

- ☐ Reference: F:\1355-01\Engrg\Index-Concrete-A.Mcd
- ☐ Reference: F:\1355-01\Engrg>Loading-HL-93.Mcd

Abutment Footings Under Ends Of Bridge

Non-Factored Gravity Loadings Applied To Bearing Abutment Footings

Note: Bearing Abutments Are Identical On East And West Ends Of Bridge

Non-Factored Gravity Dead Weight Of Applied To Soil Under Bearing Abutment Footings

ID := "Non-Factored Gravity Dead Weight Applied To Soil Under Bearing Abutment Footings"

Note: "Impact Factor" Not Required To Be Applied To Foundation Loadings

Weight Of Bearing Abutment Walls, Including Extensions And Footings

$$M_{\text{AbutModules}} := \frac{W_{\text{Bridge}}}{\text{Module}_{\text{Mono}}} \quad M_{\text{AbutModules}} = 5$$

$$\text{Weight}_{\text{StdBlocks}} := \text{Wgt}_{\text{BlkStd}} \cdot N_{\text{Std}} \cdot M_{\text{AbutModules}} \quad \text{Weight}_{\text{StdBlocks}} = 0.00 \text{ kip}$$

$$M_{\text{BrgModules}} := \frac{L_{\text{Brg}}}{\text{Module}_{\text{Mono}}} \quad M_{\text{BrgModules}} = 7 \quad N_{\text{Returns}} := 0$$

$$\begin{aligned} \text{Weight}_{\text{MonoBlocks}} := & \text{Wgt}_{\text{BlkMono}}(M_{\text{AbutModules}}, N_{\text{Returns}}) \cdot (N_{\text{Mono}} - 1) \dots \\ & + \text{Wgt}_{\text{BlkMono}}(M_{\text{BrgModules}}, N_{\text{Returns}}) \cdot 1 \end{aligned} \quad \text{Weight}_{\text{MonoBlocks}} = 43.36 \text{ kip}$$

$$\text{Weight}_{\text{Footing}} := \gamma_{\text{Conc}} \cdot \text{Area}_{\text{Brg}} \cdot H_{\text{Brg}} \quad \text{Weight}_{\text{Footing}} = 24.61 \text{ kip}$$

Weight Of Bridge Deck

$$\text{Weight}_{\text{BridgeDeck}} := \frac{\text{BridgeDeck}}{2} \quad \text{Weight}_{\text{BridgeDeck}} = 43.88 \text{ kip}$$

Weight Of (Future) Wearing Surface

$$\text{Weight}_{\text{WearSurface}} := \frac{\text{WearSurface}}{2} \quad \text{Weight}_{\text{WearSurface}} = 5.43 \text{ kip}$$

Weight Of Guardrails

$$\text{Weight}_{\text{Guardrails}} := \frac{\text{Guardrails}}{2} \quad \text{Weight}_{\text{Guardrails}} = 4.50 \text{ kip}$$

Weight Of Water Line

$$\text{Weight}_{\text{WaterLine}} := \frac{\text{WaterLine}}{2} \quad \text{Weight}_{\text{WaterLine}} = 1.13 \text{ kip}$$

ID = "Non-Factored Gravity Dead Weight Applied To Soil Under Bearing Abutment Footings"

Weight Of Soil On Toe And Heel Of Footing Units

Note: Footing Centered Under Abutment Wall

$$\text{Toe} := \frac{W_{\text{Brg}} - W_{\text{Blk}}}{2} \quad \text{Toe} = 2.50 \text{ ft}$$

$$H_{\text{Toe}} := \text{Embed}_{\text{Abut}} - H_{\text{Brg}} \quad H_{\text{Toe}} = 7.54 \text{ ft}$$

$$\text{Weight}_{\text{ToeSoil}} := \gamma_{\text{FrontFill}} \cdot \text{Toe} \cdot H_{\text{Toe}} \cdot L_{\text{Brg}} \quad \text{Weight}_{\text{ToeSoil}} = 44.54 \text{ kip}$$

$$\text{Heel} := \frac{W_{\text{Brg}} - W_{\text{Blk}}}{2} \quad \text{Heel} = 2.50 \text{ ft}$$

$$H_{\text{Heel}} := \text{Height}_{\text{BrgAbut}} - H_{\text{Brg}} \quad H_{\text{Heel}} = 9.88 \text{ ft}$$

$$\text{Weight}_{\text{HeelSoil}} := \gamma_{\text{BackFill}} \cdot \text{Heel} \cdot H_{\text{Heel}} \cdot L_{\text{Brg}} \quad \text{Weight}_{\text{HeelSoil}} = 51.84 \text{ kip}$$

$$\text{Extension}_{\text{EachEnd}} := \frac{L_{\text{Brg}} - W_{\text{Bridge}}}{2} \quad \text{Extension}_{\text{EachEnd}} = 2.50 \text{ ft}$$

$$\gamma_{\text{Extn}} := \max(\gamma_{\text{FrontFill}}, \gamma_{\text{BackFill}}) \quad \gamma_{\text{Extn}} = 135.00 \text{ pcf}$$

$$\text{Height}_{\text{Extn}} := \max(H_{\text{Toe}}, H_{\text{Heel}}) - H_{\text{Brg}} - H_{\text{BlkMono}} \quad \text{Height}_{\text{Extn}} = 7.37 \text{ ft}$$

$$\text{Weight}_{\text{Extensions}} := 2 \cdot \gamma_{\text{Extn}} \cdot W_{\text{Brg}} \cdot \text{Extension}_{\text{EachEnd}} \cdot \text{Height}_{\text{Extn}}$$

$$\text{Weight}_{\text{Extensions}} = 37.34 \text{ kip}$$

$$\text{Weight}_{\text{Soil}} := \text{Weight}_{\text{ToeSoil}} + \text{Weight}_{\text{HeelSoil}} + \text{Weight}_{\text{Extensions}}$$

$$\text{Weight}_{\text{Soil}} = 133.72 \text{ kip}$$

Weight Of Pre-Existing Soil At Footing Bearing Surface Elevation

$$\text{SoilDepth}_{\text{PreExisting}} := \min(H_{\text{Toe}}, H_{\text{Heel}}) \quad \text{SoilDepth}_{\text{PreExisting}} = 7.54 \text{ ft}$$

$$\text{SoilWeight}_{\text{PreExisting}} := \gamma_{\text{BackFill}} \cdot \text{SoilDepth}_{\text{PreExisting}} \cdot W_{\text{Brg}} \cdot L_{\text{Brg}}$$

$$\text{SoilWeight}_{\text{PreExisting}} = 118.78 \text{ kip}$$

Working Dead Weight Of Bridge Structure System Bearing On Soil Under Each Abutment

$$\begin{aligned} \text{DeadWeightWkg} := & (\text{WeightStdBlocks} + \text{WeightMonoBlocks} + \text{WeightFooting}) \dots \\ & + \text{WeightBridgeDeck} + \text{WeightWearSurface} + \text{WeightGuardrails} \dots \\ & + \text{WeightWaterLine} + \text{WeightSoil} \end{aligned}$$

DeadWeightWkg = 256.63 kip

$$\text{DeadWeightIncreaseWkg} := \text{DeadWeightWkg} - \text{SoilWeightPreExisting}$$

DeadWeightIncreaseWkg = 137.84 kip

Non-Factored Gravity Live Load Applied To Soil Under Bearing Abutment Footings

ID := "Non-Factored Gravity Live Load Applied To Soil Under Bearing Abutment Footings"

Note: "Impact Factor" Not Required To Be Applied To Foundation Loadings

$$\text{LaneLive} := \text{QLane} \cdot \text{WLane} \cdot \frac{\text{LBridge}}{2} \qquad \text{LaneLive} = 14.40 \text{ kip}$$

$$\text{TandemLive} := \text{QTan} \cdot \frac{[\text{Span} + (\text{Span} - \text{SpcgTan})]}{\text{Span}} \qquad \text{TandemLive} = 47.65 \text{ kip}$$

$$\text{TruckLive} := \text{QTrk} \cdot \left[\frac{\text{Span} + (\text{Span} - \text{SpcgTrkMin})}{\text{Span}} \right] + \text{QTrkSteer} \cdot \left(\frac{\text{Span} - 2 \cdot \text{SpcgTrkMin}}{\text{Span}} \right)$$

TruckLive = 56.19 kip

$$\text{LiveLoadWkg} := \text{LaneLive} + \max(\text{TandemLive}, \text{TruckLive})$$

LiveLoadWkg = 70.59 kip

Compute Actual Contact Footing Soil Bearing Pressure

Total Dead Weight Plus Live Load Applied To Soil Under Bearing Abutment Footings

$$\text{TotalLoadWkg} := \text{DeadWeightWkg} + \text{LiveLoadWkg}$$

$$\text{TotalLoadWkg} = 327.21 \text{ kip}$$

$$q_{\text{SoilBrgWkg}} := \frac{\text{TotalLoadWkg}}{W_{\text{Brg}} \cdot L_{\text{Brg}}}$$

$$q_{\text{SoilBrgWkg}} = 2.49 \text{ ksf}$$

Compute Increase In Contact Footing Soil Bearing Pressure

$$\text{TotalLoadIncreaseWkg} := \text{TotalLoadWkg} - \text{SoilWeightPreExisting}$$

$$\text{TotalLoadIncreaseWkg} = 208.43 \text{ kip}$$

Confirm Soil Bearing Pressure Within Limits Set By Geotech Engineer

Bearing Pressure Increase

$$q_{\text{SoilBrgIncreaseWkg}} := \frac{\text{TotalLoadIncreaseWkg}}{\text{AreaBrg}}$$

$$q_{\text{SoilBrgIncreaseWkg}} = 1.59 \text{ ksf}$$

$$\text{RatioChk}(q_{\text{SoilBrgIncreaseWkg}}, \text{BrgSoil}) = (\text{"Ratio ="} \quad 0.88 \quad \text{"Thus Is"} \quad \text{"OK"})$$

Apply VERY Conservative "Composite" Load Factor To Working Load Moments And Shears To Establish Factored Load Moments And Shears In Footing Units And In Extension Units

$$\gamma_{\text{Composite}} := 3.0$$

Confirm Standard Mono Block Reinforcement Adequate For Footing Units

$$q_{Net} := q_{SoilBrgWkg} - \min(\gamma_{FrontFill} \cdot H_{Toe}, \gamma_{BackFill} \cdot H_{Heel}) - \gamma_{Conc} \cdot H_{Brg}$$

$$q_{Net} = 1287.43 \text{ psf}$$

$$Cant := \frac{W_{Brg} - W_{Blk}}{2} \quad Cant = 2.50 \text{ ft}$$

Factored Load Moment Demand

$$M_{WkgFtgUnit} := q_{Net} \cdot W_{Blk} \cdot \frac{Cant^2}{2} \quad M_{WkgFtgUnit} = 10.06 \text{ kip} \cdot \text{ft}$$

$$M_{UltFtgUnit} := \gamma_{Composite} \cdot M_{WkgFtgUnit} \quad M_{UltFtgUnit} = 30.17 \text{ kip} \cdot \text{ft}$$

Moment Resistance Provided By Standard Mono Block Reinforcement

$$N_{BarsTop} := 4 \quad Size_{BarsTop} := 5$$

$$A_{sTop} := N_{BarsTop} \cdot RebarA(Size_{BarsTop}) \quad A_{sTop} = 1.24 \text{ in}^2$$

$$N_{BarsBot} := 4 \quad Size_{BarsBot} := 5$$

$$A_{sBot} := N_{BarsBot} \cdot RebarA(Size_{BarsBot}) \quad A_{sBot} = 1.24 \text{ in}^2$$

$$d := CAd(H_{BlkMono}, Cover_{Blk}, Size_{BarsBot}, Size_{Hoops}, N_{Lyrs}) \quad d = 11.31 \text{ in}$$

$$d' := CAd'(Cover_{Blk}, Size_{BarsTop}, Size_{Hoops}, N_{Lyrs}) \quad d' = 3.69 \text{ in}$$

$$a := CAa(A_{sBot}, F_yRebar, F'c_{Blk}, W_{Blk}) \quad a = 0.97 \text{ in}$$

$$M_{FtgU} := CAMu(\phi_{Cf}, F_yRebar, A_{sBot}, d, a, A_{sTop}, d') \quad M_{FtgU} = 60.41 \text{ kip} \cdot \text{ft}$$

$$RatioChk(M_{UltFtgUnit}, M_{FtgU}) = (\text{"Ratio"} = 0.50 \text{ "Thus Is"} \text{ "OK"})$$

Confirm Footing Unit Not Overstressed In Shear

Factored Load Shear Demand

$$V_{UltFtgUnit} := \gamma_{Composite} \cdot q_{Net} \cdot W_{Blk} \cdot \left(\frac{W_{Brg} - W_{Blk}}{2} \right) \quad V_{UltFtgUnit} = 24.14 \text{ kip}$$

$$V_{FtgU} := \phi_{Cv} \cdot W_{Blk} \cdot 0.06 \cdot \sqrt{\frac{F'c}{ksi}} \cdot ksi \cdot d \quad V_{FtgU} = 44.89 \text{ kip}$$

$$RatioChk(V_{UltFtgUnit}, V_{FtgU}) = (\text{"Ratio"} = 0.54 \text{ "Thus Is"} \text{ "OK"})$$

**Confirm Standard Mono Block Reinforcement Adequate
For Abutment Extension At Each End Of Bearing Abutment**

$$q_{Net} := q_{SoilBrgWkg} - \min(\gamma_{FrontFill} \cdot H_{Toe}, \gamma_{BackFill} \cdot H_{Heel}) - \gamma_{Conc} \cdot (H_{Brg} + H_{BlkMono})$$

$$q_{Net} = 1099.93 \text{ psf}$$

$$Cant := ExtensionEachEnd \quad Cant = 2.50 \text{ ft}$$

Factored Load Moment Demand

$$M_{WkgExtnUnit} := q_{Net} \cdot W_{Blk} \cdot \frac{Cant^2}{2} \quad M_{WkgExtnUnit} = 8.59 \text{ kip} \cdot \text{ft}$$

Apply Conservative "Composite" Load Factor To Working Load Moment And Shear

$$M_{UltExtnUnit} := \gamma_{Composite} \cdot M_{WkgExtnUnit} \quad M_{UltExtnUnit} = 25.78 \text{ kip} \cdot \text{ft}$$

Moment Resistance Provided by Standard Mono Block Reinforcement

$$N_{BarsTop} := 4 \quad Size_{BarsTop} := 5$$

$$A_{sTop} := N_{BarsTop} \cdot RebarA(Size_{BarsTop}) \quad A_{sTop} = 1.24 \text{ in}^2$$

$$N_{BarsBot} := 4 \quad Size_{BarsBot} := 5$$

$$A_{sBot} := N_{BarsBot} \cdot RebarA(Size_{BarsBot}) \quad A_{sBot} = 1.24 \text{ in}^2$$

$$d := CAD(H_{BlkMono}, Cover_{Blk}, Size_{BarsBot}, Size_{Hoops}, N_{Lyrs}) \quad d = 11.31 \text{ in}$$

$$d' := CAD'(Cover_{Blk}, Size_{BarsTop}, Size_{Hoops}, N_{Lyrs}) \quad d' = 3.69 \text{ in}$$

$$a := CAa(A_{sBot}, F_yRebar, F'c_{Blk}, W_{Blk}) \quad a = 0.97 \text{ in}$$

$$M_{FtgU} := CAMu(\phi_{Cf}, F_yRebar, A_{sBot}, d, a, A_{sTop}, d') \quad M_{FtgU} = 60.41 \text{ kip} \cdot \text{ft}$$

$$RatioChk(M_{UltExtnUnit}, M_{FtgU}) = ("Ratio =" \quad 0.43 \quad "Thus Is" \quad "OK")$$

Confirm Footing Unit Not Overstressed In Shear

Factored Load Shear Demand

$$V_{UltExtnUnit} := \gamma_{Composite} \cdot q_{Net} \cdot W_{Blk} \cdot \left(\frac{W_{Brg} - W_{Blk}}{2} \right) \quad V_{UltExtnUnit} = 20.62 \text{ kip}$$

$$V_{FtgU} := \phi_{Cv} \cdot W_{Blk} \cdot 0.06 \cdot \sqrt{\frac{F'c}{ksi}} \cdot ksi \cdot d \quad V_{FtgU} = 44.89 \text{ kip}$$

$$RatioChk(V_{UltExtnUnit}, V_{FtgU}) = ("Ratio =" \quad 0.46 \quad "Thus Is" \quad "OK")$$