

# Elevating the safety zone



**While installation of effective fall protection systems can be undertaken at any time, inclusion at the drawing board stage can prevent many complications later.**

David P. Evangelista, PE, Evan Corporation, USA

## • Creating a safer workplace •

Over the past few years, fall protection systems have become an essential component of public assembly facilities where rigging or maintenance activities require personnel to work at elevation. Existing facilities have installed systems to comply with OSHA regulations and provide a safe working environment. New facilities have included provisions for fall protection at different stages of construction ranging from the design phase to inclusion of the fall protection systems as an element of the FFE (furniture, fixtures and equipment) package.

Past experience has proven that future fall protection projects would benefit from early incorporation of the design and installation of fall protection

systems into the overall construction plan for new facilities. This would result in a more comprehensive system that forms an integral component of the building, providing better fall protection coverage with a reduction in the overall cost.

Most facility owners, operators, architects and engineers now recognize that providing fall protection for personnel that work at heights above six feet is not only required by law, but is essential for providing a safe working environment. This transition has taken place over time. Arena operators were among the first to recognize the need for a safe workplace and began to advocate for fall protection in the facilities under their control. Fall protection systems have been

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installed in numerous existing facilities, sometimes at a price either in terms of the effectiveness of the coverage and installation, or in monetary terms. This has become evident in two ways:

- When designing and installing a fall protection system for an existing facility, the structure must be analyzed to ensure that it is able to withstand the loads imparted in the event of a fall. In existing facilities, this is typically a loading condition that was not originally contemplated by the structural engineers. As a result, Evan Corporation has encountered installations where structural modifications or supplementary steel have been required, resulting in additional costs charged to the project. In addition, installation of these systems can be labor intensive due to workers having to perform drilling and welding from lifts or temporary lifelines to attach the system to the structural steel;
- As provisions for fall protection were typically not contemplated when these facilities were built, Evan Corporation has encountered other projects where there has been significant interference from HVAC ducts, electrical conduit systems and raceways, sprinkler systems and lapendaries. As a result, there were compromises on the extent or effectiveness of the fall protection coverage that could be installed

### **Essential in the design phase**

In new facilities under construction, fall protection systems have often been installed as a last minute item. Sometimes it has been left to the facility operator to acquire fall protection as part of the facility's FFE package. As with installations in existing facilities, systems installed after completion of new building construction can require compromises in terms of the extent of coverage due to unforeseen obstacles or capacity limitations and can be costly in terms of installation labor.

### **“Facility owners, operators, architects and engineers now recognize that providing fall protection for personnel is essential to create a safe working environment”**

Recently, architects and engineers have begun to provide plans and specifications indicating the extent of coverage and the quality of the materials and workmanship required for fall protection systems to be installed in new facilities as part of the construction documents.

Two recent examples of this are the Nationwide Arena in Columbus, Ohio, where Heinlein Schrock/NBBJ were the lead project architects, and the Conseco Fieldhouse in Indianapolis, Indiana, where Ellerbe Becket was the lead architect and engineer. In both of these arenas, fall protection systems were included as part of the contract documents.

The new Nationwide Arena will be home to the National Hockey League's (NHL) new franchise, the Columbus Blue Jackets, as well as a venue for a

wide range of family entertainment, including concerts, ice shows and other sporting events.

In this facility, fall protection systems have been designed for personnel working on the rigging grid and for others performing maintenance activities on the roof. For the rigging grid, Evan Corporation was able to design and install supplementary steel stanchions that bolted directly to the grid structural members. These stanchions effectively support the horizontal lifeline system at 6ft 8in above the

walking surface, thereby providing an obstruction-free workplace for the riggers. On the rooftop, the company designed a 12in high fall restraint system. This system is designed to permit workers to gain safe access to the perimeter of the building to perform maintenance tasks while ensuring that they cannot step off the edge, thereby effectively preventing the onset of a fall.

The Conseco Fieldhouse, which opened in the fall of 1999 and is home to the Indiana Pacers, is another example of current fall protection design and installation. This particular facility, which is supported by long span arched trusses that run the length of the building, required a two-way cable system. Horizontal lifelines were designed and installed to provide coverage both along the arched trusses and

over secondary steel that framed between them. For this design, in-line shock absorbing devices were incorporated to limit the loads delivered to the cable support members.

Although many facilities have experienced problems with fall protection installations, both of the referenced examples were successfully designed and installed without compromise.

Nevertheless, Evan Corporation has learned from the experiences that additional benefits can be achieved by providing for a fully integrated fall protection system in the design and construction phase of new facilities. These benefits include:

#### **Co-ordination with other trades**

Typically, fall protection is viewed as a "stand alone" item and not considered in the way it relates to the other building systems. Often this is not a problem. However, as previously described, the company has encountered projects where there has been significant interference from other building systems resulting in compromises on the extent or

effectiveness of the fall protection coverage. Why leave it to chance to determine whether there will be interference with the other

### **“Systems installed after completion can require compromises in coverage due to unforeseen obstacles or capacity limitations”**

trades when these types of problems can be resolved through design and ‘coordination drawings’ between contractors?

By incorporating fall protection into the initial design and viewing it as one of the building systems, it becomes possible to coordinate with the other disciplines and ensure that the system provides the requisite coverage without compromise.

#### **Compatible structural design**

In most arenas and convention centers, fall protection is provided utilizing horizontal lifelines. Of all the various types of OSHA recognized fall protection methods, horizontal lifelines provide riggers with the flexibility to safely perform their work and yet are the least obtrusive from the worker's perspective. The performance of a horizontal

lifeline is dependent on many factors including the total length of cable, length of the individual spans, cable diameter, material

properties, number of users for which the cable is designed and whether there are in-line load arrestors incorporated into the system.

All of these factors have an effect on how the lifelines behave and the resulting tension that is developed in the cable.

Ultimately, these tensions are delivered to the roof or grid support members and must be safely resisted.

Evan Corporation's experience has revealed two conditions in which accommodation of the loads imparted in the event of a fall this can be a problem roof trusses and rigging grids.

- Roof trusses Riggers often perform their work directly from the roof trusses. To the layperson, the roof trusses of a modern-day arena may appear more than adequate to support the reactions from horizontal lifelines.

However roof trusses are designed primarily to resist vertical loads. Fall protection lifelines impart essentially horizontal loads, a condition for which most truss members are not designed. These loads must be considered together with the other loading combinations that the roof structure must resist including dead, live, wind, snow and rigging loads. Frequently, the high dynamic tensions of a horizontal lifeline, in combination with the other structural loading



conditions, can cause local overstressing of individual members. When this is the result, some type of structural reinforcement, or bracing, must be introduced to remedy the problem.

If left until the time when the fall protection is installed, reinforcement of the roof structure can become a costly proposition requiring skilled steel erectors, welders, high reach man lifts and costly cranes.

- **Rigging grids** In an effort to provide thorough rigging coverage, most modern arenas and convention centers incorporate some type of rigging grid. These are typically supported at the truss lower chord elevation, or suspended some distance below.

Under either scenario, Evan Corporation has encountered problems when there simply has not been suitable structure for attachment of intermediate or end supports for the cable systems.

In some cases, the company has come across grids that were suspended with members that were suitable for tension only, precluding the possibility of making an attachment that would impart any lateral load. In these cases, Evan Corporation has custom-designed steel stanchions, or supports, that are then installed as part of the contract. Once again, this requires the use of skilled labor and equipment and becomes a very labor intensive and costly undertaking.

Providing for a fall protection system during the design of the building structure, and including the loads from the system included as one more condition

that the roof or grid must support, enables the structural engineers to accommodate these conditions in their design by providing adequate or different types of structural members. The cost associated with this type of design modification is a fraction of what it is to retrofit or reinforce an existing roof structure.

### **Installation Cost Savings**

Historically, fall protection has been installed by employees working from lifts or temporary lifelines installed on the roof trusses. Typically, a crew will carry a 30-60 lb magnetic drill, lay out the hole pattern and drill holes to make bolted attachments. Occasionally, the attachments may be welded. Under either scenario, this is an extremely labor intensive, time consuming and costly form of work.

By incorporating the fall protection system into the initial design, and preparing shop layout drawings, Evan Corporation is able to have end and intermediate attachments drilled or welded by the structural steel contractor as part of the shop fabrication process, a more cost effective way of performing these tasks.

For example, Evan Corporation is currently under contract to Gilbane/Smoot, a joint venture, for an installation in the Comcast Center at the University of Maryland, a facility that is scheduled to open in August 2002.

For this project, we were able to save the client nearly 30% on the cost of installation by having this work performed in the shop. Additionally, the fall protection installation time will be

proportionately reduced, thereby creating less of an inconvenience during the last several weeks prior to the facility's opening.

All facilities where rigging or maintenance activities require personnel to work at elevation should have fall protection systems installed to comply with OSHA regulations, minimize the risk of injury and provide a safe working environment.

An effective fall protection system can be installed in existing or recently completed facilities, sometimes with minor compromises. However, by engaging competent qualified professionals and incorporating the design and installation of the fall protection systems into the overall construction plan for a new facility, owners, architects, engineers and operators can realize an integrated cost-effective system that maximizes coverage while reducing costs. ■

*David P. Evangelista, PE is president and owner of Evan Corporation, a design-build consulting engineering and specialty contracting firm specializing in the design and installation of fall protection systems.*