

SUN-SHADE PAVILION: THE IDEA BEHIND IT

A Sustainable and Lightweight Pavilion for Montessori-School Penzberg

This idea paper outlines the Research & Development of the Sun-Shade Pavilion for Montessori-School Penzberg, prioritizing both environmental and economic factors. We believe in inspiring and encouraging a culture of sustainability, especially among our present and future generations.

Our education journey began with understanding the importance of sustainability and lightweighting competences in schools. We aimed to qualify younger generations on responsible resource use to protect our environment and resources for our sustainable future. This holistic perspective guided our whole product development.

To achieve a lightweight and sustainable design, we decided a holistic approach in a “frontloading process”. We utilized our management method called "Sustainability Value" analysis. This eco-management instrument measures and assesses both environmental and economic impacts, ensuring a balance that minimized the environmental footprint while maintaining cost-effectiveness and efficiency.

Environment-friendly materials were a top priority. Basalt fiber, derived from volcanic rock, offers an outstanding strength-to-weight ratio and fire resistance. Bio-based resin, a renewable resource, replaced traditional petroleum-based resins. Additionally, recyclable materials were incorporated wherever possible.

Our radical innovative xFK in 3D process technology offers a platform for "Rethinking lightweight construction and sustainability." This innovative approach considered several design principles:

- **Design for Circularity:** We prioritized materials that could be easily disassembled, reused, and recycled at the end of the pavilion's (first) life cycle.
- **Design for Environment:** Material selection focused on minimizing environmental impact throughout the entire product life cycle, from resource extraction to the end of its first life.
- **Design for Manufacturing:** The design was optimized for efficient winding technique using xFK in 3D process technology, minimizing waste and production time.
- **Design for Longevity:** Incorporating durable surface treatments will complement the well-designed structure, ensuring a long lifespan for the pavilion and minimizing the need for replacements.

Throughout the xFK in 3D design and development process, we collected data to analyze and evaluate different concepts. This data-driven approach helped us identify the optimal combination for the final “Sun-Shade Pavilion” design. We imagined one of the 45 modular structures, designed for easy assembly and disassembly, built with basalt fiber and a bio-based resin system. By combining all 45 parts, we could create a pavilion measuring 6 by 3 meters. This modular design was efficiently wound using “xFK in 3D” process technology, utilizing both “pure” and “consolidated” forms to prioritize durability and sustainability.

The prototype “Sun-Shade Pavilion” was developed as a lightweight demonstrator using calculations and simulations of environmental factors, usability, functionality, and structural integrity. This "*learning by doing*" approach allowed for real-world testing and refinement of the design. Data gathered during the prototyping stage further informed future iterations and ensured the final product met sustainability and lightweight goals.

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