EVERYPLAY NEWS

EVERPLAY International Inc.

Volume 17, Issue 1, January 2010

January 2010

Are Protective Surfacing Standards Adequate?

Any examination of the adequacy of playground protective surfacing must include the mechanics of play, and the benefits of play in relation to the potential of an injury to the participant. Both the injury severity, its long-term effects on the body part that is injured are important to the discussion. Play is extremely important in the development of children. Children will find age appropriate activities based on their abilities and in some cases as a result of the activities of their peers and siblings. Play consists of creative, social, physical and quiet play and can take place anywhere including the formalized structure based playground.

Although play occurs in many settings and injuries are not restricted to the formalize playground, it is the injuries in the formalized playground that has created the need for injury prevention and standards. The initial work in standards was to prevent injuries that could cause death. These included the prevention of head and neck entrapments, strangulation, protrusions that could penetrate in the eye socket and impact related injuries with surfacing that could cause a life-threatening head injury. The scope of almost all playground standards around the world state that compliance with the standard should prevent, to the extent possible, the life-threatening and debilitating injury.

In reviewing playground injury statistics it becomes obvious that falls from the play structure to the surface below is by far the leading cause of injury in the formal playground setting. As a result all playground standards have a requirement for the provision of an impact attenuating protective surface within the use zone of each play structure. Given that these standards are based upon prevention of the life-threatening injury, the pass/fail that has been established has been based on values above which a life-threatening head injury could occur. For all areas other than those covered by the Cen standards these values have been that the Gmax shall not exceed 200 and the HIC shall not exceed 1000 from the fall height and use zone stipulated for each piece of equipment in the relevant standard. These values were originally developed through injury prevention studies in the automotive industry.

For the past decade there have been a number of authors and studies who have questioned the adequacy

News from ASTM F08.63

The meeting in Atlanta saw advances in the poured-in-place performance standard. This standard will be of assistance to suppliers and purchasers in providing reliable surfacing.

Following a round robin utilizing 6 Rotational Penetrometers, this test method has been advanced and should move through the final balloting over the winter.

A task group is working on the development of a performance standard for loose rubber as a protective surface.

Another task group is working on a test method for flammability.

New items include the review of the pass/fail values for ASTM F1292.

The performance standard for sand as a protective surface appears to be stalled in task group.

of playground protective surface impact attenuating standards in the protection of children. To properly review the question of adequacy, we will have to review the level of injury society finds acceptable in relation to the benefit of play in the playground. The automotive industry has looked at the measure of severity of injury in a number of ways. One way is to look at the diminishment in the quality of life as a result of injury, while another is to look at the cost of treatment of the injury, and another would be to look at the frequency of a type of injury. These do not always rank in the same direction.

Playground injuries related to falls to the surface where some form of medical attention is required are most highly related to the head injury or a long bone injury. Prevention of the life-threatening head injury has been a component of playground related standards and guidelines since 1979. The discussion today is twofold with consideration as to whether the HIC value not exceeding 1000 is appropriate in preventing the lowest reversible head injury. Studies using anthropomorphic child dummies have indicated that the value would more correctly be not exceeding 840 HIC. Additionally the National Highway Safety Traffic Administration (NHTSA) have developed injury criteria for use with various child crash test dummies (six-year-old, HIC 700; three-year-old, HIC 570; and one-year-old, HIC 390). An alternative view comes from injury prevention studies in hockey and football which focused upon the prevention of concussions which suggests that the Gmax of any impact should not exceed 100.

Many researchers have come to consider the prevention of the long bone injury as the next frontier in reducing playground injuries. Studies in Montréal, Sydney and Toronto have looked at long bone injuries and their relationship to playgrounds. They have alternatively looked at the height of the playground from which the fall took place, the height of old play structures versus new play structures and correlated them to an injury. Others have looked at severity of a fracture caused by a fall from a playground structure as opposed to falling from a standing height. Studies in both Montréal and Sydney looked at the incidence of long bone injuries and impact attenuating values of the surface and found that long bone injuries can occur at Gmax values as low as 100 and the risk of a long bone injury are three times greater for values above 200 Gmax as compared to values below 150 Gmax.

The human head is a complex system consisting of skin, bone and it's contents; however in the case of playground impact injuries to the head, we are mostly concerned with damage to the contents which includes the brain and the soft tissue membranes around the brain. Injuries to the brain are the result of either a head impact or an abrupt head movement and the resulting injuries may be due to a skull fracture, the brain impacting the interior of the skull, or from external stress to the brain. Automotive research and more recently research using multiple accelerometers inside football helmets have shown that this type of injury can be related directly to the g's and the time duration of the impact. It is for this reason that playground surface testing takes into consideration the Gmax and the HIC.

The long bone injury is much more complicated in determining the direct factors related to each type of fracture. Studies related to long bone injury in child abuse (M.C. Peirce et al.) have pointed out that the type and location of a fracture is a direct reflection of the type, direction and magnitude of forces required to cause that specific fracture type in that specific bone and location in that age-specific child. A fracture is a direct reflection and result of the destructive energy generated by the injury event. The fracture morphology reflects: (1) the forces and result in stress generated by the specific mechanism and (2) the ability of the bone (with its surrounding soft tissues) to resist these forces. The effects of force acting on the body include acceleration (or deceleration), and deformation (Hall, 1999, p. 77). Factors that influenced deformation include strength, elasticity and geometry of the object. If the yield point or elastic limit is exceeded and deformation is permanent, a bowing or plastic deformation of bone tissue results (Mabrey & Fitch, 1989). When deformation exceeds the ultimate failure point, mechanical failure of the structure occurs, which in the case of bone is manifested as a fracture. As a result the use of Gmax in evaluating playground surfacing in the prevention of long bone injuries would be valid. Hyde and others have found that bone may withstand a higher force (ultimate load) when the force is rapidly applied than it may sustain when a lower force is applied slowly. In other words bone is stronger under dynamic loading than static loading. An example would be the application of a large load to lower extremity over an extended period of time would produce a greater risk of fracture than the same load applied rapidly. This would bring into consideration the use of a force over time calculation similar to HIC or looking at the jerk value associated with the impact.

Since a long bone injury from an impact with the surface is also related to the angle of the bone to the vector of the impacting force and any rotational forces applied during the impact moment, it is very difficult to establish a single criterion in the prevention of the long bone injury. Playground structures can allow a child to fall from a standing height to up to 5 meters above the surface. An assumption being made is that most falls in the playground are accidental and therefore the orientation of the body will be haphazard. With the velocity due to gravity being 9.8 m/s per second, and taking into consideration that the average adult reaction time in a automotive braking situation is 1.5 seconds there is no chance that the child will be able to orient their body in such a way as to minimize the results of the fall.

Statistics from Safe Kids Canada indicate that approximately 2500 children each year are noted to hospitals as a result of falls to the playground. Of these approximately 80% are for the treatment of broken bones, while an additional 14% are for head injuries and the balance are for injuries such as dislocations in open wounds. Close to half of the playground injuries take place during the summer months and the bulk of the injuries take place on playgrounds, parks and school grounds.

No discussion on playground protective surfacing would be complete without a review of some of the more popular materials that are used for this purpose. Although the focus here is to look at the injury prevention characteristics of surfacing, it is beneficial to add the additional aspect of accessibility in the review of the surfacing. This is primarily as a result of standards and legislation recommending and requiring a minimum of one accessible route at ground level through each playground.

The discussion below makes the assumption that the materials, although potentially highly variable, have been tested to ASTM F1292 to provide a critical height that is higher than the fall height of the play structures in the playground. All playground surfacing should have a geotextile separation between the sub-base and surfacing material. A common property to all impact attenuating materials will be a yielding to the application of a load. In the case of synthetic surfaces and generally also engineered wood fibre the surface returns to it's got a rest position following impact. For loose fill systems there is usually a displacing and dispersing associated with the impact attenuation, resulting in the need to physically return it to the impact location as part of a regular maintenance program. The degree of maintenance for all systems will be dependent upon the system itself and the intensity of use that the playground receives.

Pea gravel or metering stone have been used for decades as protective surfacing in playgrounds. Typically these are uniformly sized, washed, rounded stone and generally available within 200 km of the actual playground. When installed and maintained to a depth greater than 30 cm, the surface can provide excellent impact attenuating properties. This surface, depending upon the source of the stone, has a tendency to form hardpan which diminishes the impact attenuating properties. Additionally pea gravel does not provide the firmness and stability required for an accessible surface.

Sand is one of the most abundant and universally occurring materials around the world and has for this reason become one of the most popular playground surfaces. Although recent published news reports would suggest that sand is an exceptional impact attenuating material, it is important to note that not all sand is good protective surfacing. Certain sands installed and maintained provide exceptional impact attenuation, while others would barely protect a child. The more impact attenuating the sand is the less firm and stable it will be, making it unsuitable as an accessible surface.

Woodchips are a generic material that can be manufactured in a number of different ways. There is no standard for this material and it could contain wood chips, bark and leaves and twigs which may be undesirable. It is up to the purchaser to determine the suitability of the material. Generally this material has good impact attenuating and accessibility properties but these will have to be confirmed in a field test. Depending upon the installation technique this material can be disrupted in high traffic areas and will require maintenance to continue to be used as an accessible surface.

Engineered wood fibre is a material that meets the requirements of ASTM F2075 which stipulates its properties. EWF when installed and maintained to a minimum depth of 30 cm is an exceptional impact attenuating surface. This surface also provides the firmness and stability required for an accessible route; however maintenance will be required in areas of high traffic to provide a smooth surface.

Rubber mats and tiles are some of the oldest synthetic playground surfacing types. These surfaces are typically purchased with the first consideration to cleanliness and accessibility. Depending upon the manufacture and thickness of the mat the impact attenuation properties, although meeting a standard, may be less than desirable. As a result it is incumbent upon the purchaser to require that when tested in the field these products yield a Gmax

EVERPLAY INTERNATIONAL INC.

18 Automatic Rd., Unit 12,
Brampton, Ontario,
L6S 5N5
Canada

Phone: 416-410-3056
Fax: 905-494-1136
Email: rolf@everplay.com
henry@everplay.com
adam@everplay.com
Web www.EVERPLAY.com

State of the art is not a limit, it is a point of departure

less than 125 and HIC less than 800 from the tops of the associated play structures. A minimum of a five-year warranty, including compliance to impact attenuation standards from the initial drop height, is essential.

Poured-in-place surfacing is generally a multilayered system involving the bonding of rubber crumb and chips to one homogeneous surface. These surfaces have typically been purchased for their cleanliness and firmness and stability as an accessible surface. Generally these surfaces have been known to have marginal impact attenuation properties and with exposure to sunlight tend to fail impact attenuation standards within a few years after installation. As a result it is incumbent upon the purchaser to require that when tested in the field these products yield a Gmax less than 125 and HIC less than 800 from the tops of the associated play structures. A minimum of a five-year warranty, including compliance to impact attenuation standards from the initial drop height, is essential.

There have been a number of surfaces invented for playground use since the year 2000 that incorporate a sheet material or synthetic turf. Since these are relatively new to the market, it is essential that the owner/operator establish sound purchasing criteria and require the same performance as expected for a rubber mat or poured-in-place surface.

Although there have been many injury prevention studies over the past 15 years, they tend to fall short from the point of view of the playground practitioner, the owner/operator and the child looking for active and challenging play from the play structure environment. A general conclusion appears to be that lower structures also have lower incidence of injury however most of these conclusions are based on a correlation of data structure and incidence of injury without consideration for the impact attenuating properties of the surfacing at the time of the injury. The work done in Australia comes closest to measuring the impact attenuating performance of the surface in conjunction with play and injuries as a result of play.

A beneficial playground study should consider the type and severity of the injury and the impact attenuating properties of the specific injury location. With the cooperation of the owner/operator, testing of the surface at the location and drop height of the injury can be performed within 48 hours. Gmax, HIC, jerk and critical time would be the data collected. This information could then be used to enhance playground standards that would better protect children.

It would appear that the current playground standards are inadequate and that the impact attenuating properties of playground protective surfacing should require a Gmax less than 100 and an HIC less than 700 for play structures designed for children 5 to 12 and HIC less than 570 for playgrounds designed for children 18 months to 5 years.