

Report:

In-Situ Testing of the Keeneland Training Track

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INTRODUCTION:

A novel approach to testing of racetrack surfaces has been developed over the past three years. This track testing technique provides in-situ measurement of the track performance characteristics based on biomechanics of horse racing. Two characteristics have been identified which represent the primary performance criteria for a track; the vertical track modulus (or stiffness) and the horizontal shear strength (or cuppiness). These two measures were identified based on research into the biomechanics of the hoof-track interface. These studies have been performed over a number of years at Colorado State University, University of California Davis and Washington State University as well as other institutions. The new measurements techniques that have been developed do not define how the track should be designed; instead the measurements allow different surface materials and conditions to be compared to determine the effects on the biomechanics of the track.

The test that has been developed makes it possible to simultaneously measure the vertical and horizontal characteristics of the track at individual points. The test also loads the track at the speed and with the loads seen in actual racing. Most previous testing has used lower loads and loading rates which do not give the true track performance. The test is a point measurement so sampling consistency and protocol must be consistent in order to understand the variability of the tracks. Initial studies have used a basic test protocol so that data can be compared between tracks. This is the basis for a discussion of track surfaces that can be independent of particle size, moisture content, fibers or any other details of the track composition. Instead comparisons of tracks can be made based on the response that the horse would experience from the track when racing or training.

During the course of the testing several important issues have become evident. First, the role of compaction in track maintenance appears to be an important factor in providing a safe and consistent racing surface. Initial studies suggest that soil compaction may occur at depths up to one foot or more. A compounding effect from continuing hoof strikes on the track may continue for as many as 10 or more hoof strikes. Repeated hoof strikes in a location may increase the peak loads on the leg by 300% or more. An increase in peak loads of 100% can occur even when normal track maintenance techniques are employed and all hoof prints are removed. This progression of this compaction process is probably the most

significant factor in the high degree of spatial variation observed in track surfaces. Improved control of the inputs such as water and organic matter content can significantly reduce the effects of compaction in racetracks. Other approaches, such as synthetic track material may make it possible to reduce the effects of compaction. Second, control of inputs such as water and organic matter appear to be a significant contributing factor to spatial variation in track properties. Improved control of inputs, particularly water, may reduce variability.

A renewed interest in synthetic tracks raises questions about how best to control and care for these new tracks. Assuming that the synthetic tracks address issues associated with control of moisture and organic material in traditional track design, synthetic tracks remain unproven in long term usage. It is well known that using a polymeric material at a temperature near the melting temperature (or above the glass transition temperature) results in creep sensitivity in the material. At the same time to get the dynamic performance required from a racetrack it may be desirable to use some polymeric components at temperature closer to their melting temperature. If a creep sensitive material was used in a synthetic track it would not provide any better resistance to compaction than the current organic track materials and careful control of static loading such as trucks would be critical.

For synthetic tracks, oxidation of the polymer and changes in the cross-link density present additional challenges for the types of low cost polymers that are currently used in synthetic tracks. It is not unusual for a polymer to increase its modulus by 100% or more due to changes in cross link density. A worst case scenario then for a synthetic track is that a sunny area of a track could be double the stiffness of a shaded area due to differences in the modulus of the polymer caused by ultraviolet absorption. Accelerated degradation due to the presence of atmospheric pollutants, especially ozone, may also be an issue. In general, the stability of the polymers becomes a critical issue when placed in an environment such as a racetrack. Like traditional tracks however, none of these details of the polymer matter to the horse owner, trainer or the betting public, as long as a safe and consistent track can be provided day in and day out. Thus, a system based on biomechanical measurements of the two key identified parameters of a track surface will allow the durability and consistency of the synthetic surfaces to be compared to traditional surfaces.

TESTING APPROACH

The evaluation of the Keeneland surface focused on measurement of the vertical track modulus or stiffness and the horizontal shear strength or cuppiness. These parameters compare the basic biomechanical efficiency and safety of race tracks. The variability around the track and resistance to compaction are of particular interest. However, most importantly the relative stiffness and shear strength should be evaluated to determine how it compares to existing track surfaces. The testing described was done over the Thanksgiving week at Keeneland's training track.

RESULTS

Data obtained in November 2004 from training track at Keeneland suggests that the track is comparable to that of a higher vertical modulus “California Style” tracks. The higher clay content and the presence of clays with higher cohesiveness on some of the California tracks leads to a faster and a slightly higher vertical modulus on the track. This lack of cuppiness is desirable and a moderately high modulus is often found with faster tracks. However, when clay is used to obtain a faster track, the track is also very sensitive to moisture content. It is important to note then, that while the overlap in properties between the tracks may be significant, the variability over time may be much lower with the synthetic track, if moisture content is difficult to control at the traditional track.

The data obtained at Keeneland followed the protocol established at the California tracks. However, at the Keeneland training track two out of more than 100 measurements were excluded from the analysis. These tests were associated with unusually high vertical modulus measurements. No evidence of variation in the track was evident from visual inspection. The high values could have been caused by inhomogeneity of the track surface (a large piece of rubber or a clump of material), unevenness in the base, or track contamination. Because the ground penetrating radar was not available to identify the source of the high readings, these high values were excluded from the statistical analysis of the data. In the California data none of the high values excluded form the test results reported unless they were associated with an equipment malfunction.

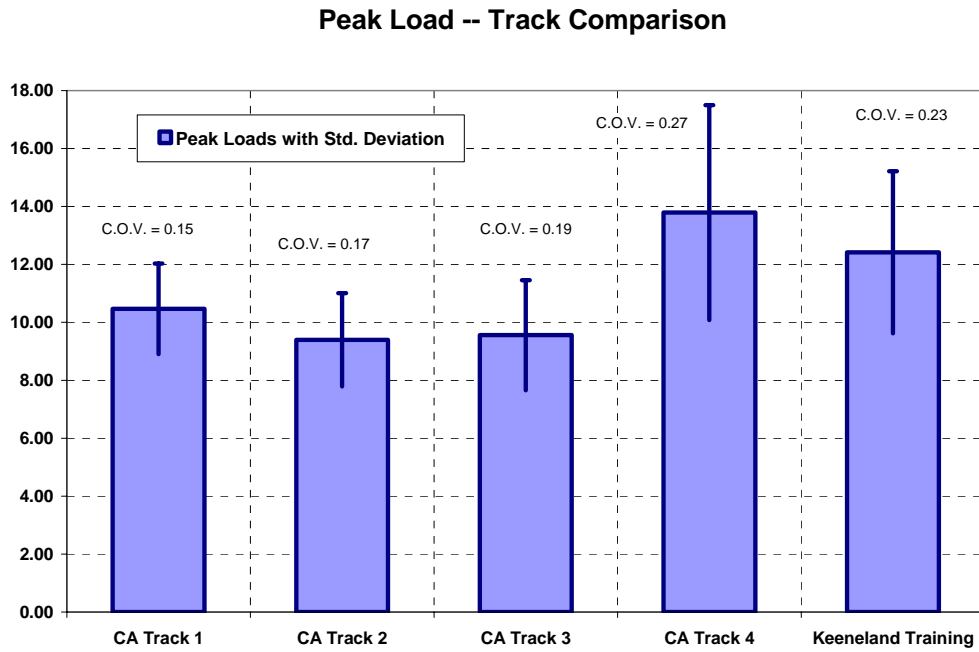


Figure 1: Comparison of peak load (vertical modulus) of Keeneland synthetic track surface to 4 California thoroughbred race tracks.

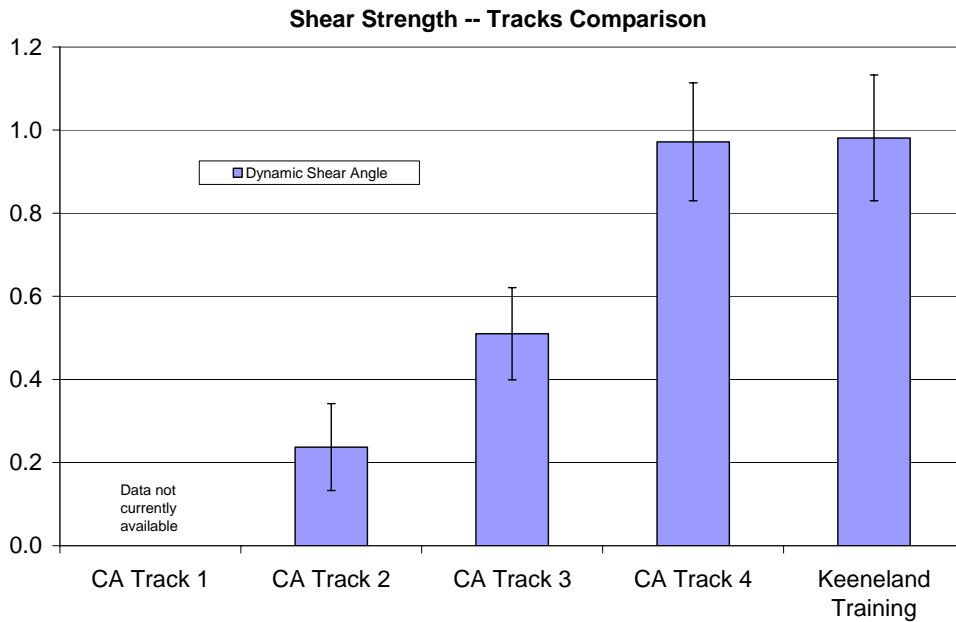


Figure 2: Comparison of shear strength (“cuppiness”) of Keeneland synthetic track surface to 4 California thoroughbred race tracks.

PRELIMINARY CONCLUSIONS

A basic statistical analysis of the data has been performed to determine if the Keeneland track surface for the time tested is significantly different that a well maintained track at one of the California tracks. Track number 3 was chosen from the California tracks since the testing at this track was the most extensive of any track studied and the surface has been an area of concern.

Using a student t statistical test, we assume that the samples have approximately equal variance, that the samples are normally distributed, and that the samples are random representatives of locations on the track. On this basis it was found that the Keeneland surface has both a higher vertical modulus ($p=0.011$) and a higher shear strength ($p=0.0007$). Both of these were statistically significant, (p value is less than 0.05). However it is notable that the vertical modulus was not found to have great statistical strength. This result suggests that the variability is sufficiently high that any difference in the modulus may not be significant from a practical perspective. Clearly the Polytrack surface appears to be significantly stronger, which would reduce the cuppiness and the likelihood of soft tissue injuries. Preliminary data also suggests that the Keeneland surface shows a very significant improvement in the compaction performance of the material.

Looking at the initial results:

- 1) The variability of the synthetic track is not statistically lower than an organic California track. This is probably a result of inhomogeneity (and clumping) of the mixture rather than the compaction seen in the California track. However, a portion of the data that was too small to be statistically significant clearly showed evidence of truck travel on the track. This area of the track has since been tilled and the issues were addressed. The elimination of the hard portion of the track from truck travel may significantly reduce the variability in the Polytrack surface.
- 2) The peak loads on the leg of a horse training on the Keeneland surface may be higher than the typical California tracks. This observation may not hold up with additional testing because it is not clear that the difference has limited statistical strength. However, with the reduced variation (and lowered load) from the elimination of the compacted area of the Polytrack, this observation again may change. It is important to note, that the issues with the Polytrack are somewhat different than that of an organic track since the maintenance procedures are still in the developmental stage. Also, there is currently no data available that allows the performance of the Polytrack to be compared to an "Eastern style" track.
- 3) Preliminary data, not shown, appears to indicate that the compaction performance of the synthetic track is superior to an organic track. Differences in the way this measurement was made in Kentucky and California make quantitative comparison difficult. However, in general the training track at Keeneland appears to significantly address the compaction issue