MK & Associates

Expert Report

17-095: NACSP Fall Protection System Certification of Testing

Submitted to:

Mr. Ronald Kempker
North America Construction Safety Products
1325 Aerotek Drive
Jefferson City, MO 65109

October 22, 2019

By:

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Descriptive Information

This report has been prepared in compliance with ASTM Designation E 620-04, "Standard Practice for Reporting Opinions of Technical Experts." It was prepared on October 22, 2019, under our file titled "17-095: NACSP Fall Protection System Certification." The opinions contained within have been rendered by Mark A. M. Ezra, PE of MK & Associates, LLC., P.O. Box 460440, St. Louis, Missouri 63146.

The following items were reviewed and inspected during our original testing of the subject fall protection system on February 1, 2018:

1. An exemplar test section 60 foot in length of the subject roof perimeter fall protection system installed on a warehouse roof;
2. 24 photos taken by the author on the date of testing, February 1, 2018, of the 60 foot exemplar test set up for the subject roof perimeter fall protection system, as it was installed for testing;
3. United States Department of Labor OSHA regulation 1926.502 for Construction Fall Protection.
4. United States Department of Labor OSHA regulation 1926.502(b)(3) for Construction Fall Protection load;
5. United States Department of Labor OSHA regulation 1926.502(b)(4) for Construction Fall Protection load;
6. (SOR) Statutory Orders and Regulations / 86-304 / 2.12 (1)(a);
7. (SOR) Statutory Orders and Regulations / 86-304 / 2.12 (1)(b);
8. (SOR) Statutory Orders and Regulations / 86-304 / 2.12 (1)(c); and
9. (SOR) Statutory Orders and Regulations / 86-304 / 2.12 (2);

We have now been requested to review the US Corps of Engineers standard EM 385-1-1 section 21.F.01.C (4) Steel Cable (Wire Rope) Railings for Fall Protection Systems. We have reviewed EM 385-1-1 section 21.F.01.C (4) Steel Cable (Wire Rope) Railings and compared these requirements with our test results of the Fall-Ban wire rope railing system we tested on February 1, 2018.

Persons present during the February 1, 2018 load testing of the subject Fall-Ban protection system were Mark A. M. Ezra, PE (author), Mr. Ronald Kempker, and Mr. Thomas Scheppers.

Testing was conducted at a builder facility located at 3807 Route CC, Jefferson City, MO, 65109. The exemplar 60 foot run of the perimeter fall protection system was installed on a flat roofed warehouse structure, located at the above address. We were informed that the warehouse structure was approximately 44 years old at the time of the test.

The purpose of the presence of Mark A. M. Ezra PE, the author, was to certify the load application to the test section of the exemplar perimeter fall protection system during the system conformance tests and witness the results of the test load application.

Pertinent Facts

When the author arrived at the test site on February 1, 2018, the subject exemplar 60 foot long test section of the roof perimeter fall protection system was already installed. Mr. Kempker supplied a mechanical scale, which was to be used for the required load application during the actual testing of the upper run or rail of the fall protection system. The author, with Mr. Kempker and Mr. Scheppers, proceeded to calibrate the mechanical load scale used for load application by first measuring a load on a previously calibrated digital weigh scale. This calibration load was

210 lbs. This same calibration load was then placed on the mechanical load scale to be used for load application in the testing. The zero set point adjuster of the mechanical scale was then turned in the appropriate direction such that the mechanical load application scale read 210 lbs. This calibrated the mechanical load scale in the range of the test load(s) to be used during the testing of the fall protection system.

Post testing verification of the ***calibrated digital electronic scale*** showed that the test electronic digital scale was reading a calibrated 196 lbs. load as 196.2 lbs. Therefore, a small error of ***1/10th of 1% of load*** existed in the calibrated digital scale at this post-testing verification. The calibrated digital scale used at certification testing for the fall protection system is therefore considered accurate since the mechanical scale used for load application could only register to +/- 1 lb. Therefore, a calibration error of 0.2 lb. in 200 lbs. is considered negligible and has been ignored.

Testing

Figures 1 through 24 are photographs of the test set up; Figure 1 shows the complete 60 foot test section. On the left of Figure 1, one of the terminating stanchions is seen, then moving to the right in the photograph the next vertical element is a mid-rail. Further to the right, a standard stanchion is seen. The load during testing was applied in the middle of the section situated between the 1st mid-rail and the second stanchion, seen in Figure 1 of the test set up.

Figure 10 shows the test set up with the feet of the stanchions and mid-rails located on the above mentioned 2”x4” pieces of lumber. These pieces of 2”x4” wood served to protect the roof surface of the warehouse used for testing as well as providing a clean horizontal reference plane for measurements during testing. Figure 8 shows the “come-along” manual winch used to

tension the top cable run. The cable is multi-strand ¼ inch diameter steel cable. Figure 9 shows the anchor plate used at one end of the test set up and the two "come-along" manual winches used for all the cable runs.

Figure 16 shows the 39 inch high role tape set up as a "go/no-go gauge" for the maximum deflection of the top cable run. Figure 16 further shows the positioning of the mechanical load scale used to apply the test load and the manner that the test load will be applied. Figure 18 shows the upper end of the "go/no-go gauge" relative to the top cable run of the perimeter fall protection system prior to load being applied.

Discussion of Opinions and Basis Thereof

The exemplar perimeter fall protection system, whose testing was witnessed by the author on February 1, 2018, is to be marketed under the name "Fall-Ban," manufactured by North America Construction Safety Products, 1325 Aerotek Drive, Jefferson City, MO 65109, USA.

The general concept of fall protection of placing a temporary guard railing at the edge of a roof surface while work is being performed is standard industry practice. In the United States of America, such temporary work guarding is required by OSHA regulation and by the US Corps of Engineers through their general standard EM 385-1-1. Similar workplace requirements exist in Canada.

The purpose of the witnessed testing on February 1, 2018 of the Fall-Ban design of a perimeter fall protection system was to certify that the tested system conforms with both United States Department of Labor OSHA regulation 1926.502 as well as the Canadian regulation SOR/86-304 section 2.12 (1)(a). With our review of the US Corps of Engineers Standard 385-1-1

we may now extend the test results from our February 1, 2018 testing to include conformance with US Corp of Engineers Standard EM 385-1-1 section 21.F.01.C (4) Steel Cable (Wire Rope) Railings.

It should be noted that a complete assembled 60 foot section of the "Fall-Ban" system was tested on an actual roof as it would be installed if the test roof were being worked on. Therefore, the testing witnessed represented "real world" conditions of installation and not a testing laboratory set up, which often lacks any direct relationship to "in-use" system set up.

Corp of Engineers Standard EM 385-1-1 section 21.F.01.C (4) Steel Cable (Wire Rope) Railings, United States Department of Labor OSHA regulation 1926.502, as well as the Canadian regulation SOR/86-304 section 2.12 (1)(a), require that the top run or rail of a guard rail system withstand a load of 890 N load (200.08 lbs.). The OSHA regulation explicitly states that under such a load application the upper rail shall not deflect to a height of less than 39 inches above the base plane on which the guardrail is mounted. The Corp of Engineers Standard EM 385-1-1 section 21.F.01.C (4) Steel Cable (Wire Rope) Railings The testing witnessed that both the test loads applied, sequentially and in orthogonal directions, were in excess of the regulation required 890 N/200 lbs. test loads. Further, the deflection of the upper cable run of the Fall-Ban perimeter fall protection system did not, under the vertical test load, deflect to a height less than 39 inches above the horizontal reference surface on which the exemplar Fall-Ban perimeter fall protection system was mounted nor did it deflect more than 3 inches. No failure of the upper cable run or other components of the exemplar Fall-Ban occurred. It was further noted that upon removal of the 890+ N/200+ lbs. test load, the Fall-Ban system returned immediately to its original unloaded shape and position without the need for any remedial tightening of cables or adjustment of the test installation.

After the vertical load testing to 890+ N / 200+ lbs. was completed and without adjusting or re-tensioning the system, an outward load applied at 90 degrees to the vertical load and in the direction of the drop-off side of the roof was performed. The system did not fail or buckle and upon removal of the outward load, the Fall-Ban system returned immediately to its original unloaded shape and position without the need for any remedial tightening of cables or adjustment of the test installation.

Test Results:

1. Vertical loading to **205 lbs./911.8 N** resulted in the top cable run descending to a height of ***39.5 inches*** above the reference horizontal measuring plane; and
2. **Outward loading of 210 lbs./934.1 N** at 90 degrees to the vertical test loading direction was fully supported by the Fall-Ban system with no permanent deformation of the system being observed upon load removal.

Opinions and Conclusions:

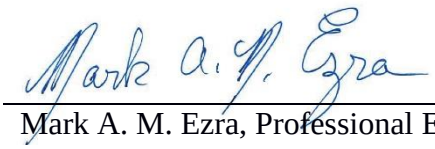
It is our opinion within a reasonably degree of engineering certainty, that:

1. The testing conducted on the exemplar Fall-Ban perimeter fall protection system shows that the system meets and exceeds the vertical load requirements of both the **Corp of Engineers Standard EM 385-1-1 section 21.F.01.C (4) Steel Cable (Wire Rope) Railings**, the United States Department of Labor **OSHA regulation 1926.502**, as well as the **Canadian regulation SOR/86-304 section 2.12 (1)(a)**; and
2. The testing conducted on the exemplar Fall-Ban perimeter fall protection system shows that the system meets the outward loading requirements of both the **Corp**

of Engineers Standard EM 385-1-1 section 21.F.01.C (4) Steel Cable (Wire Rope) Railings, the United States Department of Labor **OSHA regulation 1926.502**, as well as the **Canadian regulation SOR/86-304 section 2.12 (1)(a)**.

Signatures

Opinions given by:



Mark A. M. Ezra, Professional Engineer, Missouri License, No. E 2002003156

Qualifications

Qualifications of signatory are hereto attached as Exhibit A.