Footing and Shoeing

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Importance of Footing

There can be no doubt as to the importance of good footing. Different types of footing have advantages and disadvantages with regard to performance and soundness. The ideal footing for a specific arena or track varies with the type of sport being performed, the local climate, and location (indoors or outdoors). It is easier to choose a suitable surface for a single sport in an indoor arena than it is to cater to the needs of several different sports in an outdoor arena, where the unpredictable effects of the weather play a role. The capital investment and the practicalities of maintaining the surface on a day-to-day basis are also important and, as a result, the end product is often a compromise between the ideal and the practical/affordable. When choosing a work surface for performance horses, two important properties are the impact resistance and the shear resistance of the surface material.

Impact Resistance

Impact resistance describes the ability of the footing to absorb impact energy. Surfaces with a high impact resistance (e.g. concrete) absorb little energy during the impact phase, and are associated with high impact shock. Surfaces with a lower impact resistance, such as wood or rubber chips, absorb energy as they deform during impact, so there is less concussion on the limbs.

Shear Resistance

Shear resistance describes the ease with which the footing is displaced by a shearing force, such as occurs when the hoof slides into the surface at impact or pushes off at the end of the stance phase. For sport horses, the ideal surface has an intermediate shear resistance that allows the toe to penetrate the surface as the hoof breaks over (figure 1). This reduces tension in the inferior check ligament and pressure in the navicular region. Hard surfaces (concrete, blacktop) have a high shear resistance, which does not allow the toe to penetrate (figure 1). On the other hand, surfaces with a very low shear resistance, such as deep, dry sand, allow the toe to penetrate deeply but tend to give way as the horse pushes off (figure 1). Consequently, the horse must push harder and expend more energy, leading to early onset of fatigue.

Footing Materials

It is useful to compare the physical characteristics of different footing materials in relation to their effect on the horse's stride. Hard surfaces, such as concrete, asphalt, and hard soil, have high impact resistance and high shear resistance. When a horse works on these surfaces, the limbs are subjected to considerable concussion at impact and, since the toe is unable to penetrate the surface during breakover, there are high loads in the navicular region in terminal stance.

These effects are used to advantage by veterinarians, who will evaluate the horse's locomotion on a hard surface during a lameness examination.

Sand is the most commonly used footing due to its availability and cost effectiveness. However, sand varies widely in its physical properties and some types of sand make much better footing than others. The relevant considerations are size, shape and hardness. Particle size affects dustiness, compaction, and water retention. Ideally, arena sand should be predominantly medium coarse (0.25-0.5 mm) and coarse grains (0.5-1.0 mm). Sand with a lot of fine particles is dusty when dry and compacts when wet. Angular sand grains are preferable to round grains because they are more stable and require less maintenance. Round grains tend to roll more easily giving a less stable footing. Hard sand is more durable, whereas soft sand tends to break down and turn to dust after relatively little use. Hardness can be tested by placing a few grains of the sand on a hard surface and compressing them with a teaspoon. If the grains crush easily, the sand is soft. Sand has lower impact resistance than hard soil, combined with a low shear resistance, which allows the toe to penetrate deeply. Deep, dry sand tends to give way during push off resulting in loss of traction. This type of surface is very tiring for the horse to work on. When sand has a high moisture content, the particles adhere to each other due to surface tension, so wet sand is more stable and less tiring to work on than dry sand (think of running on the beach).

Amendments, such as rubber, wood chips or fibers, may be added to sand to improve its properties as a riding surface. Fibers or shredded materials stabilise the sand particles - this mimics the effect of the rooting system of turf, which has a stabilising effect on the surrounding soil particles. Rubber and wood products give more resilience and reduce packing. Wood products also help to hold moisture in the surface.

Bonding agents, such as water and polymers are added to arena surfaces primarily to reduce dust. Hygroscopic agents, such as magnesium chloride, take up and retain water, so their addition to a surface reduces the frequency of watering.

Turf can be a very good footing for horses, but it is difficult to maintain in perfect condition. Under ideal soil moisture conditions, turf has an intermediate shear resistance, which is ideal because it allows the toe to penetrate the surface as the hoof rotates, but it does not give way as the horse pushes off because the roots stabilize the soil. The impact resistance of turf depends on several factors, notably the moisture content of the soil. As the soil dries out the impact resistance increases. Although a high moisture content lowers the impact resistance, too much moisture allows slipping. Well-maintained turf provides excellent footing, but it is difficult to keep turf in this condition. Deterioration in surface characteristics under conditions of drought or excess rainfall are a problem for turf arenas and tracks.

Importance of Farriery

Trimming and shoeing have a marked effect on performance and soundness of the equine athlete. Ideally, trimming optimises the interaction between the hoof and ground during locomotion. The objectives of trimming include aligning the dorsal hoof wall with the pastern axis, and ensuring that the bearing surface of the hoof lies beneath the weight-bearing axis of the limb. This is accomplished by adjusting the absolute and relative lengths of the heels, the quarters and the toe.

When the hoof is balanced in this manner, it usually contacts the ground flat-footed or slightly heel first (figure 2).

Radiographic studies have shown that the proximal phalanx is always a little more upright (vertical) than the middle and distal phalanges, with the three phalanges being most closely aligned when the hoof is trimmed with the front of the hoof wall parallel to the pastern axis. This configuration is favoured because it optimises the forces on the supporting soft tissue structures. However, it should not be assumed from this statement that the pastern angulation is constant and unchanging. In fact, there is an inverse correlation between the hoof and pastern angles; an increase in hoof angle (more upright) is associated with a reduction in the pastern angle (more sloping) within an individual horse and vice versa.

Mediolateral balance evaluates the hoof as seen from in front or behind. The objectives are to have the hoof land flat when viewed from in front (figure 3), to optimize weight-bearing on the medial and lateral sides of the hoof, facilitate breakover at the natural position (toe, medial side, lateral side), and straighten the flight arc of the limb when viewed from in front or behind. If breakover is encouraged to occur in the natural position, it will often produce a straighter flight arc. If necessary, wedges may be added to the medial or lateral side in an attempt to achieve a flat-footed contact of the hoof with the ground when viewed from in front or behind.

At gaits faster than a walk it is difficult to evaluate hoof motion with the unaided eye. In this situation slow motion replay of a video recording is invaluable. Video recordings made from in front and/or behind the horse as it walks and trots on a straight line are replayed at normal speed, in slow motion, and in single frame advance mode to evaluate the flight pattern of the limb and hoof contact with the ground. During corrective shoeing, video recordings are used to evaluate the effects of each stage in the process. When recording videos to evaluate hoof balance, the camera should be as close to the ground as possible.

Hoof Angle

Older texts generally recommend hoof angles of 45-50^{o} in the fore hooves and 50-55^{o} in the hind hooves, but recent studies indicate that, in most horses, a steeper hoof angle is needed to align the hoof-pastern axis. For example, one study of Thoroughbred-type horses showed that the hoof-pastern axis was aligned at a mean hoof angle of 54^{o} (range 48-55^{o}) in the fore limbs, and 55^{o} (range 49-60^{o}) in the hind limbs.

Some trainers favour a more acute hoof angle because they believe that the long toe-low heel conformation enhances performance by increasing stride length. When the trot stride was compared for a normal hoof angle versus an acute hoof angle, there were no significant changes in stride length or the flight arc of the hoof. However, the acute hoof angle was associated with an increased frequency of toe-first contacts (figure 2), which was thought to be a consequence of the proprioceptive reflexes ensuring a fairly flat placement of P3 regardless of the shape of the hoof capsule. Toe-first contacts are associated with a tendency to trip or stumble. The duration of breakover was prolonged with the acute hoof angulation and the orientation of the limb segments at the start of breakover suggested an increased tension in the check ligament and navicular ligaments. However, the effects of an acute hoof angle on breakover may be mitigated on a softer surface that allows penetration of the toe during terminal stance. The study failed to reveal any enhancement of performance due to an acute hoof angle, and this type of conformation or trimming may predispose to navicular disease due to the greater tension in the supporting ligaments, which then exert pressure on the navicular bone. Other pathological conditions that have been associated with an acute hoof angle include osteoarthritis of the fetlock, pastern, and coffin joints, chip fractures of the fetlock and carpal joints, sesamoid bone fractures, and sesamoiditis.

Horses trimmed with normal angles in their fore hooves and acute angles in their hind hooves show a prolongation of breakover and delayed lift off in the hind hooves. However, the normal limb coordination pattern and placement sequence are restored by the time of ground contact. Therefore, delaying breakover in the hind hooves is unlikely to have a beneficial effect in horses that interfere. A more effective solution to interference problems may be to hasten breakover in the fore hooves by bringing back the breakover.

Effect of Shoes

The weight of a shoe affects hoof mechanics, and the material properties of the shoe affect impact shock. Studies using accelerometers attached to the hoof wall have shown that impact shock is higher when horses are shod with steel shoes than when they are barefoot. Certain shoes or combinations of shoes and pads might reduce concussion.

Weighted shoes are used to give horses more action. Doubling the weight of the shoe does not affect stride length, stride duration, or breakover. It does, however, increase the maximal heights of the hoof, fetlock, and carpus during the swing phase, and the peak height of the flight arc tends to occur later in the swing phase with heavy shoes. Also, the hoof and pastern segments have a more acute angle at ground contact, probably as a result of increased momentum of the lower limb during the swing phase. Heavier shoes require greater energy expenditure in the elbow muscles to overcome inertia at the start of the swing phase and to overcome the limb's momentum at the end of the swing phase.

Weighted shoes, bell boots, or pastern wraps can be used to strengthen the elbow flexors, which may have some merit for improving the expressiveness of motion. Use of such devices is more effective and safer during slow speed (collected) work. During high speed exercise (extended gaits) there is a risk that the horse may lose control of hoof placement as a consequence of not compensating for the increased momentum as the limb swings forward.

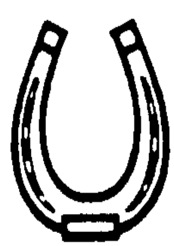

Figure Headings

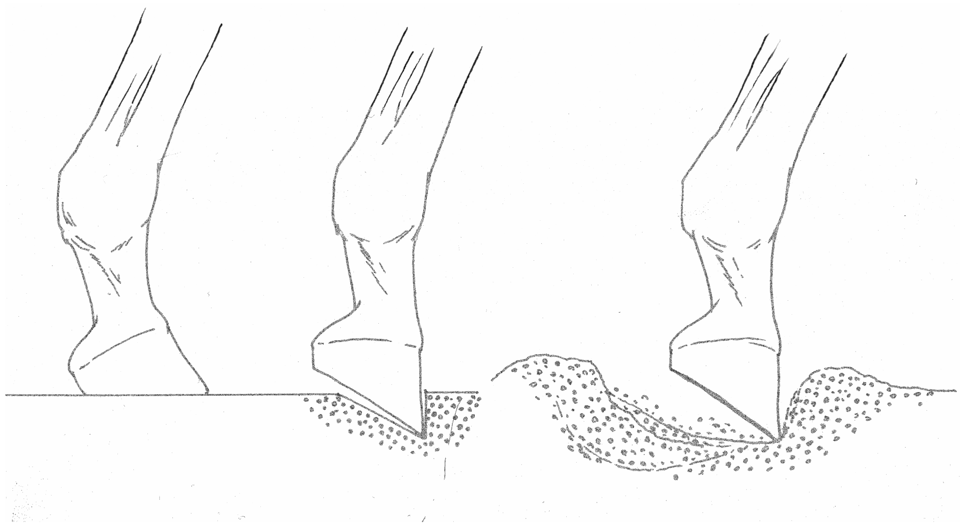

Figure 1: Effect of shear resistance of the surface. Surfaces with high shear resistance do not allow the toe to penetrate (left). Surfaces with intermediate shear resistance allow the toe to penetrate but offer sufficient resistance during push off (center). Surfaces with low shear resistance give way as the hoof pushes off (right).

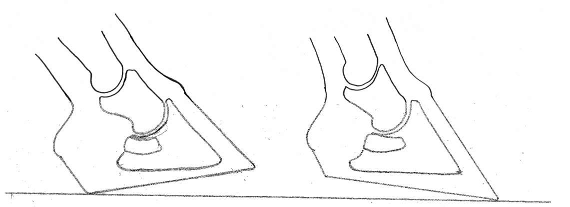

Figure 2: View from the side shows heel first contact (left) and toe first contact (right).

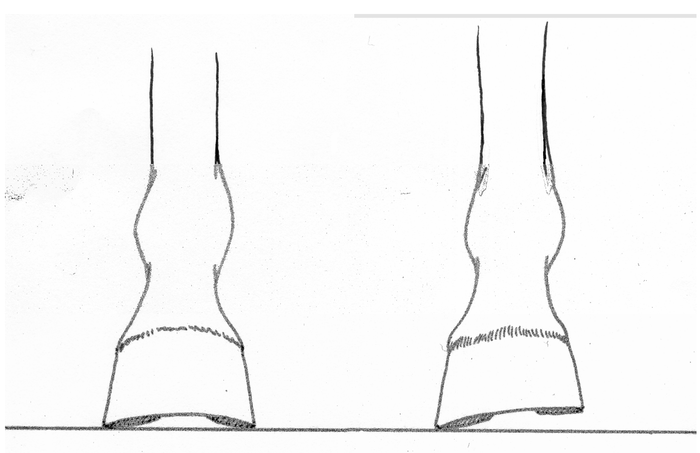

Figure 3: View from in front shows flat contact (left) and contact with one side of the hoof (right).