Industry Factsheet

Selecting diameters for grabrails

PEER REVIEWED

Purpose

This Industry Factsheet supports design reasoning in the specification of grabrail outside diameter for an individual in their home environment. Satisfactory outcomes, as determined by the consumer, service provider, and builder, are more likely when the consumer's safety and dignity are considered at all stages of the project: from conceptualisation, prescription, design and installation of the grabrail. This Factsheet provides criteria for determining the best-fit grabrail outside diameter in specific contexts and accordingly, targets people designing, prescribing and installing grabrails for older people and people with a disability. This includes occupational therapists, architects, and builders.

This Factsheet provides information supplementary to the HMinfo Clearinghouse document **Industry Checklist: Selecting diameters for grabrails**, available on the Evidence Based Practice Reviews page in the Resource Library at www.homemods.info. Both the Checklist and Factsheet assume the reader understands construction principles required by Australian building codes and regulations. This Factsheet provides critical specifications and definitions for each criterion of the Industry Checklist for Class 1 buildings and within the sole-occupancy units of Class 2 buildings, however, it is intended as a starting point only and does not provide exhaustive detail for each criterion.

Background

This paper translates research results from a systematic review completed by the HMinfo Clearinghouse in January 2006. The research considered determinants of optimal grabrail diameters. The results of this study are available in the paper titled **Evidence Based Research: Selecting diameters for grabrails** available on the Evidence Based Practice Reviews page in the Resource Library at www.homemods.info.

Industry Factsheet: Selecting diameters for grabrails
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This Industry Factsheet supports best practice recommendations for the selection of grabrail diameters for use within private residences. The HMinfo Clearinghouse evidence based research considered the design issues that relate to grabrail diameter. There are other issues involved in grabrail prescription which this Factsheet doesn't cover, such as offset from wall, fixings, load tolerance and maintenance.

The research reviewed grabrail attributes in relation to the Building Code of Australia 2004 (BCA) requirements, and Australian Standard's Design for access and mobility 2001 (AS 1428.1). The Australian Building Codes Board released the Draft Disability Standards for Access to Premises for public comment in 2004. As part of the review, draft amendments to the BCA and parts of AS 1428.1 were also released for comment. This Industry Factsheet and the Evidence Based Research paper consider the requirements of the current BCA and AS 1428, not the proposed amendments.

Typically, the BCA calls up AS 1428.1 for technical specifications of grabrails provided for people with a disability. The BCA and AS 1428.1 grabrail requirements are not mandatory within Class 1 or 2 buildings although they do serve as a default or baseline for design. Consequently, many professionals prescribe and or design grabrails in accordance with AS 1428.1 for use in private residences.

The reason for this adherence to AS 1428.1 might be due to an absence of appropriate design guidelines or due to perceived liability issues. Where injury occurs and the design or installation varies from the standard, the onus is on the designer or builder to justify the variations. Designers and or builders require evidence to support design decisions. This Factsheet should contribute to the required evidence. Furthermore, dismissing available evidence could be considered negligent.

For example, consistent with AS 1428.1, a designer may prescribe a 38mm outside diameter grabrail for an older woman to use in toilet transfers. If the woman has small hands, research indicates that a 38mm diameter could be too large to enable adequate grip strength during transfer; thereby increasing the risk of a fall. Duty of care requires that the designer consider all available evidence including the woman's anthropometric data. In the absence of other constraints, a smaller diameter grabrail would be more appropriate.

The above example considers only one element in the complex activity of grabrail prescription and design. Recent research indicates that a number of elements interact to support or constrain effective and safe use of grabrails. Assessment and prescription of grabrails should consider each element and accommodate the individual variance of a situation in relation to the person, activity and environment. Grip strength and an ability to form an effective grasp are critical considerations in prescribing an appropriate grabrail diameter. A power grasp is the most effective grasp with grabrails - the hand encircles the grabrail enabling all segments of the hand contact with the grabrail. Grip strength can be increased by enlarging the surface contact area between the hand and the grabrail while maintaining a power grasp.

Maximal contact area alone does not increase grip strength. The grabrail diameter and or profile must allow a person to form a power grasp. As such, the person's hand size is essential in prescribing the grabrail diameter. Figure 1 demonstrates the relationship between grabrail diameter and grip. Over grip occurs where the diameter is too small, relative to the hand size. Over grip causes increased muscle tension in the hand, forearm and shoulder. Under grip occurs when the grabrail diameters are too large, increasing the risk of the grasp failing i.e. the hand may slip from the grabrail.

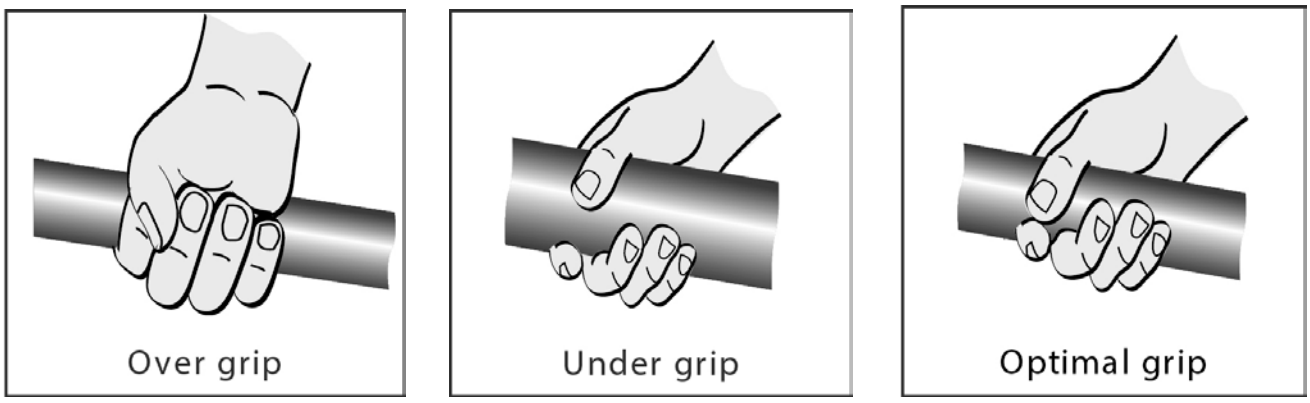


Figure 1. The effect of grabrail diameter on grip

The position of the wrist during an activity also affects grip strength. Typically, the wrist should be in a neutral position to achieve maximum grip strength i.e. the wrist and forearm are aligned as shown in Figure 2. Therefore, wrist deviation from neutral should be minimised while performing the activity e.g. sit-to-stand transfers. Where this is not possible, an optimal surface contact area between the hand and grabrail becomes more critical.

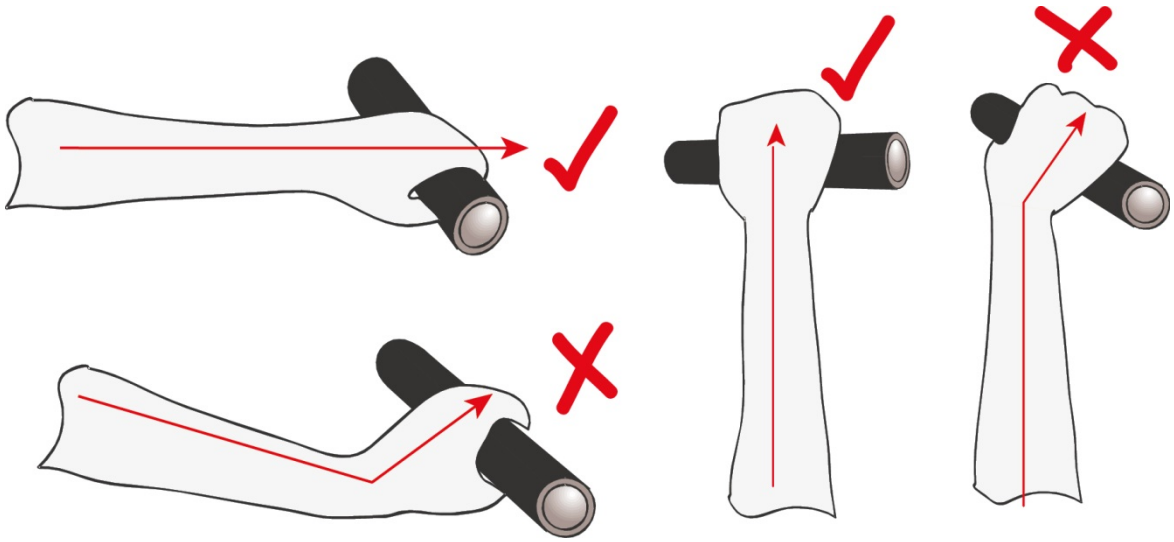


Figure 2. Alignment of wrist and forearm to achieve maximal grip strength

The frictional properties of the grabrail surface impact directly on the grip strength required to maintain grasp stability. The lower the coefficient of friction, the greater the grip strength required to prevent the hand from slipping. Fall risk increases if the hand slips when using a grabrail. A number of factors may influence the coefficient of friction including the finished surface of grabrails and exposure to contaminants. Exposure to contaminants such as soap, water and mould decreases the coefficient of friction. Grabrail design should then consider the environment where the grabrail will be located, i.e. the likelihood of exposure to contaminants.

Greater contact surface area increases friction between the hand and grabrail. Grabrail diameter therefore influences stability of grasp through adequate friction and the ability to form and maintain a power grasp.

Design

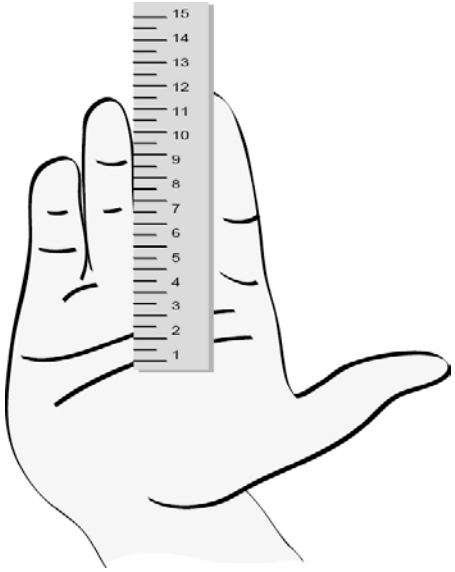
Although grabrails are prescribed for many purposes, good design will always consider the person, activity, and environment, i.e. hand size, the activity performed, frictional properties and the location of the grabrail. An occupational therapist should provide this information following an assessment of functional ability and anthropometrics at the predesign stage.

Person

Functional ability

The occupational therapist will assess how the individual can reach and grasp a grabrail. This may include consideration of:

- Coordination and range of movement (ability to reach out and grasp the grabrail).
- Strength and stamina (ability to maintain a grasp with adequate strength and stability throughout the activity).
- Balance (purpose of the grabrail to stabilise or to reduce the severity of a fall).
- Cognitive ability (need for cues or prompts to use the grabrail).
- Weight and size (load tolerance required).



Anthropometrics — palm length

Research indicates that the optimal outside diameter of a grabrail maximises the contact surface area between the grabrail and hand. Customary behaviour for measuring grip circumference is to record the distance from the tip of the third finger to the distal palmar crease as shown in Diagram 3.

The required grip diameter can then be calculated using the following formula: **Diameter = Circumference / Pi** for a diameter of 30mm may be recommended.
This relationship has not been tested by rigorous research at this time.

Figure 3. Measuring palm length

Grip Strength

Grip strength relates to the hand's holding power or a measure of the firmness of a grasp. Functional grip strength is the strength required to maintain the grasp while completing a given activity. The required grip strength changes with different activities and during an activity as the physical demands of the activity change. For example to maintain grasp stability, greater grip strength is generally required in transferring from a toilet to standing than is required for steadying oneself while standing. If balance were lost, however, maximal grip strength would be required to arrest a fall in both of these activities. Where the purpose of grabrail installation is safety and injury minimisation, design should facilitate maximal grip strength. This includes provision of an optimal grabrail diameter and maintenance of a neutral wrist position.

Grasp

There are many forms of grasp that can be used to hold a grabrail. Typically, a power grasp enables the recommended maximal grip strength on a grabrail. Some older people and people with a disability are unable to use a functional power grasp. An occupational therapy assessment will consider the ability to form an effective power grasp. If it cannot be formed, the therapist will determine the type of grasp most suitable to the activity that generates the greatest grip strength. The type of grasp employed will influence grabrail design and optimal outside diameters.

Activity

Although grip strength and grasp type are critical factors in the safe and effective use of grabrails, grabrail design should also consider the activity to be performed.

Orientation to grabrail

The functional forward reach and side reach affect the quality and safety of an activity while using a grabrail. Functional reach is the comfortable distance reached while maintaining adequate control and strength during completion of the activity. To maximise safety and injury reduction, the distance to the grabrail should be within the functional reach range on the dominant/unimpaired side. This requirement is central in determining the grabrail height, configuration, and distance from the user to the grabrail. The orientation also affects the wrist position when grasping the grabrail.

Grabrail use in sit-to-stand transfer

Because body position changes during a sit to stand transfer, the wrist cannot maintain a neutral position throughout the transfer. Maximising grip strength through the selection of appropriate contact surface area is therefore critical.

Grabrail use in standing

Grabrails are also prescribed for support or stability in standing. Completion of an activity in standing typically involves altering the body position relative to the centre of gravity, e.g. when entering a shower, adjusting clothing following urination (male), or at a single step. Again, the wrist may vary from a neutral position throughout these activities; maximising grip strength through optimal contact surface area is critical.

The environment

Grabrail design and prescription should consider the attributes of the finished surface of a grabrail in relation to the installed location of the grabrail.

The texture of a grabrail can influence the ability to maintain a stable grip. The performance of a given texture, in relation to slip resistance, may vary with moisture levels and the presence of contaminants. As slip resistance decreases, the grip strength needed to maintain a stable grasp increases. Research indicates that slip resistance of smooth finished surfaces decreases when wet, while textured surfaces enable the water to be displaced and so reduce slipperiness. Textured surfaces, however, are more likely to collect and hold contaminants. Over time, the contaminants offered by the textured surface (Figure 4).

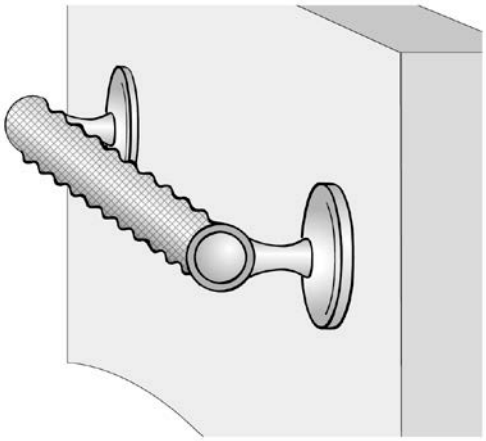


Figure 4. Textured finish

The cross-sectional profile of the grabrail influences the surface contact area. Circular, and some oval profiles maximise the contact between the hand and the rail, thereby reducing the strength required to maintain adequate grasp.

Summary

Increase potential grip strength

- Hand size
- Ability to form power grasp
- Wrist in neutral position
- Functional reach range
- Grabrail cross sectional profile and configuration

Ability to maintain grasp stability

- Friction at hand grabrail interface
- Finished surface texture
- Exposure to contaminants

***This information was correct at time of printing.*