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Buckling Temperature and Buckling Stress of a Steel Member with Lateral Bracing Caused by a Thermal Load

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Abstract

This paper deals with the buckling of a slender steel member with lateral bracing. The buckling phenomenon is buckling by a thermal load, not by an external force. The buckling quantities of interest are the buckling temperature and the buckling stress. A theoretical method to obtain the relations between these quantities and the bracing rigidity is shown in this paper.

Keywords: steel structure; lateral bracing; thermal load; buckling temperature; buckling strength; theoretical analysis

1 Introduction

A slender steel member is often in danger of buckling. The cause of buckling is a compression force that occurs due to various factors. To avoid this buckling, it is necessary to increase the buckling strength. Several intermediate points on a slender member are often supported by lateral bracing. The relation between the buckling strength and the bracing rigidity of such a braced member has been actively studied [1]. For example, the elastic buckling strength of a slender member braced at its center is calculated by the mechanics model shown in Figure 1. The lateral bracing is treated as an elastic spring. In Figure 1a, both ends of the member rotate freely (pinned support), and in Figure 1b, neither end of the member can rotate freely (fixed support).

The elastic buckling strength P_e of these two mechanics models is found in equation (1) by using a slope-deflection equation for stability. It is assumed that the braced member does not have any initial imperfection.

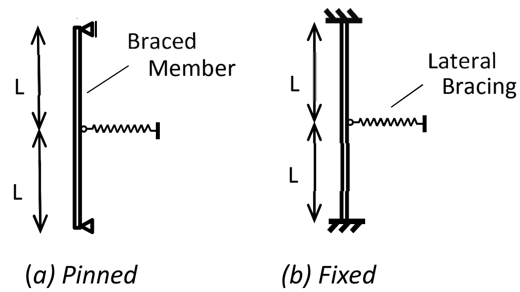

Figure 1. Braced member with lateral bracing

$$P_e = \left(\frac{Z}{\pi}\right)^2 \cdot \frac{\pi^2 EI}{L^2} \tag{1}$$

Here, Z is the value found by equation (2a) in the case of a pinned support, and by equation (2b) in the case of a fixed support. E is Young's modulus, and I is the second moment of the area. L is the unbraced length.

$$\frac{Z^3 \cos Z}{\sin Z - Z \cdot \cos Z} + \frac{L^3}{2EI} \cdot K_s = 0 \tag{2a}$$

$$\frac{Z^3 \cdot \sin Z}{1 - \cos Z - Z \cdot \sin Z} + \frac{L^3}{2EI} \cdot K_s = 0 \tag{2b}$$

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