CLIMBABLE GUARDS: THE SPECIAL ENEMY OF THE WORLD'S 2- AND 3-YEAR-OLD CHILDREN

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About the Author

Elliott O. Stephenson has been active in codes and standards development for more than 50 years. He has served as a building official in California; a representative of the American Iron and Steel Institute; and a private consulting structural and fire protection engineer. During the past 10 years, he has toured no fewer than 30 countries promoting the revision of codes to provide improved safety for children.

He is now retired and living in Sun City West, Arizona.

THIS ARTICLE PRESENTS a few significant facts that pertain to the safety of young children at elevated locations in buildings and other structures. Some facts are obvious to concerned individuals and others are based upon investigations.

For many decades, the needs of young children in buildings have been given inadequate consideration by building codes with the result that there are literally millions of unsafe guards and rails in existing homes, apartments, motels, hotels and schools as well as in other buildings where young children can be expected to be present.

Parents and guardians of young children assume that the safety of children in buildings has been given the same degree of attention by building officials and building designers as has been given to the needs of adults. This has not been the case.

With the publication of the article entitled "The Silent and Inviting Trap"[1] in 1989, building officials learned that the opening limitation applicable to the design of guards should be lowered. During the 1990s, the allowable size of openings in guard rails at elevated locations in buildings was reduced from 6 inches (151 mm) to 4 inches (101 mm). Once they had the facts, building officials acted to remedy the problem of young children passing through guard rail openings.

CPSC'S ROLE IN CODE DEVELOPMENT

A major contribution of the U.S. Consumer Product Safety Commission (CPSC) of special significance to the building officials has been the maintenance of the National Electronic Injury Surveillance System (NEISS). Detailed information describing injuries treated in the emergency rooms of a very limited number of hospitals considered to be representative of those throughout the country is recorded in the NEISS database.

During late 1999 and early 2000, 195 pages of fall and jump incident reports that occurred during the period from January 1, 1994, through October 19, 1999, were reviewed. Each page had from 25 to 32 descriptions of injuries to children up to the age of 10. The reports, received from 101 hospitals, pertained to the following four categories of injury-incident causes.

- Falls from balconies and porches, 115 pages
- Jumps from balconies and porches, 52 pages
- Falls from banisters and rails,13 pages
- Jumps from banisters and rails, 15 pages

It is important to realize that the information reviewed in the NEISS reports related to injuries treated in the emergency facilities of relatively few hospitals, out of the more than 5,400 hospitals that existed in the United States. In order to draw proper conclusions from the reports concerning the total effects of the injuries on the patients and their families, it appears that multiplication of the incidents by a factor of 40 would be a relatively conservative approach. It is clear that the numbers tabulated from NEISS reports can be compared to the tip of a very large iceberg.

The following tabulation does not include falls against a railing or banister, through a banister, caused by structural failure, down a stairway or steps, while sliding down a stairway banister, or falls while running or jumping on a porch. It also does not include injuries from splinters while sliding on a porch or deck, a relatively common occurrence.

The average number of recorded incidents is 16,300 annually and 65 or 2,600 (65 × Factor 40 = 2600) make specific reference to climbing.

The following information relating to the falls and jumps on (or from) porches and balconies was received from **Jacqueline Elder**, Deputy Assistant Director, Hazard Identification and Reduction, U.S. Consumer Products Safety Commission on September 10, 1999.

In 1988 and 1989, the estimated number of emergency-room-treated injuries to children less than five years of age, who were reported to have fallen or jumped on or from a porch or balcony, was approximately 15,000 to 16,000 annually.

In another communication dated September 9, 1999, Elder wrote, "The staff of the U.S. Consumer Products Safety Commission agrees that the *International Building Code®* (IBC) should include requirements to address the safety hazard that occurs when young children are able to climb guardrails."

Reported Incidents — 5 2/3 Year Period

Type of Incident	Actual Reports	Multiplied by a Factor of 40
Falls from balconies and upper levels	313	12,520
Jumps from balconies and upper levels	34	1,360
Falls from porches and decks	1,159	46,360
Jumps from porches and decks	217	8,680
Falls from or off a banister or rail	414	16,560
Jumps from or off a banister or rail	29	1,160
Falls over a banister or rail	153	6,120
Jumps over a banister or rail	18	720
Falls onto a banister or rail (straddle)	23	920
Total falls and jumps	2,360	94,400

DETERMINING ABILITY OF CHILDREN TO CLIMB GUARDS

During the past two years a series of tests was conducted to investigate the ability of children to climb typical guard assemblies. The observed and photographed incidents developed the following facts.

Most building officials active in the International Code Council (ICC) are probably not aware that the two 42-inch-high (1067 mm) guards shown in Photos 1 and 2 are not safe for young children because many children 2 and 3 years of age have enough arm and shoulder strength to hoist themselves over a bar 34 inches (857 mm) high.

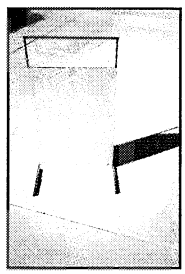

Photo 1

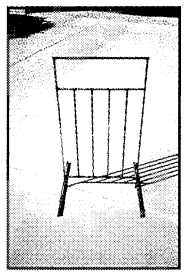

Photo 2

Photo 3 on the next page clearly shows how a 3-year-old girl climbed through the opening in a 42-inch-high (1067 mm) guard with ease. In this case the opening is only $6^1/_2$ inches high

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(164 mm); in another guard, as shown in Photo 4, the 3-year-old boy is ready to climb through the opening which can be as high as $7^3/_4$ inches (195 mm) in a 42-inch-high (1067 mm) guard. One might reasonably ask why such construction should be permitted now that this evidence is available and why the opening should be limited to a maximum of 4 inches (101 mm) or eliminated entirely.

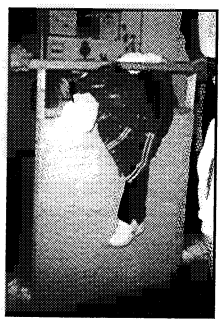

Photo 3

Photo 4

Although a 42-inch-high (1067 mm) guard of woven wire with $1^1/_4$-inch-wide (32 mm) openings provides toe holds (see Photo 5), a child is also able to put his or her fingers through openings $^3/_4$ of an inch wide (19 mm) and place his or her feet flat against the guard and still be able to climb it. The arching of the body as is being done by the 3-year-old boy in Photo 6 was a common method of climbing when the child was able to grasp the top rail of a guard.

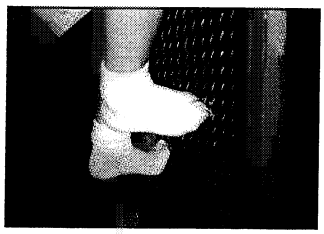

Photo 5

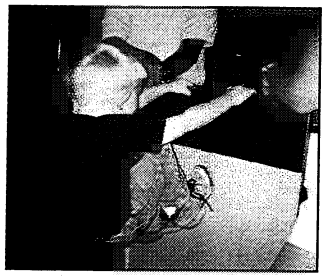

Photo 6

During the testing described, every guard type illustrated could be climbed by some 4-year-old children. That includes solid guards 42-inches-high (1067 mm) without openings included in the test program but not illustrated in this report.

None of the 2- and 3-year-old children could climb the 42-inch-high (1067 mm) guard with a 4-inch opening below its top and bottom rails as shown in Photo 7.

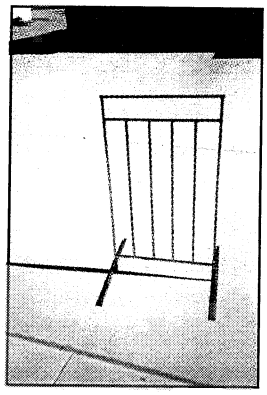

Photo 7

NETHERLANDS

The Dutch have a special problem in that a large percentage of their country has surface water that poses a hazard to young children. Numerous public parks and residences are located on canals and other waterways, unlike the situation that exists in most parts of the U.S. where the water hazard represented by a backyard pool predominates.

In an attempt to evaluate the effectiveness of five types of guards, the Netherlands' Consumer Safety Institute, the equivalent of the U.S. Consumer Product Safety Commission, sponsored a test program in 1994. It is one of the most comprehensive programs and resulted in acquiring

many needed facts concerning the safety of young children in buildings and elsewhere.

Sixty-six children, $2^1/_2$ to 6 years of age, divided into seven separate age groups, participated in the investigation. The minimum number of children in any of those groups was seven and the maximum was 11. The height of the guards in four of the five assemblies tested was $39^1/_3$ inches high (1000 mm) and the remaining guard was tested at three different heights — $31^1/_3$ inches (800 mm), $39^1/_3$ inches (1000 mm) and $47^1/_4$ inches (1200 mm).[2]

A Wire Fence Guard With a Solid Top Rail

Of the eight children in the $2^1/_2$ to 3 age group, 63 percent could not climb the $31^1/_2$-inch-high (800 mm) guard; 80 percent could not climb the $39^1/_3$-inch-high (1000 mm) guard and none of them were able to climb the $47^1/_4$-inch-high (1200 mm) guard.

Of the nine children in the 3 to $3^1/_2$ age group, only 14 percent were stopped by the $31^1/_2$-inch-high (800 mm) and $39^1/_3$-inch-high (1000 mm) guards and 29 percent were unable to climb the $47^1/_4$-inch-high (1200 mm) guard.

Few of the children in the remaining five age groups were unable to climb this type of guard.

A Guard With a Taut Top Wire Between Rigid Posts

All of the children in the $2^1/_2$ to 3 year age group were stopped by a taut top wire between rigid posts.

Two-thirds of the children in the 3 to $3^1/_2$ age group were stopped by this type of guard.

The percentage of children who were stopped in the other age groups varied widely, ranging from a minimum of 11 percent to a maximum of 40 percent.

A Flexible Guard

Instead of rigid posts, flexible glass-fiber-reinforced polyester posts were used together with a flexible top wire of this $47^1/_4$-inch-high (1200 mm) guard. A platform 8 inches high (200 mm) was placed in front of the guard for children to stand on.

None of the 17 children in age groups $2^1/_2$ to 3 and 3 to 3 ½ years could climb it.

In the other five age groups the percentage of children unable to climb this guard assembly varied from 60 to 80 percent.

According to the Consumer Safety Institute, this type of guard has not become popular because of damage caused by older children playing and sitting on it.

A Rigid Guard With Rigid Verticals

Round verticals spaced $5^{19}/_{20}$ inches (150 mm) apart were used in this $39^1/_3$-inch-high (1000 mm) guard assembly.

None of the 24 children less than 4 years old could climb this guard assembly nor could any of the 11 children in the $4^1/_2$ to 5 age group. The percentage of children stopped by this guard in the remaining three age groups varied from 60 to 80 percent.

Dutch law presently limits the size of openings in this type of guard to 4 inches (100 mm).

A Welded Wire Panel Guard

The verticals in this $39^1/_3$-inch-high (1000 mm) guard were spaced on 2-inch (51 mm) centers horizontally and the horizontals on 8-inch (200 mm) centers.

None of the children in the $2^1/_2$ to 3 age group climbed it and less than half of those in the 3 to $3^1/_2$ age group were able to do so.

The percentages of children stopped by this type of guard assembly in the remaining age groups varied from 30 percent to none.

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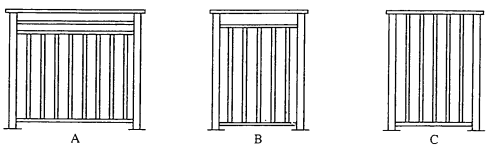
NEW ZEALAND

During 2000, the Building Industry Authority of New Zealand, sponsored the testing of nine different guard assemblies. The contractors for the project were Alchemy Engineering and Design Limited, Wellington, New Zealand. A total of 24 children, ranging in age from 9 months to 4.8 years, participated in the climbing. Two of the children were less than 1 year old; three were between 1 and 2 years; eight were between 2 and 3 years; six were between 3 and 4 years; and five were 4 years old. Ten were boys and 14 were girls.

All of the guard assemblies were $39^{1}/_{3}$ inches high (1000 mm) and involved either solid panels, partially solid panels, spaced vertical bars, or a combination of spaced vertical and horizontal bars. Each had a solid top rail. Two of the guards were of special interest because they each had an overhang on the accessible side.

Three of the eight 2-year-old children climbed the guards with 4-inch (100 mm) and 8-inch (200 mm) overhang. Four of the six 3 year olds climbed the guard with the 4-inch (100 mm) overhang and five of them climbed the guard with the 8-inch (200 mm) overhang. All of the 4 year olds were able to climb the two guards.

There were three guard assemblies comprised principally of vertical elements spaced 4 inches (100 mm) apart, two with top openings as shown in the sketches.



Two of the 3 year olds and two of the 4 year olds climbed the guard shown in Sketch A. Three of the five 4-year olds climbed the guard shown in Sketch B. Only one of the 24 children, a boy 4.8 years of age, climbed the guard shown in Sketch C.

The following is a condensation of some of the investigators' principal conclusions.[3]

The children in the 2-year-old group were possibly at the most dangerous age. They could climb some guards but did not yet have the knowledge to prevent injury.

The 3 year olds were able to use their knees and body strength more effectively than the 2 year olds to leverage themselves over many of the guards.

The 4 year olds were able to climb almost all of the guards. The exception was the guard having verticals spaced 4 inches (100 mm) apart extending to the top rail from a single toe hold 4 inches (100 mm) above the floor.

A series of horizontal projections extending only $^{4}/_{10}$ of an inch (10 mm) from the solid plywood face of a guard and spaced 12 inches (305 mm) apart vertically provided sufficient toe holds for some of the 3 year olds to climb that guard.

AUSTRALIA

A 1979 report on an investigation conducted by the Department of Child Health of the Royal Children's Hospital, Brisbane, Australia,[4] describes the results of testing 515 children, 393 boys and 122 girls, at barriers ranging in height from 24 inches (610 mm) to 54 inches (1372 mm). The ages of the children involved ranged from 2 to 8 years.

The barriers consisted of welded wire panels conforming to the

then-current standards for pool fences, with horizontal elements not closer together than 36 inches (900 mm) in those panels exceeding 36 inches (900 mm) in height. The spacing of the vertical elements is not specified in the report but it was apparently wide enough to provide a toe hold every 36 inches (900 mm) for the children climbing the barriers.

Significant reported results of the climbing tests were:

- Approximately 20 percent of the 2 year olds could climb the 24-inch-high (600 mm) barrier but none could climb the taller barriers.
- All the boys and three-fourths of the girls 3 years of age could climb the 24-inch (600 mm) barrier.
- Approximately one-half of the 3 year olds could climb the 36-inch-high (900 mm) barrier and about 20 percent could climb the 48-inch (1219 mm) barrier.
- There was very little difference between the climbing abilities of the two sexes.

INTERNATIONAL REGULATION OF CLIMBABLE GUARDS

It can be shown that there are few truly effective specific provisions related to the design of guards that are intended to limit climbing by young children. Most existing provisions generally require a judgment decision on the part of the building control authorities who enforce each particular code, possibly following the evaluation of testing to establish a guard's effectiveness. These codes that contain only a limitation on the size of potential toe holds or a statement to the effect that a guard design shall not provide a "ladder effect" will not really prevent climbing unless proper judgment is used by the controlling authority.

Investigation of this worldwide problem has revealed that there are only three guard designs that will effectively prevent 2- and 3-year-old children from climbing them. One is the flexible wire guard tested in the Netherlands, but it would not be a practicable application at most locations inside of buildings. The remaining two are the guards having only vertical elements in all of their parts except the bottom and top 4 inches (100 mm).

Those countries that have provisions in their national building codes intended to inhibit the climbing of the guards by young children are Austria, Australia, Canada, Czech Republic, Denmark, England, France, Germany, Ireland, New Zealand, Norway, Romania, Scotland, Slovak Republic, Spain, Sweden, Switzerland, Netherlands, and Wales. Other countries have provisions but they are unavailable in English translation at this time.

References

1. Elliott O. Stephenson, "The Silent and Inviting Trap," *The Building Official and Code Administrator.* Building Officials and Code Administrators International, Inc., November/December, 1988 and March/April, 1989.
2. R. F. M. Jaartsveld, S. A. ten Wolde, and D. A. van Aken, "The Protective Effect of Fences: Providing Protection to the 0-4 Year Old," *International Journal for Consumer Safety*, 1995, Vol. 2, Consumer Safety Institute, Amsterdam, The Netherlands.
3. Alchemy Engineering & Design Limited, *Child Resistant Barrier Tests*, Building Industry Authority of New Zealand, Wellington, New Zealand, August 2000.
4. J. W. Nixon, J. H. Pearn and G. M. Petrie, "Childproof Safety Barriers," *Australian Paedeatric Journal*, 1979.