Structural Calculations For:
Old Navy
South Hill Mall
Puyallup, WA
2021-0718
July 2, 2021

Prepared by:

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CONSULTING ENGINEERS

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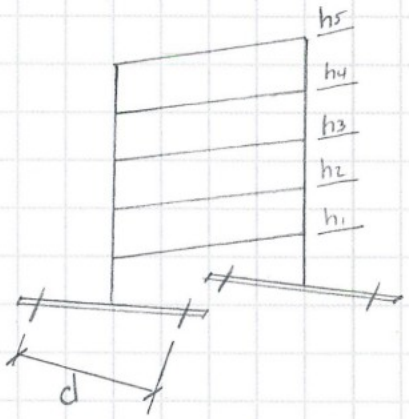
SHELVING FIXTURE

2018 WASHINGTON STATE BUILDING CODE
SITE CLASS D (PRESUMED)
DESIGN CATEGORY D
$S_{DS} = 0.843$
$I_p = 1.0$
$R_p = 2.5$
$a_p = 2.5$

T-SHAPE FIXTURE

$h_1 = 30_{IN}$ $h_4 = 120_{IN}$
$h_2 = 60_{IN}$ $h_5 = 124.5_{IN}$
$h_3 = 90_{IN}$ $d = 36_{IN}$



ASSUME 500# MAX LOAD EA SIDE (1000# TOTAL)
ASSUME (4) SHELVES DISTRIBUTED EVENLY

$W_{SIDE} = 500^{\#}$
$W_{POST} = 75^{\#}$

$$F_p = \frac{0.4 a_p S_{DS} W_p}{R_p / I_p} = \frac{0.4 \times 2.5 \times 0.843 \times W_p}{2.5 / 1.0} = 0.337\ W_p \leftarrow \text{CONTROLS}$$

$F_{p\,MIN} = 0.3 S_{DS} I_p W_p = 0.253 W_p$
$F_{p\,MAX} = 1.6 S_{DS} I_p W_p = 1.349 W_p$

$V_{ASD} = 0.7 \times 0.337 \times (2 \times 75 + 2 \times 500) = 271^{\#}$

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Project No: _____ Sheet No: F2
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OVERTURNING MOMENT

LOAD TOP SHELF ONLY

$M_{OVT} = 0.337 \times \left(120 \times 250 + \frac{124.5}{2} \times 75\right) = 11.7\ K\text{-}IN$

$M_{STATIC} = (250 + 75) \times 18 = 5.85\ K\text{-}IN$

$T = \frac{M_{OVT} - (0.9 M_{STATIC})}{d} = 179\#$

LOAD TOP (2) SHELVES

$M_{OVT} = 0.337\left(120 \times 250 + 90 \times 250 + \frac{124.5}{2} \times 75\right) = 19.3\ K\text{-}IN$

$M_{STATIC} = (250 \times 2 + 75) \times 18 = 10.3\ K\text{-}IN$

$T = 279\#$

LOAD TOP (3) SHELVES

$M_{OVT} = 0.337\left(120 \times 250 + 90 \times 250 + 60 \times 250 + \frac{124.5}{2} \times 75\right) = 24.3\ K\text{-}IN$

$M_{STAT} = (250 \times 3 + 75) \times 18 = 14.85\ K\text{-}IN$

$T = 304\#$ ← CONTROLS

LOAD ALL SHELVES

$M_{OVT} = 0.337\left(120 \times 250 + 90 \times 250 + 60 \times 250 + 30 \times 250 + \frac{124.5}{2} \times 75\right) = 26.8\ K\text{-}IN$

$M_{STAT} = (250 \times 4 + 75) \times 18 = 19.35\ K\text{-}IN$

$T = 261\#$

ANCHOR DESIGN * ASSUME 4" SLAB ON GRADE $f'c = 3000\ PSI$

$T = 304\#$ $\quad T_{ALLOW} = 830 \times 0.75 = 623\# > 304$ [OKAY IN TENSION]

$V = 271$ $\quad V_{ALLOW} = 1735 \times 2_{ANCHORS} = 3470\# > 271$ [OKAY IN SHEAR]

$\frac{T}{T_{ALLOW}} + \frac{V}{V_{ALLOW}} = 0.571 \leq 1.0$ [OKAY IN COMBINED TENSION & SHEAR]

USE (2) 1/4" × 2 1/2" HILTI KWIK HUS-EZ ANCHORS

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L-SHAPED FIXTURE

$S_{DS} = 0.843$
$h = 144_{IN}$
$d = 18_{IN}$

ASSUME 500# MAX LOAD @ 100# PER FRAME
ASSUME (4) SHELVES EVENLY DISTRIBUTED

$F_p = 0.337 W_p$
$V = 0.7 \times 0.337 \times (2 \times 100 + 500) = 165^{\#}$

OVERTURNING MOMENT

LOAD TOP SHELF ONLY
$M_{OVT} = 10.9$ K-IN
$M_{STAT} = 2.93$ K-IN
$T = 459^{\#}$

LOAD TOP (2) SHELVES
$M_{OVT} = 15.4$ K-IN
$M_{STAT} = 4.05$ K-IN
$T = 655^{\#}$

LOAD TOP (3) SHELVES
$M_{OVT} = 18.5$ K-IN
$M_{STAT} = 5.13$ K-IN
$T = 769^{\#}$

LOAD ALL SHELVES
$M_{OVT} = 20.0$ K-IN
$M_{STAT} = 6.3$ K-IN
$T = 796^{\#}$ ← CONTROLS

ANCHOR DESIGN

* ASSUME 4" SLAB ON GRADE $f'_c = 3000$ PSI

$T = 796^{\#}$
$V = 165^{\#}$

$T_{ALLOW} = 623^{\#} > 398^{\#}$ [OKAY IN TENSION]
$V_{ALLOW} = 3470^{\#} > 82.5^{\#}$ [OKAY IN SHEAR]
$\frac{T}{T_{ALLOW}} + \frac{V}{V_{ALLOW}} = 0.660 \leq 1.0$ [OKAY IN COMBINED TENSION & SHEAR]

$T_{FRAME} = 398^{\#}$
$V_{FRAME} = 82.5^{\#}$

USE (2) 1/4" x 2 1/2" HILTI KWIK HUS-EZ ANCHORS

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