

Quantifying Solar Light-Induced Thermal Comfort Effects of Architectural Windows

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Problem Statement

- Shortwave solar irradiance could transmit into indoors and alter thermal comfort of human beings in the near-window zones.
- How architectural windows with different properties influence these solar light-induced thermal comfort effects?

Introduction

- The predicted mean vote (PMV) model could be used to predict human thermal comfort, which is indispensable for human well-being;
- Shortwave solar irradiance could be converted into longwave solar irradiance, and incorporated into the PMV model;
- The spectrally-resolved method considers the spectral nature of solar irradiance, window transmittance, and skin absorbance;
- IGDB database offers optical data for a range of glazing products.

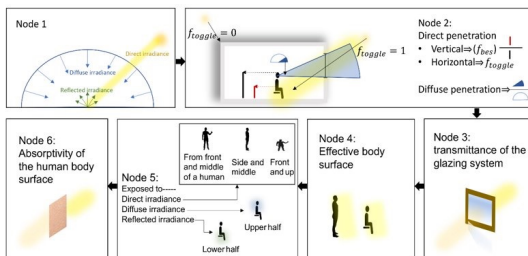


Fig. 1. Dominant factors in the spectrally-resolved method.

Methods

MRT delta calculations for windows present in the IGDB

- The spectrally-resolved method was employed to calculate MRT delta values for the glazing products present in the IGDB using some default settings and assumptions.
- Out of the total 5683 glazing products in the database, 5138 glazing products were selected for the calculations.

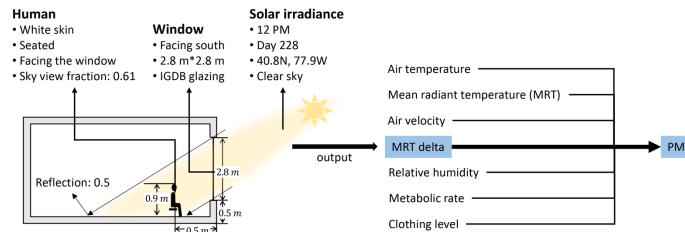


Fig. 2. Calculation process and default settings for the solar light-induced thermal comfort effect

Preferred MRT delta values under various indoor environments

- The preferred MRT delta values were calculated for specific indoor environmental settings listed in the table below. The target PMV value for achieving the preferred MRT delta was set at 0.

Number	Air temperature (°C)	MRT (°C)	Air velocity (m/s)	Relative humidity (%)
E1	25	25	0.1	50
E2	22	22	0.1	50
E3	19	19	0.1	50
E4	22	22	0.2	50
E5	22	22	0	50
E6	22	22	0.1	30
E7	22	22	0.1	60

Results

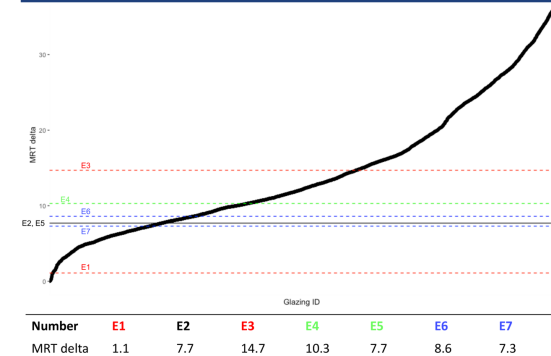


Fig. 3. The MRT delta values for glazing products present in the IGDB and the preferred MRT delta values for various indoor environments.

- The MRT delta values range from 0.0014 to 36.15, which corresponds to a difference of approximately 6.5 difference in PMV values.
- The preferred MRT delta values differ across various indoor environmental conditions. E.g. With the increment of air temperature, the preferred MRT delta decreases.

Conclusion

- With the solar light-induced effect being considered and additional MRT delta value included in the model, the original PMV range is exceeded, which reflects the significant and influencing solar light-induced thermal effect of windows.
- Different windows would require different indoor environment conditions to maintain thermal comfort, thereby offering the potential for energy savings.