

SINTEF Building and Infrastructure confirms that

Gokstad Hus building system

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

SIA Gokstad Hus
 Mazas skolas 2-1
 1050 Riga
 Latvia

2. Product description

2.1 General

Gokstad Hus building system is a construction system based on prefabricated timber frame elements, transported to site and assembled to residential buildings, commercial office buildings or schools. Field of use is described in chapter 3.

2.2 Content of approval

The approval covers prefabricated external walls, internal walls, floor elements and roof elements. Elements are based on a wooden load bearing system performed of wooden studs and wooden beams.

The approval contains the standard design for the constructions, described in chapters 2.3 to 2.6 with related materials and components as given in table 1. This includes also standard details, as described in chapter 2.7.

The approval does not include internal surface treatments, windows or doors and other supplementary building parts which not are mentioned in this approval. These components have to be specified and considered separately for each specific project.

2.3 External walls

The principle design of external walls is shown in Fig. 2. Heights and lengths of the different elements are adapted to the different needs of the single projects. Maximum element length is restricted by transportation and can be up to 12,0 m. Element height can be adjusted the height of the floors to a maximum of ca. 3,2 m.

External walls will be delivered from factory including external cladding, wind barrier, thermal insulation, vapour barrier and inside battens. Connections of vapour barrier to other units and the internal lining will be assembled on site.

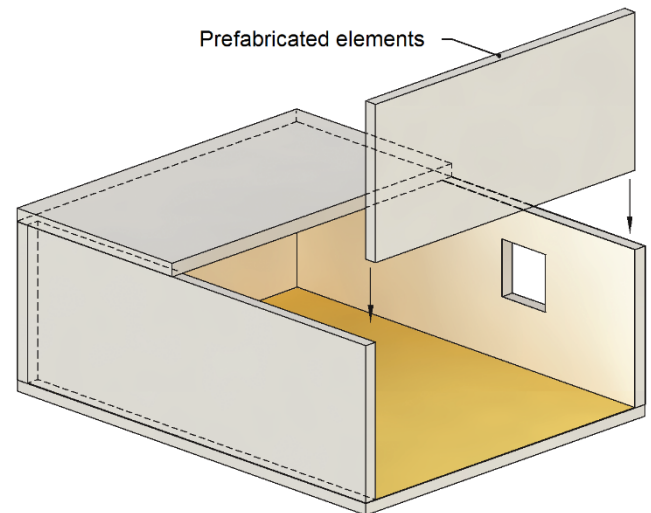


Fig. 1
Principle Gokstad Hus building system

2.4 Internal walls / Apartment limiting walls

The principle design of standard internal walls and apartment limiting walls are shown in Fig. 3 and Fig. 4. The element height and length are adapted to the needs of each specific project.

Internal and apartment limiting walls are, depending to the project, delivered from factory only with framework or with single or double-sided lining and insulation.

2.5 Floors

The principle design of a floor element is shown in Fig. 5. Length and structural need of joists in the elements are adapted to each specific project.

Floor elements are delivered from factory including upside structural plate, insulation between joists and most other components. Finishing floor layers and ceiling will be assembled on site.

Tabell 1
Gokstad Hus building system. Material specifications

Material / component	Specification (Not shown dimensions for materials are either defined in the "standard construction details" or shall be considered for each single project.)	CE-marking
Load bearing components		
Timber	Construction timber according EN 14081 part 1 to 3 with strength class C24, or according specific structural design consideration. Moisture content $\leq 18\%$	X
Glue lam	Glue lam EN 14080, with strength class GL 24 h, or according specific structural design consideration Emission class for formaldehyde = E1	X
I-Joist	Hunton I joist w/LVL flange according SINTEF Technical Approval 20381	X
Steel components	Load bearing steel components according EN 10025, EN 1090-1 and EN 1090-2	X
Construction plates		
Sub-floor-plate	18 and 22 mm Kronospan OSB/3 ECO sub-floor-plates according SINTEF Technical Approval 20155 Plates satisfy requirements for sub-floor-plates according EN 1991-1-1, included testing for point load according EN 12871	X
Wind barrier plates	9,5 mm Gyproc Wind barrier plates (GTS 9) type EH2-9,5 according EN 520	X
Sub-roof-plates	15 mm Kronospan OSB/3 ECO plates according SINTEF Technical Approval 20155	X
Claddings		
External cladding	Min. 19 mm wooden cladding class A according EN 15146	X
Internal lining	12 mm Kronospan OSB/3 ECO plates according SINTEF Technical Approval 20155 12,5 mm Gyproc NORMAL (GN 13) type A-12,5 according EN 520 12,5 mm Gyproc PROTECT F (GF 15) type DFI-15,4 according EN 520	X
Insulations		
Thermal insulation	Isover mineral wool according EN 13162, with declared conductivity of $\lambda_D = 0,035$ W/mK Paroc eXtra mineral wool according EN 13162 with declared conductivity of $\lambda_D = 0,036$ W/mK	X
Barriers		
Wind barrier	SIGA Majvest and SIGA Majcoat wind barrier and combined sub roofing and wind barrier according SINTEF Technical Approval 20131	X
Vapour barrier	Air Guard® vapour barrier according SINTEF Technical Approval 20321	X
Tightening of gaps	SIGA Wigluv, SIGA Sicrall, SIGA Rissan, tape according SINTEF Technical Approval 20134 Trelleborg ST-strip, rubber gaskets, for use between foundation and External walls ELTETE ELT PAM 400 Geo-membrane-product as barrier between foundation and External walls Isover SK-C glas wool rolls as thermal insulation between windows and framework Soudal Fix All joint filler	
Roofing	Protan waterproofing membrane according SINTEF Technical Approval 2008 Protan roofing membrane according SINTEF Technical Approval 2010 Icopal Two-layer roofing membrane according SINTEF Technical Approval 2012	X
Fasteners		
Glue	ESSVE Trålim mounting glue	
Nails / screws / steel connectors	Nails, screws and steel connectors for fastening of all connection shall in minimum be warm galvanized or have a similar corrosion prevention. Nails and screws shall be produced according EN 14592.	

2.6 Roof elements

The principle composition of prefabricated roof elements is shown in Fig. 6. Length and structural need of rafters in the elements is adjusted to each single project. Elements are delivered from factory including sub roof, insulation between rafters, vapour barrier and battens underneath. Roofing, connection, connection of vapour barrier to other units and ceiling will be assembled on site.

2.7 Construction details

Specifications for the different materials and components for the building system are shown in table 1. Characteristics for use of materials and components are to be documented by the suppliers.

The detailed element construction design is described in "Standard konstruksjonsdetaljer for Gokstad Hus tilhørende SINTEF Teknisk Godkjenning nr. 20436". The version of the construction details filed at SINTEF at any time is a formal part of the approval.

3. Fields of application

Gokstad Hus building system, shown in Fig. 2 to 6 can be used in buildings in hazard class 1-6 in fire class 1 and in buildings up to three floors if each dwelling unit has direct access to the ground level (not via stairs or stair cases). Building system field of use should be mainly residential buildings.

For other field of application or other requirements, a fire safety analysis must be performed for the specific project.

4. Properties

4.1 Load-carrying capacity

In general the design regarding structural capacities and structural loads shall be considered according chapter 6.2. *Structural design considerations.*

4.2 Reaction to fire

Gyproc PROTECT F (GF) and Gyproc NORMAL (GN) gypsum boards have a reaction to fire class A2-s1,d0. Kronospan OSB/3 with minimum thickness 12 mm has a reaction to fire class D-s2,d0. Classifications are performed according to EN 13501-1 and are valid for use on substrates of mineral wool and timber.

Thermal insulation has to have reaction to fire class A1 or A2-s1,d0.

Protan PVC roofing membranes satisfying reaction to fire class B_{ROOF(t2)} on substrates as given in SINTEF Technical Approval no. 2008 and 2010. Icopal 2-Layer roofing membrane satisfying reaction to fire class B_{ROOF(t2)} on substrates as given in SINTEF Technical Approval no. 2012. Classifications are performed according EN 13501-5.

4.3 Fire resistance

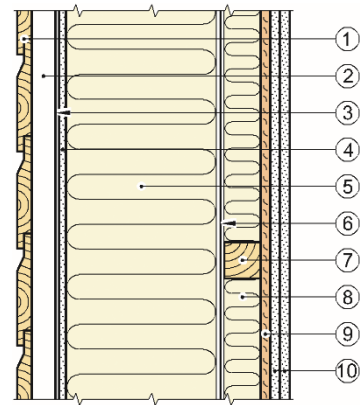
The fire resistance for the building elements, equivalent to the classification system in EN 13501-2, are given in table 2. There shown fire resistances requires the specified build-up, with cladding as mentioned in table 2 and fully insulated cavities. Fire resistances are determined in accordance to the handbook "Brändsäkra Trähus" version 3.

The fire resistance is based on fire exposure from the inside for external walls and from the bottom side for floors and roofs. Load-bearing Internal walls with R 15 or R 30 are exposed to fire from both sides.

Table 2
Fire resistance of elements

Element	Equivalent fire resistance ¹⁾
Cladding on fire exposed side	
External wall	
1 layer Gyproc NORMAL (GN 13)	REI 15
External wall (Fig. 2)	
2 layers Gyproc NORMAL (GN 13)	REI 30
Internal wall	
1 layer Gyproc NORMAL (GN 13)	REI 15
Internal wall (Fig. 3)	
2 layers Gyproc NORMAL (GN 13)	REI 30
Apartment limiting wall (Fig. 4)	
2 layers Gyproc NORMAL (GN 13)	REI 30
Floor elements	
1 layer Gyproc NORMAL (GN 13)	REI 15
Floor elements (Fig. 5)	
2 layers Gyproc NORMAL (GN 13)	REI 30
Roof elements	
1 layer Gyproc NORMAL (GN 13)	REI 15
Roof elements (Fig. 6)	
2 layers Gyproc NORMAL (GN 13)	REI 30

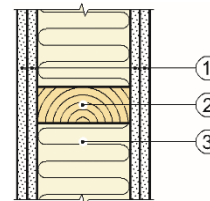
¹⁾ Fire resistance classification according EN 13501-2



Vertical section

1	19 mm wooden cladding	6	Vapour barrier
2	36 x 48 mm battens	7	45 mm battens
3	Wind barrier	8	45 mm insulation
4	9 mm Gyproc Wind barrier plate (GTS 9)	9	12 mm Kronospan OSB3/ECO
5	195 mm framework c-c 600 mm with insulation	10	2 x 12,5 mm Gyproc NORMAL (GN 13)

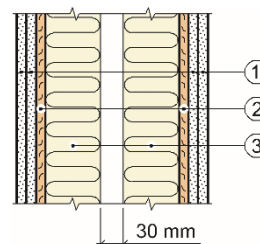
Fig. 2
Principle build-up of External walls of prefabricated elements



Horizontal section

1	2 x 12,5 mm Gyproc NORMAL (GN 13) on both sides	3	45 mm insulation
2	95 mm framework c/c 600 mm		

Fig. 3
Principle build-up of Internal walls of prefabricated elements



Vertical section

1	2 x 12,5 mm Gyproc NORMAL (GN 13) on both sides	3	75 mm framework with insulation
2	12 mm Kronospan OSB3/ECO		

Fig. 4
Principle build-up of apartment limiting walls of prefabricated elements

Due to the fire protection given by the internal claddings on the fire exposed side of the building elements, charring of the structural elements will not occur during the given fire exposure time. The ultimate limit state in case of fire is therewith not specifying the serviceability of the construction.

For fire resistance, the distance between fasteners of the lining should be less than 300mm

4.4 Sound insulation

The apartment limiting wall construction, shown in Fig. 4, and the assembling details to other building units are described in "Standard konstruksjonsdetaljer for Gokstad Hus tilhørende SINTEF Teknisk Godkjenning nr. 20436", are the expected sound insulation properties according EN ISO 16283-1 / -2 and EN ISO 717-1 / -2 as shown in table 3 for finished building. Values are equivalent to sound classification C according NS 8175.

Table 3
Expected sound insulation in finished building

Construction	Airborne sound-insulation R'_w	Impact sound insulation $L'_{n,w}$
Apartment limiting wall (Fig. 4)	≥ 55 dB	≤ 53 dB

This performance meets the minimum requirement of sound insulation between dwellings according guideline of TEK, means sound class C according NS 8175 without correction factor for improved frequency range of low frequent sound. Sound insulation is also dependent to the quality of assembling technical installations. Necessarily should these challenges be considered for every single project.

4.5 Thermal insulation

Table 4 shows heat transfer coefficients, U-values, for standard building elements, described in chapter 2, calculated according EN ISO 6946.

Values for External walls are based on a wooden fraction of approximately 11,25 % and includes no additional wooden constructions around openings for doors and windows in the walls.

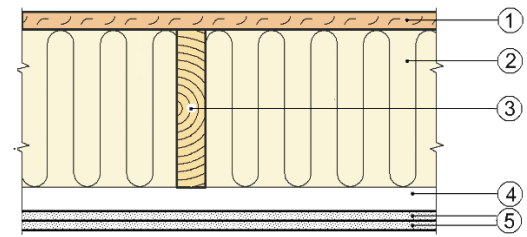
4.6 Durability

The constructions elements are satisfying general requirements of SINTEF Building and Infrastructure for the durability of the tightness and therewith durability.

Table 4
Thermal transmittance, U-value for Gokstad Hus

Type of element	Insulation thickness ¹⁾	U-value W/m^2K
External wall (Fig. 2)	145 + 45 mm	0,21
	195 + 45 mm	0,17
	220 + 45 mm	0,16
Roof (Fig. 6)	220 + 70 mm	0,14
	220 + 120 mm	0,12

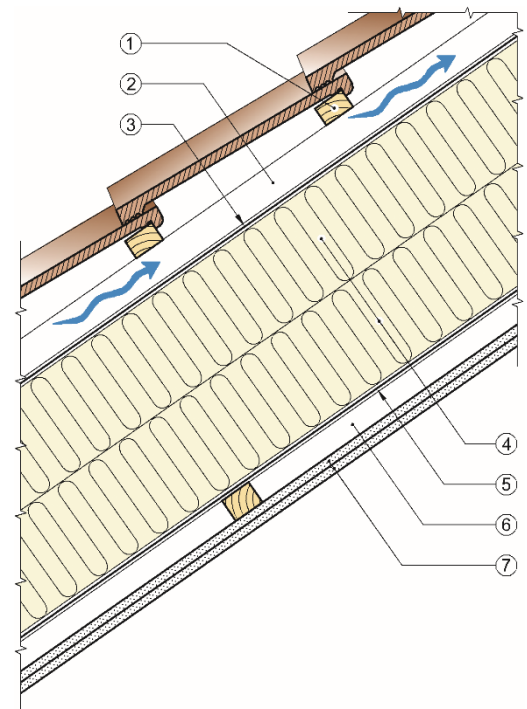
¹⁾ Insulation with a thermal conductivity of $\lambda_D = 0,035$ W/mK



Section perpendicular to the joists

1	22 mm Kronospan OSB3/ECO	4	25 x 50 mm battens
2	220 mm insulation	5	2 x 12,5 mm Gyproc NORMAL (GN 13)
3	45 x 220 mm joists		

Fig. 5
Principle build-up of floor construction of prefabricated elements



Section parallel to rafters

1	Roofing and battens	5	Vapour barrier
2	45 x 45 mm counter battens	6	30 mm battens
3	Combined subroofing and wind barrier	7	2 x 12,5 mm Gyproc NORMAL (GN 13)
4	290 – 340 mm insulation Rafters in c-c 600, 400, 300 mm		

Fig. 6
Principle build-up of roof construction of prefabricated elements

5. Environmental aspects

Substances hazardous to health and environment

Gokstad Hus building system contains 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.

Effect on indoor environment

Gokstad Hus building system is 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.

Effect on soil, surface water and ground water

External wooden cladding is not tested regarding leaching to soil or water. The leaching properties of the other products are evaluated to have no negative effects on soil or ground water.

Waste treatment/recycling

Gokstad Hus building system shall be sorted as timber, metal, gypsum, residual waste and other eventual relevant waste fractions on the building/demolition site. The product shall be delivered to an authorized waste treatment plant for material recovery, energy recovery or depositing.

Environmental declaration

An environmental declaration (EPD) has not been worked out for the product.

6. Special conditions for use and installation*6.1 Design requirements in general*

The production and delivery of each building element shall be based on a structural design, fire resistance, sound insulation and thermal insulation required for the relevant building. The calculations shall be available before production and deliverance of the building elements.

6.2 Structural design considerations

Load bearing components in the elements shall be considered according NS-EN 1995-1-1 with related Norwegian national annex NA for each project and delivery. Loads shall be assessed according NS-EN 1991-1 with related Norwegian national annex NA.

The structural design of the building elements shall include vertical and horizontal capacity, anchoring to the foundations, wind anchoring of the roof structure, capacity of beams over door and window openings and structural connections between building elements.

Floors shall be designed according to the stiffness requirements given in SINTEF Building Research detail 522.351 *Trebjelkelag. Dimensjoner og utførelse.*

6.2 Design considerations for safety in case of fire

For each specific project or delivery the fire resistance has to be checked according to TEK (technical requirements for building works). Elements which will have a load bearing and a fire separation property must be considered regarding the design loads for ultimate limit state in case of fire. Fire resistance will be specifying the build-up of the construction.

Apartment limiting walls must have separated load bearing for each apartment. The need for fire resistance from the outside for External walls and roofs must be considered in each specific project.

6.3 Design considerations for penetrations

Penetrations in the elements with declared fire resistance and details to other building components have to be performed that they do not undermining fire resistance of the element. See also in SINTEF Building and Infrastructure's detail directive 520.342 *Branntetting av gjennomføringer.*

For example, there is to be used cables, conduits, electrical boxes, cable duct with documented fire resistances in case for need of an electrical connection point in the element with declared fire resistance.

6.4 Design considerations for thermal insulation

For each building element delivery, the required maximum thermal resistance and transmittance for the external building parts shall be determined, and the thermal performance of the building elements to be designed in order to fulfil these requirements.

In cases where U-values for building elements are higher than required in TEK, the calculations of heat loss and buildings energy needs shall be performed for the complete building structure.

6.5 Installation

Elements shall be assembled according "*Standard konstruksjonsdetaljer for Gokstad Hus tilhørende SINTEF Teknisk Godkjenning nr. 20436*" and project specific assembling details for each specific building.

6.6 Transport and storage

The elements shall be protected for precipitation exposure during transport and storage. To avoid unwanted deformation and exposure from water underneath the elements have to be stored on a stable substructure with ventilation gaps simulating a flat and dry area.

7. Factory production control

The product is produced by SIA Gokstad Hus, Mazas skolas 2-1, 1050 Riga, Latvia.

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

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

SIA Gokstad Hus has a quality system certificated by Det Norske Veritas GL according EN 9001. Certificate No. 201095-2016-AQ-LVA-FINAS.

8. Basis for the approval

The approval is based on evaluations of the element system, the construction details and relevant documentation for specified materials and components as well as construction properties specified according following references:

- Standard konstruksjonsdetaljer for Gokstad Hus byggesystem tilhørende SINTEF Teknisk Godkjenning nr. 20436
- SINTEF Byggforsk Note, dated 07.06.2017, Calculation of U-Values

9. Marking

For each delivery of elements shall follow as minimum a delivery note with information about producer's name and address, project identification and relevant assembling information for the specific building. Construction details should be equivalent to the details in "*Standard konstruksjonsdetaljer for Gokstad Hus Byggesystem tilhørende SINTEF Teknisk Godkjenning nr. 20436*". The approval mark for SINTEF Technical Approval No. 20436 may also be used.



Approval mark

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 Byggforsk

Hans Boye Skogstad
Approval manager