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EXPERIMENTAL ANALYSIS OF DELTA WING WITH VARIOUS PROFILES

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ABSTRACT
This study investigates the aerodynamic performance of delta wings with various profiles to understand their impact on lift, drag, and overall efficiency. Delta wings, known for their application in high- speed aircraft, present unique aerodynamic characteristics influenced by their geometric profiles. This experimental analysis includes testing a series of delta wing models with different profiles in a wind tunnel to collect data on their aerodynamic behaviour. The profiles examined range from simple flat plates to more complex cambered and thickness variations. The study employs a systematic approach, using both qualitative and quantitative methods, to measure key aerodynamic parameters such as lift coefficient, drag coefficient, and lift-to-drag ratio. Flow visualization techniques are also utilized to observe flow patterns and vortex formations. Results indicate that the profile of a delta wing significantly affects its aerodynamic performance, with cambered profiles generally providing higher lift coefficients and improved lift-to-drag ratios compared to flat plate profiles. However, the trade-offs in terms of drag and stability are also highlighted. This comprehensive analysis provides valuable insights for the design and optimization of delta wings in various aerospace applications .The findings contribute to a deeper understanding of the aerodynamic characteristics of delta wings and offer guidance for future research and development in the field of high-speed aerodynamics.

Keywords:
Wing, Wind tunnel, Angle of Attack, Leading edge

I. Introduction
The delta wing, characterized by its triangular shape and swept-back leading edges, is a prominent design in modern aerospace engineering, particularly for high-speed aircraft. Its unique geometry provides several aerodynamic advantages, such as improved lift-to-drag ratios and enhanced stability at supersonic speeds. However, the aerodynamic performance of a delta wing is highly sensitive to its profile, making the choice of profile a critical aspect in the design and optimization process [1].
This study focuses on the experimental analysis of delta wings with various profiles to determine how these different configurations impact aerodynamic characteristics such as lift, drag, and overall efficiency. The profiles under consideration include flat plate, cambered, and thickness variations, each offering distinct aerodynamic behaviours[4].

II. Experimental Analysis:
II.I Wind tunnel Description
The subsonic wind tunnel features a test section with dimensions of 600 mm by 600 mm by 4000 mm, designed to achieve a maximum velocity of 45 m/s. With a contraction ratio of 9:1, the tunnel efficiently streamlines airflow, minimizing turbulence and enhancing flow uniformity. It is powered by a motor with a maximum output of 22 kW and can reach up to 1500 rpm

II.II Model Description

Basic layout of the delta wing model is shown in Fig 3. The wing has a leading edge sweep of 600, no twist and no camber. Model root chord is 278mm and the wing span is 320mm [2] and the wing's maximum thickness is 14mm. Delta wing was fabricated using pine wood and aluminium

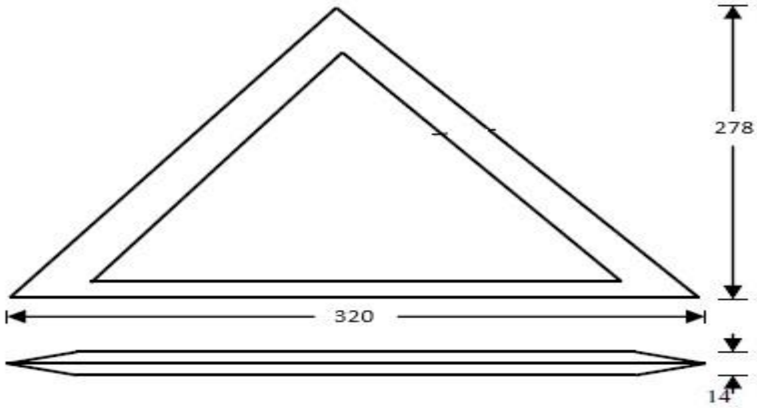

Fig.1: Delta Wing

Fig.2:Al Delta Wing Model

Fig.3:Pine Wood Delta Wing Model

Fig:4.Windtunnel Experimental Setup

II.III. Flow Visualisation of Pine wood Delta Wing

Fig: 5. Wood Model Mounted in Wind tunnel

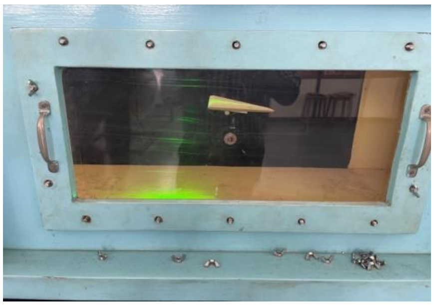

Fig: 6.Al Model Mounted in Wind tunnel

Fig:7. Flow Visualisation at 0° angle of attack

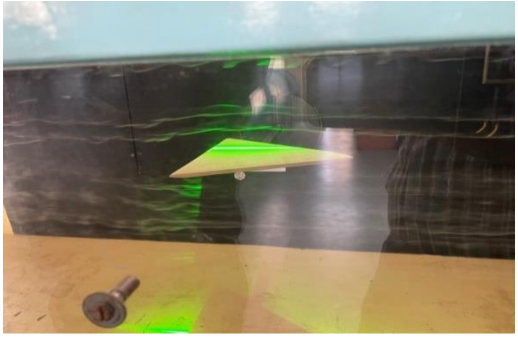

Fig: 8. Flow Visualisation at 2° angle of attack

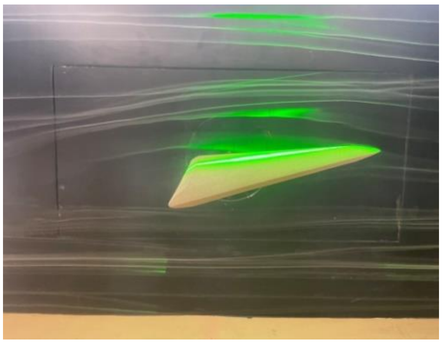

Fig.9: Flow Visualisation at 6° angle of attack

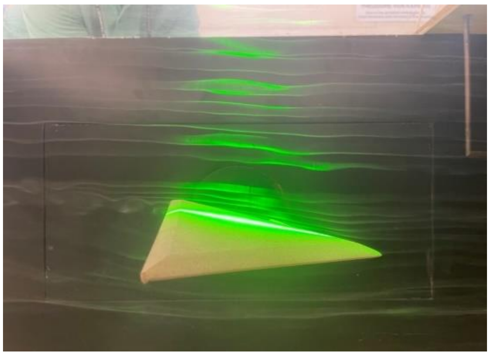

Fig.10: Flow Visualisation at -2° angle of attack

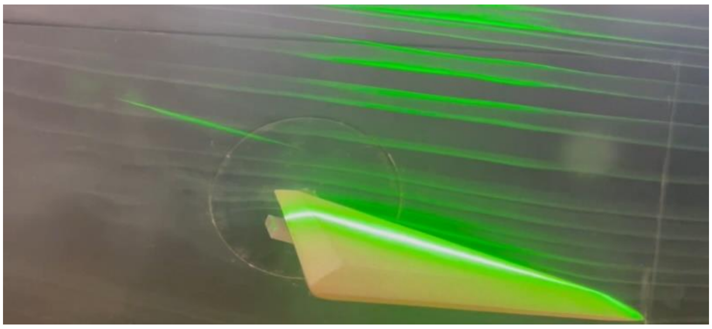

Fig.4.9: Flow Visualisation at -6° angle of attack

II.IV. Force Momentum Data for Delta Wing (Pine Wood Model):

Condition	Mach No 0.95	Mach No 0.95	Mach No 0.95	Mach No 0.95	Mach No 0.95	Mach No 0.95
Force in X direction	62.14	56.71	51.45	85.46	74.49	83.35
Force inY direction	24.47	24.25	22.14	28.37	28.80	29.03
Force in Z direction	-32.44	-29.72	-7.42	1.07	2.56	34.69
M (Pitch)	-2.33	-1.80	-1.46	-3.41	-3.32	-2.43
L (Roll)	-0.08	-0.10	-0.03	0.06	0.06	0.14
N(Yaw)	1.80	1.56	1.31	2.01	2.00	1.94
Angle of Attack	0	-2	-6	0	2	6

Table.1: Force Momentum for Pine Wood Model

II.V. Flow Visualisation of Al Delta Wing

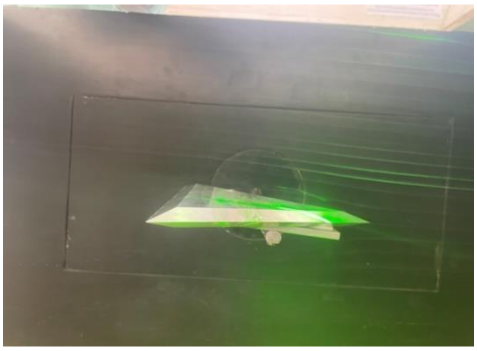
Fig.10: Flow Visualisation at 0° angle of attack

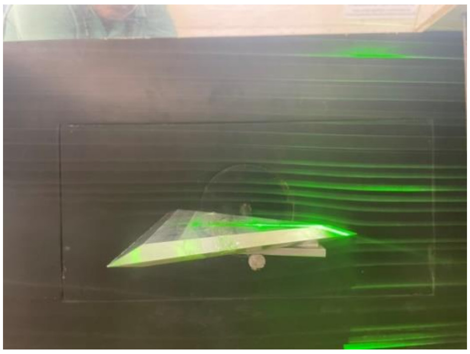
Fig.11: Flow Visualisation at 2 angle of attack

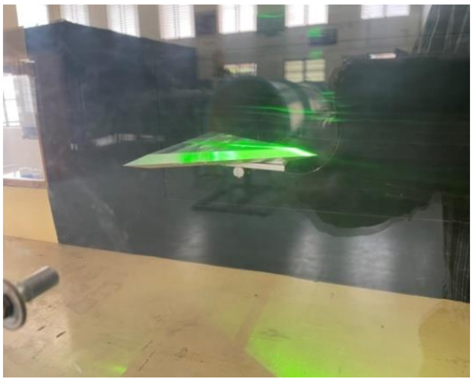
Fig.12: Flow Visualisation at 6° angle of attack


Fig.13: Flow Visualisation at -2° angle of attack

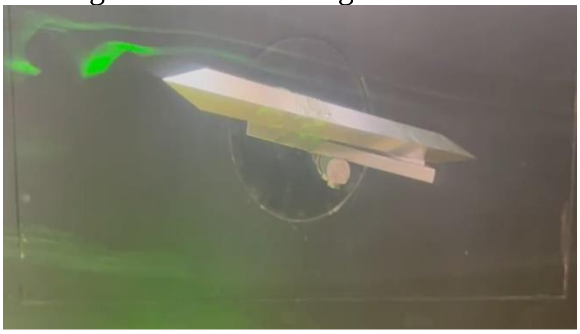
Fig.14: Flow Visualisation at -6° angle of attack

II.VI. Force Momentum Data for Delta Wing (Al Model):

Condition	Mach No 0.95	Mach No 0.95	Mach No 0.95	Mach No 0.95	Mach No 0.95	Mach No 0.95
Force in X direction	52.14	53.71	55.45	43.46	77.49	83.35
Force inY direction	24.37	27.25	22.14	28.37	28.80	29.03
Force in Z direction	-31.44	-26.72	-7.52	1.07	2.56	34.69
M (Pitch)	-2.33	-1.80	-1.96	-3.41	-3.32	-2.43
L (Roll)	-0.08	-0.10	-0.03	0.06	0.06	0.14
N(Yaw)	1.90	1.56	1.61	2.01	2.20	1.94
Angle of Attack	0	-2	-6	0	2	6

Table.4.2: Force Momentum MS Model

These findings provide valuable insights for aerospace engineers and designers, aiding in the development of more efficient delta wings for a variety of high-speed aircraft. Future research can build on these results to explore additional profile modifications and their effects on aerodynamic performance.

III. Conclusion

The results of this study underscore the importance of wing profile selection in delta wing design. Cambered profiles offer significant advantages in terms of lift and efficiency, making them ideal for high-speed aerospace applications. Moderate thickness variations can also enhance performance. These findings provide valuable insights for aerospace engineers and designers, aiding in the development of more efficient delta wings for a variety of high-speed aircraft. Future research can build on these results to explore additional profile modifications and their effects on aerodynamic performance.

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