Proposed ventilation formula when only primary openings are present:

$$(1)\quad q_{\max} = A_{window-\max} \cdot \sqrt{\left(c_{p1} - c_{p2}\right) \cdot W^2 + C_1 \cdot H \cdot \left|\Delta T\right| + C_2}\ , [m^3/s]$$

Proposed ventilation formula when additional secondary openings (resistance) are present:

$$(2)\quad q_{\max} = A_{window-\max} \cdot \sqrt{\left(c_{p1} - c_{p2}\right) \cdot A_{\sec}{}^2 \cdot W^2 + C_1 \cdot H \cdot \left|\Delta T\right| + C_2 \cdot A_{\sec}{}^2}\ , [m^3/s]$$

Available cooling capacity of the natural ventilation:

$$(3)\quad Q_{\max} = q_{\max} \cdot c_{air} \cdot \rho_{air} \cdot \left(T_{outside} - T_{inside}\right), [W]$$

The resulting actuators position will follow the ratio of the required airflow/cooling and available airflow/cooling capacity.

$$(4)\quad A_{required} = \max \begin{cases} A_{openings-\max} \cdot \dfrac{q_{required}}{q_{\max}}, \\ A_{openings-\max} \cdot \dfrac{Q_{required}}{Q_{\max}}, \end{cases} \left[m^2\right]$$

Where:

$q_{\max}$ – Available maximum natural ventilation airflow, $[m^3/s]$

$A_{window-\max}$ – Maximum size of primary openings (windows, roof lights, etc.), $[m^2]$

$A_{\sec}$ – Secondary openings size (such as ducts, double skin, etc.), $[m^2]$

W – Wind speed, $[m/s]$

ΔT – Temperature difference between the inside and outside, $[^o C]$

H – Height difference in between the lower and upper openings, $[m]$

$c_{p1,2}$ – Wind pressure coefficients, [–]

$C_{1,2}$ – Constants, [–]

$Q_{\max}$ – Available maximum cooling capacity of natural ventilation, $[KW]$

c_{air}, ρ_{air} – Air parameters: Specific heat capacity, $[KJ/(Kg \cdot K)]$ and density, $[Kg/m^3]$

$A_{required}$ – Required new natural ventilation openings, $[m^2]$

$q_{required}$, $Q_{required}$ – Required ventilation rate $[m^3/s]$ or cooling $[KW]$ as an output of room controller