VIVA-TECH IJRI
ANNUAL RESEARCH JOURNAL
VIVA-TECH INTERNATIONAL JOURNAL FOR RESEARCH AND INNOVATION
ANNUAL RESEARCH JOURNAL
ISSN(ONLINE): 2581-7280

Design of HVAC System for Multi-specialty Hospital

Krunal Patil, Pooja Thakur, Smit Mithari, Dhaval Naik
(Dept of Mechanical Engineering, Viva Institute of Technology/ Mumbai University, India)
(Dept of Mechanical Engineering, Viva Institute of Technology/ Mumbai University, India)
(Dept of Mechanical Engineering, Viva Institute of Technology/ Mumbai University, India)
(Dept of Mechanical Engineering, Viva Institute of Technology/ Mumbai University, India)

Abstract: *Heating ventilation and air conditioning (HVAC) systems consumes nearly 50 to 60% of the total power consumption in any building and thus, offers huge potential and challenge to reduce the energy consumption by employing various innovative systems designs. For air conditioning systems, the measures include selecting the right temperature, minimizing the space for air conditioning and closing of dampers/grills for areas where air conditioning is not required. The aim of this project is to design a HVAC with minimum operating cost while not compromising with the human comfort. With increasing number of patient due to covid-19 outbreak there has been overgrowing importance of multi-specialty hospital with good air conditioning. This project focuses on reducing the energy consumption by conducting heat load calculation for entire building and necessary component of HVAC system.*

Keywords - *Air-conditioning, Air distribution, Energy consumption, Heating, Human comfort, ventilation.*

I. INTRODUCTION

The Hospitals represent one of the most complex building types combining several functions operating 24/7 including emergency rooms, Operating rooms, divisions, long and short -stay rooms, laboratories etc. And of course, different bedroom typologies. The interaction between the functions as well as a wide network of technological systems strongly contribute to increase this complexity which influences the ageing of the building at different levels: On the one hand, services and equipment's are strictly necessary to keep adequate service level and indoor comfort conditions, but the adopted technologies often update very quickly and require constant maintenance and replacement; on the other hand, the progresses in the medical field impact on the space use and arrangement requiring some transformation and adaptations without which the hosted activities can be totally interrupted. Retrofitting is mainly aimed at reducing energy consumption and optimizing economic benefits by replacing outdated equipment with efficient ones as one of the most effective solutions. Energy retrofitting is consequently aimed at both reducing energy demand and increasing available resources for health services while maintaining or improving the quality of indoor conditions referred to thermal comfort, pollution level, usability and healthiness. The existing hospital buildings will be demolished, restored and upgraded to boost energy efficiency, sustainability, and savings.

In the current times, the pressure on the healthcare system is increasing due to less availability of hospital/beds per patient. As per the last survey by the World bank there are a total 0.7 beds available per 1000 people in India. With the pandemic like COVID-19 the number of patients has increased a lot and hospitals need to expand their infrastructure for meeting the current requirements. But the expansion of the hospital is a very complex process and detailed guidelines are required for the retrofitting of the hospital infrastructure for reducing cost and improving efficiency. Heating ventilation and air conditioning (HVAC) systems consume nearly 50 to 60% of the total power consumption in any building and thus, offers huge potential and challenge to reduce the energy consumption by employing various innovative systems designs. No -cost measures for reducing the energy bills. For air conditioning systems, the measures include selecting the right temperature [no over cooling or overheating, minimizing the space for air conditioning and closing of dampers/ grills for areas where air conditioning is not required. The aim of this project is to design a HVAC with minimum operating cost while not

compromising with human comfort. With an increasing number of patients due to covid-19 outbreak there has been an overgrowing importance of multi-specialty hospitals with good air conditioning. Because of which there has been growth in energy consumption in the medical sector. This project focuses on reducing the energy consumption by conducting heat load calculation for the entire building and necessary components of the HVAC system.

II. LITERATURE REVIEW

This research is based on the design of HVAC for multi-specialty Hospital. We have given human comfort importance; however, we have brought in some energy solutions so as to reduce overall cost. We have tried to keep the system simpler so as to reduce the installation time which improves the productivity.

For this project we have went through different research papers and come out with various key findings which helped through the project.

In the paper "HVAC and indoor thermal conditions in hospital operating in hospital operating rooms" we have learnt regarding indoor thermal condition in operating rooms and related use of HVAC system.

In the paper "Indoor environmental quality in Hellenic hospital operating rooms. Energy and Buildings" we have learnt the perception of satisfactory indoor environmental quality (IEQ) i.e. (satisfactory comfort conditions and air quality) reduces the number of health complaints and improves working conditions, even in a challenging operating room (OR).

In the paper "Experimental investigation of noise characteristics for HVAC silencers" we learnt that it is necessary to control or reduce the noises produced inside the ducting system, so they have tested various types of silencers of different geometry and compare their efficiencies.

In the paper "Passive Cooling Techniques, Design Concept and Ventilation Techniques" we have learnt that these RCC roofs tend to make the indoor temperature very high around the 41°C. This is due to high roof top temperature of around 65 °C in arid regions. Solar shading with locally available materials like terracotta tiles, hay, inverted earthen pots, date palm branches etc. reduce this temperature significantly.

III. The Problem Statement

Design of Air Conditioning and Ventilation System for a MULTI- SPECIALITY HOSPITAL BUILDING that pertains to Comfort Cooling, Ventilation and Indoor Air Quality.

- In ground floor:

Reception, Doctor Consulting Room, Emergency Room, Testing Rooms, Admin Rooms such as Billing Accounts and MD Room, General Wards, Physiotherapy Room, Scan Room, House Keeping Room, Staff Rest Room, Nurse Station, Pharmacy, Canteen and Toilets are available.

- In first floor:

Individual wards, Urology, ENT and Intestine Medicare rooms, visitor's room, conference room, Operation Theatres. Isolation Room, Doctor's room, staff room and toilets are available.

2.1 Objective:

1. The objective of this project is to design HVAC systems for multi-specialty hospitals so as to provide a comfortable environment to patients. Doctors and staff will also be able to work more comfortably and concentrate on their duty in a better manner.
2. To achieve a highly quality system that functions effectively and energy-efficient and cost-effective.
3. The design is to provide good indoor air quality.
4. Designing a complete energy efficient HVAC system with all important subsystems.
5. Assuring better IAQ measures and ventilation measures undertaken to address human comfort and to take care of foul air to avoid suffocation.

IV. METHODOLOGY

1. Basis of design
   - Outdoor Design Condition
   - Inside Design Conditions
   - Fresh Air
   - Assumptions
   - Noise Level Design Criteria
2. Equipment Selection
   - Indoor equipment
   - Outdoor equipment
3. Building Dimensions
   - The dimension of the Hospital which is to be air conditioned is 31542 Sq.ft in size. It has two floors including the ground floor. The Exterior Walls Thickness of hospital is 230 mm and Interior Wall Thickness is 115mm. Floor to bottom of slab is 3.6m, Floor to beam bottom is 3m, Floor Slab Thickness is 0.2m
   - The glass consists of single glass materials of 12 mm thick with frame panel.
4. Duct Design

Steps in Duct Design
   - Equipment Selection during Duct Design
   - Air Flow Diagram.
   - Duct Design Using Duct Sizer.
   - Select Grill or Diffuser.
5. Heat Load Calculation
6. Thermal Comfort Design
7. Life Cycle Cost Analysis

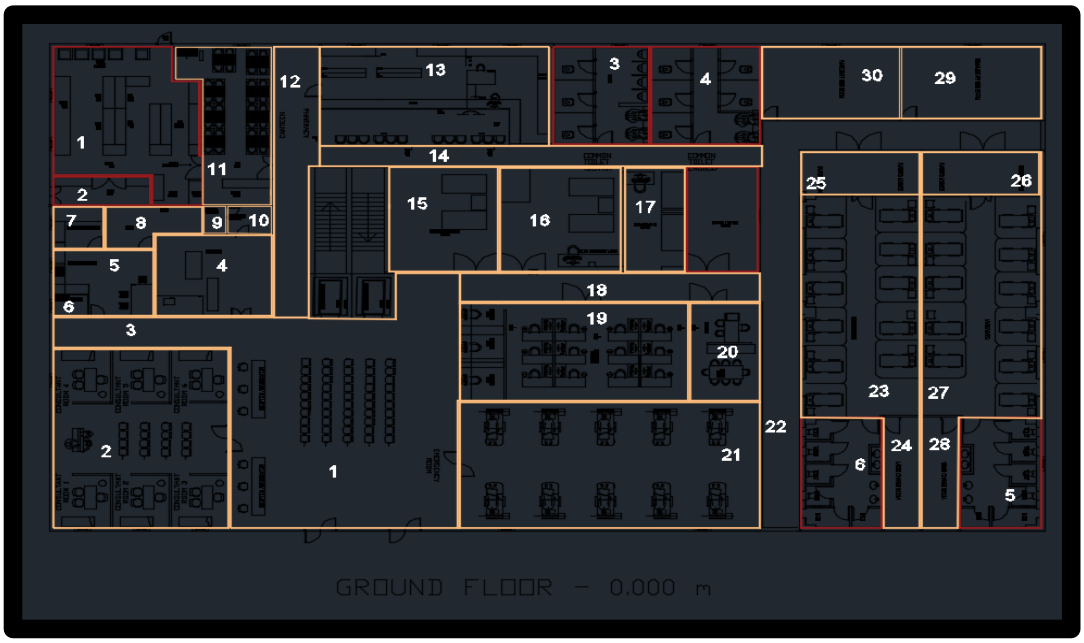

Fig. 1 Zone layout of ground floor

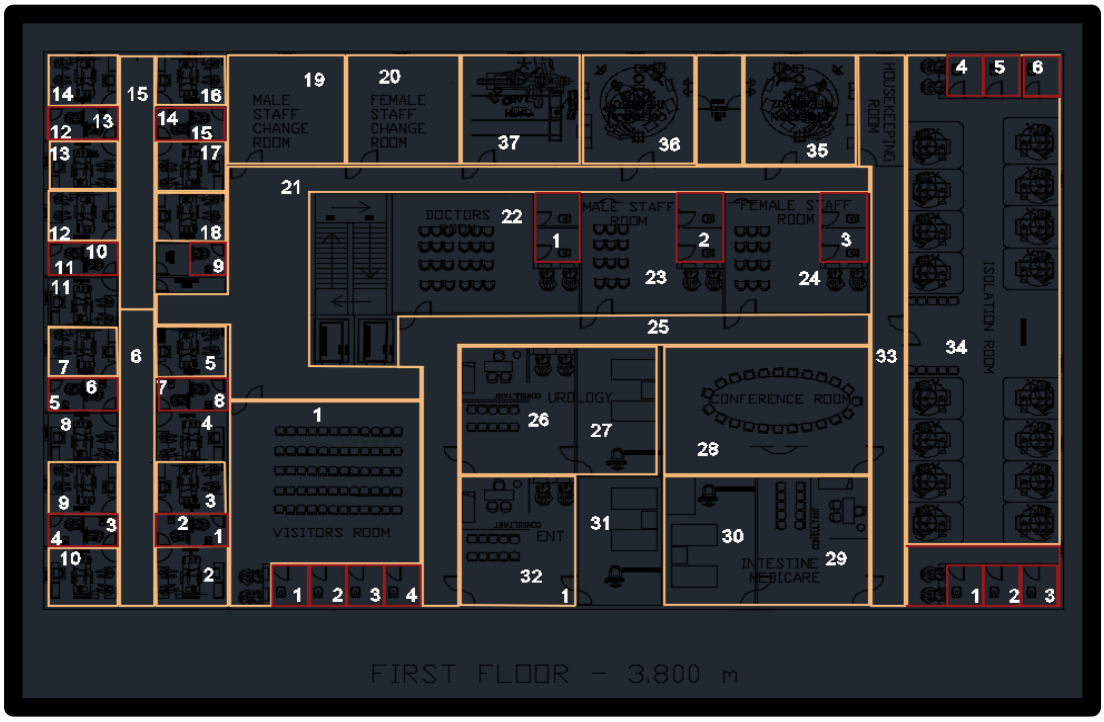

Fig.2 Zone layout of first floor

Fig. 3 Ground floor

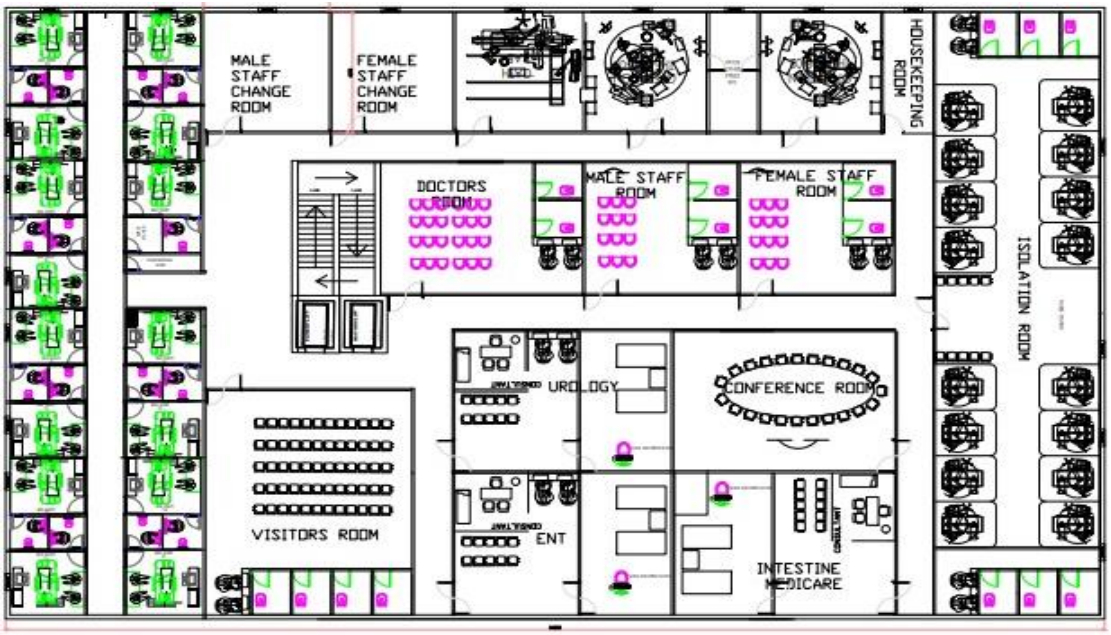

Fig. 4 First floor dbr

V. CONCLUSION

This article only touches upon a few critical aspects of hospital designing. With growing sophistication, each area like Laboratory, CSSD, Imaging, Blood Bank, OPD etc. have their own design challenges and needs With India's edge in medical tourism, hospitals in future will rub shoulder with their counterparts in developed countries. In addition, the explosive growth in second and third tier cities of India will also bring quality healthcare players in the market like Fortis and Apollo have announced their plans to construct several hospitals in the coming years. The government too has opted for modernization of its existing hospitals and adding several more. HVAC engineers will have a major role to play in the design and operation of these sophisticated buildings of the future

- For designing the duct, building cooling load and air flow rate is calculated and the duct design for building is done by using equal friction method.
- Frictional pressure drop are different for all three ducts runs.
- The value of total pressure is critical since it affects fan selection of evaporative cooling system.

REFERENCES

Journal Papers:

[1]. Md Sadiqul Hasan Taludker, "Heating, Ventilation & Air Conditioning (HVAC) System," IOSR Journal of Mechanical & Civil Engineering [IOSR-JMCE] ISSN:2320-334x, Vol. 13, Issue Sept-Oct 2016, PP.28-35

[2]. X.cui, "Modelling and performance evaluation of an air handling unit for an air treatment system with regulated outdoor - air fraction", The 8th International Conference on Applied Energy – IACE 2016, PP.4718-4723

[3]. K. Venkatachary, "Design of An Air Conditioning For A Multi Storey Office Building", International Journal of Research Publications In Engineering & Technology [IJRPET] Vol. 4 Issue January 2016, PP.30-38

[4]. Ajay N Bhagwat, "Energy Efficient Air Distribution Systems For Air Handling Unit", International Journal of Scientific & Engineering Research, Vol. 8, Issue 3, March-2017,PP.40-45

[5]. Virendra V. Khakre, "Design of Duct for a Three Storey retail Shop", International Journal of Engineering & Technology [IRJET], ISSN 239S-0056, Vol. 04, Issue 02 Feb 2017, PP. 329-332

[6]. Satyanarayan Choudhary, Manvendra singh thakur, Nitesh Dogne, ""Passive Cooling Techniques, Design Concept and Ventilation Techniques", AICMT: National conference on Alternative & innovation Construction Materials & Techniques TEQIP-II/Civil/AICMT-2

[7]. Basavaraja K. T, T. Kiran, T. Sushanth, Thummala Saiteja Reddy, "Heat Load Calculation with Duct Design of a Multi Storeyed Residential Building", International Journal of Trend in Scientific Research and Development (IJTSRD) Volume: 3 | Issue: 3 | Mar-Apr 2019 e-ISSN: 2456 – 6470 @ IJTSRD | Unique Paper ID – IJTSRD23301 | Volume – 3 | Issue – 3 | Mar-Apr 2019 Page: 1150

Books:

[8]. AIR CONDITIONING AND REFRIGERATION JOURNAL, Vol. 12, No. 4, pp.48-74, October-December 2009.