

# Ground Penetrating Radar, Compaction Measurement Techniques and Methods

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Over the last two years a study has been undertaken to develop a tool that will allow the track surface impact characteristics at the same loads and loading rates produced by a horse at a gallop. The first phase was the development of the machine along with pilot data which was funded by AQHA Racing. The second phase was a comparison test of a number of tracks in California. The second phase is being performed over the course of the summer of 2004, and has been supported by the Thoroughbred Owners of California, California Thoroughbred Trainers, the California Association of Racing Fairs and a number of racetracks including Santa Anita, Hollywood Park and Del Mar. The test system differs from previous studies in that the loads applied to the track are as high as those encountered from the impact of a hoof on the ground. This is important since previous work has been only able to characterize the performance of the cushion, or top layer of the track. Using the higher loads, the strength and stiffness of the cushion and the pad have been measured. The resulting quantitative information can then be used to compare track surfaces. A summary of results for Del Mar in the summer of 2004 is shown in figure 1. The most significant observation was the change in the track at Del Mar over the first week of the 2004 meet. From the data it is clear that over this time significant changes occurred to the track. Peak loads experienced on the track increased significantly.

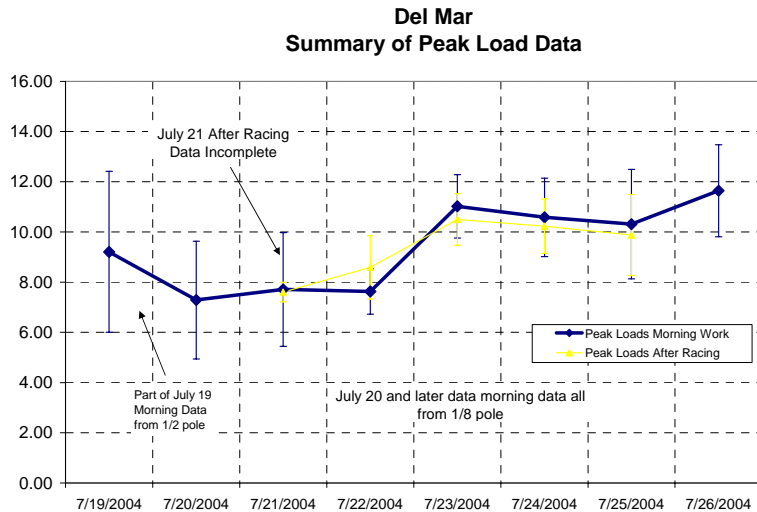


Figure 1: Peak load data from Del Mar during 2004 meet.

From the observed standard deviation and the changes over time seen in the track at Del Mar it appears that these changes are most likely to be a result of changes in track compaction. Unevenness in the track (seen as the size of the range bar in figures 1) would be most likely to be caused by compaction. An effort should be undertaken to understand track material compaction and the effect on the track surface.

# Penetrating Radar for Track Characterization

Pilot data has been obtained that has shown the ability of ground penetrating radar to be used to characterize racetrack surface materials. Such a system has the potential to provide important information regarding subsurface compaction and spatial variation in moisture content on dirt race tracks and training surfaces. To demonstrate the system, a 1.5 GHz ground penetrating radar system was used to detect the bottom of a clay lined pit built using Hollywood Park and Santa Anita track materials. The clay base material was used as an example of a base material that might be found at a race track. In addition several regions of increased depth were added to show the ability to find uneven portion of the base. In the figure 2 the red lines are added to show detection of the uneven section of the track under 4 to 6 inches of track material. It is clear that the ground penetrating radar is easily able to penetrate these track materials.

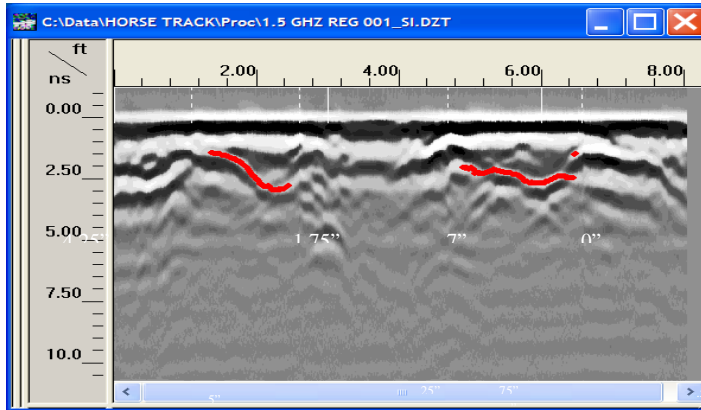


Figure 2: Alignment of ground penetrating radar image with a model of the test pit, showing ground contour image.

## Budget

This effort will result in a broader understanding of the issues associated with track compaction and determine if the variation seen in the initial testing is in fact related to track compaction. Success in these phases will allow a future effort to be undertaken that can help to select materials or to support maintenance procedures for tracks to reduce the compaction observed in the initial work.

### Compaction Survey using Ground Penetrating Radar

Labor	Salary -- Graduate Student Statistical Work	\$5,000	
	Salary -- Engineering Graduate Student	\$7,500	
Hardware	Ground Penetrating Radar	\$31,500	
	Consumables	\$2,250	
	Wiring Modifications	\$1,800	
	Receiver Hitch	\$500	
Operating Expenses	Shipping	\$1,500	
	Insurance	\$2,000	
	Support Vehicle	\$700	
	Travel	\$1,000	
	Shipping	\$1,200	
	Room	\$2,520	
	Per Diem	\$840	
	<b>Total</b>		<b>\$58,310</b>