

INTERNATIONAL STANDARD

ISO
10303-225

First edition
1999-12-01

Industrial automation systems and integration — Product data representation and exchange —

Part 225:

Application protocol: Building elements using explicit shape representation

*Systèmes d'automatisation industrielle et intégration — Représentation et
échange de données de produits —*

*Partie 225: Protocole d'application: Éléments de construction utilisant la
représentation des formes explicites*



Reference number
ISO 10303-225:1999(E)

AVA **Documents**
© ISO 1999
Document Sharing Hub

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

© ISO 1999

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 734 10 79
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

1	Scope	1
2	Normative references	3
3	Definitions and abbreviations	4
3.1	Terms defined in ISO 10303-1	4
3.2	Terms defined in ISO 10303-31	5
3.3	Other definitions	5
3.3.1	building design	5
3.3.2	building component	5
3.3.3	enclosing and separating elements	5
3.3.4	explicit shape representation	5
3.3.5	fixtures and equipment	5
3.3.6	service elements	5
3.3.7	spaces	6
3.3.8	spatial configuration	6
3.3.9	structural elements	6
3.4	Abbreviations	6
4	Information requirements	7
4.1	Units of functionality	7
4.1.1	advanced_geometric_representation UoF	8
4.1.2	building_component UoF	8
4.1.3	building_composition UoF	9
4.1.4	building_items UoF	10
4.1.5	design_administration UoF	11
4.1.6	elementary_csg_representation UoF	11
4.1.7	elementary_geometric_representation UoF	12
4.1.8	faceted_csg_representation UoF	12
4.1.9	faceted_geometric_representation UoF	12
4.1.10	property_and_classification UoF	13
4.1.11	space_boundary_representation UoF	13
4.2	Application objects	14
4.3	Application assertions	58

5	Application interpreted model	67
5.1	Mapping table	67
5.2	AIM EXPRESS short listing	155

6	Conformance requirements	220
---	--------------------------	-----

Annexes

A	AIM EXPRESS expanded listing	233
B	AIM short names of entities	307
C	Implementation method specific requirements	316
D	Protocol Implementation Conformance Statement (PICS) proforma	317
E	Information object registration	318
E.1	Document identification	318
E.2	Schema identification	318
F	Application activity model	319
F.1	Application activity model definitions and abbreviations	319
F.2	Application activity model diagrams	322
G	Application reference model	328
H	AIM EXPRESS-G	336
J	AIM EXPRESS	366
K	Bibliography	367
	Index	368

Figures

Figure 1	Data planning model	xii
Figure 2	Nested relationship of shape representation functionality	xiii
Figure 3	Building components	9
Figure 4	Building levels	23
Figure 5	Building section	26
Figure 6	Detail, outline and envelope shapes	30
Figure 7	Kinds of element assemblies	36
Figure 8	Examples of reference curves	41
Figure 9	Kinds of openings	43
Figure 10	Services element: HVAC system	48
Figure 11	Breaklines and survey points in site_shape_representation	50
Figure 12	Spaces	51
Figure 13	Kinds of Structure_enclosure_elements	53
Figure F.1	IDEF0 basic notation	319

Figure F.2 - A-0: design, construct, and manage building in IDEF0	323
Figure F.3 - A0: design, construct, and manage building (decomposition) in IDEF0	324
Figure F.4 - A2: create and approve preliminary building design in IDEF0	325
Figure F.5 - A3: create detailed design/award contract in IDEF0	326
Figure F.6 - A4: construct, manage, and maintain building in IDEF0	327
Figure G.1 - ARM diagram 1 of 7 in EXPRESS-G	329
Figure G.2 - ARM diagram 2 of 7 in EXPRESS-G	330
Figure G.3 - ARM diagram 3 of 7 in EXPRESS-G	331
Figure G.4 - ARM diagram 4 of 7 in EXPRESS-G	332
Figure G.5 - ARM diagram 5 of 7 in EXPRESS-G	333
Figure G.6 - ARM diagram 6 of 7 in EXPRESS-G	334
Figure G.7 - ARM diagram 7 of 7 in EXPRESS-G	335
Figure H.1 - AIM diagram 1 of 29 in EXPRESS-G	337
Figure H.2 - AIM diagram 2 of 29 in EXPRESS-G	338
Figure H.3 - AIM diagram 3 of 29 in EXPRESS-G	339
Figure H.4 - AIM diagram 4 of 29 in EXPRESS-G	340
Figure H.5 - AIM diagram 5 of 29 in EXPRESS-G	341
Figure H.6 - AIM diagram 6 of 29 in EXPRESS-G	342
Figure H.7 - AIM diagram 7 of 29 in EXPRESS-G	343
Figure H.8 - AIM diagram 8 of 29 in EXPRESS-G	344
Figure H.9 - AIM diagram 9 of 29 in EXPRESS-G	345
Figure H.10 - AIM diagram 10 of 29 in EXPRESS-G	346
Figure H.11 - AIM diagram 11 of 29 in EXPRESS-G	347
Figure H.12 - AIM diagram 12 of 29 in EXPRESS-G	348
Figure H.13 - AIM diagram 13 of 29 in EXPRESS-G	349
Figure H.14 - AIM diagram 14 of 29 in EXPRESS-G	350
Figure H.15 - AIM diagram 15 of 29 in EXPRESS-G	351
Figure H.16 - AIM diagram 16 of 29 in EXPRESS-G	352
Figure H.17 - AIM diagram 17 of 29 in EXPRESS-G	353
Figure H.18 - AIM diagram 18 of 29 in EXPRESS-G	354
Figure H.19 - AIM diagram 19 of 29 in EXPRESS-G	355
Figure H.20 - AIM diagram 20 of 29 in EXPRESS-G	356
Figure H.21 - AIM diagram 21 of 29 in EXPRESS-G	357
Figure H.22 - AIM diagram 22 of 29 in EXPRESS-G	358
Figure H.23 - AIM diagram 23 of 29 in EXPRESS-G	359
Figure H.24 - AIM diagram 24 of 29 in EXPRESS-G	360
Figure H.25 - AIM diagram 25 of 29 in EXPRESS-G	361
Figure H.26 - AIM diagram 26 of 29 in EXPRESS-G	362
Figure H.27 - AIM diagram 27 of 29 in EXPRESS-G	363
Figure H.28 - AIM diagram 28 of 29 in EXPRESS-G	364
Figure H.29 - AIM diagram 29 of 29 in EXPRESS-G	365

Tables

Table 1 - Examples of building element classifications	37
Table 2 - Shape component usage for Structure_enclosure_element	56
Table 3 - Mapping table for advanced_geometric_representation UoF	69
Table 4 - Mapping table for building_component UoF	71
Table 5 - Mapping table for building_composition UoF	76

Table 6 - Mapping table for building_items UoF	109
Table 7 - Mapping table for design_administration UoF	133
Table 8 - Mapping table for elementary_csg_representation UoF	142
Table 9 - Mapping table for elementary_geometric_representation UoF	145
Table 10 - Mapping table for faceted_csg_representation UoF	146
Table 11 - Mapping table for faceted_geometric_representation UoF	147
Table 12 - Mapping table for property_and_classification UoF	151
Table 13 - Mapping table for space_boundary_representation UoF	154
Table 14 - Conformance classes	222
Table 15 - Conformance class elements	224
Table B.1 - AIM short names	307

Foreword

The International Organization for Standardization (ISO) 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.

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

International Standard ISO 10303-225 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data*.

ISO 10303 consists of the following parts under the general title *Industrial automation systems and integration - Product data representation and exchange*:

- Part 1, Overview and fundamental principles;
- Part 11, Description methods: The EXPRESS language reference manual;
- Part 12, Description method: The EXPRESS-I language reference manual;
- Part 21, Implementation methods: Clear text encoding of the exchange structure;
- Part 22, Implementation method: Standard data access interface specification;
- Part 23, Implementation method: C++ language binding to the standard data access interface;
- Part 24, Implementation method: C language binding to the standard data access interface;
- Part 26, Implementation method: Interface definition language binding to the standard data access;
- Part 31, Conformance testing methodology and framework: General concepts;
- Part 32, Conformance testing methodology and framework: Requirements on testing laboratories and clients;
- Part 34, Conformance testing methodology and framework: Abstract test methods;
- Part 35, Conformance testing methodology and framework: Abstract test methods for SDAI implementations;
- Part 41, Integrated generic resources: Fundamentals of product description and support;

- Part 42, Integrated generic resources: Geometric and topological representation;
- Part 43, Integrated generic resources: Representation structures;
- Part 44, Integrated generic resources: Product structure configuration;
- Part 45, Integrated generic resource: Materials;
- Part 46, Integrated generic resources: Visual presentation;
- Part 47, Integrated generic resource: Shape variation tolerances;
- Part 49, Integrated generic resource: Process structure and properties;
- Part 101, Integrated application resource: Draughting;
- Part 104, Integrated application resource: Finite element analysis;
- Part 105, Integrated application resource: Kinematics;
- Part 106, Integrated application resource: Building construction core model;
- Part 201, Application protocol: Explicit draughting;
- Part 202, Application protocol: Associative draughting;
- Part 203, Application protocol: Configuration controlled design;
- Part 204, Application protocol: Mechanical design using boundary representation;
- Part 205, Application protocol: Mechanical design using surface representation;
- Part 207, Application protocol: Sheet metal die planning and design;
- Part 208, Application protocol: Life cycle management - Change process;
- Part 209, Application protocol: Composite and metallic structural analysis and related design;
- Part 210, Application protocol: Electronic assembly, interconnect, and packaging design;
- Part 212, Application protocol: Electrotechnical design and installation
- Part 213, Application protocol: Numerical control process plans for machined parts;
- Part 214, Application protocol: Core data for automotive design;
- Part 215, Application protocol: Ship arrangement;
- Part 216, Application protocol: Ship moulded forms;

- Part 217, Application protocol: Ship piping;
- Part 218, Application protocol: Ship structures;
- Part 221, Application protocol: Functional data and their schematic representation for process plant;
- Part 222, Application protocol: Exchange of product data for composite structures;
- Part 223, Application protocol: Exchange of design and manufacturing product information for casting parts;
- Part 224, Application protocol: Mechanical product definition for process plans using machining features;
- Part 225, Application protocol: Building elements using explicit shape representation;
- Part 226, Application protocol: Ship mechanical systems;
- Part 227, Application protocol: Plant spatial configuration;
- Part 229, Application protocol: Exchange of design and manufacturing product information for forged parts;
- Part 230, Application protocol: Building structural frame: Steelwork;
- Part 231, Application protocol: Process engineering data: Process design and process specification of major equipment;
- Part 232, Application protocol: Technical data packaging core information and exchange;
- Part 301, Abstract test suite: Explicit draughting;
- Part 302, Abstract test suite: Associative draughting;
- Part 303, Abstract test suite: Configuration controlled design;
- Part 304, Abstract test suite: Mechanical design using boundary representation;
- Part 305, Abstract test suite: Mechanical design using surface representation;
- Part 307, Abstract test suite: Sheet metal die planning and design;
- Part 308, Abstract test suite: Life cycle management - Change process;
- Part 309, Abstract test suite: Composite and metallic structural analysis and related design;
- Part 310, Abstract test suite: Electronic assembly, interconnect, and packaging design;

- Part 312, Abstract test suite: Electrotechnical design and installation;
- Part 313, Abstract test suite: Numerical control process plans for machined parts;
- Part 314, Abstract test suite: Core data for automotive mechanical design;
- Part 315, Abstract test suite: Ship arrangement;
- Part 316, Abstract test suite: Ship moulded forms;
- Part 317, Abstract test suite: Ship piping;
- Part 318, Abstract test suite: Ship structures;
- Part 321, Abstract test suite: Functional data and their schematic representation for process plant;
- Part 322, Abstract test suite: Exchange of product data for composite structures;
- Part 323, Abstract test suite: Exchange of design and manufacturing product information for casting parts;
- Part 324, Abstract test suite: Mechanical product definition for process plans using machining features;
- Part 325, Abstract test suite: Building elements using explicit shape representation;
- Part 326, Abstract test suite: Ship mechanical systems;
- Part 327, Abstract test suite: Plant spatial configuration;
- Part 329, Abstract test suite: Exchange of design and manufacturing product information for forged parts;
- Part 330, Abstract test suite: Building structural frame: Steelwork;
- Part 331, Abstract test suite: Process engineering data: Process design and process specification of major equipment;
- Part 332, Abstract test suite: Technical data packaging core information and exchange;
- Part 501, Application interpreted construct: Edge-based wireframe;
- Part 502, Application interpreted construct: Shell-based wireframe;
- Part 503, Application interpreted construct: Geometrically bounded 2D wireframe;
- Part 504, Application interpreted construct: Draughting annotation;
- Part 505, Application interpreted construct: Drawing structure and administration;

- Part 506, Application interpreted construct: Draughting elements;
- Part 507, Application interpreted construct: Geometrically bounded surface;
- Part 508, Application interpreted construct: Non-manifold surface;
- Part 509, Application interpreted construct: Manifold surface;
- Part 510, Application interpreted construct: Geometrically bounded wireframe;
- Part 511, Application interpreted construct: Topologically bounded surface;
- Part 512, Application interpreted construct: Faceted boundary representation;
- Part 513, Application interpreted construct: Elementary boundary representation;
- Part 514, Application interpreted construct: Advanced boundary representation;
- Part 515, Application interpreted construct: Constructive solid geometry;
- Part 517, Application interpreted construct: Mechanical design geometric presentation;
- Part 518, Application interpreted construct: Mechanical design shaded representation.

The structure of this International Standard is described in ISO 10303-1. The numbering of the parts of the International Standard reflects its structure:

- Parts 11 to 12 specify the description methods,
- Parts 21 to 26 specify the implementation methods,
- Parts 31 to 35 specify the conformance testing methodology and framework,
- Parts 41 to 49 specify the integrated generic resources,
- Parts 101 to 106 specify the integrated application resources,
- Parts 201 to 232 specify the application protocols,
- Parts 301 to 332 specify the abstract test suites, and
- Parts 501 to 518 specify the application interpreted constructs.

Should further parts be published, they will follow the same numbering pattern.

Annexes A, B, C, D, and E form a normative part of this part of ISO 10303. Annexes F, G, H, J, and K are for information only.

Introduction

ISO 10303 is an International Standard for the computer-interpretable representation and exchange of product data. The objective is to provide a neutral mechanism capable of describing product data throughout the life cycle of a product, independent from any particular system. The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and archiving.

This International Standard is organized as a series of parts, each published separately. The parts of ISO 10303 fall into one of the following series: description methods, integrated resources, application interpreted constructs, application protocols, abstract test suites, implementation methods, and conformance testing. The series are described in ISO 10303-1. This part of ISO 10303 is a member of the application protocol series.

This part of ISO 10303 specifies an application protocol (AP) for the exchange of building element shape, property, and spatial configuration information between architecture, engineering, and construction (AEC) application systems and related systems using explicit three-dimensional shape representations.

Many different institutions are engaged in the design, erection, management, and maintenance of buildings and constructions. As these institutions shift toward the increased application of three-dimensional Computer-Aided Design (CAD) modelling systems, data exchange is of crucial importance for all participants in the design and construction process. A fundamental component of the data exchange is the shape and arrangement of the elements of which a building is composed. This part of ISO 10303 specifies a standard which allows the exchange of this data between systems.

Figure 1 contains the data planning model that provides a high level description of the requirements for this application protocol, as well as the relationships between the basic data components.

The planning model illustrates that a building complex consists of buildings and a site shape; a building consists of building sections; and a building section is composed of building items. Each building item is composed of shape component that may be explicitly represented by a faceted, an elementary, or an advanced shape. A faceted shape consists of lines and planes. An elementary shape consists of lines, planes, circles, ellipses, hyperbolas, parabolas, b-spline curves, cylindrical surfaces, conical surfaces, toroidal surfaces, and spherical surfaces. An advanced shape can consist of any kind of curve or surface defined in ISO 10303-42. Figure 2 illustrates the nested relationship between these shapes; the elements that compose a faceted shape are a subset of those that compose an elementary shape, and the elements that compose an elementary shape are a subset of those that compose an advanced shape. Both building elements and shape components can be further described by properties and classifications.

This AP does not address functional or performance characteristics of building systems or the information required for design analysis such as structural or thermal analysis.

This application protocol defines the context, scope, and information requirements for the exchange of building elements using explicit shape representation and specifies the integrated resources necessary to satisfy these requirements.

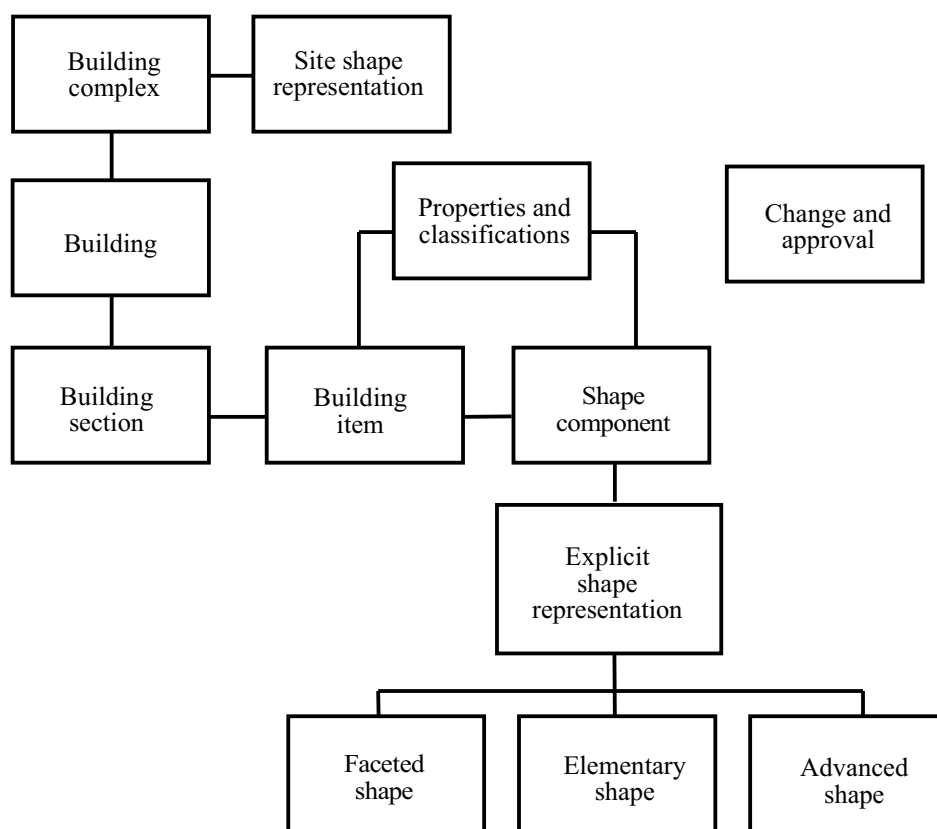


Figure 1 - Data planning model

Application protocols provide the basis for developing implementations of ISO 10303 and abstract test suites for the conformance testing of AP implementations.

Clause 1 defines the scope of the application protocol and summarizes the functionality and data covered by the AP. Clause 3 lists the words defined in this part of ISO 10303 and gives pointers to word defined elsewhere. An application activity model that is the basis for the definition of the scope is provided in annex F. The information requirements of the application are specified in clause 4 using terminology appropriate to the application. A graphical representation of the information requirements, referred to as the application reference model, is given in annex G.

Resource constructs are interpreted to meet the information requirements. This interpretation produces the application interpreted model (AIM). This interpretation, given in 5.1, shows the correspondence between the information requirements and the AIM. The short listing of the AIM specifies the interface to the integrated resources and is given in 5.2. Note that the definitions and EXPRESS provided in the integrated resources for constructs used in the AIM may include select list items and subtypes which are not imported into the AIM. The expanded listing given in annex A contains the complete EXPRESS for the AIM without annotation. A graphical representation of the AIM is given in annex H. Additional requirements for specific implementation methods are given in annex C.

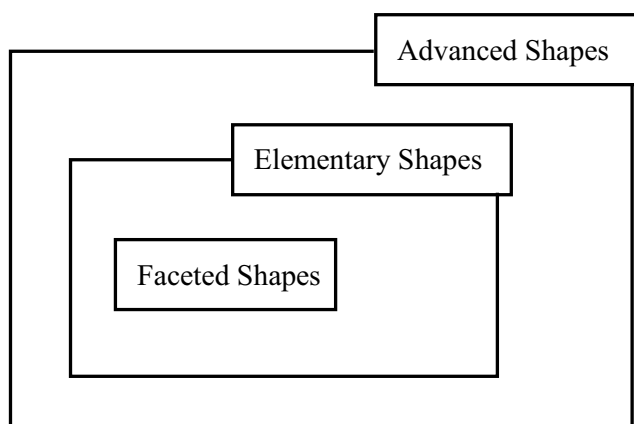


Figure 2 - Nested relationship of shape representation functionality

Industrial automation systems and integration — Product data representation and exchange — Part 225: Application protocol: Building elements using explicit shape representation

1 Scope

This part of ISO 10303 specifies the use of the integrated resources necessary for the scope and information requirements for the exchange of building element shape, property, and spatial configuration information between application systems with explicit shape representations. Building elements are those physical things of which a building is composed, such as structural elements, enclosing and separating elements, service elements, fixtures and equipment, and spaces.

NOTE 1 - See 3.3.1.3 for definitions of these terms and concepts.

Building element shape, property, and spatial configuration information requirements can be used at all stages of the life cycle of a building, including the design process, construction, and maintenance. Building element shape, property, and spatial configuration information requirements specified in this part of ISO 10303 support the following activities:

- concurrent design processes or building design iterations;
- integration of building structure designs with building systems designs to enable design analysis;
- building design visualization;
- specifications for construction and maintenance;
- analysis and review.

NOTE 2 - "Support" of these activities does not imply satisfaction. Satisfaction of the information requirements for construction, for example, would require a complete building design. This part of ISO 10303 only satisfies a portion of information requirements for this activity. See 3.3.1.1.

EXAMPLE 1 - A design analysis function combines the building structure design with building service systems designs (for systems such as heating, ventilation, and air condition (HVAC) and piping) to check for interferences of the structural elements with piping and air conditioning elements.

NOTE 3 - The application activity model in annex F provides a graphical representation of the processes and information flows that are the basis for the definition of the scope of this part of ISO 10303.

The following are within the scope of this part of ISO 10303:

- explicit representation of the three-dimensional shape of building elements using boundary representation (B-rep) solid models, swept solid models, or constructive solid geometry (CSG) models.
- the spatial configuration of building elements that comprise the assembled building;
- building structures that represent physically distinct buildings that are part of a single building complex;
- non-structural elements that enclose a building or separate areas within a building;
- the shape and arrangement of equipment and service elements that provide services to a building;

EXAMPLE 2 - Service elements include items such as plumbing, ductwork, and conduits. Equipment includes items such as compressors, furnaces, or water heaters.

- the shape and arrangement of fixtures in a building;

EXAMPLE 3 - Fixtures include items such as furniture and installed items like doorknobs.

- specification of spaces and levels;

EXAMPLE 4 - Spaces include rooms, accesses, and hallways. Levels include concepts such as floors and mezzanines of a building.

- the shape of the site on which the building will be erected;
- specification of properties of building elements, including material composition;
- specification of classification information;

EXAMPLE 5 - Elements may be classified for reasons which include cost analysis, acoustics, or safety.

- association of properties and classification information to building elements;
- changes to building element shape, property, and spatial configuration information;
- association of approvals with building element shape, property, and spatial configuration information;
- as-built record of the building.

The following are outside the scope of this part of ISO 10303:

- 2D shape representation and draughting presentation;

- the contents of building standards;
- implicit representation of building elements through selection of standard parameters;
- structural analysis of building structures, including loads, connections, and material properties required for analysis;
- thermal analysis of buildings;
- the assembly process, joining methods, and detailed connectivity of building elements;
- building maintenance history, requirements, and instructions;
- approval, revision, versioning, and design change histories;
- building elements without explicit shape representation;
- bills of quantities.

NOTE 4 - In industries other than AEC, bills of quantities are often referred to as bills of material.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 10303. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 10303 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 8824-1:1994 *Information technology - Open systems interconnection - Abstract syntax notation one (ASN.1) - Part 1: Specification of basic notation.*

ISO 10303-1:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 1: Overview and fundamental principles.*

ISO 10303-11:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 11: Description methods: The EXPRESS language reference manual.*

ISO 10303-21:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 21: Implementation methods: Clear text encoding of the exchange structure.*

ISO 10303-31:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 31: Conformance testing methodology and framework: General concepts.*

ISO 10303-41:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 41: Integrated generic resources: Fundamentals of product description and support.*

ISO 10303-42:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 42: Integrated generic resources: Geometric and topological representation.*

ISO 10303-43:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 43: Integrated generic resources: Representation structures.*

ISO 10303-44:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 44: Integrated generic resources: Product structure configuration.*

ISO 10303-45:1998, *Industrial automation systems and integration - Product data representation and exchange - Part 45: Integrated generic resources: Materials.*

3 Definitions and abbreviations

3.1 Terms defined in ISO 10303-1

This part of ISO 10303 makes use of the following terms defined in ISO 10303-1:

- application;
- application activity model (AAM);
- application interpreted model (AIM);
- application object;
- application protocol (AP);
- application reference model (ARM);
- conformance testing;
- implementation method;
- integrated resource;
- PICS proforma;
- product;
- product data;
- unit of functionality (UoF).

3.2 Terms defined in ISO 10303-31

This part of ISO 10303 makes use of the following terms defined in ISO 10303-31:

- abstract test suite (ATS);
- conformance class;
- implementation under test (IUT);
- protocol information and conformance statement (PICS).

3.3 Other definitions

For the purposes of this part of ISO 10303, the following definitions apply.

3.3.1 building design: the information that constitutes a specification sufficient for the evaluation, construction, and maintenance of a building.

3.3.2 building component: named features that represent functional characteristics of the building element.

EXAMPLE 6 - A beam may be composed of additive components such as a shaft and brackets and negative subtractive components such as notches. The components are treated as independent items for design changes and manipulation, such as for moving the notch on the beam.

3.3.3 enclosing and separating elements: physical, non-structural building elements. Enclosing elements are attached to the exterior of a building for weather protection or appearance. Separating elements divide interior spaces creating compartmentation of the structure.

NOTE - Structural elements may serve enclosing or separating functions. Enclosing and separating elements are distinguished by the fact that they do not carry loads. Enclosing elements may also serve separating functions.

3.3.4 explicit shape representation: the geometric data that describes or defines the three-dimensional volumetric boundaries (i.e., the shape) of a building element.

3.3.5 fixtures and equipment: discrete building element that are installed within a building to provide a function or service.

EXAMPLE 7 - Doors, windows, and furniture are examples of fixtures and equipment.

3.3.6 service elements: components of systems that provide services to a building.

EXAMPLE 8 - Plumbing, power, heating, and cooling are services typical in buildings.

3.3.7 spaces: areas or volumes of a building formed by structural, enclosing, or separating element.

EXAMPLE 9 - Spaces include interior and exterior areas and volumes such as rooms, hallways, clearance spaces, loading docks, offices, and entrances.

3.3.8 spatial configuration: the position and orientation of a building element within the spatial or geometric context of an aggregate object which is comprised of the elements.

EXAMPLE 10 - One may refer to the "spatial configuration" of the building elements within a building section, for example.

3.3.9 structural elements: load bearing elements of a building.

EXAMPLE 11 - Load bearing elements of a building include things like walls, floors, columns, beams, and foundations.

3.4 Abbreviations

For the purposes of this part of ISO 10303, the following abbreviations apply:

AAM	Application Activity Model
AEC	Architecture, Engineering, and Construction
AIC	Application Interpreted Construct
AIM	Application Interpreted Model
AP	Application Protocol
ARM	Application Reference Model
ATS	Abstract Test Suite
B-rep	Boundary representation
CAD	Computer-Aided Design/Draughting
GIS	Geographic Information System
CSG	Constructive Solid Geometry
HVAC	Heating, Ventilation, and Air Conditioning
PICS	Protocol Implementation and Conformance Statement
UoF	Unit of Functionality
URL	Uniform Resource Locator

4 Information requirements

This clause specifies the information required for the exchange of building element shape, property, and spatial configuration information between application systems using explicit shape representation.

The information requirements are specified as a set of units of functionality, application objects, and application assertions. These assertions pertain to individual application objects and to relationships between application objects. The information requirements are defined using terminology of the subject area of this application protocol.

NOTES

- 1 - A graphical representation of the information requirements is given in annex G.
- 2 - The information requirements correspond to those of the activities identified as being in the scope of this application protocol in annex F.
- 3 - The mapping table specified in 5.1 shows how the integrated resources and application interpreted constructs are used to meet the information requirements of this application protocol.

There are two fundamental assumptions that underlie the requirements in this clause. The first assumption is this application protocol will be used for data exchange by basic AEC CAD systems. The second assumption is that the geometry requirements for these application systems will be met by ISO 10303-42; detailed requirements for geometry, therefore, are not included in this part of ISO 10303.

4.1 Units of functionality

This subclause specifies the units of functionality for the building elements using explicit shape representation application protocol. This part of ISO 10303 specifies the following units of functionality:

- advanced_geometric_representation;
- building_component;
- building_composition;
- building_items;
- design_administration;
- elementary_csg_representation;
- elementary_geometric_representation;
- faceted_csg_representation;

- `faceted_geometric_representation`;
- `property_and_classification`;
- `space_boundary_representation`.

The units of functionality and a description of the functions that each UoF supports are given below. The application objects included in the UoFs are defined in 4.2.

4.1.1 `advanced_geometric_representation` UoF

The `advanced_geometric_representation` UoF are geometric elements that consist of any kind of curve or surface. They are used to represent the complete shape and component shapes of building elements.

The following application objects are used by the `advanced_geometric_representation` UoF:

- `Advanced_b_rep`;
- `Advanced_curve`;
- `Advanced_face_with_thickness`.

4.1.2 `building_component` UoF

The `building_component` UoF represents the component shapes that may be combined to define the shape of a building element. The building component may correspond to the main shape of a building element or any of several positive or negative additions to the main shape. Many building components correspond to common terms such as shaft, bracket, door opening, window, and recess.

EXAMPLE 12 - A block can be used to represent the shape of the shaft as a structural component of a column. Another shape can be used to represent the shape of a positive addition on top of the shaft. A block may be used to represent a recess as a negative component of the column. Figure 3 illustrates the use of components in defining a shape.

The following application objects are used by the `building_component` UoF:

- `Building_element_component`;
- `Component_location_in_element`;
- `Component_shape`;
- `Negative_component`;
- `Opening`;

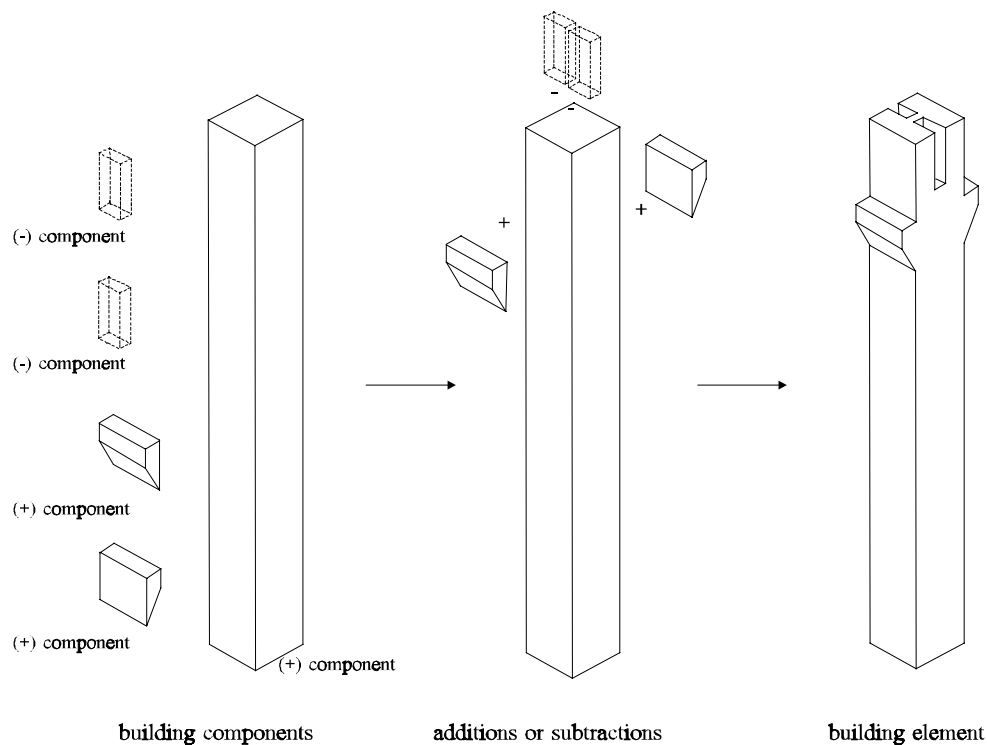


Figure 3 - Building components

— Positive_component;

— Recess.

4.1.3 building_composition UoF

The building_composition UoF represents the collection of building items and assemblies that specifies the arrangement of items within a building complex. A building complex is composed of buildings; a building is decomposed into building sections; each building section is composed of building elements, such as structural elements, enclosing elements, service elements, fixtures, equipment, or spaces. Assemblies or groups of building items can be defined.

The following application objects are used by the building_composition UoF:

— Building;

— Building_complex;

— Building_item;

— Building_level;

- Building_position_in_complex;
- Building_section;
- Gis_position;
- Item_assembly;
- Item_group;
- Item_position_in_section;
- Item_proximity_relationship;
- Level_position_in_section;
- Placement;
- Section_position_in_building;
- Simple_curve;
- Sublevel.

4.1.4 building_items UoF

The building_items UoF represents the discrete, large-scale, shape-related aspects of a building or things in the building. These aspects may be physical items that contribute to the form or function of the building, or may be abstract spaces that describe the usage of the building. A building item is an aspect of a building which has shape and is commonly used in discourse concerning the form or function of a building.

The following application objects are used by the building_items UoF:

- Building_element;
- Building_item;
- Component_shape;
- Component_shape_representation;
- Fixture_equipment_element;
- Service_element;

- Space;
- Structure_enclosure_element.

4.1.5 design_administration UoF

The design_administration UoF represents the management of building element shape, property, and spatial configuration information by specific individual(s). The management includes the approval, modification, acceptance, or confirmation of the building element shape, property, and spatial configuration information. Approvals and change requests are based upon the evaluation criteria derived from the perspective of a given functional discipline. The individual performing the evaluation is recognized, acknowledged, and accepted as qualified to perform the evaluation. The modifications may be necessary to ensure that the building element shape, property, and spatial configuration information meets certain requirements. Change requests can be initiated by almost any person involved in the design process of a building.

EXAMPLE 13 - The structural engineer reviews and evaluates the building design information with respect to structural performance and approves it if it meets the requirements specified in building design standards.

The following application objects are used by the design_administration UoF:

- Approval;
- Building_document_reference;
- Building_item_identification;
- Change_request.

4.1.6 elementary_csg_representation UoF

The elementary_csg_representation UoF consists of CSG primitives which are bounded by simple geometric surfaces such as cylinders, cones, torii, and spheres. The primitives are used to represent the complete shapes and component shapes of the building elements; they can be combined using boolean operations.

The following application objects are used by the elementary_csg_representation UoF:

- Elementary_face_with_thickness;
- Right_circular_cylinder;
- Solid_of_linear_extrusion;
- Solid_of_revolution;
- Trimmed_sphere;

- Trimmed_torus;
- Truncated_cone.

4.1.7 elementary_geometric_representation UoF

The elementary_geometric_representation UoF are geometric curves (such as lines and circles) and surfaces (such as planes, cylinders and cones) that are used to represent the complete shapes and component shapes of the building elements.

NOTE - An elementary_geometric_representation does not include advanced surfaces such as b-splines.

The following application objects are used by the elementary_geometric_representation UoF:

- Elementary_b_rep;
- Elementary_curve.

4.1.8 faceted_csg_representation UoF

The faceted_csg_representation UoF consists of CSG primitive elements that are bounded by planar surfaces. The primitives are used to represent the complete shapes and component shapes of building elements; they can be combined using boolean operations.

The following application objects are used by the faceted_csg_representation UoF:

- Block;
- Truncated_pyramid.

4.1.9 faceted_geometric_representation UoF

The faceted_geometric_representation UoF are geometric elements that consist of straight line segments and elements that are bounded by planar faces. It is a representation that may consist of:

- straight lines;
- planes bounded by straight lines;
- volumes bounded by planes.

They are used to represent the component shapes of Building_item objects.

The following application objects are used by the faceted_geometric_representation UoF:

- Facet_trigon;
- Faceted_b_rep;

- Faceted_curve;
- Faceted_face_with_thickness;
- Faceted_surface_representation;
- Point;
- Point_and_line_representation;
- Polyline;
- Site_shape_representation.

4.1.10 property_and_classification UoF

The property_and_classification UoF represents non-shape information that is associated with building elements and components. The information augments the shape information and is used to complete the specification of the building element, and enables the element to be produced.

EXAMPLE 14 - Simple material information, such as concrete type, is a property of a wall or a column that may be specified for the approval or construction of a building. Such Properties are commonly specified as grades, ratings, or parameters that are documented in national or international codes and standards.

The following application objects are used by the property_and_classification UoF:

- Item_classification;
- Property.

4.1.11 space_boundary_representation UoF

The space_boundary_representation UoF represents the shape of spaces within a building. Face and shell representations completely represent the shape of the space.

The following application objects are used by the space_boundary_representation UoF:

- Advanced_shell;
- Elementary_shell;
- Faceted_shell;
- Ground_face.

4.2 Application objects

This subclause specifies the application objects for the building elements using the explicit shape representation application protocol. Each application object is an atomic element that embodies a unique application concept and contains attributes specifying the data elements of the object. The application objects and their definitions are given below.

4.2.1 Advanced_b_rep

An **Advanced_b_rep** is a boundary representation solid that is composed of faces with underlying surfaces that may be one of the following: plane, cylindrical surface, conical surface, spherical surface, toroidal surface, or b-spline surface.

NOTE - Compare with the definition of **Elementary_b_rep** (see 4.2.21) and **Faceted_b_rep** (see 4.2.26).

4.2.2 Advanced_curve

An **Advanced_curve** is a one-dimensional path through three-dimensional space that may be mathematically described with one of the following types of curve: line, polyline, circle, ellipse, hyperbola, parabola, or b-spline curve.

NOTE - Compare with definitions of **Elementary_curve** (see 4.2.22) and **Faceted_curve** (see 4.2.27).

4.2.3 Advanced_face_with_thickness

An **Advanced_face_with_thickness** is a three-dimensional shape that has two parallel surfaces of one of the following types: plane, cylindrical surface, conical surface, spherical surface, toroidal surface, or b-spline surface. The surfaces have identical but arbitrary boundaries and are separated by a normal distance that is very small in comparison to the overall dimensions of the two surfaces.

NOTE - Compare with the definition of **Elementary_face_with_thickness** (see 4.2.23) and **Faceted_face_with_thickness** (see 4.2.28).

4.2.4 Advanced_shell

An **Advanced_shell** is a contiguous, closed collection of topological faces with underlying surfaces that may be of one the following types: plane, cylindrical surface, conical surface, spherical surface, toroidal surface, or b-spline surface.

4.2.5 Approval

An **Approval** is the acknowledgement that a building element shape, property, and spatial configuration information meets evaluation criteria established from a certain functional perspective. The evaluation and subsequent approval or disapproval is performed by an individual or organization that is recognized and accepted as capable of making the evaluation.

EXAMPLE 15 - An architect has the approval responsibility for ensuring that the building meets community design standards.

The data associated with an Approval are the following:

- approver;
- date;
- purpose;
- status.

4.2.5.1 approver

The approver specifies the individual or organization who made the approval.

4.2.5.2 date

The date specifies the date that the approval was made.

4.2.5.3 purpose

The purpose specifies the functional role or objective of the evaluation or assessment performed in order to make the approval.

4.2.5.4 status

The status specifies the state of the approval.

EXAMPLE 16 - "Approved" and "Not approved" are examples of status.

4.2.6 Block

A Block is a three-dimensional, right, rectangular solid primitive. The size and shape of a Block is described by three real values, which represent the length, width, and height dimensions of the Block.

4.2.7 Building

A Building is a man-made structure erected to house, enclose, protect, or serve one or more human enterprises or endeavours.

The data associated with a Building are the following:

- address;
- description;

— name;

— owner;

— status.

4.2.7.1 address

The address specifies the alphanumeric designation used to identify the location of the building in accordance with local postal codes. The address need not be specified for a particular Building.

4.2.7.2 description

The description specifies a textual explanation of the purpose or function of the building.

4.2.7.3 name

The name specifies a descriptive title assigned to the building.

4.2.7.4 owner

The owner specifies the individual or organization who by legal acknowledgement possesses the building.

4.2.7.5 status

The status specifies a label indicating that the information associated with a building is at or has achieved a certain level of life-cycle maturity.

4.2.8 Building_complex

A Building_complex is a collection of buildings located on a site.

The data associated with a Building_complex are the following:

— description;

— global_position;

— name;

— owner;

— surrounding_grounds_shape.

4.2.8.1 description

The description specifies a textual explanation of the purpose or function of the building_complex.

4.2.8.2 global_position

The global_position specifies the information necessary for positioning the Building_complex on the earth. See 4.3.1 for the application assertion.

4.2.8.3 name

The name specifies a descriptive title assigned to the Building_complex.

4.2.8.4 owner

The owner specifies the individual or organization who by legal acknowledgement possesses the Building_complex.

4.2.8.5 surrounding_grounds_shape

The surrounding_grounds_shape specifies a geometric description that represents the topography of the site on which a Building_complex is located. The surrounding_grounds_shape need not be specified for a particular Building_complex. See 4.3.2 for the application assertion.

4.2.9 Building_document_reference

A Building_document_reference is the identification of a document and a section within the document that pertains to a Building_item (see 4.2.12) or a Building_element_component (see 4.2.11).

The data associated with a Building_document_reference are the following:

- document_type;
- identifier;
- item_in_document.

4.2.9.1 document_type

The document_type specifies a label that specifies a descriptive label that indicates the purpose, function, or role of the document.

4.2.9.2 identifier

The identifier specifies a designation that uniquely identifies a particular Building_document_reference.

4.2.9.3 item_in_document

The item_in_document specifies a paragraph, section, or component of the document.

4.2.10 Building_element

A Building_element is a type of Building_item (see 4.2.12) that is a physical part of a building or building system that has a characteristic function. A Building_element may be one of the following: a Structure_enclosure_element (see 4.2.57), a Service_element (see 4.2.51), or a Fixture_equipment_element (see 4.2.31).

EXAMPLE 17 - "Characteristic functions" include purposes such as enclosing, supporting, furnishing, and providing a service.

The data associated with a Building_element are the following:

- additions_and_subtractions;
- main_component.

4.2.10.1 additions_and_subtractions

The additions_and_subtractions specifies a collection of Building_element_components objects (see 4.2.11) each of which has an explicit three-dimensional shape; the Building_element_components are added to or subtracted from each other to form the shape of a Building_element. The additions_and_subtractions need not be specified for a particular Building_element. See 4.3.3 for the application assertion.

NOTE - The aggregate is ordered because the implied boolean operations of addition and subtraction of the positive and negative components are order dependent. Different orderings would result in different shapes for the Building_element.

4.2.10.2 main_component

The main_component specifies the primary shape component of a Building_element. See 4.3.4 for the application assertion.

NOTE - This shape is modified through the additions_and_subtractions to give the final shape of the Building_element.

4.2.11 Building_element_component

A Building_element_component is a basic compositional constituent of the shape of Building_element (see 4.2.10) object that can imply a functional role and a stereotypical shape. A Building_element_component is either a Positive_component (see 4.2.46) or a Negative_component (see 4.2.40).

EXAMPLE 18 - A Structure_enclosure_element such as column consists of the component's shaft, brackets, and openings.

The data associated with a Building_element_component are the following:

- approval_information;
- component_characterization;
- component_class;
- description;
- document_reference;
- identifier;
- position;
- shape.

4.2.11.1 approval_information

The approval_information specifies a collection of approvals of the Building_element_component objects. The approval_information need not be specified for a particular Building_element_component. See 4.3.5 for the application assertion.

4.2.11.2 component_characterization

The component_characterization specifies a collection of properties of the Building_element_component. The component_characterization need not be specified for a particular Building_element_component. See 4.3.11 for the application assertion.

4.2.11.3 component_class

The component_class specifies a collection of designations; each designation classifies a Building_element_component as a member of some predefined category. The component_class need not be specified for a particular Building_element_component. See 4.3.10 for the application assertion.

4.2.11.4 description

The description specifies a textual explanation of purpose or function of the Building_element_component.

4.2.11.5 document_reference

The document_reference specifies a document that contains information pertinent to the Building_element_component. The document_reference need not be specified for a particular Building_element_component. See 4.3.6 for the application assertion.

4.2.11.6 identifier

The identifier specifies a Building_item_identification (see 4.2.13) that uniquely identifies a particular Building_element_component. See 4.3.7 for the application assertion.

4.2.11.7 position

The position specifies the location of a Building_element_component in a coordinate space common to other Building_element_component objects which comprise a Building_element (see 4.2.10). The positions of the Building_element_component objects are such that they form an assembly that represents the shape of the Building_element (see 4.2.10). See 4.3.8 for the application assertion.

4.2.11.8 shape

The shape specifies a shape model that defines a volume that represents shape of the Building_element_component. See 4.3.9 for the application assertion.

4.2.12 Building_item

A Building_item is a part of a building that has a characteristic function. A Building_item is either a Building_element (see 4.2.10) or a Space (see 4.2.56).

The data associated with a Building_item are the following:

- approval_information;
- description;
- document_reference;
- identifier;
- item_characterization;
- item_class;
- level_assignment;
- status.

4.2.12.1 approval_information

The approval_information specifies a collection of approvals of the Building_item. The approval_information need not be specified for a particular Building_item. See 4.3.12 for the application assertion.

4.2.12.2 description

The description specifies a textual explanation of the purpose or function of the Building_item.

4.2.12.3 document_reference

The document_reference specifies a document that contains information pertinent to the Building_item. The document_reference need not be specified for a particular Building_item. See 4.3.13 for the application assertion.

4.2.12.4 identifier

The identifier specifies a Building_item_identification (see 4.2.13) that uniquely identifies a particular Building_item. See 4.3.14 for the application assertion.

4.2.12.5 item_characterization

The item_characterization specifies a collection of properties of the Building_item. An item_characterization need not be specified for a particular Building_item. See 4.3.17 for the application assertion.

4.2.12.6 item_class

The item_class specifies a collection of designations; each designation classifies a Building_item as a member of some predefined category. The item_class need not be specified for a particular Building_item. See 4.3.16 for the application assertion.

4.2.12.7 level_assignment

The level_assignment specifies the Building_level (see 4.2.14) objects to which a Building_item is assigned. The level_assignment need not be specified for a particular Building_item. See 4.3.15 for the application assertion.

4.2.12.8 status

The status specifies a label indicating that the information associated with a Building_item is at or has achieved a certain level of life-cycle maturity.

4.2.13 Building_item_identification

A Building_item_identification is an alphanumeric designation that uniquely identifies a Building_section (see 4.2.16), a Building_item (see 4.2.12), a Building_element_component (see 4.2.11), or a Building_level (see 4.2.14). The designation is unique and persistent across all systems that use the building information and throughout the duration of a building construction project.

The data associated with a Building_item_identification are the following:

- administrator;
- item_identifier;
- project.

NOTE - The designation that is unique is the combination of the item_identifier, the administrator assigning the identifier, and the project in which the assignment is made.

4.2.13.1 administrator

The administrator specifies the individual or organization that assigned the identifier to or is responsible for the item.

4.2.13.2 item_identifier

The item_identifier specifies an alphanumeric string assigned to the item.

4.2.13.3 project

The project specifies the building construction project in which the item must be uniquely distinguishable from other items.

4.2.14 Building_level

A Building_level is a part of a Building that consists of one or more areas accessible through primarily horizontal access paths. A Building_level may be a Sublevel (see 4.2.58) or may have Sublevels.

NOTES

1 - A Building can be thought of as being composed of multiple levels, often called "floors" or "storeys". An access to different areas within one level is achieved primarily through horizontal movement; access between Building_levels is achieved through primarily vertical movement. Figure 4 illustrates building levels.

2 - Building_level is the same thing as "storey" as defined in ISO/CD 4157-2. [3]

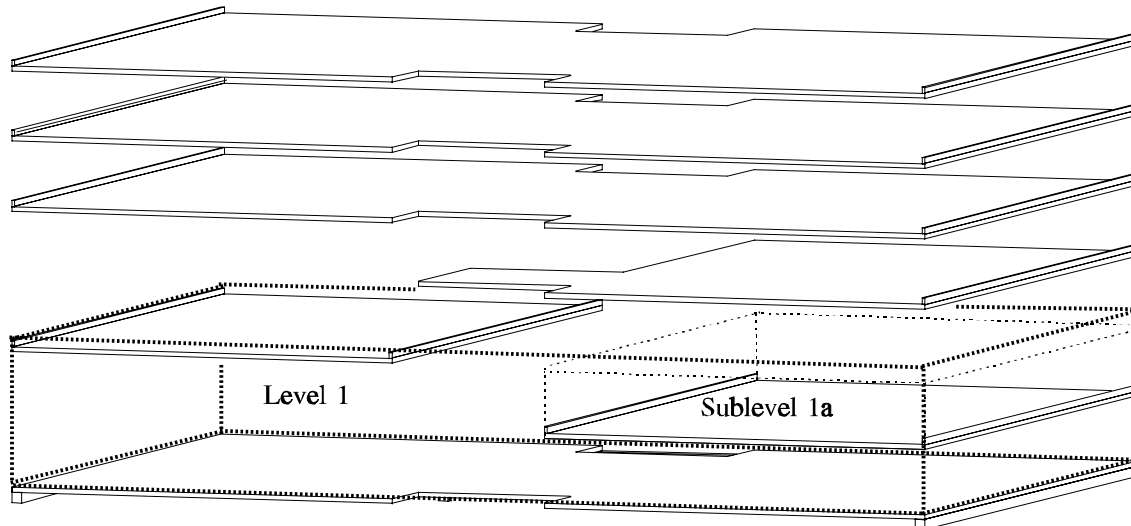


Figure 4 - Building levels

The data associated with a `Building_level` are the following:

- identifier;
- level_characterization;
- level_class;
- name;
- space_shapes.

4.2.14.1 identifier

The identifier specifies a `Building_item_identification` (see 4.2.13) that uniquely identifies a particular `Building_level`. See 4.3.18 for the application assertion.

4.2.14.2 level_characterization

The `level_characterization` specifies a collection of properties of the `Building_level`. The `level_characterization` need not be specified for a particular `Building_level`. See 4.3.20 for the application assertion.

4.2.14.3 level_class

The level_class specifies a collection of designations; each designation classifies a Building_level as a member of some predefined category. The level_class need not be specified for a particular Building_level. See 4.3.19 for the application assertion.

4.2.14.4 name

The name specifies a descriptive title of the Building_level.

4.2.14.5 space_shapes

The space_shapes specifies a collection of Ground_face objects (see 4.2.33), Faceted_shell objects (see 4.2.29), Elementary_shell objects (see 4.2.24), or Advanced_shell objects (see 4.2.4) that bound or delimit a volume of space that represents or encloses a Building_level. The space_shapes need not be specified for a particular Building_level. See 4.3.21, 4.3.22, 4.3.23 and 4.3.24 for the application assertion.

4.2.15 Building_position_in_complex

A Building_position_in_complex is a combination of a Building_complex (see 4.2.8) and positioning information that enables a Building (see 4.2.7) to be positioned within the spatial context of the Building_complex. The aggregation of all Building_position_in_complex objects with the same Building_complex as a context constitutes the buildings that comprise the Building_complex.

The data associated with a Building_position_in_complex are the following:

- location;
- positioned_building;
- positioned_within.

4.2.15.1 location

The location specifies the positioning and orienting information required to place a building within the spatial context of the Building_complex. See 4.3.27 for the application assertion.

4.2.15.2 positioned_building

The positioned_building specifies the Building that is to be placed within the spatial context of the Building_complex. See 4.3.25 for the application assertion.

4.2.15.3 positioned_within

The positioned_within specifies the Building_complex that establishes a spatial context in which buildings are positioned. See 4.3.26 for the application assertion.

4.2.16 Building_section

A Building_section is a logical segment of a building. Logical segments of a building are defined based on local coordinate systems for functional or definitional convenience.

EXAMPLE 19 - Buildings are often designed as individual sections that are integrated into a single structure at a later point in time. The wings of a hospital, library, or office complex are typical building sections. Figure 5 illustrates three building sections; a usage scenario might be that a new section is added every other year to satisfy the spatial needs of a growing company.

The data associated with a Building_section are the following:

- description;
- identifier;
- name;
- status.

4.2.16.1 description

The description specifies a textual explanation of the purpose or function of the Building_section.

4.2.16.2 identifier

The identifier specifies a Building_item_identification (see 4.2.13) that uniquely identifies a particular Building_section. See 4.3.28 for the application assertion.

4.2.16.3 name

The name specifies a descriptive title of the Building_section.

4.2.16.4 status

The status specifies a label indicating that the information associated with a Building_section is at or has achieved a certain level of life-cycle maturity.

4.2.17 Change_request

A Change_request is a modification to some aspect of a building element shape, property, and spatial configuration information, a request for a change to a building element shape, property, and spatial configuration information, or the documentation of a change that has been incorporated.

The data associated with a Change_request are the following:

- approval_information;

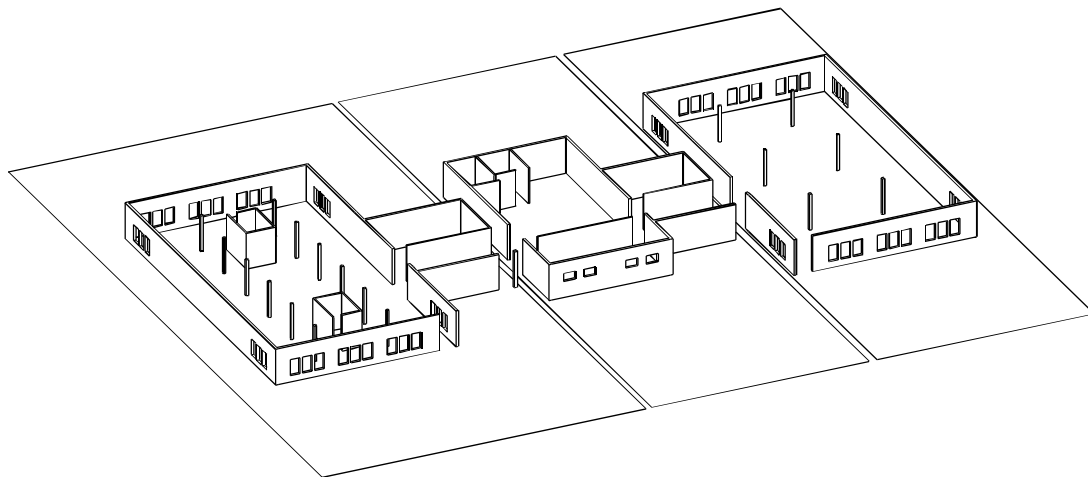


Figure 5 - Building section

- change_from;
- change_to;
- description;
- reason;
- request_date;
- requestor;
- responsibility;
- solution;
- status.

4.2.17.1 approval_information

The approval_information specifies a collection of authorizations to incorporate a requested change into a building element shape, property, and spatial configuration information or the status of the authorization. See 4.3.29 for the application assertion.

4.2.17.2 change_from

The change_from specifies the identifier of some aspect of a building element shape, property, or spatial configuration information that is deemed unsatisfactory. See 4.3.32 for the application assertion.

4.2.17.3 change_to

The change_to specifies the Building_item (see 4.2.12) or the Building_element_component (see 4.2.11) that represents the new condition for some aspect of a building item which is proposed as a replacement for the change_from condition. The change_to need not be specified for a particular Change_request. See 4.3.31 and 4.3.30 for the application assertions.

4.2.17.4 description

The description specifies a request that a change be made or provides an explanation of a change to the building element shape, property, and spatial configuration information.

4.2.17.5 reason

The reason specifies a textual explanation of a problem with the existing building element shape, property, and spatial configuration information and the rationale for changing the design to eliminate the problem.

4.2.17.6 request_date

The request_date specifies the calendar day on which the change is requested.

4.2.17.7 requestor

The requestor specifies the individual or organization that requests that a change to the building element shape, property, and spatial configuration information be made.

4.2.17.8 responsibility

The responsibility specifies the individual or organization that requested the change or is responsible for executing the change.

4.2.17.9 solution

The solution may specify a textual explanation of the action that has been taken with respect to the requested change. The solution need not be specified for a particular Change_request.

4.2.17.10 status

The status specifies a label indicating that the information associated with a Change_request is at or has achieved a certain level of life-cycle maturity.

4.2.18 Component_location_in_element

A Component_location_in_element is the information necessary to position a Building_element_component (see 4.2.11) within the coordinate space of the Building_element (see 4.2.10) of which it is a part.

4.2.19 Component_shape

A Component_shape is the shape of a Building_element_component (see 4.2.11).

The data associated with a Component_shape are the following:

- representations.

The representations specifies the collection of geometric information that represents the shape of the Building_element_component.

NOTE - The shape of a building_element_component may be represented by one or more shape models. If multiple models are used, they should all represent the same shape; they may represent different views of the same shape, e.g., envelope, outline, detailed.

4.2.20 Component_shape_representation

A Component_shape_representation represents a single, cohesive, explicit representation of the shape of a single Component_shape (see 4.2.19).

NOTE - In use, an instance of this entity may correspond to a geometric model that defines the shape of an object.

The data associated with a Component_shape_representation are the following:

- representation_element;
- representation_type.

4.2.20.1 representation_element

The representation_element specifies the Advanced_b_rep (see 4.2.1), the Advanced_curve (see 4.2.2), the Advanced_face_with_thickness (see 4.2.3), the Block (see 4.2.6), the Elementary_b_rep (see 4.2.21), the Elementary_curve (see 4.2.22), the Elementary_face_with_thickness (see 4.2.23), the Faceted_b_rep (see 4.2.26), the Faceted_curve (see 4.2.27), the Faceted_face_with_thickness (see 4.2.28), the Right_circular_cylinder (see 4.2.49), the Solid_of_linear_extrusion (see 4.2.54), the Solid_of_revolution (see 4.2.55), the Trimmed_sphere (see 4.2.59), the Trimmed_torus (see 4.2.60), the Truncated_cone (see 4.2.61), or the Truncated_pyramid (see 4.2.62) that is the Component_shape_representation. See 4.3.34, 4.3.35, 4.3.36, 4.3.37, 4.3.38, 4.3.39, 4.3.40, 4.3.42, 4.3.43, 4.3.41, 4.3.44, 4.3.45, 4.3.46, 4.3.47, 4.3.48, 4.3.49, and 4.3.50 for the application assertions.

4.2.20.2 representation_type

The representation_type specifies the level of detail or precision of the geometric representation. The value of the representation_type is either user supplied or one of a set of predefined values.

NOTE 1 - A user supplied value may be "analysis".

The value of the `representation_type` attribute may be one of the following:

- detail;
- envelope;
- outline.

NOTE 2 - See 4.2.20.2.1 - 4.2.20.2.3 for the definition of each permissible value for `opening_type`.

NOTE 3 - Figure 6 illustrates examples of detail, outline, and envelope shapes for an air conditioning unit. Detail shapes are usually used to produce visually accurate pictures. Outline shapes are usually used for rapid display refresh during interactive design. Envelope shapes are usually used for clash detection.

4.2.20.2.1 detail: a three-dimensional spatial volume that corresponds to the complete surface representation (or part of a complete representation) of a `Component_shape` (see 4.2.19).

4.2.20.2.2 envelope: a simple three-dimensional spatial volume that completely encloses or bounds a `Component_shape` (see 4.2.19) and may also enclose usage or work spaces.

4.2.20.2.3 outline: a simple three-dimensional spatial volume that encloses a `Component_shape` (see 4.2.19).

4.2.21 Elementary_b_rep

An `Elementary_b_rep` is a boundary representation solid model that is composed of faces with underlying surfaces that may be one of the following: plane, cylindrical surface, conical surface, spherical surface, or toroidal surface.

NOTE - Compare with the definition of `Advanced_b_rep` (see 4.2.1) and `Faceted_b_rep` (see 4.2.26).

4.2.22 Elementary_curve

An `Elementary_curve` is a one-dimensional path through three-dimensional space that may be mathematically described with one of the following types of curve: line, polyline, circle, ellipse, hyperbola, or parabola.

NOTE - Compare with the definition of `Advanced_curve` (see 4.2.2) and `Faceted_curve` (see 4.2.22).

4.2.23 Elementary_face_with_thickness

An `Elementary_face_with_thickness` is a three-dimensional shape that has two parallel surfaces of one of the following types: plane, cylindrical surface, conical surface, spherical surface, or toroidal surface. The surfaces have identical but arbitrary boundaries and are separated by a normal distance that is very small in comparison to the overall dimensions of the two surfaces.

NOTE - Compare with the definition of `Advanced_face_with_thickness` (see 4.2.3) and `Faceted_face_with_thickness` (see 4.2.23).

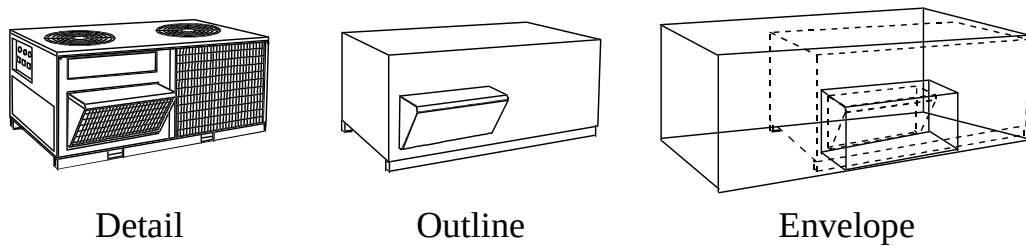


Figure 6 - Detail, outline and envelope shapes

EXAMPLE 20 - The shape of cladding, glazing, and other thin, laminar structures can be most easily represented with a `face_with_thickness`.

4.2.24 Elementary_shell

An `Elementary_shell` is a contiguous, closed collection of topological faces with underlying surfaces that may be of one the following types: plane, cylindrical surface, conical surface, spherical surface, or toroidal surface.

4.2.25 Facet_trigon

A `Facet_trigon` is a triangular, planar surface element with straight-line boundaries.

The data associated with a `Facet_trigon` are the following:

— border.

The border specifies a collection of three `Points` (see 4.2.43) that establishes the linear boundaries of the `Facet_trigon`. Three unique pairs of points can be formed from the three points of the trigon; if more than one `Facet_trigon` exists, then at least one pair of points shall be shared by an adjacent `Facet_trigon` such that the points and the line implied by the points constitute a shared boundary of the trigons. See 4.3.51 for the application assertions.

4.2.26 Faceted_b_rep

A `Faceted_b_rep` is a boundary representation solid that is composed of planar, polygonal faces.

4.2.27 Faceted_curve

A `Faceted_curve` is a one-dimensional path through three-dimensional space that may be mathematically described with one of the following types of curve: line or polyline.

NOTE - Compare with the definition of `Advanced_curve` (see 4.2.2) and `Elementary_curve` (see 4.2.22).

4.2.28 Faceted_face_with_thickness

A `Faceted_face_with_thickness` is a three-dimensional shape that has two parallel, planar surfaces. The surfaces have identical but arbitrary boundaries composed of line or polylines and are separated by a normal distance that is very small in comparison to the overall dimensions of the two surfaces.

NOTE - Compare with the definition of `Advanced_face_with_thickness` (see 4.2.3) and `Elementary_face_with_thickness` (see 4.2.23).

4.2.29 Faceted_shell

A `Faceted_shell` is a contiguous, closed collection of topological faces in which each face is planar and has a polygonal boundary.

4.2.30 Faceted_surface_representation

A `Faceted_surface_representation` is a type of `Site_shape_representation` (see 4.2.53). A `Faceted_surface_representation` is an open surface that is composed of a connected set of planar, triangular faces.

The data associated with a `Faceted_surface_representation` are the following:

— facets.

The facets specifies the collection of planar, triangular faces that represent the contour of the terrain on which a building is or will be located. See 4.3.52 for the application assertion.

4.2.31 Fixture_equipment_element

A `Fixture_equipment_element` is a type of `Building_element` (see 4.2.10) that is a solid, tangible part of a building placed or installed in the building. It is a standalone element that provides a service without complex interdependence on other building elements.

EXAMPLE 21 - Doors, furniture, window shades, hand railing, fireplace mantelpiece, installed shelving, ornamental molding.

The data associated with a `Fixture_equipment_element` are the following:

— functional_type.

The functional_type specifies a descriptive label that indicates the function of the element. The value is either user defined or predefined.

The predefined value of the functional_type attribute is one of the following:

- ceiling;
- covering element;
- door;
- floor covering;
- furniture;
- wall covering;
- window.

NOTE - See 4.2.31.1 - 4.2.31.7 for the definition of each permissible value for functional_type.

4.2.31.1 ceiling: the upper interior surface of a room.

4.2.31.2 covering element: material that is applied to a surface of a Building_item (see 4.2.12) to protect, insulate, or decorate.

4.2.31.3 door: a movable element that is used to seal an accessway.

4.2.31.4 floor covering: a covering element that is applied to an lower interior surface of a room.

4.2.31.5 furniture: movable articles used in living or working activities that are not implements of production.

4.2.31.6 wall covering: a covering element that is applied to a surface of a wall.

4.2.31.7 window: a framed structure which is spanned with glass and mounted in a window opening; it may be mounted to permit opening and closing.

4.2.32 Gis_position

A Gis_position is the positioning and orientation information necessary for transforming coordinate values between a local coordinate space and the global coordinate space of earth. Transformation procedures depend upon the GIS coordinate system. Each Gis_position object designates the global position and orientation of either a Building_complex (see 4.2.8) or a Site_shape_representation (see 4.2.53).

The data associated with a Gis_position are the following:

- height;
- scale;

- system;
- x_axis_delta_x;
- x_axis_delta_y;
- x_coordinate;
- y_coordinate;
- zone.

4.2.32.1 height

The height specifies the distance above sea level or reference level in the GIS coordinate system.

4.2.32.2 scale

The scale specifies a transformation factor applied to the conversion of point coordinates between a local coordinate system and a GIS coordinate system. The precise application of the transformation will depend on the GIS system.

4.2.32.3 system

The system specifies the identifier of the GIS system being used.

EXAMPLE 22 - Gauss-Krueger, Universal Transverse Mercator (UTM), and State Plane are examples of GIS systems used for global positioning.[2]

4.2.32.4 x_axis_delta_x

The x_axis_delta_x specifies the abscissa value of the end point of a vector indicating the positive x axis of GIS coordinate space in the local coordinate system.

4.2.32.5 x_axis_delta_y

The x_axis_delta_y specifies the ordinate value of the end point of a vector indicating the orientation or the positive x axis of GIS coordinate space in the local coordinate system.

EXAMPLE 23 - The GIS coordinate system XY00 has an origin at the intersection of the equator and the Greenwich meridian; the x axis of the coordinate system runs East (positive) and West (negative); the y axis runs North (positive) and South (negative); the positive z axis is up. An x_axis_delta_x of 1.0 and x_axis_delta_y of 1.0 indicates x axis of the GIS coordinate space makes a +45° angle with respect to the x axis of the local coordinate; if the local coordinate space were superimposed on the GIS coordinate space, the positive x axis of the local coordinate system would point in a South-East direction (-45°).

4.2.32.6 **x_coordinate**

The **x_coordinate** specifies the distance from the y axis of the coordinate space defined by the GIS system and zone.

4.2.32.7 **y_coordinate**

The **y_coordinate** specifies the distance from the x axis of the coordinate space defined by the GIS system and zone.

4.2.32.8 **zone**

The **zone** specifies a subdivision of the earth's surface based on the GIS system.

EXAMPLE 24 - The Gauss-Krueger GIS system subdivides the earth into 120 zones that are 3° in longitudinal width. Each zone is identified as 3°, 6°, 9°, etc., from the Greenwich meridian.

4.2.33 **Ground_face**

A **Ground_face** is a planar bounded surface that represents a floor space within a building.

4.2.34 **Item_assembly**

An **Item_assembly** is an assemblage of **Building_item** objects (see 4.2.10) or **Item_assembly** objects that are combined to form a larger object.

NOTES

1 - An **Item_assembly** is an aggregation of components of a building that is defined at an intermediate level between the individual piece-part elements of a building (e.g., a beam) and a major subdivision of a building (e.g., a building section or level).

2 - The components in an **Item_assembly** are physically positioned within the spatial coordinate system of the assembly. Contrast this with **Item_group** (see 4.2.36), which is simply a logical collection of **Building_item** objects.

EXAMPLE 25 - Trusses and frames are typical element assemblies for structural elements. A pipeline is a typical example of an element assembly for building services equipment.

The data associated with an **Item_assembly** are the following:

- **approval_information**;
- **assembly_characterization**;
- **assembly_class**;
- **assembly_type**;

- components;
- description;
- identifier;
- name.

4.2.34.1 approval_information

The approval_information specifies a collection of approvals of the Item_assembly objects. The approval_information need not be specified for a particular Item_assembly. See 4.3.53 for the application assertion.

4.2.34.2 assembly_characterization

The assembly_characterization specifies a collection of properties of the Item_assembly. The assembly_characterization need not be specified for a particular Item_assembly. See 4.3.57 for the application assertion.

4.2.34.3 assembly_class

The assembly_class specifies a collection of designations; each designation classifies an Item_assembly as a member of some predefined category. The assembly_class need not be specified for a particular Item_assembly. See 4.3.56 for the application assertion.

4.2.34.4 assembly_type

The assembly_type specifies a descriptive label that indicates the form or function of the assembly. The value is either user defined or predefined.

EXAMPLE 26 - Figure 7 illustrates several examples of element assemblies.

The predefined value of the assembly_type attribute is one of the following:

- roof;
- stairway;
- vertical passage enclosure.

NOTE 2 - See 4.2.34.4.1 - 4.2.34.4.3 for the definition of each permissible value for assembly_type.

4.2.34.4.1 roof: the covering or upper part of a building that has a primary function of protecting the building from weather.

4.2.34.4.2 stairway: one or more flights of stairs used to pass from one floor of a building to another. The flights of stairs are often separated by landings and the stairway includes the supporting structure.

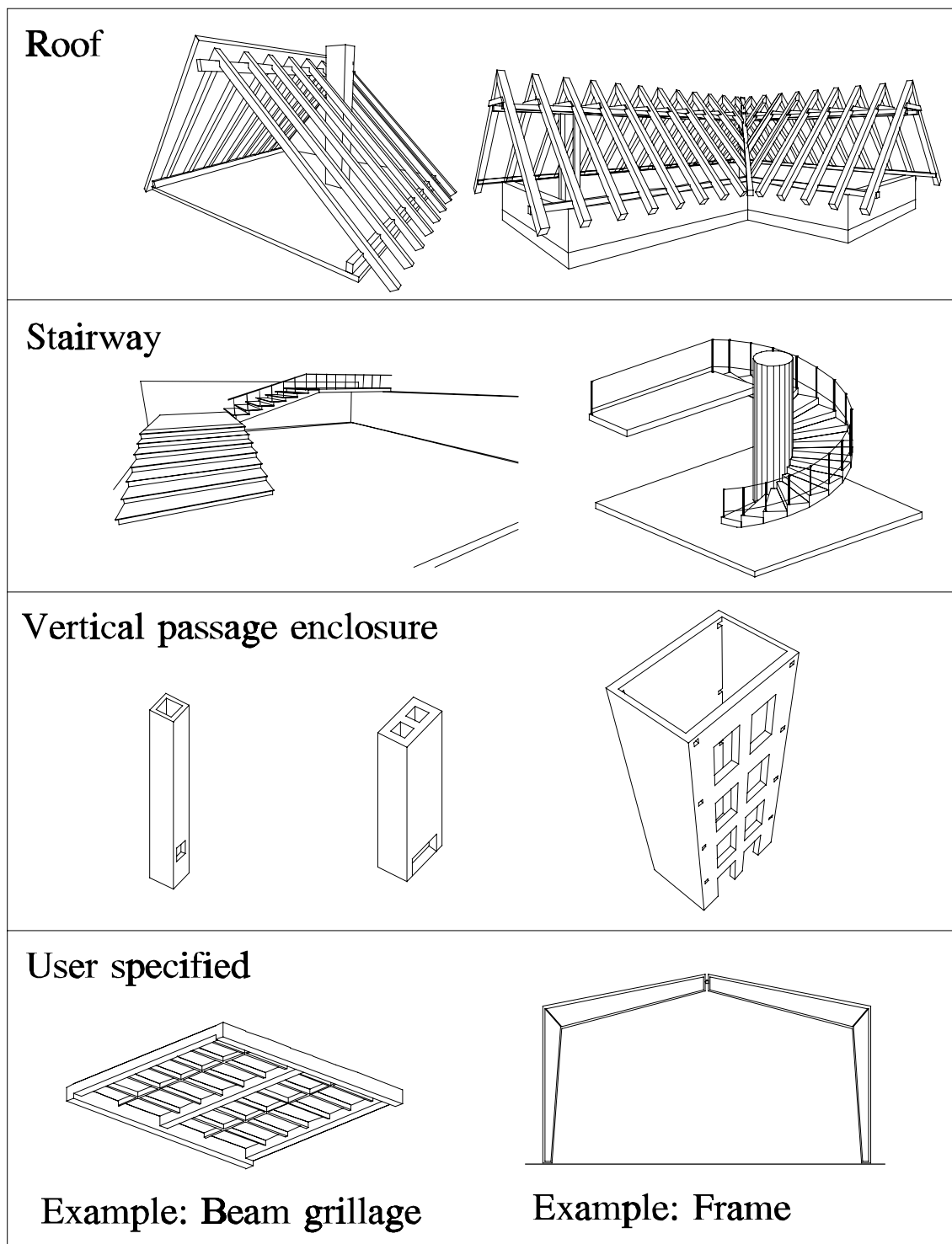


Figure 7 - Kinds of element assemblies