The Research Council of Norway

Evaluation of Mathematics, ICT and Technology 2023-2024

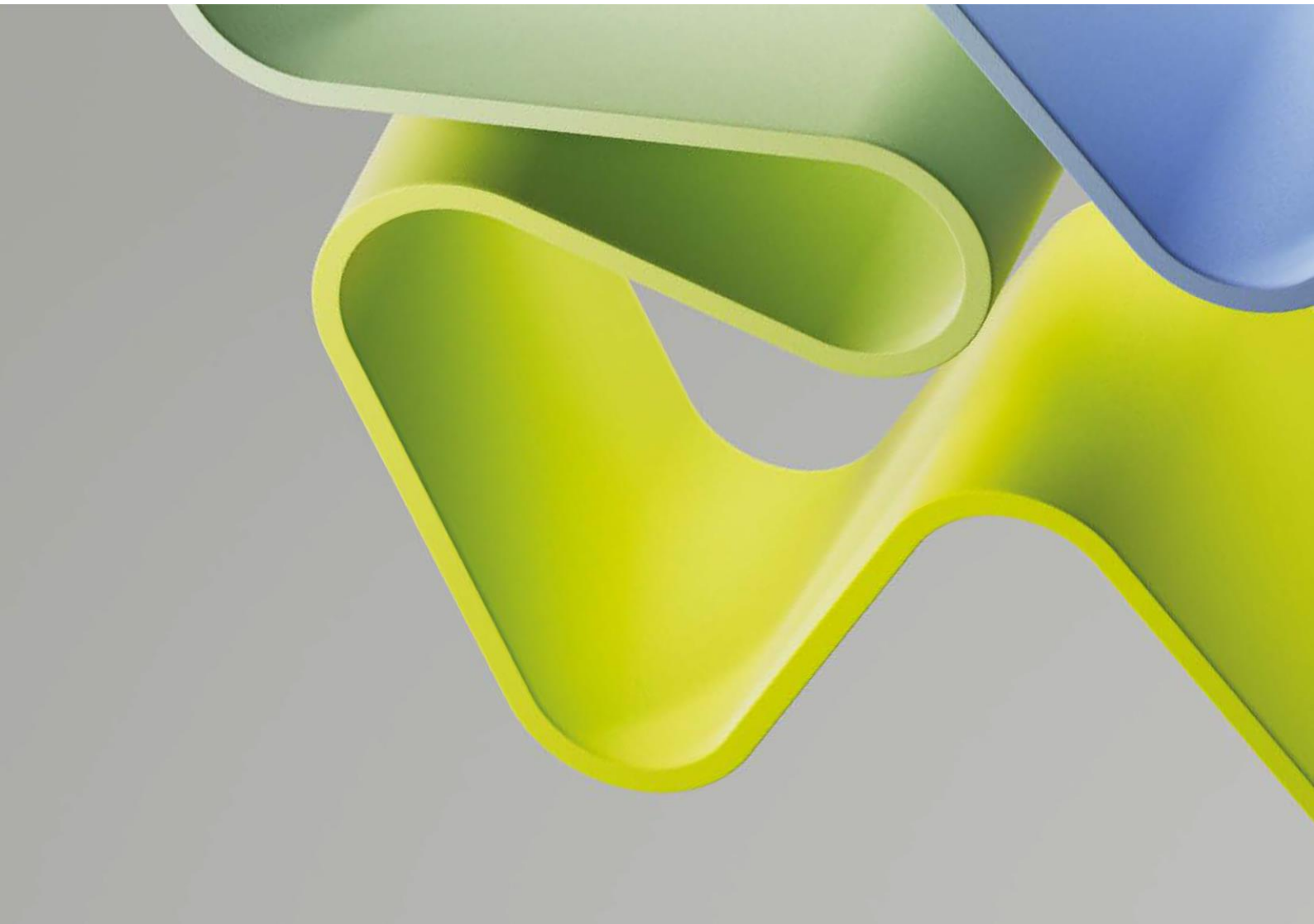
Evaluation Report for Administrative Unit

Administrative Unit: **Department of Structural Engineering**

Institution: **Norwegian University of Science and Technology, NTNU**

Evaluation Committee Higher Education Institutions 4

December 2024



Contents

Statement from Evaluation Committee Higher Education Institutions 4

The members of this Evaluation Committee have evaluated the following administrative units at the higher education institutions/research institutes within Mathematics, ICT and Technology 2023-2024 and has submitted a report for each administrative unit:

- Department of Building, Energy and Material Technology, UiT The Arctic University of Norway
- Department of Architecture and Technology (IAT), Norwegian University of Science and Technology (NTNU)
- Department of Civil and Environmental Engineering (DCEE), Norwegian University of Science and Technology (NTNU)
- Department of Geoscience (IGV), Norwegian University of Science and Technology (NTNU)
- Department of Structural Engineering (KT), Norwegian University of Science and Technology (NTNU)
- Department of Manufacturing and Civil Engineering (IVB), Norwegian University of Science and Technology (NTNU)
- Department of Energy and Process Engineering (EPT), Norwegian University of Science and Technology (NTNU)
- Department of Built Environment (BE), Oslo Metropolitan University (OsloMet)
- Department of Energy and Petroleum Engineering (IEP), University of Stavanger (UiS)
- Department of Mechanical and Structural Engineering and Material Science (IMBM), University of Stavanger (UiS)
- Department of Process, Energy and Environmental Technology (PEM), University of South-Eastern Norway (USN)

The conclusions and recommendations in this report are based on information from the administrative units (self-assessment), digital meetings with representatives from the administrative units, bibliometric analysis and personnel statistics from the Nordic Institute for Studies of Innovation, Research, and Education (NIFU) and Statistics Norway (SSB), and selected data from the National survey for academic staff in Norwegian higher education and the National student survey (NOKUT). The digital interviews took place in the autumn 2024.

The members of the Evaluation Committee are in collective agreement with the assessments, conclusions and recommendations presented in this report. None of the committee members has declared any conflict of interest.

The Evaluation Committee has consisted of the following members:

Professor Claudio Mazzotti, University of Bologna (Chair)

Professor David Baglee
University of Sunderland
Professor Sebastian Geiger
TU Delft
Professor Mohamed Pourkashanian
, University of Sheffield

Professor Elsa de Sá Caetano
University of Porto
Professor Per Heiselberg
Aalborg University

Description of the Administrative Unit

The scientific staff of the Department of Structural Engineering at the Norwegian University of Science and Technology (NTNU) includes 18.4 professors, 15.6 associate professors, 11 postdocs, 8.3 researchers, 1.4 assistant professors, and 44 PhD candidates. Increasing the number of female scientific staff is a priority, and efforts are being made through direct calls and dedicated committees to improve gender distribution.

The Head of Department, supported by two Deputy Heads (one for education and one for research), provides research leadership. The management team, comprising the department head, deputies, group leaders, laboratory leader, PhD coordinator, head of administration, and a PhD student, meets regularly to discuss university and faculty research initiatives and plans. Research groups receive support from HR, HES, and economics advisors, as well as lab technicians and IT engineers. Research group leaders are tasked with initiating research and coordinating research applications, especially within their group and across other subject areas.

The research is organised in the following research groups:

- Concrete Group
- Nano and Biomechanics
- Structural Impact Laboratory (SIMLab)
- Structural Mechanics Group (KMEK)

The AU aims to produce high-quality research and elevate its research groups to top international levels. While the groups have significant freedom in setting priorities, effective communication ensures coordinated responses to new challenges. They are open to interdisciplinary topics and leverage their networks to form strong teams. The AU is also building expertise in bio- and nano-mechanics. Focusing on sustainable structures, the AU's mission is to educate engineers at all academic levels and develop new knowledge of material behaviour in structural engineering and computational mechanics. This aligns with the university's strategy of developing "knowledge for a better world." The AU aims to improve structural design methods, reduce the structural carbon footprint, and enhance clinical treatment procedures for better health outcomes.

The AU's research is largely interdisciplinary, requiring extensive collaboration with groups that have complementary expertise. This includes both national and international partnerships. Researchers are encouraged to leverage their networks to tackle challenging questions. Nationally, the AU works closely with industry, contract research institutes, the public sector, and other university faculties. Internationally, it collaborates with numerous universities, primarily in Europe, through programs funded by the European Commission, such as MSCA, ERA-NET, COST, and Joint Undertakings Europe's Rail. These collaborations provide access to advanced laboratory equipment, benefiting industrial partners, and allow for the sharing of specialised knowledge, enhancing learning for all participants.

Overall Assessment

The research at the Department of Structural Engineering is organised in four groups: Concrete, Nano and Biomechanics, SIMLab and Structural Mechanics. Although the Nano and Biomechanics group results from a recent merger, its scientific staff is involved. Therefore, according to the Terms of Reference [ToR, 1], this assessment addresses the activities, track record and impact of the scientific members of these groups.

In the Terms of Reference, the Committee is asked to provide a qualitative assessment of the AU as a whole [ToR,2]. The assessment should consider the current international trends regarding:

a) Strategy, resources and organisation.
b) Research production, quality and integrity.
c) Diversity and equality.
d) Relevance to institutional and sectoral purposes.
e) Relevance to society.

The research strategy of the AU is aligned with that of NTNU and the AU's mission, namely regarding Sustainable Structures and the "development of knowledge for a better world", supporting education and research. The research topics and priorities of the team members are defined individually and communicated through group leaders through a very informal organisation. The AU implements monitoring and coordination between the groups without operating a strong steering.

The research groups have access to several well-equipped laboratories and numerical facilities provided by NTNU. They have the support of HR and HES. An innovation coordinator has been hired recently. Overall, the AU is very well positioned at the national and international levels, and it is known for the quality of its research. The group dimension is very good and has very good dynamics. A broad range of topics are covered. The research is aligned with modern trends and the general objectives of NTNU.

The AU secures considerable funding from diversified sources, and the links with industry, institutes and national partners are of particular relevance. Access to relevant infrastructures and funding facilities for recently recruited researchers is among the aspects that evidence the excellent working conditions of the AU. The research allocation time is adequate.

The research team produces high-quality research, above the average at the national level and close to the top among Norwegian universities regarding the number of publications, the citation record, and the number of international publications.

The AU has demonstrated high societal impact exemplified by the relevance of its research on the community, both in terms of direct impact and technology transfer.

The light management that is executed has contributed to the creation of a pleasant working environment and enabled the researchers to have significant freedom regarding the choice of research topics and collaborations. The AU has grown considerably during the evaluation period. However, the research strategy is very dependent on individual interests and networks and does not favour the consolidation of a certain profile for the AU.

Also, although there is a high awareness and commitment to produce high-quality research, benchmarks for scientific outputs are not clear, and neither is the recruitment and retainment policy. Gender balance is one aspect where the AU has not managed to improve during the evaluation period.

Finally, although the AU implements different actions to support grant applications, the actual selection of funding schemes is very much determined by external request and funding opportunities and less by the construction of a specific vision by the AU.

In relation to the plans described in the strategy and self-assessment, the prospects are that the AU will maintain its national relevance and continue growing. However, some measures should be taken to enhance the international position, to define the research profile better, and to diversify funding opportunities.

The Terms of Reference for the administrative unit is attached to the report.

Recommendations

1. Clarify the research strategy, management, and infrastructure access in order to increase awareness among the staff and help them communicate better with other research and industry centres.
2. Set a long-term strategy including the actual ambition of “following the available fundings” but also targeting the evolution of the way of doing research (mission oriented). It should also include societal needs and an ambition to influence them, at least at a national level.
3. Define more AU-specific benchmarks to help researchers plan their activities and careers. For example, the number of PhD students per member of permanent staff should be targeted to grow from the present value of 1.4 to at least 2, in order to excel at international level.
4. Establish a more robust recruitment and retainment policy to guarantee the continuity of the research while enabling a renovation of the team.
5. Promote transdisciplinary research across the different research groups and other parts of the university owning infrastructures, to increase internal cooperation and exploit the available potential.
6. Increase the visibility of the AU and its facilities to boost international collaboration and create more EU-funding opportunities, i.e. by showcasing the available infrastructures and success cases.
7. Establish a more effective policy to improve the gender balance within the AU.

1. Strategy, Resources, and Organisation of Research

The research at the Department of Structural Engineering is organised in four groups: Concrete, Nano and Biomechanics, SIMLab and Structural Mechanics. Although the Nano and Biomechanics group results from a recent merger, the same scientific staff are involved. Therefore, according to the Terms of Reference [ToR, 1], this assessment addresses the activities, track record, and impact of the scientific members of these groups.

In the Terms of Reference, the committee is asked to provide a qualitative assessment of the AU as a whole [ToR,2]. The assessment should consider the current international trends regarding:

- Strategy, resources and organisation.
- Research production, quality and integrity.
- Diversity and equality.
- Relevance to institutional and sectoral purposes.
- Relevance to society.

1.1 Research Strategy

The research strategy of AU follows the goals of NTNU and the faculty's mission, contributing to the objective of "development of knowledge for a better world" by supporting education and research namely regarding Sustainable Structures.

The research combines experimental and mathematical modelling of materials and structures, covering a broad range of areas within Structural Engineering, organised in four groups: Concrete, Nano and Biomechanics, SIMLab, and Structural Mechanics.

These groups address the more traditional structural engineering topics and new disciplines, such as Nano and Biomechanics.

Research topics are freely identified and chosen within the research groups but are aligned with the university and AU's goals and mission. The AU implements monitoring and coordination between the groups without operating a strong steering. This is done consciously to enable all groups to perform at their best.

The AU aims to produce high-quality research that is highly positioned at an international level.

Apart from setting a high standard for scientific output and internationalisation, and defining the framework for research, the AU does not apply a specific strategy for its research and progression or its positioning in the international landscape. Instead, the search for funding is used as the guiding principle for the research. This may be effective in the short term but does not strongly contribute to determining scientific priorities and setting a path for innovation.

Recruitment and retainment of staff are not discussed in the self-assessment but were brought up during the interview; the strategy is to recruit professors and researchers with skills and competencies partially overlapping that of more senior staff to guarantee the succession of topics by younger researchers, both in education and in research, ensuring the continuity of each research group even in a future situation of staff reduction.

Overall, it can be concluded that the AU strategy is aligned with the institutional strategy and it promotes research on innovative areas and development of high-quality research with high productivity. Yet, the light management and coordination do not support a long-term positioning of the AU at both the national and international levels.

Recommendations to the AU.

- The AU should work to define a stronger strategy for its research and positioning at the national and international levels. If the AU would like to grow and excel, a strategy which is more future-proof is needed.
- Despite the light management and freedom given to the research staff to define their research topics, it would be convenient to set benchmarks more clearly in order to help the researchers align their goals with those of the AU and the university.
- An internationalisation strategy should be promoted in the AU to increase the independence of research topics from funding opportunities and diversify the funding sources, as well as through an increased focus on European funds.

1.2 Organisation of Research

The research priorities and topics are defined freely within the research groups, which generally apply a "flat" structure and have light coordination and ample freedom for the researchers to follow their own interests.

The university provides means to research groups in terms of well-equipped laboratories and support from HR, HES, and economic advisors.

Research is organised into four groups. This division is a compromise between scientific interests, educational obligations, human resources management, and laboratory services. However, there is a good balance between the dimensions of the four research groups. Research is organised by projects or work packages within the research groups.

Education is organised by the university, and the AU's contribution is linked to the research at the AU.

Communication across the research groups is done through the group leaders who participate in the management team. The decisions of research topics and initiatives for projects and consultancies are taken individually within the groups but communicated through the group leaders. Networks and international collaborations are also established at an individual level.

The light organisation structure enables enormous freedom for the researchers and puts responsibilities on them. Nevertheless, a common strategy for the AU to address specific topics does not seem to exist.

The AU has strong links to the industry and established a formal consortium 25 years ago. All the research groups, except the Nano- and Biomechanics, have significant connections with the industry, with many research projects driven by external interests. PhD students participate in projects.

From 2023, the AU has an innovation coordinator to promote and follow up on innovation issues with the research staff.

The Nano and Biomechanics group is one of the youngest and least established groups; therefore, the AU recruited a professor using an ERC grant to strengthen it.

With respect to growth of the AU, the organisational structure is suitable, contributing to a light and creative environment and enabling ample freedom for the scientific staff. At the same time, a more structured approach would help the AU as a whole to develop its vision and achieve its priorities.

Recommendations to the administrative unit.

- The AU has successfully secured funding according to available opportunities. However, there is potential to improve internal and external collaborations through a more coordinated strategy linking the AU's competencies to prioritised research topics.
- The AU should put in place a long-term recruitment and retainment policy aiming at securing a smooth succession within the research groups, following retirements or leaves of senior staff.
- The innovation coordinator is an excellent initiative to foster research and should be used as an instrument to increase grant applications, especially at an international level. Therefore, his/her role should be more clearly specified by the AU.

1.3 Research Funding

The AU's annual budget amounts to 100 MNOK per year, with a share dedicated to research of 60%.

The basic funding per year of the AU is 27.6 MNOK. An additional 70.1 MNOK are obtained from national grants (66.2 MNOK), national research contracts (1.6 MNOK), and

international grants (3.9 MNOK). Funding from RCN amounts to 36.3 MNOK, representing 52% of the external funding. On average, the total research funding per staff member per year is almost 1 MNOK, which is an appropriate amount. This level of funding, particularly the funding for national grants, reflects the high quality of the research.

The funding across the four groups varies, with SIMLab and the Structural Mechanics groups having secured external funding of about 20 MNOK, while the Concrete and Nano and Biomechanics groups having secured funding of about 13 MNOK.

The international funding is relatively low, representing less than 6% of the total external funding. The SIMLab group reports no international funding. Discussions during the interview however contradicts this information. Nevertheless, it is recognised that international funding is scarce within this group.

The Concrete, SIMLab and Structural Mechanics groups have a fair share of industrial funding. In contrast, Nano and Biomechanics reports modest industrial funding. This is claimed to be a consequence of this group's characteristics despite being considered strategic for the AU.

From information provided during the interview, it is observed that a significant number of funding applications have been submitted (79, in the period 2020-2024, with rates of success of the order of 20% to 50% per research group and final values of external funding of the order 1.5 MNOK to 3.9 MNOK per permanent member of the scientific staff over the four research groups. Such capacity of permanent staff members to secure external funding is very relevant. These numbers evidence the Department's commitment to supporting funding applications by promoting several actions, such as workshops, seminars, and training sessions on grant writing.

Recommendations to the administrative unit.

- The significant and diversified research funding is appreciated, and the AU should continue its way of securing it.
- The AU is highly committed to supporting funding applications. However, an effort should be made to promote more applications to international funding schemes. This is particularly relevant to the SIMLab group.

1.4 Research Infrastructures

The research groups have access to several laboratories and numerical facilities provided by NTNU. HR, HES, and economic advisors also support the research groups.

NTNU has several well-equipped infrastructures, particularly the structures and materials laboratory. This laboratory is the largest of its kind in Norway and supports the research groups. The NTNU Nano Lab is part of the national infrastructure NorFab. The AU also has access to Sigma2 high-performance computing and large-scale data storage.

The AU does not participate directly in an international infrastructure.

None of the research groups hosts a laboratory, except SIMLab, which manages a Linux cluster. The AU covers the costs of running the laboratories by charging a fee for their use; this is a good scheme, allowing for sustainability.

The AU is working to ensure compliance with FAIR principles.

Recommendations to administrative unit.

- The AU has access to outstanding facilities and should showcase the available infrastructure on a website aiming to increase international cooperation.

1.5 National and international collaboration

Based on the interdisciplinary nature of the research, collaboration with other universities, institutes, hospitals, and industries is necessary and promoted within the AU. Such collaborations are seen by the AU as an added value to the research quality and are encouraged to be developed on a personal basis, through personal networks, and also at national and international levels.

The exemplified collaborations involve relevant national partners such as the Norwegian Public Roads Administration, SINTEF, NORCEM, and St. Olavs University Hospital in Trondheim. At the international level, two collaborations are mentioned in the area of Concrete, but also collaborations with several universities are described, mostly with institutions situated in Europe.

Therefore, it can be concluded that the AU is receptive and open to collaborative initiatives including cross-sectoral and interdisciplinary collaborations, as well as collaborations with non-academic/public partners.

Nevertheless, the strong links with national and some international institutions seem to be organised at an individual level rather than being initiated by the AU on a more strategic basis. If taking a look at the publications, the NIFU data shows that national collaboration is relatively limited (12.3%, in 2022) taking as reference the national average (24.3%, in 2022). Instead, international collaboration in publications (65.4%, in 2022) exceeds the national average (56.9%, in 2022). An opposite pattern is observed for funding, i.e., funding secured at national level is considerably larger than funding secured at international level (section 1.3).

Recommendations to administrative unit.

- The AU has several national collaborations involving the industry and important stakeholders. Such collaborations should be incremented and further exploited in terms of research outputs.
- Across all research groups, international collaboration should be promoted, especially taking advantage of the excellent infrastructure provided by NTNU. This could enhance opportunities to secure EU-funding.

1.6 Research staff

The research staff spans the age of 30 to 68.

The team has about 100 members and, according to NIFU data, it has grown about 60% from 2013 to 2021. About 40% of this growth is associated with the number of PhD students (44) (32 to 46, 2013–2021). The number of associate professors has grown from about 8 to 15,6. This number is linked to a growth in the number of postdocs and researchers in 2013–2021 (7 to 30), which actually total 19.3. Finally, the number of professors (18.4) has been stable.

The share of women at the AU, 20%, has been stable from 2013 to 2021. While the share of female PhD students has also been stable and of the order of 26% (presently, 32%), the share of female professors and associate professors is relatively low (13.5% and 7.7%, respectively). Postdocs and researchers have a share of 27% and 24%.

This low share of women among the research staff is being considered by the AU, which mentions efforts to recruit women and a dedicated committee, although no specific policies

are described. Significant diversity is achieved with the presence of researchers of mixed nationalities.

It is relevant to mention the support to newly recruited staff, who are attributed funding to hire a PhD student. The staff have good working conditions and a good division of their activities: 40% research, 40% lecturing, and 20% administration. Furthermore, the AU supports the progression of their career.

Sabbaticals constitute another important measure to promote internationalisation, encouraging mobility and networking. According to information given during the interview, the AU allocates funds that could allow about 10% of the staff to go on sabbatical every year. Despite this important measure, it is mentioned that only some of the staff members use this opportunity due to personal constraints.

Overall, based on the growth of the team and the scientific productivity, it can be concluded that the AU has set up an efficient practice to support the researchers' careers. Nevertheless, it has not been possible to improve the gender balance. The team is diverse, with an adequate wide age span and generally good dynamics, expressed by the high number of PhD students and early career researchers, and a relevant number of associate professors. The distribution of research time among the staff is adequate.

The policy for recruitment, promotion and the criteria for attribution of sabbatical periods are not described in the self-assessment.

Recommendations to the administrative unit

- A staff recruitment and renewal policy should be set to accommodate senior retirements and gradually engage new staff.
- Specific measures to increase the share of women among the academic staff should be implemented.
- Try implementing some strategy, facilitation or incentives to foster sabbatical leaves, including investigating the possibility of shorter periods. Sabbaticals are an important instrument to establishing international visibility and relevance.

1.7 Open Science

NTNU has a policy for Open Science since 2020, which applies to all research results, teaching, and dissemination activities. The FAIR principles for data storage and sharing apply. The main responsible unit for carrying out the development plan is the University Library.

The AU's most important contributions are open-source software and open-access data, which are available via different national and international repositories, such as Zenodo, GitHub, and Bird (NTNU). Open access to manuscripts is also available on arXive.

The NIFU data shows that from 2013 to 2022, archived data increased from 20.7% to 42.2%, and golden access publications increased from 2.4% to 16.1%. Therefore, non-open-access publications decreased from 76.8% to 41.7%. Compared with the national average for archive, golden access, and non-open access (41.5%, 35.3%, and 23.2%), it can be concluded that a higher percentage of publications from the AU is still non-open access. Since the research groups have considerable interactions with the industry, some constraints to open access are most likely dictated by project contracts. However, this aspect is not sufficiently detailed in the self-assessment report.

Recommendations on how to promote open science

- The AU should analyse the barriers keeping the share of open access publications below the national average acting on the sources to remove them.
- An increased focus should be on open access of the publications, mainly through existing university agreements with some publishers and journals.
- A more integrated policy regarding the availability of open-source software should be established, for example, through a website gathering and mapping the location of available software.

2. Research production, quality and integrity

The AU focuses mainly on civil and structural engineering, with smaller contributions to chemical engineering and other areas.

Publications are classified mainly in Construction Engineering. Chemistry and Material Sciences is a second area of publication. Finally, a much smaller number of publications are produced in the areas of Informatics, Mathematics, Multidisciplinary Technologies, and Geosciences. Publications of the AU can be found in reputed international journals, such as Cement and Concrete Research, Engineering Structures, and Acta Biomaterialia.

According to the NIFU data, the number of publications of the AU grew from 82 in 2013 to 211 in 2022. This represents a publication rate of 2.1 papers per research member per year, and the percentage of all author shares is 2.2%. These numbers put the AU at a top level. The high quality of the overall research is evidenced by the 12.5% participation in the 10% most cited papers and the normalised citation index of 121 in 2023. This participation slightly grew over the 10-year assessment period, as did the citation index, 107 in 2013.

Regarding co-authorship at the national and international levels, the AU has a share of 12.3% for the first and 65.4% for the latter. Compared to the national average of 24.3% and 56.9%, respectively, it can be concluded that collaborations at the national level with other institutions are less well represented. On the contrary, international collaborations are significantly higher. Over the 2013-2022 period, national collaborations reduced from 20.7% to 12.3%, and international collaborations increased from 56.1% to 65.4%, meaning that the AU has increased its international collaborations at the cost of lesser cooperation at national level.

International collaborations involve mostly European highly reputed universities.

2.1 Research quality and integrity

The four research groups are generally highly reputed. They have access to excellent infrastructure and high visibility in Norway, establishing collaborations with relevant partners and the industry, as well as internationally.

Although at different levels, the research groups are securing relevant and diversified funding for their research.

Despite multiple international collaborations, especially with European universities, the international funding secured by the research groups is relatively low.

The AU follows the university's general policy for research integrity.

NTNU follows international guidelines for good research and ethical practices. The university Code of Ethics places the responsibility on the employees and supervisors. NTNU follows national regulations regarding data collection in projects involving individual personal data.

PhD students are mandatorily engaged in an introductory course that includes a lecture on research ethics, publications, co-authorship, and Vancouver recommendations.

Research group Concrete overall assessment

The group is well resourced with good and unique laboratory facilities, large grant capture, interdisciplinary collaborations, national and international collaborations, industry engagement and participation in international committees. The group attracts a good level of funding from national and international sources and publishes in prestigious journals. The group's research is making an outstanding contribution in the field of concrete both nationally and internationally. Evidence of its excellent research is provided by prizes awarded to their staff. The group is making significant contributions via their educational role, the drafting of standards and regulations, participation in international committees and their research for sustainable concrete solutions. Though it is clear that their work is providing important knowledge to industry and academia, their societal contribution is not well quantified. Overall, in terms of research environment and research outputs, the group operates at international standards.

Research group Nano- and Biomechanics overall assessment

Due to the recent merger of two former groups, the Nano and Biomechanics group has a broad profile and addresses rather diverse application areas. However, there are common disciplinary aspects that should be further supported to fully exploit the potential of the group and so to establish a strong international position in their fields of expertise. The research output is of high quality and the group's involvement in collaborative projects is significant. The recent increase in acquiring international funding is a very positive development that should be continued. The research topics and applications areas pursued by the group are of importance to both society and national industry. The results achieved so far, and the plans outlined indicate that the group is in a good position to achieve a leading role in their area of expertise, also internationally, and significantly contribute to developments in applications areas identified as relevant both nationally and internationally.

Research group SIMLab overall assessment

The main strength of the RG is its high level of scientific expertise ranging from basic theoretical modelling to experimental research, which allows the group to alter easily their research focus to new emerging scientific and societal challenges. According to the self-assessment, the funding of the RG is dominated by national sources. The risk is that if this source of funding diminishes, the group's research will be affected. Hence, as also indicated in section 3 of the self-assessment report, active participation in international funding applications, especially the EU, is an opportunity. The group has established a wide collaboration network both nationally (industrial companies) and internationally (universities). In the listed publications five out of 15 have international collaborators. The quality of the publications is excellent, and they are published in the most respected journals in the field of applied mechanics. In an international context, the scientific level of the group is high.

Research group Structural Mechanics overall assessment

The research group has a clear and focused benchmark, with demanding targets. It develops mainly applied research, in many cases driven by the industry, although collaborations and interactions with diverse institutions have occurred. Through relevant,

stable and diversified funding, the quality of the researchers, and the connections with public institutions, including RCN, the industry, and international collaborations, the group has considerably grown during the period of evaluation and has excellent prospects regarding the achievement of their goals. The research group has a very good publication level and international recognition through participation in several European-funded projects and international collaborations with reputed partners. However, despite these collaborations and interactions, the group does not show a specific synergy among its members. It seems to be moved more by funding opportunities and industrial challenges and less by a vision of future positioning in research. This is not a robust approach. The research group expects lesser funding for the future from the government and industry. It recognises that, despite the increase of the sustainable component in structural mechanics, future societal needs may imply an adjustment of research and teaching. They have elected future topics, such as digital workflow from design to construction, maintenance, inspection, and reuse, showing their proactivity in facing future constraints. However, results of research in such topics seem to be still at the initial stage. The group does not mention transdisciplinary research, which is odd considering the focus areas on digitalisation and the use of artificial intelligence. No preoccupation is shown with gender equality (50% female PhD students, none in other staff categories).

3. Diversity and equality

NTNU has a gender diversity and equality policy. In the self-assessment, the AU mentions two university documents as the basis for the policy against discrimination: one, establishing the resources for gender equality and diversity, and another, on unacceptable behaviour-harassment of conflict, for employees. The links for those documents are not active.

The AU has taken part and has been a case study in the RCN-funded project BALANSE. However, the gender imbalance, in particular, has maintained stability in the period 2013-2022. According to the NIFU data, the share of women among research staff in 2013 was 20%. The same share was observed in 2021. Although it is natural that among the highest academic positions, this share changes more slowly, it is observed that in 2021, the share of women among postdocs and researchers was 17% and even lower than that of 2013 (29%). Therefore, it can be concluded that the actions taken by the AU have not been effective and need to be revised.

Regarding the integration of international researchers, statistics show that the percentage of staff members with a PhD obtained internationally has grown from 9% in 2013 to 29% in 2021. This growth is observed across academic and researchers' positions, meaning an internationalisation of the staff.

4. Relevance to institutional and sectorial purposes

As part of NTNU, the AU is the largest unit in Norway providing MSc and PhD candidates to the construction and building sector. Yearly 120 MSc students graduate in Structural Mechanics and Design.

Since research staff is involved in lecturing, their research is gradually incorporated into education, starting with the supervision of master theses based on PhD results and then continuously including new features at bachelor level, such as the focus on sustainability and environmental impact due to materials and design, digitalisation and artificial intelligence aspects.

Given the good collaboration with the industry, it is understood that graduates also have access to such interactions, which help them start and build their careers. However, no specific information is given about career opportunities offered by the research unit to young graduates.

The AU also has a focus on innovation and has recently appointed an innovation coordinator to help establish a vision and strategy for the AU.

Despite the AU's intensive research, evidence of innovation and commercialisation results is moderate, including regulations and recommendations, software, material models, one patent, and a method for health assessment.

5. Relevance to society

The activities developed by the four research groups align with the overall ambitions on sustainability, environmental issues, and digitalisation, defined by NTNU and embedded in their courses. Several of the UN Sustainable Development Goals are addressed, and also the main points of the Norwegian long-term plan for research and higher education.

The Concrete group has contributed with research and education to society on using sustainable materials and structures.

SIMLab group has focused on the behaviour of structures under extreme loadings.

The Nano- and Biomechanics group has developed tools for medical applications.

The Structural Mechanics group has developed research on structural health monitoring, addressing the extension of the service life of infrastructures.

The AU has provided impact cases demonstrating the societal impact of the research, the relevance of technology transfer, how this exchange contributes to continuously updating courses, and the capacity to change policies through improved guidelines and design standards (for example, participation in commissions behind Eurocode 5).

5.1 Impact cases

Comments to impact case 1: The Tretten Bridge collapse

The Tretten Bridge was a timber bridge that was part of the E6 highway in Norway and suffered a sudden collapse after ten years of service. The collapse occurred under moderate traffic conditions and with a load much lower than the design load. Although no serious injuries occurred, the collapse of the bridge had a wide impact, as the E6 highway was partially blocked. Besides, since the reason for the collapse was not evident, 14 other similar bridges in Norway were closed for traffic until the technical reasons for the failure were found.

The Structural Mechanics group investigated the occurrence through diverse studies to assess the strength, stiffness, dynamics, and design, concluding that the collapse occurred due to the block pull-out failure of one connection due to fatigue. It was also concluded that the design did not incorporate such verifications, as design regulations did not exist before.

This impact case evidences the societal relevance of the activities developed by the AU. At the same time, the studies developed gave origin to 9 PhD theses, and two related research projects were conducted, showing how practical challenges can "feed" research. The research results had consequences in terms of recommendations and methods for assessment and retrofit of the other bridges and were analysed in the context of the commissions behind Eurocode 5.

Comments to impact case 2: An accurate and cost-efficient model for ductile failure of thin metallic material

This impact case consists of developing and validating a ductile failure model capable of predicting the initiation and propagation of cracks and fractures in thin-walled metallic components used in the automotive industry. The model was developed at the SIMLab research group and was validated experimentally. It resulted from a long collaboration with the industrial partners of SFI-CASA and was implemented into the commercial versions of the software LS-DYNA and VPS-PAMCRASH. The model is used daily to design metallic components.

The developed model and software gave origin to a project funded by RCN to explore the commercialisation potential, which resulted in the creation of the spin-off ENODO.

Besides the development and technological transfer, the developed model was lectured as part of the Impact Mechanics Course and is incorporated into the SIMLab project. The model is used in the context of master theses, through which, besides the automotive industry, other possible applications in building construction have been explored.

Comments to impact case 3: Virtual Mitral Valve Surgery Using Echocardiographic Recordings

This impact case consists of developing and validating a numerical pipeline to create patient-specific digital-twins of the digital mitral valve from 3D echocardiographic records and studying them in a finite element framework. The study led to the development of a general annuloplasty procedure that may be sufficient to achieve valve closure compared to conventional surgery.

Again, the societal impact of such a development is enormous.

The development is highly multidisciplinary and involved structural engineering, medical technology and medicine, as well as a collaboration with the Department of Heart Disease at Haukeland University Hospital in Bergen.

The research was published in diverse journals and conferences. Most of all, it contributed to an increased understanding of the type of Barlow mitral disease and a better surgical treatment choice.

Methods and limitations

Methods

The evaluation is based on documentary evidence and online interviews with the representatives of Administrative Unit.

The documentary inputs to the evaluation were:

- Evaluation Protocol that guided the process
- Terms of Reference
- Administrative Unit's self-assessment report
- Administrative Unit's impact cases
- Administrative Unit's research groups evaluation reports
- Bibliometric data
- Personnel and funding data
- Data from Norwegian student and teacher surveys (only for HEI's)

After the documentary review, the Committee held a meeting and discussed an initial assessment against the assessment criteria and defined questions for the interview with the Administrative Unit. The Committee shared the interview questions with the Administrative Unit three weeks before the interview.

Following the documentary review, the Committee interviewed the Administrative Unit in an hour-long virtual meeting to fact-check the Committee's understanding and refine perceptions. The Administrative Unit presented answers to the Committee's questions and addressed other follow-up questions.

After the online interview, the Committee attended the final meeting to review the initial assessment in light of the interview and make any final adjustments.

A one-page summary of the Administrative Unit was developed based on the information from the self-assessment, the research group assessment, and the interview. The Administrative Unit had the opportunity to fact-check this summary. The Administrative Unit approved the summary without adjustments.

Limitations

The Committee judged that the Administrative Unit self-assessment report was insufficient to assess all evaluation criteria fully. However, the interview with the Administrative Unit filled gaps in the Committee's understanding, and the information was sufficient to complete the evaluation.

List of administrative unit's research groups

Institution	Administrative Unit	Research Groups
Norwegian University of Science and Technology, NTNU	Department of Structural Engineering	Nano and Biomechanics
		Structural Mechanics Group (KMEK)
		Concrete Group
		Structural Impact Laboratory (SIMLab)

Terms of Reference (ToR) for the administrative unit

The board of the Faculty of Engineering, Norwegian University of Science and Technology (NTNU), mandates the evaluation committee appointed by the Research Council of Norway (RCN) to assess the *Department of Structural Engineering (KT*) based on the following Terms of Reference.

Assessment

You are asked to assess the organisation, quality, and diversity of research conducted by KT as well as its relevance to institutional and sectoral purposes and to society at large. You should do so by judging the unit's performance based on the following five assessment criteria (a. to e.). Be sure to take current international trends and developments in science and society into account in your analysis.

a) Strategy, resources, and organisation.

b) Research production, quality, and integrity.

c) Diversity and equality.

d) Relevance to institutional and sectoral purposes.

e) Relevance to society.

For a description of these criteria, see Chapter 2 of the mathematics, ICT and technology evaluation protocol. Please provide a written assessment for each of the five criteria. Please also provide recommendations for improvement. We ask you to pay special attention to the following aspects in your assessment:

1. At KT there are 4 research groups, Concrete, Nano – and Biomechanics, SIMLab and Structural Mechanics, all within the domains of mathematics, ICT, and technology. In 2022, two of our research groups, the Biomechanics group and Nanomechanics group, were reorganized into one group, the Nano-and Biomechanics group. The reorganization is recent, but in total consists of the same scientific staff as earlier, we should be evaluated with respect to the activities, track record, and impact of the scientific members in the existing groups.
2. As a department under NTNU's Faculty of Engineering, KT follows common strategic goals and priorities from both a faculty level and centrally at NTNU, as well as on a departmental level. Relevant strategic documentation from NTNU has been listed under "Documentation". Note that the Faculty of Engineering's Research Strategy for 2018-2022 is still valid. We would very much like your report to provide a qualitative assessment of the Department as a whole.

Documentation

The necessary documentation will be made available by the mathematics, ICT and technology secretariat at Technopolis Group.

The documents will include the following:

- A report on research personnel and publications within mathematics, ICT, and technology commissioned by RCN.
- A self-assessment based on a template provided by the mathematics, ICT, and technology secretariat.
- Strategic plans of relevance from NTNU and its Faculty of Engineering, (hyperlinks to NTNU-sites included): NTNUs main strategy 2018-2025 (e)
    - NTNUs development agreement with the ministry 2023-2025 (n)
    - NTNUs wider contribution to innovation, (n)
    - NTNUs international development plan 2023-2025 (e)
    - NTNUs development plan for open science 2023-2025 (e)
    - NTNUs development plan for gender equality and diversity 2023-2025 (e)
    - Faculty of engineering main strategy 2018-2025 (n)
    - Faculty of engineering research strategy 2018-2022 (e)

Interviews with representatives from the evaluated units

Interviews with will be organised by the evaluation secretariat. Such interviews can be organised as a site visit, in another specified location in Norway, or as a video conference.

Statement on impartiality and confidence

The assessment should be carried out in accordance with the *Regulations on Impartiality and Confidence in the Research Council of Norway*. A statement on the impartiality of the committee members has been recorded by the RCN as a part of the appointment process. The impartiality and confidence of committee and panel members should be confirmed when evaluation data from KT are made available to the committee and the panels, and before any assessments are made based on these data. The RCN should be notified if questions concerning impartiality and confidence are raised by committee members during the evaluation process.

Assessment report

We ask you to report your findings in an assessment report drawn up in accordance with a format specified by the mathematics, ICT, and technology secretariat. The committee may suggest adjustments to this format at its first meeting. A draft report should be sent to the KT and RCN. The KT should be allowed to check the report for factual inaccuracies; if such inaccuracies are found, they should be reported to the mathematics, ICT, and technology secretariat within the deadline given by the secretariat. After the committee has made the amendments judged necessary, a corrected version of the assessment report should be sent to the Faculty of Engineering, NTNU, and the RCN no later than two weeks after all feedback on inaccuracies have been received from KT.

Appendices

1. Description of the evaluation of EVALMIT
2. Invitation letter to the administrative unit including address list
3. Evaluation protocol
4. Template of self-assessment for administrative unit (short-version)

The Research Council of Norway

Norges forskningsråd
Besøksadresse: Drammensveien 288
Postboks 564
1327 Lysaker

Telefon: 22 03 70 00

post@forskningsradet.no
www.forskningsradet.no

Publikasjonen kan lastes ned fra
www.forskningsradet.no/publikasjoner

Design: [design]
Foto/ill. omslagsside: [fotokreditt]

ISBN 978-82-12-04163-9 (pdf)