World Academy of Science, Engineering and Technology
International Journal of Mechanical and Industrial Engineering
Vol:18, No:12, 2024

Nonlinear Dynamics of a Rock Drill Based on a Buffer System-Rock Model

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Abstract : In response to the instability issues occurring during the drilling operation of rock drilling machines, this paper studies the principle of hydraulic rock drilling machines, considering the impact of the buffer system on the shock characteristics, and establishes a four-degree-of-freedom physical model. The viscous and non-viscous modes are analyzed, and the periodic trajectories of the non-smooth dynamical system's mathematical model are segmented. Using the pseudo-arclength continuation method and Floquet theory, the buffer pressure is treated as a control parameter to study the dynamic characteristics of multi-attractor coexistence in the buffer system. Multistable attractors cause the rock drill to switch between multiple steady states, and external disturbances allow the system to jump from one steady state to another. Simulation shows that in order for the rock drill to operate on a period-1 trajectory, d1 should be selected between 0.2 and 0.225. The correctness of the drilling dynamics model is validated through laser testing.

Keywords : fluid transmission and control, hydraulic rock drill, buffer model, continuation, multistability
Conference Title : ICAMMME 2024 : International Conference on Applied Mechanics, Mechanical and Materials Engineering
Conference Location : Istanbul, Türkiye
Conference Dates : December 23-24, 2024