje, Keven and our translator Liu Qing, a nice staff in our hostel) went to a Karaoke room, not for fun (seriously) but for indoor acoustics measurements. In Europe countries, most of the karaoke is a wide space with a group of people. However, it is common that people sing in a private room in Asian countries. Today acoustics group found and tested two different private karaoke rooms, using measurement equipment to measure the reverberation time and Speach Transmission Index. Although our karaoke "neighbours", who sang in a high volume like sopranos, brought a little trouble to our measurements, the acoustics group still managed to accomplish their mission.

At the end of the day we joined up again and finished the day playing games at the hostel.

DAY 8

he start of the 8th day was early and rushed as usual after 15.000 snoozes before waking up and having our luxurious breakfast of toast with butter and jam. Oh yeah, the butter was out so just toast and jam. Anyways, we took off towards S.A.M.O.O., the largest and top engineering and architecture firm for 10 years straight in South Korea. Their head office is located in the Songpa district of Seoul, which is an award-winning district for being the most liveable and the largest in Seoul. As we entered the building, we must sav we had a warm welcome with a sign posted in the lobby and also in every elevator in the building especially for TU/e with our name on it. The design architect greeted us and escorted us to the conference room that could probably host a UN General Assembly (just slightly exaggerated) due to its size and interiors, where we were seated and generously served with some beverages.

The start of the presentation was about the background of the company that showed the international influence S.A.M.O.O. has. The main topic relevant to us building physics and services students was a project designed by S.A.M.O.O. that is a Zero Carbon Building.

The project was the ECO Energy R&D Centre located in Daejeon, South Korea. It is a mixed-use building that consists of two laboratories and an office designated space. The design process was split into three stages: passive design, active design and renewable energy design stages. The lead architect was present to answer our countless questions after the description of the building characteristics and design strategies.

A fter our interesting visit to S.A.M.M.O.O., we were just across the street of the LOTTE world tower. We decided to take a peek. These are the mind blowing numbers: 5th tallest building in the world, it is 555 meter high. After taking the high speed elevator (IOm/s) the group arrived at the 3rd highest observation deck of the world,



Figure 7. LOTTE world tower (555 meter high)

485m high (calculate travel time). Here we enjoyed the breath-taking views of Seoul (Figure 7). Almost everyone was brave enough and dared to step onto the glass floor, looking all the way down.

A fterwards we were able to walk through the LOTTE Concert Hall (Figure 8). For the die-hard acousticians, this is the first Box-in-box system applied in a building in Korea, designed by Nagata Acoustics. The group was clapping their way around the hall and where surprised to "measure" a long reverberation time (over 3 seconds). The tour guide's explanation was that it was needed to protect the fragile sound produced in classical music.

DAY 9

On this day we travelled to the famous Gangnam district to visit the architect and design office of Planning Korea (Figure 9 and 10). We were warmly welcomed with a cup of coffee and tea which was very useful after a short night of sleep.

Planning Korea is a company with a modern approach, taking into account not only the aesthetics but also the sustainability and the profit in terms of increasing the value of the building for the owner and the surroundings of the building. The architects draw their inspiration from art and nature which was visible in the large number of projects. In general, the main scopes of the designs are:

- Profit for citizens & the country
- Create an example with no examples
- Leave a legacy for next generation

This company participated in several design competitions and won several prices with their designs. For instance Seoul Culti Polis – Farming City, which brings together different functions in one building.

As the cherry on top, we had the honour to meet the chairman of Planning Korea and take a peak in his office. Even though this man is a very successful architect, he was very humble and happy with the gifts from the Netherlands the committee offered him (stroopwafels and the INSide magazine).

A fter this interesting morning, everybody had some free time to buy some souvenirs and eat dinner. The acoustics group went off to perform measurements in karaoke rooms again. Eventually, we closed the day with an interesting game of werewolves again.

DAY 10

In the morning we got breakfast in two groups: one group was leaving earlier to perform measurements at the Yonsei University and the other group left later in time for the presentations. After a 30 minute walk (surprisingly reminiscent



Figure 8. LOTTE Concert Hall



Figure 9. Architect and design office of Planning Korea



Figure 10. Architect and design office of Planning Korea



Figure 11. Presentations at the university of Yonse



Figure 12. The City Hall by the Seoul Metropolitan Government (SMG)

of our flip-flop mountain hike) through some small streets and Seoul alleyways, we arrived. We were greeted with some beverages and the presentations started. There were four presentations from us and four from them about several projects (Figure 11).

The topics that the students of Yonsei University presented were mostly related to indoor comfort in offices and cars. After the presentations we had a typical Korean box-lunch provided by the university. After filling our bellies, we went to check out the climate chamber and a testing car on the roof. A fter taking several group pictures guided around campus and saw that our campus could learn a thing or two from theirs when it comes to big buildings and beautiful greenery. After the tour, the students were kind enough to lead us all the way to the busses and give us directions on how to go to our next stop: City hall.

he City Hall is a beautiful, new building housing the Seoul Metropolitan Government (SMG) (Figure 12). The presentation that the SMG gave was about their plan to decrease nuclear power plants and increasing sustainable energy sources by, for instance, increasing solar energy, using waste as resources and making buildings more energy efficient. When the presentation was done, we all had free time. We checked out the metropolitan government building and after that we split up to either get souvenirs, go to Dongdaemun Plaza (Figure 13), and of course get something to eat.

At about 10pm we met up at the hostel and went to bed early of course.

DAY 11

Day II was the day everyone was "looking forward to". We went to the Myogaksa temple in the north of Seoul for a traditional Korean style Buddhist temple stay. Because we had to leave the hostel for a day, everyone had to pack their bags and get ready to leave. Maybe we really should have gone to bed earlier last night...

Upon arrival we changed into traditional clothing and we were requested to go to the main hall for the introduction. A story was told about a Buddha who saw a lot of pain, poverty and injustice all around him. He decided to gain control of his body and mind by withstanding himself from 3 'poisons' of the soul: desire, anger and ignorance. The 5 desires are: money, food, sleep, love and power. When you can't withstand the urge of any of the sins, anger comes into your mind and 'poisons' you. After the prince changed his life and could withstand his urges, he achieved enlightenment and got a "Buddha mind".

Prostration time. We were shown exactly how to bow. This ritual was necessary for every ceremony. As a fact, it was just like an exhausting workout, because 108 bows were required. We actually were supposed to be glad, because some other temples require ten times more bows a day! The instructor performs 108 bows a day, which she can do in only 10 minutes. Because it was our first time, it took almost half an hour for us. Most of us finished the challenge and probably felt it the day after!

The second part was meditation. We sat down in the same position for 25 minutes while focusing on our breath only. Two rules were: no sleeping and don't make noisey! A lot of us learned today that sitting still and thinking of nothing is not so easy as it looks. Some of us learned this the hard way.

The evening ceremony started at 17.00 when the gong/bell was rang. The practising Buddhists sang and we bowed a few times. The ceremony took only fifteen minutes, while the morning ceremony and the meditation tomorrow both will take an hour!

ood was served at the cafeteria after the evening ceremony. All food has been donated to the temple and does not contain meat. Since 2002 tourists are welcome in the temple. Before that time, the monks ate only three different vegetables, every day the same. However, a chef is paid to cook nowadays. The monks can appreciate that.

In the free time after dinner, we explored the surroundings of the temple and took some pictures. It was beautiful, especially after sunset when the lampion turned on.



Figure 13. Dongdaemun Plaza (Zaha Hadid)

21.00, time to sleep. The meditation combine our inner peace with physical rest we definitely needed after a tough week. Too bad we need to sleep on a thin mattress...

DAY 12

With one day to go, everyone except for Keven got up at 04.00am, after spending the night at the Myogaksa temple. At 04.50am, while wearing our uniforms again, we all gathered to ring the big bell. A couple of people could already feel the 108 prostrations from the previous day when they walked up the steps to the bell. At 05.00am exactly, the bell was rung 28 times. This number is for the 28 levels of hell and to honour the ones that passed away. Under supervision and in groups of five, we rang the bell.

fter ringing, we went back to the temple for the morning ritual. This ritual existed out of more prostrations but luckily not as many as the 108 of yesterday! After the ritual, it was time for meditation. There were only two rules: don't fall asleep and don't make noisey! After mediation, it was time for breakfast, followed by the tea ceremony. For the tea ceremony, we made groups of three people. One was the tea master and the other two were his/her guests. The tea master prepared the tea for the guests. A couple of tea masters prepared a really nice cup of green tea, but a couple of guests got tea that was quite bitter. After cleaning of the meditation room and restaurant the temple stay came to an end and we returned to the hostel.

The last day in Seoul was a free day. In smaller groups, the last locations were visited. One group visited a service in a church with a gospel choir. This church has one of the biggest communities in the world. Another group went to visit the Bongeun-sa temple, the Olympic Park and EWHA Women's University (Figure 15). And the last group had to watch Diyako buy even more souvenirs.



Figure 14. Traditional Korean style Buddist temple stay (The Myogaksa temple)



Figure 15. The last day in Seoul

n the beginning of the evening we gathered at the hostel again. On this last night we went for Korean BBQ with the entire group in a restaurant recommended by the hostel owner. One of the girls working in the hostel had become our adopted participant during our stay at the hostel. The Chinese girl Liuging has helped us so much the last week and she spend every night with us. So it should not be a surprise that we took her with us to dinner. In groups of five, we barbecued our own meat in the middle of the table. In the small room and the limited ventilation system resulted into a room filled with blue smoke, but this didn't stop our fun.

The night was concluded by singing the Mollier anthem proudly all together one final time.

DAY 13

Unfortunately, on this day the study trip had come to an end. At IO am we have departed the hostel, accompanied by the owner and some of the employees. After the final photo had been taken, the 2Oh travel has begun. With a short stop in Frankfurt, where Diyako and Gerton were checked for explosives and measuring equipment, we have arrived at Amsterdam. Low on energy, but full with a positive, after-trip vibe.

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Determining the effect of multilayer reflecting foil in timber construction elements

INTRODUCTION

o comply with the ever stricter building code and new era of sustainable buildings, it is of importance to incorporate highly efficient insulating materials into a building. More and more innovative materials are being introduced and one of these materials is the so called 'multi-layer reflection foil', which is mainly used in timber construction elements. This product consists of multiple thin aluminum layers spaced by small air cavities each being enclosed in low emissivity surfaces, which enhances the thermal property by reflecting radiative energy. To analyze the internal heat transfer of these elements a so called Hot Box measurement method can be used.

METHOD

The Hot Box measurement method makes use of two climatised rooms creating a known temperature difference, resulting in an outward going heat flux flowing through the specimen element. A derivative approach has been adopted by positioning a heavily insulated cubic box inside an actively

controlled cooling facility in which different specimen timber construction elements can be placed and measured, see Figure 1. Both the internal and external surface temperatures were measured continuously for a variety of different elements until a steady state situation was reached. In compliance with the NEN-ISO-8990 a temperature difference of at least 20 °C and a mean temperature of approximately 20 °C has been established by controlling a heat source inside the cube [1]. To obtain a more comprehensive analysis of the internal functioning of these elements, temperature sensors were placed at the transition of all internal construction layers. The acquired temperature distribution was used to fit thermal resistance values to the internal construction lavers. This fitting process was achieved by assigning known thermal resistance values from literature to the mineral wool and multiplex [2] which resulted in fitted thermal resistance value for both the multi-layer reflecting foil and its adjacent air cavities.

RESULTS AND CONCLUSION

arious timber construction elements have been analyzed, including single and double layer variants of insulating material. Table 1 shows the temperature distribution of 'element A' for the different construction layers and their corresponding fitted thermal resistance values highlighted in purple. This study found that, when a second layer of insulating material separated by an air cavity is applied, as for 'element A', then the second layer shows an average performance loss of 23% compared with the first layer. Furthermore, when applying two layers of insulating material stacked together, an average performance loss of even 39% is observed when comparing the second layer with its first layer. Further investigation is needed to validate the assumption that the applied mineral wool has been performing as stated by its theory and was not affected by the presence of the multi-layer reflecting foil. 🔳

Table I. Analysis of temperature distribution element A

	1 105 S	No. 1	
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Figure 1. Measurement configuration placed in cooled facility

Flement A experifitted

Liement	ment	resistar	ice
Construction layer name:	∆T [°C]	R: [m²K/W]	∆T [°C]
Multiplex + gypsum board	1,06	0,15	1,16
Air cavity 20 [mm] 1st	3,06	0,4	3,10
Multi-layer reflecting foil 1st	8,88	1,1	8,53
Air cavity 20 [mm] 2nd	0,21	0,03	0,23
Multi-layer reflecting foil 2nd	7,09	0,9	6,98
Air cavity 27 [mm] 3rd	0,45	0,06	0,47
Mineral wool 100 [mm]	20,68	2,7	20,95
Total element	41,43	5,34	41,43

NEN-EN-ISO 8990, Thermal insulation – determination of steady state thermal transmission properties – Calibrated and guarded hot box, 1st edition, February 1997

[2] Bureau of Standards Letter Circular No. 227, nd., in Weast, R. C., Editor-in Chief, Handbook of Chemistry and Physics, 48th Edition, 1967-68, Cleveland: The Chemical Rubber Co., 1967, page E-5

Measuring is knowing but you only see it if you understand it

Author dr. ing. L. (Lada) Hensen Centnerová

t is well known that "Measuring is Knowing", but do we always understand our measurements? Famous Dutch soccer icon Johan Cruijff (1947-2016) used to say "you only see it if you understand it."

et's have a look at indoor environment. Everybody at BPS unit knows that people spend 90% of their time indoors. Maybe not everybody knows that 65% of that time is spent inside the home [1]. For most people home is a very important place. People tend to spend a lot of money on not only energy and maintenance, but also things to make it nice and comfortable. However, many people do not know how their internal home environment can have a significant impact on their health and wellbeing and even on their life expectancy.

There are approximately 7.5 million homes in the Netherlands, of which 55% are owner-occupied homes [2]. That means more than 4 million dwellings where approximately 9 million people live. The health and wellbeing of all these people is largely influenced by their own home. How can we help to make these homes healthy and their owners (rentals) aware of how their home influences their health?

People understand homes have electricity, gas and water meters. People also understand the more energy they use, the more money they have to pay (except if they live in zero energy house). But what about indoor environment? Do people measure their indoor environment? And if they do, do they understand it? As an example I want to use the measurements in our own house.

owadays is it possible to buy different types of sensors which can measure the basic factors of the indoor environment (temperature, humidity, CO2 concentration or noise). Some sensors have very friendly interfaces that you can control from your smart phone or your laptop. We (my husband actually) bought a few of these sensors and installed them in our living room and bedrooms. And we were surprised! Surprised how high CO2 concentration can rise in our living room and how an unexpected fluctuation of CO2 concentration was in our upstairs bedrooms. It took us some time to understand the measurements but now we do and we can anticipate on it using our knowledge about indoor environment and its impact on our health and wellbeing.

Measuring is knowing. That's right. At the same time, it is also true that you only see it if you understand it.

hat's why I would like to work more in this area of 'measuring and understanding of indoor environment in dwellings' and that's why I organize (as a guest of Prof. Nelissen, Chair Building Sustainability) measurements at Frits Philips lyceum in Eindhoven. We measure (using sensors like in our house) at two locations of this school (old buildings) and we plan to do the same measurements next year after the whole school has moved to a new building. We want to understand and see the differences in indoor environment and to see if there is an influence on cognitive functions of students and inform school management so that they know and understand it as well and can enhance situations in other buildings.

By the way, for this project we are looking for master student(s) who speaks Dutch as a master project or graduation project.



Figure 1. How can we help to make homes healthy?

- [1] ASHRAE, "10 Tips for Home Indoor Air Quality," 2017. [Online]. Available: https://www.ashrae.org/resources--publications/freeresources/10-tips-for-home-indoor-air-quality. [Accessed: 08-Feb-2017].
- [2] "Eigen huis verliest gouden glans," 2015. [Online]. Available: https://www.ing.nl/media/Eigen huis verliest gouden glans Visie op de Nederlandse huizenmarkt 2015-2025 - ING Economisch Bureau_tcm162-81534.pdf.



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Design of the innovative bio-concrete using miscanthus fibres

Author J. (Jonathan) Ezechiëls

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ABSTRACT

n the quest to reduce the harmful destruction of the ecosystem and to produce low cost polymeric based composites, increasing amounts of research are emerging with policies of manufacturing composites using natural fibres, which are entirely biodegradable and enhance the environment. The present study aims to research the characterization and properties of Miscanthus x giganteus fibers (M. x giganteus) as a lightweight aggregate (filler material) in a cementitious matrix to design a natural fiber-based concrete. The compatibility between the Miscanthus fibres and cement has been found to be moderately compatible, indicating that the fibres do not behave aggressively and do not have a deleterious effect on the cement hydration process. With increasing fibre amount, the workability, density and compressive strength of the bioconcrete decreases, but the decrease is minimal and the values still fall within acceptable range. The durability of the Miscanthus-based bio concrete has been found to be acceptable for the Miscanthus-based bio concrete, containing less than 15% fibres (vol. %).

INTRODUCTION

Any countries have imposed rules and regulations to reduce solid waste in material manufacturing industries, in order to protect the environment. Various researchers and material scientists all over the world are focusing their attention on new environmentally friendly and sustainable alternatives, thus reducing the energy consumption and costs. The concept of applying natural fiber in cement-based materials was developed in the 1970's, when natural fibers were evaluated as substitutes of manufacture of fibres [1]. Motivations for their use include decreased raw materials costs and contribution to sustainability. According to [1], natural fibers present several interesting advantages, particularly low density, high specific stiffness, strength, biodegradability, renewable character, low processing energy in the case of chopped natural fibers, and



Figure 1. Utilized chopped Miscanthus fibres

availability at modest cost and variety of morphologies and dimensions. Nevertheless, natural fibers also have a number of disadvantages, which make their application in concrete not fully accepted. The major disadvantages include the poor compatibility between fiber and matrix, their relatively high moisture sorption and the biological degradation of the natural fibers.

arious natural fibres, in different shapes, length and sizes, have been applied to produce natural fibre-based concrete materials [2, 3] and their utilization has gained a lot of attention in recent years primarily because of the improvement in process technology, economic factors and increased sustainability concerns. One of the main objectives of this project is to develop a bio concrete containing M. x giganteus fibers for outdoor application. Miscanthus x giganteus is likely to become more popular due to its versatility and favorable properties, such as low moisture content. Nevertheless, lack of information exists regarding the chemical composition of the fibres and their compatibility with cement. Hence, this study focusses on: 1) the detailed characterization of the fibres (morphological, physical and chemical properties); 2) the compatibility of the fibres with Portland cement; 3) the effect of the fibres on the fresh properties of Miscanthus-based concrete matrix; 4) the evaluation of the mechanical properties of the designed Miscanthusbased bio concrete; 5) the durability of the designed Miscanthus-based bio concrete



RESEARCH METHODOLOGY AND RESULTS Fibres characterization Chemical properties

The aim of this analysis is to determine the content of lignin, cellulose, hemicellulose and glucose of M. x giganteus fibres. The determination of the lignin content was carried out according to Tappi T222 and Tappi UM250. The leachate was obtained by mixing the fibres with water, with a water to fibre ratio of 5:1, and boiling the mixture at 80°C for two hours.

Table I. Chemical composition of the utilized Miscanthus fibres

Miscanthus Analysis	amounts
Acid insoluble lignin and Acid soluble lignin (%)	17.93
Extractives (%)	5.1
Cellulose (%)	40.21
Hemicellulose (%)	43.24
Components from the leachate	amounts
Glucuronic acid (mg/ml)	0.01
Galacturonic acid (mg/ml)	0.02
Glucose (mg/ml)	0.19

t can be concluded that the utilized M. x giganteus fibres have a lower cellulose content, as well as a slightly higher hemicellulose and lignin content, compared to that of other well-known natural fibres [4, 5].

Physical properties

To determine the physical properties of the M. x giganteus fibres, various measurements were conducted,



(1)

Figure 2. SEM images of M. x giganteus fibre: A) surface, C) cross-section

Table 2. Particle density of the utilized Miscanthus fibres for fraction size below 2 mm, between 2 and 4 mm, above 4 mm and unsieved sample, using the helium pvcnometer.

Fraction size	Particle density (kg/m³)
< 2mm	222.2 ± 3.9
2-4mm	250.0 ± 1.0
> 4mm	235.3 ± 1.2
Unsieved	230.08 ± 4.5

including morphology and moisture content and water absorption rate. The results of these tests are shown in Table 2 and Figures 2 and 3.

he water absorption of the M. x giganteus fibres in this research was determined and was recorded at roughly 300% (mass %). In [6], the water absorption of raw M. x giganteus fibres was recorded at 320%, which is almost equal to the water absorption results in the current research. From Figure 3 it can be seen that this water absorption rate is quite high and occurs rapidly.

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he morphology of the M. x giganteus fibres are determined and it can be seen (Fig. 2) that the fibre has a relatively rough outer surface and very porous internal structure.

Fibre-cement compatibility

hen a cement matrix containing natural fibres is incompatible, a lowering of the physical properties of the sample is usually the consequence, leading to samples without physical integrity. In the current research, the compatibility of the M. x giganteus fires with cement was evaluated by conducting calorimetric measurements. The compatibility (using the CA factor) and setting time were evaluated by the normalized heat flow (Fig. 4). The Ca-factor was chosen as determining

 $C_{A = \frac{Q_{rej}}{Q_{sample}}}$ Equation 1. The CA factor

factor. If the chemical process of cement hardening is undisturbed or disturbed just to a low extent (CA >68 %) by the presence of natural fibres, this cement matrix is labelled as compatible. Otherwise, they are labelled as incompatible (CA<28 %). The CA factor can be calculated using equation 1. Where CA is the CA factor, Q_{ref} is the heat release of the reference paste within a specified period (J/g) and is the heat release of the sample, Q. containing fibres, within a specified period (J/q).

Fresh properties, mechanical properties and durability Slump flow and fresh density

ollowing EN-12350-5 (2010), the slump flow test was performed using



Equation 2. The fresh density

the Abrams cone with the internal upper/lower diameter equal to 130/200 mm and height equal to 200 mm. The 700 mm square flow table is hinged to a rigid base and placed on a flat surface, proved with a stop that allows the far end to be slightly raised. And the results are presented in Fig. 5 and figure 6A. the fresh density is determined via equation 2. Where D is the density of the fresh concrete (kg/m^3); MI is the mass of the container (kg); M2 is the mass of the container and concrete (kg); V is the volume of the container (m³).

By determining the fresh density, a linear relation can be obtained between unit weight (wet density) and fibre content. According to [7] the unit weight (wet density) of fresh concrete







Figure 4. Effect of different amounts of untreated M. x giganteus fibres on (left) the normalized heat flow and right): normalized heat of cement paste

is a strength determining factor of the concrete.

Compression test

he mechanical strength tests were performed to measure the compressive strength of the designed MBBC following EN-12390-2 (2001). According to Stephens (1994), during water curing, moisture absorbed in the fibres detrimentally affected the bond between the concrete matrix and the fibres and thereby reduced the tensile strength of the concrete. While most researches with natural fibres in concrete use the water curing method, Ni et al. (1995) mentioned multiple cases where air or humid curing proved more beneficial for concrete. The cubical specimens (15 x 15 x 15 cm3) are demolded approximately 24 h after casting and subsequently cured in a humid container at about 21 °C and 99% RH. After curing for 7, 21 and 28 days, the specimens are tested. At least three specimens are tested for each mixture (Fig. 7).

Water permeability test

he durability of a material relates to its resistance to deterioration resulting from external causes as well as internal causes [8]. Therefore, in the current research, the water permeability is evaluated, in order to specify the concrete's quality and durability. Specimens with varying fibre contents were tested to determine their resistance to the ingress of water by determining their sorptivity and permeability. In the current research the water permeability tests was performed conform EN 12390-8 (2009): depth of penetration of water under pressure, as was done in [9]. In general, the water tightness of concrete depends on the capillary porosity, its connectivity and the pore structure. These parameters are directly related to the w/b ratio and the progress of cement hydration. This test measures the depth of water penetration into MBBC specimens (15×15×15 mm3) subjected to 0.5 MPa (72.5 psi) of hydrostatic pressure over a period of three days. After three days the specimen is split in half, perpendicular to the face on which the water pressure was applied (see Fig. 8). The water penetration front on the specimen is then determined at various position on the specimen to get an average value (in cm) (see Fig. 9).

The absorption testing is a popular method of determining the watertightness. In this research, the water tightness of the MBBC specimens (I5×15×15 mm³) was performed conform EN-480-5 (2005). This test is used to determine the rate of absorption (Sorptivity coefficient) of water by measuring the increase in the mass of a specimen resulting from absorption of water as a function of time, when only one surface of the specimen is exposed to water ingress of unsaturated concrete



Figure 5. Fresh properties of the MBBC



Figure 6. A) Concrete paste from slump flow test; B) compression test of the cubicle MBBC



Figure 7. Compressive strength results of MBBC: Mix series 3



Figure 8. A) Specimens in apparatus; B) vertical splitting of the specimens after 3days (after water penetration test)

by capillary suction during initial contact with water (see Fig. 10). According to EN-480-5 (2005), the capillary water absorption (C_A) is calculated in g/cm² as follows:

$$C_{A} = \frac{M_{j-}M_0}{A} \tag{3}$$

Equation 3. The capillary water absorption.

Where M_o is the initial mass of the test specimen, in g, after storage for 28 days, Mj is the mass of the test specimen, in g, after the required absorption time.

CONCLUSION

rom the current results, it can be concluded that even though the addition of M. x giganteus fibres in mortar/concrete significantly decreased the density, workability, strength and the durability of the designed MBBC and MBBM, the values are still within acceptable range. From the calorimetric tests, performed with fibres and cement, it was concluded that the M. x giganteus fibres are not aggressive and do not possess chemical components (and sugars) which influences the hydration process of cement largely; hence, the M .x giganteus are labeled as moderate compatible, based on the amount of heat released per specimen. It is also seen that a good workability of the paste for the MBBC was acquired.

Whith the addition of 2% and 5% fibres, the compressive strength of the MBBC specimens of mix series 1 only decrease by 4 % and 12 %, respectively, compared to the reference specimen, reaching compressive strengths of 73 MPa and 67 MPa, respectively. From the compressive strength results of the MBBC, it can be seen that the compressive strength values falls between the Cl6/20 and C55/67 strength class. Indicating that high strength of the bio-concrete is obtained with the inclusion of M. x giganteus fibres. The durability of the MBBC was tested based on its permeability and the capillary water absorbing capability. From the results it was concluded that the values fall within acceptable range, if fibre inclusion is kept equal or below 10% (vol. %). ■



Figure 9. Water penetration depth of the MBBC



Figure 10. Capillary water absorption of MBBC: specimen M2, M5, M10 and M15

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- [1] Santos, S.F. et al., 2015. Non-conventional cement-based composites reinforced with vegetable fibers: A review of strategies to improve durability. Materiales De Construccion, 65(317), p.20.
- [2] Dias, R. et al., 1999. The use of sisal fibre as reinforcement in cement based composites. Revista Brasileira de Engenharia Agrícola e Ambiental, (32), pp.245–256.
- [3] Bledzki, A., & Gassan, J., 1999. Composites reinforced with cellulose based fibres. Progress in Polymer Science, 24(2), pp.221–274.
- [4] Fiore, V., Scalici, T. & Valenza, A., 2014. Characterization of a new natural fiber from Arundo donax L. as potential reinforcement of polymer composites. Carbohydrate Polymers, 106, pp.77–83.
- [5] Pude, R. et al., 2005. Suitability of Miscanthus genotypes for lightweight concrete. Bodenkultur, 56(1–4), pp.61–69.
- [6]Le Ngoc Huyen, T. et al., 2011. Saccharification of Miscanthus x giganteus, incorporation oflignocellulosicby-productincementitious matrix. Comptes Rendus Biologies, 334(11).biologies, 334(11).biologies, 334(11).biologies, 334(11).
- [7] Marar, K. & Eren, Ö., 2011. Effect of cement content and water/cement ratio on fresh concrete properties without admixtures. International Journal of the Physical Sciences, 6(24), pp.5752–5765.
- [8] Sivaraja, M., Velmani, N. & Sudhakaran Pillai, M., 2009. Study on durability of natural fibre concrete composites using mechanical strength and microstructural properties., 33(6), p.10.
- Yu, Q.L., Spiesz, P. & Brouwers, H.J.H., 2015. Ultra-lightweight concrete: Conceptual design and performance evaluation. Cement and Concrete Composites, 61, pp.18–28.



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Overpressure in airtight houses in case of a fire

Author N.A.J. (Nick) Tenbült

Supervisor ir. R.A.P. van Herpen MSc. FIFireE

INTRODUCTION

arlier performed studies towards fires in airtight dwellings call attention for the safety of residents and fire services in case of a fire. With experiments and simulations pressure peaks in an early stage of the fire were experienced, which makes it harder for residents to escape from the building [1,2]. The executed experiments and simulations focused on the building envelope and neglected balanced mechanical ventilation systems. The goal of the research was to gain insight in the influence of the balanced mechanical ventilation system on the overpressure in case of fire in airtight dwellings.

METHOD

n multiple dwellings Nieman Raadgevende Ingenieurs performed airtightness measurements with and without mechanical vents included. With the acquired data the equivalent surface area of the mechanical vents can be calculated. The surface area is required to perform simulations in a multi-zone model, CFAST. However, CFAST assumes turbulent air flows through openings with a default flow exponent of 0.5, while according to the measurements laminar flows with higher flow exponents occur. This limitation will result in an underestimation of the air flows which leads to an overestimation of the pressure differences.

A correction model has been developed to change the surface area of the openings for different pressure intervals, in order to simulate the airflow through openings more accurately. After running the correction model two times the airflow simulated in CFAST corresponds with the measurement results.

RESULTS

The simulations that consider ventilation openings show little differences with the simulations that neglected ventilation openings (Figure I). Due to the ventilation openings the pressure peak is reduced, but in an early stage of the fire development the pressure increase is similar.

n order to assess the results, a threshold of 30 Pascal was established, which is seen as the maximum pressure difference whereby residents can open the front door by pulling. For all three fire growth rates consideration of the mechanical ventilation openings cannot prevent exceedance of the threshold within roughly two minutes (Figure 1). For single-family dwellings with people who can leave without assistance the required total evacuation time is 3 minutes [3].

he model contained multiple compartments and since some connections between compartments were relatively small it was expected that there would be pressure differences between compartments. Compartment 2 and 3 were connected by a 2 cm high slit under a closed door and compartment 2 had an 'open' connection with compartment 1 and 4. When a fire was started in compartment 3 the pressure increase in this compartment was larger than in the other compartments. However, this difference in pressure increase does not prevent exceedance of the threshold for save evacuation in compartment 1, where the front door is located.

CONCLUSION

Despite the fire growth rate and location of the fire, the pressure increase in airtight dwellings is too high in the first three minutes to assure safe evacuation of building occupants. The mechanical ventilation system has only an influence on the pressure peak, which can be reduced with a few hundreds of Pascal, depending on the fire scenario. The extension of available evacuation time is only a few seconds.

odern airtight buildings maintain a potential danger for building occupants due to high pressures which make it more difficult to escape. Smoke gas explosion and backdraft are still potential risks for fire services.



Figure 1. Pressure increase after ignition for different fire growth rates, mechanical vents included and excluded

- [1] van den Brink, V. (2015). Fire safety and suppression in modern residential buildings. TU Eindhoven master thesis
- [2] Fourneau et al. (2012). Comparison of fire hazards in passive and conventional houses. Chemical engineering transactions 26: 375-380
- [3] Hagen, R., & Witloks, L. (2014). The basis for fire safety. Arnhem: Instituut Fysieke Veiligheid.

Effect of Gurney flap on the Aerodynamic Performance of Vertical Axis Wind Turbines

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INTRODUCTION

ertical axis wind turbines (VAWT) can be suitable for integration into the built environment due to their omnidirectional capability, reduced noise and ability to perform well in turbulent winds [1]. The main drawback of VAWTs is their lower aerodynamic performance compared to horizontal axis wind turbines. A modification of the VAWT blades that could potentially improve the aerodynamic performance is the addition of a Gurney flap (GF). This is a small vertical flap that is generally installed at the trailing edge of the airfoil. The flow mechanism in Figure 1, first observed by Liebeck [2], shows that the Gurney flap creates two counter rotating vortices, which turn the flow downwards, resulting in an increased effective camber of the airfoil. Also the pressure difference is increased, due to an increased suction over the upper side and a reduced flow (separation bubble) for the lower surface of the airfoil, resulting in an increased lift [3]. This project aims to investigate whether a Gurney flap can improve the aerodynamic performance of a VAWT and find the optimum GF location and height.

METHOD

n order to investigate this, Computational Fluid Dynamics (CFD) analysis is performed with ANSYS Fluent. First, a validation study is performed on a static airfoil with GF to identify the minimum grid resolution on the GF, which is later used for the VAWT model. The validation results show satisfactory agreement with experimental values [4]. Next, the performance of the VAWT with GF is investigated for different GF locations (inner side, outer side and both sides



Figure 1. Streamlines and pressure coefficient contours around a GF on the inner side of a VAWT blade

of the blade) and for different GF heights (0.5-2%c). The aerodynamic performance is assessed based on the moment and power coefficient of the VAWT.

RESULTS AND CONCLUSION

he moment coefficient results of the parametric study in Figure 2 show that the optimal GF location is on the outer side of the VAWT blade and that the optimal GF height is 1% of the airfoil chord length. This optimal case resulted in a 1.78% increase of the power coefficient of the turbine compared to a VAWT blade with no GF. A 2% GF on the outer side results in an increased performance during the first half of the . VAWT rotation, but the performance loss during the second half outweighs this. A promising future study would therefore be to investigate a deployable GF which can be retracted during the second half of the turbine's rotation.



Figure 2. Instantaneous moment coefficient results for the top blade during the last revolution of the VAWT

 M. R. Islam, S. Mekhilef, and R. Saidur, "Progress and recent trends of wind energy technology," Renew. Sustain. Energy Rev., vol. 21, no. August 2015, pp. 456–468, 2013.

- [2] R. H. Liebeck, "Design of Subsonic Airfoils for High Lift," J. Aircr., vol. 15, no. 9, pp. 547–561, 1978.
- [3] J. J. Wang, Y. C. Li, and K. S. Choi, "Gurney flap-Lift enhancement, mechanisms and applications," Prog. Aerosp. Sci., vol. 44, no. 1, pp. 22–47, 2008.
- [4] Y. Li, J. Wang, and P. Zhang, "Effects of Gurney flaps on a NACAOO12 airfoil," Flow, Turbul. Combust., vol. 68, no. 1, pp. 27–39, 2002.



Resultaat door betrokkenheid **Kuijpers & Mollier**



Kuijpers is een professionele technisch dienstverlener. We zijn een familiebedrijf - opgericht in 1921 - en ontwerpen, bouwen én onderhouden technische installaties in gebouwen en industrie. Onze ambitie is om alleen nog energieneutrale en gezonde installaties te realiseren. Maatschappelijke betrokkenheid en persoonlijke relaties met onze klanten en medewerkers zijn voor ons erg belangrijk. Samen ontwikkelen we ons. Om zo het beste in elkaar naar boven te halen. Met een betrokkenheid die leidt tot resultaat!

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عسال



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Voort is een bundeling van kracht en expertise van KP&T en TRACÉ. Onze persoonlijke aanpak hebben we behouden. Ons landelijk netwerk aanzienlijk vergroot.

Wij geloven in de mensen achter de techniek. Bij wie innovatie voorop staat. De ambitieuze denkers en de ijverige doeners. Zij die het onmogelijke mogelijk maken. Door hen te verbinden ontstaat vooruitgang. Dat is wat we doen. We brengen technische professionals bij elkaar. En we brengen ze verder. We doen er alles aan om ze boven zichzelf uit te laten stijgen. De juiste persoon op de juiste plek. Dat is een plek waar je kunt groeien. Jezelf kunt ontwikkelen.





Stichting Promotie Installatietechniek (PIT)

De Stichting PIT zet zich in voor promotie en innovatie binnen de installatiebranche. Wij financieren projecten die in technisch, economisch of wetenschappelijk opzicht vernieuwend zijn. Dat doen we voor organisaties die zich zonder winstdoelstelling bezighouden met onderwijs en kennisontwikkeling in de branche. Denk bijvoorbeeld aan universiteiten en onderzoeksinstituten.

Zo draagt Stichting PIT bij aan het genereren van nieuwe kennis en innovatieve ontwikkelingen waarvan de gehele installatiebranche kan profiteren. Daarbij moet altijd sprake zijn van substantiële cofinanciering. Zo waarborgen we dat er binnen de branche draagvlak bestaat voor onderzoeken en projecten die door de Stichting financieel worden ondersteund.







Net-Zero Energy Communities

management structures are complex

beneficial as the load diversification is

possible with the different building types

located in the community. They usually

have a mix of occupancy patterns which

energy. Also, some of the buildings are

On the other hand, NZECs can be

can lead to a more efficient use of

INTRODUCTION

Recently, there is a growing interest towards net-zero Energy Communities (NZEC). It is seen as a future target for the design of neighborhoods and cities which contribute to a more sustainable future. However, it is difficult to find a standardized definition, assessment criteria or guidelines regarding net-zero energy communities.

he objectives of this research project (M1) are to study the definition of netzero energy concept and its evolution throughout history, at building level as well as at community level, and also to explore the potentials and challenges of achieving NZECs through example projects and a case study.

METHOD

t the first step, a literature research is conducted regarding the definitions, approaches and examples of net-zero energy communities. In literature, most trusted definition of a net-zero energy community (NZEC) has been done by National Renewable Energy Laboratory (NREL). According to their definition:

" A net-zero energy community is, one that has greatly reduced energy needs though efficiency gains of the buildings such that the balance of enerau for vehicles, thermal, and electrical energy within the community is met by renewable energy." [1]

his definition additionally mentions "transportation" and "community infrastructure" which are not included in net-zero energy building definitions.

t the second step, three examples of \bigwedge NZEC in different parts of the world are examined in terms of their NZEC goals, design strategies, renewable energy potentials and performances. These projects are namely, West Village (US), BedZED (UK), Zernez Village

(CH). These examples help to find out common design approaches, challenges and requirements tosatisfy NZEC performance criteria.

t the third step, a small Aneighborhood in central Anatolia (TUR) is selected as a case study (Figure 1). In order to determine the energy demand of the neighbourhood residents are interviewed and occupancy types are created. For on-site energy generation, locally available renewable energy sources are investigated. Finally, energy matching of the neighbourhood is examined with different scenarios by considering performance indicators OEM (On-site Energy Matching) and OEF (On-site Energy Fraction), when the number of stakeholders considered. Here OEM refers to the proportion of on-site generated energy that is used by the building rather than being exported or dumped. OEF indicates the proportion of the total building demand covered by on-site generated energy.



neighbourhood in Turkey

RESULTS

Orientation I Orientation II Orientation III

Figure 3. BadZED, UK



Figure 4. Zernez, CH

CONCLUSION

n conclusion, the NZEC concept has been receiving a growing attention internationally. In order to scale up this concept, a further study must be done for standardizing the definitions, calculations and guidelines of net-zero energy communities.

N. Carlisle, O. Van Geet, and S. Pless, "Definition of a ' Zero Net Energy ' Community," Natl. Renew. Energy Lab., no. November, pp. 1–14, 2009.

his research showed that achieving

net-zero energy goals at a large

behaviour and inhabitants' participation

level brings its challenges. Occupant

heavily impact energy consumption.

compared to traditional constructions.

Initial investment costs are higher

Additionally, ownership and

not necessarily net-zero by themselves since the renewable energy produced on-site can be distributed within the community.



Figure 2. West village, US



ENGIE's innovative way of balancing the grid

Company ENGIE

or a stable electrical grid the supply and demand of power must always match, on a second-by-second basis. Primary reserve, also known as Frequency Containment Reserve (FCR), is the first line of defence in keeping supply and demand in balance and guaranteeing a stable grid. ENGIE is piloting with innovative and sustainable new ways in keeping the grid balanced and providing FCR, very much in line with ENGIE's ambitions of becoming a leading player with regards to the energy transition.

TenneT, the Dutch Transmission System Operator (TSO), procures roughly 100 MW of FCR capacity each week. This FCR capacity is power which needs to be available 24/7 in order to inject power into the grid within seconds in the case of insufficient supply (in which case the grid frequency will drop slightly below 50 Hz) or to draw power from the grid whenever supply is too great (leading to a frequency slightly greater than 50 Hz)¹. Traditionally this primary reserve capacity is provided by power plants which essentially need to run at suboptimal levels in order to be able to provide symmetrical power; for instance running a power plant at 80% of maximum capacity in order to be able to ramp up (or down) a further 20% whenever the grid frequency fluctuates. ENGIE is creating a pool of flexible

assets, controlled by a smart digital platform, to keep the grid balanced in an innovative and efficient new way.

Whether a power plant is briefly ramped up to temporarily increase the supply of power, or a pool of electric vehicles are instructed to temporarily charge at a slightly lower rate to decrease the demand of power, the effect on the national grid is the same. The problem is that electric vehicles may not have the same amount of flexible power available 24 hours a day, and the power which can be activated may not always be symmetrical. To counter this issue it is essential to pool different sorts of assets to create a pool with the

1. Please see http://www.mainsfrequency.com/ for the current frequency of the grid



characteristics of a (virtual) power plant for FCR. ENGIE therefore intends to pilot with the pooling of various assets such as small or large (second life) batteries, (heat) pumps, water boilers, electric vehicles or even industrial processes and residential assets. Another advantage of having a pool of assets, is that a merit order can be created. As most grid frequency variations are fairly small and occur all the time, it could be sensible, for instance, to activate electric vehicles to counter these fluctuations first and only opting to influence an industrial process in moments of a very unbalanced grid. This also creates interesting business models and opportunities.

NGIE develops its businesses (power, natural gas, energy services) around a model based on responsible growth to take on the major challenges of energy's transition to a low-carbon economy: access to sustainable energy, climatechange mitigation and adaptation and the rational use of resources. By enabling asset owners to use all sorts of assets to provide FCR and participate in keeping the grid in balance, ENGIE is paving the way for a more balanced grid as is required in a world with more intermittent renewable energy sources whilst simultaneously creating business opportunities for these asset owners.

NGIE Nederland consists of ENGIE Energie and ENGIE Services and is a leading energy and services company that employs 6.400 people. In 2015 ENGIE Nederland achieved revenues of €1.85 billion. We are leading the way and establishing the energy transition through innovative and sustainable energy solutions. We give enable this change by helping customers (companies, institutions and consumers) to make the transition from fossil to 100% sustainable energy and to shift towards decentralization, as quickly and cost effectively as possible. ENGIE Nederland is part of the ENGIE Group that employs 153,090 people worldwide and achieved revenues of €69.6 billion in 2016. ■

ENGLE bestaat in Nederland uit ENGLE Energie, ENGLE Services, ENGLE E&P, ENGLE Fabricom en ENGLE Laborelec. Wij zijn het bedrijf dat voorop loopt in de energietransitie en dat, dankzij innovatieve en duurzame energieoplossingen, de energietransitie ook echt waarmaakt. Wij geven richting aan deze verandering en helpen klanten (bedrijven, instellingen en consumenten) om de stap van een fossiele naar een 100% duurzame energiehuishouding, en tevens de beweging naar decentralisatie, zo snel en zo kostenefficiënt mogelijk te maken.

ENGIE telt wereldwijd 154.950 medewerkers en boekte in 2015 een omzet van 69,9 miljard euro. In Nederland werken circa 6200 medewerkers.

ENGIE Services is Europees marktleider op het gebied van duurzame technologische oplossingen voor energie en milieu. Hierdoor kan de klant zich volledig concentreren op de realisatie van de eigen doelstellingen. Wij doen dit met innovatieve concepten en integrale, duurzame oplossingen. Onze efficiënte en effectieve toepassingen in technologieën verbinden wij met vakkennis in financiële, proces- en beheersmatige aspecten van het werk dat wij uitvoeren voor onze klanten. Of dat nu gaat over nieuwbouw, onderhoud en beheer en services.

Onze specialisten hebben een passie voor techniek en zitten vaak al in de conceptfase bij de klant aan tafel. Naast het ontwerp en het realiseren van de technische installaties, beheren en onderhouden we als geen ander de installaties van onze klanten: het totaalpakket is bij ENGIE in goede handen.

Markante projecten zijn hiervan het resultaat: de warmte/koudeopslag op het Oosterdokeiland in Amsterdam, de aanleg en het onderhoud van de installaties in de Beneluxtunnel, en de bekabeling van baggerschip Vos Maxima. Wij werken voor allerlei klanten zoals; Heineken, Schiphol, Shell en Rijkswaterstaat. Geen dag is hetzelfde – dat is typisch ENGIE. Samen werken we met plezier aan het eindresultaat en daarbij aan het behoud van onze klanten.

ENGIE. Ver vooruit in duurzame technologie



Secretary, Commissioner External Relations, Treasurer and then?

Author E. (Ellen) Boesten

My name is Ellen Boesten, a.k. former 15th & 16th board member and editor in chief of the INSide. As an alumni I'm asking myself this:

-How would my life have been without Mollier-

probably would have missed a bunch of friendships, good parties and a lot of associated experiences.

Before my life as a Mollier'ster, I have studied Built Environment (HTS). After that I went to the TU/e studying Building Physics and Services. During these study years on the TU/e I gladly joined the one and only study association Mollier, as secretary of the 15th and treasurer of the 16th board and how could I forget as editor in chief of the INSide. All these nice experiences: The trip to Mumbai India, the 90's party, the inauguration of the board, it was fun and I would love to do it again. I would not swap it for ... a couple of Jagermeisters!



Figure 2. 15th board of Mollier. F.I.t.r. Tom Thomassen, Sander Uittenbosch and Ellen Boesten.

But yeah, you cannot do all these fun things and have a job. The first job I had was at the engineering consultancy firm Valstar Simonis in Rijswijk and Eindhoven as a mechanical engineer for 3 years. I have written and drawn preliminary- and final design descriptions and detailed technical descriptions. During this time I also followed some additional courses of mechanical ventilation. Most of the job you learn by doing and/or in some cases a specific study or graduation project could give you a hit start.

Nowadays, I work at BAM Bouw en Techniek for almost a 1 year as a technical developer at the department of Planning & Development. I 'm a member of a multi-disciplinary team, working on tender projects. For almost all tenders a calculation, planning and an execution plan needs to be submitted. I gather all the information and together with the team I make the planning and lay-outs. Each project is different which makes this an interesting job. And, because I like activities, I joined in both companies the staff committee, planning activities like a barbecue for colleagues. It's always a lot of fun.

n my spare time, I like to play sports and to travel. In the last couple of years after my study I have been snowboarding in Austria, diving in Curacao, hiking in Nepal. I enjoy experiencing different cultures. After your study life is of course more regulated and so are my trips.



Figure 1. Visiting a temple site at a tour in Nepal

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