Ten questions to ask yourself when beginning work on your next steel-framed retrofit project.

steelwise

OLD BONES

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THE U.S. HAS ALWAYS BEEN the land of opportunity. But in many cases, those opportunities manifest not when looking forward but rather back—especially when it comes to the built environment.

Scattered across the country, often in larger urban centers, are numerous historic abandoned buildings that have outlived their original intended purpose but are located in very desirable areas. Fortunately, beneath the façade of crumbling masonry and plaster lies, more often than not, a rigid skeleton of structural steel. Why does that matter? Because steel maintains its strength and usefulness well beyond the life of other materials, regardless of the finishes, offering easier—and more attractive—renovation opportunities. Where a historic concrete-framed building might need to be demolished in its entirety, a steel-framed building can typically be saved, with members being replaced or reinforced on an as-needed basis.

Not only does renovation preserve history, but it also provides a more sustainable outcome. According to Carl Elefante, director of sustainable design at Quinn Evans Architects, the greenest building is the one that is already built.

If you're going to renovate a historic steel-framed structure, you need to know what you're dealing with. Here are ten questions to ask in order to help you evaluate the existing framing in your next retrofit job:

1. When was the building built? Knowing when the original building was built will help you identify historical records as well as steel production, design and fabrication practices of the time. Consider that in the early 20th century, steel mills such as Carnegie Steel Company, Jones & Laughlin Steel Company and Inland Steel Company all produced proprietary structural shapes, meaning that each mill had its own unique catalog of different shapes. Also note that over the past century, the base yield strength of structural steel shapes has varied from 30 ksi to 50 ksi (and today, even higher). A good source for historical information on structural steel is AISC Design Guide 15: *AISC Rehabilitation and Retrofit Guide A Reference for Historic Shapes and Specifications* (available at **www.aisc.org/dg**; a recent update contains a new chapter of examples for evaluating existing steel). Many other historical resources are also available to AISC members, including past AISC manuals, specifications, out-of-date publications and pre-AISC publications from structural steel producers. Visit **www.aisc.org/publications** to find out more.

2. Are existing drawings available? The original construction drawings, when available, are the best source of information concerning a structure's steel framing system, and many industrial building owners have maintained such records and drawings; community-owned building drawings are usually retained by the municipality.

Another source of valuable information is the original shop and erection drawings. In many cases, especially for abandoned utility and industrial buildings, these drawings are readily available and will provide you with not only the sizes of the existing members but also the configurations of the end connections.

If existing drawings are not available, it may be necessary to produce as-built drawings of the existing structure. This will require extensive field measuring of the structure, includ-

▲ Many historic structures originally used rivets for resisting connection loads.

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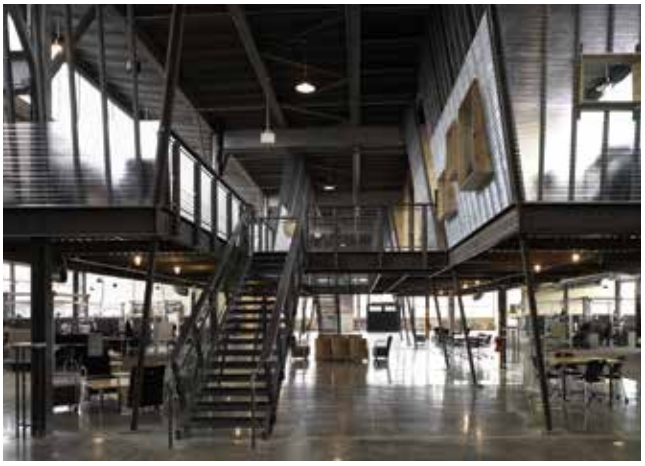
Laser scanning was used for New York's Fulton Center, which incorporated the historical landmark Corbin Building. (The project was featured in last month's IDEAS^2 Awards coverage.)



A structural renovation project in Des Moines, the new headquarters for Two Rivers Marketing Group, incorporated a new steel-framed mezzanine within the existing walls of a former GM warehouse. (See "Second Chance" in the February 2007 issue.)

ing the bay size measurements and beam and column locations. Dimensions of the actual beams and columns will also need to be determined, then compared to historical data to determine shape properties (I_x, S_x, etc.) The as-built drawings can then be produced from this information before beginning any structural renovation.

3. What are current site conditions? Visiting the building site is important for obtaining any additional information regarding the structure's condition. Make sure that the original structural steel framing is visible for inspection. Has corrosion affected the structure? Have alterations been made beyond the original construction? Are end connections riveted, welded or bolted? What is the accessibility to the interior and exterior of the structure for renovation?

4. Is asbestos or lead paint present? Asbestos was commonly used for insulating structures between 1930 and 1950 but was banned in 1973. As such, all "Presumed Asbestos Containing Material" must be investigated. All friable asbestos that will be disturbed during renovation or remain in the structure must be abated by a licensed asbestos abatement company or sealed to prevent fibers from becoming airborne.

It was also common for historic structures to use lead paint. If paint is present on the steel and the structure was built prior to 1978, then the paint will more than likely contain lead. The lead paint should be abated in the areas where welding, burning or grinding will take place, and air monitoring must also take place during welding as an extra precaution. Even if lead is removed from the direct surfaces where welding is to take place, adjacent areas may become heated and emit lead-borne fumes. These include areas like the back of a beam flange or a beam web adjacent to the welded surface. Using proper respirators, workers can drill on lead-painted surfaces with no adverse effects.

5. Were standard shapes used for the structural members? Standard structural shapes have been produced ever since the early 20th century, but there was not always a wide availability of shapes with the required strength and configuration. For example, during World War II, structural steel shapes were in short supply for buildings, so it is not uncommon to find channels, plates and tees from that era built up into a custom fabricated structural shape to meet the required loading. Careful evaluation is required when attaching to these built up members. How are the members attached to each other? Are they riveted, welded or bolted? When attaching to these members, be sure to develop your attachment through the entire member and not just to the face of the member.

6. Was the building built per the plans? Having the original construction documents will help tremendously in determining the existing building dimensions, but many times during construction, field alterations are made to account for original fabrication or design issues and/or site conditions. In addition, there are always fabrication and erection tolerances that can cause the dimensions to vary from the construction documents. Today, laser scanning of the structure can be used to confirm the actual as-built dimensions of the building. Laser scanning produces a point cloud where each surface that the laser encounters becomes a point. Dimensions to each beam and column can be obtained quickly and accurately through laser scanning. Care must be taken to interpret the points plotted from the laser scan on the existing members to match the actual structural shape producing the points. The existing members may consist of built-up shapes as opposed to standard rolled shapes. This will require a physical measurement and inspection of the nonstandard structural shape that the laser encountered. A knowledge of when the building was constructed will help when producing a plot of the laser scan. In lieu of laser scanning, spot checking existing floor critical dimensions by surveying can help to confirm the as-built conditions (see question 2).

7. What is the strength of the existing connections? Before attaching to existing members, be sure to investigate the member and connection capacities. One common retrofit trend is converting abandoned industrial structures into residential

▲▼ The former Ottawa Power Station in Lansing, Mich., was reborn as the headquarters for Accident Fund Insurance Company of America. (See "An Inside Job" in the December 2010 issue.)

▲ Exposed, historic steel—including rivets—at AISC's headquarters at One Prudential Plaza in Chicago.

structures. Industrial structures were (and are) designed to resist very heavy loads, so there may be reserve capacity in these connections.

Also, many historic structures used rivets to resist connection loads, and AISC Design Guide 15 lists historic shear values for rivets. The method for analyzing a riveted connection is very similar to the present method used for designing bolted connections. Limit states, such as bearing and shear rupture, for all of the angles and plates used as connecting material are the same for riveted and bolted connections. Another possible source of information on riveted connection design is historic design manuals, which may contain examples and tables showing connection design practices for that time period. Be cautious when evaluating riveted connections based upon the strength and diameter of the rivet. If there is a concern about the diameter, evaluate it with the assumption that it is one size smaller than what was used.

The structure's past use also needs to be considered. Some industrial structures were used for processes that created a corrosive environment. The condition of the existing rivets and bolts should be examined before relying on them for strength, as the heads and nuts may be corroded. In addition, the areas in the shear zone of the bolt or rivet may not be visible and may be corroded due to past processes or moisture from long-term weather exposure. The condition around the holes may not be conducive to providing the required resistance. Again, watch for corrosion and cracking from past overloading. Welds should be carefully examined for cracking via visual, mag particle or other nondestructive testing means before being relied upon for adequate connection strength.

8. Where will new members be attached? Will there be interference between the new member/connection and the existing connection? Can the existing connection be used as a part of the new connection? You must use an on-site visual evaluation to determine the location of the new member connections, and you should also document the existing connection conditions including the size of the existing members, thickness of the connection material and the configuration and size of the bolts, rivets and welds. Each area where a new member will attach must be photographed, measured and sketched to evaluate the new connection.

9. Is the existing material weldable? A representative sample of the existing steel material should be tested to find the chemical composition for developing a welding process. A sample original steel member that will be removed as part of the renovation can be chemically analyzed to determine weldability. After this analysis, the selected welding process should be performed on a sample and tested to be sure the process will work when welding to the existing structure. If, through testing, the existing material is not deemed weldable, it will be necessary to use bolted connections for field altering the existing structure. This is usually limited to cast members and steel members produced in the early 20th century and late 19th century.

10. Where is dimensional variation accounted for in the new structure? New members should account for dimensional variations in existing members by using slotted double angles or a long-slotted connection plates to provide for adjustment. Often, these slots can be designated for erection bolts, and the final connection may be welded to resist the required loading.

These are some of the major questions to answer when considering a historic renovation project. While such projects are challenging, the end results can be extremely rewarding in terms of preserving the historical feel of a building or area and providing a sustainable path forward for the ever-growing stock of abandoned buildings that have outlived their original purpose. If they're framed in steel, you and they are in luck, as they can be updated for the future while maintaining their original character. ■