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A. 1) The **aim of U-value testing** is to measure how effective elements of a building's fabric are at preventing heat from transmitting between the inside and the outside of a building hence, help evaluate the insulation of the building. [4]

Advantages of U-value testing It helps to determine how effective a material of the buildings fabric is as a thermal insulator. It also takes into account real life factors such as variation in moisture content of material, inconsistencies in building practices etc. which are otherwise not accounted for. [5]

Disadvantages of U-value testing It is a long and time consuming process. Multiple tests need to be done in order to obtain a representative average.

Description of the Data The data from the U-value testing was sampled over four days from 19/03/2015 at 16:00 until 22/03/2015 16:00 taking five minute intervals between each data recording. The heat flux density (W/m^2), the internal surface temperature and the external surface temperature were measured in the data. A total of 867 data recordings were made.

Using the in-situ measurements we have

HF [W/m^2] average(q)=5.92632

T_s_in [°C] average(T_{si})=16.3153

T_s_ext [°C] average(T_{se})=6.18751

$$R_{elem} = \frac{T_{si} - T_{se}}{q}$$ [1]

⇨ $R_{elem} = 1.70894$ m^{2}K/W

$R_{si} = 0.13$ m^{2}K/W

$R_{se} = 0.04$ m^{2}K/W

$R_{total} = R_{elem} + R_{si} + R_{se}$

⇨ $R_{total} = 1.87894$ m^{2}K/W

$$U = \frac{1}{R_{total}}$$ [1]

⇨ **U = 0.5322149723 W/m^{2}K**

2)

Table 1 R value of individual layers of wall

Material Used In Layer	Thermal Conductivity (λ) [W/mK] [2]	Thickness (x) [m]	R-Value (x/ λ) [m^2K/W]
Plaster	0.22	0.01	0.04545455
Aerated Concrete Blocks	0.20	0.1	0.5
Cavity Filled With Urea Formaldehyde Insulation Foam	0.040	0.065	1.625
Exposed Bricks	0.77	0.77	0.12987013

$R_{total} = R_{si} + R_{se} + R_{plaster} + R_{concrete} + R_{insulation} + R_{bricks}$

⇨ $R_{total} = 2.47032468\ m^2K/W$

$$U = \frac{1}{R_{total}}$$

⇨ **$U = 0.40480509\ W/m^2K$**

We observe discrepancies in the U- values calculated from in-situ measurements and from information of layers-they differ by 0.1274098823 W/m^2K

Potential Sources of discrepancies Regardless of the construction method used, the in-situ U-value of the element can vary significantly from a calculated value due to potential sources such as inhomogeneous materials, variations in the level of moisture content of materials, exposure of an element to wind and rain, inconsistencies in building practices and workmanship and inaccuracies embedded in material libraries used for running calculations. [5]

Implications of discrepancies Such discrepancies indicate that the U-value calculated from the in-situ measurements may be more accurate in determining the buildings thermal performance than the calculated U-value as the above mentioned sources of discrepancies are better taken into account.

3) $R_{element} = R_{plaster} + R_{concrete} + R_{insulation} + R_{brick}$

⇨ $R_{element} = 2.30032468\ m^2K/W$

$Q = U_{element} A (T_{s\text{-}internal} - T_{s\text{-}external})$ [1]

$$q = \frac{Q}{A} = U_{element}\ (T_{s\text{-}internal} - T_{s\text{-}external})$$

$$\Rightarrow\ q = \frac{1}{R_{element}}\ (T_{s\text{-}internal} - T_{s\text{-}external})$$

$$\Rightarrow\ q = \frac{1}{2.30032468}\ (16.3153 - 6.18751)$$

$$\Rightarrow\ q = 4.398418227\ W/m^2$$

$$Q = \frac{1}{R_{layer}} A\ (T_{int} - T_{ext})$$ [3]

$$T_{ext} = T_{int} - q.\ R_{layer}$$

Table 2 Temperature At The Boundary of Wall Layers

Layer	**R_{layer} [m^2K/W]**	**T_{int} at boundary [^oC]**	**T_{ext} at boundary [^oC]**
Plaster	0.04545455	16.3153	16.11537188
Aerated Concrete Blocks	0.5	16.11537188	13.91616276
Cavity Filled With Urea Formaldehyde Insulation Foam	1.625	13.91616276	6.768733146
Exposed Bricks	0.12987013	6.768733146	6.187509999

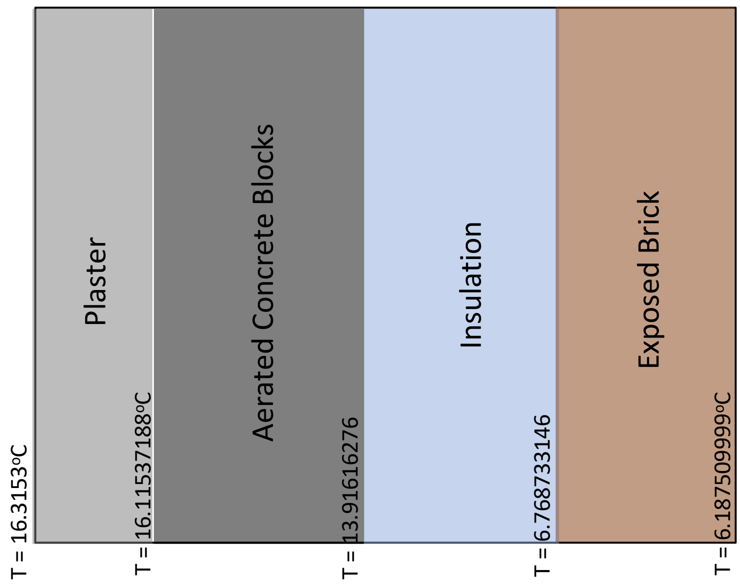

Figure 1 Temperature at different layers of wall

B. CITY - Prague

1) The main principle behind passive stack ventilation(PSV) is that hot air rises and the wind that blows across the dace of the roof/walls causes a negative pressure which pulls out the hot air. PSV uses this basic principle to cause ventilation within a building. “Passive stack ventilation expands on these same natural principles in order to provide ventilation by way of extract vents within the wet rooms of your property such as en-suites, bathrooms and kitchens which are routed vertically to the outlet vents at the ridge of your roof. Replacement air is then supplied by trickle vents in your windows or wall vents.” [9]

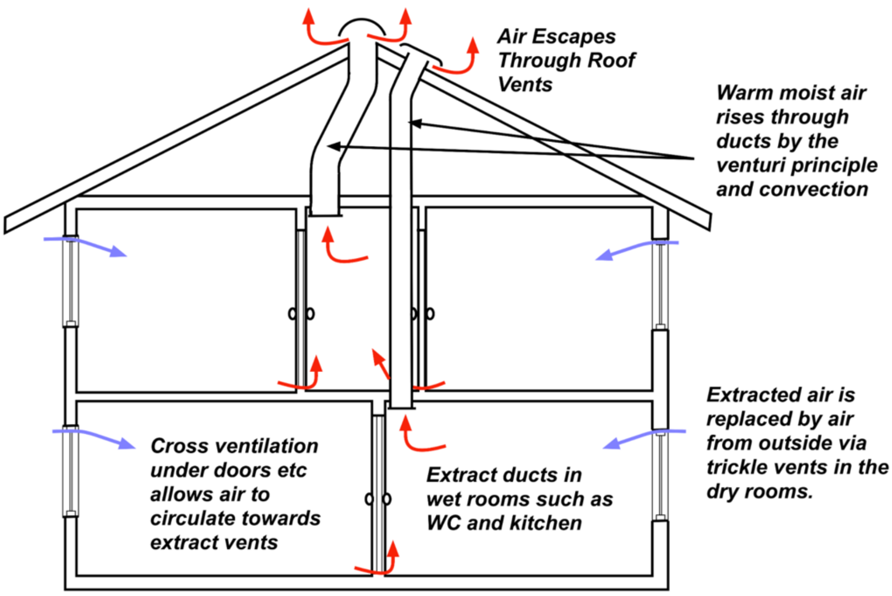

Figure 2 Passive Stack Ventilation *Source: eco-home-essentials.co.uk*

2) Formula used is $P_s = -\rho_{273} \, . \, g \, . \, 273 . (z_2 - z_1) \left[\frac{1}{T_{ext}} - \frac{1}{T_{in}}\right]$

Pressure difference due to stack effect (Pa)

Air density at 273 K (=1.29 kg/m^3)

Acceleration due to gravity (=9.8 m/s^2)

Length of ducting system (=4m)

External Temperature (K)

Internal Temperature (K)

Winter

T_{ext} = -2.4 ^{o}C = -2.4 + 273.15 K = 270.75 K
T_{in} = 18.5 ^{o}C = 18.5 + 273.15 K = 291.65 K

Ps = - 3.653879867 Pa

Summer

T_{ext} = 25.3 ^{o}C = 25.3 + 273.15 K = 298.45 K
T_{in} = 24 ^{o}C = 24 + 273.15 K = 297.15 K

Ps = 0.2023645608 Pa

3) We can observe that the magnitude of P_s is greater during winter than the summer. This can be attributed to the fact that there a greater temperature difference between inside and outside during winter than during summer.

The value of P_s in winter is negative which indicates that heat is lost from the system and the positive value of P_s in summer indicates that heat is gained from the system.

"Stack effect is air movement caused by thermal differences. Higher-temperature air is less dense than cooler air. As the warmer air rises, it creates a pressure difference, with lower pressure below and higher pressure above. In buildings during the winter, the lower pressure allows cooler air from outside to move to the bottom floors. During summer or in warmer climates, stack effect is reversed. The hot air outside enters the upper portion of the cooler building and creates a draft down" [8][9][10]

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