

ONDERZOEKSOPDRACHT KCNR FEBRUARI 2021

Titel van de opdracht

Structural damage monitoring of historical structures for earthquakes and effects of climate change

Korte omschrijving van het onderzoeksvraagstuk

This assignment is part of an ongoing project funded by Ministry OCW and RCE (Rijksdienst voor het Cultureel Erfgoed). The project is about seismic monitoring of historical buildings in Groningen.

Seismic monitoring is a structural health monitoring activity where the structures are instrumented with very sensitive vibration or deformation sensors, and the data are collected and interpreted continuously. Small changes due to temperature, humidity or rains, as well as instantaneous changes such as heavy wind load and earthquakes, can be recorded. In this way, the response (i.e. the answer) of the building to such effects can be analyzed and measures can be taken, if needed.

Groningen is subject to induced earthquakes, not to natural earthquakes. Induced earthquakes are caused by human activities in deep underground, usually due to energy exploitation projects. Groningen is the most affected induced seismicity region in the world in terms of physical and social effects of the earthquakes. The induced earthquakes in Groningen are repeated and of small magnitude, imposing damages on historical masonry throughout the entire gas field. Groningen is the largest gas field in Europe and 10th in the world. Due to the extensive gas extraction induced earthquakes of relatively “larger” magnitude have been recorded in the last decade. More than 1,300 small earthquakes are recorded, the largest of which was ML3.6.

Monitoring is an important tool for proving the damage-to-earthquake correlation and eventually material for compensation schemes in induced earthquakes. Structural health monitoring in historical structures is even more important because, additionally to the benefits of proving causality, it can also provide vital information on long-term structural response, weaknesses, trends, abrupt changes and seismic response. Such information, if properly collected and evaluated, can give insights regarding the repair, protection and, if needed, retrofitting of these important structures.

The RCE project, that is the topic of this assignment, is a project that is devised for establishing pilot case studies in the Groningen gas field area for i) developing methodologies of proper evaluation of the monitoring data, ii) for establishing standards of structural monitoring in case of induced earthquakes, and for iii) increasing awareness among professionals on “why” and “how” to do structural monitoring in historical buildings in the region. The main focus of the project is both monitoring and also interpretation of results from the monitoring activities, which are the effects of maintenance and/or structural operations as well as the added value of monitoring in protecting historical buildings.

We also found in our research that the changes in ground water due to excess rain or draught may also effect the structural integrity. This is because in types of soil, like in Groningen, change in ground water causes soil movements, that may cause damages on structures. So extreme rain or extreme draught can eventually cause structural damages.

Aansluiting bij thema's NoorderRuimte

(Meerdere thema's aankruisen is mogelijk)

- Aardbevingen
- Duurzaamheid & Overvloed
- Gezondheid & Welzijn
- Leefbaarheid

Aanleiding tot de onderzoeksopdracht en de huidige situatie

Monitoring is an activity where a lot of data is streamed into the system continuously. Interpretation of this data require a multidisciplinary approach, a combination of knowledge on the structures and knowledge on some basics sensor data. This assignment is not very much related to the sensors themselves but to the data and structural meanings instead. This is because the sensors that will be used in this project are already defined, standard commercial products for which no further research is needed or planned within this project. The need is more on the collected data and what these data mean for the structure.

The research here will also require contact with a sensor company in the region. StabiAlert, that is the largest manufacturer of tiltmeters in the North Netherlands, provides sensors to our research group for monitoring of structures. We need to understand their sensors and the data better, and also what their data mean for the buildings. In order to do that, we will look at the slow data (i.e. for slow movements related to soil and water effects) and also the fast data (i.e. the high-frequency data that is recorded in instantenous events such as earthquakes).

We will be monitoring 3 structures in the Groningen region and the tool to be developed will have access and will make use of all these three historically important structures.

The assigment has very much relation with what is actually going on in the outside world at the moment. This is beacuse the structural sensors became cheaper and easier to access, and the awareness has increased. This is reason why more and more structures are equipped with structural sensors. There is abundance of data but teh challenge now is how to make these data more understandable for non-experts, managers, desicion makers and simple inhabitants. It is part of IoT - Internet of Things, and also Big Data.

Gewenste situatie met betrekking tot het vraagstuk

In this assignment, the students are expected to :

- get familiar with our structural monitoring system at three case study structures in Groningen
- understand how the sensor data are structured (file formats, content, etc.)
- understand the meaning of the data in relation to the structures
- collect water and meteorological data, combine with the structural monitoring data
- evaluate the past and potential future damages on these structures, combine with the data measured during the past earthquakes and other climate changes (long lack of rain and extensive rain fall etc.)

The work will take part at NoorderRuimte. The students from disciplines of civil technique, architecture or built environment are suitable for this task. We prefer a group of 2 students.

The students are expected to deliver a report with their findings on the effects of earthquakes and effects of climate-related issues on their monitoring results. All the data will be provided to the students as well as assistance on how to evaluate these data. We will have a short training of students on the meaning of the data.

Afstudeeropdracht, stage-opdracht ...

(Meerdere mogelijkheden aankruisen is mogelijk)

De opdracht is geschikt als:

- Afstudeeropdracht binnen bureau NoorderRuimte: semester in jaar 4
- Stage (mogelijkheden/opleidingseisen in overleg bekijken)
- Onderzoeksoopdracht binnen het curriculum in andere studie jaren
- Honours onderzoeksoopdracht
- Buitenwerkplaats SABE (2^e jaars Built Environment - looptijd semester 2)
- Vastgoedlab (3^e jaars Vastgoed & Makelaardij - looptijd semester)
- Schakelstudent: deel van schakeltraject met RUG.
- Anders, namelijk

Vacatures voor studenten van de opleidingen

Noodzakelijke opleidingen bij het onderzoek:

Opleiding	x aantal studenten	Onderzoeksintek voor deze discipline
<i>Built Environment</i>	2	<i>Students civil engineering, architecture, built environment</i>
<i>Kies uit de lijst</i>		
<i>Anders, namelijk...</i>		<i>Sensortechnologie en Bio-informatica</i>

Wenselijke opleidingen bij het onderzoek:

Opleiding	x aantal studenten	Onderzoeksintek voor deze discipline
<i>Kies uit de lijst</i>		
<i>Kies uit de lijst</i>		
<i>Kies uit de lijst</i>		

De volgende kennis/skills zijn noodzakelijk en/of gewenst

Skills on MS Excel
Basic understanding of dealing with data
Basic understanding of structural damage (cracks, structural elements etc.)

Interne opdrachtgever

Contactpersoon: Katerina Paxinou

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Lectoraat: Aardbevingsbestendig kansrijk Groningen

Onderzoeksprogramma:

Website:

Problemeigenaar, externe partner/opdrachtgever

Bedrijf/organisatie(s): StabiAlert

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