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# Integrated analysis model for assessing CO<sub>2</sub> emissions, seismic performance, and costs of buildings through performance-based optimal seismic design with sustainability

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## < Highlights >

- An integrated sustainable seismic analysis model for evaluating environmental impacts of seismic designs of buildings for various performance objectives is presented.
- In the model, a green seismic analysis model is presented in the form of performance-based optimal seismic design with sustainability (PBODS) to derive optimal design schemes.
- Environmental impacts and costs of low- and mid-rise buildings are quantitatively analyzed depending on performance objectives.
- Dominant design constraints for PBODS are examined according to the building size and performance objective.

## ABSTRACT

An integrated sustainable seismic analysis model is developed to investigate the relationships of CO<sub>2</sub> emissions, the seismic performance, and material production costs of seismic design schemes of buildings. In this study, a green seismic analysis model is presented in the form of performance-based optimal seismic design with sustainability (PBODS) that considers the economic feasibility, environmental sustainability, and seismic performance of a building based on the life cycle assessment (LCA) data subject to various performance objectives prescribed in performance-based seismic engineering. This analysis model is applied to reinforced concrete (RC) frame buildings, which comprise two heterogeneous materials—concrete and steel—that have different environmental impacts and thus have a high potential for CO<sub>2</sub> emission mitigation. In the PBODS method presented in this study, CO<sub>2</sub> emissions, material production costs, and the coefficient of variation (COV) of the inter-story drift ratio, which reflects the seismic performance, are set as the objective functions, and optimal designs that can minimize these three objective functions. The optimal designs for a 4-story and a 10-story RC buildings are then evaluated with respect to environmental sustainability, economic feasibility, and seismic performance using the presented integrated analysis model. Furthermore, the proposed model is used to quantitatively investigate the variations in CO<sub>2</sub> emissions and material production costs depending on variations in the performance objectives.

**Keywords:** Embodied CO<sub>2</sub> emissions, Sustainable structural design, Performance-based green seismic design, Optimal structural design.

## 1. Introduction

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