

Comparison of Cooling Load Estimation by CLTD Method and Computer Software

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Abstract - In earlier days, load calculation for installing air conditioning systems is done either by hand calculation or idea based estimation on the basis of experience of the professional in this field. But manual calculation is lot of problems like time taking, laborious as well as it is not that much accurate because human error is always there. Now a day cooling load calculation is done by using computer software but it is not free to use in India, but still there are many software those are open source or can be used their free trial. So, in this paper Elite CHVAC software is taken for the comparison of result by using ASHRAE CLTD method and CHVAC method. The main motto is to provide right software for calculation of cooling load in India.

Key Words: Cooling Load, HVAC, CLTD, Elite CHVAC, ASHRAE

1. INTRODUCTION

This is mandatory to calculate cooling load before installing HVAC because without calculation if HVAC will installed then it becomes difficult to get desire effect, basically air-conditioning system is designed to provide comfort to human beings it is be installed in home, office, even bus, train etc, because human comfort is the first priority now a day. Estimated cooling load required because to installed proper sized HVAC system which becomes more effective [1].

Well, cooling load estimation has started long time ago in India, but now a day it necessary to upgrade cooling load estimation way. So in this paper it is shown that how to save time as well as use free trial software to calculate cooling load of a complex building. The method used here ASHRAE CLTD and Elite CHVAC software to compare both results.

2. WAYS TO CALCULATE COOLING LOAD

There are two way to calculate cooling load, either manual or software but in manual CLTD method used widely and software, there are many but here CHVAC is used.

Here are methods to calculate cooling load-

Total Equivalent Temperature Difference (TEDF): This is the first version of cooling calculation by ASHRAE (American Society of Heating Refrigerating and Air-Conditioning Engineers), this method is simple for cooling load hand calculation but before CLTD/CFL method.

Transfer Function Method: In short it is also known as TFM, this is one of the effective methods but it is complex and required vast knowledge about advanced spreadsheet.

Cooling Load Temperature Difference/Cooling Load factors/Solar Cooling Load (CLTD/CLF/SCL): Basically this method is driven from TFM method and uses tabulated data to make it simple for calculation process. The method can be easily implement for load calculation time it is time taking and of course may be there would be some error during calculation.

Radiant Time Series (RTS): This method is developed by ASHRAE, here are steps followed to calculate load-

1. Calculate 24 hours profile of component heat gains for design day (for conduction, first consider for conduction time delay by using conduction time series).
2. Need to split heat gains into radiant and convective parts.
3. Apply appropriate radiant time series to radiant part of heat gains to consider for time delay in conversion to cooling load.
4. Sum convective heat gain part and delayed radiant heat gain part to find out cooling load for each hour for each cooling load component [2].

Heat Balance (HB): This method is also developed by ASHRAE, this method have high level language program to get high accuracy value [3].

3. CLTD METHOD TO CALCULATE COOLING LOAD:

To calculate cooling load by using CLTD method, there are few formulas required as given below-

3.1 Heat Gain Due to Solar Radiation

Heat gain taking place due to solar radiation, actually when sun ray fall on the glass then what happened few rays

transmitted through glass and therefore heat gain taking place, here is the formula used to calculate heat gain because of solar radiation [4].

Transmission heat gain through glass:

$$Q = UA(CLTD)_{corr}$$

By solar radiation:

$$Q = A \times SHGF_{max} \times SC \times CLF$$

SHGF_{max} = maximum solar heat gain factor (W/m²)

SC = shading coefficient depends on its type of shading have

CLF = cooling load factor

3.2 Heat Gain Due to Human Beings

The human body in a cooled space involved cooling load of sensible and latent heat. In an air conditioned room, sensible heat load and it all happened due to temperature different between body and room air. The heat gain from occupants is based on the average number of people that are expected to be present in a conditioned space. The heat load produced by each person depends upon the activity of the person. The value of heat gain increases with increase in activity of the human being [5].

The heat gain from occupancy or people are calculated by following equations:

Sensible heat gain from occupants

$$Q_s, \text{ person} = q_s, \text{ person} \times N \times CLF$$

Latent heat gain from occupants

$$Q_l, \text{ person} = q_l, \text{ person} \times N$$

Where,

N = total number of people present in conditioned space

CLF = cooling load factor

$q_s, \text{ person}$ = sensible heat gain/person (W)

$q_l, \text{ person}$ = latent heat gain/person (W)

3.3 Heat Gain Due to Other Electric Equipments

$$Q_{\text{equipment}} = \text{Total wattage of equipment} \times \text{Use factor} \times CLF$$

CLF = 1.0, if operation is 24 hours or of cooling is off at night or during weekends.

3.4 Heat Gain Because of Infiltration

Amount of infiltration air = (Volume of the Space Required Air-Conditioning)/60 m³/min

The diagram of the examination office is given below for which cooling load calculation is done.

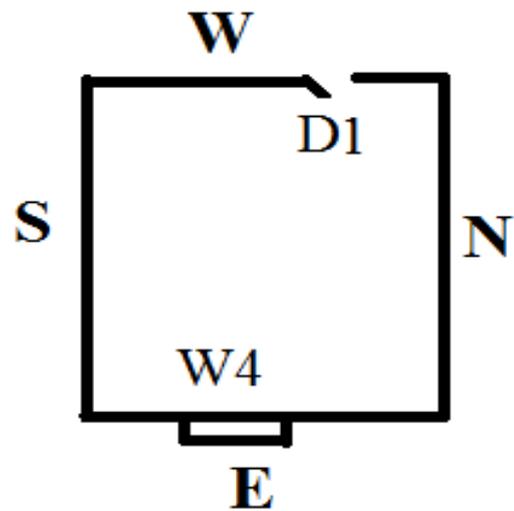


Fig- 1: Diagram of Examination Office.

Length of the room= 7.37m

Width of the room= 5.64m

Height of the room= 3.35m

Area of glass (W4)= 2.38 × 1.52=3.62 m²

Area of the door (D1)= 2.07 × .944= 1.95 m²

Outside wall area (E)= 5.64×3.35-3.62=15.27m²

Partition wall areas (S, W, N)= 7.37×3.35×2+5.64×3.3-1.95=66.04m²

Now the amount of infiltration air through windows and walls is =(7.37 ×5.64 ×3.35)/60=2.32 m³/min

Ventilation requirement/m² = 0.02 m³/min

Total ventilation required = 0.02×41.57 =0.83m³/min

Occupant heat gain for office: - SHG = 70W/person and LHG = 45W/person

Lighting heat gain for office = 12W/m²

By using all these formulas and table, cooling load of an examination office by using CLTD method is 2.59 TR (Ton of refrigeration), the same way cooling load has been calculated for a class room in Mahendergarh (Haryana) [6]

$q_l, \text{ person}$ = latent heat gain/person (W)

4. COMPUTER SOFTWARE USED TO CALCULATE COOLING LOAD:

There are numerous computer programs available to calculate cooling load [7], but here Elite CHVAC is used for calculation of cooling load, here is the steps followed to calculate cooling load by using this software, it can be used flow chart here [8] but here steps are shown which have been followed-

1. The very first step is General Project data, here it is required to enter different data like Project description, client information, company information, design information and even more information about design, the user interface is given below for adding general project data.

2. Step next is operating profiles, add here information about different operating profiles like human beings, light equipment and it is depend on condition and requirement of people.
3. Outdoor and indoor condition: In this step, information about outdoor and indoor condition like temperature, humidity provided.
4. Mater data: added here information about roof, shading, walls, glasses used in windows or doors and of course partitions used in the building or room.
5. Air handler data: added here information about infiltration, ventilation, duct sizing and of course about equipment in the room.
6. Room data: Though calculation of cooling load done here for an examination room, so room data is most important, added here data for roof type, wall type and of course glass type too.
7. This is the last step, added here all detail information and of course U- factor also added here for getting accurate result.

After follow above all steps here is the output result got screen shot is given below-

Check Figures

Total Air Handler Supply Air (based on a 10° TD)	83	L/s
Total Air Handler Vent. Air (100.00% of Supply)	83	L/s
Total Conditioned Air Space:	42	Sq.m
Supply Air Per Unit Area:	1.9966	L/s/Sq.m
Area Per Cooling Capacity:	5.1124	Sq.m/kW
Cooling Capacity Per Area:	0.1956	kW/Sq.m
Heating Capacity Per Area:	0.00	Watts/Sq.m
Total Heating Required With Outside Air:	0.00	kW
Total Cooling With Outside Air:	8.13	kW
		2.31 Tons

So, total cooling load required is 2.31 TR for the examination office.

3. CONCLUSIONS AND RESULT

The result shows when used CLTD method, the total cooling load o examination office of an institute is 2.54 TR.

In order to verify the accuracy of calculation, here also used cooling load calculation software and after inserting all required data of examination office, here is the report given by CHVAC (Elite). As in the report found that total load required to cool the examination office is 2.31 TR and by using CLTD method it is found that total load required is 2.59 TR after taking safety factor, after adding safety factor to CHVAC software total cooling load will be 2.54 TR, load calculated by CLTD and CHVAC are almost same.

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