Computer Program for Cooling Load Estimation and Comparative Analysis with Hourly Analysis Program (HAP) Software

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***Abstract*—Energy efficiency building design the cooling load estimation plays a vital role because now a day's major part of the power is consumed to run the heating ventilation air conditioning (HVAC) system. Hence to design and development of cooling load software is mandatory to incorporate the energy efficiency features to reduce the power consumption and accurate and fast results. Previously cooling load estimation was done manually which is quite tedious, complex, time consuming and liable to error due to complex architectural design. The present endeavor to design and develop a software which has an edge over the various other complexes and costly software available in market. The present software is enhanced user friendly and minimum data input with accurate results obtained. This software is based on the carrier data book used for cooling load estimation based on cooling load transfer and solar heat gain factor method. The programming language has been done in Visual Basic 6.0 and Microsoft Access has been used to create the data base. The approach in the present work is divided in three modules and prepares the individual algorithm, flow chart, and individual form design for each part. Step by step the data input will be given as per the architecture design and finally the result sheet will come after finishing all data input. The testing & validation of this software is done by solving one sample project with this software and carrier hourly analysis program software (HAP v 4.90) which is available in world wide market. The comparative results obtained by both of the software are so close and accurate and finally the level of accuracy of present software is 98.1%.**

***Key Words:* Ventilation, Hourly analysis program, cooling load, solar heat gain, Air Conditioning etc**

I. INTRODUCTION

Human civilization came to existence, human's need of comfort, satisfaction and luxury increased manifolds. The advent of air-conditioning system played an important role in this direction of human need. There is definite range of temperature and humidity within which best human efficiency and comfort can be obtained. HVAC engineers aim to provide these conditions with optimum saving of energy by selecting the correct sized equipment with minimum cost. From engineering point of view, determining the cooling load of HVAC system is the most .Important task. Cooling/heat load of building consists of outside heat transmission through building envelopes as well as internal loads due to occupancy, electrical appliances and outside air. It is most importance in cooling/heating load calculation, to know the exact amount of these load components. Estimated load makes a basis of selecting different equipments such as chillers; air handling units, boilers, cooling towers, pumps, fan coil unit etc. in actual practice intelligent HVAC system has been developed, where the system adjusts automatically according to the load conditions. These are highly energy efficient HVAC systems.[1] carriers hourly analysis program (HAPv4.90) is commercial software that forms the cooling/heating load calculation on hourly basis which assists engineers in designing HVAC systems for all kind of buildings. [2]Air-conditioning is utilized to supply a controlled atmosphere to public buildings such as offices, halls, homes, and industries for the comfort of human being or for the proper performance of some industrial processes. Full air-conditioning implies that the purity, movement, temperature and relative humidity of the air be controlled within the limits imposed by the design specification. For any air conditioning system to perform satisfactorily, equipment of the proper capacity must be selected based on the instantaneous peak load requirements. [3] The HAP program can be used for any building design to calculate the load and select the systems.

Cooling load estimation through computer application sounds reasonable to replace tedious and time consuming manual methods. To achieve this computer automation, software is developed using "visual basic 6.0" programming language tool and "MS access" used as a data base system.

There are many software's developed for HVAC system design etc. all software has some advantages and limitations. The present work focuses on the limitations of other software and aim at their limitation.

Me mate HVAC software [4] is available in the market in which the distinctive feature is calculation of cooling and heating load in unlimited number of spaces. Me-mate HVAC uses a traditional approach to HVAC design, with computerized calculations and drafting. White rose [5] is another software, in which data globalization facilities for the rapid entry of data psychometric analysis of room, heat gains and sensible heat ratio, integrating product moisture loss calculations for sensible to latent heat adjustment built-in solar aspect temperature difference adjustment of walls and ceiling exposed to external ambient condition are taken care of. Next focus on the elite software [6] for HVAC system is in two parts CHVAC and RHVAC. CHVAC software of elite quickly and accurately calculates the maximum heating and cooling loads for commercial buildings and RHVAC use for residential buildings. The cooling loads can be calculated with either the cooling load temperature difference (CLTD) method or the new radiant time series (RTS) method. The program allows an unlimited number of zones, which can be grouped into as many as 100 air handling systems. CHVAC automatically looks up all cooling load and correction factors necessary for computing loads. In addition, it can look up outdoor design weather data for over 2000 cities located around the world. There is also provision for editing the weather data as well as adding data for other cities.

A. Objective of present work

It is well known that the greater the accuracy in finding out the cooling load of the building envelope throughout the year, the more energy can be saved. so it is very important to know which methods give the best cooling effect. This purpose can be served by comparing the results obtained by different methods. Various methods have been developed and used for this purpose for last few decades.

For energy savings and costs concerns, both fixed and running costs should be considered.

Present work aims at developing the computer operated comprehensive software to estimate cooling load. Software must be user friendly and should involve minimum operation time. cooling load estimation by the present software is compared with the other commercial software.

Ultimately after going through all the available software it can be concluded that these software's require skilled operator. These software's are more versatile and have lot of facilities but the computational time is more. as such they are not very much user friendly. The present software is an effort to take care of all such limitations. The software is based on visual basic and MS access. Visual basic is the programming language and MS access is the data base system. All data are taken from carrier hand book [7].

B CLTD method/SCL /CLF method

This method is used for the manual heat load or cooling load calculation on hourly basis. The CLTD method makes use of cooling load temperature difference in the case of walls, roofs, partition wall. Solar cooling load factor (SCL) in the case of solar heat gain through windows glass and cooling load factor vary with time and are function of environmental conditions and building parameters.

Cooling Loads are classified in six categories.

i. Heat gain by transmission medium (Through glass only sensible load)
ii. Heat gain by solar energy(Through Walls and Roof only sensible load)
iii. Heat gain by other transmission medium (Through partition wall, partition glass, ceiling and floor sensible load)
iv. Infiltration and ventilation air load (both sensible and latent load)
v. Internal Load (Through People ,appliances ,lighting etc both sensible and latent load)
vi. Safety factor and supply duct heat loss and duct leakage loss both sensible and latent

C Mathematical Formulations

i) Heat gain by transmission medium (Through glass only sensible load) this is the heat gain due to transmission of solar energy radiation through transparent part of the building in all directions through glass

$$Q\ rad = Ag(SC)(SHGF)(CLF) \text{ ------------------------ } [\ I\ ]$$

Ag= Area of the glass
SC = Shading coefficient
SHGF = solar heat gain factor for externally shaded windows
CLF = cooling load factor, w/ (sq.m-k)

$$Q_\theta = A\ (SC)\ SCL_\theta$$

ii) Heat gain by solar energy
(Through Walls and Roof only sensible load)

$$q_\theta = UA\ (CLTD_C)_\theta \text{ -- } [II]$$

U = Design heat transfer coefficient for roof or wall, W/(sq.m-k).
A = Area of roof, wall, or glass, calculated from building plans, sq. m.

The tabulated CLTD must be corrected for the different inside and outside temperature and daily range when the conditions differ. This can be done using the following equation.

$$CLTD\ corrected = CLTD + (78 + t_i) + (t_{om} - 85)$$

where,

t_i = Actual inside dry bulb temperature, ^{0}c

$t_{om} = t_o - dr/2$, Mean outside design dry bulb temperature, ^{0}c

where,

t_o = Outside design dry bulb temperature, ^{0}c

dr = Daily Range, ^{0}c

Finally

$$Q\ wall = U_{wall} * A_{wall} * T_{Equivalent\ Temperature\ difference} \text{ ------------ } (III)$$

$Q_{roof} = U_{roof} * A_{roof} * T_{\text{Equivalent Temperature difference}}$ ------------- (IV)

U_{Wall} and $E_{\text{quivalent Temperature difference}}$ values can be taken from carrier hand book tables

iii) Heat gain by other transmission medium (Through partition wall, partition glass, ceiling and floor sensible load)

Cooling load from partition walls and other glass
Q partition wall=UA(to – ti)

Q Other glass=UA(to – ti)

Cooling load from ceiling and floor

$Q_{Ceiling}$ = U*A*[(to – ti) -5]----------------------------------(V)

Q_{Floor} = U*A*[(to – ti) -5]----------------------------------(VI)

Where,
U = design heat transfer coefficient for partition walls and windows
A = area of partition walls, other glass, ceiling ,floor calculated from building Plans
to = temperature in adjacent space
ti = inside design temperature (constant) in conditioned space

iv) Infiltration air load (both sensible and latent load)

Q sensible = CFM *DBT Difference* 1.08 --- ----------(VII)

Q latent = CFM (ωo - ωi)* 0.68------- ---------------(VIII)

Where CFM= crack length* leakage rate CFM/ft + CFM/door * No's of doors

Q infiltration total=Q sensible +Q latent
to, ti = outside, inside air temperature, °C
ωo, ωi = outside, inside air humidity ratio, kg (water)/kg (dry air)

Ventilation Air load estimation

CFM or Fresh air supply from outdoor= (CFM/person * No's of persons) + (CFM/sqft * area in sq ft)

v) Internal Load (Through People, appliances, lighting etc both sensible and latent load)

Internal Heat gain by people

Qs = N(Sensible heat gain/person)--------------------(IX)
Ql = N(Latent heat gain/person) -------------------- -(X)
N = number of people in space, from best available source.
CLF = cooling load factor, by hour of occupancy

Internal Lights load

Qlight = (N)(W) (BF) * 3.4----------------------------(XI)
N = number of lights in space.
BF = Ballast factor, 1.0 for incandescent bulb and 1.25 for fluorescent light

W = watts input from electrical plans or lighting fixture data
Appliances and equipments

Qe = (N)(W)(CLF) -------------------------------------(XII)

N = number of appliances and equipments in space.
W = watts input from electrical plans

CLF = cooling load factor, by hour of occupancy and room furnishings; 1.0 for 24 hours of operation

vi) Safety factor and supply duct heat loss and duct leakage loss both sensible and latent

Leak loss through duct = 5 % of TRSH

Leak loss latent through duct =5 % of TRLH

Total sensible heat loss= safety factor+ Supply duct

heat gain+ supply duct leak loss + fan heat gain

Total latent heat loss= safety factor + supply duct leak loss

Outdoor air heat loss= return duct heat gain+ return duct leak heat gain +H.P pump heat gain+ Pipe loss

Approximately total (5%-10%) losses in both sensible and latent heat gain.

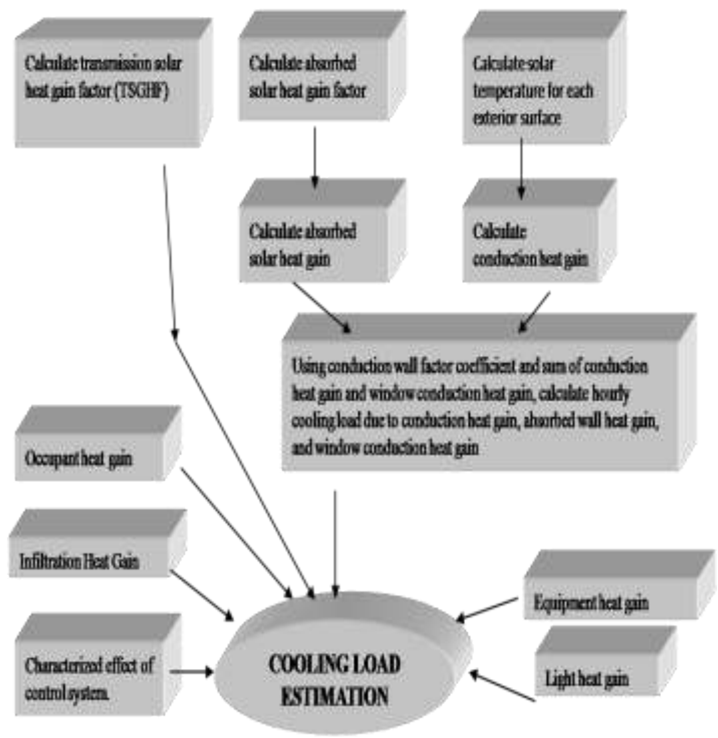

Fig 1. Flow Chart representation for hourly basis cooling load estimation

D .Methodology:

The approach in the present work is divided in three modules and prepares the individual algorithm, flow chart, and individual form design for each part. For cooling load estimation we divide the work into three parts. Each part has a separate form, and for each separate form separate logic and programming is done. This software is very reliable, versatile, user friendly easy to operate, involving less computation time, and minimum error. The main property of this software is that it is optional and with the minimum input data maximum output can be achieved, it gives online help at critical stages for the type of load. At the end of proper execution of program, it gives the final results, which have complete description about the cooling load estimation

For finding the cooling load estimation, twelve forms has been design with separate algorithm and flow chart.

Twelve step of cooling load estimation with different forms

1) Selection of CFM ventilation
2) Outside and inside design condition
3) Solar heat gain through glasses
4) Solar heat gain through wall
5) Solar heat gain through other transmission medium (all glass)
6) Solar Heat gain through other transmission medium (partition wall)
7) Solar heat gain through other transmission medium (ceiling & floor)
8) Sensible heat gain by infiltration & Ventilation
9) Sensible internal heat load (people & apparatus)
10) Latent internal heat gain (people)
11) Apparatus dew point temperature selection
12) Final result sheet of cooling load Estimation

For Example CFM Ventilation Calculation Prompts (Form1) design based on algorithm, flow chart and Form 1 design.

ALGORITHM: FORM-1

STEP 1 START
STEP 2: INPUT JOB, PURPOSE, AREA, HEIGHT, NO OF AIR CHANGE, & NO OF PERSON
STEP 3: CALCULATE CFM1 BY AREA= (VOLUME OF AREA' X 'NUMBER OF AIR CHANGE') / 60
STEP 4: CALCULATE CFM2 BY PERSON = 20 X 'NO OF PERSON'
STEP 5: IF CFM1>CFM2 THEN CFM = CFM1ELSE CFM = CFM2
STEP 6: PRINT'CFM VENTILATION' CFM
STEP 7: STOP

FLOW CHART- FORM-1

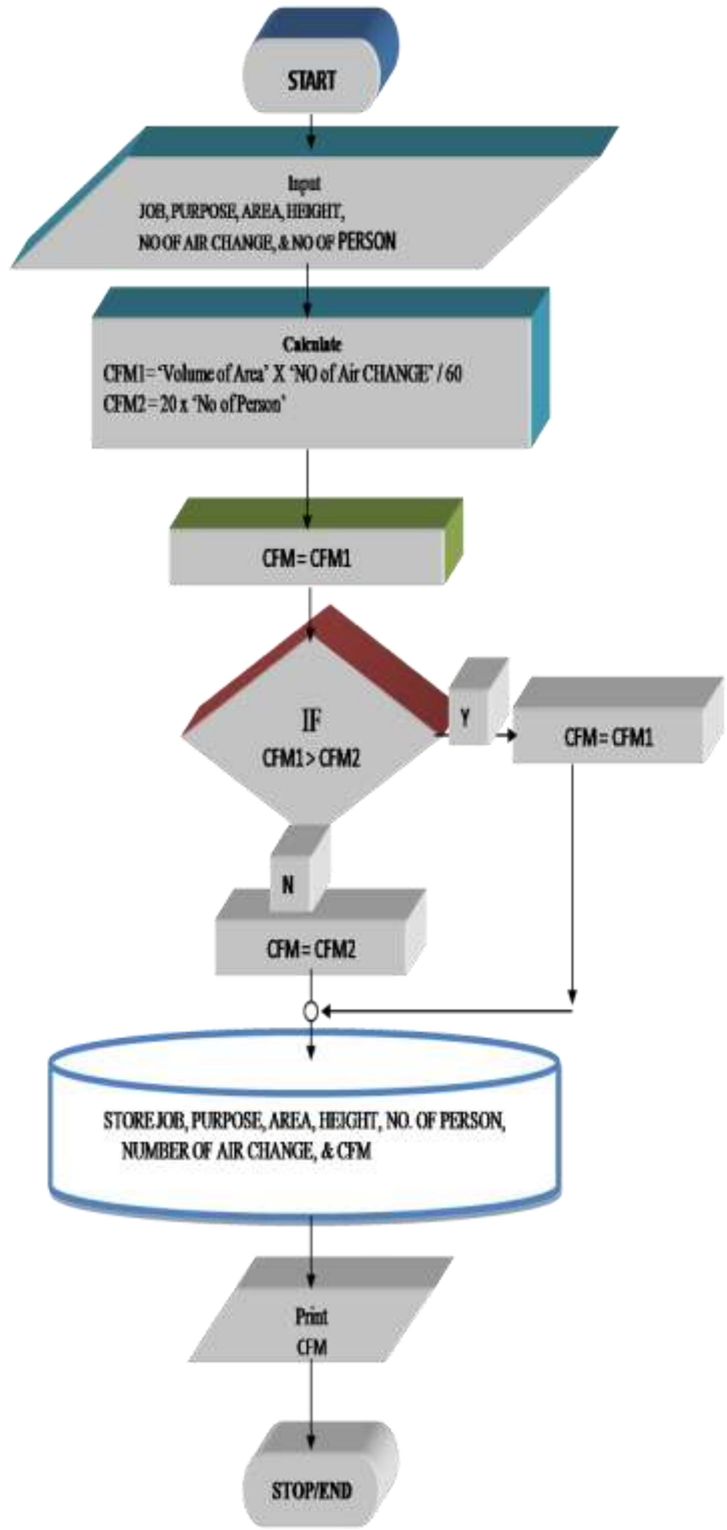

Fig 2. Flow Chart Representation for CFM Selection

FORM -1 Design

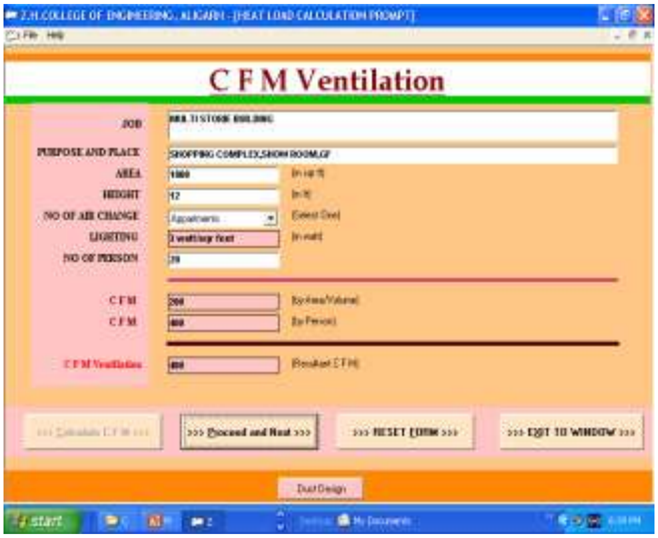

Fig -3 Form Design

E Testing and Comparative Analysis

It was envisaged by the present authors to write a computer program on the basis of this cooling load estimation form and compare the results with the commercially available hourly analysis software(HAPv 4.9)

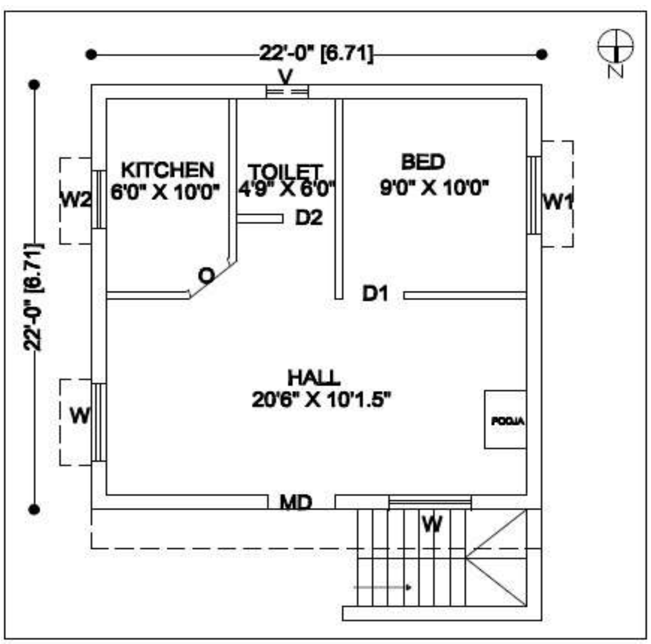

Fig. 4: A Sample Residential House Layout

Consider the location of the project is New Delhi. The required cooling load design is obtained at the peak period of summer. The result obtained by the present software and careers hourly analysis program (HAP v 4.90) .The comparative analysis is done on the basis of results obtained in both of the cases.

1. Design Data: Source 2001ASHRAE Hand Book

Project Name: Prakriti

Purpose: Residential House

Whether Station: New Delhi, India, Asia Pacific

Peak Month and solar time: June, 13:00 PM

Latitude: 28.6 Degree North

Longitude: 77.2 Degree East

Elevation: 708 feet

Summer outside Design Condition,

Dry Bulb Temperature (DBT): 107^0 F

Wet Bulb Temperature (WBT): 72^0F

Summer daily range (DR): 21.6 ^{0} F

Relative Humidity (RH) value: 20%

Inside design, DBT: 75^0F

Inside RH value: 50%

Cooling Coil temperature

Apparatus Dew Point Temperature (ADP):55^0F

2 Building Survey:

There is no existing building in front or behind of the building which means that the sides of the building are directly open to atmosphere and the building is north facing.

*2.1 Case study **1:** Hall Room Results by HAP v 4.90, 2014*

To test the software (estimate cooling load) a model room with following characteristics was assumed:

- Room Area: 231 Square feet
- Height:10 feet
- Roof: 100 mm light weight concrete without suspended ceiling.
- Wall: Group 9" Face Brick + Air Space
- East wall, West wall and North wall as sunlit wall and South wall as partition wall.
- Windows = Sunlit, 13 mm clear ordinary glass with U = 3.0 W/m^2 C
- Light = 25W/m^2
- of floor area
- ACH (Air Change/hour) = 1/hour
- Hall room, accommodating 3 people

TABLE-I Air System Sizing Summary for Fan Coil Unit (FCU) Selection, Hall Room

Air System Sizing Summary for FCU hall

Project Name: Resedential House
Prepared by: ddu

05/10/2018
12:25AM

Air System Information

Air System Name	FCU hall		Number of zones	1	
Equipment Class	SPLT AHU		Floor Area	231.0	ft²
Air System Type	SZCAV		Location	New Delhi, India	

Sizing Calculation Information

Calculation Months	Jan to Dec	Zone CFM Sizing	Sum of space airflow rates
Sizing Data	Calculated	Space CFM Sizing	Individual peak space loads

Central Cooling Coil Sizing Data

Total coil load	2.4	Tons	Load occurs at	Jun 1300	
Total coil load	29.3	MBH	OA DB / WB	103.6 / 71.3	°F
Sensible coil load	27.8	MBH	Entering DB / WB	75.7 / 63.1	°F
Coil CFM at Jun 1300	1435	CFM	Leaving DB / WB	57.2 / 56.0	°F
Max block CFM	1435	CFM	Coil ADP	55.2	°F
Sum of peak zone CFM	1435	CFM	Bypass Factor	0.100	
Sensible heat ratio	0.951		Resulting RH	50	%
ft²/Ton	94.8		Design supply temp.	58.0	°F
BTU/(hr-ft²)	126.6		Zone T-stat Check	1 of 1	OK
Water flow @ 10.0 °F rise	N/A		Max zone temperature deviation	0.0	°F

TABLE 2 Cooling Load Summary for Fan Coil Unit (FCU) Hall

	DESIGN COOLING		
	COOLING DATA AT Jun 1300 COOLING OA DB / WB 103.6 °F / 71.3 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	96 ft²	2935	-
Wall Transmission	279 ft²	2053	-
Roof Transmission	231 ft²	2471	-
Window Transmission	96 ft²	2672	-
Skylight Transmission	0 ft²	0	-
Door Loads	35 ft²	910	-
Floor Transmission	231 ft²	0	-
Partitions	210 ft²	2023	-
Ceiling	0 ft²	0	-
Overhead Lighting	273 W	930	-
Task Lighting	924 W	3152	-
Electric Equipment	230 W	785	-
People	3	885	1365
Infiltration	-	696	-32
Miscellaneous	-	0	0
Safety Factor	10% / 10%	1951	133
>> Total Zone Loads	-	21464	1467
Zone Conditioning	-	21193	1467
Plenum Wall Load	0%	0	-
Plenum Roof Load	0%	0	-
Plenum Lighting Load	0%	0	-
Return Fan Load	1435 CFM	0	-
Ventilation Load	29 CFM	867	-38
Supply Fan Load	1435 CFM	213	-
Space Fan Coil Fans	-	0	-
Duct Heat Gain / Loss	5%	1073	-
>> Total System Loads	-	23346	1429
Central Cooling Coil	-	27825	1429
Central Heating Coil	-	-4479	-
>> Total Conditioning	-	23346	1429
Key:	Positive values are clg loads Negative values are htg loads		

TABLE-3 Result Summary Sheet Obtained by Present Software for Hall (Case Study -1)

JOB	Resential House		DATE	5/10/2018 12:18:32 AM	
PURPOSE	Hall		AREA	231 (SQFT)	HEIGHT 10 (FT)

HEAT LOAD

HEAT THROUGH GLASSES	(BTU/Hr.)	HEAT GAIN THROUGH WALL	(BTU/Hr.)			
				HEAT LOAD (OTHER)	3748.8	(BTU/Hr.)
		North East	0	HEAT LOAD (INFILTER)	945	(BTU/Hr.)
South West	0	East	1935	HEAT LOAD (INTERNAL)	4417.25	(BTU/Hr.)
North	1909	South East	0	TOTAL SENSIBLE HEAT	23327.06	(BTU/Hr.)
North East	0	South	0	ERSH	24493.41	
East	0	South West	0	TOTAL LATENT HEAT	818.15	
South East	0	West	916.76	ERLH	859.06	
South	0	North West	0	ERSHF	0.97	
West	7824	North	1631.25	ADP	0	
North West	0	ROOF	0	HUMIDITY RISE	23.86	
Horiz	0	SHADED ROOF	0	SUPPLY CFM	950.36	CFM
TOTAL HEAT LOAD (GLASS	9733	TOTAL HEAT LOAD (WALL)	4483.01	TON OF REF.	2.33	Ton

2.2 Case study-2 Bed Room Results by HAP v 4.90, 2014

To test the software (estimate cooling load) a model room with following characteristics was assumed:

- Room Area: 90 Square feet
- Height:10 feet
- Roof: 100 mm light weight concrete without suspended ceiling.
- Wall: Wall: Group 9” Face Brick + Air Space
- East wall & south wall as sunlit wall and others wall as partition wall.
- Windows = Sunlit, 13 mm clear ordinary glass with U = 3.0 W/m^2 C
- Light = 25W/m^2
- of floor area
- ACH (Air Change/hour) = 1/hour
- Hall room, accommodating 1 people

TABLE-4 Air System Sizing Summary for Fan Coil Unit (FCU), Bed Room

Air System Sizing Summary for FCU,bed room

Project Name: Resedential House
Prepared by: ddu

05/10/2018
01:17AM

Air System Information

Air System Name	FCU,bed room		Number of zones	1	
Equipment Class	SPLT AHU		Floor Area	90.0	ft²
Air System Type	SZCAV		Location	New Delhi, India	

Sizing Calculation Information

Calculation Months	Jan to Dec	Zone CFM Sizing	Sum of space airflow rates
Sizing Data	Calculated	Space CFM Sizing	Individual peak space loads

Central Cooling Coil Sizing Data

Total coil load	1.0	Tons	Load occurs at	Jun 1400	
Total coil load	12.0	MBH	OA DB / WB	105.4 / 71.8	°F
Sensible coil load	11.6	MBH	Entering DB / WB	76.2 / 63.6	°F
Coil CFM at Jun 1400	604	CFM	Leaving DB / WB	58.0 / 56.8	°F
Max block CFM	604	CFM	Coil ADP	56.0	°F
Sum of peak zone CFM	604	CFM	Bypass Factor	0.100	
Sensible heat ratio	0.962		Resulting RH	50	%
ft²/Ton	89.8		Design supply temp.	58.0	°F
BTU/(hr-ft²)	133.7		Zone T-stat Check	0 of 1	OK
Water flow @ 10.0 °F rise	N/A		Max zone temperature deviation	0.1	°F

TABLE-5 Result Summary Sheet Obtained by Present Software for Bed Room.(Case Study-2)

JOB	Resedential House			DATE	5/10/2018 1:12:29 AM
PURPOSE	Bed room			AREA 90 (SQFT)	HEIGHT 10 (FT)

HEAT LOAD

HEAT THROUGH GLASSES	(BTU/Hr.)	HEAT GAIN THROUGH WALL	(BTU/Hr.)			
				HEAT LOAD (OTHER)	3159	(BTU/Hr.)
		North East	0	HEAT LOAD (INFILTER)	945	(BTU/Hr.)
South West	0	East	1146.6	HEAT LOAD (INTERNAL)	2057.5	(BTU/Hr.)
North	0	South East	0	TOTAL SENSIBLE HEAT	9645.1	(BTU/Hr.)
North East	0	South	1665	ERSH	10127.36	
East	672	South West	0	TOTAL LATENT HEAT	239	
South East	0	West	0	ERLH	250.95	
South	0	North West	0	ERSHF	0.98	
West	0	North	0	ADP	0	
North West	0	ROOF	0	HUMIDITY RISE	23.86	
Horiz	0	SHADED ROOF	0	SUPPLY CFM	392.95	CFM
TOTAL HEAT LOAD (GLASS	672	TOTAL HEAT LOAD (WALL)	2811.6	TON OF REF.	0.92	Ton

TABLE-6 Air System Design Load Summary Fan Coil Unit (FCU), Bed Room

	DESIGN COOLING		
	COOLING DATA AT Jun 1400 COOLING OA DB / WB 105.4 °F / 71.8 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	48 ft²	2180	-
Wall Transmission	152 ft²	1048	-
Roof Transmission	90 ft²	1403	-
Window Transmission	48 ft²	1408	-
Skylight Transmission	0 ft²	0	-
Door Loads	0 ft²	0	-
Floor Transmission	90 ft²	0	-
Partitions	190 ft²	1834	-
Ceiling	0 ft²	0	-
Overhead Lighting	106 W	362	-
Task Lighting	0 W	0	-
Electric Equipment	100 W	341	-
People	1	295	455
Infiltration	-	240	-18
Miscellaneous	-	0	0
Safety Factor	10% / 10%	911	44
>> Total Zone Loads	-	10023	480
Zone Conditioning	-	9627	480
Plenum Wall Load	0%	0	-
Plenum Roof Load	0%	0	-
Plenum Lighting Load	0%	0	-
Return Fan Load	604 CFM	0	-
Ventilation Load	10 CFM	324	-25
Supply Fan Load	604 CFM	90	-
Space Fan Coil Fans	-	0	-
Duct Heat Gain / Loss	5%	501	-
>> Total System Loads	-	10542	455
Central Cooling Coil	-	11574	455
Central Heating Coil	-	-1033	-
>> Total Conditioning	-	10542	455

TABLE-7 Comparative Summary Results:

Case study 1-results and case study 2 -results obtained by carriers HAP v4.5 program software and the present software.

S.No	Design parameters	Case study 1 Hall Room Results		Case Study 2 Bed Room Results	
		HAP v 4.5	Present Software	HAP V 4.5	Present Software
1	Total Coil Load (TR)	2.4	2.33	1	0.92
2	Total CFM Coil	1330	1435	605	492
3	Sensible Heat Factor(SHF)	0.95	0.97	0.96	0.98
4	Coil ADP(^{0}F)	55.2	55	56	56.9
5	ERSH(BTU)	23346	24493.4	10542	10127
6	ERLH(BTU)	1429	818.15	455	239
7	Total Heat,((BTU)	24775	25311.55	10997	10366
8	Area (Ft^2/TR)	94.8	99.14	89.9	97.8
9	BPF	0.1	0.1	0.1	0.1

II. CONCLUSION

In this paper the software is designed to find the cooling load estimation. To finding the accuracy and validity of the designed software the comparative analysis is done by worldwide market existing software tool .i.e. Hourly analysis program (HAP v 4.90) version, 2014.

As per the tabulated summary sheet (Table -8) following conclusions have been made.

i. The total cooling load obtained by the present software for the Hall is 2.33TR and the cooling coil load obtained by HAP software is 2.4TR after considering the safety factor the results obtained by both of the software is almost same.
ii. Other results obtained like Sensible heat factor, supply CFM, Coil ADP , Effective Room Sensible Heat(ERSH),Effective Room Latent Heat(ERLH),Room total heat, Area required per TR, BPF etc are also somewhat correlated and the results are almost similar. By present software it is found that each TR can cover 99.14 square feet of area for air conditioning of hall while for HAP software it is found that each TR can cover 94.8 square feet of area.
iii. In the present software which is more realistic, User friendly and less time consuming with accurate results.

III. LIMITATIONS & FUTURE WORK

The present software limitations are that the data is that the weather data only limited it's not based on hourly analysis. As well as the various energy efficiency factors can incorporate in this software for designing of energy efficiency HVAC system design in future.

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