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Environmental management for concrete and concrete structures —

Part 1: General principles

Management environnemental du béton et des structures en béton —

Partie 1: Principes généraux

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13315-1 was prepared by Technical Committee ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete*, Subcommittee SC 8, *Environmental management for concrete and concrete structures*.

ISO 13315 consists of the following parts, under the general title *Environmental management for concrete and concrete structures*:

— *Part 1: General principles*

A Part 2 on system boundary and inventory data is under preparation.

Introduction

Environmental issues are now grave subjects for the human race. Fortunately, mankind has clearly recognized the nature of the problem and created the concept of “sustainable development,” which can be regarded as an environmental revolution. This concept means development that meets the needs of not only the present but also future generations without endangering the natural systems that support life on Earth, the atmosphere, the waters, the soils, and the living things, and at the same time acknowledging that global economic growth is a basis for future global welfare. The incorporation of the concept of sustainability is required in every aspect of social, economic, and cultural activities. The construction industry, which consumes enormous amounts of resources and energy to provide the infrastructure for the diversified activities of mankind, has a strong impact on the environment.

ISO has already published the ISO 14000 series on environmental management for goods and services as a system for improving the impact on the environment. This series of International Standards provides general rules for assessing the impact on the environment, as well as for environmental labels/declaration based on such an assessment. Meanwhile, ISO 15686-6 and ISO 21930 were formulated to tailor this series to structures. Whereas the former provides a basic framework for the procedures of environmental consideration for buildings and constructed assets, the latter presents a framework for environmental declaration in regard to building products.

Concrete is widely used as one of the key materials for constructing infrastructures such as buildings, bridges, dams, tunnels, etc., with its consumption being the second largest on the planet after water. While construction activities using concrete naturally entail adverse environmental impacts, they also provide environmental beneficial impacts. Improved infrastructures alleviate traffic congestion and prevent natural disasters. Also, the development of compact cities may control the expansion of adverse environmental impacts. Industrial wastes and byproducts from other industries are used as materials, fuels, and supplementary materials for producing cement. Accurate assessment of environmental impacts is therefore essential for minimizing adverse environmental impacts derived from construction activities using concrete while maximizing beneficial environmental impacts.

Concrete structures consume large amounts of aggregates, cement and steel, which emit large amounts of CO_2 in their production processes. Concrete utilizes industrial waste and byproducts, and uses different aggregates in different regions. Concrete is delivered to the construction site in the form of partially finished products. Concrete structures are built in a wide variety of forms with specific requirements, used in various environments for a long time, and demolished, recycled and disposed of in various forms. The ISO 13315 series of standards is intended to provide the basic rules on environmental management for concrete and concrete structures having such characteristics. It is also intended to contribute to continued improvement of the environmental impacts resulting from the activities related to concrete and concrete structures. This series ensures consistency with the existing environmental ISO 14000 series, as well as ISO 15686-6 and ISO 21930. Figure 1 shows the relationship between the ISO 13315 series of standards, including those to be established in the future, and other existing ISO standards. Figure 2 shows the basic framework of the ISO 13315 series of standards.

The ISO 13315 series of standards covers all people involved in concrete and concrete structures: owners, designers, concrete manufacturers, constructors, users, certification bodies, and those who develop environmental standard specifications.

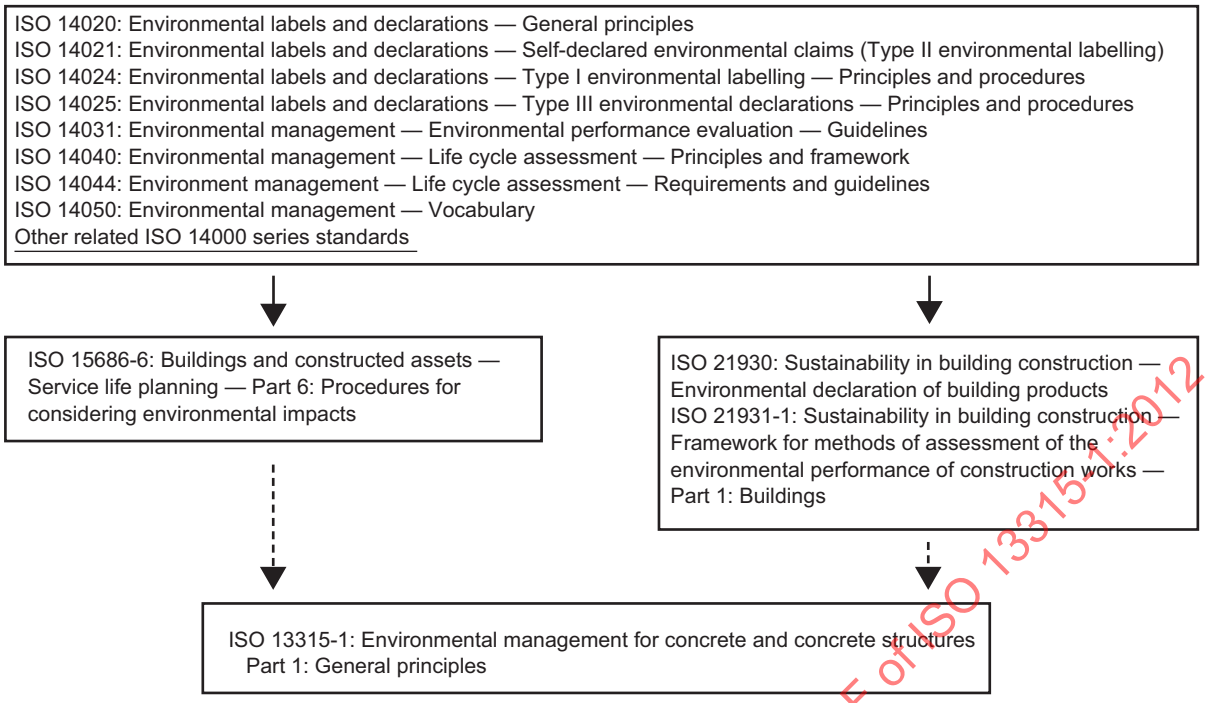

Figure 1 — Relationship between the ISO 13315 series of standards and other existing ISO environmental standards

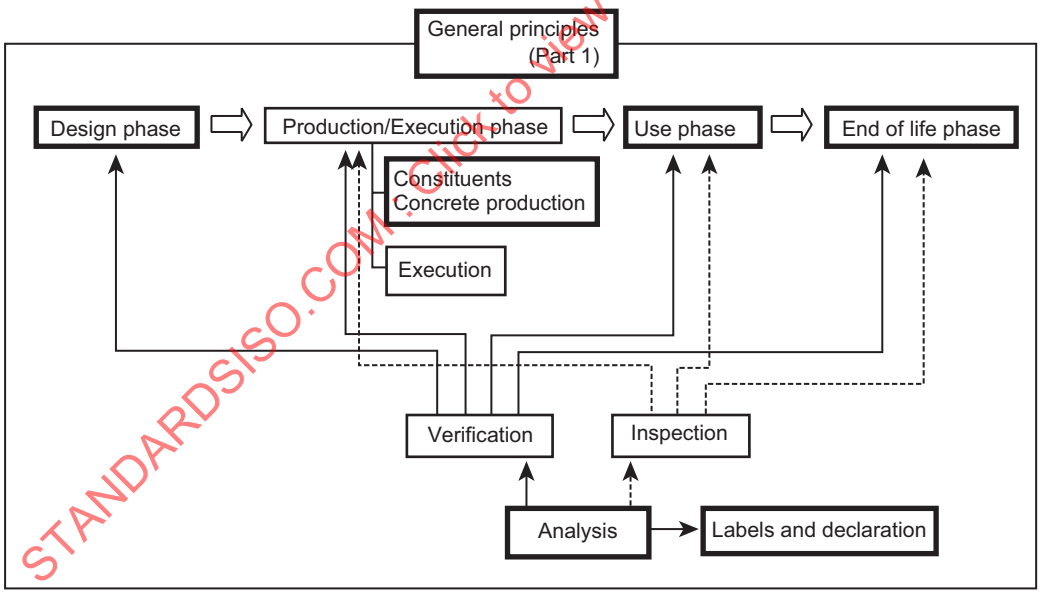

Figure 2 — Basic framework of the ISO 13315 series of standards

Environmental management for concrete and concrete structures —

Part 1:
General principles

1 Scope

This part of ISO 13315 provides a framework and basic rules on environmental management related to concrete and concrete structures. This includes the assessment of the environmental impacts and methods of implementing environmental improvement based on the assessment.

This part of ISO 13315 is used when assessing the environmental impacts and implementing the environmental management of concrete and concrete structures for the environmental consideration in activities related to the production of concrete constituents, the production, recycling and disposal of concrete, and the design, execution, use and demolition of concrete structures. It is applied for their entire lifecycles, respective stages of the lifecycles, or certain ranges of the lifecycles. This part of ISO 13315 is relevant to newly produced concrete and newly constructed concrete structures, and also existing concrete and concrete structures.

This part of ISO 13315 applies not only to single concretes but also to concrete families and not only to single concrete structures but also to concrete structure complexes. For materials other than concrete, the related ISO standards are applied where available. In the case where no ISO standard is available, such materials are appropriately dealt with referring to this part of ISO 13315 and the normative references.

The environments covered by this part of ISO 13315 include global, regional and local environments. The indoor pollution of buildings and the environments for workers in concrete producing plants and on concrete structure construction sites are not specifically covered by this part of ISO 13315. This part of ISO 13315 does not directly deal with the environmental impacts resulting from the operation of equipment installed in concrete structures. However, the special properties of concrete and concrete structures affecting the operational efficiency of such equipment are considered in this part of ISO 13315.

This part of ISO 13315 covers secondary effects of the production of concrete and execution of concrete structures.

This part of ISO 13315 may also cover the economic and social effects of environmental consideration in the production of concrete and execution of concrete structures.

NOTE 1 ISO 16814 is available for reference as a standard for the indoor pollution of buildings.

NOTE 2 The working environments of plants and construction sites are generally prescribed by industrial safety and health laws.

NOTE 3 In buildings, global warming substances are mainly emitted from energy consumption due to the operation of heating, ventilating and air-conditioning equipment.

NOTE 4 The beneficial effects such as thermal mass and other functions of concrete and concrete structures may be taken into account.

NOTE 5 The secondary effects of the production of concrete include the future possibility of leaching of heavy metals from concrete or the absorption of heavy metals from the environment, the effect of waste treatments on the environment, etc.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14050, *Environmental management — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14050 and the following apply.

3.1
byproduct
secondary substances produced by an industrial process

3.2
client's brief
working document which specifies at any point in time the relevant needs and aims, resources of the client and user, the context of the project and any appropriate design requirements

3.3
concrete demolition material
material generated in demolition of concrete structures

3.4
ecosystem
system of interrelations among nature, animals and human beings

3.5
environmental monetary cost
costs necessary to fulfill environmental requirements

3.6
environmental design
design of a structure in which environmental impacts are considered

3.7
environmental impact
any change, which may be adverse or beneficial, to the environment, wholly or partially resulting from concrete-related activities

3.8
environmental performance
quantitative or qualitative results of environmental influence from activities related to concrete and concrete structures

3.9
execution
all activities carried out for the physical completion of the work, and the inspection and documentation thereof

EXAMPLE Procurement, scaffolding, formwork, reinforcing, concreting, curing, erection of precast elements, etc.

3.10
global environment
environment that is affected by global climate change, ozone depletion, changes in ecosystems, resource use and other factors on a global scale

3.11
inspection
examination to determine whether environmental performance attained in a product or an activity satisfies specified requirements

3.12
local environment
environment that is affected by noise, vibration, dust and other factors in a built environment

3.13
regional environment
environment that is affected by air pollution, soil contamination, or water pollution on an intermediate scale

EXAMPLE City, province and country.

3.14
sustainability
state in which components of the ecosystem and their functions are maintained for present and future generations

NOTE 1 Sustainability is the goal of sustainable development and can result from the application of the concept of sustainable development.

NOTE 2 "Components of the ecosystem" includes plants and animals, as well as humans and their physical environment. For humans, this includes a balancing of key elements of human needs: the economic, environmental, social and cultural conditions for societies' existence.

3.15
soil contamination
phenomenon in which soil is polluted by deleterious substances

3.16
verification
process to check whether environmental performances estimated in a product or an activity satisfy specified requirements

3.17
waste
unusable substances emitted from activities related to concrete and concrete structures

3.18
water pollution
phenomenon in which water is polluted by deleterious substances

4 General framework

4.1 General

The concept of sustainability through environmental management shall be considered in various activities related to the production of concrete and execution of concrete structures. In addition to the environmental aspect, sustainability has economic and social aspects which influence one another. Consideration of the environmental aspect may relate to the economic aspect such as environmental monetary cost. Consideration of the environmental aspect may relate to the social aspect, which involves issues of intergenerational ethics, such as securement of the quality of society and life, inheritance of tradition and culture, and consensus building for preserving ecosystems. The economic and social aspects of environmental consideration should therefore be clearly recognized in activities related to the production of concrete and execution of concrete structures, and these aspects may be appropriately considered based on the required priorities.

Environmental management of concrete and concrete structures shall be implemented with the aim of minimizing the adverse environmental impacts and maximizing the beneficial environmental impacts.

The objects of environmental management shall include the environmental impacts generated in the entire lifecycle of concrete and concrete structures or its phases including design, production, execution, use and end of life phase.

The basic flow of environmental management for concrete and concrete structures is shown in Figure 3. Environmental management shall be carried out with the Plan-Do-Check-Act process at the respective phases

of the concrete structures or through the lifecycle. This includes determining or confirming the types and values of environmental performance requirements; analysing the environmental performance of concrete, concrete structures and related activities, and verifying that the environmental performances satisfy or dissatisfy the required values; inspecting actual environmental performance during the respective phases or after them; and taking appropriate measures in the event of problems. The activities and their results shall be documented and the documents shall be stored.

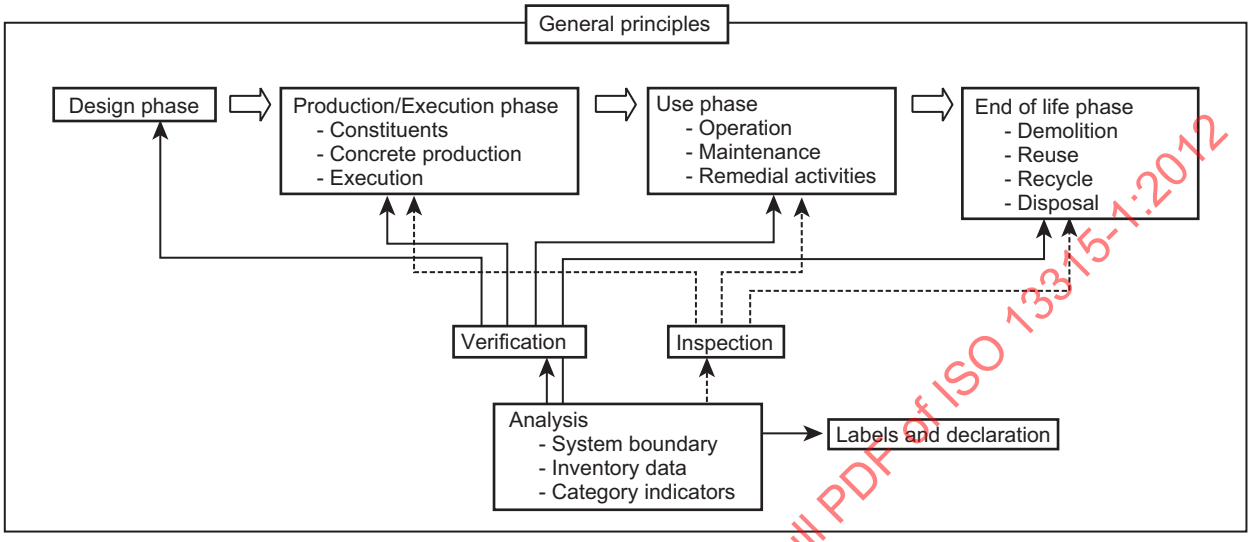

Figure 3 — Basic flow of environmental management for concrete and concrete structures

4.2 Phases in the lifecycle

The lifecycle of concrete and concrete structures consists of the following phases:

— Design phase (4.5): phase in which the specifications of concrete structures are determined to satisfy the environmental performance requirements based on the client's brief and legislation, and they are documented.

— Production/execution phase (4.6): phases including the manufacture of constituents, the production of concrete and the execution of concrete structures.

— Use phase (4.7): phase of operation and maintenance and remedial activities of concrete structures.

— End of life phase (4.8): phase of demolition of concrete structures, reuse of some elements, and recycling and disposal of concrete.

4.3 Environmental impact categories

The following items shall be considered as environmental impacts of concrete and concrete structures:

— global climate change;

— natural resources use (materials, water and fuel);

— stratospheric ozone level;

— land use and habitat alteration;

— eutrophication;

— acidification;

- air pollution:
  - smog (tropospheric ozone formation),
  - particulate matter air pollution,
  - other air pollution (toxics, etc.),
  - indoor air pollution;
- water pollution;
- soil contamination;
- pollution due to radioactive substances;
- impacts due to waste generation;
- noise/vibration.

When assessing the environmental impacts, it is necessary to appropriately judge if the range of the impact is limited to the local environment of the concrete structure or whether it reaches the regional or global environment.

NOTE The elements of environmental impacts generated at each phase of the lifecycle of concrete structures are shown in Annex A.

4.4 Analysis

4.4.1 General

Analysis refers to calculation of the impact category indicators of concrete and concrete structures under certain system boundaries using appropriate indicators.

Analysis shall be carried out according to the following procedure:

- determination or confirmation of the system boundaries and impact category indicators;
- preparation of data corresponding to the impact category indicators;
- calculation of impact category indicators.

Analysis shall be conducted to verify the environmental performance of concrete or a concrete structure at each phase of its lifecycle and to inspect it at each phase except for the design phase. For the assessment of environmental performance, the system boundaries and indicators shall be appropriately determined. If the system boundaries and indicators have already been determined, their validity shall be verified.

The environmental performance shall either be assessed for the entire lifecycle, or a phase or phases of a lifecycle.

When using a specific tool, this tool shall be described and it should only be used after thoroughly understanding its characteristics.

4.4.2 System boundary

To determine the system boundary, the geographic range, time range, and the range of relevant industries shall be defined. It is necessary to reasonably define the ranges of input and output for the assessment of environmental performance of concrete and concrete structures for the lifecycle, or a phase or phases of lifecycle, as well as the service lives when assessing the environmental performance of concrete structures for their lifecycle.

Concrete may effectively utilize byproducts from other industries, such as ground granulated blast-furnace slag, fly ash and silica fume. Recycled concrete aggregate may be output to other industries. Therefore, the system boundary between relevant industries should be appropriately determined.

The determined system boundaries shall be clearly documented to show their validity.

4.4.3 Inventory data

Inventory data shall be acquired for all activities during the lifecycle of concrete and concrete structures within the determined system boundary with objectiveness and transparency.

Inventory data shall be determined based on existing or acquired information. When direct acquisition is difficult, inventory data may be acquired by determining alternative data and converting them.

In any event, the means and conditions of acquiring the inventory data, and the information sources where required, shall be clearly documented in writing.

4.4.4 Category indicators

Category indicators specifically express the environmental performances in regard to the environmental impacts given in 4.3. Category indicators that can express the magnitude of environmental impacts qualitatively or quantitatively shall be employed.

When using two or more category indicators, the environmental performance may be assessed by each category indicator. Assessment may also be conducted by integrating multiple category indicators.

The conditions and methods of acquiring data to calculate the indices corresponding to the category indicators shall be specified. The data sources shall also be specified as required.

4.5 Design phase

Figure 4 shows the general flow for the environmental design of concrete structures.

The environmental performance requirements for concrete or concrete structures shall be established to conform to the client's brief while meeting the laws and regulations, and shall be indicated by suitable indicators.

Meanwhile, the environmental performance that the resulting concrete structure would possess shall be calculated by the methods specified in 4.4 from the performance of concrete and the specifications of the concrete structure established to materialize the client's brief.

The above-mentioned performance requirements and the performances that the structure would possess shall be compared to verify whether or not the estimated performance satisfies the required performance. When the expected performance is proven to satisfy the performance requirements, the details of the design shall be documented. When the expected performance is proven to dissatisfy the performance requirements, the performance of concrete and/or the specifications of the concrete structure shall be corrected so that the environmental performance that the concrete or concrete structure would possess can satisfy the performance requirements. In case the original requirements are not satisfied, the requirements may be changed through the assessment of the consequences. In case the accomplishment of the project is judged to be impossible, a decision to quit the project may be made.

The details on the performance of concrete and/or the specifications of the concrete structure at the design phase provide vital information for the activities in the respective phases. For this reason, all information related to the performance settings and verification shall be appropriately documented and stored.

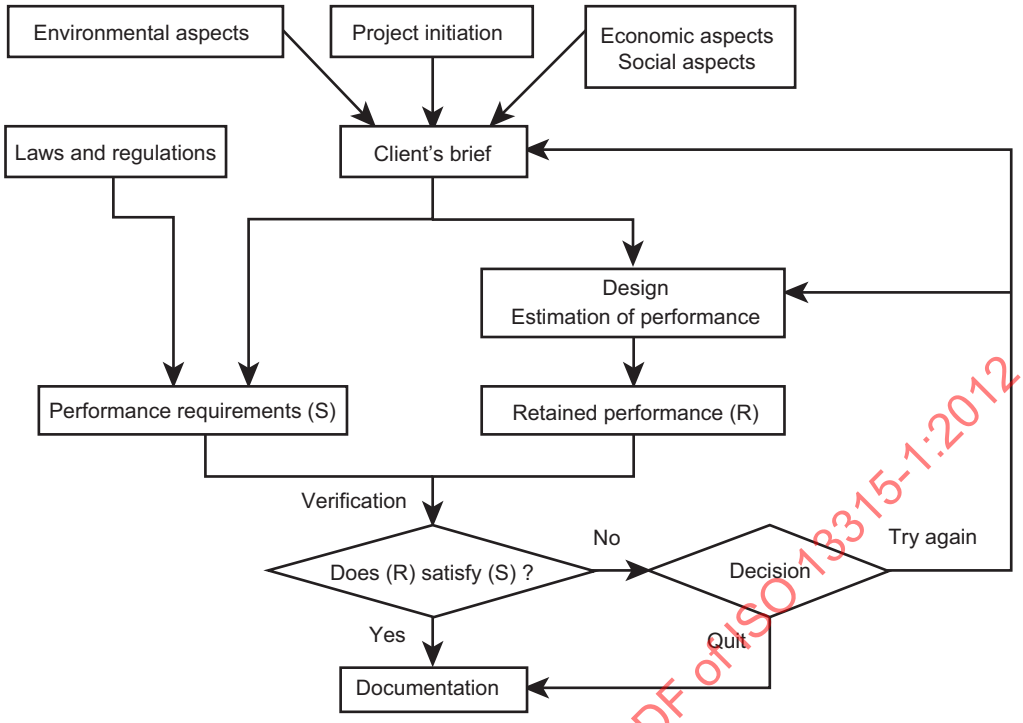

Figure 4 — Environmental design of structures

The structural design and durability design of a concrete structure should be conducted separately from the environmental design. A structure shall also be designed in such a way that it has a pleasing aesthetic appearance, with appropriate integration into its surroundings.

4.6 Production/execution phase

When producing concrete or executing a concrete structure, the production plan and execution plan shall be formulated after confirming or establishing the performance requirements, and the environmental impacts generated from the production/execution processes shall be calculated. The calculated performance shall be proven to satisfy the performance requirements. The calculation shall conform to 4.4. The production of concrete and execution of the concrete structure shall conform to the production/execution plan. The actual environmental impacts shall be confirmed during and after the production/execution. Should the actual environmental impacts dissatisfy the performance requirements, measures shall be taken to improve the environment. The environment-improving effect shall be confirmed during and after the completion of the improvement measures, and a series of activities shall be repeated until the performance requirements are satisfied.

The environmental impacts embodied in concrete shall be calculated through the processes of collecting/mining/manufacturing of constituents and transporting them to concrete plants, and producing concrete and transporting it to construction sites. The environmental impacts embodied in reinforcing material shall be calculated as well.

The production and transportation of concrete shall be carried out to reduce the use of natural resources, energy consumption and waste generation and to minimize damage due to noise/vibration, dust and water pollution.

The execution of concrete structures shall be carried out to reduce energy consumption and waste generation during the procurements, scaffolding, formwork, reinforcing, concreting, curing, erection of precast elements, etc., and to minimize damage due to noise/vibration, dust, air pollution, water pollution and soil contamination.

All activities related to this clause shall be appropriately documented and stored.

4.7 Use phase

In the use phase of concrete structures, whether or not the required performance established in the environmental design is demonstrated shall be examined. Should the performance requirements not be

satisfied, appropriate measures shall be taken. Even if the structure satisfies the performance requirements at an early stage of the use phase, whether or not the environmental performance of the structure satisfies the performance requirements shall be examined when there are changes in the requirements or standards related to the operation, or when the environmental performance of the structure may be changed by the implementation of maintenance and remedial activities. Should the performance requirements not be satisfied, appropriate measures shall be taken.

NOTE Remedial activities include all activities related to repair, rehabilitation, refurbishment, renewal, renovation, conversion, retrofitting, strengthening and protection against corrosive agents.

When work not established in the design phase is to be carried out in the maintenance and remedial activities, a work plan shall be formulated, and the environmental impact generated from the work plan shall be calculated. The calculated environmental impact shall be proven to satisfy the newly established performance requirements. The calculation shall be done to conform to 4.4. The work shall be carried out following the work plan that satisfies the performance requirements. The environmental impacts that actually result from the work shall be confirmed during and after the work. Should the actual environmental impact not satisfy the performance requirements, measures shall be taken to improve the environment. The environment-improving effect shall be confirmed during and after the completion of the improvement measures and a series of activities shall be repeated until the performance requirements are satisfied.

When part or all of the functions of the structure are suspended for maintenance and remedial activities, measures shall be taken to reduce the resulting environmental impact. Consideration shall be given to, for instance, the environmental impacts of the substitute facilities/equipment during such stoppage and traffic congestion due to repair of road structures.

Operational energy including heating and cooling shall be included.

All activities related to this subclause shall be appropriately documented and stored.

4.8 End of life phase

In the stage of demolition of concrete structures, the stage of reuse of elements and the stage of recycling of concrete demolition material or final disposal of waste, the demolition of concrete structures, the reuse of elements and the recycling or final disposal of concrete demolition waste shall be carried out after establishing or confirming at the respective stages or all of these stages:

— the required values of the degrees of noise/vibration/dust and amount of waste to be disposed of;

— the environmental impact of the related activities;

— that the environmental impacts are above or below the required values.

After these activities have been carried out, the results shall be inspected, and, in the event of problem, appropriate measures shall be taken. The activities carried out at each stage and their results shall be appropriately documented and stored.

When demolishing concrete structures, demolition shall be carried out so that the demolition work causes no harm to the neighbouring community and the arrangement of the resulting waste materials does not hamper the recycling work. Consideration shall be given so that minimal negative impacts occur after final disposal.

Concrete demolition material shall be recycled by methods that do not require excessive energy and do not generate large amounts of waste, without causing harm to the neighbouring community due to noise, vibration and dust. The materials and products resulting from recycling shall have the performance suitable for their use.

Concrete demolition material and waste shall be transported without causing harm to the areas along the transportation route due to noise, vibration and dust.

When concrete demolition material cannot be recycled, it shall be disposed in a final disposal site where measures have been taken to prevent soil/water contamination and damage to the landscape. When waste contains irremovable hazardous substances, it shall be appropriately disposed of by a method that ensures safety.

Concrete structures or concrete elements may be left in-situ at the end of their lives if safety, environmental impacts, and other related impacts are appropriately evaluated and it is deemed acceptable.

4.9 Labels and declaration

The results of environmental impact assessment for concrete and concrete structures can form a basis for environmental labels and environmental declaration.

Annex A
(informative)

Phases and environmental impact factors to be considered in lifecycle of concrete and concrete structures

Table A.1 — Phases and environmental impact factors to be considered in lifecycle of concrete and concrete structures

Phase	Sub-phase		Global climate change	Natural resources use	Stratospheric ozone level	Land use/ habitat alteration	Eutrophication	Acidification	Air pollution	Water pollution	Soil contamination	Pollution due to radioactive substances	Impacts due to waste generation	Noise/ vibration	Environmental impact improvement
Design	Design														Consideration of environmental benefit and load mitigation by service life extension Multifunctional design
Production/Execution	Material supply	Cement	CO_2	Fossil fuel, Non-metallic mineral (limestone)		Change in land use, Habitat alteration	NO_x	NO_x, SO_x	NO_x, SO_x, PM	Heavy metal	Heavy metal				Use of industrial by-products and waste
		Mixing water	CO_2	Water			NO_x	NO_x, SO_x	NO_x, SO_x, PM						
		Aggregate[a]	CO_2	Non-metallic mineral, Water		Change in land use, Habitat alteration	NO_x	NO_x, SO_x	NO_x, SO_x, PM	Heavy metal	Heavy metal	Radon-222	Powder, Sludge		Use of industrial by-products
		Supplementary cementitious material	CO_2				NO_x	NO_x, SO_x	NO_x, SO_x, PM	Heavy metal	Heavy metal	Radon-222			Use of industrial by-products
		Chemical admixture	CO_2				NO_x	NO_x, SO_x	NO_x, SO_x, PM	Nonyl phenol derivative	Nonyl phenol derivative				
		Reinforcement[b]	CO_2	Fossil fuel, Iron			NO_x	NO_x, SO_x	NO_x, SO_x, PM						Recycling of steel
	Concrete production		CO_2	Fossil fuel			NO_x	NO_x, SO_x	NO_x, SO_x, PM				Sludge	Noise/ vibration	
	Production of pre-cast concrete	Formwork	CO_2	Iron			NO_x	NO_x, SO_x	NO_x, SO_x, PM				Waste		
		Consolidation	CO_2	Fossil fuel			NO_x	NO_x, SO_x	NO_x, SO_x, PM					Noise/ vibration	
		Curing	CO_2	Water, Fossil fuel			NO_x	NO_x, SO_x	NO_x, SO_x, PM	Heavy metal			Waste		