Technical Report

ISO/TR 5863

Integrative design of the building envelope — General principles

Conception intégrée de l'enveloppe du bâtiment — Principes généraux

First edition
2025-01

Reference number
ISO/TR 5863:2025(en)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

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

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

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 205, *Building environment design*.

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

The building envelope is either a boundary or a space, or both, separating the indoor and outdoor environments of a building. It is comprised of roofs, walls (above grade and under grade), windows, doors and foundation. Windows and other openings for daylighting and ventilation are deemed to be an interface between the indoor and outdoor environments. They transfer physical environment elements such as air, heat and cold, light, sound and water. A good building envelope secures high environmental performance in the building with low energy use as well as structural soundness and an aesthetically pleasing appearance.

The building envelope bears a direct relationship to the design and construction of the building. Designing the building envelope requires a wide range of considerations covering structural, environmental and aesthetic functions. A comprehensive approach is essential and achieved through an integrated design process for buildings. This document focuses on the environmental factors and provides design principles for the quality and energy-efficient building envelope.

The building envelope can also meet structural and safety requirements including earthquake protection, wind resistance, flood resistance, fire resistance, durability, maintainability and security. However, those requirements are out of the scope of this document, and can be found in other international standards, guides and reports.

Integrative design of the building envelope — General principles

1 Scope

This document provides an overview of the design principles for the building envelope in order to achieve a high quality and energy efficient built environment. The design principles include:

— thermal performance;

— daylight and visual environment;

— air quality;

— provisions of natural and mechanical ventilation;

— air barrier (airtightness);

— watertightness;

— moisture proof;

— soundproofing;

— sustainability and integration with technical building systems and controls.

This document is applicable to new buildings and the retrofit of existing buildings.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

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

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

3.1
building envelope
elements of a building as a boundary or barrier separating the interior volume of a building from the outside environment

[SOURCE: ISO 12569:2017, 3.5, modified — The words “elements of a building as a” have been added to the beginning of the definition.]

3.2
building envelope commissioning
BECx
process of enhancing the delivery of the design and construction of a building envelope by verifying and documenting the building envelope concepts, designs, materials, components, assemblies and systems that have been designed, installed and performance tested, and are maintainable, in accordance with the owner's project requirements

[SOURCE: ISO 21105-1:2019, 3.5, modified — The words "enclosure" and "OPR" have been replaced by "envelope" and "owner's project requirements" respectively.]

3.3
daylight sensing control
device that automatically regulates the power input to electric lighting near the fenestration to maintain the desired workplace illumination, thus taking advantage of direct or indirect sunlight

[SOURCE: ISO 16818:2008, 3.54]

3.4
design team
group of people who are responsible for building design

Note 1 to entry: The design team can consist of an architect, an interior designer, a lighting designer, a landscape designer, engineers in electrical engineering, illuminating engineering, HVAC systems, structural engineering and construction management and other specialists.

[SOURCE: ISO 19454:2019, 3.5]

3.5
heat island effect
phenomenon of elevated temperatures in urban and suburban areas compared to their outlying rural surroundings

Note 1 to entry: The temperatures can be influenced by various aspects, including the presence of denuded landscaping, impermeable surfaces, massive buildings, heat-generating vehicles and machines and pollutants.

[SOURCE: ISO 21929-1:2011, 3.14]

3.6
heat transfer coefficient
U-value
heat flow rate divided by the temperature difference between two environments

Note 1 to entry: Expressed in $W \cdot m^{-2} \cdot K^{-1}$.

3.7
HVAC system
system that provides heating, ventilation or air conditioning for buildings

[SOURCE: ISO 16814:2008, 3.18]

3.8
rooflight
daylight opening on the roof or on a horizontal or near horizontal area of a building

[SOURCE: ISO 16817:2017, 3.19, modified — The words "or near horizontal" have been added.]

3.9
solar heat gain coefficient
SHGC
ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation

Note 1 to entry: Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted or convected into the space.

[SOURCE: ISO 16818:2008, 3.216]

3.10
technical building system
technical component for heating, cooling, mechanical ventilation (filtration and exhaust), humidification, dehumidification, domestic hot water, water supply, drainage and sanitary equipment, lighting, building automation and control, and electricity production on site

Note 1 to entry: A technical building system can refer to one or to several building services (e.g., heating, cooling, lighting and domestic hot water).

Note 2 to entry: Lifts and fire extinguishing systems can be included in technical building systems.

Note 3 to entry: A technical building system is composed of different sub-systems.

Note 4 to entry: Electricity production can include cogeneration, wind power and photovoltaic systems.

[SOURCE: ISO 16813:2024, modified — The words “on site” have been added.]

3.11
thermal mass
materials with mass heat capacity storing or releasing heat as the interior or exterior temperature, or both, convective and radiant conditions fluctuate, and affecting building thermal load

Note 1 to entry: Expressed in $J \cdot K^{-1}$.

3.12
thermal resistance
R-value
ratio of the temperature difference between the two faces of a material to the rate of flow of heat unit area normal to the faces

Note 1 to entry: Expressed in $m^2 \cdot K \cdot W^{-1}$.

3.13
ventilation rate
magnitude of air flow to a room or building through the ventilation system, device or building elements

Note 1 to entry: Expressed in h^{-1}.

3.14
window-to-wall ratio
WWR
ratio of the net glazing area to the gross exterior wall area above the ground

[SOURCE: ISO 16818:2008, 3.249, modified — The word “fenestration” has been replaced with “net glazing” and the words “above the ground” have been added.]

4 Design philosophy and principles for the building envelope

4.1 General

Both the client and the designer can have a philosophy and set ethics concerning building environment in general terms. They can also rely on ideas related to architectural and environmental design. Philosophy

and ethics are a base on which the target level of each environmental element is determined and the design strategies are planned. A building is evaluated from different aspects. Clients and designers can wish to decide which aspect is crucial or less critical on the basis of their own philosophy and ethics. This consideration is possible, provided it does not violate the environment design criteria. Philosophy and ethics relate to the aspects which are determined on more than the others. The theories also encourage a designer to employ a particular design strategy and work as the rationale on which the behaviours and functions of a building from its structure are based.

This document introduces Gero's theory in design[9] and expands it. Four classes of variables can be defined to describe different aspects in designing buildings as follows:

— function (F) variables that describe the teleology of the object, i.e. for what it is;

— behaviour (B) variables that describe the attributes that are derived or expected to be derived from the structure (S) variables of the object, i.e. what it does;

— structure (S) variables that describe the components of the object and their relationships, i.e. what it is;

— experience (E) variables that describe the interaction between the object and users, i.e. how it is utilized.

The notion of function (F) refers to the teleological characteristics of an artefact. The purpose of designing is to transform function (F; where is a set) into a design description of structure (S) in a such a way that the artefact being described is capable of producing the functions. The design description is expressed and documented in the form of drawings and notes.

The notion of behaviour (B) refers to the characteristics of an artefact or mechanisms of an artefact that are deterministically derived or expected to be derived from the structure (S) of the artefact and that articulate the functions (F) of the artefact. The physical properties of an artefact are classified into behaviour (B).

The notion of structure (S) refers to the substantial characteristics of an artefact that can be determined directly in designing. The structure (S) represents an artefact's elements and their relationships, and determines the behaviours of the artefact.

The notion of experience (E) refers to the interactive characteristics between an artefact and users. Humans build connections between the function (F), behaviour (B) and structure (S) through experience (E) and development of causal models based on interactions with an artefact.

For example, consider designing a library. One of the objectives of a library is to provide a built environment where occupants can read books comfortably. This objective can be expressed in terms of functions of the library, that is, visual performance, visual comfort and visual safety. The functions are articulated in terms of values of behavioural variables such as luminance, illuminance and colour temperature of light. The structural variables – form and materials – are determined to meet the requirements of the above variables.

Since the structure of a building envelope can enhance the behaviour of a certain environmental element and detract from the behaviour of another environmental element, to design a building envelope is to solve a multi-objective optimization problem. However, the problem definition is not so easy in the sense that the formulation of its evaluation function depends on the requirements for the building envelope. The requirements are co-defined by the clients, architects, engineers and other specialists involved in the design.

Each of the diverse functions of a building can be articulated as a combination of the behaviours of certain environmental elements. The behaviour of each environmental element is affected by the structure of the building environment. Therefore, the relationship between the structure and the behaviour of each environmental element is meant to be clarified prior to designing the building envelope.

4.2 One thing increases, another decreases

Philosophy 1: There are trade-offs between function variables in a project definition, and more than one optimum solution exist. There is no logical method to select an optimum solution.

Principle 1: A design team determines what is crucial and what is less crucial among the function variables.