Introducing SEI/ASCE 37-02 Design Loads on Structures during Construction

What the engineering professional should know...

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Are more structures failing during construction, or does it just seem like there are? What, if anything, is being or could be done to reverse this trend? Whose problem is it? How does the recently issued ***SEI/ASCE Standard 37-02, "Design Loads on Structures During Construction"*** *fit into this issue, and what future efforts should be made? It is hoped that this article will initiate a wider dialog in the structural engineering community about design engineers and their role in designing structures for loads encountered during the construction period.*

Origin of SEI/ASCE 37-02

It had long been recognized that there was a "hole" in the structural design-construction process. There have been no standardized definitions of loads that should be used in the design and/or checking of structures during their construction phases. The new standard, *SEI/ASCE 37-02, Design Loads on Structures During Construction* is intended to plug that hole.

Current design codes and standards are mostly silent on the subject of construction loads, or give such general statements as "Proper provisions shall be made for stresses . . . during erection . . . of the building" and "Adequate temporary bracing shall be provided to resist wind loading . . . during the erection and construction phases." The questions, of course, are: what is adequate and what are proper provisions? The answers often depend on who gives them: the designer, the contractor, the owner, or the building official.

The development of ***SEI/ASCE 37*** was preceded by a survey of several structural design and construction related organizations and practicing engineers. All participants endorsed the idea of developing guidelines or a consensus standard for design loads on structures during construction.

The group recognized that a set of standardized construction loads could contribute substantially to the mitigation of construction failures (*See Figure 1*). It would call attention to the need for serious design for the construction process, and would specify reasonable guidance on the magnitudes of expected construction loads. It would provide a common "language" just as other codes and standards do for completed structures during their service lives.

In October 1987, ASCE's Board of Directors approved the development of a new ASCE Standard for *Design Loads on Structures During Construction*. A committee of ninety-six people, representing a cross section of industry professionals and stakeholders, was formed and organized into six subcommittees: Purpose and Scope, Loads and Load Combinations, Dead and Live Loads, Construction Loads, Lateral Earth Pressures, and Environmental Loads.

After fourteen years of thoughtful development and debate, observing ANSI rules and procedures that included public balloting, the document was published in early 2002 as ***SEI/ASCE 37-02***. Now we have industry-wide guidance on design loads for temporary structures and permanent structures during their construction phases.

The intent is that *"The design loads shall provide for a level of safety of partially completed structures, and temporary structures used in construction, that is comparable to the level of safety of completed structures."* The Standard's provisions, however, are not intended to account for loads caused by gross negligence and error.

While specifying the design loads for temporary constructions, the Standard does not specify who is responsible for the design. Roles and responsibilities during the design-construction process are defined by state laws and the contracts effective among the involved parties.

Like the standards for permanent construction, this standard is applicable to both Design-Bid-Build (DBB) and Design-Build (DB) project delivery. In the DBB method, the way in which the standard is used is expected to vary according to the requirements of the authority having jurisdiction. Considering that the SER in a DBB arrangement can only postulate means and methods without the benefit of controlling them during construction, the standard does not at first appear to be a useful addition to the SER toolbox. This raises the question; what does the standard mean to them?

What the practicing SER should know about the standard…

The use of ***SEI/ASCE 37*** as an extension to the widely-used SEI/ASCE 7, *Minimum Design Loads for Buildings and Other Structures*, is meant to enhance the SER's ability to evaluate structural issues which occur during the construction phase.

Figure 1 SEI/ASCE 37 is a new tool to aid engineers avoid failures such as this. (Photo courtesy of Wiss, Janney, Elstner Assoc.)

The SER should evaluate with the client whether the contract should enforce special structural engineering requirements on the contractor for the construction phase.

When ***SEI/ASCE 37*** is referenced as the design load specification, there is substantial reduction in the potential for misunderstanding as to magnitudes of the loads accounted for during the various phases of the construction.

Since this is a new standard, intended to apply to a broad user base, it is clear that some specific sections of the standard may deviate from current practice (e.g., practice as expressed in Section 2.3.3 Overturning and Sliding and Section-6.5 Earthquake). These provisions should be reviewed carefully and may warrant specific comment in the contract documents.

What Is SEI/ASCE 37?

Scope

"This standard addresses partially completed structures and temporary structures used during construction."

Purpose

"To provide minimum design load requirements during construction for buildings and other structures."

Objective

To establish design loads, load combinations and safety factors to be used in the analysis and design of structures during transient stages of construction, as well as temporary structures used in construction operations.

What Is New?

"The construction loads, load combinations and load factors herein account for the often short duration of loading, and for the variability of temporary loads."

Level of Safety

"The design loads shall provide for a level of safety of partially completed structures, and temporary structures used in construction, that is comparable to the level of safety of completed structures."

Design Responsibility

"The standard does not specify who the responsible party is for the design of temporary structures or temporary supports or for the temporary use of incomplete structures."

Alternate Standards

"When a construction loading is covered in a document, acceptable to the authority having jurisdiction, written to address a specific material or method of construction, the more applicable document shall be permitted to be followed."

Who is responsible to evaluate the structure during its construction life?

The document is a load standard, not a design standard that defines analysis methods or other structural design tasks. How an engineer uses the loads or evaluates strength and stability is a matter of her/his professional practice.

In the DBB arrangement, the SER and the client should discuss whether explicit analysis during the construction phase of the structure is to be the SER's concern or if it is to be left to the contractor.

If the SER must perform the evaluation, ***SEI/ASCE 37*** will be helpful in the development of the base case construction scheme. This scheme will illustrate how ***SEI/ASCE 37*** was used in the evaluation, a process that is analogous to final design plans developed based on traditional load standards.

Two realities need to be considered: first, the SER in a Design-Bid-Build arrangement will not have complete knowledge of means and methods and, secondly, the freedom to innovate is integral to the competitive bid process. Considering these, it is certain that the base design will not be all inclusive and will likely change. However, it is not a wasted effort to consider such a base design, since its existence will provide a clear benchmark to better define the scope of the project to be bid, as well as facilitate the management of contractor innovation.

The base design can include engineering evaluations of the erection sequence for stress or stability concerns; structural design of construction means and methods, such as excavation support and access scaffolding; and structural evaluation of special loadings, such as stacked materials or special equipment that may impose loads in excess of the service-life design during construction.

The outcome of this discussion with the client may be that there are no special concerns, there are concerns that can be addressed on the documents or there are concerns that the SER should address.

Benefits of Standardized Construction Loads
- A Constructors View Point

Standardization provides a "common language for construction phase loads, this should cut confusion

Does use of ASCE 37-02 require modification to DBB specifications and drawings? What goes in the specifications? What goes on the drawings?

Modifications to the drawings and specifications will be dependent upon whether the local jurisdiction explicitly considers the construction life of the structure.

If the owner does not wish to explicitly analyze the construction phase, then it is anticipated that the specifications would need to clarify for the bidder what, if any, engineering needs to be considered in the bid, and to define the mechanism to review the engineering performed by the Contractors Structural Engineer (CSE) during construction.

Standardized construction loads offer an opportunity to improve practice.
- A Constructors View Point

It is in the Owner's best interest for the SER to create a design that considers a structures construction phase.

This will reduce the incidence of failures by placing the level of safety during construction at par with that of the rest of the structures life cycle.

SEI/ASCE 37 facilitates these check and balance mechanisms with a standard "language" for loads, providing the transparency needed to confirm that things are on the right track and providing a benchmark for evaluating alternate means and methods. Definition of design loads should not stifle innovation in construction.

It is expected that ASCE 37-02 loads and load combinations, when used, will be recorded on the contract drawings within a context. The context is important considering the transient nature of construction. As a result depiction of assembly sequences appears to be an effective way of conveying the context of design loads. Also useful would be the identification of load restrictions and seasonal work limitations. As a result, these plans could prove useful in the event of future retrofit, rehabilitation and disassembly.

What does the standard mean to the SER involved with DB project delivery? Or to the CSE working within the context of DBB delivery?

The existence of the load standard means that engineers designing for contractors will have a common "language" for design loads. This benchmark will promote transparency in design level communications between the contractor and the owner's reviewers.

The arrangement of the standard is sensitive to the fact that the nature of engineering for construction is dynamic; as a result it may be best thought of as a "thinking" standard. Loads are provided for situations customary of the construction phase. Commentary is also provided that discuss the context of these loads and issues that could be encountered by the engineer during design.

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Recognizing that many of these issues are to be resolved by reaching a consensus with the authority having jurisdiction, the commentary is provided to form the base needed to develop the design rather than being definitive.

The "Bottom Line"

There was a time in the last century when professional engineers and contractors were one-in-the-same. Projects were brought to completion by a single design/build entity. For decades now, the delivery method has been different. There has been separation between the designers and the builders of major works.

Perhaps this separation has, in part, contributed to construction failures. Under present practice, there can be confusion and misunderstanding between the intent of the SER and the practice of the contractor. There also has been little authoritative load-definition guidance for engineers serving contractors.

SEI/ASCE 37 is intended to be a tool for the collaboration of professionals in DB contracts and for clarity and safety in the construction process in both DB and DBB delivery methods. A component of the successful evolution – and perhaps in general improvement in structural safety during construction – could be a more active participation of the SER in the construction process, either through a direct role or through more comprehensive reviews of construction activities. This potential to efficiently improve safety during construction will be realized if industry professionals avail themselves of new tools, such as this standard, to foster the evolution of engineering and construction practice and safety at all stages of the design, construction, and use of built works.

In recent years, the delivery method has begun an evolution that takes it back toward its prior form. DB contracts are designed to foster efficiency and safety in both the design and construction phases. Such relationships bring together professionals from both arenas; professionals that have had institutional arms-length relationships in recent years.

As with any standard, ***SEI/ASCE 37*** is a living document; it depends on input from its users and those impacted by its use. The authors encourage the reader to take part in the support of this new standard.■

Further Reading

Detailed discussions of the background, purpose and content of the standard can be found in the following series of four papers published in the *Proceedings of the 2003SEI/ASCE Structures Congress*, May 29-31, 2003, Seattle, WA, and in *Forensic Engineering, Proceedings of the Third Congress*, ASCE, October 19-21, 2003, San Diego, CA.

- *SEI/ASCE 37-02 Design Loads on Structures During Construction Standard – Background, Purpose and Scope*, by Robert T. Ratay;
- *Loads and Load Combinations in SEI/ASCE 37-02*, by John F. Duntemann;
- *Construction Loads in SEI/ASCE 37-02*, by John S. Deerkoski;
- *Environmental Loads in SEI/ASCE 37-02*, by Donald O. Dusenberry.

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