

Transportation Safety Division

Grinding Pavement for 3M™ Stamark™ Tape Marking Installations

Technical Memorandum
August 2021

1 Introduction

Replacing existing markings with 3M™ Stamark™ tapes and recessing Stamark tapes in grooves require grinding and grooving of roadway surfaces, respectively. To ensure optimal adhesion of surface installations, all existing markings must be removed prior to tape installation. When installing Stamark tapes in grooves, roadway surfaces must be grooved to the required depth to help protect the tape and its retroreflective beads from snowplow damage, extending their service lives. Marking removal and grooving operations both remove paving material by grinding, which can weaken the resultant surface layer of pavement and lead to pavement marking failures as the surface layer of pavement fails. This document describes the characteristics of ground or grooved pavement surfaces that are known to produce Stamark tape pavement marking installations of good adhesion, durability, and performance.

3M has observed that the installation and equipment requirements presented in this document reliably result in durable pavement marking installations. Pavement marking installers that apply 3M Stamark tape to surfaces that do not conform to the specifications described here in, and those that use grinding equipment that does not conform to the specifications described here in forfeit their right to any warranty claim based on adhesion failure.

Regardless of installation method or equipment used, 3M is not responsible in any way for pavement marking failures resulting from substrate failures.

For a full description of the 3M Warranty and its associated terms and conditions, refer to the 3M Product Bulletin for the relevant 3M Stamark tape.

2 Groove Specifications

Grooves only protect pavement markings if they fully recess the markings below the pavement surface, provide structurally sound surfaces that markings can adhere to, and allow required marking alignment. Figure 1 shows a typical section of a pavement marking in a groove, with the required groove width and depth indicated.

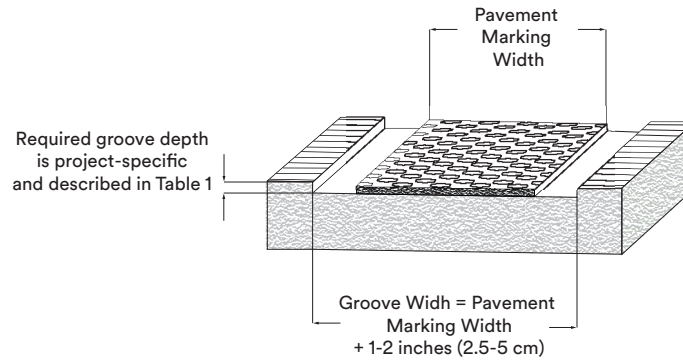


Figure 1. Cross sectional illustration of a typical section of pavement marking in a groove.

2.1 Groove Placement

Place groove at least two inches away from surface joints.

2.2 Groove Depth

Table 1 presents the required groove depths for different 3M Stamark tape, respectively.

Table 1. Uniform groove depths required for 3M Stamark tape markings.

Pavement Marking Material	Required Groove Depth	
	Minimum	Maximum
3M Stamark Pavement Marking Tapes (Series 380AW, 380I ES, and 270 ES)	150 mils (3.81 mm)	200 mil (5.08 mm)

Note: Deeper grooves help protect markings from more aggressive traffic and harsher climates.

2.3 Groove Width - Longitudinal Markings

As shown in Figure 1, the typical groove width must be at least one inch (2.5 cm) wider than the width of the pavement marking. A groove that is two inches (5 cm) wider than the marking can be used to facilitate straight installation of the marking into a groove and make it easier to tamp the edges of tapes. Narrower grooves can be used to better protect pavement markings but extra care must be taken when cutting narrow grooves to ensure they are cut straight enough to enable straight alignment of markings within grooves.

2.4 Groove Smoothness

The bottoms of grooves must be smooth, having ridges that rise no more than 10 mils (0.254 mm) above the base of the groove. See Section 3 for further details regarding groove topographies and equipment requirements.

2.5 Grooved and Recessed Intersection Markings

Intersection markings, such as crosswalks and stop bars, can be grooved into a pavement surface and recessed by making multiple side-by-side passes with grooving equipment typically used for long line pavement markings. Making multiple side-by-side passes allows for the placement of wider intersection markings into a groove.

Cutting grooves with multiple passes can result in ridges between passes. Such ridges are due to the stops on each side of the gang-stacked diamond cutting head resting on different levels of the pavement surface. The first grooving pass is completed with both stops resting on an even surface, as shown in Figure 2.

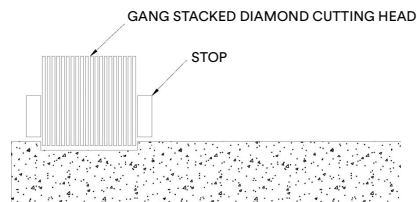


Figure 2. Position of cutting gang-stacked diamond cutting head during initial pass of a multiple-pass intersection groove cut.

After the first pass, one stop sits on the old pavement surface while the other sits slightly lower, in the newly cut groove, as illustrated in Figure 3. This produces unacceptable ridges.

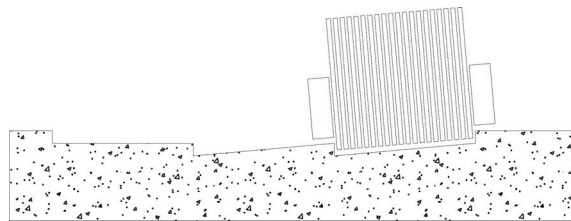


Figure 3. Position of gang-stacked diamond cutting head during subsequent passes that results in ridges along the cutting head edges.

To prevent ridges, adjust the stops on either side of the gang-stacked diamond cutting head after the first pass, or grind off the ridges prior to placing the pavement marking in the groove. One can also use a metal plate, with a thickness equal to the depth of the groove, to support the stop that sits on the freshly grooved surface and move the plate over for each new pass.

Legends and symbols can be grooved and recessed by grooving large square or rectangular areas that fit the pavement markings. Refer to [3M Information Folder 5.8](#) for more information.

Use wider gang-stacked diamond cutting heads (place more gang-stacked diamond blades on the saw auger) to reduce the number of passes needed to make wide grooves. The same can be done to reduce the number ridges formed by multiple passes.

Curbs and median obstacles may not allow grooves to be cut across the entire width of an intersection marking using large, truck-mounted equipment. In such instances, use smaller equipment near obstacles to achieve grooves of required depths.

3 Cutting Heads

Several different cutting head configurations are available from different equipment manufacturers that specialize in cutting and grooving equipment. The use of groove-cutting equipment with free-floating, independent heads is recommended. Such configurations allow the cutting head to follow irregularities in pavement surfaces and produce grooves of consistent depth. Different grooves will result from the use of different cutting heads and grooving equipment.

Gang-stacked diamond cutting heads produce optimal groove surfaces and must be used to produce surface to which Stamark tapes are to be applied.

3.1 Gang-Stacked Diamond Cutting Heads

A single, large diameter (12-18 inch saw blades) cutting head with gang-stacked 1/8"–1/4" (0.30–0.63 cm) diamond cutting blades (Figure 4) can be used in place of purpose-built grooving equipment. When doing so, place spacers between diamond cutting blades to provide gaps for the wider cutting head tips and decrease the number of blades required to fill the cutting head.



Figure 4. Gang-stacked diamond cutting head.

Wider blade spacings may result in heavily “ribbed” (also referred to as “ridged” or “corduroy”) patterns that are not recommended for pavement marking applications. Use of gang-stacked diamond cutting heads can create corduroy or ribbed patterns, as shown in Figure 5. Ribbed, or corduroy, patterns must not be irregular or large enough to prevent tape from conforming to the shapes of their lowest areas. If a tape bridges the low areas of a pattern instead of making contact with the pavement surface, moisture will penetrate the tape and result in poor adhesion.



Figure 5. Cross section illustration of a coarse tooth ribbed pattern produced by widely spaced or worn blades. Replace blades and/or change spacing to avoid such groove patterns.

Thinner spacers may be used between blades to prevent irregular groove patterns. This will result in a grooves with smoother surfaces, as illustrated in Figures 6, 7, and 8. Groove ridges must rise no more than 10 mils (0.254 mm) above the base of the groove.



Figure 6. Cross section illustration of a smooth groove made with thin spacers and new blades.

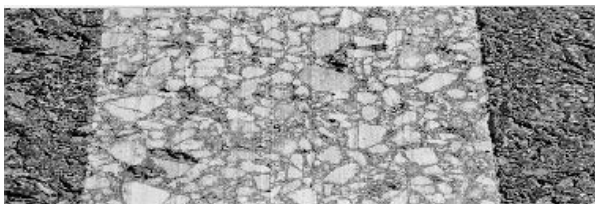


Figure 7. Photo of an asphalt cement concrete groove with a light corduroy pattern, made with properly spaced, gang-stacked diamond cutting blades.

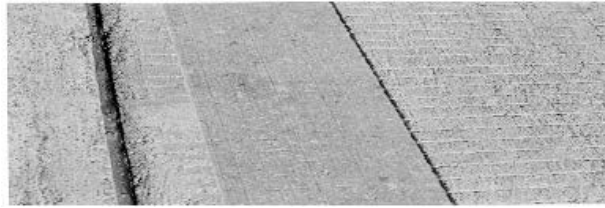


Figure 8. Portland cement concrete groove with a light corduroy, pattern, made with properly spaced, gang-stacked diamond cutting blades.

3.2 Multi-Box or Multi-Pass Grinding/Grooving Procedures

Grinding and grooving may be completed using a multi-box, or multi-pass, approach, however, gang-stacked diamond cutting blades must still be used when preparing pavement for 3M Stamark tape installations. If the installer is unable to use gang-stacked diamond cutting blades for all grind boxes or passes, the following procedure may be used.

The first grind box or pass may be performed with a polycrystalline diamond (also commonly known as “PCD”) cutting head. When removing previous markings for surface-applied installations, no more than 50% of the previous marking may be removed using the polycrystalline diamond head. For grooved installations, no more than 50% of the total groove depth may be cut using the polycrystalline diamond head.

The second (and third, if applicable) grind box or pass must be performed with a gang-stacked diamond cutting head. When removing previous markings for surface-applied installations, the remaining 50% or more of the previous marking must be removed using gang-stacked diamond cutting heads. For grooved installations, the remaining 50% or more of the total groove depth must be cut using gang-stacked diamond cutting heads. Regardless of number heads or passes used, all grinding and grooving operations must produce surfaces that conform to the specifications of Section 2. Figure 9 illustrates the multi-box and multi-pass grinding procedure.

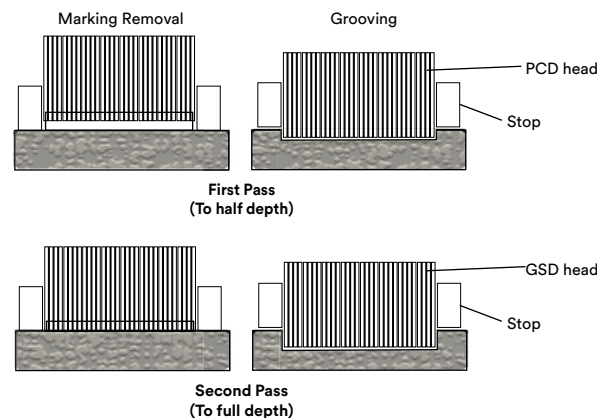


Figure 9. Illustration of the multi-box/multi-pass procedure.

Finishing the groove with a gang-stacked diamond cutting head helps to produce a suitably textured groove and minimize the risk of micro-fracturing the resultant pavement surface.

4 Clean Ground Surface Prior to Application of Stamark Tape

Prior to installing Stamark tapes, clean grooves completely using an air compressor with at least 185 CFM of air flow and 120 PSI of air pressure. There should be no more than 50 feet of ¾-inch (inside diameter) hose between the compressor and the air nozzle, and the air nozzle should have an inside diameter of no less than ½-inch. The compressor should also be equipped with a moisture and oil trap. When cleaning the groove, it is recommended that the air nozzle be no more than two feet from the ground. A street sweeper or pick-up broom may also be used to clean effectively, but a pass with an air compressor is still required to completely clean the bottoms of grooves.

4.1 Vacuum system

Ensure grooving equipment is fitted with vacuum system in good working order. A high-performance vacuum system will facilitate final cleaning and reduce air-born dusts. See Section 6 for further guidance regarding respirable crystalline silica.

4.2 Groove Cleaning

For some applications and equipment, it may be necessary to cool the gang-stacked diamond cutting head with water. In general, long continuous groove cuts for edge line installations are more likely to require water cooling of blades. Cutting grooves for skip, dash, or other intermittent markings allows blades to cool between cutting operations and may not require water cooling. If water cooling is required, flush grooves immediately after cutting with a high pressure power washer to remove any cement dust/water slurry build-up. Grooves must also be flushed when dry grooving during rainfall. If freshly cut grooves are not flushed, slurry may harden in them and they may not meet the required specifications.

Note: If water is present during groove cutting for any reason, allow grooves to dry for, at minimum, 24 hours prior to pavement marking installation. Grooves must be clean and dry for proper pavement marking installation.

Once dry, clean grooves completely using an air compressor with an air flow of at least 185 CFM and an air pressure of at least 120 PSI, prior to pavement marking installation. Cleaning grooves with an air compressor is required to completely clean the bottoms of grooves.

Note: Open grooves may be left open over night if they have been blown out or flushed out at the time of grooving. Grooves must be cleaned with compressed air as described in Section 4 prior to pavement marking installation.

5 Surface testing

Micro-fractures are very small cracks that form at or near a pavement surface and result in a thin, weak surface layer of pavement. Micro-fractures can result from improper grooving or grinding and, as with the presence of old existing markings or surface contamination, they can lead to adhesion failures of newly applied pavement markings. As noted in Section 3.2 above, using gang-stacked diamond blade grinding heads helps to minimize the risk of micro-fracturing and, thus, adhesion failure.

This section describes two methods that can be used to help identify the presence of a potential weak surface layer following grooving or grinding.

5.1 Pavement Surface Strength Peel Test Method

The pavement surface strength peel test ("Peel Test") probes pavement surface strength by pulling a small piece of well adhered Stamark tape up from the pavement with sufficient force to remove it. Pavement surface strength is then assessed by rating the quantity and type of material present on the adhesive.

5.1.1 Apparatus

Testing Equipment and Materials:

- New, Stamark tape with adhesive
- Vehicle for tamping tape to test surface
- Cutting tool (utility knife or other)
- Wide-bladed scraper to assist with starting the tape removal

5.1.2 Procedure

1. Place a piece of Stamark tape, adhesive side down, on the pavement test area.
 - Tape should be about 4 to 6 inches wide and 18 to 24 inches long for convenience, although the dimensions are not critical.
2. Tamp tape repeatedly and thoroughly with vehicle tire.
 - Drive very slowly over the tape, taking at least 2 to 3 seconds to drive over the 18 to 24 inch long piece of tape. Roll straight over the tape - do not turn the tire while tamping (turning the tire can twist, deform, and tear the tape).
 - Make sure that the vehicle tire tamps the full width of the tape; either have a partner watch the tamping process to ensure proper tamping or find another way to visually confirm that the tire passes fully over the tape. Do not guess about alignment - ensure visual confirmation.
 - Perform at least 12 tamping passes, preferably 18 to 36 (tape cannot be over-tamped).
 - Tamping can be done in stages, with minutes or hours between sets of tamping passes.
 - **Tamping is the most important step of this test.** The goal in is to maximize adhesion to the pavement surface in order to remove as much weak surface material as possible during the peeling step.
3. Immediately after final tamping pass, prepare one end of the tape for peeling
 - The tape should now be strongly bonded to the pavement and a knife or scraper tool is very useful for separating a corner or end of it from the pavement.
 - Remove enough tape from the pavement that the loose end can be folded and rolled to create a tab or handle that can be gripped by hand (at least 4 to 6 inches).
 - Fold and roll the tape with the adhesive side in to facilitate handling.
4. Standing and straddling the tape, as shown in Figure 10, grip the prepared end firmly with both hands.



Figure 10. Grip tape firmly with both hands while standing astride the marking.

5. Pull straight up, pulling hard and fast, until the piece of tape is completely removed from the pavement.
 - **Note:** Peel force is higher when tape is peeled quickly. A larger peel force removes more weak surface material and provides a more accurate evaluation of the pavement surface.
 - The tape can also be peeled using a force gauge equipped with a gripping clamp. The use of a force gauge allows one to record the average, minimum, and maximum peel force values, adding further detail to the evaluation. While useful, peel force measurements are not necessary for this test method.
6. Examine the adhesive side of the removed tape under good light and carefully observe the contamination present on the adhesive.
 - At night, vehicle high beam headlights can provide helpful illumination.
7. Carefully examine the pavement surface from which the tape was peeled for further evidence of the nature and extent of a weak surface layer.

5.1.3 Surface Strength Peel Test Ratings

Closely examine the adhesive surface of the peeled tape for contamination, and rate and record particle size and coverage area. Generally, a strong pavement surface has low coverage and small contaminants.

Fraction of Area Covered with Contaminants

Perform a close visual inspection of the tape sample and feel it with your fingertips. Rate the percentage of the area that is contaminated with foreign material, such as dust, dirt, sand, gravel, or other debris, and is not sticky. [Less contamination is better]

(5 = 0–20% contaminated)

(4 = 20–40% contaminated)

(3 = 40–60% contaminated)

(2 = 60–80% contaminated)

(1 = 80–100% contaminated)

Size of Contaminants

Examine the peeled tape sample and assess the average or typical size of the contaminants covering the adhesive, if any. Smaller average contaminant size is better, however, its presence is an indication that further cleaning of the surface is required.

(5 = Dust)

(4 = Sand)

(3 = Small Gravel, ~ 1/16")

(2 = Gravel, ~ 1/8")

(1 = Small Aggregate, greater than 1/8")

5.2 ASTM Test Method

The near-surface tensile strength of a substrate can be tested using ASTM method C1583, "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-Off Method)." Results of this test indicate a surface's suitability for overlay application of pavement marking materials, with stronger surfaces being better suited to pavement marking applications. Refer to ASTM C1583 for full a full description of the test method.

6 Health and Safety Information

Dry pavement preparation techniques, dry grooving methods, and dry groove cleaning methods are recommended because they optimize pavement marking tape adhesive performance and facilitate immediate pavement marking application without the need for a 24-hour drying period.

Always follow applicable temporary traffic control procedures and safe work zone practices. For example, eye, ear, respiratory, or other protection may be appropriate during grooving, surface preparation, or removal of existing pavement markings. For respiratory protection requirements, please refer to the OSHA Respirable Crystalline Silica Standard and the Small Entity Compliance Guide for Respirable Crystalline Silica Standard for Construction, which can be found at www.osha.gov. If wet grinding or grooving procedures are used, including those listed in Table 1 of the referenced OSHA standards, grooves must be cleaned immediately with high pressure water spray to prevent the resulting cement dust/water slurry from hardening in the groove. Cleaning with water must be followed by a 24 hour drying period prior to pavement marking installation.

Read all health hazard, precautionary, and first aid statements found in the Safety Data Sheets (SDS), Article Information Sheets, and products labels of any materials for important health, safety, and environmental information prior to handling or use. Also refer to SDSs for information regarding the volatile organic compound (VOC) contents of chemical products. Consult local regulations and authorities for possible restrictions on product VOC contents and/or VOC emissions. To obtain SDSs and Article Information Sheets for 3M products, go to 3M.com/SDS, contact 3M by mail, or for urgent requests call 1-800-364-3577.

7 Other Product Information

Always confirm that you have the most current version of the applicable product bulletin, information folder, or other product information from 3M's Website at <http://www.3M.com/roadsafety>.

8 Literature Reference

For additional information on 3M Stamark Pavement Marking Tapes, application recommendations, or 3M application equipment, refer to the following publications:

3M IF 3.2	3M™ Stamark™ Removable Tapes Pavement Surface Preparation and Application Procedures
3M IF 5.7	Pavement Surface Preparation and Application Techniques for 3M™ Stamark™ Tapes
3M IF 5.8	Instructions for Precut Symbols and Legends
3M IF 5.18	3M™ Stamark™ Pavement Marking Tape and Liquid Pavement Markings Application Guidelines for Pavement Markings in Grooved Pavement Surfaces
3M IF 5.20	Application Guidelines for Liquid Pavement Markings
3M IF 5.22	3M™ All Weather Paint Application Guidelines
3M IF 5.23	3M™ Connected Roads All Weather Elements Application Guidelines for 3M Connected Roads All Weather Elements
3M IF 5.24	3M All Weather Thermoplastic application guidelines
3M IF 5.28	Liquid Pavement Marking Application Guidelines Series 5000
3M PB 270 ES	3M™ Stamark™ Pavement Marking Tape Series 270 ES
3M PB 380I ES	3M™ Stamark™ High Performance Tape Series 380I ES
3M PB 380AW	3M™ Stamark™ High Performance All Weather Tape Series 380AW
3M PB AWT	All Weather Thermoplastic
3M PB CR AWE	3M™ Connected Roads All Weather Elements
3M PSD	Personal Safety Division's Tips for New OSHA Silica Regulations
3M Road Surface Guide	3M™ Road Surface Guide for 3M™ Stamark™ Pavement Marking Tapes

ASTM Test Methods are available from ASTM International, West Conshohocken, PA.

For Information or Assistance

Call: 1-800-553-1380

In Canada Call:

1-800-3M HELPS (1-800-364-3577)

Internet:

<http://www.3M.com/roadsafety>

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