Damage Detection of Steel Plate Shear Walls by Wavelet Transform

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1-Introduction

Structural damages such as shear, corrosion, buckling, lamination, etc. can be produced by different methods, causing decrease of structural hardness and density. One of the methods for damage detection is change of physical qualities such as hardness which alters dynamic qualities of structures including natural frequencies and mode shapes. Development of damage or lack of damage can be detected with comparison of modal response of the structure between healthy condition and damaged condition. When there is no healthy structural behavior, damage is detected through using damaged structural responses.

One of the used methods is a dynamic one based on signals that can be used to detect damage in structures by using signal processing. In this method, the signal is the damaged structure's response which is processed as an input signal and shows the accurate location of damage. Wavelet transform is the most practical approach that has been used in recent decades.

Damage detection of a structure can be investigated by using wavelet transform by placing a sensor in certain balance of the structure. This can determine the damage done to each part of the structure. Each sensor adds responses from the structure as an input signal to process signal into wavelet transform. Then, the transform with input signal analysis can detect damage if it has occurred.

2-Modeling of Steel Plate Shear Walls (SPSW)

To introduce damage in the structure, eight damage scenarios have been imagined on steel plate shear walls. Here, three damage scenarios have been investigated in Table.1. In the study, damage has been described in different parts of the plate and damage detection is examined through a decrease of elasticity module of the material and the accuracy of the wavelet algorithm is investigated.

As said here, the signal is processed on the responses obtained from the structure. In this study, the modal responses of steel shear wall in each balance is registered as an input signal by defined sensors and the signal is processed on the wall by using wavelet transform. If the algorithm observes damage along the structure it can determine its accurate location. The mode shape of the first and second structure has been used for input signals of the wavelet algorithm.

Table 1. Damage scenarios defined in SPSW model (origin: down corner of the left plate)

Damage scenario	Severity of damage	Location of damage
1	1 element 5*5 cm by decreasing elasticity module 10%	X=1.5m, Y=1.5 m
2	3 elements 5*5 cm by decreasing elasticity module 10%	X_1=1.5m, X_2=1.5m, $X_{3=}$2m, Y=1.5m

3- Damage Detection of Steel Plate Shear Walls

With damage scenario defined in the plate, scenarios have been introduced in the head of networking plate balance for signal processing of each rank separately. In the location of scenarios, sampling has been designed for each point on the length of the wall, registering signals from the mode shape for the whole wall. The results of damage detection of the first and second damage scenarios have been presented in Fig. 1 and Fig. 2 for the first mode shape of the.

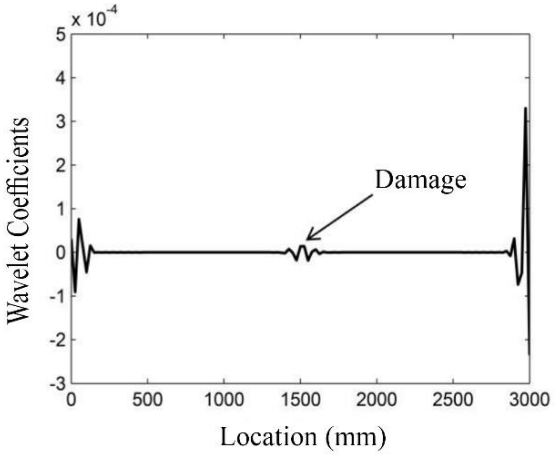

Fig. 1 Determining damage location of the first damage scenario for the first mode shape of the structure with wavelet function rbio3.5.

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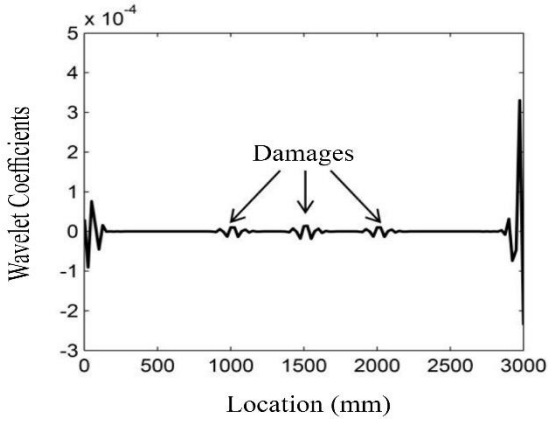

Fig. 2 Determining damage location of the second damage scenario for the first mode shape of the structure with wavelet function rbio3.5

Also, damage detection of damage scenario for the second mode shape of the structure has been presented in Fig. 3.

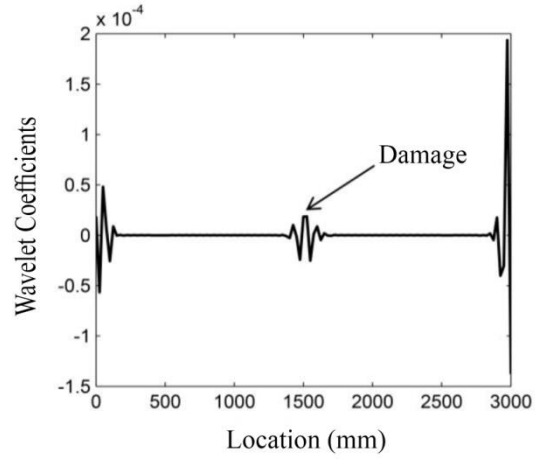

Fig. 3 Determining damage location of the first damage scenario for the second mode shape of structure with wavelet function rbio3.5.

4- Conclusion

The results of this study are summarized as follows:

1. The wavelet function has the most effect on accurate determination of damage location.
2. With economic aspects of the study, damage scenarios are detected in related self balance through increasing the number of sensors.3. By using higher mode shapes, accurate location of damage can be detected even for a little damage.4. If there arefew discontinuities (for damage), wavelet function must have had not only frequency analog to the signal but also high frequency concept to determine their accurate location well.