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The Silent and Inviting Trap

By Elliott O. Stephenson

Current model code requirements limiting guardrail openings to 6 inches present an unacceptable risk of serious falls by small children, the author maintains. After pursuing extensive research, Mr. Stephenson argues that the allowable opening should be reduced to 4 inches.

Five-year-old Tara Marie Kelpatrick, fell eight stories to her death from an exterior balcony of a Fort Lauderdale condominium while visiting her grandmother. The police reported, "The guardrail openings were just high enough and wide enough for her to slip her tiny body through."

Crystal Webb, 17-months-old, fell five stories through a large, open light and ventilation shaft from the roof of the fourth story of a San Diego, California, hotel, landing on the hood of an automobile parked in the basement garage. The roof was used as a recreational area. A large opening in the roof, serving as a light and ventilation shaft for the basement, was surrounded at the roof level with guardrails having 8½-inch wide openings between the vertical pickets. Brain damage and physical injuries of a permanent nature are this young girl's penalty for being a normal child in one of the worst of environments. The out-of-court settlement in this case during May, 1988, was $35 million to be paid over the lifetime of the girl.

An extremely fortunate youngster is Ryan Lee of East Falmouth, Massachusetts, a 17-month-old boy who fell from the tenth floor balcony of a Marco Island, Florida, hotel on May 27, 1988. Fractures of the skull, vertebrae and shoulder, together with a black eye and a few bumps and bruises were reportedly the injuries Ryan received when his fall was broken by the fronds of a palm tree, another tree, and soft ground only two feet from a steel and concrete drain. The 100-foot fall was initiated when he climbed through a guardrail with openings varying from 5¼ to 5⅞ inches in width.

Detailed evidence available during the past decade, which clearly proved that our national guardrail standards are grossly inadequate, is still being disregarded by many to the detriment of the safety and well-being of children throughout the United States. It's now quite clear that the maximum dimension of openings in guardrails at locations accessible to the public should not exceed 4 inches or even a lesser dimension.

The logical concerns of mothers and fathers are frequently being reflected in their urgent letters to newspaper editors, managers of multi-story shopping malls, hotels and to the building officials responsible for the three model building codes adopted and enforced by our cities, counties and states. Many such letters describe close calls they have experienced with their small children at the location of guardrails with excessively wide openings and urge that prompt remedial action be taken.

And, tragically, we too often read about these instances where parents have been unable to react quite quickly enough, or have been briefly distracted, with the result that their child has either plunged to his or her death, or has been critically injured in a fall after passing through a guardrail opening.

When we visit a shopping mall, municipal auditorium or convention center, airport or bus terminal, large hotel, motel, or other place to which the public is invited, we usually assume that sufficient care has been taken in the design of the building's construction features to provide safety under normal circumstances. In the case of guardrail design, this is far from the situation.

Code Requirements to Date

For the past two decades the *BOCA National Building Code* of Building Officials and Code Administrators International, widely adopted in the central and northeastern portions of the United States, has limited the openings in the guardrails accessible to the public to a maximum dimension of 6 inches.

The *Life Safety Code* of the National Fire Protection Association, utilized as a standard reference, also allows 6-inch wide openings in guardrails at locations accessible to the public.

The *Standard Building Code* sponsored by the Southern Building Code Congress International, widely adopted by building code-enforcing jurisdictions throughout the southern states, has generally limited openings in guardrails to a maximum of 6 inches during the past quarter century. A special provision allows larger openings in guardrails at open decks of one- and two-family dwellings facing a beach front whenever the height of the deck above the beach doesn't exceed 6 feet.

A brief summary of the guardrail opening allowances of past and current editions of the *Uniform Building Code* of the International Conference of Building Officials (ICBO), adopted almost exclusively throughout those portions of the United States situated west of the Mississippi River, is of interest:

1970 and 1973 Editions allowed 11-inch max. openings
1976 and 1979 Editions allowed 9-inch max. openings
1982, '85 and '88 Editions allow 6-inch max. openings

Thus, it's evident that a series of changes has been made during the past 18 years, each of which undoubtedly reflected concern over the safety of young children. Since each action represented a compromise between those interested in retaining the feeling of openness in buildings and those who had serious concerns regarding public safety, it's not surprising that the reductions have been gradual.

Why does this situation exist today? In my opinion, it boils down to ignorance of the available facts by building designers and owners, and a natural reluctance on the part of the building officials and political leaders to take effective action until they have facts clearly proving that remedial action on their part is essential. However, once building and other officials have the facts supporting a change in the codes and standards, action is often quickly forthcoming.

Four-inch Standard is Justified

I have gathered sufficient information concerning the present problem to justify needed action and have submitted proposed changes to each of the three model building code and standards-sponsoring organizations to reduce the present 6-inch allowance to 4 inches.

The architects and designers of buildings have been no help in the past and, during the period 1978-1980, vigorously opposed efforts to revise the *Uniform Building Code*. The code allowance at that time was for guardrail opening widths of 9 inches. The 1982 Edition is the first of that code to contain a 6-inch maximum opening size limitation, and most code enforcing jurisdictions in the west have now adopted it.

And what was the two-fold basis of the American Institute of Architect's opposition to the change? One was that no one should be attempting to tell the architects how to design their buildings—they argued that they should be able to use their own individual judgement in each case. The other was that no proof had been presented that the 9-inch wide opening was unsafe. The published reason for the architect's objection to reducing the 9-inch opening allowance to 6 inches read: "Preference is to stay with current 9-inch provision."

Such attitudes on the part of many of our country's architects and building designers have too long caused the delay of effective action on this critical national problem. It's obviously absurd to conclude that a 9-inch opening will provide safety for children.

Unfortunately, the architects appear to have little to worry about from a legal liability standpoint as long as they meet the minimum requirements of the recognized building codes and standards. In a District of Columbia case involving the fatal fall of a 22-month-old child from a fifth floor apartment balcony, the courts ruled that the architect could not be held liable for the accident. The distance between the vertical members in the guardrail through which the child climbed varied from 5 to 5½ inches and the design standard commonly used by architects in that area was based on a permissible 6-inch spacing. In other words, the architect was complying with the code requirements applicable at the time and could not be held responsible for any inadequacies in such laws.

The architect responsible for the design of a guardrail at the mezzanine at the Municipal Auditorium and Exhibition Hall in Charleston, South Carolina, was not so fortunate, however. According to witnesses, a two-year-old child walked through a guardrail having openings of 11 inches between the verticals without touching any of them, falling 18 feet to a concrete floor below and sustaining serious head injuries. The architect's response to a question during a pre-trial deposition reportedly was as follows: "The rails were more pleasing to the eye and gave the feeling of more spaciousness in the areas where they were."

Settled out of court, the case resulted in total payments of $200,000 plus medical expenses being paid by the architect and the insurance carrier for the auditorium. The cost of the addition of a 1-inch square tube between each of the existing verticals reportedly cost the auditorium only $1,318.

The development of tempered glass guardrails and their growing use in buildings of all types is an obvious answer to an architect's desire for that feeling of openness. The tempered glass guardrails, although substantially more costly than well-built metal or wood guardrails, can provide an important service for architects or designers desiring improved vision from level to level of a building.

Guardrails at elevated locations should be designed to inhibit climbing by children. Many children incur what is described in medical terms as a "saddle" injury when they climb on top of a railing and then slip and fall directly upon it, thereby "straddling" the railing. Concussions are also often the type of injury sustained when a child falls from the top of a railing onto an adjacent porch floor. More critical, however, are the types of injuries received from falls over or through a railing to the ground or to a floor below a balcony or mezzanine.

Studies reveal that 950 out of 1,000 children less than 10 years of age can pass through a 6-inch wide opening.

The Ideal Design

The ideal design is, of course, a solid, smooth guard with no openings or projections upon which children can climb or be injured during a fall against the railing itself. Alternatively, a railing with a series of closely-spaced round vertical pickets extending continuously from the bottom to the top, with no intermediate horizontal components upon which the child can climb or be injured when he or she falls against the railing is also ideal. Building codes in the United States will undoubtedly eventually include provisions intended to discourage the climbing of guardrails, at least at those locations where children are most frequently exposed to major falls. The building code of Australia, discussed herein, already contains such provisions.

What should the maximum size of openings in a guardrail be? The results of the following two significant investigations go far toward providing the answer:

"Physical Characteristics of Children as Related to Death and Injury for Consumer Product Design and Use," prepared by the Highway Safety Research Institute, The University of Michigan for the U.S. Consumer Product Safety Commission, Final Report, May 31, 1975.

"Anthropology of Infants, Children and Youth to Age 18 for Product Safety Design," prepared by the Highway Safety Research Institute, The University of Michigan, prepared for the U.S. Consumer Product Safety Commission, Final Report, May 31, 1977.

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The breadth of a child's head is the key to determining if he or she can pass completely through an opening in a guardrail. If the head can get through, the balance of the body is usually no problem. This fact introduces an additional problem.

In some instances children have squeezed their bodies through an opening in a railing and strangled because their head breadth was too large to allow the head to pass through. It's for this reason that the baby crib and play pen standards in effect in the United States establish a 2⅜-inch maximum opening limitation.

Table No. 1 lists the mean head breadth and chest depths of children between 10 and 48 months of age and shows the differences which would permit such children to slip their torsos through an opening and not be able to get their heads through.

Comparison shows that the chest depth of children four years old and younger is approximately 90 percent of head breadth. The chest and buttocks of about five percent of those children one-to-two years old would be able to pass through an opening 3½ inches in width. Almost half of the children one-year-old can squeeze their chests and buttocks through a 4-inch wide opening.

However, I do not believe that it would be possible to revise the model building codes at this time to limit guardrail openings to anything less than 4 inches. There will be some who argue that even the proposed 4-inch limitation is too conservative and will unduly increase building costs.

A Series of Compromises

Perhaps at some point in the future the applicable standards will be revised to eliminate totally all of the hazards associated with guardrails. But, as previously stated, code changes usually occur over a period of time and represent a series of compromises as new information is obtained.

One factor worthy of note is that the pickets in guardrails are quite frequently spaced during fabrication with their centerline distance equal to the number of inches specified in the building code. Thus, the specified maximum allowable opening of 6 inches has often resulted in the clear distance between pickets being 5½ inches or less. A specified maximum opening of 4 inches will probably result in many guardrails with clear openings only 3½ inches in width.

The two foregoing described studies measured numerous features of the body, the first involving a total of almost 4,000 infants and children under the age of thirteen, and the second involving 4,100 infants and children up to the age of eighteen. Numerous localities throughout the country were included in the latter study, which had representative mixtures of social and economic levels as well as races, and was sufficiently broad to be indicative of the population of the country as a whole.

Graphs No. 1 and No. 1A are plots of head breadths versus the children's ages as determined from the described studies. To the best of my knowledge, there are no previously published graphs that show the details of minimum head breadth dimensions for children below the 95 percent confidence iterval.

Table No. 2 is a tabulation of the minimum head breadth dimensions of very young children as reported in the May 31, 1975, Final Report. Confidence levels have been calculated at 99.0 and 99.8 percent.

The following conclusions can be reached from an evaluation of the results of the measurements of head breadths of the more than 8,000 individuals included in the two studies:

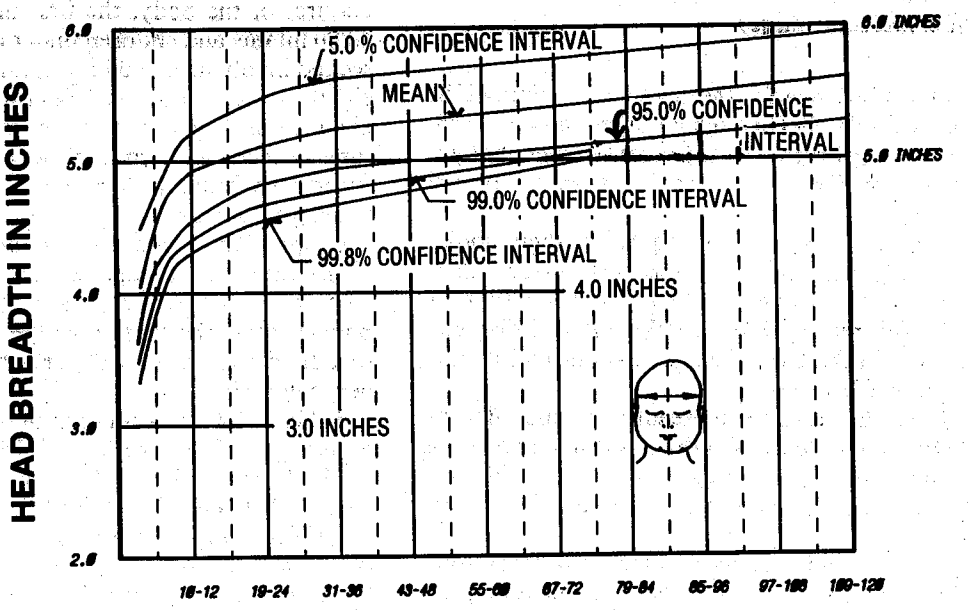
1. Only two or three out of 1,000 children nine months old can pass completely through a 4-inch wide opening. It appears that virtually no child 12 months or older can pass completely through a 4-inch wide opening.
2. About 50 out of 1,000 children one year old and about ten in 1,000 children 13 to 18 months in age can pass completely through a 4½-inch wide opening.
3. Virtually all children under four years of age and approximately 500 out of 1,000 children ten years old can pass completely through a 6-inch wide opening.

Some cities and other code-enforcing jurisdictions have already acted to solve these problems. For example, during January, 1988, the City of Tucson, Arizona, adopted an ordinance limiting the openings in guardrails in public places and residences to a maximum of 4 inches. This ordinance was the direct result of parents demanding action to eliminate the hazard of the 5¾-inch wide guardrail openings in a large local two-story shopping mall. In the words of Mr. James R. Singleton, Administrator of Tucson's Building Safety Division:

"Upon completion of the extensive study made by our staff and the city's Building Code Committee, it was apparent to us that the revision of the building code to limit

TABLE NO. 1
COMPARISON OF CHEST DEPTHS AND HEAD BREADTHS

Age of Child Months	Mean Head Breadth (in.)	Mean Chest Depth (in.)	Ratio of Chest Depth to Head Breadth
10-12	4.88	4.21	.86
13-18	5.00	4.29	.86
19-24	5.16	4.53	.88
25-30	5.28	4.57	.87
31-36	5.28	4.68	.89
37-42	5.31	4.80	.90
43-48	5.35	4.84	.90



VERSUS

MINIMUM HEAD BREADTHS

DATA PLOTTED IS BASED UPON HEAD BREADTH MEASUREMENTS REPORTED IN THE MAY 31, 1975, FINAL REPORT.

GRAPH 1

guardrail openings to maximum 4-inch dimensions was fully justified and essential. The city has responded to the valid concerns expressed by the patrons of the mall. Although the code revision is not retroactive in its application, we believe that serious problems in future new construction have been forestalled as a result of the action taken by our City Council."

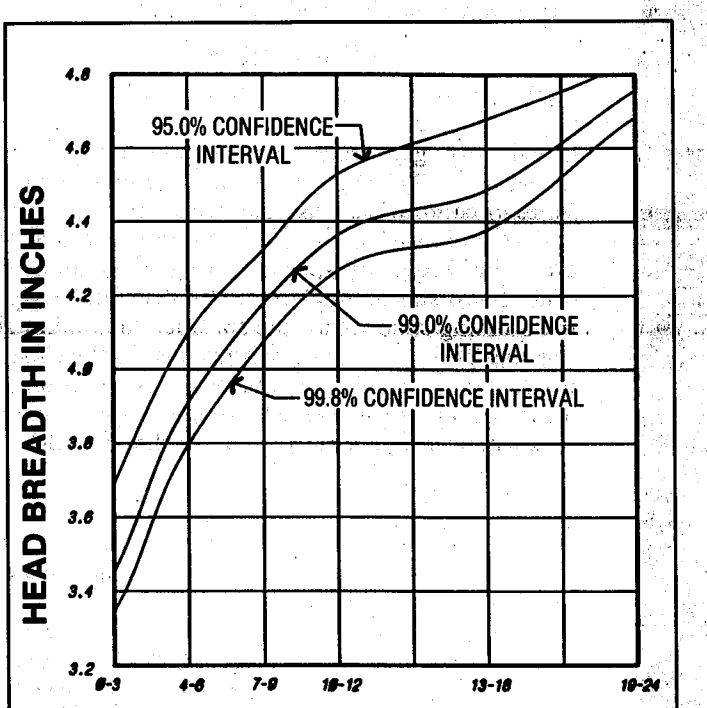
Others Use 4-Inch Standard

The *South Florida Building Code* used throughout Dade and Broward Counties has the same 4-inch limitation in residential and institutional buildings. The *National Building Code of Canada,* enforced throughout the provinces of our neighboring country, limits the open spaces in guardrails to a maximum of 100 millimeters (3.94 inches) at all locations to which children may be expected to have access in residential occupancies and in day-care centers, nurseries and similar occupancies.

British Standard BS 3049 has specified a maximum horizontal gap in pedestrian guardrails of 100mm (just under 4 inches) since 1976. Thus, it is clear that the United Kingdom has been ahead of the United States for more than a decade in this important matter.

The National Spa and Pool Institute, representing a broad spectrum of individuals and groups in the United States concerned with the safety of children exposed to the hazards associated with swimming pools, water recreation areas and spas, has endorsed a recommended 4-inch maximum opening limitation in enclosures provided for such facilities.

The building code of Australia, which serves as the uniform technical basis of all Australian State and Territory building regulations, has a somewhat different and more complete approach to the control of the clear distances



GRAPH 1A

Note: Graph 1A is an enlargement of the applicable portion of Graph 1.

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between balusters in balustrades (guardrails or railings in U.S.A. model building code terms).

In other than a laboratory, manufacturing plant, storage warehouse or similar occupancies where the public would not be expected to have access, the maximum clear opening between balusters at balconies, stairways, ramps and landings is limited to 125mm (4.92 inches), except that at balconies having a height of more than 3 meters (9.84 feet), the openings in balustrades within 150mm (5.90 inches) of the balcony floor level may not exceed 100mm (3.94 inches). Additional limitations specify that at stairways, ramps, landings and balconies having a height of more than 3 meters above a lower floor or ground level, those portions of the balustrades more than 150mm and less than 760mm (29.92 inches) from the bottom of the balustrade may have only vertical balusters, or balusters that do not provide a toe-hold for children to climb on.

The Australian code specifically states that the requirements applicable to balustrades are intended to prevent, as far as practicable, children climbing over or through them; persons accidentally falling from an upper level; and objects accidentally falling through them and striking a person at a lower level.

Owners Take Voluntary Action

It's been shown that the owners and managers of existing shopping centers and other buildings will take action to correct an existing guardrail hazard when it is brought to their attention by concerned parents and others using their facility. During 1987, the Tucson shopping mall mentioned herein voluntarily installed a new vertical bar between each pair of existing verticals in railings having a total length of one-half mile on floor openings in its second story. It's of special interest to note that the very conscientious owners and managers of the mall were not required to make these alterations and that they were initiated prior to the adoption of the above described revision to the Tucson City Building Code. The existing verticals were spaced 5¾ inches apart, less than the 6 inches allowed by the building code. After the addition of more than 5,000 new verticals, the openings in the guardrails were reduced to only slightly more than 2½ inches.

Quoting Mr. Greg McFarland, General Manager of the Tucson Mall:

"The Tucson Mall responded quickly to a perceived risk by installing the additional vertical railings. Our property is more than just a lot of stores—it is a place of social interaction augmented by tree-lined avenues and glistening fountains that is aesthetically pleasing to our patrons. We have and will continue to provide our customers with a safe, clean environment. We were not pressured into this measure; we reacted out of social consciousness. Our message to the citizens and guests of Tucson is: 'This is your mall. We are here because of you and for you, and we will use all available resources in order to offer you the best facility and shopping experience possible.' "

It's interesting to compare the actions taken by those responsible for the shopping mall in Tucson with that of the managment of the Marco Island hotel. The general manager of the hotel is quoted in a Naples, Florida, newspaper following the fall of Ryan Lee as follows:

"We don't have any plans to change anything about the railings at this time. The national (safety) code calls for a gap of 6 inches and the space between the railing bars is less than 6 inches."

Perhaps the time when the owners and managers of this hotel will change their minds and take some effective remedial action won't be until another, less fortunate, child falls from one of the hotel's upper story balconies and doesn't find a palm tree to break the impact when he or she lands. What better evidence could there be to show that the revision of our building codes and standards is the answer to the problem?

Injuries Quite Common in U.S.

Injuries to children from balconies, porches or elevated decks are quite common in the United States. I have personally reviewed descriptive reports of 7,699 such related injuries to children ten years of age and younger given treatment at hospital emergency facilities during the period 1978-1988, provided by the U.S. Consumer Product Safety Commission.

Hospitals throughout the country report all types of injuries to the Commission through what is known as the National Electronic Injury Surveillance System (NEISS). This data is used by the commission to evaluate the public safety aspects of problems related to all types of consumer products.

The 7,699 reported injury-causing accidents evaluated by the author included 3,728 falls to the ground level or to a lower floor level from balconies and porches. This total does not include falls from stairways or onto steps leading to balconies or porches nor to falls from a balcony or porch onto a stairway. Nor does it include injuries which occurred upon a porch or balcony itself, or from falls from a railing onto the railing itself, or onto a porch or balcony from a railing. It also does not include the numerous instances where children intentionally jumped from a porch or balcony. The 3,728 falls include only those in which a child fell from a porch or balcony either as a result of climbing over or through a railing or as a result of there being no protective railing at all.

TABLE NO. 2
TABULATION OF MINIMUM HEAD BREADTH DIMENSIONS OF VERY YOUNG CHILDREN

Age of Child	99 Percent Confidence Interval		99.8 Percent Confidence Interval	
	Centimeter	Inch	Centimeter	Inch
7-9 mo.	10.65	4.19	10.35	4.07
10-12 mo.	11.11	4.37	10.86	4.27
13-18 mo.	11.41	4.49	11.16	4.39
19-24 mo.	12.07	4.75	11.86	4.67
25-30 mo.	12.11	4.77	11.86	4.67
31-36 mo.	12.37	4.87	12.16	4.79
37-42 mo.	12.21	4.81	11.96	4.71
43-48 mo.	12.57	4.95	12.36	4.87

4.00 inches = 10.16 centimeters
4.50 inches = 11.43 centimeters
5.00 inches = 12.70 centimeters
6.00 inches = 15.24 centimeters

The severity of the injuries received from the 3,728 reported falls from porches and balconies, shown in Graph No. 2, can be described as follows:

2,946 or 79 percent of the injuries involved fractures, head lacerations, concussion, or more extensive damage. Dislocations and other lesser injuries were involved in the remaining 21 percent.

603 or 16 percent of the injuries involved concussion, fractured neck, arm crushing or other injuries of a more serious nature.

There were a total of 274 reported falls of 8 feet or more, many being a distance of 15 to 20 feet. The remaining falls were generally from a distance of 3 to 6 feet. Although many of the reports refer to the patient falling through an opening within a railing to the ground or floor below, the hospital records do not go into sufficient detail to state the actual width of such openings. It's probable, however, that many of the falls resulted from the excessive spacing of pickets within the guardrails. In any event, all of the falls are a clear reflection of the hazards involved when children are exposed to elevated situations without proper guardrail protection.

In addition to the 3,728 falls resulting in injuries to children, there were 34 reported falls resulting in death, 28 of those being children three years or less in age.

Major Code Revision Effort

I am presently undertaking a major effort to revise the three model building codes of the United States and the NFiPA *Life Safety Code* to limit the openings in guardrails to a maximum of 4 inches at all locations to which the public is invited and to which young children may be at hazard. The battle may not be an easy one, but its ultimate outcome is not in doubt in my opinion.

What needs to be done to obtain the needed revisions to the building codes and standards now in effect? The following actions would quickly resolve the matter:

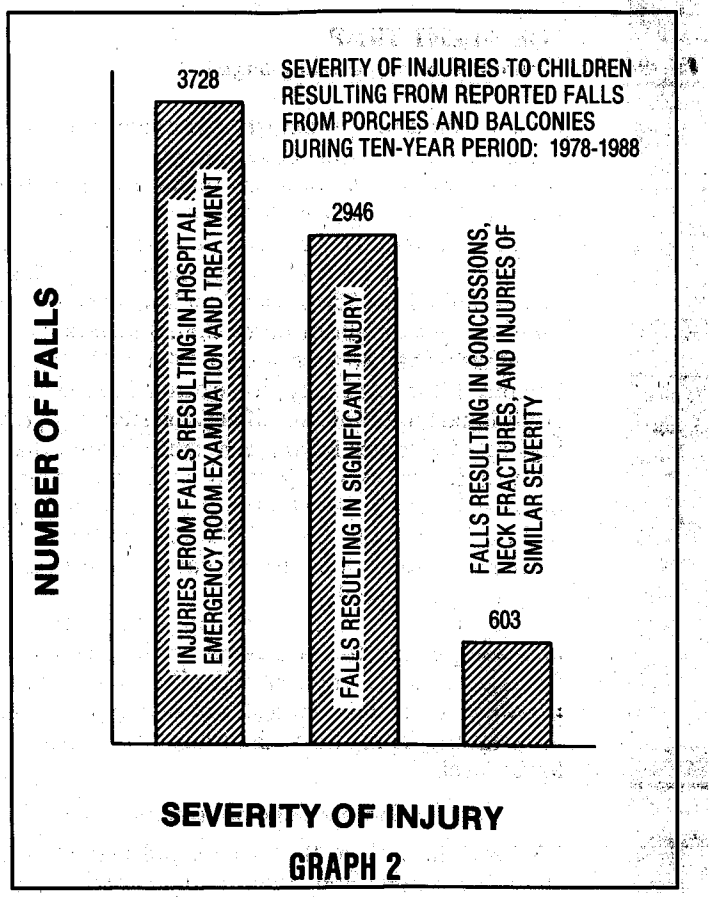
1. The American Institute of Architects should support the adoption of the 4-inch limitation. The American Academy of Pediatrics, through its Committee on Accident Prevention, has been urging the architects to take such action for many years. It's time for the architectural profession to wake up to the fact that openings larger than 4 inches will continue to take an unnecessary toll on the lives and health of young children. Prompt and effective action now by the architects in our country will help prevent many future serious hazards.

2. The building official organizations responsible for the publication of the three model building codes adopted throughout the United States need to take a positive stand on this important matter and revise their codes to eliminate the serious hazards in guardrails. The needed facts are now available—there's no valid reason for further delay.

3. Mothers, fathers, grandparents and others interested in the welfare of children should act through letters to the editors of their local newspapers and to their City Councils or their County Board of Supervisors demanding that attention be given to the matter and that existing codes be revised. In many cases, where hazards exist, remedial action should be taken retroactively, with building owners given a certain specified length of time to solve their problem.

4. Building owners need to carefully inspect their existing facilities to determine if there's something they can voluntarily do to remedy potentially hazardous conditions.

5. Insurance companies writing liability insurance for building owners should take a real interest in the elimination of the present guardrail hazards. The recent $35 million settlement in the Crystal Webb case would have paid for a lot of guardrail construction and improvement. I gave a pretrial deposition for the plaintiff in this case, testifying on the applicable building code requirements and records of falls by children from elevated balconies and porches.



GRAPH 2

It all adds up to the fact that we in the United States need to take action at all levels to correct some of our silent and inviting traps, many of which will continue to be constructed tomorrow, next year and for years to come unless we act now.

Elliott O. Stephenson served as Superintendent of Building for the City of Pasadena, California, following WWII and was very active in the committee work of the International Conference of Building Officials (ICBO) during that time. He joined the American Iron and Steel Institute (AISI) in 1954 as its West Coast Regional Engineer and then moved to New York where he served as AISI's Chief Structural Engineer for fifteen years. During 1955-1970, Stephenson represented AISI at BOCA committee hearings and annual meetings on a regular basis and was well known to BOCA members. He returned to the west coast for AISI during 1970 and was awarded ICBO's prestigious John Fies Award for outstanding contributions in the field of building code development and administration in 1978, prior to his retirement from AISI. Stephenson is licensed as both a structural and fire protection engineer and has continuously maintained a deep interest in all matters related to safety in buildings. He now resides in Tucson, Arizona.

Comment By Author of "The Silent and Inviting Trap"

A correction is necessary to the article entitled "The Silent and Inviting Trap," that begins on Page 28 of the November/December, 1988, issue of the BOCA Magazine. The correction was submitted by the author of the article, Mr. Elliott O. Stephenson, Tucson, Arizona, as follows:

A remark made by an elementary school teacher about the size of some of the ten-year-old children in her class has led me to again review in detail the published data on the anthropometry of children, with the result that I've discovered a change in one of my conclusions included in the article is necessary.

At approximately the age of six years, a child's chest depth can become the controlling dimension in determining whether many children can pass completely through a 6-inch-wide opening.

The ratios of chest depth to head breadth for children between the ages of four to ten years are listed in the following tabulation:

Age in Months	Mean Head Breadth (")	Mean Chest Depth (")	Ratio of Mean Chest Depth to Mean Head Breadth	Ratios at Five Percent Confidence Interval
49-54	5.39	5.00	0.93	0.98
55-60	5.49	5.04	0.92	1.01
61-66	5.49	5.12	0.93	0.99
67-72	5.47	5.24	0.96	1.03
73-78	5.47	5.31	0.97	1.01
79-84	5.51	5.43	0.99	1.05
85-96	5.51	5.51	1.00	1.10
97-108	5.59	5.75	1.03	1.14
109-120	5.59	5.87	1.05	1.16

It will be recognized that the foregoing information does not affect the findings that virtually all children four years in age and younger can pass completely through a 6-inch-wide opening, nor does it affect the proof that revisions to the building codes to reduce the allowable openings in guardrails and railings from 6 inches to 4 inches is fully justified and needed. We all recognize that the children at greatest risk by the present excessive 6-inch opening allowance are less than six years of age.

In summary, the following facts relating to the ability of children to pass through openings in railings and guards are clearly evident.

1. Virtually all children less than six years in age can pass completely through a 6-inch-wide opening.
2. Virtually no child one year or older in age can pass completely through a 4-inch-wide opening.
3. Approximately 50 percent of all children ten years old can pass completely through a 6-inch-wide opening.
4. Approximately 50 percent of children 13 to 18 months old can pass through a 5-inch-wide opening.
5. About 50 out of 1000 children one year old can pass completely through a 4½-inch-wide opening.

Update on the Silent and Inviting Trap

by Elliott O. Stephenson

Structural and Fire Protection Engineer
Sun City West, Arizona

During 1988 and 1989, ***Mr. Stephenson*** *reported on the results of his extensive investigations of the dimensions of the head breadths and chest depths of young children. These efforts led to the revision of the Uniform Building Code™ (U.B.C.) at ICBO's 67th Annual Conference in Palm Desert, California. His article "The Silent and Inviting Trap" appeared in the January-February, 1989, issue of* Building Standards, *with additional information provided in the March-April, 1989, issue. Section 1712 (a) of the 1991 edition of the U.B.C. will limit the size of openings of guardrails used on balconies, landings and open stairways to a maximum of 4 inches.*

Briefly, the article stressed the following facts not previously available to building code-writing and enforcement authorities:

1. *Almost no child one year of age or older can pass completely through a 4-inch-wide opening.*
2. *Approximately 50 percent of all children 13 to 18 months old can pass completely through a 5-inch-wide opening.*
3. *Virtually all children less than six years of age can pass completely through a 6-inch-wide opening.*

Since sharing this research with Building Standards *readers, he has traveled throughout the world in an effort to circulate the facts presented in his article to building officials and building code authorities. The following report provides an update on this issue and reflects the need for energetic, productive and democratic organizations such as ICBO.*

Mr. Stephenson was recently named a 1990 Marksman by Engineering News-Record, *the McGraw-Hill construction weekly, for his significant achievements in limiting the size of openings between guardrails.*

The views expressed here are those of the author and do not necessarily reflect the opinion or agreement of the International Conference of Building Officials.

Since leaving home in September 1989, I initially traveled to some of the countries down under and spent four months in the Fiji Islands, New Zealand, Australia and Indonesia. In each major city along the way, I met with the building surveyor (the building official) and with the building control authorities of each state, province and nation to discuss their existing building code provisions. While learning about the principal features of each code, I also distributed copies of "The Silent and Inviting Trap" and met with considerable success in convincing building authorities that the maximum width of openings between balustrades (guardrails) accessible to young children should be limited to 100 millimeters (mm) (approximately 4 inches).

As of January 1990, I had met with the building surveyors and building control authorities in 17 large cities, five different states and four separate countries. Copies of the article were distributed widely to code development committees in Fiji, New Zealand and Australia and may soon be included in the journals of the New Zealand and Australian Building Surveyor Associations. Such publication may eventually lead to needed revisions to building codes in this part of the world.

One item of considerable interest has been the major differences in local codes within each country. In both New Zealand and Australia, I discovered that the volume of local amendments made to nationally sponsored codes is frequently more extensive than the national code itself. Many code-enforcing jurisdictions appear to have their own standards as to what is acceptable construction. In Australia, for example, openings in balustrades are currently limited to 150 mm (6 inches) in two states, to 200 mm (8 inches) in two other states and to 120 mm (slightly less than 5 inches) in yet another state. The national government of Australia is currently studying the problem of nonuniformity of building code enforcement and, hopefully, will be able to take some effective actions.

New Zealand currently has a 150 mm (6 inches) limitation on openings in balustrades but does not regulate those in single-family residences, one of the most common locations where accidents occur. The Indonesian Building Code contains no reference whatsoever to openings in balustrades, and designers and builders are permitted to do as they wish. The code specifies a minimum height of 90 mm (approximately $3^1/_2$ inches) but has no minimum strength requirements. Plans are reportedly underway to develop a new National Building Code for Indonesia to replace the 1941 edition still

in use. Hopefully, many variations in the design and construction of guardrails in these jurisdictions will be eliminated as the facts reported in my article become generally known.

Two incidents which occurred during my travels in Australia are of particular interest. While visiting the recently completed House of Parliament in Canberra, which was constructed at a cost in excess of $1 billion, I noticed that the balustrades in one part of the second story had openings 125 mm wide (approximately 5 inches). While I was inspecting them, two security officers noticed my interest in the construction and told me that a young child had recently climbed through one of these openings and was seen standing on a narrow ledge about to fall 15 feet to a marble floor below, either to his death or serious injury. Fortunately, the horrified guards rescued the child before he fell. After hearing of this incident, I wrote both the Speaker of the House of Representatives and the president of the Senate and urged them to take prompt action to reduce the allowable openings in balustrades to 100 mm in the Australian Building Codes and to take remedial action in the House of Parliament. I have since received a letter from the Speaker of the House, the Honorable Leo McLeay, stating that the matter is being fully investigated and brought to the attention of the national committee responsible for drafting the appropriate standards.

The second incident was described to me while I was visiting close friends in Melbourne. After reading my article, my hosts reported that one of their granddaughters, then three years old, had climbed through the 5-inch-wide openings in a balcony guardrail at their vacation home and had fallen approximately 12 feet onto a lawn area, landing only a few inches from the edge of a concrete patio slab. Except for treatment by a doctor for bruises, the incident went unreported, but the family now notices that the child, currently eight years old, has an unusual ridge extending down the top of her head, apparent evidence of an undetected concussion that occurred at the time of her fall. The guardrail was promptly modified following the accident so as to prevent further problems.

The following are some of my impressions of what I have learned concerning building codes and their enforcement at both city and state levels:

1. Individuals who receive *Building Standards* magazine or publications from another model code organization tend to keep them in their homes and to not disseminate much of the information or articles to various individuals within cities and other jurisdictions and organizations which they represent.
2. The building code situation tends to be fractured and disorganized due to:
   a. Reliance on national government commissions or federally sponsored committees to write the codes.
   b. Extensive local amendments to the government-sponsored codes. In both New Zealand and Australia, the building officials reported that the volume of the local amendments adopted can often exceed the volume of the national code.
   c. Some building officials complain that architects and builders often disregard the building code and get away with whatever they wish to do.
   d. A great deal of nonuniformity can exist as a result of the amendments to a national code enforced at the local level.
3. Final decisions on the provisions to be included in the national codes are frequently made by a very small group of individuals. There is an opportunity for each of the state groups in Australia, for example, to react to and make recommendations concerning the various proposed provisions of the national code, but that appears to be the extent of their influence other than to promote the adoption of local amendments within their state.

My year-long, around-the-world trip of 50,000 miles also included visits to Singapore, Malaysia, India, Greece, Yugoslavia, Austria, West Germany, Switzerland, Italy, France, Portugal, Spain, Morocco, Great Britain, Ireland and Belgium. Six of the 20 countries visited had no specific regulations whatsoever relating to the allowable size of openings in guardrails and railings at open stairways, balconies and elevated porches. Most of the remaining countries allowed 150 mm (6 inches) openings and a few cities allowed as much as 200 mm (8 inches). Only three of the countries—France, Ireland and Great Britain—currently enforce a 100 mm limitation, a sensible limitation which I urged in all code-enforcing or code-promulgating jurisdictions and organizations contacted.

In July 1990, Mr. Stephenson met with Juan Antonio Campos Morales, principal administrator of the Internal Market and Industrial Affairs Directorate-General of the Commission for the European Communities in Brussels, Belgium.

Of special importance in Europe is the work of several technical committees of the Commission for the European Communities, headquartered in Brussels, Belgium. A group of six technical committees within the Internal Market and Industrial Affairs Directorate-General is responsible for the promulgation of new performance standards intended to be applicable to the design, construction and use of buildings within each of the 12 member countries of the community. Copies of my article were distributed to each member of the Technical Committee on Essential Requirements—Safety in Use. I anticipate that the 100 mm maximum opening limitation will be adopted and enforced throughout Europe in the near future.

During my travels, all of the building officials and code and standards authorities were most hospitable and helpful. Although only a few knew anything about the building code development and enforcement conditions in the United States, all expressed keen interest in my descriptions of them. Many officials look forward to participating in the World Organization of Building Officials and in learning more about United States' code development and enforcement. ■