

Surface Safety, Step By Step

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What type of impact do various terrains actually have on the health of a horse's hooves and legs? French researchers are using a highly sensitive 3-D dynamometric shoe and other instruments to give unprecedented insight into the biomechanical effects of diverse surfaces on not only a horse's limbs, but his entire musculoskeletal system.

Researchers attached the shoe to the front right hoof of surrey-driven trotting horses and digitized the results, comparing them with other tools that measure the detailed physical properties of the horse's movement. They analyzed the force of impact, sliding distances, foot vibrations, and the acceleration and braking phases of each individual step.

Named the "Sequisol Project," a play on French words for "safe," "equestrian," and "terrain," the combination of studies is headed by Nathalie Crevier-Denoix, DVM, PhD, and Henry Chateau, DVM, PhD, both researchers in the Equine Biomechanics and Musculoskeletal Pathology department of the Ecole Vétérinaire de Maisons Alfort, and the INRA, the French national agricultural research institution.

"It's common knowledge that there is a link between the quality of the terrain and the risk of accident in race and sport horses, particularly fractures and tendonitis," Crevier-Denoix said. "The nature of the terrain has a direct effect on the length of the gait and locomotive symmetry. But until now we have not had an accurate method to measure or analyze these effects on the musculoskeletal system of the horse. Our goal through the Sequisol project is to be able to define mechanical criteria to optimize the security and comfort of racing and sport horses."

The group's recent research focused on the comparison of the biomechanical effects on the horse when trotting at 35 km/hour (22 mph) on a hard-packed dirt road, a soil-based training track, and a track made of cinders.

The dynamometric shoe measured the force applied to the hoof in three spatial directions and the trajectory of the center of pressure. A second instrument, a three-directional accelerometer attached to the hoof wall, measured the shock of the impact and the vibrations generated by this shock. Two additional tools--an ultrasound system attached to the leg to measure force on the tendon, and units attached to the horse's back to measure mobility and symmetry--were also used and will soon be incorporated into the results to complete the work, according to Chateau.

The researchers filmed all movements to visually associate the biomechanical effects with the different phases of the step ([watch a video](#)). The researchers attached the numerous pieces of equipment to record data, including laptop computers, to the surrey and connected the instruments via cables passing along the harness.

Force of impact and high frequency vibrations generated by shock were significantly greater on the hard dirt surface. The study also revealed significant differences among various maintenance levels of the same terrain. For example, the results showed that a track that has been tilled and moistened has nearly three times as much shock absorbency than the same track not maintained for several days.

The Sequisol project is expected to also yield a better understanding of the mechanics of the step in each gait, Chateau said, as the general measures of force distribution and the analyses of different phases of a step are readily visible and comparable with real-time data.

Researchers have carried out previous Sequisol research on a variety of terrain types, including sand, grass, and an all-weather waxed fiber track.

Preliminary results of the Sequisol project, which has been in progress since 2006, were most recently presented at the 2009 Equine Research Day held in Paris in February. The presentation was followed by a round-table discussion on the project by major French horse racing industry leaders and a track design specialist.

"In the horse racing profession, it's well known that the quality of the track is a determining factor for the industry," said Christian de la Garde, agricultural engineer and project manager for France Galop, the governing body for flat and

steeplechase horse racing in France. "Horse people say, 'No hoof, no horse,' but we say, 'No track, no horse.' We must absolutely find a solution to optimize our tracks."

As the Sequisol project is still a work in progress, Chateau said it is too soon at this point to make definite classification statuses for various terrains.

A preliminary report on the technology, "Design and validation of a dynamometric horseshoe for the measurement of three-dimensional ground reaction force on a moving horse," was published in the February 2009 *Journal of Biomechanics*.

Readers are cautioned to seek the advice of a qualified veterinarian before proceeding with any diagnosis, treatment, or therapy.



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PHOTOS COURTESY ECOLE VÉTÉRINAIRE DE MAISONS ALFORT, FRANCE

Researchers with the Sequisol Project are using new instruments to analyze horses' gaits on a variety of surfaces.



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This information could lead to the development of safer surfaces.



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