"NETHERLANDS STUDY"

Summary

The Stichting Consument en Veiligheid (Consumer Safety Institute) has carried out a study into the ease with which fences can be climbed over. The study investigated the minimum standards which must be imposed on fences in order for them to act as a barrier to children from the risk group in particular (2 and 3-year-olds). The study sought to establish the minimum height usable, because a fence of this type can be climbed more easily by older children and young people, and hence damage due to vandalism is less likely to occur. This is very important, because damage of this kind also destroys the fence's ability to protect very young children. Aesthetic and financial objections can also be countered by using the lowest feasible fence. A practical study was carried out and recommended choices from among a number of types of fences available in the Netherlands were formulated.

Background
Drowning accidents play a significant role as a cause of death among young children in the Netherlands. This is primarily due to the fact that there is so much surface water in the Netherlands, including the immediate home surroundings of the potential victims.
The best way of preventing drowning accidents would be to ensure that the water is so shallow that it is safe even for the very youngest children. However, this is not possible, given that these children can drown in water just 10 cm. deep, and most ponds need a particular depth of water by the nature of their function. Children must therefore be prevented from getting to the water. One way of achieving this is the use of barriers.

In practice, there appears to be resistance to the use of barriers. Among the factors involved in this are aesthetic objections and the costs; and both the purchase costs and the maintenance costs are very important elements of the costs. Particularly stringent demands are made upon fences in public places, because of vandalism. Many fences around ponds come to a premature end because older children and young people destroy them in order to reach the water to fish, to skate in winter, or to fetch a ball which has landed on the other side of the fence. It is not so dangerous for this group to be able to reach the water - they are aware of the dangers - but the damage they cause to the fence means that very young children can also get to the water easily. The idea is that fences which older children and young people can easily climb over will be less quickly damaged, and will therefore be able to act as a barrier to the real risk group - the young children - for longer. Some additional advantages of lower fences are the fact that they are less noticeable (aesthetic benefit), and that the purchase costs are also lower. The aim of the present study is to investigate the minimum standards which fences must meet in order to serve as a barrier to very young children in particular.

Design of the study
The study consisted of two parts. First a study of literature was carried out to find out what kinds of requirements are made of fences, and what parameters are involved in determining how easy a fence is to climb over. Then a practical study investigated the effect of the different parameters on the climbability of fences.

The practical study investigated the extent to which seven fences could be climbed over by children from 2½ to 5½ years old. Fences 120 cm high were used in these tests, and could be given an effective height of 120, 100 or 80 cm by the use of a step in front of and behind the fence. The fences were produced and supplied by Heras Hekwerk B.V. in the Netherlands. All the fences had a smooth top, without serrations or barbed wire. The following five types of fences were tested:
Rail: Fence made of chain-link fabric with rigid posts and a top rail. The mesh size of the

(1)

chain-link fabric was 50 x 50 mm. There was a horizontal rail at the top of the fence with a diameter of 43 mm (Type: Zeus wire mesh fence: ZZ-12). The effect of the fence was tested at effective heights of 80, 100 and 120 cm. The results of these tests are indicated by "B-80", "B-100" and "B-120" respectively.

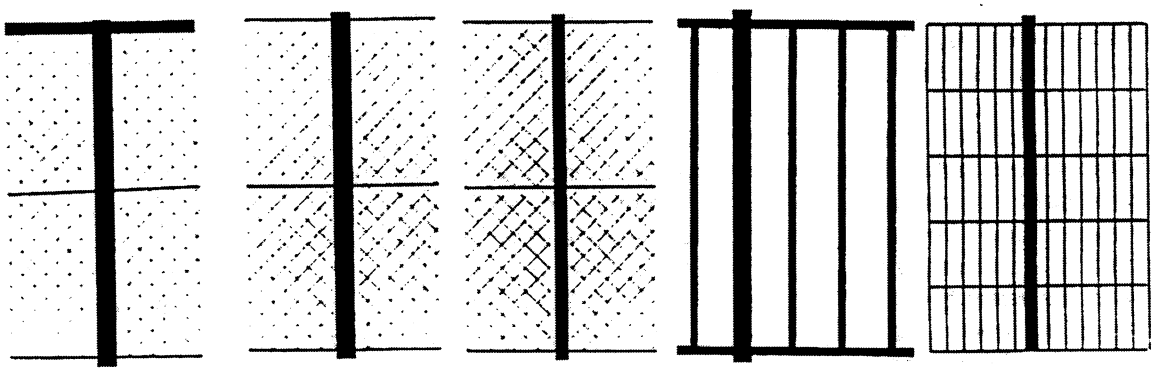
Line: As "Rail", but a line wire was used in place of the top rail. This fence had an effective height of 100 cm (Type: Zeus wire mesh fence: Z-120).

Flex: As "Line", but in place of rigid posts, flexible glass fibre reinforced polyester posts were used (Type G-120). Effective height 100 cm.

Bar : Fence made up of bars (diameter 26 mm) spaced at intervals of 150 mm. The top and bottom of this fence was finished with a single-sided convex profile without serrations (50 x 30 x 25 mm). The effective height of this fence was 100 cm (Type: Heracles 125 bar fence).

Panel: Fence made up of panels of welded steel wires with a mesh size of 50 x 200 mm (w x h). The panels are made up of vertical wires (diameter 6 mm) and double horizontal wires (diameter 8 mm). The top is made up of horizontal wires without protruding vertical parts (Type: Pallas 120 steel mesh panel fence).

Figure S.1 Type of fences used. From left to right: rail, line, flex, bar, panel



The testers were 31 boys and 35 girls divided up according to age (by half years), producing 7 groups of roughly 10 children each. The children were asked to climb over the fence in question. For the children aged from 2½ to 3, a ball was placed behind the fence and they were asked to fetch it. These children were thus encouraged to climb over the fence. In practice, children will frequently not be motivated to climb over a fence, so that in many cases a fence which can be climbed relatively easily will be sufficient. However, if there is something interesting on the far side of the fence (lost toy, pond, other children, etc.), children may be motivated and will try to climb over the fence.

Results of survey of literature

The standards relating to barriers in the Netherlands include standards for parapets and staircase railings [Building decree: Ministry for Housing, Regional Development and the Environment, 1991], for railings around playground equipment [NUSO et al., 1978], and for railings around cradles and playpens [Stichting Consument en Veiligheid]. These standards define the height, the distance between the bars or the size of the mesh, the absence of steps or stiles, and the space between the bottom of the fence and the ground. Mention is also made of flexible fences, where the flexible posts are considered to affect the ease of climbing over.

Much research has been carried out in the United States and Australia into protective fences around private swimming pools. One important study of this kind was carried out by J. Nixon in 1979. Nixon's study investigated the effect of different heights on the ease with which a particular type of fence rarely used in the Netherlands could be climbed (fence conforming to the Australian standard AS-1926, 1986). Foreign literature also contains recommendations for fence heights, distance between the bars, mesh sizes, steps or stiles, and gates. A study by the Trauma Foundation [1992] presented information about the ease of climbing through bar fences as a function of the distance between the bars. The foreign literature contains recommendations that fences should be as high as possible: 120 - 140 cm. Almost no attention is paid to vandalism, nor is any answer given to aesthetic concerns.

Besides the characteristics of the fence, the literature also contained characteristics of the users which may relate to their ability to climb over fences. The factors mentioned include: age, height, sex, climbing technique used, clothing and shoes.

Results of practical study
In presenting the results a distinction has been made between the characteristics of the children, and those of the fences.

Personal characteristics
Because of the relatively small number of test subjects, it is difficult to make definitive statements about the influence of specific personal characteristics. Although this has not been investigated precisely, it is for example possible that wearing a particular type of shoes may be related to sex or age. The effect of the type of shoes would then be derived from a difference in the age or sex of the test subject. With that reservation, we present the following results:

Age:	Age appears to play an important role in the ability to climb over a fence. The older the child, the more likely he/she is to succeed in an attempt to climb over, and the faster he/she will climb over.
Height:	The child's height is only relevant the time needed to climb over the steel mesh panel fence, and to the different heights of the mesh fence with top rail: taller children climb over the fence more quickly than those who are relatively short.
Climbing technique:	The way in which children try to climb over the fence is relevant to the success or failure of their attempt. This is most clearly seen in the case of the bar fence, where children have to jump up and support themselves on their hands immediately in order to get over it.
Shoes:	The type of shoes is only relevant in the case of the mesh fence with top rail; children wearing wide shoes have more difficulty in getting their feet into the mesh. The suppleness of the children's shoes is relevant in the case of the steel mesh panel fence: it is easier to place plimsolls vertically in the rectangular meshes of this fence.
Clothing:	(Summer) clothing does not appear to be relevant to the ability to climb over a fence. Apparently all types of clothing provide roughly the same amount of freedom of movement.

Characteristics of fences
Table S-1 shows the percentages of children who were stopped by the fence, for each fence and for each age group, and the mean time needed to climb over the fence.

Table S-1 **Protective effect of fences. This table shows the percentage of children (per age group) stopped by a particular fence. The values in brackets give the mean time in seconds required for succesful attempts.**

Age in years	Type of fence						
	B-80	B-100	B-120	Span	Flex	Spijl	Mat
2.5	63	86	100	100	100	100	100
	(30)	(41)	(n/a)	(n/a)	(n/a)	(n/a)	(n/a)
3.0	14	14	29	67	100	1001	56
	(36)	(24)	(25)	(26)	(n/a)	(n/a)	(38)
3.5	0	0	0	29	71	100	0
	(11)	(9)	(15)	(23)	(28)	(n/a)	(18)
4.0	0	10	10	11	67	89	0
	(14)	(14)	(15)	(13)	(17)	(30)	(11)
4.5	18	27	27	40	80	100	30
	(12)	(10)	(11)	(17)	(35)	(n/a)	(8)
5.0	9	9	9	18	73	64	9
	(7)	(10)	(11)	(15)	(18)	(10)	(11)
5.5	0	0	0	20	60	40	0
	(7)	(7)	(9)	(14)	(11)	(9)	(14)

Children were regarded as having been stopped by a fence if an attempt to climb over it failed, or if they refused to climb over that fence. Refusals might occur because the children themselves did not expect their attempt to succeed, or because they did not dare to make the attempt. As mentioned earlier, because of the relatively small number of test subjects (approx. 10 per category), the individual percentages are relatively strongly influenced by exceptional cases (e.g. an extremely agile child in one particular group, and a child which refused to cooperate in another).

Conclusions and recommendations

General

The wire mesh fences investigated ("Rail", "Line" and "Flex") were made of chain-link fabric with a mesh size of 50 x 50 mm. The children were found to be able to climb this easily, because their shoes could partly fit into the spaces in the mesh. We therefore recommend that fabric with a smaller mesh size should be used (40 x 40 mm). This is available as standard.

The chain-link fabric was found to be relatively vulnerable to vandalism: the wires can easily be bent apart and twisted loose.

When installing these fences, the horizontal line wires and the supports of the cornerposts must be situated on the far side of the fence, to prevent children from using them as a step for climbing up.

Rail

Three different heights of the mesh fence with top rail were tested. Even a number of 2½-year-olds could climb over the 80 cm high fence. The 80 cm fence was easier to climb over than the 1 metre fence, but for the somewhat older children even raising the height of the fence from 1 m to 1.20 m made virtually no difference to the ease of climbing over: in both cases the children got over the fence.

Line

If the top rail is replaced with a line wire, the fence appears to be more difficult to climb over

(compare "Line" in this respect with "B-100", which is also 1 metre high). Here, too, it was found that the 1 metre high fence had little ability to stop young children other than the 2½ to 3-year-olds.

Flex
The fence with the flexible posts was found to be a very effective means of stopping children. Its effectiveness is based on the fact that the fence bends towards the climber, making it very difficult to climb over. The children also perceive this flexible fence as frightening. The fence was 1.20 metres high, with a step reducing it to 100 cm high. This fence will sway more than a lower fence which is 100 cm high without the step; the height of 120 cm would therefore seem to merit a recommendation. In 1984 the local authority of Veenendaal installed 9,600 metres of 80 cm high flexible fencing at the bottom of a slope, in combination with a stumbling barrier at the top of the slope (a stumbling barrier is a metal rail 30 cm high which is designed to prevent children on bicycles from rolling down the slope into the flexible fence). The fence was found to work very well [Van Appeldoorn & Wiechers, 1990].

Bar
The bar fence was also found to be very effective at stopping the children. It appears to be less vulnerable to damage than the mesh fences, but it is of course also much more expensive. Older children appear to be able to climb over this type of fence easily, because they do not need any support for their feet, and can support themselves on the top edge of the fence while climbing over. The tests found that the distance between the bars (12.7 cm) was too large, because small children can squeeze through between the bars. This can be dangerous not only because the children can get through the fence easily, but also because there is a risk that they may get their heads stuck. A maximum distance of 10 cm between the bars is preferable.

Panel
Although the steel mesh panel fence is more effective than the mesh fences with rigid poles ("Rail" and "Line"), it is also not capable of stopping the somewhat older children. It is however suitable for the very youngest children. The steel mesh panel fence is less vulnerable to damage than the mesh fences.

TABLE

Fence Hight	1 meter	Climb ability	Details
Bar (1 meter)		Difficult	Children of age 4 yrs and older can climb over this type of fence.
Flex (1 meter) Buigt naar de klimmer toe		Difficult	Children of age 3-3,5 yrs and older can climb over this type of fence.
Line (1 meter)		Easy	Children of age 2,5-3 yrs and older can climb over this type of fence.
Panel (1 meter)		Easy	Children of age 2,5-3 yrs and older can climb over this type of fence.
Rail (1 meter)		Very Easy	Children of age 2,5 yrs and older can climb over this type of fence.

SOURCE:

- SUMMARY, pgs 1-5: S.A. ten Wolde, R.F.M. Jaartsveld. The Protective effect of fences: a research on climbability of fences by children from 2 through 5 years of age. Amsterdam: Consumer Safety Institute; 1994
- TABLE, pg 6: Consumer Safety Institute, The Netherlands