CASE STUDY

GREEN ROOF'S THERMAL PERFORMANCE IN TROPICAL CLIMATE

- An experiment conducted by the University of Moratuwa, Sri Lanka (a tropical climate nation) indicates that houses experience a maximum outdoor and indoor temperature of 32 °C and 29.5 °C respectively. By implementing the green roof system, the outdoor and indoor temperatures are decreased by 8 °C and 3 °C respectively.

STACK VENTILATION STRATEGIES

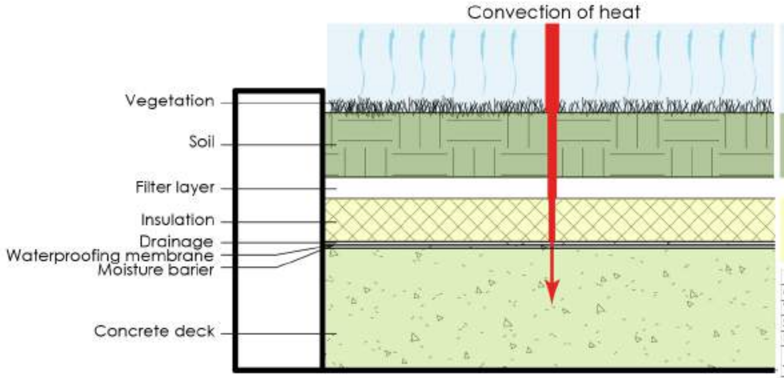
- The C. K. Choi Building in Vancouver does not have any air conditioning system within the building. Raised roof monitors are present to draw air in through the vents below and allow stack ventilation to occur. The stack effect induced by the pressure difference present at the lower and upper outlet areas extracts hot air out of the building, thus lowering indoor dry bulb temperature.

VERTICAL LIVING WALL SYSTEM

- An experiment conducted by HortPark, Singapore, shows 8 types of vertical greenery systems with different plant typologies. Each vertical wall system gives varying results in terms of temperature drop, and it was found that systems 3 and 4 give the most temperature drop, which is 10.94 °C and 4 to 12 °C respectively in daytime

GREEN ROOF

A green roof or living roof is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. The green roof protects the building from direct solar heat, thus decreasing heat radiation to the interior space



Evaporative cooling
Evapotranspiration carried out by the vegetation will take away some heat from the roof

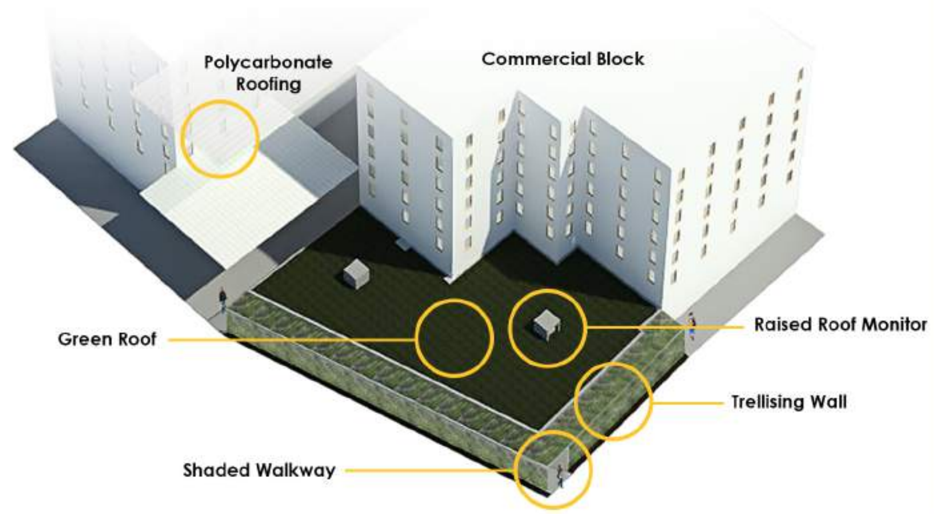
Soil
The soil medium contributes to the thermal resistance of the roof, which slows down the heat transfer to the concrete roof

Thermal Insulation Layers
The high thermal resistance of the insulation layers slows down the heat transfer to the concrete roof

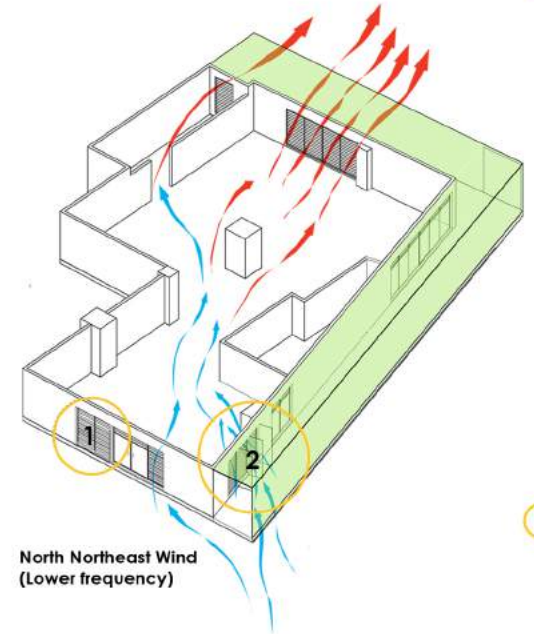
Material	Thickness (m)	Thermal Conductivity [W/(mK)]	Thermal Resistance [m²C/W]	U- Value [W/m²k]
Outside Surface			0.059	
Vegetation Layer	—	—	—	
Soil Layer	0.345	0.14	2.46	
Filter Layer	0.005	0.06	0.08	
Thermal Insulation Layer	0.05	0.03	1.67	
	0.1		3.33	
Drainage Layer	0.06	0.08	0.75	
Waterproof Layer	0.07	0.17	0.41	
Moisture Barrier	0.003	0.055	0.55	
Concrete Slab	0.05	1.16	0.04	
Concrete Floor	0.2	0.39	0.51	
Inside Surface			0.132	
		Total	9.991	0.100090081

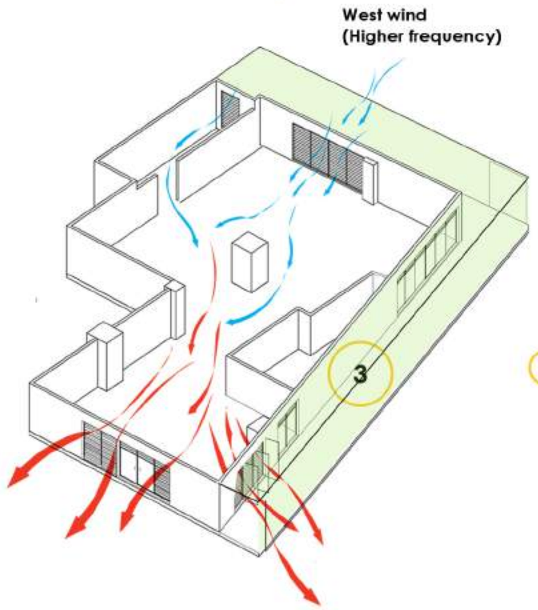
The thermal insulation layers contribute to the high thermal resistance of the green roof, thus lowering the U-value of the roof by 0.49233 W/m²k

ISOMETRIC VIEW

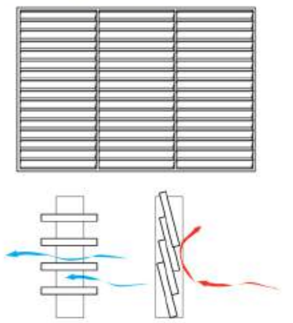


CROSS VENTILATION



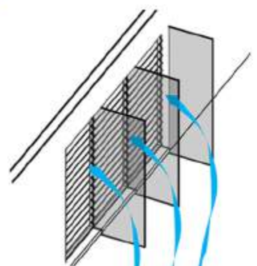


1 OPERABLE FLOOR TO CEILING LOUVRE WINDOWS



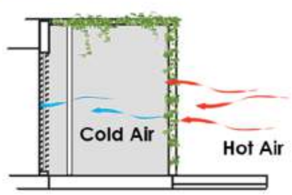
Operable louvre windows allow cold air to enter the space when they are opened, and can be closed manually to prevent hot air or rain from entering the space.

2 TEMPERED GLASS WING WALL



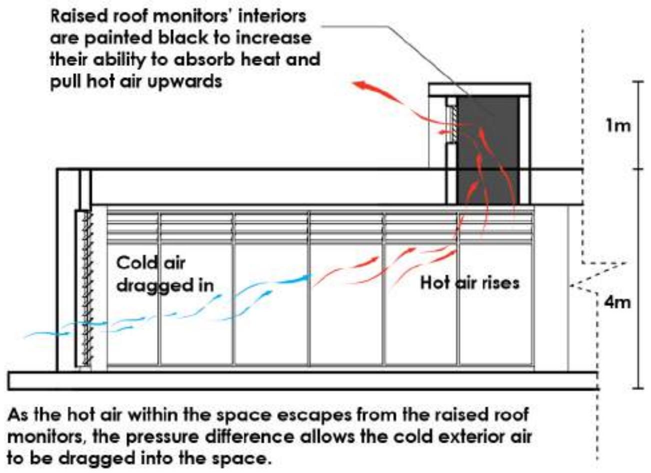
The wing walls extend from the existing wall to function as wind scoops, drawing in wind which blows from the North Northeast direction.

3 TRELLISING WALL



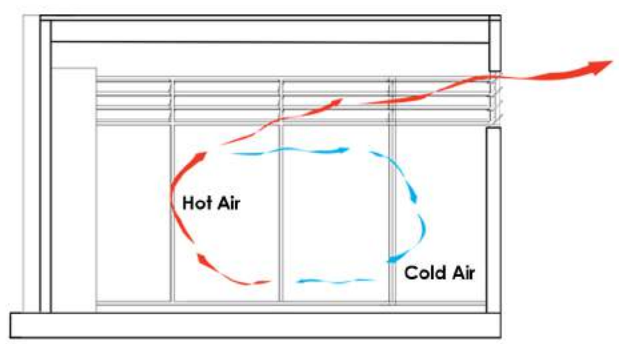
Trellising walls act as shading device and reduce the temperature of the wind flowing through it via evapotranspiration of the climber plants.

STACK VENTILATION

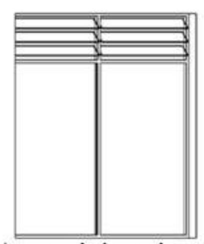


Stack ventilation allows considerable amounts of hot air to be expelled from the space in the absence of ventilation, thus lowering the indoor dry bulb temperature naturally. The system relies on the differences in air temperatures and densities within CoDA.

CONVECTION



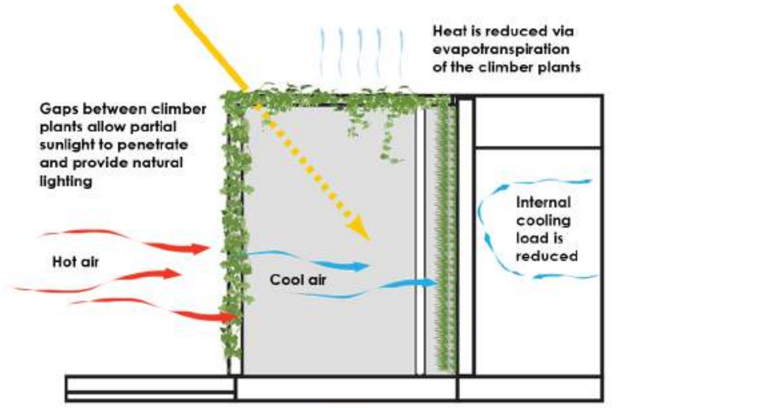
Convection removes hot air to the exterior environment in the absence of wind breezes, thus lowering the indoor dry bulb temperature. The louvered windows increase the rate of hot air replaced by cool air within CoDA



Louver windows above doors and walls

LIVING WALL

The key factor of the living wall's cooling system is through its substrate (soil). The high thermal resistance of the substrate resists heat flow into the interior space.



BEFORE

Material	Thicknes s (m)	Thermal Conductivity [W/(mK)]	Thermal Resistance [m²C/W]	U- Value [W/m²k]
Outside Surface			0.055	
White Paint	0.0002	—	—	
Cement Plaster	0.01	0.72	0.001	
Concrete	0.2	1	0.2	
Cement Plaster	0.01	0.72	0.001	
White Paint	0.0002	—	—	
Inside Surface			0.123	
		Total	0.38	2.6315789

The low thermal resistance of the concrete walls allows them to have a higher U-value.

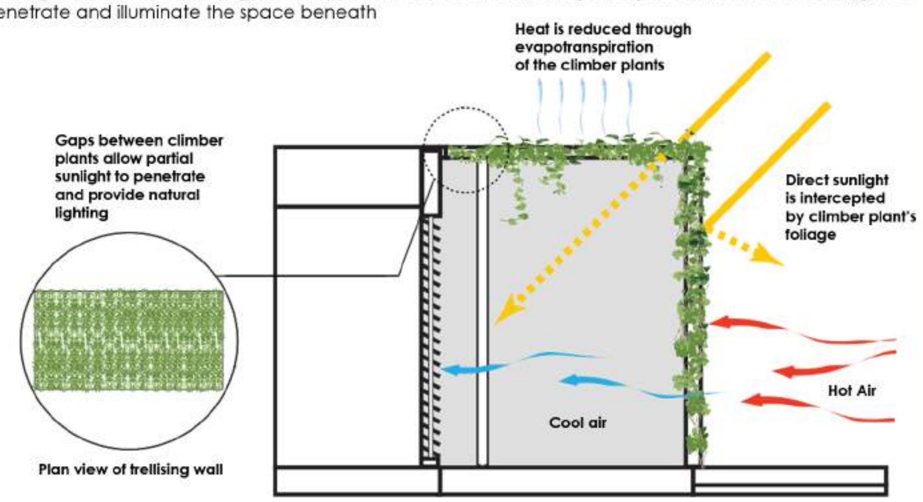
AFTER

Material	Thicknes s (m)	Thermal Conductivity [W/(mK)]	Thermal Resistance [m²C/W]	U- Value [W/m²k]
Outside Surface			0.059	
Vegetation Layer	—	—	—	
Soil	0.2	1.45	0.137931034	
White Paint	0.0002	—	—	
Cement Plaster	0.01	0.72	0.001	
Concrete	0.2	1	0.2	
Cement Plaster	0.01	0.72	0.001	
White Paint	0.0002	—	—	
Inside Surface			0.153	
		Total	0.551931034	1.8118206

The living wall, which functions as an insulation layer, provides a higher thermal resistance and lowers the concrete wall's U-value by 0.81976 W/m²k.

TRELLISING WALL

Heat from solar radiation is absorbed and removed by the climber plants via evapotranspiration. The trellising walls act as a shading device, yet at the same time allowing adequate amount of natural light to penetrate and illuminate the space beneath



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