Wind & Seismic Design of a Steel Preheater Tower - Adapting Ductility Capacity to Demand

Peter Paul Hoogendoorn, Ignacio Fernando Ares Gestal, María Alonso Zalacaín

Martínez Segovia, Madrid, Spain

Contact: peter_paul.hoogendoorn@martinezsegovia.com

Abstract

Preheater towers in cement plants are tall, multi-storey buildings housing heavy equipment. Their lateral load design for wind and seismic loads is an important cost-driving aspect. A case study of a mainly steel preheater tower located in the Philippines, a region with high hurricane and earthquake hazard, is used to assess how wind and seismic design affect the structural steel weight. In particular, the impact on steel weight is quantified for low and high-ductility seismic designs. Finally, performance-based design procedures are used to evaluate the seismic performance of these designs. It is shown that, for the given load conditions, high ductility seismic design leads to a significant increase in steel weight while offering no superior performance for the design and maximum credible earthquake level. Essentially elastic, low-ductility, seismic design is shown to be most economic and simple from design, fabrication, and erection perspective.

Keywords: tall buildings, industrial, preheater, wind, earthquake, ductility, pushover analysis, response history analysis, performance-based design.

1 Introduction

Preheater towers in cement plants are essential to the energy efficiency of clinker production, housing heavy equipment that exchange the heat between the hot kiln outlet gases and the raw meal before entering the kiln.

The typical process arrangement leads to tall, and relatively slender, multi-storey support structures of square or rectangular floor plan with a total height of roughly 100 m.

In general, their structural design is governed by the gravity loads from heavy equipment and -as is common for tall building structures- wind and seismic actions. As case study a reference project is used for a steel preheater tower located in the Republic of the Philippines, a region that is especially prone to hurricanes and earthquakes. Therefore, the wind and seismic design showed to be technically challenging and cost driving.

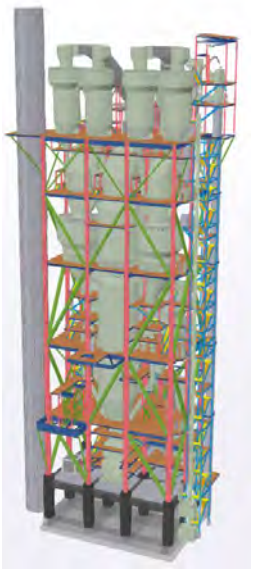

Figure 1. 3D-model of a preheater tower