SINTEF Technical Approval

TG 2593

Issued first time: 26.08.2009
Revised: 26.11.2021
Amended: 01.03.2024
Valid until 01.03.2027
Provided listed on
www.sintefcertification.no

SINTEF confirms that

Unihouse building modules and elements

has been found to be fit for use in Norway and to meet the provisions regarding product documentation given in the regulation relating to the marketing of products for construction works (DOK) and regulations on technical requirements for building works (TEK), with the properties, fields of application and conditions for use as stated in this document

1. Holder of the approval

Unihouse S.A.
ul. Rejonowa 5
17-100 Bielsk Podlaski, Poland
www.unihouse.pl

2. Product description

2.1 General

Unihouse building modules are prefabricated modules based on timber structures in walls, floors and roof. The structures are also delivered as a construction system with prefabricated external wall elements and elements for floors and roof. Unihouse building modules and elements are mainly used for low and multi-storey housing. The field of application is more precisely specified in chap. 3.

The modules and elements are normally delivered with external cladding, internal lining, windows, doors and technical installations installed in the factory. Finished roofing may also be included. The modules are also delivered with wet rooms.

The module size is customised to each individual building. Maximum module width is 5.5 m, maximum length is 16.0 m, and maximum height is 3.3 m. Elements are manufactured according to specifications for each individual building, delivered as a package, and assembled on site. Maximum element length is 16.0 m, and maximum height is 3.3 m.

2.2 Scope of the approval

The modules and elements are based on a standard design as described in this approval. The modules and elements are otherwise custom made for each building project. The approval covers the standard design of the construction system according to chap. 2.3 for walls, floors and roof, including bathroom design, standard connections between modules/elements, and the principle design of connections to foundations.

The approval does not cover surface treatment materials, flooring, windows and doors. Neither other supplementary building parts such as stairs, balconies, roof drainage, sanitary equipment and technical installations like electrical systems and ventilation systems. These components are documented individually for each building project. The approval does neither cover control of assembling nor any other work performed on the building site.

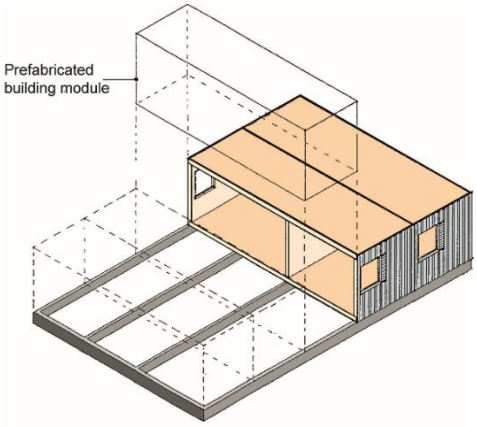


Fig. 1
Principle use of Unihouse building modules.

2.3 Construction details

Specifications of materials and components used in the modules and elements are shown in Table 1. The properties of these products shall be documented by the product manufacturers. The materials shown in Table 2 are installed on the construction site and are not covered by the approval. These materials are specified for the assessment of the properties of finished constructions given in chap.°4, and to verify that standard construction details are in accordance with SINTEF's recommendations.

Examples of the principle design of standard wall, floor and roof designs are shown in fig. 2 – 14. The number of lining boards depends on the required fire resistance, see Table 3. External walls may also be produced with double studs to provide increased load capacity and fire resistance.

External walls may be supplemented with 50 x 50 mm battens and 50 mm mineral wool inside the water vapour control layer in order to increase the thermal resistance.

The detailed standard module and element construction design and the principle design of module and element connections are described in *"Standard Construction Details for Unihouse building modules and elements belonging to SINTEF Technical Approval No. 2593"*. The version of the construction details filed at SINTEF at all times is a formal part of the approval.

3. Fields of application

Unihouse building modules and elements can be used for low rise and multi-storey housing in fire class 1 and 2. Use of the modules and elements in fire class 3 is not covered by the approval and must be separately documented by the responsible designer for each specific building project.

Before Unihouse building modules and elements are chosen for use in a project, it must also be controlled whether the project demands higher or different performances other than the pre accepted solutions given in the guideline to TEK.

Table 1 Unihouse building modules and elements – Material and component specifications

Material / component	Specification 1)	TG/PS 2)	Fire classification 3)	CE-marking 4)
Structural components				
Solid timber components	Structural graded timber with strength class according to specific structural calculations. Moisture content ≤ 18 %	-	D-s2,d0	EN 14081-1
Finger jointed solid timber components	Structural graded timber from KD Spruce KVH, Milwood LCC, Hasslacher Preding Holzindustrie Gmb, or Stora Enso AB, with strength class according to specific structural calculations. Moisture content ≤ 18 %	-	D-s2,d0	EN 15497
Glued laminated timber	- Glued laminated timber from Hasslacher Preding Holzindustrie GmbH or Stora Enso AB, with strength class according to specific structural calculations - Products with SINTEF Technical approval for relevant application	-	D-s2,d0	EN 14080
Timber I-joists	Steico I-joists with strength class according to specific structural calculations	-	D-s2,d0	ETA 06/0238
Laminated veneer lumber	- Steico LVL R and X, strength class according to specific structural calculations - Kerto LVL, strength class according to specific structural calculations - Ultralam R and X, strength class according to specific structural calculations - Products with SINTEF Technical approval for relevant application	- TG 2142 - -	D-s2,d0	EN 14374
Sheathing				
Subfloor and roof sheathing	- 12 - 22 mm Kronospan or Egger OSB/3 with formaldehyde class E1 - 9 – 22 mm Swiss Krono OSB/3 -16-22 mm Forestia particle board - Products with SINTEF Technical approval for relevant application	- TG 2575 TG 2280 -	D-s2,d0	EN 13986
Floor underlay	- 4 – 30 mm Steico Underfloor and Isorel soft fibreboard - 10 – 25 mm Fermacell gypsum fibreboard - 30 mm Fermacell Estrich-Element with mineral wool - 20 – 25 mm Rigips Rigidur E fibre gypsum board - 30 mm Rigips Rigidur E with mineral wool - Products with SINTEF Technical approval for relevant application	- - - - - -	E A2-s1,d0 A2fl,s1 A2-s1,d0 A2-s1,d0 -	EN 13986 ETA 03/0050 ETA-18/0723 EN 15283-2 - -
Internal wall sheathing	- 8 – 18 mm Kronospan, Sonae Arauco or Egger OSB/3 - 9 – 18 mm Swiss Krono OSB/3 - Products with SINTEF Technical approval for relevant application	- TG 2575 -	D-s2,d0 D-s2,d0	EN 13986 EN 13986
External wall sheathing	- 12,5 mm Fermacell gypsum fibreboard type GF-W2 - 12,5 mm Rigips Riduro - 12,2 mm Rigips Rigidur H - 8 – 18 mm Kronospan or Egger OSB/3 - 9 – 18 mm Swiss Krono OSB/3 - Products with SINTEF Technical approval for relevant application	- - - - TG 2575 -	A2-s1,d0 A2-s1,d0 A2-s1,d0 D-s2,d0 D-s2,d0 -	ETA 03/0050 EN 520 EN 15283-2 EN 13986 EN 13986 -
Plywood	4 – 25 mm plywood type EN 636-2 and EN 636-3 from Sklejka-Pisz Paged S.A - Products with SINTEF Technical approval for relevant application	-	t < 9 mm: E t ≥ 9 mm: D-s2,d0	EN 13986
Claddings and linings				
External timber cladding	Min. 19 mm solid timber cladding class A according to EN 15146	-	D-s2,d0	EN 14915
External board cladding	- 8 -12 mm Cembrit fibre cement boards - 10 - 12 mm Cedral fibre cement boards - 8 - 12 mm Cetris cement bonded particleboards - Products with SINTEF Technical approval for relevant application	TG 20085 - - -	A2-s1,d0 A2-s1,d0 A2-s1,d0 -	EN 12467 EN 12467 EN 13986 -
Internal lining	- 12,5 mm and 15 mm Rigips, Siniat or Gyproc gypsum board type A, DF, H1, H2 - 12,5 mm Rigips Riduro gypsum board - 12,5 mm Rigips Rigidur H fibre gypsum board - Products with SINTEF Technical approval for relevant application	- - - -	A2-s1,d0 A2-s1,d0 A2-s1,d0 -	EN 520 EN 520 EN 15283-2 --

Material / component	Specification [1)]	TG/PS [2)]	Fire classification [3)]	CE-marking [4)]
Thermal insulation				
Insulation between studs, joists and trusses	- Isover Piano glass wool with λ_D = 0,037 W/mK - Isover Mata glass wool with λ_D = 0,039 W/mK - Isover Super Mata glass wool with λ_D = 0,033 W/mK - Isover Aku-Plyta glass wool with λ_D = 0,037 W/mK - Rockmin Plus stone wool with λ_D = 0,037 W/mK - Rockwool Ventiroc Super stone wool wool with λ_D = 0,033 W/mK - Rockton and Toprock Super stone wool with λ_D = 0,035 W/mK - Paroc WAS 35tt stone wool with λ_D = 0,033 W/mK - Paroc eXtra stone wool with λ_D = 0,036 W/mK - Paroc FPY 1 and UNM 37 stone wool with λ_D = 0,037 W/mK - Paroc FPS 17 stone wool with λ_D = 0,038 W/mK	-	A1	EN 13162
Membranes and barriers				
Water vapour barrier	- Min. 0,15 mm RaniMoBar polyethylene - Products with SINTEF Technical approval for relevant application	TG 20201 -	- -	EN 13984 -
Wind barriers	- Tyvek® FireCurb Soft - Delta Vent WB - Products with SINTEF Technical approval for relevant application	TG 2043 TG 2586 -	B-s1,d0 - -	EN 13859-2 EN 13859-2 -
Combined roof underlay and wind barrier	- Tyvek® Pro, Pro Super or Pro Xtra - Delta Vent N polypropylene - mdm Ventia Neo and Gold - Products with SINTEF Technical approval for relevant application	TG 2134 - - -	E - - -	EN 13859-1 EN 13859-1 EN 13859-1 -
Roof covering	- Protan SE PVC roofing membrane - Bauder PRO 40 bitumen roofing membrane - Bauder Thermofol U15 PVC roofing membrane - Products with SINTEF Technical approval for relevant application	TG 2010 TG 2377 TG 20024 -	B_{ROOF}(t2 B_{ROOF}(t2 B_{ROOF}(t2) B_{ROOF}(t2)	EN 13956 EN 13707 EN 13956 -
Tapes	- SIGA tape system - Tectis Sitko tape system - Tyvek® Vindsperre Tape - Products with SINTEF Technical approval for relevant application	TG 20134 TG 20448 TG 2043 -	-	-
Pipe penetration sealing	- HILTI Firestop Intumescent Sealant CFS-IS - HILTI CFS-F FX Flexible firestop foam - Walraven Pacifyre IWM III Fire Strip - Products with SINTEF Technical approval for relevant application	- - - -	E E E -	ETA 10/0406 ETA 10/0109 ETA 18/0916 -
Fastener products				
Nails and screws	Type and dimensions for load bearing applications in accordance with individual structural design. Corrosion protection shall be equivalent to hot dip zinc coating according to EN ISO 1461 for exterior applications, and equivalent to zinc coating according to ISO 2081 for interior applications	-	A1	EN 14592
Joist hangers	Simpson Strong-Tie joist hangers	-	A1 A1 A1	ETA 04/0042 ETA 06/0034 ETA 07/0043
Glue for board installation	- Kiilti Kestopur 200/40 polyurethane adhesive - Kiilti Kestopur 1C30 polyurethane adhesive - Kiilti Kestopur D300 polyurethane adhesive	- - -	-	-

Bathroom products				
Watertight membrane	- Kiilto KeraSafe+ foil membrane system - Kiilto KeraPro liqued applied watertight covering kit	TG 20672 TG 20671	- -	-
Water pipes	- Uponor Aqua Pipe - Uponor Combi Pipe - Høiax pipe in pipe system - Products with SINTEF Technical approval for relevant application	PS 0017 PS 0981 TG 20359 -	- - - -	-
Wastewater pipes	- Wavin Astolan-PP - Geberit Silent PP - Pipelife PP Smartline according to DNV GL type approval certificate K-6318 - Products with SINTEF Technical approval for relevant application	PS 0701 - - -	- - - -	-
Floor gullies	Purus Joti	PS 3339	-	-

[1] Dimensions not specified in the table shall be as stated in "Standard construction details" or according to design specifications worked out for each individual delivery or project

[2] The component shall be in accordance with the specified SINTEF Technical Approval (TG) or SINTEF Product Certificate (PS)

[3] Classification of reaction to fire according to EN 13501-1, applied in the construction according to chap. 2 of the approval

[4] The component shall be CE-marked according to the specified product standard or ETA

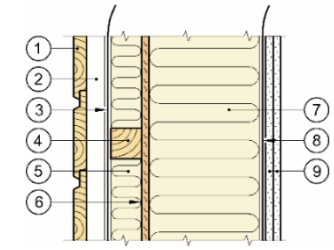
Table 2 Unihouse building modules and elements – Specification of materials installed on site

Material / component	**Specification [1])**	**Fire classification [2]**	**CE-marking [3]**
Flooring	14 mm hardwood flooring boards	D_{fl}- s1	EN 14342
Floor underlay	7 mm soft fibreboard sheets - Steico Underfloor	E	EN 13986
Concrete screed	50 mm fibre reinforced concrete screed (grade C8 or C10)	A1	-
Separation layer	0,2 mm RaniMobar PE foil	F	EN 13984
Acoustic Insulation Slab	50 mm Rockwool Steprock Super stone mineral wool	A1	EN 13162

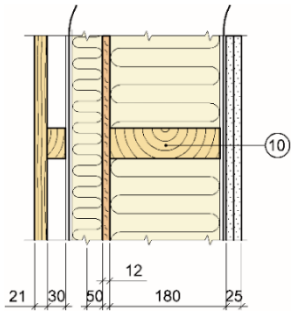
[1] Dimensions not specified in the table shall be as stated in "Standard construction details" or according to design specifications worked out for each individual delivery or project

[2] Classification of reaction to fire according to EN 13501-1, applied in the construction according to chap. 2 of the approval

[3] The component shall be CE-marked according to the specified product standard or ETA



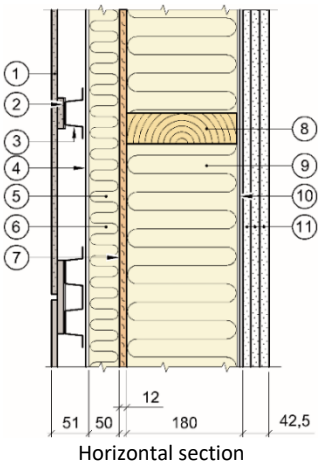
Vertical section



Horizontal section

1	Timber cladding	6	12 mm OSB/3 board
2	30x50 mm battens c/c 600 mm	7	Mineral wool 180 mm
3	Wind barrier	8	Water vapour barrier
4	50x50 mm battens c/c 600 mm	9	Double layer of 12.5 mm gypsum board type A or DF
5	Mineral wool 50 mm	10	50x180 mm studs c/c 600 mm

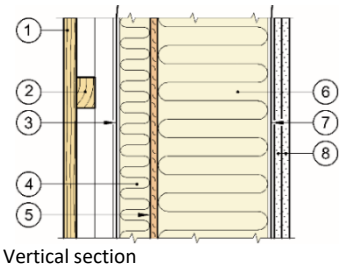
Fig. 2
Principle design of standard external walls with horizontal timber cladding



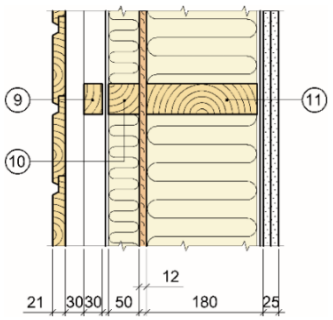
Horizontal section

1	Fibre-cement board	7	12 mm OSB/3 board
2	EPDM washer	8	50x180 mm studs c/c 600 mm
3	Vertical steel battens c/c 600 mm	9	Mineral wool 180 mm
4	Wind barrier	10	Water vapour barrier
5	Horizontal 50x50 mm battens spaced c/c 600 mm	11	Three layers of 12.5 or 15 mm gypsum boards type DF
6	Mineral wool 50 mm		

Fig. 4
Principle design of external walls with improved fire resistance and fibre-cement board cladding



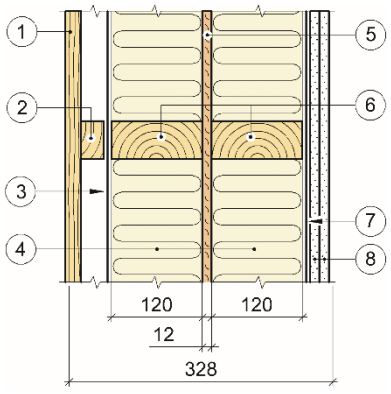
Vertical section



Horizontal section

1	Timber cladding	7	Water vapour barrier
2	30x50 mm battens c/c 600 mm	8	Double layer of 12.5 mm gypsum board type A or DF
3	Wind barrier	9	30x50 mm battens c/c 600 mm
4	Mineral wool 50 mm	10	50x50 mm battens c/c 600 mm
5	12 mm OSB/3 board	11	50x180 mm studs c/c 600 mm
6	Mineral wool 180 mm		

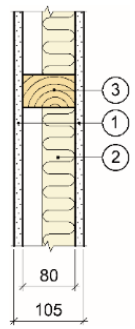
Fig. 3
Principle design of standard external walls with vertical timber cladding



Horizontal section

1	Timber cladding	5	12 mm OSB/3 board
2a	30x50 mm battens	6	Vapour barrier
3	Wind barrier	7	12.5 mm gypsum board type DF
4	Rock wool 120 mm	8	50 x 120mm studs c/c 600 mm

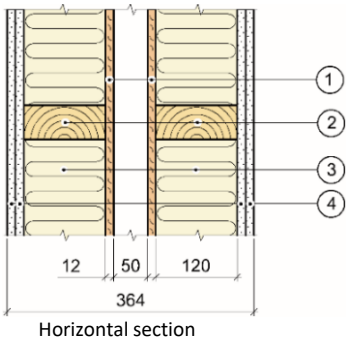
Fig. 5
Principle design of external walls with double wall structure and horizontal timber cladding. Extra horizontal 50 mm x 50 mm battens may be added on the inside or the outside of the studs to increase thermal insulation thickness



Horizontal section

1	Internal lining board	3	50 x 80 mm studs spaced c/c 600 mm
2	Mineral wool 50 mm		

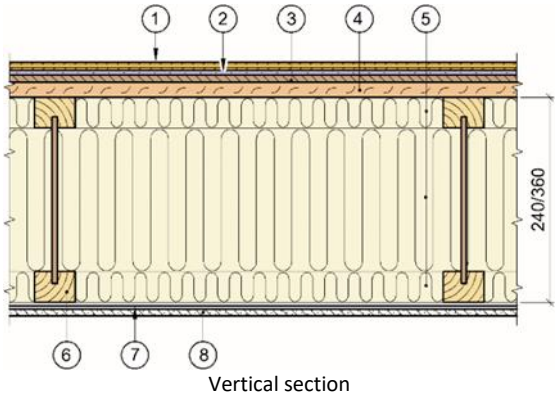
Fig. 6
Principle design of standard internal walls



Horizontal section

1	12 mm OSB/3 board	3	Mineral wool 120 mm
2	50 x 120 mm studs c/c 600mm	4	Two layers of 12.5 type A

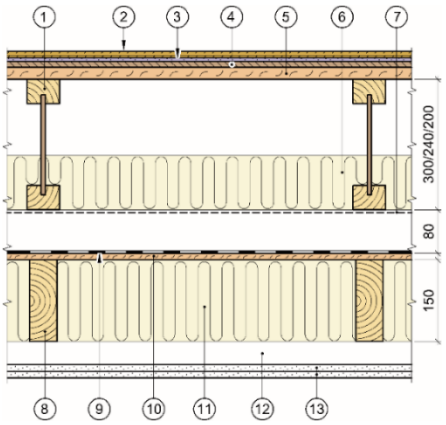
Fig. 7
Principle design of standard separating walls



Vertical section

1	Stiff flooring material	5	Mineral wool
2	7 mm fibreboard underlay	6	Floor joists c/c 600 mm
3	11 mm soft fibreboard	7	Wind barrier
4	22 mm OSB/3 boards	8	10 mm Fermacell board

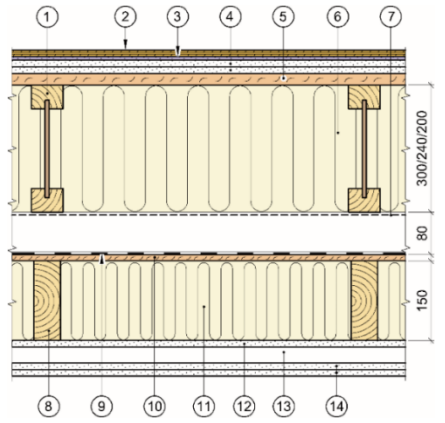
Fig. 8
Principle design of suspended ground floor.
Joist size according to specific structural calculations



Vertical section

1	Floor joists c/c 600 mm	8	50x150 mm ceiling joists
2	Stiff flooring material	9	Vapour permeable membrane
3	7 mm fibreboard underlay	10	12 mm OSB/3 boards
4	11 mm soft fibreboard	11	Mineral wool 150 mm
5	22 mm OSB/3 boards	12	30x50 mm battens c/c 600 mm
6	Mineral wool 100 mm	13	Double layer of 12.5 mm gypsum board type DF
7	Steel mesh		

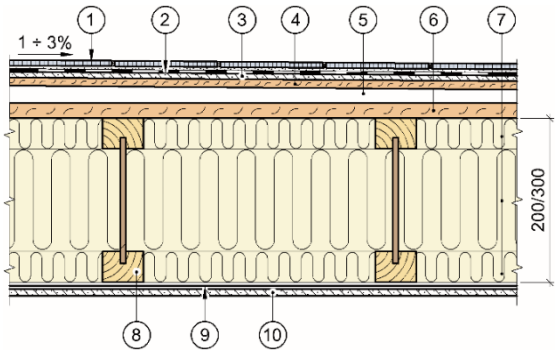
Fig. 9
Principle design of standard separating floors between modules. Upper part is the floor structure of the upper module and lower part is the ceiling structure of the lower module. Joist size and spacing according to specific structural calculations



Vertical section

1	Floor joists c/c 600 mm	8	50 or 60x150 mm ceiling joists
2	Stiff flooring material	9	Vapour permeable membrane
3	7 mm fibreboard underlay	10	12 mm OSB/3 boards
4	Double layer of 12.5 mm gypsum board type DF	11	Mineral wool 150 mm
5	22 mm OSB/3 boards	12	12.5 mm gypsum board type DF
6	Mineral wool	13	30x50 mm battens c/c 600 mm
7	Steel mesh	14	Double layer of 12.5 mm gypsum board type DF

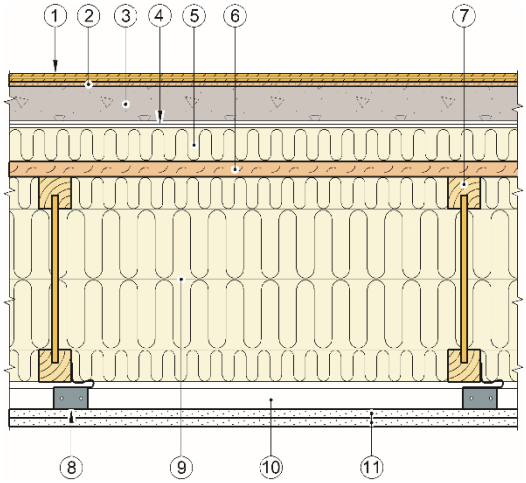
Fig. 10
Principle design of standard separating floors with improved fire resistance between modules. Joist size and spacing according to specific structural calculations



Vertical section

1	Ceramic tiles	6	22 mm OSB/3 board
2	Watertight membrane	7	Mineral wool
3	10 mm Fermacell board	8	Floor joists, max c/c 300 mm
4	12 mm OSB/3 board	9	Wind barrier
5	30x50 mm sloped battens c/c 250 mm	10	10 mm Fermacell board

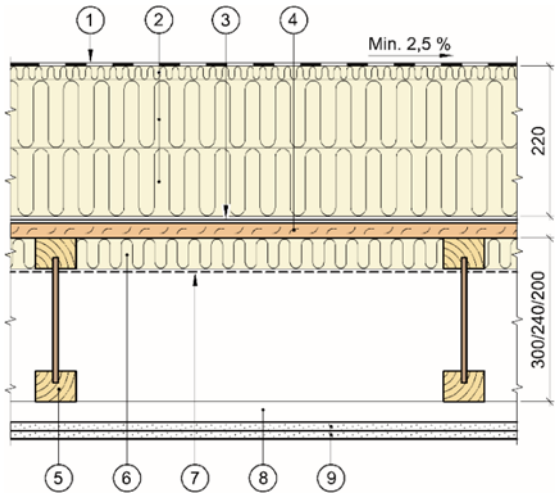
Fig. 11
Principle design of bathroom ground floor. Joist size and spacing according to specific structural calculations. In floors between modules are wind barrier and ceiling board replaced by steel mesh



Vertical section

1	Stiff flooring material (on site)	7	Floor joists
2	7 mm soft fibreboard (on site)	8	Glava acoustical hanger type I
3	50 mm concrete screed (on site)	9	Mineral wool 300mm
4	Separation layer (on site)	10	30x50 mm battens c/c 600 mm
5	50 mm mineral wool acoustic board (on site)	11	12.5 mm gypsum board type A or DF
6	22 mm OSB/3 board		

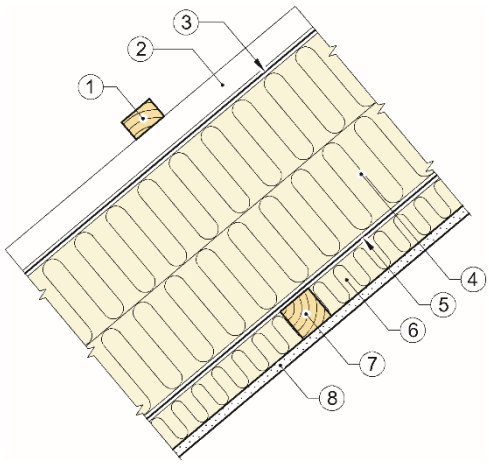
Fig. 12
Principle design of separating floors between housing units. Joist size and spacing according to specific structural calculations.



Vertical section

1	Roof membrane	6	Mineral wool 50 mm
2	Mineral wool	7	Steel mesh or steel wires
3	Water vapour barrier	8	30x50 mm battens c/c 600 mm
4	22 mm OSB/3 board	9	Double layer of 12.5 mm gypsum board type DF
5	Roof beams		

Fig. 13
Principle design of flat roof construction.
Joist size and spacing according to specific structural calculations



Vertical section

1	30x50 mm battens c/c max 350 mm	5	Water vapour barrier
2	36x50 mm battens c/c 600 mm	6	Mineral wool 50 mm
3	Combined roofing underlay and wind barrier	7	50x50 mm battens c/c 600 mm
4	Mineral wool and rafters c/c 600mm	8	12.5 mm gypsum board type DF

Fig. 14
Principle design of insulated roof element

4. Properties

4.1 Load bearing capacity

The mechanical resistance and stability of all structural components are calculated case by case for each building project, see chap. 6.1.

4.2 Reaction to fire

Reaction to fire classifications according to EN 13501-1 for products included in Unihouse building modules and elements are given in Table 1. The classification is valid for the way the products are used in the building system.

4.3 Fire resistance

The fire resistance of the building components is given in Table 3. The fire resistance has been determined by tests and by calculations according to EN 1995-1-2 and the manual Brandsäkra Trähus version 3. The declared fire resistances assume construction specifications according to *"Standard Construction Details for Unihouse building modules and elements belonging to SINTEF Technical Approval No. 2593"*and materials as specified in Table 1.

Design load capacity at limit state fire after the specified fire resistance time is given in Table 3 as vertical load capacity for walls and bending moment capacity for joists and rafters. The fire resistance given in Table 3 assumes one sided fire exposure, from the inside of external walls and from the underside of floors and roof. The fire resistance for internal walls assumes also one sided fire exposure, unless specified otherwise in Table 3.

Design load capacity for walls at limit state fire is given as maximum centric axial load per meter wall (kN/m) in Table 3. Design load capacity for floors and roof with single span is given as maximum bending moment (kNm) per joist or rafter. "Full capacity" means that no charring of load-bearing material will take place during the specified fire resistance time. Hence the design capacities determined for ultimate and serviceability limit states are applicable also in case of fire.

Mineral wool insulation in floors and roofs must in some cases be secured to stay in place during a fire, see chap. 6.2.

4.4 Sound insulation

With standard separating structures between housing units as described in chap. 2 and in *"Standard Construction Details for Unihouse building modules and elements belonging to SINTEF Technical Approval No. 2593"*, the expected sound insulation performance according to EN ISO 16283-1 and EN ISO 717-1 and -2 are as follows for assembled buildings:

- Estimated weighted apparent airborne sound reduction index $R'_w \geq 55$ dB
- Estimated weighted normalized impact sound pressure level $L'_{n.w} \leq 53$ dB

The values satisfy the minimum requirements in the guideline to TEK17 for sound insulation between house units, i.e class C according to NS 8175:2012 without spectrum adaptation term for enlarged frequency range. Supplementary measures must be undertaken to satisfy SINTEF's recommended sound insulation performance between house units, see SINTEF Building Research Design Guide 522.511. The sound insulation depends also on the installation of technical service components like pipes, ducts etc., and must be assessed case by case in each building project.

Table 3
Unihouse building modules and elements – Fire resistance and design load capacity at accidental limit state fire

Structure [1]		**Fire resistance** [2]	**Design load capacity at fire** [3]
External walls, fig. 2 and 3			
Alt. A	Lining with two layers of 12.5 mm gypsum boards type A, single studs	REI 30	No reduction
Alt. B	Lining with two layers of 12.5 mm gypsum boards type A, single studs, and additional 50 mm battens and mineral wool on the inside	REI 30	No reduction
Alt. C	Lining with two layers of 12.5 mm gypsum boards type DF, single studs C24	REI 30	No reduction
		REI 60	128 kN/m
Alt. D	Lining with two layers of 12.5 mm gypsum boards type DF, double studs C24	REI 30	No reduction
		REI 60	256 kN/m
External walls with improved fire resistance, fig. 4			
Alt. A	Lining with two layers of 15 mm gypsum boards type DF plus one layer of 12.5 mm gypsum boards type DF, single studs C24	REI 90	70 kN/m
Alt. B	Lining with two layers of 15 mm gypsum boards type DF plus one layer of 12,5 mm gypsum boards type DF, double studs C24	REI 90	140 kN/m
External walls, fig. 5			
Alt. A	Lining with two layers of 12.5 mm gypsum boards type A, double studs C24	REI 30	No reduction
Separating walls, fig. 7			
Alt. A	Lining with two layers of 12.5 mm gypsum boards type DF or one layer of 12.5 mm gypsum board type DF plus one layer of 12.5 mm fibre gypsum board (e.g. Rigips Riduro or Rigidur H), single studs C24	REI 30	No reduction
		REI 60	45 x 100: 6,0 kN/m [4] 50 x 100: 8,2 kN/m [4] 60 x 100: 13,9 kN/m [4] 80 x 100: 31,9 kN/m [4]
Alt. B	Lining with two layers of 12.5 mm gypsum boards type DF or one layer of 12.5 mm gypsum board type DF plus one layer of 12,5 mm fibre gypsum board (e.g. Rigips Riduro or Rigidur H), double studs C24	REI 30	No reduction
		REI 60	45 x 100: 12,0 kN/m [4] 50 x 100: 16,4 kN/m [4] 60 x 100: 27,8 kN/m [4] 80 x 100: 63,8 kN/m [4]
Separating floors between modules, fig. 9 and 10			
Alt. A	Standard floor according to fig. 9, ceiling structure with two layers of 12.5 mm Siniat gypsum board type DF, 300 mm Steico I-joists SJ_{HB} 60/ SJ_{OSB} 60/ $SJ_{LVL,HB}$ 60/ $SJ_{LVL,OSB}$ 60 and 50 mm Rockwool Rockmin Plus with density 31 kg/m^3	REI 60	Bending moment 5.4 kNm/m Shear force 5.2 kN/m
Alt. B	Floor and ceiling structure with improved fire resistance according to fig. 10, with two layers of 15 mm and one layer 12.5 mm Siniat gypsum board type DF, timber beams 60 x 150 mm C24 and 150 mm Rockwool Toproc with density 44 kg/m^3	REI 90	No reduction
Separating floors between housing units according to fig. 12			
Alt. A	Two layers of 12,5 mm type A or DF gypsum board in the ceiling	REI 30	No reduction
Roof, fig. 13			
Alt. A	Ceiling with two layers of 12.5 mm Siniat gypsum boards type DF [5], 300 mm Steico I-joists SJ_{HB} 60/ SJ_{OSB} 60/ $SJ_{LVL,HB}$ 60/ $SJ_{LVL,OSB}$ 60, and 50 mm Rockwool Rockmin Plus with density 31 kg/m^3 between joists	REI 60	Bending moment 5.4 kNm/m Shear force 5.2 kN/m
Alt. B	Ceiling with two layers of 18 mm Siniat gypsum boards type DF, 300 mm Steico I-joists SJ_{HB} 60/ SJ_{OSB} 60/ $SJ_{LVL,HB}$ 60/ $SJ_{LVL,OSB}$ 60, and 50 mm Rockwool Rockmin Plus with density 31 kg/m^3 between joists	REI 60	Bending moment 5.4 kNm/m Shear force 5.2 kN/m
Alt. C	Ceiling with two layers of 18 mm Siniat gypsum boards type DF plus suspended ceiling with 12.5 mm gypsum board type A, 300 mm Steico I-joists SJ_{HB} 60/ SJ_{OSB} 60/ $SJ_{LVL,HB}$ 60/ $SJ_{LVL,OSB}$ 60, and 50 mm Rockwool Rockmin Plus with density 31 kg/m^3 between joists	REI 60	Bending moment 5.4 kNm/m Shear force 5.2 kN/m

[1] Structures insulated with stone wool ≥ 27 kg/m^3, and with maximum wall height 2.5 m
[2] Fire resistance equivalent to classification according to EN 13501-2. Internal fire exposure
[3] Vertical design load capacity at accidental limit state in case of fire. "No reduction" means no reduction in capacities determined at ultimate limit state
[4] Design load capacity for one individual wall leaf, stud size as indicated, maximum wall height 2.63 m

4.5 Thermal insulation

Table 4 shows thermal transmittance values, U-values, for standard module and element designs described in chap. 2, calculated according to EN ISO 6946. U-values for external walls are based on 12.5 % timber proportion, and do not include thermal loss due to extra timber around door and window openings. U-values for roof with thermal insulation installed on top of the modules on site is calculated case by case for each building project. See also cl. 6.4 concerning thermal loss design.

Extra vertical 50 mm x 50 mm battens on the inside of external wall studs, or 50 mm x 50 mm horizontal battens on the outside, may be added to increase total thermal insulation thickness.

4.6 Durability
The standard module and element design satisfies the general requirements recommended by SINTEF regarding climate resistance and durability.

Table 4
Thermal transmittance, U-values, for standard building structures based on mineral wool insulation with declared thermal conductivity λ_D= 0.035 W/(mK)

Structure	Total thermal insulation thickness mm	U-value W/m²K
External walls according to fig. 2, 3 and 4 with single studs	230	0.18
External walls according to fig. 2, 3 and 4 with double studs	230	0.20
External walls according to fig. 5	240	0.18
Suspended ground floor with I-joists according to fig. 8	240	0.15
	300	0.12
	360	0.11
Bathroom floor with I-joists according to fig. 11	240	0.16
	300	0.13

5. Environmental aspects
5.1 Chemicals hazardous to health and environment
The structures contain no hazardous substances with priority in quantities that pose any increased risk for human health and environment. Chemicals with priority include CMR, PBT or vPvB substances.

5.2 Effect on indoor environment
The structures are not regarded as emitting any particles, gases or radiation that have a perceptible impact on the indoor climate, or to have any significant impact on health.

5.3 Effect on soil and ground water
The leaching properties of the structures are evaluated to have no negative effects on soil or ground water.

5.4 Waste treatment/recycling
The materials in the modules and elements shall be sorted as wood, metal, gypsum, residual waste or other appropriate waste fractions, and delivered to an authorized waste treatment plant for material recovery, energy recovery or disposal.

5.5 Environmental declaration
No environmental declaration (EPD) has been worked out for Unihouse building modules and elements.

6. Special conditions for use and installation
6.1 Structural design
For cases not covered by declared structural properties given in cl. 4.1 all load-bearing components shall be specifically designed according to EN 1995-1-1 and EN 1991-1 with national annexes NA for each specific building project.

The structural design shall cover applicable imposed loads, wind loads and snow loads, and include wind anchoring to foundations and connections between modules and between elements.

Floor structures shall also be designed to meet the recommended stiffness requirements given in SINTEF Building Research Design Guide 522.351.

6.2 Safety in case of fire
For each building project the required fire resistance according to the building regulations (TEK) shall be determined specifically for loadbearing and/or fire separating building structures. The structures must be designed and documented for limit state fire according to EN 1995-1-2, Brandsäkra Trähus version 3 or relevant instructions in SINTEF Building Research Design Guides.

The choice of products for internal and external surfaces, behind ventilated claddings, insulation etc., must be based on pre accepted performances given in the guideline to TEK. Specific measures to prevent spread of fire along facades must be evaluated for each building project.

Board materials for internal lining shall be installed according to the suppliers' instructions and the principles in SINTEF Building Research Design Guide 543.204.

Penetrations through building structures with required fire resistance, and connections to other building parts, must be made in a way which do not reduce the fire resistance performance. See SINTEF Building Research Design Guide 520.342.

Shafts for technical installations between modules must be designed with a fire resistance equivalent to the required fire resistance of the modules or sealed against fire penetration at each fire cell division.

The insulation in roof and floor must be kept in place by steel wire with minimum diameter of 1,5 mm, spaced maximum c/c 350 mm, and with minimum three wires per insulation board. Alternatively, a wire net with wire diameter minimum 1,5 mm can be installed under the beams. Fastening with minimum 50 mm long staples.

6.3 Design of sound insulation between house units
For use in buildings with multiple housing units must the modules and elements be produced with floors and supporting walls designed for reduced sound transmission according to "*Standard Construction Details for Unihouse building modules and elements belonging to SINTEF Technical Approval No. 2593*".

Elastic connections must be established at all walls and penetrations. Acoustic washers are placed between the upper floor bottom sill and an edge beam or a separate sill on top of the lower module. The washers must be specifically designed for the relevant loads.

Water pipes, ventilation ducts and other technical installations which penetrate sound insulating structures should be avoided.

6.4 Thermal insulation design
The required energy efficiency according to TEK shall be determined for each building project. The U-values shown in chap. 4.5 may be used to check the minimum requirements for thermal insulation performance in TEK. The total energy loss for each individual building must be calculated with a specific calculation program.

6.5 Foundations
The building modules and elements shall be installed on a basement structure, perimeter wall foundation or an open foundation which satisfy the manufacturer's requirements for tolerances on dimensions and flatness. The foundation must satisfy the principles for ventilation under modules and floor elements, and moisture transport to wood materials must be prevented as recommended in the SINTEF Building Research Design Guides.

6.6 Module and element installation
The modules and elements shall be installed and connected on the building site according to the details shown in "*Standard Construction Details for Unihouse building modules and elements belonging to SINTEF Technical Approval No. 2593*", and according to specific installation details worked out for each individual project.

6.7 Bathrooms
Bathrooms and other wet rooms shall be designed and executed in accordance with the principles and the recommendations in SINTEF Building Research Design Guides and the construction industry's Wet Room Standard (BVN), and according to the product certificates and technical approvals for the materials and components shown in Table 1 for bathroom products.

6.8 Transport and storage
The modules and elements shall be protected from precipitation under transport and storage with a watertight cover until the modules are permanently protected by a watertight roof.

During transport and storage, the modules and elements must be placed on supports with positions equivalent to what is presumed in the structural design of the modules.

7. Factory production control
Unihouse building modules and elements are produced by Unihouse S.A., ul. Rejonowa 5, 17-100 Bielsk Podlaski, Poland.

The holder of the approval is responsible for the factory production control to ensure that the modules are produced in accordance with the preconditions applying to this approval.

The manufacturing of the modules and elements is subject to continuous surveillance of the factory production control in accordance with the contract regarding SINTEF Technical Approval.

The manufacturer's quality system is certified according to ISO 9001.

8. Basis for the approval
The evaluation of Unihouse building modules and elements is based on test reports and documentation owned by the holder of the approval. Assessments of the designs of technical details are based on the recommendations in the SINTEF Building Research Design Guides.

9. Marking
For each delivery of modules and elements a set of delivery documents shall be available, and shall include the name of the manufacturer, project identification and specific installation specifications for the individual project. Construction details shall be in accordance with "*Standard Construction Details for Unihouse building modules and elements belonging to SINTEF Technical Approval No. 2593*". The approval mark for SINTEF Technical Approval No. 2593 may also be used.

10. Liability
The holder/manufacturer has sole product responsibility according to existing law. Claims resulting from the use of the product cannot be brought against SINTEF beyond the provisions of Norwegian Standard NS 8402

for SINTEF



Hans Boye Skogstad
Approval manager