

University of Borås Self-assessment Report – Building Technology

1. UNIT OF ASSESSMENT:

Building technology

1.1. Research area

Research conducted by the group is defined by each senior researcher's area of competence. The group is inclusive and open for individual researchers and research groups doing scientific-, technologic- and/or empiric-based research in the field of building technology or fields where interdisciplinary work may be synergetic.

The core of the research group is made up by; Dr L. Hägerhed (Assoc. prof. and principle of study 2019 - 2021), Dr H. Movaffaghi (Assoc. prof. and coordinator for quality control at the faculty of textiles, engineering and business 2022 -), Dr A. Nagy (Assoc. prof. and board member for research and education board at the University of Borås 2016 -), Dr M. Sadagopan (Post doc.) and Dr S. Svensson (Prof. and member of the academic employment and assessment committee at the University of Borås 2017-2019).

Affiliated to the research group are: Ms H. Askemar (Ph.D.-student), Mr A. Oliva Rivera (Ph.D.-student), Mr J. Pyykkö (Ph.D.-student), Mr A Kadawo (Assis. prof.), Mr K. Kurkinen (Assis. prof.), Dr K. Malaga (Adj. prof.), Mr C. Samuelsson (CEO), Dr C. Markusson (Senior researcher), Dr. D. Ekwall (Prof.) and Dr J. Wittsten (Prof.)

At present the active research is focused on the topics:

Wood-water relations. Mechanics of yielding fasteners enclosed in timber or concrete. Performance of hybrid structural elements combining concrete, timber, and steel. Optimization of structure and structural elements regarding structural performance, environmental footprint, and economy. Indoor climate and air quality including energy efficient demand-controlled ventilation. Recycling aggregates of concrete, CO₂ uptake of concrete waste.

1.2. Contact person

Staffan Svensson

2. Profile of the unit of assessment

2.1. Description of recent history and organizational development

The research group was established 2014. Prior this research in the field of building technology was conducted by one assistant professor Dr A. Nagy and one Ph.D.-student Mr K. Kurkinen, the latter connected to Chalmers university of technology. The research was, however, not organized in a research group. In 2014 funds was granted by Mr. Gunnar Ivarson to Borås University (HB) for hiring two professors in the field of building technology. It became one full time professor in building technology Dr S. Svensson, one associate professor in building physics Dr L. Jagemar and one adjunct professor in concrete Dr K. Malaga. The role of research group leader of building technology is a task included in the position of the professor on the topic.

Additional funding by Mr Gunnar Ivarson and by Sparbanken Sjuhärads was given to build and equip a laboratory. The laboratory took close to four years to establish, inaugurated May 2018, during this time however experimental research was performed in the operational parts of the laboratory.

Since the inauguration the laboratory is continually being equipped with required apparatus for ongoing projects and education. In 2020 a part time laboratory assistant was associated to the laboratory.

In June 2015 the first Ph.D.-project in building technology was initiated at HB. Since HB didn't and doesn't have examination rights in any subject within civil engineering, examination was possible through the help of Uppsala University (UU). In March 2019 the thesis of the Ph.D.-project was successfully defended. During this time additional two Ph.D.-projects was initiated within building technology. One of the candidates was enrolled at UU and one at recourse recovery at HB.

In 2017 and in 2018 two assistant professors Dr L. Hägerhed and Dr H. Movaffaghi were hired by HB to cover teaching deficits in the civil engineering programs. Both were included in the research group. Assoc. prof. Dr L. Jagemar unexpectedly and tragically deceased in the spring of 2020. It was decided by the prefect of resource recovery and building technology to leave the position as Assoc. Prof. in building physics vacant.

In the period 2020 to 2022, the research groups' three assistant professors, Dr L. Hägerhed, Dr H. Movaffaghi and Dr A. Nagy were assessed and promoted to associate professors. In 2021 Dr M. Sadagopan joined the research group as junior researcher. The same year the research group leader proposed at a research group meeting to close down the research group. The majority of the research group was against this proposal.

2.2 Special factors of influence

Building technology is not a prioritized research field of HB. Teaching is the main task of the research groups' core members. There is no indication from HB, faculty or department to change the status of the research field nor the teaching burden of the core members of the research group.

In 2019 it was suggested by the prefect of the department for resource recovery and building technology Dr P. Therning and decided by the dean of the faculty for textiles, engineering and business, Dr R. Emardson to close the advanced program in sustainable building technology. In 2020 it was suggested by the same prefect and decided by the same dean to start a new bachelor program to be led and taught by the building technology teaching staff.

In September 2021 the main benefactor for building technology research at HB, Mr. G. Ivarson sadly passed away.

During the covid pandemic the laboratories were in principle closed. Teaching burden was also significantly increased for all research group members during this time.

3. Research Environment

3.1 Description of competences and opportunities for merit and skills development.

The competence of the research group members, see 1.1, is of course the fundament of skills, knowledge and experience of the research group. The theoretical work, mathematical description and quantification, spans from material physics to assessment of constructions sustainability. Experimental work is both verification and exploration. It spans from monitoring volatile molecules in indoor air to the overall performance of structures.

Research is the prerequisite for development. No group-member is hindered to publish, submit applications nor conduct research due to the fact of belonging to the research group of building technology. At HB employment as associated prof. grants 20% of workload to research and skills development. For full professors at the faculty of textiles, engineering and business 40% is granted for research, research administration and academic administration. The plan for Ph.D. students, is negotiated with their employer (all at present being the regional industry). The aim from the research group is always that the Ph.D.-student spend 80 % on research of the Ph.D.-project in the academic environment of HB.

3.2 Description of research facilities and infrastructure.

The research facilities are foremost the laboratories with their equipment, later described, but also workstations with software. The mathematical modelling is both analytic with closed solutions and numerical using methods of discretization. This means there is a range of different software used and the type of application determines which software to be used.

The laboratory equipment at the research group's disposal enables e.g: Manufacturing, preparing and conditioning test specimens. Grinders and sifts for concrete aggregates. Mixers and moulds for casting concrete, mortar and cement paste. Fall tables and cones for testing consistency of concrete mixtures. Microscopy of material surface structure, failure surface, etc. Material diagnostic with ultrasound.

Thermogravimetric analyses and chemical spectroscopy. Measuring and controlling climate parameters. Constant climate facility, freezing and thawing equipment and CO₂ cabinets. Dynamic material testing and Charpy impact testing. Mechanical testing of material specimen and structural components in frame with uniaxial excitation. Deformation measurements with camera and lvdt-transducers during mechanical testing and climatic testing including long-term material or component monitoring. In-situ monitoring of climate parameters and in-situ mechanical testing with load cells and transducers.

At HB the infrastructure for research, in addition to the laboratories, are library support, it-support for software and workstations, grants and innovation office and a well-staffed communication office.

3.3 Description of research seminars

Research seminars is not organized by the research group on a regular basis. The research group members participate in international conferences in their topic of expertise. Under the organizations of COST, ISIAQ, RILEM and Nordic concrete research, group members partake in workshops with international research seminars. Short presentation of a popular kind on ongoing research is done annually to the full teaching staff in building technology at HB.

It should be obvious that the research group is very small with five core members out of which there are four senior researchers. Each senior researcher has her/his expertise in an area of research, within the vast research field of building technology, other than the fellow senior researcher of the group.

3.4 Description of academic network and collaboration.

The heading of this paragraph invites to a long list of institution names. To spare the reader, a somewhat descriptive story will instead be given on the academic network followed by some examples on ongoing and former academic collaborations.

At the national level the group members have one or several contacts with all universities (universitet och högskolor) from Luleå to Malmö that conducts research and/or have educational programs in building technology.

At the European level the academic network is also extensive. Through many years participation in umbrella organizations such as COST, ISIAQ, ECCOMAS, INTER, RILEM and others the academic contacts span a network at European universities and institutions where research in the fields of Building materials, Building physics, Structural safety and Timber engineering are conducted. The list of institution names will exceed the interest of most readers, on request a list will of course be assembled and tabled.

Outside Europe, the academic network is mostly concentrated to North America, Japan, Australia and New Zealand.

Examples of academic collaboration where research have rendered in joined publication are Technical University of Denmark, University of Ljubljana, ETH Zürich, Jönköping university, Research institute of Sweden, University of Edinburgh.

Examples of academic collaboration of assessing academic quality are Uppsala University, Technical university of Vienna, Linnaeus University, Chalmers university of technology, Royal institute of technology (KTH), Luleå University of technology.

Examples of academic collaboration of joint supervision of Ph.D.-students, Ph.D.-classes and invited lecturer to seminars (not conferences) or teacher to Ph.D.-classes are Norwegian University of Science and Technology, Delft university of technology, Aalto University, Lund University, Uppsala University, Research Institutes of Sweden, Linnaeus University.

Research visits at other research institutes by the group members or hosting researchers from other research institutes have been as academic collaboration with Auckland University, University of Kassel, University of Ljubljana and examples of planned hosting of researchers for 2023 and 2024 there will be in collaboration with Technical Research Centre of Finland.

3.5 Description on how the research group promotes equality and sustainability

The composition of the research group's core members promotes by itself equality.

Members have, furthermore, initiated and are organizing meetings and lecture on equality for students on the three education programs within civil engineering at HB.

Research conducted by the group on construction materials and structural performance originates from curiosity on how to perform sustainable building technology. Core members of the group planned, initiated, taught, supervised, administrated and examined the one-year master program in sustainable building technology. All active Ph.D.-students associated with the research group have been students at this master program. The program was, without assessing consequences for the building technology research group, closed down 2019 by the dean of academy, see 2.2.

4. PRODUCTIVITY AND IMPACT

A short exposé on establishing productivity is here required. The research group is small and only two core members were with the group from the start 2014. One of the members was hired in 2014 with one task being to establish research in building technology. Laboratory infrastructure was in the deal of this employment. The plan was to have the laboratory for building technology in place within one year. The timeline of the plan was not held due to changes of organization at HB leading to new and additional managers with interests other than building technology research and hence laboratory. It took most of core members' productivity for three and a half years to establish laboratories feasible for building material and mechanical research.

Numbers on the groups productivity from the start 2014 are as follows. Two Ph.D.-candidates have successfully defended their thesis. Three assistant professors have been assessed and deemed qualified for advancement to associated and HB have therefore

granted them positions as associated professor. 21 refereed manuscripts by the core members have been published, since the start, in recognized international research journals. Together with the groups Ph.D.-students the core groups members have presented work at a dozen and one international research conferences. The h-index is in average 9.6 for the core group with indices ranging from 4 to 20.

Quantifying research impact requires hope and good faith. That the examined Ph.Ds. continued their academic career, one at University of Ljubljana and one staying with the group indicates that their research have had impact that leads to employment and financing. That research institutes sends or plan to send researcher on visit, see 3.4, to the building technology group at HB is also an indication that the research has impact. That core members are also members in executive committees of research organizations and/or in advising committees for authorities and organizations are most probably also due to impact of their research. Another way of quantifying research impact could be, counting citation of published work. In the research fields of building technology, a criterium of research impact could be about hundred citations of a publication. The core group members have produced eleven such publications. If criterium for significant impact is set at five hundred citations, the number of significant publications by the core group members are four.

5. COLLABORATION

The research group in building technology is closely connected to the center for sustainable community building¹ at HB. The mission of the center is to initiate, support, develop and coordinate multidisciplinary collaboration between research and society. Projects with Borås municipality and regional industry is the most common projects of the research group. The projects could be as Ph.D.-projects, three candidates working on their Ph.D.-degree at present are financed by and partly work at industrial collaborators. There have also been and probably will be shorter research projects where collaboration was/will be financed by industry/municipality/region (VGR)/national research grants (Vinnova).

Research on construction materials and mechanics of structural components has the aim to give a more nuanced knowledge base for the European structural codes. Research group members are involved through e.g. COST with pre-work for the continuous ongoing revisions of the codes. Dissemination of research results through standards is of course not a fast way to give back to society. The research is also merged and filtered with other research results, best of knowledge and tradition. The impact on the construction of our future built society is, however, immense.

6. CONNECTION BETWEEN EDUCATION AND RESEARCH

The main task of all senior core members of the research group is teaching, see 2.2. This being a fact, the teaching is exclusively on undergraduate level due to the close down of the graduate program in sustainable building, see 2.2. The students on undergraduate

¹ <https://www.hb.se/forskning/forskningsportal/centrumbildningar/centrum-for-hallbart-samhallsbyggande-chs/>

level does not have the mathematical knowledge to be able to comprehend theory of the ongoing research in building technology. In ordinary education on undergraduate level held by senior members of the research group novel empirical research results is when appropriate included but theoretical base of research, is when included in education, of historical origin.

The building technology laboratories was funded by Mr. G Ivarson with the condition that they should facilitate both research and education. Students from all three building programs will at more than one occasion work in the laboratory where also experimental research is ongoing. The work done by the students in the laboratory is most often supervised by researchers.

During students' diploma work about a dozen students chose to take part in experimental work directly connected to ongoing research. Supervision of this kind of diploma work is always done by active researchers.

7. DEVELOPMENT AND STRATEGY

Sustainability is and have been the new black for a decade or three. Politics of the modern world have at last acquired the fact of limited resources. In civil engineering the main task is now to transform and develop the built environment and its services towards sustainability. In the field of building technology sustainability have forced a change on how to construct buildings, from solely an economic perspective.

The ongoing work by the research group in building technology at HB are all with the angle towards sustainability. In the construction material and structural engineering areas, the objective is to continue work on replace, use less, re-use and recycle without undermining structural safety nor serviceability of buildings. The effect of altering building technology by monitoring and comparing real cases for the full construction and service cycle of buildings or their components are also topics that are and will be active within the research group. In all, it clear that ongoing research within the research group is in the forefront of the general developments in the research field of building technology.

The strategy is to convince the leadership of HB, faculty and department that building technology is an important research field not only for society but also for HB. To develop further as a research group in the field, the teaching burden of the core group must decrease and the number of young researchers must increase.

8. DISCUSSION AND CONCLUSIVE EVALUATION

To conclude, research in building technology is of low priority at HB. The research group is small and the senior core members main task assignment is teaching. The strength of the group is its close contact with regional industry, ability to include research in teaching, equipped and partly staffed laboratory and a large network of researchers or research groups nationally and internationally.

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