atmosphere

MDPI

Article

New Surrogate Model for Wind Pressure Coefficients in a Schematic Urban Environment with a Regular Pattern

Tam Nguyen Van [1,2,*] and Frank De Troyer [1]

[1] Department of Architecture, Faculty of Engineering Science, KU Leuven, Kasteelpark Arenberg 1-box 2431, 3001 Heverlee, Belgium; frank.detroyer@kuleuven.be

[2] Civil Engineering Department, College of Technology, Cantho University, 3/2 Street, 900000 Cantho City, Vietnam

* Correspondence: tam.nguyenvan@kuleuven.be or ngvtam.ae@gmail.com

Received: 30 January 2018; Accepted: 16 March 2018; Published: 19 March 2018

Abstract: Natural ventilation and the use of fans are recognized as sustainable design strategies to reduce energy use while reaching thermal comfort. A big challenge for designers is to predict ventilation rates of buildings in dense urban areas. One significant factor for calculating the ventilation rate is the wind pressure coefficient (Cp). Cp values can be obtained at a high cost, via real measurements, wind tunnel experiments, or high computational effort via computational fluid dynamic (CFD) simulation. A fast surrogate model to predict Cp for a schematic urban environment is required for the integration in building performance simulations. There are well-known surrogate models for Cp. The average surface pressure coefficient model integrated in EnergyPlus considers only a box-shaped building, without surrounding buildings. CpCalc, a surrogate model for Cp, considers only one height of neighbouring buildings. The Toegepast Natuurwetenschappelijk Onderzoek (TNO) Cp Generator model was available via web interface, and could include several box-shaped buildings in the surrounding area. These models are complex for fast integration in a natural ventilation simulation. For optimization processes, with thousands of simulation runs, speed is even more essential. Our study proposes a new surrogate model for Cp estimation based on data obtained from the TNO CP Generator model. The new model considers the effect of different neighbouring buildings in a simplified urban configuration, with an orthogonal street pattern, box-shaped buildings, and repetitive dimensions. The developed surrogate model is fast, and can easily be integrated in a dynamic energy simulation tool like EnergyPlus for optimization of natural ventilation in the urban areas.

Keywords: wind pressure coefficient; airflow network; multiple linear regression; natural ventilation; urban layout; surrogate model; schematic urban environment

1. Introduction

Building energy consumption is responsible for about 40% of the global energy demand [1–3]. Due to increasing comfort requirements, global warming, and the urban heat island effect, the demand for air conditioning by individual households has risen [4–6]. To reduce energy consumption, "passive architecture" or "nearly zero energy buildings", together with sustainable occupant behavior, have become essential.

Natural ventilation is crucial for passive design in warm and hot humid climates, and also important in other conditions [7]. Studies in the context of Malaysia and Singapore have proven that thermal comfort can be reached for a large period of the year only with ventilation [8]. Airflow through building openings is a critical factor that influences heat and moisture exchange between thermal zones and the outdoor environment [9–12]. The wind pressure is the driving force for airflow and should be predicted carefully [13]. In the next section, an airflow network model and existing surrogate models for wind pressure coefficient (Cp) values are reviewed, in order to develop an improved model. The aim is to have a surrogate model that can easily be integrated into dynamic energy simulations in schematic urban environments.

2. Literature Review

2.1. Multi-Zone Airflow Network Model

Airflow networks have been applied in almost all building performance simulations. The airflow network model, embedded in the standard version of building performance simulation as EnergyPlus, provides the ability to simulate airflow, which is driven by wind pressure, through multiple zones. The air flow rate highly influences the predicted energy requirement [14]. In order to obtain the air flow rates, the building performance simulation takes the wind's velocity and direction from the hourly weather data, and predicts the wind pressure coefficients at different external nodes (Figure 1).

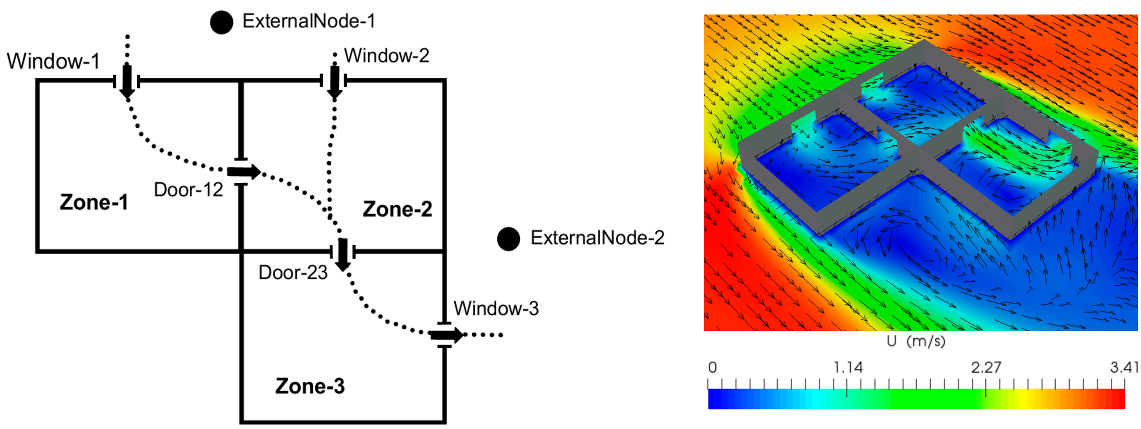

Figure 1. Plan view of a simple airflow network and computational fluid dynamic (CFD) results show possible airflow pattern.

2.2. Wind Pressure Coefficient Estimation Method

The wind pressure distribution on the envelope of a building is described by Cp, which is defined as the ratio of the dynamic pressure at a point on the surface over the dynamic pressure in the undisturbed flow pattern, measured at a reference height. Cp values, used to simulate multi-zone airflow network models for natural ventilation, can be obtained from many sources. The first source is full-scale measurements when an existing building is being studied. Precise pressures on a particular building in a specific environment can be measured. However, those pressures are only applicable to that specific building-layout and to that unique environment. Thus, they offer less relevant results for new designs. Moreover, these real scale measurements require a long measurement period and generate a high cost. Another source is wind tunnel tests, which can give more relevant results, because changes in building layout and urban layout are made easily. The limitations of wind tunnels include the requirement of special tools and large wind tunnels for investigating urban models. Finally, the computational fluid dynamic (CFD) approach has the same advantages as wind tunnel tests. CFD analysis is done on powerful computers, but is still time-consuming, requiring validation and user expertise.

The Cp Generator of TNO (Netherlands Organisation for Applied Scientific Research), a meta-model available via the web, was developed in the Netherlands [15]. This meta-model is based on finite element calculations, and has been verified through wind tunnel experiments [16] and measured data [17]. This approach offers a rather good correlation between measurements and meta-model predictions. The TNO Cp Generator approach was also used in another study, in order to obtain the Cps for a large urban fragment [18].

The CpCalc model was developed by analysing data from wind tunnel tests using a parametrical approach [19]. The CpCalc model considers only one height of neighbouring buildings. The model considers climate, environment, and building parameters. These independent parameters were varied to generate the data that were used to obtain polynomial functions via regression. Beside the climate parameters, the model allows variance in parameters, such as plan area density, relative building height, building layout, and relative position on façades. The model uses many regression functions. For each of them, the appropriate parameters have to be loaded from a data table. Using many data tables makes it complex to integrate the model into a whole-building energy simulation program.

Blocken and his group have compared the Cp values estimated through these different methods: CpCalc, Cp Generator, and Cp integrated in EnergyPlus [19]. Cp integrated in EnergyPlus is the average surface wind pressure coefficient based on the method developed by Swami and Chandra in 1988. Results of the three methods are similar [20].

To date, only a few studies consider surrogate models for the wind pressure coefficient of terraced buildings in urban areas, such as CpCalc, TNO Cp Generator, and free-standing average Cp [19,21]. A new parametric equation for the wind pressure coefficient for low-rise buildings fits the Tokyo database values with a goodness-of-fit value of $R^2 = 0.992$ [22]. Although existing surrogate models for Cp are good for analysing individual cases without obstructions, or considering average height of neighbouring box buildings, these models are not appropriate to be integrated into a dynamic simulation with parametric models or an optimisation process. Therefore, as a novelty in this research, a new surrogate model for Cp is developed. This model offers time saving and easy incorporation into the optimization processes, whereby a large number of simulations are required and both building geometry and urban layout can be changed.

3. Data Description and Methods

The method consists of five steps: (1) defining a schematic urban environment; (2) collecting Cp data from Cp Generator of TNO; (3) multiple linear regression; (4) CFD simulation; and (5) sensitivity analysis. Cp data for 36 orientations for each urban layout are collected to obtain regression functions for each orientation (in steps of 10°).

3.1. Schematic Urban Environment

The simplified urban layout model, as shown in Figure 2, can be considered as a representation for major urban areas with terraced housing around the world. This urban layout is described by the following key parameters: the height of each of the surrounding buildings (H1 to H14), road width in two directions (Rd, Rl), back garden (Bg), the building depth (D), and building length (L). Different urban layouts are generated based on the ranges and step size mentioned in Table 1. These ranges are defined based on case studies [23,24].

Table 1. Numerical variables and their design options for urban layout.

Design Parameters	Parameters	Range (m)	Step Size (m)
Height of surrounding buildings	H_1 to H_{14}	3 to 36	3
Width of road parallel with terraced row	R_w	12 to 24	4
Width of road perpendicular with terraced row	R_l	12 to 24	4
Back garden depth	B_g	8 to 24	4
House row depth	D	12 to 20	2
House row length	L	40 to 120	10

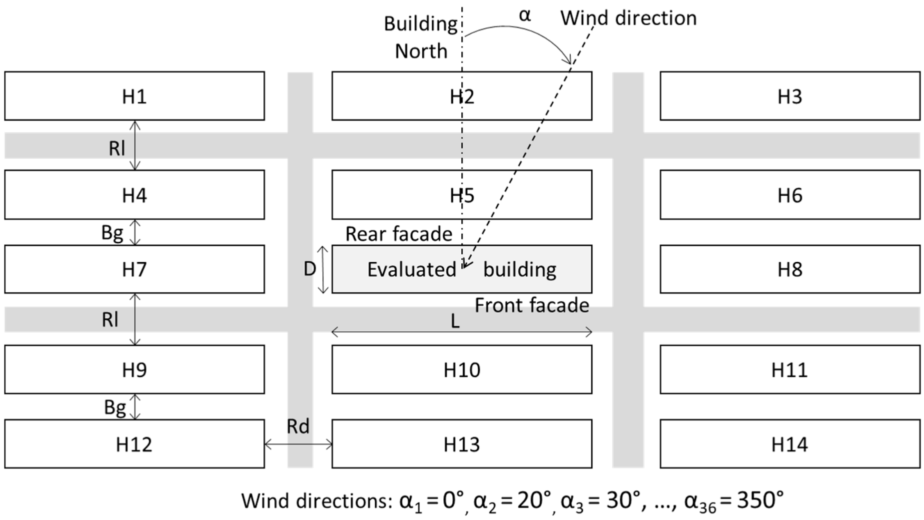

Figure 2. Schematic urban environment (for dimensions see Table 1).

3.2. Collecting Cp Data from the TNO Cp Generator

The "Latin Hypercube Sampling method" is applied to generate 200 combinations of 19 independent parameters (14 building heights and five urban parameters) of the building and urban layouts. Input data of those combinations for the Cp Generator consists of defining the terrain's roughness for the wind's different flow directions (kept constant as "urban") as well as "obstacles". In the TNO Cp Generator, each obstacle is referred to via a unique name. The following characteristics are associated: locations (x, y) of a corner point, orientation (β), and size of the buildings. Those data have to be transmitted to the programme as a text file with the correct formatting. In a next step, the text files are uploaded. The results of the Cp values are returned, and consist of a data table for each evaluated point on facades and roofs, and of graphical files, as can be seen in Figures 3 and 4. For our meta-model, seven points are considered: red points on the front facade, blue points on the rear façade, and the green point on the roof. Other positions on the facades will be considered in further research. Points on each facade are equally distributed over the height in the middle of the building. The point on the roof is in the middle.

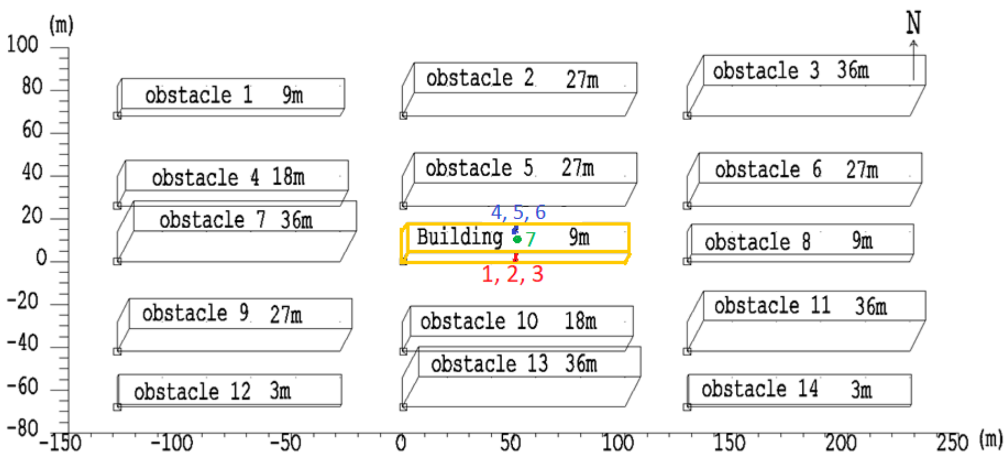

Figure 3. The geometry of the building and obstacles as submitted to the Toegepast Natuurwetenschappelijk Onderzoek (TNO) Cp Generator TNO. Results are obtained for points 1, 2, and 3 on the front façade; and points 4, 5, and 6 on the rear facade. with heights from the ground 1.5 m, 4.5 m, and 7.5 m, respectively. Point 7 is located in the middle on the roof.

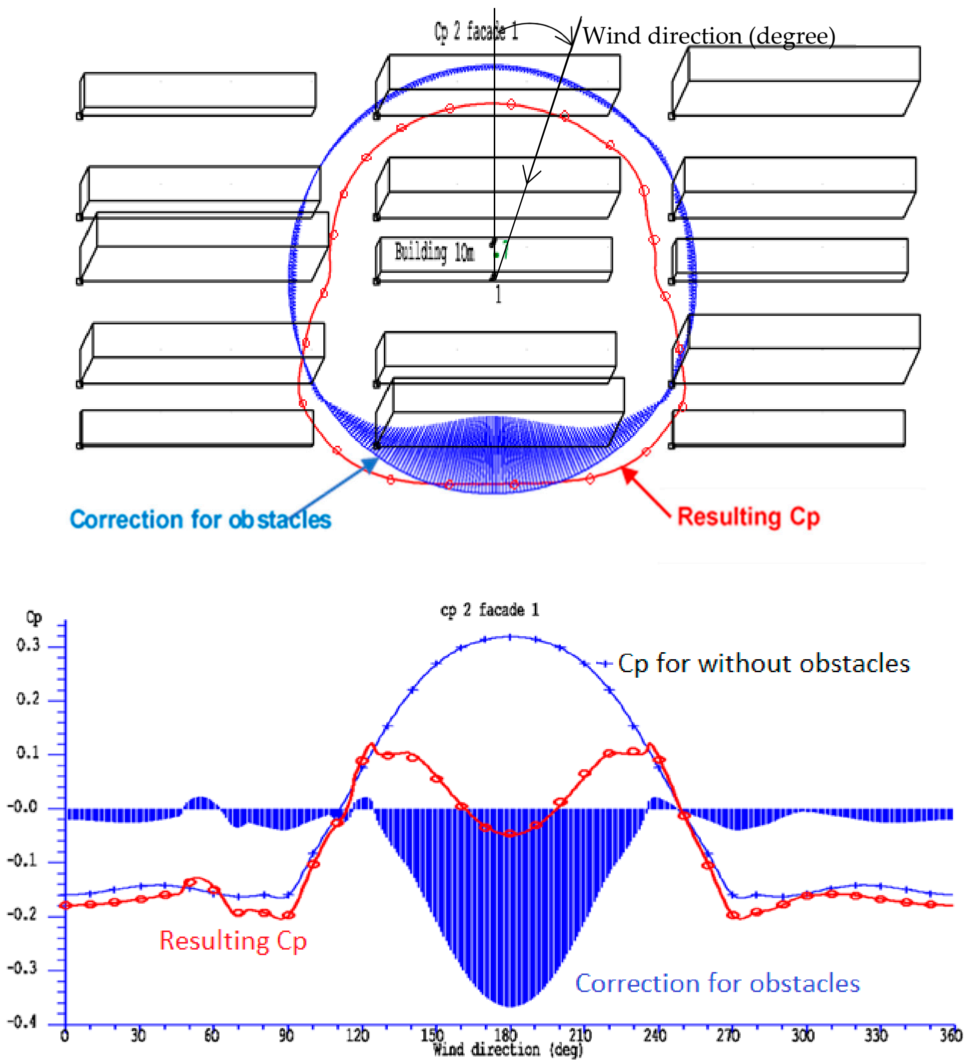

Figure 4. Wind pressure coefficient values of the middle point in the front façade of the terraced house, two buildings in front of the terraced building largely influence the wind pressure coefficient of direction 150° to 210°.

3.3. Surrogate Model: Multiple Linear Regression

The multiple linear regression approach is a well-known technique for modelling the relationship between two or more parameters. It was selected to develop the surrogate model of wind pressure coefficient. The general multiple linear regression model with parameter X is represented by the following equation.

$$Y = a_0 + a_1X_1 + a_2X_2 + \ldots + a_nX_n \quad (1)$$

where, Y is the predicted value; a_o, a_1, ... a_n are constant coefficients of the regression function; X_1, X_2, ... X_n are values of n parameters.

To develop the regression model for the wind pressure coefficients, 200 generated design cases were randomly separated into two sub-samples: the training samples (90% of the cases) and testing samples (10% of the cases). The training dataset was used for model development. The testing data was used to evaluate the model.

Initial trials showed a very low correlation between Cp values and urban parameters, including the orientations. However, Cp values had a very high correlation with the urban parameters when the regression function was developed for each orientation. Therefore, the surrogate model algorithms consisted of 36 functions for 36 orientations (in steps of 10°). The subdivision into 36 regression functions for 36 orientations was also based on the concept of the wind shadow model [25,26]. The surrogate model for the wind pressure coefficients is described by the following equations.

- Cps in middle of front facade:

$$Cp_{frontj} = a_{fr0j} + \sum(a_{frij} * H_i) + (a_{fr5j} * D) + (a_{fr6j} * L) + (a_{fr17j} * R_d) + (a_{fr18j} * R_L) + (a_{fr19j} * B_g)$$

- Cps in middle of rear facade:

$$Cp_{rearj} = a_{re0j} + \sum(a_{reij} * H_i) + (a_{re15j} * D) + (a_{re16j} * L) + (a_{re17j} * R_d) + (a_{re18j} * R_L) + (a_{re19j} * B_g)$$

- Cps in middle of the roof:

$$Cp_{roofj} = a_{ro0j} + \sum(a_{roij} * H_i) + (a_{ro5j} * D) + (a_{ro16j} * L) + (a_{ro17j} * R_d) + (a_{ro18j} * R_L) + (a_{ro19j} * B_g)$$

where *j* is the orientation, *j* = 1, 2, . . . , 36 (wind orientations); *i* is the number of neighbouring buildings (*i* = 1, 2, . . . , 14 buildings in Figure 2); Cp_{frontj}, Cp_{rearj} and Cp_{froofj} are wind pressure coefficients of front, rear and roof surfaces, respectively; H_i, L, D, Rw, RL and Bg were defined in the Table 1.

3.4. Computational Fluid Dynamic Simulation

In this section, the CFD is used to provide qualitative and quantitative results to understand the effect of the different wind directions and the urban layout on Cp values. The CFD simulations use OpenFoam with Reynolds-Averaged Navier-Stokes (RANS) equations and a simple algorithm. The computational domain is (600 × 600 × 110) m^3, full scale. All buildings are 9 m high and 24 m for Rl, Rd, and Bg. The depth and length of the terraced building are 24 m and 120 m, respectively. The basic square grids size is 5 m × 5 m × 5 m, but the mesh (grid) is resized near the buildings, in order to increase the quality of the calculation, Figure 5. The dimensions of the computational domain were chosen based on best practice guidelines by Franke et al. [27] and Tominaga et al. [28]. The inlet flow with fixed velocity and the outlet with free pressure were applied for this simulation.

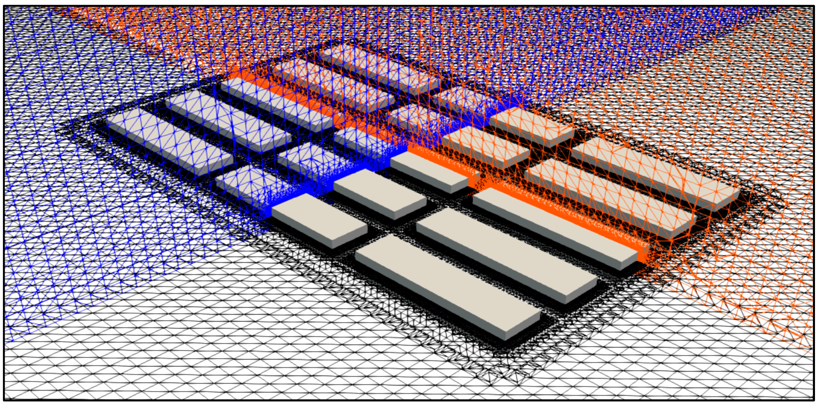

Figure 5. The computational domain (600 × 600 × 110) m^3 full scale with the grid is resized near the buildings.

3.5. Sensitivity Analysis

In this study, the standardized regression coefficient (SRC) was used to identify the impact of each urban parameter on Cp values. SRC_i is calculated by dividing the standard deviation of each parameter (σ_{xi}) by the standard deviation of the Cp (σ_{Cp}), and multiplying the regression coefficient

(a_i) of each parameter in the multiple linear regression model. The building and urban parameters, together with Cp results of 200 urban layouts, were used to obtain SRC. The parameters with a high absolute value of SRC have an important impact on the Cp values.

$$SRC_i = a_i \times \frac{\sigma_{xi}}{\sigma_{Cp}}$$

4. Results and Discussion

4.1. Cp Surrogate Model Based on the TNO Cp Generator

The model was developed by using 90% case data and 10% data for testing. The predicted Cp results of 20 cases from the testing data were good predictions compared with the TNO Cp Generator values, with R^2 = 0.93 as shown in Figure 6. The testing process is repeated with random data sets, and similar R^2 results were always obtained. The few cases with larger errors when predicting Cp are the cases whereby many neighbouring buildings reach the maximum height (36 m).

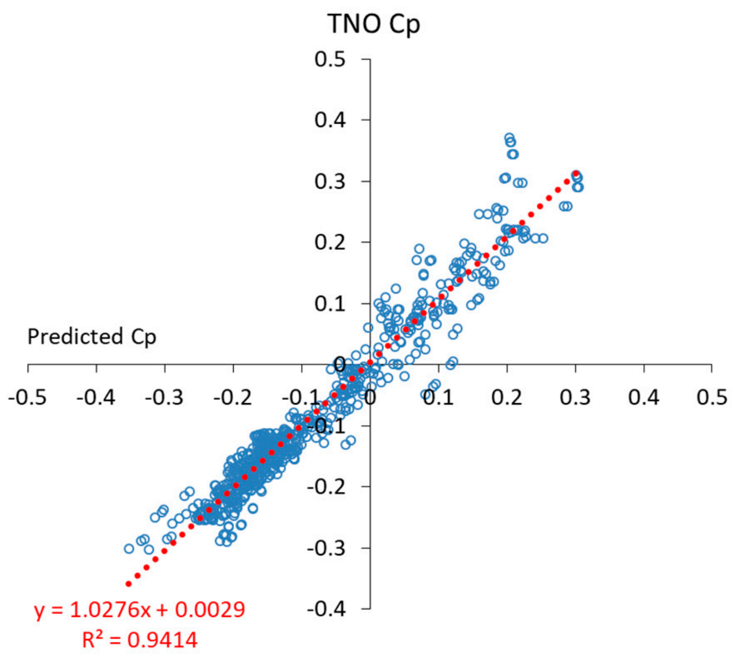

Figure 6. Predicted Cp and Cp obtained by the TNO Cp Generator of 20 urban forms of the testing data. A total of 720 points (36 orientations × 20 cases) are represented in the Scatter chart.

The factors of the multiple linear regression are reported in the Appendix 5. The regression functions show a high correlation (Figure 7). For each urban layout, the R^2 value for 36 Cp values is calculated, in order to obtain the correlation between Cp values obtained from the TNO Cp Generator and estimated Cp values. The R^2 values of 200 urban layouts are shown in Figure 8.

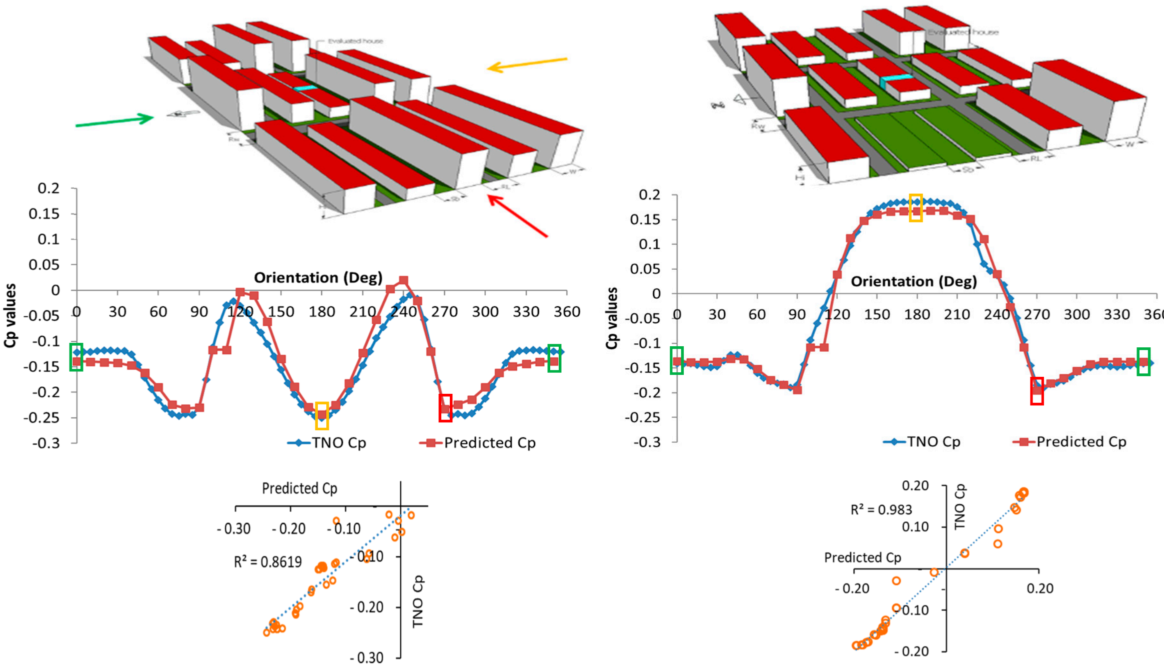

Figure 7. Cp value estimation for terraced house patterns by using regression approach, based on Cp results of 200 scenarios from the TNO Cp Generator web base. 3D models at the left and right show two examples of randomly-generated urban layouts. The analysed building is always in the centre.

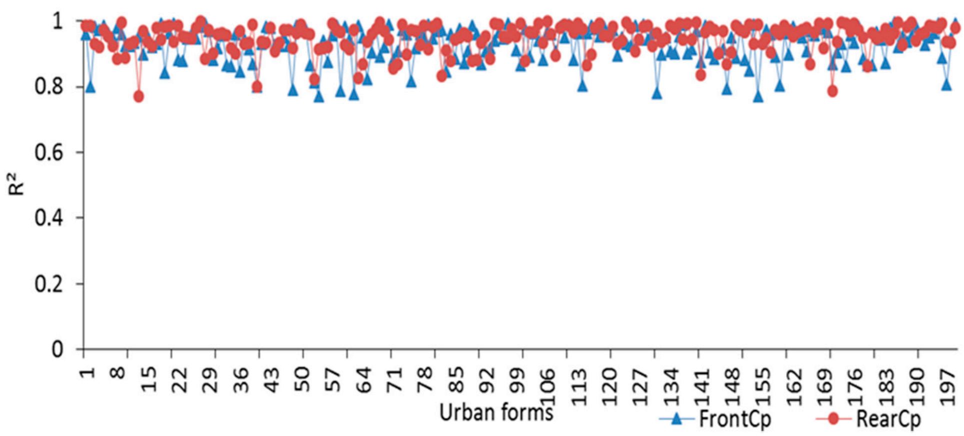

Figure 8. Goodness-of-fit value (R^2) values of the linear link between the predicted Cp values and Cp values of the TNO Cp Generator of 200 urban patterns; average R^2 of the front façade = 0.93 and average R^2 of the rear façade = 0.95.

4.2. Computational Fluid Dynamic Results and Sensitivity Analysis of Cp Values for the Schematic Urban Layout

The neighbouring buildings modify the external wind flow around the evaluated building. The velocity and pressure of the wind is related to the urban parameters and different angles of attack. The CFD result visualized in Figure 9 shows the effect of the urban layout on the wind pressure and wind direction.

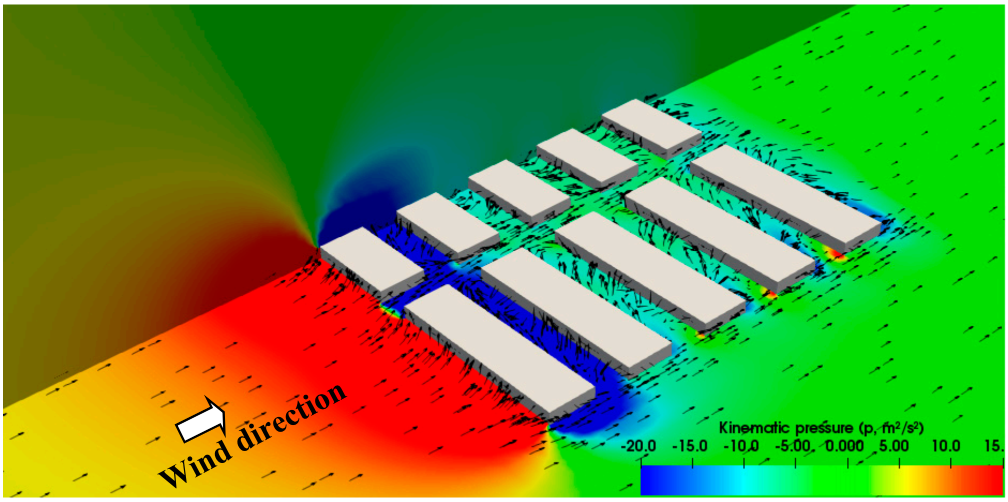

Figure 9. The external air pressure of the case when the wind angle is 0° (perpendicular the front façade).

The detailed graphical and numerical results are provided in Figures 10–13. The Cp values of the middle point on the front façade of 200 cases were used to calculate SRC (the right part of the Figures 10–13). The results shows the air pressure in a horizontal plane at half the building height above the ground, and in the Section A-A (Figure 10). On the right, the SRC of Cp results from the TNO model indicate the impact of each parameter on the Cp values for a certain direction.

- If the wind angle is 0° (Figure 10), the height of building in font (H5) has the strongest effect on the Cp values. The width (D), length of the building (L) and the back garden (Bg) also have a strong impact on the Cp. They impact the turbulence of the wind flow. Buildings H2 and H5 block the wind flow and generate negative Cp on the front façade of the evaluated building.
- If the wind angle is 30° (Figure 11), building H5 has also a high impact on the Cp value.
- If the wind angle is 60° (Figure 12), building H10 has a very high effect on the Cp value, because the back garden varies from 8 m to 24 m.
- When the wind flows parallel to the façade (Figure 13), building H10 and the width of road parallel the terraced row strongly impact on the Cp value.

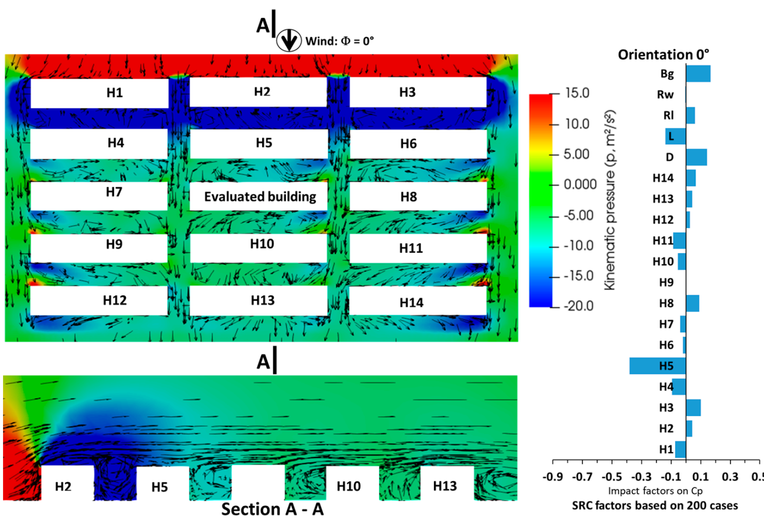

Figure 10. (**Left**) visualization of pressure (colour) and wind direction (arrows); **(Right)** Standardized regression coefficient (SRC) for orientation at 0° for the 19 variables, based on input data and Cp values of 200 cases.

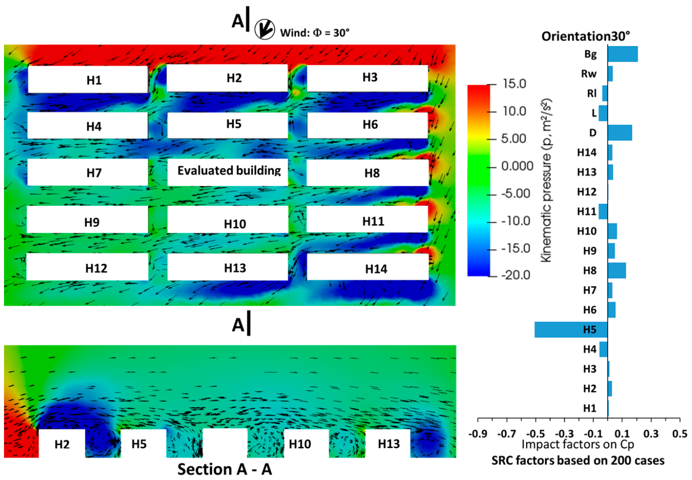

Figure 11. (**Left**) visualization of pressure (colour) and wind direction (arrow); (**Right**) SRC for orientation at 30° for the 19 variables, based on input data and Cp values of 200 cases.

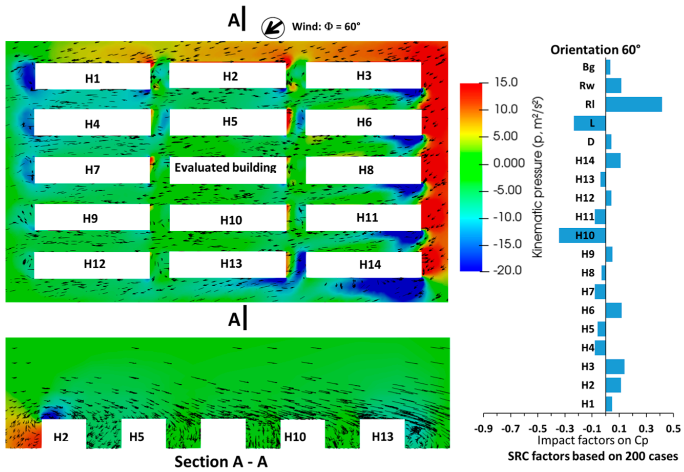

Figure 12. (**Left**) visualization of pressure (colour) and wind direction (arrows); (**Right**) SRC for orientation at 60° for the 19 variables, based on input data and Cp values of 200 cases.

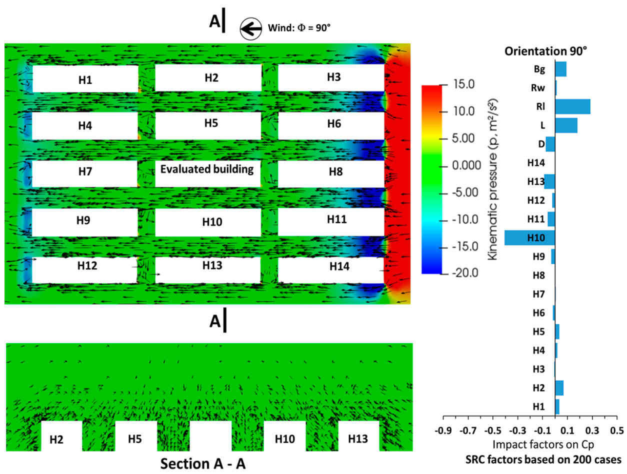

Figure 13. (**Left**) visualization of pressure (colour) and wind direction (arrows); (**Right**) SRC for orientation at 90° for the 19 variables, based on input data and Cp values of 200 cases.

The four cases illustrate that the dimensions of the neighbouring buildings and the width of the roads will generate various Cp values. This physical effect depends on the interplay of several parameters, such as wind direction, building layout, and obstructions. Figures 10–13 support the understanding for different wind directions, wind pressures, and the wind speed at different locations in 3D.

The Figure 14 shows that the height of the buildings in front (H10) and behind (H5) the evaluated building impact strongly the Cp of the front façade. The width of the road parallels the evaluated building (Rl) also has a strong effect on Cp values.

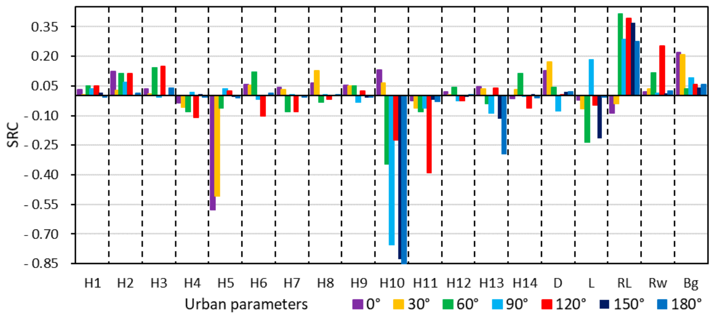

Figure 14. SRC results for different orientations: 0°, 30°, 60°, 90°, 120°, 150°, and 180° for the Cp values on front facade.

5. Conclusions

A computationally intensive step to calculate Cp values of various urban patterns and building geometries was solved by developing a surrogate model. This multiple linear regression model, with different functions for different orientations, is based on other surrogate models that were developed based on measurement in situ, wind tunnel measurement, and CFD simulations.

The developed meta-model of wind pressure coefficients allows for the inclusion of the effect of the schematic urban environment. The regression functions of this meta-model show a high correlation with the values of the existing surrogate model. This meta-model is able to predict the Cp values on different surfaces very quickly.

This surrogate model is very significant in a case where a huge number of simulations is required, like in an optimization process. However, the new Cp model considers the middle terraced unit of the terraced row. Estimating Cp of a house located closer to the edges of the terraced row requires further research. A more robust model will have to consider the Cp along the evaluated building, instead of only at the middle points of the building.

Author Contributions: This research was supported by KU Leuven University, Cantho University and the Ministry of Education and Training of Vietnam.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix

Cp of the front façade:

$$Cp_{front} = a_{fr0} + a_{fr1} * H_1 + \ldots . a_{fr14} * H_{14} + a_{fr15} * D + a_{fr16} * L + a_{fr17} * Rd + a_{fr18} * Rl + a_{fr19} * Bg$$

Orientation	afr0	afr1	afr2	afr3	afr4	afr5	afr6	afr7	afr8	afr9
0	-2.06×10^{-1}	1.24×10^{-4}	5.15×10^{-4}	1.44×10^{-4}	-1.49×10^{-4}	-2.39×10^{-3}	2.38×10^{-4}	1.77×10^{-4}	2.63×10^{-4}	2.22×10^{-4}
10	-2.02×10^{-1}	8.97×10^{-5}	4.03×10^{-4}	1.28×10^{-4}	-1.44×10^{-4}	-2.21×10^{-3}	2.35×10^{-4}	1.44×10^{-4}	2.93×10^{-4}	2.24×10^{-4}
20	-1.91×10^{-1}	7.09×10^{-5}	2.21×10^{-4}	7.09×10^{-5}	-1.61×10^{-4}	-1.76×10^{-3}	2.04×10^{-4}	9.45×10^{-5}	3.13×10^{-4}	1.92×10^{-4}
30	-1.76×10^{-1}	1.40×10^{-5}	6.68×10^{-5}	2.56×10^{-5}	-1.38×10^{-4}	-1.19×10^{-3}	1.28×10^{-4}	7.31×10^{-5}	2.97×10^{-4}	1.13×10^{-4}
40	-1.55×10^{-1}	-1.18×10^{-4}	6.73×10^{-5}	1.61×10^{-4}	-1.52×10^{-4}	-6.12×10^{-4}	-3.28×10^{-5}	-6.38×10^{-5}	1.45×10^{-4}	-4.14×10^{-7}
50	-1.69×10^{-1}	-4.51×10^{-5}	2.00×10^{-4}	3.70×10^{-4}	-4.57×10^{-5}	-1.81×10^{-4}	4.96×10^{-5}	-1.08×10^{-4}	-4.07×10^{-5}	6.48×10^{-5}
60	-2.10×10^{-1}	1.02×10^{-4}	2.41×10^{-4}	2.96×10^{-4}	-1.70×10^{-4}	-1.25×10^{-4}	2.50×10^{-4}	-1.69×10^{-4}	-6.61×10^{-5}	1.04×10^{-4}
70	-2.13×10^{-1}	1.21×10^{-4}	2.07×10^{-4}	1.08×10^{-4}	-1.77×10^{-4}	1.06×10^{-4}	1.50×10^{-4}	-1.84×10^{-4}	-8.77×10^{-5}	1.10×10^{-4}
80	-2.21×10^{-1}	1.17×10^{-4}	2.08×10^{-4}	4.54×10^{-5}	-4.06×10^{-5}	1.26×10^{-4}	3.68×10^{-5}	-3.14×10^{-5}	7.54×10^{-5}	8.87×10^{-6}
90	-2.12×10^{-1}	8.58×10^{-5}	1.73×10^{-4}	-1.55×10^{-5}	4.54×10^{-5}	8.34×10^{-5}	-4.14×10^{-5}	1.47×10^{-5}	5.76×10^{-6}	-7.38×10^{-5}
100	-1.28×10^{-1}	8.56×10^{-5}	9.53×10^{-5}	-6.54×10^{-5}	4.58×10^{-5}	8.97×10^{-5}	-5.95×10^{-5}	-1.58×10^{-5}	-4.42×10^{-5}	-1.34×10^{-4}
110	-7.11×10^{-2}	-5.57×10^{-5}	1.24×10^{-4}	1.79×10^{-4}	7.22×10^{-6}	1.06×10^{-4}	-1.45×10^{-4}	-6.48×10^{-5}	6.38×10^{-5}	-1.67×10^{-4}
120	-4.51×10^{-2}	2.13×10^{-4}	4.70×10^{-4}	6.22×10^{-4}	-4.50×10^{-4}	9.95×10^{-5}	-4.27×10^{-4}	-3.36×10^{-4}	-7.09×10^{-5}	1.05×10^{-4}
130	2.37×10^{-2}	1.20×10^{-4}	7.62×10^{-4}	5.18×10^{-4}	-3.38×10^{-4}	2.35×10^{-4}	-3.54×10^{-4}	-3.91×10^{-4}	-2.53×10^{-4}	2.37×10^{-4}
140	8.53×10^{-2}	4.50×10^{-5}	3.32×10^{-4}	3.49×10^{-4}	-9.37×10^{-5}	2.10×10^{-4}	-3.65×10^{-4}	-1.78×10^{-4}	1.18×10^{-4}	5.14×10^{-5}
150	1.19×10^{-1}	2.01×10^{-4}	3.69×10^{-5}	6.98×10^{-5}	1.43×10^{-4}	-8.99×10^{-5}	-4.03×10^{-5}	7.69×10^{-5}	7.24×10^{-5}	-1.34×10^{-4}
160	1.00×10^{-1}	1.09×10^{-4}	1.27×10^{-4}	3.10×10^{-4}	2.60×10^{-5}	-1.74×10^{-4}	1.86×10^{-4}	2.21×10^{-6}	5.42×10^{-5}	-1.36×10^{-4}
170	7.39×10^{-2}	-1.47×10^{-5}	1.78×10^{-4}	5.73×10^{-4}	-4.85×10^{-5}	-1.79×10^{-4}	2.37×10^{-4}	-8.12×10^{-5}	6.17×10^{-5}	-1.08×10^{-4}
180	6.49×10^{-2}	-7.62×10^{-5}	2.08×10^{-4}	6.76×10^{-4}	-7.07×10^{-5}	-1.58×10^{-4}	2.13×10^{-4}	-1.22×10^{-4}	3.59×10^{-5}	-1.16×10^{-4}
190	7.71×10^{-2}	-3.41×10^{-6}	1.68×10^{-4}	5.52×10^{-4}	-4.03×10^{-5}	-1.79×10^{-4}	2.39×10^{-4}	-7.62×10^{-5}	5.99×10^{-5}	-1.13×10^{-4}
200	1.06×10^{-1}	1.20×10^{-4}	1.12×10^{-4}	2.76×10^{-4}	2.63×10^{-5}	-1.62×10^{-4}	1.60×10^{-4}	1.86×10^{-5}	4.76×10^{-5}	-1.59×10^{-4}
210	1.21×10^{-1}	1.70×10^{-4}	5.39×10^{-5}	1.22×10^{-4}	2.62×10^{-4}	-1.21×10^{-4}	-2.45×10^{-5}	4.67×10^{-6}	1.48×10^{-4}	1.88×10^{-5}
220	8.66×10^{-2}	1.50×10^{-4}	4.25×10^{-4}	4.52×10^{-4}	-2.17×10^{-4}	2.04×10^{-4}	-2.91×10^{-4}	-1.43×10^{-4}	-7.18×10^{-5}	7.89×10^{-5}
230	-7.08×10^{-3}	-2.78×10^{-4}	5.10×10^{-4}	5.57×10^{-4}	-4.78×10^{-4}	1.74×10^{-4}	-1.78×10^{-4}	8.19×10^{-5}	-1.21×10^{-6}	-3.46×10^{-4}
240	-4.80×10^{-2}	-9.34×10^{-5}	1.59×10^{-4}	4.88×10^{-4}	-3.71×10^{-4}	-6.83×10^{-5}	-2.38×10^{-4}	1.62×10^{-4}	9.48×10^{-5}	-1.23×10^{-3}
250	-5.11×10^{-2}	1.06×10^{-4}	1.85×10^{-4}	1.35×10^{-4}	2.34×10^{-5}	-7.86×10^{-5}	-8.19×10^{-5}	-6.09×10^{-6}	-7.71×10^{-6}	-9.20×10^{-4}
260	-1.28×10^{-1}	8.60×10^{-5}	9.73×10^{-5}	-7.15×10^{-5}	3.68×10^{-5}	8.91×10^{-5}	-5.80×10^{-5}	-9.11×10^{-6}	-3.51×10^{-5}	-1.71×10^{-4}
270	-2.14×10^{-1}	9.09×10^{-5}	1.77×10^{-4}	-3.43×10^{-6}	4.20×10^{-5}	8.94×10^{-5}	-2.91×10^{-5}	7.76×10^{-6}	9.83×10^{-6}	-5.83×10^{-5}
280	-2.10×10^{-1}	-1.34×10^{-5}	1.97×10^{-4}	6.50×10^{-5}	-1.04×10^{-4}	-4.42×10^{-6}	-7.83×10^{-6}	8.26×10^{-5}	5.75×10^{-5}	5.32×10^{-5}
290	-2.23×10^{-1}	2.12×10^{-5}	2.79×10^{-4}	1.28×10^{-4}	-7.74×10^{-5}	-2.89×10^{-5}	8.59×10^{-5}	-1.44×10^{-4}	2.06×10^{-5}	4.53×10^{-5}
300	-1.92×10^{-1}	1.05×10^{-4}	1.63×10^{-4}	1.77×10^{-4}	3.90×10^{-5}	-7.21×10^{-5}	-1.90×10^{-4}	-9.17×10^{-5}	-8.87×10^{-5}	-8.35×10^{-5}
310	-1.60×10^{-1}	2.05×10^{-4}	1.21×10^{-5}	1.33×10^{-4}	-1.55×10^{-4}	-2.40×10^{-4}	-1.85×10^{-4}	-1.28×10^{-5}	4.54×10^{-5}	-7.32×10^{-5}
320	-1.65×10^{-1}	1.58×10^{-4}	-1.54×10^{-5}	7.50×10^{-6}	-1.61×10^{-4}	-6.58×10^{-4}	5.96×10^{-5}	8.94×10^{-5}	1.41×10^{-4}	4.68×10^{-5}
330	-1.76×10^{-1}	1.13×10^{-4}	5.76×10^{-5}	2.41×10^{-6}	-1.34×10^{-4}	-1.27×10^{-3}	1.60×10^{-4}	6.64×10^{-5}	2.52×10^{-4}	1.47×10^{-4}
340	-1.92×10^{-1}	7.08×10^{-5}	2.37×10^{-4}	7.94×10^{-5}	-1.64×10^{-4}	-1.82×10^{-3}	2.07×10^{-4}	1.04×10^{-4}	3.11×10^{-4}	1.97×10^{-4}
350	-2.02×10^{-1}	9.44×10^{-5}	4.21×10^{-4}	1.33×10^{-4}	-1.43×10^{-4}	-2.24×10^{-3}	2.36×10^{-4}	1.47×10^{-4}	2.88×10^{-4}	2.22×10^{-4}

Orientation	afr10	afr11	afr12	afr13	afr14	afr15	afr16	afr17	afr18	afr19
0	5.45×10^{-4}	-9.71×10^{-5}	8.15×10^{-5}	1.86×10^{-4}	-4.95×10^{-5}	2.18×10^{-3}	-3.28×10^{-5}	-7.51×10^{-4}	1.68×10^{-4}	1.89×10^{-3}
10	4.87×10^{-4}	-1.18×10^{-4}	6.62×10^{-5}	1.83×10^{-4}	-1.96×10^{-5}	2.04×10^{-3}	-2.44×10^{-5}	-6.67×10^{-4}	2.12×10^{-4}	1.76×10^{-3}
20	3.56×10^{-4}	-1.47×10^{-4}	4.70×10^{-5}	1.27×10^{-4}	2.71×10^{-5}	1.86×10^{-3}	-3.34×10^{-5}	-4.82×10^{-4}	2.19×10^{-4}	1.48×10^{-3}
30	1.52×10^{-4}	-1.46×10^{-4}	9.69×10^{-6}	8.48×10^{-5}	7.16×10^{-5}	1.67×10^{-3}	-6.23×10^{-5}	-1.92×10^{-4}	1.64×10^{-4}	1.03×10^{-3}
40	-8.81×10^{-5}	-1.36×10^{-4}	4.41×10^{-5}	6.93×10^{-5}	1.06×10^{-4}	9.64×10^{-4}	-9.34×10^{-5}	2.09×10^{-4}	-1.17×10^{-5}	5.60×10^{-4}
50	-3.72×10^{-4}	-5.14×10^{-5}	1.01×10^{-4}	-1.26×10^{-4}	1.91×10^{-4}	4.00×10^{-4}	-1.72×10^{-4}	7.35×10^{-4}	4.88×10^{-5}	4.40×10^{-4}
60	-7.25×10^{-4}	-1.70×10^{-4}	8.78×10^{-5}	-8.29×10^{-5}	2.36×10^{-4}	3.90×10^{-4}	-2.08×10^{-4}	1.85×10^{-3}	5.16×10^{-4}	1.57×10^{-4}
70	-1.28×10^{-3}	-3.21×10^{-4}	8.05×10^{-5}	-1.05×10^{-4}	2.40×10^{-4}	2.64×10^{-4}	-2.65×10^{-4}	2.15×10^{-3}	4.82×10^{-4}	1.46×10^{-5}
80	-1.76×10^{-3}	-2.72×10^{-4}	9.60×10^{-5}	-1.86×10^{-4}	2.20×10^{-4}	-9.46×10^{-5}	-1.68×10^{-4}	2.11×10^{-3}	4.93×10^{-4}	3.60×10^{-4}
90	-1.88×10^{-3}	-1.48×10^{-4}	-5.71×10^{-5}	-2.20×10^{-4}	-4.75×10^{-6}	-7.89×10^{-4}	1.91×10^{-4}	1.49×10^{-3}	7.32×10^{-5}	4.79×10^{-4}
100	-1.00×10^{-3}	-1.20×10^{-4}	-1.03×10^{-4}	-1.29×10^{-4}	-1.71×10^{-4}	-4.98×10^{-4}	4.38×10^{-4}	5.10×10^{-4}	4.65×10^{-5}	4.16×10^{-4}
110	-2.42×10^{-4}	-8.02×10^{-4}	-1.70×10^{-4}	7.35×10^{-5}	4.05×10^{-5}	-4.58×10^{-4}	3.71×10^{-4}	1.03×10^{-3}	6.43×10^{-4}	4.36×10^{-4}
120	-9.35×10^{-4}	-1.63×10^{-3}	-1.09×10^{-4}	1.61×10^{-4}	-2.51×10^{-4}	1.27×10^{-4}	-7.91×10^{-5}	3.45×10^{-3}	2.22×10^{-3}	5.17×10^{-4}
130	-3.86×10^{-3}	-1.01×10^{-3}	1.94×10^{-4}	-3.51×10^{-4}	-3.38×10^{-4}	7.29×10^{-5}	-6.92×10^{-4}	6.02×10^{-3}	2.46×10^{-3}	3.26×10^{-4}
140	-7.50×10^{-3}	-5.51×10^{-4}	1.05×10^{-4}	-8.56×10^{-4}	-1.27×10^{-4}	6.09×10^{-4}	-1.10×10^{-3}	8.62×10^{-3}	1.35×10^{-3}	7.03×10^{-4}
150	-1.10×10^{-2}	-2.49×10^{-4}	-6.36×10^{-5}	-1.53×10^{-3}	1.33×10^{-4}	1.21×10^{-3}	-1.21×10^{-3}	1.04×10^{-2}	3.61×10^{-4}	1.18×10^{-3}
160	-1.33×10^{-2}	-2.99×10^{-4}	-1.02×10^{-4}	-3.01×10^{-3}	6.53×10^{-5}	1.48×10^{-3}	-7.90×10^{-4}	1.05×10^{-2}	7.12×10^{-4}	1.48×10^{-3}
170	-1.45×10^{-2}	-3.84×10^{-4}	-9.71×10^{-6}	-4.52×10^{-3}	-9.06×10^{-5}	1.59×10^{-3}	-2.57×10^{-4}	1.03×10^{-2}	7.81×10^{-4}	1.92×10^{-3}
180	-1.49×10^{-2}	-4.52×10^{-4}	3.69×10^{-5}	-5.10×10^{-3}	-1.41×10^{-4}	1.50×10^{-3}	-3.86×10^{-5}	1.01×10^{-2}	8.23×10^{-4}	2.15×10^{-3}
190	-1.44×10^{-2}	-3.74×10^{-4}	-1.96×10^{-5}	-4.39×10^{-3}	-7.39×10^{-5}	1.60×10^{-3}	-3.05×10^{-4}	1.03×10^{-2}	7.76×10^{-4}	1.87×10^{-3}
200	-1.31×10^{-2}	-2.79×10^{-4}	-8.70×10^{-5}	-2.85×10^{-3}	6.57×10^{-5}	1.43×10^{-3}	-8.50×10^{-4}	1.06×10^{-2}	6.67×10^{-4}	1.48×10^{-3}
210	-1.06×10^{-2}	-3.49×10^{-4}	-1.64×10^{-4}	-1.40×10^{-3}	1.59×10^{-4}	9.98×10^{-4}	-1.19×10^{-3}	1.01×10^{-2}	5.66×10^{-4}	7.62×10^{-4}
220	-7.09×10^{-3}	-6.04×10^{-4}	-3.34×10^{-4}	-7.34×10^{-4}	3.09×10^{-4}	8.16×10^{-4}	-1.15×10^{-3}	8.36×10^{-3}	1.39×10^{-3}	6.99×10^{-4}
230	-3.58×10^{-3}	-2.01×10^{-4}	-4.77×10^{-4}	-2.44×10^{-4}	6.16×10^{-4}	1.22×10^{-3}	-8.12×10^{-4}	6.12×10^{-3}	2.65×10^{-3}	6.65×10^{-4}
240	-9.85×10^{-4}	-1.35×10^{-4}	-5.01×10^{-4}	9.42×10^{-5}	3.43×10^{-4}	3.21×10^{-4}	-1.92×10^{-5}	3.41×10^{-3}	2.14×10^{-3}	3.39×10^{-4}
250	-3.06×10^{-4}	-6.50×10^{-5}	-1.23×10^{-4}	2.32×10^{-5}	-1.44×10^{-4}	-8.08×10^{-4}	4.28×10^{-4}	8.16×10^{-4}	3.35×10^{-4}	1.76×10^{-4}
260	-1.10×10^{-3}	-7.73×10^{-5}	-9.45×10^{-5}	-1.40×10^{-4}	-1.63×10^{-4}	-4.76×10^{-4}	4.16×10^{-4}	6.09×10^{-4}	4.26×10^{-7}	4.35×10^{-4}
270	-1.90×10^{-3}	-1.71×10^{-4}	-5.55×10^{-5}	-2.15×10^{-4}	1.90×10^{-5}	-7.55×10^{-4}	1.56×10^{-4}	1.58×10^{-3}	1.02×10^{-4}	4.79×10^{-4}
280	-1.61×10^{-3}	-1.31×10^{-4}	9.98×10^{-5}	-2.56×10^{-4}	2.59×10^{-4}	-1.91×10^{-4}	-2.00×10^{-4}	1.71×10^{-3}	7.39×10^{-4}	9.80×10^{-5}
290	-1.17×10^{-3}	-2.11×10^{-4}	2.32×10^{-4}	-8.06×10^{-5}	2.69×10^{-4}	4.05×10^{-4}	-2.25×10^{-4}	2.05×10^{-3}	6.54×10^{-4}	-2.39×10^{-4}
300	-6.26×10^{-4}	-2.20×10^{-4}	2.47×10^{-4}	5.56×10^{-5}	2.21×10^{-4}	-2.52×10^{-4}	-2.34×10^{-4}	1.98×10^{-3}	4.96×10^{-4}	-3.18×10^{-5}
310	-1.43×10^{-4}	-9.77×10^{-5}	1.18×10^{-4}	2.18×10^{-5}	1.86×10^{-4}	9.03×10^{-6}	-1.52×10^{-4}	8.17×10^{-4}	-3.07×10^{-5}	4.10×10^{-4}
320	-8.61×10^{-6}	-1.02×10^{-4}	4.77×10^{-5}	5.21×10^{-5}	1.62×10^{-4}	1.08×10^{-3}	-9.62×10^{-5}	2.71×10^{-4}	-9.05×10^{-5}	6.31×10^{-4}
330	1.76×10^{-4}	-1.42×10^{-4}	2.31×10^{-5}	7.08×10^{-5}	4.66×10^{-5}	1.68×10^{-3}	-7.15×10^{-5}	-1.43×10^{-4}	5.53×10^{-5}	1.14×10^{-3}
340	3.70×10^{-4}	-1.45×10^{-4}	4.99×10^{-5}	1.37×10^{-4}	2.52×10^{-5}	1.86×10^{-3}	-3.10×10^{-5}	-4.94×10^{-4}	2.24×10^{-4}	1.52×10^{-3}
350	4.98×10^{-4}	-1.18×10^{-4}	7.01×10^{-5}	1.82×10^{-4}	-2.31×10^{-5}	2.06×10^{-3}	-2.58×10^{-5}	-6.87×10^{-4}	2.13×10^{-4}	1.77×10^{-3}

Cp of the rear façade:

$Cp_{rear} = a_{re0} + a_{re1} * H_1 + \ldots .\ a_{re14} * H_{14} + a_{re15} * D + a_{re16} * L + a_{re17} * Rd + a_{re18} * Rl + a_{re19} * Bg$

Orientation	are0	are1	are2	are3	are4	are5	are6	are7	are8	are9
0	6.45×10^{-2}	-9.34×10^{-4}	-4.09×10^{-3}	-9.79×10^{-4}	-2.19×10^{-4}	-1.55×10^{-2}	2.42×10^{-4}	1.69×10^{-4}	-3.09×10^{-4}	-6.44×10^{-4}
10	7.46×10^{-2}	-9.25×10^{-4}	-3.40×10^{-3}	-9.47×10^{-4}	-1.92×10^{-4}	-1.51×10^{-2}	3.06×10^{-4}	2.17×10^{-4}	-3.25×10^{-4}	-5.90×10^{-4}
20	9.70×10^{-2}	-8.97×10^{-4}	-2.03×10^{-3}	-9.20×10^{-4}	-2.00×10^{-5}	-1.41×10^{-2}	3.57×10^{-4}	3.06×10^{-4}	-3.62×10^{-4}	-5.36×10^{-4}
30	1.10×10^{-1}	-8.43×10^{-4}	-8.58×10^{-4}	-1.03×10^{-3}	1.33×10^{-4}	-1.20×10^{-2}	3.39×10^{-4}	2.48×10^{-4}	-4.23×10^{-4}	-5.30×10^{-4}
40	1.00×10^{-1}	-6.42×10^{-4}	-1.55×10^{-4}	-1.24×10^{-3}	1.48×10^{-4}	-8.84×10^{-3}	2.83×10^{-4}	1.60×10^{-4}	-3.97×10^{-4}	-4.74×10^{-4}
50	6.36×10^{-2}	-3.22×10^{-4}	-1.06×10^{-5}	-1.24×10^{-3}	1.13×10^{-4}	-5.28×10^{-3}	9.55×10^{-5}	7.91×10^{-5}	-4.07×10^{-4}	-2.75×10^{-4}
60	-2.37×10^{-2}	-1.45×10^{-4}	-5.78×10^{-5}	-3.85×10^{-4}	-1.78×10^{-4}	-1.93×10^{-3}	-8.03×10^{-4}	2.36×10^{-4}	-2.25×10^{-4}	-4.29×10^{-4}
70	-7.49×10^{-2}	9.54×10^{-5}	1.20×10^{-5}	1.33×10^{-4}	-6.43×10^{-5}	-2.36×10^{-4}	-1.01×10^{-3}	1.95×10^{-5}	-1.51×10^{-4}	-1.25×10^{-4}
80	-1.32×10^{-1}	-6.89×10^{-6}	4.01×10^{-5}	-4.52×10^{-5}	-4.84×10^{-5}	-9.37×10^{-4}	-1.36×10^{-4}	-3.97×10^{-6}	-9.94×10^{-5}	-1.75×10^{-4}
90	-2.14×10^{-1}	-1.15×10^{-4}	8.61×10^{-5}	-1.83×10^{-4}	-6.61×10^{-5}	-2.14×10^{-3}	7.80×10^{-6}	-8.36×10^{-6}	-1.27×10^{-4}	-1.91×10^{-4}
100	-2.06×10^{-1}	-1.79×10^{-4}	5.94×10^{-5}	-3.20×10^{-4}	-8.33×10^{-6}	-2.17×10^{-3}	8.19×10^{-5}	-3.79×10^{-5}	-1.36×10^{-4}	-1.63×10^{-4}
110	-2.02×10^{-1}	2.94×10^{-6}	4.33×10^{-5}	-3.58×10^{-4}	-1.74×10^{-5}	-1.66×10^{-3}	1.45×10^{-4}	-1.90×10^{-5}	-2.39×10^{-4}	-8.05×10^{-5}
120	-1.93×10^{-1}	8.88×10^{-5}	8.27×10^{-5}	-2.35×10^{-4}	-7.33×10^{-5}	-1.15×10^{-3}	6.61×10^{-5}	7.50×10^{-5}	-2.01×10^{-4}	-9.19×10^{-5}
130	-1.75×10^{-1}	-4.16×10^{-5}	4.65×10^{-5}	-1.44×10^{-5}	-6.83×10^{-5}	-5.03×10^{-4}	-1.82×10^{-5}	-1.26×10^{-5}	-1.50×10^{-4}	6.73×10^{-5}
140	-1.62×10^{-1}	-7.40×10^{-5}	9.82×10^{-6}	-3.47×10^{-5}	3.16×10^{-5}	-4.33×10^{-5}	-8.71×10^{-5}	-2.68×10^{-5}	1.63×10^{-5}	8.74×10^{-5}
150	-1.50×10^{-1}	-4.81×10^{-5}	-5.11×10^{-5}	-7.03×10^{-5}	-5.44×10^{-5}	3.96×10^{-4}	-8.61×10^{-5}	-1.93×10^{-5}	3.75×10^{-5}	7.30×10^{-6}
160	-1.53×10^{-1}	-2.67×10^{-5}	-1.30×10^{-4}	-1.34×10^{-4}	-8.24×10^{-5}	7.68×10^{-4}	-1.28×10^{-4}	-3.43×10^{-5}	-1.79×10^{-5}	-2.91×10^{-5}
170	-1.58×10^{-1}	3.82×10^{-5}	-2.09×10^{-4}	-1.94×10^{-4}	-4.79×10^{-5}	1.01×10^{-3}	-1.61×10^{-4}	-2.31×10^{-5}	-4.36×10^{-5}	-6.68×10^{-5}
180	-1.60×10^{-1}	6.01×10^{-5}	-2.35×10^{-4}	-2.14×10^{-4}	-3.95×10^{-5}	1.09×10^{-3}	-1.77×10^{-4}	-2.54×10^{-5}	-6.85×10^{-5}	-9.24×10^{-5}
190	-1.58×10^{-1}	3.34×10^{-5}	-2.05×10^{-4}	-1.91×10^{-4}	-5.61×10^{-5}	9.87×10^{-4}	-1.58×10^{-4}	-2.74×10^{-5}	-3.93×10^{-5}	-6.18×10^{-5}
200	-1.53×10^{-1}	-2.68×10^{-5}	-1.21×10^{-4}	-1.24×10^{-4}	-8.39×10^{-5}	7.29×10^{-4}	-1.29×10^{-4}	-3.03×10^{-5}	-1.11×10^{-5}	-2.62×10^{-5}
210	-1.52×10^{-1}	-3.58×10^{-5}	-2.30×10^{-5}	-7.00×10^{-5}	-8.28×10^{-5}	3.49×10^{-4}	-6.67×10^{-5}	-2.62×10^{-5}	4.38×10^{-5}	5.41×10^{-7}
220	-1.52×10^{-1}	2.07×10^{-5}	9.80×10^{-6}	-5.69×10^{-5}	-6.32×10^{-5}	1.09×10^{-5}	-5.26×10^{-5}	-1.44×10^{-4}	-2.48×10^{-5}	-1.50×10^{-6}
230	-1.62×10^{-1}	-4.74×10^{-5}	6.88×10^{-5}	4.62×10^{-5}	-1.67×10^{-4}	-5.34×10^{-4}	-7.34×10^{-5}	-1.07×10^{-4}	-7.75×10^{-5}	4.03×10^{-5}
240	-1.97×10^{-1}	-9.77×10^{-5}	5.41×10^{-6}	-1.08×10^{-4}	-8.34×10^{-5}	-1.07×10^{-3}	5.13×10^{-5}	9.79×10^{-5}	-8.58×10^{-5}	1.62×10^{-4}
250	-2.04×10^{-1}	-1.58×10^{-4}	8.48×10^{-5}	-3.39×10^{-4}	-2.39×10^{-5}	-1.84×10^{-3}	1.90×10^{-4}	4.92×10^{-5}	-1.09×10^{-4}	-2.80×10^{-5}
260	-2.00×10^{-1}	-2.44×10^{-4}	9.02×10^{-5}	-3.33×10^{-4}	-3.81×10^{-5}	-2.32×10^{-3}	9.08×10^{-5}	1.14×10^{-4}	-8.63×10^{-5}	-1.38×10^{-4}
270	-2.14×10^{-1}	-1.27×10^{-4}	7.09×10^{-5}	-1.68×10^{-4}	-6.81×10^{-5}	-2.05×10^{-3}	1.32×10^{-6}	-7.80×10^{-6}	-1.24×10^{-4}	-2.02×10^{-4}
280	-1.31×10^{-1}	2.04×10^{-5}	1.03×10^{-7}	-3.93×10^{-5}	-1.61×10^{-4}	-8.10×10^{-4}	-6.32×10^{-5}	5.92×10^{-6}	-9.78×10^{-5}	-1.70×10^{-4}
290	-8.25×10^{-2}	-9.61×10^{-5}	9.10×10^{-5}	2.08×10^{-4}	-1.12×10^{-3}	-2.27×10^{-4}	-1.72×10^{-4}	7.93×10^{-5}	-3.14×10^{-4}	-2.05×10^{-4}
300	-4.34×10^{-2}	-6.36×10^{-4}	1.58×10^{-4}	-2.88×10^{-5}	-1.24×10^{-3}	-2.06×10^{-3}	1.09×10^{-4}	1.98×10^{-4}	-4.11×10^{-4}	-2.84×10^{-4}
310	5.10×10^{-2}	-1.22×10^{-3}	1.91×10^{-5}	-7.37×10^{-4}	-3.67×10^{-4}	-5.56×10^{-3}	3.60×10^{-4}	1.16×10^{-4}	-3.22×10^{-4}	-3.04×10^{-4}
320	7.89×10^{-2}	-1.32×10^{-3}	-2.78×10^{-4}	-7.82×10^{-4}	-9.92×10^{-5}	-9.17×10^{-3}	3.50×10^{-4}	2.97×10^{-4}	-1.62×10^{-4}	-5.93×10^{-4}
330	9.63×10^{-2}	-9.67×10^{-4}	-9.07×10^{-4}	-9.40×10^{-4}	1.16×10^{-4}	-1.22×10^{-2}	3.90×10^{-4}	3.34×10^{-4}	-3.14×10^{-4}	-5.27×10^{-4}
340	9.51×10^{-2}	-8.59×10^{-4}	-2.18×10^{-3}	-9.47×10^{-4}	-2.33×10^{-5}	-1.42×10^{-2}	3.43×10^{-4}	2.75×10^{-4}	-3.86×10^{-4}	-5.30×10^{-4}
350	7.17×10^{-2}	-9.28×10^{-4}	-3.52×10^{-3}	-9.46×10^{-4}	-2.01×10^{-4}	-1.52×10^{-2}	2.96×10^{-4}	2.09×10^{-4}	-3.25×10^{-4}	-5.99×10^{-4}

Orientation	are10	are11	are12	are13	are14	are15	are16	are17	are18	are19
0	-3.08×10^{-4}	2.32×10^{-4}	-6.08×10^{-5}	-3.95×10^{-4}	2.31×10^{-4}	2.67×10^{-3}	1.53×10^{-4}	2.34×10^{-3}	2.73×10^{-5}	1.12×10^{-2}
10	-2.18×10^{-4}	2.43×10^{-4}	-1.24×10^{-5}	-3.53×10^{-4}	3.38×10^{-4}	2.78×10^{-3}	-1.17×10^{-4}	2.28×10^{-3}	-9.36×10^{-5}	1.12×10^{-2}
20	-8.64×10^{-5}	2.33×10^{-4}	2.30×10^{-6}	-2.63×10^{-4}	4.96×10^{-4}	2.67×10^{-3}	-6.13×10^{-4}	2.08×10^{-3}	-2.15×10^{-4}	1.11×10^{-2}
30	-1.20×10^{-5}	1.89×10^{-4}	-6.09×10^{-5}	-2.55×10^{-4}	4.96×10^{-4}	2.41×10^{-3}	-8.92×10^{-4}	1.48×10^{-3}	1.22×10^{-4}	1.07×10^{-2}
40	3.34×10^{-5}	1.69×10^{-4}	-2.42×10^{-5}	-4.11×10^{-4}	5.47×10^{-4}	1.12×10^{-3}	-9.32×10^{-4}	8.51×10^{-4}	1.82×10^{-4}	1.04×10^{-2}
50	4.32×10^{-6}	8.81×10^{-5}	5.06×10^{-5}	-2.76×10^{-4}	3.46×10^{-4}	7.83×10^{-4}	-8.77×10^{-4}	1.85×10^{-4}	3.57×10^{-4}	9.25×10^{-3}
60	1.85×10^{-5}	-1.46×10^{-4}	-6.98×10^{-6}	-2.03×10^{-4}	2.04×10^{-4}	1.57×10^{-3}	-3.03×10^{-4}	-4.09×10^{-5}	1.26×10^{-3}	5.46×10^{-3}
70	-1.52×10^{-5}	-9.34×10^{-5}	5.30×10^{-6}	-1.82×10^{-4}	3.74×10^{-5}	-7.72×10^{-5}	3.72×10^{-4}	-3.05×10^{-5}	7.72×10^{-4}	1.73×10^{-3}
80	1.80×10^{-5}	-1.12×10^{-4}	3.29×10^{-5}	-1.54×10^{-5}	-1.69×10^{-5}	-6.77×10^{-4}	5.15×10^{-4}	1.40×10^{-4}	3.38×10^{-4}	3.99×10^{-4}
90	5.49×10^{-5}	-3.60×10^{-5}	5.96×10^{-5}	-9.72×10^{-5}	4.80×10^{-5}	-1.32×10^{-3}	4.13×10^{-4}	1.90×10^{-4}	3.96×10^{-4}	1.58×10^{-3}
100	-2.98×10^{-5}	-1.05×10^{-4}	4.09×10^{-6}	-1.42×10^{-4}	1.06×10^{-4}	-8.64×10^{-4}	8.78×10^{-5}	1.61×10^{-4}	2.94×10^{-4}	2.82×10^{-3}
110	-1.02×10^{-4}	-4.72×10^{-5}	-5.65×10^{-5}	-1.39×10^{-4}	7.11×10^{-5}	1.84×10^{-4}	-1.80×10^{-4}	-6.71×10^{-5}	3.43×10^{-6}	3.30×10^{-3}
120	-1.27×10^{-4}	2.27×10^{-4}	-7.14×10^{-5}	-1.38×10^{-4}	2.12×10^{-4}	6.23×10^{-4}	-2.93×10^{-4}	-1.36×10^{-4}	2.62×10^{-5}	3.18×10^{-3}
130	-1.70×10^{-4}	1.33×10^{-4}	-1.57×10^{-5}	-7.17×10^{-5}	3.87×10^{-4}	7.55×10^{-4}	-2.76×10^{-4}	2.41×10^{-4}	-1.31×10^{-4}	2.09×10^{-3}
140	-3.54×10^{-4}	4.41×10^{-5}	3.81×10^{-5}	-3.75×10^{-5}	3.25×10^{-4}	5.23×10^{-4}	-7.73×10^{-5}	6.39×10^{-4}	-5.87×10^{-5}	3.39×10^{-4}
150	-7.53×10^{-4}	1.21×10^{-4}	1.16×10^{-4}	7.56×10^{-6}	2.20×10^{-4}	4.95×10^{-4}	3.56×10^{-5}	7.95×10^{-4}	9.13×10^{-5}	-9.51×10^{-4}
160	-1.20×10^{-3}	1.87×10^{-4}	7.79×10^{-5}	1.33×10^{-4}	1.50×10^{-4}	6.79×10^{-4}	1.18×10^{-4}	1.08×10^{-3}	8.39×10^{-5}	-1.56×10^{-3}
170	-1.52×10^{-3}	2.81×10^{-4}	3.60×10^{-5}	3.04×10^{-4}	9.12×10^{-5}	8.58×10^{-4}	1.53×10^{-4}	1.35×10^{-3}	-4.34×10^{-5}	-1.97×10^{-3}
180	-1.63×10^{-3}	3.28×10^{-4}	2.26×10^{-5}	3.88×10^{-4}	6.62×10^{-5}	9.84×10^{-4}	1.58×10^{-4}	1.44×10^{-3}	-7.77×10^{-5}	-2.16×10^{-3}
190	-1.50×10^{-3}	2.72×10^{-4}	3.89×10^{-5}	2.91×10^{-4}	9.58×10^{-5}	8.47×10^{-4}	1.52×10^{-4}	1.32×10^{-3}	-3.12×10^{-5}	-1.94×10^{-3}
200	-1.15×10^{-3}	1.83×10^{-4}	8.24×10^{-5}	1.18×10^{-4}	1.55×10^{-4}	6.78×10^{-4}	1.12×10^{-4}	1.04×10^{-3}	9.40×10^{-5}	-1.52×10^{-3}
210	-6.91×10^{-4}	1.63×10^{-4}	1.61×10^{-4}	-2.32×10^{-5}	2.30×10^{-4}	5.02×10^{-4}	2.58×10^{-5}	7.02×10^{-4}	1.46×10^{-4}	-8.92×10^{-4}
220	-2.49×10^{-4}	1.13×10^{-5}	3.26×10^{-4}	-1.72×10^{-4}	2.16×10^{-4}	2.67×10^{-4}	-1.41×10^{-4}	5.59×10^{-4}	-2.09×10^{-5}	4.33×10^{-4}
230	-9.71×10^{-5}	-7.86×10^{-5}	2.01×10^{-4}	-1.57×10^{-4}	1.20×10^{-4}	4.51×10^{-4}	-2.87×10^{-4}	9.97×10^{-5}	-8.01×10^{-5}	2.09×10^{-3}
240	-2.12×10^{-4}	-1.24×10^{-4}	4.37×10^{-5}	-1.59×10^{-4}	1.78×10^{-4}	5.83×10^{-4}	-3.06×10^{-4}	-1.56×10^{-4}	2.53×10^{-4}	3.21×10^{-3}
250	-1.04×10^{-4}	-5.61×10^{-5}	-3.01×10^{-5}	-1.18×10^{-4}	1.42×10^{-4}	2.60×10^{-4}	-1.70×10^{-4}	-2.31×10^{-4}	2.25×10^{-4}	2.98×10^{-3}
260	6.56×10^{-5}	-6.98×10^{-6}	-2.74×10^{-5}	-1.79×10^{-4}	1.20×10^{-4}	-8.14×10^{-4}	9.37×10^{-5}	-1.77×10^{-4}	3.64×10^{-4}	2.57×10^{-3}
270	5.90×10^{-5}	-5.88×10^{-5}	5.97×10^{-5}	-9.05×10^{-5}	3.92×10^{-5}	-1.35×10^{-3}	4.41×10^{-4}	2.15×10^{-4}	4.05×10^{-4}	1.46×10^{-3}
280	4.22×10^{-5}	-1.11×10^{-4}	4.96×10^{-5}	1.65×10^{-5}	-2.88×10^{-5}	-7.18×10^{-4}	5.23×10^{-4}	6.95×10^{-5}	3.10×10^{-4}	3.80×10^{-4}
290	5.26×10^{-5}	-1.99×10^{-4}	4.83×10^{-5}	-2.26×10^{-4}	4.64×10^{-5}	-2.24×10^{-4}	3.90×10^{-4}	-1.23×10^{-5}	9.92×10^{-4}	2.25×10^{-3}
300	-1.21×10^{-4}	-1.50×10^{-4}	7.98×10^{-5}	-3.55×10^{-4}	4.56×10^{-4}	1.81×10^{-3}	-2.88×10^{-4}	2.58×10^{-4}	1.43×10^{-3}	5.54×10^{-3}
310	-1.16×10^{-4}	1.34×10^{-4}	5.34×10^{-5}	-3.27×10^{-4}	5.45×10^{-4}	1.57×10^{-3}	-8.51×10^{-4}	3.18×10^{-4}	6.73×10^{-4}	8.85×10^{-3}
320	1.65×10^{-4}	1.28×10^{-4}	3.68×10^{-5}	-3.69×10^{-4}	5.81×10^{-4}	1.84×10^{-3}	-9.32×10^{-4}	6.69×10^{-4}	6.34×10^{-4}	1.07×10^{-2}
330	2.77×10^{-5}	2.00×10^{-4}	-3.97×10^{-5}	-2.45×10^{-4}	6.05×10^{-4}	2.56×10^{-3}	-8.83×10^{-4}	1.46×10^{-3}	1.30×10^{-4}	1.08×10^{-2}
340	-1.06×10^{-4}	2.20×10^{-4}	-3.12×10^{-6}	-2.66×10^{-4}	4.60×10^{-4}	2.67×10^{-3}	-5.64×10^{-4}	2.13×10^{-3}	-2.36×10^{-4}	1.11×10^{-2}
350	-2.33×10^{-4}	2.40×10^{-4}	-1.60×10^{-5}	-3.58×10^{-4}	3.23×10^{-4}	2.77×10^{-3}	-7.12×10^{-5}	2.29×10^{-3}	-7.57×10^{-5}	1.12×10^{-2}

Cp of the roof:

$$Cp_{roof} = a_{ro0} + a_{ro1} * H_1 + \ldots . \ a_{ro14} * H_{14} + a_{ro15} * D + a_{ro16} * L + a_{ro17} * Rd + a_{ro18} * Rl + a_{ro19} * Bg$$

Orientation	aro1	aro1	aro2	aro3	aro4	aro5	aro6	aro7	aro8	aro9
0	-4.12×10^{-1}	3.93×10^{-4}	2.87×10^{-3}	5.90×10^{-4}	-2.61×10^{-4}	1.44×10^{-3}	3.33×10^{-5}	4.55×10^{-4}	4.66×10^{-4}	6.89×10^{-4}
10	-4.13×10^{-1}	3.62×10^{-4}	2.33×10^{-3}	5.01×10^{-4}	-2.68×10^{-4}	1.43×10^{-3}	-1.85×10^{-5}	3.76×10^{-4}	5.04×10^{-4}	5.81×10^{-4}
20	-4.24×10^{-1}	3.26×10^{-4}	1.39×10^{-3}	4.31×10^{-4}	-3.60×10^{-4}	1.35×10^{-3}	-6.55×10^{-5}	2.50×10^{-4}	5.50×10^{-4}	4.33×10^{-4}
30	-4.37×10^{-1}	3.20×10^{-4}	6.40×10^{-4}	5.01×10^{-4}	-3.54×10^{-4}	1.03×10^{-3}	-1.66×10^{-4}	2.13×10^{-4}	4.86×10^{-4}	2.97×10^{-4}
40	-4.39×10^{-1}	3.54×10^{-5}	1.60×10^{-6}	7.64×10^{-4}	-3.28×10^{-4}	7.36×10^{-4}	-1.24×10^{-4}	1.87×10^{-5}	4.07×10^{-4}	1.22×10^{-4}
50	-4.13×10^{-1}	9.46×10^{-7}	9.64×10^{-6}	7.78×10^{-4}	6.74×10^{-5}	5.49×10^{-4}	2.32×10^{-4}	-2.47×10^{-4}	1.44×10^{-4}	1.40×10^{-4}
60	-3.81×10^{-1}	1.20×10^{-4}	-2.14×10^{-4}	3.09×10^{-4}	8.63×10^{-5}	-2.69×10^{-5}	9.21×10^{-4}	-1.39×10^{-4}	7.04×10^{-5}	-2.19×10^{-5}
70	-3.32×10^{-1}	-3.46×10^{-5}	-9.61×10^{-5}	5.17×10^{-5}	-1.09×10^{-4}	-6.93×10^{-5}	5.05×10^{-4}	-1.40×10^{-4}	-6.10×10^{-5}	-1.50×10^{-4}
80	-2.17×10^{-1}	5.84×10^{-5}	6.02×10^{-5}	-7.24×10^{-5}	-9.33×10^{-6}	2.55×10^{-5}	5.05×10^{-5}	-6.45×10^{-5}	-1.83×10^{-4}	-7.15×10^{-5}
90	-2.04×10^{-1}	6.49×10^{-5}	5.81×10^{-5}	-1.60×10^{-4}	5.31×10^{-5}	2.75×10^{-4}	1.11×10^{-4}	-1.18×10^{-4}	-1.24×10^{-4}	-2.33×10^{-5}
100	-2.13×10^{-1}	6.11×10^{-5}	8.72×10^{-5}	-8.22×10^{-5}	4.61×10^{-5}	7.29×10^{-5}	-1.02×10^{-5}	-4.61×10^{-5}	-1.25×10^{-4}	-3.62×10^{-5}
110	-3.00×10^{-1}	-3.76×10^{-5}	-5.70×10^{-5}	-4.51×10^{-5}	2.83×10^{-5}	4.04×10^{-5}	-1.77×10^{-4}	-9.06×10^{-5}	-1.89×10^{-4}	-9.09×10^{-5}
120	-3.42×10^{-1}	-1.55×10^{-4}	-1.34×10^{-4}	-1.93×10^{-4}	3.61×10^{-5}	2.91×10^{-5}	-8.67×10^{-5}	4.40×10^{-5}	-2.23×10^{-4}	1.10×10^{-4}
130	-3.94×10^{-1}	-4.15×10^{-4}	-2.88×10^{-4}	-2.23×10^{-4}	2.26×10^{-4}	1.35×10^{-5}	1.21×10^{-5}	1.91×10^{-4}	3.63×10^{-4}	2.80×10^{-4}
140	-4.11×10^{-1}	-2.31×10^{-4}	-3.41×10^{-4}	-2.23×10^{-4}	-4.81×10^{-5}	-5.58×10^{-5}	7.14×10^{-5}	3.28×10^{-4}	3.03×10^{-4}	5.39×10^{-5}
150	-4.27×10^{-1}	-3.04×10^{-4}	-2.30×10^{-4}	-1.07×10^{-4}	-3.26×10^{-4}	-8.45×10^{-5}	-1.20×10^{-4}	2.09×10^{-4}	1.33×10^{-4}	1.35×10^{-4}
160	-3.95×10^{-1}	-2.66×10^{-4}	-3.89×10^{-4}	-2.88×10^{-4}	-3.86×10^{-4}	-4.11×10^{-5}	-3.63×10^{-4}	2.66×10^{-4}	1.23×10^{-4}	1.60×10^{-4}
170	-3.71×10^{-1}	-2.56×10^{-4}	-4.40×10^{-4}	-4.30×10^{-4}	-4.06×10^{-4}	-9.59×10^{-5}	-3.42×10^{-4}	3.16×10^{-4}	1.38×10^{-4}	1.60×10^{-4}
180	-3.65×10^{-1}	-2.70×10^{-4}	-4.36×10^{-4}	-4.62×10^{-4}	-4.20×10^{-4}	-1.39×10^{-4}	-2.81×10^{-4}	3.30×10^{-4}	1.92×10^{-4}	1.66×10^{-4}
190	-3.74×10^{-1}	-2.55×10^{-4}	-4.43×10^{-4}	-4.22×10^{-4}	-4.07×10^{-4}	-8.91×10^{-5}	-3.47×10^{-4}	3.13×10^{-4}	1.35×10^{-4}	1.61×10^{-4}
200	-4.00×10^{-1}	-2.66×10^{-4}	-3.74×10^{-4}	-2.70×10^{-4}	-3.86×10^{-4}	-3.69×10^{-5}	-3.50×10^{-4}	2.52×10^{-4}	1.18×10^{-4}	1.68×10^{-4}
210	-4.32×10^{-1}	-3.15×10^{-4}	-2.32×10^{-4}	-1.61×10^{-4}	-3.87×10^{-4}	-7.08×10^{-5}	-1.13×10^{-4}	2.73×10^{-4}	1.60×10^{-4}	5.54×10^{-5}
220	-4.04×10^{-1}	-1.88×10^{-4}	-3.47×10^{-4}	-1.83×10^{-4}	7.84×10^{-5}	-2.38×10^{-5}	-2.67×10^{-5}	1.22×10^{-4}	2.67×10^{-4}	3.42×10^{-5}
230	-3.49×10^{-1}	1.29×10^{-5}	-1.48×10^{-4}	-8.90×10^{-5}	2.02×10^{-4}	-7.63×10^{-5}	5.59×10^{-6}	-3.92×10^{-4}	2.57×10^{-5}	3.94×10^{-4}
240	-3.75×10^{-1}	-8.53×10^{-5}	-2.02×10^{-4}	1.25×10^{-4}	1.82×10^{-4}	1.15×10^{-4}	-1.99×10^{-4}	-1.89×10^{-4}	-1.18×10^{-5}	8.76×10^{-4}
250	-3.07×10^{-1}	-1.64×10^{-4}	-6.81×10^{-5}	-9.13×10^{-6}	2.34×10^{-5}	1.63×10^{-4}	-1.02×10^{-4}	3.02×10^{-6}	-5.57×10^{-5}	3.88×10^{-4}
260	-2.11×10^{-1}	3.83×10^{-5}	9.71×10^{-5}	-8.07×10^{-5}	4.01×10^{-5}	4.76×10^{-5}	1.61×10^{-5}	-5.01×10^{-5}	-1.21×10^{-4}	-5.14×10^{-5}
270	-1.93×10^{-1}	-1.26×10^{-4}	3.52×10^{-5}	-8.72×10^{-5}	3.21×10^{-6}	-7.64×10^{-6}	2.67×10^{-5}	7.26×10^{-5}	-1.09×10^{-4}	1.15×10^{-5}
280	-2.22×10^{-1}	3.42×10^{-5}	7.72×10^{-5}	-6.31×10^{-5}	-3.78×10^{-5}	-4.68×10^{-6}	7.00×10^{-5}	-6.57×10^{-5}	-1.59×10^{-4}	-8.64×10^{-5}
290	-3.26×10^{-1}	-6.97×10^{-5}	-8.63×10^{-5}	-2.31×10^{-5}	4.31×10^{-4}	1.84×10^{-5}	-2.94×10^{-5}	-4.50×10^{-5}	-6.06×10^{-5}	-2.32×10^{-4}
300	-3.33×10^{-1}	4.37×10^{-4}	-4.87×10^{-4}	-1.88×10^{-4}	6.06×10^{-4}	-3.51×10^{-5}	-2.97×10^{-4}	1.05×10^{-4}	1.41×10^{-4}	-4.30×10^{-4}
310	-4.08×10^{-1}	8.48×10^{-4}	-1.94×10^{-4}	1.34×10^{-4}	7.81×10^{-5}	4.28×10^{-4}	-9.80×10^{-5}	1.58×10^{-4}	5.27×10^{-4}	-1.56×10^{-5}
320	-4.42×10^{-1}	7.71×10^{-4}	1.36×10^{-4}	2.86×10^{-4}	-9.78×10^{-5}	7.25×10^{-4}	1.08×10^{-5}	1.98×10^{-4}	4.99×10^{-4}	2.87×10^{-4}
330	-4.24×10^{-1}	4.47×10^{-4}	6.71×10^{-4}	4.01×10^{-4}	-3.36×10^{-4}	1.04×10^{-3}	-1.70×10^{-4}	1.46×10^{-4}	4.30×10^{-4}	3.30×10^{-4}
340	-4.21×10^{-1}	2.92×10^{-4}	1.48×10^{-3}	4.53×10^{-4}	-3.62×10^{-4}	1.37×10^{-3}	-5.27×10^{-5}	2.76×10^{-4}	5.48×10^{-4}	4.40×10^{-4}
350	-4.12×10^{-1}	3.69×10^{-4}	2.42×10^{-3}	5.14×10^{-4}	-2.60×10^{-4}	1.44×10^{-3}	-1.29×10^{-5}	3.88×10^{-4}	5.00×10^{-4}	5.99×10^{-4}

Orientation	aro10	aro11	aro12	aro13	aro14	aro15	aro16	aro17	aro18	aro19
0	1.50×10^{-4}	-3.34×10^{-4}	7.78×10^{-5}	-1.14×10^{-5}	-1.42×10^{-4}	3.95×10^{-3}	1.99×10^{-4}	-6.58×10^{-4}	1.04×10^{-4}	-2.26×10^{-3}
10	4.95×10^{-5}	-3.62×10^{-4}	1.05×10^{-5}	4.81×10^{-5}	-1.83×10^{-4}	4.15×10^{-3}	3.41×10^{-4}	-5.45×10^{-4}	1.72×10^{-4}	-2.39×10^{-3}
20	-5.67×10^{-5}	-3.47×10^{-4}	-1.80×10^{-5}	9.08×10^{-5}	-1.64×10^{-4}	4.84×10^{-3}	5.27×10^{-4}	-3.67×10^{-4}	2.59×10^{-4}	-2.47×10^{-3}
30	-3.36×10^{-5}	-2.56×10^{-4}	3.77×10^{-5}	6.83×10^{-5}	-4.15×10^{-5}	6.29×10^{-3}	4.88×10^{-4}	-1.13×10^{-5}	8.21×10^{-5}	-2.25×10^{-3}
40	-3.39×10^{-5}	-2.87×10^{-4}	6.31×10^{-5}	4.02×10^{-5}	7.51×10^{-5}	8.38×10^{-3}	3.32×10^{-4}	5.75×10^{-4}	-2.87×10^{-5}	-2.38×10^{-3}
50	-1.92×10^{-4}	-6.03×10^{-5}	5.22×10^{-5}	-9.15×10^{-5}	2.75×10^{-4}	8.35×10^{-3}	1.54×10^{-4}	4.17×10^{-4}	-6.50×10^{-4}	-1.27×10^{-3}
60	-1.27×10^{-4}	1.05×10^{-4}	-7.35×10^{-5}	-2.04×10^{-4}	9.70×10^{-5}	8.60×10^{-3}	-1.69×10^{-4}	2.61×10^{-4}	-4.23×10^{-4}	4.24×10^{-4}
70	-3.62×10^{-5}	-3.83×10^{-5}	-8.54×10^{-5}	-4.66×10^{-5}	1.43×10^{-4}	6.83×10^{-3}	1.42×10^{-5}	5.79×10^{-4}	2.71×10^{-4}	1.98×10^{-4}
80	-4.92×10^{-5}	-6.00×10^{-5}	-9.37×10^{-6}	-5.52×10^{-5}	-1.49×10^{-5}	5.63×10^{-4}	1.94×10^{-4}	2.41×10^{-4}	1.81×10^{-4}	3.98×10^{-4}
90	-1.76×10^{-4}	-1.75×10^{-4}	-1.00×10^{-4}	-1.05×10^{-4}	-2.62×10^{-5}	9.14×10^{-4}	6.63×10^{-5}	6.39×10^{-5}	6.11×10^{-5}	5.45×10^{-4}
100	-1.37×10^{-4}	-8.90×10^{-5}	-5.24×10^{-6}	-7.50×10^{-5}	-2.85×10^{-5}	6.37×10^{-4}	1.19×10^{-4}	-1.73×10^{-6}	2.11×10^{-4}	6.25×10^{-4}
110	-8.52×10^{-5}	4.62×10^{-4}	-6.68×10^{-5}	-1.34×10^{-4}	-5.16×10^{-5}	6.31×10^{-3}	-5.47×10^{-6}	-4.10×10^{-4}	-8.92×10^{-5}	9.15×10^{-4}
120	-3.93×10^{-4}	9.39×10^{-4}	8.46×10^{-5}	-2.96×10^{-4}	5.61×10^{-4}	8.52×10^{-3}	-2.13×10^{-4}	-5.39×10^{-4}	-7.49×10^{-4}	4.87×10^{-4}
130	-4.74×10^{-5}	5.51×10^{-4}	-1.35×10^{-6}	-4.91×10^{-4}	1.07×10^{-3}	9.05×10^{-3}	3.54×10^{-5}	-1.02×10^{-3}	-1.02×10^{-3}	6.86×10^{-5}
140	7.49×10^{-4}	2.51×10^{-4}	-3.01×10^{-5}	-1.39×10^{-4}	7.73×10^{-4}	8.16×10^{-3}	3.46×10^{-4}	-1.27×10^{-3}	-7.36×10^{-4}	-7.93×10^{-4}
150	1.31×10^{-3}	1.48×10^{-4}	-9.40×10^{-5}	4.47×10^{-4}	1.51×10^{-4}	7.20×10^{-3}	7.16×10^{-4}	-1.95×10^{-3}	-9.69×10^{-5}	-8.15×10^{-4}
160	1.73×10^{-3}	1.80×10^{-5}	-2.03×10^{-4}	1.30×10^{-3}	1.15×10^{-5}	5.73×10^{-3}	6.68×10^{-4}	-1.99×10^{-3}	-1.44×10^{-4}	-9.71×10^{-4}
170	1.92×10^{-3}	8.34×10^{-5}	-2.99×10^{-4}	2.27×10^{-3}	9.35×10^{-5}	5.28×10^{-3}	3.87×10^{-4}	-1.74×10^{-3}	-2.93×10^{-4}	-1.26×10^{-3}
180	1.98×10^{-3}	1.40×10^{-4}	-3.42×10^{-4}	2.69×10^{-3}	1.46×10^{-4}	5.28×10^{-3}	2.43×10^{-4}	-1.64×10^{-3}	-2.64×10^{-4}	-1.48×10^{-3}
190	1.92×10^{-3}	7.58×10^{-5}	-2.87×10^{-4}	2.19×10^{-3}	8.35×10^{-5}	5.33×10^{-3}	4.13×10^{-4}	-1.77×10^{-3}	-2.92×10^{-4}	-1.23×10^{-3}
200	1.71×10^{-3}	2.62×10^{-5}	-2.21×10^{-4}	1.19×10^{-3}	3.12×10^{-5}	5.89×10^{-3}	6.90×10^{-4}	-2.00×10^{-3}	-1.15×10^{-4}	-1.01×10^{-3}
210	1.08×10^{-3}	2.50×10^{-4}	-4.51×10^{-5}	4.03×10^{-4}	1.35×10^{-4}	7.38×10^{-3}	7.15×10^{-4}	-1.80×10^{-3}	-1.50×10^{-4}	-6.59×10^{-4}
220	7.46×10^{-4}	2.57×10^{-4}	6.10×10^{-4}	-1.98×10^{-4}	2.71×10^{-4}	7.94×10^{-3}	3.24×10^{-4}	-1.21×10^{-3}	-8.82×10^{-4}	-7.98×10^{-4}
230	2.46×10^{-4}	-6.82×10^{-5}	1.04×10^{-3}	-2.87×10^{-4}	3.52×10^{-5}	8.35×10^{-3}	-1.03×10^{-4}	-8.43×10^{-4}	-1.58×10^{-3}	-4.07×10^{-4}
240	-1.57×10^{-4}	3.87×10^{-5}	3.97×10^{-4}	-4.01×10^{-4}	1.33×10^{-4}	8.70×10^{-3}	-2.88×10^{-4}	-4.94×10^{-5}	-6.24×10^{-5}	6.33×10^{-4}
250	-2.00×10^{-4}	-6.59×10^{-5}	-8.26×10^{-5}	-1.92×10^{-4}	2.77×10^{-5}	6.38×10^{-3}	-6.12×10^{-5}	-2.45×10^{-4}	6.78×10^{-5}	8.10×10^{-4}
260	-1.30×10^{-4}	-6.55×10^{-5}	-9.94×10^{-6}	-5.47×10^{-5}	-1.82×10^{-5}	6.15×10^{-4}	1.18×10^{-4}	-3.87×10^{-5}	2.16×10^{-4}	5.61×10^{-4}
270	6.45×10^{-6}	-3.96×10^{-5}	-9.90×10^{-5}	-1.58×10^{-4}	6.16×10^{-5}	8.24×10^{-4}	6.67×10^{-5}	-4.79×10^{-4}	3.31×10^{-4}	2.59×10^{-4}
280	-3.21×10^{-5}	-4.52×10^{-5}	5.62×10^{-6}	-4.92×10^{-5}	8.14×10^{-7}	5.85×10^{-4}	2.20×10^{-4}	2.74×10^{-4}	2.31×10^{-4}	3.56×10^{-4}
290	6.42×10^{-5}	-7.02×10^{-5}	1.12×10^{-4}	-1.12×10^{-4}	8.79×10^{-5}	6.59×10^{-3}	1.05×10^{-5}	7.47×10^{-4}	2.01×10^{-5}	4.46×10^{-5}
300	-4.57×10^{-5}	5.33×10^{-5}	8.96×10^{-5}	1.42×10^{-4}	-3.51×10^{-5}	7.36×10^{-3}	-1.94×10^{-4}	3.69×10^{-4}	-4.80×10^{-4}	-1.62×10^{-4}
310	1.77×10^{-5}	-5.16×10^{-5}	2.30×10^{-5}	4.99×10^{-5}	2.36×10^{-6}	8.03×10^{-3}	1.80×10^{-4}	2.84×10^{-4}	-8.98×10^{-4}	-1.12×10^{-3}
320	1.11×10^{-5}	-2.25×10^{-4}	-3.68×10^{-5}	1.99×10^{-5}	1.59×10^{-4}	7.83×10^{-3}	3.06×10^{-4}	5.65×10^{-4}	-4.57×10^{-4}	-2.23×10^{-3}
330	-9.81×10^{-5}	-2.63×10^{-4}	-7.73×10^{-6}	5.63×10^{-5}	-1.50×10^{-4}	6.02×10^{-3}	5.00×10^{-4}	3.75×10^{-5}	-8.43×10^{-5}	-2.28×10^{-3}
340	-5.99×10^{-5}	-3.44×10^{-4}	-1.10×10^{-5}	9.77×10^{-5}	-1.67×10^{-4}	4.72×10^{-3}	5.15×10^{-4}	-3.94×10^{-4}	2.72×10^{-4}	-2.47×10^{-3}
350	6.14×10^{-5}	-3.56×10^{-4}	1.68×10^{-5}	4.03×10^{-5}	-1.76×10^{-4}	4.09×10^{-3}	3.19×10^{-4}	-5.76×10^{-4}	1.65×10^{-4}	-2.37×10^{-3}

References

1. Pérez-Lombard, L.; Ortiz, J.; Pout, C. A review on buildings energy consumption information. *Energy Build.* **2008**, *40*, 394–398. [CrossRef]
2. Fiaschi, D.; Bandinelli, R.; Conti, S. A case study for energy issues of public buildings and utilities in a small municipality: Investigation of possible improvements and integration with renewables. *Appl. Energy* **2012**, *97*, 101–114. [CrossRef]
3. Costa, A.; Keane, M.M.; Torrens, J.I.; Corry, E. Building operation and energy performance: Monitoring, analysis and optimisation toolkit. *Appl. Energy* **2013**, *101*, 310–316. [CrossRef]
4. Santamouris, M. On the energy impact of urban heat island and global warming on buildings. *Energy Build.* **2014**, *82*, 100–113. [CrossRef]
5. Santamouris, M.; Cartalis, C.; Synnefa, A.; Kolokotsa, D. On the impact of urban heat island and global warming on the power demand and electricity consumption of buildings—A review. *Energy Build.* **2015**, *98*, 119–124.
6. Oh, S.J.; Ng, K.C.; Thu, K.; Chun, W.; Chua, K.J.E. Forecasting long-term electricity demand for cooling of Singapore's buildings incorporating an innovative air-conditioning technology. *Energy Build.* **2016**, *127*, 183–193. [CrossRef]
7. Nguyen, A.T.; Reiter, S. Passive designs and strategies for low-cost housing using simulation-based optimization and different thermal comfort criteria. *J. Build. Perform. Simul.* **2013**, *7*, 1–14.
8. Liping, W.; Hien, W.N. Applying Natural Ventilation for Thermal Comfort in Residential Buildings in Singapore. *Archit. Sci. Rev.* **2007**, *50*, 224–233.
9. Hens, H.S.L.C. *Heat, Air and Moisture Transfer in Insulated Envelope Parts: Performance and Practice, International Energy Agency*; Final Report Annex 24; International Energy Agency: Paris, France, 2002.
10. Strømann-Andersen, J.; Sattrup, P.A. The urban canyon and building energy use: Urban density versus daylight and passive solar gains. *Energy Build.* **2011**, *43*, 2011–2020. [CrossRef]
11. Bady, M.; Kato, S.; Huang, H. Towards the application of indoor ventilation efficiency indices to evaluate the air quality of urban areas. *Build. Environ.* **2008**, *43*, 1991–2004. [CrossRef]
12. Bady, M.; Kato, S.; Takahashi, T.; Huang, H. Experimental investigations of the indoor natural ventilation for different building configurations and incidences. *Build. Environ.* **2011**, *46*, 65–74. [CrossRef]
13. Cóstola, D.; Blocken, B.; Hensen, J.L.M. Overview of pressure coefficient data in building energy simulation and airflow network programs. *Build. Environ.* **2009**, *44*, 2027–2036. [CrossRef]
14. Hopfe, C.J.; Hensen, J.L.M. Uncertainty analysis in building performance simulation for design support. *Energy Build.* **2011**, *43*, 2798–2805. [CrossRef]
15. Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (TNO). 2012. Available online: http://cpgen.bouw.tno.nl/cp (accessed in 19 March 2013).
16. Heijmans, N.; Wouters, P. *Impact of the Uncertainties on Wind Pressures on the Prediction of Thermal Comfort Performances*; IEA ECBCS Annex 35; International Energy Agency: Paris, France, 2003.
17. Knoll, B.; Phaff, J.C.; de Gids, W.F. Pressure Simulation Program. In Proceedings of the 16th AIVC Conference, Palm Springs, CA, USA, 18–22 September 1995.
18. Sun, Y.; Heo, Y.; Tan, M.; Xie, H.; Wu, C.F.J.; Augenbroe, G. Uncertainty quantification of microclimate variables in building energy models. *J. Build. Perform. Simul.* **2014**, *7*, 17–32. [CrossRef]
19. Grosso, M. Wind pressure distribution around buildings: A parametrical model. *Energy Build.* **1992**, *18*, 101–131. [CrossRef]
20. Ramponi, R.; Angelotti, A.; Blocken, B. Energy saving potential of night ventilation: Sensitivity to pressure coefficients for different European climates. *Appl. Energy* **2014**, *123*, 185–195. [CrossRef]
21. Swami, M.V.; Chandra, S. Correlations for pressure distribution on buildings and calculation of natural-ventilation airflow. *ASHRAE Trans.* **1988**, *94*, 243–266.
22. Muehleisen, R.T.; Patrizi, S. A new parametric equation for the wind pressure coefficient for low-rise buildings. *Energy Build.* **2013**, *57*, 245–249. [CrossRef]
23. Kesten, D.; Tereci, A.; Strzalka, A.M.; Eicker, U. A method to quantify the energy performance in urban quarters. *HVACR Res.* **2012**, *18*, 100–111.

24. Van, T.N.; de Troyer, F. Deriving Housing Preferences from advertising on the web for improving decision making by Economic and Social actors. In Proceedings of the "At Home in the Housing Market"—RC43 Conference 2013, Amsterdam University, Amsterdam, The Netherlands, 10–12 July 2013.
25. Walker, I.S.; Wilson, D.J.; Forest, T.W. Wind Shadow Model for Air Infiltration Sheltering by Upwind Obstacles. *HVACR Res.* **1996**, *2*, 265–282. [CrossRef]
26. Sawachi, T.; Maruta, E.; Takahashi, Y.; Ken-ichi, S. Wind Pressure Coefficients for Different Building Configurations with and without an Adjacent Building. *Int. J. Vent.* **2006**, *5*, 21–30. [CrossRef]
27. Franke, J.; Sturm, M.; Kalmbach, C. Validation of OpenFOAM 1.6.x with the German VDI guideline for obstacle resolving micro-scale models. *J. Wind Eng. Ind. Aerodyn* **2012**, *104–106*, 350–359. [CrossRef]
28. Tominaga, Y.; Mochida, A.; Yoshie, R.; Kataoka, H.; Nozu, T.; Yoshikawa, M.; Shirasawa, T. AIJ guidelines for practical applications of CFD to pedestrian wind environment around buildings. *J. Wind Eng. Ind. Aerodyn.* **2008**, *96*, 1749–1761. [CrossRef]