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Wind Tunnel for Aerodynamic Development Testing

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***Abstract*—**The study of the aerodynamics related to the improvement in the acting of airplanes and automobiles with the objective of being reduced the effect of the attrition of the air on structures, providing larger speeds and smaller consumption of fuel. The application of the knowledge of the aerodynamics not more limits to the aeronautical and automobile industries. Therefore, this research aims to design and construction of a wind tunnel to perform aerodynamic analysis in bodies of cars, seeking greater efficiency. Therefore, this research aims to design and construction of a wind tunnel to perform aerodynamic analysis in bodies of cars, seeking greater efficiency. For this, a methodology for wind tunnel type selection is designed to be built, taking into account the various existing configurations in which chose to build an open circuit tunnel, due to the lower complexity of construction and installation; operational simplicity and low cost. The guidelines for the project were teaching: the layer that limits study and analyze specimens with different geometries. For the variation of pressure in the test, section of a switched gauge used a pitot tube. Thus, it was possible to obtain quantitative and qualitative results, which proved to be satisfactory.

***Keywords*—**Wind tunnel, Aerodynamics, Air.

I. Introduction

THE effect of the air if moving around a vehicle effects of three different manners your behavior. These three manners are:

- Resistance to the movement;
- Sustentation effects;
- Effect of lateral winds.

The builders' first concern was exactly with the problem of the aerodynamic resistance, since this affects the potency sensibly consumed by the vehicle. Although the first detailed studies have been initiate in 1920, until today most of the cars possesses a form that takes the waste of potency of the order from 30 to 40%. With relationship to the lateral winds, the project of the drag of the models in production almost disrespects completely them [1]-[5]. These facts are due mainly the following causes:

- Almost completely aerodynamic study should be experimental or numeric, with great expenditure of time and money;
- The best solutions in terms of aerodynamics adapt badly to an automobile project, in design terms and internal space [1].

The study of the forces generated on submerged objects in a draught it is applied to the development and optimization of projects and products in areas as sport, ergonomics, industrial design and it would engineer mechanics and civil. The aerodynamic study can be accomplished being used tunnels of wind of different types, which can be classified in function of the construction position (vertical or horizontal), of the type of the camera (open or closed) and of the speed of the fluid (subsonic or hypersonic). In general, a convergent mouthpiece, a test section and a fan compose a wind tunnel. The convergent mouthpiece is a fundamental component for an aerodynamic evaluation with smaller involved uncertainties. According to [2]-[9] the principal effects of the mouthpiece are the reduction of the flotation of speed in the test, section and the increase of the medium speed of the drainage. The test section requests cares in the production and assembly allowing the drainage to be as uniform as it is possible, it exempts of angles and with the minimum of whirls [10]-[17]. This study proposes the project and the construction of a wind tunnel for the accomplishment of aerodynamic rehearsals seeking the best understanding of the interaction between the fluid and the structure, on the part of the academics of the course of mechanical engineering of the Federal University of Rio Grande do Norte.

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II. Materials and Methods

To simulate the effect of the air passing on the surface of the trucks of the vehicles, it was necessary the construction of an aerodynamic tunnel.

The tunnel possesses the following characteristics: total length of 4,5m; rehearsal section with dimensions of 0,50m X 0,50m, with 0,25m2 area; maximum speed of approximately 9,7m/s, obtained using a monophasic electric motor, with maximum potency of 5HP (3.7kW). Diffuser with reason of contraction of 2:1, in other words, with larger section of 1m X 1m, and section smaller 0,50m X 0,50m, that according to [4], does with that flowed him when passing for that area has an increase of the speed due to decrease of the pressure. Figs. 1-6 and Table I detail the construction and assembly of the tunnel [18]-[20].

Fig. 1 Molds for the diffuser

Fig. 2 First built piece

Fig. 3 Assembly of the contraction

Fig. 4 Armed diffuser

Fig. 5 Construction of the section of rehearsals

Fig. 6 Centrifugal fan

TABLE I
SIZING THE NUMBER OF COLLECTORS

Length	4,5 m
Maximum Height	1 m
Maximum Width	1 m
Type of the Tunnel	Soprador
Maximum Potency of the Motor	5 HP (3,7 kW)
Area of the Rehearsal Section	0,25m^2
Maximum Speed of the Rehearsal Section	9,7m/s

Fig. 7 Box of harmonization of the type beehive

In the tunnel of used wind, a centrifugal fan, moved by a motor alternating current tramway, blows the air. The air goes by a diffuser in which there is in your exit extremity to a box of the type beehive. It was also projected and built a camera of stabilization with a rectification of flow of the type beehive. They considered in the dimension of the camera of stabilization the observations of [8], according to which the length of the honeycomb should be from six to eight times the medium diameter of the cell, and the recommendation of [6], that stipulates a strip for the thickness of the wall of the cells between 0.5 and 2.0mm. The beehive was built starting from tubes of PVC that were cut with 200mm of length each one. Those parts were mounted and agglutinated, forming 625 cells of square section 50x50mm. In Fig. 7, the final assembly of the beehive can be observed.

After the diffuser, the drainage suffers an acceleration, due to the presence of a contraction in which the drainage suffers a pressure loss, that is, turns into kinetic energy (speed) that goes to the rehearsal section. The whole construction of the structures of the tunnel (diffuser, contraction, rehearsal section), they were accomplished by techniques used by [4]. Parts as: The box of harmonization of the drainage; the cooker hood to retain the coming vibrations of the motor and the helix of the motor for generation of the wind, technical were accomplished used at the Laboratory of Aerodynamics of Vehicles of the Lutheran University of Brazil - ULBRA. Figs. 8 and 9 show a view of the Pitot tube.

Fig. 8 Pitot tube

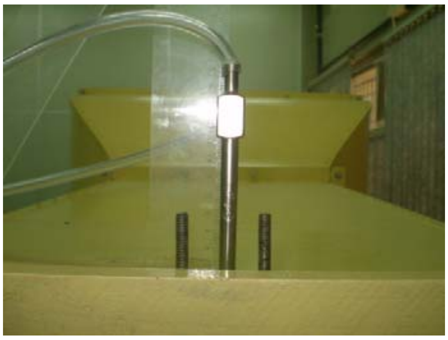

Fig. 9 Height adjustment of the Pitot tube

III. Results and Discussion

In Fig. 10, the tunnel of projected wind is presented. However, the project stage and construction is in final phase, as aerodynamic scale and system of smoke for visualization, for the longed for didactic practices.

An important result was obtained starting from the star-up of the tunnel. It treated initially of the inclusion need to the project foreseen of the expansion camera with the harmonization beehive, reason of the rotation effect imposed to the drainage by the axial fan. For it tests them initials objects of different formats they were used, chosen in a random way.

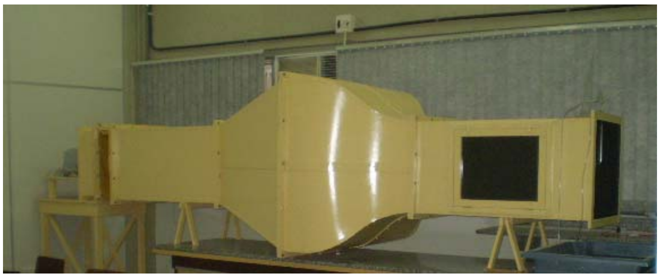

Fig. 10 Tunnel of installed wind

IV. Conclusion

Before the rehearsals accomplished in elapsing of this research, the wind tunnel behaved in a satisfactory way, having reached the objective for which was built, being this of easy construction, simplified operation and of low cost. The expansion camera with beehive was fundamental to minimize the effect of the rotation imposed to the drainage by the axial fan.

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