

Benefits of Using Optimization Methods in Structural Engineering: Case Studies

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An optimal design solution is a very challenging task to achieve in structural engineering. It is often a rigorous iterative process to produce the best solution in terms of the prescribed engineering criteria or objective while satisfying the design constraints. In recent years, optimization software tools are utilized in many diverse areas of structural engineering. Even though the benefits of optimization tools are well recognized, these tools are not efficiently integrated into practicing engineer's design workflow.

This paper intends to show benefits of using an optimization software tool integrated with an analysis tool. Two examples are selected to serve this purpose. The first example deals with period optimization of a braced moment resisting frames. This is accomplished by finding optimum configuration of braces so that minimum structural period is obtained. The second example addresses a two-span concrete bridge supplemented with a base-isolator, in which optimal choices of the base-isolator properties plays a significant role in mitigating bridge damages. In this work, a nonlinear dynamic analysis is conducted for a selected range of different ground motion histories and it is aimed to find optimal isolator properties to keep bridge damages at minimum.

In the paper, two software packages including a finite element analysis library and an optimization library are coupled together to find optimum solutions for the aforementioned examples. Both software packages are stand-alone libraries. In other words, they are not developed for any specific domain. This level of separation provides a great flexibility to apply them to a broad range of engineering problems. The optimization package is developed as a general tool for rapid implementation of optimization applications. The finite element analysis software is developed for nonlinear static\dynamic analysis of any type of structures. To demonstrate the benefits of these two packages, they are integrated into the solution framework enabling design engineers to achieve the improved design solutions. It is intended to show that optimization and structural analysis tools can be effectively used together to provide supplemental design information for structural engineers.

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