Selecting Head Protection for Construction Work

A traumatic brain injury (TBI) is an injury that affects how the brain works. It can be caused by a bump, blow, jolt, or penetrating injury to the head. TBIs can be mild, but more serious TBIs can lead to disability and even death.[1]

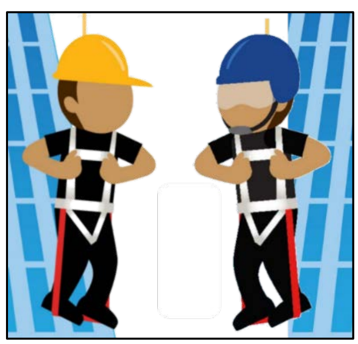
Based on historical data, over 50,000 nonfatal work-related TBIs are treated on average annually in United States (US) emergency departments.[2] Nonfatal TBIs can be life-altering events; 43% of hospital patients treated for a TBI did not attend ordinary work for five years after their injury, which means these individuals were receiving a social transfer payment such as sickness absence benefits, experiencing short- or long-term sickness, or had died.[3] Among all US industries, construction has the highest number of both nonfatal[2] and fatal work-related[4] TBIs. **Between 2003 and 2010, 2,210 construction workers died from a TBI.** These deaths represented 25% of all construction fatalities and 24% of work-related TBI fatalities among all industries during the same period.[5] More recent data show a similar pattern, with 2,297 fatal intracranial injuries in construction from 2015 to 2022.[6]

Construction workers are at higher risk for TBIs because, in their work environment, they may be struck by falling or flying objects and may experience different kinds of slips, trips, and falls – from falls on the same level to falls from ladders and equipment to falls from multi-story buildings or scaffolding dozens of feet in the air. Over a third of all nonfatal work-related TBIs are attributed to falls, and among workers 55 years and older, the majority result from same level falls.[2] **When it comes to fatal work-related TBIs, more than half are caused by falls, especially from roofs, ladders, and scaffolds.[5]**

Wearing protective headgear, such as a hardhat or safety helmet, is essential for reducing the risk of a TBI. A study by Kim et al. found individuals who had a work-related fall and were wearing a safety helmet were less likely to have head injuries compared to individuals who were not wearing a safety helmet.[7] Protective headgear should be selected based on your trade, type of work, and work environment. **Rather than recommending a one-size-fits-all solution, the goal of this guidance document is to provide you with information on types of protective headgear, factors to consider, and additional resources**.

Acknowledgements

CPWR – The Center for Construction Research and Training would like to thank its ***Expert Evaluation Panel on Construction Headgear*** for their feedback throughout the inception and development of this document. In 2023, CPWR convened experts from academia, labor, government, manufacturing, and others to participate in an evaluation panel on the use of safety helmets with chin straps versus traditional hardhats. The goal of this expert evaluation panel was to: (1) assess industry awareness and adoption of ANSI/ISEA Z89.1 Type II protective headgear with and



without chin straps over time; and (2) establish and disseminate recommendations for use of protective headgear.

The information that follows does not represent the individual views of any one person or organization on this panel. Participants were consulted for their expertise, but all final decisions regarding this guidance were made by CPWR.

Please note: This is a living document and will be updated when new information becomes available. Visit https://cpwr.com/research/preventing-head-injuries for the most up-to-date version. Construction safety helmets are emerging technologies and new research is being conducted on how to rate safety helmets for safety. We encourage you to speak with manufacturers about different options that are available.

Hardhats vs. Safety Helmets: What's the Difference?

Depending on where you look or who you talk to, the terminology used around hardhats and safety helmets can be confusing and sometimes contradictory. The current ANSI/ISEA Z89.1 standard refers to all approved headgear as "protective helmets" or "head protection devices,"[8] and the Occupational Safety and Health Administration's (OSHA) standard refers to both "protective helmets" and "head protection."[9] Neither use the term "hardhats." Despite this, many in the industry have historically referred to protective headgear as "hardhats" and are now using the term "safety helmets" to refer to the newer styles of headgear.

One goal of this guidance document is to clarify that this use of "hardhats" vs. "safety helmets" is a stylistic differentiation and is not based on performance. Therefore, the name or term used does not provide all necessary safety information to make an informed decision regarding protective headgear. Instead, it is important to focus more on the protective characteristics and other features when selecting protective headgear and less on the style.

The difference between a "hardhat" and a "safety helmet" is not currently outlined in the ANSI/ISEA Z89.1 or OSHA standard, which focuses on performance rather than style. Therefore, it is up to the discretion of the manufacturer. We anticipate an update to the ANSI/ISEA Z89.1 standard that clarifies the differences between the two overarching types of headgear and will update this document accordingly if/when that occurs. For the time being, we are differentiating the two as follows: **Hardhats** typically refer to the traditional style of head protection, which often includes a webbed ribbon-style suspension with a gap between the top of the head and the hardhat, a brim, and may or may not be equipped with a chin strap. **Safety helmets**, on the other hand, typically refer to a climbing style of headgear that is more rounded and consistently has a chin strap. Instead of a webbed suspension, they may have a foam liner or a combination of a webbed suspension and a foam liner.

Images courtesy of Dr. Michael Bottlang. Photos show examples of suspension and padding types only and do not make up a comprehensive list or guide.

ANSI/ISEA Z89.1 Type I vs. Type II Headgear: What's the Difference?

The ANSI/ISEA Z89.1-2014 (R2019) standard currently identifies two categories for industrial headgear testing: Type I and Type II. The standard is currently being updated, however, and the protection levels are likely to shift based on the new technological advances being made. We will update this document accordingly once those updates have been issued, but until that time, the information included here is based on the most recent version of the standard. **Type I protective headgear is intended to reduce the force of collision resulting from a blow only to the top of the head, whereas Type II protective headgear is intended to reduce the force of collision resulting from a blow to the top or sides of the head. Any Type II protective headgear automatically meets Type I protection standards.** In addition, all protective headgear can be rated for additional hazards such as electricity and can be equipped with a chin strap.

Remember, these testing categories apply to ALL protective headgear regardless of whether it is designated as a hardhat or safety helmet.

Type I and Type II testing both share the same performance requirements for flammability, force transmission, apex penetration, and electrical classifications, but differ on other measures. **Type II protective headgear includes additional testing for impact energy attenuation and off-center penetration.** Although the ANSI/ISEA standard does not require a chin strap for Type I or Type II protective headgear, if Type II protective headgear is equipped with a chin strap, it must meet width, retention, and elongation requirements in the standard.

Image courtesy of Milwaukee Tool

OSHA, the only body that regulates construction safety and health nationwide, mandates in CFR 1926.100 that "employees working in areas where there is a possible danger of head injury from impact, or from falling or flying objects, or from electrical shock and burns, shall be protected by protective helmets." The OSHA standard cites the ANSI/ISEA voluntary consensus standard, Z89.1. The current OSHA rule states employers must provide each employee with head protection that meets the specifications contained in the following versions of the standard: Z89.1-2009, Z89.1-2003, or Z89.1-1997. There has been a more recent consensus standard approved in May 2014 and updated and reaffirmed in April 2019. OSHA CFR 1926.100 also specifically states head protection for each employee exposed to high-voltage electric shock and burns must meet specifications contained in Section 9.7 of any of these consensus standards.[9] In addition, **the OSHA standard requires ALL protective headgear to be tested and designated as either Type I or Type II according to the guidelines in the ANSI/ISEA Z89.1 standard.**

Research indicates that Type II headgear provides more complete protection than Type I headgear. For those interested in some of the published research, a list can be found at https://cpwr.com/research/preventing-head-injuries. Additional studies are currently underway and are expected to provide further clarity to the issue of efficacy between head protection options.

Key Elements of ANSI/ISEA Z89.1 Type I & II Testing for Industrial Head Protection[8]

	Type I	Type II
Flammability	A flame cannot be visible five seconds after the test flame is removed from the surface of the headgear.	
Force Transmission (Figure 1)	• Headgear may not transmit a force to the test headform that is greater than 4,450 Newtons, or 1,000 pounds. • If headgear is preconditioned, for each stated precondition, an average will be calculated of the maximum transmitted force of individual test samples. Averaged values should not be greater than 850 pounds of force.	
Apex Penetration (Figure 2)	No contact can be made between the penetrator and the top of the test headform.	
Electrical Classification (Class G, Class E, or Class C)	• Class G headgear must be able to withstand 2,200 volts for one minute and maximum leakage cannot be greater than three milliamperes. • Class E headgear must be able to withstand 20,000 volts for three minutes following impact (force transmission) and maximum leakage cannot be greater than nine milliamperes. • Class C headgear is not required to be tested for electrical insulation as it is NOT intended to provide electrical protection.	
Impact Energy Attenuation (Figure 3)		Impact energy is evaluated by dropping the headgear at a range of angles onto a spherical object that is above a dynamic test line. Acceleration shall not be greater than 150g.
Off-Center Penetration (Figure 4)		The headgear is rotated at various angles above a dynamic test line while a penetrator is dropped vertically. The penetrator cannot make contact with the test headform.
Chin Strap Retention (optional) (Figure 5)		Chin straps are not required for Type II headgear. However, if a chin strap is provided and attached to the headgear before leaving the manufacturer, it shall be tested for retention and must meet width and elongation requirements. Chin straps must be at least 0.5 inches wide. Strap elongation cannot be greater than 1 inch.

Figure 1: TYPE I & TYPE II FORCE TRANSMISSION TESTING

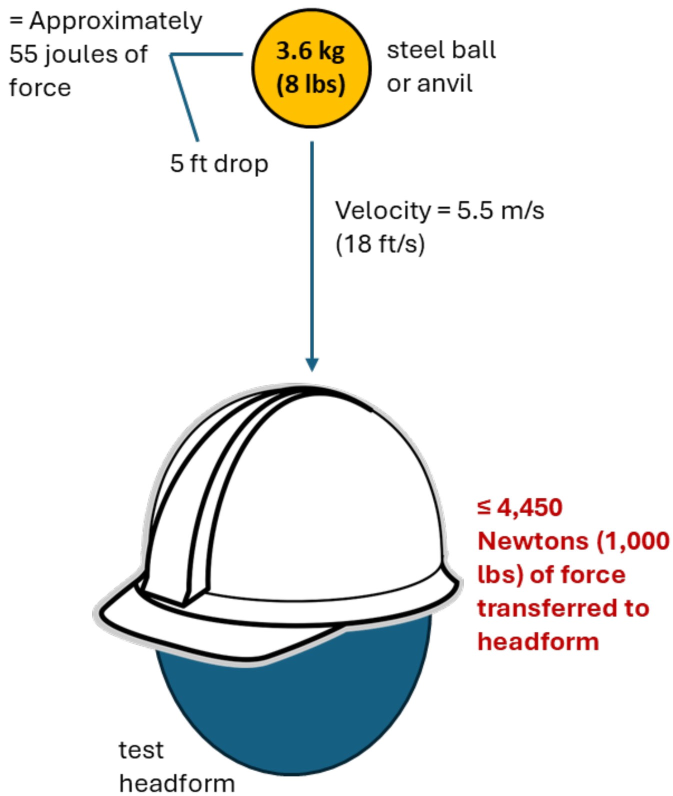


Figure 2: TYPE I & TYPE II APEX PENETRATION TESTING

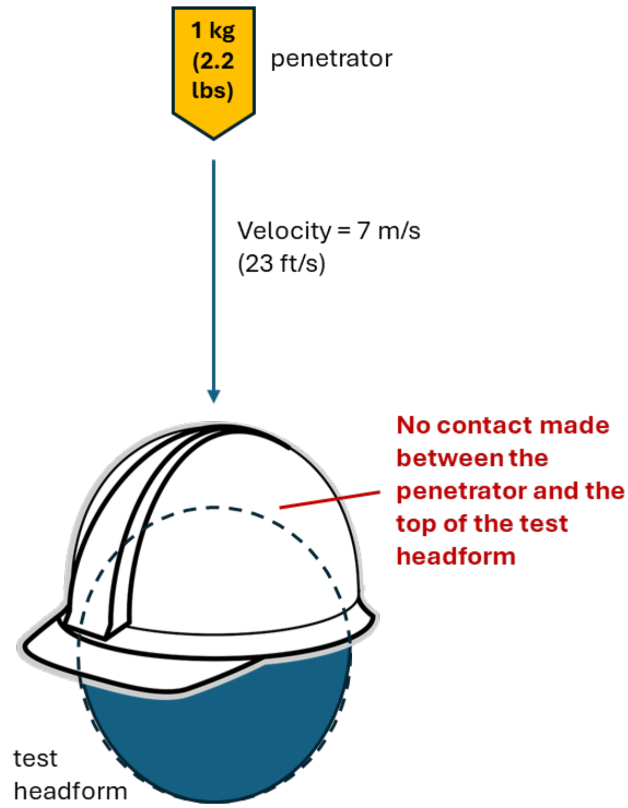


Figure 3: TYPE II ONLY IMPACT ENERGY ATTENUATION

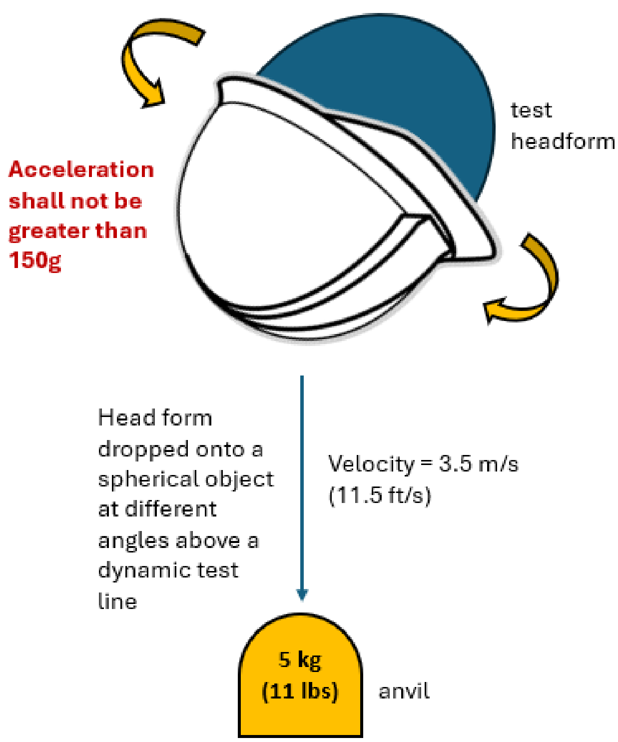


Figure 4: TYPE II ONLY OFF-CENTER PENETRATION TESTING

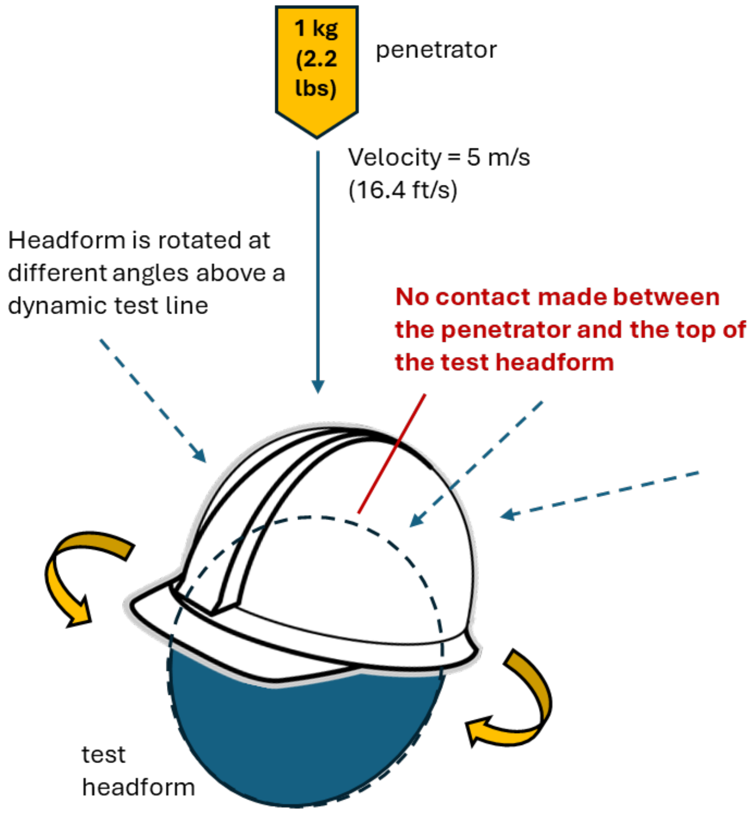
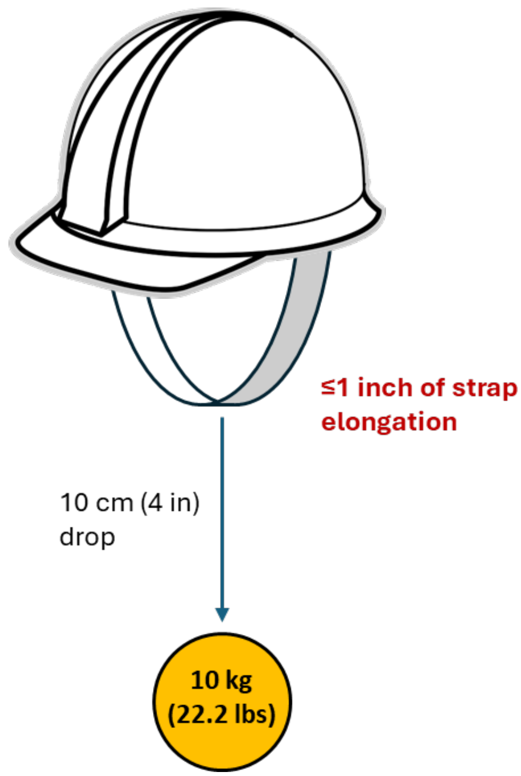


Figure 5: TYPE II CHIN STRAP RETENTION



Limitations

The ANSI/ISEA Z89.1 standard acknowledges a set of limitations in protection. As the standard states: “Protective helmets reduce the amount of force from an impact blow but cannot provide complete head protection from severe impact and penetration. Helmets that meet this standard provide limited protection but should be effective against small tools, small pieces of wood, bolts, nuts, rivets, sparks and similar hazards.” It is important for users to be aware that protective headgear that passes testing standards should “never be viewed as a substitute for good safety practices and engineering controls.”

In addition to limitations stated within the standard, users may also consider the limitation of a lack of testing requirements, specifically the use of third-party testing and certification. Although ANSI/ISEA provides thorough descriptions of testing procedures, there is no oversight and no third-party certification requirements like those found in government regulations. Testing is often performed by the manufacturers themselves or a third party selected by the manufacturer. There is also some flexibility in how testers perform and administer testing for specific components of the standard. For example, Type II Energy Impact Attenuation testing directs testers to “strike the test sample anywhere above the dynamic test line." While some testers may seek out the weakest spots above the dynamic test line, others may not.

Although there is no third-party testing or certification required for Type I or Type II designations, you can talk to your manufacturer about their testing methods and results. Ask who conducted the testing and how the head protection performed. You can request a Certificate of Compliance and/or a Declaration of Conformity from the manufacturer that attests the protective headgear has been produced in conformance with applicable specifications and outlines the standards and level of protection it meets. Keep in mind that a certification that testing has taken place is not the same thing as a certification that the product passed the testing based on the standard.

Additional Testing for Headgear

Some U.S. manufacturers also use criteria from the European Standard for Mountaineering Helmets (EN 12492) to test their head protection products. As the name suggests, this is not a construction industry standard. The EN 12492 standard includes vertical, front, side and rear energy absorption capacity testing and retention system testing, including testing of chin straps. **Head protection may pass testing for *either* the ANSI/ISEA Z89.1 Type I or Type II standard *and* the EN 12492 standard, however EN 12492 is neither a substitute nor equivalent to Z89.1.** Lateral impact testing in EN 12492 is less stringent than Type II testing for three reasons: less impact energy, less coverage, and a flat instead of more focused hemispherical impactor. The EN 12492 standard also allows more force to be passed from the safety helmet to the headform (or head/neck).

Making Your Selection: Primary Factors to Consider

The first step in deciding what protective headgear to purchase or wear is conducting a hazard analysis or risk assessment. The level and type of protection needed, along with stylistic choices and accessories, is influenced by the tasks being done and the work environment. *Some factors to consider include:*

1. Work at Heights

Consider purchasing ANSI/ISEA Z89.1 Type II protective headgear with a chin strap for the best protection of workers at heights but be aware that even if your work does not involve work at heights, workers can still experience a fall on the same level if they trip or slip. Chin straps secure protective headgear to your head and will help prevent it from slipping off your head when bending over or in the event of a fall. Construction safety helmets have a built-in chin strap, while many hardhats do not (you can, however, purchase a chin strap to attach to a hardhat). If a fall does occur, it's possible for a worker to hit their head on an object or objects as they fall. For this reason, protection from impact on both the top and sides of the head may be best for those working at heights at or above 6 feet. Some manufacturers are even starting to consider products that can minimize rotational force to the head. Rotational forces are thought to be important in causing brain injuries, including concussion. Using new materials and technologies to dampen torque and the associated movement of the brain inside the skull has been shown to decrease risk for brain injury in some studies.[10,11]

2. **Slips, Trips, and Falls at the Same Level**

   You don't have to be working at heights to experience a fall. Many TBIs occur from slips, trips, and falls at the same level.[3,11] Like falls from heights, workers can hit their head on the ground or an object as they fall. ANSI/ISEA Z89.1 Type II head protection will provide better protection to the front, back and sides of the head, and a chin strap will keep the protective headgear in place.

3. **Struck-by Hazards**

   Part of the reason for wearing headgear is to protect workers from falling and flying objects. If workers are consistently operating away from unsecured objects that could fall from heights or fly across space, ANSI/ISEA Z89.1 Type I headgear may be sufficient. However, only about 15% of impacts occur to the headgear crown[12] and the vast majority of impacts occur to the front, side, and rear. This makes Type II protective headgear the safer choice in any working environment, but especially when there is overhead work that could lead to objects falling from heights or unsecured materials nearby that could fly away.

4. **Use of Accessories**

   Different accessories can be attached to protective headgear, such as face shields and hearing protection, to protect workers from various hazards. Construction safety helmets are still relatively new to the market, so there may be fewer accessory options available (e.g., welding hoods) compared to hardhats, which have been around for longer. Talk to your manufacturer as there are constantly new devices and accessories hitting the market.

5. **Electrical Hazards**

   In addition to Type I and Type II classifications, the ANSI/ISEA Z89.1 standard provides hazard-specific categories for headgear: Class C, Class E, and Class G. Class G and Class E headgear must meet performance requirements for electrical classifications. Class G (General) headgear is intended to reduce the danger of contact with low-voltage conductors and electrical hazards to the head only. It must be able to withstand 2,200 volts for one minute and maximum leakage cannot be greater than three milliamperes. Class E (Electrical) headgear is intended to reduce the danger of contact with higher voltage conductors and hazards to the head only. It must be able to withstand 20,000 volts for three minutes following impact and maximum leakage cannot be greater than nine milliamperes. Class C (Conductive) headgear is not required to be tested for electrical insulation and may include venting and other options not allowable in headgear that provides electrical protection.[8] Class C should only be used by workers with no risk of electrical exposure.

6. **Weather and Temperature**

   Construction workers are exposed to varying weather conditions and temperatures at work. Existing research on head protection and temperature focuses on heat. Ventilation is an option on Class C protective headgear to help circulate air, which keeps the head cool and dry in warmer environments. It is not an option for Class E and G headgear meant to provide protection against electrical hazards. The findings from research studies, however, differ regarding the possible benefits of ventilation.[13,14] How hot protective headgear gets also depends on its color, with lighter colors absorbing less solar radiation and generating less heat than darker colors.[15] In addition, cold weather is also a consideration for product selection, because some cold weather head protection accessories are only compatible with specific head protection models. ANSI/ISEA Z89.1 provides guidance on optional protective headgear features including preconditioning for high and low temperature applications.[8]

7. Visibility Needs

Depending on the time and location of work (e.g., road work), it may be helpful to have high visibility headgear. ANSI/ISEA Z89.1 provides non-mandatory requirements for protective headgear to be marked as high visibility (HV). To earn the HV marking, construction protective headgear must demonstrate the appropriate levels of chromaticity and luminance factor.[8]

8. Cost

Construction safety helmets are currently more expensive than hardhats. A hardhat typically costs between $10-30, while a safety helmet can cost between $55-150. However, construction safety helmets have a five- to ten-year service life, depending on the manufacturer and factors such as impact, penetration, chemical exposure, and sun exposure. Traditional hardhats with strap suspensions, on the other hand, generally need to be replaced more often. The typical service life of hardhats ranges from two to five years, and the suspension should be replaced every year. The need to purchase fewer safety helmets over the years may outweigh the initial costs of construction safety helmets. In addition, as safety helmets gain more acceptance and new companies enter the market, the cost may decrease. Always talk to your manufacturer about the lifespan of the headgear – it can vary even with different products from the same manufacturer!

9. Fit and Comfort

The overall look and fit of construction safety helmets are different from hardhats. Some experts contend that construction safety helmets are less bulky, more comfortable, and offer a better fit than hardhats, while others say chin straps can be uncomfortable and cause chafing and irritation.[16] This may be dependent on the wearer and their head shape/size, amount of hair, and hair style. Hardhats and construction safety helmets both range in weight, from around 0.75 pounds to slightly more than a pound. It should be noted that, while they offer additional protection compared to ANSI/ISEA Z89.1 Type I headgear, Type II hardhats and safety helmets tend to be heavier than Type I due to the additional padding. Shifting to safety helmets may be difficult for some workers who have spent years wearing hardhats. Others may welcome a style of headgear they are familiar with from sports activities.

Additional Resources

- **Hardhats to Helmets** provides information on the transition from hardhats to safety helmets, including information on manufacturers, and success stories.
- **National Institute for Occupational Safety and Health (NIOSH) Science Blog**: Construction Safety Helmets and Work-Related Traumatic Brain Injury.
- **Hard Hats and Helmets. Keeping Workers Safe**: A video by ISEA and NIOSH.
- **ISEA Choosing the Right Head Protection: Know Your Facts**

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