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Quality Assurance of Bridges in England

Assurance de la qualité des ponts en Angleterre

Die Qualitätssicherung von Brücken in England

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SUMMARY
Quality Assurance of structures does not consist merely of their design in accordance with published codes. Control is required from the very beginning, right through to the end of the service life of the structure. Procedures as applied to Highway Bridges in England are described.

RESUME
L'assurance de la qualité des constructions ne consiste pas qu'uniquement en leur conception conforme avec des normes publiées. Le contrôle est nécessaire dès le début et jusqu'à la fin de l'utilisation de la construction. Les procédés appliqués aux ponts routiers en Angleterre sont décrits.

ZUSAMMENFASSUNG
Die Qualitätssicherung von Tragwerken besteht nicht nur darin, dass sie nach geltenden Normen geplant werden. Von Anbeginn bis zum Ende der Nutzung der Tragwerke sind Kontrollen erforderlich. Die in England bei Strassenbrücken angewendeten Verfahren werden beschrieben.

1. INTRODUCTION

It is the standard practice in England for bridges to be fully designed and tenders invited for the construction only. The designs are carried out in accordance with national codes, supplemented by Design Standards issued by the Department of Transport (DTp). This takes care of the anticipated behaviour of the structure making due allowance, with a sufficient margin of safety, for variation of loads and strengths of materials from their expected values. However this is only one aspect of quality assurance which in its wider sense also covers the quality control of the design and construction processes together with the control in use and the systematic inspection and maintenance of the structure. This paper describes these processes as applied to highway bridges in England.

2. QUALITY CONTROL IN DESIGN

2.1 Faulty design due to human error may result from misunderstanding of broad philosophical principles, poor judgment consciously applied, ignorance or indifference, arithmetical errors and other errors resulting from the increasing complexity of modern analytical methods. The Department of Transport's Technical Approval procedures which were introduced in 1973 were framed with these factors in mind, to ensure that the possibility of human error occurring in bridge design is reduced to a minimum.

2.2 All DTp bridge designs of any significance have to be formally approved in principle by a Technical Approval Authority (TAA), which may be the DTp's Bridge Engineering Division in London or one of its Regional Offices called Road Construction Units (RCU). At Approval in Principle the TAA and the designer agree the parameters and criteria to be used in the design of a particular structure - the type of structure, geometry, loading, standards to be used selected from a general schedule of standards (TAS), any known departures from these standards, any known aspects not covered by the standards, design methods and any computer programs to be used.

2.3 Approval in Principle is formally given by the TAA signing a form TA1 which sets out the parameters and criteria agreed. It is at this stage that the category of the structure for checking purposes is agreed. This dictates the type of independent check which a structure is to be given (see para. 2.6 below).

2.4 On completion of the Approval in Principle detailed design proceeds and although the TAA do not check calculations they are frequently involved at this stage because it is unlikely that the design and check will be completed without

- The need for specific interpretation of particular requirements within the published list of standards.
- The need to use material or methods which lie outside the practice defined by the list.
- The need to settle disagreement between checker and checked.

Each case has to be referred to the TAA which will thereby fulfil its role of arbiter and interpreter. As practice and experience are good teachers a store of solutions to problems will be built up in the TAA. The process is, therefore, one by which problems select themselves and the important by-product is that the issue of new technical memoranda, the initiation of new standards and codes of practice, and the commission of new work in the DTp's research and development programmes reflect current problems and their priorities, preventing practice from racing ahead of its support technology.

2.5 In accordance with the philosophy described, the degree of check needs to vary with the economic consequences at risk. However, the check cannot be continuously variable and broad categories have to be chosen. Three broad categories have now been established as follows

- Category I: Certificate required stating that the design has conformed to the TA list and TAA instructions; has been accurately translated into contract drawings and that all these have been checked.

- Category II: Two certificates are required: one stating that the design has conformed to the TA list and so on, and a second stating that the design has been checked by an independent team in the design office.

- Category III: As for category II but the independent team must be from a different design organisation.

2.6 The TAA's selection of a category for a bridge is flexible, thus enabling the TAA to make judgments which cannot be written down in concrete terms and acknowledge the risks inherent in design complexity.

2.7 On completion of the design and check the designer provides the TAA with certificates that the structure has been designed in accordance with and checked for compliance with the Approval in Principle as set out on the TA1 form.

2.8 These procedures give the best assurance possible against human error and, of course, the procedure is allied with the selection and monitoring of the design agencies involved. The Department's staff are particularly briefed to ensure that innovation is encouraged but responsibly undertaken.

3. QUALITY CONTROL IN CONSTRUCTION

3.1 In the design of the structure it is assumed that the materials used and the workmanship will be to a certain quality and standard. These are specified in the DTp's Specification for Road and Bridge Works. It has long been our practice for the Contractor's work to be supervised by a Resident Engineer assisted by adequate numbers and quality of staff at different levels to ensure that the work is done to specification. Specialist Inspectors are appointed to supervise fabrication off the site and to carry out non-destructive testing where necessary. In our experience, this kind of close supervision has proved useful in ensuring that the work is done to

specification. While we have not found the need for a general review of our arrangements in this respect, we are nevertheless continuing to look for an optimum deployment of resources to obtain best value for money.

3.2 There have however been failures of falsework resulting, sometimes, in loss of life. According to our Conditions of Contract, the temporary works are the responsibility of the Contractor although the Engineer will check them to ensure the safety of the permanent works. Since 1974, we have introduced an additional clause in the Conditions of Contract which requires the Contractor, in certain cases, to submit a certificate from an independent person that his proposals for erection and temporary works are satisfactory. This amounts to an independent check which is paid for by the employer within the Contract without changing in any way the responsibilities of the various parties. We have considered that the money spent in these special cases is worth the extra assurance that we are buying.

4. INSPECTION AND MAINTENANCE

4.1 According to our Conditions of Contract the Contractor is responsible for maintaining the works for a period of one year after completion. After this maintenance period is over, bridges are maintained for the Department by County Councils acting as the Agents of the Department.

4.2 During the construction period, the Resident Engineer's Staff will complete the "As-built" drawings. These, together with calculations and maintenance schedules for major structures, will be handed over to the Agents. About three months before the end of the maintenance period, a joint inspection is carried out by the RE's Staff, the Agents and the Contractor, to ensure that the structure is fully serviceable. Any faults found are made good by the Contractor.

4.3 The following inspections are carried out during the service life of the bridge

- Superficial inspection, not necessarily made regularly. Absence of defects are not recorded but the purpose is to report fairly obvious defects which if unattended could lead to traffic accidents or high maintenance costs.

- General inspection, carried out at intervals not exceeding 2 years by Engineering Staff who record the visual condition of the bridge against a check list.

- Principal inspection carried out by Engineering Staff at intervals not exceeding 6 years. This requires close examination of all parts of the structure and a written report on its condition.

- Special inspection after a special event, eg flooding, extraction of coal, passage of an exceptionally heavy load or to examine a special condition or other similar reason.

4.4 It is essential that these inspections are carried out diligently and the necessary maintenance carried out if the structures are to be used with assurance. It is possible that a feature which gives rise to a fault discovered on one bridge could be built in to other bridges of similar design. These need to be identified quickly and monitored or remedied. To facilitate this a data bank is being built up of all bridges on trunk roads with the maximum amount of technical information as possible. This will enable quick retrieval of the necessary information.

5. PROJECT MANAGEMENT

5.1 In addition to applying quality control measures during preliminary design, final design, construction through to handing over the structureto the maintaining authority, it is also necessary to ensure that these are properly linked together with effective co-ordination of these activities. In my Department this function is carried out by a Project Manager and for large bridges, the task would be carried out by one person through all the stages. All the tasks that he has to perform, together with the stages at which these have to be executed are written in the Department's Highways Manual and these include both Administrative and Technical functions.

6. CONTROL OF VEHICULAR LOADING

6.1 Bridges in UK are designed to carry Standard Loading which simulates trains of normal vehicular loading of up to 32 tons and also for controlled movement of Abnormal Loading of up to 180 tons.

6.2 The gross weight, axle weight and axle spacings of normal vehicles are controlled by law. The Department of Transport takes the lead in any changes to these regulations and the Bridge Office is consulted to ensure that changes will not produce greater load effects on existing bridges.

6.3 It is also the law in the UK that vehicles of gross weight between 32 tons and 150 tons should give notice of their movement. This will enable Highway Authorities to check that the Bridges on the routes will not be overstressed.

6.4 Vehicles of gross weight over 150 tons need a Special Order. Authorisation is given only if a safe route is available. The Special Order includes a mandatory route and these journeys are normally made under police escort.

7. CONCLUSION

During the last ten years, new procedures have been introduced in England for the Quality Control of Design and also for control of erection. These have certainly resulted in greater assurance and we believe that now the optimum amount of effort is applied at each stage to ensure overall quality assurance.

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