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Study of the impact force of falling chains using force sensor

The impact force exerted by falling chains was investigated using a plastic cup attached on the top of a force sensor. Two different linear mass densities of the chains with mass of 0.1452 and 0.1956 kg/m was examined by releasing one meter of their lengths from rest with the lower end just touching at the bottom of the plastic cup. The force sensor was connected with LabQuest and the sample rate was set to be 1000 Hz. The motion of the chain was recorded using a video camera with 60 FPS. The total time of the falling chain was analyzed using tracker video analysis and compared with the total time of the impact forces hitting on the cup. The results show that the total time of falling chain, starting from the increase of impact force exerted by the lower end until the upper end touching on the bottom of the cup, evaluated by the data from LabQuest and tracker video analysis program is agreement well with the time of freely falling condition but the experimental results are slightly lower than theoretical prediction due to a small pile of the chain occurring. Furthermore, the instantaneous force or apparent weight increases quadratically in time and equal 3 times the weight of the part of the chain and the maximum force exerted on the cup is also 3 times the total weight of the chain. These results can be explained by two forces exerted by the chain. For the first force, a part of the chain lied at rest, resulting the weight due to gravity whereas the second one comes from the change of momentum per unit time due to the collision between the remaining part of the falling chain and the cup.

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