■ SCIENCE UPDATE

KENTUCKY EQUINE RESEARCH
Equine Review

SU 46

Review of "Effect of track maintenance on mechanical properties of a dirt racetrack: A preliminary study"

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Why was this study done?

Musculoskeletal injuries are common in horses that are training and racing, and properties of the racetrack surface are often mentioned as factors that may cause or influence these injuries. These properties are not consistent in all areas of the track, and also tend to change significantly after routine track maintenance.

Efforts to investigate hardness and other qualities have been going on for at least 25 years. Studies have looked at the relationship of injuries and vertical impact on dirt surfaces; horizontal shear strength of the track; and parameters of force applied by lighter and heavier loads dropped onto the surface.

The racehorse's hoof produces not only a downward load, but also horizontal forces as the hoof hits the track, sustains the horse's weight, and pushes off in the next stride. To measure the energy involved in each footfall and relate it to the chance of injury, it is necessary to quantify both the vertical and horizontal forces involved and the reactions of the track material to those forces. To more completely understand the forces generated by a galloping horse, it is also necessary to measure the changes in track surface characteristics caused by training and racing use and by routine maintenance. The purpose of this study was to compare the properties of the surface before and after periodic maintenance. This maintenance consisted of light harrowing after training periods and between races, as well as periodic deeper tilling and compacting. These procedures create a partially compacted intermediate layer of soil between the lightly harrowed top cushion and the firmer base.

How was the research conducted?

A specialized apparatus was designed to reproduce the hoof velocity in vertical and horizontal directions. The hoof-shaped device had sensors that recorded loads, decelerations on impact with the ground, and effect of the deeper track layers on hoof impact. The authors describe the implement and testing method as follows: "The testing system developed for this study uses two axes of motion to reproduce the loads and speeds of the forelimb of a horse at a gallop. The slide with a synthetic hoof attached moves 1.6 meters down a pair of steel rails and impacts with an energy of 540 joules. A second set of linear rails is attached to the slide and held in position by a gas spring. When the hoof impacts the ground the second axis with the spring is compressed. Due to a difference in angle between the two sets of rails, the hoof impacts the surface and must slide forward…the system replicates the impact and deceleration of the hoof."

A one-mile dirt track was used for testing, which was done after training in the morning and after racing in the afternoon. Measurements were made for three sample impacts in each furlong, or 24 impacts for the full mile. Soil samples were taken at each quarter-mile post from under one of the impact points of the test machine. Moisture and organic content analyses were performed on each sample, and x-ray diffraction of the clay component was also done. The study began after a week of racing during which the only track maintenance had been use of a harrow with a rolling center section and six rows of evenly spaced tines that penetrated 6.7 centimeters below the plane of the wheels. This harrow was used during morning training breaks and between afternoon races. A harrow that cut 6.0 centimeters below the surface of a compacted top layer was also used once a day, performing substantially deeper cuts into the track. This treatment resulted in a surface with a layered compaction profile with a partially compacted layer underneath the looser upper layer. On the second day, a pavement ripper was used to make a 15-centimeter cut below the compacted track surface. A rototiller was then used, after which the loose material was rolled and the track surface was then harrowed as on other days.

What results were found?

The average moisture content of the tested samples was 9%. The track material contained 2.4% organic material, 13.3% silt and clay, 65.1% medium and fine sand, and 20.3% coarse sand. The cohesive component of the surface was rather low. The percentage of clay effective in binding the material, and therefore contributing to shear strength, measured at only 5% of the material passing the finest sieve.

There was a range of results for the 24 data points. Before heavy maintenance, the mean peak load was 13,800 newtons. After maintenance, the mean peak load was 9,110 newtons. This was a reduction by 34% after loosening and recompacting the track. It was noted that the standard deviation increased considerably from the first day to the second day. The authors pointed out that, at two standard deviations, the peak load on the hoof could vary by almost 60% at different locations in a single circuit around the track. As a result, the horse would be absorbing much more impact energy on some strides and much less on others.

What does this research tell us about racetrack surface characteristics and the potential for injuries in racehorses?

The track surface tested in this study had a composition typical of tracks in the western United States. For tracks of this type, the study shows that maintenance type and frequency are significant factors in characteristics of the track surface. Even if regulations were in place to standardize maintenance on all tracks, the changes in surface characteristics caused by maintenance might be difficult to eliminate.

In this study, racetrack surface shear strength characteristics did not appear to be significantly impacted by maintenance. However, this was not true for peak load. The reduction in peak load on the hoof as a result of maintenance was significant, and the differences found in different areas of the track were on the same order as those found between completely different tracks. The authors commented that horses can adapt to the conditions on different surfaces, but the effort required to adapt to different conditions on practically every stride might be a factor that could lead to an increased risk of injury.

The full text of this article can be found in Equine Veterinary Journal (2008) 40(1).