South Africa

COTO

Committee of Transport Officials

TMH 9

MANUAL FOR VISUAL ASSESSMENT OF ROAD PAVEMENTS
PART B: FLEXIBLE PAVEMENTS

Committee Draft Final
May 2016

Committee of Transport Officials

TECHNICAL METHODS
FOR HIGHWAYS

TMH 9

MANUAL FOR VISUAL ASSESSMENT OF ROAD PAVEMENTS
Part B: Flexible Pavements

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Compiled under auspices of the:

Roads Coordinating Body (RCB)
Committee of Transport Officials (COTO)
Road Asset Management Systems (RAMS) Subcommittee

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Synopsis

TMH 9 provides the procedures for the visual assessment of the condition of roads. Assessment procedures and requirements for road segment information data are specified. Different distress types are classified and detailed descriptions of degree of distress (including photographic plates illustrating condition) for each of the distress types are given. TMH 9 is a companion document to TMH 22 on Road Asset Management Systems.

Withdrawal of previous publication:

This publication replaces the previous Draft TMH9 “Standard Visual Assessment Manual For Flexible Pavements” published in 1992. This previous publication is effectively withdrawn with the publication of this document.

Technical Methods for Highways:

The Technical Methods for Highways consists of a series of publications in which methods are prescribed for use on various aspects related to highway engineering. The documents are primarily aimed at ensuring the use of uniform methods throughout South Africa, and use thereof is compulsory.

Users of the documents must ensure that the latest editions or versions of the document are used. When a document is referred to in other documents, the reference should be to the latest edition or version of the document.

Any comments on the document will be welcomed and should be forwarded to coto@nra.co.za for consideration in future revisions.

Document Versions

Working Draft (WD). When a COTO subcommittee identifies the need for the revision of existing, or the drafting of new Technical Recommendations for Highways (TRH) or Technical Methods for Highways (TMH) documents, a workgroup of experts is appointed by the COTO subcommittee to develop the document. This document is referred to as a Working Draft (WD). Successive working drafts may be generated, with the last being referred to as Working Draft Final (WDF). Working Drafts (WD) have no legal standing.

Committee Draft (CD). The Working Draft Final (WDF) document is converted to a Committee Draft (CD) and is submitted to the COTO subcommittee for consensus building and comments. Successive committee drafts may be generated during the process. When approved by the subcommittee, the document is submitted to the Roads Coordinating Body (RCB) members for further consensus building and comments. Additional committee drafts may be generated, with the last being referred to as Committee Draft Final (CDF). Committee Drafts (CD) have no legal standing.

Draft Standard (DS). The Committee Draft Final (CDF) document is converted to a Draft Standard (DS) and submitted by the Roads Coordinating Body (RCB) to COTO for approval as a draft standard. This Draft Standard is implemented in Industry for a period of two (2) years, during which written comments may be submitted to the COTO subcommittee. Draft Standards (DS) have full legal standing.

Final Standard (FS). After the two-year period, comments received are reviewed and where appropriate, incorporated by the COTO subcommittee. The document is converted to a Final Standard (FS) and submitted by the Roads Coordinating Body (RCB) to COTO for approval as a final standard. This Final Standard is implemented in industry for a period of five (5) years, after which it may again be reviewed. Final Standards (FS) have full legal standing.

Table of Contents

ITEM **PAGE**

List of Figures

FIGURE **PAGE**

No table of figures entries found.

List of Tables

TABLE **PAGE**

B. FLEXIBLE PAVEMENTS

B.1 General

The assessment of flexible pavements will follow the procedures for defining the degree and extent as discussed in Part A (sections A.2.2. and A.2.3). Although only three degrees of distress are illustrated in this document (degree 1, 3 and 5), use should be made of degrees 2 and 4 where necessary. The definitions for these two categories are described in Part A, section A.2.2.

For flexible pavements, the engineering assessment is divided into two fundamental categories:

- Surfacing
- Structural

B.2 Engineering assessment (surfacing)

B.2.1 Current surfacing

If required by an authority, the assessor records the surfacing type currently visible on the surface by using one of the abbreviations from the short list in Table B.1 below. The list has been kept simple as it is often not possible to distinguish visibility between the various subtypes of surfacing. If necessary, other codes specified by the individual road authorities could be added to the list.

Table B.1: TRH 14 codes for different surfacing types

Code	Description
AC	Asphalt surfacing - continuously-graded.
AG	Asphalt surfacing - gap-graded.
AS	Asphalt surfacing – semi-gap-graded.
AO	Asphalt surfacing - open-graded.
S1	Surface Treatment – single seal
S2	Surface Treatment – multiple seal
S3	Sand Seal
S4	Cape Seal / Single seal and slurry
S5	Slurry Seal

B.2.2 Macro Texture

The macro texture, especially the texture depth, plays an important role in skid resistance under wet conditions. A coarse textured surface may also require a pre-treatment (e.g. fine slurry) before a reseal. The macro texture depends on the aggregate size and the quantity of binder in the layer. The

macro texture can be expressed as fine, fine-medium, medium, medium-coarse or coarse, or varying, if it varies across the width of the road (refer to Table B.2).

Macro texture and voids are not used in the condition index calculation, but could assist in the determination of maintenance needs (including reseals).

Table B.2: Description of Macro texture types

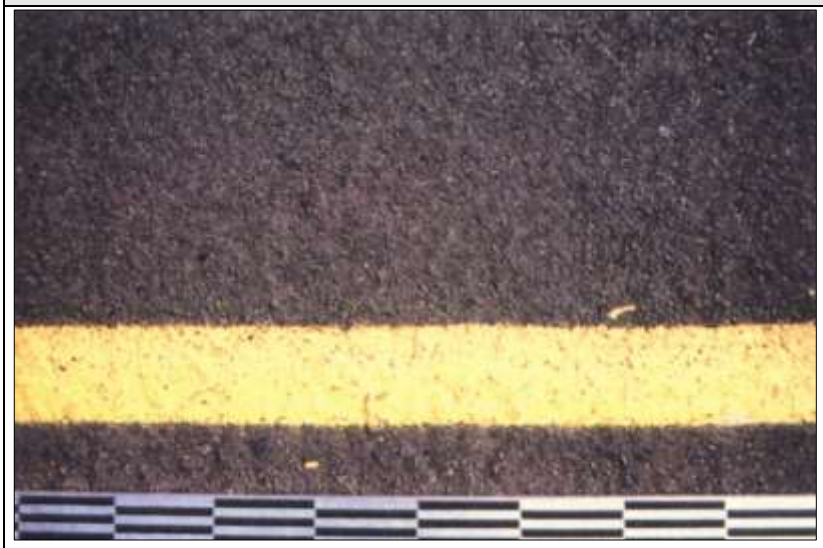
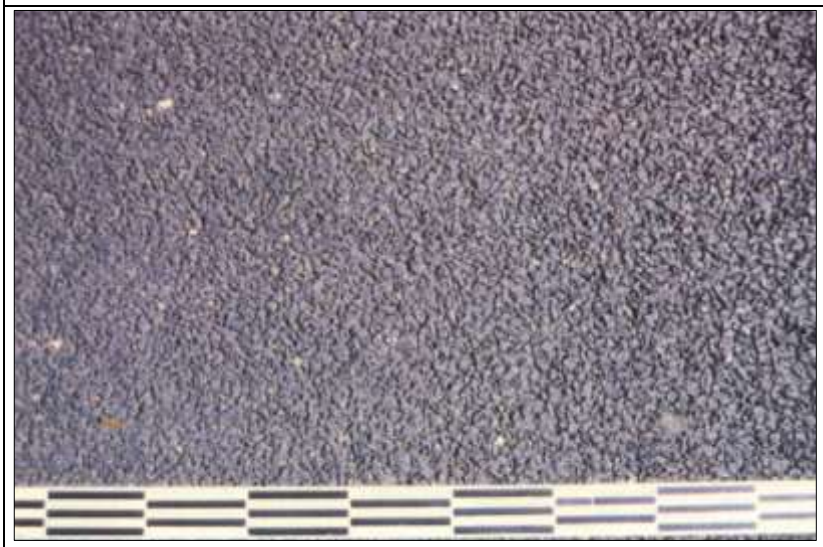
Macro texture Type	Description
Very Coarse MPD > 1.2mm	The surfacing appears very coarse, with coarse aggregate clearly visible, e.g. a new 14 mm single seal.
Coarse	
Medium	The surfacing appears smooth. Coarse aggregate may be visible, but the surface does not appear coarse, because a fine aggregate is present between the coarse aggregate - e.g. normally a new 7mm single seal or 14/7 mm double seal.
Fine 0.4<MPD<0.6	
Very Fine MPD < 0.4mm	The surfacing appears smooth and the coarse aggregate (if present) in the surfacing is not visible. For example a sand seal, fine slurry seal or smooth asphalt.
Varying	The texture varies over the cross-section of the road surface, e.g. the surface appears smooth in the wheel paths with a different texture elsewhere. If the texture is rated as varying, the different types of texture that are observed should also be noted. Varying only important if there is a big difference to identify texture treatment.

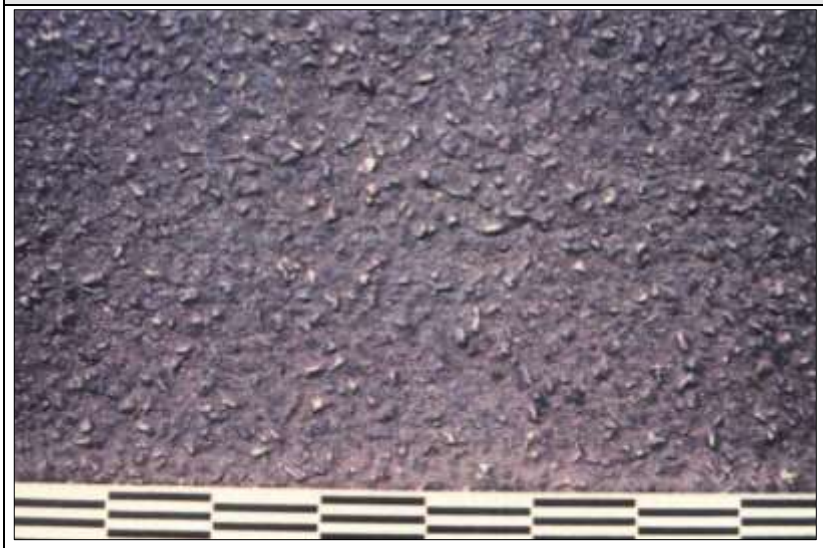
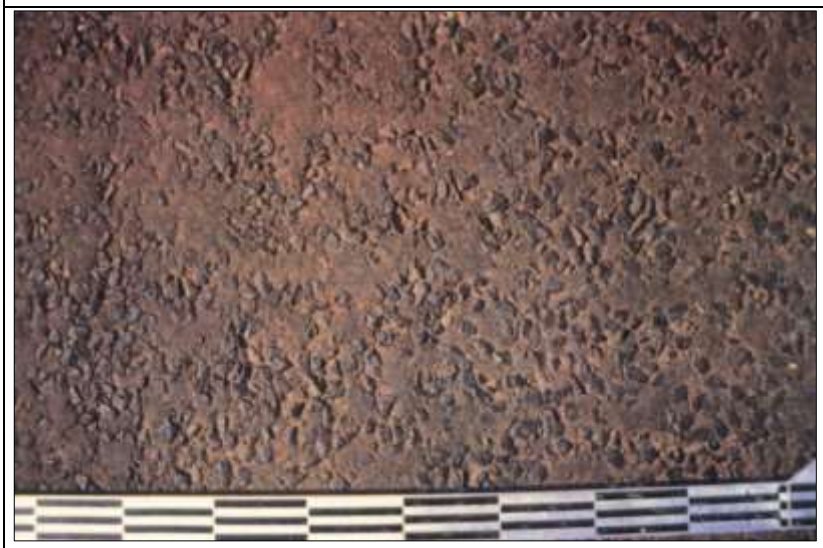
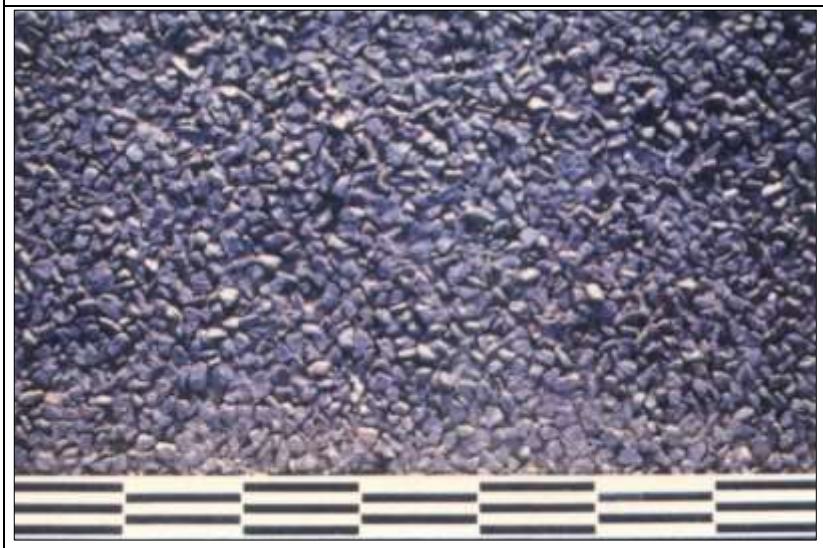
MPD = Mean Profile Depth as measured with laser

If the macro texture varies over the length of the segment (e.g. two types of seal were applied) both should be named under “Current seal” and the macro texture should be marked for both. It should not be rated as Varying, except if the macro texture of one or both seals varies across the width of the road. Typical examples are the following:

- Two types of seal are present on a segment. The first kilometre has fine slurry on the surface whereas the remainder is resurfaced with a new 13mm single seal. Macro texture should be marked as “Fine” and “Coarse”, but not Varying.
- A road segment with a 13mm single seal is bleeding in the wheel paths. The macro texture should be marked as “Varying” and “Fine” to “Coarse”.

Isolated areas where the macro texture differs from the remainder of the segment should not be recorded since these areas should, if necessary, be corrected individually and should not influence the choice of the seal or pre-treatment.

SURFACING: TEXTURE	
	Fine Slurry Seal
	Medium Double Seal e.g 14/7 but not 20/10
	Medium 7mm Single Seal

SURFACING: TEXTURE	
	Medium Cape Seal
	Coarse Asphalt with rolled in chips
	Very Coarse 14mm Single Seal

B.2.3 Voids

The size of the aggregate and the quantity of binder have a direct influence on the available interconnected surface voids in a surfacing. When aggregate is removed from a surfaced treatment during evaluation (see section B1.2.4), voids under the aggregate should also be checked in order to finalise this rating.

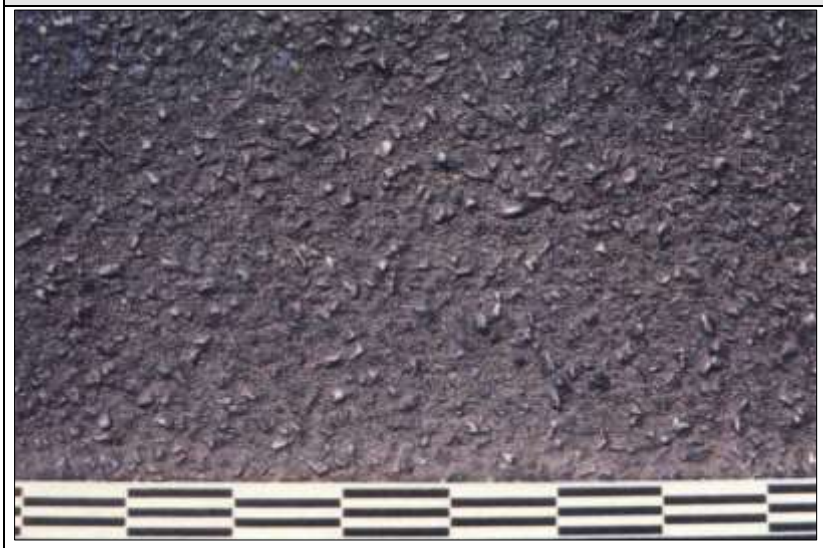
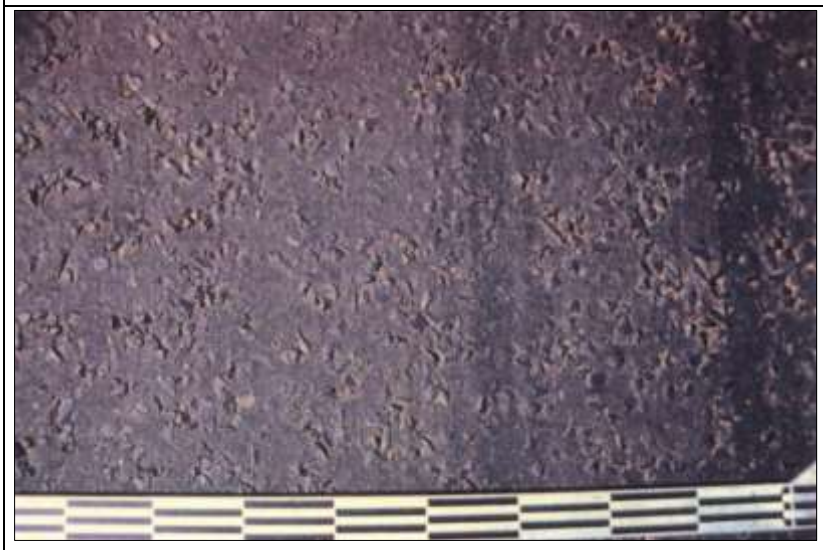
The amount of voids is directly related to the potential absorption of a diluted emulsion by the surfacing. By answering the following question the assessor can obtain some idea of the amount of voids. “If diluted emulsion is sprayed on the surfacing, will it be absorbed or not?” If not, the amount of voids is expressed as none (e.g. fine slurry or a bleeding seal). If it will be absorbed completely, the amount of voids can be expressed as many. The description of void classes is given in Table B.3. Ratings between the major classes can also be recorded (None – Few or Few – Many).

Table B.3: Description of void classes

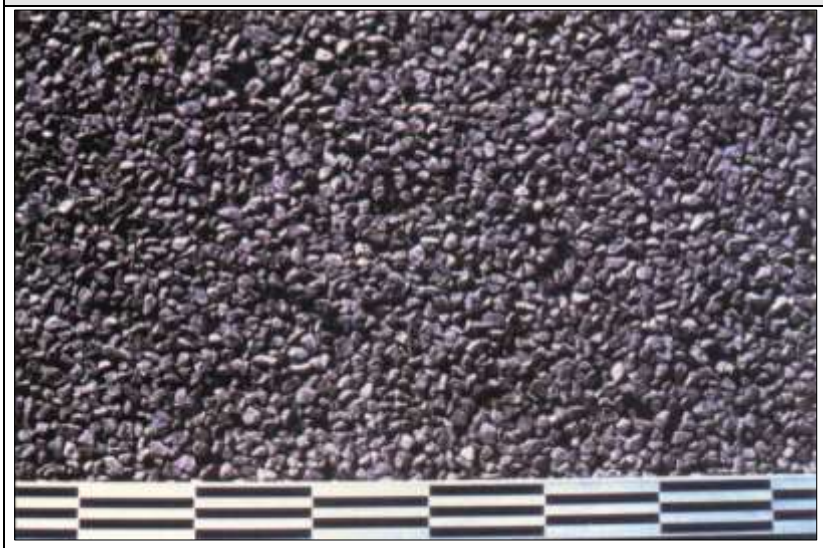
Void Classes	Description
None	The surfacing is dense (or bleeding) and no voids are visible.
None – Few	
Few	Some voids are visible, surfacing is fairly dense.
Few-Many	
Many	Many voids are visible, surfacing is open. Aggregates are well proud of binder.
Varying	This implies the variation of the voids in the cross-section of the road surface, e.g. the surface appears sealed in the wheel paths with many voids elsewhere. If the voids are rated as varying, the different degrees of voids that are observed should also be noted.

If the voids vary over the length of the segment (e.g. two types of seal were applied) both should be named under “Current seal” and the voids should be marked for both. It should not be rated as varying, except if the voids of one or both seals vary across the width of the road. Typical examples are the following:

- Two types of seal are present on a segment. The first kilometre has a bleeding, fine slurry on the surface while the remainder is resurfaced with a new open 13mm single seal. Voids should be marked as “None” and “Many”, but not varying.
- A road segment with a 13 mm single seal is bleeding only in the wheel paths. The voids should be marked as “Varying” and “None” to “Many”.

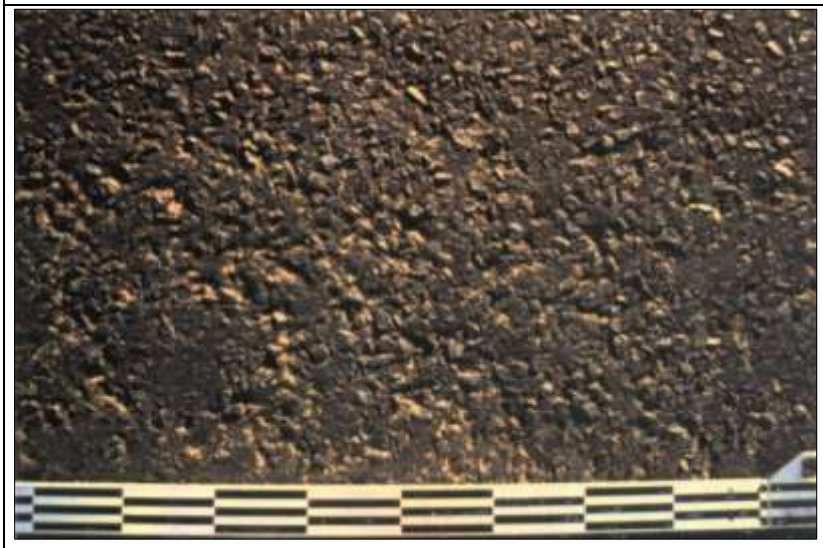
SURFACING: VOIDS	
	
	Few
	Cape Seal
	
	Few
	Slurry Seal
	
	Few
	Asphalt with Rolled in Chips

SURFACING: VOIDS



Many

Single Seal



Many

Asphalt

Varying

None - Many

B.2.4 Surfacing failures

Surface failure is the loss of the aggregates and binder in the surfacing layer and therefore results in the exposure of the underlying layer. Surfacing failure excludes structural failures, which are described in section B2. Typical examples of surfacing failure are surface related potholes caused by:

- Delamination of the surfacing due to surfacing hardening and cracking;
- Loss of the surfacing due to poor seal construction i.e. preparation of the underlying layer is poor, for example too wet, not clean enough, or if insufficient tack coat was applied;
- Localised loss of surfacing due to poor bonding with the underlying layer;
- Distress due to salt damage to the surfacing, and
- Mechanical damage.

NOTE: The loss of a surface seal in a localised area is not normally referred to as a structural pothole if the underlying layer has not been significantly affected (especially in cases of reseals or overlays).

Where only the aggregates of a seal have been lost, with the binder remaining, the distress is described as aggregate loss (section B2.6.).

The degree of distress for failure is related mostly to the diameter or area of these failures, as given in Table B.4.

Table B.4: Description of Degrees of Surfacing Failures

Degree	Description
1	Failures difficult to discern from moving vehicle. Small areas of surfacing are lost (diameter <50 mm).
3	Significant failure visible from moving vehicle (diameter ≈ 150mm).
5	Failures occur over large areas and/or secondary defects have developed owing to the failures (diameter > 300mm).

SURFACING FAILURES

1

X	2	3	4	5

Small areas of surfacing are lost (diameter <50 mm) , not easily visible from a moving vehicle

3

1	2	X	4	5

Significant failure visible from a moving vehicle (diameter ≈ 150mm).

5

1	2	3	4	X

Occur over large areas, failures > 300mm in diameter.

B.2.5 Surfacing patching

Surfacing patching can be described as minor patching with no distinct joint cuts on asphalt patches. Patches that are cut square or with distinct square edges are deemed structural but exceptions do exist. Geotextile patches are normally applied over areas with crocodile/fatigue cracking in the wheel path (Structural failure) not over surfacing cracking or surfacing failures. Therefore, recommended to rate under structural patching.

Table B.5: Description of degrees of surfacing patching

Degree	Description
1	Small areas of surfacing are patched (diameter < 100 mm).
3	Significant patches visible from a moving vehicle (diameter ≈ 300 mm).
5	Patching occurs over large areas (diameter > 500 mm).

Although the location of the patches can be used as guide to assess if patch is surface patch – typically outside the wheel paths, or structural patch - typically within the wheel paths, the size and shape of the patch should also be considered as exceptions do exists.

SURFACING PATCHING

1

X	2	3	4	5

Small areas of surfacing are patched (diameter < 100 mm).

3

1	2	X	4	5

Significant patches visible from a moving vehicle (diameter ≈ 300 mm).

5

1	2	3	4	X

Patching occur over large areas (diameter > 500 mm).

B.2.6 Surfacing cracks

Surfacing cracking relates to cracking only in the bituminous surfacing. Typically causes are:

- Shrinkage of the bituminous surfacing as a result of reduced binder volume. This occurs when the binder ages and loses its lighter oils and aromatics. These surfacing cracks typically start off as star pattern cracking and develop into small irregular blocks, similar to crocodile pattern cracking.
- Closely spaced transverse cracking – due to rolling of asphalt during construction. The initial cracking could be observed as fine closely spaced transverse cracking over the full road width. The severity of the cracking increases with ageing, forming a star pattern. In this state, secondary cracking induced by traffic around the shrinkage cracks is often evident. The basic pattern of shrinkage cracks can be lost through deterioration caused by lack of maintenance.
- Transverse cracking starting from the edge of the road and creeping towards the centre (typical of thicker surfacing layers hardening with time). Please note that due to the new item “Edge defects”, cracking only occurring at the edge of the road should only be rated under edge defects.

Surface cracks are more commonly found in dense surfacing such as sand seals, slurry seals, etc. and are more easily observable on finely textured surfaces.

Surface treatments older than about eight years may have areas of crocodile cracking over most of the road width, especially the fast lane on multi-lane highways. In these cases it is necessary to inspect the less severely cracked areas for evidence of the characteristic star crack pattern resulting from binder shrinkage. Surfacing cracks are normally not confined to the wheel paths, as is the case with traffic associated crocodile cracks. This behavioural feature should be used to help distinguish surface cracks from crocodile cracks. However, when in doubt, record the distress as crocodile cracking. The description of the degrees or surfacing cracks is given in Table B.6.

Table B.6: Description of Degrees of Surfacing Cracks

Degree	Description
1	Faint cracks. In some instances small cracks appear in a star pattern.
3	Distinct cracks. Slight spalling may be visible. Easily observable when driving slowly. Emergence of a crocodile crack pattern.
5	Open cracks with severe spalling. Crocodile crack pattern complete.

Please note that due to the new item “Edge defects”, cracking only occurring at the edge of the road should only be rated under edge defects.

SURFACING CRACKS

1

X	2	3	4	5

Faint cracks

3

1	2	X	4	5

Distinct cracks, easily observable from a slow moving vehicle

5

1	2	3	4	X

Open cracks with severe spalling

B.2.7 Aggregate loss

Aggregate loss (ravelling) is the loss of the surfacing aggregate, usually as a result of traffic abrasion. Aggregate loss is mostly construction related, and occurs shortly after construction or during the first cold period/winter due to insufficient binder, wrong grade of binder, contaminated stone aggregates or aggregates with poor adhesion properties. Aggregate loss later in the life of surface layer is mostly related to certain types of aggregate (white quartzite) that disintegrates, as seen in photos below.

In the case of thin surface treatments, aggregate loss could eventually result in exposure of the underlying layer (then defined as a surfacing failure), and if this is an unbound base layer, potholing will occur. In the case of asphalt surfacing, the surfacing gradually disintegrates and eventually cracks, spalls and deteriorates into potholes.

In assessing the degree of aggregate loss the following must be considered:

- A single surface treatment consists of one layer of single-size stone aggregates and consequently any aggregate loss exposes the underlying layer. In the case of multiple surface treatments, ravelling is characterised by loss of the fine aggregates on the surface, followed by loss of the larger aggregates in successively exposed layers. Asphalt surfacings consists of a mixture of aggregates of various sizes and often also include a final layer of pre-coated aggregates. Because of the different manifestations of the distress in different surfacings, the degree of aggregate loss is defined differently for each case. The type of surfacing inspected should therefore be recorded accurately.

- Tell-tale signs of aggregate loss can be seen on the side of the road. However, the aggregate at the side of the road may be evidence of previous aggregate loss (before the application of a diluted emulsion). The loss of excess aggregate (“over-chipping”), should not be regarded as aggregate loss. All aggregate loss, irrespective of activity, should be recorded under this item.

The description of degrees of aggregate loss is given in Table B.7.

Table B.7: Description of Degrees of Aggregate Loss for various types of surfacing

Degree	Description		
	Slurry Seals	**Chip and Spray**	**Asphalt Surfacing**
1	Very little discernible loss of aggregates. Loss of individual aggregate visible on close inspection. Difficult to discern from a vehicle.	Very little discernible loss of aggregates. Loss of individual aggregates visible on close inspection. Difficult to discern from a vehicle.	Very little discernible loss of aggregate or pre-coated chips. Difficult to discern from a vehicle.
3	Distinct aggregate loss in small areas, easily discernible from moving vehicle. Also general pitted appearance through distinct but scattered loss of aggregate.	Distinct aggregate loss in small areas, or general pitted appearance through scattered loss of aggregate clusters, loosing shoulder to shoulder matrix.	Distinct disintegration of asphalt layer in small areas and/or general loss of pre-coated aggregates. Distinct pitted appearance.
5	General loss of slurry in large patches.	General loss of stone in large areas.	General disintegration of total asphalt layer.

The activity of the aggregate loss must be assessed. Aggregate loss is defined as active if there are signs that the loss is ongoing. For example, evidence of a fresh bitumen face where an aggregate has become dislodged from a seal. A close inspection of the surface should be carried out to determine if the aggregate loss is active.

Aggregate loss that has been stopped by a diluted bitumen emulsion treatment must be rated as non-active. Aggregate loss activity must be rated as per Table B.8 If uncertain, the aggregate loss must be rated as active.

Table B.8: Indication of Aggregate Loss Activity

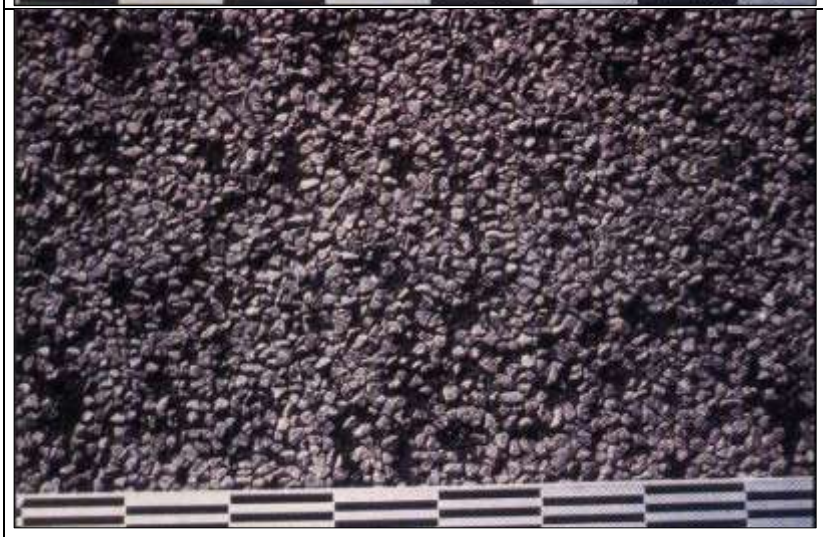
Degree of Activity	Description
Active	Aggregate loss is continuing.
Non-Active	No continuing aggregate loss is visible. Maximum degree rating should not exceed 2

AGGREGATE LOSS (Chip and Spray)

1

X	2	3	4	5

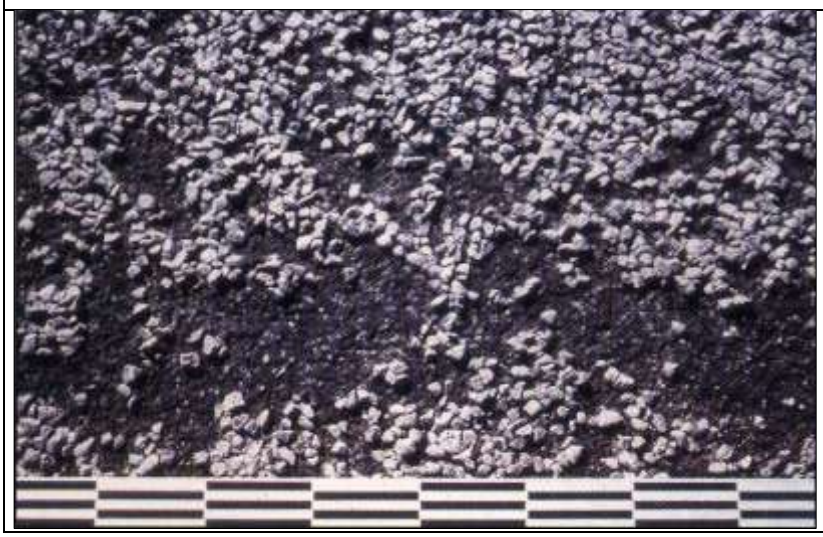
Loss of individual aggregates visible on close inspection



3

1	2	X	4	5

Distinct active aggregates loss in small areas



5

1	2	3	4	X

General active loss of aggregates in large areas.

B.2.8 Binder condition (Dry/Brittle)

Bituminous binders in surface treatments and asphalts become dry and brittle with time. In surface treatments, with relatively thick films, there is an initial loss of the lighter, more volatile oils and aromatics and an increase in oxidation of the surface of the film. These oxidised products partially dissolve in water and tend to shrink, exposing fresh surfaces after each rainfall, allowing the oxidation to penetrate deeper into the binder film. In asphalts the binder film is thinner, but loss of oils and oxidation is restricted by the low voids in the mix.

To assess this defect, it is necessary to remove an aggregate or two from the surfacing between the wheel tracks and to test whether the binder is dry (lifeless) or not. The use of a screwdriver is recommended to remove aggregate from the surfacing. The colour of the binder on the removed aggregate also gives an indication of the brittleness. If the binder is dry the colour will normally be dull and if the binder is 'lively' it will be bright black. The defect must not only be assessed visually on the road surface, because the colour of the aggregate can be misleading.

Note: When evaluating the binder condition of a Cape seal, the tack coat dryness should be evaluated and not the dryness of the slurry. This aspect to be discussed further because of the possibility that the slurry can be very dry and ravelling, while the tack coat is still fresh.

Note: Temperature could influence the brittleness assessment of the binder. Conventional and polymer binders normally appear hard and dry below road temperatures of 20° C.

The inspection of the shrinkage crack pattern may provide another clue to the dryness of the binder. See section B.2.6. The description of degrees of binder condition is given in Table B.9.

Table B.9: Description of Degrees of Binder Condition

Degree	Description
1	Binder not fresh but is sticky, and colour still bright black and/or very easy to dislodge aggregate from seal. (No shrinkage cracks yet).
3	Binder appears dull, binder is brittle owing to hardening and/or aggregates can be dislodged from seal with relatively little effort. (Shrinkage cracks may have appeared in slurries or asphalt.)
5	Binder is dull and very brittle (not sticky at all), binder elasticity is very low and/or aggregate very difficult to dislodged from seal. (Except surface cracks in asphalt and slurries, and aggregate loss on stone seals.)

If the degree of binder condition is not rated as "0", then the extent should be rated as "5", unless there are significant variations in binder condition over the length of the road segment.

The secondary defects of dry binder condition, shrinkage cracks and aggregate loss, are described in sections B.2.6 and B.2.7

B.2.9 Bleeding / flushing

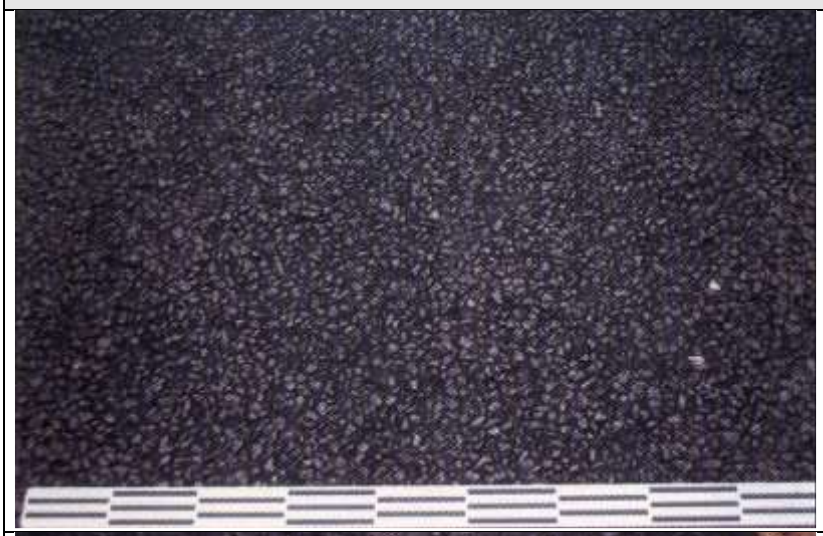
Bleeding occurs when excess binder moves upwards relative to the aggregate and reduces the surface texture depth. Measuring this form of distress is complicated by the pronounced difference in macro texture obtained in the different forms of newly laid surfacings (e.g. asphalt, gap-graded asphalt with pre-coated aggregates, etc.). A common scale for the degree of bleeding for all types is desirable. Table B.10 gives a description of the degree of bleeding with particular reference to the presence of excess binder.

Table B.10: Description of Degrees of Bleeding

Degree	Description
1	Surfacing is slightly rich in excess binder. Aggregates well proud of binder for surface seals
3	Surfacing rich in excess binder. Smooth appearance, but aggregates visible in the binder.
5	Surfacing very rich in excess binder. Film of excess binder covering all aggregates in wheel paths. Surface is tacky during hot weather, and/or wheel prints are visible in binder with possible pick-up of binder.

Degree 1 represents texture depth that would be considered adequate for skid resistance of roads carrying high speed traffic, whereas degree 5 indicates the worst possible condition for skid resistance for all roads.

BLEEDING / FLUSHING



1

X	2	3	4	5

Surfacing is slightly rich in excess binder.

3

1	2	X	4	5

Surfacing rich in excess binder. Smooth appearance, but stones visible in the binder.

5

1	2	3	4	X

Surfacing very rich in excess binder covering all aggregates in wheel paths

B.2.10 Surface deformation / Shoving

This is a common defect in urban areas at intersections where acceleration and/or braking forces of trucks cause shoving of the surfacing. Surface deformation/Shoving can occur in the longitudinal and or transverse directions. The severity of surface deformation is best assessed from within a moving vehicle at the average speed of the road.

Note: In case of transverse deformation, care should be taken not to double count with “Rutting” or “Failures”

Table B.11: Description of Degrees of Surface Deformation

Degree	Description
1	Visible signs, less than 10mm, and not felt in a light vehicle
3	10-20mm and can be felt and speed reduction is necessary
5	>20mm and drivers avoid the defect by selecting a different path and drive very slowly.

SURFACE DEFORMATION /SHOVING

1

X	2	3	4	5

Visible but less than 10mm and not felt in a light vehicle

3

1	2	X	4	5

10-20mm and can be felt – speed reduction necessary

5

1	2	3	4	X

>20mm and drivers select a different path and move very slowly

B.3 Engineering assessment (structural)

This section provides guidelines for the evaluation of the current condition of the pavement structure as manifested through visible distress. This assessment will, together with the surfacing assessment, be used to determine the need for maintenance (including reseal and rehabilitation).

The defects are the result of deterioration of the strength of the pavement structure caused by, for example, a poor surfacing, ingress of water, traffic, climate, quality of material in pavement layers and the age of the pavement.

The following modes of distress which indicate the defects in the pavement structure are to be evaluated with regard to degree and extent:

- cracking;
- pumping;
- deformation;
- patching; and
- failures / potholing.

B.3.1 Cracks

The following types of cracking are assessed:

- block;
- longitudinal;
- transverse; and
- crocodile.

NOTE: Cracks that have been sealed are not rated as cracks, except if they have opened up again.

B.3.1.2 Block cracks

Block cracks are normally caused by the shrinkage of treated (stabilised) pavement layers. The cracks are not confined to the wheel paths. The cracks have a definite block pattern, although the longitudinal and transverse cracks do not always meet. The spacing of the cracks (Table B9) depends on the type of material, the type and quantity of stabilising or modifying agent used, and the degree of secondary distress (e.g. spalling of cracks).

Block cracks do not necessarily indicate a significant deterioration of the pavement, but a potential for deterioration. Traffic action may lead to the formation of secondary cracks, which could eventually lead to severe distress.

It is often difficult to distinguish between block cracks and a combination of longitudinal and transverse cracks on a particular road segment, and it is recommend that if two corners of the potential block are visible – then rated as block cracks. Important to note that in these instances cracks should be classified under only one of the two options, i.e. the more predominant type.

Note: Small blocks <300mm to be rated as crocodile cracking.

The description of degrees of block cracks is given in Table B.12.

Table B.12: Description of Degrees of Block Cracks

Degree	Description
1	Faint cracks (≈1 mm).
3	Distinct, open cracks (≈ 3 mm) with slight spalling, deformation or secondary cracking at corners in the form of triangles.
5	Open cracks (> 3 mm) with significant spalling, secondary cracking or deformation evident around open cracks, or wide open cracks (> 5 mm) with little or no secondary defects.

BLOCK CRACKS

1

X	2	3	4	5

Faint (≈ 1mm)

3

1	2	X	4	5

Distinct, open (≈ 3mm) with slight spalling

5

1	2	3	4	X

Open cracks (> 3mm) with significant spalling, or wide open cracks (> 5 mm)

B.3.1.3 Longitudinal/slip cracks

This item includes the following two crack types:

- Longitudinal

  These cracks are not restricted to the wheel paths and may be due to poor construction techniques (e.g. asphalt overlay construction joint), settlement of embankments or active clay subgrades. These are line cracks running longitudinally along the pavement.

  Although these cracks are not normally caused by traffic, traffic action or lack of maintenance may cause them to deteriorate further.

- Slip

  These cracks are related to the movement of embankments and to embankment foundations. They often occur in circular/parabolic patterns and are not restricted to wheel paths. A difference in height between affected and adjacent unaffected areas, separated by a crack at the tension zone between the two areas, could indicate subsidence or slip. The cracks may also occur at embankments and approaches to bridges and box culverts.

  These cracks normally require major routine maintenance and, if left unattended, may lead to road failure, especially in the case of high embankments.

Note: Longitudinal edge cracks due to poor shoulder support < 300mm from edge - to be rated under edge defects.

The description of degrees of longitudinal/slip cracks is given in Table B.13.

Table B.13: Description of Degrees of Longitudinal Cracks

Degree	Description
1	Faint cracks (≈ 1mm)
3	Distinct, open cracks (≈ 3 mm) with slight spalling, deformation or secondary cracking.
5	Open cracks (> 3 mm) with significant spalling, secondary cracking or deformation evident around open cracks, or wide open cracks (> 10 mm) with little or no secondary defects.

LONGITUDINAL / SLIP CRACKS

1

X	2	3	4	5

Faint (≈ 1 mm) (exaggerated by dust and fine aggregate in photo)

3

1	2	X	4	5

Distinct, open (≈ 3mm) with slight spalling

5

1	2	3	4	X

Open cracks (> 3mm) with significant spalling, or wide open cracks (> 10 mm)

B.3.1.4 Transverse cracks

Transverse cracks are line cracks across the pavement. They are often a first manifestation of shrinkage in a cement stabilised base or subbase. Transverse cracks can also be a sign of temperature associated fatigue and seasonal effects. They are normally not related to structural problems, but further deterioration of the pavement may occur with the ingress of water through the cracks.

These cracks often also occur at drainage structures or where services have been installed subsequent to initial construction by the pavement layers. They could indicate poor compaction of the material in the immediate vicinity of the cracks.

Note: Fine closely spaced transverse cracking over the full road width, which appears in asphalt surfacing's, should not be noted as transverse cracks, but as surfacing cracks.

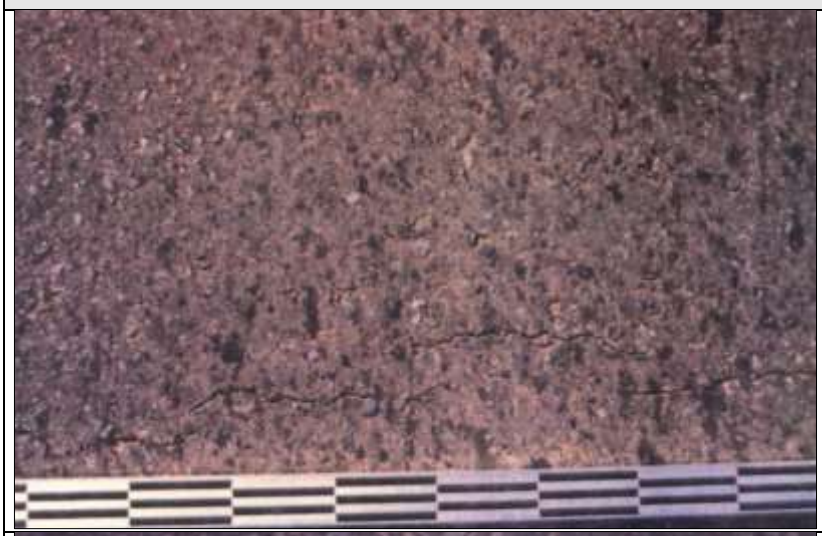
Note: Short transverse cracks at the edge of the surfacing (usually extending less than 300 mm from the edge of the surfacing) should be assessed separately from transverse cracks and recorded under edge defects (Section B.4.5)

The description of degrees of transverse cracks is given in Table B.14.

Table B.14: Description of Degrees of Transverse Cracks

Degree	Description
1	Faint cracks (≈ 1 mm)
3	Distinct, open cracks (≈ 3 mm) with slight spalling, deformation or secondary cracking.
5	Open cracks (> 3 mm) with spalling, secondary cracking or deformation evident around open cracks, or wide open cracks (> 10 mm) with little or no secondary defects.

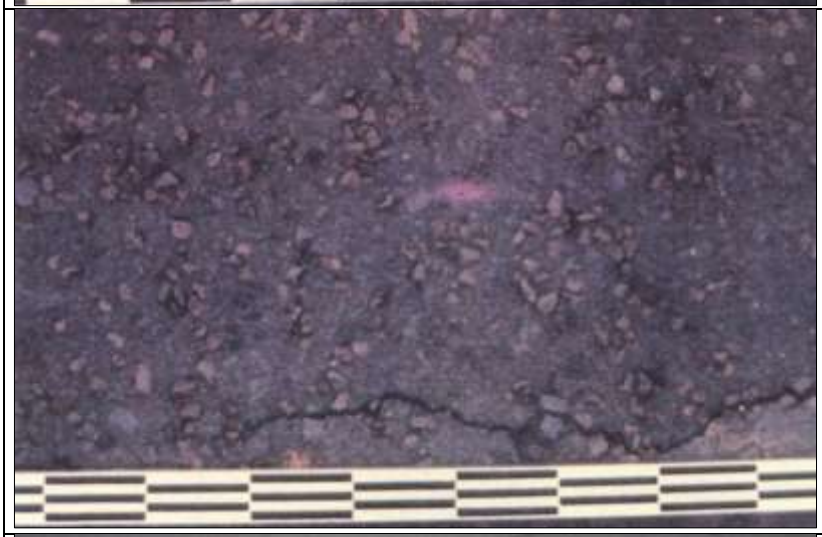
TRANSVERSE CRACKS



1

X	2	3	4	5

Faint (≈ 1 mm)



3

1	2	X	4	5

Distinct, open (≈ 3mm) with slight spalling

5

1	2	3	4	X

Open cracks (> 3mm) with significant spalling, or wide open cracks (> 10 mm)

B.3.1.5 Crocodile (fatigue) cracks

Crocodile cracking is often limited to the wheel paths. Crocodile cracks normally occur as a result of fatigue failure of surfacing or base layers and are related to the inability of the pavement to carry the traffic load. They may also occur in the wheel paths of dry brittle surfacing layers caused by traffic action. In such cases there is initially no sign of rutting but this can occur if the cracks permit the ingress of water into the pavement layers. Crocodile cracks also occur in isolated patches where failure is caused by poor drainage and sealed in moisture.

In some cases, crocodile cracking could start as fine, irregular longitudinal cracks in the wheel paths which grow progressively closer and eventually interconnect to form the familiar crocodile pattern. These initially fine, irregular longitudinal cracks, should however be classified as longitudinal cracks for the purpose of the assessment. Crocodile cracking also occurs as secondary cracking around primary line cracks. Higher degrees (degree ≥ 3) of crocodile cracking are often accompanied by deformation and pumping.

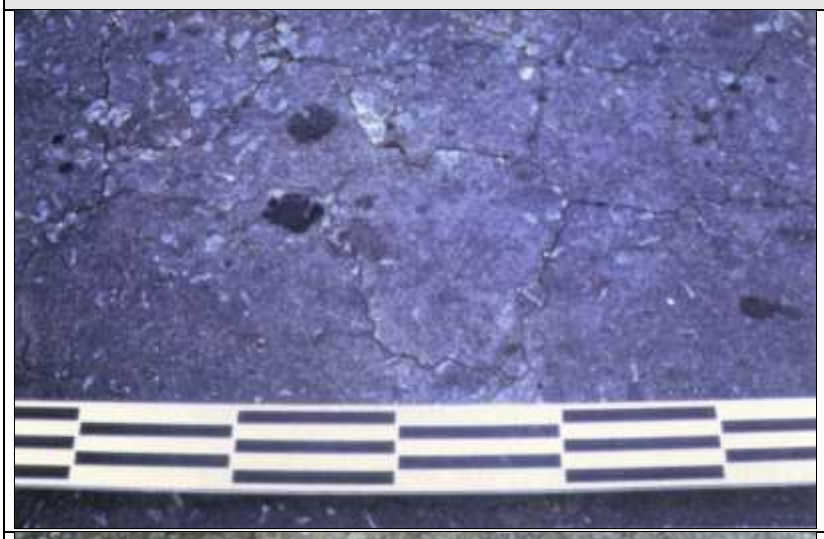
Surface treatments older than about eight years may have areas of cracking with crocodile pattern over most of the road width, and not just confined to the wheel paths, especially the fast lane on multi-lane highways. In these cases the cracking is more likely surfacing cracking resulting from binder shrinkage. Surfacing cracks are normally not confined to the wheel paths, as is the case with traffic associated crocodile cracks. This behavioural feature should be used to help distinguish surface cracks from crocodile cracks. However, when in doubt, record the distress as crocodile cracking.

The description of the degrees of crocodile cracks is given in Table B.15.

Table B.15: Description of Degrees of Crocodile cracks

Degree	Description
1	Faint cracks (≈ 1 mm) in wheel paths. Only visible on close inspection and crocodile pattern not fully developed.
3	Distinct cracks (≈ 3mm) with slight deformation/movement and/or pumping of cracked areas and/or slight spalling of the edges.
5	Open cracks (> 3mm) with severe deformation/movement and/or severe pumping of cracked area and/or extensive spalling of edges. Crocodile cracking has spread outside the wheel paths. High density of crocodile crack pattern.

CROCODILE CRACKS



1

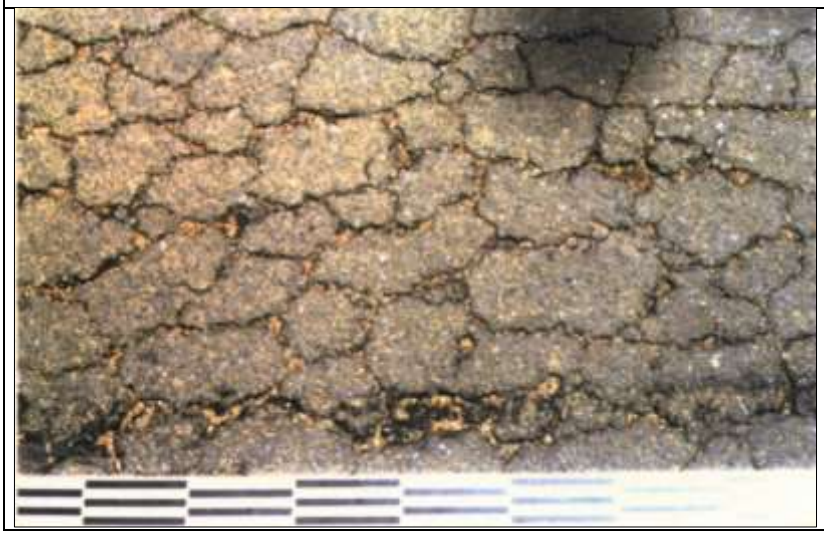
X	2	3	4	5

Faint (≈ 1 mm) cracks within wheel path and crocodile pattern not fully developed

3

1	2	X	4	5

Distinct, open (≈ 3mm) with slight deformation/movement and/or pumping within wheel paths



5

1	2	3	4	X

Open (> 3mm) with severe deformation/movement and/or pumping within wheel paths

B.3.2 Pumping

Pumping occurs when pore pressure under traffic loading pump fine material from within the pavement to the surface, normally through existing cracks. Pumped out fines are visible along the cracks on the surfacing and there is usually a thin layer of fines next to the cracks after recent rains. Deformation at the edge of the cracking with no visible fines may occur from degree 3 or higher degree pumping.

Pumping of fines is affected by rainfall and cracks should therefore be inspected carefully for signs of pumping. The description of the degrees of pumping is given in Table B.16.

Table B.16: Description of degrees of pumping

Degree	Description
1	Pumping faintly visible on close inspection.
3	Pumping clearly visible from vehicle. Only slight or no deformation of road surface next to the crack.
5	Extensive deposits of fines alongside the cracks and/or severe deformation at cracks.

PUMPING

1

X	2	3	4	5

Faintly visible on close inspection.

3

1	2	X	4	5

Clearly visible from vehicle. Only slight or no deformation.

5

1	2	3	4	X

Extensive deposits of fines alongside the cracks

B.3.3 Deformation

Deformation is a change in the road surface profile. This will manifest as an area of the pavement having its surface either above or below that of the original level. The following types of deformation are assessed:

- Rutting;
- Undulation/settlement.

Note: Please see B.2.10 for surface deformation/shoving.

B.3.3.1 Rutting

Rutting results from compaction or deformation through the action of traffic and is limited to the wheel paths. When the rutting is fairly wide and even-shaped, the problem is normally in the lower pavement layers. When rutting is narrower and more sharply defined, the problem normally lies within the upper pavement layers. Rutting frequently occurs with crocodile cracking, especially for pavement structures with thin bituminous layers.

The assessor is not expected to measure rut depths using a straight edge, but for calibration purpose rutting is defined as the maximum deviation measured under a two metre straight edge placed transversely across the rut. The description of the degrees of rutting is given in Table B.17.

Table B.17: Description of Degrees of Rutting

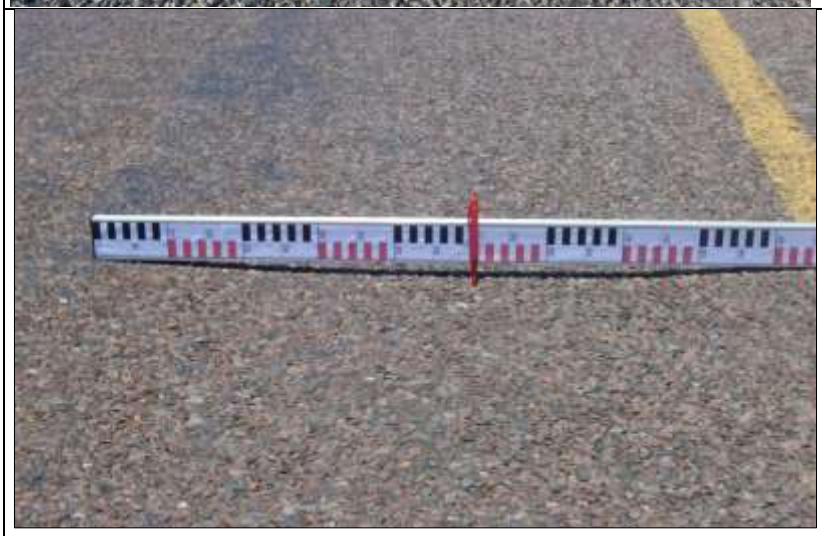
Degree	Description
1	Difficult to discern unaided (< 5mm)
3	Easily discernible (≈ 10 – 15mm)
5	Severe, dangerous. Very obvious from moving vehicle, even at high speed. Affects directional stability (> 20mm).

RUTTING

1

X	2	3	4	5

< 5mm - not readily visible with the eye



3

1	2	X	4	5

≈ 10 – 15mm - easily discernible

5

1	2	3	4	X

> 20mm - obvious from moving vehicle, even at high speed

B.3.3.2 Undulation/Settlement

Undulation is a wavy form of deformation of the type usually associated with the settlement (especially differential settlement) of embankments at culverts and bridges or mole activity. It is often associated with adverse foundation conditions, e.g. in-situ foundation materials with a slow rate of consolidation or heaving clays affected by changes in moisture conditions.

The degree of undulation is fairly subjective. Table B.18 serves as a guide to link the degree of undulations to the riding quality of the road and therefore the safety of the road user. Although there is an overlap of this item with riding quality, the purpose of this rating is to highlight the presence of differential settlement, consolidation or heaving related deformation.

NOTE: Unevenness caused by patches, potholes, corrugations and failures should not be assessed as undulation/ settlement. General unevenness of the road resulting from construction or other minor problems should not be assessed under this item, but will be reflected in the riding quality assessment.

Table B.18: Description of degrees of undulation

Degree	Description
1	Undulations causes slight unevenness of road profile, ride is still smooth and acceptable
3	Undulation is clearly visible and has an effect on riding quality. Motorists may have to reduce driving speed if extent is more than merely localised.
5	Ride very poor and very uncomfortable owing to undulations, road unsafe at normal speed limit. Speed restrictions may have been imposed.

UNDULATIONS/SETTLEMENTS

	1 X 2 3 4 5 Visible but not felt in a light vehicle
	3 1 2 X 4 5 Can be felt – speed reduction necessary
	5 1 2 3 4 X Vehicles select a different path and drive very slowly

B.3.4 Structural Patching

Structural patches indicate the existence of previous defects.

The assessment of the average size of the structural patches can give an indication of the extent of the distress type that was repaired with the patch. The size of patches should be assessed as per Table B.19. Distress types within a patch (e.g. cracking and pumping) should be rated separately under individual defects.

Geotextile patches are normally applied over areas with crocodile/fatigue cracking in the wheel path (Structural failure) not over surfacing cracking or surfacing failures. Therefore, recommended to rate under structural patching.

Table B.19: Description of size of Structural Patching

Degree	Size
1	$< 2\ m^2$
3	$\approx 5\ m^2$
5	$> 10\ m^2$

Note: The following items are not regarded as structural patching:

- Rut filling.
- Repair work constructed with major plant using the following items as guidelines:
  - Width of repair work equal or greater than the width of one lane; and/or
  - Length of repair work more than 50 metres.
- Service crossings (urban environment) are not regarded as patching.
- If a patch has failed, it should be assessed as a structural failure / pothole.

B.3.5 Potholes

Potholes (loss of material from the base layer) refer to structural failures and exclude surfacing failures (owing to loss of just surfacing) described in section B.2.4.

Potholes are generally a secondary form of distress that develops from cracking or extreme loss of aggregate and progress from the top of the road downwards. They are traffic induced and normally develop from structural cracking in the wheel paths. Moisture enters into the pavement resulting in potholes.

The degree of potholing can generally be expressed by the diameter and depth of the potholes. The description of degrees for potholes is given in Table B.20.

Table B.20: Description of Degrees of Potholes

Degree	Description
1	Potholes < 250 mm diameter with depth less than 30 mm
3	Potholes > 250 mm diameter and of significant depth (± 60 mm).
5	Potholes > 500 mm diameter and of serious depth (> 75 mm) and/or severe secondary defects.

Note: Distress types within a failure (e.g. cracks and pumping) should not be rated separately. Edge breaking should not be rated as potholes unless it extends into a wheel track.

Service crossings (urban environment) that are poorly done and/or failed are not regarded as failures.

POTHOLES

1

X	2	3	4	5

< 250 mm diameter and depth less 30 mm

3

1	2	X	4	5

> 250 mm diameter and of significant depth (± 60 mm)

5

1	2	3	4	X

> 500 mm diameter and of serious depth (> 75 mm)

B.3.6 Failures

Structural failures mostly manifest as lateral displacements of the surfacing and base course. These are generally caused by a loss of shear strength in the base course (or sometimes underlying layers) usually as a result of deterioration of the layer materials (durability problems) or by excessive moisture in the layer. They are traffic induced and form mounds towards the edge of the road adjacent to depressions in the wheel-paths.

Descriptions of degrees for failure are given in Table B.21.

Table B.21: Description of Degrees of Failures

Degree	Description
1	Failure initiated. Minor depression (< 30 mm). Start of surface distress and shoving.
3	Failure developing. Visible depression (± 50 mm). Surfacing cracked and shoving with obvious mounding.
5	Severe failure with loss of surfacing and base material or severe depression (>90 mm), cracking of seal and significant shoving and mounding.

Note: Distress types within a failure (e.g. cracks and pumping) should not be rated separately. Edge breaking should not be rated as failures unless it has been caused by loss of strength in the underlying layer.

STRUCTURAL FAILURES

1

X	2	3	4	5

Minor depression (< 30 mm) with signs of shoving

3

1	2	X	4	5

Visible depression (± 50 mm). Surfacing cracked and shoving with mounding

5

1	2	3	4	X

Severe, loss of surfacing and base material or severe depression (> 90 mm) and shoving

B.4 Functional assessment

Comfort, safety and speed of travel are the variables which define the level of service a road user generally perceives.

The functional features used to define this perception are the roughness, skid resistance, surface drainage, condition of the shoulders and edge breaking.

B.4.1 Roughness (Riding Quality)

The roughness of a pavement is defined as the extent to which road users, through the medium of their vehicles, experience a ride that is smooth and comfortable, or bumpy and therefore unpleasant or perhaps unsafe. This is determined by the unevenness of the road profile (longitudinal deformation, rutting variance in wheel paths, etc.), the loss of surface or base layer material (potholes, extreme ravelling, etc.) and uneven patching. The description of degrees of roughness is given in Table B.22.

Table B.22: Description of Degrees of Roughness

Degree	Description
1	Ride very smooth and very comfortable, no unevenness of the road profile, no potholes, ravelling or uneven patching.
2	Ride smooth and comfortable, slight unevenness of the road profile, no potholes, slight ravelling or uneven patching.
3	Ride fairly smooth and slightly uncomfortable, intermittent moderate unevenness of the road profile, moderate variance in rutting, ravelling or uneven patching.
4	Ride poor and uncomfortable, frequent moderate unevenness of the road profile, frequent potholes/failures, uneven patching, comfortable driving speed below speed limit.
5	Ride very poor and very uncomfortable, extensive severe unevenness of the road profile, extensive potholes/failures, uneven patching, comfortable driving speed much lower than speed limit, road unsafe owing to severe unevenness.

Note: Problems resulting in poor riding quality can be indicated on the assessment form (if required), by marking the appropriate block(s), if provided on the form.

These problems include:

- potholes/failures;
- patching
- undulations;
- corrugation; and
- general unevenness.

B.4.2 Skid Resistance

Skid resistance is the ability of the road surface to prevent skidding when wet, in all manoeuvres executed by vehicles. The property that largely determines skid resistance is the surface texture. The two important characteristics of the surface texture are the surface macro texture, visual coarseness of surface and the surface micro texture related to roughness of the aggregate surfaces.

The surfacing macro texture depth relates to the voids between the aggregates protruding from the surface. The micro texture or roughness of the aggregates can be qualitatively assessed by examining the aggregate and determining if they are rough and angular or smooth and rounded (polished by traffic action). The description of degrees of skid resistance is given in Table B.23.

Table B.23: Description of Degrees of Skid Resistance

Degree	Description
1	Skid resistance adequate for roads carrying high speed traffic, surface macro texture coarse, many voids. Aggregate micro texture very rough, edges sharp to the touch.
3	Skid resistance intermittently inadequate for high speed traffic and/or surface macro texture medium to fine, few voids. Aggregate micro texture not very sharp or very rough to touch.
5	Skid, resistance inadequate for all traffic and/or macro texture fine, no void, film of binder covering all aggregates. Aggregates rounded and smooth to the touch. (Example: Severe bleeding and/or very smooth asphalt surface on curve or rolling terrain).

Note: Problems resulting in poor skid resistance can be indicated on the assessment form. These problems include:

- bleeding (described in section B.2.9.); and
- polished aggregates (described above)

SKID RESISTANCE					
	1				
	X	2	3	4	5
	Coarse Macrotexture and rough micro texture				
	3				
	1	2	X	4	5
	macro texture medium to fine and micro texture not that rough				
	5				
	1	2	3	4	X
	macro texture fine and micro texture rounded and smooth to touch				

B.4.3 Drainage

B.4.3.1 Surface drainage

The surface drainage of a road is a measure of the general ability of the road to keep the riding surface clear of water. This is related to the speed at which water runs off during rain and to the extent of the ponding of water during and after rain. It is an important factor which affects the skid resistance and the volume of water sprayed on to other vehicles. The function of good surface drainage is also keep the road surface clear of grit washed onto the road from the verges. Overall drainage, including side drains should not be assessed as part of surface drainage. Surface drainage includes only the area up to two metres from the outside yellow line (paved and unpaved shoulders).

The description of degrees is given in Table B.24.

Table B.24: Description of Degrees of Surface Drainage Ratings

Degree	Description
1	No visible problem that could retard the run-off of water from the road and shoulders.
3	Problems exist that could lead to general slight ponding or severe localised ponding.
5	Problems exist that could lead to widespread severe ponding in the wheel paths.

Note: Problems leading to inadequate surface drainage can be indicated on the assessment form. These problems include the following:

- Alignment: Horizontal or vertical alignment problems;
- Shoulders: Too high or overgrown, leading to ponding of water on the road; and
- Rutting: Water ponding in wheel ruts on relatively flat roads

B.4.3.2 Side drainage

Although a side drainage problem is not a pavement distress type and therefore not an indication of pavement condition, problems with the side drains could lead to premature pavement failure. If there are problems, they are only noted by marking the side drain block and not rated as degree and extent. Side drainage problems could include:

- overgrown side drains;
- blocked side drains, or
- non-existent side drains.

SURFACE DRAINAGE

1

X	2	3	4	5

No visible problem that could retard the run-off of water

3

1	2	X	4	5

Shoulder overgrown, leading to slight ponding of water on the road

5

1	2	3	4	X

Widespread severe ponding in the wheel paths due to ruts

B.4.4 Unpaved Shoulder Condition

The unpaved shoulder is rated in terms of the availability of the shoulder as a safe recovery area. Several problems might render the unpaved shoulder unsafe, for example:

- the erosion of the shoulder by water;
- wearing out by traffic;
- level differences between edge of carriageway and shoulder;
- the width of the shoulder is too narrow;
- the cross-sectional slope of the shoulder is too steep; or
- sight distances are obstructed by overgrown vegetation.

If the paved shoulder width is less than 2 m, the verge (unpaved area) should be rated as part of unpaved shoulder.

The description of the degrees of unpaved shoulder conditions is given in Table B.25.

Table B.25: Description of Degrees of Unpaved Shoulder Condition

Degree	Description
0	If the edge of the road is defined by a kerb or there are no shoulders e.g. in a mountain pass.
1	Shoulder can be safely used as stopping area at the posted speed limit.
3	Problems may be expected if the shoulder is used as stopping area at the posted speed limit (routine maintenance required).
5	Shoulder is unsafe to be used as stopping area at the posted speed limit. Scheduled maintenance required e.g regravelling or substantial work required

UNPAVED SHOULDER CONDITION

	1 X 2 3 4 5 Shoulder can be safely used as stopping area at the posted speed limit.
	3 1 2 X 4 5 Problems may be expected if the shoulder is used as stopping area
	5 1 2 3 4 X Shoulder is unsafe to be used as stopping area

B.4.5 Edge defects

Edge defects are more common on narrow roads due to traffic moving closer to the edges. The condition of the road edge is rated according to the following distress types:

- Edge break: Edge breaks are caused by the breaking away of the surfacing at the outside edges of the surfacing. This is often due to poor unpaved shoulder maintenance. The degree of edge breaking is rated by measuring the average distance from the edge of the pavement to the maximum points of breakage.
- Short transverse cracks: These cracks are initiated at the edge of the road and migrate inwards.
- Longitudinal cracking within 300mm of the edge of the road.
- Drop-off: This is the step between the surfacing and the shoulder caused by erosion.

The description of degrees of edge defects is given in Table B.26.

Table B.26: Description of Degrees of Edge Defects

Degree	Description		
	Edge break	**Short transverse or Longitudinal cracks**	**Drop-off**
1	< 50 mm	Faint	< 50mm
3	≈ 150 mm	Distinct (up to 3mm)	≈ 75mm
5	> 300 mm Safety hazard to traffic.	Open (> 3mm) with spalling	>100mm

Note: Edge breaking extending into the wheel path should be classified as potholing.

EDGE BREAKING

1

X	2	3	4	5

< 50 mm

3

1	2	X	4	5

≈ 150 mm

5

1	2	3	4	X

> 300 mm - safety hazard

SHORT TRANSVERSE CRACKS

	1 X 2 3 4 5 Faint
	3 1 2 X 4 5 Distinct (up to 3mm)
	5 1 2 3 4 X Open (> 3mm) with spalling

DROP-OFF

1

X	2	3	4	5

< 50mm

3

1	2	X	4	5

≈ 75mm

5

1	2	3	4	X

>100mm

B.5 Summary

This section defines the summarised pavement condition and need information to be recorded by the assessor. The information is not used in data processing, but provides checks for the verification of the condition assessment data.

B.5.1 Overall condition of the pavement

The description of the overall condition of the pavement is given in Table B.27. A general rating for the condition of the pavement is useful for data verification.

Table B.27: Description of Degrees of Overall Condition of Pavement

Degree	Description
1	Very few or no defects. Degree of defects < 3 (less than warning).
2	Few defects. Degree of structural defects mostly less than warning.
3	A few defects with degree of defects seldom severe. Extent is only local if degree is severe (excluding surfacing defects).
4	General occurrence of particular structural defects with degrees warning to severe.
5	Many defects. The degree of the majority of structural defects is severe and the extent is predominantly general to extensive.

B.5.2 Other problems

Certain items requiring possible maintenance measures that are not recorded under standard defects should be noted on the assessment form. These include problems such as service crossings (trenches), mechanical damage, mole damage or root damage or any other problems not listed on the form.

B.6 Assessment form

VISUAL ASSESSMENT : FLEXIBLE PAVEMENTS

South Africa COTO Committee of Transport Officials

ROAD AUTHORITY :
REGION / SUBURB :
ROAD NO / STREET NAME :
SEGMENT (FROM - TO) :
SEGMENT DIMENSIONS : LENGTH ____ m WIDTH ____ m

ROUTE CLASS :	1	2	3	4	5
TRAFFIC :	VL	L	M	H	VH
GRADIENT :	Flat		Med		Steep
TERRAIN :	Flat		Rolling		Mount

ENGINEERING ASSESSMENT

SURFACING

CURRENT SURFACING :

	TEXTURE	COARSE	MEDIUM	FINE	VARYING
	VOIDS	MANY	FEW	NONE	VARYING

	DEGREE						EXTENT				
	MINOR		WARNING			SEVERE	ISOLATED				EXTENSIVE
	0	1	2	3	4	5	1	2	3	4	5
SURFACING FAILURES											
SURFACING PATCHING											
SURFACING CRACKS											
BINDER CONDITION (DRY / BRITTLE)											
AGGREGATE LOSS (A / N)											
BLEEDING / FLUSHING											
SURFACING DEFORMATION / SHOVING											

STRUCTURAL

	DEGREE						EXTENT				
	MINOR		WARNING			SEVERE	ISOLATED				EXTENSIVE
	0	1	2	3	4	5	1	2	3	4	5
BLOCK CRACKS											
LONGITUDINAL CRACKS											
TRANSVERSE CRACKS											
CROCODILE CRACKS											
PUMPING											
RUTTING											
UNDULATIONS / SETTLEMENT											
PATCHING											
FAILURES / POTHOLES											

FUNCTIONAL ASSESSMENT

ROUGHNESS		1	2	2	4	5
	Problem	potholes	patching	undulations	gen uneven	corrugations
SKID RESISTANCE		1	2	2	4	5
	Problem				bleeding	polished
SURFACE DRAINAGE		1	2	2	4	5
	Problem		rutting	shoulders	alignment	side drains
SHOULDERS (unpaved)	0	1	2	2	4	5
	Problem	eroded	overgrown	inclined	too high	too narrow
EDGE DEFECTS	0	1 2	3 4	5	1 2	3 4 5
	Problem			edge break	drop off	edge cracks

SUMMARY

OVERALL PAVEMENT CONDITION	1	2	3	4	5
COMMENTS:					
OTHER PROBLEMS	service crossings	trees	moles		mechanical damage

ASSESSOR : ____ DATE : ____