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DAMAGE DETECTION IN TRUSS STRUCTURES USING WAVELET TRANSFORMATION

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The problem of non-destructive damage detection plays an important role in monitoring of the engineering structures. This issue has been the subject of studies undertaken by many scientists who proposed some approaches based on e.g. evolutionary algorithms [1], load optimization [7], information of natural frequencies [2], heat transfer [11], inverse analysis [3, 4] and artificial neural networks [8, 10]. Another, relatively modern tool, which can be effectively used for damage detection is wavelet transformation (WT) [9] also in its discrete form (DWT) [5, 6].

The paper presents the issue of damage detection considering the influence of external loads. An examined structure refers to Town-type truss which was formerly used as a railway viaduct support structure. The truss is modeled as the set of two-node finite elements with three degrees of freedom per node and exact shape functions. Axial displacement of element is described by linear shape functions and bending is described by polinominals of third order corresponding to Euler-Bernoulli beam fields of deformation. The local damage in truss structure is modeled as local stiffness reduction of one or two lower and upper chord element. Additionaly, local stiffness reduction is also introduced in skew bars of considered structure. The analysis of a structural response is conducted with the use of signal processing tool namely wavelet transformation in its discrete form. Daubechies 4 wavelet with two vanishing moments was implemented. The aim if this work is to detect the localization of defect provided that damage exists in the considered truss structure. Numerical investigation is executed basing on signal analysis of structural static response. Some numerical examples are presented.

The novelty in the present approach is gathering the data in one measurement point in equal time intervals. The structural response signal is expressed in vertical displacements or angle of rotations of one selected node of the truss structure. DWT appeared to be very efficient in damage detection and properly identifies the presence and position of damage, even though the whole truss is rigid structure. It also discovers small disturbances in response signal of damaged structure and does not require the reference to a signal from undamaged structure (additional errors avoided). Effectiveness of the proposed method is illustrated in the Figure 1, where the damage is properly localized, even for a relatively small number of measurements.

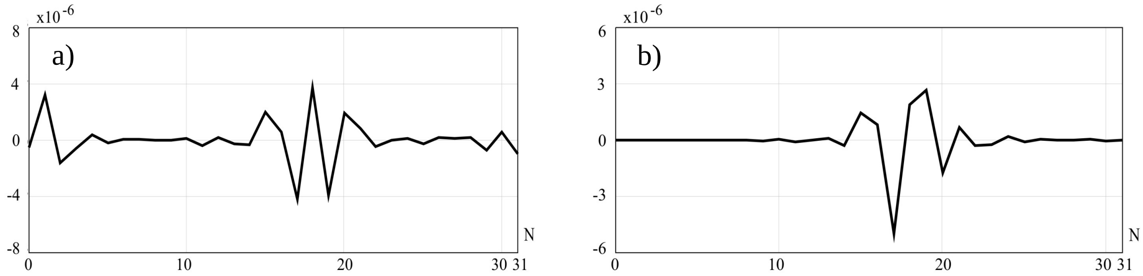

Figure 1. DWT (Daubechies 4, detail 1) of: a) vertical displacements, b) rotation angles of one node of truss structure; N = 32.

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