INTERNATIONAL STANDARD

ISO 13315-2

First edition
2014-05-01

Environmental management for concrete and concrete structures —

Part 2: System boundary and inventory data

Management environnemental du béton et des structures en béton —

Partie 2: Limite du système et données d'inventaire

Reference number
ISO 13315-2:2014(E)

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is 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*

— *Part 2: System boundary and inventory data*

NOTE The ISO 13315 series provides specifications for concrete and ensures consistency with the existing environmental ISO 14000 series, ISO 15392, ISO 21930, etc.

Introduction

Concrete is a material that is indispensable for the construction of infrastructure including civil structures and buildings. Massive amounts of resources are used for construction of this infrastructure and large amounts of concrete rubble are generated when these structures are demolished. Concrete can therefore be regarded as a material having a critical impact on the formation of a recycling-based society from the aspect of not only resource consumption but also future waste generation. Meanwhile, a significant amount of CO_2, a greenhouse gas, is discharged from activities related to architecture and civil engineering. Various documents indicate that the concrete sector is emitting 5% to 10 % of the global CO_2 by producing and conveying cement and concrete and by construction of concrete structures. On the other hand, concrete can absorb CO_2. Concrete has to, therefore, play an important role in solving recycling and global warming problems. Consideration has to also be given to the emission of air pollutants, noise, vibration, and other impacts during transportation of constituent materials and concrete, and construction and demolition of concrete structures.

Application of optimum environmental impact-mitigating techniques and use of environmentally conscious products are important issues for concrete structures at each stage of their life cycle: the production of cement and aggregate, the production and transportation of concrete, and the construction, use, and demolition of concrete structures. To meet these requirements, it is necessary to compare the environmental impacts resulting from different concretes as well as the structural forms, using life cycle inventory analysis (LCI) and life cycle assessment (LCA). LCI and LCA has to be conducted under the same conditions. In other words, it is important to clearly define a range of time and space for assessment, and quantitatively grasp the types and amounts of resources, energy, constituents, and components input into the range, as well as the products and structures output as a result of activities within the range, and also the byproducts, waste, and other releases discharged. As shown in Figure 1, the boundary between the system under assessment and the outer region is referred to as 'system boundary,' and the input/output data transferred between the assessment system and the outer region is referred to as 'inventory data.' When conducting LCI and LCA, a system boundary has to be defined, and inventory data has to be quantitatively developed. ISO 13315-2 provides fundamental rules for defining system boundaries and acquiring inventory data.

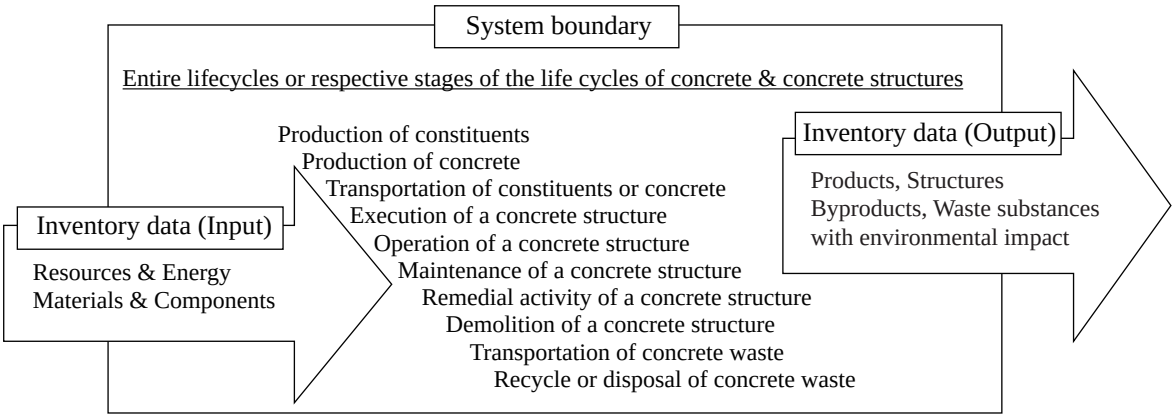


Figure 1 — System boundary and inventory data

Environmental management for concrete and concrete structures —

Part 2:
System boundary and inventory data

1 Scope

This part of ISO 13315 provides a general framework, principles, and requirements related to the determination of system boundaries and the acquisition of inventory data necessary for conducting a life cycle assessment (LCA) of concrete, precast concrete, and concrete structures.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 14025, *Environmental labels and declarations — Type III environmental declarations — Principles and procedures*

ISO 14050, *Environmental management — Vocabulary*

3 Terms and definitions

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

3.1
data collection boundary
boundary between the region, within which data shall be collected, and another region

3.2
input
resources, energy, materials, or components which enter a product system

3.3
inventory data
set of items that should be considered in an LCA and the corresponding quantitative measurements

3.4
life cycle inventory analysis
phase of LCA involving the compilation and quantification of inputs and outputs, for a given product system throughout its life cycle

3.5
output
products, byproducts, emissions to air and water, wastes, and other releases which leave a product system

3.6
system boundary
boundary between the system under assessment and the outer region, specifying which unit processes are part of a product system

3.7
unit-based inventory data
inventory data per unit quantity in time, mass, length, area, volume, etc.

4 System boundary

4.1 General

When conducting an LCA of concrete or a concrete structure, its system boundary shall be demarcated. Demarcation of a system boundary means defining the range of consideration for the assessment. For comparison among multiple alternatives, the system boundary shall be the same for all alternatives. When the acquisition of inventory data are difficult or cost-constrained, the target data can be excluded from the system boundary, but the exclusion should be expressly indicated.

For system boundary demarcation, the life cycle stages and geographical system ranges to consider should be appropriately defined.

The system boundary of concrete and concrete structures shall be based on a cradle-to-gate or cradle-to-grave basis and shall precisely describe what is included in the following activities: production of cement, water, additions, admixtures, and aggregates, which are constituents of concrete; production of reinforcing steel; production of concrete; construction of concrete structures; use of concrete structures; demolition of concrete structures; reuse of concrete members; recycling and disposal of demolished concrete.

It is not necessary in principle to include in the system boundary the environmental impacts related to the production of equipment/machinery necessary for the production of concrete or the construction, use, demolition, and recycling of concrete structures.

When explicit consideration of environmental impacts related to the production of equipment/machinery is deemed necessary, care shall be taken to eliminate double counting or omissions.

Activities indirectly related to the production of each material or to the construction of concrete structures, such as sales/administration, might have to be included in the system boundary.

4.2 Constituents

4.2.1 Cement

The system boundary related to the production of cement is generally expressed in Figure 2.

The system boundary for the production of cement shall include the following:

— the processes of quarrying, transporting, and treating raw materials necessary for the production of clinker;

— transportation of the fuel necessary for the production of clinker;

— transportation of byproducts;

— transportation related to waste-derived fuels;

— all of the processes of material/fuel treatment, calcination, and finishing of cement;

— the process of additional treatment to byproducts used for the production of clinker;

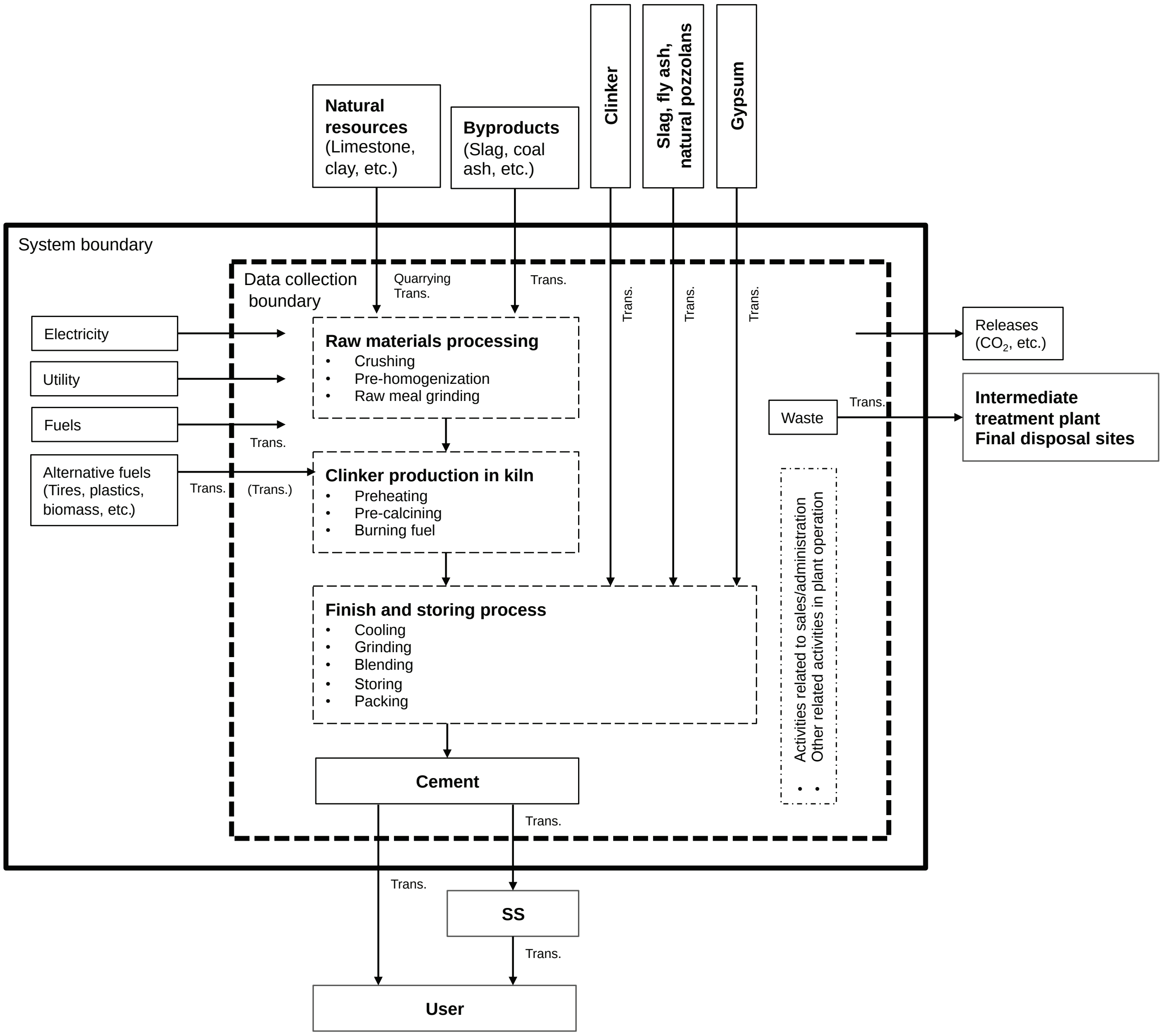
— the process of additional treatment to waste-derived fuels for the production of clinker;

— transportation of cement from cement plants to supply stations (SS).

NOTE 1 The material/fuel treatment process includes crushing and adjustment of the materials/fuels.

NOTE 2 The finishing process includes clinker crushing and addition blending.

The system boundary for the production of cement shall not include transportation of cement from SS or cement plants to the place of use.



NOTE Activities related to sales/administration and/or other related activities in plant operation might have to be considered.

Figure 2 — System boundary of cement production

4.2.2 Additions and admixtures

The system boundary related to the production of additions and admixtures is generally expressed in Figures 3 and 4, respectively.

The system boundary for the production of additions and admixtures shall include the following:

— transportation and storage of raw materials;

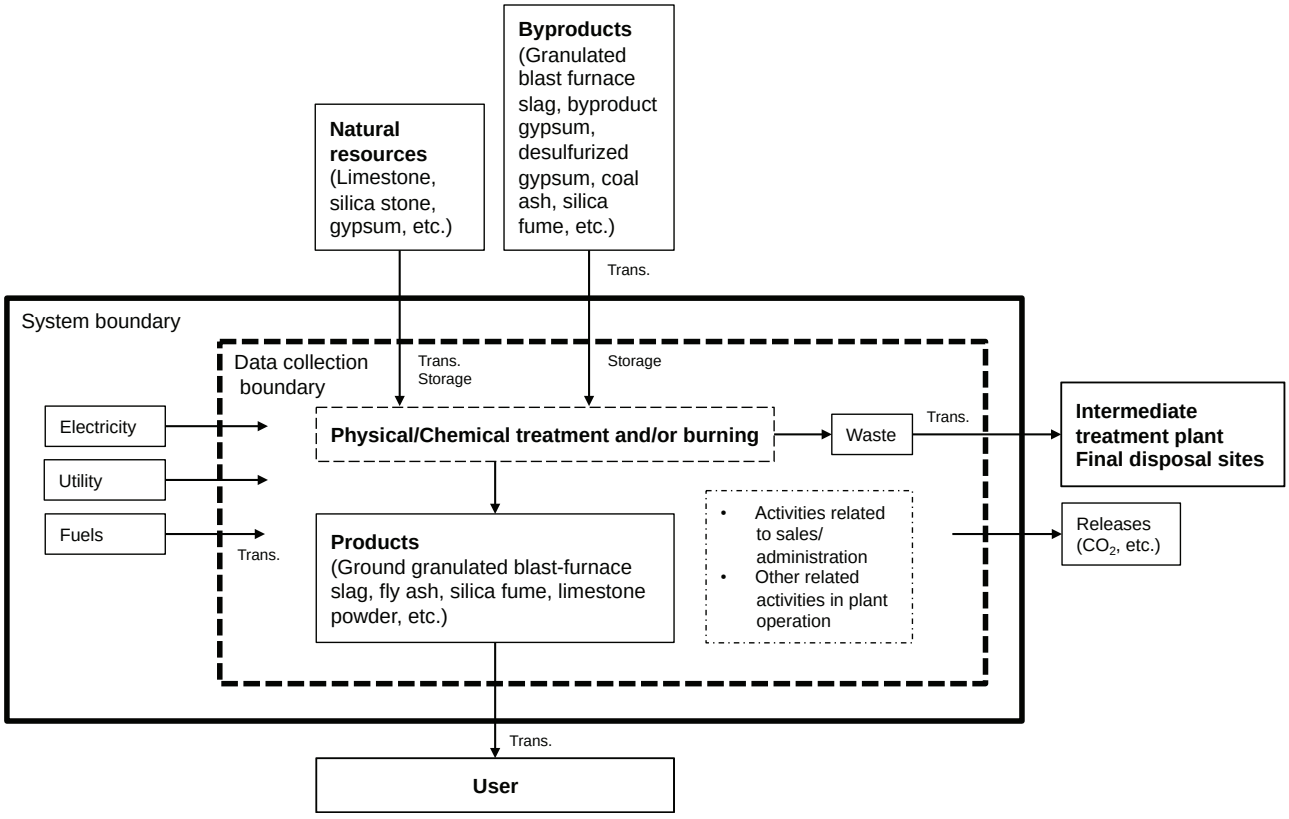
— transportation of fuels necessary for the production of additions and admixtures;

— physicochemical treatment of raw materials at addition and admixture production plants;

— transportation of waste to intermediate treatment sites and/or final disposal sites.

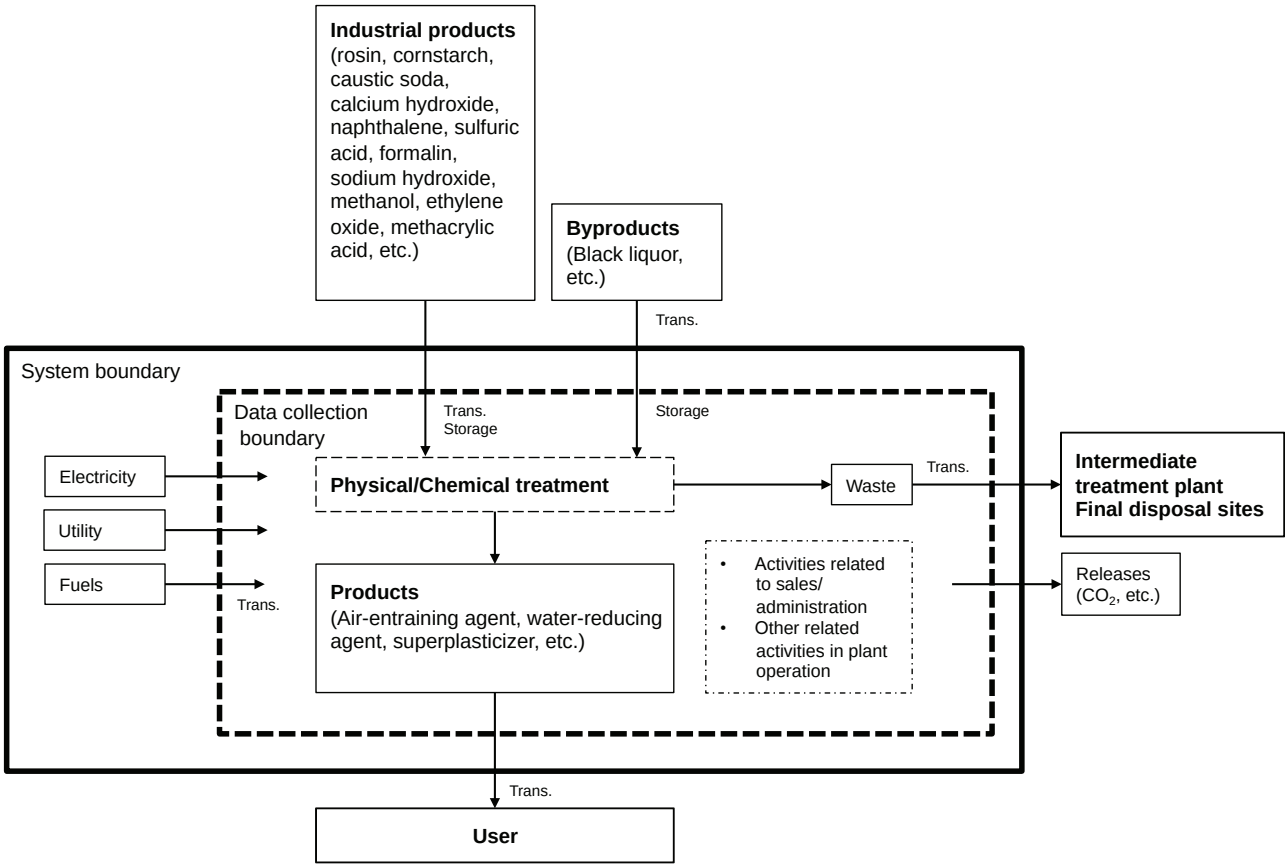
NOTE Since the combinations of raw materials for concrete admixtures widely vary, it is advisable to define the system boundary based on whether the raw materials are supplied at the expense of the user or the supplier.

Transportation of additions and admixtures from their production plants to the place of use shall not be included in the system boundary.



NOTE Activities related to sales/administration and/or other related activities in plant operation might have to be considered.

Figure 3 — System boundary of additions



NOTE Activities related to sales/administration and/or other related activities in plant operation might have to be considered.

Figure 4 — System boundary of admixtures

4.2.3 Aggregate

The system boundary related to the production of aggregate is generally expressed in Figures 5, 6, and 7.

The system boundary for the production of aggregate shall include the following:

— mining and transportation of natural resources;

— transportation of fuels necessary for the production of aggregate;

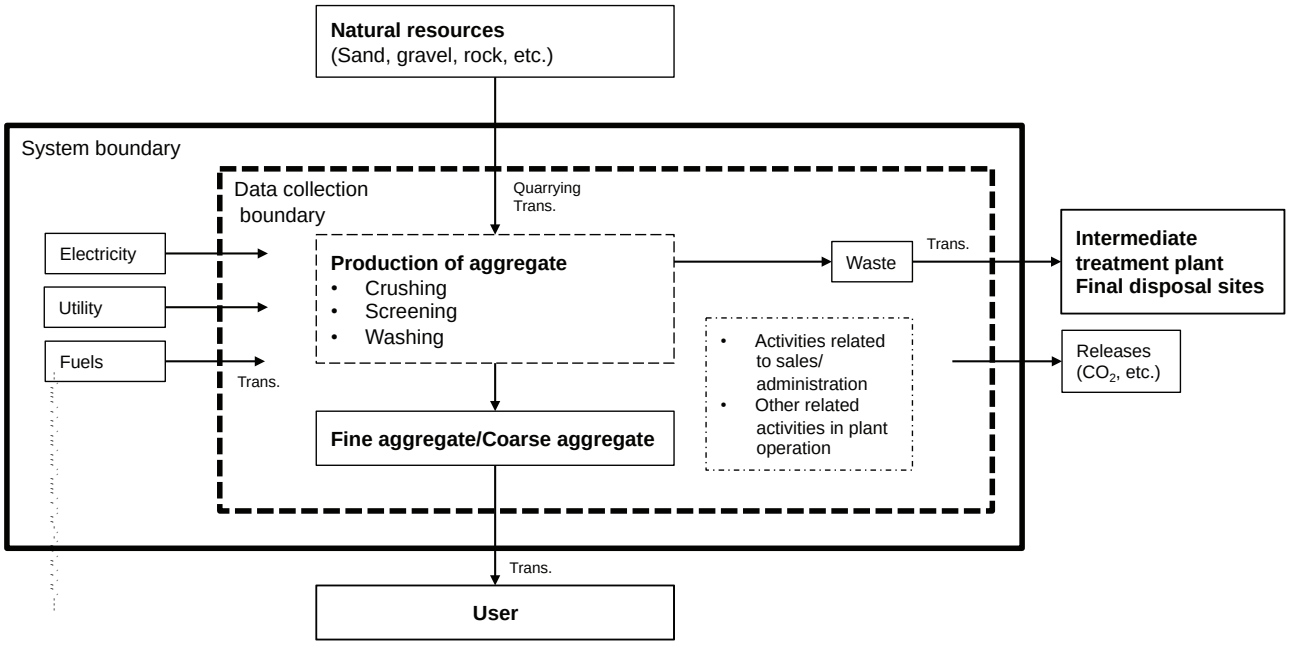
— all processes related to the production of aggregate;

— transportation of waste generated in the process of aggregate production to intermediate treatment plants and/or final disposal sites.

The system boundary for the production of aggregate shall not include the following:

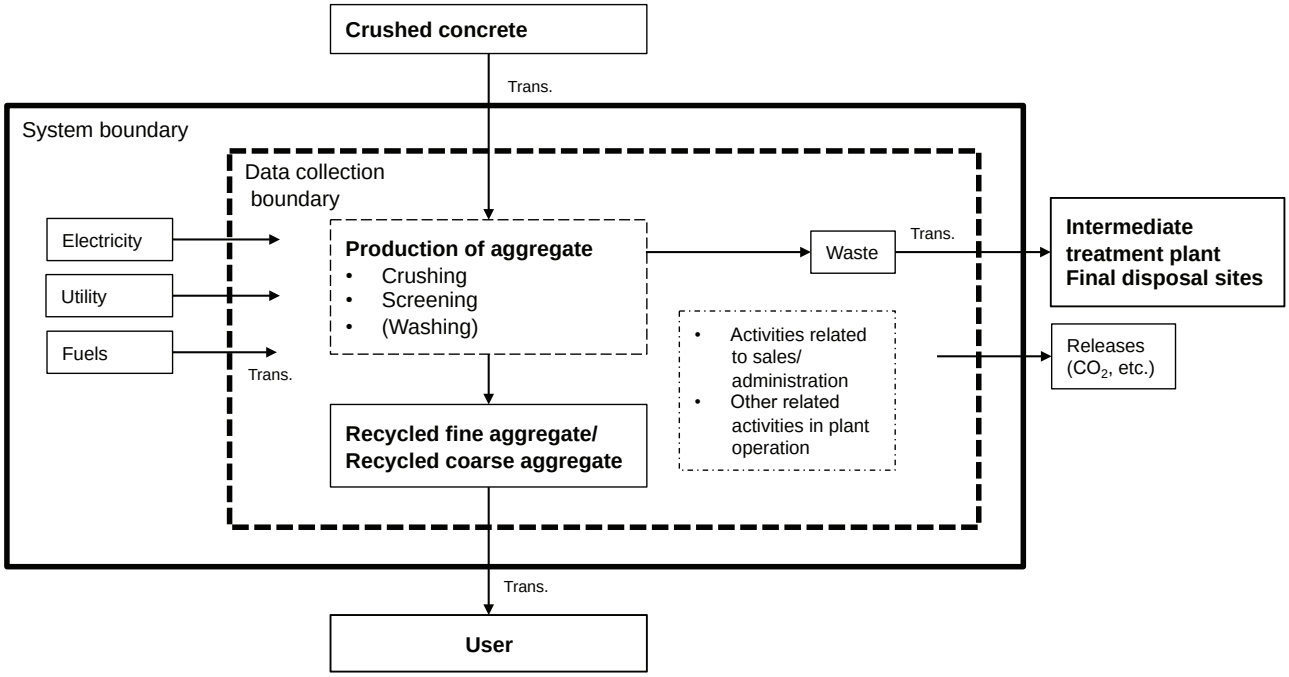
— transportation of crushed concrete and byproducts necessary for the production of aggregate;

— transportation of aggregate from aggregate production plants to the place of use.



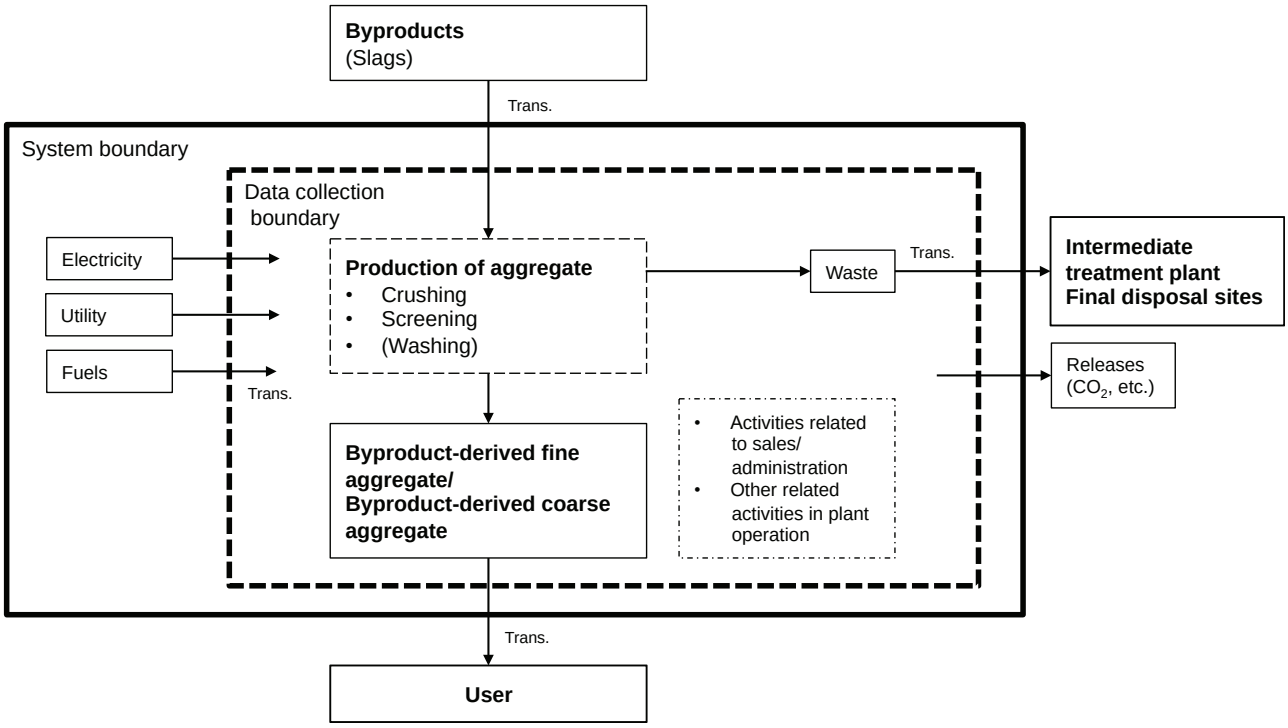
NOTE Activities related to sales/administration and/or other related activities in plant operation might have to be considered.

Figure 5 — System boundary of natural resource-derived aggregate



NOTE Activities related to sales/administration and/or other related activities in plant operation might have to be considered.

Figure 6 — System boundary of recycled aggregate



NOTE Activities related to sales/administration and/or other related activities in plant operation might have to be considered.

Figure 7 — System boundary of byproduct-derived aggregate

4.2.4 Other materials

The system boundary related to the production of other materials such as non-metallic fibres, non-metallic fibre-reinforced plastics, etc., shall be appropriately set.

4.3 Reinforcing and prestressing steel

The system boundary related to the production of reinforcing and prestressing steel is generally expressed in Figure 8.

NOTE Relevant standards such as ISO 14404-1 and ISO 14404-2 can be used.

The system boundary for the production of reinforcing and prestressing steel shall include the following:

— transportation of raw materials;

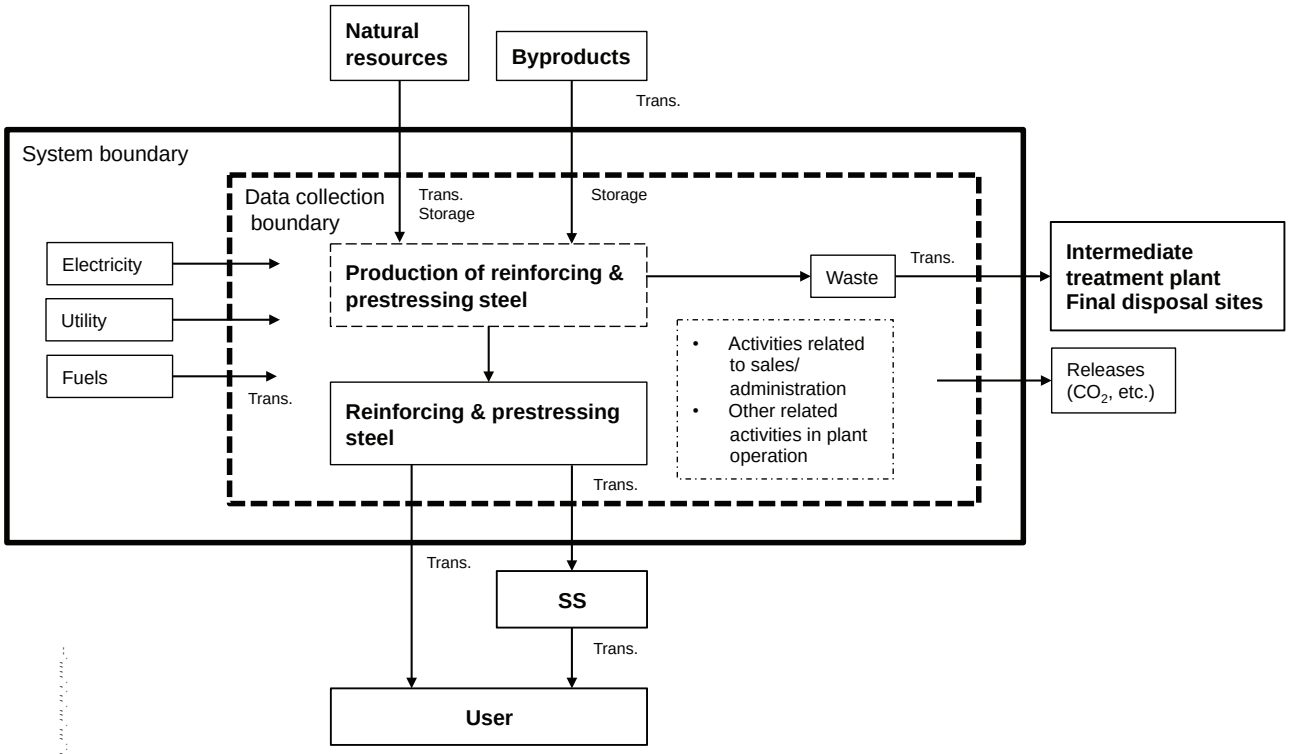
— transportation of fuels necessary for the production of reinforcing and prestressing steel;

— all processes related to the production of reinforcing and prestressing steel;

— transportation of waste generated in the process of reinforcing and prestressing steel production to intermediate treatment plants and/or final disposal sites;

— transportation of reinforcing and prestressing steel from plants to supply stations (SS).

Transportation of reinforcing and prestressing steel from the production plants or SS to the place of use shall not be included in the system boundary.



NOTE Activities related to sales/administration and/or other related activities in plant operation might have to be considered.

Figure 8 — System boundary of reinforcing and prestressing steel

4.4 Formwork, falsework, and machinery

The system boundary related to the production of formwork/falsework components and machinery is generally expressed in Figure 9.

The system boundary for the production of formwork/falsework components and machinery shall include the following:

— transportation of natural resources;

— transportation of fuels necessary for the production of formwork/falsework components and machinery;

— all processes related to the production of formwork/falsework components and machinery;

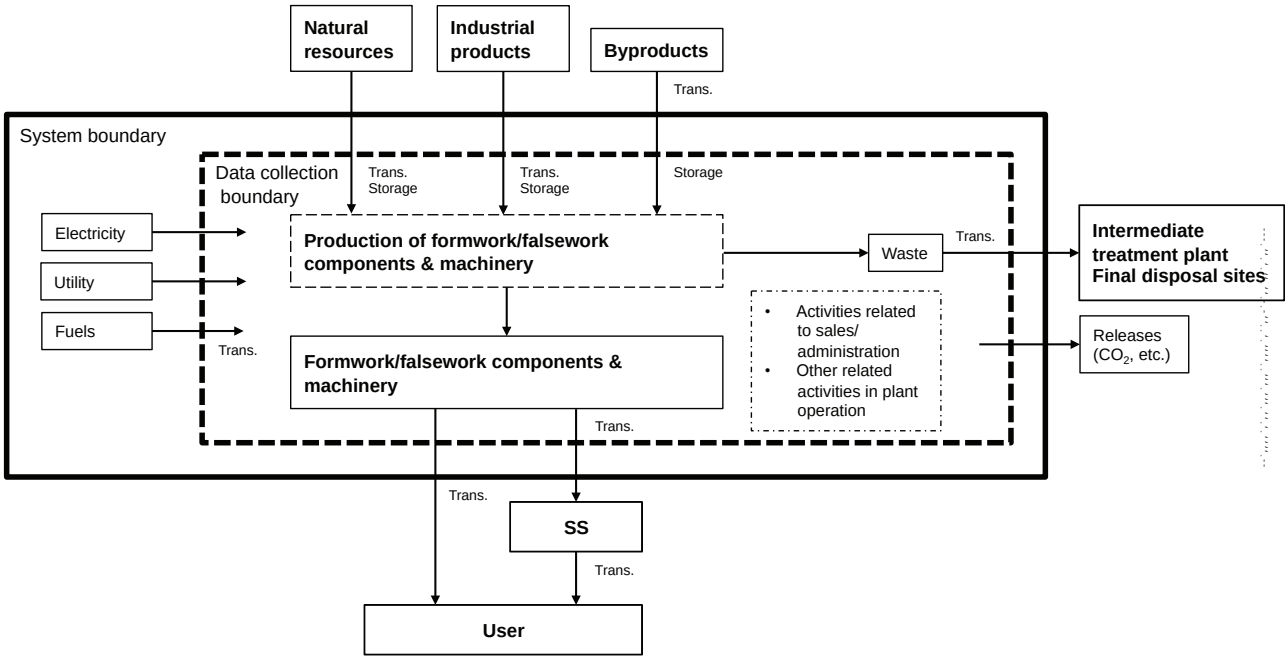
— transportation of waste generated in the process of the production of formwork/falsework components and machinery to the intermediate treatment plants and/or final disposal sites;

— transportation of formwork/falsework components and machinery from their production plants to supply stations (SS).

The system boundary for the production of formwork/falsework components and machinery shall not include the following:

— transportation of formwork/falsework components and machinery from their production plants or SS to the place of use;

— transportation of byproducts used for production of formwork/falsework components and machinery.



NOTE Activities related to sales/administration and/or other related activities in plant operation might have to be considered.

Figure 9 — System boundary of formwork/falsework components, and machinery

4.5 Concrete

The system boundary related to the production of concrete is generally expressed in Figure 10.

The system boundary for the production of concrete shall include the following:

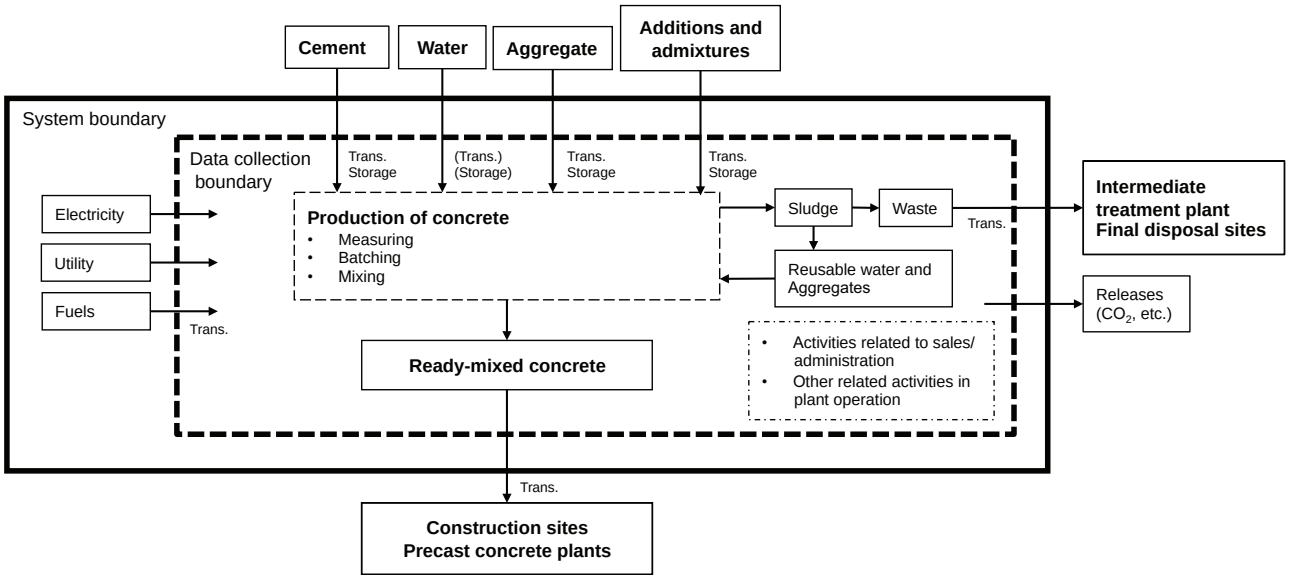
— transportation and storage of constituents;

— transportation of fuels necessary for the production of concrete;

— all processes related to the production of fresh concrete;

— in-plant treatment of waste generated in the production/supply process of concrete and transportation of such waste to intermediate treatment plants and/or final disposal sites.

Transportation of concrete from production plants to the place of use shall not be included in the system boundary.



NOTE Activities related to sales/administration and/or other related activities in plant operation might have to be considered.

Figure 10 — System boundary of concrete production

4.6 Precast concrete

The system boundary related to the production of precast concrete is generally expressed in Figure 11.

The system boundary for the production of precast concrete shall include the following:

— transportation and storage of constituents;

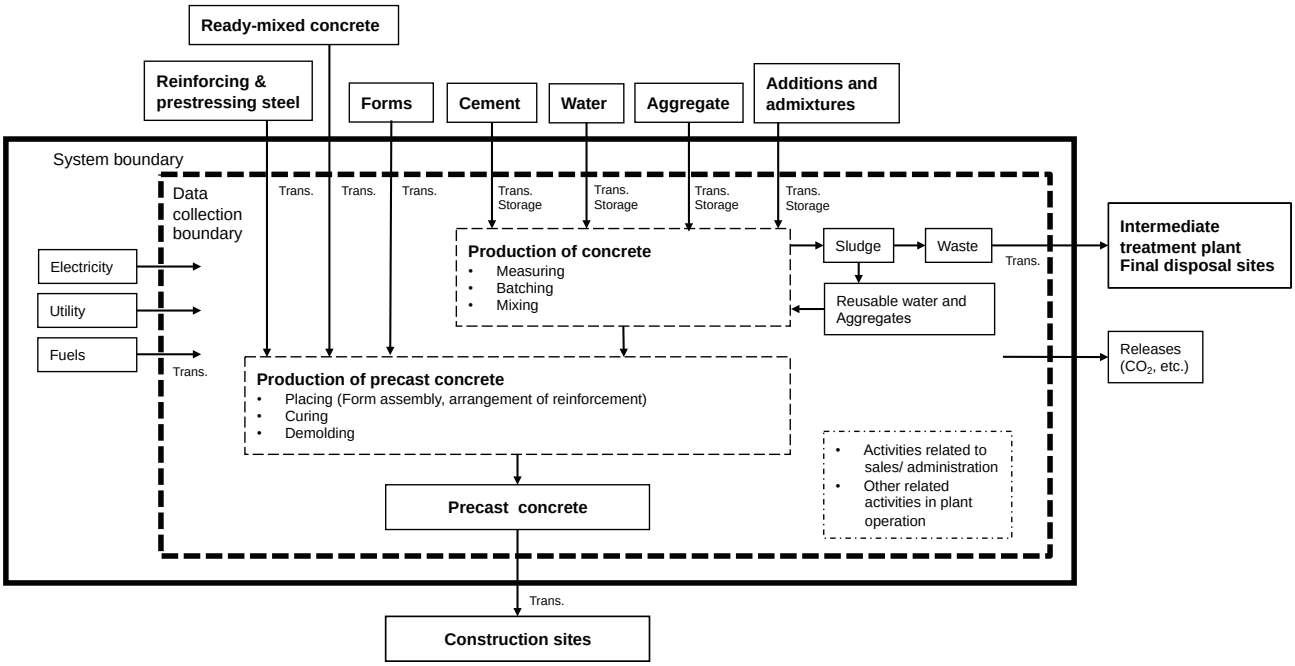
— transportation of fuels necessary for the production of precast concrete;

— all processes related to the production of fresh concrete;

— in-plant treatment of waste generated in the production/supply process of concrete and transportation of such waste to intermediate treatment plants and/or final disposal sites;

— in the production of precast concrete, the placement, consolidation, curing, and demoulding of concrete.

Transportation of precast concrete from production plants to the place of use shall not be included in the system boundary.



NOTE Activities related to sales/administration and/or other related activities in plant operation might have to be considered.

Figure 11 — System boundary of precast concrete production

4.7 Execution of concrete structures

4.7.1 Composing items

The system boundary related to the execution of concrete structures is generally expressed in Figure 12.

The execution of concrete structures is composed of

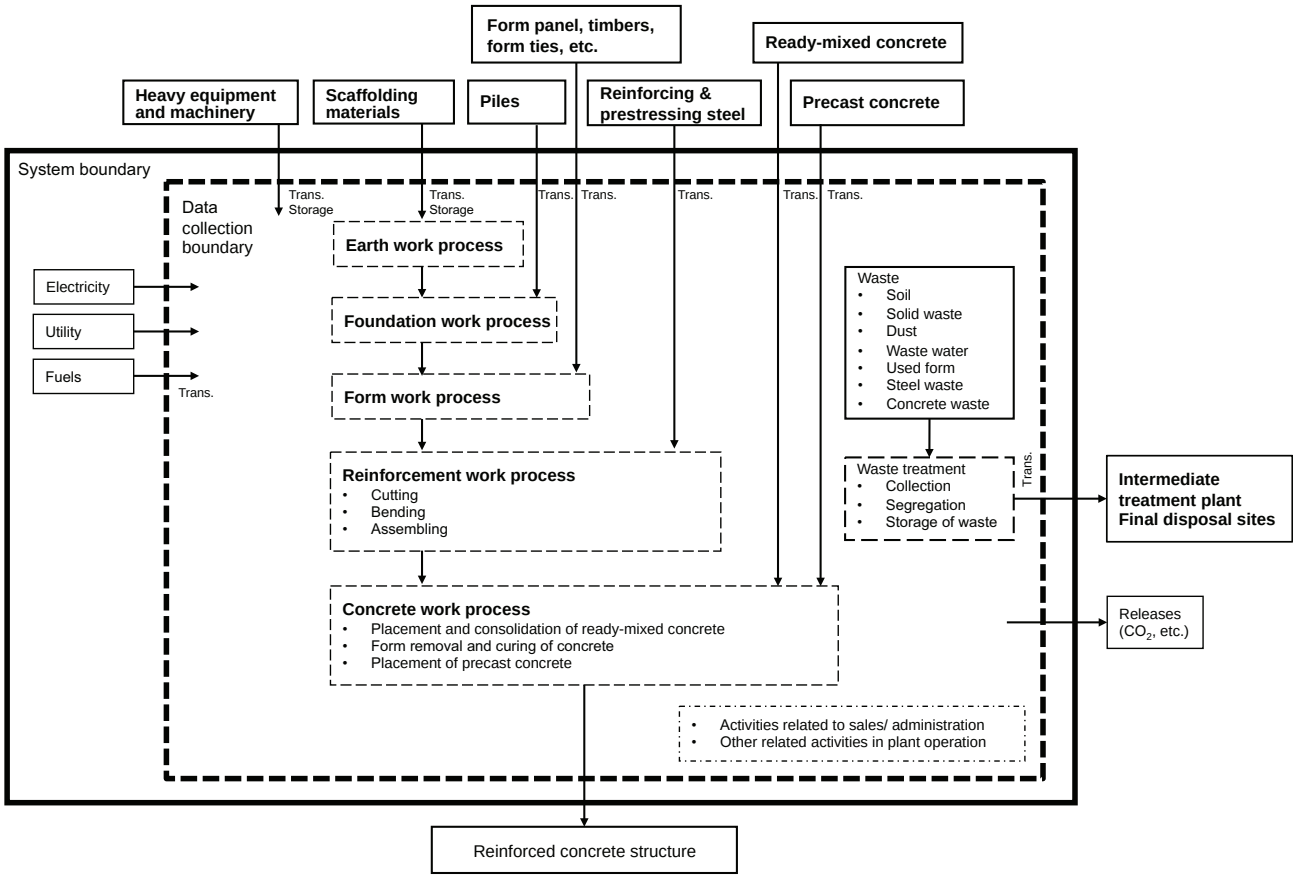
— earthwork and foundation work,

— formwork,

— reinforcement work,

— concreting work, and

— waste treatment.



NOTE Activities related to sales/administration and/or other related activities might have to be considered.

Figure 12 — System boundary of execution of concrete structures

4.7.2 Earthwork and foundation work

The system boundary related to the earthwork and foundation work shall include the following:

— transportation of scaffolding materials, piles, and other materials to the construction site;

— assembly of scaffolding materials for earthwork and foundation work;

— transportation, storage, and operation of heavy equipment and machinery necessary for earthwork and foundation work.

4.7.3 Formwork

The system boundary related to the formwork shall include the following:

— transportation of scaffolding, form panels, timbers, form ties, and other materials to the construction site;

— transportation, storage, and operation of heavy equipment and machinery necessary for formwork.

4.7.4 Reinforcement work

The system boundary related to the reinforcement work shall include the following:

— transportation of reinforcing and prestressing steel to the construction site;

— cutting, bending, and assembly of reinforcing and prestressing steel;

— transportation, storage, and operation of heavy equipment and machinery necessary for the execution of reinforcement work.

4.7.5 Concreting work

The system boundary related to the concreting work shall include the following:

— transportation of concrete and precast concrete;

— placement, consolidation, curing, and form removal of concrete;

— installation and jointing of precast concrete;

— transportation, storage, and operation of heavy equipment and machinery necessary for concreting work.

4.7.6 Waste treatment

The system boundary related to the treatment of waste generated during the execution of concrete structures shall include the following:

— collection, segregation, and storage of waste;

— transportation of waste to intermediate treatment plants and/or final disposal sites.

4.8 Use of concrete structures

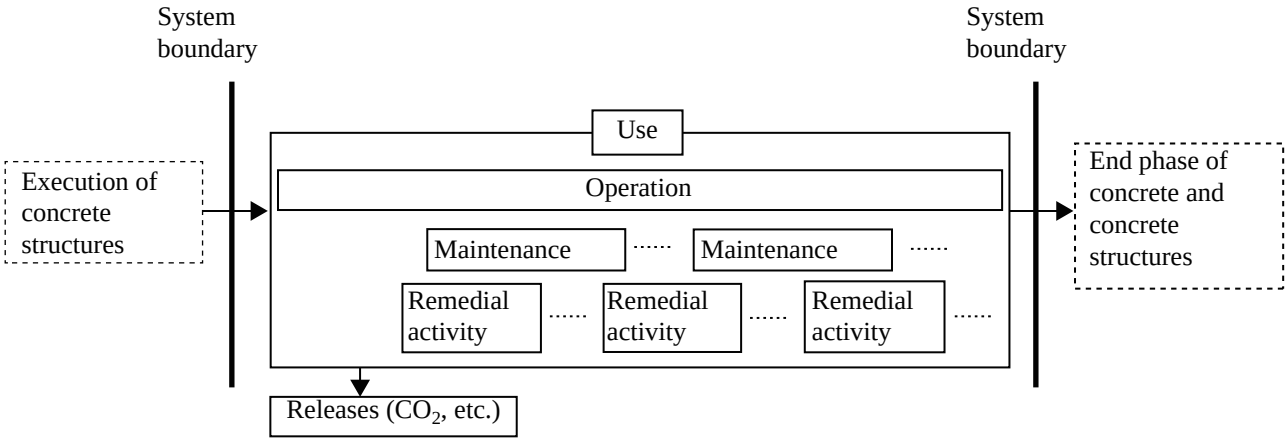
4.8.1 Composing items

The system boundary related to the use of concrete structures is generally expressed in Figure 13.

The use of concrete structures is composed of

— operation, and

— maintenance and remedial activity.



NOTE 1 When remedial activities are addressed, the system boundary can collectively include all remedial activities or can be individually defined for each remedial activity.

NOTE 2 The input of CO_2 into the system can be considered.

Figure 13 — System boundary of use of concrete structures

4.8.2 Operation

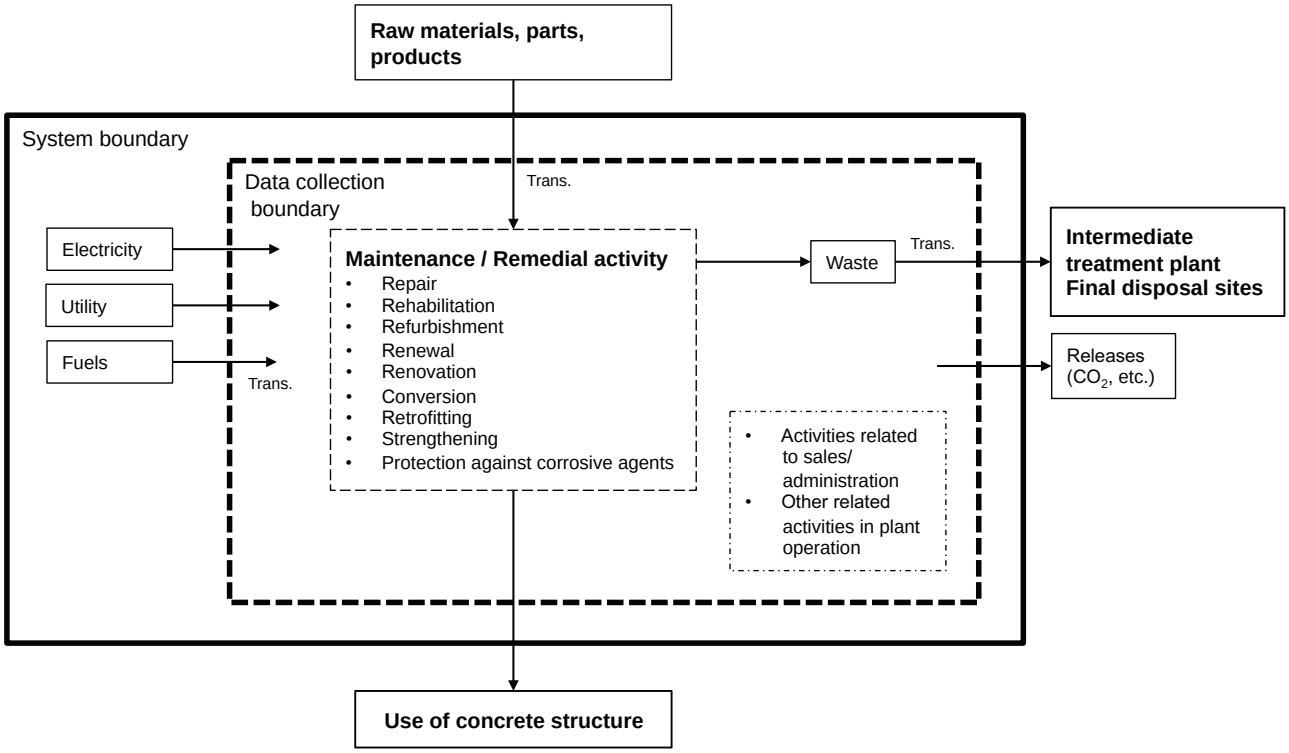
The system boundary for the operation of a concrete structure shall include the operation of any equipment installed in the concrete structure and contributing to the fulfilment of its function.

4.8.3 Maintenance and remedial activity

The system boundary related to the remedial activities is generally expressed in Figure 14.

The system boundary for the maintenance of concrete structures shall include the operation of vehicles and machinery necessary for maintenance.

The system boundary for the production of materials, members, and equipment/machinery necessary for remedial activities shall be defined according to 4.2 to 4.6.



NOTE Activities related to sales/administration and/or other related activities might have to be considered.

Figure 14 — System boundary of maintenance and each remedial activity

4.9 End phase of concrete and concrete structures

4.9.1 Composing items

The end phase of concrete and concrete structures is composed of

— demolition,

— intermediate treatment, and

— final disposal.

4.9.2 Demolition work

The system boundary related to the demolition work is generally expressed in Figure 15.

The system boundary for the demolition of concrete structures shall include the following:

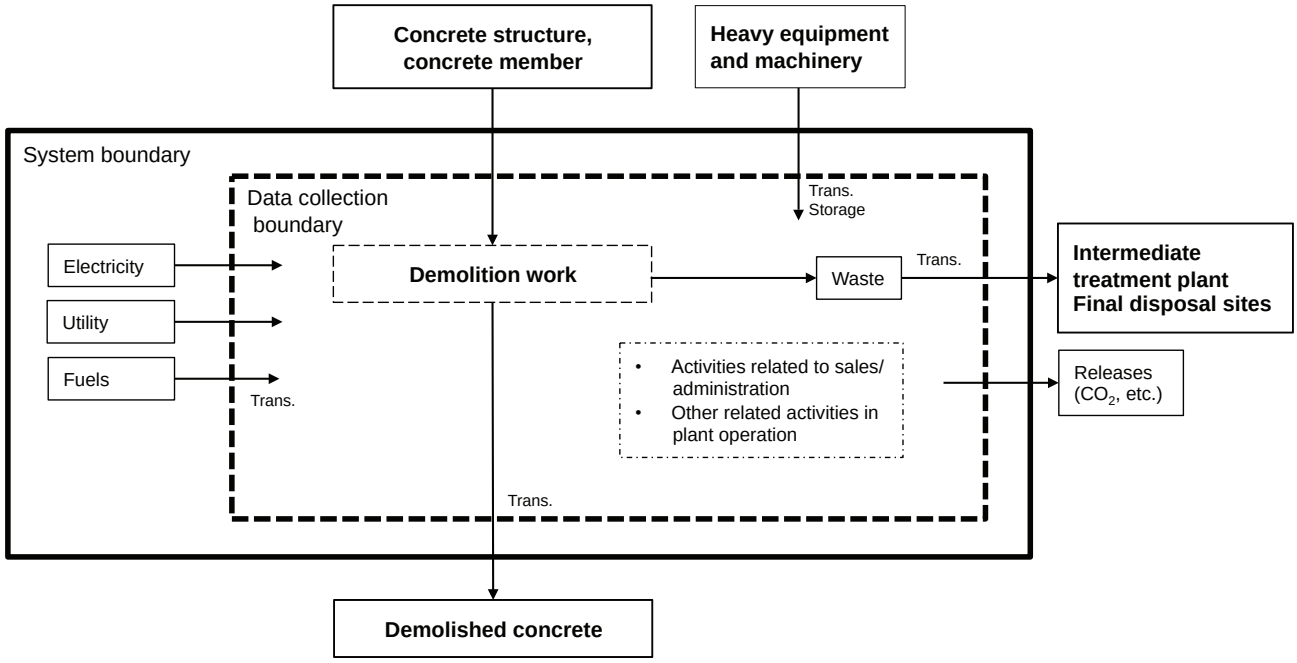
— transportation and operation of heavy equipment and machinery;

— transportation of releases such as explosives;

— transportation of fuel;

— storage of waste generated from demolition work;

— transportation of waste to intermediate treatment plants and/or final disposal sites.



NOTE Activities related to sales/administration and/or other related activities might have to be considered.

Figure 15 — System boundary of demolition work

4.9.3 Intermediate treatment

The system boundary related to the intermediate treatment is generally expressed in Figure 16.

The system boundary for intermediate treatment shall include the following:

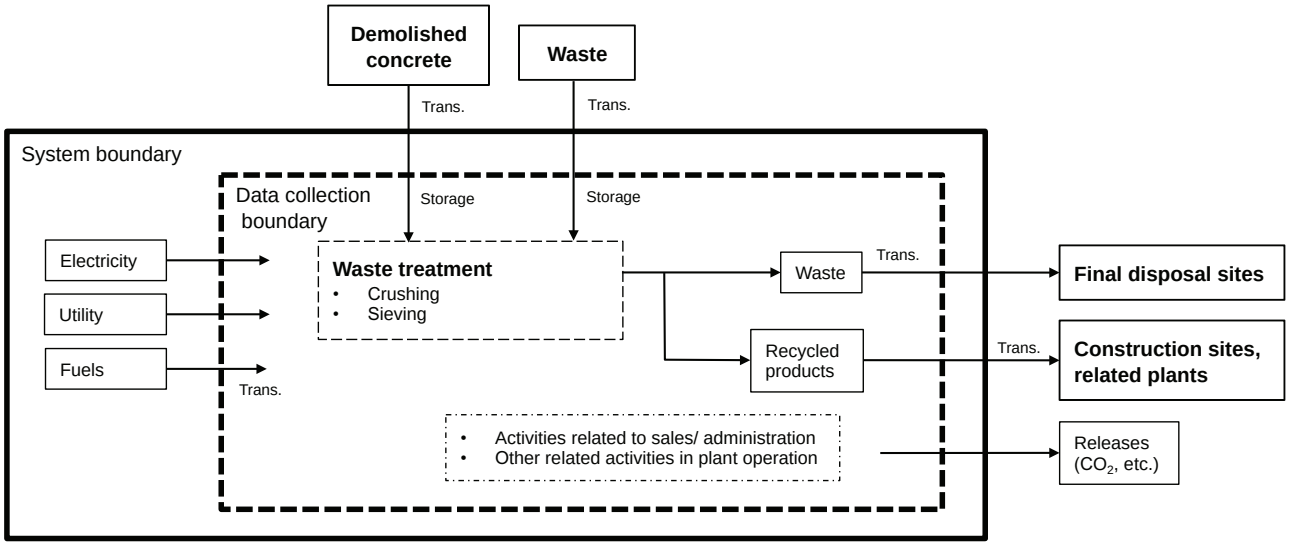
— storage of accepted waste;

— operation of heavy equipment and machinery;

— storage of waste generated from intermediate treatment;

— transportation of waste to final disposal sites.

Transportation of products produced by intermediate treatment shall not be included in the system boundary.



NOTE Activities related to sales/administration and/or other related activities in plant operation might have to be considered.

Figure 16 — System boundary of intermediate treatment

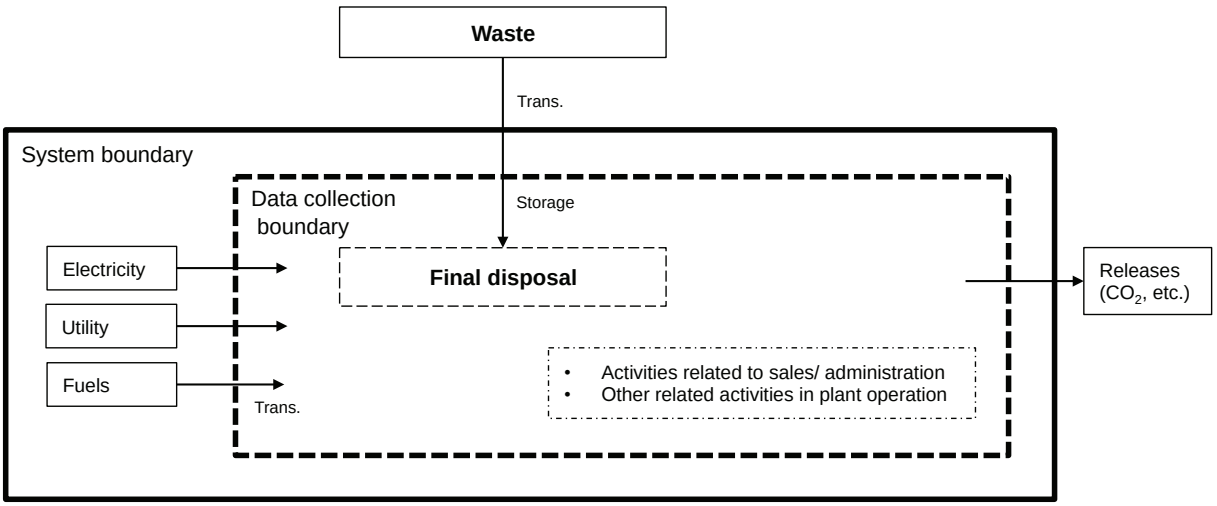
4.9.4 Final disposal

The system boundary related to the final disposal is generally expressed in Figure 17.

The system boundary for final disposal shall include the following:

— storage of accepted waste;

— operation of heavy equipment and machinery necessary for final disposal.



NOTE The input of CO_2 into the system can be considered.

Figure 17 — System boundary of final disposal

5 Inventory data

5.1 General

Inventory data necessary for calculating environmental impacts generated from activities carried out within a system boundary according to Clause 4 shall be acquired and calculated.

NOTE The activities include production of concrete materials, production of concrete and precast concrete, execution of concrete structures, use of concrete structures, demolition of concrete structures, and all or part of the life cycle of concrete structures.

Inventory data include the following:

— data on the types and amounts of resources, energy, materials, and components input into the system boundary;

NOTE Byproducts of other industries used as resources, energy, and materials are included.

— data on the types and amounts of constituents of concrete, concrete, concrete products, and concrete structures output from the system boundary;

— data on the types and amounts of environmental impact releases, such as CO_2 and NO_x, byproducts, and waste output from the system boundary.

NOTE The absorption of CO_2 into concrete and the reduction of energy consumption by thermal mass effect can be considered.

Direct and indirect input and output should be considered separately as inventory.

The amounts of resources and energy used per unit amount of concrete constituents, concrete, concrete products, or concrete structures produced, as well as the amounts of environmental impact releases, byproducts, and waste discharged per unit amount thereof, shall be calculated as unit-based inventory data.

NOTE Unit-based inventory data are necessary for the comparison of environmental impacts among products and structures and will be very useful information when producing a similar product or structure by a similar method or process in the future.

Inventory data shall be objective, transparent, and reproducible. In order to accurately acquire and calculate such inventory data, it is desirable to conduct actual condition surveys and trial experiments regarding resources, energy, materials, and components to be input, products and structures to be produced, and environmental impact releases, byproducts, and waste to be output. However, unit-based inventory data acquired and calculated in the past under the same conditions can be utilized if available. Also, reliable unit-based inventory data can be used, if available, with the consent of interested parties. The means, conditions, and information sources of the acquisition of inventory data and the calculation of unit-based inventory data shall be expressly indicated in writing.

Resources and energy input as raw materials and fuels shall be classified according to whether they are natural or byproduct- or waste-derived. Also, resources and energy shall be classified into recyclable and unrecyclable.

When the amounts of environmental impact releases generated using certain resources, energy, materials, or components are expected to be negligible with respect to the total amount of environmental impact releases generated within a defined system boundary, the calculation can be omitted. However, the uncalculated items and reasons for omitting calculation shall be expressly indicated.

When multiple products are produced in a single system boundary, the environmental impacts to be borne by each product shall be reasonably prorated according to the proportions of production, economic value, etc. Also, when using byproducts from other industries or when supplying byproducts to other

industries, the environmental impacts can be prorated by a method agreed upon with those industries. The method of proration shall be expressly indicated.

NOTE ISO 14044 can be used for the proration.

5.2 Constituents

5.2.1 Cement

Direct input includes the following:

— exhaustible natural resources used as raw materials of cement production;

— byproduct- or waste-derived resources used as raw materials of cement production;

— raw materials and fuels input for production of purchased clinker;

— fossil fuels used in kilns;

— alternative fossil fuels used in kilns;

— biomass fuels used in kilns;

— fuels used in other than kilns;

— wastewater input into kilns;

— purchased electricity used for cement production.

Indirect input includes the following:

— purchased electricity used in other than cement production;

— fuels input into the production and processing of fossil-derived fuels;

— fuels input into the processing of alternative fossil fuels and biomass fuels;

— fuels input into third parties' transportation for input and output.

Direct output includes the following:

— output from calcination of carbonates used for cement production;

— output from combustion of organic carbon contained in raw materials used for cement production;

— output from kiln combustion of fossil fuels;

— output from kiln combustion of alternative fossil fuels;

— output from kiln combustion of biomass fuels;

— output from combustion of fuels used in other than kilns;

— output from combustion of carbon contained in wastewater input in cement production;

— noise, vibration, and odorous smell generated from cement production;

— dust generated from cement production.

Biomass fuel can be considered to be nearly carbon neutral. The utilization of biomass fuel and the releases from that should be reported.

NOTE 1 Fuels used in other than kiln include those necessary for the operation of thermal process facilities, vehicles, HVAC (heating, ventilating, and air conditioning) equipment, etc.

NOTE 2 When wastewater is thrown into kiln, it is not normally regarded.

Indirect output includes the following:

— output from generation of external power used at cement plants;

— output from external clinker production when clinker is purchased and crushed in-house;

— output from the production and processing of fossil-derived fuels;

— output from the processing of alternative fossil fuels and biomass fuels;

— output from third parties' transportation for input (raw materials, fuels, etc.) and output (cement, clinker, etc.).

5.2.2 Additions and admixtures

Direct input includes the following:

— exhaustible natural resources as raw materials of addition and admixture production;

— byproduct- and waste-derived resources as raw materials of addition and admixture production;

— raw materials for additions and admixtures as industrial products;

— purchased electricity used for additions and admixture production;

— fossil fuels used for addition and admixture production;

— alternative fossil fuels used for addition and admixture production;

— biomass fuels used for addition and admixture production;

— fuels for in-house power generation to be used for addition and admixture production.

Indirect input includes the following:

— purchased electricity used in other than addition and admixture production

— fuels used in other than addition and admixture production;

— raw materials and fuels used for production as industrial products;

— fuels used for production and processing of fossil-derived fuels;

— fuels used for processing of alternative fossil fuels and biomass fuels;

— fuels used for third parties' transportation for input and output.

Direct output includes the following:

— solid waste generated from addition and admixture production;

— liquid waste generated from addition and admixture production;

— output from combustion of fossil fuels used for addition and admixture production;

— output from combustion of alternative fossil fuels used for addition and admixture production;

— output from combustion of biomass fuels used for addition and admixture production;

— output from combustion of fuels for in-house power generation used for addition and admixture production;

— noise, vibration, and odorous smell generated from addition and admixture production;

— dust generated from addition and admixture production.

Indirect output includes the following:

— output from generation of external power used at addition and admixture production plants;

— output from combustion of fuels used in other than addition and admixture production;

— output from combustion of fuels used for production of industrial products;

— output from combustion of fuels used for production and processing of fossil-derived fuels;

— output from combustion of fuels used for processing of alternative fossil fuels and biomass fuels;

— output from combustion of fuels used for third parties' transportation for input and output.

5.2.3 Aggregate

Direct input includes the following:

— exhaustible natural resources used as raw materials of aggregate production;

— byproduct- and waste-derived resources used as raw materials of aggregate production;

— purchased electricity used for aggregate production;

— water used for aggregate production;

— fossil fuels used for aggregate production;

— alternative fossil fuels used for aggregate production;

— biomass fuels used for aggregate production;

— fuels for in-house power generation to be used for aggregate production.

Indirect input includes the following:

— purchased electricity for uses other than aggregate production;

— fuels used in other than aggregate production;

— fuels used for production and processing of fossil-derived fuels;

— fuels used for processing of alternative fossil fuels and biomass fuels;

— fuels used for third parties' transportation for input and output.

Direct output includes the following:

— solid waste generated from aggregate production;

— wastewater generated from aggregate production;

— output from combustion of fossil fuels used for aggregate production;

— output from combustion of alternative fossil fuels used for aggregate production;

— output from combustion of biomass fuels used for aggregate production;

— output from combustion of fuels for in-house power generation to be used for aggregate production;

— noise, vibration, and odorous smell generated from aggregate production;

— dust generated from aggregate production.

Indirect output includes the following:

— output from generation of external power used at aggregate production plants;

— output from combustion of fuels used in other than aggregate production;

— output from combustion of fuels used for production and processing of fossil-derived fuels;

— output from combustion of fuels used for processing of alternative fossil fuels and biomass fuels;

— output from combustion of fuels used for third parties' transportation for input and output.

5.2.4 Other materials

Direct and indirect input and output related to other materials shall be appropriately considered.

5.3 Reinforcing and prestressing steel

Direct input includes the following:

— exhaustible natural resources used as raw materials of reinforcing and prestressing steel production;

— byproduct- and waste-derived resources used as raw materials of reinforcing and prestressing steel production;

— purchased electricity used for reinforcing and prestressing steel production;

— fossil fuels used for reinforcing and prestressing steel production;

— alternative fossil fuels used for reinforcing and prestressing steel production;

— biomass fuels used for reinforcing and prestressing steel production;

— fuels for in-house power generation to be used for reinforcing and prestressing steel production.

Indirect input includes the following:

— purchased electricity used in other than reinforcing and prestressing steel production;

— fuels used in other than reinforcing and prestressing steel production;

— water for producing granulated blast-furnace slag;

— sand for producing cast metal;

— fuels used for production and processing of fossil-derived fuels;

— fuels used for processing of alternative fossil fuels and biomass fuels;

— fuels used for third parties' transportation for input and output.

Direct output includes the following:

— solid waste generated from reinforcing and prestressing steel production;

— wastewater generated from reinforcing and prestressing steel production;

— output from combustion of fossil fuels used for reinforcing and prestressing steel production;

— output from combustion of alternative fossil fuels used for reinforcing and prestressing steel production;

— output from combustion of biomass fuels used for reinforcing and prestressing steel production;

— output from combustion of fuels for in-house power generation to be used for reinforcing and prestressing steel production;

— noise, vibration, and odorous smell generated from reinforcing and prestressing steel production;

— dust generated from reinforcing and prestressing steel production.

Indirect output includes the following:

— output from generation of external power used at reinforcing and prestressing steel production plants;

— wastewater generated from production of granulated blast-furnace slag;

— waste sand generated from production of cast metal;

— output from combustion of fuels used in other than reinforcing and prestressing steel production;

— output from combustion of fuels used for production and processing of fossil-derived fuels;

— output from combustion of fuels used for processing of alternative fossil fuels and biomass fuels;

— output from combustion of fuels used for third parties' transportation for input and output.

Information provided by reinforcing and prestressing steel manufacturers can be used as inventory data on reinforcing and prestressing steel.

5.4 Formwork, falsework, and machinery

Direct input includes the following:

— exhaustible natural resources used as raw materials for production of formwork, falsework, and machinery;

— byproduct- and waste-derived resources as raw materials for production of formwork, falsework, and machinery;

— industrial products used as materials for production of formwork, falsework, and machinery;

— purchased electricity used for production of formwork, falsework, and machinery;

— fossil fuels used for production of formwork, falsework, and machinery;

— alternative fossil fuels used for production of formwork, falsework, and machinery;

— biomass fuels used for production of formwork, falsework, and machinery;

— fuels for in-house power generation to be used for production of formwork, falsework, and machinery.

Indirect input includes the following:

— purchased electricity used in other than production of formwork, falsework, and machinery;

— fuels used in other than production of formwork, falsework, and machinery;

— raw materials and fuels for production of the industrial products;

— fuels used for production and processing of fossil-derived fuels;

— fuels used for processing of alternative fossil fuels and biomass fuels;

— fuels used for third parties' transportation for input and output.

Direct output includes the following:

— solid waste generated from production of formwork, falsework, and machinery;

— wastewater generated from production of formwork, falsework, and machinery;

— output from combustion of fossil fuels used for production of formwork, falsework, and machinery;

— output from combustion of alternative fossil fuels used for production of formwork, falsework, and machinery;

— output from combustion of biomass fuels used for production of formwork, falsework, and machinery;

— output from combustion of fuels for in-house power generation to be used for production of formwork, falsework, and machinery;

— noise, vibration, and odorous smell generated from production of formwork, falsework, and machinery;

— dust generated from production of formwork, falsework, and machinery.

Indirect output includes the following:

— output from generation of external power used in formwork, falsework, and machinery production plants;

— output from combustion of fuels used in other than production of formwork, falsework, and machinery;

— output from combustion of fuels used for production of industrial products;

— output from combustion of fuels used for production and processing of fossil-derived fuels;

— output from combustion of fuels used for processing of alternative fossil fuels and biomass fuels;

— output from combustion of fuels used for third parties' transportation for input and output.

Information provided by the manufacturers of formwork/falsework components and machinery can be used as inventory data on formwork, falsework, and machinery.

5.5 Production of concrete

Direct input includes the following:

— exhaustible natural resources as raw materials for concrete production;

— byproduct- and waste-derived resources as raw materials for concrete production;

— purchased electricity used for concrete production;

— fossil fuels used for concrete production;

— alternative fossil fuels used for concrete production;

— biomass fuels used for concrete production;

— fuels for in-house power generation to be used for concrete production.

Indirect input includes the following:

— purchased electricity used in other than concrete production;

— water used in other than concrete production;

— fuels used in other than concrete production;

— fuels used for production and processing of fossil-derived fuels;

— fuels used for processing of alternative fossil fuels and biomass fuels;

— fuels used for third parties' transportation for input and output.

Direct output includes the following:

— solid waste generated from concrete production;

— wastewater generated from concrete production;

— output from combustion of fossil fuels used for concrete production;

— output from combustion of alternative fossil fuels used for concrete production;

— output from combustion of biomass fuels used for concrete production;

— output from combustion of fuels for in-house power generation to be used for concrete production;

— noise, vibration, and odorous smell generated from concrete production;

— dust generated from concrete production.

Indirect output includes the following:

— output from generation of external power used in concrete production plants;

— output from combustion of fuels used in other than concrete production;

— output from combustion of fuels used for production and processing of fossil-derived fuels;

— output from combustion of fuels used for processing of alternative fossil fuels and biomass fuels;

— output from combustion of fuels used for third parties' transportation for input and output.

5.6 Execution of concrete structures

Direct input includes the following:

— exhaustible natural resources as raw materials for execution of concrete structures;

— byproduct- and waste-derived resources as raw materials for execution of concrete structures;

— industrial products used for execution of concrete structures;

— water for curing used for execution of concrete structures;

— purchased electricity used for execution of concrete structures;

— fossil fuels used for execution of concrete structures;

— biomass fuels used for execution of concrete structures;

— fuels for in-house power generation to be used for execution of concrete structures.

Indirect input includes the following:

— purchased electricity used in other than execution of concrete structures;

— water used for preventing dust scatter during execution of concrete structures;

— fuels used in other than execution of concrete structures;

— fuels used for production and processing of fossil-derived fuels;

— fuels used for processing of biomass fuels;

— fuels used for third parties' transportation for input and output.

Direct output includes the following:

— solid waste generated from execution of concrete structures;

— wastewater generated from execution of concrete structures;

— output from combustion of fossil fuels used for execution of concrete structures;

— output from combustion of biomass fuels used for execution of concrete structures;

— output from combustion of fuels for in-house power generation to be used for execution of concrete structures;

— noise, vibration, and odorous smell generated from execution of concrete structures;

— dust generated from execution of concrete structures.

Indirect output includes the following:

— output from generation of external power used in execution of concrete structures;

— output from combustion of fuels used in other than execution of concrete structures;

— output from combustion of fuels used for production and processing of fossil-derived fuels;

— output from combustion of fuels used for processing of biomass fuels;

— output from combustion of fuels used for third parties' transportation for input and output.

5.7 Use of concrete structures

Direct input includes the following:

— exhaustible natural resources as raw materials used for remedial activities of concrete structures;

— byproduct- and waste-derived resources as raw materials used for remedial activities for concrete structures;

— industrial products used for remedial activities for concrete structures;

— water for curing used for remedial activities for concrete structures;

— purchased electricity used for activities during the use of concrete structures;

— fossil fuels used for activities during the use of concrete structures;

— biomass fuels used for activities during the use of concrete structures;

— fuels for in-house power generation to be used for activities during the use of concrete structures.

Indirect input includes the following:

— purchased electricity used in other than the use of concrete structures;

— water used for preventing dust scatter during the use of concrete structures;

— fuels used in other than the use of concrete structures;

— fuels used for production and processing of fossil-derived fuels;

— fuels used for processing of biomass fuels;

— fuels used for third parties' transportation for input and output.

Direct output includes the following:

— solid waste generated from remedial activities for concrete structures;

— wastewater generated from remedial activities for concrete structures;

— output from combustion of fossil fuels for the use of concrete structures;

— output from combustion of biomass fuels for the use of concrete structures;

— output from combustion of fuels for in-house power generation for the use of concrete structures;

— noise, vibration, and odorous smell generated from remedial activities for concrete structures;

— dust generated from remedial activities for concrete structures;

— leaching, discharge, and release of deleterious or radioactive releases during the operation of concrete structures.

Indirect output includes the following:

— output from generation of external power for remedial activities of concrete structures;

— output from combustion of fuels used in other than the use of concrete structures;

— output from combustion of fuels used for production and processing of fossil-derived fuels;

— output from combustion of fuels used for processing of biomass fuels;

— output from combustion of fuels used for third parties' transportation for input and output.

NOTE The heat-storing effect of concrete during operation can be considered.

5.8 End phase of concrete and concrete structures

Direct input includes the following:

— waste to be input into the end phase of concrete and concrete structures;

— materials used for demolition;

— water used for demolition to prevent dust scatter;

— electricity used for the end phase of concrete and concrete structures;

— fossil fuels used for the end phase of concrete and concrete structures;

— biomass fuels used for the end phase of concrete and concrete structures;

— fuels for in-house power generation to be used for the end phase of concrete and concrete structures.

Indirect input includes the following:

— electricity used in other than direct activities at the end phase of concrete and concrete structures;

— fuels used in other than direct activities at the end phase of concrete and concrete structures;

— fuels used for production and processing of fossil-derived fuels;

— fuels used for processing of biomass fuels;

— fuels used for third parties' transportation for input and output.

Direct output includes the following:

— solid waste generated from the end phase of concrete and concrete structures;

— wastewater generated from the end phase of concrete and concrete structures;

— output from combustion of fossil fuels for the end phase of concrete and concrete structures;

— output from combustion of biomass fuels for the end phase of concrete and concrete structures;

— output from combustion of fuels for in-house power generation to be used for the end phase of concrete and concrete structures;

— noise, vibration, and odorous smell generated from the end phase of concrete and concrete structures;

— dust generated from the end phase of concrete and concrete structures;

— leaching of hazardous releases during the end phase of concrete and concrete structures.

Indirect output includes the following:

— output from generation of external power used at the end phase of concrete and concrete structures;

— output from combustion of fuels used in other than the end phase of concrete and concrete structures;

— output from combustion of fuels used for production and processing of fossil-derived fuels;

— output from combustion of fuels used for processing of biomass fuels;

— output from combustion of fuels used for third parties' transportation for input and output.

6 Critical review and its storage

The demarcation of system boundary and acquisition and calculation method of inventory data shall be subjected to critical reviews by internal or external experts. The provisions given in ISO 14025 shall apply. The results of critical reviews shall be maintained as a review statement.

Bibliography

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

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

[3] ISO 14404-1, *Calculation method of carbon dioxide emission intensity from iron and steel production — Part 1: Steel plant with blast furnace*

[4] ISO 14404-2, *Calculation method of carbon dioxide emission intensity from iron and steel production — Part 2: Steel plant with electric arc furnace (EAF)*

[5] ISO 21930, *Sustainability in buildings and civil engineering works — Environmental declaration of building products*

[6] ISO 21931-1, *Sustainability in building construction — Framework for methods of assessment of the environmental performance of construction works — Part 1: Buildings*

ICS 91.080.40;91.100.30;13.020.10

Price based on 28 pages