VLBA

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Fall Protection for Inclined Ladders

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Abstract

Inclined ladders present unique fall protection challenges. We discuss special considerations for inclined ladders, applicable OSHA standards, and ladder safety equipment.

Introduction

Inclined ladders are common on Radio Telescopes and Earth Station Dishes. They are installed on the quadrupod legs to provide access to the telescope apex. Stairways are generally ruled out by blockage and weight considerations.

These ladders require fall protection when lengths exceed 20 feet. This will be the case on most telescopes over 10 meters diameter.

Commercially available fall arrest systems are designed primarily for vertical and/or horizontal applications. While many commercial systems can be used on inclined ladders, they are not ideal for this purpose.

OSHA Regulations (Standards - 29 CFR)

Radio telescopes and earth station dishes are covered by OSHA General Industry Standards, 29 CFR Part 1910. However, the Construction Industry Standard, 29 CFR Part 1926, offers a more comprehensive coverage of ladders and ladder safety devices. We have endeavored to comply with both standards.

The OSHA publications listed below are relevant to fall protection on inclined ladders:

29 CFR Part 1910: General Industry Standards
Subpart D - Walking-Working Surfaces
1910.27 - Fixed ladders.
1910.27 (d)(5) - Ladder safety devices.
29 CFR Part 1926: Construction Industry Standards
Subpart M - Fall Protection
1926.501 - Duty to have fall protection.
1926.502 - Fall protection systems criteria and practices..
1926.502(d) - Personal fall arrest systems.
1926.503 - Training requirements.
1926 Subpart M App C - Personal Fall Arrest Systems - Non-Mandatory Guidelines for Complying with 1926.502(d).

Subpart X - Stairways and Ladders
1926.1053(a)(19)(i) - Ladder safety devices.
OSHA 3124: Stairways and Ladders

Special Aspects of Inclined Ladder Safety

Where's the Gravity?

In a fall from a vertical ladder, there is no 100% reliable force induced. Because of this, vertical ladder fall arrestors must rely on the user to apply a force to release the locking mechanism. On a vertical ladder, it is easy for the user to lean away from the ladder, applying an outward force to the fall arrest trolley. Most commercially available systems are designed to lock to the rail in the absence of this outward force.

On inclined ladders, it is difficult to maintain a steady outward force on the trolley. Where gravity supplies the outward force on a vertical ladder, the user of an inclined ladder must actively push himself away from the ladder to disengage the trolley. This becomes nearly impossible when both hands are not free.

In a fall from an inclined ladder, gravity pulls the victim straight down while the rail trolley is constrained to move back and down simultaneously. This means that a sideways force is always developed in a fall from an inclined ladder. This sideways force can be used to lock the trolley to the rail.

Swing Falls.

Falling from an inclined ladder will result in a dangerous swing fall. Therefore, it is essential to keep lanyards short.

Recovery.

If someone does fall, recovery from an inclined ladder will be difficult if the victim is left dangling underneath. Another reason to keep lanyards short.

Employee Acceptance.

In order to be effective, safety procedures must be accepted by the employees. At remote antenna sites, where constant supervision is impossible, this becomes especially important. We tried a variety of commercially available ladder safety devices on the antenna quadrupod legs, but all met with complaints from the employees. This is why we set out to build a ladder safety device specifically for inclined ladders.

Fall Protection Equipment

There are many ways to protect against falls from ladders. Some of the more common methods are described below.

Successive Tie-off

If the ladder is adequately designed and anchored, climbers can attach dual lanyards directly to the ladder. While inexpensive and simple, this method has obvious drawbacks in convenience and efficiency.

Cages and Handrails

Climbers of quadrupod ladders frequently carry bulky tools and equipment. Cages make this difficult. They also pose a hazard of dropping things as a result of bumping them against the cage.

Cages and handrails also block the antenna surface. This reduces the antenna collecting area and can induce diffraction. They add weight to the antenna tipping structure, increasing gravitational deflection and lowering servo response. Although small, these effects are undesirable and should be avoided if possible.

Safety Nets and Landings

Generally impractical in this situation.

Self-retracting Lifelines

The potential for swing falls rules out use of self-retracting lifelines on inclined ladders.

Ladder Safety Devices

Cable and Rope Grab Systems

These systems consist of a tensioned cable attached to the ladder. Removable trolleys run along the cable. The cable is supported at intervals along the ladder, and the trolleys pass over the supports without unhooking. Cable tension is maintained by a tensioner mounted at the bottom of the ladder.

These systems are excellent for vertical ladders, but for inclined ladders they suffer the problems described above under "Where's the Gravity".

Rigid Rail Systems

Similar to cable and rope grab systems, these systems use a rigid rail in place of the cable. The rail is commonly a notched pipe, aluminum extrusion, or flat bar. No tensioner is required.

Rigid rails are more durable than cables, and they do not require correct tensioning to function properly. For these reasons, we find them preferable to cable systems.

Commercial Rail Systems

We investigated rigid rail systems offered by French Creek Productions, DBI/SALA, Sellstrom Manufacturing, and Miller/Dalloz. The Sellstrom system is not recommended for inclined ladders. The other systems can be used with inclined ladders, but work best on vertical installations. Contact information for these companies is included in the references.

A Custom-Designed Rail System

Figure 1 depicts the trolley and rail for our in-house design. Under normal use, the swing-arm on the trolley is vertical, allowing the trolley to roll smoothly. In a fall, the swing-arm is pulled to the side, engaging locking cams against the rail. Not shown is the safety hook attached to the bolt at the top of the swing-arm. This hook snaps to the user's front D-ring.

As of this date, preliminary load and performance tests have been performed on a prototype of this system with satisfactory results. The next step is on-antenna performance tests, followed by static and dynamic proof-load tests. We hope to be in production by October, `99.

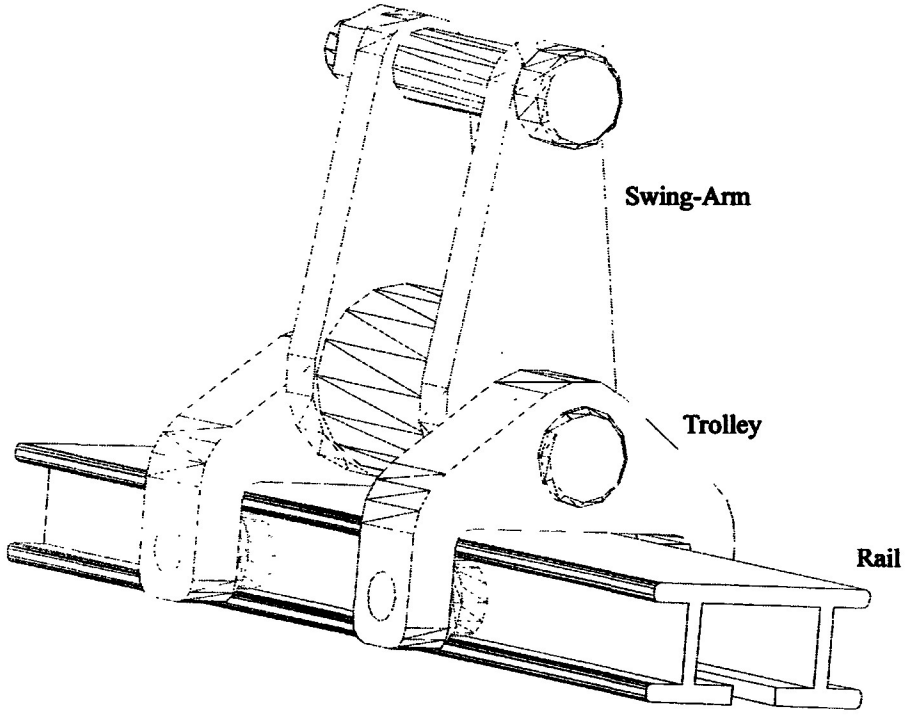

Figure 1

Comparison of Custom and Commercial Systems

The commercial systems mentioned above work on vertical ladders. The custom system only works on inclined ladders. This lack of versatility is compensated by better performance and employee acceptance.

Component cost of the custom system will be about $250 per antenna for rail and $200 per trolley. Costs for a French Creek system installed inApril, `99 on antenna 21 were $500 for rail and $250 per trolley.

Summary

Many radio telescopes and earth station antennas are provided with inclined quadrupod leg ladders.

OSHA requires fall protection for ladders exceeding 20 feet in length.

Ladder safety devices, particularly those of the rigid rail variety, are the best means of providing fall protection for quadrupod leg ladders.

Commercially available ladder safety devices are designed primarily for vertical ladders and are difficult to use on inclined ladders. By giving up the ability to operate on vertical ladders, a ladder safety device that performs well on inclined ladders has been built and tested.

References & Acknowledgments

I thank the NRAO Antenna Mechanics for giving me a clear understanding of the shortfalls of currently available fall protection systems in use on our antennas. I also thank Jon Thunborg for his help in the conceptual design and finite element analysis. And, I thank Clint Janes for his support of our efforts to improve safety on the antennas.

OSHA Regulations

Current OSHA Regulations and guidelines are available online. See:

- *http://www.osha-slc.gov/OshStd_toc/OSHA_Std_toc.html*
  Top page for CFR 29.
- *http://www.osha-slc.gov/Publications/OSHA3124/osha3124.html*
  "a generic, non-exhaustive, overview of" Stairways & Ladders".

Manufacturers of Rigid Rail Ladder Safety Devices

DBI/SALA
Manufacturer of Railok® Rigid Rail System and Notched Rail systems
3965 Pepin Av
Red Wing, MN 55066
612-388-8282

French Creek Production, Inc.
Distributor of TS Safety Rail System.
626 Thirteenth St
Franklin, PA 16323
814-437-1808

Miller - Dalloz Fall Protection
SureTrack® System (Very similar to the TS System)
1355 15th St.
Franklin, PA 16323
Tel: 800-873-5242

Sellstrom Manufacturing
Manufacturer of Climb-Rite® rigid rail system
One Sellstrom Dr.
Palatine, IL 60067
800-323-7402

TS Products, Inc.
Manufacturer of TS Safety Rail System.
136 Whittington Course
St. Charles, IL 60174
630-377-1442