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Computational Fluid Analysis of Windtunnel with Cascading Effuser

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***Abstract:** It has been surveyed that wind tunnels, such as those commonly used in aerodynamic studies to analyze the flow over the aircrafts or any solid objects have come across many challenges in designing various types of the wind tunnel and achieving the streamline flow with conventional design requirements. A new attempt has been made in the wind tunnel era which overcomes these challenges. An innovative idea of using an aerofoil shaped effuser has been brought into this analysis field in which the honey-comb usage is merely necessary. Added to this, the analysis of windtunnel with cascading effuser work got much to talk about the achievement of streamline flow inside the wind tunnel in the absence of honey comb structure. Comparatively, the analysis work also resulted in greater efficiency. The construction process of this type wind tunnel falls within the economic level. Reduction in the frontal area, less maintenance, simple design contributes to the advantage of this effuser.*

***Keywords:** aerofoil shaped effuser, cascading, subsonic speed, suction type.*

1. INTRODUCTION

As we all know that the wind tunnel, an apparatus setup that is used for finding the aerodynamic forces, pressure distribution, boundary layer separation etc. In regard to this testing, fluid (air) is the most important factor which contributes much in this research work. In any type of subsonic wind tunnel the fluid is not directly sent into the test section. The flow pattern should be streamlined before the fluid reaches the test section.

Thus the honeycomb structures are used in most of the subsonic wind tunnels to ensure that the flow is streamlined. Looking deep into the honeycomb construction, wherein any single cell gets damaged by external or internal criteria, it definitely collapses the streamline path of the fluid. Whereas on the other side these honeycomb structures has to be designed to that of the size of the effuser's inlet. Added, the loss due to friction is also merely high. But this project deals with something to say that the flow can be made streamline even without the use of honeycomb. In this project the structure of the effuser is modified to make the flow streamliner. Frictional losses can be reduced to a larger level.

2. CONSTRUCTION

In general the subsonic wind tunnels being in operation uses honeycomb structure followed by the effuser. Whereas in this paper work, the effuser is in the frontal area with no honeycomb structure taken into design consideration. The whole construction resembles the shape of an unsymmetrical airfoil. This effuser is brought into picture by the way that the lower layer of the effuser follows the structure of upper camber line of the unsymmetrical airfoil meanwhile the upper curved layer of the effuser follows the shape of lower camber line of the unsymmetrical airfoil. The size of the effuser inlet is 2.5m*2.5m and its outlet is 0.5m*0.5m. The length of the effuser is 4m long. The interesting part is the arrangement of sharp edged cascade blades parallel inside to that of effuser, which plays a major role in achieving the streamline flow.

3. THEORETICAL WORKING

Like its construction, the working of the effuser is very much simple as the airfoil. The working condition of the effuser follows the Bernoulli's principle because the shape of the effuser being similar to the airfoil design. The pressure variation occurring at the walls of curved area causes not only the fluid to flow in streamlined path but also induces the velocity of the fluid flow. As the flow of the fluid is in subsonic speed, there is only mere turbulence occurring inside the effuser. Practically it is very negligible.

4. EXPERIMENTAL ANALYSIS

For analysis purpose three different designs have been considered. And various results have taken in which the best one is opted.

Case 4.1. No cascade

For every experimental analysis there is always a reference which is to be considered. Initially an effuser with no cascade arrangement is designed. The Fig.1 gives the design of such effuser. The effuser is designed with the help of CATIA V5 having the same dimensions as mentioned in the construction part.

The design is taken to computational analysis. It is analyzed with the help of an analyzing software called ANSYS. The design is actually analyzed to watch the flow behavior. The result of the flow determined from this design is given in the Fig.2.

Case 4.2. With single blade cascading

For a comparative study another effuser with single cascade is taken into consideration. The Fig.3 gives the design of this type effuser. The effuser is designed with the help of CATIA V5 having the same dimensions as mentioned in the construction part with only changes having the single cascade aligned in parallel to effuser. The design is taken to computational analysis. It is analyzed with the help of an analyzing software called ANSYS. The design is actually analyzed to watch the flow behavior. The result of the flow determined from this design is given in the Fig.4.

Case 4.3. Effuser with two blade cascading

The third design comprises of two cascade arrangements which was also designed with the help of CATIA V5. The Fig.5 gives the design of such effuser. Having the same dimensions as been mentioned in the construction part, the effuser is designed. The design is taken to computational analysis. It is analyzed with the help of an analysis software called ANSYS. The design is actually analyzed to watch the flow behavior. The result of the flow determined from this design is given in the Fig.6.

5. RESULTS

As the three distinct cases been taken to analyzing area, we finally arrived with three different results which are quite similar but among which the best one is been concluded. The first design with no cascade answered us that the flow is streamlined but there is some flow separation in the walls of the effuser. That is at a very low speed (say 30m/s) the flow seems to be very fine whereas when it is increased the flow is disturbed by the turbulence occurring at their walls.

Now looking into the second design, the one with single cascade had a little bit improvement than the design 1. The flow path was very clear and streamlined comparatively to that of the previous one. Later the final design was taken into consideration where it consisted of two cascade arrangement. Their results where even better than the effuser with single cascade. It's quite impressive that even the velocity had increased.

6. CONCLUSION

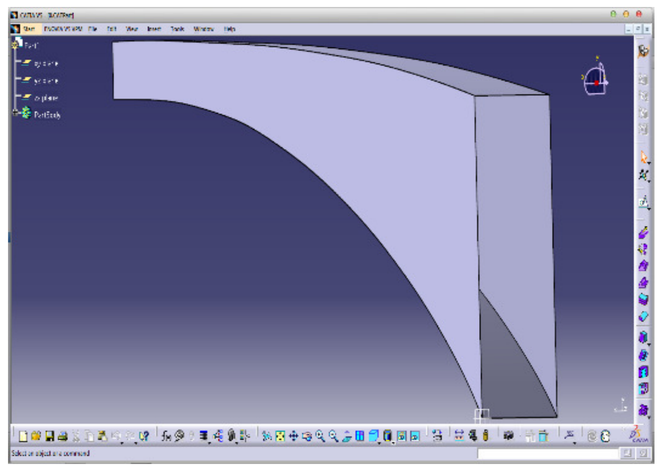
The objective being to achieve the streamline flow without the honeycomb structure, these effuser with cascade arrangements made simply possible to get that. From all the distinct results arrived from the results we got during the analysis we conclude to use the third design which had two cascade arrangements in the effuser. The design 3 actually resulted in achieving a greater streamline flow and increasing the fluid flow velocity.

On using this type of effuser we could easily get rid of constructing the honey comb structures. And a better fluid flow path is also achieved in here. Meanwhile the size being the only criteria that adds to the disadvantage.

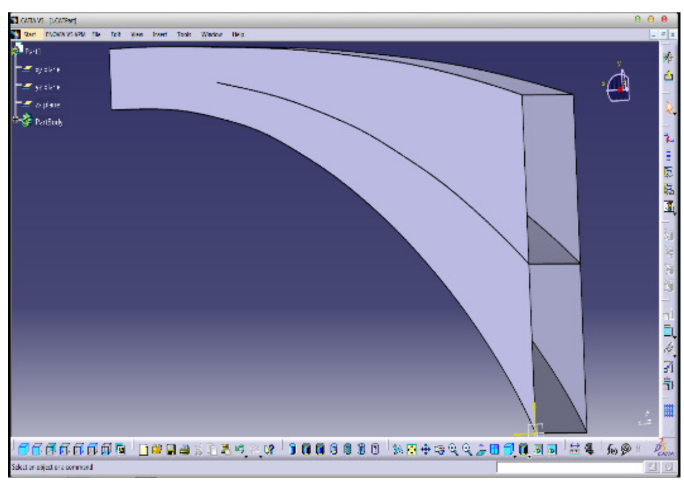
7. FUTURE WORK

This is an amateur project where only few parameters have been concentrated on. The future work can add up on using the cascade design itself in an airfoil shape which still could give a better performance in flow as well as in their velocity. This project needs some more advancement and funds in the future for the development of a real-time model.

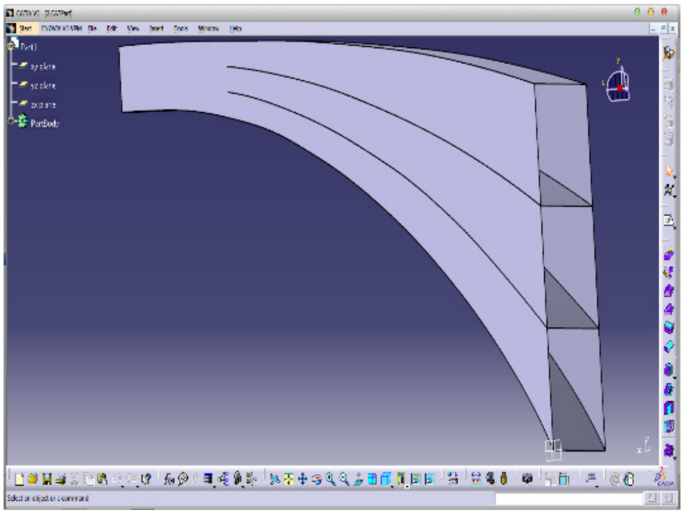
8. ANALYZED MODELS



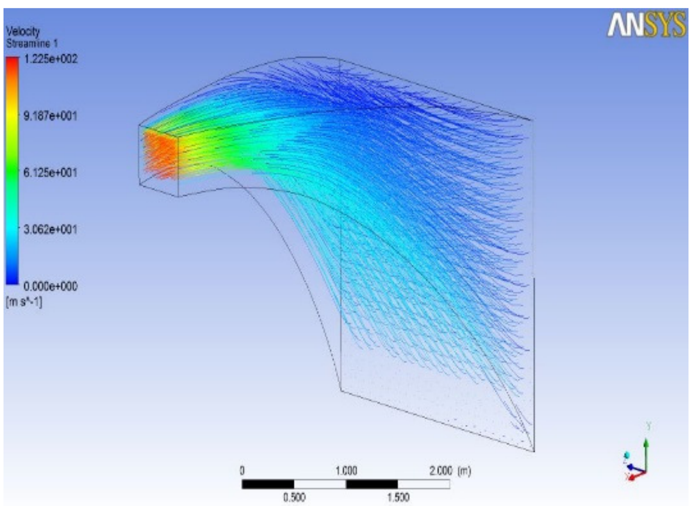
Φιγυρε 1. Εφφυσερ ωιτη νο χασχαδινγ



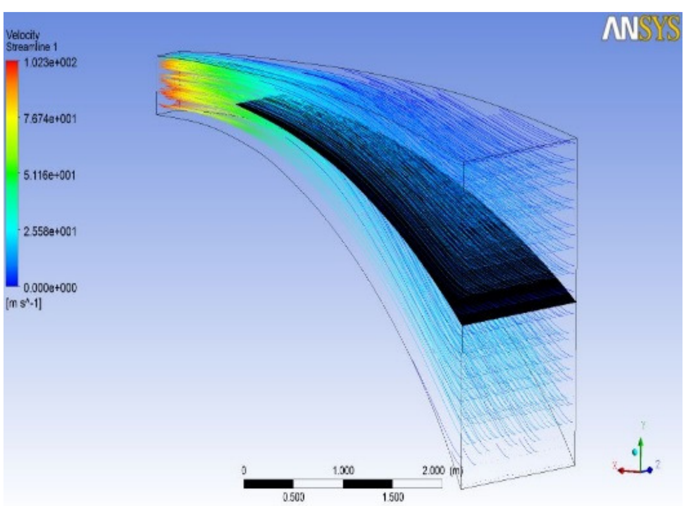
Φιγυρε 3. Εφφυσερ ωιτη σινγλε βλαδε χασχαδινγ



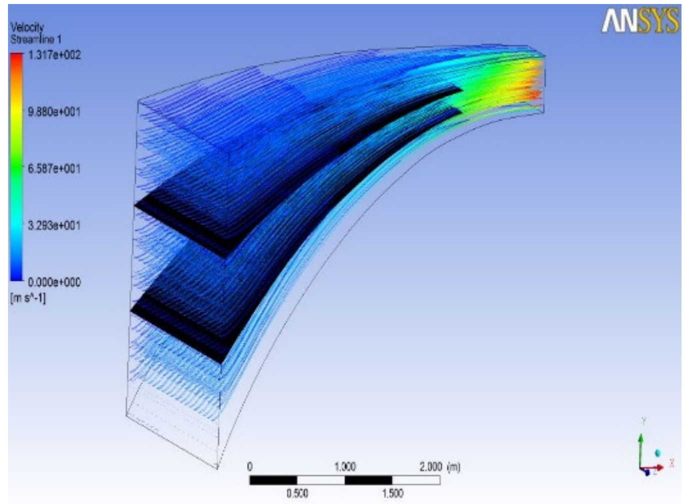
Φιγυρε 5. Εφφυσερ ωιτη τωο βλαδε χασχαδινγ



Φιγυρε 2. Αναλψσισ οφ εφφυσερ 1



Φιυρε 4. Αναλψσισ οφ Εφφυσερ 2



Φιγυρε 6. Αναλψσισ οφ Εφφυσερ 3

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REFERENCES

[1] Jewel B. Barlow., William H. Rae., and Jr. Alan Pope of "Low-Speed Wind Tunnel Testing", 3rd edition published by Wiley India Pvt Ltd in the year 2010.

[2] Richard Deloach., "The Modern Design of Experiments for Wind Tunnel Testing", published by Academic Press, ISBN-13:9780124165861.

[3] Ahmad Kassaee., Jewel B. Barlow., William H. Rae., and Jr. Alan Pope of "Low-Speed Wind Tunnel Testing", 4th revised edition published by John Wiley And Sons Ltd.

[4] Christopher Snyder., "Wind Tunnel Testing for Drag Reduction", published by Biblioscholar in the year 2012, ISBN-13:9781288369058.

[5] Jerome Clarke Hunsaker, Edgar Buckingham., "Reports on Wind Tunnel Experiments in Aerodynamics", published by Nabu Press in the year 2012, ISBN-13:9781286324875.

[6] Craig A. Zehrung., "Comparative Analysis of a Low-Speed Wind Tunnel Designed for Renewable Energy Applications", Proquest, Umi Dissertation Publication, ISBN-13:9781249846406.

[7] N.A. Ahmed., "Wind Tunnel: Designs And Their Diverse Engineering Applications"., Intech Publishers.