PREDICTING SOLAR RADIATION ON TILTED SURFACES FOR TROPICAL COUNTRIES

[1]S. Sendanayake, [2]M. T. R Jayasinghe

[1]South Asian Institute of Technology and Medicine, Malabe, Sri Lanka.
[1]E-mail: sisuru.s@saitm.edu.lk ; sisuru.saitm@gmail.com
[1]Telephone: +94-11-2413331; Fax: + 94-11-2413332

[2]Department of Civil Engineering, University of Moratuwa, Moratuwa, Sri Lanka.
[2]E-mail: thishan@civil.mrt.ac.lk ; mtrjayasinghe@yahoo.com
[2]Telephone: +94-11-2650567-8 (Ext.2006 - 2001) ; Fax: + 94-11-2651216

ABSTRACT

Solar energy has been identified as one of the most viable sources of renewable energy to replace carbon emitting fossil fuels, especially for tropical and sub tropical countries. However, solar radiation incident at any given site is a variable influenced by the geometrical parameters such as the latitude and altitude, and the meteorological parameters such as the cloud cover, relative humidity and ambient temperature. Further, the sun azimuth and elevation angles change in accordance with the change of time. In engineering and architectural design processes, estimation of radiation incident on tilted surfaces of the building envelope is useful in calculating the radiation heat gain and for power generating Photovoltaic (PV) system designing. If a monthly global tilt factor R_m can be defined as the ratio between G_{m-h} and G_{m-h} , where G_{m-h} is the monthly mean global radiation on a horizontal surface and $G_{m-\beta}$ is the corresponding monthly mean global radiation on a tilted surface for any month of the year, for each calendar month R_m can be tabulated for a given β , and a set of curves can then be developed for R_m against β , (β = 0^0 to 90^0) for the year, which can be used as a design tool. This study focuses on developing a simplified method presented in graphical form based on the predictive model for R_m using correlation factors and taking the tilted surface to be facing south ($\gamma = 0$) and ground reflectivity ρ as 0.5 for low reflectivity in tropical surroundings. From correlations developed for the monthly mean diffuse radiation on a horizontal surface, the above equation can be further simplified for tropical countries since solar elevation (h_{st}) can be safely assumed to be 90^0 (or $\pi/2$) throughout the year. The measured values of G_{m-h} and D_{m-h} are obtained from Solar and Wind Energy Resources Authority (SWERA) of United States Department of Energy Typical Meteorological Year (TMY) data for greater accuracy and reliability.

Key words: Solar radiation, Tilted surfaces, Ground reflectivity, Solar elevation