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Dynamical systems and stability in fractional solid mechanics

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Abstract: The use of fractional calculus gets more and more importance in material modeling. It can take into account non-localities in both space and time domains. Quite simply, for example, by changing (local) conventional derivative to one of the non-local fractional derivatives, the effect of the time history (or of the values in a neighborhood) can 'automatically' be taken into consideration. The reason is that such fractional derivative is a combination of a derivation and an integral operator. In stability analysis such models may cause problems starting from stability definitions to the complicated forms of characteristic equations. The selection of the fractional derivative (Caputo, Riemann-Liouville, Caputo-Fabrizio, Atangana-Baleanu etc.) has an important effect on that. The paper studies how the type of fractional derivatives effects the problems of stability investigation. From engineering point of view, the study aims constitutive modeling via instability phenomena. By observing the stability/instability behavior of some material we can be informed about the form of fractional derivative in its mathematical model.

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