Bridge Design - Concrete Columns

Course Number: CE-02-410

PDH: 5

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Course Author: Mathew Holstrom

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CONCRETE COLUMNS

1.1 INTRODUCTION

Columns are structural elements that support the superstructure, transfer vertical loads from superstructure to foundation, and resist the lateral loads acting on the bridge due to seismic and various service loads.

1.2 TYPES OF COLUMNS

Columns are categorized along two parameters (Chen, 2014 and MacGregor, 1988): shape and height:

- Columns sections are usually round, rectangular, solid, hollow, octagonal, or hexagonal.
- Columns may be short or tall. The column is called either short or tall according to its effective slenderness ratio (Kl_u/r).

  where:

  K = effective length factor

  l_u = unsupported length of a compression member

  r = radius of gyration

1.3 DESIGN LOADS

The considered design loads as specified in AASHTO 3.3.2 are:

- Dead loads (DC)
- Added dead loads (DW)
- Design vehicular live loads:
  1. Design vehicle HL-93 shall consists of a combination of (Truck + Lane) or (design tandem + Lane) including dynamic load allowance (IM).
  2. Permit vehicle (P15) including the dynamic load allowance (IM).
- Wind loads (WS, WL)

- Braking force (BR)
- Thermal effects (TU)
- Prestress shortening effects (CR, SH)
- Prestressing secondary effects (PS)

1.4 DESIGN CRITERIA

Columns are designed for Service, Strength, and Extreme Event limit states (AASHTO, 2012 and Caltrans, 2014). The Extreme Event I limit state must be in accordance with the current the Caltrans Seismic Design Criteria (*SDC*) version 1.7 (Caltrans, 2013). Columns should be designed as ductile members to deform inelastically for several cycles without significant degradation of strength or stiffness under the design earthquake demand (see *SDC* seismic design criteria chapters 3 and 4 for more details). Columns supporting a superstructure that is built using balanced cantilevered construction, or other unusual construction loads, are not addressed herein.

1.4.1 Limit States

As stated above, columns are designed for three limit states:

- Strength Limit State
- Service Limit State
- Extreme Event Limit State

1.4.2 Forces

Bridge columns are subjected to axial loads, bending moments, and shears in both the longitudinal and transverse directions of the bridge.

1.5 APPROXIMATE EVALUATION OF SLENDERNESS EFFECTS

The slenderness of the compression member is based on the ratio of Kl_u/r (AASHTO 5.7.4.3), while the effective length factor, K (AASHTO 4.6.2.5), is to compensate for rotational and transitional boundary conditions other than pinned ends.

Theoretical and design values of K for individual members are given in AASHTO Table C4.6.2.5.-1.

Slenderness s effect is ignored if:

$Kl_u/r < 22$ (members not braced against sidesway)

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