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Metallic Dampers for Retrofit of Pile-Supported Wharves

[سید امین موسوی Seyed Amin . Mousavi]
[خسرو برگی Khosrow . Bargi]

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1- Introduction

Commonly, there are two types of damages induced to pile-supported wharves during a ground motion, liquefaction-induced displacement and pile drift. Accordingly, in absence of liquefaction conditions, pile drift can be considered as a suitable index in order to evaluate the performance of these short period structures under seismic events. Some techniques which rely on increasing stiffness, namely inclined piles, have been investigated in earlier studies [1-3] as a method in order to suppressing displacement of pile-supported wharves which is a costly alternative. Some other techniques such as soil improvement in the backfill and installation of a sheet pile wall at the toe of the embankment have been also proposed, by Salah-Mars et al [4], in order to suppressing permanent displacement. Nowadays passive controls are increasingly using in civil engineering structures to mitigating vibrations which some of them have been described by Soong and Dargush [5]. Earlier studies on passive control methods are commonly restricted to long period structures, such as tall buildings, long-span bridges etc., and there are a few studies about effects of these methods on short period systems. In this study, a passive control method was investigated in order to reduce the response of pile-supported wharves which fall into short period structures class. Among various passive controllers, metallic yielding damper seems to be more suitable for implementing in pile-supported wharves, because they are low cost and easy to manufacture and also virtually they need no maintenance. Supplemental energy dissipation devices have been first proposed by Bergman and Hanson in 1989 and then developed by Xia and Hanson [6]. Up to now many studies have been focused on metallic yielding dampers as an energy dissipation device and their parameters have been optimized [6- 8] for building structures which were implemented in conjunction with chevron braces. Pile-supported wharves commonly have a relatively short period but in this study flexible wharves were also considered. Flexible wharves are considered because nowadays by increasing the size of ships, it is necessary to deepen berth of wharves and this means that new generation of pile-supported wharves will have relatively larger periods. It should be noted that in the case of a building structure there is no limitation on selecting the yielding force of the metallic damper but in the case of a pile-supported wharf, with respect to position of the metallic damper, as depicted in Fig. 1, the stability conditions of the retaining wall, which can be a sheet pile, caisson etc., dictate the maximum allowable yielding force of the metallic damper.