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RESEARCH ON COLUMN BUCKLING UNDER INTERNAL PRESSURE OF PLANE-CONE SHAPED
METAL BELLOWS

Abstract

In china,rocket uses plane-coned shaped metal bellows accumulator to control POGO vibration.These metal bellows will occur column instability under internal pressure.In this paper,a theoretical study on the column instability is presented, the nonlinear buckling method using finite element software is tested and verified, and a calculation method of critical pressure of column buckling which combines the theoretical formula and finite element software is given.

The formula for calculating the critical column buckling pressure of plane-cone shaped metal bellows under internal pressure is deduced from Euler formula,the influence of the waveform on the column instability is mainly reflected in the axial stiffness.The tensile and compressive axial stiffness of plane-cone shaped bellow are different,the difference is analyzed in this paper and a empirical formula for calculating the axial stiffness of these bellows is obtained.The plane-cone shaped metal bellow is equivalent to a thin-walled cylinder when analyzing column instability,the axial stiffness inconsistent of metal bellows will lead to a tensile and compressive elastic modulus inconsistent of the thin-walled cylinder.In this paper, the flexural rigidity of thin-walled cylinder is deduced theoretically.Knowing the flexural rigidity, based on the Euler formula and the method of numerical fitting, the calculation formula of critical pressure of column buckling under internal pressure of plane-cone shaped metal bellows is presented.

When filling with internal pressure,the membrane of some size of metal bellows will be deformed, and the middle part of membranes will be contacted which lead to a change in axial stiffness.The empirical formula of stiffness have big error in this case.Therefore, the infinite element software is used to simulate the tensile and compressive axial stiffness of the bellows under internal pressure.Plug the stiffness value obtained from infinite element software into the calculation formula of critical pressure of column buckling,the critical pressure can be obtained. And the formula calculation results are compared and analyzed with the experiment results.