DAMAGE DETECTION IN 4-STORY STEEL BRACED FRAMES USING RESIDUAL FORCES BASED ON WAVELET TRANSFORM

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Wavelet transform which was proposed from 1980, is a mathematical operation that makes new functions from basic ones (Roland, 2000). Wavelet analysis is an efficient tool to detect structural damages like cracks and stiffness degradation (Kim and Melhem, 2004).

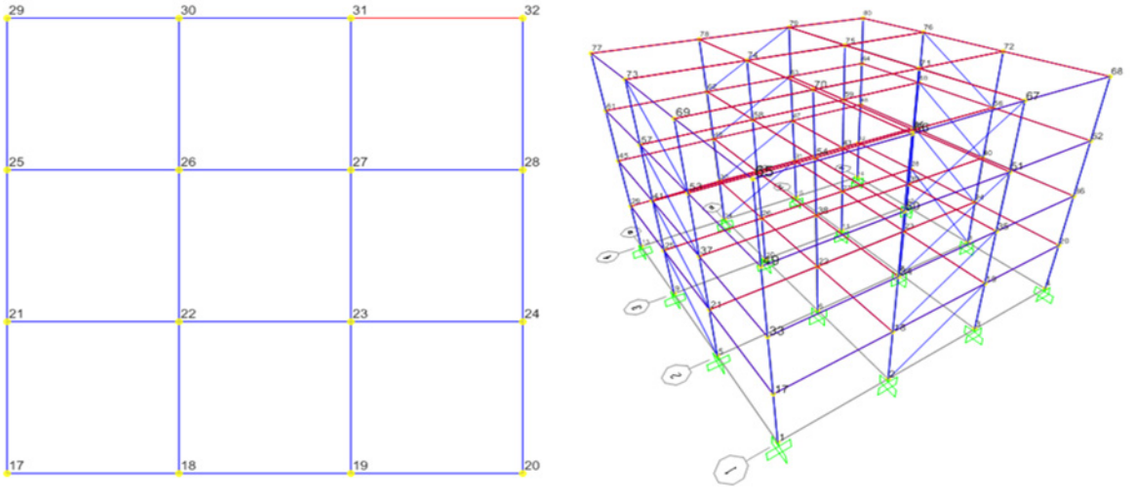
In this study, residual forces and damage detection procedure by wavelet transform of residual forces were described. A four story space frame with diagonal braces with several damage states was considered. For every state of damage mass and stiffness matrices, mode shapes and natural frequencies were evaluated. Finally dynamic responses of structure were conducted under wavelet analysis and for all cases, damages were successfully detected.

At the next step a plane braced frame was assessed. Nonlinear dynamic analysis was performed and structural responses have been evaluated. After wavelet analysis on responses, wavelet analysis curves of residual forces showed peak points on degree of freedoms of damaged members.

First damage state: removal of beam as damage: At this part, 31-32 beam element of structure was considered as damage (Figure 1). For this purpose, that element removed and by evaluation of responses from damaged structure, using residual force concept, wavelet analysis was implemented. It is expected that this element removal be shown as a peak point on its associated degree of freedom in output curve of wavelet analysis.

As it is depicted in Figure 2, in first mode, degree of freedom 32 has peak point, which evidences the existence of damage in this degree of freedom.

The damage locations, when damage occurs, are easily determined simultaneously by the ridges in the residual forces based on wavelet transform. The degrees-of-freedom that have large magnitudes in residual wavelet force (RWF) are associated with the potential damage members within the structure.



(a) (b)

Figure 1. The first case of damage a: 2-Dimensional view, b: view of 3-Dimensional structures

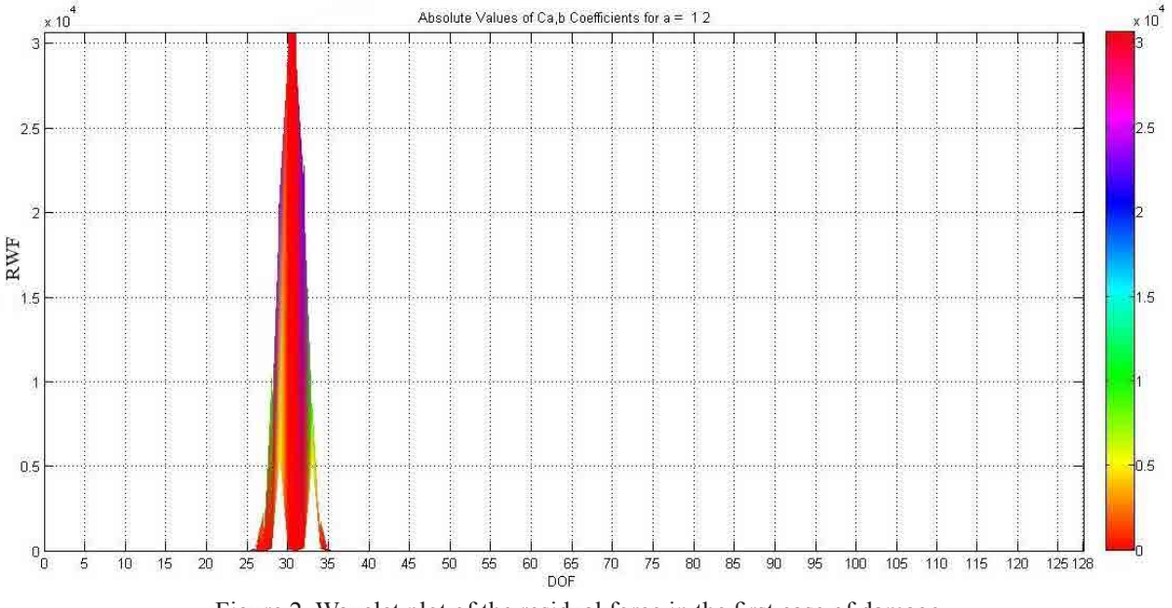


Figure 2. Wavelet plot of the residual force in the first case of damage

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