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DEVELOPMENT OF A BIOMECHANICALLY VALIDATED TURF TESTING RIG

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INTRODUCTION

Many sports are increasing the use of artificial turf, especially with the development of 3rd generation turf. FIFA has decreed that any artificial surface that meets its performance criteria can be used for competitive soccer games [1]. However, it has been suggested that the applied loads in current testing procedures do not reflect the loading actions that occur during actual sporting movements [2,3]. The aim of this study was to develop an artificial turf testing rig that applied biomechanically validated vertical, shear and torque loads to the surface. Results of initial testing on 3rd generation artificial turf and natural grass soccer pitches are presented.

METHODS

The Strathclyde turf testing rig (Fig. 1) was designed to be portable, so that surfaces can be tested *in situ.* The rig was based on a drop-mass/spring/mass system. The basic operation of the test rig involved the use of two weighted pendulum systems to apply loads in a vertical, horizontal and rotational direction. Electromagnets were triggered to release the pendulums at the same time. Loads were applied to a test foot with a pimpled rubber or studded tread design to allow testing on different types of surfaces. A force transducer/ accelerometer complex, positioned just above the test foot provided a measurement of the applied impact loads and accelerations.

Figure 1: Strathclyde turf testing rig

A battery of tests was developed to characterize sports turfs. This included an assessment of linear traction (with a static and dynamic vertical load), rotational traction, vertical impact and a combined vertical, shear and torque impact test. Five trials of each test were conducted on five areas of each pitch.

RESULTS

Table 1 indicates that the traction coefficient and the peak torque measured on the 3G surface were generally lower than the natural grass pitch. The peak vertical forces were similar. The variability in the results reflects the different areas of the pitch tested. The combined impact test (Fig. 2) produced similar loading profiles on both surfaces, although a greater resistance to torque was measured on the natural, dry grass surface.

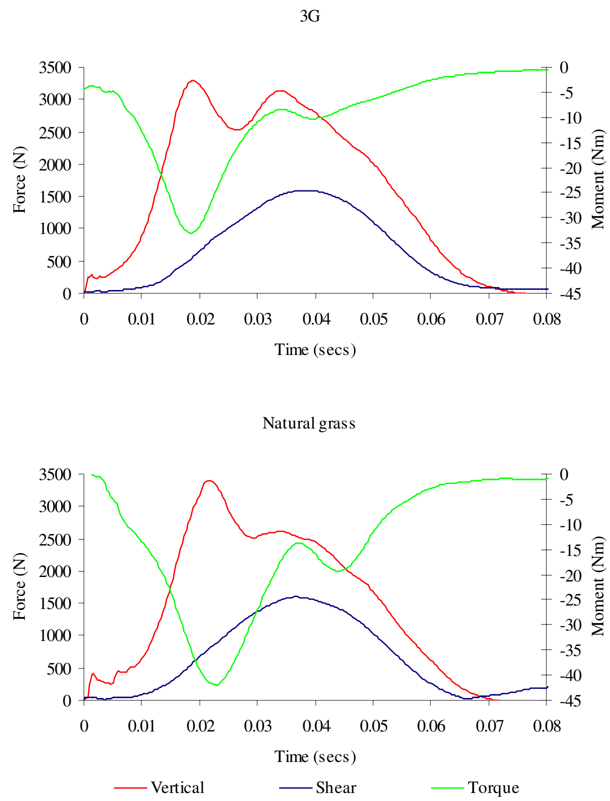

Figure 2: Vertical, shear and torque loads applied during combined impact test on 3G and natural grass surfaces

DISCUSSION

The appropriate loading profiles applied by the test rig were derived from a biomechanical assessment of the player/surface interaction [4].

The operation of the rig is flexible so that different loads can be applied unidirectional or multidirectional in one impact action. This study demonstrated the potential of a new, portable rig to mechanically characterize artificial and natural turfs used in competitive sport.

REFERENCES

1. FIFA. *Laws of the Game*. www.fifa.com, 2004.
2. Nigg, B.M. *Med Sci Sports Exerc*, **22**, 1.131-139, 1990.
3. Dixon, S.J. *Int.J.Sports Med.* **20**, 209-218,1999
4. Blackburn, S.J. *et al. Proceedings of ISB XIX,* Dunedin, New Zealand, 2003.

Surface	Linear traction coeff. (μ)	Peak torque (Nm)	Peak vertical force (N)	Vertical loading rate (kN/s)
3G (*Fieldturf*)	1.9 – 2.9	13.5 – 16.5	3352 - 3405	323.7 – 369.6
Natural Grass	2.1 – 3.2	11-3 – 23.8	3326 - 3478	237.9 – 417.9

Table 1: Ranges of critical surface characteristics derived from test battery.