

Ontario Structure Inspection Manual (OSIM)



MINISTRY OF TRANSPORTATION

TRANSPORTATION INFRASTRUCTURE MANAGEMENT
DIVISION
CONTRACTS AND STANDARDS BRANCH
STRUCTURES OFFICE
April 2026

ISBN XXX-X-XXXX-XXXX-X

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RECORD OF REVISIONS

RECORD OF REVISIONS

November 2003 Revisions

The purpose of these revisions was:

- to clarify the level of detail required during the inspection,
- to redefine Asphalt defects in term of top-down and bottom-up defects,
- to clarify the Condition State Table for inspection of asphalt covered concrete decks,
- to clarify recommended work and add a 6-to-10-year timeframe for recommended work,
- to address other minor clarifications.

April 2008 Revisions

The purpose of these revisions was:

- to clarify the definition of biennial inspection and of culverts,
- to revise wood defects and defects related to soil steel structures,
- to change the units of measure for some bridge elements and to add some elements as optional.
- to change the way recommended work is recorded for elements and for the overall structure.
- to address other minor clarifications.

May 2018 Revisions

The purpose of these revisions was:

- to clarify inspection of light pole anchorages,
- to address other minor clarifications, and errors
- to reformat the entire document for clarity and Accessibility requirements
- to add Field Review Inspections for non-MTO structures
- to amalgamate with the Retaining Wall Inspection Guidelines, July 2005

(February 2026) Revisions

The purpose of these revisions was:

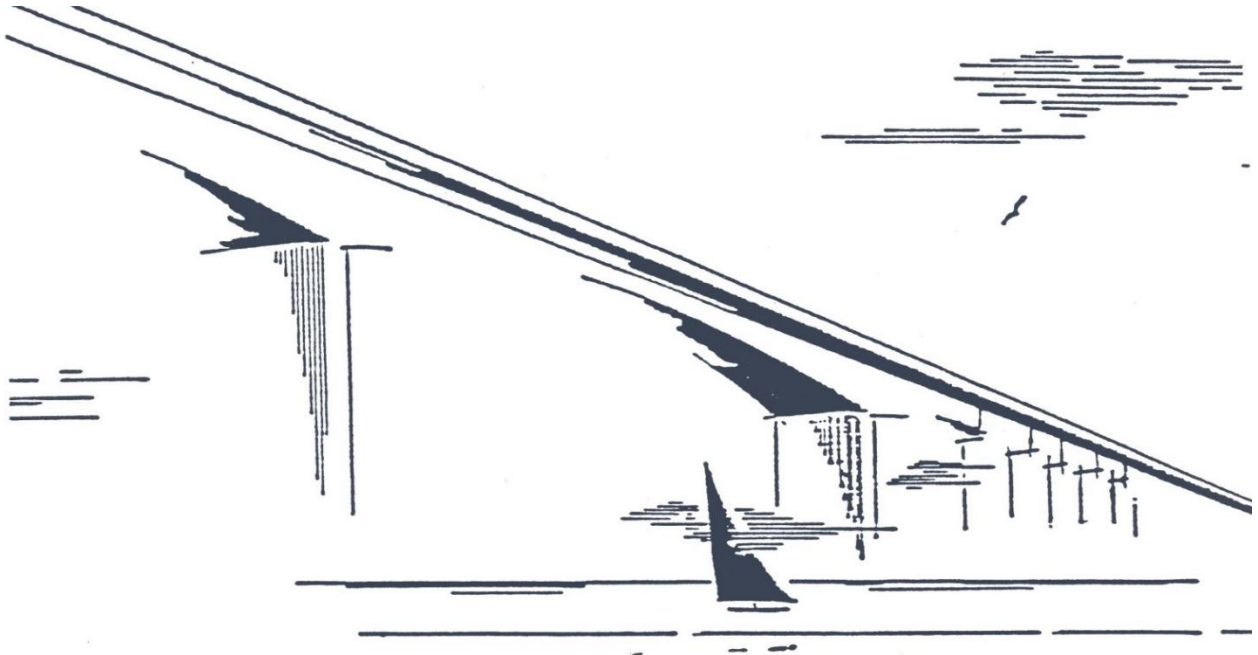
- To provide more clarity on the frequency and duration of inspections
- To provide more clarity on the differences between Regular OSIM inspections and Enhanced OSIM inspections
- To add Drone and thermal camera information as a resource for biennial inspections
- To update outdated or unclear photos throughout the manual
- To add delayed ettringite formation as a concrete defect
- To clearly describe the downgrading of elements from excellent to good and the timelines for the transition

RECORD OF REVISIONS

- To provide organizational clarity to the document for new inspectors and to have consistent wording between OSIM, inspection reports, and the BMS system
- To refine the definitions of element environment types and provide an element table listing examples
- To add Critical Element information as an additional criterion for inspections
- To update the Forms section such that it follows the same format as the inspection report for better consistency between the mediums.
- To update the inspection report to reflect changes in the manual
- To revise qualifications of inspectors for MTO and non-MTO structures
- To address other minor clarifications and errors
- To reformat the document for clarity and accessibility requirements
- To update the Field Guidelines to reflect changes made in manual
- Removed inspector's responsibility to recommend major capital work
- Removed unused appraisal indices
- Removed Live Loads section (previously section 1.14)
- To add water testing requirements



Ministry of
Transportation



ONTARIO STRUCTURAL INSPECTION MANUAL

(OSIM)

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PREFACE

The Ontario Structure Inspection Manual has been used for bridge inspections in Ontario since 1985. The manual underwent significant modifications in the year 2000. The manual will continue to evolve, and comments and suggestions will be recorded and, if necessary, revisions will be made.

NOTATIONS

NOTATIONS

AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highways and Transportation Officials
ACR	Atmospheric Corrosion Resistant
AREMA	American Railway Engineering & Maintenance of Way Association
ASTM	American Society for Testing and Materials
AWPA	American Wood Preservers Association
BCI	Bridge Condition Index
BMS	Bridge Management System
CDED	Contract Design, Estimating and Documentation
CHBDC	Canadian Highway Bridge Design Code, CSA S6
CNWA	Canadian Navigable Waters Act
CPCI	Canadian Prestressed Concrete Institute
CPS	Contract Preparation System
CSA	Canadian Standards Association International
CSP	Corrugated Steel Pipe
DA	Design Aids
DD	Design Details
DOT	Department of Transportation
DSM	Designated Sources of Materials
ERT	Effective Rubber Thickness
FHWA	Federal Highway Administration
FIDR	Foundation Investigation and Design Report
FLS	Fatigue Limit State
GFRP	Glass Fibre Reinforced Polymer
HPC	High Performance Concrete
HSS	Hollow Structural Section
HWL	High Water Level
kN	Kilonewton
m	Metre
MASH	Manual for Assessing Safety Hardware
mm	Millimetre
MPa	Mega Pascals
MSE	Mechanically Stabilized Earth system (also known as RSS)
MTOD	Ministry of Transportation of Ontario Drawing
MUP	Multi-Use Path
NCHRP	National Cooperative Highway Research Program
NSSP	Non-Standard Special Provision
NTS	Not to Scale
OHBDC	Ontario Highway Bridge Design Code
OSIM	Ontario Structure Inspection Manual
OPSD	Ontario Provincial Standard Drawing
OPSS	Ontario Provincial Standard Specifications
PI	Point of Intersection
PTFE	Polytetrafluoroethylene Polymer
RSS	Retained Soil System (also known as MSE)

NOTATIONS

ROV	Remotely Operated Vehicle
SC	Spiral to Curve
SLS	Serviceability Limit States
SPCSP	Structural Plate Corrugated Steel Pipe
SS	Structural Standard
SSD	Structural Standard Drawing
SSP	Standard Special Provision
TAC	Transportation Association of Canada
TC	Tangent to Curve
TL	Test Level
TMB	Temporary Modular Bridge
TTI	Texas Transportation Institute
ULS	Ultimate Limit States
WP	Work Project/Working Point
WWR	Welded Wire Reinforcement

INTRODUCTION

INTRODUCTION

The need for mobility requires that Ontario's highway system be kept in good repair. Structures are a vital part of this system. The efficiency of the system is impaired and the public inconvenienced if a structure fails or its load-carrying capacity is reduced for any reason. To avoid such failings, an effective structure management system is required.

An essential input of a structure management system involves the systematic inspection of the structures on the highway network.

This manual sets standards for detailed visual inspection and condition rating of structures and their elements. It provides a uniform inspection approach for all structures in Ontario.

- Part 1** outlines the manual's purpose, the types of structures included, inspection frequencies and recommended timing, the types of detailed visual inspections, and descriptions of key components and elements.
- Part 2** sets out requirements for detailed visual inspection and condition rating of structures and their elements.
- Part 3** provides guidelines for the need to carry out further investigations and special studies.
- Part 4** describes various types of procedures and equipment for the non-destructive testing of materials and provides guidelines and requirements for carrying out these tests.
- Part 5** provides guidelines and requirements for underwater investigations.

INTRODUCTION

GENERAL DEFINITIONS

- Abutment - A substructure unit which supports the end of the structure and retains the approach fill.
- Auxiliary Components - A component of a structural system that does not constitute part of the intended load-sharing system. Note: Auxiliary components include expansion joints, approach slabs, rails and barriers, and deck drains.
- Biennial Structure Inspection - An inspection performed in every second calendar year to assess the condition of the structure, in accordance with the methodology described in OSIM.
- Bridge - A structure which provides a roadway or walkway for the passage of vehicles, pedestrians, cyclists, or animals across an obstruction, gap or facility and is greater than or equal to 3 m in span.
- Bridge Condition Index - The Bridge Condition Index (BCI) is an index developed and used by the Ministry of Transportation to rate a structures condition and help to prioritize capital works within a a large structural inventory. The BCI is calculated using asset management principals based on the remaining economic worth of the bridge. It is based on the premise that a bridge starts at a new condition and deteriorates to a lower condition with time. It uses actual inspection condition data from the various bridge elements and lowers the overall bridge condition as the elements degrade and have a lower economic value. Further information on the BCI can be found in other MTO documents.
- Bridge Mounted Signs - Bridge Mounted Signs are signs that are attached to the bridge with MTO standard attachments (Type I, Type II, Type III) as described in the Ontario Sign Support Manual.
- Chord - The upper and lower main longitudinal member in trusses or arches extending the full length of the structure.
- Coating - The generic term for paint, lacquer, enamel, sealers, galvanizing, metallizing, etc.

INTRODUCTION

Concrete Deck Condition Survey

- A detailed inspection of a concrete deck in accordance with the Structure Rehabilitation Manual

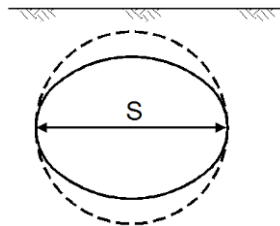
Critical Elements

- An element whose failure would be expected to result in collapse or the structure, or in a significant loss of load-carrying capacity, stability, or serviceability of the bridge.

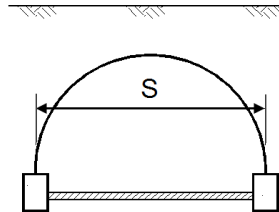
Culvert (Major)

- All culverts are structures that forms an opening through soil. Culverts discussed in this manual also must meet the following and are considered to be major culverts:

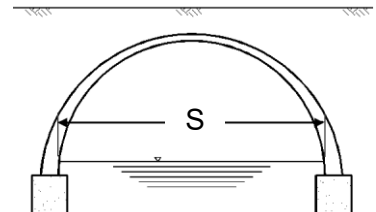
- a) Has a span of 3 metres or more (e.g., S in the diagrams below), or



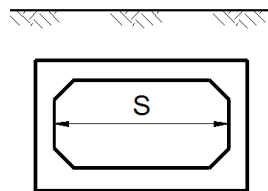
i – Soil Steel (Any Shape)



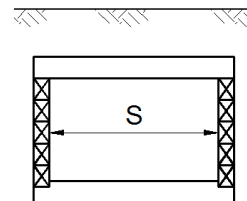
ii – Soil Steel Arch



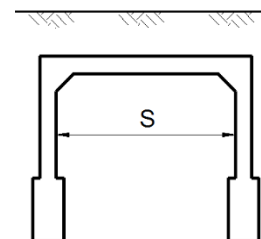
iii – Concrete Barrel Arch



iv – Concrete Box



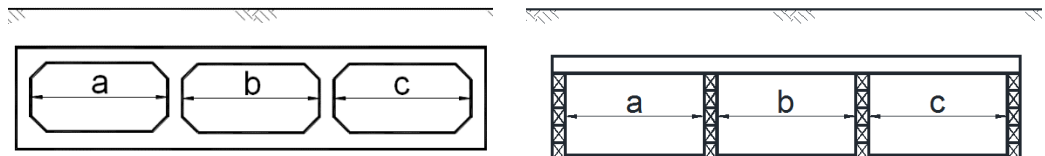
v – Timber



vi – Concrete Open Footing

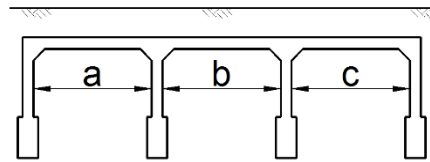
- b) Has the sum of the individual spans of 3 metres or more, for adjacent multiple cell culverts (e.g., $a+b+c$ in the diagrams below), or

INTRODUCTION



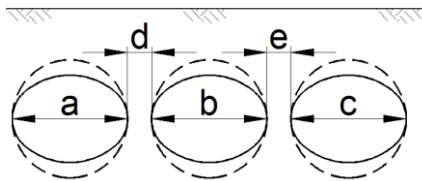
i – Concrete Box

ii – Timber

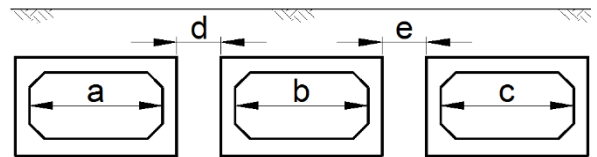


iii – Concrete Open Footing

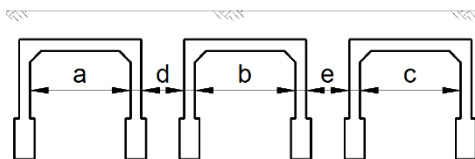
- c) Has the sum of the individual spans of 3 metres or more, for multiple cell culverts (each with spans at least 2 m) separated by soil (a width not more than the span of smallest individual cell) (e.g. $a+b+c$ in the diagrams below, where a , b , and c are all $\geq 2.0\text{m}$ and d and e are both \leq the minimum of a , b , and c), or



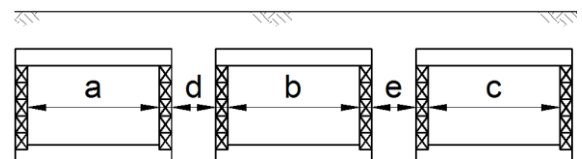
i – Multi-Cell Soil Steel



ii – Multi-Cell Concrete Box



iii – Multi-Cell Concrete Open Footing



iv – Multi-Cell Timber

- d) Has been designated by the Owner as qualifying as a culvert.

Culverts that do not meet these requirements are considered minor culverts and within the MTO are managed as a highway asset.

INTRODUCTION

A bridge Owner may choose to apply only criteria a) with a criteria of >3 m as the definition.

- Defect - An identifiable, unwanted condition that was not part of the original intent of design.

- Detailed Visual Inspection - An element-by-element visual assessment of material defects, performance deficiencies and maintenance needs of a structure.

- Deterioration - A defect that has developed over a period of time.

- Diagonals - Element which spans between the top and bottom chord of a truss or arch in a diagonal direction.

- Distress - A defect produced by loading.

- Elements - The individual parts of a structure defined for inspection purposes. Several bridge components may be grouped together to form one bridge element for inspection purposes

- Engineer - A member or licensee of the Professional Engineers of Ontario.

- Environment - -An element's exposure to salt spray:
 - Benign - Not exposed (e.g., River Pier)
 - Moderate - Exposed but element protected.
(e.g., Asphalt covered and waterproofed deck)
 - Harsh - Exposed and element not protected. This includes elements that are within 5 meters of a traveling lane.
(e.g., Exposed concrete deck, Barrier Wall)

- Evaluation - The determination of the load carrying capacity of structures in accordance with the requirements of the Canadian Highway Bridge Design Code.

INTRODUCTION

- Floor Beam - Transverse beams that span between trusses, arches or girders and transmit loads from the deck and stringers to the trusses, arches, or girders.
- Highway - A common and public thoroughfare including street, avenue, parkway, driveway, square, place, bridge, designed and intended for, or used by, the general public for passage of vehicles, pedestrians, or animals.
- Lateral Bracing - Bracing which lies in the plane of the top or bottom chords or flanges and provides lateral stability and resistance to wind loads.
- Maintenance - Any action which is aimed at preventing the development of defects or preventing deterioration of a structure or its elements.
- Masonry - Structure made up of natural stones separated by mortar joints, usually in uniform courses. Masonry in existing structures is usually in retaining walls, abutments, piers, or arches.
- Masonry Ashlar - Stone worked to a square shape or cut square with uniform coursing height and vertical joints staggered. The stone has a minimum course height of 200 mm set in joints with an average thickness of 10 mm or less.
- Masonry Squared Stone - Stone in natural bed thicknesses or roughly squared stones with course height less than 200 mm and joints greater than 10 mm but not over 20 mm.
- Masonry Rubble - Stone masonry constructed with rough field stones or only roughly squared stones set in mortar joints with average thickness greater than 20 mm. Also, any squared stone masonry in which the joints are greater than 20 mm, but less than 30 mm in thickness.
- Minister - The Minister of the Ministry of Transportation of Ontario or his nominee.
- Ministry - The Ministry of Transportation of Ontario
- Non-Critical Element - An element for which sufficient redundancy exists such that its failure would not be expected to result in collapse or a significant loss of load-carrying capacity, stability, or serviceability of the structure.

INTRODUCTION

- Overhead - A structure that carries MTO highway spanning over railway tracks and under the Ministry ownership.
- Owner - The entity having responsibility for and control of a bridge or structure.
- Person - An individual, board, commission, partnership, or corporation, including a municipal corporation, and employees, agents, successors and assigns of any of them.
- Plans - All drawings, descriptions, and specifications, being parts of the contract, and all drawings and descriptions produced by the constructor for the erection of a bridge or structure, and all revisions thereto.
- Portal Bracing - Overhead bracing at the ends of a through truss or arch and provides lateral stability and shear transfer between trusses.
- Primary Components - A component of a structural system that performs an essential role in load transfer and, on becoming ineffective, will substantially reduce the load-carrying capacity of the system or cause the collapse of a single-load path structure.
- Rehabilitation - An alteration, strengthening, or treatment of a structure, geotechnical systems/backfill, their component, or system of elements to address a deficiency or extends its service life.
- Repair - Any modification, alteration, retrofitting or improvement to a component of the structure which is aimed at correcting existing defects or deficiencies.
- Retained Soil System (RSS) - A proprietary system listed in the Designated Sources for Materials (DSM) used to retain horizontal loads for applications such as true and false abutment structures, retaining walls and steep slopes; or, to retain vertical loads for application such as embankments over soft ground. Also commonly referred to as Mechanically Stabilized Earth systems (MSE)
- Retaining Wall - An independent structure not connecting to a bridge that holds back fill. A stand-alone retaining wall is retaining wall built not immediately adjacent to a bridge.

INTRODUCTION

- Secondary Components - A component of a structural system that does not have an essential role in load transfer and whose removal from the structure would result in at most a minor redistribution of load effects to adjacent components.
- Sign Support - A metal, concrete or timber structure, including supporting brackets, service walks and mechanical devices where present, which support a luminaire, sign, or traffic signal and which span or extend over a roadway, including overhead span, cantilever, bridge mounted and pole mounted types as well as tolling gantries.
- Span - The horizontal distance between adjacent supports of the superstructure of a bridge, or the longest horizontal dimension of the cross-section of a culvert or tunnel taken perpendicular to the walls.
- Stringers - Stringers span between floor beams and provide the support for the deck above.
- Structure - Bridge, culvert, tunnel, ferry dock, retaining wall (include RSS/MSE wall) or sign support.
- Subway - A structure that carries railway traffic over an MTO highway.
- Suspected Performance Deficiency - A Suspected Performance Deficiency should be recorded during an inspection, if an element's ability to perform its intended function is in question, and one or more performance defects exist.
- Sway Bracing - Vertical bracing spanning between through trusses or arches, or outside of half-through trusses or arches and providing lateral stability and shear transfer between the trusses or arches.
- Tunnel - A structure with a minimum length of 90 m that is constructed below water level or through soil with at least 600mm of fill cover, used to convey vehicles, pedestrians, cyclists, or animals, and is usually incorporated with some design considerations such as special lighting, ventilation, fire protection systems or emergency egress measures.
- Verticals - Elements which span between the top and bottom chords of a truss or arch in the vertical direction.

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PART 1 – TECHNICAL INFORMATION

PART 1 – TECHNICAL INFORMATION**1.1 STRUCTURAL INSPECTIONS****1.1.1 Scope**

This manual applies to Highway Bridges, Culverts with span ≥ 3 m, Tunnels and Retaining Walls, along with other bridge or culvert-related highway appurtenances. This section establishes the goals and objectives of structural inspections, identifies the types of inspections, and clarifies which structures are covered.

This part of the manual outlines the manual's purpose, the types of structures included, inspection frequencies and recommended timing, the types of detailed visual inspections, and descriptions of key components and elements.

1.1.2 Goal And Objectives of Structural Inspections**1.1.2.1 Goal**

The goal of structural inspections is to ensure, within an economic framework, an acceptable standard for structures in terms of public safety, comfort, and convenience.

1.1.2.2 Objectives

The main objectives of Structural Inspections are:

- to maintain structures in a safe condition.
- to protect and prolong the useful life of structures.
- to identify maintenance and repair needs of structures.
- to provide a basis for a structure management system for the planning and funding of the maintenance and rehabilitation of structures.

1.1.3 Inspection Of Structures

To achieve the goal and objectives of structural inspections, detailed visual inspections of bridges should be performed regularly. This manual sets standards for detailed visual inspection and condition rating of structures and their elements and provides a uniform inspection approach for all structures in Ontario.

A detailed visual inspection is an element-by-element “close-up” visual assessment of material defects and performance deficiencies of a structure. It is ultimately assessing the condition of the structure and ensuring that the structure is safe.

In the following subsections the different types of detailed visual inspections will be described as well as the frequency they should be completed, and the minimum duration of time that should be spent on completing them.

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When completing a detailed visual inspection, the inspector must understand the structure's behaviour, span configuration, Critical Elements, and articulation. This knowledge helps identify where critical stresses occur and supports an accurate assessment of deficiencies. Routine inspections also serve to detect changes in condition and verify overall safety. Given this purpose, the need for a qualified inspector to evaluate the structure's condition cannot be overstated.

1.1.3.1 Structures Requiring Structural Inspections

The following structures require routine structural inspections:

- All Bridges (including moveable bridges), Tunnels and culverts with spans greater than or equal to 3 meters. The inspection procedures in this manual do not apply to the mechanical or electrical components of movable bridges.
- Standalone retaining walls that meet any of the following criteria:
 - Exposed wall height greater than 2 metres.
 - Located within twice the wall height of a travelled lane.
 - Failure would cause significant adverse effects (e.g., walls near utilities, near MTO property limits);
 - Retaining superimposed surcharge loads.

Retaining walls are deemed to be “standalone” (and require a site number) when:

- i) They are built away from a structure (bridge, culvert, etc.); or
- ii) They are built immediately beside a structure but are significantly longer than typical. In these cases, a construction joint, differing construction year, material change, or another convenient break should be used to separate the portion associated with the bridge from the standalone wall.

Wingwalls are normally constructed monolithically with bridge abutments and are typically less than 6 metres long.

Concrete Retaining Walls or RSS/MSE systems may be used instead of or in addition to wingwalls. When such retaining walls are built immediately adjacent to a bridge abutment, are reasonably short, and can be inspected or rehabilitated together with the structure, they should be treated as an element of the bridge or culvert rather than as standalone retaining walls.

The inspection of overhead sign support structures (not roadside signs) is covered in the Ontario Sign Support Inspection Manual (OSSIM). Bridge-mounted sign supports and their related hardware must also be inspected in accordance with OSSIM. For efficiency, bridge-mounted components should be inspected during the biennial bridge inspection when the inspector is already on site.

1.1.3.2 Frequency of Regular Inspections

The following structures shall be inspected on a Biennial cycle (every two years):

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- All Bridges, Culverts, and Tunnels with spans of 3 metres or greater.
- All Retaining Walls as described in Section 1.5.1.4.
- All movable bridges.

For culverts with 3 to 6 metre spans or stand-alone Retaining Walls, the inspection interval can be increased to four years if the culvert or retaining wall is in good condition and the engineer believes that the condition will not change significantly before the next inspection.

The timeframe of two years (and four years) refers to calendar years. The inspection may be performed at any time in the calendar year, regardless of when in a prior calendar year the previous inspection was performed. *Example:* If the last structural inspection was completed in June 2025, the next biennial inspection must be completed by December 31, 2027. If the structure is on a four-year inspection cycle, the next inspection must be completed by December 31, 2029.

One of the primary purposes of routine structural inspections is to identify changes in bridge condition.

The frequency of inspections given above, applies to all structures in good repair. The maximum inspection interval and the level of inspection may however vary for certain structures. Some structures may have to be inspected more frequently as directed by the Engineer. Such action can be justified based upon the type of structure, construction details, existing problems or restrictions, and material and performance condition history. Structures or components require more frequent inspection where one or more of the following conditions exist:

- Structures with a high proportion of elements in the Poor Condition state.
- New types of structures or details with no previous performance history.
- Structures with load limits or clearance restrictions.
- Single load path structures.
- Structures with fatigue prone details.
- Structures with fracture critical components.
- Pins and hangers in arch structures.
- Pins in suspended spans and pinned arches.

Often, more detailed investigations and non-destructive testing techniques are required to identify defects for the above cases. The inspector should recommend that these specialized additional investigations be performed, when warranted, as described in Part 3 of this Manual.

1.1.3.3 Inspector Time at Site

The amount of time an inspector spends at a site shall be commensurate with the complexity and condition of the structure being inspected. Key factors influencing inspection duration include, but are not limited to, the size of the structure, number of spans, number and type of elements, and the age and overall condition of the structure.

For newer structures (e.g., less than five years old), changes in condition between inspection cycles may be minimal, and inspection time may be reduced accordingly. Regardless of

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structure age, the inspector must be satisfied that all reasonable efforts have been made to adequately assess the condition of all structural elements.

As a general principle, inspection time is expected to increase as structural size, complexity, and the extent or severity of defects increase, in order to ensure a thorough and accurate assessment of all elements.

The table below provides guidance on the minimum on-site time required to complete a comprehensive inspection for standard structure categories. Actual inspection time may exceed these minimums where site conditions, access constraints, traffic control requirements, or observed deficiencies warrant additional effort.

Table 1.1.1: On-Site Inspection Time - Guidelines

Structure Type	Typical Characteristics	Minimum On-Site Inspection Time
Structural Culvert	Limited number of elements; Length <100m	0.5 hours
	Length > 100m	1.0 hour
Small Bridge	Deck area < 600 m ² ; typically 1–2 spans	1.0 hour
Medium Bridge	Deck area 600–1,000 m ²	1.5 hours
Large Bridge	Deck area > 1,000 m ² ; or complex type or critical structure	2.0 hours +
Bridge in Poor Condition	Any size with widespread, advanced, or critical defects	2.0 – 3.0 hours +

1.1.3.4 Regular OSIM Inspection

A Regular OSIM inspection is defined as an element-by-element detailed visual assessment of material defects, performance deficiencies, and maintenance needs of a structure. This inspection is conducted from ground level using hand tools and ladders, as described in Part 2, Section 2.1.4. Where ground access permits, inspectors shall position themselves close enough to each element to determine its condition through methods such as sounding, touching, and measuring.

When elements cannot be adequately viewed from ground level, inspectors may use ladders, binoculars, or other tools to complete the assessment. This includes components such as bearings, soffits located over live traffic, median barriers, and other areas that are not easily visible by eye, from ground level.

For areas that are inaccessible, such as those above the inspector's reach, over live traffic lanes, or where traffic control is not provided, it is acceptable for the inspector to estimate the condition of the inaccessible portions. Such estimation shall be made by visually comparing these areas with similar element surfaces that were inspected more closely (visually or sounded).

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If, during a Regular OSIM inspection, the inspector observes or suspects a potential defect or performance deficiency in an element that is out of reach and presents a concern for structural safety, the inspector shall arrange for the necessary equipment and traffic control to access the specific location. Conducting enhanced inspection or additional investigation for a single localized concern does not reclassify the inspection as an Enhanced inspection. Further guidance is provided in Section 1.1.3.4 and 1.1.3.5.

1.1.3.5 Enhanced OSIM Inspection

An Enhanced OSIM inspection is defined as an element-by-element detailed visual assessment of material defects and performance deficiencies of a structure that is conducted “close-up” and “within arm’s length” of every element, including sounding, touching, and measuring by hand. For the purposes of this requirement, “close-up” shall be defined as a distance close enough to determine the condition of the element.

Periodically, a structure should be inspected more thoroughly by getting within arm’s reach of all areas of the structure. Enhanced inspections require appropriate specialized access equipment, such as a BridgeMaster, bucket truck, scissor lift, boat, ladder, to allow the inspector to safely reach and examine all areas of the structure.

An Enhanced OSIM inspection shall be completed for structures that are approaching their next rehabilitation cycle. The Engineer may also place a structure on a routine Enhanced Inspection schedule if there are concerns about the progression of defects or performance deficiencies in areas that cannot be adequately monitored during a Regular OSIM Inspection.

Notwithstanding the criteria outlined above, the Engineer may require an Enhanced OSIM inspection for any structure, regardless of the next expected rehabilitation cycle, where professional judgement determines that such an inspection is warranted. This may include situations where potential safety concerns, uncertainty in condition, or observed deficiencies indicate that a close-up inspection is necessary to adequately assess structural performance and risk. This may also include the need to inspect the inside of steel and concrete box girders.

The additional effort required for an Enhanced OSIM inspection shall include the following activities:

- Inspectors shall tap concrete surface with a hammer to determine limits of delamination and spalling.
- Inspectors shall tap wood surface with a hammer to determine limits of rot and shall conduct selective wood coring to correlate tapping results with the presence of internal rot or other damage.
- Inspectors shall clean and wire-brush steel surfaces, including connections, splice plate, bearing conditions, to ascertain the presence and extent of section loss or other suspected steel defects like fatigue cracks and others.

Where accessible, interior surfaces of box girder surfaces shall be inspected to detect fatigue cracks and other defects. Where access is limited remote tools (borescope, ROVs, etc.) may be used. Additional resources and or equipment are needed to safely access the interior of the structure which is often a confined or restricted space.

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In addition to detailed inspections, routine inspections by maintenance crews are essential, and should be performed regularly to identify sudden changes in bridge condition. Details of these routine maintenance-lead inspections are not included in this manual. This manual describes the procedures for carrying out detailed visual inspections only.

1.1.3.6 Field Review Inspection for Non-MTO Structures

Structures built and owned by other jurisdictions or private owners, but located within or crossing the Ministry right-of-way, are classified as **non-MTO structures**. These structures may be located over, under, or beside MTO highways or MTO-owned structures.

A Field Review Inspection is a high-level visual assessment carried out by the Ministry to confirm the apparent overall condition, performance, and safety of a non-MTO structure as it relates to the Ministry right-of-way. A Field Review Inspection does not include detailed element-level assessments or quantification of deficiencies. It is not intended to replace the Owner's responsibility to carry out proper inspections, maintenance, and rehabilitation of their structure. The purpose of a Field Review Inspection is solely to identify any observable concerns that may affect public safety, highway operations, or adjacent MTO assets.

Non-MTO Structures can include the following:field

1. **Structures owned by municipalities, 407 ETR, transit agencies, or private entities**
 - These owners have responsibilities under PTHIA Ontario Regulation 104/97 to inspect their Structures every two years and keep them in a state of good condition.
 - When ownership is known, the Ministry will notify the owner of their inspection obligations and obtain the owner's inspection report for Ministry records. The Ministry will not complete a Regular OSIM inspection; instead, it will perform a Field Review Inspection to verify that the structure appears to be in safe operating condition.
 - When ownership is unknown, the Ministry will conduct a full Regular OSIM inspection until ownership and responsibility are confirmed.
2. **Structures owned by railway companies**
 - Railway companies are responsible under the Railway Safety Act for conducting annual inspections of their tracks and supporting structures.
 - For subway structures, the Ministry will notify the owner at least every two years of their inspection obligations and obtain the inspection report for Ministry records. The Ministry will not perform a Regular OSIM inspection but will conduct a Field Review Inspection to confirm the structure appears safe.
 - For overhead railway structures, the Ministry will complete a Regular OSIM inspection at least every two years.

1.1.3.7 Emergency Inspections

An emergency situation exists when a structural element contributing to overall stability of the structure has failed or is in imminent danger of failure or public safety is in any way at risk. In

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such cases, a detailed visual inspection should be carried out immediately. Typical problems that may cause an emergency situation to develop are:

- Vehicle collision with a structure.
- Natural disaster or extreme weather events:
 - Flooding or high-water events affecting scour-prone elements.
 - Earthquakes.
 - Tornadoes.
 - Sudden loss of embankment or slope supporting the bridge.
 - Wildfire exposure.
- Cracks in steel elements.
- Hazardous Materials Incident
 - Chemical spill that may compromise concrete, steel or bearings
- Loose concrete in an overhead structure.

Emergency inspections shall not replace Regular or Enhanced OSIM inspections but may later be used to supplement OSIM quantities for future inspections. Emergency inspections must meet Enhanced inspection requirements, and a full report must be saved in BMS.

1.1.3.8 Additional Investigations

If during a detailed visual inspection, the inspector feels that more detailed information is needed based on the issues identified, additional investigations can be requested. Some of these investigations are:

- Material Condition Survey for:
 - Bridge Deck Condition Survey (See MTO Structural Rehab Manual for more detail).
 - Non-destructive Delamination Survey of Asphalt Covered Decks.
 - Concrete Substructure Condition Survey.
 - Detailed Coating Condition Survey.
 - Detailed Timber Structure Investigation.
 - Post-Tensioned Strand Investigation.
- Underwater investigation.
- Fatigue investigation.
- Seismic investigation.
- Structure evaluation.
- Monitoring of deformations, settlement and movements.
- Monitoring of crack widths.

Parts 3, 4, and 5 of this manual provide direction on specialized investigations that may be required beyond a detailed visual inspection.

1.2 COMPONENTS AND ELEMENTS OF STRUCTURES

In the following sections of Part 1, the components of a structure and their structural functions are described. These sections identify the different components and elements that make up a structure and explain their roles within the structural system. Components are categorized as

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primary, secondary, or auxiliary based on their structural function. Inspectors shall be familiar with these components and their functions to recognize potential behavioural concerns.

The component categories are defined as follows:

Primary Component: A component of a structural system that performs an essential role in load transfer and, on becoming ineffective, will substantially reduce the load-carrying capacity of the system or cause the collapse of a single-load path structure.

Secondary Component: A component of a structural system that does not have an essential role in load transfer and whose removal from the structure would result in at most a minor redistribution of load effects to adjacent components.

Auxiliary Component: A component of a structural system that does not constitute part of the intended load-sharing system.

Elements differ from the components as they are the individual parts of a structure defined for inspection purposes. Several bridge components may be combined into a single element for inspection purposes. Elements are further described in Part 2, Section 2.2.

A **Critical Element** is an element whose failure would be expected to result in collapse or in a significant loss of load carrying capacity, stability, or serviceability of the structure. All Critical Elements are considered Primary Components but, not all Primary Components are Critical Elements. See Part 2, Section 2.3 for more details.

1.3 SUPERSTRUCTURES

Superstructures normally consist of all components of structures supported on the substructures. The following components of superstructures are covered in this section:

- Beams and girders.
- Thick slabs.
- Trusses.
- Arches.
- Culverts.
- Soil Steel Structures.
- Movable bridges in fixed position.
- Suspension bridges.
- Stringers and floor beams under the decks.
- Diaphragms.
- Sway bracings.
- Lateral bracings.

Other parts of the superstructure, such as, decks, curbs, sidewalks, parapet walls, railings and expansion joints are covered in other sections of OSIM.

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Movable bridges shall be inspected and recorded by the type of the main load carrying components. Inspection of mechanical or electrical parts of movable bridges is not covered in OSIM.

1.3.1 Beams and Girders

Beams and girders are made of reinforced or prestressed concrete, steel, or wood.

Beams and girders may be simply supported, semi-continuous for live and superimposed dead loads, continuous, or cantilevered beyond the support with a drop-in section added to complete the span.

Concrete beams or girders are cast-in-place or precast, either as one unit or in segments. They may be T-shape, rectangular or trapezoidal in shape and may have single or multiple voids of various shapes in them.

Steel beams or girders are rolled into standard shapes or built-up into I-shape, rectangular or trapezoidal boxes by riveting, bolting, or welding. They may be unstiffened or stiffened with vertical or longitudinal stiffeners. They may be erected as single units or in segments.

Wood beams or girders may be sawn, laminated or glued and are, normally, rectangular in shape. They are erected as single units but may sometimes be spliced together with steel plates, fasteners, or gang-nail plates.

Beams and girders support decks directly on them except in the case of half-through girders in which the load from the deck is first transferred to stringers and floor beams and then to the girders.

Beams and girders may have diaphragms and lateral bracings between them. Concrete girders, normally, have solid concrete diaphragms whereas steel girders may have diaphragms made of steel beams, girders, channels, or angles. Steel girders may also have lateral bracings made of steel angles or channels.

Beams and girders carry loads by flexural, shear or torsional resistance. Examples of typical beams and girders are illustrated in Figure 1.3.11.1.

1.3.2 Thick Slabs

Thick slabs are made of reinforced or prestressed concrete or a combination of these.

They may be simply supported or continuous.

They may be solid or contain round, rectangular, or trapezoidal voids, and are normally cast-in-place. The deck slabs of rigid frames are to be considered as thick slabs.

The top surface of thick slabs acts as the deck and shall be inspected as detailed in Section 1.4.

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Thick slabs carry loads by flexural, shear, torsion and axial forces depending on the fixity and configuration of the support systems. Examples of thick slabs used are illustrated in Figure 1.3.11.2.

1.3.3 Trusses

Trusses are made of steel or wood. A few trusses made of cast iron are still in existence.

Trusses may be single or multiple spans and may be simply supported or continuous. They may also be cantilevered beyond the support with a 'drop-in' truss section to complete the span.

Trusses consist of top and bottom chords, verticals, and diagonals.

Types of trusses commonly encountered are the through truss, half-through (pony) truss, deck truss and the bailey bridge truss.

Through trusses are connected across the top chords above the roadway level by transverse portals, sway frames and lateral bracings. The bottom chords are connected below the roadway level by transverse floor beams which support longitudinal stringers and the deck. The bottom chords are also connected by lateral bracings below the deck.

Half-through trusses are not connected across the top chords allowing for unrestricted overhead clearance. Sway braces or rakers are connected between the top chords and floor beams, or needle beams, to provide lateral restraint to the top chord. The bottom chords are connected below the roadway level by transverse floor beams which support longitudinal stringers and the deck. The bottom chords are also connected by lateral bracings below the deck.

Deck trusses are located entirely below the roadway level. They may directly support the deck, or the deck may be supported on longitudinal stringers and transverse floor beams resting on the deck trusses. Adjacent trusses are also commonly connected by transverse cross bracing between the top and bottom chords, and by additional lateral bracing between the bottom chords.

Temporary modular bridge trusses (generally referred to as Bailey Bridges) are built of components that can be erected into several different configurations depending on span, with the most common being the half-through type. Sway bracings, lateral bracings, and floor systems for the bailey bridges are like the half-through trusses described above.

Components of steel trusses consist of individual rolled sections or are built-up by bolting, riveting, or welding several sections together. Older steel trusses may contain solid bars such as round, square, or eye-bars. More recent steel trusses may also contain tubular sections.

Components of wood trusses are typically made from solid rough-sawn sections or are built-up by bolting or gluing several sections together. Steel rods are also often used for tension components in wood trusses.

Individual truss components are connected at joints with splice plates or gusset plates fastened by pins, rivets, bolts, lag-screws, nails or by welding.

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While their overall configuration may vary, trusses are built up of individual components interconnected in triangular arrangements in such a manner that the components resist applied loads axially, through compression or tension.

However, depending on the degree of fixity, either actual or assumed, at the connections, and on the location of the applied load on the member, some of the truss components may also be subject to flexural, shear or torsional loads. Trusses and common terminology used to describe their components are illustrated in Figure 1.3.11.3 and Figure 1.3.11.4.

Typical Bailey Bridge configurations and components are shown in Figure 1.3.11.5 and Figure 1.3.11.6. For a complete coverage of Bailey Bridges see Reference 1. Note that there are other manufactures of temporary modular bridges with various different configurations and permutations with various other arrangements of components and component types that provide the same convenience to the Bailey Bridge system.

1.3.4 Arches

Arches are made of concrete, steel, wood, or masonry.

Arches may be single or multiple spans and may be hinged or fixed at the supports. They may have an intermediate hinge at their crown.

Arches consist of arch ribs, top or bottom chords, verticals, and diagonals.

Types of arches commonly encountered are the tied (bowstring) arch, through arch, open spandrel arch, filled spandrel arch and barrel arch.

Tied (Bowstring) arches are used where the soil is not capable of resisting the horizontal thrust of the arch rib. The bottom chord, or tie, may also support the deck system as they are usually at the same level. There may also be a system of portal or sway frames and lateral bracing between the arch ribs over the roadway. In steel tied arches there may also be a system of lateral bracing under the deck.

Through arches are used where the soil can resist the horizontal thrust of the arch. In this arch, the deck and floor system is suspended from the arch rib by hangers. The arch ribs are also connected across the top by a system of portal and sway frames and lateral bracing. There may also be a system of lateral bracing under the deck.

Open spandrel arches are used where the soil can resist the arch thrust. In this type of arch, the deck is located above the level of the arch crown, and the deck and floor system is supported on columns carried down to the arch rib(s).

In steel spandrel arches there are two or more parallel ribs interconnected by a bracing system. Concrete spandrel arches may have several ribs interconnected with diaphragms but are also commonly built with only one solid arch, the full width of the deck.

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Filled spandrel arches are commonly used for short spans and is usually fixed ended. The arch is backfilled with earth, granular or other suitable fill which forms the base for the deck. The sides of this arch are closed by retaining walls and wingwalls.

Barrel arches are like the filled spandrel arches except that the sides are open and therefore there are no retaining walls.

Components of steel arches consist of individual rolled sections or are built-up by bolting, riveting, or welding several sections together. Older steel arches may contain solid round or square bars or eye-bars, while more recent steel arches may also contain tubular sections.

In steel arches, the components are connected at joints with splice plates or gusset plates fastened by pins, rivets, bolts or by welding. In comparison, concrete arches are usually constructed monolithically with the deck system, ties, railings, hangers, and arch rib rigidly connected so that interaction and stress distribution among the components is extremely complex.

While their overall configuration may vary, the arrangement and connection of their components and the degree of fixity at the supports and between the connections determine the distribution of applied loads internally in the arch and the transfer of load to the foundation or soil. The arch ribs resist applied loads mainly by compression and flexure. The arch ties resist loads mainly by tension and some flexure depending on the location of the applied loads.

Concrete arches are usually monolithically cast, with the result that the interaction and stress distribution among the components is extremely complex. Also, when the arches have fixed ends, they are very sensitive to differential settlement or rotation of the foundation, which may produce overstressing and cracking locally.

Arches and the common terminology used to describe them are illustrated in Figure 1.3.11.7.

1.3.5 Culverts, Tunnels, and Soil-Steel Structures

Culverts and soil-steel structures are bridges embedded in fill. In most cases, they convey water through an embankment; however, occasionally they provide access to pedestrian, rail, or vehicular traffic through the embankment.

A tunnel is a bridge constructed through existing ground. In most cases it provides access to pedestrian, rail, or vehicular traffic. Occasionally, it is designed to convey water.

Culverts and tunnels may be made of concrete (cast-in-place or precast) or wood. Soil- steel structures are comprised of corrugated steel pipe or plates, and soil, designed and constructed to induce a beneficial action between the structure and the soil. Soil-steel structures are constructed in several shapes (Ex. namely, round, ellipses, pipe arches, superspans and with or without ears or relieving slab).

High embankments or fills may impose very large vertical and lateral earth loads on culverts and tunnels which can result in structural failure of the roof, floor slab or walls.

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The strength of a soil-steel structure is derived from the interaction between the structure and the surrounding soil. Vertical loads from the overlying soil and traffic are transmitted by arching action to the underlying soil. If the side support is not provided due to inadequate placement, compaction or loss of soil or backfill material; then, failure of the structure can result.

Culverts, tunnels, and soil-steel structures are divided into two main types according to cross-section: namely, open invert and closed invert. An open invert structure has a floor of natural soil, bedrock or other material that is not structurally integral with the walls. A closed invert structure is one where the floor is structurally integral with the walls.

Where these structures are used to carry water, their basic components can be divided into inlet, barrel, and outlet as shown in Figure 1.3.11.8. The inlet channels water into the barrel and the outlet channels the water back into the stream. The inlet and the outlet may also contain headwalls, cut-off walls, wingwalls, headwalls and aprons to provide protection against scour and piping. The barrel and outlet may also contain drop-outlets, stilling basins, chutes, and stepped flumes to dissipate the energy of the water before it re-enters the stream, as shown in Figure 1.3.11.9.

When a roadway is widened or when the road grade is raised, extensions to these structures may be built using different materials. It is necessary to inspect the full length of these structures.

Typical examples of culverts, tunnels and soil-steel structures are illustrated Figure 1.3.11.10 and Figure 1.3.11.11.

1.3.6 Diaphragms

Diaphragms are made of steel, wood, or concrete components.

Diaphragms span between the primary load carrying components such as beams, girders, deck trusses or are located inside box sections. They are normally located in the vertical plane.

Diaphragms may be solid or built up from individual steel or wood sections which are assembled to form x-frames or k-frames using rivets, bolts, nails or by welding.

Diaphragms can be distinguished as load bearing or non-load bearing. Load bearing diaphragms directly support superstructure reactions or are designed for jacking purposes. Non-load bearing diaphragms provide lateral support or restraint to other superstructure components.

Typical diaphragms are illustrated in Figure 1.3.11.12.

1.3.7 Sway Bracings

Sway bracings are made of concrete, steel, or wood.

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Sway bracings are the transverse bracings between primary components and are normally located in the vertical plane. In the case of half-through trusses the sway bracings are attached to the outside of each truss instead of between the trusses.

Sway bracings may be solid or built up from individual steel or wood sections which are assembled to form x-frames or k-frames using rivets, bolts, nails or by welding.

Typical sway bracings are illustrated in Figure 1.3.11.3 and Figure 1.3.11.7.

1.3.8 Lateral Bracings

Lateral Bracings are made of steel or wood.

Lateral bracings are the transverse bracings between primary components such as beams, girders, trusses, and arches and are normally located in the horizontal plane.

Lateral bracings are normally made from single components but sometimes may be made into frames.

Typical lateral bracings are illustrated in Figure 1.3.11.4, Figure 1.3.11.6 and Figure 1.3.11.13.

1.3.9 Primary Components

The following are considered primary elements:

- Deck
- Girders / Beams
- Stringers
- Floor system (floor beams, diaphragms, cross-frames)
- Trusses
- Arches
- Bearings
- Abutments
- Piers
- Pier caps
- Column and Piers
- Piles and Footings

1.3.9.1 Material Defects of Primary Components

Material defects are described in Part 2, Section 2.5.

1.3.9.2 Performance Defects of Primary Components

Performance defects in primary components are related to their ability to support the dead and live loads imposed on them and to transmit those loads to the substructure without excessive deformations or vibrations.

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1.3.10 Secondary Components

The following are to be considered as secondary components:

- Non-load bearing diaphragms that do not directly support or transmit wheel loads.
- Sway bracings.
- Lateral bracings.
- Connections to secondary components.
- Inlet and outlet treatments of culverts.

1.3.10.1 Material Defects of Secondary Components

Material defects are described in Part 2, Section 2.5.

1.3.10.2 Performance Defects of Secondary Components

The performance condition rating of non-load bearing diaphragms is based upon their ability to restrict relative vertical and transverse movements between the primary components and thus transmit vertical and transverse loads between them without excessive or permanent deformations.

The performance condition rating of sway bracings is based upon their ability to restrict relative transverse and vertical movements between primary components and thus prevent lateral buckling of primary components.

The performance condition rating of lateral bracings is based upon their ability to restrict relative longitudinal and transverse movements between primary components and thus transmit longitudinal and transverse loads between them without excessive or permanent deformations.

The performance condition rating of inlet and outlet treatments of culverts is based upon their ability to provide for the functions they are designed for.

1.3.11 References

1. The Bailey and Uniflote Handbook, 1974, Acrow Corporation of America
2. MTO Bailey Bridge Manual, 1990

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BEAMS & GIRDERS

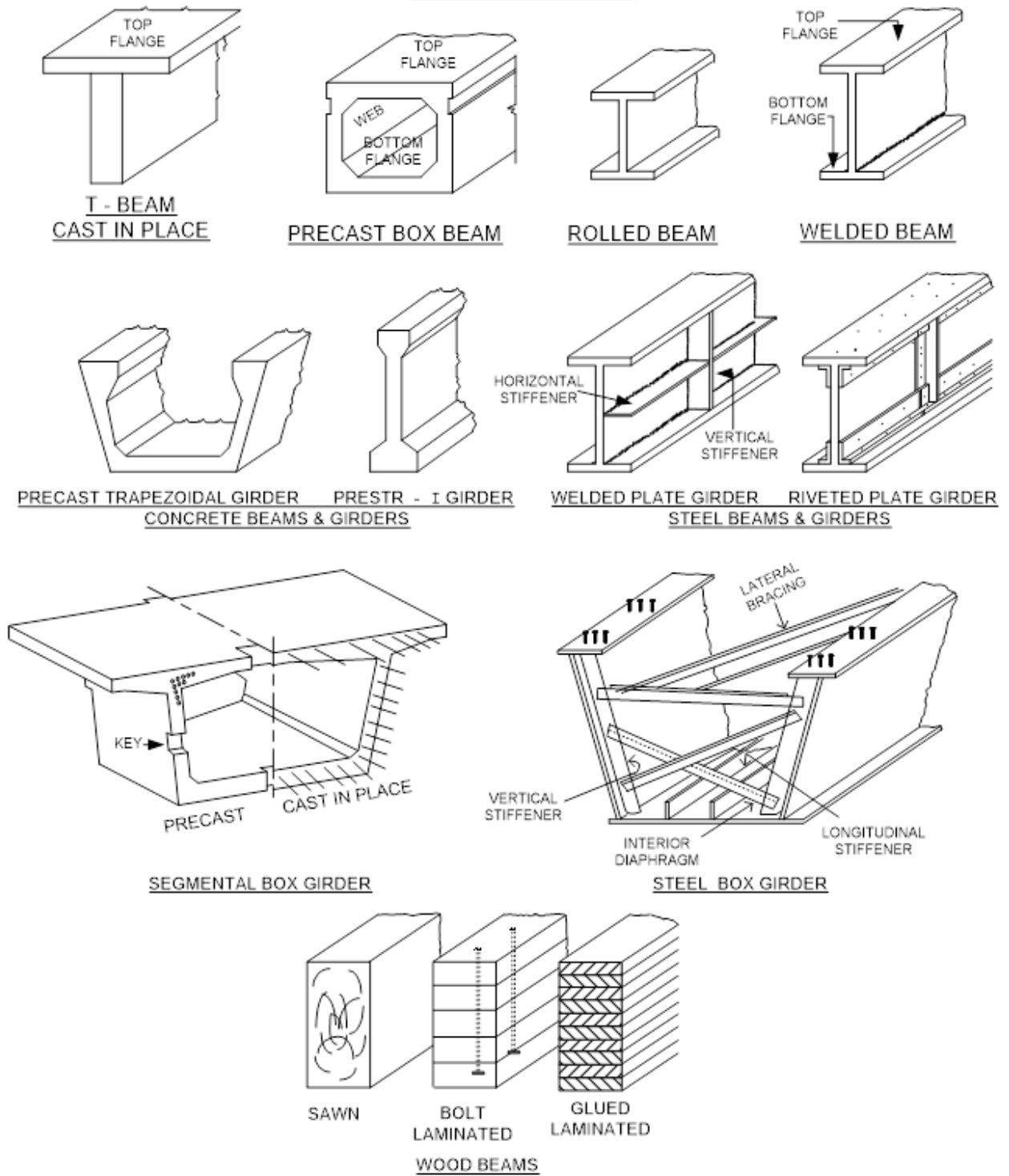


Figure 1.3.11.1 Beams and Girders

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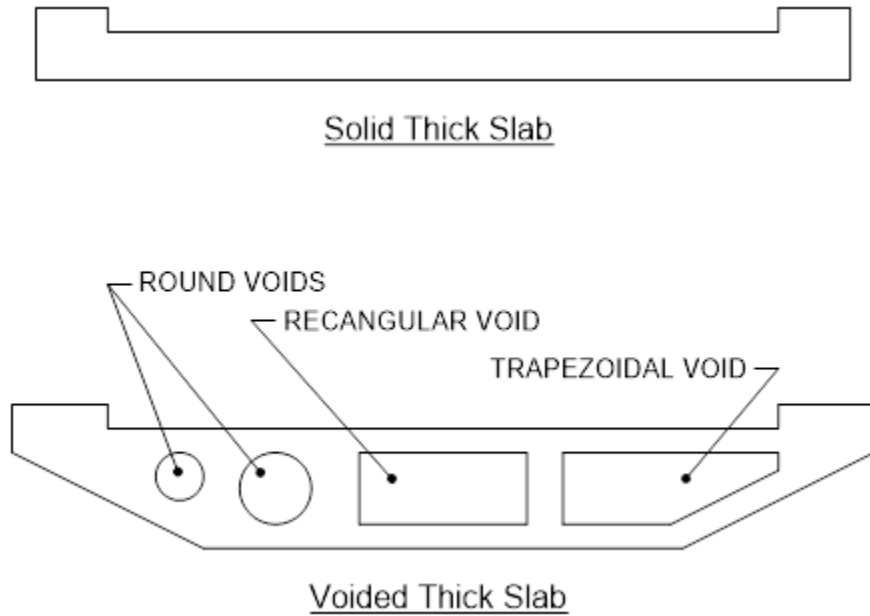


Figure 1.3.11.2 Thick Slabs

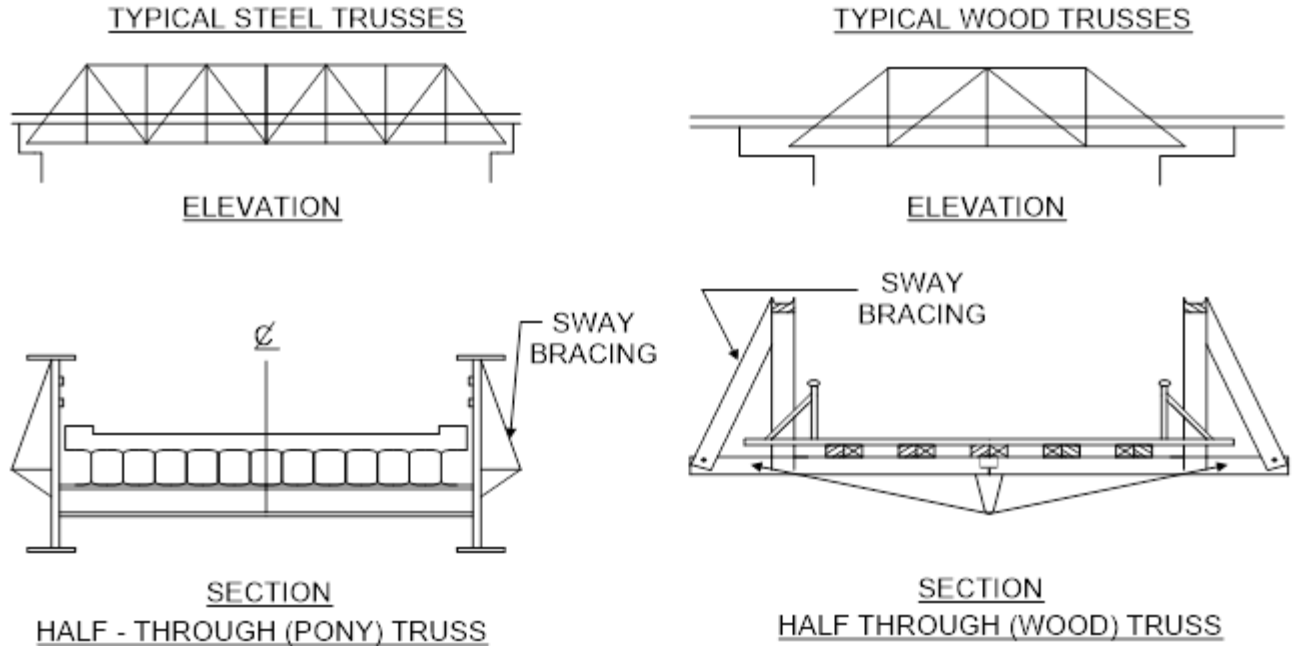


Figure 1.3.11.3 Trusses

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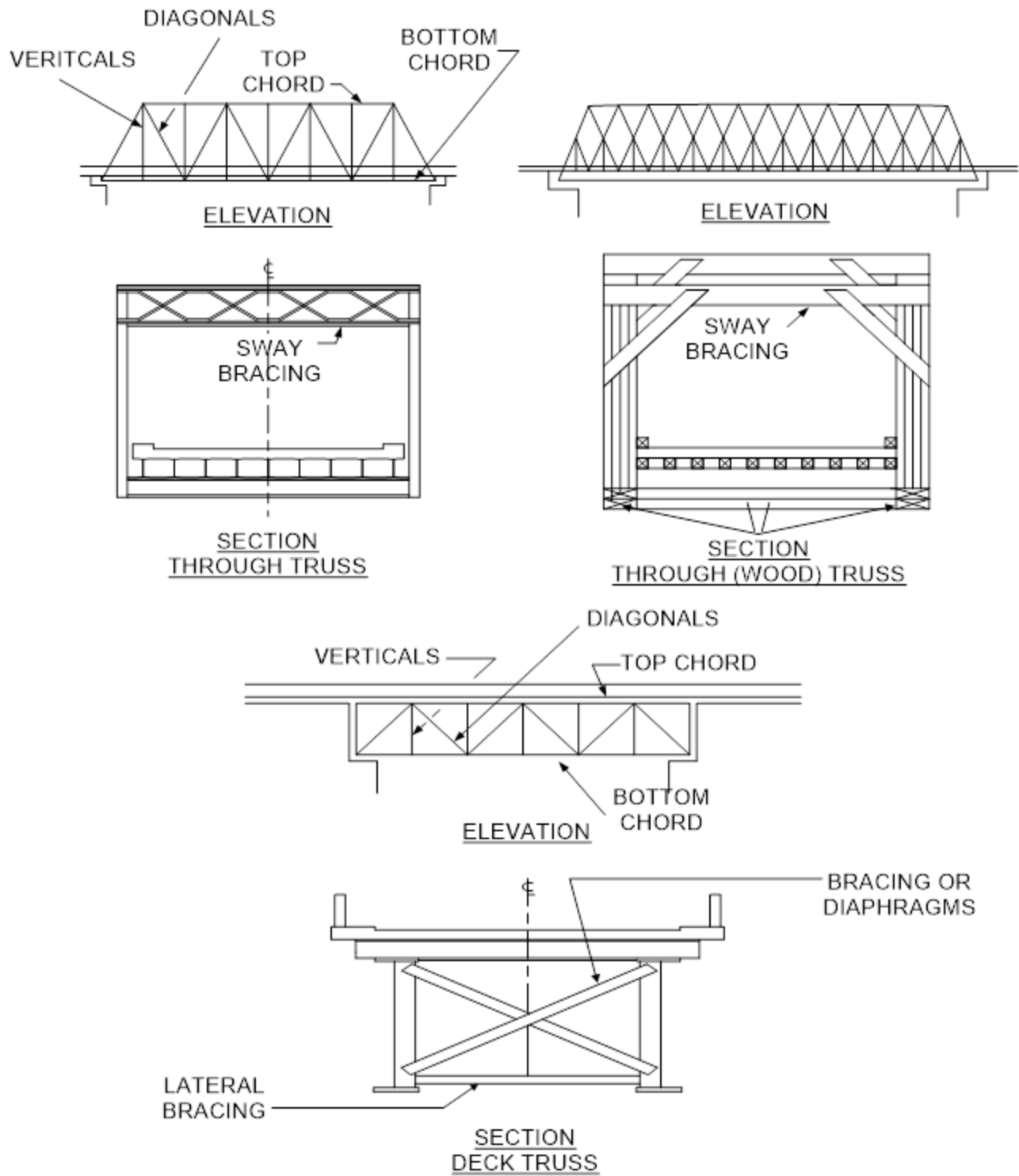


Figure 1.3.11.4 Trusses (cont.)

PART 1 – TECHNICAL INFORMATION

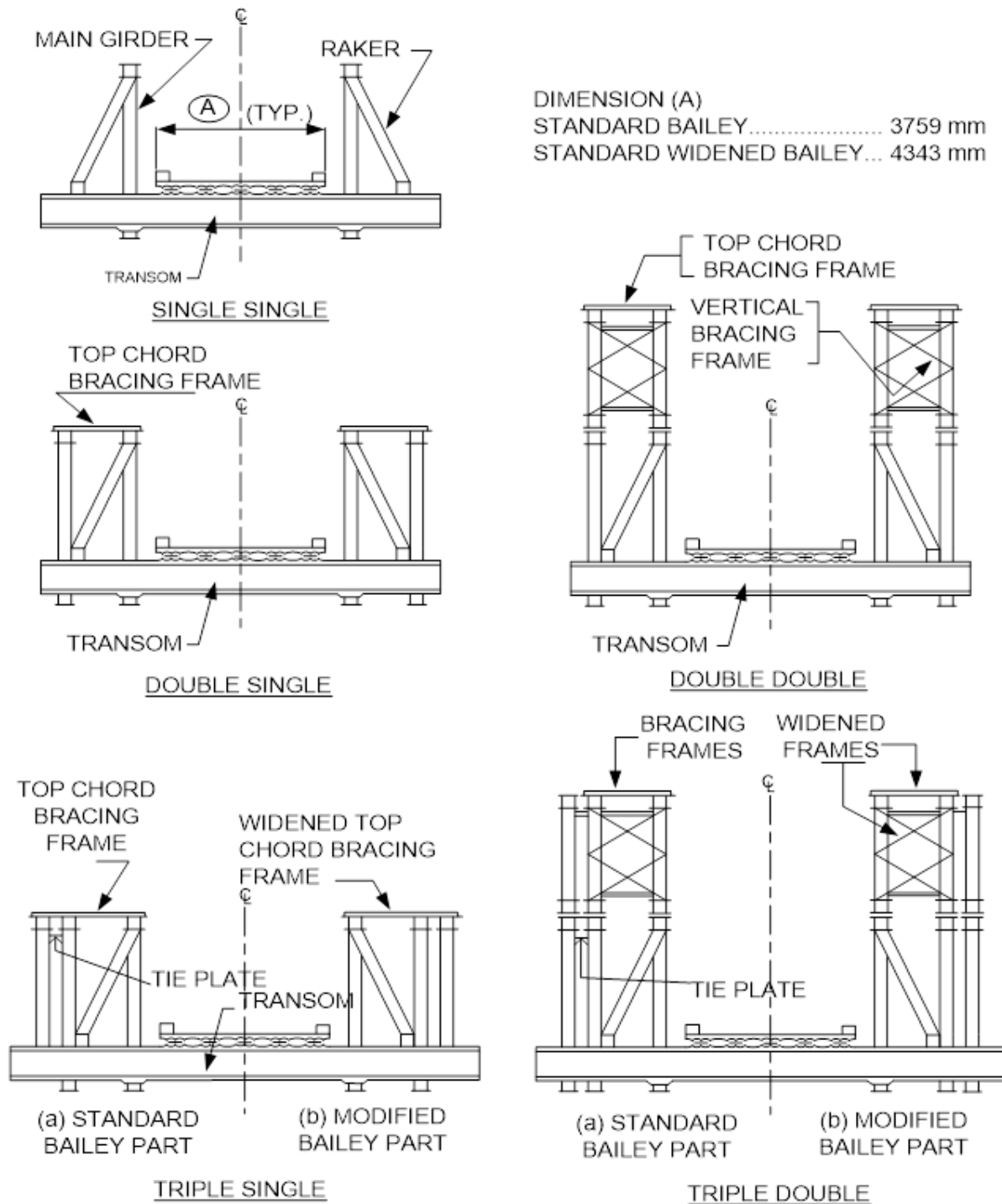


Figure 1.3.11.5 Typical Bailey Configurations

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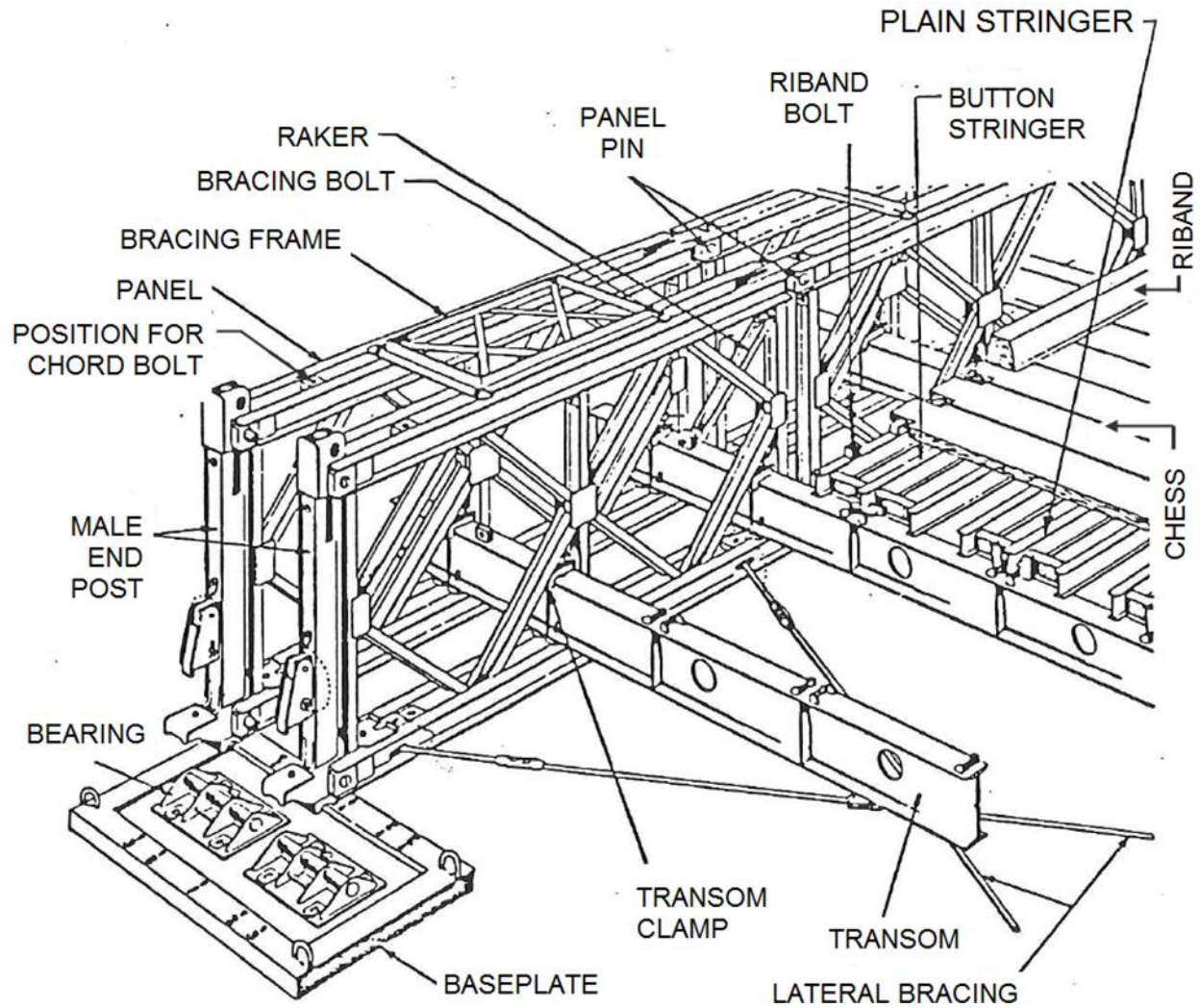


Figure 1.3.11.6 Typical Bailey Components

PART 1 – TECHNICAL INFORMATION

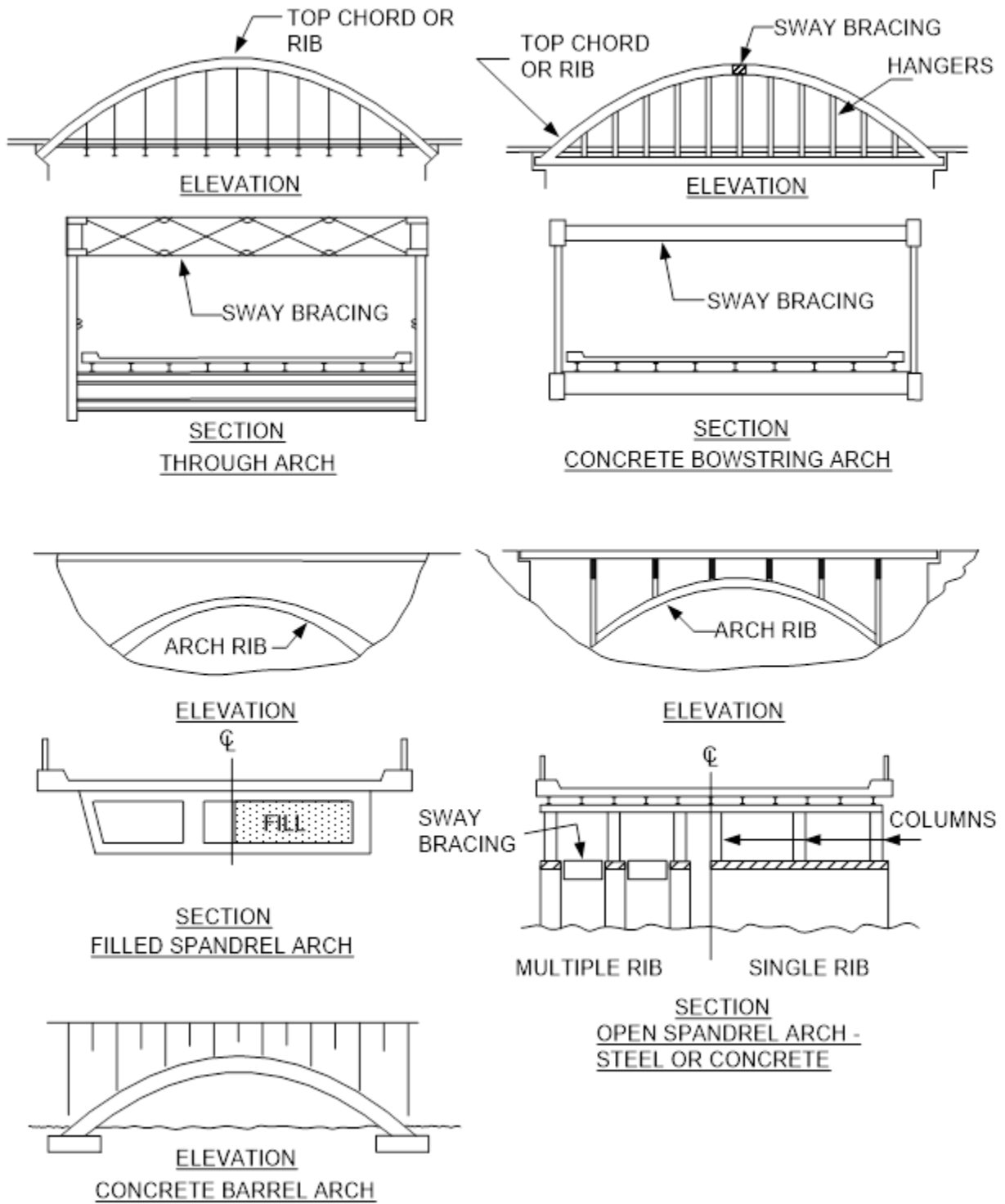


Figure 1.3.11.7 Arches

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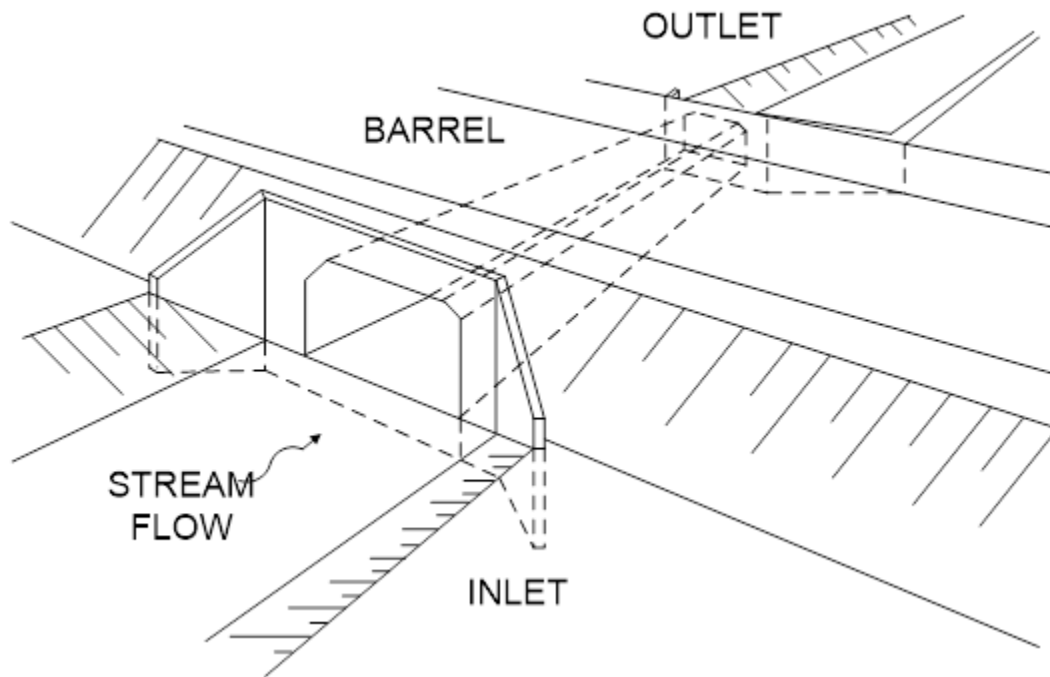


Figure 1.3.11.8 Basic Culvert, Tunnel, and Soil-Steel Structure Components

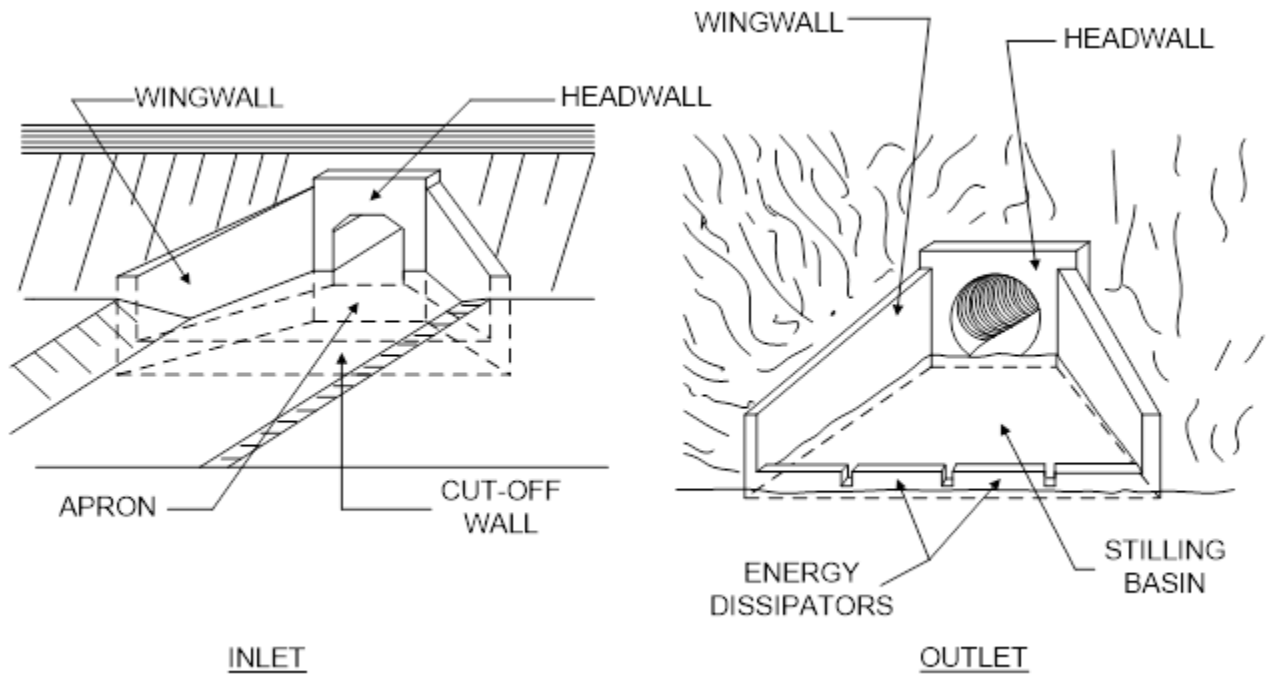
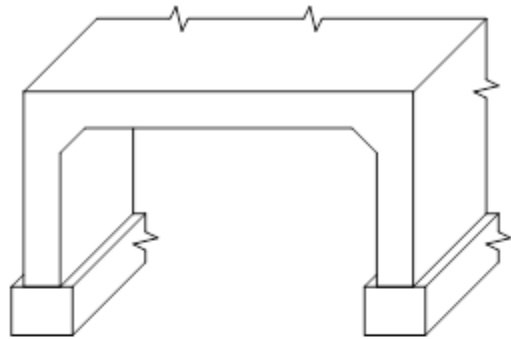
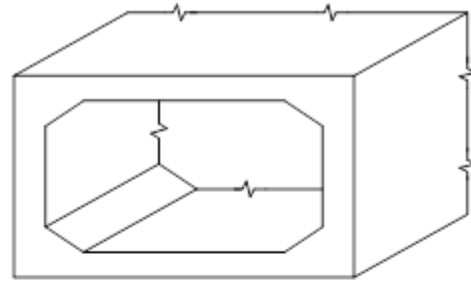


Figure 1.3.11.9 Typical Inlet and Outlet Components

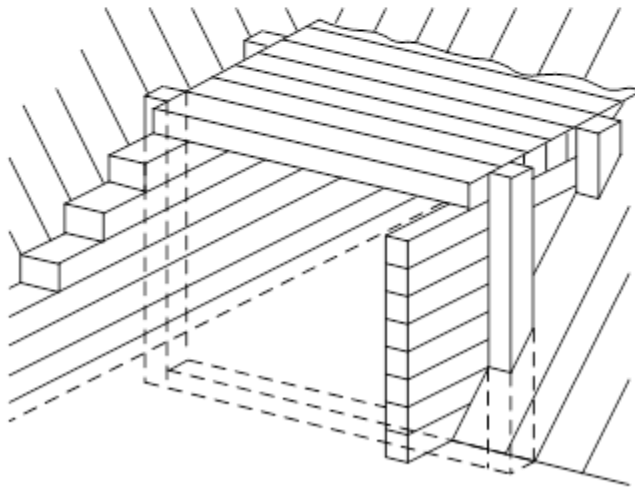
PART 1 – TECHNICAL INFORMATION



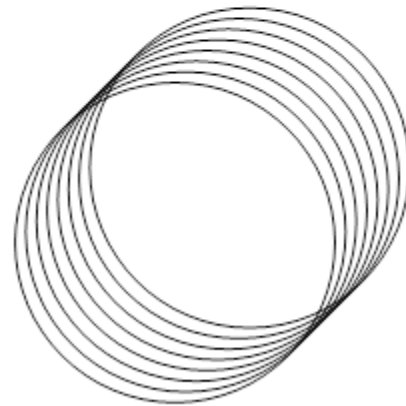
OPEN FOOTING CONCRETE CULVERT



CONCRETE BOX CULVERT



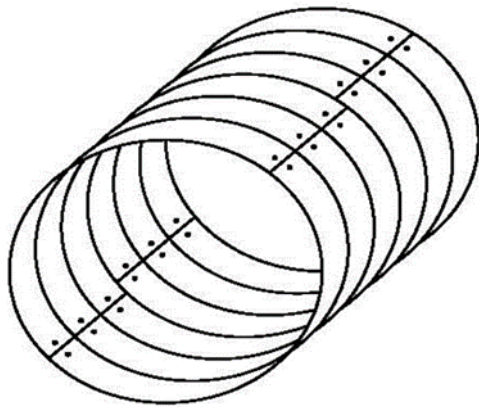
WOOD CULVERT



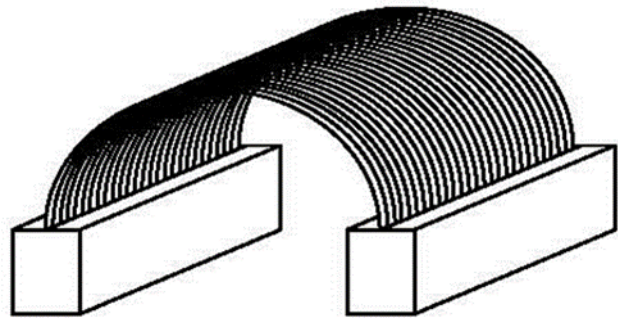
ROUND CORRUGATED PIPE CULVERT

Figure 1.3.11.10 Typical Culverts and Tunnels

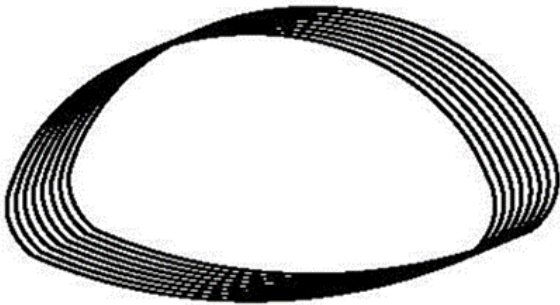
PART 1 – TECHNICAL INFORMATION



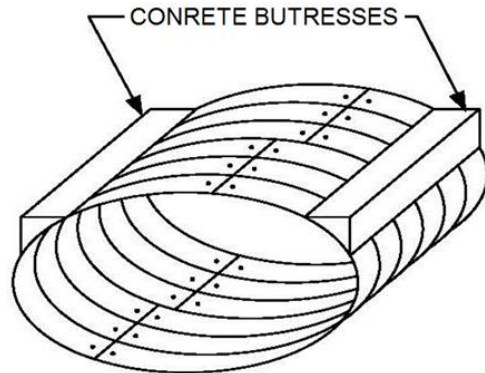
ROUND CORRUGATED STEEL PLATE



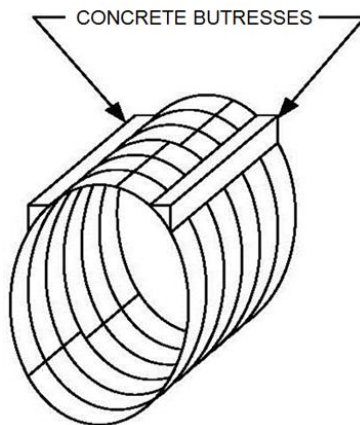
CORRUGATED STEEL PLATE OPEN FOOTING ARCH



CORRUGATED STEEL PLATE PIPE ARCH



CORRUGATED STEEL PLATE SUPERSPAN ELLIPSE



CORRUGATED STEEL PLATE INVERTED ELLIPSE

Figure 1.3.11.11 Typical Soil-Steel Structures

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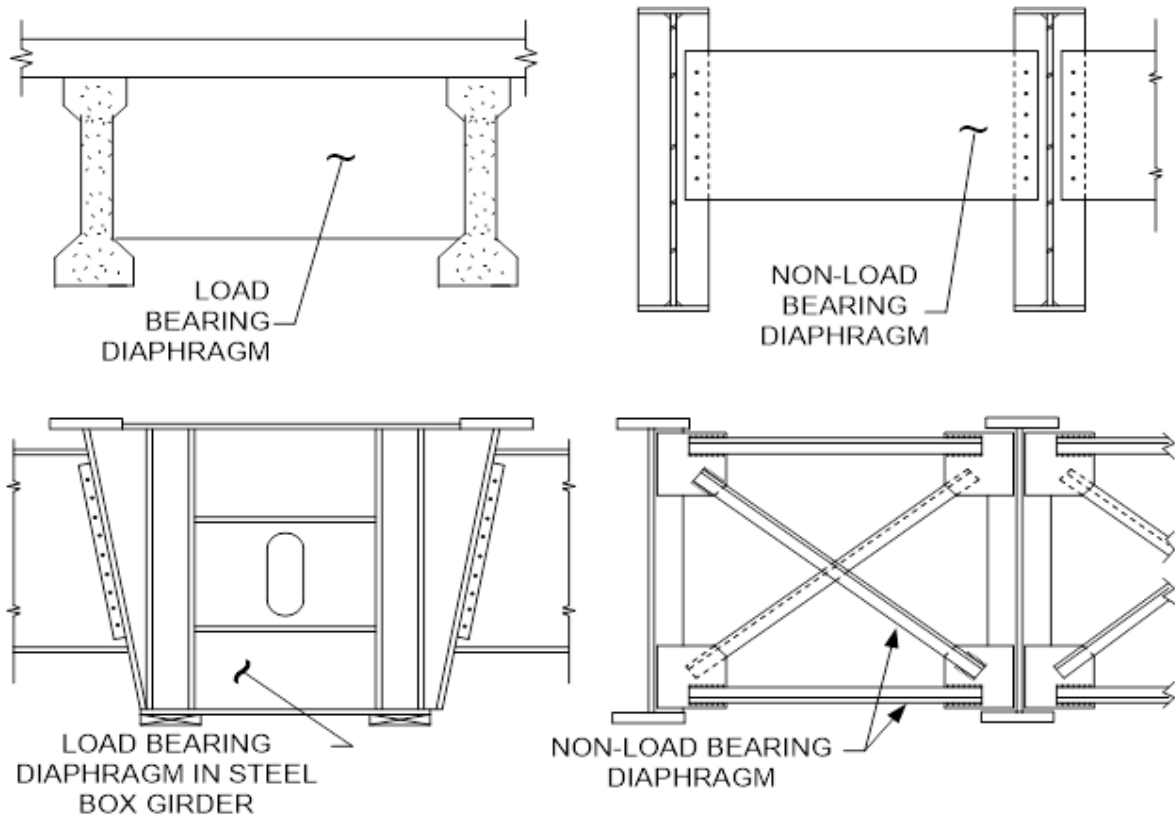


Figure 1.3.11.12 Diaphragms

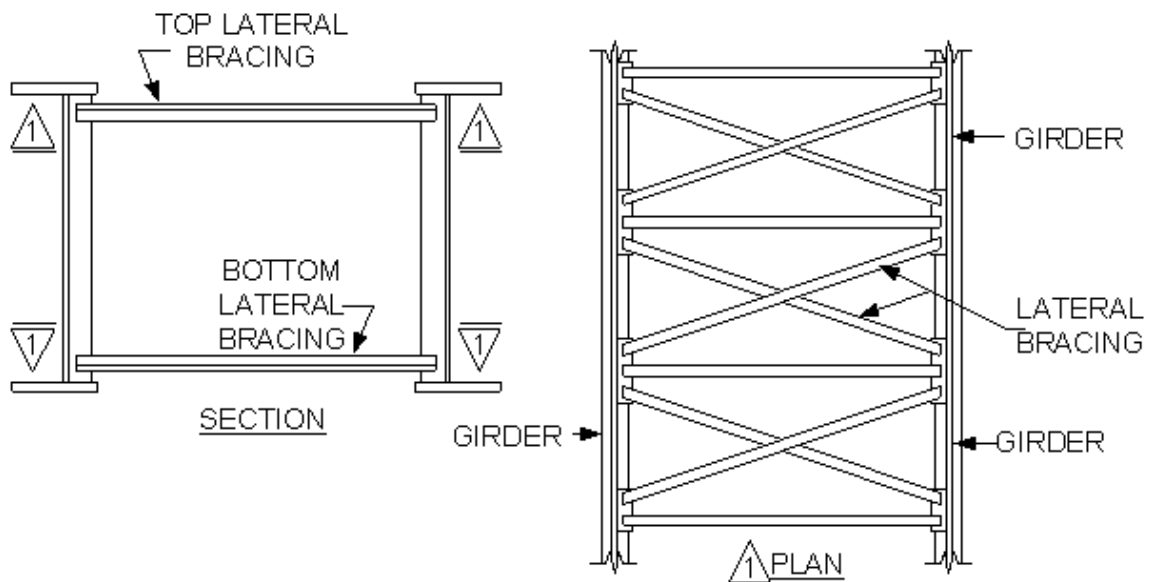


Figure 1.3.11.13 Lateral Bracing

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1.4 DECK COMPONENTS

1.4.1 Deck Components

The following components are considered in this section:

- Decks
- Wearing Surfaces
- Curbs and Sidewalks
- Approaches and Approach Slabs and Ramps
- Drainage and Deck Drains

1.4.1.1 Decks

The types of decks commonly used are:

- Reinforced Concrete Decks;
- Wood Decks;
- Orthotropic Steel Decks;
- Open Grating Steel Decks; and
- Corrugated Metal Sheeting Decks.

Reinforced concrete decks are the most common type of deck used in structures.

They are commonly cast-in-place but may also be pre-cast. This type of deck includes slab on beams, and the top surface of solid or voided thick slabs, or of rigid frames.

Wood decks are commonly used on secondary roads and rural highways. Types of wood decks commonly used include longitudinal and transverse laminated wood decks, prestressed wood decks, plank decks and composite wood and concrete decks.

Orthotropic steel decks consist of a flat steel top plate surface welded to a supporting system of steel girders, floor beams and ribs. Flat bars or studs are often welded to the top steel plate to improve the bond with the wearing surface.

Prefabricated steel grating is sometimes used as decking material. The open mesh grating panels are installed over a network of steel floor beams and stringers to form the riding surface. A variation of this deck is produced by placing a concrete infill slab over the grating to form a composite deck surface.

Corrugated metal sheeting decks have been used in a few cases. They are normally overlaid with asphalt or concrete wearing surface.

Figure 1.4.5.1 illustrates the types of decks commonly encountered.

1.4.1.2 Wearing Surfaces

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The top surface of the deck is either left exposed and acts as the wearing surface or is protected by an additional wearing surface. A waterproofing membrane placed between the deck and asphalt wearing surface also provides additional protection.

Reinforced concrete and steel decks are typically covered with an asphalt wearing surface, with or without waterproofing. Wood decks are typically covered with an asphalt, concrete or wood planking wearing surface, normally without waterproofing.

Wearing surfaces are shown in Figure 1.4.5.1.

1.4.1.3 Curbs and Sidewalks

Curbs and sidewalks are located parallel to the side limits of the roadway and are typically elevated between 100mm and 250mm in height above the roadway surface. Both these components include a vertical face and a horizontal portion. For the purposes of this manual, the only differentiation between a curb and a sidewalk shall be width. A width of less than 1500mm shall be identified as a curb and 1500mm or greater shall be identified as a sidewalk. This definition is used, despite the fact the many large curbs with widths of 600mm or more can safely accommodate pedestrians in rural areas. The difference between curbs and sidewalks is illustrated in Figure 2.4.2.3 of Part 2.

Sidewalks and curbs are sometimes built on supports which cantilever beyond the deck limits. These supports shall be inspected as part of the floor system (floor beams, stringers, etc.) while only the face, top and bottom surfaces of the curb or sidewalk shall be included with the curb/sidewalk component.

Curbs and sidewalks can be constructed of concrete, wood, asphaltic concrete, or steel. Precast masonry is sometimes used as well.

Typical examples of curb and sidewalk construction are illustrated in Figure 1.4.5.1 and Figure 1.4.5.2.

1.4.1.4 Approaches, Approach Slabs, and Ramps

Approaches shall be inspected immediately adjacent to the structure. The length to be inspected shall be the length of the approach slab, or the length to the end of the wingwall (whichever is greater). For jurisdictions where separate inspection of roadway features are not performed, a longer section of approach may be inspected for some elements (e.g., include approach guide-rail or include longer length of approach sidewalk or curb).

Approach slabs are located at each end of the structure; however, they may not be present at some structures on lightly travelled roads or on gravel roads.

Approach slabs, where present, are constructed upon the approach embankment. One end of the approach slab is anchored to the ballast wall or abutment wall, the other end rests upon the approach fill and is free to move.

Where approach slabs are present, they are often paved over with an asphalt wearing surface.

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Approach ramps are sometimes provided at the approach to Bailey bridges and shall be categorized as approach slabs.

A typical concrete approach slab is illustrated in Figure 1.4.5.3.

1.4.1.5 Drainage and Deck Drains

Surface drainage on structures is channelled along the curbs and drained through deck drains or allowed to drain off the deck. Drainage from the approaches, when the highway is in sag, is normally drained into drainage ditches or caught at catch basins before it reaches the structure.

Deck drains are usually located along the curb lines. Deck drains are typically made of steel, although concrete, aluminum, acrylonitrile butadiene styrene (ABS) and polyvinylchloride (PVC) are sometimes used as well. Steel drains are usually galvanized or made of atmospheric corrosion resistant steel and in some cases for bridges built after 2020, stainless steel. Deck drains are anchored to the deck by metal bars or rely on their shape and bonding forces to secure them in place.

Deck drains vary in size and shape and vary from single pipes to prefabricated pipe and catch basin units. Deck drains can also occur individually or be interconnected to an extensive collection system terminating at storm sewers. In either case, deck drains must extend below or away from structure components below the deck to prevent water discharge or spray from falling on those components.

Deck drains, in concrete decks, normally have drainage holes in them, at the interface between the deck top surface and the asphalt wearing surface, to drain water that has penetrated through the wearing surface.

Concrete decks with dams at expansion joints usually have 25mm diameter PVC tubes placed through the deck, from the interface of the wearing surface and deck top surface, to drain water which penetrates through the wearing surface.

Precast concrete box girders and steel box girders have drain holes in the bottom flange to drain off any water that finds its way into the boxes. These also serve to provide ventilation.

Drainage ditches, gutters and catch basins in the approaches to the structure are detailed in References 1 and 2.

Figure 1.4.5.4 and Figure 1.4.5.5 illustrates typical examples of drainage systems and deck drains commonly encountered.

1.4.2 Primary Components

Decks and wearing surfaces shall be considered as primary components.

1.4.2.1 Material Defects of Primary Components

Material defects are as described in Part 2, Section 2.5.

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The top surfaces of exposed decks are directly subject to the adverse effects of weather, traffic and the use of de-icing salts and chemicals. This results in rapid deterioration of the decks.

Even with the added protection of the wearing surfaces, the deck top surfaces below the wearing surfaces of covered decks are often prone to similar deteriorations as exposed decks. Unfortunately, the wearing surfaces may hide these defects on the deck surfaces until they are well advanced.

Most bridges built after the 1973 have been built with a waterproofing membrane on top to protect and slow down deck top deterioration. Over time the materials have improved and as a result it has been shown that deck top deterioration at the first rehab cycle (ie 30-40yrs) does not display as much deck top deterioration as structures built pre-1973

1.4.2.2 Performance Defects of Primary Components

Performance of decks relate to their ability to support imposed live and dead loads, to transit those loads to the supporting superstructure components and to provide safe and smooth riding surfaces for traffic.

Performance of wearing surfaces relate to their ability to provide safe and smooth riding surfaces and to protect the underlying decks from deterioration.

1.4.3 Secondary Components

Curbs, sidewalks, approaches, approach slabs, and ramps are to be considered as secondary components.

1.4.3.1 Material Defects of Secondary Components

Material defects are as described in Part 2, Section 2.5.

1.4.3.2 Performance Defects of Secondary Components

Performance of curbs and sidewalks relates to their ability to provide safe and comfortable passage for pedestrians, and to protect structure components beyond the roadway limits from vehicular collision and damage. Curbs also serve to channel roadway surface drainage to deck drainage systems.

Performance of approaches, approach slabs, and ramps relates to their ability to provide smooth transition for traffic onto and off the structure. Performance of approach slabs also relates to their ability to distribute live loads through the embankment and to the abutment wall.

1.4.4 Auxiliary Components

Deck drains, drainage ditches, gutters and catch basins shall be considered as auxiliary components.

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1.4.4.1 Material Defects of Auxiliary Components

Material defects are as described in Part 2, Section 2.5.12.

1.4.4.2 Performance Defects of Auxiliary Components

The performance of deck drains and drainage systems relates to their ability to remove water from the deck and approaches, and to direct and discharge it safely away from the structure and its components.

Trapped or ponded water is a safety hazard, particularly when frozen, as it can lead to loss of vehicle control. It can also result in deterioration of the deck and other components.

1.4.5 References

1. Highway Drainage Design Standards 2024
2. Roadside Design Manual (2023 Update)

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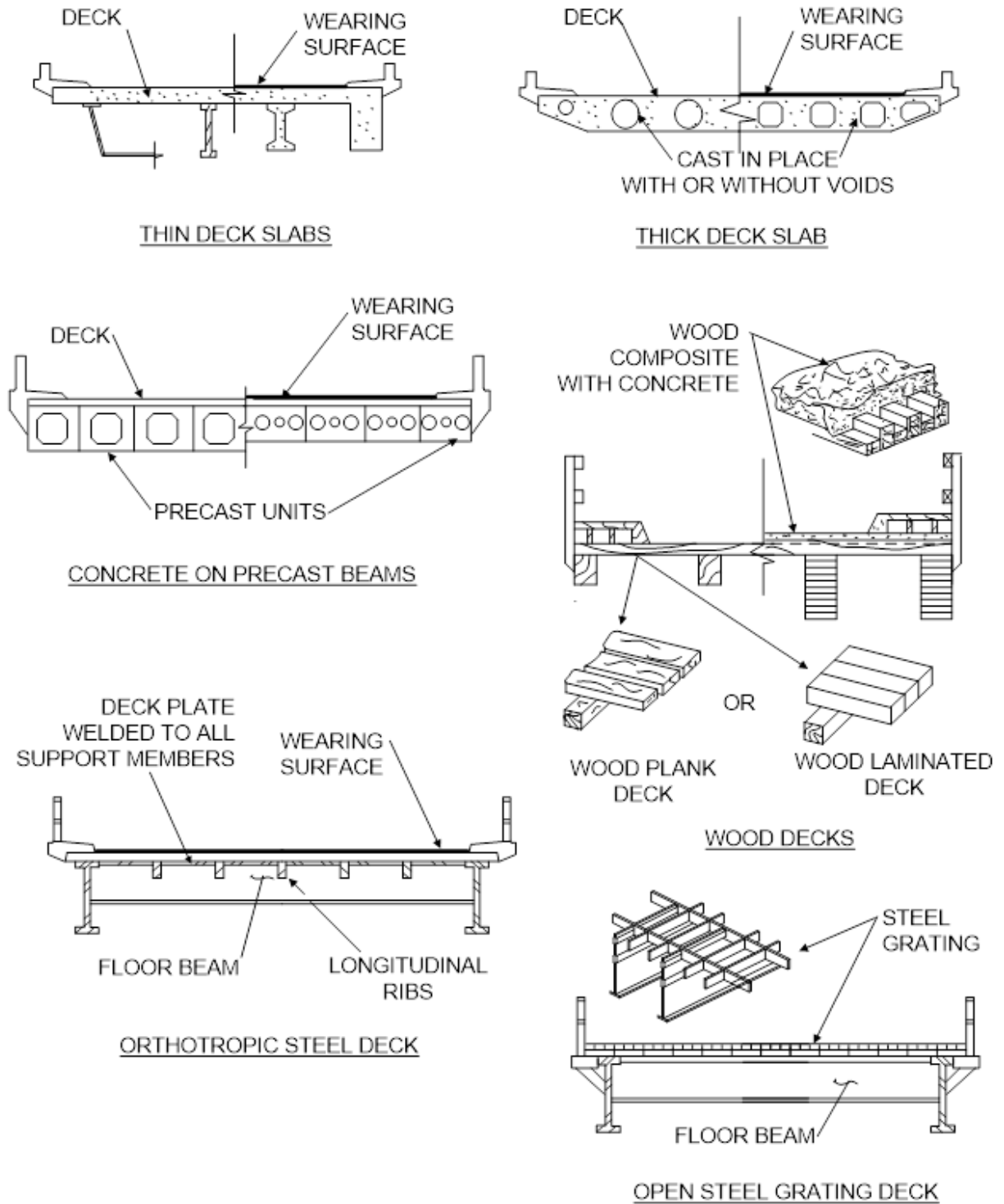


Figure 1.4.5.1 Typical Decks

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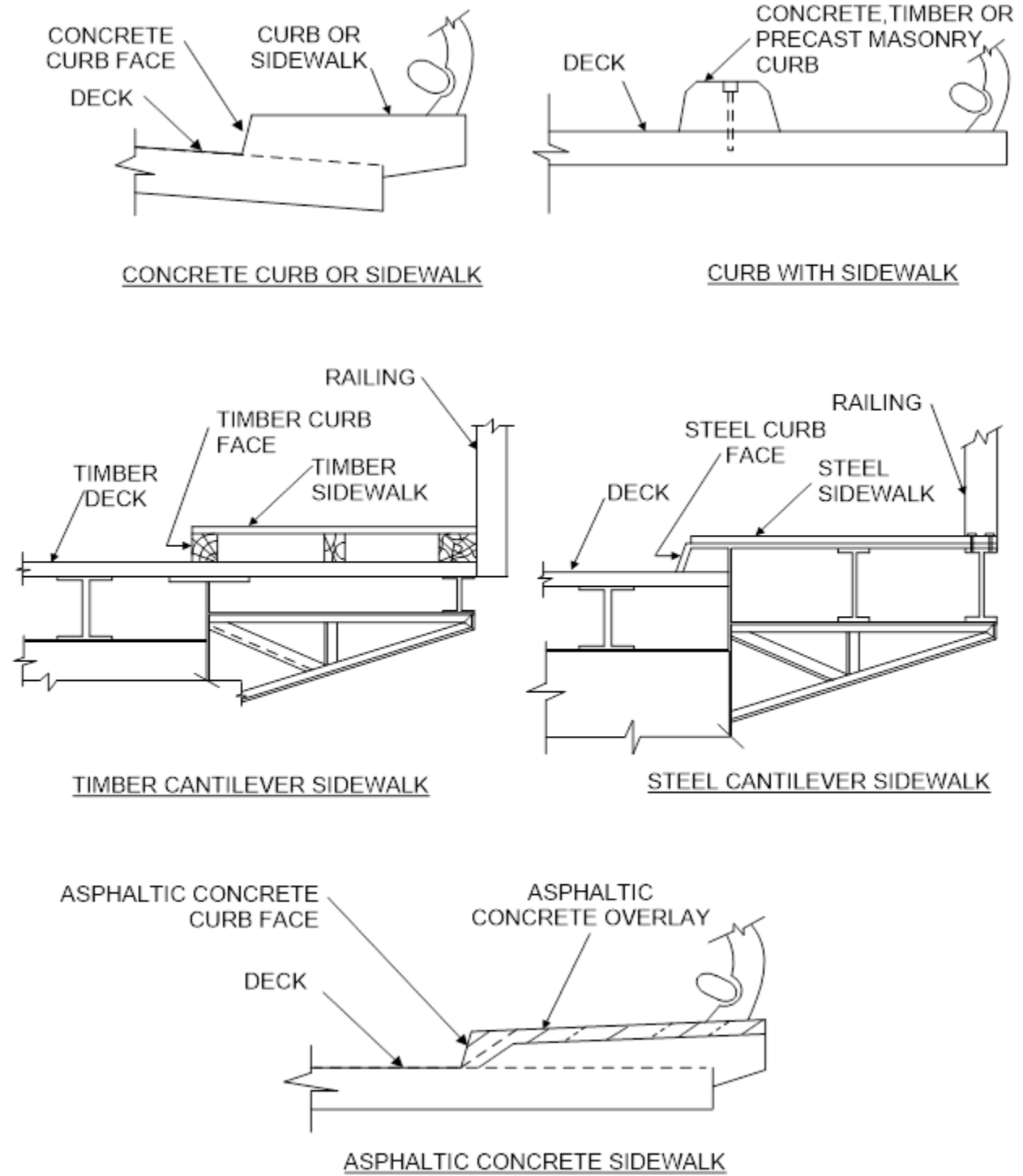


Figure 1.4.5.2 Typical Curbs and Sidewalks

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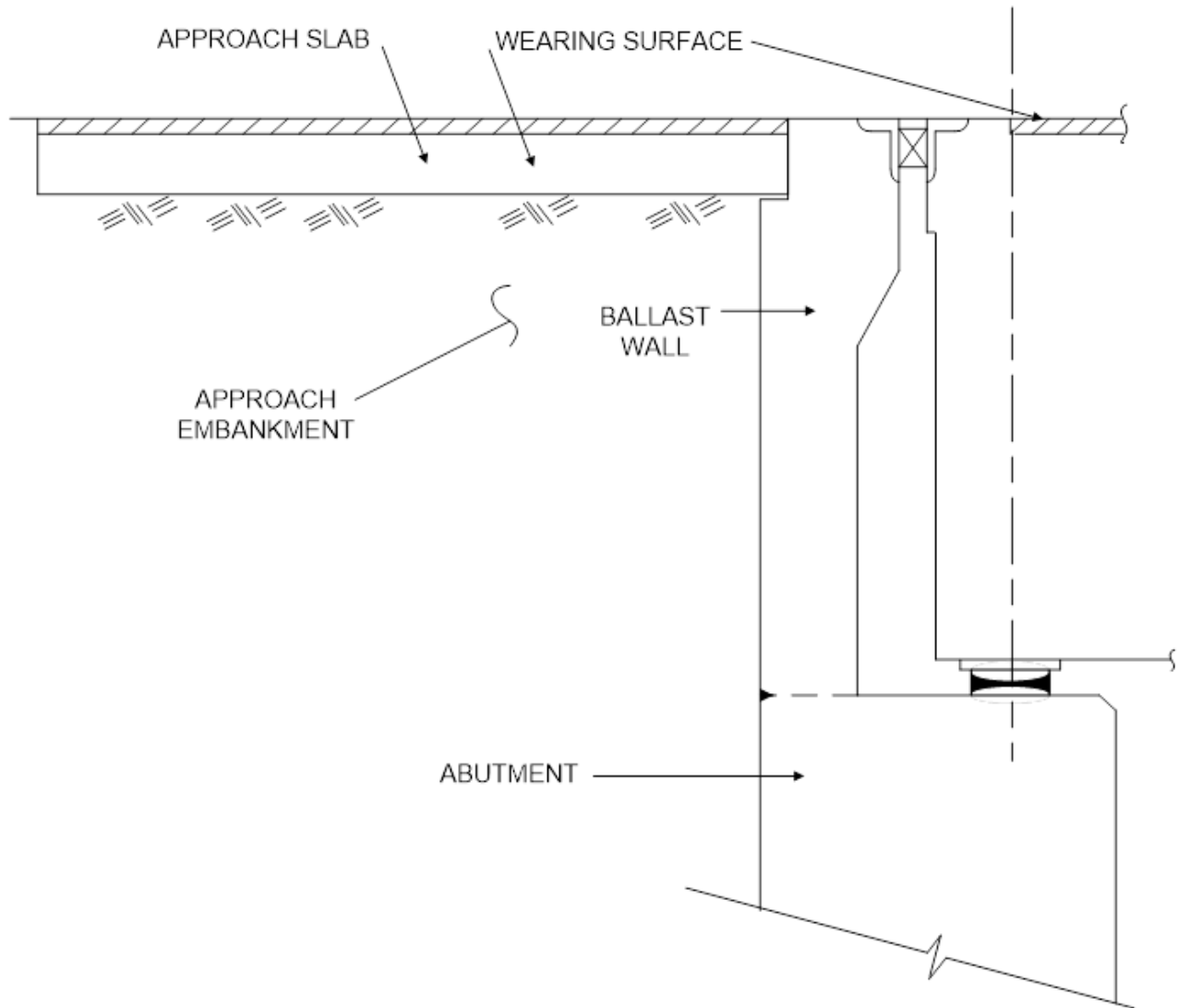


Figure 1.4.5.3 Concrete Approach Slab