Buckling and Postbuckling of a Long-Hanging Elastic Column Due to a Bottom Load

M. M. Bernitsas¹ and T. Kokkinis². The results derived in the paper are valid in two cases:

1. For columns for which one end can move freely laterally, i.e., an end that does not admit horizontal forces, and that have length greater than 10 bending lengths.

2. For columns for which both ends are the same vertical line in the limit as their length approaches infinity.

However, in the second case the results are not applicable to columns of large finite length, which is the case of most practical applications. In this case the governing equation, corresponding to equation (4) in the paper, is inhomogeneous, because the column admits horizontal forces at both ends. Global equilibrium of the entire column in the deformed configuration proves this point. For this reason the convergence of the stability boundaries to those of a column of infinite length does not occur within 10 bending lengths. Actually it occurs within 1 percent for lengths greater than $10^2$ bending lengths.

Correct results for this case can be derived for all types of boundary conditions by quasi-asymptotic analysis of the solution to the inhomogeneous problem. The detailed mathematical derivation is in reference [1]. A summary is presented in reference [2].

References


Author's Closure

My paper investigated the case where the bottom load is free to move horizontally. Drs. Bernitsas and Kokkinis correctly stated the validity of my results. I have not studied the interesting case where both ends are always vertically aligned.

Authors' Closure

The authors wish to thank Dr. Allman for bringing his paper to their attention and express their regret for having overlooked his work.

We wish to mention, however, that the method of approach of the two papers is quite different despite the fact that both are based on essentially similar assumptions and that the resulting governing differential equations are also different. We feel the method used in our paper, which deals directly with the components of stress which is the main object of the analysis, is more direct and simple. In this way, a closed-form solution that is adaptable for any possible adhesive layer flexibility and capable of satisfying all the boundary stress conditions of the joint is obtained. To illustrate the application of the present unified theory and to examine the

References


An Analysis of Adhesive-Bonded Single-Lap Joints

D. J. Allman². I note that the paper by Chen and Cheng [1] develops an essentially identical theory to my paper [2] published in the Quarterly Journal of Mechanics and Applied Mathematics, 1977. Although the latter paper is often referenced by British authors [3, 4], it seems to have not yet penetrated the American technical literature. The paper presents analytic solutions for a wide range of lap joints with very thin adhesive layers, rigid adherends, typical metal adherends, and typical composite adherends. It is also relevant to mention the finite element application of the theory to lap joints with dissimilar adherends which is described in reference [5].

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References

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