

Strength and stability of structures

Basis of structural design for load-bearing structures



Ympäristöministeriö
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Foreword

From 1 January 2017 onward, the Ministry of the Environment publishes in the National Building Code of Finland the recommendations for strength and stability related to the basis of structural design for load-bearing structures. The instruction also includes the provisions concerning the basis of structural design from the Land Use and Building Act and the Decree of the Ministry of the Environment on Load-bearing Structures (477/2014).

The National Annex to the instruction also includes the provisions from the Decree of the Ministry of the Environment (3/16) concerning the national choices regarding the basis of structural design when applying standard SFS-EN 1990, and the recommendations related to the use of the Eurocode. The beginning of the annex presents those clauses in the standard where national choice is permitted, and where such a choice has been made.

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1. Legal basis

Land Use and Building Act ([21.12.2012/958](#))
Section 117(2), Requirements concerning construction

A building must be designed, constructed, altered and repaired, and its intended use changed, in a manner where the building meets the integral technical requirements set forth in sections 117 a–117 g, while taking into account the generally anticipated actions and the intended use and occupancy of the building.

Land Use and Building Act ([21.12.2012/958](#))
Section 117 a, Strength and stability of structures

A party engaging in a building project shall ensure that the building is designed and constructed in a manner where its structures are strong and stable, suitable for the conditions at the construction site and able to last for the planned service life of the building. The design and dimensioning of load-bearing structures shall be based on the rules of structural mechanics and a generally accepted basis of design, or reliable test results or other available information. Building products that are suitable in terms of structural strength and stability shall be used in the construction of the buildings.

The building shall be designed and constructed in a manner where the actions it is subjected to during construction and use will not cause it to collapse, create deformations that affect strength or stability, or damage the other parts of the building or the equipment or permanent fittings. Furthermore, the building shall be designed and constructed in a manner where any damage caused to the structures by an external contributor is not disproportionately large when compared to the event that caused it.

A decree of the Ministry of the Environment may be used to issue more detailed provisions for the construction of a new building, repair and alteration of an existing building or a change in the intended use and occupancy of the building, as regards:

- 1) the strength and stability required from the structures;
- 2) the design and dimensioning of the load-bearing structures;
- 3) the actions during construction and use;
- 4) the building products used for load-bearing structures.

Land Use and Building Act ([21.12.2012/958](#))

Section 117 a, Fire safety

A party engaging in a building project shall ensure that the building is designed and constructed in a manner that makes the intended use and occupancy of the building safe in terms of fire protection. The risk of fire shall be limited. The load-bearing structures in the building shall be such that, in the case of fire, they can last for a specific minimum time, taking into account the collapse of the building, ensuring safe exit, rescue activities and gaining control of the fire. It shall be possible to limit the development and spreading of fire and smoke within the building and the dispersion of the fire into the nearby buildings. Building products and technical equipment that are suitable in terms of fire safety shall be used in the construction of the building.

The building shall be such that the persons inside it can rescue themselves or be rescued in case of fire. The safety of the rescue personnel shall be taken into account in the construction. If the location is particularly demanding in terms of exit safety, the licensing authority may require the preparation of a safety analysis report.

A decree of the Ministry of the Environment may be used to provide detailed provision concerning the construction of a new building, repair and alteration of an existing building

or a change in the intended use and occupancy of the building, as regards:

- 1) the prevention of the starting and spreading of fire, and the fire safety of the building technology and the equipment used for heating;
- 2) the load-bearing capacity of the structures during a fire and the related characteristics of construction products;
- 3) the limiting of the creation and dispersion of fire and smoke and the characteristics of construction products and equipment related to it;
- 4) exit safety and the safety analysis report;
- 5) the arrangements for firefighting and rescue tasks.

Land Use and Building Act ([21.12.2012/958](#))

Section 117 d, Operational safety

A party engaging in a building project shall ensure that the building is designed and constructed in a manner that is commensurate with its intended use and that ensures its safe operation and maintenance. The building or its exterior spaces and access routes may not cause a risk of accident that cannot be considered acceptable.

A decree of the Ministry of the Environment may be used to issue more detailed provisions for the construction of a new building, repair and alteration of an existing building or a change in the intended use and occupancy of the building, as regards the operational safety expected from the building.

2. Design of load-bearing structures

2.1 Scope

Decree of the Ministry of the Environment on Load-bearing Structures (477/2014)

Section 1 Scope of application

This Decree applies to the design and execution of load-bearing structures and bracing systems, to the repair and alteration of structures, and to the design and execution of the strengthening of structures. This Decree also applies to the design and execution of constructions and supplementary structures that are important for the users' safety, and to their repair and alteration, if damage to these structures might pose a danger to personal safety.

Instruction

In accordance with the Land Use and Building Act (Section 113), a 'building' is a construction, structure or installation which is fixed or intended to remain in one place, and which is intended for living, working, storage or some other use, and which, because of its attributes, requires supervision by the authorities for reasons of safety, health, the landscape, comfort and pleasantness, the environment or other reasons related to the objectives of this Act.

However, lightweight structures of minor size or smallish installations shall not be considered buildings unless they have special impact on land use or the environment. Structures significant in terms of operational safety, as referred to in the decree, are structures whose operation or maintenance involves a risk of accident or damage that cannot be considered acceptable. Such structures may include special structures, such as towers and, for example, guard rails, stairs, ladders, maintenance platforms, suspended ceilings, supporting structures for machinery and equipment and other similar structures, including non-loadbearing separating walls and facade, window and door structures.

2.2 Strength and stability of structures

Decree of the Ministry of the Environment on Load-bearing Structures (477/2014)

Section 2 Strength and stability of structures

A party engaging in a building project shall ensure that structures are designed and executed in such a way that the structures maintain sufficient strength and stability for the duration of their planned service life. During its use, the structure shall be sufficiently stable for its intended use and location with regard to harmful deformations, cracking, vibration, deflection and other harmful effects.

Instruction

When demonstrating the reliability of a structure, the influence of actions and environmental conditions on a structure is assessed by applying the rules of structural mechanics, the calculation basis referred to in this Decree and other methods for demonstrating qualification, or by relying on reliable test results or other available information. At this point, account will be taken of any holes, notches and other similar impairments in the structure, the effects of work precision and the manufacturing method, and the changing of strength and deformation properties during the intended life of the structure.

Holes and notches may only be created in the structures according to the structural designer's instructions.

The reliability of the structure during execution shall be at least equal to its reliability during operation. If necessary, both short-term and long-term design situations shall be analysed. The reliability during execution is determined by using structures that are subjected to execution-time actions and that have been braced and supported according to the structural plan.

2.3 Design and execution of load-bearing structures and bracing systems

Decree of the Ministry of the Environment on Load-bearing Structures (477/2014)

Section 3 Design and execution of load-bearing structures and bracing systems

The essential technical requirements for load-bearing structures and bracing are met if these are designed and executed in accordance with the Eurocodes and the relevant national choices issued as Ministry of the Environment decrees. In addition, the structural designer shall take into consideration the construction site conditions.

If design and execution systems other than those specified in subsection 1 are applied, the party engaging in a building project shall demonstrate to the building control authority, if so required by the authority, that the design and execution fulfil the essential technical requirements regarding the strength and stability of the structures, serviceability and service life.

Only one unified design and execution system may be used for new structures that function as one structural unit.

Instruction

The Eurocodes and national choices present the minimum values for structural loads that must be followed during the design. However, it is possible that, for natural loads, local special conditions may lead to higher load values and/or a different load distribution than the one presented in the Eurocodes or the national choices. In these cases, a value of action

that is sufficient with regard to the conditions shall be used in the design. Such cases include, for example, conditions that create exceptional snow loads, such as the exceptional distribution of snow loads due to flow conditions and/or the shape of the structures.

The building control authority may approve the use of a different design system on a per-case basis, assuming that the level of reliability of the design system in question is approximately the same as the level of reliability achieved with a structure designed according to the Eurocodes and their relevant national choices.

The starting point for a harmonised design and execution system is to ensure the reliability of structures and to prevent the risks related to the operation of structures resulting from the mixing of different systems. The reliability of a structure that operates as a single entity is based on the strength and stability of the entire structure. Structures that operate as a single entity include, for example, the foundations and load-bearing frame of a building.

2.4 Consequences of failure

Decree of the Ministry of the Environment on Load-bearing Structures (477/2014)

Section 4 Seriousness of consequences

The susceptibility of the building or structure to risk and any expected consequences of potential damage or defect shall be taken into consideration in the design and execution of structures.

Consequences are deemed severe if the potential damage or defect in a structure could cause significant personal injury or have extensive effects on society. Extremely demanding structures, specified in section 150d of the Land Use and Building Act (132/1999), and exceptionally demanding structures, specified in section 120d of the Act, are included in the severe consequences class. The terms 'extremely demanding structures' and 'exceptionally demanding structures' can be considered to refer to structures in relation to which the requirement for an exceptionally in-depth knowledge of the related theoretical principles and design methods is emphasised, and to innovative structures with regard to which no prior design experience is available. Consequences are medium if they are neither severe nor low. These are demanding structures where the design and dimensioning require good knowledge of the related theoretical principles. Consequences are low if the repercussions attributable to the potential damage or defect in a structure with regard to personal injury, or effects on society, are small or negligible.

In cases where the building or structures consist of structurally independent parts, the seriousness of consequences for each part may be determined separately.

Instruction

The seriousness of consequences and the difficulty of the design tasks are affected by several factors, such as the size and intended use of the building, the site and its immediate surroundings and the proportions and characteristics of the structures. Therefore, the seriousness of the consequences and the difficulty of the design task shall be assessed on a per-case basis. For example, the design of a sports hall and a storage hall may be difficult;

however, the consequences may be severe in the case of a sports hall but medium in the case of a storage hall. The difficulty classes of the design tasks are presented in the Ministry of the Environment's guidelines on the difficulty classes of design tasks, YM1/601/2015.

The consequences are considered to be severe in the following cases, for example:

- a) The load-bearing system with its bracing parts in buildings which are often occupied by a large number of people, such as
 - residential buildings, office buildings and commercial buildings with more than 8 storeys, including a possible basement
 - concert halls, theatres, sports and exhibitions halls and spectator stands
 - heavily loaded buildings or buildings with long spans.

However, small floors that are separate from the main frame are in the medium consequence class if they do not form a part of the stiffening system of the whole structure.

- b) Special structures, such as high towers.
- c) Ramps as well as embankments and other structures that are located in environments sensitive to adverse effects of displacements, especially in areas of fine-grained soils.
- d) Masts and chimneys located in strategic areas, such as industrial areas, power plant sites or densely populated areas. Significant masts or chimneys on located in industrial areas, where the economic and social consequences of failure would be very significant.
- e) Silos and tanks when:
 - they are located in urban areas or densely populated areas and have a capacity of more than 5,000 tonnes.
 - their capacity exceeds 100 tonnes and the temperature of the contents exceeds 65°C.
 - they contain toxic or explosive liquid or liquefied gas.

Consequences are considered to be medium when they are neither severe nor low.

The consequences are considered to be minor in the following cases, for example:

- a) Buildings with 1 or 2 storeys where people are only residing temporarily, such as small warehouses and agricultural production buildings with a maximum floor area of 300 m² or a maximum span of 6 metres. The possible basement is included in the

number of storeys. Visiting the building daily is considered temporary staying, but not staying for a longer time.

- b) Structures which, when damaged, do not pose a major risk, such as
 - low terraces and basement floors without cellar rooms
 - roofs with crawlspaces, when the load-bearing structure is the floor below
- c) walls, windows, doors and other similar structures, which are mainly loaded horizontally by air pressure difference and which do not have a load-bearing or stabilising function in the load-bearing system.
- d) Masts and conventional chimneys which, when damaged, are not likely to cause human injuries.
- e) Silos and tanks which have a capacity of ≤ 100 tonnes and which, when damaged, are not likely to cause human injuries.

As regards Eurocodes, the consequences classification is presented in the national choices for standard SFS-EN 1990, which concerns the basis of structural design. The national annex of the standard in question also presents the consequences classification for special structures, such as masts, chimneys, silos and tanks. A building or structure in a specific consequences class may contain structures that belong to different consequences classes; in this case, for example, the consequences class of the entire building may be different from an individual structural member.

In the Eurocodes, the consequences of damage to a structure are taken into account by means of consequences classes in a manner where the partial factors of unfavourable actions are multiplied by the load factor KFI pursuant to standard SFS-EN 1990. In the severe consequences class CC3, therefore, the partial factor for actions is 10% higher, and in the minor consequences class CC1, it is 10% lower than in the medium class CC2. A similar practice may be applied when using other design systems.

As the consequences and susceptibility to risk of a structure increase, the demands for the execution of the structures are made stricter.

2.5 Structural design plans

Decree of the Ministry of the Environment on Load-bearing Structures (477/2014)

Section 5 Structural design plans

The structural design plans shall show, as applicable to the design task, the following:

- 1) models describing the structural function and the bracing of the structural system;
- 2) the seriousness of consequences, requirements for execution or execution class, class describing the stress on the environment and, where applicable, the tolerance class;
- 3) loading and combinations of loads;
- 4) force variables;
- 5) requirements for construction product properties;
- 6) ultimate limit state and serviceability limit state design, and the appropriate accident design verification and fire design;
- 7) dimensions of structures and functional parts of structures, dimensions of fastenings and joints and the weight and centre of gravity of elements to be lifted;
- 8) durability and service life verification;
- 9) bracing and stability design for the duration of the execution and the finished structure;
- 10) structures to be restored and demolished during repair and alteration work;
- 11) data affecting the use and maintenance of new and restored structures.

The execution class referred to above in subsection 1(2) is a set of classes of itemised execution requirements that may apply to the entire construction project or a specific detail.

Instruction

In general, the structural plans should present the matters in this list. For small or limited projects, presenting all the information in the list is not necessary; in this case, the structural plans present the matters within a scope applicable with the design task.

The severity of consequences has been described by means of example structures in the rationale for section 4. As regards Eurocodes, similar levels are presented as consequences classes in the Ministry of Environment's Decree concerning national choices for the basis of structural Design, when applying standard SFS-EN 1990.

The requirements concerning execution are presented in the plans. The requirements may be presented by means of the execution classes for execution standards used with the Eurocodes, the classes describing exposure caused by environmental conditions and tolerance classes.

In the design, the design situations are selected in a manner that takes into account all limit states and scenarios that can be reasonably expected to occur during the execution and use of the structure. The duration of the design situations shall be taken into account in the analyses. The design of the structure may be performed on a calculated or experimental

basis or based on statistical analyses.

The plans present the critical locations in terms of structural strength and stability as regards the use and maintenance of the structure and provide instructions on how and how often their condition should be monitored in order to ensure that the structures operate according to plan.

2.6 Execution documents for structures

Decree of the Ministry of the Environment on Load-bearing Structures (477/2014)

Section 6 Execution documents for structures

The structural designer shall prepare the execution documents containing the technical specifications and requirements needed for the execution of the structures before the execution of the structure in concern is started. The execution documents include the calculations, drawings, work specification, a structural condition assessment and any other reports that may be required. If Eurocodes are applied in the design and execution process, the execution specification is considered to be an execution document. When verification of the performance of the structure in accordance with structural plans requires inspections at certain intervals during the service life of the structure, the inspection locations and intervals shall be indicated in the plans and in the usage and maintenance instructions.

Instruction

The execution documents contain all the information and requirements that are needed for executing the structure. The construction stage cannot be started before the execution documents concerning it are ready. The scope and contents of the execution documents essentially depend on the nature of the construction works. As regards Eurocodes, the information and requirements needed for the execution of the structures are collected in the execution specification. The Eurocode execution standards provide instructions concerning the contents of the execution specification.

When verification of the performance of the structure in accordance with structural plans requires periodic in-service inspections, the designer shall present the locations to be inspected and the inspection intervals in the structural plans, and ensure that the information is transferred to the usage and maintenance instructions.

2.7 Inspection plan for structural designs

Decree of the Ministry of the Environment on Load-bearing Structures (477/2014)

Section 7 Inspection plan for structural designs

The structural designer shall ensure the quality control of structural designs so that the structural plans are inspected before they are submitted to the building control authority. The quality control of the plans focuses on the calculations, drawings and text documents prepared by the structural designer, and on other design data provided by the structural designer.

The scope of the inspection plan for structural designs is determined on the basis of the consequences for the building or a specific structural member, and on how demanding the design task is. In order to ensure the quality of the plans, an inspection plan for structural designs must be drawn up describing the plan inspection procedure, persons responsible for the inspection and the relationship of these persons to the project organisation of the design project, if the potential consequences for a building or specific structural member are severe or medium.

For severe consequences or design tasks classified as exceptionally demanding or extremely demanding, quality control shall, in accordance with the procedures of the design organisation, be carried out by a third party or a person assigned exclusively to quality control in the project and who has the qualifications for the competence class of the design task. For medium consequences or design tasks classified as demanding, quality control shall be carried out by a person who has the qualifications for the competence class of the design task.

Instruction

The quality assurance for the plans is linked to the severity of the consequences in a manner where a higher severity class also requires more comprehensive quality assurance for the structural plans. If the authority requires a quality assurance report pursuant to section 121 a of the Land Use and Building Act, the inspection plan for the structural plans is appended to the quality assurance report.

When the consequences are minor or the requirements of the design task are conventional, the designer may inspect the plans personally.

2.8 Design working life

Decree of the Ministry of the Environment on Load-bearing Structures (477/2014)
Section 8 Planned service life

The structural designer shall define the planned service life of the structure, i.e. the period during which the structure or structural member is expected to be used for the planned purpose with the anticipated maintenance measures, and the stress categories representing exposure to environmental conditions.

A party engaged in a building project shall ensure that a structure is designed and executed so that the required properties laid down in the plans for the structure and for the building materials used are maintained throughout the entire planned service life.

Instruction

For conventional buildings, the planned service life of the structure may be considered to be not less than 50 years; for significant valuable structures, the service life shall be not less than 100 years. Temporary structures and parts thereof that may be disassembled and reused for the same purpose shall be designed for a service life of not less than 50 years. In the interest of durability, foundations and other structural members that are hard to replace should be designed for a longer service life than the rest of the structure.

The remaining service life for structures that will be preserved during repair or alteration work is based on a condition survey of the structures.

The durability of the structure is ensured already at the execution stage by protecting the structures against weather effects to the necessary degree.

Normally, the characteristic values of actions are specified as values that correspond to a return period of 50 years.

Unless more detailed analyses are provided, the characteristic value of loads caused by the climate may be seen to depend on the planned service life in a manner where, if the planned service life exceeds 50 years, the characteristic values of actions are increased by 10%, and if the planned service life exceeds 100 years, the characteristic values of actions are increased by 20%. Loads caused by the climate include snow, wind and ice loads and loads caused by temperature variation. The characteristic values of imposed loads are generally considered to be independent of the planned service life.

2.9 Work plan for the execution of structures

Decree of the Ministry of the Environment on Load-bearing Structures (477/2014)

Section 9 Work plan for the execution of structures

A party engaged in a building project shall ensure that a work plan for the execution of structures is drawn up and that the work plan contains sufficient data for the execution.

When the potential consequences of a defect or damage in a building or structure are severe or medium, a quality control plan shall be prepared for the building as part of the work plan for the execution of the structure. This plan shall contain an assessment of the executing party's competence and resources in terms of the requirements that have been set, a description of the executing party's project organisation and its responsible persons, the principles of the inspection and responsibilities, and a plan for the quality control measures and records.

Instruction

The constructor shall also create an execution quality plan if the execution document presents a requirement concerning such.

The execution quality plan is a building project quality control document that includes an assessment of the constructor's capabilities to complete the construction project, a description of the execution organisation and its responsible persons, the principles of inspection with the related responsibilities and a plan of the quality control activities and records.

In small construction works, the quality plan may, with permission from the building control authority, be replaced by an existing construction inspection document; a separate, written quality plan is not required for such sites.

2.10 Load-bearing capacity of structures in repair and alteration work and for changes in the intended use

Decree of the Ministry of the Environment on Load-bearing Structures (477/2014)

Section 10 Load-bearing capacity of structures in repair and alteration work and for changes in the intended use

In the planning and execution of building repair and alteration work and of changes in the intended use, the properties and conditions of a building and its structures shall be taken into account and, for special reasons, clarification of these shall be provided, and the possibility of an increase in loading on the structures shall be determined. For partial alteration of structures, it shall be ensured that the alterations to the structural system do not affect the fulfilment of requirements, in accordance with section 4 of this Decree.

When the repair and alteration work in buildings or changes in the intended use do not cause an increase in the loading on structures, but the condition of the structures is such that the strengthening of them is required, the regulations valid at the time of the construction of the building and the best building practices in effect at that time may be applied.

When the repair and alteration work in buildings or changes in the intended use do cause an increase in the loading on structures, sections 2 to 5 of this Decree shall apply in the design and execution of load-bearing structures with regard to new structures and structures to be strengthened.

Instruction

The repair or alteration work of a building requires special knowledge of the materials, working methods and structures used in the construction. A special reason may be the poor condition of the structures that necessitates their repair even if the loading of the structures is not increased. In particular, the condition of the structures shall be analysed to the necessary extent if the alteration or change of intended use causes the loading of the structures to increase when compared to the situation before the work in question. The report shall also concern the foundation structures to the extent required by the repair or alteration work.

A special reason due to which the characteristics and condition of the building and its structures must be analysed may also be that the building is significant in terms of cultural history, a protected building whose condition is not completely known. This is important in terms of the technical success of the renovation and the preservation of the building heritage.

2.11 Construction products

Decree of the Ministry of the Environment on Load-bearing Structures (477/2014)
Section 11 Construction products

The properties of construction products used shall meet the requirements presented in the respective design plans and the construction products shall be suitable for the construction site conditions.

The construction products selected shall enable the construction of the designed structure by following the execution documents and by applying the working methods according to the plans.

Construction products whose properties have remained unchanged regardless of their transfer, transport, storage or installation shall be used. A party engaged in a building project shall ensure that the suitability of the construction products is checked prior to the execution of their use.

Instruction

The conditions at the site refer to both the geological conditions and climate conditions of the site. The impacts are accounted for by selecting construction products that suit the site conditions and methods of working that are suitable for the execution, and by protecting the construction products during construction and use.

The conformity of the construction products can be assessed by using the declaration of performance related to the CE marking, type approval, verification certificate or certification of production quality control.

If necessary, the conformity of a construction product can be assessed by means of verification at the site. The declaration of performance related to the CE marking provides information concerning the characteristics of a product, but not the conformity of the product for the site in question. In addition to authority regulations and instructions, the conformity assessment can use the national application standards of the harmonised product standards (SFS 7000 series).

The radiation safety of construction products is regulated by the Radiation Act and the decrees issued on its basis.

2.12 Compliance of structures

Decree of the Ministry of the Environment on Load-bearing Structures (477/2014)
Section 12 Suitability of structures

A party engaged in a building project shall ensure that structures and construction products fulfil the requirements set on them.

Instruction

In case of unsatisfactory quality of structures, construction materials or products, the available quality control documentation is used to determine the occurrences and causes of unsatisfactory quality. On the basis of this analysis, a plan is drawn up concerning which actions are required in order to bring the structure or construction product to an acceptable state. The significance of dimensioning deviations in the completed structure or construction product can usually be determined by means of calculation. The resistance of a structure or construction product of unsatisfactory quality can also be determined by means of a test load.

Defective or damaged construction products or parts may only be used if they have been appropriately repaired or if the damage or defect is so minor that it will not negatively affect the ability of the structures to operate according to the plans. The repair activities for defects that impact the structural performance of the products are planned, and the plans and working instructions are approved by the responsible structural designer or, depending on the situation, by the responsible foundation designer before the repair is started and, if necessary, submitted to the building control authorities before the repair is started.

3. References

If the version of a reference has not been specified, the latest edition of the reference (with amendments) is applied.

SFS-EN 1990 Eurocode. Basis of structural design

National Annex to standard SFS-EN 1990

1. Scope

Ministry of the Environment Decree (3/16)
concerning national choices for the basis of structural design, when applying standard SFS-EN 1990
Section 1 Scope

This Decree is applied in the selection of the basis of structural design and is used in conjunction with the latest version of standard SFS-EN 1990.

Instruction

As regards standard SFS-EN 1990, the recommended values set forth in standard SFS-EN 1990 and all the annexes to standard SFS-EN 1990 are followed unless otherwise stated in this National Annex.

National choice concerning buildings is permitted in the following clauses of Standard SFS-EN 1990:

- A1.1(1)
- A1.2.1(1)
- A1.2.2 Table A1.1 Section 2 2
- A1.3.1(1) Table A1.2(A) Section 3
- A1.3.1(1) Table A1.2(B) Section 3
- A1.3.1(1) Table A1.2(C) Section 3
- A1.3.1(5) Section 3
- A1.3.2(1) Table A1.3 Section 4
- A1.4.2(2) Instruction in Section 4

A national choice has been made in the clauses marked •.

2. Combination factors for variable actions

Ministry of the Environment Decree (3/16)
concerning national choices for the basis of structural design, when applying standard SFS-EN 1990
2 Combination factors for variable actions

The combination value of a variable action s_k , the frequent value of a variable action s_{k1} , and/or the quasi-permanent value of a variable action s_{k2} for buildings where national choice is allowed in accordance with Annex A1, clause A.1.2.2, of the standard are:

- 1) Category C: congregation areas, the value of s_{k2} is 0.3 for the imposed load;*
- 2) Categories F and G: imposed loads on traffic areas, the value of s_{k2} is 0 for access ways;*
- 3) the value of s_{k1} is 0.4 for snow loads, if the characteristic value of snow loads on the ground is less than 2.75 kN/m². The value of the s_{k1} factor is 0.5, if the characteristic value of snow loads is at least 2.75 kN/m²;*
- 4) for outdoor terraces and balconies of residential, office, and traffic areas in Categories A, B, F and G, the combination value of the s_k factor is 0 for snow loads;*
- 5) when there are different categories of actions in a building that cannot clearly be separated into different groups, the values for the combination factors that give the most unfavourable effect should be used; and*
- 6) for ice loads due to frost, freezing rain and sleet, the value of the s_k factor is 0.7, the value of the s_{k1} factor is 0.3 and the value of the s_{k2} factor is 0.*

Instruction

Standard SFS-EN 1993-3-1 and its related national values are complied with as regards steel masts.

Values of coefficients ψ

A1.2.2(1)

The values of coefficients ψ for buildings are set forth in Table 1.

Table 1. Values of coefficients ψ for buildings

Load	ψ_0	ψ_1	ψ_2
Imposed loads in buildings, category (SFS-EN 1991-1-1)			
Category A: areas in domestic and residential buildings	0.7	0.5	0.3
Category B: office areas	0.7	0.5	0.3
Category C: congregation areas	0.7	0.7	0.3
Category D: shopping areas	0.7	0.7	0.6
Category E: storage areas	1.0	0.9	0.8
Category F: traffic areas, vehicle weight ≤ 30 kN	0.7	0.7	0.6 ^{**)}
Category F: traffic areas, vehicle weight $30 \text{ kN} < \text{vehicle weight} \leq 160$ kN	0.7	0.5	0.3 ^{**)}
Category H: roofs	0	0	0
Snow load (see EN 1991-1-3 ^{*)}), when			
$s_k < 2.75 \text{ kN/m}^2$	0.7	0.4	0.2
$s_k \geq 2.75 \text{ kN/m}^2$	0.7	0.5	0.2
Ice load ^{***)}	0.7	0.3	0
Wind loads on buildings (SFS-EN 1991-1-4)	0.6	0.2	0
Temperature (non-fire) in buildings (SFS-EN 1991-1-5)	0.6	0.5	0
^{*)} Outdoor terraces and balconies $\psi_0 = 0$ combined with categories A, B, F and G. Note: In case there are different categories of loads in one building that cannot clearly be separated into different sections, values for ψ giving the most unfavourable effect should be used. ^{**)} On access ways $\psi_2 = 0$ ^{***)} Applies to ice loads caused by frosting, freezing rain and sleet			

For structures other than buildings, the values for coefficients ψ are provided in connection with the Eurocodes concerning the structures in question.

Characteristic values of ice loads are given in ISO 12494:2001, among others.

3. Design values of actions in persistent and transient design situations

Ministry of the Environment Decree (3/16)
concerning national choices for the basis of structural design, when applying standard SFS-EN 1990
Section 3 Design values of actions in persistent and transient design situations

Static equilibrium of buildings shall be verified by using equation 6.10 for determining the design value of actions, in accordance with clause A1.3.1(3) of the Annex to the standard.

The resistance of structural members where geotechnical actions have no effect shall be verified by using equations 6.10a and 6.10b for determining the design value of actions, in accordance with clause A1.3.1(4) of the Annex to the standard.

For the design of structures that are affected by geotechnical actions and load-bearing capability of the soil, resistance shall be verified by using Design Approach 2 and equations 6.10a and 6.10b, in accordance with Annex A1, clause A1.3.1(5) of the standard. Design Approach 3 and equation 6.10 are used for the design procedures for slopes and overall stability.

One way of achieving reliability differentiation is by distinguishing classes of KFI factors to be used in fundamental combinations for persistent and transient design situations, in accordance with Annex B, clause B3.3(1) of the standard. This factor is not used in accidental situations or in fatigue or limit state verification. The KFI factor depends on the reliability class according to Annex B. Reliability classes RC1, RC2 and RC3 may be associated with the consequences classes CC1, CC2 and CC3.

Instruction

Design values of actions in persistent and transient design situations

A1.3.1(1)

Tables 2, 3 and 4 provide the values to be used in Finland for the symbols of Tables A1.2(A), A1.2(B) and A1.2(C) of SFS-EN 1990. The characteristic value is adopted as the design value for actions caused by constrained deformations and the settlement of supports. Standard SFS-EN 1993-3-1 and its national annex are complied with as regards steel masts.

Table 2. Design values of the actions (static balance) (Series A)

Persistent and transient design situations	Permanent actions		Leading variable action (*)	Accompanying variable actions (*)
	Unfavourable	Favourable		
(Eq. 6.10)	1.1 $K_{FI} G_{kj,sup}$	0.9 $G_{kj,inf}$	1.5 $K_{FI} Q_{k,1}$	1.5 $K_{FI} \psi_{0,i} Q_{k,i}$
(*) Variable actions are those considered in Table A.1.1.				

K_{FI} depends on the reliability class given in Table B2 of Annex B as follows:

In reliability class RC3 $K_{FI} = 1.1$

In reliability class RC2 $K_{FI} = 1.0$

In reliability class RC1 $K_{FI} = 0.9$

Table 3. Design values of the actions (durability of the structural members and geotechnical load-bearing capability)
(Set B)

Persistent and transient design situations	Permanent actions		Leading variable action (*)	Accompanying variable actions (*)
	Unfavourable	Favourable		
(Eq. 6.10a)	$1.35 K_{FI} Q_{kj,sup}$	$0.9 G_{kj,inf}$		
(Eq. 6.10b)	$1.15 K_{FI} Q_{kj,sup}$	$0.9 G_{kj,inf}$	$1.5 K_{FI} Q_{k,1}$	$1.5 K_{FI} \psi_{0,i} Q_{k,i}$
(*) Variable actions are those considered in Table A.1.1.				

Note 1. This can be expressed as a design formula in such a way that the most unfavourable of the two following expressions is used as a combination of loads when it should be noted that the latter expression only contains permanent loads:

$$\left\{ \begin{array}{l} 1,15 K_{FI} G_{kj,sup} + 0,9 G_{kj,inf} + 1,5 K_{FI} Q_{k,1} + 1,5 K_{FI} \sum_{i>1} \psi_{0,i} Q_{k,i} \\ 1,35 K_{FI} G_{kj,sup} + 0,9 G_{kj,inf} \end{array} \right.$$

Note 2. See also γ values of partial safety factors applied in forced movement or constrained deformation states in standards SFS-EN 1992 ... SFS-EN 1999.

Note 3. All characteristic values of permanent actions coming from one source are multiplied by the partial safety factor $\gamma_{G,sup}$, if the total action effect is unfavourable, and by the partial safety factor $\gamma_{G,inf}$, if the total action effect is favourable. For example, all actions originating from the self-weight of the structure may be considered as coming from one source; this also applies if different materials are involved.

Note 4. For particular verifications, the values for γ_G and γ_Q may be subdivided into γ_g and γ_q and the model uncertainty factor γ_{sd} . A value of $\gamma_{sd} = 1.05 \dots 1.15$ can be used in the most common cases.

Note 5. In respect of geotechnical design of foundations, see standard SFS-EN 1997-1 with its National Annex.

Table 4. Design values of the actions (strength of structural members and geotechnical resistance)
(Set C)

Persistent and transient design situations	Permanent actions		Leading variable action (*)	Accompanying variable actions (*)
	Unfavourable	Favourable		
(Eq. 6.10)	$1.0 K_{FI} Q_{kj,sup}$	$1.0 G_{kj,inf}$	$1.3 K_{FI} Q_{k,1}$	$1.3 K_{FI} \psi_{0,i} Q_{k,i}$
(*) Variable actions are those considered in Table A.1.1.				

A1.3.1(5)

Approach 2 is used in Finland. For verifications of stability of slopes and the total stability, Approach 3 is used.

Concerning geotechnical design of foundations, see also the national choices for standard SFS-EN 1997-1.

4. Design values of actions in the accidental and seismic design situations

Ministry of the Environment Decree (3/16)
concerning national choices for the basis of structural design, when applying standard SFS-EN 1990
Section 4 Design values of actions in the accidental and seismic design situations

Design values of accidental actions shall be determined with equations 6.11a/b, in accordance with Table A.1.3.2(1) of the standard. However, when the main variable action is something other than snow, ice or wind action, the quasi-permanent value of a variable action $\psi_{2,1}$ is used. When the main variable action is snow, ice or wind action, the value of the combination factor shall be taken as the frequent value of a variable action $\psi_{1,1}$.

The design values for seismic combinations of actions shall be determined with equations 6.12a/b. The seismic design situation may only be used when specified by the client.

Instruction

Design values of actions in accidental and seismic design situations

A1.3.2(1)

Table 5 provides the values used in Finland for the symbols of Table A1.3 of SFS-EN 1990. The characteristic value is adopted as the design value for actions caused by constrained deformations and the settlement of supports.

Table 5. Design values of actions for use in accidental and seismic combinations of actions

Design situation	Permanent actions		Leading accidental or seismic action	Accompanying variable actions (*)	
	Unfavourable	Favourable		Main (if any)	Others
Accidental (Eq. 6.11a/b)	$G_{kj,sup}$	$G_{kj,inf}$	A_d	$\psi_{1,1} Q_{k,1}$ (**)	$\psi_{2,i} Q_{k,i}$
Seismic (***) (Eq. 6.12a/b)	$G_{kj,sup}$	$G_{kj,inf}$	γA_{Ek} or A_{Ed}	$\psi_{2,i} Q_{k,i}$	

(*) Variable actions are those considered in Table A.1.1.
(**) However, when the main action is other than snow, ice or wind action, the value $\psi_{2,1}$ is used.
(***) The seismic design situation should only be used when specified by the client. See also standard SFS-EN 1998-1.

Serviceability criteria

A1.4.2(2)

The serviceability criteria are presented in the Eurocodes concerning the material in question.

5. Management of structural reliability for construction works

Ministry of the Environment Decree (3/16)
concerning national choices for the basis of structural design, when applying standard SFS-EN 1990
Section 5 Management of structural reliability for construction works

The consequences class procedure and the K_{FI} factors given in Table B3 of the standard are applied to the management of structural reliability. K_{FI} factors cannot be improved by additional quality control or other means.

6. Consequences classes for buildings and structures

Ministry of the Environment Decree (3/16)
concerning national choices for the basis of structural design, when applying standard SFS-EN 1990
Section 6 Consequences classes for buildings and structures

Buildings and structures shall be classified to consequence classes CC1, CC2 and CC3 by considering the consequences of failure or malfunction of the structure.

Consequence class CC3 comprises buildings and structures with a high consequence for loss of human life or the economic, social or environmental consequences are very great.

Consequence class CC2 comprises buildings and structures with a medium consequence for loss of human life or the economic, social or environmental consequences are considerable. This class includes buildings and structures not included in classes CC3 or CC1.

Consequence class CC1 comprises buildings and structures with a low consequence for loss of human life or the economic, social or environmental consequences are small or negligible.

Instruction

Consequences classes

B3.1(1)

Consequences classes are presented in tables 6a, 6b and 6c.

Table 6a. Determination of consequences classes for buildings and structures

Consequences Class	Description	Examples of buildings and civil engineering works
CC3	High consequences due to loss of human life <i>or</i> very large economic, social or environmental consequences	The load-bearing system ¹⁾ with its bracing parts in buildings which are often occupied by a large number of people, such as - residential, office and business buildings with more than 8 storeys ²⁾ - concert halls, theatres, sports and exhibitions halls and spectator galleries - heavily loaded buildings or buildings with long spans. Special structures, such as high towers. Ramps as well as embankments and other structures that are located in environments sensitive to adverse effects of displacements, especially in areas of fine-grained soils.
CC2	Medium consequences due to loss of human life <i>or</i> considerable economic, social or environmental consequences	Buildings and structures not belonging to classes CC3 or CC1.
CC1	Low consequences due to loss of human life <i>or</i> small <i>or</i> negligible economic, social or environmental consequences	Buildings with 1 or 2 storeys ²⁾ where people are only staying temporarily ³⁾ , such as small warehouses and agricultural production buildings with a maximum floor area of 300 m ² or a maximum span of 6 metres. Structures which, when damaged, do not pose a major risk, such as - low terraces and basement floors without cellar rooms - roof with crawl space, when roofing deck is the actual loadbearing structure - walls, windows, doors and other similar structures, which are mainly loaded horizontally by air pressure difference and which do not have a load-bearing or stabilising function in the load-bearing system.

¹⁾ however, small roofs and floors that are separate from the load-bearing system are in class CC2 if they do not form a part of the stiffening system of the whole structure.

²⁾ underground floors included.

³⁾ Visiting the building daily is considered temporary staying but not staying for a longer time.

Table 6b. Determination of consequences classes for masts and chimneys

Consequences class	Description	Examples of masts and chimneys
CC3	High consequences due to loss of human life <i>or</i> very large economic, social or environmental consequences	Masts and chimneys located in strategic areas, such as industrial areas, power plant sites or densely populated areas. Significant masts or chimneys on located in industrial areas, where the economic and social consequences of failure would be very significant.
CC2	Medium consequences due to loss of human life <i>or</i> considerable economic, social or environmental consequences	Masts and conventional chimneys not belonging to classes CC3 or CC1.
CC1	Low consequences due to loss of human life <i>or</i> small or negligible economic, social or environmental consequences	Masts and conventional chimneys which, when damaged, are not likely to cause human injuries.

Table 6c. Determination of consequences classes for silos and tanks

Consequences class	Description	Examples of silos and tanks
CC3	High consequences due to loss of human life <i>or</i> very large economic, social or environmental consequences	Silos and tanks located in urban areas or densely populated areas, with a capacity of more than 5,000 tonnes. Tanks that have a capacity of more than 100 tonnes and where the temperature of the contents exceeds 65°C. Tanks that contain toxic or explosive liquid or liquefied gas.
CC2	Medium consequences due to loss of human life <i>or</i> considerable economic, social or environmental consequences	Silos and tanks not belonging to classes CC3 or CC1.
CC1	Low consequences due to loss of human life <i>or</i> small or negligible economic, social or environmental consequences	Silos and tanks which have a capacity of \leq 100 tonnes and which, when damaged, are not likely to cause human injuries.