Probabilistic local buckling strength analysis of compressive plates for normal and bridge high performance steels

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Summary

Probabilistic analysis of local buckling strengths (LBS) for compressive plates of normal and bridge high performance steels was conducted. The Monte Carlo simulation method as well as the response surface method was employed to obtain the statistical distribution of LBS. As sources of variability of LBS, the initial out-of-plane displacement and the residual stress are considered as the stochastic variables. The response surface methods are employed to approximate LBS by a simple polynomial function of the initial displacement and the residual stress. For each value of the width-thickness ratio parameter R, a response surface of the normalized LBS is identified based on 114 finite element analysis results with different residual stresses and initial displacement. The response surface models are used in the Monte Carlo simulation to evaluate probabilistic distribution of LBS.

Keywords: local buckling strength, safety factor, probability density function, outstanding compressive plate, bridge high performance steel.

1. Introduction

A current trend in structure design code development is to employ the partial factor format, whose partial factors including the load factor are determined on the basis of reliability evidence. In order to identify the partial factors, probabilistic information, such as probabilistic density function, or at least the mean and standard deviation of strengths is requires. The probabilistic information on local buckling strengths (LBSs) of compressive plates was gathered from experimental data in most previous studies, which may include variability due to experimental conditions, such as improper boundary condition in test procedure. Another problem in the probabilistic information from experiments is deviation between experimental specimens and practice in steel plate structures. For example, LBS date for newly developed bridge high performance steels are not included in a dataset for the current LBS design equation, and most experimental results obtained form thinner steel plate test specimens.

In this paper, probabilistic characteristics of LBSs of outstanding compressive plates are investigate through nonlinear finite element analysis and Monte Carlo simulation. The initial out-of-plane displacement and residual stress are considered as independent stochastic variables, which result in variability of LBS. The variability of the yield strength is excluded in the current study, because the partial safety factors for LBS normalized by the yield strength and material strength are considered separately. Six different steel grades including two bridge high performance steels (SBHS500, SBHS700), which are recently has been standardized into Japanese industrial standards, are considered. In addition, steel plates with thicknesses up to 100mm are taken into account, which are not considered in most previous studies.

2. Deterministic finite element analysis

Nonlinear finite element analyses were carried out to obtain local buckling strength of outstanding plates. Fig. 1 shows the dimensions of an outstanding plate with a width of b and length of a. The

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