AERODYNAMIC PERFORMANCE ANALYSIS BY ADDING *U-GROOVE* RIBLETS ON *FLAPS* WITH NACA 43018 *AIRFOIL*

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ABSTRACT
At this time NACA 43018 *airfoil is* only used on the *wing of* ATR 72 aircraft both 500 and 600 series. With the addition of *U-groove riblets* on NACA 43018 *airfoil is* expected to be used in other aircraft. Because with the addition of *U-groove riblets* that can increase the *coefficient of lift* and decrease the *coefficient of drag* so that it can increase the *performance of the airfoil*. with good *airfoil performance* it will save fuel for the aircraft and can delay separation. In this study, the analysis of aerodynamic characteristics on the airfoil was carried out by simulating the air on the test object in the form of NACA 43018 *airfoil geometry* which was given an *extension in the* form of *riblets* with variations in the shape of *u-groove* and *slotted wing*. The *software* used is ANSYS R22. Data processing using the *Computational Fluid Dynamic* (CFD) method.The results of this study are as follows C_l, C_d and C_l/C_d The results of this study show that the addition of *U-groove riblets* helps improve the *aerodynamic* performance of the NACA 43018 *airfoil flap*. With an average percentage increase C_l of all *angles of attack* given is 2% and the average percentage of decrease C_d of all angles of *attack* given is 9%

Keywords: *Airfoil*, NACA 43018, *Riblets*

1. INTRODUCTION

Due to the simple structure of the lateral interface, some typical two-dimensional groove surfaces, such as V-shaped grooves, fan-shaped grooves, and blade-shaped grooves were selected to thoroughly study the surface microstructure model of the grooves in the flow direction. However, the drag reduction rate of these surface microstructure models is not very prominent. In order to improve the surface drag reduction rate, the effect of surface hydrophobicity was proposed. Neihuis et al. Studied the surface microstructure of 300 species of plants, finding spherical crown structures and microscale waxy substances present on the rough surfaces of plants. The microstructure of the plant surface showed obvious hydrophobicity. Watson et al. Studied the microstructure of termite and cicada wings, and found spherical crown-like protrusions scattered on their wings. The microstructure of the spherical crown-like protrusions can be proposed in a new direction to improve the degree of surface drag reduction.

NACA 43018 airfoil is only used on the *wing of* ATR 72 aircraft both 600, and 500 series. With the addition of *U-groove riblets* on NACA 43018 *airfoil is* expected to be used in other aircraft. Because with the addition of *U-groove riblets* that can increase the *coefficient of lift* and decrease the *coefficient of drag* so that it can increase the *performance of the airfoil*. with good *airfoil performance* it will save fuel for the aircraft and can delay separation.

2. METHODS

2.1 Computational Fluid Dynamics (CFD)

Computational Fluid Dynamics (CFD) is a computer-based *tool* for simulating the behavior of a system involving airflow, heat transfer, and other physical processes. By the way it works is to solve the equations of the air flow equation (in a certain form) covering an area of interest, with conditions on the boundaries of the area are specific and known. (Maulana, 2018)

3. RESULTS AND DISCUSSION

The results obtained from this simulation research are in the form of a description of the *eddy viscosity contour* which aims to see the *turbulance flow* on the *airfoil*, the *pressure contour* on the *airfoil* so that the value can be calculated. C_l and C_d of NACA 43018 *airfoil* with *ribblet* and *slotted* studied. The following are the results of simulations that have been carried out at each variant of *angel of attack*

It can be seen in table 4.1 and table 4.2 which show that the greater the *Angel of Attack, the greater* the *coefficient of lift* and the greater the drag produced. By adding *riblets* to the *flap* successfully increases the *coefficient of lift* and reduces the *coefficient of drag* so as to increase the performance of the NACA 43018 *airfoil*. The maximum *lift* occurs in the NACA 43018 *airfoil* test specimen *with u-groove riblets* at the *angel of* attack with a lift coefficient of 1776. 15° with a *lift coefficient of* 1776.1512 and the maximum *drag coefficient* that occurs at *angel of* attack 20° with a *drag coefficient of* 420.91111.

Table 4.1 comparison on C_l without and with the use of *NACA* 43018 *airfoil riblets*.

Angel of attack	C_l Without Riblets	C_l With Riblets	Persentase kenaikan C_l
0°	323.31456	335.31158	4%
2°	577.06288	593.98116	3%
3°	713.56042	731.11208	2%
6°	1079.4913	1096.9029	2%
7°	1189.6724	1216.9837	2%
10°	1458.3794	1477.6252	1%
12°	1615.5229	1635.6648	1%
15°	1747.1629	1776.1512	2%
17°	1613.2519	1634.4114	1%
20°	1578.0188	1598.7068	1%

Table 4.2 Total comparison on *NACA* 43018 *airfoil*.

Angel of attack	C_d Without Riblets	C_d With Riblets	Persentase penurunan C_d
0°	38.138433	33.225961	13%
2°	45.321797	40.413218	12%
3°	50.50093	41.382269	11%
6°	72.690032	65.620513	9%
7°	82.105282	76.548964	8%
10°	118.47954	109.66413	8%
12°	159.17026	151.6974	5%
15°	243.14325	235.88777	3%
17°	325.14571	317.28423	3%
20°	427.75984	420.91111	2%

It can be seen in table 4.3 which shows that the greater the Angel of Attack, the smaller the *viscous drag*. By adding riblets to the flap successfully reduces drag at each *angel of attack*, in table 4.4 which shows that the greater the Angel of Attack, the greater the *presure drag*. Maximum *presure drag* that occurs at angel of attack 20°with a drag coefficient of 416.50914.

Table 4.3 comparison of Viscous Drag on *NACA* 43018 *airfoil*.

Angel Of attack	Viscous Drag With Riblets	Viscous Drag Without Riblets	persentase penurunan
0°	15.500312	15.501806	0%
2°	15.412656	15.508086	-1%
3°	15.407532	15.381274	0%
6°	15.192561	15.205815	0%
7°	15.037597	15.091204	0%
10°	14.730482	14.6445	1%
12°	14.277489	14.253401	0%
15°	12.879033	13.184104	-2%
17°	12.447847	12.181788	2%
20°	11.422942	11.250699	2%

Table 4.4 comparison of *Presure Drag* on *NACA* 43018 *airfoil*.

Angel Of attack	*Presure Drag with Riblets*	*Presure Drag without Riblets*	*Persentase penurunan*
0°	18.725649	22.636628	-21%
2°	25.000562	29.813711	-19%
3°	25.974737	35.119656	-35%
6°	50.427952	57.484216	-14%
7°	61.511367	67.014079	-9%
10°	94.93364	103.83504	-9%
12°	137.41991	144.91686	-5%
15°	223.00874	229.95914	-3%
17°	304.83638	312.96392	-3%
20°	409.48817	416.50914	-2%

Figure 4.1 shows a comparison of the *coefficient of lift* on the NACA 43018 *airfoil* with several angles of attack. It shows that the addition of *riblets* will increase the *coefficient of lift*. In Figure 4.2, it can be seen that the *drag coefficient increases* as the *angel of attack* increases, the two figures collaborate in *aerodynamic* performance, namely the ratios of C_l and C_d.

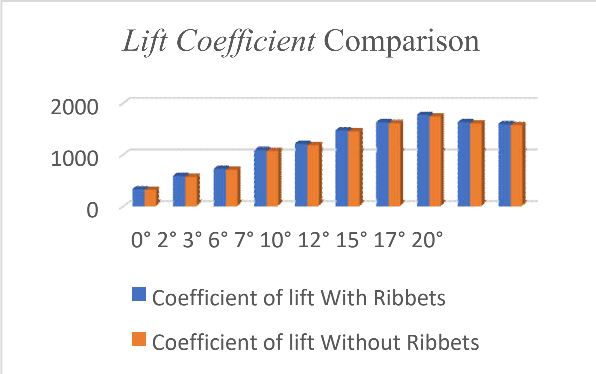

Figure 4.1 *Lift Coefficient* Comparison

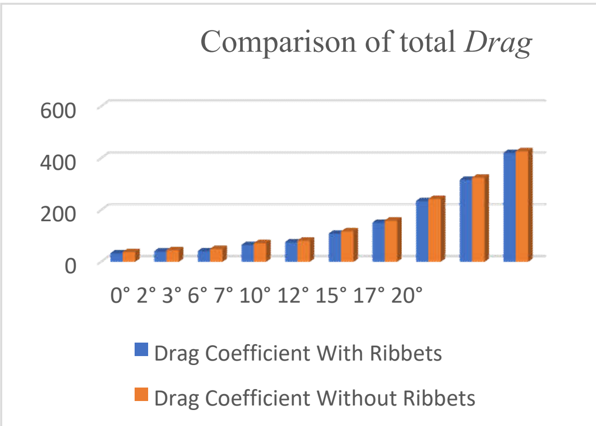

Figure 4.2 Comparison of *Drag Coefficient*

Figure 4.3 shows the ratio of C_l and C_d that the addition of *riblets* on the NACA 43018 *airfoil slotted flap* can increase the *coefficient of lift* and can reduce the *coefficient of drag*. Figure 4.4 shows the comparison ratio of *presure drag* that the greater the Angel of Attack, the greater the *presure drag* produced. Figure 4.5 shows the comparison ratio of *viscous drag* that the greater the Angel *of Attack, the* smaller the *viscous drag*.

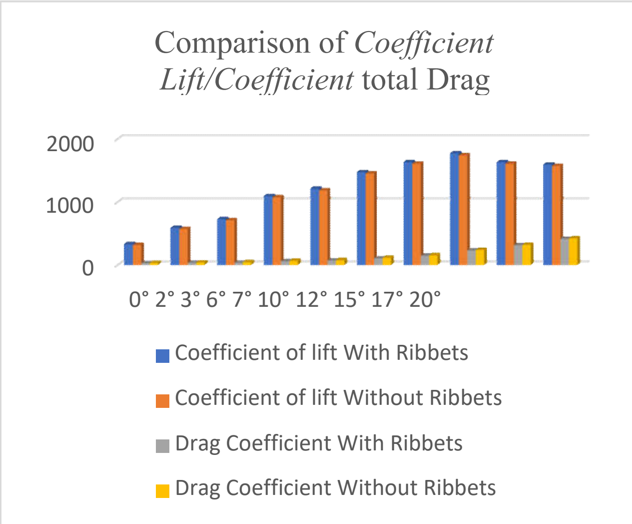

Figure 4.3 Comparison C_l/C_d

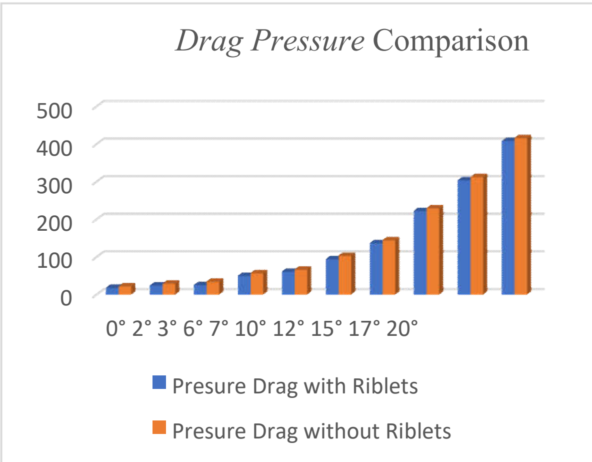

Figure 4.4 Comparison of *Drag Pressure*

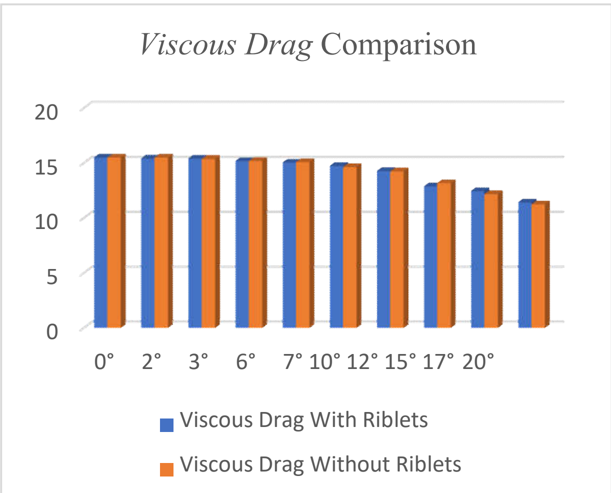

Figure 4.5 *Viscous Drag* Comparison

4. CONCLUSION

1. The addition of *u-groove riblets* on the NACA 43018 *airfoil flap* affects *aerodynamic* performance *with an average percentage reduction in drag coefficient of* 9% and an average percentage *increase in lift coefficient of* 2%.
2. Changes in *Angle of Attack* variations on NACA 43018 *airfoil flaps* affect *aerodynamic* performance with an average percentage reduction in *drag coefficient of* 9% and an average percentage *increase in lift coefficient of* 2%.

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