VARIABILITY IN ROTATIONAL TRACTION TESTING OF ARTIFICIAL TURF SURFACES

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Rotational traction is a key test to ensure optimum safety and performance of artificial turf surfaces. The FIFA rotational traction test device (RTT) involves manually rotating a studded test plate and measuring the peak torque (Fig. 1a). Variability in the results comes from two main sources, the operator, and the surface [2]; however, the contribution of each source to the total variation remains unknown. Investigating where and why variability arises helps promote a greater understanding of traction and traction testing. The aim of this study was to quantify the contributions of the two sources of variability in peak torque by comparing results obtained from the FIFA RTT with those from an automated RTT.

Testing was completed using the manual FIFA RTT and an automated RTT (ARTT) manufactured at Loughborough University (Fig 1b), operating under the same normal load and base plate design. Three different third generation artificial turf samples were constructed and tested using both devices (Table 1). Using the manual device, an experienced operator followed the FIFA Quality Programme test procedure [1]. The automated device recreated the FIFA test conditions [1], with rotational velocity set at 72 °/s and angular acceleration set at 800 °/s^2. Each device was used to measure peak torque at 15 locations on each surface sample. The samples were rolled 50 times using a studded roller prior to testing and raked every five trials.

The mean, standard deviation (SD) and coefficient of variation (CoV) in peak torque were calculated for each surface and device. The SD for the manual device includes contributions from both operator and surface, whereas the SD value for the automated device includes the variability of the surface only. Therefore, the individual contributions of turf and operator to the variability in the manual RTT results can be estimated by combining data for the two devices. CoV is used as the measure of variability due to the different peak torques measured on different surfaces:

$$\%CoV_{TURF} = 100 \times \frac{CoV_{ARTT}}{CoV_{RTT}} \qquad \%CoV_{OPERATOR} = 100 \times \frac{CoV_{RTT} - CoV_{ARTT}}{CoV_{RTT}} \qquad (1)$$

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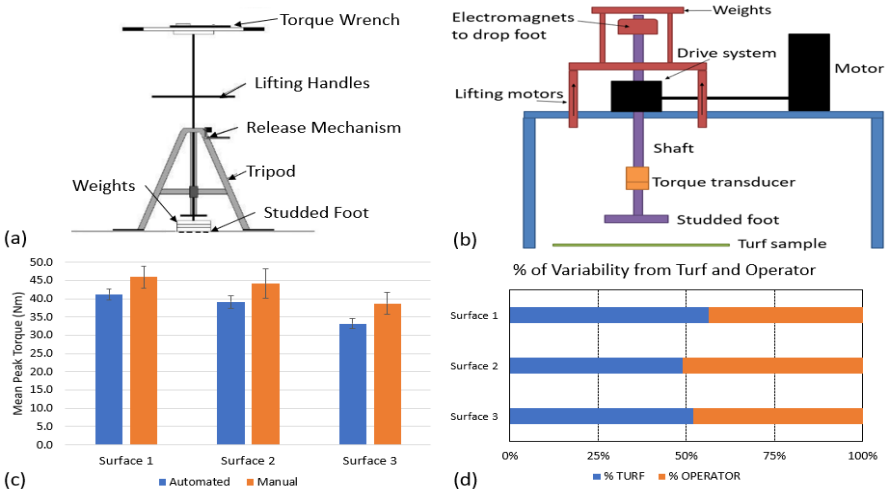

Fig 1(a) Manual (FIFA) RTT [1], (b) Automated RTT (c) Mean (±SD) peak torque for each surface using each device, (d) % CoV from the turf and operator for the manual RTTs.

Table 1. Surface constructions and the mean, SD, and CoV in peak torque for each device.

	Surface Properties						Manual Device			Automated Device		
Surface	Carpet & Fibre Length (mm)	Shockpad	Infill Depth (mm)	SBR Size (mm)	SBR (kg/m^2)	Sand (kg/m^2)	Mean Peak Torque (Nm)	SD	CoV	Mean Peak Torque (Nm)	SD	CoV
1	Monofilament 50mm	No	36.3	0.8 - 2.5	12	17	46.0	2.9	6.4	41.2	1.5	3.6
2	Monofilament 60mm	No	42.2	0.8 - 2.5	15	15	44.1	4.0	9.1	39.2	1.7	4.4
3	Monofilament 60mm	No	42.3	2.0 - 6.0	15	15	38.7	3.0	7.7	33.2	1.3	4.0

The automated RTT reduced the CoV in peak torque from 7.7% ± 1.4% to 4.0% ± 0.4% on each surface compared to the manual device. These results suggest that the contributions to variability in peak torque for the manual RTT are approximately evenly split between the operator and turf (48% operator versus 52% turf, based on eq. (1)). Thus, there is significant scope to improve the consistency of peak torque measurement using an automated device that eliminates the operator variability, for example, in rotational speed. Further testing is being conducted with an expanded range of surfaces and operators.

The variability in peak torque measurement for artificial turf when using the FIFA manual RTT emanates approximately equally between variability from manual operation and from the surface. To improve the validity of results the study requires further investigation, incorporating a greater range of artificial turf surfaces and additional manual operators during testing.

1. FIFA. Quality Concept: Handbook of Test Methods. www.fifa.com, 2015.
2. Twomey DM, Connell M, Petrass LA (2014) Rotational Traction Testing: How can we improve the improve the current test device? *Procedia Engineering*, 72, pp.919-924.

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