

Heat Load Calculation and Coordination of Multispecialty Hospital Using Revit Modelling Software

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Abstract - In this particular work, we are going to design an air-conditioning and ventilation system with the help of heat load calculations for a multispecialty hospital using Revit Modelling software. Autodesk's Revit building information modelling (BIM) software is going to be used for 3D building design and construction documentation tool. Revit had allowed designers to analyze the annual and peak heating and cooling loads of their designs using Energy plus BTO's opensource building energy modelling engine. It provides architects with directional guidance, steering them towards the load-reducing building shapes, space plans. and envelope designs that are the bones of any energy-efficient building. The heat load calculations for the multispecialty hospital are going to be done manually. The design standards used will be as per the ISHRAE standards. The design of air conditioning and ventilation system using the Revit modelling software will be suggested for the multispecialty hospital.

Key Words: HVAC system design, VRF system, Chilled water system, Air handling unit (AHU), Chillers.

1. INTRODUCTION

Heat load calculation is a fundamental skill for HVAC designers and consultants. Consider that space cooling is among the highest energy expenses in buildings, especially during the summer. However, to properly size a space cooling system, first we must know the amount of heat that must be removed - this is precisely the purpose of heat load calculation. Heat in buildings can come from internal sources such as electrical appliances, or from external sources such as the sun. A heat load calculation considers all sources present and determines their total effect. The sum of all these heat sources is known as the heat gain (or heat load) of the building, and is expressed either in BTU (British Thermal Units) or Kw (Kilowatts). For an air conditioner to cool a room or building its output must be greater than the heat gain. It is important before purchasing an air conditioner that a heat load calculation is performed to ensure it is big enough for the intended application. Revit Building Information Modelling software helps engineers, designers and contractors across the mechanical, electrical and plumbing (MEP) disciplines model to a high level of detail and co-ordinate with building project contributors.

1.1 Problem Statement

To design an air conditioning and ventilation system with the help of heat load calculations for the multispecialty hospital using Revit modelling software.

1.2 Objective of work

- To study the basics of Heating Ventilation and Air Conditioning (HVAC) system.
- To get the core knowledge about different HVAC systems.
- To make heat load calculations of multispecialty hospital.
- To understand the working of Revit Modelling software.
- To design HVAC system for a multispecialty hospital using Revit modelling software.

1.3 Scope of work

This project briefly introduces the principal components of cooling load of a building, namely, wall transmission, solar effect, internal heat gain (light, equipment, occupants) orientation of building, etc. The building sector is growing at a rapid pace and is the third largest consumer of energy, after industry and agriculture. Environmentally benign technologies and practices in this sector can address sustainability issues and contribute to conservation of national resources, besides saving on the operating costs.

2. METHODOLOGY

In designing of heat ventilation and air conditioning (HVAC) system, a flow chart of methods had to be used to describe it systematically.

The steps include:

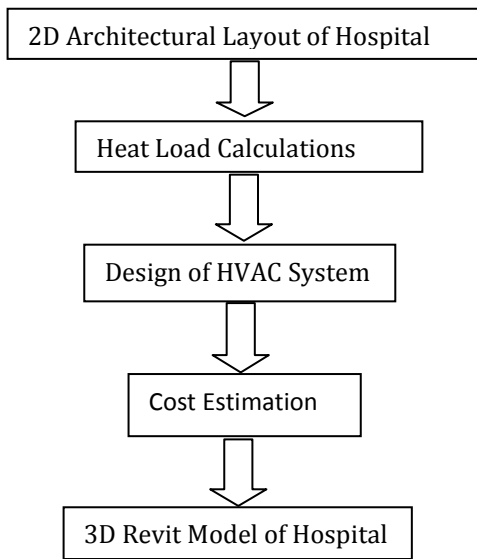


Fig-1: Methodology Flow Chart

3. LITERATURE REVIEW

Sharad Shukla et. al. [1] have designed the energy efficient HVAC system for a school building. The use of air conditioning systems for residential/office buildings were very minimum in the earlier days of 1980's. Due to the technology advancement and industrial growth buildings were started construction in a closed area and construction of apartment also increased after 1980's with increased population. Also, ambient temperatures are changed drastically due to global warming effect. The necessity of design of air conditioning system for residential/office buildings is increasing day-by-day and lot of professionals have been developed in this field and adapted themselves into this field as consultants/designers due to the increased requirement. Hence, they also felt necessity to learn this subject and upgrade their knowledge in this field of air conditioning.

Ren Lu-luet. et. al. [2] have designed an office building in Nanjing as an example to use the BIM technology for the 3-dimensional optimization. With the detailed layout of pipelines, it sets the elevation to replan the original unreasonable designing.

V. Nikithaet. et.al. [3] have discussed the cooling load calculations for a commercial building by using Revit software. Window air conditioners, split air conditioners are used in small buildings and offices etc but in big buildings and commercial complex we use central air conditioning systems these systems are installed far away from the buildings. The cooled air is supplied to the building with the help of ducts. When ducts are not properly designed, then it will lead to problem such as frictional loss, higher

installation cost, increased noise and power consumption. For minimizing this problem, a proper design of duct is needed. Equal friction method is used to design the duct; it gives the comparison of pressure drop in rectangular duct and circular duct. Central air conditioning is more reliable for easy operation with a lower maintenance cost. Cooling load items such as, people heat gain, lighting heat gain, infiltration and ventilation heat gain can easily be done by using REVIT SOFTWARE. The programme can also be used to calculate cooling load due to walls and roofs. And results were compared with the standard data given by ASHRAE and CARRIER. The RULE OF THUMB method is used to calculate the heat developed in the rooms. These methods are used for lower power consumption capital cost and improve aesthetics of building.

Minjae Shina et. al. [4] have designed building energy simulation programs can be useful tools in evaluating building energy performance during a building's lifecycle, both at the design and operation stages. In addition, simulating building energy usage has become a key strategy in designing high performance buildings that can better meet the needs of society without consuming excess resources. Therefore, it is important to provide accurate predictions of building energy performance in building design and construction projects. Although many previous studies have addressed the accuracy of building energy simulations, very few studies of this subject have mentioned the importance of Heating, Ventilation, and Air-Conditioning (HVAC) thermal zoning strategies to sustainable building design. This research provides a systematic literature review of building thermal zoning for building energy simulation. This work also reviews previous definitions of HVAC thermal zoning and its application in building energy simulation programs, including those appearing in earlier studies of the development of new thermal zoning methods for simulation modelling. The results indicate that future research is needed to develop a well-documented and accurate thermal zoning method capable of assisting designers with their building energy simulation needs.

Cary A. Faulkner et. al. [5] have stated to minimize the indoor transmission of contaminants, such as the virus that can lead to COVID-19, buildings must provide the best indoor air quality possible. Improving indoor air quality can be achieved through the building's HVAC system to decrease any concentration of indoor contaminants by dilution and/or by source removal. However, doing so has practical downsides on the HVAC operation that are not always quantified in the literature. This paper develops a temporal simulation capability that is used to investigate the indoor virus concentration and operational cost of an HVAC system for two mitigation strategies: (1) supplying 100% outdoor air into the building and (2) using different HVAC filters, including MERV 10, MERV 13, and HEPA filters. These strategies are applied to a hypothetical medium office building consisting of five occupied zones and located in a

cold and dry climate. They showed that the ASHRAE recommended MERV 13 filtration reduces the average virus concentration by about 10% when compared to MERV 10 filtration, with an increase in site energy consumption of about 3%. In contrast, the use of 100% outdoor air reduces the average indoor concentration by about an additional 1% compared to MERV 13 filtration, but significantly increases heating energy consumption.

Guangcai Gonget et. al. [6] have defined the radiant heating and cooling has been widely acknowledged as an important energy saving technique for building air-conditioning. This paper put forward the concept of Air Carrying Energy Radiant-air-conditioning System (ACERS) to solve some of the limitations of existing radiant air-conditioning systems. Since the orifice plate of ACERS would enable 2 radiant and convective heat transfer with indoor surfaces, using the traditional load calculation method could result in inaccuracy. Therefore, a correction coefficient method for load calculation for ACERS was developed. Based on experiments conducted in summer and winter, in a room installed with ACERS, the cooling and heating loads of the test room were calculated by traditional and newly developed Computational Fluid Dynamics (CFD) simulation method. Then the cooling and heating load calculation results of two methods were compared as the approximate correction coefficient of ACERS, which was validated as about 0.75 in summer cooling and 0.8 in winter heating. The load calculation is the foundation of ACERS design and application, and should also contribute to energy conservation in usage of Heating, Ventilating, Air-conditioning (HVAC).

Yungang Pan et. al. [7] have stated the purpose of the study is to discuss the appropriate HVAC operations in civil buildings from a perspective of engineering experience, to provide a safe and healthy indoor environment for working and living, responding to the prevention of COVID-19 transmission in buildings. The study reviewed the previous theoretical studies of relations between increased ventilation and the transmission of the virus, and based on a premise of value orientation, addressed that increasing the ventilation was still one of the most effective ways to promote the antiepidemic property in the buildings. The study thus summarized the current characteristics of different HVAC systems in buildings, and put forward the target operation strategies respectively, which effectively increased the fresh air flow rate and meantime ensure the normal operation of the buildings.

4. ANALYSIS AND EVALUATION

Specific Assumptions:

- [1] Conditioned space: Entire hospital (all floors)
- [2] Location: Pune
- [3] Inside conditions:

Dry bulb temperature = 75 °F
 Wet bulb temperature= 62.5 °F
 Relative humidity= 50%

- [4] Outside Conditions:
 Dry bulb temperature = 104 °F
 Wet bulb temperature= 75 °F
 Relative humidity= 50%
 Daily range = 32 °F

Designed Assumptions:

- [1] Hospital timings 24 hours
- [2] Height of room 10 ft.

Load Assumptions:

- [1] Density of air is constant.
- [2] The peak time will be 4 p.m.
- [3] Ventilation in toilets is free flow.

HEAT LOAD CALCULATION:

Room: OPD-1

1. Area and volume
 Feet = (10.36 * 11.81)
 Area = 10.36 * 11.81 = 122.35 feet²
 Volume = 122.35 * 10 = 1223.5 feet³
2. Sensible Heat
 - Solar heat gain through glass
 Window Direction= South
 $Q=UA\Delta T$
 $Q=0.65*(6*4)*12=187.2$ British Thermal Unit (BTU)/hr
 - Solar Heat Gain through Wall
 Wall 1: South direction
 $A=(10*11.8)-(6*4)=94.1$ Ft²
 $\Delta T = \text{Equivalent temp} + \text{correction factor}$
 $\Delta T = 16+9 = 25$
 $Q=0.31*94.1*25=729.275$ BTU/hr.
 - Transient Heat gain
 - i. All Glasses
 $A=6*4=24$ Ft²
 $\Delta T = \text{DBT}_{\text{Outside}} - \text{DBT}_{\text{Inside}} = 104 - 75 = 29^{\circ}\text{F}$
 $Q=UA\Delta T$
 $Q=0.65*24*29=452.4$ BTU/hr.
 - ii. Floor:
 $Q=UA\Delta T$
 $Q=0.23*12.35*24=675.37$ BTU/hr.
 - Ventilation
 Fresh Air CFM = (CFM/person*No of person) + (CFM/Sq.ft.* Area in Sq. ft.)
 $= (5*3) + (0.06*122.35)$
 $= 22.341$
 $Q_{\text{Heat Gain}} = Q_{\text{fresh Air}}*\Delta T*B.F*1.08$
 $= 22.341*29*0.12*1.08 = 83.966$ BTU/hr.

- Infiltration
Window Infiltration: Crack length= 2*(7+7)
= 28 ft²
 $Q_{infiltration} = 28 * 0.375 = 10.5$
- $Q_{sensible} = Q_{infiltration} * \Delta T * 1.08$
 $= (10.5) * 29 * 1.08 = 328.86 \text{ BTU/hr.}$
- Internal sensible heat
 - 1) People:
 $Q = \text{No of person} + \text{Sensible heat / person}$
 $= 3 * 245$
 $= 735 \text{ BTU/hr.}$
 - 2) Lighting:
 $Q = \text{Area} * 3.4$
 $= 122.35 * 3.4$
 $= 415.9913 \text{ BTU/hr.}$
 - 3) Equipment:
Printer = 50 W
Computer = 200 W
 $Q = (50 + 200) * \text{hours running} / (24 * 3.4)$
 $= (50 + 200) * 8 / (24 * 3.4)$
 $= 283.33 \text{ BTU/hr.}$
- Total sensible Heat (TSH) =sum of all sensible heats=87.2+729.275+452.4+675.37+83.966+328.86+735+415.99+283.33
 $= 3891.391 \text{ BTU/hr.}$
- Effective Room Sensible Heat (ERSH)
 $ERSH = (TSH + 0.1) * TSH = (3891.391 + 0.1) * 3891.391 = 4280.530 \text{ BTU/hr.}$

3. Latent Heat:

- People = No of person * Latent Heat / Person = 3 * 205 = 615 BTU/hr.
- Ventilation = Q Fresh air * Specific Humidity ($\Delta\omega$)
 $* 0.12 * 1.08 = 22.341 * 25.6 * 0.12 * 1.08 = 74.122 \text{ BTU/hr}$
- Infiltration = Q infiltration CFM * $\Delta\omega * 0.68 = (10.5) * 25.6 * 0.68 = 182.784 \text{ BTU/hr.}$
- Total room latent heat (TLH) = 615+74.122+182.784= 871.906 BTU/hr.
- Effective Room Latent Heat (ERLH)
 $ERLH = TLH + 0.1 * TLH$
 $871.906 + 0.1 * 871.906 = 915.5013 \text{ BTU /hr.}$
- Room total heat = ERSH+ERLH= 4280.530+915.5013 = 5196.0313 BTU/hr
- Outside Air Heat= Q sensible = Q Fresh air * $\Delta T * 0.88 * 1.08 = 22.341 * 29 * 0.88 * 1.08 = 615.754 \text{ BTU / hr.}$

- $Q_{latent} = Q_{Fresh\ air} * \Delta\omega * 0.88 * 0.68 = 22.341 * 25.6 * 0.88 * 0.68 = 543.56 \text{ BTU/ hr}$
- Grand Total = ROOM TOTAL + Q Sensible+ Q Latent = 5196.0313+615.754+543.56= 6355.345 BTU/hr.
- Effective Room Sensible Heat Factor (ERSHF)
 $ERSHF = ERSH/\text{Room total heat} = 4280.530 / 5196.0313 = 0.8238$
- Therefore, Apparatus Dew Point (ADP) = 54
- 4. Dehumidified Rise= (1- B.F) *(Room temp - ADP) = (1 - 0.88) * (75 - 54) = 2.52
- 5. Dehumidified CFM = (Room sensible heat / DR) * 1.08= 3891.391 / (2.52 * 1.08) = **1429.817 CFM**
- 6. Total CFM = (Dehumidified CFM * Dehumidified Rise) / (Room temp - ADP) = (1429.817 * 2.52) / (75 - 54) = 171.578 BTU/hr

Calculation Summary for Ground Floor:

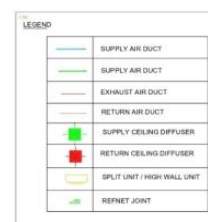
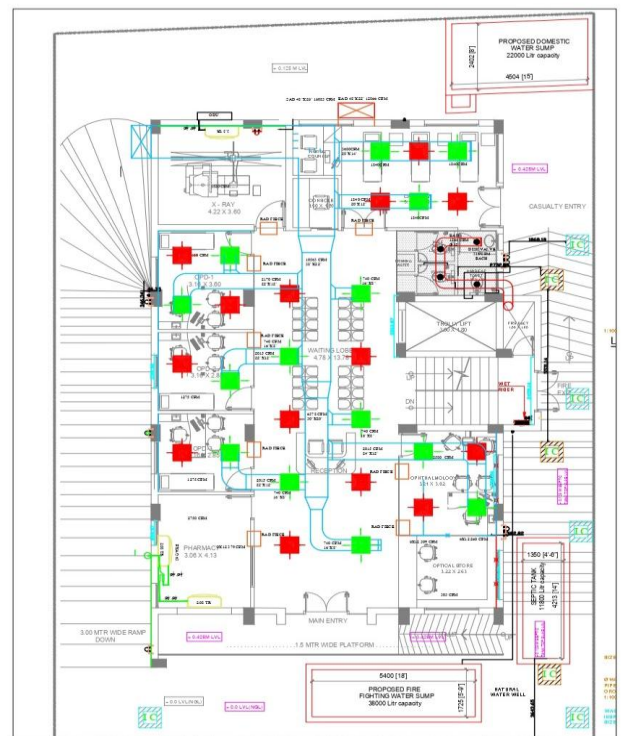


Fig-2: Detail layout and HVAC system implementation (Ground floor)

Table-1: Calculation summary for Ground Floor using VRV System:

Sr. No.	Room Name	Dehumidified CFM	Tonnage of Refrigeration (TR)	Indoor Unit	Outdoor Unit
1.	Pharmacy	2750	6.8	FXAQ100 (DAIKIN VRV System Reference Guide)	RXYQ18A (DAIKIN VRV System Reference Guide)
2.	X-Ray	1520	3.8	FXAQ100 (DAIKIN VRV System Reference Guide)	RXYQ18A (DAIKIN VRV System Reference Guide)

Calculation Summary for First Floor:

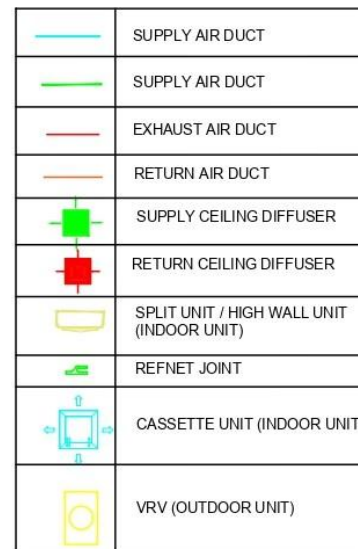


Table-2: Calculation summary for Ground Floor using Chilled water System:

Sr. No.	Room Name	Dehumidified CFM	Tonnage of Refrigeration (TR)	Indoor Unit	Outdoor Unit
1.	OPD-1	1430	3.57	2 supply and 2 return ceiling diffusers	Chilled Water System with 2 Air Handling Unit (AHUs)
2.	OPD-2	1275	3.18	1 supply and 1 return ceiling diffusers	Chilled Water System with 2 AHUs
3.	OPD-3	1275	3.18	1-supply and 1 return ceiling diffusers	Chilled Water System with 2 AHUs
4.	Waiting Lobby	3700	9.25	5 supply and 5 return ceiling diffusers	Chilled Water System with 2 AHUs
5.	Casualty	5520	13.8	3 supply and 3 return ceiling diffusers	Chilled Water System with 2 AHUs
6.	Optical Store	303.85	0.75	1 supply and 1 return ceiling diffusers	Chilled Water System with 2 AHUs
7.	Ophthalmology	2580	6.45	2supply and 2 return ceiling diffusers	Chilled Water System with 2 AHUs

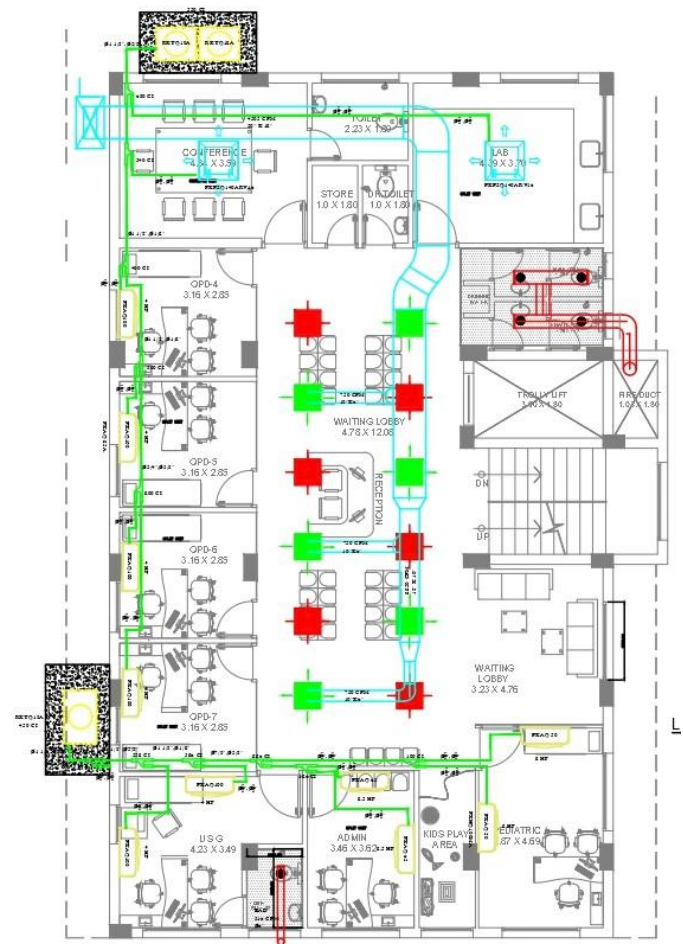


Fig-3: Detail layout and HVAC system implementation (First floor)

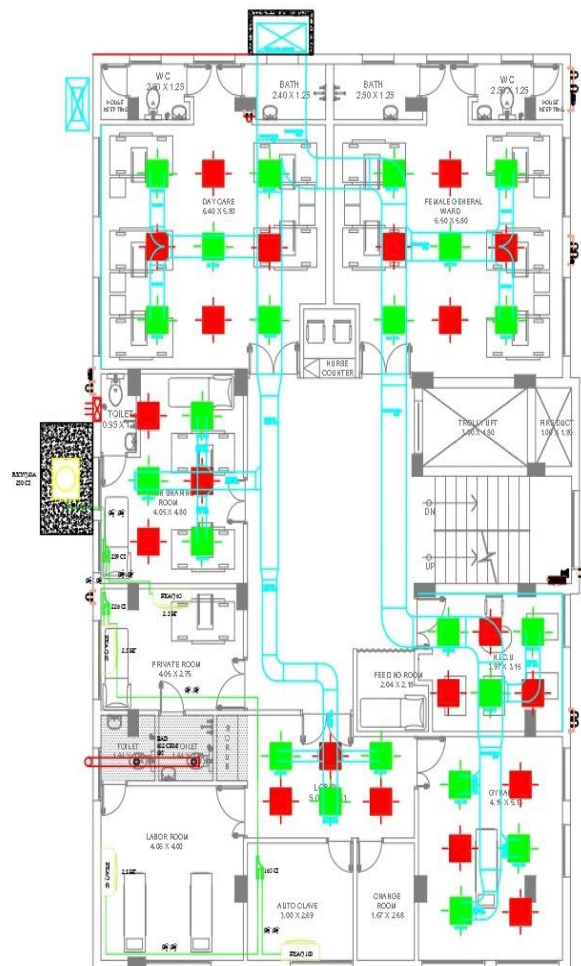
Table-3: Calculation summary for First Floor using VRV System:

Sr. No.	Room Name	Area (Sq. ft)	Dehumidified CFM	Tonnage of Refrigeration (TR)	Indoor Unit	Outdoor Unit
1.	Conference Room	167.70	4505	11.2	FXFSQ140 ARV16 Cassette unit. (DAIKIN VRV System Reference Guide)	RXYQ10 A, RXYQ12 A (DAIKIN VRV System Reference Guide)
2.	Admin room	134.82	1670	4.1	FXAQ 63 (2 units)	RXYQ18 A
3.	Lab Room	174.83	5000	12.5	FXFSQ140 ARV16 Cassette unit	RXYQ10 A, RXYQ12 A
4.	OPD-4	96.86	1330	3.3	FXAQ100	RXYQ10 A, RXYQ12 A
5.	OPD-5	96.86	1330	3.3	FXAQ100	RXYQ10 A, RXYQ12 A
6.	OPD-6	96.86	1330	3.3	FXAQ100	RXYQ10 A, RXYQ12 A
7.	OPD-7	96.86	1330	3.3	FXAQ100	RXYQ10 A, RXYQ12 A
8.	Pediatric Room	144.88	1266	3.1	FXAQ 50 (2 units)	RXYQ18 A
9.	USG Room	133.82	2725	6.8	FXAQ100 (2 units)	RXYQ18 A

Table-4 Calculation summary for Ground Floor using Chilled water System:

Sr. No.	Room Name	Area (Sq. ft)	Dehumidified CFM	Tonnage of Refrigeration	Indoor Unit	Outdoor Unit
1.	Waiting Lobby	167.70	4500	11.2	6 supply and return ceiling diffusers	Chilled Water System with 2 AHUs

Calculation Summary for Second Floor:



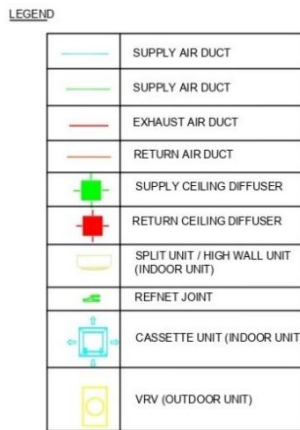


Fig-4 Detail layout and HVAC system implementation (Second Floor)

Table-5 Calculation summary for First Floor using VRV System:

Sr. No.	Room Name	Area (Sq. ft)	Dehumidified CFM	Tonnage of Refrigeration (TR)	Indoor Unit	Outdoor Unit
1.	Private Room	119.87	1635	4	FXAQ63 (DAIKIN VRV System Reference Guide)	RXYQ10A (DAIKIN VRV System Reference Guide)
2.	Labour room	179.79	834	2	FXAQ63	RXYQ10A
3.	Auto Clave room	86.85	1514	3.7	FXAQ63	RXYQ10A

Table-6 Calculation summary for Ground Floor using Chilled water System:

Sr. No.	Room Name	Area (Sq. ft)	Dehumidified CFM	Tonnage of Refrigeration (TR)	Indoor Unit	Outdoor Unit
1.	Twin sharing room	209.24	2008.3	5	3 supply and return ceiling diffusers	Chilled Water System with AHUs

2.	Day care Room	399.53	4577.2	11.4	5 supply and return ceiling diffusers	Chilled Water System with AHUs
3.	Female general ward	405.77	4940	12.3	5 supply and return ceiling diffusers	Chilled Water System with AHUs
4.	N.I.C.U Room	134.69	1601.6	4	3 supply and return ceiling diffusers	Chilled Water System with AHUs
5.	Gynae OT Room	229.14	2230	5.5	3 supply and return ceiling diffusers	Chilled Water System with AHUs
6.	Lobby	384.94	2013	5	3 supply and return ceiling diffusers	Chilled Water System with AHUs

Description and Layout of Plant room

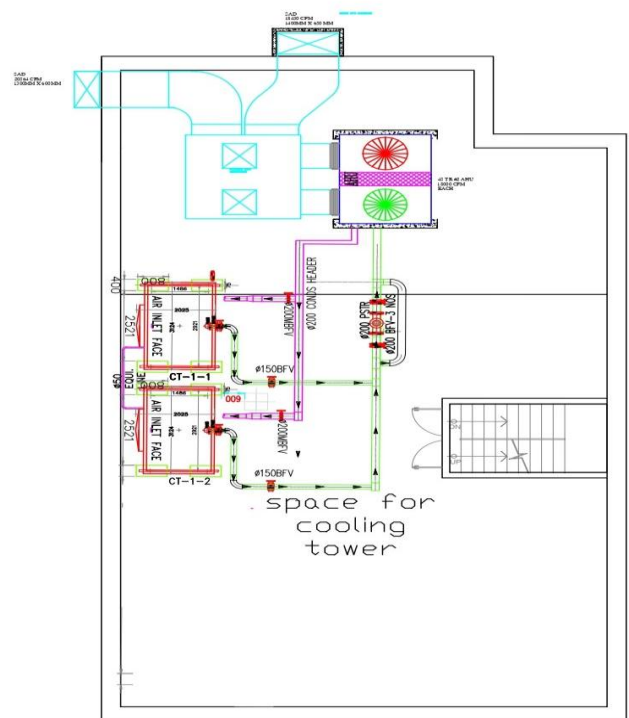


Fig-5: Layout of Plant room

Plant Room is located at the terrace of Hospital Building. It consists of 2 AHU (Air handling unit) with capacity of 45 TR each. They are connected to 2 SAD (Supply air duct) with capacity of 20564 CFM and 18430 CFM. Cooling tower is used to extract waste heat from a system and ejecting it into the atmosphere primarily through evaporation.

Why Variable Refrigerant Volume (VRV) system?

VRV is a trademark of Daikin Industries, Ltd. In the small/medium sized building environment where air conditioning is required, it is common for Variable Refrigerant Volume (VRV) systems to be installed to maintain internal building conditions.

VRV systems operate with multiple indoor air-conditioning units connected to a single outdoor condensing unit. Depending on each zone's condition, the refrigerant volume is varied to each indoor unit. Hotels, schools, hospitals, cinema hall courthouses, residential, central plant, multi-storied buildings, Commercial buildings, office buildings, and industrial unit are good examples for VRV systems.

VRV is a technology that alternates the refrigerant volume in a system to match a building's precise requirements. Only a minimum amount of energy is required for a system to maintain set temperatures, and ensure that it automatically shuts off when no occupants are detected in a room. This unique mechanism achieves more sustainability in the long run, as end users save on energy costs while reducing their system's carbon emissions.

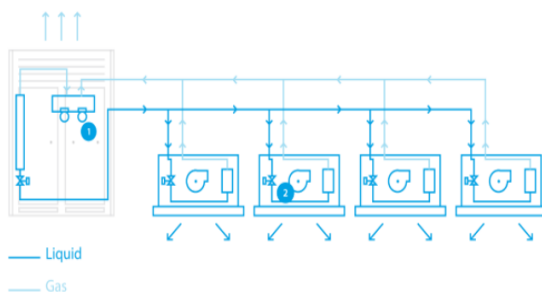


Fig-6: VRV Combined unit

With up to 64 indoor units connected to 1 outdoor unit, the VRV system operates similar to a multi-split system. Each individual indoor unit determines the capacity it needs based on the current indoor temperature and requested temperature from the remote control (set point).

The total demand among all indoor units will determine how the outdoor unit adjusts the refrigerant volume and temperature accordingly. By only supplying the cooling or heating that is needed, the inverter compressor continues to save a large amount of energy during VRV operation.

Modern VRV systems provide some major advantages, such as consistent comfort, energy efficient, quiet operation, zoning, individual temperature control, minimized ductwork, excluding the need for secondary fluids (chilled-water or hot-water distribution), and associated costs. This all-electric technology consists of a single outdoor condensing unit, multiple indoor units serving various zones, refrigerant piping with branch selectors, and associated controls.

Why Chilled water system?

Carrier invented the first centrifugal chiller, which made it possible to provide large-scale air conditioning for buildings. Chillers have undergone much innovation and there are many different types of chillers. However, the purpose of a chiller remains the same: To remove heat from water.

Chilled Water Loop:

The chilled water loop consists of pipes and pumps that move chilled water around a building. A chilled water pump (CHWP) pushes chilled water through the chiller and through the chilled water line around the building.

The chilled water that exits a chiller is called the chilled water supply (CHWS). The chilled water supply temperature is usually about 45 °F.

The chilled water supply is pumped through the chiller and to the building's various air conditioning units such as air handling units (AHU's) and fan coil units (FCUs):

1. In the AHUs and FCUs, the chilled water is passed through a heat exchanging coil to reduce the temperature of the coil.
2. While the heat exchanging coil is cooled by the chilled water, a fan blows air through the coil to provide cold air to the building's space. The supply air temperature that is blown out of AHUs and FCUs is usually about 55 °F.
3. After exiting the heat exchanging coil, the chilled water return (CHWR) returns to the chiller, where it is cooled again, and the process repeats.

Water Cooled Chiller:

Water-cooled chillers are almost always located inside of a building. They work almost the same way as air-cooled chillers. The difference is that they remove heat from chilled water by exhausting the heat to a second, isolated water line called the condenser water line.

The condenser water flows through the chiller and picks up heat. The condenser water then returns to the cooling tower. The cooling tower is almost always located outside of

the building and removes heat from the condenser water by evaporating some of the condenser water into the atmosphere.

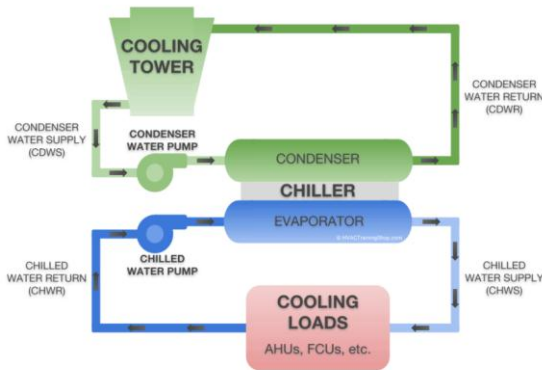


Fig-6: Chilled Water System

As some of the condenser water evaporates, heat is removed from the condenser water, and the cool condenser water flows back to the chiller. This process is then repeated all over again.

Chilled water systems provide some major advantages, such as longer lifespan, quiet operation, energy efficient, safety, lesser cost, practicality, better indoor air quality, and flexibility.

What is REVIT?

Revit was intended to allow architects and other building professionals to design and document a building by creating a parametric three-dimensional model that included both the geometry and non-geometric design and construction information, which is also known as building information modeling or BIM. Revit is a parametric change propagation engine that relied on a new technology, context-driven parametric's, that was more scalable than the variational and history-driven parametric's used in mechanical CAD software. The term parametric building model was adopted to reflect the fact that changes to parameters drove the whole building model and associated documentation, not just individual components.

The Revit work environment allows users to manipulate whole buildings or assemblies (in the project environment) or individual 3D shapes (in the family editor environment). Modelling tools can be used with pre-made solid objects or imported geometric models. However, Revit is not a NURBS modeler and also lacks the ability to manipulate an object's individual polygons except on some specific object types such as roofs, slabs, and terrain or in the massing environment.

Revit includes categories of objects ('families' in Revit terminology). These fall into three groups:

- System families, such as walls, floors, roofs, ceilings, major finishes, and even furniture built inside a project.
- Loadable families/components, which are built with primitives (extrusions, sweeps, etc.) separately from the project and loaded into a project for use.
- In-place families, which are built in-situ within a project with the same toolset as loadable components.

An experienced user can create realistic and accurate families ranging from furniture to lighting fixtures, as well as import existing models from other programs. Revit families can be created as parametric models with dimensions and properties. This lets users modify a given component by changing predefined parameters such as height, width or number in the case of an array. In this way a family defines a geometry that is controlled by parameters, each combination of parameters can be saved as a type, and each occurrence (instance in Revit) of a type can also contain further variations. For example, a swing door may be a Family. It may have types that describe different sizes, and the actual building model has instances of those types placed in walls where instance-based parameters could specify the door hardware uniquely for each occurrence of the door.

3D Revit Model for multispecialty hospital:

In this work, we designed a 3D architectural view of multispecialty hospital building, HVAC components including indoor and outdoor units, plant room, etc., using Autodesk Revit modelling software.

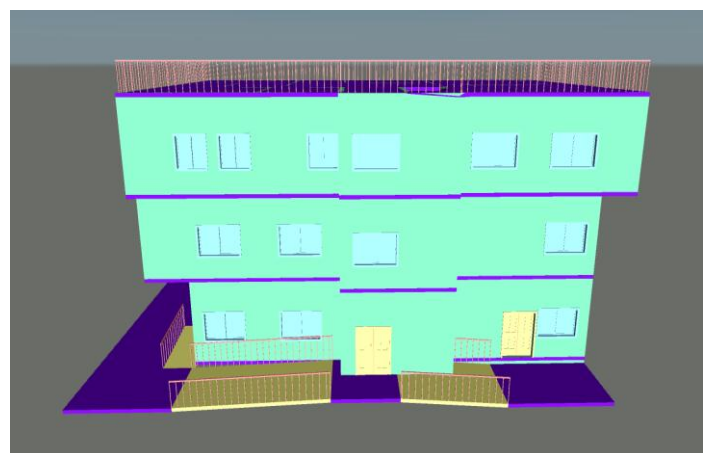


Fig-7: 3D Architectural model of multispecialty Hospital Building

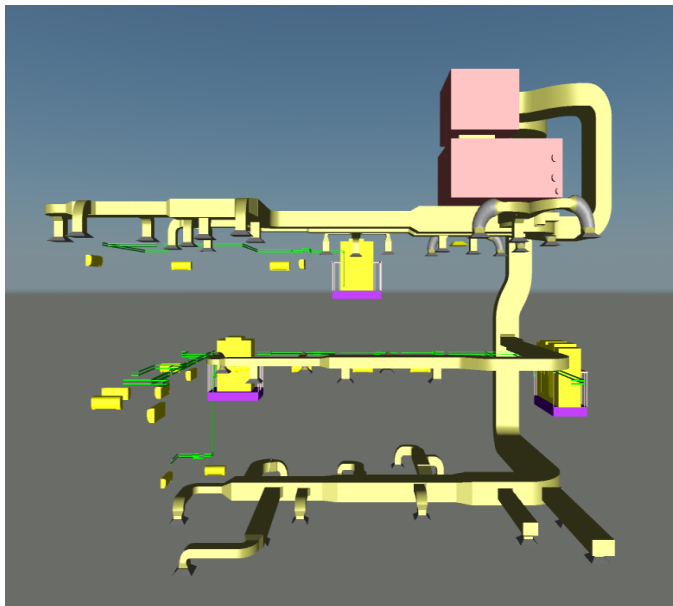


Fig-8: HVAC system installation model of multispecialty Hospital

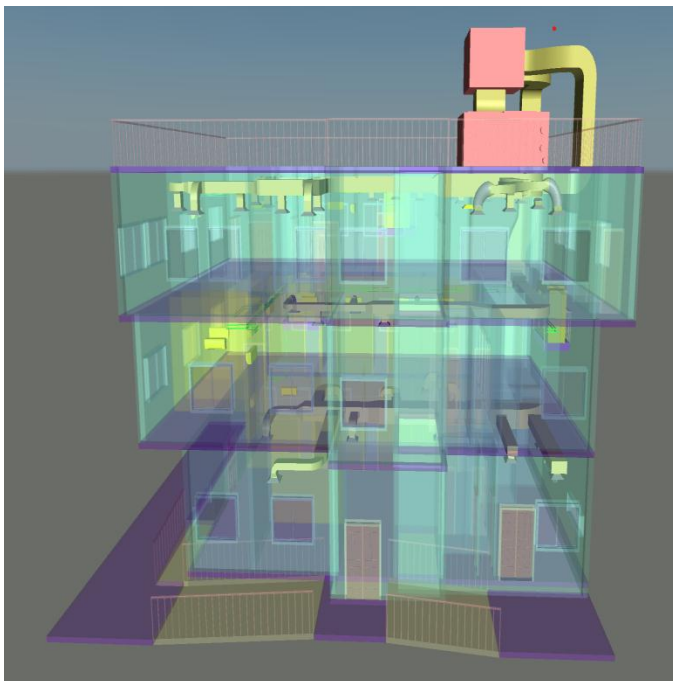


Fig-9: Combined 3D model of multispecialty Hospital

The figure 7,8,9 shows the actual position of air conditioning units to be placed in the individual rooms of hospital. Further, the plan will be shared with architects and civil engineers to construct building accordingly.

5. RESULTS AND DISCUSSING

Results:

- Total Tonnage of Refrigeration of VRV system used in entire multispecialty Hospital: **71.2 TR {85.44 Horsepower (HP)}** (1 TR = 1.2 HP)
- Total Tonnage of Refrigeration of chilled water system used in entire multispecialty Hospital: **94.63 TR (113.55 HP)**
- Total Tonnage of Refrigeration= **165.83 TR (198.99 HP)**

Cost Estimation:

- According to design, the cost for installation of VRV system for multispecialty Hospital will cost approximately 30-35 lakhs INR.
- According to design, the cost for installation of chilled water system (AHU system) for multispecialty Hospital will cost approximately 15-20 lakhs INR.

6. CONCLUSIONS

The influence of building envelop parameters; HVAC systems design, selection and operational techniques and lighting system design on energy consumption in the selected multispecialty hospital buildings from different climate zones have been studied. The study has been conducted in different stages to accomplish the research objectives. In the initial phase, extensive literature was assessed for HVAC system operation, energy efficiency in buildings, energy conservation and thermal comfort. It was apparent from earlier studies that energy efficiency in buildings and thermal comfort conditions were primarily allied with HVAC system planning and procedure. In most countries one of the major contributions in energy consumption for buildings come from HVAC system and especially a largest electric consumption found in commercial buildings by HVAC. Through some studies conducted, apprehension about preserving and improving an existing building energy system has guided designers to pay a lesser amount of consideration towards comparative study for the proposed buildings. It was necessary to assess the current common practices adopted in hospital building energy systems to identifying the impact and potential of energy efficiency measures in different climate zones of India. Engineering design of a HVAC system for the multispecialty hospital using revit modeling software is presented in this research paper.

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