Louisiana Public Schools
LARMA
Risk Management Agency

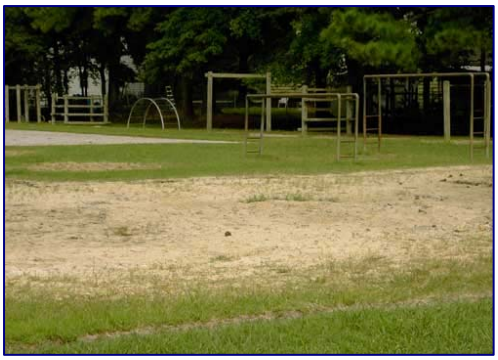
Risk Control Bulletin

Choosing Playground Surfacing Material

The surface under and around playground equipment can be a major factor in determining the injury-causing potential of a fall. It is self evident that a fall onto a shock absorbing surface is less likely to cause a serious injury than a fall onto a hard surface. Because head impact injuries from a fall have the potential for being life threatening, the more shock absorbing a surface can be made, the more is the likelihood that the severity of the injury will be reduced. However, it should be recognized that all injuries due to falls cannot be prevented no matter what playground surfacing material is used.

1. Determining Shock Absorbency of a Surfacing Material

No data are available to predict precisely the threshold tolerance of the human head to an impact injury. However, biomedical researchers have established two methods that may be used to determine when such an injury may be life threatening.



One method holds that if the peak deceleration of the head during impact does not exceed 200 times the acceleration due to gravity (200 G's), a life threatening head injury is not likely to occur. The second method holds that both the deceleration of the head during impact and the time duration over which the head decelerates to a halt are significant in assessing head impact injury. This latter method uses a mathematical formula to derive a value known as Head Injury Criteria (HIC) [NOTE: Collantes, Margaritsa, Evaluation of the Importance of Using Head Injury Criterion (HIC) to Estimate the Likelihood of Head Impact Injury as a Result of a Fall Onto Playground Surface Materials; U.S. Consumer Product Safety Commission, Washington, D.C. 20207, October 1990.] Head impact injuries are not believed to be life threatening if the HIC does not exceed a value of 1,000.

The most widely used test method for evaluating the shock absorbing properties of a playground surfacing material is to drop an instrumented metal headform onto a sample of the material and record the acceleration/time pulse during the impact. Such a method is described in an ASTM

Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment, ASTM F1292. [ASTM, 1916 Race Street, Philadelphia, PA 19103]

2. Critical Height

This is a term originating from Europe and is used to describe the shock absorbing performance of a surfacing material. As it is used in this publication, the Critical Height for a surfacing material is defined as THE MAXIMUM HEIGHT FROM WHICH THE INSTRUMENTED METAL HEADFORM, UPON IMPACT, YIELDS BOTH A PEAK DECELERATION OF NO MORE THAN 200 G'S AND A HIC OF NO MORE THAN 1,000 WHEN TESTED IN ACCORDANCE WITH THE PROCEDURE DESCRIBED IN ASTM F1292. Critical Height, therefore, can be considered as an approximation of the maximum fall height from which a life-threatening head injury would not be expected to occur.

The surfacing material used under and around a particular piece of playground equipment should have a Critical Height value of at least the height of the highest accessible part of the equipment.

3. Highest Accessible Part of Equipment

Recommendations for the "highest accessible part" for various pieces of playground equipment are as follows.

Swings -- Since children may fall from a swing seat at its maximum attainable angle (assumed to be 90 from the "at rest" position), the highest accessible part of a swing structure is the height of the pivot point where the swing's suspending elements connect to the supporting structure.

Elevated Platforms Including Slide Platforms -- Since children may climb onto or over guardrails, the highest accessible part of a platform surrounded by guardrails is the height above the playing surface of the top of the guardrail. Since protective barriers are designed to minimize the likelihood of climbing, the highest accessible part of a platform surrounded by protective barriers is the height of the platform surface above the ground.

Climbers and Horizontal Ladders -- For structures that are intended to be climbed upon, the highest accessible part is the maximum height of the structure.

Merry-Go-Rounds -- The highest accessible part is the height above the ground of any part at the perimeter on which a child may sit or stand.

Seesaws -- The highest accessible part is the maximum height attainable by any part of the seesaw.

Spring Rockers -- The highest accessible part is the maximum height above the ground of the seat or designated play surface.

4. Acceptability of Various Surfacing Materials

Hard surfacing materials, such as asphalt or concrete, are unsuitable for use under and around playground equipment of any height unless they are required as a base for a shock absorbing unitary material such as a rubber mat. Earth surfaces such as soils and hard packed dirt are also not recommended because their shock absorbing properties can vary considerably depending on climatic conditions such as moisture and temperature. Similarly, grass and turf are not recommended because their effectiveness in absorbing shock during a fall can be reduced considerably due to wear and environmental conditions.

Acceptable playground surfacing materials are available in two basic types, UNITARY or LOOSE-FILL.

Unitary Materials -- are generally rubber mats or a combination of rubber-like materials held in place by a binder that may be poured in place at the playground site and cures to form a unitary shock absorbing surface. Unitary materials are available from a number of different manufacturers many of whom have a range of materials with differing shock absorbing properties. Persons wishing to install a unitary material as a playground surface should request test data from the manufacturer that should identify the Critical Height of the desired material. In addition, site requirements should be obtained from the manufacturer because, as stated above, some unitary materials require installation over a hard surface while for others this is not required.

Loose-Fill Materials -- can also have acceptable shock absorbing properties when installed at a sufficient depth. These materials include, but are not confined to, sand, gravel, and shredded wood products. Loose-fill materials should not be installed over hard surfaces such as asphalt or concrete.

Because loose-fill materials are generally sold for purposes other than playground surfacing, many vendors are unlikely to be able to provide information on their shock absorbing performance. For that reason, CPSC staff has conducted tests to determine the relative shock absorbing properties of some loose-fill materials commonly used as surfaces under and around playground equipment. Appendix B contains a description of the tested materials. The tests were conducted in accordance with the procedure in the voluntary standard for playground surfacing systems, ASTM F1292. Table 2, below, lists the critical height (expressed in feet) for each of seven materials when tested in an uncompressed state at depths of 6, 9, and 12 inches. The table also reports the critical height when a 9 inch depth of each material was tested in a compressed state.

The table should be read as follows: If, for example, uncompressed wood mulch is used at a minimum depth of 6 inches, the Critical Height is 7 feet. If 9 inches of uncompressed wood mulch is used, the Critical Height is 10 feet. It should be noted that, for some materials, the Critical Height decreases when the material is compressed.

Table: Critical Heights (In Feet) of Tested Materials

Material	Uncompressed depth			Compressed Depth
	6 INCH	9 INCH	12 INCH	9 INCH
Wood Mulch	7	10	11	10
Double Shredded Bark Mulch	6	10	11	7
Uniform Wood Chips	6	7	12	6
Fine Sand	5	5	9	5
Coarse Sand	5	5	6	4
Fine Gravel	6	7	10	6
Medium Gravel	5	5	6	5

The Critical Heights shown in the above table may be used as a guide in selecting the type and depth of loose-fill materials that will provide the necessary safety for equipment of various heights. There may be other loose-fill materials such as bark nuggets or shredded tires that have shock absorbing properties equivalent to those in the above table. However, no tests have been conducted on these materials by CPSC staff.

The depth of any loose-fill material could be reduced during use resulting in different shock-absorbing properties. For this reason, a margin of safety should be considered in selecting a type and depth of material for a specific use.

5. Accessibility to the Disabled

The Americans with Disabilities Act of 1990 (ADA) prohibits discrimination on the basis of disability in employment, public services, transportation, public accommodations -- including many services operated by private entities -- and telecommunications. Title III of the legislation includes within the definition of public accommodation: "a park, zoo, amusement park, or other place of recreation"; a school, including nursery schools; a day care center; and a gymnasium, health spa, or "other places of exercise or recreation." Specific Federal requirements for accessibility to playgrounds by the disabled are expected to be published.

The Department of Parks and Recreation in the State of California has advised that after January 1, 1991, regulations requiring that all types of play activity in new and redone play areas must be accessible to the disabled. Other states may similarly issue accessibility requirements. Playground designers, installers and operators are reminded that they should determine what Federal and State requirements for accessibility are in effect. These requirements could necessitate changes to existing playgrounds as well as when new playgrounds are planned or existing playgrounds refurbished.

6. Other Characteristics of Surfacing Materials

Selection of a surfacing material for a specific location may be governed by the environmental conditions at that location. Appendix A lists some characteristics of surfacing materials that may influence the choice for a particular playground.

Appendix A- Summary Characteristics of Organic and Inorganic Loose-Fill Materials, and Unitary Synthetic Materials

Organic Loose Material: wood chips, bark mulch, etc.

FALL ABSORBING CHARACTERISTICS -- Cushioning effect depends on air trapped within and between individual particles, and presupposes an adequate depth of material. See Table for performance data.

INSTALLATION/MAINTENANCE: Should not be installed over existing hard surfaces (e.g., asphalt, concrete). Requires a method of containment (e.g., retaining barrier, excavated pit). Requires good drainage underneath material. Requires periodic renewal or replacement and continuous maintenance (e.g., leveling, grading, sifting, raking) to maintain appropriate depth and remove foreign matter.

ADVANTAGES: Low initial cost. Ease of installation. Good drainage. Less abrasive than sand. Less attractive to cats and dogs (compared to sand). Attractive appearance. Readily available.

DISADVANTAGES: The following conditions may reduce cushioning potential: 1. Environmental conditions; rainy weather, high humidity, freezing temperatures. 2. With normal use over time, combines with dirt and other foreign materials. 3. Over time, decomposes, is pulverized, and compacts. 4. Depth may be reduced by displacement due to children's activities or by material being blown by wind. Can be blown or thrown into children's eyes. Subject to microbial growth when wet. Conceals animal excrement and trash (e.g., broken glass, nails, pencils, and other sharp objects that can cause cut and puncture wounds. Spreads easily outside of containment area. Can be flammable. Subject to theft by neighborhood residents for use as mulch.

Inorganic Loose Material: sand and gravel

FALL ABSORBING CHARACTERISTICS -- See Table for performance data.

INSTALLATION/MAINTENANCE: Should not be installed over existing hard surfaces (e.g., asphalt, rock). Method of containment needed (e.g., retaining barrier, excavated pit). Good drainage required underneath material. Requires periodic renewal or replacement and continuous maintenance (e.g., leveling, grading, sifting, raking) to maintain appropriate depth and remove foreign matter. Compacted sand should periodically be turned over, loosened, and cleaned. Gravel may require periodic break up and removal of hard pan.

ADVANTAGES: Low initial cost. Ease of installation. Does not pulverize. Not ideal for microbial growth. Nonflammable. Materials are readily available. Not susceptible to vandalism except by contamination. Gravel is less attractive to animals than sand.

DISADVANTAGES: The following conditions reduce cushioning potential: 1. Environmental conditions: rainy weather, high humidity, freezing temperatures. 2. With normal use, combines with dirt and other foreign materials. 3. Depth may be reduced due to displacement by children's activities and sand may be blown by wind. May be swallowed. Conceals animal excrement and trash (e.g., broken glass, nails, pencils, and other sharp objects that can cause cut and puncture wounds).

SAND: Spreads easily outside of containment area. Small particles bind together and become less cushioning when wet; when thoroughly wet, sand reacts as a rigid material. May be tracked out of play area on shoes; abrasive to floor surfaces when tracked indoors; abrasive to plastic materials. Adheres to clothing. Susceptible to fouling by animals.

GRAVEL: Difficult to walk on. If displaced onto nearby hard surface pathways, could present a fall hazard. Hard pan may form under heavily traveled areas.

Unitary Synthetic Materials: rubber or rubber over foam mats or tiles, poured in place urethane and rubber compositions

FALL ABSORBING CHARACTERISTICS -- Manufacturer should be contacted for information on Critical Height of materials when tested according to ASTM F1292.

INSTALLATION/MAINTENANCE: Some unitary materials can be laid directly on hard surfaces such as asphalt or concrete. Others may require expert under-surface preparation and installation by the manufacturer or a local contractor. Materials generally require no additional means of containment. Once installed, the materials require minimal maintenance.

ADVANTAGES: Low maintenance. Easy to clean. Consistent shock absorbency. Material not displaced by children during play activities. Generally low life cycle costs. Good footing (depends on surface texture). Harbor few foreign objects. Generally no retaining edges needed. Is accessible to the handicapped.

DISADVANTAGES: Initial cost relatively high. Under surfacing may be critical for thinner materials. Often must be used on almost level uniform surfaces. May be flammable. Subject to vandalism (e.g., ignited, defaced, cut). Full rubber tiles may curl up and cause tripping. Some designs susceptible to frost damage.

Appendix B- Description of Loose Fill Surfacing Materials In Table

1. WOOD MULCH -- Random sized wood chips, twigs, and leaves collected from a wood chipper being fed tree limbs, branches, and brush.

2. DOUBLE SHREDDED BARK MULCH -- Similar to shredded mulch commonly used by homeowners to mulch shrubs and flower beds.

3. UNIFORM WOOD CHIPS -- Relatively uniform sized shredded wood fibers from recognized hardwoods. Sample contained no bark or leaves.

4. FINE SAND -- Particles of white sand purchased in bags marked "play sand." The material was passed through wire-cloth screens of different sizes in accordance with ASTM Standard Method C136-84a and yielded the following results:

Screen Size	Percent Passing Through Screen
#16	100
#30	98
#50	62
#100	17
#200	0-1

5. COARSE SAND -- Sample was obtained from a supplier to the landscaping and construction trades. ASTM C136-84a test results were:

Screen Size	Percent Passing Through Screen
#4	98
#8	73
#16	4
#30	1
#50	0-1

6. FINE GRAVEL -- Sample was obtained from a supplier to the residential landscaping market. Gravel particles were rounded and were generally less than 3/8 inch in diameter. ASTM C136-84a test results were:

Screen Size	Percent Passing Through Screen
3/8 inch	100
#3 1/2	93
#4	65
#8	8

#16	5
#30	4

7. MEDIUM GRAVEL -- Particles were rounded as found in river washed or tumbled stone. ASTM C136-84a test results were:

Screen Size	Percent Passing Through Screen
1/2 inch	100
3/8 inch	80
5/16 inch	58
#3 1/2	20
#4	8
#8	7
#16	3

For further information, write: U.S. Consumer Product Safety Commission Washington, DC 20207. To report a product hazard or a product-related injury, write to the U.S. Consumer Product Safety Commission, Washington, DC 20207, or call the toll-free hotline: 800-638-2772. A teletypewriter for the deaf is available at 800-638-8270. This document is in the pubic domain. It may be reproduced in part or in whole by an individual or organization without permission. If it is reproduced, however, the Commission would appreciate knowing how it is used. Write the U.S. Consumer Product Safety Commission, Office of Information and Public Affairs, Washington, DC 20207. The U.S. Consumer Product Safety Commission (CPSC) is an independent regulatory agency charged with reducing unreasonable risks of injury associated with consumer products.