

Substructure and Foundation Identification Guide



NEBRASKA

Good Life. Great Journey.

DEPARTMENT OF TRANSPORTATION
BRIDGE DIVISION

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Introduction

This guide is published by NDOT Bridge Division for the use in conjunction with the NDOT BIP Manual to determine the type of substructure and foundation in the field B.SB.04 and B.SB.06 in BrM. The information published here is solely a guide to be used with judgment by certified inspectors.

Substantial effort has been made to find common substructure and foundation types found in Nebraska. It is likely that some other types or variations have been overlooked. If assistance is needed to help identify the substructure or foundation type please contact the NBIS Program Manager Wayne Patras at wayne.patras@nebraska.gov with the drawings, pictures, and the structure number in question. Bridge Division will assist in determining the appropriate classification of the substructure or foundation type.

There is no functional difference between piers and bents. Both serve as an intermediate support between abutments. There is some debate among engineers as to the exact meaning and usage of these terms, and often their definitions depend on local custom and/or owner-agency preference. According to the NDOT Bridge Design Manual, bents are defined as "bridge supports between abutments that are supported on a single row of piles without a footing." All other intermediate supports located between the abutments are referred to as pier.

Nebraska Abutment Types

A01 Abutment – cantilever/wall

Item ID	B.SB.04	Substructure Type
Code	A01	Abutment – cantilever/wall
Description	Per the BIRM “Extends from the grade line of the roadway or water way below, to that of the road overhead.” (Ryan et al., 2023).	

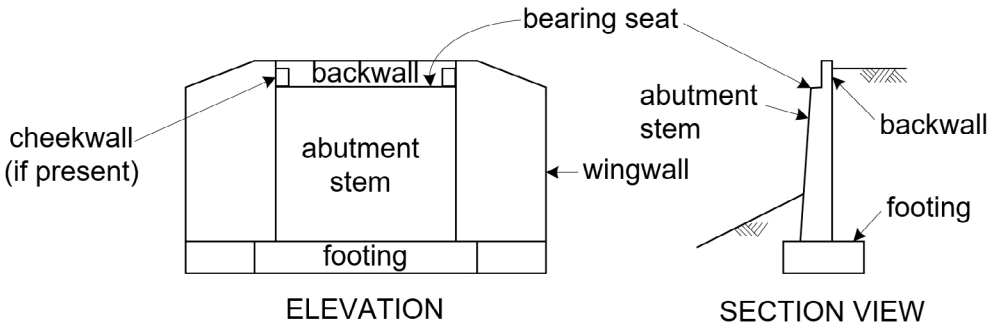


Figure 4.1.70 Sketch of Full Height Abutment

Reprinted from Ryan et al. (2023)



Structure №: SS16F00917



Structure Nº: S002 20292



Structure Nº: SS13D00093



Structure №: C000104710

A02 Abutment – stub

Item ID	B.SB.04	Substructure Type
Code	A02	Abutment – stub
Description	Use code A02 for partial height abutments that do not extend to near the bottom of the embankment fill. Use code A02 for abutments that are larger height than a pile cap or have features such as a backwall that exceed the purpose of a pile cap.	

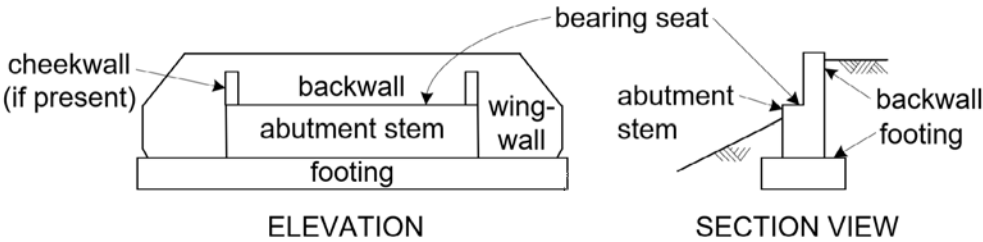


Figure 4.1.71 Sketch of Stub Abutment
Reprinted from Ryan et al. (2023)



Structure Nº: S080 28726

A03 Abutment – open/spill through

Item ID	B.SB.04	Substructure Type
Code	A03	Abutment – open/spill through
Description	Per the BIRM “Spill-through, or open, abutments tend to be similar in construction to multi-column piers. Instead of being retained by a solid wall, the approach roadway embankment extends on a slope below the bearing seat and between (through) the supporting columns. Only the topmost few feet of the embankment are actually retained by the abutment cap.” (Ryan et al., 2023).	

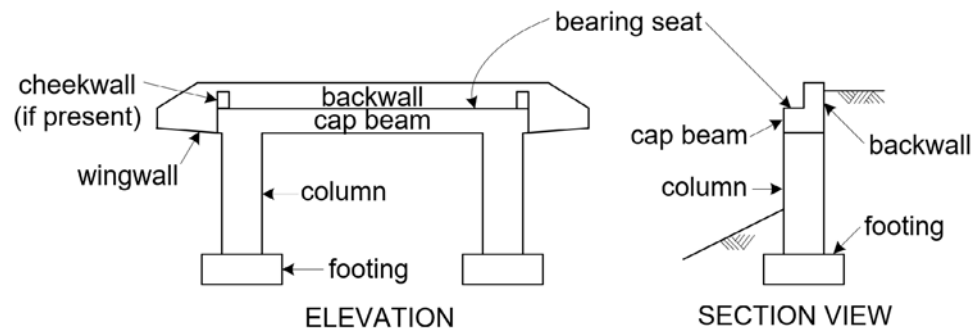


Figure 4.1.72 Sketch of Spill Through/Open Abutment

Reprinted from Ryan et al. (2023)

A04 Abutment – integral

Item ID	B.SB.04	Substructure Type
Code	A04	Abutment – integral
Description	Abutments type that is placed on vertical piles with sufficient flexibility so that the superstructure can contract and expand with changes in temperature. Girder ends are cast into the abutment during construction. Allows the expansion joint to be moved to the grade beam. – NDOT BDM	

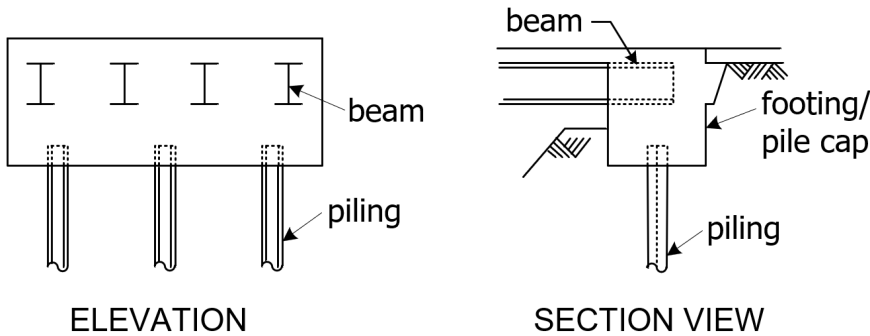


Figure 4.1.73 Sketch of Integral Abutment
Reprinted from Ryan et al. (2023)



Structure Nº: S066 12487

A05 Abutment – semi-integral

Item ID	B.SB.04	Substructure Type
Code	A05	Abutment – semi-integral
Description	Per the BIRM “Semi-integral abutments may be similar to integral abutments, however, the superstructure and the top of the abutment act as one unit, but the bottom portion acts independently of the superstructure. This is achieved by a joint between the top and bottom portions of the abutment that provides for unrestrained rotation and thermal movement.” (Ryan et al., 2023).	

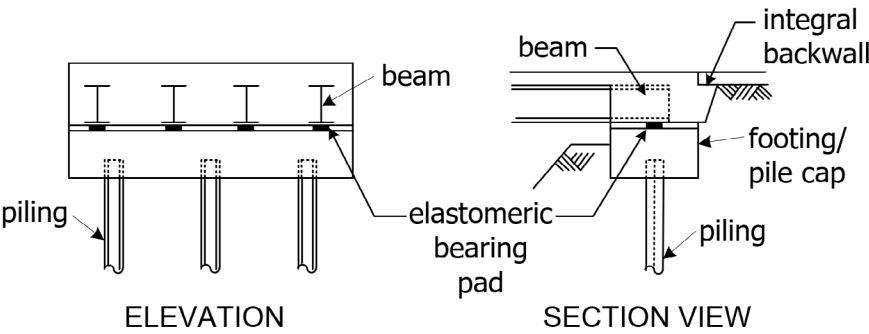


Figure 4.1.74 Sketch of Semi-Integral Abutment
Reprinted from Ryan et al. (2023)



Structure Nº: S002 20305

A06 Abutment – gravity

Item ID	B.SB.04	Substructure Type
Code	A06	Abutment – gravity
Description		

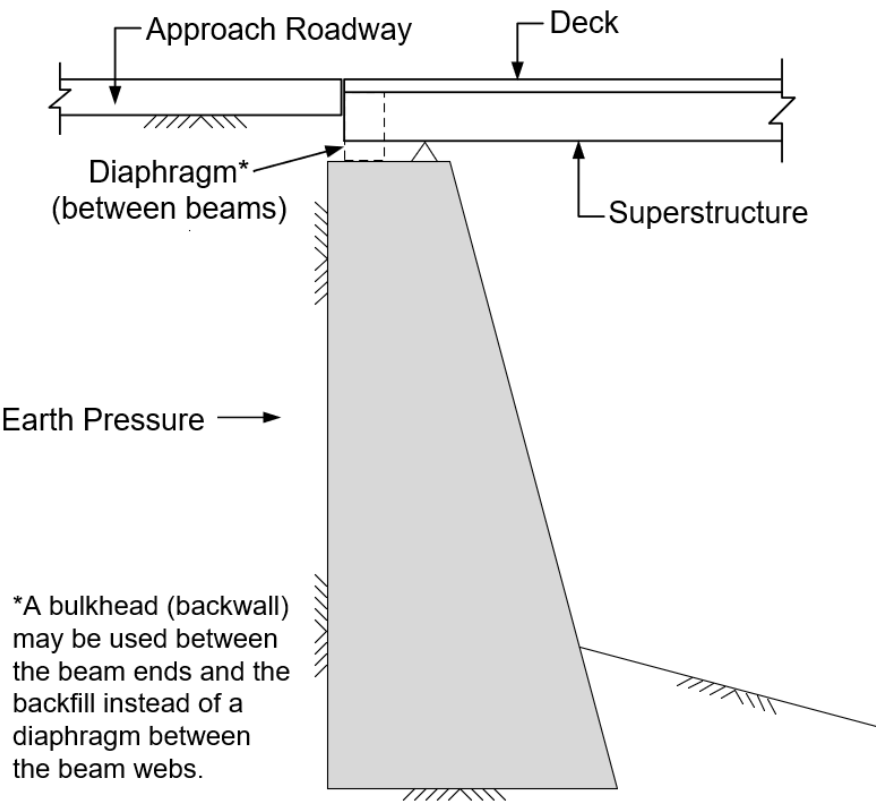


Figure 14.2.22 Gravity Abutment
Reprinted from Ryan et al. (2023)

A07 Abutment – counterfort or buttressed

Item ID	B.SB.04	Substructure Type
Code	A07	Abutment – counterfort or buttressed
Description	Per the BIRM “Counterfort abutments utilize thin walls called counterforts that connect the vertical stem to the footing. The counterforts are typically spaced at regular intervals along the stem, causing both the vertical stem and heel to act as continuous slabs, which is a distinction from the cantilever action in cantilever abutment stems.” (Ryan et al., 2023).	

A08 Abutment – pile bent with lagging

Item ID	B.SB.04	Substructure Type
Code	A08	Abutment – pile bent with lagging
Description	Per the BIRM lagging is defined as “horizontal members spanning between piles to form a wall” (Ryan et al., 2023). Be careful not to confuse one or more wales for lagging. The actual structure of the wall that is in contact with soil must be spanning horizontally to be considered lagging.	



Structure №: C000101320

A09 Abutment – crib

Item ID	B.SB.04	Substructure Type
Code	A09	Abutment – crib
Description	Per the BIRM “Cribbed abutments are most commonly constructed of timber but can also be made of precast concrete or steel. They consist of individual pieces stacked horizontally, in a log-cabin style, to create an overall structure.” (Ryan et al., 2023).	

A10 Abutment – cellular/vaulted

Item ID	B.SB.04	Substructure Type
Code	A10	Abutment – cellular/vaulted
Description	Per the BIRM “A cellular abutment, or vault, is an abutment in which the space between the wings, vertical stem, approach slab, and footings is hollow.” (Ryan et al., 2023). Use code A10 when the space between wingwalls, abutment stem, approach slab, and footings is hollow.	

A11 Abutment – reinforced soil mass

Item ID	B.SB.04	Substructure Type
Code	A11	Abutment – reinforced soil mass
Description	Use code A11 when the superstructure rests directly on the reinforced soil mass.	

A12 Abutment – footing or cap only

Item ID	B.SB.04	Substructure Type
Code	A12	Abutment – footing or cap only
Description	Use code A12 when the superstructure rests only on a footing, grade beam, thrust block, or pile or shaft cap with embedded piles or shafts that are not part of a bent.	

AX Abutment – other

Item ID	B.SB.04	Substructure Type
Code	AX	Abutment – other
Description		

Nebraska Bent Types

B01 Bent – column or open

Item ID	B.SB.04	Substructure Type
Code	B01	Bent – column or open
Description	Refer to Code P03 for multiple column.	

B02 Bent – column with web wall

Item ID	B.SB.04	Substructure Type
Code	B02	Bent – column with web wall
Description	Refer to Code P04 for multiple column with web wall.	

B03 Bent – pile

Item ID	B.SB.04	Substructure Type
Code	B03	Bent – pile
Description	Refer to Code P04 for multiple column with web wall.	



Structure №: S080 40872A



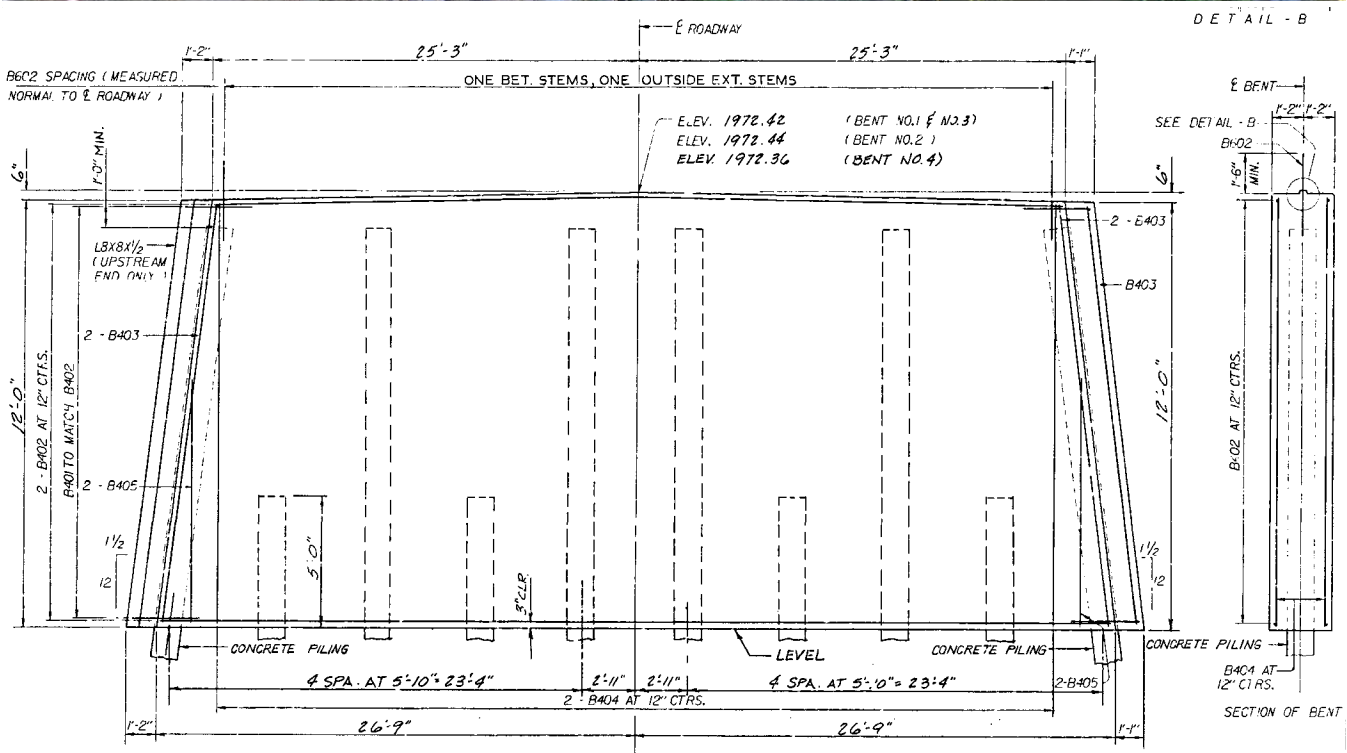
Structure №: S066 12231

B04 Bent – straddle or c-shaped

Item ID	B.SB.04	Substructure Type
Code	B04	Bent – straddle or c-shaped
Description	Refer to P05 for straddle or c-shaped.	

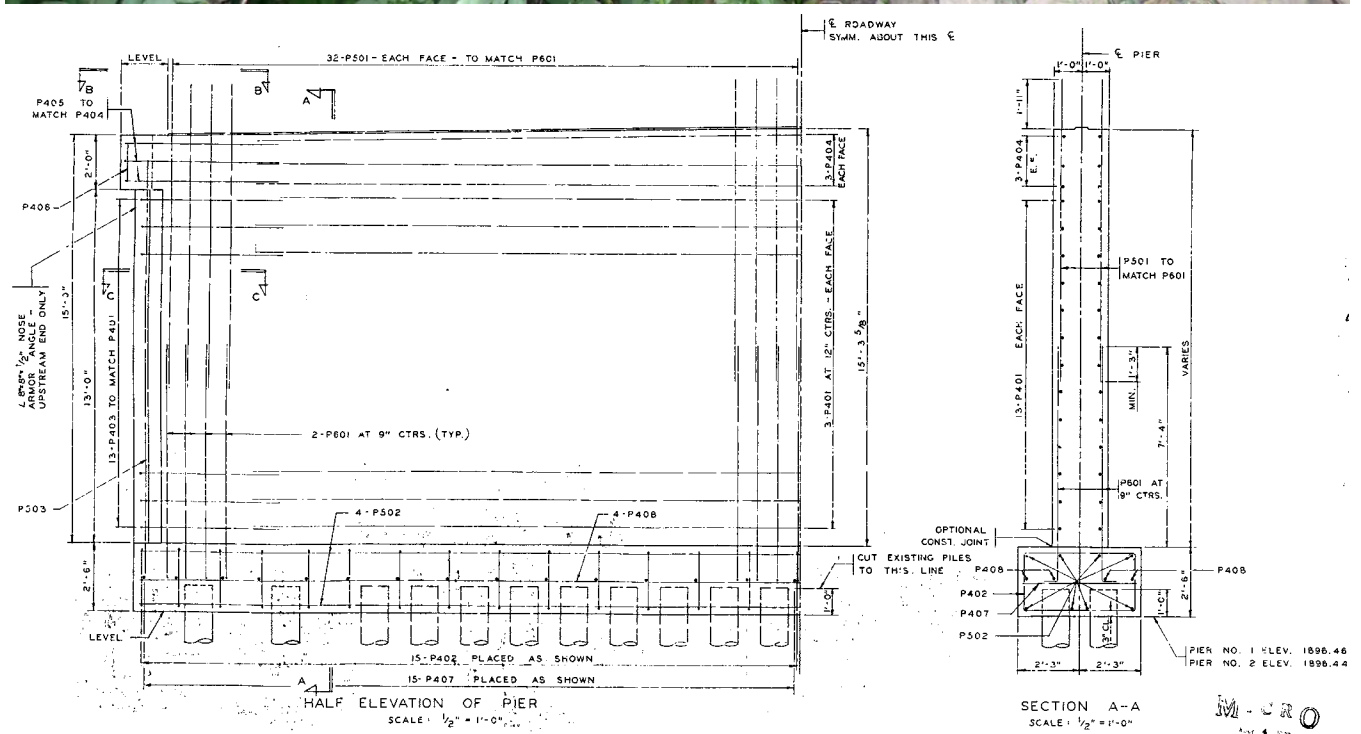
BX Bent – other

Item ID	B.SB.04	Substructure Type
Code	BX	Bent – other
Description	A common type of intermediate support structure found in Nebraska is a fully enclosed single row of piles without a footing.	



P01 Pier – wall

Item ID	B.SB.04	Substructure Type
Code	P01	Pier – wall
Description		



Structure N°: S002 34747

P02 Pier – single column

Item ID	B.SB.04	Substructure Type
Code	P02	Pier – single column
Description		



Structure №: S006 36428A

P03 Pier – multiple column

Item ID	B.SB.04	Substructure Type
Code	P03	Pier – multiple column
Description		



Structure Nº: S006 36428A

P04 Pier – multiple column with web wall

Item ID	B.SB.04	Substructure Type
Code	P04	Pier – multiple column with web wall
Description		

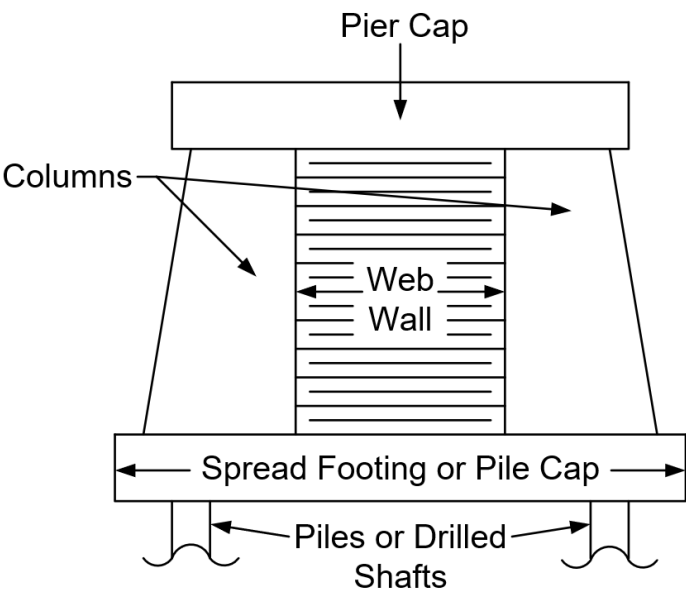
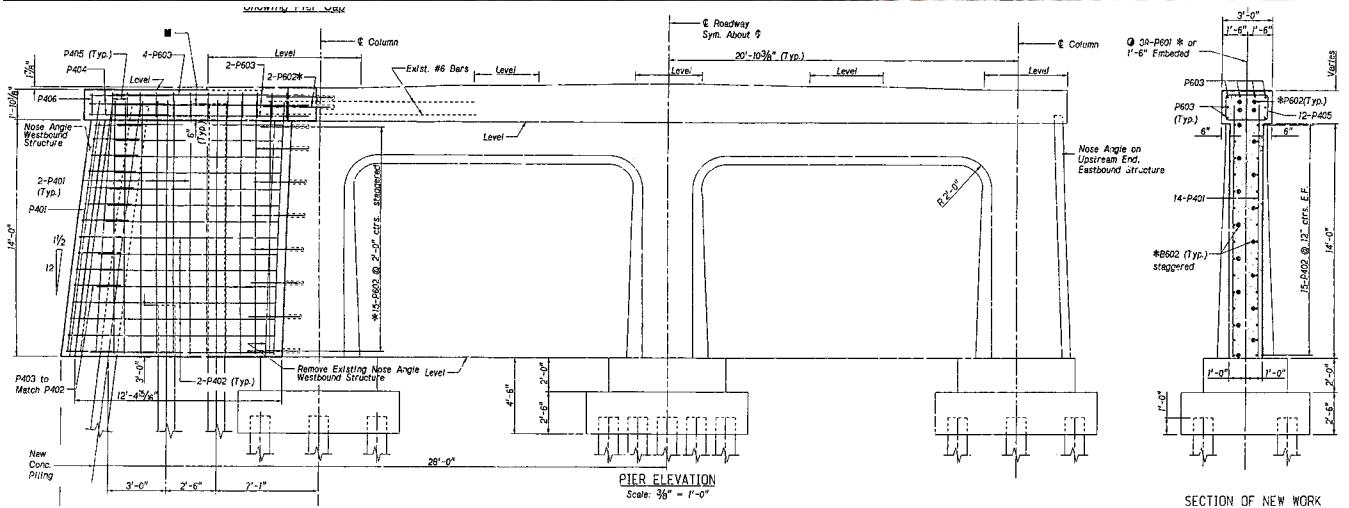


Figure 14.2.43 Column Pier with Web Wall Schematic
Reprinted from Ryan et al. (2023)



Structure No: S080 20100R



Structure No: S067 03943

P05 Pier – straddle or c-shaped

Item ID	B.SB.04	Substructure Type
Code	P05	Pier – straddle or c-shaped
Description	"A multicolumn pier in which an extremely wide column spacing is used to allow for the passage of a roadway directly below the pier, such that the pier is 'straddling' the roadway or other feature below the bridge." (Coletti & Sheahan, 2022)	



Structure Nº: S006 36428B



Structure Nº: S006 36484C (upper)



Structure N^o: S006 36428A (upper) and S006 36466A (lower)
The upper structure is classified as a straddle pier and the lower as a wall pier.

P06 Pier – movable bridge

Item ID	B.SB.04	Substructure Type
Code	P06	Pier – movable bridge
Description	Use code P06 for piers that support movable bridges and the equipment needed to open and close the bridge.	

P07 Pier – tower

Item ID	B.SB.04	Substructure Type
Code	P07	Pier – tower
Description	Use code P07 for towers of complex bridges such as cable-stayed and suspension bridges.	

P08 Pier – footing or cap only

Item ID	B.SB.04	Substructure Type
Code	P08	Pier – footing or cap only
Description	Use code P08 when the superstructure rests only on a footing, grade beam, thrust block, or pile or shaft cap with embedded piles or shafts that are not part of a bent.	

PX Pier – other

Item ID	B.SB.04	Substructure Type
Code	PX	Pier – other
Description		

X Other

Item ID	B.SB.04	Substructure Type
Code	X	Other
Description		

Nebraska Foundation Types

E01 Earth – reinforced soil

Item ID	B.SB.06	Foundation Type
Code	E01	Earth – reinforced soil
Description	Use code E01 when the superstructure bears directly on reinforced soil, reinforced bedding material, or the reinforced soil mass.	

E02 Earth – unreinforced soil

Item ID	B.SB.06	Foundation Type
Code	E02	Earth – unreinforced soil
Description	Use code E02 when the superstructure bears directly on unreinforced soil or unreinforced bedding material.	

E03 Earth – rock

Item ID	B.SB.06	Foundation Type
Code	E03	Earth – rock
Description	Use code E03 when the superstructure bears entirely on rock.	

F01 Footing – not on rock

Item ID	B.SB.06	Foundation Type
Code	F01	Footing – not on rock
Description	Use codes F01 to F03 for footings or when the substructure bears directly on ground at grade or below grade, e.g. grade beams, floor slabs, gravity walls, crib walls, etc.	

F02 Footing – on rock

Item ID	B.SB.06	Foundation Type
Code	F02	Footing – on rock
Description	Use codes F01 to F03 for footings or when the substructure bears directly on ground at grade or below grade, e.g. grade beams, floor slabs, gravity walls, crib walls, etc. Use code F02 only if the design plans, or subsequent subsurface investigation, indicate that the entire foundation is supported by rock.	

F03 Footing – on reinforced soil

Item ID	B.SB.06	Foundation Type
Code	F03	Footing – on reinforced soil
Description	Use codes F01 to F03 for footings or when the substructure bears directly on ground at grade or below grade, e.g. grade beams, floor slabs, gravity walls, crib walls, etc. Use code F03 if the superstructure load is supported by a substructure unit, which is in turn supported by the reinforced soil mass.	

P01 Pile – steel H-shape

Item ID	B.SB.06	Foundation Type
Code	P01	Pile – steel H-shape
Description		



Structure Nº: S001 00166



Structure №: S001 00266



Structure №: C000101005

P02 Pile – steel pipe

Item ID	B.SB.06	Foundation Type
Code	P02	Pile – steel pipe
Description	Use code P02 for filled or unfilled steel pipe piles.	



Structure Nº: S002 48543R



Structure Nº: S066 12231

P03 Pile – concrete, cast-in-place

Item ID	B.SB.06	Foundation Type
Code	P03	Pile – concrete, cast-in-place
Description	Use code P03 for cased and uncased cast-in-place concrete piles, and for driven corrugated, fluted, or spiral-welded shell-cased concrete piles.	

P04 Pile – prestressed concrete

Item ID	B.SB.06	Foundation Type
Code	P04	Pile – prestressed concrete
Description	Use code P04 for solid or hollow-core square, octagonal, or cylindrical piles.	



Structure №: S002 20292

P05 Pile – timber

Item ID	B.SB.06	Foundation Type
Code	P05	Pile – timber
Description		



Structure Nº: C000101320



Structure Nº: S080 40872A



Structure Nº: S080 40872A

P06 Pile – auger cast

Item ID	B.SB.06	Foundation Type
Code	P06	Pile – auger cast
Description	Use code P06 for piles that have concrete or grout placed by pumping through the stem of the auger pipe as the auger is withdrawn.	

P07 Pile – micropile

Item ID	B.SB.06	Foundation Type
Code	P07	Pile – micropile
Description	Use code P07 for small diameter piles, typically less than 12 inches, that are drilled, then grouted.	

P08 Pile – composite

Item ID	B.SB.06	Foundation Type
Code	P08	Pile – composite
Description	Use code P08 for piles in which the length is composed of two or more pile types or materials, excluding pile tips.	

P09 Pile – FRP composite

Item ID	B.SB.06	Foundation Type
Code	P09	Pile – FRP composite
Description	Use code P09 when FRP composite piles are used for construction but not as repairs to existing piles of a different type.	

PX Pile – other

Item ID	B.SB.06	Foundation Type
Code	PX	Pile – other
Description		

S01 Drilled shaft – single

Item ID	B.SB.06	Foundation Type
Code	S01	Drilled shaft – single
Description	Use codes S01 and S02 for cased or uncased drilled shafts.	

S02 Drilled shaft – multiple

Item ID	B.SB.06	Foundation Type
Code	S02	Drilled shaft – multiple
Description	Use codes S01 and S02 for cased or uncased drilled shafts.	



Structure №: S275 12627R

S03 Caisson

Item ID	B.SB.06	Foundation Type
Code	S03	Caisson
Description	Use code S03 for footings sunk into position by excavation through or beneath the caisson structure.	

X Other

Item ID	B.SB.06	Foundation Type
Code	X	Other
Description		

References

Ryan, T. W., Lloyd, C. E., Pichura, M. S., Tarasovich, D. M., Fitzgerald, S., & Michael Baker International. (2023). *Bridge Inspector's Reference Manual (BIRM) (2022 NBIS)* (dot:71829; Technical Report No. FHWA-NHI-23-024). U.S. Department of Transportation Federal Highway Administration National Highway Institute. <https://rosap.nhl.bts.gov/view/dot/71829>

Nebraska Department of Transportation. (2025). *Bridge Design Manual*. <https://dot.nebraska.gov/business-center/bridge/>

Coletti, D., & Sheahan, J. (2022). *Steel Bridge Design Handbook Chapter 16: Substructure Design* (Technical Report Nos. B916-22; Steel Bridge Design Handbook). National Steel Bridge Alliance, a division of the American Institute of Steel Construction. <https://www.aisc.org/nsba/design-and-estimation-resources/steel-bridge-design-handbook/>