Performance of thin-walled steel structures by longitudinally and transeversely profiled steel plates

Takuji KUMANO
Assistant Manager
Kawatetsu Bridge and Steel Structure ,Tokyo, Japan
kumano@kawatetsu-bs.co.jp

Kunitomo SUGIURA
Professor
Kyoto Univ., Kyoto, Japan
sugiurak@mbox.kudpc.kyoto-u.ac.jp

Takashi YAMAGUCHI
Assoc. Professor
Osaka City Univ., Osaka, Japan
yamaguti@civil.eng.osaka-cu.ac.jp

Eiichi WATANABE
President
RPI
Osaka, Japan
wataei@circus.ocn.ne.jp

Yasuo SUZUKI
Research Associate
Utsunomiya Univ.
Utsunomiya, Japan
yasuo-s@cc.utsunomiya-u.ac.jp

Summary

Longitudinally profiled steel plates can be applied to steel bridges and make it possible to reduce the construction cost including fabrication cost and material cost. Proposed herein is the longitudinally and transversely profiled steel plates; namely, steel plates with varied thickness in two orthogonal directions. Structural performace superior in strength and ductility will be expected by using such plates to a flange plate as well as a web plate of girders and columns. Parametric study on such a steel plate with several boundary and loading conditions is carried out by means of the elasto-plastic finite displacement analysis. In case of a simply supported steel plate subjected to uniaxial compression, it is concluded that the plate whose thickness along the supported edge is larger can have higher strength and ductility.

Keywords: longitudinally/transversely profiled steel plate, strength, ductility, elasto-plastic finite displacement analysis

1. Introduction

Longitudinally profiled steel plates (LP plate) is a steel plate whose thickness is continuously varied in the direction of rolling as shown in Fig. 1(a), and have been applied to steel bridge. It was successful to reduce the construction cost consisting of fabrication cost and material cost[1,2]. Furthermore, their application to steel bridge piers are now being carried out after Hyogoken-Nanbu Earthquake in 1995 in order to improve seismic performance in conjunction with economical aspect[3,4]. On the other hand, paying attention to the stress distribution in the cross section, the applicability of the steel plate with the varied thickness in the direction perpendicular to the primary stress transfer direction as shown in Fig. 1(b) and (c) has been also assessed[5].

Based on the effective width theory on load carrying capacity of the compressive thin steel plate, the structural superiority of transversely tapered steel plate; namely, large thickness in effective width may be expected to improve strength. Therefore, in this research, focusing on the thickness variation of the steel plate in the direction perpendicular to the loading direction, discussed are the effect of the longitudinally and transversely varied thickness of the steel plate on ultimate strength and deformation capacity by using a elasto-plastic finite displacement analysis.

First of all, the mechanical behavior of a simply supported square steel plate with transverse taper subjected to uniform compressive force is investigated in order to assess the local buckling strength of box sections as shown in Fig. 2(a). Secondarily, the outstanding steel plate with transverse taper are examined, so as to assess the stability of compressed flanges of I-girder section as shown in Fig. 2(b). Finally, the applicability of the transversally tapered steel plate to bridge piers with box section as shown in Fig. 2(a) is demonstrated.

https://doi.org/10.2749/weimar.2007.0705