Consideration of construction methods and sequences

No. 4.04

Scope

This Guidance Note discusses the interaction between Designer and Contractor in producing a satisfactory construction method or sequence. The consideration of alternative designs (for example a steel composite deck instead of a prestressed concrete deck, or 3 long spans instead of 5 shorter spans), is outside the scope of this Guidance Note.

The designer's construction method

For many bridges it would be ideal if the design of the bridge for function and the design of how it is to be built were undertaken together. Whilst this is possible with the Design & Build type procurement process, it is precluded by the traditional procurement process where the Client employs a Designer to prepare a design in advance of tender. Here the Designer has to anticipate a cost effective construction method – a method that, in the event, may or may not be used.

The Designer carries the entire responsibility for the permanent works design, and as such he develops a construction method to the extent that it is possible:

- to ensure that the effects on the completed bridge of at least one construction method are correctly quantified
- to satisfy himself that the design can be built safely in a practicable way, to fulfil his obligations under Health and Safety legislation (including CDM Regulations)

Under the CDM Regulations, the Principal Designer is responsible for coordinating the flow of information for all design activity, including temporary works, to ensure that all teams are working with common and correct information. The detail of the Principal Designer's legislative duties is not considered in the guidance note, but it should be noted that the Contractor or the Designer may be the Principal Designer.

The Designer should describe the anticipated method and related design assumptions in the contract documents. The information given should include:

- a diagram of the construction sequence
- information from the risk assessment
- information concerning the stability of the steelwork during construction (bracing requirements, limits on loading, etc.)
- ideally, the envelope of permanent load effects permitted should be stated.

However, it is not the Designer's responsibility to prescribe the construction method that must be used. While it is good practice to choose a method/sequence that is less likely to preclude alternatives, when choosing a method, advice should be sought from fabricators or erectors.

The Contractor's construction method

The Contractor is responsible for the development of the detailed construction method within the constraints defined by the Designer.

A contractor (or a steelwork contractor working as a sub-contractor to the main contractor) may propose a different method or sequence of construction for a bridge from the method anticipated by the designer of the bridge in the design phase. In some instances, the Client may actively encourage tenderers to do this, with a view to obtaining best value.

An **alternative construction method** is when the bridge retains the same structural arrangement or one very similar to the original design, but the bridge is built in a different way to that envisaged by the Designer. For example the original design may show erection of the steelwork by launching from one abutment whereas the contractor may prefer to erect the girders by crane.

An **alternative construction sequence** is where the bridge is the same as or very similar to the original design, but components of the bridge are constructed in a different sequence to that envisaged by the Designer. For example the contractor may wish to concrete the deck slab of a composite deck all at once rather than in stages.

When a different construction method or sequence is used, the design assumptions may be invalidated, and the design must be revisited.

The Client's requirements
The main consideration for the Client is to achieve value for money in securing his project objectives. He will require overall economy with the minimum risk to health and safety, and the minimum environmental impact whilst meeting planning constraints.

The Client will normally identify in the instructions to tenderers his particular requirements regarding alternative construction methods including among other things:

- whether tenderers are permitted to submit alternative designs
- qualifications relating to the submission of alternative construction methods
- planning constraints and any need for further approvals
- aesthetic requirements (e.g. CABE approval)
- environmental constraints (e.g. temporary piers in rivers)
- Approval in Principle procedures
- requirements for independent checking.

None of the above would normally be expected to constrain a proposal for an alternative construction sequence, although in some instances changes in stress levels arising from the changed sequence will require further independent checking unless shown to be within the envelope of permanent load effects already defined.

Reasons for alternative proposals
As the Contractor is responsible for the detailed construction methodology and the successful execution of the works, he requires the latitude to develop the methodology to comply with these obligations.

Competitive tendering challenges contractors to use their expertise and ingenuity to devise how to build the bridge most economically, yet profitably. The choice of construction method is fundamental to a successful bid, so it is important that the tenderers are not inhibited unnecessarily in proposing alternatives that make best use of their expertise and resources.

Following award of contract, there are many factors that can change sufficiently to require change of method for reasons of practicability, safety, or environmental impact, as well as cost.

On occasion, a design will prove to be deficient when the details of the erection are worked up by the contractor. In such cases the contractor will need to propose modifications which demonstrate that the bridge can be built.

Evaluation of an alternative proposal
There can be very good grounds for using a construction method differing from that anticipated in the design of the permanent works, so it is important that the final choice is discussed by the parties on the basis of the technical and economic merits of the options, and comparative risks to safety and environment.

A change of construction method that affects the original design of the permanent works will almost always require the Designer to do more work, perhaps under severe time constraints. In addition there may be an Independent Checker also having to do more work. These are matters that the Client and Designer should anticipate in preparing for and managing the procurement process.

Extra costs incurred for additional design work and/or checking by the Designer (and Checker) are a commercial issue for the Client. Where costs are incurred during the tender period this would normally be allowed for in the agreement between the Designer and the Client. If a change of method after award requires the design to be revisited then, the cost would normally be dealt with under the terms of the contract. Often the Contractor is required to meet this cost as part of the overall cost of the alternative proposal.

Responsibilities
The Contractor is responsible for how the bridge is built and usually for the design of the temporary works, and for satisfying himself and the Designer that the effects of construction on the permanent works are not detrimental, noting the comment above re-

garding the role of the CDM Principal Designer.

An alternative construction method or sequence may involve some modification to the design: change of precamber, alterations to stiffeners, additional stiffeners, repositioning of splices, changes to bracing and changes in plate sizes are all possible outcomes. It is incumbent upon the Client to recognise that the acceptance of proposals for alternative construction methods or sequences will frequently result in such changes.

Depending on contractual arrangements, the Designer may be required to take full responsibility for the changes to the design so that they effectively become his own. Alternatively, the Contractor may become the “Designer” and the original Designer the Checker. Whatever the arrangement, responsibilities should be clearly defined, not be in conflict (the commanding mind and the independent assurance must be clearly separated) and must be understood by all parties. And fundamentally the arrangements must satisfy the requirements of the CDM Regulations with respect to the duties of the Principal Designer.

Summary
The building of a bridge requires the combined skills, expertise and resources of both the Designer and the Contractor. The engineering of the construction method is important to both, so decisions need to be made in a co-operative way that produces the best outcome, not necessarily the one that was first anticipated. The fact that the acceptance of an alternative method or sequence supplants the Designer’s method is not a reflection on the Designer; rather it signifies an appropriate application of the particular expertise and resources of the Contractor.