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WIND TUNNEL TESTING

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Abstract: -Wind tunnel testing has long been an important component common to many introductory fluid mechanics and aerodynamics courses. wind tunnel was designed and fabricated to reduce the drag and lift forces. A wind tunnel consists of a tubular passage with the object under test mounted in the middle. Air is made to move past the object by a powerful fan system or other means. The test object, often called a wind tunnel model, is instrumented with suitable sensors to measure aerodynamic forces, pressure distribution, or other aerodynamic-related characteristics. The main work of the wind tunnel is to improve the design according to the aerodynamic shapes. It was observed that velocity is increases and pressure is decreases on the solid object with gradually increasing height up-to maximum height along the length. Understanding physical characteristics is very important to automotive aerodynamic design, for maximizing fuel economy, and in the teaching of basic principles of aerodynamic design as applied to aircraft.

Keywords: - *Aerodynamics, fabrication, design, drag and lift.*

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I INTRODUCTION

Wind tunnel was a tool used in aerodynamic investigation to evaluate the influence of air travelling pass solid objects. It involves a closed tubular passage with powerful fan system. Wind mills were confirmed in large wind tunnels, but due to huge amount of expenses to work computer modelling is used. Wind tunnels were used to evaluate the airflow around large buildings. The earliest wind tunnels were invented towards the end of the 19th century, in the early days of aeronautic research, when many attempted to develop successful heavier than-air flying machines. The US built the largest wind tunnels in 1941 situated at Wright Field in Dayton, Ohio [5].

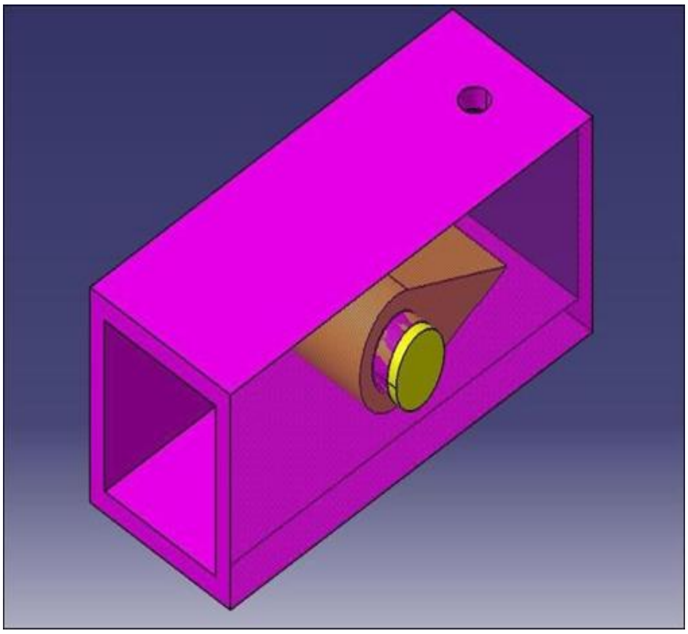
German scientists faced the problems related with spreading the valuable choice of large wind tunnels. The large natural caves which were enhanced in size by pit and then closed to stock large volumes of air can be routed through these tunnels. This advanced methodology had permitted the lab research in high-speed regimes and had enhanced the advancement of aeronautical engineering. Three different supersonic wind tunnels were developed in Germany. The design of wind tunnel and uniform air flow in the test section of wind tunnel is a challenging problem. The manufacturing cost, and vibration in each section due to the high velocity of wind flow in narrow section are the limitations. Axial fan produce a swirl.

These wind whirl passes through the wind tunnel produces dissimilar impact on the airfoil like object. According to the wind speed, the selection of shape and size of wind tunnel is a challenge in its design and fabrication. Later on, wind tunnel study came into its own: the effects of wind on manmade structures or objects needed to be studied when buildings became tall enough to present large surfaces to the wind, and the resulting forces had to be resisted by the building's internal structure. Determining such forces was required before building codes could specify the required strength of such buildings and such tests continue to be used for large or unusual buildings.

II DESIGN PROCEDURE

The parameters that need to be defined in order to start the overall design are: Width (WTC), Height (HTC) and length (LTC) These parameters allow computing the cross-sectional area: STC= WTC HTC, and the hydraulic diameter: DTC=2 WTC HTC / (WTC+ HTC).

Contraction ratio, N≈5 for low quality flow, and N≈9 for high quality flow Maximum operating speed, VTC. The analysis of the components of Wind Tunnel has been done after designing them in CATIA software according design procedure.



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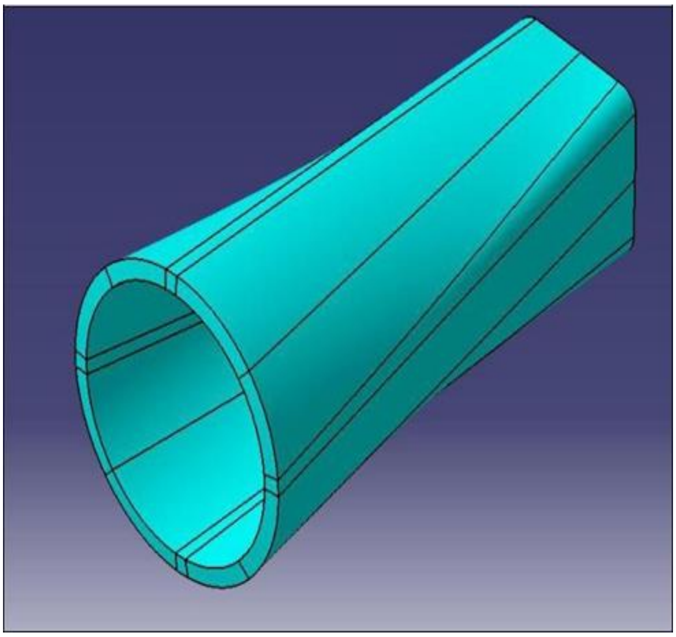
Test Section And Airfoil

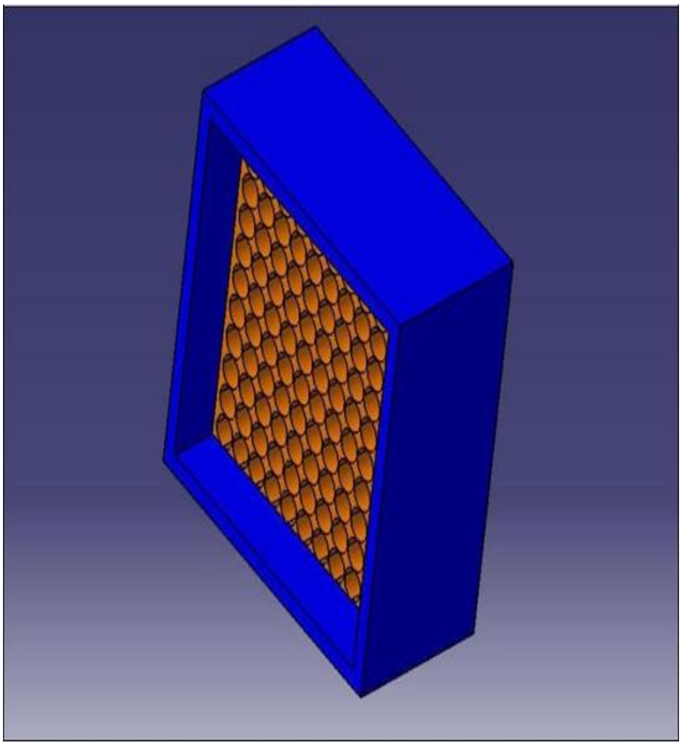
Design and fabrication of test section is one of the most important components of the wind tunnel. Before fabrication of test section need of size of test section, shape and required flow velocity is important parameters must be analyzed. The test section is the chamber in which measurements and observations were made. The size of test chamber should be large enough so that flow disturbance resulting from contraction cone sufficiently damped before reaching to the object. The test section was made with the help of plywood and fiber glass. The manufacturing of test section top and bottom surface of the test section was fabricated of plywood and side surface was fabricated with the fiber glass. All these part were assemble to each other and form a cuboids shape of box. Transparent fiber glass material was used to visualization the airstream coming from the contraction chamber and also the behavior of object with high speed.

In this test section the wind speed was approximately come with 20 m/s and the uniform air come from the contraction chamber at the end of honey comb structure. These test result was better due to uniform air and no vibration was present in these section. Damper was added on each joint of the test section which absorb vibration and prevent leakage of air from the joint.



Diffuser

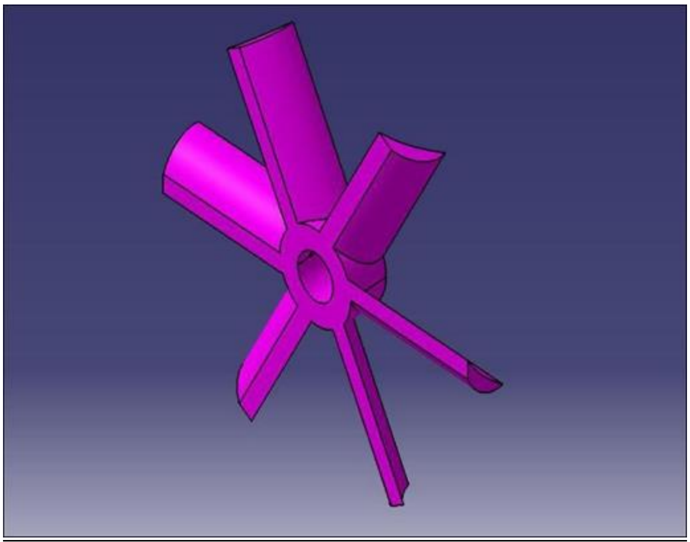
Diffuser is the most important part of wind tunnel which increases the speed of wind in test section. Diffuser create vacuum inside the test tube. Due to the vacuum creation inside the test tube the restriction decrease and increase the velocity of wind inside the tube. The design of diffuser was made on the SOLIDWORKS software shown in Fig.6. Diffuser for wind tunnel was fabricated by using plywood, fevicol and nail. We add damper in wind tunnel they absorb the vibration of diffuser and also no leakage of air at assemble joint. We add damper then they absorb the vibration of diffuser produce by the high velocity wind flow inside the diffuser. Vibration is absorb then the wind flow in uniform and minimum turbulence of wind stream. Fabrication of diffuser was carried out as per the specification



Settling Chamber With

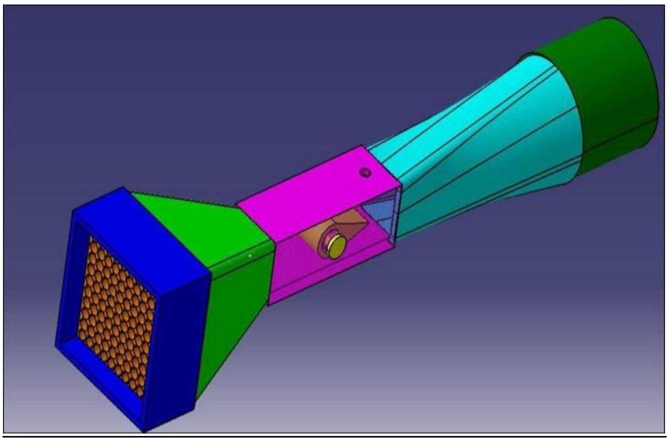
Honey Comb Structure

Settling chamber with honeycomb section in shown in Fig.1. Set- tling chamber is used for maintaining uniform wind velocity inside the wind tunnel. Manufacturing of honeycomb section is very difficult. In this work honeycomb section was created with the cutting and gluing of aluminium piece. Two settling chamber was fabricated. First we cut the four piece of plywood whose thickness is 19.05 mm thickness, length of all sides was 1000 mm. Each four piece was assemble and form a cube like structure with the help of nail and fevicol. Fevicol was used due to the two rea- son there first one is to prevent the leakage of air and another one is to increase the strength. Manufacturing of honeycomb section is quite difficult with the help of large no of circular pipes with high strength of bond between two circular pipes. The length of circular pipes was 100 mm and inner diameter was 31 mm, outer diameter was 32 mm. In honeycomb aluminium pipes was used due to low weight and high strength. The bond between two circular pipes with the help of adhesive glue makes stronger bond. Theses bond sustain a high velocity of wind striking on the aluminium pipes with high pressure. These pipes convert swirl winds, in a uniform wind and inters into the contraction chamber. We apply the adhesive glue between the two outer surfaces of pipes and then forms a bond between two pipes.



Fan

Assembly of different parts of wind tunnel was complicated along the line of alignment. There were several parts of wind tunnel viz., fan, settling chamber, contraction cone, test section and diffuser. For heavy motor and fan was fixed at a single position. A foundation was made for the driven unit then fan was fitted with settling chamber. A damper was fitted with the foundation to damped induced vibration from the prime mover. Motor and fan unit come a right position on the foundation. A plywood whose size of 1160mm×1160mm cross-section with a hole whose size of 980mm diameter was used to attached the fan with settling cham- ber.



When swirl air strike to the honeycomb, its produce vibration and honeycomb converts swirl wind into a uniform wind. Settling chamber consist the honeycomb and construction of honey comb with the help of pipe and adhesive gum shown in Fig.1. The con- traction cone was assembled with the settling chamber with the help of damper, nuts and bolts. The test section was assembled with contraction cone and test section was assembled with the diffuser. The leakage of air was checked at each section of joint. All parts of wind was assembly along the line of alignment shown in Fig.8. Stars the motor and check the leakage of air in at all matching parts of wind tunnel and then found no leakage of wind after which conduct the test in test section with the help of ane- mometer and digital pitot tube.

III ASSEMBLY OF WIND TUNNEL

Assembly of different parts of wind tunnel was complicated along the line of alignment. There were several parts of wind tunnel viz., fan, settling chamber, contraction cone, test section and diffuser. For heavy motor and fan was fixed at a single position. A foundation was made for the driven unit then fan was fitted with settling chamber. A damper was fitted with the foundation to damped induced vibration from the prime mover. Motor and fan unit come a right position on the foundation. A plywood whose size of 1160mm×1160mm cross-section with a hole whose size of 980mm diameter was used to attached the fan with settling cham- ber.

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ADVATAGES:

- Easier, cheaper way to conduct experiments rather than flight test.
- Many parameters are adjustable (wind speed, in certain wind tunnels also temperature pressure).
- Really clean, steady, laminar flow can be achieved.
- Fluid flow can be made visible with some mist, Schileren, PIV or other methods.
- Instrumentation on the model can be more extensive than in flight test.

Disadvantages:

- Limitation in size - almost everything has to be scaled down, which changes the aerodynamic characteristics like Reynold's number.
- Limitation in motions – aircraft makeovers are difficult to simulate.
- Wind tunnel walls influences the flow – boundary layer and some sort of clogging. However both effects can be reduced with more expensive wind tunnel components.

IV CONCLUSION:

There are very few wind tunnels even in some developed countries. By and large, they are of smaller/medium size and hence not suitable for automobile /energy sector trials i.e. automobiles aerodynamic studies and wind energy related testing. This is the main hurdle in research and development of these sectors. Research in this area cannot be done at college level as such facilities are not available with educational institutes. UG/PG level projects in this area cannot be taken by students. Thus entire research work in these areas is done by the industry. If more wind tunnels of medium and high capacity are constructed at university and college levels then young engineers can work on some innovative areas such as development of low speed wind turbines, efficiency improvement of vehicle by modifying it shape etc.

Wind tunnels and test models aren't cheap to build. That's why more and more organizations are deactivating their wind tunnels and shifting to computer modelling, which is now often used in place of physical models and tunnels. What's more, computers let engineers adjust infinite variables of the model and the test section without time consuming manual labour. However, physical tunnels are used to retest the results of computer modelling. Such retesting is essential in many fields and hence wind tunnels have got its own importance.

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