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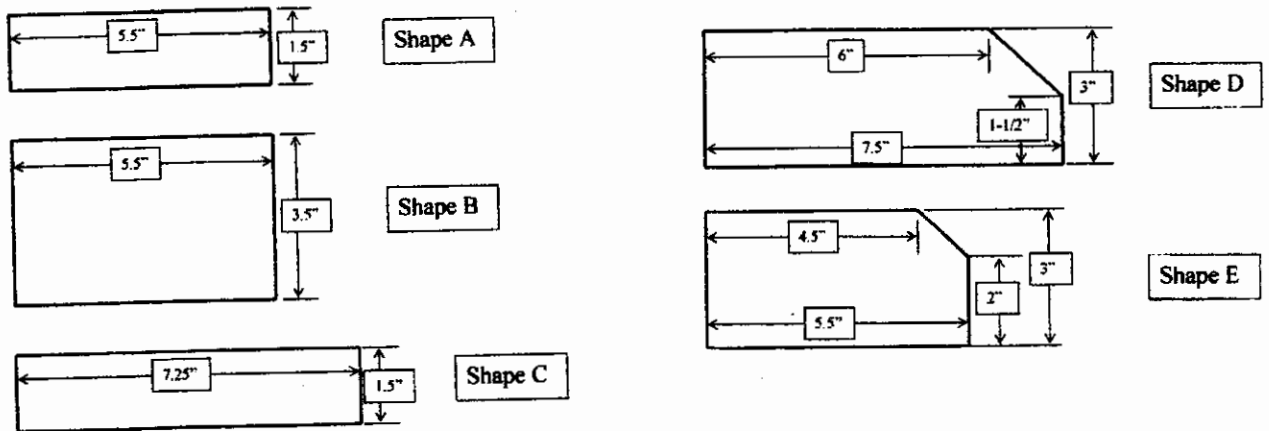
AN INVESTIGATION OF THE PERFORMANCE OF GUARDS HAVING VARIOUS SIZES OF TOP RAILS PROJECTING FROM A GUARD'S ACCESSIBLE SIDE

By Elliott O. Stephenson
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INTRODUCTION

It is the purpose of this investigation to determine if the extension of the Top Rail of a readily climbable guard above the head of a child attempting to climb it at a balcony or other elevated location will either prevent a young child from climbing it or will inhibit such climbing.

TOP RAIL CONFIGURATIONS VARIED



Drawings courtesy of Bob Lee, Cave Creek, Arizona



This is a front view of a readily climbable guard, with the Top Rail set at a height of 42 inches. The Top Rail is a 4 x 6 wood beam measuring 5 ½ inches in width and 3 ½ inches in depth,. The top horizontal rail is removable when the Top Rail is set to provide a 36 inch high guard.

Note the thick padding on the accessible side to provide protection for a falling child and the 180 pounds of red paving brick on the inaccessible side to resist the overturning moments



Allisa 3 years



Jake 4.5 Years

This brother and sister act stole the show. The above photographs show a 3 year old girl readily climbing a guard having a Top Rail measuring 5 ½ inches in width and 1½ inches deep with a total height of 42 inches. There was no difference in the time it took each of them to reach the top of this readily climbable guard. In each case it was a simple matter for the child to climb high enough to reach over and grab the back side of the Top Rail and pull his or her body to the top side of the Top Rail.

Surprisingly, the testing performed revealed that the design of the Top Rail Extension make no difference in the ability of young children to climb a guard when the extension was only 5 ½ inches or 7 ¼ inches.

And yet, it should not be surprising when we know that the average height of three year old boys in America is 39 inches and at four years is 42 inches Girls run a close second with average 38 ½ inches at three years and 41 ¾ inches at four years, It's obvious that many of our four year olds can look directly over a 42 inch high guard without any climbing at all.

INFLUENCE OF PROJECTION OF TOP RAILS ON THE DESIGN OF GUARDS

The most obvious problem concerning the use of Top Rails with a flatt top surface is that once a child reaches the top, he or she is likely to use it to sit on and enjoy the view. The possibility for another child pushing the child off of the rail would be sharply increased There is also the increased opportunity for a child to walk on a Top Rail to consider.

It should be noted that the use of horizontal projections of a Top Rail on the accessible side will require special attention to the design of their anchorage to the floor. Vertical elements will need to resist the overturning moments caused by a child hanging from the front edge of the Top Rail. Guards consisting of horizontal or other elements unable to resist an overturning moment will need a moment resisting frame, or shear and moment resisting panels similar to those used in this test program, spaced along the length of the guard.

It is also possible that projecting Top Rails will effect the required width of stairways and the width of exit aisles located at the edge of a balcony could also be effected.

PROPOSED REVISIONS OF CHAPTERS 2 OF BOTH CODES

Add one of the following Definitions of " FOOT HOLD"

THE LEAST EFFECTIVE

Foot Hold . A horizontal element or the bottom edge of an opening 1 1/2 inches (38 mm) in length.

THE MOST EFFECTIVE

**Foot Hold. Any of the following on the accessible side of a guard having a length of 1 1/2 inches (38 mm) or more. A horizontal element ; the horizontal bottom edge of an opening ; a horizontal recess 1/4 of an inch (6.25 mm) in depth,
A projection of 1/4 of an inch (6.25 mm) or more.**

THE ABOVE IN A DIFFERENT FORMAT

Foot Hold. One or more of the following on the Accessible Side of a Guard

**A horizontal element or the horizontal bottom edge of an opening,
1 1/2 inches (38 mm) or more in length or width.**

**A horizontal recess 1/4 of an inch (6.25 mm) or more
in depth and a length of 1 1/2 inches (38 mm) or more.**

A projection of 1/4 of an inch (6.25 mm) or more

PROPOSED DEFINITION OF A CLIMBABLE GUARD

Climbable Guard. A guard having one or more Foot Holds on the accessible side between the height of 4 inches (102 mm) and 32 inches (813 mm) above the floor upon which it is located.

LIST OF COUNTRIES KNOWN TO HAVE PROVISIONS IN THEIR NATIONAL BUILDING CODES INTENDED TO INHIBIT THE CLIMBING OF GUARDS BY YOUNG CHILDREN AND A BRIEF DESCRIPTION OF THEIR APPLICATION

AUSTRIA – The Building Code of the City of Vienna is reportedly used by most jurisdictions in the country. It reads in part as follows: In Apartments guard rails for verandas, balconies, french doors or terraces must be designed so that small children cannot slip through or climb over them.

AUSTRALIA – In Dwellings, a required balustrade must prevent, as far as practicable, children climbing over or through it. In other building occupancies in which young children can be expected to be present, at floors more than 4 meters (13 feet) above the ground , any horizontal elements within the balustrade or other barrier between 150 mm and 760 mm above the floor must not facilitate climbing.

CANADA – Unless it can be shown that the location and size of openings do not present a hazard, a guard shall be designed so that no member, attachment or opening located between 140 mm and 900 mm above the level protected by the guard will facilitate climbing.

CZECH REPUBLIC and SLOVAK REPUBLIC– The minimum height of the top of the vertical elements or solid section of the guard above the floor shall be 600 mm.

DENMARK – Openings in guards shall be designed for optimum child safety.

ENGLAND, SCOTLAND and WALES – Acceptable Solutions Related to Climbing by Children
Where buildings are likely to be used by children under five years, the construction should be such that children will not readily be able to climb it.

FINLAND – A guard without horizontal elements is required at locations where the difference in height is more than 700 mm (2.3 feet) and children have access to it.

IRELAND and GERMANY – In buildings in which the presence of children can be anticipated , guards are to be designed without the ladder effect in order to make them difficult for small children to climb.

ISRAEL – Guards in Apartment Buildings and in Malls are to be designed to inhibit climbing.

ITALY – Regional Code of Lombardy, a Province in northern Italy, specifies that no horizontal elements that facilitate climbing are to be used in guards.

NEW ZEALAND – Barriers located in a part of a building likely to be frequented by children under the age of six years shall have no toe holds between the heights of 150 mm and 750 mm above the floor level.

NORWAY – Horizontal elements must be so designed and constructed so as to make it impossible for children to climb or fall through them.

ROMANIA – Guard shall be without horizontal or decorative elements that allow climbing.

SPAIN – In dwellings and buildings in which children are habitual or common, the design of elements of a guard shall be such that it will not allow climbing.

SWEDEN – Guards in spaces where children can be present shall be designed so that the risk of injury to persons due to climbing or crawling is limited.

SWITZERLAND – Guards are not to be so designed that they invite their being climbed on. Sharp edges are to be avoided. Guards are to be constructed so that they do not entice children to climb them

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PROPOSED REVISION TO SECTION R312 OF THE IRC

Add the following paragraph to Section R312.1

Such guards shall not be climbable as defined in Chapter 2 when more than 11 feet (3.36 m) above the floor level below or more then 13 feet (4 m) above an unpaved or rock free grade below.

PROPOSED REVISION OF SECTION 1012.1.1 OF THE IBC

Add new text as follows :

1012.1.1 Climbable Guards . Climbable guards as defined in Chapter 2 shall not be located within the public areas of the following occupancies at locations at which children below the age of five years can be expected to be present.

Assembly Group A-3 Amusement Arcades, Gymnasiums, Libraries, Museums, and Passenger Station Waiting Rooms.

Assembly Group A-5 Amusement Park Structures, and Bleachers

Assembly Group E ; All

Assembly Group I Child Care and Day Care Facilities,

Assembly Group M Malls

Assembly Group R-1 Hotels and Motels

Assembly Group R-2 Apartment Houses

PROPOSED REVISION OF SECTION 1012.3 OF THE IBC

Revise Section 1012.3 as Follows .

~~1012.3 Opening limitations. Open guards shall have balusters or ornamental patterns such that a 4 inch diameter (102 mm) sphere cannot pass through any opening up to a height of 34 inches (864 mm). From a height of 34 inches (864 mm) to 42 inches (1067 mm) above the adjacent walking surface, a sphere 8 inches (203 mm) in diameter shall not pass. The elements of guards shall be of such a design that a 4 inch (102 mm) diameter sphere cannot pass through any openings.~~

Exceptions:

1. through 4. (No change to current text)

(PA#3)

Climbable Guards

An Unnecessary Hazard To Children

Part II

by Elliott O. Stephenson

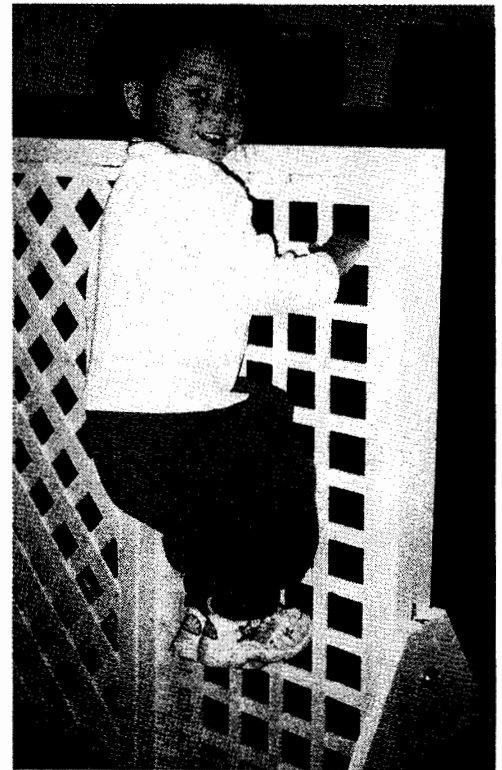
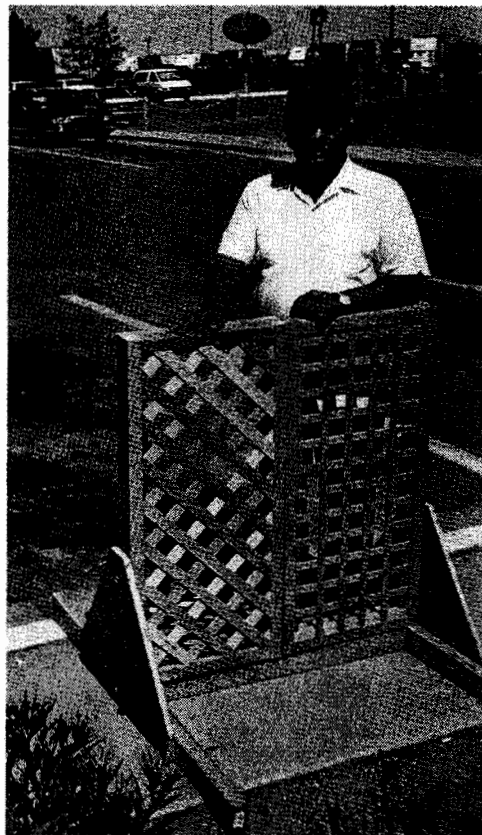
Introduction

It is the purpose of this Part II of the author's article "Climbable Guard—An Unnecessary Hazard to Children," published during 1998 by each of the three model building code sponsoring organizations in the United States, to bring additional information regarding climbable guards to the attention of building code authorities around the world. Recent tests conducted by the author and actions taken by the International Code Council with respect to the new International Building Code in response to the results of those tests have not been previously reported.

Climbing Tests Conducted at Preschool

The 42-inch high guard assembly shown in the photograph was constructed with two inch by two inch openings in both halves with those on the left half rotated 45 degrees. Children two and three years old attending a large preschool were then invited to climb it with the following results: most of the two years olds could climb it and all of the three year olds did so with ease. The right half of the assembly was then modified to reduce the horizontal dimension of the openings to 1 1/2 inches with the following results: approximately one half of the two year olds could still climb the assembly and all of the three year olds could climb it. The right half of the assembly was again modified to reduce the width of the openings to 1 1/4 inches and none of the children were able to climb it.

Joe R. Garcia, senior plans examiner for the Pima County Building Department in Tucson, Arizona, and expert cabinet maker, is shown next to the test assembly he constructed for the author. He also made the four sided test assembly used during 1993 by the author to demonstrate that children could easily pass completely through openings measuring five and six inches in height or width and has been supportive of the author's efforts to improve the safety of children in buildings for the past ten years.



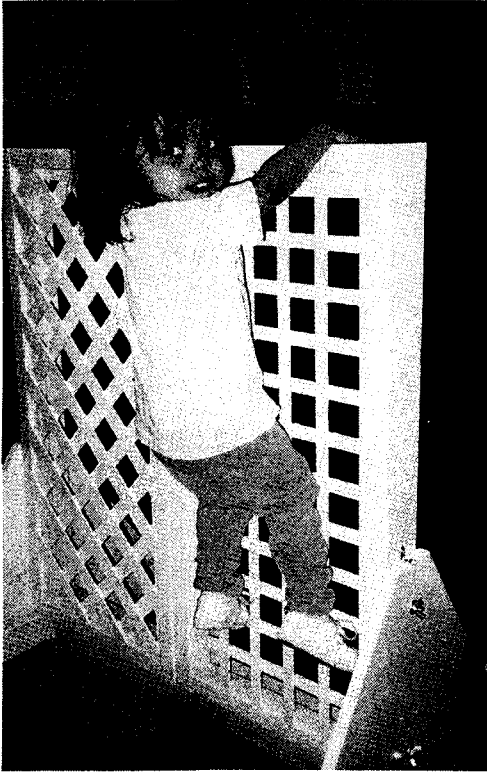
This three year old smiles as she demonstrates her ability to climb the guard.

ICC Committees Act During March 1999

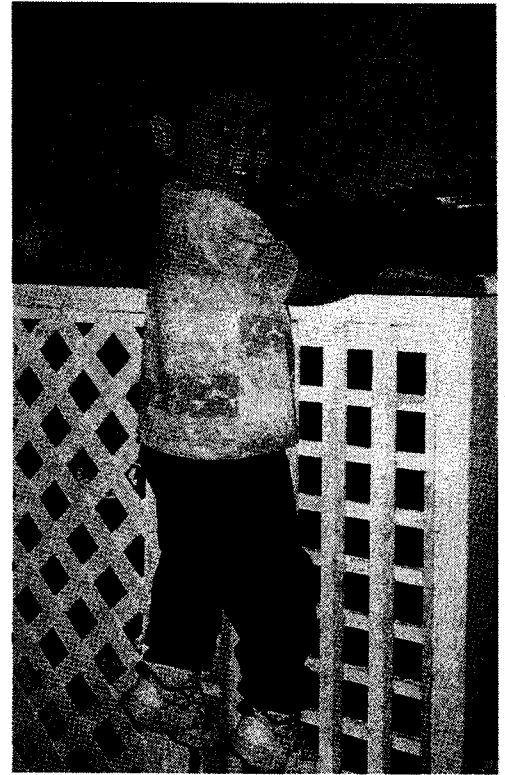
The following proposal submitted by the author for the addition of a new Section 1003.2.12.3 to the International Building Code was approved by the IBC Means of Egress Subcommittee on March 17. It will be noted that the provisions do not require the building official to guess in which building occupancies young children can be expected to be present. They also establish the acceptable design of required guards between the heights of 4 inches and 34 inches.

1003.2.12.3 Climbing limitations. In the following Use Groups, those portions of guards between the heights of 4 inches (102 mm) and 34 inches (864 mm) shall consist of vertical elements,

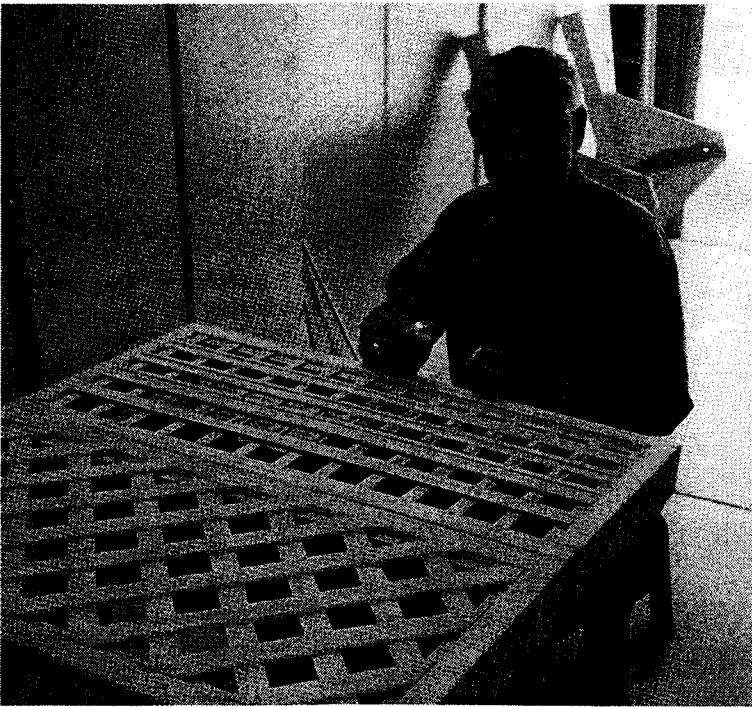
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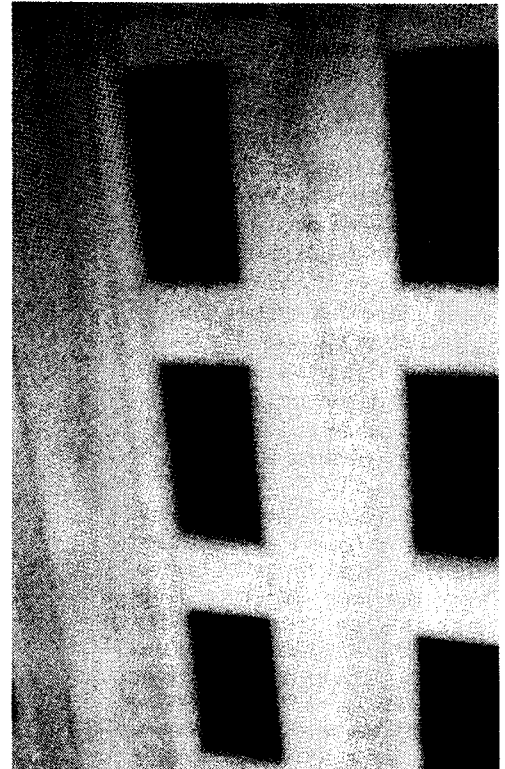
This two year old quickly climbed the guard with 2-inch wide openings.



This two year old demonstrates the ease with which he climbed the guard assembly having 1 1/2-inch wide opening.



The author is shown here adding 1/2-inch wide strips to reduce the width of openings from 2 inches to 1 1/2 inches.



Close-up of original openings reduced from 2 inches to 1 1/2 inches.

solid or semi-solid panels, or a grid of intersecting elements in which the width of openings do not exceed 1 1/4 inches (32 mm).

Educational-Group E

Residential-Group R

Institutional-Group I-4 (See Section 308.5.2)

Public areas in the following Use Group A

Occupancies: Motion Picture Theaters, Libraries, Restaurants, Museums, Amusement Arcades, Gymnasiums, Waiting Areas in Passenger Stations, Skating Rinks, Swimming Pools, All Use Group A-5.

The ICC Residential Code Committee considered this important matter at its meeting of March 24 and voted to retain the following wording of Section R306.2 of the September 1998 Draft International Residential Code that it had previously endorsed.

R316.2 Guardrail opening limitations. Required guards on open sides of stairways, raised floor areas, balconies and porches shall have intermediate rails or ornamental closures which do not allow passage of a sphere 4 inches (102 mm) or more in

diameter. Required guards shall not be constructed with horizontal rails or other ornamental pattern that results in a ladder effect.

Exception: The triangular openings formed by the riser, tread and bottom rail of a guard at the open side of a stairway are permitted to be of such a size that a sphere 6 inches (153 mm) cannot pass through.

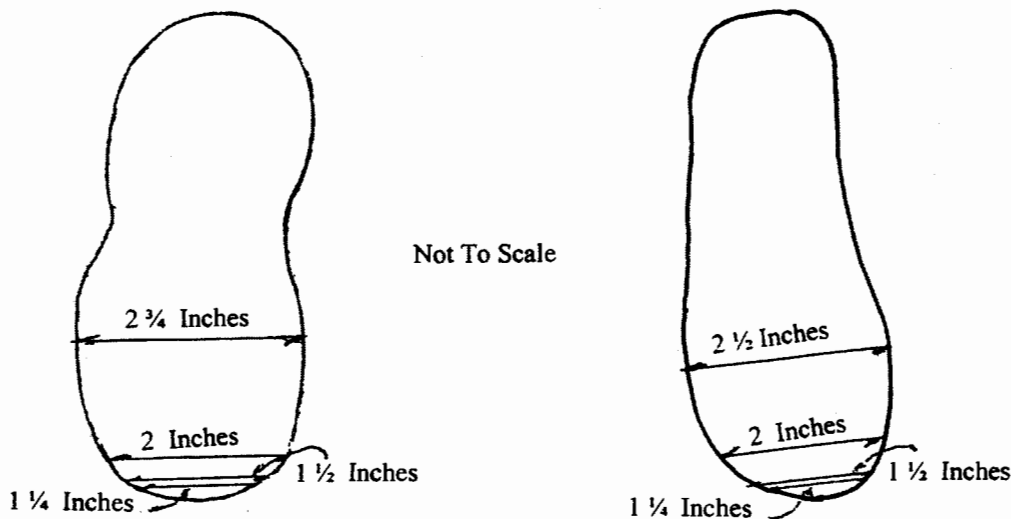
Foot Breadth Measurements of Children Reported

The table below is a Highway Safety Research Institute report titled "Physical Characteristics of Children As Related to Death and Injury For Consumer Product Design and Use," dated May 21, 1975, sponsored by the U.S. Consumer Product Safety Commission. The dimensions of numerous parts of the body of 3819 children living in several locations in the USA are reported and those related to the foot breadths of children of both sexes ranging in age from 24 months to 48 months are tabulated below. Also tabulated are the 95 and 99 percent confidence intervals calculated by the author's son, William Stephenson.

Foot Breadth Combined Sexes

Max Age in Months	N	Mean		Std. Dev.	Confidence Intervals			
		CM	IN		95% z = 1.96 min	95% z = 1.96 max	99% z = 2.58 min	99% z = 2.58 max
24	66	5.2	2.05	0.4	5.10	5.30	5.07	5.33
30	61	5.4	2.13	0.4	5.30	5.50	5.27	5.53
36	101	5.5	2.17	0.4	5.42	5.58	5.40	5.60
42	268	5.6	2.20	0.4	5.55	5.65	5.54	5.66
48	285	5.7	2.24	0.4	5.65	5.75	5.64	5.76

Sizes of Toe-Holds Illustrated



Outline of 3 Year Old Boy's Shoe

Shoes add approximately one half inch to the breadth of a foot.

Outline of 2 Year Old Girl's Shoe

It is apparent from these two sketches of the typical outline of two of the children's shoes that those children who climbed the guard having 1 1/2 inch openings needed only a very small toe-hold in comparison with the area of their shoe sole. It is also evident that the overall breadth of a foot plays little or no role in the determination of a child's ability to climb a guard. In each

case, the distance between the tip of the shoe and the location of the 1 1/4 inch shoe width was 3/16 inch which implies that if a series of intersecting elements having a thickness of more than 3/16 inches are used, the vertical elements should be on the accessible side of the guard.