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Transport Infrastructure Ireland

TII Publications



Rolling Crown Construction Methods

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Document Attributes

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NRA DMRB and MCDRW References

For all documents that existed within the NRA DMRB or the NRA MCDRW prior to the launch of TII Publications, the NRA document reference used previously is listed above under 'historical reference'. The TII Publication Number also shown above now supersedes this historical reference. All historical references within this document are deemed to be replaced by the TII Publication Number. For the equivalent TII Publication Number for all other historical references contained within this document, please refer to the TII Publications website.

Interim Advice Note 11/16

Rolling Crown Construction Methods

January 2016

Summary:

This NRA Interim Advice Note (NRA IAN 11/16) provides guidance on the best practice approach to the construction of rolling crowns on the National Road network, and requirements for designers and contractors in the completion of the proposals for such works. It is intended that the use of this NRA IAN 11/16 will enhance the compliance with pavement surface tolerances at rolling crowns while acknowledging other important considerations such as driver comfort and avoidance of excessive pavement joints in surface courses.

NRA INTERIM ADVICE NOTE 11/16
ROLLING CROWN CONSTRUCTION
METHODS

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1. INTRODUCTION

- 1.1 This NRA Interim Advice Note has been prepared to provide guidance on the methods of construction of rolling crowns, and requirements for designers and contractors in the completion of the proposals for such works, to ensure that they are constructed in accordance with industry best practice.
- 1.2 This Interim Advice Note introduces concepts relating to pavement joint layouts to be implemented up to and including the binder course at rolling crowns to enhance compliance with pavement tolerance requirements contained in the NRA Series 700. These concepts are intended to provide guidance on how to plan joint layouts, but are not intended to be the only joint layouts permitted. Designers and contractors must assess every rolling crown with consideration of site specific circumstances encountered.
- 1.3 This Interim Advice Note introduces a works proposal template which shall be completed by designers and contractors before the construction of a rolling crown. This template lists the information which must be provided, where applicable, to enable road authorities to be confident that rolling crowns will be constructed to the highest standard achievable. The awarding of contracts for the inclusion of rolling crowns on the existing National Road network shall utilise a quality / price mechanism to determine the best value for money outcome and Contractors are encouraged to apply their knowledge and expertise in relation to such factors as improvements and innovations in paver design and level control technology when seeking appointment for such work.

Scope

- 1.4 This Interim Advice Note is applicable to the design and construction of rolling crowns on all National Roads.

Implementation

- 1.5 This Interim Advice Note shall be used primarily for the design of schemes involving the renewal, reconstruction or widening of National Roads. The inclusion of rolling crowns is not permitted in the design of new National Road schemes subject to the conditions outlined in Clause 1.6.
- 1.6 The use of rolling crowns may only be permitted for scheme types other than renewal, reconstruction or widening of National Roads subject to receipt of an Approved Departure from Standards, and where;
 - the design has been completed;
 - the extent of land acquisition has been determined;
 - a Statutory Consent has been confirmed prior to the publication of this Interim Advice Note; and
 - it can be shown that all other design options have been exhausted.

2. REQUIREMENT FOR ROLLING CROWNS

Assessment of Need

- 2.1 Rolling crowns are generally introduced on road alignments where traditional means of introducing superelevation cannot be implemented while at the same time satisfying the requirements of NRA IAN 09/13.
- 2.2 There are locations along the existing National Road network where sections of pavement do not satisfy the requirements of NRA IAN 09/13 and there is potential for excess surface water on the carriageway. However, this does not automatically result in the need to retrospectively introduce a rolling crown.
- 2.3 At any location identified on the National Road network where there may be scope to enhance surface water drainage characteristics, designers should first perform a risk assessment of the site to determine whether a rolling crown is warranted.

Risk Assessment Factors

- 2.4 Designers must visit the site to examine the existing pavement and its surroundings to establish whether there are any site conditions other than pavement geometry which could be a factor in the potential for excess surface water. Possible issues which should be examined include but are not limited to:
 - a) Clogged up drainage networks;
 - b) Excessive vegetation growth at the pavement edge;
 - c) Debris or material such as soil deposited on the carriageway;
 - d) Visible deformation/rutting of the existing pavement.
- 2.5 Where the potential for excess surface water appears to be primarily related to the pavement geometry, designers should consider the following factors before deciding to introduce a rolling crown:
 - a) Whether the excess surface water is forming in a critical location, i.e. the wheel track zone, or is it contained in the hard shoulder?;
 - b) Over what distance is the excess surface water present on the carriageway, i.e. is the excess surface water limited to a short length which is unlikely to significantly interfere with the friction between the road surface and a vehicles tyre?
- 2.6 Upon completion of the site visit and consideration of all possible factors, designers should complete the site specific risk assessment to be used in combination with a NRA IAN 09/13 assessment to determine whether the introduction of a rolling crown is warranted.

3. ROLLING CROWN CONSTRUCTION

Compliance with Pavement Tolerances

- 3.1 Series 700 of the NRA MCDRW includes requirements relating to permissible pavement tolerances for each of the various pavement layers, e.g. surface course, binder course, etc. While it is considered that these tolerances can be readily achieved on pavements with uniform crossfall or at standard superelevation rollovers, there have been instances where there has been difficulty in satisfying these tolerances at rolling crown locations on the National Road network.
- 3.2 Where rolling crowns are required on the National Road network it is important that due care and consideration is given to their design and construction. The guidance in this Interim Advice Note is intended to facilitate greater compliance with pavement tolerances at rolling crown locations. However, it is acknowledged that compliance with pavement tolerances for the surface course can be difficult to achieve at the apex of rolling crowns.
- 3.3 In order to achieve the profile of the rolling crown it is important that each pavement layer is constructed carefully. For the pavement layers up to and including the binder course this can be achieved by thorough planning of the joint layout.

Joint Layout

- 3.4 This Interim Advice Note outlines two possible approaches for the planning of joint layouts in the pavement layers up to and including the binder course which will ensure that the pavement tolerances specified in NRA Series 700 are satisfied. These approaches are not intended to be definitive and designers and contractors are encouraged to consider all site specific issues when planning joint layouts for individual rolling crowns. In addition, Contractors should apply their knowledge and expertise in relation to such factors as improvements and innovations in paver design and level control technology to optimise the overall resultant product.

Approach 1: Paving Parallel to the Crown Line

- 3.5 This approach shown in Figures 3/1 and 3/2 requires the use of mini-pavers along with a standard paver in the laying of the pavement layers. Mini-pavers enable narrower widths to be paved allowing for a greater length of pavement material to be initially laid parallel to the crown line.
- 3.6 The first step involves laying the pavement material parallel to either side of the rolling crown line. The second step allows for laying of the material parallel to the pavement edge to infill the remaining extent of the layer in the rolling crown area. For the example shown in Figures 3/1 and 3/2 a standard motorway cross-section has been assumed. The screed of standard pavers ranges between 2.5m and 3.0m in width. The screeds of mini-pavers generally have a standard width of approximately 1.25m, and can lay widths up to 2.2m.
- 3.7 Initially a standard paver is used to lay a strip of material 2.5m in width (refer to Figure 3/1). As the paver travels along the crown line, one side of the screed is extended at specific locations to provide a 'key' for the next pavement strips to tie-in to. Once the standard paver runs out of space the mini-paver can be utilised to extend the strip along the crown line albeit at a reduced width of 1.25m.
- 3.8 Following this, standard and mini-pavers are used to lay the material in strips parallel to the pavement edge. These strips are to run from the crown line to the extents of the rolling crown area (refer to Figure 3/2). Guidewires can be used for the installation of each of the strips to help increase the accuracy of the finished pavement levels. In Figure 3/2 the strips are laid using a mini-paver for the 2.0m wide strips and a standard paver to lay the 2.5m wide strip.

- 3.9 The first step outlined above will result in irregular shaped areas which could be either hand placed or filled in by a mini-paver by constantly adjusting the screed to match the varying width. Most of these areas will be confined to the hard shoulder and the central reserve hardstrip, minimising the amount of hand placing required.
- 3.10 The joint layout shown in Figures 3/1 and 3/2 is indicative for an idealised straight section and is not intended to be definitive. The site-specific joint layout for each rolling crown shall be assessed by designers taking consideration of the site conditions encountered.

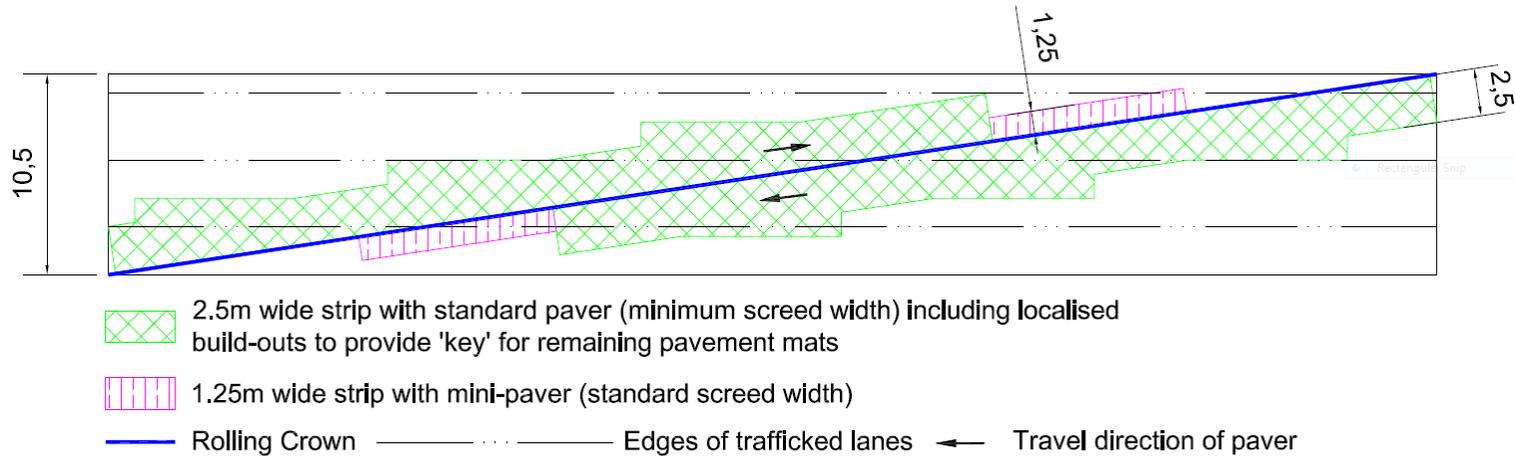


Figure 3/1: Paving Strips Parallel to the Rolling Crown

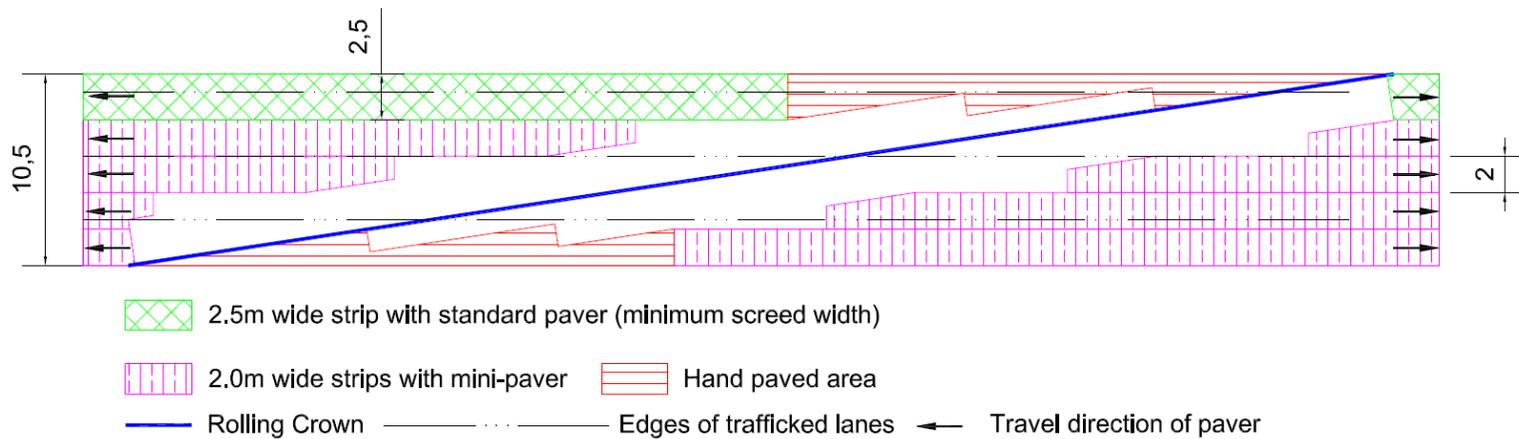


Figure 3/2: Paving Strips Parallel to the Pavement Edge

Approach 2: Timber Screeds

- 3.11 The approach shown in Figures 3/3 and 3/4 requires the erection of timber screeds which follow the profile of the desired crown line.
- 3.12 The first step involves laying the pavement material parallel to the pavement edge with the paver approaching and crossing over the timber screed. The second step allows for laying of the material on the opposite side of the crown line, travelling parallel to the pavement edge towards the crown line and stopping at the timber screed.
- 3.13 Rather than laying pavement parallel to the crown line, the first step (refer to Figure 3/3) is to lay material parallel to the pavement edge with a mini-paver approaching and crossing over the timber screed. This will result in an over-run area past the crown line where the excess pavement shall be removed to facilitate the laying of the material on the opposite side of the crown line.
- 3.14 Following the removal of the excess paving material and the removal of the timber screed, pavement is then laid with a mini-paver on the opposite side of the crown line, again travelling parallel to the pavement edge towards the crown line (refer to Figure 3/4). Guidewires can be used for the installation of each of the strips to help increase the accuracy of the finished pavement levels. The pavers should continue up to the point where the front edge of the paving machine reaches the timber screed.
- 3.15 After these two steps, there will remain small wedges of pavement which will be hand placed.
- 3.16 This approach makes greater use of mini-pavers. The joint layout shown in Figures 3/3 and 3/4 is indicative for an idealised straight section and is not intended to be definitive. The site-specific joint layout for each rolling crown shall be assessed by designers taking consideration of the site conditions encountered.

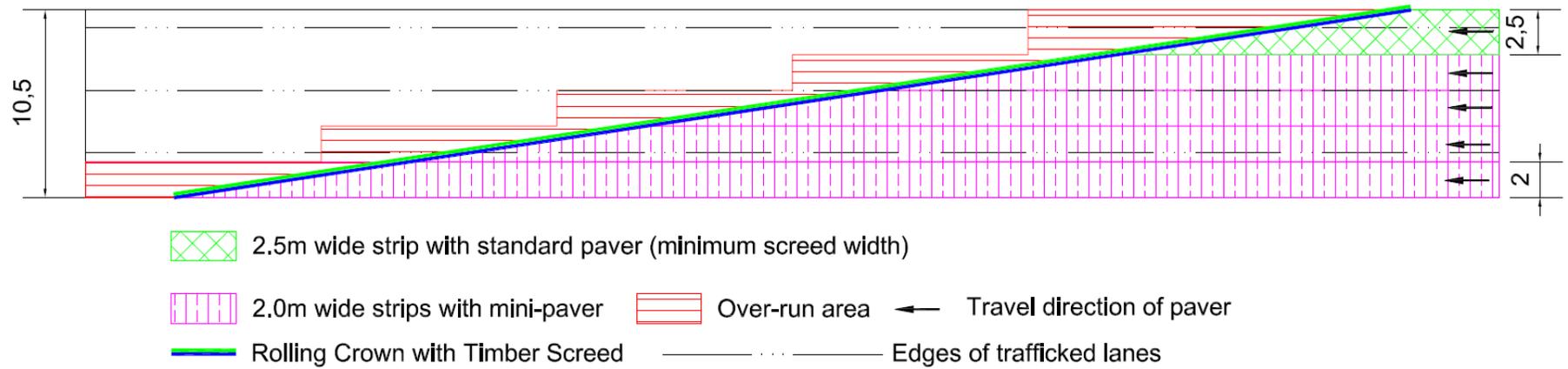


Figure 3/3: Paving Strips Across Timber Screed

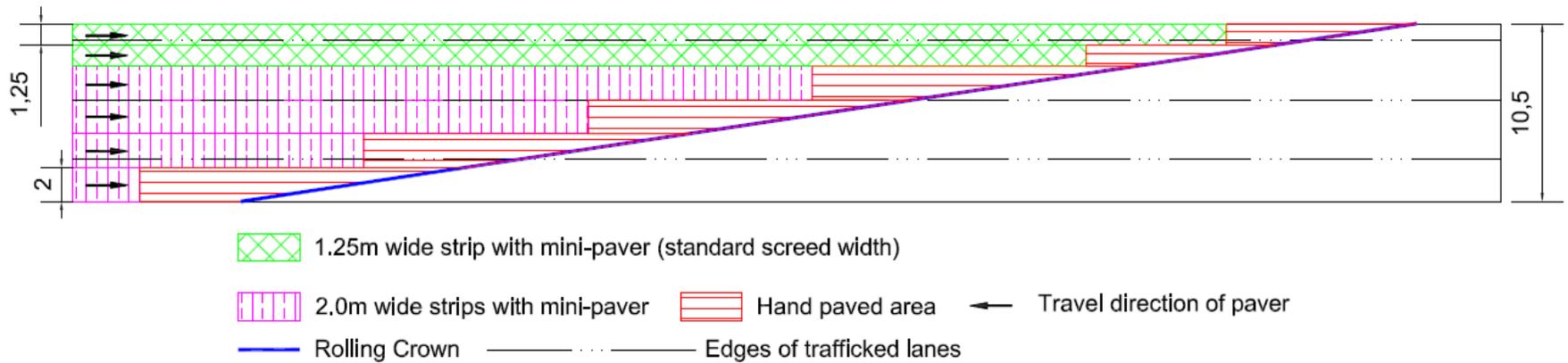


Figure 3/4: Paving Strips Towards Rolling Crown

Joint Formation

- 3.17 Both of the approaches outlined above will result in the formation of extra joints in the pavement, up to an including the binder course layer, than would generally be found on a standard pavement where the crossfall is uniform.
- 3.18 Accordingly it is imperative that all joints are treated in accordance with NRA Series 900 to minimise the risk of damage to the material over the pavement's lifetime.
- 3.19 Possible measures to mitigate weakness at joints include the use of a multiple pavers. Placing adjacent strips in echelon allows for 'hot matching' of the joints.
- 3.20 Where it is not feasible to deploy multiple pavers or where the pavement strip layout does not permit such an approach it is vital that the requirements of NRA Series 900 are strictly adhered to.
- 3.21 Where the rolling crown is formed using 'Approach 1' particular attention needs to be given to the joint at the apex to ensure its integrity.

Surface Course Joint Layout

- 3.22 The joint layout for the surface course is more straightforward than those for the lower pavement layers. Once it can be demonstrated that the lower pavement layers have been installed within specified tolerances, the surface course material can be laid by pavers travelling directly across the rolling crown apex, parallel to the direction of travel and the pavement edge. This would be the case for the installation of surface course material on sections with constant crossfall.
- 3.23 It is acknowledged that, in the direct vicinity of the rolling crown apex, this will result in an area where the surface course pavement tolerances will be difficult to achieve. However the primary purpose of the rolling crown is to remove surface water from the carriageway, and this shall still be achieved while limiting the potential for driver discomfort caused by a sharp apex.
- 3.24 The surface course pavement tolerances included in NRA Series 700 shall be satisfied up to the point where the front edge of the paving machine reaches the apex of the rolling crown travelling parallel to the pavement edge, and then again from the point where the rear edge of the screed has passed over the apex of the rolling crown as shown in Figure 3/5 below.
- 3.25 The area of surface course pavement where the surface tolerance requirements are difficult to achieve will vary at each rolling crown depending on factors such as the length of the rolling crown apex, its corresponding skew to the direction of traffic and the type of paving machines in use by the Contractor.
- 3.26 While the requirements for surface course tolerances shall be relaxed in the area of pavement shown in Figure 3/5, the thickness of pavement laid throughout this section shall be no more than 6mm below the nominal layer thickness specified for the surface course.
- 3.27 Recent experience in rolling crown construction, where the paving machine has travelled directly over the apex of the crown to place the surface course, has been shown to generally result in a crest curve at the apex with a 'k' value in the range of approximately 10 to 20 as well as a crest curve length in the range of approximately 10m to 20m.

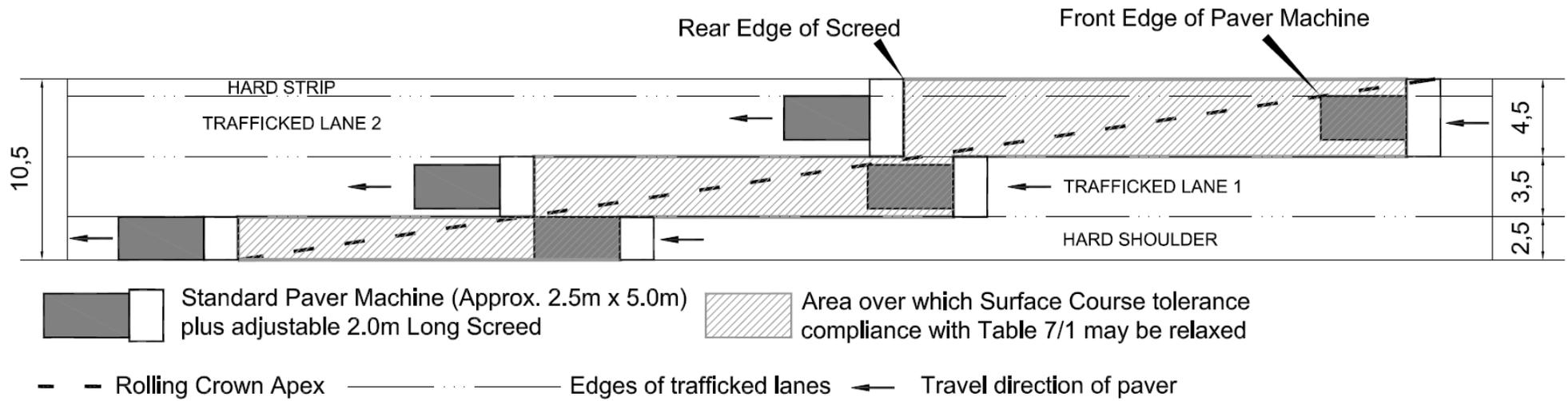


Figure 3/5: Area of Pavement Where Surface Course Tolerance Compliance may be Relaxed

4. WORKS PROPOSAL

General

- 4.1 The works proposal template included in Appendix A shall be completed for use in the design and construction of rolling crowns on the National Road network.
- 4.2 The template includes sections to be completed by both the Designer and the Contractor.
- 4.3 The title boxes of sections to be completed by the Designer are shaded grey.
- 4.4 The information filled in by the relevant parties shall take the form of either descriptive text or shall make reference to attached document(s) or drawing(s) depending on the level of detail required.

Design

- 4.5 The Designer shall prepare a specimen joint layout for the construction of the pavement layers up to and including the binder course.
- 4.6 Along with the specimen joint layout the Designer shall provide the following information to be handed over to the Contractor:
 - a) Extent of the proposed rolling crown;
 - b) Details of the horizontal and vertical geometry of the alignment in the vicinity of the proposed rolling crown;
 - c) Detailed survey data with levels taken on a tight grid, i.e. maximum 2m x 2m spacing for spot levels;
 - d) Details of any impacts on existing roadside features such as drainage, safety barriers etc. and the remedial works required; and
 - e) Details of the pavement build-up required, i.e. type and depth of surface course material and binder/regulating course material.

Construction

- 4.7 Contractors seeking appointment for the construction of the rolling crown shall be provided with the design information listed above and shall then be responsible for submitting the remaining information required to ensure that the Contracting Authority has confidence that the construction of the rolling crown will adhere to industry best practice.
- 4.8 The information supplied by the Contractor will be reviewed in relation to the quality aspect of their tender submission and the Contractor is encouraged to apply their knowledge and expertise in relation to such factors as improvements and innovation in paver design and level control technology to optimise the overall resultant product.
- 4.9 The information to be supplied by the Contractor is outlined in the sections below.

Joint Layout

- 4.10 The Contractor shall review the specimen joint layouts prepared by the designer and is required to either accept the specimen joint layout or, should the Contractor consider there is an alternative approach which would be of benefit to the Contracting Authority, submit an alternative joint layout.

- 4.11 Should the Contractor accept the specimen joint layout it shall then become their works proposal and it is the Contractor's responsibility to deliver it successfully.

Construction Programme

- 4.12 Once the contractor has determined the joint layout for the rolling crown he is required to submit details of his proposed construction methodology to the Employers Representative.
- 4.13 The Contractor is required to submit a detailed programme for the construction of the rolling crown.
- 4.14 The programme shall clearly outline the timelines associated with each task such as cold milling of existing pavement, installation of binder/regulating course, installation of surface course, remedial works to existing drainage elements, safety barriers etc. as required.

Plant

- 4.15 The Contractor shall provide details of the specific plant to be used in the construction phase. It will not be sufficient for contractors to submit a generic information sheet listing all of their available plant and they shall demonstrate what specific plant they consider necessary to successfully implement their proposed joint layout.
- 4.16 The Contractor shall demonstrate that the plant to be used is sufficient to enable his proposed construction sequence to be achieved, i.e. is the proposed number of pavers sufficient to satisfy the timeline for the works and can the rollers proposed achieved the compaction requirements of NRA Series 900?

Phasing

- 4.17 To support their programme the Contractor is required to submit drawings showing the phasing of the rolling crown construction illustrating the sequence of cold milling works of existing pavement, if required, and the sequencing of the installation of each pavement mat.
- 4.18 The Contractor shall consider the possibility of night work / 24 hour working should this be a possibility under his traffic management proposals.

Traffic Management

- 4.19 The Contractor is required to submit details of the traffic management measures necessary to construct the rolling crown.
- 4.20 Generic traffic management templates will not be acceptable as the Contractor shall demonstrate an understanding of the constraints imposed by the rolling crown site and whether the works can be achieved through either lane closures or a complete road closure.
- 4.21 Where the Contractor believes road closures are necessary, details of alternative routes are required in the traffic management plan. This shall require consultation and agreement with the relevant road authority affected by the road closure proposal and the Contractor shall demonstrate that such consultation has either taken place or is ongoing. Approval of the traffic management plan shall be required prior to the works commencing on site.
- 4.22 The Contractor shall show that the proposed traffic management proposals are compatible with the proposed programme for the Works. For example should the works require a road closure the Contractor should consider night work / 24 hour working to complete the scheme as efficiently as possible.

Quality Control

- 4.23 It is acknowledged throughout the pavement industry that the design and construction of rolling crowns requires careful consideration and construction.
- 4.24 Accordingly contractors shall submit details of their on-site quality control measures to illustrate how they will ensure that the pavement tolerances included in NRA Series 700 will be achieved.
- 4.25 The Contractor is expected to highlight any locations where he anticipates that hand placing of pavement material will be required and shall outline what control measures will be in place to ensure that any hand laid sections will achieve the best finish possible.

Post Construction

As-Built Records

- 4.26 The Contractor shall submit As-Built Records for the works in accordance with NRA GD 101.
- 4.27 Following construction of the rolling crown the Contractor shall submit an as-built survey of the rolling crown to the Employer's Representative to demonstrate both compliance with the pavement tolerances included in NRA Series 700, where applicable, and to facilitate the development by the Designer of a contour model to demonstrate compliance with the requirements of IAN 09/13.
- 4.28 The spot levels included in this survey shall be taken on a grid no larger than 2m x 2m, reducing to 1m x 1m through the area of pavement adjacent to the rolling crown apex where pavement surface tolerance compliance may be relaxed.

5. ENQUIRIES

- 5.1 All technical enquiries or comments on this document or any of the documents listed as forming part of the NRA DMRB should be sent by e-mail to infoDMRB@tii.ie, addressed to the following:

Director of Professional Services
Transport Infrastructure Ireland
Parkgate Business Centre
Parkgate Street
Dublin 8
D08 DK10



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Helen Hughes
Director of Professional Services

APPENDIX A: TEMPLATE LAYOUT

Information to be provided by the Designer pre construction	
Route No:	
Location (Direction of travel, start and finish co-ordinates):	
Carriageway Type (Single / Dual):	
Carriageway Width (m) (incl. Hard Shoulders / Hard Strips):	
Horizontal Geometry at Rolling Crown Location (Straight / Curve Radius and Direction):	
Vertical Geometry at Rolling Crown Location (Gradient / Crest Curve Radius / Sag Curve Radius):	
Length of Rolling Crown (m):	
Crossfall at Start of Rolling Crown (%):	
Crossfall at End of Rolling Crown (%):	
Details of Specimen Joint Layout (Drawing Reference):	

Information to be provided by the Designer pre construction	
Pavement Make-up Required (incl. reference to relevant NRA Series 800 and 900 Clauses):	<p>Surface Course (mm):</p> <p>Binder Course/Regulating Course (mm):</p> <p>Base Course (mm):</p> <p>Sub-base (mm):</p>
Any Impact on Existing Roadside Elements (Drainage / Safety Barrier etc.):	
Details of Remedial Works for Existing Roadside Elements:	
Extents of Detailed Survey:	
Survey Data (Electronic file etc.)	

Information to be provided by the Contractor	
Details of Proposed Joint Layout and Construction Sequence (Drawing / Document Reference):	
Construction Programme (Document Reference):	Please note that the construction programme is to include items for all tasks required to construct the rolling crown, i.e. cold milling, installation of each pavement course, remedial works (if required).
Details of Plant Required for Construction:	Please note that a generic sheet outlining all plant available to the Contractor is not sufficient. Please provide details of the specific plant required for the construction of this rolling crown and compaction of the material.
Traffic Management Details (Drawing / Document Reference):	Please note that a generic traffic management layout is not sufficient. Please include detailed traffic management plans specific to the location of this rolling crown.
Construction Quality Control Details (Document Reference):	Please note that a generic quality statement is not sufficient. For installation of the pavement works, the Contractor is referred to Clause 10 of the NRA Series 900. Please provide details of what measures the Contractor will provide to ensure that compliance with pavement tolerances in NRA Series 700 is achieved where applicable.
Post Construction Survey (Electronic file etc.)	

Information to be provided by the Designer post construction	
Assessment of constructed rolling crown for compliance with IAN 09/13 (Electronic file etc. :)	The Designer shall state his opinion regarding compliance of the constructed rolling crown with the requirements of IAN 09/13.



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