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Technical Bulletin

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Handrails - Part 2

Lessons Learned

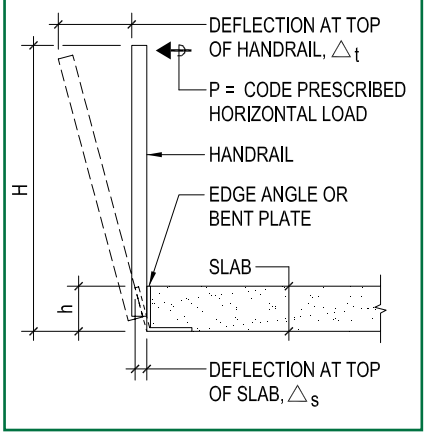
Introduction

Our previous **Technical Bulletin, "Handrails- Part 1: Guidelines You Can Lean On,"** explored criteria which handrail assemblies are designed, as well as the primary elements which makeup the handrail assembly. This Technical Bulletin will discuss underlying issues with handrail design as well as alternate details and design considerations to help prevent these underlying issues.

Why Exceed Code Minimums

Handrail assemblies must be designed to resist the minimum loads prescribed by the governing building code. The primary function of building code provisions is the safety of the building occupants. In other words, the handrail assembly must be designed to prevent failure. This is accomplished by sizing the handrail components and connections to be within acceptable stress limits. However, the code does not provide a limit on handrail deflection. Excessive deflection of the handrail can cause serviceability issues (wobble). Although the handrail assembly may be properly designed to resist the code prescribed handrail loads, occupants may feel uncomfortable with excessive handrail movement. To put it in perspective, think of 'bouncy' or 'excessively deflecting' floor structure. Even though the floor system has been properly designed to resist loads, occupants may feel uncomfortable walking on it, doors may not close, etc. Therefore, it is imperative to consider deflection in the handrail design and detailing.

Handrail Deflection Diagram



Underlying issues

Cantilevered handrail systems depend on vertical posts to transfer handrail loads down to the supporting structure. Other handrail assemblies may consist of the handrail spanning horizontally to vertical supporting structure (walls, columns, etc.). This Technical Bulletin concentrates on

cantilevered handrail systems. The critical location for cantilevered handrail assemblies is at the base of the vertical post. In particular, the connection of the vertical post to the supporting structure (slab, edge angle, etc.). As shown in the 'Handrail Deflection Diagram' (on reverse), even though the deflection at the edge angle may be small, the deflection at the handrail may be significant. This is due to the culmination of the edge angle deflection and the vertical post deflection. The vertical post is typically a lot stiffer than the edge angle, so the majority of the handrail deflection results from the edge angle. The deflections of both the vertical post and edge angle can be calculated using trigonometry, the theory of similar triangles and cantilevered beam formulae.

Case Study

Issues can arise if the handrail deflection or the vertical post connection is overlooked. One such example is a cantilevered handrail assembly where the vertical posts are welded to the outside of the slab edge angle. The handrail assembly and slab edge angle can be properly designed to resist the code-prescribed forces. However, the slab edge angle design must be considered. Upon installation of the handrail assembly, one may find the handrail to be 'wobbly'. Even though the deflection at the top of the edge angle is very small, the deflection at the handrail, a few feet above, may not be.

Common Design Solutions

There are many different ways to detail a handrail system, depending on its layout, aesthetics and function. A few ways to limit handrail deflection in cantilevered systems are:

- Connect the vertical posts directly to the top of the concrete slab.
- Increase the thickness of the slab edge angle (or bent plate).
- Utilize a continuous HSS Tube member in lieu of an edge angle.
- Add headed studs to the inside heel of the edge angle (to rigidly connect the angle to the slab) – note that the headed studs may need to be field welded to prevent 'tripping hazards' per OSHA.

Conclusion

The handrail assembly must be designed and detailed to resist code-prescribed loads. However, deflection must be considered. The primary method to prevent excessive handrail deflection is to properly detail the vertical post connection along with the supporting structure. This will insure both the safety of the building occupants as well as their sense of comfort.

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