Interpretation of dynamic retaining wall model tests in light of elastic and plastic solutions

Christos Giarlelis*, George Mylonakis

Department of Civil Engineering, University of Patras, 26500 Rio, Greece

Article info

Article history:
Received 14 January 2010
Received in revised form 27 June 2010
Accepted 5 July 2010

Abstract

The dynamic response of rigid and flexible walls retaining dry cohesionless soil is examined in light of experimental results and analytical elastodynamic and limit analysis solutions. Following a brief review of the problem, experimental findings from three different testing programs on retaining walls are presented, and compared with theoretical predictions based on the above-mentioned approaches. Reasonable agreement is found depending on the assumptions. It is shown that wall flexibility – which is not taken into account in classical design approaches – should be considered to establish the point of application of seismic thrust on the wall. Detailed calculations and set of graphs and charts are presented, which highlight salient aspects of the problem.

Contents lists available at ScienceDirect

Soil Dynamics and Earthquake Engineering

journal homepage: www.elsevier.com/locate/soildyn

0267-7261/$ – see front matter © 2010 Elsevier Ltd. All rights reserved.

A R T I C L E  I N F O

Article history:
Received 14 January 2010
Received in revised form 27 June 2010
Accepted 5 July 2010

A B S T R A C T

The dynamic response of rigid and flexible walls retaining dry cohesionless soil is examined in light of experimental results and analytical elastodynamic and limit analysis solutions. Following a brief review of the problem, experimental findings from three different testing programs on retaining walls are presented, and compared with theoretical predictions based on the above-mentioned approaches. Reasonable agreement is found depending on the assumptions. It is shown that wall flexibility – which is not taken into account in classical design approaches – should be considered to establish the point of application of seismic thrust on the wall. Detailed calculations and set of graphs and charts are presented, which highlight salient aspects of the problem.

© 2010 Elsevier Ltd. All rights reserved.

1. Background

Despite extensive research carried out over the years, the dynamic behavior of retaining structures is far from being well understood. Significant unresolved issues, both of practical and theoretical nature persist, which appear to have impeded advances in design methods and seismic regulations. These include: (1) dependence of soil thrust on magnitude of earthquake acceleration; (2) importance of wall kinematics on the distribution of earth pressures; (3) importance of the dynamics of the backfill; (4) description of boundary condition pertaining to wave radiation away from the wall; (5) role of pore water pressure and associated loss of strength behind and under the wall; (6) importance of pre-existing and stress-induced inhomogeneities in the soil; (7) influence of construction processes on the above. Evidence of a lack of understanding comes from past-phenomena investigations (notably in Kobe [1] and Chi-Chi [2]) which have reported extensive damage on a number of retaining structures, which were thought to have been properly designed against seismic action.

Past analyses of dynamic response of earth-retaining systems can be roughly classified into two main groups: (a) limit-state analyses, in which the wall is considered to displace and/or rotate sufficiently at the base to fully mobilize the shearing strength of the backfill and (b) elastic analyses, in which the wall is considered to be fixed at the base, while the backfill is presumed to respond in a linearly elastic or viscoelastic manner. Repre-