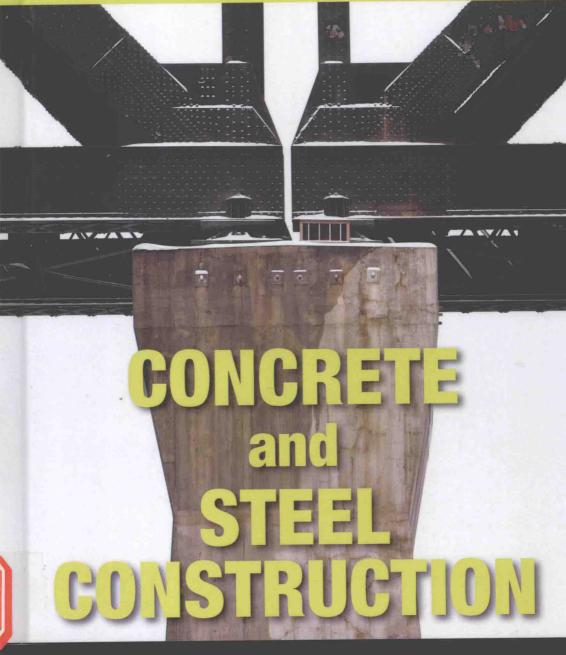
Mohamed A. El-Reedy



Quality Control and Assurance



CONCRETE and STEEL CONSTRUCTION

Quality Control and Assurance

Mohamed A. El-Reedy



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Preface

Nowadays there is huge competition among personnel and among companies as well. The main tools to make gains in the race are being aware and clearly understanding the principles of how to achieve high quality with lower costs. The construction industry in general is growing very fast, and due to globalization any company can gain a contract anywhere.

The aim of the book is to present up-to-date, effective quality techniques that can be used in the construction industry. This book provides practical and theoretical information about total quality management and all the quality tools that can be used during a project's life cycle.

This book can be used as a handbook by quality inspectors, junior and senior design engineers, the construction industry, and concrete and steel construction project management.

Construction quality control is the main way to achieve a competitive edge in the market, so this book is prepared for easy use by civil and structure engineers and any engineer working in project or construction management of concrete and steel projects. This book steers away from complicated statistics terms but a strong theoretical background is helpful for understanding concrete construction quality control criteria.

This book is comprised of eight chapters. The first two chapters provide the total quality management tools that can be applied during construction at any stage of a project—from the client idea to operation and maintenance. The next four chapters cover the principles of quality control for the concrete industry with the practical tests that can be used in fresh and hardened concrete including advanced concrete technology such as self-compacting concrete and high-strength concrete. Chapter 7 focuses on quality control for steel structures by focusing on welding terminology and procedures, and Chapter 8 presents the nondestructive tests for a steel structure and the proper way to achieve the best quality.

Author

Dr. Mohamed A. El-Reedy's background is in structural engineering. His main area of research is reliability of concrete and steel structures. He has provided consulting to engineering companies and oil and gas industries in Egypt, and to international companies including the International Egyptian Oil Company (IEOC) and British Petroleum (BP). He also provides different concrete and steel structure design packages for residential buildings, warehouses, telecommunication towers, and electrical projects with WorleyParsons Egypt. He has participated in liquefied natural gas (LNG) and natural gas liquid (NGL) projects with international engineering firms. Currently, El-Reedy is respon-



sible for project management of green and brownfield projects for onshore concrete structures and offshore steel structure platforms.

Dr. El-Reedy has consulted with and trained executives at many organizations, including the Arabian American Oil Company (ARAMCO), BP, Apache, Abu Dhabi Marine Operating Company (ADMA), the Abu Dhabi National Oil Company, the Kingdom of Saudi Arabia's Interior Ministry, Qatar Telecom, the Egyptian General Petroleum Corporation, Saudi Arabia Basic Industries Corporation (SAPIC), the Kuwait Petroleum Corporation, and Qatar Petrochemical Company (QAPCO). He has taught technical courses worldwide about repair and maintenance for reinforced concrete structures and advanced materials in the concrete industry, especially in the Middle East.

Dr. El-Reedy has written numerous publications and presented many papers at local and international conferences sponsored by the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Concrete Institute, the American Society for Testing and Materials, and the American Petroleum Institute. He has published many research papers in international technical journals and has authored six books about corrosion of steel reinforcement and concrete repair, advanced materials in concrete structure, design and construction for onshore and offshore structures, for onshore and offshore structures, construction management for industrial projects, and the reliability of reinforced concrete structure. He earned his bachelor's degree in 1990, his master's degree in 1995, and his PhD in 2000, all from Cairo University.

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Introduction

The civilization of any country is measured by its construction projects such as bridges, high-rise buildings, and industrial projects. The development of these mega projects means that there were best quality management systems applied for these projects to be successful.

Concrete and steel are the main materials utilized in the construction industry. In ancient Egypt, they used concrete in their buildings and temples. They used crushed stone as an aggregate and clay as an adhesive. The Greeks used concrete in their buildings and called it *santorin tofa* (El-Arian and Atta 1974). The Romans used a material-like concrete called pozzolana.

After that, concrete disappeared for long time but then reappeared in the 18th century. Following are some of the famous scientists who worked with concrete:

- John Smeaton used it to construct Eddystone Lighthouse.
- Joseph Parker patented several cements.
- Odgar created an artificial cement from limestone and clay.
- · Louis Vicat also used cement made from limestone and clay.
- · Joseph Aspdin patented Portland cement.

At the end of 19th century and the beginning of 20th century, there were major changes to the shapes of buildings as architectural engineers and builders changed their point of view. They harkened to the ideas of the European Renaissance of using columns and arches and functional buildings. Concrete was best economical solution for architectural form and function.

Two of the tallest buildings in the world are the Dubai Tower (Figure 1.1) and the famous PETRONAS Twin Towers in Malaysia (Figure 1.2). Imagine how just one centimeter deviation would affect these buildings; *quality* is the secret word to achieving these big project. Indeed the trademarks of quality are the pyramids in Egypt as presented in Figure 1.3, which are more than 7000 years old.

Due to globalization, many contractors and international engineering companies have been founded recently. There is a critical need from clients to ensure that the product and services they receive from these companies are of high quality and these companies need to control the quality of their work for each of their branches worldwide. Therefore, ISO 9000 was established

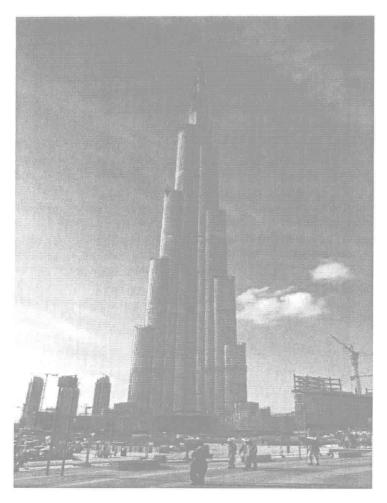


FIGURE 1.1 Dubai Tower.

to guarantee that products or services comply with specifications. This type of quality management system also ensures that companies worldwide are working with the same level of quality. Variations in cultural, social, and economic levels make it difficult to use the same specifications and codes for every country as the loads affect the buildings and the loads depend on the way of life of people and the laws of each country. For example in some countries it is easy to convert residential buildings to commercial buildings, but other countries prohibit this conversion. Moreover, the dead load variations in value depend on the construction quality. Also, the competency of the engineers, supervisors, and laborers is different from country to country, affecting the quality of concrete and steel structures.



FIGURE 1.2 PETRONAS Twin Towers in Malaysia.

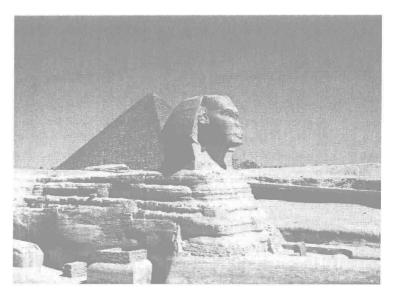


FIGURE 1.3 Pyramids in Egypt.

Therefore the target of the quality for the whole project and the construction onsite is to provide a system of quality assurance and quality control and to have projects match the requirements of the designer and the requested specifications. For example, in the case of a design done by the British Standard (BS), the quality control on site should follow BS, and if the design was done according to American Concrete Institute (ACI) code, the construction quality should comply with ACI. Although the construction crew on site was not involved in engineering design, they should follow the designers' specifications clearly. The main objective of managing the quality on site is to reduce the variation for all the phases of construction from receiving the materials that should be matched with the allowable deviation stated in the specification.

To achieve the complete project management in the construction project in a practical and professional matter, Chapter 2 details the process for auditing the suppliers, contractor, or the engineering firm in addition to presenting the procedure of internal auditing of the company.

The main problem in quality in construction project is the variation on the quality of the concrete itself. Concrete strength is measured by the concrete compressive strength test after 28 days and if you crushed many samples there will be a variation in the strength. In addition the concrete specimen is immersed in water for 28 days. Because this cannot be done for the whole building, we go through the curing process. The traditional way of curing is by spraying water for 7 days, hence the strength of the concrete specimen will be different from the concrete strength in the structure element. In addition, as noted by El-Reedy (2012), there are variations of the location of the concrete. So the target of the quality system as a whole for the project is to ensure that the processes of construction and receiving the materials are within the specification so the variation on strength and the load will be within the allowable limits of the safety factor in design.

The selection of concrete constitutes different materials, and the mixing design should comply with the standard and the technical practice corresponding to the available materials near the project site. It is worth mentioning that sand and aggregate are available in the Middle East, for example, but in some countries the coarse aggregate is rare so recycled concrete is used or the coarse aggregate is imported from nearby countries. However, even within the same country the raw materials from sand to coarse aggregate can vary from one location to another. Therefore the concrete component should comply with the standard specifications before it is used. Therefore, Chapter 3 discusses the concrete materials and different tests that control the quality of the concrete, and also presents the new materials that can be used to enhance the concrete strength and performance and aid the environment (e.g., recycled concrete). The quality control of the modern materials such as HPC, HSC, and SCC will be presented, as well as the required tests of steel reinforcement.

The concrete design mix is different from one code to another and every code has its requirements for calculating the required concrete strength. Chapter 4 presents concrete materials tests as well as onsite quality control tests for fresh concrete.

The main challenge of the project and construction manager is to control the quality during the execution phase. This will be discussed in Chapter 5 by illustrating the methods for receiving the wooden or steel form, and the steel detailing with the curing process in normal and hot climates.

The nondestructive test is performed for the hardened concrete to assure the quality of the concrete structures and in case if there is a debate between the contractors and the consultant engineers in case of a failed concrete compressive strength test after 28 days. All these tests with their advantages and disadvantages will be presented in Chapter 6 in addition to how to select the best method for your case.

The variation in steel structures is less than that in the concrete industry as the steel sections and plates are delivered from the mills under the control of the manufacturer, so the control of quality is very high. However, the quality inspector onsite should receive and accept these materials within the allowable limits of the code. Chapter 7 focuses on the quality control of the construction of the steel structures and explains terminology and precaution to be used during construction. The main problem in steel structure is in either bolted or welded connections. The quality control inspector should be familiar with all types of welding that are used in steel construction and the main issues that should be checked in reviewing and inspecting the welding.

Chapter 8 covers nondestructive tests for the steel structures, such as the visual inspection technique and tools, radiographic test, ultrasonic test, dye penetration, and magnetic penetration test.

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