Design Criteria Manual

Chapter 2: Bridges & Crossing Culverts

Public Works Department

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1 Scope

This Manual shall be used for design and construction of all new bridges, and stream crossing culverts[1] and replacement bridges and culverts within the Matanuska-Susitna Borough (MSB) right-of-way (ROW), easements, on public property and in subdivisions with private streets, except in the cases listed below. In this document the word "bridges" is intended to refer to both bridges culverts that cross streams, pathway tunnels or other large diameter structural pipes, unless otherwise noted.

This manual does not apply to the design or construction of:

- Bridges within the jurisdiction of the Alaska Department of Transportation and Public Facilities (DOT&PF). This includes bridges on State roads.
- Bridges on private property (except as noted for subdivisions with private streets)
- Existing bridges

2 References

The following design guidelines, manuals, and standards are referenced in this Manual. Use the editions—with all amendments, revisions, provisions, and modifications--published at time of contract execution:

American Association of State Highway and Transportation Officials (AASHTO):
"*A Policy on Geometric Design of Highways and Streets*" (GB)
"*Design Guide for Very Low Volume Roads (GDVLVLR)*"
"*Load and Resistance Factor Design (LRFD) Bridge Design Specifications (BDS)"*
"*Guide Specification for LRFD Seismic Bridge Design*"
"*Manual for Bridge Evaluation*"
"*Guide for the Development of Bicycle Facilities*"
"*Drainage Manual*"

DOT&PF:
"*Alaska Highway Drainage Manual*"
"*Alaska Traffic Manual" (ATM)*
"*Pre-construction Manual* (HPCM)"
"*Standard Specifications for Highway Construction (SSHC)*"

Federal Highway Administration (FHWA):
"*Manual on Uniform Traffic Control Devices (MUTCD)*"

[1] Although culverts less than 20 feet in diameter and other bridge-like structures less than 20 feet long (in the direction of traffic or structure span) are not considered "bridges" by the FHWA and AASHTO, the provisions of this Manual are to be applied to such elements.

U.S. Fish and Wildlife Service (USFWS):
"Culvert Design Guidelines for Ecological Function"
"Stream Simulation Guidelines"

Other:
National Cooperative Highway Research Program (NCHRP) 350 Report: "*Recommend procedures for the safety performance evaluation of highway features*"

Western Wood Preservers Institute, "*Best Management Practices (BMPs) for the Use of Treated Wood in Aquatic and Other Sensitive Environments*"

3 General

A number of general studies, reports, and submittals are required in the planning and design of all new bridges. These include but are not limited to traffic volume, classification, design speed and functional geometry, utility and ROW surveys, accident analysis, geotechnical, hydraulics/hydrology, permitting and environmental, and corrosion control. These items shall be subject to approval by the MSB Department of Public Works (DPW) Director.

3.1 Traffic Volume, Design Speed and Functional Geometry

The MSB will provide the Average Daily Traffic (ADT), Annual Average Daily Traffic (AADT), and design speed for each new crossing.

Grade, alignment, and sight distance shall meet the requirements of *"A Policy on Geometric Design of Highways and Streets."* Design speed shall match the approach roadway design speed.

The clear roadway width[2] on the bridge shall be not less than the value from Table 4.1. NOTE: Table 4.1 is applicable only to "Local Roads and Streets" and "Collector Roads and Streets", as defined in *"A Policy on Geometric Design of Highways and Streets"*. For "Urban and Rural Arterials" and "Freeways" follow the guidance in *"A Policy on Geometric Design of Highways and Streets"*.

Table 4.1 Minimum clear roadway width on bridge

ADT	Total crossing length[3] (feet)	Minimum clear roadway width (feet)
≤ 2000	Any length	Approach roadway width[4], but not less than 28 feet
> 2000	≤ 100 feet	Approach roadway width, but not less than 30 feet
> 2000	> 100 feet	Traveled way + 3 ft (each side) [5], but not less than 30 feet

[2] Clear roadway width is the distance between the inside face of curbs or vehicular railings, whichever is less.
[3] Total crossing length is the distance between "begin bridge" and "end bridge" stations measured along stationing.
[4] Approach roadway width is the distance curb-to-curb or traveled way plus shoulder width.
[5] On long bridges, where the cost per foot is greater than short bridges, narrower widths are usually considered acceptable.

Vertical clearance between the lowest member of the bridge structure and the water surface shall be in accordance with Section 4.7 of this manual. Provide clearance for vessel traffic if the waterway is navigable.

Vertical clearance between the top of the bridge roadway and any overhead cable or structure shall be at least 16 feet 6 inches. This criterion is unique to the MSB.

Design the bridge to support existing and future utilities.

See Section 3.7 for pathway requirements.

3.2 Survey

A survey shall be performed for each new bridge. This shall include the location of all adjacent property and structures, the location of the roadway including centerline (CL), edge of pavement, side slopes and ditches, ordinary high water (OHW), and other features as required. Provide the basis of survey including coordinate system, north arrow, survey monuments and project datum elevation. The survey shall also include the location of all above and below ground utilities in the vicinity (typically 200 feet) of the crossing. The survey shall clearly show the ownership of each parcel and any existing or proposed right-of-way at the proposed crossing.

The survey drawing shall be signed and sealed by a Professional Land Surveyor (PLS) registered in the State of Alaska.

3.3 Accident Analysis

If the new bridge will be replacing an existing bridge the designer will conduct an accident analysis. The designer will examine accident reports from the existing bridge and approaches going back 10 years. The report will summarize the number of accidents and discuss possible contributing factors such as geometry, speed limits, sight distance and other factors.

The accident analysis shall be signed and sealed by a Professional Engineer registered in the State of Alaska.

3.4 Geotechnical Field Work and Foundation Report

A geotechnical field exploration program shall be conducted for each crossing and a foundation report shall be provided.

Exception: a field program and report are not required for culverts less than 48 inches in diameter.

Exploratory holes deeper than the foundation elements shall be advanced. The foundation report shall include the types of material found in the field exploration, historical geotechnical information, the bearing capacity of the soils, abutment design guidelines, pile design guidelines (if a pile foundation is selected) including pile capacity with scour allowance, and other items. The geotechnical work shall meet the requirements outlined in the BDS and the *"Pre-construction Manual."* Coordinate with the engineer responsible for the hydraulics and hydrology analyses.

The foundation report shall be sealed by a Professional Engineer registered in the State of Alaska.

3.5 Hydraulics and Hydrology

A hydraulics and hydrology study shall be conducted for each new crossing. This shall include a hydraulic site survey. The details of this are covered in Section 5 of this document.

3.6 Permitting and Environmental

A permitting and environmental study shall be completed for each new crossing. This report shall outline all permits and environmental issues related to the project along with an action plan to obtain the required permits and to mitigate any impacts. All applicable required permits shall be identified. These include but are not limited to:

- United States Coast Guard (USCG) Section 9 Bridge Permit
- United States Army Corps of Engineers (USACE) Section 10 Navigable Waterways
- USACE Section 401 Water Quality
- USACE Section 404 Excavation and/or fill in waters of the US
- Alaska Department of Fish and Game (ADF&G) Title 16 Fish Habitat
- Alaska Department of Natural Resources (DNR) Land Use
- Environmental Protection Agency (EPA) Storm Water Pollution Prevention Plan (SWPPP)
- MSB Flood Plain Development Permit
- MSB ROW Permit

In addition, construction impacts shall be considered in the planning stage. These include but are not limited to:

- Erosion, sediment, and silt containment
- Dust control
- Noise control/abatement
- Channel diversion
- Temporary stream crossing
- Dewatering criteria
- Staged construction, detour route or structures, traffic control

A written permitting and environmental study outlining the above and additional items as applicable to the specific crossing shall be submitted in the planning stages of the project.

3.7 Pathways on Bridges

The full width of any existing sidewalks, pathways, bike lanes, equestrian lanes, or shared-use pathways on the roadway being served shall be continued over the new bridge. If no such pathways exist, the MSB will identify bridge pathway requirements. The minimum width of a pathway on a bridge shall be ten feet. If the expected volume of traffic on the pathway is very low and the bridge is short, the minimum width may be reduced to six feet[6].

Grating, manhole covers, and other items shall be bicycle and pedestrian "safe" as outlined in the "*Guide for the Development of Bicycle Facilities*."

All pathways on the bridge shall be signed and striped as outlined in the MUTCD.

Railings, fences, or barriers on each side of a pathway shall be a minimum of 4.5 feet high.

3.8 End Terminals, Approach Guard Railing, and Transition to Bridge Rail

Provide end terminals, approach guard railing, and guardrail-to-bridge rail transitions in accordance with the "*Pre-Construction Manual.*"

See Section 5.6 for bridge rail requirements.

3.9 Signage, Marking, and Striping

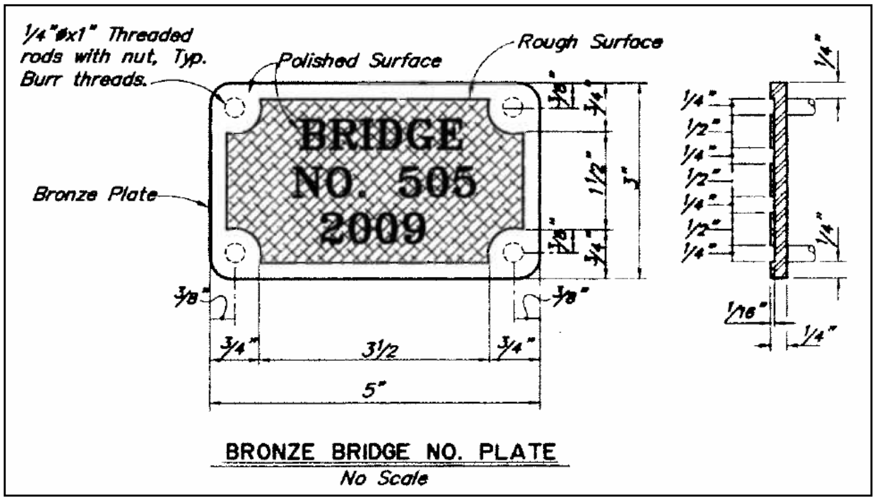
All bridges shall be marked and signed as outlined in the ATM. In certain cases this may include:

- Narrow bridge
- Speed restrictions
- Load limits

Identify all bridges with a number assigned by the DOT&PF. The bridge number and year of construction shall be displayed on a bronze plate as shown in Figure 4.9, permanently affixed to the structure near each end, on the right-hand side of approaching traffic. The exact location of plates will be determined by the MSB.

[6] In the absence of other published criteria or a specific directive from the MSB, the minimum width may be reduced to six feet if the ADT is less than 400 and the bridge length is less than 40 feet.

Figure 4.9 – Bronze bridge number plate - example
Use bronze conforming to American Society of Testing Materials (ASTM) B98, Alloy “A” or “B”. Use “Century” font. Braze ¼” diameter threaded rod to back of plate. Use locking nut or lock washers with nuts. Rod and hardware shall conform to Unified Numbering System (UNS) C65100 or C65500.



3.10 Durability and Corrosion Control

Comply with BDS requirements for durability. All new bridges shall be evaluated for corrosion control requirements. Structural steel members shall be coated, galvanized or constructed from weathering steel. Provide coated or galvanized reinforcing bars in concrete components subjected to deicing salts or salt water. Provide adequate concrete cover and/or membranes to protect reinforcing bars. Provide positive drainage to direct runoff from the deck away from beam seats, bearings, and other structural members. If foundation members are located in tidal-influenced saltwater or brackish water, provide a cathodic protection system such as sacrificial anodes or other means of protection. The geotechnical report shall address the corrosivity of soil and ground water and their effects on foundation elements.

A written corrosion control study outlining the above and additional items as applicable to the specific crossing shall be submitted in the preliminary design stage of the project.

3.11 Study Phase Submittals

Provide study phase submittals to the MSB DPW. Study phase submittals are subject to DPW approval and shall include:

- Survey of existing site along with proposed new structure location
- Accident analysis
- Foundation report
- Hydraulic and hydrology report
- Permitting and environmental study

3.12 Design Phase Submittals

Provide design phase submittals to the MSB DPW. Design phase submittals are subject to DPW approval and shall include:

- Preliminary design with functional geometry and load ratings
- Structural computations
- Corrosion control study
- Erosion and sediment control plan (ESCP)
- Final design drawings and specifications
- Record or as-built drawings
- Engineer’s estimate of quantities and cost

A Professional Engineer registered in the State of Alaska and proficient in bridge engineering shall seal all final bridge design documents, including drawings, special provisions, and structural computations.

4 Hydraulics and Hydrology

4.1 General

Stream crossing structures must provide for the passage of flood flows, ice movement, sediment transport, debris transport and fish passage. In addition, the design must protect the bridge foundation, adjacent stream banks, and not present a safety hazard to people. In recent years, due to the failure of bridges from scoured foundations during large flood events, the National Transportation Safety Board (NTSB) has placed increased emphasis on special attention to design and maintenance of scour processes in the vicinity of bridge foundations.

Conform to the requirements of the following publications:

- *Alaska Highway Drainage Manual*[7]
- BDS[8]

The design process shall include hydraulic and hydrologic studies and assessment as a part of the preliminary plan development. At a minimum, this shall include the following elements:

- A site-specific hydraulic survey including cross sections,
- Identifying the hydraulic history of the site including previous flood events and historical high-water elevations,
- Developing the design flood events and low water flow,

[7] The *Alaska Highway Drainage Manual* is available online at the DOT&PF web site. It is based in part on the predecessor to the BDS.
[8] BDS Section 2.6 “Hydrology and Hydraulics” contains a complete outline of appropriate hydrology and hydraulic design criteria. Other sections refer to scour and foundation design.

- A hydraulic analysis including the effects of the new bridge in regard to high-water elevation, energy grade elevation, energy slope, and channel velocity,
- A scour analysis including the effects of channel contraction and pier and abutment scour depths,
- Abutment and bank protection including the size of riprap material, embankment slope and placement of armoring,
- Features as may be required for fish passage, ice movement and debris accumulation Coordinate fish passage analysis with State of ADF&G, Habitat Division,
- Coordination with the geotechnical engineer

A report outlining the above listed items and sealed by an engineer registered in the State of Alaska shall be provided.

4.2 Hydraulic Site Survey and Site information

For each new bridge a hydraulic site survey shall be performed. This shall include:

- Provide a basis of survey including coordinate system, north arrow, survey monuments and project datum elevation.
- Identifying OHW elevation. Include a description of high-water evidence such as a distinct mark on the bank, erosion, shelving, changes in vegetation or other distinctive characteristics.
- A minimum of four cross-sections downstream and three upstream of the structure. Cross-sections are taken normal to the flow direction that defines the floodplain. The cross sections shall include the banks and channel bottom structure. They shall be spaced approximately one channel width apart. Each cross section shall be long enough to encompass the limits of the 500-year floodplain.
- A survey of horizontal and vertical location of other private and public structures that may be affected by the project and/or the hydraulic structure's performance. This may include downstream crossing if the new crossing will increase the channel cross section and remove a restriction to channel flow.

4.3 Hydraulic History of the Site

For each new bridge identify and outline the hydraulic history of the site. This shall include records of past floods, available United States Geological Survey (USGS) records, local observations, high water marks and other historical data.

4.4 Design Flood Event

Develop the flood magnitude estimations for the site, including the 50-, 100-, and 500-year flood events. This shall include the estimated flow rates and elevation for each event. Hydraulic Analysis

Model the 50-, 100-, and 500-year floods, and note design high water elevation, energy grade elevation, energy slope, channel velocity and Froude number. In most cases a one-dimensional

Hydrologic Engineering Centers River Analysis System (HEC–RAS) computer model will suffice for this. Both the existing condition and the condition with the proposed bridge shall be modeled.

Conduct a floodplain study and compare the results to FIRM maps, to determine what the backwater elevation increases will be as a result of the bridge. Provide design methods to alleviate unwanted increases.

4.5 Scour Analysis

Analyze scour potential for the proposed structure for the 100-year and 500-year floods, including estimated degradation, contraction, abutment, and pier scour depths.

Provide counter measures for scour.

4.6 Ice Analysis

Report shall recommend ice thickness and strength for structural design of piers. Provide recommendations for use with BDS ice load provisions.

4.7 Clearance

The minimum vertical clearance between the lowest member on the structure (low chord) and the 100-year flood shall be 3 feet, except where larger clearance is required by the USCG for navigable waterways. The designer shall also consider whether larger clearances are required for debris, ice, and aufeis, based on the environment and the potential for ice or log jams.

The hydraulics and hydrology report shall specify the clearances required for bridge design.

4.8 Abutment and Bank Protection

Provide the size of rip rap required, the method of placement (to include geotextile or filter fabric underlayment), the extents of the protected areas, and the depth of the key and length of toe.

Vegetative streambank stabilization measures should be employed where flow levels are appropriate.

4.9 Fish Passage Analysis

Determine whether the stream contains anadromous fish or not. ADF&G, Division of Habitat, maintains a catalog of waters deemed important to the spawning, rearing or migration of anadromous fish. If the stream in question is listed by ADF&G as anadromous, provide a bridge or a fish passage culvert in accordance with Section 7 of this chapter, and coordinate with the ADF&G, Habitat Division for construction permitting.

4.10 Storm Water Drainage

The bridge structure and approaches must conform to the current Alaska Storm Water Regulations, both for the construction and in service maintenance periods.

5 Structural[9]

5.1 General

Design new bridges, including buried structures such as culverts, in accordance with the BDS, as modified herein.

Bridge design and construction shall be based on the materials and other requirements described in the "*SSHC"* as modified herein.

5.2 Deck

Bridge decks shall be cast-in-place or pre-cast reinforced concrete at least 6 inches thick. All reinforcing steel in the deck shall be epoxy-coated (for precast girders this includes the stirrups). The concrete cover on reinforcing steel in cast-in-place and pre-cast decks shall be at least 2.5 inches. Use a full-width membrane on all concrete bridge decks, overlaid with four inches of asphalt[10]. Include 50 psf for the total dead load of surfacing on concrete decks.

Open-grid steel decks shall not be used.

Stay-in-place forms may be used only with the prior approval of the MSB.[11]

If the ADT is less than 400[12], then a preservative-treated timber deck conforming to the BDS and Section 5.5 may be used. Unless otherwise permitted by the MSB, timber decks shall be provided with a bituminous wearing surface at least two inches thick in accordance with the BDS (either plant mix asphalt or chip seal). An allowance of 26 psf for the dead load of future surfacing on timber decks is required.

[9] Most of these requirements are from the DOT&PF *Pre-construction Manual* (as of 2013) and comments by DOT&PF on this document. The *Manual* requirements have been modified to improve clarity and to change references to the chief bridge engineer, the state foundation engineer, and the state geotechnical engineer.
[10] This allows future milling operations without damaging the membrane.
[11] Stay-in-place forms are discouraged because they hinder future inspection of the under-side of the deck. Stay-in-place forms have been accepted on a case-by-case basis in Alaska – most often in steel box girders, where they also improve lateral and torsional stiffness during construction.
[12] A road with an ADT less than 400 is considered to be a very low volume road. For example, in a suburban setting, a local road with an ADT of 400 might serve 40 residences.

5.3 Superstructure

The bridge superstructure (girders, beams, diaphragms) shall be reinforced concrete, pre-stressed concrete, or steel. See Section 5.10 for use of rail cars and other non-bridge components for bridge superstructure.

Exception: if the ADT is less than 400, and if not prohibited by environmental permit requirements, then the bridge superstructure may be preservative-treated timber. See Section 5.5 regarding the use of preservative-treated wood.

5.4 Substructure

5.4.1 Materials

The bridge substructure (abutments, piers, foundations) shall be constructed from any combination of the following materials:

- cast-in-place or pre-cast reinforced concrete or pre-stressed concrete,
- steel piles,
- reinforced concrete piles or piers.

Also, Mechanically Stabilized Earth (MSE) systems may be used to support abutments of bridges, under the following conditions:

- MSE systems are prohibited at all water crossings,
- if used for multi-span bridges, differential settlement between piers and abutments shall be addressed in the geotechnical report and the structural computations,
- if piles are used with MSE systems, the geotechnical report and structural computations shall consider vertical and lateral interactions between the two components.

Exception: if the ADT is less than 400, and if not prohibited by environmental permit requirements, then preservative-treated wood abutments and piers may be used, including preservative-treated timber piles. See Section 5.5 regarding the use of preservative-treated wood.

5.4.2 Elastomeric bearings

Elastomeric compounds used in the construction of bridge bearing pads shall contain only virgin natural polyisoprene (natural rubber) as the raw polymer. Do not use Neoprene. The prohibited use of Neoprene is unique to the MSB. ASBM allows for the use of Neoprene depending on the availability of natural rubbers. Use design method “B” in accordance with BDS Article 14.7.5.

5.5 Use of preservative-treated wood

As noted in previous sections, preservative-treated wood may be used for bridge components if not prohibited by environmental permit requirements. In addition, notwithstanding the requirements of SSHC Section 714:

- All treated wood products in this project[13] shall be produced in compliance with the BMP.
- All treated wood in this project shall be certified by an independent third-party inspection agency to have been produced in compliance with the BMPs.
- Bridge construction contract documents shall require the contractors and pertinent sub-contractors to be familiar with and apply as appropriate the installation and maintenance guidelines in the BMPs.
- Do not use creosote-treated wood for components subject to frequent public contact (such as pedestrian/equestrian/bicycle railing).

5.6 Bridge rail

Of the multiple rail options provided in the Alaska Bridges and Structures Manual (ABSM), the MSB requires the use of DOT&PF "Alaska Multi-State Bridge Rail" unless an alternative is approved or directed by the MSB.[14] At culverts, alternatively use a traffic barrier that complies with the *"Pre-Construction Manual."*

Bridges on residential and collector roads or bridges with pedestrian pathways shall have a rail with a minimum height of 42" and gaps between post no greater than 4" where the pedestrian traffic will be located.

5.7 Design live loads

5.7.1 Typical live load

The design live load shall be HL-93[15] for bridges on all of the following:

- major hauling routes
- routes to major shipping points
- routes to resource areas
- routes to an industrial site

The MSB will identify bridges on these routes.

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[13] As of 2020, the *SSHC s* only require "timbers" to be produced in compliance with the BMPs; they do not require glued-laminated products and piling to be produced in compliance with the BMPs.

[14] Some other crash-tested rail (such as a concrete shape) may be desirable in some circumstances; such bridge rail shall comply with NCHRP 350 Test Level Three. These requirements are from the *"Pre-Construction Manual"* (as of 2013). NOTE: on very low volume, low speed local roads, Test Level One may be appropriate since, according to the BDS ¶13.7.2, p. 13-7, Test Level One is "taken to be generally acceptable for…very low volume, low speed local roads."

[15] This is the current design load required by DOT&PF and the BDS for highway bridges. The HL-93 loading corresponds to a uniform lane load plus a tractor-trailer weighing 36 tons or a single tandem trailer with closely spaced axles weighing 25 tons.

Also, the design live load shall be HL-93 for:

- bridges with total span of 100 feet or more between abutment bearings
- bridges with two or more traffic lanes in each direction
- any bridge funded in whole or part by federal aid
- any other bridge specifically identified by the MSB to be designed for HL-93

5.7.2 Reduced live load for low truck-volume roads[16]

If the Average daily truck traffic (ADTT) is between 100 and 1000, inclusive, then 95 percent of the force effect of HL-93 may be used for design, and if the ADTT is less than 100, then 90 percent of the force effect of HL-93 may be used.

No other reductions in design live load will be allowed, regardless of traffic volume.

The ADTT and percentage of HL-93 used for design shall be shown on the design drawings.

5.8 Seismic – special requirements

The "*Guide Specifications for LRFD Seismic Bridge Design*" may be used in lieu of the seismic requirements in the BDS.

The ends of the superstructure of simply supported multiple span structures shall be tied together and to the substructure with longitudinal restrainers designed for the force specified in the BDS.

Do not use skew angles for bridges greater than 30 degrees unless approved by the MSB.

Do not use steel rocker bearings.

Provide all bearings with transverse restraints.

Anchor bolts shall not be used to resist lateral loads.

Provide all abutments with a full-width, continuous-bearing seat.

[16] These provisions are from BDS, 2008 Interims, 3.6.1.1.1 commentary, p. 3-18. They will result in slightly more economical bridges for routes with low truck volume while still allowing safe passage of fire trucks, concrete trucks, fuel and water trucks, busses, etc. For reference, Indiana Department of Transportation Design Memorandum No. 07-05, dated March 22, 2007, lists the following approximate weights of typical vehicles: school bus carrying up to 84 passengers (15 tons), loaded garbage truck (27 tons), single-unit fire engine (27 tons), loaded ready-mix-concrete truck (30 tons), and tractor-apparatus fire engine (36 tons). These example vehicle weights have not been verified and should not be used for design.

For concrete abutment and retaining walls, use dowels in addition to normal shrinkage and temperature steel on the compression face to connect the stemwall to footing.
Concrete spread footings for abutments and piers shall have reinforcement in the top face to resist seismic forces. Concrete footing reinforcement in abutments and piers shall be a minimum reinforcement of #8 bars at 8 inches each way, top and bottom.

Extend concrete column reinforcement as far as possible into the pier cap beam and footing.

Splices of vertical concrete column reinforcement shall occur only within the centermost (mid-height) section of columns or in accordance with the *"Guide Specifications for LRFD Seismic Bridge Design."*

5.9 Skewed bridges

In a skewed bridge, the loads tend to distribute to the supports in a direction normal to the support. This causes a greater portion of the load to be concentrated at the obtuse corners of the span and less at the acute corners. The structural computations shall demonstrate that this effect has been evaluated. On concrete girders, additional shear reinforcing shall be provided; on steel girders, additional transverse stiffeners may be required, depending on diaphragm type and location.

5.10 Use of railcars and other non-bridge structures

Use of non-bridge components such as flat rail cars, truck trailers, and landing ramps (all of which are hereafter called "non-bridge components") for the superstructure of bridges is discouraged, whether refurbished or not, and is allowed only under the following conditions:

- ADT is less than 100.
- A Professional Engineer, registered in the State of Alaska, shall evaluate the condition of the non-bridge components and shall rate the non-bridge component's deck and structure capacity in accordance with the *"Manual for Bridge Evaluation"* using the Design Load Rating procedure for the HL-93 loading at the Inventory level.
- Calculated Rating Factor (RF) shall not be less than 0.90.
- In addition to all other required computation submittals, the load rating computations shall be sealed and submitted to the MSB for their records.
- Abutments, deck, bearings, connections, and all other bridge elements shall be designed in accordance with the BDS for at least the rated load.
- The ADT and percentage of HL-93 used for design of the abutments shall be shown on the design drawings.
- The deck wearing surface shall comply with the BDS and shall be preservative-treated timber planks securely fastened to the deck, or plant-mix asphalt or chip seal.
- Bridge rail shall comply with Section 5.6

5.11 Welding

All welding shall be in accordance with *SSHC* Section 504. The minimum level of non-destructive examination is specified in American Welding Society (AWS) D1.5 Section 6.7. The contractor shall provide all required QC inspection and non-destructive examination.

6 Stream Crossing Culverts

6.1 General Requirements

The following criteria apply to all culverts that cross waterbodies, such as rivers, lakes, streams and drainage ways with intermittent flow:

- Prior to preliminary plat submittal, contact the ADF&G, Division of Habitat to determine if a stream reach harbors fish. If so, stream crossing culverts shall be designed, constructed, and maintained according to section 6.2 Fish Passage Culverts.
- Stream crossing culverts shall be placed as close to the pre-existing channel alignment as possible. Avoid placing culverts at pools and stream bends.
- Road alignment shall be as close to perpendicular to the stream channel as possible.
- Culvert slope shall be within 25 percent of the natural stream slope. For example, if the natural stream slope is 1.0 percent, the minimum design slope of the culvert would be 0.75 percent and the maximum design slope would be 1.25 percent.
- Culvert outlet and inlet protection shall be used as necessary to reduce the risk of scour and perching.
- Stream crossing culverts shall be composed of a single pipe or arch for at least the bankful width of the stream channel. Additional width is required for streambanks in fish passage culverts per section 7.1.
- Overflow culverts may be used but should be placed at a higher elevation so that flows up to the ordinary high-water mark (OHWM) pass through the primary culvert.
- Stream crossings shall maintain the connectivity of wetlands adjacent to stream channels and shall accommodate sheet flow within such wetlands.
- Stream crossing culverts shall not interfere with the functioning of floodplains and shall be designed to accommodate the 100-year flow.
- In cases of crossings within high entrenchment ratio environments, the ratio of the flood prone width to the OHW width is greater than 2.2, floodplain overflow culverts may be beneficial to floodplain connectivity and can be used to pass the design flow. Minimum width requirements for the primary culvert still apply.
- Stream crossing culverts shall have a minimum diameter of three feet.
- Stream crossing culvert pipes and arches shall be metal.

- Round stream crossing culverts shall have a minimum invert burial depth in the stream substrate of forty percent (40%) of the culvert diameter, as measured from the thalweg.
- Box culverts and pipe arch culverts, should have a minimum invert burial depth of twenty percent (20%) of the culvert’s rise into the substrate.
- Bottomless culverts with footers need to have sufficient burial depth and armor material to protect the footings from potential scour over the life of the structure.
- Culverts longer than 100 feet require appropriate maintenance access.

6.2 Fish Passage Culverts

These criteria provide general design guidance for road, pathway or other crossings of fish-bearing streams using culverts to maintain the full hydrologic functioning of the water body they are crossing. Site-specific conditions, such as multi-thread or braided channels, may require alternate design approaches, such as a bridge.

6.2.1 Pre-design Conference

For privately owned roads, schedule a fish passage pre-design conference with DPW prior to permit submittals. The pre-design conference is to:

- determine required permits,
- coordinate interagency requirements,
- determine any site-specific design requirements; and
- establish a plan review process.

6.2.2 Stream Simulation Method

Stream simulation methodologies shall be used for the design of all fish-bearing stream crossings. The stream simulation method uses reference data from a representative section, or reference reach, of the specific water body crossed. This method attempts to replicate the natural stream channel conditions found upstream and downstream of the crossing. Sediment transport, flood and debris conveyance, and fish passage are designed to function as they do in the natural channel.

Reference Reach Investigation

- The design engineer shall select a reference reach on the water body being crossed that is outside any anthropogenic influence, such as an existing culvert. In most cases for new crossings, the reference reach can be at the crossing location.
- The length of the reference reach should be a minimum of 20 times the reference bankfull width and no less than 200 feet and shall include at least 3 stable grade control features.
- If there is not a suitable reference reach on the water body being crossed, a reference reach may be chosen from another water body with similar geomorphic and hydrologic

characteristics. The reference reach characteristics should meet the following criteria in comparison to the water body being crossed:

  - The reference reach bankfull width should be at least one-half and no more than two times that of the water body being crossed.
  - The reference reach bankfull discharge should be at least one half and no more than one- and one-half times the bankfull discharge of the water body being crossed; and
  - The stream order of the reference reach should be within one stream order of the water body being crossed.

- For a reference reach from another water body, the geomorphic characteristics of the crossing shall be scaled using ratios of the bankfull conditions.
- The reference reach bankfull dimensions should be determined in the field by surveying a detailed cross section at the upper 1/3 of a representative riffle.
- Reference data shall include, at a minimum:
- channel width at OHW,
- bankfull width,
- bankfull cross-sectional area,
- bankfull slope based on the longitudinal profile,
- substrate, and
- potential for floating debris.

Culvert Size, Slope, and Substrate

In addition to the criteria identified in Section 6.1, the following criteria apply to all fish passage culverts:

- **Minimum Sizes:** Round culvert pipes shall have a minimum diameter of seven (7) feet and full-invert box arch culverts should have a minimum height of seven (7) feet. Culverts shall have a minimum vertical clear distance of four (4) feet from the constructed stream thalweg to the top of the culvert.
- Under normal flow conditions, the channel within or under the fish passage culvert shall not differ from the reference reach condition in regard to the channel width at OHW, cross-sectional area, slope, substrate, and ability to pass floating debris.
- The width of fish passage culverts shall not be less than the greater of 1.2 times the channel width at OHW and 1.0 times the bankfull width.
- The use of smooth wall culverts is prohibited.
- The use of trash racks or debris interceptors is prohibited.
- Round culvert pipes shall have a minimum invert burial depth of 40 percent of the culvert diameter into the substrate. Arch or box culverts shall have a minimum invert burial depth

of 20 percent of the culvert's rise into the substrate, unless scour analysis shows less fill is acceptable. The minimum invert burial depth is one foot.

- **Substrate Material:** The gradation of the substrate material within a fish passage culvert shall be designed to be a dense, well-graded mixture with adequate fines to ensure that the majority of the stream flows on the surface and the minimum water depth is maintained. The combined gradation should have a minimum of 5% passing the #10 sieve (2mm).
- Substrate material within or under the fish passage culvert shall remain dynamically stable at all flood discharges up to and including a 50-year flood. Dynamic stability means that substrate material mobilized at higher flows will be replaced by bed material from the natural channel upstream of the crossing. For crossings without an adequate upstream sediment supply, the substrate material within the crossing shall be designed to resist the predicted critical shear forces up to the 100-year flood. For culverts in sand bed channels or with a slope of 6 percent or greater, substrate retention sills may be required to allow the bed load to continuously recruit within the culvert.
- If substrate retention sills are used, they shall have a maximum weir height of one half of the culvert invert burial depth. Substrate retention sills shall be spaced so that the maximum drop between weirs is 4 inches. The use of sills without substrate is not allowed.
- **Low Flow Channel**: Substrate material within or under the fish passage culvert shall incorporate a low flow channel. The low flow channel should mimic the reference reach where possible. If the low flow channel dimensions are not discernable from the reference reach, the low flow channel should have a cross-sectional area of 15 to 30 percent of the bankfull cross-sectional area and a minimum depth of 4 inches for juvenile fish and 12 inches for adult fish. The low flow channel should be defined by rock features that will resist critical shear forces up to the 100-year flood.
- **Streambanks**: Except as listed below, constructed streambanks shall be included inside fish passage culverts to protect the culvert from abrasion, provide resting areas for fish, capacity for flood stage flow increases and provide for small mammal crossing. The streambanks shall be constructed of rock substrate designed to be stable at the 100-year flood. The streambank width should be a minimum of 1.5 times the maximum sieve size of the streambed material (D_{100}). The crossing culvert width shall be increased to allow for the channel width plus the streambanks.
- Streambanks are not recommended for the following locations:
    - Sand bed streams
    - Low slope (<1%) wetland complexes
    - Permafrost and aufeis areas
    - Streams with significant ice floes

7 Appendices

7.1 Appendix 1 - Bridge Final Design Check List

Bridge Final Design Checklist

№	DESCRIPTION	PREPARED	DATE
1.	Check Stationing against the roadway plans for each bridge structure: Bridge №: _____, Station ____________________. Bridge №: _____, Station ____________________. Bridge №: _____, Station ____________________.	__________ __________ __________	______ ______ ______
2.	Check profile grade against the roadway plans for each bridge structure: Bridge №: _____, elevations at begin _____, end _____. Bridge №: _____, elevations at begin _____, end _____. Bridge №: _____, elevations at begin _____, end _____.	__________ __________ __________	______ ______ ______
3.	Does the Hydraulic and Hydrologic Summary Table match the Final Hydraulic and Hydrologic Report?		
4.	Does Foundation Summary Table match the Final Foundation Engineering Report?		
5.	Does the bridge naming conform to standards		
6.	Have all of the bridge components been addressed in the Specifications for material requirements, construction tolerances, method of payment, etc?		
7.	Do the bridge plans sheets have the following titles? • General Layout • Site Plan • MSE / Retaining Wall / Foundation Layout • Abutments • Abutment Details • Piers • Pier Details • Typical Section • Framing Plan • Girders • Girder Details • Miscellaneous Details • Approach Slabs • Steel Bridge Railing • Log of Test Holes		
8.	Is the bridge number provided on all bridge plan sheets?		
9.	Does the vertical clearance under the bridge satisfy the DCM requirements?		
10.	Are all of the plans stamped and signed by the Engineer of Record?		
11.	Are all plans readable when reduced in size?		

12.	Have all of the applicable standard plans been identified?		
13.	Has all specifications language been included in the specifications and NOT on the plan sheets?		
14.	Has staged construction and traffic control been shown if required?		
15.	Have all cross references between plan sheets been verified?		
16.	Have bridge railing to roadway guardrail transitions been addressed?		
17.	Have provisions been made for current and future utilities (always inboard of the fascia girder) and blockouts in the diaphragms and backwalls?		
18.	Have bridge mounted utilities been shown and properly identified on the plans?		
19.	Are reinforcing steel schedules / bend diagrams provided on the bridge plans?		
20.	Check for embankment treatment (matching of dirt to wall) at abutments and wingwalls.		
21.	Check for side slope consistency or transition from roadway slopes (____) to bridge side slopes at abutment (____).		
22.	Have the Plans, Specifications, and Estimate been compared against one another and checked?		
23.	Do all of the pay item names and numbers match the specifications?		
24.	Is the terminology used throughout the PS&E used appropriately and consistently?		
25.	Is the PS&E free of brand names, product names, trade names, and other proprietary items?		
26.	Are all estimated quantities appropriately rounded?		
27.	Have nonstandard practice and items of work been reviewed and approved by the MSB?		