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Design of HVAC System for a Commercial Building

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Abstract

As there is an increase in global warming, many important steps have to be taken to decrease its effect and from this project by considering all the factors according to the norms and adding some techniques, it would be helping towards this work. HVAC and R systems stand for heating, ventilation, air conditioning, and refrigeration. As the HVAC systems are used in every sector nowadays, like hotels, private and official sectors, industries, and other commercial offices, this project aims to achieve an energy-efficient HVAC system for the given commercial building layout. This project particularly deals with the heat load calculation, selection of materials, selection of systems taking into consideration of various factors like structure of the building, glass material, sun's path, and climate conditions. The project will follow all safety standards and the norms regarding human comfort and also consider the environmental aspects. The outcome of the project will be a plan of complete HVAC & R systems of the layout of the building with consideration of all the aspects including the latest technologies in HVAC industries.

Keywords: Chillers, CPVC pipe, fresh air, ISHRAE data book, human comfort chart, HVAC, HVAC system, life safety

INTRODUCTION

HVAC stands for "Heating ventilation, air conditioning, and the project we are presenting has all the HVAC safety norms and standards provided by the ASHRAE standards (American Society of Heating, Refrigeration and Air conditioning Engineer) and also consider the environmental conditions and aspects according to the assigned region for the project and also human comfort. The project is plan and done to satisfy all the needs and considerations according to building layout and the HVAC system are designed considering all the latest technologies which will be helpful towards the best outcome.

From domestic HVAC systems to large commercial grade HVAC systems, and everything in between, they come with varying features and functionality. A well-equipped HVAC system can control easily, and can offer a high level of indoor air quality and can provide heating or cooling depending on what is the need so its engineers have to consider all the factors like application, special requirement of the processes, space available, load variations, operating reliability, energy conservation, and total cost. While selecting the equipment, HVAC systems are classified as air-cooled chiller system, water-cooled chiller system, VRF system, DX system.

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METHODOLOGY

As the blueprint was provided by the ISHRAE (The Indian Society of Heating, Refrigerating and Air Conditioning Engineers), we study the blueprint of the commercial building in Aurangabad [1]. Getting all the required details and data from the blueprint, the heat load calculation is been done, the TR is been calculated for all the rooms and sum of the full structure is taken [2]. The heat load is been calculated considering the points like orientation of building, region/location (Figure 1). Dimensions of area that to be air-conditioned (floor, roof, glass, doors, partition walls, etc.). U value of civil wall/ roof/glass. Number of people and their activity. Fresh air load/ infiltration load/ IAQ [3].

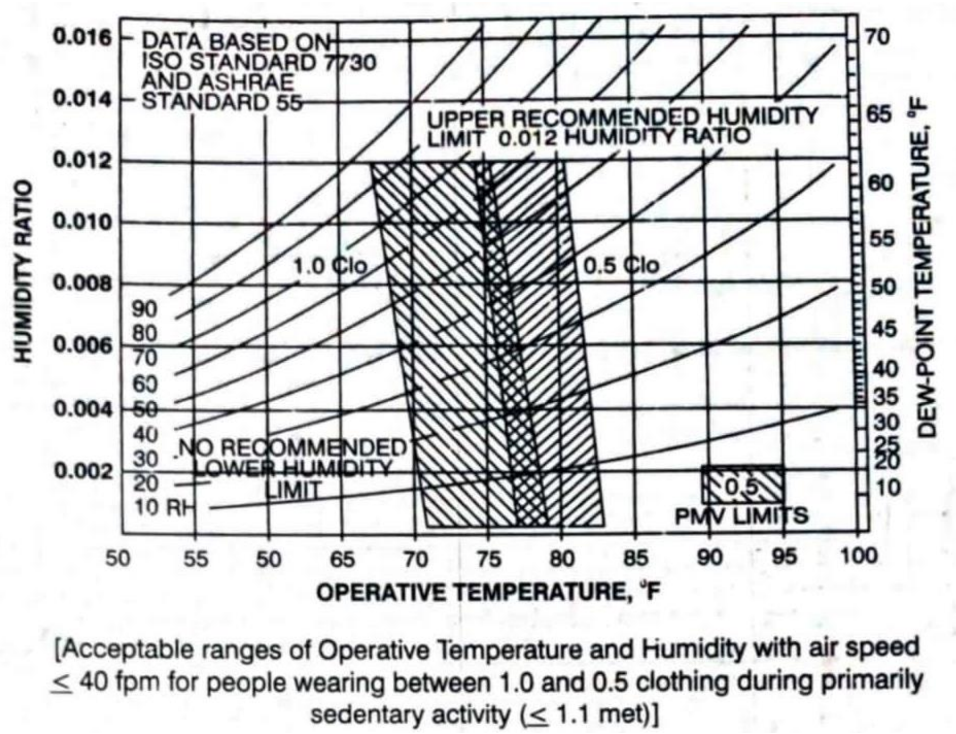

Figure 1. Human comfort chart.

Thereafter selection of the various building material has been done according to the environment condition and the requirements of the building, considering their u values for further calculations (roof and ceiling, glass, external wall, internal wall). All the standards were considered according to the ISHRAE handbook [4]. Then we studied the equipment loads and lighting loads and calculated the total energy consumption which was important for the further calculations. The number of people in the room has also been considered [5]. After doing all the calculations, the total TR came out to be 159 TR [6]. After getting the heat load system, selection is been done. Considering the TR which came out to be 159 TR, two air chillers were been selected of 80 TR each for the circulation of the air one in working mode and one in standby mode [7]. After the selection of the main component, various other components for the circulation of the fresh air throughout the building is been selected [8]. AHU were selected 2 for each floor fitted with the MERV 13 filter for the better quality of air [9]. Various other components for circulation and providing the air throughout the building is been used (ducts, VRF, swirl diffuser) [10]. Ventilation has been done for the kitchen washroom, and basement with different considerations. The calculations have been done for each area differently so the standard can also be maintained over there [11].

The pressurization method uses mechanical fans to produce a positive pressure on the stairwells. To reduce the consumption of energy and making it more sustainable and green building, the 3Rs of Reduce, Reuse, and Recycle is been applied during the design of the project (Figure 2). The IGBC norms were been considered during the design to make the building withstand as a green building. Considering some points, the project is been assigned as a gold standard green building.

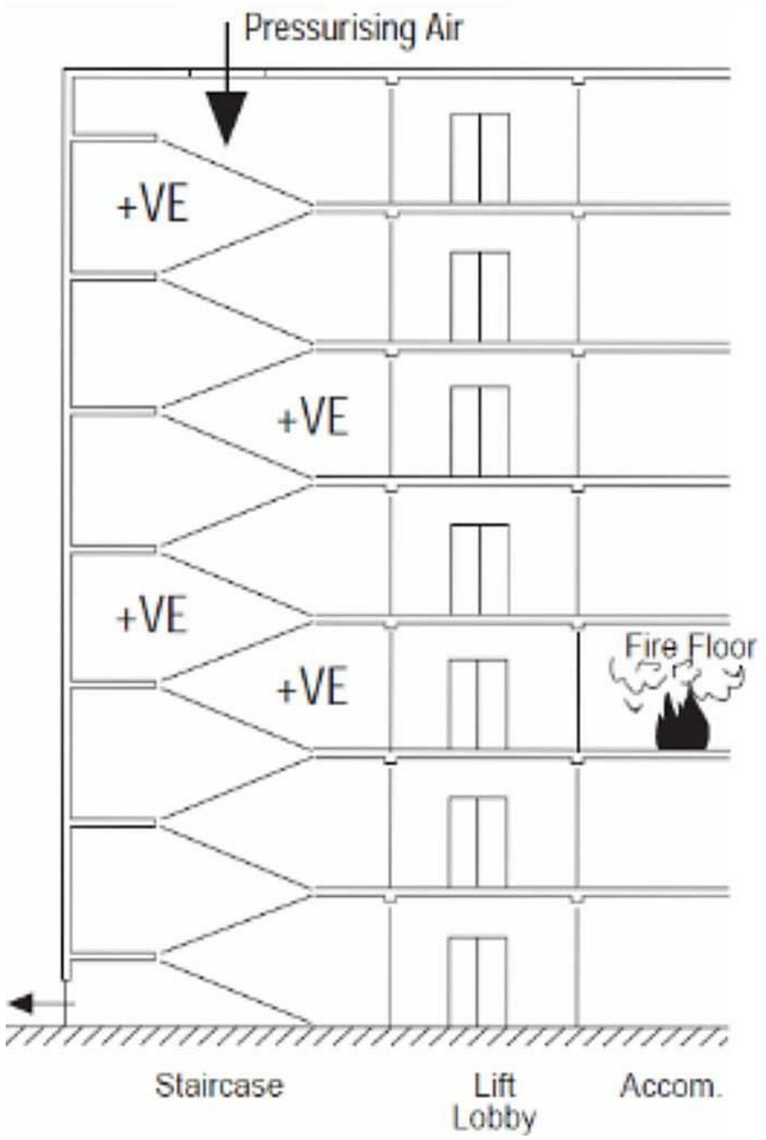

Figure 2. Smoke control by pressurization.

SYSTEMS USED

- 2 air cooled chillers of 80 ton each which will be in working mode.
- 1 air cooled chiller of 80 ton which will be in standby mode.
- Each AHU consist of UVGI.
- Cassette type of air conditioning for corridor area.
- Swirl diffuser for office areas.
- Jet nozzle for foyer area.
- Grill and diffuser for proper flow of air. Kitchen hood, jet fan, and mechanical fan drive for the ventilation.

LIFE SAFETY

- Stairwell pressurisation system are accompanied with a vent system.
- VLT HVAC drive is used to overcome the problem of over pressurization.

Value Engineering and Certification

- VFD for AHU, fans, and pumps
- Primary pump and AHU with VFD
- BTU meter
- CPVC pipe
- Building management system
- Movement activated air conditioner

Innovation

- Effective utilization of open terrace
  a. Indoor farming
  b. Outside canteen
  c. Turf for sports activities
- Skylight in the basement
- Rainwater harvesting
- Wastewater reuse

RESULT AND DISCUSSION

- The energy consumption is been reduced by proper applications and well-engineered design of the HVAC system in the building.
- Proper use of natural ventilation is done in the area with open access to the nature to reduce the consumption of energy.
- Use of the skylight in different areas and the consideration of proper glass has reduced the consumption of energy.
- Rather than wasting the water, it has been retreated to reuse, and rain water harvesting plans are also done hence water consumption is reduced.
- Proper utilization of space within the commercial building hence no wastage.
- Innovative idea considering the new technologies.

CONCLUSION

Applications of all the new technologies and the proper use of nature towards working the project have withstood all the ability to serve as a fully functional building as per the requirements with less energy consumption.

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