Effects of surface depth and compaction on impact deceleration of dirt and synthetic surface materials for equine racetracks

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INTRODUCTION

The 3 main types of racetrack surface for Thoroughbred racehorses are dirt, synthetic, and turf. Dirt and turf racetrack surfaces have been used traditionally in horse racing, but synthetic surfaces were introduced to racetracks in the 1990's in England. Nine major racetracks have replaced their dirt surface with a synthetic surface in the USA in the past 5 years (Shulman, 2007) with a primary goal of reducing the incidence of racehorse injuries. However, there is a lack of scientific information about the effects of surface materials, surface construction, and maintenance on mechanical performance. Additionally, measurements taken in the field are affected by environmental conditions, particularly temperature and moisture content. The goal of this study was to assess the effects of surface type, depth, and compaction on impact decelerations and residual deformations during impact in controlled laboratory conditions. These findings are expected to be useful in racetrack surface design and management.

METHODS

The combinations of 2 kinds of equine racetrack surface (dirt and synthetic), 2 different compaction methods (5 blows and 15 blows), and 4 different layers (approximately 2", 4", 6", 8" of surface material) were tested in a completely randomized order. A total of 32 trials were performed. The surfaces were contained within a 12" by 12" rigid square box (with no bottom) over a concrete floor (Figure 1). Deceleration was measured in units of Clegg Impact Values (CIV), where one CIV unit is equivalent to 10 g (Figure 2). Because the maximum CIV of the first four impacts is the most repeatable measurement (ASTM D5874-02, 2007), the maximum of the first four impacts (4th CIV) and the residual deformation of the 4th impact (4th deformation) were compared. The effects of surface, compaction, layer, and all interactions on 4th CIV and 4th deformation values were compared using analysis of variance.

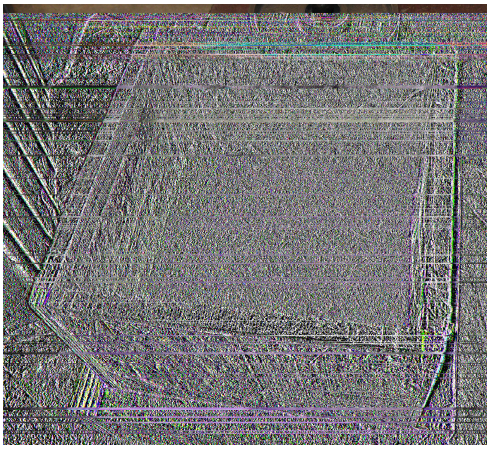

Figure 1: Rigid square box with 4" of synthetic surface.

RESULTS AND DISCUSSION

All main effects and all interaction terms, except for the interaction of surface and compaction and the interaction of surface, layer, and compaction, had a significant

Figure 2: Picture just prior to impacting surface with Clegg Hammer.

effect ($p<0.05$) on the 4th CIV values. The moisture content (% by mass) was 8.85 ± 0.29% for the dirt and 7.37 ± 0.70% for the synthetic surface. The 4th CIV of the dirt surface (7.3±3.8 CIV) was 19% greater and significantly different than that of the synthetic surface (6.1±2.8 CIV). The 4th CIV of the 1st (12.0±1.8 CIV), 2nd (5.6±0.4 CIV), 3rd (4.9±1.1 CIV) and 4th (4.3±0.8 CIV) layers were all significantly different from each other, but the CIV values appear to approach an asymptote near the 3rd and 4th layers. The 4th CIV of the two compaction levels were also significantly different, but the 4th CIV for 15 blows was only 6% greater than that for 5 blows. The results of the interaction between surface and compaction showed that the synthetic surface tends to be more resistant to the hardening effects of compaction than the dirt surface. The 4th deformation of the dirt surface (1.6±0.4") was 13% deeper than that of the synthetic surface (1.4±0.3"). The 4th deformation values continued to increase as the number of layers increased, and all layers were significantly different. As expected, the more compacted condition (15 blows) resulted in a smaller deformation than the less compacted condition (5 blows). Note that the Clegg Hammer was not able to read values less than 2.6 CIV, and therefore often could not read the deceleration of the first impact, but the CIV and deformation differences between surfaces tended to increase from the 1st to the 4th impact.

SUMMARY AND CONCLUSION

This study is one of the few which scientifically compares two of the main equine racetrack surfaces: dirt and synthetic. The results of this study not only provide useful information to racetrack managers, such as how each material reacts to different amounts of compaction, but it also provides useful information for future studies which will attempt to recreate the racetrack surface within the laboratory. However, the extension of the results of this exploratory study should be limited, as the compaction levels used here are not the same as those at the racetrack. Additionally, the impact device used was only 4.5 kg, which does not adequately imitate the impact of a galloping racehorse hoof into a racetrack surface.

REFERENCES

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