Designing & Analysis of Air Ducting system based on Different Duct Shapes and Conducting Internal CFD analysis Comfort Calculation using Design Builder

[1]Mohd Mohsin Ahmed, [2]Dr.N.Ravinder Reddy, [3]Syed Mauzzam Ali
[1]M.Tech Student, VJIT, Hyderabad, India.
[2]Professor, VJIT, Hyderabad, India.
[3]Technical Director TEC, Hyderabad, India.

Abstract: The main aim is to demonstrate the correlation of various duct shapes which is created on Machine with Energy Analysis and Conducting Internal CFD examination Comfort Calculation utilizing Design Builder. CFD when associated with structures can give the originator information on conceivable velocities, weights and temperatures that will happen whenever through a predefined air volume in and around building spaces. Cutoff conditions are resolved which may consolidate the effects of air, inside warmth increments and HVAC systems. DesignBuilder CFD can be used for both outside and inside examinations. Internal CFD examination gives data on the conveyance of air speed, weight and temperature all through within building spaces. Likewise figured is 'period of air' to demonstrate the relative 'freshness' of the air through the area and furthermore a solace record. This data can be utilized to survey the adequacy of different HVAC and regular ventilation framework outlines and to assess ensuing inside solace conditions.

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1. INTRODUCTION

This incorporates Duct Designing, Selection of duct material, Selection of Duct Gauge, Classification of Duct, Selection of Duct Shapes according to prerequisite, Ducting format utilizing CAD.

Undoubtedly, today the accentuation is no more on understanding air conditioning 'items' yet on making 'solutions', but rather 'tweaked solutions' that suit needs of particular business and foundations. The designer who comprehends the dynamics of those customers' business will probably offer preferred long haul arrangements over who does not.

What is Ducting?

Ducting is defined as passage of cooled air or heated air through metal or pipes from one place to another. A duct system is usually called as ductwork. The main purpose of duct is to carry air without being in contact with outside atmosphere [1].

2. DUCT MATERIALS

Galvanized steel

Galvanised mild steel is the standard and most regular material utilized in creating ventilation work in light of the fact that the zinc covering of this metal averts rusting and maintains a strategic distance from cost of painting. For protection purposes, metal pipes are normally fixed with confronted fiberglass covers (pipe liner) or wrapped remotely with fiberglass covers (duct wrap). [2]

Aluminum (Al)

Aluminum ventilation work is easy to install. Additionally, custom or extraordinary states of ducts can be effectively manufactured in the shop or on location. The ventilation work development begins with the following of the conduit layout onto the aluminum pre-insulated

board. The parts are then regularly cut at 45°, twisted if required to acquire the distinctive fittings (i.e. elbows) lastly gathered with stick. Aluminum tape is connected to all creases where the outside surface of the aluminum foil has been cut. An assortment of ribs is accessible to suit different establishment prerequisites. Every single interior joint are fixed with sealant. Aluminum is additionally used to make round duct, yet it is substantially less regular than galvanised steel. [2]

Flexible ducting

Flexible ducting is regularly made of adaptable plastic over a metal wire curl to shape a tube. They have an assortment of designs. In the United States, the protection is generally glass fleece, yet different markets, for example, Australia, utilize both polyester fiber and glass fleece for warm protection. A defensive layer encompasses the protection, and is generally made out of polyethylene or metalized PET. It is normally sold boxes containing 25' of duct compacted into a 5' length. It is accessible in widths running from as little as 4" to as large as 18", however the most usually utilized are even sizes going from 6" to 12".

Flexible duct is extremely advantageous for connecting supply air outlets to the inflexible ventilation work. It is generally appended with long zip ties or metal bands. In any case, the pressure loss is higher than for most different sorts of conduits. All things considered, planners and installers endeavor to keep their introduced lengths (runs) short, e.g. under 15 feet or somewhere in the vicinity, and attempt to limit turns. Crimps in adaptable ducting must be avoided. Some adaptable conduit markets want to abstain from utilizing adaptable channel on the arrival air parts of HVAC frameworks, anyway adaptable pipe can endure direct negative weights. The UL181 test requires a negative weight of 200 Pa. [2]

3. TYPES OF DUCTS

Rectangular Duct

Advantages:

It can be installed in fewer heights. It can be fabricated easily at site.

Disadvantages:

Friction is high in rectangular duct when compared to other ducts.

Square Duct

Advantages:

Friction is less when compared to rectangular duct.

Material required to fabricate is less compared to rectangular duct.

Disadvantages:

These ducts are installed on more heights compared to rectangular duct.

Round Duct

Advantages:

This has lowest friction.

Very less material required for fabrication.

Disadvantages:

Height required to install is big. It takes more time to fabricate.

Methodology

Cooling load is assessed for occasional conditions utilizing Software program HAP (Hourly Analysis Program) thinking about the Building introduction, Location, Materials utilized in development, calculating stream of Air for Duct Design. Air Terminal Selection [Diffusers, Disk Valve, and Supply and Return Linear Bar Grill] would be conveyed by utilizing BETA Program as indicated by the ASHRAE proposals.

Cooling and Ventilation Duct Designing would be done by SMACNA proposals utilizing Equal Friction strategy on "McQuay Duct Sizing" program. ESP [External Static pressure] figuring is done to decide the blower limit of AHU's, FCU's, FAHU's and Exhaust Fan.

The HVAC shop drawing will be readied utilizing CAD with various conduit shapes Design Builder Tool (Software) - Internal air flow and thermal examinations utilizing Computation Fluid Dynamics (CFD). Computational Fluid Dynamics (CFD) is the term used to depict a gathering of numerical methods used to discover the temperature, speed and distinctive other fluid properties all through an area of room. [3]

- Drawing the Model Geometry for CFD:

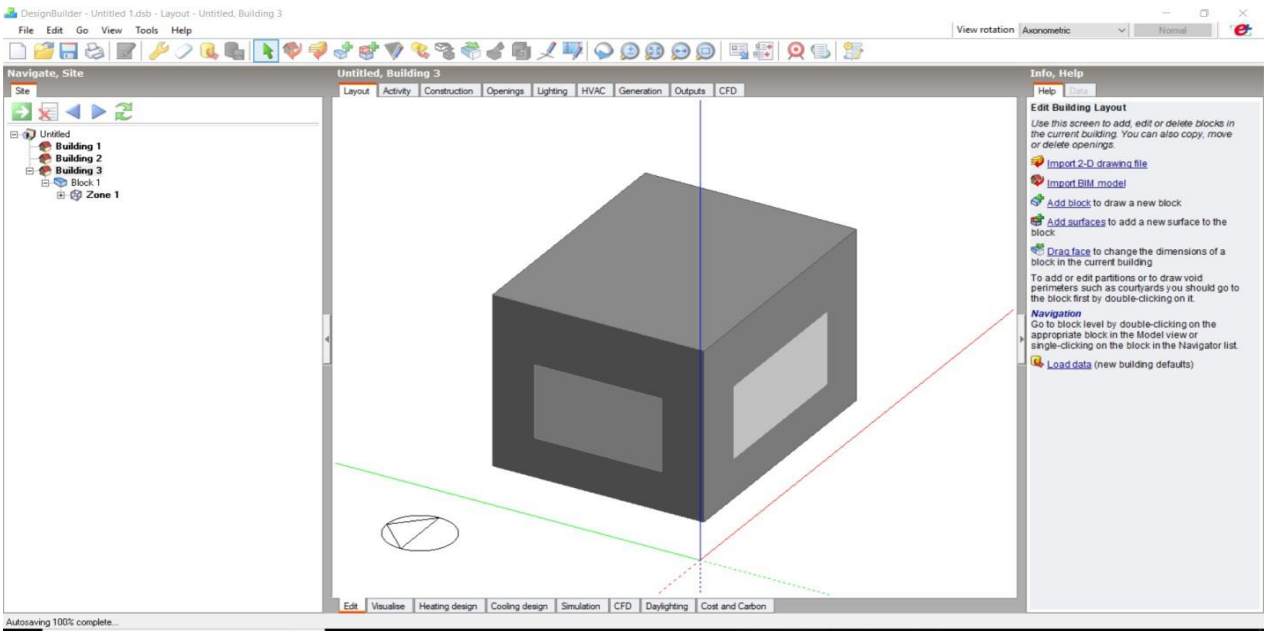

Figure 1: Model geometry in CFD.

- The above figure is a basic geometry of a room onto which CFD analysis is carried out by considering ducting with air terminal devices.

- Restricted Volume Grid and Geometric Modeling Considerations Building stages and CFD Analysis
- CFD external farthest point Conditions.
- Farthest point Conditions for Inside CFD Analysis Fragment Blocks and mix of CFD Boundaries.
- Setting Up a New outside CFD Analysis.
- Setting Up a New Inside CFD Analysis Changing the CFD Grid.
- CFD Grid Information.
- Putting Up CFD Cell Monitor Points CFD Calculation Options.

- Residuals and Cell Monitor Graphs.

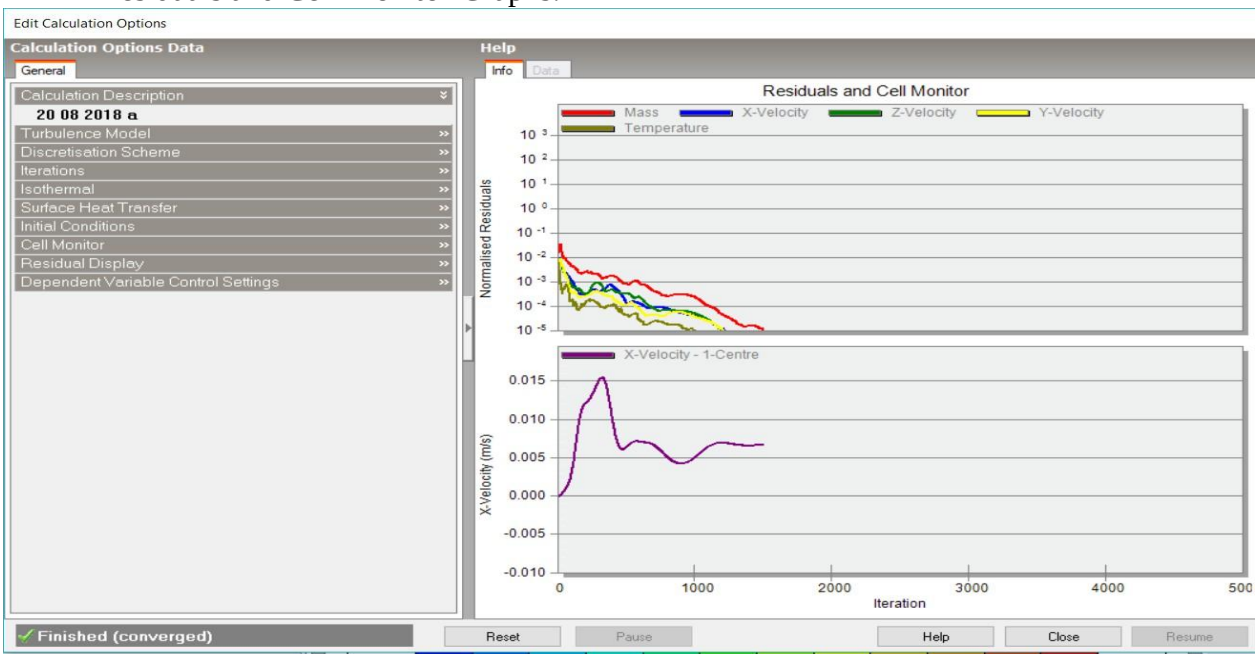

Figure 2: Residual and cell monitor graphs

- After giving input all the values like flow rate, chiller selection, number of iterations, we have to perform CFD calculations and this graph gets highlighted depending upon number of iterations carried out.
  - Challenges and adjustment.
  - Showing Results

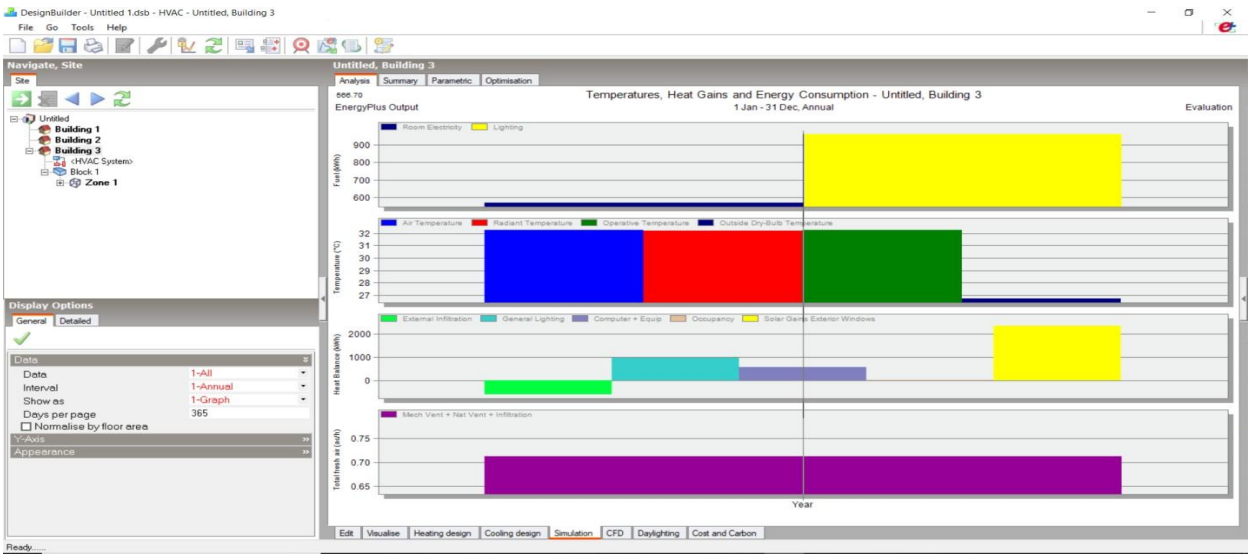

Figure 3: Temperatures, heat gains and energy consumption

- The above figure is a basic CFD simulation where we give input values like lighting load, equipment load, CFD/person, glazing details, roof surface details etc and then calculate annual energy consumption, heat and temperature.

- Directing CFD Comfort Calculations

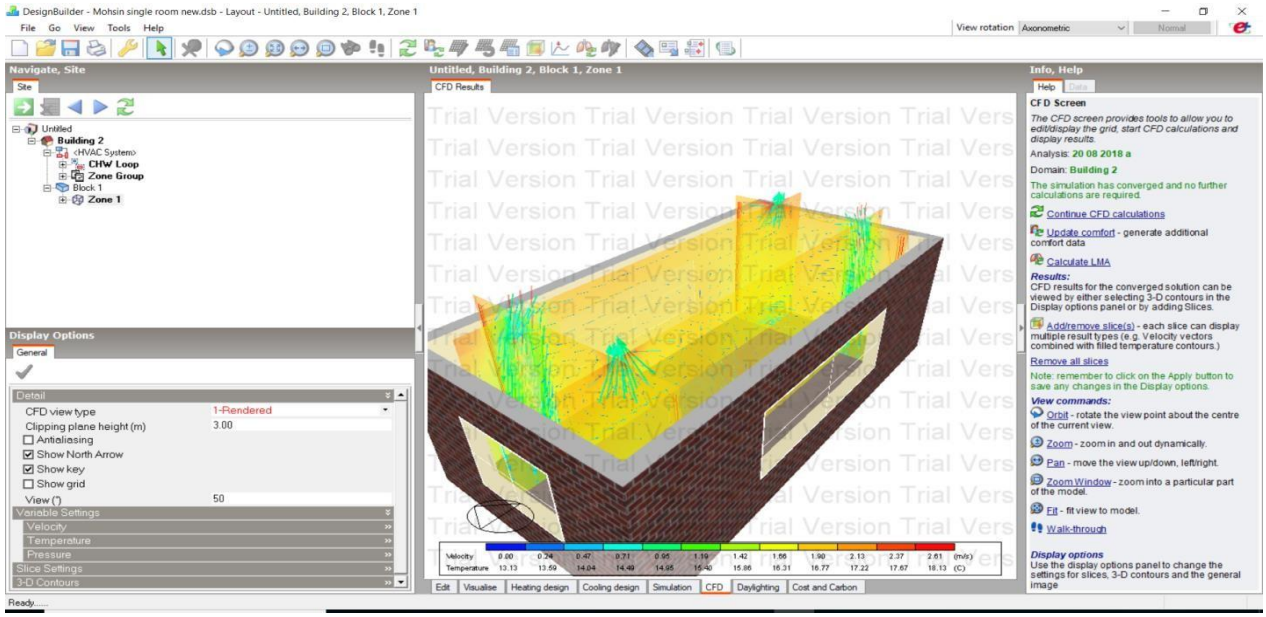

Figure 4: Air, velocity, temperature distribution through diffusers in a rendered room

- This figure explains how supply air is distributed into the space through air terminal devices whereas how return air is taken by return air terminals. This is in rendered view type. Velocity and temperatures are also shown in above figure.

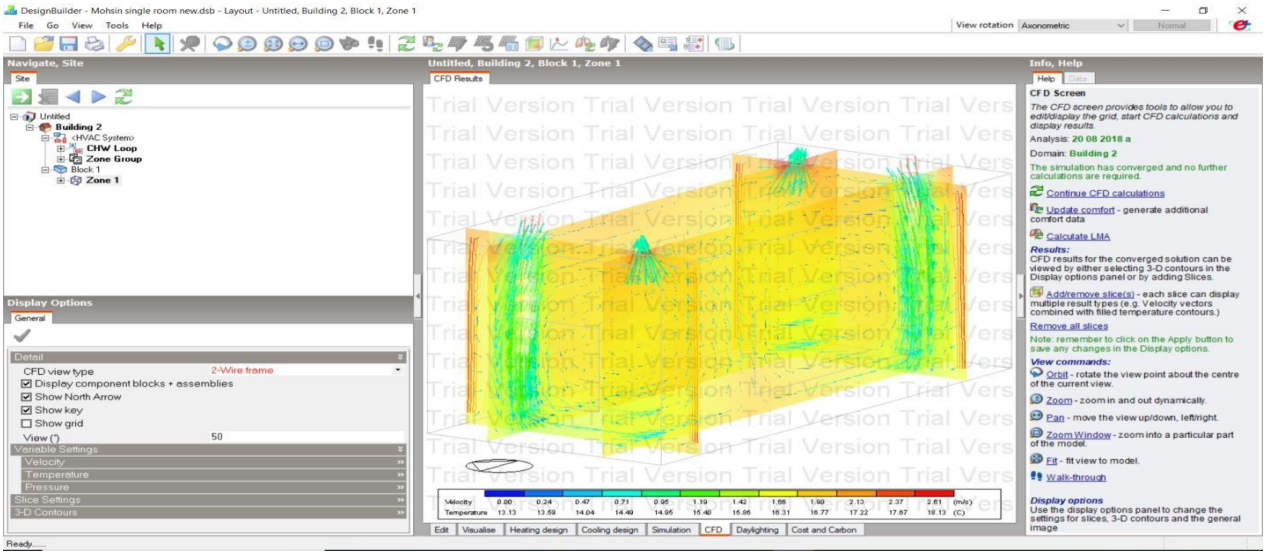

Figure 5: Air, velocity, temperature distribution in wire frame view type

- The above figure is similar to figure 4, this is shown in wireframe view type.

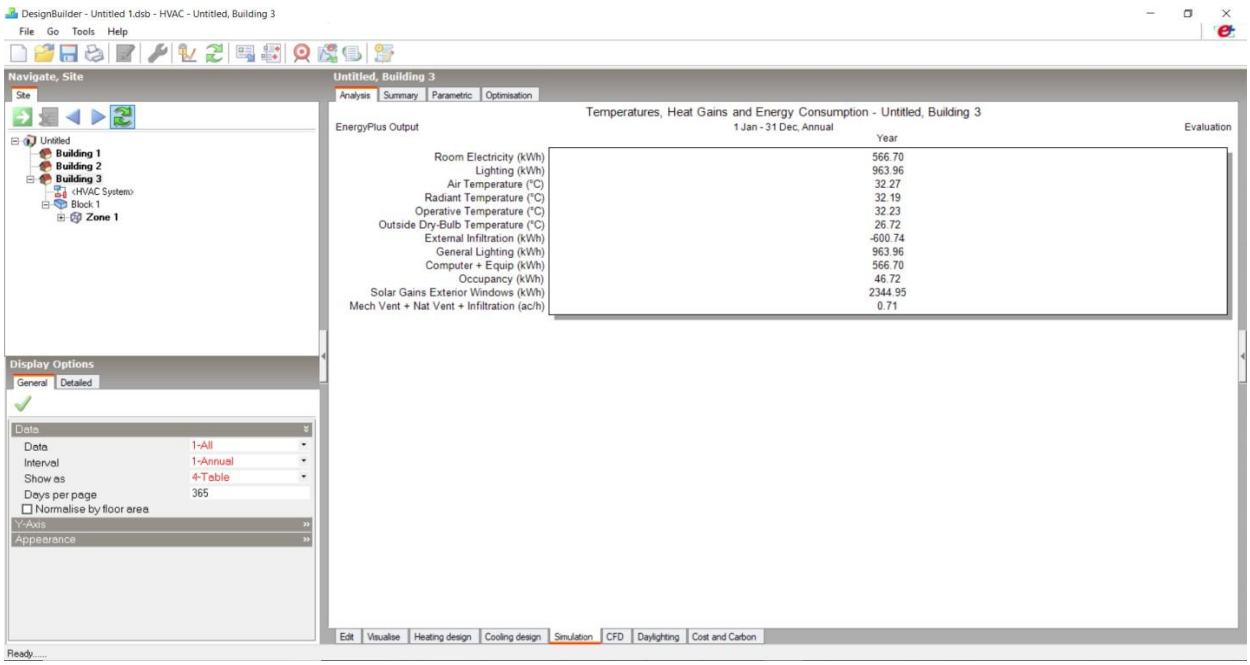

Figure 6: All annual consumption values of a given system

- This is similar to figure 3, here all individual consumption values are shown in table whereas in figure 3 it is displayed in graph.

4. CONCLUSION

A CFD analysis of air distribution for FCU with air cooled chiller has selected.
The dimensions of the room are 4m*5m*3.5m (l*b*h).
The building envelope i,e. Heat transfer coefficients for,

Wall = 0.440 w/m^2 ^oc

Roof = 0.409 w/m^2 ^oc

Internal floor = 2.47 w/m^2 ^oc

Ground floor = 0.409 w/m^2 ^oc

Glazing Details:
Window to Wall ratio (WWR) = 40%
Solar heat gain coefficient (SHGC) = 0.25
Variable light transmission (VLT) = 0.49
Sill height = 0.8m

Occupancy = 0.1076 people/m^2

Lighting power density (LPD) = 10.8 w/m^2

By performing CFD analysis onto a building, we get detailed information regarding temperature distribution, velocity, air distribution, thermal comfort, energy consumption, loads acting etc now a days CFD is playing a vital role in heating ventilation and air conditioning.
The main approach of this work is to explain how the parameters effect onto a building with air conditioning. We can decrease energy consumption by using CFD analysis. It gives us the energy consumption in various seasons like summer, winter, rainy, etc.

REFERENCES

1. The Fundamentals volume of the ASHRAE Handbook, ASHRAE, Inc., Atlanta, GA, USA, 2005.
2. HVAC Systems – Duct Design, 3rd Ed., SMACNA, 1990.
3. ASHRAE Design Manual, SMACNA Design Manual, ISHRAE Air conditioning Guide, ISHRAE Ventilation Guide, ISHRAE Journals, Carrier HVAC Design Manual.

Conflicts of Interest: The authors declare no conflict of interest.