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Numerical and experimental soil-structure-interaction of a bridge pier model at the Volvi-Greece European Test Site

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ABSTRACT: This paper presents the experimental and numerical actions that have taken place within the context of the preparation of the man-made excitations of a model bridge pier which is constructed at the Volvi – Greece European Test Site for the study of the dynamic pier-foundation-soil system interaction. In particular, a set of in-situ low level dynamic tests have been performed which were complemented by laboratory tests and preliminary finite element analysis in order to optimize the design of the structure towards the maximization of the SSI effects while retaining the system within the available force level capabilities that can be applied on site. Both experimental and numerical results have contributed to the optimal design of the structure and the preliminary prediction of its dynamic behavior.

1 INTRODUCTION

Although the effect of soil-structure interaction on the dynamic response of typical residential or commercial structures and infrastructure (i.e. bridges) has long ago attracted scientific attention, it is widely recognized that there is an urgent need for its experimental support and validation. This need is far more crucial in cases where the structure responds inelastically and/or the soil conditions favor the appearance of SSI phenomena. Along these lines, significant effort has been undertaken within the context of the Euroseis-Risk Project (http://euroseis.civil.auth.gr), for Earthquake Engineering, Engineering Seismology and Geotechnical Earthquake Engineering that has been continuously funded by the European Union for the last decade. This large physical laboratory (Test Site), is located 30 km distant from Thessaloniki.

One of the main objectives of the project is to utilize the facilities at the Aristotle University Laboratory as well as those at Volvi in order to:

- define soil flexibility and damping properties.
- use Model Structures in-situ to investigate the beneficial or detrimental role that the soil-foundation flexibility (SSI) has on the overall dynamic response.
- introduce structural yielding on the model structures and investigate the coupling between the structural yielding and the SSI effects.
- examine the nature and the effect of the waves transmitted by the oscillation of the superstructure to the foundation level and the surrounding soil.
- use the Aristotle University Laboratory facilities to verify post-elastic behavior of model bridge pier as well as effectiveness of repair techniques.
- use the in-situ measurements to validate empirical, analytical or numerical simulations of this soil-foundation-structural flexibility and damping on the dynamic and seismic structural response.

Despite the disadvantages of being unable to produce significant in-situ levels of ground motion, when desired, as can be generated by an earthquake simulator, this is in part compensated by the realistic foundation conditions, which are present for this model structure that is supported on the soft soil deposits in-situ (Pitilakis et al., 1999). In fact the structure is susceptible to SSI effects according to Eurocode 8 (CEN, 2002) criteria since the corresponding shear wave velocity Vs at the surface is approximately 100m/sec. The current extension of the in-situ facility includes the possibility of subjecting the model structures to low-medium intensity man-made excitations (i.e. a number of simple pull-out test) as well as explosions.

2 OVERVIEW OF THE EXPERIMENTAL AND NUMERICAL APPROACH

A series of preliminary activities were undertaken for the optimal design of the model structure and a