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Design of an Air Conditioning System for a 16-Seater Bus-Automobile

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Abstract: The Heating Ventilation and air-conditioning (HVAC) system is arguably the foremost complicated system put in within the Bus and is answerable for a considerable element of the whole energy use. Maintaining best temperature and air circulation area unit the idea of a snug indoor atmosphere. This role is compete by HVAC (Heating, Ventilation and Air Conditioning) systems. Due to the increase and decrease of the customers regularly to the bus. however, a full HVAC style involves quite simply the load estimate calculation; the load calculation is that the opening moves of the repetitive HVAC style procedure. This strategy guideline discusses the knowledge required to style the air distribution system to deliver the correct quantity of conditioned air to an area. A Complete air conditioning system was designed to control the temperature, relative humidity, air movement etc. The layout of a 16-seater automobile bus is made by Autodesk REVIT software After taking the plan, heating and cooling load calculations were taken by the design department. In this project calculations were done by using the Revit air conditioning software. The same values will be used in the Revit software at human comfort condition to get indoor temperatures DBT, WBT and MEAN RANGE VALUE.I. Introduction

In the present days, as the population increases the need for the comfort also increases. The human being needs more comfort because of inferior environment (like light, sound, machine which produce heat). Sound, lightweight and warmth have an effect on human comfort plenty. They may adversely affect the human comfort positively or negatively. Researchers suggest that, human body is lower or higher than this temperature of 22'C to 25'C. When the temperature of room is lower or higher than this temperature, then the human body feels uncomfortable. This is because, the human body is structured in away that, it should receive a certain amount of light, failure to which it can cause sunburns and other skin conditions. There are many types of air conditioning systems like window air conditioners, split air conditioners etc, but these AC systems are used in small room or office where cooling load required is low. When the cooling load required is very high like multiplex building, hospital etc,central AC's system are used. In central AC's system the cooled air is directly not distributed to rooms or spaces to be cooled in order to provide comfort condition. When the cooled air cannot be supplied directly from the air conditioning equipment to the spaces to be cooled, then the ducts are installed. The duct systems convey the cold air from the air-con instrumentality to the correct air distribution purpose and conjointly carry the come air from the space back to the air conditioning equipment for reconditioning and recirculation.

As the duct system for the proper distribution of cold air, costs nearly 20% to 30% of the total cost of the equipment required. Thus, it is necessary to design the air duct system in such a way that the capital cost of the ducts and the cost of running the fans is lower.

I. HVAC (HEATING, VENTILATION AND AIR CONDITIONING)

Heating, ventilation and air-con (HVAC) system is meant to realize the environmental necessities of the comfort of occupants and a method. HVAC systems square measure additional employed in differing types of buildings like industrial, commercial, residential and institutional buildings. The main mission of HVAC system is to satisfy the thermal comfort of occupants by adjusting and changing the outdoor conditions, the outdoor air is to drawn into the buildings and heated or cooled before it is distributed into the occupied spaces, then it is exhausted to the ambient air or reused in the system. The selection of HVAC systems in a given building will depend on the climate, the age of the building, the individual preferences of the owner of the building and a designer of a project, the project budget, the architectural design of the buildings.

HVAC systems can be classified according to necessary processes and distribution process. The required methods embody the heating process, the cooling method, and ventilation method. Other processes can be added such as humidification and dehumidification process. These processes can be achieved by using suitable HVAC equipment such as heating systems, air-conditioning systems, ventilation fans, and dehumidifiers. The HVAC systems need the distribution system to deliver the required amount of air with the desired environmental conditions. The distribution system mainly varies according to the refrigerant type and the delivering method such as air handling equipment, fan coil, air ducts, and water pipes.

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II. DESIGN

A. Automobile Revit Software

Autodesk Revit is building info modeling code for architects, landscape architects, structural engineers, MEP engineers, designers and contractors. The original Revit Technology Corporation in 2000, and acquired by Autodesk in 2002. The software system permits users to style a building and structure and its parts in 3D, annotate the model with 2D drafting elements, and across building information from the building model's database. Revit is 4D BIM capable with tools to set up and track numerous stages within the building's lifecycle, from concept to construction and later maintenance and demolition.

B. Some Of The Shortcuts Used In The Software

1) *CL [Structural Column]:* Adds a vertical load-bearing element to the building model.
2) *CM [Place a Component]:* Place a component.
3) *DR [Door]:* Adds a door to the room or building.
4) *GR [Grid]:* Places column grid lines within the building style.
5) *LL [Level]:* Places a level in view.
6) *RM [Room]:* Creates a space delimited by model part and separation lines.
7) *RP [Reference Plane]:* Creates a reference plane exploitation drawing tools.
8) *RT [TAG space; ROOM TAG]:* Tags the chosen space.
9) *SB [Structural Floors]:* Adds structural floors to a building model.
10) *WA [Architectural Wall]:* Creates an on-bearing wall or a structural wall in the building model.
11) *[Window]:* Places a window in a very wall or fanlight in a very roof.

C. Manual Steps For Calculating Load Factors

1) *Step 1*

Finding the location, dry bulb temperature, wet bulb temperature, relative humidity, specific humidity and dew point temperature.

2) *Step 2*

Glass

Radiation: $Q = \mu \times A \times \Delta T$

Transmission $Q = U \times A \times \Delta T$

Where, U= coefficient of heat transfer and μ= transparency factor

3) *Step 3*

Walls

$Q = U \times A \times \Delta T$

4) *Step 4*

Roof

$Q = U \times A \times \Delta T$

5) *Step 5*

Ceiling/Floor

$Q = U \times A \times \Delta T$

6) *Step 6*

Portions

$Q = U \times A \times \Delta T$

7) *Step 7*

Equipments

$Q = w \times 4.16$

8) *Step 8*

People = BTU/hr person × no. of people

9) *Step 9*

Infiltration

$Q = CFM \times 1.08(\text{Sensible}) \times A$

$Q = CFM \times 0.68(\text{Latent}) \times A$

10) Step 10

Ventilation

Q = CFM×1.08(Sensible)

Q = CFM×0.68(Latent)

Air Change

Cfm=(V×NACPH)/60

Where, NAPCH = no. of air changes per hour

11) Step 11

Sum of sensible heat = Glass+ Wall+ Roof+ Floor/Ceiling+ Portion+ Equipment+ People+ Infiltration+ Ventilation

12) Step 12

Effective Sensible Heat = Total Sensible Heat×10% of Total Sensible Heat Step

13 Sum of Latent Heat = People+Infiltration+Ventilation

13) Step 14

Effective Latent heat = Total latent heat×5% of Total Latent Heat

14) Step 15

Ton of Refrigeration =(Effective sensible heat + Effective latent heat)/12000

15) Step 16

Effective Sensible Heat Factor = (Effective sensible heat + Effective latent heat)/Effective sensible heat

16) Step 17

ADP = Apparatus Dew Point Temperature

17) Step 18

Sensible Heat at Heat Engine = CFM×1.08A Latent Heat at Heat Engine = CFM×0.68A

18) Step 19

CFM = Effective sensible heatfactor/Apparatus dew point (BF)

Where, BF = By Pass Factor

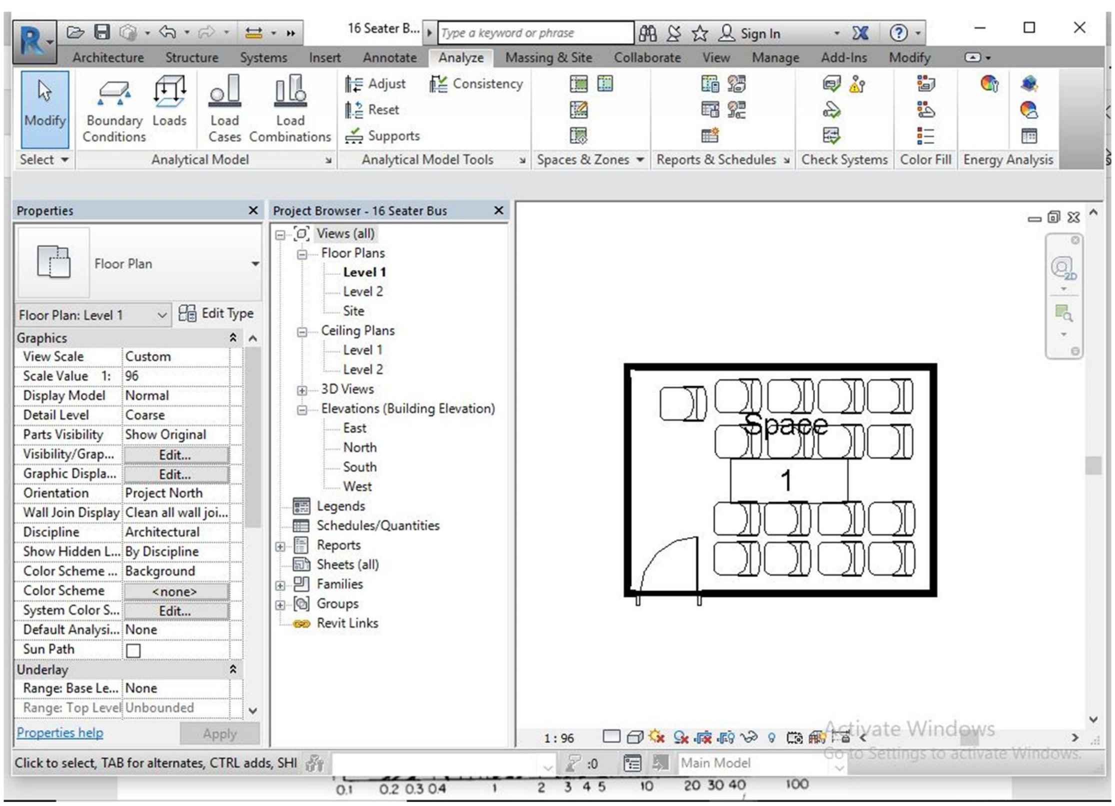

Fig:1 Defining Space of the Layout

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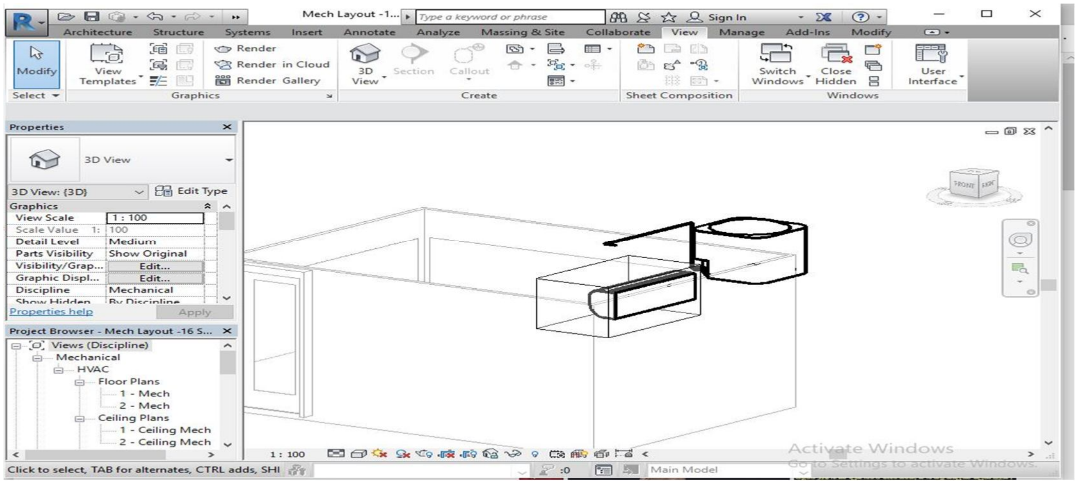

Fig:2Layout of an Outer Unit

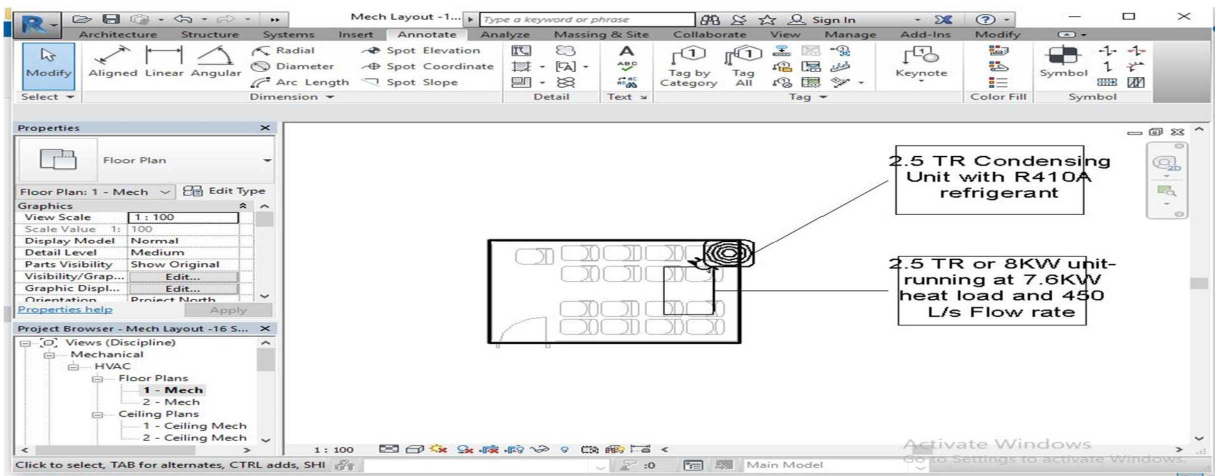

Fig:3Capaciy of an HVAC Unit

III. METHODOLOGY

A. Bus layout in revit software
B. Analyzing space
C. Placing equipment

The following system design methodology is used for HVAC design in Automobile:

1) *Effective System Zoning:* A HVAC system are often controlled via a single-zone strategy or a multi-zone strategy. With a single zone strategy, all areas served by the system receive the same amount of heating, cooling or air conditioning as defined by the control logic of the unit. However, different areas can have different energy requirements depending on a number of factors as outlined in section 2 above. Areas with similar end energy use requirements should be grouped and served from the same HVAC system. This will ensure the optimum amount of heating, cooling or ventilation is provided to the spaces when required.
2) *Single Zone Requirements Driving a Multi-Zone System:* The requirements of the areas being served by a unit should be as similar as possible, to prevent a single area driving the end energy use. For example, if an area on a multi-zone system has a humidity requirement of 40-50% RH while other areas on the system don't require humidity control, this area should not be served by the Evaporator. Smarter volume of air is being conditioned for humidity purposes than is required. This may also result in unnecessary heating and cooling occurring as the supply air may require cooling to remove moisture from the air and then require heating to achieve the correct supply-air temperature. This is the foremost energy intensive mode of operation for AN AHU. It should be applied to the minimum volume of supply air as actually required, according to the real energy service requirement. All the parameters should be challenged and the reason for their specification questioned.

3) *Waste-Heat Recovery:* Waste-heat recovery devices recover thermal energy from exhaust air and transfer it to the incoming fresh-air supply. This can result in a reduction in the energy that would normally be needed to heat or cool air to the temperature requirements of the system. A properly designed and put in heat recovery device are able to do savings upwards of 100% of the running value of the HVAC system.

IV. TABLE OF SUMMARY

Inputs				
Area (m^2)	12			
Volume (m^3)	34.96			
Wall Area (m^2)	42			
Roof Area (m^2)	0			
Door Area (m^2)	2			
Partition Area (m^2)	0			
Window Area (m^2)	15			
Skylight Area (m^2)	0			
Lighting Load (VA)	125			
Power Load (VA)	150			
Number of People	3			
Sensible Heat Gain / Person (kW)	0.07			
Latent Heat Gain / Person (kW)	0.06			
Infiltration Airflow (L/s)	16			
Space Type	Transportation (inherited from building type)			
Calculated Results				
Peak Cooling Load (kW)	7.2			
Peak Cooling Sensible Load (kW)	6.8			
Peak Cooling Latent Load (kW)	0.4			
Peak Cooling Airflow (L/s)	420			
Peak Heating Load (kW)	1.5			
Peak Heating Airflow (L/s)	161			
	Cooling		**Heating**	
Components	**Loads (kW)**	**Percentage of Total**	**Loads (kW)**	**Percentage of To**
Wall	3.1	43.23%	1.0	68.62%
Window	2.9	41.25%	0.3	21.80%
Door	0.1	1.01%	0.0	2.66%
Roof	0.0	0.00%	0.0	0.00%
Skylight	0.0	0.00%	0.0	0.00%
Partition	0.0	0.00%	0.0	0.00%
Infiltration	0.2	3.18%	0.1	6.92%
Lighting	0.1	1.45%		
Power	0.1	1.74%		
People	0.6	8.14%		
Plenum	0.0	0.00%		
Total	**7.2**	**100%**	**1.5**	**100%**

V. RESULT

1 Spaces

Space Name	Area (m^2)	Volume (m^3)	Peak Cooling Load (kW)	Cooling Airflow (L/s)	Peak Heating Load (kW)	Heating Airflow (L/s)
1 Space	12	34.96	7.2	420	1.5	161

Considering the Space of a 16 seater automobile bus we get the following results
Peak Cooling Load = 7.2 KW Peak Cooling Sensible Load = 6.8 KW
Peak Cooling Latent Load = 0.4 KW
Peak Cooling Airflow = 420 L/S
Peak Heating Load = 1.5 KW Peak Heating Airflow = 161 L/S

VI. CONCLUSION

There don't seem to be any experimental information concerning the bus air con system within the open literature. In this work, all the experimental results square measure provided together with external and internal temperatures, temperatures and ratio values at the recess and outlet of the evaporator. Using the strategy explained during this work, it's doable to see whether or not a specific air con system meets its style and luxury needs through on-vehicle epitome testing. The main motive of design of an HVAC system built purely depends on the human comfort values, should be maintained irrespective of location of the project.

All the equipment's are installed as per the manufacturer's recommendations to achieve its best efficient performance.

The heat load estimated provides the requirement of cooling for the project, provides a guideline for the selections of machines. Thus, the Project Report clearly identifies the requirement of the project & Provides an effective way of Air-Conditioning to achieve Human comfort for the occupants.

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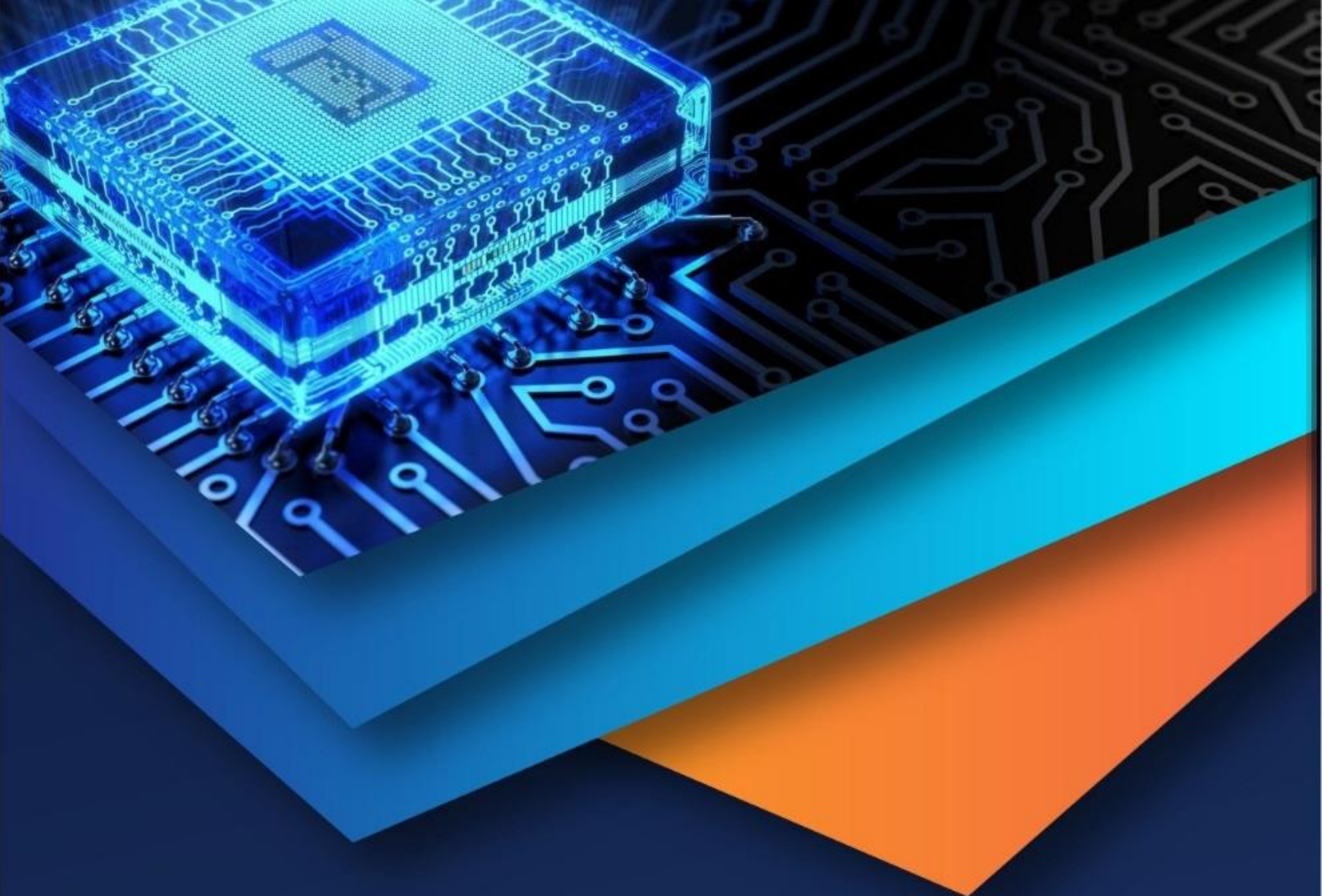

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