8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

SEISMIC PERFORMANCE OF STEEL BRIDGE PIERS

***Eiki Yamaguchi[1], Yuta Matsuki[1], Eri Nakamura[1] and Kiyoshi Ono[2]**

[1]Dept. of Civil Engineering
Kyushu Institute of Technology
Kitakyushu 804-8550, Japan
yamaguch@civil.kyutech.ac.jp

[2]Dept. of Civil Engineering
Tokyo Institute of Technology
Meguro-ku, Tokyo 152-8550, Japan
ono.k.ae@m.titech.ac.jp

Key Words: *Steel Bridge Piers, Seismic Loading, Cyclic Plasticity, Local Buckling, Nonlinear Finite Element Analysis.*

ABSTRACT

A large number of steel structures were damaged in the 1995 Hyogo-ken Nanbu Earthquake, Japan. The damage of steel bridge piers could be found attributable to cyclic horizontal load due to the earthquake coupled with the weight of a superstructure. Therefore, steel bridge pier specimens have been tested under the combination of constant vertical load and cyclic horizontal load. The local buckling observed in the 1995 Hyogo-ken Nanbu Earthquake were then successfully reproduced in laboratories.

Although experiments are undoubtedly important, the number of test specimens has to be limited because of time and/or cost constraints. The numerical simulation of steel bridge piers therefore needs be conducted, too. In the present study, we carry out the seismic analysis of steel bridge piers. The loading condition is the combination of constant vertical load and cyclic horizontal load. The finite element method is employed, and the steel bridge pier specimen is modeled by shell and beam elements. The relevant finite element mesh is first explored for this class of analysis. The difference between the finite element meshes appears in the post-peak region where local buckling emerges and develops. However, such difference diminishes, as the mesh becomes finer. With the appropriate finite element mesh thus determined, the loading test of a steel bridge pier is simulated numerically. The results show that excellent agreement can be obtained by the three-surface plasticity model, as can be realized in Figures 1 and 2.

With this numerical procedure, the mechanical behavior of a steel bridge pier under cyclic loading is studied. Particular emphasis is placed on the pier made of high strength steel. While the empirical formula for evaluating the maximum load has been proposed for steel bridge piers of mild steel, the present results indicate that the formula may not be applicable to bridge piers made of high tensile strength steel. Typical results are presented in Figure 3, The cause for this discrepancy is discussed based on the way steel behaves in the plastic region.

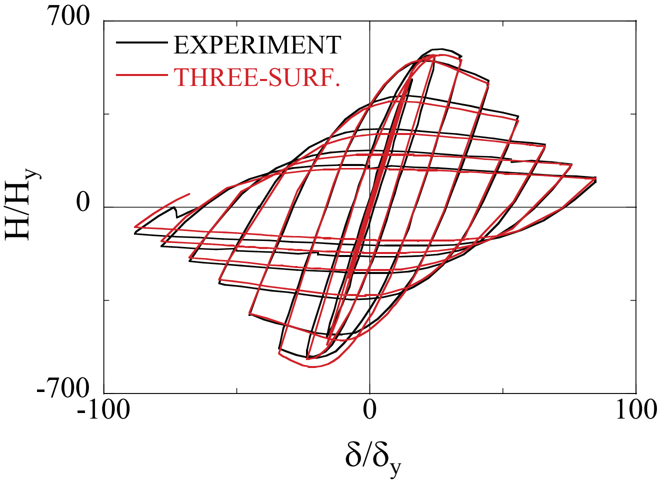
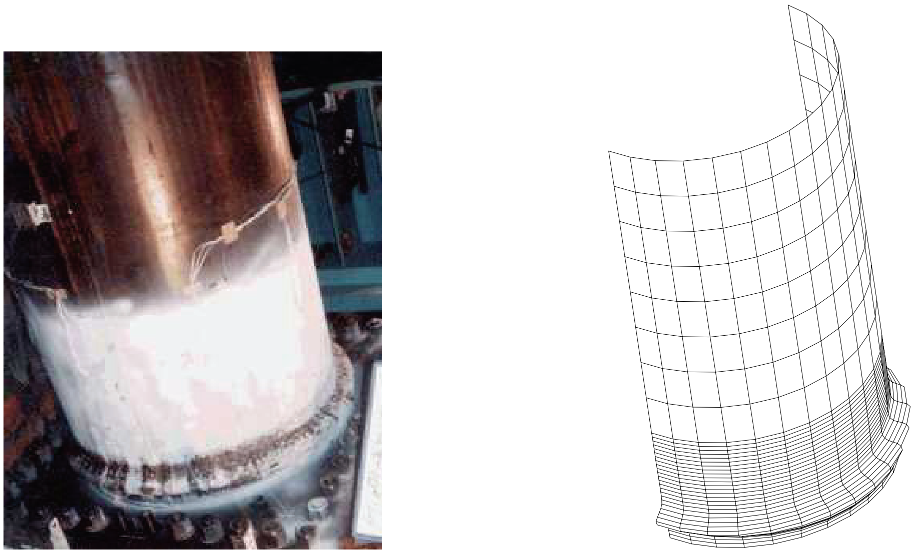


Figure 1: Horizontal load-displacement curves



(a) Experiment (courtesy PWRI, Japan)

(b) Present analysis

Figure 2: Deformed configurations

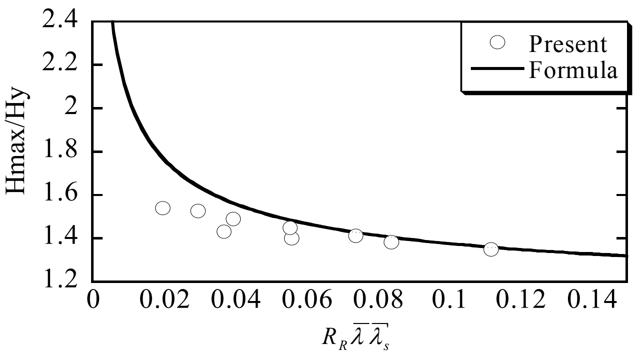


Figure 3: Comparison with the empirical formula for steel bridge piers of mild steel.