PROPOSING A TWO-DIMENSIONAL DYNAMIC FORCE REDUCTION VALUE OF SYNTHETIC TURF

Harutoshi YUKAWA[1], Haruki KOSHI[2] and Shozo KAWAMURA[3]
[1] Aichi University, 1-1 Machihata, Toyohashi, Aichi, 441-8522, Japan
[2] Senoh Corp., 250 Matsuhidai, Matsudo, Chiba 270-2214, Japan
[3] Toyohashi University of Technology, 1-1 Hibarigaoka, Tempaku, Toyohashi, Aichi,441-8580, JAPAN

The purpose of this study is to propose a two-dimensional dynamic force reduction (DFR) value for evaluating the shock attenuation properties of synthetic turf with spike stud. In general, shock attenuation properties are evaluated with force reduction (FR) value calculated from the maximum force onto the concrete and turf only in the vertical direction [1]. Meanwhile, actual sports activities have a wide range of impact angles and intensities. For this reason, a two-dimensional impact test device with an angle sensor was developed to measure not only the vertical impact force but also that of horizontal direction [2]. In this device, 60 kg drop mass with coil spring is dropped onto the sensor unit. The sensor unit has parallelogram linkage which divides the vertical impact force onto the upper part of the parallelogram linkage into the horizontal and vertical impact forces simultaneously. Additionally, the linkage angle, horizontal and vertical displacement during impact is measured by angle sensor and laser displacement sensors. To avoid the uncertainty of data caused by unevenness of the surface top and to perform the impact test which is very similar to the real situation in football or rugby football, 6 spike studs were installed under the sensor unit. Three studs are installed along the horizontal impact direction with a distance between the studs are 65 mm each. And the two rows of studs 35 mm apart have been installed at the bottom of the sensor unit.

In this study, a long pile synthetic turf specimen which has 63 mm length monofilament yarns and a 39 mm thick top layer consisting of sand and rubber chips on a 5 mm thick bottom sand layer was used. The ratio of sand/rubber chips of this sample is as normal use and certified by FIFA, i.e. FR value is 57% with AA test. The impact tests were performed with initial impact angle, 10, 15, 20 degrees from the vertical line, and intensities were varied by drop height at 55, 80, 105 mm. The force reduction values are usually calculated with absorbed maximum force and maximum force on the concrete in the same condition. But this may cause unexpected FR values because the horizontal maximum impact force increased with increasing impact angle during the impact period. Fig.1a shows the impact

Corresponding author email: email.address@email.address

angles during each impact period. In this figure, the maximum impact angle of trials with an initial angle of 20 degrees (green lines) reached almost 30 degrees during impact. Therefore, the DFR value should be proposed to calculate FR values that correspond to the impact angle in each moment. To do this, the maximum impact force in each direction must be estimated at each impact angle. Therefore, a two-dimensional impact test against the rigid floor with various angles is performed to obtain the regression equation to estimate the unreduced values for calculating DFR. Fig.1b shows the maximum DFR values of each trial at an initial angle of 20 degrees with each drop height. In this figure, the horizontal DFR values increased with increasing drop height despite the vertical DFR values being almost the same values.

In conclusion, two-dimensional DFR (dynamic force reduction) values are calculated from time series force and angle data. Even in the certified specimen, the results from two-dimensional shock attenuation are quite different from the current regulation with the vertical property. Further investigation should be performed to understand the two-dimensional shock attenuation properties.

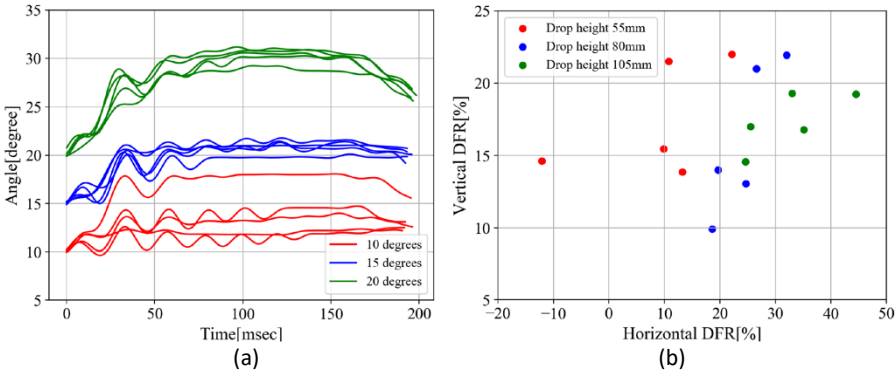

Fig. 1: (a) The time-series impact angles during each impact period of initial angle 20 degrees, (b) horizontal and vertical maximum DFR values in each trial.

1. FIFA, FIFA Quality Programme for Football Turf - Handbook of Test Methods-, (2015).
2. Harutoshi Yukawa, Noriyuki Gyokusen and Shozo Kawamura (2018) Two-Dimensional Mathematical Model of Sports Surfaces with Angled Multi-Intensity Impact Tests. The 12th Conference of the International Sports Engineering Association.

Corresponding author email: email.address@email.address