Road pavement acceptance during construction

Guide note

NORTHERN TERRITORY GOVERNMENT

Document title	Road pavement acceptance during construction
Contact details	Department of Infrastructure Planning and Logistics
Approved by	Project Director Civil Assets Management
Date approved	29/11/2019
Document review	Annually
TRM number	2017/0362-0001.02

Version	Date	Author	Changes made
1.0	29/11/2019	Andrew Batson	New Template

Acronyms	Full form

Contents

1. Definitions

Pavement:	That portion of a road constructed for the structural support of, and to form the wearing surface, for traffic. The pavement structure refers to the pavement layers, in combination, above the subgrade surface, to support the traffic loadings. May be sealed or unsealed. Excludes the shoulders.
Subgrade:	The trimmed, treated or prepared portion of the formation (predominantly using the in-situ material available on site) on which the pavement is constructed. Generally taken to relate to the upper line of the formation
Sub-base:	One or more layers of material placed over the subgrade and below the basecourse extending for the full width of the pavement and shoulder.
Basecourse:	That upper-most layer of constructed material immediately above the subgrade or sub-base and below the pavement surface (sealed or unsealed) extending for the full width of the pavement and shoulder.
Formation:	The surface of finished earthworks on which a road pavement is constructed. It includes the earthworks, subgrade surface, the general shaping of the road and drainage.
Wearing surface:	The uppermost surface of a roadway that directly bears the tyre loads of travelling vehicles. In the NT, it is either a spray sealed surface or an asphalt surface. On unsealed roads, the wearing surface is the gravel base layer. Also known as the running surface.
Sealing work:	The activities undertaken to apply a finished spray seal wearing surface to a finished pavement. Includes supply of materials, application of binder and aggregates, rolling and after care, traffic management and other ancillary activities.

1.1. Applicability of this guide note

This guide note has been prepared to assist Departmental Supervisors and Superintendent's Representatives for the delivery of roadworks projects for the NTG Civil and Infrastructure programs. It provides commentary on key elements of the pavement finishing process to assist in decision making in the field.

It is also acknowledged that this Guide will be used by industry and local government for various internal and external purposes. Nonetheless, the language and context are mainly for operational supervisors and superintendents representatives involved in project delivery.

2. Introduction

The objective of this document is to assist Departmental staff to understand the process of accepting a reworked or newly constructed road pavement, that meets the intent and requirements of the Standard Specification for Roadworks (the Specification), and so is considered suitable for construction of a bituminous wearing surface.

Fundamentally, pavement acceptance is not part of the wearing surface construction.

The various activities that form the two distinct phases of pavement works and surfacing works are summarised in the following table.

Pavement Works **(Section 6 of Spec)**	Winning, hauling, placing pavement materials Stick picking Moisture conditioning Mixing and compaction Final trimming Survey for level control Conformance Requirements are a HOLD POINT: 1. Layer Integrity 2. Conformance Testing 3. Proof Rolling 4. Dry back 5. Surface Roughness 6. Other tolerances Rotary brooming and final pavement surface preparation. Other tolerances need to be met. **A HOLD POINT exists at this point, termed 'PAVEMENT ACCEPTANCE', to be signed off by the Department.**
Sealing Works **(Section 8 of Spec)**	Ball Penetrometer testing for Seal design (8.13.3) Final preparation with sweeping (this is not brooming) (8.6) Dampening pavement (8.6) Prime Seal coat(s) Rolling and Brooming after sealing Aftercare Conformance Testing (as a minimum): 1. ALD, Flakiness, grading of aggregate 2. Bitumen Quality **A WITNESS Point exists prior to spraying, and requires the contractor to give 48hrs notice of spraying work. (8.13)** **A HOLD POINT exists on the application rates to be sprayed. (8.13)**

3. Specification requirements

There are two relevant sections in the Specification that cover the two distinct phases of construction relating to Pavement Acceptance.

Firstly, the 'Pavement and Shoulders' chapter sets out requirements as follows:

> *6.7.1 - Conformance Requirements – Hold Point*
>
> *Hold point – Obtain the Superintendent's approval for pavement and shoulders acceptance prior to any surfacing work, including satisfying all requirements for:*
>
> - *Proof Rolling*
> - *Conformance Testing*
> - *Dry back*
> - *Final Pavement Layer Integrity*
> - *Surface Roughness*
> - *Other Tolerances*
>
> *For unsealed pavements, obtain the Superintendent's approval for pavement conformance at conclusion of pavement works.*

Secondly, the 'Spray Sealing' chapter sets out requirements as follows:

> *8.6 - Preparation of Pavement*
>
> *Remove raised reflective pavement markers. Repair any damage to the pavement surface caused by the removal of raised reflective markers with an emulsion/sand mixture before sealing.*
>
> *Remove deleterious materials, rocks, refuse and organic materials such as timber, branches, roots and the like by manual stick picking methods.*
>
> *Sweep the entire pavement surface to remove loose stones, dust, dirt and foreign matter immediately before spraying.*
>
> *Do not use steel brooms on Fine Crushed Rock type or low plasticity type materials nor on Airstrips.*
>
> *Maintain the prepared surface.*
>
> *Remove adherent patches of foreign material with a steel scraper.*
>
> *Dampen the prepared surface lightly immediately before spraying (for priming and primersealing only)*
>
> *Remove water from the surface of primed or sealed pavements before applying binder.*
>
> *Do not allow traffic on the prepared surface.*

These two sections are complimentary, and do not contradict each other. It is important to understand that the acceptance of the pavement is an activity covered under the Pavements and Shoulders section of the specification, and the hold point relates to that. The preparation activities that are called up in the Spray Sealing section, are only activities that principally enable the prime to be sprayed in readiness for the final coat(s). The difference between brooming and sweeping is an important one. The Spray Seal clause essentially assumes that the pavement has been prepared, tested, broomed and accepted. Sweeping is only to remove foreign matter that has fallen onto the pavement, especially leaves and settled dust or moisture, and is done with a light nylon broom.

4. Workmanship tips and expectations

a. General

The pavement is constructed of either natural gravel or fine crushed rock, and can consist of 1 to 2 layers which may include the Sub Base, Base Course and a Wearing course. The wearing course is the seal coat or asphalt layer.

To achieve a uniform and homogeneous pavement it is critical that the Sub Base and Base materials are mixed uniformly and have even moisture content throughout. This ensures that in the longer term, the pavement will equilibrate to its environmental moisture content in a uniform way. From a construction perspective, uniform moisture ensures uniform levels of compaction are achieved, provided a consistent level of compactive effort is applied.

Proof rolling is a good tool to ensure construction layers are uniformly mixed and they do not have excessively high moisture content particularly when working natural gravels. Areas of excessive moisture under proof rolling will cause visible deformation as material bulges, cracks or displaces like a sponge. Proof rolling is a requirement of the specification and should be completed on all pavement layers when the pavement is still green prior to dry back. The timing of proof rolling is often done concurrently with conformance testing, depending if the contractor has undertaken process or final conformance testing. The key issue is that proof rolling is done when the pavement moisture contents are still high and close to optimum when the pavement was worked and compacted. When the moisture content is still in this range and newly compacted, the pavement is considered 'green'. Proof rolling of Fine Crushed Rock base layers is a careful operation, and is discussed below.

Construction of the final layer is recommended to be slightly higher than finished surface level so the final trim is a cut to expose the stone within the base materials. This will also avoid the creation of laminations. Laminations or "false layers" is material which has not been constructed in an adequate thickness to provide any structural support in the pavement layer. Laminations lead to premature failure of the pavement, as the layer does not act as one uniform structural layer.

A good tool for checking for laminations is to firmly tap the surface with a vertical pick handle. Should a dull hollow sound be heard when dropped from a height of about 30cm, this will generally mean there are laminations. Also, should a hard dull sound be heard this could also indicate that the pavement has not sufficiently dried back.

The general order of activity is as follows:

1. Pavement material is placed, mixed, moisture conditioned, worked, compacted and process tested.
2. Surface is trimmed to near level tolerances
3. Proof rolling and conformance testing (compaction and bulk sampling to check material properties) when pavement is still green
4. Roughness testing
5. Brooming of the final surface
6. Dry back with testing, including ball embedment

b. Brooming v Sweeping and other on-site considerations

It is the Department's policy that all prepared basecourse surfaces are to be rotary broomed before any priming or sealing works take place, including Fine Crushed Rock base layers. Please seek advice from the Bitumen Surfacing Group if for any reason the surface cannot be broomed. An example would be a gap

graded pea gravel, with high silt content, but this situation is rare. The requirement for brooming is called up under Section 6. Brooming removes the surface fines and exposes the matrix of harder stone. It produces a lot of dust in the process, but will ideally lead to exposing a tight hard surface with harder gravel visible (refer attached photos).

Sweeping refers to the preparation of the pavement prior to sealing work, and is called up under Section 8. Its purpose is to remove loose foreign objects or dust from the pavement prior to priming or primersealing. Often it is required to remove leaves, litter, ash, and other items blown onto the pavement.

In many instances however, these two distinct activities are combined, given the spray sealing sub-contractor will mobilise to site with a broom as part of the priming operation. This has the unfortunate situation arise whereby if the brooming operation is being done for the first time, it may reveal defects in the pavement, and will thus render the pavement 'Not Accepted', yet the prime truck is ready to spray. This places the Supervisor under duress to accept a pavement for priming that does not meet the requirements of a tightly bonded, uniform, defect free surface. Similarly, the brooming may reveal laminations that cannot be accepted or simply 'matted out'.

Brooming forms part of the Hold Point, and the site supervisors should enforce it. It is a matter for the Principal Contractor to deal with the costs to re-mobilse the spray seal sub-contractor, after the pavement has been rectified and re-presented for acceptance. The Principal Contractor has taken the risk that brooming and sweeping are done as one in the same activity.

Often the suggestion arises from the Principal Contractor, or even the spray seal subcontractor, that defects in the pavement can be matted out using small sized stone and emulsion seal, or even correction asphalt. This should not be accepted by the Site Supervisor. These forms of rectification leave the surface rough and prone to future potholing. From an asset management perspective, the pavement life is greatly reduced and adds significantly to the running costs of the road. What is perceived as a saving for the Contractor, actually becomes a cost to the Department in the long term.

c. Fine crushed rock basecourse layers

The finishing of Fine Crushed Rock pavements present particular challenges. This arises because the fines content is generally of low plasticity, and may even be non-plastic. Plasticity Index (PI) values of 1 to 6 are called up in the Specification, but often the values are 2 or lower. This means that producing a tightly bonded surface relies on mechanical interlock of the particles rather than a 'glueing' effect of the clayey component.

Proof rolling needs to be carried out in a narrow moisture content window, and timing is important. As FCR layers are usually compacted well above OMC, there can be noticeable movement and squelching of a surface slurry layer under rollers even when close to 100%MMDD. It is not desirable to proof roll when the moisture is still at this elevated condition, however, neither is it desirable to do proof rolling when the pavement has dried out and close to the dry-back condition. The challenge for FCR layers is that this difference may only be a few days, particularly in the hotter months. Unlike natural gravels, continued rolling will also bring moisture to the surface, and hasten the drying out of the pavement. For Supervisors, they need to remain vigilant to timing of finishing of the FCR layer and the amount of ongoing rolling, to ensure testing is done "not too wet, and not too dry". In terms of OMC, the most suitable time for proof rolling would be approximately 1 to 2% dry of OMC (noting that in the dry back condition, the top 75mm is often 3 to 4% dry of OMC).

Due to the low PI of FCR, they are prone to ravelling and dusting up when they are dried back after compaction and final trimming, even under modest construction traffic, and certainly under traffic

conditions on projects with no detour. Accordingly, brooming needs to be done very carefully and skilfully. The best starting point is to adopt a light brooming methodology, using nylon bristled brooms, at low rotational speed, only just lightly touching the pavement surface. This can be adjusted to suit the conditions. It may take several sets of passes to do the operation, rather than trying to broom all material in one set of passes. Several passes with a very light broom has been used effectively to achieve an acceptable surface, but needs close supervision.

When the wearing surface is spray seal, getting the brooming done correctly is essential. An asphalt wearing layer is a little more forgiving, but best endeavours should be made even for asphalt.

d. Other workmanship considerations

When construction of the basecourse takes place, the Department has an expectation that the Principal Contractor will implement best practice techniques. Project Supervisors should monitor all these stages of the construction.

When supervising basecourse construction, the following should be borne in mind.

Lamination Issues	• Lamination is a common problem when the shaping or final trimming stage is happening, especially if design levels have not been reached after compaction. This occurs when the final trim grader operator drags material (mainly fines) across the top of the road to achieve correct levels, thus creating a false unstable layer that has not interlocked into the surface below, (refer photo's 5-8). • Do not allow the surface to be "slurried" just to make it look good. (refer photo 5) • This slurry technique just brings the fines to the top and it has no resistance to the impact of the traffic on the aggregate, because there is no mechanical strength. The sealing aggregate will punch into the base course and you will end up with a flushed or bleeding seal. • For some materials, proof rolling may expose a surface lamination in the form of crocodile cracking.
Compaction Issues	• Problems arise with sheep foot or pad foot type rollers when used on the base course compaction process as they leave uneven compaction zones and indentations due to compacting from bottom up, (refer photo 6). Sheep and pad foot rollers are better suited to fill and subgrade layers. • If sheep foot rollers are used, the multi tyred and flat drum rollers can't successfully compact into sheep foot holes as they will straddle the indentations and not achieve a suitable compaction for sealing (refer photo 9). These uncompacted holes will allow the aggregate to punch into the pavement and you will end up with a flushed or bleeding seal. • The preferred method for the base is to use multi tyre rollers as they compact from the top down, and knead the material into place. Flat drum rollers can be used, but careful finishing is needed to tighten the top surface. • It is always preferable for the surface to be finished off with a multi-tyred roller rather than a smooth drum. The multi will work and

	tighten up the surface really well. Smooth drum rollers can usually get density into a layer, but are not as effective in tightening up the top surface. • Repair density test holes using stabilised material, suitable compacted and finished off.
Shape and Tolerance Issues	• The pavement needs to be constructed to the designed cross fall and shape. • The spray sealing will not readily correct irregularities in shape and laminations within the base course. • Out of shape pavements will increase the likelihood of false pavements and laminations.
Ongoing Watering	• It is common practice to water the surface of a finished pavement to hold it close to the dry back condition. This is especially important if long lengths of road are being held until sealing. • This is carried out to ensure the dry back does not occur to the extent that deep cracking and ravelling start to occur. • Keeping moisture up to the surface with 'regular' watering does not saturate the pavement, but just serves to hold the surface together in the dry back condition, and hold the overall moisture condition at a level that suits later longer term moisture movements. • If ongoing watering is overdone such that the surface is softened and grooved by tyres of construction traffic, this needs to be corrected prior to surfacing.
Brooming and final acceptance issues	• Ensure the pavement is free of tearing, longitudinal depressions and grader blade cut marks. Generally created at trimming stage from large rocks and or sticks etc. • Excessive roots and sticks in the pavement can also cause pavement failures into the future due to the rotting of the materials and the creation of voids in the pavement surface. These should be removed during the screening operation in the gravel pit, or by intentional and effective stick picking when laid out on the formation. • The final surface has to be uniform after brooming. It should *not* have patches where the base course loose stone is exposed in one section and a slurried look in others (refer photo 10). • Brooming on different surfaces need different techniques, for new works brooming should only be performed with nylon bristles, no steel bristles should be used. For Fine Crushed Rock or low plasticity materials the brooming has to be very light, whereas high plasticity natural gravels the brooming may have to be heavier to remove the fines on top. • The final surface should be hard dense and have a stone mastic look to it, you should see the stone in the gravel, this stops the aggregate punching into the pavement (refer photos 1-4). • Remember that brooming is part of the ***pavement construction process***, not the ***sealing process***.

	• Before acceptance of the pavement by releasing the Hold point, ensure brooming takes place. If you are not sure of the integrity of the pavement then test with a hand broom or encourage the contractor to bring in a broom earlier before sealing crew arrive on site.
Engineering Judgement	• Historically, the NT has relied on pavement materials that have known workmanship characteristics that are overcome with good construction practice. The range of manufactured FCR materials, laterite gravels, calcrete gravels, and even sand clay, do not present too many surprises or difficulties to experienced contractors. • If a contractor suggests a 'material cannot be compacted to the required density', this is generally because the moisture condition of the material is not being suitably managed. It is likely the material is dry of optimum, and suitable curing has not been undertaken to ensure uniform moisture contents. • Generally our issues relate to grading and plasticity concerns, with few density/compaction issues arising. • There may be rare occasions when engineering judgement is required to accept a pavement layer that may not be in accordance with all specified requirements (for example, proof rolling of a remote re-gravel project, or construction under traffic that limits roughness surveys, proof rolling or dryback testing). Experienced advice should be sought in all such situations, as the long term asset performance needs to be considered in decisions to accept the pavement. Short term decision making to accept a pavement without consideration of all compliance issues, invariably leads to early intervention to rehabilitate or re-surface.
Wet Season Construction	• If pavements are being constructed and sealed during the wet season, there will be particular challenges in achieving the desired pavement surface. • Ball embedment values could exceed the 3mm target, and full dry back may be difficult to achieve. Various strategies can be employed to control these risks, and engineering judgement should be applied if sealing cannot be deferred. • Various treatments such as use of emulsion seals, armour coating with a small sized aggregate (<7mm), modification with lime and staged sealing may have to be considered.

e. Measurement & payment

New versions of the Specification will call up a scheduled item for the payment of 'Pavement Acceptance'. This seeks to encourage contractors to explicitly price the plant, labour and time to manage the pavement acceptance processes.

5. Process and conformance testing

Process control testing is carried out by the Contractor (at their cost) as a means to build confidence in their placement and compaction methodology in order to meet the specification requirements. This is

distinct from conformance testing that is used to determine compliance with the specification in order to release a hold point.

Ideally, process control testing is done by the Contractor early in the project when the won materials are being worked, and optimal moisture contents and rolling patterns are determined. However, sometimes the contractor will call up conformance testing as a means to ascertain if they have developed an appropriate methodology. Rather than carrying out process control testing, and then presenting the pavement for conformance, conformance testing is done through the methodology and may be premature.

For supervisors, providing encouragement to the contractors to undertake process control testing through the early stages of a project to establish their methodology is of high value to all parties. It reduces risk to the project, and disputes over testing rarely occur.

All pavements must be tested for conformance, and test results compiled together before sealing begins. The pavement hold point should not be released without all tests received and conforming, including survey, and at times, straight edge testing where required.

The following tests are mandatory as part of the Pavement Acceptance process, and are outlined in the Conformance section of the standard Specification.

Compaction (usually 100% MMDD for base)	• If not achieved, rutting, flushing and bleeding will likely occur. The pavement layer is also prone to moisture ingress and softening which may lead to seasonal road closures or weight restrictions.
Material Quality (Grading, PI, CBR etc)	• Ensure materials will perform according to the design expectation.
Dry Back	• Allows the pavement to "Bake" out as such, to release moisture • If not achieved then the moisture will come to the surface below the seal and the aggregates will punch into the pavement • This also indicates there is *hardness* in the surface

Ball Penetration	• If greater than 3mm seek specialised advice from Bitumen Surfacing group (see discussion below)
	• Austroads Guide indicates if greater than 3mm:
	  ○ Re rolling will be required
	  ○ False pavement maybe present
	  ○ It is not hard and dense

Roughness	• Refer to Panel Contract for Materials Testing, Schedule C.
Survey	• This is a requirement in the specification, the works need to meet certain criteria you should have this information before any sealing works take place

a. A Note on 'Hardness v Density'

It is important to remember that surface hardness does not equate to density. They are distinctly different properties.

Hardness of the surface is a function of its moisture content at any given time, and ideally, we want the pavement to dry back to induce a good surface hardness. A pavement with good hardness provides surety about the spray seal design and performance.

Density however, is related to how tightly the soil particles are compacted together. We specify relative density requirements to ensure the pavement layer will have the strength and modulus to support the wheel loadings over its full 30 year life.

Do not accept a pavement that fails on the relative density requirements, but appears hard and strong on the surface.

b. A Note on Ball Embedment Testing

Ball embedment testing has been used in the NT as part of the seal design process to determine bitumen spray rates for the seal coat. There has been a general rule of thumb, that if embedment values exceed 3mm, then the pavement is not suitable for sealing. This has reflected requirements in other State Road Authority specifications, as well as Austroads seal design guidelines.

In new versions of the Specification, the 3mm requirement is now formally part of the pavement acceptance process. The 3mm requirement represents an absolute upper limit for any test, there is to be no averaging. However, well constructed pavements in the NT will generally give values less than 2mm, and a 1mm target remains preferred. In other words, whilst 3mm is set as an acceptance criteria, good workmanship should produce values much lower than this. For example, the pavement surfaces shown in Photos 1 and 2 will have embedment values less than 1mm.

6. Seal design request

All spray sealing in the NT shall have a seal design performed.

Current practice is for competent Departmental staff in the Bitumen Group to perform this task and record the information supplied and endorse the design.

The Bitumen group must have the correct information from the Project Officer to provide a correct design.

7. Photos

1. A good, tightly knitted, uniform surface for sealing

2. A good surface for sealing, showing plenty of coarse aggregate

3. A primed surface, ready for seal coat. This looks to be a good surface, nice and uniform, with exposed stone evident.

4. This primed surface looks uniform, with exposed stone and the prime is well penetrated. Note a machine/vehicle has turned on the surface without scuffing or tearing, so it is hard, tight and dense, ready for seal coat.

5. This primed surface looks blotchy and variable in quality. It is likely that too many fines are on the surface and the prime has sat up. The presence of fines possibly hides inconsistencies below.

6. This broomed surface has exposed a number of problems. It is evident that a pad foot roller has been used, and fines have been dragged over the surface to hide the indentations. The highly variable surface finish is also a problem from a seal design point of view.

7. Brooming has exposed a problem area. It is likely that the surface was low, and fines have been worked into the depression, but have torn away on brooming revealing the lamination. Elsewhere the pavement looks reasonable.

8. This is similar to Photo 7 above. Brooming has pulled away material to expose a lamination caused by correction of the shape during trimming and finishing.

9. Brooming has revealed a problem with the shoulder. It appears that the shoulder wasn't tightened up with the multi tyre roller in the same way the pavement was done. There is a good amount of stone in the pavement.

10. The broomed surface reveals a zone of loose material, likely to be a result of final trimming and shape correction between two harder areas. Elsewhere, pavement looks reasonable.

11. This situation must be avoided. The contractor has had a problem with level control, and has created a nasty lamination to achieve final pavement levels. To make matters worse, the final inspection occurred after priming, when the situation was exposed due to 'drummieness' with an axe handle.

12. This primed surface has failed under light construction traffic (compare photo 4). The prime looks a bit fatty and sitting high, suggesting the pavement may not have been effectively broomed, or the surface was slurried up to create a weak zone at the surface.