Industrial rope access techniques applied to an unusual modern building with steel and glass curtainwall. Helmut Jahn's Thompson Center in Chicago, Illinois.

Industrial RopeAccess for Structural Inspection, Testing and Condition Surveys

By: Kent Diebolt and James V. Banta

Structural engineers and architects are frequently asked to render opinions on the conditions of building facades and other structures, but may not be allowed a budget that permits hands-on inspection using traditional means of access such as pipe staging, suspended scaffolding or aerial lifts. Relying purely on visual condition assessments made from a distance often results in a high degree of uncertainty during the design and construction phases of a restoration project, leading to construction change orders and cost over-runs.

Hands-on visual inspection of stone masonry at Cleveland Tower, Princeton University, Princeton, New Jersey.

Structure size and configuration, as well as surrounding landscape and streetscape conditions, may prohibit the use of conventional approaches for inspection access. Other areas that pose access challenges are pitched roofs, spires, domes, steeples, high parapet walls, and towers where the cost for scaffolding may prevent getting "hands-on" during the pre-construction or investigation phase of a project.

"Industrial Rope Access" (IRA) is one solution to this problem. IRA utilizes lightweight, highly adaptable rigging systems to position workers in hard-to-reach locations in vertical environments to gather data essential to structural engineers. This field of expertise was developed from techniques used in rock climbing and caving, as well as search and rescue operations that utilize specialized rope skills.

Why is Industrial RopeAccess useful to Structural Engineers?

The structural engineer needs to determine the investigation program and the data required. The IRA technicians are the key component in obtaining that information, because the careful and systematic reporting of existing conditions ensures that informed decisions are made in maintenance plans, design documents, and repair campaigns. Industrial Rope Access techniques provide an efficient and safe means to this end. With IRA professionals integrated into the initial survey team, structural engineers are able to present fully-developed scopes of work to clients, building owners, and contractors. The result is greater project cohesion with enhanced mutual expectations fulfilled amongst team members.

IRA techniques have been used for inspection of building facades and civil structures such as dams and bridges. Because of its comparative low cost, the IRA approach is particularly useful for conducting mandatory periodic inspections of building facades and bridges, allowing engineering professionals a more complete understanding of the rate of structural deterioration, and allowing for development of more comprehensive maintenance plans and design and construction documents. Reduced access costs, combined with increased certainty in project diagnostic and design phases, are proving to be a powerful combination for design professionals.

How does Industrial RopeAccess work?

IRA systems are inherently redundant, relying on two independent ropes on which technicians are suspended in industry-specific climbing and suspension harnesses. One rope is termed the "working line" and the second "fall protection" line is used as backup. Technicians typically tie off ropes to structural members at the roof, tower, or attic level and descend on the two fixed lines to perform an investigation. With safety factors often as great as 15:1, IRA rigging is extremely secure.

Hands-off descent control devices are integrated into site-specific rigging systems in the industrial rope access worksite. These devices are designed to stop the descent if a worker lets go of the device, a key feature for both safety and convenience.

IRA techniques are the means for gaining access, and technicians employ various methods for providing documentation of conditions. These include hand written notes in combination with supporting photographs or video clips, as well as live video feeds to a viewing monitor where the structural engineer can communicate with the technician and discuss the structure features. Some IRA specialists carry computer tablets or PDAs

Water infiltration and exiting conditions study at the Chrysler Building, New York City.

When does IRA come into a project?

IRA services are invaluable on projects where access would not be gained until a contractor has been selected and scaffolding has been erected. Integration of these techniques into the design process at the beginning of a project provides practical information and up-close observation of existing conditions that can be incorporated into bid documents. Thorough documentation and quantification of conditions at the investigation stage reduces uncertainty during construction.

Keeping the investigation within the purview of the design team, rather than opening it to construction contractors, allows more objective documentation of existing conditions. As such, the company providing the investigation retains an unbiased point of view, free of inevitable conflicts of interest with regard to future maintenance, repair or restoration contracts.

Mandatory periodic building façade inspections in many major cities in the U.S. such as New York, Boston, and Chicago are driven by life-safety concerns. IRA techniques satisfy these inspection requirements while providing a relatively unobtrusive and rapid solution to evaluating large areas of a building. There is currently a standard for façade inspections being developed by the American Society for Testing and Materials (ASTM E 2270-03, *Standard Practice for Periodic Inspection of Building Façades for Unsafe Conditions*). Other entities developing standards are ANSI (American National Standards Institute) and ISO (International Organization for Standardization). As this trend towards compliance with standardized building façade ordinances continues, IRA will help reduce the financial burden on building owners and increase compliance with these ordinances.

What are the abilities and limitations of IRA?

Unlike typical swing stage scaffolding, Industrial Rope Access minimizes physical impact or intrusion on the building fabric or structure. Due to the mobility and flexibility of light-weight rigging systems, these techniques can also increase the sample size and frequency of observations when compared to swing stage set up and inspection time.

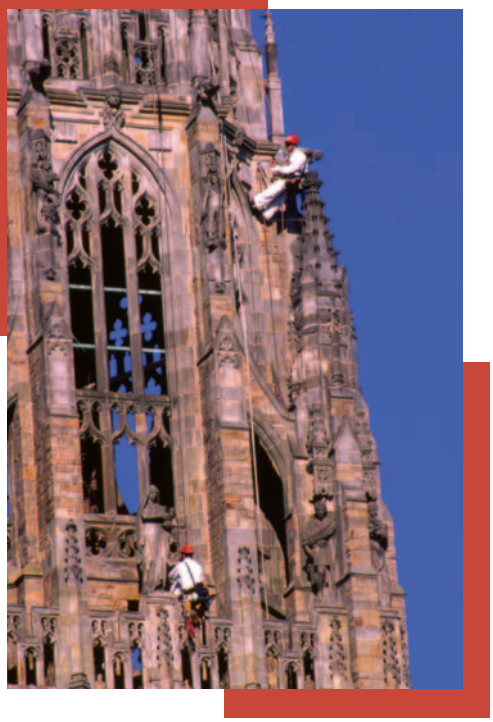
and can enter notes directly to digital media, making the transfer of data and the development of CAD documents more efficient and accurate.

What sort of structures might these techniques be used on?

While the majority of the Industrial Rope Access professionals worldwide are focused on the offshore oil industry, there is increasing demand for this expertise with regard to buildings, monuments, and civil structures. In the United States and Great Britain, IRA has been used for the inspection and testing of a variety of religious, educational, government, commercial and civil structures as well as monuments and sculptures, representing a wide range of historic and modern building materials. Any structures difficult to access by conventional means such as aerial lifts, pipe scaffolding, or hanging scaffolds are excellent candidates for Industrial Rope Access techniques.

Hands-on inspection of two monumental historic structures on lower Broadway in Manhattan.

Sometimes IRA may be used in combination with conventional means of access to provide a specialized method for completing the survey of a structure in those hard-to-reach areas. IRA used along with nondestructive testing techniques as well as invasive probes



Undertaking a "stone-by-stone" conditions survey at Harkness Tower, Yale University, Hew Haven, Connecticut.

can be very effective for an engineer's survey of an existing structure. (*See sidebars on Capabilities, Pros and Cons of IRA*)

How do you plan an investigation?

As in all conditions surveys, it is up to the design professional to determine the necessary extent of investigation and testing. A prioritized approach that takes advantage of IRA techniques in the most critical (i.e. potentially hazardous), difficult, and inaccessible locations of a building or structure is best.

Public safety is of utmost importance when incorporating Industrial Rope Access into a project. To ensure safety for all parties it may be necessary to close streets, sidewalks, entrances, or public spaces surrounding a building. Team members should develop a public safety plan prior to beginning the site work.

History of Industrial RopeAccess

Beginning in the 1980s, mainly in France and England, a new approach to accessing a variety of vertical structures began to emerge. This approach, now known as Industrial Rope Access, allows trained technicians safe and ready access to a variety of "extreme" work sites. Industrial Rope Access is practiced world-wide. In the dozen or so years since records have been kept on millions of person-days of site work, Industrial Rope Access has a near-perfect safety record. To date, the rope access trades have maintained an excellent safety record, with 7,500,000 hours expended with zero lost time incidents or accidents working on ropes *(McCurley, L., Safe, Practical, Professional Rope Access, Occupational Health and Safety).*

Although international standards exist, Industrial Rope Access in the U.S. is evolving towards certification standards. Currently, OSHA (Occupational Safety and Health Association) regulations address the specific use of rope access techniques only peripherally.

The organizations active in establishing consensus-driven, professional standards for Industrial Rope Access are SPRAT (Society of Professional Rope Access Technicians) and IRATA (Industrial Rope Access Trade Association). SPRAT is a U.S.-based trade organization that is in the process of creating standardized safe practices and certification for rope access personnel. IRATA is the organization involved in safety, training, and certification in the U.K. and Europe.

Conclusion

Uncertainty is minimized when all building conditions are well understood. Cost estimates, quantification of materials, design of repair details, and accuracy of technical specifications are improved with a thorough condition assessment. Industrial Rope Access techniques offer an efficient and cost-effective means of accessing buildings and other structures for doing periodic or pre-construction surveys. These techniques minimize disruption to building occupants while reducing the physical impact to a structure.

Industrial Rope Access utilizes lightweight rigging systems to allow for efficient and safe "hands-on" access to areas where scaffolds and swing-stages may be difficult to use, potentially damaging to the structure, or prohibitively expensive. IRA is different than the common perception of controlled descent in that Industrial Rope Access is a total plan of work. When correctly planned and executed, IRA incorporates job safety analysis, an access permit, and specially trained and certified personnel.

The goal of gathering and sharing information on existing conditions is at the core of Industrial Rope Access as applied to buildings, monuments and civil structures. IRA techniques are a means to this end and the ultimate service provided is the collection, management, presentation, and sharing of condition survey data with the triumvirate of design team, owner, and construction contractor.■

Specific capabilities or methods of investigation used in Industrial Rope Access work include:

- *Borescope and fiber-optic investigation*
- *Carbonation testing*
- *Close visual, "tactile" inspections*
- *Confined space observation*
- *Core, mortar and other materials sampling*
- *Crack/fault mapping*
- *Crack gauge and transducer installation*
- *Determination of line, level and plumb*
- *Hammer sounding*
- *Interactive, live-feed video*
- *Nondestructive testing including ultrasonic thickness gauging, x-ray, radar, impact echo*
- *Photo and video documentation*
- *Wall tie population survey (metal detection)*
- *Wall cavity inspection with limited probes and repairs*
- *Water/flood testing*

"Pros" of Industrial Rope Access:

- *Rapid deployment and relocation at inspection "drop" locations*
- *Flexible and highly adaptable rigging systems*
- *Building-friendly approach*
- *Exemplary safety record*
- *Minimal disruption to building operations*
- *Permits intimate contact with building conditions*

"Cons" of Industrial Rope Access:

- *Physical limitations of working on ropes*
- *Horizontal movement can be problematic*
- *Limited to small swath of inspection area*
- *Micro- vs. macro-view (i.e. sometimes investigation is conducted too close to the structure to see overall patterns or conditions)*

Kent Diebolt is President and founder of Vertical Access, LLC, Ithaca, NY.
James V. Banta is an architectural conservator and inspection technician with Vertical Access, LLC.

A bibliography for this article is available online at **www.structuremag.org**