TRACTION OF SPORTS FOOTWEAR

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INTRODUCTION

Whether an athlete suffered trauma to the lower limbs during acceleration and/or changes in direction would depend on the capacity of the body structures to withstand the ground reaction force (GRF) imposed on them assuming that the GRF in the lateral directions or traction could be fully developed. The traction mobilized would depend primarily on the nature, composition and geometry of the interacting surfaces and the normal load imposed and can only be found empirically [1]. Many traction devices have been used to measure traction [2] but none in concert with the measurement of the vertical movement of the footwear, described as sinkage (or heaving), on either court or field surfaces. Details of the computer controlled traction device that was used to translate and rotate the footwear over the surface has been reported elsewhere [3,4]. Furthermore, none of the research reviewed fitted the data with exponential functions [5] that mimicked the traction-displacement data for the particular footwear-surface combination tested. These functions yielded a number of traction parameters, namely residual and peak or asymptotic traction and stiffness (Figure 1) that were coupled with sinkage and used for statistical analysis. Finally, the influence of different type, length and configuration of cleats on the traction parameters was examined using modeled footwear (steel plates) bearing only on air-dry sand to minimize surface and outsole material variability and to reflect the behavior of cleats on football boots.

METHODS

Four football boots with different cleat types and patterns were translated & rotated on three moist natural surfaces (Netlon™ & river loam turf and Sports 40™ sand) at up to nine different moisture levels. In translation the long axis of the boots were orientated at four angles to the slide direction. In rotation the boots were turned up to 90¡ in both a clockwise & anti-clockwise direction. The modeled footwear with different cleat configurations was tested in translation & rotation on the air-dry Sports 40™ sand.

All data were fitted with exponential functions by non-linear regression using the Levenberg-Marquardt method to obtain coefficients of determination and the footwear-surface limiting traction and stiffness parameters for 1656 traction tests (Figure 1). Multivariate analysis of variance techniques (MANOVA) were used to identify if any significance difference ($p \leq 0.05$) existed between these traction parameters & sinkage as the dependent variables, and a number of independent variables, for example, boot or cleat type, moisture content, surface prior condition, and the length, number & spacing of cleats. Scheffe and Tamahane *post hoc* tests to determine where the differences occurred followed the MANOVA tests.

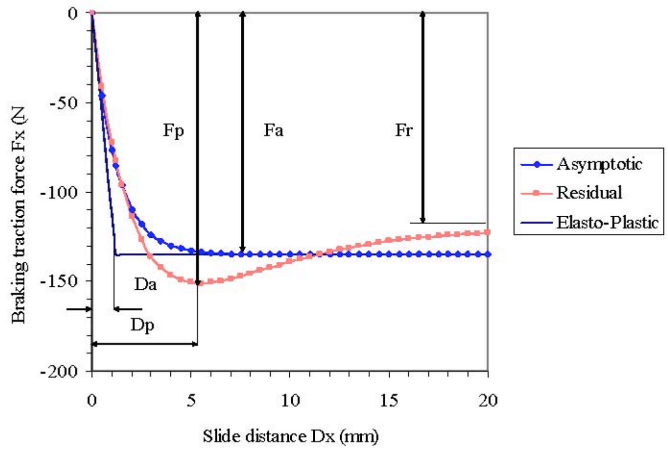

Figure 1: The translation traction-displacement residual and asymptotic exponential models for footwear/surface combination

RESULTS AND DISCUSSION

Linear relationships existed between normal force and translation and rotation traction for the steel plates sliding on air-dry sand, and the length, number, location and type of cleat, and plate shape influenced the traction parameters. In translation, the longer the key the greater the traction and sinkage, and increasing key numbers increased traction, stiffness and sinkage. Cleats placed within the middle third region developed the greatest traction force and sinkage. Paradoxically in rotation, cleats placed closer to the axis of rotation developed a larger traction torque and smaller sinkage than more distant cleats, and four cleats rather than eight or ten developed greater traction torque and had smaller sinkage.

CONCLUSIONS

Apart from developing new paradigms and procedures for the production, acquisition and reduction of traction data, these results could be utilized to compare the relative merits of various footwear-surface combinations and the most favorable geometric configuration of cleats to ameliorate foot fixation.

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