Computers and Structures 139 (2014) 1–17

Contents lists available at ScienceDirect

Computers and Structures

journal homepage: www.elsevier.com/locate/compstruc

A hierarchy of sources of errors influencing the quality of identification of unknown parameters using a meta-heuristic algorithm

M. Fontan [a,*], D. Breysse [b], F. Bos [b]

[a] OXAND France, 49 Avenue Franklin Roosevelt, 77210 Avon, France[1]
[b] University of Bordeaux, I2M – GCE, UMR 5295, 351 Cours de la Libération, 33405 Talence cedex, France

ARTICLE INFO

Article history:
Received 4 September 2012
Accepted 7 April 2014
Available online 6 May 2014

Keywords:
Identification of error sources
Inverse analysis
Metrology set
Model error
Parameter identification
Particle swarm optimization

ABSTRACT

The aim of structural monitoring is to get mechanical and valuable information concerning structural parameters. A generic frame was developed in order to identify unknown parameters thanks to an iterative process using a meta-heuristic algorithm. It combines data obtained through structural monitoring, a mechanical model and an optimization algorithm. The quality of identification depends on the quality of the data set, on that of the mechanical model and on the algorithm efficiency. It is shown through several tests on two case studies how uncertainty or errors arising from various sources can impact the accuracy of predicted values.

© 2014 Elsevier Ltd. All rights reserved.

1. Introduction

More and more ageing buildings need either reinforcement or repair to assure the safety of users and goods in adequate conditions. They are suffering from significant deteriorations but funding is often missing to repair everything. So as to rank priorities and prepare appropriate maintenance plans, engineers can investigate buildings to assess their structural safety level [1–3]. Many methods can be used (including monitoring, non-destructive and destructive techniques) either to investigate the structures or to estimate the material properties, cf. Fig. 1, [4,5]. Nevertheless, all methods are suffering from various problems:

- they should keep as much as possible the integrity of the structure and non-destructive testing for structural health monitoring (SHM) has to be privileged,
- investigations are often focused on a local area and the extrapolation to the building overall response may be difficult,
- accuracy strongly depends on the expertise of who is in charge of the analysis.

Many research works cf. Table 1 [6,7–11], have been dedicated during the past decade to estimate mechanical parameters in order to monitor structures. The concept of inverse analysis is central. The principle consists in comparing field data with predicted data obtained via a mechanical model, while an optimization algorithm minimizes their difference by modifying the unknown parameters at each iteration. This concept has been successfully used by several authors to identify:

- soil mechanical parameters, especially for the Mohr-Coulomb characteristics behaviour [12–14],
- structural parameters of truss structures regarding the presence of defaults, or identifying the stiffnesses of a continuous beam bearing on elastic supports [16–18],
- monitoring a structure, for instance the displacement of the buildings around tunnelling works [8,9,15].

2. Inverse analysis strategy

Fig. 2 details the architecture of the different tools used when an inverse analysis is carried out. The field data, point 1, concerns the measurements carried out on the structure. Measurement may be of any nature under the condition that it is possible to establish a link between the parameters to identify (point 5) and these measurements. The mechanical model, point 3, can be numerical or analytical as long as it correctly reproduces the structural response.

* Corresponding author. Tel.: +331 83 88 70 01.
E-mail address: maxime.fontan@oxand.com (M. Fontan).
[1] Formerly at the Ecole Normale Supérieure, LMT-Cachan, France.

http://dx.doi.org/10.1016/j.compstruc.2014.04.001
0045-7949/© 2014 Elsevier Ltd. All rights reserved.

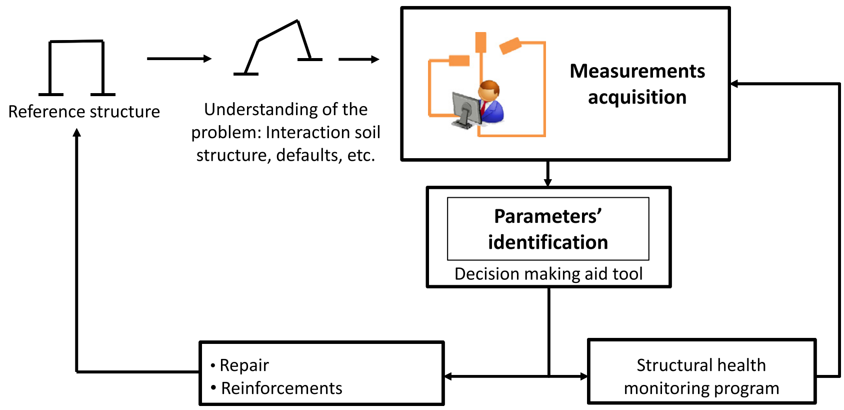

Fig. 1. Structural health monitoring process integrating a parameter identification program.

Table 1
Illustrative list of recent applications using an inverse analysis approach in order to identify parameters in different construction problems [6].

Description of the work	Studied structure	Identified parameters	Used technique	Authors
Identification of stiffnesses in pin jointed structure by using several meta-heuristics algorithms	Pin jointed structure	Stiffnesses	PSO, GA, SA, AC	Hasançebi et al. 2009 [7]
Use of deflections, rotation and strain to identify the condition of bridge supports and material properties	Bridge	Both mechanical model and mechanical parameters	Search algorithm PGSL (Probabilistic Global Search Lausanne)	Robert-Nicoud et al. 2005 [8]
Estimation of bridge reliability using environmental monitoring data (temperature, wind loads) and displacements data	Model bridge	Reliability of the truss of the bridge under several loading scenarios	FORM and SORM using 2D and 3D FEM models	Necati Catbas 2008 [9]
Identification of geotechnical parameters combining a meta heuristic algorithm (PSO), support machine vector and numerical analysis to integrate non-linear relationship between displacement and mechanical properties	Soil Parameters	Stress in the soil	Vector machine, PSO	Zhao and Yin 2009 [10]
Identification of the water infiltration in an unsaturated soil column by using a modified PSO algorithm	Soil Parameters	Water content, conductivity, pressure	PSO and Descent Gradient	Zhang et al. 2009 [11]
Identification of several geotechnical parameters on two cases: an odometer test and an application on a natural slope	Natural slope	Effective cohesion and friction angle, dilatancy angle	PSO	Meier et al. [12,13]
Identification of Mohr-Coulomb parameters combining displacements data, the GA and a Plaxis© model	Excavation wall	Cohesion and effective friction angle	GA	Levasseur et al. 2007 [14]
Application of the inverse analysis to modify excavation project in progress using displacement data of the buildings around the site	Excavation wall	Soil strength, deflections and displacements	Interactive design adapted to the case of uncertain geotechnical behaviour	Schmitt and Schlosser 2007 [15]

PSO: Particle Swarm Optimization; GA: Genetic Algorithm; SA: Simulating annealing; AC: Ant Colony.

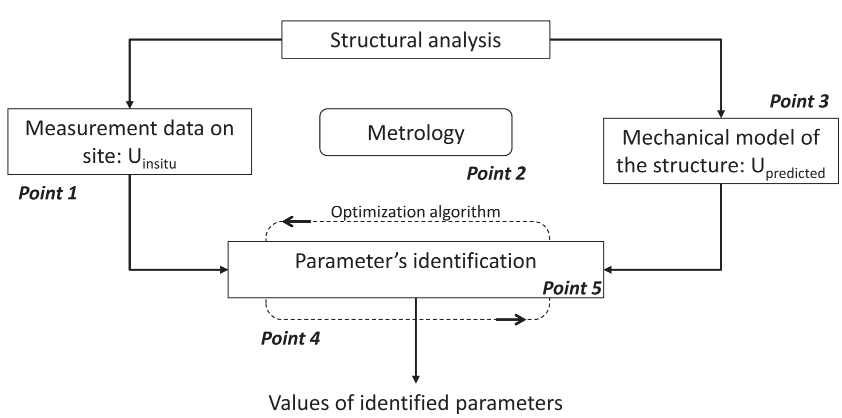

Fig. 2. Organization of the different tools to identify mechanical parameters by inverse analysis.

If not, model errors appear and the accuracy decreases [19]. In this paper, both numerical and analytical models will be used. The difference between measured and predicted data is minimized thanks to an optimization algorithm, point 5 [20,21]. Usual algorithms have often a limited efficiency because of local minima and errors on field data. This justifies the use of meta-heuristic algorithms that are capable of overcoming the presence of local minima and to converge towards the solution of the problem. This flowchart

دریافت فوری ← متن کامل مقاله

ISIArticles
مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات