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PROPOSAL OF A METHOD TO DETECT BUCKLING AND UNSTABLE DEFORMATION IN DYNAMIC ANALYSIS

Abstract

Technology of deployable space structures is necessary for spacecraft to challenge advanced missions. It is important in designing the deployable space structures that they are reliably repeatable. Traditional approach for improving the repeatability was conducted by investigating errors and its effect to the deployment. However, the traditional approach has a problem that results change depending on estimation of the errors. With that background, the author studies numerical methods to enable selection of robust deployable structures against the errors. The repeatability is decreased due to occurrence of the buckling and the unstable deformation caused by the errors. Therefore, a structure not occurring the buckling and the unstable deformation should be selected for designing of a reliably repeatable structure. The buckling and the unstable deformation are detected by non-positive eigenvalues of a stiffness matrix of the structure in static analysis. However, detection of the buckling and the unstable deformation in dynamic analysis is difficult because the eigenvalue is also non-positive when the structure has rigid-body motion. The author previously proposed a method to distinguish rigid-body modes from modes including deformation by defining the rigid-body modal space exactly for the structure under motion. Subsequently, the buckling mode or the unstable deformation mode is defined as a mode including deformation with zero or negative eigenvalue in the method. However, the method is not accurate for a mode where the local deformation and the local rigid-body motion occur simultaneously because of effect of the eigenvalue derived from the local rigid-body motion. That is to say, when a mode consists of stable deformation and rotational rigid-body motion with compressive strain, the mode may be wrongly determined as the unstable deformation mode. In the same way, when a mode consists of unstable deformation and rotational rigid-body motion with tensile strain, the mode may be wrongly determined as the stable deformation mode. In this paper, the author proposes a new method to solve the problem. In the new method, the buckling and the unstable deformation are detected not by the eigenvalue but by work of the deformation. The work of the deformation is calculated for the mode including deformation. When the work is positive value, the deformation can be regarded as being stable. When the work is negative value, the deformation can be regarded as being unstable. Finally, the author confirmed the adequacy of the new methods by dynamic analyses of deployment of a membrane structure.