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Republic of the Philippines
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
OFFICE OF THE SECRETARY
Manila

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DEPARTMENT ORDER) SUBJECT : **DPWH Standard Specifications for Forms and Falseworks, Item 414**
No. 50)
Series of 2006) 10.09.06

In line with the mandate of the Department in providing effective standard specifications to be used in the implementation of various infrastructure projects and in view of the need of setting standard specifications for forms and falseworks, the attached DPWH Standard Specifications for Forms and Falsework, Item 414, are hereby prescribed for the guidance and compliance of all concerned.

These specifications shall form part of the DPWH Standard Specifications (Volume II - Highways, Bridges and Airports).

This Order shall take effect immediately.

HERMOGENES E. ERDANE, JR.
Acting Secretary

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DPWH STANDARD SPECIFICATION FOR

ITEM 414 FORMS AND FALSEWORKS

414.1 Description

This Item shall consist of designing, constructing and removing forms and falsework to temporarily support concrete, girders and other structural elements until the structure is completed to the point it can support itself.

414.2 Material Requirements

414.2.1 Formwork

The materials used for smooth form finish shall be plywood, tempered concrete-form-grade hardboard, metal, plastic, paper or other acceptable materials capable of producing the desired finish for form-facing materials. Form-facing materials shall produce a smooth, uniform texture on the concrete. Form-facing materials with raised grain, torn surfaces, worn edges, patches, dents, or other defects that will impair the texture of concrete surfaces shall not be permitted. No form-facing material shall be specified for rough form finish.

414.2.1.1 Formwork accessories

Formwork accessories that are partially or wholly embedded in concrete, including ties and hangers shall be commercially manufactured. The use of non fabricated wire form ties shall not be permitted. Where indicated in the Contract, use form ties with integral water barrier plates in walls.

414.2.1.2 Formwork release agents

Commercially manufactured formwork release agents shall be used to prevent formwork absorption of moisture, prevent bond with concrete, and not stain the concrete surfaces.

414.2.2 Falsework

The materials to be used in the falsework construction shall be of the quantity and quality necessary to withstand the stresses imposed; it may be timber or steel or a combination of both. The workmanship shall be of such quality that the falsework will support the loads imposed on it without excessive settlement or take-up beyond as shown on the falsework drawings.

414.3 Construction Requirements

414.3.1 Design

Falsework and Formworks design and drawings shall be in accordance, with Item 407 Concrete Structure subsection 407.3.9 and 407.3.12 respectively.

414.3.1.1 Formwork and Falsework Drawings

When complete details for forms and falseworks are not shown, prepare and submit drawings to the Engineer, showing the following:

1. Details for constructing safe and adequate forms and falsework that provide the necessary rigidity, support the loads imposed, and produce in the finished structure the required lines and grades. See subsection 414.3.1.2 for design loads. See Subsection 414.3.1.3 for design stresses, loadings and deflections. See subsection 414.3.2 for manufactured assemblies.

2. The maximum applied structural load on the foundation material. Include a drainage plan or description of how foundations will be protected from saturation, erosion, and/or scour see subsection 414.3.3.1.

3. The description of all proposed material. Describe the material that is not describable by standard nomenclature (such as AASHTO or ASTM specified) based on manufacturer's test and recommended working loads. Provide evaluation data for falsework material showing that the physical properties and conditions of the material can support the loads assumed in the design.

4. The design calculations and material specifications showing that the proposed system will support the imposed concrete pressures and other loads. Provide an outline of the proposed concrete placement operation listing the equipment, labor, and procedures to be used for duration of each operation. A superstructure placing diagram showing the concrete placing sequence and construction joint locations shall be included.

5. Design calculations for proposed bridge falsework. A registered professional engineer proficient in structural design shall design, sign, and seal the drawings. The falsework design calculations shall show the stresses and deflections in load supporting members.

6. Anticipated total settlements of falsework and forms shall be shown. Include falsework footing settlement and joint take-up. Design for anticipated settlements not to exceed 20 millimeters. Design and detail on falsework supporting deck slabs and overhangs on girder bridges so there is no differential settlement between the girders and the deck forms during placement of deck concrete. Design and construct the falsework to elevations

that include anticipated settlement during concrete placement and required camber to compensate for member deflections during construction.

7. Support system for form panels supporting concrete deck slabs and overhangs on girder bridges.

8. Details for strengthening and protecting falsework over or adjacent to roadways and railroads during each phase of erection and removal. See subsection 414.3.3.2.

9. Intended steel erection procedures with calculations in sufficient detail to substantiate that the girder geometry will be correct. See subsection 414.3.3.3.

Details of proposed anchorage and ties for void forms shall be submitted. See subsection 414.3.4 for void form requirements.

Separate Falsework drawings for each structure shall be submitted to the Engineer for approval, except for identical structures with identical falsework design and details.

414.3.1.2 Design Loads for Forms and Falsework

414.3.1.2.1 Vertical Design Loads

Dead loads include the mass of concrete, reinforcing steel, forms and falsework. Consider the entire superstructure, or any concrete mass being supported by falsework to be a fluid dead load with no ability to support itself. If the concrete is to be prestressed, design the falsework to support any increase or readjusted loads caused by the prestessing forces.

The assumed density of concrete, reinforcing steel, and forms shall be not less than 2600 kilograms per cubic meter for normal concrete and not less than 2100 kilograms per cubic meter for lightweight concrete.

Consider live loads to be actual mass of equipment to be supported by falsework applied as concentrated loads at the point of contact plus a uniform load of not less than 1000 pascals applied over the area supported, plus 1100 newtons per meter applied at the outside edge of the deck falsework overhangs.

The total vertical design load for falsework shall be the sum of vertical dead and live loads. The total vertical design load used shall be not less than 4800 pascals.

414.3.1.2.2 Horizontal Design Loads

Use an assumed horizontal design load on falsework towers, bents frames and other falsework structures to verify lateral stability. The assumed horizontal load is the sum of the actual horizontal loads due to equipment construction sequence, or other causes and an allowance for wind. However, in no case is the assumed horizontal load shall be less than 2 percent of the total supported dead load at the location under consideration.

The minimum wind allowance for each heavy-duty steel shoring having a vertical load carrying capacity exceeding 130 kilonewtons per leg is the sum of the products of the wind impact area, shape factor and the applicable wind pressure value for each height zone. The wind impact area is the total projected area of all elements in the tower face normal to the applied wind. Assume the shape factor for heavy duty shoring to be 2.2. Determine wind pressure value from Table 1.

Table 1
Design Wind Pressure-Heavy Duty Steel Shoring

Height Zone Above Ground meter	Wind Pressure Value-Pa	
	Adjacent To Traffic	At Other Locations
0	960	720
9-15	1200	960
15-30	1450	1200
Over 30	1675	1450

The minimum wind allowance on all other types of falsework, including falsework supported on heavy-duty shoring, is the sum of the products of the wind impact area and the applicable wind pressure value for each height zone. The wind impact area is the gross projected area of the falsework and unrestrained portion of the permanent structure, excluding the areas between falsework posts or towers where diagonal bracing is not used. Used design wind pressures from Table 2.

Table 2
Design Wind Pressure-Other Types of Falsework

Height Zone Above Ground meter	Wind Pressure Value-Pa	
	For Members Over and Bents Adjacent to Traffic Openings	At Other Locations
0	320 Q	240 Q
9-15	400 Q	320 Q
15-30	480 Q	400 Q
Over 30	560 Q	480 Q

Note: Q=0.3+0.2*W*, but not more than 3. *W* is the width of the falsework system in meters measured in the direction of the wind force being considered

414.3.1.2.3 Lateral Fluid Pressure

For concrete with retarding admixture, fly ash or other pozzolan replacement for cement, design form, form ties and bracing for a lateral fluid pressure based on concrete with a density of 2400 kilograms per cubic meter. For concrete containing no pozzolans or admixtures, which affect the time to initial set, the lateral fluid pressure shall be determined based on concrete temperature and rate of placement according to ACI Standard 347R, Guide for Formwork for Concrete.

414.3.1.3 Design Stresses, Loads and Deflections for Forms and Falsework

The allowable maximum design stresses and loads listed in this section are based on the used of undamaged high-quality material. If lesser quality material is used, reduce the allowable stresses and loads. The following maximum stresses, loads and deflections in the falsework design shall not be exceeded.

414.3.1.3.1 For Timber

Compression perpendicular to the grain = 3100 kilopascals

Compression parallel to the grain (1) $= \frac{3309}{(L/d)^2}$ megapascals

Note: (1) Not to exceed 11 megapascals

Where:

L = Unsupported length

d = Least dimension of a square or rectangular column or the width of a square of equivalent cross-sectional area for round columns

Flexural stress = 12.4 megapascals

Note: Reduced to 10 megapascals for members with a nominal depth of 200 millimeters or less

Horizontal shear = 1300 kilopascals

Axial tension = 8.3 megapascals

Deflection due to the mass of concrete may not exceed 1/500 of the span even if the deflection is compensated for by camber strips

Modulus of elasticity (E) for timber = 11.7 gigapascals

Maximum axial loading on timber piles = 400 kilonewtons

414.3.1.3.2 For Steel

For identified grades of steel the design stresses (other than stresses due to flexural compression) specified in the Manual of Steel Construction as published by the AISC shall not be exceeded.

When the grade of steel cannot be positively identified, the design stresses other than stresses due to flexural compression shall not be exceeded, either specified in the AISC Manual or ASTM A 36M structural steel or the following:

Tension, axial and flexural = 150 megapascals

Compression, axial = $110\,000 - 2.6(L/r)^2$ kilopascals

Note: L/r shall not exceed 120

Shear on the web gross section of rolled shapes = 100 megapsacals

Web crippling for rolled shapes = 185 megapascals

For all grades of steel, do not exceed the following design stresses and deflection:

Compression flexural[(1)] = $\frac{82,750}{Ld/bt}$ megapascals

Note: (1) Not to exceed 150 megapascals for unidentified steel or steel conforming to ASTM A 36. Not to exceed 0.6 F_y for other identified steel.

Where:

L = Unsupported length

d = Least dimension of a square or rectangular column or the width of square of equivalent cross-sectional area for round columns or the depth of beams

b = Width of the compression flange

t = Thickness of the compression flange

r = Raduis of gyration of the member

F_y = Specified minimum yield stress for the grade of steel used

Deflection due to the mass of concrete may not exceed 1/500 of the span even if the deflection is compensated for by camber strips.

Modulus of elasticity (E) for steel = 210 gigapascals

414.3.1.3.3 Other requirements

Limit falsework spans supporting T-beam girder bridges to 4.3 meters plus 8.5 times the overall depth of T-beam girder.

414.3.2 Manufactured Assemblies

For jacks, brackets, columns, joist and other manufactured devices, the ultimate load carrying capacity of the assembly shall not exceed the manufacturer's recommendations or 40 percent based on the manufacturer's tests or additional tests ordered. The maximum allowable dead load deflection of joists shall be 1/500 of their spans.

Catalog or equivalent data shall be submitted to the Engineer showing the manufacturer's recommendations or perform tests, as necessary to demonstrate the adequacy of any manufactured device proposed for use. No substitution is allowed on manufacturer's components unless the manufacturer's data encompasses such substitutions or field tests reaffirm the integrity of the system.

If a component of the falsework system consists of a steel frame tower exceeding 2 or more levels high, the differential leg loading within the steel tower unit shall not exceed 4 to 1. An exception may be approved if the manufacturer of the steel frame certifies, based on manufacturer's tests, that the proposed differential loadings are not detrimental to the safe load carrying capacity of the steel frame.

414.3.3 Falsework Construction

The falsework construction shall be in accordance whenever applicable, with Item 407 Concrete Structure subsection 407.3.10 Falsework Construction.

414.3.3.1 Falsework Foundations

All ground elevations at proposed foundation location shall be verified before design.

Where spread footing type foundations are used, determine the bearing capacity of the soil. The maximum allowable bearing capacity for foundation material, other than rock, is 190 kilopascals.

The edge of footing shall not be located closer than 300 millimeters from the intersection of the bench and the top of the slope. Unless the excavation for footings is adequately supported by shoring, the edge of the footings shall not be closer than 1.2 meters or the depth of excavation, whichever is greater, from the edge of the excavation.

When falsework is supported by footings placed on paved, well-compacted slopes of berm fills, do not strut the falsework to columns unless the column is founded on rock or supported by piling.

The spread footings to support the footing design load at the assumed bearing capacity of the soil shall be designed without exceeding anticipated settlements. Steel reinforcement shall be provided in concrete footings.

When individual steel towers have a maximum leg loads exceeding 130 kilonewtons, uniform settlement under all legs or each tower under all loading conditions shall be provided.

Protect the foundation from adverse effects for the duration of its use.

414.3.3.2 Falsework Over or Adjacent to Roadways and Railroads

Falsework shall be designed and constructed to be protected from vehicle impact. This includes falsework posts that support members crossing over a roadway or railroad and other falsework posts if they are located in the row of falsework posts nearest to the roadway or railroad and if the horizontal distance from the traffic side of the falsework to the edge of pavement or to a point 3 meters from the centerline of track is less than the total height of the falsework.

Additional features shall be provided to ensure that this falsework will remain stable if subjected to impact by vehicles. Use vertical design loads for these falsework posts, columns, and towers (but not footings) that are greater than or equal to either of the following:

1. 150 percent of the design load calculated according to subsection 414.3.1.2 but not including any increased or readjusted loads caused by prestressing forces.

2. The increased or readjusted loads caused by prestressing forces.

Temporary traffic barriers shall be installed before erecting falsework towers or columns adjacent to an open public roadway. Barriers shall be located so that falsework footings or pile caps are at least 75 millimeters clear of concrete traffic barriers and all other falsework members are at least 300 mm clear. Do not remove barriers until approved.

Use falsework columns that are steel with a minimum section modulus about each axis of 156,000 cubic millimeters or sound timbers with a minimum section modulus about each axis of 4,100,000 cubic millimeters.

Mechanically connect the base of each column or tower frame supporting falsework over or immediately adjacent to an open public road to its supporting footing or provide other lateral restraint to withstand a force of not less than 9 kilonewtons applied to the base of the column in any direction. Mechanically connect such columns or frames to the falsework cap or stringer to resist a horizontal force of not less than 4.5 kilonewtons in any direction. Neglect the effects of frictional resistance.

Brace or tie exterior girders, upon which overhanging bridge deck falsework brackets are hung, to the adjacent interior girders as necessary to prevent rotation of exterior girders or overstressing the exterior girder web.

Mechanically connect all exterior falsework stringers and stringers adjacent to the end of discontinuous caps, the stringer or stringers over points of minimum vertical clearance and every fifth remaining stringer, to the falsework cap or framing. Provide mechanical connections capable of resisting load in any direction, including uplift on the stringer, if not less than 2.2 kilonewtons. Connections shall be installed before traffic is allowed to pass beneath the span.

16 millimeters diameter or larger bolts to connect timber members shall be used to brace falsework bents located adjacent to roadways or railroads.

Sheath falsework bents within 6 meters of the centerline of a railroad track solid in the area between 1 and 5 meters above the track on the side facing the track. Construct sheathing of plywood not less than 16 millimeters thick or lumber not less than 25 millimeters nominal thickness. Adequate bracing shall be provided on such bents so that the bent resists the required assumed horizontal load or 22 kilonewtons, whichever is greater, without the aid of sheathing.

Provide at least the minimum required vertical and horizontal clearances through falsework for roadways, railroads, pedestrians, and boats.

414.3.3.3 Falsework for Steel Structures

Falsework design loads shall consist of the mass of structural steel, the load of supported erection equipment, and all other loads supported by the falsework.

Falsework and forms for concrete supported on steel structures shall be designed so that loads are applied to girder webs within 150 millimeters of flange or stiffener. Distribute the loads in a manner that does not produce local distortion of the web. Do not use deck overhang forms that require holes to be drilled into the girder webs.

Strut and tie exterior girders supporting overhanging deck falsework brackets to adjacent interior girders to prevent distortion and overstressing of the exterior girder web.

Do not apply loads to existing, new or partially completed structures that exceed the load carrying capacity of any part of the structure according to the load factor design methods of the AASHTO Bridge Design Specifications using load group IB.

Build supporting falsework that will accommodate the proposed method of erection without overstressing the structural steel, as required and will produce the required final structural geometry, intended continuity and structural action.

414.3.4 Forms

The forms construction shall be in accordance whenever applicable, with Item 407 Concrete Structure subsection 407.3.13 Formwork Construction.

Form panels to be used shall be in good condition free of defects on exposed surfaces. If form panel material other than plywood is used, it shall have flexural strength, modulus of elasticity and other physical properties equal to or greater than the physical properties for the type of plywood specified.

Furnish and place form panels for exposed surfaces in uniform widths of not less than 1 meter and in uniform lengths of not less than 2 meters except where the width of the member formed is less than 1 meter.

Arrange panels in symmetrical patterns conforming to the general lines of the structure. Place panels for vertical surfaces with the long dimension horizontal and with horizontal joints level and continuous. For walls with sloping footings which do not abut other walls, panels may be placed with the long dimension parallel to the footing.

Form panels shall be precisely aligned on each side of the panel joint by means of supports or fasteners common to both panels.

Use form ties and anchors that can be removed without damaging the concrete surface. Construct metal ties or anchorages within the forms to permit their removal to a depth of at least 25 millimeters from the face without damage to the concrete. Fill cavities with cement mortar and finish to a sound, smooth, uniform colored surface.

Support roadway slab forms of box girder type structures on wales or similar supports fastened, as nearly as possible, to the top of the web walls.

Form exposed curved surfaces to follow the shape of the curve, except on retaining walls that follow a horizontal curve. The wall stems may be a series of short chords if all of the following apply:

1. Chords within the panel are the same length.

2. Chords do not vary from a true curve by more than 15 millimeters at any point.

3. All panel points are on the true curve.

When architectural treatment is required, make the angle points for chords in wall stems fall at vertical rustication joints.

Earth cuts as forms for vertical or sloping surfaces shall not be used unless otherwise required or permitted by the Contract.

414.3.4.1 Stay in place deck forms

Use permanent or stay inplace forms only when permitted by the contract.

Fabricate permanent steel bridge deck forms and supports from steel conforming to ASTM A653M coating designation 2600, any grade except grade 340 class 3.

Install forms according to accepted fabrication and erection drawings. Do not rest form sheets directly on the top of stringer or floor beam flanges. Securely fasten sheets to form supports. Place form supports in direct contact with the stringer flange or floor beam. Make all attachments with permissible welds, bolts or clips. Do not weld form supports to flanges of steels not considered weldable or to portions of flanges subject to tensile stresses.

Clean wire brush and paint 2 coats of zinc dust zinc-oxide primer (FSS TT-P-641 type II no color added) any permanently exposed form metal where the

galvanized coating has been damaged. Minor heat discoloration in areas of welds need not be touched up.

Locate transverse construction joints in slabs at the bottom of a flute. Field drill 6 millimeter diameter weep holes at not less than 300 millimeters on center along the line of the joint.

414.3.4.2 Void forms

Store void forms in a dry location to prevent distortion. Secure the forms using anchors and ties which leave a minimum of metal or other supporting material exposed at the bottom of finished slab.

Make the outside surface of the forms waterproof. Cover the ends with waterproof mortar tight caps. Use premolded 6 millimeters thick rubber joint filler around the perimeter of the caps to permit expansion.

Provide a PVC vent near each void form. Construct vents so the vent tube shall not extend more than 13 millimeters below the bottom surface of the finished concrete after form removal. Protect void forms from the weather until concrete is placed.

414.3.4.3 Metal Forms

The specification for forms relative to design, mortar tightness, filleted corners, beveled projection, bracing, alignment, removal, reuse and oiling also apply to metal forms.

414.3.5 Removal of Forms and Falsework

The removal of forms and falsework shall be in accordance whenever applicable, with Item 407 Concrete Structure subsection 407.3.11 Removing falsework and subsection 407.3.14 Removal of forms and falsework.

Where necessary remove all forms except the following:

1. Interior soffit forms for roadway deck slabs of cast-in-place box girders.

2. Forms for the interior voids of precast members

3. Forms for abutments or piers when no permanent access is available into the cells or voids

Install a reshoring system if falsework supporting the sides of girder stems with slopes steeper than 1:1 are removed before placing deck slab concrete. Design the reshoring system with lateral supports which resist all rotational forces acting on the stem, including those caused by the placement of deck slab concrete. Install the

lateral supports immediately after each form panel is removed and before release of supports for the adjacent form panel.

414.3.6 Acceptance

Forms and falsework (including design, construction, and removal) shall be evaluated and approved by the Engineer.

When the falsework installation is complete and before concrete placement or removal begins, the falsework shall be inspected by the Engineer. The Engineer shall certify in writing that the installation conforms to the contract, the approved falsework drawings (including approved changes) and acceptable engineering practices.

414.4 Method of Measurement

When the Contract stipulates that payment will be made for forms and falsework on lump-sum basis, the pay item will include all materials and accessories needed in the work.

Whenever the Bill of Quantities does not contain an item for form and falsework, the work will not be paid directly but will be considered as a subsidiary obligation of the contractor under other Contract Items.

414. 5 Basis of Payment

The accepted quantities measured as prescribed in subsection 414.4, shall be paid for at the Contract lump-sum price for Forms and Falsework which price and payment shall be full compensation for designing, constructing and removing forms and falsework, all materials and accessories needed and for furnishing all labor equipment tools and incidentals necessary to complete the item.

Payment will be made under:

Pay Item Number	Description	Unit Measurement
414	Forms and Falsework	Lump Sum

References :

1. ACI 301M-99 - Specifications for Structural Concrete - Reported by ACI Committee 301
2. Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, U.S. Department of Transportation, Federal Highway Administration, 1996
3. DPWH Standard Specification for Highways, Bridges and Airports, Volume II (2004)
4. DPWH Standard Specification for Building, Ports and harbor, Flood Control and drainage structures and Water supply systems , Volume III (1995)