SINTEF Technical Approval

TG 20462

Issued first time: 05.01.2016
Revises: 22.03.2021
Amended: 20.09.2024
Valid until 01.02.2027
Provided listed on
www.sintefcertification.no

SINTEF confirms that

SigmaSlab®

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

CCL Engineering Norway AS
Postboks 9163
6023 Ålesund
www.cclnorway.no

2. Product description

SigmaSlab® is a concept for in-situ cast concrete slabs supported by columns and/or walls and beams. The main reinforcement is post-tensioned unbonded tendons. SigmaSlab® differentiates from ordinary concrete slabs because steel fibre reinforcement partly replaces the non-tensioned reinforcement required by NS-EN 1992-1-1. The punching shear resistance of fibre reinforced concrete in SigmaSlab® is calculated as additional contribution to the shear resistance from PT tendons, concrete and possible shear reinforcement. The fibre reinforced concrete is calculated as an integrated part of the total flexural strength of the slab.

This approval includes the design principle for SigmaSlab® with a detailed calculation basis for design in all limit states.

The approval does not cover the components in the concrete slab. Each component should be specified for every building project and are presumed to meet the provisions regarding product documentation given in the regulation related to the marketing of products for construction works (DOK), and shall be CE-marked where it is required according to the regulation.

3. Fields of application

SigmaSlab® can be used as elevated or as ground supported concrete slabs in buildings within Consequences Class CC1 or CC2 relating to Reliability Class RC1 or RC2 in accordance with NS-EN 1990.

4. Properties

4.1 Load-carrying capacity

The load-carrying capacity of SigmaSlab® will correspond to a post-tensioned concrete slab with traditional reinforcement without steel fibres.

4.2 Fire resistance

SigmaSlab® has a fire resistance capacity corresponding to concrete slabs with traditional reinforcement.

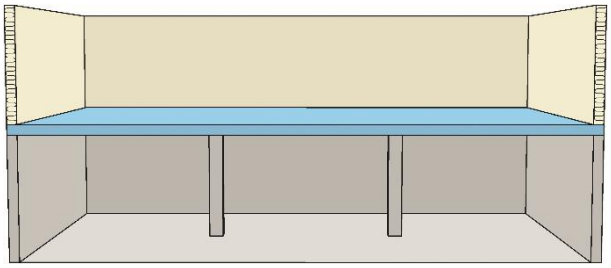

Fig. 1
Example of field of application for SigmaSlab®

Required slab thickness and concrete cover of the PT tendons and reinforcement shall be calculated in accordance with NS-EN 1992-1-1 in each case, depending on required fire resistance class. The steel fibres within the cover zone on the exposed side should not be included in the load carrying capacity in case of fire exposure.

Incidentally the capacity of SigmaSlab® in the fire limit state is documented in accordance with SINTEF report No. 2018:00165: *"TG 20462 - Retningslinjer for prosjektering."*

4.3 Sound insulation

SigmaSlab® has soundproofing properties corresponding to traditional massive concrete slabs.

Values for air sound insulation and step sound level can be found in Byggforskserien 522.513 *Sound insulation heavy floor separators*.

4.4 Thermal insulation

The U-factor for SigmaSlab® is the same as for concrete slabs with traditional reinforcement.

4.5 Durability

SigmaSlab® is suitable for use in exposure classes X0, XC1-XC4 and XD1-XD3 according to NS-EN 1992-1-1 and NS-EN 206.

For exposure classes XD1-XD3 the steel fibres' contribution in the outer 10 mm of the exposed side should not be included in the calculations in serviceability and ultimate limit states.

SigmaSlab® shall not be used where chlorides from seawater may appear.

5. Environmental aspects

The environmental aspects of each component in the SigmaSlab® are not considered. It is assumed that substances hazardous to health and environment and their effect on the indoor environment are documented for each component and each material used for construction of the SigmaSlab®.

6. Special conditions for use and installation

6.1 Design considerations

CCL Engineering Norway AS is responsible for the design of SigmaSlab®.

Reliability requirements according to NS-EN 1990:2002 shall be documented in each case according to NS-EN 1992-1-1 and SINTEF report No. 2018:00165: *"TG 20462 - Retningslinjer for prosjektering."*

For use in buildings within Reliability class RC2, sufficient moment capacity without fibre contribution should be documented when the load and material factors are set equal to 1.0.

6.2 Manufacturing of concrete

Concrete with steel fibres shall be manufactured according to NS-EN 206 and additional control requirements given in SINTEF report No. 2018:00165: *"TG 20462 - Retningslinjer for prosjektering."* Fibre reinforced concrete used in all SigmaSlab® is pre-documented by initial testing and determination of the characteristic residual tensile strength, $f_{ftk,res,2.5}$, in accordance with SINTEF report No. 2018: 00165, based on measured bending tensile strength in accordance with NS-EN 14651. The fibre reinforced concrete used in SigmaSlab® can be self-compacting.

6.3 Reinforcement

The main load carrying system consists of post-tensioned tendons. The cables are placed concentrated in one direction and evenly distributed in the other direction, see Fig. 2.

The distance between the uniformly distributing tendons must be designed and executed in accordance with SINTEF report No. 2018:00165: *"TG 20462 - Retningslinjer for prosjektering".*

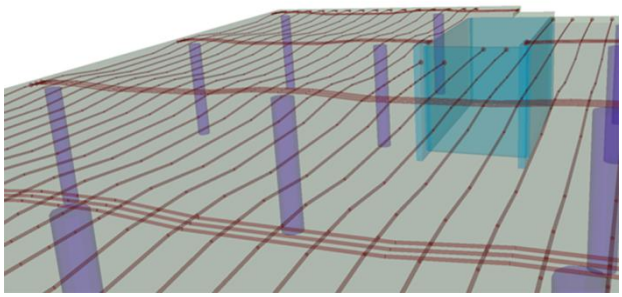

Fig. 2
Typical layout for post-tensioned reinforcement

If sufficient capacity is documented in all limit states, the reinforcement can be omitted, except for:

- Robustness reinforcement in the lower part of the slab above internal columns
- Minimum reinforcement in the upper part of the slab above columns
- Splitting strength reinforcement in areas where multiple tendons are anchored
- Reinforcement through casting joints

6.4 Execution and casting

Independent of current Consequence- and Reliability Class, the inspection of execution for SigmaSlab® shall be according to Execution Class 3 in NS-EN 13670.

The diameter of the pipeline shall be at the least 1.5 times the length of the fibres if the concrete is cast by pumping.

A fibre distribution and orientation in accordance with the design calculations shall be aimed for. Fibre-balling can be avoided by pumping through a grid.

Special considerations should be taken with respect to possible weak zones with uneven fibre distribution in structural elements due to changes in cross section areas, tendon groups, plastic tubes or other installations.

Concrete delivery and casting should be planned to avoid unintended casting joints which may create weak zones.

7. Factory production control

CCL Engineering Norway AS is responsible for the design and conditions for the control of fibre reinforced concrete production and construction to ensure that SigmaSlab® is manufactured in accordance with the conditions on which the approval is based.

SINTEF carries out random checks on design, fibre reinforced concrete production and execution of SigmaSlab® in accordance with the contract regarding SINTEF Technical Approval.

8. Basis for the approval

The evaluation of *"the product"* is based on reports owned by the holder of the approval.

9. Marking

The approval mark for SINTEF Technical Approval TG 20462 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

Hans Boye Skogstad
Approval Manager