SINTEF Technical Approval

TG 2220

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Provided listed on
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SINTEF confirms that

Moelven Module

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

Moelven ByggModul AS
P.O.Box 163
NO-2391 Moelv
www.byggmodul.moelven.com

2. Product description

2.1 General

Moelven Modules are prefabricated timber housing modules connected on site to form larger buildings.

Each module is made of floor-, wall- and roof elements manufactured and assembled in the factory. The modules are based on traditional timber frame building structures with standard member spacing c/c 600 mm, internal lining and mineral wool insulation. External building parts include also water vapour control layer, wind barrier and cladding or roofing. The roof design is a cold and ventilated construction. Alternatively, a warm roof with internal drainage is used. Such roofs are built on top of the modules in the factory and completed on site.

Module width and length are customised to each building project. The modules are made in widths from 2,5 m to 4,2 m, and lengths up to 13,2 m. Internal room height is from 2,4 m to 2,8 m, with a total module height from 2,9 m to 3,5 m.

Modules which are linked together may have open long and/or short sides. Module connections and sealing of joints between modules are performed on site. The modules may be supplemented on site with a separate roof structure above the module roof.

This approval covers the standard design of the construction system, i.e. wall, roof and floor structures, including wet room design, joints between building sections and connection to foundations.

Specifications of incorporated materials and components are shown in Table 1.

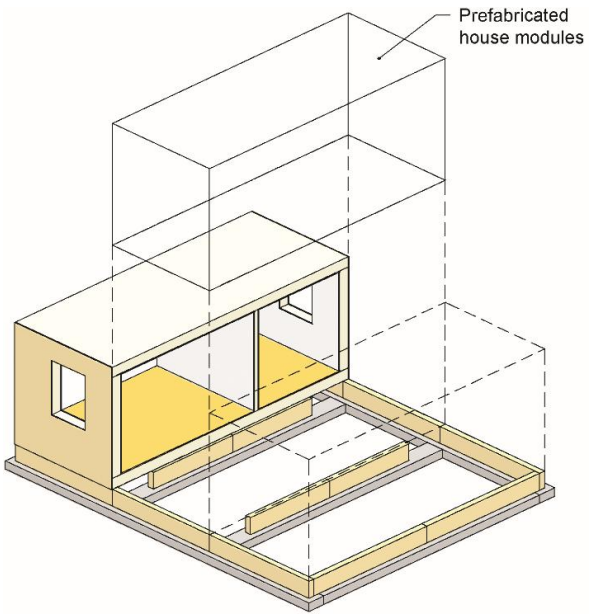


Fig. 1
Principle use of Moelven Module with several housing modules connected on site. The modules may be supplemented with a separate roof structure on top.

The approval does not cover surface materials, supplementary components and structures like foundations, stairs, windows and doors, balconies, roofs built on site, electrical installations and ventilation systems. The approval covers neither roof details like eaves, gutters and drainage pipes which have to be designed separately for each individual project.

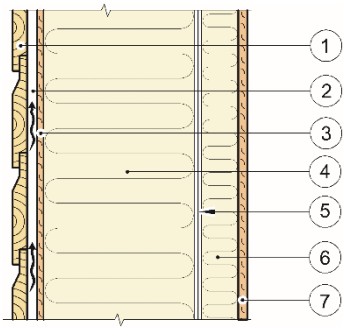
2.2 Construction design and details

The principle design of the module elements is shown in chap. 2.3 - 2.7 and fig. 2 - 10. Table 1 shows the specifications for the individual materials and components.

Construction and assembly details are described in more detail in *"Standard Construction Details for Moelven Module belonging to SINTEF Technical Approval 2220"*. The set of construction details which at any time is filed at SINTEF constitutes a formal part of the approval.

2.3 External walls

Fig. 2 shows the principle design of external walls. Thermal insulation, water vapour control layer and internal lining are installed in the factory, partly after the elements are assembled to modules.

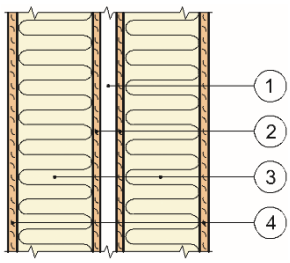


1	External cladding	5	Water vapour barrier
2	19 mm ventilated space	6	48 x 48 mm vertical battens + 50 mm mineral wool
3	Wind barrier board	7	Internal lining
4	36 x 173/198 mm studs + 175/200 mm mineral wool		

Fig. 2
Principle design of external walls with horizontal ventilated timber cladding. External walls are delivered with 175, 200 or 250 mm thermal insulation. Alternatively, may ventilated board-on board or vertical double rebated timber cladding installed on 28 mm horizontal battens and 9 mm vertical battens be applied.

2.4 Walls between modules

Fig. 3 shows the principle design of walls for installation towards an adjacent module. Walls between modules may have a different design due to sound insulation or fire requirements, see cl. 4.2 - 4.4. Extra studs are installed beside wall openings and for supporting concentrated loads from upper structures according to specific structural design for each individual building.

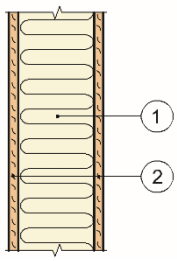


1	Min. 22 mm air space	3	36/48 x 98 mm studs + 100 mm mineral wool
2	9 mm OSB board	4	Internal lining

Fig. 3.
Principle design of walls between modules. The walls may have an additional board layer on the room side for better sound insulation and fire resistance performance, see Table 2.

2.5 Partition walls inside modules

Fig. 4 shows the principle design of partition walls inside modules.

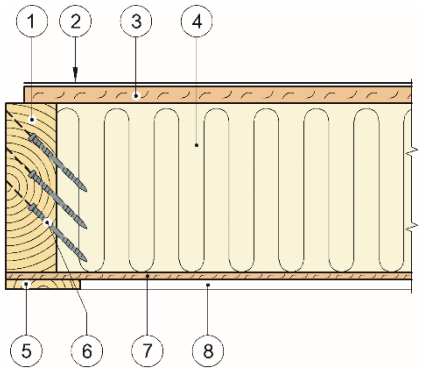


1	36/48 x 68/98 mm studs + 70/100 mm mineral wool	2	Internal lining

Fig. 4.
Principle design of walls inside modules. The walls may also have more than one board layer.

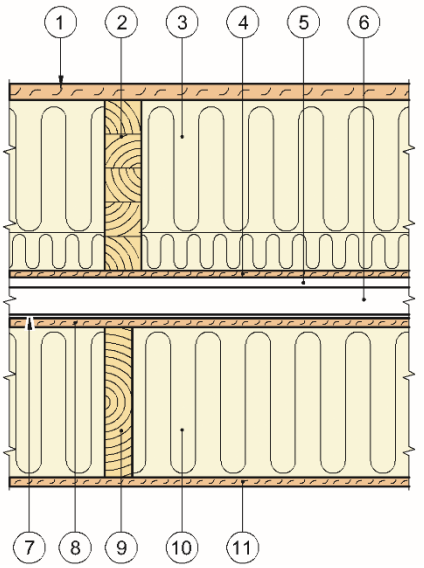
2.6 Floors

Fig. 5 – 7 shows the principle design of floors above foundations. The floor elements have longitudinal main beams (edge beams) on each side, and transvers floor joists. Beams and joists are designed according to structural calculations in each individual case for the relevant loads and span.



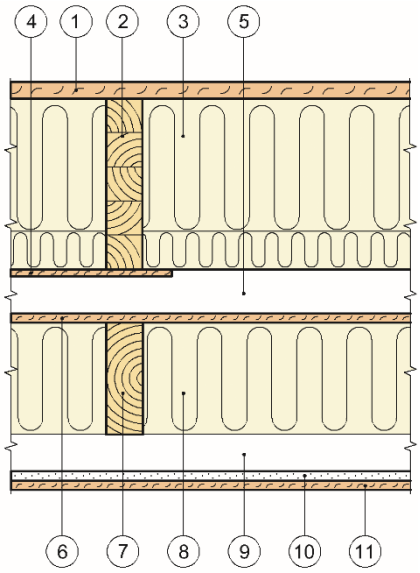
1	Edge beam	5	13 x 98 mm sill
2	Flooring	6	2 – 4 pieces 6,5 mm slanted screws into transvers joists, depending on module witdth and loads
3	22 mm particleboard	7	9 mm moisture resistant particleboard
4	Min. 36 x 223 mm joists + 225 mm mineral wool	8	13 mm batten

Fig. 5.
Example of module floor design. Also 270 mm high beams and joists with equivalent mineral wool thickness are used. On the underside may also 9 mm gypsum board or plywood be used. Flooring may also be parquet or laminate flooring.



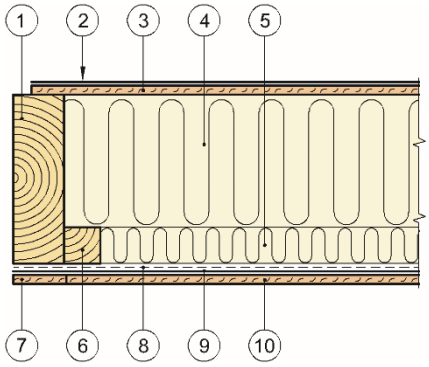
1	22 mm particleboard	7	PVC transport membrane (may be kept permanent in finished building)
2	48 x 225 mm BN glulam joist c/c 600 mm	8	12 mm particleboard
3	175 + 50 mm mineral wool	9	36 x 198 mm ceiling joists
4	9 mm moisture resistant particleboard	10	200 mm mineral wool
5	13 mm battens	11	12 mm particleboard
6	36 mm sill installed on site		

Fig. 6.
Example of horizontal section between two modules.



1	22 mm particleboard	7	48 x 198 mm ceiling joists C24 c/c 600 mm
2	48 x 225 mm BN glulam joists c/c 600 mm	8	150 mm Glava Proff 35 mineral wool
3	175 + 50 mm mineral wool	9	48 x 48 mm battens C24 c/c 300 mm
4	9 mm OSB / wind barrier (roll product)	10	15 mm Gyproc GF Protect gypsumboard
5	25 mm spacing	11	12 mm foliated particleboard
6	12 mm particleboard		

Fig. 7.
Horizontal section with fire resistance REI 60 between two modules.



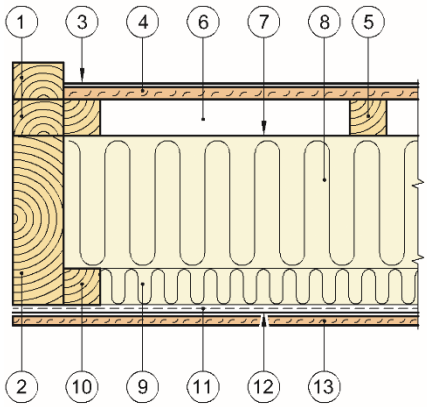
1	Edge beam	6	Joist support
2	PVC transport membrane	7	12 x 70 mm particleboard strip
3	12 mm particleboard	8	Wire net when EI 30 is required
4	36/48 x 198 mm ceiling joists + 150 mm mineral wool	9	Water vapour barrier
5	50 mm mineral wool	10	12 mm foliated particleboard

Fig. 8.
Design of floors under attic rooms. Stone wool insulation is required in certain cases, see Table 2.

2.7 Roof elements

Fig. 9 shows the principle design of flat roofs. Longitudinal main beams (edge beams) and secondary transvers beams are designed according to structural calculations in each individual case for the relevant loads and span.

Modules for houses with roof structures built on site are delivered without a roofing membrane and built-up slope, but with a transport membrane for temporary protection.



1	Two 67 x 48 mm battens	8	36 x 223 mm beams + 175 mm mineral wool
2	67 x 223 mm edge beam	9	50 mm mineral wool
3	PVC roofing membrane	10	Beam support, or screws as in fig. 5
4	16 mm moisture resistant particleboard	11	Steel wire net
5	48 x 20/70 roof slope battens	12	Water vapour barrier
6	Ventilated space	13	12 mm foliated particleboard
7	Wind barrier		

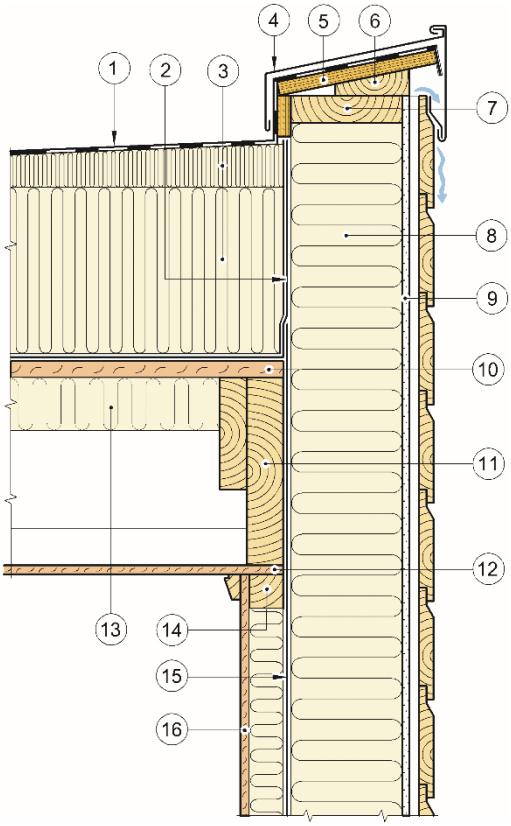
Fig. 9.
Example of flat, ventilated roof design. Total thermal insulation thickness may vary from 225 mm to 325 mm, depending on thermal loss calculations for each individual house. Stone wool insulation is required in certain cases, see Table 2.

Fig. 10 shows the principle design of compact roofs with thermal insulation placed on top of the load-bearing structure. This roof design has internal water drainage. The prefabricated roof element is only partially insulated with fixed fire insulation since most of the thermal insulation is positioned on top of the roof structure.

The thermal insulation is installed on site after the assembling of modules. Roofing with PVC or bitumen based membrane is installed on site, minimum slope 1 / 40.

Insulation thickness is determined according to energy calculations for each individual project.

The transport membrane becomes water vapour barrier in the finished roof, see fig. 10.



1	Roofing (extended over the parapet)	9	Wind barrier (9 mm gypsum board)
2	Water vapour barrier	10	22 mm moisture resistant particleboard
3	Rigid stone wool (and slope built up)	11	Edge beam, 48 x 248 mm
4	Parapet flashing (installed on site)	12	Ceiling board
5	18 mm plywood (may be installed on site)	13	70 mm mineral wool
6	"Johansen"-wedge (may be installed on site)	14	48 x 48 mm batten
7	Top sill, 36 x 148 mm	15	Water vapour barrier, wall
8	Thermal insulation (exterior wall)	16	Foliated particleboard, 12 mm

Fig. 10.
Compact roof design. Total thermal insulation thickness may vary from 200 mm to 400 mm, depending on thermal loss calculations for each individual house.

3. Fields of application

Moelven Module is assessed to fulfil preaccepted performances for buildings in risk class 1 – 6 in fire class 1 and 2 according to the guide to the Norwegian building regulations TEK17.

Use of the product in other fire classes is not covered by this approval, and must be documented separately by the responsible designer for each individual project. Use in other type of buildings with stricter requirements and preaccepted performances than given for residential houses in TEK17 with guide must be considered individually in each particular case. See chap. 6 concerning special conditions for use and installation.

The modules are suitable for being moved and relocated.

The modules may be installed on basements or perimeter walls. See in addition chap. 6.

Tabell 1
Material specifications Moelven Modul

Material / component	Specification [1)]	TG/PS [2)]	Fire classification [3)]	CE-marking [4)]
Structural components				
Solid wood timber	Structural timber grade C18 or C24 according to EN 338 or according to specific structural design for structural purposes, otherwise C14. Moisture content max. 18 %	-	D-s2,d0-	EN 14081-1
Glued laminated timber	- Glulam GL30c and split glulam GL28c, or according to specific structural design. Formaldehyde class E1 - BN-beam - Kerto LVL (Fire classification depending on thickness and underlay)	- TG 20034 TG 2142	D-s2,d0 D-s2,d0 See TG	EN 14080
Studs	Iso3-studs	TG 2610	See TG	
Panels/Boards				
Subfloor	22 mm Forestia Gulv particleboard, class P6, formaldehyde class E1	TG 2280	D-s2,d0	EN 13986
Strengthening panels in wet rooms	Metsä Wood plywood	TG 2059	See TG	EN 13986
Flooring underlay	36 mm Hunton Silencio soft fibreboard	TG 2330	E_{fl}	EN 13986
Roofboards, flat roofs	Min. 16 mm Forestia Taktro particleboard, class P7	TG 2280	D-s2,d0	EN 13986
Wind barrier boards	- 9,5 mm Gyproc Glasroc H Storm gypsum board - 9,5 mm Gyproc GUB Bris gypsum board - 9 mm Sterling OSB/3	TG 20251 TG 20473 -	A2-s1,d0 A2-s1,d0 D-s2,d0	EN 15283-1 EN 520 EN 13986
Internal sheathing	- 12 mm OSB/3 in wet room walls - 15 mm Gyproc GF15 Protect F	-	D-s2,d0 A2-s1,d0	EN 13986 EN 520
Boards in module separation walls	9 mm Sterling OSB/3	-	D-s2,d0	EN 13986
Boards in module roof	Min. 12 mm Forestia particleboard type P5	-	D-s2,d0	EN 13986
Claddings and linings				
External cladding	- 19 mm board-on-board vertical timber cladding class 1 according to EN 15146 and SN TS 3186 - 19 mm horizontal rebated cladding class 1 according to EN 15146 and SN TS 3186 - 19 mm vertical rebated cladding class 1 according to EN 15146 and SN TS 3186 - Teknos FR Facade fire painted cladding	- - - -	D-s2,d0 D-s2,d0 D-s2,d0 B-s3,d0	EN 14915 EN 14915 EN 14915 EN 14915
Internal lining	-12 mm Forestia foliated particleboard type P1, formaldehyde class E1 -12 mm Forestia Tak-ess; particleboard type P1, formaldehyde class E1 -12,5 mm Gyproc GN13 gypsum board -12,5 mm Gyproc GR13 Robust gypsum board -15,0 mm Gyproc GF15 Protect gypsum board -11 mm Huntonit Bygningsplate; painted fibreboards -12 mm MDF Firax Spanolux, painted fire resisting fibreboard -Min. 12 mm Moelven Trepanel -Ecophone Focus (acoustical ceiling towards lining board)	- - - - - TG 2038 - - -	D-s2,d0 D-s2,d0 A2-s1,d0 A2-s1,d0 A2-s1,d0 See TG B-s1,d0 D-s2,d0 A2-s1,d0	EN 13986 EN 13986 EN 520 EN 520 EN 520 EN 13986 EN 13986 EN 14915 EN 13964
Sheathing towards foundations	-9 mm Gyproc Glasrock H Storm gypsum board -9 - 12 mm Forestia moisture resistant particleboard min. class P5 -9 mm Egger OSB/3 -9 mm Tebopin III plywood treated with Wolsin FL-P3 -9-12 mm Moelven Vänerply K20/70 Prevent	TG 20251 - - - -	A2s1,d0 D-s2,d0 D-s2,d0 - -	EN 15283-1 EN 13986 EN 13986 EN 13986 EN 13986
Thermal insulation	Rockwool stone wool with declared conductivity λ_D = 0,037 W/mK	-	A1	EN 13162,
	Paroc ROB, ROBSTER, ROS, ROX 2, ROU, ROV, GRS stone wool with declared conductivity λ_D = 0,035 – 0,039 W/mK	-	A1	EN 13162
	Glava glass wool with declared conductivity λ_D = 0,032 (climate separation), 0,034 (fire separation) and 0,038 (other use) W/mK	-	A1	EN 13162
	Glava Teknisk isolasjon	-	-	-

(continued on page 6)

Table 1 continued

Material / component	Specification [1]	TG/PS [2]	Fire classification [3]	CE-marking [4]
Air and moisture barriers				
Wind barrier (roll products)	-T-Emballage Vindskydd Bas according to SP certificate SC0142-15 -Vempro vindsperre	- -	- -	EN 13859-2 EN 13859-2
Water vapour barrier	0,15 or 0,20 mm Tommen Gram polyethylene film	TG 2554	-	EN 13984
Roofing	-1,2 mm Protan SE PVC-roof membrane or similar -1,0 mm Protan Takfuktsperre, PVC-transport membrane -Sikaplan 12 og 15 VGWT	TG 2010 - TG 2057	See TG - See TG	EN 13956 - EN 13956
Fire spread protection	Graft FR Grafhite Board	-	-	-
	Graft FR Pipe Wrap	-	-	-
Fastening and sealing products				
Nails / screws	Nails, screws and fittings for cladding installation, anchoring etc. shall be hot dipped zink coating according to EN ISO 1461 or have equivalent corrosion protection.	-	-	EN 14592 [6]
Steel plate connectors	Hot dipped zink coated plates with holes	-	-	-
Tape, internal use	Siga Rissan	TG 20134	-	-
Tape, external use	-Siga Wigluv and Siga Fentrim 2 -Tapes belonging to wind barrier boards with TG 20251 and TG 20473	TG 20134 -	- -	- -
Glue	- Bostik 700PVAc glue for subfloor installation - Bostik Startac/Startac Combi and BVD for vinyl flooring installation - Bostik Startac ST PVAc glue for roof membrane installation - Jotun lim ekstra - Casco Cascol Floor M1 - Flugger adhesive 378 strong - Multi Tack 252 - D3 Ude 430	-	-	-
Sealants	- Soudal Soudaseal 215 LM for joints in Fibo-Trespo panels - Soudal Acrycub - Soudal Fireacryl FR - Soudal Soudaseal 222 - Soudal Fix All Flexi - Soudal Fix High Tack - Soudal Malerakryl - Soudal Silirub AL2T - Soudal Silirub+ 8100 - Soudal Soudaseal 240 FC	TG 2289 - - - - - - - - -	-	-
Expanding foam	- Soudal Soudafoam All Season Gun - Soudal Flexifoam All Season Gun	-	-	-
Paint	- Jotun Jotaproff Akryl 07 - Jotun Jotaproff PVA 07 - Jotun Våtrom 20	-	-	-
Filler	- Jotun Lettsparkel (fine/medium) - Flugger Sandplast LSR	-	-	-
Glass fibre burlap	Jotun Glassfiber	-	-	-
Floor materials				
Floor covering	Tarkett IQ Granit vinyl flooring according to EN 649	-	-	-
Wet rooms				
Water pipes	Uponor PEX tap water system	TG 20013	-	-
Waste-water pipes	- Rehau Raupiano PP - Wavin PP	PS 0397 PS 3557	-	-
Floor gully	- Purus Joti A-Flex and K-Flex floor gully - Purus Joti floor gully	PS 3339 PS 3340	-	-
Wall panels	Fibo-Trespo bathroom panel	TG 2289	D-s1,d0	-
Floor panels	MDF panels with 5 mm x 8 mm grooves facing down	-	-	-
Wet room membrane	TarkoDry wet room membrane	TG 2598	-	-
Flooring	Tarkett Aquarell wet room flooring	-	-	-
Wall covering	Tarkett Aquarelle wall covering	-	-	-

(continued on page 7)

Table 1 continued

Material / component	Specification [1]	TG/PS [2]	Fire classification [3]	CE-marking [4]
Miscellaneous				
Collars for water vapour barrier	DAFA Profoil collars	TG 20504	-	-
Elastic supporting pads	Vibisol (or similar for elastic support of floor structures)	-	-	-
Steel wire net	Steel wire net with 0,9 m width and 1,0 mm wire diameter ("chicken net"), or 1,5 mm steel wire spaced c/c 0,3 m	-	-	-
Windows and doors are not part of the approval, but the products which are installed in the modules shall satisfy the requirements concerning thermal insulation and air tightness as specified in the Norwegian building regulations (TEK)				

[1] Non-specified material dimensions shall be in accordance with dimensions specified in "Standard construction details" or according to specific design for each individual building project
[2] The component shall be in accordance with the given SINTEF Technical Approval (TG) or SINTEF Product Certificate (PS)
[3] Fire classification according to chap. 4.2
[4] The component shall be CE-marked according to the given product standard, technical specification or ETA

4. Properties

4.1 Structural performance

Load-bearing structures are calculated specifically for each individual building project. Each module is structurally designed according to EN 1995-1-1 and EN 1991, including national annexes for Norway.

The structural design of wall and roof elements may also be done with reference to Building Research Design Guide 523.251 *Timber walls in low rise houses* and 525.814 *Timber rafters.*

4.2 Reaction to fire

Fire classification according to EN 13501-1 for products incorporated in the modules are shown in Table 1. The classification applies to the use as specified for the building system. Where a specific product name is not given in the Table must products with fire classification according to the guide to the technical regulations TEK17 be used.

4.3 Fire resistance

Fire resistance for the module parts is shown in Table 2. The fire resistance has been determined on the basis of calculation methods in the handbook *Brandsäkra Trähus version 3* and fire resistance tests. The declared fire resistances assume construction specifications according to the Table, chap. 2.2 – 2.7 and materials given in Table 1.

The fire resistance applies to 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 2.

Design load capacity for walls at limit state fire is given as maximum centric axial load per meter wall (kN/m with c/c 600 mm spacing between studs). 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 because the lining protects the structure. Hence the design capacities determined for ultimate and serviceability limit states are applicable also in case of fire.

The insulation in roof and floors must in some cases be secured to stay in place during a fire, see chap. 6.2 *Safety in case of fire* concerning special conditions for use and installation.

4.4 Sound insulation

Walls between modules as shown in fig. 3, installed with minimum 22 mm free spacing, have an expected airborne sound insulation $R'_w \geq 48$ dB. With 48 mm x 98 mm studs and double board lining on the room sides the expected airborne sound insulation is $R'_w \geq 55$ dB.

For floors between modules as shown in fig. 5 and 6, installed according to the standard construction details, the expected airborne sound insulation is $R'_w \geq 52$ dB. Expected impact sound pressure level for floors between modules is $L'_{n,w} \leq 58$ dB, providing a vinyl flooring with soft underside (impact sound insulation quality) or similar.

If the modules shall meet the impact sound insulation requirements according to Norwegian Standard NS 8175 ($L'_{n,w} \leq 53$ dB), the floors must be supplemented with parquet and Silencio parquet underlay over a floating particle board floor on an elastic support of soft fibreboards or rigid mineral wool.

4.5 Thermal insulation

Table 3 shows examples of thermal insulation coefficients, U-values, for standard module parts as described in chap. 2, calculated according to EN ISO 6946. The values for external walls are based on 12,5 – 13,0 % timber proportion, and do not include thermal loss due to extra timber around door and window openings. Other thermal conductivities and timber proportions give other U-values. See in addition chap. 6.3 concerning thermal insulation design.

Table 3
Examples of U-values for building parts insulated with mineral wool with thermal conductivity λ_D = 0,034W/mK

Building part	Insulation thickness mm	U-value W/m²K
Floor over foundations	225 225 270	0,18 0,16 [1] 0,15
External wall	175 200 250	0,22 0,20 0,16
Roof [2]	225 325	0,18 0,13

[1] Depending on type of construction design
[2] Compact roofs are insulated according to specific thermal calculations for each individual building

Table 2
Fire resistance for fire separating and structural building parts

Building parts according to "*Standard construction details for Moelven Module belonging to SINTEF Technical Approval no. 2220*" Build-up from fire exposed side	Fire resistance [1)]	Design load capacity at fire [2)]
External wall, fig. 2 (YV1, YV2, YV3): - 12 mm Forestia Ferdigvegg /11 mm Huntonit Bygningsplate - 36 x 173/198/(198+48) mm studs grade C18 - 175/200/250 mm Glava with density min. 16 kg/m³ - Glava Vindsperre Wall height maximum 3,0 m	REI 45 [5)]	15 kN per meter wall length
Non loadbearing internal wall, fig. 4 (IBV1): - 12 mm foliated particle board - 48x68 mm studs grade C24 - 70 mm stone wool - 12 mm foliated particle board Wall height maximum 2,4 m	EI 30	-
Non loadbearing internal, fig. 4 (IBV2, IBV3, IBV4): - 12 mm Forestia 3 Vegg Standard P2 / 12,5 mm gypsum board type A - 36x98 mm studs grade C24 - 100 mm Glava Økonomi 38 insulation - 12 mm Forestia 3 Vegg Standard P2 Wall height maximum 3,0 m	EI 30 [5)]	-
Double partition wall, fig. 3 (BIV1, BIV2, BIV3): - 12 mm Arbor Standard Vegg particleboard / 12 mm Forestia 3 Vegg Standard P2 / 12,5 mm gypsum board type A - 36/48 mm x 98 mm studs grade C24 - 100 mm Glava Proff 34 insulation - 9 mm OSB-plate density min. 550 kg/m³ - wall spacing, etc. Wall height maximum 3,0 m	REI 30 [5)]	36 x 98 mm studs: 8 kN per meter wall length [3)] 48 x 98 mm studs: 18 kN per meter wall length [3)]
Double partition wall, fig. 3 (BIV4): - 12 mm particleboard / 11 mm fibreboard, density min. 680 kg/m³ - 12,5 mm gypsum board type A - 100 mm glass wool with density min. 15 kg/m³ - 48x98 mm studs grade C24, top and bottom sill 48x98 mm - wall spacing, etc. Wall height maximum 2,5 m	REI 30	32 kN per meter wall length [3)]
Double partition wall, fig. 3 (BIV5, BIV6): - 11 mm Huntonit Bygningsplate / 12,5 mm gypsum board type A - 15 mm Gyproc GF 15 Protect F - 68x98 mm studs grade C24 (sills grade C24) - 100 mm Glava Proff 35 Plate - 9 mm OSB/3-plate with density min. 600 kg/m³ - 22 mm wall spacing, etc. - Wall height maximum 2,7 m	REI 60 [5)]	25 kN per meter wall length [3)]
Separating floor, fig. 6 (E1, E2, E3, E6): - 12 mm particleboard with density min. 680 kg/m³ - "Chicken net" - 200 mm glass wool with density min. 15 kg/m³ - 36 mm x 198 mm joists grade C24 - 12 mm particleboard with density min. 500 kg/m³ - spacing - 9 mm particleboard with density min. 500 kg/m³ - 36 mm x 223 mm joists grade C24 - 175+50 mm glass wool with density min. 12 kg/m³ - 22 mm particleboard with density min. 500 kg/m³	REI 30 R 30	6,0 kNm per joist in floor (compression or tension on fire exposed side) [4)]
Separating floor, fig. 6 (E4, E5 og E7): - 12 mm Forestia Ferdigvegg, or 12,5 mm gypsum board type A - 15 mm Gyproc GF15 Protect - 48 mm x 48 mm battens, grade C24, c/c 300 mm - 150 mm Glava Proff 35 - 48 mm x 148 mm joists grade C24, c/c 600 mm - 12 mm Forestia Vegg Standard - spacing - 175+50 mm Glava Økonomi 38 - 48 mm x 225 mm BN-glued laminated beam, c/c 600 mm - 22 mm Forestia Gulv Standard	R 60 REI 60	Full capacity

(continued on page 9)

Table 2 continued

Ceiling towards attic, fig. 8 (T4): - 12 mm particleboard with density min. 680 kg/m³ - "Chicken net", fasteners with min. 50 mm length - 50 mm stone wool with density min. 50 kg/m³ - 150 mm glass wool with density min. 15 kg/m³ - 36 mm x 198 mm structural timber grade C24 - 12 mm particleboard with density min. 500 kg/m³.	REI 15 EI 15	7,4 kNm per beam [4)]
Ventilated roof, fig. 9 (T1): - 12 mm s particleboard with density min. 680 kg/m³ - "Chicken net" - 100 mm stone wool with density min. 50 kg/m³ - 125 mm glass wool with density min. 15 kg/m³ - 36 mm x 223 mm structural timber grade C24, c/c 600 mm - wind barrier	REI 30 EI 30	5,8 kNm per beam [4)]
Ventilated roof, fig. 9 (T1): - 12 mm particleboard with density min. 680 kg/m³ - 15 mm gypsum board type F - "Chicken net" - 225 mm glass wool with density min. 15 kg/m³ - 36 mm x 223 mm structural timber grade C24, c/c 600 mm - wind barrier	REI 30 EI 30	4,8 kNm per beam [4)]

[1)] Fire resistance equivalent to classification according to EN 13501-2. Separating property (EI) and loadbearing property (R) expressed in minutes
[2)] Residual load capacity in accidential limit state fire. Full capacity means the structural capacity is not reduced in comparison with capacity in ultimate and serviceability limit states
[3)] Capacity for each single wall part
[4)] Insulation must be secured to stay in place during a fire
[5)] The structure is not classified, but has a fire classification based on calculations equivalent to what is declared

4.6 Durability
Modules with flat roofs have limited roof ventilation. Depending on local climatic conditions may ice and standing water on the roof be expected from time to time, which may reduce the lifetime of the roofing.

5. Environmental aspects
5.1 Chemicals hazardous to health and environment
The products in Moelven Module 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 products in Moelven Module 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
Leaching from roofing materials in Moelven Module is evaluated to have no negative effects on soil or ground water.

5.4 Waste treatment/recycling
During demolition the module materials and components 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, disposal and/or handled as hazardous waste.

5.5 Environmental declaration
No environmental declaration (EPD) has been worked out for Moelven module.

6. Special conditions for use and installation
6.1 Structural design
The following calculations/documentation shall be worked out for each delivery, customized to each individual building and building project:

- Structural design of roof structure
- Structural design of walls, including beams over wall openings, studs at opening sides and possible single columns
- Determination of floor joist dimensions according to the principles in Building Research Design Guide 522.351 *Timber floors. Structural design and execution*, or relevant approval of wood-based joists with specified strength class
- Structural design and specification of wind anchoring, including installation guide

6.2 Safety in case of fire
For each delivery shall required fire resistance according to TEK be determined for structural building parts and parts with fire separating functions. Design load capacity at accidental limit state fire must be checked by comparison with load capacities shown in chap. 4.3. Choice of construction is determined by required fire resistance.

Products for internal and external surfaces, behind ventilated claddings, insulation etc. must be used according to preaccepted performances in the guideline to TEK. Necessary 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 principles in Building Research Design Guide 543.204 *Installation of gypsum- and fibreboards in walls and ceilings*. At connections between building parts with fire resistance must joints in internal lining be sealed with fire sealing products or supported and sealed with timber battens behind.

Penetrations through building parts 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 Guide 520.342. See Building Research Design Guide 520.342 *Fire sealing of penetrations*.

For insulation which has to be kept in place during fire is this done by using steel wire or steel wire net with minimum thread diameter 1,5 mm, fixed with minimum 50 mm long staples under the joists/beams. Wire and staple spacing must be maximum c/c 350 mm, and minimum three wires per insulation board.

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

6.3 Thermal insulation design
The required energy efficiency according to TEK shall be determined for each building project. Necessary U-values beyond what is shown in chap. 4.5 must be specified.

6.4 Foundations
The modules shall be placed on a foundation that meets the module manufacturer's requirements concerning tolerances on dimensions, planarity and directional deviation, and which is secured from moisture damages. Moisture from foundations into wood materials shall be prevented by a capillarity breaking membrane. The foundation must otherwise be in accordance with the recommended principles shown in Building Research Design Guide 521.203 *Foundations with perimeter walls and ventilated crawl space*.

Installations above underground garages etc. must be specifically design for each individual building project.

6.5 Windows and doors
Windows and doors installed in the modules are assumed to have adequate documented tightness, thermal insulation and resistance to climate exposure.

6.6. Installation on site
The modules shall be installed according to the construction principles in *"Standard Construction Details for Moelven Module belonging to SINTEF Technical Approval 2220"*, and design provisions worked out for each delivery as mentioned in chap. 6.1 – 6.7.

The modules shall be anchored to the foundations according to specific structural calculations for each delivery, possibly with reference to Building Research Design Guide 520.241 *Wind anchoring and bracing of small timber houses* or 520.243 *Wind anchoring and bracing of light timber buildings*.

6.7 Roof structures
When connecting several modules to one building which is wider than the module length must specific construction details be designed to secure adequate ventilation of cold roof designs.

6.8 Wet rooms
Bathrooms and other wet rooms shall be designed and executed to at least satisfy the minimum requirements of the preaccepted performances given in the guidance to TEK, and the SINTEF Product Certificates and SINTEF Technical Approval for the materials and components used in the wet rooms, see table 1.

6.9 Transport and storage
The modules shall be protected transport and storage with a solid transport covering on the module roof, extending 20 – 30 cm down on the walls. Provisional transport bracings shall be installed in modules with large openings.

7. Factory production control
The modules are produced at the following locations:
- Moelven ByggModulAS, Moelv (Norway)
- Moelven ByggModulAS, Hjellum (Norway)

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

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

8. Basis for the approval
The approval is based on an assessment of the module system's specified materials and components with the belonging documentation, and the assessment of contruction details and performance according to recommendations in Building Research Design Guides.
- SINTEF. Building Research Design Guide 523.251 Timber wall framing in small houses. Structural design and execution
- SINTEF. Building Research Design Guide 471.010 – 013 (Thermal insulation)
- SINTEF. Building Research Design Guide 523.255 Timber frame external walls. Thermal insulation and sealing
- SINTEF Building Research Design Guide520.321 – 322 (Fire resistance)

9. Marking
Each module delivery shall be followed by a set of delivery documents which as a minimum include the name and address of the manufacturer, project identification, specific installation guides for each delivery, and construction details comprising the relevant details in *"Standard Construction Details for Moelven Module belonging to SINTEF Technical Approval 2220"*.

The approval mark for SINTEF Technical Approval No. 2220 may also be used.

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

for SINTEF

Hans Boye Skogstad

Hans Boye Skogstad
Approval Manager