EXPERIMENTAL STUDY ON THE EFFECT OF SLAT TO AERODYNAMICS PERFOMANCE OF AN AIRFOIL

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2017

DECLARATION

I declare that this project report entitled "Experimental study on the effect of slat to aerodynamic performance of airfoil" is the result of my own work except as cited in the references

Signature :……………………………

Name :………………………………

Date :……………………………….

.

SUPERVISOR'S DECLARATION

I have checked this report and this report can now be submitted to JK-PSM to be delivered back to supervisor and to second examiner

Signature	:……………………………
Name of supervisor	:……………………………
Date	:……………………………

DEDICATION

To my beloved mother and father

ABSTRACT

Slat to aerodynamic that effect the efficiency, performance and quality of aerodynamic system. The purpose of this study is to determine which slat have the effect to aerodynamic performance or not with compare the lift coefficient and drag coefficient of airfoil with has slat and the lift coefficient and drag coefficient of airfoil without slat. The angle of airfoil and slat are change for different type of experiment. The difference in lift and drag coefficient of airfoil with slat and airfoil without slat are being investigate. The results obtained from the measurement and analysis is compared of airfoil with slat and airfoil without slat. Airfoil with slat show more preferred result compare to airfoil without slat in term of lift and drag coefficient. Airfoil with slat show more high in lift coefficient compare to airfoil without slat. Overall, for airfoil with angle of slat -30^{o} (downward) and angle of attack of airfoil 20^{o} show the most preferable result because this experiment get the highest in lift coefficient and lowest in drag coefficient. Based on the results, recommendations and suggestions are made to improve the aerodynamic performance.

ABSTRAK

Kesan bidai terhadap kecekapan,prestasi, dan kualiti sistem aerodinamik. Tujuan kajian ini adalah untuk menentukan sama ada bidai memberi impak terhadap kecekapan aerodinamik atau tidak, dengan membandingkan pekali daya angkat dan seretan pekali aerofoil degan mempunyai bidai dan pekali daya angkat dan seretan pekali aerofoil tanpa bidai. Sudut aerofoil dan bidai diubah untuk belainan jenis eksperimen. Perbezaan dalam pekali daya angkat dan seretan pekali aerofoil dengan bidai dan aerofoil tanpa bidai akan disiasat. Keputusan yang diperolehi daripada pengukuran dan analisis dibandingkan aerofoil dengal bidai dan aerofoil tanpa bidai. Aerofoil dengan adanya bidai persembahkan hasil yang lebih diutamakan berbanding dengan aerofoil tanpa bidai dari segi pekali daya angkat dan pekali seretan. Aerofoil dengan bidai menunjukan lebih tinggi dalam pekali daya angkat bandingkan dengan aerofoil tanpa bidai. Secara keseluruhan, bagi lelayang dengan sudut bidai -30^{o} (ke bawah) dan sudut serang aerofoil 20^{o} menunjukkan hasil yang paling digemari disebabkan ujikaji in mendapat bacaan yang tinggi dalam pekali daya angkat dan bacaan rendah dalam pekali seretan.. Berdasarkan keputusan, cadangan dibuat untuk meningkatkan prestasi aerodinamik.

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TABLE OF CONTENTS

CHAPTER TITLE PAGE

DECLARATION **ii**

SUPERVISOR DECLARATION **iii**

DEDICATION **iv**

ABSTRACT **v**

ABSTRACK **vi**

ACKNOWLEDGEMENT **vii**

TABLE OF CONTENTS **viii**

LIST OF TABLES **xi**

LIST OF FIGURES **xii**

LIST OF SYMBOLS **xiv**

CHAPTER 1 INTRODUCTION **1**

1.1 OVERVIEW 1
1.2 Problem Statement 2
1.3 Objectives 2
1.4 Scope 3
1.5 General methodology 3

CHAPTER 2 LITERATURE REVIEW **5**

2.1 OVERVIEW 5

2.2 Experimental instigation on the effect of slat geometrical configuration on aerodynamic noise 5

2.2.1 Methodology 6

2.2.2 Result and discussion 7

2.2.3 conclusion 9

2.3 Transient phenomena in separation control over a NACA 0015 airfoil 10

2.3.1 Methodology 10

2.3.2 Results and discussion 11

2.3.3 conclusion 13

2.4 Investigation of slat heel effect on the flow field over multi-element aerofoils 14

2.4.1 methodology 14

2.4.2 Results and discussion 17

2.4.3 Conclusion 18

2.5 Effect of an excrescence in the slat cover: flow field, acoustic radiation andcoherent structure 20

2.5.1 methodology 21

2.5.2 Result and discussion 24

2.5.3 conclusion 25

2.6 Failure mechanism analysis and reliability assessment of an aircraft slat 26

2.6.1 Methodology 26

2.6.2 Result 28

2.6.3 Conclusion 30

Chapter 3 METHODOLOGY 32

3.1 Overview 32

3.2 Introduction 32

3.3 flow chart 33

3.4 Equipment and Materials 34

3.4.1 clay 34

3.4.2 wind tunnel 35

3.4.3 filament abs 36

3.4.4 3D printer 36

3.5 Design the airfoil 37

3.6 Conducting Experiment 42

3.7 Data Collection 47

CHAPTER 4 RESULTS AND DISCUSSION 49

4.1 Overview 49

4.2 Experimental Results 50

4.2.1 Result for the base case (experiment 1) 51

4.2.2 Result for the air foil with slat at leading edge with 0° angle of slat (experiment 2) 52

4.2.3 Result for the air foil with slat at leading edge with +30° angle of slat(experiment 3) 52

4.2.4 Result for the air foil with slat at leading edge with -30° angle of slat (experiment 4) 54

4.3 Analysis 55

4.3.1 Analysis of experiment 1 56

4.3.2 Analysis of experiment 2 58

4.3.3 Analysis of experiment 3 61

4.3.4 Analysis of experiment 4 63

4.3.5 Experiment compare 65

CHAPTER 5 CONCLUSION AND RECOMMENDATION 68

REFERENCES 70

LIST OF TABLES

NO. TITLE

3.7.1 table use for base case in experiment

3.7.2 table use for slat and airfoil experiment

4.2.1 LIST OF EXPERIMENT

4.2.1 result for the base case

4.2.2 Result for the test of 0° angle of slat.

4.2.3 Result for the test of 30° angle of slat

4.2.4 Result for the test of -30° (downward) angle of slat

4.3.1 data and symbol

4.3.1.1 angle of attack with drag and lift coefficient

4.3.2.1 angle of attack with drag and lift coefficient

4.3.3.1 angle of attack with drag and lift coefficient

4.3.4.1 angle of attack with drag and lift coefficient

LIST OF FIGURE

Figure 1 : airfoil with slat ……….. 2
Figure 2 : schematic view of the 143 pressure tappings... 6
Figure 3 : conventional beamforming (a,b and c) / DAMAS (d,e and f) 8
Figure 4 : mea velocity profiles. a) uncontrol, seperate case b) control, attache steady case…11
Figure 5 : shear stress velocity profiles. a) uncontrolled, seperated case b) controlled , attached steady case ……..………..……………... 12
Figure 6 show the result if contour map of the pressure ad velocity correlation….................. 13
Figure 7 show the time evolution of the flow field over the airfoil... 13
Figure 8 : NACA 4412 15
Figure 9 : Four-bar FHW mechanism, notation and wind tunnel measurement 16
Figure 10 : mean velocity vector with advance slat 17
Figure 11 : mean velocity vector with conventional slat 18
Figure 12 : Scheme of the slat region... 22
Figure 13 time-averaged streamlines in the central sec-tion of the slat cove region................ 23
Figure 14 : average time streamline in cove region 24
Figure 15: methodology modelling 27
Figure 16: slat simulation model 28
Figure 17: comparison of dynamic result 29
Figure 18: result of parameter study 30
Figure 19 : .clay.. 34
Figure 20 wind tunnel... 35
Figure 21 filament abs…... 36
Figure 22 3D printer.. 36
Figure 23: naca 0015 coordinate in the website 38
Figure 24 : NACA 0015 design in solid work 38
Figure 25: slat of naca 0015 39
Figure 26: CubePro Duo 3D printer 40
Figure 27: NACA and slat 41
Figure 28 : NACA and slat (+30° angle of slat)……………………................................... 42

Figure 29 : NACA inside the wind tunnel 43
Figure 30 : protractor at top of wind tunnel Figure 31 : slope lever of pressure water 45
Figure 32: speed control module……….. 45

LIST OF SYMBOL

CD	=	coefficient lift
CL	=	coefficient drag
P	=	pressure
ρ	=	density
T	=	temperature
HIV	=	high voltage cable
$(^{0})$	=	degree
mm	=	millimeter
Hz	=	Hertz
N	=	newton
T	=	temperature
^{o}C	=	degree celcius

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

An experimental investigation on the use of NACA 0015. Airfoil is the shape of wing or a structure with curved surface designed ad with aerodynamic shaped, in this experiment the airfoil is combine with slat, as shown in figure 1. The airfoil made from ABS (acrylonitrile butadiene styrene) filament, ABS filament is made from oil-based resources and has a much high melting point, it's also hard and strong. The airfoil had a slat at leading edge. Slat actual is a narrow of plastic, slat ca change the shape of the wing when they are extended and allow the wing to produce more lift so that the airplane can fly relaxed.

The amount of lift generated by a wing depends on the shapes pf the airfoil. Slat are aerodynamic surface on the lading. This experiment is to test either the slat has an effect to aerodynamic performance of airfoil.3. lift force that directly opposes the weight of an aerodynamic object and holds the airplane in the air which it is positive force. Lift force only exist if has motion. No motion, no lift.

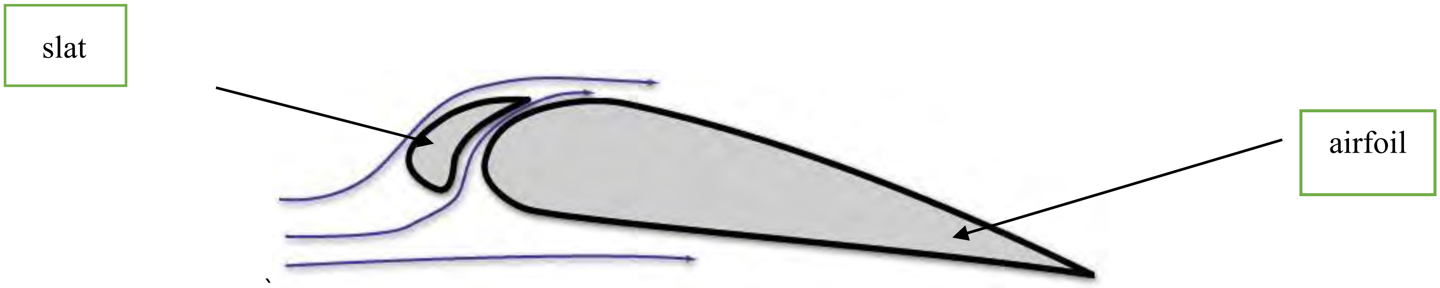

Figure 1 : airfoil with slat

1.2 PROBLEM STATEMENT

Many researchers have studied the airfoil for separation control of airfoil without slat. Most of their studies were focused on an airfoil in various applications. Since, there is a lack of study in determine drag and lift coefficient for the airfoil with has slat on it. Compare drag and lift coefficient by using different angle of attack and different angle of slat. Slat allow the airplane generate more lift and reduce the power usage of airplane, nowadays the airplane use extra power on the engine because the drag force and need to use more fuel.

1.3 OBJECTIVE

The objectives of this project are as follow:

- Measure the effect of angle-attack on slat and airfoil
- Study the effect of leading edge slat on lift and drag coefficients
- Compare the result of application of slat to the one with no slat

1.4 SCOPE OF PROJECT

The scope of this project are:

- Design and material of airfoil
- 9m/s air velocity
- Measure CL and CD
-

1.5 General methodology

The action that need to be carry out to achieve the objectives in this project are shown:

1. Literature review
    - Journals, article, book or any materials regarding the project will be review.
2. Inspection
    - The velocity profile will be determined and discuss with the supervisor.
3. Measurement
    - The measurement will conduct at a lab. For airfoil test will be conducted inside wind tunnel. The venue of test is still in discussion with supervisor due to insufficient equipment used to conduct the test. Measurement data of lift and drag force will be collected and compare with the different usage of slat angle and airfoil angle.

4. Analysis and proposed solution

   - Analysis will be present on how slat effect on lift and drag coefficient velocity of wind and the angle of attack will help in creating vortex near the surface as well as the different angle of airfoil need to be determining to lift and drag coefficient. Solution will be proposed base on analysis.

5. Report writing

   - A report on this study will be write at the end of the project.

Chapter 2

LITERATURE REVIEW

2.1 overview

Literature review is focused on previous study in the related field to obtain knowledge and information for the present study. In this chapter, journal and technical reports from other researchers are selected to be reviewed. The results obtained from the previous study will be compared.

2.2 Experimental instigation on the, effect of slat geometrical configuration on aerodynamic noise

The present study have addressed the slat noise on slat, deflection angle and overlap although slat noise level and ghostlike content are subject of increasing concern in aeronautic engineering. The paper show new experimental data on the topics. A selection of microphones placed in a closed-section wind tunnel was use in the experiment. Beam forming signal processing enhanced by DAMAS (Deconvolution Ap- proach for the Mapping of Acoustic Sources) was useful to the data. The investigational data covered a range of angles of attack and Mach numbers, for which the characteristic slat noise signature features high-level narrow-band peaks, broadband noise and a single broad tone. The narrow-band peaks frequently dominate the slat noise ranges and arise at Strophe numbers up to approximately 5. The broadband noise is well branded for Strophe numbers between 5 and 20, whereas the broad tone arises for Strophe above 20. A total of 10 dissimilar slat configurations, including variations in slat, overlap and deflection angle were verified. The slat noise dependence on slat, overlap and slat deflection angle was measured by letting each of them vary distinctly.

2.2.1 Methodology

This running process of experiment begins with aerodynamic and aeroacoustic measurement were conduct in close circuit wind tunnel. The test section was 1.3 m high, 1.7 m wide and 3.0 m long. The reduction ratio was 1:8 and the flow was determined by an eight blade axial fan. Then, do a pressure measurement and instrumentation , The wing was instrumented for chord-wise static pressure measurements at the middle span with a single line of 143 pressure tappings as shown in figure 2

Figure 2 : schematic view of the 143 pressure tappings

Next design the array and acoustic instrumentation, An array composed of 62 1/4-inch repolarized pressure microphones. The array, intended as an optimized Archimedean single-arm twisting. Then do a Geometrical sets of the high-lift model.

2.2.2 Result and discussion

- Effect of slat setting on the mean surface pressure distributions.

    The result of the circulations of a forward positioned element is to reduce the flow acceleration over the suction side close to leading edge of element, there are 2 results from a downstream lifting element, for example the main element relative to the slat. They are called ‘circulation effect’ and ‘dumping effect’.

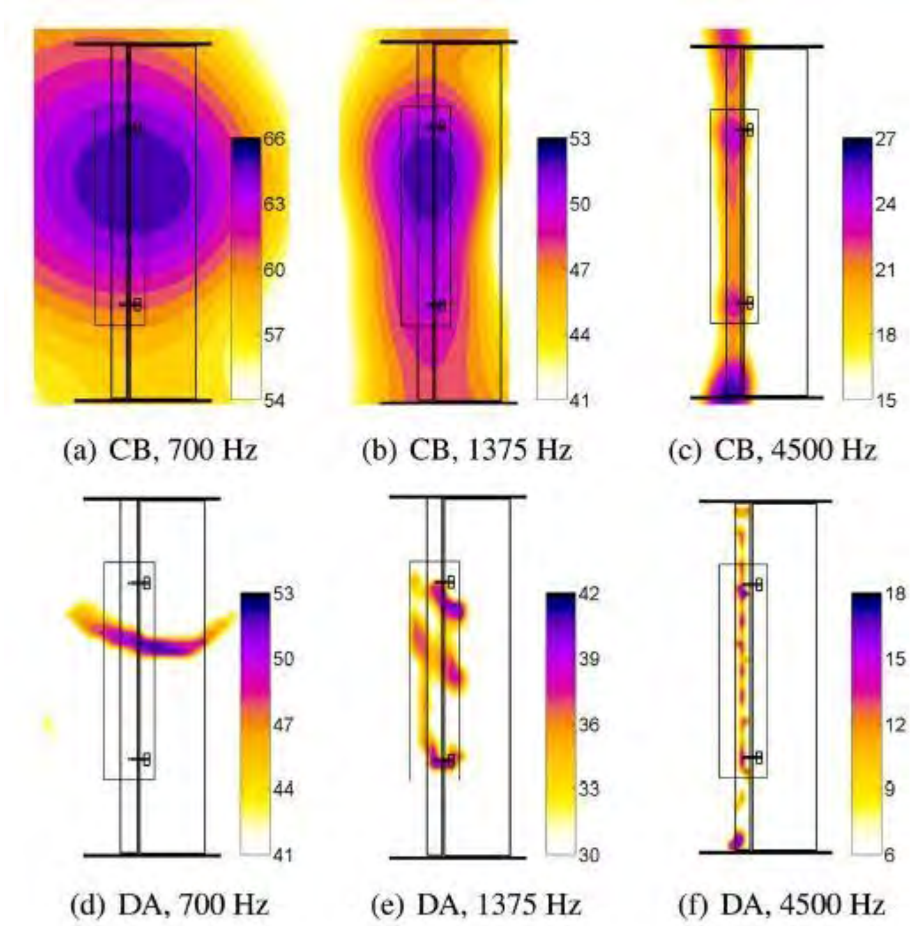

Figure 3 : conventional beamforming (a,b and c) / DAMAS (d,e and f)

The ‘circulation effect’ is related to the up wash in the trailing-edge region of the slats reason by the circulation on the main element and promote a rise in the circulation of the slat for the kutta (principle in steady-flow fluid dynamics) condition to gratified.

2.2.3 conclusion

In conclusion for a huge portion of the parameter range investigated, the small frequency multiple narrow band peaks are the supreme silent feature of the slat noise. I overall, such a noise component reduces as the angle of attack and gap increase. The data are limited, on the other hand, they suggest the gap result on the slat noise may be powerfully dependent on the overlap configuration, meanwhile the increase in the narrow band peaks with a gap reduction.

2.3 Transient phenomena in separation control over a NACA 0015 airfoil

The article show transient phenomena occurring during the impulsive control of flow separation over a NACA 0015 airfoil at an incidence angle of and a chord Reynolds number of 1 million. Actuation is did via pneumatic vortex generators, impulsively triggered in order to examine the transient phenomena corresponding to the attachment procedure and, conversely, to transient re-separation happening when the actuators are switched off. Capacities are performed using a linear array of tottering pressure transducers and an only traversing crosswire.

2.3.1 Methodology

The experiment run in the wind tunnel with test section size of 2.4 meter by 2.6 meter, with a velocity of air 40 meter per second. Naca0015 with chord length 0.35m and span with length 2.4m. airfoil pitched at an incidence 11°. This Angle-of-Attack corresponds to a 2D separation occurring 30% of chord up stream of the trailing edge. The stream wise coordinate, *x* is defined from the tailing edge (TE), *x A* corresponds to the distance from the leading edge (LE); *y* is normal to the wind tunnel axis, *z* being the span wise way. Time is non dimension allied with the length of the separation, T + = tU ∞ / L sep , where U ∞ is the external velocity and L sep = 1/3c is the length of the separated area. A limited series of smoke visualizations have been performed on a larger NACA 0015 profile still at AoA of 11 °in a small speed visualization wind tunnel.