PLAYGROUND SURFACING

Canadian Standards & Practice

Textbook by

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Table of Contents

Introduction

This course is intended to provide the participant with an overview of the current standards affecting playground surfacing as well as relevant government guidelines, regulations, and rules. Playground safety is related to the health and safety of the child using the playground. However, because playground safety also affects the exercise of professional judgement, due diligence, and liability, the course will discuss best practices as well.

In her introductory letter to the Handbook for Public Playground Safety, Ann Brown, Chairman of the U.S. Consumer Product Safety Commission (CPSC), wrote:

> "Unfortunately, more than 200,000 children are treated in U.S. hospital emergency rooms each year for injuries associated with playground equipment. Most injuries occur when children fall from the equipment onto the ground."

In Canada, these accident statistics are collected by the Canadian Hospital Injury Reporting and Prevention Program (CHIRPP). In 1996, playground injuries resulted in 4,000 emergency room visits to 16 reporting hospital across Canada. As the U.S. National Recreation and Parks Association (NRPA) states in their promotion of the ASTM F1487-98 Standard Consumer Safety Performance Specification for Playground Equipment for Public Use:

> "About three fourths of these injuries result from falls, primarily to the surface on which the equipment was located."

World-wide, statistics indicate that 55% to 75% of all playground injuries result from falls to the surface.

Protecting children from life-threatening and debilitating playground injury has been the subject of standards, articles, and handbooks throughout the world. In some cases, such as the CPSC Handbook for Public Playground Safety and the Canadian CSA Z614-98 Children's Playspaces and Equipment, the surface performance and the specifications for play equipment are in the same document. In the United States, however, there are standards for each topic — the ASTM F1487 (play equipment) and the ASTM F1292 (surface performance). In addition there are guidelines for accessible playgrounds and the associated standards ASTM F1951 and ASTM F1487. The ASTM F2000 standard covers playground fences.

In this course, we are concerned with the CSA Z614-98. Reference will be made to ASTM F1487 from time to time, as there has been significant harmonization between the two. The CSA Z614 takes precedence as the national standard for playspaces in Canada. ASTM F1487 is referenced for information and an explanation of practices not mentioned in the CSA Z614, such as accessibility.

It is incumbent upon all persons involved with design, specification, acquisition, installation, inspection, and maintenance to be familiar with these standards as a minimum. This is part of their due diligence obligation where there is the potential for harm to oneself or others. Due diligence is the exercise of professional judgement. CSA Z614 Standard defines professional judgement as:

> "The ability of an individual with current knowledge, skill or experience, or both in the field of playgrounds/playground equipment design, use or operations, which

> enable the person to form an opinion or make a decision, or both, concerning a matter within that field of expertise."

The lack of due diligence may be construed as negligence — a legal term that is most associated with liability. You should contact a legal professional or risk manager to determine the specific exposure that would relate to your specific circumstances. For purposes of this discussion it is enough to introduce you to the most commonly held definition. In 1856, Baron Alderson stated that negligence is:

> "the omission to do something which a reasonable man, guided upon those considerations that ordinarily regulate the conduct of human affairs, would do, or something which a prudent or reasonable man would not do."

The CPSC Handbook for Public Playground Safety, in its discussion of the Determining Shock Absorbency of a Surfacing Material, states:

> "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). Head impact injuries are not believed to be life threatening if the HIC does not exceed a value of 1,000."

Once the professional becomes knowledgeable about playground surfacing and the type and severity of possible injury, the next step is prevention through implementing the standards and the recommendations of the CPSC Handbook. The standards set minimums for performance for playground surfaces related to the allowable impact force to the head. Those are:

Gmax <200 and HIC < 1000.

An impact force above these levels could result in a life-threatening head injury.

CSA Z164-98 defines the “protective surfacing” as “surfacing material(s) to be used within the protective surfacing zone of an playground equipment. These materials are chosen so as to yield a gmax of 200 g or less and a HIC of 1000 or less when tested according to the requirements of ASTM Standard F1292.”

Remember, the CPSC recommendation and the threshold levels for pass/fail in the standards are the levels that can produce a life-threatening head injury. Remember to review “Best Practices” at a later point.

Knowing the maximum allowable impact forces, you must now decide which test method to use for determining the impact-absorbing properties of the surface. Section 4.1 of the CPSC Handbook for Public Playground Safety states:

> “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 materials and record the acceleration/time pulse during the impact. Test methods are described in ASTM Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment, ASTM F1292.”

The CSA Z614-98 provides a section on playspace layout in section 14.

Section 14.1.1 on Protective Surfacing Zone states:

> There shall be a protective surfacing zone for each play structure, which shall consist of obstacle-free surfacing that conforms to the requirements of Clause 10 appropriate for the fall height of the equipment.

The ASTM F1487, Standard Consumer Safety Performance Specification for Playground Equipment for Public Use, makes specific and repeated reference to the surface test procedure as follows:

> Section 9.1.1
>
> There shall be a use zone for each play structure, which shall consist of obstacle-free surfacing that conforms to Specification F1292 appropriate for the fall height of the equipment.

Section 11.2 for Owner/Operator's Responsibilities states:

> The owner/operator shall install protective surfacing within the use zone of each play structure in accordance with Specification F1292 appropriate for the fall height of each structure.

Section 13 for maintenance states:

> 13.2 Protective Surfacing
>
> 13.2.1 The owner/operator shall maintain the protective surfacing within the use zone of each play structure in accordance with Specification F1292 appropriate for the fall height of each structure.
>
> 13.2.2 The owner/operator shall maintain the protective surfacing within the use zone of each play structure free from extraneous materials that could cause injury, infection or disease.
>
> 13.3 The owner/operator shall establish and maintain detailed installation, inspection, maintenance, and repair records for each public-use playground equipment area.

The CSA Z614-98, Section 10.5.1 on Maintenance of Protective Surfacing states:

> The owner/operator shall maintain the protective surfacing within the protective surfacing zone of each piece of play equipment in accordance with Clause 10, appropriate for the fall height of each piece of equipment, as per Clause 15.

One important consideration in this section is that surfacing is dynamic. It must first be installed to meet the minimum performance of the ASTM F1292 and be maintained at or better than the same minimum performance. The requirement to keep detailed records implies that, should there be an injury of any type, these records can be required in any litigation. Should they not exist, be inadequate or lack specifics or indicate uncorrected failures, the owner/operator will suffer the consequences.

The reader should be starting to notice that there is significant liability on the owner/operator's shoulders. You will also notice that the word "shall" continues to appear. In the language of a standard, this is mandatory and therefore a requirement.

No-Encroachment Zone

The CSA Z614 makes a specific effort with the inclusion of a no-encroachment zone to provide for circulation around play structures that are specifically designed to provide movement of the user. This provides for an unobstructed space where a pedestrian user of the playspace would have the opportunity to avoid an impact with a moving user of a particular piece of equipment such as a swing or slide. The no-encroachment zone shall extend a minimum of 1800mm (72 inches) out from the protective surfacing zone. The surface type of the no-encroachment zone does not have to conform to Clause 10 of the CSA Z614-98. In addition where there are two pieces of equipment that require a no-encroachment zone, they can share this space.

Standards — A Short Discussion

Before proceeding, it is appropriate to look at the way standards affect due diligence and the exercise of professional judgement. Standards set minimum performance and use language that is suggestive (recommended or should) or a requirement (shall). It is the role of the user of the document to provide a level of care that is at least that of the standard. However, the user of the standard must clearly assess the minimums in the standards to determine whether they will meet the specific need of a particular circumstance. This is known as “Best Practice.” We will return to this subject later in our discussions.

There are a number of materials that have been used as protective surfacing materials. Although the manufacturer, supplier or installer will argue that their surfacing system is the best that money can buy, there is no best. Each product has advantages and disadvantages. It is the buyer’s responsibility to exercise due diligence in:

- understanding the alternatives
- making sure that the advantages meet their needs
- ensuring that the disadvantages can be dealt with either through a combination of other materials, warranties or maintenance.

Playground surfaces are typically of two types: Loose Fill Materials and Unitary Materials.

Loose Fill Materials include traditional surfaces such as sand and pea gravel. Over the past 20 years, woodchips, bark mulch, engineered wood fibres, and shredded tires have been installed in playgrounds. Unitary materials include mats, tile and poured-in-place surfaces. The traditional view is that loose fill materials have a lower initial cost and higher long-term maintenance than unitary materials. This is over-simplified and generally wrong. Each system has distinct advantages and disadvantages.

Advantages and Disadvantages of playground surfacing systems

There are a number of surfacing systems that have over many years been utilized as traditional materials or invented for application as a playground surfacing system. Each of these systems has advantages and disadvantages related to cost, performance, and maintenance. In some cases, a combination of surfaces would be best suited to a particular circumstance. Generally combinations use a unitary material and a single loose fill material. Caution must be exercised prior to specification or installation of any combination of loose fill material. Approval of the compatibility of one material with the other must be confirmed with the manufacturer/ supplier of each.

Each surface type should be considered in light of the advantages and disadvantages that follow. Confirmation of properties and components or raw materials with the manufacturer/supplier will be of assistance to the specifier.

The following information is inclusive and designed to allow for a thorough discussion of any single type of surface system. Some products overlap in advantages or disadvantages. However, each surface type will have unique qualities.

Organic Loose Fill Material

Wood Chips and Bark Mulch

Bark mulch generally results from pruning and disposing of trees as part of an urban tree management and landscape maintenance program or the debarking of trees in the forest or mill. It can contain twigs and leaves from the trees and shrubbery processed. Wood chips are generally uniformly crushed shreds or chips that contain no bark or leaves. The wood must be separated prior to chipping or processing to ensure that no woods containing toxic substances or allergens are included in the final product. An ASTM standard for wood engineered products went into the balloting process in January 2001. This is discussed in the following section.

The impact attenuating properties of the wood chips and bark mulch depend on many factors. It can only be determined through testing the material to the requirements of ASTM F1292. Field-testing the surface once installed and annually, using the ASTM F1292 test method, will ensure that the installed material meets the contract specification and continues to provide protection for the user.

Wood chips and bark mulch must not be installed over existing hard surfaces such as asphalt or concrete. A method of containment — retaining barrier, excavated pit, etc. — is required. A drainage system and geotextile are required between the sub-base and the wood chips or bark mulch. Since wood chips and bark mulch can be a broad spectrum of shapes and sizes, maintenance of each site will be specific to the site. Maintenance will require continuous levelling, raking, grading, sifting, packing, etc. to provide adequate cover and resilience. Inspection of the surface for foreign materials is required on a regular basis. Replenishing of the surface to accommodate decomposition and compression is required. The entire material must be removed and replaced should the bulk of the surface be decomposed. Bacteria and moulds can occur as a result of a combination of decomposition, wet or damp materials, and temperatures ranging from 35°F to 100°F.

Wood chips and bark mulch provide the owner/operator with a number of advantages such as:

- low initial cost
- easy to install

- allows for good drainage
- is less abrasive than sand
- readily available
- is less attractive to cats and dogs as compared to sand
- mildly acidic composition of some woods retards the infestation of insects and retards fugal growth
- generally users of the playground will not use the wood chips for other purposes or play with it

Wood chips and bark mulch provide the owner/operator with a number of disadvantages that may reduce the ability of the surface to conform to various performance standards such as:

- rainy weather, high humidity, freezing temperatures
- with normal use over time, combines with dirt and other foreign materials
- over time, decomposes, is pulverized and compacts. The greater the quantity of leaves or moisture, the faster the rate of decomposition
- depth may be reduced by displacement due to children's activity 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 or puncture wounds)
- spreads easily outside of the containment area
- can be flammable

Engineered Wood Fibre

(new ASTM Standard F2075)

Engineered wood fibre generally results from grinding virgin or new wood that has been debarked and contains no leaves to specific dimensions and performance criteria. The wood must be separated prior to chipping or processing to ensure that no woods containing toxic substances or allergens are included in the final product. The ASTM F2075 also specifies other tests to ensure a uniform product.

The impact attenuating properties of the engineered wood fibre will depend on many factors. It can only be determined through testing the material to the requirements of ASTM F1292. Field-testing the surface once installed and annually, utilizing the test method of ASTM F1292, will ensure that the material installed meets the contract specification and continues to provide protection for the user.

Engineered wood fibre may be installed over existing hard surfaces (e.g. asphalt, concrete) provided:

- it conforms to the ASTM F2075 standard
- it conforms to the ASTM F1951 standard
- the initial and maintained depth provides for a minimum depth of 12 inches after compaction
- that in high traffic areas, such as under swings and at slide exits, an impact attenuating mat that conforms to the requirements of ASTM F1292 is installed
- a drainage system, such as stone aggregate sandwiched within two layers of geotextile cloth, is installed under the entire engineered wood fibre system

A method of containment (e.g. retaining barrier, excavated pit, etc.) is required. A drainage system and geotextile are required between the sub-base and the engineered wood fibre. Maintenance will require regular levelling, raking, grading, sifting, packing, etc. to provide adequate cover and resilience. Inspection of the surface for foreign materials is required on a regular basis. Replenishing of the surface to accommodate decomposition and compression is required. The entire material must be removed and replaced when the bulk of the surface be decomposed. Bacteria and moulds can occur as a result of a combination of decomposition, wet or damp materials, and temperatures ranging from 35°F to 100°F.

Engineered wood fibre provides the owner/operator with a number of advantages such as:

- easy to install
- allows for good drainage
- is less abrasive than sand
- readily available
- is less attractive to cats and dogs as compared to sand
- mildly acidic composition of some woods retards the infestation of insects and retards fugal growth
- generally users of the playground will not use the wood chips for other purposes or play with it
- must conform to ASTM F2075 engineered wood fibre standard
- must conform to the ASTM F1951 standard (accessibility)
- must conform to the ASTM F1292 standard
- is free of bark and leaves
- is less likely than other loose fill material to conceal animal excrement and trash (e.g. broken glass, nails, pencils and other sharp object that can cause cut or puncture wounds)

Engineered wood fibre provides the owner/operator with a number of disadvantages that may reduce the ability of the surface to conform to various performance standards such as:

- rainy weather, high humidity, freezing temperatures
- with normal use over time, combines with dirt and other foreign materials
- over time, decomposes, is pulverized and compacts. The greater the level of moisture, the faster the rate of decomposition
- depth may be reduced by displacement due to children's activity or by material being blown by wind
- can be blown or thrown into children's eyes
- subject to microbial growth when wet
- can conceals animal excrement and trash (e.g. broken glass, nails, pencils and other sharp object that can cause cut or puncture wounds
- spreads easily outside of the containment area
- can be flammable

Inorganic Loose Fill Material

Sand

Sand is a naturally occurring material that will vary in texture and composition depending on the source and geographic location from which it is mined. Once mined, the raw sand is processed or manufactured to provide specific grades and classifications through washing, screening, and other actions

The impact attenuating properties of sand will depend on many factors and can only be determined through testing of the material to the requirements of ASTM F1292. Field-testing the surface once installed and annually, utilizing the test method of ASTM F1292, will ensure that the material installed meets the contract specification and continues to provide protection for the user.

Sand must not be installed over existing hard surfaces (e.g. asphalt, concrete). A method of containment (e.g. retaining barrier, excavated pit, etc.) is required. A drainage system and geotextile are required between the sub-base and the sand. Maintenance will require continuous levelling, raking, grading, sifting, packing, etc. to provide adequate cover and resilience. Inspection of the surface for foreign materials is required on a regular basis. Periodically the compacted sand must be turned over, loosened, and cleaned. Total replacement of the sand will be required when turning and loosening no longer provide the performance required by ASTM F1292.

Sand provides the owner/operator with a number of advantages such as:

- low initial cost
- easy to install
- does not easily support microbial growth
- readily available
- non-flammable
- not susceptible to vandalism except by contamination

Sand provides the owner/operator with a number of disadvantages that may reduce the ability of the surface to conform to various performance standards such as:

- will not meet the requirements for accessibility and the performance required by the ASTM F1951 standard
- finding sand that has passed the ASTM F1292 laboratory testing will be difficult
- rainy weather, high humidity, freezing temperatures
- with normal use over time, combines with dirt and other foreign materials
- depth may be reduced by displacement due to children's activity or by material being blown by wind
- can be blown or thrown into children's eyes
- may be swallowed
- conceals animal excrement and trash (e.g. broken glass, nails, pencils and other sharp object that can cause cut or puncture wounds)
- spreads easily outside of the containment area
- small particles bind together and become less cushioning when wet; when thoroughly wet, sand reacts as a rigid material
- may be tracked onto other surfaces; when installed in conjunction with a unitary surface the fine particles can reduce the shock absorbing properties of porous unitary material. The abrasive characteristic of sand can damage most other surfaces including non-porous unitary materials and surfaces outside the playground.
- adheres to clothing

Gravel

Gravel is a naturally occurring material that will vary in texture and composition depending upon the source and geographic location from which is mined. Once mined, the raw gravel is processed or manufactured to provide specific grades and classifications through the washing, screening and other actions. Crushed or broken gravel is unacceptable, as this material will not allow of the displacement of the particles.

The impact attenuating properties of gravel will depend on many factors and can only be determined through the testing of the material to the requirements of ASTM F1292. Field-testing the surface once installed and annually, utilizing the test method of ASTM F1292, will ensure that the material installed meets the contract specification and continues to provide protection for the user.

Gravel must not be installed over existing hard surfaces (e.g. asphalt, concrete). A method of containment (e.g. retaining barrier, excavated pit, etc.) is required. A drainage system and geotextile are required between the sub-base and the gravel. Maintenance will require continuous levelling, raking, grading, sifting, packing, etc. to provide adequate cover and resilience. Inspection of the surface for foreign materials is required on a regular basis. Periodically the hardened gravel must be turned over, loosened and cleaned. Total replacement of the gravel will be required when turning and loosening no longer provides the performance required by the ASTM F1292 standard.

Gravel provides the owner/operator with a number of advantages such as:

- low initial cost
- easy to install
- does not easily support microbial growth
- readily available
- non-flammable
- not susceptible to vandalism except by contamination
- gravel is less attractive to animals than sand

Gravel provides the owner/operator with a number of disadvantages that may reduce the ability of the surface to conform to various performance standards such as:

- will not meet the requirements for accessibility and the performance required by the ASTM F1951 standard.
- rainy weather, high humidity, freezing temperatures
- with normal use over time, combines with dirt and other foreign materials
- depth may be reduced by displacement due to children's activity
- can be thrown into children's eyes
- may be swallowed
- may become lodged in bodily openings such as nose and ears
- conceals animal excrement and trash (e.g. broken glass, nails, pencils and other sharp object that can cause cut or puncture wounds)
- spreads very easily outside of the containment area
- small particles bind together and become less cushioning and forms hard pan
- may be tracked onto other surfaces. When on other hard surfaces, the rolling nature of the gravel can be a contributor to slip-fall injuries.
- difficult to walk on

Shredded Tires

Shredded tire materials are the result of either grinding, buffing or crushing the whole tire or any part of the tire. The tire particle must not contain any metals or foreign contaminants. Some processing techniques provide for the pigmenting of the outside of the black rubber; this must be non-toxic and contain no allergens such as latex.

The impact attenuating properties of the shredded tires will vary depending upon the process, shape and particle size of the product and can only be determined through testing the material to the requirements of ASTM F1292. Field-testing the surface once installed and annually, utilizing the test method of ASTM F1292, will ensure that the material installed meets the contract specification and continues to provide protection for the user.

Shredded tires must not be installed over existing hard surfaces (e.g. asphalt, concrete). A method of containment (e.g. retaining barrier, excavated pit, etc.) is required. A drainage system and geotextile are required between the sub-base and the shredded tire. Maintenance will require continuous levelling, raking, grading, sifting, packing etc. to provide adequate cover and resilience. Inspection of the surface for foreign materials is required on a regular basis. Periodically the shredded tires must be turned over, loosened and cleaned.

Shredded Tires provide the owner/operator with a number of advantages such as:

- easy to install
- not abrasive
- does not easily support microbial growth
- not susceptible to vandalism except by contamination
- less attractive to animals than sand

Shredded tires provide the owner/operator with a number of disadvantages that may reduce the ability of the surface to conform to various performance standards such as:

- will not meet the requirements for accessibility and the performance required by the ASTM F1951 standard
- may contain wires or other metal components
- depth may be reduced by displacement due to children's activity or by material being blown by wind
- can be blown or thrown into children's eyes
- may be swallowed
- may contain lead and other toxins
- small or dust sized particles may enter and remain in lungs
- when wet, small particles will stick to clothing and skin
- may become lodged in bodily openings such as nose and ears
- conceals animal excrement and trash (e.g. broken glass, nails, pencils and other sharp object that can cause cut or puncture wounds)
- spreads easily outside of the containment area
- difficult to walk on

Inorganic Unitary Materials

Mats or Tiles

Mats or tiles are generally the result of the combination of a chemical binder and rubber filler product. The mats or tiles can be manufactured using any of a combination of heat, pressure or ambient application of a mixture within a form or mold. The mats or tiles can appear to be monolithic in a single or multiple layer system or have a support or leg structure combined with a firm top. Mats or tiles can be porous or nonporous to water. Pigmentation of the surface can be provided through the pigmentation of the binder holding the rubber particles or utilizing coloured rubber particles or chips. Mats or Tiles are manufactured in various thicknesses, length, and width depending upon the properties desired by the manufacturer.

The impact attenuating properties of the mats or tiles will vary depending on the particular product and can only be determined through testing of material to the requirements of ASTM F1292. Field-testing the surface once installed and annually, utilizing the test method of ASTM F1292, will ensure that the material installed meets the contract specification and continues to provide protection for the user.

Mats or tiles can be installed over a variety of bases from compacted crushed granular to a hard surface (e.g. asphalt, concrete). They are on occasion installed within a loose fill material to reduce compaction or disruption of the loose fill materials in high traffic, repeated impact and entrance areas. The manufacturer's procedure as to the base preparation must be followed for each particular mat or tile. The installation procedure may be such as to provide for installation by the owner/operator or specialized labour. In addition, methods of fixing the mats or tiles (bonding, pins, interlocking edges, anchors etc) will be specified by the manufacturer and adhered to. The maintenance of mats or tiles can consist of the removal of large debris with sweeping or blowing, while the removal of smaller particles such as sand from porous mats or tiles will require mechanical cleaning such as a vacuum. For some mats or tiles, snow can be removed mechanically and de-icing materials can be used as per the manufacturer's recommendations. When a mat or tile has lost its effectiveness to attenuate impact as a result of degradation or contamination, the affected area will have to be removed and replaced.

Mats or tiles provide the owner/operator with a number of advantages such as:

- 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)
- harbour few foreign objects
- generally no retaining edges required
- accessible to people with disabilities

Mats or tiles provide the owner/operator with a number of disadvantages that may reduce the ability of the surface to conform to various performance standards such as:

- initial cost is relatively high
- base materials may be critical for thinner materials
- often must be used on almost smooth uniform surfaces without deviation in slope
- may be flammable
- subject to vandalism (e.g. ignited, defaced, cut)
- may curl up and cause tripping
- may shrink and cause the accumulation of dirt and debris that does not absorb impact
- may become hard over time as a result of environmental degradation. This would mean a total removal and replacement and the associated costs unless covered by warranty or insurance
- some designs are susceptible to frost damage.
- location of seams, anchors and other fasteners may not attenuate impact to the same degree as the balance of the mat or tile
- mechanical fasteners or anchors can become dislodged and present a hazard to the user

Poured-in-Place

Poured-in-place surface is generally the result of the combination of a chemical binder and rubber filler product. The poured-in-place surface can be manufactured using single or multiple layers of materials and binders and generally are monolithic. Poured-in-place surfaces are generally porous, however can be nonporous to water through the application of a non-porous material. Pigmentation of the surface can be provided through the pigmentation of the binder holding the rubber particles or utilizing colored rubber particles or chips. Poured-in-place surfaces are manufactured in various thicknesses depending upon the properties desired by the manufacturer.

The impact attenuating properties of the poured-in-place surfaces will vary depending upon the particular chemistry, components, installation technique, etc and can only be determined through testing of material to the requirements of ASTM F1292. Since the playground site is also the site of manufacture, inconsistencies can develop in the installation process, providing for detrimental variation in performance. The owner/operator may be best served with the site testing of the surface to confirm compliance. Field-testing the surface once installed and annually, utilizing the test method of ASTM F1292, will ensure that the material installed meets the contract specification and continues to provide protection for the user.

Poured-in-place surfaces can be installed over a variety of bases from compacted crushed granular to a hard surface (e.g. asphalt, concrete). Poured-in-place surfaces can also be made to conform to slopes and other shapes provided in the play environment. They are on occasion installed within a loose fill material to reduce compaction or disruption of the loose fill materials in high traffic, repeated impact and entrance areas. The manufacturer's procedure as to the base preparation, must be followed for each particular poured-in-place surface. The installation procedure is almost always through specialized labour and equipment. The maintenance of the poured-in-place surface can consist of the removal of large debris with sweeping or blowing, while the removal of smaller particles such as sand from the porous surface will require mechanical cleaning such as a vacuum. For some poured-in-place surfaces, snow can be removed mechanically and de-icing materials can be used as per the manufacturer's recommendations. When a poured-in-place surface has lost its effectiveness to attenuate impact as a result of degradation or contamination, the affected area will have to be removed and replaced.

Poured-in-place surfaces provide the owner/operator with a number of advantages such as:

- low maintenance
- easy to clean
- consistent shock absorbency
- material not displaced by children during play activities
- generally low life cycle costs
- does not require smooth uniform surfaces without deviation in slope
- good footing (depends on surface texture)
- harbor few foreign objects
- generally no retaining edges required
- accessible to people with disabilities

Poured-in-place surfaces provide the owner/operator with a number of disadvantages that may reduce the ability of the surface to conform to various performance standards such as:

- initial cost is relatively high
- base materials may be critical for thinner materials
- may be flammable
- subject to vandalism (e.g. ignited, defaced, cut)
- may shrink and cause the accumulation of dirt and debris that does not absorb impact at edges
- may become hard over time as a result of environmental degradation. This would mean a total removal and replacement and the associated costs unless covered by warranty or insurance
- some designs are susceptible to frost damage.

Combination Inorganic Loose Rubber Fill and Tile or Poured-in-place

Combination inorganic loose rubber fill covered by a tile or poured-in-place surface is generally the result of laying an appropriate depth of rubber granules or shreds covered by a plastic matting, tile or poured-in-place tops as previously described. Combination inorganic loose fill and tile or poured-in-place surface is by definition multiple layers of materials and binders and are monolithic. They are generally porous, however can be nonporous to water through the application of a non-porous material. Pigmentation of the surface can be provided through the pigmentation of the binder holding the rubber particles or utilizing colored rubber particles or chips. Combination inorganic loose fill and tile or poured-in-place surfaces are manufactured in various thicknesses depending upon the properties desired by the manufacturer.

The impact attenuating properties of the combination inorganic loose fill and tile or poured-in-place surfaces will vary depending upon the particular chemistry, components, installation technique, etc and can only be determined through testing the material to the requirements of ASTM F1292. Since the playground site is also the site of manufacture, inconsistencies can develop in the installation process, providing for detrimental variation in performance. Field-testing the surface once installed and annually, utilizing the test method of ASTM F1292, will ensure that the material installed meets the contract specification and continues to provide protection for the user.

Combination inorganic loose fill and tile or poured-in-place surfaces cannot have the loose fill components installed over a hard surface (e.g. asphalt, concrete) whereas the tile or poured-in-place surface can be installed over a hard surface (e.g. asphalt, concrete). The installation procedure is almost always through specialized labour and equipment. The maintenance of the combination inorganic loose fill and tile or poured-in-place surface can consist of the removal of large debris with sweeping or blowing, while the removal of smaller particles such as sand from porous is extremely difficult. When a poured-in-place surface has lost its effectiveness to attenuate impact as a result of degradation or contamination, the affected area will have to be removed and replaced. Movement and displacement of the loose fill material as a result of activity or subjection to water will require the removal of the topping materials and reinstallation of the system.

Combination inorganic loose fill and tile or poured-in-place surfaces provide the owner/operator with a number of advantages such as:

- lower initial cost to poured-in-place or mats or tiles
- consistent shock absorbency provided the loose material stays in place
- generally low life cycle costs
- good footing (depends on surface texture)
- harbour few foreign objects
- accessible to people with disabilities provided it remains smooth; ask for test results

Combination inorganic loose fill and tile or poured-in-place surfaces provide the owner/operator with a number of disadvantages that may reduce the ability of the surface to conform to various performance standards such as:

- initial cost is relatively high
- loose fill material can be displaced by children during play activities
- sub-base materials may be critical for thinner materials
- may be flammable
- subject to vandalism (e.g. ignited, defaced, cut)
- surface layer may shrink and cause the accumulation of dirt and debris that does not absorb impact at edges
- generally retaining edges required
- may become hard over time as a result of environmental degradation
- some designs are susceptible to frost damage
- loose fill material can shift, requiring reinstallation.

In-The-Can Inorganic Surfaces

There has of late been a development of inorganic surfacing materials that consist of a rubber crumb component premixed with a binding agent that is intended for installation by the purchaser. In most cases, the manufacturer of the product provides installation instructions as to thickness and some other techniques. Since this system, as with any poured-in-place system, requires special installation techniques and skilled labour, it is not recommended for use by the inexperienced person. Duplication of original manufacturer's result will be difficult in the field. These products are typically best suited to repairs or small additions to poured-in-place surfaces that are known to comply to the ASTM F1292 through the use of field testing.

In-the-can inorganic surfaces provide the owner/operator with a number of advantages such as:

- lower initial cost to having a specialist in poured-in-place or mats or tiles perform a repair
- consistent shock absorbency provided the installation procedures are meticulously followed
- generally low life cycle costs
- good footing (depends on surface texture)
- harbour few foreign objects
- accessible to people with disabilities provided it remains smooth

In-the-can inorganic surfaces provide the owner/operator with a number of disadvantages that may reduce the ability of the surface to conform to various performance standards such as:

- initial cost is relatively high
- sub-base materials may be critical for thin-

ner materials
- may be flammable
- surface layer may shrink and cause the accumulation of dirt and debris that does not absorb impact at edges
- may become hard over time as a result of environmental degradation.

Considerations regarding Advantages and Disadvantages

As with any product, playground protective surfacing systems must be considered on their merits. At each stage of selection, specification, acquisition, installation, maintenance, and repair, there will be costs that must be balanced with the advantages and disadvantages of the surface system or combination of systems.

Through careful specification, monitoring of the installation, and warranties, the owner/operator can shift some of the potential pitfalls and issues that can be related to premature replacement or liability to the manufacturer/supplier/installer.

Performance Requirements for Protective Surfacing

Both the CPSC Handbook for Public Playground Safety and the ASTM F1487 require that the playground protective surface conform to the requirements and test methods of ASTM F1292. This standard was originally published as ASTM F1292-91. The most recent version is ASTM F1292-99. The highlights of the standard are:

- two test methods — ASTM F355, Procedure C and the Free Fall Test Method.
- two types of tests — the three-temperature laboratory test and field testing surfaces at ambient temperature
- two forces measured — Gmax and HIC
- three heights to be considered — Critical, Drop and Fall

A summary of the ASTM F1292 is found in Section 5 as follows:

> Representative playground surface systems or surfacing material samples, or both, are tested in accordance with Test Method F355 or the free fall test method described in Annex A.1. Conduct laboratory tests at various drop heights and test temperatures. Conduct the field tests at the drop height specified and at the ambient temperature of the site within a specified range. The laboratory test method will determine the maximum drop height at which the g-max does not exceed 200 or the HIC does not exceed 1000. The field test method will determine the g-max and the HIC from the drop height specified by the initial owner/operator at the ambient temperature of the test.

The Test Methods

The traditional test was based on the method in ASTM F355 Procedure C, which consists of a head-shaped metal headform mounted to a rail or guide wires. The headform is connected to special electronic equipment that records and generates the results of the test. This instrumentation is extremely cumbersome and is very expensive to transport to a site and perform a field test. During the 1990s, a portable test instrument was developed, tested, refined, and accepted as equivalent to F355, Procedure C. As a matter of fact, a round-robin comparison in six laboratories across North America between the two test methods indicates that the results of the Free Fall Test Method are both more repeatable and reproducible than the F355, Procedure C. A summary of the round robin results is published in section 15 of the ASTM F1292-99.

The free fall test method provides a portable instrument that allows the owner/operator to readily test surfaces at the time of installation and during its life. Contractual requirements can be confirmed and warranty commitments enforced. Loose fill materials are more readily maintained when those responsible for maintenance can perform benchmark testing. The instrumentation is easily transported to the scene of an injury to record site information close to the time that the injury occurred.

Types of Tests and Performance

Section 4 of the ASTM F1292 describes two specific styles of tests, the conditions, and the performance requirements for the surface being tested. It also stipulates the action to be taken when the surface does not meet the requirements of the standard.

This is a very important section for the owner/operator because it sets out the obligations that must be fulfilled both prior to the installation and during the life of the playground. That includes the owner/operator's obligation to specify the height from which the drop is to be made for each playground surface system and playground site. Failure to comply with this section could be a significant source of liability.

Section 4.1 requires that "all surface systems must be tested in accordance with the performance requirements in 4.2", the laboratory test. This section contains two key words for the owner/operator: all and must. There are no exemptions or exceptions.

Furthermore, ASTM F1487 Section 13.3 (Records) requires that "the owner/operator shall establish and maintain detailed installation…. records." The results of the laboratory tests performed on the surface under the play equipment will be the first record that is required. Other details that should be recorded include any available description of the surface system from the manufacturer/supplier catalogues that would help to identify it. The description of the surface system —as delivered — must conform specifically to the description of the materials tested.

For loose fill materials, descriptive detail should include information such as the type of material (sand, pea gravel, etc.), sieve curve analysis of the materials, source of materials, specific weight, percentage fines. Other information specific to material such as with loose rubber would include whether the materials are from recycled tires or industrial waste and the percentage and chemical make-up of the rubber provided. In some cases, recycled rubber containing a latex component will be critical to those with latex allergies. For pea gravel, the fact that it is washed and the maximum and minimum particle size are important. The latter is also true for sand surfaces.

For synthetic surfaces, assurances that the raw materials — binders, rubber crumb, and other components — are identical to those used in the tested samples should be included.

For mats, a description of the thickness of the structure top compared to legs must be recorded as well as a description of the mechanical structure of the mat. This could be the shape, size, and layout of the support legs. In some cases, records should include the size of the rubber, the source of rubber (recycled or new materials), chemistry of the rubber (SBR, latex, Butyl, EPDM, etc.), type of particle (shreds, buffings or crumb). Changes in any or all of these components will have an affect on the outcome of the test results for the product in which they are used.

For poured-in-place systems, the same component information must be provided as well as the assurance that the installation labour has been trained to exactly duplicate what has been provided in the samples submitted for laboratory testing.

These issues raise the reason for the recommendation in Section 4.1 of the ASTM F1292 Standard that "surfaces may also be tested in accordance with 4.3." This is the field test at ambient temperature. It allows the owner/operator the opportunity to fulfill the requirement in ASTM F1487 Section 13.3 for detailed records of installation and inspection.

Recording Velocity at Impact

One key element for both the free-fall test procedure and the ASTM F355 Procedure C is that the velocity at the point of impact must be recorded. The velocity measurement is used to confirm the drop height. The velocity recorded for the physical drop height must be within ±0.5 ft/s of the theoretical velocity for the drop height given. This assures the user of the test results that, for the free fall method, the device was actually dropped from the location reported and, for the guided method, that there is no friction in the drop system that would adversely affect the results. With this component it is virtually impossible to fake or provide erroneous drop heights and data for the drops either in the laboratory or in the field. The written record of the results of the velocity, the Gmax and HIC will be invaluable in assessing an injury or in litigation.

Laboratory Testing

As discussed above, ASTM F1292 Section 4.2 stipulates that

> " When tested in accordance with Test Method F355 or the free fall test method in Annex A1, using an average of the last two of three drops, no value shall exceed 200 g-max or 1000 HIC for laboratory tests at temperatures of 30, 72, and 120°F (-1, 23, and 49°C), respectively."

At least nine samples are delivered in a prescribed size. Loose fill systems are tested in a box that is 18"x 18" x a depth sufficient to hold the materials in the box during the test. For non-loose fill materials, the minimum sample size is 12" x 12" x the thickness of the system to be installed. In addition, the samples shall be representative of the way they are to be found in the playground, "including seams, partitions, corners and fasteners, or other areas that may result in less than optimal impact characteristics."

Each sample is preconditioned at 50±10% relative humidity and 72±5°F for a minimum of 24 hours. The samples are then tested at three temperatures, 30, 72 and 120°F after conditioning at that temperature for a minimum of four hours.

The impact tests are carried out to a maximum drop height in one-foot increments, provided that neither the Gmax exceeds 200 nor the HIC exceeds 1000. Tests are performed at one foot above and below this maximum drop height. Three drops are performed at each incremental drop height. The drop height at which either the Gmax exceeds 200 or the HIC exceed 1000 at any of the three temperatures is the critical height for the surfacing system. This is a key measure for the manufacturer, supplier, installer, and the owner/operator since a head impact with greater forces could result in a life-threatening injury.

The laboratory test results will provide the critical height for the surface system. When due diligence is applied, no part of the structure that is determined to be the potential location from which a child could fall shall exceed the critical height of the surfacing system.

Field Testing

The field test differs from the laboratory test in a number of respects. The most important is that it determines the Gmax and HIC for the surfacing system from the drop height originally stipulated by the owner/operator prior to purchase. This test is to be performed at the ambient temperature at the time of the test without any preconditioning of the area for temperature, humidity or compaction.

The field test is important in that it provides the owner/operator with a number of opportunities. The first is to confirm that the contractual obligation regarding the performance of the materials purchased is greater or equal to the performance specified in the contract and can be recorded. The second is to provide maintenance staff with the opportunity to see how the surface system should be maintained to provide adequate performance. Thirdly, annual testing can go a long way to meeting the requirements set out in ASTM F1292, ASTM F1487, and the CPSC Document 325. A fourth opportunity is for the owner/operator to determine compliance to warranty performance where this forms part of the warranty.

The field test is performed at ambient temperature at the time of the test. The temperature of the surface is recorded. In Northern areas, this could mean that the surface temperature is well below that of the lower laboratory test temperature. In southern areas or areas of high solar radiation, the surface temperature could exceed the laboratory high temperature threshold. For the field-test, this has no bearing on the collection or recording of data. There must also be no preconditioning of the surface and, specifically, the person performing the test shall select impact sites that include areas displaying less than optimum impact characteristics. The test generally is to determine failures, should there be any at the playground location. Therefore, areas of high traffic, compressed or worn materials, or areas containing seams, partitions, corners and fasteners/anchors are to be sought out.

For the field test, a minimum of three locations at each playground are tested. At each location, three drops are performed from the height specified by the original owner/operator. The Gmax, HIC, and velocity at the point of impact are determined and recorded. The Gmax and HIC results for the last two of the three drops for each value are averaged and the Gmax and HIC for the location are determined. The velocity reading is important in determining that the velocity and the theoretical velocity do not vary by more than ±0.5 ft/s at the drop height used.

Results of the Field Tests

For interpretation of the results of the field test, ASTM F1292 Section 4.4 provides that “the surface system should be made to comply or the playground equipment on the surface should not be used until the surface complies” when the test is performed at ambient temperature and the results exceeds 200 Gmax or 1000 HIC at the height specified by the owner/operator. The reasons for the failure could include frozen and winter conditions; however, the standard does not make any exception for these circumstances. This becomes a matter of risk management and the exercise of professional judgement as to how to take a playground structure out of service. This will b a consideration for all owners and operators where freezing is a fact of life.

In any event, a failure of the field test means owner will be required to take action. This should include closing the playground until the surface can be maintained or replaced. Failure to do so could place the user at risk and raise the exposure to liability for the owner/operator. Where it is determined that the surfacing system must be replaced, the Field Test Procedure can be used to map the specific areas that would be the subject of the replacement. This can reduce the cost of the replacement, as the entire area would be otherwise replaced. Follow-up testing is to be used to determine that the playground surfacing system from the drop height as originally determined does conform to the requirements of the Standards. Detailed records of the process are to be made and kept.

It is important that all repairs or replacements that do not cover the entire playground be made with original materials and by the original manufacturer/supplier. Failure to do this may cause contamination of or conflict with the existing or replacement materials.

Playground Layout

CSA Z614-98 Section 14 outlines the extent to which protective surfacing and no-encroachment zones must be provided for each piece of playground equipment in general and certain specific pieces of equipment. These are minimums. It is incumbent upon the owner/operator to exercise due diligence in the areas that would best accommodate their users. The specifics for layout are in the following table.

Structure Type	Section in CSA Z614-98	Protective Surface Zone measured from unloaded structure	Protective Surface Zone Special Rules	Protective Surface Zone Overlap of other PS Zones	No-Encroachment Zone
Stationary	14.2.1.2	> 1800mm (72 inches)		May overlap	No
Rocking/ Springing For sitting	14.2.2.1	> 1800mm (72 inches) in all directions		May overlap	No
Rocking Springing For standing	14.2.2.2	> 2100mm (84 inches) in all directions		No	No
Rotates around vertical axis	14.3.1.1	> 1800mm (72 inches)		No	Yes
Rotates around horizontal axis	14.3.1.2	> 1800mm (72 inches)		No	Yes
To-Fro Swings open seat direction of the motion	14.3.2.1.1	2Y to front and back where Y is the distance from loaded seat to pivot point		No	Yes
To-Fro Swings Enclosed seat direction of the motion	14.3.2.1.2	2Y to front and back where Y is the distance from the sitting surface to pivot point		No	Yes

To-Fro Swings 90° to direction of motion	14.3.2.1.5	> 1800mm (72 inches) from the support structure	At least as wide as the length of the suspending beam	Support structure zones may overlap	No
Rotating Swings	14.3.2.2.1	> 2Y where Y is the distance between the top of the seat and the pivot point	Extend >1800mm (72 inches) from structure	No overlap to other structures	Yes
Slides in direction of no motion	14.4.1	> 1800mm (72 inches)		Yes	No
Slides in direction of motion with platform ≤ 1200mm (48 inches)	14.4.2.2.1	> 1800mm (72 inches) from the end of the slide		No	Yes
Slides in direction of motion with platform > 1200mm (48 inches)	14.4.2.2.	X + 1200mm (48 inches) from transition, X is the height of the platform above the protective surface	Lower exit is where transition is to less than 5° or from the end of the slide. ≥1800mm (72 inches) from lower exit and may be no greater than 4200mm (68 inches)	No	Yes
Track Rides	14.5	≥1800mm (72 inches) in all directions		No	No
Cable Rides	14.6	≥ 1800mm (72 inches) along cable, centred on cable	≥ 1800mm (72 inches) around structure	No	Yes at the sides

The Three Heights of Playgrounds

In the previous sections, the noun “height” has been used repeatedly with one of three adjectives: critical, drop or fall. Each of these has a specific meaning within the standards, their application, and their relationship to the exercise of due diligence.

The Fall Height is the height that has been defined in CSA Z614-98 as the vertical distance between a designated play surface or the top of a guardrail and the protective surfacing beneath it. The designated play surface is any elevated surface for standing, walking, sitting or climbing or any flat surface greater that two inches (51mm) wide and having an angle of less than 30° from horizontal. For swings, the fall height is the vertical distance from the protective surface to the pivot point where the swing is attached to the supporting beam.

The Critical Height is the maximum height from which the instrumented headform could be dropped at any one of the three laboratory test temperatures and either the Gmax ≥ 200 or the HIC ≥ 1000. This is also the height from which it can reasonably be expected that, when forces exceed those allowed in the test, a life-threatening head injury could occur.

The Drop Height is the vertical unobstructed distance from the underside of the instrumented headform to the surface being tested. In the laboratory, the Drop Height is incrementally raised until the Critical Height is determined. In purchase specifications, contracts, and the field test procedure, the Drop Height is the height specified by the original owner/operator of a playground surface, prior to purchase, from where the instrument head is to be dropped for data acquisition and reporting and recording the Gmax and HIC for that specific surface.

Since the scope of ASTM F1292 states that this Standard covers minimum impact attenuation requirements, the owner operator has the option of setting both the Drop Height and allowable performance, provide that performance is better than the requirement of the Standard.

All of the data indicates that for forces greater than the pass/fail of the Standard, a life-threatening head injury could occur. In addition every playground surface is dynamic and subject to change resulting from either active play or environmental influences — with the likely result of worsened impact attenuation properties. Since the CPSC Handbook for Public Playground Safety and ASTM F1487 both require that the protective surface be maintained to the minimum performance of ASTM F1292, it is only prudent that the surface system — when initially installed and as much as possible while in use — provide forces lower than those required in the Standards. The owner/operator, their consultants, and risk managers should set these performances.

The determination of the Drop Height for the purpose of specifications, contracts, warranties, and the field tests are totally at the discretion of the owner/operator, provided the determination is made prior to the purchase of the protective surface. As a minimum, the drop height for each piece of playground equipment must not be less than the fall height as determined in the CPSC Handbook for Public Playground Safety or ASTM F1487. Since the forces tested are related to gravity, it is only logical that the higher the point from which a child falls, the higher and worse the forces will be. As a result the owner/operator must set the

Drop Height and the point from which the surface performance will be measured. It should be a height which the children using the playground can be expected to "climb to, or jump from" during active play.

As a result of the exercise of due diligence, the owner operator makes various determinations of the playground under consideration, the relevant Standards, the design of the structures, and the expected pattern of play expected from the children using the structures. An example of this process could be as follows:

A particular structure has been designed to meet the requirements of ASTM F1487. It has raised platforms with the appropriate protective barriers, which are designed to prevent both inadvertent and deliberate attempts to pass through, but could still be climbed. The circumstances that lead the child to climb the barrier are not material. Everyone has seen children, from time to time, pass over a barrier. If this is determined to be likely, then the Drop Height would be set at the top of the barrier railing and above the Fall Height — the platform, in this case — provided the railing does not have a flat surface greater than two inches.

The process of real-world assessment of the playground is the responsibility of all those involved in the specification, design, and acquisition. With this process in place, a combination of field inspections of both the structures and surface systems — at the time of installation and throughout the life of the playground — and the provision of financial, labour, and material resources to maintain the playground can keep it within the originally intended design and specifications.

The Canadian experience has been to provide accessibility as required and through the exercise of professional judgement. Major initiatives such as the Ontario Parks Association Playability Program provide guidance for providing access to a playspace.

Although good practice should promote access to facilities, in the United States this has become the jurisdiction of a federal agency know as the Access Board, established in 1973. The board's role is to promote federal design standards to remove architectural barriers for people with disabilities, to make rules or guidelines, and to enforce implementation. Detail on the Access Board can be found on the internet at www.access-board.gov.

During the 1990s, interested stakeholders came together to develop Accessibility Guidelines for Play Areas. At ASTM, one new standard (ASTM F1951) was developed by the F08.63 sub-committee for playground surfacing. ASTM F1487 has included Section 8, which provides for accessibility. In late 2000, the Access Board published a new section (15.6) to its ADA Accessibility Guidelines (ADAAG) that covers all newly built or altered playgrounds. Now that these have been adopted, the Department of Justice will be tasked with enforcement.

In this course, we look at accessibility as it relates to surfacing for the use zone and circulation, including the accessible route, materials that can be used, and the maintenance required to meet Section 15.6 (ADAAG).

The Access Board has determined that a playground consists of a collection of individual play components. A minimum number are required to be accessible. Of the total number of play activities in a playground, a certain number must be accessed at ground level. This rule changes under certain circumstances. It is incumbent upon the designer, manufacturer, installer, and owner/operator to become familiar with the detail of the Guidelines. The following tables provide an overview of the requirements:

Ground Level Play Components

Two criteria must be met with Ground level components;

- Access is required to at least one of each type provided
- The number of elevated components also determines the minimum number and variety to be provided.

Play Components

Number of Elevated Provided	Ground Level Components Required
2 - 4	1
5 - 7	2 (at least 2 types)
8 - 10	3 (at least 3 types)
11 - 13	4 (at least 3 types)
14 - 16	5 (at least 3 types)
17 - 19	6 (at least 3 types)
20 - 22	7 (at least 4 types)
23 - 25	8 (at least 4 types)
over 25	8 plus 1 for each additional 3 over 25, or fraction thereof (at least 5 types)

Elevated Play Components

At least one-half of the elevated play components must be accessible by either a ramp or transfer station.

Total Provided	Ramp Access	Ramp or Transfer System Access
less than 20	not required	50% min.
20 or more	25% min.	25% min.

Accessible surfacing must be "firm, stable and slip resistant" as defined in the ADAAG and meet the ASTM Standard F1951, as well as ASTM F1292.-99.

ASTM F1487, Section 10, Accessibility

There is no requirement that all of the protective surface in the playground must provide accessibility; however, ASTM F1487 says that "at least one accessible route within the use zone shall be provided from the perimeter to all accessible play structures or components." Where necessary, more than one accessible route is to be provided. This accessible route must not be less than 60" in width and must meet the requirements of ASTM F1292. As a result, the surface cannot be a hard material such as asphalt, concrete or structural wood. In addition, the accessible route must be designed to minimize the possibility of tripping or having a wheelchair slide off the edge and tip over. Combination surface systems may not be able to meet this latter requirement.

ASTM F1951 - Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment.

As with the ASTM F1292, this is a performance-based standard. At the present time, it only provides for a laboratory test procedure to determine the suitability of the surface system for use under the ADAAG. The test procedure is laboratory based. A 4ft x 8 ft sample of product is submitted for testing. One procedure requires a straight traverse, while the second requires that a 90° turn be negotiated.

The intent of this test is to provide comparative information regarding crossing a 6.56 ft test surface within seven seconds for a minimum of five trials each on the product sample and on a smooth, hard, 1:14 sloped surface. The wheelchair user must be 165, +11, -4.4lb to qualify for the test. In addition, the surface sample may be levelled and compacted between test runs. The work required traversing each sample and the control surface are measured and recorded separately for the straight and turn traverses.

The performance requirements of this standard are such that the work required to traverse the playground system must be less than the traverse up the sloped, smooth surface.

A part of the test procedure is the complete description of the playground system tested. Provided enough detail is available at the time of the test and when a surface system is presented to an owner/operator, there should be some assurance as to similarity between the sample tested and the product to be delivered.

When assessing the use of a surface that has passed the requirements of the ASTM F1951, the practitioner and owner/operator must consider a number of aspects of both the surface being proposed and the test procedure. The average weight of the maximum user for the playground, a 12-year-old child, is 94 lbs. for girls and 89 lbs. for boys. Therefore, an expectation of similar performance to the results achieved by a 165 lbs. rider may not be reasonable. The test results indicate the amount of work required to traverse the surface in a specific amount of time. As a result, there may be a need to accommodate users of the playground with a combination of loose fill materials that have passed ASTM F1951 and unitary materials that have the same or better traversing properties.

Best Practice, Due Diligence, and Supervision

Standards set the minimum performance for the surfacing system and are the starting point to determine better practices and due diligence. This becomes the best defence in terms of negligence and liability.

Our initial objective in this discussion on playground surfacing was to eliminate as much as possible life-threatening head injuries and reduce the severity of all other injuries resulting from a fall to the playground surface. The standards and guidelines that have been reviewed are minimum values and at the threshold that could lead to the life-threatening head injury. Reduction of injuries in the playground is many-facetted. Virtually all standards throughout the world recognize that injuries will occur.

The preface to CSA Z614-98 indicates the historic roots of the document. Action was required to improve play equipment and playspaces, with the goal of reduced injuries. There is no specific statement regarding injury within the body of this standard. ASTM F1292 Section 1.2 states:

> "this specification does not imply that an injury cannot be incurred if the surface system complies with this specification."

ASTM F1487 goes further, stating:

> "This consumer safety performance specification does not eliminate the need for supervision of children on public playground equipment. It is intended to minimize the likelihood of life-threatening or debilitating injuries, such as those identified by the CPSC."

The CPSC Handbook for Public Playground Safety states:

> "Because all playgrounds present some challenge and because children can be expected to use equipment in unintended and unanticipated ways, adult supervision is recommended….. A playground should allow children to develop progressively and test their skills by providing a series of graduated challenges. The challenge presented should be appropriate for age-related abilities and should be ones that children can perceive and choose to undertake."

The reality is that when the playground no longer provides the challenges that children need to develop mentally, socially, and physically, they will find those challenges outside the playground and potentially be faced with greater risks than in the playground.

The practitioner involved in any aspect of the playground must use professional judgement in his or her work. Where possible, performance results of certain aspects of the playground should be stipulated in specifications, contracts, and warranties to be better than the minimums required in the standards. This is the application of "best practice." Best practice will be determined by those involved with each playground and will be specific to the needs of the users of the playground environment. Since the standards require that documentation be developed and maintained, a section that relates to the application of the relevant standards should be included.

Application and Enforcement of Standards

All of the Standards related to playgrounds and the CPSC Handbook on Public Playground Safety are voluntary. CSA is a standard writing body that does not have the mandate or ability to enforce the practices, specifications, standards, or guidance that are provided in their publications. Although persons with regulatory abilities are welcome and do sit on various committees, the activity at CSA is to develop standards. Section 6.1 of CSA Z614-98 does require that:

> "playground equipment represented as complying with this Standard shall meet all applicable requirements specified herein. Anyone claiming compliance with this Standard shall keep such essential records as are necessary to document the claim that the requirements of this Standard have been met."

Any risk manager will dispel the notion that, since the standards are voluntary, they do not have to be followed. If nothing else, failure to comply to standards that have been set through a consensus process by persons considered to be expert in a particular subject will draw considerable liability to everyone involved in deciding not to implement the standard. Disregard for a standard is a very perilous activity.

Mandating standards is the purview of those with the authority — either through legislative authority or contract.

The installation of any playground or component will involve a contract between the owner/operator and the manufacturer/supplier/contractor. Logic dictates that there will be — at minimum —a description of the services or product to be provided, an agreed price, delivery date, and some agreement to pay. This is a contract. This will also form a major part of the documentation required in CSA Z614-98.

It is in the contract and specification that the owner/operator exercises his or her ability to mandate the standards. Beyond the legal description of the parties and general terms and conditions, the detail of the specification for a playground surface will include the following:

- Location of the installation site
- Layout and other dimensional information regarding the quantity of material to be installed
- Drop height for the field testing of the surface; i.e. tops of all horizontal railings for the composite structure
- Gmax must be less than ### (maximum is 200) and HIC must less than ### (maximum is 1000) from the specified drop height
- The number of years in which the playground surface will be field tested and required to meet the performance above at the drop heights specified with this compliance being the responsibility of the manufacturer/supplier/installer
- The number of years the surface manufacturer/supplier/installer must warrant the surface and that the warranty must, along with defects in materials and workmanship, cover the maintained surface to meet a stated performance for impact attenuation
- The manufacturer/supplier/installer must provide a certificate that the materials used in the playground site are of same like, kind, and source as the surface systems for which test certificates are being submitted; that unitary surfaces and especially multi-layer surfaces are the same formulations and per-

centage used as those for which test certificates are submitted

- The manufacturer/supplier/installer must provide a certificate from an independent third party laboratory for tests with regard to ASTM F1292, ASTM F1951 and any other standards relating to playground surfaces as dictated by the intended use of the surface
- An agreement to abide by the results of any field testing, provided it is performed as prescribed in ASTM F1292-99
- For unitary systems, a certificate from the manufacturer of the polymer binders that they have been design for outdoor playground use and are stable specifically to UV and submersion in water from time to time.

The alternate form of mandate is legislative. This is where a federal, provincial or municipal governing authority produces a specific piece of legislation or uses existing legislation to develop a regulation that requires the use of any specific standard or guideline. For playground safety issues, this is generally under the jurisdiction of health agencies or agencies that provide licensing for a facility such as daycare centres. For other issues such as accessibility, the relevant governing body would provide the mandate — for example, a municipal policy.

Two mandates of standards worth noting are the California Playground Regulations and the Province of Ontario, Canada, Day Care Policy. Each of these demonstrates that the standards they mandate are recognized as being the minimum standard for playground safety for the jurisdiction. For California, the documents references are the CPSC Publication # 325 and ASTM F1487-98. The Province of Ontario references CSA Z614-98 Children's Playspaces and Equipment.

The California Playground Regulations are worth noting in that they take certain sections of each document and make them a requirement. As well, they have legislated a change in the language of the documents from suggestive to mandatory. This legislation makes specific reference to the design, assembly, installation, and maintenance sections of ASTM F1487 and CPSC documents. This has the effect of placing into law the obligations for the designer/manufacturer and the owner/operator. This regulation requires that all playgrounds be initially inspected by October 1, 2000 and that operators implement the changes required in the inspection. Specific details on the regulation can be found at www.dhs.ca.gov/epic/html/playgrnd.htm.

The procedure to mandate in the Province of Ontario, Canada was to develop a policy under the Day Nurseries Act. All licensed daycare facilities must be inspected by an independent third party inspector for compliance with CSA Z614-98. All playground surfaces are to be inspected using the field test method of ASTM F1292. As a result of the inspection, the owner/operator must bring the structures and surfaces into compliance with CSA Z614-98. The policy requires annual inspections.

There is a trend on the part of regulators to adopt and mandate part or all of the standards as they have been published. In some cases, local health inspectors are using their powers under existing legislation to mandate the standards through health inspections. Generally this follows the logical progression that failure to perform to the requirements of the standard could lead to a life-threatening or debilitating injury. Since the inspector has the obligation to protect the public from this type of hazard, he or she takes whatever steps they are empowered to take to correct the situation.

Even with the trend to mandate compliance to standards, it is, if nothing else, the moral obligation of the person, group or organization involved with providing the playground to review existing policies, procedures, inventories and bring them into compliance. All injuries will not be prevented through the application of the standards — as each standard recognizes — however taking positive steps can lead to reductions that would not happen otherwise.

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3. American Society of Testing and Materials, ASTM F -1487-98
4. American Society of Testing and Materials, ASTM F -1951-99
5. Handbook on Public Playground Safety, publication # 325, date code 009711, Consumer Product Safety Commission, Bethesda, MD
6. Consumer Product Safety Commission, Bethesda, MD., Impact Attenuation Performance of Surfaces Installed Under Playground Surfaces, Feb 79
7. Watson & Tipp, Safety Surfaces for Children's Playgrounds
8. Theodora Briggs Sweeney, "Playground Accidents: a new perspective" Trial, the National Legal News Magazine, volume 15, no. 4, April 1979.
9. Theodora Briggs Sweeney, Statement before the U.S. Consumer Product Safety Commission, May 11, 1977
10. Peter Werner, "Playground Injuries and Voluntary Product Standards for Home and Public Playgrounds", Paediatrics Vol. 69 No. 1, January 1, 1982
11. U.S. Consumer Product Safety Commission, A Handbook for Public Playground Safety, Volume 1, 1981

12. U.S. Consumer Product Safety Commission, A Handbook for Public Playground Safety, Volume 2, 1981

13. Canadian Standards Association, CAN/CSA-Z614-98, Children's Playspaces and Equipment, National Standard for Canada, 1998

14. Oppenheim, Lloyd's Non-Marine Underwriters, Insurance Bureau of Canada Bulletin Report AM93-02, Feb 93

15. California Code of Regulations, Title 22. Social Security, Division 4. Environmental Heath, Chapter 22 Safety Regulations for Playgrounds

16. Accessibility Guidelines for Play Areas, Access Board, www.access-board.gov.play, January 2001.

About the Author

Rolf Huber, a graduate of McMaster University, has been involved in the manufacture and installation of playground surfaces since 1981. From 1981 to 1984, he was involved in the development and manufacture of Elastocrete and training sessions in Europe. Following 1984, Rolf Huber worked with his team to invent the EVERPLAY poured-in-place systems and the EVERPLAY Mat systems.

Rolf Huber is a member since 1990 of the CSA Z614 task group for the Canadian Standard for Playspaces, the ASTM F08.63 sub-committee that sets the standard for impact attenuation, accessibility, and flammability of playground surfaces and Co-chair of the ASTM F08.23 sub-committee for Tennis Courts and Running Tracks.

He has worked to educate owners and operators of playgrounds on the need for effective and well-maintained surfacing.