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DIRECT INTEGRATION METHOD FOR SUBSTRUCTURE PSEUDO DYNAMIC TEST HAVING ROTATIONAL DEGREE OF FREEDOM

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ABSTRACT

The pseudo dynamic test method is hybrid testing method [1] combining the numerical integration of the motion of complex structure and the experimental measurement of the restoring forces which result from the motion. The pseudo dynamic test method may be extended in order to test structures even larger than the laboratory, such as buildings, by introducing a substructuring technique [2],[3]. The determination of the motion of the D.O.F. is based on the use of an appropriate numerical scheme, which approximates the time integration of equation of motion. To perform the hybrid testing, we should adopt the time integration method which is stable and accuracy such as the constitutive operator splitting method [4].

The constitutive operator splitting method (OS-method) is unconditionally stable when assuming that the initial stiffness is higher than or equal to the tangent stiffness of the structure and only requires the initial stiffness matrix related to the boundary at the first step to solve an equation [4].

In the loading system, the vibration system has the higher mode related to the rotational degree of freedom, and stiffness suddenly increased due to unavoidable friction forces in the experimental system. Hence, we cannot help choosing the larger assumed the initial stiffness to prevent unfavourable higher-mode oscillation, and the resulting responses include a large period distortion. Then we propose the scheme in which the period was kept right and an unfavourable higher-mode oscillation was strongly suppressed. To suppress the error growth under a few unavoidable higher-mode oscillations, numerical dissipation for the higher mode is introduced by using the α-method [5]. This scheme is called the αT-OS method to distinguish it from the α-OS method in this paper.

To show the effectiveness and validity of the presented αT-OS method, free vibration tests of a cantilever column with masses at its top and bottom were performed. These results show the following:

1) There is no higher-mode oscillation when we choose a large enough initial stiffness.

2) Period distortion was detected in the results obtained by the α-OS method, but there was none in the results obtained by the αT-OS method.

3) Once a cycle oscillation occurred when the velocity was zero. Numerical dissipation introduced by the α-OS method decreases with increasing assumed stiffness in the scheme. Hence, an appropriate assumed stiffness should be set in the scheme to make the response stable.

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