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| PARADIGM  CONCRETE BRIDGE - FALSEWORK AND FORMWORK - SWS-P  tender |
| December 2017 |

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|  | SPECIAL WORK SPECIFICATION |
| This paradigm for Special Work Specifications, SWS-P, for falsework and formwork is divided into a left-hand column with indicative keywords etc., and a right-hand column with indicative paradigm text, which may be included or changed where relevant. The left column is to be deleted before completion. | Concrete Bridge - Falsework and Formwork - SWS is a supplementary work specification for Concrete Bridge - Falsework and Formwork - GWS, August 2012. |
|  | GENERAL |
| The following shall be stated for bridges on national roads and in the context of Banedanmark: | The Contractor shall base his work on the *Supervision Handbook on Falsework*. The Contractor shall, in consultation with the Client, use and fill out the forms provided here in a way that complies with the stated guidance. |
| The requirements for parti­cipation in courses, specific to the field, are stated here, cf. SWS-P Management and Cooperation. | The following requirements to participation in courses on falsework shall be met: |
|  | 1. Course C for technicians (engineers, construction architects, etc.) shall have been completed for the Falsework Supervision and Falsework Coordinator before commencing the planning and designing of falsework, i.e. no later than by the first falsework meeting. |
|  | * All persons who act as Falsework Coordinators, Falsework Engin­eers (incl. calculator of rafters and formwork), Falsework Super­visor and Falsework Assessor – cf. Supervision Handbook on Falsework, Chapter 1 - shall have completed Course C before starting their work on the falsework. The course is provided by VEJ-EU. |
|  | * Competences shall be documented for the Falsework Coordinator and Falsework Engineer. |
|  | * Course B for Site Mangers (foremen, gangers, etc.) shall have been completed before starting the planning of the execution of the work. The course is provided by VEJ-EU. |
|  | * Course A for hourly paid workers (skilled, unskilled, etc.) shall have been completed before starting the execution of the work. The Client provides the instructor at the Contractor's request. |
|  | The project-specific courses D, E and F are arranged by the Contractor on the construction site immediately before commencing the work. Here the relevant falsework and formwork and project shall be reviewed. |
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| Requirements shall be stated here for document­ation of competencies for the Falsework Coordinator, Falsework Engineer and any third party Falsework Assessor. | For the Falsework Coordinator and Falsework Engineer, at least 3 years of experience with falsework is required.  The competencies shall be documented, cf. the Supervision Handbook on Falsework.  Appendix 1 to this SWS shows in table form how this documentation is to be presented. |
| For large and/or complex bridges, including bridges that need to be lowered, stringent requirements may be set for the competencies of the Falsework Coordin­ator, and Falsework Engineer and any third party Falsework Assessor. | For the following structures, the Falsework Coordinator and Falsework Engineer are required to have at least 5 years of experience with falsework:  …………………..  …………………..  The competencies shall be documented, cf. the Supervision Handbook on Falsework.  Appendix 1 to this SWS shows in table form how this documentation is to be presented. |
| Competence requirements for the Falsework Assessor and Falsework Supervisor. | The competence form for the Falsework Assessor and Falsework Supervisor may be presented at the Contractor's request. |
| For larger and / or complex falsework constructions and similar in CC3, it should be stated that the Contractor can expect a stringent level of evaluation. | For falsework constructions and other temporary constructions classified in Consequence Class CC3, the evaluation level is "Approval with review and control" |
| The Client shall decide whether the supervision handbook should apply to:   * Temporary structures in connection with the loweri­ng (and maybe sideways sliding) of bridge decks. | The Contractor shall base his work with lowering (or other type of relocation) of bridge decks on forms B3, E, F, K and N in the Supervision Handbook on Falsework. |
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| The Client shall decide whether the supervision handbook should apply to:   * Installation and bracing of prefab structural elements | The Contractor shall base his work with assembly and bracing of prefabricated structural elements and subsequent casting together of the elements on the Supervision Handbook on Falsework. |
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| The Client may decide that the supervision handbook shall apply to e.g.: |  |
| * Temporary supportive structures in connection with bridge lifting or pier replacement. |  |
| * Temporary pedestrian bridges and platforms to carry demolished concrete and/or equipment |  |
| * Installation and dismant­ling of other supporting structures. |  |
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| In each individual case, the SWS text shall describe how to apply the supervision handbook’s provisions. In addition, the requirements for project documentation shall be stated. |  |
| Special measures for critical operations, e.g., in con­nect­ion with casting or the erection and dismantling of falsework, if relevant. |  |
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|  | Openings for traffic |
| The following should be treated in SWS Work Site:  Specific provisions relating to the establishment of openings for traffic in the falsework, including the identification of a clearance profile, periods for main­tenance and use, and special drainage requirem­ents through falsework should be stated, if relevant. | Reference is made to SWS Work Site. |
|  | Containment measures on bridges and falsework and formwork |
| The following should be treated in SWS Work Site:  Measures for protection against falling objects and protection against free fall and danger of falling should be stated, including requirements for a close screen and guardrails with a height of minimum 1.2m. Requirements for a close screen when working with high-pressure flushing and shotcrete, etc. should be stated. | Reference is made to SWS Work Site. |
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|  | References |
| Additional valid references should be added. | The following reference should be provided first:   * Handbook, Design Basis for Falsework, XXXX 2017 |
| In case the above-ment­ioned references contain instruct­ions and notes, etc. that should not be regarded as requirements, this should be stated. |  |
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| Preparation of contingency plans is a mand­atory requirement that shall be implemented through SWS Falsework and Form­work until the document becomes part of the Super­vision Handbook on Falsework. | The following document applies to the work:   * Contingency plan in connection with falsework, XXXX 2017   The Contractor shall prepare a contingency plan in accord­ance with the guidelines in the document and in accordance with the format shown in "Paradigm for contingency plan in connection with falsework" for all critical activities listed in the document.  The contingency plan should be included as an appendix to the Health and Safety Plan (HSP) and should be dealt with in con­nection with the safety meetings for the contract before casting, lowering and similar activities, see SWS Management and Cooperation. |
|  | Documentation |
| The following text should be inserted: | The design and execution of all temporary constructions, including falsework, formwork and falsework, lifting and lowering devices, etc., is the responsibility of the Contractor. |
| The following text concern­ing formwork and falsework should be added: | **Formwork** |
|  | The calculation and drawing documentation of formwork-bearing elements and formwork skin as well as supports and braces shall be included in the overall falsework documentation.  Retention of terminal formwork at bridge ends and special braces in con­nection with sloping bridge ends, where rafters are cut or implem­ented asymmetrically, shall be documented with calculations and drawings.  All mechanical connections for bracing, formwork skin and blocks/tapers shall be stated in the drawing documentation. |
|  | Submission and approval of documentation |
| In the implementation sched­ule, a minimum of 3 months should be set aside from the conclusion of the contract to the first submis­sion of the foundation and falsework and formwork project.  Time limits for the submis­sion of drawing and calcul­ation documentation and for the supervision's review and com­ments should be set, taking into account the complexity of the falsework project. For simple bridge castings, the deadline of 25 working days stated in GWS 1.2.1 should thus be relaxed and for larger bridge castings where the 25 working days are not expect­ed to be suffic­ient, the dead­line should be extended. The registered deadline shall be included in the Client's tender schedule. This should be coor­dinated with other deadlines stated in SWS Management and Cooperation.  Further, it should be stated, how far in advance the Contractor shall be obliged to notify the super­vision of the time of delivery of the documentation.  Finally, it may be stated whether it is permissible to divide the documentation into lots, e.g., for formwork, foundation and falsework. |  |
| For text in Section 1.2 of the GWS regarding an accred­ited type-approval testing institute, it shall be added: | The independent accredited testing institute for "standard falsework" shall be a European institute accredited by EU. |
|  | Design basis |
|  | General |
| Here, it should be stated whether the relevant falsework over road or track in use should be classified as Consequence Class CC3. | For bridge No. ………, falsework and lowering structures shall be classi­fied as Consequence Class CC3. However, those parts of the false­work/ formwork outside the span of the opening for traffic, which do not influence the load-carrying capacity of the falsework above the span of the opening for traffic, can be classified as Consequence Class CC2.  Falsework for bridge No. …… over streams shall be classified as Consequence Class CC2. |
| For falsework over roads, tracks and paths in use, add: | The falsework shall be fitted with a closed plywood deck under the cast, located along the entire width of the bridge plus 0.5 m on each side. The deck can be placed between the load-carrying steel beams. The deck shall be able to absorb a vertical load of 5 kN/m 2 in the accident limiting state. |
| If the falsework is permitted to be classified as Design Class B2, add: | Falsework falling within Consequence Class CC2 may be assigned to Design Class B2 in pursuance of DS/EN 12812, if:   * The design rules stated in DS 2427:2011, Annex C, are observed, including C.5.3 (3), but with the exception of the first “bullet”. |
| Regarding characteristic friction coefficients, it shall be added: | The following shall be changed in table DS 2427-C.1:   * In the 2nd horizontal row, "Painted steel" should be changed to "Painted or oiled steel". * The friction coefficient between "Painted or oiled steel" and "Soft wood, sawn surfaces" shall in both cases be 0.15. * The friction coefficient between "Painted or oiled steel" and "Hard wood" shall in both cases be 0.00. * The friction coefficient between "Soft wood, sawn surfaces" and "Concrete" shall in both cases be 0.40. |
|  | In addition, the following characteristic friction coefficients should be added:   |  | Aluminium | For casting flakes, film-coated (water-repellent) | | --- | --- | --- | | Untreated steel | 0.15 | 0.05 | | Painted or oiled steel | 0.10 | 0.00 | | Concrete | 0.10 | 0.15 | | Soft wood,  saw cut surfaces | 0.20 | 0.05 | | Hard wood | 0.20 | 0.10 | | Planed surfaces | 0.20 | 0.05 | | Aluminium | 0.15 | 0.05 | |
|  | Standard falsework |
| The following text regarding standard scaffolding shall be added: | If the load-carrying capacity stated in the type approval is based on tests and thus cannot be documented by calculation, the additional required/ built-in safety shall be maintained when determining the calculated load-carrying capacity in accordance with the Danish safety system. |
| The following shall be added for standard supports used as supports for span of the opening for traffic: | When using conventional standard falsework (shoring), built of pipes, with spindles at the top and bottom as supports for the girders spanning trafficked areas, the spindles at the top and bottom shall be further secured with braces in both directions, e.g., by means of diagonals. If it is not possible to place additional braces/diagonals, the load-carrying capacity of the spindles shall be reduced by 20%. |
|  | Steel structures |
| For steel structures, add: | The Contractor shall, as a part of his project, prepare a general note for steel structures, where execution classes and requirements for steel grades, mechanical joints, welding joints, etc. as well as requirements for inspection are stated. |
|  | For verification of columns that are built up of different elements in extension of each other, e.g., shimming-up in combination with steel profiles, the stiffness of the individual elements and the joints between these and eccentricities/imperfections shall be determined conservatively. In addition, the displacement of supports and 2nd order effects shall be included. |
|  | Where crossbeams are placed below and/or above columns, their stiffness shall be taken into account when determining the critical column length and when demonstrating the capacity of the columns. |
|  | Stacking used in connection with lowering shall be limited in total height and designed to have cross-sections with bending stiffness to limit the column effect as much as possible. It shall be ensured that there is pressure over the entire cross-section for all load combin­ations for demonstration subject to STR/GEO Set (B). |
| The following should be added for on site welds: | Secondary welds defined, for example, as braces for fork bearings and body braces are permitted to be carried out on site. Secondary welds on site must only be carried out as edge seams with an a-dimension of maximum 6mm, and may in total be considered utilised to a maximum of 2/3 of the normal load-carrying capacity in the applicable Consequence Class.  Welds made on site shall comply with the current quality and approval requirements, including requirements for welding certificates, etc., corresponding to the current execution class. |
| This should be added for existing steel structural elements, designed according to previous standards: | Existing steel structural elements designed according to previously current standards, are permitted to be used, if the load-carrying capacity is documented subject to present standards.  If the steel quality cannot be documented, it is permitted to determine the steel quality and the associated strength parameters based on the guidelines in "Design Guide for Load and Calculation Basis for Bridges". |
|  | Design of timber structures |
| If it is permitted to use class 2 for joists and rafters, the following should be added: | Rafters may, however, be classified as Application Class 2, in case systematic moisture measurements are made immediately prior to casting to document that the limit has not been exceeded. If the limit has been exceeded, those rafters and joists shall be reinforced that do not satisfy the requirement. |
| For wooden structures this should be added: | The stability of form-bearing joists and rafters shall be documented. Rounded edges shall be taken into account during the demonstration. |
| Requirements for safety against overturning may be omitted, where this does not seem relevant, e.g., for replacement of edge beams. | If the stability cannot be demonstrated, safety against overturning shall be provided, e.g., in the form of diaphragms and full-height cross braces with a centre distance of max. 2.0 m in the transverse direction.  Longitudinal safety against overturning shall be placed above support lines for rafters and joists. Deviations from this may, however, be accepted if there is calculated verification for this. |
|  | When designing safety against overturning, joints between rafters/joists and bases or form skin shall be considered as hinges. |
|  | For falsework in Consequence Class CC3, safety against overturning shall always be provided to protect against the progressive collapse of rafters and joists , cf. DS 2427:2011 Annex C, Section C.5.4. |
|  | The horizontal load Q3 shall be used as loads, see DS 2427:2011 Annex C, Section C.5.1, plus the tilting load corresponding to the maximum grad­ient of the base in the section being considered, since rafters and joists shall be assumed to be erected perpendicular to the base. The load shall be assumed to act at the same level as the underside of the form skin. |
|  | If the pressure from the cast displaces the rafter from its plane, this contribution shall be included. Stabilising contributions from end casts at bridge ends may not be included in the dimensioning. |
|  | The rafters and joists shall be designed for the additional forces imposed by the safety against overturning. |
|  | Where cassettes are used, each cassette shall be individually safeguarded against overturning. |
|  | When designing diaphragms and cross braces, a traditional board or plywood formwork (t > 20mm) can be assumed to have sufficient plate action effect to distribute the loads locally to the nearest diaphragms and cross braces, if all parts of the formwork are connected to the rafters via mechanical connections (nails or screws) at a maxim­um distance of 250mm along each individual rafter. |
|  | Foundation |
| On robustness it should be added for foundation: | Usual foundations (and soil) and piles are not considered to be key elements in documentation of robustness in CC3.  For foundations on and close to slopes, a resultant safety greater than 1.20 shall be obtained when verifying the slope stability. |
| For steel plate foundation it should be added: | The use of sheet steel foundation is not permitted in CC3.  When verifying steel plate foundations, the steel plate shall be considered to be divided into individual foundations for each falsework leg (load point). The following conditions and procedure shall be applied:   * Steel plates cannot be considered to offer load distribution between individual load points due to the limited rigidity. When calculating the load-bearing capacity of the soil, this shall, therefore, be based on the critical yield line pattern/yield line method for each individual load point. Where the reaction distributions overlap, the plate can be considered as a continuous single foundation affected by dense point loads. Points are considered to be dense, where the distance is less than 500mm for a plate thickness of 10mm, less than 600mm for a 14mm plate and less than 800mm for a plate thickness of 25mm. * For verification of the stress of the steel plate, this shall be based on a uniformly divided reaction distribution from the soil equal to the most critical load situation for the steel plate for each load point. * Stresses in the steel plate shall be determined for sections perpendicular to the primary load-carrying directions. When verifying, it is permitted to distribute the torque evenly across a width equal to the width of the reaction distribution in each primary load-carrying direction, and it is permitted to determine the load-carrying capacity using the plastic modulus of resistance. Where the critical section goes through any cut-outs or apertures, the load-carrying capacity shall be reduced accordingly. |
|  | Loads |
| The following shall be added under loads: | The payload Q2 covers loads from both fresh and hardened concrete. Loads from fresh concrete shall be considered as a free variable load, while loads from hardened concrete shall be considered as a bound load. |
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| Verification of falsework over road against impacts. | Falsework systems above and/or along underpasses need not be calculated for impacts, but shall be secured in another way against impacts. |
|  | Deformations |
|  | Structures for lowering |
| In case the bridge is to be lowered, this shall be stated: | Physical lateral steering mechanisms shall be provided for the lowering of bridge decks. |
|  | Shimming that temporarily supports the bridge deck in the elevated position shall be designed as described below. |
|  | In general, it applies to the below verifications that imperfections and eccentricities (incl. gradients) exceeding the standard acceptable execution tolerances, cf. relevant sections of DS/EN 1090-2, and additional eccentricities resulting from horizontal movements during lowering shall be included in the calculations. |
|  | Lowering arrangement with lateral steering  At least 2 physical lateral steering mechanisms shall be provided for the lowering of bridge decks.  The lateral steering shall be provided and designed such that:   * It protects against horizontal movements and rotations of the bridge deck in connection with the lowering; * It ensures that the overall stability of the bridge deck, since jacks and shimming shall not be considered to contribute to the absorption of global horizontal forces. |
|  | The lateral steering shall be able to absorb a global horizontal load (mass load), whose characteristic value is established as 2.5% of the associated characteristic vertical force from the total dead load of the bridge deck. The force shall be assumed to be able to act in any horizontal direction. Reactions from the lateral steering shall be transmitted to the ground. |
|  | Lateral steering shall provide sufficient rigidity. The maximum horizon­tal movement of the bridge deck may not exceed 20mm, including contributions from the lateral steering mechanism’s free motion. The lateral steering mechanism’s free motion may not exceed 10mm at the commencement of the lowering, distributed with 5mm to either side. |
|  | Each support, consisting of either jack or stack and associated support structure, shall be designed for the worst possible out-of-plumb installation of the individual components (jacks, stacks, supports). It shall be assumed that individual components can be 2.5% out of plumb. Based on this, the sub-elements and the foundation shall be verified for the following load combinations, since the above supports can be calculated as being supported horizontally by the bridge deck. |
| The tender documents shall contain information on reactions from the lowering, both when jacks carry the deck and when shimming supports the deck. The sensitivity to the reaction distribution due to differ­ences in the lowering shall be stated. | The vertical reactions on jacks and shimming shall be calculated based on the actual location, geometry and displacement of the supports, jacks, stacks and foundation. The magnitude of the reactions shall be assessed as a function of the displacement using the 3D FE model of the bridge deck used by the designer of the bridge deck. It cannot be expected that the reactions will be evenly distributed. The Contractor shall provide information on the rigidity of the sub-components included in the lowering equipment. |
|  | The following basic load conditions shall be applied in the design of the structures for lowering incl. foundations:   1. Load scenarios corresponding to equation (6.10b) for STR/GEO Set (B), where the horizontal mass load is regarded as an imposed load. A partial coefficient of 1.40 shall be applied to the horizon­tal mass load. For the vertical dead load, a partial coefficient of 1.0 is used regardless of whether it is destabilising or stabilising. In addition, KFI shall be applied to the destabilising loads. Natural loads are not applied in this load scenario. 2. Load scenarios corresponding to equation (6.10a) for STR/GEO Set (B), where the permanent load is dominant. In this case, a partial coefficient of 1.25 shall be applied for the dead load. The horizontal mass load shall be assumed to be fully correlated with the vertical load corresponding to the same partial coefficient as is used for both vertical and horizontal loads. In addition, KFI shall be applied to the destabilising loads. Natural loads are not applied in this load scenario. 3. Impact load and possible other accidental loads in accordance with load combination 4, as specified in DS2427: 2011 section C.5.1. |
|  | Under the above procedure, lateral steering is allowed to be con­sidered as a non-key element in the documentation of robustness. |
|  | Shimming for temporary support of the bridge deck.  Shimming and associated supports intended to carry the bridge deck after tensioning but prior to the installation of lateral steering and lowering shall be designed for the aforementioned loads and load scenarios while, at the same time, it shall be verified that the globally acting horizontal mass load and any impact loads can be absorbed. The bridge deck cannot be considered a horizontal support point for absorption of these loads.  For bridges longer than 120m, it shall be documented that movem­ents from creep, shrinkage and temperature can be absorbed with­out reducing the safety of the shimming. |
| If lowering without lateral steering is accepted, the following shall be added: | Lowering arrangement without lateral steering  Physical lateral steering may be omitted where the following is satisfied:   * A documented measuring program is implemented for the monitoring of both vertical and horizontal movements during the entire lowering procedure. * During the entire lowering procedure, there shall be suf­fic­ient equipment on site for the correction of horizontal move­ments (reversing). In case of deviations greater than 20mm, a correction shall be effected. * Where lowering is permitted without lateral steering, jacks and other lifting and lowering devices and associated sup­ports shall be designed for the above-mentioned loads and load scenarios while, at the same time, it shall be verified that the globally acting horizontal mass load and any impact load can be absorbed. * For the purpose of the verification, the horizontal load shall be distributed across the support points based on rigidity and an additional eccentricity of 50mm shall be assumed for the support points as a result of unintended lateral move­ment of the bridge deck. * Documentation of robustness shall be according to relevant regulations for both temporary and permanent construction elements involved in the lowering. |
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| The following text shall be added regarding requirem­ents for lowering equip­ment, etc., that is adapted to the actual task to the extent necessary: | The Contractor shall plan, dimension and design the entire arrangement for:   * Establishment, installation and removal of interim structures for lowering of the bridge deck * Safety equipment, including any emergency power supply * Hydraulic or other system for lowering, including calibration * Equipment for controlling the lowering, including: * Equipment for protection against overloading of the supports that carry the jacks * Equipment for ensuring that requirements for differential deformations are not exceeded * Lateral steering. |
|  | Machinery and equipment for lowering shall be planned, dimens­ioned and designed pursuant to the Machinery Directive, cf. the Danish Work­ing Environment Authority's Executive Order No. 612 of 25 June 2008, "Design and layout of technical aids" with sub­sequent amend­ments. Accordingly, a risk assessment shall be prepared. The Machinery Direct­ive 2006/42/EC with subsequent amendments shall be complied with. |
|  | In the risk assessment, the Contractor shall, in addition to compliance with the requirements set out in the Machinery Directive, document:   * That all construction parts and equipment comply with requirements for clearance profiles, * That the work does not involve a risk of falling, * That access conditions meet the needs and requirements, * That there are no loose objects that can fall down, * That there is no risk of outflow or dripping of liquids onto the carriageway, * That the bridge structure can be supported by shimming that 'catches' the structure and secure against uncontrollable settling if a hydraulic or mechanical component fails, * That permissible differential movements in connection with the lowering can be measured continuously, and that cor­rections can be made continuously at each individual support point, including that measurements and the control of the lowering are based on at least 2 independent systems. |
|  | The following shall be complied with, especially for the jacks:   * The jacks shall be tested before lowering, including a trial lift with the expected load and subsequent relief * The jacks shall be fitted with a safety nut, or it shall be ensured in some other way that there is no sudden settling due to the loss of oil pressure * The lowering function shall take place via electrically operated control stations or similar * Pressure in cylinders shall be measurable and controlled individually * If supports are lifted in groups, the force distribution for each support shall be distributed evenly, e.g., through hydraulically coupled cylinders. |
|  | materials |
|  | Falsework |
| If the aim is to permit the use of new products, e.g., PEHD sheets as support for the falsework towers, the following should be added:  A higher degree of safety may be prescribed. | New products that are not covered in the design basis for falsework in GWS may in exceptional cases be approved, if documentation is available to show:   * Characteristic strength properties for both short-term and long-term conditions, defined in accordance with the principles described in DS/EN 1990, including DK NA, which cover all relevant forms of rupturing such as bending, displacement, pressure and tension as well as concentrated pressure * Representative work curves for both short-term and long-term conditions for relevant impacts * Deformation properties for both short-term and long-term conditions for relevant impacts * Durability properties regarding relevant environmental impacts, including UV radiation, etc. * Previous use of the product for similar purposes. |
|  | Formwork |
| The use of toothed plate con­nectors is permitted under special circumstances. | Toothed plate connectors may be used for rafter joints, provided the following requirements are met:   * Completely new rafters shall be used, manufactured for the actual project. However, rafters may be re-used, where the bridge deck is cast in two or more phases, if a supplementary procedure is available to ensure that the toothed plates do not work their way out of the wood. * Galvanised tooth plates with a thickness of at least 1.3mm and tooth length of at least 14mm * The toothed plate connectors shall be calculated corresponding to Usage Class 3 for both wood and toothed plate connectors (and other joining elements), unless Usage Class 2 is permitted. * A method description shall be prepared for setting up the rafters, which ensures that the rafters are set up corresponding to the support conditions as assumed in the calculations (location of lattice nodes in relation to support lines/points, etc.). * The method description shall also account for the storage of rafters on the site, including necessary covering, etc. * The drawings shall specify tolerances for the installation (location in relation to support lines/points, distance between rafters, etc.). |
|  | The rafters shall be included in the control plan (execution control and incoming inspection as well as checking concerning the erection). The plan shall also contain a spot check to be carried out no earlier than a few days prior to casting to ensure that the toothed plates have not worked themselves out. |
| Here, it shall be stated whether tests should be performed to verify the strength, stiffness and/or surfaces of the formwork systems. |  |
|  | Board form (rough and planed) |
| For board formwork, the construction of the form shall be stated for all visible surfaces of the bridge, inclu­d­ing the bridge façade, the soffit of the bridge deck, columns, end columns, wings, the soffit of the tunnel deck and tunnel walls.  In addition, requirements for board direction (vertical/ horizontal) and any require­ments for location of laps shall be stated. |  |
| For non-visible surfaces, any relaxed requirements shall be stated. |  |
|  | Panel form |
| Provisions concerning the allowed or required use of panel form and special requirements for such use shall be stated: | The use of panel form is allowed if, as far as possible, the slabs are of the same size and shape. Size and lap location shall be determined in advance by agreement with the supervision. |
|  | Execution |
|  | Falsework |
|  | Foundation |
| Provisions on the depth, to which the concrete foun­dations of the falsework shall be removed or piled foundations shall be cut off, shall be stated.  Requirements that the outermost row of posts along an opening for traffic shall be founded on a continuous concrete foundation shall be stated together with the depth of the foundation. |  |
|  | Wooden sleepers (railway sleepers and timber joists) shall not be used as falsework foundations in Consequence Class CC3. |
|  | Steel plates shall be laid out so that there is full contact with the underlying compacted gravel bed. |
|  | Design and erection |
| The following should be added under design and erection: | Form-supporting elements, e.g., rafters and joists as well as cassettes shall be mechanically attached to the form skin (form boards, plywood boards, etc.) at the top and to tapers at the bottom, so that the form-supporting elements and shimming/support wedges cannot move during casting.  Shimming shall be made of C14 construction wood or a more rigid/ stronger material. |
|  | Shimming of form or form-supporting elements shall, as far as possible, be designed as coherent shimming strips. Shimming strips shall be placed centrally on the underlying girder with a maximum deviation of ±10mm and shall be fixed at each end and in between at a maximum spacing that ensures that the above tolerance is complied with everywhere after erecting rafters, joists and cassettes. |
|  | Point-wise shimming of formwork or form-supporting elements shall be placed centrally on the underlying girder with a maximum deviation of ±10mm. The total length of the shimming perpendicular to the rafters/joists shall be at least 200mm. The distance from the outside of the rafters/joists to the edge of the point-wise shimming shall be at least 40mm. Each point-wise shimming shall be attached to the rafters/joists and/or to the underlying structure. |
|  | For inspection purposes, point-wise shimming is not permitted where a working deck or similar is provided between the girder and the shimming. When using shimming strips placed on top of the working deck, it shall be ensured that the position of the underlying steel girders is precisely marked by means of screws or nails or inspection holes. |
|  | Continuous transverse braces for rods under pressure in lattice rafters shall be secured to diaphragms or similar. The transverse bracing shall be implemented without joints between the diaphragms. |
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| Tolerances for placement of steel components/ elements. | Individual steel components/elements, including loose centring strips, cannot be expected to be placed with a tolerance less than ±20mm.  In case a physical template or similar is used to control the location, the tolerance may be reduced to ±5mm. |
| Steel crossbeams below and/or above steel columns. | Steel crossbeams placed above and/or below columns in a row of columns, carrying the longitudinal girders, shall be provided with welded body bracing at the support points, unless there is detailed computational evidence that they can be dispensed with or replaced by another solution. |
|  | **Impact protection of falsework** |
|  | Reference is made to SWS Workplace. |
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|  | **Impact protection during lowering** |
|  | Reference is made to SWS Workplace. |
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|  | Formwork |
|  | Tightness and design |
| Specification of where triangle strips in visible, outward edges are not wanted.  If vertical board form is permitted using rough boards, this should be stated.  It shall be stated where surface formwork is required. |  |
| In case of hollow concrete cross sections to which manholes are not estab­lished, this should be stated. | Design and location of openings for removal of formwork for recesses and voids shall be submitted to the supervision for approval. |
|  | 3.2.3 Anchorage of lateral formwork |
| Special requirements for construction and location of tie bars and formwork plugs for visible surfaces should be stated. |  |
|  | Structures for lowering |
| The following should be added where lowering is part of the project: | Jacks shall be mounted vertically. In this connection, a method description shall be available for the levelling and fixing of jacks to ensure that they are plumb. |
|  | Stacks and supports shall be placed vertically and comply with the assumed tolerances to limit any eccentricities. The maximum permiss­ible lifting force from each jack shall be indicated on the drawings. |
|  | Stacks, bricks and similar made of concrete are not permitted to be used unless the concrete is held together effectively across the steel profiles. |
| Requirements shall be added for geometry check in connection with lowering.  The text shall be adapted to the specific project. | Before beginning the lowering, the Contractor shall carry out a geometric check of the bridge deck by levelling, at a minimum of two points in each support line, so that the lowering can be corrected during its execution in accordance with these starting positions. |
|  | During lowering of the bridge deck and during lifting of the bridge deck from the falsework, the maximum vertical difference relative to the theoretically correct location between two supports in the longitudinal direction of the bridge must not “……..” mm. In order to limit the skewed rotation of the bridge deck and the differential deflection, the deviation shall not exceed ”……..” mm measured across the outer contour lines of the bridge deck on the soffit. |
|  | It shall be ensured that "difference settling" in the event of the failure of a jack does not lead to exceeding the above values, e.g., when using mechanical locking rings or the like. The lifting capacity of the jacks shall not exceed the load-carrying capacity of the interim structure, unless it is otherwise ensured and documented that the interim structures will not be overloaded. |
|  | The Contractor shall continuously document that the above require­ments for "differential settlements" have been complied with during the lowering (per maximum 100mm lifting/lowering), and also con­tinuously check oil pressure in jacks and piston travel. If necessary, a correction shall be made relative to the position at the beginning of the lowering. |
|  | Following the lowering, the following tolerances shall be observed:   * The vertical difference relative to the theoretically correct location between two supports in the longitudinal direction of the bridge must not exceed ± “…….” mm. * Across the bridge deck, the deviation must not exceed ± “……..” mm measured between the outer contour lines of the bridge deck on the soffit. |
|  | checking |
| The following text should be inserted regarding checking: | All component assemblies in the falsework shall be inspected after installation.  If containment measures or covers prevent inspection, they shall be dismantled, or inspection hatches provided.  Where continuous shimming strips are used for the form, the location shall be checked at each end of the girder and continuously for each 3.0m both before and after installation. |
|  | Where point-wise shimming of rafters and joists is used, the location shall be checked for each and every shimming point. |
|  | **Milestone inspection** |
|  | Milestone inspections shall be carried out if, during the falsework work, there are situations where a partial work can advantageously be checked, e.g., because it would be difficult to inspect later, or because an inspection can determine whether the partial work has been carried out correctly. The work can then be continued without having to repeat the inspection of the approved partial work later.  The Contractor shall plan and convene the milestone inspections, and these invitations shall appear in the construction meeting minutes.  For falsework in CC3, at least two milestone inspections shall be carried out for ordinary falsework:   * When the Contractor is ready to install the parts of a falsework that are to be placed over any clearance profile at trafficked areas * When the Contractor is ready to begin the erection of rafters and formwork. |
|  | In both cases, the Contractor shall submit the necessary document­ation to the supervision no later than 24 hours before the milestone inspection is to be carried out, e.g., including foundation parameters, compaction checks and measurements.  The milestone inspection involves the Contractor and the super­vision, as well as the key persons who have participated in the work to date, including, e.g., the Falsework Coordinator, the Falsework Engineer, the Falsework Inspector and Falsework Assessor - cf. the terms in the Supervision Handbook on Falsework.  The Contractor shall, no later than 3 days after the milestone inspect­ion, prepare a report of the milestone inspection, including any action points and forward this to the supervisor and the Client. These minutes shall be considered at the next construction meeting. |
|  | **Rafters with tooth plates** |
|  | It shall be checked 96 hours, at the earliest, before casting that the tooth plates in the rafters are still pressed all the way into the wood. The joint between the rafter wood and the underside of the tooth plate shall not exceed 1mm and shall not appear on more than 25% of the anchorage area in any structural part in any joint. All visually accessible joints shall be inspected. If the presence of air is detected in the joint, it shall be measured. A control record shall be prepared, which shall be approved by the Rafter Supplier. |
|  | **Rafters and joists classified as Use Class 2** |
|  | Checking the moisture content by performing systematic representative moisture measurements immediately before casting for documentation that the moisture content limit has not been exceeded. |
|  | **Inspection of welds** |
|  | Inspection of welds shall be carried out in accordance with the requirements for the assumed Execution Class (EXC) as specified in DS/EN 1090-2 and in accordance with what is otherwise assumed in the project. Inspection of welds shall be pursuant to DS/ISO 17635. |
| Checking edge seams on existing falsework equip­ment, designed according to previous standards | Existing scaffolding equipment with fillet welds with an effective throat thickness of up to 12mm, designed according to previously applicable standards, shall be able to meet the requirements for checking corre­sponding to the required Execution Class (EXC) when assessing conditions. |
|  | Structures for lowering |
| The following should be added when lowering is part of the project: | The gradient shall be measured for all jacks. The deviation from the vertical shall not exceed 0.5%. |

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| **Appendix 1 Competence form for Falsework Coordinator (Falsework Engineer)** | | | |
| Name |  | | |
| Education and seniority |  | | |
| Position |  | | |
| Responsibility in the project |  | | |
| Related tasks within the last 3 (5) years | | | |
| Project title and short project description | | **Responsibility in the project** | **Brief description of falsework and lowering structures that the task includes (type, size, etc.)** |
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