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[Rakul * *et al.*, 7(5): May, 2018]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

VIBRATION AND NOISE ANALYSIS OF GALVANISED STEEL DUCTS

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DOI: 10.5281/zenodo.1246961

ABSTRACT

In HVAC (Heating, Ventilating & Air Conditioning) systems, ducts are used to deliver and remove air. Most commonly used material for the ducts are galvanized steel. Thin sheets are used for making various shapes of duct and duct accessories. When air flows through it, noise and vibration occurs in ducts. Applying enough load conditions to the structure of ducts become a failure, and thus increase in noise and vibration inside the duct system occurs. The focus of this paper will be on using ANSYS software to study distribution of air in the ducts, and its noise and vibration. Then after the analysis in software the experimental setup of the design is made and the setup is analysed using various instruments and studied about the details of the flow inside the ducts.

Keywords: hvac, sound, vibration, Ansys.

I. INTRODUCTION

The goal for acoustical layout of hvac systems and system is to make sure that the acoustical environment in a given space isn't unacceptably laid low with hvac system-associated noise or vibration. Sound and vibration are created via a supply, are transmitted alongside one or extra paths, and reach a receiver. Treatments and adjustments may be implemented to all or any of these factors to lessen undesirable noise and vibration, even though it's also only and least costly to lessen noise at the source. Fluid-structure interplay trouble is applicable to the noiseless design of flow ducts where the thin duct wall panels are without delay in contact with a flowing fluid. The unsteady stress growing from flow may additionally excite the bendy panel to vibrate and produces noise.Noise manage in hvac machine design includes examining sound and vibration assets, transmission paths, and receivers. Resources are the components that either generate noise and vibration (e.g., enthusiasts or pumps) or produce noise whilst airflow passes via them (e.g., dampers or diffusers). Paths are the routes with the aid of which the sound travels: thru the air, over barriers, or along a ducted system. Receivers are generally the folks that occupy a building or live within the nearby community.

Sound is a propagating disturbance in a fluid (gas or liquid) or in a stable. in fluid media, the disturbance travels as a longitudinal compression wave. Sound in air is known as airborne sound or just sound. It's far generated by using a vibrating floor or turbulent fluid movement. in solids, sound can journey as bending, compressional, torsional, shear, or different waves, which, in turn, are sources of airborne sound. Sound in solids is commonly known as structureborne sound. In hvac machine design, each airborne and structureborne sound propagation are critical. In the HVAC industry, most sound or noise is generated via rotating equipment and air and fluid movement through ducts and pipes. This movement creates vibration, sound, or noise. Technically, sound is a wave of mechanical energy that moves through matter. Noise is undesirable sound or sound without value. In this discussion, we will use sound and noise synonymously.

Vibration in its simplest form can be considered an oscillation or repetitive motion of an object around an equilibrium position. In the HVAC industry, sound is not generated without some form of vibration from equipment. Although sound is not present without vibration, there can be vibration without sound noticeable to the human ear. Therefore, the best way to reduce sound is to limit the vibration produced by mechanical equipment. Examples are rotating shafts or gears, thermal processes such as combustion, or fluid dynamic means such as airflow through a duct or fan interactions with air. Generated noise can be calculated with the empirical equation

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$L_N = 10 + 50 \log (v) + 10 \log (A)$
Where, L_N = sound power level (dB)
V = air velocity (m/s)
A = air duct cross sectional area (m^2)

II. MATERIALS AND METHODS

For this project, we are using galvanized steel duct. A model has been created using Ansys and scrutinized it using Ansys software. In the design model created, there is one inlet and four outlets. The boundary conditions given to the model are the fluid flow inside the ducts will be 6m/s. The air flow rate at inlet of the duct will be 1000L/s. The air flow rate at outlet will be of 250L/s.

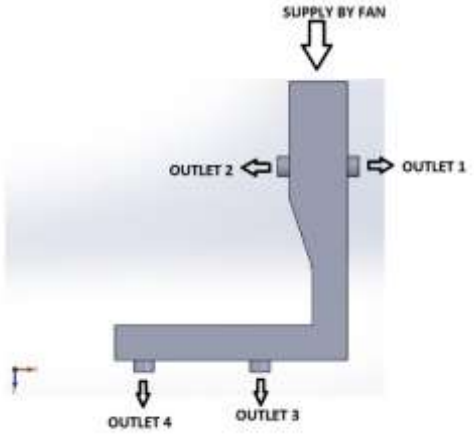

Figure 1. Ways of flow in duct model

Figure 2. Duct designing

The sizing of duct is done using Ductsizer software. While designing we use uniform velocity throughout the duct. Then we use Ansys-Fluent for analyzing the fluid flow inside the ducts. By usingthis method, we can find that the pressure is generated in some areas of the duct due to the fluid flow. Then we take this result and link it with Ansys-Random Vibration. Thus by using this we can find the occurring of vibration inside the ducts.

Also link the result with Ansys-Harmonic response. Thus we can calculate the sound generated inside the duct. The vibration and sound generated will be explored by this method. Rainbow colour analyzing is used for analyzing this result. We can also forecast the failure of the system and the disturbance occurred while air flow through duct and its fittings. Here for analysis, we use duct fittings such as reduces and elbows. The change in flow characteristics can also studied by this method.

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III. RESULTS AND DISCUSSION

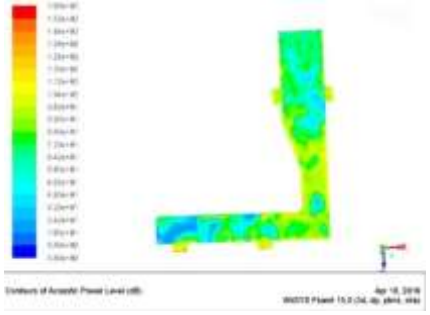

Fig.3. Sound developed when air flows

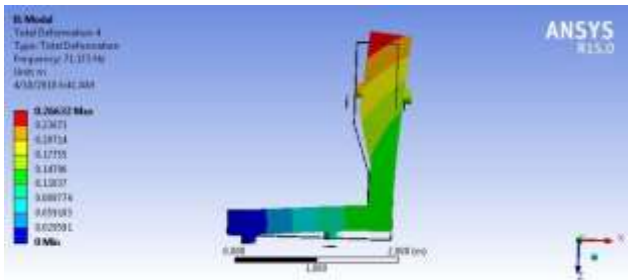

Fig. 4 . Vibration developed when air flows through duct at 6m/s through duct at 6m/s

As the problem has identified, various software and HVAC has been studied in detail. Then one model has been created. The size of the duct is calculated using Ductsizer software. We use velocity reduction method for calculation of the duct size. The model thus created has been made in Ansys geometry. We linked the geometry to Ansys-Fluent. Then we meshed that geometry to fine, to have a finite element analysis. Then we give name to faces such as inlet, wall & outlet. This model is given to analysis in fluent. Then we started making experimental setup for analyzing the sound and vibration.

Table 1, Sound level measured

SL. NO.	AIR VELOCITY	SOUND LEVEL MEASERED IN DECIBEL (dB)			
		OUTLET 1	OUTLET 2	OUTLET 3	OUTLET 4
1	8m/s	82	81	80	78
2	6m/s	66	65	63	61
3	4m/s	55	54	52	49

A fan is provided for making required air flow. A regulator is used for regulate the current, so that the fan speed is controlled. The air velocity of 4 m/s, 6m/s, 8m/s is taken into consideration. By using instruments such as anemometer, sound level meter and accelerometer, the sound level and vibration occurring in different outlets are observed.

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fig .5. experimental model

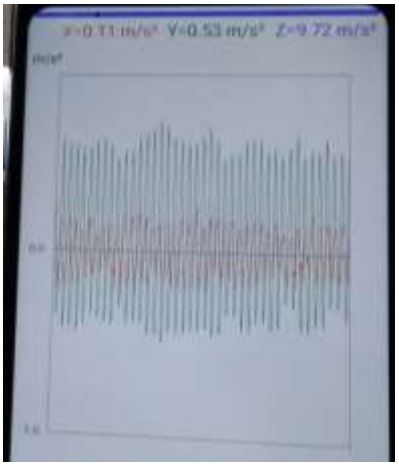

Fig.6. Vibration at outlet1 when air velocity 6m/s

IV. CONCLUSION

By American Society for Heating Refrigeration & Air Conditioning Engineers (ASHRAE), the comfort condition is made by regulating temperature, relative humidity, dust filtration, noise etc. So noise formed in duct is an important factor to be considered in the case of HVAC designing. The allowable noise level transmitted to the room by duct is ranged from 45 dB to 65 dB .

The analysis is about the noise and vibration of HVAC ducts with an experimental apparatus. The test model is created as by the ratio of calculated hvac size using duct sizer. The instruments such as sound level meter, accelerometer, and anemometer are used for making conclusion. The experimental setup is designed with a ratio of 3:1.As the air moves away from the fan, or when the inlet terminal / indoor unit place away from the air terminal of the duct, the sound and vibration decreases.

V. ACKNOWLEDGEMENTS

I express my sincere and heart-felt gratitude to the management of **RVS COLLEGE OF ENGINEERING AND TECHNOLOGY**, for providing me with the entire necessary infrastructure and other facilities to successfully complete this project.

I would like to express my thankful to **Dr. V.R.SIVAKUMAR** ME., Ph.D., Professor and Head of the Department & Project Coordinator, Department of Mechanical Engineering for his encouragement and support throughout the project.I would like to express my thankful and gratitude to my guide**Mr. U. SATHISHKUMAR** ME., (Ph.D) Asst.Professor, Department of Mechanical Engineering, for his valuable suggestions towards the completion of the project.I also thank all the Teaching and Non-Teaching staffs who supported me in many aspects for the completion of the project

ISSN: 2277-9655
Impact Factor: 5.164
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CITE AN ARTICLE

Ravi, R. A., & Sathishkumar, U. (2018). VIBRATION AND NOISE ANALYSIS OF GALVANISED STEEL DUCTS. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY,7*(5), 241-245.