

# Enhanced limit state analysis using computational homogenization and machine learning

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## Summary

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*Equivalent single layer (ESL) approach whereby the stiffened panel is replaced with a single plate is an efficient means to model and perform non-linear analyzes of large or composite structures [1]. The basis for the approach are the unit cell simulations, which describe the underlying structural behavior and need to be run beforehand to enable homogenization. This is also the biggest bottleneck of the methodology. Therefore, the objective of this work is developing a surrogate model that could replace the unit cell analysis using data-driven and machine learning methods. As the ESL model would be used for buckling response, vibration response, accidental and ultimate limit state analysis, the developed surrogate model could potentially cover all these loading scenarios but can also be limited to only one of those scenarios.*

Research field:	Environmental, marine and coastal technology
Supervisor:	Mihkel Kõrgesaar
Availability:	This position is available.
Offered by:	School of Engineering Kuressaare College
Application deadline:	Applications are accepted between June 01, 2024 00:00 and June 30, 2024 23:59 (Europe/Zurich)

## Description

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### Tasks (preliminary, not exhaustive)

- Use existing routines already developed for buckling to run unit cell analysis and generate database of stiffness matrices for different structural configurations
- Identify the candidate machine learning (ML) models compatible with stiffness data and build ML surrogate
- Embed the surrogate model in FE package Abaqus using subroutines
- Explore applicability for alternative loading conditions (vibration, collision, fracture, etc)
- Embed machine learning model into Abaqus user subroutines
- Demonstrate the applicability of the approach

### Supervision

Main supervision: Mihkel Kõrgesaar

Co-supervisors: Jasmin Jelovica (UBC), Teguh Putranto (ITS)

### Requirements

The performed work combines computational and experimental research. The applicant should have good understanding of solid mechanics and ship structures. Since positions presumes development of data-driven models a prior experience in machine learning methods and/or statistical analysis is considered a plus, but not strictly required. Experience in coding and programming (e.g. python) is considered beneficial. The candidate should prove his/her capabilities in writing the technical report and scientific papers in high quality journals. Good skills in English, writing and oral, are required. Experience in collaborative research/publication with the existing TalTech staff is also a plus. The applicant for the position must have a Master's degree and must fulfill the requirements for doctoral students at the Tallinn University of Technology (<https://taltech.ee/en/phd-admission>). During the assessment emphasis will be put on your potential for research, motivation, and personal suitability for the position.

**Employment & Funding:** The position is at the Tallinn University of Technology and includes some work as a teaching assistant in our courses. The expected duration of doctoral studies is four years, but following a standard practice the contract is first made for 4 months. The extension is subject to the advance of studies and research. The base salary is according to the salary system of Tallinn University of Technology, but flexible depending on the candidates capabilities.

**How to apply to this position:** Follow the instructions in <https://taltech.ee/en/phd-admission> and for hybrid meeting email [mihkel.korgesaar@taltech.ee](mailto:mihkel.korgesaar@taltech.ee)

1. Motivation letter (maximum one A4 page, important: provide clear, but honest, evidence of your skills related to the job description and requirements above)
2. CV and other proof of scientific activity (publications, conference papers etc.)
3. A copy of the bachelor's and master's degree certificate and an official transcript of records, and their translations, if the originals are not in English.
4. An English abstract or summary of the MSc thesis.
5. Introducing two referees who can be contacted, directly.
6. Proof of proficiency in English
7. A copy of the identification page of your passport

### Further information

- Application open until suitable candidate is found. If the application period has ended on GlowBase, please contact the supervisor to apply.
- Job location: Kuressaare, Estonia

### Relevant literature

[1] Putranto, T., Kõrgesaar, M., & Tabri, K. (2022). Application of Equivalent Single Layer Approach for Ultimate Strength Analyses of Ship Hull Girder. *Journal of Marine Science and Engineering* 2022, Vol. 10, Page 1530, 10(10), 1530. <https://doi.org/10.3390/JMSE10101530>

[2] Putranto, T., Kõrgesaar, M., & Jelovica, J. (2022). Ultimate strength assessment of stiffened panels using Equivalent Single Layer approach under combined in-plane compression and shear. *Thin-Walled Structures*, 180, 109943. <https://doi.org/10.1016/J.TWS.2022.109943>

[3] Putranto, T., Kõrgesaar, M., Jelovica, J., Tabri, K., & Naar, H., (2021). Ultimate strength assessment of stiffened panel under uni-axial compression with non-linear equivalent single layer approach. *Marine Structures*, 78, 103004.



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