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APPLICATION OF THE SPLITTING LEMMA IN THE STABILITY ANALYSIS

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ABSTRACT

Elastic structures with finite degrees-of-freedom are analysed. There is a critical point if the gradient of its potential energy function is zero and the Hessian matrix is singular. (*m* denotes its corank). The Splitting lemma [1] says: in the neighbourhood of this critical point the energy function is equivalent to the sum of an active and a passive function (a Morse function with *m* variables). The active part depends on *m* variables, and shows every important feature of the energy function.

Unfortunatelly the Splitting lemma does not state that suitable transformations can be found in a finite number of numerical steps. Although we can use truncated algebra if we know the determinacy of the catastrophe point, there are two difficulties. The coeffitients of the Taylor series depend on (load and imperfection) parameters, and the load parameter has a special role in the analysis of equilibrium paths and imperfection sensitivity, so we cannot mix it with the imperfection parameters.

Papers [2, 3] illustrating the different types of critical points use usually simple models which have no passive variables, so they do not need the application of the Splitting lemma.

In the lecture we analyse different elastic models with a few degrees-of-freedom. They might have different numbers (1 or 2) of active variables, different type of catastrophes (cusp, butterfly, double cusp), different level of determinacy, different types of imperfections. We show the splitting algorithm both for the perfect and the imperfect structures, the equilibrium paths and the imperfection sensitivity curves or surfaces.

Before using the splitting algorithm the truncated Taylor series of the potential energy function is decomposed into two parts: the first one belongs to the perfect structure at the critical load, while the second part is the remainder. The splitting algorithm to be presented consists of two main steps of transformations of the variables: first we split the first part of Taylor series into an active and a passive part, than we adapt these transformations on the second part of the Taylor series, which is a perturbation of the first one. In this second step only some of the coefficients can be eliminated, and the originally non-zero coefficients can be transformed to their original values.

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REFERENCES

[1] T. Poston and I. Stewart, *Catastrophe theory and its applications*, Pitman, 1978.

[2] J.M.T. Thompson and G.W. Hunt, *A general theory of elastic stability*, Wiley, 1973.

[3] Z. Gaspar, Mechanical models for the subclasses of catastrophes, In: M. Pignataro, V. Gioncu (eds) *Phenomenological and mathematical modelling of structural instabilities*, CISM Courses and Lectures No. 470, Springer, pp. 277-336, (2005).