Multi
Volume 1 Number 1 (Autumn/Winter 2007) Page 8

Floating Ramps

Daniel Baldwin Hess, PhD
School of Architecture & Planning
University at Buffalo. State University of New York
Buffalo, New York USA

Keywords accessibility, disasters, evacuation, extreme event, Hurricane Katrina, ramps

Abstract A first hand account of flood damage caused to accessible ramps by Hurricane Katrina in New Orleans is provided. The impacts of this damage to and destruction of ramps on the mobility and evacuation older adults and disabled people in affected areas is discussed, and the extent and causes of the damages are explained and quantified. An overview of various sponsors of existing ramp design guidelines is provided. Interventions are proposed, such as the establishment of additional specifications to enhance and strengthen ramp connections and mitigate future flood damage affecting the disabled and elderly. Issues for future investigation and research are discussed. Among them are the advisability of portable, temporary ramps in case of ramp failure from flood; flood preparedness/proofing of lifts for future raised housing; and the advisability of institutional partnering of various organizations such as FEMA, disability, veteran affairs and human services, insurance providers, as well as engineers, architects, and urban planners for establishing flood resistant design specifications for ramp design and construction and incentives that encourage compliance with such specifications.

Shortly after Hurricane Katrina struck New Orleans, nearby levees were breached and a flood up to 19 feet in depth inundated the city. Floodwaters caused damage to many accessible ramps at entrances to commercial buildings and private residences [*Figure 1*]. This ramp damage is similar to damage to other auxiliary structures such as sheds and porches. More seriously for ramp users, a number of ramps were raised from their foundations by the floodwaters, disengaged from their connections to porches and doorways, and then floated freely [*Figure 2*]. In other cases, floodwaters lifted ramps from their moorings and caused the ramp's connections to the ground and buildings to fail [*Figure 3*]. Site visits throughout New Orleans' residential neighborhoods shortly after floodwaters receded showed many accessible ramps in states of disrepair, disconnected from their moorings.

Figure 1. This medical office building is located near Lindy Boggs Medical Center in New Orleans' Mid-City neighborhood. The accessible ramp sat underwater for several days and experienced both superficial and structural damage, but it remained moored to the ground and the building.
Source: Image by Daniel Baldwin Hess © Hess 2005.

Figure 2 [top]. This accessible ramp disengaged from the rear entrance to a home in New Orleans' Gentilly neighborhood.

Figure 3 [bottom]. The accessible ramp at this house in the Seventh Ward of New Orleans detached from the front entry and settled on top of a fence in the side yard.
Source: Images by Daniel Baldwin Hess © Hess 2005.

An accurate count of accessible ramps serving New Orleans residences prior to Hurricane Katrina does not exist because not all residents who install a ramp file a building permit. However, 102,000 people in New Orleans five years of age or older report a disability, of which 46 percent report a physical disability. Among older adults age 65 and above, 50 percent report a disability (U.S. Census 2000). These disability rates suggest that loss of operability of these ramps is serious cause for concern, especially in an extreme event when these residents with disabilities might have to evacuate their homes quickly and perhaps without assistance (AFE Facilities Engineering 2005).

A ramp may provide the only feasible access and egress to a residence for the disabled who are unable to negotiate stairs and might be trapped inside if an accessible ramp becomes inoperable. In addition, a ramp could be critical for an individual with a cane, walker, wheelchair or power scooter to self-evacuate, or for caretakers or emergency workers to evacuate a home patient in a hospital bed or dependent on life support equipment.

Why Do Ramps Fail?

Simple laws of physics help explain why ramps stand up and why they may fail. A ramp is designed to withstand an active force (F_A) created by a user being pushed or self-propelling up or down a ramp. At the same time, the ramp responds to F_A with an implied normal force (F_N) acting perpendicular to its surface and a weight force as in (F_G) pulling the user gravitationally toward earth [*Figure 4*]. Summing these three forces, and including a friction factor at the ramp's surface, results in a vector sum of zero. At this point the ramp is stable, and active forces—created by ramp users—are absorbed by counteracting forces and the ramp remains standing.

What damaged—and in some cases uprooted and moved—accessible ramps? As water from the levee breaches flooded New Orleans, an upward hydrostatic force (F_H) caused by rising floodwaters *[Figure 5]* raised accessible ramps that were not sufficiently tied down or otherwise secured into a sidewalk or earth at grade. In some cases, ramp connections to a building gave way, and ramps or parts of ramps floated freely. Other ramps with adequate tie-downs or supports but inadequate connections failed under the stress of a hydrostatic force. Either way, the failure of an accessible ramp during an extreme event was serious because it limited access and egress.

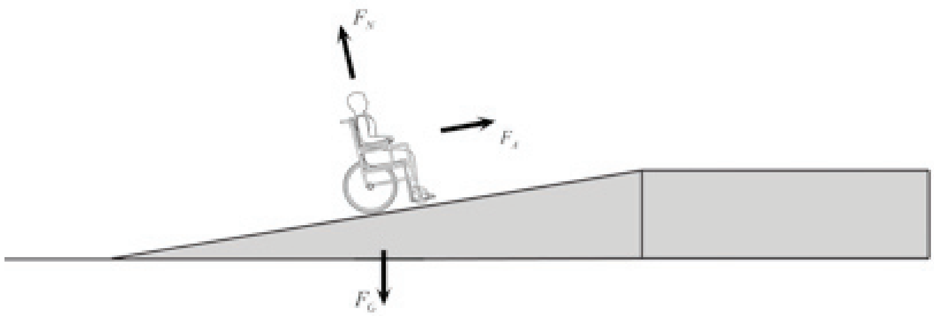

Figure 4. Forces acting an object ascending or descending a ramp.

Source: Image by Daniel Baldwin Hess © Hess 2007.

Ramp Construction

Observations following Katrina indicate that the quality in design and construction of accessible ramps varies, often based on an owner's ability to pay. For example, most accessible ramps in residential neighborhoods throughout New Orleans were of post and beam butt-joint construction and configured to fit the unique characteristics of an entryway or porch. In general, the design of accessible ramps is governed by local zoning ordinances and in some cases building guidelines and guidelines from state departments of health, human services, safety, and/or welfare. In New Orleans, however, there are no city or state guidelines for the design of ramps. The New Orleans Mayor's Council for Citizens with Disabilities refers residents who inquire about ramps to the Americans with Disabilities Act (ADA) Standards for Accessible Design (U.S. Department of Justice 1994). The guidelines specify design characteristics but do not provide specifications that define how ramps and ramp supports should be anchored to the ground so they resist the force of possible floods.

The ADA includes guidelines for ramp slope (1:20 gradient or less is recommended; 1:12 gradient should not be exceeded), width, landing platforms, level landings, and handrails (U.S. Department of Justice 1994). A variety of reports interpret the ADA and offer guidelines for home modifications and universally designed residential entries and ramps (Barrier Free Environments 1991; National Association of Home Builders and Center and Barrier Free Environments 1996; Kearney 1995) and how-to manuals (Frechette 1996) illustrate ramp design and construction. But none of these publications offer guidelines for tying down ramps and ramp supports adequately to prevent against flood damage and ensure emergency egress during an extreme event.

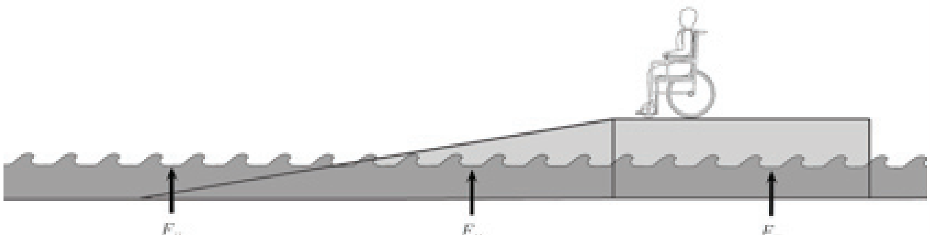

Figure 5. A hydrostatic force from below created by rising water can lift a ramp.
Source: Image by Daniel Baldwin Hess © Hess 2007.

Various disability advocacy groups do indeed offer construction guidelines for ramps, such as the Dallas Ramp Project and Home Ramp Project of Minnesota. The Home Ramp Project (1993) guidelines illustrate landing pads for ramp posts that connect with non paved surfaces and suggest that the posts at the base of ramps should be set into the ground 24 inches.

If not governed by building guidelines, perhaps adequately securing an accessible ramp to the ground is simply sound building practice. Builders account for various active forces on ramps, as well as unexpected forces like a tree branch falling on top of a ramp, but do not necessarily account for forces from underneath a ramp, such as a hydrostatic force from a flood. The cost to install an accessible ramp at a single family residence can range from $500 to $5,000 and the cost to improve construction by better fastening the ramp to the ground and building can raise the cost by up to 50 percent.

Recommendations

The floodwaters in New Orleans rose above the heights of many accessible ramps and stayed at that height for many days before receding; the severity of the flood resulted in drastic emergency evacuations and rooftop rescues (Krueger 2005), including evacuations of people with disabilities (Giarrusso 2006). Thinking beyond New Orleans, a hurricane zone or flood region could experience floodwaters of only a few feet that rise and fall quickly, perhaps damaging non-secured ramps and leaving residents trapped inside homes (Reese and Hardy 2006). A modular or temporary ramp is even less likely than a permanent ramp to be adequately bolted down.

The following interventions and recommendations are motivated by first-hand observation of damage to ramps and newspaper accounts detailing the difficulty of evacuation. In addition to upgrading the quality and improving the construction of accessible ramps, support structures should be firmly secured to the ground, especially in coastal areas and flood and hurricane zones. Securing ramps can prevent floods from damaging ramps or washing them away; more importantly, securing ramps can help maintain reliable access to and egress from residences for people with disabilities. Unsecured ramps that detach from homes create post-disaster debris that may limit access to and egress from ramps, homes, and even neighborhoods. Accessibility researchers should also investigate the development of disposable or one-time use emergency ramps that residents keep inside their homes that can be deployed to exit the home during or after an extreme event when a traditional accessible ramp becomes unusable. Naturally, the benefit-cost ratio of a sturdier ramp design increases where there is greater likelihood of floods.

Looking ahead, damaged residences will be rebuilt and new residences will be constructed to replace the hundreds of thousands of homes destroyed by Katrina and other storm areas of the southeastern U.S. New building methods for these homes—including modular designs and structures raised on stilts 10 feet or more high (Bohannon and Enserlink 2005, Eaton 2007)—will surely have even greater accessibility challenges. New types of lifts that will be built for these elevated homes must be storm worthy and flood resistant, helping to remove barriers for people with disabilities.

Finally, to better insure safe access and mobility for older adults and people with disabilities (American Red Cross 2004, Johnson 2007), various organizations responsible for the health and safety of this population (Moore 2005) such as the Department of Justice and the Veterans Administration should consider collaborating with the Federal Emergency Management Administration, the American Society of Civil Engineers, the National Association of Home Builders, the National Council on Independent Living, and insurance providers. Such collaborations could help establish guidelines as well as incentives to that make code compliance (including not only design but also construction) a precondition to reimbursement for assistive mechanisms like ramps or eligibility for flood insurance.

As the baby boom generation ages and older adults constitute a larger share of the population, we can increase our communities' resilience by maintaining safe and reliable accessible entrances to buildings and residences—including ramps that can withstand extreme events.

References

AFE Facilities Engineering. 2005. "Report Recommends Federal Changes in Emergency Planning for Disabled People." *AFE Facilities Engineering: A Publication of the Association for Facilities Engineering.* July/August 2005. pp. 27.

American Red Cross. 2004. "Preparing for Disaster for People with Disabilities and Other Special Needs." Report No.A5091. Retrieved April 6, 2007 from http://www.redcross.org/services/disaster/beprepared/disability.pdf.

Barrier Free Environments. 1991. *The Accessible Housing Design File.* New York, New York: Van Nostrand Reinhold.

Bohannon, John and Martin Enserlink. 2007. "Scientists Weigh Options for Rebuilding New Orleans." *Science Magazine.* vol. 309. pp. 1808-1809.

Eaton, Leslie. 2007. "Katrina Victims Find a Solution: Modular House." *New York Times.* January 6, 2007.

Frechette, Leon A. 1996. *Accessible Housing.* New York, New York: McGraw Hill.

Giarrusso, Courtney. 2006. "The Disabled Deserve a Better Way Out." *New Orleans Times-Picayune*. March 1, 2006. p. 7.

Home Ramp Project, Metropolitan Center for Independent Living. 1993. *How to Build Ramps for Home Accessibility.* 4th edition. St. Paul, Minn.: Metropolitan Center for Independent Living.

Johnson, Alan. 2007. "Disabled Urged to Form Disaster Plans." *Columbus Dispatch.* March 12, 2007. p. 3B.

Kearney, Deborah S. 1995. *The ADA in Practice.* Kingston, Mass.: RS Means Company.

Krueger, Curtis. 2005. "Rare Rescue Method Becomes Standard." *St. Petersburg Times.* September 8, 2005. p. 1B

Moore, Martha T. 2005. "States Review Evacuation Plans for the Elderly, the Disabled." *USA Today.* December 30, 2005. p. 4A

National Association of Home Builders Research Center and Barrier Free Environments. 1996. "Residential Remodeling and Universal Design: Making Homes More Comfortable and Accessible." Washington, D.C.: U.S. Department of Housing and Urban Development.

Reese, Phillip and Terri Hardy. 2006. "Grand Juries Level Criticism: Sacramento Jurors Rip County Over Lack of Flood Evacuation Plan." *Sacramento Bee*. July 1, 2006. p. B1.

U.S. Census. 2000. Summary File 3.

U.S. Department of Justice. 1994. *ADA Standards for Accessible Design.* Code of Federal Regulations, 28 CFR Part 36. Washington, D.C.: Department of Justice.

Authors' Note: All images by Daniel Baldwin Hess © Hess 2005. Site visits in New Orleans were performed on behalf of the Multidisciplinary Center for Earthquake Engineering Research at the University at Buffalo, State University of New York and supported primarily by the Earthquake Engineering Research Centers Program of the National Science Foundation under NSF Award Number EEC-9701471. Dr. Hess spent eight days in the New Orleans area approximately four weeks after Hurricane Katrina struck conducting research on emergency preparedness and response. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect those of the National Science Foundation. Alex Bitterman, Domenick Bovenzi, Angelika Breinlich, Page McCranie, Carl Sadowski, Melynda Smyntek, and Dorothy Tao provided assistance.