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STOCHASTIC MODELING OF THE IMPACT ENERGY OF A PENDULUM HITTING A BARRIER VARYING THE PIVOT-WALL DISTANCE

Rubens Sampaio[a], Marta Rosales[b,c] and Fernando Buezas[c,d]

[a]*Departament of Mechanical Engineering. Pontifícia Universidade Católica do Rio de Janeiro. Rua Marquês de São Vicente 225, Rio de Janeiro RJ-22453-90, Brazil, rsampaio@puc-rio.br, http://www.unmeseta.edu.ar/gia*

[b]*Departamento de Ingeniería, Universidad Nacional del Sur, Av. Alem 1253, 8000 Bahía Blanca, Argentina, mrosales@criba.edu.ar*

[c]*CONICET, Argentina.*

[d]*Departamento de Física, Universidad Nacional del Sur, Av. Alem 1253, 8000 Bahía Blanca, Argentina, fbuezas@gmail.com*

Abstract. This paper analyzes the energy exchange when a rod, acting as a pendulum, impacts upon a body (wall, barrier) as a function of the distance between pivot point of the pendulum and the wall. In each case, the distance is varied from zero to the rod length. The initial conditions are the same for all the cases. The objective of such setup is to hit the barrier successively in the most effective way, as for example is the case in drilling for oil when one uses successive percussions to enhance the rate of penetration of the drill bit, or in compaction problems (e.g. dynamic compaction of soil using percussive devices). The problem is posed in the context of plane Finite Elasticity. The rod is modeled as a rectangular 2D body and the wall is a semi-infinity domain with a given stiffness without mass. The function of interest is the impact energy due to the shock in terms of the distance between the pivot point and the wall. One searches for the optimal distance, that is, the one that produces the highest energy delivered by the pendulum to the wall. The problem is computationally very demanding. For each fixed distance a highly nonlinear, finite-elasticity problem has to be simulated which takes days of CPU to run. Furthermore, in order to obtain a reasonable approximation of the energy function, the computation was done for 100 points. The shape of the resulting function is completely unexpected. Finally, in order to evaluate the robustness of the model, a stochastic model is made in which the stiffness of the barrier body is assumed stochastic. When the impact problem is modeled as the interaction of two discrete systems, as a mathematical pendulum hitting a wall, the results obtained are puzzling. So, a more precise model, in the Finite Elasticity context, is being studied in order to better understand the physics of this impact problem.