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Compatibility: *Your* Connection

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Introduction

Workers at height routinely make connections when designing and implementing personal fall protection systems. The integrity of those connections determines the success or failure of that system. The purpose of this paper is to emphasize the importance of the end user in the evaluation process and identify some key factors in determining compatibility.

By far, the most frequent activity performed by an end user is making a connection. For example, tower climbers may during their ascent make dozens of connections in a very short period of time. Depending on the placement of the snaphook and a number of other variables, that connection may result in system failure. It's critical to properly educate the end user in evaluating those connections.

Background

Failures of fall protection system connections are responsible for many accidents involving fall protection equipment. Specifically, the connection that is made at the anchorage, not between equipment, is to blame for many accidents.

Every major fall protection equipment manufacturer has in its product line a large diameter snaphook or carabiner that eliminates the need for an additional anchorage connector. And every country is witnessing an increase in the use of such connectors.

Because of variations in the shape, location, and surrounding area of the structural connection, "engineering-out" the problem is next to impossible. This "arms-length" connection, made by the user, can only be evaluated by the user. Until certified anchorages are available in every work location, it is imperative that the knowledge level of end users is increased to address *all* factors influencing compatibility.

How the industry views routine connections must change and is changing. Historically, the geometrical relationship between the connectors and the type of locking mechanism were the only criteria used to determine compatibility. As a result, the industry has witnessed trends in stronger gates and attempts to standardize the size and shape of connecting members. But this did not solve all the problems. Transverse loading, vibration during a fall, and the relationship between the gate and nose of the connector are relatively new issues. And no matter what design or standardization methods are employed, ultimately it's the end user that is critically involved in making, and evaluating, *their* connection.

This is a topic in which the opinions of industry professionals (equipment manufacturers, hardware manufacturers, end-users, and safety professionals) vary greatly. Many believe that incompatibility can be eliminated entirely by design, whereas others believe it will always exist and that education of the user, regardless of design, is the solution.

What is Compatibility?

Compatibility refers to the harmonious interplay of connecting components. Variations in size, shape, and configuration affect compatibility and disengagement potential.

Preliminary research conducted by Gravitec has identified eight criteria that can be used to evaluate compatibility. These include geometry, anchor location, tension, environment, the number of connectors, national standards, flexibility and examination. The acronym "GATE SAFE" was developed to help users remember these criteria when evaluating connections. Each letter represents one criterion.

This can be further dissected to "GAME," which stands for Geometry, Anchor location, Movement (flexibility) and Examine, for a more cursory examination of compatibility. This is what every authorized person should know.

Geometry

The geometric relationship between the anchor and connector is one aspect of many affecting compatibility. As a general rule of thumb, the "A" dimension of the anchor should be greater than the "B" dimension of the connector to prevent gate loading. See Exhibit 1.

A geometrically compatible connection is designed so that the gate cannot be pressured against the anchor. Users must be properly educated and familiar with the suitability of a connector's shape and/or dimension with a specific connection or anchor point.

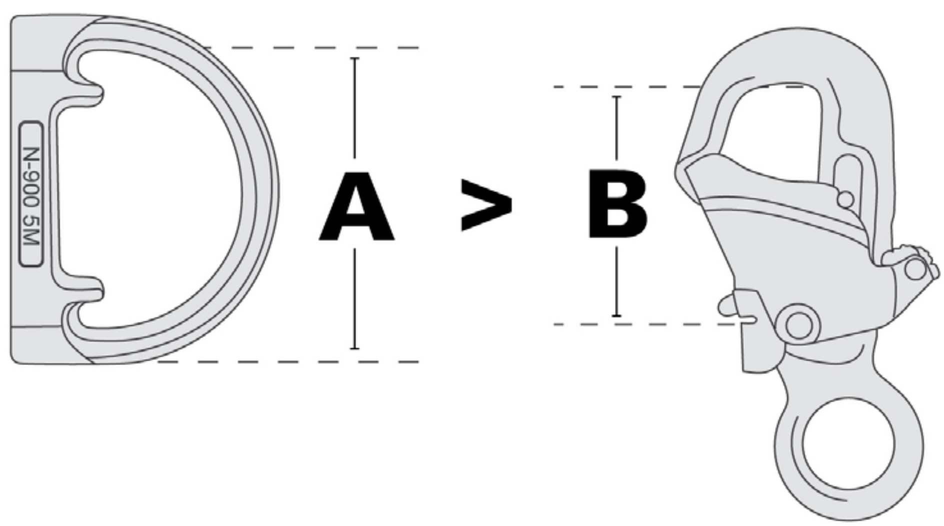

Exhibit 1. The "A" dimension of the anchor should be greater than the "B" dimension of the connector for a geometrically compatible connection.

There is also a common misconception that connectors with increased gate strength eliminate this issue. Testing, however, has shown otherwise.

High-speed video testing (7,500 frames per second) showed potential for disengagement during misuse or incompatible connections, even when using snaphooks with 3,600 lb rated gates. These videos can be viewed online at: www.gravitec.com/resources.

Anchor Location

Another important consideration is anchor location. The location of the anchor can affect the compatibility of a connection. Overhead anchors ensure proper alignment of a connector with the help of gravity. Connections made at foot level are at greater risk for disengagement and rollout. As the worker moves, the snaphook will pass between states of tension and slack. There is potential for the hook to misalign or load incorrectly if the anchor is improperly located.

Tension

Connectors are designed to be loaded along the major or long axis. Loading of the snaphook in any fashion other than along its long axis may lead to failure or disengagement. Transverse loading occurs when the snaphook is paired with incompatible anchor and can be loaded in such a way to cause separation of the nose from the gate. See Exhibit 2.

Education of the end user is needed to prevent misuse and incompatible connections.

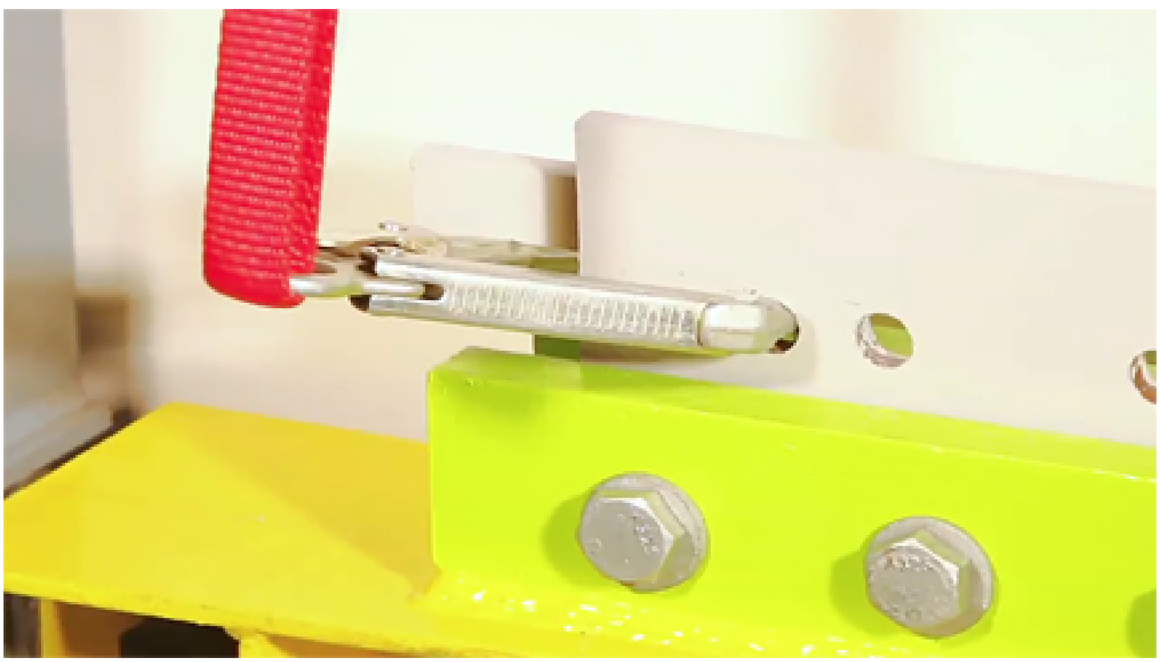

Exhibit 2. An example of transverse loading is pictured above.

Environment

Environmental conditions are difficult to predict and guard against. Structure, tools, equipment or other foreign objects may interfere with connectors. Competent and authorized persons must examine the surrounding environment when making connections.

Single

When connecting two snaphooks into one D-ring, there is the concern that the user will connect one snaphook into the other. The use of two connectors in one D-ring is also undesirable because one may act against the other or open the other. This was an issue when non-locking snaphooks were being used in lineman's belts.

Today, the use of two snaphooks in one D-ring is fairly common practice and often necessary when transitioning between systems, conducting a rescue or during rope access work. It is recommended to only leave two snaphooks in one D-ring for brief amounts of time.

ANSI

Systems are changing. It is not uncommon for connectors to realize 6 to 8 kN of force when used with energy absorbers designed for twelve foot free falls. These forces can be multiplied if that connector is perched or in a bad position

To guard against roll out or disengagement potential, ANSI requires that all snaphooks be self-closing and self-locking, and require two consecutive and deliberate actions to be opened. The ANSI/ASSE Z359.12 standard also requires that snaphooks and caribiners be capable of withstanding a minimum load of 3,600 lbs. (ANSI 2009). See Exhibit 3. Use of ANSI-compliant snaphooks with 3,600 lb. rated gate strength are strongly recommended.

Exhibit 3. Markings on the snaphook indicate a gate rating of 3,600 lbs. (16 kN).

Flexible

Connections with flexible properties promote proper alignment and are preferred.

Four classifications of connections based on flexibility are proposed: Class 1 (Flexible connector to flexible anchorage); Class 2 (Semi-rigid - semi-flexible anchor to flexible snaphook); Class 3 (Rigid anchor to flexible connector); Class 4 (Rigid anchor to rigid connector). Class 1 connections are ideal. Without flexibility, there is no ability for the hook to align to the axis.

Examine

In order to use the equipment properly, users have to be educated in its proper use. Training must include an examination of the connection. Users can evaluate geometry, anchor location, tension, environment, single connections and the flexibility of the system component by twisting and turning the connector from arms-length in what has been coined as the “rattle game.”

Conclusion

Each connection presents an opportunity for misuse. That’s why it’s so critical to educate end users on how to properly evaluate connections. Use of connectors with 16 kN (3600 lb.) rated gates are preferred since they offer the highest level of security for *your connections*, but there is still a potential for disengagement. It’s important to consider all factors affecting compatibility: geometry, anchor location, tension, environment, use of single connections, standards, flexibility and examine connections accordingly.

Because not all locking mechanisms are created equal, design requirements for innovative locking mechanisms should be reviewed and new test protocols for transverse loading, nose separation and locking mechanisms examined.

Bibliography

American National Standards Institute (ANSI). 2009. *Safety Requirements for Connecting Components of Personal Fall Arrest Systems*. (ANSI/ASSE Z359.12-2009). Des Plaines, IL: American Society of Safety Engineers (ASSE).