Asphalt Concrete Surface Inspection Guide

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Preface

This Asphalt Concrete Surface Inspection Guide will be used to assist in the identification and severity of segregation and the identification of surface defects on asphalt concrete paving projects. It is intended to supplement and promote uniform specification interpretation, but not override specification requirements. The guide has been prepared to help Ministry, consultant and contractor staff recognize the types of surface defects, and the severity of segregation that may be seen on Ministry of Highways asphalt concrete paving projects. Images are included to assist users to identify surface defects and segregation consistently throughout the province.

Questions and comments may be directed to the Materials and Surfacing Unit of the Bridges and Materials Branch.

Revision History

Revision #	Date	Description of Change
0	May 2020	Working Draft
1	May 2021	Initial Release
2	November 2023	Update

Disclaimer

The information within this document is intended to supplement but not override specification requirements. It is intended to promote uniform interpretation leading to fair and consistent application.

Table of Contents

Table of Figures

1. Definitions

Term	Definition	Reference
Segregation	An area of the pavement where the texture differs visually from the texture of the surrounding pavement. For the purposes of classifying pavement segregation, only segregated areas greater than 0.1 m² and Centre-of-Paver Streaks greater than 1 m in length will be considered. Moderate or severe segregated areas which do not meet these size parameters will be considered Surface Defects.	Standard Specification 4112, Definitions
Segregation Severity	None - A completely uniform surface texture. The matrix of asphalt and fine aggregate is in place between the coarse aggregate.	Standard Specification 4100, Definitions
	Slight – The matrix, asphalt cement and fine aggregate is in place between the coarse aggregate. However, there is more stone in comparison to the surrounding acceptable mix.	Standard Specification 4112, Definitions
	Moderate – Significantly more stone than the surrounding mix; moderately segregated areas usually exhibit a lack of surrounding matrix.	Standard Specification 4112, Definitions
	Severe – Appears as an area of very stony mix, stone against stone, with very little or no matrix.	Standard Specification 4112, Definitions
	Centre-of-Paver Streak – Appears as a continuous or semi-continuous longitudinal "streak" typically located in the middle of the paver "mat".	Standard Specification 4112, Definitions
Surface Defects	Surface Defects that are due to the Contractor's operation shall include, but shall not be limited to the following: areas of Segregation less than 0.1 m²; areas containing excess or insufficient Asphalt; areas of open texture; improper matching of longitudinal and transverse joints on final lift of Asphalt Concrete; roller marks on final lift of Asphalt Concrete; cracking or tearing; contamination by diesel fuel, hydraulic fluids, detergent or other harmful products; foreign objects or materials that are detrimental to the Asphalt Concrete; a clay ball, pick-outs, and any loss of aggregate from the surface of the asphalt concrete mat, pothole, or other.	Standard Specification 4112, Definitions; Special Provisions for Asphalt Concrete in Place (EPS); Asphalt Concrete Surface Defect and Segregation Rating Sheet.

2. Introduction

Surface defects and segregation are to be documented for newly constructed asphalt concrete surfaces. The Asphalt Concrete Surface Defect and Segregation Rating Sheet is used to document surface defects and rate segregation for asphalt concrete pavements. This evaluation is performed as part of acceptance testing as indicated in Standard Specifications 4100 For Asphalt Concrete and End Product Specification 4112 For Asphalt Concrete. This guide is not intended to repeat those specifications, but to provide field staff with examples of segregation of varying severity and of various surface defects. The standard specifications also describe pay adjustments and repairs for segregation and surface defects.

3. Segregation

Segregation is the separation of the coarse aggregate particles from the finer particles in a new asphalt mix. The texture differs visually from the texture of the surrounding pavement and may appear to be stony or open textured. Segregation in the pavement surface allows surface moisture to enter into the asphalt concrete layer, creating the potential for aggregate loss. This may ultimately lead to localized pavement failures and potholes.

Segregation can occur at virtually every phase of the asphalt mix production process and during the hauling, spreading and compaction operations. Some potential causes of segregation from construction operations are:

- Method of aggregate stockpiling
- Operation of batch plant cold feed, surge and storage bins
- Method of truck loading and unloading
- Operation of paver

Other factors can influence the potential for an asphalt mix to segregate. Such factors include: use of mix types with large aggregate top size; use of gap-graded mixes with low asphalt content; low mix temperatures causing asphalt binder viscosity to increase.

For the purposes of classifying pavement segregation, only segregated areas greater than 0.1 m^2 and centre-of-paver streaks greater than 1 m in length will be considered. Moderate or severe segregated areas which do not meet these size parameters will be considered as Surface Defects.

The severity of segregation is classified into the following types, which may affect any repair requirements and pay adjustments. There is a range of segregation severity, and the transition between categories is not exact. The photos below have been included to assist Ministry, consultant and contractor staff in the determination of segregation severity.

3.1 No Segregation

The asphalt concrete mat has a uniform surface texture. The matrix of asphalt and fine aggregate is in place between the coarse aggregate.

Figure 1: No segregation

Segregation is not observed in Figure 1. The surface texture is consistent throughout the full lane width.

3.2 Slight Segregation

Segregation severity is considered slight when the matrix, asphalt cement and fine aggregate is in place between the coarse aggregate. However, there is more stone in comparison to the surrounding acceptable mix.

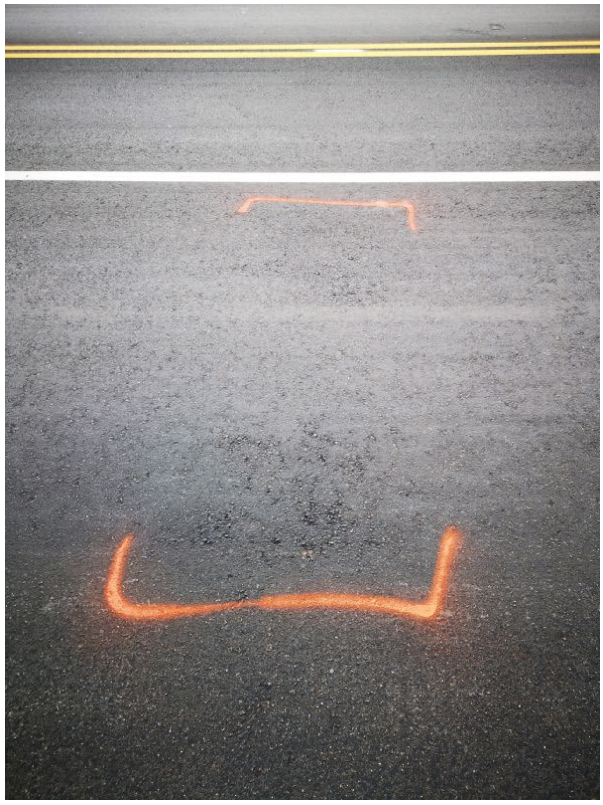


Figure 2: Slight Segregation

Figure 2 shows a localized area larger than 0.1 m^2.

More stone is observed in areas when compared to the surrounding asphalt concrete. The matrix is in place between the coarse aggregate.

Figure 3: Slight Segregation

Figure 3 shows localized, slight segregation but the area is less than 0.1 m^2.

In accordance with applicable specifications, this may be classified as a Surface Defect.

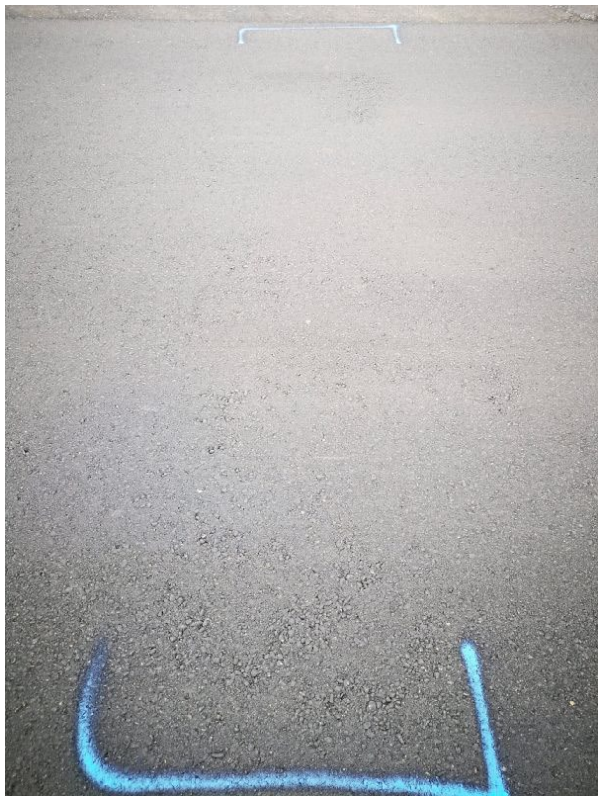


Figure 4: Slight Segregation

Figure 4 shows noticeable areas where larger aggregate is concentrated, but the matrix is in place between the coarse aggregate.

Adjacent areas show consistent texture.

Figure 5: Slight Segregation

Figure 5 displays a slightly segregated area of approximately 1.0 m^2.

Matrix and fine aggregate components are in place, but the affected area has a more stony appearance than the surrounding asphalt concrete.

Figure 6: Slight Segregation

Figure 6 displays an area of slight segregation. Although the area is larger, than previous examples, the severity is slight.

Matrix and fine aggregate components are in place, but the affected area has a more stony appearance than the surrounding asphalt concrete.

A roller mark and areas of concentrated fines are also evident on the surface.

Figure 7: Slight Segregation

Figure 7 shows an area of slight segregation.

The coarse aggregate is more concentrated, but the matrix and fine aggregate is intact between the coarse aggregate.

Figure 8: Slight Segregation

Figure 8 shows a localized area of slight segregation.

3.3 Moderate Segregation

Segregation severity is classified as moderate when there is significantly more stone than the surrounding mix. Moderately segregated areas usually exhibit a lack of surrounding matrix.

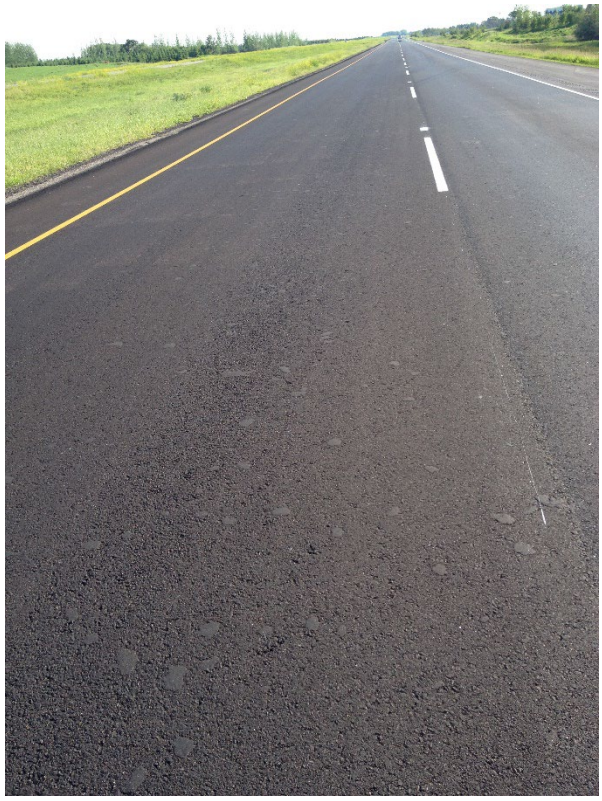


Figure 9: Moderate Segregation

Figure 9 shows moderate severity segregation. There are noticeable areas where there is more stone and a lack of surrounding matrix.

This figure also shows areas of concentrated fines on the surface that have been picked up and deposited by a pneumatic tire compactor.

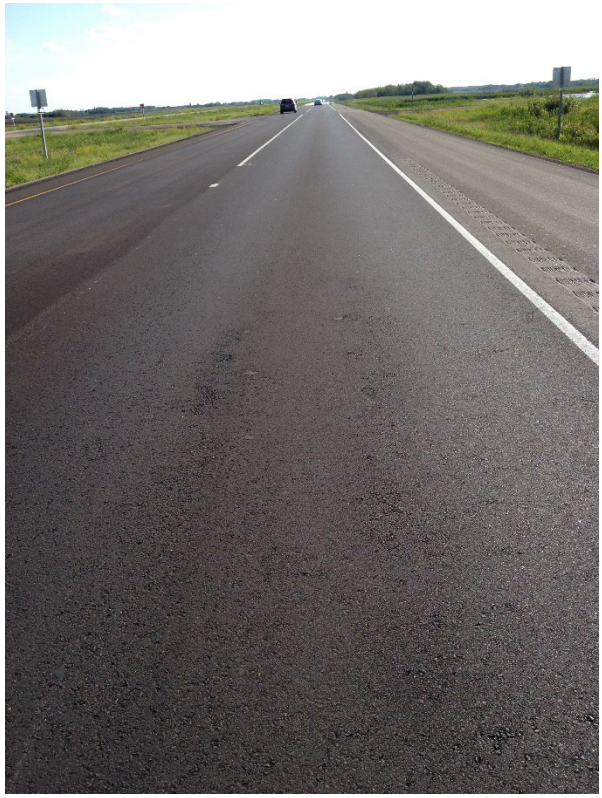


Figure 10: Moderate and Severe Segregation

Figure 10 shows a larger area of moderate severity segregation, and some areas of severe severity segregation within this larger area.

The coarse aggregate is exposed, and the matrix between the coarse aggregate is reduced.

Figure 11: Moderate Segregation

Figure 11 displays moderate segregation severity, and may also be classified as Centre-of-Paver Streak.

The surrounding matrix is consistently reduced within the streak. The surface, in this example, also looks open textured.

3.4 Severe Segregation

Severe segregation appears as an area of very stony mix, stone against stone, with very little or no matrix.

Figure 12: Severe Segregation

Figure 12 shows areas of severe segregation.

The asphalt concrete appears very stony and is missing much of the matrix.

Figure 13: Severe Segregation

Figure 13 shows severe segregation.

The texture appears to be stone against stone, with the supporting matrix being much diminished.

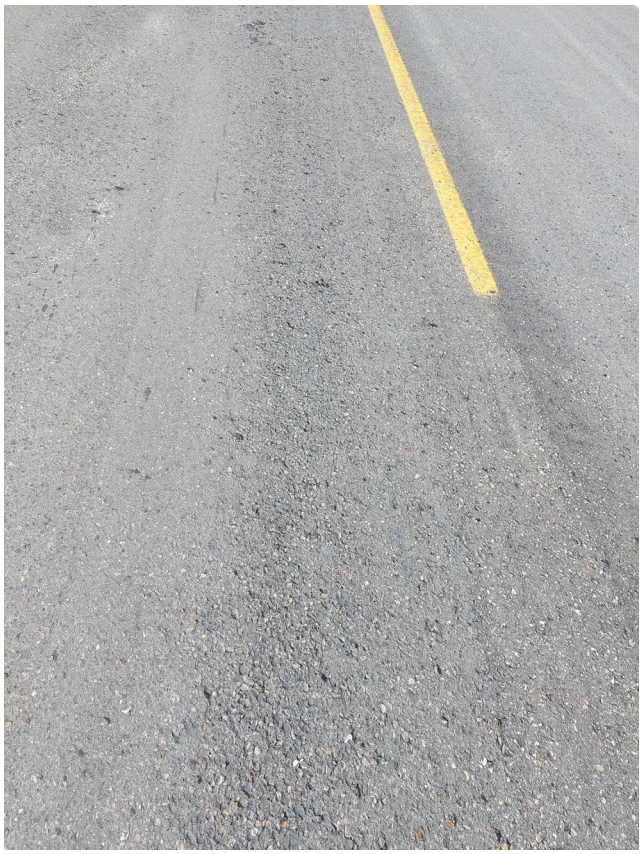


Figure 14: Severe Segregation

Figure 14 shows areas of severe and moderate segregation.

The asphalt concrete appears very stony and is missing much of the matrix.

4. Surface Defects

Surface Defects refer to a variety of flaws caused by the contractor's operation. Surface Defects include, but are not limited to, areas of segregation less than 0.1 m^2, areas containing excess or insufficient asphalt binder, areas of open texture, improper matching of joints, roller marks, cracking, tearing, pick-outs, contamination, inclusion of foreign objects, potholes, and clay balls.

The above noted surface defects will be further described.

4.1 Excess and Insufficient Asphalt Binder

Figure 15: Excess Asphalt Binder

Figure 15 displays a surface with excess asphalt binder with bleeding occurring in areas.

An asphalt binder film is evident, which may appear shiny, smooth or reflective.

Figure 16: Insufficient Asphalt Binder

A surface with insufficient asphalt binder is shown in Figure 16.

The surface has a lighter colour than the adjacent lane and the exposed faces of some of the coarse aggregate have little or no asphalt film. Pneumatic roller marks are also visible.

4.2 Open Texture

Areas with an open textured surface will have a greater volume of air voids at the surface and will look porous. Asphalt mix types with larger allowable coarse aggregate sizes may look more open textured than mixes with smaller aggregate top sizes. It should be noted that an open textured appearance in some asphalt mixes is not a result of the contractor's operation, but a result of the mix design.

There are many potential causes for an open textured surface. As discussed in Section 3 of this guide, segregation can result in an open textured surface. Low asphalt mix delivery temperatures and temperature differentials between different sections of the surface during compaction can result in an open texture.

Figure 17: Open Texture

An open textured surface is displayed in much of the lane width in Figure 17.

Centre-of-paver streak is also observed. The streak has a more open texture than the remainder of the surface.

Figure 18: Open Texture

Figure 18 shows a surface with a consistently open textured surface across the lane width.

4.3 Longitudinal and Transverse Joints

Proper matching of transverse and longitudinal joints will have an effect on the ride (smoothness) of the road and may affect the longevity of the asphalt concrete surface near the seam. Improperly matched joints include bumps, elevation differences, gaps, and excessive overlap at asphalt concrete seams.

Figure 19: Improper Matching of Longitudinal Joint

Figure 19 shows a longitudinal joint that is not matched well. A gap is evident on the centerline seam.

The vertical edge at the centreline seam is also damaged.

Figure 20: Improper Matching of Longitudinal Joint

Figure 20 shows a gap along the centerline.

Figure 21: Improper Matching of Longitudinal Joint

The centreline joint in Figure 21 shows a visibly distinct area with poor compaction.

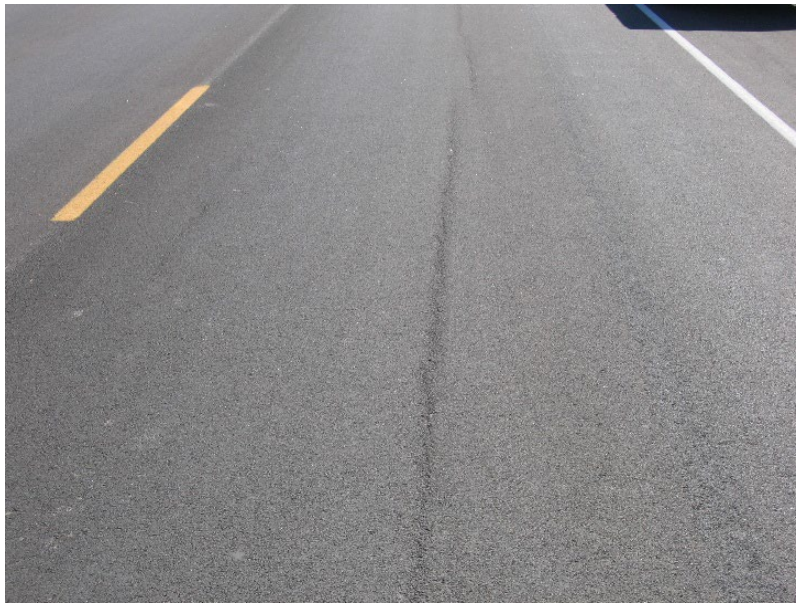
4.4 Roller Marks

Roller marks may appear as indentations, grooves, ripples, and arc-shaped or longitudinal lines. In addition, areas of open texture or segregation may result from pneumatic tire roller pick-up. Pneumatic tire roller pick-up occurs when the fine aggregate from the asphalt concrete sticks and is removed by the compactor tires.

The causes of most roller marks are due to the operation of the compaction equipment. Sharp turns, rapid acceleration and deceleration, rollers remaining stationary on surfaces that have not cooled, timing and sequencing of compaction, and cold pneumatic tires can create roller marks. Asphalt concrete that is not adequately compacted prior to cooling, or asphalt mixes that are tender may also result in roller marks.

Figure 22: Arc-shaped Roller Mark, Tearing/Discontinuity

Figure 22 showing an arc-shaped roller mark created by the turning motion of a steel drum compactor.



Longitudinal roller marks are seen in Figure 23, created by a steel drum roller.

Figure 23: Longitudinal Roller Mark, Tearing/Discontinuity

Pneumatic tire pick-up marks are shown in Figure 24.

Some of the matrix has been removed from the surface leaving an open textured or segregated appearance.

Figure 24: Pneumatic Tire Pick-up

Figure 25 shows pneumatic tire pick-up marks. The asphalt concrete matrix has been removed, exposing the larger sized aggregate.

Figure 25: Pneumatic Tire Pick-up

Figure 26 shows roller marks with a loss of asphalt film and exposed aggregate surfaces.

Figure 26: Roller Marks, Asphalt Film Loss

Figure 27: Roller Marks, Ridges and Depressions

Figure 27 shows an uneven surface, with ridges and depressions formed by compaction with pneumatic tire rollers.

Figure 28: Roller Marks, Ridges and Depressions

Figure 28 shows an uneven surface, with ridges and depressions formed by compaction with pneumatic tire rollers.

Figure 29 shows roller marks created by a vibrating steel drum.

Potential causes for this type of roller mark are incorrect vibration amplitude and frequency, over-densification, and compaction on a cool mat.

Figure 29: Roller Marks From Vibrating Steel Drum

4.5 Cracking and Tearing

Cracking occurs under loading when tensile forces exceed the asphalt concrete's tensile strength. The causes of cracking in newly constructed asphalt concrete surfaces can differ from cracking that develops in aged surfaces. The cracking described in this guide applies to newly constructed surfaces. There are numerous causes for the development of cracks.

Cracking can occur at **longitudinal and transverse seams**, where the asphalt mix density is often lower than the adjacent areas of the surface. Cracking can be induced at the seams when there is a combination of factors: lower density asphalt concrete near the seams, an inadequate amount of asphalt mix and improper compactor operation at the seams. Cracking at the shoulder seam could also result from compactive effort over shoulders that have inadequate underlying structure, or on shoulders that are in poor condition.

Longitudinal cracking (not at the seams) can result from poor compaction of underlying layers, such as the base course. Subsequent settlement or deflection in the underlying layers will induce longitudinal cracking. Longitudinal cracking can also be caused by inadequate preparation of underlying asphalt concrete layers. Depressions, or raised sharp edges below the new asphalt concrete could also be the cause of longitudinal cracking.

Micro-cracking or "checking" are short transverse cracks that are usually shallow and narrow in width. Micro-cracking may be caused by tender (unstable) mixes that shove under compaction. Micro-cracking could also be the result of deflection of underlying layers, or compacting an asphalt concrete where the surface has cooled substantially relative to the asphalt concrete below the surface.

Slippage failures also result in cracking and tearing. Poor bonding to the underlying layer may result in slippage, shoving and cracking of the asphalt concrete. Common causes of slippage failures include

inadequate application of tack coat (application rate too low, poor surface coverage), contamination of the underlying surface or asphalt mix (hydraulic fluid, diesel fuel, loose material on the underlying surface), and water trapped below the new asphalt concrete (paving on a wet surface).

Tearing of the asphalt concrete can occur when parts of the asphalt mix are dragged by the paver. There are many causes of tearing including worn or warped screed plates, cold screed plates, thin asphalt concrete mats, and insufficient quantity of asphalt mix delivered to areas of the screed or screed extensions. Insufficient mix quantity near the auger gear box may result in tearing/segregation, resulting in Centre-of-Paver Streak.

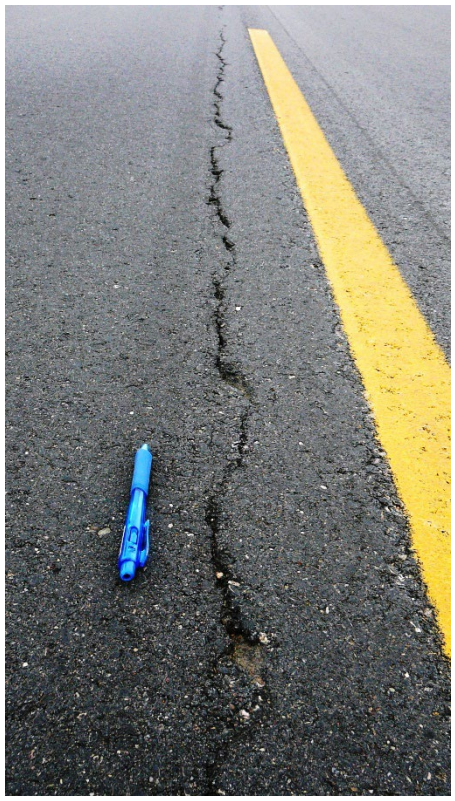


Figure 30: Longitudinal Cracking Near Centreline

Figure 30 shows longitudinal cracking near the centerline.

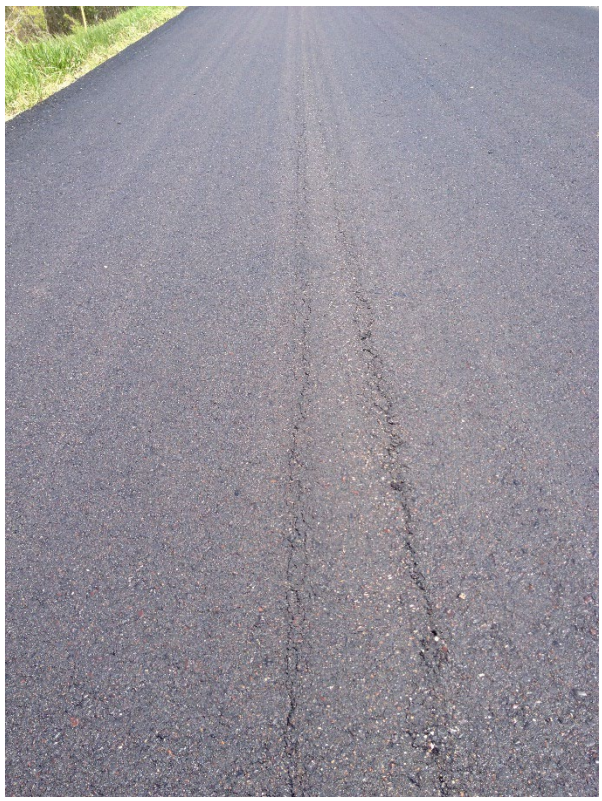


Figure 31: Longitudinal Cracking

Longitudinal cracking is visible in Figure 31 at the interface of a change in cross slope on the shoulder.

Figure 32: Longitudinal Cracking

Figure 32 shows longitudinal cracking along the shoulder edge and at the interface of the cross slope change on the shoulder.

Figure 33: Micro-cracking

Micro-cracking is shown in Figure 33.

The cracking appears to be near the starting or stopping point of the compactor path, which could indicate a tender asphalt mix.

The asphalt mix also appears to have insufficient asphalt binder content.

Figure 34: Micro-cracking

Figure 34 shows micro-cracking.

The asphalt mix also appears to have insufficient asphalt binder content.

Figure 35 shows a slip failure.

A tender asphalt mix may also be contributing to the slip failure.

Figure 35: Slip Failure

Tearing is seen in Figure 36.

In this case, the tearing appears as Centre-of-Paver Streak and may have been caused by insufficient quantity of asphalt mix near the paver's auger gear box.

Figure 36: Tearing

4.6 Pick-outs

Pick-outs (also called pop-outs) are characterized by stones missing from the asphalt concrete surface, and may be caused by source aggregate quality and/or contractor operations. Deleterious materials that can cause pick-outs include soft or flaky particles, clay, shale, ironstone, and sand clumps. Pick-outs will develop as the road surface wears under traffic and as environmental conditions affect the road surface. Poor quality aggregates absorb moisture, expand when frozen, and then break free of the asphalt concrete pavement surface, resulting in a pick-out in the asphalt mat. Pick-outs may be observed within the construction or warranty period.

Single stone pick-outs may develop into multi-stone pick-outs. Multi-stone pick-outs are more prone to spalling, cracking, and surface break-ups.

Figure 37: Shale and Ironstone Pick-Outs

Figure 37 shows shale and ironstone pick-outs.

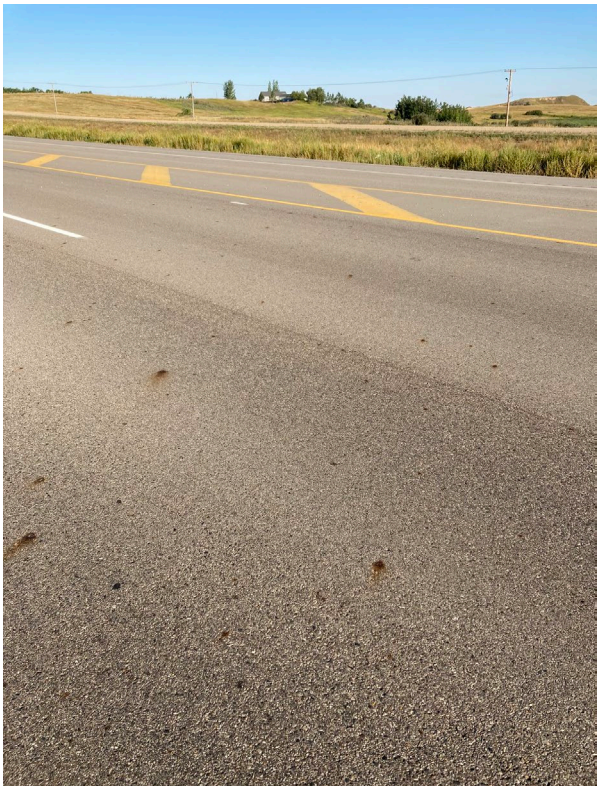


Figure 38: Ironstone Pick-Outs

Figure 38 shows ironstone that has oxidized and broken apart leaving rust staining and voids in the asphalt concrete surface.

Figure 39: Ironstone

Figure 40: Single-Stone Pick-Outs

Figure 40 shows a high extent of single-stone pick-outs.

Figure 42 shows a multi-stone pick-out.

Figure 41: Multi-Stone Pick-Out

4.7 Contamination, Inclusion of Foreign Objects, Deleterious Materials and Other Defects

The durability of asphalt concrete is compromised when contaminants are introduced to the surface, into the asphalt mix, or when foreign or deleterious objects are included in the mix. Contamination from materials such as diesel fuel, hydraulic fluid, detergents, and other solvents dissolves the asphalt binder and rapidly deteriorates the asphalt concrete. Contaminants can be introduced by equipment leaks onto the pavement surface, from equipment cleaned with solvents (truck boxes, paver hoppers), or from compaction equipment using harmful products as release agents on drums and tires.

Foreign objects or deleterious materials may include soft or flaky particles, shale, clay, loam, ironstone, sand clumps, clumps of hydrated lime, coal, organics, oversized aggregate, oversized reclaimed asphalt pavement particles, lightweight aggregate, and any other object that is detrimental to the asphalt mix. In addition to compromising asphalt concrete performance, the loss of deleterious materials from the surface will result in pick-outs, voids or potholes, and will accelerate surface cracking and raveling.

Clay and sand balls will break down creating a void in the asphalt concrete, enabling moisture infiltration, creating potholes, raveling, and reduced structural integrity.

Other surface contaminants include, but are not limited to, clay patties, and asphalt tack coat build-up, caused by release of such materials from truck tires.

Figure 42: Contaminant Leaks on Surface

Figure 43 shows contaminant leaks on the road surface, likely hydraulic fluid.

Figure 43: Contaminant Leaks on Surface

Figure 44 depicts an asphalt concrete surface that has been contaminated with diesel fuel.

Diesel fuel was used as a release agent on the compactor resulting in the asphalt binder being stripped from the surface, as observed by the exposed aggregate faces and overall orange tinge.

Figure 45 shows the remainder of a clay ball that was in the asphalt concrete surface.

Figure 44: Inclusion of Clay Ball

Oversized aggregate is evident within the asphalt concrete surface in Figure 46.

Figure 45: Inclusion of Oversize Aggregate

Figure 47 shows a clump of hydrated lime in the asphalt concrete surface. A pothole will form after the lime clump breaks apart.

Figure 46: Inclusion of Lime Clump

Figure 47: Pothole/Void

Figure 48 shows a pothole/void formed in the surface after deleterious material dislodged.

Figure 48: Surface Contaminated With Aggregate

Figure 49 shows pockets of dry aggregate within the surface.

A foreign object is depicted within the surface in Figure 50.

Figure 49: Inclusion of Foreign Object

Figure 51 shows inclusion of a foreign object.

Figure 50: Inclusion of Foreign Object

Figure 51: Inclusion of Tree Root

A tree root in the asphalt mat is shown in Figure 52.