
QA and QC in the design and construction of second Thane Creek bridge

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With a view to ensure durability in the design and construction of the second Thane Creek bridge, the Public Works Department (PWD) of the Government of Maharashtra sought the assistance of Rendel Palmer and Tritton, U.K., who were appointed as the proof consultant for the project. The proof consultants drafted "Quality Assurance" (QA) and "Quality Control" (QC) systems. The paper describes the QA and QC systems in outline.

In the post-war economic activity in many parts of the world, investment in infrastructure lead to the construction of many outstanding civil engineering projects. These projects included major highway schemes in the western world and in the many newly-formed independent nations, which embarked upon the road to development and industrialisation.

The fast pace of construction coupled with inadequate attention to quality control in design and construction, particularly in connection with durability, resulted in the construction of many engineering structures which were soon to show signs of distress.

The economic slow-down in the west together with a political desire for value engineering, accountability and better management of public assets led the construction professionals to look for quality control systems which hitherto had been associated with complex projects such as the nuclear power installations, oil rigs and the aerospace industry. A formalised documented methodical approach to "Quality Assurance" (QA) and "Quality Control" (QC) in the design and construction of civil engineering works was established.

Need for QA

QA methods have developed over the past 30 years for complex multi-disciplinary projects such as nuclear power

installations, offshore oil rigs and the aerospace industry etc. in which design and construction operations of many groups require very careful co-ordination and checking, and the level of documentation and auditing is very high.

Conventional and relatively simple construction operations such as bridge construction have rarely called for the fully co-ordinated and highly documented QA procedures of the more complex projects. All responsible design, construction and surveillance organisations have their 'in-house' procedures which amount to quality assurance, but normally these do not involve high levels of documentation either internally or between organisations.

Quality assurance has been described as 'common sense written down' and because the size of management teams on most civil engineering projects are relatively small, there is some resistance to extensive, and sometimes, time-consuming documentation of 'the obvious'. Indeed, it is only in the last few years that moves have been made to introduce formalised 'Quality Assurance' into the civil engineering design and construction industry. Appropriate methods and level of documentation are getting established only now.

The main concern of the officials of the Public Works Department (PWD) involved in the construction of the second Thane Creek road bridge was to establish surveillance methods for their supervising team that would reduce the risk of reoccurrence of the corrosion problems as was witnessed in the first Thane Creek bridge constructed in the early seventies. Quality is essentially the responsibility of the contractor who is undertaking the construction and who is in charge of the management of the project.

The PWD supervising team would not attempt project management, but their surveillance, if well organised into a "Quality Plan", would provide quality assurance.

Consistent and comprehensive methods of checking and approval of works are achieved by establishing set step-by-step procedures. These procedures reduce human errors, omissions and differences in approach between individuals.

The main elements of the PWD's "Quality System" comprise:

1. objectives and organisation
2. outline of quality plan
3. drawings and documents
4. survey control
5. temporary works
6. method statements
7. materials
8. workmanship
9. non-compliance procedures
10. application of QA
11. quality audit.

Objectives and organisation

Objectives

It is the policy of the Public Works Department (PWD), Government of Maharashtra, that construction of all public works is carried out to the standards specified to ensure durability and serviceability for the full design life of the structure.

For the second Thane Creek bridge, the objective of the PWD supervising organisation was to ensure that this policy was fulfilled for the construction of the bridge. In order to achieve this objective, the PWD established, and as far as possible, maintained an effective and efficient "Quality System" which was planned and developed to suit the circumstances of this particular project.

Organisation

Site supervision team

The site supervision was headed by the Executive Engineer (EE) and was supported by an Assistant Executive Engineer, Deputy Engineers, Junior Engineers and drawing office and clerical staff. The level of staffing was varied to reflect the changing demands of the project. The EE reported to the Chief Engineer

(Special Projects) who is supported by Superintending Engineer (Construction) and Superintending Engineer (Designs Circle). The job description defining duties and functions for all levels of staff was issued.

Quality assurance manager

The Executive Engineer designated a senior member of staff to act as "Quality Assurance Manager" whose duties included:

1. responsibility for implementation of the "Quality System"
2. continually reviewing the quality procedures
3. instigating revisions where shortcomings existed, or
4. making improvements where appropriate.

Quality audit

A "Quality Audit" team, responsible for regular audits was appointed by the PWD. The audit team's duties included the following:

1. to review the "Quality Assurance Manual"
2. to identify areas not adequately covered by the quality system
3. to carry out checks that the QA procedures are being followed
4. to report findings to the Executive Engineer.

The proof consultants

Rendel Palmer and Tritton, as the proof consultants for the PWD reviewed the design, construction method statements and advised on materials and workmanship standards. During construction, when requested by the PWD, the proof consultants carried out snapshot audits. These included, design and construction related activities and a review of audit records made by the site audit team.

Job descriptions

Descriptions of jobs were issued to PWD staff in relation to supervision of construction as it relates to quality assurance of construction.

The job descriptions for each individual issued by the Executive Engineer included the duties in detail. In the following, a general description of the Executive Engineer's

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duties is given.

The Executive Engineer

The Executive Engineer had (and continues to have) overall responsibility for the supervision of construction and administration of the contract. His duties and responsibilities were wide-ranging. They were as defined to him by the employer and a detailed description here, in a document relating to quality assurance, would be inappropriate.

However, insofar as it relates to quality assurance, the Executive Engineer's duties included the following.

1. Organisation and structure of PWD site staff
2. Reviewing, amending, reissuing organisation chart to suit site conditions
3. Issuing written job descriptions to individuals
4. Ensuring satisfactory execution of the works in accordance with the specification
5. Ensuring the correct and efficient execution of duties by individual staff members; these included:
 - regular objective assessment of individual job performance
 - guidance and direction in areas of shortcomings
 - overall staff organisation for maximum efficiency taking account of individual strengths and weaknesses.
6. Designating the QA Manager and ensuring that QA procedures are followed
7. Ensuring that quality audits are carried Out
8. Approval of work. His duties included ensuring that the correct levels of approval authority are maintained as defined in the PWD document Circular No RMR-1087/4845/Roads-1, dated December 9, 1987 In all cases the Executive Engineer is (and continuous to be) finally responsible for work approval, irrespective of approvals or rejections by subordinate staff
9. Holding meetings with the contractor to ensure proper superintendence of work by the contractor. Matters relating to construction problems, materials and

workmanship, method statements, trials etc. would be discussed.

10. Correspondence and records. The Executive Engineer is (and continues to be) responsible for ensuring that all facts and salient points relating to execution of the works are comprehensively recorded in written correspondence and records.

Outline of quality plan

The outline below describes briefly the main headings that comprised the "Quality System".

Drawings

Registers of drawings were kept to ensure that only the latest approved drawings were used for the execution of the works and that drawings were prepared in a timely manner to avoid delays to construction.

Survey control

The setting out of the works was controlled by the establishment of approved survey control stations and setting out points. The establishment of these stations and points was the responsibility of the contractor. The responsibility for checking and approval of them lay with the Executive Engineer, PWD.

Temporary works

In order to ensure that the works were constructed in accordance with the permanent works drawings and with safety for site personnel it was essential that temporary works were designed, checked and approved by competent qualified engineers. The contractor proposed, designed and produced drawings and calculations for the temporary works. The checking and approval of temporary works was the responsibility of the site supervising team.

Method statements

The contractor put forward written method statements detailing his exact proposals for execution of the works in accordance with the specifications. These would be checked by the site supervision team. When approved, it was a requirement that the method statements would be strictly followed. No changes in the working methods would be permitted unless these were resubmitted by the contractor and approved by the Executive Engineer.

Materials

Of fundamental importance for QA was the testing and approval of materials. This comprised all the constituent parts of composite materials both in their initial and final states.

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Assurance of quality of materials forms a major part of the quality system and, together with all other aspects, is essential if long-term durability and serviceability of the structure are to be achieved.

Workmanship

In order to ensure that works were carried out to specifications, it was essential that strict procedures were followed whereby written requests for inspection were submitted by the contractor before execution of each part of the works and written approvals were obtained before works proceeded. It is at this stage that all the component activities outlined in the preceding paragraphs converge to produce a finished product and a measure of compliance with the QA requirements in respect of the component activities is reflected in the assurance of the quality of the finished product.

The inspections would not only cover the particular part of the works requested for approval (for example, pier shutters,

reinforcement, etc) but also that the arrangements had been made for execution of the works in accordance with the approved method statements for plant, labour, materials and temporary works.

Conclusion

Through formalised documented procedures, which include clearly-defined duties of individuals, tasks to be carried out, methods for carrying them out and recorded periodic checks in design and construction, it is the proof consultants' opinion that QA and QC procedures have assisted in the improvement of quality in design and Construction of the second Thane Creek bridge.

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