

GENERAL WORK SPECIFICATION

CONCRETE BRIDGE – FALSEWORK AND FORMWORK – GWS

TENDER SPECIFICATION

AUGUST 2012

DISCLAIMER

The translation into English of Road Standards (Vejregler) and Tender Specifications is to be regarded entirely as a service. In the event of any discrepancy or shortcomings in the translation, the Danish version will prevail. At any time the Danish versions of Road Standards (Vejregler) and Tender Specifications are those in force.

VEJREGLER

TABLE OF CONTENTS

1	GENERAL	3
1.1	References	3
1.2	Documentation	4
1.2.1	Submission and approval of documentation	4
1.3	Design basis	4
1.3.1	General	4
1.3.2	Proprietary falsework	5
1.3.3	Steel structures	5
1.3.4	Timber structures	5
1.3.5	Foundation	5
1.3.6	Loads	5
1.3.7	Deformations	6
2	MATERIALS	6
2.1	Falsework	6
2.2	Formwork	6
2.2.1	Board form (rough and planed)	6
2.2.2	Panel form	7
3	EXECUTION	7
3.1	Falsework	7
3.1.1	Foundation	7
3.1.2	Design and installation	8
3.2	Formwork	8
3.2.1	Tightness and design	8
3.2.2	Surface treatment of forms	9
3.2.3	Anchorage of side forms	9
3.2.4	Embedments and recesses	9
3.2.5	Preparation of form	10
3.2.6	Formwork removal	10
4	VERIFICATION	10

CONCRETE BRIDGE – FALSEWORK AND FORMWORK

1 GENERAL

1.1 References

The following standards and descriptions apply in order stated to the work, including any supplements and deviations stated in the work specification as well as the general design documentation:

DS 2427:2011	Concrete execution – Rules for application of EN 13670 in Denmark
DS/EN 12812:2008	Falsework – Performance requirements and general design
DS/EN 1090-2:2009	Execution of steel structures and aluminium structures – Part 2: Technical requirements for steel structures
DS/EN 12813:2004	Temporary works equipment – Load bearing towers of prefabricated components – Particular methods of structural design
DS/EN 12811-3:2002	Temporary works equipment – Part 3: Load testing
DS/EN 13377:2002	Prefabricated timber formwork beams – Requirements, classification and assessment
DS/EN 1990:2007	Eurocode 0: Basis of structural design, including DK NA
DS/EN 1991-1-1:2007	Eurocode 1: Actions on structures – Part 1-1: General actions – Densities, self-weight, imposed loads, including DK NA
DS/EN 1991-1-3:2007	Eurocode 1: Actions on structures – Part 1-3: General actions – Snow loads, including DK NA
DS/EN 1991-1-4:2007	Eurocode 1: Actions on structures – Part 1-4: General actions – Wind actions, including DK NA
DS/EN 1991-1-5:2007	Eurocode 1: Actions on structures – Part 1-5: General actions – Thermal actions, including DK NA
DS/EN 1991-1-6:2007	Eurocode 1: Actions on structures – Part 1-6: General actions – Actions during execution, including DK NA
DS/EN 1991-1-7:2007	Eurocode 1: Actions on structures – Part 1-7: General actions – Accidental actions, including DK NA
DS/EN 1992-1-1+AC:2008	Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings, including DK NA
DS/EN 1993-1-1+AC:2007	Eurocode 3: Design of steel structures – Part 1-1: General rules and rules for buildings, including DK NA
DS/EN 1993-1-5:2007	Eurocode 3: Design of steel structures – Part 1-5: Plated structural elements, including DK NA
DS/EN 1993-1-8+AC:2007	Eurocode 3: Design of steel structures – Part 1-8: Design of joints, including DK NA
DS/EN 1993-1-10+AC:2007	Eurocode 3: Design of steel structures – Part 1-10: Material toughness and through-thickness properties, including DK NA
DS/EN 1995-1-1+AC:2007	Eurocode 5: Design of timber structures – Part 1-1: General – Common rules and rules for buildings, including DK NA
DS/EN 1997-1:2007	Eurocode 7: Geotechnical design – Part 1: General rules, including DK NA.

The guidelines, notes etc. stated in the references shall be regarded as requirements that shall only be deviated from if so stated in the Project Documents.

Reference to application standards shall also be regarded as a reference to the relevant standard(s).

1.2 Documentation

The Contractor shall be responsible for design and installation of falsework and formwork.

Well before construction of the falsework and formwork is planned to start, the Contractor shall prepare documentation – in the form of drawings and calculations – that shows:

- that the falsework and formwork have the necessary strength, stability and stiffness, in any of the load conditions occurring during the work
- and that the falsework foundation has the necessary load-carrying capacity, stability and stiffness.

For "proprietary falsework", meaning prefabricated equipment/systems, the load-carrying capacity shall be documented either by calculations based on an existing type approval prepared by an independent accredited testing institute, or the like, or by the use of load testing.

In exceptional cases where there is a request for the use of "proprietary falsework" with expired type approval, the load-carrying capacity shall be documented by load testing. As an alternative to load testing, it shall be acceptable to prepare a supplementary technical statement specifying how load-carrying capacities and installation tolerances shall be corrected in order to meet the applicable standards and codes of practice. It is a precondition that the supplier's original design instructions, installation instructions and type approval are available.

If the load-carrying capacity of the "proprietary falsework" is to be documented by load testing, the characteristic load-carrying capacity shall be determined as specified in DS/EN 12811-3. For towers reference shall also be made to DS/EN 12813.

For the foundations of the falsework, the Contractor shall ensure that the necessary data concerning the strength and deformation parameters of the soil is available and, if necessary, shall carry out supplementary investigations.

1.2.1 Submission and approval of documentation

At least 25 working days prior to the planned commencement of the construction of falsework and formwork, the Contractor shall submit drawings and calculations of the falsework and formwork for approval by the Employer.

No construction of falsework or formwork shall be commenced until approval of the Contractor's drawings and calculations has been given by the Employer.

1.3 Design basis

1.3.1 General

Forms, formwork elements and falsework structures shall be designed in accordance with DS 2427.

Forms and formwork elements shall be assigned to consequence class CC2. See, however, C.5.4 in DS 2427.

The falsework structure shall as a minimum be assigned to consequence class CC2. Structural elements forming part of a load-carrying falsework construction which spans operational railway tracks, motorways and major roads shall be assigned to consequence class CC3.

Falsework shall be assigned to design class B1, see DS/EN 12812 and Annex C in DS 2427, unless otherwise specified in the Project Documents.

The Contractor shall specify execution tolerances in his falsework design. The tolerances shall be shown on the drawings and the falsework calculations shall take into account the specified tolerances.

Realistic tolerances which can be verified in the field shall be used. See also section 4.

1.3.2 Proprietary falsework

In connection with the use of "proprietary falsework" where the load-carrying capacity is documented on the basis of type approval, it shall be permitted to verify the falsework in accordance with the calculation rules specified in the type approval in question. However, the safety levels and loads specified in this work specification shall be applied as a minimum.

1.3.3 Steel structures

Steel components shall be made in accordance with the normal verification class.

For the design of steel components with a risk of stability failure (plate buckling, torsional buckling, column buckling), the static models shall accurately reflect the actual supports and relative stiffnesses of the components and, in respect of this, shall include both designed eccentricities and eccentricities corresponding to assumed tolerances.

1.3.4 Timber structures

The design of timber structures shall be based on the conditions set out in DS 2427, Annex C.

Additional loads from local accumulations shall be regarded as K-load.

In-plane shear action of the formwork shall not be taken into account for the distribution of horizontal forces unless it is documented by calculation that the forces acting can be distributed by elements and joints for that purpose.

1.3.5 Foundation

Determination of the geotechnical category for the falsework foundation shall be carried out in accordance with DS/EN 1997-1 DK NA. The foundation shall as a minimum be assigned to geotechnical category 2.

Reduction of partial coefficients for the soil strength in connection with the design of falsework foundations shall not be permitted, meaning that the value $\alpha = 1.0$ shall be used.

1.3.6 Loads

The load basis for falsework and formwork appear from DS 2427, Annex C.

It must be ensured that horizontal forces which arise in connection with e.g. pouring against an existing backstop and concreting with upper formwork can be absorbed by the falsework.

1.3.7 Deformations

The arrangement and installation of the formwork shall comply with the tolerances specified for the falsework design, see section 1.3.1, and the dimensional tolerances for the structure specified in *Concrete – GWS*.

Vertical deflection or horizontal deflection of forms, bearers and stringers shall not exceed 1/400 of their span.

Deflection of formwork girders/beams shall not exceed 1/200 of the span of the beams.

If the deflection of the formwork girders/beams exceeds 1/400 of the span, or if the span is more than 6 m, deflection shall be prevented in advance with a corresponding opposing camber of the beam or by packing up the formwork.

It shall be ensured that deflections have a uniform appearance throughout the structure, if necessary by the use of ballasting.

Any camber due to the deformations of the finished structure shall be specified in the Project Documents.

In addition, the Contractor shall, by agreement with the Employer, provide falsework and formwork for deck, beams and the like, with cambers corresponding to the expected initial and time-dependent settlement of the falsework foundation.

2 MATERIALS

2.1 Falsework

Materials and structural elements must be free from defects, in a good state of maintenance and correspond to new materials as regards strength.

When applying used "standard falsework", it must be documented that the condition of the components has been inspected after their last use and that they have been repaired for reuse. This must be documented by a written statement from the contractor or the supplier of the "standard falsework".

2.2 Formwork

Shaped wood must be well-seasoned so that it is dimensionally stable during use, cf. section 1.3.4, and does not damage the cast concrete.

2.2.1 Board form (rough and planed)

Visible surfaces

- The form shall be made of boards with a thickness of at least 25 mm and a constant width of no more than 125 mm
- All visible surfaces shall be cast against the rough side of the formwork
- The formwork shall use band-sawed, thickness-planed, pinewood boards

- For vertical board forms, the boards shall be tongue-and-groove, or their tightness shall be ensured in an equally effective manner
- Horizontal board forms may be made of edge-planed non-tongue-and-groove boards, provided that measures are taken to prevent leakage, e.g. wetting
- Element orientation (board direction) shall be as follows:
 - Underside of bridge deck: Parallel to the direction of the road/track passing over
 - Edge beams and sides of bridge deck: Parallel to the top of the edge beams
 - Pier stems/shafts: Parallel to the edges of the pier stems/shafts. Where pier stems/shafts do not have a constant cross section, jointing shall be carried out by taper-cutting (symmetrical) to the centreline of each pier stem/shaft surface
 - Walls, including wing walls: Vertical
 - Abutment: Vertical
- If the structural height of the bridge deck varies - and consequently also the height of the sides of the bridge deck – taper-cutting of the boards shall be performed using the following width limitations: Max. 150 mm, min. 50 mm
- The same shall apply to taper-cut boards used on piers with a cross section which is not constant (see above): Max. 125 mm, min. 50 mm
- For curved surfaces, the board width and length shall ensure that the finished concrete surface appears with an even curvature. Boards must be taper-cut
- New or used boards which are free of defects, have been carefully cleaned, and have retained their surface structure shall be used. For the same type of structural element, boards of a uniform quality and appearance shall be used. New and used forms shall not be used randomly together
- For repair materials, the formwork materials shall be chosen to ensure that any visible new surfaces shall be similar to the remaining existing surfaces. The board direction on visible surfaces shall be parallel to the existing formwork marking.

Non-visible surfaces:

- The formwork shall be made of thickness planed boards with a minimum thickness of 25 mm
- The boards shall be flawless and carefully cleaned.

2.2.2 Panel form

Panel forms means, e.g. steel forms, plastic forms, forms made of water-resistant plywood sheets or tongue-and-groove boards which have been glued together and planed after assembly.

The forms shall be made of panels with sufficient stiffness and thickness so that irregularities during construction are avoided.

3 EXECUTION

3.1 Falsework

3.1.1 Foundation

The Contractor shall verify that the foundation conditions correspond to the assumptions in the falsework design, including verifying the soil parameters and recording pile-driving logs for any falsework piling.

Necessary measures shall be taken to protect the soil around and under the falsework foundations against erosion, softening, frost etc.

In cases where the falsework is founded on concrete foundations or on piles, they shall be removed or be cut off after use as stated in SWS (*Special Work Specifications*).

3.1.2 Design and installation

The falsework system shall be designed in a way which allows fine adjustment of heights and lowering to be performed, e.g. by means of hardwood wedges or by the use of threaded spindles.

Falsework and formwork shall be designed and installed in such a way that necessary movement is possible, and it shall be ensured that movement joints and the like are not blocked during casting.

In cases where "proprietary falsework" is used, the original factory guidelines and/or the work instructions of the supplier shall be followed in every detail.

The Employer may require that a specialist from the supplier verify the completed installation.

3.2 Formwork

3.2.1 Tightness and design

The formwork shall be so tight that the formed concrete surface shall appear level and without any large ridges.

Drying-out of a board form, which may result in cracks and leaks, shall be prevented by adequate wetting during execution.

In forms where difficult casting/placing conditions have to be taken into account, openings shall be arranged, e.g. openings or hatches from which concrete placement, compaction and inspection may be carried out.

Normally, the openings shall be arranged in form sides for non-visible surfaces and always by agreement with the Employer. Closure shall be planned in a manner which ensures that interruption to casting is avoided.

Any necessary top formwork on sloping upper surfaces of wing walls, etc. shall be executed as demountable panels of a length to allow careful casting from below and trowelling in sections.

Furthermore, the following shall apply to forms for visible surfaces:

- Board forms shall be made with staggered joints so that visible accumulation of joints is avoided. All joints shall be with full contact
- For joints in panel forms, it shall be ensured that dilatation of the panels is not hindered and that the joints are tight
- Visible vertical construction joints shall be limited by use of accurate vertical forms
- In horizontal, visible construction joints, the Contractor shall ensure that the construction joint line shall be completely horizontal and uniform by inserting trapezoidal timber fillets
- In all outward edges, triangular fillets with a side line of 20 mm shall be inserted. In visible outward edges the fillets shall be planed
- Vertical and inclined construction joints shall be formed and the formwork shall be cut out for any reinforcement passing through.

3.2.2 Surface treatment of forms

Surface treatment of forms with release agents, wax, lacquer or similar agents shall be agreed with the Employer. Declarations for surface treatment agents for forms shall be submitted to the Employer for review.

3.2.3 Anchorage of side forms

Side forms shall be anchored robustly with round bars and "form clamps" or a similar effective anchorage method.

By agreement with the Employer, positioning of tie bars and spacers on visible surfaces shall be arranged in a uniform pattern which harmonizes with the contours of the structural element.

At construction joints, anchorages shall be installed that allow re-tightening prior to continuing the casting process.

At the surface of the form, tie bars shall be surrounded by a tapered plug which, at least in the thickness of the cover, forms a recess with a clearly defined circular edged hole around the tie bar.

Any use of special, combined anchorage/spacer systems shall be agreed in advance with the Employer.

The strength and the stiffness of the system used shall be documented, if necessary by the use of load tests by agreement with the Employer.

For systems which require ducts passing through, the closure of the ducts shall be ensured in a satisfactory manner and in compliance with the necessary tightness requirements.

For filling of recesses and repairs, anchoring of formwork on surfaces in the same plane as surfaces in an existing structure shall be performed in a manner ensuring that level differences in the surface and deposit of mortar on the existing concrete surfaces are avoided.

3.2.4 Embedments and recesses

Movement joints shall be formed to ensure that they are not covered or filled by concrete, and the joint edges must appear in a clean and regular manner without any damaged corners/edges.

Decorative mouldings, drip rebates, edge fillets and the like which are placed in the form shall be smooth and shall be made with a longitudinal central groove on the side facing towards the form so that optimum tightness against the form is achieved.

Drips shall be semi-circular or trapezoidal. Along the outer edge of the underside of the bridge deck, the drip shall stop approximately 150 mm from adjacent vertical concrete surfaces. Release agents shall be applied to the fillets in order to facilitate removal of formwork. See, however, section 3.2.2.

Where it is specified that plastic water stops shall be used for covering joints, care shall be taken to ensure that all the water stops are carefully cast in and placed in the correct positions. During casting, the water stops shall be held in place by wedging in the restraining form and by careful tying to the reinforcement mesh.

Hollow pipes, ducts and conduits for cables shall be protected against uplift and instability. In addition, fixing points for ducts and conduits shall be placed close enough to each other to ensure

that the process shall proceed as assumed and that installation of pipes and cables can be carried out without any obstructions.

3.2.5 Preparation of form

Reference is made to *Concrete – GWS*, section 3.6.

3.2.6 Formwork removal

Removal of the supporting formwork and falsework shall be performed at a point in time when the structure shall not be damaged or have deformations which are larger than anticipated, or when the structure is made self-supporting in connection with tensioning of prestressing cables.

Non-load-carrying side forms shall be removed no earlier than 3 maturity days after casting.

Removal of formwork shall not be carried out until the requirements for temperature differences and keeping moist specified in *Concrete – GWS* can be met.

Compliance with the appropriate strength requirement shall be documented subject to agreement with the Employer, see *Concrete – GWS*.

Removal of formwork shall be carried out with caution and care to avoid damage to concrete surfaces and edges. When removing formwork, the form shall be removed without removing the fillets. The fillets shall not be removed until natural drying-out has occurred.

Wedges or threaded spindles shall be loosened gradually in a predefined order to ensure that sudden harmful stresses in the concrete structures are prevented.

If the casting process indicates that the structure is not flawlessly concreted, the Contractor shall carry out partial removal of formwork to clarify that there are no casting defects prior to initiating removal of formwork, dismantling of falsework or cable tensioning.

Casting of or loading with overlying structural elements shall only take place when the underlying structural elements have had the formwork removed and are in proper condition.

For weather protection measures, refer to section 14.

4 VERIFICATION

Prior to casting, the following shall be verified:

- that the falsework installation has been carried out in accordance with the latest versions of the drawings, material specification and description of the construction method
- that the falsework installation complies with the tolerances assumed in the calculations, including tolerances in connection with built-in eccentricities and the geometrical imperfection of struts.

Verification measurements shall be performed with a degree of accuracy which is 10 times smaller than the assumed tolerance.

Settlements of the falsework, beam deflections and horizontal deformation of falsework and formwork shall be verified throughout casting work by levelling, measurement to string lines or other equally good methods of measurement.

Embedment items and recesses shall be verified for correct placement in accordance with the drawings as well as for adequate fixing to prevent displacement during casting.

In addition, verification of the formwork shall be carried out as indicated in *Concrete – GWS*.



Niels Juels Gade 13
PO Box 9018
DK-1022 Copenhagen K
Tel. +45 7244 3333

vd@vd.dk
vejdirektoratet.dk

vejregler@vd.dk
vejregler.dk

EAN: 9788793248588



VEJREGLER