Choice of recorded acceleration time histories for non-linear seismic analysis of reinforced concrete structures

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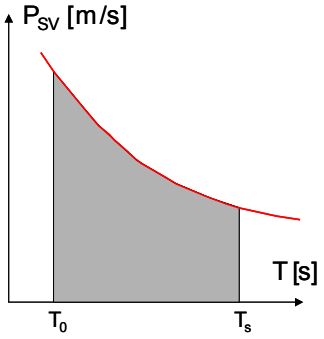
OBJECTIVE :
The research project dealt with an important aspect of seismic structural response that is still not fully understood. Its objective was to develop criteria to choose suitable earthquake recordings to be used in non-linear dynamic analyses for seismic design, evaluation and upgrade of ductile reinforced concrete structures.

METHODOLOGY :
The methodology consisted of systematic investigations of the non-linear response of single-degree-of-freedom-systems (SDOF system) subjected to 164 earthquake recordings, taken from the European Strong Motion Database.
The final displacement or ductility demand of the SDOF systems was correlated with different earthquake characteristics, such as effective peak ground acceleration, spectral acceleration, slope of response spectra, spectral intensity, etc. As expected from the literature, the spectral intensity defined by Nau and Hall gave a fairly good correlation with the displacement or ductility demand. As illustrated in Figure 1, a modified spectral intensity was proposed in order to improve this correlation. This modification takes into account the structure's "initial" natural frequency and the design ductility.



$$SI\,b\left(\zeta, T_0, R\right) = \frac{1}{T_s - T_0}\int_{T_0}^{T_s} P_{SV}\left(\zeta\right)\cdot dT\,, \quad \zeta = 5\%\,,$$

where $T_s = T_0 \cdot \sqrt{R} = \frac{\sqrt{R}}{f_0}$

P_{SV} is the pseudo-velocity spectrum and ζ the damping ratio. T_0 is the initial natural period and T_S corresponds to the secant stiffness. R is the strength reduction factor.

FIGURE 1: Modified definition of the spectral intensity proposed in the study.

RESULTS :
In order to increase the reliability of non-linear seismic analyses, the following recommendations can be given to structural engineers for the choice of acceleration time histories to be used:
-The spectral acceleration S_a of the acceleration time history should be equal or close to the spectral acceleration of the given design spectrum at the initial fundamental period T_0 of the structure under study.

-The "severeness" of several time history candidates that fulfil the above condition can be ranked with the aid of the newly defined spectral intensity SI b: the larger SI b, the higher the displacement and ductility demand.

PROJECT SIGNIFICANCE :
It is expected that more and more non-linear seismic analyses will be performed in the future. The results of the present research project allow to choose the acceleration time histories needed for such calculations in a more rational manner than before.

PUBLICATIONS:
Schwab P., Lestuzzi P., Koller M, Lacave C.: *Choice of Recorded Acceleration Time Histories for Non-linear Seismic Analysis of Reinforced Concrete Structures*. Research Project Report. EPFL-ENAC-IS-IMAC, Applied Computing and Mechanics Laboratory. Publication Nr. 2. Lausanne, August, 2003.

Lestuzzi P., Schwab P., Koller M, Lacave C.: *How to Choose Earthquake Recordings for Non-linear Seismic Analysis of Structures*. 13th World Conference on Earthquake Engineering, Vancouver, 2004. (in preparation)