Calculation of displacements for base isolation systems with bilinear behaviour

Heiko Müller
Civil Engineer
Bauhaus-University
Weimar, Germany
heiko.mueller@uni-weimar.de

Heiko Müller, born in 1974, received his civil engineering degree from the Bauhaus-University of Weimar in 1999.

Ursula Freundt
Professor
Bauhaus-University
Weimar, Germany
ursula.freundt@uni-weimar.de

Ursula Freundt, born 1946, received his civil engineering degree from the Bauhaus-University of Weimar

Summary

The concept of seismic isolation is, beside the ductile design, state-of-the-art in the field of the seismic design of structures. In the case of seismic isolation, the relative displacement due to earthquake is an important effect, which must be calculated with an adequate reliability.

Since in isolation systems devices with nonlinear deformation characteristics are often used, the isolation system is usually to be considered with its nonlinear characteristics. This paper deals with the computation of the relative displacements for bilinear elastic-plastic isolation systems by means of equivalent linear computations using different linearization methods, the method 'Geometric Stiffness', recommended in Eurocode8, and the method 'Average Period and Damping'.

In extensive parameter studies the relative displacements determined with these procedures will be compared with the accurate results, which were determined with nonlinear time history calculations. Based on the statistical evaluation of the differences the quality of results will be shown and rated. The conditions for using this procedure will be taken into account.

Keywords: Earthquake; Seismic Isolation; Equivalent linear computation, Eurocode 8

1. Introduction

1.1 Seismic Isolation

The concept of seismic isolation is, beside the ductile design, state-of-the-art in the field of seismic design of structures. At the seismic isolation the dynamic characteristics of the building which is to be protected are modified, in order to reduce the seismic loads [1], [2], [3]. Therefore in an isolation interface, which is usually located between the building and the soil (and/or the substructures), an isolation system is arranged, which has a small horizontal stiffness and appropriate damping characteristics.

Usual isolation systems consist of a plurality of isolation devices, for instance laminated elastomeric bearings, sliders, friction pendulums and hysteretic or viscous dampers. Most of the isolation systems, used in practice, therefore have nonlinear force-deflection characteristics.

1.2 Calculation of relative displacements

The calculation of relative displacements, which are an important effect of the seismic isolation, has to be done with consideration of the nonlinear characteristics of the isolation system. Two fundamental methods are available, the nonlinear time history computation with consideration of the nonlinearities and approximation methods, which are based either on an approximation of the nonlinear system by equivalent linear systems or on an empirical description of the behaviour.

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