Trial erection & temporary erection

No. 7.04

Scope

This Guidance Note gives a general introduction to trial and temporary erection, the need for such activities and the use that they serve.

General

Temporary erection, more commonly known as trial erection, is a test of overall geometry and the standard of fit between the components forming that structure or part structure.

As with any other test, its extent should reflect the consequences of error.

The erection of a structure under or over a busy railway or motorway in a short closure requiring many weeks of advance notice will always justify a full trial erection for those spans so affected.

However, structures constructed on green field sites by experienced fabricators seldom warrant trial erection. Many major bridges in this country and abroad have been constructed successfully with little or no trial erection.

Problems can still arise on green field sites, but if the dimensions of major components are thoroughly checked in the factory before dispatch, then the solution to geometric problems and lack of fit on site can simply be the provision of a special splice plate or bracing which, with the aid of modern communications, can be provided to most locations in the UK within 48 hours.

The aggregate delay arising from problems resolved in the manner outlined above is generally much less than the time to carry out a full trial erection of the same structure. The physical solution to the problem is usually the same whether detected in a trial erection or on site.

Trial erection generally requires a large amount of space and on significant structures can take several weeks to carry out. Trial erection may appear to be a cheap operation and therefore prudent to specify, but it often represents a considerable loss of opportunity in terms of a quicker completion, the benefit of which might well have gone to the Client.

Think of trial erection as an insurance policy. The point to be assessed is what premium is paid for what cover.

Specifying a trial erection

Clause 6.10 of EN 1090-2 (Ref 1) requires the specifier to decide whether temporary erection is required, and if so, then to what extent. Clause 9.6.4 of EN 1090-2 gives some details of why trial erection might be considered, while Clause 12.7.1 gives an opportunity to specify any particular requirements for inspection of the trial erection.

Specification of trial erection, where considered necessary, should be made in the project specification for steel bridge works. A trial erection should only be necessary for reasons such as:

(a) When it is important that the steel fits together on site without any undue delay and/or remedial work (e.g. when erecting during a possession or in a remote location). See GN 7.04.

(b) When a deviation from nominal geometry would have a significant effect on internal forces and moments.

(c) When there are functional constraints, such as cross-fall and longitudinal vertical curve for clearance or drainage.

(d) When required to check the alignment of visually critical elements, e.g. fascias.

(Requirements for a), c) and d) should be given as functional tolerances; requirements for b) should be given as essential tolerances.)

Further advice on what to consider is given in EN 1090-2 and SHW Series 1800. Clause 1806.10 identifies that the accurate fit-up of holes and weld preparations should be undertaken where a full or staged trial assembly is undertaken.

The decision whether to specify a trial erection should be based on a properly considered risk assessment of the consequences of lack of fit, or of incorrect geometry.

The specifier will act in the Client's best interests if he considers the matter from the standpoint of why should there be a trial erection rather than the reverse position.

If a trial erection is required, its extent should be clearly specified.

Mode of trial erection
The fabricated steelwork components for a bridge structure are usually dimensioned for the unstressed condition, i.e. where all self-weight and superimposed loads have been removed (see GN 4.03).

The fit-up of components should be checked in a similar condition, i.e. they should be supported such that there are no significant self-weight deflections in the components being assembled. An example of a support system for a three-span bridge is shown in Figure 1 (cambered profile exaggerated for effect).

Specification clauses that require trial erections to be supported only at the bearing positions achieve little in terms of proving structural fit-up, especially in the case of continuous bridges. There may well be some unusual circumstances where such a requirement is desirable, but in the general case it would only serve to add time and cost without benefit and should therefore be avoided.

Similarly, clauses requiring the temporary erection to reflect the construction sequence achieve little in terms of a normal project and should not be specified.

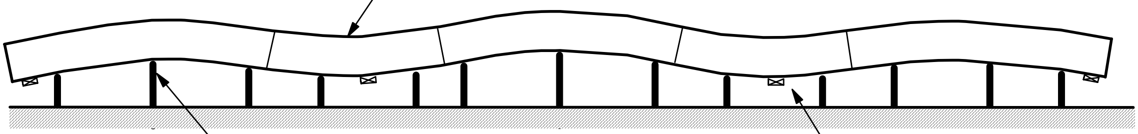

Figure 1 *Typical support arrangement for trial erection of a continuous three-span bridge*

Full trial erections can take up a large amount of space, often more space than is required for construction on site. If space is a constraint to the fabricator then incremental trial erection is usually quite satisfactory.

Plate girders are normally assembled on their side when checking camber or when trial assembled to verify the bridge profile and fit-up at field splices. Girders are regularly supported (approx.. 4 metre intervals) on assembly benches.

When trial erection is specified to verify the fit-up of the cross framing, cross beams or steel decks transverse splices, plate girders are assembled with the webs vertical. In this case the main girders are propped at the supports, at field splice positions and at intermediate positions if necessary to prevent sagging.

Virtual trial assembly can be used when the steelwork has been defined using 3D modelling. It is particularly useful for controlling and proving the accuracy of very large unwieldy assemblies that cannot be assembled due to lack of space, where there is a significant risk of lack of fit and where the rectification of fit-up errors on site would prove unacceptable or difficult. Key features of each fabrication are surveyed using a total station to prepare clouds of 3D survey data to represent each assembly. These data clouds are then docked with adjoining assemblies using the control data provided by the fabrication model.

For structures with significant longitudinal fall, it is often of benefit to rotate levels to avoid excessively high supports in trial erection. It should be remembered, however, that if the structure has plan curvature then it should be anticipated that such rotations will lead to webs being out of vertical in a number of locations. The amount and direction are predictable.

In a similar manner it may well be the case that heavily skewed bridges designed with composite concrete decks may require the girder ends to be out of vertical on erection so that the subsequent concreting operation tends to bring the girders back to vertical. (See GN 1.02)

It is desirable that only a proportion (typically about 25%) of the bolts are used in trial erection. The inspector of the trial erection will then be better able to assess the general alignment of the holes in any group. A bolt in every hole could be concealing evidence that significant force has been used to bring the components together. Some force will always be required, but if bolt holes show distortion through excessive drifting, or local distortion of members is evident, undue force has been used.

Temporary bolts, generally referred to as service bolts, should be used in trial erection. Service bolts may be of any grade, but must be of the same shank diameter as the permanent bolts and of sufficient length. The permanent bolts should not be used. It is suggested that about 25% of the holes should be filled with service bolts for web and flange splices, and about 50% of the holes should be filled in bracing connections and the like.

Some fabricators use the trial erection to match mark groups of holes critical to overall structural geometry or to back mark preparations for site welded joints. Generally there should be no need to reassemble the structure after hole groups so marked are drilled or welded joint preparations cut.

It is often prudent to include the bearings in the trial erection. This is the major interface between the superstructure and the substructure and experience shows that this is where things go wrong most often. Inspection of the trial erection is made easier if bearings are included.

Inspection of trial erection

Persons required to carry out the inspection of a trial erection should carefully plan how and what they intend to inspect, taking access into account.

They should familiarise themselves with the appropriate tolerances in the contract before they start, and they should also agree the expected dimensions for the trial erection with the fabricator several days before the inspection is due.

The following check list has been compiled to assist inspection.

First, check the overall geometry:

- Span dimensions, including diagonals (remember to differentiate between slope and plan dimensions).
- Girder spacings at all supports (again remember to differentiate between slope and plan dimensions).
- Skew angles/offsets.
- Relative levels of girders at supports. Generally the most practical way to do this is to survey at top flange level. Remember that where there is longitudinal fall in the structure it is important to locate these points accurately. Remember to allow also for any flange thickness changes which may alter levels
- Relative levels at girder joints, or at mid-span for single span structures.
- Verticality of girder webs at supports.

Secondly, check fit-up:

- The alignments of all splices and butt joints (see Clause 8.1 of EN 1090-2).
- The proper bedding of splice plates in preloaded bolted joints (see GN 2.06).
- The alignment of bolt holes, so that bolts can be installed without undue force.
- The alignment of bracing members with their respective stiffener connections.
- Fixing of the correct bearing plates to the correct girders, (i.e. differentiate between those for fixed bearings, guided bearings and free bearings).
- Orientation of each bearing plate, in terms of any taper.
- Orientation of fixing hole groups in each taper plate, and diameter of holes.

Note any missing items or incomplete fabrication.

As a guide, a well organised two man team can carry out the above inspection regime on a bridge eight girders wide and two spans long in a day.

References

1. EN 1090-2:2008+A1:2011, Execution of steel structures and aluminium structures. Part 2: Technical requirements for the execution of steel structures.
2. Manual of Contract Documents for Highway Works, Volume 1, Specification for Highway Works, Series 1800 Structural Steelwork, Amendment 2014, TSO.

