Structural behavior and design criterion of air-cushion considering change of internal pressure and plasticity of film

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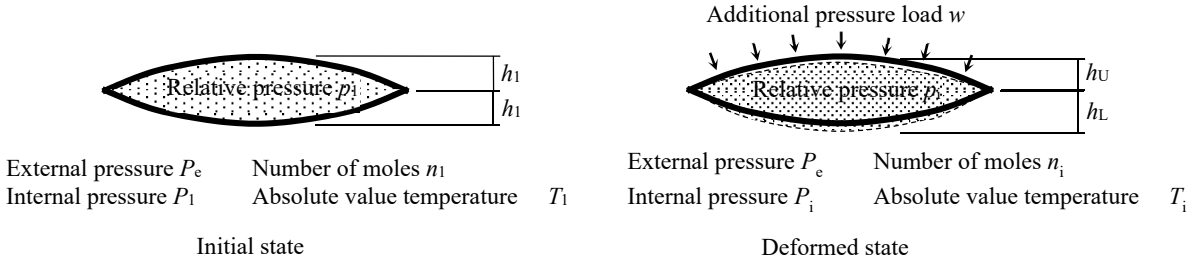
Abstract

Since the pressurized space of the air cushion is independent and the film has high airtightness including the welded portion, it is theoretically possible to seal the air cushion without needing to feed air. However, in actual design, in many cases, the blower is constantly operated to maintain internal pressure from the viewpoint of leakage prevention. Therefore, in many cases, the internal pressure is designed to be constant. However, the air cushion with a small volume of inclusive air tends to fluctuate the internal pressure against disturbance such as external force, temperature change, atmospheric pressure fluctuation. Also, in the steady state of the air cushion, low pressure and a small amount of air can be blown. Therefore, ducts connected to the cushion are generally used with small diameters. Therefore, it is expected that the instantaneous volume change occurring in the air inside the cushion due to the dynamic wind pressure exceeds the air movement amount via the duct, and the internal pressure greatly fluctuates during wind storms. In Japan where load conditions such as wind storms, snow cover, heavy torrential rains are severe, it is particularly important to design air cushions taking these influences into consideration.

The strength and stiffness of the film are lower than that of the coated fabric. Also, the film produces a large plastic strain when stress exceeds the yield point. When the stress of the film exceeds the yield point between about 1/2 and 2/3, creep and relaxation are conspicuous. Therefore, in design, it is essential to properly consider these film-specific properties.

The purpose of this paper is as follows. First of all, paying attention to the axial object deformation mode of the circular air cushion, simplifying the model by replacing the entire system with a two-mass point piston model. Next, obtain an exact solution of the state equation of the air cushion taking into consideration the Boyle-Charles law. It is to clarify the effect of pneumatic stiffness by the contained air, the wrinkles of the film and plasticization, the influence due to the change in air volume.



Firure-1 Analysis condition of circular air cushion

References

[1] M. Coelho, D. Roehl and K. Bletzinger, "Numerical simulation of burst-test of an ETFE membrane", *Proceedings of the IASS-SLTE 2014 Symposium*, Brasilia, Brazil, September 15-19, 2014.

[2] M. Kawabata, T. Takemura and S. Furutani, "Structural Design of Membrane Structure Using Plastic Stretch and Heat Shrink of ETFE Film", *Proceedings of IASS 2016 Symposium*, Tokyo, Japan, September 26-30 2016,