To Estimate the Cooling Load of the- ***Lecture Hall 1 , 2***

COURSE- ME621REFRIGERATAION AND AIR CONDITIONING

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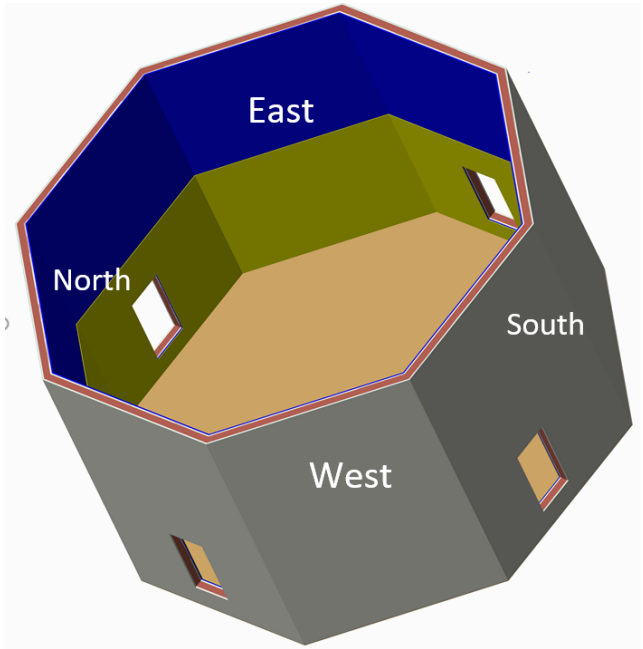


- Lecture hall 1

Meteorological Conditions of Guwahati and Design Conditions

Location	Guwahati
Outdoor DBT	35°C
Outdoor RH	80%
Indoor DBT	25°C
Indoor RH	55%
Wind Velocity	3.1 Kmph
Month under consideration	July

So, Where Heat Load comes From?

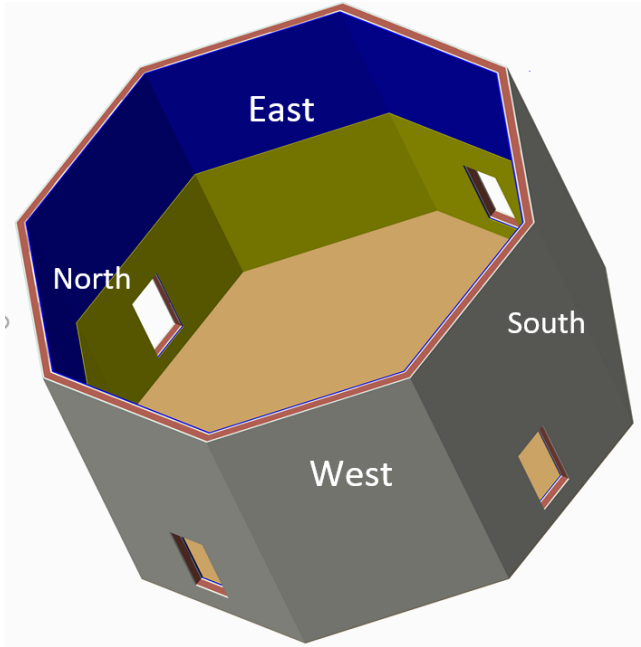
1)Convection
2)Conduction
3)Radiation
4)Occupancy and appliances
5)Outdoor & indoor differences
6)External or Solar

Space Characteristics

- Orientation
- Size and shape
- Construction material
- Windows, doors, openings
- Surrounding conditions
- Ceiling
- Occupants(activity, number, duration)
- Appliances (power, usage)
- Air leakage (infiltration or exfiltration)
- Lighting

Characteristics of the hall

- Octagonal Space with false Ceiling
- Side of Octagon- 25 ft
- Capacity-250 person
- Number of lights-50
- 4 Doors
- Wood lining and Acoustic fiber Lining on wall



Cooling load calculations

Calculation of CLTD Correction:

- **$CLTD_c$= [CLTD + (78 –TR) +(TM –85)]**

Here:

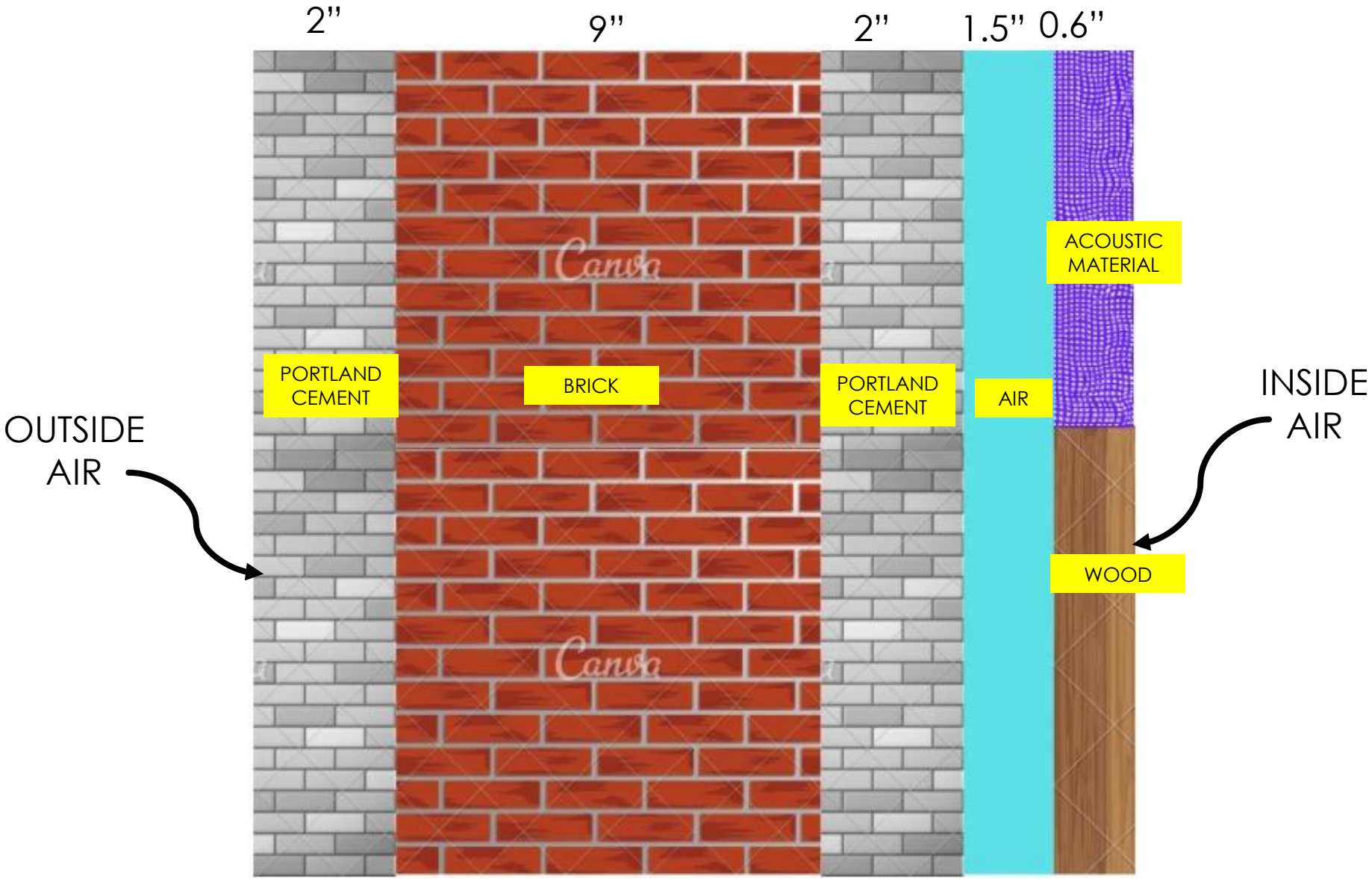
TR = Inside design temperature = 25°C =77°F

Daily range = Maximum DBT –Minimum DBT

= 37-27 =10°C or18 °F

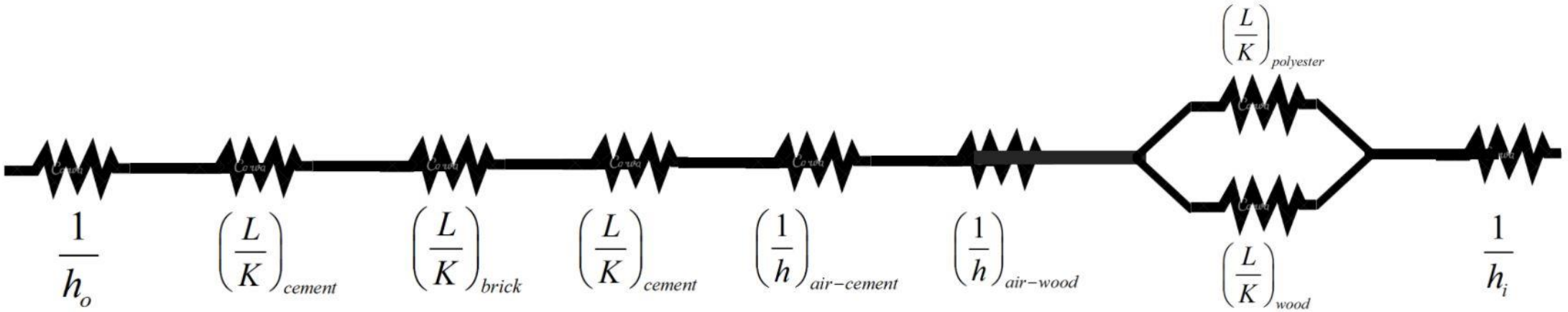
TM = Mean outdoor temperature = Maximum outdoor DBT-(Daily range /2)

= 89.6°F



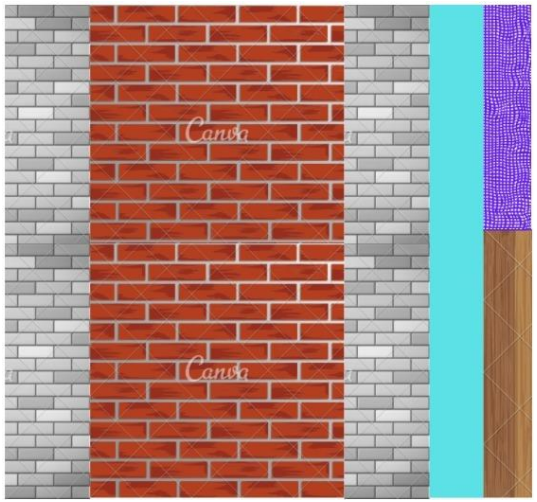
Layers of The wall

To calculate the overall heat transfer coefficient of the wall



U= $0.156 Btu/ft^{2\circ}F$

COMPONENT	Air outside	Cement	brick	Air-wood	Air-cement	Wood	Polyester	Air inside
K or h	8.805	0.167	0.462	1.76	0.8805	0.115	0.05	3.522
length	NA	2"	9"	1.5"	1.5"	0.6''	0.6"	NA

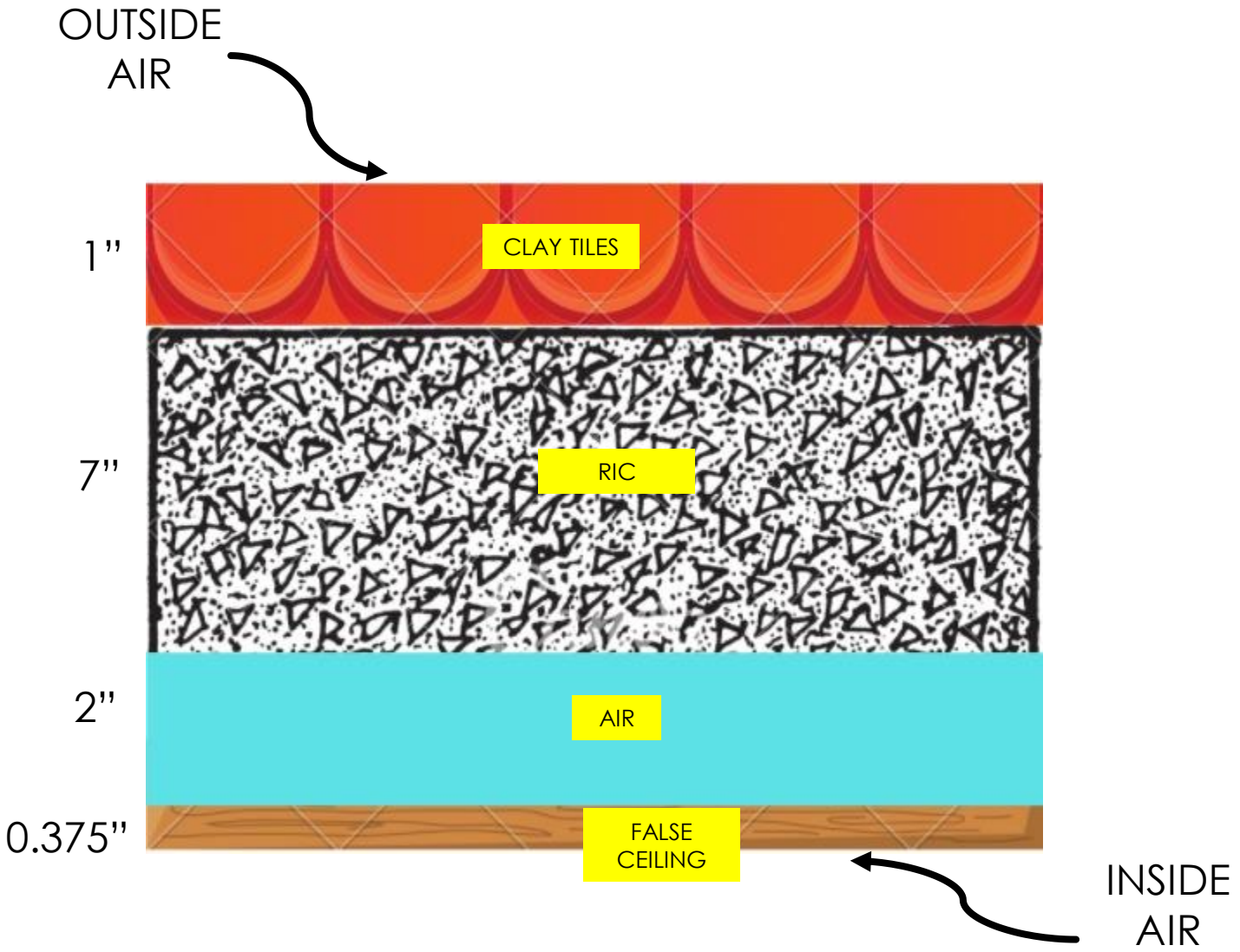


For East Wall

- **$CLTD_c$= [CLTD + (78 –TR) +(TM –85)]**
- Length =25 ft
- Height =30 ft
- Area= 750 ft^2
- Door =4
- CLTD=33
- Inside design Temp=77
- Mean Outdoor temp=89.6
- Corrected CLTD=38.6

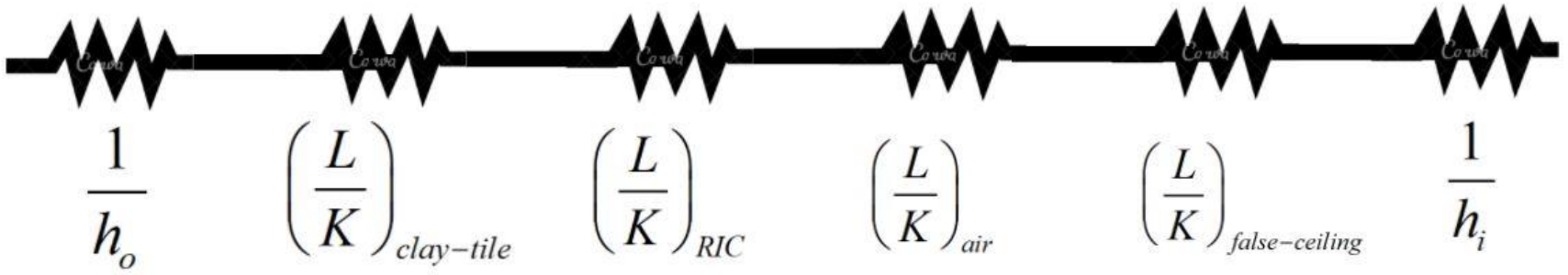
Cooling Load for the Wall

ORIENTATION	OVERALL h.t.c	CLTDc/TD	LOAD Btu/hr
NORTH	0.156	18	2106
NORTH WEST	0.156	18	1895.4
WEST	0.156	18	2106
SOUTH WEST	0.156	38.6	4064.58
SOUTH	0.156	38.6	4516.2
SOTH EAST	0.156	38.6	4064.58
EAST	0.156	18	2106
NORTH EAST	0.156	18	1895.4 **Btu/hr**



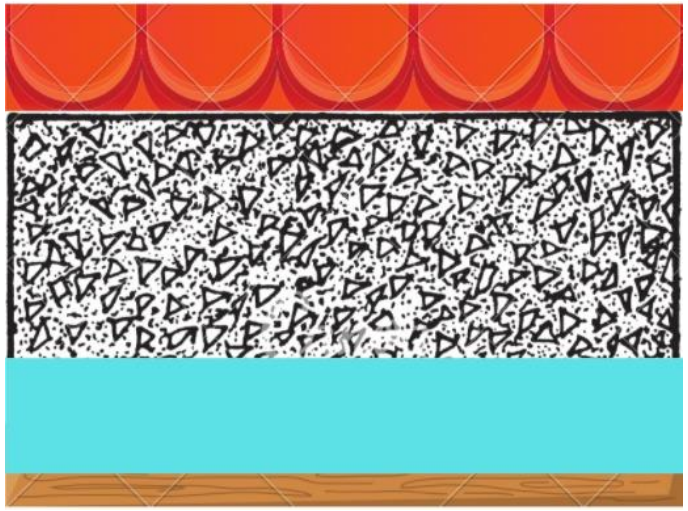
Layers of The roof

To calculate the overall heat transfer coefficient of the Roof



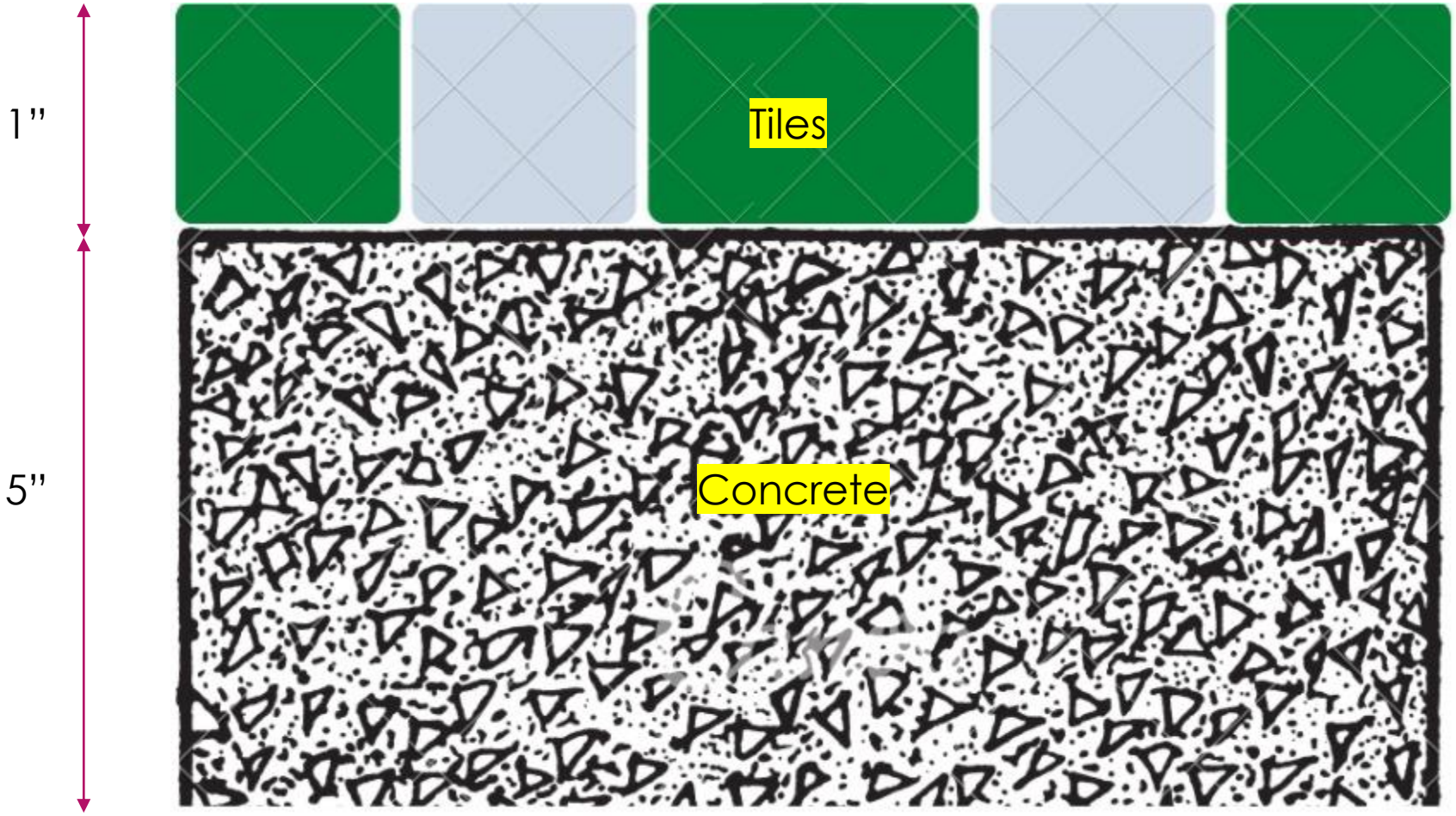
$$U = 0.14 Btu/ft^2 °F$$

COMPONENT	Air outside	Clay tile	RIC	Air	False-Ceiling	Air inside
K or h	8.805	0.167	0.462	1.76	0.8805	3.522
length	NA	2"	9"	1.5"	1.5"	NA



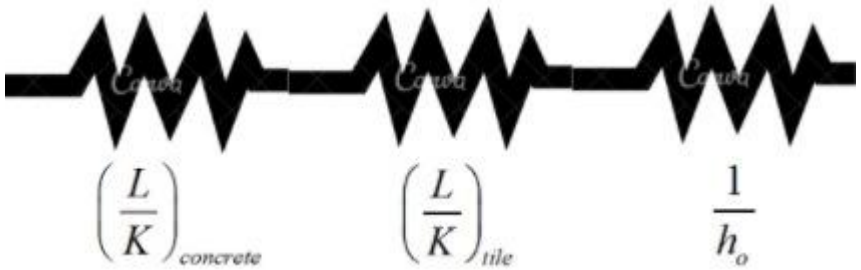
Cooling Load for the Roof

TYPE	OVERALL h.t.c	CLTDc/TD	LOAD
ROOF	**0.14**	**33**	**13943.16Btu/hr**



Components of Floor

To calculate the overall heat transfer Coefficient of the Floor



$$\mathbf{U(floor) = 0.345 Btu/ft^2 °F}$$

COMPONENT	Air outside	tile	Concrete
K or h	8.805	0.7	0.462
length	NA	1"	5"

Cooling Load for the Floor

Type	Length (ft)	Area (ft^2)	TD	Overall heat transfer coefficient	Cooling load
Concrete flooring with tiles	25	3018	9	0.345	9370.89 **Btu/hr**

Load From Occupants

Heat load From occupants

Sensible heat	Latent heat
▶ No of people= 250 ▶ Type of Activity = Rest , at 78 F ▶ Sensible heat gain =210 Btu/hr.person ▶ Cooling Load factor= 0.3 ▶ Total **Sensible** heat = 210*250*0.3=**15750 Btu/hr**	▶ Latent heat= 140 Btu/hr.person ▶ No of people= 250 ▶ Type of Activity = Rest , at 78 F ▶ Total **Latent** heat= 1*250*140=**35000Btu/hr**

Heat load from Lightning system

- 100 W LED tubes
- No of tubes=50
- Cooling Load factor =1
- Ballast Factor =1.3
- Total head load=3.41*Wattage*CLF*BF*N

  =100*3.41*50*1.3*1= **22100 Btu/hr**

Heat load for Appliances

Sensible Heat load

- Q Sensible = Qin x Fu x Fr x (CLF)
- Fr= Radiation factor
- CLF = Cooling Load Factor

Latent heat Load

- Q Latent = Qin x Fu
- Fu= Usage factor

Load from Appliances

Sensible heat load

Type	Conversion factor	Rated Power	CLF	Usage factor	Radiation factor	Quantity	Cooling load
Speakers	3.4	150	1	1	0.15	10	765
PC	3.4	240	0.4	0.3	0.15	1	14.688
Projector and UPS	3.4	500	0.4	0.3	0.2	1	40.8
						Total	820.488 **Btu/hr**

Infiltration Heat Load

Infiltration Sensible Heat

- Q Sensible = 60 * CFM * ρ * CP * ΔT
- ρ = Air density (0.075 lbm/ft3)
- Cp = Specific heat of air (0.24 Btu/lb °F)
- CFM=5 cfm / person;
- ΔT = Outdoor air minus indoor air temperature difference (To -Ti)

Infiltration Latent Heat load

- Q Latent = 4840 * CFM * ΔW
- ΔW = (Wo – Wi)

Infiltration Sensible heat load

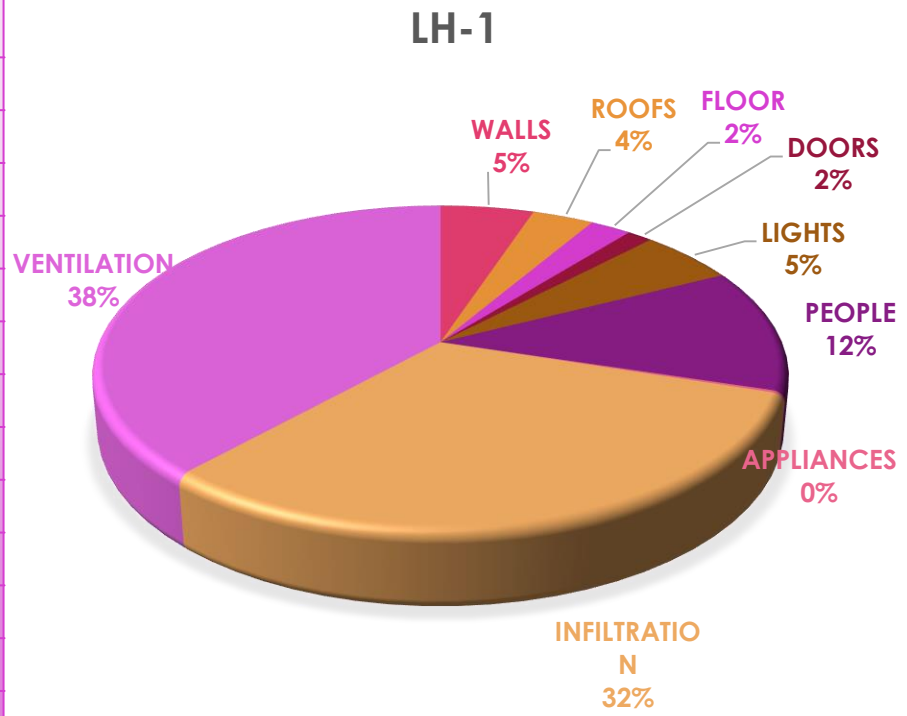
Type	Constant	CFM	TD(To-Tc)	Number of persons	Cooling load
Sensible	1.08	5	18	250	24300 **Btu/hr**

Infiltration Latent Heat load

Type	Constant	CFM	HD(Wo-Wi)	Number of persons	Cooling load
Latent	4840	5	0.0177	250	107085 **Btu/hr**

Summary of Heat load for Hall 1

Cooling Load Components	Sensible load	Latent load	TOTAL LOAD IN Btu/hr
WALLS	*21174.66*	*0*	*21174.66*
ROOFS	13943.16	0	13943.16
FLOOR	9370.89	0	9370.89
DOORS	5783.04	0	5783.04
LIGHTS	22100	0	22100
PEOPLE	15750	35000	50750
APPLIANCES	820.488	0	820.488
INFILTRATION	24300	107085	131385
VENTILATION	46170	111925	158095
Total	159412.238	254010	413422.238
Room Total sensible Load	**88942.238**		
Room Total latent Load	**35000**		
Total room load			**123942.238Btu/hr**

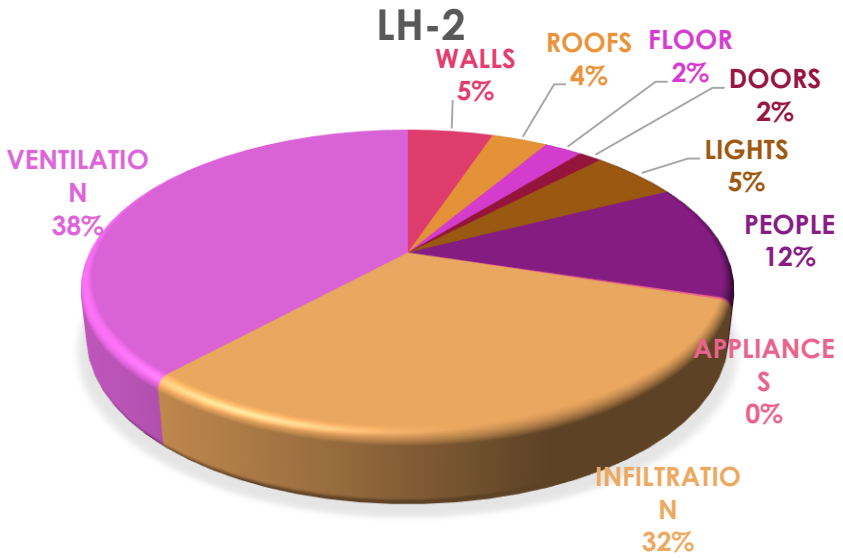


Sensible heat factor 0.7176

TONNES OF REFERIGERATION	**34.45**

Summary of Heat load for Hall 2

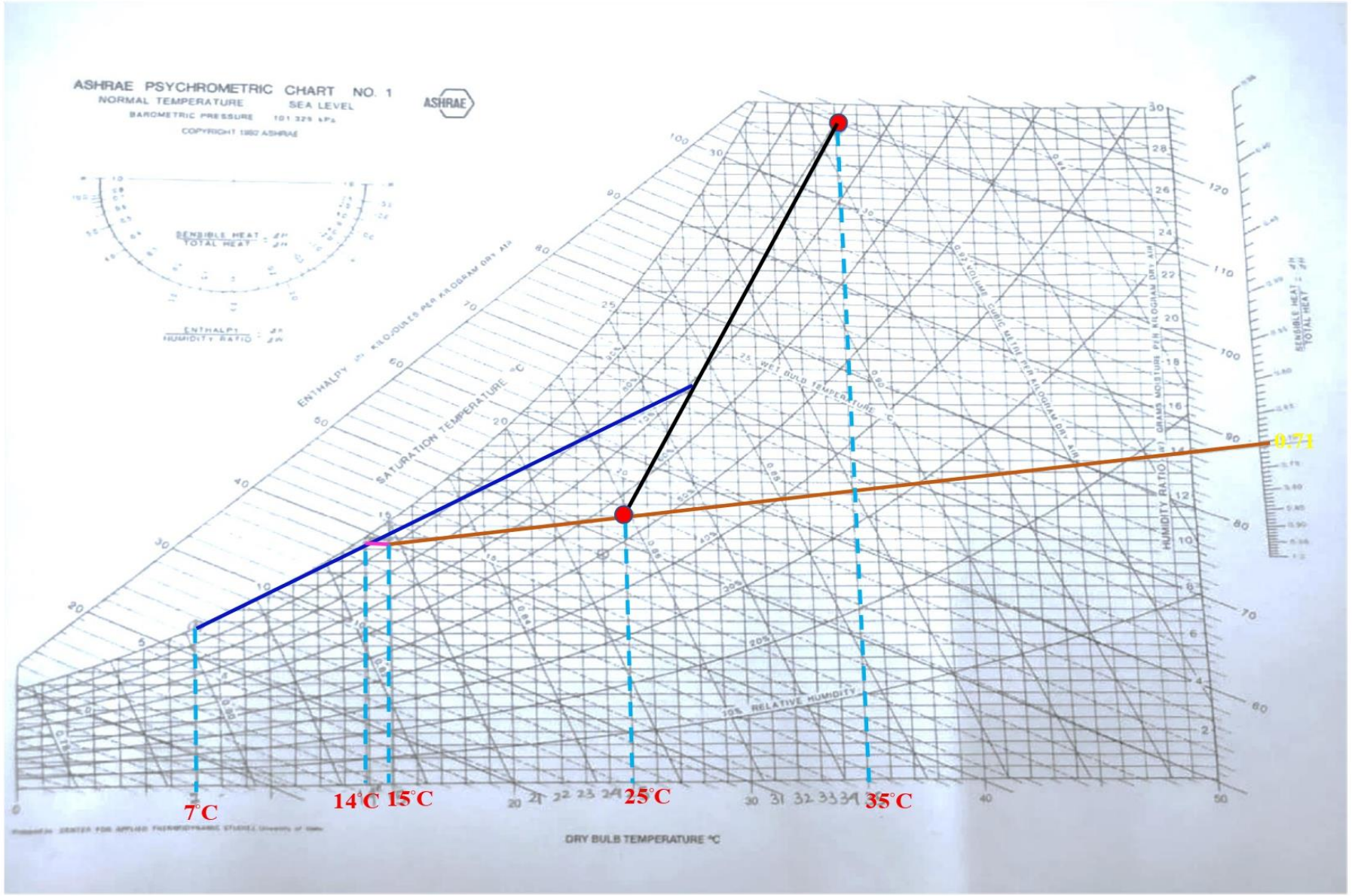
Cooling Load Components	Sensible load	Latent load	TOTAL LOAD IN Btu/hr
WALLS	*22754.16*	*0*	*22754.16*
ROOFS	13943.16	0	13943.16
FLOOR	9370.89	0	9370.89
DOORS	5783.04	0	5783.04
LIGHTS	22100	0	22100
PEOPLE	15750	35000	50750
APPLIANCES	820.488	0	820.488
INFILTRATION	24300	107085	131385
VENTILATION	46170	111925	158095
Total	160991.738	254010	415001.738
Room Total sensible Load	**90521.738**		
Room Total latent Load	**35000**		**125521.738 Btu/hr**



Sensible heat factor = 0.7211

TONNES OF REFERIGERATION **34.58**

Psychrometry Chart



Hall 1

ha= 108.5
hb= 53.5
hc=70
hd=23
he=39
SHF=0.72 for both halls 1
Qt=Mt*(hb-he)
Qt=255327. Btu/hr
Mt=1.467 Kg/s
Va=0.915 M3/Kg (from the given outside conditions)
Total flow of air =1.4765*0.915
=1.34226 m3/s=1.34226*35.315*60
=**2844.97 CFM**
We have 250 People so
=2862.58/250=11.38 CFM per person of total air
As we have the 30% recirculation so we have
=0.3*11.38
=**3.414 CFM of fresh air per person**
Cooling coil Capacity
= mt*(hc-he)=**12.997 Tr**

Hall 2

ha= 108.5
hb= 53.5
hc=70
hd=23
he=39
SHF=0.72 for both halls 1
Qt=Mt*(hb-he)
Qt=256906 Btu/hr
Mt=1.47647 Kg/s
Va=0.915 M3/Kg (from the given outside conditions)
Total flow of air =1.47647*0.915
=1.351 m3/s=1.351*35.315*60
=**2862.573 CFM**
We have 250 People so
=2862.573/250=11.45 CFM per person of total air
As we have the 30% recirculation so we have
=0.3*11.45
=**3.435 CFM of fresh air per person**
Cooling coil Capacity
= mt*(hc-he)=**13.077 Tr**

Summary

Hall 1

- **TONNES OF REFERIGERATION=34.45 Tr**
- **Cooling Coil Capacity=12.997 Tr**

Hall2

- **TONNES OF REFERIGERATION=34.58 Tr**
- **Cooling Coil Capacity=13.077 Tr**

* Thank You *