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Opera suspicionată (OS)	Opera autentică (OA)
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OS	Bibire, L., Cobrea, C.R., "Theoretical considerations about the influence of seismological parameters on high structure response", *Modelling and Optimization in the Machines Building Field (MOCM)*, vol.2, no.12, 2005, p.171-174.
OA	Iervolino, I., Cornell, C.A., "Record Selection for Nonlinear Seismic Analysis of Structures", *Earthquake Spectra*, vol.21, no.3, August 2005, pp.685-713. Disponibil la: http :// wpage . unina . it / iuniervo / papers / Iervolino_and_Cornell_SPECTRA.pdf.

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THEORETICAL CONSIDERATIONS ABOUT THE INFLUENCE OF SEISMOLOGICAL PARAMETERS ON HIGH STRUCTURE RESPONSE

BIBIRE LUMINITA
COBREA CODRIN RUDOLF

University of Bacau

Abstract: This paper presents a determinedly transparent study of the question of selection and scaling of accelerograms for predicting the non-linear dynamic response of a structure at a specific site. The preferred current practice is to select carefully records that reflect the expected magnitude, distance and other characteristics of the source of the events that are in some sense most likely to threaten the structure. The records are then typically scaled to some common representative level. Neither aspect of this process, neither selection nor scaling, has received significant research attention to ascertain their effects on the conclusions.

Keywords: high structure, response, seismic, parameters

1. INTRODUCTION

This paper approaches these subjects inversely; it hypothesizes that neither the usual principal seismological characteristics nor scaling of records matters to the nonlinear response of structures. It then investigates under what conditions this hypothesis may not be sustainable.

The study deals with *ordinary records*; softer soil site and specific near-fault effects, such as directivity-induced pulses, both of which may cause narrow-band response spectra are carefully avoided. Nonlinear analysis case studies consider different periods, force-displacement characteristic relationships (backbones), ductility levels and structural types.

Two classes of records sets are compared in each case: one class is carefully chosen to represent a specific magnitude and distance scenario (a “target set”), and another class is chosen randomly from a large catalogue (an “arbitrary set”) and scaled to match the target set in general amplitude. Results of time-history analyses are formally compared by a simple statistical hypothesis test to assess the difference, if any, between non-linear demands of the two classes of records.

The effect of the degree of scaling (by first-mode spectral acceleration level) is investigated in the same way. Results here show:

(1) Little evidence to support the need for careful site-specific process of record selection by magnitude and distance, and

(2) That concern over scenario-to-scenario record scaling, at least within the limits tested, may not be justified. This study does not explain the role of systematic spectral shape deviations, such as those due to: soft soil, directivity, or scenarios calling for non-median ground motions.

The study is aimed at improving the bases for guidelines for earthquake engineering practice in terms of:

(1) Characteristic that should be taken into account in accelerograms selection;

(2) Scaling of records in order to get scenario (target) intensity;

(3) Sufficient size of record sets. Moreover it will also shed light on other issues such as structural period and/or backbone sensitivity.

2. PROCEDURES FOR KNOWLEDGE OF THE INFLUENCE OF SEISMOLOGICAL PARAMETERS ON THE HIGH STRUCTURE RESPONSE

It is an unstated but implicit assumption that all this care is taken about the selected records' earthquake properties (e.g., magnitude and distance) because they (may) matter to linear or nonlinear response. But little information on this effect is available by earthquake engineers to pass on the seismologist responsible for the selection.

Lack of knowledge of the influence of seismological parameters on the structural response has driven the seismologists to be prudent and assume that all features (magnitude, faulting style, etc.) matter to structural response and so they do their best to provide records accordingly. The question of "how best to select records?" is equivalent to asking "what earthquake parameters we have to try to match when selecting the records?"

The concept of parsimony in engineering practice implies that the easiest way to try to answer this question is by first assuming that "it doesn't matter", which is equivalent to saying that the choice of records is a non-issue. Then, whether and under what conditions this assumption cannot be sustained is evaluated by a large number of examples and cases studies.

The following procedure is used to test the importance of considering magnitude and distance when selecting records. First, a "target" group of sets is selected from a narrow magnitude-distance (M-R scenario) bin of available records.

Then three size-ten samples of target sets are selected, each has two subsets representing the two horizontal components, yielding a total of six samples of size ten. The target sets scenario is a comparatively high-magnitude, small-distance one.

To minimize potential directivity effects all values of the distance are greater than 15 km. For each structure considered these records in the sample target sets are scaled to their overall median spectral acceleration at the first-mode period. This intra-bin scaling has been shown to be a good practice with respect to reducing the variance of the results of nonlinear analyses without introducing bias (Shome et al. 1998). The reduced variance increases the power of the statistical test to follow.

Second, another group of records, referred to as "arbitrary sets", is considered. These arbitrary sets are characterized by having been chosen (almost) at random with respect to the same features, magnitude and distance, which were carefully considered in the target sets. Five size-ten samples are selected, the two horizontal components yielding a total of ten arbitrary samples of size ten.

The arbitrary sets are also scaled to the common median first-mode period spectral acceleration of the target sets in order to mimic how any selected set of records might be scaled to the design target response spectrum.

Third, the structure in question is subjected to a nonlinear dynamic analysis under each of the many records. Median responses are estimated for all six plus ten (16) record sets. The median of each of the arbitrary sets is compared with each of the target sets (six times ten or 60 comparisons).

The comparison of medians is statistical and performed by a simple, conventional hypothesis test (Benjamin and Cornell 1970). Consistent with the assumption that "record selection doesn't matter", the null hypothesis is that the ratio of arbitrary-set median response to target-set median response is unity, i.e., that the medians are equal.

The question of the effect of scaling proposed record sets (such as one of these arbitrary sets) to the desired level (e.g., that of the median of the target sets here) was addressed next. The ten arbitrary sets did not require a degree of scaling significantly greater than 1 to reach the median of the six targets above. Therefore another group of stronger target sets was constructed for this phase of the study.

These were selected from records obtained within 15 km. As described below; care was taken to avoid records with significant directivity effects. In all other respects the same three steps above were repeated. The null hypothesis is, again, that such scaling "does not matter" (i.e., that median response to a scaled arbitrary set is the same as that median response to the target set).

All the records used came from the Pacific Earthquake Engineering Research Center (PEER) database (http://peer.berkeley.edu/smcat/), ensuring uniform processing. However all the accelerograms in both of the groups of sets have been selected with some boundary conditions in order to better reduce the influence of those factor that are not in the objective of the study.

These features make the records definable as "ordinary", avoiding site and housing response effects. Moreover for addressing the selection issue the records belong to the *far field* (defined here as closest distance to rupture) greater than 15 km in order to better avoid directivity pulse type effects.

Other features such as hanging/foot wall and fault mechanism are permitted to vary among the record sets considered as they do not cause systematic peaks in the spectra. Next we address how the various record sets were selected from the "reduced" catalogue defined above.

3. CONCLUSIONS

Based on the investigation of the nonlinear response of a suite of model structures to sets of records selected to match a specific moderate-magnitude and distance scenario and other moderate-magnitude records selected arbitrarily, this study has found no consistent evidence to suggest that it is necessary to take great care in the selection of records with respect to such factors.

The conclusion must be conditioned by the characteristics of the uniform catalog available at the time of the study and by the selected magnitude limits. The magnitudes used were limited to moderate values,

(a) Because higher values (within the constraints cited above) were not available in the catalog and
(b) Because smaller values would in practice be unlikely to be chosen for a scenario event in the 7 range as the catalog does have an adequate number and larger events and records from which to choose a sample of typical size (ten or less). The mean magnitudes of the A and T sets are known. The former number suggests, as expected, that the lower magnitudes in the range are more common than the larger. The latter number shows that the T set was indeed selected from the upper tail of the histogram of magnitudes in the catalog. The differential is 0.5 magnitude units.

A reduction of the lower bound would have somewhat facilitated meeting the authors' restrictions designed to avoid overlapping of the samples for the A sets, but it would not have helped the more challenging T set selection.

This lower bound change would have reduced the overlap between records in the T sets with those in the A sets, which would have been somewhat beneficial statistically; it also would have increased the differential in mean magnitudes which would likely have been a stronger challenge to the posed null hypothesis.

As stated, the choice of a lower magnitude was based on argument that it was the practical choice, while being a full magnitude unit below the largest value.

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