TECHNISCHE UNIVERSITÄT DARMSTADT

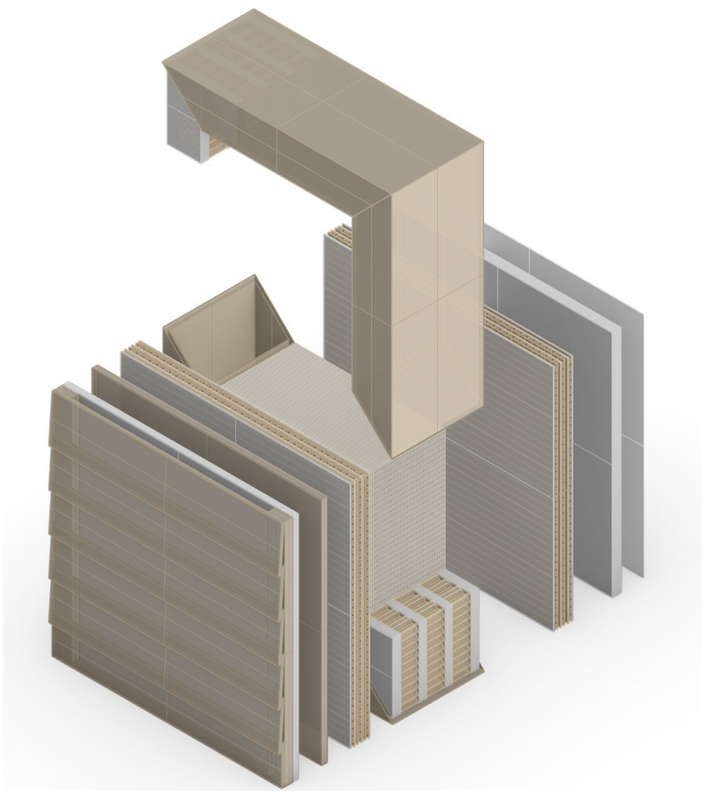
ISM+D
Institute of Structural Mechanics and Design
Institut für Statik und Konstruktion

Paper Construction and Design

CIRCULAR EXTERIOR WALL SYSTEM BASED ON PAPER

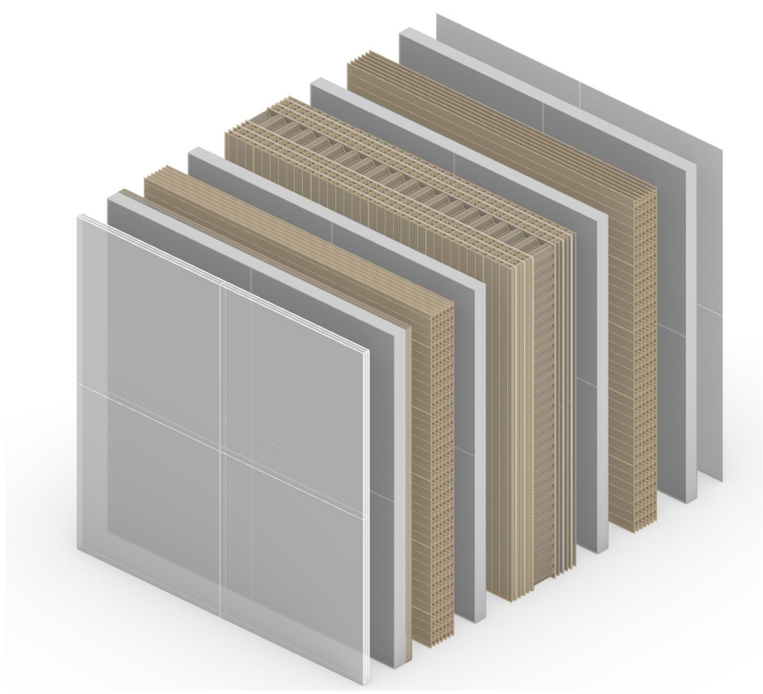
For exterior wall systems, there is a wide range of solutions on the market. In general, monolithic, layered and skeletal constructions. Mineral, metallic, petroleum and wood-based building materials are common. Often, a combination of the mentioned materials is used. The production of purely mineral systems is associated with a high CO2 footprint. With other systems, it is often difficult to separate the composite and layered structures by type, which is particularly problematic from a recycling point of view.

The use of paper building materials as exterior walls is a very new field of application. The project is considered to target the market of individual house construction, specially prefabricated, through the design of functional paper mono-material constructive systems. This would address the market demand for a recyclable and prefabricated mono-material building product made of paper for use as an exterior wall.



Project drawing of subvariant 1.1a, transom and mullion lightweight paper tube structure. TUDa 2023.

Image of 50 x 50 cm protype of Subvariant 1.2a, massive functional layered structure. TUDa 2024.



Project drawing of Subvariant 1.2a, massive functional layered structure. TUDa 2023.

BACKGROUND

Currently, building materials made of paper are only used to a limited extent in buildings; there is a considerable need for development in order to define new products and open up markets. According to the state of the art, paper materials are used in buildings, but not as a stand-alone material, but only as a support and sub-component. For example, gypsum plasterboard usually has a cardboard layer on both sides to reinforce the stability of the boards. For interior doors honeycomb inserts are often used, the core here consists of lightweight honeycombs made of folded cardboard. The inner workings of the door are not visible to the user, and there is usually no conscious awareness of paper as a building material. As insulation materials, cellulose flakes are used in particular as blow-in insulation. In this case, cavities are filled, for example in roof areas or in the area of external insulation.

PROJECT OBJECTIVE

The overall objective of the present cooperative project is the conception, research and development of exterior wall systems made of paper, suitable for use on 1-3 storey buildings. This overall objective is to be realized through a circular layered structure with functional layers made of paper. In addition to the connection technology of the layers to each other, the connection technology of individual exterior wall panels is to be researched and developed, and a system catalogue for constructive joining is to be created. The project includes a concept and planning phase, the production of samples on a small and real scale, as well as the implementation of structural-physical, static-constructive and mechanical tests. A wall construction is to be carried out with the help of prototypes, and an active & passive fire protection concept is to be tested. At the end of the project, implementation concepts for scaling up production are to be developed.

TECHNICAL CHALLENGES

Technical challenges present mainly in terms of statics (load-bearing capacity, compressive strength, fatigue strength), fire protection and weather resistance. In particular, the technical challenges are as follows:

- Construction of the element from different layers, selection of suitable layer structures and materials to meet the structural requirements.
- Use of water-repellent components and coatings that exclude moisture penetration and water vapor.
- Ensuring fire protection.
- Analysis of test procedures for accelerated ageing of the elements.
- Development of methods for manufacturing the elements on a laboratory and pilot scale.
- Bonding techniques between layers and joining techniques between the elements.

FUNDING PROGRAM
Zentrales Innovationsprogramm Mittelstand (ZIM)

PROJECT PERIOD
01.07.2023 – 30.06.2025

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