PERFORMANCE-TO-WEIGHT RATIO: SIMPLIFYING BALLISTIC HELMET COMPARISONS

Performance-to-weight ratio can help you objectively evaluate different helmets

Whether you're choosing ballistic helmets for military or law enforcement use, making an informed decision involves identifying your needs and assessing the various advantages and trade-offs. Ballistic protection relates to greater survivability whilst maintaining comfort and mobility. Regardless of whether the operational emphasis is to maximize ballistic protection or to minimize helmet weight, the best solution should be a helmet that offers the highest ballistic protection (resistance to penetration) at the lowest weight possible.

While there are many performance specifications that are common among helmet manufacturers, there are also differences in some important measures, particularly with weight, cut, coverage and surface area. To evaluate helmet differences, data should be simplified and normalized to the most important factors.

Using a normalized performance-to-weight ratio to assess helmet choices provides a consistent means of comparison and should be an important part of the decision-making process.

THE PERFORMANCE-TO-WEIGHT RATIO

The basic calculation to offer this objective comparison between helmets is:

$$\frac{\text{Ballistic Performance}}{\text{Aerial Density}} = \text{Performance-to-Weight Ratio}$$

The first step is to define what is being calculated. A meaningful and internationally recognized measure of ballistic performance is the V50 ballistic resistance against the 17-grain, .22-caliber FSP (fragment-simulating projectile). The resulting velocity is measured in either meters per second (m/s) or feet per second (ft/s). For calculating performance-to-weight, either can be used as the ratio's numerator (as long as units are kept consistent across all calculations).

Using the helmet shell aerial density (AD) eliminates the variables of helmet size, cut and system accessories when determining weight. The AD for the helmet can be calculated by taking the trimmed shell weight and dividing it with the surface area of the trimmed shell. It is important to note that the inner and outer surface areas differ due to the curved shape of the helmet. In addition, a thicker helmet has a larger outer surface area than a thinner one of the exact same shape and trim.

To eliminate the inconsistencies in the AD calculation that can be caused by using either the inner surface or the outer surface only, an average of the two surfaces should be used (as the mid-plane surface of the ballistic laminate). Aerial density is measured in kilograms per square meter (kg/m^2) or pounds per square foot (lbs/ft^2). Either can be used as the ratio's denominator (as long as units are kept consistent across all calculations).

The next step is to obtain this information for the helmet options that match the threat levels and mission requirements of your end users. If it is not readily provided on the specification sheet, request the information from the manufacturer.

As reference, the performance-to-weight ratio for the widely known Advanced Combat Helmet (ACH) is calculated as follows: The ACH specification has a V50 17-grain, .22-caliber FSP ballistic measure of 670 meters per second. Its aerial density is 11 kilograms per square meter. Therefore, the performance-to-weight ratio for the ACH is 61.

Since the ACH was first fielded, there have been significant advances in materials, manufacturing and helmet design that have resulted in helmets with much better performance-to-weight ratios.

For helmets that meet a given ballistic requirement, the higher the performance-to-weight ratio, the better. This provides a simple and objective means to compare helmets that are of different shapes, sizes and coverage areas. This comparison ratio is only valid when based on the V50 ballistic resistance capability of different helmets against the same threat, such as the 17-grain, .22-caliber FSP. The 17-grain FSP is the most commonly used threat for V50 ballistic resistance specifications worldwide).

ON THE HORIZON

One trend that is driving improvements in today's ballistic helmets – and leading to better performance-to-weight ratios – is the use of advanced materials, specifically, a material known as ultra-high molecular weight polyethylene (UHMWPE).

A highly oriented fiber made from high-density polyethylene, UHMWPE offers superior strength-to-weight and elongation-to-failure characteristics. Helmets that use the material can reduce equipment weight burden while maintaining or increasing protection levels.

Because it is still a fairly new material, helmet suppliers are making the custom forming and molding development of UHMWPE a long-term focus. They also are making constant refinements by using laminate hybridizations to help optimize design trade-offs between stiffness and ballistic protection.

Because the development of UHMWPE materials has yet to reach its potential, you can expect helmets in the future to offer increased ballistic performance at even lighter weights. So, what may be an excellent performance-to-weight ratio today could be average in a matter of years.

PERFORMANCE-TO-WEIGHT CHART

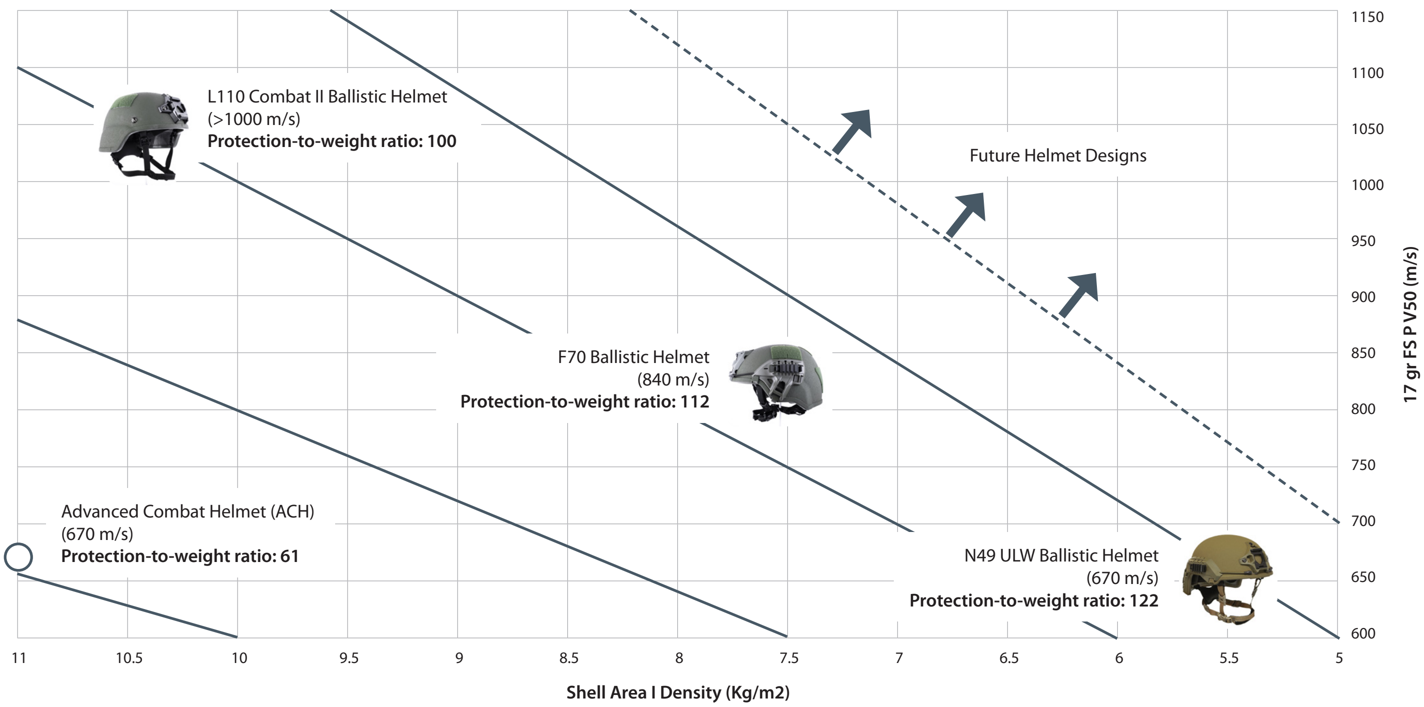

Figure 1. This chart shows an array of ballistic helmets available on the market from Avon Protection and how they compare in performance-to-weight ratios. It demonstrates how the L110, F70 and N49 helmets from have greater performance-to-weight ratios than the ACH helmet.

CLARITY FROM CONFUSION

With all the different helmet options available in the marketplace – and the varying information about them – it can be a struggle to compare them and evaluate which one best meets your requirements.

Identifying the performance-to-weight ratio of different helmets can bring clarity to your decision-making process and can help make sure you are getting the most from today's advanced helmets to protect against threats.

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