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THE SOUTH AFRICAN NATIONAL ROADS AGENCY LIMITED

M3-1: VISUAL ASSESSMENT MANAUAL FOR CONCRETE PAVEMENTS

PREPARED AND ISSUED BY:

CHIEF EXECUTIVE OFFICER
SOUTH AFRICAN NATIONAL ROADS AGENCY LIMITED
PO BOX 415
PRETORIA
GAUTENG
0001

SYNOPSIS

This manual provides guidelines for the visual assessment of the condition of rigid paved roads at network level for use in pavement management systems. Both jointed concrete pavements and continuously reinforced concrete pavements are considered in this manual. 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 type of distress are given and should be used in conjunction with TRH 22 on pavement management systems.

SINOPSIS

Hierdie handleiding voorsien riglyne vir die visuele evaluering van die toestand van betonplaveisels op netwerkvlak, vir gebruik in plaveiselbestuurstelsels. Beide gevoegde en deurlopend gewapende betonplaveisels word in dié dokument vervat. Evalueringsprosedures en vereistes vir padsegmentering word gespesifiseer. Verskillende verswakkingsmeganismes is geklassifiseer en gedetaileerde beskrywings van graad van verswakking (insluitende foto's wat die toestand illustreer) word vir elke verswakkingsmeganisme gegee en moet in samewerking met TRH 22, oor Plaveiselbestuurstelsels gebruik word.

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1. GENERAL INFORMATION

1.1 INTRODUCTION

1.1.1 PURPOSE AND BACKGROUND

This document provides guidelines for the visual evaluation of the condition of rigid paved roads at network level for use in pavement management systems. Flexible pavements are dealt with separately and must be assessed in accordance with TMH9. This manual does not make provision for rigid pavements that have been resealed or given an asphalt overlay and therefore have to be evaluated according to TMH 9.

Visual evaluations can be used for determining:

- visual condition indices;
- maintenance and rehabilitation needs; and
- prioritisation at network level.

This document should be used in conjunction with the TRH 22 document on pavement management systems.

This visual assessment manual is intended for visual assessors of the condition of pavements for the pavement management systems and should be used for the training of assessors.

1.2 EVALUATION OF CONDITION OF PAVEMENT

The condition of the pavement is considered from two points of view, namely that of the road user and that of the roads engineer. Since the road user regards the road as a service, the condition of the pavement is appraised in terms of those functional characteristics that affect quality of travel, notably comfort, safety and vehicle operating costs. The engineer, on the other hand, not only recognises the functional requirements, but also views the pavement as a load bearing structure to be maintained in good time if it is to remain serviceable at optimum cost. The assessment of the condition of the pavement is therefore based on functional descriptions related to the condition of the pavement surfacing and the pavement structure.

Visible distress is an important input in the assessment of the condition of a pavement structure. Distress is described by recording its main characteristics, the so-called attributes of distress, namely the **type**, **degree** and **extent** of occurrence (see section A2).

To reduce the amount of subjectivity involved in the assessment, the assessor should follow the assessment procedures as set out in this guide as closely as possible.

1.3 INFORMATION TO BE OBTAINED FROM VISUAL EVALUATION DATA

As mentioned briefly in section A1.1, the following two main outputs can be achieved by processing the visual assessment data:

(a) A visual condition index for each assessment length through the combination of -

- the rating for degree and
- extent for each distress type, together with
- a weight factor based on the importance of the distress type.

The visual condition index can be used -

- to give an indication of the condition of the pavement of each assessment segment;
- to indicate the change in the condition of a pavement over time; and
- to classify the road section into one of five condition categories for statistical or visual presentation.

VERY GOOD	GOOD	FAIR	POOR	VERY POOR
1	2	3	4	5

(b) Identification of certain required **maintenance** and/or **rehabilitation measures** and **priorities**. These identified needs are generally not for use at project level (implementation), but are used as input for programming and budgeting at network level.

1.4 DEFINITIONS

(a) Road section

A road section is a length of road with a unique section number (refer to Section A4.2).

(b) Assessment segment

An assessment segment is the length of road for which one assessment rating is recorded.

(c) Shoulder

A shoulder is the area adjacent to the slow lane (or fast lane on dual carriageway roads), but within 3,5 meters of the yellow or white line (or edge of the slow lane). The shoulder does not extend beyond a kerb (if any). Only shoulder types applicable to rigid pavements are defined in this document. The following options are defined:

i) Paved shoulders >1.0 m

Distinction is made between the type of paved shoulder and could therefore be rigid or flexible paved shoulders. The shoulder condition is assessed separately from the rigid pavement. Only the condition index as defined in paragraph A1.3 is given i.e. good (G), fair (F) or poor (P). Individual types of distress is not assessed separately.

ii) Paved shoulders < 0,6 m

It seldom if ever happens that rigid pavements have no or a narrow shoulder. In the event of this occurring, the condition of the paved area outside the traffic lanes is not assessed as a shoulder, but individual types of distress are assessed under the relevant headings with the rest of the pavement. The condition of the gravel area is assessed under item B3.4 and C3.4 (Unpaved shoulders).

(d) Condition "Warning"

The condition of various defects is often referred to as "warning". This term indicates a condition that has developed a moderate level of distress and some action in the near future is required and/or a problem that may develop into a serious one is evident.

(e) Jointed concrete pavements (JCP)

Rigid pavements in which transverse joints are provided for the control of cracking are called jointed concrete pavements. In South Africa, short slab (≤4,5 m) are used and pavements constructed with load transfer between slabs by aggregate interlock only or by aggregate interlock and dowel bars. Slabs are generally not reinforced, except where special conditions exist i.e where the L/W ratio >1.5.

(f) Continuously reinforced concrete pavements (CRCP)

A continuously reinforced concrete pavement (CRCP) is one with no transverse joints and due to the heavy, continuous steel reinforcement in the longitudinal direction, the pavement develops narrow cracks at close intervals. These crack spacings vary on a given project, generally between 0,5 to 3,0 m. These cracks are not sealed. When the paving operations are interrupted transverse construction joints are formed. Near structures contraction joints are also provided.

(g) Pavement slab

Jointed concrete pavements have transverse and longitudinal joints. The longitudinal joints divide the carriageway into a number of concrete strips. The transverse joints divide each of these strips into blocks of concrete pavement. Each of these blocks of concrete pavement are called a pavement slab. Continuously reinforced concrete pavements do not have transverse joints and therefore cannot be divided into pavement slabs. Continuously reinforced concrete pavements do have longitudinal joints and are therefore divided into concrete strips.

(h) Sealed joints

Joints are formed between the different slabs in a jointed concrete pavement and the strips formed in a continuously reinforced pavement. These joints have to be sealed to avoid the ingress of water and other foreign matter.

1.5 LAYOUT OF THE MANUAL

The manual comprises five parts:

Part 1 provides information to the assessor which should be studied as background to the detailed distress descriptions in Parts 2 and 3.

Part 2 provides detailed descriptions of the various distress types and the descriptions of the various degrees of distress, for **jointed concrete pavements**. The various degrees of distress are discussed under the heading measurement for each distress type. To illustrate these descriptions, colour photographs of typical examples of each distress type (where available) are provided.

Part 3 provides detailed descriptions of the various distress types and the descriptions of the various degrees of distress, for **continuously reinforced concrete pavements.** The various degrees of distress are discussed under the heading measurement for each distress type. To illustrate these descriptions, colour photographs of typical examples of each distress type (where available) are provided.

Part 4 provides examples of typical assessment forms.

Part 5 Formula and weight factors for visual condition index (VTI)

Part 6 References.

1.6 ATTRIBUTES OF DISTRESS

1.6.1 GENERAL

The appearance of distress is varied and often extremely complex. The task of describing this is achieved by recording its main characteristics - the so-called attributes of distress. The attributes referred to in this manual are :

- type;
- degree;
- extent; and
- spacing or activity (where applicable),

and are defined below in general terms. Each of these attributes is described in more detail in Parts 2 and 3. In some cases information is also provided on the mechanisms and causes of distress.

1.6.2 TYPES OF DISTRESS

(a) Classification of types of distress

Distress occurs in various ways. These are called **modes** of distress, for example pumping or cracking. Each of these modes of distress may occur in one of several different typical manifestations. These are called the various **types** of distress, for example transverse cracks, longitudinal cracks or cracked slabs.

The various types of distress are classified as **essential** or **desirable**. All visual assessments should contain the essential items, which constitute information necessary for basic statistics. The assessment of other distress types which will enhance and improve the quality of pavement management data and outputs, but which are not essential, are indicated as desirable. Visual assessment items for rigid pavements are given and classified accordingly in Table A1. Provision is made for distress types unique to either jointed concrete pavements or continuously reinforced concrete pavements and this is also indicated in Table A1. Descriptions of the distresses can be found in Part B (jointed concrete pavements) and Part C (continuously reinforced concrete pavements). The various items are also classified under the following headings:

- Surfacing assessment;
- Structural assessment; and
- Functional assessment.

TABLE 1.1: VISUAL ASSESSMENT ITEMS AND REQUIREMENTS

VISUAL ASSESSMENT ITEM	ASSESSMENT REQUIREMENTS			
	JOINTED CONCRETE PAVEMENTS		CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS	
	ESSENTIAL	DESIRABLE	ESSENTIAL	DESIRABLE
SURFACING ASSESSMENT				
Joint spalling	X		X	
Joint seal condition	X		X	
Texture		X		X
STRUCTURAL ASSESSMENT				
Joint associated cracks	X			
Cracked slabs	X			
Shattered slabs	X			
Faulting	X		X	
Random cracking			X	
Longitudinal cracks			X	
Transverse cracking < 0,5m			X	
Blow -ups/failures/potholes	X		X	
Undulation/Settlement		X		X
Patching	X		X	
Pumping	X		X	
FUNCTIONAL ASSESSMENT				
Riding quality		X		X
Skid resistance		X		X
Drainage: Surface		X		X
Side		X		X
Shoulder condition	X		X	
OVERALL CONDITION	X		X	

(b) Discussion of listed desirable items in Table A1

The **texture** of the pavement surface plays a significant role in determining the ultimate skid resistance of the pavement. The drainage of water from the surface of the pavement is also influenced by the texture. Concrete pavers usually construct the pavement with a smooth texture. The surface therefore has to be roughened during or soon after construction to provide the desired texture. Various methods of macro texturing are used and these include tining (the provision of shallow grooves into the pavement surface), brushing, burlap drag or brooming of the newly placed concrete pavement or the removal of fine aggregates from the surface exposing the coarse aggregate. It is difficult to assess the texture from a vehicle. It is recommended that the texture of each section is closely inspected by stopping. A note should be made on the assessment form should the surface texture be very smooth or should the tining grooves be eroded away by traffic action. Tining grooves in a sound condition should generally be 2-5mm deep. Brushing or brooming should appear abrasive to the naked eye to be in a good condition. Where the texture was created by exposing the course aggregate, note should be taken that the aggregate is not polished to a shiny smooth surface.

Undulation/settlement data can be implied from riding quality measurements; their assessment is therefore not considered essential.

Riding quality data is considered essential for the calculation of a pavement condition index. Where measured riding quality measurements are available, these should be used in the calculation as they are more accurate than the rating of the visual assessor. However, if no measured data is available, the assessment of riding quality should be included in the visual assessment.

Skid resistance, the macro- and micro-texture of a road is very difficult to determine accurately from a visual assessment. However the visual assessment data could be used to indicate apparent severe problem areas. These areas could then be investigated further by instrumental measurements.

Surface drainage problems can be related to other defects, for instance shallow or no tining grooves or road cross-fall. It is very difficult to assess such problems under dry conditions.

Side drainage problems may result in pavement failure. It is often difficult to assess drainage outside the wet season. In some road management systems, data on side drainage problems are identified by the maintenance management system. However, it should be recorded if any overgrowth with vegetation, blockage of, or damage to the drainage structures occur.

1.6.3 DEGREE

The degree of a particular distress is a measure of its severity. Since the degree of distress can vary over the pavement section, the degree to be recorded should, in connection with the extent of the occurrence, give the **best average assessment of the seriousness** of a particular type of distress. The degree of distress for each distress type is discussed in detail in Parts B and C of this document. The parameters are given to indicate when a particular distress should be considered noteworthy of being recorded.

Degree of distress is rated in three formats:

(i) Firstly there are some defects where the actual degree rating is not recorded. The extent is recorded if the degree is worse than a defined minimum severity. An example of this format is the rating of blow-ups, failures and potholes (See section B2.3)

(ii) For some of the distress types the extent is recorded separately for two predefined degrees. An example is Joint Spalling (See section B1.1), where the extent of spalling is rated for moderate and severe degrees of spalling.

(iii) The third format of rating degree of distress is where the degree is recorded as the best representative assessment of the seriousness of the distress corresponding to the extent rating. This is similar to the format of rating used for flexible pavements (As in TMH 9). An example of how this format is used is the rating of cracking on continuously reinforced pavements (See section C2.1).

1.6.4 EXTENT

The extent of distress is a measure of how widespread the distress occurs over the length of the road segment. As with degree of distress different formats for the recording of extent of distress is used:

(i) Generally the extent of occurrence of distress on jointed concrete pavements is expressed as the number of pavement slabs or joints affected by the particular distress type per segment length (200 m). A detailed description of the extent of occurrence of each distress type is given under the relevant distress type in Part B of this document.

(ii) In the case of continuously reinforced concrete pavements the extent of most distress types is recorded by counting the number of occurrences per segment.

(iii) Other distress types found on continuously reinforced pavements are assessed in a manner similar to those on flexible pavements (TMH 9). A number from 1 to 5 is assigned to the distress type indicating the extent of occurrence over the assessment segment length (200 m) . For a detailed description of the extent of occurrence on continuously reinforced pavements see section C2.1 of this document.

1.7 SEGMENT LENGTHS

It is not the purpose of the assessment to identify uniform sections of distress on the road and to complete an assessment form for each of these uniform sections. The road network should be evaluated and compared according to previously identified road segments. The recommended standard segment lengths for rural and urban roads is given in Table A2.

TABLE 1.2: RECOMMENDED SEGMENT LENGTHS FOR DIFFERENT TYPES OF ROAD (RURAL AND URBAN)

TYPE OF PAVEMENT RECOMMENDED	SEGMENT LENGTHS(km)
Jointed concrete pavements (JCP)	0,200
Continuously reinforced concrete pavements (CRCP)	0,200

Example of typical segments (rural and urban)

A road segment is defined as a 0,200 km length of road beginning at a multiple of 0,2, eg. km 5,2 or 10,4 and ending at a multiple of 0,2, eg. 10,0 or 15,8. If the route/section begins, for example, at a municipal border and/or ends at a district border or crosses another route, the following rules apply where the distance from the border to the next multiple of 0,2 is less than 0,2 km. If it is less than 0,1 km in length, it is added to the next road segment and the specific length is considered, for example, km 9.77 to km 10.0. If the difference between the start and the next multiple is more than or equal to 0.1 km, it is regarded as a separate segment, for example km 4.85 to km 5.0 The same applies for the end of the route/section, for example, km 55.0 to km 55.23 and km 55.0 to km 55.16 would each be considered as a road segment. See Figure A1 for an illustration of this example.

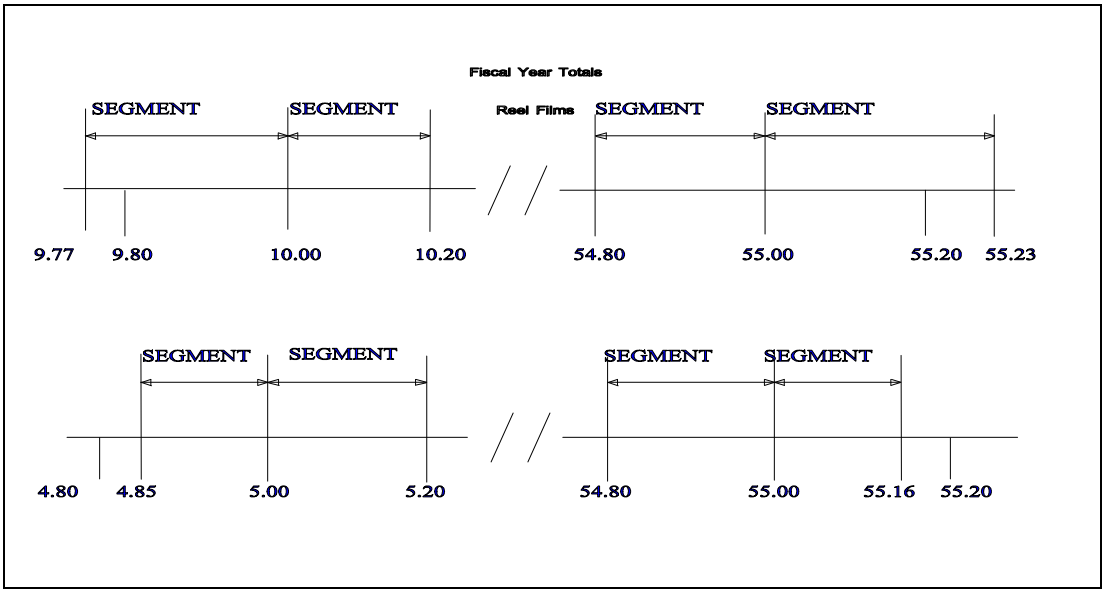


FIGURE 1.1: ILLUSTRATION FOR DEFINING SEGMENTS

1.8 ROAD SEGMENT INFORMATION

1.8.1 INTRODUCTION

The various items of road segment information that are required for the definition of a road network are presented in Table A3 together with an indication of importance.

NOTE: Some of the data described below is stored in the PMS data base and not all the items are required on the assessment form. Items that are printed on the assessment form, should where possible, be checked by the assessor to confirm the accuracy of the database.

TABLE 1.3: ROAD INFORMATION ITEMS

ITEM	IMPORTANCE OF ITEM	
	ESSENTIAL	DESIRABLE
Road number	X	
Name of assessor	X	
Start and end kilometer distance	X	
Date	X	
Road category	X	
Road classification	X	
Road type		X
District/region		X
Climate	X	
Terrain	X	
Road width	X	
Pavement structure	X	
Pavement age	X	
Shoulder width	X	
Traffic class	X	

1.8.2 ROAD NUMBER (essential item)

This item should cover the number of the road and section concerned, for example:

N001/01 N (National Route 1, Section 1, Northbound carriageway)

N004/12 E (National Route 4, Section 12, East bound carriageway)

If a dual carriageway is evaluated, each carriageway should be evaluated separately. The two carriageway segments will have the same road number and kilometer distances. The direction of travel relative to the distance markers should be used to indicate which of the two sections is evaluated. For example "N" after the road number would indicate that the traffic on the particular carriageway is travelling northwards. "E", "S" and "W" would similarly indicate East, South and West respectively.

1.8.3 NAME OF ASSESSOR (essential item)

The name(s) of the person or panel, in case of a panel inspection, carrying out the evaluation. This is useful for reference purposes should a problem occur.

1.8.4 START AND END KILOMETER DISTANCE (essential item)

The start and end distance of the segment is essential and should be recorded to the nearest 0,1 km.

1.8.5 DATE (essential item)

The month and year of when the evaluation is being done should be recorded in the format MM/YY eg. 05/93.

1.8.6 ROAD CATEGORY (essential item)

The road category should be defined according to a combination of parameters, such as importance, level of service, traffic and standard of construction. The road category information is used in data processing, for example, in the selection of the rehabilitation measure. Four road categories are described in Table A4. Refer to the TRH 4 document for detailed descriptions of the parameters used in the definitions.

TABLE 1.4: DEFINITION OF ROAD CATEGORIES

ROAD CATEGORY	DESCRIPTION RURAL (TRH4)
A	Interurban freeways, major interurban roads.
B	Interurban collectors, major rural roads, major industrial roads.
C	Lightly trafficked rural roads, strategic roads.
D	Light pavement structures, rural access roads.

1.8.7 ROAD CLASSIFICATION (essential item)

Roads can be classified into groups depending on their functional importance. A summary of the road classification system is given in Table A5. This information can be used for the presentation of PMS results.

TABLE 1.5: DEFINITION OF ROAD CLASSES

ROAD CLASSES	BRIEF DESCRIPTION
Level 1 (Primary)	Roads which provide mobility in the national context. Normal features: long distance traffic; high-speed design standards; and minimum interference of through traffic.
Level 2 (Secondary)	Roads which provide mobility in the regional context. Normal features: moderate distance traffic; slightly lower design standards than level 1; and links between towns not situated on level 1 road network.
Level 3 (Tertiary)	Roads which provide mobility in the context of a magisterial district. Normal features: short trips between district centres and between higher level roads.
Level 4 (Tertiary)	All local access roads providing only the local population access to the rest of the road network.

1.8.8 ROAD TYPE (desirable item)

The road type should be indicated according to the parameters listed in Table A6, for example: D2R, which would indicate a divided four lane (two lanes per carriageway) road with a rigid (Portland cement) shoulder.

TABLE 1.6: ROAD TYPE PARAMETERS

PARAMETER	OPTIONS (CODES)
Carriageway category	Divided (D) or Undivided (N)
Number of lanes per carriageway	1; 2; 3; 4; etc.
Shoulder	Rigid/Concrete (R), Flexible/Asphalt (A) or Unpaved/gravel (U)

1.8.9 CLIMATE (essential item)

The specific climatic region is indicated, according to TRH 4. In specific areas where microclimates are different from the macroclimates, the climatic rating should be adjusted accordingly. Provision has been made for localised 'very wet' areas. Climatic regions are given in Table A7.

TABLE 1.7: CLIMATIC REGIONS

CODE	CLIMATIC REGION
D	Dry
M	Moderate
W	Wet
V	Very wet

1.8.10 TERRAIN (essential item)

The terrain type is used for the calculation of excess user costs, and one of the types must be selected from Table A8. The terrain type is defined by gradient and/or curvature, always selecting the worst case. These are very broad guide-lines only. Refer to the CB Roads Manual for more detailed definitions.

TABLE 1.8: DESCRIPTIONS FOR TERRAIN TYPES

TERRAIN TYPE	GRADIENT	CURVATURE
Flat	Gradient mostly flat (<3%)	Curvature has no effect on vehicle running costs
Rolling	Generally medium gradient (<4%) with many sags and crests.	Significant curves for at least 30% of the length.
Mountainous	Generally steep gradient (<7%) with many sags and crests.	Very sharp curves for at least 30% of the length.

1.8.11 ROAD WIDTH (essential item)

The road width can vary over the length of a segment. However, unless otherwise indicated, the average width of the paved area should be recorded to the nearest 0,1 m.

1.8.12 PAVEMENT STRUCTURE (essential item)

There are four major pavement types, as defined in TRH 4 and they are given in Table A9. Only rigid (concrete) pavements are considered in this manual. It should be noted that two types of concrete pavement can be encountered and these are also listed in Table A9.

TABLE 1.9: CLASSIFICATION OF PAVEMENT STRUCTURES

CODE	CLASSIFICATION
PCC	Rigid pavements: - Jointed concrete pavements (JCP) - Continuously reinforced concrete pavements (CRCP)
A	Flexible pavement with an asphalt base
G	Flexible pavement with a granular base
C	Flexible pavement with a cemented base

1.8.13 PAVEMENT AGE (essential item)

The pavement age is classified in Table A10. The actual year of construction should be recorded in the data base.

TABLE 1.10: CLASSIFICATION OF PAVEMENT AGE

AGE CATEGORY	DESCRIPTION
	PAVEMENT AGE (years)
New (N)	< 5
Intermediate (I)	5 - 15
Old (O)	15 - 25
Very old (V)	> 25

1.8.14 SHOULDER WIDTH (essential item)

Information on the width of shoulder should be given by recording the average width of the paved and/or gravel shoulder to the nearest 0,1 m. Refer to section A1.4(c) for the definitions.

1.8.15 TRAFFIC

The traffic volumes are classified in Table A11. The actual traffic volumes should be recorded in the data base.

TABLE 1.11: CLASSIFICATION OF TRAFFIC

TRAFFIC CLASS	ANNUAL AVERAGE DAILY TRAFFIC (AADT) (Total two direction traffic)
T1	< 500
T2	501 - 1 500
T3	1 501 - 4 500
T4	4 501 - 13 500
T5	> 13 500

1.9 ASSESSMENT PROCEDURE AND QUALITY ASSURANCE

1.9.1 TRAINING/CALIBRATION OF VISUAL ASSESSORS

The accuracy of the visual assessment depends largely on the knowledge, experience and commitment of the assessors. To minimise the element of subjectivity and to ensure good knowledge of the assessment procedures, it is absolutely essential to train and calibrate all assessors annually before the visual assessments are carried out. The intensity and duration of the training session will depend on the experience of the assessors.

It is proposed that the training and recalibration session be held even if all the assessors were trained during previous years. Changes to the guidelines and procedures should also be presented and problems with the previous assessment should be discussed.

The training programme for assessors should include the following:

(i) An overview of the objectives of the visual assessment together with a brief description of the data processing procedures and applications of the final results.

(ii) An overview of the methods of assessment, including descriptions of the various types of distress and ratings for each type. The use of colour slides to show examples is recommended. The visual assessment manual should be studied by all before the start of the training session.

(iii) An overview of the format of the assessment sheet.

(iv) Practical training, assessing a number of road segments, preferably in different conditions. The inspectors should then complete the assessment for the remaining segments independently. Notes should be compared afterwards and problems should be discussed. If necessary, more segments should be assessed and discussed individually until reasonable agreement is reached.

In addition, it is advisable for each project leader to meet with all the assessors within days after the start of the formal assessment to check the initial assessments.

1.9.2 PROCEDURE FOR VISUAL ASSESSMENT

Visual assessments should preferably be carried out in or towards the end of the rainy season and over the same period each year. January to April would generally be suitable to carry out assessments. Surveys should be completed within limited periods, preferably only two to three months. The length of surveys should not exceed 60 km per day. Shorter daily lengths may be expected if the condition of the road is very variable. The best results are obtained with the assessors driving at a speed of less than 20 km/h on the shoulder, stopping at least once per kilometre.

To ensure an accurate assessment the inspection should be carried out by two trained people. Two persons enhance the safety of the assessors, as one could drive and keep an eye on the traffic, while the second assessor does the visual inspection. To ensure the safety of the assessors the vehicle must be equipped with an amber flashing light and reflective signs. The assessors must wear reflective safety jackets at all times when leaving the vehicle to inspect the pavement.

The first segment to be evaluated on a road requires a thorough orientation to adjust the assessor to the prevailing conditions, because the position of the sun (preferred from the rear), the amount and variability of cloud cover and a wet surface will influence the visibility of the defects (e.g. cracks). When the road is wet, it is difficult to observe distress and this leads to erroneous ratings; the survey should only be carried out under dry conditions.

To evaluate skid resistance, joint sealant condition and texture, it is necessary that the assessors stop at least once per kilometre. The assessor should leave the vehicle during these stops to examine the road more closely.

During the visual assessment of a segment, dots can be made on the assessment form in the appropriate positions to indicate any type of distress that is observed. At the end of a segment, these dots are used to mark an average degree of distress for each type of defect. After completing the form, the assessor should also check road segment information, i.e. the correct start and finish information, road width, etc.

1.9.3 FIELD CHECKING

A representative sample (say approximately 10%) of all the roads assessed should be checked independently to confirm the correctness of the assessments made. The checking could be done by assigning an inspection team or person to check all the other inspectors. Alternatively cross checking could be done where the inspectors each re-evaluate sections of road assessed by another inspector.

Roads for field checking should be selected from processed data, using highest priority roads in various rehabilitation/maintenance categories. Data errors shown by the data verification modules, which could not be solved in the office, should also be checked in the field.

2. DETAILED DESCRIPTION OF TYPES OF DISTRESS ON JOINTED CONCRETE PAVEMENTS

NOTE: Examples and the actual dimensions presented in Part B are given as guidelines only and should not be regarded as fixed rules.

2.1 SURFACE

This section covers the evaluation of the current visual condition of the surfacing.

2.1.1 JOINT SPALLING (essential item)

Joint spalling is the cracking and chipping of the edges of the slab at the construction joint. Extreme spalling results in the breaking of the slab edge along the transverse or longitudinal joints. Spalling does not extend throughout the whole thickness of the slab, but rather intersects the joint at an angle. The spalling could vary in depth from a few millimetres to more than 50 mm. Joint spalling could be a result of :

- foreign incompressible materials entering the joint. When thermal expansion or traffic loads are then imposed on the pavement, excessive stresses occur in the affected joints;
- disintegration of the concrete;
- over-working that results in weak concrete at the joint;
- poorly designed or incorrectly constructed load transfer devices such as misaligned dowel bars which prevent thermal movement;
- sub-base movement on undoweled pavements where vertical movement across the joint is possible;
- incorrect joint cutting operations during the construction stage.

Measurement:

The **extent** of spalling is measured by counting the number of joints classified as moderate or severely spalled separately. A joint where cracks indicate that spalling occurred, but the aggregate has not been removed from the joint, is still recorded as spalled. The **degree** of spalling is given in Table B1. The depth of the spalling does not influence the degree of spalling.

TABLE 2.1: THE DEGREE AND EXTENT OF JOINT SPALLING

EXTENT	DEGREE	DESCRIPTION
Number of spalls per segment	**Moderate**	Spalling that extends between 20 and 50 mm wide on either slab edge, irrespective of the length of spalling.
	Severe	Spalling that extends between 50 and 200 mm wide on either slab edge, irrespective of the length of spalling.

2.1.2 JOINT SEAL CONDITION (essential item)

The joint seals prevent water and foreign matter from entering the joint. Two types of seals are normally used. Field moulded sealants are formed by pouring the sealant into the joint. Factory moulded seals are compressed into the joint. Should water enter the joint structural damage could result and pumping of the sub-base is possible. Foreign matter entering the joint causes secondary defects in the form of spalling, blow-ups and eventually disintegration of the concrete. Joint seals that protrude from the joint also reduces riding quality and increases noise.

Measurement:

The **extent** of joint seal damage is not rated. The degree is rated as good (1), fair (3) or poor (5) per segment. Good indicates an undamaged seal while "poor" indicates a joint seal that has been damaged in any way. Examples of damage that occur include:

- seals that extrude from the joint;
- field moulded seals that lose bondage with the concrete and therefore lose the ability to keep water and foreign matter out of the joint;
- factory moulded seals that have lost their elasticity, leaving the joint open although the seal is still in place;
- seals that have torn or been damaged in any way.
- weed growth.

TABLE 2.2: DEGREE AND EXTENT OF JOINT SEAL CONDITION

DEGREE	DESCRIPTION
1 (Good)	No damage to seal. New or functioning adequately.
3 (Fair)	Not functional i.e. sagging, protruding, not adhering to concrete or torn.
5 (Poor)	Dislodged from joint.
EXTENT	Not rated.

In situ joint seal test for field moulded seals.

Method: Ruler test.

Place a steel ruler vertically into the joint. (Refer to Fig. A2). Exert enough pressure to allow proper contact between the sealant and the short edge of the ruler. Turn the ruler through an angle of between 20 and 40 degrees and maintain this position while inspecting the adhesion face. If this action is able to loosen the seal from the sides, it indicates that the seal is in a fair to poor condition and has lost its adhesive ability to stick to the concrete and prevent water and foreign matter to infiltrate the joint.

2.1.3 TEXTURE (desirable item)

Concrete road surfaces are textured (macro) to allow for drainage of surface water and improve skid resistance. The texturing could consist of any one of the following:

- Tinning, comprising of narrow - about 3mm wide - surface grooves on the pavement at close spacing. The tinning grooves could be transverse, longitudinal or angled. The depth of sound tinning is 3-6mm but could even be more in high rainfall areas;
- A roughened texture created by transverse brushing or brooming of the surface;
- Exposing the coarse aggregate in the concrete. This could be done by washing away the fine aggregate before the concrete completely hardens after construction or by removal of the fine aggregate with chemicals soon after construction;
- Grinding or cutting grooves into the surface;
- Burlap drag.

Measurement:

Stopping to inspect the pavement closely is recommended to assess the condition of the texturing. Measuring the depth of the tinning could assist in determining the condition of the surface. Good tinning is more or less as deep as a match thickness.

No special provision has been made for recording this defect and any problems with the texture should be noted under general comments on the assessment form.

A note should be made on the assessment form should the surface texture be very smooth or for instance the texture be eroded away by vehicle wheels. Tinning in a sound condition should generally be 3-6mm deep. Brushing or brooming should appear abrasive to the naked eye to be in a good condition. Where the texture was created by exposing the coarse aggregate, note should be taken that the aggregate is not polished to have a shiny smooth surface.

2.1.4 JOINT ASSOCIATED CRACKS, CRACKED AND SHATTERED SLABS

Jointed concrete pavements are designed to crack in a controllable manner at predefined positions, i.e. in the joints. Therefore uncontrolled cracking is considered as a distress. The extent of cracking is recorded by the number of slabs exhibiting the distress and three different situations of cracking are considered:

2.1.4.1 JOINT ASSOCIATED CRACKS (essential item)

Cracks that are associated with the joints, are recorded under this distress type. This crack type includes:

- Cracks that run parallel to the joint, less than 1,0m from the joint;
- D-shaped cracks starting and ending in the same joint;
- Corner cracks. At least one leg of the triangle formed where the crack and the two adjacent joints meet must be shorter than 1,0 m;
- Cracks on the edge of a slab which form the edge of the carriageway.
- Cracks that form where a joint should have been sawn.

Only the number of slabs with joint associated cracks are recorded. More than one joint associated crack on a single slab is therefore recorded as one slab with joint associated cracks.

2.1.4.2 CRACKED SLAB (essential item)

When only one crack appears in a slab and this crack is not associated with any joints as discussed in paragraph B2.1.1, the slab is recorded as a cracked slab.

2.1.4.3 SHATTERED SLAB (essential item)

When a slab contains two or more cracks that are not associated with a joint, the slab is recorded as shattered. The cracks, other than joint associated cracks, divide the slab into three or more distinct pieces.

Note: When a slab is recorded as shattered it can not be recorded as cracked. A slab with two joint associated cracks would not be classified as a shattered slab, but the cracks would be recorded as one slab with joint associated cracks. See figure B.1 for examples of how to record the different crack types. Do not rate other defects on a shattered slab.

The degree of distress is further divided into the following classification and is applied to each of the three situations described above.

- ***Open cracks:***

  Cracks that are easily discernable from a slow moving vehicle would be classified as open cracks. (<1mm)

- ***Spalled cracks:***

  Crack spalling has the same consequences as joint spalling but occurs at a crack. Spalling occurs under the same situations as described in paragraph B1.1. Added to this is traffic movement. The crack does not always extend vertically through the slab, but often extends down at an angle. The result is a small triangular section of concrete at the surface of the slab, which chips under traffic load to form spalling. Cracks that have spalled more than 20 mm on either side of the crack are considered to be spalled, irrespective of the spalled length.

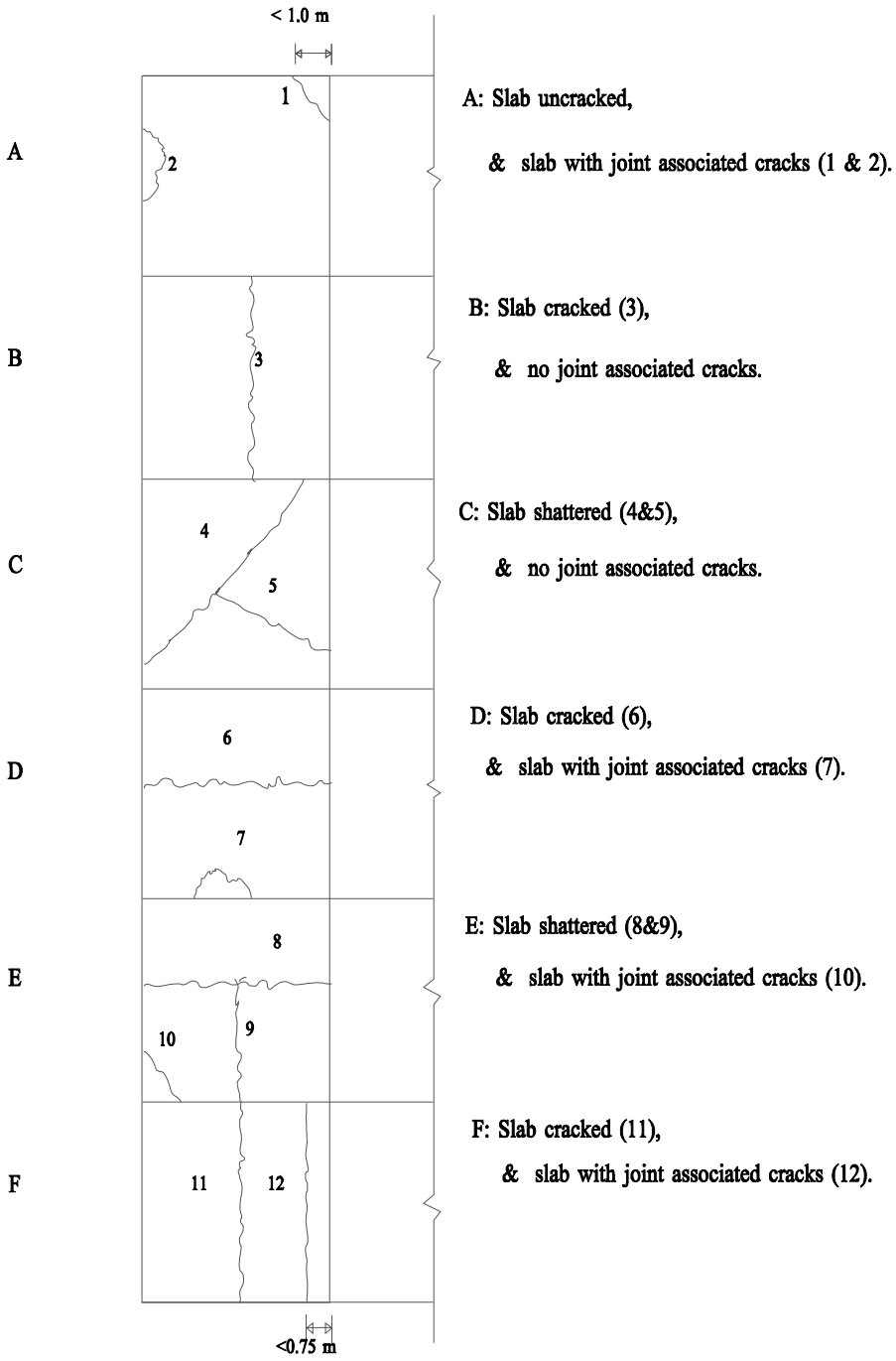
- ***Sealed or patched cracks:***

  Cracks recorded under this classification include cracks that have been sealed or patched with new material. Should a sealed or patched crack re-open it is classified as an open crack.

TABLE 2.3: DEGREE AND EXTENT OF CRACKING OF SLABS (JCP)

EXTENT	DEGREE
Record the number of: JOINT ASSOCIATED CRACKED SLABS OR CRACKED SLABS OR SHATTERED SLABS per segment	OPEN CRACKS - easily discernable from slow moving vehicle.
	SPALLED CRACKS - cracks that have spalled more than 20 mm, irrespective of spall length.
	SEALED OR PATCHED CRACKS

FIGURE B.1: DIAGRAMATICAL ILLUSTRATION OF CRACKING



NOTE: The cracks shown are all numbered. The numbers in brackets after the description indicate which crack(s) influenced the particular classification.

FIGURE 2.1: DIGRAMATICAL ILLUSTRATION OF CRACKING

2.1.5 FAULTING (essential item)

Faulting is the difference in elevation across a joint or a crack. When loose material builds up under the approach slab near a joint and/or the departure slab settles due to the material compressing or pumping out under the slab, the result is faulting. Faulting generally only occurs on pavements where there is no or poor load transfer between the slabs. The rocking, warping or curling of the slab contributes to the joint faulting and could also lead to cracking as secondary effect.

Faulting is most noticeable when you look back on the road or when the assessor looks in his vehicle's rear view mirror.

Measurement:

Both transverse and longitudinal joints are considered. The extent of transverse and longitudinal joint faulting is recorded by counting the number of joints, in a segment, where faulting is observed, distinguishing between the degree as moderate or severe, as defined in Table B4.

TABLE 2.4: THE DEGREE AND EXTENT OF FAULTING (JCP)

EXTENT	DEGREE	DESCRIPTION
Record number of slabs with faulting per segment	**Moderate**	Between 5 and 10 mm.
	Severe	More than 10 mm.

2.1.6 BLOW-UPS, FAILURES and POTHOLES (essential item)

Blow-ups, failures and potholes are recorded under one item when doing visual assessments. The maintenance required to rectify any of these defects is very similar and could therefore be assessed under the same item.

Blow-ups could occur at wide cracks (usually transverse cracks) and joints. When the slabs expand due to thermal forces, which are more than what the expansion joint can absorb, blow-ups develop. Blow-ups manifest as a result of the upward movement of the concrete and result in the shattering of the concrete or even crushing of the slab in that area.

Severely cracked slabs or cracked joints could lead to loose concrete (concrete failure) that is removed by moving traffic. This leads to potholes forming. A blow-up would under traffic loading eventually deteriorate to form a pothole.

Measurement:

The extent of the distress is recorded as the number of blow ups, failures and/or potholes occurring over each segment. The degree of the defect is not considered. To distinguish between a blow-up and a pothole forming is extremely difficult. It is therefore recorded as the same defect.

TABLE 2.5: DEGREE AND EXTENT OF BLOW-UPS, FAILURES AND POTHOLES (JCP)

DEGREE	Not rated.
EXTENT	Record the number of defects occurring per segment.

Note: Unfilled core holes should be rated as potholes.

2.1.7 UNDULATION/ SETTLEMENT (desirable item)

Undulations on and settlement of concrete pavements are surface areas having elevations lower than those of the surrounding pavement. There is generally significant slab cracking in these areas due to uneven settlement. This distress type is usually associated with another type of distress. Pumping at the joints would lead to joint faulting and this might result in settlement. Consolidation of the lower layers could lead to settlement, while alkaline aggregate reaction could cause undulations. Poor or uneven compaction during construction causes settlement and can frequently be found above culverts. Settlement of concrete pavements usually occurs over a couple of meters because of the rigid nature of concrete.

Measurement:

The area of settlement must be recorded under the general comments. Only settlement or undulations that are visible to the naked eye or that could be felt in the slow moving vehicle need to be recorded. Settlement or undulations of patches must not be recorded here but rather as described in paragraph B2.5. Most of the distress would be recorded while doing other recordings e.g. riding quality.

2.1.8 PATCHING (essential item)

If any portion of a slab, but not the entire slab has been removed and replaced by new material, it is considered patched. Patches could consist of either concrete or asphalt.

Measurement:

The number of patches occurring in each segment is recorded as the extent of patching. The size of the patch does not influence the classification. Three

distinctions for degree of patching are made and these are recorded separately as in Table B6.

TABLE 2.6: DEGREE AND EXTENT OF PATCHING (JCP)

EXTENT	DEGREE
Record the number of patches per segment	No defect. Concrete patches in good condition.
	With defects. Concrete patches that show signs of settlement, undulation, cracking and/or breaking up.
	Asphalt patch. Irrespective of condition

Note: Filled core holes should not be rated as a patch.

2.1.9 PUMPING (essential item)

Pumping is the ejection of water or material from under the pavement slab through joints and unsealed cracks, caused by the vertical movement of a slab under wheel loads. Water that has entered the cracks or joints acts as a lubricant and therefore promotes pumping. As the water is ejected, clay, sand, silt or even gravel is carried to the surface, resulting in the progressive loss of slab support. This loss of support under the slab leads to further cracking, the rocking of the slab and faulting.

The material pumped out usually stains the pavement surface and could also accumulate around cracks and joints. Water seeping out of cracks indicates the potential of pumping and should be rated as pumping.

Measurement:

The degree of pumping is not rated as a visual inspection of the pavement alone and is not sufficient to assess the severity of the defect. This is usually done with ground penetration radar. The extent of pumping is recorded as the number of slabs exhibiting signs of pumping. Pumping in cracks and joints is regarded similarly. Pumping from a joint between slabs is recorded as one slab with pumping.

TABLE 2.7: DEGREE AND EXTENT OF PUMPING (JCP)

DEGREE	Not rated.
EXTENT	Record the number of slabs per segment showing any signs of pumping

2.2 FUNCTIONAL FEATURES

The function of a road is to provide a service to the user. This section assesses the aspects that influence the standard of this service. When functional distresses appear in a pavement they affect the safety, comfort and travelling speed of the road user.

Features assessed in this section comprise riding quality, skid resistance, surface and side drainage and the shoulder condition.

2.2.1 RIDING QUALITY (desirable item)

The comfort or lack of comfort that the occupants of a vehicle travelling on a road experience is defined as the riding quality of the pavement. The factors that influence riding quality are the longitudinal unevenness of the road profile, the loss of surface material (e.g. blow-ups, potholes and scaling), and the quality of patches.

TABLE 2.8: DESCRIPTION OF DEGREES OF RIDING QUALITY (JCP +CRCP)

DEGREE	DESCRIPTION	APPROX. PSI*
1 (Very good)	Ride very smooth and very comfortable. No unevenness of the road profile or uneven patching.	>3.5
2 (Good)	Ride smooth and comfortable. Slight unevenness of the road profile or uneven patching.	3.0
3 (Fair)	Ride fairly smooth and slightly uncomfortable. Intermittent moderate unevenness of the road profile or uneven patching.	2.5
4 (Poor)	Ride poor and uncomfortable. Frequent moderate unevenness of the road profile or frequent uneven patching. Comfortable when driving below speed limit.	2.0
5 (Very poor)	Ride very poor and very uncomfortable. Extensive severe unevenness of the road profile or extensive uneven patching. Comfortable when driving much below speed limit, road unsafe owing to severe unevenness.	<1.5

* PSI: Present Serviceability Index.

Measurement:

It is not possible to accurately determine the riding quality doing a visual evaluation. The best method is to do separate riding quality measurements using the appropriate equipment. When this is not possible and no measured data is available, a value has to be assigned to riding quality by the assessors, doing the visual inspection. The riding quality is expressed as a number between 0 and 5. Table B8 gives a description of the degrees of riding quality.

2.2.2 SKID RESISTANCE (desirable item)

The ability of the road surface to prevent vehicles from skidding, is called skid resistance. Skid resistance is important to ensure the safety of road users. The texture (micro and macro) of the concrete pavement is the single most important property that influences skid resistance. While a smooth surface texture promotes good riding quality, a certain amount of roughness is needed to ensure that the pavement provides skid resistance. Surface drainage also influences the skid resistance. Water ponding on the pavement surface could lead to vehicles aquaplaning and water which drains slowly over the pavement could deposit mud and sand on the surface and fills the texture, creating a slippery surface.

Section B1.3 gives a description of the evaluation of the texture. Where the skid resistance seems to be inadequate, it should be recorded as a general comment together with the position of the area that exhibits this defect.

2.2.3 DRAINAGE

2.2.3.1 Surface drainage (desirable item)

The riding surface of the road should be kept clear of water. The drainage of the surface is influenced by the cross fall of the pavement, vertical sag-curves, undulations on the surface, condition of the texture and patches, as well as the maintenance immediately adjacent to the edge of the road surface. It is difficult to assess the surface drainage in dry conditions. A general comment should be made of any defect that could lead to water ponding on the riding surface; These include:

- Problems with horizontal or vertical alignment ;
- Patches or undulations that will retain ponds of water during rain;
- Shoulders (or at the edge of surfacing where shoulders are paved) that are too high or overgrown, lead to water ponding on the road.

The presence of sand and grit on the surface of the road after rain could indicate a possible problem with the surface drainage. Building up of material and grass on the

edge of the shoulder or grass that is placed too high or has grown too high also indicate possible drainage problems. These should be recorded as a comment on the assessment form for further investigation.

2.2.3.2 Side drainage (desirable item)

Side drainage is not considered a pavement distress type and is therefore not an indication of the pavement condition. Side drainage problems should be recorded as a general comment on the assessment form. Side drainage problems include overgrown, blocked, damaged and/or non-existent side drains.

2.2.4 SHOULDERS (desirable item)

The condition of the paved shoulder (>1.0m) is assessed separately from the rest of the pavement i.e., individual distresses on the shoulder are not recorded. There are two types of paved shoulders i.e. rigid (R) or flexible shoulders (A). The degree of the shoulder condition is noted as G, F or P. Table B9 gives the different degrees and extends of shoulder conditions.

TABLE 2.9: DESCRIPTION OF DEGREES OF SHOULDER CONDITIONS (JCP)

DEGREE	DESCRIPTION
Very good & good (G)	Very few or no structural defects.
Fair (F)	Few structural defects (These defects are not large defects)
Poor & very poor (P)	Many structural defects
EXTENT	NOT RATED.

Note: Paved shoulders <1.0m form part of the rest of the pavement.

2.3 OVERALL GENERAL CONDITION (essential item)

The overall condition of the road has to be assessed using Table B10. The relevant number indicating the general overall condition of the road should be recorded in the column provided on the assessment form.

TABLE 2.10: DESCRIPTION OF DEGREES OF OVERALL PAVEMENT CONDITION (JCP +CRCP)

DEGREE	DESCRIPTION
1 (Very good)	Very few or no structural defects.
2 (Good)	Few structural defects.
3 (Fair)	General occurrences of which most are severe. Only local occurrence if degree is severe.
4 (Poor)	General occurrence of defects of which a large number is severe.
5 (Very poor)	Many structural defects of which the majority is severe.

Note: Patches with no defect or sealed cracks do not influence overall condition

3. CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS (CRCP) – DISTRESS TYPES

NOTE *Examples and dimensions presented in this section are given as guidelines only and should not be regarded as fixed rules.*

3.1 SURFACE

This section covers the evaluation of the current visual condition of the surfacing.

3.1.1 JOINT SPALLING (essential item)

Joint spalling is the cracking and chipping of the edges of the slab. Extreme spalling results in the breaking of the slab edge along the joints. Spalling does not extend throughout the whole thickness of the slab, but rather intersect the joint at an angle. The spalling could vary in depth from a few millimetres to more than 50 mm. Joint spalling could result from the following:

- foreign incompressible materials entering the joint. When thermal expansion or traffic loads are then imposed on the pavement, excessive stresses occur in the affected joints;
- disintegration of the concrete;
- over-working that result in weak concrete at the joint;
- heavy repeated traffic loads.

Measurement:

The extent of spalling is measured by counting separately the number of spalls per segment. A joint where cracks indicate that spalling has occurred, but the aggregate has not been removed from the joint, is still recorded as spalled. The degree and extent of spalling is given in Table C1. The depth of the spalling does not influence the degree of spalling

TABLE 3.1: THE DEGREE AND EXTENT OF JOINT SPALLING (CRCP)

EXTENT	DEGREE	DESCRIPTION
Record the number of spalls per segment	**Moderate**	Spalling that extends between 20 and 50 mm wide on either slab edge, irrespective of the length of spalling.
	Severe	Spalling that extends between 50 and 200 mm wide on either slab edge, irrespective of the length of spalling.

3.1.2 JOINT SEAL CONDITION (essential item)

The joint seals act to prevent water and foreign matter from entering the joint. Two types of seals are normally used. Field moulded sealants are formed by pouring the sealant into the joint. Factory moulded seals are compressed into the joint. Should water enter into the joint structural damage could result and pumping of the sub-base is possible. Foreign matter entering into the joint causes secondary defects in the form of spalling, blow-ups and eventually disintegration of the concrete. Joint seals that protrude from the joint also reduces riding quality and increases noise.

Measurement:

The extent of joint seal damage is not rated. The degree is recorded as good (1), fair (3) or poor (5) per segment. "Good" indicates an undamaged seal while "poor" indicates a joint seal that has been damaged in some way. Examples of damage that occur include:

- seals that extrude from the joint;
- field moulded seals that have lost their bond with the concrete and therefore lost their ability to keep water and foreign matter out of the joint;
- factory moulded seals that have lost their elasticity, leaving the joint open although the seal is still in place;
- seals that have torn or been damaged in any way.
- hardening of the filler
- weed growth.

TABLE 3.2: DEGREE AND EXTENT OF JOINT SEAL CONDITION (JCP)

DEGREE	DESCRIPTION
1 (Good)	No damage to seal. New or functioning adequately.
3 (Fair)	Not functional i.e. sagging, protruding, not adhering to concrete or torn.
5 (Poor)	Dislodged from joint.
EXTENT	Not rated.

In situ joint seal test for field moulded seals.

Method: Ruler test.

Place a steel ruler vertically into the joint. (Refer to Fig. A2 p.26). Exert enough pressure to allow proper contact between the sealant and the short edge of the ruler. Turn the ruler through an angle of between 20 and 40 degrees and maintain this position while inspecting the adhesion face. If this action is able to loosen the seal from the sides, it indicates that the seal is in a fair to poor condition and has lost its adhesive ability to stick to the concrete and prevent water and foreign matter to infiltrate the joint.

3.1.3 TEXTURE (desirable item)

Concrete road surfaces are textured (macro) to allow for drainage of surface water and improve skid resistance. The texturing could consist of any one of the following:

- Tinning, comprising of narrow - about 3mm wide - surface grooves on the pavement at close spacing. The tinning grooves could be transverse, longitudinal or angled. The depth of sound tinning is 3-6mm but could even be more in high rainfall areas;
- A roughened texture created by transverse brushing or brooming of the surface;
- Exposing the coarse aggregate in the concrete. This could be done by washing away of the fine aggregate before the concrete completely hardens after construction or by removal of the fine aggregate with chemicals soon after construction;
- Grinding or cutting grooves into the surface;
- Burlap drag.

Measurement:

Stopping to inspect the pavement closely is recommended to assess the condition of the texturing. Measuring the depth of the tinning could assist in determining the condition of the surface. Good tinning is more or less as deep as a match thickness. No special provision has been made for recording this defect and any problems with the texture should be noted under general comments on the assessment form.

A note should be made on the assessment form should the surface texture be very smooth or for instance the texture be eroded away by vehicle wheels. Tinning in a sound condition should generally be 3-6mm deep. Brushing or brooming should appear abrasive to the naked eye to be in a good condition. Where the texture was created by exposing the coarse aggregate, note should be taken that the aggregate is not polished to have a shiny smooth surface.

3.2 STRUCTURE

3.2.1 FAULTING (Essential item)

Faulting is the difference in elevation across a joint or a crack. When loose material builds up under the approach slab near a joint and/or the departure slab settles due to the material compressing or pumping out under the slab, the result is faulting. Faulting generally only occurs on pavements where there is no or poor load transfer between the slabs. The rocking, warping or curling of the slab contributes to the joint faulting and could also lead to cracking as secondary effect.

Faulting is most noticeable when you look back on the road or when the assessor looks in his vehicle's rear view mirror.

Measurement

Both transverse and longitudinal joints are considered. The extent of transverse and longitudinal joint faulting is recorded using the same classification for extent as given in table C3.

TABLE 3.3: THE DEGREE AND EXTENT OF FAULTING (CRCP)

EXTENT	DEGREE	DESCRIPTION
Use TABLE C5	MODERATE	Between 5 and 10mm
	SEVERE	More than 10mm

3.2.2 CRACKING (Essential item)

Continuously reinforced concrete pavement is characterized by the presence of continuous steel reinforcement and by the absence of transverse contraction joints. Continuously reinforced concrete pavements are designed to crack transversely in order to distribute thermal and shrinkage movements. Transverse cracks appear in a fairly regular uniformly spaced pattern. Fine shrinkage cracks , with a crack width of less than 0,5mm do not affect the pavement strength as water usually will not ingress into such small cracks. Larger cracks seriously affect the performance of the pavement and may result in the following:

- Water could enter the pavement structure, which in turn would weaken the sub-base and eventually cause pumping.
- The ingress of water could cause corrosion of the reinforcement, which could lead to blow ups and also reduce the strength of the steel by decreasing its diameter.
- Although the appearance of a pavement does not affect its performance, cracked pavements are not pleasing to the eye of the public.

When stresses due to temperature and loading are greater than the strength of the steel, the reinforcement ruptures. Indications of sheared or decreased diameter reinforcement are faulted and/or wide spalled cracks. Wide cracks could be formed at any stage during the pavement life and could be caused by a number of factors, e.g.:

- The increase of traffic loadings to a level higher than what the original design was based on.
- Excessive shrinkage of the slab.
- Contraction cracks that are constrained by the ingress of foreign materials.
- The movement or settlement of the subgrade or sub-base.
- Sheared or stretched reinforcement steel.

Measurement:

Provision for three types of cracks have been made on the assessment form. The degree of distress for cracks is classified as a number from 0 to 5. The degree of cracking could vary over the length of the segment, the best representative degree of cracking should be recorded. Table C4 gives the description for the classification of degree.

- **Random cracks:** Random cracks are cracks that cannot be classified as transverse or longitudinal cracks. These include cracks that run at an angle to the direction of the pavement cracks that split into two (Y-shaped cracks) and any other crack that is not longitudinal or transverse cracks.
- **Longitudinal cracks:** Are those cracks that run parallel to the travelled direction of the pavement.
- **Transverse cracks:** Continuously reinforced concrete pavements are designed to crack transversely. Only those cracks at a closer spacing than 0.5m are considered as a defect. Wide transverse cracks (longer than 3mm) or spalled transverse cracks are also considered as a defect and must be recorded.

TABLE 3.4: DESCRIPTION OF DEGREE CLASSIFICATION FOR CRACKS (CRCP)

DEGREE	SEVERITY	DESCRIPTION
0	-	Only hairline cracks with no faulting, steel rupture or spalling.
1	Slight	Cracks distinguishable from vehicle. Only the first signs of distress are visible.
2	Between slight and moderate	
3	Moderate	Cracks are distinct. Start of secondary defects like spalling. Distress is notable with respect to possible consequences. Maintenance may be required in the near future.
4	Between moderate and severe	
5	Severe	Cracks are extreme (wide). Secondary defects are well developed (high degree of secondary defects) like spalling and faulting and/or extreme severity of cracking that could present a safety or tyre damage hazard. Urgent maintenance or rehabilitation is required.

The most important categories of degree are 1, 3 and 5. If there is any uncertainty regarding the condition, the cracking may be marked as 2 or 4 respectively. The extent of cracking is classified as a number from 1 to 5 as in Table C5 and a diagrammatical description is provided by Figure C1.

FIGURE C.1: DIAGRAMMATICAL ILLUSTRATI0N OF EXTENT

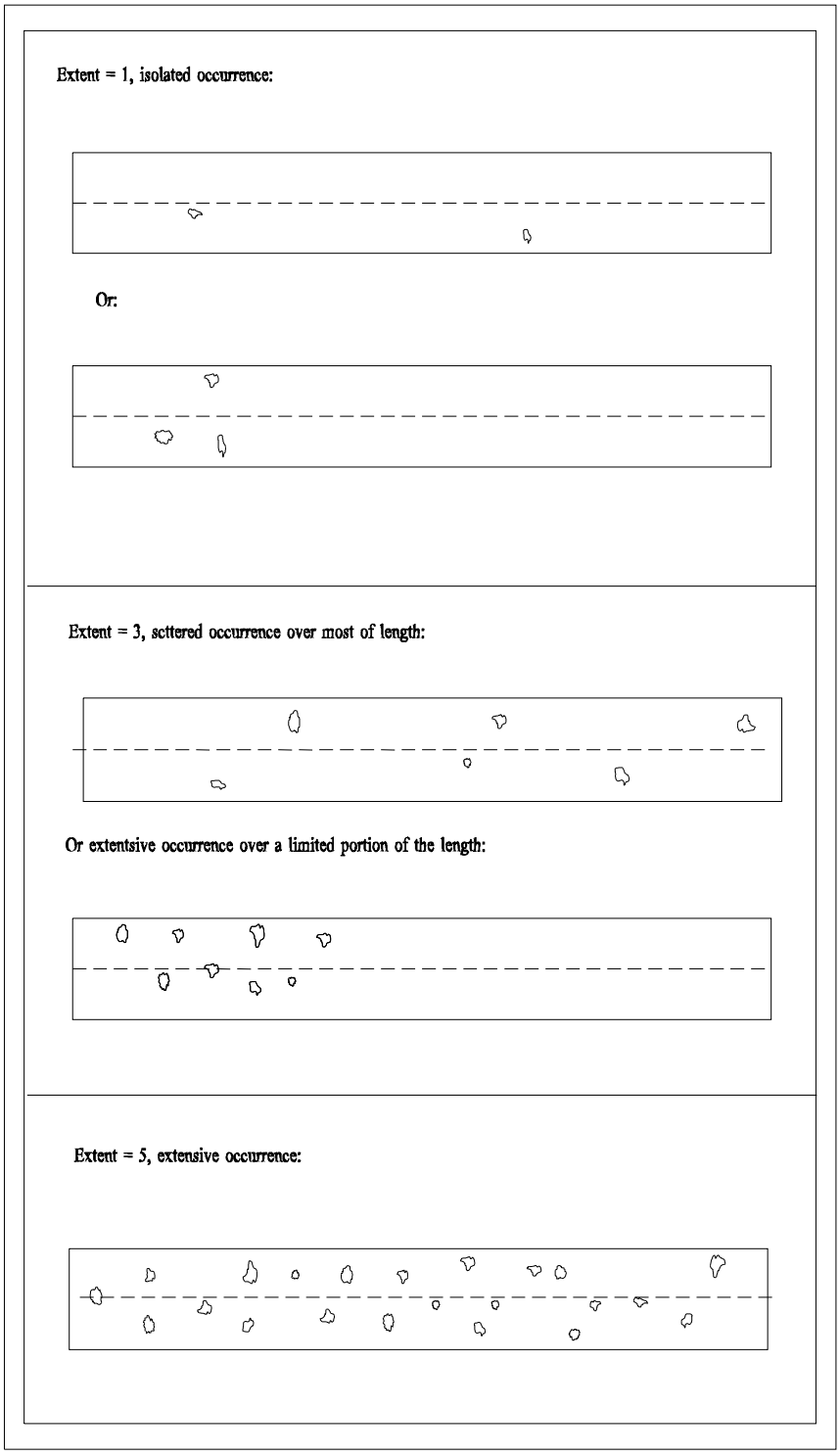


TABLE 3.5: GENERAL DESCRIPTION OF EXTENT CLASSIFICATIONS FOR CRACKS

EXTENT	DESCRIPTION
1	Isolated occurrence, not representative of the segment length being evaluated .
2	Intermittent occurrence over parts of the segment length (more than isolated).
3	Scattered occurrence over most of the segment length or extensive occurrence over a limited portion of the segment length.
4	More frequent occurrence over a major portion of the segment length.
5	Extensive occurrence over the whole segment length.

Examples of use of degree and extent

The following examples illustrate the combined use of degree and extent:

(i) If random cracking of degree 5 occurs seldom (i.e. extent 1) and random cracking of degree 3 occurs extensively (i.e. extent 5), the degree 3/extent 5 cracking is recorded as the best representative indication of the severity of random cracking over the specific pavement segment in terms of rehabilitation/maintenance action. In such a case the degree 5 cracking will be viewed as an area of localised distress requiring routine attention.

(ii) If longitudinal cracks of degree 5 and extent 2, and longitudinal cracks of degree 1 and extent 4 occur, degree 5 with extent 2 is recorded as the best representative indication of the problem that is most significant in terms of possible action. Cracking of degree 1 is not considered significant in terms of possible action.

3.2.3 BLOW- UPS, FAILURES and POTHOLES (essential item)

Blow-ups, failures and potholes are recorded under one item when doing visual assessments. The maintenance required to rectify any of these defects is very similar and could therefore be assessed under the same item.

Blow-ups could occur at wide cracks (usually transverse cracks) and joints. When the slabs expand due to thermal and/or moisture forces, which are more than what the expansion joint can absorb, blow-ups develop. Blow-ups manifest as the upward movement of the concrete and result in the shattering of the concrete or even crushing of the slab in that area.

Severely cracked slabs or cracked joints could lead to loose concrete (concrete failure) that is removed by moving traffic. This leads to potholes forming. A blow- up would, under traffic loading eventually deteriorate to form a pothole.

TABLE 3.6: DEGREE AND EXTENT OF BLOW-UPS, FAILURES AND POTHOLES

DEGREE	Not rated**.**
EXTENT	Record the number of defects occurring per segment.

3.2.4 UNDULATION/SETTLEMENT (desirable item)

Undulations on and settlement of concrete pavements are surface areas having elevations lower than those of the surrounding pavement. There are generally significant random cracks in these areas due to uneven settlement. This distress type is usually associated with another type of distress. Pumping at the cracks might result in settlement. Consolidation of the lower layers could lead to settlement, while alkaline aggregate reaction could cause undulations. Poor or uneven compaction during construction causes settlement and can frequently be found above culverts. Settlement of concrete pavements usually occurs over a couple of meters because of the rigid nature of concrete.

Measurement:

The area of settlement must be recorded under the general comments. Only settlement or undulations that are visible to the naked eye or that could be felt in the slow moving vehicle need to be recorded. Settlement or undulations on patches must not be recorded here but rather as described in paragraph C2.5. Most of the distress would be recorded while measuring riding quality.

3.2.5 PATCHING (essential item)

If any portion of the pavement has been removed and replaced by new material, it is considered patched. Patches could consist of either concrete or asphalt. A patch is classified as a portion of the pavement up to the full lane width but not longer than 15m.

Measurement:

The number of patches occurring in each segment is recorded as the extent of patching. The size of the patch does not influence the classification. Two distinctions for degree of patching are made and these are recorded separately as in Table C7.

TABLE 3.7: DEGREE AND EXTENT OF PATCHING

EXTENT	DEGREE
Record the number of patches per segment	No defect. Concrete patches in good condition, with normal cracking
	With defects. Concrete patches that show signs of settlement, undulation, wide cracking and/ or breaking up. Patches smaller than 1.0m^2 with normal transverse cracks.
	Asphalt patch - irrespective of condition.

3.2.6 PUMPING (essential item)

Vertical movement of the slab results in water or material being ejected from under the pavement slab through unsealed open cracks or damaged joint seals. Pumping occurs by the vertical movement of the slab when wheel loads pass over the pavement. Water that has entered the cracks acts as a lubricant and therefore promotes pumping. The loss of material from under the slab leads to further cracking and faulting.

The material pumped out usually stains the pavement surface and could also accumulate around cracks. Water seeping out of cracks indicate the potential of pumping.

Measurement:

The degree of pumping is not considered as visual inspection of the pavement alone is not sufficient to assess the severity of the defect. The extent of pumping is recorded using the same classification for extent as is given in Table C5. See Table C8 and illustrated in Figure C1.

TABLE 3.8: DEGREE AND EXTENT OF PUMPING

DEGREE	EXTENT
Not rated	Use table C5

3.3 FUNCTIONAL FEATURES

The function of a road is to provide a service to the user. This section assesses the aspects that influence the standard of this service. When functional distresses appear on a pavement it affects the safety, comfort and travelling speed of the road user.

The features assessed under this consideration include riding quality, skid resistance, surface and side drainage and the shoulder condition.

3.3.1 RIDING QUALITY (desirable item)

The comfort or lack of comfort that the occupants of a vehicle travelling on a road experience is defined as the riding quality of the pavement. The factors that influence the riding quality is the longitudinal unevenness of the road profile, the loss of surface material (e.g. blow ups, potholes and scaling), and the quality of patches.

TABLE 3.9: DESCRIPTION OF DEGREES OF RIDING QUALITY

DEGREE	DESCRIPTION	APPROX. PSI*
1 Very good	Ride very smooth and very comfortable. No unevenness of the road profile, or uneven patching.	>3.5
2 Good	Ride smooth and comfortable. Slight unevenness of the road profile, or uneven patching.	3.0
3 Fair	Ride fairly smooth and slightly uncomfortable. Intermittent moderate unevenness of the road profile, or uneven patching.	2.5
4 Poor	Ride poor and uncomfortable. Frequent moderate unevenness of the road profile, or uneven patching. Comfortable when driving below speed limit.	2.0
5 Very poor	Ride very poor and very uncomfortable. Extensive severe unevenness of the road profile, or uneven patching. Comfortable when driving much below speed limit, road unsafe owing to severe unevenness.	<1.5

* PSI: Present Serviceability Index.

Measurement:

It is not possible to accurately determine the riding quality doing a visual evaluation. The best method is to do separate riding quality measurements using the appropriate equipment. When this is not possible and no measured data is available a value has to be assigned to riding quality by the assessors doing the visual inspection. The riding quality is expressed as a number between 1 and 5. Table C9 gives a description of the degrees of riding quality.

3.3.2 SKID RESISTANCE (desirable item)

The ability of the road surface to prevent vehicles (executing normal manoeuvres) from skidding, is called skid resistance. The skid resistance is important to ensure the safety of the road users. The texture (micro and macro) of the concrete pavement is the single most important property that influences skid resistance. Where a smooth surface texture promotes a good riding quality, a certain amount of roughness is needed to ensure that the pavement offers a degree of skid resistance. Surface drainage also influences the skid resistance. Water ponding on the pavement surface could lead to vehicles aquaplaning and water slowly draining over the pavement deposit mud and sand on the surface which fills the texture creating a slippery surface.

Section C1.1 gives a description of the evaluation of the texture. Where the skid resistance seems to be inadequate, it should be recorded as a general comment together with the position of the area that exhibits this defect.

3.3.3 DRAINAGE

3.3.3.1 Surface drainage (desirable item)

The riding surface of the road should be kept clear of water. The drainage of the surface is influenced by the cross fall of the pavement, vertical sag-curves, undulations on the surface, condition of the texture and patches, as well as the maintenance immediately adjacent to the edge of the road surface. It is difficult to assess the surface drainage in dry conditions. A general comment should be made of any defect that could lead to water ponding on the riding surface; these include:

- Problems with horizontal or vertical alignment ;
- Patches or undulations that will retain ponds of water during rain;
- Shoulders (or at the edge of surfacing where shoulders are paved) that are too high or overgrown, lead to water ponding on the road.

The presence of sand and grit on the surface of the road after rain could indicate a possible problem with the surface drainage. Building up of material and grass on the edge of the shoulder or grass that is placed too high or has grown too high also indicates possible drainage problems. These should be recorded as a comment on

the assessment form, for further investigation.

3.3.3.2 Side drainage (desirable item)

Side drainage is not considered a pavement distress type and therefore not an indication of the pavement condition. Problems with side drainage could, however, lead to premature pavement failure. Side drainage problems should be recorded as a general comment on the assessment form. Included as side drainage problems are overgrown, blocked, damaged and/or non-existent side drains.

3.3.4 SHOULDERS (essential item)

The condition of the shoulder is assessed separately from the rest of the pavement. The individual distresses on the shoulder is not recorded. The degree of the shoulder condition is noted as a general comment. There are two types of shoulders, i.e. rigid (R) or flexible (A). Table C10 gives the different degrees of shoulder condition. The extent is not rated.

TABLE 3.10: DESCRIPTION OF DEGREES AND EXTENTS OF SHOULDER CONDITIONS

DEGREE	DESCRIPTION
Very good & good (G)	Very few or no structural defects.
Fair (F)	Few structural defects .
Poor & very poor (P)	Many structural defects.
EXTENT	NOT RATED

Note: Potholes with no defect or sealed cracks do not influence shoulder condition **4.**

3.4 OVERALL GENERAL CONDITION (essential item)

The overall condition of the road has to be assessed using Table C11 to define the degree of the condition. The relevant number indicating the general overall condition of the road should be recorded in the column provided on the assessment form.

TABLE 3.11: DESCRIPTION OF OVERALL PAVEMENT CONDITION (JCP+CRCP)

DEGREE	DESCRIPTION
1 Very good	Very few or no structural defects.
2 Good	Few structural defects.
3 Fair	General occurrence of which most are only local occurrences if degree is severe.
4 Poor	General occurrence of which a large number is severe.
5 Very poor	Many structural defects of which the majority is severe.

Note: Potholes with no defect or sealed cracks do not influence overall condition. **.**

4. EXAMPLES OF PAVEMENT ASSESSMENT FORMS

The assessment forms shown in this section are examples of the forms used by the Department of Transport. These are only typical examples and any other prescribed forms could be used.