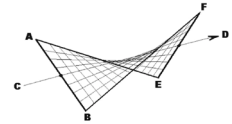


# Hypar Pavilion

ITE STEGREIF | 16.04.26 – 20.04.26



Professorship for Structural Design  
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Institute of Structural Design  
TU Braunschweig

EN

## Fiber Pavilion North Campus TU Braunschweig

Design of a lightweight pavilion based on fiber winding and smooth poly-hypar surfaces

### 1. Background

This Stegreif introduces students to the design of lightweight architectural structures through the combination of fiber winding, hyperbolic paraboloid (HPP) geometries, and smooth poly-hypar surface systems.

The task is informed by two parallel research directions. On the one hand, recent work on smooth poly-hypar membrane structures demonstrates how combinations of hyperbolic paraboloids can generate continuous, ruled, structurally efficient surfaces with smooth transitions and clear axial load paths.

Current research from TU Braunschweig / ITE and collaborators explores fiber-based reinforcement and fabrication in digital construction. This includes dynamic winding processes, robotic fiber winding, frame winding, and the combination of fiber systems with Shotcrete 3D Printing (SC3DP). These studies show that fibers are not only reinforcement, but can also become a form-giving, structural, and fabrication-defining element.

In this Stegreif, students are asked to use these ideas not as a purely technical exercise, but as the basis for an architectural pavilion on the North Campus: a place of shelter, gathering, and spatial identity.

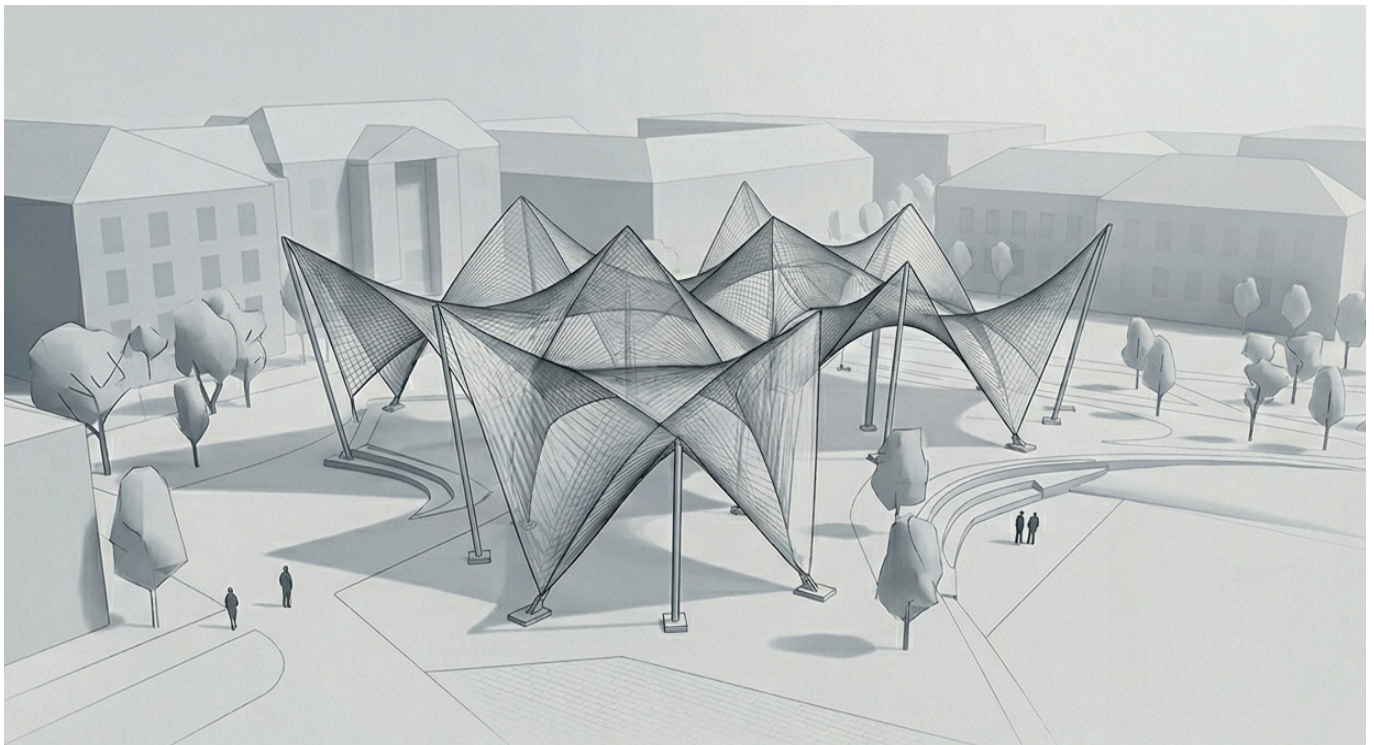


Figure 1: Exemplary structure on the North Campus of TUBS, Credit: ITE TUBS

## 2. Why Fiber?

Fiber-based systems are especially relevant for contemporary lightweight construction because they offer several advantages over conventional reinforcement and heavy construction systems.

Continuous fibers such as glass or carbon fibers are lightweight, flexible, corrosion-resistant, and well suited to automated and individualized fabrication. In current research, these properties are used to produce tailored reinforcement strands and freeform reinforcement structures through dynamic and robotic winding processes.

Research at TU Braunschweig has shown that fiber winding can operate at different scales and in different roles:

- as individualized reinforcement strands produced by a Dynamic Winding Machine,
- as robotically placed reinforcement structures for additively manufactured concrete,
- as stay-in-place formwork and reinforcement for shell-like concrete elements through robotic frame winding,
- and as part of larger digital workflows combining reinforcement, fabrication, and structural form.

For this Stegreif, fiber winding should therefore be understood broadly: not only as a method of making a component, but as a design logic that can shape geometry, organize force-flow, define surface density, generate porosity, and produce structure.

## 3. Task

Design a lightweight pavilion for the North Campus that explores the architectural, structural, and fabrication potential of fiber winding in combination with HPP / smooth poly-hyper geometry.

The pavilion should serve as a small public structure for students, researchers, and visitors. It may function as a place for meeting, resting, informal exchange, small exhibitions, or temporary events. The proposal should create a clear spatial identity on campus while demonstrating an intelligent use of material and geometry.

You can develop your idea or design using digital software such as Rhino, or by creating a physical model.

The pavilion must be developed as an integrated system in which geometry, structure and fabrication logic are conceived together from the beginning.

The project should not be understood as a conventional roof supported by columns. Instead, students are encouraged to think of the pavilion as a surface-active, frame-active, or hybrid lightweight structure, in which wound fibers and HPP-derived geometries generate both spatial experience and structural performance.

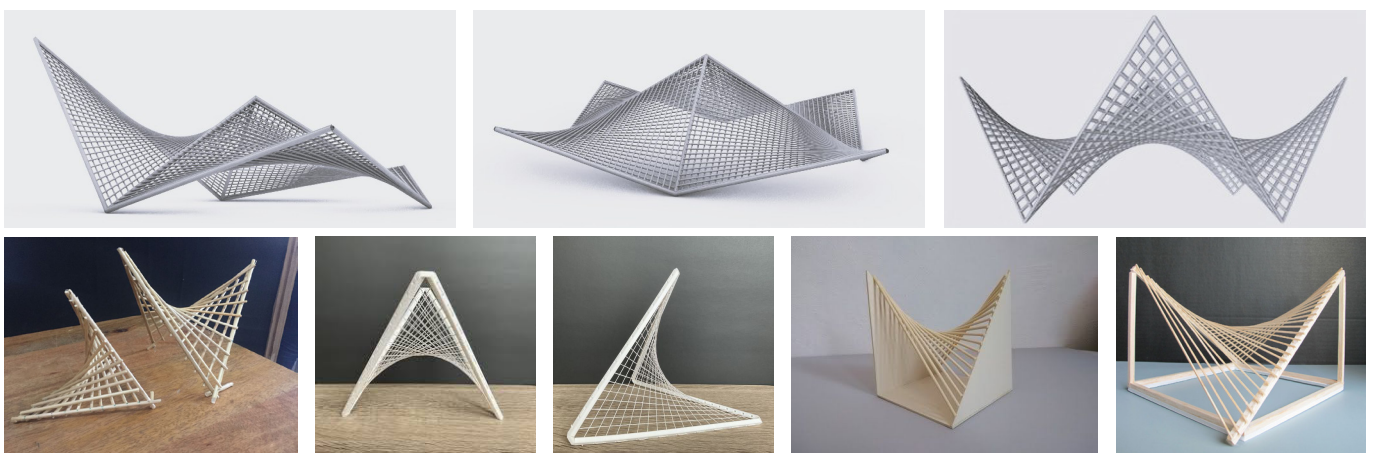


Figure 2: Exemplary structure of digital and handcrafted HPP models, Credit: ITE TUBS

#### 4. Site

The pavilion is to be located on the North Campus.



#### 5. Design Objectives

The design should address the following goals:

- develop an architectural pavilion based on fiber winding principles
- use hyperbolic paraboloid / smooth poly-hypar logic as a geometric driver
- create a lightweight and materially efficient structure
- respond specifically to the site conditions on the North Campus

Students must choose a specific location and justify it through site analysis. The proposal should respond to:

- movement flows and access
- visibility and orientation
- sun, shadow, and weather
- relation to buildings and landscape
- opportunities for gathering and staying

The pavilion should establish a meaningful relationship between site, program, and structure.

#### 6. Program/Function

The pavilion should provide space for small-scale public use, such as:

- sitting and resting
- informal meetings
- studying outdoors
- small talks or presentations
- temporary exhibitions
- shelter from sun and light rain

The design should remain compact, clear, and focused.

Indicative size:

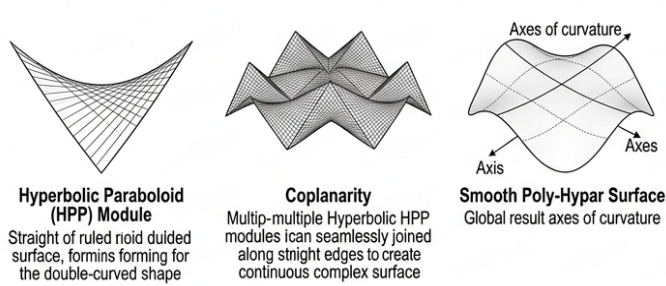
- approximately 25–60 m<sup>2</sup> covered area

#### 7. Deliverables

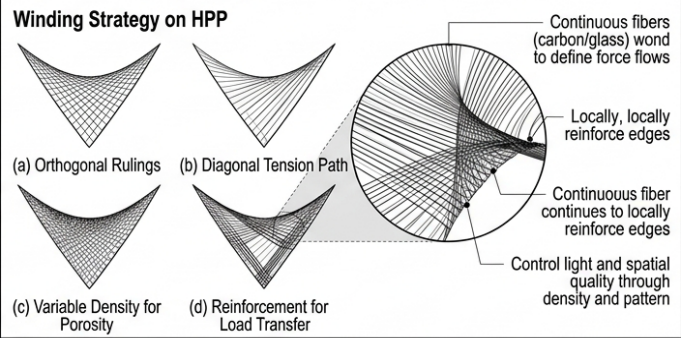
The final submission is on 20.04.2026 12:00 pm, digital as pdf to [fatemeh.amiri@tu-braunschweig.de](mailto:fatemeh.amiri@tu-braunschweig.de) and should include:

- concept statement
- site plan and site analysis
- plans, sections, elevations
- diagrams of geometry and structural concept
- renderings or atmospheric views
- one physical model and/or material prototype or digital model

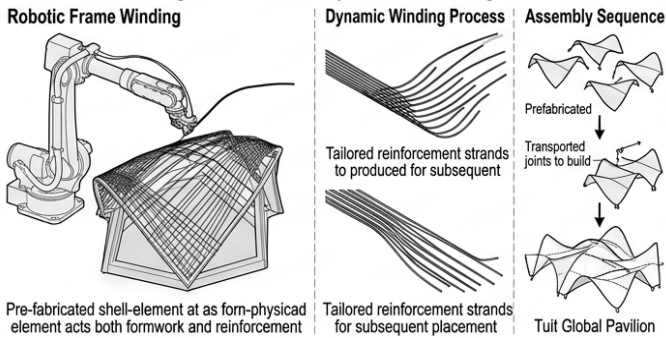
## 1. Geometric Principles: HPP & Smooth Poly-Hypar



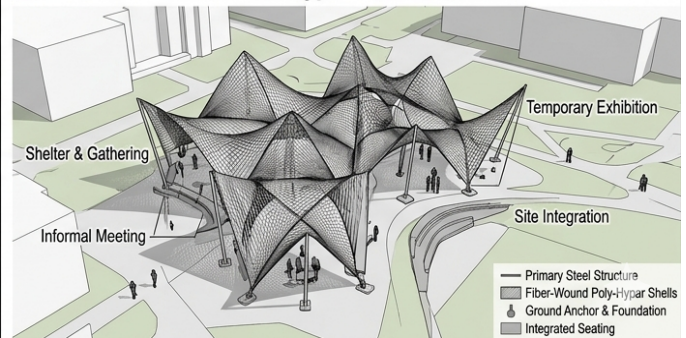
## 2. Fiber as Design Logic: Force Flow & Surface Density



## 3. Fabrication Logic: Robotic & Dynamic Winding



## 4. Architectural Result: The Hypar Umbrella Pavilion



## 8. Suggested References from the Research Team (Uploaded Papers)

- Cao, T.; Wan, Z.  
Smooth poly-hypar membrane structure: A strut-and-membrane system based on combinations of hyperbolic paraboloids.  
Journal of Building Engineering, 2025.
- Hack, N.; Bahar, M.; Hühne, C.; Lopez, W.; Gantner, S.; Khader, N.; Rothe, T.  
Development of a Robot-Based Multi-Directional Dynamic Fiber Winding Process for Additive Manufacturing Using Shotcrete 3D Printing.  
Fibers, 2021.
- Rothe, T.; Pösch, J.; Gantner, S.; Hack, N.; Hühne, C.  
Optimization of tensile properties and bond behaviour to concrete of fibre reinforcement strands produced within a dynamic fibre winding process.  
CICE 2023.
- Rothe, T.; Gantner, S.; Hack, N.; Hühne, C.  
A Dynamic Winding Process of individualized fibre reinforcement structures for Additive Manufacturing in Construction.  
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- Gantner, S.; Rothe, T.; Hühne, C.; Rennen, P.; Hack, N.  
Reinforcement Strategies for Additive Manufacturing in Construction based on Dynamic Fibre Winding: Concepts and Initial Case Studies.  
2022.
- Rennen, P.; Gantner, S.; Rothe, T.; et al.  
Structural Evaluation of Shotcrete 3D Printing and Robotic Fiber Winding for Thin Shell Elements.  
IASS 2024.
- Gantner, S.; Rennen, P.; Amiri, F.S.; Rothe, T.; Hühne, C.; Lowke, D.; Kloft, H.; Hack, N.  
Robotic frame winding: prefabricated fibre structures as formwork and reinforcement for digitally fabricated shell-like concrete elements.  
Construction Robotics, 2025.
- Dörrie, R.; Gantner, S.; Amiri, F.S.; et al.  
From Digital to Real: Optimised and Functionally Integrated Shotcrete 3D Printing Elements for Multi-Storey Structures.  
Buildings, 2025.
- Kloft, H. et al.  
Interaction of reinforcement, process, and form in Digital Fabrication with Concrete.  
Cement and Concrete Research, 2024.

Please find the papers for download here: [Papers](#)

Link: <https://www.swisstransfer.com/d/114b3a05-a704-4bed-9a7e-7263ba8d7d17>