Building Information Modelling (BIM) — Data templates for construction objects used in the life cycle of any built asset — Concepts and principles

Contents

Foreword

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This document was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 442, *Building Information Modelling (BIM)*, in collaboration with ISO Technical Committee TC 59, *Buildings and civil engineering works*, Subcommittee SC 13, *Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM)*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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

Building information modelling (BIM) provides a digital technology for describing and displaying information required in the planning, design, construction and operation of constructed facilities. Increasingly this modelling approach is expanding to encompass all aspects of the built environment, including civil infrastructure, utilities and public space.

ISO 19650 (all parts) sets out the recommended concepts and principles for business processes across the built environment sector in support of the management and production of information during the life cycle of built assets when using building information modelling (BIM). To support the management and production of information in these business processes, standardization is of the highest importance. Machine-readable data is essential to provide a reliable and sustainable exchange of information in an asset life cycle process.

Data templates will enable construction project stakeholders to exchange information about construction objects through an asset life cycle, using the same data structure, terminology, and globally unique identifiers to enable machine-readability.

Data templates should be standardized and made available across the built environment sector through data dictionaries based on ISO 12006-3:2007*.*

Data templates should be used in conjunction with Industry Foundation Clauses (IFC) in ISO 16739:2018 to enable and support open BIM processes.

1   Scope

This document sets out the principles and structure for data templates for construction objects. It is developed to support digital processes using machine-readable formats using a standard data structure to exchange information about any type of construction object, e.g. product, system, assembly, space, building etc., used in the inception, brief, design, production, operation and demolition of facilities.

This document provides the specification of a taxonomy model that defines concepts from ISO 12006-3:2007, objects, collections, and relationships between them, to support the information need for the specific purpose of the data template.

This document provides an EXPRESS specification with extensions of the EXPRESS-G notation and specification from ISO 12006:2007. These extensions have been provided to support market needs developed since the publication of ISO 12006-3 in 2007.

This document provides the rules for linking between data templates and IFC classes within a data dictionary based on ISO 12006-3:2007.

This document provides the rules for linking between data templates and classification systems within a data dictionary based on ISO 12006-3:2007.

The target audience of this document is software developers, and not construction industry domain experts appointed to create data templates based on sources describing information needs.

It is not in the scope of this document to provide the content of any data templates. The data structure provided is intended to be used for developing specific data templates based on standards developed in ISO/IEC, CEN/CENELEC, national standardization organizations, or other sources describing information needs.

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 10303-11, Industrial automation systems and integration -- Product data representation and exchange -- Part 11: Description methods: The EXPRESS language reference manual

ISO 12006-3:2007, Building construction -- Organization of information about construction works -- Part 3: Framework for object-oriented information

3   Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
component
named and individually scheduled physical item and feature that might require management, such as inspection, maintenance, servicing or replacement, during the in-use phase

Note 1 to entry: Components can serve as interacting objects in a system.

[SOURCE: ISO 6707-1:2017, 3.4.1.4, modified – Note 1 to entry has been added.]

3.2
data dictionary
centralized repository of information about data such as meaning, relationships to other data, origin, usage and format

Note 1 to entry: the definition is from Dictionary of IBM & computing Terminology.

3.3
data template
data structure used to describe the characteristics of *construction object*s (3.4)

Note 1 to entry: The relevant scope of the data template canbe used together with the term "data template". E.g. a data template for a product can be named "product data template". A data template for a system can be named "system data template", etc.

Note 2 to entryA data template can be used in an information exchange for a specific purpose for a construction object in the inception, brief, design, production, operation and demolition of facilities.

EXAMPLE 1:   A data template provides a view based on an information exchange, e.g. a heating, ventilation, and air conditioning (HVAC) system designer is asking for the descriptions of the HVAC products that can be loaded into the design system.

EXAMPLE 2:   A data template provides manufacturers a standardized data structure that can be applied to any internal system and/or process of handling product data, e.g. one or several product information management systems can apply or map to this structure to enable machine readability, both internally and with any requests from any software using the same data template structure. An HVAC product manufacturer can then answer the request from any stakeholder including the HVAC system designer.

3.4
construction object
object of interest in the context of a construction process

EXAMPLE 1   The construction object "wall" is a type of system.

EXAMPLE 2   The construction object "calcium silicate masonry unit" is a type of product.

[SOURCE: ISO 12006-2:2015, 3.1.2, modified — EXAMPLEs 1 and 2 have been added.]

3.5
Enumerated type value
data type consisting of a set of named values called elements, members, enumeral, or enumerators of the type

3.6
globally unique identifier
GUID

5

unique identifier generated using an algorithm

Note 1 to entry: In ISO 16739-1 and ISO 12006-3 the compressed version of GUID is used.

[SOURCE: ISO/IEC 11578:1996]

3.7
group of properties
collection enabling the *properties* (3.10) to be prearranged or organized
Note 1 to entry: In this document group of properties is used for organizing properties through the use of xtdCollection.

[SOURCE: ISO 23386:2019, 3.14, modified – Note 1 has been added]

3.8
Industry Foundation Classes
IFC
conceptual data schema and exchange file format for Building Information Model (BIM) data

[SOURCE: ISO 16739:2013]

3.9
product
construction product
item manufactured or processed for incorporation in construction works

[SOURCE: ISO 6707-1:2017, 3.4.1.3]

3.10
property
inherent or acquired feature of an item

Note 1 to entry: When a property is named together with reference to a technical specification, where the instructions to assess the performance are available (usually standards), it is to be regarded as a specific property. The relationship between the property and the specific property is modelled as a parent child relationship.

EXAMPLE 1   Length, sound reduction index (properties).

EXAMPLE 2   Length according to EN 12058, sound reduction index according to ISO 10140-4 (specific properties).

[SOURCE: ISO 6707-1:2017, 3.7.1.3, modified – Note 1 to entry and EXAMPLEs 1 and 2 have been added.]

3.11
quantity
property of a phenomenon, body, or substance, where the property has a magnitude that can be expressed by means of a number and a reference

Note 1 to entry: Quantities can appear as base quantities or derived quantities.

EXAMPLE 1   Length, mass, electric current (ISQ base quantities).

EXAMPLE 2   Plane angle, force, power (derived quantities).

[SOURCE: ISO 80000-1:2013, 3.1, modified – Note 1 to entry and EXAMPLE 1 and 2 have been added]

3.12
reference document
publication that is consulted to find specific information, particularly in a technical or scientific domain

Note 1 to entry: A reference document can be associated with any data present in a data dictionary. It can include document date and version.

EXAMPLE EN 771-1:2011+A1:2015 Specification for masonry units, Part 1: Clay masonry units.

[SOURCE: ISO 23386, 3.18, modified – EXAMPLE has been added]

3.13
system
interacting objects organized to achieve one or more stated purpose

[SOURCE: ISO/IEC/IEEE 15288:2015]

3.14
UML
Unified Modelling Language

language to provide system architects, software engineers, and software developers with tools for analysis, design, and implementation of software-based systems as well as for modeling business and similar processes

[SOURCE: ISO/IEC 19505-1:2012]

3.15
unit
unit of measurement
measurement unit
real scalar *quantity* (3.11), defined and adopted by convention, with which any other quantity of the same kind can be compared to express the ratio of the second quantity to the first one as a number

[SOURCE: ISO 80000-1:2013, 3.9

4 Data template structure – UML diagram

Objects, collections and relationships are the basic entities of the model in ISO 12006-3:2007. A data template is a subset of this model, providing the concepts and relations needed to describe information about construction objects.

This clause provides the general structure of a data template, and how it is modelled in UML based on ISO/IEC 19505. The UML diagram in figure 1 provides the rules that apply to a data template established within a data dictionary based on ISO 12006-3:2007.

The concepts used in the UML diagram are in accordance with ISO 12006-3:2007, while in this document some of the concept names have been modified to better fit with market terminology. Table 1 provides the link between the terminology in this document and ISO 12006-3:2007.

Table 1 – ISO 23387 and ISO 12006-3:2007 naming relations

ISO 23387 names	ISO 12006-3 names
Data template	xtdBag

ISO 23387 names	ISO 12006-3 names
Reference document	xtdExternalDocument
Construction object	xtdSubject
Group of properties	xtdNest
Generic property	xtdProperty
Specific property	xtdProperty
Quantity	xtdMeasureWithUnit
Unit	xtdUnit
Enumerated value	xtdValue

The UML diagram in figure 1 provides the data structure for data templates using objects, collections, and relationships between them. The multiplicities in the UML diagram specifies the range of allowable cardinality values, giving a specification of a data template within a data dictionary.
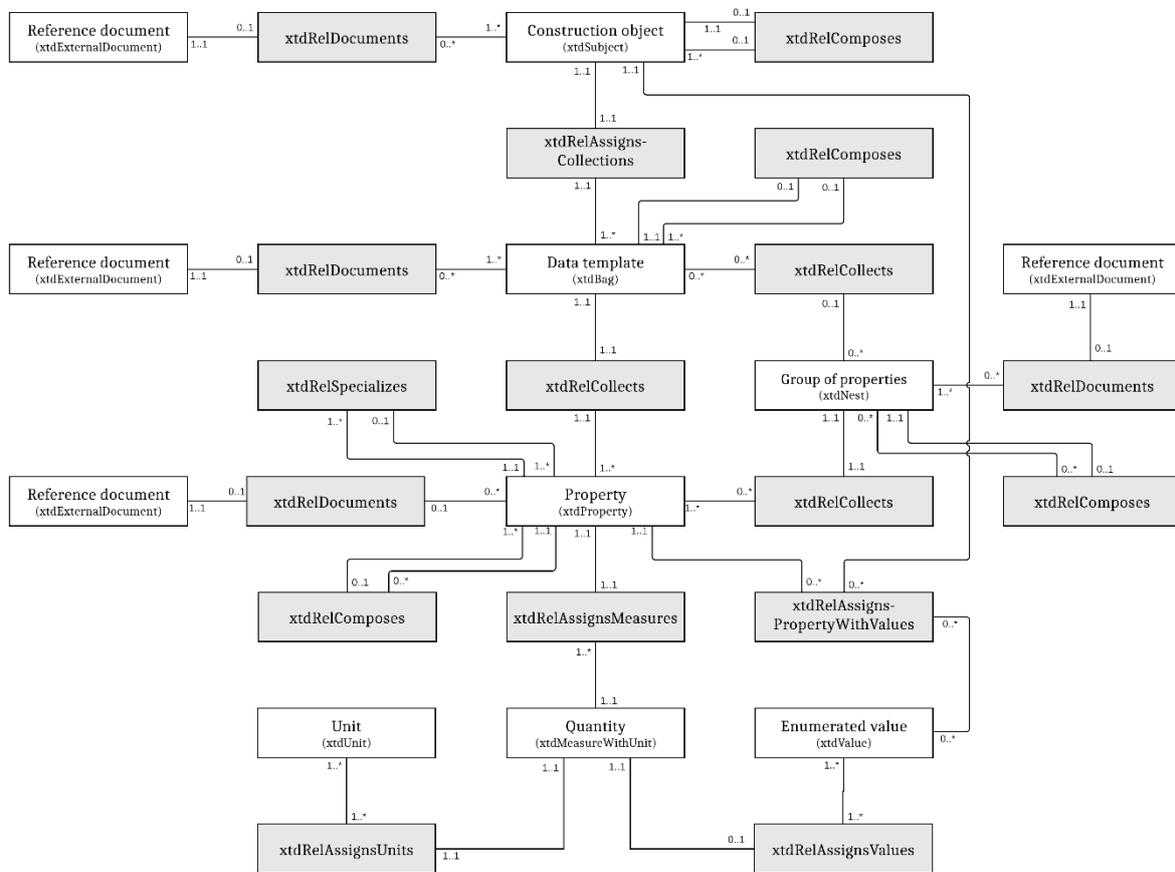

Figure 1 – The data template represented in UML

For the xtdRelSpecializes makes relations between properties and specializations of properties. The upper line refers to the abstract property, and the lower line refers to its specializations.

The names of the objects and collections according to ISO 12006-3:2007 are provided in brackets. The names of the relationships between objects and collections are provided only with names according to ISO 12006-3:2007.

The reference document concepts can represent different instances of reference documents related to different concepts. E.g. the reference document related to group of properties can be

different than a reference document related to one of the properties that belong to this group of properties.

The UML diagram supports dependencies between properties. This means that scenarios where a property value of one property is dependent on the value of another property, are supported. For this purpose, *xtdRelComposes* should be used as the relationship between the two properties.The diagram supports the relations between different data templates. This means the data structure allows for creating systems with components, e.g. a wall with products, an alarm system with components, a door with components etc. Relationships between different data templates should be made according to Table 2.

Table 2 – Relations between different data templates

Data template 1 concept	Relationship	Data template 2 concept
Data template	xtdRelComposes	Data template
Construction object	xtdRelComposes	Construction object

Annex B provides a UML representation of how the relationships in table 2 are used to relate data templates to each other

5   Linking data templates to IFC classes

The IFC schema contains entities with entity types, property sets with properties, and quantity sets with quantities that are implemented and used by BIM software tools. These parts of the IFC schema have been developed to support exchange of generic data about building elements. To enable support of local business needs, it is necessary to link the local business semantics to IFC. Data dictionaries and data templates support the description of any local business need, at any level of specific information need, and should therefore be used to describe the information needs in exchanges using IFC. This document describes one of the possible linking mechanisms, through creating relationship rules between IFC classes and data template concepts of relevance within a data dictionary based on ISO 12006-3:2007.

As a prerequisite for this linking mechanism, IFC classes of relevance shall be established in a data dictionary, using objects, collections and relationships according to ISO 12006-3:2007.

Table 3 provides IFC classes of relevance, the relationship used from ISO 12006-3:2007, and the data template objects of relevance:

Table 3 – IFC classes link to data template concepts

IFC class	ISO 12006-3 relationship	Data template concept
Entity/Entity type	xtdRelAssociates	Construction object
Property/quantity	xtdRelAssociates	Property/Specific property
MeasureWithUnit	xtdRelAssociates	Quantity

Figures 2-4 provides the same rules in UML. Objects and collections from the data template are linked to IFC classes of relevance using the relationship type xtdRelAssociates.
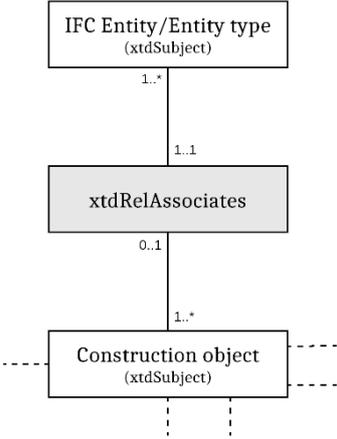
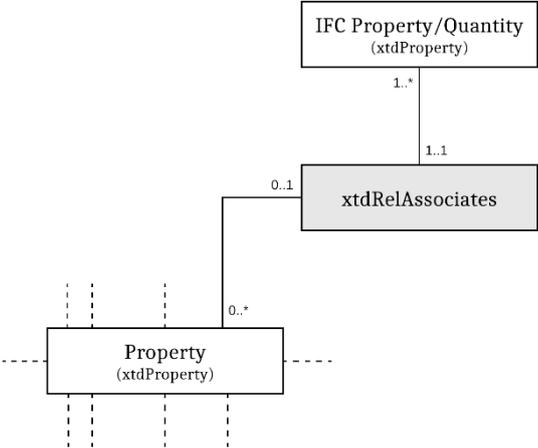**Figure 2 – Making a relationship between construction object and IFC Entity/Entity type**

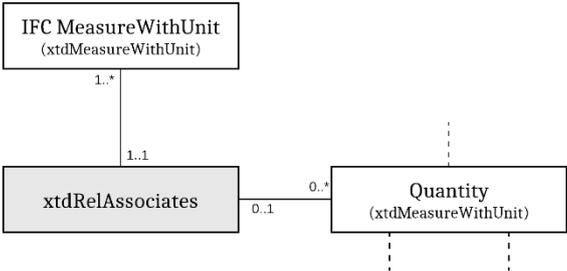**Figure 3 – Making a relationship between property and IFC property/quantity**

Figure 4 – Making a relationship between quantity and IFC MeasureWithUnit

6   Linking data templates to classification

With the digital change in the construction industry, and with the growing needs of exchanging information internationally, it is essential to find a connecting mechanism between different existing classification systems. Data templates within a data dictionary provide such a mechanism and enables interoperability between actors and software using existing classification systems within established work processes.

As a prerequisite for this linking mechanism, classification systems should be modelled in a data dictionary based on ISO 12006-3:2007 as the concept xtdClassification.

Table 4 provides classification levels, the relationship used from ISO 12006-3:2007, and the data template objects of relevance

Table 4 – Classification levels linked to Data template concepts

Classification	ISO 12006-3 relationship	Data template concept
Classification level	xtdRelClassifies	Data template
Classification level	xtdRelClassifies	Construction object
Classification level	xtdRelClassifies	Property

Figure 3 provides the same rules in UML. Objects and collections from the data template are linked using the relationship xtdRelClassifies.
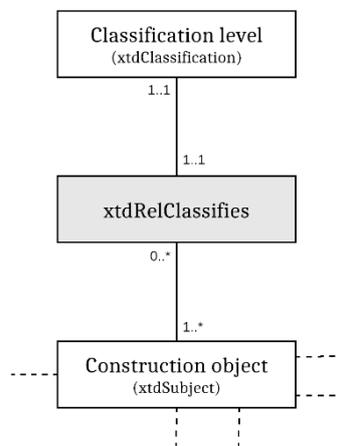
Figure 3 – Making a relationship between construction object and a classification level
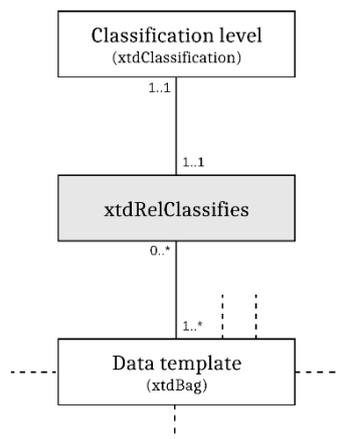
Figure 3 – Making a relationship between data template and a classification level
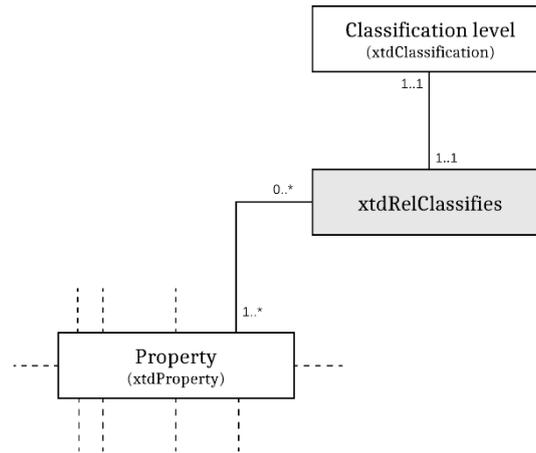
Figure 3 – Making a relationship between property and a classification level

7   EXPRESS specification

7.1   General

The model in this document is specified using the EXPRESS data definition language according to ISO 10303-11.

The model is described formally in the EXPRESS language specification presented in 7.2 and as an EXPRESS long form specification in 7.3.

The UML diagram in Figure 1 is based on the rules as defined in ISO 12006-3:2007, however it includes some extensions of the EXPRESS-G notation and specification from ISO 12006-3:2007. The formal specification in the language EXPRESS given in this clause describes the extensions which have been used.

Annex A provides the model with extension needs from this document, in accordance with the EXPRESS-G notation.

7.2   EXPRESS specification

7.2.1   General

This formal specification is provided in the EXPRESS language.

Express specification

(*
EN_ISO_23387_VERSION_1

EXPRESS specification:
*)
SCHEMA EN_ISO_23387_VERSION_1;
(*

7.2.2   xtdClassification

xtdClassification is a specialization of xtdObject that is used to classify an xtdObject.

EXPRESS specification:

```
*)
        ENTITY xtdClassification
                SUBTYPE OF (xtdObject)
        END_ENTITY;
(*
```

7.2.3 xtdRelClassifies

xtdRelClassifies is a specialization of xtdRelationship that handles the classification of things.

EXPRESS specification:

```
*)
        ENTITY xtdRelClassifies
                SUBTYPE OF (xtdRelationship)
                RelatedThings                   : SET [1:?] OF xtdRoot;
                RelatingClassification  : xtdClassification;
        WHERE
        WR1 : SIZEOF(QUERY(Result <* RelatedThings |
                RelatingClassification :=: Result)) = 0;
        END_ENTITY;
(*
```

Attribute definitions:

RelatingClassification classification describing the related things.

RelatedThings set of things that are described by a classification.

Formal propositions:

WR1   The instance to which the attribute relating classification points shall not be contained in the list of related things.

7.2.4 xtdRelAssociates

xtdRelAssociates is a specialization of xtdRelationship that represents the association of a relating xtdRoot to a set of related instances of xtdRoot.

EXPRESS specification:

```
*)
 ENTITY xtdRelAssociates
   SUPERTYPE OF (ONEOF (xtdRelComposes,        xtdRelSpecializes))
 SUBTYPE OF(xtdRelationship);
        RelatedThings : SET [1:?] OF xtdRoot;
        RelatingThing : xtdRoot;
   WHERE

WR1 : SIZEOF(QUERY(Result <* RelatedThings |
    RelatingThing :=: Result)) = 0;
 END_ENTITY;
(*
```

13

Attribute definitions:

RelatingThing thing that is the target of the relationship.

RelatedThings set of things that is associated with a target thing.

Formal propositions:

WR1   The instance to which the attribute relating thing points shall not be contained in the set of related things.

7.2.5   xtdRelDocuments

xtdRelDocuments is a specialization of xtdRelationship that handles the documentation of things by relating these things to the documents where they are described. Each document can relate to many things.

EXPRESS specification:
```
*)
ENTITY xtdRelDocuments
  SUBTYPE OF(xtdRelationship);
RelatedThings            : SET [1:?] OF xtdRoot;
RelatingDocument              : xtdExternalDocument;
END_ENTITY;
(*
```

Attribute definitions:

RelatedThings set of things that are described in the external document

RelatingDocument external document describing the related things

7.3   EXPRESS long form specification

```
SCHEMA ISO_23387_VERSION_1;
REFERENCE FROM ISO_12006_3_VERSION_3 -- ISO 12006-3
(xtdGlobalUniqueID,
xtdLabel,
xtdText,
xtdToleranceTypeEnum,
xtdValueRoleEnum,
xtdValueTypeEnum,
xtdVersionID,
xtdDate,
xtdBag,
xtdCollection,
xtdDescription,
xtdExternalDocument,
xtdLanguage,
xtdLanguageRepresentation,
xtdMeasureWithUnit,
xtdName,
xtdUnit,
xtdRoot,
```

```
xtdProperty,
xtdSubject,
xtdRelAssignsCollections,
xtdRelAssignsMeasures,
xtdRelAssignsProperties,
xtdRelAssignsPropertyWithValues,
xtdRelSequences,
xtdValue,
xtdNest
                );


USE FROM ISO_12006_3_VERSION_3  -- ISO 12006-3
                (xtdRelCollects,
                xtdRelationship,
                xtdObject
                );


ENTITY xtdRelAssociates
SUPERTYPE OF (ONEOF (
        xtdRelComposes,
        xtdRelSpecializes))
         SUBTYPE OF(xtdRelationship);
                RelatedThings : SET [1:?] OF xtdRoot;
                RelatingThing : xtdRoot;
WHERE
WR1 : SIZEOF(QUERY(Result <* RelatedThings |
    RelatingThing :=: Result)) = 0;
END_ENTITY;


ENTITY xtdRelSpecializes
  SUBTYPE OF(xtdRelAssociates);
  WHERE
   WR1 : SIZEOF(QUERY(Result <* SELF.RelatedThings |
       NOT(TYPEOF(SELF.RelatingThing) = TYPEOF(Result)))) = 0 ;
END_ENTITY;


ENTITY xtdRelComposes
  SUBTYPE OF(xtdRelAssociates);
  WHERE
   WR1 : SIZEOF(QUERY(Result <* SELF.RelatedThings |
    NOT(TYPEOF(SELF.RelatedThings) = TYPEOF(Result)))) = 0 ;
END_ENTITY;


ENTITY xtdRelDocuments
  SUBTYPE OF(xtdRelationship);
RelatedThings    : SET [1:?] OF xtdRoot;
RelatingDocument : xtdExternalDocument;
END_ENTITY;


ENTITY xtdRelClassifies
```

```
        SUBTYPE OF (xtdRelationship)
RelatedThings : SET [1:?] OF xtdRoot;
                RelatingClassification  : xtdClassification;
        WHERE
        WR1 : SIZEOF(QUERY(Result <* RelatedThings |
    RelatingClassification :=: Result)) = 0;
END_ENTITY;

ENTITY xtdClassification
        SUBTYPE OF (xtdObject)
END_ENTITY;

END_SCHEMA;
```

Annex A
(informative)
EXPRESS-G diagrams

This annex provides an informal EXPRESS-G specification that uses the EXPRESS-G notation given in two diagrams. The purpose of these diagrams is to demonstrate compatibility with ISO 12006-3:2007, and to provide the extensions needs from this document.

Where an object is represented with a named reference to ISO_12006_3_version_3, the EXPRESS specification schema version used in ISO 12006-3:2007, the object is already supported in ISO 12006-3:2007. Each object without this named reference is an extension based on the requirements in this document.

For a relationship with a named reference to ISO 12006-3 version 3, the relationship supports the requirements in this document. Each relationship without a named reference represents a requirement from this document to modify the constraints from ISO 12006-3:2007.

The model from ISO 12006-3:2007 with extension needs from this document is described informally in Figure A.1 and Figure A.2, conforming to the EXPRESS-G notation.
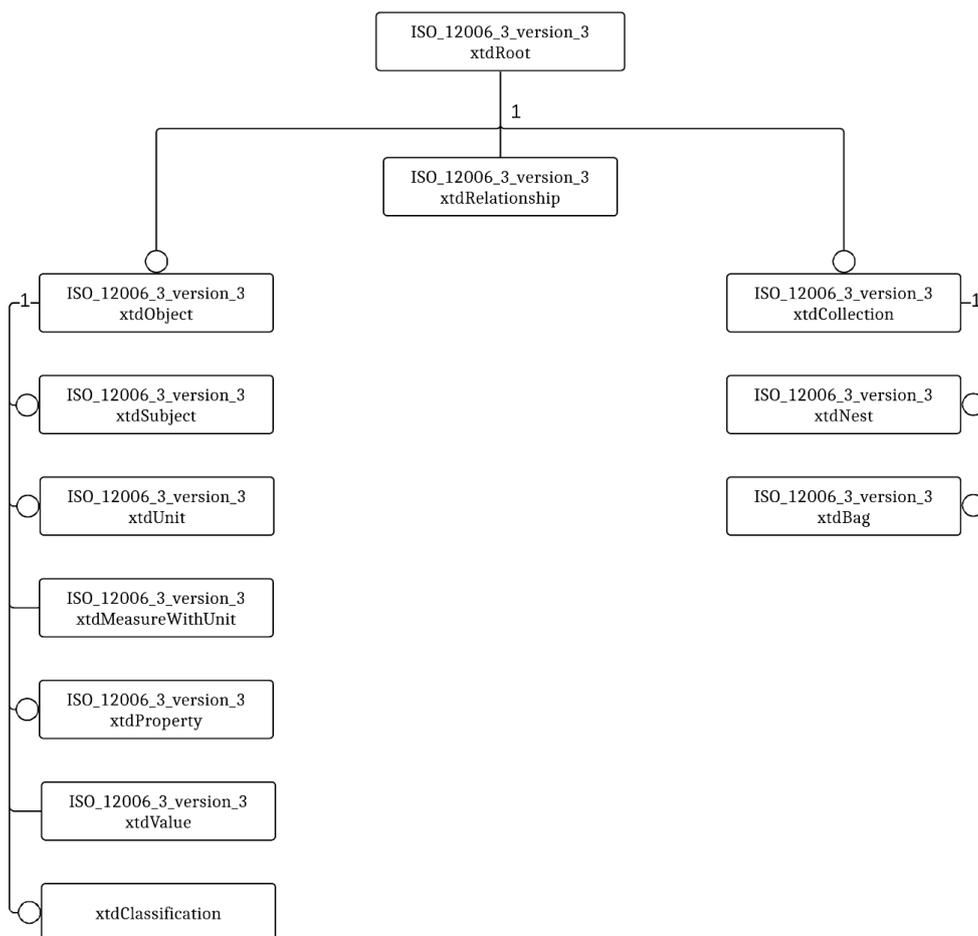

Figure A.1 - EXPRESS-G diagram - Top level with root concept

Figure A.2 - EXPRESS-G diagram – Relationships

Annex B
(informative)
UML diagram – systems with components

Figures B.1 and B.2 show how relationships should be created for data templates representing systems and the systems' components. The relationships are created using xtdRelComposes between the construction object concepts and between the data template concepts.
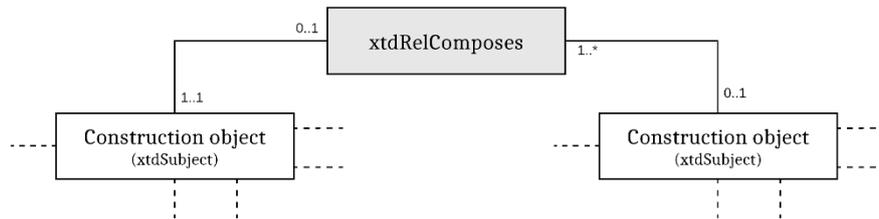

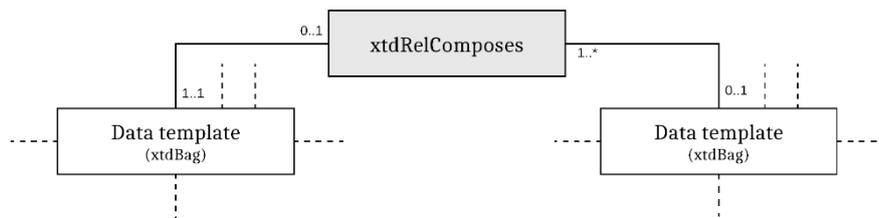**Figure B.1 –Relation between two construction objects**

Figure B.2 –Relation between two data templates

Bibliography

[1]   ISO/IEC 19505 (all parts), Information technology -- Object Management Group Unified Modeling Language (OMG UML)

[2]   ISO/DIS 1087, terminology work and terminology science -- vocabulary

[3]   ISO 6707-1, Buildings and civil engineering works -- Vocabulary -- Part 1: General terms
[4]   ISO 10140-4, Acoustics — Laboratory measurement of sound insulation of building elements — Part 4: Measurement procedures and requirements [5] ISO   12006-2,   Building construction -- Organization of information about construction works -- Part 2: Framework for classification

[6]   EN 12058, Natural stone products. Slabs for floors and stairs. Requirements

[7]   ISO 16739-1:2018, Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries – Part 1: Data schema

[8]   ISO 19650, Organization of information about construction works -- Information management using building information modelling

[9]   ISO 80000-1, Quantities and units -- Part 1: General