PRACTICAL ISSUES IN SEQUENTIAL DYNAMIC ANALYSIS OF SIMPLE INELASTIC OSCILLATORS

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The analytical evaluation of seismic structural behavior under repeated earthquake shocks, that can potentially cause failure due to damage accumulation, often makes recourse to sequential dynamic analysis of a numerical model. One such dynamic analysis strategy is the so-called, back-to-back incremental dynamic analysis (B2B-IDA), whereupon one accelerogram is scaled in such a way as to bring the structure to a specific conventional damage state and is then followed by a second accelerogram which is scaled in amplitude over a wide range of shaking intensity levels, forcing structural response to span the entire range of possible damage states. The need to effectively capture record-to-record variability of response for seismic reliability analyses, means that B2B-IDA is typically applied using a multitude of ground motions representing both the first damaging shock as well as the second shock in the sequence that affects the damaged structure. The present study uses a variety of such SDOF inelastic structures to explore a series of practical issues that arise in running B2B-IDA and post-processing the results. This investigation uses the DYANAS graphical user interface, which was previously developed with the contribution of the authors as a tool that can be also used for streamlining this type of analysis. The first issue that is addressed in this study is the number of records used to represent both the first and the subsequent seismic shock affecting the structure. Previous research has shown that the statistical inference concept of estimation uncertainty can be used as a tool to quantify the effect of the record sample size, used in single-event dynamic analysis, on the accuracy of the results obtained. The present article picks up on that methodology and seeks to extend it in the context of B2B-IDA. A second practical issue considered is the implementation of a hunt-and-fill algorithm in order to minimize the number of runs needed to efficiently represent a single B2B-IDA curve. Such an algorithm can allow the rapid transformation of B2B-IDA curves from one IM to another when combined with appropriate interpolation techniques. Finally, this article briefly addresses updates in the DYANAS software that were explicitly implemented to facilitate the extraction of results from B2B-IDA for the purpose of obtaining so-called state-dependent fragility functions, that is models providing the conditional probability of a structure transitioning from one damage state to another, given shaking intensity.

Keyword **:** *structural reliability, non-linear dynamic analysis, fragility function, ground motion record selection, performance-based earthquake engineering, statistical inference.*

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