인공근육용 압전복합재료 작동기의 섬유배향각이 총유효모멘트에 미치는 영향

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The Effect of Fiber Ply Orientation on the Total Effective Moment in PZTCA of Artificial Muscle

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Key Words: Piezoelectric Zirconate Titanate Composite Actuator (압전복합재료 작동기, PZTCA), Fiber Ply Orientation (섬유배향각), Total Effective Moment (총유효모멘트, M^E)

Abstract : Due to the diversified use of recent Piezoelectric Zirconate Titanate Composite Actuator (PZTCA), various PZTCAs with the different ply orientation of the fiber layer have been applied. For this reason, the applicable bending moment equation is necessary even though the fiber layer ply orientation and the laminate configuration are changed. The aim of this research is to evaluate the relationship between the total effective moment (M^E) and Bernoulli-Euler bending moment (M) when the ply orientations of UD CFRP are changed. In conclusions, 1) As the performance test results by the CFRP ply orientation, the performance of [0] and [90] were stable. However, while the performance of [+45] was suddenly decreased after 5 hours. 2) The change of M^E by the CFRP ply orientation was evaluated. As the CFRP ply orientation was increased from [0] to [+60], the M^E were gradually decreased. However, they became a little bit increased from [+60] to [90]. 3) After the change of M by the CFRP ply orientation was evaluated, it was found that $M^E=2.2M$ was valid for just [0] and that there was a relationship between M^E and M according to the ply orientation.

총유효모멘트와 베르누이-오일러 굽힘모멘트를 이용한 PZTCA의 작동변위-곡률반경 관계식 제안

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Suggestion of the Equation to Performance Stroke-Radius Curvature in PZTCA using the Total Effective Moment and Bernoulli-Euler Bending Moment

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Key Words: Bernoulli-Euler Bending Moment (베르누이-오일러 굽힘모멘트, M), Performance Stroke (작동변위, Δh), Radius of Curvature (곡률반경, ρ), Fiber Ply Orientation Factor (섬유배향계수, F_{po})

Abstract : The aims of this study were to define the relationship between the total effective moment(M^E) of PZTCA and Bernoulli-Euler bending moment(M), to endure the limitations of the previous equation and $M^E=2.2M$, and to suggest and evaluate the applicable stroke equation for the general ply orientations. It was confirmed from numerical analysis that some relationship between M^E and M existed for CFRP ply orientations [+30], [+45], [+60] and [90]. Therefore, a parameter to modify $M^E=2.2M$ is required. This study suggested the modifying parameter, that was the fiber ply orientation factor(F_{po}). The previously used equation can be applied to just [0]. If the CFRP ply orientation in PZTCA was changed, the results generally would be the same. Therefore, there is some limitation not to apply. However, since the suggested new equation considered the change of curvature radius by the CFRP ply orientation, it was found that the relationship between the performance stroke and the curvature radius of the CFRP ply orientation in PZTCA was clear.