Relationships Between Selected parameters For The Evaluation of Hardwood Sports Surfaces

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Introduction

Six floors were tested to determine the ball reflection, shock absorption, standard vertical deflection (StVv). And area indentation, according to the DIN standard 18032 part II (1991) for the evaluation of sports surfaces. The relationships between these four parameters were examined. It was hoped that strong relationships could be found between several of the parameters, and that these relationships could ultimately be used to simplify the current testing procedures. The significant relationships which exist between floor performance and safety characteristics, will help to guide future floor designs. These relationships will also provide a starting point for re-evaluating the test procedures currently used on hardwood sports surfaces.

Review and Theory

Little, if any, scientific or engineering principles have been applied to developing new basketball floors to improve safety, or performance. Such scientific principles were applied to the design of indoor running tracks by McMahon and Green (1978). They developed a simple model of human muscles and reflexes, and used this model to tune the stiffness of the track to improve the times of the athletes performing on the track. Design of basketball floors is more complicated. While improving the safety is of course a major concern, the floor must maintain certain ball rebound characteristics. The characteristics of hardwood athletic floors are commonly obtained using the DIN standard 18032 (1991). If scientific and engineering principles are to be used to improve current floor design, then the relationships between the most important characteristics must be examined. This study does not fully endorse any current materials test, as materials tests have been found to be poorly correlated to subject tests (Nigg and Yeadon, 1987). The significant relationships determined in this study, can also be used as a starting point to improve current materials testing methods, and hopefully improve the correlation between the subject and materials tests along the way.

Procedures

Data collection was performed using current data acquisition technologies. Data was stored on an NEC DX-4 75 MHz notebook computer. The NEC computer was connected to an Hewlett Packard 75000 B-sized VXI mainframe. The HP 75000 contained the multimeter and multiplexer used to perform the analog to digital conversion of signals from respective transducers. Control of the HP-VEE, (Hewlett Packard's Visual Engineering Environment software). Ball Rebound height was measured using a Massa 411/40 ultrasonic distance sensor. Impact forces were recorded using model 53 Sensotec load-cells. The deflections of the playing surface were measured using Sensotec model MLV7A Linear-Velocity-Displacement-Transducers (LVDTs).

The characteristics analyzed in this study include: ball reflection, shock absorption, standard vertical deflection, and area indentation. Tests and analysis were performed according to the DIN standard 18032 part II (1991), only slight modifications to the procedures were made. These modification were only to ease the analysis of the data, and the accu-

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racy of the measurement. Ball reflection is determined by using the rebound height obtained on concrete, and on the playing surface in the following equation:

$$\text{Ball Reflection} = \frac{Height_{(floor)}}{Height_{(concrete)}} \, x\, 100$$

Impact test equipment was developed for the shock absorption test according to the DIN standard 18032 part II, (1991). Shock absorption was obtained by using the maximum force generated on the floor system to the maximum force generated on a rigid surface (DIN standard 18032 part II, 1991). In both tests where the impact force is recorded, the impact is generated by dropping a known mass onto a spring of known stiffness.

$$\text{Shock Abs.} = \left(1 - \frac{F_{\max,\, floor}}{F_{\max,\, rigid\ concrete}}\right) x\, 100$$

Six floors of various resiliency were tested over a three month period, and the aforementioned parameters were obtained. Testing was performed at 9 points spaced over one half of the playing surface. Testing for each parameter was carried out according to the DIN standard. Linear regression was then used to determine if the average characteristics of each floor parameter were related to each other.

Results

Two significant relationships were found to exist between the average characteristics of the playing surface. The equations illustrating the relationships and respective correlation coefficients are presented in Table 1 (B.R. is ball reflection, STV is standard vertical deflection, and S.A. is shock Absorption. Ball reflection and standard vertical deflection were found to be significantly related to the shock absorption characteristic. Ball reflection and shock absorption were found to be negatively related. In other words increasing the shock absorption properties of a floor system, will tend to reduce the rebound height obtained on the same system which is not desirable. Standard vertical deflection was found to be positively related to shock absorption. Increasing shock absorption of a playing surface will increase the StVv, and this is desirable according to the current DIN standard.

Table 1: Significantly Related DIN Standard 18032 Parameters

Parameters (X-Y)	**Regression Equation**	**R**
SA-BR	SA = -4.1 BR + 448	0.84
SA-STV	SA = 18.0 STV + 24	0.81

Discussion

This study has found that significant relationships do exist between current DIN standards. It shows that changing one of the floors characteristics will have an effect on other characteristics. These studies suggest that one floor which produces high shock absorption, ball reflection, and standard vertical deflection, will be difficult to develop. While this is true, new floor designs can be developed which keep the requirements in mind. Floors intended for the weekend athlete or children can be designed with high shock absorbing characteristics, but at the expense of lower ball rebound heights, and larger area indentations. Floors with high caliber athletes as the main end-user, can be designed with optimal ball rebound characteristics but shock absorbing properties will have to be sacrificed. The fact that significant relationships exist between several of the current DIN standard characteristics can be used to develop a new simpler test procedure. If new tests are to be developed, they should be based on fundamental biomechanical knowledge, in hopes that they will be more closely related to subject tests.

References

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