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Applying Double Skin Façade with ETFE Membrane Assembly for Energy Saving and Acoustic Protection for the Building of the Czech Institute of Informatics, Robotics and Cybernetics in Prague

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Abstract: Multidisciplinary, integrated planning approach by architects, engineers, scientists and manufacturers to reduce energy consumption of buildings. The CIIRC Complex, located on the main campus of Czech Technical University in Prague consists of two buildings, newly constructed building and adaptive reuse of existing building. CIIRC—Czech Institute of Informatics, Robotics and Cybernetics is a contemporary teaching facility of new generation and use for scientific research teams. New building has ten above-ground floors, on the bottom 4 floors of laboratories, scientist modules, classrooms, above are offices, meeting rooms, teaching and research modules for professors and students. Offices of the rector are on the last two floors of the building. On the top floor is congress type auditorium, in the basement is fully automatic car park. Double skin pneumatic cushions façade. In the project are introduced series of architectural and technical features and innovations. Probably the most visible is the double skin façade facing south-transparent double layer membrane ETFE (Ethylen-TetraFluorEthylen) cushions with triple glazed modular system assembly. Acting as solar collector, recuperating of hot air on the top floors, saving up to 30% of an energy consumption.

Key words: Double skin façade as solar collector, ETFE membrane cushions as outer skin, air-recuperation from façade (top floors).

1. Introduction

Function of the building: scientist modules, computer laboratories, offices, teaching facilities.

Objective: multidisciplinary, integrated planning approach by architects, engineers, scientists and manufacturers to reduce energy consumption of buildings.

The CIIRC Complex (see Figs. 1 and 2), located on the main campus of Czech Technical University in Prague, consists of two buildings: a newly constructed building and an existing building that has been adapted for re-use.

CIIRC—Czech Institute of Informatics, Robotics and Cybernetics is a contemporary teaching facility of new generation and use for scientific research teams.

The new building consists of 10 above-ground floors: the lower four floors house laboratories, scientist modules and classrooms floors, five to nine floors above are offices, meeting rooms, teaching and research modules for professors and students. Offices of the rector of the University occupy the last two floors of the building. On the 10th floor is a congress-type auditorium, in the basement is a fully automatic car park for 190 cars (see Fig. 1).

2. Method and Materials

Double skin pneumatic cushions façade: The project introduces series of original architectural and technical features and unusual innovations. Of those probably the most advanced is a double skin façade (fifth to ninth floor) south facing with transparent double

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Fig. 1 Double skin façade using ETFE membrane as a solar collector.

Fig. 2 The CIIRC Complex, a newly constructed building in forefront.

layer membrane ETFE (Ethylen-TetraFluor Ethylen) cushions with triple glazed modular system assembly. Welded cushions are kept under constant air pressure 300 Pa, calculations of wind load pressure and snow load impacts are taking in consideration [1]. See Figs. 3-6.

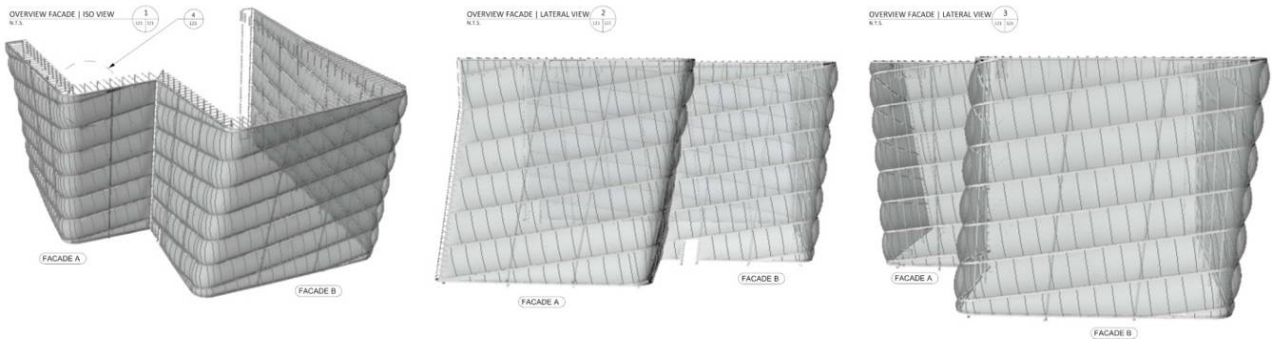

Fig. 3 ETFE pneumatic cushions façade in 3D, South and West elevations [1], showing the positions of welding seems.

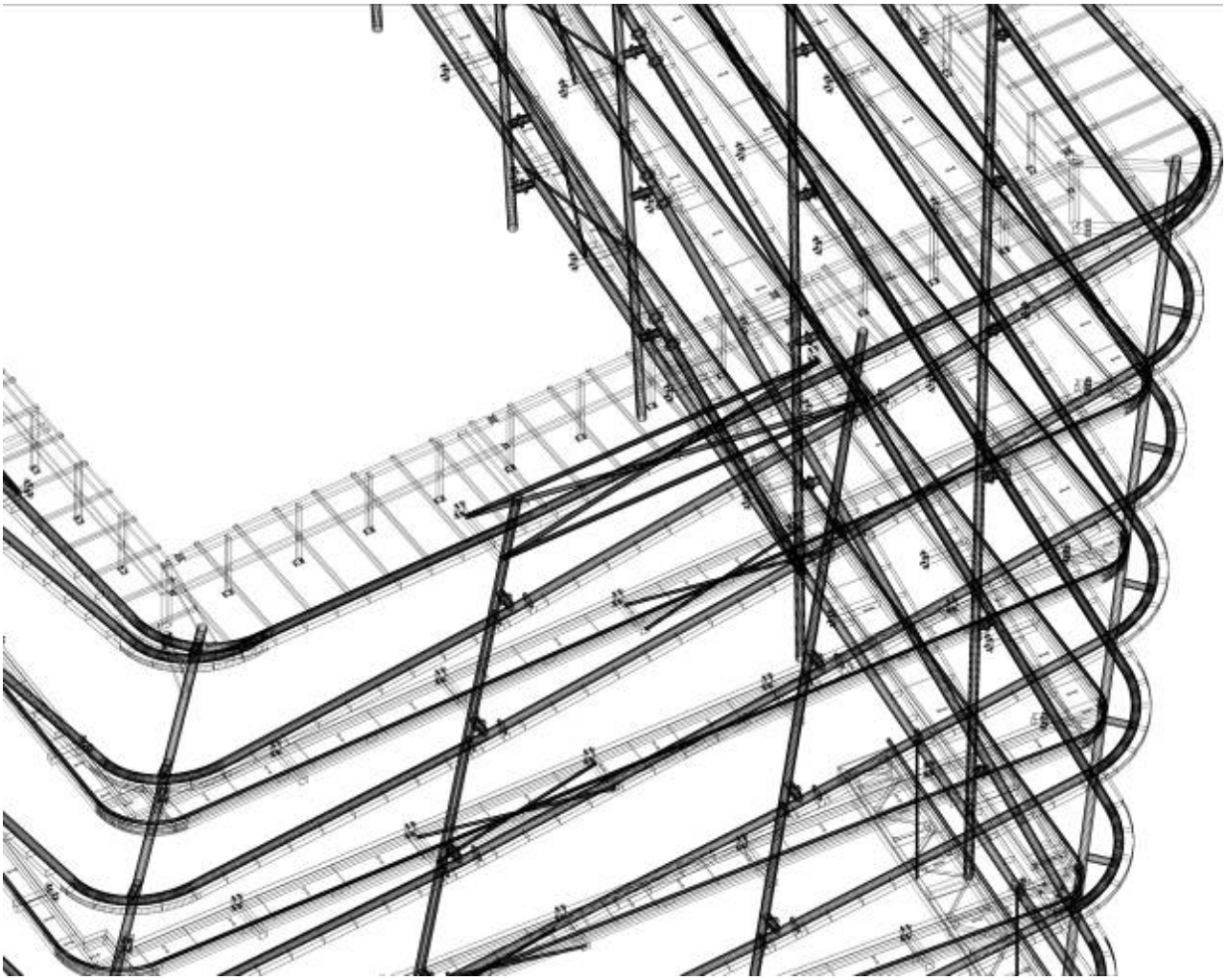

Fig. 4 Steel structure and aluminium ETFE detailing—structure engineer's 3D model [2].

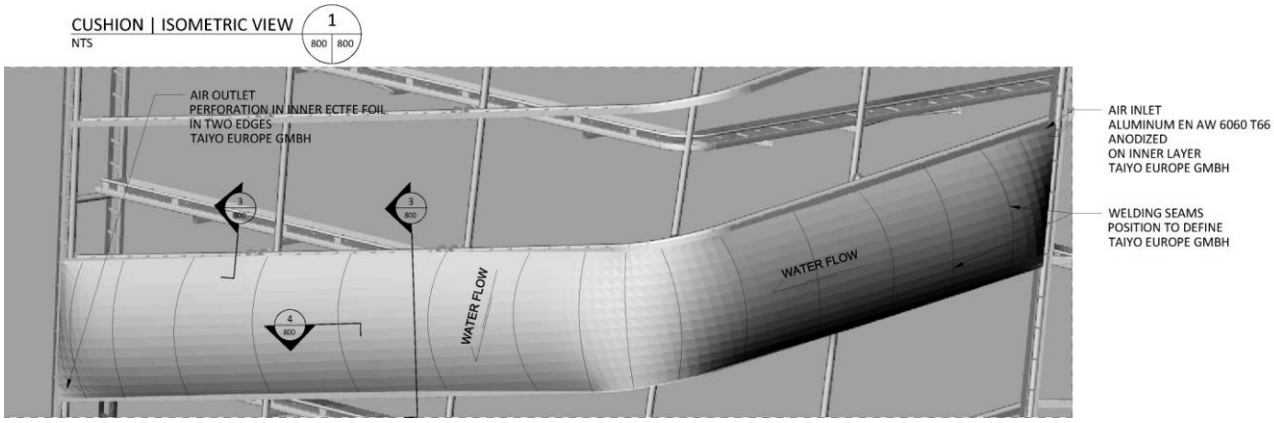

Fig. 5 Turning of the corner of diagonally placed cushion of ETFE membrane detail [1].

Fig. 6 Turning the corner—ETFE pneumatic cushions façade in 3D [1].

Transparent double layer membrane ETFE cushion with triple glazed modular system assembly acting as solar collector (see Figs. 7 and 8).

Such building envelope has high acoustic protective value (57 dB) and, at the same time is acting as a solar collector for the recuperation of hot air on the top floors, saving up to 30% of energy consumption.

Protected from the wind behind the ETFE cushions are horizontal blinds, the inner climate is controlled by BMS system (see Fig. 7). Chilled beams are installed for heating and cooling.

Outside air is sucked into the ventilation units on each floor from two places—from the solar collector (façade between the glass facade and the facade of the ETFE facing south). From south façade for the winter and transition period and from the north façade in the summer (see Figs. 9 and 10).

Recuperation of hot air on the top floors, saves up to 30% of an energy consumption:

Fig. 7 Space between triple glazing and membrane ETFE, horizontal blinds fixed to mullions on the left. Catwalk is used for maintenance [1].

Fig. 8 Transparent membrane ETFE with triple glazing in second plane [1].

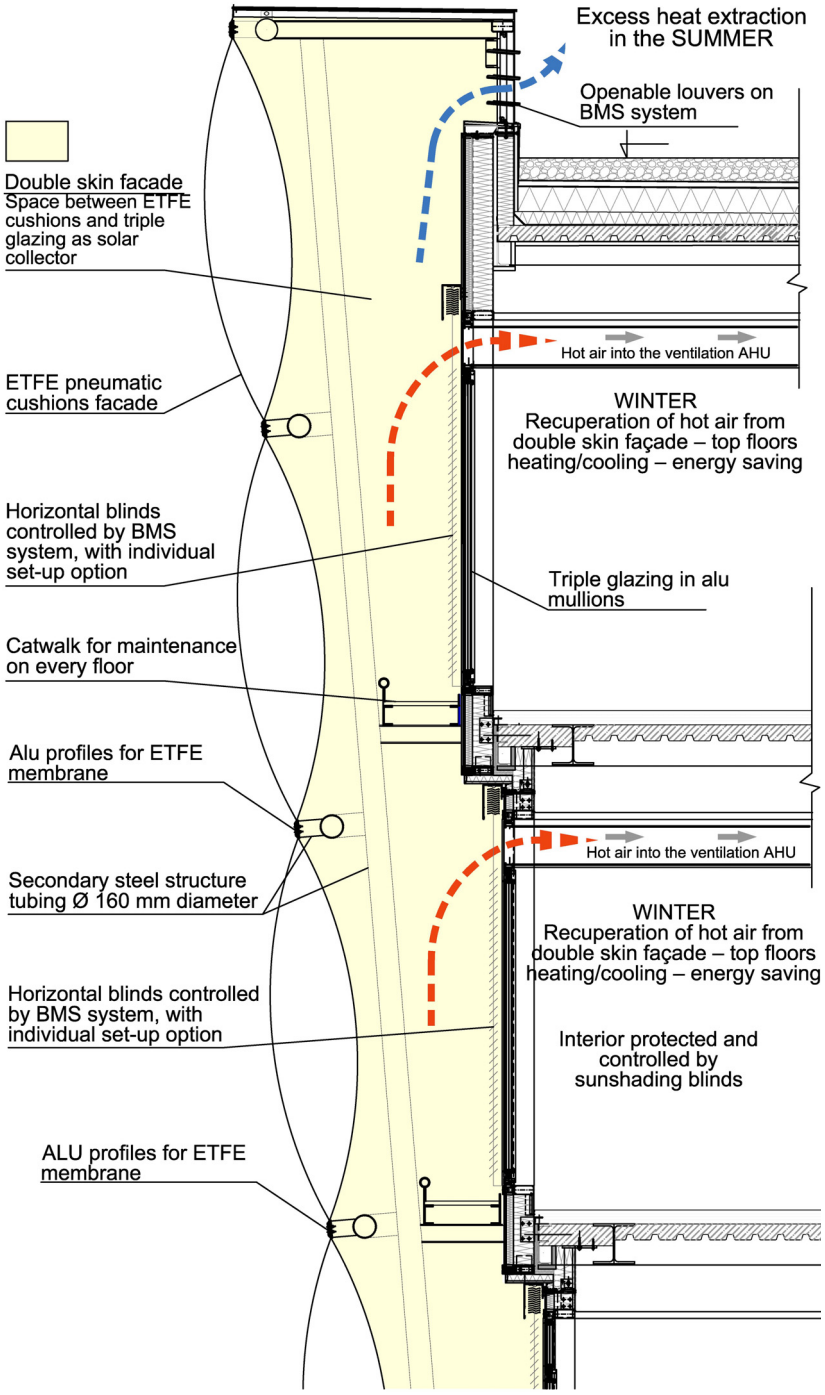

Fig. 9 Detail of air-recuperation on the last floors [3].

Fig. 10 Schema of recuperation and air distribution to chilled beams [3].

In the laboratories, lecture halls and offices, chilled beams are installed for the distribution of air and heat control. For cooling those are using water with temperature above the temperature of dew point with the effect, that there is no condensation of air humidity on the cooling element, built in the chilled beams.

During cooling there is no condensation of air humidity, and thus no loss of latent cooling performance, otherwise consumed by condensation and without use is flowing into sewage. Proportion of latent cooling is approx. 30% of the overall performance, which represents the savings of about 30% of the power in the operation costs. By using the cooling without condensation we save cca 30% of energy, needed for production of cooling water performance. Cooling equipment also is using free cooling, where in lower temperature is water for chilled beams chilled/cooled directly on cooling towers, with no need for cooling compressors.

3. Results

Advantages of double skin façade using ETFE membrane for outer transparent skin are as follows:

(a) Weight is 1% of glass installation of outer skin;

(b) Larger width between structural members—longest double layer cushion 3 m wide × 62 m;

(c) Acoustical properties—in combination with triple glazing system (47 dB) adds 9-10 dB to 57 dB in composite calculation;

(d) HVAC (heating/cooling) values—recuperation of hot air from façade as solar collector—installation at top 2 floors—energy saving up to 30%;

(e) Self cleaning exterior of the façade—ETFE membrane with additive chemical component rejecting dirt-automatic cleaning of the façade with rain water;

(f) Protection of the automatic exterior blinds on inner triple glazed façade mullions;

(g) Aesthetics-added value—large span between structural members, etc.;

(h) ETFE membrane – 50-years lifespan of the material.

Acknowledgements

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