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Multi-layer facades: What happens behind?

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Abstract

Many recent buildings are equipped with multi-layer facades composed of opaque exterior elements located in front of the glazed surfaces, such as fixed external lamellas, metallic fabrics, perforated plates, wooden claddings, etc. In most cases these systems are mainly motivated by aesthetic considerations. The presence of outer layers in front of opaque parts of the facade may have a low influence on the building performance, but when windows are covered, a substantial weakening of the daylight availability and energy performance can be observed. This paper assesses three representative multi-layer facade systems and compares their performance with the one of an efficient single layer facade equipped with external automated blinds. Dynamic simulations are run with DIAL+ software (v2.5) in order to compare the energy performance and indoor comfort conditions. Simulations with the Three-Phase method are carried out to evaluate the annual daylight availability (sDA, UDI).

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Keywords: Type your keywords here, separated by semicolons ;

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1. Introduction

Context

Today's techniques and technologies enable to build very energy efficient buildings. High insulation, suitable glazings and effective shading devices lead to very low heating loads, good coverage of daylight requirements and control of summer overheating risks. All these demands can be met with a conventional envelope, which means composed of a single layer alternating opaque and glazed surfaces with movable blinds. However, observation of recent architectural production shows that many new buildings are built today with an additional outer layers.

Beyond the aesthetic aspects that we are not in a position to judge, the presence of these external elements results in a certain change of the interior spaces, both in terms of energy performance and visual comfort. This paper aims to examine the impact of these external elements on daylight availability, energy balance in winter, overheating risk in summer and view to the outside. Thus this paper proposes to compare three *representative* multi-layers facade systems (see Fig.1), and to compare their performance with the one of an efficient single layer facade equipped with external automated blinds.

Selected case-studies

The selected case studies are supposed to be representative of existing buildings. However, the examples mentionned below are merely illustrative and the conclusions of the article can in no case be applied stricto-sensus to these buildings. The comparative approach is entirely based on simulations (no survey/monitoring).

Main features

The room used for comparison is a medium size openspace office (width: 18.30m, depth: 7.75m, height: 2.88m). The building is located in an urban environment of medium density (outdoor masks altitude = 25°, reflection coef. 0.25, albedo = 0.10). The indoor reflection coeficients are as follows: floor: 0.30; vertical walls: 0.50; ceiling: 0.70. The room is equiped with standing luminaires with the following characteristics: 3 rows of 5 luminaires; 93W; 12'505 lm (134 lm/W); automated dimming and absence sensors. Simulations are run with DIAL+ [1] software with the climatic data of Lausanne. The occupied period is 8AM to 6PM.

Reference case (REF)

The reference case is equipped with a double glazing ($\tau = 0.80$, $g = 0.62$, Uglass = 1.1W/m2K). The windows are fitted with automated external venetian blinds ($\rho = 0.50$)

(Analogy with EPFL Innovation Park, Lausanne, Switzerland, arch. Richter Dahl Rocha 2011).

Case Study 1 (CS1): Fixed horizontal blades

The external layer is composed of horizontal blades in ultra-high performance fiber-reinforced concrete (UHPC) with the following characteristics: Width: 20 cm; Thickness: 3 cm; Spacing: 25 cm, Reflection coefficient: 0.15.

(Analogy with Pavillon 52 building, Lyon, arch. R. Ricciotti 2016).

Case Study 2 (CS2): Fixed tilted lamellas

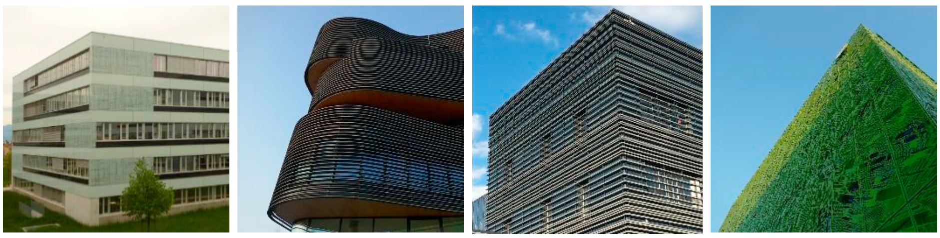
The additional external layer is composed of tilted aluminium blades with the following characteristics: Width: 17 cm; Spacing: 38 cm; Tilting angle: 40°; Reflection coefficient: 0.40.

(Analogy with Ecotox Building, Valence, France, arch. Brunet Saunier, 2016).

Case Study 3 (CS3): Perforated metal sheets

The additional outer layer is composed of perforated sheets with an average perforation rate estimated at 0.56.

(Analogy with "Cube-Vert" building, Lyon, France, arch. Jakob MacFarlane, 2014).



REF: Analogy with "*EIP*" CS1: Analogy with "*Pavillon 52*" CS2: Analogy with "*Ecotox*" CS3: Analogy with "*Cube-Vert*"

Fig. 1 External views of 4 emblematic buildings showing an analogy to the selected cases studies. Photos Estia.