Frauenhof Institute for Building Physics

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Officially recognised test station for the approval of new building materials, building parts and building methods.

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Calculation of heat insulation, and climatic conditioned dampness protection, of a roofing system with EPS hard foam elements

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1. Guidelines for Assessment

Heat insulation is to be calculated and assessed in accordance with DIN 4108 (Heat Insulation in Building Construction). The publication of approved technical regulations, as well as material values for calculating heat insulation, is to be observed in accordance with provisions in the Federal Bulletin. Compliance with standards that came into force on Jan. 01, 1995, for residential buildings with up to two storeys is necessary. Individual external building parts must meet requirements with regard to heat transmission.

2. Investigated Roofing System

A roofing system with EPS hard foam elements, with no moisture barrier or vapour barrier was investigated. The roof had no rear ventilation layer. The assembly is described in Table 1 and is illustrated in Figure 1. A distinction has been made between the standard cross-section and the span range.

3. Heat Conductivity and Diffusion Resistance of the Building Material

The values calculated for heat conductivity are presented in Table 1.

The values calculated for diffusion resistance are presented in Table 2.

4. Investigation Results

4.1 Heat Insulation of the Roof and Requirements in accordance with DIN 4108

4.1.1 Heat Resistance

The heat resistance calculation of the roofing system is presented in standard cross-section and in span range in Table 1. The results, together with the minimum requirements according to DIN 4108 are presented in Table 3.

Assessment

The investigated roof satisfies the heat insulation requirements of DIN 4108.

4.2 Heat Insulation of Building Casing and Requirements according to new Heat Insulation Law

4.2.1 Heat Transmission Co-efficiency

For small residential buildings with up to two and not more than three accommodation units, the requirements specified in Figures 1 and 6 of the heat insulation law apply, if the maximum heat transmission co-efficiency does not exceed the ^{K}max specified in Table 2. The results of the roof calculations are presented together with the minimum requirements in Table 4.

Assessment

The heat transmission co-efficiency requirements for external building parts in residential buildings, in this case with regards to EPS hard foam, have been met.

4.3 Climatic Conditioned Dampness Protection

4.3.1 Condensation Loss and Evaporation as a result of Water Vapour Diffusion

Investigation of the roofing system with regard to DIN 4108, water vapour diffusion, proved no condensation loss from vapour diffusion during the condensation period.

Assessment

The investigated roof satisfies requirements for safety against damaging condensation loss as a result of water vapour diffusion.

This test report consists of 3 pages, 4 tables and 1 figure.

Stuttgart, Feb.6, 1995

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Table 1 Assembly of building parts, heat conductivity of building materials and calculation results

Method and Assembly of Building Parts: Roof with EPS Hard Foam Elements

20mm Brick Densification
16mm Air Film (Not Ventilated)
150mm EPS Hard Foam Building Elements
160mm Wooden Rafters (Width 100mm, Distance Apart 750mm) Air Film (Not Ventilated)
24 mm Wooden Laths (Width 48mm, Distance Apart 750mm) Air Film (Not Ventilated)
19mm Wood Casing

Assembly	Thickness	Heat Transmission	Heat Resistances of Layers		Density	Surface Area^2
	m	W/(m ·K)	m^2 ·K/W	m^2 ·K/W	kg/m^3	Kg/m^2
Brick Densification	0.020	0.68	0.029	0.029	1000	20
Air Film	0.016	-	0.17	0.17	-	-
EPS Hard Foam Elements	0.150	0.035	4.29	4.29	30	4
Air Film	0.184	-	0.17	-	-	-
Wooden Rafters	0.160	0.13	-	1.23	800	34
Wooden Laths	0.024	0.13	-	0.18	800	2
Wood Casing	0.019	0.13	0.15	0.15	800	30
Heat Conduction Resistance		m^2 ·K/W	4.81	6.05	Total	90
Heat Transition Resistance					Total	
Internal		m^2 ·K/W	0.13	0.13	SurfaceArea^2	
External		m^2 ·K/W	0.04	0.04		<300
Heat Transmission Resistance		m^2 ·K/W	4.98	6.22		
Rafter Area Proportions		%	87	13		
Heat Transmission Co-efficiency		W/(m ·K)	0.20			

Heat Conduction Resistance	$m^2 \cdot K/W$	4.83

Surface Area[2] of building element layers 66kg/m^2

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Table 2 Diffusion Resistance Calculations for Individual Building Elements. Values in accordance with DIN 4108 (Heat Insulation in Building Construction)

Building Material	Diffusion Resistance Value µ
Brick	10
EPS Hard Foam	40
Wooden Rafters	40
Wooden Laths	40
Wood Casing	40

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Table 3 Heat Transmission Resistance and Minimum Requirements for Heat Insulation in accordance with DIN 4108, Section 2, Edit 1981.

Building Part	Heat Transmission Resistance				
	Calculation Result			Requirements according to DIN 4108	
	In Middle	In Roof	In inconvenient places (Rafters)	In Middle	In inconvenient places
	$m^2 \cdot K/W$	$m^2 \cdot K/W$	$m^2 \cdot K/W$	$m^2 \cdot K/W$	$m^2 \cdot K/W$
Roof against External Air (Table 1) (Table 2)	4.83	4.81	6.05	1.10 0.82	0.80

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Table 4 Calculated and maximum permissible heat transmission co-efficiency values, of individual external building parts for small residential buildings, according to the new heat transmission law (WSVO) 1995.

Heat Transmission Co-efficiency k				
Maximum Permissible Values (WSVO 1995)		Calculated Values		Requirements Met?
Building Part	^{K} max. W/(m^2 K)	Building Part	^{K} max. W/(m^2 K)	
External Walls	$\leq$ 0.50*)			
External windows, French windows and skylights	$\leq$ 0.7 **)			
Floors under unconverted roof rooms and floors (roof slope rooms) from top to bottom	$\leq$ 0.22	Roof against external air Standard cross section Rafter area Total roof	 0.20 0.16 0.20	Yes
Cellar floors, walls and floors against unheated rooms as well as floors and walls that border with soil	$\leq$ 0.35			

The requirements are deemed as having been met w if masonry in a wall strength of 365 mm with building materials with heat conductivity from $\leq$ 0.21 W/(m^2 K) is carried out.