UNNC – SDU Doctoral Training Partnership

(Transportation Infrastructures strand)

It's essential that you have contacted the UNNC and/or SDU supervisors before applying.

Formal applications should follow the instructions in 'How to apply' section.

Research areas

1. Smart Construction
2. Building Materials
3. Intelligent Transportation
4. Geotechnical Engineering

Available PhD topics

PhD topic	**Structural health monitoring nonlinear response of cellular composite structures subjected to bending loading using advanced hybrid CNN method**
SDUTI Supervisor	Dr. Yang ZHANG
UNNC Supervisor(s)	Amin Farrokh Abadi
Short introduction & description of the PhD project	This research aims to design, fabricate, and characterize a novel energy-absorbing structure utilizing advanced continuous-fiber reinforced composites for automotive applications. The core methodology employs topology optimization to architect a structure for maximal specific energy absorption. The optimized design is manufactured and subjected to experimental quasi-static/dynamic crushing tests. Full-field deformation and strain measurements are acquired during testing using three-dimensional Digital Image Correlation (3D-DIC). These experimental results are subsequently integrated with and validate high-fidelity Finite Element (FE) simulations. The synergistic, multi-scale dataset generated from this combined experimental-computational approach serves as the foundation for training a machine learning (Artificial Intelligence, AI) model. The ultimate objective is to develop a robust AI-driven framework for Structural Health Monitoring (SHM), enabling accurate prediction of mechanical performance and proactive damage detection in complex composite structural systems.

Contact points	Informal inquiries may be addressed to Dr. Amin Farrokh Abadi amin-farrokh.abadi@nottingham.edu.cn and Dr. Prof. ZHANG Yang (yangzhangdr@126.com).
PhD topic	**Life-Cycle Performance Evaluation and Repair Design for Existing Concrete Infrastructure**
SDUTI Supervisor	Prof. Jianhong Wang
UNNC Supervisor(s)	Yung-Tsang Chen
Short introduction & description of the PhD project	The expansive scale of modern infrastructure necessitates rational and systematic approaches to its management and maintenance. In particular, bridge and tunnel facilities often exhibit structural degradation—including deformation, concrete cracking, and water leakage—due to factors such as differential settlement, adjacent construction activities, and sustained operational loads. These damage mechanisms lead to a marked decline in structural performance and a corresponding rise in maintenance expenditure. Consequently, there is a pressing need to advance research in intelligent damage detection, structural safety evaluation and diagnosis, and the development of cost-effective rehabilitation strategies. This study aims to develop an analytical framework for assessing damaged concrete structures, grounded in concrete fracture and cracking mechanics. The research will involve detailed investigation of existing structures, whereby historical and operational loads will be reconstructed by calibrating numerical models against observed damage patterns. Utilizing the load factor method as a theoretical basis, a performance evaluation methodology will be established to quantify the influence of various defects on structural behavior. Furthermore, the efficacy of different repair techniques will be examined, along with their effect on restored performance. The outcome will be an integrated solution capable of predicting life-cycle performance, which will subsequently be validated through field application and monitoring.
Contact points	Informal inquiries may be addressed to Dr Yung-Tsang Chen (Yung-Tsang.Chen@nottingham.edu.cn) and Prof. Jianhong Wang (J.H.Wang@sdu.edu.cn).
PhD topic	**Seismic Behaviour and Resilience Evaluation of Transport Infrastructure Crossing Active Faults**
SDUTI Supervisor	Prof. Jianhong Wang
UNNC Supervisor(s)	Yung-Tsang Chen
Short introduction & description of the PhD project	Transport Infrastructure such as tunnels and bridges crossing active faults is more vulnerable to earthquake damage due to the intense and unexpected ground movement from the faults. The seismic behaviour of the transport infrastructure near or cross active faults therefore needs to be analysed further to ensure their satisfactory seismic performance, as the near-fault ground movement may cause strong ground acceleration and permanent ground displacement to the infrastructure. In addition to conventional structural analysis following current design codes, a resilience analysis adopting the concepts of robustness, rapidity, redundancy, and resourcefulness (4R) should

	also be used to account for the seismic resistance and repairability of current existing transport infrastructure. In this project, relevant research literature review will be conducted first, followed by the analysis of the seismic behaviour of transport infrastructure near or crossing active faults. Numerical simulation of transportation infrastructure subjected to intense earthquake excitations will be conducted, and seismic behaviour and failure modes be analysed and compared with the current structural design codes. Scale-down model tests using shaking tables may as well be conducted to verify the simulation results. Meanwhile, the structural resilience of transport infrastructure under near-fault earthquakes will be investigated, with the aim of proposing indexes for the purpose of resilience evaluation. Measures for disaster prevention, in terms of disaster mitigation and post-disaster recovery methods, will be developed. Finally, a comprehensive resilience evaluation method and the associated resilience index will be proposed and applied in real engineering projects, such as Chuanzang Railway connecting Sichuan and Tibet.
Contact points	Informal inquiries may be addressed to Dr Yung-Tsang Chen (Yung-Tsang.Chen@nottingham.edu.cn) and Prof. Jianhong Wang (J.H.Wang@sdu.edu.cn).
PhD topic	**Investigation on damage evolution mechanism at two-phase interfaces of solid waste asphalt mixture and their durability synergistic improvement**
SDUTI Supervisor	Prof. Jizhe Zhang
UNNC Supervisor(s)	Dr. Shu Liu
Short introduction & description of the PhD project	Filler is an indispensable component of asphalt mixture. With the shortage of natural stone supply, it is urgent to develop alternative filler materials. Solid waste powders, such as red mud, steel slag, and flyash et al., have the potential to replace limestone filler due to their unique physical and chemical characteristics. However, the strength evolution mechanism of solid waste asphalt mixtures differ from that of the conventional mixture. This study aims to investigate the evolution mechanism and the moisture permeation mechanism of the interfaces of powder-bitumen and solid waste asphalt mastic-aggregate, with the goal of enhancing the service performance of solid waste modified asphalt mixture. The success of this research would not only provide a theoretical basis for the modification and design of solid waste modified asphalt mixture, but also effectively improve its service durability and promote its large-scale application in road engineering.
Contact points	Informal inquiries may be addressed to Prof. Jizhe Zhang (jizhe.zhang@sdu.edu.cn) and Dr. Shu LIU (shu.liu@nottingham.edu.cn).

PhD topic	**Molecular Dynamics Simulation Study of Fabric Reinforced Cementitious Matrix**
SDUTI Supervisor	Professor Tao LI
UNNC Supervisor(s)	Dr. Bo LI
Short introduction & description of the PhD project	1. Research Background Fabric reinforced cementitious matrix composites are increasingly used in sustainable construction due to their high strength, durability, and corrosion resistance. However, the long-term performance in some extreme conditions is limited by interfacial degradation between fabric and the cementitious matrix. Current experimental methods face challenges in directly observing nanoscale interfacial phenomena, which are critical to understanding mechanical and durability behaviour. This project proposes a molecular dynamics (MD) simulation approach to uncover the atomic-scale interactions at the fabric-cement interface, providing fundamental insights that complement experimental research and theoretical guidance for the design of sustainable construction materials. 2.Research Objectives This study aims to investigate the nanoscale interfacial mechanisms between fabric and cementitious matrices using molecular dynamics simulations, with the goal of improving the durability and mechanical performance of fabric-reinforced cementitious composites. The objectives include: (1) Quantifying the adhesion energy and interaction behavior at the fabric-cement interface under mechanical loading. (2) Analyzing the effects of environmental factors on interfacial degradation (e.g. moisture ingress, Freeze-hot cycles, alternating dry and wet conditions, carbonization and ion migration). (3) Proposing material modification strategies based on atomic-scale insights to enhance interfacial compatibility and long-term performance. 3.Research Content The research will focus on three tasks: (1) Model Development • Construct atomistic models of common fabric filaments (e.g., polyethylene, glass, and carbon fibers) and calcium silicate hydrate (C-S-H) gel, the primary binding phase in cement. • Validate models using existing experimental data on density, surface energy, and mechanical properties. (2) Interfacial Behavior Simulation • Simulate tensile and shear deformation at the fabric-C-S-H interface using reactive force fields (ReaxFF) to capture bond breaking and formation.

	• Calculate interfacial strength, stress transfer efficiency, and failure modes through strain-controlled simulations. (3) Environmental Effects • Introduce water molecules and aggressive ions (e.g., chlorides, sulfates) into the interface region to study their diffusion patterns and chemical interactions. • Evaluate how moisture and ions, and other environmental factors affect interfacial adhesion, hydrogen bonding networks, and long-term stability under cyclic hygrothermal conditions. The expected outcomes include atomic-scale insights into debonding mechanisms, correlations between nanoscale interactions and macroscale properties, and practical guidelines for optimizing fabric selection or surface treatments to improve composite durability.
Contact points	Informal inquiries may be addressed to LI TAO Professor tao.lee@sdu.edu.cn And Dr. Bo LI bo.li@nottingham.edu.cn
PhD topic	**Development of a Novel Anchor System for Offshore Floating Wind Turbine Foundation**
SDUTI Supervisor	Kai Yao Chun Fai Leung
UNNC Supervisor(s)	Ahmad Mousa
Short introduction & description of the PhD project	The global transition to renewable energy has positioned offshore wind power as a leading source of energy. Floating wind platforms enable turbine installation in deep ocean waters beyond 50 meters, where traditional fixed foundations are not feasible. Projections indicate an installed capacity of 4,000 GW by 2050. However, high construction costs remain a challenge for the widespread of offshore floating wind technology. The anchoring foundation system, a crucial component of the platform, represents 30-40% of the total cost. In deep-water environments, these systems must withstand complex environmental forces, including waves, tides, ocean currents, and diverse seabed conditions, all of which affect platform stability and safety. Current anchor foundations demonstrate limitations in their load-bearing capacity, stability, and performance under severe marine conditions. This research proposes the development of an innovative and cost-effective anchoring system for deep-water floating wind platforms. The project encompasses three key aspects: design optimization, installation efficiency, and performance enhancement. In doing so, the research entails five objectives: 1.Optimize anchor structural parameters to suit diverse marine geological settings 2.Develop efficient, cost-effective installation methods for deep-water environments 3.Evaluate foundation performance using finite element analysis (FEA) and fluid-structure interaction simulations

	4.Assess ultimate load-bearing capacity and analyze failure mechanisms under extreme conditions 5.Investigate system stability through nonlinear dynamics and vibration analysis The intended analysis integrates FEA and machine learning (ML) capabilities. Combining the strengths of FEA and ML will serve as an intelligent design optimization tool for developing the new anchoring systems. The research will ultimately provide more reliable anchorage foundation technology for floating wind turbines. The new system shall ensure operational safety in extreme marine environments at an attractive overall cost for large-scale use.
Contact points	Informal inquiries may be addressed to Kai Yao (yaokai@sdu.edu.cn) and Ahmad Mousa (Ahmad.Mousa@nottingham.edu.cn).
PhD topic	**Monopile-Soil Interaction Behaviour for Offshore Wind Turbines**
SDUTI Supervisor	Kai Yao Chun Fai Leung
UNNC Supervisor(s)	Juan Wang
Short introduction & description of the PhD project	Offshore wind energy is rapidly becoming one of the most important renewable technologies, producing clean electricity at prices that increasingly match, and often beat, those of traditional fossil-fuel sources. At the heart of every offshore wind turbine is its foundation system. Whether it is a monopile, anchor, or suction caisson, the foundation alone can account for around 30% of the total construction cost. These foundations play a crucial role in how the turbine moves and vibrates, so any weakness or unexpected behaviour can speed up structural ageing, cause damage, or, in the worst cases, lead to failure. This is why engineers place so much emphasis on understanding the stability and deformability of these foundations, especially when they are subjected to lateral loads from wind and waves. Despite this importance, current design methods still assume that foundations behave as if they were simply "wished into place," ignoring the effects of how they were actually installed. Recent studies show that installation processes can significantly change the stress state around a monopile and therefore alter its lateral response. This makes it clear that modelling the installation phase is essential for accurately predicting how the soil and monopile interact. Once in service, monopiles are exposed to repeated lateral loading from wind, waves, and turbine operation. Over time, these cyclic loads can cause the foundation to deform, lose stiffness, and alter the behaviour of the surrounding soil. Much of the existing research has focused on sand and has relied on soil models such as Mohr–Coulomb or Tresca, which are unable to capture the effects of cyclic pile-soil interaction. Although more advanced models, such as SANISAND, SANICLAY, and hypoplastic soil models, can capture soil behaviour under cyclic loading conditions, they are rarely used because they are difficult to implement and not widely available. The challenge becomes even more complex in floating wind farms. In these systems, monopiles often act as anchors that connect multiple turbines through mooring cables. This means the monopile is loaded from several directions at

	once, with each load having its own frequency and amplitude. Traditional design tools, such as the one-dimensional p–y curve, cannot easily be extended to capture this kind of multidirectional cyclic behaviour. This PhD project aims to fill these gaps by developing a comprehensive understanding of how monopiles interact with clay soils. The work focuses on three key areas: Influence of installation methods on monopile behaviour in clay Effects of cyclic lateral loading on monopile–clay interaction Behaviour of monopiles under multidirectional cyclic loading in floating wind networks Together, these research strands will deepen scientific understanding and improve practical modelling of offshore monopile foundations. The outcomes will support the design of more reliable, costeffective, and resilient offshore wind infrastructure.
Contact points	Informal inquiries may be addressed to Kai Yao (yaokai@sdu.edu.cn) and Juan Wang (Juan.Wang@nottingham.edu.cn).
PhD topic	**Digital Twin for Geotechnical Monitoring of Offshore Wind Monopile Foundations**
SDUTI Supervisor	Kai Yao Chun Fai Leung
UNNC Supervisor(s)	Juan Wang
Short introduction & description of the PhD project	Offshore wind turbines rely on large steel foundations called monopiles that are driven deep into the seabed. From a geotechnical engineering perspective, these foundations are critical because their performance depends on how the soil and the structure interact over many years. Once a monopile is buried, it becomes extremely difficult to inspect. The surrounding soil hides any early signs of corrosion, cracking, or changes in stiffness. If these issues go unnoticed, the turbine may start to tilt, vibrate, or in extreme cases fail. This makes it essential to find new ways to understand what is happening underground, even though we cannot directly access the foundation. This PhD project aims to address this challenge by developing a digital twin that can sense what is happening inside the foundation and how it interacts with the soil. The key geotechnical focus is understanding how soil conditions influence the behaviour of the monopile. Soil stiffness, scour, settlement, and environmental changes all affect how loads and vibrations travel through the structure. As these conditions evolve, the response of the foundation changes as well. To monitor these changes, the project uses ultrasonic guided waves. These are special sound waves that travel along the steel wall of the monopile. Their behaviour is influenced by both the steel and the surrounding soil. If the soil becomes softer or stiffer, or if it starts to separate from the pile, the wave patterns change. If the steel develops a defect, the waves change again. By

	analysing these patterns, engineers can infer what is happening underground without excavation or direct access. The project brings together three main components: Laboratory testing to understand how guided waves behave under different soil conditions Finite element simulations to model soil–structure interaction in realistic offshore environments Data-driven methods to interpret the signals and predict how the foundation will behave in the future, supported by Bayesian inference to help the digital twin update its understanding as new information becomes available The goal is to create a system that can detect early signs of geotechnical problems such as loss of lateral stiffness, soil degradation, or changes in pile–soil bonding long before they become serious. In the long term, this work will help offshore wind farms operate more safely and efficiently by giving engineers a clearer picture of how foundations behave beneath the seabed, where traditional inspection methods cannot reach.
Contact points	Informal inquiries may be addressed to Kai Yao (yaokai@sdu.edu.cn) and Juan Wang (Juan.Wang@nottingham.edu.cn).
PhD topic	**Sustainable Reuse of Coal Gangue and Coal-Based Solid Wastes in Pavements and Embankments**
SDUTI Supervisor	Kai Yao Zhanyong Yao
UNNC Supervisor(s)	Bo Li
Short introduction & description of the PhD project	Coal gangue is the principal solid waste generated during coal mining and coal washing processes, composed primarily of silica- and alumina-rich sedimentary rocks with varying amounts of residual carbon. China, as the world's largest coal producer, generates millions of tonnes of coal gangue annually, leading to extensive surface stockpiling. The improper disposal of coal gangue occupies valuable land resources and poses serious environmental risks, including spontaneous combustion, dust emissions, groundwater contamination, and long-term ecological degradation. Effective and large-scale reuse of coal gangue is therefore a critical challenge for sustainable development in coal-producing regions. The mineralogical composition and mechanical characteristics of coal gangue indicate substantial potential for its reuse as a geomaterial. With appropriate processing and performance enhancement, coal gangue can serve as an alternative to natural aggregates in unbound pavement layers (subgrade, subbase, and embankments) as well as in bound pavement applications when activated as a cementitious or alkali-activated binder. Such reuse pathways can significantly reduce the consumption of natural resources, lower greenhouse gas emissions, and support the Sustainable Development Goals by promoting waste valorization and a circular economy in infrastructure construction.

	However, several technical and environmental challenges limit the large-scale reuse of coal gangue. These include variability in material properties, low early-age strength in unbound conditions, particle breakage and durability concerns under traffic loading, and uncertainties regarding the leaching behavior of trace elements. Addressing these limitations requires systematic material characterization, performance-based evaluation, and the development of targeted improvement strategies. This project aims to establish a comprehensive framework for the safe, durable, and sustainable reuse of coal gangue in pavement and embankment engineering, positioning it as a viable alternative to conventional natural materials. The scope of the work includes: (a) Material Characterization: Comprehensive physicochemical, mineralogical, mechanical, and leaching characterization of coal gangue, with comparison to other coal-based solid wastes such as Class C and Class F fly ash. (b) Performance Evaluation: Laboratory-based assessment of strength, stiffness, durability, and leaching performance for use as pavement and embankment materials, with identification of key technical and environmental risks. (c) Performance Enhancement Strategies: Development and evaluation of improvement methods, including unbound blending with secondary or industrial by-products and the use of coal gangue as a precursor in alkali-activated or geopolymer binders for bound pavement applications. (d) Sustainability and Feasibility Assessment: Life-cycle assessment and cost analysis to quantify environmental and economic benefits relative to conventional materials and practices. The project will be conducted within a multidisciplinary research environment, offering access to advanced laboratory facilities and providing strong opportunities for collaboration with industry and research partners. The Ph.D. offers excellent prospects for high-quality journal publications, international collaboration, and impact-driven research aligned with global sustainability goals.
Contact points	Informal inquiries may be addressed to Kai Yao (yaokai@sdu.edu.cn) and Bo Li (Bo.Li@nottingham.edu.cn).
PhD topic	**Development of soil solidification materials and construction technology for offshore wind power pile foundation scour protection**
SDUTI Supervisor	Kai Yao Zhanyong Yao
UNNC Supervisor(s)	Fangfang Zhu
Short introduction & description of the PhD project	Offshore wind produces clean electricity that competes with, and sometimes is cheaper than, existing fossil fuel-based technology and tackles the greenhouse effect and environmental pollution. Offshore wind turbines must be grounded on various types of foundations, such as monopiles, anchors, tripods, or suction caissons, which usually account for 30% of the construction cost. However, the offshore wind power pile foundations are subjected to cyclic waves, due to which local scour of the sea bed around the foundation occurs and poses a severe threat to the safety of offshore wind turbines. Therefore, it is necessary to develop an anti-scouring solidification material for offshore wind power pile

	foundations by modifying the engineering properties of the soft soil of the seabed. In addition, developing an in-situ solidification technology significantly enhances the project's applicability. For in-situ solidification, the slurry should be grouted directly into the seabed surface around the pile foundations. Moreover, the grouting slurry should have good workability and scour resistance/anti-washout characteristics in addition to strength. The grouting slurry should flow autonomously to the area that needs protection and be unaffected by the waves and currents to maintain the stability of the pile foundation. In summary, the slurry should have anti-washout characteristics for rushing water, proper mechanical strength, and be harmless to the environment. The most popular method to strengthen and stabilize soft soil is the addition of additives, which include cement and lime. However, the use of cement production contributes to 10% of global carbon emissions and is extremely harmful to the geoenvironment due to its hyper-alkalinity and high carbon footprint. Moreover, the modern age demands sustainable infrastructure with minimal environmental impact, and therefore, low-carbon footprint construction materials that can contribute to the circular economy are being investigated extensively. In this way, geopolymerization techniques may present a viable alternative to cement and lime, offering the potential to improve the strength and durability of soil with a comparatively reduced carbon footprint. In geopolymer technology, raw materials rich in silica and alumina are made to react with suitable alkaline silicates or hydroxides to create a stable compound with a polymeric structure of interconnected -Si-O-Al-O-Si- bonds. The developed anti-scour-resistance material should also be durable enough in the seawater. This PhD project aims for a comprehensive evaluation of the development of new anti-scouring solidification materials with high water stability and low permeability for offshore wind power pile foundations, including research on the detailed reinforcement mechanism of the developed material, development of coupled numerical simulation method for pile foundation-seawater-seabed-solidified soil, that will summarize the key design parameters of solidified soil, formed a control index system for scour protection of solidified soil, and proposed a set of in-situ solidified soil design solutions.
Contact points	Informal inquiries may be addressed to Kai Yao (yaokai@sdu.edu.cn) and Fangfang Zhu (fangfang.zhu@nottingham.edu.cn).
PhD topic	**Green Reclamation Technology of Open-pit Coal Mine Waste Dump**
SDUTI Supervisor	Kai Yao Zhanyong Yao
UNNC Supervisor(s)	Shu Liu
Short introduction & description of the PhD project	Open-pit coal mining, while supporting energy supply, generates vast quantities of coal-based solid waste that accumulate into waste dumps. This leads to severe issues such as land occupation, soil degradation, heavy metal pollution, and ecosystem destruction. Particularly in ecologically fragile regions like Xinjiang, the ecological restoration of waste dumps has become a critical challenge constraining regional sustainable development and ecological security. Traditional reclamation techniques primarily rely on imported soil coverage and simple vegetation restoration. These methods suffer from limitations such as high

	costs, slow soil reconstruction, inadequate control of heavy metal migration risks, and unsustainable restoration outcomes. Consequently, they fail to achieve large-scale, safe, and resource-efficient disposal of solid waste. This project aims to systematically research and develop an integrated ecological reclamation technology system for open-pit coal mine waste dumps in arid and semi-arid climates. The research focuses on synergizing the resource utilization of coal-based solid waste with ecological function restoration. By establishing a comprehensive solution encompassing "matrix materials—stabilization techniques—vegetation restoration—process integration," it achieves efficient, economical, and sustainable land rehabilitation of waste dumps. Specific research covers the following four core objectives: 1. Systematically investigate the blending mechanisms of local coal-based solid waste with soil and organic waste, optimize the physical structure, nutrient supply, and plant compatibility of the materials, and develop novel reclamation substrate materials primarily composed of coal-based solid waste 2. For characteristic pollutants in waste dumps (e.g., Cr, Pb, Cd), investigate their migration and transformation patterns in geological media, and develop multi-synergistic stabilization technologies 3. Based on regional climate and soil conditions, screen locally adapted plant species that are stress-tolerant, fast-growing, and have extensive root systems. Investigate their interaction mechanisms with the modified substrate to establish rapid establishment and community construction techniques 4. Integrate key processes including substrate formulation, layered filling, stabilization treatment, and vegetation configuration to develop standardized, replicable construction techniques for waste dump reclamation This study will provide the theoretical foundation and technical support for large-scale ecological restoration of open-pit coal mine waste dumps and the resource-based utilization of coal-based solid waste. This work holds significant scientific value and practical implications for promoting ecological security in mining areas and advancing regional green development.
Contact points	Informal inquiries may be addressed to Kai Yao (yaokai@sdu.edu.cn) and Shu Liu (Shu.Liu@nottingham.edu.cn).
PhD topic	**Integrated design of anchoring foundation-upper structure systems for floating offshore wind under complex wave loading**
SDUTI Supervisor	Kai Yao Chun Fai Leung
UNNC Supervisor(s)	Fangfang Zhu
Short introduction & description of the PhD project	The global demand for renewable energy is rapidly increasing, and offshore wind energy is emerging as a promising solution to meet this demand. Floating offshore wind turbines (FOWTs) are particularly attractive as they enable deployment in deep and remote waters where fixed-bottom foundations are not feasible, thereby unlocking vast new areas for wind energy development. However, the design of floating offshore wind systems remains highly

	challenging, as it requires reliable solutions for structural integrity, stability, and long-term performance under harsh and highly variable marine environments. In deep-water conditions, floating offshore wind systems are subjected to complex and strongly coupled environmental loads, among which wave-induced actions play a dominant role in governing global motions and internal load transfer. The overall response of the system is controlled by the interaction between anchoring foundations, mooring systems, and the floating upper structure that supports the wind turbine. Current design approaches often rely on simplified hydrodynamic representations and partially decoupled analysis procedures, which may be insufficient to accurately capture nonlinear wave effects, viscous damping, and the interaction between the upper structure and its foundation system. As a result, significant uncertainties remain in load prediction, safety assessment, and the consistency between numerical simulations and actual offshore behaviour. This project aims to address these challenges through an integrated investigation of anchoring foundation-upper structure systems for floating offshore wind applications. (a) The research will focus on clarifying the load-bearing behaviour and failure mechanisms of anchoring foundations subjected to complex loading conditions, with particular emphasis on combined and time-varying effects induced by wave-dominated marine environments and the dynamic response of the upper structure. (b) To better represent the influence of complex wave loading, computational fluid dynamics (CFD) will be employed in conjunction with coupled dynamic analysis to resolve key hydrodynamic features that are not adequately captured by conventional methods, thereby improving the accuracy of load transfer and global response prediction for the integrated foundation–upper structure system. (c) Building on the improved understanding of foundation behaviour and wave-induced coupled dynamics, the project aims to develop a comprehensive and broadly applicable integrated design methodology for anchoring foundation–floating offshore wind systems, supporting rational design decisions for the upper structure and its foundation under both operational and extreme conditions. By advancing an integrated, wave-informed design approach, this research seeks to enhance the reliability, safety, and efficiency of floating offshore wind systems and to support the sustainable development of offshore renewable energy in deep and remote marine environments.
Contact points	Informal inquiries may be addressed to Kai Yao (yaokai@sdu.edu.cn) and Fangfang Zhu (fangfang.zhu@nottingham.edu.cn).
PhD topic	**Theoretical and Experimental Investigation of Multiphysics Coupling in Underground Caverns for Compressed Air Energy Storage**
SDUTI Supervisor	Kai Yao Chun Fai Leung

UNNC Supervisor(s)	Jing Bie
Short introduction & description of the PhD project	Under the accelerated global transition toward a low-carbon energy system, compressed air energy storage (CAES) has emerged as a key technology for enabling large-scale and long-duration energy storage. Underground cavern-based CAES systems create sealed storage spaces within subsurface rock formations, allowing effective mitigation of the intermittency of renewable power generation and improving the peak-shaving and frequency-regulation capability of power systems. Projections indicate that, with the continued expansion of renewable energy capacity, CAES will assume an increasingly important role in future energy infrastructures. However, the construction and long-term operation of underground CAES caverns remain challenging. As the primary load-bearing and containment structure, the cavern must maintain airtightness and structural stability under high-pressure cyclic loading, while accounting for a substantial share of system costs. Moreover, complex geological conditions, high in situ stresses, and repeated air injection–withdrawal cycles induce coupled thermo-hydro-mechanical effects that may compromise surrounding rock stability and long-term safety. Existing CAES caverns exhibit limitations in load-bearing capacity, sealing performance, and long-term stability when subjected to high-pressure cyclic loads. This research proposes the development of a safe, reliable, and economically feasible cavern structure and operational strategy for underground CAES systems. The study focuses on three main aspects: cavern structural design, surrounding rock response mechanisms, and the enhancement of operational performance and safety. Accordingly, five research objectives are defined: 1. Develop a thermo-hydro-mechanical multiphysics coupling theoretical model for underground CAES caverns 2. Investigate surrounding rock deformation, damage, and fracture evolution under high internal pressure cyclic loading 3. Analyze cavern response characteristics under different geological conditions and operational scenarios using numerical simulation methods 4. Validate the proposed multiphysics coupling model through physical model experiments and related testing approaches 5. Identify long-term stability criteria and safety control indicators for underground CAES caverns This study integrates numerical simulations and experimental investigations to establish a multiphysics coupling framework for CAES caverns, providing a scientific basis for cavern design optimization and operational parameter selection. The outcomes aim to support safe, stable, and economically viable underground CAES systems for large-scale deployment.
Contact points	Informal inquiries may be addressed to Kai Yao (yaokai@sdu.edu.cn) and Jing Bie (Jing.Bie@nottingham.edu.cn).

PhD topic	Physics-data driven models for real-time evaluation on the stability of rainfall slope and intelligent risk warning
SDUTI Supervisor	Prof Pei-Zhi Zhuang
UNNC Supervisor(s)	Prof Juan Wang
Short introduction & description of the PhD project	Mountainous terrain accounts for approximately 70% of the national land area. Owing to complex geological conditions and frequent rainfall, slope failures and related geological hazards occur frequently, resulting in severe damage to critical infrastructure. Consequently, real-time risk assessment and early warning of slope instability under heavy rainfall conditions are of significant importance for ensuring slope safety. Conventional slope monitoring methods predominantly rely on surface displacement measurements. However, such approaches often fail to provide sufficient lead time for effective mitigation once excessive deformation is detected. Moreover, deformation-based monitoring alone is inadequate for revealing the underlying mechanisms governing landslide initiation and evolution. This project aims to develop an artificial intelligence–based framework that integrates monitored data with physical mechanisms for real-time slope stability assessment. The proposed integrated model enables high-accuracy computation and early warning of slope. The main research contents are as follows: 1. Development of a physics-informed machine learning for slope stability analysis. 2. Experimental validation and risk evaluation. Laboratory-scale slope model experiments are conducted to validate the proposed physics–data driven framework. Based on multiple factors, including slope safety factor and infrastructure importance, a standardized slope risk classification system is established to support intelligent early-warning decision making.
Contact points	Informal inquiries may be addressed to Juan Wang (juan.wang@nottingham.edu.cn) and Pei-Zhi Zhuang (zhuangpeizhi@sdu.edu.cn).

Other potential supervisors

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SDU (QILU)		

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