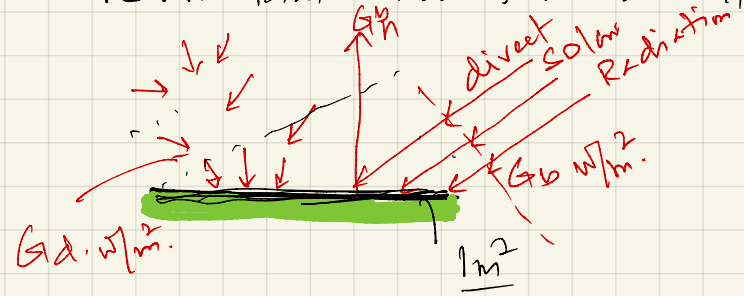
Terrestrial Radiation on tilted Surface :- 05 Feb 2021.

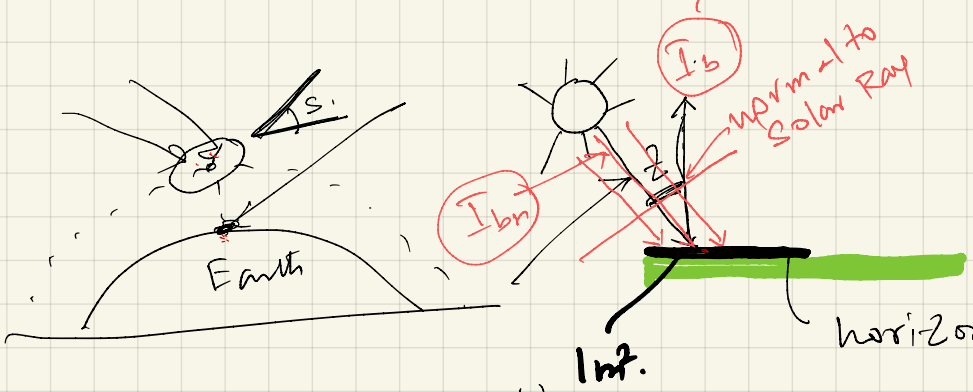



→ Beam or direction Radiation:

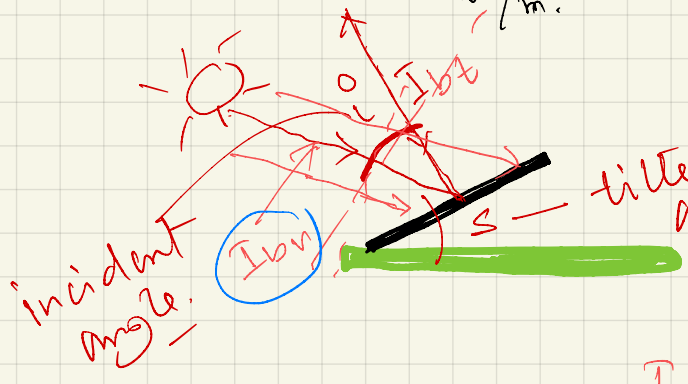
→ diffuse Radiation

→ Reflected Radiation.

→ Solar insolation Raw basis.




$$Ws\text{-}2 = \frac{I_b}{I_{bn}} \quad \text{--- (1)}$$




$$Ws\,i = \frac{I_{bt}}{I_{bn}} \quad \text{--- (2)}$$

beam radiation on at tilted surface.

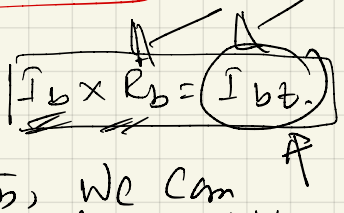
$$\frac{Ws\,i}{Ws\text{-}2} = \frac{I_{bt}}{I_{bn}} \times \frac{I_{bn}}{I_b} = \frac{I_{bt}}{I_b} \equiv R_b$$

So, $\boxed{I_{bt} = R_b \cdot I_b}$

$= R_b$.

→ $R_b$ is called beam radiation tilt factor.

$$I_{b,t} \times R_b = I_{b,t} \quad \text{--- (3)}$$




$$R_b = \frac{Ws\,i}{Ws\text{-}2} =$$

For simplicity, We can consider → South facing tilted surface at Northern hemisphere,

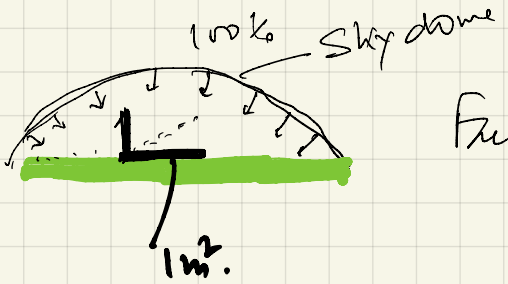
$$R_b = \frac{Ws\,i}{Ws\text{-}2} = \frac{\cos(L-S).\cos\delta\cos h + \sin(L-S).\sin\delta}{\cos L.\cos\delta\cos h + \sin L \sin\delta.}$$

$R_b$ = $I_{bt}$

$$I_{bt} = R_b \cdot I_b \quad \text{—} (*)$$

(2)

Solar insolation from the diffused radiation is $I_d$ W/m²




Factor $\left(\frac{1+\cos S}{2}\right)$, $S = 0°$, $= 2/2 = 1$

if $S = 90°$, Factor 0.5, on the tilted surface is

The diffuse sky radiation

$$\boxed{I_d \left(\frac{1+\cos S}{2}\right)} \quad (*)$$

(3) Reflected Radiation:

Assume the reflectivity of ground = $\rho_g$.

The factor of reflective radiation will be

$$\boxed{\rho_g \left(\frac{1-\cos S}{2}\right)}$$

Total reflective Solar radiation

$$= (I_b + I_d)\left[\rho_g \left(\frac{1-\cos S}{2}\right)\right] \quad \text{—} (*)$$

So Total radiation coming to the tilted Surface

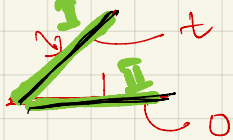
$$I_{tilt} = I_b \cdot R_b + I_d \left(\frac{1+\cos S}{2}\right) + (I_b + I_d)\rho_g \left[\frac{1-\cos S}{2}\right]$$

$I_{tilt}$ = terrestrial solar radiation at tilted surface

$I_b \cdot R_b$ → beam

$I_d \left(\frac{1+\cos S}{2}\right)$ → diffuse

$(I_b + I_d)\rho_g \left[\frac{1-\cos S}{2}\right]$ → Reflected




$I_b + I_d = I$ → $\pm 5° / \pm 10°$

4 times in a year.

Total radiation tilt factor. $I_t = I_b + I_d + I_g$

$$R = \frac{I_t}{I_{oh}} = \frac{I_b}{I} R_b + \frac{I_d}{I}\left(\frac{1+\cos s}{2}\right) + \rho_g\left(\frac{1-\cos s}{2}\right) \quad (*)$$

Problem: A surface located at 40° N Latitude and tilted towards the equator at 50° slope. Estimate the beam and total radiation factor and the beam and total incident radiation on the tilted surface at 10:30 am solar time, on Feb 10. There is no snow on the ground.

$\delta = ?? \; -14.5°$

$h = 10.30$ am. $\quad 22°5'$

$n = 10$ Feb. $= 41$

$s = 50°$.

$R_b = ?$

$R = ?$

$I_b = ?$

$I_{bt} = ?$

$$R_b = \frac{\cos i}{\cos z} = 1.78$$

$R =$

$I_{bt}$ ←

$I_d = 17$ ← given.

Problem (2): Estimate the beam radiation tilt factor for a surface located at 35° N latitude and tilted 45° at 2 pm, solar time, on March 10. if the beam radiation at normal ($I_{b,n}$) incidence is 500 W/m². Estimate the beam radiation on the tilted surface ($I_{b,t}$).

$n = 69$

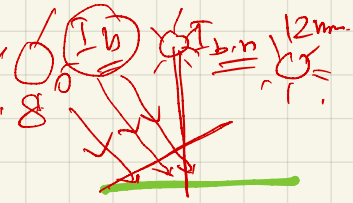
$h = +30°$

$S = 45°$

$L = 35° N,$

$I_{bn} = 950\ W/m^2.$

So, $\delta = -4.8$




$R_b = 1.312$

$$R_b = \frac{\omega_1}{\omega_2} = \frac{\sin(L-S)\sin\delta + \cos(L-S)\cos\delta\cos h}{\sin L\sin\delta + \cos L\cos\delta\cos h}$$

$I_{b,t} = I_{bn} \times R_b = 950 \times 1.312$

$\equiv 1181\ W/m^2$

$$\omega_2 = \frac{I_{bn}}{I_b} \Rightarrow I_b = \frac{I_{bn}}{\omega_2} = \frac{950}{0.66}\ W/m^2$$

$= 1364\ W/m^2$

1387 W/m²

$W,\ I_{b,t} = (1364 \times 1.312)\ W/m^2.$

$I_{b,t} = 1790\ W/m^2.$

**Problem-2** Calculate the day's Solar radiation on a horizontal surface. ($H_o$), in the absence of the atmosphere at latitude of 30° N on 31 May 2010.

$n = 151$

$\delta = 21.9$

$L = 35° N,$

$\rightarrow h_s = \omega^{-1}(-\tan L \tan\delta)$

$= 103.4°$

$H_{oH} = 40.8\ MJ.$

Thank you!

For a flat plate collector of 2m2 area installed at Pune tilted at 21 deg. Let us evaluate solar radiation Incident on the collector surface on 2Feb between 12 noon to 1 pm. The collector is south facing. Location of Pune 18.53 E latitude and 72.5 N longitude. [hint: we are interested in quantity of energy collection between 12 noon to 1 pm. So you can take middle instant of time like 12.30pm ]