

Study in the Context of the Research Initiative “Zukunft BAU” (“Future Building”)

Summary Report of Research Study - ETICS Modulation

Modulation Possibilities for Exterior Cladding using Thermal-Sensitive Procedures

Modern insulation systems today offer only a limited scope for individualised design. Yet at the same time, they will play an increasingly important role in future, as legal regulations and technical requirements when implementing customised solutions are becoming more and more difficult to master. As a consequence, the necessary refitting of buildings to optimise energy efficiency will change the face of our cities to an extent we have never experienced before. This creeping process bears the risk of many cityscapes becoming arbitrary.

This study, sponsored by the German Federal Ministry of Transport, Building and Urban Affairs in the context of the research initiative “Zukunft Bau” (*“Future Building”*), sees the optimisation of energy efficiency of buildings not merely as an engineering challenge but also as a creative task and an exciting opportunity.

Within the context of a concrete study object, ways were elaborated in which to couple creative expression with the use of external thermal insulation composite systems (ETICS). This did not simply imply “embellishing” existing systems, but further developing their aesthetic potential and the consequences thereof.

Most attempts at architecturally designing ETICS fail, as they try to imitate solid stucco surfaces. The technical conditions of the materials alone make such an analogy impossible. Only rough plaster cladding can be used to avoid the system overheating and cracking. Similarly just a limited amount of plaster frames and similar structural forms are available due to the highly moisture-sensitive ETICS. Even the use of colours is restricted, as certain norms regarding the lightness of colour have to be adhered to.

Therefore the concept followed in this study did not start with the stucco, but with the thermal insulation below. Its characteristics actually allow processing: they can be formed, as long as horizontal expanses, which would create moisture problems, are avoided. If the thermal insulation were to be modelled three dimensionally or precision-cut, however, the surface of a building would become an individually configurable area, allowing for much more subtle gradations than those commonly used in solid constructions. Instead of counting on the mimicry of stucco, this study focuses on an aesthetic solution developed from the intrinsic qualities of ETICS itself. It intends no more than to make its function readable within the design of the façade. The differing thermal reactions of the various components of the existing façade underlie the ensuing considerations. If the insulation material is adapted to the unequal thermal transmittance factor, the surface becomes modulated as the building components react differently to the thermal state. A computer programme analyses thermographic pictures to measure thermal transmittance and faults in the thermal envelope,

temperature distribution and water vapour permeance of the building and simulates this in a 3D model. In fact, this modulation, which is based on the hygrothermal performance of the façade could already form the relief of the insulation material. However, the surfaces thus created would consist of compound curves and could only be manufactured in an elaborate precision-cutting process. Additionally, there are no three dimensionally formable stucco fabrics. The study thus examined modulations, which adhere to the thermal transmission of the model as described above, yet promise to be easier to fabricate.

A series of tests on variations of the original model focus on the translation of convexities into "contour lines". Thus a model can be made from comparably thin EPS panels. The number of panels necessary to represent the respective amplitude was examined in various resolutions. The disadvantage of this approach is that there are lots of horizontal areas, which are structurally difficult to deal with. Another way of translating the results of the research is not to build the convexities layer by layer but to precision-cut them out from the material following the contour lines. If thus cut horizontally, we get a completely different picture, but the model still has a lot of horizontal areas. Vertical cuts help to avoid this problem, but depending on the resolution the cuts are relatively difficult to execute. A fourth possibility is triangulation. The convex surfaces are dissolved into triangles and in this way create smooth surfaces, which can be covered with fabric and form a homogenous transition to their respective neighbouring parts. Fundamentally, the triangulation, depending on the resolution, could be split into standard triangular shapes, which would ideally make a modulation as such possible without cutting.

The simulation of thermal transience thus becomes the basis of various interesting design possibilities and simultaneously gives rise to investigate the individual possibilities to finish insulation elements. So not only do we get a completely novel façade appearance, but we also save on valuable resources, as only as much insulation is used as is required at that particular spot. In this way, the exterior insulation and finishing system takes on form. Once the insulation panels are finished, they have to be, as in all conventional ETICS, attached to the substrate or wall and then covered with mesh and finish coat.

In the processing experiments, various models were finished using different methods, to guarantee both a technical and artistic verification. When using both suitable tools and materials the desired results were achieved. Workmanship in particular is more complex than with conventional systems. Yet it is manageable. A technical evaluation examines the modulated thermal materials also in regard to structural strength, the effects of humidity or exposure to sun, and material thickness. A first impulse has thus been created for the further exploration of ETICS products under new artistic viewpoints to achieve an aesthetic, which pays the material justice.