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Environmental management for concrete and concrete structures —

Part 3: Production of concrete constituents and concrete

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Foreword

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This document 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*.

A list of all parts in the ISO 13315 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Concrete, a material essential for constructing buildings and civil structures forming infrastructure, is extensively used worldwide, requiring huge amounts of natural resources for its production, including the production of its constituents. A variety of byproducts from other industries are also used for their production. Moreover, the production of concrete constituents and concrete causes emissions of global warming gases including CO_2 and air pollutants such as NOx and SOx, water pollutants, as well as discharges of waste such as concrete rubble. Cement, one of the primary constituents of concrete, causes a large amount of CO_2 emissions during its production. Extraction of mineral resources, which are materials for concrete constituents, can also change the land use and alter the habitats of flora and fauna.

In this context, when producing concrete constituents and concrete, environmental consideration is necessary from every aspect including effective use of resources and prevention of global warming.

Environmental management for concrete and concrete structures —

Part 3:
Production of concrete constituents and concrete

1 Scope

This document provides the principles and procedures for environmental management related to production of concrete constituents and concrete. This document covers the following:

— concrete constituents: cement, admixtures, additions, aggregate and mixing water;

— concrete and precast concrete.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 13315-1, *Environmental management for concrete and concrete structures — Part 1: General principles*

ISO 13315-2, *Environmental management for concrete and concrete structures — Part 2: System boundary and inventory data*

ISO 13315-4, *Environmental management for concrete and concrete structures — Part 4: Environmental design of concrete structures*

ISO 13315-6, *Environmental management for concrete and concrete structures — Part 6: Use of concrete structures*

ISO 13315-8, *Environmental management for concrete and concrete structures — Part 8: Environmental labels and declarations*

ISO 14040, *Environmental management — Life cycle assessment — Principles and framework*

ISO 14044, *Environmental management — Life cycle assessment — Requirements and guidelines*

ISO 14050, *Environmental management — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13315-1, ISO 13315-2, ISO 13315-4, ISO 13315-6, ISO 13315-8, ISO 14040 and ISO 14050 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
target product
product for which environmental consideration is given

3.2
reference product
standard product, having the same function as a target product, or a product prior to environmental improvement, to be used for comparison in the environmental management related to production of concrete constituents and concrete

4 Symbols

Symbols used in this document are as follows:

$P_{tpr}(i)$	expected or attained environmental performance of the target product expressed as a function of indicator i;
$P^{e}_{tpr}(i)$	expected environmental performance of the target product expressed as a function of indicator i;
$P^{a}_{tpr}(i)$	attained environmental performance of the target product expressed as a function of indicator i;
$P_{rpr}(i)$	environmental performance of the reference product expressed as a function of indicator i;
$S_{pr}(i)$	environmental performance requirement of the product expressed as a function of indicator i;
$R^{a}_{tpr}(i)$	reduction amount of environmental impact of the target product in comparison with reference product;
$R^{r}_{tpr}(i)$	reduction rate of environmental impact of the target product in comparison with reference product.

5 Principles and procedure for environmental management related to production of concrete constituents and concrete

5.1 General

This clause provides the principles and procedures to appropriately carry out environmental management related to production of concrete constituents and concrete.

NOTE ISO 22965-2 serves as a reference for the specification of constituent materials, production of concrete and compliance of concrete.

5.2 Principles

In the production of concrete constituents and concrete, environmental management shall be carried out to reduce the environmental impacts of these products.

5.3 Procedure

Environmental management for the production of concrete constituents and concrete shall be conducted in accordance with ISO 14040, ISO 14044, and with the following procedure:

a) setting of the environmental performance requirements (see 5.4);

b) production design (see 5.5);

c) estimation (see 5.6);

d) verification (see 5.7);

e) production and related works (see 5.8);

f) inspection (see 5.9);

g) documentation (see 5.10).

Figure 1 shows the flow chart of the procedure.

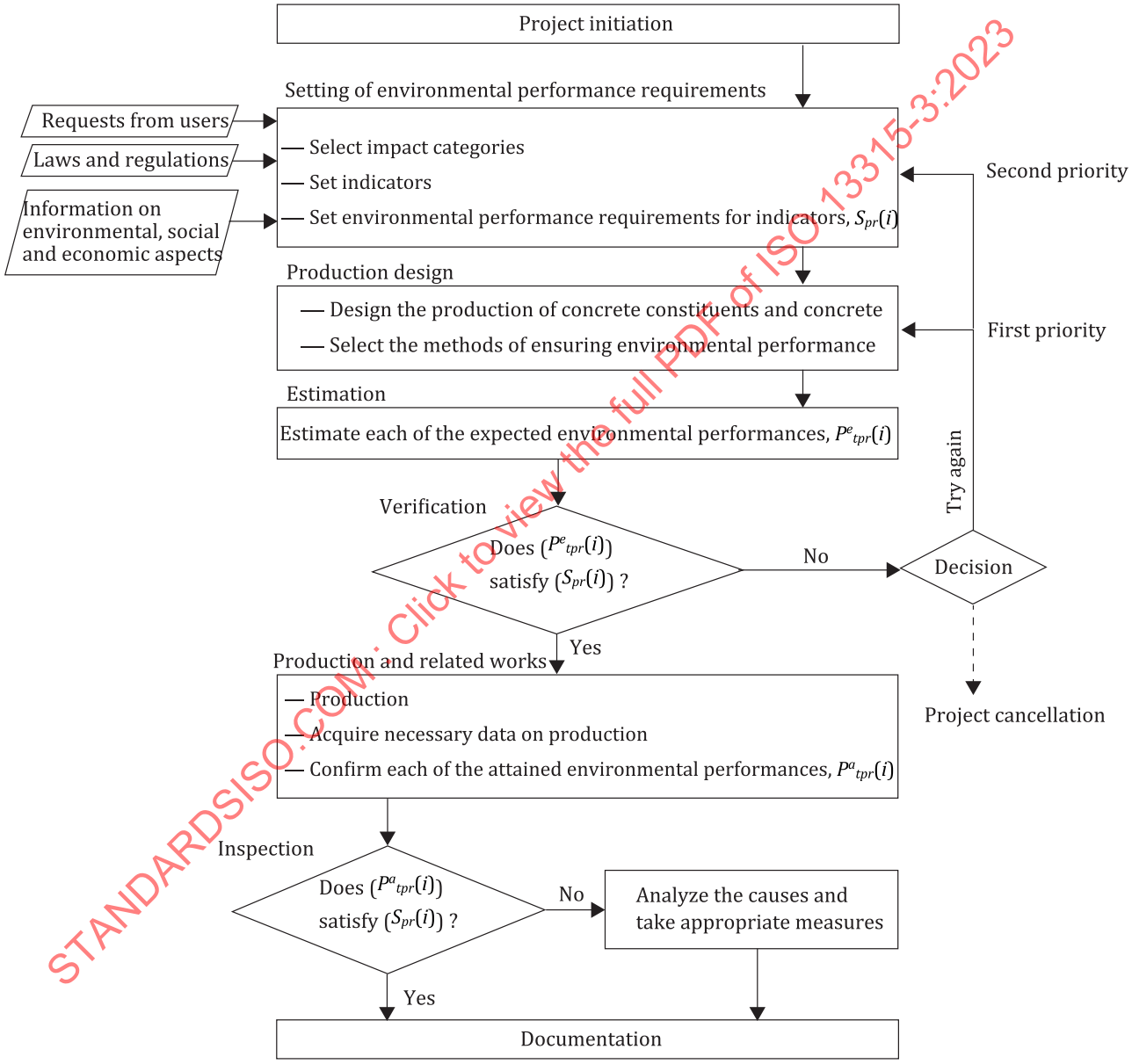

Figure 1 — Procedure for environmental management of production of concrete constituents and concrete

5.4 Setting of environmental performance requirements

5.4.1 General

The producer shall collect information on environmental, social and economic aspects necessary for the setting of environmental performance requirements. The environmental performance requirements can be set either based on the goals set by the producer or based on requests from users of the products. The producer shall select impact categories suitable for the performance requirements and set necessary indicators.

5.4.2 Selection of impact categories

Impact categories to be considered shall be selected from the following items:

- global climate change;
- natural resources use (materials, water and fuel);
- stratospheric ozone level;
- land use/habitat alteration;
- eutrophication;
- acidification;
- air pollution;
  - photochemical oxidant creation,
  - 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.

NOTE Mandatory impact categories are specified for an environmental product declaration in ISO 21930.

5.4.3 Setting of indicators

Appropriate indicators shall be set for each category selected.

The reduction amount of environmental impact or the reduction rate of environmental impact of the target execution activity in comparison with the reference execution activity may be used as an indicator. The environmental performance of the reference execution activity shall be appropriately estimated.

NOTE Annex A serves as a reference for setting indicators.

5.4.4 Setting of environmental performance requirements for indicators

An environmental performance requirement shall be set for each indicator.

The environmental performance requirements shall be quantitatively set in the form of upper limits, lower limits, or ranges, when the indicators are expressible in numerals.

NOTE The reduction amount of environmental impact of the target product, $R^{a}_{tpr}(i)$, refers to the difference between the environmental performance of the reference product and the expected or attained environmental performance of the target product. It is defined as Formula (1).

$$R^{a}_{tpr}(i) = P_{rpr}(i) - P_{tpr}(i) \quad (1)$$

The reduction rate of environmental impact of the target product, $R^{r}_{tpr}(i)$, refers to the ratio of the reduction of the environmental impact, $R^{a}_{tpr}(i)$, to the environmental performance of the reference product. It is defined as Formula (2).

$$R^{r}_{tpr}(i) = \frac{P_{rpr}(i) - P_{tpr}(i)}{P_{rpr}(i)} \quad (2)$$

5.5 Production design

5.5.1 General

Production design shall be conducted to meet the environmental performance requirements set in 5.4.

5.5.2 Methods of environmental consideration

Methods to ensure the required environmental performance in the production of concrete constituents and concrete include, for instance, the following:

a) selection of materials with low environmental impacts (for example, use of byproducts and wastes);

b) selection of energy sources with low environmental impacts [for example, use of recyclable energy sources and wastes (waste tires, waste plastics, refuse-derived fuels (RDF))];

c) selection of machinery/equipment with low environmental impacts;

d) appropriate control/treatment of substances emitted from plants (for example, use of treatment equipment for waste gas and water);

e) appropriate control/treatment of substances disposed of in plants (for example, use of equipment to prevent dust dispersion);

f) application of appropriate sound-proof/vibration-proof measures (for example, installation of sound insulating walls);

g) selection of suppliers of materials in consideration of environmental impacts of transportation.

NOTE Annex B serves as a reference for methods of environmental consideration.

5.6 Estimation

The expected environmental performances of the products by the production design prescribed in 5.5 shall be estimated by collecting necessary data. The methods of collecting data include the following items:

a) trial production;

NOTE 1 In contrast to the execution stage of a structure, trial production (e.g. trial mixing of concrete) is possible, at the production stage of a product, for estimating its performance.

b) referring to production experience;

c) inventory data published by a reliable independent organization.

NOTE 2 ISO 21930 serves as a reference for inventory analysis for construction products. ISO 13315-2 provides general framework, principles and requirements related to the determination of system boundaries.

NOTE 3 When applying cut-off rules, ISO 14044 serves as a reference for defining the cut-off criteria and assessing the impact of the cut-off criteria.

NOTE 4 When conducting allocation, ISO 14044 serves as a reference.

5.7 Verification

Verification shall be made as to whether or not each of the expected environmental performances estimated in 5.6, meets the performance requirements set in 5.4. If any of the expected environmental performances fail to meet the environmental performance requirements, then the product shall be re-designed by returning to 5.5. If the re-design fails to meet the requirements, the environmental performance requirements shall be reviewed by returning to 5.4.

5.8 Production and related works

Production shall be carried out based on the production design, and necessary data shall be acquired. Based on the acquired data, each of the attained environmental performance of the product shall be confirmed.

5.9 Inspection

Inspection shall be conducted as to whether or not the attained environmental performances meet the environmental performance requirements. If the performances fail to meet the requirements, the cause shall be analysed to serve as a reference for subsequent production of the products.

5.10 Documentation

All information related to environmental management of the production of the products shall be recorded regardless of the results of verification and inspection, and the record shall be stored by the designer and user for the required period.

Information related to environmental management of production serve should preferably be used to help the planning of future production of the products.

NOTE ISO 13315-8 serves as a reference when the results of environmental management are to be used for environmental labelling and declarations of the products.

Annex A
(informative)

Example of indicators for the environmental management

Tables A.1 to A.12 show examples of indicators for respective impact categories.

Table A.1 — Example of indicators on global climate change

Indicator	Greenhouse gas emission can be set as an indicator. Greenhouse gases include, for example: — carbon dioxide (CO_2) — methane (CH_4) — dinitrogen monoxide (N_2O) — hydrofluorocarbons (HFCs) — perfluorocarbons (PFCs) — sulfur hexafluoride (SF_6)

NOTE Global climate change can be characterized as CO_2 equivalent.[1]

Table A.2 — Example of indicators on natural resource use

Indicator	The amount of mined abiotic resources can be set as an indicator. Abiotic resources include, for example: — rock for producing aggregate; — limestone and silica stone used for producing cement and additions; — natural resources (e.g. iron ore) used for producing section steel and coal as materials for coke; — natural resources (e.g. tungsten ore) used for producing rare metals (e.g. tungsten) contained in the attachments of heavy machinery. The amount of water used can be set as an indicator. Water includes, for example, tap water, industrial water, and groundwater. The amount of each type of fossil fuel used can be set as an indicator. Fossil fuel includes, for example, heavy oil, heating oil, light oil, and natural gas. The amount of materials made of biotic resources can be set as an indicator. Biotic resources include, for example, raw wood used for producing plywood for formwork.

NOTE Abiotic resources can be characterized as antimony equivalent.[2]

Table A.3 — Example of indicators on stratospheric ozone level

Indicator	Discharge amount of ozone-depleting substances can be set as an indicator. Ozone-depleting substances include, for example, the following: — CFCs (including, for example, CFC-11 and CFC-113) — halons (including, for example, halon 1301) — carbon tetrachloride — methyl-chloroform — HCFCs (including, for example, HCFC-225) — HBFC (including, for example, $CHFBr_2$) — bromo-chloromethane — methyl bromide

NOTE Stratospheric ozone level can be characterized as CFC-11 equivalent.[1]

Table A.4 — Example of indicators on land use/habitat alternation

Indicator	Amount of land to be altered can be set as indicators. The amount of land includes, for example, the following: — land area — soil volume — soil weight

Table A.5 — Example of indicators on eutrophication

Indicator	As to discharged water, concentration of eutrophication contributors and the amount of discharged water can be set as indicators. Eutrophication contributors include, for example, the following: — chemical oxygen demand (COD) — total nitrogen — total phosphorus — total organic carbon (TOC) As to exhaust gas, concentration of eutrophication contributors and the amount of exhaust gas can be set as indicators. Eutrophication contributors include, for example, the following: — NOx — ammonia

NOTE Eutrophication can be characterized as phosphate equivalent.[3]

Table A.6 — Example of indicators on acidification

Indicator	Amount of acidification contributors can be set as an indicator. Acidification contributors include, for example, the following: — nitrogen oxides (NOx) — sulfur oxides (SOx) — ammonia (NH_3) — hydrochloric acid (HCl)

NOTE Acidification can be characterized as SO_2 equivalent.[4]

Table A.7 — Example of indicators on air pollution

Indicator	Amount of air pollutant emission can be set as an indicator. Air pollutants in urban environment include, for example, the following: — nitrogen oxides (NOx); — sulfur oxides (SOx); — particulate matter (PM). Air pollutants in smog include, for example, the following: — non-methane volatile organic compounds (NMVOC). Air pollutants in indoor environment include, for example, the following: — volatile organic compounds.

Table A.8 — Example of indicators on water pollution

Indicator	Amount of water pollution contributors released into nature can be set as an indicator. Water pollution contributors include, for example, the following: — heavy metals — alkaline substances — acidic substances — toxic chemicals

Table A.9 — Example of indicators on soil contamination

Indicator	Amount of soil contamination contributors discharged into soil can be set as an indicator. Soil contamination contributors include, for example, the following: — heavy metals — alkaline substances — acidic substances — toxic chemicals

Table A.10 — Example of indicator on pollution due to radioactive substances

Indicator	Radioactivity can be set as an indicator.

Table A.11 — Example of indicators on impacts due to waste generation

Indicator	Waste generation can be set as an indicator. Waste includes, for example, the following: — rubble (e.g. concrete rubble, crushed brick and pottery waste) — waste plastic — rubber — sludge — wood chips — fibrous waste — paper waste — waste oil — incineration residue — asbestos — waste acid/waste alkali

NOTE Waste generation can be characterized as final disposal volume.[5]

Table A.12 — Example of indicators on noise/vibration

Indicator	Noise/vibration can be set as an indicator. Noise/vibration include, for example, the following: — sound level [dB] — vibration level [dB]

Annex B
(informative)

Examples of the methods of environmental consideration in production of concrete constituents and concrete

Table B.1 shows the examples of environmental considerations related to cement production.

Table B.1 — Methods of environmental consideration in cement production

Target impact category	Methods	Commentary
Global climate change	Reduction of the amount of limestone used for cement	Suppress emission of global warming substances and reduce resource consumption by re-calcining waste concrete to reduce the amount of limestone used for cement.
	Utilization of waste heat	Suppress emission of global warming substances and reduce energy resource consumption by utilizing waste heat generated during cement calcination to reduce fuel consumption.
	Application of equipment with high energy efficiency	Reduce energy consumption by introducing a high efficiency crusher (vertical mill) or incorporating a precrusher (roller mill-type precrusher) for coarse crushing in the crushing process to enhance the crushing efficiency.
	Application of carbon capture and storage (CCS)	Suppress emission of global warming substances by chemically separating/reclaiming and storing CO_2 emitted from cement kilns.
Natural resource use	Utilization of waste for fuel	Reduce resource consumption of fossil fuels by using waste plastics as fuel for cement calcination.
	Utilization of byproducts as materials	Reduce resource consumption by using copper slag as a clinker material.
Noise/vibration	Installation of soundproof walls	Suppress noise from cement crushing by installing soundproof walls.