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Radiant Cooling System Performance Analysis

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Abstract: ***The overall study of my project measured performance analysis of a radiant cooling system using ceiling panels in an office space to design and implement the data. The Radiant Cooling with Ceiling system incorporates the pipe network in each panel and the piping connected to the chiller through these pipes the chilled water will be circulated. The observational data conducted during the design indicate how much of the tonnage required for the whole area with which we can distribute the temperature in the surface through radiant ceiling panels. Our designing will make sure a load of light, equipment load, and the sensible heat generated by the occupants present in the office space which will define total tonnage required. This work will reduce the chance of increasing in humidity when increasing the personals due to continuous circulation of cool water, which will scale down the indoor temperature quickly. Our calculations determine the coil size too for fixing it at the ceiling, the coil size will determine to fix it at ceiling for connecting it to the pipes which are travelling from the chiller unit by carrying the chilled water. These determinations will be really helpful in optimizing and controlling the strategies of HVAC system combining with ventilation, which does not require a separate air duct we need only a small duct for the fresh air which will pour at each ceiling panel.***

Keywords: Radiant cooling system, Ceiling panels, Pipe network, Cool water, HVAC, coil size.

I. INTRODUCTION

A. Radiant cooling:

Usually, the Radiant cooling systems are involved in chilled ceiling beams or panels, with the advantage of convection air cooling as well as average radiant temperature to be attained. As the cool air flows downwards, it gets cooled while passing through the chilled beam panel and the cooled air is supplied to space. It is significant that Convection should take place in case of radiant cooling panels, compared to the radiant floors, where the surface is in the contact with the occupants. Hence due to this, the radiant floors are also referred as "chilled beams". Also, the radiant air conditioning systems can be installed within the floors.

Designers can include the radiant system for any climate in newly constructed buildings due to many good reasons. Merchandising complexes mainly cooled by radiant means are more convenient than the complexes cooled by conventional HVAC systems. The initial amount of radiant system is compared with conventional VAV systems (variable air volume), where the long life savings by the energy can be saved by radiant air conditioning system is over 25 percent than the VAV system.

B. Background

All the conventional air condition system needs to have an indoor unit where in my radiant system it is using only ceiling panels which are attached to the ceiling and it will have coil network with an inlet fed and an outlet which will be connected to the pipes which are circulating the cooled water. Moreover, to this, the radiant cooling concept is interested and the historical usage of it.

The radiant cooling system initially introduced for the heating purposes, in which the hot air from the flue gas used to be circulated under th floors or through the walls then after the water based heating and cooling is introduced.Radiant cooling systems are different from those of air systems, while heat transfer methods to remove the heat from the surface is different in both the radiant cooling system and other air conventional systems. Nearer to 50% of heat transfer is done by the radiation.Theory related to heat transfer fundamental processes used for transferring heat from the buildings and the analysis related to this is present many handbooks and textbooks like ASHREA2009, KUEHN ET AL.1998, etc., many scholars have written that there are two heat transfer processes. One is the transfer between the radiant layer and the conditioning space. The second is the radiant layer and the water loop.In the radiant cooling system, the sensible heat in a room will be removed at radiant surfaces.

II. OBJECTIVES

Following are the objectives proposed for the study of my work

A. Examine the heat load, to find the heat load we are considering the different parameters.
B. Study over to find the cooling capacity estimations.

C. find the minimum air flow required to make the surface cooled and the people feel more comfortable.
D. Study to find the coil sizing for my work

III. METHODOLY

For calculating the heat load there is a standard software HAP(hourly analysis program) which will give us the entire description to find cooling condition capacity, similarly, duct sizer for calculating the area of a duct and pipe sizer is for calculating pipe size for water flow through it.
ASHRAE and ISHREA standards are also available to take the values and expressions to find the coil size which we will use in the ceiling panels.

A. HAP

Hourly Analysis Program (HAP) is a computer based software which helps engineers to design an HVAC system for various buildings.

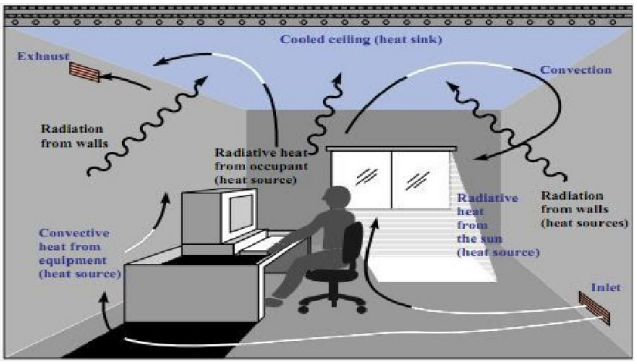
B. Duct Sizer

Constant velocity method or static regain equal friction are used to calculate the maximum duct size by using a powerful design tool design as duct sizing program. The sizes of duct are calculated as round, square, rectangular or oval shaped.
To work on the duct sizer we need the following things:
1) CFM
2) Friction Loss rate
3) Velocity

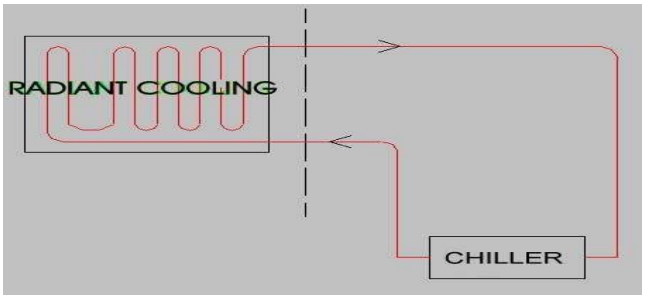
C. Pipe Sizer

As all we should understand that how the water flow to reach the radiant ceiling panels that equipment is the pipe, which can carry and allows any kind of fluid to flow through it. The pipe size calculation will be done based on the water flow in us gpm, and the head loss must not be more than 2.5 ft/100ft. Manually we can select the pipe size based on the water flow, head loss and the water velocity using schedule 40 chart.*Figures*

1) Radiant cooling from ceiling



2) water supply from chiller



3) radiant cooling panel attached to ceiling

E. Sample Calculations With Result

1) Total BTU/hr = 500 x gpm x liv. Water temp-ent water temp

Where 500 = lbs / gal x min/hr x sp heat water

Lbs/gal = 8.33

Min/hr = 60

Sp. Heat water = 1

Total BTU/hr = 500 x 4.8 x (22-12)

Total BTU/hr = 24000 BTU/hr

(each panel of ground floor LHS is having 1.96tr to convert that in BTU multiplied with 12000 i.e, 2x12000 = 24000 BTU/hr)

$$\text{Rows deep} = \frac{\text{total BTU/hr}}{\text{face area(sqft)} \times \text{WSF} \times \text{Med.x U} \times F_{FR}}$$

$$\text{Rows deep} = \frac{24000}{2.15 \times 1.2 \times 17 \times 155 \times 1}$$

Rows deep = 3.6

therefore a 4rows KWD84-6x51 will meet the required load for each panel.

6” dimension and 51” or 53” nominal tube length.

KW is the coil type

D is double serpentine

in 84 (80 is the fin series) and (4 is the rows deep)

IV. CONCLUSION

As it was discussed in my objective to find the supply cooling to the surface of the office space, using a ceiling panel at each panel 2tr of cooling is delivered with the dimension of 2400mmX600mm of panel size and the total schedule based load is 215tr for the whole three floor space (including ground floor, first floor, and second floor). And the cfm at each panel is considered 860cfm with the water flow of 516gmp for the scheduled load.Coil size which is used for the each panel is KWD84-6x51 with dual serpentine is selected where the pump value is 14.80hp(±15%) is used for flow of water in pipes sizes like 4” and $3\frac{1}{2}$".

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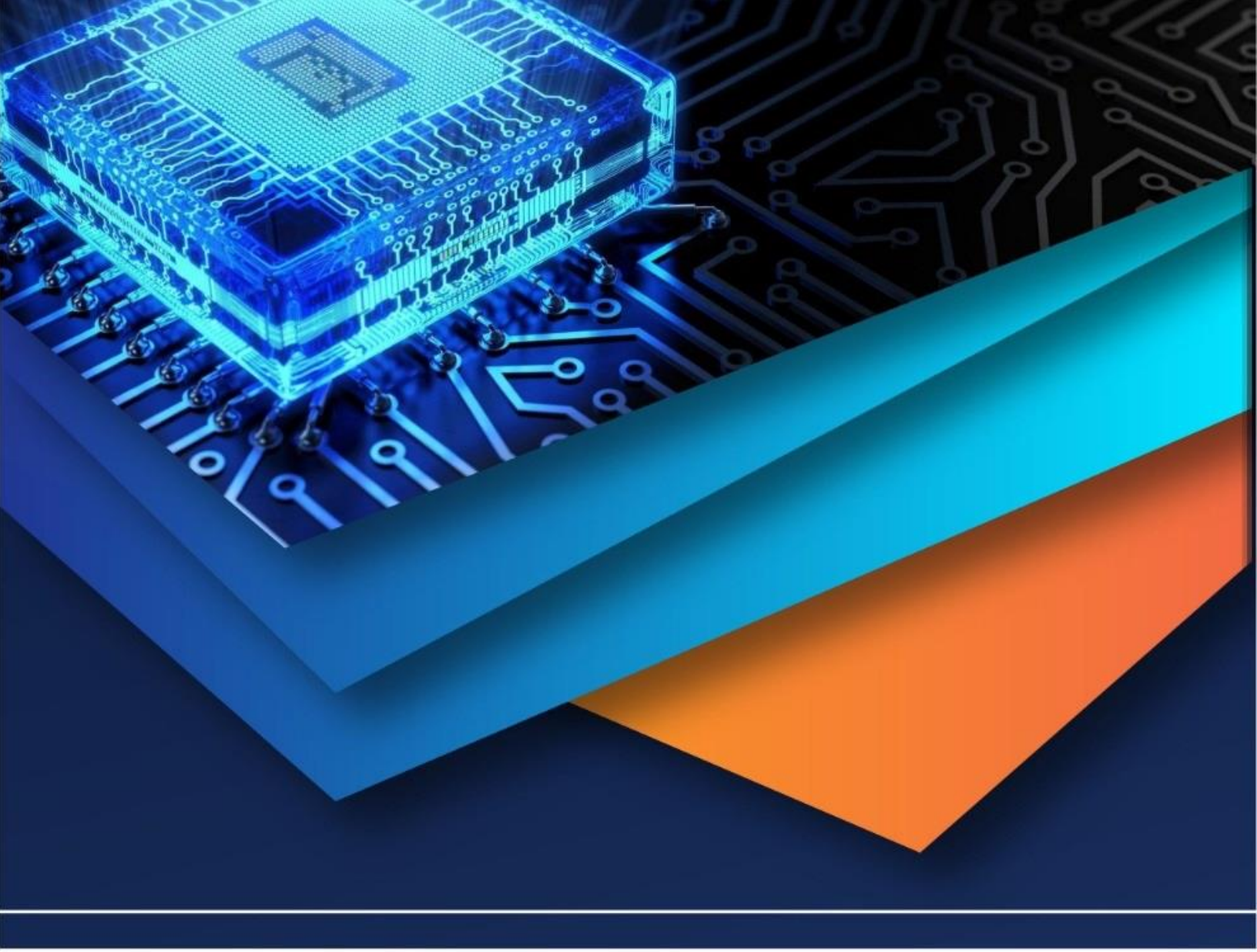

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