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بابک دیزنگیان

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کارشناسی، ارشد و دکتری: دانشگاه سیستان و بلوچستان

مقالات علمی-پژوهشی

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1-1	Novel decoupled framework for reliability-based design optimization of structures using a robust shifting technique	Mohammad Reza Ghasemi Charles V. Camp Babak Dizangian	Frontiers of Structural and Civil Engineering	1.5	2018
1	Practical optimization of deployable and scissor-like structures using a fast GA method	Salar, M; Ghasemi, MR; Dizangian, B.	Frontiers of Structural and Civil Engineering	1.5	2018
2	Border-search and jump reduction method for size optimization of spatial truss structures	Dizangian, Babak; Ghasemi, Mohammad Reza	Frontiers of Structural and Civil Engineering	1.5	2018
3	An Efficient method for Reliable Optimum Design of Trusses	Dizangian, Babak; Ghasemi, Mohammad Reza;	steel and composite structures	3.2	2016
4	A Fast Ga-Based Method for Solving Truss Optimization Problems	Salar, Masoud; Ghasemi, Mohammad Reza; Dizangian, Babak;	International Journal of Optimization in Civil Engineering	علمی پژوهشی	2015

2010	علمی پژوهشی	Asian Journal of Civil Engineering (Building and Housing)	Mohammad Reza Ghasemi Babak Dizangian,	Size, Shape and Topology Optimization of Composite Steel Box Girders Using PSO Method	5
2015	ISI, IF= 2.75	Journal of Mechanical Design - Transactions of the ASME	Babak Dizangian, Mohammad Reza Ghasemi	Ranked-based sensitivity analysis for size optimization of structures	6
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با تشکر
بابک دیزنگیان

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صفحه اول مقالات منتخب

Ranked-Based Sensitivity Analysis for Size Optimization of Structures

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This article proposes a novel ranked-based method for size optimization of structures. This method uses violation-based sensitivity analysis and borderline adaptive sliding technique (ViS-BLAST) on the margin of feasible nonfeasible (FNF) design space. ViS-BLAST maybe considered a multiphase optimization technique, where in the first phase, the first arbitrary local optimum is found by few analyses and in the second phase, a sequence of local optimum points is found through jumps and BLASTs until the global optimum is found. In fact, this technique reaches a sensitive margin zone where the global optimum is located, with a small number of analyses, utilizing a space-degradation strategy (SDS). This strategy substantially degrades the high order searching space and then proceeds with the proposed ViS-BLAST search for the optimum design. Its robustness and effectiveness are then defied by some well-known benchmark examples. The ViS-BLAST not only speeds up the optimization procedure but also it ensures nonviolated optimum designs. [DOI: 10.1115/1.4031295]

Keywords: violation-based sensitivity analysis, borderline adaptive sliding technique, size optimization

1 Introduction

Over the last decades, a number of optimization techniques have been developed and used for structural optimization problems [1,2]. They may be generally divided into two categories: (i) gradient-based and (ii) stochastic-based techniques. Since there are some known downsides in the application of gradient-based techniques in structural optimization problems, stochastic-based techniques have expanded popularity in recent years [3]. Genetic algorithms [4–10] and simulated annealing algorithms [11,12] are the most notable stochastic-based optimization techniques used in the solution of engineering problems. They do not require the evaluation of gradients of objective and constraint functions, but they involve a substantial extent of computational efforts.

More recently, another branch of nature-inspired algorithms has attracted the attention of researchers in all optimization fields including those addressing structural problems. Algorithms belonging to this field imitate the collective behavior of a group of social insects (for example, bees, termites, ants, and wasps) to solve complex engineering *problems* (e.g., Refs. [13–20]). These algorithms have become vastly popular. One of the reasons for such popularity is that these metaheuristic algorithms are simple and easy to implement and yet they can solve very diverse and often highly nonlinear problems. They are being progressively enhanced and recognized by researchers for many different studies of structural optimization. However, there is no guarantee that a specific algorithm could perform the best solution for all structural optimization problems [21]. In all nature-inspired methods, the optimization procedure starts from fully random design points and a number of individuals called agents have the duty of finding a better solution by means of time-consuming step-by-step iterations. However, the main problem arises as the number of design variables increases, and thus rising number of agents may be inevitable. For instance, in the first iterations after nature-inspired algorithms begin operations, a large number of analyzes may take place without an output contentment. This thread is very serious for the structural problems whose analysis is time-consuming. Another insufficiency of such methods is that a large number of parameters should be tuned for every type of problem with a considerable parameter setting.

In this paper, a new method based on ViS-BLAST is proposed to overcome most of the deficiencies of other methods used in structural optimization. The key concept in ViS-BLAST is based on the ranked-based sensitivity analysis that is computed near the FNF border. ViS-BLAST is defined as a two-phase technique. First, using a few number of analyses, it computes the initial local optimum. In the second phase, the sequence of optimum solutions is searched via Jump and BLAST concepts, leading finally to the global optimum. Finally, to demonstrate the capabilities of ViS-BLAST, some well-known benchmark truss problems were solved. Results illustrate the advancements of ViS-BLAST in the fact that it finds *feasible* optimum solutions for all problems attempted, a major point not being specifically emphasized upon by many researchers. Another fact about the proposed method is that it then requires relatively a significant low computational effort to determine the global optimum solution. Although only structural size optimization is considered here, the proposed technique may also be used for problems with shape, topology, and/or hybrid types of design variables.

2 Size Optimization Formulation

Size optimization of structural systems involves reaching optimum values for design variables as member cross-sectional areas **A** that minimize the objective function f, usually the structural weight W. This is expressed mathematically as

$$\text{Minimize } f = W(\mathbf{A}) = \sum_{j=1}^{n} A_j L_j \rho_j \qquad (1)$$

where A_j, L_j, and ρ_j are the cross-sectional area, length, and unit weight of the jth member, respectively, and n is the total number of members. The vector **A** is selected between lower A^L and upper A^U bounds. Equation (1) is subjected to the following normalized constraints:

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TECHNICAL PAPER

A fast decoupled reliability-based design optimization of structures using B-spline interpolation curves

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Abstract This paper introduces a new method for reliability-based design optimization (RBDO) of structures. In RBDO of structural problems unlike the conventional two-level approaches, sometimes it is not necessary to carry out reliability analysis for each deterministic design. The proposed method may be categorized as a decoupled method for reliable optimum design; however, it is based on the safety factor (SF) concept. To briefly describe the proposed method, a deterministic design optimization (DDO) point is obtained based on an arbitrary SF. The corresponding failure probability (P_f) is then determined using Monte Carlo simulation (MCS). The P_f is then compared with the targeted P_f. If the relative distance error is greater than a desirable tolerance, the cubic B-spline interpolation concept is then employed as a result of which a modified SF is extracted. For the modified SF found, DDO procedure is carried out. The above procedure is iteratively repeated until convergence occurs and the reliable optimum point is found. Finally, the proposed method was applied to solving some structural problems. The obtained results were favourably in accordance with those recorded in the literature while only a fraction of P_f computations was necessary.

Keywords Decoupled · Reliability · Optimization · Structural · B-spline · Interpolation

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1 Introduction

Reliability-based design optimization (RBDO) implements structural optimization considering simultaneously the uncertainties in the structural materials properties and/or applied loading. The general structural RBDO problem with both deterministic and probabilistic design constraints can be expressed as:

$$
\begin{aligned}
&\text{Min/Max } f(\boldsymbol{d}) \\
&\text{Subject to:} \\
&P(G_i(\boldsymbol{d},\boldsymbol{X}) \leq 0) \leq P_f^i, \quad i = 1,\ldots,N_{PC} \\
&\text{and/or } \sigma_j(\boldsymbol{d}) \leq \sigma_{all.}, \quad j = 1,\ldots,N_m \\
&\text{and/or } u_k(\boldsymbol{d}) \leq u_{all.}, \quad k = 1,\ldots,N_{DOF} \\
&\text{and/or } \boldsymbol{d}^L \leq \boldsymbol{d} \leq \boldsymbol{d}^U
\end{aligned}
\tag{1}
$$

where $\boldsymbol{d} = [d_1, d_2, \ldots, d_n]^T$ is a column vector of n deterministic design variables, $\boldsymbol{X} = [x_1, x_2, \ldots, x_m]^T$ is the m-dimensional vector of random variables, $f(\boldsymbol{d})$ is the objective function, $P(G_i(\boldsymbol{d},\boldsymbol{X}) \leq 0)$ denotes the failure probability for the i-th limit state function $G_i(\boldsymbol{d},\boldsymbol{X})$. P_f^i is the target failure probability of i-th constraint and N_{PC} is the number of probabilistic constraints. In Eq. (1), σ and u are the stress of jth member and the nodal displacement of k-th degree of freedom, respectively. $\sigma_{all.}$, $u_{all.}$, $\boldsymbol{d}^L$, $\boldsymbol{d}^U$, N_m and N_{DOF} are respectively allowable member stress, allowable nodal displacement, lower and upper bounds of $\boldsymbol{d}$, total number of members of the structure and total number of degrees-of-freedom. The target failure probability can be expressed in terms of the target reliability index, $P_f^i = \Phi(-\beta_{ti})$, as $\Phi(.)$ is the standard normal cumulative distribution function.