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What is a Building Envelope: A Short Note

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Abstract

The building envelope is the physical barrier between the exterior and interior environments enclosing a structure. Generally, the building envelope is comprised of a series of components and systems that protect the interior space from the effects of the environment like precipitation, wind, temperature, humidity, and ultraviolet radiation. The internal environment is comprised of the occupants, furnishings, building materials, lighting, machinery, equipment, and the HVAC (heating, ventilation and air conditioning) system.

Introduction

Recall sitting in your office shivering from cold drafts, or fanning yourself from the heat? Building envelope design is the cause. A building envelope is the structural barrier between the interior and exterior of a building. It is responsible for maintaining climate control within the interior of a building. Climate control refers to cooling and heating a building [1]. The building envelope also keeps the interior free from moisture, sound, and light. The building envelope structure includes the:

- Roof,
- Walls,
- Foundation,
- Doors, and
- Windows.

Common materials are used to form the building envelope structure and contribute to the structure by having long lasting, insulating, water repellent, sound blocking, and light filtering characteristics. Common roof material includes asphalt, composite, wood, metal, clay, slate, and rubber [2]. Typical wall material includes brick, stone, stucco, glass block, wood, concrete, and vinyl. The building envelope foundation simply consists of stone, brick, or forms of concrete. Window frames and doors share common materials such as aluminum, composite, fiberglass, vinyl, and wood. Specialty coatings and tints, along with gases, are commonly applied to any glass on both windows and doors. Building envelope material is dependent on the climate, culture, and available resources [3].

The foundation is the structural component that transmits the loads from the building to the underlying substrate. Typically, some combination of reinforced concrete walls, slabs, and footings constitute the structural components of the foundation. However, the foundation must also be designed to control the transfer of moisture and thermal energy into the interior space. The transfer of thermal energy through the foundation can be controlled by providing insulation between the interior and exterior environments; however, in some cases the foundation insulation is neglected to reduce construction costs [4].

Waterproofing the foundation is typically completed by applying a liquid applied asphaltic damproofing. Additional waterproofing products such as sheet-applied membranes, liquid membranes, cementitious waterproofing, and built-up systems are also viable options [5].

Drainage around the perimeter of the foundation must be provided to prevent long-term underwater submersion of the waterproofing membrane. One example of a perimeter foundation drain is weeping tile placed in trench complete with gravel ballast backfill, also known as a french drain. In some cases, a sump pit and pump system will be required in addition to the perimeter drain [6].

The roofing system is an important part of any house, as it keeps weather out. It consists of shingles on the outside, which are on top of tar sheeting as a vapor barrier. Inside of the tar paper is wood sheathing. Beyond this, the attic areas in most houses are insulated with fiberglass spray insulation. It tends to be fluffy, pink fiberglass. Inhaling fiberglass is extremely bad for a person's respiratory system, so it is important to wear a mask if this insulation type is in one's roofing system [7].

The building envelope is the physical barrier separating the interior of the building from the exterior environment, which includes the roof, walls, foundations, windows, and doors. So, in definition, the building envelope acts as structural support for the building and controls climate elements such as air, water, heat, and light exchange with the exterior environment [8].

The many functions of the building envelope fall into three categories: support, control, and finish. Support functions are to resist and transfer structural and dynamic loads. Control functions include directing the flow of matter and energy of all types. Finish functions mean meeting the desired visual aesthetics both on the inside and outside.The control function of a building envelope focuses, on rain control, air control, heat control, and vapor control [9].

Rain control is essential. There are multiple strategies to defend against weather, namely, barriers, drained screens, and mass storage systems. One of the primary purposes of a roof is to resist water. Two broad types of roofs are flat and pitched. Flat roofs slope up to 10° or 15° but are built to withstand standing water. The design of pitched roofs is to shed water but not resist standing water, which can happen during wind-driven rain or ice damming. Pitched roofs are typically used for residential buildings and are covered with an underlayment

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material beneath the roof covering material as the second line of defense. Residential roofs may also be ventilated to help eliminate moisture due to leakage and condensation [10].

Many components of the building envelope structurally support the building. In addition to the support functionality, building envelope elements provide climate control for how air, heat, light, and other environmental elements move in and out of the house. For example, effective building envelope control moisture migration and intrusion into a building. It also regulates heat transfer in and out of the building. However, building envelope components form the exterior of the house as well. So, the building envelope contributes to the aesthetic view of the building and needs to meet certain architectural requirements and adhere to cultural preferences [11].

The building envelope design accounts for the following:

- Determining the type of system that should be used in building the exterior of the building to resist the environmental elements.
- Provide structural support and satisfy architectural and aesthetic requirements.

The designer starts by identifying and quantifying the different environmental elements that surround the building. For example, the designer lists the following:

- Daily and annual temperature and humidity at the location of the building.
- The type of soil and its moisture
- The amount of sunlight and heat that potentially enters the building
- The amount of rain, hail, and snow that falls.

For example, the region of the building is identified according to its storm susceptibility, history of past hurricanes, and their category. Wind speed and prevailing direction are gathered from a data source such as a nearby airport. If the house is located in an area with a history of severe storms and hurricanes, the building design will need to reflect that in the form of larger size walls, roofs, and foundations and more watertight windows and doors [12]. Climate data gathered include the number of hot and cold days in a year, the amount of sunlight, and the angle of the sunlight that potentially enters the building. A sound barrier around the house may be needed if a busy highway is nearby to reduce noise. Acoustic insulation might also be needed in the walls and roof depending on the level of noise outside. The designer also determines if groundwater is likely to get close to the building basement and what type of soil is below the building. If groundwater is needed, waterproofing will likely be needed to isolate the basement and prevent moisture from intruding, causing structural problems, smell, and mold. If a body of water such as a river or a lake is nearby and it floods in the winter or rainy summer days, it poses a threat to the house, and the designer will need to pay special attention to implementing countermeasures [13].

The design of the building envelope depends on the environment the building is surrounded by. Therefore, the type of building envelopes corresponds to the type of environment and can be grouped into four main types:

- Arid Climates
- Tropical Climates
- Cold Climates
- Mixed Hot and Cold Climates

A tight building envelope allows very few air leaks. This is achieved by the aforementioned insulation, sealants, and energy-efficient windows. Why create such a tight seal? Indoor environmental control. The tighter the seal on the building envelope, or shell, the more control people have over the indoor environment. A tightly sealed building allows for a higher level of comfort control, reduced moisture issues, and more energy efficiency. Of course, with a tighter seal comes less natural ventilation, so more mechanical ventilation is needed [14].

On the other hand, a loose envelope allows for more natural ventilation, so more outside air can flow inside without the need for mechanical means. Loose envelopes can be achieved by design, but poor construction can result in a loose envelope as well.

The drawbacks associated with loose building envelopes can include unwanted moisture (i.e., mold and mildew); indoor air quality potentially being affected by nearby contaminants; other equipment in the building performing less efficiently; and greater loss of air conditioning and heat, which results in higher energy use and costs.

Conclusion

A building envelope plays a key role in the climate, the structural soundness, and the energy efficiency of a building. The foundation, walls, windows, doors, and other barrier materials work together to keep inside, conditioned air in and outside air and heat (or cold) out.The strength and flexibility of the materials used help to make the building last by preventing moisture and movement damage. Finally, a sound building envelope uses less energy, which is good for environmental sustainability and provides building owners the added benefit of energy savings.

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Conflict of Interest

None

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