INSTITUT DES ZIMMERER- UND HOLZBAUGEWERBES

Development of Construction details for low energy buildings

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Final-report – Brief Summery

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1 Situation and aims of the investigation

Construction timber is a native and growing raw material which has the advantage that – compared with most other materials – it is ecological and takes care of sources. The primary energy is the half of calcareous sandstone, the native production is not central and the forest management is lasting. [1] With those construction-systems used in timber work since decades, low energy houses are built with some minor deviations and manufacturings which are able to fulfill today's and tomorrow's requirements.

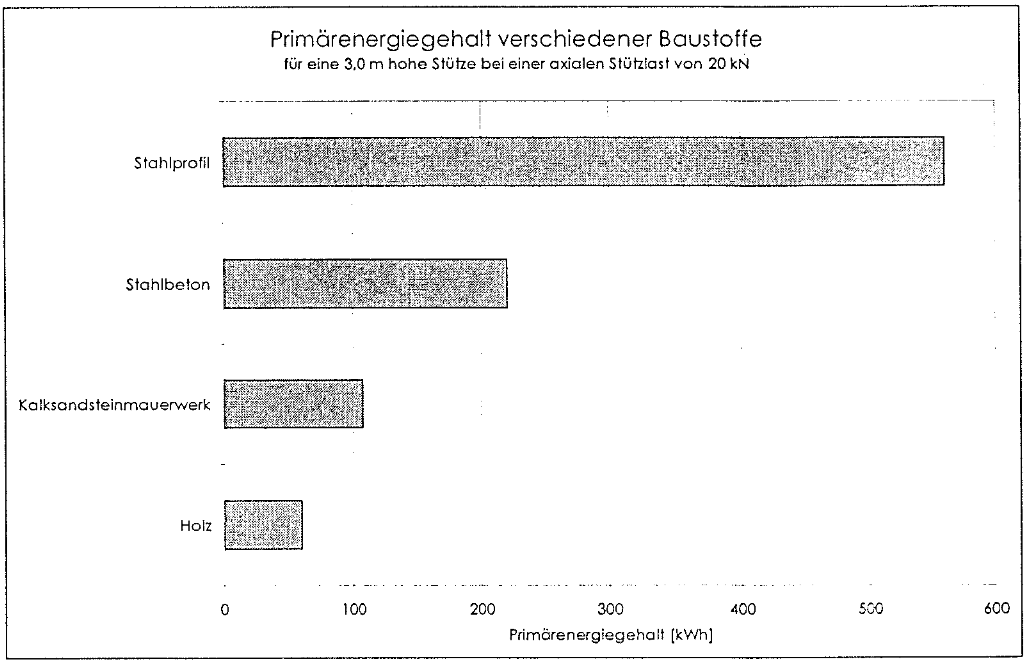


Fig. 1: Primärenergiegehalt verschiedener Baustoffe im Vergleich. Verglichen wurden jeweils 3,0 m hohe und für eine axiale Stützlast von 20 kN bemessene Stützen. (nach [2])

Fact is that only a little number of timber houses are built. The reasons are differently. All construction-timbers and joints of them must be planned and documented individually for every building. A standardisation – existing for example by buildings with bricks or iron - is not usual for the individual building in timber work. That is why the work outs for planning and the costs for manufacturing are more high.

This high regard to timber as a building material is not considered in concrete decisions to build a house of wood. General reservations and unsurenesses concerning the ability and durability of wood houses and the image of wood as a building-material are reasons. Negative opinions of builders are, that wood houses are traditionell, not in vogue, not equal quality and not cheap. [3]

Architects claim that the great cross-sections, which are caused statically, are much to heavy and that they do not appeal in architectural way. [4]

That is why in the last years named experts demand a development of timber and timber-constructions.

In spite of the high regards of low energy buildings of wood and the high acceptance of the non-polluting material timber only 6 % of one- and two-family houses are built of wood. The following obstacles stop the convertation of convincing low energy concepts in timber:

- the HOAI, because the more intensive plannings in comparison with solid constructions are not considered
- arithmetical unsureness of the planer and the builder concerning a high number of various constructions (unique manufacturing)
- technical unsureness of planer and builder concerning constructional details

To build low energy buildings in wood is an environmental, ressource-gentle and economical possibility to take care of our fossil energies and to reduce the emission of CO_2.

Low energy houses of wood have the additional advantage over other building-methods (solid buildings with brick-walls) that the necessary constructional-area for the room-concluding exterior is lower in spite of the same calorific value of one year. This means, in spite of the same building-area the area for living is greater.

The following recommandations can be derived from the results.

- the work for planning of low energy buildings can be reduced because this report provides tried and tested constructional solutions
- the planer (as well as building-enterprise and builder) can go back to projects of the past for the calculation of the performances
- technical unsureness concerning constructional details can be avoided because of functional, scientific and practical constructional solutions

As a basic for the constructions buildings in timber-frame construction were chosen. Storey-buildings and balloon-framing buildings were differentiated.

Timber-frame construction (fig. 2) was chosen because the measurement of the wall construction is identical with a wood panel construction. The wood panel construction and the timber-frame construction used by the enterprises of the german industry for prefabricated-buildings cover the main part of timber houses which are built today and in the next years. Timber frame is used for reconstructions or for buildings which already exists when neighbour-houses must be highly considered. Skeletal structures and room-cell buildings are not usual, only a few manufacturers are specialised for this type of construction.

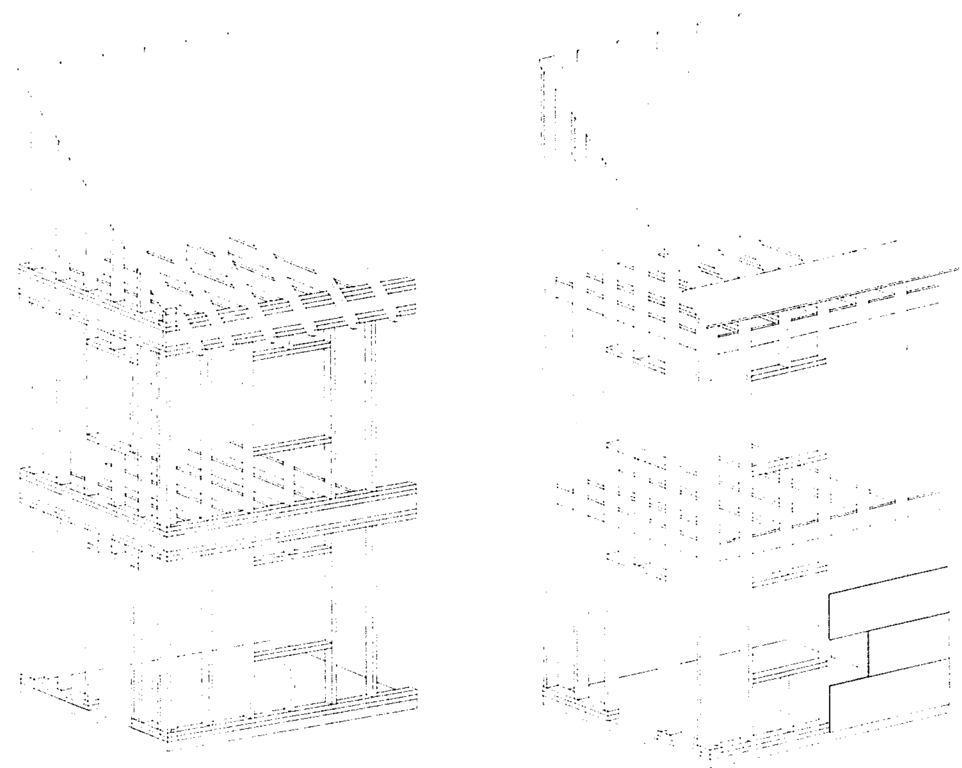


Fig. 2: Prinzipdarstellung einer Gebäudeecke mit Dachkonstruktion für ein zweigeschossiges Gebäude in Holzrahmenbauweise (links: Stockwerkbauweise, rechts: Balloon-Framing)

2 Contents

Because it is not necessary to describe the choice of constructions and measurements of low energy buildings of wood – walls, cloths, roofs – we put the main emphasis on physical conditions as follows:

- Thermal protection
- Moisture insulation
- Air-tightness / Wind-tightness
- Acoustic protection
- Fire protection
- wood protection

As far as useful the demands are shown in tables or pictures. As example see the grafical demonstration of necessary applied insulation thickness in dependency on the arithmetical value of thermal conductivity to fulfill DIN 4108-2 table 2 (fig. 3).

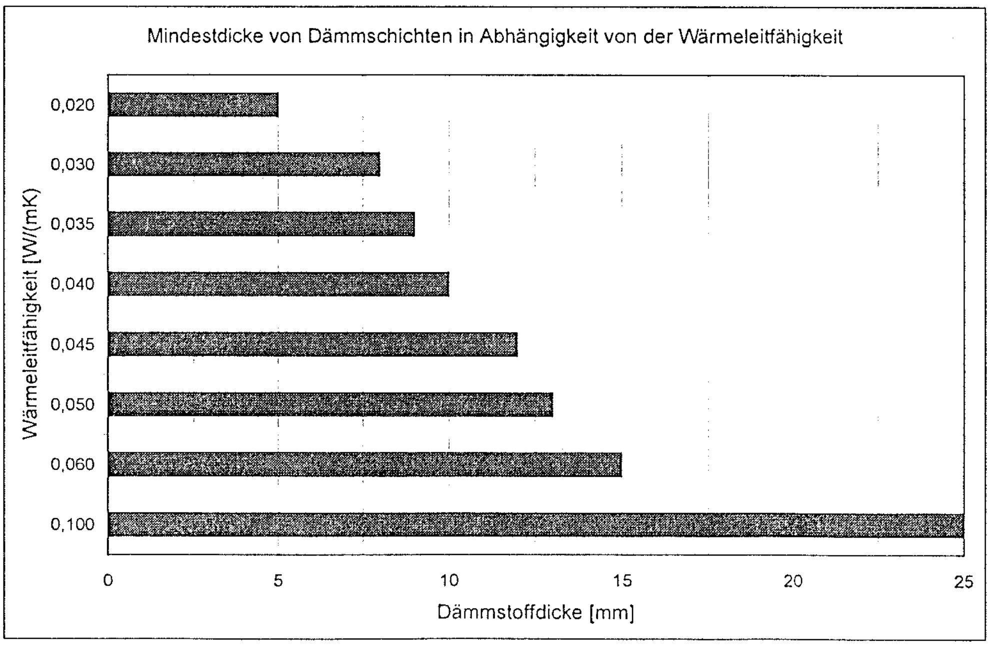


Fig. 3: Erforderliche Schichtdicken von Dämmschichten in Abhängigkeit vom Rechenwert der Wärmeleitfähigkeit zur Erfüllung der Anforderungen nach DIN 4108-2 Tabelle 2

Detailed statements of numerical values or products are given to ensure a fast and save assessment of variant constructions. For example a table is included to assess the necessary thickness of thermal insulation in dependency on the strained coefficient heat transfer, the group of thermal conductivity for the used insulating material as well as the proportion of the share of stringer- and panel. This table can be used for all member constructions in wood panel construction (tab.1). Similar it would be acted by other demands of members / member constructions.

Tab. 1: Erforderliche Dämmstoffdicke in Abhängigkeit vom Gefachanteil in einer Holzkonstruktion in Holztafelbauart und der WLG des verwendeten Wärmedämmstoffes

Wärmeleitfähigkeitsgruppe Wärmedämmstoff	Gefachanteil in %				
	50	60	70	80	90
erf. Dämmstoffdicke [mm] bei $k_m \leq 0{,}50$					
WLG 030	150	130	110	95	80
WLG 035	150	130	110	95	80
WLG 040	150	140	120	100	90
WLG 045	160	140	130	110	100
erf. Dämmstoffdicke [mm] bei $k_m \leq 0{,}30$					
WLG 030	250	215	185	155	125
WLG 035	260	225	195	170	140
WLG 040	265	240	210	180	155
WLG 045	275	250	220	195	170
erf. Dämmstoffdicke [mm] bei $k_m \leq 0{,}22$					
WLG 030	345	300	260	215	170
WLG 035	360	315	275	230	190
WLG 040	370	330	290	250	210
WLG 045	380	350	300	270	230
erf. Dämmstoffdicke [mm] bei $k_m \leq 0{,}154$ (z.B. Dachschrägen und Decken gegen Außenluft unter Berücksichtigung der um etwa 30% erhöhten Anforderungen der künftigen Energiesparverordnung)					
WLG 030	500	440	375	310	250
WLG 035	515	460	400	335	280
WLG 040	530	480	420	365	310
WLG 045	550	495	440	390	335

The demands of building products are figured. The minimum demands are given, in which the insulting materials for thermal protection, moisture insulation and acoustic protection and the structural materials for the production of the air- and wind-tightness are specially described.

3 Results and recommandings

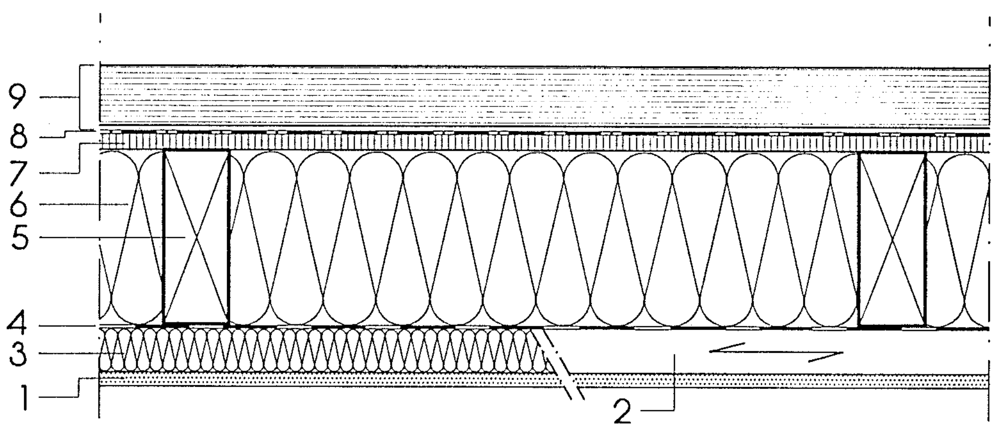
The Results are combined in several enclosures in thematic groups. Each Group of constructional details is – if it is necessary because of the peculiarities – preceded some introductery words.

Following enclosures / groups of member constructions are included:

-A- constructional details – suggestions for standard cross sections and constructional details for the connection of exterior walls

The standard cross sections are figured by

- a scaled drawing,
- In a tabel of the usable structural material, in which the pecularities are pointed and
- In another tabel, which combined the physical capacity-dates



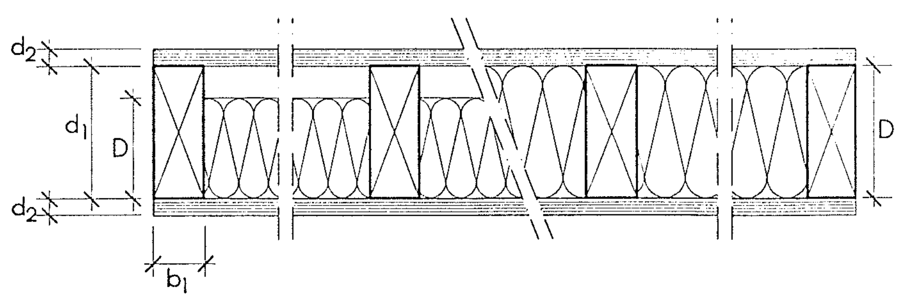
Leistungsdaten Bauphysik und Holzschutz		
Wärmeschutz	k_{Gefach} = 0,196 W/(m²K) k_{Rippen} = 0,430 W/(m²K)	Mittelwert des k-Wertes k_m durch die Berücksichtigung des tatsächlichen Rippenanteils berechnen
Feuerwiderstandsklasse nach DIN 4102-4	F 30-B	Klassifizierte Konstruktionen nach DIN 4102-4, s. Anlage B
Baustoffklasse der raumseitigen Oberfläche	A	
Schalldämmung	–	
Holzschutz DIN 68 800 -2, -3	GK 0	GK = Gefährdungsklasse nach DIN 68 800-3

ZN	Bauteilschicht / Bau- und Werkstoffe	Materialbedarf je m²			Dicke [mm]	Bemerkungen / Hinweise
		netto	Ver-schnitt	brutto		
1	Gipsbauplatten (Gipskartonplatten, bzw. Gipsfaserplatten)	1,0 m²			12,5	
2	Unterkonstruktion	1,6 m			30,0	e = 625 mm
3	Wärmedämmstoff (WLG 040)	0,9 m²			30,0	Anwendungsfall GK 0 beachten
4	Luftdichtheitsschicht [1] aus Folien, Pappen, Papieren	1,0 m²			-	$s_d \geq 2{,}00$ m ,
5	Holzrippe aus Vollholz	1,6 m			160,0	e = 625 mm, $u_m \leq 18\%$, vorzugsweise aus KVH
6	Wärmedämmstoff (WLG 040)	0,9 m²			160,0	Anwendungsfall GK 0 beachten
7	Beplankung	1,0 m²			15,0	
8	Äußere Bekleidung / Abdeckung und Winddichtheitsschicht	1,0 m²			-	$s_d \leq 1{,}50$ m, Stöße müssen dicht verklebt sein;
9	Wandbekleidung gemäß Bekleidungsvarianten 1 - 6;	-			-	siehe A 02.01 – A 02.06

[1] Je nach Ausführung der äußeren Wandbekleidung ist zu prüfen, ob zur Gewährleistung der Tauwasserfreiheit der Einbau einer dampfbremsenden Schicht erforderlich ist.

By the depiction of constructions to achieve particular fire gradings was the act the same. Following an example for a weight-bearing, not room-concluding wall in wood panel construction.

-B- constructional details – wall constructions to achieve particular fire gradings



	Bauteilschicht				Feuerwider-standsklasse
	Benennung	Dicke [mm]	zul σ_D [N/mm^2]	Bemerkung / Hinweise	
b_1	Rippe aus Vollholz	$b_1 \times d_1$ $\geq 50 \times 80$	2,5	Bauschnittholz nach DIN 1052-3 bzw. DIN 4074-1	F 30-B
d_2	Beplankung / Bekleidung aus Holzwerkstoffplatten	≥ 25 $\geq 2 \times 16$	Rohdichte $\rho \geq 600$ kg/m^3		
d_2	Beplankung / Bekleidung aus GKF-Platten	≥ 15			
d_2	Beplankung / Bekleidung aus GKB-Platten	≥ 18			
D	Dämmschicht	Brandschutztechnisch nicht erforderlich			

At the same principle the depiction of all other groups of constructions are built up.

-C- constructional details – suggestions for standard cross sections and constructional details for the connection of interior walls (lightly screen)

-D- constructional details – interior wall constructions to achieve particular fire gradings

-E- constructional details – suggestions for standard cross sections for floor ceilings to heated rooms

-F- constructional details — suggestions for standard cross sections for floor ceilings to unheated rooms

G- constructional details – Ceiling constructions to achieve particular fire gradings

-H- constructional details – suggestions for the connection of the layers for wind- and air-tightness

[1] Informationsdienst Holz: Holz - ein Rohstoff der Zukunft nachhaltig verfügbar und umweltgerecht. Hrsg. Deutsche Gesellschaft für Holzforschung e.V., Verfasser: Frühwald, A.; Wegener, G., Krüger, S.; Beudert, M.; 1994

[2] Jordan, Horst-Dieter: Wald schützen - Holz nützen ; Holz-Zentralblatt Nr. 126, S. 2037 ff

[3] Sell, J.: Holz- Baustoff der Zukunft. in: Tagungsunterlagen zum Deutschen Holzbautag 1991 in Freiburg; BDZ im ZDB; Bonn, 1991

[4] Kroth, W.; Kollert, W; Filippi, M: Analyse und Quantifizierung der Holzverwendung im Bauwesen. Untersuchung im Auftrag des Bundesministeriums für Ernährung, Landwirtschaft und Forsten. Lehrstuhl für Forstpolitik und Forstliche Betriebswirtschaftslehre der Ludwig-Maximilians-Universität, München 1991, S. 114