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EVALUATION OF DYNAMIC CHARACTERISTICS OF STRUCTURES BY DYNAMIC ANALYSIS OF STRUCTURES

Nasim JAFARI
Civil Engineering, Urmia University of Technology, Urmia, Iran
nasimjafari90@gmail.com

Javad MOKARI-RAHMDEL
Civil Engineering, Urmia University of Technology, Urmia, Iran
j.mokari@uut.ac.ir

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System Identification (SI) is the process of modeling an unknown system based on a set of input–outputs and is employed in different fields of engineering. In the case of structural system identification, this can be done in the form of: (a) Identifying structural parameters such as stiffness, vibration signatures such as frequencies, mode shapes, and damping ratios, and stress and strain, or (b) Structural response.

In some studies, some of the physical parameters have been identified using the result of the modal parameters SI. Peterson et al. determine localized damage in timber beams based on the comparison of the differences in modal strain energy between undamaged and damaged structures. Ndambi et al. use Eigen frequencies and mode shape derivatives for detecting cracks in Reinforced Concrete (RC) beams. Ren and De Roeck and Unger et al. use modal data to find the location of damage and the severity of the damage defined as a change in the stiffness of concrete beams and prestressed concrete beams, respectively.

In the context of this paper, by the use of the differential equation method of the natural frequency relationship for identifying 1DOF system, exclusively for mass parameter, and then using the independent add-on matrix in a free vibration mode, for identifying 1DOF, 2DOF and 3DOF systems has been investigated. In this study, considered 1DOF system and natural frequency is in accordance with Equation 1:

$$\omega = \sqrt{\frac{k}{m}} \tag{1}$$

By concluding the Equation 1 and using the differential equation method, the final relation is:

$$d\omega = -\frac{\omega}{2m}dm \tag{2}$$

In this way, 1DOF can be achieved for the main structure of the structure. By assuming a shear frame of a floor with vibration, releasing this structure and receiving the frequency outputs of a structure of a class, one degree of freedom can be obtained using the Equation 2 to the structure's mass. Which is presented in Table 1 and as shown in Figure 1, it can be achieved by adding frequency and mass difference, added mass-to-mass diagram can be obtained to zero to the main mass of the structure.

Table 1. Dynamic characteristics of a system of 1DOF by differentiating Equation 1.

Num	$\mathbf{dm}(kg)$	$\mathbf{d\omega(rad/sec)}$	$\mathbf{m = -\frac{\omega}{2d\omega}dm(kg)}$	$\mathbf{k = m \times \omega^2(\frac{kg}{m})}$
1	0·5	−0·0719	114·4436718	123980·4227
2	1	−0·1434	114·762901	124326·2537
3	2	−0·14245	115·5282555	125155·3863
4	5	−0·13978	117·7350122	127546·0351
5	10	−0·1355	121·4538745	131574·7955

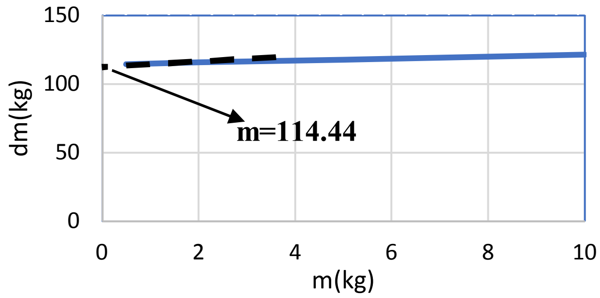

Figure 1. Added mass-to-mass diagram can be obtained to zero to the main mass of the structure.

The three shear frameworks are separately investigated in terms of frequency variations with added mass and without added mass. Then, for the three-story shear structure, the system identification steps are performed, and the detected mass matrix of the proposed method is investigated. The 3DOF shear frame with its own mass is free vibration structure, with initial displacement on the second floor, at 1 cm, and with an added mass with similar vibrational conditions, as shown in Figure 2, the frequency-free variations increased mass with added mass.

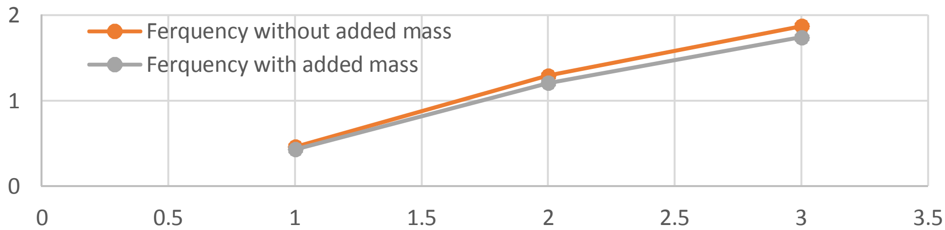

Figure 2. Frequency changes without added mass and with added mass to the three-story shear frame.

In the study of the three-story shear structure in three measurements, the results are shown in this method by applying the stimulation to the subset of the degrees of structural freedom. This can be used to complete the system identification in several steps. In addition to this important advantage, the proposed methods are able to calculate through the identification of dynamic characteristics (mass matrices, drops and stiffness, etc.), not only the frequency characteristics and the system's modulus, but also the image of the probability of failure in the structure.

Table 2. Comparison of the matrices of the mass matrix identified in the 3rd floor structure.

Available mass	$m_1 = 114 \cdot 7$	$m_2 = 114 \cdot 7$	$m_3 = 114 \cdot 7$
Mass detected in the first measurement	$116 \cdot 2329$	$117 \cdot 2534$	$118 \cdot 1705$
	$\varepsilon = 1 \cdot 53\%$	$\varepsilon = 2 \cdot 55\%$	$\varepsilon = 3 \cdot 47\%$
Mass detected in the second measurement	$116 \cdot 3408$	$117 \cdot 1141$	$118 \cdot 0296$
	$\varepsilon = 1 \cdot 64\%$	$\varepsilon = 2 \cdot 41\%$	$\varepsilon = 3 \cdot 32\%$

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