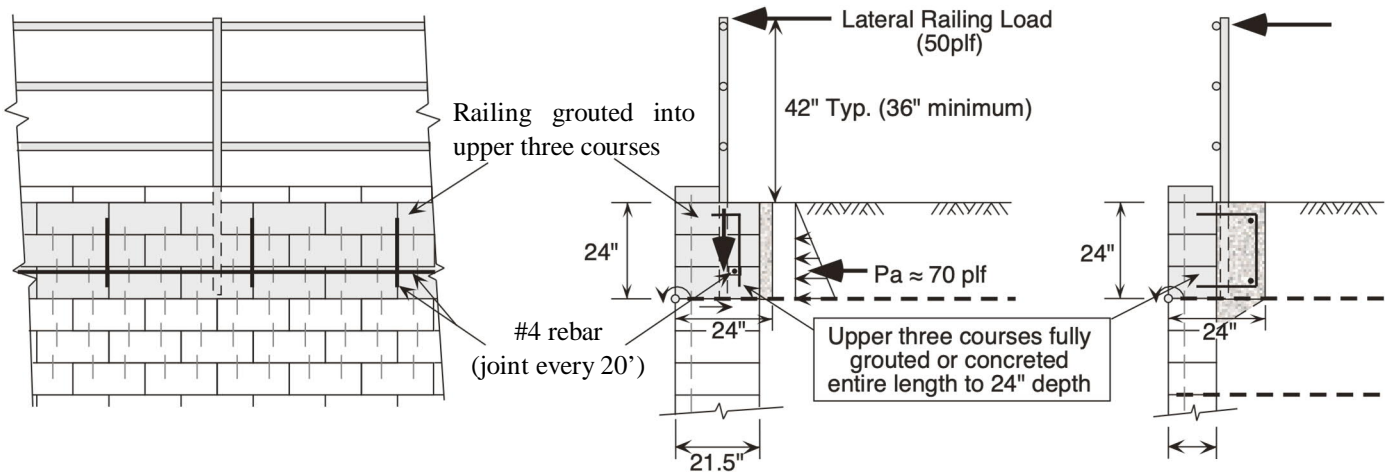


Typical Railing Design

Direct Mount - 50 plf



Typical Railing Elevation

Standard Unit Section

Alternate 12" Depth Section

Introduction

It is difficult for a railing design to satisfy structural design requirements when considering the direct mounting on or into the Keystone modular wall system. The small unit size and mass provides minimal resistance to overturning by itself so additional mass must be engaged to provide the required resistance. Modular wall units are typically not large enough to satisfy an IBC lateral design loading without additional structure.

Railing Analysis

Shear resistance of Standard units (>1000 plf) and 12" Depth units (>600 plf) exceeds the driving forces by a wide margin in gravity wall applications and is not a critical evaluation. Overturning at the top of wall (local stability) is the critical evaluation. A 50 plf or greater loading typically requires the addition of concrete and reinforcement for mass and strength. The higher 50 plf and 200lb load combination required by AASHTO for highway projects requires that the railing design and analysis be treated differently.

Driving Moments (50 plf load)

$$\begin{aligned} \text{Railing } 50 \text{ plf} \times 5.5' \text{ arm} &= 275 \text{ ft-lbs/ft} \\ \text{Soil } 70 \text{ plf} \times 0.67' &= 47 \text{ ft-lbs/ft} \\ \text{Total} &= 322 \text{ ft-lbs/ft} \end{aligned}$$

Resisting Moments (units filled with grout @ 140 pcf)

$$\begin{aligned} 2' \times 2' \times 140 \text{ pcf} \times 1.0' &= 560 \text{ ft-lbs/ft} \\ 0.33' \times 0.88' \times 120 \text{ pcf} \times 0.44' &= 15 \text{ ft-lbs/ft} \\ \text{Total} &= 575 \text{ ft-lbs/ft} \end{aligned}$$

$$FS_{ot} = 575/322 = 1.78 < 1.50 \text{ minimum, OK}$$

Design Note:

Keystone Standard units are always recommended in situations where railings are considered for direct mounting on the wall system.

Keystone 12" Depth units require additional reinforcement and concrete to provide the overturning mass necessary to resist design loadings. 12" Depth unit designs should consider offset railings as a simpler and more economical alternative.