Hamid Vossoughi, P.E.[1], and Rehan I. Siddiqui[1]

Industrial Rope Access – An Alternate Means for Inspection, Maintenance, and Repair of Building Facades and Structures

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Abstract: Access is an integral part of inspection, maintenance, and repair of building facades and structures. The criteria for selection of access to building facades is widely varied and, in part, depends on the characteristics of the building (roof, height, set backs, overhangs, etc.), site constraints (traffic, sidewalk, etc.), and economics (time and money).

Some of the most traditional means of access to building facades include boom truck, man lift, swing staging, aerial platform, and scaffolding. Advantages and disadvantages of each type of access should be considered in the selection process. Depending on the complexity of the project, one or more of these types of access may be selected to meet project demands. One technique, which is widely used in Europe and now gaining acceptance in the United States, is Industrial Rope Access (Rope Access). This technique is often a supplementary means of access, and not necessarily a substitute for the traditional means of access to building facades and structures.

This paper presents a general overview on the past, present and future of this technique for inspection, maintenance, and repair of building facades and structures.

Keywords: means of access, Industrial Rope Access, safety, flexibility

Access Solutions in the Age of Facade Ordinances

Maintenance and repair of the exterior facades of buildings are required in order to extend their useful life, minimize the rate of deterioration, and avoid unsafe conditions. Exterior facades are exposed to the elements, but nonetheless, proper maintenance of many buildings is often deferred. The potential threat to public safety brought about by this trend has caused several major cities to enact laws requiring periodic inspection,

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[1] Director of U.S. Operations, and Managing Director, respectively, Ropelink Ltd, 230 Park Ave., Suite 864, New York, NY, 10169.

maintenance, and repair of building facades. In cities such as Chicago and New York, with the largest number of aging building stock in the United States, pedestrian sidewalk protection has become a part of the city landscape.

The scope and requirements of these facade ordinances are varied. Some require detailed critical examination of all walls at regular intervals, as well as an annual visual inspection and maintenance program during successive critical examinations. Others require visual inspection of representative portions of exterior facades. Apart from the ordinances, some proactive building owners and asset managers have developed preventive maintenance and repair programs to preserve their investment and extend the useful life of their buildings. However, on some occasions, the threat of deteriorated, distressed, or unsafe conditions may require immediate attention following the inspection, such as emergency stabilization and/or temporary repairs, until a more permanent and long-term repair can be implemented.

Some of the facade ordinances require detailed inspections, and some require a visual representative inspection of the exterior facade. As a result of the inspection, a maintenance and repair program is developed and will probably be implemented. It is likely that the maintenance and repair is spread throughout the entire facade, often making the cost of the access and the logistics of the project more complex and disproportionate to the scope of work. Advantages and disadvantages of each means of access must be evaluated accordingly.

Brief History of Rope Access

In order to surmount the unique challenges of a given project while maintaining the schedule and budget, and considering the risk and reward factors, the construction industry has always been forced to be creative and innovative. Continually, such challenges have given rise to innovations and the application of new techniques to the construction industry.

A classic example of innovation in the construction industry occurred during the construction of the Hoover dam in the early 1930s, where stabilization of the deteriorated walls of the canyon was a major priority prior to the start of the construction. The canyon walls were deteriorated due to the freeze and thaw cycling of built-up water in the canyon crevasses. In that case, the work was successfully accomplished by using skilled miners, known as “high-scalers,” to access the sides of the cliffs, utilizing a single rope as a safety line, while hauling their equipment with them. However, because of the primitive equipment and lack of proper safety provisions, there were fatalities among the high-scalers. In the early 1970s, a much safer use of lightweight equipment for descending and ascending on suspended ropes became commonplace in the sport of caving (Figure 1). In the mid to late 1970s, the improved techniques

Figure 1 - *Caving*

and equipment were used once again in the construction industry, this time in France, for stabilization and containment of falling hazards on the side of a cliff above a church.

In the early 1980s, the possibilities and advantages of utilizing the mountaineering and caving techniques and equipment were recognized, improved, and became more widely used in the construction industry in Europe, leading to the creation of the profession currently known as "Rope Access." In the mid to late 1990s, the same potentials were realized, and Rope Access started to flourish in the United States.

What is Rope Access?

Rope Access combines specialized technical skills and equipment that originated in mountaineering and caving with further development for industrial use. It provides safe access to buildings and structures by descending and ascending as well as laterally maneuvering by climbing on suspended or tensioned ropes.

In the sports of mountaineering and caving, there is an element of risk associated with the activity. An important difference between these sports and Rope Access is that only calculated and managed risk is acceptable in Rope Access. The main suspension equipment used in Rope Access is double static rope (typically with less than 5% stretch) with independent and redundant anchor points for each rope, specialized descent and ascent equipment, full seat and chest harness (forming a full body harness), and safety helmet. One of the two ropes is the primary (suspension), and the other is the backup (fall arrest) rope. The configuration and arrangement of the harnesses and the equipment (known as the 'rig') is such that the point of suspension is at waist level to maintain a low center of gravity to facilitate a comfortable sitting position to allow for maneuverability. The attachment to the backup line is from a higher point at chest level and holds the body in a safe upright position in the event of a failure of the primary suspension line or in the case of an unconscious personnel. Having the attachments at the front allows for a relatively straightforward rescue of the individual.

Advantages of Rope Access

In comparison with the traditional means of access, the lightweight and flexible nature of Rope Access provides many advantages, as noted below:

- Ease of access – Fast and easy access to structures with minimal equipment requirements;
- Speed of setting up and vacating sites – Rope Access systems can be set up and dismantled quickly, maximizing production, while accommodating project constraints;
- Minimal disruption to adjacent work areas and building operations – Access to structures is independent of site conditions, such as nearby excavations, adjacent buildings, alleyways, train tracks, bridges, bodies of water, etc;
- Flexibility and versatility – Because of the speed and flexibility of this system, project mobilization and demobilization is minimized, thus reducing costs and lead times;

- Security – Most equipment can be removed at the end of each day, reducing the potential for unauthorized access, theft, or vandalism;
- “Hands on” – Rope Access allows close tactile inspections and a more time effective area coverage than other forms of access; and
- Building sensitive – Rope Access has the least visual impact on building structures, and does not damage the building fabric. This is especially valuable when working on historic structures.

Rope Access can be applied to any type of building structure, including mid- to high-rise buildings, historic and ornate buildings, bridges, dams, cliffs, embankments, antennas, masts, chimneys, space frames, and offshore structures. The advantages of this form of access should be evaluated on case by case basis. Due to the history of the Rope Access outside North America, Rope Access is equally weighed in comparison to the traditional forms of access for projects by engineers, architects, contractors, and building owners and managers.

Rope Access Guidelines and Standard Codes of Practice

As the use of Rope Access increased in Europe, companies engaged in Rope Access services, manufacturing, and sales of equipment formed trade organizations and developed guidelines for the use of this technique. The first and most detailed guideline for the use and standardization of this technique was developed and published in the United Kingdom in 1993. A similar movement begun in the United States in 1998 when several companies involved in mountaineering, manufacturing, and equipment sales initiated a trade organization for the Rope Access industry. At the national level, the ASTM International E06 Subcommittee on Rope Access has been preparing the Standard Practice for Industrial Rope Access since 1998. Several drafts of the standard have been reviewed and it will likely be approved in the near future.

Rope Access Personnel and Training

The original Rope Access technicians and personnel were from the sports of mountaineering and caving. As the industry grew, so did the need for training and certification of Rope Access personnel. Tradesmen and professionals were trained in the Rope Access technique to be able to apply their skills at heights more efficiently.

The United Kingdom Rope Access trade association guidelines provide three levels of qualifications for Rope-Access-trained personnel. The qualifications are attained through formal training, experience, and knowledge in the field of Rope Access. The lowest (or the entry level) is Level 1, and the most experienced level is Level 3. During training, there are two instructors to a maximum recommended number of six students per class. The duration of a basic training course (Level 1) is five days and is directed by Level 3 Rope-Access-training personnel. Training includes two days of class work and three days of practice and familiarization with Rope Access equipment and techniques and an examination.

All personnel involved in Rope Access must have the appropriate attitude as well as physical aptitude for such work. They must be physically fit and free from any disability that may prevent them from working safely at heights.

On project sites, a minimum of two Rope Access technicians is required as a safety requirement. Depending on the scope of each project, the recommended number of Rope Access technicians is increased as required. Each qualified person is required to maintain a personal record of the hours and the nature of the Rope Access work carried out. Reassessment of Rope Access personnel is required every three years.

Rope Access Safety Record

The United Kingdom Rope Access trade association maintains the most widely available and documented record for use of Rope Access in the inspection, maintenance, and repair of structures. The available records from 1989 to 1999 indicates that nearly 6,000,000 man hours of work were performed using Rope Access, with a total of 266 incidents. From the total reported incidents, 1 was a major accident, and 25 were reportable under the Reporting of Injuries, Diseases, and Dangerous Occurrences Regulations 1995 (RIDDOR, Approved Code of Practice for the Safe Use of Work Equipment in the United Kingdom). The total rate of the incidents over a period of 11 years in the use of Rope Access is thus 4.6 incidents per 100,000 man hours of work, which is very low. Most of the incidents were minor, none were due to Rope Access techniques, and the majorities were due to falling objects, handling of tools, or blown debris.

Rope Access Case Studies

With a growing awareness and interest, Rope Access techniques are gaining acceptance in the construction industry in the United State and becoming an integral part of any inspection, maintenance, or repair project, joining the ranks of the most traditional means of access, such as boom truck, man lift, swing staging, aerial platform, and scaffolding. Below are some sample projects that highlight the various advantages of Rope Access.

Case Study 1 - Inspection

The scope of work was to perform a detailed condition assessment of the various steep roofs of a historic building with complex geometries, 80-m above the street level. Conventional means of access such as pipe staging would have made the investigation cost prohibitive. Rope Access provided the engineers (Figure 2) ease of access, as well as an economical, flexible, and versatile, hands-on evaluation of the roof structure.

Figure 2 - *Case Study 1*

Figure 3 - *Case Study 2*

Case Study 2 - Inspection

The project budget and requirements imposed a preliminary condition assessment of the exterior facade of an historic building occupying an entire city block, with a 110-m tall bell tower, in a short duration. The Rope Access solution allowed engineers to inspect about 20% of the building facade hands-on (Figure 3) in a period of three days. Using conventional means of access would have taken considerably longer at greater expense, and access to the bell tower would not have been practical.

Case Study 3 – Inspection

Rope Access facilitated a successful hands-on inspection (Figure 4) of defects on the exterior facade of a 185-m tall building. Existing house rigs were not operational, and the mast-climbing scaffolding, installed for the facade repairs, could not be operated due to a city-wide ban on the use of these platforms. Rope Access was also used to perform weld inspections on the radio antenna above the same building, 265-m above the ground, and perform the interior inspection of the 185-m chimney liner in the building. The antenna and chimney inspections were performed over a weekend to minimize down time to the radio antenna and the building's heating system.

Figure 4 – *Case Study 3*

Case Study 4 – Maintenance and Emergency Stabilization


Figure 5 – *Case Study 4*

Initially, hands-on inspection of the exterior facade of a 12-story tall, ornamental and historic building occupying an entire city block was completed in four days utilizing Rope Access. Deteriorated conditions of the exterior facade and potential vibration damage from the adjoining construction activity made the need for emergency stabilization of the facade a necessity. Excavation at two sides of the building, a deep wood-framed cornice and lack of proper tie-backs prevented the use of scaffolding, boom truck, or lifts for the repairs. Rope Access technicians implemented the engineers' emergency stabilization and temporary repairs (Figure 5) (removing loose debris, stitching, netting, and banding displaced and cracked masonry) economically and efficiently.

Case Study 5 - Maintenance and Emergency Stabilization

The building, located in an historic section of the city, is five stories and about 25-m tall with a mansard roof. The exterior walls are load-bearing masonry faced on the exterior with brownstone and brick. During a condition survey of the exterior building envelope, engineers identified loose and incipient spalls in the brownstone on the two street elevations and to the rear of the building. Under direction of the engineers, Rope Access technicians performed a hands-on inspection and removed loose and incipient spalls (Figure 6). Pedestrian protection and debris nets were installed along the street elevations, and the technicians installed debris net over a neighboring roof to protect it from potential falling hazards during the scope of work.


Figure 6 – *Case Study 5*

Case Study 6 - Repair

Rope Access technicians assisted the engineers with a condition assessment of the exterior facade of a museum over a period of four days. The condition assessment of the facade identified loose stone modillions below the vertical joint of the cornice. Because of the manicured grounds, safety, security and visual concerns, the client was adamant that technicians minimize the impact of the emergency repair activities on the museum.

Rope Access technicians removed loose modillions, and the balance of the modillions were anchored to the backup and load tested (Figure 7).

Figure 7 – *Case Study 6*

Figure 8 – *Case Study 7*

Case Study 7 – Repair

The scope of work on a 12-m high sea wall was removal of existing brick masonry repairs and replacement with matching brownstone block (Figure 8). The Rope Access technicians contended with changes in tides of up to 11-m (most of the work site was underwater at high tide), and using Rope Access techniques, the technicians had the ability to work with the rising and falling of the tide, quickly moving from lower to higher locations, and resuming work. All equipment and materials had to be removed from the site and contained in secure storage between shifts.

Conclusions

In comparison to the traditional means of access, the advantages offered by Rope Access can make this technique an attractive and viable option for structural and facade inspection, maintenance, and repairs. Outside of the United States, Rope Access has been accepted as an alternative means of access, with an exemplary safety record, meeting the highest level of safety requirements and standards of the regulatory bodies. In the United States, it is only a matter of time for the construction industry to learn, appreciate, and take advantage of Rope Access.