American Buildings & Bridges Continue to Age & Deteriorate

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As our nation's buildings and bridges continue to age and deteriorate, contractors are regularly challenged with completing retrofit, painting, abatement and other upgrades, without overloading or damaging the existing structures. With more and more federal, state, and local entities rewriting their specifications to put the structure evaluation and certification responsibility on the contractor, it has resulted in a new set of challenges for an industry not familiar with this complex issue.

Serious risk to worker and structure safety can result from the substantial loads imparted by temporary work platforms and scaffold systems, as well as the extreme wind forces that can develop when an improper containment program has been implemented. Coordination between the engineer designing the temporary access/containment systems, engineer certifying the existing structure, specialty subcontractors, general contractor, and the owner's reviewing representatives, can be a drawn out process fraught with complications. Therefore, a clear understanding of the actual structure condition and its potential vulnerabilities is critical in project planning and execution.

The Certification Challenges:

- Many structures in the United States well over 100 years old, and complete or legible as-built drawings are not commonly available.
- Engineers and/or contractors are forced to perform extensive field surveys to determine framing sizes, and must estimate material properties.
- Current load demands coupled with excessive deterioration has already pushed many of these structures to their limit.
- Many engineers with experience in analysis or design of these structures have no experience in the temporary access and containment design industry.
- Many engineers in the temporary access and scaffold industries do not have experience or willingness to evaluate and certify the permanent structures.
- Older buildings and bridges were regularly constructed with framing built-up out of many small plates, channels, and lattice assemblies; riveted together to form large sections. In comparison to the large solid steel beams and columns used in today's construction, these historic shapes are much more time consuming to evaluate.

In a world of razor thin margins, it is critical that bidders request and evaluate the structure design loads, as-built documentation, levels of deterioration, or reserve capacities, prior to presenting their proposal. State and federal agencies are getting better at outlining these resources and requirements in the bid documents, however, inconsistencies are still commonplace, and can results in tens of thousands of dollars in unexpected design fees, when overlooked.

The Document Impact:

A. When the reserve load rating of the bridge or building is provided in the project specifications, the costs involved in the structure certification is typically minimal.
B. When complete as-built plans and stress sheets are provided, costs can be kept under control, as a complete structural analysis is not always necessary.
C. When complete and detailed as-built plans are available, but no stress sheets are provided, the design costs can be significant as a full structural analysis is often necessary.
D. When no plans are available, the fees to collect complete structure dimensions and details, and ultimately prepare a full structural analysis, can be extremely high.

The following case studies demonstrate many of the challenges discussed so far in this article, and although each experienced different challenges, the common themes exhibited were the following:

- All projects were all completed successfully.
- DHC was involved in both the temporary access/support system design and structure evaluation.
- All parties were proactive in their coordination and planning.

A Historic Challenge

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Case Study – Myrtle Street Water Tank - Enclosure of existing bridges, towers and tanks with netting or shrink-wrap, can often result in these structures being exposed to higher wind forces than they were originally designed to sustain. Therefore, a wind monitoring program and enclosure removal plan is regularly developed to ensure that a critical load limit is never exceeded. For the massive steel water tank located in Seattle, WA, the as-built plans were examined, and a complete 3D computer model of the structure was developed in order to determine at what wind speeds the system could remain enclosed. The time and expense to remove and reinstall enclosure or access systems can be extreme, and therefore a careful evaluation of various wind speeds vs. structure and access solutions is important on many jobs.

Myrtle Street Water Tank (Photo copyright 2012 Google Maps)

Case Study – Golden Gate Bridge Ft. Point Arch -In order to complete the retrofit of this historic structure, a complex scaffold, suspended platform, cable frame, and containment system was erected over the Civil War Fort Below. Approval from the bridge authority was contingent on the contractor proving that no existing framing would be overloaded at any time. Although, surprisingly detailed plans and stress sheets were available, a complete structural analysis of each and every framing member was performed, with many pushed to the design limit. It was careful planning, coordination between all trades, and a professional submittal package, that proved critical in gaining approval for installation.

Wakefield Building

Case Study – Wakefield Building - When this 1920's 5 story reinforced concrete structure was rocked by the 1989 Loma Prieta earthquake, much of its damage remained hidden for many years. It wasn't until significant retrofit work had begun in the basement, that it was discovered that various primary structural support columns were completely shattered. Designing an emergency shoring system capable of supporting all the floors above while columns were cut and replaced at the basement level, required an extensive assessment of the existing structure and careful evaluation of various shoring options. In lieu of a costly custom fabricated steel support system, a dense matrix of relatively light system scaffold was erected. This system was installed on all floor levels, effectively collected the weight of the building and diverted it away from the damaged columns, and allowed the contractor make the cuts and repairs, while using a very cost-effective and locally available resource.

Golden Gate Bridge

A Historic Challenge

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Case Study – Salinas River Bridge - The California Department of Transportation has traditionally required that painting and abatement platforms be designed for a live load of 45 psf, with an additional concentrated load of 1,000 lb. Using historic inspection reports and performing a supplemental structural analysis, it was determined the existing highway bridge could not support the proposed 45 psf required by the state. Therefore, close coordination with contractor and DOT was necessary in order to develop detailed construction procedures and load monitoring program to ensure loading stayed within the bridge's reserve capacity. In this specific case, the DOT allowed for a load rating of less than that outlined in the specifications, however, this variance has not been consistently approved on all bridges.

Salinas River Bridge

Looking Forward:

With proactive planning, a clear understanding of project documents, and the involvement of experienced professionals, even projects with the most sensitive of structures can be repaired/painted successfully and under budget. It is my hope that through education, clear specifications, and an expanded industry awareness, contractors will not be hit with unexpected delays and design costs on such a regular basis.

D. H. Charles Engineering, Inc. has been in the shoring, scaffold, and temporary structure's design industry for over 20 years, and has developed complex and simple solutions for buildings and bridges throughout the United States and Canada. Our ability to evaluate and certify the existing structure while simultaneously developing and designing a wide array of access, containment, and shoring systems, has given our customers the confidence to pursue these jobs without reservation. www.charlesengineering.com.

SSFI Technical Bulletin

Use of Scaffolds as Fall Arrest Anchorages

The Scaffolding, Shoring and Forming Institute (SSFI) is an industry association comprising designers and manufacturers of scaffolding, shoring, and forming products. For many years, members of SSFI have been familiar with, and have been very active in, the engineering and standards development work associated with fall protection equipment.

SSFI members are aware of the increased use of scaffolds as fall arrest anchorages. The members recognize that scaffold erectors and users are being required to use Personal Fall Arrest Systems (PFAS) in some jurisdictions. Scaffold components may seem to be a convenient anchorage, and in many situations scaffold components are the only readily available components for use as a fall arrest anchorage; however, many scaffold systems and components were not designed or manufactured specifically to withstand fall arrest forces. These forces are quite substantial, and personal fall arrest systems impose dynamic loads on anchorages. SSFI cautions users and erectors that not all scaffold components and systems are designed for the purpose of providing an adequate fall arrest anchorage.

Personal Fall Arrest Systems (PFAS) should, if possible, be attached to a permanent structure. If a permanent structure is not available, the scaffold component may be used as a PFAS anchorage PROVIDED the manufacturer has determined such use to be feasible and safe through design and testing. In this case, it is essential that the manufacturer's instructions are followed exactly.

Design and testing of scaffold components used as a PFAS anchorage must comply with the fall arrest standards that apply in the jurisdiction in which the scaffold is being used.

This Technical Bulletin was prepared by members of the SSFI Scaffolding Section. SSFI is a trade association comprising manufacturers of scaffolding, shoring, forming, and suspended scaffolding. The institute focuses on engineering and safety aspects of scope products.

This bulletin does not purport to be all-inclusive nor to supplant or replace other additional safety and precautionary measures to cover usual or unusual conditions. If this bulletin conflicts in any way with a state, local, federal or other government statute or regulation, said statute or regulation shall supersede this bulletin and it shall be the responsibility of each user to comply therewith. This bulletin has been developed as an aid to users of scaffolding equipment.

June 2003, Revised February 2014 This Bulletin is reviewed periodically. Check www.ssfi.org for the latest version.

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