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Neoprene–concrete friction relationships for seismic assessment of existing precast buildings

Gennaro Magliulo [a,*], Vittorio Capozzi [a], Giovanni Fabbrocino [b], Gaetano Manfredi [a]

[a] Department of Structural Engineering, University of Naples Federico II, Via Claudio 21, 80125 Napoli, Italy

[b] Department SAVA, Engineering & Environment Division, Engineering & Environment Division, University of Molise, Via De Sanctis, 86100 Campobasso, Italy

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ABSTRACT

In Italy many precast industrial buildings built between 1950s and 1970s present beam–column connections with strength coming from neoprene–concrete friction. Numerical studies recently performed by the authors confirm that, in order to determine the seismic vulnerability of such structures, a reliable value of the neoprene–concrete friction coefficient has to be known. Technical bibliography provides many and different values for this coefficient; consequently, in order to define reliable values, a specific experimental campaign is carried out. Three types of experimental tests are performed: tests on neoprene hardness, tilting tests and pulling tests; in the last case, the specimen is also axially loaded.

Tilting tests provide a value of the mean friction coefficient equal to about 0.5, with very low C.O.V.. Pulling tests underline a friction strength dependence on axial load and, in particular, a decrease in the friction coefficient as the axial load increases; a relationship for compressive stress–neoprene–concrete friction coefficient is proposed.

1. Introduction

This research was developed in the frame of a project concerning the seismic vulnerability of precast industrial buildings built in Italy between the 1950s and the 1970s [1,2].

The part of the project already carried out may be divided into two phases. The first one is characterized by the definition of the typologies and structural characteristics of the considered buildings, with particular reference to connections, by a large bibliography research, interviewing technicians who worked in the field of precast structures during the reference period and studying actually executed projects. Consequently, some reference buildings representative of the most spread typologies during the reference period are selected. The second phase, instead, is characterized by numerical analyses, in particular modal elastic analyses and nonlinear static and dynamic ones. Such analyses showed that, even under seismic forces characterizing, a medium intensity Italian seismic zone, precast existing buildings, whose beam–column connections are based on neoprene–concrete friction strength, can collapse due to the loss of support (Fig. 1). Consequently, in order to determine the seismic vulnerability of such structures, it is necessary to know the value of the neoprene–concrete friction coefficient.

Few references related to the determination of such coefficient can be found in bibliography and its value often concerns applications different from structural ones [3–6]. Interesting indications can be found in CNR 10018 [7], Schrage [8], PCI design handbook [9] and UNI-EN 1337:3 [10].

CNR 10018 [7] provides the relationship between the rubber–concrete friction coefficient μ and the compressive stress σ_v:

$$\mu = 0.1 + \frac{0.2}{\sigma_v}, \tag{1}$$

where σ_v is the compressive stress in N/mm^2; Eq. (1) is valid for compressive stress not lower than $\sigma_{v,\min} = 1.5$ N/mm^2. This equation is determined by means of the friction tests carried out in 1964 by the Munich Technical University under the auspices of the International Railroad Association (UIC [11]). The tests take into account laminated bearings and bearing pads of several European countries. The results underline that the rubber-bearing's friction coefficient depends on average normal stress. The NCHRP report [12] discusses these European studies, but setup, materials, pad dimensions and shear loading rate used in the tests are not specified.

* Corresponding author. Tel.: +39 0817683656; fax: +39 0817683491.
E-mail addresses: gmagliul@unina.it (G. Magliulo), vittorio.capozzi@unina.it (V. Capozzi), giovanni.fabbrocino@unimol.it (G. Fabbrocino), gamanfre@unina.it (G. Manfredi).

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