A PROJECT REPORT

ON

DESIGN AND FABRICATION OF ARTILLERY ROCKET WITH TAIL FINS IN PLUS OR CONFIGURATION

SUBMITTED TO

Department of Aerospace Engineering,
University of Petroleum & Energy Studies,Dehradun
MAY,2010

SUBMITTED BY

Abhinav Jain (R180206003)
Harshal Jha (R180206022)

THE REPORT

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Harshal Jha (R180206022)

Under the guidance of

Dr.Om Prakash

CERTIFICATE

This is to certify that the work content in this report title "A Project Report on Design and Fabrication of an artillery rocket with tail fins in plus/configuration "has been carried out by "Abhinav Jain and Harshal Jha as a group" under my supervision and during their project they were very hard working and punctual, also his conduct found to be very good.

We wish all the success in future endeavors.

Dr. Om Prakash

(Project mentor)

COE UPES

ACKNOWLEDGEMENT

The project has been successfully completed under the supervision of Dr. Om Prakash.With deep sense of gratitude we wish to place our sincere thanks to him for his invaluable guidance during our project.

My most sincere thankful to Dr. Om Prakash (HOD) for his invaluable advice, guidance and encouragement for throughout our project.

Abhinav Jain

Harshal Jha

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ABSTRACT

To design and fabricate an artillery rocket with tail fins in plus/configuration.

An artillery rocket is a type of artillery equipped with rocket launchers instead of conventional guns or mortars.These rockets are capable of very destructive strikes by delievering a large mass of explosives simultaneously,thus increasing the shock effect and giving the target less time to take cover.The tail fins are basically used to ensure the directional stability of a moving object through a fluid such as air or water.Usually there are 3 or 4 fins used in the design and fabrication of an artillery rocket.Tail fin area is usually calculated by using empirical formulae depending on whether it's a 3 fin or a 4 fin rocket.Based on all the selected design parameters customer demand,market potential and function and industry proven results it's a good option for the aviation industry in the upcoming future.

1. INTRODUCTION

Artillery Rocket : -

Artillery rocket is a type of artillery equipped with rocket launchers instead of conventional guns or mortars.

Types of Artillery Rocket pieces include multiple rocket launchers.

Artillery rocket vs Artillery tube :-

Conventional artillery systems produce significant recoil while rockets produce no recoil. Rocket artillery is much more mobile and can change position easily.It could, conceivably, fire on the move. Rocket systems produce a significant amount of backblast.

- They are capable of very destructive strikes by delivering a large mass of explosives simultaneously.
- They typically have a very large fire signature, leaving a clear smoke-trail.
- Tube artillery shells are typically cheaper and less bulky than rockets, so they can deliver a larger amount of explosive.
- The higher accuracy of gun artillery means that it can be used to attack an enemy close to a friendly force.

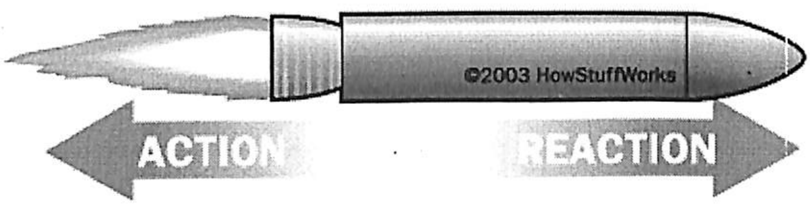
Rocket

A rocket is a missile, spacecraft, aircraft or other vehicle which obtains thrust by the reaction of the rocket to the ejection of a jet of fast moving fluid exhaust from a rocket engine..

They are used for fireworks, weaponry, ejection seats, launch vehicles for artificial satellites, human spaceflight and exploration of other planets.They are inefficient for low speed use, they are very lightweight and powerful, capable of generating large accelerations.

Chemical rockets store a large amount of energy in an easily-released form, and can be very dangerous. However, careful design, testing, construction and use minimizes risks.

HOW ROCKET ENGINE WORKS :-



Rocket engines are fundamentally different.They are reaction engines.It works on the Newton's second law that is "to every action there is an equal and opposite reaction." A rocket engine is throwing mass in one direction and benefiting from the reaction that occurs in the other direction as a result.

This concept of "throwing mass and benefiting from the reaction" can be hard to grasp at first, because that does not seem to be what is happening. Rocket engines seems to be about flames and noise and pressure, not "throwing things."

COMPONENTS OF A ROCKET :-

Hardware

Rockets at minimum have propellant, a place to put propellant and a nozzle. They nearly always also have one or more rocket engines, directional stabilization device(s) and a structure to hold these components together. Rockets are intended for high speed atmospheric use also have an aerodynamic fairing such as a nose cone, which usually holds the payload.

As well as these components, rockets can have any number of other components, such as wings, wheels even in a sense, a person..

Rocket engines

Rocket engines employ the principle of jet propulpsion.The rocket engines powering rockets come in a great variety of different types, a comprehensive list can be found in rocket engine. Most current rockets are chemically powered rockets that emit a hot exhaust gas. A rocket engine can use gas propellants, solid propellant, liquid propellant, or a hybrid mixture of both solid and liquid..With combustive propellants a chemical reaction is initiated between the fuel and the oxidizer in the combustion chamber, and the resultant hot gases accelerate out of a rocket engine nozzle (or nozzles) at the rearward-facing end of the rocket.

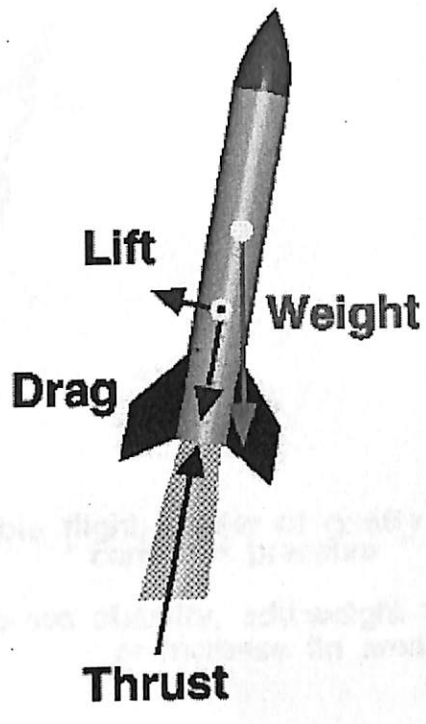
Rocket propellant

Rocket propellant is mass that is stored, usually in some form of propellant tank or casing, prior to being used as the propulsive mass that is ejected from a rocket engine in the form of a fluid jet to produce thrust..For chemical rockets often the propellants are a fuel such as liquid hydrogen or kerosene which is burned with an oxidizer such as liquid oxygen or nitric acid to produce large volumes of very hot gas. .

Sometimes the propellant is not burned but still undergoes a chemical reaction, and can be a 'monopropellant' such as hydrazine, nitrous oxide or hydrogen peroxide that can be catalytically decomposed to hot gas.

For smaller, low performance, rockets such as attitude control thrusters where high performance is less necessary, a pressurised fluid is used as propellant that simply escapes the spacecraft through a propelling nozzle.

FORCES ON A ROCKET IN A FLIGHT : -

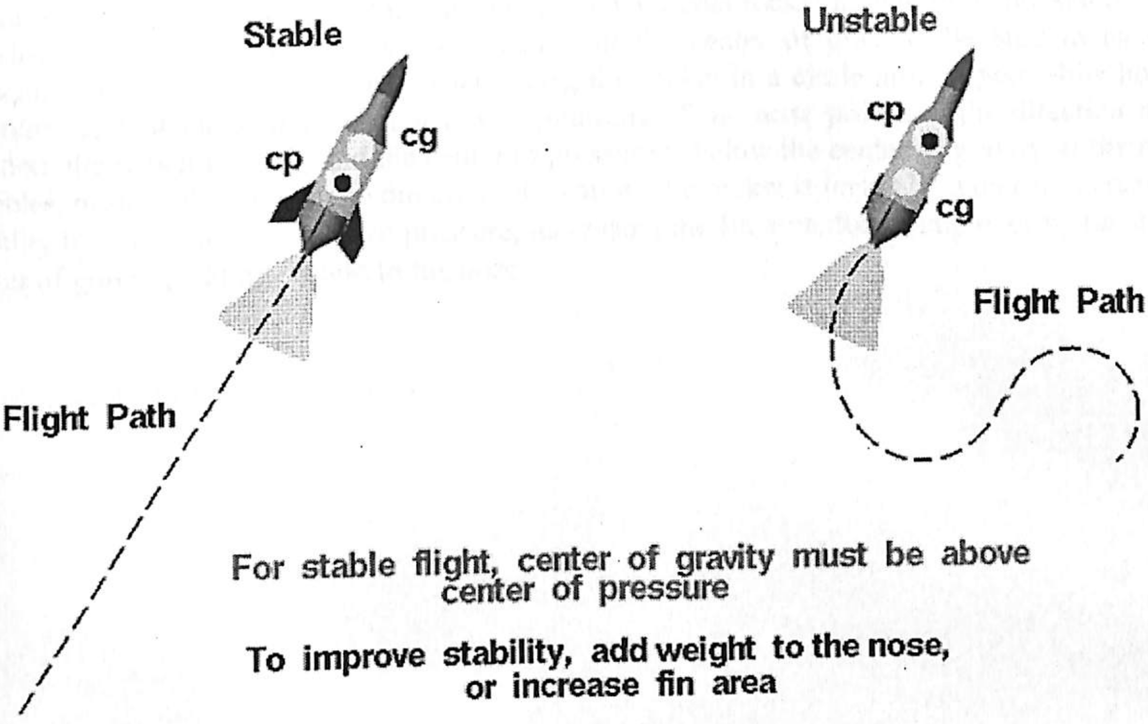


Flying rockets are primarily affected by the following:

- Thrust from the engine(s)
- Gravity from celestial bodies
- Drag if moving in atmosphere
- Lift; usually relatively small effect except for rocket-powered aircraft

, The Forces acting on the rocket naturally causes the vehicle to follow a roughly parabolic trajectory termed a gravity turn, and this trajectory is often used at least during the initial part of a launch.Vehicles can thus maintain low or even zero angle of attack which minimizes transverse stress on the launch vehicle; permitting a weaker, and hence lighter, launch vehicle.

Rocket Stability Condition



During the flight of a model rocket small gusts of wind, or thrust instabilities can cause the rocket to "wobble", or change its attitude in flight. Like any object in flight, a model rocket rotates about its center of gravity cg, shown as a yellow dot on the figure. The rotation causes the axis of the rocket to be inclined at some angle a to the flight path. Whenever the rocket is inclined to the flight path, a lift force is generated by the rocket body and fins, while the aerodynamic drag remains fairly constant for small inclinations. Lift and drag both act through the center of pressure cp of the rocket, which is shown as the black and yellow dot in the figure.

If the center of gravity is located above the center of pressure, the rocket will return to its initial flight conditions if it is disturbed. Engineers call this a restoring force because the forces "restore" the vehicle to its initial condition and the rocket is said to be stable. Such a flight condition is shown on the left of the figure.

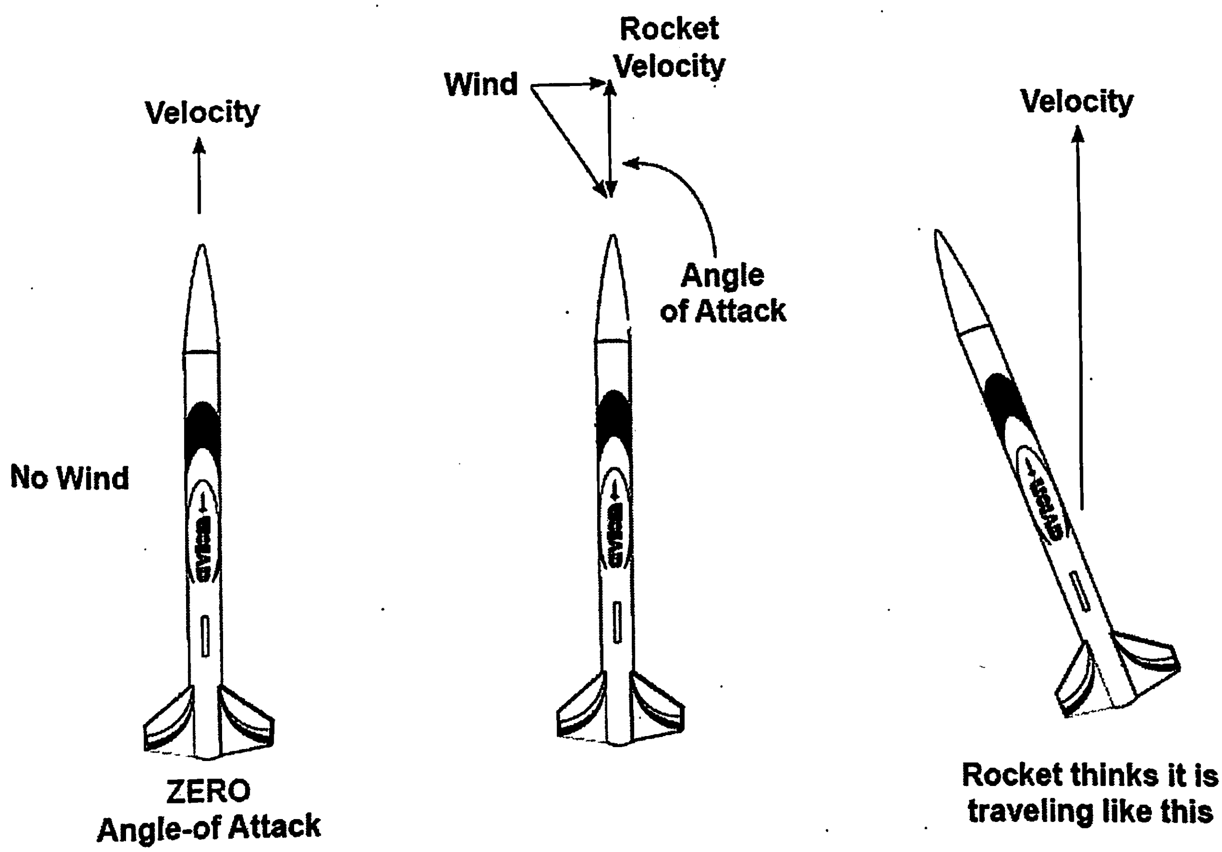
If the center of pressure is above the center of gravity, the lift and drag forces maintain their directions but the direction of the torque generated by the forces is reversed. This is called a de-stabilizing force. Any small displacement of the nose generates forces that cause the displacement to increase. Such a flight condition is shown on the right of the figure where the rocket is unstable .

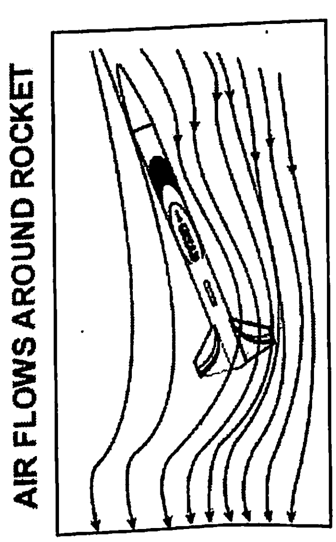
For a stable model rocket, the center of pressure must be located below the center of gravity. To increase the stability of your rocket, add weight to the nose, or increase the area of the fins.

There is a relatively simple test that you can use on a model rocket to determine the stability. Tie a string around the body tube at the location of the center of gravity. Be sure to have the parachute and the engine installed. Then swing the rocket in a circle around you while holding the other end of the string. After a few revolutions, if the nose points in the direction of the rotation, the rocket is stable and the center of pressure is below the center of gravity. If the rocket wobbles, or the tail points in the direction of rotation, the rocket is unstable. You can increase the stability by lowering the center of pressure, increasing the fin area, for example, or by raising the center of gravity, adding weight to the nose.

a

Angle - of - Attack





A rocket flying at an Angle-of-Attack creates lift, and therefore it also creates "Induced Drag."

Flying at an Angle-of-Attack always reduces the performance of the rocket.

HIGH MOBILITY ARTILLERY ROCKET SYSTEM :-

A new member of the multiple rocket launch rocket system family.It's a highly mobile artillery rocket system that offers MLRS firepower on a wheeled vehicle.The HIMARS launcher is lighter in weight compared to the MLRS launcher.

HIMARS design concept will include the familiar launcher module,fire control and digital command and control systems and a self-reload capability.HIMARS is based on the need for a lighter weight,more deployable.

MULTIPLE LAUNCH ROCKET SYSTEM :-

A multiple rocket launcher is a type of unguided rocket artillery system.Like other rocket artillery,multiple rocket launchers are less accurate and have a much lower rate of fire than atteries of traditional artillery guns. However,hey have the capability of simultaneously dropping of many hundreds of kilograms of explosive,with devastating effect.

USES OF ARTILLERY ROCKET :-

.They produce significant recoil.

.They could,conceivably fire on the move.

.They can deliever a large mass of explosives simultaneously.

.They typically have very large fire signature,leaving a clear smoke-trail.

.They are much more mobile and can change position easily.

.The higher accuracy of it means that it can be used to attack an enemy close to a friendly force.

TAIL FINS

The fins provide the stabilizing force to keep the rocket moving along a safe trajectory.

.Fins should be positioned at the back of the rocket for maximum efficiency.

.Tail fins are at the back of the main body.

.Tail fins are basically used to ensure the directional stability of an object..

.Usually there are 3 or 4 fins used in the design and fabrication of a rocket.

TAIL FINS SIZE : -

Emperical Formulae for Tail fins size –

For a 3 Fin Rocket :-

Fin area in square inches for each fin

0.17*[(d+0.5)*L]

Where d = Body tube diameter in inches

L = Body tube Length in inches

For a 4 Fin Rocket :-

Fin area in square inches for each fin

0.13*[(d+0.5)*L]

For calculating the Fins size :-

Fins size = 1/3 * Length of rocket tube

And

= 3* wide as rocket tube

2. METHODOLOGY : -

Step 1 :- Literature survey

Step 2 :- Selecting design parameters from the available literature

Step 3 :- Computing aerodynamic and flight performance parameters theoretically.

Step 4 :- Fabrication of the model based on the selected design parameters.

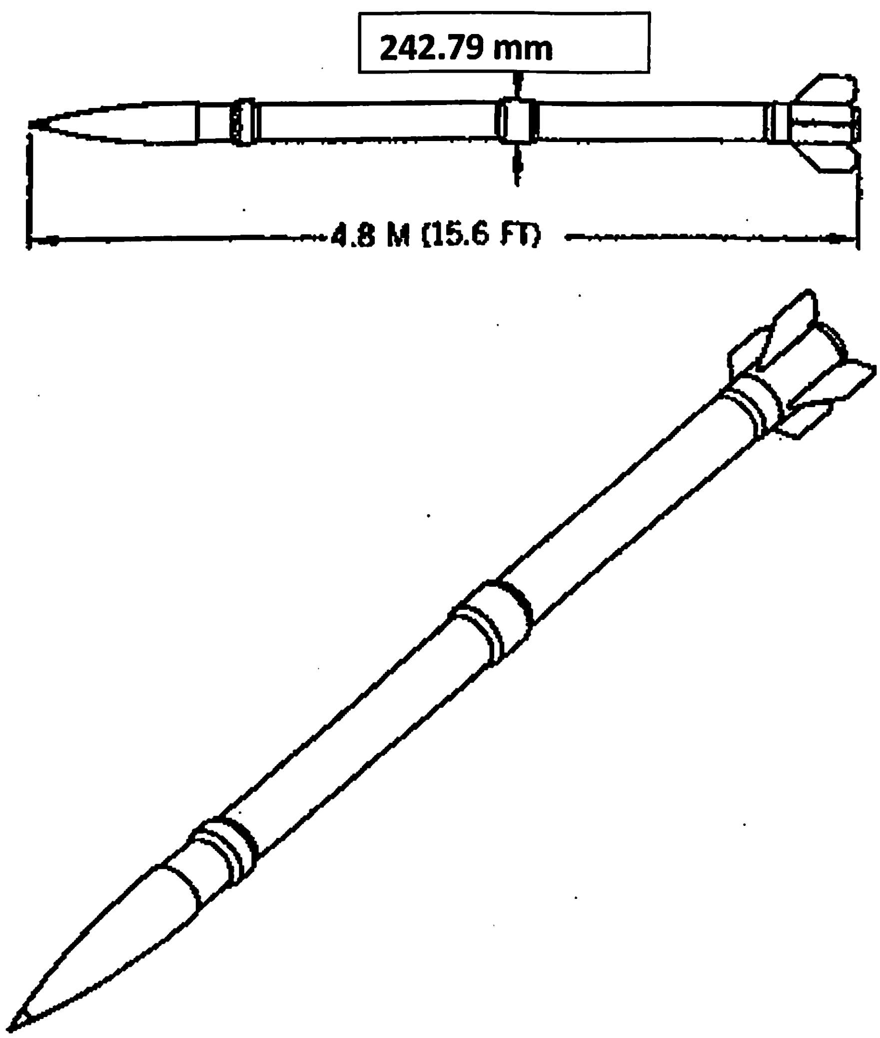
Step 5 :- Wind tunnel testing

Step 6 :- Calculation of actual parameters and comparision with theoretical values.

Step 7 :- Trajectory Simulation

Step 8 :- Flight trials test

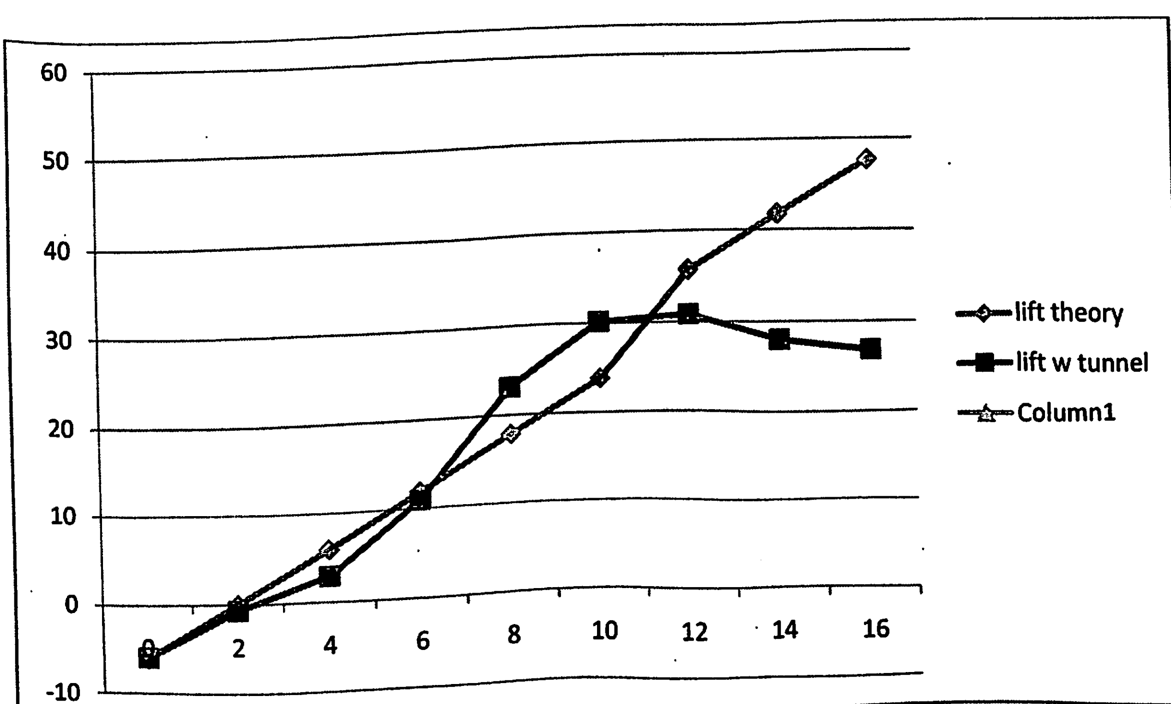
3. SPECIFICATIONS :-



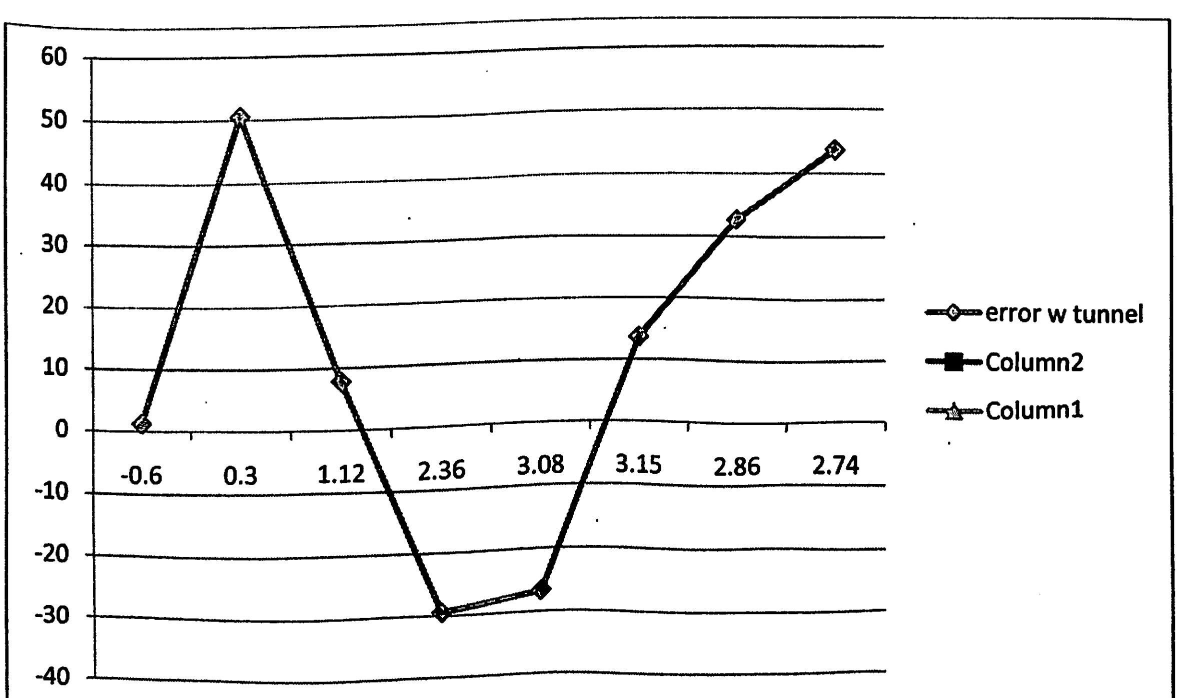
WM – 80 MULTIPLE LAUNCH SYSTEM

Crew	3
Rocket Length	4,582 mm
Rocket Weight	980 g
Warhead	150 kg
Maximum Firing Range	80 km
Rate of Fire	8 rounds in 40 seconds
Number of Tubes	8

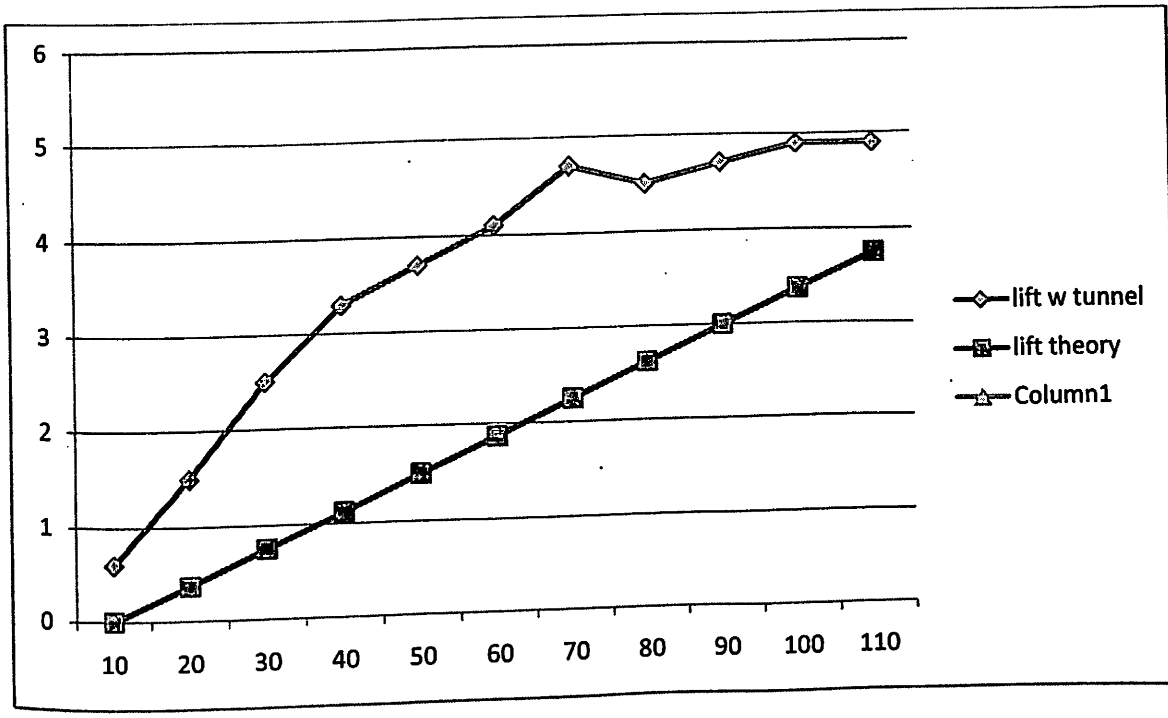
alpha	C_L	Lift Theory		Lift W tunnel
-2	-0.12	-5.9	-0.6	-5.88
0	0	0	-0.07	-0.68
2	0.12	5.9	0.3	2.94
4	0.25	11.9	1.12	10.97
6	0.38	17.86	2.36	23.12
8	0.51	23.82	3.08	30.18
12	0.77	35.73	3.15	30.87
14	0.9	41.69	2.86	28.02
16	1	47.64	2.74	26.85



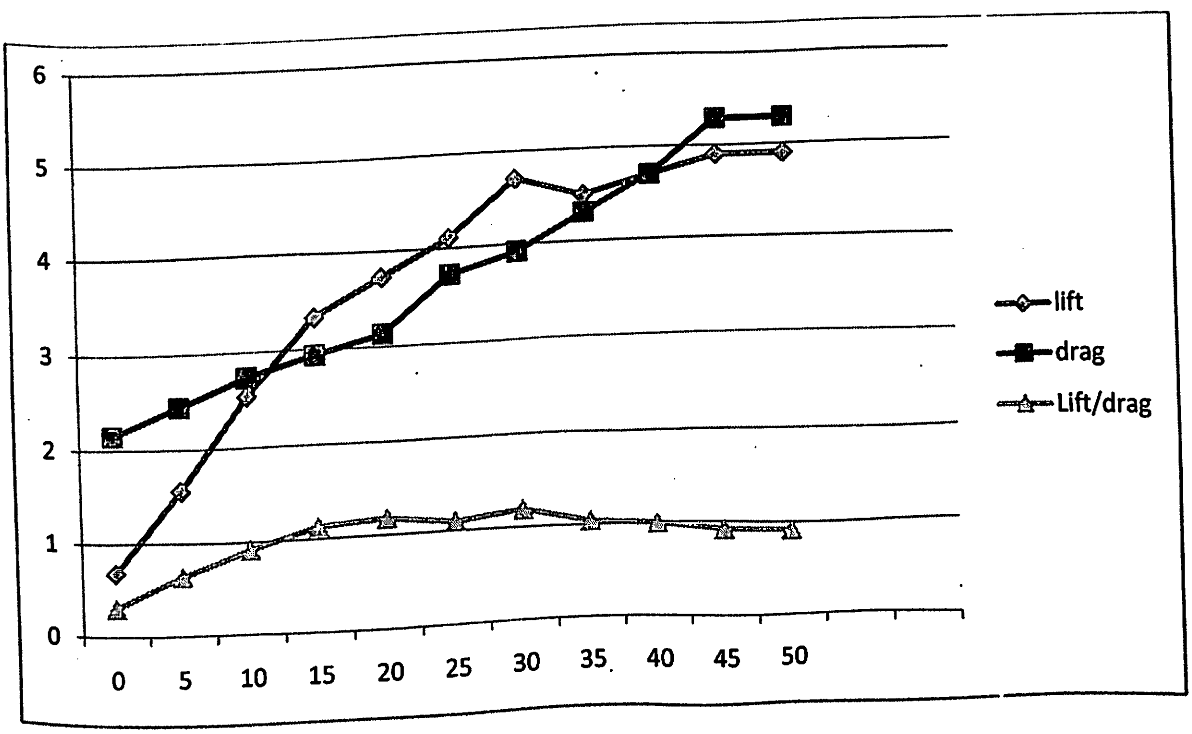
alpha	C_l	Lift Theory		Lift W tunnel	Error w tunnel
-2	-0.12	-5.95	-0.6	-5.88	1.27
2	0.12	5.95	0.3	2.94	50.63
4	0.25	11.91	1.12	10.97	7.85
6	0.38	17.86	2.36	23.12	-29.43
8	0.51	23.82	3.08	30.18	-26.69
12	0.77	35.73	3.15	30.87	13.61
14	0.90	41.69	2.86	28.02	32.77
16	1	47.64	2.74	26.85	43.64



alpha	Lift Wtunnel	Drag	Lift/drag	Lift Theory
0	0.6	2.15	0.31	0
5	1.5	2.45	0.64	0.37
10	2.5	2.74	0.92	0.75
15	3.3	2.94	1.13	1.12
20	3.7	3.13	1.18	1.50
25	4.1	3.72	1.10	1.87
30	4.7	3.92	1.19	2.25
35	4.5	4.31	1.04	2.62
40	4.7	4.7	1	3.00
45	4.9	5.29	0.92	3.37
50	4.9	5.29	0.92	3.75


6
5
4
3
2
1
0
10
20
30
40
50
60
70
80
90
100
110
lift w tunnel
lift theory
Column1

Alpha	lift	drag	Lift/drag
0	0.68	2.15	0.31
5	1.56	2.45	0.64
10	2.54	2.74	0.92
15	3.33	2.94	1.13
20	3.72	3.13	1.18
25	4.11	3.72	1.10
30	4.7	3.92	1.19
35	4.5	4.31	1.04
40	4.7	4.7	1
45	4.9	5.29	0.92
50	4.9	5.29	0.92



4. RESULTS :-

Considering WM-80 Multiple Launcher system as a reference we have

Length = 1m

Diameter = 242.79mm

Therefore, L/D = 4.120

Now we have to take the design parameters such that L/D remains the same

Thus, we have

Length = 450mm

Diameter = 109.2mm

Therefore,

L/D = 4.120

As we are designing for 4 fins

Therefore we have,

For Tail fins size

Fin size in length = 9.6cm or 96mm

Fin size in Width = 8cm or 80mm

Mass of Rocket = 980g

5. CONCLUSION

Based on all the above information and considering the necessary parameters customer demand,market potential,competitive advantage,increased usability and function and industry proven resultsmakes this artillery rocket a good option for the aviation industry.

It was a great learning experience from this project.We hope to have some other similar kind of projects in the upcoming future.

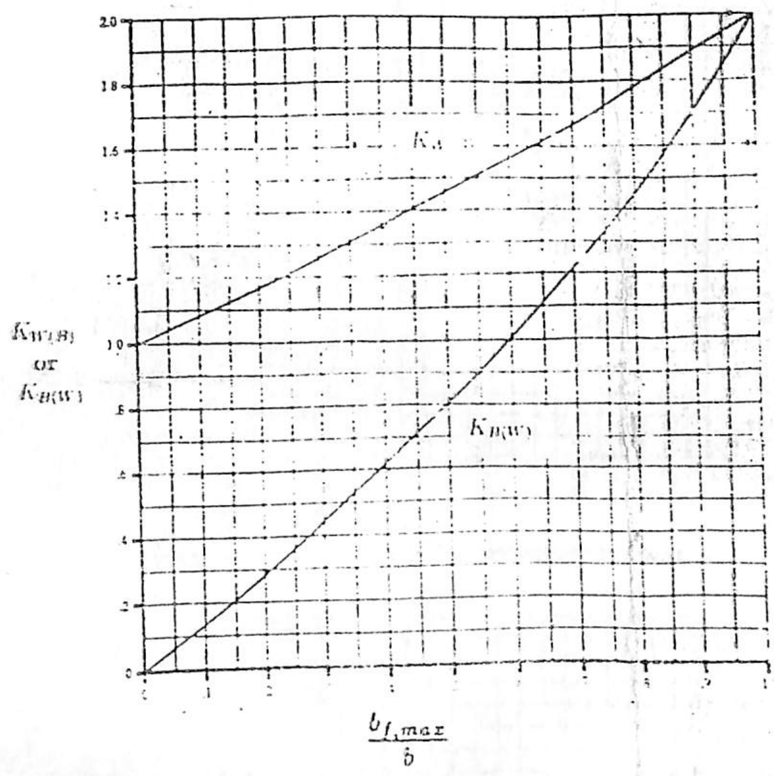


Fig. 3.17 Lift ratios $K_{W(B)}$ and $K_{B(W)}$ (Ref. 1).

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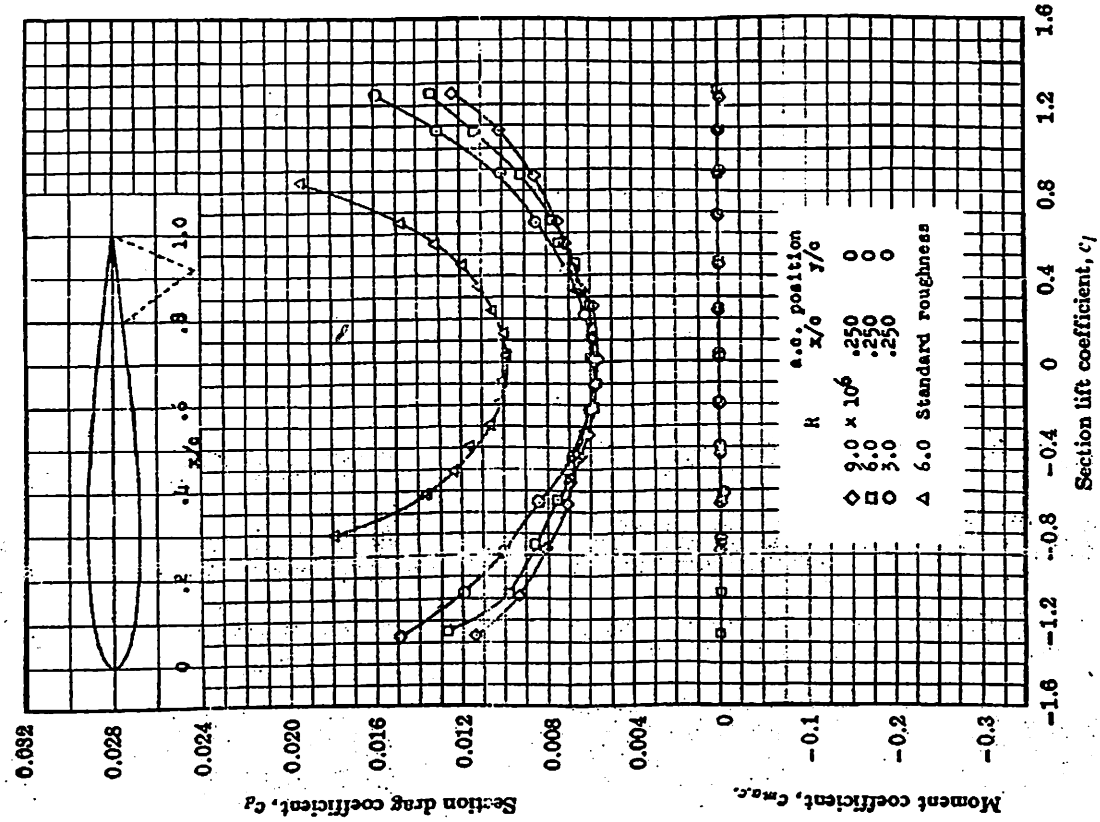
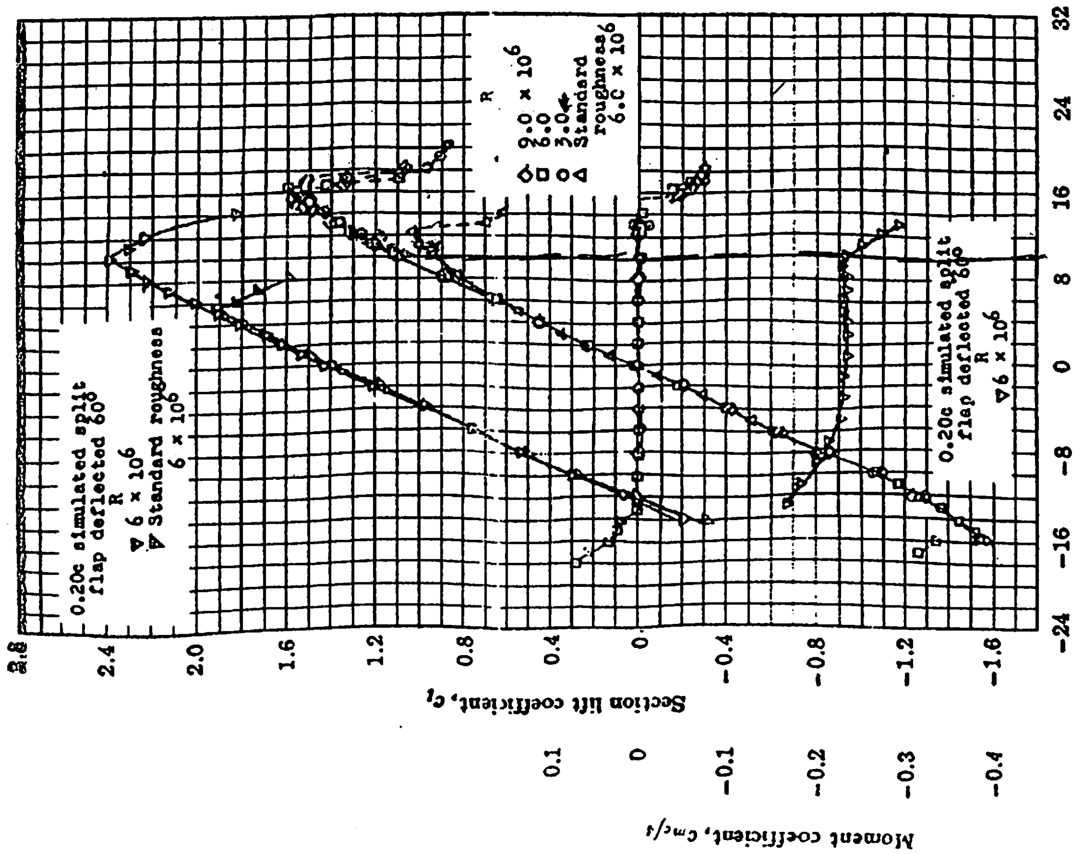

Section drag coefficient, c_d
Moment coefficient, $c_{m_{a.c.}}$
Section lift coefficient, c_l
R
◇ 9.0 × 10^6
□ 6.0
○ 3.0
△ 6.0 Standard roughness
a.c. position
x/c .250 .250 .250
y/c 0 0 0
x/c


Section lift coefficient, c_l
Moment coefficient, $c_{m_{c/4}}$
Section angle of attack, α_0, deg.
R
◇ 9.0 × 10^6
□ 6.0
○ 3.0
△ Standard roughness, 6.0 × 10^6
0.20c simulated split flap deflected 60°
R
▽ 6 × 10^6
▽ Standard roughness 6 × 10^6

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