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Guide Standard Specification for Bridge Temporary Works



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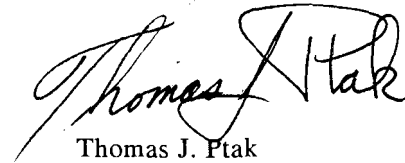
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FOREWORD

This study is part of the Federal Highway Administration's Temporary Works Research Program, conducted as a result of the falsework collapse of the Route 198 bridge over the Baltimore/Washington Parkway, Maryland. This report is intended to act as a guide for the State highway agencies to use in developing their own specification. It will be of interest to bridge falsework design and inspection engineers, contractors, and specification writers.

Additional copies may be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.




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16. Abstract <p>Following the collapse of the Route 198 bridge over the Baltimore/Washington Parkway in 1989, the FHWA established the temporary works research program. The program was guided by the Scaffolding, Shoring, and Forming Task Group as formed by the FHWA. The objective of this report is to develop a guide standard specification that establishes contractual requirements at the bid preparation stage that will apply to all bridge construction projects. Ultimate responsibility for insuring that the requirements are met has been placed on the contractor's registered professional engineer.</p> <p>This report is a series of reports produced under this program. The other reports in this series are:</p> <table border="0" data-bbox="224 1333 1442 1528"> <tr> <td>FHWA-RD-91-062</td> <td>Synthesis of Falsework, Formwork, and Scaffolding for Highway Bridge Structures</td> </tr> <tr> <td>FHWA-RD-93-032</td> <td>Guide Design Specification for Bridge Temporary Works</td> </tr> <tr> <td>FHWA-RD-93-033</td> <td>Certification Program for Bridge Temporary Works</td> </tr> <tr> <td>FHWA-RD-93-034</td> <td>Construction Handbook for Bridge Temporary Works</td> </tr> </table>				FHWA-RD-91-062	Synthesis of Falsework, Formwork, and Scaffolding for Highway Bridge Structures	FHWA-RD-93-032	Guide Design Specification for Bridge Temporary Works	FHWA-RD-93-033	Certification Program for Bridge Temporary Works	FHWA-RD-93-034	Construction Handbook for Bridge Temporary Works
FHWA-RD-91-062	Synthesis of Falsework, Formwork, and Scaffolding for Highway Bridge Structures										
FHWA-RD-93-032	Guide Design Specification for Bridge Temporary Works										
FHWA-RD-93-033	Certification Program for Bridge Temporary Works										
FHWA-RD-93-034	Construction Handbook for Bridge Temporary Works										
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PREFACE

Highway structures have been successfully built for centuries with a highly favorable record of safety and success for both the temporary works needed to erect the structure and the finished project. Virtually every construction contract incorporates requirements that have allowed this enviable record to be obtained. All public and private agencies that have responsibility for numerous structures have both existing standard specifications that establish contractual requirements at the bid preparation stage that will apply to all projects, and supplemental specifications and/or special provisions that will be more project specific.

Recent events, however, have required reexamination of these long-standing contractual requirements and, even though the fully successful projects still vastly outnumber those encountering problems during the construction stage, modifications to standard practices were deemed necessary. This guide standard specification is intended to clarify the intent of the specifications rather than to close gaps that have caused failures. This is necessary more because of the litigious nature of our society than deficiencies in contractors' procedures. But, for whatever reason, this guide has been developed to provide a model with which existing specifications can be compared and revised, if necessary, to better ensure a safe and successful construction project.

A primary purpose of this guide specification is to ensure that temporary works are designed, constructed, inspected, and maintained by persons knowledgeable in the specific requirements of temporary, as opposed to permanent, projects. The temporary works should not have a lower level of safety than the permanent structure. Ultimate responsibility for ensuring that the requirements are met has been placed on the Contractor's registered professional engineer.

This guide standard specification was developed by the Scaffolding, Shoring, and Forming Task Group, as established by the Federal Highway Administration, with assistance from Wiss, Janney, Elstner Associates, Inc., and includes the following representatives from Federal and State governments and industry:

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol	Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH					LENGTH				
in	inches	25.4	millimeters	mm	mm	millimeters	0.039	inches	in
ft	feet	0.305	meters	m	m	meters	3.28	feet	ft
yd	yards	0.914	meters	m	m	meters	1.09	yards	yd
mi	miles	1.61	kilometers	km	km	kilometers	0.621	miles	mi
AREA					AREA				
in ²	square inches	645.2	square millimeters	mm ²	mm ²	square millimeters	0.0016	square inches	in ²
ft ²	square feet	0.093	square meters	m ²	m ²	square meters	10.764	square feet	ft ²
yd ²	square yards	0.836	square meters	m ²	m ²	square meters	1.195	square yards	yd ²
ac	acres	0.405	hectares	ha	ha	hectares	2.47	acres	ac
mi ²	square miles	2.59	square kilometers	km ²	km ²	square kilometers	0.386	square miles	mi ²
VOLUME					VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL	mL	milliliters	0.034	fluid ounces	fl oz
gal	gallons	3.785	liters	L	L	liters	0.264	gallons	gal
ft ³	cubic feet	0.028	cubic meters	m ³	m ³	cubic meters	35.71	cubic feet	ft ³
yd ³	cubic yards	0.765	cubic meters	m ³	m ³	cubic meters	1.307	cubic yards	yd ³
NOTE: Volumes greater than 1000 l shall be shown in m ³ .									
MASS					MASS				
oz	ounces	28.35	grams	g	g	grams	0.035	ounces	oz
lb	pounds	0.454	kilograms	kg	kg	kilograms	2.202	pounds	lb
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")	Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact)					TEMPERATURE (exact)				
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C	°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
ILLUMINATION					ILLUMINATION				
fc	foot-candles	10.76	lux	lx	lx	lux	0.0929	foot-candles	fc
fl	foot-Lamberts	3.426	candela/m ²	cd/m ²	cd/m ²	candela/m ²	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS					FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N	N	newtons	0.225	poundforce	lbf
lbf/in ²	poundforce per square inch	6.89	kilopascals	kPa	kPa	kilopascals	0.145	poundforce per square inch	lbf/in ²

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

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SPECIFICATION

1.0 DESCRIPTION

This work consists of the design, construction, inspection, and removal of temporary works for the construction and repair of highway structures. Such temporary works include, but are not limited to, falsework, formwork, and excavation supports.

Falsework is any temporary construction used to support the permanent structure until it becomes self-supporting. Formwork is the temporary structure or mold used to retain plastic or fluid concrete in its designated shape until it hardens. Access scaffolding is a temporary structure that functions as a work platform that supports construction personnel, materials, and tools, but is not intended to support the structure. Scaffolding systems that are used to temporarily support permanent structures (as opposed to functioning as work platforms) are considered to be falsework under the definitions given. Shoring is a component of falsework such as horizontal, vertical, or inclined support members. Excavation supports are structures used to temporarily hold the surrounding earth and water out of excavations and to protect adjacent property and facilities during construction of the permanent work. Where the term "temporary works" is used, it includes all of the temporary facilities used in bridge construction that do not become part of the permanent structure.

The Contractor is responsible for designing and constructing safe and adequate temporary works that will support all loads imposed and provide the necessary rigidity to produce in the finished structure, the lines and grades shown on the plans.

2.0 MATERIALS

The selection of materials suitable for temporary works is the responsibility of the Contractor; however, it must be consistent with safety and quality required by the design assumptions. Manufactured devices supplied to the jobsite shall be in compliance with the requirements of the *Certification Program for Bridge Temporary Works*. The Engineer shall have authority to reject material on the basis of its condition, inappropriate use, safety, or nonconformance to the plans. Allowable

COMMENTARY

1.0 DESCRIPTION

"Temporary Works" is the preferred term for temporary structures and construction. The other terms defined are also preferred for those elements of construction. Since these terms define portions of the total system, and each have very specific requirements, it is imperative that the definitions be used consistently. It is not intended that only these definitions be acceptable for use, but that the requirements for each of the elements be properly defined.

Access scaffolding is under the jurisdiction of the Occupational Safety and Health Administration's regulations, and/or State and local regulations, and thus is not covered in this specification. Temporary supports for erection of structural steel are covered under temporary works and will fall under the requirements of falsework.

In the tradition of American public works, the Contractor has the ultimate responsibility for satisfactory completion of the work. At the same time, the owner's Engineer has the right and duty to review and approve or disapprove the work where public and individual safety, substantial property damage, and/or project delays are involved.

2.0 MATERIALS

Properly maintained or tested and graded materials adequate to support the design loads are required.

The *Certification Program for Bridge Temporary Works* was developed by the Scaffolding, Shoring, and Forming Institute. It is designed to ensure quality, consistency, and ease of inspection at a jobsite. The program is aimed at the supplier of equipment to the jobsite.

SPECIFICATION

loads or stresses for all materials or manufactured devices shall be clearly identified on the plans. The Contractor shall revise the plan and shall notify the Engineer if any change to materials or material strengths is required. Where the term "Engineer" is used (with a capital "E") it shall mean the owner's Engineer.

3.0 DESIGN REQUIREMENTS

3.1 Design

The design of temporary works shall be in compliance with the requirements of the *Guide Design Specification for Bridge Temporary Works*. When manufactured devices are to be employed, the design shall not result in loads on such devices in excess of the load ratings recommended by the manufacturer.

For equipment where the rated capacity is determined by load testing, the design load shall be as stated in the *Guide Design Specification for Bridge Temporary Works*.

3.2 Working Drawings

The Contractor shall provide working drawings for items specified in the contract, or required by the Engineer, with design calculations and supporting data in sufficient detail to permit a structural and safety review of the proposed design of the temporary work.

When concrete placement is involved, such data shall include the drawings of proposed sequence, rate of placement, direction of placement, and location of all construction joints. The number of copies to be furnished shall be in accordance with the contract requirements.

Whenever a structure spans more than 4.88 m (16 ft) or has a height greater than 4.27 m (14 ft), or whenever traffic, other than workmen involved in constructing the bridge, will travel under the structure, the drawings shall be prepared under the guidance of, and sealed by, the Contractor's registered professional engineer licensed by the State where the temporary work is being built. The

COMMENTARY

3.0 DESIGN REQUIREMENTS

3.1 Design

The Contractor's certification does not relieve the Engineer of the obligation to inspect such manufactured devices to ascertain their condition. Where there is doubt, a replacement load test may be required.

3.2 Working Drawings

FHWA report FHWA-RD-91-062, *Synthesis of Falsework, Formwork, and Scaffolding for Highway Bridge Structures*, identifies 35 States that require a professional engineer's seal on falsework plans. The remaining 15 States do not have specific requirements for the sealing of plans.

SPECIFICATION

engineer shall be knowledgeable in temporary works design.

3.3 Review and Approval

The Engineer is responsible for the review and approval of temporary works' drawings.

The working drawings shall be submitted sufficiently in advance of proposed use to allow for their review, revision (if needed), and approval without delay to the work.

The time required to complete the initial and subsequent reviews will be as stated in the contract. When specified, the Contractor shall submit a schedule showing the proposed dates on which working drawings will be delivered to the Engineer.

The Contractor shall not start construction of any temporary work for which working drawings are required until the drawings have been approved by the Engineer. Such approval will not relieve the Contractor of the responsibility for the correctness and adequacy of the working drawings.

The time period for review of the working drawings does not begin until complete drawings and design calculations are received by the Engineer. The drawings shall not be approved in any case where it is necessary to refer to the calculation sheets for information needed to complete an independent design review.

The drawings shall show all information necessary to allow the design of any component to be checked independently as determined by the Engineer.

If requested by the Engineer, the Contractor shall submit with the working drawings manufacturer's catalog data listing the weight of all construction equipment that will be supported on the temporary work. Anticipated total settlements and/or deflections of falsework and forms shall be shown on the working drawings. These shall include falsework footing settlements, joint take-up, and deflection of beams or girders. Falsework and forms supporting deck slabs and overhangs on girder bridges shall be designed so that there will be no differential settlement between the girders and the deck forms during placement of deck concrete.

COMMENTARY

3.3 Review and Approval

This article emphasizes the need for timely submission of complete and adequate plans for all temporary works. While not spelled out in the specifications, the Engineer is implicitly required to perform a punctual and conscientious review to allow the contract schedules to be met. However, the Contractor also has the obligation to submit documents for review as far in advance as possible, but not less than the minimum specified, to allow the Engineer to perform an adequate review. A safe and successful project is not only to the Owner's and Contractor's advantage, but also to the advantage of the public.

SPECIFICATION

One set of the reviewed and approved working drawings will be returned to the Contractor.

4.0 CONSTRUCTION REQUIREMENTS

Temporary works shall be constructed in conformance with the approved working drawings. The quality of materials and workmanship employed shall be consistent with that assumed in the design of the temporary works. Welding of falsework members to any portion of the permanent structure shall not be allowed unless approved by the Engineer. Any welding to the permanent structure shall be shown on the approved construction drawings.

Tell-tales attached to the forms and extending to the ground, or other means, shall be provided by the Contractor for accurate measurement of falsework settlement. Anticipated compressive settlement and/or deflection of falsework shall not exceed 25.4 mm (1 in). For cast-in-place concrete structures, the calculated deflection of falsework flexural members shall not exceed 1/240 of their span regardless of whether or not the deflection is compensated by camber strips.

4.1 Maintenance and Inspection

The Contractor shall inspect and maintain the temporary work in an acceptable condition throughout the period of its use. The Contractor shall certify that the manufactured devices have been maintained in a condition to allow them to safely carry their rated loads. Each piece shall be clearly marked so that its capacity can be readily determined at the jobsite. Marking of the system shall be in accordance with the *Certification Program for Bridge Temporary Works*, unless determined otherwise by the Engineer.

An indepth inspection of an applicable portion(s) of the temporary works shall be performed, in the presence of the Engineer, not more than 24 hours prior to the beginning of each concrete placement. Other temporary works shall be inspected at least once a month to ensure that they are functioning properly. Cofferdams, shoring, sheathing, support of excavation structures, and support systems for load tests shall be inspected by the Contractor's registered professional engineer prior to loading.

COMMENTARY

4.0 CONSTRUCTION REQUIREMENTS

Welding or tampering with permanent steel structures can be a potential fatigue problem in the life of the structure, therefore this method is discouraged.

4.1 Maintenance and Inspection

The inspections required by this article are also required for shoring used in the erection of structural steel. Because wind loads on structural steel are a primary cause of problems with this type of construction, temporary works include horizontal bracing to ensure stability until the permanent cross frames are installed.

As stated in FHWA report FHWA-RD-91-062, *Synthesis of Falsework, Formwork, and Scaffolding for Highway Bridge Structures*, 15 States put the responsibility of inspection on the Contractor, while 35 States put the responsibility on the State.

SPECIFICATION

The results of the inspections shall be furnished in writing to the Engineer prior to placing concrete or loading the temporary work, with certification that the system(s) meets the requirements of the contract and working drawings. Inspection and certification by the Contractor prior to placing concrete shall be in accordance with applicable sections of the *Certification Program for Bridge Temporary Works*.

4.2 Foundations

The Contractor is responsible for determining the safe bearing capacity of the foundation material on which the supports for temporary works will rest. The Engineer may require load tests to verify proposed bearing capacity values that are marginal or in other high risk situations.

The Contractor may use the foundation support values shown on the contract plans of the permanent structure if the foundations are on the same level and on the same soil as those of the permanent structure.

Site drainage or soil protection must be adequate to prevent soil saturation and washout of the soil supporting the temporary works supports.

If piles are used, capacities may be estimated and later confirmed during construction, using standard procedures based on the driving characteristics of the pile. The Contractor may elect to use load tests to confirm the estimated capacities; or the Engineer may require load tests to verify bearing capacity values that are marginal or in other high risk situations.

Pile and soil bearing capacities proposed by the Contractor shall be reviewed and approved by the Engineer.

5.0 REMOVAL

Unless otherwise permitted by the Engineer, all temporary works shall be removed by and shall remain the property of the Contractor upon completion of the work with care being taken not to disturb or otherwise damage the finished work. The area shall be restored to its original or planned condition and cleaned of all debris.

COMMENTARY

4.2 Foundations

The determination of safe bearing capacity may be based on the guidelines shown in AASHTO's *Standard Specification for Highway Bridges*. Examples of high risk situations are: (1) the use of values from the maximum side of the table without a clear technical basis, (2) uncertainty in the characteristics of underlying subsurface layers, (3) questionable ability to protect the foundation from saturation during construction, or (4) catastrophic consequences of foundation failure.

Where the soil supporting temporary works is subject to saturation or washout by virtue of its location, the design has to accommodate this potential loss of support, or the foundation has to be protected to prevent its occurrence.

Driving piles to refusal with a suitable hammer is an acceptable alternative to test piles or load tests, subject to the Engineer's concurrence. Pile-bearing capacities determined in the same manner as permanent piles may be used in lieu of pile load tests. All estimates should be confirmed, based on the driving characteristics of the pile or, in unusual situations, based on load tests.

SPECIFICATION

Removal of temporary works shall be in conformance with the contract documents. Their removal shall be in such a manner as to permit the structure to uniformly and gradually take the stresses due to its own weight.

6.0 METHOD OF MEASUREMENT

Unless otherwise specified, temporary works shall not be directly measured, but shall be considered incidental to the pay items requiring temporary works.

7.0 BASIS OF PAYMENT

Unless otherwise specified, the payment for temporary works shall be considered included in the contract price for pay items requiring temporary works.

COMMENTARY

6.0 METHOD OF MEASUREMENT

For large structures that involve very substantial investments in temporary works before work on "pay items" begin, the Owner may consider making the temporary works a separate pay item to reduce the front-end costs to the Contractor, which could be passed on to the Owner through hidden charges.

7.0 BASIS OF PAYMENT

A lump sum payment item is recommended if temporary works are a pay item.

REFERENCES

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