ERC Starting Grant 2021

Research proposal [Part B1][[1]](#footnote-1)

*(Part B1 is evaluated both in Step 1 and Step 2,*

*Part B2 is evaluated in Step 2 only)*

Proposal Full Title

PROPOSAL ACRONYM

**Cover Page:**

* Name of the Principal Investigator (PI)
* Name of the PI's host institution for the project
* Proposal duration in months

Text highlighted in grey should be deleted.

Proposal summary (identical to the abstract from the online proposal submission forms, section 1).

The abstract (summary) should, at a glance, provide the reader with a clear understanding of the objectives of the research proposal and how they will be achieved. The abstract will be used as the short description of your research proposal in the evaluation process and in communications to contact in particular the potential remote referees and/or inform the Commission and/or the programme management committees and/or relevant national funding agencies (provided you give permission to do so where requested in the online proposal submission forms, section 1). It must therefore be short and precise and should not contain confidential information.

Please use plain typed text, avoiding formulae and other special characters. The abstract must be written in English. There is a limit of 2000 characters (spaces and line breaks included).

**Section a: Extended Synopsis of the scientific proposal (max. 5 pages, references do not count towards the page limits)**

Explain and justify the cross-panel or cross domain nature of your proposal, if a secondary panel is indicated in the online proposal submission forms. There is a limit of 1000 characters, spaces and line breaks included.

*[The Extended Synopsis should give a concise presentation of the scientific proposal, with particular attention to the ground-breaking nature of the research project, which will allow evaluation panels to assess, in Step 1 of the evaluation, the feasibility of the outlined scientific approach. Describe the proposed work in the context of the state of the art of the field. References to literature should also be included. Please use a reference style that is commonly used in your discipline such as American Chemical Society (ACS) style, American Medical Association (AMA) style, Modern Language Association (MLA) style, etc. and that allows the evaluators to easily retrieve each reference.]*

***Please respect the following formatting constraints: Times New Roman, Arial or similar, at least font size 11, margins (2.0cm side and 1.5cm top and bottom), single line spacing.***

**Section b: Curriculum vitae**

**PERSONAL INFORMATION**

Family name, First name: Tran, Quoc Anh Tran

ORCID: 0000-0001-5987-435X

Date of birth: March 15th, 1990

Nationality: Vietnamese

URL for web site: https://www.ntnu.edu/employees/quoc.a.tran

* **EDUCATION**

2019 PhD in Geotechnical Engineering - awarded: 20th November 2019

Department of Civil Engineering, Aalto University, Finland

Name of PhD Supervisor: Wojciech Sołowski

2015 Master in Geomechanics, Civil Engineering and Risks

3SR Laboratory, Grenoble Alpes University, France

* **CURRENT POSITION(S)**

2021 – Senior Researcher

Department of Civil and Environmental Engineering, Norwegian University of Science and Technology, Norway

* **PREVIOUS POSITIONS**

2020 – 2021 Postdoctoral fellow

Department of Civil and Environmental Engineering, Norwegian University of Science and Technology, Norway

* **FELLOWSHIPS AND AWARDS**

2021-2023 **Marie Skłodowska-Curie Individual Fellowship**. A prestigious fellowship (€214,000) awarded by European Commission (12% acceptance rate).

2022 **Top 5 finalists for best presentation** in the Early careers offshore site investigation geoscientists and geotechnical engineers’ presentation competition.

2021 **NTNU Incentive program**. Top up funding for coordinator of a EU project (€32,000).

2020 **Seal of Excellence** by European Commission for the project 'Submarine landslides and impacts on offshore structure', under Horizon 2020’s Marie Skłodowska-Curie actions.

2020 **Postdoctoral Fellowship**. A 2-year salary funded by Faculty of Engineering, NTNU.

2020 **Resource and travel grants**: 40M CPU hours from Norwegian E-infrastructure; DNB bank (15,000 NOK); EU next-generation of Researcher GEOLAB training (10,000 NOK).

2015 **Grenoble INP fellowship**. A research grant (€5000) from Grenoble Institute of Technology.

2014 **French Government Scholarship**. A competitive full scholarship (€10,000 a year) to obtain a Master’s degree in France.

2014 **Golden Medal in the Soil Mechanics** awarded by National Olympiad on Mechanics.

* **SUPERVISION OF GRADUATE STUDENTS AND POSTDOCTORAL FELLOWS**

I have actively contributed to the success of multiple Master’s theses and Ph.D. dissertations, resulting in joint journal articles despite not being the main supervisor. This highlights my dedication to nurturing young researchers.

**Lists of PhD students:**

2019 – 2022 Hervé Vicari: Investigation of debris flow entrainment and mitigation using flexible barriers at NTNU. We have maintained our collaboration even after his departure from NTNU. He is currently a Postdoctoral Researcher at ETH Zurich. Our ongoing collaboration focuses on the study of snow avalanches.

2020 - present Erik Sørlie: Impact of submarine slides on anchors and mooring line systems at NTNU. We have collaborated on several articles together.

2020 – present Gebray Alene: Visualization of debris flow through virtual reality at NTNU. We have collaborated on several articles together.

**Lists of Master students:**

2021 Lukas Hartnik: Experimental Study of Submarine Landslides and Impact Forces on Offshore Constructions at NTNU, resulting in a published journal article together. He is currently Project Engineer at Norwegian Geotechnical Institute.

2022 Agnete Rogstad: Empirical and Numerical Analysis of the Retrogression in the Gjerdrum Landslide at NTNU, leading to a journal article. She is Project Engineer at Norconsult.

2022 Nursultan Sharipkhanov: T-bar penetration test at NTNU. He is currently Project Engineer at Norconsult.

* **TEACHING ACTIVITIES**

2021 – Invited lecture, Foundation and Slopes, Master level course – Norwegian University of Science and Technology, Norway. I had delivered lectures where I shared my expertise and provided state-of-the-art knowledge on the topic of submarine landslides.

2017 – 2020 Teaching assistant – Advanced Soil Mechanics, Master/Doctoral level course - Aalto University, Finland. I supported students at the Master's and Doctoral levels in their understanding and application of the soil mechanics.

2017 – 2020 Teaching assistant – Finite Element Method, Master/Doctoral level course - Aalto University, Finland. As a teaching assistant, I contributed to the instruction of the implementation and application of Finite Element Method in geotechnics.

* **MOBILITY**

I have actively pursued collaborations, engaging in impactful research visits that have led to joint articles. Notable collaborations include: (1) University of Utah, USA: 3-month visit in 2018, resulting in 2 articles. (2) Delft University of Technology, the Netherlands: 1-month in 2018, leading to a conference paper. (3) Port and Airport Research Institute, Japan: 1-month visit in November 2022, resulting in a journal paper. These experiences have expanded my research network and contributed to the advancement of our field.

* **REVIEWING ACTIVITIES**

2022 Reviewer for the Outstanding PhD Presentation (EGU23 General Assembly).

2021 Scientific Committee member for Nordic Geotechnical Meeting in Helsinki, Finland contributing to the selection and evaluation of research papers for the conference.

2019 – Reviewer for esteemed international journals (> 20 reviews for 10 different journals).

* **MEMBERSHIPS OF SCIENTIFIC SOCIETIES**

2022 – **EGU**, European Geoscience Union.

2022 – **SIAM**, Society for Industrial and Applied Mathematics.

2022 – **IAHR**, International Association for Hydro-Environment Engineering and Research.

2022 – **Interpore**, International Society for Porous Media.

2019 – **Finnish Geotechnical Society**, scientific committee for conferences organized by Finnish Geotechnical Society.

* **SELECTED SOFTWARE REPOSITORIES**

2019 – GitHub.com/Uintah/Uintah: I have contributed to development of a 3D Material Point Method C++ within the Uintah framework. My personal GitHub page, where I actively share and collaborate on this project, has garnered a strong following of **31 followers**.

* **SELECTED MAJOR COLLABORATIONS**

2019 – Prof. James Guilkey at the University of Utah, Salt Lake City, USA, on the development of Material Point Method in high-performance software. Our collaboration have leveraged the software and resulted in three articles showcasing our joint research efforts.

2021 – Dr. Shinji Sassa at the Port and Airport Research Institute in Japan, on earthquake-induced submarine landslides. This partnership combined experimental expertise from Japan and computational analysis from Norway, with a shared goal of advancing our understanding of submarine landslide mechanisms.

***Appendix: All current grants and on-going and submitted grant applications of the PI (Funding ID)***

*Mandatory information (does not count towards page limits)*

**Current grants (Please indicate "No funding" when applicable):**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Project Title* | *Funding source* | *Amount*  *(Euros)* | *Period* | *Role of the PI* | *Relation to current*  *ERC proposal[[2]](#footnote-2)* |
|  |  |  |  |  |  |
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**On-going and submitted grant applications (Please indicate "None" when applicable):**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Project Title* | *Funding source* | *Amount*  *(Euros)* | *Period* | *Role of the PI* | *Relation to current*  *ERC proposal2* |
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**Section c: Early achievements track-record**

I completed my PhD at Aalto University in Finland under the supervision of Prof. Wojciech Solowski in 2019. During my PhD, I made contributions to improving the Material Point Method's accuracy and stability (**J1**), explaining the interaction between granular particles and geotextiles in micro-scale using simulations (**J2**), and studying the mechanism of a full-scale sensitive clay landslide on-site (**J3**). I have gradually developed an advanced understanding of the Material Point Method. As a result of my contributions to the Material Point Method, I was invited to write a review paper on the topic for Advances in Applied Mechanics, which has helped establish my expertise in this area. I have also actively sought out collaborations with leading research groups worldwide, resulting in several joint publications with the University of Utah in the US (3 publications), Delft University of Technology in the Netherlands (2 publications), and 3SR laboratory in France (2 publications). Since 2017, I has been a developer of the open-source Uintah software, which is considered the most advanced and efficient MPM code to date[[3]](#footnote-3).

After my PhD in 2020, I started a postdoctoral fellowship position at the Norwegian University of Science and Technology. Soon after, I won the prestigious Marie Skłodowska-Curie Individual, which allowed me to continue my work on the Material Point Method. During this fellowship, I contributed to the field of risk assessment for landslides by developing a model that combines Computational Fluid Dynamics and the Material Point Method refer as CFD-MPM model (**J4**). Throughout my career, I have maintained a high degree of independence, innovative thinking, and collaboration with various research groups.

**Scientific impact of my Marie Curie Fellowship**

Submarine landslides are complicated because they involve a transition from a solid to a liquid phase during debris flow. Engineers currently have to use two different methods to assess the risk of submarine landslides. First, they use finite element analysis to evaluate the marine slope. If the slope has a low safety factor, they then use CFD to predict the consequences of the debris flow. Our CFD-MPM model can do both in a single simulation. Moreover, it can provide insights into the triggering mechanism, the evolution of water pressure, temperature, and how marine sediments, seawater, and offshore structures interact with each other. These features improve risk assessment and mitigation strategies for submarine landslides.

*Dissemination:* In November 2022, I presented my findings on LinkedIn, and it quickly gained attention with 400 likes, 20 shares and 25,000 impressions within a month. As a result, I was invited to present my findings at several workshops, including (1) Use Modelling of rapid mass movements in Norway, (2) Offshore site investigation for geoscientists and geotechnical engineers by the Society for Underwater Technology, and (3) Debris flow & steep Creek Hazard Mitigation by Association of Geohazard Professionals. The model has been used by a PhD student to evaluate the risk of submarine landslides in Norwegian fjords. Furthermore, it has also been utilized for assessing earthquake-induced liquefied debris flows through collaboration with the Port and Airport Research Institute in Japan. Moreover, two separate research groups have approached me inquiring about the possibility of using this model for their research purposes.

|  |  |
| --- | --- |
| *Communication and Outreach*  Through my research efforts, I have been able to garner interest from various outlets, for example the Norwegian Research Infrastructure Service, who have interviewed and featured my work in their newsletter. | https://www.sigma2.no/simulating-sensitive-clay-landslides |

**Publication overview**

I have published in leading journals in computational geomechanics such as Computers and Geotechnics, Geotextiles and Geomembranes, International Journal for Numerical Methods in Engineering, Engineering Structures etc.

|  |  |  |
| --- | --- | --- |
| **Item** | **Number** | **Notes** |
| Peer-reviewed journal articles | 14 | 8 as first author, 9 without PhD advisor |
| Peer-reviewed conference proceedings | 13 | 11 as first author, 2 as corresponding authors |
| Conference/workshop contribution | 13 | 11 as presenter |
| Total citations (Scopus/Google Scholar) | 172/222 | As of October 2023 |
| H-index (Scopus/Google Scholar) | 8/9 | As of October 2023 |

**Assessment of the specific stage of my career**

I consider myself as an Early-Career Researcher according to ERC criteria. Since finishing my Marie Curie Fellowship, I have acquired skills to enhance my independence. I am a senior researcher at the Norwegian University of Science and Technology with plenty of ideas to implement and yet few resources to do so. Setting up a team with a variety of specialists is a logical step toward making progress in the field of computational geomechanics. ERC Starting grant provides an ideal solution for such an evolution.

**Five selected publications (EXCLUDING SELF-CITATIONS)**

**[J1] Q. A. Tran**, W. Sołowski (2019). Temporal and Null space filter for the Material Point Method. *International Journal for Numerical Methods in Engineering*; 120(3): 328-360.

**Citation: 20 (Scopus); 25 (Google Scholar). Most downloaded paper in Wiley 2018 – 2019.**

By leveraging the theory of null space in linear algebra, I develop a theoretical framework that enhances the numerical stability of the Material Point Method. Our framework effectively eliminates null-space errors, resulting in unparalleled accuracy in stress prediction, even in the presence of extreme deformations in saturated materials. As the primary author, I single-handedly conceived the research idea and conducted all the analysis presented in this work. Notably, our paper quickly garnered attention, becoming one of the most downloaded papers in Wiley in 2019, despite only being published in November of that year.

**[J2] Q. A. Tran**, P. Villard, D. Dias (2019). Discrete and Continuum Numerical Modeling of Soil Arching between Piles. International Journal of Geomechanics; 19(2).

**Citation: 15 (Scopus); 18 (Google Scholar). Without PhD supervisor**

In this study, we delved into the intricate interplays of granular grains within embankments to uncover the soil arching mechanisms at the macroscale. Our findings were instrumental in advancing the design guidelines of piled reinforcement embankments in France. I was responsible for performing numerical analysis and interpreting all of the data presented in this research. Additionally, this work is the result of a collaborative effort with the 3SR Laboratory, further highlighting my ability for collaboration.

**[J3] Q. A. Tran**, W. Sołowski (2019). Generalized Interpolation Material Point Method modelling of large deformation problems including strain-rate effects – Application to penetration and progressive failure problems. *Computers and Geotechnics*; 106: 249-265.

**Citation: 30 (Scopus); 45 (Google Scholar). Top 25 Most Downloaded Articles in last 90 days Elsevier.**

Our paper demonstrates the Material Point Method's ability to capture complexities of real-world scenarios. We validate our model using a high-quality cone penetration experiment at the University of Oxford and reveal the dynamic behavior of a sensitive clay landslide in Sainte Monique, Quebec based on a detailed soil investigation at Laval University. As the primary author, I initiated the idea, performed all the numerical analysis, and contributed to the research methodology. Our research sheds new light on landslide behavior and paves the way for more accurate modeling of sensitive clay landslide.

**[J4] Q. A. Tran**, G. Grimstad, S.A.G. Amiri (2023). MPMICE: A hybrid CFD-MPM model for simulating coupled problems in porous media. Application to seismic induced submarine landslides.  *International Journal of Numerical Methods in Engineering*.

**Citation: 0 (Scopus); 0 (Google Scholar). Without PhD supervisor**

In our study, we developed an innovative CFD-MPM model that can simulate the entire process of a submarine landslide induced by an earthquake. This includes earthquake-triggered marine slope failure, excess water pressure in soil, movement of soil blocks, turbulent flow between seawater and debris, and even the resulting tsunami in a single simulation. It is my flagship publication of my Marie Skłodowska-Curie Individual Fellowship and has already gained significant attention in the research community. With 400 likes and 25,000 impressions on LinkedIn within one month, this work has led to invitations to present at several workshops and inquiries to use the model from two distinct research groups.

**[J5]** H. Vicari, **Q. A. Tran**, S. Nordal, V. Thakur (2022). MPM modelling of debris flow entrainment and interaction with an upstream flexible barrier. *Landslides* 19 (9), 2101-2115.

**Citation: 4 (Scopus); 5 (Google Scholar). Without PhD supervisor**

In this work, we developed a numerical model to investigate the complex dynamics of wet debris flows interacting with barriers. Our findings shed light on the critical factors influencing the effectiveness of barrier-based mitigation strategies. H. Vicari, a PhD student and experimentalist, has worked closely with me to develop the numerical model. Our collaboration not only resulted in a publication in a top journal, but also a lasting relationship with H. Vicari even after he completed his PhD. This project exemplifies my commitment to mentoring and collaborating with young researchers.

ERC Starting Grant 2021

Research proposal [Part B2]

**Section a. State-of-the-art and objectives**

**Section b. Methodology**

1. Instructions for completing Part B1 can be found in the ‘*Information for Applicants to the Starting and Consolidator Grant 2021 Calls’*. [↑](#footnote-ref-1)
2. Describe clearly any scientific overlap between your ERC application and the current research grant or on-going grant application. [↑](#footnote-ref-2)
3. A. de Vaucorbeil, V.P. Nguyen, S. Sinaie, J.Y. Wu, Material point method after 25 years: theory, implementation, and applications, in: Advances in Applied Mechanics, vol.53, Elsevier, 2020, pp.185–398. [↑](#footnote-ref-3)