The information contained in Chapter Eight: Surfacing, dated May 2022, has been updated to reflect the October 2023 Errata. The errata incorporates DES 22-04: "Policy for the Installation of Centerline Rumble Stripes" (approved by the Nebraska Division of the FHWA on January 19, 2023), incorporates DES 23-03: "Policy for the Installation of Edgeline Rumble Stripes" (approved by the Nebraska Division of the FHWA on October 2, 2023), incorporates the Material and Research Policy MR 23-02: "Policy for Longitudinal Joints – Limit Concrete Panel Width" (approved by the NDOT Deputy Director for Operations on March 14, 2023), addresses errors, changes in procedure, changes in NDOT department titles, changes in other Roadway Design Manual chapters and other reference material citations occurring since the latest publication of this chapter.

Chapter Eight presents guidance for the design of New, Reconstructed, and 3R projects; additional design guidance for 3R projects is provided in Chapter Seventeen.

Chapter Eight
Surfacing

1. PAVEMENT DESIGN DETERMINATION

The **Materials and Research Division** (**M&R**) will provide pavement determinations to the **Roadway Design Division** (**Roadway Design**). Pavement determinations may include:

- The type and thickness
- Whether a foundation course is required
- Type of subgrade treatment
- Type of subgrade drainage
- The shoulder treatment to be used

1.A Pavement Design Input

M&R uses design-year traffic projections, existing pavement structure, condition of pavement, performance period, reliability, maintenance history, project type, subgrade soil types, and environmental factors (e.g. roadbed swelling and frost heave), the number of lanes, the design speed, and the shoulder treatment as input into the pavement design determination. An additional important consideration is input of problem areas from the **District Engineer** (**DE**).

M&R uses traffic data from the **Nebraska Department of Transportation** (**NDOT**) "Pavement Optimization Program" for projects utilizing the existing roadway cross-section on the existing alignment. Other projects use traffic data available from the **Strategic Planning Division**.

1.B Pavement Determination Development

The surfacing recommendation is developed as part of the "Project Process Initiation" (NDOT Form 73), which is routed to stakeholders, which includes the **Division Heads**, for review and comment. Once any changes to the document indicated by the routing have been approved by the **Program Management Engineer**, the **DE**, and the **Deputy Director-Engineering** an electronic copy of NDOT Form 73 will be placed in OnBase.

Changes may be made to the pavement determination throughout the life of the project as circumstances dictate (e.g. new information regarding surface condition, additional lanes). The opportunity to address these changes is included in "Planning Pavement Determination" (Clarity Task 5258), "Approved Pavement Determination" (Clarity Task 5364), and "Final Pavement Determination" (Clarity Task 5406). The documentation for any changes will be filed in OnBase by **M&R** and transmitted to **Roadway Design** for review and comment.

The "Final Pavement Determination" requires the signature of the **Pavement Design Engineer**, the **M&R Engineer**, and the **DE** prior to distribution to **Roadway Design**.

2. PAVEMENT TYPES

There are three types of pavement, rigid, flexible, and a composite of rigid and flexible. **M&R** recommends the pavement type and thickness.

2.A Rigid (Concrete) Pavement

Rigid pavement is constructed with Portland Cement Concrete (PCC). Due to the potential for water infiltration at the joints, a foundation course and a means of draining the foundation course may be included in the design of a rigid pavement.

2.A.1 Portland Cement Concrete Pavement Design Policy

1. Rigid pavements will be plain jointed PCC. Epoxy coated dowel bars will be included at transverse joints.
2. The minimum pavement thickness of PCC pavement on the State Highway System will be as follows:

    - Interstate System ..... 12 inches
    - Expressway System..... 10 inches
    - Other Highways ..... 9 inches
    - Low Volume Highways..... 8 inches

    The concrete thickness should be shown in the plan build note and on the typical roadway cross-section(s).
3. The maximum spacing for transverse joints is 16 feet - 6 inches, placed perpendicular to the centerline of the roadway (See Standard Plan 329 in the Standard/Special Plans Book (*Standard Plans*), Ref. 8.1) (https://dot.nebraska.gov/business-center/design-consultant/stand-spec-manual/).
4. See Section 2.A.2.a of this chapter for longitudinal joint spacing.
5. If PCC shoulders are built with the mainline, they will be tied to the travel lanes and the tie bars will be subsidiary to the concrete pavement. If concrete shoulders are built adjacent to an existing concrete mainline the tie bars will be a separate pay item. For additional information see the *Standard Plans*, Ref. 8.1, Standard Plan 329.

2.A.2 Pavement Joints

Diagrams showing the joint locations will be included in the plan set for PCC pavement; typical joint diagrams for concrete pavement are available in the *Standard Plans* (Ref. 8.1), Standard Plan 329. A joint diagram plan must be developed, however, for complicated intersections and/or lane drops. When plans call for the widening of existing surfacing and the new joints are to match the existing joints, a note to that effect on the plans will be sufficient. Ideally, joints should correspond to the pavement markings. The designer will submit the joint diagrams to the **M&R Pavement Design Engineer** and to the **Traffic Engineering Division** (**Traffic Engineering**) for review.

PCC pavement requires the following types of joints to control cracking from the stresses induced by volume changes in concrete:

1. Contraction joints are located in the pavement to relieve stresses caused by shrinkage, thermal contraction, and moisture or thermal gradients. Joint spacing generally divides the pavement into sections of approximately the same length and width (the length to width ratio will not exceed 1.5). Longitudinal contraction joints are normally located between traffic lanes (see Section 2.A.2.a of this chapter). Transverse contraction joints are perpendicular to the centerline and will include load transfer devices across the joint.
2. Expansion or Isolation joints are used primarily to provide separation between the pavement and other structures such as bridges and inlets or at other pavement sections such as pavement slabs at intersections.
3. Construction joints shall be placed at the end of each day's work or whenever the paving operation ceases for over 30 minutes. Construction joint location will be determined in the field.

Load transfer devices (smooth steel dowel bars) are used at transverse joints to transfer the load across the joints; these devices offer little resistance to longitudinal movement at the joint. Tie bars (deformed reinforcing steel) are used to hold the faces of adjacent slabs in firm contact with one another and are not designed to act as load transfer devices.

The following joints will have the specified connections:

Transverse Joints

Joint Type	Connection Type
Contraction	Dowel bar
Expansion	Dowel bar
Construction	Dowel bar

Longitudinal Joints

Joint Type	Connection Type
Between Lanes	Tie bar
Construction	Tie bar

See the *Standard Plans* (Ref. 8.1), Standard Plan 329 for details of bars at joints and joint spacing.

2.A.2.a Policy for Longitudinal Joints

NDOT has determined that PCC pavement that is wider than 12 feet shall be designed with the following guidelines:

- 28-foot-wide roadways with 14 feet wide panels will not have a longitudinal joint regardless of pavement thickness
- Outside lanes as part of an expressway or Interstate *will have* a longitudinal joint between the 12-foot-wide driving lane and outside shoulder, regardless of pavement thickness
- Inside lanes as part of the Interstate system *will not* have a longitudinal joint between the inside lane and the inside shoulder when the inside shoulder width is four foot or less
- Inside lanes as part of an expressway system that have a 10-inch thickness or less *will have* a longitudinal joint between the inside lane and the inside shoulder.
- Lane width dimensions to the back of curb greater than 14 feet *will have* a longitudinal joint at the width of 12 feet
- Roundabout transverse and longitudinal joint widths will not exceed 14 feet

2.A.3 Joining Existing Pavement

When a project includes new concrete pavement to be placed adjacent to existing concrete pavement it will be necessary to install tie bars on the longitudinal joints. Tie bars are pay items when joining to existing pavement, the designer is responsible for calculating the tie bar quantities. Build notes for these tie bars are not required, the information shown on the summary of quantities sheet is considered to be sufficient.

Dowel bars are required when joining new pavement to existing pavement at a transverse joint. Dowel bars are not paid for directly but are subsidiary to doweled concrete pavement.

2.A.4 Tining

PCC pavement will be tined when the posted speed limit of a roadway is 40 mph or greater. When a mainline is tined, intersections, acceleration lanes, deceleration lanes, left turn lanes, and ramps will also be tined; tining details are included in the *Standard Plans* (Ref. 8.1), Standard Plan 329. If only part of a project is to be tined a note will be placed on the Typical Cross-Section sheet itemizing the areas which will not be tined (See Chapter Eleven: Highway Plans Assembly, Section 4.B, of this manual).

2.B Flexible Pavement

Flexible pavement is characterized by an asphaltic structure which depends on aggregate durability and gradation, air voids, binder content, and angularity for strength, cohesion and stability.

2.C Surfacing Aggregates

Crushed rock or gravel may be used to surface county roads, driveways, at the end of driveway or intersection returns, for temporary roads, for temporary access to properties during project construction, etc. When crushed rock or gravel surface course is specified for a temporary road the designer will also specify crushed rock or gravel embedment.

3. PAVEMENT SUBDRAINS

Because drainage is an important factor in pavement performance, subgrade drainage is an important consideration in pavement design. **M&R** determines the need for and type of subgrade drainage during the pavement determination process. **M&R** also prepares the special provisions for subgrade drainage.

Granular subdrains are built by digging a trench that is sloped to convey water away from the roadway which is then backfilled with granular material. When the granular subdrain runs parallel to the roadway it is referred to as a “Longitudinal Subdrain” and the pay item is in units of linear feet; all other material and labor is subsidiary. When granular material is used as an outlet to convey water to the roadside ditch it is referred to as a “Granular Subdrain” and the pay item is each, all other material and labor is subsidiary.

When additional water conveyance is needed a slotted pipe is placed at the bottom of the trench, which has been lined with a filter fabric, and is then backfilled with granular material. The pay item for this installation is “Pipe Underdrain”, paid for by the linear foot, all other material and labor being subsidiary.

The measurement of the spacing between granular subdrain or pipe underdrain outlets should begin at the outlets located in sag locations. Outlets should be constructed at intervals of 200 feet where the grade is 1% or greater and at intervals of 100 feet on grades of less than 1%.

For additional information, see the “Information” section of the *Standard Plans* (Ref. 8.1), plans 430 and 431.

4. SHOULDERS

The minimum shoulder width is established by the functional highway classification as described in the Nebraska Minimum Design Standards (*MDS*) (Ref. 8.2) (https://dot.nebraska.gov/media/1z1n5kmb/nac-428-rules-regs-nbcs.pdf).

4.A Concrete Shoulders

Concrete shoulders will be paid for as "** inch Concrete Pavement". "Earth Shoulder Construction" (See Section 4.D of this chapter) must be paid for and will be shown on the Typical Cross-Section sheet (See Chapter Eleven: Highway Plans Assembly, Section 4.B, of this manual). "Shoulder Subgrade Preparation" may be used when shoulders are added to an existing highway; the excavated soil is used for shouldering and there is no pay item for earth shoulder construction in this case. The shoulder dimensions will be shown on the Typical Cross-Section sheet; a note will be included on the typical section referring to the material to be removed by the surfacing contractor.

4.B Asphalt Shoulders

The pay items for asphalt shoulders include "Asphaltic Concrete" (in tons), "PG Binder" (in tons), "Tack Coat" (in gallons), "Hydrated Lime/Warm Mix Asphalt" (each), and "RAP Incentive" (each).

4.C Earth Shoulder Construction

Where new pavement is being built the subgrade will be designed an additional 0.2 feet high for trimming. This excess material is available for incorporation into the earth shoulder, as shown in EXHIBITS 8.1a & 8.1b. Soil materials used for earth shoulder construction must have the capability to support vegetation. Trimming of the subgrade for shouldering material will be completed prior to the Stabilized Subgrade operation. Sources of shoulder materials include:

- Excess excavation
- Located sites within state right-of-way (station-to-station)
- Locations outside the state right-of-way (borrow pits, contractor's responsibility)

Areas designated as sources of shoulder material should not be disturbed. Disturbed areas will be protected from erosion through cover crop seeding, sodding, etc. See Chapter Two: Erosion and Sediment Control, Section 6, of the Drainage Design and Erosion Control Manual (*Drainage Manual*) (Ref. 8.3) for additional information (https://dot.nebraska.gov/media/ajjpyh3d/e-chap-2-erosion-control.pdf).

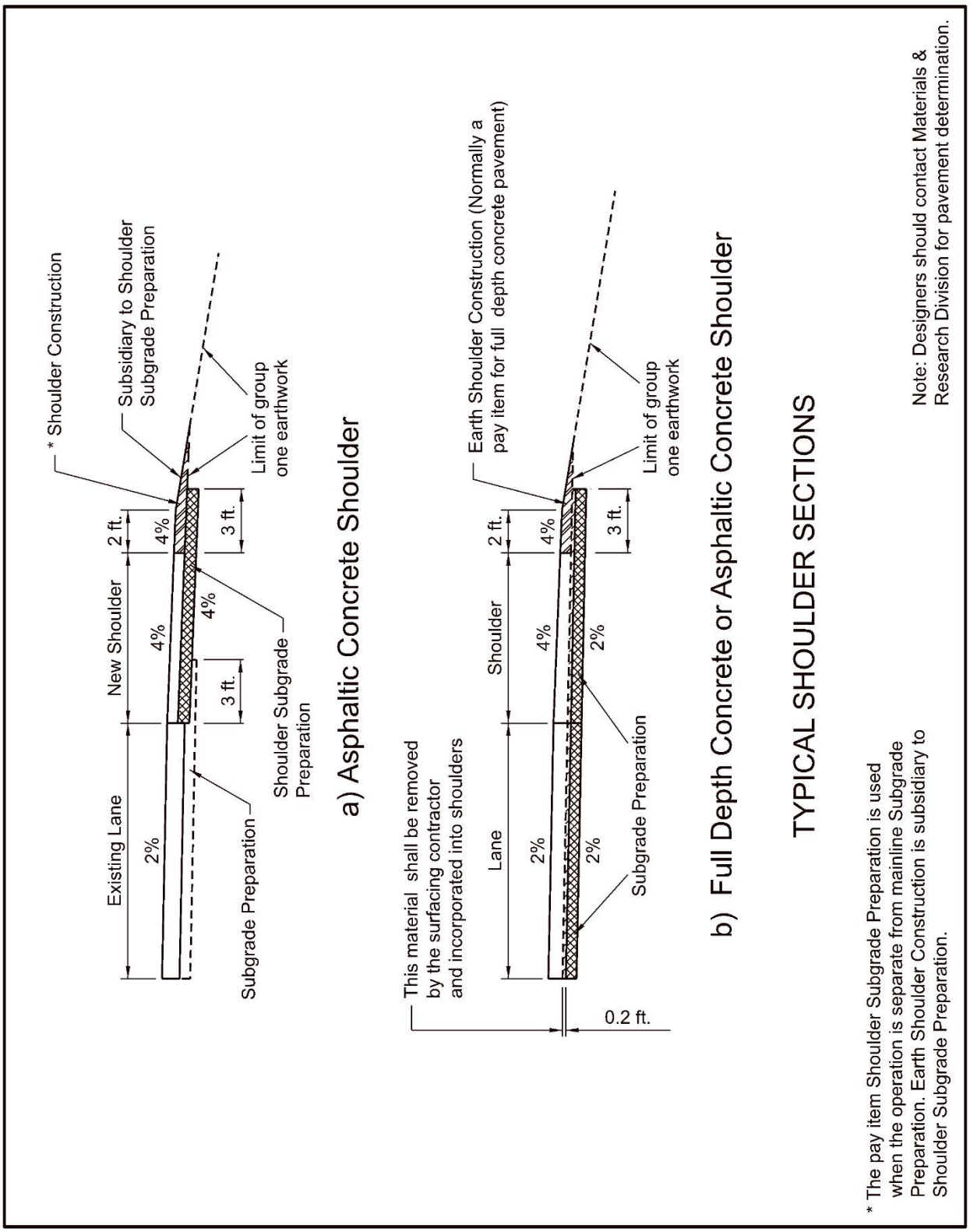

Exhibit 8.1a Typical Shoulder Construction (Uncurbed Section)

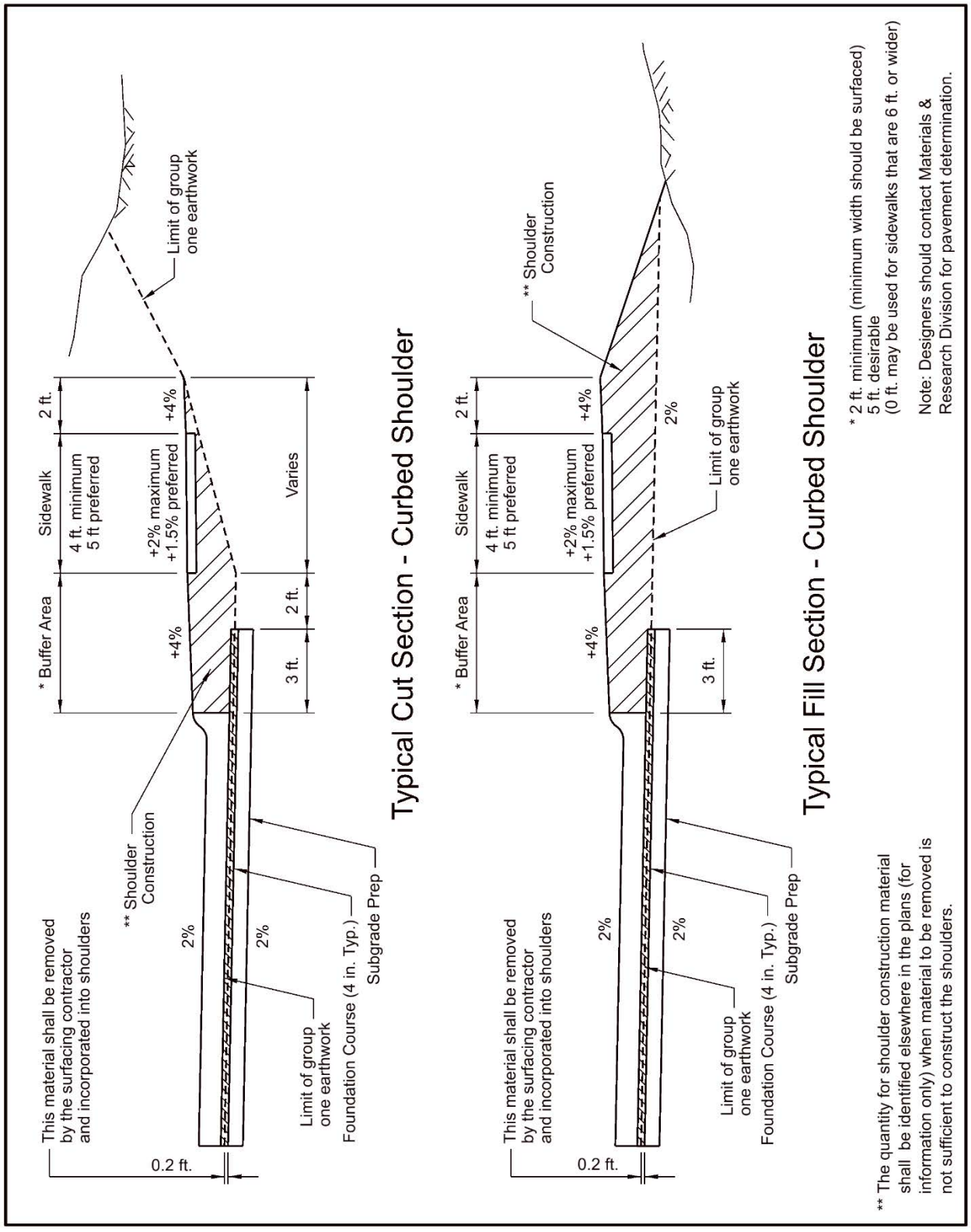

Exhibit 8.1b Typical Shoulder Construction (Curbed Section)

5. PAVEMENT REHABILITATION

Pavement rehabilitation techniques have been developed to extend or enhance the service life of a roadway. Pavement rehabilitation analysis is performed to:

- Determine the cause(s) of pavement distress
- Develop a list of possible solutions to cure and prevent recurrence of the problem(s)
- Select the preferred rehabilitation method, accounting for economic and other project constraints

Data used to determine the cause(s) of the problem(s) include those items described in Section 1.A as well as the pavement condition-distress severity and extent.

5.A Types of Rehabilitation

See Chapter One: Roadway Design Standards, Sections 6.B & 6.C, and Chapter Seventeen: Resurfacing, Restoration and Rehabilitation (3R) Projects, Section 1, of this manual.

5.B Removal of Existing Surfacing

The pay items “Remove Asphalt Surface” and “Remove Pavement” refer to the removal of the surfacing down to the roadway base. Existing surfacing may be removed when it is no longer cost effective to repair and to accommodate surfacing thickness requirements at railroad crossings, bridge ends or other locations shown on the plans. When the final thickness of surfacing is reduced by milling, **M&R** should be consulted to confirm that the reduced thickness will provide adequate structure. For additional information, see Chapter Seven: Earthwork, Section 1.C, of this manual.

5.B.1 Cold Milling

Cold milling is the removal of existing asphaltic concrete by a milling machine. Cold milling may be one of several different types, depending on the depth of milling and slope requirements outlined in the pavement determination from **M&R**. The different types vary from milling to remove surface irregularities to milling to remove the entire depth of existing asphalt. Milling is paid for at the contract unit price per Sta. or per SY as detailed in the *Spec Book* (Ref. 8.4), Section 510 (https://dot.nebraska.gov/media/g4qp4y0d/2017-specbook.pdf).

5.B.2 Brick Removal

A special provision is required whenever brick surfacing is removed and salvaged. The roadway designer will note the need for this provision in the final plans package for **PS&E**. For additional information see Chapter Twelve: Cost Estimating and Funding of this manual.

5.B.3 Concrete Surface Milling

Concrete Surface Milling is the removal of concrete by a milling machine and is described by the typical cross-sections and special provision. Concrete Surface Milling is paid for at the contract unit price per Sta. or per SY as detailed in the *Spec Book* (Ref. 8.4), Section 510.

5.C Concrete Repair and Bituminous Pavement Patching

Concrete Pavement - Repair of concrete pavement consists of the removal and replacement of irregular areas of existing concrete pavement including overlaying bituminous surfacing and/or unstable base course. See the *Spec Book* (Ref. 8.4), Section 605, for additional information.

Asphaltic Concrete - Patching of asphaltic concrete consists of the removal and disposal of unstable or deteriorated materials (including base course, if necessary) and the placing and compacting of the appropriate type of asphaltic concrete. Quantities for pavement patching will be included in the project cost estimate; the designer will include the pay items for the rental of loader, motor grader, and dump truck with asphalt patching. See Section 516 of the *Spec Book* (Ref. 8.4) for additional information.

5.D Overlays and Transitions

Asphaltic concrete overlays are used in a variety of situations. A specified depth or grade line of existing bituminous material is removed by cold milling and then the asphalt is laid down. At locations where differences in elevation occur as the result of an overlay, a transition detail or inlay detail is required on the Typical Cross-Section Sheet (See Chapter Eleven: Highway Plans Assembly, Section 4.B, of this manual). A minimum taper rate of 33 feet to one-inch change in grade should be used on high-speed ($V \geq 50$ mph) roadways; the preferred taper rate of an overlay on a high-speed roadway is 50 feet to each inch change in grade (e.g. for a two-inch mill with a four-inch overlay: 2 x 50 = 100 feet). The taper rate for a low-speed ($V \leq 45$ mph) roadway is 25 feet to each inch change in grade.

5.D.1 Template Correction

Template correction is used when the existing cross slopes are different from the design cross slopes (e.g. 3% existing cross-slope vs 2% design cross slope). **Roadway Design** will provide an estimate of the additional tons of asphalt needed for the cross slope correction to **M&R** when the project is being prepared for **PS&E** turn-in.

5.D.2 Superelevation Improvement

Superelevation improvement is considered when the existing superelevation does not meet the *MDS* (Ref. 8.2) guidance. **Roadway Design** will provide an estimate of the additional tons of asphalt needed for the superelevation improvement to **M&R** when the project is being prepared for **PS&E** turn-in. For additional information see Chapter Seventeen: Resurfacing, Restoration and Rehabilitation (3R) Projects, Section 3.B.1, of this manual.

5.E Pavement Dropoffs During Construction

It is the responsibility of the roadway designer to inform **Traffic Engineering** of projects being built under traffic where grading operations are adjacent to the existing roadway.

6. SURFACING QUANTITY COMPUTATIONS

The procedure for computing quantities of surfacing material depends on the type of pavement to be placed. Cost estimates will be made based on the computed quantities. For additional information see Chapter Twelve: Cost Estimating & Funding of this manual.

6.A Rigid Pavement

The roadway designer is responsible for computing PCC pavement pay quantities, including the following items:

- Concrete pavement, including intersections and driveways, for each design pavement thickness (See Chapter Four: Intersections, Driveways and Channelization, Sections 3.A and 3B, of this manual)
- Concrete curb
- Left-in-Place Median Crossovers (See Chapter Five: Interstates, Grade Separations, and Interchanges, Section 1.H.4, of this manual).

The designer will compute separate total areas for each pavement thickness, including the mainline, intersections, driveways, approaches, turnouts, etc. This area, in sq. yds., is the estimated pay item quantity for each depth of concrete pavement.

Concrete pavement quantities should be itemized and shown on the computation sheets in such a manner that the segments of pavement represented can be easily recognized. In cases where the design is very complex sketches should be included with the computation sheets. The designer should refer to Chapter Twelve: Cost Estimating & Funding, EXHIBITS 12.8 & 12.9, for a list of surfacing pay items. The designer will submit the typical sections, plan and profile or large scale sheets, intersection and driveway sheets and locations, and the concrete pavement pay item quantities to **M&R**; **M&R** requires this information to compute the quantities for Subgrade Preparation and Foundation Course.

6.B Flexible Pavement

The designer will submit the essential project information, including typical sections, complete plan and profile or large-scale sheets, driveway sketches and locations, surfacing under guardrail details, etc. and the summary of asphaltic concrete quantities to **M&R**, which is responsible for computing the final pay quantities for asphaltic concrete surfacing.

The roadway designer will verify that the flexible pavement quantities include asphaltic concrete surfacing used for:

- Driveways and intersections (See Chapter Four: Intersections, Driveways and Channelization, Section 3, of this manual)
- Mailbox turnouts (See Chapter Ten: Miscellaneous Design Issues, Section 10, of this manual)
- Surfacing under guardrails (See Chapter Nine: Guardrail and Roadside Barriers, Section 3.G, of this manual)
- Surfacing for detours, temporary roads, crossovers, and temporary pavement (See Chapter Fourteen: Traffic, Section 6, of this manual)
- Asphaltic concrete curb

For a list of surfacing pay items, see Chapter Twelve: Cost Estimating & Funding, EXHIBITS 12.8 & 12.9.

6.C Surfacing Aggregates

Quantities for aggregates used for surfacing are computed either by the ton or cu. yd., depending on the **District**. In **Districts 1, 2 and 3** surfacing aggregate estimates will be calculated in tons; when surfacing aggregates are needed in **Districts 4 through 8** the designer should consult with the **DE** during the plan-in-hand to determine the unit of measurement and the type of aggregate to be used. The following weight to volume factors should be used in estimating:

Crushed rock for surfacing:	1.25 tons/cu. yd.
Gravel for surfacing:	1.35 tons/cu. yd.

On projects where grading disrupts property access, the designer should consult with the **DE** on the plan-in-hand field inspection regarding the use of gravel, crushed rock, or millings to provide temporary access to the impacted properties. The designer should include a lump sum for these quantities in the preliminary project estimates; the quantities should vary between 100 to 200 tons per mile, depending on the size of the access and the type of roadway (e.g. two-lane vs. four-lane, municipal vs. rural). Quantities will be shown to the nearest ton. The designer will submit plans, cross-sections, and preliminary quantity estimates of locations using surfacing aggregates to **M&R** for the computation of the final quantities.

For a list of surfacing pay items see Chapter Twelve: Cost Estimating & Funding, EXHIBITS 12.8 & 12.9.

6.D Foundation, Base, and Surface Courses

Pay item quantity units and methods of measurement for roadway foundation, base, and surface courses are found in the *Spec Book* (Ref. 8.4), Division 300.

6.E Sawing Pavement

The pay item "Sawing Pavement" will be included when removing pavement, sidewalk, driveway, integral curb, or similar flatwork when the removal does not extend to an existing joint. The pay item includes both full depth and partial depth cuts. "Sawing Pavement" is required when removing concrete overlaid with asphalt.

The designer should calculate the length of the transverse cut and longitudinal integral cuts required to remove a curb, portion of a lane, or similar cuts. The quantity should be rounded to the nearest 10 feet. "Sawing Pavement" is not calculated when the removal occurs at existing joints. Sawing notes should not be shown in the plans.

7. RUMBLE STRIPS AND RUMBLE STRIPES

Reducing the occurrence of vehicles deviating from their assigned lane by either leaving the roadway or encroaching on or crossing into opposing lanes is one of the critical emphasis areas for the Nebraska Strategic Highway Safety Plan (https://dot.nebraska.gov/safety/shsp/). Installation of rumble strips and rumble stripes is a cost-effective measure, recognized by federal and state transportation agencies, for alerting errant drivers of lane departure and providing the driver with an opportunity to correct back into their lane, potentially mitigating lane departure crashes.

Rumble strips are grooved patterns in the pavement, typically spanning 6 inches and either 12 inches or 16 inches wide on 12-inch spacing. When a vehicle crosses a rumble strip the vehicle shakes and the vibration causes a noise, alerting the driver that the vehicle is leaving the travel lane. Shoulder rumble strips are milled into the shoulder surfacing.

Rumble stripes are relatively narrow, 8 inches wide on 12-inch spacing. Edge line rumble stripes are placed in the location of the white edgeline and are generally used where the surfaced shoulders are less than 6 feet in width. Centerline rumble stripes are milled on each side of the joint separating opposing lanes of traffic. Rumble stripes are placed in the paint stripe of the centerline and/or at the edge line of the lane but will not be on a joint. Rumble stripes will be paid for as rumble strips.

Rumble strips will not be placed on bridge decks or bridge approach slabs.

Rumble strip installation should follow Special Plan 320 (See the *Standard Plans*, Ref. 8.1).

Each shoulder receiving rumble strips shall be measured separately, in stations of 100 feet. Centerline rumble strips shall be measured in stations of 100 ft. Stations are measured horizontally along the project centerline between the project beginning and ending points. Deductions will be made by the **District** for all areas where rumble strips are not required, the roadway designer is not responsible for the deductions.

Rumble strips are paid for by the Station (Sta). The appropriate pay items are "Rumble Strips, Asphalt", "Rumble Strips, Concrete", and/or "Centerline Rumble Strips".

When rumble strips, edge line rumble stripes or centerline rumble stripes are placed they will be perpetuated on subsequent projects and will not be obliterated without their function being replaced with a similarly effective mitigation measure for road departures (e.g. lighting). Since the installation of rumble strips/stripes will substantially modify the run-off road crash history, use of the warrants to justify continued use of the rumble strips/stripes would be inaccurate. If **NDOT** maintenance operations or activities obliterate the rumble strips/stripes, they are not required to be reinstalled until the next resurfacing project. Rumble strips/stripes may be restored earlier if directed by the **DE**. Rural areas which become urban may eliminate the rumble strip/stripe.

Additional information may be found at:

- NCHRP Report 641, Guidance for the Design and Application of Shoulder and Centerline Rumble Strips, 2009.
- Low-Cost Treatments for Horizontal Curve Safety, FHWA, 2006.
- Shoulder and Edge Line Rumble Strips, FHWA Technical Advisory T 5040.39, November 7, 2011
- NCHRP Synthesis 339, Centerline Rumble Strips, 2005

For additional rumble strip/stripe guidance on 3R projects, see Chapter Seventeen: Resurfacing, Restoration and Rehabilitation (3R) Projects, Section 8.B, of this manual.

7.A Shoulder Rumble Strips

After reviewing the crash data and research literature, **NDOT** has determined the following to be guiding principles for the installation of shoulder rumble strips on the state highway system.

- Shoulder rumble strips will be constructed on the shoulders, including the median shoulders, for all rural Interstate and rural expressway projects (new construction, reconstruction, and 3R).
- Shoulder rumble strips should be constructed on 6-foot-wide or wider surfaced shoulders for all new construction and reconstruction projects on rural high-speed ($V \geq 50$ mph) two-way two-lane highways.
- Shoulder rumble strips should be constructed on 3R projects over one-half mile in length on rural high-speed ($V \geq 50$ mph) highways with continuous surfaced shoulder widths of 6 foot or greater.
- Existing rumble strips will be perpetuated on 3R projects over one-half mile in length. When project lengths are less than one-half mile, the rumble strips may be added to another project in the area to reduce mobilization fees.
- Projects with surfaced shoulders with curb and flume will be reviewed for inclusion of milled in rumble strips by **Roadway Design**.

Shoulder rumble strips may be placed at the direction of the **Traffic Engineer** or designee to address other traffic operations issues beyond those presented here.

7.B Edgeline Rumble Stripes

NDOT has determined through demonstration projects, national studies, and Nebraska crash history analysis that the installation of edgeline rumble stripes is an effective countermeasure for roadway departure crashes on two-lane two-way roadways. **NDOT** also recognizes that installing edgeline rumble stripes utilizes transportation funds that could be available for other transportation needs on the state highway system. A systematic or systemic approach to the implementation of safety mitigation strategies is important regardless of the mitigation strategy to be used. Due to the random occurrence of roadway departure crashes, it is important to recognize that any roadway departure crash could be a fatality based upon the random presence of another vehicle, the roadside configuration, and the health of the individuals involved in the crash. Consequently, this policy for implementation is based upon the total number of roadway departure crashes.

After reviewing the crash data and research literature, **NDOT** has determined the following to be guiding principles for the installation of edgeline rumble stripes on the state highway system new pavement projects. Edgeline rumble stripes may be placed on existing state highway pavement at the direction of the **M&R Engineer** or designee.

- Roadway type – Rural two-lane undivided with two-way traffic
- Lane width – 12 feet with two-feet integral shoulders for a 28-foot minimum total top width
- Pavement section with a recommended minimum overlay thickness of two inches of pavement and the surface in good condition
- Posted speed limit of 50 mph or greater

After edgeline rumble stripes are installed, they will be perpetuated on subsequent projects unless their function is replaced by a similarly effective mitigation measure for roadway departure crashes, speed limit of the segment is reduced to 45 mph or lower, or the new pavement overlay thickness is less than two inches. Edgeline rumble stripes may be placed on new pavement overlays with a thickness of less than two inches at the direction of the **M&R Engineer** or designee.

7.C Centerline Rumble Stripes

NDOT has determined through demonstration projects, national studies, and Nebraska crash history analysis that the installation of centerline rumble stripes is an effective countermeasure for lane departure crashes on two-lane two-way roadways. **NDOT** also recognizes that installing centerline rumble stripes utilizes transportation funds that could be available for other transportation needs on the state highway system. A systematic or systemic approach to the implementation of safety mitigation strategies is important regardless of the mitigation strategy to be used. Due to the random occurrence of lane departure crashes, it is important to recognize that any lane departure crash could be a fatality based upon the random presence of another vehicle, the roadside configuration, and the health of the individuals involved in the crash. Consequently, this policy for implementation is based upon the total number of lane departure crashes.

After reviewing the crash data and research literature, **NDOT** has determined the following to be guiding principles for the installation of centerline rumble stripes on the state highway system new pavement projects. Centerline rumble stripes may be placed on existing state highway pavement at the direction of the **M&R Engineer** or designee.

- Roadway type – Rural two-lane undivided with two-way traffic
- Lane width – No less than 11 feet; the lane width will be 12 feet minimum where edgeline rumble stripes are present
- Pavement section with a recommended minimum overlay thickness of two inches of pavement and the surface in good condition
- Posted speed limit of 50 mph or greater

After centerline rumble stripes are installed, they will be perpetuated on subsequent projects unless their function is replaced by a similarly effective mitigation measure for lane departure crashes or if the new pavement overlay thickness is less than two inches. Centerline rumble stripes may be placed on new pavement overlays with a thickness of less than two inches at the direction of the **M&R Engineer** or designee.

8. BEVELED EDGE

See Chapter Six: The Typical Roadway Cross-Section, Section 2.C, of this manual.

9. SURFACING ELEVATIONS

See Chapter Eleven: Highway Plans Assembly, Section 4.J.1, of this manual.

10. REFERENCES

8.1 Nebraska Department of Transportation, Standard/Special Plans Book (*Standard Plans*), Current Edition. (https://dot.nebraska.gov/media/g4qp4y0d/2017-specbook.pdf)

8.2 Board of Public Roads Classifications and Standards, Nebraska Minimum Design Standards (*MDS*), Current Edition. (https://dot.nebraska.gov/media/1z1n5kmb/nac-428-rules-regs-nbcs.pdf)

8.3 Nebraska Department of Transportation, Drainage Design and Erosion Control Manual (*Drainage Manual*), Current Edition. (https://dot.nebraska.gov/business-center/design-consultant/rd-manuals/)

8.4 Nebraska Department of Transportation, Standard Specifications for Highway Construction (*Spec Book*), 2017. (https://dot.nebraska.gov/media/g4qp4y0d/2017-specbook.pdf)

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