Handrail Use by the Disabled

What we know:

In 1986 the landmark study “Hands on Architecture” by Ed Steinfeld, et.al.* provided cornerstone information for the development of access standards used today. Hand anthropometrics, Biomechanics, and Psychomotor Abilities of 130 persons with disabilities were focused upon to provide a database for the design of products manipulated by the hand that are used in buildings.

*http://www.access-board.gov/research/HandsOnArch/report.htm

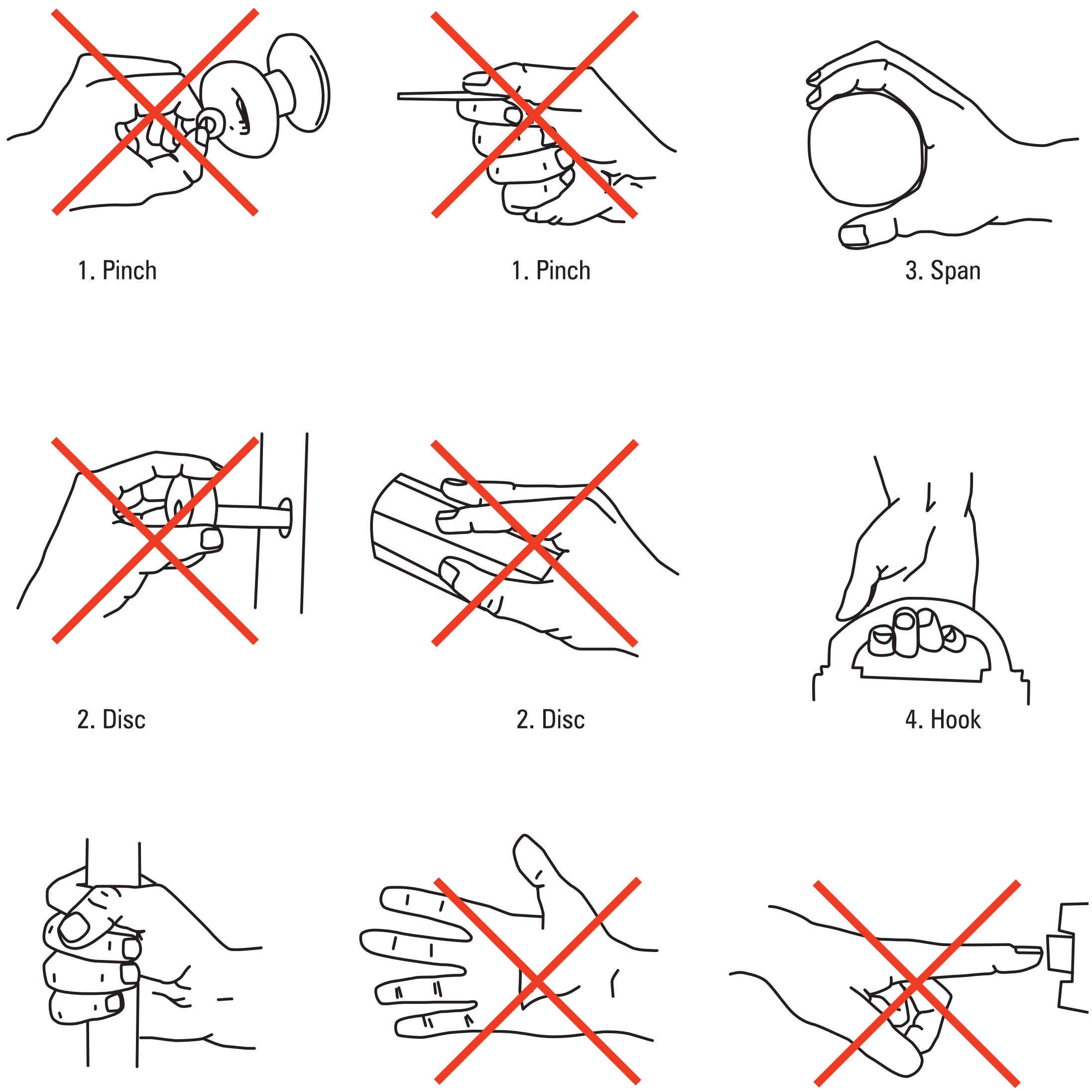

Figure 1.5a Project Grip Typology

Identification of Three Grips used for Handles, Handrails and Grab Bars –

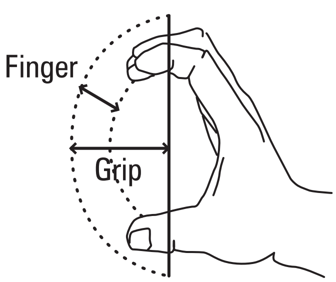

Figure 1.5d-3: Grip
Example: Power, Span

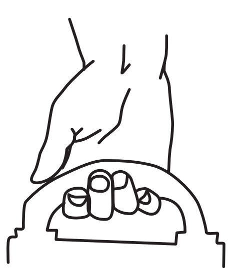

Figure 1.5a-4: Grip
Example: Hook

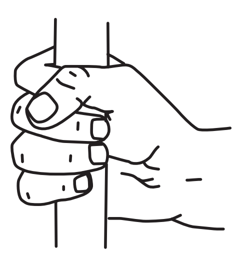

Figure 1.5a-5: Grip
Example: Power

The Power, Span grip is pictured as an “opened” Power Grip. The Pinch Grip made with fingertips is not used with handrails.

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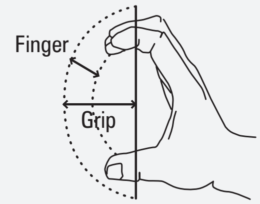
Hands on Architecture—Research & Tests

"...The strongest impact on ability was related to shape."

The study also included:

Validation of the Value of the Span Grip –

"In relation to Grip Size...The span grip was easier to complete by a small number of subjects. A strong relationship was found between the maximum perimeter gripped using the cone" (grip size measuring device) "and the maximum span grip."



Validation of the need for designed grip options and alternatives –

"The requirements for the operation of controls and equipment should be revised to limit handles" (considered bars like handrails) "to those that can be operated with a fist, a hook, flat hand or finger push grip.
Rationale: These are the grip types that are most "forgiving" -- they are easiest for hand disabled people to use. Devices usable by these also allow alternate grips most readily."

Recognition of the need for Grip shapes other than cylinders –

"Wherever possible, grip shapes that do not require the use of the power grip should be selected. The perimeter of a grip shape can be used as a design criterion in place of, or in addition to, grip shape and width. This allows precise evaluations between regular cross sections and more irregular shapes."

"Hands on Architecture" Defined, *__But Did Not Test Handrails:__*

"**ASSISTS:** Devices such as handrails, grab bars and railings that are gripped in order to aid in movement or provide support while shifting posture."

"*Although no assists were studied in the laboratory or in the field*, the recommendations..."

Biomechanics Testing revealed object shape to be most critical –

"The ability to apply forces to standard shapes was influenced by several interrelated factors:

1. orientation of the object;
2. direction of the force exerted;
3. size of the object;
4. operating height; and
5. shape of the object.

The degree of force that could be exerted appears to be a function of at least two or more of the factors."

SMA Funded Independent Testing

The Points to Grasp:

Although "Hands on Architecture" does an excellent job of identifying the key elements of graspability needs for disabled persons and correlating them with that of an able-bodied control group it does not provide the design specifics. But rather it "poses" pertinent questions.

- How do we provide functional handrails that meet the needs of the disabled?
- How do we take advantage of "object shape" and realize the strongest impact on ability to use a handrail?
- How can we provide design criteria for handrails that permit multiple grip options?
- How do we define graspable shapes other than cylindrical and provide needed alternatives?

SMA funded independent testing provides the answers:

- Specific testing of handrail shapes
- Understanding the grip forces applied to a rail in independent tests in each direction
- Dynamic testing of extremes of stabilization - arresting a fall
- Identification of what makes them graspable by both span-power and hook grips
- Scientific determination of parameters for width, crown and graspable recesses that define *Type II Handrails*

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Gripping Issues

Myth: A pinch grip requires twisting of the wrist.

TRUTH: A pinch grip is made with the fingertips to grasp a small object like a coin, or key. Twisting of the wrist is not required to form the grip and would only be incidental to the performance of some action while using or to use the pinch grip as in turning a key in a lock.

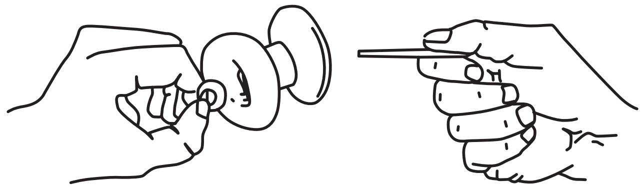


Figure 1.5a-1: Grip Example: Pinch

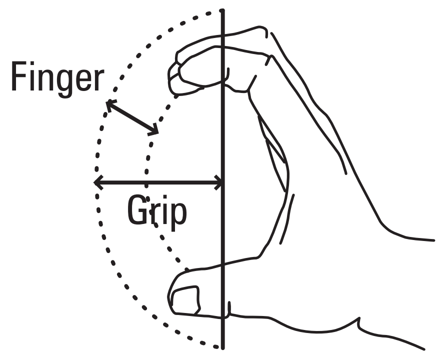


Figure 1.5d-3: Power, Span

Myth: Type II rails require a pinch grip

TRUTH: Type II rails are grasped with a Span Grip or what is also called a ***Power, Span grip*** in the access board's study "Hands on Architecture" which is characterized as a power grip without the fingers touching. Type II rails also accommodate the hook grip by use of the required recess. These additional grip functions allow greater opportunity for alternate uses by those with disabilities of the hand. A pinch grip is not used on handrails or grab bars.

Myth: The Power grip is the only effect grip for handrails.

TRUTH: Early studies of stabilization with the use of handrails did not measure transverse forces that are perpendicular to the rail. Transverse forces used to stabilize the body and arrest falls pull the rail toward the user and the maximum force is achieved with a ***hook*** grip. Think of doing a chin up and remember how the thumb pulls away from the bar.

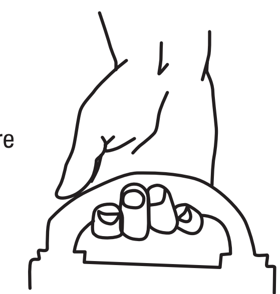
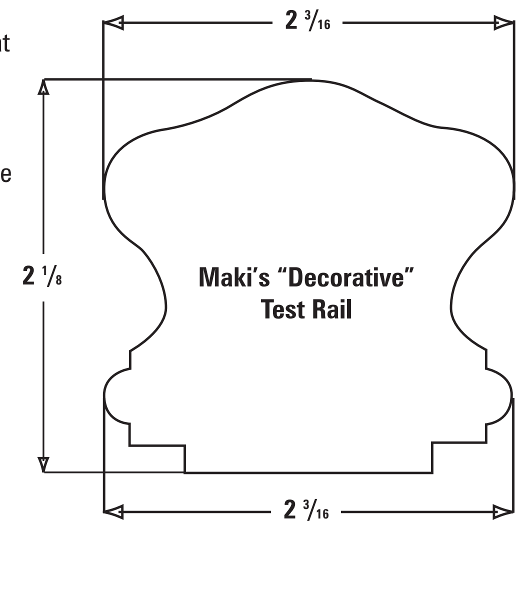


Figure 1.5a-4: Grip Example: Hook

Handrail Testing

Myth: Early Studies by Brian Maki tested "Profiled Rails"

TRUTH: In the industry a "Profile" is a detailed shape that is applied to square stock by moulding or extrusion processes. Historically rail profiles have been made to fit the hand and offer desired aesthetic details. Of the rails tested only one example of this nature was tested, a profile that is not recognized in the US or Canada, contributed to the research study by round rail manufacturers. Limited tests of this profile resulted in a ***flawed recommendation eliminating ALL larger profiled rails without Size and shape tests as to why.***



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Myth-Busting

Handrail Testing

Myth: 1985 study of Handrail Stabilization by Brian Maki tested the “dynamics” of stabilization.

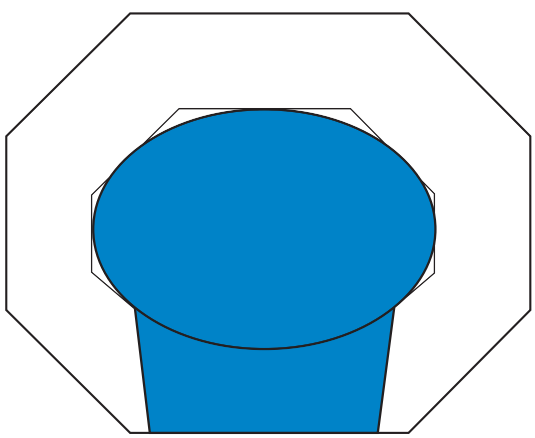
TRUTH: The 20 subjects in the study were strapped to a wall and asked to push and pull on a rail. The only dynamic was that of pushing and pulling in a longitudinal direction. Only when later studies by Maki sponsored by the SMA involved movement of the subject inducing a fall requiring a grasp response was the complete dynamic evaluated. These later independent studies revealed ***major discrepancies in the 1985 study i.e. effect of transverse forces, axis of rotation in a fall, position of the hand relative to the body.***

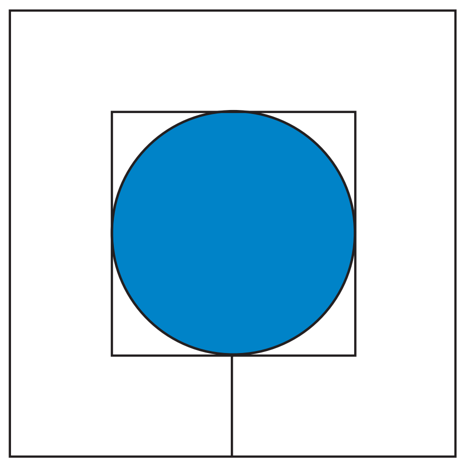
Myth: The studies by SGH testing the forces applied to handrails were not dynamic.

TRUTH: These tests were dynamic and measured the maximum forces applied to many handrail shapes in each of the primary directions used to stabilize the body. The rail was pulled from the hand of the subjects seated to represent the position of the body relative to the rail when the handrail is used to arrest the loss of balance. More than 73 subjects male and female ages 10 to 83 were tested.

Myth: Round pegs fit into square holes

TRUTH: The bones of the hand are straight segments connected in a such a way that if you could remove the tissue from the bones you would easily be able to trace a polygon or multi sided object within the closed hand, *Something much different than a circle.*





The tighter you close the hand the greater the voids. Because of the tissue and muscle around the bones you may not fully realize this effect unless you compare extremes of size.

The wider the grip the fewer the voids.

However this is precisely the reason that certain shapes perform much better as handrails especially in the longitudinal direction than round pegs…in square holes. No photo magic, just proven scientific fact.

Type II rails allow the grip surface to be designed to allow better distribution of the pressure on the soft tissue and bone structure of the hand. This results in greater contact area with more friction less discomfort. This is one of the reasons for their superior performance over rounds in longitudinal force tests.

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