November-December 2019
ISSN: 0193-4120 Page No. 5091 - 5100

Estimation of Stiffness Derivative of an Ogive for Specific Heat Ratio 1.666

Aysha Shabana[1], Renita Sharon Monis[2], Asha Crasta[3], and S.A.Khan[4*]
[1] *Research Scholar, Mathematics Dept., M.I.T.E, Moodabidri, and Assistant Professor, SCEM, Mangaluru, Karnataka, India*
[2] *Research Scholar, Mathematics Dept., M.I.T.E, Moodabidri and Assistant Professor, SMVITM, Bantakal, Karnataka, India*
[3] *Associate Professor, Mathematics Department, M.I.T.E, Moodabidri, Karnataka, India*
[4] *Professor, Department of Mechanical Engineering, Faculty of Engineering, IIUM, Gombak Campus, Kuala Lumpur, Malaysia.*

Article Info
Volume 81
Page Number: 5091 - 5100
Publication Issue:
November-December 2019

Article History
Article Received: *5 March 2019*
Revised: *18 May 2019*
Accepted: *24 September 2019*
Publication: *24 December 2019*

Abstract:
This paper focusses attentionon studying the effect of the flow medium on the aerodynamic characteristics of the ogive at significant inertia levels. Accordingly, the hypersonic similitude is used to findanalytical expression to evaluate the pressure dissemination on the exterior of the ogive and hence, finally to get the stiffness derivatives for Mach quantities from M = 5 to 15, and the streamricochetdirections in the range from 100 to 250. This study considers two values of the λ = 5, and 10 are for the ogival shape of the nose. The γ value considered is 1.666. Using this value of the specific heat ratio the expression for rigidityderived for an ogive through the assumption that the gas is in-viscid and ideal, the indication is semi-steady, and the front noseapproach of the ogive is to such an extent that the inertia level behindhand the tremorM2after the shock M2 ≥ 2.5 . The consequencesdesignate that with the rise in the Mach number since M = 5 to M = 15, initially the magnitude of the stiffness derivative and later with superfluousrise in the Mach (M), it befitsself-regulating of inertia level and Mach independence principle has revisited. When the λ = 10, there is a swing of the midpoint of force towards the leading edge.

I. INTRODUCTION:

The knowledge of firmness derives in the arena due to the proportion of terrain, and the rate of the angle of attack is of prime importance. The prediction of their numerical values is of utmost importance. During the flight, whenever there is an increase in the angle of attack, this would results in a pitch up moment. Under these circumstances, to bring back the aerodynamic object to its equilibrium position, the stiffness derivative shows asignificantpart. The magnitude of the stiffness is dependent on the center of gravity of the object, the stressspreading on the apparent,and the position of resultant center of stress, which decides static margin in case of the aerodynamic vehicle. The present work assesses strength subsidiaries in terrain for non-thin axis-symmetric Ogives wavering in hypersonic stream. At hypersonic speediness, the "frontpinecones" regularly have a low L/D ratio; usually, the nose is blunt and obtuse. The tenacitybehindhand such anoperation is the issue of streamlined bodies, the extraordinary temperature created at the nose, which is significant that may lead to ablation of the surface material. In spitefulness of the statement that the contemporary work

November-December 2019
ISSN: 0193-4120 Page No. 5091 - 5100

isn't for streamlinedforms with separate out steps when a postulate is generatedaimed at the ogives with a high-pitchedfront nose, it would now be competent to be extended out to reenter earth graduallydowncast to connection the ambient atmosphere.

It is sincerelyenthralling to proceedsannotation of that the exploration of high Machtributaries, which has restricteditself for theframeswith high L/D ratio, ought to accomplish a phase of the bodies with low L/D ratio with non-aerodynamiccontours and universallyline of attack torrents,talented and underscored expansion of creativeimminent hypersonic outlines.

Ghosh (1977) constructed up alternative large Mach similitude with the devotedarc shock and Mach value just after the shockwaveactualityextranotable> 2.5. This comparison is considerable for the upwindexternal of aero-foil with mammoth stream circumvention. Theireffort furtherstretched out to swaying with curved wedges by Crasta and Khan to figure andrationalizedendowingsmallholdings, both Supersonic(M < 5)) Ghosh (1984) and Hypersonic streams (M>5) Asha Crasta et al.(2014).

The enormousrerouting comparability of earlier research has been overextended by Ghosh(1984) to axisymmetric figures with appended tremors. The likeness ofextra cylinder movement, which has essentialevenness that been fabricated up. The coneconsequences that have been transformed of a wedgecorpulent the along with the flowwith a hinge, that comparable upset offree liquid section Ghosh (1977) yields a pivotally conical-annular interplanetary. He further showed that the torrentbygone a pinecone/semi funnel seems to be comparative to a containerdrive in conical-annular cosmos that was recognized asa level of the similitude. Despite the statement that Ghosh (1984) gives comparability for cones, he contributes an answer dependent on likeness for a cone as it were. The arrangement shows an even thickness shockfilm. Henceforth the steady thickness type of the unstable Bernoulli's condition is utilized to discover weight on the conduitexterior. The outcomes are becoming useful for high-speed flow for perfect gas over variableconduits of various inertia levels & flow deflection angles.

II. ANALYSIS

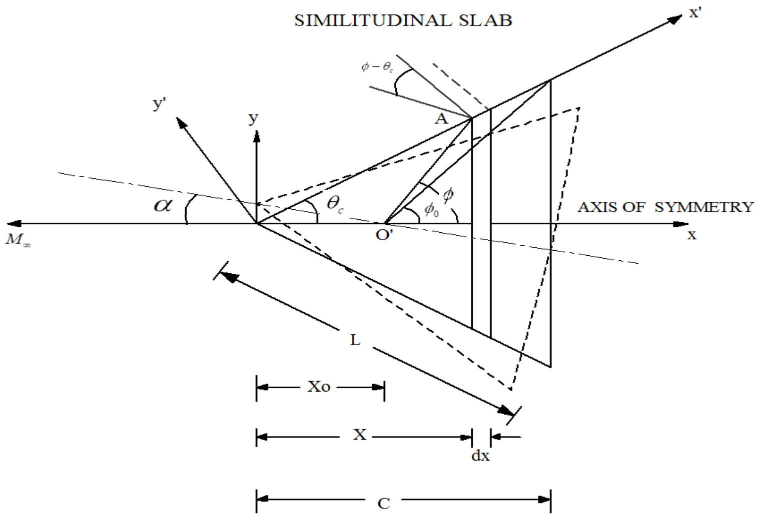

Figure 1: Cone Geometry

TEST Engineering & Management
November-December 2019
ISSN: 0193-4120 Page No. 5091 - 5100

With Fig. 1 we have

$$\tan\phi = \frac{x\tan\theta_c}{(x-x_0)}\ ;\ \tan\phi_0 = \frac{c\tan\theta}{(c-x_0)}$$

Everywhere ϕ is the slantshaped by A at O' with x-axis, for thediverseposition at A , ϕ fluctuates between π to ϕ_c ,

$\theta_c + \lambda$ is the half-angle ofthe ogive, and c being the dominant chord length?

The demarcation of the Rigiditymeasurementsymbolized by C_{m_α} is

$$C_{m_\alpha} = \left[\frac{\partial M}{\partial \alpha}\right]_{\alpha,q\to 0} \frac{1}{\frac{1}{2}P_\infty U_\infty^2 S_b c}$$

Here S_b = base space of ogive = $\pi(c\tan\theta_C)^2$,

c = triad size of ogive.

After simplification we get, the following equation

Equation ofcompressionquotient of a fixed cone ifa shock is devoted to the nose, is

$$\frac{P_{bo}}{P_\infty} = 1 + \gamma M^2{}_{po}\left(1 + \frac{1}{4}\varepsilon\right) \tag{1}$$

Everywhere the concretenessquotient is

$$\varepsilon = \frac{2 + (\gamma - 1)M^2{}_{po}}{2 + (\gamma + 1)M^2{}_{po}} \tag{2}$$

M_{po} = piston inertiaquantity of the correspondingmotion of the piston, working in a conical-annular space, P_{bo} is the stress onframeexterior atprevalence are zero.

$$M_{po} = M_\infty \sin\theta_c$$

Everywhere θ_c = flow deflection angle?

Hence

$$\frac{dP_{bo}}{dM_{po}} = 2\gamma P_\infty M_{po}\left[1 + \frac{1}{4}\left(\varepsilon + \frac{1}{2}M_{po}.\frac{d\varepsilon}{dM_{po}}\right)\right] \tag{3}$$

Where

$$\frac{d\varepsilon}{dM_{po}} = \frac{-8M_{po}}{N^2} + \lambda' f\left\{\frac{8K(3(\gamma+1)K^2 - 2)}{N^3}\right\} \tag{4}$$

And $N = \left[2 + (\gamma+1)M_{Po}^2\right]$

On resolving (3), we have

$$\frac{dP_{bo}}{dM_{po}} = 2\gamma P_\infty M_{po}\left[(a_1 + \lambda' a_2) - \frac{2a_2\lambda' h\tan\phi}{\tan\phi - \tan\theta_c}\right] \tag{5}$$

Everywhere $h = \frac{x_0}{c}$,

November-December 2019
ISSN: 0193-4120 Page No. 5091 - 5100

$$\lambda^{'} = \frac{\lambda}{\tan\theta_c},$$

$$a_1 = 1 + \frac{\varepsilon}{4} - \frac{K^2}{N^2}$$

$$a_2 = 1 + \frac{\varepsilon}{4} - \frac{K^2(N+8)}{N^3}$$

Utilizing the expressions obtained as above are used to evaluate the magnitude of the stability derivatives,

$$C_{m_q} = [C_{m_q}]_{cone} + \frac{\lambda^{'} a_2}{15(1+n^2)}\left[\begin{array}{l} h^4\{5(2n^2-3n^4-1) - 4h(3n^2-6n^4-1)\} + \\ (1-h)\{H(9H+(2n^2-3H)h + 2(2H+3n^2)h^2 + 12n^2h^3) - n^4h^2(1+3h-24h^2)\}\end{array}\right]$$

Where

$$[C_{mq}]_{cone} = (D/2)\left[h^4(2n^2-3n^4-1) - (1-h)\{H(3H + h(H+2n^2) + 2h^2n^2) + n^4h^2(1+3h)\}\right]$$

$$D = \frac{2}{3(1+n^2)}\left[1 + \frac{1}{4}\left(\varepsilon + \frac{1}{2}K\frac{d\varepsilon}{dM_{po}}\right)\right] \qquad (7)$$

$$H = (1 - h + n^2)$$

$$n = \tan\theta_c$$

Outcomes are computed for anextensivecollection of angles of incidence, the inertia level M, and the ogive shapes are discussed.

III. RESULTS AND DISCUSSIONS

This primary focus of the study is to find influence of the specific heat ratio, the level of inertia, and the angles of incidence with the variations in the hinge positions.

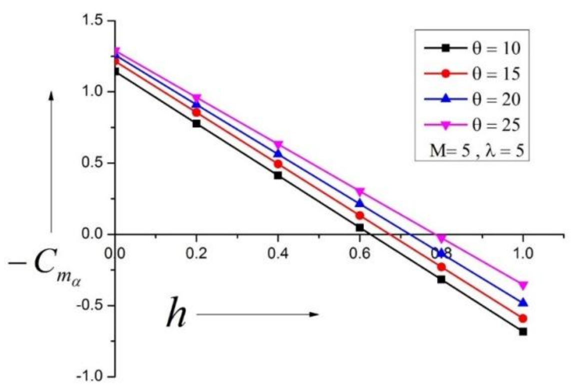

Fig. 1 Variant of stiffness derived Vs. h, Mach M = 5

Fig. 1 shows the toughnessderived variations for different hinge positions from h = 0 to 1. The stiffness derivative has a similar trend for the completechoice of the inertia levels and the stream deflection angle from 10^0 to 25^0. Results show that it starts with the highest value and decreases progressively crosses the point of the center of pressure and then continues to decrease till h = 1. While the stream drift is increased from 10^0 to 15^0, 15^0 to 20^0, and 20^0 to 25^0 for a fixed Mach M = 5 and the ogive shape where λ = 5, there is a maximum increase of 19% and a decrease of 27%. It is also seen that near the center of pressure, this increase is maximum and becomes 176%. For the next range of θ from 15 to 20 degrees, the increase marginal for the positions very closed to the nose; however, rightnear the epicenter of stress, it is 62%. For the locations beyond the center of pressure, the enhancement in the magnitude is 42%. For the highest range of the θ from 20 to 25 degrees, the gain for the 40 % of the nose is up to 12%, near the center of pressure, it is around 41 %, and beyond the center of pressure

November-December 2019
ISSN: 0193-4120 Page No. 5091 - 5100

on the negative side, it is 82 %. From the results, we observea considerable rise in the toughnessspinoffs for all the positions of the hinge h. The situation of the epicenter of stress is anxious; there is a continuous shift towards the trailing edge, which will be very handy as far as the stability of the aerospace vehicle. Due to this shift in the center of pressure, there will be a considerable increase in the moment arm and will result in a considerable increase in the nose-down moment to bring the aerospace vehicle to its equilibrium position once it is disturbed from its equilibrium position.

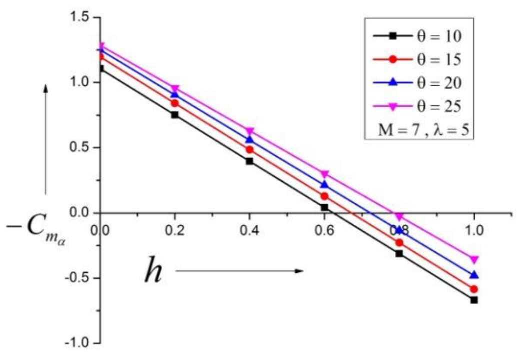

Fig. 2 Variant of stiffness derived Vs. h, Mach M = 7

Figure 2 displays variations in stability derivative for a slightly large Mach number for M = 7. This upsurge in the Mach number effects in a marginal reduction in the stability derivatives as it is seen while scanning the literature that indicates that there is anadvancedreduction in the stability byproducts in view of the rise in M which results in atotally different pressure distribution on the external of the ogive. The flow pattern will be totally dissimilar from that of the cone surface. We know that for cone, there will be a robustslanting shock that will be located at the nose of the cone. This oblique shock will results in a pressure jump after the shock, which indicates the strength of the oblique shock. This strength of the oblique shock will be different at diverse Mach & the flow deflections. The remaining pattern remains the same as discussed above.

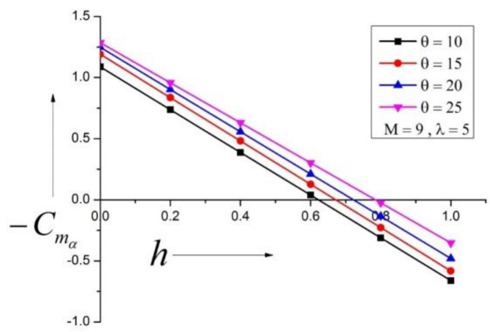

Fig. 3 Variant of stiffness derived Vs. h, Mach M = 9

Fig. 3 presents the variant of the stability derivatives Vs. the hinge point for an increased inertia from M = 7 to M = 9. As discussed earlier, due to this upsurge in Mach, the shock power will be increased, leading to changed forcespreading on the ogive exterior and hence, the decreased values of the stability derivatives. The center of stress lies from h = 0.62 to 0.8, and this shift is linear all along with the angles. Outcomes showa marginal increase in the percentage change on the positive side, whereas beyond the epicenter of stress on the negative range is identical. The results indicate that the extremeupsurge is 231 %, which is maximum at h = 0.6 for λ = 5, and the flow deflection angle increase from 10 to 15 degrees. For other flow deflection angle θ = 20 and 25 degrees, this growth in the stability derivative remains in the kind from 45 to 65 percent. Since the Mach number for the present case is M = 9, which seems to be very closed to inertia when the Mach number liberationbeliefprevails. Any further growth in the inertia level will not produce any variation in the stability derivatives.

November-December 2019
ISSN: 0193-4120 Page No. 5091 - 5100

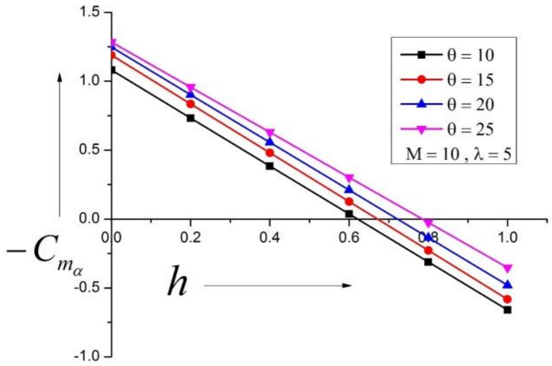

Fig. 4 Variant of stiffness derived Vs. h, Mach M = 10

Results for Mach M = 10 are shown in Fig. 4. Due to the growth in the inertia level,nearby is a further increase in stiffness stability derivative at hinge location of h = 0.6 by nearly ten percent. When θ = 20^0 and 25^0, there is a marginal increase in the value of $C_{m\alpha}$. Locations of the center of pressure also remained the same. The results at this Mach number also displaythesame trend, as existed seen in the earlier cases.

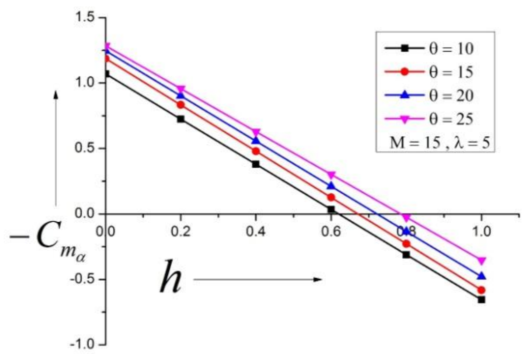

Fig. 5 Variant of stiffness derived Vs. h, Mach M = 15

Figure 5 displaysoutcomes of stiffness derivatives for M = 15, which is the highest inertia level considered. It is found, the growth in the inertia level results ina further increase in the percentage enhancement of the stiffness derivatives at h = 0.6, which is 264 %. However, for θ = 20^0 and 25^0, the percentage increase remains nearly the same as was seen for lower Mach numbers. As far as the center of pressure location is concerned, there is a marginal shift towards the leading edge. Except for these changes, remaining parameters show similar trends, as was comprehended at Mach M = 5 to 10.

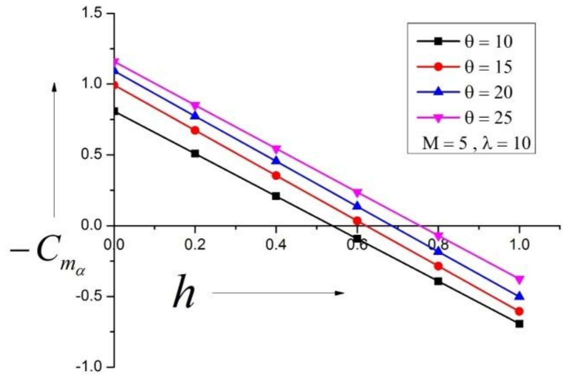

Fig. 6 Variant of stiffness derived Vs. h, Mach M = 5

Figure 6 displays the consequences of the toughnessspinoffsfor increase ogive arc for the lowest Mach number M = 5 for different pivot positions. The percentage escalation in the stiffness derived is in the sort from 22.8, 32.4, 69.7, -136.7, -27, and -12while the flow ricochetslant θ is augmentedfrom 10^0 to 15^0. The % centage growth in the toughnessimitative is in the assortment from 10, 15, 28.7, 301, -36, and -17 while the streamricochet θ is amplifiedfrom 15^0 to 20^0. The percentage upturn in the stiffness derived ranges from 6, 10, 19.8, 74.9, -62, and -25 for the driftricochet θ is increased 20^0 to 25^0. It is observed that the positions of the center of pressure for different θ = 10^0, 15^0, 20^0, and 25^0, the location of epicenter of stress is at h = 0.52, for θ = 15^0 the site of epicenter of stress has relocatedin the route of the stragglingverge, is located at h = 0.62, for θ = 20^0 the of epicenter of stress has shifted further in the course of the behind edge

TEST Engineering & Management

November-December 2019
ISSN: 0193-4120 Page No. 5091 - 5100

and is established to be at h = 0.69, for θ = 25^0 it has further advanced and shifted towards the straggling edge and is located at h = 0.76. The reasons for this trend may be the ogival arc, which has changed the geometry of the nose. Due to the increased arc radius, it will modify the flow field completely on the surface of the ogive. The increased radius has modified the flow field in such a way that the epicenter of stressstimulatedon the way to the leading end.

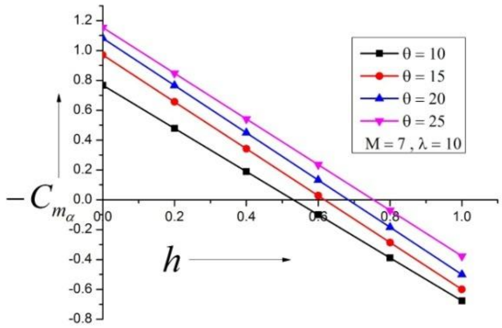

Fig. 7 Variant of toughness derived Vs. h, Mach M = 7

The sameoutcomes are seen in figure 7 when Mach is augmented from M = 5 to 7.The percentage intensification in the stiffness derived remains from 26.5, 37.3, 80.9, -128.2, -26, and -11.5while the streamricochet angle θ is increased 10^0 to 15^0. The % centage growth in the toughnessderived is in the variety from 11, 17, 32, 371, -36, and -17 when the flow deflection angle θ is augmented 15^0 to 20^0. The percentage growth in the stiffness derived remained from 7, 11, 21, 77, -61.7, and -25while the streamricochetslant θ is augmented from 20^0 to 25^0. The center of pressure remained at h = 0.52 to h = 0.77. Rest of the pattern remained the same.

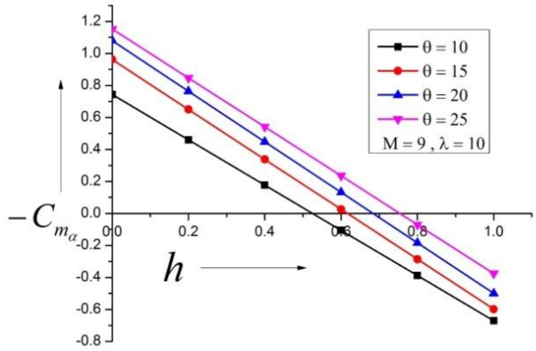

Fig. 8 Variant of stiffness derived Vs. h, Mach M = 7

Results at Mach number M = 9 for λ = 10 be presentlydisplayed in figure 8 for various streamricochetslants. The percentage growth in the stiffness derived ranges from 29, 41, 90, -124.6, -26.3, and -10.9while the flow ricochetviewpoint θ is augmented 10^0 to 15^0. The % centage growth in the toughnessderived varied in the range from 12.2, 17.5, 32.5, 408.9, -36, and -16.4while the streamricochetslant θ is augmented from 15^0 to 20^0. The percentage growth in the stiffness derived ranges from 7, 11, 20.9, 78.5, -61.7, and -24.7 while the flow reboundviewpoint θ is augmented 20^0 to 25^0. As seen earlier with the growth in the streamricochet angle θ = 10^0 to 25^0, this would lead to enhancement in the planform area of the ogive. This increased surface area will change the pressure pattern along the length of the ogive. The center of pressure also will change, with increasing θ it will shift towards the downstream. The shift of the center of pressure with an increase in θ will result in an increased value of the stability derivatives as the center of gravity is fixed; it will not change.

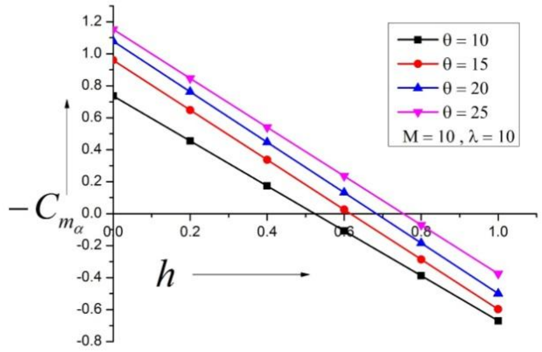

Fig. 9Variant of stiffness derived Vs. h, Mach M = 10

Results at Mach number M = 10 for λ = 10 are displayed in figure 9 for various driftricochetslants. The percentage rise in the stiffness derived ranges from 30.4, 42.5, 93.6, -124.6, -26.3, and -10.7while the flow ricochetslant θ is augmentedfrom 10^0 to 15^0. The percentage proliferation in the stiffness derived ranges from 12.4, 17.7, 32.8, 419.5, -35.7, and -16.4 whenviewpoint θ is improved 15^0 to 20^0. The percentage growth in the stiffness derived ranges from 6.8, 11, 21, 78.7, -61.7, and -24.7 when angle θ is amplified 20^0 to 25^0. This increased surface area will change the pressure pattern along the length of the ogive. The center of pressure also will change, with increasing θ it will shift towards the downstream. The shift of the center of pressure with an increase in θ will result in the improvedworth of the stability derivatives as the center of gravity is fixed; it will not change.

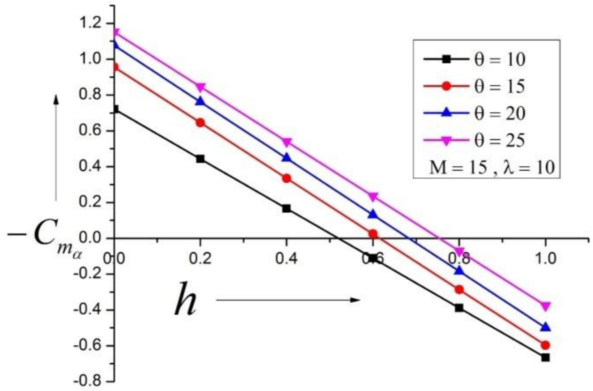

Fig. 10 Variant of stiffness derived Vs. h, Mach M = 15

Outcomes at M = 15 for λ = 10 are displayed in figure 10 for various flow deflection angles. The percentage rise in the stiffness derived ranges from 32.6, 45.5, 101.6, -121.8, -26.4, and -10.4 while the flow ricochetviewpoint θ is amplifiedfrom 10^0 to 15^0. The % centage rise in the toughnessderived ranges from 12.6, 18, 33, 440, -35.7, and -16.3 once angle θ is increased 15^0 to 20^0. The percentage upsurge in the stiffness derived ranges from 7, 11, 21, 79, -61.7, and -24.7 as soon as the flow bendviewpoint θ is amplified 20^0 to 25^0. As seen earlier by way of the growth in the stream deflection point of view θ = 10^0 to 25^0, this would lead to enhancement in the planform area of the ogive. This increased surface area will change the pressure pattern along the length of the ogive. The center of pressure also will change, with increasing θ it will shift towards the downstream. The shift of the center of pressure with an increase in θ will result in the increased value of the stability derivatives as the center of gravity is fixed; it will not change.

IV. Conclusions:

Recognized on the belowpondering, weenticement the succeedingdecisions:

November-December 2019
ISSN: 0193-4120 Page No. 5091 - 5100

- The stiffness declines with the rise of inertia level, and for inertia level, M = 10 and beyond,nearby,the presentis no modification in the magnitude of the stability derivative leading to the Machunconventionalityopinion.
- There is anenlightenedgrowth in the firmnessderivedfrom the ogive due to the growth in the streamricochetslantowed to the growth in the surface space of the ogive. Also, it is seen that by a proliferation in the flow deflection viewpoint, there is anincessantswing in the center of pressure in the direction of the downstream.
- It is seen that when the λ = 10, there is a move in the epicenter of pressure towards the foremost edge. This shift will change the stability scenario of the ogive forebody.

References

1. Ghosh, K. ,1977. A New Similitude for Aerofoils in Hypersonic Flow. Proceedings of the 6th Canadian Congress of Applied Mechanics, Vancouver, Canada, May 29-June 3, pp. 685-686.
2. Ghosh, K., 1984. Hypersonic large deflection similitude for oscillating delta wings. The Aeronautical Journal, pp. 357-361.
3. S. A. Khan and Asha Crasta, "Oscillating Supersonic Delta wing with curved Leading Edges," International Journal of Advanced Studies in Contemporary Mathematics, Volume 20, No. 3, pp. 359-372, July 2010, ISSN: 12293067.
4. Asha Crasta, Pavitra S., S. A. Khan, "Estimation of Pressure Distribution on A Delta Wing with Curved Leading Edges in Hypersonic/Supersonic Flow", International Journal of Energy, Environment, and Economics published by NOVA Science Publishers, Volume 24, Issue 1, pp. 67-73, 2016 (ISSN: 1054-853X).
5. S. Pavithra, S. Lavanya, S. A. Khan, and Asha Crasta, "Estimation of Aerodynamic Derivatives in Pitch of a Wedge in Hypersonic Flow", Indian Journal of Science and Technology, Volume 9, Issue 34, pp. 1-4, September 2016, ISSN (Print):0974-6846, ISSN (online): 0974-5645, DOI: 10.17485/v9i34/100958.
6. S. Pavitra, Musavir Bashir, S. Lavanya, and S. A. Khan, "Estimation of Stability Derivatives in Pitch for an oscillating 2-D Wedge in Supersonic Flow", International Journal of Advances and Applications in Fluid Mechanics , Volume 19, Issue 4, pp. 873-882, 2016, ISSN: 0973-4686, DOI: http://dx.doi.org/10.17654/FM019040873.
7. S. A. Khan, and Mohammad Asad Ullah, "Estimation of Stability Derivatives in Pitch for an Oscillating Wedge in Hypersonic Flow," IOP Publishing House, IOP Conf. Series: Materials Science and Engineering 184, pp. 1-7, April 2017 012003 DOI:10.1088/1757-899X/184/1/012003.
8. Musavir Bashir, S. A. Khan, Leelanadh Udayagiri, and Asim Noor, " Dynamic Stability of Unguided Projectile with 6-DOF Trajectory Modelling," 2017 2nd International Conference for Convergence in Technology (I2CT), India, December 2017, published by IEEE Explorer USA, pp.1121-1125, DOI:10.1109/I2CT.2017.8226302, URL: http://ieeexplore.ieee.org/stamp/stamp.Jsp? tp = & arnumber = 8226800 & isnumber = 8226083.
9. Pavitra S, Lavanya S., and S. A. Khan, "Stability derivatives of oscillating wedges in viscous hypersonic flow," IOP Publishing House, IOP Conf. Series: Materials Science and Engineering 370, pp. 1-9, May 2018, 012051, DOI: 10.1088/1757 899X /370 /1/ 012051.
10. Aysha Shabana, Renita Sharon Monis, Asha Crasta, and S. A. Khan, "Computation of Stability Derivatives of an oscillating cone for specific heat ratio 1.66", IOP Publishing House, IOP Conf. Series: Materials Science and Engineering 370, pp. 1-11, May 2018, 012059 DOI: 10.1088/1757 899X /370 /1/ 012059.
11. Aysha Shabana, Renita Sharon Monis, Asha Crasta, and S. A. Khan, "Estimation of Stability Derivatives in Newtonian Limit for Oscillating Cone," IOP Publishing House, IOP Conf. Series:

Materials Science and Engineering 370, pp. 1-10, May 2018, 012061 DOI: 10.1088/1757 899X /370 /1/ 012061.

12. Ayesha Shabana, Renita Sharon Monis, Asha Crasta, and S. A. Khan, “The Computation of Stiffness Derivative for an Ogive in Hypersonic Flow”, International Journal of Mechanical and Production Engineering Research and Development (IJMPERED), Vol. 8, Issue 5, pp. 173-184, June, 2018, ISSN (online): 2249-8001, ISSN (Print): 2249-6890.
13. Renita Sharon Monis, Asha Crasta, and S. A. Khan, “Evaluation of Stiffness Derivative for a Delta Wing with Straight Leading Edges in Unsteady Flow,” International Journal of Engineering and Advanced Technology (IJEAT), ISSN: 2249–8958, Volume 8, Issue 3S, pp. 754-762, February 2019.
14. Sher Afghan Khan, Abdul Aabid, Ahamed Saleel C, “CFD Simulation with Analytical and Theoretical Validation of Different Flow Parameters for the Wedge at Supersonic Mach Number”, International Journal of Mechanical & Mechatronics Engineering IJMME-IJENS, Vol. 19, No. 01, pp. 170-177, February, 2019, ISSN: 2077-124X (Online) , ISSN: 2227-2771 (Print), ISSN: 2227-2771 (Print).
15. Renita Sharon Monis, Aysha Shabana, Asha Crasta, and S. A. Khan, “Effect of Sweep Angle and a Half Sine Wave on Roll Damping Derivative of a Delta Wing” International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume 8, Issue 2S3, pp. 984-989, August 2019, DOI : 10.35940/ijrte.B1184.0782S319.
16. Aysha Shabana, Renita Sharon Monis, Asha Crasta, Sher Afghan Khan, “Damping Derivative Evaluation in Pitch for an Ogive at High Mach Numbers”, International Journal of Innovative Technology and Exploring Engineering (IJITEE), Volume-8, Issue-12, pp. 1307-1317, October 2019, ISSN: 2278-3075, DOI: 10.35940/ijitee.L3918.1081219.
17. Renita Sharon Monis, Asha Crasta and S. A. Khan, “Estimation of Damping Derivatives for Delta Wings in Hypersonic Flow for Straight Leading Edge,” International Journal of Mechanical and Production Engineering Research and Development (IJMPERD), pp. 255-264, October 2019, DOI : 10.24247/ijmperdoct201922.
18. Renita Sharon Monis, Asha Crasta, Mohammed Faheem, and S. A. Khan, “Analysis of Damping Derivatives for Delta Wings in Hypersonic Flow for Curved Leading Edges with Full Sine Wave,” International Journal of Engineering and Advanced Technology (IJEAT), Volume 9 Issue-1, pp. 5457-5466, October 2019, ISSN: 2249 – 8958, DOI: 10.35940/ijeat.A3086.109119.