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Experimental Determination of the Impact of Floats on the Aerodynamic Characteristics of an OSA Model in Symmetric Flow

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Abstract. This paper presents the results of experimental determination of the impact of floats on the aerodynamic characteristics of an OSA model in symmetric flow. The studies have been performed in the low-speed wind tunnel at the Military University of Technology (MUT, Warsaw, Poland). The aircraft model was examined at the dynamic pressure q = 500 Pa in the following angle of attack range α = -28°÷28°. The investigations have been performed for an aircraft model under plain configuration with floats and without floats. The influence of elevator and flap inclination on the aerodynamic characteristics of the model has also been analysed. The obtained values of aerodynamic drag coefficient, lift coefficient, pitching moment coefficient and lift-to-drag ratio have been presented in the form of tables and graphs.

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The studies performed demonstrated that the use of floats causes the increase of aerodynamic drag coefficient C_D, maximum lift coefficient C_{Lmax} as well as critical angle of attack α_{cr}. The decrease of lift-to-drag ratio has also been observed. Its value in the case of the model with floats was up to 20% lower than in the model without floats. The studies also showed that the model equipped with floats had a lower longitudinal static stability margin than the model without floats.
Keywords: mechanical engineering, aerodynamics, wind tunnel, flow around aircraft model

1. INTRODUCTION

At the Aerodynamics Laboratory of the Institute of Aviation Technology, Military University of Technology (Warsaw, Poland), in a low-speed wind tunnel with a measuring space diameter of D = 1.1 m, the influence of floats on the aerodynamic characteristics of the OSA model was tested in symmetric flow. OSA belongs to the class of very light aeroplanes (up to 750 kg take-off weight) intended for utility purposes. Due to its versatility, it can be used by the military, Border Guard, Fire Brigades and other patrolling and monitoring services. The results of research on the aerodynamic characteristics of this aircraft can be found, among others, in [1] and [2]. Description of the design process of an aircraft equipped with floats can be found in [3]. The original chassis is a classic wheeled chassis with a front wheel. In order to increase the operational capabilities of the aircraft, it was decided to equip it with floats and study their impact on the basic aerodynamic characteristics. For this purpose, researchers at the Aircraft Construction and Operation Department of the Institute of Aviation Technology of the Military University of Technology built a 1:10 scale model of the aircraft using the latest technologies of digital mapping and surface shaping. A photograph of an aircraft model with and without floats, suspended in the test space of the wind tunnel in preparation for tests in symmetric flow, is shown in Photo 1.

The methodology and the programme of performing the aerodynamic characteristics calculations were developed on the basis of [4, 5, 6].

The aircraft model was examined at the dynamic pressure of q = 500 Pa $(V \approx 30$ m/s$)$, in the angle of attack range α = $-28^{\circ}\div28^{\circ}$. The aerodynamic coefficients in symmetric flow were related to the model wing area of S = 0.108 m^2 and mean aerodynamic chord of b_A=0.12 m. The model tested has a span of L = 0.9 m, and the length of the model with floats is 0.643m. The lift-to-drag (L/D) ratio in the tunnel necessary to calculate the corrections described in [6] was 0.82.

The model of the aircraft was suspended in the wind tunnel test space so that the axis of the pitching moment of the wind tunnel balance passed through the point corresponding to the centre of the aircraft mass, i.e. 0.18 m from the model nose (which corresponds to 25% SCA) and the longitudinal axis of the model coincided with the axis of the aircraft weight drag.

The lift and drag coefficients were determined in the flow-related system, i.e. the Ox_a axis was parallel to the direction of air flow and directed in the direction of the velocity vector, the Oy_a axis was perpendicular to Ox_a directed towards the right wing, and Oz_a axis was perpendicular to the Ox_ay_a plane. The test model was equipped with 0.534 m long and 0.083 m wide floats. The projected area of the floats on the horizontal plane was S_{pl} = 0.037 m^2. The centre of mass of the actual floats was located at the point 40% along their length.

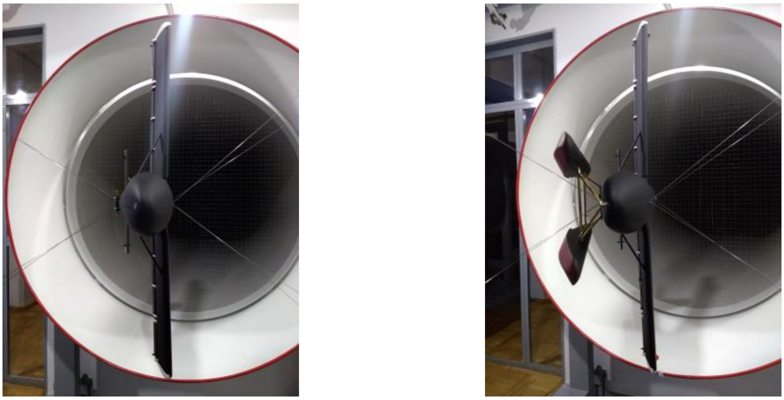

Photo 1. The OSA model with and without floats, suspended in the wind tunnel test space.

The tests were carried out for the aircraft model in the plain configuration (rudders and elements of the wing mechanization in the levelled position) with either dismantled or mounted floats. The impact of floats on the aerodynamic characteristics was also examined for the aircraft model with flaps inclined by the angle of δ_{kl} = 21° and δ_{kl} = 44° as well as elevator inclined by the angles of δ_H = ±30°, δ_H = ± 20°, δ_H = ±10°. Due to finite stream diameter in the wind tunnel, the results obtained were converted on the basis of the methodology provided in [6].

The study results were presented in the form of graphs demonstrating the course of the basic aerodynamic characteristics:

- $C_D = f(\alpha)$ – drag coefficient as a function of the angle of attack;
- $C_L = f(\alpha)$ – lift coefficient as a function of the angle of attack;
- $C_m = f(\alpha)$ – pitching moment as a function of the angle of attack;
- $K = f(\alpha)$ – lift to drag ratio as a function of the angle of attack;
- $C_L = f(C_D)$ – drag polar of the aircraft model.

2. THE IMPACT OF FLOATS ON THE AERODYNAMIC CHARACTERISTICS OF THE AIRCRAFT MODEL IN PLAIN CONFIGURATION AND WITH INCLINED FLAPS

The study of the impact of floats on the aerodynamic characteristics of the aircraft model in plain configuration and with flaps inclined by the angles of $\delta_{kl} = 21^o$ and $\delta_{kl} = 44^o$ was performed in the angle of attack ranges $\alpha = -28^{\circ} \div 28^{\circ}$ in steps of 2° and at the dynamic pressure of q = 500 Pa, which corresponded to the stream velocity at the level of $V \approx 30$ m/s and $Re \approx 210000$. The strain gauges used in the test facilitated the force measurement with the accuracy of ±0.01N, and the dynamic pressure reading from the pressure transmitter was performed with the accuracy of ±1Pa.

Drag coefficient $C_D = f(\alpha, \delta_{kl})$

The impact of floats on the patterns of drag coefficient characteristics for the aircraft model in plain configuration ($\delta_{k\ l} = 0$) and with two angles of flap inclination is presented in Fig. 1, while Table 1 specifies the most important data regarding these patterns.

Table 1. Basic data regarding the patterns of $C_D = f(\alpha, \delta_{kl})$

	model without floats			model with floats		
$\delta_{kl}{}^o$	0	21	44	0	21	44
α^o ($C_{D\ min}$)	2	0	0	2	0	-2
$C_{D\ min}$	0.09	0.10	0.14	0.131	0.15	0.19
$C_D(\alpha = -28^o)$	0.50	0.48	0.50	0.65	0.62	0.63
$C_D(\alpha = 28^o)$	0.45	0.53	0.61	0.54	0.61	0.69

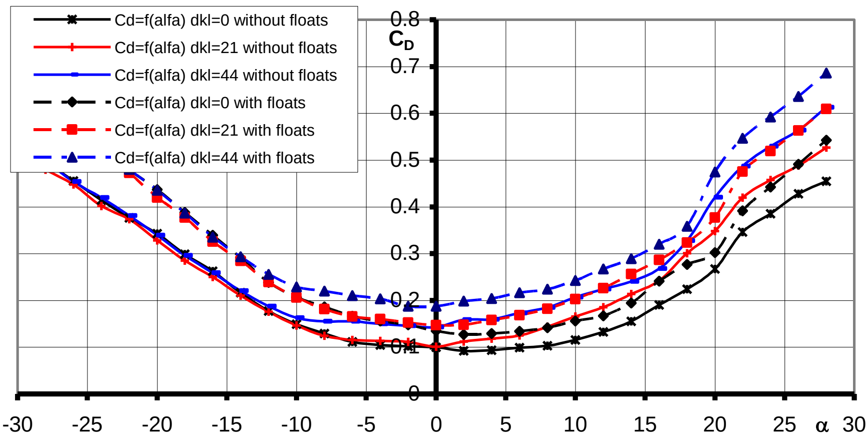

Fig. 1. Characteristics of $C_D = f(\alpha)$ for various angles of flap inclination

The analysis of the characteristics presented indicates that the presence of floats causes significant increase of the drag coefficient.

Flap inclination results in additional increase of the drag coefficient; for δ_{kl} = 21° when the angle of attack exceeds α = 0° and in the case of flap inclination by the angle of δ_{kl} = 44°, this effect is observed at $\alpha > -10°$. The situation is similar in the case of the model with floats, with the exception of δ_{kl} = 44° for which $C_{D\,a}$ increase takes place at the angles of attack $\alpha > -12°$.

Lift coefficient $C_L = f(\alpha, \delta_{kl})$

The impact of floats on the patterns of lift coefficient characteristics for the aircraft model in plain configuration and with two angles of flap inclination is presented in Fig. 2, while Table 2 specifies the most important data regarding these patterns.

Table 2. Basic data regarding the patterns of C_L= f(α, δ_{kl})

	model without floats			model with floats		
δ_{kl}°	0	21	44	0	21	44
α° (C_L = 0)	-2	-6	-9	-1	-5	-8
C_L (α = 0)	0.11	0.40	0.62	0.09	0.39	0.61
$C_{L\,min}$	-0.57	-0.52	-0.57	-0.77	-0.69	-0.74
α_{cr}°	18	16	16	20	18	18
$C_{L\,max}$	1.27	1.56	1.45	1.36	1.62	1.53

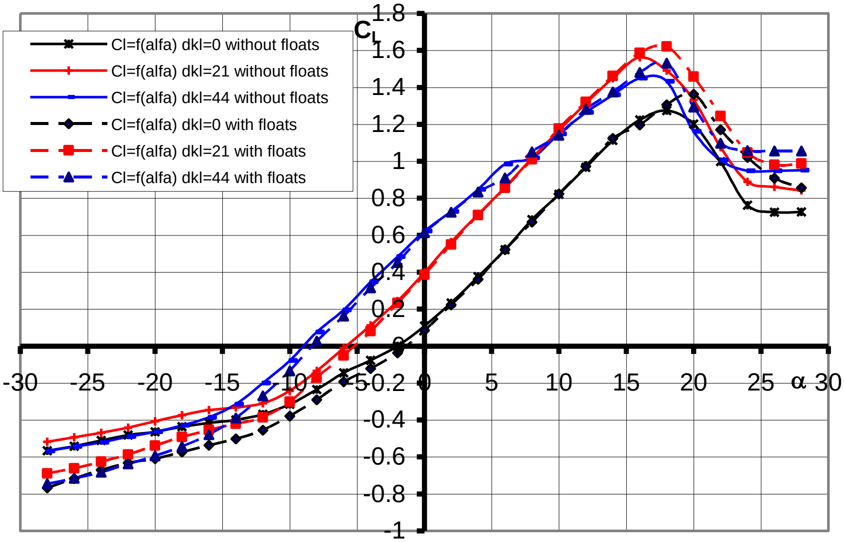

Fig. 2. Characteristics of C_L=*f*(α) for various angles of flap inclination

The analysis of patterns of the characteristics presented on the graph C_L = f(α) shows that, in every variant of flap inclination, floats cause the increase of critical angle of attack α_{cr} and C_{Lmax}. In the linear range, the above mentioned characteristics overlap for the model with and without floats.

These characteristics also demonstrate that a flap inclined by the angle of δ_{kl} = 44° is effective up to the angle of attack α = 5° in the case of the model with floats and the angle of attack α = 6° in the case of the model without floats. At higher angles of attack, C_L values are equal or lower than C_L values for δ_{kl} = 21°, which proves lower efficiency of flap inclined by the angle of δ_{kl} = 44°.

Pitching moment coefficient $C_m = f(\alpha, \delta_{kl})$ and $C_m = f(C_L, \delta_{kl})$

The pitching moment coefficient patterns as a function of the angle of attack are shown in Fig. 3a, while Fig. 3b shows the correlation of the pitching moment coefficient as a function of the lift coefficient.

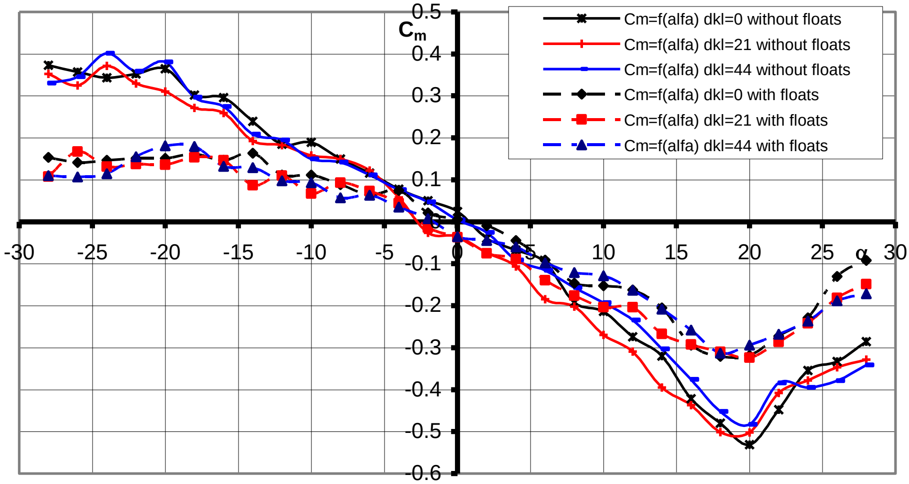

Fig. 3a. Characteristics of C_m=f(α) for various angles of flap inclination

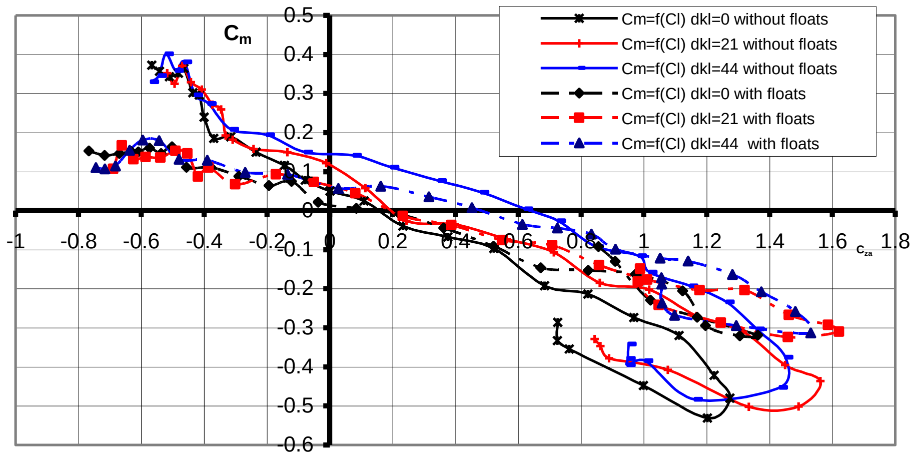

Fig. 3b. Characteristics of C_m=f(C_L) for various angles of flap inclination

The characteristics obtained show that flap inclination in the case of the model with or without floats does not cause significant quantitative changes. However, the impact of the floats at a given flap inclination angle is apparent. For the model without floats, the derivative $\partial C_m/\partial \alpha$ is more negative. By calculating the derivative [7],

$$\frac{\partial C_m}{\partial C_L} = \frac{x_Q}{b_A} - \frac{x_F}{b_A}$$

the stability margin can be determined. These values are presented in Table 3. They show that the model tested is statically longitudinally stable, but in the model without floats, the value of the stability margin is higher. It can also be seen that with the increase of the flap inclination angle, the value of the stability margin decreases.

Table 3. Basic data regarding patterns C_m=f(α, δ_{kl}) and C_m=f(C_L, δ_{kl})

	model without floats			model with floats		
$\delta_{kl}{}^o$	0	21	44	0	21	44
α^o (C_m=0)	1	-3	0	0	-3	-2
C_m (α=0)	0.02	-0.04	0	0	-0.04	-0.04
C_L (C_m=0)	0.17	0.19	0.62	0.09	0.16	0.454
$C_m(\alpha_{cr})$	-0.48	-0.44	-0.38	-0.32	-0.31	-0.31
$C_{m\ min}$	-0.53	-0.50	-0.48	-0.32	-0.32	-0.31
$\frac{\partial C_m}{\partial C_z}$	-0.36	-0.32	-0.3	-0.22	-0.2	-0.18

Lift-to-drag ration *K* = f(α, δ_{kl})

The patterns of lift-to-drag as a function of the angle of attack K = f(α, δ_{kl}) are presented in Fig. 4, while the numerical values in characteristic points are presented in Table 4.

Table 4. Basic data regarding the patterns of K = f(α, δ_{kl})

	model without floats			model with floats		
$\delta_{kl}{}^o$	0	21	44	0	21	44
$-\alpha_{opt}{}^o$	-10	-12	-16	-12	-12	-16
K_{min}	-2.11	-1.75	-1.49	-1.91	-1.61	-1.43
$\alpha_{opt}{}^o$	12	12	6	12	12	12
K_{max}	7.32	7.09	5.70	5.83	5.84	4.80

As the graphs show, despite the fact that floats cause the increase of the C_{Lmax} value, the simultaneous drag increase results in the decrease of lift-to-drag ratio.

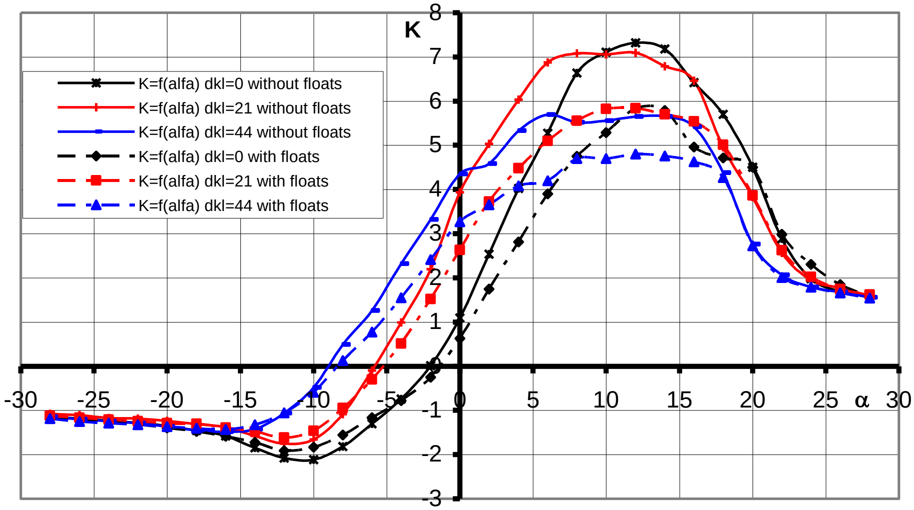

Fig. 4. Characteristics of K=f(α) for various angles of flap inclination

Drag polar C_L = f(C_D)

The drag polar of the aircraft model presented in Fig. 5 has a typical pattern. The drag polar can be used to determine the characteristic aerodynamic parameters: C_{Lmin}, C_{Lmax}, C_{Dopt}, K_{max}, K_{min}, which have been provided in the previously analysed characteristics.

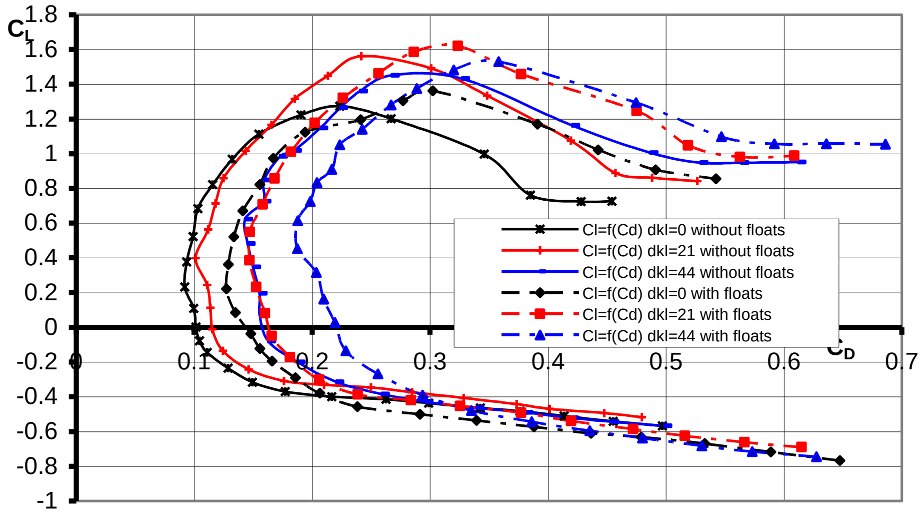

Fig. 5. Characteristics of C_L=f(C_D) for various angles of flap inclination

3. THE IMPACT OF FLOATS ON THE AERODYNAMIC CHARACTERISTICS OF THE AIRCRAFT MODEL WITH INCLINED ELEVATORS

The study of the impact of floats on the aerodynamic characteristics of the aircraft model with inclined elevators was performed for the cases of $\delta_H = \pm 30^o$, $\delta_H = \pm 20^o$, $\delta_H = \pm 10^o$ with flaps in the levelled position. The adopted positive elevator inclination angles were the ones causing negative pitching moment (downward inclination of the elevator trailing edge). For comparison, the graphs include model characteristics in plain configuration, that is for $\delta_H = 0^o$.

Drag coefficient $C_D = f(\alpha, \delta_H)$

The patterns of drag coefficient (Fig. 6 and Fig. 7) for the case of flow around the model without floats and with floats have parabolic shapes. The characteristics obtained for the model with floats are shifted towards higher C_D values in relation to the characteristics obtained for the model without floats. In both cases considered, the lowest C_D values occur in the case of elevator inclination by the angle of $\delta_H = 0^o$, but for the model with floats this value is 38% higher than the values obtained for the model without floats.

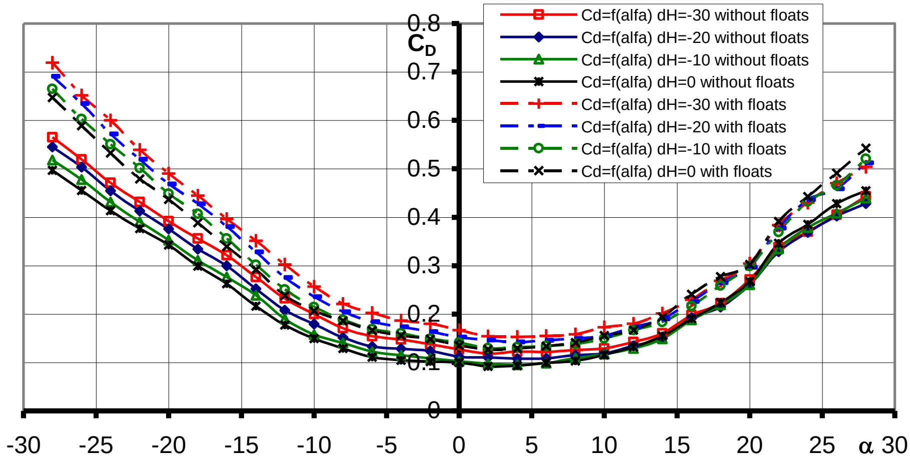

Fig. 6. The characteristics of C_D=f(α) for the model with floats and without floats with inclined elevator, dH from -30° to 0°

Table 5. The basic data regarding C_D=f(α, δ_H) patterns for dH from -30° to 0°

	without floats				with floats			
$\delta_H{}^o$	-30	-20	-10	0	-30	-20	-10	0
α^o ($C_{D\ min}$)	2	4	4	2	4	4	2	2
$C_{D\ min}$	0.12	0.11	0.09	0.09	0.15	0.14	0.13	0.13
$C_D(\alpha=-28^o)$	0.56	0.55	0.52	0.50	0.72	0.69	0.67	0.65
$C_D(\alpha=28^o)$	0.44	0.43	0.44	0.45	0.50	0.51	0.52	0.54

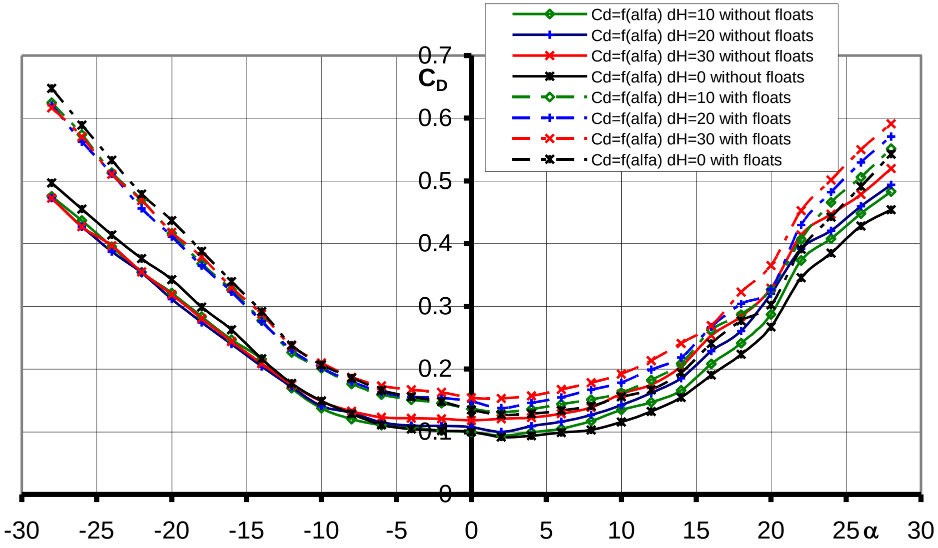

Fig. 7. The characteristics of C_D=f(α) for the model with floats and without floats with inclined elevator, dH from 0° to 30°

Table 6. The basic data regarding C_D=f(α, δ_H) patterns for dH from 0° to 30°

	without floats				with floats			
δ_H°	0	10	20	30	0	10	20	30
α° ($C_{D\ min}$)	2	2	2	0	2	2	2	2
$C_{D\ min}$	0.09	0.09	0.10	0.12	0.13	0.13	0.14	0.15
C_D(α=-28°)	0.50	0.48	0.47	0.47	0.65	0.62	0.62	0.62
C_D(α=28°)	0.45	0.48	0.49	0.52	0.54	0.55	0.57	0.59

Lift coefficient C_L = f(α, δ_H)

The patterns of lift coefficients for the model without and with floats are presented in Figures 8 and 9, while the significant numerical data are presented in Tables 7 and 8. In each of the cases considered, the use of floats caused the increase of α_{cr} by 2° and the increase of C_{Lmax} by about 5% to about 7,5% depending on the angle of elevator inclination.

Table 7. The basic data regarding C_L=f(α, δ_H) patterns for dH from -30° to 0°

	without floats				with floats			
δ_H°	-30	-20	-10	0	-30	-20	-10	0
α° (C_L=0)	0	0	-1	-2	0	0	-1	-1
C_L (α=0)	0	0	0.06	0.11	0	0	0.04	0.09
$C_{L\ min}$	-0.63	-0.63	-0.61	-0.57	-0.82	-0.81	-0.79	-0.77
α_{cr}°	18	18	18	18	20	20	20	20
$C_{L\ max}$	1.15	1.17	1.21	1.27	1.22	1.25	1.30	1.36

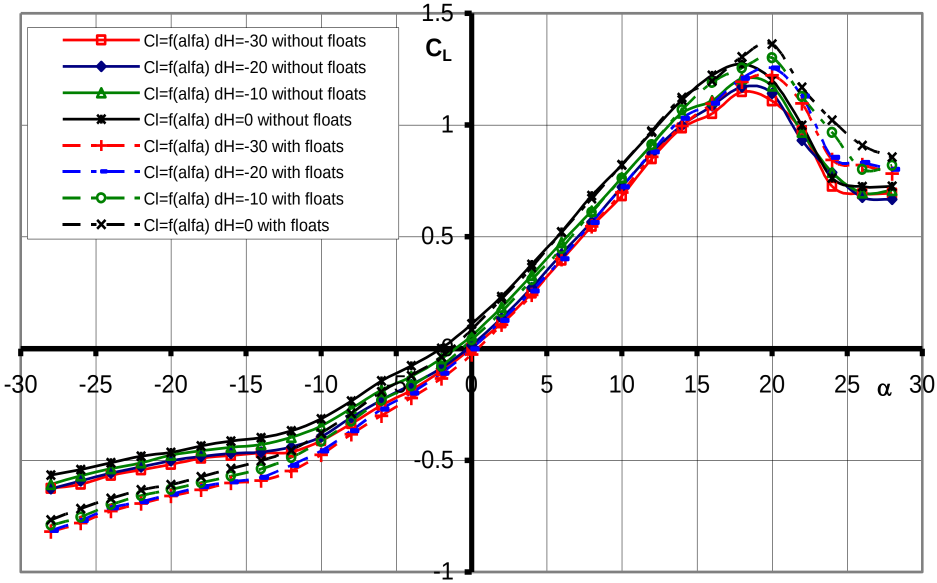

Fig.8. The characteristics of C_L=f(α) for the model with floats and without floats with inclined elevator, dH from -30° to 0°

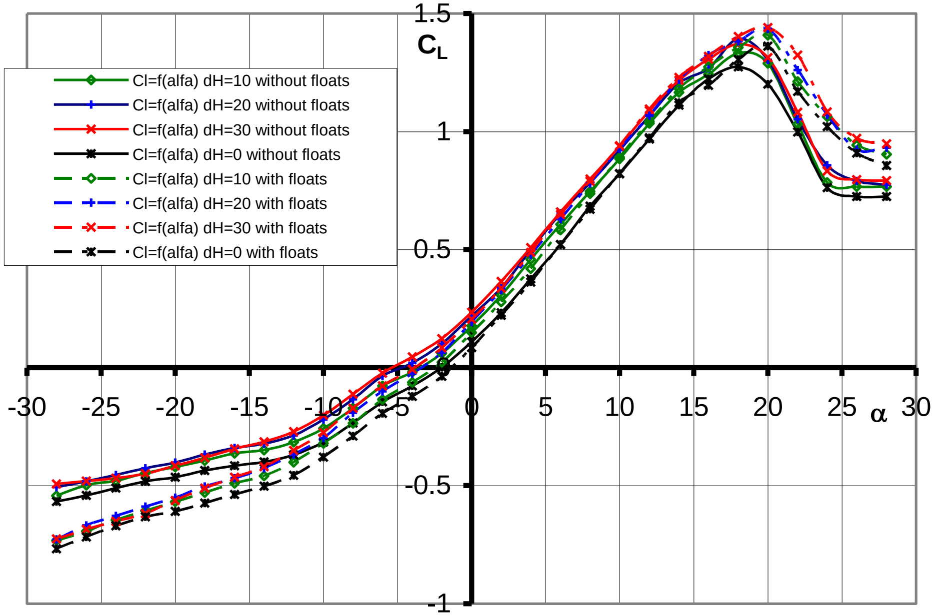

Fig. 9. The characteristics of C_L=f(α) for the model with floats and without floats with inclined elevator, dH from 0° to 30°

Table 8. The basic data regarding C_L=f(α, δ_H) patterns for dH from 0° to 30°

	without floats				with floats			
δ_H°	0	10	20	30	0	10	20	30
α° (C_L=0)	-2	-3	-4	-5	-1	-2	-3	-4
C_L (α=0)	0.11	0.18	0.22	0.23	0.09	0.15	0.19	0.21
C_{Lmin}	-0.57	-0.54	-0.51	-0.49	-0.77	-0.735	-0.73	-0.73
α_{cr}°	18	18	18	18	20	20	20	20
C_{Lmax}	1.27	1.33	1.391	1.37	1.36	1.41	1.43	1.44

Pitching moment coefficient C_m = f(α, δ_H)

The patterns of the pitching moment coefficient as the function of the angle of attack are presented in Figures 10 and 11, while the significant numerical data are included in Tables 9 and 10. The elevator inclination, both for the model with floats and without floats, caused the ‘downward’ shift of the characteristics along with the elevator inclination angle increase. The impact of the floats on C_m = f(α) patterns is also apparent. Similarly to the tests with inclined flaps, we can see that in the case of the model without floats, derivative $\partial C_m/\partial \alpha$ is more negative.

Table 9. The basic data regarding C_m=f(α, δ_H) patterns for dH from -30° to 0°

	without floats				with floats			
δ_{kl}°	-30	-20	-10	0	-30	-20	-10	0
α° (C_m=0)	13	11	8	1	16	16	9	0
C_m (α=0)	0.32	0.28	0.16	0.02	0.30	0.27	0.13	0
C_L (C_m=0)	0.92	0.80	0.62	0.17	1.10	1.10	0.68	0.09
C_m(α_{cr})	-0.15	-0.20	-0.29	-0.48	-0.04	-0.05	-0.19	-0.32
$C_{m\ min}$	-0.28	-0.23	-0.36	-0.53	-0.04	-0.07	-0.21	-0.32

Table 10. The basic data regarding C_m=f(α, δ_H) patterns for dH from -30° to 0°

	without floats				with floats			
δ_{kl}°	0	10	20	30	0	10	20	30
α° (C_m=0)	1	-8	-12	-13	0	-14	-20	-19
C_m (α=0)	0.02	-0.16	-0.24	-0.29	0	-0.15	-0.28	-0.28
C_L (C_m=0)	0.17	-0.17	-0.29	-0.29	0.09	-0.46	-0.55	-0.54
C_m(α_{cr})	-0.48	-0.60	-0.67	-0.75	-0.32	-0.47	-0.55	-0.59
$C_{m\ min}$	-0.53	-0.64	-0.70	-0.75	-0.32	-0.50	-0.55	-0.62

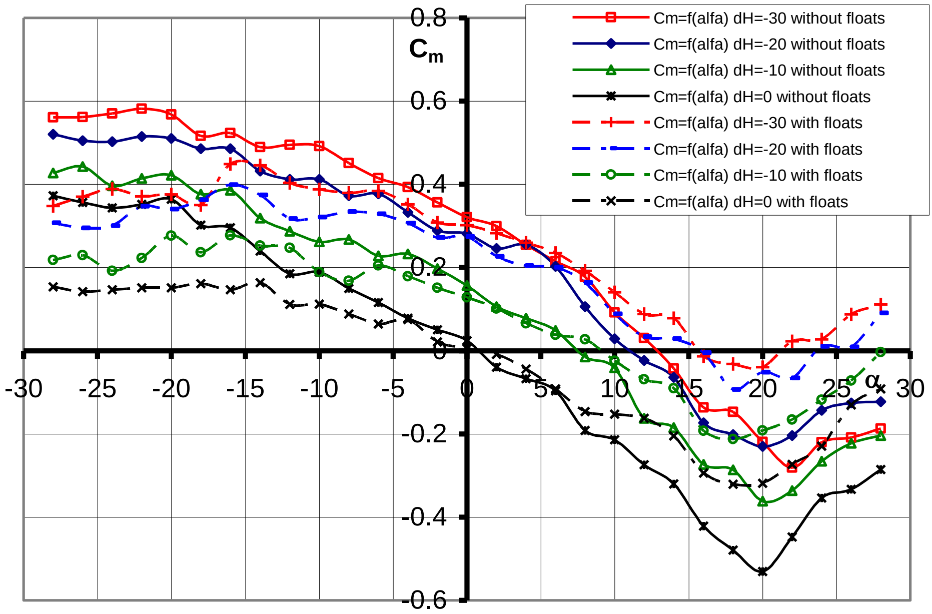

Fig.10. The characteristics of C_m=f(α) for the model with floats and without floats with inclined elevator, dH from -30° to 0°

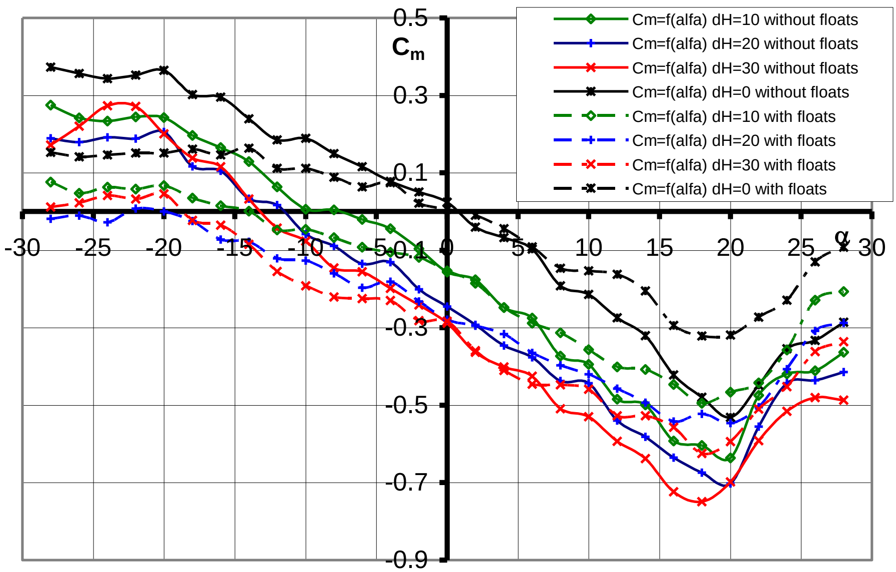

Fig.11. The characteristics of C_m=f(α) for the model with floats and without floats with inclined elevator, dH from 0° to 30°

Lift-to-drag ratio K = f(α, δ_{kl})

The patterns of lift-to-drag characteristics as the function of the angle of attack with variable elevator inclination angle are presented in Figures 13 and 13, while significant numerical values are presented in Tables 11 and 12.

Table 11. The basic data regarding K=f(α, δ_{kl}) for dH from -30° to 0°

	without floats				with floats			
$\delta_{kl}{}^o$	-30	-20	-10	0	-30	-20	-10	0
$-\alpha_{opt}{}^o$	-10	-10	-10	-10	-10	-10	-10	-12
K_{min}	-2.07	-2.20	-2.21	-2.11	-1.85	-1.94	-1.94	-1.91
$\alpha_{opt}{}^o$	14	14	14	12	14	14	14	12
K_{max}	6.16	6.68	7.08	7.31	4.95	5.42	5.83	5.83

Table 12. Basic data regarding K=f(α, δ_{kl}) patterns for dH from 0° to 30°

	without floats				with floats			
$\delta_{kl}{}^o$	0	10	20	30	0	10	20	30
$-\alpha_{opt}{}^o$	-10	-10	-12	-12	-12	-12	-12	-12
K_{min}	-2.11	-1.87	-1.67	-1.55	-1.91	-1.77	-1.60	-1.48
$\alpha_{opt}{}^o$	12	12	12	12	12	12	14	12
K_{max}	7.31	7.04	6.59	6.22	5.83	5.72	5.59	5.13

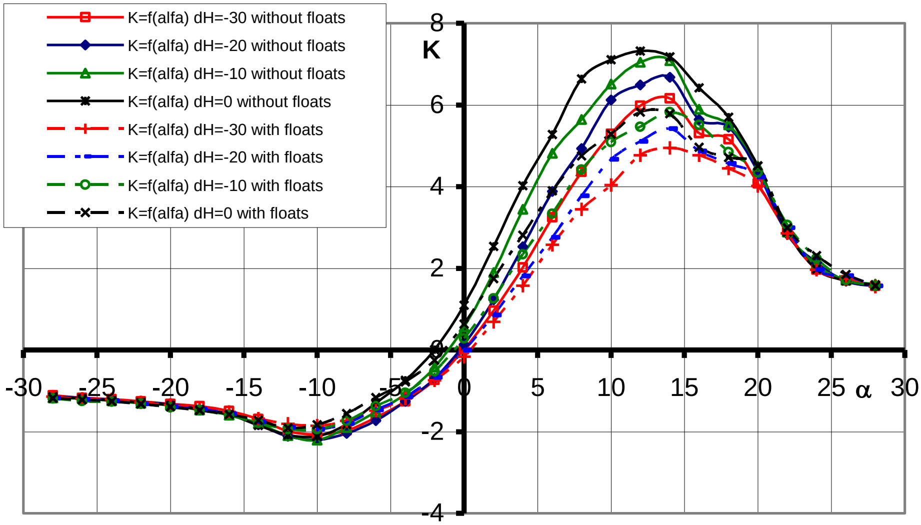

Fig. 12. The characteristics of K=f(α) for the model with floats and without floats with inclined elevator, dH from -30° to 0°

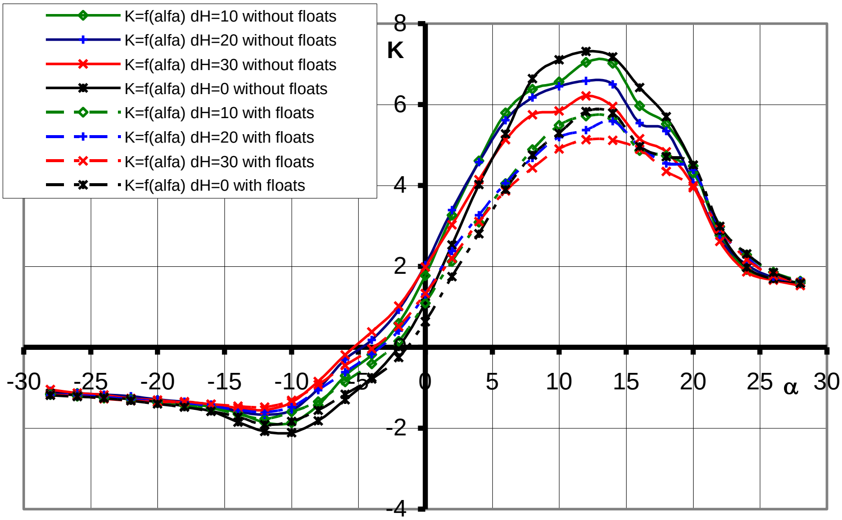

Fig. 13. The characteristics of $K=f(\alpha)$ for the model with floats and without floats with inclined elevator, dH from 0° to 30°

The analysis of the presented data shows that the presence of floats significantly reduces the value of the maximum lift-to-drag value by 15% to 20%, depending on the elevator inclination angle. However, no significant influence of the presence of floats on the value of the optimal angle of attack was observed.

Drag polar $C_L = f(C_D)$

The patterns of the lift coefficient as a function of the drag force coefficient of the aircraft model with and without floats are shown in Figures 14 and 15.

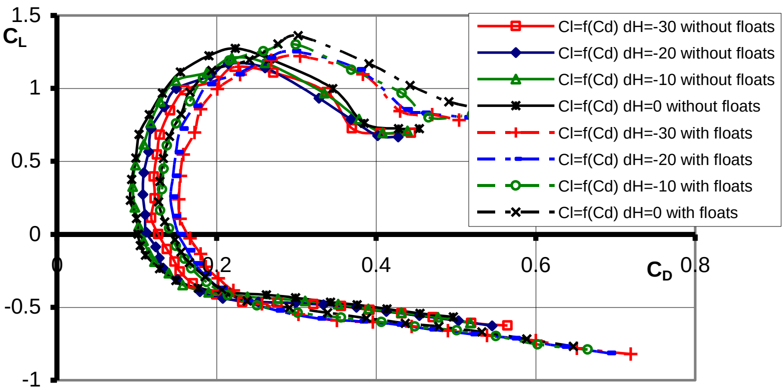

Fig. 14. The characteristics $C_L = f(C_D)$ for various angles of elevator inclination angles for the model without floats

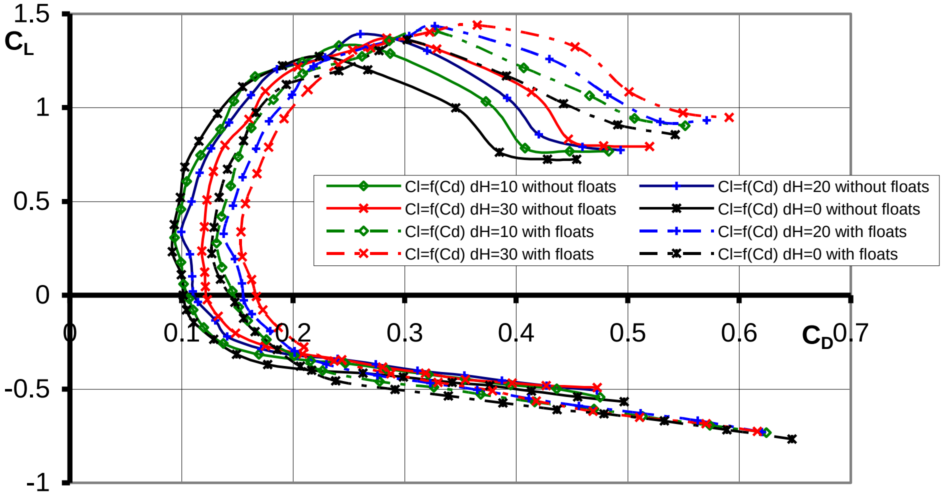

Fig. 15. The characteristics of C_L=f(C_D) for various angles of flap inclination angles for the model with floats

The drag polar for different cases of the elevator inclination are characterized by typical patterns. The values of aerodynamic coefficients including C_{Lmin}, C_{Lmax}, C_{Dopt}, K_{max}, K_{min}, which can be determined from the patterns shown, have been provided earlier in this article.

4. CONCLUSIONS

The experimental studies performed of the aerodynamic characteristics of OSA model showed a significant impact of the floats on their patterns. The studies on the model were carried out in a wind tunnel, which, due to the finite diameter of the stream and the specified value of the lift-to-drag ratio (L/D) in the tunnel, required the conversion of the obtained results according to the algorithm presented in [6].

The use of floats causes the increase of drag coefficient C_D, maximum lift coefficient C_{Lmax} as well as critical angle of attack α_{cr}. The decrease of lift-to-drag ratio has also been observed. Its value in the case of the model with floats was up to 20% lower than in the model without floats.

The studies also showed that the model equipped with floats had lower longitudinal static stability margin than the model without floats.

In the course of the studies, it was found that a flap inclined by the angle of δ_{kl} = 44° produces a higher C_L value only if the model does not exceed the angle of attack $\alpha = 5°\div6°$. In the scope of $\alpha = 6°\div12°$ C_L values obtained for δ_{kl} = 21° and δ_{kl} = 44° reach similar values, while for $\alpha > 12°$ the C_z values for $\delta_{kl} = 44°$ is lower than the one obtained for $\delta_{kl} = 21°$.

When we additionally consider the drag increase caused by higher flap inclination, it turns out that the lift-to-drag ratio *K* after exceeding $\alpha = 1^o \div 2^o$ is lower for $\delta_{kl} = 44^o$ compared to $\delta_{kl} = 21^o$.

The results obtained from experimental studies of the basic aerodynamic characteristics of the aircraft model will serve as a basis for further research, including numerical analyses of the aircraft aerodynamics necessary to study the dynamics of its motion.

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REFERENCES

[1] Olejnik Aleksander, Łukasz Kiszkowiak, Adam Dziubiński. 2016. Problemy analizy aerodynamicznej samolotów klasy general aviation. W *Mechanika w lotnictwie ML-XVII*, 85-102. Warszawa: Polskie Towarzystwo Mechaniki Teoretycznej i Stosowanej.

[2] Olejnik Aleksander, Łukasz Kiszkowiak, Adam Dziubiński, 2017. „Aerodynamic analysis of General Aviation airplanes using computational fluid dynamics methods". *Mechanik*, 90 (8-9) : 802-804.

[3] Stinton Darrol. 1987."Aero-marine design and flying qualities of floatplanes and flying-boats". *Royal Aeronautical Society, Aeronautical Journal*.

[4] Kaczmarczyk Jan, Jan Maruszkiewicz. 1970. *Poradnik do ćwiczeń laboratoryjnych z mechaniki płynów*. Warszawa: Wydawnictwo Wojskowej Akademii Technicznej.

[5] Penkchjerst Richard, D. Cholder. 1955. *Tiechnika eksperimienta w aerodynamiczeskich trubach*. Moskwa: Izdatielstwo Innostrannoj Literatury.

[6] Pope Alan. 1954. *Wind-Tunnel Testing*. New York: John Wiley & Sons.

[7] Krzyżanowski Adam. 2009. *Mechanika lotu*. Warszawa: Wydawnictwo Wojskowej Akademii Technicznej.

Doświadczalne wyznaczenie wpływu pływaków na charakterystyki aerodynamiczne modelu samolotu OSA w opływie symetrycznym

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Streszczenie. W pracy przedstawiono wyniki badań doświadczalnych wpływu pływaków na charakterystyki aerodynamiczne modelu samolotu OSA w opływie symetrycznym. Badania wykonano w tunelu aerodynamicznym małych prędkości WAT. Model zbadano przy ciśnieniu dynamicznym q = 500 Pa w zakresie kątów natarcia α = -28[deg]-+28[deg]. Badania wykonano dla modelu samolotu w konfiguracji "gładkiej" w wersji z pływakami i bez pływaków. Zbadano również wpływ wychylenia usterzenia poziomego oraz klap na podstawowe charakterystyki aerodynamiczne badanego modelu. Uzyskane wartości współczynnika oporu aerodynamicznego, współczynnika siły nośnej, współczynnika momentu pochylającego oraz doskonałości aerodynamicznej przedstawiono w formie tabel i wykresów. Przeprowadzone badania wykazały, że zastosowanie pływaków powoduje wzrost wartości zarówno współczynnika siły oporu aerodynamicznego, maksymalnej wartości współczynnika siły nośnej jak i wartości krytycznego kąta natarcia α_{kr}. Zauważalny jest także spadek wartości doskonałości aerodynamicznej która dla modelu z pływakami jest nawet o 20% mniejsza od doskonałości uzyskanej dla modelu bez pływaków. Badania pokazały również, że model wyposażony w pływaki ma mniejszy zapas stateczności statycznej podłużnej niż model bez pływaków.

Słowa kluczowe: tunel aerodynamiczny, inżynieria mechaniczna, aerodynamika, opływ modelu samolotu