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HASIL PENILAIAN SEJAWAT SEBIDANG ATAU PEER REVIEW  
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Judul Jurnal Ilmiah (Artikel) : Toward Standards Harmonization In Asean Economic Community: A Comparative Study Of National Standardization Bodies In Indonesia And Malaysia

Jumlah Penulis : **Bambang Purwanggono\***, Arfan Bakhtiar, Hery Suliantoro, Priska Retnosari Setyowati

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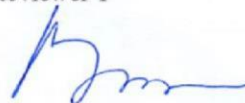
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- Kecukupan dan kemutakhiran data/informasi dan metodologi:** Comparative analysis is not clear
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Semarang,  
Reviewer 1



Prof Dr Dradjad Irianto  
 NIP. 196206231988021001  
 Unit kerja : Dept. Teknik Industri ITB  
 Kelompok Keahlian Sistem Manufaktur ITB  
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Nilai Pengusul = 60%	17.4	19.95	18.675

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Reviewer 1



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## Toward standards harmonization in asean economic community: A comparative study of national standardization bodies in Indonesia and Malaysia (Article)

Purwanggono, B., Bakhtiar, A., Suliantoro, H., Setyowati, P.R.

Industrial Engineering Department, Diponegoro University, Jl. Prof. Sudharto, Semarang, SH 50239, Indonesia

### Abstract

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National Quality Infrastructure (NQI) is the institutional framework that establishes and implements standardization practices, including service conformity assessment, metrology and accreditation. Along with the implementation of the ASEAN Economic Community, the strength and endurance of standards development organizations should be strengthened to compete in international markets and be able to keep abreast of the time. However, there are still differences in the internal conditions and external standards development organizations in some ASEAN countries. It is then important to understand these differences. This research was aimed at measuring them by conducting a comparative analysis between standards development organizations in Indonesia and in Malaysia. The reason is that Malaysia as a neighbouring country of Indonesia has been quite far beyond it in terms of the development of the national quality infrastructure. This research was based on literature study and interviews. It is expected that Indonesia can learn the existing weaknesses and follow the positive aspects from the experience of Malaysia. The analyses used the SWOT method, IFAS-EFAS and QSPM Matrices. Results of this research are some strategies that should be prioritized in Indonesia as a consequence of learning the adoption of the policy in Malaysian institutions. The strategies are essential to improve the institution in Indonesia. © School of Engineering, Taylor's University.

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# **TEMPLATE PAPER**

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Malaysia \*Corresponding Author: anna\_a\_lee@web.abc.cd

**Abstract**

An investigation has been made to predict the effects of forebody and afterbody shapes on the aerodynamic characteristics of several projectile bodies at supersonic speeds using analytical methods combined with semi-empirical design curves. The considered projectile bodies had a length-to-diameter ratio of 6.67 and included three variations of forebody shape and three variations of afterbody shape. The results, which are verified by comparison with available experimental data, indicated that the lowest drag was achieved with a cone-cylinder at the considered Mach number range. It is also shown that the drag can be reduced by boattailing the afterbody. The centre-of-pressure assumed a slightly rearward location for the ogive-cylinder configuration when compared to the configuration with boattailed afterbody where it was the most forward. With the exception of the boattailed afterbody, all the bodies indicated inherent static stability above Mach number 2 for a centre-of-gravity location at about 40% from the body nose.

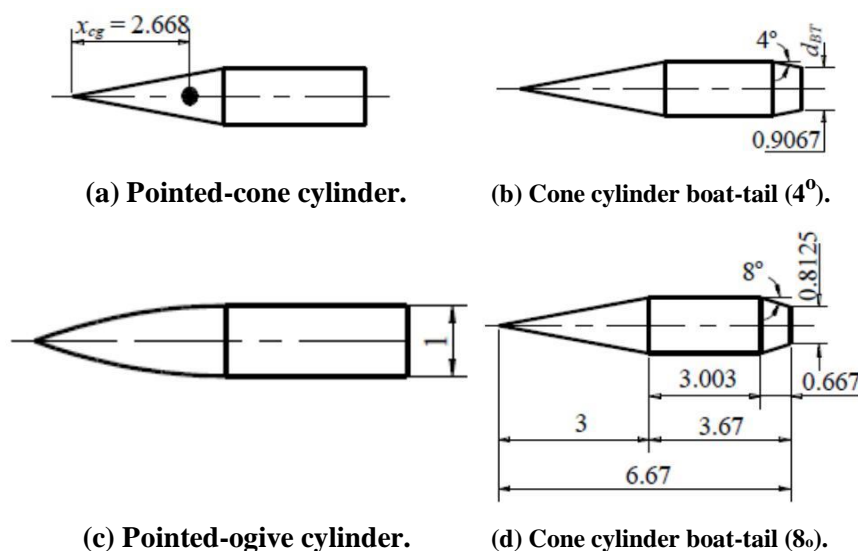
Keywords: Aerodynamics, Forebody and afterbody, Next keyword, Projectile, Supersonic speed.

## 1. Introduction

The shape of a projectile is generally selected on the basis of combined aerodynamic, guidance, and structural considerations. The choice of seeker, warhead, launcher, and propulsion system has a large impact on aerodynamic design [1]. Consequently, various configurations have evolved, each resulting from a series of design compromises. During supersonic flight, the drag component that results from the change of the cross section of the projectile is referred to as wave drag and it is attributed to the shock waves formed. This normally happens at the forebody (nose) and afterbody (tail). Since the wave may be the prevailing drag form at supersonic speeds, careful selection of the nose and tail shapes is mandatory to ensure performance and operation of the over-all system.

Shahbhang and Rao [2] conducted an experimental investigation to determine aerodynamic characteristics of cone-cylinder and ogive-cylinder bodies of different fineness ratios at Mach number of 1.8. Their results indicated that the normal force for ogive-cylinder body is slightly higher than that for cone-cylinder body of nose fineness ratio 3 and lower than that for cone-cylinder body for nose fineness ratio 7 and there is crossing of normal force curves for nose fineness ratio equal to 5. This interesting phenomenon requires further investigation.

The objectives of this paper is to predict the aerodynamic characteristics of projectiles using analytical and semi-empirical methods and study the effect of body shape; forebody and afterbody, on the aerodynamic characteristics of projectiles at supersonic speeds. For this purpose five widely used projectile shapes are investigated. The geometry and full dimensions of these projectile shapes are shown in Fig. 1. The models are: (a) cone-cylinder, (b) ogive-cylinder, (c) blunted cone-cylinder, (d) cone-cylinder boattail ( $4^\circ$ ), and (e) cone-cylinder boattail ( $8^\circ$ ). All the models have a fineness ratio of 6.67 and a centre-of-gravity location at about the 40% body station. The supersonic Mach number range considered is from 1.6 to 5 for zero-angle of attack.



**Fig. 1. Investigated shapes of projectiles (Geometry and dimensions).**

## 2. Prediction of Aerodynamic Coefficients

Analytical methods and design charts used for the prediction of zero-lift drag coefficient  $C_{D0}$ , normal-force-curve slope  $C_N$ , and centre-of-pressure location  $x_{cp}$  of body of revolution at supersonic speeds are presented in this section. The analytical methods are based on supersonic linearised theory and thus they are limited to slender bodies and low angles of attack, i.e., in the linear range of the normal-force-curve slope while the design charts are produced from semi-empirical results. The design charts are coupled with the analytical methods to improve the accuracy of the results. These design charts used for the prediction of aerodynamics characteristics are adapted from Refs. [3, 4] and converted to numerical data, as outlined in *Appendix A*.

### 2.1. Zero-lift drag coefficient $C_{D0}$

The total zero-lift drag coefficient of the body is usually considered to be of three components; friction drag, wave drag, and base drag as shown in Eq. (1). These different components are further discussed in the following sub-sections.

$$C_{D0} = C_{Dfr} + C_{Dw} + C_{Db} \quad (1)$$

#### 2.1.1. Friction drag coefficient

For fully-turbulent and compressible flow, the friction coefficient is given by Eq. (2) [5, 6]

$$C_{Dfr} = \frac{0.455(\log_{10} Re)^{-2.58} S_{wet}}{0.21M^{0.467} D^{0.467} S_{ref} + 1} \quad (2)$$

#### 2.1.2. Wave drag coefficient

The main contribution to the wave drag arises from nose and afterbody. The magnitude of the wave drag depends primarily on the Mach number, the shape and dimensions of the nose or afterbody [7-10]. Therefore, the total wave drag of the body is simply the summation of the nose and afterbody wave drags

$$C_{Dw} = (C_{DwN}) + (C_{DwBT}) \quad (3)$$

The wave drag of pointed cone-cylinder  $(C_{Dw})_{cone}$  and pointed ogive-cylinder  $(C_{Dw})_{ogive}$  can be obtained from Figs. A-1 and A-2 (*Appendix A*) as a function of nose fineness ratio  $N$ , and Mach number. For blunted cone-cylinder the wave drag can be determined as a function of  $N$ , Mach number, and diameter of nose bluntness  $D_0$  using Eq. (4) [4]

$$(C_{Dw})_{blunted\ cone} = (C_{Dw})_{cone} (1 - D_0^2 \cos^2) + (C_{Dw})_{sphere} \frac{D_0^2}{D^2} \quad (4)$$

where  $(C_{Dw})_{cone}$  is the wave drag of the original pointed cone with and  $(C_{Dw})_{sphere}$  is the wave drag of hemispherical nose, which can be determined from Fig. A-3 as function of  $N$  and Mach number

The wave drag of conical boattail ( $C_{DW})_{BT}$  can be evaluated from Fig. A-4 as a function of  $BT$ ,  $BT$  and Mach number.

### 2.1.3. Base drag coefficient

At supersonic speeds the base drag of the body, caused by a large negative pressure, results in a substantial increase in the body drag. The base drag coefficient of the body is related to the base pressure coefficient as follows [4]

$$C_{D_b} = -p_b K_b^2 \quad (5)$$

where  $p_b$  is the base pressure coefficient for cylindrical base (determined from Fig. A-5 as a function of Mach number), and  $K_b$  is a correction factor, which depends on the geometry of boattail  $K_b = f(C_{BT}, M)$ , obtained from Fig. A-6 [4], where

$$C_{BT} = \frac{1 - BT}{2 BT BT^2} \quad (6)$$

## 2.2. Normal-force-curve slope $C_N$

The total normal-force-curve slope of nose-cylinder-boattail body is determined by the summation of the normal-force-curve slopes of the nose (with the effect of cylindrical part) and afterbody.

$$C_{N_a} = (C_{N_a N}) + (C_{N_a BT}) \quad (7)$$

At supersonic speeds design charts are presented for estimating the normal-force-curve slope of bodies of revolution composed of conical or ogival noses and cylindrical afterbodies.

The normal-force-curve slope of blunted cone-cylinder can be evaluated from [3] as a function of  $N$ , Mach number, and  $D_0$

$$(C_{N_a})_N = (1 - D_2) + (C_{N_a cone}) + (C_{N_a sphere}) D_2 \quad (8)$$

where  $(C_{N_a})_N$  is the normal-force-curve slope of pointed cone with hemispherical nose-force-the normalis  $(C_{N_a sphere})_N C$ , and  $(C_{N_a Cyl})_N$  and

## 2.3. Location of the centre-of-pressure $x_{cp}$

The identification of the location of the centre of pressure of a projectile body is motivated by the need for calculating aerodynamic moments, stability and structural analyses. The centre-of-pressure location of bodies composed of conical noses and cylindrical afterbodies is determined as follows [5]

$$(x_{cp})_N = (0.667 + C_{Cyl}) L_N \quad (9)$$

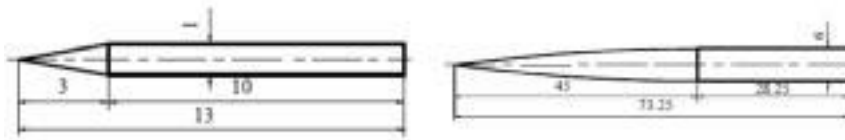
### 3. Computer Programme: Validation and Verification

To ensure the validity and accuracy of the calculations, the results are compared to available experimental wind tunnel data. Normal force coefficient and base drag coefficient are compared as a function of Mach number and angle of attack. Two typical projectile configurations (as shown in Figs. 2 and 3) are selected for this purpose. The specifications of the models and test conditions are shown in Table 1.

**Table 1. Test model specifications and test conditions.**

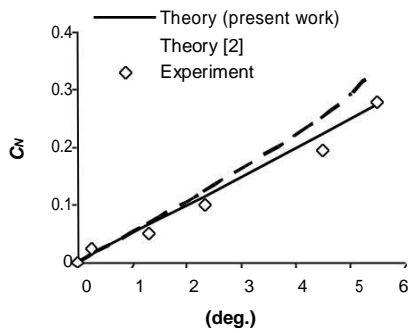
	Model No. 1 [2]	Model No. 2 [7]
<b>Configuration Type</b>	Cone-cylinder	Ogive-cylinder
<b>Body fineness ratio</b>	13	12.2
<b>Nose fineness ratio</b>	3	7.5
<b>Body Diameter, <math>d</math> (inches)</b>	1	6
<b>Reference length, <math>L_{ref}</math></b>	$d$	$d$
<b>Reference area, <math>S_{ref}</math></b>	$d^2/4$	$d^2/4$
<b>Testing Mach number</b>	1.77	1.5, 1.6, 1.79, 1.99
<b>Testing angle of attack (deg.)</b>	0 – 6	0

Figures 2 and 3 show the comparison between the current results and the wind tunnel experimental data. Figure 2 shows that at low angles of attack the normal force coefficients are in excellent agreement with the experimental data. This is to be expected due to the assumption of small angle of attack. The figure also shows that the current results are closer (average percentage error less than 0.5%) to the experimental data than those predicted analytically (average percentage error about 6%) by Shahbahang and Rao [2]. This is expected as the analytical methods contained a number of simplifying assumptions that limit their accuracy and range of use.

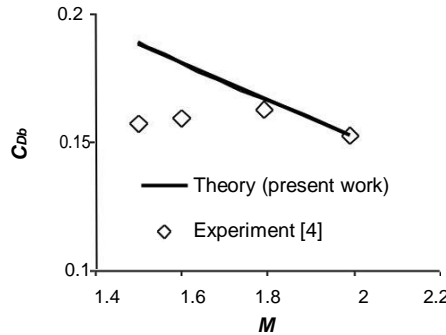


**Pointed-Cone Cylinder [2].**

**Pointed-Ogive Cylinder [7].**



**Fig. 2. Variation of normal force vs. angle of attack at  $M = 1.77$ .**



**Fig. 3. Variation of base drag coefficient vs. Mach number.**

A comparison of base drag coefficient as a function of Mach number is shown in Fig. 3. The comparison shows that at low supersonic Mach numbers the average percentage error is 12%, while at higher Mach number the accuracy is excellent (error less than 2%). At low supersonic Mach numbers the base drag contribution drag contribution is the largest [8]. However the obtained accuracy is still within design of projectiles and missiles [9].

## 4. Results and Discussion

The prediction of the aerodynamic coefficients of the investigated projectiles shown in Fig. 1 was carried using the methods and the computer programme described above. The effects of forebody and afterbody shapes on the aerodynamics at supersonic speeds are analysed in this paper.

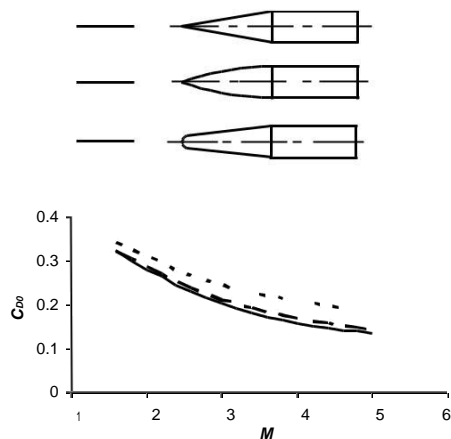
### 4.1. Effect of forebody

#### 4.1.1. Zero-lift drag $C_{D0}$

Figure 4(a) shows the effect of nose shape on  $C_{D0}$  with cylindrical afterbody as a function of Mach number. The drag of cone-cylinder combination was the lowest at the considered Mach numbers. It is clear that the bluntness of nose causes the drag to increase.

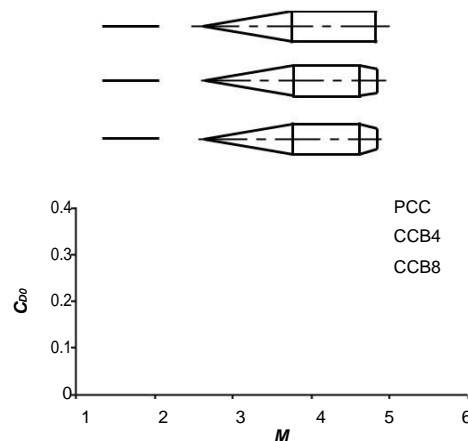
#### 4.1.2. Normal-force-curve-slope $C_N$ and location of centre-of-pressure $x_{cp}$

The effect of forebody on the normal force curve slope and centre-of-pressure location for the cylindrical afterbody is shown in Figs. 4(b) and (c) as a function of Mach number. For all three shapes the variations of  $x_{cp}$  are reasonably similar and pressure locations are apparently a result of the normal force distribution over the more rearward  $x_{cp}$ .



(a) Zero-lift drag coefficient  $C_{D0}$ .

**Fig. 4. Effect of forebody shape on the aerodynamic characteristics.**



(a) Zero-lift drag coefficient  $C_{D0}$ .

**Fig. 5. Effect of afterbody shape on the aerodynamic characteristics.**

For conical, ogival, and blunted cone forebody shapes, an inherent static stability occurs for a centre-of-gravity location of about 40% body length at Mach number above around 1.6, 1.8 and 2 respectively. Such a centre-of-gravity location may not be difficult to achieve with a projectile [10].

## 4.2. Effect of afterbody

### 4.2.1. Zero-lift drag $C_{D0}$

For the projectile configuration comprising conical forebody and boattail, the effect of boattail shape on the drag is shown in Fig. 5(a) as a function of Mach number. For all the investigated configurations, the zero-lift drag coefficient, decreases as Mach number increases. This is a typical behaviour for this curve for all bodies flying at supersonic speeds. The high drag for the cone-cylinder combination was primarily a result of higher base drag than the bodies with boattail. It is also seen from this figure that the higher the angle of boattail the lower is the drag.

### 4.2.2. Normal-force-curve-slope $C_N$ and location of centre-of-pressure $x_{cp}$

The effect of afterbody shape on the normal-force-curve slope and centre-of-pressure location for conical nose are shown in Figs. 5(b) and (c) as a function of Mach number. The variations with Mach number are reasonably similar with the most forward location of  $x_{cp}$  occurring with the boattail. The increasing of the angle of boattail results in decreasing of the projectiles static stability.

Accordingly the projectile with cone-cylinder is statically stable above the entire Mach number range, while the projectile with boattail ( $4^\circ$ ) is stable above Mach number 1.8. The cone-cylinder boattail ( $8^\circ$ ) projectile is shown to be stable only within the Mach number range 2 to 4. This is confirmed by Hii et al. [11].

## 5. Conclusions

An investigation has been made of the effects of forebody and afterbody shapes of a series of projectiles on the aerodynamic characteristics at Mach numbers from 1.6 to 5. This is done using analytical methods combined with semi-empirical design curves. Some concluding observations from the investigation are given below.

- A pointed cone-cylinder produced the lowest drag at the considered Mach number range, and the highest drag was produced by the blunted cone-cylinder.
- The shape of forebody slightly affects the normal force and centre-of-pressure location. The farthest aft centre-of-pressure locations were obtained with the ogive-cylinder and the most forward locations with a boattailed afterbody.
- With the exception of the boattail afterbody, all the considered projectile shapes indicated inherent static stability above a Mach number of about 2 with the centre-of-gravity location of about 40% body length.
- Configurations with boattail have higher wave drag but appreciably lower base drag with a resultant decrease of total drag. The decrease of the boattail angle increases the base drag but reduced the projectile wave drag with a resultant decrease of the total drag.

**Nomenclatures**

$C_{BT}$	Boattail factor
$D_o$	Ratio of diameter of nose blunting to cylinder diameter ( $2r_o/d$ )
$d$	Body diameter, m
$K_b$	Correction factor for base drag
$L_N$	Original nose length of pointed conical nose (Fig. 1), m
$M$	Freestream Mach number
$p_b$	Base pressure coefficient for cylindrical boattail
Re	Reynolds number
$r_o$	Radius of nose blunting (Fig. 1), m
$S_{ref}$	Reference area ( $d^2/4$ ), m <sup>2</sup>
$x_{cp}$	Centre-of-pressure location measured from the nose apex, m

**Greek Symbols**

	Angle of attack, deg.
	Mach number parameter,
	$M_2 - 1$
$BT$	Ratio of base diameter to cylinder diameter ( $d_{BT}/d$ )
	Ratio of cylindrical part length to nose length of pointed cone shape
$N^{Cyl}$	Fineness ratio of original pointed cone ( $L_N / d$ )
	Semi-vertex angle of the conical nose (Fig. 1), deg.

**Abbreviations**

ISA	International Standard Atmosphere
JESTEC	Journal of Engineering Science and Technology
NACA	National Advisory Committee for Aeronautics
WHO	World Health Organization

**References**

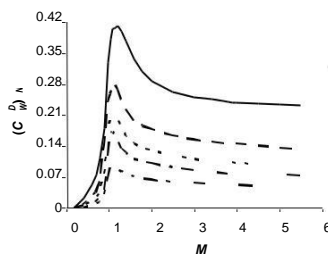
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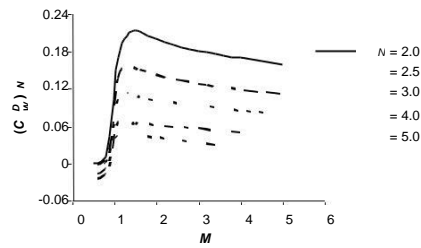
## Appendix A

### Representation and Figures of Design Charts

In the present work a number of empirical and semi-empirical design charts are used for the prediction of the aerodynamic characteristics (Figs. A-1 and A-2). These figures are adapted from the design charts given by Lebedev and Chernobrovkin [3] and Jankovic [4]. The curves of those charts are read and converted to numerical data and then stored in a separated subroutine in a computer programme described by Al-Obaidi [8]. A simple linear interpolation is used to find the value of the parameters used in the calculations.



**Fig. A-1. Wave drag coefficient of conical noses with different fineness ratios [3].**



**Fig. A-2. Wave drag coefficient of ogival noses with different fineness Ratios [3].**

## Appendix B

### Computer Programme

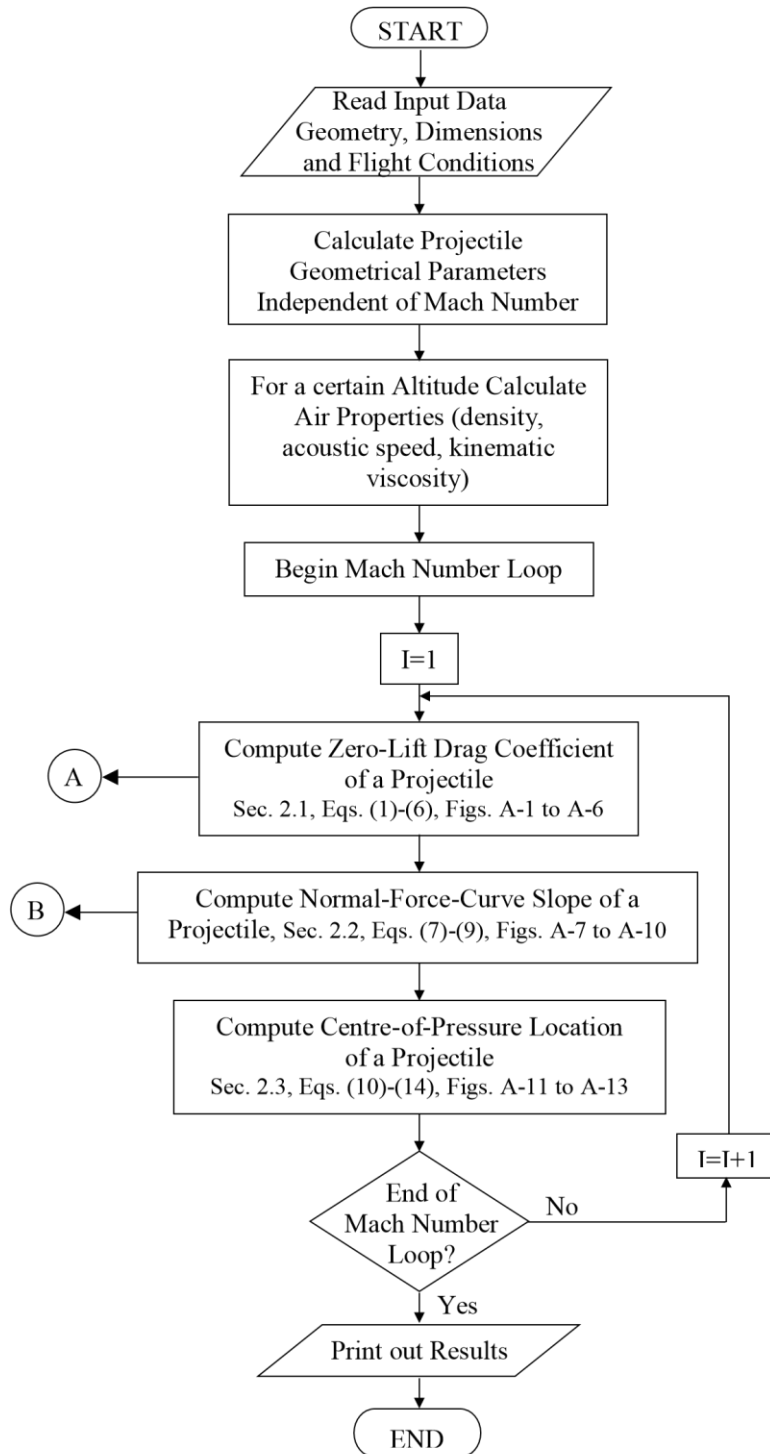
#### B. 1. Introduction

A computer code, for the prediction of projectile aerodynamic characteristics as a function of projectile geometry, Mach number and altitude of flight, is developed empirical methods presented in section 2.

The computer programme can serve two main purposes: firstly, in the design stage, a rapid parametric study of configuration can be performed to allow the secondly, by calculating the forces acting on a projectile at a range of speeds, the programme is used in conjunction with both trajectory and stability calculations to provide a complete picture of the projectile over its whole flight.

#### B. 3. Programme Structure and Description of Subroutines

Fortran-77 language is used in programming the prediction methods. Each estimation method is programmed in a separate subroutine for case of programme. These charts are converted to numerical data (*Appendix A*) and stored in a separate subroutine for convenience. The main flow chart of the programme is shown in Fig. B-1.



**Fig. B-1. Main Flow Chart of the Computer Programme Used in this Study.**