

# NRA Pavement Standards Training

Worked Example: Bituminous Mixtures

From Perspective of:  
Designer/Compiler, Producer, Contractor  
and Employer's Representative

# Introduction

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Aim: Give you a knowledge on how to use the documents within the MCDRW and DMRB in order to:

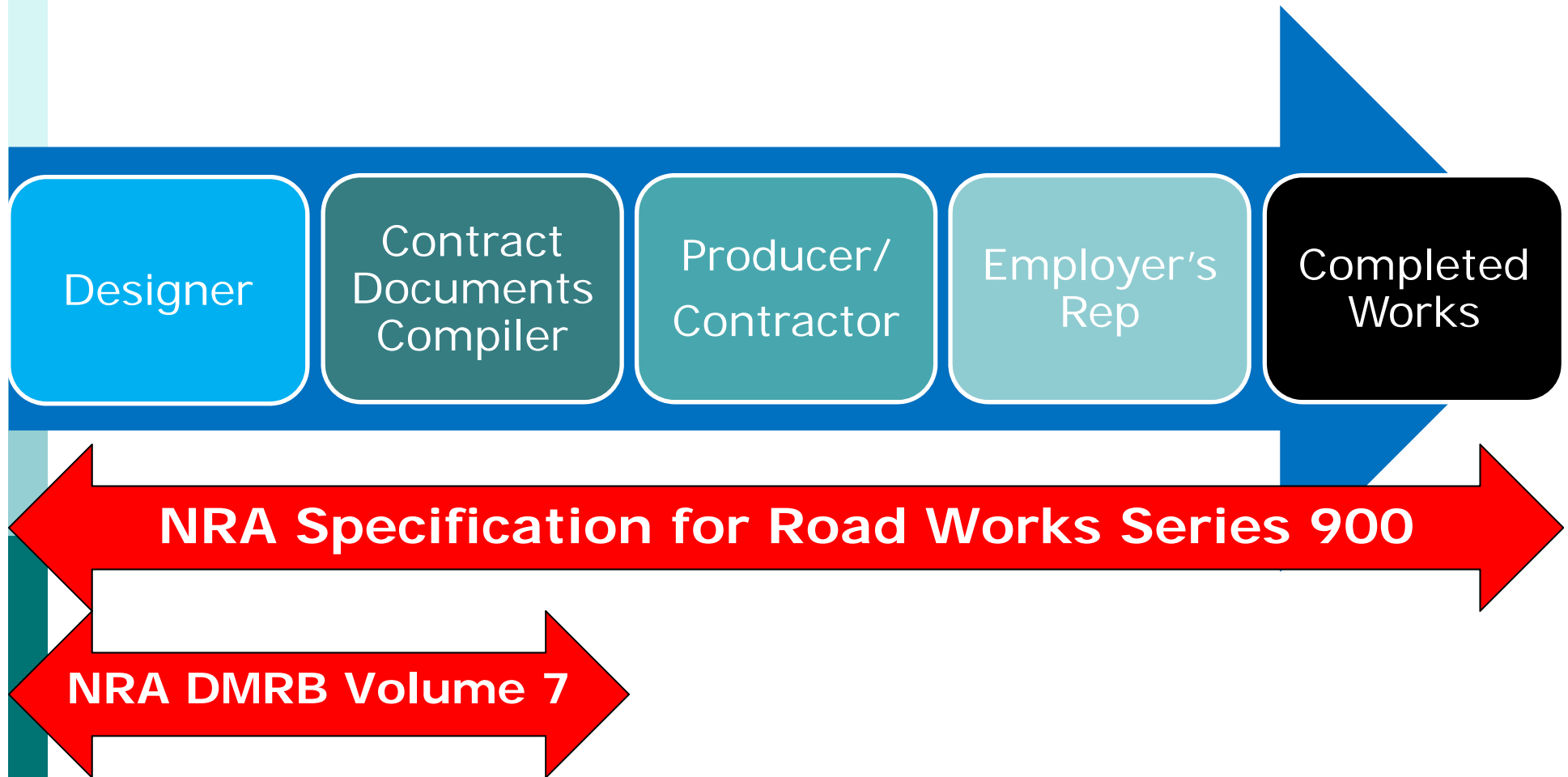
- Prepare the Contract Documents for Pavement Works [DESIGNER / COMPILER]
- Design and produce the bituminous mixture [PRODUCER]
- Install & Compact the bituminous mixture [CONTRACTOR]
- Monitor the Works [EMPLOYER'S REP]

Core Documents:

- NRA HD 300, NRA HD 25-26, NRA HD 36, Series 900 and NG 700

# Introduction

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# Sections

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1. Worked example from perspective of the Designer →  
Completing Appendix 7/1
2. Requirements from perspective of the Producer →  
CE marking, DoP, Type Test Report
3. Requirements from perspective of the Contractor & ER →  
Series 900 requirements

Debate / Q & A throughout

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# NRA Pavement Standards Training

Bituminous Mixtures – Worked Example

## 1. Completing Appendix 7/1

# Worked Example

## Design & Appendix 7/1 - Who's Responsible?

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Who is responsible for the pavement design?

### Pavement Design → The Designer

Traffic loading ; Constraints Study

Consult the DMRB

Select appropriate materials

Appropriate for the **INTENDED USE**  
and **DURABLE** for its expected **LIFE**

# Worked Example

## Design & Appendix 7/1 - Who's Responsible?

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Who is responsible for completing the Appendix 7/1?

### Contract Documents → The Compiler

Complete Contract Specific Documents

Completes Appendices to the Specification 1/5, 7/1, etc.

How the Works Requirements meet the Designer's Requirements

Appropriate for the **INTENDED USE** and **DURABLE** for its expected **LIFE**

# Worked Example

## Where to Start?

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### **NRA HD 300 Chapter 1 - Roadmap - What documents to use?**

- For general information at start of the process... **... NRA HD 23!!**
- General information on bituminous mixtures... **... NRA HD 37!!**
- Design of the pavement and the product to be installed in the Works... **... NRA HD 300!!**
- For general requirements pertaining to construction products, Declaration of Performance and CE marking of products... **... NRA Series 000 & NG 000!!**
- Preparing Contract Specification and Specification Appendix / Appendices relevant to the Contract...  
**... NRA Series 900 & NG 900,  
NRA Series 700 & NG 700!!**



# Worked Example

## Flexible Pavement - Appendix 7/1

1	Location:	General Requirement
2	Grid for checking surface levels of pavement courses, if different from the requirements of CI 702.4:	Long dim: N/A Trans dim: N/A
3	Surface regularity (CI 702.7 and CI 702.8):	Category of Road: [A or B] Long Reg.: Trans Reg.:
4	Requirements for coarse aggregates - Polished Stone Value (PSV), Aggregate Abrasion Value (AAV) (Series 900 CI 3.2.2, 5.2.2, 6.2.2, 8.4.1.1, 8.6.1.1):	N/A
5	Requirements for pre-coated chippings - Polished Stone Value (PSV) for general use mixtures, PSV for mixtures for roundabouts, Aggregate Abrasion Value (AAV) (Series 900 CI 4.2.4):	N/A
6	Requirement for testing for Polished Stone value using the friction after polishing test (NRA HD 300 Clause 2.25)	[Yes/No]
7	Freezing and thawing (soundness) category if different from the requirements of Series 900 Tables 1, 4, 7, 10 and 17:	N/A
8	Compaction control and extraction of cores if different from the requirements of Series 900 CIs 10.1.9, 10.1.9.1, 10.1.9.2, 10.1.9.3, 10.1.9.4.	N/A
9	Requirements for monitoring resistance to permanent deformation of HRA (Series 900 CI 10.1.10.1)	[Yes/No]
10	Sealant to be applied to the whole of any freestanding edge on the outside of the finished pavement on the low side of the camber (Series 900 CI 10.1.8):	[Yes/No]
11	Any tests additional to those required by IS EN 13108-20, IS EN 13108-21 or the relevant SRW (Series 900 CI 1.2 and 1.3):	N/A
12	Whether subbase material may be spread in more than one layer (CI 802.4).	[Yes/No]

Pavement Course	Clause	Mixture Designation / Material	Thickness (mm)	Particular Requirements [Insert appropriate requirements from Tables NG 7/1 to 7/2]
Surface Course				
Binder Course				
Base				
Sub-base				[Whether material may be frost susceptible (801.4)].
Total Pavement Thickness (excluding sub base)				

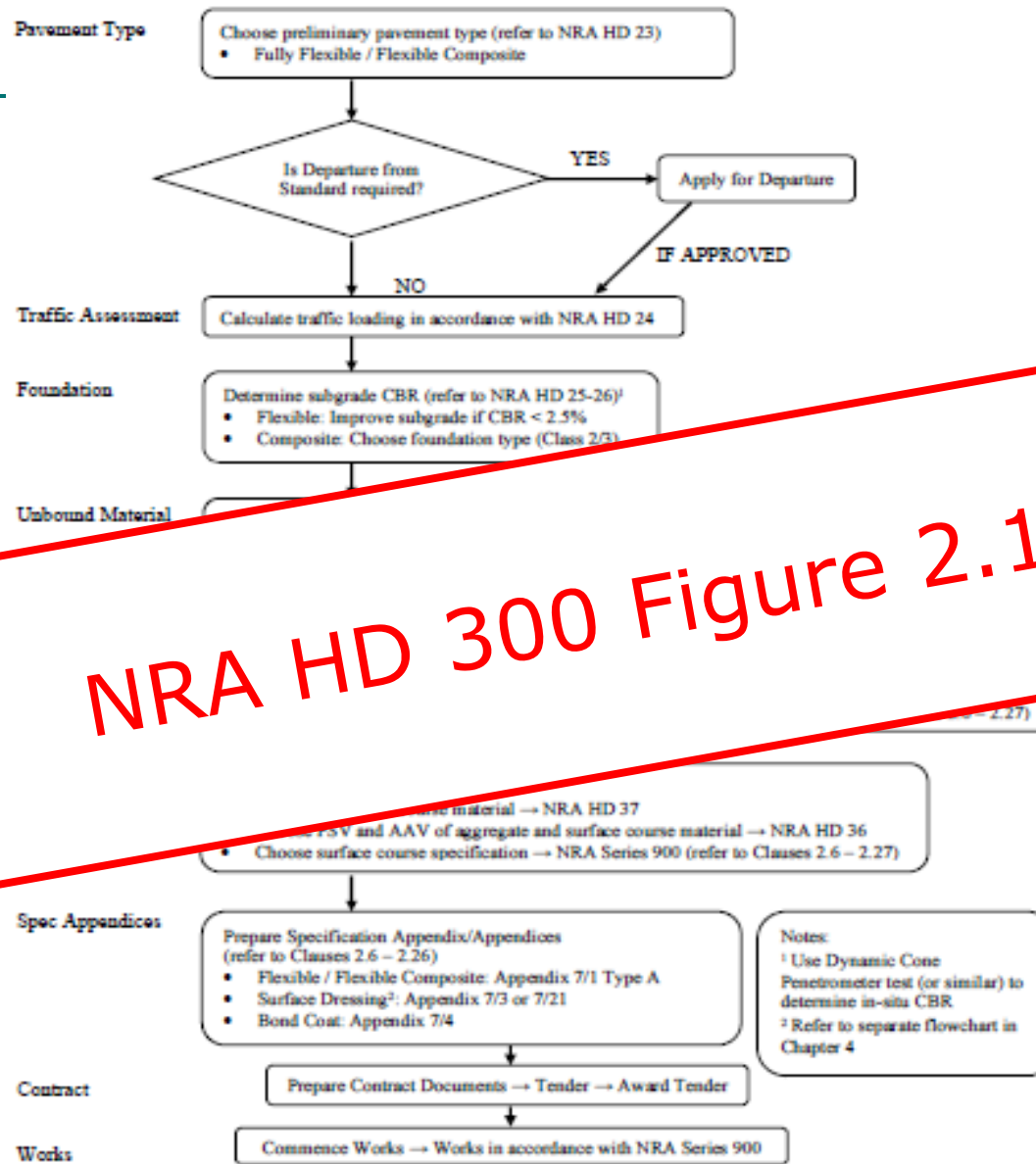
### Notes:

- 1.0 Capping is not / is required as described in Appendix 6/7. [Compiler to delete as appropriate]
- 2.0 Bond coat to be applied to all surfaces including HBM layers.
- 3.0 [Any specific requirements – e.g. Geotextile, High Friction surfacing, msa design requirements].

Use Workbook!

# Worked Example

## Flexible



NRA HD 300 Figure 2.1

Figure 2.1 – Process Flowchart for Fully Flexible Pavement – New pavement/full reconstruction of existing pavement

# Worked Example

## Flexible Pavement - First Step

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What is the first step, the first decision to be made?

- A. Decide on materials?
- B. Test Foundation?
- C. Decide on Pavement Type?

**C. Decide on pavement type**

# Worked Example

## Flexible Pavement - Choose Type

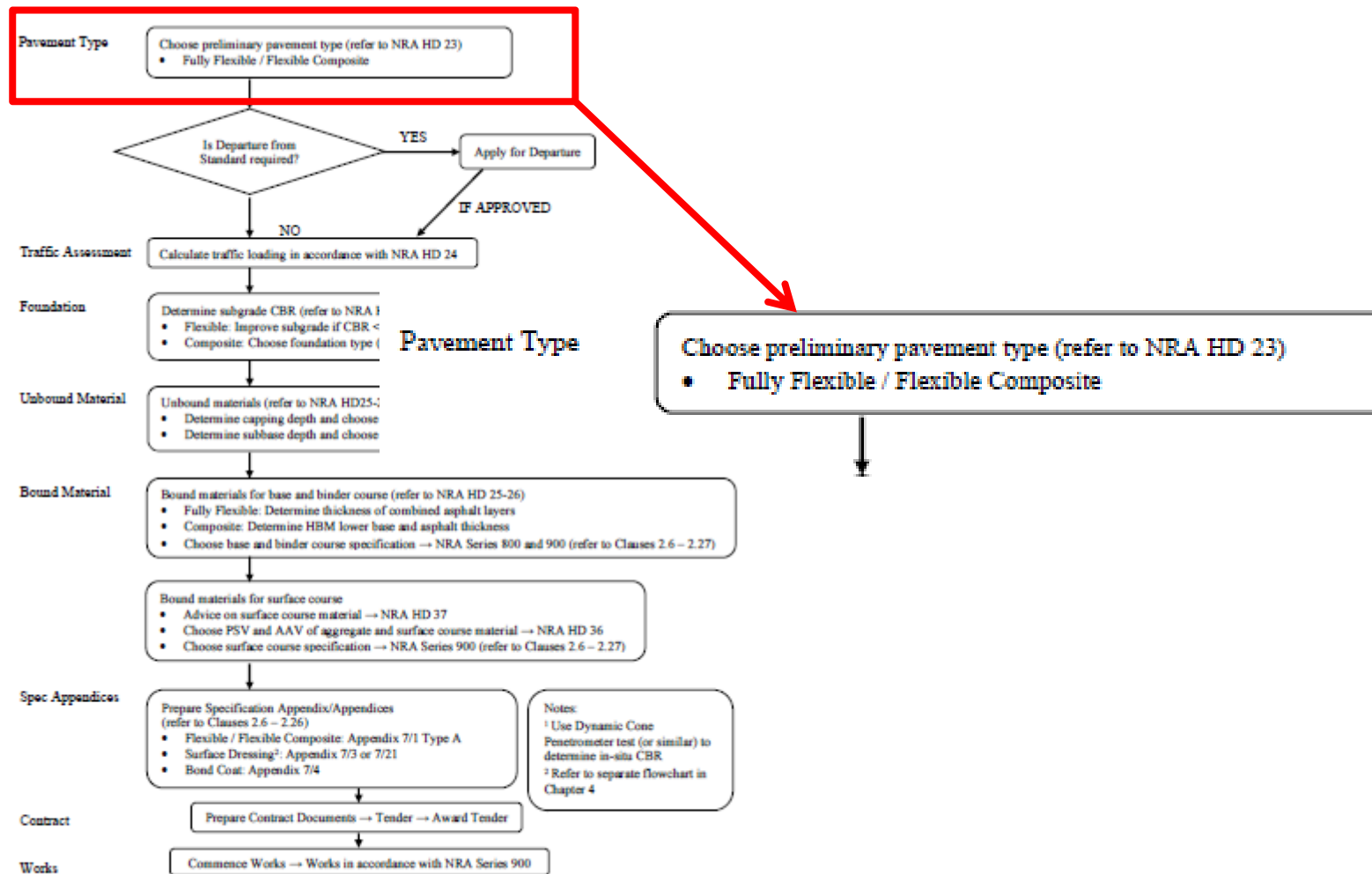


Figure 2.1 – Process Flowchart for Fully Flexible Pavement – New pavement/full reconstruction of existing pavement

# Worked Example

## Flexible Pavement - Choose Type

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- Choose preliminary pavement type → NRA HD 23
- Choose Type of Pavement → list in NRA HD 23 Clause 2.9

### Pavement Types

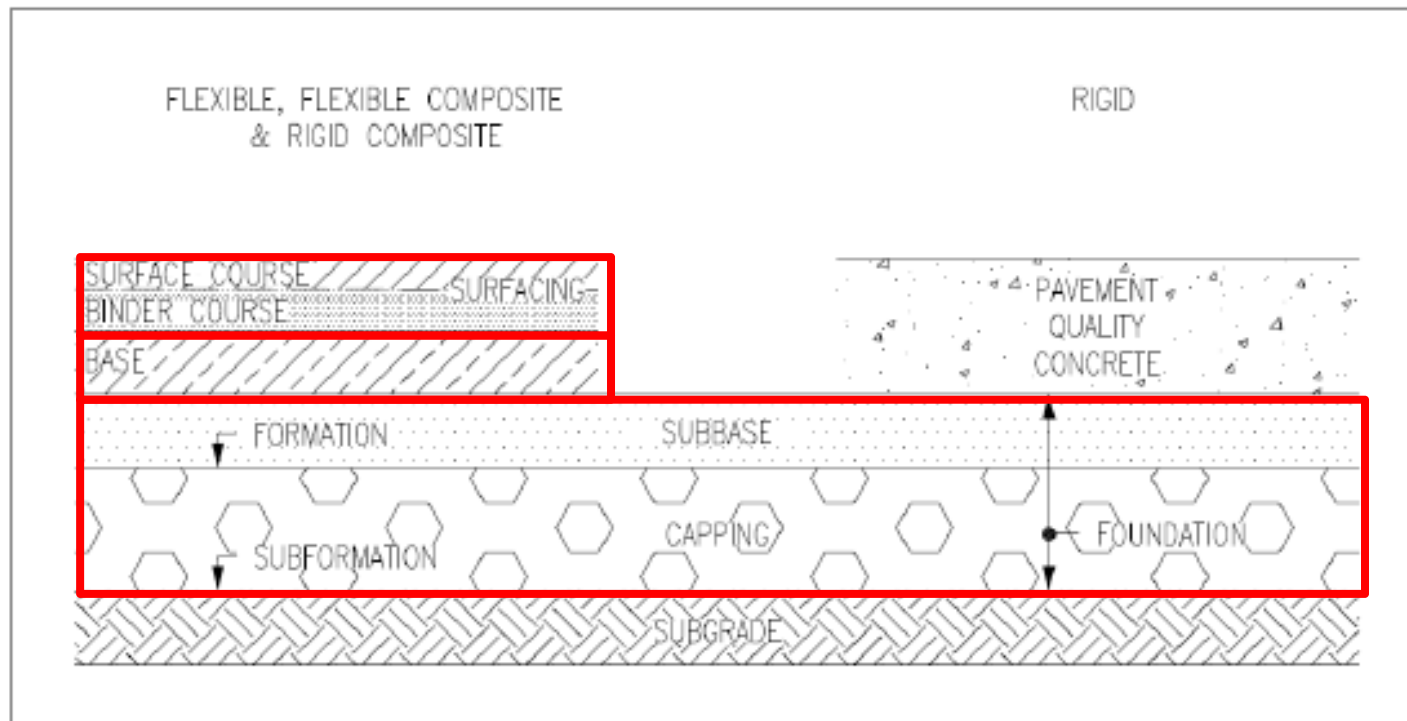
2.9 Four different types of pavement are defined by the National Roads Authority.

- a) Flexible: The surfacing and base materials are bound with bituminous binder.
- b) Flexible Composite: The surfacing and upper base (if used) are bound with bituminous binder on a base or lower base of cement bound material.
- c) Rigid: Pavement quality concrete is used for the combined surfacing and base. The concrete can be:-
  - (i) Jointed unreinforced (URC)
  - (ii) Jointed reinforced (JRC)
  - (iii) Continuously reinforced (CRCP)
- d) Rigid Composite: Continuously reinforced concrete base (CRCP) with bituminous surfacing.

# Worked Example

## Flexible Pavement - Choose Type

- Start Point → NRA HD 23



# Worked Example

## Flexible Pavement - Departure Required?

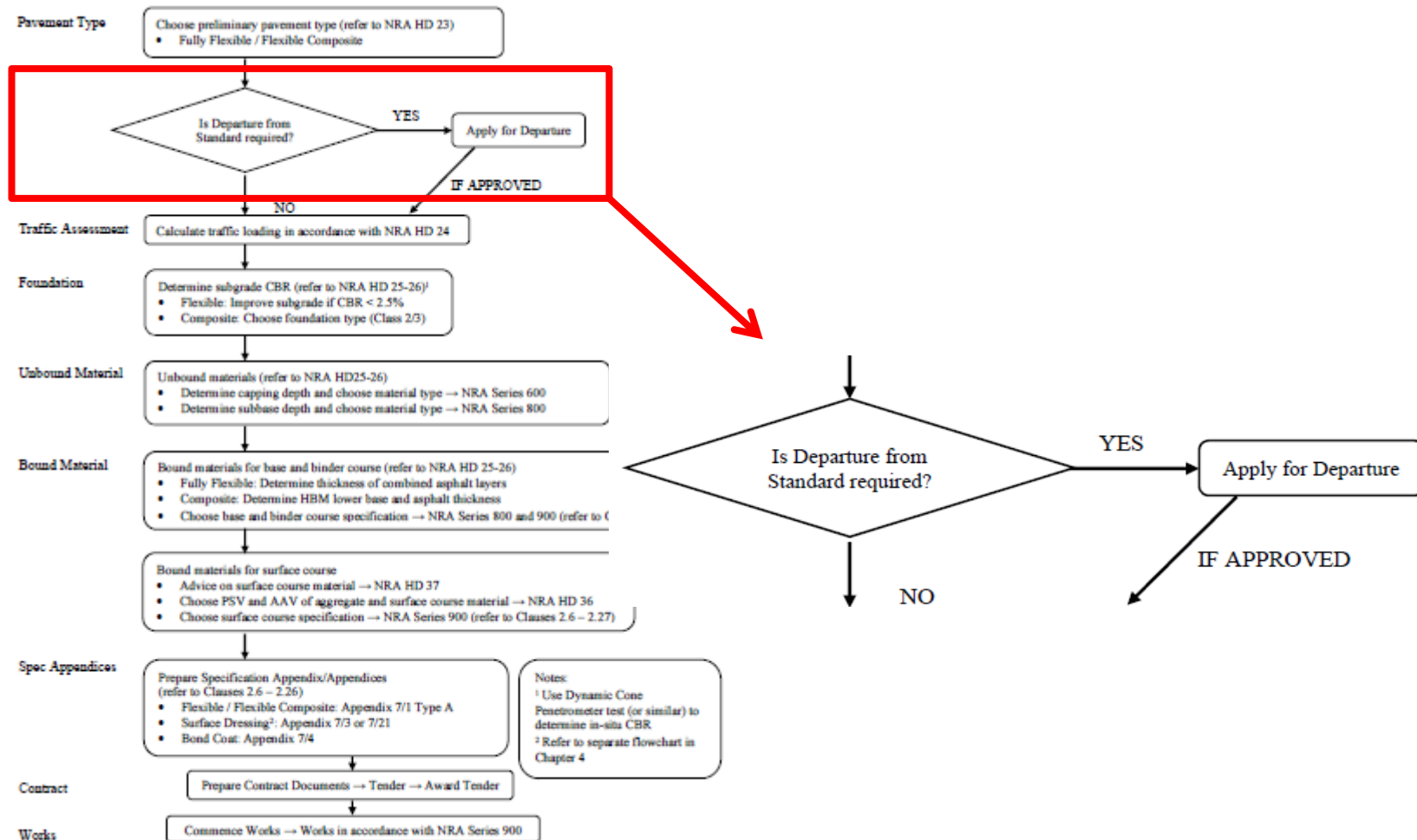


Figure 2.1 – Process Flowchart for Fully Flexible Pavement – New pavement/full reconstruction of existing pavement

# Worked Example

## Flexible Pavement - Next Step

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What is the next step, the next decision to be made?

- A. Determine capping & subbase depth?
- B. Calculate traffic loading in accordance with NRA HD 24?
- C. Determine thickness of combined asphalt layers?

**B. Calculate traffic loading in accordance with NRA HD 24**



# Worked Example

## Flexible Pavement - Traffic Loading

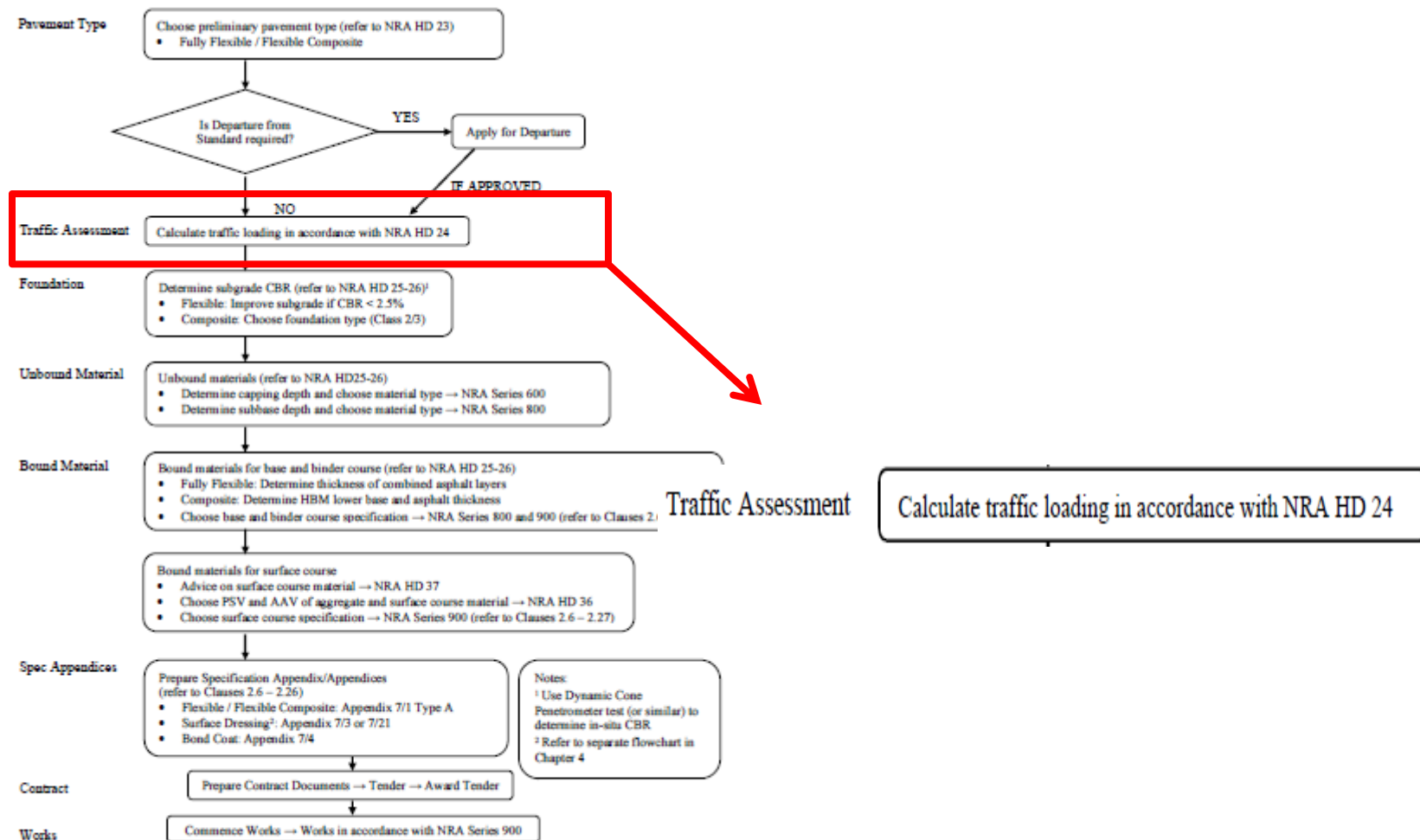


Figure 2.1 – Process Flowchart for Fully Flexible Pavement – New pavement/full reconstruction of existing pavement









# Worked Example

## Flexible Pavement - Traffic Loading

Formula for Design Traffic ... NRA HD 24

[www.nratrafficdata.ie](http://www.nratrafficdata.ie)

NRA Traffic Data Site

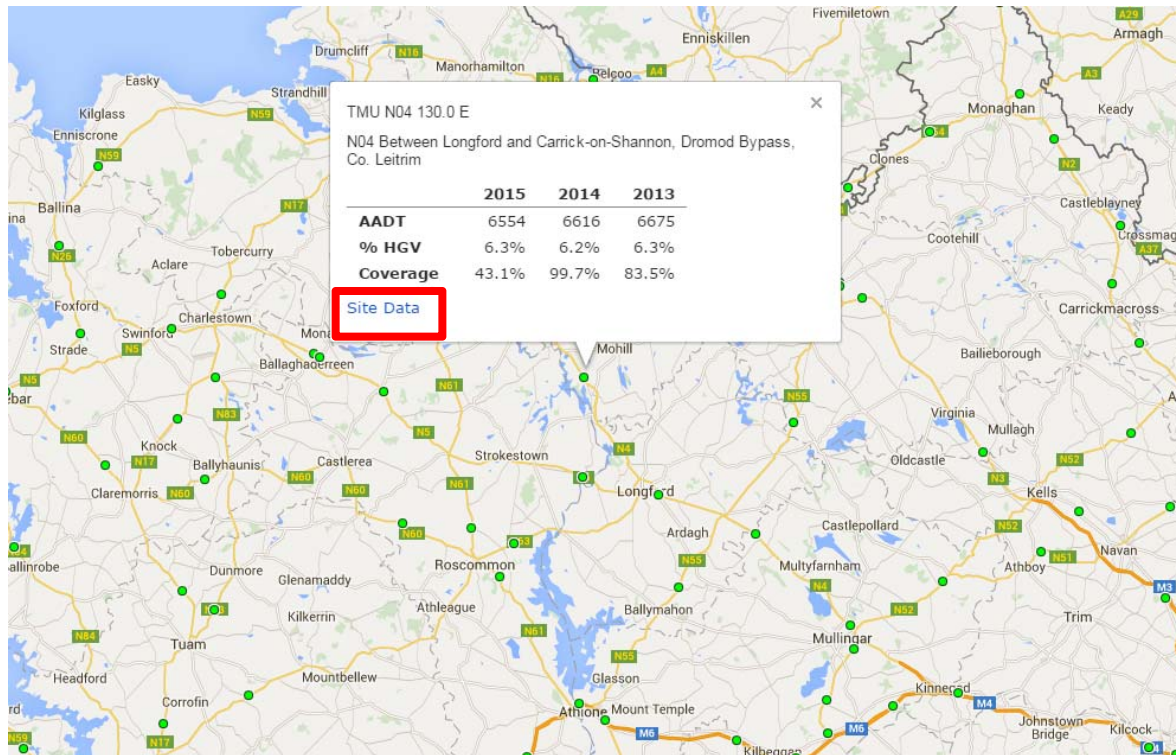
Commercial vehicle (cv)	cv class*	cv category
	Buses and Coaches	PSV
	2-axle rigid	OGV1
	3-axle rigid	
	3-axle articulated	OGV2
	4-axle rigid	
	4-axle articulated	
	5-axle articulated	
	6 (or more) -axle articulated	









# Worked Example

## Flexible Pavement - Traffic Loading

Formula for Design Traffic ... NRA HD 24

[www.nratrafficdata.ie](http://www.nratrafficdata.ie)



Commercial vehicle (cv)	cv class*	cv category
	Buses and Coaches	PSV
	2-axle rigid	OGV1
	3-axle rigid	
	3-axle articulated	OGV2
	4-axle rigid	
	4-axle articulated	
	5-axle articulated	
	6 (or more) -axle articulated	

# Worked Example

## Flexible Pavement - Traffic Loading









Formula for Design Traffic ... NRA HD 24

[www.nratrafficdata.ie](http://www.nratrafficdata.ie)

Setup	Channel	Time Period	Precision	Exclude data:
Setup0278	All directions	1 hour	Normal	None

	Average Flow	MBIKE	CAR	LGV	BUS	HGV_RIG	HGV_ART	CARAVAN	Invalid Reading	%HGV
00:00	16	0	16	0	0	0	0	0	0	0.0
01:00	43	0	42	0	0	1	0	0	0	2.3
02:00	49	0	43	6	0	0	0	0	0	0.0
03:00	53	0	43	8	0	2	0	0	0	3.8
04:00	28	0	23	4	1	0	0	0	0	0.0
05:00	24	0	20	2	0	1	1	0	0	8.3
06:00	25	0	21	3	0	0	1	0	0	4.0
07:00	36	0	32	1	1	0	1	1	0	2.8
08:00	35	0	33	1	0	1	0	0	0	2.9
09:00	68	0	63	3	0	0	1	1	0	1.5
10:00	113	0	109	3	1	0	0	0	0	0.0
11:00	210	0	200	7	0	1	1	1	0	1.0
12:00	318	1	310	6	0	1	0	0	0	0.3
13:00	425	1	403	16	1	0	2	2	0	0.5
14:00	470	0	450	14	2	3	1	0	0	0.9
15:00	495	0	479	13	0	0	3	0	0	0.6
16:00	434	0	413	17	2	1	1	0	0	0.5
17:00	375	1	359	10	0	2	2	1	0	1.1
18:00	260	1	250	8	0	1	0	0	0	0.4
19:00	217	0	209	7	0	0	1	0	0	0.5
20:00	206	0	197	2	2	0	5	0	0	2.4
21:00	136	0	129	4	0	1	2	0	0	2.2
22:00	87	0	80	2	1	0	4	0	0	4.6
23:00	52	0	44	2	0	0	6	0	0	11.5
07-19	3239	4	3101	99	7	10	12	6	0	0.7
06-22	3823	4	3657	115	9	11	21	6	0	0.8
06-24	3962	4	3781	119	10	11	31	6	0	1.1
00-24	4175	4	3968	139	11	15	32	6	0	1.1
am Peak	11:00	-	11:00	03:00	04:00	03:00	05:00	07:00	-	05:00
Peak Volume	210	-	200	8	1	2	1	1	-	4.2
pm Peak	15:00	12:00	15:00	16:00	14:00	14:00	23:00	13:00	-	23:00
Peak Volume	495	1	479	17	2	3	6	2	-	11.5

Commercial vehicle (cv)	cv class*	cv category
	Buses and Coaches	PSV
	2-axle rigid	OGV1
	3-axle rigid	
	3-axle articulated	OGV2
	4-axle rigid	
	4-axle articulated	
	5-axle articulated	
	6 (or more) -axle articulated	

# Worked Example

## Flexible Pavement - Next Step

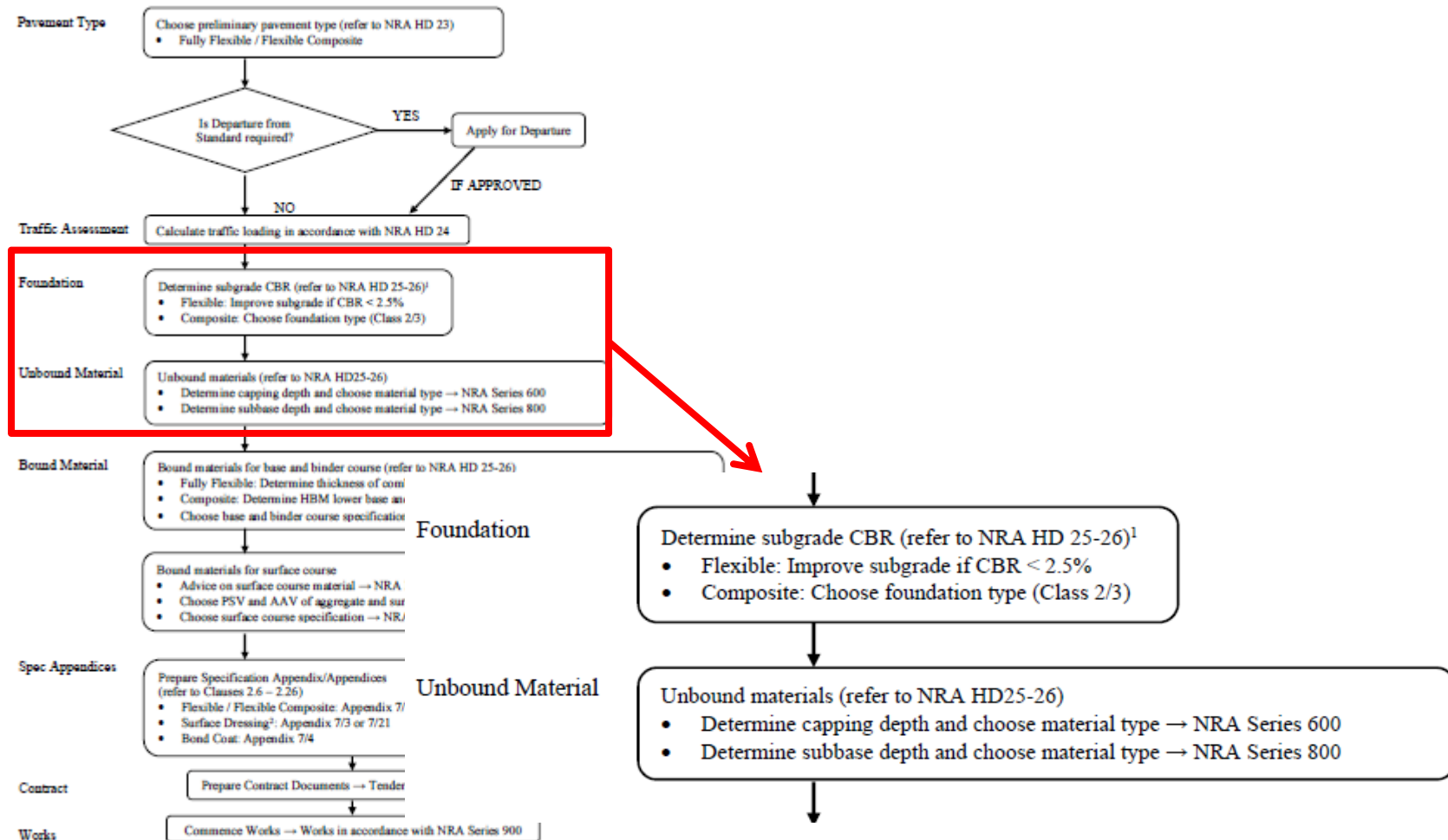


Figure 2.1 – Process Flowchart for Fully Flexible Pavement – New pavement/full reconstruction of existing pavement

# Worked Example

## Flexible Pavement - Foundation Design

- Foundation Design
  - NRA HD 25-26 Figure 4.1
- Subgrade CBR – determined on site or through samples tested in a laboratory...
- CBR → Foundation Thickness using:
  - Capping & Subbase
  - or
  - Subbase only

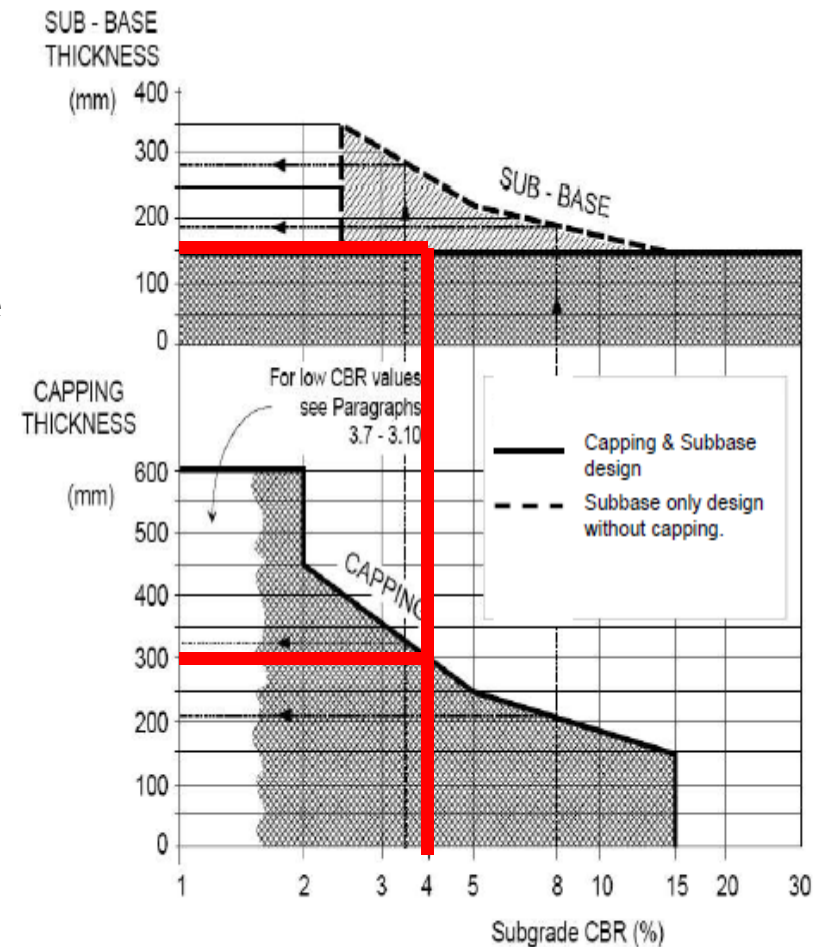


Figure 4.1 Foundation design charts for flexible pavement

# Worked Example

## Flexible Pavement - Foundation Design

- Foundation Design

Pavement Course	Clause	Mixture Designation / Material	Thickness (mm)	Particular Requirements [ <i>Insert appropriate requirements from Tables NG 7/1 to 7/2</i> ]
Surface Course				
Binder Course				
Base				
Sub-base	<b>804</b>	<b>Granular Material Type B</b>	<b>150</b>	<i>[Whether material may be frost susceptible (801.4)]. <b>NO</b></i>
Total Pavement Thickness (excluding sub base)				

**Notes:**

1.0 Capping is not / is required as described in Appendix 6/7. [Compiler to delete as appropriate]

# Worked Example

## Flexible Pavement - Next Step

---

What is the next step, the next decision to be made?

- A. Choose surface course PSV & AAV?
- B. Choose surface course?
- C. Determine thickness of combined asphalt layers?

**C. Determine thickness of combined asphalt layers**



# Worked Example

## Flexible Pavement - Bound Layers

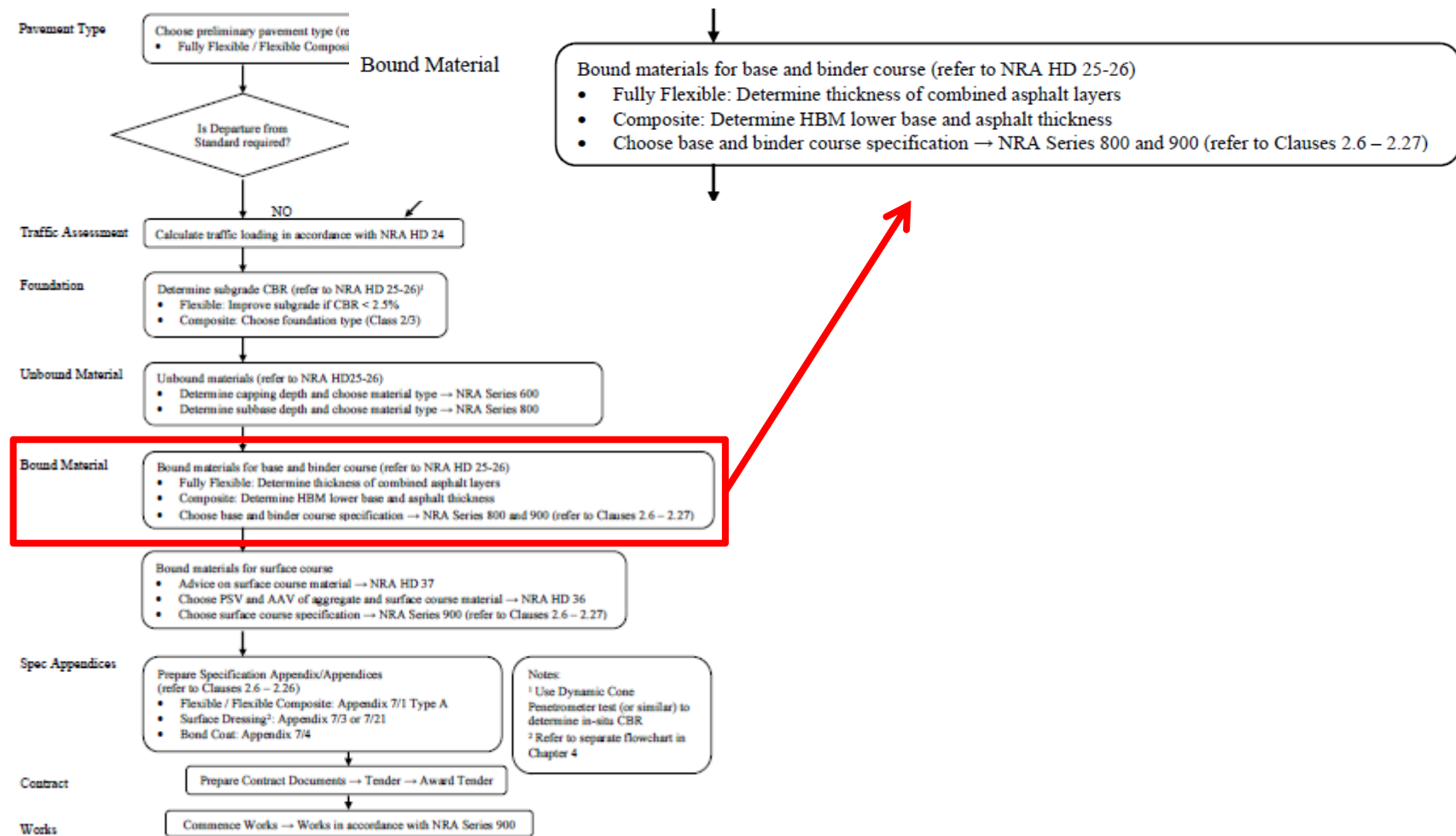


Figure 2.1 – Process Flowchart for Fully Flexible Pavement – New pavement/full reconstruction of existing pavement

# Worked Example

## Flexible Pavement - Bound Layers

- Bound Layer Design → NRA HD 25-26 Figure 4.2

- Design Traffic (msa) as per NRA HD 24, using:

- 40/60 pen
- or
- 70/100 pen

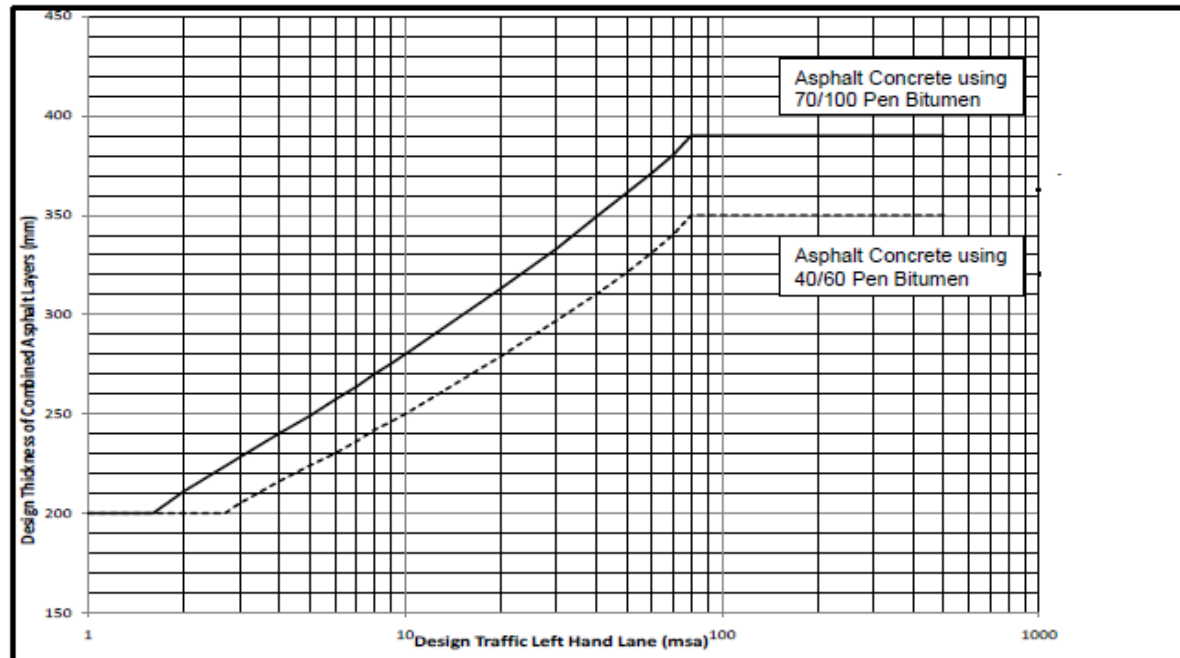
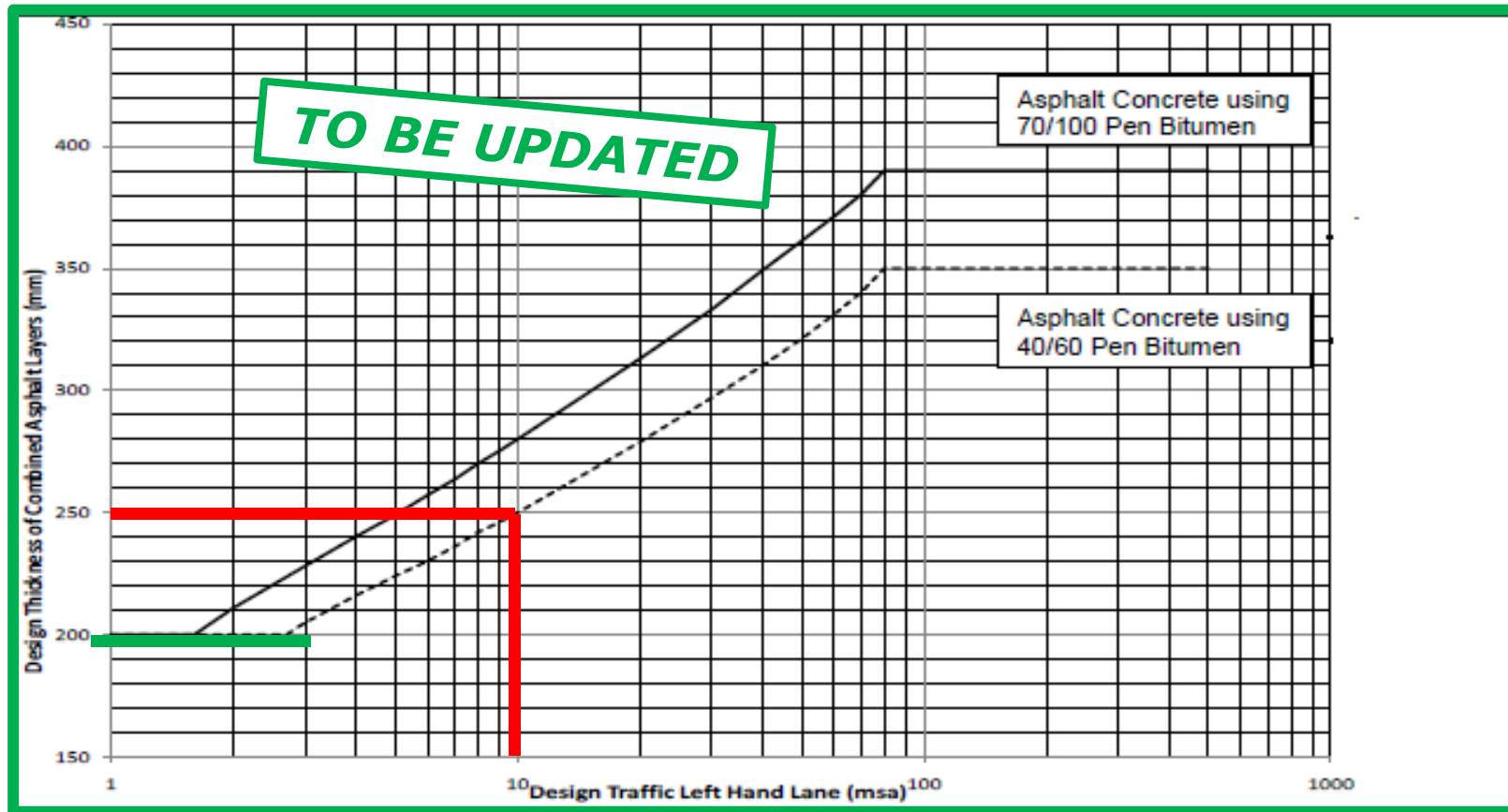


Figure 4.2 Design chart for fully flexible pavement

# Worked Example

## Flexible Pavement - Bound Layers



# Worked Example

## Flexible Pavement - Bound Layers

- Combined Asphalt Thickness → Appendix 7/1
  - How do you determine individual layer thicknesses...??

Pavement Course	Clause	Mixture Designation / Material	Thickness (mm)	Particular Requirements [ <i>Insert appropriate requirements from Tables NG 7/1 to 7/2</i> ]
Surface Course				
Binder Course				
Base				
Sub-base				<i>[Whether material may be frost susceptible (S01.4)].</i>
Total Pavement Thickness (excluding sub base)				

Notes:

- Capping is not / is required as described in Appendix 6/7. [*Compiler to delete as appropriate*]
- Bond coat to be applied to all surfaces including HBM layers.
- [Any specific requirements – e.g. Geotextile, High Friction surfacing, msa design requirements].*

# Worked Example

## Flexible Pavement - Bound Layers

- Layer Thickness → NRA HD 300 Chapter 2
  - *The Designer shall choose layer thicknesses for each pavement course required. The layer thicknesses shall comply with the nominal thickness requirements of NRA Series 900 Tables 3, 6, 9 and 12.*

**Table 3 Asphalt Concrete – Requirements of the Works**

hEN reference	
Table column reference	1
Layer	Base
Mixture designation	AC 32 dense/HDM <sup>1</sup> base des
<b>Alignment, levels, tolerances, thickness &amp; regularity (mm)</b>	
Horizontal alignment	
Levels	
Tolerances	± 15
Adjacent to a surface water or linear drainage channel	
Layer thickness - nominal	70 to 150
Layer thickness - minimum	55
Surface regularity	

# Worked Example

## Flexible Pavement - Bound Layers

- Layer Thickness → NRA HD 300 Chapter 2
  - Base and binder course should be laid in thicker lifts to minimise the number of layers and, hence, interfaces.*

**Table 3 Asphalt Concrete – Requirements of the Works**

hEN reference		
Table column reference	1	2
Layer	Base	Binder
Mixture designation	AC 32 dense/HDM <sup>1</sup> base des	AC 20 dense/HDM <sup>1</sup> bin des
<b>Alignment, levels, tolerances, thickness &amp; regularity (mm)</b>		
Horizontal alignment		
Levels		
Tolerances	± 15	± 6
Adjacent to a surface water or linear drainage channel		
Layer thickness - nominal	70 to 150	50 to 100
Layer thickness - minimum	55	40
Surface regularity		

# Worked Example

## Flexible Pavement - Bound Layers

- Layer Thickness

- Sample combinations below.

Table 3 Asphalt Concrete – Requirements of the Works

hEN reference			
Table column reference		1	2
Layer		Base	Binder
Mixture designation		AC 32 dense/HDM <sup>1</sup> base des	AC 20 dense/HDM <sup>1</sup> bin des
<b>Alignment, levels, tolerances, thickness &amp; regularity (mm)</b>			
Horizontal alignment			
Levels			
Tolerances		± 15	± 6
Adjacent to a surface water or linear drainage channel			
Layer thickness - nominal		70 to 150	50 to 100
Layer thickness - minimum		55	40
Surface regularity			

Combined Asphalt Layer Thickness required (mm)	Layer
250	Surface
	Binder
	Upper Base
	Base / Lower

Combined Asphalt Layer Thickness required (mm)	Layer	Sample Pavement Build-up		
		Option 1	Option 2	Option 3
180	Surface	45mm HRA 35/14	40mm SMA 14	30mm SMA 10
100	Binder	85mm AC 20	80mm AC 20	60mm AC 20
	Upper Base	-	-	60mm AC 20
	Base / Lower Base	120mm AC 32	130mm AC 32	100mm AC 32

# Worked Example

## Flexible Pavement - Next Step

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What is the next step, the next decision to be made?

- A. Check is material proposed suitable for use?
- B. Tender Contract?
- C. Finalise Appendix 7/1?

**A. Check is material proposed suitable for use**



# Worked Example

## Flexible Pavement - Materials Suitable?

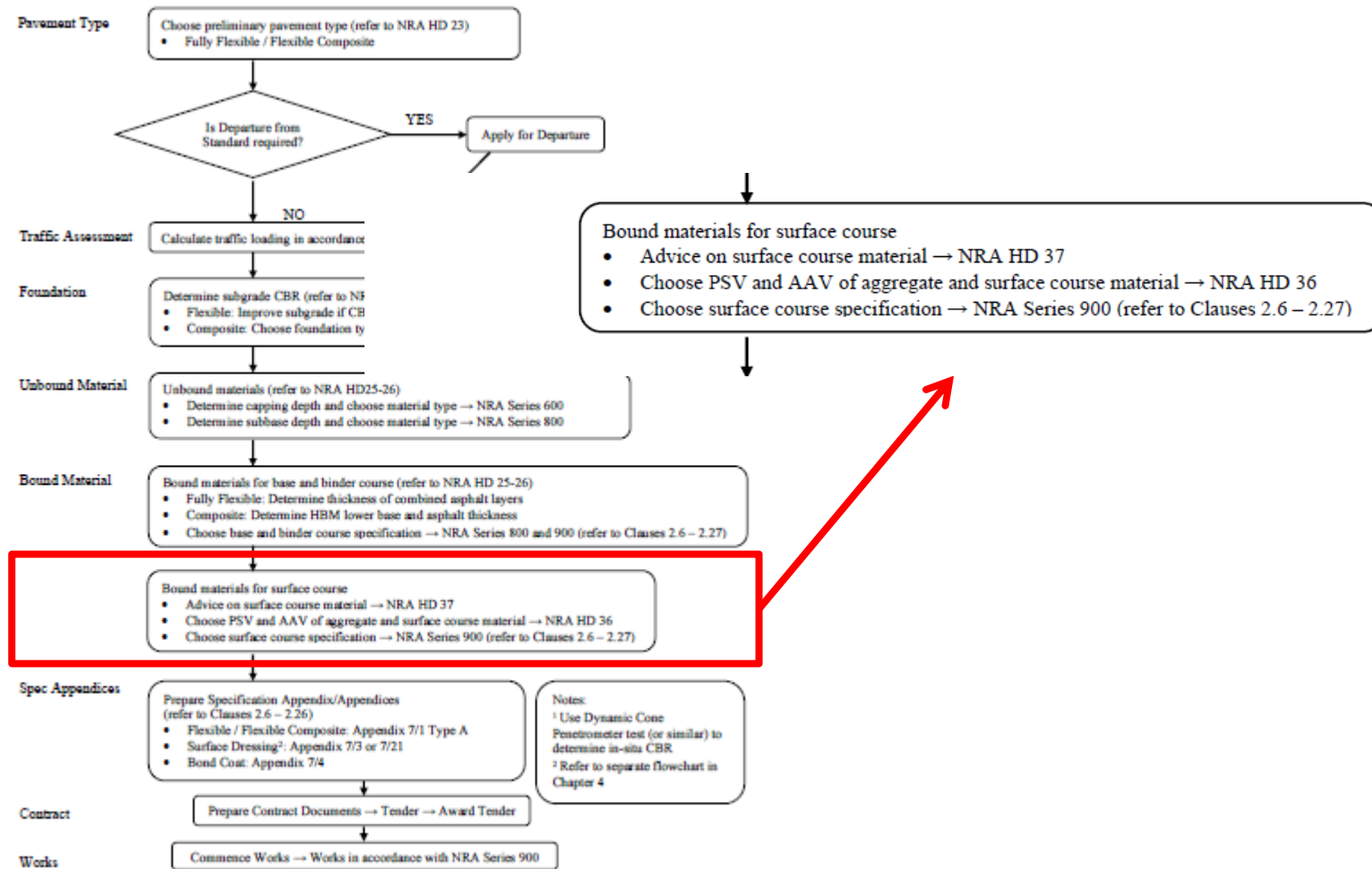


Figure 2.1 – Process Flowchart for Fully Flexible Pavement – New pavement/full reconstruction of existing pavement

# Worked Example

## Flexible Pavement - Materials

Is the material suitable for use in accordance with NRA Standards...?

- **NRA HD 36**
  - Table 2.1: Permitted Pavement Surfacing Materials for the Construction, Improvement or Maintenance of National Roads
  
- **NRA HD 37**
  - Advice on material choice

Fully Flexible and Flexible Composite Pavements

Traffic volume	Posted speed limit	Use without restriction	Departure required
5,000 AADF <sup>1</sup> and above	Above 60 km/h	SMA <sup>2</sup> Hot Rolled Asphalt <sup>3</sup> Surface dressing <sup>3,6</sup> High Friction Surfacing <sup>4</sup>	Porous Asphalt
	60 km/h or below	SMA <sup>2</sup> Hot Rolled Asphalt Asphalt Concrete surface course <sup>5</sup> Surface dressing <sup>6</sup> High Friction Surfacing <sup>4</sup>	Microsurfacing
Below 5,000 AADF	Above 60 km/h	SMA <sup>2</sup> Hot Rolled Asphalt <sup>3</sup> Surface Dressing <sup>3,6</sup> High Friction Surfacing <sup>4</sup>	Porous Asphalt
	60 km/h or below	SMA <sup>2</sup> Hot Rolled Asphalt Asphalt Concrete surface course <sup>5</sup> Surface dressing <sup>6</sup> High Friction Surfacing <sup>4</sup>	Microsurfacing

Notes:

1. Average Annual Daily Flow (one way).
2. SMA using binder grade 40/60 shall not be permitted on roads carrying greater than 100 commercial vehicles per lane per day.
3. See Clause 2.6 in relation to noise.
4. Use of high friction surfacing is subject to prior approval by the Head of Standards of the National Roads Authority, see Clause 4.12.
5. For use only where the posted speed limit is 50km/h or less.
6. Use of surface dressing shall be in accordance with NRA HD 300 Table 4.3.

Table 2.1: Permitted Pavement Surfacing Materials for the Construction, Improvement or Maintenance of National Roads

# Worked Example

## Flexible Pavement - Materials Suitable?

- Layer Thickness → NRA Series 900 and NRA HD 300

- Sample pavement build-ups, based on a 250mm combined asphalt thickness, are given in Table 2.1 below

**Benefits of Option 2 .v. Option 1??**

Minimum Layer Thickness required (mm)	Layer	Sample Pavement Build-up		
		Option 1	Option 2	Option 3
250	Surface	45mm HRA 35/14	40mm SMA 14	30mm SMA 10
	Binder	85mm AC 20	80mm AC 20	60mm AC 20
	Upper Base	-	-	60mm AC 20
	Base / Lower Base	120mm AC 32	130mm AC 32	100mm AC 32

# Worked Example

## Flexible Pavement - Mixture Designations

- Mixture Designations → NRA Series 900

### 3.1 Mixture Designations

The mixture designations available are:

3.1.1	AC	32	dense	base	40/60	des	
3.1.2	AC	32	dense	base	70/100	des	
3.1.3	AC	20	HDM	base	40/60	des	
3.1.4	AC	20	dense	bin	40/60	des	
3.1.5	AC	20	dense	bin	70/100	des	
3.1.6	AC	20	HDM	bin	40/60	des	
3.1.7	AC	14	close	surf	70/100	des	
3.1.8	AC	14	close	surf	160/220	des	
3.1.9	AC	10	close	surf	70/100	des	
3.1.10	AC	10	close	surf	160/220	des	
3.1.11	AC	14	open	surf	70/100	des	
3.1.12	AC	14	open	surf	160/220	des	
3.1.13	AC	10	open	surf	70/100	des	
3.1.14	AC	10	open	surf	160/220	des	
3.1.15	AC	6	dense	surf	70/100	des	
3.1.16	AC	6	dense	surf	160/220	des	

BASE							
3.1.1	AC	32	dense	base	40/60	des	

BINDER COURSE							
3.1.4	AC	20	dense	bin	40/60	des	

Each mixture shall comply with the requirements regarding constituents, composition and installation into the Works as laid out in this Series. It is the responsibility of the Designer to ensure the particular mix chosen is suitable for the site location and the applicable design criteria required shall be recorded in Appendix 7/1.

# Worked Example

## Flexible Pavement - Mixture Designations

- Material Designations → NRA Series 900

### 5.1 Mixture Designations

The mixture designations available are:

5.1.1	SMA	10	surf	PMB 65/105-60	des
5.1.2	SMA	10	surf	40/60	des
5.1.3	SMA	14	surf	PMB 65/105-60	des
5.1.4	SMA	14	surf	40/60	des
5.1.5	SMA	6	bin	40/60	des
5.1.6	SMA	6	bin	70/100	des
5.1.7	SMA	6	bin	PMB 65/105-60	des
5.1.8	SMA	10	bin	40/60	des
5.1.9	SMA	10	bin	70/100	des
5.1.10	SMA	10	bin	PMB 65/105-60	des
5.1.11	SMA	14	bin	40/60	des
5.1.12	SMA	14	bin	70/100	des
5.1.13	SMA	14	bin	PMB 65/105-60	des

**SURFACE COURSE**

5.1.3 SMA 14 surf PMB 65/105-60 des

NOTE: Mixture designations 5.1.2 and 5.1.4 above are not permitted on roads carrying greater than 100 commercial vehicles per lane per day.

- 2.13 A Polymer Modified Binder (PMB) may provide a number of benefits compared with a paving grade binder depending on the course in which the PMB is used. In a surface course, the increased viscosity of a PMB allows a thicker binder film to be obtained in more open mixtures which can aid the durability, longevity, and prevent binder drainage of the mixture due to reduced hardening or ageing in service.

# Worked Example

## Flexible Pavement - Mixture Designations

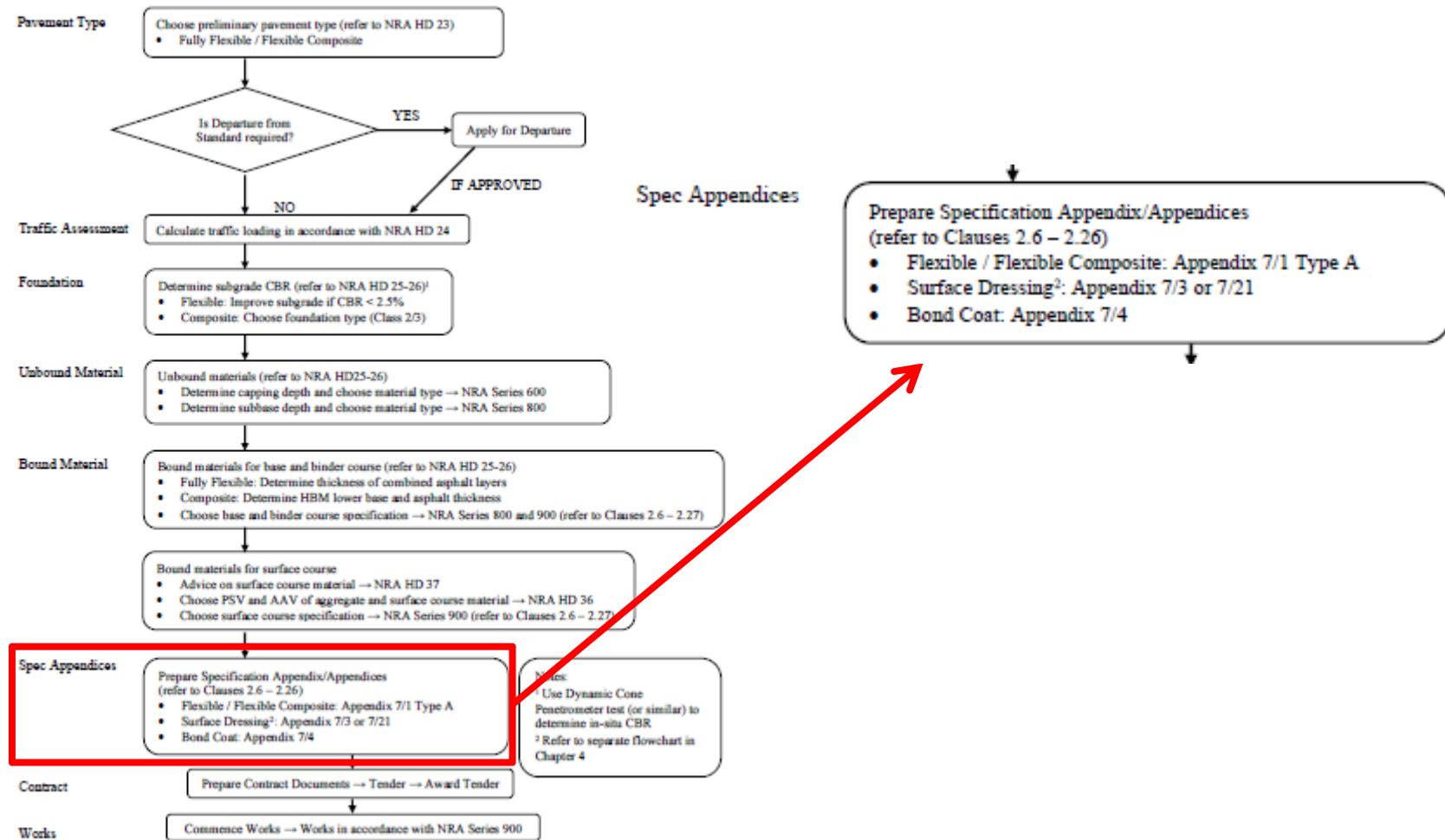


Figure 2.1 – Process Flowchart for Fully Flexible Pavement – New pavement/full reconstruction of existing pavement

# Worked Example

## Flexible Pavement - Completing Appendix 7/1

- Pavement Design

Pavement Course	Clause	Mixture Designation / Material	Thickness (mm)	Particular Requirements <i>[Insert appropriate requirements from Tables NG 7/1 to 7/2]</i>
Surface Course				
Binder Course				
Base	<b>Series 900 Clause 3.1.1</b>	<b>AC 32 dense base 40/60 des</b>	<b>130</b>	
Sub-base	<b>804</b>	<b>Granular Material Type B</b>	<b>150</b>	<i>[Whether material may be frost susceptible (801.4)]. <b>NO</b></i>
Total Pavement Thickness (excluding sub base)				

# Worked Example

## Flexible Pavement - Completing Appendix 7/1

- Pavement Design

Pavement Course	Clause	Mixture Designation / Material	Thickness (mm)	Particular Requirements <i>[Insert appropriate requirements from Tables NG 7/1 to 7/2]</i>
Surface Course				
Binder Course	<b>Series 900 Clause 3.1.4</b>	<b>AC 20 dense bin 40/60 des</b>	<b>80</b>	
Base	<b>Series 900 Clause 3.1.1</b>	<b>AC 32 dense base 40/60 des</b>	<b>130</b>	
Sub-base	<b>804</b>	<b>Granular Material Type B</b>	<b>150</b>	<i>[Whether material may be frost susceptible (801.4)]. <b>NO</b></i>
Total Pavement Thickness (excluding sub base)				



# Worked Example

## Flexible Pavement - Completing Appendix 7/1

- Pavement Design

Pavement Course	Clause	Mixture Designation / Material	Thickness (mm)	Particular Requirements <i>[Insert appropriate requirements from Tables NG 7/1 to 7/2]</i>
Surface Course	<b>Series 900 Clause 5.1.3</b>	<b>SMA 14 surf PMB 65/105-60 des</b>	<b>40</b>	
Binder Course	Series 900 Clause 3.1.4	AC 20 dense bin 40/60 des	80	
Base	Series 900 Clause 3.1.1	AC 32 dense base 40/60 des	130	
Sub-base	804	Granular Material Type B	150	<i>[Whether material may be frost susceptible (801.4)]. <b>NO</b></i>
Total Pavement Thickness (excluding sub base)				

# Worked Example

## Flexible Pavement - Completing Appendix 7/1

---

- Pavement Design

Pavement Course	Clause	Mixture Designation / Material	Thickness (mm)	Particular Requirements <i>[Insert appropriate requirements from Tables NG 7/1 to 7/2]</i>
Surface Course	Series 900 Clause 5.1.3	SMA 14 surf PMB 65/105-60 des	40	
Binder Course	Series 900 Clause 3.1.4	AC 20 dense bin 40/60 des	80	
Base	Series 900 Clause 3.1.1	AC 32 dense base 40/60 des	130	
Sub-base	804	Granular Material Type B	150	<i>[Whether material may be frost susceptible (801.4)]. <b>NO</b></i>
Total Pavement Thickness (excluding sub base)				

# Worked Example

## Flexible Pavement - Completing Appendix 7/1

- Completing Appendix 7/1

1	<i>Location:</i>	<b>General Requirement</b>
2	Grid for checking surface levels of pavement courses, if different from the requirements of CI 702.4:	Long dim: N/A Trans dim: N/A
3	Surface regularity (CI 702.7 and CI 702.8):	Category of Road [A or B] Long Reg.: Trans Reg.:
4	Requirements for coarse aggregates - Polished Stone Value (PSV), Aggregate Abrasion Value (AAV) (Series 900 CI 3.2.2, 5.2.2, 6.2.2, 8.4.1.1, 8.6.1.1):	N/A
5	Requirements for pre-coated chippings - Polished Stone Value (PSV) for general use mixtures, PSV for mixtures for roundabouts, Aggregate Abrasion Value (AAV) (Series 900 CI 4.2.4):	N/A
6	Requirement for testing for Polished Stone value using the friction after polishing test (NRA HD 300 Clause 2.25)	[Yes/No]

# Worked Example

## Flexible Pavement - Completing Appendix 7/1

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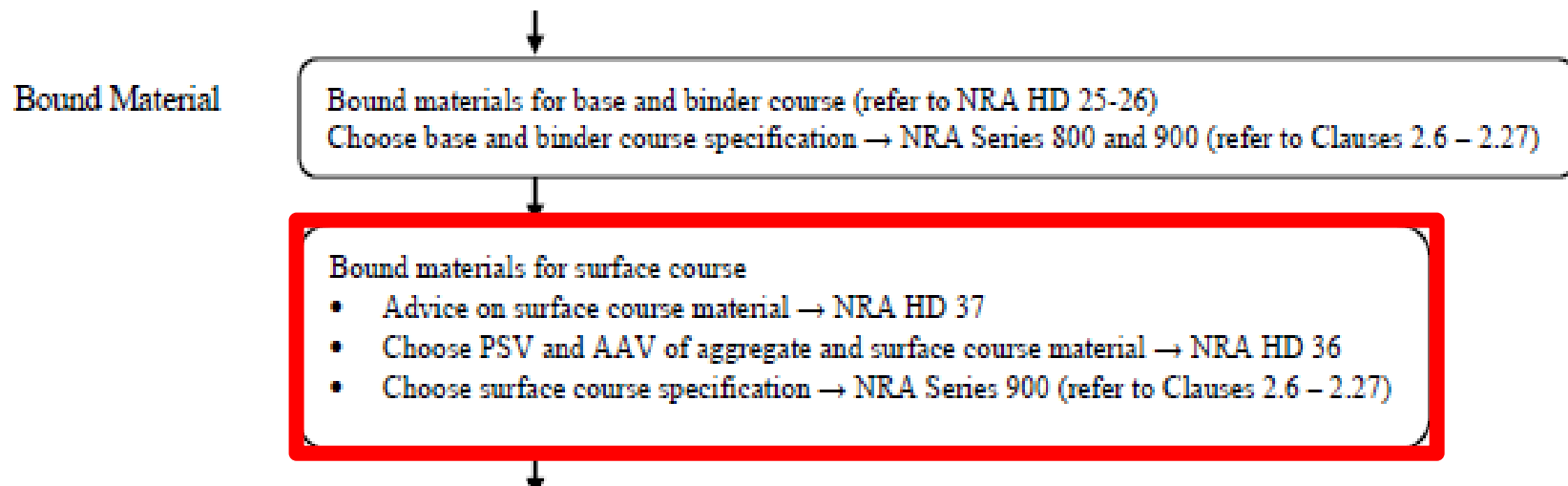
- Completing Appendix 7/1

7	Freezing and thawing (soundness) category if different from the requirements of Series 900 Tables 1, 4, 7, 10 and 17:	N/A
8	Compaction control and extraction of cores if different from the requirements of Series 900 Cls 10.1.9, 10.1.9.1, 10.1.9.2, 10.1.9.3, 10.1.9.4.	N/A
9	Requirements for monitoring resistance to permanent deformation of HRA (Series 900 Cl. 10.1.10.1)	<i>[Yes/No]</i>
10	Sealant to be applied to the whole of any freestanding edge on the outside of the finished pavement on the low side of the camber (Series 900 Cl 10.1.8):	<i>[Yes/No]</i>
11	Any tests additional to those required by IS EN 13108–20, IS EN 13108–21 or the relevant SRW (Series 900 Cl 1.2 and 1.3):	N/A
12	Whether subbase material may be spread in more than one layer (Cl 802.4).	<i>[Yes/No]</i>

# Worked Example

## Flexible Pavement - Completing Appendix 7/1

- Completing Appendix 7/1











5	general use m Abrasion Val (Series 900 Cl	<b>Aggregate</b>	
	Requirement 1	2.22	In accordance with NRA Series 900 Tables 1, 4, 7 and 10, the Designer shall detail the PSV and AAV requirements for the surface course.
6	polishing test (NRA HD 300	2.23	The minimum PSV of aggregate is required to ensure adequate microtexture to provide suitable friction properties to the road surface and the values in NRA HD 36 should be used.
		2.24	The maximum AAV of aggregate is required to ensure adequate resistance to abrasion by traffic and the values in NRA HD 36 should be used.

# Worked Example

## Flexible Pavement - Completing Appendix 7/1

Table 4.1: Minimum PSV of Chippings, or Coarse Aggregate in Unchipped Surfaces, for new Surface Courses

Site category and definition (see NRA HD 28)		IL	Minimum PSV required for given IL, traffic level and type of site						
			Traffic (Commercial Vehicles per Lane per Day) at opening						
			<250	251-500	501-750	751-1000	1001-2000	2001-3000	Over 3000
A	Motorway	0.30	50						
		0.35		50*	50*	55	55	55*	60*
B	Dual carriageway non-event	0.30							
C	Single carriageway non-event	0.35							
		0.40							
G1	Gradient 5-10% longer than 50m	0.40							
		0.45							
		0.50							
G2	Gradient >10% longer than 50m	0.40							
		0.45							
		0.50							
K	Approaches to traffic signals, pedestrian crossings	0.50							
		0.55							
Q	Approaches to and across major and minor junctions	0.40							
		0.45							
R	Roundabout	0.45							
		0.50							
S1	Bend radius <250m – dual carriageway	0.45							
		0.50							
S2	Bend radius <250m – single carriageway	0.45							
		0.50							

Commercial vehicle (cv)	cv class*	cv category
	Buses and Coaches	PSV
	2-axle rigid	OGV2
	3-axle rigid	
	3-axle articulated	
	4-axle rigid	OGV2
	4-axle articulated	
	5-axle articulated	
	6 (or more) axle articulated	

Traffic (cv/lane/day) at opening (see Clause 4.11)	<250	251-1000	1001-1750	1751-2500	2501-3250	>3250
Max AAV for chippings for hot rolled asphalt and surface dressing, and for aggregate in microsurfacing systems	14	12	12	10	10	10
Max AAV for aggregate in SMA and asphalt concrete	16	16	14	14	12	12

Notes:

1. The maximum AAV requirement for porous asphalt is specified in Table 10 of the NRA Specification for Road Works Series 900.

Table 4.2: Maximum AAV of Chippings, or Coarse Aggregates in Unchipped Surfaces, for New Surface Courses<sup>5</sup>

Notes:

- Site categories are grouped according to their general (IL) for specific categories are defined in NRA HD 28 specific site on which the material is to be laid, as does the table represent combinations of traffic and IL that
- For roads in site categories A, B and C where some br increased polishing stresses compared with most local marked with an asterisk.
- Investigatory Levels and averaging lengths for site cat be extended when justified by local site characteristics
- Throughout this Table, H means specialised high frict Specification for Road Works Series 900.
- Although minimum PSV values have been included for all types of site and traffic level, some combinations are unlikely to occur in practice.

# Worked Example

## Flexible Pavement - Completing Appendix 7/1

- Completing Appendix 7/1

Traffic (cv/lane/day) at opening (see Clause 4.11)	<250	251-1000	1001-1750	1751-2500	2501-3250	>3250
Max AAV for chippings for hot rolled asphalt and surface dressing, and for aggregate in microsurfacing systems	14	12	12	10	10	10
Max AAV for aggregate in SMA and asphalt concrete	16	16	14	14	12	12

Max. AAV



Notes:

- The maximum AAV requirement for porous asphalt is specified in Table 10 of the NRA Specification for Road Works Series 900.

Table 4.2: Maximum AAV of Chippings, or Coarse Aggregates in Unchipped Surfaces, for New Surface Courses<sup>5</sup>

Table 4.1: Minimum PSV of Chippings, or Coarse Aggregate in Unchipped Surfaces, for new Surface Courses

Site category and definition (see NRA HD 28)		IL	Minimum PSV required for given IL, traffic level and type of site						
			Traffic (Commercial Vehicles per Lane per Day) at opening						
			<250	251-500	501-750	751-1000	1001-2000	2001-3000	Over 3000
S1	Bend radius <250m – dual carriageway	0.45	60						
		0.50		65	68*	H / 70+	H / 70+	H / 70+	H / 70+
S2	Bend radius <250m – single carriageway	0.45	60						
		0.50		65	68+	H / 70+	H / 70+	H / 70+	H / 70+

Notes:

- Site categories are grouped according to their general character and traffic behaviour. Site categories and the Investigatory Levels (IL) for specific categories are defined in NRA HD 28. The IL to be used here must be that which has been allocated to the specific site on which the material is to be laid, as determined by following the procedures in NRA HD 28. The shaded sections of the table represent combinations of traffic and IL that do not form part of NRA HD 28.
- For roads in site categories A, B and C where some braking regularly occurs (e.g. on 300m approach to an off-slip) there may be increased polishing stresses compared with most locations in these categories. In such situations add 5 to the PSV value where it is marked with an asterisk.
- Investigatory Levels and averaging lengths for site categories K and Q are based on the 50m approach to the feature but this shall be extended when justified by local site characteristics.
- Throughout this Table, H means specialised high friction surfacing (HFS) conforming to Clauses 7.3 and 10.2.4 of the NRA Specification for Road Works Series 900.
- Although minimum PSV values have been included for all types of site and traffic level, some combinations are unlikely to occur in practice.

Min. PSV

# Worked Example

## Flexible Pavement - Completing Appendix 7/1

- Completing Appendix 7/1

1	<i>Location:</i>		<b>General Requirement</b>
2	Grid for checking surface levels of pavement courses, if different from the requirements of CI 702.4:	Long dim: Trans dim:	N/A <b>N/A</b> N/A <b>N/A</b>
3	Surface regularity (CI 702.7 and CI 702.8):	Category of Road Long Reg.: Trans Reg.:	[A or B] <b>A</b> <b>300m</b> <b>20m</b>
4	Requirements for coarse aggregates - Polished Stone Value (PSV), Aggregate Abrasion Value (AAV) (Series 900 CI 3.2.2, 5.2.2, 6.2.2, 8.4.1.1, 8.6.1.1):		<b>Min. PSV: 68+</b> <b>Max AAV: 16</b>
5	Requirements for pre-coated chippings - Polished Stone Value (PSV) for general use mixtures, PSV for mixtures for roundabouts, Aggregate Abrasion Value (AAV) (Series 900 CI 4.2.4):		N/A <b>N/A</b>
6	Requirement for testing for Polished Stone value using the friction after polishing test (NRA HD 300 Clause 2.25)		[Yes/No] <b>YES</b>



# Worked Example

## Flexible Pavement - Completing Appendix 7/1

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- Completing Appendix 7/1

7	Freezing and thawing (soundness) category if different from the requirements of Series 900 Tables 1, 4, 7, 10 and 17:	N/A <b>N/A</b>
8	Compaction control and extraction of cores if different from the requirements of Series 900 Cls 10.1.9, 10.1.9.1, 10.1.9.2, 10.1.9.3, 10.1.9.4.	N/A <b>N/A</b> N/A <b>N/A</b>
9	Requirements for monitoring resistance to permanent deformation of HRA (Series 900 Cl. 10.1.10.1)	[Yes/No] <b>N/A</b>
10	Sealant to be applied to the whole of any freestanding edge on the outside of the finished pavement on the low side of the camber (Series 900 Cl 10.1.8):	[Yes/No] <b>YES</b>
11	Any tests additional to those required by IS EN 13108–20, IS EN 13108–21 or the relevant SRW (Series 900 Cl 1.2 and 1.3):	N/A <b>N/A</b>
12	Whether subbase material may be spread in more than one layer (Cl 802.4).	[Yes/No] <b>NO</b>

# NRA Pavement Standards Training

Bituminous Mixtures – Worked Example

## 2. Designing and Producing the Bituminous Mixture

# Worked Example

## Producing the Mixture - Who's Responsible?

---

**Bituminous mixture design and production →**

**The Producer**

Type Testing per design

Declare the Performance (DoP)  
& CE Mark

Maintain test results

Produce mixture in accordance with  
NRA Series 900 so that it is  
Appropriate for the **INTENDED USE**  
and **DURABLE** for its expected **LIFE**

# Worked Example

## Producer's Perspective - Completed Appendix 7/1

- Completed Appendix 7/1

Pavement Course	Clause	Mixture Designation / Material	Thickness (mm)	Particular Requirements <i>[Insert appropriate requirements from Tables NG 7/1 to 7/2]</i>
Surface Course	Series 900 Clause 5.1.3	SMA 14 surf PMB 65/105-60 des	40	N/A
Binder Course	Series 900 Clause 3.1.4	AC 20 dense bin 40/60 des	80	N/A
Base	Series 900 Clause 3.1.1	AC 32 dense base 40/60 des	130	N/A
Sub-base	804	Granular Material Type B	150	<i>[Whether material may be frost susceptible (801.4)]. NO</i>
Total Pavement Thickness (excluding sub base)				

# Worked Example

## Producer's Perspective - Completed Appendix 7/1

- Completed Appendix 7/1

1	<i>Location:</i>		General Requirement
2	Grid for checking surface levels of pavement courses, if different from the requirements of CI 702.4:	Long dim: Trans dim:	N/A <b>N/A</b> N/A <b>N/A</b>
3	Surface regularity (CI 702.7 and CI 702.8):	Category of Road Long Reg.: Trans Reg.:	[A or B] <b>A</b> <b>300m</b> <b>20m</b>
4	Requirements for coarse aggregates - Polished Stone Value (PSV), Aggregate Abrasion Value (AAV) (Series 900 CI 3.2.2, 5.2.2, 6.2.2, 8.4.1.1, 8.6.1.1):		<b>Min. PSV: 68+</b> <b>Max AAV: 16</b>
5	Requirements for pre-coated chippings - Polished Stone Value (PSV) for general use mixtures, PSV for mixtures for roundabouts, Aggregate Abrasion Value (AAV) (Series 900 CI 4.2.4):		N/A <b>N/A</b>
6	Requirement for testing for Polished Stone value using the friction after polishing test (NRA HD 300 Clause 2.25)		[Yes/No] <b>YES</b>

# Worked Example

## Producer's Perspective - Completed Appendix 7/1

- Completed Appendix 7/1

7	Freezing and thawing (soundness) category if different from the requirements of Series 900 Tables 1, 4, 7, 10 and 17:	N/A <b>N/A</b>
8	Compaction control and extraction of cores if different from the requirements of Series 900 Cls 10.1.9, 10.1.9.1, 10.1.9.2, 10.1.9.3, 10.1.9.4.	N/A <b>N/A</b> N/A <b>N/A</b>
9	Requirements for monitoring resistance to permanent deformation of HRA (Series 900 Cl. 10.1.10.1)	[Yes/No] <b>N/A</b>
10	Sealant to be applied to the whole of any freestanding edge on the outside of the finished pavement on the low side of the camber (Series 900 Cl 10.1.8):	[Yes/No] <b>YES</b>
11	Any tests additional to those required by IS EN 13108–20, IS EN 13108–21 or the relevant SRW (Series 900 Cl 1.2 and 1.3):	N/A <b>N/A</b>
12	Whether subbase material may be spread in more than one layer (Cl 802.4).	[Yes/No] <b>NO</b>

# Worked Example

## Producing the Mixture - CE Mark, DoP

---

- Producers are currently carrying out testing to ensure their products meet the Series 900 Specification requirements
- For CE marking and DoP requirements, NRA Series 900 Clause 1.5 'Bituminous Mixtures' states that:

*Demonstration of the conformity of the production of bituminous mixtures shall be as described in:*

*(i) IS EN 13108-20 **Type Testing**; and*

*(ii) IS EN 13108-21 **Factory Production Control***

Where:

- **Type Testing** = initial test of the product
- **FPC**
  - 3rd party assessment of production process (for Bituminous Mixtures)
  - part of system of assessment and verification of constancy of performance (AVCP)

# Worked Example

## Producing the Mixture - CE Mark, DoP

---

### Prior to Works commencing

*For each product to be incorporated into the Works, ...  
the DoP, CE Mark, and Type Test reports shall be  
supplied to the Employer's Representative for review  
prior to commencement of the Works.*



# Worked Example

## Producing the Mixture - CE Mark, DoP

---

### DoP and CE marking information in NRA Series NG 000

#### **NG 000 Clause NG 006.9 states that:**

*The relevant hEN (harmonised European standard) provides further details of information that the DoP is required to contain. The Type Test reports shall form part of the DoP*

#### **NG 000 Clause NG 006.11 – 13 states that:**

*By affixing a CE Marking **the manufacturer indicates that he is responsible for conformity of the construction product with the declared performance** and compliance with all applicable requirements laid down in the CPR.*

*The CE Mark contains similar information to the DoP...*

*The CE marking symbol must be affixed to the product, packaging or accompanying documents such as a delivery docket / ticket.*

# Worked Example

## Producing the Mixture – Type Test Report

---

Refer to IS EN 13108-20

### **Type Test Report shall include:**

All information to 'fingerprint' the mixture, such as:

- Mix type and production plant
- Constituents – source and type
- Constituents – test results to show compliance with any requirements
- Mixture formulation – binder content and grading
- Mixture test results – the performance element

Note that **any** change to the type or source of aggregates and filler or a change in the bitumen grade requires a new Type Test report, DoP and CE Mark

# Worked Example Producing

## Sample Type Test Report

Type Testing Report number: TP100

in accordance with EN 13108-20:2006

**Mix Type:** EN 13108- 1 AC Design mix  
**Production Plant Name:** Any Co Ltd Plant  
**Product code/ Material name:** AC 20 dense bin 70/100  
**Mix Validation Method:** Production Validation EN 13108-20 Clause 6.5 3b

Declared Conformity Categories reference EN 13108-20, Annex B, Table B.1				
Parameter	Annex C	Value	Category	Remarks/ Supporting documents
Grading	n/a	see Mix Formulation	-	-
Binder Content	n/a	see Mix Formulation	-	-

Mix Constituents			
Name	Source	Type	Remarks / Supporting documents
Aggregate 1	Belgard	Limestone	LA, Soundness, Water Absorption and Density, Fines Content test certificates attached
Aggregate 2	Belgard	Limestone	
Aggregate 3	Belgard	Limestone	
Binder 70/100	Irish Tar and Bitumen Suppliers	EN 12591 PG Bitumen	Penetration and Softening Point test certificates attached
Permissible range of properties ref. EN 13108-1 AC			
Control methods reference EN13108			

Mix Formulation				
Reference for Targets	EN 13108			
Reference for Tolerance	BS EN 13108-21:2006 Table A.1 Large Aggregate Mix			
Sieve	Designation	Target %	Tolerances	Spec. limits
31.5 mm	1.4 D sieve	100	-2 +0	98 - 100
20 mm	D Sieve	99	-9 +5	90 - 100
10 mm	D/2 or char coarse sieve	62	-9 +9	53 - 71
6.3 mm	1st Optional coarse sieve	47	-9 +9	38 - 56
2 mm	2mm sieve	30	-7 +7	23 - 37
0.250 mm	Characteristic fine sieve	13	-5 +5	8 - 18
0.063 mm	0.063mm sieve	5.5	-3.0 +3.0	2.5- 8.5
Binder	Binder	4.9	-0.6 +0.6	4.3 - 5.5
Binder Category EN 13108-1 AC B <sub>min</sub> 4.8				
<b>Minimum void content</b>		V <sub>min</sub> 4,3	EN 12697-8; EN 12697-6 procedure B SSD; EN 12697-5 procedure A in water	
<b>Maximum void content</b>		V <sub>max</sub> 6,7	EN 12697-8; EN 12697-6 procedure B SSD; EN 12697-5 procedure A in water	
<b>Water sensitivity</b>		76%	EN 12697-12 Method A	
<b>Maximum Temperature</b>		176°C		
<b>Minimum Temperature</b>		142°C		
<b>Stiffness</b>	1830 Mpa	EN 12697-26 Annex B		
<b>Additional Information</b>				
None				
<b>Declaration of Performance Ref</b> -				

**DECLARATION OF PERFORMANCE**

No. 001 CPR 2015-01-01

1. **Unique identification code of the product-type:**  
 Asphalt Concrete  
 AC 20 dense bin 70/100
2. **Type, batch or serial number or any other element** allowing identification of the construction product as required under Article 11(4):  
 Asphalt Concrete  
 AC 20 dense bin 70/100 — 0001
3. Intended use or uses of the construction product, in accordance with the applicable harmonised technical specification, as foreseen by the manufacturer:  
 For binder courses
4. Name, registered trade name or registered trade mark and contact address of the manufacturer as required under Article 11(5):  
 Any Co Ltd,  
 X Street,  
 Dublin, Ireland  
 Tel. +353 1 234 5678  
 Fax: +353 1 234 5679  
 E-mail: anyco@provider.ie
5. Where applicable, name and contact address of the authorised representative whose mandate covers the tasks specified in Article 12(2):  
 N / A
6. System of assessment and verification of constancy of performance of the construction product as set out in CPR, Annex V:  
 System 2+
7. In case of the declaration of performance concerning a construction product covered by a harmonised standard:  
 National Standards Authority of Ireland  
 Notified body No. 0050

Performed:

the initial inspection of the manufacturing plant and evaluation of factory production control and the continuous surveillance, assessment and evaluation of factory production control under system:

2+

and issued:

the certificate of conformity of the factory production control

Declared performance.

Essential characteristics	Performance	Harmonised technical specification																
Adhesion of binder to aggregate Stiffness Resistance to permanent deformation Resistance to fatigue Skid resistance Resistance to abrasion Reaction to fire Dangerous substances Durability		EN 13108-1:2006																
3, 4, 5, 6, 9	Target grading passing sieve <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Sieve mm</th> <th>Passing %</th> </tr> </thead> <tbody> <tr><td>31,5</td><td>100</td></tr> <tr><td>20</td><td>99</td></tr> <tr><td>10</td><td>62</td></tr> <tr><td>6,3</td><td>47</td></tr> <tr><td>2</td><td>30</td></tr> <tr><td>0,250</td><td>13</td></tr> <tr><td>0,063</td><td>5,5</td></tr> </tbody> </table>	Sieve mm	Passing %	31,5	100	20	99	10	62	6,3	47	2	30	0,250	13	0,063	5,5	EN 12697-2
Sieve mm	Passing %																	
31,5	100																	
20	99																	
10	62																	
6,3	47																	
2	30																	
0,250	13																	
0,063	5,5																	
2, 3, 4, 5, 6, 9	Target binder content 4,9%	EN 12697-1																
2, 4, 5, 9	Minimum and maximum void content $V_{min} 4,0; V_{max} 7,0$	EN 12697-8; EN 12697-6 procedure B SSD; EN 12697-5 procedure A in water																
9	Water sensitivity $ITSR_{70}$	EN 12697-12 Method A																
2, 3, 4, 9	Maximum Temperature 180 °C Minimum temperature 140 °C																	
9	Minimum Stiffness $S_{min}$ 1800	EN 12697-26 Annex B																

The performance of the product identified in points 1 and 2 is in conformity with the declared performance in point 8. This declaration of performance is issued under the sole responsibility of the manufacturer identified in point 4.

ned for and on behalf of the manufacturer by:

.....  
(Name and function)

.....  
(Place and date of issue)

.....  
(Signature)

Figure NG 0/1 – Example DoP

# Worked Example

## Producing the Mixture - CE Mark, D

Sample CE mark in NRA Series NG 000


 0050																	
Any Co Ltd, X Street, Dublin, Ireland 15 001-CPR-2015/01/01																	
EN 13108-1:2006 <div style="border: 2px solid red; padding: 5px; text-align: center;">           Asphalt Concrete            AC 20 dense bin 70/100 — 0001         </div>																	
binder courses																	
Void content:	max. 7,0 % <div style="border: 1px solid red; padding: 2px;">min. 4,0 %</div>																
Water sensitivity	<div style="border: 1px solid red; padding: 2px;">min. 70</div>																
Maximum Temperature of the mixture 180 °C Minimum Temperature of the mixture 140 °C																	
Grading target composition																	
<table border="1"> <thead> <tr> <th>Sieve size mm</th> <th>Passing %</th> </tr> </thead> <tbody> <tr><td>31,5</td><td>100</td></tr> <tr><td>20</td><td>99</td></tr> <tr><td>10</td><td>62</td></tr> <tr><td>6,3</td><td>47</td></tr> <tr><td>2</td><td>30</td></tr> <tr><td>0,250</td><td>13</td></tr> <tr><td>0,063</td><td>5,5</td></tr> </tbody> </table>	Sieve size mm	Passing %	31,5	100	20	99	10	62	6,3	47	2	30	0,250	13	0,063	5,5	
Sieve size mm	Passing %																
31,5	100																
20	99																
10	62																
6,3	47																
2	30																
0,250	13																
0,063	5,5																
Target Binder content	4,9 %																
Minimum stiffness	1 800 MPa																

Figure NG 0/2 – Example CE Mark

**ARUP**

# Worked Example

## Producing the Mixture - CE Mark, DoP

---

### During the Works

*During production of bituminous mixtures for incorporation into the Works, ...*

***the operating compliance reports required under factory production control shall be submitted at weekly intervals to the Employer's Representative.***

*The minimum Operating Compliance Level (OCL) for the frequency of analysis of finished product shall be Level X as set out in IS EN 13108-21 Table A.3.*

# Worked Example

## Producing the Mixture - Series NG 900

### NG 1.2a – Procedural Guidelines for Bituminous Products to IS EN

Step	Step	Respon party	Step	Responsible party	Description	Controls	Employer's Representative Checklist	
1	3	Bitumin mixture manufac	6	Bituminous mixture manufacturer	<p><b>CE Marking</b></p> <p>The data from the FPC, Product type testing and DoP permit the manufacturer to affix a unique CE Mark to each mixture to allow the product to be placed on the market.</p> <p>See Annex ZA of the relevant part of IS EN 13108.</p>	<p>A current FPC certificate and a current DoP for each product to be available prior to the CE Mark being affixed.</p> <p>Responsibilities for certification:</p> <p>(i) System 2+ Notified Body involvement</p> <p>All products should be delivered under a CE marked delivery ticket in accordance with Annex ZA of the relevant part of IS EN 13108.</p>	<p>Review documentation for compliance with specified mixture performance requirements. May reserve the right under the CPR to initiate further inspection, testing, etc.</p> <p>Witness the collection, splitting and dispatch of any site samples.</p>	
	<p><b>Notes</b></p> <p>For requirements for constituent materials refer to Series 900 Tables 1, 4, 7 or 10.</p> <p>For requirements for product composition and properties refer to Series 900 Tables 2, 5, 8 or 11.</p>							
	4	Bitumin mixture manufac				<p>laboratory. IS EN 12697-38 contains the minimum competency expected.</p> <p>FPC is subject to independent accreditation by a Notified Body. Notified Body must be listed on EU Nando website (<a href="http://ec.europa.eu/enterprise/newapproach/nando">http://ec.europa.eu/enterprise/newapproach/nando</a>) as being registered for the relevant part of IS EN 13108.</p>	<p>further inspection, testing, etc.</p> <p>Market Surveillance or Competent National Authority may audit production controls right back to Initial Type Testing and constituent materials, including auditing the competence of the laboratories used for testing.</p> <p>Ask to see copy of the FPC certificate.</p>	
2	5	Bituminous mixture manufacturer			<p><b>Declaration of Performance (DoP)</b></p> <p>A declaration that the properties found from the Product Type testing complies with the requirements for the mixture.</p>	<p>The DoP to include sufficient details to establish:</p> <p>(i) the constituents used</p> <p>(ii) the test methods used for the testing</p> <p>(iii) the test results achieved</p>	<p>Review documentation for compliance with specified mixture performance requirements. May reserve the right under the CPR to initiate further inspection, testing. Ask to see a copy of the DoP.</p> <p>Market Surveillance or Competent National Authority may audit production controls right back to product type testing and constituent materials, including auditing the competence of the laboratories used for testing.</p>	

# NRA Pavement Standards Training

Bituminous Mixtures – Worked Example

## 3. Installing, Compacting and Checking the Works



# Worked Example

## The Works - Who's Responsible?

---

**Installing, compacting, in situ testing →  
The Contractor**

Find a Producer

Demonstrate the material is compliant

Organise and undertake the Works &  
arrange for in situ testing to be completed

Appropriate for INTENDED USE &  
DURABLE for EXPECTED LIFE

# Worked Example

## The Works - Who's Responsible?

---

### Monitoring the Works for the Employer → The Employer's Rep.

Oversee Translation of the Designers requirements into the end product

Seek documentation demonstrating material compliance prior to & during Works

Conduct checks to ensure pavement performance consistent with Series 900

Appropriate for INTENDED USE &  
DURABLE for EXPECTED LIFE

# Worked Example

## Contractor's Perspective - Completed Appendix 7/1

- Completed Appendix 7/1

Pavement Course	Clause	Mixture Designation / Material	Thickness (mm)	Particular Requirements <i>[Insert appropriate requirements from Tables NG 7/1 to 7/2]</i>
Surface Course	<b>Series 900 Clause 5.1.3</b>	<b>SMA 14 surf PMB 65/105-60 des</b>	<b>40</b>	<b>N/A</b>
Binder Course	<b>Series 900 Clause 3.1.4</b>	<b>AC 20 dense bin 40/60 des</b>	<b>80</b>	<b>N/A</b>
Base	<b>Series 900 Clause 3.1.1</b>	<b>AC 32 dense base 40/60 des</b>	<b>130</b>	<b>N/A</b>
Sub-base	<b>804</b>	<b>Granular Material Type B</b>	<b>150</b>	<i>[Whether material may be frost susceptible (801.4)].</i> <b>NO</b>
Total Pavement Thickness (excluding sub base)				

# Worked Example

## Contractor's Perspective - Completed Appendix 7/1

- Completed Appendix 7/1

1	<i>Location:</i>		<b>General Requirement</b>
2	Grid for checking surface levels of pavement courses, if different from the requirements of CI 702.4:	Long dim: Trans dim:	N/A <b>N/A</b> N/A <b>N/A</b>
3	Surface regularity (CI 702.7 and CI 702.8):	Category of Road Long Reg.: Trans Reg.:	[A or B] <b>A</b> <b>300m</b> <b>20m</b>
4	Requirements for coarse aggregates - Polished Stone Value (PSV), Aggregate Abrasion Value (AAV) (Series 900 CI 3.2.2, 5.2.2, 6.2.2, 8.4.1.1, 8.6.1.1):		<b>Min. PSV: 68+</b> <b>Max AAV: 16</b>
5	Requirements for pre-coated chippings - Polished Stone Value (PSV) for general use mixtures, PSV for mixtures for roundabouts, Aggregate Abrasion Value (AAV) (Series 900 CI 4.2.4):		N/A <b>N/A</b>
6	Requirement for testing for Polished Stone value using the friction after polishing test (NRA HD 300 Clause 2.25)		[Yes/No] <b>YES</b>

# Worked Example

## Contractor's Perspective - Completed Appendix 7/1

- Completed Appendix 7/1

7	Freezing and thawing (soundness) category if different from the requirements of Series 900 Tables 1, 4, 7, 10 and 17:	N/A <b>N/A</b>
8	Compaction control and extraction of cores if different from the requirements of Series 900 Cls 10.1.9, 10.1.9.1, 10.1.9.2, 10.1.9.3, 10.1.9.4.	N/A <b>N/A</b> N/A <b>N/A</b>
9	Requirements for monitoring resistance to permanent deformation of HRA (Series 900 Cl. 10.1.10.1)	[Yes/No] <b>N/A</b>
10	Sealant to be applied to the whole of any freestanding edge on the outside of the finished pavement on the low side of the camber (Series 900 Cl 10.1.8):	[Yes/No] <b>YES</b>
11	Any tests additional to those required by IS EN 13108–20, IS EN 13108–21 or the relevant SRW (Series 900 Cl 1.2 and 1.3):	N/A <b>N/A</b>
12	Whether subbase material may be spread in more than one layer (Cl 802.4).	[Yes/No] <b>NO</b>

# Worked Example

## The Works - Introduction

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In terms of the Contractor, focus on:

- The detail within Clause 10 of Series 900; what's in the Clause and what's new
- Clause 11 look-up tables containing the requirements for the Works for each product
- Requirements for in situ testing

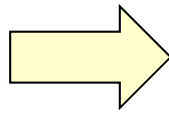
# Worked Example

## The Works - Series 900 Requirements

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NRA Series 900 – NEW

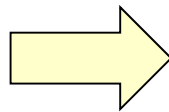
Clause 2



### **Preparatory Work**

- Cold Milling of Bituminous Bound Flexible Pavement
- Regulating

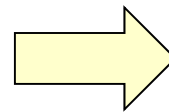
Clause 10



### **Works**

Clause 10.1: Bituminous Mixtures

Clause 11



**Tables 3, 6, 9, 12 and 20**

# Worked Example

## The Works - Series 900 Requirements

### Requirements for Works Bituminous Products

**Table 9 Stone Mastic Asphalt – Requirements of the Works**

hEN reference	EN 13108 – 5 Stone Mastic Asphalt														
Table column reference	1	2	3	4	5	6	7								
Layer	Binder	Binder	Binder	Surface	Surface	Surface	Surface								
Mixture designation	SMA 14 bin des	SMA 10 bin des	SMA 6 bin des	SMA 14 surf des	SMA 10 surf des	SMA 14 surf des <sup>2</sup>	SMA 10 surf des <sup>2</sup>								
Alignment, levels, tolerances, thickness & regularity (mm)															
Horizontal alignment				See Clause 702											
Levels				See Clause 702											
Tolerances	±6	±6	±6	±6	±6	±6	±6								
Adjacent to surface water or linear drainage channel	+10 - 0	+10 - 0	+10 - 0	+10 - 0	+10 - 0	+10 - 0	+10 - 0								
Layer thickness - nominal	30 to 60	20 to 50	15 to 40	35 to 50	25 to 50	35 to 50	25 to 50								
Layer thickness - minimum	25	15	10	30	20	30	20								
see Clause 702															
		Delivery	Rolling	Delivery	Rolling	Delivery	Rolling	Delivery	Rolling	Delivery	Rolling	Delivery	Rolling		
		130	100	130	100	130	100					130	100	130	100
		125	90	125	90	125	90								
		145	115	145	115	145	115	145	115	145	115				
		V <sub>min 2,0</sub>		V <sub>min 2,0</sub>		V <sub>min 2,0</sub>		To be recorded		To be recorded		To be recorded		To be recorded	
		V <sub>min 3,0</sub>		V <sub>min 3,0</sub>		V <sub>min 3,0</sub>		To be recorded		To be recorded		To be recorded		To be recorded	
		To be recorded		To be recorded		To be recorded		To be recorded		To be recorded		To be recorded		To be recorded	
		To be recorded		To be recorded		To be recorded		To be recorded		To be recorded		To be recorded		To be recorded	
		na		na		na		1,3		1,1		1,3		1,1	
		na		na		na		1,8		1,6		1,8		1,6	
		na		na		na		1,0		0,9		1,0		0,9	
boulds		na		na		na		1,0 <sup>1</sup>		1,0		1,0 <sup>1</sup>		1,0	
		na		na		na		1,5 <sup>1</sup>		1,5		1,5 <sup>1</sup>		1,5	
		na		na		na		0,9 <sup>1</sup>		0,9		0,9 <sup>1</sup>		0,9	

**Table 20 Test Methods and Conditions – Works**

Property	Test method	Sample Preparation
Grading	EN 12697-2	EN 12697-28
Binder content	EN 12697-1 or 39	EN 12697-28
Void content in situ in laid material & Void content in situ within 100mm of joint	EN 12697-8	EN 12697-27
	Using bulk density to EN 12697-6 procedure B SSD	CI 4.7 cores 150mm diameter
	maximum density to EN 12697-5 procedure A in water	EN 12697-27
		CI 4.3 sample from augers <sup>1</sup> or cores used for bulk density
Void content at refusal	EN 12697-32	EN 12697-27
	Using bulk density to EN 12697-6 procedure B SSD	CI 4.7 cores 150mm diameter
	maximum density to EN 12697-5 procedure A in water	(using same cores extracted for void content)
Water sensitivity	EN 12697-12 method A	EN 12697-27
		CI 4.3 sample from augers <sup>1</sup>
Resistance to permanent deformation	EN 12697-22	EN 12697-27
	procedure B 60°C Small device	CI 4.7 cores 300mm min diameter or CI 4.8 saw cut slabs 320mm x 260mm
Resistance to permanent deformation HRA	EN 12697-22	EN 12697-27
	procedure A 60°C Small device	CI 4.7 cores 300mm min diameter
Stiffness	EN 12697-26	EN 12697-27
	IT-CY 20°C	CI 4.7 cores 150mm diameter
Stiffness LERM	EN 12697-26	150mm cylindrical specimens, thickness 75 mm
	IT-CY 20°C	
Hydraulic Conductivity	EN 12697-40	
Macrotexture	EN 13036-1	
Notes		
	<sup>1</sup> Preferably from the same location as where the cores will be taken	



# Worked Example

## The Works - Series 900 Requirements

---

### Requirements for the Works (Bituminous Mixtures)

General	→	Series 900 takes precedence over BS 594987
Preparation	→	Repair Works and Cold Milling
Works Proposals	→	Contractor to submit to ER
Transport	→	<i>Asphalt shall remain covered whilst awaiting tipping</i>
Weather Conditions	→	Surface temp, Air temp, Rain, etc.
○ Specific to PA and SMA		
Temperatures	→	Delivery and Rolling temp. to Table 3/6/9/12
Aftercare	→	Temperatures of surface and mat temperature prior to opening to traffic

# Worked Example

## The Works - Series 900 Requirements

---

### Requirements for the Works (Bituminous Mixtures)

#### **Bond Coat**

*A bond coat shall be sprayed onto all surfaces including HBM layers prior to laying all bituminous products to improve the adhesion between layers and increase the impermeability of the underlying layer.*

***minimum rate of 0,30kg/m<sup>2</sup> of residual binder***

The Contractor shall ensure a quality management system in accordance with **IS EN ISO 9001** is implemented for the application of bond coats

Also have:

- Documented procedures for carrying out rate of spread and accuracy of spread tests in accordance with IS EN 12272-1.
- Quality Plan for checking and visually assessing spray accuracy
- Binder distributors shall have controlled metering and be capable of uniform distribution

# Worked Example

## The Works - Series 900 Requirements

---

### Requirements for the Works (Bituminous Mixtures)

#### Laying



Hand laying, hand raking, etc.

- Specific to HRA
- Specific to PA

Application of HRA chippings, 'shoulder to shoulder' cover

*Shall be laid by machine and compacted within three hours of mixing*

#### Joints



Cutting and treating joints

- Specific to PA

*All joints shall be offset by at least 150mm from parallel joints in the layer beneath.*

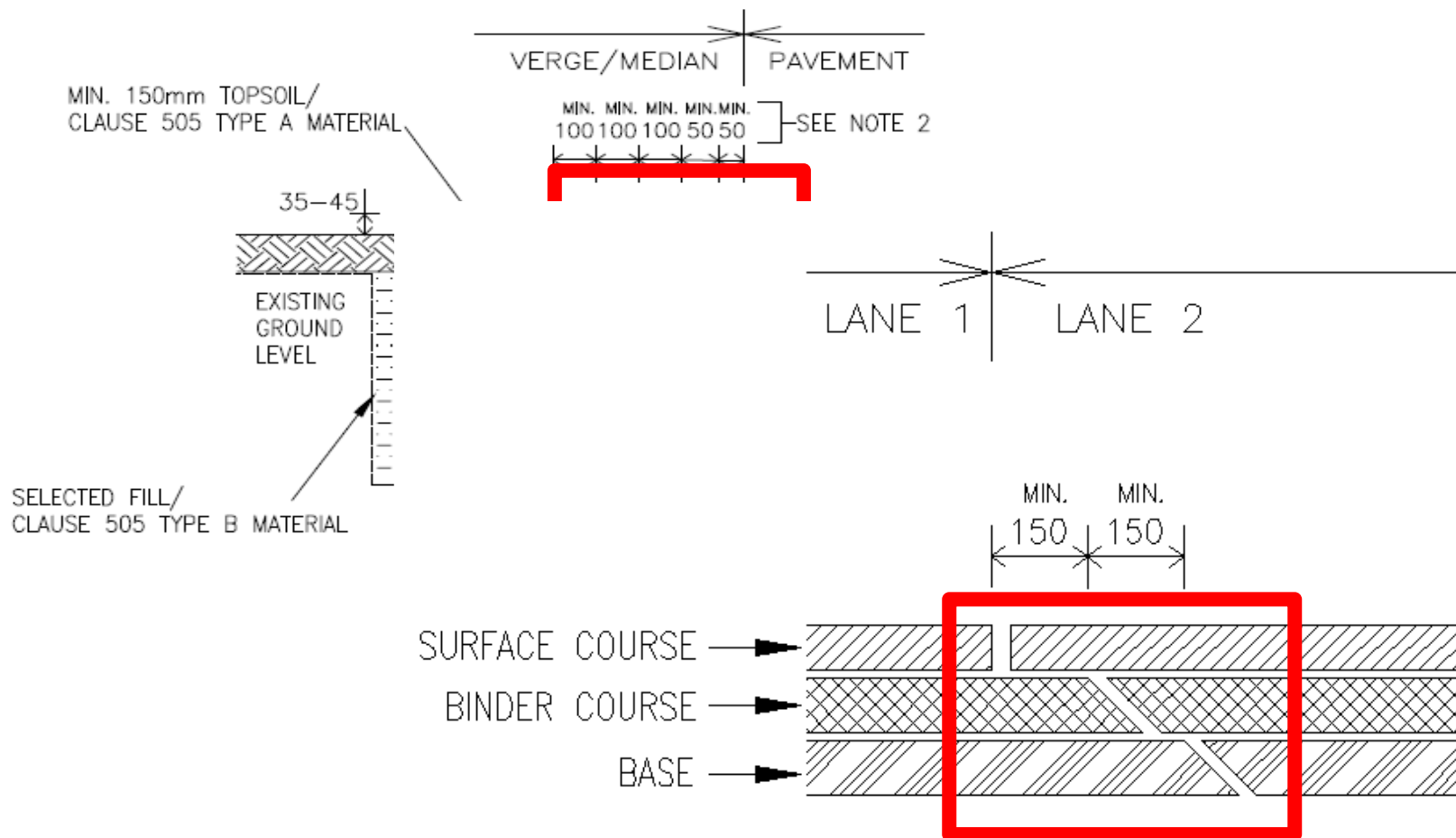
*Cut Vertical Joint where:*

- *Layer less than 50mm*
- *All Transverse Joints*

# Worked Example

## The Works - Series 900 Requirements

### Requirements for the Works (Bituminous Mixtures)



# Worked Example

## The Works - Series 900 Requirements

---

### Requirements for the Works (Bituminous Mixtures)



# Worked Example

## The Works - Series 900 Requirements

### Requirements for Works Bituminous Products

hEN reference	EN 13108 – 5 Stone Mastic Asphalt															
Table column reference	1		2		3		4		5		6		7			
Layer	Binder		Binder		Binder		Surface		Surface		Surface		Surface			
Mixture designation	SMA 14 bin des		SMA 10 bin des		SMA 6 bin des		SMA 14 surf des		SMA 10 surf des		SMA 14 surf des <sup>2</sup>		SMA 10 surf des <sup>2</sup>			
<b>Alignment, levels, tolerances, thickness &amp; regularity (mm)</b>																
Horizontal alignment	See Clause 702															
Levels	See Clause 702															
Tolerances	± 6		± 6		± 6		± 6									
Adjacent to surface water or linear drainage channel	+ 10 - 0		+ 10 - 0		+ 10 - 0		+ 10 - 0									
Layer thickness - nominal	30 to 60		20 to 50		15 to 40		35 to 50									
Layer thickness - minimum	25		15		10		30									
Surface regularity	see Clause 702															
<b>Temperature of the mixture - minimum</b>	Delivery	Rolling	Delivery	Rolling	Delivery	Rolling	Delivery	Rolling	Delivery	Rolling	Delivery	Rolling	Delivery	Rolling	Delivery	Rolling
40/60	130	100	130	100	130	100					130	100	130	100		
70/100	125	90	125	90	125	90										
PMB 65/105-60	145	115	145	115	145	115	145	115	145	115						
<b>Properties</b>																
Air voids minimum <sup>1</sup>	V <sub>min 2.0</sub>		V <sub>min 2.0</sub>		V <sub>min 2.0</sub>		To be recorded		To be recorded		To be recorded		To be recorded			
Air voids maximum <sup>1</sup>	V <sub>max 8.0</sub>		V <sub>max 8.0</sub>		V <sub>max 8.0</sub>		To be recorded		To be recorded		To be recorded		To be recorded			
Water sensitivity <sup>1</sup>	To be recorded		To be recorded		To be recorded		To be recorded		To be recorded		To be recorded		To be recorded			
Resistance to permanent deformation <sup>1</sup>	To be recorded		To be recorded		To be recorded		To be recorded		To be recorded		To be recorded		To be recorded			
<b>Surface Macrotexture (mm) <sup>1</sup></b>																
Mandatory speed of traffic > 60km/hr																
Average per 1000m - minimum	na		na		na		1,3		1,1		1,3		1,1			
Average per 1000m - maximum	na		na		na		1,8		1,6		1,8		1,6			
Average for a set of 10 measurements - minimum	na		na		na		1,0		0,9		1,0		0,9			
Mandatory speed of traffic ≤ 60km/hr and roundabouts																
Average per 1000m - minimum	na		na		na		1,0 <sup>3</sup>		1,0		1,0 <sup>3</sup>		1,0			
Average per 1000m - maximum	na		na		na		1,5 <sup>3</sup>		1,5		1,5 <sup>3</sup>		1,5			
Average for a set of 10 measurements - minimum	na		na		na		0,9 <sup>3</sup>		0,9		0,9 <sup>3</sup>		0,9			
<b>Notes</b>																
<sup>1</sup> Test methods and test conditions contained in Table 20																
<sup>2</sup> These mixture designations shall not be permitted for use on roads carrying greater than 100 cv/lane/day																
<sup>3</sup> Restricted conditions apply, refer to NRA HD36																

For further updates to Specs & Standards...

**N** An Údarás um Boithre Náisiúnta  
National Roads Authority

# Worked Example

## The Works - Series NG 900

### NG for Works Bituminous Products

Test	Bituminous Mixture					
	AC		HRA	SMA		PA
	Base & Binder	Surface	Surface	Binder	Surface	Surface
Layer thickness	✓	✓	✓	✓	✓	✓
Temperature	✓	✓	✓	✓	✓	✓
Water Sensitivity	✓	✓	✓	✓	✓	✓
Grading	✓	✓	✓	✓	✓	✓
Binder Content	✓	✓	✓	✓	✓	✓
Air Void content in-situ in laid material	✓	✓	✓	✓	✓	✓
Air Void content in-situ within 100mm of joint	✓					
Air Void content in-situ at refasal	✓					
Resistance to permanent deformation	✓		✓	✓	✓	
Stiffness	✓					
Surface Macrotecture		✓	✓		✓	
Hydraulic Conductivity						✓

# Worked Example

## The Works - Series NG 900

### NG for Works Bituminous Products

Test	Product group	Product group					
		AC		HRA	SMA		PA
Cores	Test	Base & Binder	Surface	Surface	Binder	Surface	Surface
Every 1000 linear metres laid per lane – not in wheel track, 1 pair	Air Void		100mm dia.	100mm dia.		100mm dia.	100mm dia.
Every 1000 linear metres laid per lane – in wheel track, 1 pair	Air Void	150mm dia.			150mm dia.		
Every 250 linear metres laid per lane – within 100mm of unsupported joint, 1 pair	Air Void	150mm dia.					
Every 1000 linear metres laid per lane – in wheel track, 1 pair	Air Void (refusal)	150mm dia.					
Every 1000 linear metres laid per lane – in wheel track, 1 core (6 in first km)	Permanent Deformation	300mm dia.		300mm dia.			
Every 1000 linear metres laid per lane – in wheel track, 1 pair	Stiffness	150mm dia.					
<b>Notes</b>							
Dia: Diameter of cores							
For schemes less than 1,000m in length, refer to Series 900 for specific requirements							

Table NG 10.2 – Coring requirements for the Works



# Worked Example

## Summary

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This section of the Workshop has:

- Outlined roles and responsibilities of the various parties
- Carried out a worked example in completing Appendix 7/1
- Outlined the issues for a Producer to be aware of
- Outlined the requirements for the Contractor and the role of the ER during the Works

# Worked Example

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**Thank you for your attention**

# NRA Pavement Standards Training