



Paper Construction and Design

The paper construction and design group is engaged in fundamental research of constructions made out of paper. Main focus of the research is the development of building materials made of paper to promote resource-saving construction possibilities. For this purpose, experimental and numerical analyses of the load-bearing behaviour and building physical performance of paper components are performed. Within recent research projects, the group developed wall, ceiling and floor prototype structures under special consideration of statically and building physical requirements and assembled them into a prototype paper house. Moreover, the group is working on 3D printing of paper material for possible usage as façade elements as well as acoustically effective panels for interior design purposes.

Structural behaviour of paperboard laminates

Structural behaviour of paperboard elements under actions like tensile, compressive and bending moment are investigated both, experimentally and numerically. The in plane and out of plane behaviour of paperboard laminates are precisely researched. To this end, tensile strength, compressive strength and shear strength tests are performed. Double Cantilever Beam (DCB) tests, End Notch Flexure (ENF) tests and Acron device tests are carried out. Thereon, numerical models are developed and validated on the basis of the measurement data obtained in these tests.

Moreover, basic connection design approaches of paperboard laminates are formulated through intensive experimental research. For example, a study determining the design criteria for single bolt connections for paper laminates is conducted. More complex connections are also planned to be investigated experimentally.

3D Paper printing

The main focus in this research is to develop a process that ensures printing quality and geometrical accuracy by using paper paste, which mainly is produced from cellulose. The research particularly aims to give solutions for façade engineering.

Many trial mixes have been carried out to optimize a mixture according to the extrusion ability and buildability, and for controlling the deformation and shrinkage after drying. Producing objects with high accuracy for the best possible structural integration is targeted. The research work is especially focussed on the shrinkage, stability and geometric regularity of the object, both in fresh and dry state.

Monitoring of a prototype paper building

As a result of the research project 'Emergency shelters made of paper', a prototype small scale building made of paper has been built on the TU Darmstadt campus.

In a follow-up project, the hygrothermal performance of this paper construction is now investigated under real climatic boundary conditions. For this purpose, extensive building physics measurement technology is installed at and within the paper construction in order to obtain information on the temperature and moisture behaviour of the structure. Data is collected over a two year period, which makes it possible to analyze the construction's performance during the different seasons of a year.

As a result of these measurements, it will be possible to determine whether there are any moisture-critical areas within the prototype paper house construction and which material or construction-related damage patterns can occur. Based on this, optimization variants can be developed that enable the design of future paper buildings for temporary or even permanent use.

