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NEW PARAMETERS FOR EVALUATION OF SPORTS SURFACES

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INTRODUCTION

This study focused on the data collected during tests which examined the deflection characteristics of sports surfaces performed using procedures similar to those in the DIN standard 18032, 1991. The data sets were examined for new evaluation criteria that were not currently included in the evaluation of sports surfaces according to the DIN standard. Some earlier studies have been performed which have stated that there is no correlation between subject tests and materials tests (Nigg, 1990). Most studies examined only the peak forces, or peak deflections produced during the testing. The additional parameters presented below will allow new avenues to be explored in finding a relationship between subject and material tests. They also offer new parameters on which uniformity of sport surfaces may be evaluated.

REVIEW AND THEORY

Several materials tests exist for the evaluation of indoor and outdoor natural and synthetic athletic sports surfaces (ASTM F355-95, F489-96, F1551-94, D2632-96, (ASTM, 1997) and DIN 18032, 1991). These tests allow the properties of sports surfaces to be economically evaluated both in laboratory and field settings. Materials tests are very repeatable, but their validity or relevance to what an athlete actually feels or produces has long been questioned (Nigg, 1990; Nigg and Yeadon, 1987), as the correlation between the two test methods is very low. While this is true, the variability associated with subject results is hard to explain. Fredrick and Hagy (1986) reported that body mass only accounts for 32% of the variability in peak forces. Only 52% of the variability could be accounted for when body mass, speed, leg length, stature, and dorsiflexion angle where examined. With such high variability within subject tests, low correlations between subject results and material test results would be expected.

The purpose of this study was to obtain as many parameters as possible from tests performed using the DIN standard 18032. The new parameters are presented in the hopes that they will be a guide to future research which strives to find a relation between subject and material test methods. While new parameters could be valuable in finding a relation, the new parameters must produce statistically different values on different floor systems.

PROCEDURES

An artificial athlete Stuttgart (DIN 18032, 1991) was developed at the Agricultural and Biological Engineering Department of Purdue University. The only deviation from the in the DIN standard 18032, was that a drop mass of 20 kg, was substituted for the specified 50 kg, to make transportation in the field easier.

The drop height was varied on each floor so that a peak force of approximately 1500 N was generated during impact. The point used to determine an appropriate drop height was determined outside of the field of testing used to map the floor systems.

Six different floors were tested, systems included floating and anchored systems. Nine points were tested on each floor. These nine points are shown in the figure below. Points were chosen so that they included high and low traffic areas for basketball and volleyball. Figure 1 contains a schematic showing the approximate locations of the 9 points tested.

RESULTS AND DISCUSSION

During the impacts the following data was recorded; impact force, deflections at impact, deflections 500 mm from impact parallel and perpendicular to the maple. Figure 2 contains a sample of the data collected during the tests for standard vertical deflection and area indentation. The DIN standard examines the Standard Vertical Deflection (StV), and area indentation (AI) (See Equations 1 and 2.)

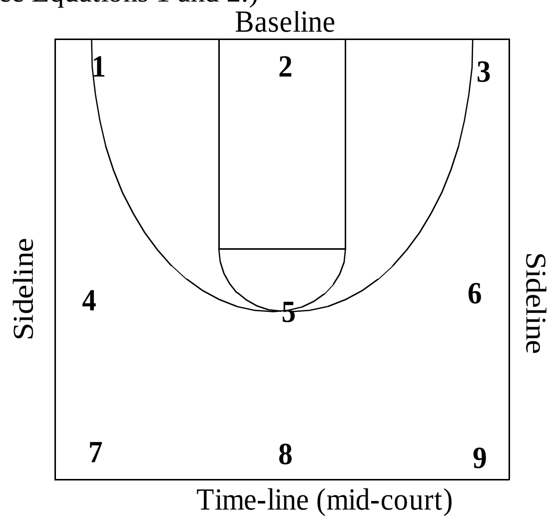

Figure 1: Schematic of points tested during field evaluation of floors.

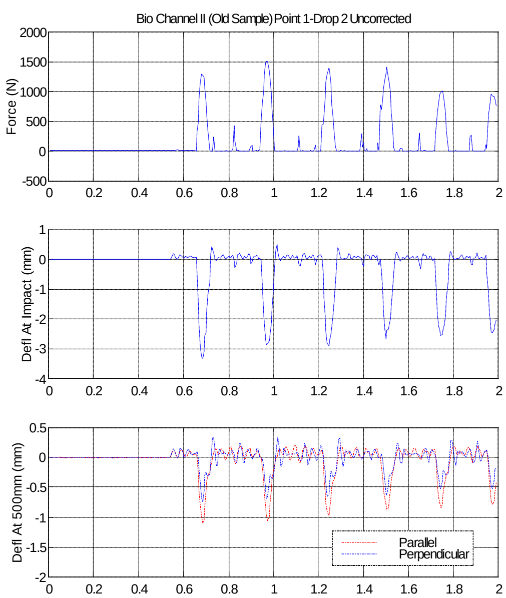

Figure 2:Sample of data collected during impacts.

$$StV = \frac{\text{Max Deflection}}{\text{Max Force}} 1500 = \frac{1}{K} 1500 \qquad [1]$$

$$AI = \frac{\text{Peak Deflection 500 mm}}{\text{Peak Deflection @ Impact}} 100 \qquad [2]$$

In addition to these two DIN parameters, the following new data can be obtained during the same test; time to peak force, duration of impact, time to peak deflection, energy returned to the drop mass, time between peak deflection at impact and 500 mm away, and stiffness. Stiffness is directly related to the DIN parameter StV, but it was thought that it would be more easily explained to end users of athletic floor systems. Energy returned to the drop mass is given by:

$$\text{E. R.} = \frac{\left[\sum_{Loading} F * D - \sum_{Unloading} F * D\right]}{\sum_{Loading} F * D} \qquad [3]$$

Where, F = Impact Force

D = Floor System Deflection

Using a Duncan test for statistical equality, it was found that the following characteristics produced statistically different groupings when evaluated for the six floors tested; time to peak force, time to peak deflection, duration of impact, energy returned, and stiffness.

CONCLUSIONS

These parameters, not previously examined, may provide a basis which would allow a correlation between materials and subject tests to be established. Further work is required to evaluate the usefulness of these characteristics in the biomechanical evaluation of floor systems. While it was not examined, similar new parameters could also be obtained during the shock absorption test outlined in the DIN standard 18032 with only minor modifications to the testing hardware.

REFERENCES

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