

RESEARCH ACTIVITY ON DESIGN RESPONSE SPECTRA FOR ITALIAN SITES

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Previous papers (1, 2) by the same authors dealt with defining expected response spectra for a given site. In particular they were interested in studying this problem for regions in which a network of strong motion recorders had only recently been established. The technique they proposed was based on the obvious consideration that in similar regions the probability of collecting a large number of records of small earthquakes, in a few years, is considerably greater than that of collecting, in a reasonable time, enough records of strong shocks for statistical purposes. So the idea was to see if the shape of an average response spectrum for the expected violent earthquakes in a given site could be derived from the spectra of small earthquakes recorded in the same site. As a parameter for the classification of violent and weak earthquakes, the spectral intensity, which is a local measure of the intensity of a recorded accelerogram, was preferred to the magnitude, which would give an overall evaluation of the intensity of an earthquake.

The comparison made between normalized spectra obtained from records taken in six different places in California (see as an example Fig. 1) gave results which are consistent with those published by H. Bolton Seed and I.M. Idriss (3) (Fig. 2): for low values of the period, the ordinates of response spectra for weak earthquakes are systematically greater than for violent shocks; as these are normalized spectra, there will be obviously an opposite tendency when the periods are longer. Nevertheless the differences between these spectra are quite small; besides this it has been shown (1, 2) that the agreement between the two sets of spectra can be largely improved by carrying out a sort of normalization on the ordinates of the above spectra, taking into account the different durations of violent and small shocks (1, 2) (Fig. 3). A stochastic approach has provided the dependence between the expected response spectrum and the quake duration, all other parameters being fixed. The normalization of spectra to account for the different durations was based on such dependence. A typical statistical test, the so-called t-test, was carried out on the significance of the point by point comparison between the two average curves. The results of this test show (2) that there is no reason for believing that the response spectra of violent earthquakes are statistically distinguishable from those of weak earthquakes.

A similar analysis was carried out on a set of records obtained during '72 in the town of Ancona in two different locations. The earthquakes considered were of magnitude between 3.4 and 4.5 and with maximum accelerations varying from .02 to .6 g. It was practically impossible to divide the earthquakes into two categories, so in Fig. 4 all the normalized response spectra

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of the sites for a damping factor = .05, are shown without the correction that would take into account the different durations.

A note on the Ancona records: the acceleration peaks recorded in Ancona during the seismic activity of '72, seem at variance with the expected values of for instance (3), where similar accelerations (up to 0.6 g) were attributed to an earthquake of magnitude 8, while at Ancona it was no more than 4.5. The same exception was found for the Parkfield earthquake (4).

Such **high** accelerations might seem due to soil characteristics and to the vicinity to the causative fault. In neither case was the recording station more than a few miles away. But other earthquakes have also been recorded in the neighbourhood of the causative fault without leading to such high accelerations, for instance:

El Centro	1940	MM int. XI	distance	4 miles	max. acc.	0.33
Hoover Dam	1948	" VI	"	4 "	"	0.121
Hollister	1951	" VI	"	3 "	"	0.04
Hawthorne	1952	"	"	5 "	"	0.03
Arvin	1953	" V	"	1 "	"	0.06
Suisun Bay	1955	" VII	"	5 "	"	0.12
Hebgen Dam	1958	" IV	"	1 "	"	0.04
Hollister	1960	" VI	"	4 "	"	0.07
Long Beach	1961	" IV	"	1 "	"	0.025
Wheeler Ridge	1963	" VI	"	5 "	"	0.057

Furthermore another peculiarity is shared by the Ancona and Parkfield records: the instruments were installed in very small buildings (e.g. in Ancona a one story building of approximately 200 square feet). So no filtering may be accounted for due to the presence of the building.

On the other hand the set of instruments installed according to the well known City of Los Angeles ordinances are located either in buildings with a floor area of more than 60.000 square feet or in buildings over ten stories in height. The Ancona records suggest reconsidering the possibility of a filtering effect due to the presence of the building in recording soil motions.

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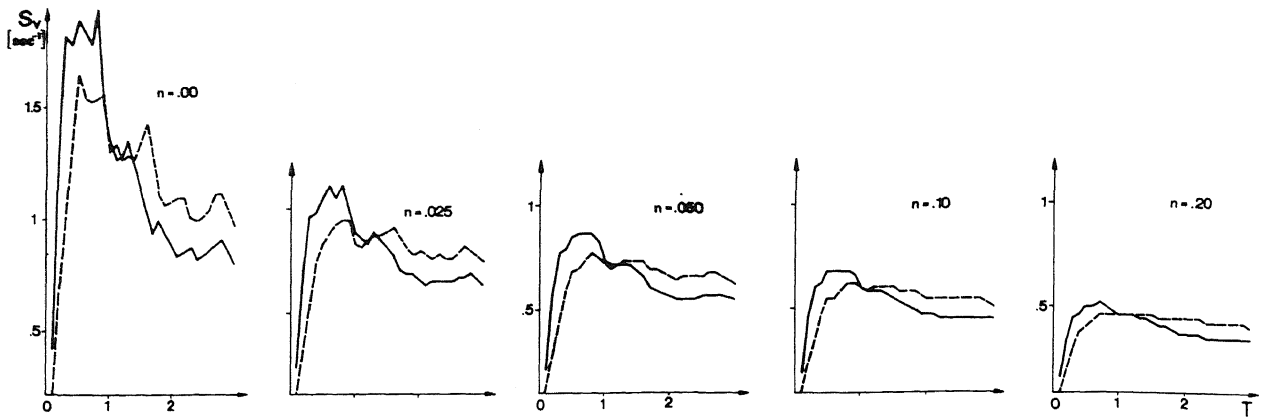


Fig. Normalized response spectra of violent (dashed line) and weak (continuous line) earthquakes. Average spectra for all six considered sites.

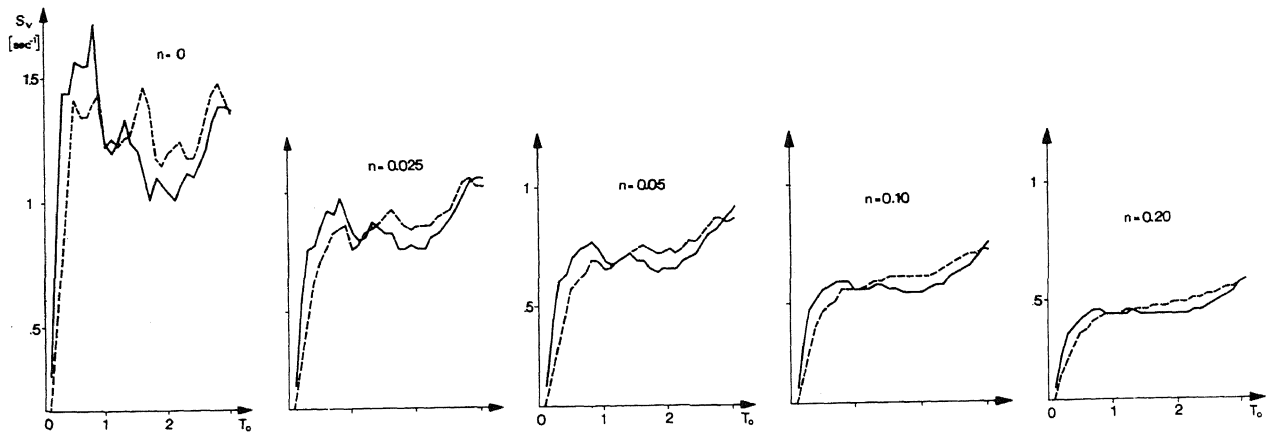


Fig.2 Normalized response spectra of violent (dashed line) and weak (continuous line) earthquakes. Average spectra for all six considered sites, when the duration correction is applied.

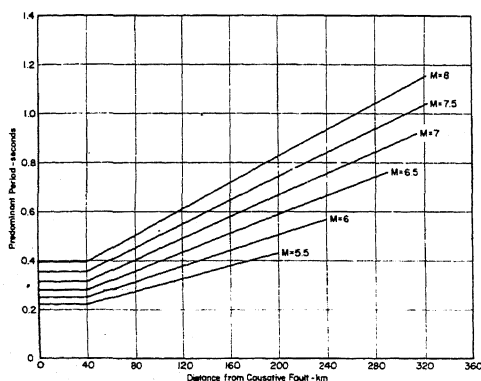


Fig.3 Predominant periods for maximum accelerations in rock (Seed and Idriss)

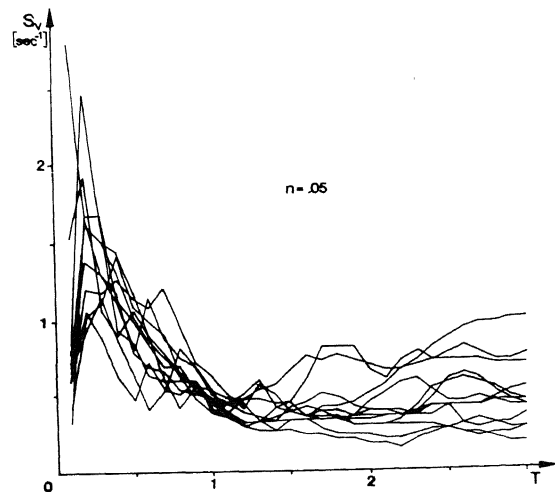


Fig.4. Normalized Ancona '72 earthquake response spectra.

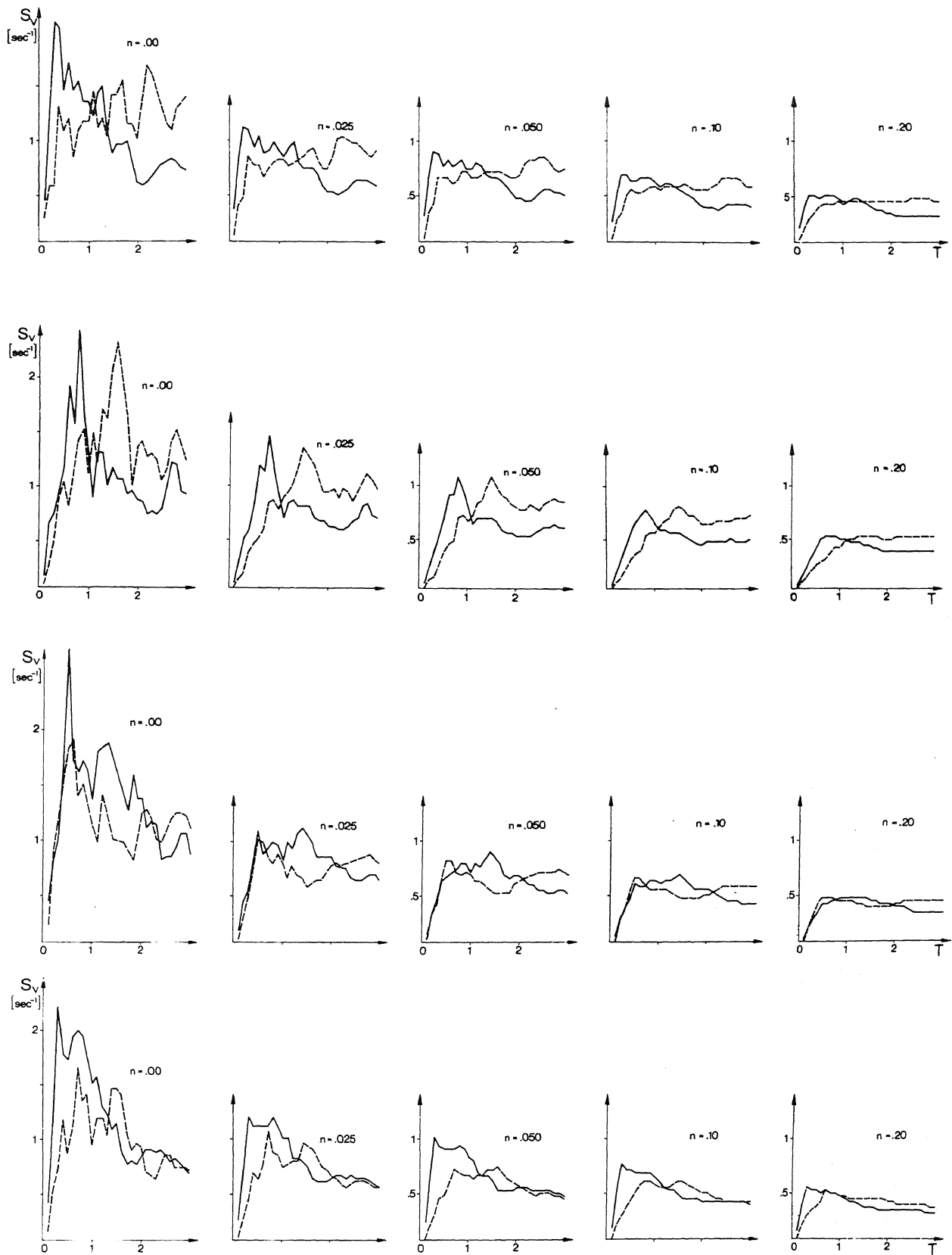


Fig.1. Average normalized response spectra of violent (dashed line) and weak earthquakes. Localities: Vernon Los Angeles, El Centro, Ferndale.