Zilong Tang

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Education

2021-2024 Master of Civil Engineering Hunan University, Changsha China
- **-GPA**: 3.87/4.00 (93.4/100, Rank: 1/305)
- **-Thesis**: Mechanical behavior of ultra-high-performance concrete (UHPC) under combined tensile and bending action (an advanced cementitious composite with steel fiber)
- **-Supervisor**: Professor Zhi Fang

2017-2021 Bachelor of Civil Engineering Hunan University, Changsha China
- **-GPA**: 3.80/4.00 (90.3/100, Rank: 3/49)
- **-Minor**: Computer Science and Technology
- **-Thesis**: Design and analysis of partial ground anchor cable-stayed bridge

Relevant Curriculum

Math	Advanced Mathematics (Calculus), Linear Algebra, Numerical Analysis, Discrete mathematics, Complex Functions, Random Process, Functional Analysis (audited)
Mechanics	Theoretical Mechanics, Materials Mechanics, Structural Mechanics, Dynamics of Structures, Elasticity and Plasticity, Fluid Mechanics, Soil Mechanics, Finite Element Method, Fracture mechanics, Variational Principles (audited)
CS	Advanced Programming (C++), MATLAB, Data Structure and Algorithm Analysis, Database Systems, Machine Learning (audited)
CE	Basic Theory of Concrete Structure, Steel Structure Design Principles, Advanced Theory of Bridges, Nonlinear Analysis and Design of Structures

Research Experiences

1. **Experimental study on the mechanical behavior of ultra-high-performance concrete (UHPC) under combined tensile and bending action** (Master's project, advisor: Professor Zhi Fang)

   Description: This study, supported by the National Natural Science Foundation of China (Grant No. 51938012), involved testing 72 UHPC specimens under axial tension (dog-bone shaped), pure bending (prisms), and combined tension and bending (U-shaped). The results showed that as the eccentricity ratio and steel fiber content increased, stresses and strains at the cracking, peak, and ultimate load also rose. Key findings included the variation patterns of cracking strength, peak strength, residual strain, stiffness degradation, and damage progression under different testing conditions. Corresponding calculation approaches were developed to predict these behaviors. Additionally, using digital image correlation (DIC) for full-field surface measurements, the fiber bridging mechanism of UHPC under combined tensile and bending loads was discussed.

   - Test parameters: steel fiber content (0 %, 1 %, 2 %, and 3 %), eccentricity ratio (0, 0.1, 0.2, 0.4, 0.8, and ∞), and load type (monotonic and cyclic load)

- Innovative Design: Specimen, Loading device, and Measurement system
- Skills involved: Experimental Skills, Device Operation, Digital Image Correlation, Programming, Data Analysis and Visualization

2. Data-driven prediction of UHPC tension constitutive (Part of Master's project)

Description: A sequence prediction model was developed to predict the tensile constitutive behavior of UHPC based on bending test results using machine learning methods, including LSTM, GRU, and BiLSTM. A novel metric, the Relative Error Curve (REC), was proposed to assess model accuracy. Results showed that the machine learning models outperformed traditional inverse analysis methods (5P-IA). Based on MABLAB App Designer, a software application, MLIA, was developed, which integrated functions such as model selection, preprocessing, and forward computation, enabling intuitive, convenient, and accurate prediction of UHPC tensile constitutive curves from bending test results.

- Dataset: 8952 pairs of curves, about 200 data of UHPC tensile strength measured by direct tensile tests and four-point bending tests
- Code: 1000 lines of MATLAB code and 200 lines of Python code
- Software: MLIA (Machine Learning Inverse Analysis)
- Skills involved: Machine Learning, Recurrent Neural Network, Finite Element Analysis, Object-oriented Programming, App Designer

3. Data-driven prediction of bond strength between UHPC and reinforcing bars (Advisor: Associate Professor Fei Peng)

Description: A Physics-Informed Neural Network (PINN) model was developed to predict the bond strength between UHPC and reinforcing bars. This model integrates physical constraints into the Neural Network (NN) via physical loss terms, which is based on the theoretical framework of thin-walled circular cylinders and the fiber-matrix discrete bond strength model. The results demonstrate that the PINN model offers superior physical consistency, effectively conforming to theoretical principles and experimental data. Compared to traditional machine learning models and mechanical models, the PINN model outperforms with a mean prediction-to-actual bond strength ratio of 0.99 and a coefficient of variation of 0.18.

- Dataset: 401 data with 8 features of ρ_f, l_f, d_f, f_c, d, f_y, l, c.
- Models: Random Forest (RF), XGBoost, Extra Trees, Support Vector Regression (SVR), Neural Networks (NN), and Physics-Informed Neural Network (PINN)
- Skills involved: Machine Learning, PINN, Elasticity Mechanics

4. Ductility evaluation and flexural failure mode recognition of Reinforced UHPC (R-UHPC) flexural members (Participating, Advisor: Associate Professor Fei Peng)

Description: A numerical model was developed to simulate the flexural behavior of R-UHPC beams, addressing the issue of low structural ductility due to crack localization, while accounting for bond slip between reinforcement and UHPC. The results indicate that when the failure is controlled by fracture of tensile steel bars after crack localization, higher reinforcing ratio, higher steel post-yield hardening strength, and lower steel fiber volume lead to more ductile behavior. When the failure is controlled by crushing of UHPC, however, higher reinforcing ratio and lower UHPC compressive strength lead to a lower ductility. A flexural failure mode recognition method and a minimum flexural reinforcement ratio are proposed to prevent low ductility in R-UHPC flexural members.

- Skills involved: Finite Element Analysis, Data curation, Regression Analysis

5. **Design and performance study of the cold-formed thin-walled steel-wood composite floor slab** (Project Leader, Project: National Student Innovation Training Project, No. S201910532138, Advisor: Professor Weijian Yi)

   Description: A steel-wood composite floor slab was designed through structural calculations and market research, achieving a significant reduction in floor height and weight. Push-out tests with different pitches of bolts for the composite slabs were designed and conducted to determine the bearing capacity and bond-slip relationship of the shear key. A calculation model for the bearing capacity of steel-wood composite floor was obtained. The project was completed and awarded second prize in national student innovation training project at Hunan University.

   - Teamwork: there were 4 students in our team, and I was the leader
   - Skills involved: Structural Design, Experimental Skills, Data Analysis, Market Research, Team Management

6. **Design and structural analysis of large span cable-stayed bridge** (Engineering Experience)

   Description: Using Midas and Abaqus software, two large-span cable-stayed bridges were analyzed and designed: the *Guanyin Temple Yangtze River Bridge*, the largest span highway cable-stayed bridge with a main span of 1160m, and the *Danjiangkou Reservoir Bridge* (**Bachelor's project**), the largest partial ground anchor mixed beam cable-stayed bridge with a main span of 760m. Calculated cable forces, structural internal forces, stresses, deformations, and vibration modes, accounting for the sag effect of the cables.

   - Skills involved: Structural Design, Finite Element Analysis, Budget Analysis, Data Analysis, Construction Drawing

Publications

[1]. **Tang Z**, Fang Z, Peng F, et al., Behavior of ultra-high-performance concrete under combined tensile and bending action, *Journal of Building Engineering*, 2024, 89, 109388. https://doi.org/10.1016/j.jobe.2024.109388.

[2]. Peng F, Deng J, Fang Z, **Tang Z**. Ductility evaluation and flexural failure mode recognition of reinforced ultra-high performance concrete flexural members. *Structures*, 2023, 51, 1881-1892. https://doi.org/10.1016/j.istruc.2023.03.127.

[3]. Fang Z, Xu Z, Luo H, **Tang Z**, et al., Fatigue resistance of ultra-high-performance concrete under combined tensile and bending action. *Journal of the Chinese Ceramic Society*, 2024, 1-14. https://doi.org/10.14062/j.issn.0454-5648.20240185. (In Chinese)

Awards and Certificates

Awards

1. **Chinese National Scholarship**, *Ministry of Education of the People's Republic of China*, Dec 2022 (The highest scholarship for top 1% students)
2. **Chinese National Encouragement Scholarship**, *Ministry of Education of the People's Republic of China*, Dec 2018, 2019, 2020
3. First Class Scholarship of Hunan University, *Hunan University*, Nov 2021, 2022, 2023
4. Outstanding Graduate of Hunan Province, *Department of Education of the Hunan Province*, May 2021
5. Second Prize of National Student Innovation Training Project, *Hunan University*, May 2021
6. Excellent Graduation Project, *Hunan University*, Jun 2021

7. **Pacemaker to Merit Student** of Hunan University, *Hunan University*, Dec 2019
   (Comprehensive rank in moral, intellectual, and physical, awarded to 1 out of 460 students)
8. Merit Undergraduate Student of Hunan University, *Hunan University*, Dec 2018, 2019
9. First Prize of Hunan Provincial Mechanics Competition, *Department of Education of the Hunan Province*, Aug 2019
10. Third Prize of National Zhou Peiyuan Competition on Mechanics, *The Chinese Society of Theoretical and Applied Mechanics*, Aug 2019
11. First Prize of Hunan Provincial Mathematics Competition, *Department of Education of the Hunan Province*, Sep 2018

Certificates

1. Chinese National Computer Rank Examination
   Rank Ⅱ: MS Office, C++, Python; **Rank Ⅲ**: Internet technology
2. Qualification Certificate of Computer and Software Technology Proficiency
   Intermediate level: Software Designer
3. Chinese National 1st class Registered Structural Engineer
   Level: Passed basic examination

Skills

Programming	C++, Python, MATLAB, SQL, HTML5
Machine Learning	Machine learning, RNN, PINN, DL, PyTorch, Scikit-learn, NumPy
Softwares	AutoCAD, ABAQUS, ANSYS, Midas, SPSS, LINGO, SolidWorks etc.
Lab Skills	Proficient in designing specimens and models, and operating loading devices and measurement systems, including servo-hydraulic machines, LVDTs, extensometers, strain measurement instruments, and DIC systems. Skilled in solving complex issues, multi-party coordination and communication, and managing emergencies.

Languages

Chinese	Mother Tongue	Fluent
English	Advanced (IELTS 6.5)	Conversationally Fluent

Hobbies

Reading, Running, Cycling, Basketball

Traits

- **Research Interests**: Enthusiastic about interdisciplinary research, scientific machine learning, computational mechanics, smart construction, health monitoring, and composite materials.
- **Career Goals**: Highly self-motivated with a strong desire to pursue an academic career.
- **Teamwork**: Demonstrates strong interpersonal, teamwork, and leadership skills. Held roles such as Class Monitor (2019-2023), Vice Minister of the Student Union (2018-2019), and Vice Minister of the Young Volunteers Association (2018-2019).
- **Self-Learning Ability**: Proactively audited and systematically studied nearly 20 courses in mathematics, mechanics, and computer science, showcasing a strong ability for independent learning.