Analytical analysis of the bifurcation behavior of creep groan

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Abstract

Creep groan is one of the low frequency vibration phenomena, which can be observed in automotive disk brakes while low driving speeds [1]. In order to study fundamental mechanisms of creep groan, a model with bristle friction law was set up, with which the bifurcation behavior of creep groan was studied numerically and a corresponding map reflecting regions with qualitatively different behavior of creep groan was obtained and compared with experimental results [2]. In the work described in this paper, an analytical method based on an approach presented in [3] is proposed as an alternative way to map the bifurcation behavior. The nonlinear creep groan model shows that the system may have three different parameter regions with different types of asymptotically stable solutions, i.e. a trivial solution, a stick-lip limit cycle, and coexistence of stick-slip limit cycle and trivial solution. The stick-slip limit cycle can be interpreted as creep groan while the trivial solution is the desired non-vibrating solution. As the region with double stable solutions divides the regions of single stable solutions it depends on initial conditions and previous behavior whether or not creep groan occurs which can be used for avoiding this awkward vibration phenomenon. The analytical results are compared with time integration solutions and experimental results.

Keywords

creep groan, bifurcation, trivial solution, stick-slip limit cycle

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