FALL PROTECTION ANCHORAGE TESTING

Are You Doing More Harm Than Good?

By Rupert Noton and Andrew T. Emmons

Each year, facility owners spend millions of dollars and countless hours designing, installing, inspecting and testing anchorages related to work at heights. Too often, the resources spent do nothing more than give the owner a false sense of security.

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This is because critical factors such as overall system use, building strength and fall clearances have not been properly addressed. It is critical to become a more educated consumer, to enhance the safety of all workers at heights and make smart investments to reduce risk.

Anchorages for work at heights are one of the most visible and costly elements of an organization's maintenance and safety programs. OSHA's updated walking and working surface regulation, which took effect January 2017, put renewed focus on the importance of anchorages that are used in support of window cleaning and facade maintenance equipment, as well as for fall protection. The authors and other members of the ANSI/ASSP Z359.6 subcommittee are concerned that improper load testing, performed with an intent to comply with OSHA regulations, could inadvertently damage anchorages, rendering them unusable.

Many owners and users of these anchorages have been led to believe that load testing is not only a viable way to prove an anchorage's capacity, but that OSHA actually requires load testing for all anchorages. In reality, neither OSHA regulations nor ANSI standards explicitly require load testing of anchorages. However, OSHA's use of the term *tested* in the anchorage requirements has led organizations to use load testing in an attempt to verify that equipment meets OSHA's strength requirements (OSHA, 2016c).

The scaffolds and rope descent systems regulation [1910.27(b)(1)(i)] states:

> Before any rope descent system is used, the building owner must inform the employer, in writing that the building owner has identified, tested, certified, and maintained each anchorage so it is capable of supporting at least 5,000 lb (268 kg), in any direction, for each employee attached.

Since building owners who are responsible for facade access equipment are required to provide assurance that their equipment meets OSHA requirements, they spend time and money on such testing; however, in some cases it may be doing more harm than good (OSHA, 2016b). Furthermore, the effort spent trying to satisfy the strength requirements distracts owners from other potentially higher risk issues, such as whether a fall protection system has sufficient clearance, the system can be safely accessed and whether employees are sufficiently trained to use the equipment. All of these issues are also required by OSHA, although less directly than the strength requirements often cited (OSHA, 2016a; d).

Consider the fact that many safety PPE and fall protection harnesses may be rendered ineffective after an incident or impact. The same concept holds true for anchorages. If an anchorage is tested to the point of breaking to prove whether it can withstand 5,000 lb of force, do you really want workers relying on it in the future to save their life in the event of a fall? If an anchorage is damaged in the testing process, it should be removed from service and replaced.

To further apply this information, it is important to understand some background on anchorage design, load testing and why it applies to fall protection anchorages, and how this impacts anchorages throughout their life cycle, from initial installation to inspection to recertification.

Anchorage Design & Required Strength

All components of an anchorage must have a design strength that exceeds or equals their required strength, or the strength it would ever need to feasibly exhibit. Many factors including component material, design specifications and geometries make up the design strength. The required strength is given by OSHA and, in several cases, must be considered.

OSHA requires that all suspended scaffold support equipment (e.g., outrigger beams, cornice hooks, parapet clamps) rest on surfaces capable of supporting at least 4 times the live load imposed on them by the scaffold operating at the rated load of the hoist, or at least 1.5 times the live load imposed on them by the scaffold at the stall capacity of the hoist, whichever is greater. Further, the stall load of a scaffold hoist may not exceed three times its rated load (OSHA, 2016b).

To clarify some of these terms, the rated load is the manufacturer's specified maximum load that may be lifted by a hoist. The stall load is the load at which the hoist stalls or its power supply is automatically disconnected due to accidental misuse. Unfortunately, while manufacturers have a good idea of their equipment's stall load range, they do not know the actual stall load of their hoists since it varies significantly with influences such as voltage drop, diameter of wire on drum and operating temperature.

Typically, most hoists have a stall load that is between 2 to 2.5 times their rated capacities. International Building Code (ICC, 2018) and ASCE 7-16 both similarly define live loads from hoists as the greater of the 2.5 times the rated load of the hoist and the stall load of the hoist. These live loads are then multiplied by a live load factor of 1.6, resulting in a required strength of the greater of 4 times the rated load of the hoist and 1.6 times the stall load of the hoist.

Load Testing 101

Load testing is not just a method applied to fall protection anchorages. It is used in other areas of structural engineering to gather a different level of information about the structure. American Institute of Steel Construction, American Concrete Institute and International Building Code all include requirements for load testing for various purposes.

Two primary types of load testing are applicable to anchorages used for fall protection: proof testing and strength testing. Before applying either of these tests, anchorage strength should be predicted using nondestructive testing and analytical methods, which may highlight issues that would render additional testing unnecessary. To predict the strength, properties of the anchorage can be obtained from existing drawings or specifications, with field verification of critical and missing values.

Proof Testing

Proof testing is typically used to validate the quality of materials and workmanship of new anchorages, and to verify that the strengths of existing anchorages have not decreased due to deterioration. The proof load is used to identify major defects in the installation and should at a minimum simulate the live load imposed on the anchorage (ANSI/ASSP, 2012). Anchorages intended for facade access are typically proof tested to twice the rated load of the hoist, applied in each direction that the anchorage may be loaded during its service life. For example, an anchorage to be used with a hoist rated at 1,250 lb would therefore be proof tested to 2,500 lb.

Building owners cannot use proof testing alone as a basis for providing written assurance that anchorages meet design strengths required by regulations and standards. Proof testing can only empirically prove that anchorages can resist the proof load. Defects that could result in failure at a load between the proof load and the required strength would go undetected. Caution must be exercised when certifying anchorage strength using analytical methods and proof testing alone. Exceptions to mandated requirements, identified during analysis and proof testing, must be clearly stated.

Strength Testing

In instances where analysis cannot reliably predict the capacity of an anchorage, strength testing is sometimes used to determine a minimum strength of an existing anchorage installation. The strength load must simulate the required strength of the anchorage mandated by regulations and standards, applied in each direction that the anchorage may be loaded during its service life. During the application of the strength load, the response of the anchorage should be monitored to identify signs of inelastic structural behavior, often indicated by permanent deformations when the load is released. It should be noted that anchorages undergoing strength testing will often require removal/replacement after testing due to permanent deformation.

However, an anchorage that is deformed after strength testing does not necessarily mean it did not meet the strength requirements set forth by OSHA. On the contrary, an anchorage that held the full

FIGURE 1
PROOF TEST

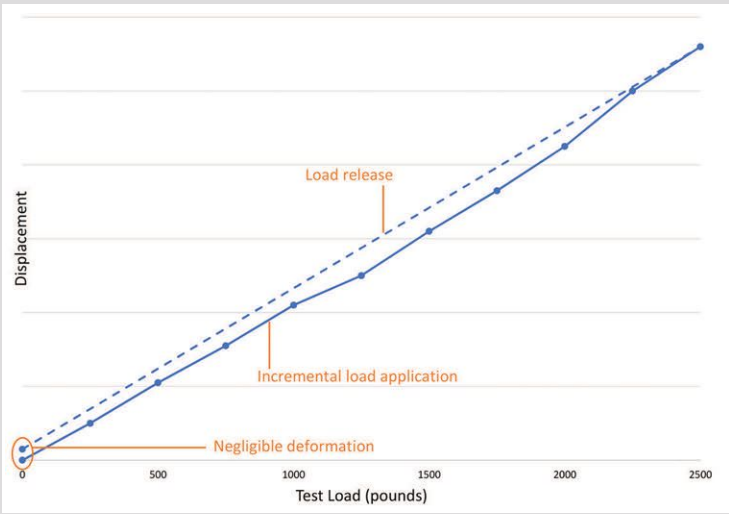
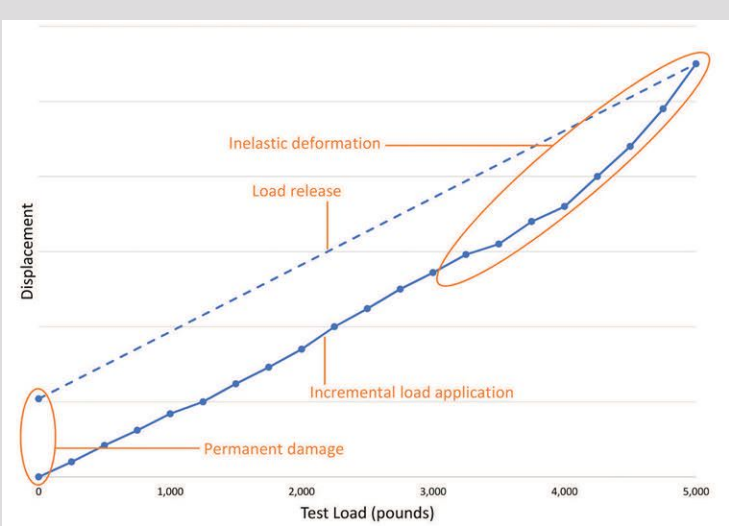


FIGURE 2
STRENGTH TEST



When this anchorage was tested to 5,000 lb, it held the load, but is now clearly deformed and unfit for use.

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An anchorage that held the full required strength and did not release the load would be considered by OSHA to have met the strength requirements, while still needing to be replaced due to permanent deformation. This apparent paradox, that the anchorage passed the test but cannot be used, is the primary reason that load testing is not the best way to prove an anchorage's capacity.

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To avoid unnecessary damage to the existing structure, the test load can be applied incrementally, and the displacement of the anchorage measured at the point of load application. A load-displacement curve can then be created that will graphically illustrate how the anchorage is performing. As shown in Figures 1 and 2 (p. 35), following each load increment, evidence of permanent damage can be identified by looking for changes in the slope of the load-displacement curve that exhibit inelastic behavior.

Fall Protection Anchorages & Certification

Several members of the ANSI/ASSP Z359.6 subcommittee have taken a particular interest in this topic, since anchorages intended for facade access are commonly used as anchorages for fall protection as well. The authors and other members of the subcommittee are concerned that improper load testing could permanently damage anchorages, which would mean they cannot be certified for fall protection. This is yet another nuance in an already complex issue of anchorage certification.

When properly accounting for and documenting all elements of a complete system, OSHA (1994; 2016a) and ANSI/ASSP Z359.2 (2017) permit a qualified person to design fall protection anchorages for a lower strength. Since OSHA intends the variables in the system to be better controlled by an individual with more training, a lower factor of safety on the strength may be used. This is often helpful when considering anchorages connected to facilities not originally intended to support these loads.

The process of documenting all elements of a fall protection system is often referred to as providing certification. The ANSI/ASSP Z359 Fall Protection Code provides certification requirements for active fall protection systems. The code defines a certified anchorage as:

> An anchorage for fall arrest, positioning, restraint or rescue systems that a qualified person certifies to be capable of supporting the potential fall forces that could be encountered during a fall or that meet the criteria for a certified anchorage prescribed in these standards. (ANSI/ASSP, 2012, p. 12)

Anchorage Inspection/Recertification

This discussion on anchorages has primarily focused on initial design or assessment of existing anchorages. It is just as critical, however, to ensure continued sustainability of anchorages throughout their life cycles. While it is essential to start with a certified system, organizations must also understand the intricacies of ongoing anchorage inspection and recertification.

Because the complexity of anchorages is often misunderstood, inspection of anchorages is frequently performed by personnel who are trained and experienced in one aspect of the anchorage, but who overlook other critical defects. A report from such an inspector might include a letter stating that the system passed the inspection, and it might even use the word *certified*. The purchaser of the inspection may reasonably believe that the inspector considered all aspects of the system, including proper use of the system, anchorage components and connection to the building structure. Unfortunately, it is more likely that only the anchorage components were inspected.

Regarding recertification, ANSI/ASSP Z359.6 (2016) says that active fall protection systems should be reviewed by a qualified person at least every 5 years. The recertification is necessary to account

for changes in the hazards or tasks that are addressed by the system, as well as updates to relevant regulations, standards or equipment components. Recertification also provides an opportunity to review the original certification document and to gather feedback from system users. Essentially, recertification gives an organization a specific timeframe and method to use to facilitate continuous evaluation and improvement of anchorages and active fall protection systems.

Conclusion

While load testing is frequently performed and provides value in some structural analysis situations, it is not the best method to prove fall protection anchorage capacity. Understanding an anchorage's strength is absolutely critical to ensure that it will support a worker in the event of a fall. However, testing it to the point of failure or permanent deformation is an unnecessary expense that can be avoided in many cases through preliminary analysis, proof testing or incremental load testing. **PSJ**

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LOAD TESTING Q&A

WITH RUPERT NOTON

Why is there so much confusion regarding anchorage testing?

Both OSHA 1910.27 and 1910.66 require that anchorages for rope descent systems and powered platform systems be "tested," but the regulations do not provide any more specifics on how the testing must be performed. This has left interpretation up to building owners, testing providers, engineers and others.

Another issue is that load testing may seem simple on the surface. You pull on something. If it breaks, do not use it. If it does not break, then you're good. Load testing is much more complex than that and requires a deep understanding of both engineering and safety issues.

Where does the 5,000-lb anchorage number come from?

There is no clear explanation as to the origin of the 5,000-lb anchorage load requirement. The value was originally defined by OSHA in the late 1960s. One theory is that 5,000 lb was the ultimate strength of hemp rope originally used in fall protection.

Today, the ANSI/ASSP Z359 standard recognizes both certified and noncertified anchorages. Noncertified fall arrest anchorages must be designed for 5,000 lb per employee attached, while noncertified anchorages may be designed by a qualified person as part of a complete system for two times the arrest load of system. Arrest loads depend on the type of energy absorber used in the system, and typically vary between 900 and 1,800 lb.

Are requirements for load testing of anchorages for fall protection provided in the ANSI/ASSP Z359 standards?

No, ANSI/ASSP Z359 does not currently discuss load testing of anchorages for fall protection.

Verifying a specific strength requirement, such as 5,000 lb, is not always appropriate. Achieving an appropriate factor of safety that balances safety and cost is more important.

What are the most critical aspects to consider when inspecting anchorages?

System use, connection to and strength of the building, strength of the anchorage components, fall clearances and a host of other aspects. If these are not addressed by the designer and installer, failure can be fatal.

What questions should organizations ask of inspectors to ensure that all aspects are really being addressed?

A big red flag is if the inspector focuses only on anchorage components. If the focus is just on whether the steelwork has corroded, or something similar, then you need to start asking more questions or find a new resource that can provide a more detailed inspection that includes evaluation of connection to roof structure, appropriateness of the solution and more.

What should building owners look for when someone comes to their site and recommends loading testing?

Load testing is a complex process that requires prework and analysis before anchorages are ever tested. If a company is ready to start pulling on anchorages, question the load testing protocols and procedures being used and whether those are customized to the unique anchorage situation. Also, because of the complexity of structural forces, not to mention the possibility of permanent damage to the anchorage, it is important to have a professional engineer and a fall protection qualified person involved.