

# DEVELOPMENT AND ANALYSIS OF ARROW FOR ARCHERY

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## ABSTRACT

This project is about the development and analysis of arrow for archery. 3 types of arrow head been designed: bullet shaped head, 3D shaped head and cone shaped head. The arrow performance measurement parameters were studied such as the FOC values, static stiffness values and the drag forces. SolidWorks 2012 was used to designs the three types of arrow head and the drag force is simulated by using SolidWork Flow Simulation. The material used for the arrow head fabrication is stainless steel 304. The arrow shafts used are carbon shaft of 5.46mm outer diameter and 7mm fiberglass and carbon fiber shaft. 3 different shaft properties are used to determine the effect of static stiffness, arrow heads weight and shaft diameter on the drag force generated at the arrow. The experimented result for Beman 570-14 arrows are slightly higher compared to simulation results obtained from SolidWorks. The possible cause is the characteristic of the arrow during flight where arrows starts to bend in C manner then straight again then bend again in reverse C manner and so on when it been shot. These deformation causes energy losses to the surrounding due to air friction, natural damping effect and shear friction. From the result obtained, it is shown that fiberglass shaft arrow has the highest drag force regardless of the arrow head types used compared to the other two types of shaft. Although Beman 570-14 shaft has smaller frontal area compared to a 7mm outer diameter carbon fiber shaft, the drag force obtained from the experiment shows that both bullet shaped head and 3D shaped head for carbon fiber shaft has lower drag force compared with the same arrow head shape.

**Keywords:** Archery. \* arrow head. \* drag force. \* static stiffness

## INTRODUCTION

Archery has been used for centuries to hunt and combat. In the modern day, archery main uses is for sport and hunting. From the mid of 19 century, the attempt to turn archery as modern sport has been done and now it is even an official Olympic games. Since then, the factors that help to promote better shooting accuracy has been investigated scientifically. Archery equipment performance is divided into: 1) the performance of the bow launching the arrow; 2) the performance of the arrow in flight; and 3) for bowhunters, the performance of the arrow-broadhead combination on impact (Barton et al., 2012).

In archery especially for sport, the performance not only rely on the bow design and characteristics. Instead, arrow design and parameter also play an important rule and has a major effect on archery accuracy and precision. There is only a few scientific studies are known on the aerodynamic properties of an arrow, although they have dominant effects on down-range velocity and also on its drift in wind (Okawa, Komori, Miyazaki, Taguchi, & Sugiura, 2013). Currently, most of the current investigation is carried out to determine certain current market arrow without designing the arrow and try to improve it. The scope of previous investigation mostly limits on the mechanics of arrow flight upon release, the interaction between bow and arrow, and measurement of arrow drag in a tunnel. Without the investigating the velocity and trajectory of the arrow.

In archery, both bow and arrow play an important roles in creating a stable, accurate and desired shooting

range. Arrows are made from stiff and low density material such as wood, fibre glass, aluminium, carbon fibre, and composite of carbon fibre and aluminium which can be either rods or tubes shaft. A good arrows must be able to bend at certain degree as the arrow will not be able to shot if the shaft is too stiff (Leach, 2014). A higher speed arrow able to remain their flight better. All the parts of arrow play an important role in providing the arrow speed as well as the flight stability. The main parameter influencing the arrow behaviour during flight are: 1) weight of arrow tip; 2) arrow spine and 3) fletching type (Barton et al., 2011).

The common materials used for arrow head are stainless steel, bronze, tungsten and aluminium. There are two parameters of the arrow head that affect the arrow flight: arrow head weight and type of arrow head. Arrow head in market comes with various weight ranging around 75gr to 125gr.

Higher arrow weight result in higher Front of Center (FOC) which allow better flight but the flight range was sacrificed. Modern arrows also come with wide range of arrow head type. The aerodynamic properties of the arrow head influences the drag force on the arrow. The drag coefficient of bullet point and bluff bodied is significantly larger than streamlined point (Mukaiyama, Suzuki, Miyazaki, & Sawada, 2011).

Arrow shaft also play an important role in giving a stable arrow flight. The common shaft materials are carbon, aluminium, fiberglass and wood (Barton et al., 2011). The characteristics of an arrow shaft that affect the flight behaviour is the weight and stiffness. Both