High insulated non load bearing exterior walls

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1. INTRODUCTION

We report on studies to develop a high insulated exterior wall system, which fulfill demands on a nearly zero energy house in Germany. Exterior walls with a heat transmission coefficient U = 0.15 W / (m² K) and below will be needed to meet these requirements.

Currently masonry – external walls get thermal insulation in practice in such large thicknesses that wall thickness of 50 cm and more are no longer the exception. On the other hand, so is the current state of the AAC technology, it is no longer possible load bearing exterior walls AAC masonry with a U-value of U = 0.15 W/(m² K) in a practicable wall thickness build. Xella currently produces a very lightweight aerated concrete, which is used as mineral thermal insulation and under the name Ytong Multipor is sold. So it seemed reasonable to investigate the possibilities of using this very lightweight AAC as the only exterior wall structures, the wall thickness to keep it under 400 mm. It was the goal, a design principle in normal house-building to develop, which allows the use of very light AAC. The studies were conducted in the years 2008 to 2010 by the Technology and Research Xella mbH.

2. INSULATION MATERIAL

The material is the Ytong Multipor mineral insulation panel produced in Germany. Table 1 shows the material properties of Ytong Multipor.

Table 1. Material Properties

Material properties	Ytong Multipor - mineral insulation boards
Approval	European Technical Approval ETA - 05/0093
Dry density	appr. 115 kg/m³
Thermal conductivity	λ_R = 0.045 W/mK
Vapour permeability	μ = 3
Compressive strength	≥ 0.35 N/mm²
Tensile strength	≥ 0.08 N/mm²

With the thermal conductivity of 0.045 W /(mK) and a wall thickness of 30 cm a heat transmission coefficient U = 0.15 W / (m² K) is reached. So the necessary thermal properties for a nearly zero energy house are existing.

The compressive strength shows that these stones can not load-bearing walls can be built.

Exterior walls are loaded horizontally through wind power. The forces have to be discharged into the adjacent supporting structure. Ytong Multipor material cannot bear the resulting flexural tensile load. So the idea was born to provide the masonry of Ytong Multipor to both sides with a reinforced plaster. The glass fiber mesh of the wall reinforcement will to accommodate the flexure tensile forces. Through the combination a composite material would form whose properties needed to be investigated. The investigations were in 2 directions.

3. STUDY ON THE DESIGN PRINCIPLE

For the concept to the construction of houses on the following assumptions for the individual components were taken:

- Roof – in conventional wood construction,
- Ceilings – reinforced concrete,
- Exterior walls supporting function: reinforced concrete or steel columns separating function: Ytong Multipor,
- Interior walls – autoclaved aerated concrete or other masonry,
- Foundation – in conventional reinforced concrete.

We examined three typical house designs to determine whether the previously-bearing exterior walls by other load-bearing components, such as reinforced concrete columns or steel columns can be replaced.

For the types of houses:

- Town Villa (2 full floors, flat timber roof),
- duplex-half = Townhouse (2 full floors, gable roof),
- Bungalow.

static tests showed that the basic construction of these houses is possible with not load-bearing exterior walls and a small number of columns.

The structure of the basement houses developed in the combination of structural steel columns, floor slabs of reinforced concrete and inner masonry shear walls. The support of the bungalow is factory-marked wooden post and beam construction in conjunction with a ceiling / roof panel made of wood composite materials.

4. STUDIES ON THE EXTERNAL WALL CONSTRUCTION

In this case, the stability provided by dead weight out to be negligible – you can easily build storey-high self-supporting walls, storey-high, from Ytong Multipor, as for the existing compressive strength is sufficient.

4.1. Wall Connections

Horizontal loads from wind power in the wall surface must have the connections have to the adjacent supporting structure safely be taken to. Similarly, the loads that occur in the window and door openings in the soffits will be introduced safely into the Ytong Multipor wall.

There were so extensive experiments performed with different versions for the connections:

– foot – release into the foundation / floor plate,
– Ceiling Connector – discharges into the ceiling plate,
– Opening connection – initiation into the wall.

By way of example in Figure 1 of the experimental setup for determining the viability of a base point is shown. The tests confirmed for all three connections the necessary strength in the ultimate limit state.

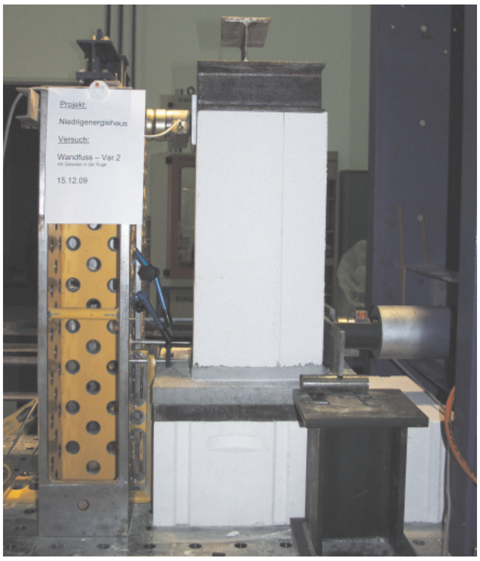

Fig. 1. Testing base point

4.2. Non-load bearing exterior walls

In addition, studies were to support bending behavior of storey-high wall parts with dimensions (L x W x H) 1.50 x 3.15 x 0.30 m and on walls with the dimensions (L x W x H) 6.00 x 3.15 x 0.30 m done. The experiments were performed in the bending test stand of Xella Technology and Research mbH in Emstal.

Figure 2 shows the structure of 6 m – wall before applying the glass fiber mesh reinforcement in the area, the reinforcement at the edges is already installed. Figure 3 shows the wall when installed in the bending test stand without the measuring equipment used.

The results showed that the existing deflection in both at serviceability limit state an ultimate limit state is much below the value of the allowable deflection. The requirements for sustainability were satisfied with this trial wall as well. It was shown that the storey-high wall structures bear up wind forces more than 3.4 kN/m² in the ultimate limit state.

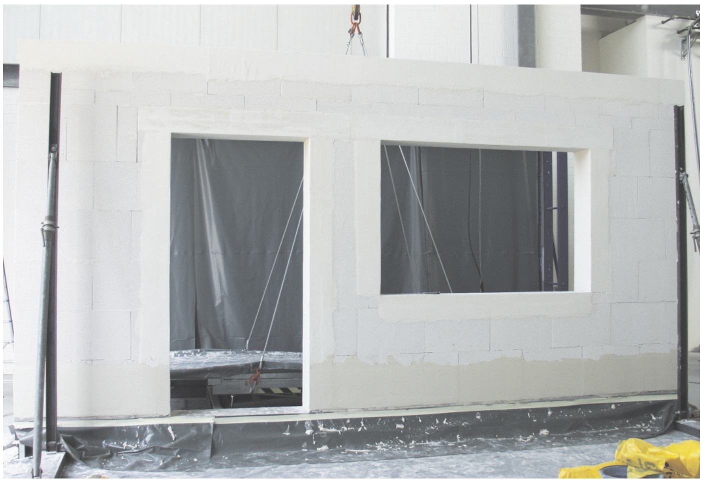

Fig. 2. Structure of test wall

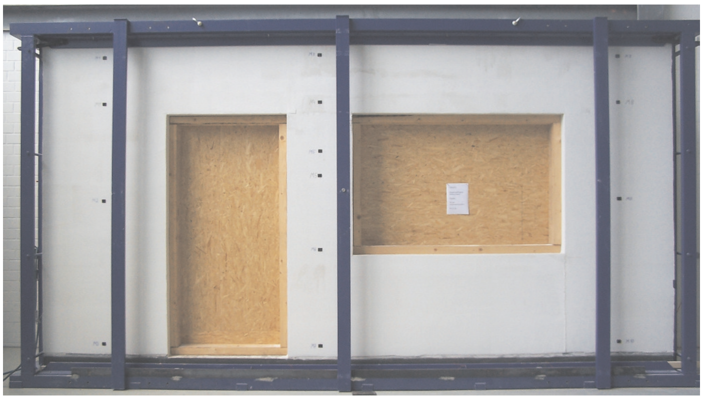

Fig. 3. Wall in bending test stand

5. RESULTS

- The performed calculations and tests have shown the possibility in principle the construction of buildings of the type with a support structure that enables the establishment of non-bearing walls were eating.
- The investigation has shown the construction of storey-high walls Ytong Multipor is possible. By means of the plaster reinforcement are derived from the horizontal loads in the load-bearing structures. It developed technical solutions for implementation of a connection to supporting structures and demonstrated its function.
- The results are well within the safe area of the load capacities.
- In partnership with a construction company, an experimental house was prepared.