Evaluation of Alternative Methodologies for Assessing Playground Surfacing Impact Attenuation Performance

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INTRODUCTION

- An average of about 218,500 children are treated in emergency rooms annually in the U.S. due to accidents on the playground (Adelson 2018).
- A wide variety of playground surfaces are used in the U.S. for fall-related injury prevention.
- ASTM F1292 is a surfacing standard that identifies allowable Head Injury Criterion (HIC) and g-max values to prevent severe head injuries from falls on playgrounds.

OBJECTIVE

Evaluate four alternative analysis methods investigating the relationship of impact metrics (HIC and g-max) to surface depth and fall height.

METHODS

- Analysis was focused specifically on 1,188 drop tests performed *in-situ* on playgrounds with installed safety surfacing.
- Data included fall height, depth of surface material, and the resulting HIC and g-max scores.
- Recorded data from the tests sites was analyzed to investigate the influence of different surface depth and fall height analysis techniques for EWF, wood chips, sand, and pea gravel surfacing recommendations.
- The four methods of analysis were:
  1. Average HIC and g-max of drops 2 and 3 at each test site (current ASTM F1292 standard).
  2. Average HIC of drops 2 and 3 at each test site (omitting g-max metric).
  3. Average HIC of drops 1, 2, and 3 at each test site (including drop 1).
  4. HIC of drops 1, 2, and 3 for each test site as unique / individual data points.

RESULTS AND DISCUSSION

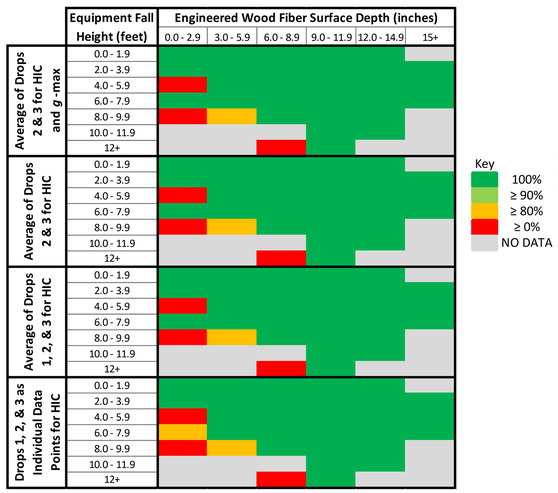
PART I (Pilot): Alternative Methods for Engineered Wood Fiber

1) No differences between the first three methods of analysis for engineered wood fiber (n=396).

2) Minor difference in the fourth method at low surface depths which would not affect surfacing depths.

3) Analysis was expanded to include wood chips, sand, and pea gravel (Part II) to determine if other materials show similar consistency.

Table 1: Compliance rate tables for alternative methods of analysis for engineered wood fiber (EWF).



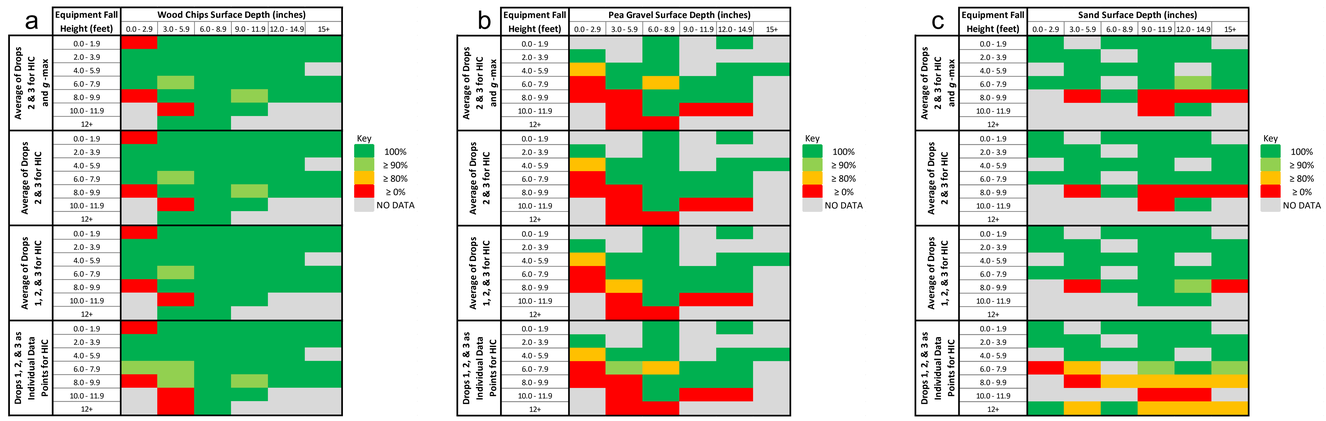
PART II (Expansion): Alternative Methods Applied to Wood Chips, Sand, and Pea Gravel

1) Wood chips (n=378) had few differences between methods with the majority being in the fourth method.

2) Pea gravel (n=120) and sand (n=102) have a greater number of differences between methods.

3) More pea gravel and sand data may decrease the differences found between the four methods and further validate the trends seen with EWF.

Table 2: Compliance rate tables for alternative methods of analysis for (a) wood chips, (b) sand, and (c) pea gravel.



PART III: Statistical Investigation to Include 1st Drop

Investigated the effect of excluding the data from the first impact attenuator drop for HIC score. Resulting p-values show no significant difference between including and excluding the first drop data for all materials. The plot of the two datasets gives an R^2 value of 0.98, showing the two datasets are closely related

Table 3: Results for first impact data exclusion analysis.

Material	Two-Tail p Value
Engineered Wood Fiber	0.9895 (no difference)
Wood Chips	0.8434 (no difference)
Pea Gravel	0.6076 (no difference)
Sand	0.4499 (no difference)

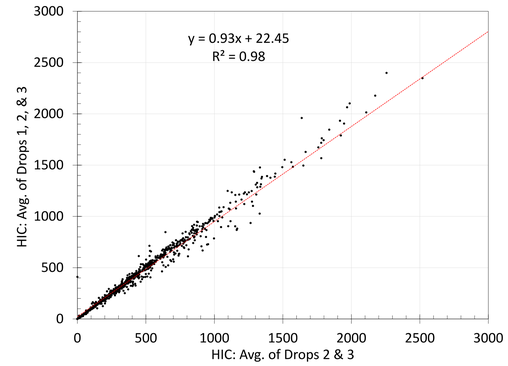


Figure 1: Plot of Average HIC of Drops 1, 2, and 3 versus Average HIC of Drops 2 and 3.

APPLICATIONS TO PRACTICE AND ONGOING WORK

Current playground safety field testing standards discard the first datapoint at each test site and utilize two independent performance metrics (HIC and g-max) which confound collection, interpretation, and reporting without affecting overall sensitivity. Alternative analysis methodologies would be better suited for real-world applications through 1) the inclusion of the first drop of the impact attenuator and/or 2) the elimination of g-max as a performance metric. This analysis demonstrates that neither of these changes would have significant effects on the resulting material compliance of playground surfaces. Future work is strongly recommended to collect more data to further validate the observed trends.

ACKNOWLEDGEMENTS

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