Construction and Maintenance of Grass Equestrian Surfaces: Racecourses, Equestrianism, and Polo

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A Bit of Basic Biomechanics in Equestrian Sports

Equestrian sports are practiced on sand, turf, or synthetic surfaces. In all cases, various authors have demonstrated that the surfaces on which equestrian sports are practiced affect both the **incidence of injuries** (Hernlund, 2016; Egenvall et al., 2013; Murray et al., 2010a; Parkin et al., 2004a; Hernandez et al., 2001) and **the performance of equine athletes** (Peterson et al., 2010).

The turf surfaces used for equestrian sports follow the general principles of all sports fields. The **choice of species**, **establishment**, and **maintenance practices** are similar to those used on any other sports field and are subject to the **environmental conditions** of the specific geographic location.

The difference lies in the fact that the "players" are **pairs composed of horse and rider**, and therefore, the **load generated during movement** is several magnitudes greater.

This generated load consists of **forces and acceleration or deceleration**, which occur repeatedly and are explained through the **biomechanical analysis of the stride** (see Figure 1).

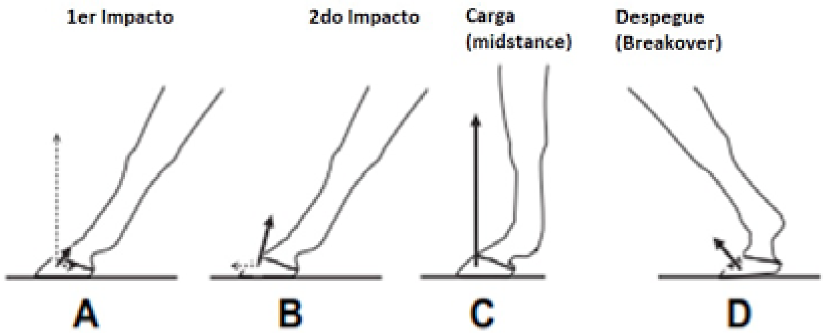

Figure 1. Phases of the stride (Thomason and Peterson, 2008).
Solid arrows indicate forces and their direction; dotted arrows indicate acceleration and its direction. The length of the arrow represents magnitude.

The simplified stride phases shown in Figure 1 summarize the alternation of impact and release and their influence on take-off. This information helps us understand the forces acting on **soft tissue and bone**, which contribute to the occurrence of **injuries and accidents**. The acceleration and force produced in each phase are naturally absorbed by the **anatomy of the limbs**, with stress falling on joints and the **suspensory apparatus**.
Because sports movements are repetitive, it is essential that surfaces respond adequately by **absorbing and supporting** these forces.

The mechanical properties of the surface are key to the turf's ability to minimize risk, and these are determined by design and maintenance.

During each phase of movement, these properties come into play in different ways.

What defines a high-quality turf for equestrian surfaces?

Quality is defined by the **consistency of mechanical properties** that help minimize injuries and **promote optimal performance** for horse-rider pairs. Therefore, both **construction design** and **turf maintenance** are closely linked to the ability to deliver these mechanical properties.

In 2014, the **International Equestrian Federation (FEI)**, after years of interdisciplinary research across various universities, defined the **functional properties** that an equestrian surface (sand or grass) must meet. These are:

- **Firmness**
- **Grip**
- **Cushioning**
- **Energy return**
- **Uniformity**
- **Consistency**

All of these must be guaranteed by the **cushioning layer**, commonly referred to in equestrian fields as **topsoil**.
These properties are now **objectively measured by the FEI** using the **Orono Biomechanical Surface Tester (OBST)** at each major international event.

In other sports, like **horse racing**, the measurements aim for the same objective.
In the United States, **The Jockey Club** supported the **Horseracing Integrity and Safety Act (HISA)**. Among other requirements, the law mandates **ongoing monitoring of the mechanical and physical properties** of surfaces, following protocols within the **Maintenance Quality System (MQS)** developed by the **Racing Surfaces Testing Laboratory (RSTL)**.

In the UK, the **British Horseracing Authority (BHA)** has established its own protocols. In Latin America, each institution sets its own standards; however, some racetracks are working towards implementing quality maintenance systems similar to those in the U.S.

Management of Equestrian Sports Fields

Based on the above, it's essential to **integrate safety** with the already well-established knowledge of **playability and agronomy** (see Figure 2). These can be classified as follows:

a) Aspects related to playability or performance of horse-rider pairs or teams (quality of play):
Until recently, much effort was dedicated to certifying playability, such as **ball roll**, defined as the distance traveled over a set time *t* when released from a specific height *H*, and the direction of roll (measured in degrees relative to a reference point).
To ensure **safe and agile performance**, specific **mowing heights** are also maintained depending on the sport:

- Polo: 1–2 cm
- Show jumping: 3–5 cm
- Turf racing: 5–8 cm
  Surface flatness is also a variable that must be recorded.

b) Aspects related to safety concerning the interaction between the **equine hoof or foot and the surface**:
These aspects directly affect the **health and safety of the horse**...

Biomechanics of sport and the epidemiology of sports surfaces have shown that the **load borne by equestrian surfaces is much greater** than that of human team sports. Among the most important aspects are:

- The **impact absorption capacity** of the surface
- The **deformation** of the surface
- The **energy return** to the hoof
- **Sliding (slip)** and
- **Traction resistance** (both longitudinal and rotational)

All of these **mechanical properties** are essential to minimizing recurring injuries and ensuring surface quality.
The turf must allow all these movements without generating excessive grip or altering the balance of forces exerted between the ground and the horse's hoof, which could lead to injuries.

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c) Agronomic aspects:
Agronomic factors help **moderate** the issues described above. Proper **construction methods**, **material selection**, and **appropriate maintenance** are essential to meeting the standards currently required by regulatory bodies.

Even if a surface is **not being prepared for international-level equestrian competition**, it is important to understand the requirements to align management practices with **quality standards** that promote **healthy conditions for horse-rider pairs**.
The growing awareness around **animal welfare and safety** demands that management practices **commit to these values**, as they increasingly influence society. This is reason enough to support and promote **programs that guarantee the highest quality** and to make such efforts **visible**.

The **FEI** and the **interdisciplinary scientific community** studying equestrian surfaces agree that the **five functional properties** are measured using the **OBST**, while **consistency** is assessed by measuring the coherence of these properties over time.

Some Specific Considerations

Turf establishment
Establishing turf for equestrian surfaces follows the same general principles as for any sports turf, but with certain **key differences** to consider.

First, it is important to define what type of surface the turf will be established on. The **topsoil**, or **cushioning layer**, can be classified into three types:

1. **Native soil**
2. **Selected sand profiles**
3. **Selected sand profiles with fiber additives**

Currently, many racetracks are built on **sand profiles with added fibers**, which improve **traction, cohesion**, and other performance variables.

If the **species to be used are established by seed**, this is especially relevant in **regions with cold to cool-temperate climates**, where **C3 or mesothermal species** are typically used.
In **transition zones** and **subtropical to tropical regions**, where **C4 or megathermic species** are used, **propagation may be either by seed or vegetative means**, depending on the species. For example, **hybrid bermudagrass** does not reproduce by seed, so vegetative propagation is required.

The **preferred seeding time for cool-season (C3) species** is **early autumn (March in the Southern Hemisphere)**.
In **transition zones**, where both types of species may coexist, the **survival of the perennial species**—which serves as the base—should always be prioritized. Thus, the **optimal sowing date** should align with the **best establishment time for the warm-season (C4) species**.

It is in **vegetative propagation** where equestrian turf differs from other sports.
The **preferred method is stolonizing or row-planting**, which allows direct placement of plant material on the chosen base layer designed to withstand equestrian use.
Stolonizing should be done from **early spring (September in the Southern Hemisphere)**, after at least two frosts. Full coverage can typically be achieved in **about 60 days**.
If **sod or turf rolls** (complete coverage) are used, **implantation can be delayed until mid-summer (February in the Southern Hemisphere)**. However, it's crucial that the **soil quality of the turf roll matches the composition of the prepared soil profile**. This ensures successful establishment and rooting before cooler weather arrives.

Using turf rolls that are mounted on material with a **different particle size distribution** or with **excessive fine clay content** can create a **layering effect** between the root zone and the new soil profile. This results in the formation of **discrete layers from the beginning**, causing **lateral water movement** rather than vertical infiltration, and **inhibits early root development**.
Such inconsistencies below the surface can negatively affect turf **coverage**, **recovery ability**, and **stability** of the cushion layer formed by the turf.

Fertilization Programs During Establishment

Fertilization should be guided by **soil tests**, the **season**, **rainfall patterns**, the **chosen soil profile, species used**, and the **traffic experienced by the surface**.

Aeration and Topdressing

Aeration is one of the most important turf management practices for equestrian surfaces.
The **20 cm cushioning layer** is not only vital for maintaining healthy turf but also plays a role in how equine limbs absorb impact, especially **below the 15 cm depth**.

Therefore, aeration is **essential for maintaining the quality** of the cushioning layer by **breaking up compacted layers** and keeping **functional properties active**.
Aeration should alternate between **solid tines and hollow tines**, depending on the level of compaction.

Topdressing should be carried out using **silica sand** with known mineralogy and particle size, matching the type of sand used in construction and considering any **fiber additions** in fiber-based systems.

Irrigation

As in any sports field, **irrigation is necessary for grass growth and development**, but it is also crucial for maintaining the **functional properties of the cushioning layer**.
Moisture in the pores affects how the surface interacts with the horse's hoof.

Knowing the area's **rainfall patterns**, ideally with **on-site weather stations**, helps define the exact **millimeters of supplemental irrigation** needed.
Dry soils not only hinder turf growth but are also **harder**.
Drought periods complicate things further—not just due to water shortage, which can be addressed through irrigation—but because **high evapotranspiration** can cause **thickening of the leaf epidermis** and **tissue hardening**, both of which can **alter surface traction**.

Divots or Traffic Injuries

Divots or turf injuries caused by traffic are **significantly larger** than those seen in other sports.
They are always related to **traffic levels**, **topsoil composition**, and **moisture at the time of use**.

In **horse racing**, the **number of races per day (and per weekend)** and the **number of horses per race** determine the severity of the injuries.
Injuries in the inner rail are especially common.
Today, **movable PVC rail systems** exist to shift the inner lane inward, allowing recovery time for damaged sections. This, of course, **reduces the effective track width**.

In **polo matches**, injuries depend on the **number of matches played**, with a **more random distribution**, though the **goal areas** are typically the most affected. Here, damage tends to be from **material dragging** (caused by the hoof).
In **show jumping arenas**, damage depends on the **number of horse-rider pairs per test**, **tests per day**, **number of jumps**, and the **duration of the event (2–3 days)**.

Typical injuries occur at the **takeoff** and **landing points**, although **pens and turns** also experience characteristic wear.

Such injuries **require immediate repair**. If left unattended, they can **worsen with continued horse traffic**, forming **dangerous potholes** and **creating uneven conditions** for subsequent participants.

To prevent this, maintenance must be carried out **between races**, **between matches**, or, in show jumping, **every 10 riders during the same test**.

These repairs involve **adding the appropriate sand or mix**, leveling with a **manual rake**, and sometimes **rolling**.
Rolling is essential for safety, and afterward, **aeration work** should be resumed as needed.

Quality Parameter Measurements

A large number of American racetracks have adhered to compliance with the **HISA law**, which entails frequent certifications by a recognized laboratory, in addition to the measurements performed by the racetrack's own maintenance team. These certifications are based on topsoil composition, particle size distribution analysis, measurements with the **OBST** (Figure 5), volumetric water content measurements (**VWC %**), and expert visits.

Figure 5

At some racetracks, the control measurements carried out by the maintenance teams rely on an English-made penetrometer known as the **Going Stick©** (Figure 6), developed by the company **Turftrax**.

Figure 6

Figure 7

This device records, through various sensors, **penetration resistance**, **longitudinal traction resistance**, and **VWC (%)** measurements. All these readings are uploaded to a digital system called **MQS**, which is accessible to all participating racetracks. In this system, each racetrack not only logs its successive measurements before races, but also records **daily maintenance practices**, **equipment inventory**, and **staff information**. Furthermore, **weather stations** are connected to enable **climate condition tracking**, thereby creating an **open system for surface quality monitoring**.

The **Going Stick©** has been adopted by many racetracks around the world as a daily control tool, just like the use of **TDR** for **VWC (%)** measurement. Another widely used tool internationally is the **Longchamps penetrometer** (Figure 7), a **simple and portable device** that has enabled researchers to establish the **relationship between surface condition and race times** (Thomas et al., 1996; Murphy et al., 1996), and more recently, has helped link surface conditions to **fatal injury risk** (Maeda et al., 2012; Maeda et al., 2016). This has generated great confidence in the data provided by this simple penetrometer.

In **jumping arenas**, certification measurements for international events are carried out by the **FEI**. These measurements are conducted using the **OBST** and **TDR (VWC %)**. Portable tools that could assist with **routine surface maintenance control** are still under development.

Rotational traction is also recorded by the **OBST**. Additionally, a **rotational traction meter** in accordance with **ASTM F2333** standard has been used, although the **reliability of rotational traction measurements** on equestrian surfaces as they relate to horses remains a subject of debate.

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