Bird McDonald Residence
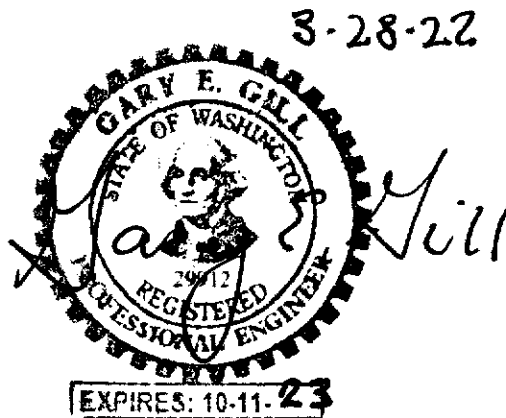
4304 East Mercer Way
Mercer Island, WA 98040

SUPPLEMENTAL
STRUCTURAL
CALCULATIONS II

March 28, 2022

3-28-22

EXPIRES: 10-11-23

Prepared by

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RW1 (H=9.0')

$A := 1$ $Tw := .66$ $B := 6$ $Tf := 1.33$ $H1 := .5$ $H := 9.0$

$ECP := .035$ $S := .008$ $Sur := .0 \cdot H$ $SoilWt := .13$

$Vecp := \dfrac{H^2}{2} \cdot ECP$ $Vecp = 1.418$ $Vs := S \cdot H^2$ $Vs = 0.648$ $Vsur := Sur \cdot H$ $Vsur = 0$

$Mot := Vecp \cdot \left(\dfrac{H}{3} + H1 + Tf \right) + Vs \cdot \left(\dfrac{H}{2} + H1 + Tf \right) + Vsur \cdot \left(\dfrac{H}{2} + Tf + H1 \right)$

$Mot = 10.948$

$Wf := (A + Tw + B) \cdot (Tf) \cdot .15 + B \cdot .15$ $Ww := (H + .5 + H1) \cdot Tw \cdot .15$ $Ws := A \cdot (H + H1) \cdot SoilWt$

$Wf = 2.428$ $Ww = 0.99$ $Ws = 1.235$

$W := Wf + Ww + Ws$ $W = 4.653$

$Mr := Wf \cdot \dfrac{(A + Tw + B)}{2} + Ww \cdot \left(B + \dfrac{Tw}{2} \right) + Ws \cdot \left(B + Tw + \dfrac{A}{2} \right)$ $Mr = 24.409$

$FOS := \dfrac{Mr}{Mot}$ $FOS = 2.229$

$xb := \dfrac{Mr - Mot}{W}$ $xb = 2.893$ $qmax := \dfrac{2 \cdot W}{3 \cdot xb}$ $qmax = 1.072$ **OK with sesimic**

Sliding

Without Seismic

$V := Vecp$ $V = 1.418$ $Vsl := W \cdot \dfrac{.4}{1.5}$ $Vsl = 1.241$ $KeyDepth := 1.0$

$Vpass := \dfrac{(Tf + KeyDepth)^2}{2} \cdot \dfrac{.3}{1.5}$ $Vpass = 0.543$ $Vsl + Vpass = 1.784$ **OK**

$Mukey := \left(Tf \cdot .3 \cdot \dfrac{KeyDepth^2}{2} + KeyDepth \cdot .3 \cdot \dfrac{KeyDepth}{2} \cdot KeyDepth \cdot .66 \right) \cdot 1.6$ $Mukey = 0.478$

With Seismic

$V := Vecp + Vs$ $V = 2.066$ $Vsl := W \cdot \dfrac{.4}{1.2}$ $Vsl = 1.551$ $KeyDepth := 1.0$

$Vpass := \dfrac{(Tf + KeyDepth)^2}{2} \cdot \dfrac{.3}{1.2}$ $Vpass = 0.679$ $Vsl + Vpass = 2.23$ **OK**

$Mukey := \left(Tf \cdot .3 \cdot \dfrac{KeyDepth^2}{2} + KeyDepth \cdot .3 \cdot \dfrac{KeyDepth}{2} \cdot KeyDepth \cdot .66 \right) \cdot 1.6$ $Mukey = 0.478$

$d := 4$ $As := .2$ $a := As \cdot \dfrac{60}{.85 \cdot 2.5 \cdot 12}$ $a = 0.471$

$PhiMc := .9 \cdot As \cdot 60 \cdot \left(d - \dfrac{a}{2} \right) \cdot \dfrac{1}{12}$ $PhiMc = 3.388$

Use: 1'-0"x8"W key with #4v @ 12"

Reinforcing

Wall

Bottom of Wall

$$Mu := 1.4 \cdot Vs \cdot \frac{H}{2} + 1.6 Vecp \cdot \frac{H}{3} + 1.6 Vsur \cdot \frac{H}{2} \qquad\qquad Mu = 10.886$$

$$d := 6 \qquad A := .75 \qquad Spac := 12 \qquad As := A \cdot \frac{12}{Spac}$$

$$a := \frac{As \cdot 60}{12 \cdot .85 \cdot 2.5} \qquad a = 1.765$$

$$PhiMc := As \cdot 60 \cdot .9 \cdot \frac{\left(d - \frac{a}{2}\right)}{12} \qquad PhiMc = 17.272 \qquad \textbf{OK} \qquad\qquad \text{Use: \#6\&\#5v @ 12"}$$

3 feet above bottom of Wall

$$H3 := H - 3$$

$$V3ecp := \frac{H3^2}{2} \cdot ECP \quad V3ecp = 0.63 \qquad V3s := S \cdot H3^2 \quad V3s = 0.288 \quad V3sur := Sur \cdot H3 \quad V3sur = \text{ }$$

$$Mu := 1.4 \cdot V3s \cdot \frac{H3}{2} + 1.6 V3ecp \cdot \frac{H3}{3} + 1.6 V3sur \cdot \frac{H3}{2} \qquad\qquad Mu = 3.226$$

$$d := 6 \qquad A := .31 \qquad Spac := 12 \qquad As := A \cdot \frac{12}{Spac}$$

$$a := \frac{As \cdot 60}{12 \cdot .85 \cdot 2.5} \qquad a = 0.729$$

$$PhiMc := As \cdot 60 \cdot .9 \cdot \frac{\left(d - \frac{a}{2}\right)}{12} \qquad PhiMc = 7.861 \qquad \textbf{OK} \qquad\qquad \text{Use: \#5v @ 12" ABV 3'-0"}$$

Footing

Bottom Bars

$$Mbu := 1.55 \cdot W \cdot (B - xb) \qquad Mbu = 22.41$$

$$d := 13 \quad A := .44 \qquad\qquad Spac := 12 \qquad As := A \cdot \frac{12}{Spac}$$

$$a := \frac{As \cdot 60}{12 \cdot .85 \cdot 2.5} \qquad a = 1.035$$

$$PhiMc := As \cdot 60 \cdot .9 \cdot \frac{\left(d - \frac{a}{2}\right)}{12} \qquad PhiMc = 24.715 \qquad \textbf{OK} \qquad\qquad \text{Use: \#6b@12" Hooked}$$

RW2 (H=9.0') Outdoor Wall at Garage Entrance

$A := 1$ $Tw := .66$ $B := 6$ $Tf := 1.33$ $H1 := .5$ $H := 9.0$

$ECP := .035$ $S := .008$ $Sur := .0 \cdot H$ $SoilWt := .13$

$Vecp := \dfrac{H^2}{2} \cdot ECP$ $Vecp = 1.418$ $Vs := S \cdot H^2$ $Vs = 0.648$ $Vsur := Sur \cdot H$ $Vsur = 0$

$Mot := Vecp \cdot \left(\dfrac{H}{3} + H1 + Tf \right) + Vs \cdot \left(\dfrac{H}{2} + H1 + Tf \right) + Vsur \cdot \left(\dfrac{H}{2} + Tf + H1 \right)$

$Mot = 10.948$

$Wf := (A + Tw + B) \cdot (Tf) \cdot .15 + B \cdot .13$ $Ww := (H + .5 + H1) \cdot Tw \cdot .15$ $Ws := A \cdot (H + H1) \cdot SoilWt$

$Wf = 2.308$ $Ww = 0.99$ $Ws = 1.235$

$W := Wf + Ww + Ws$ $W = 4.533$

$Mr := Wf \cdot \dfrac{(A + Tw + B)}{2} + Ww \cdot \left(B + \dfrac{Tw}{2} \right) + Ws \cdot \left(B + Tw + \dfrac{A}{2} \right)$ $Mr = 23.95$

$FOS := \dfrac{Mr}{Mot}$ $FOS = 2.188$

$xb := \dfrac{Mr - Mot}{W}$ $xb = 2.868$ $qmax := \dfrac{2 \cdot W}{3 \cdot xb}$ $qmax = 1.054$ **OK with sesimic**

Sliding

Without Seismic

$V := Vecp$ $V = 1.418$ $Vsl := W \cdot \dfrac{.4}{1.5}$ $Vsl = 1.209$ $KeyDepth := 1.0$

$Vpass := \dfrac{(Tf + KeyDepth)^2}{2} \cdot \dfrac{.3}{1.5}$ $Vpass = 0.543$ $Vsl + Vpass = 1.752$ OK

$Mukey := \left(Tf \cdot .3 \cdot \dfrac{KeyDepth^2}{2} + KeyDepth \cdot .3 \cdot \dfrac{KeyDepth}{2} \cdot KeyDepth \cdot .66 \right) \cdot 1.6$ $Mukey = 0.478$

With Seismic

$V := Vecp + Vs$ $V = 2.066$ $Vsl := W \cdot \dfrac{.4}{1.2}$ $Vsl = 1.511$ $KeyDepth := 1.0$

$Vpass := \dfrac{(Tf + KeyDepth)^2}{2} \cdot \dfrac{.3}{1.2}$ $Vpass = 0.679$ $Vsl + Vpass = 2.19$ OK

$Mukey := \left(Tf \cdot .3 \cdot \dfrac{KeyDepth^2}{2} + KeyDepth \cdot .3 \cdot \dfrac{KeyDepth}{2} \cdot KeyDepth \cdot .66 \right) \cdot 1.6$ $Mukey = 0.478$

$d := 4$ $As := .2$ $a := As \cdot \dfrac{60}{.85 \cdot 2.5 \cdot 12}$ $a = 0.471$

$PhiMc := .9 \cdot As \cdot 60 \cdot \left(d - \dfrac{a}{2} \right) \cdot \dfrac{1}{12}$ $PhiMc = 3.388$

Use: 1'-0"x8"W key with #4v @ 12"

Reinforcing

Wall

Bottom of Wall

$$Mu := 1.4 \cdot Vs \cdot \frac{H}{2} + 1.6 Vecp \cdot \frac{H}{3} + 1.6 Vsur \cdot \frac{H}{2} \qquad\qquad Mu = 10.886$$

$$d := 6 \qquad A := .75 \qquad Spac := 12 \qquad As := A \cdot \frac{12}{Spac}$$

$$a := \frac{As \cdot 60}{12 \cdot .85 \cdot 2.5} \qquad a = 1.765$$

$$PhiMc := As \cdot 60 \cdot .9 \cdot \frac{\left(d - \frac{a}{2}\right)}{12} \qquad PhiMc = 17.272 \quad \textbf{OK} \qquad \textbf{Use: \#6\&\#5v @ 12"}$$

3 feet above bottom of Wall

$$H3 := H - 3$$

$$V3ecp := \frac{H3^2}{2} \cdot ECP \quad V3ecp = 0.63 \qquad V3s := S \cdot H3^2 \quad V3s = 0.288 \quad V3sur := Sur \cdot H3 \quad V3sur = 0$$

$$Mu := 1.4 \cdot V3s \cdot \frac{H3}{2} + 1.6 V3ecp \cdot \frac{H3}{3} + 1.6 V3sur \cdot \frac{H3}{2} \qquad Mu = 3.226$$

$$d := 6 \qquad A := .31 \qquad Spac := 12 \qquad As := A \cdot \frac{12}{Spac}$$

$$a := \frac{As \cdot 60}{12 \cdot .85 \cdot 2.5} \qquad a = 0.729$$

$$PhiMc := As \cdot 60 \cdot .9 \cdot \frac{\left(d - \frac{a}{2}\right)}{12} \qquad PhiMc = 7.861 \quad \textbf{OK} \qquad \textbf{Use: \#5v @ 12" ABV 3'-0"}$$

Footing

Bottom Bars

$$Mbu := 1.55 \cdot W \cdot (B - xb) \qquad Mbu = 22.007$$

$$d := 13 \quad A := .44 \qquad Spac := 12 \qquad As := A \cdot \frac{12}{Spac}$$

$$a := \frac{As \cdot 60}{12 \cdot .85 \cdot 2.5} \qquad a = 1.035$$

RW3 (H=4'-0")

$A := 1.0 \qquad Tw := .66 \qquad B := 1 \qquad Tf := 1 \qquad H1 := .5 \qquad H := 4$

$ECP := .035 \qquad S := .008 \qquad Sur := 0$

$Vecp := \dfrac{H^2}{2} \cdot ECP \qquad Vecp = 0.28 \qquad Vs := S \cdot H^2 \qquad Vs = 0.128 \qquad Vsur := Sur \cdot H \qquad Vsur = 0$

$Mot := Vecp \cdot \left(\dfrac{H}{3} + H1 + Tf\right) + Vs \cdot \left(\dfrac{H}{2} + H1 + Tf\right) + Vsur \cdot \left(\dfrac{H}{2} + Tf + H1\right)$

$Mot = 1.241$

$Wf := (A + Tw + B) \cdot Tf \cdot .15 \qquad\qquad Ww := (H + .5 + H1) \cdot Tw \cdot .15 \qquad\qquad Ws := A \cdot (H + H1) \cdot .11$

$Wf = 0.399 \qquad\qquad\qquad\qquad Ww = 0.495 \qquad\qquad\qquad\qquad Ws = 0.495$

$W := Wf + Ww + Ws \qquad W = 1.389$

$Mr := Wf \cdot \dfrac{(A + Tw + B)}{2} + Ww \cdot \left(B + \dfrac{Tw}{2}\right) + Ws \cdot \left(B + Tw + \dfrac{A}{2}\right) \qquad Mr = 2.258$

$FOS := \dfrac{Mr}{Mot} \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad FOS = 1.819$

$xb := \dfrac{Mr - Mot}{W} \qquad xb = 0.732 \qquad qmax := \dfrac{2 \cdot W}{3 \cdot xb} \qquad\qquad\qquad qmax = 1.265$

$Sliding := \dfrac{Vecp + Vs}{W} \qquad Sliding = 0.294 \qquad\qquad FOS := \dfrac{.4}{Sliding} \qquad FOS = 1.362$

OK with sesimic

Reinforcing

$Mu := 1.6 \cdot \left(Vs \cdot \dfrac{H}{2} + Vecp \cdot \dfrac{H}{3} + Vsur \cdot \dfrac{H}{2}\right) \qquad\qquad Mu = 1.007$

$d := 4 \qquad A := .31 \qquad Spac := 1 \qquad As := A \cdot Spac$

$a := \dfrac{As \cdot 60}{12 \cdot .85 \cdot 2.5} \qquad a = 0.729$

$PhiMc := As \cdot 60 \cdot .9 \cdot \dfrac{\left(d - \dfrac{a}{2}\right)}{12} \qquad PhiMc = 5.071 \qquad \textbf{OK} \qquad \text{Use: } \textbf{\#5v@12"}$

RW4 (H=6'-0") Outdoor Wall at Garage Entrance

$A := 1.0 \qquad Tw := .66 \qquad B := 2.5 \qquad Tf := 1 \qquad H1 := .5 \qquad H := 6$

$ECP := .035 \qquad S := .008 \qquad Sur := 0$

$$Vecp := \frac{H^2}{2} \cdot ECP \qquad Vecp = 0.63 \qquad Vs := S \cdot H^2 \qquad Vs = 0.288 \qquad Vsur := Sur \cdot H \qquad Vsur = 0$$

$$Mot := Vecp \cdot \left(\frac{H}{3} + H1 + Tf \right) + Vs \cdot \left(\frac{H}{2} + H1 + Tf \right) + Vsur \cdot \left(\frac{H}{2} + Tf + H1 \right)$$

$$Mot = 3.501$$

$$Wf := (A + Tw + B) \cdot Tf \cdot .15 \qquad Ww := (H + .5 + H1) \cdot Tw \cdot .15 \qquad Ws := A \cdot (H + H1) \cdot .11$$

$$Wf = 0.624 \qquad\qquad Ww = 0.693$$
$$Ws = 0.715$$

$$W := Wf + Ww + Ws \qquad W = 2.032$$

$$Mr := Wf \cdot \frac{(A + Tw + B)}{2} + Ww \cdot \left(B + \frac{Tw}{2} \right) + Ws \cdot \left(B + Tw + \frac{A}{2} \right) \qquad Mr = 5.876$$

$$FOS := \frac{Mr}{Mot} \qquad\qquad FOS = 1.678$$

$$xb := \frac{Mr - Mot}{W} \qquad xb = 1.169 \qquad qmax := \frac{2 \cdot W}{3 \cdot xb} \qquad\qquad qmax = 1.159$$

Sliding

Without Seismic

$$V := Vecp \qquad V = 0.63 \qquad Vsl := W \cdot \frac{.4}{1.5} \qquad Vsl = 0.542 \qquad KeyDepth := 1.0$$

$$Vpass := \frac{(Tf + KeyDepth)^2}{2} \cdot \frac{.3}{1.5} \qquad\qquad Vpass = 0.4 \qquad Vsl + Vpass = 0.942 \quad OK$$

$$Mukey := \left(Tf \cdot .3 \cdot \frac{KeyDepth^2}{2} + KeyDepth \cdot .3 \cdot \frac{KeyDepth}{2} \cdot KeyDepth \cdot .66 \right) \cdot 1.6 \qquad Mukey = 0.398$$

With Seismic

$$V := Vecp + Vs \quad V = 0.918 \qquad Vsl := W \cdot \frac{.4}{1.2} \qquad Vsl = 0.677 \qquad KeyDepth := 1.0$$

$$Vpass := \frac{(Tf + KeyDepth)^2}{2} \cdot \frac{.3}{1.2} \qquad\qquad Vpass = 0.5 \qquad Vsl + Vpass = 1.177 \quad OK$$

$$Mukey := \left(Tf \cdot .3 \cdot \frac{KeyDepth^2}{2} + KeyDepth \cdot .3 \cdot \frac{KeyDepth}{2} \cdot KeyDepth \cdot .66 \right) \cdot 1.6 \qquad Mukey = 0.398$$

$$d := 4 \qquad As := .2 \qquad a := As \cdot \frac{60}{.85 \cdot 2.5 \cdot 12} \qquad a = 0.471$$

$$PhiMc := .9 \cdot As \cdot 60 \cdot \left(d - \frac{a}{2} \right) \cdot \frac{1}{12} \qquad PhiMc = 3.388$$

Use: 1'-0"x8"W key with #4v @ 12"

Reinforcing

$$Mu := 1.6 \cdot \left(Vs \cdot \frac{H}{2} + Vecp \cdot \frac{H}{3} + Vsur \cdot \frac{H}{2} \right) \qquad Mu = 3.398$$

$$d := 4 \qquad A := .31 \qquad Spac := 1 \qquad As := A \cdot Spac$$

$$a := \frac{As \cdot 60}{12 \cdot .85 \cdot 2.5} \qquad a = 0.729$$

$$PhiMc := As \cdot 60 \cdot .9 \cdot \frac{\left(d - \frac{a}{2} \right)}{12} \qquad PhiMc = 5.071 \qquad \textbf{OK} \qquad Use: \textbf{\#5v@12"}$$

RW1 (H=3'-0")

$$A := 1 \qquad Tw := .66 \qquad B := .66 \qquad Tf := 1 \qquad H1 := .5 \qquad H := 3$$

$$ECP := .035 \qquad S := .008 \qquad Sur := 0$$

$$Vecp := \frac{H^2}{2} \cdot ECP \qquad Vecp = 0.158 \qquad Vs := S \cdot H^2 \qquad Vs = 0.072 \qquad Vsur := Sur \cdot H \qquad Vsur = 0$$

$$Mot := Vecp \cdot \left(\frac{H}{3} + H1 + Tf \right) + Vs \cdot \left(\frac{H}{2} + H1 + Tf \right) + Vsur \cdot \left(\frac{H}{2} + Tf + H1 \right)$$

$$Mot = 0.61$$

$$Wf := (A + Tw + B) \cdot Tf \cdot .15 \qquad Ww := (H + .5 + H1) \cdot Tw \cdot .15 \qquad Ws := A \cdot (H + H1) \cdot .11$$

$$Wf = 0.348 \qquad\qquad Ww = 0.396$$
$$Ws = 0.385$$

$$W := Wf + Ww + Ws \qquad W = 1.129$$

$$Mr := Wf \cdot \frac{(A + Tw + B)}{2} + Ww \cdot \left(B + \frac{Tw}{2} \right) + Ws \cdot \left(B + Tw + \frac{A}{2} \right) \qquad Mr = 1.496$$

$$FOS := \frac{Mr}{Mot} \qquad\qquad FOS = 2.454$$

$$xb := \frac{Mr - Mot}{W} \qquad xb = 0.785 \qquad qmax := \frac{2 \cdot W}{3 \cdot xb} \qquad\qquad qmax = 0.958$$

$$Sliding := \frac{Vecp + Vs}{W} \qquad Sliding = 0.203 \qquad OK$$

Reinforcing

$$Mu := 1.6 \cdot \left(Vs \cdot \frac{H}{2} + Vecp \cdot \frac{H}{3} + Vsur \cdot \frac{H}{2} \right) \qquad Mu = 0.425$$

$$d := 4 \qquad A := .31 \qquad Spac := 1 \qquad As := A \cdot Spac$$

$$a := \frac{As \cdot 60}{12 \cdot .85 \cdot 2.5} \qquad a = 0.729$$

$$PhiMc := As \cdot 60 \cdot .9 \cdot \frac{\left(d - \frac{a}{2}\right)}{12} \qquad PhiMc = 5.071 \qquad \textbf{OK} \qquad \textbf{Use: \#5v@12"}$$

RW2a (H=4'-0")   With no toe

$$A := 0 \qquad Tw := .66 \qquad B := 2.5 \qquad Tf := 1 \qquad H1 := .5 \qquad H := 4$$

$$ECP := .035 \qquad S := .008 \qquad Sur := 0$$

$$Vecp := \frac{H^2}{2} \cdot ECP \qquad Vecp = 0.28 \qquad Vs := S \cdot H^2 \quad Vs = 0.128 \quad Vsur := Sur \cdot H \qquad Vsur = 0$$

$$Mot := Vecp \cdot \left(\frac{H}{3} + H1 + Tf\right) + Vs \cdot \left(\frac{H}{2} + H1 + Tf\right) + Vsur \cdot \left(\frac{H}{2} + Tf + H1\right)$$

$$Mot = 1.241$$

$$Wf := (A + Tw + B) \cdot Tf \cdot .15 \qquad Ww := (H + .5 + H1) \cdot Tw \cdot .15 \qquad Ws := A \cdot (H + H1) \cdot .11$$

$$Wf = 0.474 \qquad\qquad Ww = 0.495$$

$$Ws = 0$$

$$W := Wf + Ww + Ws \qquad W = 0.969$$

$$Mr := Wf \cdot \frac{(A + Tw + B)}{2} + Ww \cdot \left(B + \frac{Tw}{2}\right) + Ws \cdot \left(B + Tw + \frac{A}{2}\right) \qquad Mr = 2.15$$

$$FOS := \frac{Mr}{Mot} \qquad\qquad\qquad\qquad\qquad\qquad\qquad FOS = 1.732$$

$$xb := \frac{Mr - Mot}{W} \qquad xb = 0.937 \qquad qmax := \frac{2 \cdot W}{3 \cdot xb} \qquad\qquad qmax = 0.689$$

$$Sliding := \frac{Vecp + Vs}{W} \qquad Sliding = 0.421 \qquad FOS := \frac{.45}{Sliding} \qquad FOS = 1.069$$

OK with sesimic

Reinforcing

$$Mu := 1.6 \cdot \left(Vs \cdot \frac{H}{2} + Vecp \cdot \frac{H}{3} + Vsur \cdot \frac{H}{2}\right) \qquad\qquad Mu = 1.007$$

$$d := 4 \qquad A := .31 \qquad Spac := 1 \qquad As := A \cdot Spac$$

$$a := \frac{As \cdot 60}{12 \cdot .85 \cdot 2.5} \qquad a = 0.729$$

$$PhiMc := As \cdot 60 \cdot .9 \cdot \frac{\left(d - \frac{a}{2}\right)}{12} \qquad PhiMc = 5.071 \qquad \textbf{OK} \qquad \textbf{Use: \#5v@12"}$$

RW5 (H=2'-6") Lower Wall at South Entrance

$A := .66 \qquad Tw := .66 \qquad B := 1.33 \qquad Tf := 1 \qquad H1 := .5 \qquad H := 2.5$

$ECP := .035 \qquad S := .008 \qquad Sur := H \cdot ECP$

$Vecp := \dfrac{H^2}{2} \cdot ECP \qquad Vecp = 0.109 \qquad Vs := S \cdot H^2 \quad Vs = 0.05 \qquad Vsur := Sur \cdot H \qquad Vsur = 0.2$

$Mot := Vecp \cdot \left(\dfrac{H}{3} + H1 + Tf\right) + Vs \cdot \left(\dfrac{H}{2} + H1 + Tf\right) + Vsur \cdot \left(\dfrac{H}{2} + Tf + H1\right)$

$Mot = 0.994$

$Wf := (A + Tw + B) \cdot Tf \cdot .15 \qquad\qquad Ww := (H + .5 + H1) \cdot Tw \cdot .15 \qquad Ws := A \cdot (H + H1) \cdot .11$

$Wf = 0.398 \qquad\qquad Ww = 0.346$

$Ws = 0.218$

$W := Wf + Ww + Ws \qquad W = 0.962$

$Mr := Wf \cdot \dfrac{(A + Tw + B)}{2} + Ww \cdot \left(B + \dfrac{Tw}{2}\right) + Ws \cdot \left(B + Tw + \dfrac{A}{2}\right) \qquad Mr = 1.607$

$FOS := \dfrac{Mr}{Mot} \qquad\qquad\qquad\qquad\qquad FOS = 1.616$

$xb := \dfrac{Mr - Mot}{W} \qquad xb = 0.637 \qquad qmax := \dfrac{2 \cdot W}{3 \cdot xb} \qquad\qquad qmax = 1.006$

Sliding

Without Seismic $\qquad\qquad\qquad W := 0$

$V := Vecp + Vsu \quad V = 0.328 \qquad Vsl := W \cdot \dfrac{.4}{1.5} \quad Vsl = 0 \qquad KeyDepth := 1$

$Vpass := \dfrac{(Tf + KeyDepth)^2}{2} \cdot \dfrac{.3}{1.5} \qquad\qquad Vpass = 0.4 \qquad Vsl + Vpass = 0.4 \qquad OK$

$Mukey := \left(Tf \cdot .3 \cdot \dfrac{KeyDepth^2}{2} + KeyDepth \cdot .3 \cdot \dfrac{KeyDepth}{2} \cdot KeyDepth \cdot .66\right) \cdot 1.6 \qquad Mukey = 0.39$

With Seismic

$V := Vecp + Vs + Vsur \qquad V = 0.378 \qquad Vsl := W \cdot \dfrac{.4}{1.2} \quad Vsl = 0 \qquad KeyDepth := 1$

$Vpass := \dfrac{(Tf + KeyDepth)^2}{2} \cdot \dfrac{.3}{1.2} \qquad\qquad Vpass = 0.5 \qquad Vsl + Vpass = 0.5 \qquad OK$

$Mukey := \left(Tf \cdot .3 \cdot \dfrac{KeyDepth^2}{2} + KeyDepth \cdot .3 \cdot \dfrac{KeyDepth}{2} \cdot KeyDepth \cdot .66\right) \cdot 1.6 \qquad Mukey = 0.398$

$d := 4 \qquad As := .2 \qquad a := As \cdot \dfrac{60}{.85 \cdot 2.5 \cdot 12} \qquad a = 0.471$

$PhiMc := .9 \cdot As \cdot 60 \cdot \left(d - \dfrac{a}{2}\right) \cdot \dfrac{1}{12} \qquad PhiMc = 3.388$

Wall Reinforcing

$$Mu := 1.6 \cdot \left(Vs \cdot \frac{H}{2} + Vecp \cdot \frac{H}{3} + Vsur \cdot \frac{H}{2} \right) \qquad Mu = 0.683$$

$$d := 4 \qquad A := .2 \qquad Spac := 1 \qquad As := A \cdot Spac$$

$$a := \frac{As \cdot 60}{12 \cdot .85 \cdot 2.5} \qquad a = 0.471$$

$$PhiMc := As \cdot 60 \cdot .9 \cdot \frac{\left(d - \frac{a}{2} \right)}{12} \qquad PhiMc = 3.388 \qquad \textbf{OK} \qquad \textbf{Use: #4v@12"}$$

RW6 (H=6'-0") Upper Wall at South Entrance

$$A := 1.5 \qquad Tw := .66 \qquad B := 1.5 \qquad Tf := 1 \qquad H1 := .5 \qquad H := 6$$

$$ECP := .035 \qquad S := .008 \qquad Sur := 0$$

$$Vecp := \frac{H^2}{2} \cdot ECP \qquad Vecp = 0.63 \qquad Vs := S \cdot H^2 \qquad Vs = 0.288 \qquad Vsur := Sur \cdot H \qquad Vsur = 0$$

$$Mot := Vecp \cdot \left(\frac{H}{3} + H1 + Tf \right) + Vs \cdot \left(\frac{H}{2} + H1 + Tf \right) + Vsur \cdot \left(\frac{H}{2} + Tf + H1 \right)$$

$$Mot = 3.501$$

$$Wf := (A + Tw + B) \cdot Tf \cdot .15 \qquad Ww := (H + .5 + H1) \cdot Tw \cdot .15 \qquad Ws := A \cdot (H + H1) \cdot .11$$

$$Wf = 0.549 \qquad Ww = 0.693 \qquad Ws = 1.073$$

$$W := Wf + Ww + Ws \qquad W = 2.314$$

$$Mr := Wf \cdot \frac{(A + Tw + B)}{2} + Ww \cdot \left(B + \frac{Tw}{2} \right) + Ws \cdot \left(B + Tw + \frac{A}{2} \right) \qquad Mr = 5.394$$

$$FOS := \frac{Mr}{Mot} \qquad FOS = 1.541$$
OK w/ Seismic

$$xb := \frac{Mr - Mot}{W} \qquad xb = 0.818 \qquad qmax := \frac{2 \cdot W}{3 \cdot xb} \qquad qmax = 1.887$$

Sliding

Without Seismic $\qquad W := 0$

$$V := Vecp + Vsu \qquad V = 0.63 \qquad Vsl := W \cdot \frac{.4}{1.5} \qquad Vsl = 0 \qquad KeyDepth := 1.5$$

$$Vpass := \frac{(Tf + KeyDepth)^2}{2} \cdot \frac{.3}{1.5} \qquad Vpass = 0.625 \qquad Vsl + Vpass = 0.625 \qquad \textbf{OK}$$

$$Mukey := \left(Tf \cdot .3 \cdot \frac{KeyDepth^2}{2} + KeyDepth \cdot .3 \cdot \frac{KeyDepth}{2} \cdot KeyDepth \cdot .66 \right) \cdot 1.6 \qquad Mukey = 1.075$$

With Seismic

$V := Vecp + Vs + Vsur$ $V = 0.918$ $Vsl := W \cdot \dfrac{.4}{1.2}$ $Vsl = 0$ $KeyDepth := 1.75$

$Vpass := \dfrac{(Tf + KeyDepth)^2}{2} \cdot \dfrac{.3}{1.2}$ $Vpass = 0.945$ $Vsl + Vpass = 0.945$ OK

$Mukey := \left(Tf \cdot .3 \cdot \dfrac{KeyDepth^2}{2} + KeyDepth \cdot .3 \cdot \dfrac{KeyDepth}{2} \cdot KeyDepth \cdot .66 \right) \cdot 1.6$ $Mukey = 1.584$

$d := 4$ $As := .2$ $a := As \cdot \dfrac{60}{.85 \cdot 2.5 \cdot 12}$ $a = 0.471$

$PhiMc := .9 \cdot As \cdot 60 \cdot \left(d - \dfrac{a}{2} \right) \cdot \dfrac{1}{12}$ $PhiMc = 3.388$ **Use: 8"x1-9" Key w/#5v@12"**

Wall Reinforcing

$Mu := 1.6 \cdot \left(Vs \cdot \dfrac{H}{2} + Vecp \cdot \dfrac{H}{3} + Vsur \cdot \dfrac{H}{2} \right)$ $Mu = 3.398$

$d := 4$ $A := .31$ $Spac := 1$ $As := A \cdot Spac$

$a := \dfrac{As \cdot 60}{12 \cdot .85 \cdot 2.5}$ $a = 0.729$

$PhiMc := As \cdot 60 \cdot .9 \cdot \dfrac{\left(d - \dfrac{a}{2} \right)}{12}$ $PhiMc = 5.071$ **OK**   Use: **#5v@12"**