STANDARD
STRUCTURAL SPECIFICATIONS
FOR
MUNICIPAL PUBLIC WORKS
CONSTRUCTION

Prepared By

WASHINGTON STATE CHAPTER
AMERICAN PUBLIC WORKS ASSOCIATION

1964

Ron Boehm
Design

CITY OF SEATTLE
DEPARTMENT OF ENGINEERING
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J. D. Braman, Mayor

November 12, 1964

Engineers, Contractors and Material Suppliers:

The enclosed copy of "Standard Structural Specifications for Municipal Public Works Construction," prepared by the Washington State Chapter, American Public Works Association, is being distributed in the Seattle area by the Seattle Department of Engineering. This is a supplement to the "Standard Specifications for Municipal Public Works Construction," published and distributed in 1963.

The City of Seattle plans to use this supplement with such modifications as may appear in an addendum to the "City of Seattle Standard Plans and Specifications, Seventh Edition 1964," which is presently being edited and with any special specifications written for each contract.

Additional information is contained in the Foreword.

ROY W. MORSE
City Engineer

HWT:peg
Enc.

STANDARD STRUCTURAL SPECIFICATIONS FOR MUNICIPAL PUBLIC WORKS CONSTRUCTON

FIFTEEN SECTIONS OF SPECIFICATIONS FOR STRUCTURAL AND RELATED WORK, BEING SUPPLEMENTARY TO THE 1963 EDITION OF "STANDARD SPECIFICATIONS FOR MUNICIPAL PUBLIC WORKS CONSTRUCTION"

Prepared By

WASHINGTON STATE CHAPTER
AMERICAN PUBLIC WORKS ASSOCIATION

1964

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The Association of Washington Cities
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in cooperation with
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FOREWORD

This publication of fifteen sections of Standard Structural Specifications is supplementary to the 1963 edition of "Standard Specifications for Municipal Public Works Construction," prepared under auspices and direction of the Washington State Chapter of American Public Works Association. The structural and related sections herein were purposely omitted from the 1963 edition to enable the printing and distribution of that edition, containing the more commonly used municipal specifications, without further delay. The 15 sections herein are additive to and not corrective of the 1963 parent edition.

Taken together, the 1963 edition of 58 sections and this supplementary publication of 15 sections comprise a complete specification guide for use of engineers, contractors and materials men engaged in municipal construction in cities and towns of Washington.

The circulation of these structural and related specifications, following as they do by one year those in the parent edition, is the culmination of an ambitious goal of the Washington State Chapter to promote uniformity of municipal practices throughout Washington, with resultant benefits to engineers and contractors, and significant savings to the public funds. Incidentally, the production of municipal specifications for universal use of cities and towns of Washington is unique in that it is the only such attempt known in any state.

The formulators of these specifications lay no claim to strict originality in their production. Because of the eminence of the Washington Department of Highways specifications, these structural specifications have been closely patterned after the state specifications of like section titles. There are, however, many variations and changes therefrom, made to reflect policies and practices believed by city engineers to be more suitable in construction of municipal public works. The specifications herein were determined upon by the Committee on Structural Specifications after careful review and comments thereupon by some sixty municipal engineers who were engaged in reviewing the text, section by section, over a period of several months.

Specifications seem never to remain static; for that matter they hardly ever meet an unanimous approval, however arduously prepared or good they may be. In the constant evolution of municipal design and construction, revisions will be needed to keep specifications current with progress. To this end, assistance is solicited from the users of this and the parent publication whenever engineering practices clearly justify changes.

Additional copies of this publication may be secured through the office of the
Association of Washington Cities
3935 University Way N.E., Seattle, Washington 98105
Suggestions pertaining to corrections or amendments to future editions of
these specifications should be submitted in writing to:
Executive Secretary, Association of Washington Cities
3935 University Way N.E., Seattle, Washington 98105

ACKNOWLEDGMENTS

Washington State Chapter of American Public Works Association is proud to present these fifteen sections of structural and related specifications to add to and complement the 1963 edition of "Standard Specifications for Municipal Public Works Construction," thereby fulfilling the long cherished aim of the Chapter for uniform engineering practices in the municipalities of Washington.

Whatever credit is due this supplementary publication in making the municipal specifications complete, by this printed addition to the parent edition, is generously shared by the Chapter with other agencies that have cooperated in its preparation and publication. Without the combined efforts of all, the Chapter project of complete municipal specifications could not have been achieved. The Chapter, therefore, extends grateful appreciation for the beneficial collaboration and help as follows:

To the Washington State Highway Commission for making this supplementary publication possible by the allocation of funds for the preparation and printing of these specifications, as the Commission did also for the 1963 parent edition, and for also providing the office space and facilities for coordinating and editing the specifications material,

To the division chiefs of the Bridge Division and the Materials Research Division of the Washington Department of Highways, who helpfully advised on technical aspects of the structural requirements affecting bridge and materials specifications from state experience,

To the Association of Washington Cities and the Bureau of Governmental Research and Services of the University of Washington for making the distribution of these copies, in needed amounts, to the many cities and towns throughout the State, and for assuming the responsibility of continuing as the permanent distribution agency for the municipal specifications publications,

And, finally to the Chapter subcommittee on Structural Specifications for its exacting and time-consuming labors in preparing the text, and to the scores of municipal and private engineers who collaborated in reviewing and revising the preliminary drafts of these fifteen sections to make the specifications worthy of general acceptance by the municipalities of Washington.

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Section 100—Structures—General

100-1 DESCRIPTION

The provisions of this section of the specifications relate to certain structural features and incidental items which are either common to all types of structures or which may apply to any one of them.

The provisions herein are supplemental to detailed specifications for definite types of structures, and shall apply whenever they are relevant to any structure and if they are not in conflict with the special provisions or plans for the construction of the structure.

100-2 MATERIALS

The materials furnished and used shall comply with the provisions of the specification pertaining to the various materials and contract items which enter into and form a part of the completed structure.

100-3 CONSTRUCTION DETAILS

All construction details shall be in accordance with the detailed requirements described in this section and with the specifications for the various contract items involved.

-3.01 NAME PLATES

When specified, the Contractor shall furnish and install name plates of such form, dimension, material and design as may be shown on the plans. Unless otherwise provided, the unit contract prices for the structures shall include the cost of the name plates.

No permanent plates or markers other than those shown on the plans or approved by the Engineer will be permitted on any structure.

-3.02 BRIDGE DRAINS

The Contractor shall furnish and install drains in the roadway slab, of the type specified on the plans and in the locations shown thereon.

Bridge drains shall be made of cast steel conforming to the requirements outlined in Section 113-2.01.

Grating covers shall be fitted to the individual drain castings with which they are to be used and shall be ground to rest evenly and without rocking. Each grating cover shall be fastened to the drain casting with a one-quarter (¼) inch galvanized iron chain of length sufficient to allow the cover to be lifted from the casting and rotated to a vertical position. One end of the chain shall be welded to the end of the casting and the other end shall be welded to the inside face of the end grating web as shown on the plans.

To each drain casting there shall be a piece shop welded or threaded, either of standard galvanized steel or galvanized wrought iron pipe of the size, length and type as shown on the plans.

The length of steel pipe shall be galvanized in accordance with the provisions of ASTM Designation A 120, Black and Hot Dipped Zinc-coated Welded and Seamless Steel Pipe for Ordinary Uses, and the wrought iron pipe in accordance with the provisions of ASTM Designation A 72, Welded Wrought Iron Pipe. Galvanizing shall be done after cutting to length, grooving, threading or other fabrication.

After welding, the drain castings and grating covers shall be coated inside and outside with an asphaltum base black dipping paint, approved by the Engineer. This coating shall extend over that portion of the galvanized steel pipe adjacent to the casting far enough to cover the welds.

Payment will be made at the unit contract price per each for "Bridge Drains," which price shall be full compensation for furnishing, coating and installing the complete drain with grating cover, chain, and galvanized steel or galvanized wrought iron pipe outlet.

-3.03 DOWNSPOUTS

The Contractor shall furnish and install 4-inch and/or 6-inch standard weight steel pipe downspouts at the locations shown and as detailed on the plans.

The downspouts shall be full length pipe sections in all straight runs. If the Contractor elects, he may use other types of couplings and fittings in lieu of the grooved couplings and fittings shown on the plans, provided they are equal and are approved by the Engineer.

All downspouts shall be hot-dipped galvanized in accordance with ASTM Designation A 120 after cutting to length, grooving, threading, bending or any other fabrication.

All fastenings of the downspouts to the structure, couplings, and pipe supports shall be galvanized in accordance with ASTM Designation A 153.

Payment for downspouts will be made at the unit contract price per linear foot for "Downspouts," which price shall be full compensation for all costs in connection with furnishing and installing the downspouts, including galvanizing and all fastenings, couplings and other items as outlined herein.

-3.04 METAL RAILING

Care shall be taken in handling metal railing so that no damage of any kind will occur to the rail members. If, in the opinion of the Engineer, any of the rail members become damaged by improper handling it shall be remedied to the satisfaction of the Engineer, or be replaced with new material by the Contractor.

-3.05 CLEARING THE SITE

The Contractor shall clear all of the site of the proposed structure to the full width of the right of way of all trees, brush, stumps and debris, in the manner outlined in Section 12, Clearing and Grubbing. When no payment is specifically provided, the cost of such clearing shall be included in the unit contract prices for the various items of the structure.

Special clearing of the site such as removal of existing bridges, buildings, concrete pavements, etc., will generally be paid for at prices bid for these items, but where no such items are provided in the proposal, all cost in connection therewith shall be included in the unit contract prices for other items in the structure.

-3.05A CLEARING UTILITIES FROM SITE OF CONSTRUCTION

As described in Section 5.08, the removal, relocation or reconstruction of utilities such as telephone and electric power lines, sewer and water lines, railway tracks and appurtenances that will interfere with the actual construction will generally be performed by the Utility concerned, with its own forces and upon agreement or arrangement previously completed by the Owner (city). In some cases, however, the specifications or directions of the Engineer may require that the alterations be performed by the Contractor.

The area required for clearance of utility installations from within the practicable bounds of the completed structure or item of work will be noted on the plans or will be described in the special provisions. When the practicable bounds of the completed structure or item of work is not noted on the plans or described in the special provisions, the utilities to be cleared will be only those necessary to provide room or clearance for the completed structure or item of work.

Where the Contractor is required to perform certain of the utility alterations within the practicable bounds of the completed structure or item of work, and the payment therefor is not otherwise provided in the plans or proposal, then such work shall be performed as directed by the Engineer in compliance with sections 5.09 and 5.10, and payment will be made therefor upon basis of extra work in accordance with one of the three methods stated in Section 9.03.

Unless the special provisions provide otherwise, the Owner will not make any payment to the Contractor for the removal or alteration of any utility feature that would interfere with his equipment or construction operations outside and beyond the practicable bounds of the completed structure or item of component construction; and, if payment therefor is not provided in the plans and special provisions, the Contractor shall make arrangements with the Utility for clearance of whatever additional area is needed by him to accommodate his equipment and operations, and bear all costs of such

alterations. If the Contractor performs the alterations outside the practicable bounds of the completed structure or item of work for the purpose aforesaid, he shall comply with the protective provisions of sections 5.09 and 5.10 and to the satisfaction of the Utility concerned.

If the Owner elects to bear the costs of clearing utility installations from an enlarged area contiguous to or beyond the construction area because of special equipment or operations required to accomplish the specified type of construction, or for any other reason, the plans and special provisions will so state and the Contractor will be paid for any work required by him in the same manner as described herein for work performed by him within the practicable bounds of the completed structure or item of work hereinbefore described.

The Contractor shall, regardless of who—the Utility or Contractor—performs the utility alterations, give due notice to the Utility and to the Engineer at least fifteen (15) calendar days in advance of any work that will interfere with the utility facilities.

The Contractor shall make no claim against the Owner because of any delay by the Utility in clearing the specified areas to accommodate the construction schedule, regardless of any reasons whatsoever for the delay.

In order to effectuate the provisions of this subsection and be compatible with Section 5.08 insofar as construction of structures only is concerned, the second and concluding paragraph thereof shall be made to read:

> "It is provided that no utility, private or public, shall be moved to accommodate the Contractor's equipment or his method of operation when such utility does not interfere with the improvement under construction, unless the costs of such removal shall be at the expense of the Contractor. *It is further provided, however, that the costs of utility alterations to accommodate equipment and operations outside the practicable bounds of the completed structure or item of work will be borne by the Owner (city) whenever the plans and specifications specifically so state, and not otherwise.*"

–3.06 FOUNDATION DATA

Foundation data, when shown on the plans, have been obtained from test borings, test pits or other sources and represent the best information in the possession of the engineering department as to the character of the underlying material at the locations actually tested.

–3.07 ALIGNMENT AND GRADE

Structures on vertical curves, structures which have super-elevated roadways because of horizontal curves and those spans on which a definite finished camber is necessary in order to form a uniform grade line, all require special care and attention in regard to the elevation and alignment of their railings and curbs.

Bridge railings, including curbs, wheel guards, and collision rails, shall be so constructed that the finished vertical alignment or grade will be of pleasing appearance. Pronounced sags or humps in the grade line will not be permitted.

Rails and curbs on the curbed portion of a structure shall be constructed, insofar as possible, after the completion of the entire roadway and sidewalk slabs. In such cases, the heights of rails and curbs may be varied with respect to the grade line of the slabs in order to produce the desired appearance.

All costs in connection with the adjustments abovementioned shall be included in the unit contract prices for the various contract items involved, except as described in the last paragraph of Section 117-3.01B.

–3.08 APPROACHES TO MOVABLE SPANS

The roadway and sidewalk slabs of approach spans adjacent to each end of movable spans shall not be constructed until the moveable span is completely erected, adjusted and placed in a closed position.

–3.09 ERECTION METHODS

When requested by the Engineer, the Contractor shall submit for approval an outline of the method he proposes to follow in the erection of the structure, and submit four (4) copies of erection plans designed by and bearing the seal of a licensed professional engineer. This requirement shall apply particularly to steel spans of cantilever, suspension or movable type. The method of erection finally decided upon and approved shall be adhered to in its essential details, but approval by the Engineer shall not relieve the Contractor from his responsibility for the sufficiency of the method used.

–3.10 SAFETY NETS AND STAGING

Where workmen on bridge work are employed 25 feet or more above the ground, water or other level of construction and it is impracticable to provide temporary decking, personal safety life nets shall be provided for the protection of the employees engaged in such work.

Where temporary decking is used in bridge construction work, it shall be placed directly under and as near as possible to where the work takes place, but not to exceed ten (10) feet. The openings between the planks or decking shall not exceed nine (9) inches. Decking shall be securely fastened to prevent displacement and shall extend at least six (6) feet beyond each side of the structure. A standard hand rail, such as defined in "Safety Standards for Construction Work" by the Division of Safety of the Department of Labor and Industries, shall be placed on the outer edges. Decking shall otherwise conform to the requirements of the Department of Labor and Industries for heavy duty scaffolds as specified in "Safety Standards for Construction Work."

When safety nets are used they shall be constructed of at least ⅜ inch diameter No. 1 soft lay manila mesh ropes with ¾ inch diameter border ropes. The mesh ropes shall be arranged at 6-inch centers positively attached to avoid wear at each point of crossing and at points of contact with the ¾ inch diameter border rope, or wire mesh of equivalent strength or better, not to exceed 2 inch diameter mesh. Nets shall be placed directly under and as near as possible to where the work is being done. They shall extend at least 6 feet beyond each side of the structure.

If the nets are expected to provide protection for workmen at heights greater than ten (10) feet above the nets, the nets should be extended proportionately beyond the six feet from the sides of the structure.

It shall be the option of the Contractor to place the net under the entire structure or it may be formed in sections and placed under the areas only where work progresses and men are exposed to falling.

Where the nature of the project or portions thereof make the use of nets or decking impractical, the use of same may be waived by the Supervisor of Safety of the Department of Labor and Industries upon application by the Contractor.

All costs in connection with furnishing, installing, maintaining, and removing safety nets or staging shall be considered as incidental to the construction and shall be included in the various pay items of work involved in the project.

–3.11 NAVIGABLE STREAMS

The channels of navigable streams shall be kept clear for the safe passage of water traffic. The Contractor shall provide and maintain all necessary lights and signals in accordance with the requirements of the Corps of Engineers, U. S. Army. All material deposited in the channel shall be removed to the required depth and clearance lines.

–3.12 ARCHITECTURAL FEATURES

Architectural treatment of the various parts of concrete structures requires that the concrete be of uniform texture and color. For this reason the Contractor shall secure all cement for the structure from the same manufacturing plant unless otherwise authorized in writing by the Engineer.

–3.13 APPROVAL OF MATERIALS

The sources of all materials entering into the completed structure shall be approved by the Engineer. Promptly after the approval of the contract, the Contractor shall submit to the Engineer a list or lists showing the names of the firms or manufacturers from whom he proposes to secure the various materials. This requirement shall apply particularly to fabricated structural steel and machinery where prompt information regarding the fabricator is essential in order that mill and shop inspection may be arranged.

The quality of all materials shall be subject to the approval of the Engineer and to the provisions of Section 6, as they may apply.

–3.14 FINAL CLEANING UP

Upon completion of the structure, the Contractor shall clean up the site, remove all temporary buildings, falsework, piling, lumber, equipment and debris. He shall level off and dispose of all excess excavated material not used for backfill, and fine grade the surface of all backfilled, sloped and other areas disturbed by the construction. The decks of the structure shall be swept and washed clean. The entire site and structure shall be left in a clean and workmanlike condition.

–3.15 NORMAL TEMPERATURE

Dimensions on plans are for a normal temperature of 64° F.

100–4 MEASUREMENT

Measurement of the items included in the completed structure will be made in accordance with the specifications for the various items.

100–5 PAYMENT

Payment will be made at the unit contract prices for the various items entering into the completed structure in accordance with the specifications for the various items.

Section 101—Concrete Structures

101–1 DESCRIPTION

This section of the specifications shall apply to all concrete structures including concrete substructures, composite structures of concrete and steel, or concrete and timber, and all structures in which concrete is used. Such structures shall be built as indicated on the plans and in conformity with the lines, grades, dimensions and details there shown. They shall also be in accordance with the provisions of the specifications pertaining to the various materials and contract items which enter into and form a part of the complete structure.

Concrete manholes, catch basins, pipe, valve chambers and inlets constructed for sewers, storm drains and water distribution as described elsewhere in these standard specifications shall not be classified as concrete structures.

101–2 MATERIALS

–2.01 CONCRETE

The materials for making concrete shall be as defined in Section 107, Portland Cement Concrete for Structures.

–2.02 REINFORCING STEEL

Reinforcing steel used in constructing concrete structures shall conform to the specifications in Section 111-2, Reinforcing Steel.

–2.03 STRUCTURAL STEEL

Structural steel for composite structures of concrete and steel shall be as defined in Section 112-2, Structural Steel.

–2.04 TIMBER

Timber and lumber when required for a composite structure of concrete and timber shall meet the requirements therefor specified in Section 114, Timber and Lumber.

–2.05 PILING

Piling when required for concrete structures shall be as defined in Section 106, Piling.

–2.06 MISCELLANEOUS METALS

Castings, copper, bronze and other metals for use in concrete structures shall meet the requirements specified in Section 113 for the kind of metal item involved.

101–3 CONSTRUCTION DETAILS

All construction details shall be in accordance with the requirements of this Section 101 and also in compliance with Section 107 for portland cement concrete, Section 111 for reinforcing steel, Section 106 for piling and other sections of these standard specifications for other component things as they may apply unless otherwise provided in the special provisions or as otherwise authorized by the Engineer.

–3.01 DATE PANELS

Standard date panels shall be placed where shown on the plans. The date shall be for the year in which the structure is completed. All costs for making and placing date panels shall be included in the unit contract prices for concrete of the various classes.

–3.02 FALSEWORK

The Contractor shall submit to the Engineer for approval, detailed plans for falsework or centering, in accordance with the requirements of Section 101-3.04. For calculating the strength of falsework or centering, a weight of one hundred sixty (160) pounds per cubic foot shall be assumed for fresh concrete.

In general, falsework shall be supported on piling. Mudsills for footings in lieu of piling will not be allowed except by approval of the Engineer. Falsework piling shall be spaced and driven in accordance with the approved falsework plans.

Falsework shall be set to give the structural camber indicated on the plans or as directed by the Engineer, plus an allowance for shrinkage or settlement. Compensation for falsework and falsework piling shall be considered as incidental to the construction and the cost thereof shall be included in the unit contract prices for the several bid items in the proposal.

–3.02A Restricted Overhead Clearance Sign

Whenever the overhead clearance over railroad tracks, traveled streets or other critical traffic rights of way will be restricted by erection of construction falsework, the Contractor shall place restricted overhead clearance signs as detailed on Standard Plan No. G-10, Washington Department of Highways to serve as a warning of the restricted overhead clearance. All costs therefor shall be considered as incidental to the construction of the structure and shall be included in the unit contract prices of bid items in the proposal.

–3.03 FORMS

For the purpose of form design, concrete shall be assumed to exert on vertical surfaces the pressures per square foot as shown in the following table:

RATE OF POURING FEET PER HOUR	PRESSURES, POUNDS PER SQUARE FOOT, FOR TEMPERATURE OF CONCRETE AS SHOWN				
	40°	50°	55°	60°	70° and Above
2	725	600	560	470	375
3	900	750	690	640	555
4	1,075	875	800	725	625
5	1,250	1,000	900	815	690
6	1,425	1,125	1,000	900	750
7	1,600	1,250	1,110	990	815
8	1,775	1,375	1,215	1,075	875

The pressures in the above table have been increased to provide an allowance for vibration and impact.

Horizontal surfaces shall be designed to withstand a pressure of one hundred sixty (160) pounds per square foot for each foot of height of concrete supported.

–3.03A Requirements

All forms shall be set true to the lines designated, and the interior shape and dimensions shall be such that the finished concrete will conform exactly with the plans of the structure within the limits specified in Section 107-3.16. Before proceeding with the form work for any structure the Contractor shall submit detailed plans of the forms he proposes to use to the Engineer for approval. The plans shall be in accordance with the requirements of Section 101-3.04. In no case shall any concrete be poured in any form until the form has been checked by the Engineer.

–3.03B Form Footings and Posts

All form footings must be properly designed to carry the maximum load that can come upon them. They shall be as nearly unyielding as possible under full load. In cases of footings on rock or coarse sand and gravel, grouting may be required to ensure uniform bearing.

All systems of supports shall be provided with wedges or other devices which will permit the uniform release and take-up of forms.

3.03C Stringers and Beams

All stringers and beams used to support form work shall be particularly rigid; their design shall be determined on the basis of deflection, which shall not exceed 1/500 of the span under full load unless otherwise designated by the Engineer.

–3.03D Bracing

All bracing shall be as rigid as possible and where there is any likelihood of movement, braces shall be provided with wedges to take up such displacements.

–3.03E Lagging VACATED

–3.03F Form Ties

All ties used for securing forms shall be so arranged as to allow the removal of all metal to a depth of not less than one-half (½) inch below the surface. Threaded rods are preferred but standard manufactured form ties may be used when specifically approved by the Engineer. Examination of test data or actual tests of specimens may be required by the Engineer as a condition for approval.

Wire form ties will not be allowed.

–3.03G Face Lumber

Lumber used for facing of forms shall be plywood or matched tongue and groove lumber of good quality, not less than three-fourths (¾) inch in thickness, except that plywood one-fourth (¼) inch in thickness may be used when backed with three-fourths (¾) inch lumber.

When sheathing less than two (2) inches thick is used, the spacing of studs shall be not more than sixteen (16) inches center to center, except that the studs for framing the exposed surfaces of abutments and wing walls shall not be spaced at more than twelve (12) inches center to center. When the intrados of arches and arch rings are formed with tongue and groove lumber, it shall be two (2) inches thick, surfaced on both sides, free from knots, and be placed transversely to the center line of the roadway being supported by the arch. After the lumber is in place and nailed, all uneven joints or projecting edges shall be adzed or planed off.

The facing lumber, either plywood or matched tongue and groove, shall be free from surface defects of any kind to ensure a smooth dense concrete surface that will require a minimum of surface treatment to remove form markings as specified in Section 107-3.14.

Forms for constructing round columns shall be a self-supporting metal shell form or a form tube which will give a smooth, even surface without markings on the concrete column after form is removed. Wood forms shall not be used for constructing round columns.

All exposed corners, except on railings, shall be chamfered three-fourths (¾) inch. Railings shall not be chamfered except where called for on the plans. The corners around the window or rail openings and vertical corners on end posts shall be square.

–3.03H Oiling

Surfaces of wood forms against which concrete will be placed shall be coated with non-staining mineral oil approved by the Engineer prior to constructing the forms in place. The oil shall be applied a sufficient time prior to use so that it will be fully absorbed by the wood.

–3.03I Temporary Holes in Forms

Retaining wall forms, or other forms for structures that are over twelve (12) feet in height shall be provided with temporary construction openings eighteen (18) inch minimum size in the forms to provide access for vibrating concrete and visual inspection when concrete is being placed in accordance with the provisions of Section 107. The maximum spacing of such temporary construction openings shall be twelve (12) feet horizontally and eight (8) feet vertically. The surfaces of plugs for closing off temporary construction openings, when placed, shall meet the requirements of Section 101-3.03G.

All forms for columns, walls, beams, slabs, etc., as may be necessary, shall have large cleanout openings at their lowest points, and shall not be closed until just before placing concrete. All forms shall be thoroughly cleaned out and soaked with water before filling.

–3.03J Steel Forms

The specifications of Section 101-3.03G, as they apply to the end result, shall be applicable to the use of metal forms. The thickness of metal forms and their design shall be such as to construct the concrete to the exact dimensions required. When steel forms are used, special care shall be exercised to prevent denting, bulging or harmful rusting of the surfaces against which concrete will be placed.

–3.03K Concrete Slab Forms on Steel Spans

Forms for roadway and sidewalk slabs on steel truss or girder spans shall be constructed to provide openings, where necessary, for truss or girder members.

The openings shall be made of such size that when the forms are removed there will be a clear space between the steel member and the concrete slab of at least one and one-half (1½) inches on all sides of the steel member. All costs in connection with forming openings for steel members shall be included in the unit contract price for concrete in place.

–3.04 PLANS FOR FALSEWORK AND FORMS

The Contractor shall submit to the Engineer, for approval, four (4) copies of plans showing details of the falsework and forms intended to be used.

The plans shall show the construction of the proposed form work in sufficient detail so that all elements of construction and materials for proper evaluation of safety and adequacy of the form work can be ascertained. In addition, the plans shall specify the maximum allowable rate of pour and the manufacturer's recommended safe working capacity of all patented form ties and column clamps.

Falsework and forms shall not be constructed until the falsework plans have been approved by the Engineer, but approval by the Engineer shall not relieve the Contractor of responsibility for the sufficiency of the falsework and forms. The Contractor's plans shall be designed by and bear the seal of a licensed professional engineer.

All plans shall be drawn on sheets each measuring twenty-two (22) inches wide by thirty-six (36) inches long in overall dimensions, or on smaller sheets that are multiples of eight and one-half (8½) inches by eleven (11) inches.

–3.05 REMOVAL OF FALSEWORK AND FORMS

Forms for various parts of the structure shall not be removed before the number of days specified in the table below shall have elapsed after placing of the concrete, unless otherwise authorized by the Engineer as meeting strength requirements. The exact number of days shall be determined by the Engineer and will depend upon curing conditions subsequent to placement of concrete.

	Portland Cement	*High Early Strength Cement*
(a) Columns and wall faces (not yet supporting loads)	4 days	3 days
(b) Mass piers and abutments (not yet supporting loads) except pier caps and copings	3 days	3 days
(c) Sidewalk on bridges—Sidewalk forms shall, in all cases, be released before the main girder and slab forms are released	10 days	4 days
(d) T-beam, girder, box girder and slab, cross-beams, caps, struts, and top slabs on concrete box culverts	14 days	5 days
(e) Trestle slabs, when supported on wood stringers	10 days	4 days
(f) Slabs, when supported on steel stringers or prestressed concrete girders	10 days	4 days
(g) Pier caps and copings	7 days	3 days
(h) Arches	21 days	.....
(i) Railings	3 days	3 days

Items c, d, e, f, g and h apply to falsework and forms supporting the full load of the concrete. Side forms and forms not supporting loads may be removed at the end of the curing period.

Falsework under all spans shall be completely released before forms are constructed and concrete is placed in railings.

In order to determine the condition of column concrete, forms shall always be removed from columns before releasing supports from beneath beams and girders.

Forms shall not be released from under concrete which was placed at a temperature under fifty (50) degrees Fahrenheit without first determining if the concrete has attained adequate strength irrespective of the time element.

The forms for footings constructed within cofferdams or cribs may be left in place when authorized by the Engineer, provided that the forms so left intact will not be exposed to view when the structure is completed. The forms supporting the roadway slab of box girder type structures shall be supported on wales or similar supports fastened, as nearly as possible, to the top of the web walls, and may be left in place.

The forms supporting the roadway slab shall not be shored to or supported on the bottom slab. All other forms shall be removed whether above or below the ground line or water level. Inside forms of hollow piers, girders, abutments, etc., shall be removed through openings provided for that purpose. The removal of forms for concrete exposed to sea water or to alkaline water or soil shall be in accordance with the provisions of sections 107-3.09 and 107-3.10.

In no case shall forms, centers or falsework be removed at any time without the approval of the Engineer.

–3.06 PLACING ANCHOR BOLTS

All necessary anchor bolts in piers, abutments, or pedestals shall be accurately set, either in the original masonry, or in holes drilled after the masonry has set. If drilled, the holes shall be at least one (1) inch larger in diameter than the bolt to afford ample room for "grouting in." If set in the original masonry, the bolts shall be placed as shown on the plans. If setting in pipe is specified, the pipe must in all cases be filled with grout as outlined for grouting shoes in Section 102-3.09.

Anchor bolt sleeves, into which the anchor bolts cannot be grouted until after freezing weather, shall be protected against damage from expanded ice by filling the sleeves with an approved non-evaporating antifreeze solution.

–3.07 EXPANSION SHOES AND PLATES—NEOPRENE RUBBER PADS

Main expansion shoes and plates under girders or slabs may be either sliding or rolling, as shown on the plans. All sliding expansion plates shall be of bronze and of the grade specified in Section 113-2.05. Sliding surfaces shall be planed true and smooth and then polished. All surfaces shall be planed in a direction paralleling the movement of the joint. Expansion plates shall be well anchored and set true to line and grade as shown on the plans. All sliding surfaces of expansion plates shall be thoroughly coated with graphite and oil just before being placed in position, and special care shall be exercised to avoid placing concrete in such a manner as to interfere with their free action.

When grout is to be placed under steel shoes, the placement of the grout and the necessary steel shims shall be in accordance with Section 102-3.09.

Neoprene rubber bearing pads, when specified, shall be of neoprene rubber in accordance with current AASHO Standard Specifications for Highway Bridges, Article 1.6.47 and amendments, except that they shall be individually cast in molds (Durometer Hardness 70).

–3.08 DRAINAGE OF BOX GIRDER CELLS

To provide drainage for box girders cells, the Contractor shall furnish and install short lengths of three (3) inch asbestos-cement pipe, or equal, in the bottom slab at the low point of each cell. The pipe shall extend one-fourth (¼) inch below the bottom of the slab and shall not protrude above the top surface of the slab.

–3.09 OPENING TO TRAFFIC

Concrete structures which will support heavy vehicular traffic loads, constructed with portland cement concrete, shall remain closed to all traffic for at least twenty-one (21) days after placing of final concrete to complete such structures. This minimum requirement may be reduced by the Engineer if, in his opinion, the concrete tests justify reduction. If high-early-strength concrete is specified, the opening time to traffic will depend on tests made by the Engineer, but in no case shall the time of opening be less than seven (7) days after final concrete for the structure is placed.

The above times of opening to traffic is applicable when temperatures are above fifty (50) degrees F. When temperatures are below fifty (50) degrees F., the time of opening to traffic will be increased at the discretion of the Engineer.

Bridges with concrete decks shall not be opened to traffic without the approval of the Engineer.

–3.10 PRESTRESSED CONCRETE GIRDERS

General

This item shall consist of the furnishing and placing complete precast prestressed reinforced concrete girders constructed in accordance with the details shown on the plans and described herein. The precast girder shall be cast to the dimension shown on the plans.

The Contractor, only with the approval of and under the observation of the Engineer, will be allowed to repair rock pockets and other minor deficiencies of a non-structural character in a girder. Any girder which is repaired without approval and actual observation of the repair by the Engineer will be rejected, regardless of the extent of the repair work.

The top of the precast girder shall be kept wet continuously until the side forms are removed. Subject to the provision that he shall be fully responsible for any damage incurred therefrom, the Contractor will be permitted to remove the side forms any time after the concrete has attained a compressive strength of 3,000 psi as indicated by test cylinders cast and cured under the same conditions as the stripped girder. If a girder is stripped at this earlier period, it shall be covered immediately with a wet curing pad and the entire surface of the girder shall be kept wet continuously until the concrete has attained a strength of 5,000 psi.

When approved by the Engineer, precast prestressed concrete girders may be cured with saturated steam or by hot air. If steam or hot air is used for curing, the temperature of the concrete shall not be raised above 100° F. for a minimum period of two hours after it has been placed. After the minimum two-hour period, the temperature of the concrete may be raised to a maximum of 150° F. in increments of not more than 25° F. per hour. When steam or hot air curing is used, the test cylinders shall be placed in the lower heat zone during the curing period.

If steam is used for curing, the unit must be so arranged on the casting bed that the entire surface of each unit is enveloped in saturated steam. If hot air is used, heat shall be admitted at the end of the girder and the entire surface of each unit must be enveloped in saturated atmosphere. Curing with hot air will not be permitted until after the Engineer has approved the

methods proposed for maintaining the saturated atmosphere.

In no case shall dry heat strike the girder surface at any point. If steam or hot air curing is used, the Contractor must provide a recording thermometer so arranged and calibrated that a continuous record of the temperature of the enclosure is maintained.

The thermometer shall be placed in the vicinity where the heat first reaches the girder. At all times that steam or hot air curing is being used, a printed record of the hourly temperature readings, properly dated and identified, shall be available for inspection by the Engineer. The temperature and recording device shall be accurate within plus or minus 5° F.

The concrete for the prestressed girders shall have a minimum ultimate compressive strength of not less than 6,000 pounds per square inch at the age of 28 days.

The table below shows a concrete mix which will achieve the desired compressive strength; the Contractor, however, may deviate from this mix if he so elects, upon approval of the Engineer. The use of calcium chloride as an admixture to the concrete will not be allowed.

	Aggregate developing not less than 95% of strength of Steilacoom Aggregate	*Aggregate developing between 90.0% & 94.5% of strength of Steilacoom Aggregate*
Maximum total mixing water in gallons per 94 pound sack of cement	4.5	4.5
Sacks of cement per cubic yard	8.0	8.5
*Pounds of dry fine aggregate per 94 pound sack of cement	180	137
Pounds of dry coarse aggregate per 94 pound sack of cement	205	208

GRADING FOR COARSE AGGREGATE

Passing 1" Square Opening	100%
Passing ¾" Square Opening	95-100%
Passing ⅜" Square Opening	20- 40%
Passing No. 4 Sieve	0- 3%

*Based on aggregate with a bulk specific gravity of 2.67.

Fine aggregate shall conform to the requirements of the standard specifications for paving sand in Section 39-2.02.

The conditions of design for the prestressing of the girders are shown on the plans. The Contractor shall employ methods and related equipment in the prestressing operations which will be in conformance with the details shown on the plans, except that approved variations of such methods and equipment will be permitted if, in the opinion of the Engineer, equal results can be obtained.

Before casting the girders the Contractor shall submit to the Engineer for his approval, complete details of the method, materials and equipment the Contractor proposes to use in the prestressing operations. The Contractor shall also furnish shop plans of the girders outlining the method and sequence of stressing, details of the prestressing tendons and steel reinforcement, anchoring devices proposed for use, anchoring stresses, type of enclosures for the post-tensioning cables, and all other data pertaining to the prestressing operations.

The approval of shop plans shall be understood to be only an acceptance of the character and sufficiency of the details, and not a check of the dimensions. The arrangement of the prestressing units in the girders shall be such that the center of gravity of the prestressing steel will follow the locations shown. Steel forms shall be used for casting the prestressed girders.

Deviations from prestressing details approved by the Engineer will not be permitted unless details of such deviations are submitted well in advance of use for the engineering approval. The approval by the Engineer of any proposed method, materials or equipment shall not be construed as in any way relieving the Contractor of full responsibility for successfully completing the prestressing operations in accordance with the plans and requirements defined herein.

Before completion of the project the Contractor shall furnish the original tracings of the shop detail drawings, or acceptable reproductions showing all approved deviations of detail for the prestressed girders.

–3.10A Post-Tensioning

Each prestressing cable or bar shall be encased in a flexible metal conduit of the diameter required, or be formed within the girders by means of cores or ducts composed of rubber or other suitable material which can be removed prior to installing the post-tensioning reinforcement. The metal conduit shall be stiff enough to maintain the desired profile between points of supports and shall be completely sealed against leakage of mortar into the conduit. The ends of the conduit shall be made so as to provide free movement of end anchorage devices. Couplings or splices in the prestressing steel will not be permitted. Where cables or bars are to be curved, the metal conduit shall be set low enough to offset the tendency of the prestressing steel to straighten out when stressed. Unless otherwise specified, the locations of the cables with respect to the concrete beam (as shown on the plans) shall be construed to be the final locations after stressing.

Immediately after completion of the concrete pour, the metal conduit shall be blown out with compressed air to the extent necessary to break up and remove any mortar in the conduit before it hardens. The metal conduits shall be flushed out with water and then blown out with compressed air within 24 hours after the concrete pour.

After cables or bars have been stressed to the required tension, each conduit encasing the prestressing steel shall be blown out with compressed air. The conduit shall then be completely filled from one end with grout under pressure and a minimum of one-half (½) gallon of grout shall be pumped through the outlet to ensure the removal of air bubbles.

The grout mixture shall be as follows with the exact proportions adjusted to make a grout having the proper consistency:

1 Sack Type II portland cement
4¾ Gallons of water
1 Teaspoon unpolished aluminum powder
2 Ounces sika-plastiment

The grout shall be fluid but proportioned so that free water will not separate from the mix. Mixing, preferably in a propeller type mixer, shall be performed for several minutes until the grout is of uniform consistency, and the aluminum powder shall then be added and mixing continued until the powder is thoroughly incorporated. Commercial plastercizers used in accordance with the manufacturer's recommendation may be used provided they do not contain ingredients that are corrosive to steel.

Sufficient pressure shall be used in grouting to force the grout completely through the duct, care being taken not to rupture the duct.

–3.10B Prestressing Reinforcement

Prestressing reinforcement shall be high tensile bars or high tensile wire strands and shall be mill bright, or with light surface rust.

The requirements for breaking strength, yield strength and elongation of wire strand for longitudinal post-tensioning and pre-tensioning shall conform to ASTM Designation A 416-59T.

The Contractor may, if he elects, furnish the new 270,000-pound per square inch prestressing strand in ½ inch or 7/16 inch diameter strand in lieu of the strand designated on the plans and as outlined hereinbefore, provided that the new strand is fabricated and tested in accordance with the requirements of ASTM Designation A 416-59T with the following exceptions:

1. **½ Inch Strand**
   a. Minimum ultimate strength equals 41,300 pounds per strand.
   b. Nominal steel area equals 0.153 square inch per strand.
2. **7/16 Inch Strand**
   a. Minimum ultimate strength equals 31,000 pounds per strand.
   b. Nominal steel area equals 0.115 square inch per strand.

All wires shall be stress-relieved as a unit after the wires have been formed into a strand.

All prestressing reinforcement shall be free of dirt, rust, grease or other deleterious substance.

All prestressing reinforcement furnished for a given girder shall have a maximum elongation differential of 3 percent. All prestressing reinforcement shall be stress-relieved and all reels of strand shall be accompanied with an inspection certificate furnished by the supplier indicating the number of reels represented by the certificate and shipped for this project.

For each certificate furnished, a sample as described hereinafter shall be sent to the Engineer, or to the laboratory he may designate for testing.

–3.10C Anchorages

All post-tensioning reinforcement shall be secured at the ends of the girders and diaphragms by means of approved anchoring devices which shall be of such nature that they will not kink, neck down or otherwise damage the post-tensioning reinforcement.

Anchoring devices and couplings other than those previously approved shall be submitted to the Engineer and approved by him prior to construction.

Distribution and anchoring assemblies designed by the Contractor shall meet with the following requirements:

1. When external bearing plates are used, the maximum concentrated bearing stress in the concrete directly underneath the bearing plate shall not exceed 3,000 pounds per square inch.
2. Bending stresses in the bearing plates induced by the pull of the prestressing reinforcement shall not exceed 16,000 pounds per square inch.
3. Materials and workmanship shall conform to the applicable requirements of Section 112, Structural Steel.

If the bearing area of the anchorage device is sufficiently large so that a local concentrated bearing compressive stress of not more than 3,000 pounds per square inch is obtained in the concrete, steel bearing assemblies as above specified may be omitted.

Anchorage devices proposed for use shall be submitted for testing as provided elsewhere in this section.

After the post-tensioning cables have been anchored they shall be cut flush with the face of the anchoring device and the entire assembly shall be satisfactorily grouted in.

–3.10D Prestressing

The releasing of the pre-tensioning reinforcement or the tensioning of the post-tensioning reinforcement shall not be commenced until tests on concrete cylinders, manufactured of the same concrete and cured under the same conditions as the girders, indicate that the concrete of the particular girder to be prestressed has attained a compressive strength of 5,000 pounds per square inch when 7/16" or ½" strands are used, and 4,800 pounds per square inch when ⅜" strands are used.

All prestressing reinforcement shall be tensioned to the jacking load shown on the plans.

At such time as the jacks are to be removed from either the pre-tensioning or post-tensioning reinforcement the stress at the jack shall be relieved by gradual release before cutting of the reinforcement. Exposed pretension steel shall be burned off flush with the concrete surface and the exposed ends shall be protected with an approved epoxy coating.

Jacks shall be equipped with accurate reading calibrated hydraulic pressure gages to permit the stress in the prestressing reinforcement to be computed at any time. A certified calibration curve shall accompany each jack.

After anchoring the post-tensioning reinforcement, an approved non-shrinking cement grout shall be forced under pressure into the enclosures around the reinforcement until the entire enclosure is filled.

–3.10E Testing

The vendor shall furnish to the Engineer for testing the following samples selected at random from the lot or reels covered by each certificate:

For bars: Not less than five (5) feet of each diameter, furnished with threaded ends and nuts.

For strands: Not less than five (5) feet of each diameter, measured between near ends of fitting, furnished with or without fittings attached.

In addition to the above and for the post-tensioning reinforcement, the vendor shall furnish two anchorage assemblies of each size or type to be furnished, if anchorage assemblies are not attached to reinforcement samples.

All samples submitted shall be accompanied by a certification from the vendor certifying that the samples were taken from and are representative of the lot or reel to be furnished.

All of the above materials specified for testing shall be furnished without cost to the Owner and well in advance of anticipated time for use. The Contractor will not be entitled to any additional compensation if his work is delayed awaiting approval of the materials required for testing.

101–4 MEASUREMENT

Measurement of the various items entering into the construction of concrete structures will be made in accordance with the specifications for the several items involved.

Measurement of prestressed concrete girders will be by the linear foot measured along the bottom center line of the completed girder.

101–5 PAYMENT

Payment for the various items entering into the construction of concrete structures will be made in accordance with the specifications at the unit contract prices for the several items involved in the proposal. Payment shall include the furnishing of all materials, labor, equipment and all items of cost required to complete the work.

Payment for prestressed concrete girders will be made at the unit contract price per linear foot for "Prestressed Concrete Girders," which price shall be full compensation for all costs in connection with furnishing all labor, tools, equipment, materials, and forms necessary to construct the prestressed girders, in accordance with the details shown on the plans and specifications, all transportation costs, and complete erection at the locations shown. The unit contract price for the prestressed girders shall also include all costs in connection with furnishing and placing the high tensile steel, reinforcing steel included with the prestressed girders, anchorage assemblies, pipe sleeves, grouting in the post-tensioning strands, painting girder ends with epoxy resins, bearing pads, concrete and all other parts incidental to final acceptance of the prestressed girders.

All costs in connection with furnishing and installing cell drain pipes for box girder structures and for furnishing and placing grout and shims under steel shoes shall be considered as incidental to the construction and no payment will be made therefor.

Section 102—Steel Structures

102–1 DESCRIPTION

This section of the specifications shall apply to all steel structures, including composite structures of steel and other materials, and to all structures in which fabricated metal, except steel reinforcing bars, is used.

102–2 MATERIALS

The materials furnished and used shall be those described in Section 112, Structural Steel, and other sections for the other items involved.

102–3 CONSTRUCTION DETAILS

All construction details shall be in accordance with the requirements specified in this section, in Section 112, Structural Steel, and in other sections for the various items involved.

–3.01 STORAGE IN FIELD

All materials shall be stored in such manner as to prevent deterioration by rust or loss of minor parts. No material shall be piled to rest upon the ground or in water, but must be placed on suitable skids or platforms.

–3.02 FALSEWORK

All falsework shall conform to the specifications for falsework as specified under Section 101-3.02.

–3.03 HANDLING STEEL MEMBERS

The field assembling of the component parts of a structure shall involve the use of methods and appliances not likely to produce injury by twisting, bending or otherwise deforming the metal. No member slightly bent or twisted shall be put in place until its defects are corrected, but members seriously damaged in handling will be rejected.

–3.04 ALIGNMENT AND CAMBER

Before beginning the field connections, the structure shall be adjusted to correct grade and alignment and the elevations of panel points (ends of floor beams) properly regulated. For truss spans a slight excess camber will be permitted while the bottom chords are being connected, but the correct camber and relative elevations of panel points shall be secured before connecting the top chord joints, top lateral system, and sway bracing.

No connecting shall be done at compression joints until the blocking has been adjusted so that there will be full and even bearing over the entire joint.

–3.05 STRAIGHTENING BENT MATERIALS

The straightening of bent edges of plates, angles and other shapes shall be done by methods not likely to produce fracture or other injury. The metal shall not be heated unless permitted by the Engineer, in which case the heating shall not be to a higher temperature than that producing a dark cherry red color. The metal shall be cooled as slowly as possible after heating.

After completing the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of incipient fractures or other damage.

–3.06 ASSEMBLING AND RIVETING

All field connections and splices shall be securely drift pinned and bolted as erection proceeds. With the exception of bracing, the pinning and bolting specified herein shall be accomplished for each member as it is erected before additional weight is imposed.

Important connections in trusses, girders, floor system, etc., shall have at least 50 percent of the holes filled. An ample number of drift pins shall be used to prevent slipping at joints and splices. Structures erected by the cantilever method shall be field bolted and pinned to 75 percent full strength unless otherwise permitted by the Engineer.

The results obtained in the field assembling and riveting of the members of a structure shall conform to the requirements for shop assembling and riveting. Field driven rivets shall be inspected and accepted before being painted.

Field riveting shall be done before the falsework is removed unless special permission otherwise is given by the Engineer.

Railings may be erected but shall not be adjusted until after the falsework has been released and the deck placed.

–3.07 ADJUSTING PIN NUTS

All nuts on pins shall be thoroughly tightened and the pins shall be so located in the holes that the members will take full and even bearing upon them. All pins shall have sufficient threading to allow "burring" after the nuts are tightened.

–3.08 SETTING ANCHOR BOLTS

Anchor bolts shall be set in the masonry in accordance with requirements specified under Section 101-3.06, Placing Anchor Bolts. Anchor bolts shall be grouted in after the shoes have been set and the span is completely erected to line and camber.

–3.09 SETTING AND GROUTING SHOES

Shoes shall be set on the anchor bolts provided in the masonry and shimmed up with steel shims until the pin centers are in the proper position as to line and grade and with respect to each other. The bases of the shoes shall be level. The anchor bolt nuts shall then be drawn down tight and a recheck of the pin centers shall be made. Steel shims shall be not more than two and one-half (2½) inches square and shall be placed under the webs of shoes. Not less than three-fourths (¾) of an inch of space shall be provided under shoes for grout.

After the shoes have been set and the span completely erected, the space between the top of the masonry and the bottom of the shoes shall be filled with cement mortar or grout. Grout shall be composed of one (1) part of high-early-strength cement to one (1) part of clean, fine grained sand, well mixed with sufficient water to produce a mix that will flow. Unpolished aluminum powder shall be added in the proportion of one (1) teaspoonful per sack of cement. Great care shall be used to work the grout under all parts of the shoes.

A form shall be constructed around the base of the shoes four (4) inches outside of the base and approximately four (4) inches high. The form shall be filled to the top with grout. After the grout has set sufficiently hard, the form shall be removed and the grout outside of the shoe shall be removed to the base of the shoe and beveled off neatly to the top of the masonry.

No additional load shall be placed on the shoe until the grout has set seventy-two (72) hours.

The above procedure for setting shoes applies to shoes for all steel spans, including shoes and turning racks on movable bridges, excepting however, that main shoes for cantilever spans shall be set and grouted in before any steel work is erected.

–3.10 PLACING SUPERSTRUCTURE

No superstructure load shall be placed upon finished piers or abutments until the Engineer gives his approval. In general, a minimum time of twenty-one (21) days shall be allowed for ample curing of concrete before the superstructure load is placed thereon.

–3.11 SETTING EXPANSION BEARING BED PLATES

Expansion bearing bed plates shall be set to the proper position for a normal temperature of 64° F. Adjustment shall be made for any inaccuracy in the fabricated length so that the expansion shoe will be centered at normal temperature after the dead load camber is out.

–3.12 AIR FOR RIVETING

Air compressors and air storage tanks shall be provided, capable of delivering not less than one hundred (100) pounds per square inch of air pressure to each operating riveting hammer.

–3.13 CONCRETE FLOORS ON STEEL SPANS

Before concrete floors are placed on steel spans, the centering under the bridge shall be released and the span be supported free on its supports.

–3.14 FILLING AND DRAINING POCKETS

All pockets in shoes, in which water or debris can be deposited, shall be painted with one coat of paving asphalt of 61-70 penetration applied hot, and the pockets shall then be filled with asphalt concrete of approved proportions and materials. Where drain holes have been provided, they shall be plugged before the asphalt concrete is placed. The top of the concrete shall be well rounded so water will drain clear of the shoes.

Pockets in truss, girder and other members shall be provided with sufficient drain holes to drain all water from the pockets.

All costs incurred in filling pockets and providing drain holes shall be included in the unit contract prices for structural steel or cast steel.

–3.15 PAINTING

All structural steel and all other metal parts except steel surfaces embedded in concrete, unless otherwise provided, shall be painted three (3) coats of paint conforming to the requirements outlined in Section 116, Paints and Painting. Metal surfaces embedded in concrete shall be painted one (1) shop coat of paint as specified in Section 112-3.15. The first coat of paint shall be applied immediately after the steel has been cleaned by sand blasting.

The two field coats for roadway expansion dams shall be applied sufficient time in advance of opening to traffic to allow the paint to become thoroughly dry.

All metal surfaces which will be inaccessible for painting after erection, except those embedded in concrete, shall be painted with all three (3) coats of paint prior to erection.

The tops of all floor beams over which a slab joint occurs shall be coated on the tops and edges of the flange with a heavy mop coat of paving asphalt of 61-70 penetration applied hot, and a protective covering of 3-ply asphalt saturated roofing felt. This coating shall be applied over the shop paint and will take the place of two field coats of paint specified for other parts of the structural steel.

102–4 MEASUREMENT

Measurement of the various items entering into the construction of steel structures shall be made in accordance with the specifications for the several items involved.

102–5 PAYMENT

Payment for the various items entering into the construction of steel structures will be made in accordance with the specifications, at the unit contract price for the several bid items in the proposal.

All costs in connection with furnishing and placing grout and shims under steel shoes shall be considered as incidental to the construction and no separate payment will be made therefor. Payment shall include the furnishing of all materials, labor, equipment and all items required to complete the work.

Section 103—Timber Structures

103–1 DESCRIPTION

The provisions of this section of the specifications are intended to apply to bridges constructed primarily of timber and lumber but which are in reality composite structures in which other materials are employed to a greater or less extent. Timber bridges as thus defined shall be built as indicated on the plans and in accordance with the provisions of the specifications pertaining to the various materials and contract items which enter into and form a part of the complete composite structure.

The provisions and details of construction herein outlined shall apply, insofar as they are pertinent, to timber structures other than bridges except as such structures may be specifically mentioned elsewhere.

103–2 MATERIALS

–2.01 TIMBER AND LUMBER

Timber and lumber shall conform to the requirements of Section 114, Timber and Lumber. If preservative treatment is required, it shall conform also to the requirements of Section 115, Preservative Treatment for Timber, Lumber and Piles.

–2.02 CASTINGS

Castings used on timber bridges shall conform to the requirements of Section 113, Castings, Steel Forgings, and Miscellaneous Metals.

–2.03 BOLTS, WASHERS AND OTHER HARDWARE

Ordinary machine bolts and flat head bolts shall be made from commercial bolt stock meeting the specifications of ASTM Designation A 307, Steel Machine Bolts and Nuts and Tap Bolts, and shall be grade A. Drift bolts and dowels may be either wrought iron or medium steel. Washers may be cast iron ogee or malleable iron, or may be cut from medium steel or wrought iron plate, as specified.

–2.04 STRUCTURAL METAL

Rods, special bolts, plates, shapes and eye bars used on timber bridges and classed as structural metal shall be of structural carbon steel, conforming to the requirements of Section 112, Structural Steel.

–2.05 OTHER MATERIALS

Materials furnished and used in the construction of timber bridges and not specifically mentioned above, shall be those prescribed for the several spceifications and contract items which are required for the completed structure.

103–3 CONSTRUCTION DETAILS

–3.01 STORAGE OF MATERIAL

Timber and lumber on the site of the work shall be stored in piles. Untreated material shall be open stacked at least twelve (12) inches above the ground surface, and piled to shed water and prevent warping. Creosoted timber and piling shall be close stacked, piled to prevent warping and when required by the Engineer shall be protected from the weather by suitable covering.

The ground underneath and in the vicinity of all such piles of material shall be cleared of weeds and rubbish.

–3.02 WORKMANSHIP

Workmanship shall be first class throughout. None but competent bridge carpenters shall be employed and all framing shall be true and exact. Nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient cause for the removal of the workman causing them. The workmanship on all metal parts shall conform to the requirements specified for steel structures.

–3.03 SHOP DETAILS

The Contractor shall submit to the Engineer for approval two sets of shop detail plans of all treated timber, showing thereon the dimensions of all timbers which are cut, framed or bored. The Engineer will retain one set of the shop detailed plans and return the other approved, or with the corrections marked thereon. No material shall be framed or bored until the shop plans have been approved.

All plans shall be drawn on sheets each twenty-two (22) inches wide by thirty-six (36) inches long in overall dimensions, or on smaller sheets that are multiples of eight and one-half (8½) inches by eleven (11) inches.

–3.04 HANDLING TREATED TIMBER

Treated timber shall be carefully handled without sudden dropping, breaking of the outer fibers, bruising or penetrating the surface with tools. It shall be handled with rope or chain slings and no cant dogs, peaveys, hooks or pike poles shall be used.

All cutting, framing and boring of treated timbers shall be done before treatment, insofar as it is practicable.

–3.05 FIELD TREATMENT OF CUT SURFACES, BOLT HOLES AND CONTACT SURFACES

All cuts in treated piles or timbers and all abrasions, after having been trimmed carefully, shall be coated with two coats of hot creosote and covered with hot roofing pitch.

All bolt holes drilled in the field shall be treated with hot cresote oil, using a pressure bolt-hole treater except that, if painting is required, the bolt holes shall be pressure treated with the same preservatives as used for the timber. Any unfilled holes, after treatment with the appropriate preservative, shall be filled with plugs treated with the same preservative as applied to the holes.

For structures of untreated timber, the heads of all piles, the ends, tops and all contact surfaces of sills, caps, floor beams, stringers, wheel guards, all end joints and contact surfaces of bracing and truss members, back faces of bulkheads, and all other timber in contact with earth—all these shall be thoroughly coated with two (2) coats of hot creosote oil. Particular attention is called

to the necessary avoidance of stains from creosoting on surfaces that are to be painted.

In addition to the above treatment, all depressions or openings around bolt holes, joints or caps which may retain moisture and cause decay, shall be carefully sealed by means of a hot waterproofing pitch conforming to coal tar pitch AASHO Designation M 118. Waterproofing pitch, Type B shall be furnished unless otherwise specified. Primer for use with coal tar pitch in dampproofing and waterproofing shall conform to AASHO Designation M 117 (ASTM D 173). Special field treatment for the heads of treated piles shall be as described in Section 106-3.02G.

–3.06 PAINTING

Unless otherwise specified, rails and rail posts shall be given two (2) coats of paint of the quality specified in Section 116-3.03 and it shall be applied as described therein. The color of the paint shall be as shown on the plans, specified in the special provisions, or as designated by the Engineer. Metal parts other than the parts classified as hardware shall be painted with one coat of shop paint, and after erection be given two coats of field paint, all as specified in Section 116, Paints and Painting.

–3.07 HOLES FOR RODS, BOLTS AND BOAT SPIKES

Holes for drift bolts and boat spikes shall be bored with a bit one-sixteenth (1/16) inch less in diameter than the bolt or spike to be used.

Holes for machine bolts, flat head bolts and dowels shall be bored with a bit of the same diameter as the bolt or dowel, and holes for truss rods shall be bored with a bit of a diameter one-sixteenth (1/16) inch larger than that of the rod.

–3.08 BOLTS, WASHERS AND OTHER HARDWARE

All bolts and other hardware, which are to be galvanized and which require bending or shaping shall be hot forged to the required shape before galvanizing. Cold bending of such material will not be permitted because of the tendency toward embrittlement during the galvanizing process.

Washers of the size and type specified shall be used under all bolt heads and nuts which would otherwise come in contact with wood, except that washers are not required under the heads of standard flat head bolts.

All bolts shall be effectively checked by burring the threads after the nuts have been finally tightened. Vertical bolts shall have the nuts on the lower end.

In all cases where bolts are used to fasten timber to timber, timber to concrete or timber to steel, the members shall be bolted tightly together when they are installed and shall be retightened immediately prior to final acceptance of the contract. All bolts shall have sufficient additional threading to provide at least three-eighths (⅜) inch per foot thickness of timber for future retightening.

Standard flat head bolts shall be used in timber bridge construction unless otherwise specified.

Nails shall be round wire of standard form. Spikes shall be wire spikes or boat spikes, as specified on the plans. Bolts, dowels, washers and other hardware, including nails, shall be black or galvanized as specified on the plans, but if not so specified, all such hardware shall be galvanized if to be used in treated timber structures.

–3.09 COUNTERSINKING

Countersinking shall be done wherever smooth faces are required. Recesses formed for countersinking shall be painted with hot creosote oil and, after the bolt or screw is in place, shall be filled with hot pitch conforming to the requirements of Section 103-3.05.

–3.10 FRAMING

All lumber and timber shall be accurately cut and framed so the joints will have a close fit over the entire contact surfaces. Mortises shall be true to size for their full depth, and tenons shall make a snug fit therein. No shimming will be permitted in making joints, nor will open joints be accepted.

–3.11 FRAMED BENTS

Untreated timber for mudsills shall preferably be of cedar. Mudsills shall be firmly and evenly bedded to solid bearing and tamped in place.

Concrete pedestals for the support of framed bents shall be carefully finished so that the sills will take even bearing on them. Dowels of not less than three-fourths (¾) inch diameter and projecting at least six (6) inches above the tops of the pedestals shall be set in them when they are cast, for anchoring the sills. The concrete shall be of the class indicated on the plans and shall conform to the requirements of Section 107, Portland Cement Concrete for Structures.

Sills shall have true and even bearing on mudsills, piles or pedestals. They shall be drift bolted to mudsills or piles with bolts not less than three-fourths (¾) inch diameter and extending into the mudsills or piles at least six (6) inches. When possible, all earth shall be removed from contact with the sills so there will be free circulation of air around them.

Posts shall be fastened to sills with dowels of not less than three-fourths (¾) inch diameter extending at least six (6) inches into the posts.

–3.12 CAPS

Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to secure an even alignment of their ends. All caps shall be secured by drift bolts not less than three-fourths (¾) inch in diameter extending at least nine (9) inches into the posts or piles. The drift bolt shall be approximately in the center of the pile or post.

When the roadway grade exceeds two percent, caps shall be bevel sawed to fit the grade.

–3.13 BRACING

All pile bents over ten (10) feet high shall be braced transversely at each bent and longitudinally in alternate pairs of bents. Single story bracing shall not exceed twenty (20) feet. The ends of bracing shall be bolted through the pile, post or cap with a bolt not less than three-fourths (¾) inch in diameter. Intermediate intersections shall be bolted or boat spiked, as indicated on the plans. Sway bracing shall extend far enough to lap both upper or lower caps or sills and shall be bolted to the caps or sills at each end.

–3.14 STRINGERS

All stringers carrying laminated decking and any stringer varying in depth by more than one-eighth (⅛) inch shall be sized to an even depth at bearing points.

Outside stringers shall be butt jointed and spliced, but interior stringers shall be lapped to take bearing over the full width of the cap or floor beam at each end. Joints shall be broken if stringers cover two spans and stringers shall be either toenailed or drift bolted, as specified on the plans. Stringers may be of sufficient length to cover two spans, except on sharp horizontal and vertical curves. The ends of lapped stringers on untreated timber structures shall be separated for the circulation of air by a 1" x 3" strip of wood 2" shorter than the depth of stringer and securely fastened across the face of one of the stringers between the lap.

Between stringers, cross bridging or solid bridging, as shown on the plans, shall be neatly and accurately framed and securely toenailed at each end with at least two (2) nails for cross bridging and four (4) nails for solid bridging. The size and spacing of bridging shall be as shown on the plans.

–3.15 WHEEL GUARD AND RAILING

Wheel guards and railings shall be accurately framed and bolted in accordance with the plans and be erected true to line and grade. Wheel guards shall be laid in sections not less than twelve (12) feet long, bolted through the floor plank and through the outside stringer or nailing piece with three-fourths (¾) inch bolts spaced not over four (4) feet apart. Wheel guards shall be beveled on the roadway side as shown on the plans. Wheel guard material shall be surfaced on the top edge and roadway side or may be surfaced four (4) sides (S4S). All material for railings shall be surfaced four (4) sides (S4S).

–3.16 TRUSSES

Trusses, when completed, shall show no irregularities of line. Chords shall be straight and true from end to end in horizontal projection, and in vertical projection shall show a smooth curve through panel points conforming to the correct camber. All bearing surfaces shall fit accurately. Uneven or rough cuts at the points of bearing shall be cause for rejection of the pieces containing the defects. Unless otherwise directed by the Engineer, all trusses shall be completed, swung free of their falsework and adjusted for line and camber before the hand railing is placed.

–3.17 SINGLE PLANK FLOORS

Single plank floors shall consist of a single thickness of plank supported by stringers or joists. Unless otherwise directed by the Engineer, the plank shall be laid with the heart side down, and with tight joints. Each plank shall be spiked to each joist or nailing strip with not less than two spikes, the length of which shall be at least four (4) inches greater than the thickness of the plank. The spikes shall be placed not less than two and one-half (2½) inches from the edges of the plank. The ends of the plank shall be cut off on a straight line parallel to the center line of the roadway. The planks shall be carefully graded as to thickness and laid so adjacent planks will not vary more than one-sixteenth (1/16) inch. Roadway and sidewalk plank shall be surfaced one side and one edge (SISIE), unless otherwise specified.

–3.18 LAMINATED FLOORS

The strips shall be placed on edge and shall be drawn down tightly against the stringer or nailing strip and the adjacent strip, and shall be spiked while held in place. Each strip shall extend the full width of the deck unless some other arrangement is shown on the plans or authorized by the Engineer.

Each strip shall be spiked to the adjacent strip at intervals of not more than two (2) feet, the spikes being staggered eight (8) inches in adjacent strips. The spikes shall be of sufficient length to pass through two strips and at least half way through the third. In addition, unless bolting is specified on the plans, each strip shall be toenailed to alternate stringers with forty penny (40d) common nails and adjacent strips shall be nailed to every alternate stringer. Ends of all pieces shall be toenailed to the outside stringer. The ends of the strips shall be cut off on a true line parallel to the center line of the roadway. When bolts are used to fasten laminated floors to stringers, the bolts shall be placed at the spacing shown on the plans and the pieces shall be drawn down tightly to the bolting strips. The bolt heads shall be driven flush with the surface of the deck. Double nuts or single nuts and lock nuts shall be used on all bolts. The strips shall be spiked together in the same manner as specified above.

–3.19 PLANK SUB-FLOORS FOR CONCRETE DECKS

The plank sub-floor shall be laid surfaced side down with close joints at right angles to the center line of the roadway. The sub-floor shall be spiked in place in the same manner as specified for single plank floors in Section 103-3.17.

Floor plank shall be pressure treated with creosote as described in Section 115, Preservative Treatment for Timber, Lumber and Piles. The amount of creosote oil to be used shall be as indicated on the plans, or as specified in the special provisions.

103–4 MEASUREMENT

The quantities of timber, lumber and various other items which constitute a complete and accepted structure will be measured for payment in units as described in the specifications and proposal for each individual item.

The weight of structural metal, other than hardware, will be determined in the manner specified for structural steel in Section 112.

103–5 PAYMENT

The quantities measured as above mentioned, will be paid for at the unit contract prices for the several items which, except as otherwise provided, shall be full compensation for all labor, material, tools and equipment and for all incidental work necessary to complete the structure ready for use.

The lump sum contract price for "Structural Metal" shall include full compensation for furnishing all materials, labor, tools and equipment and all incidental work necessary to install structural metal as shown on the plans. If no item for structural metal is included in the proposal, the materials and work involved shall be considered as incidental to the construction and all costs therefor shall be included by the Contractor in the bid items of timber or lumber, or other bid items of the proposal.

Section 104—Concrete Culverts and Retaining Walls

104-1 DESCRIPTION

All drainage structures constructed of concrete that have span lengths less than twenty (20) feet, but not including concrete pipe drains, shall be considered as concrete culverts. Concrete culverts may be arched, circular, single box, double box or simple span culverts as shown on the plans.

All concrete walls, including gravity, cantilever, counterforted, buttressed and tied walls, shall be considered as concrete retaining walls.

104–2 MATERIALS

All reinforcing steel and materials for concrete shall conform to the requirements outlined in Section 111 for reinforcing steel, and in Section 107 for portland cement concrete. The classes of concrete shall be as shown on the plans.

104–3 CONSTRUCTION DETAILS

–3.01 GENERAL

Concrete culverts and retaining walls shall be constructed in accordance with the requirements specified in Section 101 for concrete structures, Section 107 for portland cement concrete for structures, and Section 111 for reinforcing steel.

–3.02 EXCAVATION AND BACKFILL

Excavation and backfill shall be in accordance with the specifications for excavation and backfill as described in Section 17.

–3.03 DRAINAGE—BACKFILL AND SUBSTRUCTURE

Backfill material placed back of retaining walls, abutments and wing walls shall be a gravel material that will drain readily. In general, when original excavation is not suitable for backfilling and unless otherwise shown on the plans or provided in the special provisions, the backfill material shall be a bank run material conforming to the requirements for Bank Run Gravel, Class A, in Section 26. Such backfill shall be placed in layers and compacted as described in Section 17-3.09.

Drainage through backfill behind walls shall be intercepted and removed by the means shown on the plans; through weep holes, tile drains, french or rock drains, or a combination of such means. If a specific method of drainage collection is not shown on the plans, the Contractor shall install such drains as may be directed by the Engineer to adequately pick up and dispose of the drainage.

Gravel backfill for drains shall conform to the requirements for filter material as described in Section 65-3.04.

104–5 MEASUREMENT AND PAYMENT

Measurement and payment for the various items involved will be made in accordance with the provisions of the specifications and the plans for those items, excepting, that all costs in the connection with the construction of weep holes and the gravel backfill for drains surrounding the weep holes shall be included by the Contractor in the unit contract price per cubic yard for concrete in place.

Payment for gravel backfill for walls shall be made at the unit contract price per ton or per cubic yard in place for "Gravel Backfill for Walls" which price shall be full compensation for all other costs and expenses necessary or incidental to furnishing, loading, hauling the full distance, and placing of the gravel backfill as specified hereinbefore.

Section 106—Piling

106–1 DESCRIPTION

These specifications cover only such piling as is shown upon the plans, or ordered in writing by the Engineer. Piling under these specifications may be of any of the several types and kinds described herein.

–1.01 TIMBER PILING

Timber piling shall be untreated, or treated with the preservatives specified in the plans and completely described in Section 115, Preservative Treatment for Timber, Lumber and Piles.

–1.02 COMPOSITE PILING

Composite piling as contemplated under these specifications shall consist of a pile made up of two (2) timber sections, or of a reinforced concrete pile and a timber pile section.

For the composite piiing made up of two (2) timber sections, the lower section shall be untreated and the upper section shall be creosote treated. For the composite piling made up of reinforced concrete and timber, the lower section shall be untreated timber and the upper section shall be either precast or cast-in-place reinforced concrete.

–1.03 PRECAST CONCRETE PILING

Precast concrete piles shall consist of concrete sections properly reinforced to withstand handling and driving stresses and shall conform to the dimensions and details shown on the plans.

If a square section is specified, the corners shall be chamfered one inch. Precast concrete piles may be either precast concrete piles with deformed steel reinforcing bars or precast-prestressed concrete piles with prestressed steel strands.

–1.04 CAST-IN-PLACE CONCRETE PILING

Cast-in-place concrete piles shall consist of steel casings or shells driven in the ground and filled with concrete.

–1.05 STEEL PILING

Steel piling shall consist of rolled steel H pile sections or other structural steel members of the size and weight shown on the plans.

106–2 MATERIALS

–2.01 TIMBER PILING

Timber piles shall have the following limiting diameters in inches:

LENGTH	BUTT		TIP
	Minimum 3 Ft. Above Butt	Maximum 3 Ft. Above Butt	Minimum
Feet	Inches	Inches	Inches
Under 40	12	20	8
40 to 50 Inclusive	12	20	7
51 to 70 Inclusive	13	20	7
71 to 90 Inclusive	13	20	6
Over 90	13	20	5

–2.01A Untreated Piling

Except where specifically provided otherwise, untreated timber piling shall be Douglas fir, Western red cedar or larch. Piling for foundations shall preferably be Douglas fir. Piling shall be cut from sound, live trees and shall contain no unsound knots. Sound knots will be permitted, provided the diameter of the knot does not exceed four (4) inches or one-third (⅓) of the small diameter of the stick at the point where they occur, whichever is smaller. Any defect or combination of defects which will impair the strength of the pile more than the maximum allowable knot will not be permitted.

Piling shall be cut above the ground swell and shall have a uniform taper from butt to tip. A line drawn from the center of the tip to the center of the butt shall not fall outside the center of the pile at any point more than one percent (1%) of the length of the pile. A spiral grain or twist in excess of one-fourth (¼) turn in ten (10) feet of length will be cause for rejection.

Untreated timber trestle piling shall have an average of at least five (5) annual rings per inch measured radially over a distance of three (3) inches at the butt, beginning at a point three and one-half (3½) inches from the heart. At least nine (9) inches of heartwood shall show at the butt.

Ring count requirements for untreated timber foundation piling and detour trestle piling will be waived.

–2.01B Creosote Treated

For creosote treated piling, Douglas fir timber shall be the same as for untreated piling except that the ring count requirement will be waived.

–2.01C Composite Piles

The treated and untreated sections of composite pile shall meet the respective requirements specified above for full length treated and untreated timber piling.

–2.02 PRECAST REINFORCED CONCRETE PILING

–2.02A Concrete

Portland cement or high-early-strength cement shall be used in all precast concrete piles.

The concrete for precast-prestressed piles shall have a minimum compressive strength of 6,000 pounds per square inch at the age of 28 days. The minimum compressive strength of concrete at the transfer of prestress shall be 4,800 pounds per square inch.

The concrete for other precast piles shall be Class AX.

Mixing, transporting, placing and curing concrete shall be in accordance with the provisions of Section 107, Portland Cement Concrete for Structures.

–2.02B Reinforcing Steel

For precast-prestressed piles, each prestressing strand shall consist of bright stress-relieved wires. Each strand shall have a nominal diameter of seven-sixteenths (7/16) inch and shall conform to the requirements of ASTM Designation A 416-57T.

For other precast piles the reinforcing steel shall be deformed bars conforming to the requirements of Section 111, Reinforcing Steel, and to the requirements of ASTM Designation A 15, intermediate grade.

–2.03 CAST-IN-PLACE CONCRETE PILING

–2.03A Steel Shells or Casings: —

–2.03A1 Self-Supporting Driven Shells

The steel shells or casings shall conform to the requirements of the specifications for Steel for Bridges, ASTM Designation A 7 or ASTM Designation A 252, Grade 2, Welded and Seamless Steel Pipe Piles.

The pipe shells shall have sufficient thickness of shell to permit driving without damage to the shell and the Contractor shall make his own determination of the shell thickness required.

Casings may be used meeting the 50,000 psi yield strength requirement as determined by mill tests, or physical tests on material as fabricated in the casings.

–2.03A2 Mandrel Driven Steel Shells

Mandrel driven steel shells shall have sufficient thickness of shell to permit driving without any damage to the shell and the Contractor shall make his own determination of the shell thickness required.

–2.03B Concrete

Class AX concrete shall be used in all cast-in-place reinforced concrete piles. Mixing, transporting, placing and curing shall be in accordance with the specifications in Section 107, Portland Cement Concrete for Structures.

–2.03C Reinforcing Steel

Reinforcing steel for cast-in-place concrete piling shall be deformed steel bars conforming to the requirements of Section 111, Reinforcing Steel.

–2.04 STEEL PILING

The material for steel piling shall conform to the requirements of the specifications for Steel for Bridges, ASTM Designation A 7. This materials specification shall apply to the pile caps and splice plates as well as the pile section itself.

106–3 CONSTRUCTION DETAILS

–3.01 GENERAL PROVISIONS

–3.01A Ordering Piling

All piling, with the exception of cast-in-place concrete piling and steel piling, shall be ordered by the Contractor in accordance with an itemized list which will be furnished by the Engineer. This list will show the number and length of piles required and will be based on information secured from the driving of test piles or other data available to the Owner. The lengths shown on this list shall be the lengths required below cutoff and the Contractor shall, at his own expense, increase the lengths the necessary amount to provide for fresh heading and to reach from the cutoff elevation up to the position of his driving equipment.

In the case of cast-in-place concrete piling and steel piling, no order list will be furnished by the Engineer and the Contractor shall determine the length required from the results obtained by the driving of the test piles called for on the plans and subsurface exploration data.

–3.01B Piling Ordered But Not Driven

Piling purchased in accordance with the Engineer's itemized list, but not incorporated in the finished structure, shall be immediately delivered to and become the property of the Owner (city). The purchase of additional piles or piles of greater length than those shown on the Engineer's list shall be at the Contractor's risk.

–3.01C Piles Destroyed in Handling or Driving

Any pile which is damaged or destroyed before or at the time it is being driven shall be replaced by the Contractor at his own expense.

–3.01D Preparation for Driving

Foundation pits, including construction of cofferdams or cribs where required, shall be completely excavated before the driving of foundation piles is begun. Allowance for upheaval of the pit bottom, due to driving the piles, shall be made, the amount of allowance depending upon the character of the material through which the piles are to be driven. Any material forced up between the piles to above the elevation shown for the bottom of the foundation pit shall be removed to the correct elevation before the foundation masonry is placed. In the event that too great an allowance is made for upheaval due to driving of piles, backfilling with gravel will, in general, be permitted to raise the pit bottom to the correct elevation.

–3.01E Penetration

In general, the penetration for any pile shall be not less than ten (10) feet in hard material and not less than twenty (20) feet in soft material. For foundation work, piles shall not be used to penetrate a very soft upper stratum overlying a hard stratum unless the piles penetrate the hard material a sufficient distance to rigidly fix the bottom of the pile.

Unless otherwise specified, all piling driven into previously placed embankment material shall be driven to penetrate through the embankment material with full bearing secured in the underlying foundation material.

To secure the minimum general depths of 10 feet and 20 feet respectively, in hard and soft materials, to penetrate hard material underlying a soft upper stratum and to penetrate through a previously placed embankment, the Contractor shall employ whatever means as are necessary to secure the required penetration without injury to the pile. The Contractor shall provide a suitable means or device to indicate the penetration of the pile. Whatever means as is employed shall be visible from the ground at any reasonable and safe distance from the pile driving.

In addition to the minimum load bearing capacity and/or penetration as specified, the Contractor shall, if directed by the Engineer, overdrive each pile to such additional penetration as requested; provided, however, that jetting or other unusual means will not be required to secure the additional penetration. If the Engineer specifically directs the Contractor to drive piles over the minimum bearing capacity specified and/or beyond the minimum penetration specified, the Contractor will not be required to remove or replace the pile at his own expense because of damage resulting from such overdriving.

–3.01F Elevation of Cutoff

The tops of all piles shall be sawed or cut to a true plane as shown on the plans, and at the elevation fixed by the Engineer. Piles which support timber caps or grillages shall be sawed to the exact plane of the superimposed structure and shall exactly fit it. Broken, split or misplaced piles shall be withdrawn and be properly replaced.

–3.01G Piles Driven Below Cutoff

Piles driven below the cutoff elevation without authority of the Engineer shall be withdrawn and replaced by new and, if necessary, longer piles at the expense of the Contractor. All piles raised during the process of driving adjacent piles shall be driven down again, if required by the Engineer.

–3.01H Equipment for Driving

–3.01H1 Hammers

Timber piles shall be driven either with drop hammers, steam or air driven hammers, or with a combination of water jets and hammers. Underwater hammers may be used, subject to approval of the Engineer. Drop hammers shall weigh not less than 3,000 pounds for piles less than fifty (50) feet long and not less than 4,000 pounds for piles over fifty (50) feet long. If a drop hammer is used for driving timber piles, it is preferable to use a heavy hammer and operate with a short drop. The maximum height of drop shall be ten (10) feet.

Steam or air driven hammers for driving timber piles shall develop not less than 13,000 foot-pounds of energy per blow.

Steel shells for cast-in-place concrete piles and steel piles, shall be driven with steam or air hammers developing not less than 13,000 foot-pounds of energy per blow.

Precast concrete piles shall be driven with a single acting steam or air hammer developing not less than 13,000 foot-pounds of energy per blow.

Diesel pile hammers will be approved for driving timber piles, steel piles and steel shells for cast-in-place concrete piles provided the ram weighs not less than 3,600 pounds and the energy developed exceeds 13,000 foot-pounds of energy per blow. Diesel pile hammers will not be approved for driving precast concrete piles.

The Contractor shall furnish the Engineer with the manufacturer's specifications and catalog for all steam, diesel or air hammers used, showing all the data necessary for computing the bearing value of piles driven. Gravity or drop hammers shall be weighed in the presence of the Engineer, or a certificate of weight may be furnished the Engineer. Hammers so weighed shall have the exact weight stamped on them.

–3.01H2 Leads

Fixed lead pile drivers shall be used in driving all piles. The use of hanging or swinging leads will not be allowed unless they are so constructed that they can be held in a fixed position during the driving operations. Leads shall be of sufficient length so that the use of a follower will not be necessary, except as hereinafter provided for timber piles. When driving treated timber piles the use of spuds and chocks in the leads shall be kept at a minimum in order that the protective treatment will not become bruised or broken. Leads adapted to the driving of batter piles shall be employed for trestle construction or for foundation work involving inclined piles.

–3.01H3 Water Jets

Water jets shall not be used unless, in the opinion of the Engineer, such use is necessary or desirable. When water jets are used the number of jets and the volume and pressure of the water at the jet nozzles shall be sufficient to freely erode the material adjacent to the pile. The plant shall have sufficient capacity to deliver at all times at least one hundred (100) pounds per square inch pressure at two (2) three-fourths (¾) inch jet nozzles. Before the desired penetration is reached the jets shall be withdrawn and the piles shall be driven with the hammer to secure the final penetration and bearing value. Piles previously driven that become loosened due to the use of the water jets shall be redriven in place or pulled and a new pile driven. A careful check shall be made during driving of piles to determine if the piles are becoming loosened by attempting to redrive at least one pile in every five piles. No allowance will be made for cost to the Contractor for redriving of loosened piles due to the use of water jets.

All costs resulting from the use of water jets shall be included in the unit contract price for driving piles and no additional compensation will be allowed.

–3.01I Test Piles

When specified on the plans or ordered by the Engineer, the Contractor shall drive test piles to determine the lengths of piling required to obtain the necessary load carrying capacity or penetration. These piles shall be driven at the locations designated by the Engineer and shall be of sufficient length to provide for any variation in soil conditions. Test piles shall be of the same material as the permanent piles which are to be driven. Test piles for treated timber piles may be either treated or untreated timber piles conforming to the requirements of these specifications. Steel shells or casings used as test piles for cast-in-place concrete piles and precast concrete and steel test piles shall have the same cross section and other characteristics as the permanent piles.

Driving equipment used to drive test piles shall be the same as that to be used for driving the permanent piles.

–3.01J Loading Tests

When specified or required by the Engineer, the size and number of piles shall be determined by actual loading tests. In general, these tests shall consist of the application of test loads placed upon a suitable platform supported by the pile, together with suitable apparatus for accurately determining the superimposed weight and the settlement of the pile under each increment of load. The safe allowable load shall be considered as fifty (50) percent of that load which, after forty-eight (48) hours application, causes a permanent settlement of not more than one-fourth (¼) inch measured at the top of the pile. At least one pile for each group of one hundred (100) piles shall be thusly tested.

–3.01K Alignment of Piles

Piles shall be driven as accurately as possible in true line and position. All piles shall be vertical unless otherwise specified or shown on the plans.

–3.02 TIMBER PILES

–3.02A Peeling

–3.02A1 Untreated and Creosote Treated Piles

Untreated and creosote treated piles shall be peeled by removing all of the rough bark and at least 80% of the inner bark. No strip of inner bark remaining on the stick shall be over three-fourths (¾) inch wide or over eight (8) inches long, and there shall be at least one (1) inch of clean wood surface between any two such strips. Not less than 80% of the surface on any circumference shall be clean wood. All knots shall be trimmed close to the body of the pile.

–3.02A2 Composite Piles

Composite piles shall be peeled in the same manner as untreated and creosote treated piles.

–3.02B Storage and Handling

The method of storing and handling shall be such as to avoid injury to the piles. Special care shall be exercised to avoid breaking the surface of treated piling, and cant hooks or pike poles shall not be used. Cuts or breaks in the surface of treated piling shall be given three (3) brush coats of hot creosote oil of approved quality. Cuts or breaks may also be cause for rejection of piling for use in the structure.

Treated piling shall be close stacked and piled so as to prevent warping.

The ground underneath and in the vicinity of the piles shall be cleared of weeds, brush and rubbish.

–3.02C Preparation for Driving

–3.02C1 Fresh Cut Heads

Timber piles, treated and untreated, shall be fresh cut on the butt end just before placing in the leads for driving. Caps, collars or bands shall be placed on the butt end of the pile when the pile is being driven in hard material to avoid crushing or brooming the head of the pile. When the area of the head of any timber pile is greater than that of the face of the hammer, the pile shall be snipped or chamfered to at least the depth of the sap to avoid splitting of the sap from the body of the pile during driving.

–3.02C2 Followers

Followers, made of steel with driving head and cap made to fit snugly over the head of the pile, may be used when driving timber piles. The use of wood followers will not be permitted.

All timber piles shall preferably be driven by striking directly on the head of the pile without the use of cushions, blocks or followers. When followers are used, one pile from every group of ten (10) shall be a long pile driven without a follower as a test pile to determine the bearing power of the group.

–3.02C3 Pointing and Placing Metal Shoes

Timber piles preferably shall be driven with squared ends; however, when conditions require they may be pointed or shod with metal shoes of a design satisfactory and subject to the approval of the Engineer.

–3.02C4 Splicing

Full length piles shall always be used where practicable, but if splices cannot be avoided the method of splicing shall be subject to the approval of the Engineer.

–3.02D Pile Bents

The location of all piles shall be "spotted" by pegs set to true line and position. For pile bents, the piles shall be reasonably uniform in size to avoid undue bending or distortion of sway bracing. Piles shall be driven with a variation of the portion above ground of not more than one-fourth (¼) inch per foot from the vertical or batter indicated. Excessive pulling or stressing of piles in a bent to bring them into suitable line and position for cutoff and capping will not be permitted. The Contractor will be required to remove and redrive piles that do not meet the above tolerance without undue stressing.

Cutoff of piles for a pile bent shall be accurately made to ensure perfect bearing between cap and piles. No shimming on top of any piles will be permitted.

The piles of any one bent shall be carefully selected as to size to avoid undue bending or distortion of the sway braces.

–3.02E Splicing Composite Piles

Composite untreated timber and treated timber piles, where shown on the plans, shall be driven the same as other timber piles, except that the lower or untreated pile shall first be driven to approximately the ground or water line before splicing the two sticks together. Splices shall usually consist of lengths of steel pipe securely fastened to both the untreated and the treated piles with spikes or bolts. The untreated piles shall have the butt end rounded to form a tight driving fit into the pipe splice. The treated piles shall have the tip end rounded, prior to treatment, to form a tight driving fit into the pipe splice. The composite pile shall then be driven to the required penetration or bearing value. Composite piles shall be driven in such a manner that the position of the splice will be well into the ground to provide lateral support for the pile, and also below the level of permanent ground water.

Before ordering lengths of piles for timber composite piles, the relative positions of the ground line and the permanent water table shall be carefully determined and the piles ordered accordingly.

–3.02F Penetration

The minimum penetration shall be approximately ten (10) feet and the Contractor shall employ whatever means as may be necessary to secure this penetration without injury to the pile.

–3.02G Treatment of Pile Heads

The heads of all untreated piles, except those encased with concrete, shall be thoroughly coated with two coats of hot creosote oil.

The heads of all treated piles, except piles covered with concrete footings or concrete caps, after being cut to correct elevation, shall be given three (3) brush coats of hot creosote oil. They shall then be capped with a covering built up of alternate layers of hot pitch or approved roofing asphalt, and waterproofing fabric conforming to the requirements of Section 118-2.02 using four (4) layers of pitch and three (3) layers of fabric. The cover shall measure at least six (6) inches more in each dimension than the diameter of the pile top. The cover shall be bent down over the pile and the edges fastened with large headed galvanized nails or secured by binding with three (3) turns of galvanized wire. The edges of the fabric shall be trimmed around the pile to give a neat appearance.

–3.02H Elevation of Pile Tops

Where untreated timber piles are used for foundations, the tops of the piles shall be kept well below the plane of permanent ground water or low water level.

–3.02I Determination of Bearing Values

In the absence of loading tests, the safe bearing values for timber piles shall be determined by the following formulas:

$$P = \frac{2WH}{S + 1.0}$$ for gravity hammers

$$P = \frac{2WH}{S + 0.1}$$ for single-acting steam or air hammers

$$P = \frac{2H\ (W + Ap)}{S + 0.1}$$ for double-acting steam or air hammers

Where
- P = safe bearing power in pounds
- W = Weight in pounds, or striking parts of hammer
- H = drop of hammer or stroke of ram, in feet
- A = area of piston in square inches
- P = steam pressure in pounds per square inch at the hammer
- S = the average penetration in inches per blow for the last five (5) to ten (10) blows for gravity hammers and the last ten (10) to twenty (20) blows for steam or air hammers.

The above formulas are applicable only when:

(a) The hammer has a free fall.

(b) The head of the pile is free from broomed or crushed wood fiber.

(c) The penetration is at a reasonably quick and uniform rate.

(d) There is no sensible bounce after the blow. Twice the height of the bounce shall be deducted from "H" to determine its true value in the formula.

The Engineer may require the installation of an adequate pressure gauge at the inboard end of the hose for the purpose of checking the pressure at the hammer.

The bearing power of timber piles, as determined by the foregoing formulas, shall be considered effective only when they are less than the crushing strength of the piles. Unless otherwise specified on the plans, timber piling driven under these specifications shall have the following minimum bearing values as determined by actual test loads or by the foregoing formulas:

(a) Timber piles in foundations, 20 tons.

(b) Timber piles for trestle bents, 15 tons.

In case water jets are used in connection with driving, the bearing power shall be determined by the above formulas from the results of driving after the jets have been withdrawn, or a test load applied.

–3.03 PRECAST CONCRETE PILING

–3.03A Forms

Forms for precast concrete piles shall conform to the general requirements for concrete form work, as provided herein under Section 101. Forms shall be accessible for tamping and consolidation of the concrete.

–3.03B Reinforcement

Reinforcing bars, hoops, shoes, etc., shall be placed as shown on the plans. All parts shall be well wired and tied together and placed to the spacings shown. All reinforcements shall be in place in the forms before any concrete is placed.

–3.03C Casting

Piling may be cast either in a vertical or horizontal position. Care shall be exercised to vibrate and tamp the concrete around the reinforcement to avoid the formation of stone pockets. The use of internal vibrating tampers will be required when placing concrete in forms. Concrete shall be placed continuously in each pile, special care being taken to avoid horizontal or diagonal cleavage planes, and to see that the reinforcement is properly embedded in the concrete.

–3.03D Finishing

As soon as the forms are removed, concrete piles shall be carefully pointed with a 1:2 mortar, filling all cavities or irregularities. Trestle piling exposed to view shall be finished above the ground line in accordance with the provisions governing the finishing of concrete columns. Foundation piling, that portion of trestle piling which will be below the ground or low water surface, and piles for use in salt water or alkali soils shall not be finished except by pointing as above specified.

–3.03E Curing

Precast concrete piling shall be cured with water, unless curing with saturated steam or other method is authorized by the Engineer. When cured with water, the piles after casting shall be kept wet continuously for ten (10) days if portland cement is used, and three (3) days if high-early-strength cement is used. Side forms of piles cast horizontally may be removed any time twenty-four (24) hours after the concrete is placed, provided the air temperature surrounding the piles is maintained at or above fifty (50) degrees F. for the remaining required curing time for prestressed concrete piles.

Piling, during the curing period, shall not be subjected to any handling stresses until the concrete has attained a minimum compressive strength of forty-eight hundred (4800) pounds per square inch, or the Class AX concrete for other precast piles has attained a strength of thirty-three hundred (3300) pounds per square inch, as determined by test cylinders cured with the piling.

Test cylinders shall be cast with each set of piles as they are poured.

For steam curing of piles when authorized, the Contractor shall provide a suitable steam curing means equipped with a recording thermometer so arranged and calibrated that a continuous twenty-four (24) hour record of the temperature of the enclosure is recorded and available for inspection by the Engineer at all times that steam curing is in progress. The temperature recording device shall be accurate to within plus or minus five (5) degrees F.

Steam curing shall start as soon as practicable after casting of piles, and for the first two (2) hours the temperature of the concrete shall not be raised above one hundred (100) degrees F. After this initial two-hour starting period, temperature of the concrete may be raised to a maximum of one hundred fifty (150) degrees F. in increments not to exceed twenty-five (25) degrees F. per hour. Thereafter, this maximum temperature in the concrete shall be maintained continuously until the concrete has attained a minimum compressive strength of thirty-six hundred (3600) pounds per square inch as determined from test cylinders cured with the piling.

After the concrete has attained the required strength, it shall be cooled to air temperature by reducing the heat in increments of not more than twenty (20) degrees F. per hour by reducing the amount of heat applied. After the units have been removed from the casting bed, they shall be protected, as necessary, to avoid cooling at a rate greater than 20 degrees F. per hour.

–3.03F Storage and Handling

The method of storing and handling shall be such as to eliminate the danger of fracture by impact or undue bending stresses in curing or transporting the piles from the forms and into the leads. In general, concrete piles shall be lifted by means of a suitable bridle or sling attached to the pile at points not over twenty (20) feet apart and not more than ten (10) feet from the ends of the pile. In no case shall the method of handling be such as to induce stresses in the reinforcement in excess of twelve thousand (12,000) pounds per square inch, allowing one hundred (100) percent of the calculated load for impact and shock effects. In handling piles for use in sea water or alkali soils, special care shall be exercised to avoid injury to the surface of the pile.

Piles shall not be subjected to any handling stress until a test cylinder, made from the concrete pour for the piles involved and cured with the piles, shows a strength of at least 4,800 pounds per square inch for precast-prestressed piles or 3,300 pounds per square inch for other precast piles.

–3.03G Age Before Driving

Precast concrete piles shall not be driven until a test cylinder, made from the concrete pour for the piles involved and cured with the piles, shows a strength of at least 6,000 pounds per square inch for precast-prestressed piles or 4,000 pounds per square inch for other precast piles.

–3.03H Protection of Head

The heads of all precast concrete piles shall be protected during driving by caps of approved design, with a suitable cushion next to the pile head and fitting into a casting which in turn supports a shock block. The diameter of the inside of the cap shall be determined before the pile is cast and the head of the pile shall be formed to make a loose fit inside the cap.

–3.03I Extensions or Build-ups

Extensions, splices or "build-ups" on precast concrete piles, when necessary, shall be made as follows after the driving is completed:

For precast-prestressed piles, any spilled concrete shall be removed and the pile shall be fresh-headed to provide a top surface that is perpendicular to the axis of the pile. Ten (10) holes, 1¼ inches in diameter shall be drilled 26 inches deep in space between prestressing strands. Deformed bars No. 6 (¾-inch in diameter) shall be grouted in the drilled holes, and the necessary formwork shall be placed to form a build-up similar in cross section to the pile, care being exercised to prevent leakage along the pile. The concrete in the build-up shall be Class AX, Section 107-3.02A.

For other precast piles the concrete at the head of the pile shall be cut away a depth of forty (40) diameters of the bar size of the vertical reinforcing steel. The final cut of the concrete shall be perpendicular to the axis of the pile. Reinforcement similar to that used in the pile shall be firmly fastened to the projecting steel and the necessary formwork shall be placed, care being exercised to prevent leakage along the pile. The concrete in the build-up shall be of the same quality as that used originally in the pile.

Just prior to placing concrete, the top of the pile shall be thoroughly moistened. The forms shall remain in place at least three (3) days. Spliced piles shall not be driven.

–3.03J Determination of Bearing Values

In the absence of loading tests the bearing values of precast piles shall be determined by the formulas under Section 106-3.02I.

Unless otherwise specified on the plans, precast concrete piles shall be driven to develop a bearing value of not less than thirty (30) tons for thirteen inch (13″) diameter or thirty-five (35) tons for sixteen inch (16″) diameter piles.

–3.04 CAST-IN-PLACE CONCRETE PILES

–3.04A Steel Shells or Casings:

–3.04A1 Self-supporting Driven Shells

The steel casings for cast-in-place piles shall be of adequate strength and rigidity to permit driving and prevent distortion due to soil pressure or driving of adjacent piles. The casings shall be sufficiently watertight to exclude water before and during placing of the concrete.

The casings may be straight, tapered, or a combination of straight and tapered.

Constant diameter pile casings shall have a minimum outside diameter of 12 inches.

Tapered casings shall have a minimum outside butt diameter of 12 inches and a minimum outside tip diameter of 8 inches. Tapered casings manufactured of steel, having a yield strength of less than 50,000 psi, shall have a minimum diameter of 10 inches at fifteen (15) feet below cutoff or original ground line, whichever is lower.

The diameter of fluted pile sections shall be measured from crest to crest of flutes.

Unless otherwise approved by the Engineer, the joints in the casings shall be electrically welded. A driving point having a wall thickness of not less than ¾ inch shall be welded to the lower end of each casing.

–3.04A2 Mandrel Driven Steel Shells

Mandrel driven steel shells for cast-in-place piles shall be of sufficient strength and rigidity to permit of their driving and to prevent distortion caused by soil pressure or the driving of adjacent piles. The minimum outside diameter for constant diameter shells shall be 12 inches. The shells shall be sufficiently watertight to exclude water before and during the placing of the concrete.

The shells may be tapered, step-tapered or a combination of either with cylindrical sections.

Stepped or tapered shells shall have a minimum outside butt diameter of twelve (12) inches for a minimum distance of 15 feet below cutoff elevation or original ground line, whichever is the lower elevation, and a minimum outside tip diameter of eight (8) inches. The average outside diameter of the pile shall not be less than ten (10) inches.

The lower end of each shell shall be provided with a steel driving point having a wall thickness of sufficient strength to prevent driving without distortion and remain watertight.

–3.04B Driving Steel Shells

The top of the steel shell shall be protected with a combination driving head and pilot of proper size for the hammer to ensure a properly distributed blow and to prevent damage to the shell during driving. Both the hammer and the pile shall be supported in rigid leads.

Pile shells shall be driven in true alignment at the locations shown on the plans and shall be plumb or battered as indicated thereon. All pile shells in each footing shall be driven and left empty until inspected and approved by the Engineer, and no shell shall be driven within fifteen (15) feet of a pile in which the concrete has set less than seven (7) days if reinforced with bars and 48 hours if the concrete does not enclose reinforcing steel bars.

–3.04C Cutting Off Steel Shells

The pile shells after being driven, inspected and approved shall be cut off on a horizontal plane at the required elevation.

–3.04D Inspection

After being driven and prior to placing concrete and reinforcing steel therein, the steel shells shall be examined for collapse or reduced diameter at any point. Any shell which is improperly driven or broken or shows partial collapse to such an extent as to materially decrease its bearing value will not be accepted and shall be replaced by the Contractor at his own expense. Driven shells shall be clean and free of water before concrete and reinforcing steel are placed. The Contractor shall have available at all times a suitable light for inspection of the shells throughout the entire length before the shells are filled with concrete and reinforcing steel.

–3.04E Determination of Bearing Values

In the absence of loading tests the bearing values of cast-inplace concrete piles shall be determined by the formulas under Section 106-3.02I. Unless otherwise specified on the plans, steel shells shall be driven to develop a bearing value of at least thirty (30) tons.

–3.04F Reinforcement

Reinforcement for cast-in-place piles shall be sufficient to provide not less than six (6) three-fourths (¾) inch round bars conforming to the requirements of ASTM Designation A 15, intermediate grade, or four (4) No. 5 high strength steel bars conforming to the requirements of ASTM Designation A 431, shall extend a minimum of fifteen (15) feet below the ground line, or longer where called for on the plans; it is excepted, however, that where self-supported steel casings are used which provide more than one-eighth (⅛) inch shell thickness no reinforcement will be required.

All bars shall be rigidly fastened together in a single unit which shall be lowered into the shell before the concrete is placed. No loose bars will be permitted. The reinforcements shall be carefully positioned and securely fastened in such a manner as to ensure proper clearance between the reinforcing bars and the pile shell. The spiral reinforcement shall be No. 2 gage spiral hooping at 6″ centers unless otherwise noted on the plans and in the special provisions.

–3.04G Placing Concrete

Concrete shall be placed continuously in each pile and be vibrated with mechanical vibrating tools, proper care being exercised to fill every part of the shell and to work the concrete around the reinforcement without displacing it. All debris and water shall be removed from the shell before concrete is placed. Placing of concrete in shells containing water will not be permitted. In case the water cannot be removed the shell shall be pulled or filled with sand and a new shell shall be driven.

–3.04H Trestle Piles

Where cast-in-place concrete piles are used for trestle bents, the metal shells or casings shall not extend above the finished ground line. The piles above the finished ground shall conform to the details shown on the construction plans therefor. The reinforcing steel for the section of pile above the ground line shall extend a minimum of four (4) feet into the lower section to tie the two sections together.

All costs for splicing and building up the pile shall be included by the Contractor in his unit contract price per linear foot for "Furnishing Concrete Piling" and no other compensation will be allowed.

–3.05 STEEL PILES

–3.05A Storage and Handling

The method of storing and handling steel piles shall be such as to avoid injury to the piles. Bent or kinked piles which, in the opinion of the Engineer, cannot be straightened without injury to the metal will be rejected.

–3.05B Driving

Piles shall have square-cut ends and the heads shall be protected during driving by a metal cap made to fit the head of the pile.

Piles shall be driven in true alignment at the locations shown on the plans and shall be plumb or battered as indicated thereon.

–3.05C Splicing

Splicing of steel piles will, in general, be permitted subject to the approval of the Engineer as to the necessity for splicing and the manner in which the splice is to be made.

–3.05D Capping

When specified on the plans, steel piles after being cut off at the required elevation shall be capped with a steel plate. In such cases the pile top shall be cut square and as smooth as practicable. The pile cap shall consist of a steel plate of the size and shape shown on the plans. The method of attachment of the pile cap shall be by electric welding in the amount and in the manner shown on the plans.

–3.05E Determination of Bearing Values

In the absence of loading tests the bearing values of steel piles shall be determined by the formulas under Section 106-3.02I. Unless otherwise specified on the plans, steel piles shall be driven to develop the following bearing values:

8″ H-pile section	24 tons
10″ H-pile section	32 tons
12″ H-pile section	40 tons
14″ H-pile section	48 tons

106–5 MEASUREMENT AND PAYMENT

1. "Driving Timber Piles (untreated or name treatment)," per each.
2. "Driving Timber Composite Piles," per each.
3. "Driving Concrete Piles," per each.
4. "Driving Steel Piles," per each.
5. "Furnishing and Driving (as specified) Test Piles," per each.
6. "Furnishing Timber Piling (untreated or name treatment)," per linear foot.
7. "Furnishing Concrete Piling," per linear foot.
8. "Furnishing Steel Piling," per linear foot.
9. "Pile Splices (timber)," per each.
10. "Pile Splices (steel)," per each.
11. "Pile Loading Test," lump sum.

Payment for the furnishing and driving of piles of the various types in place other than test piles, shall be included in the following bid items, except as may be modified in Sections 106-5.01 to 106-5.05, inclusive, for each particular kind of piling.

a. "Driving (kind) Piles," per each.
b. "Furnishing (kind) Piling," per linear foot.

No additional compensation over the contract price for "Driving (kind) Piles" will be made for driving piles to the additional penetration as directed by the Engineer and as provided in Section 106-3.01E excepting that if driving to an additional penetration of more than three (3) feet is required, the cost to the Contractor of driving more than three (3) feet additional penetration will be paid for on the basis of "Force Account Work" as covered in Section 9.04.

Measurement for "Driving (kind) Piles" shall be the number of piles driven in place.

Measurement for "Furnishing (kind) Piling," shall be made in accordance with Sections 106-5.01 to 106-5.04, inclusive, for each particular kind of piling.

Irrespective of the provisions in Section 4.03, no compensation or unit price adjustment additional to the unit contract prices will be allowed for any increase or decrease in the quantities as shown in the proposal for furnishing and driving piling as a result of information gained from the driving of test piles.

–5.01 TIMBER PILING

Payment for "Furnishing Timber Piling (untreated or name treatment)," shall be made at the unit contract price per linear foot for the number of linear feet actually driven below cutoff or as shown on the Engineer's order list.

The unit contract prices per each for "Driving Timber Piles (untreated or name treatment)," and per linear foot for "Furnishing Timber Piling (untreated or name treatment)," shall be full compensation for piling in place. The unit contract price for "Furnishing Timber Piling (untreated or name treatment)," shall be full compensation for piling ordered but not driven. The prices shall include the furnishing of all materials, tools, equipment, labor, and all expenses incidental thereto. The cost of all materials, labor, tools and equipment necessary for treatment of the pile head, as specified in Section 106-3.02G, shall be included in the unit contract price per each for "Driving Timber Piles (untreated or name treatment)."

–5.02 COMPOSITE PILING

–5.02A Treated Timber and Untreated Timber

A composite pile made with two (2) or more sticks spliced together will be considered as one (1) pile.

Payment for "Furnishing Timber Piling (name treatment)," and for "Furnishing Timber Piling (untreated)," will be made at the unit contract prices per linear foot for the number of linear feet actually driven below cutoff or as shown on the Engineer's order list for each type of pile used.

Payment of pile splices will be made at the unit contract price per each for "Pile Splices (timber)" for the number of splices made in accordance with the plans or as ordered by the Engineer.

The unit contract price per each for "Driving Timber Composite Piles," per linear foot for "Furnishing Timber Piling (untreated or name treatment)" and per each for "Pile Splices (Timber)" shall be full compensation for the piling in place. The prices shall include the furnishing of all materials, tools, equipment, labor and all expenses incidental thereto. The unit contract price per each for "Driving Timber Composite Piles" shall also include the cost incidental to treatment of pile heads as specified in Section 106-3.02G.

The unit contract price for "Furnishing Timber Piling (untreated or name treatment)" shall be full compensation for piles ordered but not driven.

–5.02B Reinforced Concrete and Untreated Timber

A composite pile made with an untreated timber lower section and a reinforced concrete upper section spliced together will be considered as one (1) pile. The reinforced concrete upper portion may be either precast concrete conforming to Section 106-3.03 or cast-in-place concrete conforming to Section 106-3.04 except as provided in Section 106-3.04H.

Payment for "Furnishing Timber Piling (untreated)" and for "Furnishing Concrete Piling" will be made at the unit contract price per linear foot for the number of linear feet actually driven below cutoff, or as shown on the Engineer's order list for each type of pile used.

Payment for pile splices will be made at the unit contract prices per each for "Pile Splices" for the number of splices made in accordance with the plans, or as ordered by the Engineer.

The unit contract prices per each for "Driving Composite Piles," per linear foot for "Furnishing Timber Piling (untreated)," per linear foot for "Furnishing Concrete Piling," and per each for "Pile Splices" shall be full compensation for the piling in place. The prices shall include the furnishing of all materials, tools, equipment, labor and all expenses incidental thereto.

The unit contract prices for "Furnishing Timber Piling (untreated)" and for "Furnishing Concrete Piling" shall be full compensation for piles ordered but not driven.

–5.03 CONCRETE PILING

Payment for "Furnishing Concrete Piling" will be made on the following basis:

Precast Concrete Piling: Payment will be made at the unit contract price per linear foot for "Furnishing Concrete Piling" for the number of linear feet actually driven below cutoff or shown on the Engineer's order list.

Cast-in-Place Concrete Piling: Payment will be made at the unit contract price per linear foot for "Furnishing Concrete Piling" for the number of linear feet actually driven below cutoff and no Engineer's order list will be furnished.

In case build-ups or splices are necessary on precast concrete piles, the built-up length will be paid for at three (3) times the unit contract price per linear foot for "Furnishing Concrete Piling." The length of build-up will include the length cut off of the pile first driven for making the splice. For precast prestressed concrete piles the built-up length will include the length in which holes are drilled and reinforcing bars are grouted. No allowance will be made for build-ups which are made necessary by damage to the pile during driving. The entire spliced pile shall be considered as one (1) pile.

The unit contract prices per each for "Driving Concrete Piles" and per linear foot for "Furnishing Concrete Piling" shall be full compensation for the piling in place. The prices shall include the furnishing of all materials, steel shells, reinforcement, tools, equipment, labor and other expenses or items necessary for casting, curing, driving, splicing and cutting off the piles.

–5.04 STEEL PILING

Payment will be made at the unit contract price per linear foot for "Furnishing Steel Piling" for the number of linear feet actually driven below cutoff and no Engineer's order list will be furnished.

The unit contract prices per each for "Driving Steel Piles" and per linear foot for "Furnishing Steel Piling" shall be full compensation for piling in place. The prices shall include the furnishing of all materials, tools, equipment, labor and expenses incidental thereto.

No payment will be made for splices.

–5.05 TEST PILES

When test piles are driven to determine the lengths of piles required, they will be paid for at the contract price for "Furnishing and Driving Test Piles," which price shall be full compensation for furnishing and driving the test piles to the bearing capacity or penetration required by the Engineer and for pulling the piles or cutting them off, as required, and for removing them from the site or for delivery to the Owner (city) for salvage when so ordered by the Engineer. This price shall also include all costs in connection with moving all pile driving equipment or other necessary equipment to the site of the work and for removing all such equipment from the site after the piles have been driven. If, after the test piles have been driven, it is found necessary to eliminate the piling from all or any part of the structure, no additional compensation will be allowed for moving the pile driving equipment to and from the site of the work.

When steel piles are used for test piles, they shall be driven in place of permanent piles and the number of piles called for on the plans shall be reduced by the number of test piles thus driven in place of permanent piles. They shall be driven to a minimum load bearing capacity of fifteen (15) tons more than the minimum load bearing capacity specified for the permanent piles.

If, in the opinion of the Engineer, any test pile is damaged by handling or driving to such extent that it is unfit for use as a permanent pile, the damaged pile shall be removed and replaced at the Contractor's expense. If the Engineer specifically directs the Contractor to drive the test pile to more than 15 tons over the minimum bearing capacity specified for permanent piling, the Contractor shall overdrive the test pile as directed but will not be required to remove and replace the test pile at his own expense because of damage resulting from such overdriving.

Timber piles, precast concrete piles, or cast-in-place pile shells when used as test piles shall not be used in place of permanent piles and shall be driven outside of the footing. Test piles shall be cut off one foot below the finished ground line. Cast-in-place concrete pile shells driven outside of the footing shall be filled with sand.

–5.06 LOADING TESTS

When loading tests are required, payment will be made on the basis of the unit contract price for "Pile Loading Tests" or, in the absence of such a price, will be paid for upon force account basis.

The unit contract price shall include the cost of all materials, equipment, labor and expenses incidental to constructing the loading platform, procuring and placing the loading materials, and the removal and disposal of the platform and material to the satisfaction of the Engineer.

When payment for loading tests is made on a force account basis, deduction will be made for such costs of material, tools and equipment as would have been incurred in any event if loading tests had not been required.

Section 107—Portland Cement Concrete For Structures

107–1 DESCRIPTION

Portland cement concrete shall consist of a mixture of portland cement, fine aggregate, coarse aggregate and water in the approximate proportions specified for the several classes of concrete hereinafter designated. It shall be designed to produce at least the minimum allowable compressive strength required for the various classes of concrete.

107–2 MATERIALS

The materials used for making concrete for structures, except for proportioning of the mixes and their classification as hereinafter specified, shall conform in all respects to the requirements for cement, aggregates and water as specified in Sections 39-2.01 through 39-2.13, pages 61 through 64 of Standard Specifications for Municipal Public Works Construction.

For the purpose of making portland cement concrete for structures, sections 39-2.01 through 39-2.13 shall be considered as sections 107-2.01 through 107-2.13, respectively, and thus make it unnecessary to reprint and include the identical texts herein. Consequently, the next subsection will become 107-2.14.

–2.14 PLASTIC WATERSTOP

Plastic waterstop shall be furnished to the cross section detailed on the plans, unless otherwise provided in the special provisions. It shall be fabricated from a plastic compound, the basic resin of which shall be polyvinyl chloride having such additional resins, plasticizers, inhibitors and other material incorporated therewith that will result in a compound that can be moulded or extruded to the required cross section as a dense, homogeneous strip free of porosity or other imperfections.

Plastic waterstop shall meet all physical and other test requirements as defined in the proceedings of the Journal of American Concrete Institute, Volume 30, June, 1959, except that the minimum tear resistance shall be one hundred sixty (160) pounds per square inch using a Die "C" test specimen.

In the production of plastic waterstop, single-pass reworked material of the same composition generated from the fabricator's operations may be used. No reclaimed polyvinyl chloride shall be used, however.

The Contractor shall furnish the Engineer with a 6-foot length for testing at least thirty (30) days before installing waterstop material.

Unless otherwise provided in the proposal, all costs for furnishing and installing plastic waterstop as required on the plans shall be considered as incidental to the construction and be included in the unit contract price for concrete.

–2.15 EXPANSION JOINT FILLER AND SEALER

Expansion joints to be sealed watertight by poured rubber sealing compound are made by placing a suitable premoulded rubber strip material or a plastic sheeting lengthwise in the joint, at the required depth, and then pouring the joint full of rubber sealing compound. Cross section details of expansion joints, location therein of the premoulded rubber strip material or plastic sheeting and depth of poured rubber seal shall be as indicated on the plans.

Premoulded rubber joint material, as shown on the plans or required by the special provisions, shall be made from rubber stock composed of a high grade tread compound made exclusively from new plantation rubber, reinforcing carbon black, zinc oxide, accelerators, antidioxidants and softeners.

Plastic sheeting (PVC) shall be an approved strip of two-inch width, 60 mils in thickness. The plastic sheeting shall be installed in the expansion joint by applying an approved anchor adhesive along the edges of the sheeting and the bottom of the concrete joint one-half inch wide. The adhesive shall be allowed to become tack free, and the concrete surface shall be thoroughly cleaned and be free of standing water before installing the plastic sheeting.

The poured rubber sealer shall conform to the current specifications for Concrete Joint Sealer by the Materials Laboratory, Washington Department of Highways. Copies of the specifications, including methods of testing, may be obtained upon request to the Materials Engineer, Materials Laboratory, 318 State Avenue, Olympia, Washington.

As listed in the Materials Laboratory specifications the physical properties of the joint sealer, when mixed in accordance with the manufacturer's recommendations, are as follows:

(a) Color: Gray or black.
*(b) Viscosity: Must be pourable and self-leveling at 50 degrees F.
*(c) Application Life: Not less than 3 hours at 72 degrees F. and 50% relative humidity.
(d) Set to Touch: Not more than 24 hours at 72 degrees F. and 50% relative humidity.
(e) Curing Time: Not more than 96 hours at 72 degrees F. and 50% relative humidity.
(f) Non-Volatile Content: Not less than 92%.
(g) Hardness Rating (Durometer "Shore A"): 5-35.
(h) Resiliency: Not less than 80%.
(i) Bond Extension Test: Shall pass four cycles of the bond extension test at 0 degrees F., using surface-dried test blocks, and two cycles using soaked blocks and specimens.

*Viscosity and Application Life may be waived, provided that the material is mixed and placed by pump and mixer approved by the Engineer.

Joint sealer primer is described in the Materials Laboratory specifications as follows:

Suitable primer, if required by the manufacturer, shall be furnished with each joint sealer. The primer shall be suitable for brush or spray application at 50 degrees F. or higher, and shall cure sufficiently at 50 degrees F. to pour the joint within 24 hours. It shall be considered as an integral part of the sealer system. Any failure of the sealer in the test described herein attributable to the primer shall be grounds for rejection or retesting of the sealer.

Acceptance of joint sealing compound for use on a project shall be on the basis of laboratory tests of samples representative of each batch of material to be used on the job. A period of at least two weeks shall be allowed for completion of tests. Each container of the compound shall be clearly identified as to batch number. A one-quart sample shall be taken

from each batch in the shipment delivered to the job site. A one-half pint sample of the accelerator and of the primer, if any to be used, shall accompany each of the quart samples of sealer.

The expansion joint shall be thoroughly cleaned by sand blasting prior to installing the joint filler and sealer. No joint sealer shall be poured when the ambient temperature is less than 50° F. except when the Contractor elects to heat the joint and the sealer prior to installation to ensure a cure within 7 days. Any expansion joint sealer which does not cure within 7 days after installation under the existing field conditions shall be rejected and removed from the structure.

–2.16 EPOXY RESIN MORTAR

The Contractor shall exercise care in the application and use of epoxy resins and comply with all precautionary measures recommended by the manufacturer of the epoxy materials.

The epoxy resin mortar specified on the plans shall conform to the following specifications:

General: The specification shall establish the composition for a two-component, mineral filled, thixotropic, flexible epoxy resin base compound for general use as a bonding and repair compound for concrete. The components and finished compound shall conform to the requirements described herein.

Depending upon the temperature of the atmosphere, pavements and materials, the compound shall be furnished in two types:

Type I—for temperatures between 68° and 104° F.
Type II—for temperatures between 40° and 68° F.

Requirements

I. **Compound Description:** The epoxy bonding compound, furnished as a two-component system for combining immediately before use, shall be of the epoxy resin-polysulfide polymer type with a suitable curing agent. The ratio of epoxy resin to polysulfide polymer shall be approximately 2:1 by weight. A suitable non-settling mineral filler shall be incorporated not to exceed 50 percent by weight of the total mixture. The final compound for application shall be thixotropic. The compound shall be essentially a 100% solids system and no diluents, wetting agents, or volatile solvents will be incorporated.

II. **Materials**

Base Polymer: The base polymer shall be thermosetting resin of the epoxy type, and shall be composed on 100 percent reactive constituents which are a condensation product of the reaction of epichlorohydrin with bisphenol A. This product shall be essentially pure liquid diglycidyl ether or bisphenol A, containing only trace amounts of hydrolyzable chlorine and no reactive diluents.

Color (Hellige)	5 max
Epoxide Equivalent	175-210
Viscosity (Brookfield) poises at 25° C.	100-180
Specific Gravity at 25/25° C.	1.15-1.18

Polysulfide Polymer: The polysulfide polymer flexibilizer shall be a dichlorethylformal polysulfide in the 1000 molecular weight range with the following properties:

Color (Hellige)	9-12
Water (%)	0.1 max
Specific Gravity at 20/20° C.	1.24-1.30
Viscosity	700-1200
p^H of Water Extract	6.0-8.0
Flashpoint, °F Cleveland Open Cup	410 Min.
Fire Point, °F Cleveland Open Cup	460 Min.
Sulphur Content %	36-40

Accelerator: The accelerator or hardening agent shall be a tertiary amine type which, when incorporated in the system, is unaffected by moisture on the surface where the compound is used or that present in the plastic portland cement concrete applied over it. These agents shall be a combination of 2, 4, 6-tridimethylaminomethyl phenol and dimethylaminomethyl phenol. The 2, 4, 6-tridimethylaminomethyl phenol may be used alone when conditions warrant.

Mineral Filler: The inert filler or extender shall be a finely divided quartz silica flour with essentially 100% passing the 325 mesh sieve, free of acid or alkali salts, or other trace substances having a deleterious effect on the compound. The mineral filler shall be non-settling when incorporated. The total quantity permitted in the compound shall be such that the minimum compressive shear strength is exceeded.

III. **Mixed Compound**

The mixed compound, ready for application, shall have the following properties:

Thixotropy: The degree of gellation shall be such that a ⅛ inch thick film can be maintained on the surface of a 2-inch round rod or tube.

Pot Life: The compound mixed, ready for use, shall remain spreadable and retain full bonding power for at least 30 minutes at 74± 2° F. The end of pot life shall be defined as the point at which a 200 gram sample in a 400 ml highform beaker reaches 85,000 cps (Brookfield).

Compressive Shear Strength: Specimens prepared and tested in a double shear shall have a minimum strength as follows:

(1) Cured at 75+ 7° F for 96 to 120 hours and tested at 75± 7° F = 400 psi min.
(2) Cured at 75± 7° F for 96 to 120 hours and a final cure of 3 hours at 200± 10° F and tested at 75± 7° F = 400 psi min.

Shear strength under test (2) shall equal or exceed that in test (1).

IV. **Standards and Methods of Testing**

The epoxy bonding compound referred to in this specification is of the quality and type available under U. S. Army Corps of Engineers Specifications for "Grout, (Adhesive) Epoxy Resin Base, Flexible, Filled" as revised May, 1959. The specification is designed to set standards for proprietary formulations commercially available for bonding portland cement concrete. The methods of test used for evaluation will be as set forth in the Corps of Engineers specifications.

V. **General Conditions for Use**

Surfaces to be bonded need not be dry but should be essentially free of standing water and completely free of dust, spalled concrete, surface dirt and all oily or wax-like materials. Broken surfaces will normally require hand cleaning only. Trowelled surfaces and those exposed for considerable periods to surface wear or industrial contaminants may require cleaning and etching with hydrochloric acid or sand blasting.

The cleaned surface shall be given an application of bonding compound 40 to 60 mils in thickness and scrubbed onto the surface. The plastic concrete should be poured while the compound is still tacky.

Mortar may be made by use of dry, clean and uniformly graded aggregates for filling holes and patching. A ratio of approximately 1 part mixed compound to 4 or 5 parts of ¼ inch minus aggregate should be applied to the surface to be patched and the mortar applied against this. Trowels and finishing tools may be dipped in aromatic solvents to yield a smooth surface in finishing operations. Soapy water may also be used as an expedient in finishing.

Equipment should be cleaned immediately in aromatic type solvents.

Under normal summer conditions, curing of the epoxy is completed in approximately 24 hours. It may be accelerated by the use of heat lamps or radiant type heaters, but temperatures should not exceed 200° F. at the epoxy surface.

VI. **Approval and Acceptance**

Approval of source of material shall be on the basis of certified test reports from an independent laboratory showing the material meets the specifications above. Test values shall be listed in the certified report.

Acceptance of a batch lot of the material for use on the project shall be on the basis of laboratory tests of samples representing the particular batch or batches of materials supplied. These tests may be performed at the Department of Highways Materials Laboratory, 318 State Street, Olympia, Washington. A one-quart kit of the bonding compound shall be taken from each batch. A period of 10 days should be allowed for testing after receipt of samples at the laboratory. All costs in connection with furnishing materials for and applying the epoxy resin mortar shall be considered as incidental to the construction where used, and shall be included in the unit contract prices for the various pay items of work involved in this project.

107-3 CONSTRUCTION DETAILS

–3.01 CLASSIFICATION—CONCRETE MIXES FOR STRUCTURES

Concrete for structures shall be of nine classes depending on the strength, workability and maximum size of aggregates required in various parts of the structure.

Classes of concrete for the several parts of the structure shall be as shown on the plans or as outlined below:

(a) Classes A, AX and E concrete shall be used in thin and heavily reinforced members, in all floor slabs subject to the abrasive action of traffic, and in all beams and girders. They shall be used, also, in all railings, arch ribs and arch rings.

(b) Classes B and F concrete shall be used in all reinforced sections other than those covered by Classes A, AX and E concrete.

(c) Classes C and G concrete shall be used only in unreinforced sections of footing blocks, pier shafts and webs, heavy walls and other mass construction.

(d) Classes D and H concrete shall be used where concrete is deposited under water.

Unless otherwise specified, portland cement shall be used for all of the above classes of concrete. When high-early-strength cement is required, it will be specified in the plans and in the proposal by the suffix (HES). Thus, when Class A concrete using high-early-strength cement is required, it will be designated as "Concrete Class A (HES)."

–3.02 PROPORTIONS FOR STRUCTURE CONCRETE MIXES

–3.02A Cement Concrete

The classes of concrete referred to in Section 107-3.01 are designed on the following assumptions regarding minimum ultimate compressive strength at the age of 28 days and the amount of mixing water required for satisfactory placement:

CLASS OF CONCRETE	A and E	B and F	C and G	D and H	AX
Compressive strength pounds per square	2,600	3,000	2,300	3,600	4,000
Maximum total water in gallons per ninety-four (94) pound sack cement	5.0	5.75	6.75	5.0	5.0

The design strength of Class D and Class H concrete is 3600 pounds per square inch. However, due to the manner of placing, the assumed strength of Class D and Class H concrete is 2200 pounds per square inch.

Concrete mixes shall be proportioned as specified in the following tables. The weight of each size of aggregate is the estimated quantity to be used with one sack of cement (94 lbs.).

TABLE I
(Proportions by Weight 1¼" Maximum Size Aggregate)

CLASS OF CONCRETE	A	B	C	D	*AX
Sacks of cement per cubic yard	6.5	5.75	5.0	6.5	7.0
Pounds of dry fine aggregate	210	255	267	180	184
Pounds of dry No. 2 coarse aggregate	280	315	383	310	256

*If the aggregate used in the concrete develops 95 percent or more of the strength of washed sand and gravel from Steilacoom, Washington when tested, in accordance with Section 39-2.02C, the following proportions of cement and aggregates may be used in Class AX concrete:

Sacks of cement per cubic yard	6.5
Pounds of dry fine aggregate	210
Pounds of dry No. 2 coarse aggregate	280

TABLE II
(Proportions by Weight 2½" Maximum Size Aggregate)

CLASS OF CONCRETE	E	F	G	H
Sacks of cement per cubic yard	6.0	5.25	4.5	6.0
Pounds of dry fine aggregate	214	264	285	188
Pounds of dry No. 2 coarse aggregate	224	257	318	245
Pounds of dry No. 3 coarse aggregate	112	128	159	122

The essential requirement for each class and design age of concrete shall be the cement content in sacks per cubic yard of concrete as specified in the above tables. The proportions of the various sizes of aggregate are given as a guide to show the approximate quantities required to produce concrete with the stated cement content. The Engineer will compare the actual cement content of the mixed concrete with the quantity required for concrete of the class that is being produced. In case there is a difference, the quantities of aggregates shall be altered so that the correct amount of cement will be present in the mixed concrete.

If, in the judgment of the Engineer, the workability and finishing characteristics of the concrete can be improved by altering the relative proportion of fine to coarse aggregate as given in tables of this section, such changes shall be made when so ordered by the Engineer.

The weights shown for each size of aggregate are based on an assumed bulk specific gravity of 2.67 for each size of aggregate. In case the actual bulk specific gravity of any aggregate differs from this value the weights shall be adjusted in proportion.

Correction of weights shall also be made for the quantity of water held by the aggregates at the time of weighing.

The volumes of the fine aggregate shown above are based on measurements in a dry condition. In case the fine aggregate contains moisture, proper correction shall be made for the bulking effect.

The above mixtures using portland cement are designed to produce the desired compressive strength at the end of twenty-eight (28) days. The above mixtures using high-early-strength cement are designed to produce the desired compressive strength at the end of ten (10) days. Concrete having the desired compressive strength at intermediate periods may be designed by the Engineer, using mixtures of portland cement and high-early-strength cement.

The quantity of water shown in the tables is estimated to be the maximum required to produce a satisfactory consistency. The quantity is the total water entering into the mix, including both the water added at the mixer and the free water held by the aggregate.

The various materials entering into and composing the concrete shall be such as to satisfy the requirements specified above.

–3.02B Air-entrained Concrete

Air-entrained concrete shall be used unless otherwise provided for in the special provisions.

Either air-entrained portland cement or an air-entrained admixture shall be added at the mixer. Both

the air-entrained cement and the air-entraining admixture shall conform to requirements of Section 39-2.01E.

The volume of air in freshly mixed concrete shall conform to that specified in Table III which follows:

TABLE III

AIR CONTENT OF FRESHLY MIXED CONCRETE

Maximum Size of Coarse Aggregate (inches)	Air Content Percent by Volume
1½, 2, and 3	5 ± 1
¾ and 1	6 ± 1
⅜ and ½	7½ ± 1

If the measured air content is found above or below the values contained in Table III, the Contractor shall immediately make changes in mixing or materials as will be necessary to comply with the requirements for air content.

An automatic dispenser, accurate to 10%, which will introduce the specified amount of air-entraining agent into the mixing water for each cycle of mixing, shall be connected to the mixer.

Aggregates shall be adjusted to compensate for increased yield resulting from air-entrainment so that the specified amount of cement is contained in each cubic yard of concrete. Adjustment shall be made by decreasing the weight of fine aggregates only, unless otherwise directed by the Engineer.

Other admixtures: Calcium chloride or any other admixture for any purpose other than air-entrainment may be added only upon approval of the Engineer and under his supervision.

–3.02C Concrete Admixtures

Concrete admixtures may be used only with the approval of the Engineer.

The additive as approved by the Engineer shall retard the setting time of the concrete, reduce the total mixing water required to obtain the specified slump, and increase the compressive strength of the concrete at 28 days by at least five (5) percent. The drying shrinkage of concrete containing the additive shall not exceed 110% of the shrinkage of the concrete without the additive mixed at the same slump and using the same aggregates and the same cement content. Drying shrinkage shall be measured on 3" x 3" x 11¼" prisms which are moist-cured for 7 days, followed by drying for 14 days at 73.4° F. ± 2° F. in air with a relative humidity of 50 + 2%. Change in length of the specimens during the 14-day curing period, measured to the nearest 0.0001", is defined as the drying shrinkage. Details of the test procedure may be obtained from the State Materials Laboratory. The air content of the concrete containing the additive shall not exceed six (6) percent.

The additive shall be used at the rate recommended by the manufacturer and as directed by the Engineer. It shall be in liquid form, and shall be introduced by means of an automatic dispensing device approved by the Engineer, or it may be added manually by pouring it on the aggregates in the skip of the mixer. In case the additive is added manually, a quantity shall first be diluted with water in proportions as directed by the Engineer, such that a volume of not less than one (1) quart of the diluted solution is measured and added to each batch of concrete.

If required by the laboratory tests, the additive shall be tested before use. A one-quart sample shall be submitted for test. The sample shall be accompanied by a detailed data sheet from the manufacturer giving the following information:

1. Recommended amount of additive to be used at a temperature between 70° F. and 110° F.
2. Approximate amount of air-entrained in a 6½ sack concrete mix per unit of additive added.
3. Recommended reduction in total mixing water in a 6½ sack concrete mix per unit of additive in terms of gallons of water per sack of cement or percentage of total mixing water.
4. Average compressive strength of concrete containing the additive at 7, 28 and 90 days compared to the same mix without the additive.
5. Volume of change of concrete containing the additive compared to the same mix without the additive.
6. Effect on setting time of concrete per unit of additive with complete description of method used to determine setting time.
7. Effect of using the additive at two and four times the recommended rate on setting time, air content, drying shrinkage and compressive strength of the concrete.
8. The test shall be made using the actual materials to be used on the job.

When the Engineer requires that an additive be used, the Contractor will be reimbursed for the actual cost of the additive plus a sum equal to eighteen (18) percent thereof in accordance with paragraph two, Section 9.04. The actual cost of the material plus eighteen (18) percent shall be full compensation for all costs in connection with furnishing the additive and incorporating it in the concrete, as outlined herein.

For the purpose of providing a common proposal for all bidders and for that purpose only, when additives are required the Engineer will estimate the cost of the item of work above described and will arbitrarily enter the amount in the bid proposal to become a part of the total bid by the Contractor.

–3.03 CARE AND STORAGE OF CONCRETE AGGREGATES

Fine and coarse aggregates for concrete shall not be stored upon the work site where passing traffic, vehicles or contractor's equipment will cause foreign matter to contaminate the aggregates. Whenever aggregates are deposited in piles directly upon the ground, the ground around and alongside the piles shall be kept moist by sprinkling. Coarse and fine aggregates that have become coated with foreign matter prior to use shall be rejected.

The distribution of aggregates shall be so made that a clear space will be left between the foot of the piles of the fine and the coarse aggregate.

Aggregates shall be handled at all times so as to prevent segregation of coarse and fine particles.

–3.04 STORAGE OF CEMENT

The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment. Bulk cement for municipal use shall not be stored in the same bin with cement which is to be used for other purposes. Cement shall be adequately protected from rain and dampness at all times. Any cement which in the opinion of the Engineer contains lumps that will not be pulversized in the mixer shall be rejected.

High-early-strength cement stored by the Contractor for a period longer than 30 days, or portland cement stored by the Contractor for a period longer than 60 days shall be held for retest. If the cement has lost strength during the period of storage, as shown by tests of a competent laboratory, sufficient additional cement shall be added to the mix at Contractor's expense to overcome such loss of strength, or the cement may be rejected by the Engineer. The amount of cement to be added to the mix shall be determined by the Engineer and his decision shall be final and binding upon the Contractor.

–3.05 MEASURING MATERIALS

Cement shall be measured by the sack of 94 pounds net. Unless specifically authorized by the Engineer in each case, batches of concrete shall be so adjusted that fractional sacks of cement are not required. When permitted by the Engineer, the addition of fractional sacks shall be accomplished by actual weight. For this purpose the Contractor shall provide suitable scales and shall station a workman whose sole duty is to make such weights.

If cement is handled in bulk it shall be weighed on scales meeting the requirements of Section 21, Weighing Equipment.

Proportions of fine and coarse aggregates shall, unless otherwise provided in the special provisions, be measured by weight, making proper corrections for the free water held by the aggregates.

The weighing of the fine aggregate and each size of coarse aggregate shall each be a separate and distinct operation, the weight for the particular aggregates being proportional to their respective bulk specific gravities. The equipment for weighing aggregates shall comply with the requirements for weighing equipment in Section 21.

–3.06 MIXING CONCRETE

–3.06A Machine Mixing

Concrete shall be thoroughly mixed in a batch mixer of an approved size and type and in one so designed as to positively ensure a uniform distribution of the materials throughout the mass. Batches shall be proportioned on the basis of integral sacks of cement.

In general, all concrete shall be mixed for a period of not less than one (1) full minute after all materials including water are in the mixer, except for classes D and H concrete, which shall be mixed one and one-half (1½) minutes. Less mixing time may be allowed by the Engineer for special types of mixing equipment if tests indicate that equal or better results are obtainable.

During the period of the mixing, the drum shall operate at the speed for which it has been designed. Such speed, preferably, shall be not less than one hundred seventy-five (175), nor greater than two hundred twenty-five (225) feet per minute at the periphery of the drum, and not less than fourteen (14), nor more than twenty (20) revolutions per minute. The entire contents of the mixer shall be removed from the drum before materials for the succeeding batch are placed therein, and the mixer preferably shall be equipped with mechanical means for preventing the addition of aggregates after mixing has commenced.

The mixer shall be equipped with a water measuring device conforming to the requirements of Section 39-3.03C2 and shall preferably be equipped with a batch meter or other device for accurately recording the number of revolutions for each batch, and an attachment for automatically locking the charging device so as to prevent the emptying of the mixer until the materials have been mixed the minimum specified time. No mixer shall be operated above its rated capacity and no mixer shall be used which has a rated capacity of less than a 2-sack batch.

The first batch of concrete materials placed in the mixer shall consist of a mixture of sand, cement and water sufficient to cover the inside surface of the mixing drum with a coating of cement mortar. Upon the cessation of mixing for any considerable length of time the mixer shall be thoroughly cleaned. Cost of materials used for coating the mixer shall be considered as incidental to the work and no compensation will be made for it.

–3.06B Hand Mixing

Hand mixing will not be permitted except in case of emergency and under written permission from the Engineer. When permitted, it shall be done only on watertight platforms. The sand shall be spread evenly over the platform and the cement spread upon it. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of a uniform color, after which it shall be formed into a "crater" and water added in an amount necessary to produce mortar of the proper consistency. The material upon the outer portion of the "crater" ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is produced. The coarse aggregate shall then be thoroughly wetted and added to the mortar and the entire mass turned and re-turned at least six (6) times and until all of the stone particles are thoroughly covered with mortar and the mixture is of a uniform color and appearance. Hand-mixed batches shall not exceed one-half (½) cubic yard in volume. Hand mixing will not be permitted for concrete to be placed under water.

–3.06C Ready-Mixed Concrete

Ready-mixed concrete may be used if approved by the Engineer. Approval will be given if investigation of the plant and delivery system indicates that concrete delivered to the site of the project will conform in all respects with the applicable requirements of Section 39-3.08, and the Standard Specification for Ready Mix Concrete ASTM C 94.

–3.06D Retempering

Concrete shall be mixed only in such quantities as are required for immediate use, and shall be used while fresh before initial set has taken place. Any concrete in which initial set has begun shall be wasted and not used in the work. No retempering of concrete will be allowed.

–3.07 CONSISTENCY

The quantity of mixing water to be used in each case shall be determined by the Engineer, and no changes shall be made without his consent. In general, a mixture shall be used which contains the minimum amount of water consistent with the required workability.

A wetter consistency will be required in Class D concrete than with other classes of concrete. With this exception, the consistency of concrete mixtures shall be such that:

1. The mortar will cling to the coarse aggregate.
2. The concrete will not be so fluid that it will segregate when transported to the place of deposit.
3. The concrete, when dropped directly from the discharge chute of the mixer, will flatten out at the center of the pile but will stand up and not flow at the edges.
4. The mortar will show no free water when removed from the mixer.
5. The upper layer of the set concrete will show a cement film upon the surface but will be free from laitance.

–3.08 PLACING CONCRETE

Concrete placing operations for concrete structures or parts thereof shall not be started by the Contractor without first obtaining approval from the Engineer, and the concrete placing shall proceed continuously, after starting, until the structure or portion of structure being placed has been completed between expansion joints, construction joints, or such other limits as required and shown on the plans, or directed by the Engineer in accordance with these specifications.

Mixed concrete shall be placed as soon as possible after mixing and before initial set has occurred. In no case shall concrete be used which does not reach its final position in the forms within one and one-half (1½) hour after water is first added to the mix. If concrete which is mixed and then transported to the job is too stiff to be properly worked after it has been placed in its final position in the forms, the time between mixing and placing the concrete in the forms shall be reduced. The method and manner of placing concrete shall be such as to avoid the possibility of segregation or separation of the aggregates, or the displacement of the reinforcing steel.

All concrete shall be placed in continuous horizontal layers and so compacted that there will be no line of separation between succeeding batches or layers. Special care shall be taken to fill each part of the forms by depositing concrete directly as near the final position as possible, to work the coarse aggregates back from the face and to force the concrete under and around the reinforcing bars without displacing them, and to avoid sand or rock pockets. When necessary, openings shall be provided in the forms, or equivalent provided, to permit the placing and consolidation of concrete in such a manner as to avoid accumulation of spattered concrete from setting hard on the forms or reinforcing steel surfaces prior to their final contact with plastic concrete.

Dropping concrete more than five (5) feet, or in large quantities and running it down long inclined slopes in the forms will not be permitted.

–3.08A Sequence of Placing Concrete

The sequence of placing shall be according to the placing diagram or notes, or as directed by the Engineer.

Copings of piers shall not be placed for at least twenty-four (24) hours after shafts and webs are placed.

Before concrete bridge floors are placed on steel spans the centering under the bridge shall be released and the span swung free on its supports.

Concrete in slabs and stems of T-beam or deck girder spans when stem of girder or beam is over 3'-0" in depth shall be placed in separate operations, i.e., the beams or girders shall be first placed to the bottom of slab fillets. Sufficient time shall elapse between placing of beam or girder stems and deck slab to allow shrinkage to occur. This time shall, in general, be approximately 12 hours.

Suitable shear keys shall be provided in the top of beam or girder stems to secure a positive and mechanical bond between the stem and the slab. The size of these keys shall be shown on the plans. In general, suitable shear keys may be formed by the use of timber blocks 2" x 8" in cross section and having a length of 4" less than the width of the stem. These keys shall be placed in the concrete along the top of beam or girder stems as required, but the spacing shall not be greater than 16" center to center. The blocks shall be slightly beveled in such manner as to ensure their ready removal. Shear keys shall be depressions in the concrete. Raised keys will not be allowed.

Concrete in slabs and stems of T-beam or deck girder spans when the depth of stem is 3'-0" or less may be placed in one continuous operation subject to approval of the Engineer and provided that completion of placing and finishing of the deck slab will be done during daylight hours.

Concrete in cross beams, bulkhead walls, brackets, etc., shall be placed either with the girders or the slabs as indicated on the plans. Shear keys shall be provided at all construction joints, and where the size of keys is not shown on the plans they shall be approximately one-third of the area of the joint and not less than 1½ inches deep.

Shear keys shall be provided at all construction joints for piers, columns, walls, etc., whether or not they are shown on the plans. The area of the depressed part of the key shall be approximately one-third (⅓) of the area of the joint.

Roadway curb and sidewalk curb to bottom of rail web shall be placed with the sidewalk slab unless otherwise provided on the plans or directed by the Engineer.

Rail posts, in general, shall be first placed and railing between posts then placed continuously. Stopping of the concreting operation at intermediate points between posts will not be allowed except when specifically shown on the plans. Whenever practicable, railing for the full length of one side of the roadway shall be placed in one operation.

The concrete in arch rings shall be placed in such a manner as to load the centering symmetrically and uniformly.

In filled spandrel arches, the arch ring shall be placed either by monolithic method, or in transverse sections. In long spans the Contractor may be required to load the crown in order to guard against unequal distortion of the forms during the process of placing. In placing the arch ring a key shall be cast, either inverted or outstanding, to take the shear of the spandrel walls. Shear steel may be substituted in place of keys if approved by the Engineer, but the steel shall be furnished by the Contractor at his own expense and shall be placed in the manner and amount directed.

In open spandrel arches the arch ribs shall be placed in sections in accordance with the pouring diagrams, leaving small key sections between large sections to be filled after the shrinkage has taken place in the large sections.

All concrete shall be placed in the sequence given in the placing notes or diagram, and each numbered or lettered section shall require continuous placing until its completion.

Wherever possible, all foundation excavations shall be completely dewatered and the concrete be deposited in the open. If it is not possible to proceed in this manner, a seal of concrete of sufficient thickness to resist any possible uplift shall be deposited under water in accordance with the requirements of Section 107-3.08C, Placing Concrete in Water.

–3.08B Placing Concrete in Cold Weather

Concrete for structures shall not be placed on frozen ground nor be mixed or placed while the atmospheric temperature is below 35 degrees Fahrenheit unless adequate means are employed to heat the aggregates and water and unless satisfactory provision has been made for protecting the work.

Concrete shall be effectively protected from cold temperatures for a period of five (5) days after placing. In addition to heating the aggregates and water prior to mixing the concrete, it shall be the responsibility of the Contractor to provide suitable means for protecting the concrete for the five-day curing period. The Contractor shall have the option of providing suitable methods of heating the concrete in the forms, insulating the forms, or using such other methods or procedures as he may devise to effectively protect the concrete from cold temperatures.

The Contractor shall assume all risks in connection with the placing of concrete during cold weather. Permission by the Engineer to place concrete during a cold weather period will in no way assure acceptance of the work by the Owner. If the concrete placed under such conditions proves unsatisfactory in any way, the Engineer shall have the right to reject the work although the plan and the work was carried out with his tacit permission.

–3.08C Placing Concrete in Water

In no case shall concrete be placed in running water. Whenever permission is given to place concrete under water it shall be so placed within the confines of a watertight compartment, such as a cofferdam, tube or caisson.

Concrete placed under water shall be mixed with more water than is ordinarily permissible in order to make it more flowable, and shall be placed by means of a tremie, or by a closed bottom dump bucket. The width of section of footing being poured shall not exceed eighteen (18) feet for each tremie or bucket used.

When the concrete is to be placed by a tremie, the method of construction shall comply with the following requirements:

(1) The tremie shall consist of a tube having a diameter not less than ten (10) inches, and a hopper which will hold at least one (1) batch.

(2) A satisfactory method of expelling the water and first filling the tremie shall be used.

(3) The tremie tube shall be kept full to the top. In placing concrete through a tremie, two distinct handling devices shall be used; (a), raise, lower and place the tremie and (b), deliver concrete to the tremie. When a batch is dumped into the hopper at the top the tremie shall be raised slightly, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper or the top of the tremie tube. The flow shall then be stopped by lowering the tremie.

(4) The seal shall be completed by placing full thickness as the seal advances from one end of cofferdam to the other, keeping the finished surface of the concrete as nearly level as possible.

(5) The concrete shall be placed continuously until the required seal is completed.

Concrete shall not be placed in water by a bucket without the written approval of the Engineer.

When concrete is to be placed by means of a **closed bottom dump bucket** the method of construction shall comply with the following requirements:

(1) The bucket shall be full and completely closed before being lowered into the water.

(2) The bucket shall be lowered slowly through the water until it rests on the bottom.

(3) The bucket shall be raised very slowly during the discharge travel, the purpose being to keep the water as still as possible at the point of discharge and to agitate the mixture as little as possible.

In either method, a tremie or closed bottom dump bucket, if for any unavoidable reason it becomes necessary to discontinue the placing before the required seal is completed, the Contractor may be required to remove all concrete placed in the seal at his own expense.

When concrete is to be placed under water, the Contractor may, if he so elects, use methods whereby the aggregates are preplaced within the cofferdam before the introduction of the cement grout, provided however, that prior approval of the proposed method and procedure is obtained from the Engineer.

–3.09 CONCRETE EXPOSED TO SEA WATER

Concrete structures that will be affected by action of sea water shall be constructed to provide maximum resistance to the deteriorative effects.

Reinforcement bars shall be stored in such manner as to avoid the formation of rust and shall be placed in the concrete in a clean and rust-free condition.

Sharp corners in concrete work exposed to sea water shall be avoided.

The concrete shall be mixed not less than two (2) minutes. The water content shall be carefully controlled and so regulated as to produce concrete of maximum impermeability. When placing the concrete it shall be thoroughly consolidated to the extent necessary to form a dense concrete disclosing no coarse aggregate pockets at the surface when forms are removed. The original surface of concrete after removal of the forms shall be left undisturbed. In order to secure a thick and dense surface film the surfaces of forms shall be heavily coated with shellac or approved form oil.

The range of possible deterioration of the concrete from an elevation below that of extreme high tide shall be determined by the Engineer and, except with his special permission, no construction joints shall be located within this range. In the determination of this range due consideration shall be given to wave action and other conditions affecting the extreme limits of possible deterioration and disintegration.

Concrete in sea water within the range as above described shall, in all cases, be deposited in the dry.

Forms shall not be removed for a period of thirty (30) days, or longer if required by the Engineer, so that the sea water will not come in direct contact with the concrete until it is thoroughly hardened.

When concrete piles are to be used in sea water special care shall be exercised to avoid slight deformation cracks caused by handling. Concrete piles for use in sea water shall be cured for not less than thirty (30) days before being used.

–3.10 CONCRETE EXPOSED TO ALKALINE SOILS OR WATER

In general, the same requirements as above specified for concrete in sea water shall govern the construction of concrete in alkaline soils or water.

Concrete shall not be allowed to come in direct contact with alkaline soil or alkaline water until it shall have been allowed to set at least thirty (30) days, and longer if possible.

No construction joint will be permitted below an elevation two (2) feet above the ground line. The surface cement film shall be left intact as it comes from the form. To secure a heavy and dense surface film the form surface shall be heavily coated with shellac or an approved form oil.

Concrete piles for use in alkaline soils, unless otherwise specified, shall be subject to the same requirements as are provided hereinbefore for concrete piles in sea water.

–3.11 VIBRATION OF CONCRETE

The Contractor shall provide suitable vibrating tampers for use in placing and compacting all concrete except that which is placed under water. The vibrators shall be of the type designed to be placed directly in the concrete and their frequency of vibration shall be not less than 4,500 impulses per minute when in actual operation. The type of vibrator and its method of use shall be subject to the approval of the Engineer.

Vibrators shall be inserted to a depth sufficient to vibrate the bottom of each layer effectively but not deep enough to affect partially hardened concrete. Care shall be taken not to apply the vibrator directly to steel which extends into partially hardened concrete.

External vibrators may be used on steel forms for precast members, but shall be supplemented as necessary by internal vibration.

In general, vibration required shall be limited to an amount necessary for concrete that is uniformly plastic and dense and free of pools of grout as a result of excessive vibration. The Contractor shall provide enough vibrators and operators necessary to obtain the required objectives, and if needed for satisfactory work he shall also do hand tamping and spading with suitable tools.

–3.12 FINISHING STRUCTURE ROADWAY AND SIDEWALK SLABS

Surface finish of the roadway slabs in a structure shall conform to these specifications and with Section 39-3.19 for cement concrete pavement, unless otherwise shown on the plans or provided in the special provisions.

Concrete for roadway slabs shall not be placed until the Engineer is satisfied that the rate of producing and placing concrete will be sufficient to complete the proposed pour and the finishing operations within the scheduled time, that experienced concrete finishers will be employed to finish the deck, and that all necessary finishing tools and equipment are on hand at the site of the work and in satisfactory condition for use.

Concrete shall be placed at such a time that finishing operations can be completed during daylight hours unless adequate lighting facilities are provided by the Contractor and approval is given by the Engineer.

Any low area shall be corrected with an approved epoxy grout which will not be higher than the surrounding finished deck surface and shall have dry portland cement applied to give it a concrete-like appearance.

High spots shall be corrected by cutting down the high areas of concrete with a diamond-faced saw type machine. The machine shall be capable of cutting through mortar and aggregate without breaking or dislodging the aggregate or causing spalls. Where the areas of concrete to be removed are less than ⅛ inch in depth, other types of grinding machines will be permitted.

Lowered or built up areas shall have substantially the same surface texture as the rest of the deck.

Concrete for sidewalk slabs shall be well compacted, then struck off with a strikeboard and floated with a wooden float. An edging tool shall be used on all edges and at expansion joints as shown in Section 39-3.19C unless otherwise authorized by the Engineer. The surface shall not vary more than ⅛ inch under a 10-foot straightedge. The surface shall have a granular texture which will not be slick when wet, i.e., Class 7 finish, as specified in Section 107-3.17D.

–3.13 CURING CONCRETE

All freshly finished concrete surfaces, such as roadway and sidewalk slabs of structures, shall be cured by one of the applicable methods described in Section 39-3.20 for cement concrete pavement until the concrete has attained the design strength of Section 107-3.02A for the class of concrete, as determined by the Engineer; it is excepted, however, that curing time shall not be less than seven (7) days for concrete made with portland cement, and not less than three days when high-early-strength cement is used. Curing shall start as soon as the fresh concrete has set to a degree that will allow application of the curing agents without damage to the finished surface.

Curing of structure concrete surfaces, protected from drying out by the forms, will not be required provided the forms remain in place the necessary time for the concrete to attain sufficient design strength. It will be required, however, that when wood forms, except for plywood, are used they shall be periodically wetted with water to prevent excessive drying.

White pigmented curing compound shall conform to the specifications outlined in Section 39-2.08.

All costs in connection with curing of concrete shall be included in the unit prices for concrete in place.

–3.14 CONSTRUCTION JOINTS

Construction joints for structures shall be made only where shown on the plans. Approval by the Engineer must be obtained before making construction joints other than where shown on the plans. All construction joints shall be either horizontal or vertical, or if the main reinforcement is inclined, the joints shall be normal to the direction of the main reinforcement.

If the section is subject to shear, sufficient material as a key, or shear steel, or both, shall be provided to transmit the shear across the construction joint.

Before placing fresh concrete against existing concrete and construction joints, the existing concrete face shall be thoroughly cleaned of all scum, laitance, honeycomb and high spots, and the surface wetted with water.

All material and labor required for the construction of construction joints shall be included in the unit contract price per cubic yard for concrete in place.

–3.15 EXPANSION JOINTS

Expansion joints for bridge structures shall be constructed to detail shown on the plans, and only where designated on the plans.

Open joints shall be placed at locations designated on the plans and shall be formed by the insertion and subsequent removal of a template of timber, metal or other suitable material. The method of insertion and removal of joint templates shall be such as to avoid the possibility of chipping or breaking down at the edges and the template shall be so constructed that removal may be readily accomplished without injury to the concrete.

The joint sealer material shall be applied to the joints by means of liquid pressure pumps or guns. Caulking grade joint sealer (non-flow type) meeting all above requirements except viscosity, may be used on vertical curb facings. On all applications, the manufacturer's instructions with regard to mixing and installation shall be rigidly followed.

When an expansion joint is offset so that part of the joint lies in a position parallel to the direction of expansion, this part of the joint shall have positive clearance between the two surfaces of at least one-half (½) inch. The clearance shall be obtained by inserting a strip at least one-half (½) inch thick in such a way that it may be removed after the concrete has set. Care shall be exercised to make these surfaces parallel to the direction of the expansion in order that no wedging action will take place during natural expansion and contraction.

Special types of expansion joints may be used when specified on the plans or ordered by the Engineer.

All costs in connection with furnishing and placing the joint filler and joint sealer material, including all necessary equipment, tools, and labor, as outlined herein, shall be considered as incidental to the construction, and shall be included in the unit contract price per cubic yard for "Concrete Class A," or "Concrete Class AX."

–3.16 FINISHING FORM-FINISHED CONCRETE SURFACES

Formed surfaces of structure concrete shall, after the removal of forms, show a smooth dense concrete face. Any surface which does not show a dense concrete surface, is pourous or is otherwise defective shall be corrected to the requirements of the specifications by whatever means as may be necessary, and at the expense of the Contractor. Surfaces formed using oiled plywood panels and properly controlled concrete will generally provide a satisfactory surface for the finishing operations. All formed surfaces shall be finished in accordance with one of the classes that follow unless otherwise indicated on the plans or in the special provisions.

–3.16A Class 1 Surface Finish

Class 1 finish shall be applied to all formed surfaces of structures prominently exposed to the public inspection for which accurate alignment and evenness of the formed surfaces are of paramount importance for appearance. Included in this category are curbs, parapets, railings and decorative features on dams, bridges and permanent buildings. Class 1 finish shall be essentially the same finish as specified for a Class 2 surface finish except that the surface smoothness tolerance shall be not more than one-eighth (⅛) inch when tested for smoothness with a ten (10) foot straightedge, or the equivalent template for curved surfaces.

–3.16B Class 2 Surface Finish

Class 2 surface finish, except as otherwise provided herein, shall be applied to all formed surfaces of structures that are exposed to public inspections. For this class of finish, the surface shall be such as to have no abrupt irregularities that exceed one-fourth (¼) inch when tested with a ten (10) foot straightedge, or an equivalent template for curved surfaces.

After removal of forms to obtain a Class 2 surface, all lips and edgings where form boards have met shall be removed with a sharp tool or stone. Form ties shall be removed to a depth not less than one-half (½) inch below the surface and the holes filled with 1:2 mortar and floated to an even and uniform surface. The surface of the concrete shall be thoroughly washed with water and a 1:1 mortar applied with brushes and well worked into the small air holes and other crevices in the face of the concrete. As soon as the mortar has taken its initial set it shall be rubbed off, using a sack or piece of carpet for that purpose. The mortar paint shall not be allowed to take its final set before being rubbed off.

Only that amount of surface that can be finished during one day shall be painted. Mortar allowed to set too hard to be rubbed off as above described, shall be removed with a carborundum stone and water. As soon as the mortar paint has set sufficiently hard, water shall be sprayed over the finished surface as a curing agent and the surface shall be kept damp for not less than two days.

The use of stones to rub all of the surfaces, thereby breaking the protective film on the face of the concrete, will not be allowed. The same brand of cement shall be used for finishing as was used in the concrete. The work shall be performed to the satisfaction of the Engineer.

Class 2 finish shall be applied to the following surfaces:

(a) Highway Structures:
   1. All surfaces of superstructures for highway grade separation structures and railroad undercrossing structures except the under surfaces of slab spans, box girders, filled spandrel arches, floor slabs between girders and inside vertical surfaces of girders.
   2. All surfaces above finished ground line of bridge piers, columns, abutments, retaining walls, and culvert head walls within one hundred fifty (150) feet of any traveled roadway or pedestrian walkway.
   3. The outside vertical surfaces of the superstructure of all structures, including the under surfaces of cantilever floor slabs overhanging outside girders or box girders.
   4. All surfaces of open spandrel arch rings, spandrel columns and abutment towers.
   5. The top surface of the bottom flange of prestressed girders.

(b) All concrete surfaces of structures that are exposed to public view, such as for sewer, water and treatment works, power stations, dams, et cetera, unless otherwise exempted by the special provisions.

–3.16C Class 3 Surface Finish

Class 3 surface finish applies to all formed surfaces upon or against which backfill or concrete will be placed or which will not be exposed to public view. The finish, in addition to the removal and repair of defective concrete and the specified curing, will require correction of surface irregularities when they exeed one-half (½) inch under a 10-foot straightedge. All form ties shall be removed and the holes be filled as specified for Class 2 finish, except that the removal of tight form ties below the surface of the concrete will not be required for surfaces buried underground or covered by fill or concrete.

Class 3 surface finish shall be applied to the following surfaces:

(a) The under surfaces of floor and roof slab spans not critical as to appearance.

(b) The inside surfaces of structures such as underground pumping plants for sewer works that are entered through small circular manhole openings not larger than three (3) feet in diameter.

(c) Surfaces which will be buried underground or covered with fill.

(d) Upstream surfaces of dams which will be under water.

(e) For the following surfaces Class 3 finish will include the removal of all lips and edges, and all air bubble holes larger than ¾ inch in diameter or ⅜ inch deep shall be filled as specified under Class 2 finish.
   1. The under surfaces of slab spans, box girders, filled spandrel arches and floor between girders for all structures.
   2. The inside vertical faces of girders for all structures.
   3. Surfaces of bridge piers, columns, abutments, retaining walls and culvert head walls which are more than one hundred fifty (150) feet from any traveled roadway or pedestrian walkway.

–3.17 FINISHES FOR FLOOR SLABS AND SIDEWALK SLABS

The finished surface of floor slabs for structures shall be one of the finishes described below as may be shown on the plans. Sidewalk slabs shall be finished to a Class 7 finish unless otherwise shown on the plans, in special provisions, or as directed by the Engineer.

–3.17A Class 4 Float Floor Finish

After the concrete for a floor slab has been placed and consolidated to the required tihckness, it shall be finished with a suitable wood float so as to produce a uniform and finely textured surface having an overall smoothness tolerance that does not exceed one-eighth (⅛) inch when tested with the standard ten (10) foot straightedge in any direction at overlapping intervals.

–3.17B Class 5 Sweat Floor Finish

After the floor has received a Class 4 finish, it shall be given sufficient time to set up so that a steel trowel can be used. The surface shall then be troweled one or more times until the surface layer of the concrete has a dense surface, even in texture and free of any irregularities. The surface when stroked with the steel trowel shall have a sweaty appearance.

–3.17C Class 6 Hard Trowel Floor Finish

This finish is in addition to a Class 5 finish. After the sweaty effect has been attained, steel troweling shall continue until a hard, dense and polished effect is obtained and no trowel marks are evident.

–3.17D Class 7 Sidewalk Slab Finish

Finish for sidewalk slabs shall be similar to Class 4 except that at the proper time the surface shall be steel troweled to produce a dense surface. The surface shall then be broomed to produce a suitable non-skid texture satisfactory to the Engineer. Before brooming, all joints and edges shall be neatly tooled with a trowel of proper shape and type.

107–4 MEASUREMENT

All concrete, except that in railings, shall be measured by the cubic yard in place for the various classes of concrete. Measurements shall be to the neat lines of the structure as shown on the plans or as authorized in writing by the Engineer, except in the case of concrete in cofferdam seals. Class D and Class H concrete used in the seals of underwater cofferdams will be paid for on the basis of the actual volume deposited as determined by the average cross sectional area of the inside of the cofferdam, excepting however, that no payment will be made for concrete outside of an area which is bounded by vertical planes one foot outside of the neat lines of the seal as shown on the plans, and parallel thereto.

No payment will be made for concrete below the established elevation of the bottom of the footing or seal. No deduction in pay concrete will be made for pile heads, reinforcing steel, structural steel or bolts enclosed in the pour.

107–5 PAYMENT

All concrete, except in railings, will be paid for at the unit contract price per cubic yard in place for the various classes of concrete.

The contract price shall be full compensation for furnishing all materials, equipment, tools, falsework, forms, expansion joint material, labor and all items required to complete the concrete work. Unless otherwise provided, the contract price shall include the furnishing and placing of scuppers and drains.

All costs incurred in construction with the furnishing of and the applying of air-entraining agents into the concrete as specified, shall be considered as incidental to the construction and shall be included in the unit contract prices per cubic yard for the various classes of concrete, and the unit contract price per linear foot for "Reinforced Concrete Bridge Railing."

If, at any time, the Contractor is ordered by the Engineer to furnish concrete requiring the use of high-early-strength cement, payment will be made at the unit contract price for the particular class of concrete with portland cement, plus an allowance consisting of the differential between the price of high-early-strength cement and portland cement, as expressed by the contract price per barrel for "Extra for Furnishing High-early-strength Cement," for the quantity of high-early-strength cement so used. If no such price is included in the schedule of unit contract prices, payment for concrete mixed with high-early-strength cement will be made at the unit contract price for the particular class of concrete involved plus an extra allowance agreed upon in writing between the Engineer and the Contractor.

Section 111—Reinforcing Steel

111–1 DESCRIPTION

Reinforcing steel shall consist of round or square deformed bars or wire mesh. Square twisted bars shall not be used.

111–2 MATERIALS

–2.01 DEFORMED STEEL BARS

Deformed steel bars for concrete reinforcement shall conform to the requirements of ASTM Designation A 15, Billet Steel Bars for Concrete Reinforcement, Intermediate Grade, ASTM Designation A 432, or ASTM Designation A 431, High Strength Billet Steel Bars for Concrete Reinforcement as noted on the plans, except that the bars shall be made only by the open-hearth process or the electric furnace process.

The form of the deformed bars shall conform to ASTM Designation A 305, Minimum Requirements for Deformations of Deformed Steel Bars for Concrete Reinforcement. Deformed bars Nos. 14 and 18 for concrete reinforcement shall conform to the requirements of ASTM Designation A 408, Special Large Size Deformed Billet Steel Bars for Concrete Reinforcement.

–2.02 WIRE MESH

Wire mesh for concrete reinforcement shall conform to the requirements of the standard specifications of ASTM Designation A 185, Welded Steel Wire Fabric for Concrete Reinforcement. All wire mesh shall be of an approved kind and quality of manufacture.

–2.03 COLD DRAWN WIRE

Cold drawn wire shall conform to the requirements of ASTM Designation A 82, Cold-Drawn Steel Wire for Concrete Reinforcement.

111–3 CONSTRUCTION DETAILS

–3.01 ORDERING

In general, a bar list and bending diagram will be included in the plans but the Contractor shall use them at his own risk and should check his order from the plans. The Contractor shall furnish the Engineer a bar shipping list including shipping weights.

–3.02 INSPECTION

–3.02A Notice of Rolling

The Contractor shall give ample notice to the Engineer of the beginning of work at the mill in order that mill inspection may be provided. No material shall be rolled or fabricated before the Engineer has been notified with whom the orders have been placed and where the material will be rolled.

–3.02B Facilities for Inspection

The Contractor shall furnish all facilities for the inspection of material and workmanship in the mill, and inspectors shall be allowed free access to the necessary parts of the premises.

–3.02C Inspector's Authority

The Inspector shall have the authority to reject materials or workmanship which do not fulfill the requirements of these specifications, but in cases of dispute the Contractor may appeal to the Engineer, whose decision shall be final.

Mill inspection is intended to be only a means of facilitating work and avoiding errors. It shall be understood that mill inspection will not relieve the Contractor from responsibility for material and workmanship or from the obligation to replace material found to be defective for any reason after delivery from the mill.

–3.02D Rejections

Rejected materials shall be replaced, corrected, or repaired promptly. Any materials accepted by the Engineer, including those corrected or repaired, shall be subject to subsequent rejection if found to be defective.

–3.03 BENDING

Steel reinforcing bars shall be cut and bent by careful and competent workmen. They shall be bent cold to templates, which shall not vary appreciably from the shape and dimension shown on the plans. All sharp bends shall be avoided, and in no case shall a bend be of less radius than three (3) diameters of the bar.

In forming hooks on the ends of bars the bends shall have a radius of at least three (3) diameters of the bar and shall extend at least six (6) diameters beyond the bend.

–3.04 PROTECTION OF MATERIALS

Reinforcing steel shall be protected at all times from injury and, when placed in the structure, shall be free from dirt, loose mill scale and rust scale, paint, oil or other defects affecting the strength or bond with the concrete.

–3.05 PLACING AND FASTENING

Reinforcing steel shall be placed in the exact positions shown on the plans and held securely during the pouring of the concrete. All reinforcement shall be put in proper position, then be securely wired and blocked before concrete is poured in any section. All abrupt bends shall be avoided except where one steel member is bent around another. Vertical stirrups shall always pass around the main tension members or be securely attached thereto, unless otherwise shown on the plans.

All reinforcing steel shall be securely blocked from the forms by means of small mortar blocks not more than one and one-half (1½) inches square, or by other approved devices. The blocks shall be constructed of mortar mixed with the proportions of two parts of sand and one part of cement. If metal chair supports are used as supports for steel reinforcing bars, they shall be hot-dipped galvanized for all surfaces not covered by at least ½ inch of concrete.

Reinforcing steel which interferes with bridge drains shall be bent in the field as may be required to clear the drains.

The minimum clear space in inches between reinforcing bars shall be as follows:

Between adjacent bars in a layer	2½"
Between adjacent layers	2 "

Except as otherwise shown on the plans, the thickness of concrete cover over reinforcing bars shall be as follows:

Between main bars and surface of concrete (except in slabs and walls)	2 "
Between main bars and surface of concrete in retaining walls	1½"
Between main bars and surface of concrete deposited against earth (without intervening forms)	2½"
Between slab bars and bottom of slab	1 "
Between slab bars and top of slab	1½"
Between stirrups and ties and surface of concrete	1 "

In concrete exposed to the action of salt or alkaline water the minimum cover over main reinforcing bars shall be three (3) inches, unless otherwise shown on the plans.

Just prior to placing concrete, all mortar, mud, loose rust, scale or other coatings that will weaken the bond with concrete shall be cleaned from the reinforcement.

In the construction of roadway and sidewalk slabs, special attention shall be given to the placing of reinforcing steel to ensure that proper cover and wearing surface is provided.

No concrete shall be deposited until the Engineer has inspected the placing of the reinforcing steel and has given permission to pour concrete. All concrete placed in violation of this provision shall be rejected and removed.

–3.06 SPLICING

–3.06A Steel Bars

All steel bars for concrete reinforcement shall be furnished in the full lengths indicated upon the plans. No splicing of bars, except where shown on the plans, will be permitted without the written approval of the Engineer.

Splices which are permitted shall have lengths each not less than thirty-five (35) times the nominal diameter of the reinforcement unless otherwise specified on the plans, and shall be well distributed or else located at points of low tensile stress.

No splices will be permitted at points where the section is not sufficient to provide a minimum distance of two (2) inches between the splice and the nearest adjacent bar or the surface of the concrete. The bars shall be rigidly clamped or wired at all splices in a manner approved by the Engineer.

–3.06B Wire Mesh

Sheets of wire mesh used as reinforcement in structural slabs shall be spliced in accordance with the following provisions:

(1) Lapped splices of wires in regions of maximum stress (where they are carrying more than one-half of the permissible stress) shall be avoided wherever possible; such splices where used shall be so made that the overlap measured between outermost cross wires of each sheet is not less than the spacing of the cross wires plus two (2) inches.

(2) Splices of wires stressed at not more than one-half the permissible stress shall be so made that the overlap measured between the outermost cross wires is not less than two (2) inches.

Sheets of wire mesh reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges.

–3.06C Welding

Welds shall be made by qualified operators certified for work under the standard procedure of the American Welding Society, or by operators who have been authorized to perform welding under standards set up by the municipality concerned. Welders having certificates shall have been prequalified within twelve (12) months previous to beginning work on the subject structure. Preparation for welding and welding procedure shall be in accordance with good practice and with the current "Standard Specifications for Welded Highway and Railway Bridges of the American Welding Society." Butt welding shall be done in accordance with "Recommended Practice for Welding Reinforcing Steel, Metal Inserts, and Connections in Reinforced Concrete," of the American Welding Society.

Welding of reinforcing bars to each other or to structural steel shapes shall conform to details shown on the drawings. Where weld sizes are not noted, welds shall have a minimum cross sectional area equal to 125 percent of the bar thus attached.

Reinforcing bars shall not be welded together or to other steel parts at cold bent points.

Steel suitable for welding shall be furnished for bars which are to be welded. In steel which is to be welded, the carbon shall not exceed 0.35 percent and the manganese shall not exceed 0.90 percent, and sulfur and phosphorous each not to exceed 0.05 percent.

The coatings of the low-hydrogen type electrodes shall be in satisfactory condition at the time of use, in accordance with the requirements in Section 112-3.33.

Where shown on the plans butt welding of the reinforcing bars shall be accomplished by the shielded metal arc process and by the direct butt method using low-hydrogen electrodes.

All costs in connection with welding the reinforcing steel as detailed on the plans and in accordance with the specifications shall be included in the unit contract price per pound for "Steel Reinforcing Bars."

111–4 MEASUREMENT

All reinforcing steel will be measured by the computed weight of all metal actually in place as shown on the plans, or as ordered by the Engineer. No allowance will be made for spreaders, form blocks, wire clips or other fastenings which must be furnished by the Contractor. When splices are made other than those shown on the plans, no allowance will be made for the extra steel required. When shear steel is required at construction joints which are not shown on the plans, and which are permitted for the Contractor's convenience, no allowance will be made for the additional steel required.

For the purpose of computing weights of reinforcing steel, the following table shall be used:

BAR REINFORCING STEEL

Deformed Bar Designation Number	*Nominal Diameter Inches*	*Unit Weight, Pounds per Foot*
2	0.250	0.167
3	0.375	0.376
4	0.500	0.668
5	0.625	1.043
6	0.750	1.502
7	0.875	2.044
8	1.000	2.670
9	1.128	3.400
10	1.270	4.303
11	1.410	5.313
14	1.690	7.650
18	2.260	13.600

111–5 PAYMENT

Payment will be made for such of the following bid items as are included and shown in any particular contract:

1. "Steel Reinforcing Bars, per pound.
2. "Wire Mesh ... Gage ... Inch Mesh" per square yard.

The unit contract prices shall include the cost of furnishing, fabricating and placing the reinforcement. In structures of reinforced concrete where there are no structural steel bid items, such minor metal parts as expansion joints and bolts will be paid for at the unit contract price for reinforcing steel, unless otherwise specified.

Section 112—Structural Steel

112–1 DESCRIPTION

Structural steel shall be of two classes: structural carbon steel and high-strength low-alloy structural steel. Those parts which are fabricated of steel other than structural carbon steel, ASTM Designation A-36, will be shown on the plans or specified in the special provisions by their ASTM Designations. All structural parts not so designated shall be fabricated of structural carbon steel, ASTM Designation A-36.

For steel structures, unless otherwise provided in the special provisions, structural steel as a bid item shall include all metal parts required for permanent connections of the component parts of the structural steel and all metals otherwise shown on the plans for use in conjunction with the completed structure, even though they are made of metal other than structural steel.

For a concrete or timber structure, unless otherwise provided in the special provisions, structural steel, other steel, cast steel, cast iron, and other metal materials shown on the plans or described in the specifications for the structure and for which payment is not specifically provided in the proposal, shall be considered as miscellaneous metals for the purpose of payment.

Payment for structural steel and miscellaneous metal will be made as specified in Section 112-5.

112–2 MATERIALS

–2.01 STRUCTURAL CARBON STEEL

Structural carbon steel shall conform to the following ASTM specifications:

(1) Steel for Bridges and Buildings, ASTM A 7.

(2) Structural Steel for Welding, ASTM A 373 or ASTM A 36.

(3) Structural Steel, ASTM A 36.

The classes of carbon steel shall, if required, be marked at the mill to distinguish them and the fabricator shall keep them carefully separated.

–2.02 HIGH-STRENGTH LOW-ALLOY STRUCTURAL STEEL

High-strength and low-alloy structural steel shall conform to the following ASTM specifications:

(1) High-Strength Structural Steel, ASTM A 440.

(2) High-Strength Low-Alloy Structural Manganese Vanadium Steel, ASTM A 441.

(3) High-Strength Low-Alloy Structural Steel, ASTM A 242.

The classes of high-strength and low-alloy steel shall, if required, be marked at the mill to distinguish them and the fabricator shall keep them carefully separated.

–2.03 STRUCTURAL RIVET STEEL

Structural rivet steel as required by the plans shall conform to the following ASTM specifications:

(1) Structural Rivet Steel, ASTM A 141.

(2) High-Strength Structural Rivet Steel, ASTM A 195.

(3) High-Strength Structural Alloy Rivet Steel, ASTM A 406.

–2.04 RIVET BOLTS

Rivet bolts shall be manufactured from steel containing 0.18 percent to 0.24 percent carbon, and 0.75 percent to 1.00 percent manganese, and having tensile strength of 70,000 pounds per square inch.

–2.05 BOLTS

–2.05A Unfinished Bolts

Unfinished bolts, (ordinary machine bolts), shall conform to the specification requirements of ASTM Designation A 307, Steel Machine Bolts and Nuts and Tap Bolts. They shall be Grade A unless otherwise specified on the plans or in the special provisions.

–2.05B Turned Bolts

Turned bolts or other special bolts shall be made from structural carbon steel as defined in Section 112-2.01, unless otherwise specified on the plans or in the specifications.

-2.05C High-strength Steel Bolts

Refer to Section 112-3.17.

112–3 CONSTRUCTION DETAILS

–3.01 MILL AND SHOP INSPECTION

–3.01A Notice of Rolling

The Contractor shall give ample notice to the Engineer of the beginning of work at the mill and shop so that inspection may be provided. No material shall be rolled or fabricated before the Engineer has been notified with whom the orders have been placed and where the material will be rolled.

–3.01B Facilities for Inspection

The Contractor shall furnish all facilities for the inspection of material and workmanship in the mill and shop, and inspectors shall be allowed free access to the necessary parts of the premises.

–3.01C Inspector's Authority

The Inspector shall have the authority to reject materials or workmanship which do not fulfill the requirements of these specifications, but in cases of dispute the Contractor may appeal to the Engineer, whose decision shall be final.

Inspection at the mill and shop is intended as a means of facilitating the work and avoiding errors, and it is expressly understood that it will not relieve the Contractor from any responsibility in regard to defective material or workmanship and the necessity for replacing the same.

The Inspector may stamp or tag each individual piece as it is accepted with a private mark previously registered with the Owner (City). The mark or tag shall be in plain view on the steel. Any piece not so marked or tagged may be rejected.

–3.01D Rejections

Any materials accepted by the Engineer, including those corrected or repaired, shall be subject to subsequent rejection if found to be defective. Rejected materials shall be replaced, corrected, or repaired promptly.

–3.02 FIELD INSPECTION

The erection of structural steel shall be subject to the inspection of the Engineer. He shall be given free access to the site of the project, and the Contractor shall cooperate with the Engineer in making possible a thorough examination of the field work while it is in progress.

Material and fabrication not previously inspected will be inspected after delivery of the fabricated material to the site of the work.

–3.03 MILL ORDERS AND SHIPPING STATEMENTS

The Contractor shall furnish the Engineer with as many copies of mill orders and shipping statements as the Engineer may direct.

–3.04 WEIGHING

Structural steel need not be weighed unless specified on the plans or in the special provisions.

In the event the weight of structural steel is required, the weight may be either calculated or obtained by scales, and as many copies of the calculations or weight slips shall be furnished as specified or directed by the Engineer. Calculated weights shall be made in compliance with American Code of Standard Practice, Section 3 as revised February 20, 1963 by American Institute of Steel Construction, Inc.

If scale weights are furnished, the weights of all tools, erection material and dunnage shall be kept separate.

–3.05 LOADING AND UNLOADING

The loading, transporting, unloading and piling of the structural material shall be so conducted that the metal will be kept clean and free of injury from rough handling.

–3.06 SHOP PLANS

The Contractor will be required to submit to the Engineer, for approval, all shop detail plans required for fabrication of the steel.

Two sets of prints shall first be submitted to the Engineer for checking, except that for grade separation structures which carry a railroad over the highway, five (5) sets of prints shall be submitted. Only drawings which have been checked by the Contractor or his agent will be accepted. One set of prints of the shop plans will be returned to the Contractor, either without change or with corrections marked thereon. After the required revisions have been made by the Contractor, additional sets of prints from five to thirteen in number, as requested, shall be furnished to the Engineer for final approval. No material shall be fabricated until the plans have been given final approval by the Engineer.

Provision for attachment of other types of materials to steel members shall be shown on the shop plans.

The approval of shop plans shall be understood to be an acceptance of the character and sufficiency of the details, and not a check of the dimensions.

No changes shall be made in any drawing after it has been approved except by the consent or direction of the Engineer in writing.

Prior to the completion of the project, the Contractor or his agent shall furnish to the Engineer the original tracings, or acceptable reproductions of the original drawings of the shop plans. All drawings shall be on sheets each twenty-two (22) inches wide by thirty-six (36) inches long in overall dimensions, or on smaller sheets that are multiples of eight and one-half (8½) inches by eleven (11) inches.

–3.07 SUBSTITUTIONS

Substitutions of sections having different dimensions than those shown on the plans shall be made only when approved in writing by the Engineer. Should the substitution of heavier members be allowed upon the Contractor's request, no extra weight over the original design section will be allowed in payment.

–3.08 SHOP STORAGE OF MATERIALS

All material stored at a steel fabricating plant shall be stored in a manner to prevent distortion, or damages from rusting. Material which shows any signs of pitting due to rust will not be accepted.

All fabricated material stored prior to shipment shall be subject to the same requirements of storage as the unfabricated material.

All structural steel shall be delivered to the job in good condition. Steel transported by salt water and which, in the opinion of the Engineer, has been damaged by salt water, shall be sandblasted and repainted with the shop coat specified on the plans after it has been unloaded from the ship.

Structural low alloy steel shall be marked at the mill to distinguish it from structural carbon steel, and the fabricator shall keep the two classes of material carefully separated.

–3.09 STRAIGHTENING MATERIAL

All deformed structural material shall be properly straightened by methods which are non-injurious prior to being laid out, punched or otherwise worked in the shop. Sharp kinks and bends will be cause for rejection.

–3.10 WORKMANSHIP AND FINISH

The workmanship and finish shall be first class and equal to the best practice in modern structural steel fabricating shops or plants. Welding, shearing, burning and chipping shall be neatly and accurately done and all portions of the work exposed to view shall be neatly finished.

–3.11 RIVET HOLES

–3.11A General Requirements

All stringer and floor beam connections, connections of main members, and any other members indicated on the plans, shall have sub-punched and reamed rivet holes, or shall be drilled from the solid. It shall be understood that this requirement does not apply to rivet holes in lateral bracing, portals, sway bracing and other secondary members, nor to their connections to the main members.

For holes where reaming is not required, material three-fourths (¾) inch or less in thickness may be punched full size. All holes in steel more than three-fourths (¾) inch in thickness shall be sub-punched and reamed, or drilled from the solid.

–3.11B Punched Holes

Full size punched holes shall be one-sixteenth (1/16) inch larger than the nominal diameter of the rivet. The diameter of the die shall not exceed the diameter of the punch by more than three-thirty-seconds (3/32) inch. Holes must be clean cut, without torn or ragged edges. If any holes must be enlarged to admit the rivets, they shall be reamed.

The punching of holes shall be so accurately done that, after assembling the component parts of a member, a cylindrical pin one-eighth (⅛) inch smaller than the nominal diameter of the punched hole may be passed through at least 75 of any group of 100 contiguous holes in the same surface, or in like proportion for any group of holes. If this requirement is not fulfilled, the badly punched pieces shall be rejected. If any holes will not pass a pin three-sixteenths (3/16) inch smaller than the nominal diameter of the punched hole, it shall be cause for rejection.

–3.11C Drilled Holes

Drilled holes shall be one-sixteenth (1/16) inch larger than the nominal diameter of the rivet. Burrs on the outside surfaces shall be removed with a tool producing a one-sixteenth (1/16) inch fillet around the edge of the hole.

–3.11D Sub-Punched and Reamed Holes

Sub-punched and reamed holes for rivets having diameters greater than three-fourths (¾) inch shall be punched three-sixteenths (3/16) inch less than the nominal diameter of the rivet, and for rivets having diameter three-fourths (¾) inch or less, the holes shall be punched one-sixteenth (1/16) inch less than the nominal diameter of the rivet. The punch and die shall have the same relative sizes as specified for full size punched holes. After punching, the holes shall be reamed to a diameter one-sixteenth (1/16) inch larger than the nominal diameter of the rivet.

–3.11E Reaming

Reaming of rivet holes shall be done with twist drills or with short taper reamers. Reamers preferably shall not be directed by hand. No oil or grease shall be used as lubricant.

Burrs resulting from reaming shall be removed with a tool producing a one-sixteenth (1/16) inch fillet around the edge of the hole.

Reaming of the holes in a built member shall be done only after its component parts are assembled and firmly bolted together, and no interchange of reamed parts will be permitted. Holes through assembled material shall not consist of both sub-punched or sub-drilled holes, and holes punched or drilled full size.

Holes for field connections in main truss members shall be reamed with the entire truss assembled.

All stringer and floor beam connections shall be reamed to a steel template. The template shall be not less than one (1) inch thick, made from a single thickness of steel, or may be from two steel plates of one-fourth (¼) inch steel rigidly spaced with hardened steel bushings, or may be other template if approved by the Engineer.

–3.11F Accuracy of Reamed and Drilled Holes

Reamed or drilled holes shall be cylindrical and perpendicular to the member and their accuracy shall be the same as specified for punched holes except that, after reaming or drilling, 85 of any group of 100 contiguous holes in the same surface, or in like proportion for any group of holes, shall not show an offset greater than one-thirty-second (1/32) inch between adjacent thickness of metal.

–3.11G Drifting of Holes

The drifting done during assembling shall be only such as to bring the parts into position, and not sufficient to enlarge the holes or distort the metal.

–3.12 SHOP ASSEMBLING

Surfaces of metals that will be in contact when shop assembled shall not be painted. These surfaces shall be thoroughly cleaned of rust, loose mill scale, dirt, oil or grease and all other foreign substances.

The component parts of built members shall be assembled, drift pinned to prevent lateral movement, and firmly bolted to draw the parts into close contact before reaming, drilling or riveting is begun. At least 25 percent of the holes shall be bolted up and the Engineer may require as much as 50 percent. Assembled parts shall be taken apart if necessary for the removal of burrs and shavings produced by the reaming operation.

The member shall be free from twists, bends or other deformations.

Preparatory to shop riveting where the rivet holes are punched full size, they shall be cleared for the admission of the rivets by reaming.

End connection angles, stiffener angles, etc., shall be carefully adjusted to correct locations and be rigidly bolted, clamped, or otherwise firmly held in place until riveted.

After the built-up members have been riveted, the entire truss or girder shall be fully assembled, properly aligned and set to camber, pinned and bolted together before drilling or reaming the holes in the field connections.

–3.13 MATCH MARKING

Connecting parts assembled in the shop for the purpose of reaming or drilling holes in field connections shall be match-marked, and a diagram showing such marks shall be furnished to the Engineer.

–3.14 SANDBLASTING

After fabrication has been completed and immediately before the first or shop coat of paint is applied, all structural steel shall be thoroughly cleaned by sand blasting. The sand blast shall be applied to an extent necessary to remove all rust, mill scale, dirt, oil, grease and other foreign substance. The resultant steel surface shall be free from all red or yellow iron rust. Small stained areas may, with approval of the Engineer, be left in place. After sandblasting, all loose dust and dirt remaining on the steel shall be removed before paint is applied.

–3.15 PAINTING

After being thoroughly cleaned by sandblasting as specified above, all structural steel shall be painted within eight (8) hours of sandblasting with one shop coat of the paint specified on the plans. The paint and its manner of application shall be as specified in Section 116, and be applied in a location sufficiently removed from the cleaning operations to avoid contamination of the cleaned steel surface or the fresh paint by the cleaning operations.

–3.16 RIVETS

The diameter of rivets indicated upon the plans shall be understood to mean their diameter before heating.

Heads of driven rivets shall be of approved shape, concentric with the shanks, true to size, full, neatly formed, free from fins and in full contact with the surface of the member.

Field rivets, for each size and length shall be supplied in excess of the actual number to be driven to provide for losses due to misuse, improper driving or other contingencies. Rivets shall be free from furnace scale on their shanks and from fins on the under side of the machine formed heads.

–3.17 BOLTS AND BOLTED CONNECTIONS

Where bolted connections are shown on the plans or are specifically authorized, all bolts, nuts and washers shall conform to the specifications for material and assembly of structural joints using high strength steel bolts as provided in articles 1.4.3, 2.10.3 and 2.10.20 of the current AASHO Standard Specifications for Highway Bridges. Contact surfaces shall fit solidly together and the contact surfaces of the joint shall be free of dirt, oil, scale, paint or lacquer and other deposits that would prevent a solid setting of the parts.

When bolted joints are used, all mill scale and rust shall be removed from the contact surfaces by sand-blasting immediately prior to erection.

–3.18 RIVET BOLTS

Rivet bolts shall be used only where specified on the plans or authorized by the Engineer in writing. The design of shank, nut and thread shall be subject to the approval of the Engineer and the holes in which they are placed shall meet the requirements of Section 112-3.11.

No additional payment will be made for rivet bolts used in place of rivets.

–3.19 RIVETING

Rivets shall be heated uniformly to a light cherry red color and shall be driven while hot. The heating of the points of rivets more than the remainder will not be permitted. When ready for driving the rivet shall be free from slag, scale and other adhering matter and when driven it shall completely fill the hole. Burned, burred or otherwise defective rivets, or rivets which throw off sparks when taken from the furnace or forge shall not be driven.

Loose, burned, badly formed or otherwise defective rivets shall be cut out. Caulking and recupping of rivet heads will not be allowed. In cutting out defective rivets care shall be taken not to injure the adjacent metal and, if necessary, the rivet shanks shall be removed by drilling.

Countersinking shall be neatly done and countersunk rivets shall completely fill the holes.

Shop rivets shall be driven by direct acting riveters where practicable. The riveting machines shall retain the pressure for a short time after the upsetting is complete.

Pneumatic hammers shall be used for field riveting.

–3.20 EDGE FINISHING

Sheared edges of material more than five-eighths (⅝) inch in thickness shall be planed to a depth of not less than one-eighth (⅛) inch when so required by the Engineer. All sheared and flame-cut edges shall be true to line and shall be free from rough corners or projections. When required by the Engineer, they shall be ground to remove the objectionable defects. Re-entrant cuts shall be filleted as large as practicable, but never less than one (1) inch radius, except when otherwise shown on the plans. Gusset plates with curved edges shall be cut to the exact radius shown on the plans and shall be ground to remove any rough corners.

–3.21 PLANING BEARING SURFACES

Ends of columns taking bearing upon base and cap plates shall be milled to true surfaces and correct bevels after the main section of these members and the end connection angles have been fully riveted.

Caps and base plates of columns and the sole plates of girders and trusses shall have full contact when assembled. The plates, if warped or deformed, shall be hot-straightened, planed or otherwise treated to secure an accurate and uniform contact. After being riveted in place, the excess metal of countersunk rivet heads shall be chipped smooth and flush with the surrounding metal, and the surfaces which are to come in contact with other metal surfaces shall be planed, or milled if necessary, to enable proper contact. Correspondingly, the surfaces of base and sole plates which are to come in contact with masonry shall be rough finished, if not free from warps or other deformations.

In planing the surfaces of expansion bearings, the cut of the tool shall be in the direction of expansion.

–3.22 ABUTTING JOINTS

Abutting ends of compression members shall be accurately faced to secure an even bearing when assembled in the structure. Facing or milling of the ends of built-up members shall be done after they have been riveted.

Ends of tension members at splices shall be rough finished to secure close and neat but not necessarily contact fitting joints.

–3.23 END CONNECTION ANGLES

End connection angles of floor beams and stringers shall be flush with each other and accurately set as to position and length of member. In general, end connection angles shall not be finished unless required by the Engineer. Faulty assembling and riveting, however, may be cause for requiring them to be milled, in which case their thickness shall be reduced not to exceed one-sixteenth (1/16) inch, nor shall their rivet bearing value be reduced below design requirements.

–3.24 BUILT MEMBERS

The several pieces forming one built member shall be straight and close fitting. Such members shall be true to detailed dimensions and free from twists, bends, open joints or other defects resulting from faulty fabrication and workmanship.

–3.25 HAND HOLES

Hand holes may be either punched or cut with burning torches. In either case they shall be true to the size and shape shown on the plans. Edges shall be true to line and shall be ground smooth.

–3.26 LACING BARS

The ends of lacing bars shall be neatly rounded unless otherwise indicated.

–3.27 PLATE GIRDERS

–3.27A Web Plates

Web plates of girders having no cover plates may be detailed with the top edge of the web flush with the backs of the flange angles. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles. Web plates of girders having cover plates may be one-half (½) inch less in width than the distance back to back of flange angles. When web plates are spliced, not more than three-eights (⅜) inch clearance between ends of plates will be allowed.

–3.27B Web Stiffeners

End stiffener angles of girders and stiffener angles intended as supports for concentrated loads shall be milled or ground to secure a uniform and even bearing against the flange angles. Intermediate stiffener angles shall fit sufficiently tight to exclude water after painting.

–3.27C Web Splices and Fillers

Web splice plates and fillers under stiffeners shall fit within one-eighth (⅛) inch at each end.

–3.28 EYEBARS

Eyebars shall be straight and true to size, and shall be free from twists, folds in the neck or head, or any other defect affecting their service strength. Heads shall be made by upsetting, rolling or forging. Welds in the body portions or in the head of bars will not be permitted. The form of the heads may be determined by the dies in use at the works where the eyebars are to be made, if satisfactory to the Engineer. The thickness of head and neck shall not overrun more than one-sixteenth (1/16) inch.

Before boring, each eyebar shall be properly annealed and carefully straightened. Pinholes shall be located on the center line of the bar and in the centers of the heads. The holes in the ends of bars shall be so accurately located that when the bars of the same truss panels are placed in a pile, the pins may be completely inserted in the pinholes without driving. All eyebars intended for the same locations in the trusses shall be interchangeable.

–3.29 ANNEALING

All eyebars shall be annealed by heating uniformly to the proper temperature, followed by slow and uniform cooling in the furnace. The temperature of the bars shall be under full control at all stages.

Slight bends on steel members of secondary importance may be made without heating the metal. Crimped web stiffeners need not be annealed.

–3.30 PINS AND ROLLERS

Pins and rollers shall be of forged steel of the class specified on the plans, accurately turned to detailed dimensions and shall be smooth, straight and free from flaws. The final surface shall be produced by a finishing cut.

Pins and rollers seven (7) inches or less in diameter may be either forged and annealed or cold-finished carbon steel shafting.

Pins larger than eight (8) inches in diameter shall have a hole not less than two (2) inches in diameter bored longitudinally through their centers. Pins showing defective interior conditions will be rejected.

Pilot nuts and driving nuts shall be furnished for each size of pin, unless otherwise specified.

–3.31 BORING PIN HOLES

Pin holes shall be bored true to detailed dimensions, smooth and straight, at right angles with the axis of the member and parallel with each other, unless otherwise required. A finishing cut shall always be made.

The length outside to outside of holes in tension members and inside to inside of holes in compression members shall not vary from detailed dimensions more than one-thirty-second (1/32) inch. Boring of holes in built-up members shall be done after the riveting is completed.

–3.32 PIN CLEARANCES

The difference in diameter between the pin and the pin hole shall be one-fiftieth (1/50) inch. All pins shall be fitted to their respective pin holes in the assembled member and numbered.

–3.33 WELDS

Welding of structural steel will be permitted only to the extent shown on the plans or for the preliminary attachment of small parts to facilitate assembling. Welding, when required, shall be by qualified welders certified as specified in Section 111-3.06C. Welding will not be accepted as a substitute for riveting. When specified all welds, welding procedure, welding materials and preparation of welded surfaces for painting shall conform to the current issue of Standard Specifications for Welded Highway and Railway Bridges by the American Welding Society, and to the following:

1. Electrodes for manual welding shall be low-hydrogen type conforming to ASTM Designation A 316, and ASTM Designation A 233. The coatings of the low-hydrogen electrodes shall be thoroughly dry when used. Electrodes, including those taken from hermetically sealed packages, shall be dried for at least two hours at temperature between 450° F. and 650° F. before they are used, unless otherwise recommended by the manufacturer. After drying, all electrodes shall be stored in an oven at 250° to 350° F. until used. Electrodes with coatings that have deteriorated and cracked, or that have been rained on or thoroughly wetted in any manner shall be discarded and not used.
2. Flux and wire for submerged arc welding shall be selected to provide a weld with physical characteristics equal to or better than the base metal. Welding flux shall be free from dirt, slag, rust or other foreign material and shall be kept dry in accordance with good industry practice.
3. Preheat may be required where indicated by the thickness of the metal and/or presence of alloying elements in sufficient quantity to so require.
4. Welding procedure shall be submitted for approval with shop drawings. This procedure shall specify the type of equipment to be used, electrode selection and preheat requirements.
5. All tension butt welds of structural steel, including the tension area of plate girder webs for a minimum length of 15 inches from the point of maximum tension, shall be subject to 100 percent X-ray inspection in accordance with the American Welding Society Standards, and the Contractor shall furnish radiographs of the specified joints to the Engineer for approval. The acceptability of the welded joints will be determined by the Engineer.

   All costs in connection with furnishing radiographs to the Engineer as outlined herein shall be included in the lump sum contract price for "Structural Low Alloy Steel," or "Structural Carbon Steel."

   Radiographic inspection of butt welds which reveal the presence of any of the following defects in excess of the limits indicated shall result in rejection of the weld as being defective:

   a. Cracks—No cracking will be allowed regardless of length or location.
   b. No overlaps, lack of penetration, or incomplete fusion will be allowed.
   c. Inclusions, including slag, porosity and other deleterious material, if less than 1/16 inch in dimension will be allowed provided the inclusions are so well dispersed that the sum of the greatest dimensions of the inclusions in any linear inch of welded joint shall not exceed 3/16 inch plus ¼T (where "T" is the thickness of the thinner plate) for groove welds or ½ the weld size for fillet welds, and there shall be no inclusion exceeding 1/16 inch in length within 1 inch of the edge of a joint.

The Contractor is referred to "Welding Handbook" of the American Welding Society, fourth edition, Section 1, page 8.38 and the American Welding Society Inspection Handbook for Manual Arc Welding B 1.1-45, Part C, page 114.

Radiographic procedure, equipment and materials shall conform to the requirements of ASME Boiler Code, Section VIII, paragraph UW-51. Radiographs shall be made by X-ray and shall be clear and of good workmanship. Two or more penetrameters shall be used, as directed by the Engineer. Layout of radiographs shall conform to the requirements as shown on the Standard Plan for Identification of Radiographs of Welds.

Radiographic operators shall be experienced and capable personnel, and shall submit a report interpreting the radiographs to the Engineer without recommendation.

The welds which are to be radiographed shall be ground or prepared by other suitable mechanical processes to a degree that the resulting radiographic contrast, due to any remaining surface irregularities, cannot be confused with that of any objectionable defect. The weld surface shall merge smoothly into the plate surface.

The welds shall be radiographed with a technique which will produce films having a sensitivity of 2 percent. As a check on the radiographic technique, suitable thickness gages or penetrameters shall be used. The material of the penetrameter shall be substantially the same as that of the plate under examination. In addition to other markings, weld areas and film must be suitably marked to allow for physically matching the radiograph with the examined metal at any time after film has been processed. Film exposed by more than one radioactive source for a single exposure will not be accepted. The minimum conditions given in the paragraph on Geometric Factors, page 8.51 of Section 1 of the Welding Handbook shall be observed.

–3.33A Corrections in Welding

In lieu of the rejection of an entire piece or member containing welding which is unsatisfactory or indicates inferior workmanship, the following corrective measures may be permitted by the Engineer, whose specific approval shall be obtained for making each correction.

Where the following requirements prescribe the removal of part or all of the weld or a portion of the base metal, such removal shall be done by chipping, grinding, oxygen cutting, oxygen gouging, or air-arc gouging.

Defective or unsound welds shall be corrected either by removing and displacing the entire weld, or as indicated below.

(a) *Excessive convexity:* Reduce to size by removal of excess weld metal.
(b) *Shrinkage cracks, cracks in base metal, craters, and excessive porosity:* Remove defective portions of base and weld metal down to sound metal, and deposit additional sound weld metal.
(c) *Undercutting, undersize, and excessive concavity:* Clean and deposit additional sound weld metal.
(d) *Overlapping and incomplete fusion:* Remove and replace the defective portion of the weld.
(e) *Slag inclusions:* Remove the parts of the weld containing slag, and fill with sound weld metal.
(f) *Removal of adjacent base metal during welding:* Clean and form full size by depositing additional weld metal.

Where corrections require the depositing of additional weld metal, the electrode used shall preferably be smaller than the electrode used for making the weld. Electrodes larger than 5/32 inch diameter preferably shall not be used for repairing undercut base metal. Surfaces shall be cleaned thoroughly before welding.

A cracked weld shall be removed throughout its length unless, by the use of acid etching, magnetic inspection, or other equally positive means, the extent of the crack can be ascertained to be limited, in which case sound weld metal two (2) inches or more beyond each end of the crack shall not be removed.

Defective parts of a weld shall be cut out without substantial removal of the base metal unless cracks or other defects remain which require further removal. The weld or base metal shall not be nicked or undercut in chipping, grinding or gouging.

Where work performed subsequent to the making of a deficient weld has rendered the weld inaccessible or has caused new conditions which would make the corrections of the deficiency dangerous or ineffectual, the original conditions shall be restored by removal of welds, or members, or both, before making the necessary corrections; or else the deficiency shall be compensated by additional work according to a revised design approved by the Engineer.

Calking of welds shall not be done. Improperly fitted and misaligned parts may be cut apart and rewelded. Members distorted by the heat of welding shall be straightened by mechanical means or by the carefully supervised application of a limited amount of localized heat. For hot-rolled steels, heated areas shall not exceed 1200° F. (a dull red color). Parts to be heated for straightening shall be substantially free of stress from external forces, except when mechanical means are used in the application of heat.

–3.34 SCREW THREADS

Screw threads shall make close fits in the nuts and shall be U. S. Standard except that for diameters greater than one and one-half (1½) inches they shall be made with six (6) threads to the inch.

–3.35 MEASURING CAMBER

A camber diagram shall be furnished the Engineer showing the camber at each panel point for each truss, taken from actual measurements while the truss is assembled.

112–5 MEASUREMENT AND PAYMENT

Payment will be made for such of the following bid items as are included and shown in any particular contract:

1. "Structural Carbon Steel," per lump sum.
2. "High-strength Low-alloy Structural Steel," per lump sum.
3. "Miscellaneous Metals," per lump sum.

–5.01 STRUCTURAL STEEL

Structural carbon steel and high-strength low-alloy steel will be paid for at the lump sum contract prices for "Structural Carbon Steel," and "High-strength Low-alloy Structural Steel," respectively. The lump sum prices for each shall be full compensation for all costs in furnishing materials, labor, tools and equipment necessary for the manufacture, fabrication, transportation, erection and painting of the steel as specified for the completed structure.

For steel structures, the estimated weight of the structural carbon steel and high-strength low-alloy structural steel in the project will be shown on the plans or in the special provisions. In the event any change in plans is made which will effect the weight of material to be furnished, payment for the additional structural carbon steel or high-strength low-alloy structural steel required as a result of the change in plans will be made at a unit price per pound obtained by dividing the Contractor's lump sum bid for the steel by the total estimated weight therefor as shown on the plans, or in the special provisions. The weight will be established by the Engineer upon the basis of 490 pounds per cubic foot of steel.

Reductions in weight due to a change in plans will be made at the same rate as described above and reduced payment will be made in accordance therewith.

The prospective bidder shall verify the estimated weight of structural carbon steel and high-strength low-alloy structural steel before submitting a bid. No adjustment other than for approved changes will be made in the lump sum bid even though the actual weight may deviate from the stated estimated weight.

Where used in conjunction with structural steel, such minor items as bearing plates, pedestals, forced steel pins, anchor bolts, field rivets, shims, ladders, stairways, sleeves, pipe, fittings and fastenings that are used in handrails on structures, et cetera, unless otherwise provided, shall be considered as structural carbon steel for the purpose of payment even though made of other material.

Any change in plans which affects the weights of materials to be furnished as provided herein will be subject to the provisions of Section 4.03.

–5.02 MISCELLANEOUS METALS

For concrete and timber structures, where structural steel is a minor item, such details as bearing plates, guard angles, expansion dams, etc., for which no provisions are made elsewhere herein, or in the special provisions, will be paid for as "Miscellaneous Metals," even though they be made out of other materials.

Miscellaneous metals will be paid for at the lump sum price bid for "Miscellaneous Metals," which price shall be full compensation for all costs in connection with furnishing all materials, labor, tools and equipment necessary for the manufacture, fabrication, transportation, erection and painting as required, including the providing and placing of such other protective coatings as may be shown on the plans or specified in the special provisions.

No estimated weight will be given for miscellaneous metals. In event any change in plans is necessary which will affect the weight of the material to be furnished, the payment for the revised quantity will be made at a unit price per pound obtained by dividing the Contractor's lump sum bid for the miscellaneous metal by the calculated weight of the original material. The calculated weight will be established by the Engineer and be based on an estimated weight of 490 pounds per cubic foot for steel.

Section 113—Castings, Steel Forgings and Miscellaneous Metals

113–1 DESCRIPTION

These specifications shall cover all castings, steel forgings and miscellaneous metals required in the completed structure as shown on the plans.

113–2 MATERIALS

–2.01 STEEL CASTINGS

Steel castings shall conform to the requirements of ASTM Designation A 27, Mild to Medium Strength Carbon-Steel Castings for General Application, Grade 65-30, unless otherwise designated on the plans or in the special provisions.

–2.02 GRAY-IRON CASTINGS

Gray-iron castings shall conform to the requirements of the standard specifications of ASTM Designation A 48 for Gray-iron Castings. The class of castings to be furnished shall be that designated on the plans or in the special provisions.

–2.03 MALLEABLE IRON CASTINGS

Malleable iron castings shall conform to the requirements of the standard specifications ASTM Designation A 47 for Malleable Iron Castings.

–2.04 STEEL FORGINGS AND STEEL SHAFTING

Steel forgings shall conform to the requirements of the standard specifications for Carbon-Steel Forgings for General Industrial Use, ASTM Designation A 235. The classes of forgings to be furnished shall be those shown on the plans or called for in the special provisions.

Steel shafting shall conform to the specifications of ASTM Designation A 108-52 T, Grade Designation 1016-1030 inclusive for Cold-Finished Carbon Steel Bars and Shafting, unless otherwise specified.

–2.05 BRONZE CASTINGS

Bronze castings shall conform to the requirements of ASTM Designation B 22 Alloy B, Bronze Castings for Bridges and Turntables.

–2.06 COPPER SEALS

Copper sheets for seals shall conform to the requirements of ASTM Designation B 152, Copper Sheet, Strip, Plate and Rolled Bar. They shall be Type FRTP, light cold rolled, and furnished in flat sheets each not less than 0.018 inch in thickness.

All splices or joints shall be carefully brazed or soldered to produce a continuous watertight seal for the full length of each unit.

–2.07 NODULAR IRON CASTINGS

Nodular iron castings shall conform to the requirements of ASTM Designation A 339, Grade 60-45-10, unless otherwise designated on the plans or in the special provisions.

113–3 CONSTRUCTION DETAILS

–3.01 GENERAL

The provisions outlined in Section 112 for structural steel and which are applicable, including painting, shall apply to castings, steel forgings and miscellaneous metals.

Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength, appearance and value for the service intended.

Castings shall be cleaned of scale and sand to present a smooth, clean and uniform appearance.

Castings shall be boldly filleted at angles and the arrises shall be sharp and perfect. The surfaces shall have a workmanlike finish.

Iron and steel castings and forgings shall be annealed prior to any machine work unless otherwise specified.

Surfaces of cast pedestals and shoes which will come in contact with metal surfaces shall be planed, and those which will bear on concrete shall be rough finished.

In planing the surfaces of expansion bearings, the cut of the tool shall be in the direction of expansion.

113–5 MEASUREMENT AND PAYMENT

Payment will be made at the lump sum price, or by the unit price per pound for the cast or forged metal (kind) or copper seals, as shown on the plans or in the proposal.

In case no bid item is included in the proposal and payment is not otherwise provided, the castings, forgings, and miscellaneous metal shall be considered as incidental to the construction and all costs therefor shall be included in the unit contract prices for other payment items involved and shown in the proposal.

Section 114—Timber and Lumber

114–1 DESCRIPTION

All timber and lumber in permanent structures except guard rail posts and guide posts, or as otherwise specified, shall be Douglas fir or larch. Guard rail posts and guide posts shall be Douglas fir, Western red cedar, West Coast hemlock, or larch, as specified on the plans.

114–2 MATERIALS

–2.01 GRADE REQUIREMENTS

Unless otherwise noted on the plans or in the special provisions, all timber and lumber shall be graded as shown on the following table:

Structural Purpose	Tabular Working Stresses: Extreme fibre in bending or tension parallel to grain, psi	Horizontal shear, max., psi	Compression perpendicular to grain, psi	Compression parallel to grain, psi	Modulus of elasticity in bending, psi	*West Coast Lumber Inspection Bureau	*Western Pine Association
Timber and Lumber in Permanent Structures							
Douglas Fir (except 4" laminated decking)	1500	120	390	1000	1,600,000	"Construction Stress Grade" Beams and Stringers	"Construction Stress Grade" Beams and Stringers
Douglas Fir, 4" laminated decking	1900	120	415	1400	1,760,000	"Select Structural" Light Framing Stress Grade	"Select Structural" Light Framing Stress Grade
Guard Rail Posts							
Douglas Fir ..	1200	120	390	1200	1,600,000	"Construction Stress Grade" Posts and Timbers	"Construction Stress Grade" Posts and Timbers
West Coast Hemlock	1200	100	365	1100	1,400,000	"Construction Stress Grade" Posts and Timbers	"Construction Stress Grade" Posts and Timbers
Larch	1200	120	390	1200	1,600,000		"Construction Stress Grade" Posts and Timbers
Guide Post							
Douglas Fir ..	1500	120	390	1200	1,700,000	"1500f Industrial" Light Framing	"1500f Industrial Light Framing
West Coast Hemlock	1500	100	365	1000	1,540,000	"1500f Industrial" Light Framing	"1500f Industrial Light Framing
Larch	1500	120	390	1200	1,700,000		"1500f Industrial Light Framing
Western Red Cedar	1300	120	145	900	1,000,000	"Select Merchantable" Joists and Planks	"Select Merchantable" Joists and Planks
Other Timber and Lumber							
All Species ...	1200	120	390	1200	1,600,000		

†Hit or miss pieces with a minus tolerance of one-sixteenth (1/16) inch will be allowed on laminated decking.

*The indicated timber and lumber grades specified in the 1961 Standard Grading and Dressing Rules of the respective associations meet the Tabulated Working Stress Requirements for the various specified stress grades. In the event the grading and dressing rules of either Association are revised, equivalent grades meeting the tabulated working stress requirements will be required on the contract unless otherwise stated in the special provisions.

114–3 CONSTRUCTION DETAILS

–3.01 SURFACING AND SEASONING

All lumber shall be sized as indicated on the plans, except that lumber which is to be painted shall in all cases be surfaced on four sides.

Lumber to be painted shall be thoroughly air dried or kiln dried to an equivalent moisture content, and shall be stored in such a manner as to remain in a thoroughly dry condition until placed in the work.

–3.02 PROTECTION AGAINST END CHECKING

Immediately upon acceptance by the inspector at the mills, all ends of sticks 3 x 3 inches and larger (except decking), which are to be used without preservative pressure treatment, shall be treated with a gloss oil or other effective protective end coating.

–3.03 INSPECTION

All timber and lumber purchased or used under these specifications shall meet the tabulated working stress requirements specified in Section 114-2.01. Lumber graded under the applicable paragraph numbers of the current grading and dressing rules of the West Coast Lumber Inspection Bureau or the Western Pine Association, as defined in Section 114-2.01, will be accepted provided the lumber is certified by a certificate of inspection executed by one of the above named associations, or by the Pacific Lumber Inspection Bureau.

Certificates of inspection shall identify the destination or job for which the material is intended and, if specified, each piece inspected and certified shall be marked to indicate such inspection. Such certification or grade marking, however, shall not constitute an acceptance of the material, and the Engineer may reject any and all lumber or timber that does not comply with the specifications. In event of a rejection of any timber or lumber by the Engineer, and if the Contractor shall dissent therefrom, the Contractor may request reinspection of the rejected material by whichever of the inspection agencies as may be satisfactory to the Engineer. The reinspection, when made, shall be in the presence of the Engineer or his inspector and shall otherwise be conducted under the reinspection provisions in the rules of the inspection agency for the materials specified in the contract.

Beams, stringers and posts that are specified to be free of heart center shall be stamped "FOHC" on each piece in close proximity to other grade marks.

–3.04 HEWN AND ROUND TIMBER

Hewn and round timbers may be substituted for sawed timber, subject to the approval of the Engineer, and shall be of the same cross section and conform to the grading rules for structural timber.

114–4 MEASUREMENT

For the purpose of measurement of timber and lumber, the nominal thickness and width shall be used; also the actual lengths of the individual pieces in the finished structure shall be used without deduction for daps, cuts or splices. In the measurement of laminated timber decking, the number of pieces shall be the required number of the size specified, after dressing, and the length of each lamination shall be the length remaining in the finished structure.

114–5 PAYMENT

Payment will be made at the unit contract price per thousand feet board measure (M.B.M.) for "Timber and Lumber (untreated or name treatment)," which price shall be full compensation for all materials, including hardware, and for all labor, tools and equipment necessary for the manufacture, fabrication, preservative treatment, seasoning, transportation, erection and painting of the timber and lumber used in the completed structure.

Section 115—Preservative Treatment for Timber, Lumber and Piles

115–1 DESCRIPTION

Preservative treatment of the type specified shall be applied to timber, lumber or piles as shown on the plans, or as required by the special provisions.

115–2 MATERIALS

–2.01 CREOSOTE OIL

Creosote for both pressure treatment and surface treatment shall meet the requirements of the standard specifications for Creosote, ASTM Designation D 390.

–2.02 CHROMATED ZINC ARSENATE (Boliden Salts)

Chromated Zinc arsenate shall have the following composition:

Arsenic acid (H_3AsO_4)	29%
Sodium arsenate (Na_2HAsO_4)	21%
Sodium dichromate ($Na_2Cr_2O_7.2H_2O$)	16%
Zinc sulfate ($ZnSO_4.7H_2O$)	43%

subject to the following tolerances:

The composition of the solid preservative, or of the preservative present in a treating solution, may vary within the following limits:

Pentavalent arsenic calculated as total H_3AsO_4 plus Na_2HAsO_4 in a ratio of 20 to 21	37% Min.
Hexavalent chromium calculated as $Na_2Cr_2O_7.2H_2O$	14% Min.
Zinc calculated as $ZnSO_4.7H_2O$	41% Min.

The ratio of arsenic acid to sodium arsenate shall be deemed to fall within the prescribed limits if the percentage of arsenic, as As_2O_5, in the solid preservative or in the salts in solution lies between 26.4 and 31.1 and the pH of a solution containing 25 grams of the preservative per liter of solution at 25° C. lies between 2.90 and 3.50.

The solid preservative shall contain at least 95 percent of the active ingredients listed above.

–2.03 TANALITH (Wolman Salts)

Tanalith shall have the following composition:

Sodium fluoride (NaF)	22% to 25 %
Sodium arsenate (Na_2HAsO_4)	22% to 25 %
Sodium chromate (Na_2CrO_4)	34% to 37.5%
Dinitrophenol $(NO_2)_2.C_6H_3.OH$	5% to 12.5%

The solid preservative shall contain at least 95 percent of the active ingredients listed above.

The pH of a treating solution shall be not less than 7.2 nor more than 7.8.

–2.04 AMMONIACAL COPPER ARSENITE (Chemonite)

Ammoniacal copper arsenite shall have the following composition:

Copper hydroxide ($Cu(OH)_2$)	55.7% to 57.7%
Arsenic trioxide (As_2O_3)	38.7% to 40.7%
Acetic acid (CH_3COOH)	1.6%

The above shall be dissolved in a solution of ammonia (NH_3) in water. The weight of ammonia contained in a treating solution shall be from 1.5 to 2.0 times the weight of the copper hydroxide.

The solid preservative shall contain at least 95 percent of the active ingredients listed above.

The net retention of the preservative shall be calculated as pounds of Cu O plus As_2O_5 deposited in the wood in the proportion of 1.5 parts of the former to 1.3 parts of the latter. An excess of either ingredient above this proportion shall not be counted in the net retention.

–2.05 PENTACHLOROPHENOL

Pentachlorophenol shall conform to the requirements of AASHO Designation M 133. Solvents used in pentachlorophenol solutions shall be petroleum oils complying with the following requirements:

	(*) HEAVY PETROLEUM SOLVENT		LIGHT PETROLEUM SOLVENT	
	Max.	Min.	Max.	Min.
Specific Gravity at 60° F/60° F.		0.85 (API 35 Max.)	0.924 (API 20 Min.)	0.825 (API 40 Max.)
Water and Sediment, percent	0.5		0.5	
Flash Point, Pensky-Martens closed tester, ° F.		190		145
Distillation: Total distillate in percent by volume to 500° F.	50		60	
625° F.				90
(**) Viscosity, Saybolt Universal at 210° F., seconds	60			10
Solvency for pentachlorophenol, 75° F., percent by weight		10		10
Wood staining characteristics	Brown to Black		Light Brown to none	

(*) Unless otherwise called for in the special provisions, heavy petroleum solvent shall be used.
(**) Petroleum of higher viscosity may be used provided that penetration requirements are met.

The preservative solution used in the treatment shall consist of not less than four and one-half (4½) percent, nor more than five and one-half (5½) percent by weight of pentachlorophenol dissolved in the proper petroleum solvent.

115–3 DETAILS OF PRESERVATIVE TREATMENT

–3.01 GENERAL REQUIREMENTS

–3.01A Seasoning Before Treatment

Timber, lumber or piling may be air seasoned or kiln dried before treatment until the moisture remaining in the wood will not prevent the injection and proper distribution of the specified amount of preservative. For air seasoning, the materials shall be stored in the following manner: Lumber shall be segregated by at least one (1) inch strips with an air space of one (1) inch or more between pieces of lumber in any layer; for caps, stringers, posts or larger timbers, at least two (2) inch strips shall be used to separate the layers. Alleys at least three (3) feet wide shall be left between rows of stacks, and the material shall be at least twelve (12) inches off the ground on concrete or treated timber sills. Piles shall be stored in like manner, placing as nearly as practicable only one (1) length in a stack, using at least two (2) inch strips or saplings of equal size between each layer and reversing butt ends of all piling in every other layer in order to keep the stacks level. The space under and between the rows of stacks shall be kept free at all times of rotten wood, weeds and rubbish. The yard shall be drained so no water will stand under the stacks or in the proximity of the storage.

–3.01B Placing in Treating Cylinders

Each cylinder charge shall consist of pieces approximately equal in size and moisture and sapwood content, into which approximately equal quantities of preservative fluid can be injected. Pieces shall be so separated as to ensure contact of steam and preservatives with all surfaces.

Timber and lumber shall be framed, bored, incised, or chamfered before treatment, whenever possible.

–3.01C Incising

In order to secure a more uniform penetration, sawed timber and lumber measuring three (3) inches or more in thickness by four (4) inches or more in width shall be incised by a machine having power driven rolls designed to incise to a uniform depth and continuity of predetermined pattern. Timber four (4) inches and more shall be incised on all four sides. Timber less than four (4) inches shall be incised on the wide faces only.

The shape of the teeth shall conform to a type so designed that the points are sharp and the edges wedge-shaped so that, upon entering and leaving the wood, a spreading of the fibers is accomplished.

–3.01D Plant Equipment

Treating plants shall be equipped with thermometers and gauges necessary to indicate and record accurately the conditions at all stages of treatment, and all equipment shall be maintained in condition satisfactory to the Owner (city). The apparatus and chemicals necessary for making the analyses and tests required by the Owner (city) shall be provided by the operators and shall be kept in condition for use at all times.

–3.02 PRESSURE PROCESSES

-3.02A Creosote Treatments:

–3.02A1 Oil Seasoning for Douglas Fir

Green Douglas fir timber or piling shall be seasoned by boiling in oil under a vacuum until the moisture remaining in the wood will not prevent the injection and proper distribution of the specified amount of preservative.

The material shall be boiled in creosote under a vacuum at temperatures not less than 180° F., and not more than 200° F. for lumber nor 220° F. for piling.

A minimum vacuum of twenty (20) inches shall be maintained during boiling. The seasoning period shall be maintained until condensation passing off from the timber is at the rate of approximately one-tenth (1/10) of a pound per cubic foot of timber per hour.

–3.02A2 Penetration

The range of temperature, pressure and time duration shall be controlled so as to result in a maximum penetration by the quantity of preservative injected. The vacuum requirements stipulated are in inches of mercury at sea level and necessary corrections shall be made for altitude.

In Douglas fir the penetration in inches and the percent of sapwood to be impregnated in a full cell process for the specified amount of creosote oil shall be as follows for piling and timber 12" x 12" and larger:

Specified retention of creosote per cu. ft.	10 lb.	12 lb.	14 lb.	16 lb.
Penetration in inches, minimum	¾	¾	⅞	1
Percent of sapwood to be impregnated, minimum	85, or 1⅝ inch maximum penetration	100	100	100

For timber less than 12" x 12" the required depth of penetration shall be determined by the following formula, but in no case shall the depth of penetration be less than ⅜":

$$P = Ps\ R/Rs$$

Where
P = required penetration
Ps = specified penetration for 12" x 12" timbers
R = ratio of the volume of the piece in question to its superficial area
Rs = ratio of the volume of 12" x 12" timber to its superficial area

The penetration of the preservative shall be based on black or dark oil and in no case will light discoloration of the wood due to treatment be taken into consideration in measuring the depth of penetration.

Tests for penetration shall be made by taking borings with an increment borer, or a five-eighths (⅝) inch augur. All bored holes shall be plugged by the Contractor with tight fitting creosoted plugs.

As many penetration tests of lumber and piling shall be made as may be considered necessary by the inspector. In case of piling, the holes shall be bored midway between the ends. In case of timber and lumber, every fourth stick of the charge may be bored.

–3.02A3 Amount of Preservative

The amount of preservative to be used shall be as shown on the plans or as specified, and this amount shall be retained in the timber unless the oil has been injected to refusal. Unless otherwise specified, the amount of preservative retained shall be as follows:

For piles and timber in general bridge construction: Full-cell process, not less than ten (10) pounds of oil per cubic foot of timber, or empty-cell process, not less than ten (10) pounds of oil per cubic foot of timber.

For piles or timber in salt water subject to the attack of marine borers: Full-cell process, not less than fourteen (14) pounds per cubic foot of timber.

–3.02A4 Heating With Oil

Air seasoned or kiln dried Douglas fir shall be heated in oil prior to the pressure treatment. The preservative shall be introduced to the timber at a temperature of 160° F. to 180° F., and the temperature shall be gradually raised to 200° F. and held at that temperature for a period of from three (3) to five (5) hours, or sufficient time to obtain an even temperature throughout the material.

–3.02A5 Full-Cell Process

Following the heating period in the case of air seasoned or kiln dried material, and the seasoning under vacuum period in the case of material that is oil seasoned, the cylinder shall be filled with creosote and the pressure shall be applied as required to a maximum limit of one hundred seventy-five (175) pounds per square inch and maintained—taking into consideration the quantity of creosote absorbed during the heating with oil—until the specified absorption of creosote has been obtained.

Temperature of the creosote during the pressure period shall be as high as possible, with a minimum limit of 160° F. and a maximum limit of 200° F. After pressure is completed, the cylinder shall be emptied of creosote and a vacuum of at least twenty (20) inches be promptly created and maintained for a sufficient period of time to free the material from dripping creosote.

–3.02A6 Empty-Cell Process

Following the heating period, in the case of air seasoned or kiln dried material, and the seasoning under vacuum period in the case of material that is oil seasoned, the material shall be subjected to an air pressure of sufficient intensity and duration that, in the judgment of the operator, is sufficient to accomplish the final retention of creosote specified. The preservative shall then be introduced, the air pressure being maintained constant, until the cylinder is completely filled.

Creosote shall then be pressed from the measuring tanks into the wood in a quantity sufficient, in the opinion of the operator, to provide the required retention at the completion of the process herein described. Maximum pressure shall in no case exceed two hundred (200) pounds per square inch. The temperature of the creosote during the pressure period shall be as high as possible, within a minimum limit of 160° F. and a maximum of 200° F.

After pressure is completed, the cylinder shall be quickly emptied of creosote and a vacuum of at least (20) inches created and maintained for such period of time as may be required to remove dripping creosote from the material.

–3.02B Chromated Zinc Arsenate (Boliden Salts) Treatment

The following pressure process shall be used for the treatment of timber and lumber with chromated zinc arsenate:

The treating solution shall be of uniform concentration and of the minimum strength necessary to obtain the required retention of preservative with the largest volumetric absorption possible.

Before treatment all timber and lumber shall be air seasoned or kiln dried until the moisture content is below twenty (20) percent. Timber containing more than twenty (20) percent moisture shall be classed as green timber and shall be given an artificial seasoning in an airtight retort by a bath of live steam at from ten (10) to fifteen (15) pounds per square inch pressure for a period of four (4) to ten (10) hours, followed by a vacuum of at least twenty-two (22) inches for one (1) hour, or with alternating periods of vacuum and pressure as may be necessary to put the timber into condition for treatment. The cylinder shall be relieved continuously or frequently enough to prevent condensate from accumulating in sufficient quantity to reach the wood.

After the seasoning process has been completed, the material shall be subjected to a vacuum of not less than twenty-two (22) inches for at least thirty (30) minutes, either before the cylinder is filled or during the period of heating in the preservative. If not already full, the cylinder shall then be filled without breaking the vacuum. The pressure shall then be raised to not more than 150 pounds per square inch. The temperature of the preservative shall not exceed 100° F. at any time during the process. The material shall be held under pressure until there is obtained the volumetric injection that will ensure the specified retention, or until the wood is treated to refusal.

After the pressure period is completed, the cylinder shall be emptied speedily of preservative and a vacuum of not less than twenty-two (22) inches be created promptly and maintained until the wood can be removed from the cylinder free of dripping preservative.

Unless otherwise stated on the plans or in the special provisions, the minimum net retention of chromated zinc arsenate shall be as follows:

Timber and lumber for use under moderate leaching conditions	1.00 lb. per cu. ft.
Timber and lumber for use not in contact with the ground nor in water	0.50 lb. per cu. ft.
Posts	1.00 lb. per cu. ft.

The minimum penetration of preservative shall be three-eighths (⅜) inch or 90 percent of sapwood for timber under five (5) inches thick, or one-half (½) inch or 90 percent of sapwood for timber over five (5) inches thick.

All timber and lumber, after treating with chromated zinc arsenate, shall be seasoned by kiln drying or air drying under cover before placing in the structure.

Penetration shall be determined by sampling each charge as may be desired. Any holes which may be bored shall be filled with tight-fitting treated plugs.

All timber and lumber, after treatment with chromated zinc arsenate, shall be seasoned by kiln drying or air drying under cover before being erected in the structure. After seasoning, the average moisture content of material six (6) inches or more in thickness shall not exceed eighteen (18) percent for the outside one and one-half (1½) inch zone and the average moisture content of material less than six (6) inches in thickness shall not exceed eighteen (18) percent for the outside one (1) inch zone.

The moisture content shall be determined by the "oven-drying" method from samples collected by increment cores or borings to the depth of the zone prescribed above for the two (2) size classes of material. Samples shall be taken from the centers of the wide faces midway between the ends of the pieces, and sufficient pieces shall be sampled to provide a truly representative test. A minimum of twelve (12) cores shall be taken for each size class in each kiln drying charge, or in each lot of air seasoned lumber.

All cores shall be combined into one composite sample if the material is all of one size class, or into two samples if both size classes are represented. The moisture content as determined from these samples shall be considered to be the moisture content of the lot of materials tested. Material having a moisture content in excess of eighteen (18) percent shall be subjected to further seasoning before it is used. All timber and lumber seasoned under this specification shall be subject to the grading rules pertaining to checks, after undergoing the seasoning process.

All holes bored for sampling timber and lumber to determine the moisture content after seasoning shall be filled with tight-fitting treated and seasoned plugs.

–3.02C Tanalith (Wolman Salts) Treatment

The following pressure process shall be used for the treatment of timber and lumber with Wolman Salts:

The treating solution shall generally have a strength of concentration in water of 1.8 percent to 2 percent of Wolman Salts in 98.2 percent to 98 percent of water; the solution shall be no stronger than necessary to obtain the required retention of preservative specified below, with the greatest volumetric absorption practicable.

All timber and lumber treated with this process shall be seasoned before treatment as described in Section 115-3.02B.

The treatment process and drying after treatment shall be as specified in Section 115-3.02B except that the temperature of the preservative during the treating process shall not exceed 140° F.

Unless otherwise stated on the plans or in the special provisions, the minimum net retention of tanalith shall be as follows:

Timber and lumber for use under moderate leaching conditions	0.55 lb. per cu. ft.
Timber and lumber for use not in contact with ground nor in water	0.35 lb. per cu. ft.
Posts	0.55 lb. per cu. ft.

The minimum penetration shall be as specified in Section 115-3.02B.

Penetration shall be determined by sampling each charge, as may be desired. Bored holes shall be filled with tight-fitting treated plugs.

–3.02D Ammoniacal Copper Arsenite (Chemonite) Treatment

The pressure process which follows shall be used for treatment of timber and lumber with ammoniacal copper arsenite.

The treating solution shall be of uniform concentration and of the minimum strength necessary to obtain the required retention of preservative with the greatest volumetric absorption possible.

Seasoning of timber, treatment and drying after treatment shall be as specified in Section 115-3.02B, except that the temperature of the preservative shall not exceed 150° F. at any time during the treating process.

Unless otherwise stated on the plans or in the special provisions the minimum net retention of ammoniacal copper arsenite shall be as follows:

Timber and lumber for use under moderate leaching conditions	0.45 lb. per cu. ft.
Timber and lumber for use not in contact with ground nor in water	0.30 lb. per cu. ft.
Posts	0.45 lb. per cu. ft.

The minimum penetration of preservative shall be as specified in Section 115-3.02B.

Penetration shall be determined by sampling each charge as may be desired. Bored holes shall be filled with tight-fitting treated plugs.

–3.02E Pentachlorophenol Treatment

Pentachlorophenol pressure treatment process shall be in accordance with the current standards of the American Wood Preserver's Association for Pressure Preserved Wood for Highway Construction. The minimum net retention of the dry salt shall be 0.50 pound per cu. ft. of wood, except as noted elsewhere in the specifications. Treatment shall be by the empty-cell process.

115–4 MEASUREMENT

Preservative treatment of timber, lumber and piles shall not be considered as a separate contract item and no method of measurement is provided apart from the material to which the treatment is applied.

115–5 PAYMENT

Payment for the preservative treatment of timber, lumber and piles shall be included in the unit contract price per thousand feet board measure (M.B.M.) for "Timber and Lumber (treatment)" and per linear foot for "Furnishing Timber Piling (treatment)."

Whenever any untreated material is required by the specifications or special provisions to receive brush treatment of a kind therein described, the cost of such treatment shall be included by the Contractor in his unit contract price per thousand feet board measure (M.B.M.) for "Timber and Lumber (untreated)."

Section 116—Paints and Painting

116–1 DESCRIPTION

Steel and timber structures, or particular parts thereof, and such concrete surfaces as may be specified, shall be coated with an appropriate paint as hereinafter set forth, or as described under the particular section dealing with the surfaces to be painted.

116–2 MATERIALS

–2.01 RAW MATERIALS

Raw materials for paints shall conform to the requirements of the specifications listed below. The acceptance of particular lots of raw materials by the Engineer shall in no way obligate him to accept lots of finished paint that do not conform to the requirements of these specifications. When not specifically detailed herein, the raw materials shall meet the requirements of the applicable Federal specification.

Red lead pigment and paste, ASTM Designation D 83, ninety-seven (97) percent grade.

Basic carbonate white lead pigment and paste, ASTM Designation D 81.

Titanium pigments, ASTM Designation D 476. Titanium dioxide for use in exterior white paints shall conform to the requirements of ASTM Designation D 476, Type 1. Titanium pigments used in tinted paints and enamels shall be of the exterior chalk resistant type.

Chrome oxide green, ASTM Designation D 263. The tinting properties shall be such that the standard color of the formulas using chrome oxide green can be produced without departing from the limits of composition given in those formulas.

Iron-Blue pigment and paste, ASTM Designation D 261.

Lampblack pigment and paste, ASTM Designation D 209.

Ochre pigment and paste, ASTM Designation D 85.

Aluminum paste, ASTM Designation D 962, Type II, Class B. Paints made with the paste shall be smooth and highly lustrous.

Chrome yellow pigment and paste, ASTM Designation D 211.

Zinc oxide pigment and paste, ASTM Designation D 79.

Flaked metallic lead paste shall consist of pig lead in the form of fine flakes combined with mineral spirits (ASTM Designation D 235) and a fatty acid to form a paste siutable for use as an ingredient in paint. It shall contain no fillers or adulterants. The paste shall conform to the following requirements:

Nonvolatile matter at 105° C to 110° C, percent	90 to 92
Easily extracted fatty and oily matter, percent	2 maximum
Total impurities other than fatty and oil matter, percent	1 maximum
Coarse particles:	
Retained on a No. 100 sieve, percent	2 maximum
Retained on a No. 200 sieve, percent	11 maximum
Retained on a No. 325 sieve, percent	20 maximum

The paste, when added to paint of the following formula in the proportion of three (3) pounds of paste to one (1) gallon of paint, shall cause a marked reduction in the gloss of the dried paint, a substantial improvement in spreading properties, and shall eliminate "crawling" of a succeeding coat of Formula B-1-57 paint applied twenty-four hours later.

Dry red lead	100 pounds
Raw linseed oil	3 gallons
Liquid drier	1.5 pints
Aromatic petroleum thinner—water white low aniline petroleum solvent Kauri-Butanol value	70 (Min.)

Raw linseed oil, ASTM Designation D 234.

Boiled linseed oil, ASTM Designation D 260.

Heat bodied linseed oil, Federal TT-L-201, Type II, Z to Z6 viscosity, shall be prepared by heat treating pure linseed oil. The treated oil shall be soluble in all proportions in turpentine and mineral spirits.

Turpentine shall be gum spirits of turpentine, ASTM Designation D 13.

Mineral spirits, ASTM Designation D 235.

Liquid drier, Federal TT-D-651c.

Spar varnish shall meet the requirements of Federal TT-V-119 except that the test liquid for hydrocarbon resistance shall be white gasoline, and in addition thereto a dried film of the varnish after immersion for twenty-four (24) hours in a two (2) percent solution of sodium hydroxide shall show no blistering, whitening or loss of film when subjected to the following test:

Immerse a clean glass test tube, one-half inch by six inches (½" x 6") into the varnish so as to coat the closed end to a depth of three (3) inches. Remove from the varnish and allow to dry, mouth downward, for forty-eight (48) hours. Immerse the tube in sodium hydroxide solution and examine at the end of twenty-four (24) hours. This varnish shall be used as a mixing varnish for aluminum paint and in the manufacture of concrete primer.

Zinc yellow (zinc chromate), ASTM Designation D 478.

Red iron oxide, ASTM Designation D 84, Class I, except that the minimum total iron oxide, calculated as Fe_2O_3, shall be 85.0%.

Yellow iron oxide, hydrated, ASTM Designation D 768.

Fibrous magnesium silicate (asbestine), ASTM Designation D 605.

Silica shall be finely ground amorphous or crystalline material. It shall have a maximum oil absorption of 50 when tested in accordance with ASTM Designation D 281.

Alkyd vehicle, Federal TT-R-266a, Type II, Class A.

Anti-skinning agent shall have no deleterious effect on the drying time of the finished paint. It shall effectively prevent skinning when added in the amounts specified in each formula and tested in accordance with Federal TT-P-141b, Method 414.1.

Aluminum stearate, Military MIL-A-15206A.

Naphthenate driers, Federal TT-D-643b.

Soya lecithin shall be pure Soya lecithin.

–2.02 PAINT FORMULAS

–2.02A General

All paints shall be made from materials meeting the requirements specified in Section 116-2.01. The paint shall be made in accordance with the formulas that follow, and shall meet the requirements set forth above as well as the special requirements set forth for each formula. The formulas are stated in terms of dry pigment. Each formula shall contain the specified raw materials which shall be proportioned to give the compositions in percentages by weight or parts by weight, as shown in the subsections that follow.

–2.02B Formula No. A-1-57—Red Lead Shop Coat for Steel

Metallic lead paste shall be supplied by the paint manufacturer as a part of this formula, to be added to the paint at the time of use at the rate of three (3) pounds of paste added to one (1) gallon of paint. A unit shall consist of a one gallon container of paint and a separate container of three (3) pounds of paste or a 5-gallon container of paint and a separate container of 15 pounds of paste.

Red lead (dry pigment)	80.2%
Raw linseed oil	18.9%
Liquid drier	0.9%
Total	100.0%
Weight per gallon (minimum)	26.7 pounds
Drying time (for test purposes)	24 hours
Grind (minimum)	3.0
Viscosity at 70° F.	85 ± 3 K.U.

Test Requirements: Prior to manufacture.

Viscosity Adjustment: Volatile thinner (turpentine or mineral spirits) will be added at the factory to obtain the specified viscosity.

–2.02C Formula No. A-2-57—Shop Coat for Steel (Alkyd-Linseed Vehicle)

Zinc chromate (dry pigment)	36.5 parts
Red iron oxide (dry pigment)	9.8 parts
Magnesium silicate (dry pigment)	4.8 parts
Silica (dry pigment)	4.2 parts
Alkyd vehicle	20.8 parts
Raw linseed oil	14.8 parts
24% Lead naphthenate drier	0.6 parts
6% Cobalt naphthenate drier	0.3 parts
Soya lecithin	0.2 parts
Aromatic petroleum thinner	5.8 parts
Mineral spirits (approximately)	2.7 parts
Weight per gallon (minimum)	12.70 pounds
Grind (minimum)	3.0
Drying time (for test purposes)	18.0 hours
Viscosity at 70° F.	80 ± 3 K.U.
Hiding power (maximum scale reading)	17
Nonvolatile content (minimum)	85.0%

Test Requirements: Prior to manufacture.

Viscosity Adjustment: Mineral spirits to be adjusted at the time of manufacture to achieve the specified viscosity.

–2.02D Formula No. A-3-57—Red Lead Sealing Paste

Red lead (dry pigment)	84.0%
Metallic lead paste	8.0%
Raw linseed oil	7.9%
Liquid drier	0.1%
Weight per gallon (minimum)	41.0 pounds
Drying time—surface dry for recoating	24 hours

This material shall be ground to a smooth, uniform paste of putty-like consistency. Additional linseed oil may be added at the time of use to reduce the paste to workable consistency for spatula or brush. This material hardens in storage and should be used within 15 days of the date of manufacturing.

–2.02E Formula A-4-59—Phenolic-Red Lead Primer

This primer shall meet the requirements of Federal Specification TT-P-86b, Type IV Paint: Red-Lead Base, Ready Mixed. The viscosity of the finished paint shall be 83 ± 3 K.U. at 70° F.

–2.02F Formula A-5-61—Vinyl Pretreatment

The primer shall meet the requirements of Federal Specification MIL-P-15328B Primer Pretreatment (Formula 117 for Metals).

–2.02G Formula A-6-61—Zinc Dust-Zinc Oxide Primer

The primer shall meet the requirements of Federal Specification TT-P-641b Primer-Paint: Zinc Dust-Zinc Oxide, Type II or Type III, except that the viscosity shall be 85 ± 5 K.U. at 70° F.

–2.02H Formula B-1-57—First Field Coat for Steel (Red Lead)

Metallic lead paste will be supplied by the manufacturer as a part of this formula to be added to the paint at the time of use at the rate of three (3) pounds of paste added to one (1) gallon of paint. A unit shall consist of a one-gallon container of paint and a separate container of 3 pounds of paste, or a 5-gallon container of paint and a separate container of 15 pounds of paste.

Red lead (dry pigment)	76.8%
Lampblack (dry pigment)	0.7%
Raw linseed oil	21.5%
Liquid drier	1.0%
Total	100.0%
Weight per gallon (minimum)	24.5 pounds
Viscosity at 70° F.	85± 3 K.U.
Drying time (for test purposes)	24 hours
Grind (minimum)	3.0

Test Requirements: Prior to manufacture.

Viscosity Adjustment: Volatile thinner (turpentine or mineral spirits) may be added at the factory to attain the desired viscosity.

–2.02I Formula B-2-57—First Field Coat for Steel (Alkyd Linseed Vehicle)

Zinc chromate (dry pigment)	36.5 parts
Yellow iron oxide (dry pigment)	9.8 parts
Magnesium silicate (dry pigment)	4.8 parts
Silica (dry pigment)	4.2 parts
Alkyd vehicle	20.8 parts
Raw linseed oil	14.8 parts
24% Lead naphthenate drier	0.6 parts
6% Cobalt naphthenate drier	0.3 parts
Soya lecithin	0.2 parts
Aromatic petroleum thinner	5.8 parts
Mineral spirits (approximate)	2.7 parts
Weight per gallon (minimum)	12.70 pounds
Grind (minimum)	3.0
Drying time (for test purposes)	18 hours
Viscosity at 70° F.	80 ± 3 K.U.
Hiding power (maximum scale reading)	17
Nonvolatile content (minimum)	85.0%

Test Requirements: Prior to manufacture.

Viscosity Adjustment: Mineral spirits to be adjusted at the time of manufacture to achieve the required viscosity.

–2.02J Formula B-4-59—Phenolic First Field Coat for Steel

The phenolic first field coat for steel shall meet the requirements of Federal Specification TT-P-86b, Type IV-Paint: Red-Lead-Base Ready Mixed, except that 0.7% of the red lead content shall be replaced with lampblack to give a resultant brown color. The viscosity of the finished paint shall be 83 ± 3 K.U.

–2.02K Formula C-1-57—Black Second Field Coat for Steel

Red lead (dry pigment)	32.5 parts
Lampblack (dry pigment)	5.5 parts
Iron blue (dry pigment)	2.8 parts
Raw linseed oil	58.0 parts
Liquid drier	1.2 parts
Weight per gallon (minimum)	11.4 pounds
Grind (minimum)	3.0
Drying time (for test purposes only)	24 hours
Viscosity at 70° F.	85± K.U.

Test Requirements: Prior to manufacture.

Mineral spirits may be added at the factory to meet the specified viscosity.

–2.02L Formula C-2-57—Gray Second Field Coat for Steel (Linseed Vehicle)

Basic carbonate of white lead (dry pigment)	62.2 parts
Lampblack (dry pigment)	0.1 parts
Ochre (dry pigment)	0.2 parts
Raw linseed oil	13.9 parts
Z_4 bodied linseed oil	13.8 parts
Varnish (TT-V-119)	2.7 parts
Liquid drier	0.6 parts
Mineral spirits	6.6 parts
Weight per gallon (minimum)	16.2 pounds
Grind (minimum)	3.0
Viscosity at 70° F.	85± 3 K.U.
Nonvolatile content (minimum)	91.0%

Color: The amounts of lampblack and ochre are approximate and must be adjusted to match a standard color sample for Formula No. C-2-57.

Test Requirements: Prior to manufacture.

Viscosity Adjustment: Mineral spirits content will be adjusted at the factory to meet the specified viscosity.

–2.02M Formula C-3-57—Gray Second Field Coat for Steel (Alkyd Vehicle)

Titanium-calcium (dry pigment)	31.9 parts
Ochre (dry pigment)	2.6 parts
Lampblack (dry pigment)	0.3 parts
Alkyd vehicle	52.5 parts
Raw linseed oil	2.1 parts
Anti-skinning agent	0.2 parts
24% Lead naphthenate drier	0.6 parts
6% Cobalt naphthenate drier	0.3 parts
6% Manganese naphthenate drier	0.1 parts
Mineral spirits	9.4 parts
Weight per gallon (minimum)	10.1 pounds
Viscosity at 70° F.	85± 3 K.U.
Grind (minimum)	3.0
Nonvolatile content (minimum)	74.0%

Dry Color Match: The amounts of lampblack and ochre are approximate and must be adjusted to match a standard color sample for Formula No. C-3-57 when dry.

Test Requirements: Prior to manufacture.

Viscosity Adjustment: Mineral spirits content will be adjusted at the factory to meet the specified viscosity.

–2.02N Formula C-4-57—Green Second Field Coat for Steel (Alkyd Vehicle)

Titanium-calcium (dry pigment)	19.7 parts
Zinc oxide (dry pigment)	6.5 parts
Chrome yellow (dry pigment)	1.8 parts
Chrome green oxide (dry pigment)	11.2 parts
Alkyd vehicle	47.0 parts
Raw linseed oil	2.0 parts
Anti-skinning agent	0.2 parts
24% Lead naphthenate drier	0.5 parts
6% Cobalt naphthenate drier	0.2 parts
6% Manganese naphthenate drier	0.1 parts
Mineral spirits	10.8 parts
Weight per gallon (minimum)	10.3 pounds
Viscosity at 70° F.	85± 3 K.U.
Grind (minimum)	3.0
Nonvolatile content (minimum)	74.5%

Dry Color Match: The amounts of chrome yellow and chrome green oxide are approximate and must be adjusted to match a standard color sample of Formula No. C-4-57 when dry.

Test Requirements: Prior to manufacture.

Viscosity Adjustment: Mineral spirits content will be adjusted at the factory to achieve the specified viscosity.

–2.02O Formula C-5-57—Green Second Field Coat for Steel (Linseed Vehicle)

Basic carbonate of white lead (dry pigment)	42.6 parts
Zinc oxide (dry pigment)	10.5 parts
Chrome green oxide (dry pigment)	6.4 parts
Chrome yellow	1.0 parts
Z_4 bodied linseed oil	13.3 parts
Varnish (TT-V-119)	2.9 parts
Raw linseed oil	13.3 parts
Liquid drier	0.7 parts
Mineral spirits	9.3 parts
Weight per gallon (minimum)	14.6 pounds
Viscosity at 70° F.	85± 3 K.U.
Drying time (for test purposes)	24 hours
Nonvolatile content (minimum)	89.0%

Dry Color Match: The chrome green oxide and the chrome yellow content are approximate and must be adjusted to match the color of a standard color sample of Formula No. C-5-57.

Test Requirements: Prior to Manufacture.

Viscosity Adjustment: Mineral spirits content will be adjusted at the factory to achieve the desired viscosity.

–2.02P Formula C-6-59—Green Phenolic Finish Coat for Steel

Zinc chromate (dry pigment)	18.8 parts
Chrome green oxide (dry pigment)	16.1 parts
Titanium dioxide (dry pigment)	16.7 parts
Yellow iron oxide (dry pigment)	1.8 parts
Fibrous magnesium silicate (dry pigment)	5.0 parts
Aluminum stearate (dry pigment)	0.2 parts
Varnish (TT-V-119)	22.1 parts
Raw linseed oil	21.4 parts
Driers	1.0 parts
Anti-skinning agent	0.1 parts
Mineral spirits	2.3 parts
Weight per gallon (minimum)	12.5 pounds
Viscosity at 70° F.	85± 3 K.U.
Grind (minimum)	6.0
Set to touch	4 hours
Dry hard	18 hours

Test Requirements: Prior to manufacture.

Viscosity Adjustment: Mineral spirits content to be adjusted at the factory to achieve the specified viscosity.

The proportions of tinting pigments may be varied to achieve the desired color. The color of the paint when dry must match the color of a standard C-5 color chip. Additional tinting pigments may be required.

–2.02Q Formula D-4-57—Black Enamel

The enamel shall meet the requirements of Federal TT-E-529 Black Enamel, Synthetic, Semi Gloss.

Test Requirements: This enamel will be sampled and tested in the ready-mixed form. No factory inspection will be required.

–2.02R Formula D-5-57—White Guard Rail Paint (Alkyd Vehicle)

Titanium dioxide (dry pigment)	28.1 parts
Zinc oxide (dry pigment)	10.9 parts
Fibrous magnesium silicate (dry pigment)	4.3 parts
Aluminum stearate (dry pigment)	0.5 parts
Alkyd vehicle	37.0 parts
24% Lead naphthenate drier	0.4 parts
6% Cobalt naphthenate drier	0.2 parts
6% Manganese naphthenate drier	0.2 parts
Anti-skinning agent	0.2 parts
Mineral spirits	18.2 parts
Weight per gallon (minimum)	11.0 pounds
Viscosity of 70° F.	85± 3 K.U.
Nonvolatile content (minimum)	70.2%
Grind (minimum)	4
Hiding power (maximum scale reading)	30
Set to touch	4 hours
Dry hard	18 hours

Test Requirements: Prior to manufacture.

Viscosity Adjustment: Mineral spirits content will be adjusted at the factory to achieve the specified viscosity.

This formula is not intended for use on unpainted wood.

–2.02S Formula D-6-57—White Guard Rail Paint (Linseed Vehicle)

Basic carbonate of white lead (dry pigment)	19.1 parts
Zinc oxide (dry pigment)	15.4 parts
Titanium dioxide (dry pigment)	9.5 parts
Fibrous magnesium silicate (dry pigment)	9.0 parts
Diatomaceous silica (dry pigment)	8.9 parts
Raw linseed oil	22.2 parts
Z_4 bodied linseed oil	7.6 parts

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Mineral spirits	6.4 parts
Liquid drier	1.1 parts
Weight per gallon (minimum)	14.0 pounds
Drying time (for test purposes only)	15 hours
Viscosity at 70° F.	85± 3 K.U.
Hiding power (maximum scale reading)	30
Grind (minimum)	4

Test Requirements: Prior to manufacture.

Primer: This formula is intended for use on previously painted surfaces. When applied to unpainted wood, turpentine shall be added as required by the character of the surface in the proportion of not to exceed one (1) quart per gallon of the above paint.

Viscosity Adjustment: Mineral spirits content will be adjusted at the factory to give the specified viscosity.

–2.02T Formula D-1-57—Aluminum Paint

Aluminum paste	2 pounds
Varnish (TT-V-119)	1.0 gallon

Aluminum paint shall be mixed on the work, and only enough for one day shall be mixed at a time. The weighed amount of paste shall be placed in a suitable mixing container and the measured volume of vehicle then poured over it. The paste shall be incorporated by vigorous stirring with a paddle.

Test Requirements: Prior to mixing.

–2.02U Formula E-1-57—White for Wood Structures

The material shall conform to Federal TT-P-102, Class A, except that the viscosity shall be 85 ± 3 K.U. at 70° F.

Test Requirements: This paint will be sampled and tested in the ready-mixed form.

Primer: Turpentine may be added to the above paint in quantities not to exceed 1½ pints per gallon of paint for use as a primer.

–2.02V Formula E-2-62—Primer for Wood

The primer shall be a ready-mixed priming paint for use over unpainted wood surfaces. It shall meet the requirements of Federal Specification TT-P-25a Primer Paint, Exterior, except that the viscosity shall be 85 ± 3 K.U. at 70° F.

Test Requirement: This paint shall be sampled and tested in the ready-mixed form.

–2.02W Formula F-3-57—Orange Equipment Enamel

The enamel shall meet the requirements for Enamel, Alkyd, Gloss Federal Specification TT-E-489C. The color, when dry, shall match that of Federal Standard No. 595 color 12246.

Test Requirements: When manufactured on contract or purchase order for maintenance use, the enamel will be sampled and tested in the ready-mix form. No factory inspection will be required, but a one-pint sample representing the batch must be submitted to the Engineer for approval prior to use.

For factory application to individual items of new equipment, samples of the enamel will not be required; the equipment manufacturer must, however, match the color and certify the quality of the enamel used.

–2.02X Formula H-1-57—Primer for Concrete

Titanium calcium pigment	24.7 parts
Fibrous magnesium silicate	6.8 parts
Silica	6.8 parts
Varnish (TT-V-119)	52.3 parts
Mineral spirits	9.4 pounds
Weight per gallon (minimum)	9.8 pounds
Drying time (for testing purposes only)	18 hours
Viscosity at 70° F.	70± 5 K.U.

Consistency: The paint shall not thicken after manufacture to an extent sufficient to impair its brushing qualities.

Test Requirements: Prior to manufacture.

–2.02Y Formula H-2-62—White Masonry Paint for Precast Curbs

Titanium dioxide (dry pigment)	11.9 parts
Calcium carbonate (dry pigment)	25.6 parts
Mica (dry pigment)	7.4 parts
Diatomaceous silica (dry pigment)	7.0 parts
Thixin (body agent)	0.6 parts
Pilolite S5-A	8.0 parts
Chlorinated paraffin 40%	4.0 parts
Chlorinated paraffin 70%	4.0 parts
Aromatic brushing thinner	31.6 parts
Viscosity at 70° F.	95± 5 K.U.
Weight per gallon (minimum)	12.1 pounds
Drying time (for testing purposes only)	18 hours

Test Requirements: Prior to manufacture.

–2.02Z Formulas J-1-57, J-2-57, J-3-57—Enamels for Signs

Formulas J-1-57 white, J-2-57 yellow, and J-3-57 black shall be water- resisting enamels made with synthetic gums. They shall be suitable for brush application to vertical metal surfaces and shall have the following characteristics:

	J–1–57	*J–2–57*	*J–3–57*
Coarse particles and skins retained on No. 325 sieve, not over	0.50%	0.50%	0.50%
Nonvolatile matter, not less than	85 %	80 %	50 %
Set to touch at room temperature, not over	5 hrs.	5 hrs.	5 hrs.
Dry hard at room temperature, not over	24 hrs.	24 hrs.	24 hrs.
Toughness, Kauri reduction test at 75° F., not less than	150 %	150 %	120 %
Hiding power, square feet per gallon by Pfund cryptometer, Model E, black plate, not less than	300	450	.....

Water Resistance: The dried films must withstand cold water for 18 hours and boiling water for 15 minutes without whitening, dulling, or change in color.

Working Properties: The enamels shall have good brushing, flowing, covering and leveling properties and must not cake in the container. When applied to vertical steel surfaces they shall dry without running, streaking or sagging.

The properties enumerated above shall be determined in accordance with Federal TT-P-141b.

Colors: Formula J-1-57 shall be pure white equal in brightness to that obtainable with rutile titanium-calcium pigment (ASTM Designation D476-48). Formula J-2-57 shall match a standard color sample for "Standard Interstate Yellow." Formula J-3-57 shall be jet black and hide completely in one coat.

–2.02AA Formula J-4-57—Brilliant Green Sign Enamel

This formula shall be a ready-mixed exterior paint meeting the requirements of Federal TT-P-71b, except that a blend of titanium dioxide and tinting pigments shall be used instead of chrome green oxide. The paint shall match the color of a "Standard Interstate Green." The paint, when reduced with an equal weight of linseed oil, shall have a hiding power of not less than 750 square feet per gallon when measured on the Pfund Cryptometer, Model E, white plate, viewed in a light of approximately 50 foot-candle intensity.

–2.02AB Formula J-5-57—Green Stain for Wood Posts and Poles

Formula J-5-57, Green Stain for Wood Posts and Poles, shall be a "permanent" green color meeting the requirements of Federal TT-S-706. The green color shall be obtained by the use of Phthalocyanine green, chrome yellow, lampblack, and titanium dioxide with zinc oxide and calcium carbonate to complete the required pigmentation. The stain when dry shall match a standard color sample of J-4-57 green sign paint, "Standard Interstate Green." The stain will be sampled and tested in ready-mixed form.

–2.02AC Traffic Signal Yellow Enamel

Traffic signal yellow enamel shall meet the provision of Federal Specification TT-E-489c—Enamel, Alkyd, Gloss—and shall match the color of "Standard Interstate Yellow."

–2.02AD Exterior Acrylic Latex Paint—White

The paint shall meet the requirements of Federal Specification TT-P-0019a Paint, Acrylic Emulsion Exterior, except that the viscosity shall be 80-85 K.U.

The paint may be used self-primed in multiple coats over salts treated wood and on interior and exterior masonry surfaces.

Test Requirements: Paint will be sampled and tested in the ready-mixed form.

–2.03 INSPECTION REQUIREMENTS

–2.03A General

Paints are classified into those requiring sampling and testing of raw materials prior to manufacture of the paint with inspection during manufacture, and paints which will be accepted on tests of the completely manufactured product. The type of test procedure required is indicated with the requirements for each formula under the heading "Test Requirements."

When the expression "prior to manufacture" is used in connection with a given formula, the manufacturer shall notify the Engineer when sufficient quantities of the necessary raw materials are on hand at the factory. The Engineer will then sample and seal each lot of material, and the lots so sealed shall be reserved for use until the Engineer notifies the manufacturer of the acceptance of the lots sampled.

The manufacturer shall notify the Engineer of the date on which manufacture will be started and the Engineer shall have the right to inspect all details of the manufacturing process and to assure himself that none but accepted lots of raw materials are used. The term "raw material" shall apply to each separate ingredient given in the formula, except that varnish and single pigments ground to paste form in the specified vehicle shall be considered as "raw material."

Quantities of 20 gallons or less of the above formulas will be accepted without inspection upon the manufacturer's notarized certificate. This certificate shall contain a statement by the manufacturer to the effect that the material meets the specified formula specification, and it shall include a list of materials and quantities used. One copy of the certificate shall accompany the paint when shipped and one copy with a sample of the paint shall be sent to the Engineer. The paint may be used at once without further release from the Engineer.

–2.03B Process of Manufacture

The following process of manufacture shall be used for each paint except aluminum paint. Pigments shall be thoroughly ground in appropriate portions of the specified vehicle to form a paste meeting the requirements set forth in Section 116-2.03H under "Fineness of Grinding." The grinding shall be done in a mill of a type approved by the Engineer. The use of the "colloid" type of mill will not be approved. Weighed quantities of the paste and weighed or measured quantities of the vehicles shall then be thoroughly mixed and strained, if necessary, to form a paint free from skins, lumps and foreign materials.

–2.03C Viscosity Adjustment

The volatile thinner content of the paint shall be adjusted at the factory to meet the required viscosity, but in no case shall the resultant weight per gallon and nonvolatile content of the paint be below that specified in the formula.

–2.03D Weight Variations

The average weight per gallon of the paint in any lot shall not be less than that stated in the formula. The paint in any container shall not vary more than two (2) percent from the specified weight per gallon.

–2.03E Drying Time and Quantity of Drier

The paint shall dry within the length of time stated in each formula but shall not contain sufficient quantities of drier to cause the paint to dry to a non-uniform or non-elastic film. The manufacturer will be permitted to vary the quantity of drier given in the formula to accomplish the above results.

–2.03F Working Properties

The paint shall contain no caked material that cannot readily be broken up by stirring with a paddle. When applied to a clean vertical surface the paint shall dry without running, streaking or sagging.

–2.03G Storage Properties

Paints manufactured under these specifications shall show no skin over the surface after 48 hours in a partially filled container, when tested as outlined in Federal Test Method Standard No. 141, Method 4141. A slight amount of skin or gel formation, where the surface of the paint meets the side of the container, may be disregarded. Variable percentages of "anti-skinning agents" are shown in those formulas that are susceptible to undesirable skin formation. The manufacturer will be allowed to vary the amount of "anti-skinning agent" given in the formulas, provided the above results are accomplished and provided the paint does not dry to a non-uniform or non-elastic film.

–2.03H Fineness of Grinding

The paint shall be ground so that all particles of pigment will be dispersed and be coated with vehicle, and so that the residue on a 325 sieve will not exceed one (1) percent by weight of the pigment when tested in accordance with ASTM Designation D 185, Standard Method of Test for Coarse Particles in Pigment, Pastes and Paints. Those paints made under formulas specifying special requirements for fineness of grind shall likewise be tested for fineness of grind as described in Federal Test Method Standard No. 141, Method 4411.

–2.03I Standard Colors

When the paint is required to match a standard color the manufacturer may obtain a sample of the required color without cost upon application to the Engineer.

–2.03J Containers

Each container shall be substantially filled with paint and sealed airtight. Each container shall be filled with the amount of paint required to yield the specified quantity when measured at 70° F.

All paint shall be shipped in new suitable containers, each having a capacity of not more than five (5) gallons. Each container shall be marked with a suitable number to identify the particular batch from which it was filled.

–2.03K Test Methods

As specified in Section 116-2.02A, all paints shall meet the special requirements set forth for each formula. The test methods used to check those special requirements shall be as specified below.

Weight per gallon: Federal Test Method Standard No. 141, Method 4184.

Set to touch: Federal Test Method Standard No. 141, Method 4061.

Dry hard (Varnishes, Lacquers and Enamels): Federal Test Method Standard No. 141, Method 4061.

Dry hard (Oil base paints): Federal Test Method Standard No. 141, Method 4062.

Viscosity (Krebs-Stormer Viscosimeter): Federal Test Method Standard No. 141, Method 4281.

Fineness of Grind: Federal Test Method Standard No. 141, Method 4411.

Non volatile content: Federal Test Method Standard No. 141, Method 4041.

Hiding power: The hiding power of the finished paint shall be such that when tested with the Pfund Cryptometer, Model E, black plate, wedge constant 0.0035 inch, and viewed in light of approximately 50 foot-candle intensity, the specified scale readings are not exceeded.

116–3 CONSTRUCTION DETAILS

–3.01 PAINTING NEW STEEL STRUCTURES

–3.01A Scope of Work

The painting of metal structures shall include, unless otherwise provided in the contract, the proper preparation of all metal surfaces, the application, protection and drying of the paint coatings, the protection of pedestrian, vehicular or other traffic upon or underneath any structure from contact with fresh paint, the protection of all portions of the structure (superstructure and substructure) against disfigurement by spatters, splashes and smirches of paint or of paint materials. It shall include, also, the supplying of all tools, tackles, scaffolding, labor, workmanship and materials necessary for the entire work.

–3.01B Number of Coats

All new structural steel work, unless otherwise especially provided upon the plans or in the contract, shall be painted three coats of paint. The first coat shall be applied before erection and immediately after the steel has been cleaned by sandblasting. The second and third coats shall be applied after all erection is complete, ex-

cepting however, that immediately following the field riveting of the members, the heads of field rivets and all abrasions of the shop coat due to handling at the shop, shipment, erection, etc., and all field erection marks shall be thoroughly covered with one coat of shop paint and be permitted to become thoroughly dry before the first field coat is applied.

–3.01C Colors of Coats

The color of each succeeding coat shall be sufficiently different from that previously applied to enable the discovery of an incomplete application of the paint coat. The colors of the coats shall be as specified on the plans or as directed by the Engineer.

–3.01D Weather Conditions

Paint shall be applied only when the air and metal temperatures are at or above 40° F. It shall not be applied upon damp surfaces, nor shall it be applied when the air is misty or otherwise unsatisfactory for the work, in the opinion of the Engineer.

Materials painted under cover in damp or cold weather shall remain under cover until dry or until weather conditions permit its exposure in the open. Painting in open yards or upon erected structures shall not be done when the metal is of a such high temperature as will cause the paint to blister and produce a porous paint film.

–3.01E Application

All paint shall be applied by brushing unless other methods are specifically stated in the special provisions or authorized in writing by the Engineer. Painting shall be done in a workmanlike manner by competent painters.

Brushes shall be either round or oval in shape, except that flat brushes four inches or less in width may be used to apply aluminum paint. The paint shall be so manipulated under the brush as to produce a uniform and even coating in close contact with the metal or with previously applied paint. In general, the primary movement of the brush shall describe a series of small circles to thoroughly fill all the irregularities in the surface, after which the coating will be smoothed and thinned with a series of parallel strokes. On all surfaces which are in accessible for brushes the paint shall be applied with sheepskin or other approved daubers especially provided for the purpose.

Particular care shall be taken to apply a heavy paint film on rivet heads, edges of plates, angles and other rolled shapes. Paint shall also be well worked into all joints and crevices. Such areas shall be given a light coating shortly ahead of the general painting, and then a second covering when the general coat is applied.

If spraying machines are permitted, they shall be capable of satisfactorily applying paint mixed strictly in accordance with the formulas given in these specifications. Volatile thinners or other substances shall not be added in excess of the amounts permitted by the formulas to make it possible to operate the spraying machines. The equipment shall be subject to the approval of the Engineer, and if satisfactory work is not obtained, the use of such equipment may be prohibited and brushing required.

Special care shall be taken in the protection of traffic and all portions of the structure as outlined in Section 116-3.01A. The Contractor shall furnish and install sufficient canvas or other covering to screen and protect traffic and the various portions of the structure adjacent to areas from damage or disfigurement from wind-blown or dripping paint.

If traffic cannot be properly safeguarded and protected against damage from wind-blown or dripping paint by installing canvas or other covering, the Contractor shall provide watchmen, when directed by the Engineer, and the painting operation shall be interrupted intermittently for the passage of vehicles.

Paint shall be thoroughly stirred by means of mechanical mixers or other means before it is removed from the containers. It shall be kept stirred while being applied in order to keep the pigments in suspension.

–3.01F Removal of Improper Paint

All metal not properly cleaned before painting, or metal coated with impure or improper paint shall be thoroughly cleaned and repainted to the satisfaction of the Engineer at the expense of the Contractor.

–3.01G Thinning

Paint shall be shipped from the factory at brushing consistency and the use of additional thinner will not be permitted, unless authorized in writing by the Engineer.

–3.01H Shop Cleaning

All surfaces of metal to be painted shall be thoroughly cleaned of rust, loose mill scale, dirt, oil, grease and other foreign substances. Oil and grease may be removed by the use of suitable solvents. The removal of rust, scale and dirt shall be done by sandblasting as specified in Section 112-3.14. Bristle or wood fibre brushes or air blast may be used for removing loose dust.

–3.01I Shop Painting

After the structural steel has been fabricated and thoroughly cleaned as specified above, all surfaces shall be painted immediately with one coat of the paint specified on the plans, except that on those surfaces which will be in contact in the finished structure, the shop coat of paint shall be only heavy enough, but not less than one (1) mill (.001 inch) in dry thickness to prevent the metal from rusting before the structural steel is erected and painted in the field. It is the intent of this specification that as little paint as possible be applied to contact surfaces.

The paint used for covering field contact surfaces shall be the same as specified for the shop coat. The addition of volatile thinner in excess of the amount allowed by the formulas will not be permitted. The light application of paint shall be confined to those surfaces which will be in contact after erection. Other surfaces which will not be in contact but which may have received only the light application of paint, shall be touched up with a normally thick coating of the shop paint and be allowed to become thoroughly dry before the first coat of paint is applied.

Structural steel shall not be loaded for shipment until after the shop coat of paint has thoroughly dried. No painting shall be done after steel has been loaded for shipment.

–3.01J Erection Marks

Erection marks for the field identification of members shall be painted upon previously painted surfaces.

–3.01K Machine Finished Surfaces

Machine finished surfaces, including abutting chord splices, column splices and column bases, shall be covered with read lead paint, Formula A-1-57 as soon as practicable after acceptance and before removal from the shop.

Surfaces of iron and steel castings, milled for the purpose of removing scales, scabs, fins, blisters or other surface deformations, shall also generally be covered with red lead paint.

–3.01L Field Cleaning

When the erection work is completed, including all riveting, straightening of bent material, etc., all metal surfaces shall be thoroughly cleaned of rust, scale, dirt, oil or grease and all other foreign substances. The removal of rust, scale and dirt shall generally be done by the use of metal brushes, scrapers, chisels, hammers, sandblasting, or other effective means, as approved by the Engineer. Oil and grease may be removed by the use of gasoline or benzine. Bristle or wood fibre brushes may be used for removing loose dust.

Pressure flushing as specified in Section 116-3.02C may be required if the structure is covered with dirt deposits or residue from concreting work.

Damage to the shop coat caused by shipping or by handling in erection, and to rivets and welds placed during erection shall normally be cleaned by thorough wire brushing prior to painting. All dirt, oil, grease and foreign materials shall be removed from the structure by use of solvents, scrapers, brushes or pressure flushing prior to the application of each coat of paint, as may be approved by the Engineer.

–3.01M Field Painting

As soon as the field cleaning is done to the satisfaction of the Engineer, the heads of field rivets and bolts, all surfaces from which the shop coat of paint has been worn off or which is otherwise defective, and all shipping and erection marks shall be thoroughly covered with one coat of the same paint as used for the shop coat. This paint shall be allowed to become thoroughly dry before the first field coat is applied.

When the paint applied for "touching up" rivet heads and abraded surfaces has become thoroughly dry, the first and second field coats may be applied. In no case shall a succeeding coat be applied until the previous coat has dried throughout the full thickness of the paint film.

All small cracks and cavities that have not become sealed in a watertight manner by the first field coat shall be filled with red lead sealing paste applied by brush or spatula before the second field coat is applied.

–3.02 REPAINTING EXISTING STEEL STRUCTURES

–3.02A Scope of Work

Unless otherwise provided, maintenance painting shall consist of the removal of the rust, scale, dead paint, dirt, grease or other foreign matter from the metal parts or portions of existing bridge structure, and the application of paint thereto.

All metal surfaces not in close contact with other metal surfaces or with wooden floor or truss members, concrete, stone masonry, etc., shall be considered as exposed to deterioration by rusting and shall be thoroughly cleaned and painted. The number of coats shall be as shown on the plans or as specified in the special provisions.

–3.02B Number of Coats

Unless otherwise provided, metal after being cleaned to the bare substrate shall be painted with three coats of paint.

–3.02C Cleaning and Painting

The requirements and methods for cleaning and repainting existing steel structures shall be the same as specified for field cleaning and painting of new structures unless otherwise specified on the plans or in the special provisions.

Rust removal shall be by means of sandblasting. The spots that are sandblasted shall be blasted to a uniform metallic gray appearance with only small areas of stain and gray mill scale permitted. There shall be no evidence of red or yellow rust at the edges of the clean area, and the sound paint edges shall be feathered to give a smooth surface.

Pressure flushing, when called for, shall be by means of water, or water and detergents. The pumping system shall operate at a minimum nozzle pressure of 150 pounds per square inch. The nozzle shall have an orifice of not less than one-fourth (¼) inch diameter and shall be so designed as to give a high pressure stream rather than a spray. The nozzle shall be operated not more than six (6) feet from the surface being cleaned.

All cracks and crevices in the cleaned areas that are not sealed by the spot coat of paint shall be sealed by use of red lead sealing paste, applied by brush or spatula before the finish coat of paint is applied.

Whenever roadway or sidewalk planking is laid too closely in contact with the metal to permit free access for proper cleaning and painting, the planks shall either be removed or shall be cut to provide at least a one (1) inch clearance for that purpose. The removal or the cutting of planks shall be done as directed by the Engineer. All planks removed shall be satisfactorily replaced and if any are broken or otherwise injured to an extent rendering them unfit for use, they shall be renewed at expense of the Contractor.

–3.03 PAINTING TIMBER STRUCTURES

–3.03A Number of Coats

Unless otherwise specified, rails and rail posts on timber bridges shall be given two coats of paint. The color shall be as shown on the plans, specified in the special provisions, or as designated by the Engineer. Unless otherwise indicated, the wheel guard shall be painted only on the top edge and roadway side.

Other timber work of structures, fences, stairways and other timber appurtenances above ground elevation shall be given three (3) coats of paint of the color specified or as designated by the Engineer, unless otherwise shown on the plans or specified in the special provisions.

–3.03B Application

All wood surfaces to be painted must be thoroughly dry and free from oil or dirt. All paint for wood shall be applied with brushes and shall be evenly spread and thoroughly worked into all seasoning cracks, corners and recesses. In no case shall a succeeding coat be applied until the previous coat has dried throughout the full thickness of the paint film. In applying aluminum paint with a brush, care shall be taken that all final strokes are made in the same direction in order that the particles of powder may "leaf" uniformly in the paint film.

Paint shall not be applied on creosoted surfaces. Painted surfaces stained from the presence of creosote shall be given one or more coats of approved shellac and the surfaces be repainted.

–3.03C Painting Treated Timber

Timber treated with creosote or oil-borne pentachlorophenol preservatives will not ordinarily be painted.

Timber treated with water-borne preservatives must be clean and dry and shall have the moisture content reduced to the 18 percent or less specified in Section 115-3.02B. Visible salt crystals on the surface of the wood must be removed by washing and brushing and the moisture content again reduced to specification level. Timbers in storage awaiting painting must be under cover and properly stacked with spreaders to ensure circulation of air.

The paint schedule shall consist of one (1) full coat of primer Formula E-2-62 and two (2) full coats of Formula D-5-57 applied to all surfaces. Each coat of paint shall be thoroughly dry before the next coat is applied.

–3.04 PAINTING BEAM GUARD RAIL

–3.04A Preparation and Preliminary Coats

Cleaning and types of paint applied to beam guard rail shall be as specified in Section 116-3.04C. All but the final field coat of paint may be applied in the shop if the Contractor so elects. Guard rail posts will not be painted.

All punching, shearing, riveting, rolling and other operations required for fabrication will be completed prior to cleaning and painting. Paints may be applied by brush or spray at the option of the Contractor; however, the requirements for the number of coats, film thickness per coat and total film thickness must be met regardless of the method of application. Forced drying of all paint coats will be permitted provided the dry film is free from blisters, bubbles and other damage and is equal in quality to an air dried film.

Before applying any paint to the beam rail, the surface shall be thoroughly clean and dry and all loose paint or scale shall be removed. No exterior painting shall be done in wet or freezing weather.

Galvanized guard rail shall be painted on the roadway face only.

–3.04B Spotting and Final Field Coat

Depending upon the option chosen by the Contractor as stated in Section 116-3.04C, the necessary coat or coats of paint shall be applied by brush or spray after all erection has been completed. After erection and prior to application of the final field coat all abrasion damage and erection damage shall be spotted to replace lost

coats of paint. Areas scarred to the metal surface or left unpainted until after erection shall be cleaned and spotted with the required number of coats of each paint to bring all painted surfaces of the rail up to the same number of coats. Formula A-6-61—Zinc-Rich Primer—may be used to spot in place of the formulas A-5-61 and A-2-57 regardless of the original system applied to the rail.

After the spot coats have dried, the surface dirt shall be removed by brushing, wiping or pressure flushing as specified by the Engineer at the job site, and be dried and given a full coat of Formula D-5-57—Alkyd Guard Rail Paint.

–3.04C Painting Galvanized Rail

All galvanized surfaces to be painted shall have all oil and grease removed by solvents. Remaining deposits may be removed by any required method which does not damage the galvanizing.

The clean and dry rail may be painted according to either of the following schedules, at the option of the Contractor:

Schedule A: First coat—Formula A-5-61
Second coat—Formula A-2-57
Third coat—Shop Finish Coat D-5-57
Fourth coat—Field Finish Coat D-5-57.

Schedule B: First coat—Formula A-6-61
Second coat—Shop Finish Coat D-5-57
Third coat—Field Finish Coat D-5-57.

The primer and shop finish coats may be force dried, if desired. Each coat must be dry before application of the next coat and all coats applied in the shop must be dried hard prior to shipment of the rail.

–3.05 PAINTING STEEL RAIL

Steel rail and fittings shall have all oil and grease removed by use of solvents. Corrosive products and other foreign materials shall be removed by sandblasting or a pickling process. Power wire brushing may be permitted at the option of the Engineer.

As soon as possible after cleaning and drying and in any event during the same working day on which cleaning takes place, the surface shall be primed with a full coat of Formula A-2-57—Shop Coat for Steel—followed by two (2) full coats of Formula D-5-57—Guard Rail Paint.

–3.06 PAINTING MISCELLANEOUS GALVANIZED SURFACES

The general procedures as outlined in Subsection 116-3.04C shall be followed with regard to surface preparation and painting of galvanized surfaces.

–3.07 PAINT FILM THICKNESS

Formula A-5-61—Vinyl Pretreatment has such rapid solvent release that wet film thickness readings are difficult to obtain; however, a full wet coat free from runs and sags yields proper film thickness. All other coatings, regardless of the method of application, shall be applied at a minimum wet thickness of 2.0 mills per coat.

The dry film thickness of Formula A-5-61—Vinyl Pretreatment shall be 0.4-0.7 mills. All other coatings, regardless of the method of application, shall yield a minimum dry film thickness of 1.5 mills per coat.

The minimum total dry film thickness for the specified paint system on any surface shall be the sum of the individual dry film thicknesses of the individual coats. In the event that the minimum total dry film thickness requirement is not met, the Engineer may specify an additional full coat of finish paint.

Wet film thickness shall be measured by a suitable gauge immediately after the paint is applied. Dry film thickness measurements shall be made by use of a suitable gauge after the coating has become thoroughly dry and hard.

116–5 MEASUREMENT AND PAYMENT

–5.01 GENERAL

No separate payment item will be included in the proposal for painting except as otherwise provided hereinafter.

–5.02 PAINTING NEW STEEL STRUCTURES

Painting new steel structures shall be considered as incidental to the construction and all costs in connection with cleaning and painting the metal surfaces, as specified herein, shall be included in the various unit contract prices for the materials specified to be painted.

–5.03 REPAINTING EXISTING STEEL STRUCTURES

Payment for repainting existing steel structures will be made as provided in the special provisions and proposal.

–5.04 PAINTING TIMBER STRUCTURES

Painting timber structures shall be considered as incidental to the construction and all costs in connection with painting the timber surfaces, as specified herein, shall be included in the unit contract price per thousand feet board measure (MBM) for "Timber and Lumber."

–5.05 PAINTING GUARD RAILS

Painting guard rails shall be considered as incidental to the construction and all costs in connection with painting the guard rails, as specified herein, shall be included in the unit contract price per linear foot for guard rail of the type specified.

Section 117—Bridge Railings

117–1 DESCRIPTION

Concrete handrailing shall consist of that portion of the railing above the roadway curb or above the sidewalk curb and shall include the rail web, cap and posts. Timber railing shall include the timber wheel guards, rail posts and horizontal railing members. Metal railing shall include posts, web members and horizontal members of sidewalk and roadway railing and, unless otherwise shown on the plans or specified in the special provisions, may be constructed either of aluminum alloy or steel.

Detailed specifications for metal railing are not included in this supplement to Standard Specifications for Municipal Public Works Construction. For any municipality not having its own design and specifications, reference is made to design drawings E 24 and E 25, which may be obtained by request to Plans and Contracts Division, Department of Highways, Highways-Licenses Bldg., Olympia, Washington. The design drawings carry complete specifications of metal materials required for metal railing.

117–2 MATERIALS

All materials shall conform to the specifications contained herein or shown on the plans for the various classes of materials from which the railings are constructed.

The fine aggregate used for concrete in bridge railings shall be as specified in Section 39-2.02B. Coarse aggregate shall comply with the table of "Grading No. 2" in Section 39-2.02C3 and with other related subsections of Section 39-2.02.

The use of high-early-strength cement will not be permitted unless specifically authorized in the special provisions.

117–3 CONSTRUCTION DETAILS

–3.01 CONCRETE RAILINGS

–3.01A General

Concrete railing shall be constructed in accordance with the specifications of Section 101—Concrete Structures, Section 107—Portland Cement Concrete for Structures, and Section 111—Reinforcing Steel. Railing, insofar as possible, shall be constructed after the roadway and sidewalk slabs are completed for the entire structure.

–3.01B Forms for Concrete Railings

Railing and curb forms shall be carefully constructed of steel, finished lumber and/or plywood conforming to the requirements for forms in Section 101-3.03, unless the special provisions provide otherwise. When completely assembled and in place above the curb sections, forms shall have interior dimensions and be of such rigidity as to accurately shape and contain the concrete to produce the railing according to the dimensions shown on the plans. The maximum allowable inside surface deviation of the forms shall be one-eighth (⅛) inch.

Rail forms in place ready for placement of concrete shall be of uniform height and be of such alignment and grade that the finished rail will present a pleasing appearance with no abrupt changes.

Wherever the height of the railing must vary from the grade of the structure to have a pleasing appearance, such as at vertical or horizontal curves or other grade points, the variation to be made shall be taken in the curb section forms and a uniform height throughout be maintained for the railing. Structure grade humps followed by sags shall be avoided in the railing by varying the curb height.

All joints and corners shall be carefully fitted. Exposed corners, except the rail web openings, shall be chamfered one-half (½) inch. Expansion and construction joints, except the top surface of rail caps, shall have one-half (½) inch chamfers on each side of the joint.

All cost to the Contractor for adjusting curb height to meet approval of the Engineer shall be considered as incidental to the railing construction, excepting however, that if the Engineer shall require forms to be again reset after once having been erected and accepted to a final elevation by him, then the additional readjustment shall be considered as extra work and will be paid for in accordance with Section 9.03.

–3.01C Removal of Forms

Forms for concrete railings shall not be removed for at least three (3) days after the placing of concrete. Curb forms may be removed as soon as practicable after the concrete is placed, upon approval of the Engineer. Forms shall be removed without injury to the concrete. After removal, all forms intended for re-use shall be cleaned and freshly coated with form oil.

–3.01D Finishing and Curing

Initial placement of concrete in forms shall be to an elevation slightly above the required top grade for the railing. The surface shall then be smoothed off to true grade, troweled and edged in a workmanlike manner to form the surface to the cross section shown on the plans. The troweled railing top shall then be lightly brushed transversely with an approved fine bristle brush.

At expansion joints in rail caps, an edger tool having a radius of one-fourth (¼) inch shall be used on each side of the joint on the top surface of the cap. Particular care shall be taken at each joint to maintain the true lines of the cap and avoid a short, unsightly incline on each side of the joint.

At all expansion joints in the railing, special care shall be employed when troweling and edging to obtain joint edges on both sides of the joint that will be true to the longitudinal grade of the railing. The finished railing top across expansion joints shall meet the requirements for surface smoothness specified for a Class 1 Surface Finish in Section 107-3.16. Upon completion of final brushing, the concrete surface shall be protected for curing by an approved method specified in Section 39-3.20.

Concrete railing shall be cured for a period of ten (10) days following the day concrete was placed and the forms shall remain in place for a minimum of three (3) days of this curing period. When forms are removed by the Contractor before the ten (10) day curing period has elapsed, the exposed railing shall be recovered immediately with the approved curing method and be kept so covered for the remaining curing time.

At the end of the curing period, the railing shall be thoroughly washed with water, all form oil shall be removed and the railing shall be given a Class 1 Surface Finish. The completed surface of the railing shall be of uniform color and texture.

When liquid membrane curing compound is to be used, each surface to which it will be applied shall receive the specified class of surface treatment, and this finish shall be accepted by the Engineer before the liquid membrane is applied. All adjacent or nearby surfaces which are to receive a surface finish shall be protected from the application of the membrane until after the specified finish is accomplished and accepted.

–3.02 TIMBER RAILINGS

Wheel guards and railings shall be accurately framed in accordance with the plans and be erected true to line and grade. On structures having horizontal or vertical curves, the heights of railings or wheel guards shall be varied at points of change in grade if, in the opinion of the Engineer, such variations will be necessary to produce the desired appearance.

Unless otherwise specified, wheel guards shall be beveled on the roadway face. Wheel guards shall be surfaced on all sides (S4S) unless the plans or special provisions specify that they be surfaced on the top edge and roadway face. Wheel guards shall be laid in sections, each not less than twelve (12) feet in length. All material for rails and rail posts shall be surfaced four sides (S4S).

Railing members shall be securely fastened together as shown on the plans. Bolts shall be tightened when they are installed and shall be retightened immediately prior to final acceptance of the contract.

Rails and rail posts shall be painted in accordance with the specifications of Section 103-3.06 and Section 116-3.03A.

All construction methods not outlined in this section of the specifications, shall be in accordance with specifications of Section 103—Timber Structures, and Section 114—Timber and Lumber.

–3.03 METAL RAILINGS

Metal railings shall be erected and fastened true to line and grade, or camber. Railings on steel spans may be erected at the same time the trusses or girders and floor systems are erected but shall not be completely fastened until after the roadway slab is in place. On spans having concrete sidewalks, the railings shall be aligned and fastened in place and strutted and tied to the trusses or girders before placing concrete in sidewalk slabs. Struts and ties shall remain in place for at least five (5) days after the slab is placed.

Top rails, usually of pipe, and all other horizontal elements shall be aligned and fastened after all dead load has been applied to the span.

Bolts shall be placed with heads of bolts facing the roadway, and all bolt heads shall have top and bottom edges parallel to the grade.

On multiple span bridges the rail and wheel guard heights at the ends of each span shall be varied a sufficient amount to produce a uniform camber or grade from end to end of the bridge.

After the metal railing has been set initially, the Contractor shall readjust the entire railing or any sections thereof, if necessary, to secure a continuous line and grade of pleasing appearance.

117–5 MEASUREMENT AND PAYMENT

–5.01 CONCRETE RAILINGS

Payment for concrete railings will be made at the unit contract price per linear foot for "Reinforced Concrete Bridge Railing" and the unit contract price per pound for "Steel Reinforcing Bars," which prices shall be full compensation for all materials, labor, tools and equipment necessary to construct and finish the railings as shown on the plans and as specified herein.

–5.02 TIMBER RAILINGS

Payment for timber handrailings will be made at the unit contract price per thousand (MBM) for "Timber and Lumber," which price shall be full compensation for all materials, including hardware, labor, tools and equipment necessary to construct and paint the railings as shown on the plans and specified herein.

–5.03 METAL RAILINGS

Payment for metal railings will be made for such of the following bid items as are included and shown in any particular contract:

1. "Standard Bridge Railing, Type ...," per linear foot.

The unit contract prices per linear foot for metal railings shall be full compensation for all materials, labor, tools and equipment necessary to construct the railings as shown on the plans and as specified herein, including fastenings, anchor bolts, galvanizing, and painting if specified.

In case no item is included in the proposal for "Standard Bridge Railing, Type ...," and payment is not otherwise provided, the costs of all metal railings and necessary accessories shall be included by the Contractor in the lump sum contract price for "Structural Carbon Steel."

Section 118—Waterproofing

118–1 DESCRIPTION

The waterproofing shall be a firmly bonded membrane composed of two (2) layers of fabric and three (3) moppings of asphalt, together with a coating of primer. The waterproofing shall be applied to those surfaces and construction joints noted on the plans, or directed by the Engineer in writing. When specified on the plans, a protective layer of portland cement mortar shall be laid over the entire surface of the waterproofing membrane.

118–2 MATERIALS

–2.01 ASPHALT FOR WATERPROOFING

Asphalt for waterproofing shall conform to the requirements of ASTM Designation D 449, Asphalt for Dampproofing and Waterproofing. Type A asphalt shall be used for application below ground and Type C for application above ground.

The material used as primer shall conform to the requirements of ASTM Designation D 41, Primer for Use with Asphalt in Dampproofing and Waterproofing.

–2.02 WATERPROOFING FABRIC

Waterproofing fabric shall be a saturated cotton fabric meeting the requirements of ASTM Designation D 173, Woven Cotton Fabrics Saturated with Bituminous Substances for Use in Waterproofing.

–2.03 PORTLAND CEMENT MORTAR

Portland cement and sand for the mortar protection course shall conform to the requirements for portland cement, and fine aggregate as described in Section 39-2.02B.

118–3 CONSTRUCTION DETAILS

–3.01 STORAGE OF FABRIC

The fabric shall be stored in a dry and protected place. The rolls shall not be stored on end.

–3.02 PREPARATION OF SURFACE

All concrete surfaces which are to be waterproofed shall be reasonably smooth and free from imperfections which might damage the membrane. The surface to be waterproofed shall be dry and shall be thoroughly cleaned of all dust and loose material. No waterproofing shall be done in wet weather, nor when the temperature is below thirty-five (35) degrees F., without authorization in writing by the Engineer.

–3.03 APPLICATION OF WATERPROOFING

The asphalt shall be heated to a temperature not lower than 300° F., and not higher than 350° F., with frequent stirring to avoid local overheating. The heating kettle shall be equipped with thermometers.

In all cases, the waterproofing shall begin at the low point of the surface to be waterproofed so that water will run over and not against or along the laps.

The application of the waterproofing shall be as follows:

Beginning at the low point of the surface to be waterproofed, a coating of primer shall be applied and allowed to dry before the first coat of asphalt is applied.

A section about twenty (20) inches wide and the full length of the surface shall then be mopped with the hot asphalt, and immediately following the mop there shall be rolled into it the first strip of fabric of half width, which shall be carefully pressed into place so as to eliminate all air bubbles and obtain close conformity with the surface. This strip and an adjacent section of the surface of a width equal to slightly more than half the width of the fabric being used, shall then be mopped with hot asphalt and a full width of the fabric shall be rolled into this, completely covering the first strip, and be pressed into place as before.

The second strip and an adjacent section of the concrete surface shall then be mopped with hot asphalt and the third strip of fabric shingled on so as to lap the first strip by not less than two (2) inches. This process shall be continued until the entire surface is covered, each strip of fabric lapping at least two (2) inches over the last strip. The entire surface shall then be given a final mopping of hot asphalt.

Under no circumstances shall one (1) layer of fabric touch another layer at any point or touch the surface, as there must be at least three (3) complete moppings of asphalt.

In all cases the mopping shall be so thoroughly done that the surfaces will be completely covered. The asphalt must be so heavily and uniformly applied that no gray spots will appear on the concrete and the weave of the cloth will be entirely concealed. On horizontal surfaces, not less than twelve (12) gallons of asphalt shall be used for each one hundred (100) square feet of finished work, and on vertical surfaces not less than fifteen (15) gallons shall be used for each one hundred (100) square feet. The work shall be so regulated that, at the close of the work day, all cloth laid that day will have received the final mopping of asphalt. Special care shall be taken to see that all laps are thoroughly sealed down.

At the edges of the membrane and at all locations where the surface is penetrated or disturbed by drains, pipes or other interferences, the Contractor shall make suitable improvisations that will effectively prevent any water or moisture getting between the waterproofing and the surface of the concrete.

All flashing at curbs and against girders, spandrel walls, etc., shall be done with separate sheets lapping the main membrane not less than twelve (12) inches. Flashing shall be closely sealed either with full metal flashing or by imbedding the upper edges of the flashing in a groove poured full of an acceptable joint cement.

There shall be no break in the waterproofing membrane at expansion joints. The fabric shall be folded so as to allow for expansion movement. At the ends of the structure the membrane shall be carried well down on the abutments and suitable provision made for the movement due to expansion and contraction.

–3.04 PROTECTION COURSE

When specified on the plans, a protective layer of portland cement mortar not less than one and one-half (1½) inches in thickness shall be laid over the entire surface of the waterproofing membrane. The protective coating shall be placed immediately after the membrane has cooled to normal temperature. The protective coating shall be composed of one part portland cement to two parts sand. The protective coating shall be uniformly distributed over the surface, gently tamped into place and finished by hand to present a smooth, hard surface. The protective coating shall be covered and kept moist for a period of one (1) week.

118–5 MEASUREMENT AND PAYMENT

Payment for "Waterproofing" will be made at the unit contract price per square yard of completed surface, which price shall be full compensation for all labor, materials, tools, and equipment required to complete the work.

The waterproofing of construction joints not shown on the plans and protective improvisations at interference of pipes, drains, etc., shall be considered as incidental to the construction and the costs thereof shall be included in the unit contract price per square yard for "Waterproofing."

INDEX TO SPECIFICATIONS

NOTE:

This is a somewhat abbreviated index of the Standard Structural Specifications for Municipal Public Works Construction. If the reader is unable to find the particular item or subject he seeks in the index, he should refer to the related section in the Table of Contents at the beginning of the book.

Page 1 of the Table of Contents contains a complete list of all 15 sections and their titles included in this supplement. Pages 1 through 4 of the Table of Contents contain complete breakdowns, in numerical sequence, of the 15 sections into entitled subsections representing the related subject matters.

The heavier and bolder type interspersed throughout the index denotes the complete titles of the various sections as they occur in alphabetic order in the index.

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