

FEMA'S BENEFIT COST-ANALYSIS TOOL FOR SEISMIC STRUCTURAL RETROFIT PROJECTS

General Guidance

The purpose of this document is to provide potential subapplicants with general guidance on FEMA's Hazard Mitigation Assistance (HMA) benefit-cost analysis (BCA) tool. The BCA is a required subapplication component. This guidance is not intended to provide complete information, but rather to outline basic requirements and considerations as subapplicants begin the analysis process. Cal OES is available to answer technical questions about BCAs and can be contacted by emailing HMA@caloes.ca.gov.

Seismic Retrofit Benefit-Cost Analysis

Structural seismic retrofits are projects that retrofit or rehabilitate the structural elements of existing residential, commercial or public buildings (i.e., structural walls, floors, roofs, beams, columns and/or foundations) to protect against structural damage, building service loss or building collapse from earthquakes.

BCA Software and Methodology

FEMA requires the use of its BCA software (version 6 for all BCAs). Subapplicants can get the software by visiting [FEMA's Benefit-Cost Analysis Guidance and Tools website](https://www.fema.gov/media-library/assets/documents/179903): <https://www.fema.gov/media-library/assets/documents/179903>.

Analysts should select *Seismic* as the hazard type, and *Structural* as the mitigation action type. The software includes three approaches, only two of which generally apply to seismic projects. The first is *modeled damages*, in which the analyst selects various input parameters and enters data related to the building and site, loss of function and occupancy, and the software calculates the benefits of the project. The second is *expected damages*, in which the analyst must establish a series of relationships between earthquake frequencies and likely damages. The third is *historic damages*, which seldom applies to earthquake projects, but is based on the same approach as *expected damages*.

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Data used in the Analysis

This subsection is intended as a general summary of data requirements for seismic structural BCAs. In order to complete a structural seismic retrofit BCA, you must have the following information (this is not intended as a comprehensive list):

1. Address or latitude and longitude.
2. Project scope and description.
3. Project useful life. Refer to the Help menu in FEMA's BCA software that provides additional information on project useful life values. The information may also be found in the 2009 FEMA BCA Reference Guide.
4. Project cost and annual maintenance cost.
5. Soil type (drop list).
6. Total building area and total building value.
7. Average number of occupants (for the modelled damages path only).
8. Building use (for the modelled damages path only; drop list).
9. Building model type (for the modelled damages path only; structure type; drop list).
10. Number of stories and building height (for the modelled damages path only).
11. Design levels (for the modelled damages path only; before and after mitigation; drop list).
12. Capacity parameters (for the modelled damages path only; generated by program based on user inputs above; users may override values, but only with technical support and documentation).
13. Value of service. The value of service is based on the net operating revenue for commercial buildings, and by the annual operating budget for public buildings (for the modelled damages path only).
14. Frequency/damage relationships for at least two potential earthquake events (for both before- and after-mitigation scenarios; for the expected damages path only).

Benefits

Benefits of structural seismic retrofit projects include protecting structures, basic contents, avoiding loss of service provided by the structure, and avoiding occupant injuries and deaths. The software also allows the use of *environmental* benefits for mitigation projects that restore developed land to one of five "open space" categories (e.g. green open space, riparian, wetlands, forest,

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marine/estuary), but these benefits seldom apply to any structural seismic retrofit.

Documentation

Cal OES and FEMA require subapplicants to provide documentation for all data that is used in a BCA. This must be included with the materials that are submitted as part of the application package. Examples of documentation sources are included in the list of data used in the analysis. For structural seismic retrofit projects, it is essential in nearly all cases to consult with a structural engineer with substantial experience with seismic evaluations of the existing buildings and with designing seismic retrofits to the desired performance level. This specific type of experience is important because evaluating the seismic vulnerability of an existing building and designing a seismic retrofit are very different from designing a new building to current building codes and require different skills and expertise. The engineer's experience should include familiarity with American Society of Engineers Standard 41-17, *Seismic Evaluation and Retrofit of Existing Buildings*. ASCE 41-17 is current version of ASCE 41 and considered the industry standard. The ASCE 41-17 "Check Lists" identify specific structural and non-structural building elements that are deficient in relation to current seismic design standards.

Best Practices

Cal OES strongly recommends that each subapplicant BCA be supplemented by a technical report prepared by a structural seismic engineer that summarizes the basic structural properties and seismic design vulnerabilities in the existing building, the structural properties and seismic design parameters of the proposed retrofitted building, and the retrofit project costs.

Cal OES also recommends the proposed seismic retrofit address all of the major elements identified by the ASCE 41-17 Check Lists. Both ASCE 41-17 and the International Existing Building Code (IEBC) have specific post-retrofit performance standards to meet.

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