ANALYSIS OF RELATIONSHIP BETWEEN HAMMER HEAD VELOCITY AND RADIUS OF CURVATURE

Norihisa Fujii and Michiyoshi Ae

Institute of Health and Sport Sciences, University of Tsukuba, Tsukuba, Japan

KEY WORDS: two dimensional simulation, leading angle of handle, normal force

INTRODUCTION: In many research papers, the relationship between the hammer head velocity and the radius of curvature of hammer was discussed. The purpose of this study was to re-examine the relationship between the hammer head velocity and change in the radius of curvature with the 2-D computer simulation.

METHOD: Two dimensional hammer was modelled as a 2-D double pendulum with Matlab, Simlink, and SimMechanics (MathWorks inc.) as shown in Figure 1. The simulation conditions were as follows: the initial velocity was 20 m/s with the 1000 N handle force and the 2.92 m radius of curvature. The handle force was linearly increased to 1500 N from 1.0 s to 1.5 s. The leading angle was set to 5° during 2.0 - 2.5 s and -5° during 3.0 - 3.5 s.

RESULTS: Figure 2 shows the hammer head velocity and the radius of curvature. The head velocity increased while the leading angle was 5°, and decreased while -5° regardless of the handle force. The larger normal force, which was perpendicular to the head velocity, had the effect on the decrease in the radius of curvature, but had no direct effect on the increase in the head velocity.

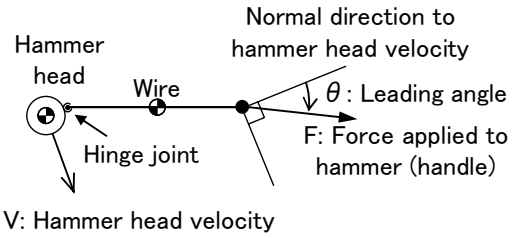

Figure 1: Two dimensional model of hammer

DISCUSSION: The decrease and increase in the radius of curvature had no relationship with the change in the head velocity while the leading angle was 0°. The mechanical power applied to the head was calculated as the scalar product of the velocity vector and force vector. The zero leading angle means that the force vector, which was parallel to the acceleration vector of the head, was perpendicular to the head velocity vector, so that the zero mechanical power could not increase the hammer head velocity. The positive leading angle generates the positive power to increase the head velocity, and negative leading angle to decrease the head velocity. It may be inferred that the thrower decreased the radius of curvature to release the handle within the throwing circle with 2.13 m diameter.

CONCLUSION: Regardless of the magnitude of pulling force, the decrease and increase in the radius of curvature had no relationship with the change in the hammer head velocity while the pulling force was oriented toward the instantaneous center of rotation. The throwing technique should be reevaluated with the results.

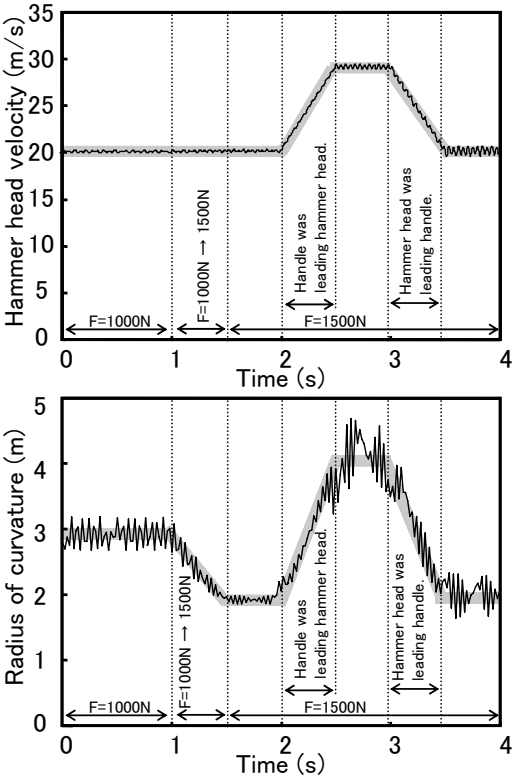

Figure 2 Simulated velocity and radius of curvature