Pavement Management
Visual Distress Survey Manual

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INTRODUCTION

In 1993, the South Dakota Department of Transportation initiated the Research Project SD93-14, Enhancement of South Dakota's Pavement Management System. As the Research Project progressed, it was determined that to better evaluate the condition of the pavement, a more detailed distress survey needed to be performed by SDDOT. The Research Technical Panel identified the failure mechanisms for pavements that were prevalent and would trigger a rehabilitation or reconstruction project in South Dakota. These distresses are listed in Table 1.

Flexible Pavements	Rigid Pavements
Transverse Cracking	D Cracking and ASR
Fatigue Cracking	Joint Spalling
Patching/Patch deterioration	Corner Cracking
Block Cracking	Faulting
Rutting	Joint Seal Damage
Roughness	Roughness
	Punchouts

Table 1: Original failure mechanisms for flexible and rigid pavements in South Dakota.

The Technical Panel and Deighton Associates staff then decided on categories of severity and extent for each distress. The extents and severity levels were based upon those given in the Strategic Highway Research Program's (SHRP) *Distress Identification Manual for the Long-Term Pavement Performance Project* 1993 Edition. A few modifications were made to better reflect conditions seen in South Dakota. The consultant then developed a process to collect data on the condition of the pavement based upon individual distresses.

At present, faulting, roughness and rut depth are collected by the Office of Transportation Inventory Management staff with a Fugro road profiler. All other distresses are currently collected by a visual distress survey performed by seasonal staff of the Office of Project Development. All distresses are collected by sections, the majority of which have a length of 0.250 mile. 1995 was the first year that the visual distress data had been collected on a statewide basis.

The distress for Longitudinal Cracking in PCC pavement was added in 2008. This is part of a requirement for the HPMS data submittal.

The distress of Continuous Reinforced Concrete Paving (CRCP) Block Cracking was added as a new distress in 2016. This distress was identified as a new failure mechanism in CRCP built after 1995 and is now part of the Pavement Management analysis.

A project has been initiated that will hopefully lead to collecting pavement images with a specialized van travelling at highway speed. The visual pavement distress rating would then be performed in the office using these images and automated methods. Some changes in the rating procedure may result by the change in data collection methods.

DISTRESS DEFINITIONS

FLEXIBLE PAVEMENT DISTRESSES

Transverse Cracking: Appears as cracks perpendicular to pavement centerline.

Fatigue Cracking: Appears initially as a single longitudinal crack in the wheel path. Later appears as a series of interconnected cracks resembling alligator skin or chicken wire.

Patching & Patch Deterioration: Appears as an area where the pavement surface has been removed and replaced, or as a localized overlay covering up other distresses. A major concern with patching is whether you have a patch or an overlay, and the effect the patch has on the distress indices that the patch is covering up. To help with the determination of whether to rate a patch as a patch or an overlay, refer to page 24.

Block Cracking: Appears as cracks which divide the surface into approximately rectangular pieces. In the low severity level, the cracks may appear as random longitudinal cracks between the wheel paths.

Rut Depth*: Appears as a surface depression in the wheel paths.

Roughness*: The rideability of the road section.

*** Note: Rut Depth and Roughness are not collected during the visual distress survey.**

RIGID PAVEMENT DISTRESSES

D-Cracking:	Appears as a series of closely spaced crescent-shaped hairline surface cracks. The crack often causes dark coloring of the surface in the surrounding area.
Alkali Silica Reactivity:	Appears as a series of interconnected cracks. Frequently, larger cracks are oriented in the longitudinal direction of the pavement and interconnected by finer transverse or random cracks.
Joint Spalling:	Appears as the cracking, breaking, chipping, or fraying of slab edges within 2 feet (0.6 meters) of a joint or crack.
Corner Cracking:	Appears as a crack extending vertically through the entire slab depth which intersects the joints at a distance less than 6 feet from the corner of the slab.
Faulting*:	Appears as the difference in elevation across a joint or crack.
Joint Seal Damage:	Appears as any condition which enables incompressible materials and/or significant amount of water to infiltrate the joint from the surface.
Punchouts:	The area enclosed by two closely spaced (usually less than 2 feet) transverse cracks, a short longitudinal crack, and the edge of the pavement or a longitudinal joint. Occurs on CRCP Only.
CRCP Block Cracking	**A**ppears as hairline transverse and longitudinal cracks that form a block pattern in CRCP pavement. Occurs on CRCP Only.
Roughness*:	The rideability of the road section.
Longitudinal Cracking:**	Cracks that are predominantly parallel to the pavement centerline

*** Note: Faulting and Roughness are not collected during the visual distress survey.**

**** Note: Longitudinal Cracking is collected as a part of the HPMS project. This distress is not a predominant failure mechanism on South Dakota Highways**

DISTRESS SEVERITY AND EXTENT

DEFICIENCY	LOW	MEDIUM	HIGH
Transverse Cracking	Crack <1/4 inch width or Routed & sealed crack < 1/2 inch	Crack > 1/4 and< 1 inch width and/or <1/4 inch depressions	Crack > 1 inch or (Crack > 1/4 inch width & >1/4 inch depressions)
Fatigue Cracking	Fine parallel cracks in the wheel path(s)	Alligator pattern clearly developed	Alligator pattern clearly developed with spalling and distortion
Patching and Patch Deterioration	Patch shows no visual distress of any type and with a smooth ride	Patch shows low or medium severity distress of any type and/ or notable roughness	Patch shows a high severity distress of any type and/ or distinct roughness
Block Cracking	Random longitudinal cracks between the wheel paths, **Or** interconnected transverse and longitudinal cracks that form blocks greater than 6 ft per side	Interconnected transverse and longitudinal cracks that form blocks 3 feet to 6 feet per side	Interconnected transverse and longitudinal cracks that form blocks less than 3 feet per side
D Cracking & ASR	Cracks are light, with no loose or missing pieces.	Cracks are well defined and some small pieces are loose or missing.	Cracks are well developed pattern with a significant amount of loose or missing material.
Joint Spalling	Spalls < 3 inches wide with no significant loss of material or Joint & Spall repair patch with cracking.	Spalls 3 to 6 inches with loss of material.	Spalls > 6 inches with significant loss of material.
Corner Cracking	Crack not spalled with no faulting & piece not broken.	Crack spalled slightly, or faulting < 1/2 inch, or piece broken.	Crack spalled, or faulting > 1/2 inch, or piece broken.
Punchout/Longitudinal Crack	NO SEVERITY LEVELS		
CRCP Block Cracking	Closely spaced Transverse shrikage cracks with occasional interconnected Longitudinal cracks occuring perpendicular to the parent Transverse cracks	The pattern between the Longitudinal and Transverse cracks create a "block" or rectangular pattern.	The pattern between the Longitudinal and Transverse cracks create a "block" or rectangular pattern. The cracking pattern is distorted and spalls are present in cracks.
Joint Seal Damage	damage to < 10% of joint.	Damage to 10% - 50% of joint.	Damage to > 50% of joint.

Table 2: Severity levels used to describe the cracking failure mechanism deficiencies.

DISTRESS SEVERITY AND EXTENT (CONTINUED)

DEFICIENCY	LOW	MODERATE	HIGH	EXTREME
Transverse Cracking	> 50 ft. spacing.	>25 ft. & < 50 ft. spacing	>12 ft. & <25 ft. spacing	< 12 ft. spacing.
Fatigue Cracking	1% to 9% of wheel path	10% to 24% of wheel path	25% to 49% of wheel path	> 49 % of wheel path
Patching and Patch Deterioration	1% to 9% of section	10% to 24% of section	25% to 49% of section	> 49 % of section
Block Cracking	1% to 9% of section	10% to 49% of section	>49% of section	N/A
D Cracking & ASR	1% to 9% of slabs	10% to 24% of slabs	25% to 49% of slabs	> 49 % of slabs
Joint Spalling	1% to 9% of joints	10% to 24% of joints	25% to 49% of joints	> 49 % of joints
Corner Cracking	1% to 9% of slabs	10% to 24% of slabs	25% to 49% of slabs	> 49 % of slabs
Punchout	<10 per mile	10 to 25 per mile	>25 per mile	N/A
CRCP Block Cracking	1% to 9% of section	10% to 24% of section	25% to 49% of section	> 49 % of section
Joint Seal Damage	1% to 9% of joints	10% to 24% of joints	25% to 49% of joints	> 49 % of joints
Longitudinal Cracking	1% to 9% of slabs	10% to 24% of slabs	25% to 49% of slabs	> 49 % of slabs

Table 4: Extent levels used to describe the cracking failure mechanism deficiencies.

DISTRESS SURVEY PROCEDURE

OVERVIEW

The distress survey processes must be able to identify and document the type, extent and all levels of severity of pavement distress, particularly the first stages of severity.

The continuous survey is conducted by driving the shoulder of the road at 8 to 15 mph. The survey is conducted from a van or minivan to provide the best (highest) perspective of the pavement deficiencies. The survey uses a two person team, a driver and a rater. The driver is responsible for, the safe operation of the van, running the Distance Measurement Instrument (DMI) and ensuring the correct location of the section being rated. The rater determines and rates the pavement deficiencies. On roadways with limited or no shoulder, the driver aids the rater by identifying and rating the pavement distresses that are being driven over by the van. The rater is responsible for recording the distress ratings (after discussions with the driver) on the laptop computer or on paper. The laptop computers add the obvious advantage of eliminating later keypunch time and costs.

All types of required visual pavement distresses are recorded during the survey. Severity levels and extents for each distress are shown in Tables 2 and 4. For most distresses, an extent is determined for each severity level. Transverse Cracking is the exception. When there is more than one level of severity of a single deficiency the "predominate" severity is recorded, with the extent being the total extent of all severities. This is further explained below in Table 5.

DISTRESS	SEVERITY RATING RECORDING METHOD	EXTENT LEVEL RECORDING METHOD
Transverse Cracking	PREDOMINATE	TOTAL
Fatigue Cracking	INDIVIDUAL	INDIVIDUAL
Patching and Patch Deterioration	INDIVIDUAL	INDIVIDUAL
Block Cracking	INDIVIDUAL	INDIVIDUAL
D Cracking & ASR	INDIVIDUAL	INDIVIDUAL
Joint Spalling	INDIVIDUAL	INDIVIDUAL
Corner Cracking	INDIVIDUAL	INDIVIDUAL
CRCP Block Cracking	INDIVIDUAL	INDIVIDUAL
Punchout/Longitudinal Cracking	N/A	TOTAL
Joint Seal Damage	INDIVIDUAL	INDIVIDUAL

Table 5: Rating methods for individual distresses

In conducting the continuous survey from a van, the crew must pay attention to the weather and the direction of the sun. Inclement weather has an effect on the crews ability to see pavement distress. Any weather event which covers the pavement surface (snow, rain puddles, etc.) should cause the crew to stop rating until conditions improve. Rating should also cease when weather conditions limit the crew's ability to be seen by passing traffic (fog, heavy rain, snow, etc.) in order to ensure the crew's safety. When driving into the sun, the most distresses can be seen. When driving away from the sun, the raters may not see all or even any of the pavement distresses. The driver and rater must constantly check behind them for pavement distresses so as not to miss any.

LAPTOP OPERATION (WINDOWS 7 Version)

The Windows 7 version of the distress data collection software was written specifically for use with a stylus-based touch pad laptop. The program can be used by a normal keyboard/mouse input laptop as well.
As you begin the program, check to ensure the date on the computer is correct, since it will be automatically recorded into the file. The distress survey program used to record the data is started by double clicking on the HR51DistSurvey Icon on the desktop (Figure 1).

Figure 1

When the program first begins, a window will pop up and ask "Please enter your crew name" (See Figure 2). Write the initials of the crewmembers with the touch pen in the following format:

RI,DI

Where RI is the Raters Initials and DI is the Drivers Initials.

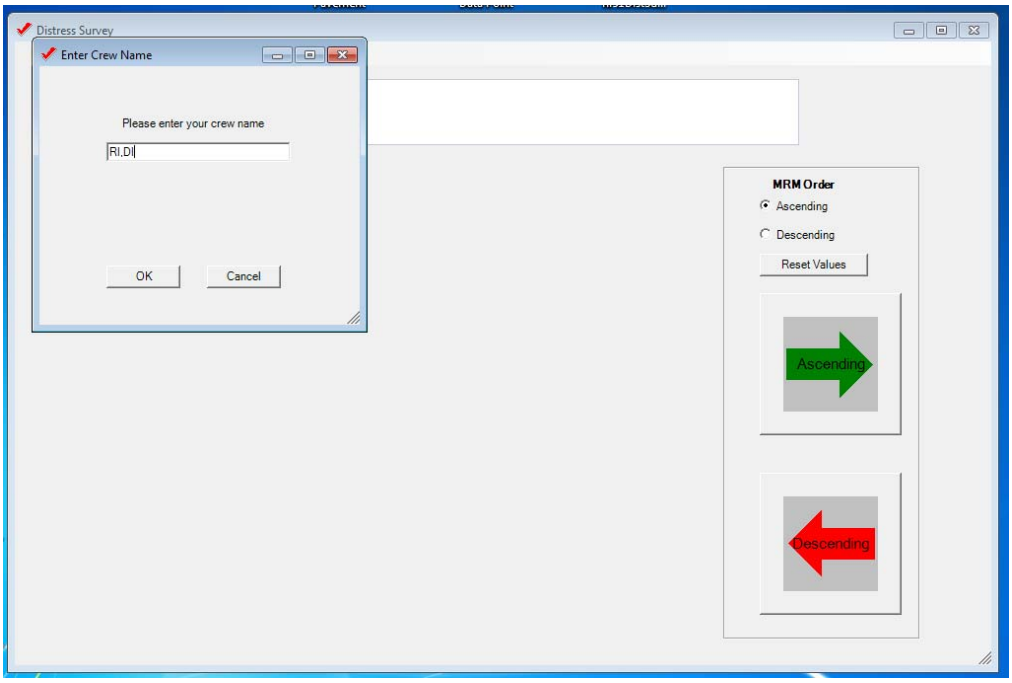


Figure 2: Crew Name Window

When "OK" is selected in the Crew Name Window, the application will start and the team's initials will be placed in the proper place once the highway and section has been selected .

The main application will open up and prompt for you to select a Highway from the drop down box (See Figure 3).

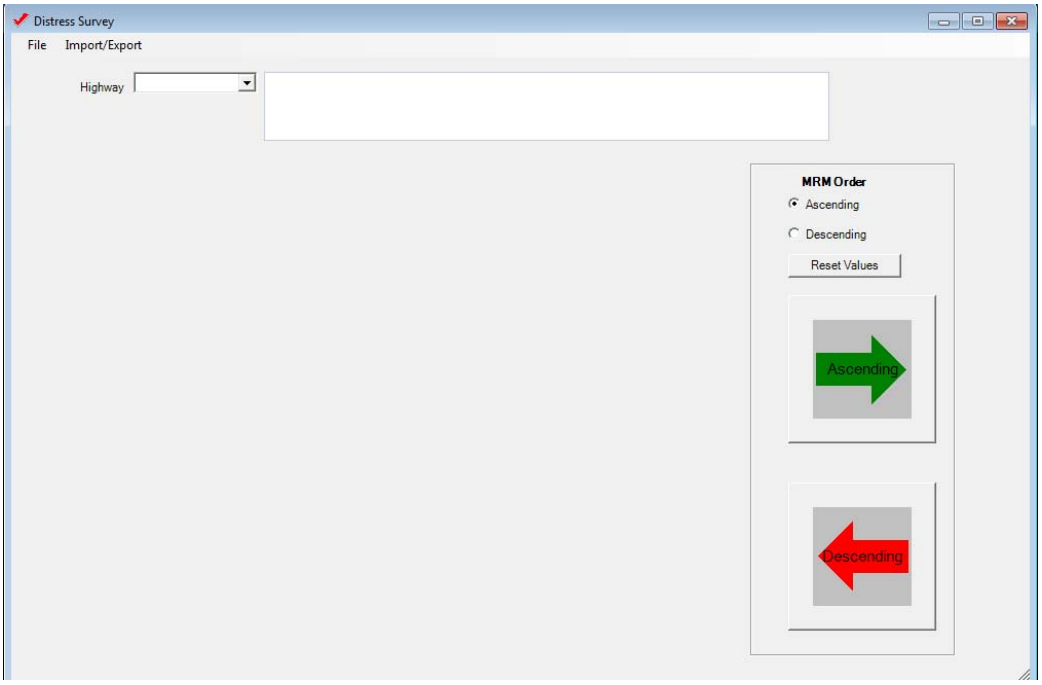


Figure 3: Start-up Window

Use the touch pen to scroll down the drop box to the highway to be rated and click on the highway number (See Figure 4).

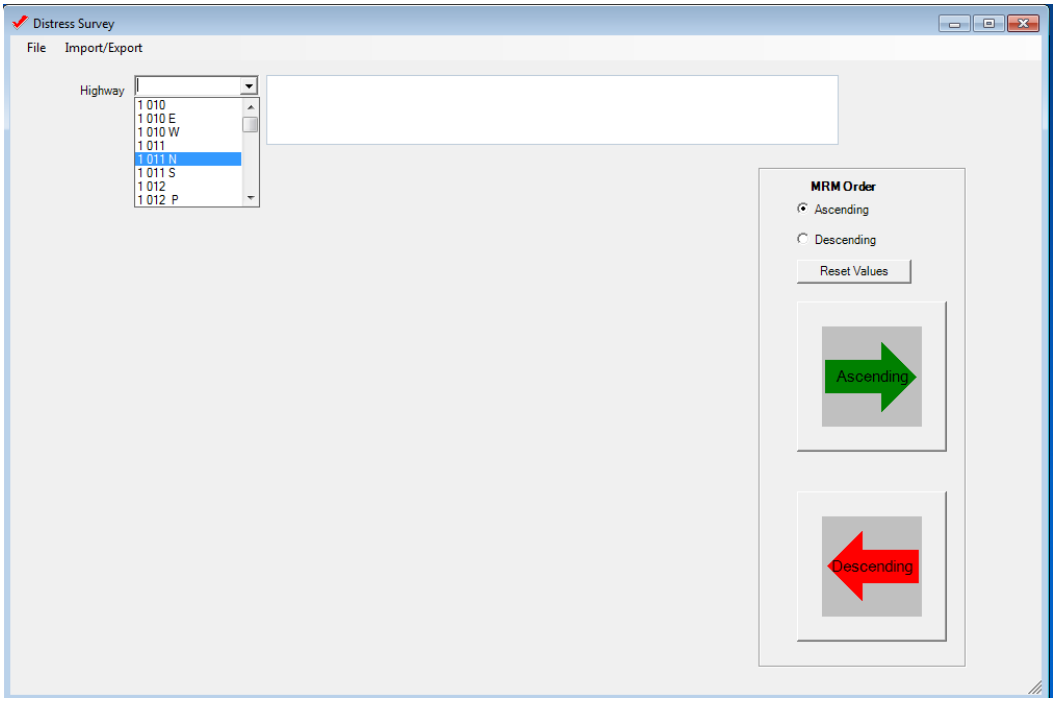


Figure 4: Highway Drop Down Box

The program will then jump to the first section of that highway. To the right of the Highway drop down box is the section selection box. This enables you to select the specific location along that Highway. To the right and below the section selection box are two "radio buttons" under the title "MRM Order" (see Figure 5). The computer needs to know whether the survey is being done in the direction of Ascending (increasing) or Descending (decreasing) MRM's. MRM's generally increase from West to East and from South to North. Select the bullet corresponding to the direction you will be surveying the highway.

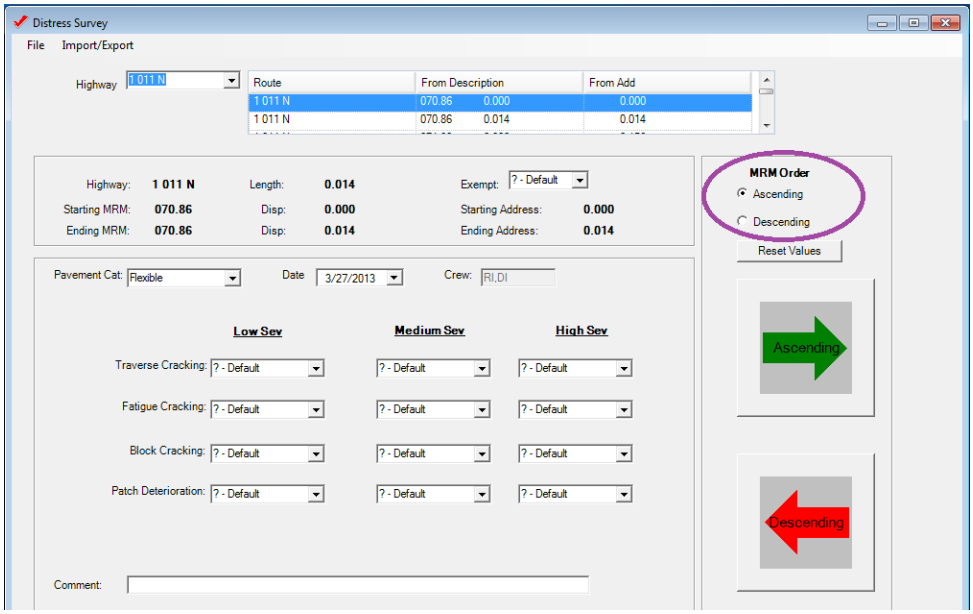


Figure 5: Direction Selection

Return to the section selection box. A list of sections appears in either ascending or descending order, depending on which bullet is chosen (See Figure 6).

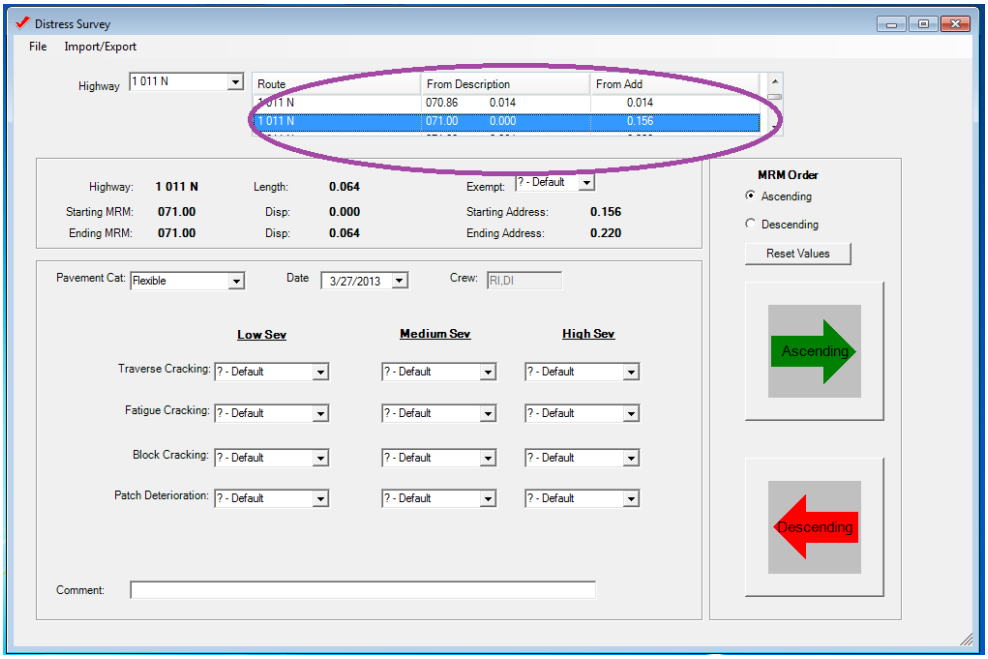


Figure 6: Section Selection Box

Scroll down the selection box and select the section you want to begin with (in the case of Figure 6, Hwy 11 N, MRM 71.00). (Note, when working in descending order, the Ending MRM is the section's beginning.) Before you begin rating, confirm with the driver the mileage on the DMI with the Address (starting when ascending, ending when traveling in descending order) .

The program will then bring up a window with the section identification data and places for data entry. The date from the computer should be already entered into the Date field, and the Teams initials should be already entered into the Crew field. Verify that the Date and Crew fields are correct. If either the Date or Crew fields are incorrect, go to the end of this section for directions on how to correct.

The first data field that needs to be entered is for the Pavement Cat(egory) field. The computer will display the last entered type for this section. The allowable types are: Flexible, Rigid and Gravel. Point to the drop box and choose the corresponding entry for the correct pavement type. Figures 7, 8, and 9 illustrate the Edit Pavement Distress Window for each pavement type.

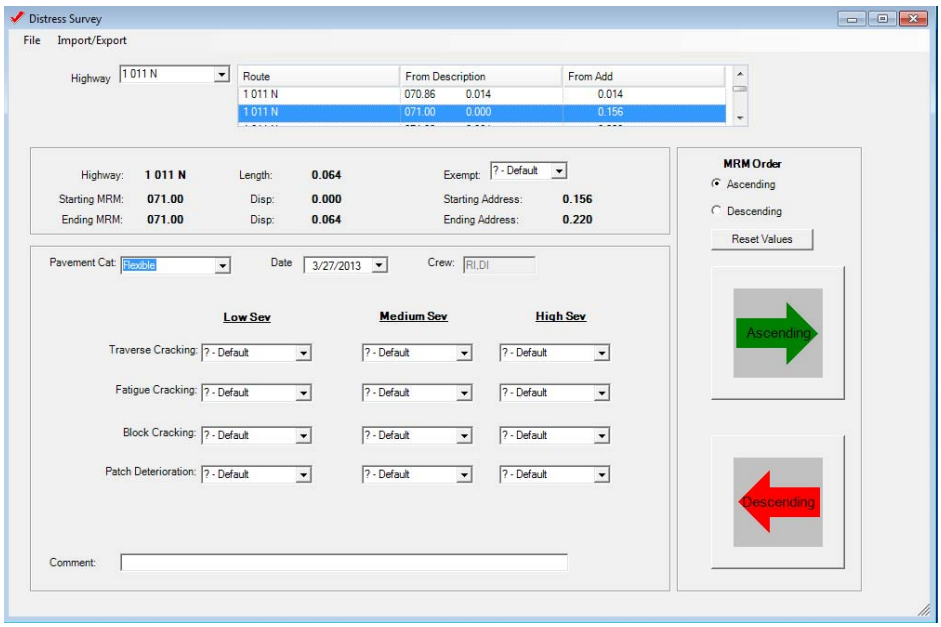


Figure 7: Flexible Pavement Window

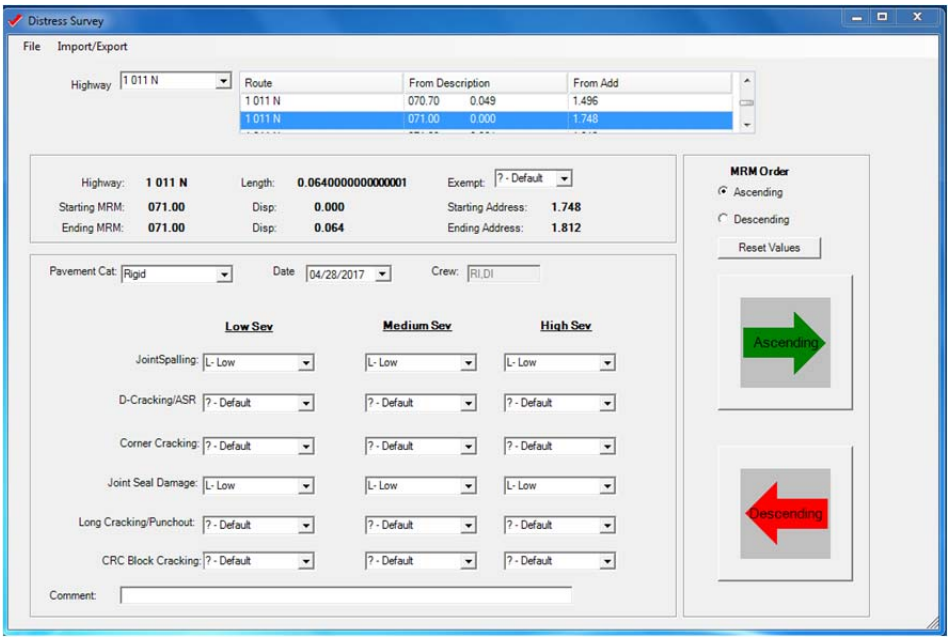


Figure 8: Rigid Pavement Window

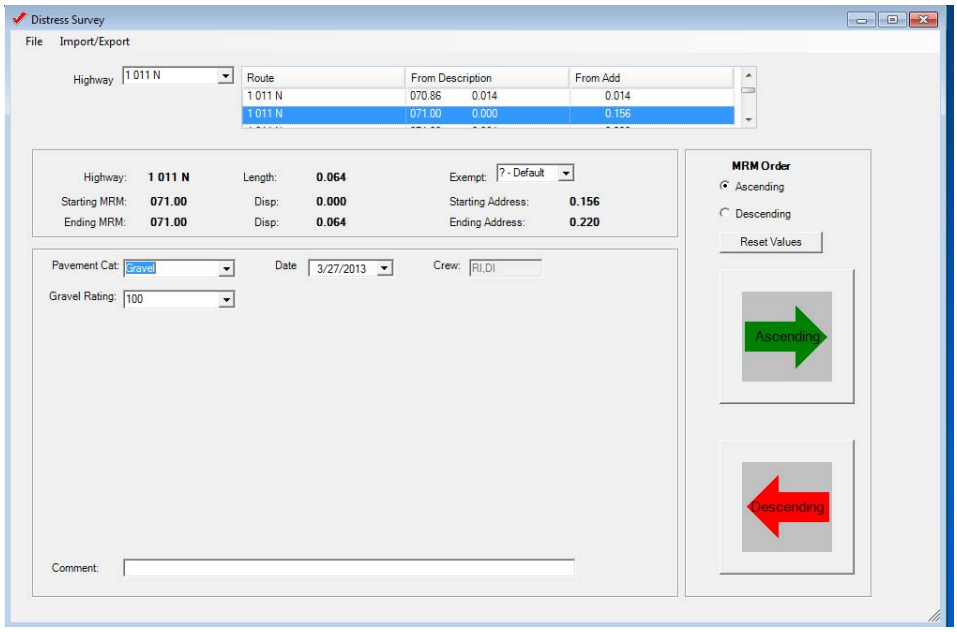


Figure 9: Gravel Surfaced Window

The program is now ready to rate the section of highway within the Starting and Ending Addresses.

From time to time, a section cannot be rated due to one of four following reasons.

1. Bridge
2. Gravel
3. Construction
4. Other

Use the Exempt drop box to show the reason why you could not rate that section of highway. The default value of '?" is to be used if the section can be rated. This drop down is illustrated in Figure 10.

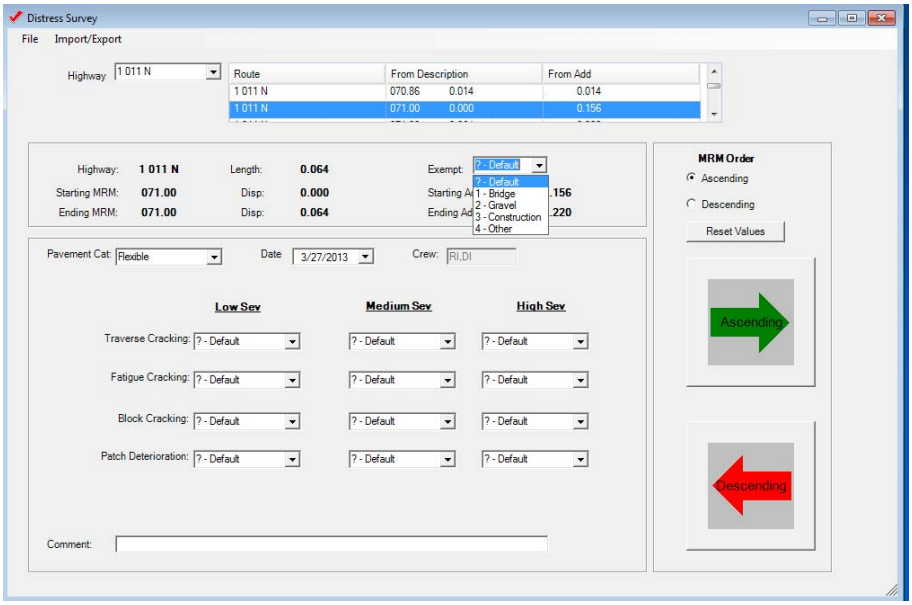


Figure 10: Exempt Code Drop Down Box

The individual distress fields below the identifier section of the window correspond to the chosen Pavement Cat(egory). When working on Flexible or Rigid pavement, for each individual distress, there is a drop box for the three severity levels (Low, Medium, and High). Use the drop down boxes to enter the value corresponding to the proper extent as follows:

? – Default (N)
L - Low Extent
M - Moderate Extent
H- High Extent
E- Extreme Extent (If applicable)
N - Not Found

See Figure 11.

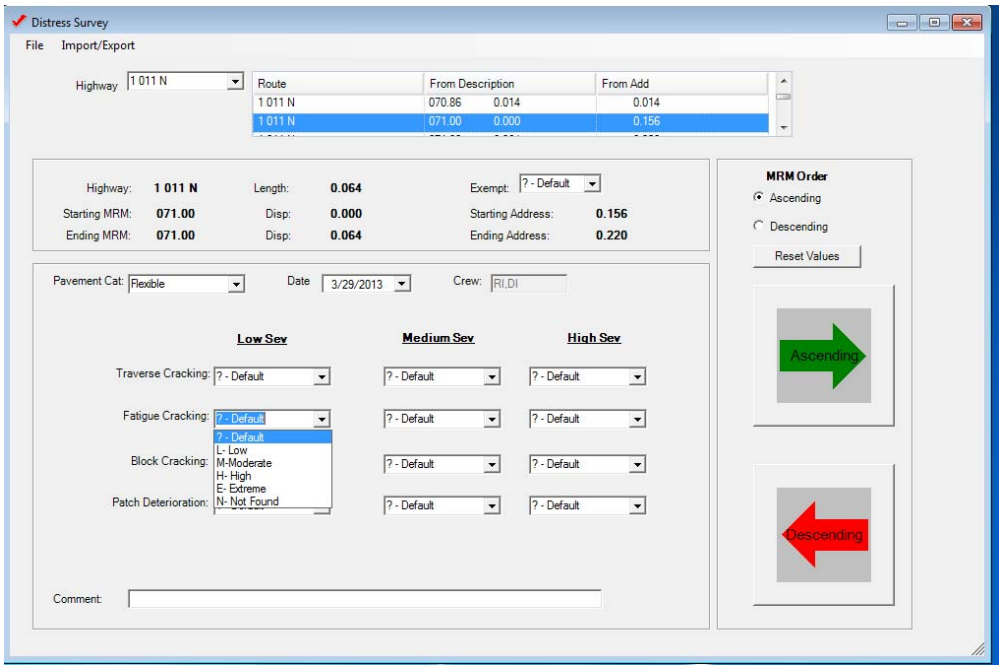


Figure 11: Individual Distress Drop Down Box

For Gravel Surfaced highways, only the Gravel Rating drop box appears (See figure 12). Clicking on the down arrow will bring up a scroll box with each number from 1 to 100 corresponding to the gravel rating (Note, if 100 is showing, you need to scroll up.).

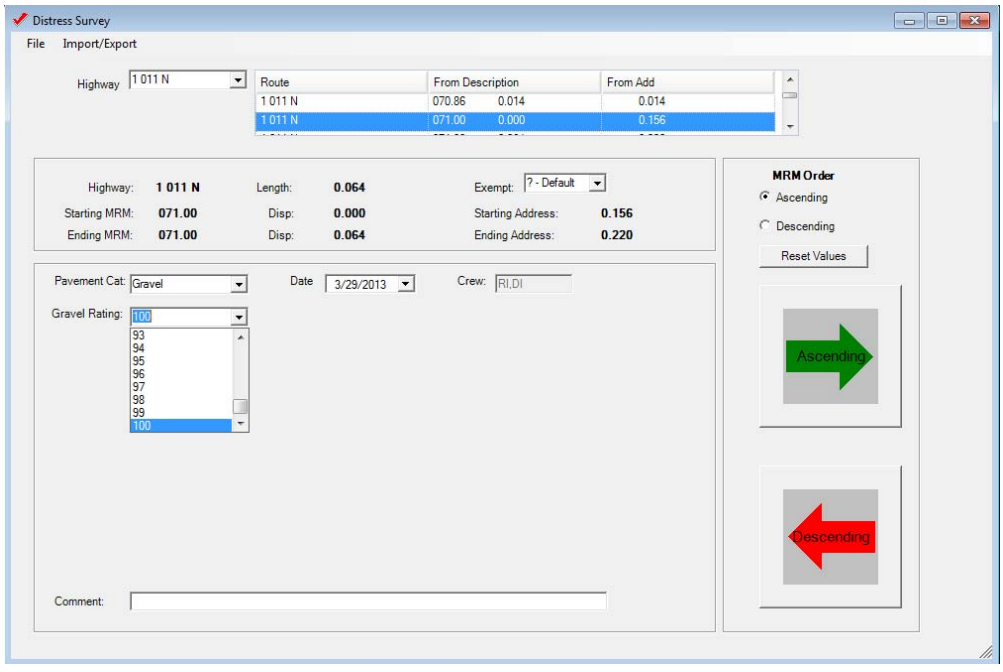


Figure 12: Gravel Rating Drop Down Box

In the event that you encounter a newly paved section of highway, all the individual distresses may be reset to default values by using the "Reset Values" button located below the MRM order toggles (see Figure 13). **Do not use the "Reset Values" button for any other purpose**.

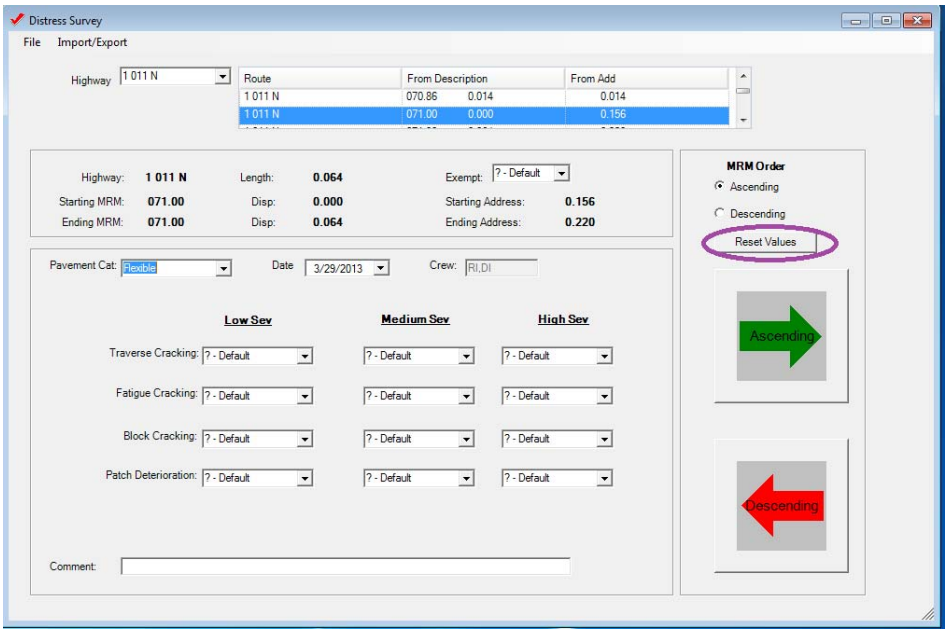


Figure 13: Reset Values button

When the input of data is complete for the section and you have reached the next section, click on the top colored arrow. If you are in Ascending mode, the top arrow will be green and point to the right. If you are in Descending mode, the top arrow will be red and pointing to the left (see Figures 14 and 15). If you need to go back a section, use the bottom arrow button.

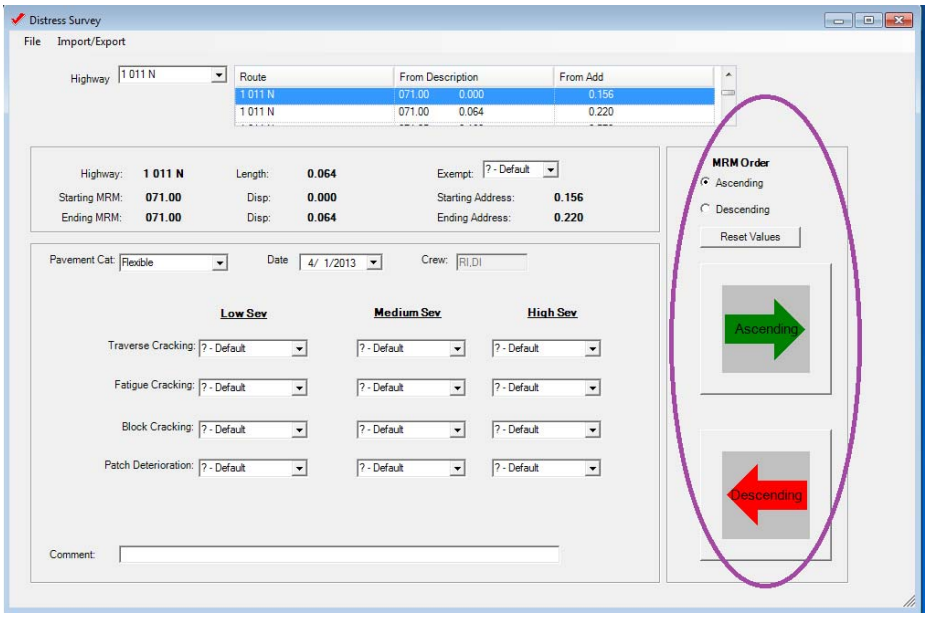


Figure 14: Arrow buttons, Ascending

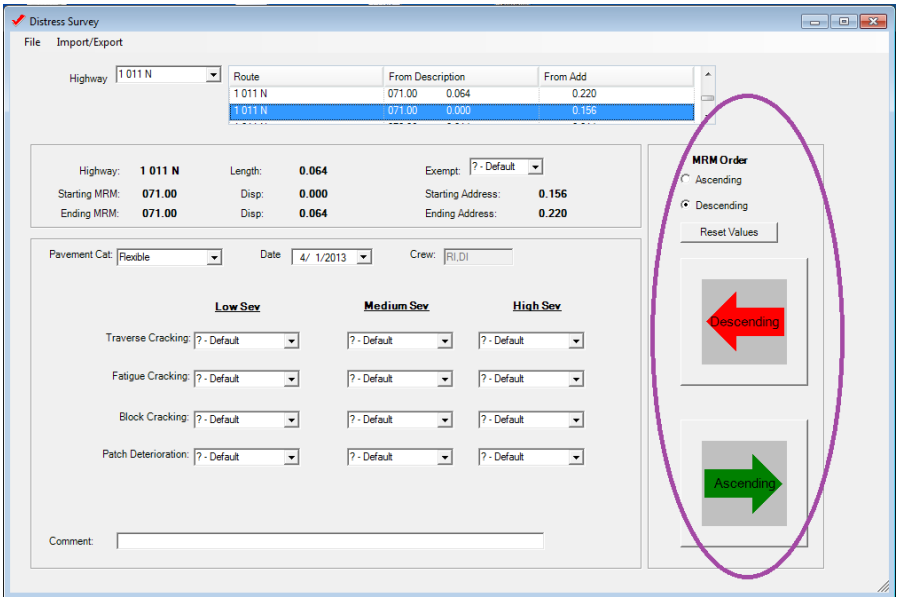


Figure 15: Arrow buttons, Descending

When you have completed the highway segment, select the next highway in the Highway drop box, choose the direction you will be rating and then select the new section in the section selection box (Figures 4, 5 and 6).

When you take a break or need to shut down the program, make sure that you save the data first. In the File menu, select save (Figure 16) and the file will save.

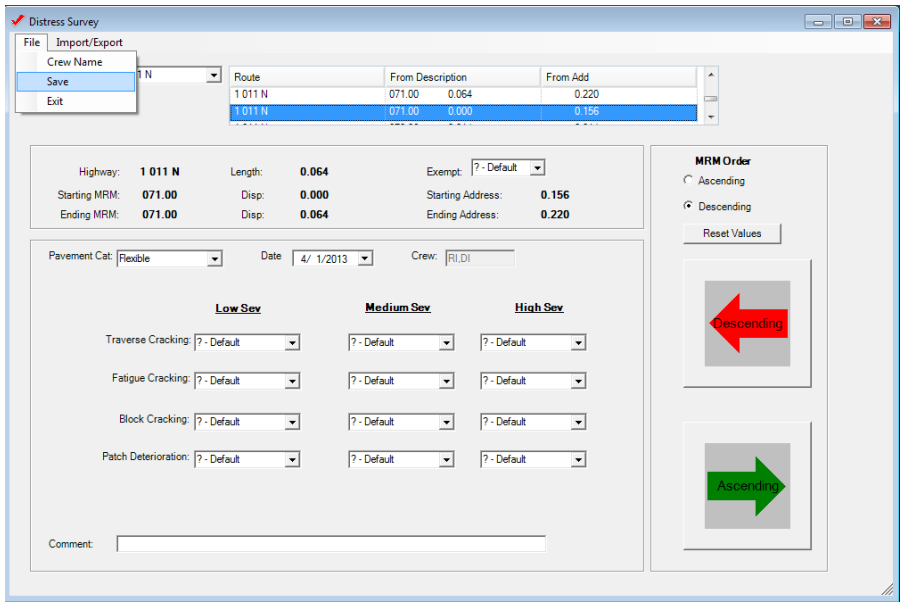


Figure 16: File menu

If you “x” out or use the File menu to exit (Figure 17) without saving, a dialog box will appear asking, “Do you want to save changes?”. Select “yes” to save, “no” not to save (Figure 16). If in doubt, select “yes”.

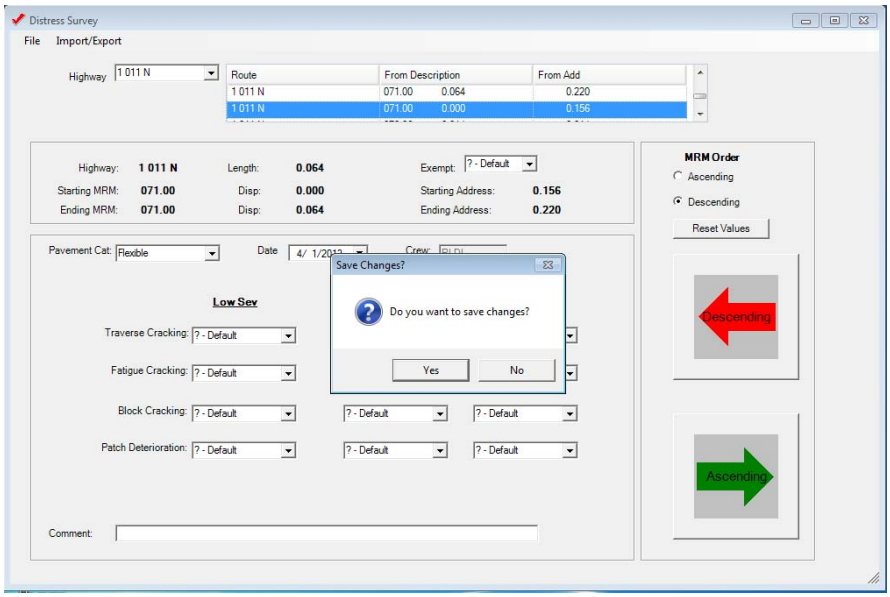


Figure 17: Save dialog box

When you are done using the program for the day, you will need to save, then do an export to the external database for backup. To do this, use the “file” menu, then select the save option as outlined in Figure 15. Once the file is saved, go to the “Import/Export” menu. You should have only one option, “Export to Access” **(if you have the option “Import to Access”, let the PM staff know as this is an administrative action only).** Click on “Export to Access”, it will take a few seconds to process. Once this is completed, a dialog box will pop up that says “Done”. See Figures 18 and 19.

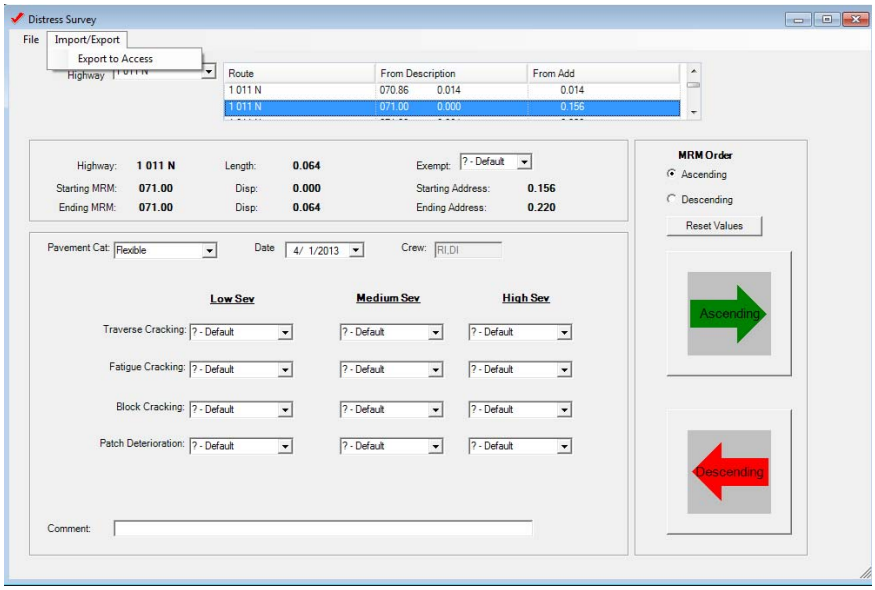


Figure 18: Export to ACCESS

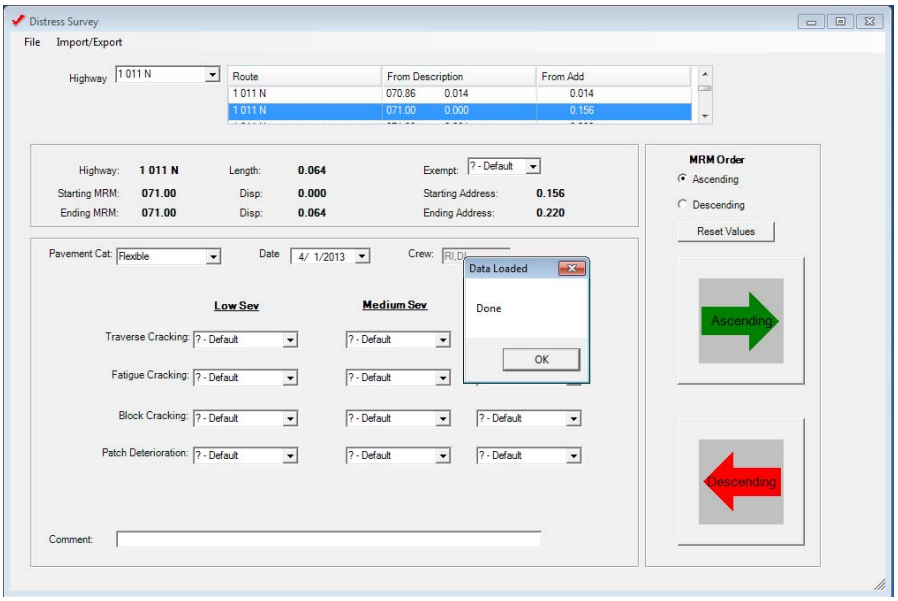


Figure 19: Export done

If the crew initials need to be changed while the program is running, click on the “File” drop down (Figure 16) on the top toolbar of the main program. Select “Crew Name” and the dialog box for Figure 2 will appear. Change the crew name and select “OK”.

PAPER ENTRY OPERATION

In the event that the laptop is unavailable, data recording is to be done on paper. Before beginning the survey, the sections should be recorded on the paper forms. Different forms are available for use on asphalt, gravel or concrete surfaces. Copies of these forms follow. To determine which form to use, locate the highway segment to be rated in the Highway Needs Analysis Book and use the sheet for the predominant pavement type. Data is to be recorded in a similar method as on the laptop, with number corresponding to the proper extent entered under the proper severity column within the observed distress column.

ASPHALT DISTRESS SURVEY FORM

DATE:________________________ RATERS:____________________________

HIGHWAY	TRANSVERSE CRACKING			FATIGUE CRACKING			PATCHING AND PATCH DETERIORATION			BLOCK CRACKING		
SEGMENT	L	M	H	L	M	H	L	M	H	L	M	H

INSERT DISTRESS EXTENT RATING UNDER THE PROPER SEVERITY COLUMN FOR EACH DISTRESS

DISTRESS TYPE	EXTENT RATING			
	1	2	3	4
Transverse Cracking	>50 ft spacing	25 ft to 50 ft	12 ft to 25 ft	<12 ft spacing
Fatigue Cracking	1 to 9% of wheel path	10 to 24% of wheel path	25 to 49% of wheel path	> 49% of wheel path
Patching and Patch Deterioration	1 to 9% of section	10 to 24% of section	25 to 49% of section	> 49% of section
Block Cracking	1 to 9% of section	10 to 49% of section	> 50% of section	

DISTRESS SEVERITY LEVELS			
DISTRESS TYPE	**LOW**	**MEDIUM**	**HIGH**
Transverse Cracking	< ¼ inch wide or Routed & sealed < ½ inch wide	> ¼ and < 1 inch crack width and/or < ¼ inch depressions	> 1 inch wide or (> ¼ inch width & > ¼ inch depressions
Fatigue Cracking	Fine parallel cracks in the wheel path(s)	Alligator pattern clearly developed	Alligator pattern clearly developed with spalling and distortion
Patching and Patch Deterioration	Patch shows no visual distress of any type and with a smooth ride	Patch shows low or medium severity distress of any type and/ or notable roughness	Patch shows a high severity distress of any type and/ or distinct roughness
Block Cracking	Random longitudinal cracks between the wheel paths, **Or** interconnected transverse and longitudinal cracks that form blocks greater than 6 feet per side	Interconnected transverse and longitudinal cracks that form blocks from 3 ft to 6 ft per side	Interconnected transverse and longitudinal cracks that form blocks less than 3 ft per side

CONCRETE DISTRESS SURVEY FORM

DATE:_______________________ RATERS:___________________

HIGHWAY	D CRACKING ASR			JOINT SPALLING			CORNER CRACKING			JOINT SEAL DAMAGE			LONG. CRACKS/ PUNCHOUT			CRCP BLOCK CRACKING		
SEGMENT	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H

INSERT DISTRESS EXTENT RATING UNDER THE PROPER SEVERITY COLUMN FOR EACH DISTRESS

DISTRESS TYPE	**EXTENT RATING**			
	1	**2**	**3**	**4**
D Cracking/ASR	1 to 9 % of slabs	10 to 24 % of slabs	25 to 49% of slabs	>49% of slabs
Corner Cracking	1 to 9 % of slabs	10 to 24 % of slabs	25 to 49% of slabs	>49% of slabs
Joint Spalling	1 to 9 % of joints	10 to 24 % of joints	25 to 49% of joints	>49% of joints
Joint Seal Damage	1 to 9 % of joints	10 to 24 % of joints	25 to 49% of joints	>49% of joints
Longitudinal Cracking	1 to 9 % of slabs	10 to 24 % of slabs	25 to 49% of slabs	>49% of slabs
Punchouts	< 10 per mile	10 to 25 per mile	> 25 per mile	
CRCP Block Cracking	1 to 9% of section	10 to 24% of section	25 to 49% of section	> 49% of section

DISTRESS SEVERITY LEVELS			
DISTRESS TYPE	**LOW**	**MEDIUM**	**HIGH**
D Cracking / ASR	Cracks are light, with no loose or missing pieces.	Cracks are well defined and some small pieces are loose or missing.	Cracks are well developed pattern with a significant amount of loose or missing material.
Joint Spalling	Spalls < 3 inches with no significant loss of material. or Joint & Spall repair patch with cracking.	Spalls 3 to 6 inches with loss of material.	Spalls > 6 inches with significant loss of material.
Corner Cracking	Crack not spalled with no faulting & piece not broken.	Crack spalled slightly, or faulting < ½ inch, or piece broken.	Crack spalled, or faulting > ½ inch, or piece broken.
Joint Seal Damage	damage to < 10% of joint.	Damage to 10 to 50% of joint.	Damage to > 50% of joint.
CRCP Block Cracking	Transverse cracks present. Longitudinal cracks present but not interconnected between Transverse	Transverse and Longitudinal Cracks interconnected to form well defined “block” or rectangular pattern.	Rectangular or “block” pattern well defined with crack distortion and spalling in the cracks.

VISUAL SURVEY DISTRESSES - FLEXIBLE PAVEMENT

TRANSVERSE CRACKING

APPEARANCE:

Appears as cracks perpendicular to pavement centerline.

CAUSES:

- Poorly constructed paving joint
- Shrinkage of the AC surface due to low temperatures or hardening of the asphalt
- Load and Moisture may accelerate the deterioration of the cracks

LOCATION:

May occur anywhere on the pavement surface

SEVERITY LEVELS:

LOW:

Crack width is less than 1/4 inch
or
Routed & sealed crack width less than 1/2 inch

MEDIUM:

Crack width is greater than 1/4 inch and less than 1 inch
and / or
Depression caused by crack is less than 1/4 inch

HIGH:

Crack width greater than 1 inch
or
(Crack width is greater than 1/4 inch
and
Depression caused by crack is greater than 1/4 inch)

Note: Associated cracking (Random Cracking) should cause the severity level to be increased by one level.

EXTENTS:

LOW:

Crack spacing is greater than 50 feet average spacing

MODERATE:

Crack spacing is less than 50 feet and greater than 25 feet average spacing

HIGH:

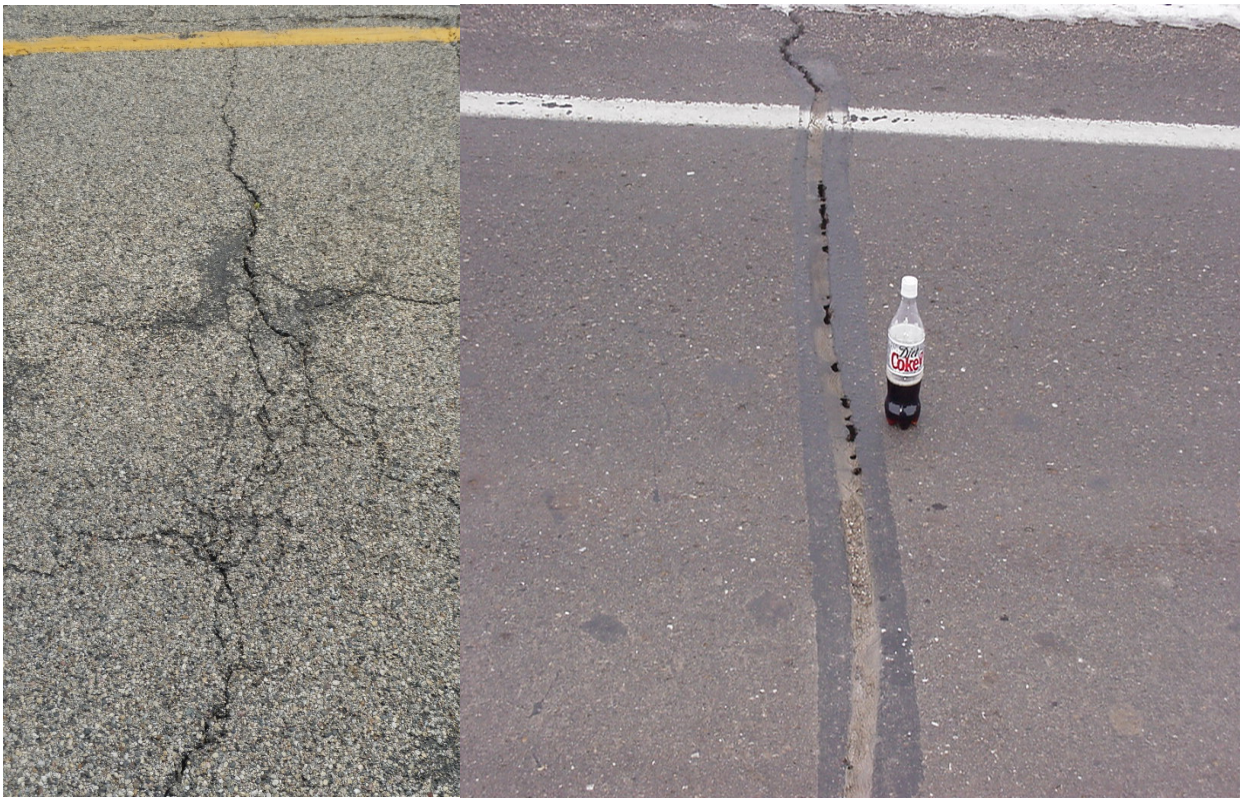
Crack spacing is less than 25 feet and greater than 12 feet average spacing

EXTREME:

Crack spacing is less than 12 feet average spacing

LOW SEVERITY TRANSVERSE CRACKING

MEDIUM SEVERITY TRANSVERSE CRACKING



HIGH SEVERITY TRANSVERSE CRACKING

HIGH SEVERITY TRANSVERSE CRACKING (With Depression)

FATIGUE CRACKING

APPEARANCE: Appears initially as a single longitudinal crack in the wheel path.
Later appears as a series of interconnected cracks resembling alligator skin or chicken wire.

CAUSES:

- Fatigue failure of the asphalt concrete surface (or base) under repeated traffic loading.
- Temperature and moisture may accelerate the initiation and propagation of the cracks.

LOCATION:

Found in the wheel paths and turning movement locations

SEVERITY LEVELS:

LOW:

Fine parallel cracks in the wheel path(s)

MEDIUM:

Alligator pattern clearly developed

HIGH:

Alligator pattern clearly developed with spalling and distortion

EXTENTS:

LOW:

1 to 9 % of the wheel path is affected

MODERATE:

10 to 24 % of the wheel path is affected

HIGH:

25 to 49 % of the wheel path is affected

EXTREME:

Greater than 49 % of the wheel path is affected.

LOW SEVERITY FATIGUE CRACKING

MEDIUM SEVERITY FATIGUE CRACKING

HIGH SEVERITY FATIGUE CRACKING

PATCHING AND PATCH DETERIORATION

APPEARANCE:

Appears as an area where the pavement surface has been removed and replaced, or as a localized overlay covering up another distress. A major concern with patching is whether you have a patch or an overlay, and the effect the patch has on the distress indices that the patch is covering up. To help with the determination of whether to rate a patch as a patch or an overlay, refer to page 24.

CAUSES:

- Often repair for some other distress
- May be caused by utility trenches across the roadway
- Traffic load, patch material, environment, and / or poor construction can accelerate deterioration

LOCATION:

Patches can occur anywhere on the pavement surface

SEVERITY LEVELS:

LOW:

Patch shows no visual distress of any type and with a smooth ride

MEDIUM:

Patch shows low or medium severity distress of any type and/ or notable roughness

HIGH:

Patch shows a high severity distress of any type and/ or distinct roughness

EXTENTS:

LOW:

1 to 9 % of the section is affected

MODERATE:

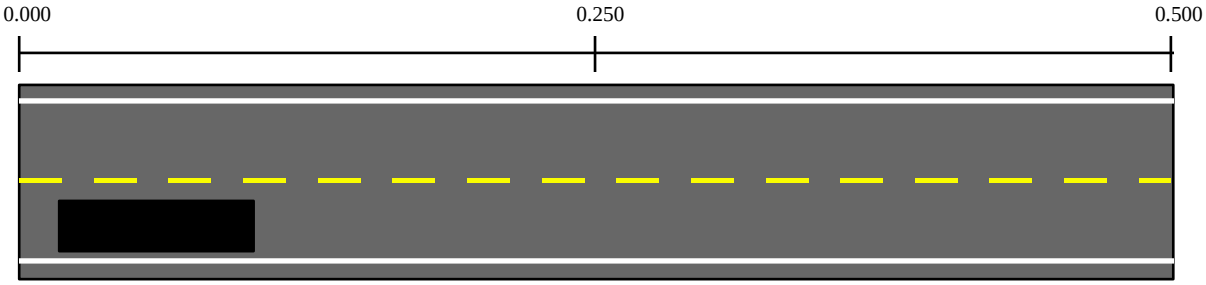
10 to 24 % of the section is affected

HIGH:

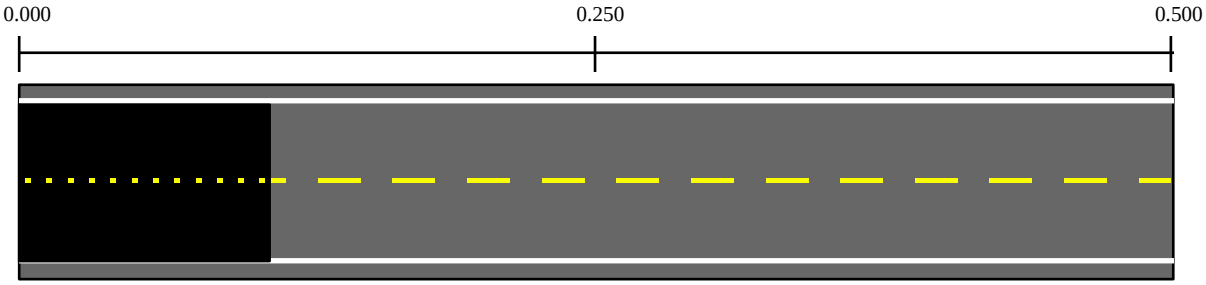
25 to 49 % of the section is affected

EXTREME:

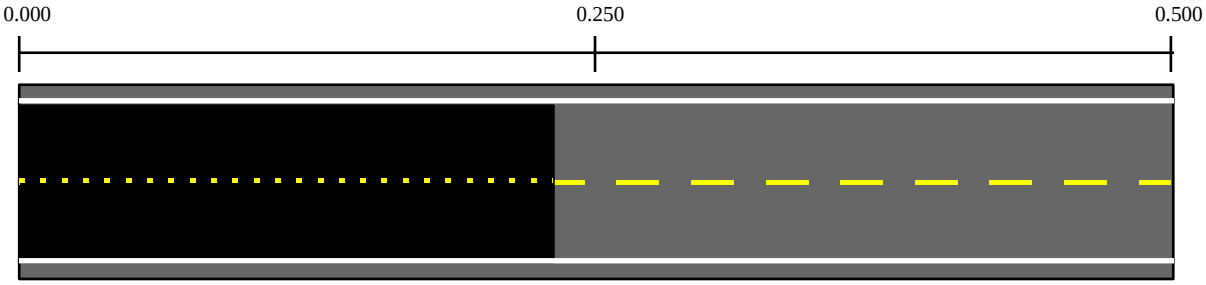
Greater than 49 % of the section is affected.



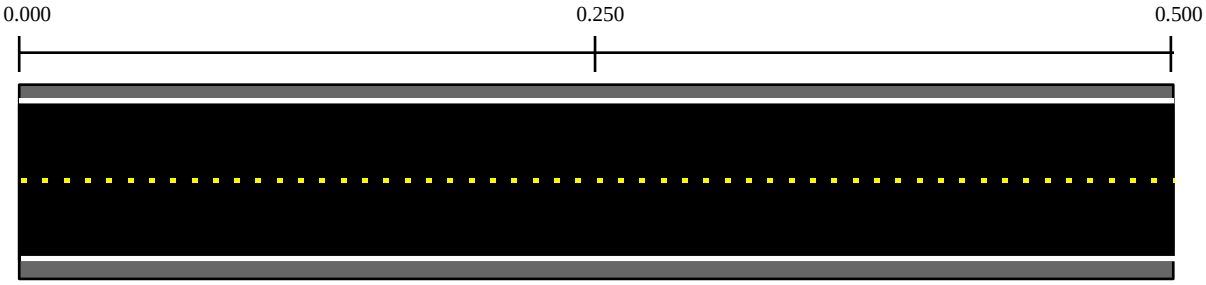
SCENARIO 1: RATE AS PATCH ONLY



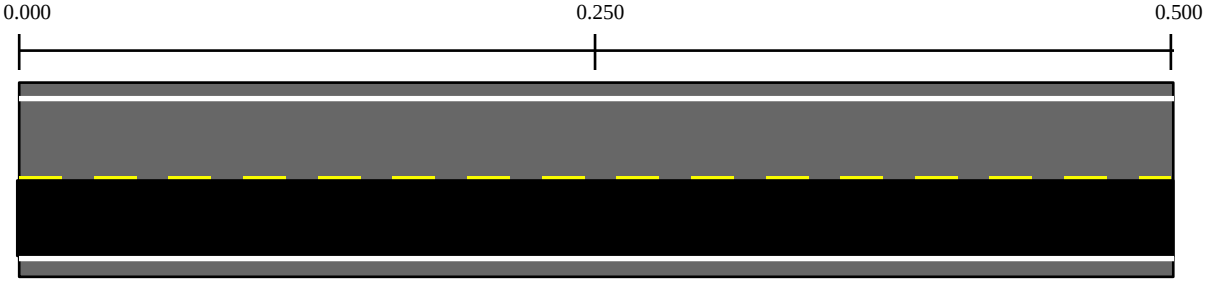
SCENARIO 2: LESS THAN HALF A SECTION, RATE AS PATCH ONLY



SCENARIO 3: GREATER THAN HALF A SECTION, RATE AS PATCH AND RATE DISTRESSES AS THEY SHOW THROUGH PATCH

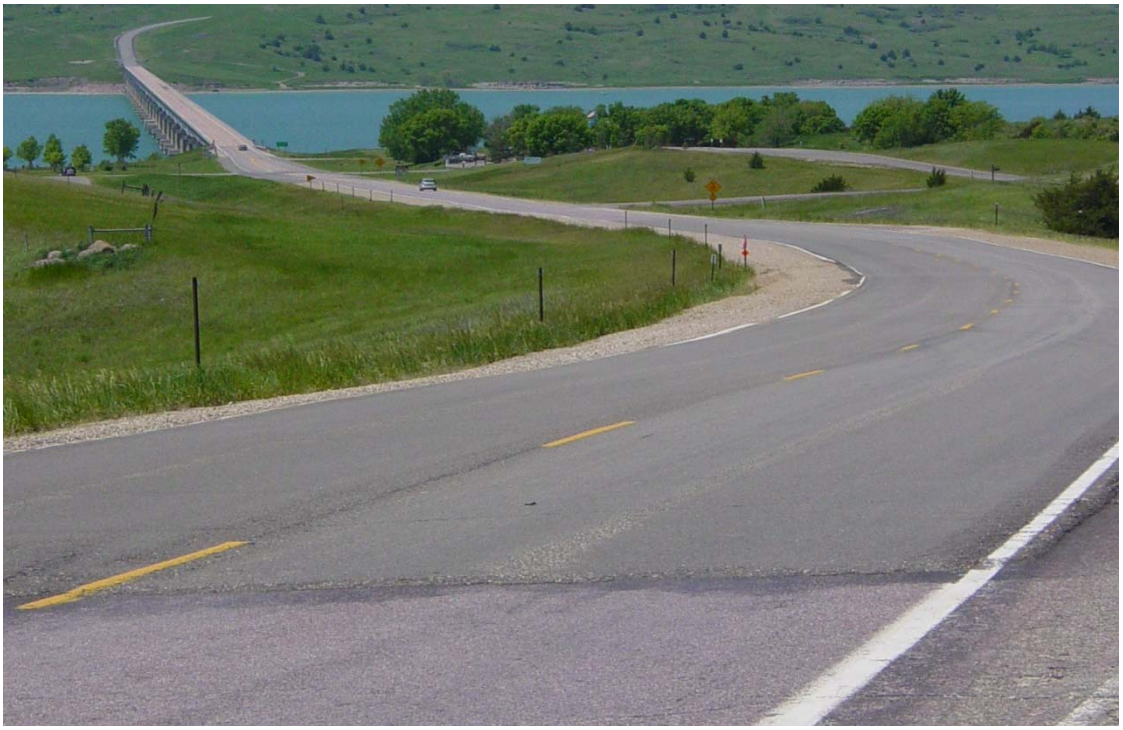


SCENARIO 4: OVERLAY, RATE DISTRESSES AS THEY SHOW THROUGH



SCENARIO 5: RATE AS PATCH ONLY

PATCH RATING SCENARIOS



LOW SEVERITY PATCHING

MEDIUM SEVERITY PATCHING

HIGH SEVERITY PATCHING

BLOCK CRACKING

APPEARANCE:

Appears as cracks which divide the surface into approximately rectangular (or block) pieces. In the low severity level they may appear as random longitudinal cracks between the wheel paths.

CAUSES:

- Shrinkage of the asphalt concrete surface
- Daily temperature cycling that results in daily stress/strain cycling
- Load can increase severity of block cracking

LOCATION:

Normally occurs over a large portion of pavement area, but sometimes it may occur only in non-traffic areas

SEVERITY LEVELS:

LOW:

Random longitudinal cracks between the wheel paths,
Or interconnected transverse and longitudinal cracks that form blocks greater than 6 feet per side

MEDIUM:

Interconnected transverse and longitudinal cracks that form blocks 3 feet to 6 feet per side

HIGH:

Interconnected transverse and longitudinal cracks that form blocks less than 3 feet per side

EXTENTS:

LOW:

1 to 9 % of the section

MODERATE:

10 to 49% of the section

HIGH:

Greater than 49 % of the section

LOW SEVERITY BLOCK CRACKING

MEDIUM SEVERITY BLOCK CRACKING

HIGH SEVERITY BLOCK CRACKING

VISUAL SURVEY DISTRESSES - RIGID PAVEMENT

DURABILITY CRACKING
(D-CRACKING)

APPEARANCE:

Appears as a series of closely spaced crescent-shaped hairline surface cracks. The crack often causes dark coloring of the surface in the surrounding area.

CAUSES:

- Presence of water
- Freeze-thaw cycles of the aggregate

LOCATION:

Adjacent and parallel to transverse and longitudinal joints and cracks, and the free edge of the pavement

SEVERITY LEVELS: (Note: Asphalt patches on concrete pavement should be rated as if the asphalt isn't there.)

LOW:

Cracks are light, with no loose or missing pieces

MEDIUM:

Cracks are well defined and some small pieces are loose or missing

HIGH:

Cracks are well developed pattern with a significant amount of loose or missing material

EXTENTS:

LOW:

1 to 9 % of the slabs are affected

MODERATE:

10 to 24 % of the slabs are affected

HIGH:

25 to 49 % of the slabs are affected

EXTREME:

Greater than 49 % of the slabs are affected

LOW SEVERITY D-CRACKING

MEDIUM SEVERITY D-CRACKING

HIGH SEVERITY D-CRACKING

ALKALI SILICA REACTIVITY
(ASR)

APPEARANCE:

Appears as a series of interconnected cracks. Frequently, larger cracks are oriented in the longitudinal direction of the pavement and interconnected by finer transverse or random cracks.

CAUSES:

- Chemical reaction between the silica in the aggregate and the alkali in the sand
- Climatic conditions affect the rate of deterioration

LOCATION:

Entire slab, may be more noticeable in the wheel path

SEVERITY LEVELS: (Note: Asphalt patches on concrete pavement should be rated as if the asphalt isn't there.)

LOW:

Cracks are light, with no loose or missing pieces

MEDIUM:

Cracks are well defined and some small pieces are loose or missing

HIGH:

Cracks are well developed pattern with a significant amount of loose or missing material

EXTENTS:

LOW:

1 to 9 % of the slabs are affected

MODERATE:

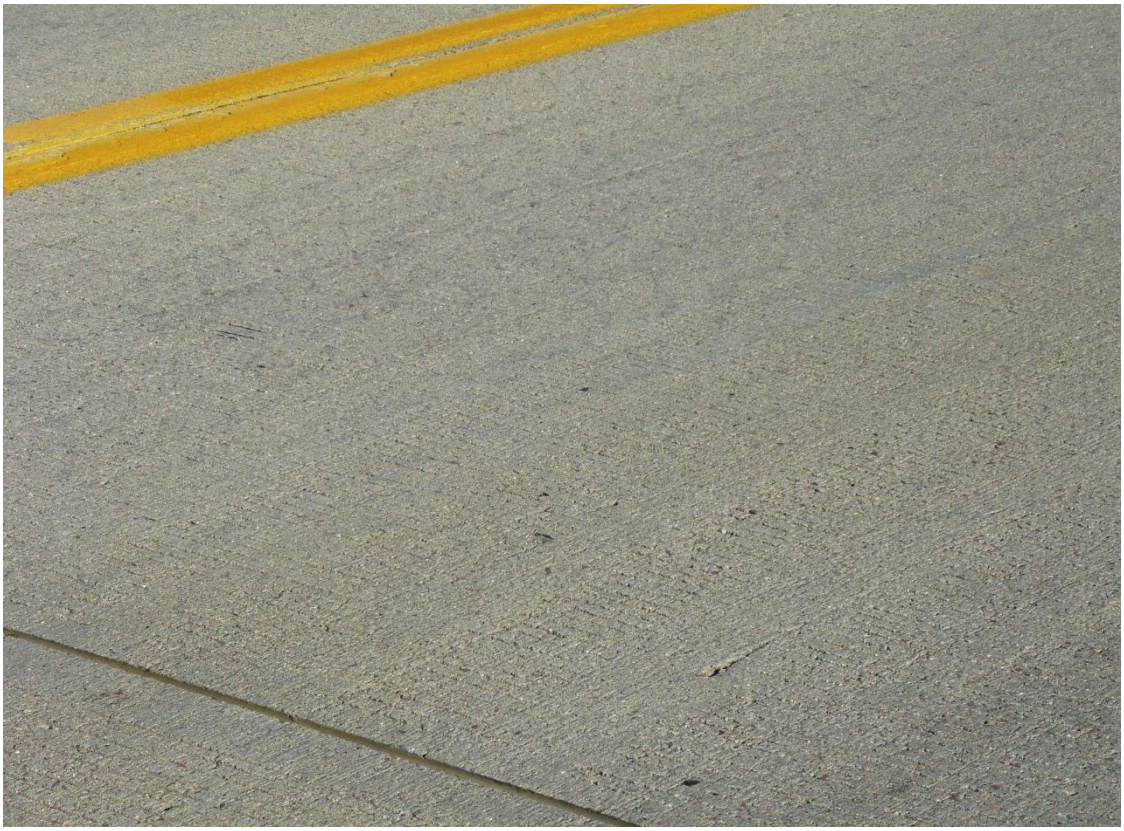
10 to 24 % of the slabs are affected

HIGH:

25 to 49 % of the slabs are affected

EXTREME:

Greater than 49 % of the slabs are affected



LOW SEVERITY ASR

MEDIUM SEVERITY ASR

HIGH SEVERITY ASR

JOINT SPALLING

APPEARANCE:

Appears as the cracking, breaking, chipping, or fraying of slab edges within 2 feet of a joint or crack.

CAUSES:

- Excessive stresses at the joint caused by infiltration of incompressible materials and subsequent expansion or by traffic loading
- Disintegration of the concrete
- Weak concrete at the joint (Caused by overworking) combined with traffic loads
- Poorly designed or constructed load transfer device

LOCATION:

Along slab edges

SEVERITY LEVELS: (Note: Asphalt patches on concrete pavement should be rated as if the asphalt isn't there.)

LOW:

Spalls less than 3 inches wide with no significant loss of material

or

Joint & Spall Repair Patch with cracking

MEDIUM:

Spalls 3 to 6 inches wide and may have loss of material

HIGH:

Spalls greater than 6 inches wide and may have significant loss of material

EXTENTS:

LOW:

1 to 9 % of the joints are affected

MODERATE:

10 to 24 % of the joints are affected

HIGH:

25 to 49 % of the joints are affected

EXTREME:

Greater than 49 % of the joints are affected.

LOW SEVERITY JOINT SPALLING

MEDIUM SEVERITY JOINT SPALLING

HIGH SEVERITY JOINT SPALLING

CORNER CRACKING

APPEARANCE:

Appears as a crack extending vertically through the entire slab depth which intersects the joints at a distance less than 6 feet from the corner of the slab

CAUSES:

- Heavy repeated loads combined with pumping, poor load transfer across the joint, and thermal curling and moisture warping of the slab

LOCATION:

Located at slab corners

SEVERITY LEVELS: (Note: Asphalt patches on concrete pavement should be rated as if the asphalt isn't there.)

LOW:

Crack is not spalled with no faulting & piece is not broken

MEDIUM:

Crack is spalled slightly, and / or faulted less than 1/2 inch, or piece broken with tight crack

HIGH:

Crack is spalled, and / or faulted greater than 1/2 inch and / or piece is broken

EXTENTS:

LOW:

1 to 9 % of the slabs

MODERATE:

10 to 24 % of the slabs

HIGH:

25 to 49 % of the slabs

EXTREME:

Greater than 49 % of the slabs

LOW SEVERITY CORNER CRACKING

MEDIUM SEVERITY CORNER CRACKING

HIGH SEVERITY CORNER CRACKING

LONGITUDINAL CRACKING

APPEARANCE:

Appears as cracks that are predominantly parallel to the pavement centerline.

CAUSES:

- Poor load transfer efficiency (LTE) of cracks and joints
- Poor subgrade conditions
- Differential settlement of slabs.

LOCATION:

Located in and between the wheel paths of the pavement. Not to be confused with the Longitudinal joint.

SEVERITY LEVELS:

NO SEVERITY LEVELS ARE RECORDED

EXTENTS:

LOW:
1 to 9 % of the slabs

MODERATE:
10 to 24 % of the slabs

HIGH:
25 to 49 % of the slabs

EXTREME:
Greater than 49 % of the slabs

LONGITUDINAL CRACKING IN AND BETWEEN WHEEL PATHS

LONGITUDINAL CRACKING BETWEEN WHEEL PATHS

LONGITUDINAL CRACKING IN WHEEL PATHS

PUNCHOUTS

APPEARANCE:

Appears as the area enclosed by two closely spaced (usually less than 2 feet) transverse cracks, a short longitudinal crack, and the edge of the pavement or longitudinal joint. **Will occur on CRCP only. May be hidden by asphalt patch or a sawed in joint for repair.**

CAUSES:

- Loss of aggregate interlock at one or two of the transverse cracks
- Loss of support due to pumping

LOCATION:

Located near the pavement edge and / or longitudinal joints

SEVERITY LEVELS:

NO SEVERITY LEVELS ARE RECORDED

EXTENTS:

LOW:

Less than 10 per mile

MODERATE:

10 to 25 per mile

HIGH:

Greater than 25 per mile

PUNCHOUT

PUNCHOUTS

CRCP BLOCK CRACKING

APPEARANCE:

Appears, in the lowest severity levels, as closely spaced transverse shrinkage cracks with occasional longitudinal cracks occurring perpendicular to the parent transverse cracks. In higher severity levels, the transverse and longitudinal cracks become interconnected and may contain distortion and spalling in both types of cracks. **Will occur on CRCP only. May be hidden by asphalt patch or a sawed in joint for repair.**

CAUSES:

- Over-development of transverse shrinkage cracks
- Cracking parallel to the longitudinal steel.
- Climatic conditions affect the rate of deterioration

LOCATION:

Entire pavement, may be more noticeable in the wheel path

SEVERITY LEVELS: (Note: Asphalt patches on concrete pavement should be rated as if the asphalt isn't there. A light staining around the cracks may be present.)

LOW:

Cracks are light, closely spaced, transverse shrinkage cracks with occasional longitudinal cracks occurring perpendicular to the parent transverse crack with little to no interconnection.

MEDIUM:

The pattern formed between the longitudinal cracks and transverse shrinkage cracks are more defined, creating a "block" pattern in the CRC pavements.

HIGH:

The "block" pattern is well defined, and the cracks are distorted with the presence of spalling in the cracks with loose or missing pieces.

EXTENTS:

LOW:

1 to 9 % of the section is affected

MODERATE:

10 to 24 % of the section is affected

HIGH:

25 to 49 % of the section is affected

EXTREME:

Greater than 49 % of the section is affected

Low Severity CRC Block Cracking

Low Severity CRC Block Cracking

Medium Severity CRC Block Cracking

High Severity CRC Block Cracking

JOINT SEAL DAMAGE

APPEARANCE:

Appears as any condition which enables incompressible materials and / or significant amount of water to infiltrate the joint from the surface.

CAUSES:

- Failure to clean joint before sealing
- Infiltration of incompressible material into the joint
- Inability of material to meet performance requirements

LOCATION:

Along transverse joints

SEVERITY LEVELS:

LOW:

Seal damage to less than 10 % of the joint

MEDIUM:

Seal damage to 10 % to 50 % of the joint

HIGH:

Seal damage to greater than 50% of the joint

EXTENTS:

LOW:

1 to 9 % of the joints are affected

MODERATE:

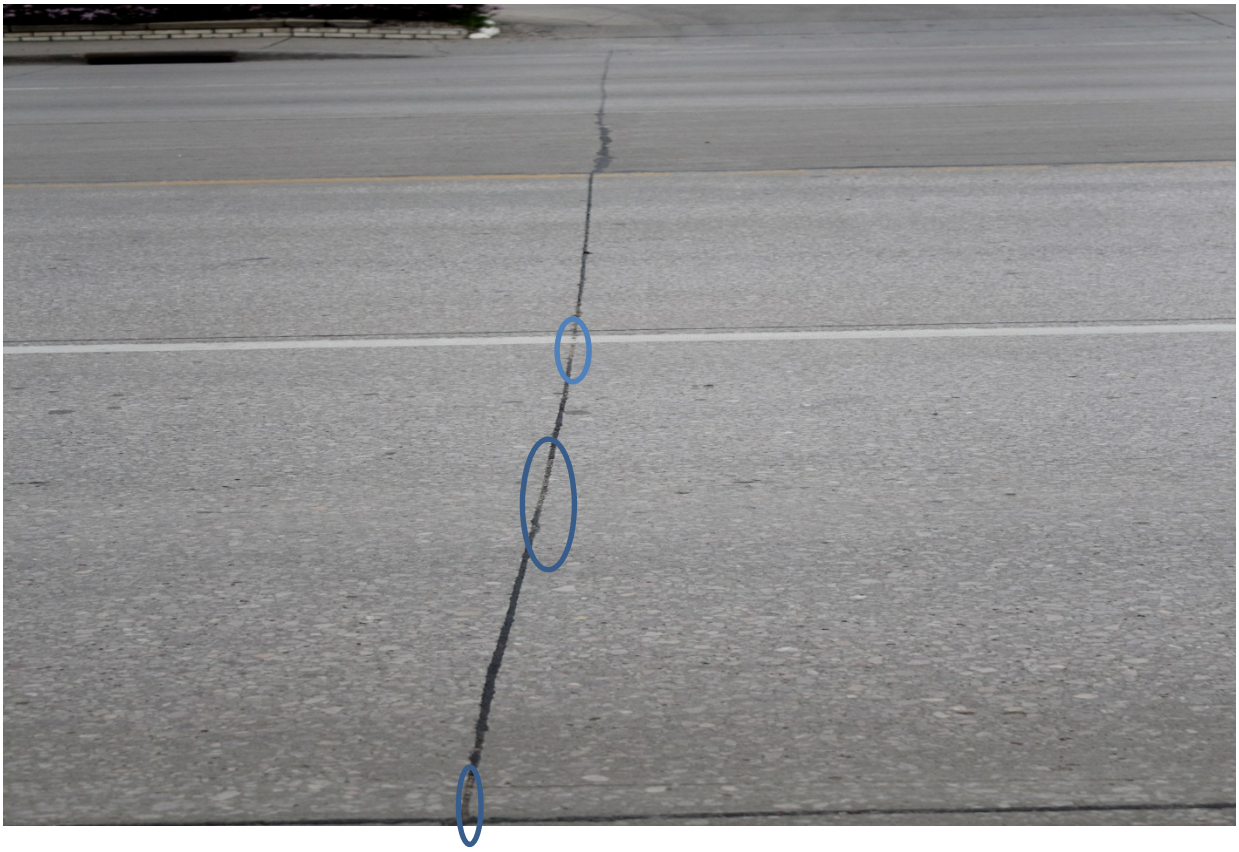
10 to 24 % of the joints are affected

HIGH:

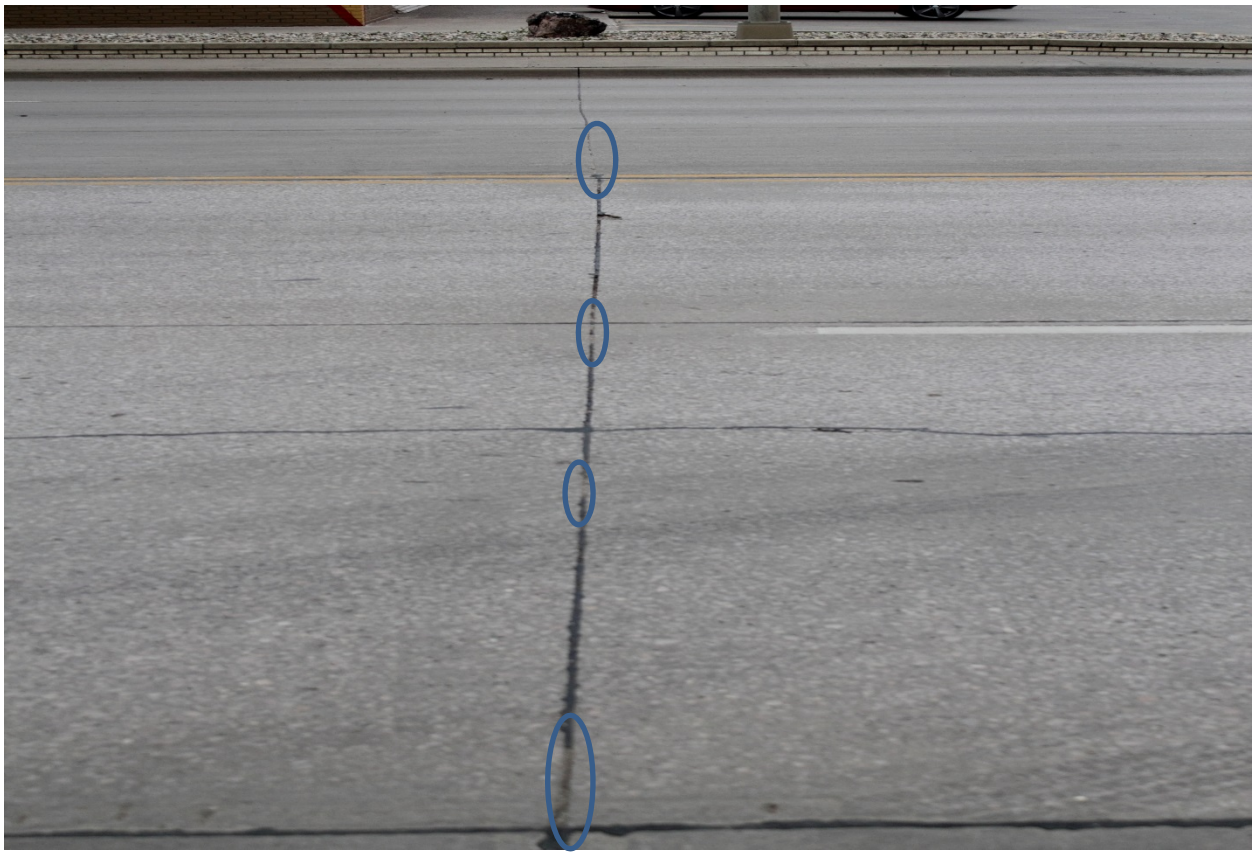
25 to 49 % of the joints are affected

EXTREME:

Greater than 49 % of the joints are affected.



LOW SEVERITY JOINT SEAL DAMAGE



MEDIUM SEVERITY JOINT SEAL DAMAGE

HIGH SEVERITY JOINT SEAL DAMAGE

VISUAL DISTRESS SURVEY ON GRAVEL SURFACED HIGHWAYS

Beginning in the Summer of 1996, the pavement distress survey included the rating of gravel surfaced state highways. The rating of gravel sections of the state highway system was included as an attempt to have a condition rating for every segment of highway on the state system. The rating of gravel surfaced highways is a combination of the procedure used on the paved highway system and the rating guide provided by the *Rural Road Condition Survey Guide* published by SDDOT's Office of Research in September 1995.

The rating is performed in a similar manner as on paved highways in that it is a continuous survey over the entire section. Sections for gravel surfaced highways are longer than those for paved highways in that section breaks are at every Uniform MRM only and hence are approximately 1.00 mile in length. The van does not drive on the shoulder of the road, but rather as close to center of highway as possible. The driver is still responsible for running the DMI and ensuring the correct location of the section being rated. The speed of the van while conducting the survey should be less than 40mph. The rater should move to the front passenger seat of the van in order to get a better feel for the roadway cross-section.

The rating of gravel surfaced highways differs from rating paved surfaced highways in that the highway is rated for an overall condition value. No individual distresses are rated. Each section is given a rating from 0 to 100, with 0 being unpassable and 100 being perfect condition. Gravel distresses that affect the rating are listed in Table 5. Gravel Rating Guidelines can be found in Table 6 and Maximum Condition Ratings are found in Table 7. The Gravel Distress Survey Form is following.

DISTRESS SEVERITY LEVELS

DISTRESS TYPE	DEFINITION	LOW	MEDIUM	HIGH
Corrugation (Washboarding)	Closely spaced ridges & valleys at fairly regulare intervals	Ridges < 1inch deep	Ridges 1 to 3 inches deep	Ridges > 3 inches deep
Dust	Loose, flying small particles of binder & aggregate	See through	Visibility moderately obstructed	Severe visibility problem
Improper Cross Section	Road surface is not shaped or maintained to carry water to the ditches	Level Surface	Bowl-shaped Surface	Severe Surface Depressions
Inadequate Roadside Drainage	Ditches & culverts are not in good enough condition to direct & carry runoff water	Very little debris	Debris, some standing water	Lack of water runoff
Loose Aggregate	Loose aggregate particles moved away from the normal wheelpath and berms formed in the center and / or along the shoulder of the roadway	Loose < 2" thick	Loose 2 to 4 inches thick	Loose > 4 inches thick
Potholes	Bowl-shaped depressions in the roadway surface	< 2 inches deep	2 to 4 inches deep	> 4 inches deep
Ruts	Surface depression in the wheelpath parallel to the centerline	< 1 inch deep	1 to 3 inches deep	> 3 inches deep

Table 5: Gravel distress definitions and severities

RATING GUIDLINES

Rating = 100 to 81
Roadway surface is in excellent condition with very good rideability. The roadway has a good gravel thickness and excellent drainage. The only distress that is typically present is dusting in dry conditions.
Rating = 80 to 61
The roadway has adequate gravel thickness, a good crown, and good drainage characteristics. Distresses that may be present include loose aggregate and washboarding. Some slight rutting (< 1in) may exist in some areas during wet weather.
Rating = 60 to 41
The roadway has a good crown (3 to 6 in). Primary ditches are present on more than 50 percent of the roadway. Secondary ditches are evident along the shoulder line, and some culvert cleaning is necessary. The gravel layer is adequate, but additional aggregate is needed in isolated areas. Moderate washboarding (1 to 2 in deep) exists over 10 to 25 percent of the area, and moderate rutting (1 to 2 in) occurs in wet weather. Occasional small potholes (<2 in deep) and some loose aggregate are present.
Rating = 40 to 21
Travel at slow speeds (<25 mph) is required. There is little or no roadway crown, moderate to severe washboarding, severe loose aggregate, and moderate potholing. Up to 25 percent of the roadway has little or no aggregate. More than 50 percent of the ditches are inadequate, secondary ditches exist along most of the roadway, and the culverts are partially filled with debris.
Rating = 20 to 0
Travel on the roadway is very difficult. There is either no roadway crown or the roadway is bowl-shaped with extensive ponding. Severe ruts and potholes exist over more than 25 percent of the roadway, and many areas (> 25 percent) have little or no aggregate. There are few if any primary ditches, and secondary ditches are evident along most of the roadway. Culverts are either damaged or filled with debris

Table 6: Gravel rating guidelines

MAXIMUM CONDITION RATINGS

	SEVERITY LEVEL		
DISTRESS CONDITION	**LOW**	**MEDIUM**	**HIGH**
CORRUGATION > 10 PERCENT ROADWAY	80	70	60
DUSTING	98	96	85
IMPROPER CROSS SECTION > 10 PERCENT ROADWAY	80	70	60
INADEQUATE ROADSIDE DRAINAGE >10% ROADWAY	80	70	60
LOOSE AGGREGATE	80	75	65
POTHOLES	70	50	30
RUTTING	70	65	50

Table 7: Maximum gravel ratings

GRAVEL DISTRESS SURVEY

DATE: ______________________________ RATERS: ________________________

SEGMENT	RATING

RATING GUIDLINES

Rating = 100 to 81

Roadway surface is in excellent condition with very good rideability. The roadway has a good gravel thickness and excellent drainage. The only distress that is typically present is dusting in dry conditions.

Rating = 80 to 61

The roadway has adequate gravel thickness, a good crown, and good drainage characteristics. Distresses that may be present include loose aggregate and washboarding. Some slight rutting (< 1in) may exist in some areas during wet weather.

Rating = 60 to 41

The roadway has a good crown (3 to 6 in). Primary ditches are present on more than 50 percent of the roadway. Secondary ditches are evident along the shoulder line, and some culvert cleaning is necessary. The gravel layer is adequate, but additional aggregate is needed in isolated areas. Moderate washboarding (1 to 2 in deep) exists over 10 to 25 percent of the area, and moderate rutting (1 to 2 in) occurs in wet weather. Occasional small potholes (<2 in deep) and some loose aggregate are present.

Rating = 40 to 21

Travel at slow speeds (<25 mph) is required. There is little or no roadway crown, moderate to severe washboarding, severe loose aggregate, and moderate potholing. Up to 25 percent of the roadway has little or no aggregate. More than 50 percent of the ditches are inadequate, secondary ditches exist along most of the roadway, and the culverts are partially filled with debris.

Rating = 20 to 0

Travel on the roadway is very difficult. There is either no roadway crown or the roadway is bowl-shaped with extensive ponding. Severe ruts and potholes exist over more than 25 percent of the roadway, and many areas (> 25 percent) have little or no aggregate. There are few if any primary ditches, and secondary ditches are evident along most of the roadway. Culverts are either damaged or filled with debris.

MAXIMUM CONDITION RATINGS

DISTRESS CONDITION	SEVERITY LEVEL		
	LOW	MEDIUM	HIGH
CORRUGATION > 10 PERCENT ROADWAY	80	70	60
DUSTING	98	96	85
IMPROPER CROSS SECTION > 10 PERCENT ROADWAY	80	70	60
INADEQUATE ROADSIDE DRAINAGE >10% ROADWAY	80	70	60
LOOSE AGGREGATE	80	75	65
POTHOLES	70	50	30
RUTTING	70	65	50

DISTRESS SEVERITY LEVELS

DISTRESS TYPE	LOW	MEDIUM	HIGH
Corrugation	Ridges < 1inch deep	Ridges 1 to 3 inches deep	Ridges > 3 inches deep
Dust	See through	Visibility moderately obstructed	Severe visibility problem
Improper Cross Section	Level Surface	Bowl-shaped Surface	Severe Surface Depressions
Inadequate Roadside Drainage	Very little debris	Debris, some standing water	Lack of water runoff
Loose Aggregate	Loose < 2” thick	Loose 2 to 4 inches thick	Loose > 4 inches thick
Potholes	< 2 inches deep	2 to 4 inches deep	> 4 inches deep
Ruts	< 1 inch deep	1 to 3 inches deep	> 3 inches deep