Zukunft Bau

STRUCTURE/STRUCTURE SUMMARY REPORT

Title

Investigation of contemporary, monolithic wall structures with regard to building physics, ecological and economic properties.

Occasion/ Initial situation

Realized projects in monolithic construction have increased in recent years, they are seen as an alternative to multi-layer constructions. What they have in common is that the choice of material or construction is based not only on the aesthetic benefits, but rather on the assumed positive effects of building physics on thermal comfort and energy demand, as well as positive influences on the life cycle of a property, on its ecological balance and costs.

Subject of the research project

The research project investigates the influence of material and construction in monolithic and corresponding multi-layer constructions on thermal energy demand, comfort, life cycle assessment as well as costs and revenues in the real estate lifecycle. The investigations are based on the research of realized structures in which monolithic constructions and available products are identified. In a next step, the information is bundled and categorized so that examination models on the component and room level can be defined for system observation in a reference building.

A total of eight design variants are being investigated, including four monolithic variants and four corresponding multi-layer variants: Aerated aerated concrete, light weight concrete, wood and bricks, as well as normal concrete + WDVS, wood + WDVS, bricks + WDVS and CEM III concrete + WDVS. All variants have the same thermal resistances.

The structural-physical examination of these variants was carried out on the component and room level by means of transient thermal simulation. The numerical evaluation of thermal bridges is based on DIN EN ISO 10211, which provides various test cases for validation in addition to modeling. For system analysis, the test room is formed in accordance with DIN EN ISO 13791. This model can be verified with TRNSYS according to DIN 19791, a validation by Transsolar is available.

The subsequent life cycle assessment of the design variants is based on the environmental product declarations (Enviromental Product Declaration, EPD) available in Ökobau. dat and the specifications of EN 15804 for seven environmental impacts (greenhouse potential, ozone depletion potential, ozone formation potential, acidification potential, overfertilization potential, non-renewable primary energy, area requirement). . The ecological-economic consideration is completed by the life cycle cost analysis. The lifecycle costs are calculated in accordance with GEFMA 220-2 and ISO 15686-5:2008, taking into account the different land consumption of the eight design variants with the resulting useful area (NuF). In the final work step, the gained building physics, ecological and economic findings are brought together. From this, recommendations for construction practice and further research requirements are derived.

Conclusion

The building physics analysis shows that with conventional external insulation, thermal bridge aggregates can be minimized somewhat more easily. The influence of the construction method on the moisture balance is very low except for cellular concrete. No relevant effect on energy efficiency or thermal comfort could be demonstrated by monolithic construction methods. Monolithic superstructures usually achieve more favourable or maximally similar environmental impacts than multi-layer structures. However, the greatest savings potential lies not in the construction but in heat supply. The lifecycle costs (LCC) vary considerably, with wood variants having the highest LCC.

Key data

Short title: Monolith

Researcher / Project management:

Prof. Dr.-Ing. Angèle Tersluisen, Dr.-Ing. Kamyar Nasrollahi, Dipl.-Ing. Klara Bauer,
M.Sc. Mehrdad Khalatbari, Dipl.-Ing. Nadine Lebong, B.Sc. Mozhgan Shirani
TU Kaiserslautern, Fachbereich Architektur, Fachgebiet Hauskybernetik (project management)

Prof. Dr. Björn-Martin Kurzrock, Dipl.-Ing. Tillman Gauer
TU Kaiserslautern, Fachbereich Bauingenieurwesen, Fachgebiet Immobilienökonomie

Prof. Dr.-Ing. Conrad Völker, M.Sc. Thomas Lichtenheld
Bauhaus-Universität Weimar, Fakultäten Bauingenieurwesen & Architektur und Urbanistik, Professur Bauphysik

Total costs: 148.224,23 €

Proportion of federal subsidy: 99.382,43 €

Project duration 18 Monate

Illustrations

Bild 1: abb01.jpg
Dwell time of a 36.5 cm thick wall made of vertical perforated brick (HLZ) and normal concrete with thermal insulation composite system (WDVS-NB-HLZ) (own representation)
Bild 2: abb02.jpg
Ψ- values of external wall corners with a U-value of 0.28 W/ (m²K) in the standard cross-section (own representation)

Bild 3: abb03.jpg
Average operating temperature of the room during the heating period (own representation)

Bild 4: abb04.jpg
Average operating temperature of the room during the cooling period (own representation)

Bild 5: abb05.pdf
Environmental impact of office buildings throughout the entire lifecycle (LCA) (own presentation)

Bild 6: abb06.jpg
Life cycle costs of office buildings (LCC) (own presentation)