REPORT NUMBER: WI-04-03

Truncated Warning Dome Systems for Handicap Access Ramps

FINAL REPORT

November 2003

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
WI-04-03		

4. Title and Subtitle	5. Report Date
Truncated Warning Dome Systems for Handicap Access Ramps	Nov-03
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Peter Kemp	WI-04-03
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Wisconsin Department of Transportation DTID/BHC/Pavements Section/Technology Advancement Unit 3502 Kinsman Blvd. Truax Center Madison, WI. 53704-2507	11. Contract or Grant No.
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Wisconsin Department of Transportation DTID/BHC/Pavements Section/Technology Advancement Unit 3502 Kinsman Blvd. Truax Center Madison, WI. 53704-2507	Final Report 2002-2003
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

A Report of product trials of Truncated Warning dome systems for handicap access ramps. The Wisconsin Department of Transportation (WisDOT) initiated this study in partnership with the Federal Highway Administration (FHWA) and the City of Madison Engineering Division in response to these new ADA guidelines. Products were installed in the fall of 2002 and were evaluated over the winter and following spring. Product trials evaluated constructability, durability, aesthetics, cost, and conformance to the standard. WisDOT has also entered into a partnership with the Minnesota Department of Transportation (MNDOT) in the evaluation of these different proprietary systems. WisDOT performed the product trials with MNDOT performing laboratory tests on the different products.

Eight systems were evaluated, Engineered Plastics cast in place and retrofit, Increte stamp, Hanover cast in place, Strongwall retrofit, Cote-L one-step and two step retrofit, Detectable warnings retrofit. Included in discussion are Stampcrete and Metadome undocumented product trails.

As a result of this study WisDOT has approved Engineered Plastics, Armor Tile. Further investigation and development will continue in areas of stamping concrete and precast inset blocks.

17. Key Words	18. Distribution Statement
Truncated Warning Dome Systems, Tacticle Systems, ADA, American With Disabilities Act, Handicap Access Ramps, Sidewalk, Blind, Sight Impaired,	No Restrictions

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		

Truncated Warning Dome Systems for Handicap Access Ramps

FINAL REPORT NUMBER: WI-04-03
WisDOT Highway Research Study # WI-02-03

by

Peter Kemp

for

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DIVISION OF TRANSPORTATION INFRASTRUCTURE DEVELOPMENT
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November 2003

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Introduction:

Truncated warning domes provide a pedestrian detectable warning system for transition into traffic areas. The blind and visually impaired population readily distinguishes the surface treatment. The domes provide a surface that is easily distinguished underfoot and by cane. The dome structure provides enough relief that they are detectable underfoot. The domes are patterned in a manner that the pedestrian maintains stability when traversing the system. The application's color contrast also provides cues to the visually impaired pedestrian that a transition is forthcoming from the pedestrian area to a vehicular area.

The recent ADA Accessible Guideline (ADAAG) standards designate truncated domes as the only acceptable detectable warnings design for curb ramps. This will require all municipalities and states to install the truncated dome systems on all new handicap access curb ramps. This requirement was originally issued in the 1991 ADAAG guidelines. The requirement was temporarily suspended pending the completion of research studies. In July of 2001 the Access Board allowed the suspension to expire based on the findings of the completed studies. The expiration of the suspension reestablished the mandate to install these systems.

The Wisconsin Department of Transportation (WisDOT) initiated this study in partnership with the Federal Highway Administration (FHWA) and the City of Madison Engineering Division in response to these new ADA guidelines. Products were installed in the fall of 2002 and were evaluated over the winter and following spring. Product trials evaluated constructability, durability, aesthetics, cost, and conformance to the standard. WisDOT has also entered into a partnership with the Minnesota Department of Transportation (MNDOT) in the evaluation of these different proprietary systems. WisDOT will perform the product trials with MNDOT performing laboratory tests on the different products.

For more information and to view the complete rule visit http://www.access-board.gov/ . To view the draft guidelines please visit http://www.access-board.gov/rowdraft.htm#1104 or http://www.access-board.gov/ada-aba/status.htm

Installations:

Sites were chosen by the City of Madison to receive installations of the truncated warning dome systems. The systems were installed on these various sites throughout the city. The sites were selected based upon the sidewalk condition, ramp configuration, and availability of incorporation into existing sidewalk contracts.

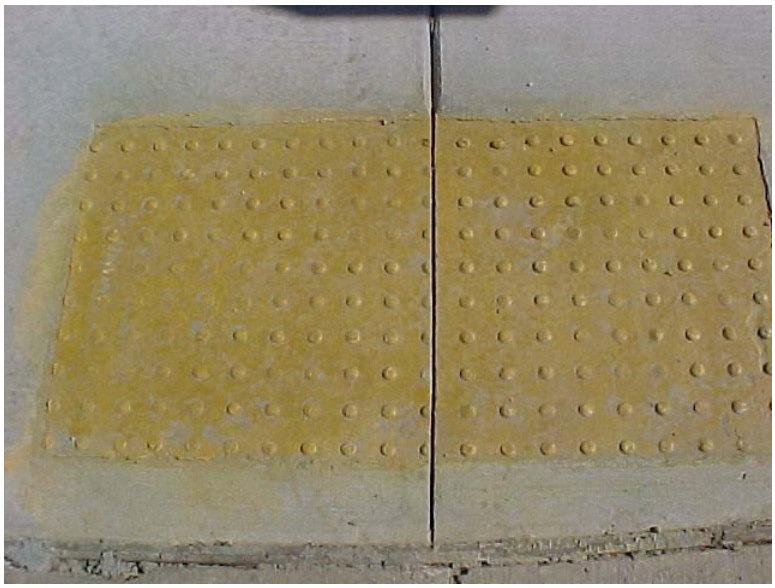
Products were selected to represent the various systems that are currently commercially available. Products were categorized into two main types, retrofit and cast in place. Retrofitted products would include any products that were glued on, either individually in sheet form or products that utilized a field material applied to the surface of the sidewalk to hold down individual domes.

Six manufactures were selected for the initial installation. Of the six manufacturers there were 8 different products installed. (See table1 and Appendix H)

WisDOT& the City of Madison
Truncated Dome Test Sites

Site	No. of Ramps	WisDOT Ramp Type	Location	Company	Schedule	Completed	Comments
1	2	I	Voges – Owl Creek	Increte	8/28/02	8/28/02	Cast in place. Color troweled in with powder release agent.
2	4	I	Kinsman – Wright	Engineered Plastics	9/10/02	9/10/02	Cast in place
3	4	II	Keys – Prospect	COTEL	9/11-12/02	9/12/02	Mat product, 1 step
3	4	II	Keys – Prospect	COTEL	9/11-12/02	9/12/02	Dome sticker sheet held on with field material, 2 step
4	6	II	University – Park	Increte	9/13/02	9/13/02	Cast in place, painted for contrast.
4	2	II	University – Park	Engineered Plastics	10/01/02	10/01/02	Cast in Place
5	5	II	STH 51 – Kinsman	Hanover	9/16/02	10/16/02	28 day cure, cast in place
6	5	II	Gilman-Carroll	Detectable Warning Systems	9/18-19/02	9/19/02	Returned day 2 for edge seal, retrofit
7	6	II	Gilman - Henry	Engineered Plastics	9/30/02	9/30/02	Retrofit
8	2	II	Packers - Schlimgen	Increte	9/25/02	9/25/02	Stamp with black granite chips.
9	1	I	Grandview – Knollwood	Engineering Plastics	10/01/02	10/01/02	Cast in place
10	1	I	Grandview – Sandwood	Increte	10/01/02	10/01/02	Stamp no color
11	2	II	West Lawn – Harrison	Strongwall	10/18/02	10/18/02	Two ramps complete, two ramps left unfinished because of low temperatures.

Table 1



Product: Increte

Location: Voges Road and Owl Creek Drive

Site: no.1

Installation Date: 8/28/02

Vendor information:
Increte Systems
1611 Gunn Highway
Odessa, FL 33556
V: 813-886-8811
800-752-4626
Fax 813-920-1516
www.increte.com

Discussion:

The concrete stamp manufactured by Increte was used to install the truncated warning dome pattern at this site. Two ramps were installed, one on the west side, one on the east of this T shaped intersection.

Cattel Construction was the contractor that did the installation along with personnel from the City of Madison and WisDOT. This method employed a stamp sold by the Increte Company. A powder colored hardener was utilized which was troweled into the fresh concrete. A powder release agent was used in conjunction with the stamp.

This installation was labor intensive and the domes were inconsistent in their formation. Some of the domes did not hold a consistent shape. The deformed domes were either domes that partially formed from the powder release agent or that not enough of the paste was pushed into the mold to have a fully formed dome.

Minor damage was experienced with snow removal operations

Conclusion: Not an effective system.

Recommendation: System not to be approved for use on Wisconsin Department of Transportation's projects.

Product: Increte

Location: Park St. and University Ave., Madison Wisconsin

Site: no.4

Installation Date: 9/13/02

Vendor information:
Increte Systems
1611 Gunn Highway
Odessa, FL 33556
Telephone 813-886-8811
800-752-4626
Fax 813-920-1516
www.increte.com

Discussion:

This consisted of two installations on the northeast corners, two on the southeast corner, and two on the southwest corner. This was done without any integral color in the concrete. A liquid release agent was used in place of the original powder release agent.

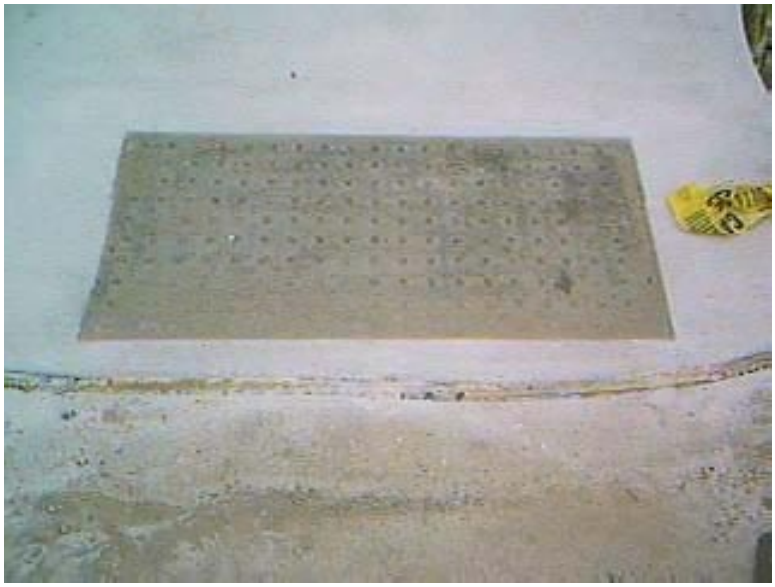
First application of the release agent was done per the manufacturer's recommended procedure. First lightly spray the area to be stamped and the stamp it's self. This yielded a crazed consistency to the dome pattern. Too much liquid was introduced into the stamping process doing this. Next was tried a method where spray release was only applied to the stamp. This produced a better result but inconsistencies still remained in the formation of the domes.

This installation was painted with a waterborne paint in early November to provide the required contrast. By spring the paint had been worn away. This installation is in the University of Wisconsin – Madison campus and received foot traffic well before an appreciable cure for the paint had been achieved.

Minor damage from snow removal operations was encountered.

Conclusion: Not an effective system.

Recommendation: System not to be approved for use on Wisconsin Department of Transportation's projects.



Product: Increte

Location: Packers Ave. and Schlimgen Dr., Madison Wisconsin

Site: no.8

Installation Date:
9-25-02

Vendor information:
Increte Systems
1611 Gunn Highway
Odessa, FL 33556
Telephone
813-886-8811
800-752-4626
Fax 813-920-1516

www.increte.com

Discussion:

This installation was done with the incorporation of one-quarter inch angular granite chips into the surface. Broadcasting and troweling incorporated these aggregates into the concrete. The installation was sprayed with water after initial set to expose the granite chips. The stamp had results that were similar to the preceding installations. Domes were inconsistent in shape and size.

No damage was evident from snow removal operations

Conclusion: Not an effective system.

Recommendation: System not to be approved for use on Wisconsin Department of Transportation's projects.

Product: Increte

Location: Grandview Ave. – Sandwoood Dr.
Madison Wisconsin

Site: no.10

Installation Date:
10-01-02

Vendor information:
Increte Systems
1611 Gunn Highway
Odessa, FL 33556
Telephone
813-886-8811
800-752-4626
Fax 813-920-1516

www.increte.com

Discussion:

This installation was placed in standard concrete. Similar results were seen as with other installations with no good consistency for the domes. Domes were inconsistent in shape and size.

Minor damage from snow removal operations was encountered.

Conclusion: Not an effective system

Recommendation: System not to be approved for use on Wisconsin Department of Transportation's projects

Product: Engineered Plastics – Armor Tile: Cast in Place

Location: Kinsman Blvd – Wright St.,Madison Wisconsin

Site: no.2

Installation Date:
10-01-02

Vendor information:
Engineered Plastics Inc.
Olympic Towers, 300 Pearl St., Suite 200
Buffalo, NY 140202-2599

V: 800-657-4336
Fax: 800-769-4463

www.engplastics.com

klawrence@engplastics.com

Discussion:

The installation was placed on all four corners of the intersection with WisDOT Type I ramps. The ramps were prepared and contraction joints tooled in, as they would normally be installed. Some additional finishing was required to the ramp to blend the product in the surface of the ramp.

A manufacturers representative then set the Armor Tile in place. The product was pushed into the wet concrete. It was placed so that the air could escape from vent holes on the transverse edge. The product has a frame approximately 1 3/8 inches thick. Ribbing is also present on the underside of the tile. Holes drilled into the side of the interior ribs allow concrete to enter and hold the product in place after the concrete has reached it's final set. Cinder blocks were placed as weight to keep the product from floating up prior to the concrete setting. The blocks were remove the following day. The product was taped and papered after installation to allow the finishers to spray cure the adjoining areas without affecting the product. Manufacturer will provide in the future a removable plastic protective coating. This will eliminate the need to tape and paper the tile as a method of protection against over spray of the cure agent.

The first installation took 15 minutes to complete including additional finishing. The second took installation took 6 minutes to complete. The third took 8 minutes, while the fourth ramp took 9 minutes. The manufacturer's representative installed the first three sites and the City of Madison's contractor, Cattell, did the fourth ramp.

No visible damage from snow removal operations.

Conclusion: An effective system

Recommendation: System approved for use on Wisconsin Department of Transportation's projects

Product: Engineered Plastics – Armor Tile: Cast in Place

Location:
Park Street and University Avenue, Madison Wisconsin

Site: no.4

Installation Date:
10-01-02

Vendor information:
Engineered Plastics Inc.
Olympic Towers, 300 Pearl St., Suite 200
Buffalo, NY 140202-2599

V: 800-657-4336
Fax: 800-769-4463

www.engplastics.com

klawrence@engplastics.com

Discussion:

This products installation was similar to the previous installation. The product went into fresh concrete. Masonry cinder blocks were left on site to hold the tile in place until initial set of concrete.

No damage was visible from snow removal operations.

Conclusion: An effective system

Recommendation: System approved for use on Wisconsin Department of Transportation's projects

Product: Engineered Plastics – Armor Tile: Retrofit
Location: Gilman St. – Henry St., Madison Wisconsin

Site: no.7

Installation Date: 9-30-02

Vendor information:
Engineered Plastics Inc.
Olympic Towers
300 Pearl St., Suite 200
Buffalo, NY 140202-2599

V: 800-657-4336
Fax: 800-769-4463

www.engplastics.com

klawrence@engplastics.com

Discussion:

The manufactures representatives' crew of two men installed the product. The ramp was ground with a large hand grinder to remove the top surface of the concrete. The concrete area along with the panel's surface was prepped with acetone. This panel is very similar to the cast in place panels. The main difference between the cast in place and the retrofit is the lack of any of the ribbing or frame. This positions the top surface approximately one quarter of an inch above the sidewalk.

Adhesive was applied to the back of the panel in a random pattern with a caulk gun The panel was set in place and pressure was applied by hand to seat the panel. Mechanical concrete anchors were installed on the corners of the tile by drilling the concrete with a hammer drill and placing the anchors in pre-countersunk recesses located on the corner domes. The beveled edge of the panel along with the adjoining concrete was cleaned with acetone. Tape was placed on the concrete and the tile to form an area to install a fillet transition from the concrete to the panel. A two-part epoxy material was placed as the fillet. The material was dry in 12 minutes. The entire process took 30 minutes per ramp to install. The manufacturer has since changed the fillet material because of material failure of the epoxy.

Minor damage was experienced by snow removal operations.

Conclusion: An effective system but the department is opting for inset systems.

Recommendation: System not approved for use on Wisconsin Department of Transportation's projects

Product:
Detectable Warnings - Retrofit

Location:
Gilman and Carroll Street, Madison Wisconsin

Site: no.7

Installation Date: 9/18-19/02

Vendor information:
Detectable Warning Systems
P.O. Box 232
17853 Santiago Blvd., #107
Villa Park , CA 92861

V: 1-800-999-7542
Fax: 714-974-3246

detectable@aol.com

www.detectable-warning.com

Discussion:

This product is a rubber type resilient mat. The ramp areas selected were scarified to remove the top layer of the old concrete. This was to remove any unwanted containments ensuring a good adhesive bond. The concrete was then cleaned with compressed air. The area to receive the mat was taped off to isolate the area. A two-part epoxy adhesive was mixed together in a pail using a wooden stick. The glue was applied to the concrete with a V notched trowel. The mat was laid in place; a small wallpaper seam roller was used to roll in between the rows of domes. A 1-foot square board was used to apply pressure to the top of the domes. This was done so that the mat had enough pressure to ensure a proper bond.

Mechanical anchors were installed on each corner of the mat. The anchors sat inside a precountersunk dome. After the mat was glued in place and the anchors were placed, a ¼ inch plywood board was laid on top of the mat installation. Sand bags were used to weight the board down. This was left overnight while the glue cured. The following day the plywood and sand bag weights were removed. An edge sealer was applied to the mats. Installation times were #1- 32 minutes to install, #2- 35 minutes to install, #3- 48 minutes to install, #4- 45 minutes to installon the first day. On the second day 10 minutes was spent to apply the edge seal and remove sand bags.
Total Ave = 50 minutes/ramp installation time

The mats performed well in resistance to damage from snow removal operations and bonding to the concrete. Problems were seen with retaining dirt in the pores of the product giving the panels a dirty and stained look.

Conclusion: Not an effective system

Recommendation: System not to be approved for use on Wisconsin Department of Transportation's projects

Product: Hanover

Location:
Kinsman Blvd. – STH 51, Madison
Wisconsin

Site: no.5

Installation Date: 9-16-02 to 10-16-02

Vendor information:
Hanover Architectural Products
240 Bender Road
Hanover, PA 17331

V: 717-637-7145
Fax: 717-637-7145

www.hanoverpavers.com

info@hanoverpavers.com

Discussion:
This product was installed in two stages. The City of Madison's contractor Cattel did the first stage. The ramp was prepared as usual. A temporary form was inserted into the fresh concrete to form a recess to accept the precast masonry panels. The form consisted of a wood frame and a plywood bottom. The form was placed in the concrete and finished around. The forms were removed, one that afternoon and the rest the following morning. All were removed with some degree of difficulty. The forms were destroyed in the process.

After a 28-day cure period the site was ready for installation of the masonry panels. A high-pressure steam power washer was used to clean out the recessed areas. After the areas were cleaned a thin-set bonding mortar was applied and used as an adhesion layer. This was applied both to the masonry block and the recessed area. Following the application of the bonding layer a thickset mortar was used a leveling bed at approximately ½ inch thick. This was applied in the recess over the top of the thin set mortar material. The masonry panels were lowered into place onto the leveling mortar bed. A grout material was applied to fill in the one-quarter inch gap that existed on the perimeter of each block. Time to install the panels were on average one hour per ramp.

The installation technique of the pavers make this system to cumbersome to install. The pavers themselves have performed well in resisting damage from snow removal operations.

Conclusion: Not an effective system

Recommendation: System not to be approved for use on Wisconsin Department of Transportation's projects

Product:
COTE – L Retrofit one step mat
Location:
Keys and Prospect Street, Madison Wisconsin

Site: no.3

Installation Date: 9/11-12/02

Vendor information:
COTE-L Industries
1542 Jefferson Street
Teaneck, NJ 07666

V: 201-836 0733
Fax: 201-836-5220

prodinfo@cotelind.com

www.cotelind.com/

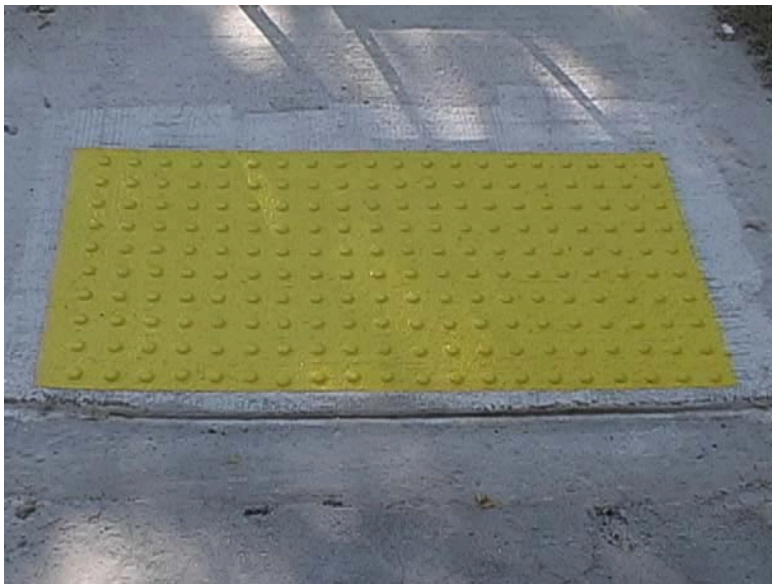
Discussion:

This product is a rubber type resilient mat. The ramp areas selected were scarified to remove the top layer of the old concrete. This was to remove any unwanted contaminants ensuring a good adhesive bond. The concrete was then cleaned with a solvent. The area to receive the mat was taped off to isolate the area. Adhesive glue was applied to the area to receive the mat. The glue was a one part adhesive that came in caulk tubes. After laying out the glue from the gun a toothed trowel was used to spread out the glue for total coverage. A one foot square board was used to apply pressure to the product. The tape was removed and the glue was allowed to dry overnight before foot traffic was allowed.

Areas of debonding were evident after several days of the installation. The product was damaged past an acceptable level with snow removal operations.

Conclusion: Not an effective system

Recommendation: System not to be approved for use on Wisconsin Department of Transportation's projects



Product: COTE – L
Retrofit two-step w/
Safti-Track

Location:
Keys Street – Prospect Street, Madison
Wisconsin

Site: no.3

Installation Date: 9/11-19/12

Vendor information:
COTE-L Industries
1542 Jefferson Street
Teaneck, NJ 07666

V: 201-836 0733
Fax: 201-836-5220

prodinfo@cotelind.com

www.cotelind.com/

Discussion:

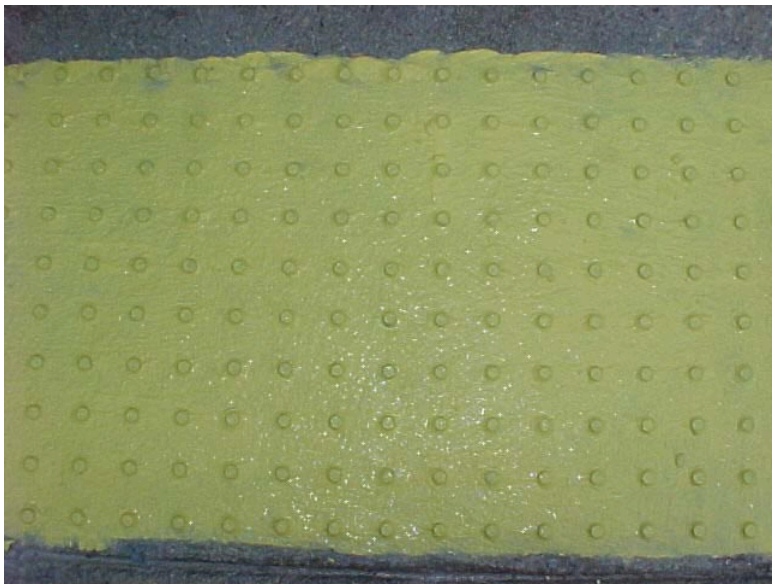
This installation is a rubber type resilient product. The ramp areas selected were scarified to remove the top layer of the old concrete. This was to remove any unwanted contaminants ensuring a good adhesive bond. The concrete was then cleaned with a solvent. The area to receive the mat was taped off to isolate the area.

A field material Safti-Track was mixed with an accelerator using a drill attachment paint mixer. The material was rolled onto the concrete using a paint roller. The field material was allowed to set up for 20 minutes to a tacky consistency. The domes supplied in a sheet, were the individual domes were adhered too. The domes were laid on top of the field material. The domes were pressed into the material using a 1-foot square board to apply pressure by hand. Domes were then individually pressed into the field material to assure adhesion. An incision was made along each row of domes to allow air to reach the field material increasing the cure rate. The installation was allowed to cure for 2 hours. The plastic sheet material was peeled off row by row. Individual domes were held down to keep them from dislodging during this part of the installation.

After the sheet material was removed a second coat of the Safti-Trax was applied and allowed to cure overnight. The next day a third coat of the field material was applied and allowed to cure for before traffic was allowed to traverse over the dome installation. The product was damaged past an acceptable level with snow removal operations.

Conclusion: Not an effective system

Recommendation: System not to be approved for use on Wisconsin Department of Transportation's projects



Product:
Strongwarn

Location:
West Lawn and Harrison Street, Madison Wisconsin

Site: no.2

Installation Date: 10-18-02

Vendor information:
Strongwall Industries, Inc.
107 chesnut Street
Ridgewood, NJ 07450

V: 201-445-4633
Fax: 201-447-2317
www.strongwall.com/

strongwall@strongwall.com

Discussion:

Strongwall was a cementitious product applied to existing concrete.

The sidewalk is scarified to clean the concrete. The concrete had any loose material removed and was then cleaned with compressed air. The concrete surface was then saturated with water to help the adhesion process of the mortar.

The product is a three-step process. The dome and field material were mixed from mortar and proprietary admixtures. The domes were applied to the ramp using a form that a cementitious material was troweled onto. Mineral spirits were applied to the mold as a release agent. When the form is removed the dome pattern remains. After curing overnight a cementitious field material is applied in two coats. The coats are allowed to cure before the next application is applied. The product is then painted to provide a color contrast.

Several domes lifted off the concrete with the mat form. The domes were reattached using the first coat of field material. Domes were damaged from snow removal operations

Conclusion: Not an effective system

Recommendation: System not to be approved for use on Wisconsin Department of Transportation's projects

Evaluation:

The products were installed in the fall of 2002 at various sites through out the city of Madison, Wisconsin. Snowfall was light with accumulations for the season being 28.8 inches [NWS, 2004]. The domes were subject to snowplowing, snow blowers, residential shoveling and salting.

The installations were inspected for damage to or loss of domes and field material. The results are summarized in Table 2.

The Minnesota Department of Transportation also evaluated the products for weathering and color loss. The Armor tile along with the Hanover product experienced minimal damage or color loss associated to the accelerated weathering (see appendix B)

Site #	Location	Company	Performance
1	Voges – Owl Creek	Increte	Minor damage
2	Kinsman – Wright	Engineered Plastics	Performed well no visible damage
3	Keys – Prospect	COTEL 1 step	Mat was torn and ripped. Loss of adhesion evident
3	Keys – Prospect	COTEL 2 step	Domes were damaged and in some areas removed by snow removal operations.
4	University – Park	Increte	Minor damage, paint for color contrast wore off
4	University – Park	Engineered Plastics	No visible damage
5	STH 51 – Kinsman	Hanover	No visible damage
6	Gilman-Carroll	Detectable Warning Systems	No damage to domes, product holding a lot of dirt giving it a stained appearance.
7	Gilman - Henry	Engineered Plastics	Minor damage
8	Packers – Schlimgen	Increte	No damage
9	Grandview – Knollwood	Engineering Plastics	No damage
10	Grandview – Sandwood	Increte	Minor damage
11	West Lawn – Harrison	Strongwall	Domes and field material severely damaged.

Table 2 Dome Performance

Color:

The requirements set forth in the ADAAG standards specify that a 70% contrast be maintained between the truncated dome warning field and the sidewalk. The more recent draft guidelines have language modifying that requirement to a light on dark or a dark on light contrast. Contrast does not control visibility as much as color does. A study conducted by the US Department of Transportation found [Bentzen, B.L. (1994)] "The contrast of safety yellow with concrete was only 40%; nonetheless it was chosen as one of the two most visually detectable contrasts." Trials done by the Wisconsin Department of Transportation in cooperation with the City of Madison, Wisconsin have supported this also. Two different color trials were conducted; the first evaluation was done looking at colored samples of masonry blocks. The blocks red in color were the most visible (see appendix C). The gloss finish was the most detectable. When compared to the safety yellow color of Engineered Plastics product the gloss red masonry panel was found to be the secondary to the yellow for contrast. The yellow was distinguishable at 33 feet almost twice the distance of the red panel at 18 feet. In comparing contrast of products

aged gray concrete (see appendix A) the yellow was found to contrast at 1.9% and the white at 65.6% compared to the contrast of the red at 65.6 %, yellow was still the preferred color This supports the ideas that color is more important than contrast. This observation is also a conclusion of a study done for the Federal Highway Administration [Bentzen, B.L.(1994)]. In a parallel study safety yellow was rated the highest detectable color by low vision participants in a study done for the Sacramento Regional Transit District [Koffman, D. (1997)].

A second trial (see appendix D) was held where an evaluation was done of colors offered by Engineered Plastics. It was found by that trail that white and safety yellow were the top choice of one of the two participants possessing a 20/400 vision. The second participant, with a lower level of vision than the first evaluator, was not able to pick out any the fields but black at a distance of 5 feet. This participant was not able to distinguish the color of the tile.

Discussion:

The system types that have shown the best durability are the Increte, Detectable Warnings, Hanover and the Engineered Plastics. The Hanover and the Detectable Warning Systems have not shown any wear through the evaluation period from September 2002 through August 2003.

The Increte system yielded inconsistent results. On average 25 % of the domes were deformed or missing. This is consistent with other experiences on other trials conducted by the New Hampshire DOT [Boisvert, D.M. (2003)]. The forms were prone to clogging of the vent holes and required frequent cleaning. The stamping success is very sensitive to concrete consistency and substantial effort would have to be taken to train contractors on the use of this system and other similar stamps available.

In undocumented informal trails in the City of Marshfield and in the City of Madison Wisconsin the Stampcrete System yielded similar problems with inconsistencies of dome size and shape. The Metadome Stamping System was also used in similar undocumented trails with much greater success and is currently being evaluated by the department in an ongoing product approval effort.

Using troweled in color was very labor intensive and is not cost effective. Painting or staining of the concrete may be the most effective way to provide the necessary color contrast. Special care would need to be taken to ensure a slip resistant surface by adding glass beads or similar material to the paint. A good gripping surface needs to be provided not only on the domes themselves but also in between the domes themselves for wheel chair access. The department is pursuing the development of a specification allowing the use of stamps.

The Hanover system performed well, no damage was seen over the evaluation period. The system provides a constant atheistic dome. The surface is similar to the concrete surface surrounding the tiles providing a good slip resistant surface. This system was found to be too labor intensive to find it cost effective. The product required that a recess be formed and finished around in the concrete. The contractor had to return later the first day to remove the form. The recess had to be left to cure for 28 days prior to installing

the precast panels. During that time cones delineated the recess that provided an obstacle to pedestrians. The recess could be filled with sand or gravel or even covered with a plate. The panels then received a thin set bonding mortar followed by a thickset mortar bed. After installation the edge joints needed filling with material.

The Department in the future will pursue and develop a specification allowing a full depth panel that is mechanically anchored to the sidewalk.

The Detectable Warning Systems product has shown good durability receiving no apparent damage in the field. The system provided an aesthetic, consistent dome. There were some problems with the product holding dirt in the pores of the material giving it a stained appearance. The product provided a good slip resistance surface.

The Cotel products did not stand up to winter snow removal. The installations exhibited loss of domes and field material. The one step or mat product had areas that debonded prior to any snowfall. These areas lifted up giving a bubbled look to the product. Both products gave a good aesthetic, consistent dome pattern. The surface of the Cote-L product was slip resistant. The installation of the two-step product was labor intensive taking two days. The volatiles given off by the product during the installation was very pronounced.

The Strongwall product provided a good slip resistant surface. It was a labor-intensive procedure for installation taking two days. The domes did not hold up to winter maintenance with a loss of field material and domes. The dome pattern was consistent. The initial bonding of the domes experienced some loss of adhesion. The initial repair was simple with domes being reattached with the first coat of field material.

Conclusion:

Engineering Plastics Armor Tile performed the best of all products in the combined evaluation of ease of construction, slip resistance (subjective), aesthetics, and durability.

The concrete stamp shows promise of becoming a useable technology with further development. Questions still remain about the uniformity of the stamped domes. How many domes can be deformed before the ramp is out of conformance? Who will inspect these ramps for conformance? How do you incorporate a color in the concrete that is not to labor intensive or requires regular maintenance? These questions need to be answered before a stamped dome pattern could be accepted.

Precast masonry panels also have shown that they are an option if a full depth panel that is mechanically anchored to the sidewalk is developed. The tested panels in this study were too labor intensive to be considered even though there performance was adequate The performance of the latex modified mortar remains to be seen and will take several years to evaluate.

Recomendations:

- Engineering Plastics Armortile be accepted as a method for conformance to the ADAAG requirements.
- Concrete stamping be further refined and reviewed with attention given to methods of coloring concrete.
- Masonry Panels be further refined and reviewed.
- Other alternatives for compliance to the ADAAG be identified and evaluated.
- Test installations continue to be monitored.

Implementation:

The Wisconsin Department of Transportation has implemented the new standard in all plans starting in July of 2003. Detail drawings, construction notes, and specifications and approved products list have been developed.

The Wisconsin Department of Transportation Technology Advancement Unit will continue development and evaluation of new products in this area including stamped concrete and precast masonry panels.

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3. Boisvert, D.M. (2003). DURABILITY OF TRUNCATED DOME SYSTEMS. , New Hampshire Department of Transportation, Study FHWA-NH-RD-MPS2002-2

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Appendix A: Selected Text from Draft Guidelines for Accessible Public Rights-of-Way (June 17, 2002) http://www.access-board.gov/1104

1103.7.1 Detectable Warnings. Where rail systems cross pedestrian facilities that are not shared with vehicular ways, a detectable warning shall be provided in compliance with **1108**.

1104 Curb Ramps and Blended Transitions

1104.1 General. Curb ramps and blended transitions shall comply with 1104.

1104.2 Types. Perpendicular curb ramps shall comply with 1104.2.1 and 1104.3; parallel curb ramps shall comply with 1104.2.2 and 1104.3; blended transitions shall comply with 1104.2.3 and 1104.3.

1104.2.1 Perpendicular Curb Ramps. Perpendicular curb ramps shall comply with 1104.2.1, and shall have a running slope that cuts through the curb at right angles or meets the gutter grade break at right angles.

1104.2.1.1 Running Slope. The running slope shall be 1:48 minimum and 1:12 maximum.

1104.2.1.2 Cross Slope. The cross slope shall be 1:48 maximum.

EXCEPTION: This requirement shall not apply to mid-block crossings.

1104.2.1.3 Landing. A landing 48 inches (1220 mm) minimum by 48 inches (1220 mm) minimum shall be provided at the top of the curb ramp and shall be permitted to overlap other landings and clear floor or ground space. Running and cross slopes shall be 1:48 maximum.

EXCEPTION: Running and cross slope requirements shall not apply to mid-block crossings.

1104.2.1.4 Flares. Flared sides with a slope of 1:10 maximum, measured along the curb line, shall be provided where a circulation path crosses the curb ramp.

1104.2.2 Parallel Curb Ramps. Parallel curb ramps shall comply with 1104.2.2, and shall have a running slope that is in-line with the direction of sidewalk travel.

1104.2.2.1 Running Slope. The running slope shall be 1:48 minimum and 1:12 maximum.

EXCEPTION: A parallel curb ramp shall not be required to exceed 15 feet (4570 mm) in length.

1104.2.2.2 Cross Slope. The cross slope shall be 1:48 maximum.

1104.2.2.3 Landing. A landing 48 inches (1220 mm) minimum by 48 inches (1220 mm) minimum shall be provided at the bottom of the ramp run and shall be permitted to overlap other landings and clear floor or ground space. Running and cross slopes shall be 1:48 maximum.

EXCEPTION: Running and cross slope requirements shall not apply to mid-block crossings.

1104.2.2.4 Diverging Sidewalks. Where a parallel curb ramp does not occupy the entire width of a sidewalk, drop-offs at diverging segments shall be protected with a barrier.

1104.2.3 Blended Transitions. Blended transitions shall comply with 1104.3, and shall have running and cross slopes of 1:48 maximum.

1104.3 Common Elements. Curb ramps and blended transitions shall comply with 1104.3.

1104.3.1 Width. The clear width of landings, blended transitions, and curb ramps, excluding flares, shall be 48 inches (1220 mm) minimum.

1104.3.2 Detectable Warnings. Detectable warning surfaces complying with **1108** shall be provided, where a curb ramp, landing, or blended transition connects to a crosswalk.

1104.3.3 Surfaces. Surfaces of curb ramps, blended transitions, and landings shall comply with 302. Gratings, access covers, and other appurtenances shall not be located on curb ramps, landings, blended transitions, and gutter areas within the pedestrian access route.

1104.3.4 Grade Breaks. Grade breaks shall not be permitted on curb ramps, blended transitions, landings, and gutter areas within the pedestrian access route. Surface slopes that meet at grade breaks shall be flush.

1104.3.5 Changes in Level. Vertical changes in level shall not be permitted on curb ramps, blended transitions, landings, or gutter areas within the pedestrian access route.

1104.3.6 Counter Slopes. The counter slope of the gutter area or street at the foot of a curb ramp or blended transition shall be 1:20 maximum.

1104.3.7 Clear Space. Beyond the curb line, a clear space of 48 inches (1220 mm) minimum by 48 inches (1220 mm) minimum shall be provided within the width of the crosswalk and wholly outside the parallel vehicle travel lane

1105.4.2 Detectable Warnings. Medians and refuge islands shall have detectable warnings complying with **1108**. Detectable warnings at cut-through islands shall be separated by a 24 inch (610 mm) minimum length of walkway without detectable warnings.

EXCEPTION: Detectable warnings shall not be required on cut-through islands where the crossing is controlled by signals and is timed for full crossing.

1108 Detectable Warning Surfaces

1108.1 General. Detectable warnings shall consist of a surface of truncated domes aligned in a square grid pattern and shall comply with 1108.

1108.1.1 Dome Size. Truncated domes in a detectable warning surface shall have a base diameter of 0.9 inches (23 mm) minimum to 1.4 inches (36 mm) maximum, a top diameter of 50% of the base diameter minimum to 65% of the base diameter maximum, and a height of 0.2 inches (5 mm).

1108.1.2 Dome Spacing. Truncated domes in a detectable warning surface shall have a center-to-center spacing of 1.6 inches (41 mm) minimum and 2.4 inches (61 mm) maximum, and a base-to-base spacing of 0.65 inches (16 mm) minimum, measured between the most adjacent domes on square grid.

1108.1.3 Contrast. Detectable warning surfaces shall contrast visually with adjacent walking surfaces either light-on-dark, or dark-on-light.

1108.1.4 Size. Detectable warning surfaces shall extend 24 inches (610 mm) minimum in the direction of travel and the full width of the curb ramp, landing, or blended transition.

1108.2 Location.

1108.2.1 Curb Ramps and Blended Transitions. The detectable warning surface shall be located so that the edge nearest the curb line is 6 inches (150 mm) minimum and 8 inches (205 mm) maximum from the curb line.

1108.2.2 Rail Crossings. The detectable warning surface shall be located so that the edge nearest the rail crossing is 6 inches (150 mm) minimum and 8 inches (205 mm) maximum from the vehicle dynamic envelope.

1108.2.3 Platform Edges. Detectable warning surfaces at platform boarding edges shall be 24 inches (610 mm) wide and shall extend the full length of the platform.

Appendix B: Minnesota DOT lab Results

Accelerated Weathering on Truncated Domes
2000 hr Weathering (8hr UV/4 hr Condensation)
Mn/DOT Chemical Lab

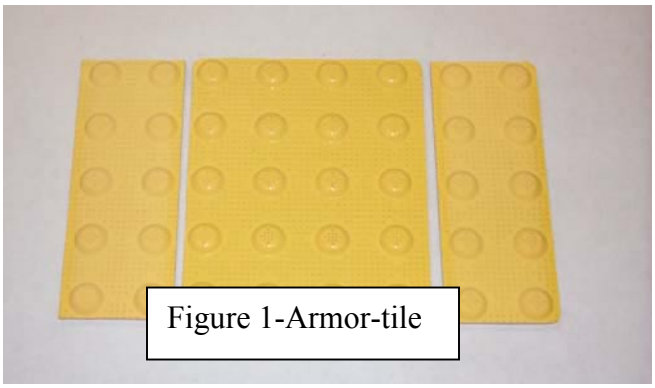


Figure 1-Armor-tile

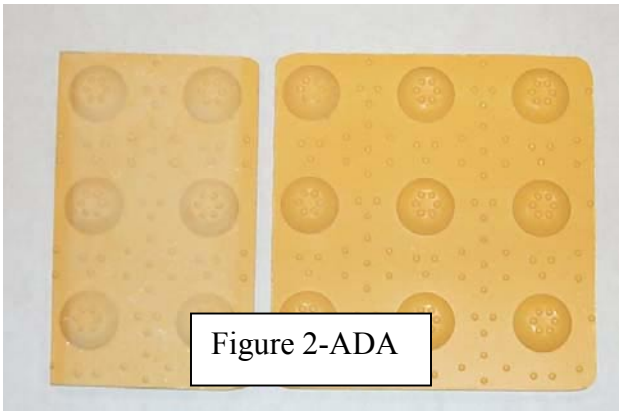


Figure 2-ADA

Figure 3- Hancor Weathered

Figure 1 shows weathered specimens on either side of the un-weathered control. The difference seen is loss of gloss.

Figure 2 shows weathered specimens on the left side of the control un-weathered specimen. It can be clearly seen that significant color fading and gloss Loss occurred.

Comparing Figure 3 to Figure 4, we see virtually no change to the Hancor samples.

Figure 4- Hancor Un-weathered

Color Instrument Readings

Truncated Dome	**δE Un-weathered Std**	**δE Concrete Core Std Un-weathered**	**δE Concrete Core Std Weathered**
ADA	10.2		
ArmorTile	3.6		
Hancor-Charcoal	3.2	13.4	10.7
Hancor-Matrix	1.8	17.3	16.5

The δE Un-weathered Std column in the chart above is a measurement in the change in color due to weathering. The un-weathered sample was used as the standard. The larger the δE number the greater the difference in color. A δE in the 2-3 range for most colors is un-noticeable. This column shows a noticeable difference on the ADA domes but not much with the other domes. The change we see in the Armor-tile photos is actually loss of gloss and not color.

The other columns measure color differences on un-weathered and weathered domes using a concrete core as the standard. This should give us an indication on contrast ratio between dome material and concrete. In this measurement we want a high δE. We see that the Hancor concrete products don't change much with weathering. My concern about the loss of color fastness seems unwarranted.

Appendix C: Notes from Color Evaluation 5/16/03

Present
Beth Cannestra, Wisconsin Department of Transportation
Patrick Flemming, Wisconsin Department of Transportation
Duane Sipploa, City of Madison
Peter Kemp, Wisconsin Department of Transportation
Betsy Gruba Assistant Technology Specialist; Wisconsin Council of the Blind (608-255-1166) was the evaluator.

Contrast is the issue not so much as the color. Yellow against white was not a good contrast inside. On signs a dark background with a white lettering is the best for visual impaired persons. 20/60 corrected vision is the limit for driving in Wisconsin. 220 or lower = Blind. At that level a person would have problems distinguishing the road from grass or the sidewalk.

Evaluated were 22 masonry panels made for The City of Madison's State Street project color demonstration, a safety yellow tile, and a black colored tile.

A dark red was okay for contrast. It was felt by Betsy that the red with the sealer was better than the dull red. The sealer gave the product a wet look. Brown was found not to give a contrast but brown with black chips was okay. Beth brought up if the panel was dirty or had leaves on it would the brown with black chips be as effective. Betsy felt that in that situation it would not be as effective. She felt that the yellow initially was not a good color.

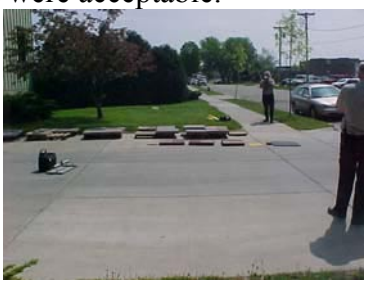
In stepping back and viewing from 33 feet the bight yellow was distinguishable. The red was not. At 18 feet the red was distinguishable. It is noted that the yellow being seen first may be a help for the impaired to see where to go for a crossing.

On a bright day the contrast is harder to pick up. The evaluation was done on a bright day.

Panel #19, 13 and 12 were the Madison numbered panels that were acceptable.

Evaluator

View at 18 feet


View at 33 feet

Appendix D Notes from Engineering Plastics Color Evaluation 7/9/03

Evaluators: Betsy Gruba Assistant Technology Specialist; Wisconsin Council of the Blind (20/200 vision), Gerard Xavier, Counselor, Madison Area Technical College (low Vision)

Location: Hwy 51 and Orin Road n Madison Wisconsin.
Contrast Rating 1 = Best

	Betsy	Jerrod
Blue	4	N/A
Rust	3	N/A
Safety Yellow	2	N/A
White	1	N/A
Black	N/A	1
Lt. Gray	N/A	N/A
Dk. Grey	N/A	N/A
Bright Yellow	2	N/A

N/A = no contrast, could not see

Distance of recognition (ft)

	Betsy	Jerrod
Blue	13	0
Rust	13	0
Safety Yellow	48	0
White	46	0
Black	10	5 (no color recognition)
Lt. Grey	0	0
Dark Grey	16	0
Bright Yellow	28	0

Appendix E: Report from City of Madison

August 11, 2003

To: Peter Kemp, Technology Advancement Engineer, Wisconsin Dept. Of Transportation

From: Duane Sippola, Coordinator & Technical Advisor, City Engineering Division, Madison

Subject: Truncated Dome Tests by Individuals and Wisconsin Council of Blind (WCB) Staff

Dave Ballmann MS, Certified Rehabilitation Counselor (WCB)

"I generally felt that the harder domes were more easily detectable with cane."

"I feel that the domes could present a barrier to the elderly , wheelchair users, baby carriages and high heel shoes. As we witnessed, they seem to collect leaves, and I am concerned about snow and ice build up."

"What seems to be most beneficial for detecting the curb and crossing by blind pedestrians is having a distinctive differentiation between curb and street, and having some kind of indication of where the crosswalk is located. Having some sort of distinctive level of change offers a good indication of the separation between sidewalk and street. I believe that this could be accomplished more safely without the use of domes. It is my feeling, that some sort of textured pavement in the ramp area, such as a sandpaper texture, would provide slip resistance and would also provide a good tactile clue through the use of a cane and to feet (by guide dog users) without being a possible safety risk."

"I appreciate you taking my comments into consideration, and I hope that a uniform design can be agreed upon that will serve all pedestrians at a high level of safety."

Clifford Blackwell, Attorney, City of Madison Equal Opportunity Commission

Prospect & Keyes, Cotel Products:

Mr. Blackwell liked the noticeable difference from plain concrete to a resilient surface. Would prefer that the warnings be placed in smaller strips (2" to 3" wide) and have the warnings start sooner. He did not think it was necessary to have it start at the back of curb. He pointed out that snow is usually plowed onto the area just back of the curb. The domes were very detectable. Overall, he thought the warning system was okay but pointed out that he would not rely on the dome warnings as his only cue. He uses change in grade at ramps, grass to sidewalk cane senses, vehicle engine noises and cane senses to detect the top of curb and curb to street grade changes.

Gilman & Henry, Armor Surface Tiles:

Cane and shoe detection were good. He thought the hollow sound was good for cane users. Stubbed his toe on the leading edge of the tile but it was not a large concern for him.

Detectable Warnings:

Cane and shoe detection were good. Area between domes were slippery to the cane but not to the shoe.

Kinsman & Wright, Armor Tile Cast in Place Tiles:

The main test here was to test his ability to locate the ramp and crosswalk, then try to cross the street within the crosswalk. His first attempt led him directly to the middle of the intersection. He made one more attempt from the same corner and was still outside of the crosswalk. He said he would not attempt to cross this intersection by himself in the future.

Marshall Flax, MS, Certified Low Vision Therapist (WCB), with friend, Bekele Haile Selassie, testing ramps at Gilman and Carroll.

Mr Flax generally felt that the truncated domes were good for the visually impaired. While some visually impaired persons will not use them he felt they should be available for those persons who can benefit from them. Low vison persons are trained to focus their attention on the environment, e.g.; listening for cross traffic, sound of traffic turning ahead, or on the side of them first, then feel for declines in elevation (change in sidewalk grade) which gives them a cue that they are on a ramp, approaching the street. The next cue for them is change in grade when the ramp ends and the curb and gutter and street pavement begins. Truncated dome cues will not be as detectable and reliable when ramps are covered with leaves, snow or ice.

"There are skilled blind travelers that will just ignore these (domes), they will not add anything to their ability." "However, a majority of travelers, maybe as high as 75 to 80%, do not have good travel skills, a lot of them are older adults with partial vision." He indicated that one thing that might be helpful is to have more contrast effect near the domed area, this would be helpful for persons with low vision. He thought maybe a dark border or striping with dark lines would be good.

Jodell Cowell, Information Services, City of Madison

The primary test with Ms. Cowel and her guide dog was to see if the dog would walk over the truncated domes. She tested at the following locations: Keyes and Prospect (Cotel), Gilman and Carroll (Detectable Warnings), Gilman and Henry (Armor Tile). Ms. Cowel said "the dog does not care about the truncated domes, they will not stop her, they are not an indication of anything to her." "They are just there, they are just little things". "I personally would not like it if that's all there was for a cue however."

Betsy Gruba, Assistive Technology Specialist (WCB)
Gerard Xavier, Counselor, Madison Area Technical College

Betsy Gruba (less than 20/200 vision) and Gerard Xavier (very low vision) assisting with tests for best color choices at highway 51 and Orin Rd. White and yellow stood out as best choices. Betsy said white becomes dirty easier however, and may not be as visible in the winter time.

Curb Line | Center Line | Curb Line

Armor Tile Yellow

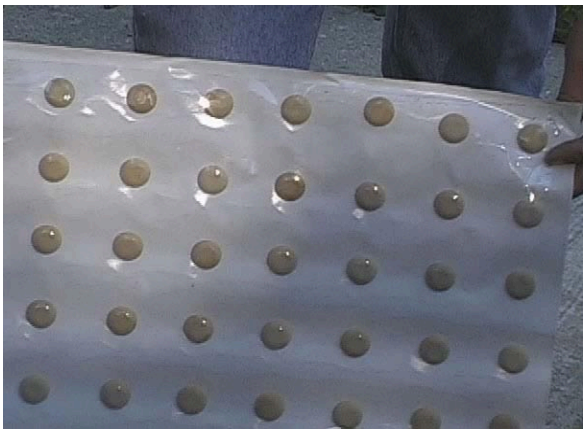
COTE-L
2 step

COTE-L

A walk-behind grinder is used to prepare the sidewalk ramp

Surface prep work using the hand grinder as an option

Xylene is used for surface prep of area to assure bonding



Domes are provided in sheet form

COTE-L

Outside perimeter is taped to provide defined working area

Accelerator is mixed into the Duriback material

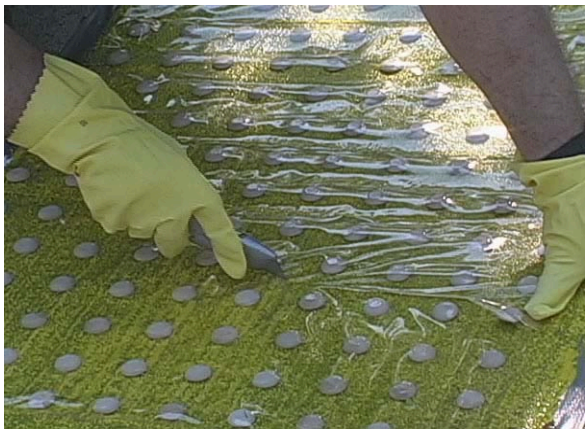
An paint pan and a special roller are used to apply the adhesive /coating to the sidewalk/domes.

1st coat is applied for initial bonding of domes

COTE-L

Domes are placed on the Duriback for bonding.

A flat board is used to apply pressure to seat the domes



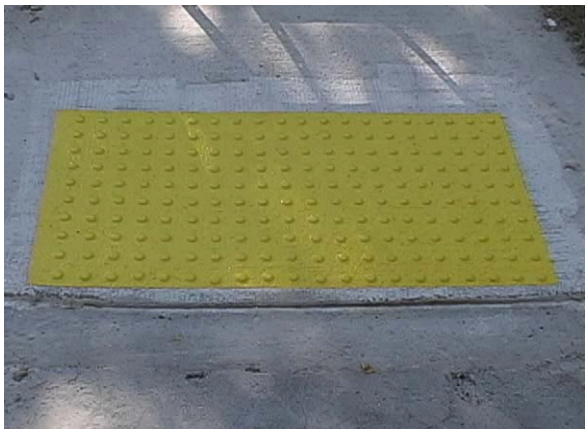
The plastic is cut into 6-inch columns after initial setup. This allows the product to cure a faster rate.

The plastic is peeled off after the product is cured. Pressure was applied to the domes in conjunction to removal of backing material.

COTE-L

A second coat of Durabak-18 is applied after 3 hours of cure time.

Applying the third coat of the Durabak-18 the following day.



Finished Duraback (2step) by COTE-L

COTE-L
1 Step

COTE-L

The domes and field material are prefabricated into a sheet form.

Measuring from the curb flow line for correct placement

The outside edges are taped to mark outer edge of adhesive coverage.

COTE-L

A caulk gun and trowel were used to apply the adhesive.

Toweling the adhesive for complete coverage.

Placing the mat.

Applying pressure with a flat board to assure good adhesion

COTE-L

Using the board to firmly press edges and between domes for good adhesion.

Finished COTE-L Duriback mat

Detectable Warning Systems

Detectable Warning Systems

View of the flexible product, the backside is smooth.

Cleaning the surface with a pressurized air after grinding.

Measuring and taping for correct placement.

Two part epoxy adhesive is mixed.

Detectable Warning Systems

Taped, measured and ready for adhesive.

Toweling on the two-part urethane adhesive.

Surface with epoxy ready for product

Laying the flexible mat down.

Detectable Warning Systems

Rolling the mat down.

A corner was trimmed to better conform with the retrofit installation site.

A piece of plywood and some weight to aid adhesion and left overnight.

Drilling holes for the anchor pins the following day.

Detectable Warning Systems

Mechanical anchor.

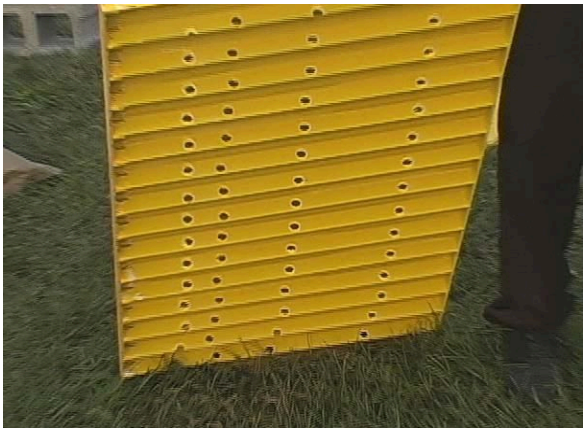
Edge sealer is applied.

Finished Installation

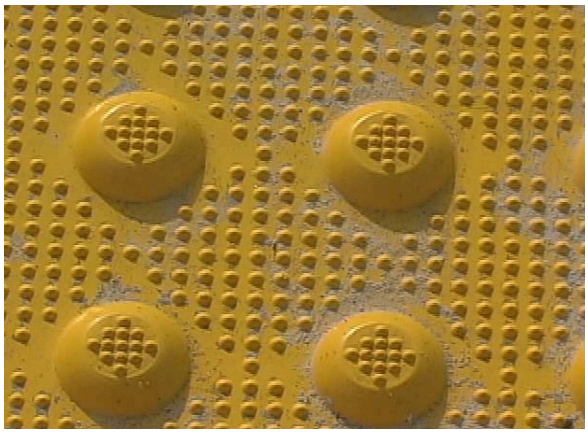
Engineered Plastics
Armor Tile
cast in place application

Armor Tile

Top side view of the Armor Tile product.



Holes in the ribs allow concrete to penetrate the ribs holding the tile in place. Vent holes at the top of each channel allow the air to escape in the installation process.



Close-up view of the Armor Tile surface pattern.

After conventional curd ramp preparation and finishing the product is set in place.

Armor Tile

Embedding the Armor Tile product.

Applying weight to hold the Armor Tile product in place during initial set (overnight).

Adjusting the depth of the Armor Tile product during final finishing.

Armor Tile

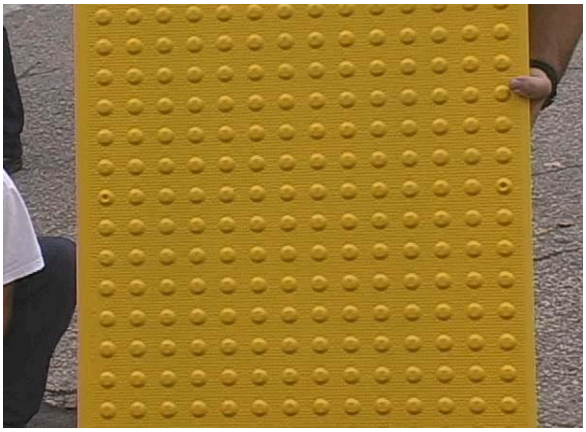
Final edge finishing of the Armor Tile product.

Final finishing of the sidewalk ramp.

Finished installation

Engineered Plastics Armor Tile retrofit application

Armor Tile



Semi-rigid sheet.

Grinding of ramp areas for proper shape

Ramp site after grinding.

Armor Tile

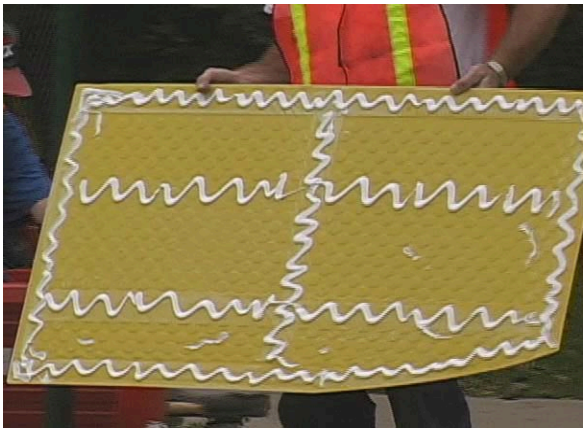
Blowing the concrete dust off with a gas powered blower.

Cleaning the ramp surface with Acetone.

Custom cutting the Armor Tile for a good fit.

Cleaning with acetone prior to applying adhesive.

Armor Tile



Applying adhesive to underside of Armor Tile.

The product is set in place.

Cleaning edges of Armor Tile with Acetone prior to taping and caulking the edges.

Armor Tile

Taping the edges of Armor Tile prior to caulking and sealing the edges.

Smoothing the caulk bead around the edges.

Installing the anchor pins.

View of the finished Armor Tile retro-fit product.

Hanover Architectural Tiles
precast application

Hanover

An oiled form is inserted into fresh concrete to create the recess for the precast panel

Finishing the concrete around the form.

The form was removed the following day.

Hanover

The finished cavity.

After 28 days of cure time the concrete is power washed to provide a clean bonding surface

A thin set mortar is applied for a bonding layer

Trowel in leveling mortar bed

Hanover

Thin set material was applied to precast block.

The tiles were set, tape was applied to keep the edge clean

Joints were filled with thin set material.

Finished installation

Increte
stamp application

Increte

Release agent being applied per the manufactures recommendation. It was later found that the best method was to apply to the stamp itself .

Tamping the mat to get the concrete to "rise" into the concave domes on the underside of the mat

After 1 minute of tamping the stamp is removed.

Increte

Paint is applied for color contrast

Finished application

Strongwall retrofit application

Strongwall

Mineral spirits are used to clean the forms and to act as a release agent when the forms are pulled after the "mortar domes" have set.

After the area is ground and cleaned the forms are set in place.

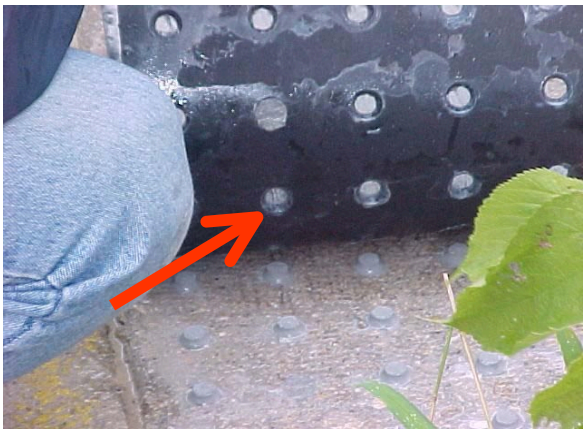
The domes parent material is mixed.

Cementitious Material is applied to the forms with a flat trowel.

Strongwall

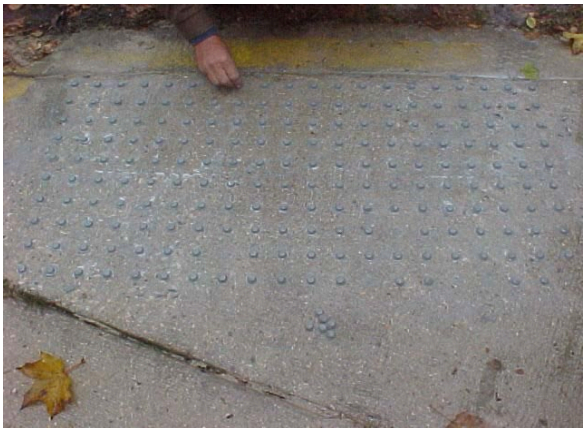
Excess material is removed

The form is pulled after 6 hours of cure time in 50 degree weather.



Some of the domes were pulled off with the form.

Strongwall



View of the product after the form was pulled. Notice that several domes did not adhere to the ramp.

Strongwall

First coat of field material applied. Loose domes were reapplied with field material.

2nd coat of field material applied the following day. Temperatures in the low 50(f)'s.

Painting the application later that same day for required color contrast.

Finished Strongwall installation.

Appendix G: Photographs through Low vision goggles simulating 20/200 Vision

Engineered Plastics, Armortile Pictures were taken at 41 feet, 33 feet, 17 feet and 2.5 feet. This is to illustrate the importance of color and contrast and in recognition of ramp treatments.

Blue

Yellow

Light Grey

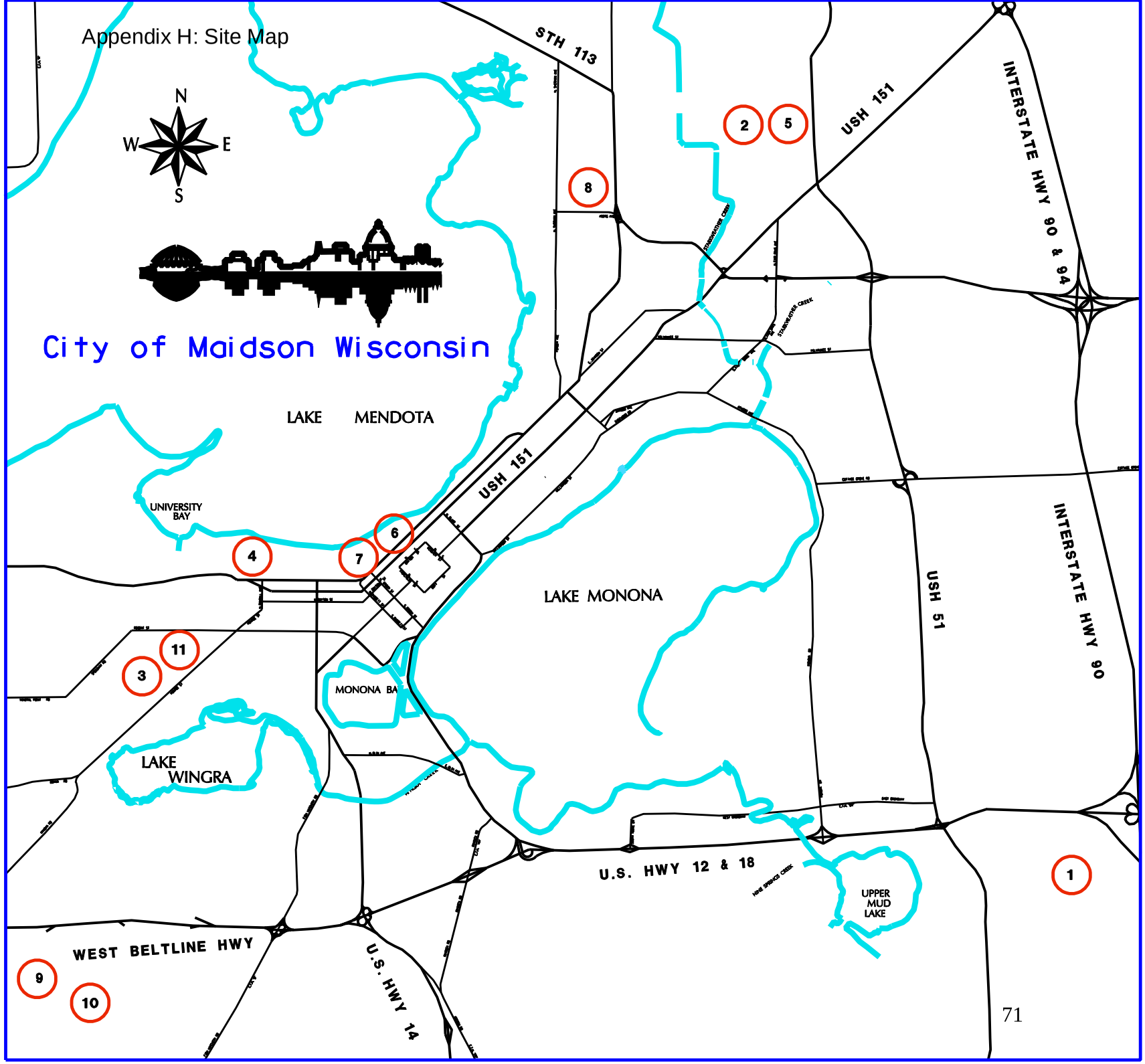
Dark Grey

Black

Red

White

Appendix H: Site Map



Appendix I: Retroreflectivity

Summary	
Red	65.6
Yellow CA	1.9
Grey, lt.	12.2
Blue	63.5
Black	95.8
Yellow	39.9
Dark Grey	67.6
White	43.1

Panel	Readings in mcd/m2/lux			SUM	AVE		Contrast w/ color = light	Contrast w/ color = dark
	RED							
1	8	10	10	28	9.3		-157.1	**61.1**
2	8	8	9	25	8.3		-188.0	**65.3**
3	8	8	7	23	7.7		-213.0	**68.1**
4	8	7	8	23	7.7		-213.0	**68.1**
	yellow Calf							
1	23	24	26	73	24.3		1.4	-1.4
2	26	27	29	82	27.3		12.2	-13.9
3	22	22	24	68	22.7		-5.9	5.6
4	24	23	25	72	24.0		0.0	0.0
	Grey, light							
1	21	20	20	61	20.3		-18.0	**15.3**
2	21	22	19	62	20.7		-16.1	**13.9**
3	21	21	23	65	21.7		-10.8	**9.7**
4	21	23	21	65	21.7		-10.8	**9.7**
								ave 12.2
	Blue							
1	8	9	9	26	8.7		-176.9	**63.9**
2	6	7	8	21	7.0		-242.9	**70.8**
3	8	10	10	28	9.3		-157.1	**61.1**
4	10	10	10	30	10.0		-140.0	**58.3**
								ave 63.5
	Black					*Assumed Value		
1	-1	-1	-1	-3	-1.0	1.0	-2300.0	**95.8**
2	0	-1	-1	-2	-0.7	1.0	-2300.0	**95.8**
3	-1	-1	-1	-3	-1.0	1.0	-2300.0	**95.8**
4	-1	-1	-1	-3	-1.0	1.0	-2300.0	**95.8**
								ave 95.8
	original yellow							
	Indoor							
1	34	38	29	101	33.7		**28.7**	-40.3
2	41	49	49	139	46.3		**48.2**	-93.1
	outdoor							
3	48	28	52	128	42.7		**43.8**	-77.8
4	37	50	31	118	39.3		**39.0**	-63.9
							ave 39.9	
	Dark Grey							
1	7	7	6	20	6.7		-260.0	**72.2**
2	7	7	7	21	7.0		-242.9	**70.8**
3	8	8	7	23	7.7		-213.0	**68.1**
4	10	9	10	29	9.7		-148.3	**59.7**
								ave 67.7
	White							
1	42	44	42	128	42.7		**43.8**	
2	42	43	42	127	42.3		**43.3**	-76.4
3	40	43	42	125	41.7		**42.4**	-73.6
4	41	43	42	126	42.0		**42.9**	-75.0
							ave 43.1	100.0
	Concrete old							
1	22	21	21	64	21.3			
2	24	24	23	71	23.7			
3	26	29	26	81	27.0			
			Over all Ave		24.0			

Contrast = $[(B_1 - B_2)/B_1] \times 100$

where B_1 = light reflectance value (LRV) of the lighter area and B_2 = light reflectance value (LRV) of the darker area.

*Note that in any application both white and black are never absolute; thus, B_1 never equals 100 and B_2 is always greater than 0.

State of Wisconsin
Department of Transportation

Facilities Development Manual

ORIGINATOR Director, Bureau of Highway Development		PROCEDURE 11-25-30
CHAPTER 11	Design	
SECTION 25	Intersections At Grade	
SUBJECT 30	Curb Ramps	

Installation of curb ramps is required by Section 66.0909 of the Wisconsin Statutes whenever new or replacement curb or sidewalk is constructed within 5 feet **(1.5 m)** of a legal crosswalk on any city, or village street, connecting highway or town road.

The US DOT has adopted the Americans with Disabilities Act **(ADA)** Accessibility Guidelines **(ADAAG)** as a standard for complying with ADA and Section 504 of the Rehabilitation Act (49 CFR, Part 27)[1]. ADAAG requires detectable warnings on curb ramps (or hazardous vehicular areas and reflecting pools). Detectable warnings are a distinctive surface pattern of truncated domes detectable by cane or underfoot, and are used to alert people with vision impairments of their approach to streets or hazardous drop-offs. Truncated domes will replace the previously accepted practice of placing an expanded mesh pattern at the bottom of a curb ramp.

Curb ramps with detectable warnings shall be installed on all state or federally funded projects with sidewalks (including resurfacing and SHRM projects) where curb ramps do not exist. This shall be done whether or not new or replacement sidewalk is programmed as part of the project. All state or federally funded projects that include new curb ramps shall include detectable warnings. At this time the retrofitting of truncated domes into existing ramps will not be required.

Currently, there are design guidance conflicts between Wisconsin Statutes and the ADA requirements. The design guidance in this procedure and the associated Standard Detail Drawings (SDD 8 D 5) address the current design requirements. The guidance throughout this procedure and the revised SDD have been developed to provide the designer with criteria that is consistent with current ADAAG guidance. Curb ramps and detectable warnings are required at all legal crossings, sidewalk and multi-use trails. These ramps provide an easily accessible connection from a raised sidewalk to the roadway surface.

The preferred design is a ramp in line with the crosswalk (Type 2, perpendicular ramp) because the crossing distance is shorter and it helps align people with vision impairments to the sidewalk on the opposite side of the street.

[1] For more information on ADAAG detectable warnings and accessible design requirements go to www.access-board.gov. Also, each WisDOT district pedestrian/bicycle coordinator has a copy of "Part 2, Designing Sidewalks and Trails For Access, September 2001" which is the primary reference for designing curb ramps and other accessibility considerations.

According to ADA the detectable warning field should be located 6 to 8 inches behind the gutter flow line. It may not be possible to place the warning field at this point on the radius of an intersection and also align the warning domes with the longitudinal path of the wheelchair. In these situations, the leading edge of the detectable warning field may be placed within an inch of the back of the curb. It is most important that the detectable warning domes, and spaces between the domes, line up with the longitudinal path of the wheelchair. Therefore, the line of domes should be parallel to the direction of travel or edge of sidewalk.

Where the terrace is less than 6 feet, the designer may need to reduce the curb height to 2 inches minimum in the triangular area shown and/or begin to slope the sidewalk down prior to the sidewalk intersection. The designer may have to show sidewalk grades on a special detail. Where the Type 2 curb ramp is not technically feasible, a Type 1 or 1A ramp may be constructed as a single ramp centered on the curb return.

The detectable warning field shall be colored to provide contrast between the adjacent concrete and the detectable warning field. The default color of the detectable warning field is Federal Yellow 33538. The product provided by Armor Tile is a vitrified polymer inset panel (set into fresh concrete) that is available in many colors. Based on limited testing with the visually impaired, the only other color acceptable to the department at this time is Federal White 37875. The designer may choose to coordinate the color to be used on the project with the community where the curb ramps will be installed. Communities may prefer white to the default color for the detectable warning field. The designer may specify white in the Standard Special Provisions (STSP's) for the color of the detectable warning field to be used.

As stated in FDM 11-20-1, "Borders," a sidewalk that is constructed along the back of the curb is 6 feet wide. The ramp side slopes for the Type 1A shall be 12H:1V as shown on SDD 8 D 5 sheet b. When the sidewalk is constructed to cross through a driveway apron, the apron side slopes (or longitudinal sidewalk slope) shall be 12H:1V or flatter also. The sidewalk cross slope is not to exceed 2 percent.

When a curb ramp is constructed on one side of a street, a companion curb ramp is required on the opposite side. When a project terminates in the middle of an intersection, curb ramps must be constructed, where sidewalk is present, on the street corners beyond the project limits (if they don't currently exist), even though no other construction may be necessary at those corners.

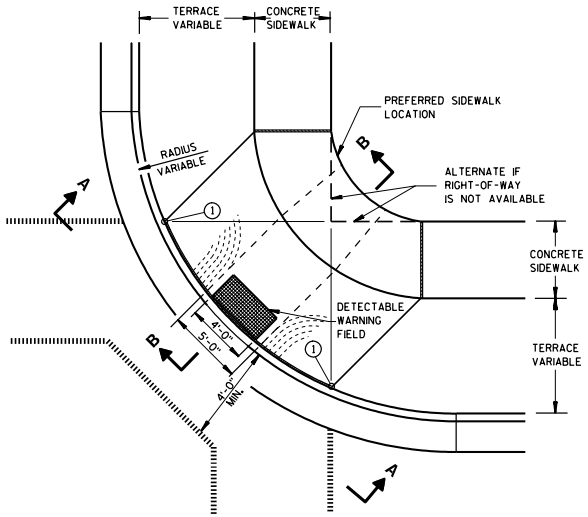
Surface water runoff from the roadway can flood the lower end of a curb ramp. Determine the grades along the curb line and provide catch basins or inlets to prevent flooding of the ramps. Verify that the drainage structure will not be in the path of a wheelchair user or pedestrian. Grade change between the gutter flag slope and the curb ramp slope is not to exceed 11%. The ADA requires curb ramps have a slope no steeper than 12H:1V or 8.33%. Gutters have a common cross slope of ¾ inch/foot or 6.25%. Designers will have to adjust these two slopes to comply with the 11% grade change value.

A landing is necessary at the top of a curb ramp. This landing is provided to allow a person in a wheelchair space to maneuver into position to use the ramp or to bypass it. In alterations of an existing roadway where the curb ramps are being modified, the landing must be at least three feet square. In new construction, a minimum four-foot square landing is required. When right-of-way constraints are not an issue, provide a larger five-foot square landing. If the landing is next to a vertical wall, a five-foot wide area is

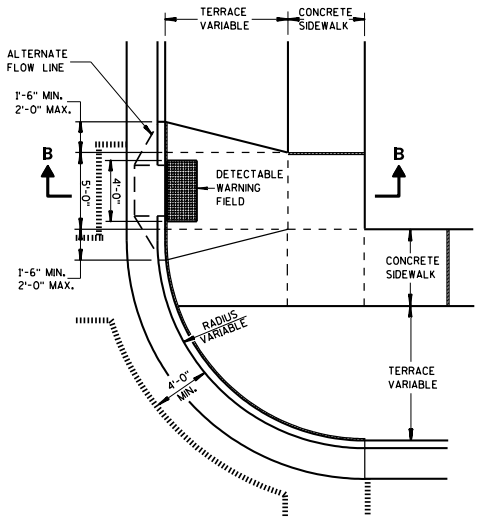
desirable to allow a person in a wheel chair more room to maneuver. Consider the need for tie bars between the concrete pedestrian curb and the sidewalk.

At signalized intersections, locate the pedestrian push buttons near the sidewalk ramps for ADA accessibility.

★



PLAN VIEW
TYPE 1 RAMP
(CENTER OF CORNER RADIUS)



PLAN VIEW
TYPE 3 RAMP
(OUTSIDE OF CROSSWALK AREA)

GENERAL NOTES

DETAILS OF CONSTRUCTION, MATERIALS AND WORKMANSHIP NOT SHOWN ON THIS DRAWING SHALL CONFORM TO THE PERTINENT REQUIREMENTS OF THE STANDARD SPECIFICATIONS AND THE APPLICABLE SPECIAL PROVISIONS.

RAMPS SHALL BE BUILT AT 12H:1V OR FLATTER. WHEN NECESSARY, THE SIDEWALK ELEVATION MAY BE LOWERED TO MEET THE HIGH POINT ON THE RAMP.

TYPE 1 RAMPS SHALL HAVE A NORMAL SIDEWALK APRON AND CURB ON BOTH SIDES OF RAMP.

DETECTABLE WARNING FIELD SHALL BE MEASURED AND PAID BY THE SQUARE FOOT AS "CURB RAMP DETECTABLE WARNING FIELD". THE CONCRETE PEDESTRIAN CURB, IF NEEDED, SHALL BE MEASURED AND PAID BY THE LINEAL FOOT AS "CONCRETE CURB PEDESTRIAN". ALL OTHER CONCRETE SIDEWALK IN THE CURB RAMP AREA SHALL BE MEASURED AND PAID BY THE SQUARE FOOT AS CONCRETE SIDEWALK.

SELECT CURB RAMP DETECTABLE WARNING FIELD MATERIALS AND DEVICES FROM THE DEPARTMENT'S APPROVED MATERIALS LIST. THE COLOR OF THE DETECTABLE WARNING FIELD IS SPECIFIED ELSEWHERE AND IS INCIDENTAL TO THE BID ITEM OF "CURB RAMP DETECTABLE WARNING FIELD".

SURFACE TEXTURE OF THE RAMP SHALL BE OBTAINED BY COARSE BROOMING TRANSVERSE TO THE SLOPE OF THE RAMP.

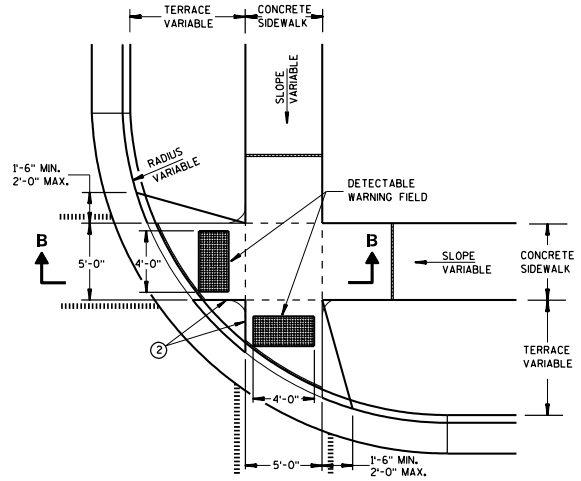
USE THE TYPE 3 RAMP ONLY WHEN A TYPE 1 OR TYPE 2 CANNOT BE ACHIEVED BECAUSE OF FIELD CONDITIONS.

(1) THIS POINT IS AN EXTENSION OF OUTSIDE EDGE OF APPROACHING SIDEWALK WHERE IT MEETS THE BACK OF CONCRETE CURB.

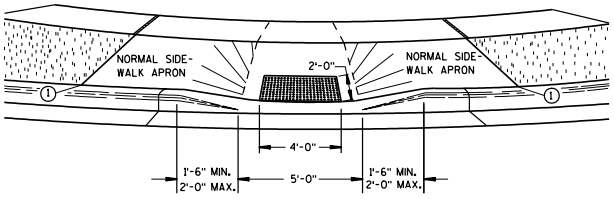
(2) WHEN THIS DISTANCE IS LESS THAN 6'-0" IT MAY BE DIFFICULT TO ACHIEVE A 12H:1V SLOPE, OR FLATTER, ON THE RAMP. REDUCE CURB HEIGHT IN TRIANGLE AREA TO ACHIEVE 12H:1V SLOPE, OR FLATTER, ON RAMP. 2" MINIMUM CURB HEIGHT.

LEGEND

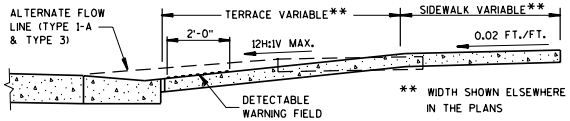
- ½" EXPANSION JOINT-SIDEWALK
- CONTRACTION JOINT FIELD LOCATED
- PAVEMENT MARKING CROSSWALK (WHITE)
- ALTERNATIVE LAYOUT



PLAN VIEW
TYPE 2 RAMP
(ON LINE WITH SIDEWALK)



VIEW A-A



SECTION B-B

CURB RAMPS
TYPES 1, 2 AND 3

STATE OF WISCONSIN
DEPARTMENT OF TRANSPORTATION

6

S.D.D. 8 D 5-9a

S.D.D. 8 D 5-9a

Standard Detail Drawing 8D5-9a

References: FDM Procedure 11-25-30 and 11-20-1

Bid items associated with this drawing:

Item #	Title
602.0501.S	Curb Ramp Detectable Warning Field (SF)
602.0405	Concrete Sidewalk 4” (SF)
602.0410	Concrete Sidewalk 5” (SF)
602.0415	Concrete Sidewalk 6” (SF)
602.0420	Concrete Sidewalk 7” (SF)

Standardized Special Provisions associated with this drawing:

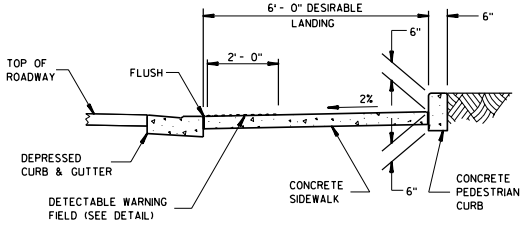
STSP #	Title
602-010	Curb Ramp Detectable Warning Field

Other SDD’s associated with this drawing: 8D5-b is required when this drawing is called for in the plans.

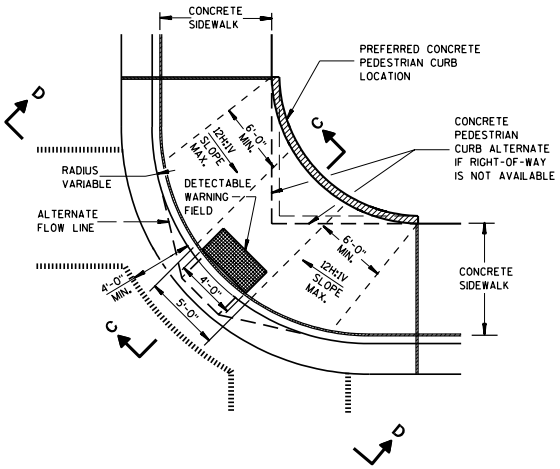
Design Notes: The Type 3 should only be used when there may be utilities or other fixed objects in the way of the curb ramp installation and can not be relocated. The typical size of Detectable Warning Field is 2’ by 4’. On multi-use paths that are typically 10’ to 12’ wide the warning field should be 2’ by 8’. The Detectable Warning Field shall be installed in fresh concrete. If a retro-fit is required it shall be installed on existing concrete. The area under the Detectable Warning Field is not also paid as concrete sidewalk. Do not show Detectable Warning Fields to be installed in or on Asphaltic Pavement. The yellow border pavement marking is no longer required.

Contact Person: Pat Fleming (608) 266-8486

July 10, 2003



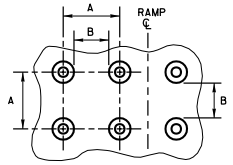
SECTION C-C



PLAN VIEW

TYPE 1-A RAMP

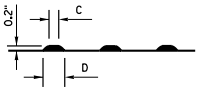
(NO TERRACE)



PLAN VIEW

	MIN.	MAX.
A	1.6"	2.4"
B	0.65"	1.5"
C	*	*
D	0.9"	1.4"

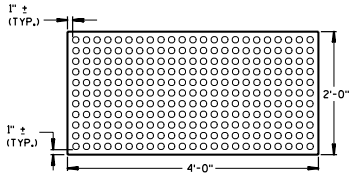
* THE C DIMENSION IS 50% TO 65% OF THE D DIMENSION.



ELEVATION VIEW

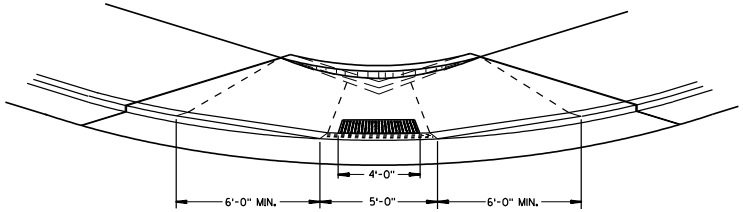
TRUNCATED DOMES

DETECTABLE WARNING PATTERN DETAIL



PLAN VIEW

DETECTABLE WARNING FIELD (TYPICAL)



VIEW D-D

LEGEND

- ½" EXPANSION JOINT-SIDEWALK
- CONTRACTION JOINT FIELD LOCATED
- PAVEMENT MARKING CROSSWALK (WHITE)
- ALTERNATIVE LAYOUT

CURB RAMPS
TYPE 1-A

STATE OF WISCONSIN
DEPARTMENT OF TRANSPORTATION

APPROVED

DATE — CHIEF ROADWAY DEVELOPMENT ENGINEER

FHWA

6

S.D.D. 8 D 5-9b

S.D.D. 8 D 5-9b

Standard Detail Drawing 8D5-9b

References: FDM Procedure 11-25-30 and 11-20-1

Bid items associated with this drawing:

Item #	Title
601.0196.S	Concrete Pedestrian Curb (LF)
602.0501.S	Curb Ramp Detectable Warning Field (SF)
602.0405	Concrete Sidewalk 4” (SF)
602.0410	Concrete Sidewalk 5” (SF)
602.0415	Concrete Sidewalk 6” (SF)
602.0420	Concrete Sidewalk 7” (SF)

Standardized Special Provisions associated with this drawing:

STSP #	Title
601-015	Concrete Curb Pedestrian
602-010	Curb Ramp Detectable Warning Field

Other SDD’s associated with this drawing: 8D5-a is required when this drawing is called for in the plans.

Design Notes: The Type 3 should only be used when there may be utilities or other fixed objects in the way of the curb ramp installation and can not be relocated. The typical size of Detectable Warning Field is 2’ by 4’. On multi-use paths that are typically 10’ to 12’ wide the warning field should be 2’ by 8’. The Detectable Warning Field shall be installed in fresh concrete. If a retro-fit is required it shall be installed on existing concrete. The area under the Detectable Warning Field is not also paid as concrete sidewalk. Do not show Detectable Warning Fields to be installed in or on Asphaltic.

Contact Person: Pat Fleming (608) 266-8486

July 10, 2003

Curb Ramp Detectable Warning Field, Item 602.0501.S.

A Description
This special provision describes placing detectable warning fields in curb ramps in accordance with the requirements of the standard specifications and as hereinafter provided.

B Materials
Furnish curb ramp detectable warning field from a manufacturer on the department's approved product list. The color shall be Federal Yellow 33538.

C Construction
Place curb ramp detectable warning field as shown and detailed in plan and as specified in 602.3 of the standard specifications.

D Measurement
The department will measure Curb Ramp Detectable Warning Field in place by the square feet of surface area acceptably completed and according to 602.4 of the standard specifications.

E Payment
The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
602.0501.S	Curb Ramp Detectable Warning Field	SF

Payment for Curb Ramp Detectable Warning Field is full compensation for requirements specified in 602.5. Payment for any concrete sidewalk bid items directly below detectable warning field is included in payment for Curb Ramp Detectable Warning Field in curb ramp.
(082003)