Construction Quality Management

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Before construction physically begins, quality in construction depends on the architectural, structural and mechanical, electrical, and plumbing drawings that accurately convey the client's intention to a contractor who is capable of constructing what is required.

When a Mechanical Engineer designs an automobile, an airplane or a toaster, the cost for design will not have to be recovered in one unit. When a Structural Engineer designs a building or an industrial support structure, usually it will be only one of a kind. It has to solve a unique need of a client, based on site and time consideration that will not be duplicated.

When the design involves an automobile, airplane, or a toaster, it will be fabricated or constructed under controlled conditions by people who are probably trained and supervised by the same people who employ the engineer.

In the type of construction that we are involved with, the Structural Engineer usually does not know who will construct the item that was designed, or their ability to understand the plans. In addition, will they be supervised? Will they have access to the engineer on site when conditions change during construction or when something is unclear or missing on the plans?

In many cases, there is a budgeted amount for structural engineering site visits and consultation with the contractor that is negotiated by the Architect with the owner. The Structural Engineer will not be paid for work with the contractor unless it is approved in advance by the Architect. I know this. I have lost work on jobs involving unknown site and existing construction conditions because I would not agree with some of these limitations. I have also witnessed large, difficult-to-resolve lawsuits that have resulted from the contractor proceeding because of a tight schedule, without input from the Structural Engineer to resolve unplanned-for problems.

Construction quality, therefore, depends on many things that may be unforeseen and outside of the control of the engineer during design. However, the following question must also be raised: Does the engineer even want to understand the construction or the application of his or her design to the finished product? Or does the engineer believe that responsibility extends only to the mathematical accuracy of his or her calculations, and that the drawings need only extend to the capacity of the CAD program used to produce them? Without understanding their role in construction quality, engineers will do nothing to assure it.

Technology in all fields of engineering has advanced dramatically in the past two centuries; and it is advancing at an accelerated pace. While building and manufacturing performed in 1800 could be comprehended and performed by ancient Roman engineers, now it depends on scientific discoveries, mathematical developments, new synthetic materials, and precision tools, as well as enormous quantities of available energy that could not be foreseen even a few decades ago.

This increase in the level of technology has created the need for specialization in design based on years of intense education. When the implementation of that design is performed in a controlled environment, such as a manufacturing assembly line, then there is a direct link for quality assurance to take place in the same process.

In our case, however, the "implementation" consists of construction at an outdoor site, which is served by a unique set of utilities, weather, and existing traffic conditions, using material obtained by an independent contractor. The contractor may have never worked with these designers before, and his workforce may consist of individuals of varying experience and education. Then, quality assurance is more complex because it involves the actions of different parties who are not under the control of the design engineer; and then it depends on something more from the designer than specialized knowledge in structural analysis.

In structural engineering, construction quality assurance requires a design based on constructability as well as structural analysis. It also requires the involvement of the Structural Engineer during construction. "Constructability" can be defined as the integration of construction knowledge and experience by the design engineer into the construction of the project.

This is why mandatory Structural Observation site visits and reports by the responsible Structural Engineer are necessary. Structural Observation does not take the place of regular inspection by the applicable governmental jurisdiction, nor of the other special inspection and testing personnel involved in Quality Control. Its purpose is to ensure proper interpretation of the construction documents and to detect and resolve questions of constructability before they become a costly problem.

To summarize, what is necessary for obtaining quality in construction is an understanding of construction and implementation of constructability in design and the involvement of the Structural Engineer at the site during construction. Without both of these, there is no way to prevent or to control questions at the site before they become problems.▪

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