The Biomechanics of Running on Artificial Turf

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OPTIMAL TRACK COMPLIANCE

McMahon & Greene (1978)
- Model human/surface interaction
- Optimize athletic track for speed
- Speed ~ contact time & step length

New Harvard Athletic Track
- 2-3 % faster
- 50% less injuries
Injury & Comfort

- Soccer injuries 33% of all injuries in NL (Vriend et al. 2005)
- Small differences in injury rates between artificial and natural turf (Ekstrand et al. 2006)
- Low player satisfaction
- Material vs. Human testing
  - different loading patterns
  - poor correlations (Nigg & Yeadon, 1987)
AIM

Evaluate the loading pattern that players experience on artificial soccer pitches
Experiments

- 20 soccer players (18-35 yr)

- 3 running conditions:
  - Preferred jogging
  - 17.5 km/h
  - Full sprint

- Kinetics & kinematics
Data Analysis

- Peak vertical and horizontal ground reaction forces

- Statistics
  - Repeated measures ANOVA (P<0.05)
Experiment 1

**Pitch A**: infill 20 mm TPE granules (2.0-2.2 mm)

**Pitch B**: infill 20 mm SBR (0.8-2.5 mm)

**Pitch C**: Pitch A + 10 mm rubber shock pad

<table>
<thead>
<tr>
<th>Pitch</th>
<th>Force Reduction (%)</th>
<th>Deformation (mm)</th>
<th>Energy Restitution (%)</th>
<th>Static Stiffness (kN/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>51.9</td>
<td>4.2</td>
<td>45.8</td>
<td>452</td>
</tr>
<tr>
<td>B</td>
<td>47.9</td>
<td>4.9</td>
<td>48.0</td>
<td>510</td>
</tr>
<tr>
<td>C</td>
<td>63.9</td>
<td>7.0</td>
<td>43.0</td>
<td></td>
</tr>
</tbody>
</table>
Vertical Forces

Vertical Force (N)

- Pitch A
- Pitch B
- Pitch C

Fpassive (BW)

JOG RUN SPRINT

Factive (BW)

0 50 100 150 200 250 300
time ms

0 500 1000 1500 2000 2500
Vertical Force (N)

Pitch A
Pitch B
Pitch C

JOG RUN SPRINT

Fpassive (BW)

JOG RUN SPRINT

Factive (BW)

JOG RUN SPRINT
1. No effect surface
2. Significant effect of speed
Discussion

• Surface properties significantly influence ground reaction forces of human runners.

• Surface optimization to minimize muscle skeletal loading within the FIFA requirements.

• Combined studies on biomechanics and injury epidemiology.
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