

NATE

THE COMMUNICATIONS INFRASTRUCTURE
CONTRACTORS ASSOCIATION

2021 NATE SEMC WIRE ROPE SAFETY SLEEVE TESTING REPORT II



Introduction

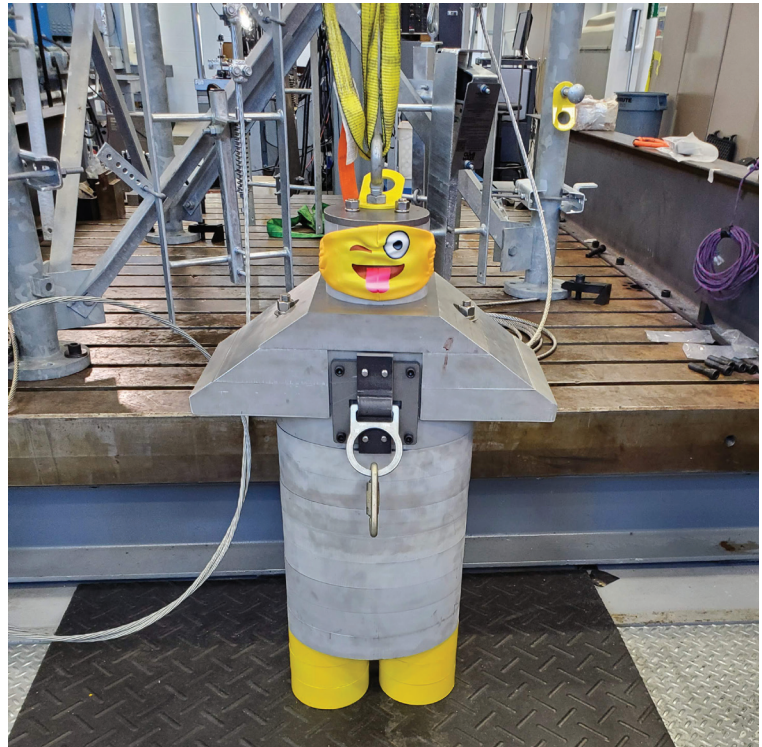
The testing event was performed to provide feedback to NATE members, industry stakeholders and manufacturers. The results of the testing event are meant to raise the bar on safety by increasing awareness and improving testing methods.

All testing was conducted at the University of Dayton Research Institute (UDRI) over the course of three days, with ten different scenarios and forty-five drop tests completed. The facility was an indoor, climate controlled environment. The testing utilized new equipment attached to an antenna supporting structure designed to the ANSI/TIA-222 (H) standard. All of the test drops were recorded and reviewed by the Safety Equipment Manufacturer Ad Hoc Committee (SEMC) to verify the accuracy of the results.

Participation was not limited to the SEMC, all relevant industry stakeholders were encouraged to participate. For the manufacturers that chose not to attend, their equipment was purchased from a reputable distributor so that it could be included in the testing. All work at height for the testing and setup was performed by a competent climber, and all equipment was installed and utilized with the input from the participating manufacturers.

The testing protocols outlined in this document were not conducted under strict American National Standard Institute (ANSI) requirements and therefore should not be construed as ANSI testing. The tests performed were not intended to conform to the current ANSI/ASSP Z359.16 testing protocol, but rather to better emulate how the wire rope safety sleeves are being utilized by authorized climbers in the telecommunications industry.

Currently in the United States, all required ANSI tests for wire rope safety sleeves are performed from a static starting position, utilizing a cylindrical 282 lb. test weight at a specified stand-off distance from the wire rope. However, previous SEMC testing indicated that the



introduction of motion to the test warranted further evaluation with regard to the performance of the wire rope safety sleeve. Therefore, the SEMC has elected to utilize a test torso to better replicate real-world scenarios; including the climber's movement, motion, placement on the system, and center of gravity. All of these factors show the importance of this type of testing.

The test weight utilized was a 310 lb. torso with an integral sternal attachment point that did not require a full body harness. All manufacturers of wire rope safety climb sleeves have a total rated capacity of 310 lbs. including worker weight



and tools, therefore testing was completed to match the total rated capacity of the wire rope safety sleeve.

To remove the variables from using a harness, such as slippage, stretch, and fitment; the test weight was designed based on the ANSI/ASSP Z359.11 Standard with an increased mass totaling 310 lbs. and an integral sternal attachment point. Utilizing a torso shaped weight creates a horizontal reaction force and thus a better representation of the climber's center of gravity applied to the system during the drop event.

Compatibility of the components that make up a 3/8" diameter wire rope safety climb system were indirectly tested by utilizing all manufacturers wire rope safety sleeves on other manufacturers wire rope safety

climbs. This included linking of the carabiner connecting devices to d-rings and wire rope safety sleeves to different wire rope constructions.

Industry data shows that most climbers carry a single wire rope safety sleeve. Based on this information, it is highly unlikely that they will have a matching wire rope safety sleeve for every manufacturer's wire rope safety climb they may encounter.

It should be noted that some manufacturers state that their wire rope safety sleeves should only be utilized with their wire rope safety climbs. SEMC testing results show that failure to adhere to these requirements may result in malfunction or equipment failure.

Test 1:

Dynamic Drop Test - Leg Mount

Purpose

The purpose is to complete dynamic performance testing to evaluate wire rope safety climb system components under ideal/environmentally controlled conditions. The drop scenario was to replicate a single climber falling on a newly installed system.

Test Setup

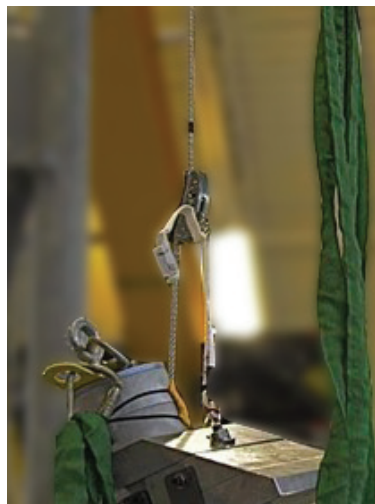
A new 20' leg mounted PerfectVision ClimbMaxx system with a 3/8", 7x19 stainless steel wire rope pretensioned to 400 lbf was installed per the manufacturer's specifications on the structure without wire rope guides, and did not have interference from appurtenances or wire rope deflection.



Drop 1



Drop 2



Drop 3



Drop 4

Results:

Drop #	Wire Rope Safety Sleeve	Initial Wire Rope Tension (lbf)	Arrested Test Torso	Wire Rope Safety Sleeve Travel Distance (inches)	Post Drop Wire Rope Condition	Post Drop Wire Rope Tension (lbf)	Notable Post Drop Wire Rope Safety Sleeve Condition	Post Drop Climbing Facility Condition
1	TUF-TUG WG-500	400	Yes	2 3/4"	Broken Individual Wires	40 ***	N/A	**
2	3M Lad-Saf X3	400	Yes	2 3/4"	Flattening	240	N/A	**
3	Skylotec Claw	400	Yes	2 5/8"	**	340	N/A	**
4	Miller Vi-Go (SW)	400	No	*	**	320	Carabiner connecting device gate sheared	**

* Caught by safety sling.

** Wire rope safety climb system, including climbing facility, showed no signs of wear or damage during/post drop test.

*** Initial drop test may have affected the top assembly and/or climbing facility, resulting in lower post drop wire rope tensions.

Test 2:

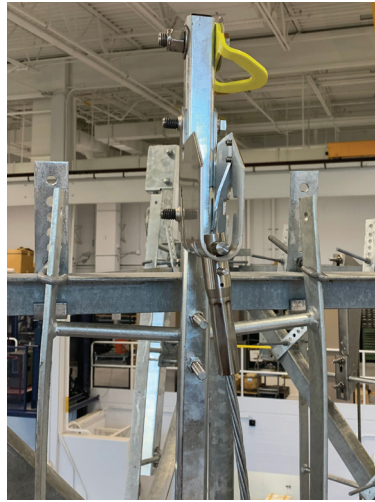
Dynamic Drop Test - Rung and Rail Mount

Purpose

The purpose is to complete dynamic performance testing to evaluate wire rope safety climb system components under ideal/environmentally controlled conditions. This test was a replication of Test 1 with a different wire rope safety climb, and wire rope construction. The drop scenario was to replicate a single climber falling on a newly installed system.

Test Setup

A new 20' 3M DBI-SALA Lad-Saf rung and rail climbing facility mount system with a 3/8", 1x7 galvanized EHS (extra high strength) strand pretensioned between 300-420 lbf was installed on the structure without wire rope guides, and did not have interference from appurtenances or wire rope deflection.



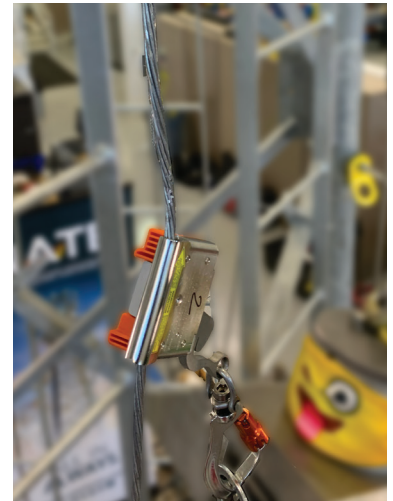
Drop 5



Drop 6



Drop 7



Drop 8

Results:

Drop #	Wire Rope Safety Sleeve	Initial Wire Rope Tension (lbf)	Arrested Test Torso	Wire Rope Safety Sleeve Travel Distance (inches)	Post Drop Wire Rope Condition	Post Drop Wire Rope Tension (lbf)	Notable Post Drop Wire Rope Safety Sleeve Condition	Post Drop Climbing Facility Condition
5	TUF-TUG WG-500	420	Yes	1 1/8"	Kinking	40	N/A	Top rung of climbing facility bent ***
6	3M Lad-Saf X3	400	Yes	5 3/4"	Kinking	340	N/A	**
7	Skylotec Claw	340	Yes	5 1/2"	Kinking, Strand separation	300	N/A	**
8	Miller Vi-Go (SW)	300	Yes	13"	Kinking, Strand separation	0	Removed without manipulation of release function	**

** Wire rope safety climb system, including climbing facility, showed no signs of wear or damage during/post drop test.
 *** Initial drop test may have affected the top assembly and/or climbing facility, resulting in lower post drop wire rope tensions.

Test 3:

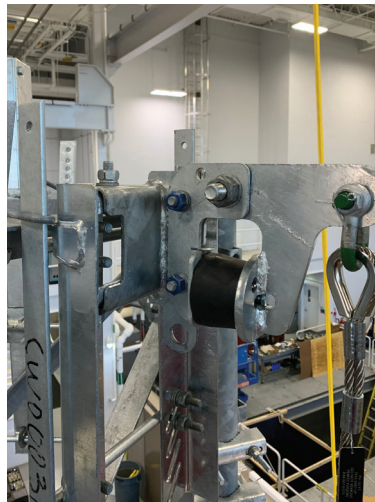
Low Tension Dynamic Test

Purpose

The purpose is to complete dynamic performance testing to evaluate wire rope safety climb system components under low wire rope tension conditions. Prior to the drop test, the wire rope safety sleeve was evaluated for resistance while ascending a low tension wire rope. The drop scenario was to replicate a single climber falling on a visibly loose wire rope safety climb system.

Test Setup

A new 20' rung and rail climbing facility mount, PerfectVision ClimbMaxx system with a 3/8", 7x19 stainless steel wire rope pretensioned to 100 lbf was installed on the structure without wire rope guides, and did not have interference from appurtenances or wire rope deflection.



Setup



Drop 10



Drop 11



Drop 12

Results:

Drop #	Wire Rope Safety Sleeve	Initial Wire Rope Tension (lbf)	Arrested Test Torso	Wire Rope Safety Sleeve Travel Distance (inches)	Post Drop Wire Rope Condition	Post Drop Wire Rope Tension (lbf)	Notable Post Drop Wire Rope Safety Sleeve Condition	Post Drop Climbing Facility Condition
9	TUF-TUG WG-500	100	Yes	1/2"	Abrasion	0	Safety pin jammed	**
10	3M Lad-Saf X3	100	Yes	13"	Kinking	0	Force required to disengage	Top assembly movement
11	Skylotec Claw	100	Yes	1 5/8"	**	100	N/A	Top assembly movement
12	Miller Vi-Go (SW)	100	Yes	2 1/4"	Flattening, Kinking	0	N/A	**

** Wire rope safety climb system, including climbing facility, showed no signs of wear or damage during/post drop test.

Test 4:

10° Forward Angle Dynamic Drop Test

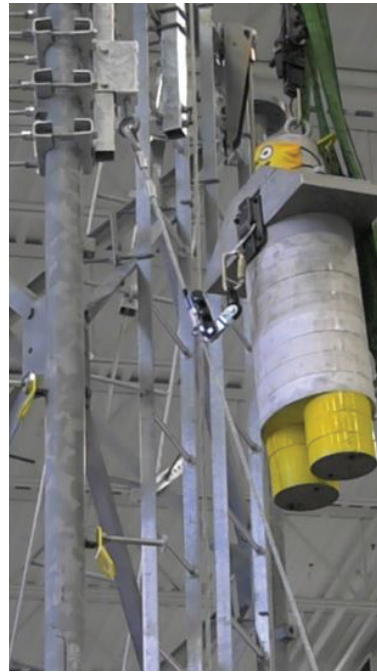
Purpose

The purpose is to complete dynamic performance testing to evaluate wire rope safety climb system components in a 10° forward angle climb. The drop scenario was to replicate a single climber falling on a self-support structure with a climb facility on a tapered base.

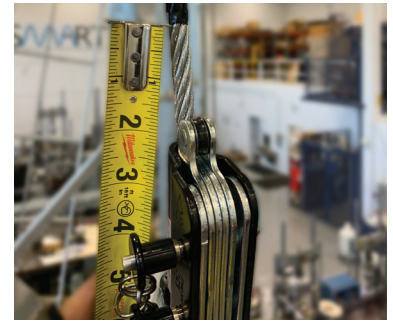
Test Setup

A new 20' TUF-TUG round climb leg system with a 3/8", 7x19 stainless steel wire rope pretensioned to 200 lbf was installed on the structure without wire rope guides, and did not have interference from appurtenances or wire rope deflection. The test torso was positioned at a 45° angle to the wire rope safety climb to simulate proper climbing techniques and prevent torso from making contact with the wire rope safety sleeve during the fall event.

Results:



Setup



Drop 13



Drop 14



Drop 15



Drop 16

Drop #	Wire Rope Safety Sleeve	Initial Wire Rope Tension (lbf)	Arrested Test Torso	Wire Rope Safety Sleeve Travel Distance (inches)	Post Drop Wire Rope Condition	Post Drop Wire Rope Tension (lbf)	Notable Post Drop Wire Rope Safety Sleeve Condition	Post Drop Climbing Facility Condition
13	TUF-TUG WG-500	200	Yes	1 3/4"	Kinking, Strand separation	60	Safety pin jammed	**
14	3M Lad-Saf X3	200	Yes	2 1/2"	Kinking	140	N/A	**
15	Skylotec Claw	200	Yes	3 3/4"	**	160	N/A	**
16	Miller Vi-Go (SW)	200	Yes	4 3/4"	Kinking, Flattening	180	Force required to disengage	**

** Wire rope safety climb system, including climbing facility, showed no signs of wear or damage during/post drop test.

Test 5:

Dynamic Drop Test with In-line Load Cell

Purpose

The purpose is to measure the applied forces to the wire rope safety climb system during dynamic performance testing to evaluate wire rope safety climb system components under ideal/environmentally controlled conditions. The drop scenario was to replicate a single climber falling on a newly installed system.

Test Setup

A new 20' rung and rail climbing facility mount system utilizing a TUF-TUG top assembly with in-line load cell, PerfectVision ClimbMaxx 3/8", 7x19 stainless steel wire rope pretensioned between 160-220 lbf and TUF-TUG base assembly. Test torso wire rope safety sleeve was positioned 9" from wire rope for all drop tests.



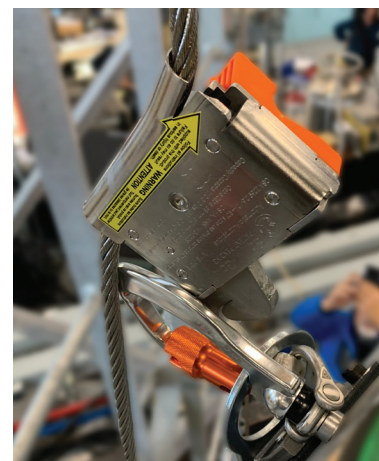
Setup



Drop 17



Drop 19



Drop 20

Results:

Drop #	Wire Rope Safety Sleeve	Initial Wire Rope Tension (lbf)	Arrested Test Torso	Wire Rope Safety Sleeve Travel Distance (inches)	Post Drop Wire Rope Condition	Post Drop Wire Rope Tension (lbf)	Notable Post Drop Wire Rope Safety Sleeve Condition	Post Drop Climbing Facility Condition	Applied Force (see note)
17	TUF-TUG WG-500	220	Yes	1/2"	**	160	N/A	Climbing facility dropped 2"	2650
18	3M Lad-Saf X3	220	Yes	3 3/4"	Bird-caging, Kinking	200	N/A	**	2302
19	Skylotec Claw	200	Yes	2"	**	180	N/A	**	1504
20	Miller Vi-Go (SW)	180	Yes	3 1/2"	Abrasion, Flattening	160	N/A	Slight climbing facility movement	2308
21	TUF-TUG WG-500 BSEN (w/Shock Pack)	160	Yes	1/2"	**	160	NA	**	1354

** Wire rope safety climb system, including climbing facility, showed no signs of wear or damage during/post drop test.

Note: All recorded forces were measured from the top assembly and shall be considered as total force applied to the wire rope safety climb system, therefore the maximum arresting force (MAF) on the sternal attachment point of the test torso was not measured.

Test 6:

Ascending Climber Dynamic Drop Test

Purpose

The purpose is to complete dynamic performance testing and evaluate the components of a wire rope safety climb system when a fall occurs by an ascending climber in motion. The drop test was to replicate a single climber falling as a result from a missed step/slip.

Test Setup

A new 20' rung and rail climbing facility mount, Skylotec Claw Line system with a 3/8", 7x19 stainless steel wire rope pretensioned between 180-260 lbf was installed on the structure without wire rope guides, and did not have interference from appurtenances or wire rope deflection. The drop occurred from a predetermined point while the torso was ascending at 0.35 ft./sec.



Setup



Drop 22



Drop 23



Drop 25

Results:

Drop #	Wire Rope Safety Sleeve	Initial Wire Rope Tension (lbf)	Arrested Test Torso	Wire Rope Safety Sleeve Travel Distance (inches)	Post Drop Wire Rope Condition	Post Drop Wire Rope Tension (lbf)	Notable Post Drop Wire Rope Safety Sleeve Condition	Post Drop Climbing Facility Condition
22	TUF-TUG WG-500	180	Yes	1 1/2"	**	0	Force required to disengage	Rail of climbing facility slightly bent ***
23	3M Lad-Saf X3	260	Yes	1 1/2"	Kinking, Strand separation	140	N/A	**
24	Skylotec Claw	200	Yes	0	**	160	N/A	**
25	Miller Vi-Go (SW)	180	Yes	3/4"	Broken individual wires in 2 locations, Kinking	0	N/A	**

** Wire rope safety climb system, including climbing facility, showed no signs of wear or damage during/post drop test.
 *** Initial drop test may have affected the top assembly and/or climbing facility, resulting in lower post drop wire rope tensions.

Test 7:

Zero Tension Straight Drop Test

Purpose

The purpose is to complete dynamic performance testing to evaluate wire rope safety climb system components on a zero tension wire rope. The drop scenario was to replicate a single climber falling on a zero tension wire rope safety climb system similar to an incomplete installation with the base assembly unattached.

Test Setup

A new 20' leg mounted Allfasteners system with a 3/8", 7x19 stainless steel wire rope with zero tension was installed utilizing the top assembly on the structure without the base assembly, wire rope guides, and did not have interference from appurtenances or wire rope deflection.

Results:



Setup



Drop 26



Drop 27



Drop 29

Drop #	Wire Rope Safety Sleeve	Initial Wire Rope Tension (lbf)	Arrested Test Torso	Wire Rope Safety Sleeve Travel Distance (inches)	Post Drop Wire Rope Condition	Post Drop Wire Rope Tension (lbf)	Notable Post Drop Wire Rope Safety Sleeve Condition	Post Drop Climbing Facility Condition
26	TUF-TUG WG-500	0	Yes	1"	Kinking	0	Force required to disengage	Deployment of TRAVEL8 Energy Absorber 6 1/2" ***
27	3M Lad-Saf X3	0	Yes	4 1/2"	Kinking	0	N/A	Deployment of TRAVEL8 Energy Absorber + 2 1/2" (9" total)
28	Skylotec Claw	0	Yes	2"	**	0	N/A	No additional deployment of TRAVEL8 Energy Absorber
29	Miller Vi-Go (SW)	0	No	*	Flattening, Kinking	0	Carabiner connecting device gate sheared	Deployment of TRAVEL8 Energy Absorber +1/4" (9 1/4" total)

* Caught by safety sling.

** Wire rope safety climb system, including climbing facility, showed no signs of wear or damage during/post drop test.

*** Initial drop test may have affected the top assembly and/or climbing facility, resulting in lower post drop wire rope tensions.

Test 8:

Unsupported Extended Rung and Rail Climbing Facility Dynamic Drop Test

Purpose

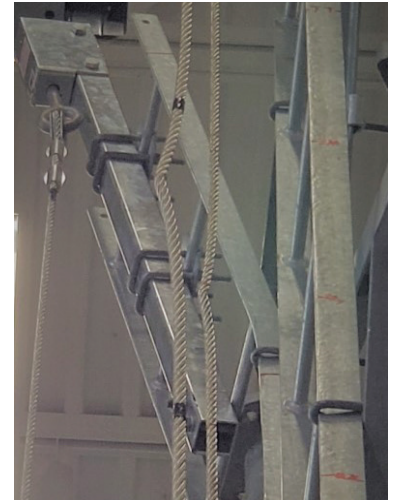
The purpose is to complete dynamic performance testing to evaluate wire rope safety climb system components when a fall occurs on an unsupported extended climbing facility. The drop scenario was to replicate a structure where the climbing facility has been extended with the top three rungs unsupported.

Test Setup

A new 20' rung and rail climbing facility mount TUF-TUG system with a 3/8", 7x19 stainless steel wire rope pretensioned to 200 lbf was installed on the unsupported rung and rail climbing facility. The top three j-bolts on the climbing facility were removed and the top assembly was installed on the unsupported section of the climbing facility (approx. 42"). No wire rope guides were used and the system did not have interference from appurtenances or wire rope deflection.



Setup



Setup Post Drop



Drop 30



Drop 32

Results:

Drop #	Wire Rope Safety Sleeve	Initial Wire Rope Tension (lbf)	Arrested Test Torso	Wire Rope Safety Sleeve Travel Distance (inches)	Post Drop Wire Rope Condition	Post Drop Wire Rope Tension (lbf)	Notable Post Drop Wire Rope Safety Sleeve Condition	Post Drop Climbing Facility Condition
30	TUF-TUG WG-500	200	Yes	1/2"	Flattening, Kinking	80	N/A	2 3/4" climbing facility deflection out from vertical plane, climbing facility dropped 1/2"
31	3M Lad-Saf X3	200	Yes	3 1/4"	Flattening, Kinking	80	N/A	4 1/4" climbing facility deflection out from vertical plane
32	Skylotec Claw	200	Yes	6 1/2"	Flattening, Kinking	60	Force required to disengage	4 1/2" climbing facility deflection out from vertical plane
33	Miller Vi-Go (SW)	200	Yes	9"	Flattening, Kinking	40	N/A	7 3/4" climbing facility deflection out from vertical plane

Test 9:

10° Lateral Dynamic Drop Test

Purpose

The purpose is to complete dynamic performance testing to evaluate wire rope safety climb system components when a fall occurs on a system with a wire rope at a 10° lateral angle. Prior to the drop test, the sleeve was evaluated for resistance while ascending on the lateral climb. The drop scenario was to replicate a single climber falling on a wire rope safety climb system transitioning across the face of the structure.

Test Setup

A new 20' rung and rail climbing facility TUF-TUG system with a 3/8", 7x19 stainless steel wire rope pretensioned between 200-220 lbf was installed on the structure without wire rope guides, and did not have interference from appurtenances or wire rope deflection. Both the wire rope safety climb system and the climbing facility were installed on the structure at a 10° lateral angle.

Results:



Setup



Drop 34



Drop 35



Drop 36

Drop #	Wire Rope Safety Sleeve	Initial Wire Rope Tension (lbf)	Arrested Test Torso	Wire Rope Safety Sleeve Travel Distance (inches)	Post Drop Wire Rope Condition	Post Drop Wire Rope Tension (lbf)	Notable Post Drop Wire Rope Safety Sleeve Condition	Post Drop Climbing Facility Condition
34	TUF-TUG WG-500	220	Yes	1/4"	Flattening	160	Force required to disengage	Climbing facility dropped 1/2" ***
35	3M Lad-Saf X3	220	Yes	6"	Flattening, Kinking	200	Force required to disengage	**
36	Skylotec Claw	200	Yes	1/2"	Flattening	180	N/A	**
37	Miller Vi-Go (SW)	200	Yes	8"	Flattening, Kinking	0	N/A	**

** Wire rope safety climb system, including climbing facility, showed no signs of wear or damage during/post drop test.

*** Initial drop test may have affected the top assembly and/or climbing facility, resulting in lower post drop wire rope tensions.

Test 10:

Multi-Climber Dynamic Drop Test

Purpose

The purpose is to complete dynamic performance testing to evaluate wire rope safety climb system components when a fall occurs with the static weight of three additional climbers. The drop scenario was designed to replicate the fourth climber falling above the additional static load of three climbers on the wire rope safety climb system.

Test Setup

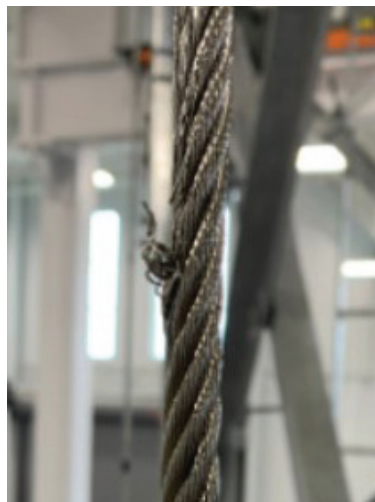
A new 20' leg mount PerfectVision ClimbMaxx system with a 3/8", 7x19 stainless steel wire rope was installed on the structure with three individual cylinder weights of 310 lbs. each. Each cylinder was secured to the wire rope by a deployed wire rope safety sleeve giving the system a preload of 930 lbf.



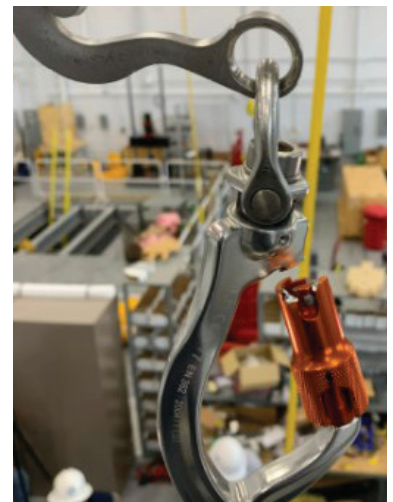
Setup



Drop 38



Drop 39



Drop 41

Results:

Drop #	Wire Rope Safety Sleeve	Initial Wire Rope Tension (lbf)	Arrested Test Torso	Wire Rope Safety Sleeve Travel Distance (inches)	Post Drop Wire Rope Condition	Post Drop Wire Rope Tension (lbf)	Notable Post Drop Wire Rope Safety Sleeve Condition	Post Drop Climbing Facility Condition
38	TUF-TUG WG-500	930	Yes	2 1/4"	Abrasion, Bird-caging, Strand separation	N/A	Force required to disengage	**
39	3M Lad-Saf X3	930	Yes	3 1/2"	Flattening, Kinking, Strand separation	N/A	Force required to disengage	**
40	Skylotec Claw	930	Yes	1 3/4"	**	N/A	****	**
41	Miller Vi-Go (SW)	930	No	*	**	N/A	Carabiner connecting device gate sheared	**

* Caught by safety sling.

** Wire rope safety climb system, including climbing facility, showed no signs of wear or damage during/post drop test.

**** Previously deployed wire rope safety sleeve.

Test 11:

Ascending Climber with Lateral Motion Dynamic Drop Test

Purpose

The purpose is to complete dynamic performance testing and evaluate the components of a wire rope safety climb system when a fall occurs by an ascending climber in motion with lateral movement. This drop scenario was designed to replicate a fall while simulating the body mechanics of a person climbing.

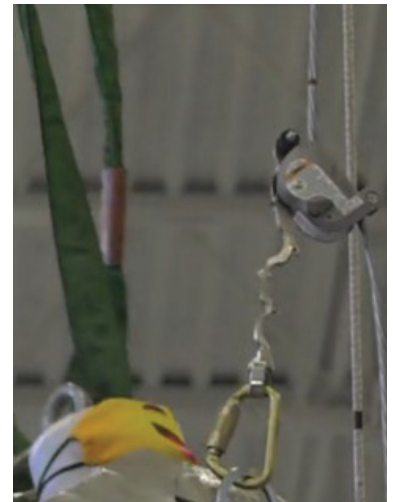
Test Setup

A new 20' rung and rail climbing facility 3M DBI-SALA Lad-Saf system with a 3/8", 7x19 stainless steel wire rope pretensioned between 200-320 lbf was installed on the structure without wire rope guides, and did not have interference from appurtenances or wire rope deflection. The drop occurred from a predetermined point while the torso was ascending at 0.35 ft./sec. with tag lines attached to induce lateral rotation of the torso.

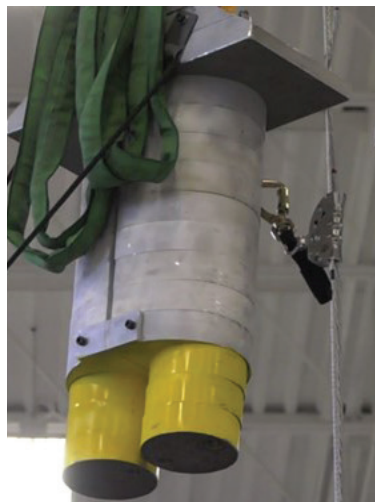
Results:



Drop 42



Drop 43



Drop 44



Drop 45

Drop #	Wire Rope Safety Sleeve	Initial Wire Rope Tension (lbf)	Arrested Test Torso	Wire Rope Safety Sleeve Travel Distance (inches)	Post Drop Wire Rope Condition	Post Drop Wire Rope Tension (lbf)	Notable Post Drop Wire Rope Safety Sleeve Condition	Post Drop Climbing Facility Condition
42	TUF-TUG WG-500	200	Yes	1/4"	Abrasion, Kinking	0	N/A	Climbing facility dropped 1/2"
43	3M Lad-Saf X3	320	Yes	5 1/4"	Kinking	300	N/A	**
44	Skylotec Claw	300	Yes	2 1/4"	Bird-caging, Flattening, Kinking	260	Force required to disengage	**
45	Miller Vi-Go (SW)	300	No	*	Bird-caging, Flattening, Kinking	0	Failed to engage ****	**

* Caught by safety sling.

** Wire rope safety climb system, including climbing facility, showed no signs of wear or damage during/post drop test.

**** Previously deployed wire rope safety sleeve.



THE COMMUNICATIONS INFRASTRUCTURE
CONTRACTORS ASSOCIATION

Acknowledgment

The SEMC would like to acknowledge NATE for their dedication to the safety of the men and women who make wireless communication possible. Without their leadership, support, and vision, this wire rope safety sleeve testing would not have been possible.

We would also like to thank the following organizations and each participant from these organizations for their support:

- 3M
- Allfasteners USA
- Crown Castle
- Deuer Development
- GME Supply Co
- MILLERCO
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- PerfectVision
- Sabre Industries, Inc.
- SBA Communications Corporation
- SKYLOTEC North America, LP
- Trylon TSF Inc.
- TUF-TUG, Incorporated
- USA Telecom Insurance Services Inc.
- University of Dayton Research Institute (UDRI)

Recommendations and User Warnings

The SEMC would like to reiterate the recommendations and user warnings previously listed in the SEMC 2020 Guide for Wire Rope Safety Climbs on Antenna Supporting Structures:

- Do not leave unattended or non-secured wire rope safety sleeves attached to the wire rope safety climb.
- The user shall verify that the wire rope safety sleeve meets and is utilized per the manufacturer's specification and is compatible with the wire rope safety climb to be used, including the wire rope diameter and construction.
- All wire rope safety climbs must be properly tensioned and installed per the manufacturer's instructions.
- Manufacturer supplied carabiners with captive pins must be used in conjunction with the wire rope safety sleeve for proper function.
- User's harness and/or body shall not come in contact with the wire rope safety sleeve while ascending or descending on the wire rope safety climb system.
- Always refer to manufacturer documentation for use and inspection.

For additional information and previous testing reports, please reference the following documents or visit natehome.com/safety-equipment-manufacturers-committee-semc-initiatives/.

**NATE Safety Sleeve Testing Final Report
2020 Guide for Wire Rope Safety Climbs on Antenna Supporting Structures**