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Air Conditioning Design for a Small Hotel Dining Area

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Abstract: This project aims at ''air conditioning design for a small hotel dining area '' a complete air conditioning system was designed to control the indoor environment conditions like temperature, relative humidity, air movement, etc. in an economical way. In this project duct design calculations were done by using the REVIT software. For the space references and calculations the REVIT Plan was taken from the civil department. After taking the plan and load calculation result like flow rate and velocity values were taken by the design department.
The same values we will give in the REVIT software at human comfort condition then we will get duct sizes like diameter, width and height. Then prepare SLD.Based on the obtained CFM values duct sizes were found for each space and ducting design was done for all the spaces by considering the quantity of CMF to be supplied. With this the capacity of equipment was estimated and selected for the installation.

I. INTRODUCTION

In the present days as the population increases the need for comfort also increases. The human being needs more comfort because of inferior environment (like light, sound, machine which produce heat) Sound, light and heat affect human comfort a lot. 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 systems 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 conditioning equipment to the proper air distribution point and also carry the return air from the room 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.

A. HVAC (Heating, Ventilation and Air conditioning)

Heating, ventilation and air conditioning (HVAC) system is designed to achieve the environmental requirements of the comfort of occupants and a process. HVAC systems are more used in different types of buildings such as 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 processes include the heating process, the cooling process, and ventilation process. 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.

II. DESIGN

A. Automobile Revit Software

Autodesk Revit is building information modelling software 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 allows users to design a building and structure and its components 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 plan and track various stages in 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 in the building design.
5) LL [Level]: Places a level in view.
6) RM [Room]: Creates a room bounded by model element and separation lines.
7) RP [Reference Plane]: Creates a reference plane using drawing tools.
8) RT [Tag Room; Room TAG]: Tags the selected room.
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) WN [WINDOW]: Places a window in a wall or skylight in a 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*
   a) Glass
   b) Radiation: $Q = \mu \times A \times \Delta T$
   c) Transmission $Q = U \times A \times \Delta T$
   d) Where, U= coefficient of heat transfer and μ= transparency factor
3) *Step 3*
   a) Walls
   b) $Q = U \times A \times \Delta T$
4) *Step 4*
   a) Roof
   b) $Q = U \times A \times \Delta T$
5) *Step 5*
   a) Ceiling/Floor
   b) $Q = U \times A \times \Delta T$
6) *Step 6*
   a) Portions
   b) $Q = U \times A \times \Delta T$
7) *Step 7*
   a) Equipment's
   b) $Q = w \times 4.16$
8) *Step 8*

a) People = BTU/hr person × no. of people
9) *Step 9*
a) Infiltration
b) Q = CFM×1.08(Sensible)×A
c) Q = CFM×0.68(Latent)×A
10) *Step 10*
a) Ventilation
b) Q = CFM×1.08(Sensible)
c) Q = CFM×0.68(Latent)
d) Air Change
e) Cfm=(V×NACPH)/60
f) Where, NAPCH = no. of air changes per hour
11) *Step 11*
a) Sum of sensible heat = Glass+ Wall+ Roof+ Floor/Ceiling+ Portion+ Equipment+ People+ Infiltration+
b) Ventilation
12) *Step 12*
a) Effective Sensible Heat = Total Sensible Heat×10% of Total Sensible Heat
13) *Step 13*
a) Sum of Latent Heat = People+Infiltration+Ventilation
14) *Step 14*
a) Effective Latent heat = Total latent heat×5% of Total Latent Heat
15) *Step 15*
a) Ton of Refrigeration =(Effective sensible heat + Effective latent heat)/12000
16) *Step 16*
a) Effective Sensible Heat Factor = (Effective sensible heat + Effective latent heat)/Effective sensible heat
17) *Step 17*
a) ADP = Apparatus Dew Point Temperature
18) *Step 18*
a) Sensible Heat at Heat Engine = CFM×1.08A
b) Latent Heat at Heat Engine = CFM×0.68A
19) *Step 19*
a) CFM = Effective sensible heat factor/Apparatus
b) Where, BF = By Pass Factor

III. METHODOLOGY

A. Site Selection
B. Building Lay Out
C. Analysis

1) *Effective System Zoning:* A HVAC system can be 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) *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 heator cool air to the temperature requirements of the system. A correctly designed and installed heat recovery device can achieve savings upwards of 10% of the running cost of the HVAC system.

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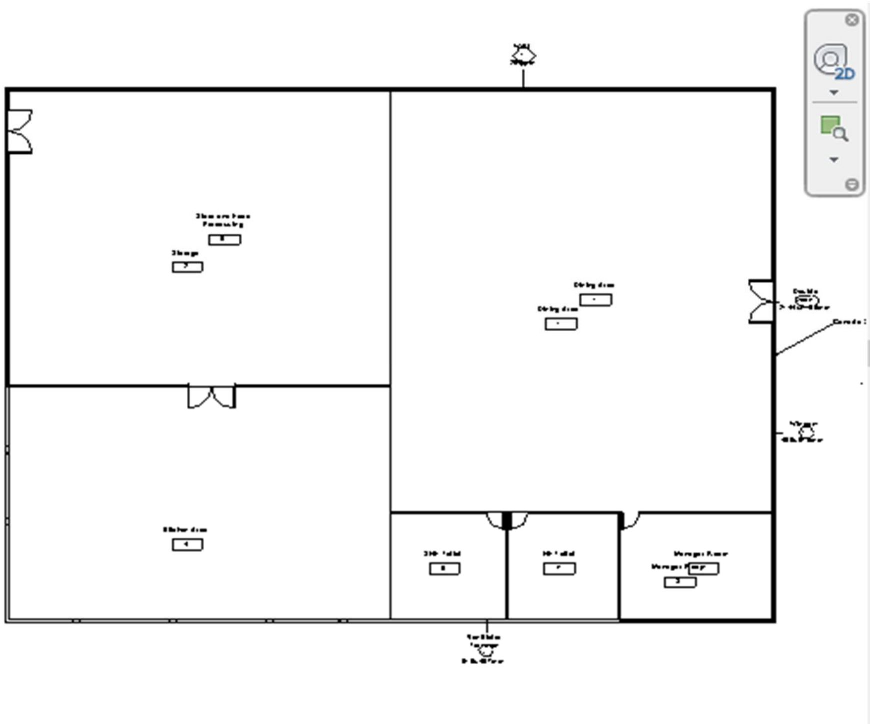
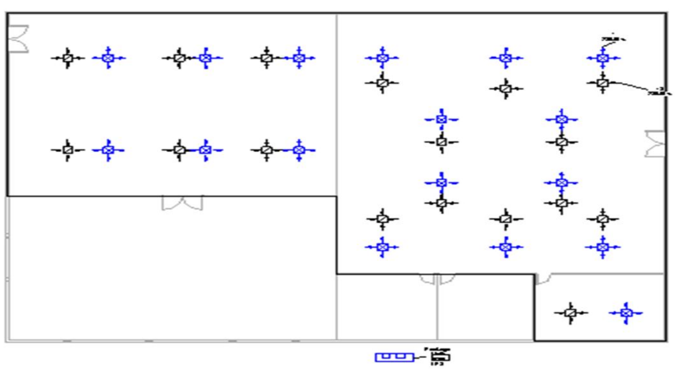
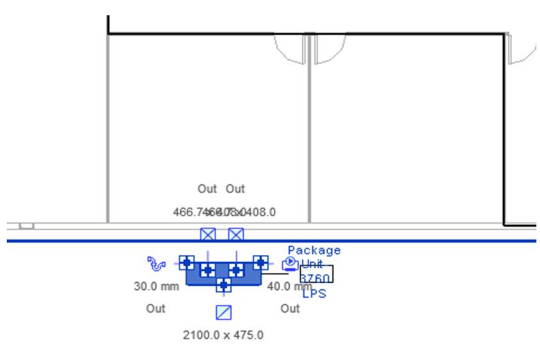
3) Civil Plan



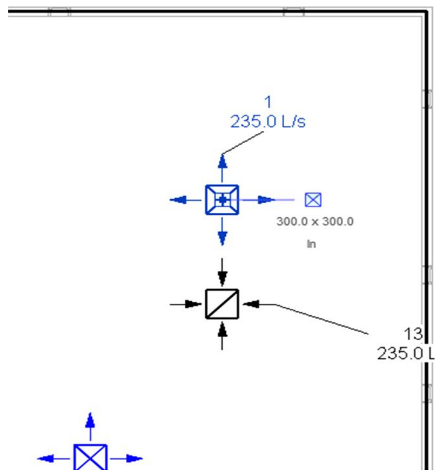
4) AC Zones



5) Package Unit



6) Supply and Return of Air



IV. RESULTS

Below are the results showing different loads and air flow rate of listed spaces in the table:

Space name	Area (m²)	Volume (m³)	Peak cooling load(W)	Cooling Airflow(L/s)	Peak heating load(W)	Heating airflow(L/s)
1.Dining Area	466	1210.47	348	034.8	-28,401	619.2
2.Storage	326	848.80	536	1,433.4	-19,782	434.2
3.Manager Room	47	121.82	4,456	209.2	-2,594	62.3

V. CONCLUSION

The capacity of unit required is 8.5TR approximately but used 5-10TR machine to avoid the fluctuations in the working. In this all the parameters were taken into consideration for high accuracy and proper estimation of suitable machine. Based on the obtained data of dining hall, the duct design was done using REVIT. The diagram was shown in the civil plan. From this we can conclude that our estimated values are enough to establish the air conditioning system in the specified location. By using HVAC system energy consumption of the building is reduced as possible by avoiding unnecessary loses. This is one of the most well designed and most useful method in the present day installations. Hence, we can conclude that the internal environment of dining hall like area can be controlled as per human comforts.

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