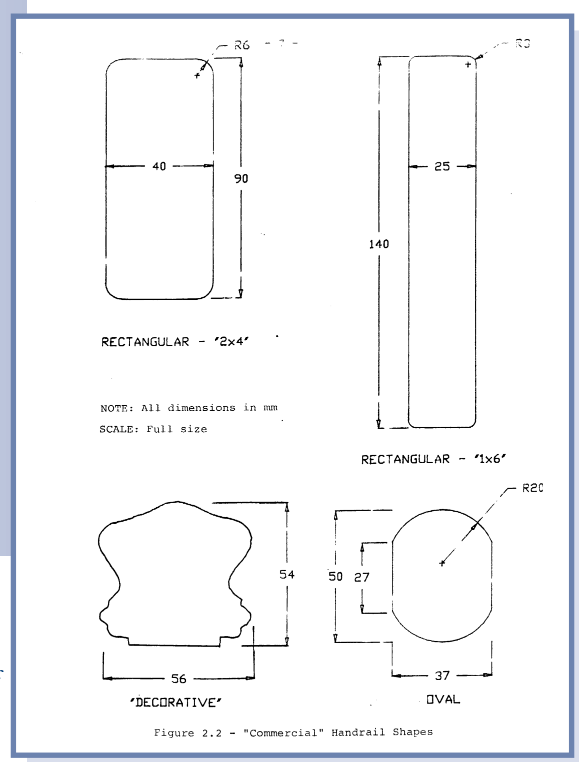
History

Decades ago, a study of just 20 subjects changed the face of the stair industry. While restrained in a standing position, pushing and pulling forces on a handrail were measured and the subjects' opinions recorded. This lead to the conclusion that a certain round shape, among those tested, provided a grasping surface against which subjects generally could generate high pushing and pulling forces.

Even though the researcher Dr Brian Maki warned of the study's static limitations and approximations, the study was in fact used to restrict the shape of handrails. Dr. Brian Maki specifically called for additional testing, however this early work was taken to the code authorities and successfully promoted to restrict the shape of handrails.

Research by Dr. Brian Maki (1985)

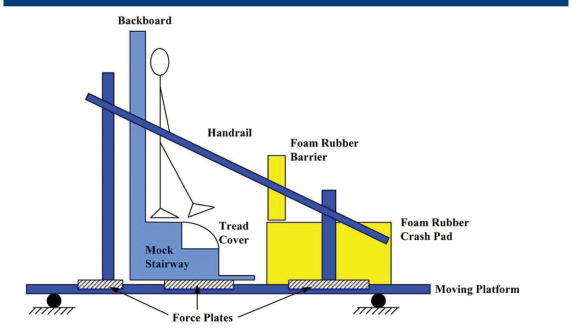
- Investigated levels of force people could exert by pushing and pulling while restrained in a standing position
- Did not study forces exerted on handrails in use
- Did not examine "sideways" or transverse forces
- Did not examine factors that make shapes graspable
- Did not test shapes representative of common shapes actually in use
- Study was limited to 10 males and 10 females
- Found 38 mm circular to be optimum "of those tested"
- Qualified his recommendation and called for additional "dynamic" testing



The shapes used in the 1985 study were not representative of common milled shapes, yet the findings were applied in error, eliminating many functional profiles.

Dr. Maki's early research was not conclusive. The forces measured were generated by actively pushing and pulling, not by the person falling away from the handrail. The research did not quantify what it was about handrail shapes that contributed to their function, the factors that make shapes graspable or the forces exerted on a handrail in use.

New Research



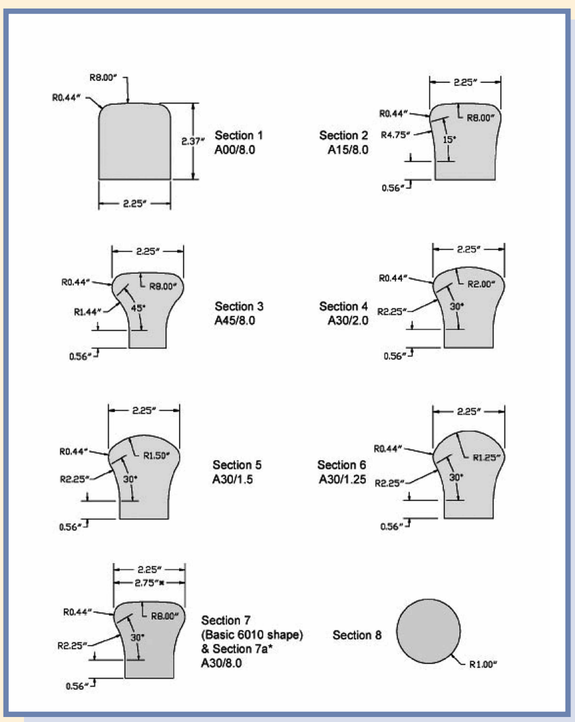
Setup for Fall Simulation Tests
(adapted from report by Maki and Perry (1996))

Additional independent testing was again performed by Dr. Brian Maki plus Simpson, Gumpertz & Heger Inc. and others.

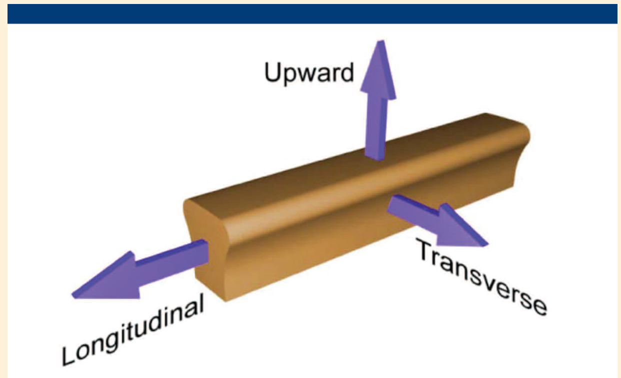
This testing included: dynamic tests of handrails in use on stairs arresting a fall, testing the maximum grip force on different shapes in each of the primary directions, more than 70 subjects aged 10 - 83, correlation of the effect of grip size, and evaluation of the the probabilities of the loss of grip.

These studies were designed to identify features that contribute to graspability and to define shapes that are graspable.

Earlier pushing and pulling tests did not simulate a handrail in use. Forces other than longitudinal are exerted on a handrail and certain factors make shapes more graspable. These factors were tested and documented.



Many handrail shapes were considered: Round plus milled with a width between 2 1/4 and 2 3/4 in. and a crown radius between 1 1/4 and 8 inches, with varying recesses on the sides.

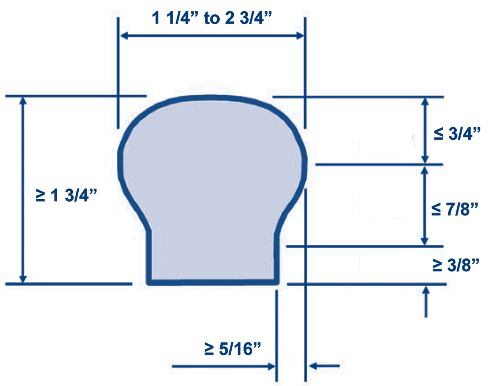


Primary Handrail Force Directions

The study indicated that subjects both pulled upward and pushed downward on the handrails. Transverse forces were inward pulls, not outward pushes. In the longitudinal direction, test subjects were pulling on the handrail, meaning that their bodies were even with or ahead of their grasping hands when they exerted the peak forces. When they exerted the peak forces, their bodies were lowered, with their arm outstretched.

The research was designed to study the features of handrails to determine what characteristics make them graspable. The intent was to be able to develop data that would allow a definition of graspable shapes.

Conclusions



On the basis of the tests and comparisons, it was proven that the influence of crown height and handrail width are minimal for the shapes that were examined. Further, it was concluded that the depth of recess defined by a sweep angle of 30 degrees provided graspability that is comparable to that of a 2 in. round handrail.

This substantiates that certain milled handrails perform as well as the code-allowed round handrail and that function is not sensitive to crown height.

Handrail Functions include:

- Guiding surface
- Stability aid
- Pull assist during ascent
- Fall arrestor

Features that Make Handrails Functional:

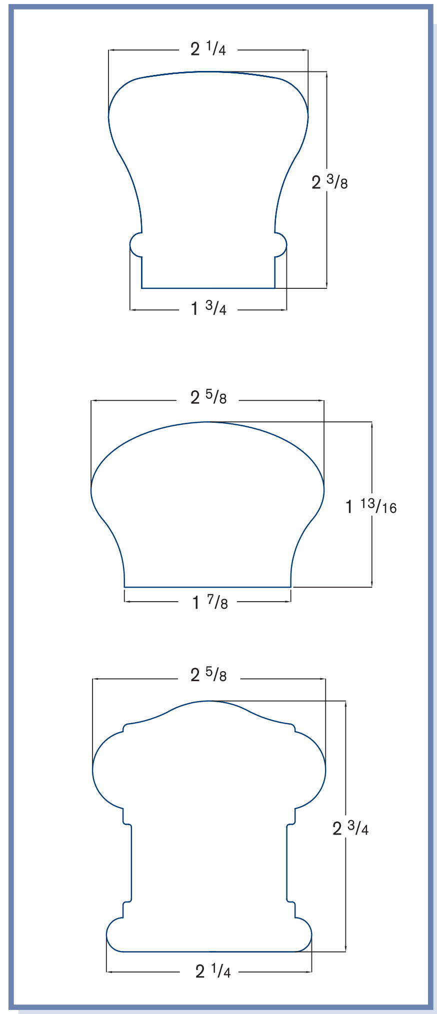
- Height
- Distance from wall
- Continuity of grasping surface
- Strength
- Profile

Features that Make the Profile Functional:

- Smooth surface without sharp edges
- Comfortable, effective grasping surface
- Uninterrupted grasping surface
- Defined finger recesses

Shapes that Serve the Purpose:

- Round or oval
- Milled shapes with Type II characteristics

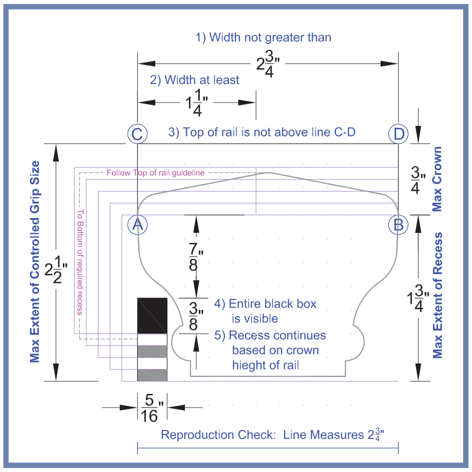


These examples exhibit the characteristics of Type II handrails and are equivalent to a 2" round handrail allowed by the current code.

These tests results and others of equal significance finally changed the International Residential Code in 2002, providing additional options. Now it is time for the same change in the International Building Code.

STAIRWAY MANUFACTURERS' ASSOCIATION SMA

Proposed Code



This is the code as it has been adopted by the IRC and is now proposed for IBC adoption:

Type II. Handrails with a perimeter greater than 6-1/4 inches (160 mm) shall provide a graspable finger recess area on both sides of the profile. The finger recess shall begin within a distance of 3/4 inch (19 mm) measured vertically from the tallest portion of the profile and achieve a depth of at least 5/16 inch (8 mm) within 7/8 inch (22 mm) below the widest portion of the profile. This required depth shall continue for at least 3/8 inch (10mm) to a level that is not less than 1-3/4 inches (45 mm) below the tallest portion of the profile. The minimum width of the handrail above the recess shall be 1-1/4 inches (32 mm) to a maximum of 2-3/4 inches (70 mm). Edges shall have a minimum radius of 0.01 inch (0.25 mm).

What is a TYPE II Handrail?

A TYPE II handrail has been designed such that it is equivalently graspable to the grip that can be achieved on a two inch round rail (allowed in all US codes) without requiring an unnatural wrapping of the bottom of the rail with the hand.

A TYPE II handrail allows the user to maintain a consistently secure natural grasp on the handrail in use on stairs without twisting the fingers under the rail where necessary attachments to a wall or guard require release.

A TYPE II handrail allows for freedom of design within the criteria and profiles as wide as 2-3/4”. This flexibility allows the possibility to design larger shapes that do not require a “power grip” for those that are impaired and cannot close their hand around smaller round profiles similar to “ hard to open bottle caps” now allowed by the code.

A TYPE II handrail has a regulated functional shape with a perimeter (complete distance around its profile) that is larger than 6-1/4” such that the grip required for safe use does need to wrap the bottom of the rail.

A TYPE II handrail profile has been designed with specific criteria that regulate the grip size and the shape of the required graspable recesses. This criteria has been scientifically proven in use on stairs under the most extreme conditions of arresting a fall.

Why is Equivalent Graspability still needed in the code?

Many profiles have not been tested or proven unacceptable. For example the determination of the grasp-ability of wider rails or rails with asymetrical recesses should continue to be allowed by the model codes.

In practice, other milled shapes not tested may be determined to have equivalent graspability.

Why do we need the TYPE II Standard?

The code already allows for “equivalent graspability” but each inspector and building official defines it differently. Many routinely avoid making a determination either because of time, liability, or simply inconsistent interpretation throughout their department. Manufacturers of any product require a standard that they can count on being accepted and be held accountable to produce. The Type II rail definition provides an enforceable standard for the manufacturer, the stairbuilder, the consumer and the building official.