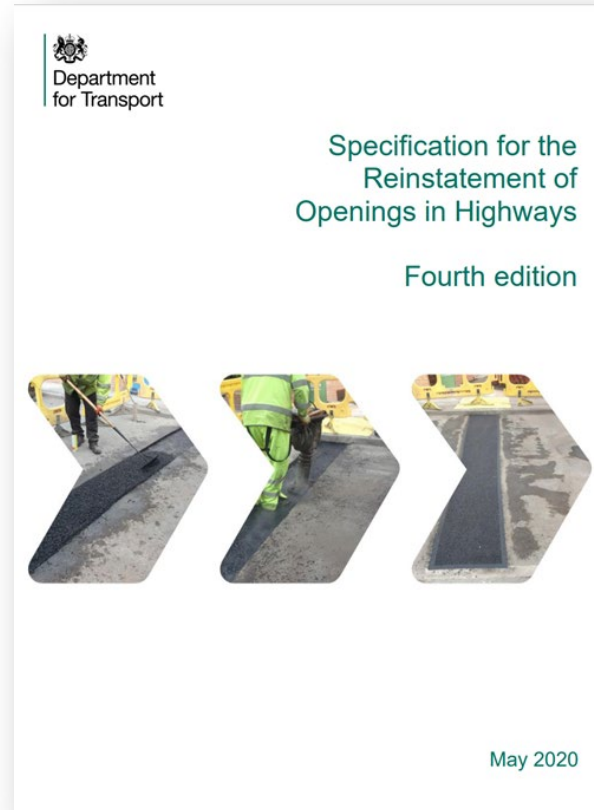


Appendix A8 – Compaction requirements



Researched, compiled and produced by



and



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Introduction- SROH Appendix 8

This advisory document is designed to assist incoming and existing Inspectors as support and refresher material. It will be provided in simple language to aid in understanding and avoiding technical or descriptive explanation.

The current edition (Ed 4) of the Specification for Reinstatement of Openings in the Highway (SROH) has been updated to assist readers in understanding, and introduce new methods and developments within street-works.

Remember, the SROH applies to works undertaken on carriageway's, footway's and verge's maintained at public expense (not private roads or land).

You will now be taken through the key items within Appendix A8 which will enable you to have a better understanding of what to look for when monitoring compaction of both bound and unbound materials.



Please note:

This document is simply to aid in understanding of the Specification for the Reinstatement of Openings in the Highway (SROH) and should not be used for any other purpose. The simplicity of language is to assist in explanation, but may detract from certain technical or descriptive specification requirements and, therefore, the SROH should be consulted for clarity.

Appendix A8 – Compaction requirements

What it says in the SROH

A8.1.1 All granular, graded granular, cohesive/granular, cohesive and cement bound materials laid above the surround to apparatus must be compacted in accordance with Table A8.1

1

A pass is when the compaction equipment has moved over the total surface of the material once.

2

Photograph shows the operative is guiding the 50kg Vibrotamper to cover the whole area of the granular material once.



3

The granular material is GSB Type 1 and it is being compacted to 150mm lift thickness as per SROH Table A8.1

4

Therefore, the area needs to be totally covered 8 times to ensure compaction. (As shown in SROH Table A8.1).

Table A8.1 Compaction requirements for granular, cohesive and cement bound materials

Compaction plant and weight category	Cohesive material (less than 20% granular content)			Granular material (20% or more granular content including cement bound material)		
	Minimum passes/lift for compacted lift thickness up to			Minimum passes/lift for compacted lift thickness up to		
	100 mm	150 mm	200 mm	100 mm	150 mm	200 mm
Vibrotamper 50 kg minimum	4	8#	NP	4	8	NP
Single drum Vibrating roller						
600-1000 kg/m	NP	NP	NP	12	NP	NP
1000-2000 kg/m	8	NP	NP	6	NP	NP
2000-3500 kg/m	3	6	NP	3	5	7
Over 3500 kg/m	3	4	6#	3	4	6
Twin drum Vibrating roller						
600-1000 kg/m	NP	NP	NP	6	NP	NP
1000-2000 kg/m	4	8	NP	3	6	NP
Over 2000 kg/m	2	3	5#	2	3	4
Vibrating plate						
1400-1800 kg/m ²	NP	NP	NP	5	NP	NP
Over 1800 kg/m ²	3	6	NP	3	5	7
All above plant	For maximum and minimum compacted lift thickness see Table A2.6					
Compaction of small openings and narrow trenches must comply with S6.5.						
Vibrotamper 25 kg minimum	Minimum 6 compaction passes Maximum 100 mm compacted lift thickness					
Percussive rammer 10 kg minimum						
Notes:						
1) NP = Not Permitted						
2) # = Not Permitted on wholly cohesive material i.e. clay or silt with no particles > 0.063 mm						
3) Single drum vibrating rollers are vibrating rollers providing vibration on only one drum						
4) Twin drum vibrating rollers are vibrating rollers providing vibration on two separate drums						
5) HBMs must be compacted in accordance with A10.2						
6) Mechanical pole tampers may be considered for compaction around iron work.						

If you have read the refresher aid for S10 of the SROH, you may recall the conversation below.

If I have a 50kg Vibrotamper and need to compact Class A granular. What should I do?

Simply, refer to Table A8.1 where it will show you how many passes of your equipment is required for each lift thickness.

What do you mean by lift thickness and passes?

A lift thickness, is what results after the layer is fully compacted with correct passes. A pass is when you have covered the whole surface of the material once.

So to compact to 150mm lift thickness is 8 passes?

Exactly!

Appendix A8 – Compaction requirements

What it says in the SROH – A8.2 Chalk materials

A8.2.1 All chalk materials, including medium and high-density chalks must be compacted in accordance with Table A8.2. However, if the chalk is unstable after compaction, it must be removed and replaced with fresh material. Fresh chalk must be compacted in accordance with Table A8.2 except that the specified number of compaction passes must be reduced by one pass. If the chalk is still unstable after compaction, it must be replaced with suitable material.

Imported chalk materials used as backfill must comply with the following requirements:

- 1) The saturation moisture content must be determined before use.
- 2) The chalk must be laid and compacted to an approved compaction procedure developed in accordance with NG1.6 (4) and A9. The compaction procedure must be proven with chalk materials of similar saturation moisture content.

Remember, chalk materials will only be available for use in the backfill layer. Do not use chalk materials in base or sub-base layers.

Table S5.1 Suitability of chalk materials for use as backfill

Chalk density	Physical assessment	Backfill suitability
High	Very difficult/impossible to break up by hand Difficult to hammer in steel pin.	Carriageways, footways and verges.
Medium	Some difficulty in breaking up by hand. Some effort needed to hammer in steel pin.	Footways and verges only.
Low	Easy to break up or crush by hand. Steel pin can be pushed in by hand.	Unsuitable for use in any reinstatement.

Note:

Chalk often contains flint inclusions and care should be taken to ensure that:

- a) the steel pin does not strike a flint
- b) the hand crushing sample does not contain any flints.

Therefore, imported chalk will require a proven method of compaction and tested in a trial trench based on SROH appendix A9 for alternative materials and technologies.

Excavated chalk to be re-used as backfill must comply with the following requirements:

- 1) Excavated chalk must be stockpiled for re-use and must not be subjected to multiple handling.
- 2) During wet weather, excavated chalk must be protected against water ingress at all times.

Table A8.2 Compaction requirements for chalk materials

Compaction plant and weight category	Chalk material		
	Minimum passes/lift for compacted lift thickness up to		
	100 mm	150 mm	200 mm
Vibrotamper 50 kg minimum	3	6	NP
Single drum Vibrating roller 600-1000 kg/m	12	NP	NP
1000-2000 kg/m	6	8	NP
2000-3500 kg/m	NP	4	6
Over 3500 kg/m	NP	NP	4
Twin drum Vibrating roller 600-1000 kg/m	6	8	NP
1000-2000 kg/m	2	4	6
Over 2000 kg/m	NP	3	4
Vibrating plate 1400-1800 kg/m ²	6	8	NP
Over 1800 kg/m ²	NP	6	8

Alternative compaction plant for restricted areas

Vibrotamper 25 kg minimum	Minimum of 6 compaction passes Maximum of 100 mm compacted lift thickness
Percussive rammer 10 kg minimum	

Notes:

- 1) NP = Not Permitted
- 2) Single drum vibrating rollers are vibrating rollers providing vibration on only one drum
- 3) Twin drum vibrating rollers are vibrating rollers providing vibration on two separate drums
- 4) Mechanical pole tampers may be considered for compaction around iron work.

Appendix A8 – Compaction requirements

What it says in the SROH – A8.3 Bituminous materials

A8.3.1 Bituminous mixtures for permanent reinstatements permitted in A2 must be compacted to the in-situ air void requirements of S10.2.8. Guidance on compaction procedures that may be capable of achieving the specified air voids values is given in NG A8.

Table S10.1 In-situ air voids content requirements

Bituminous materials	Permitted air voids			
	Carriageways		Footways, Footpaths and Cycle tracks	
	Max %	Min %	Max %	Min %
AC6 dense surface course	NP	NP	13	2
AC10 close surface course	11	2*	11	2*
HRA surface course	7	2	10	2
SMA surface course	8	2	10	2
AC binder course	10	2*	12	2*
HRA binder course	9	2	12	2
SMA binder course	6	2	NP	NP
Permanent cold-lay surfacing materials (PCSM)	10	2	13	2
Any other bituminous materials within the specification	No air-voids limits apply. Guidance on compaction contained in NGA8.3			

NP = not permitted

* If the binder content is increased as per A2.3.5 and A2.3.6 the minimum air voids is 0.5%.

Compaction should be discontinued if the mixture shows any signs of distress, regardless of whether the minimum number of passes suggested in NG A8 have been applied.



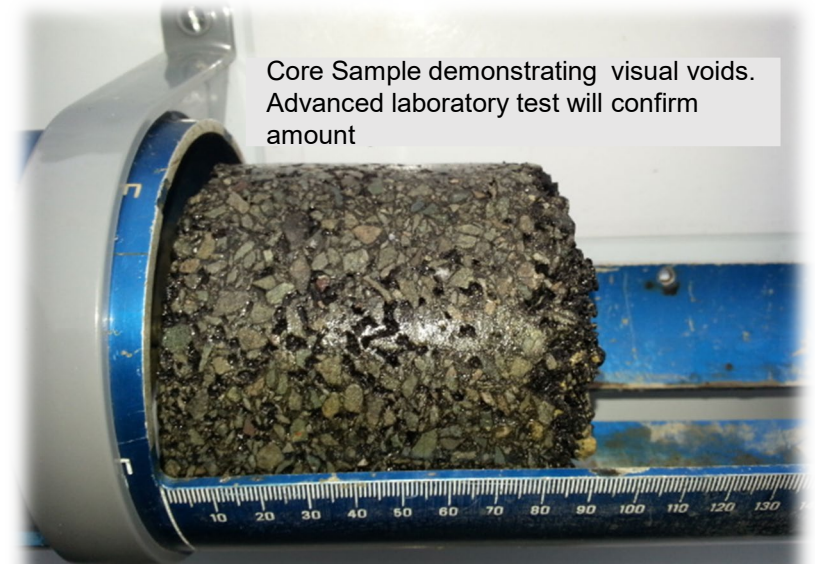
What is meant by permitted air voids?

It's between the maximum and minimum amount of air allowed in a bituminous sample.



Why is air voids content relevant?

If a bituminous material is not compacted in layers with sufficient temperature, it is likely it will have excessive air voids.



Core Sample demonstrating visual voids. Advanced laboratory test will confirm amount

Appendix A8 – Compaction requirements

Bituminous materials

If you have already read the refresher aid for SROH Section 10 you will be familiar with Table A2.5 which shows the recommended compaction lift thickness's for bituminous materials. If these are adhered to, along with correct temperature and compaction equipment, the risk of excessive air voids is greatly reduced.



REMEMBER

A “compacted lift” is the required thickness of a bituminous material for compaction. It is not to be confused with a “structural layer” (i.e. Base layer). Several compacted lifts may exist within a structural layer.



Table A2.5 Compacted lift thickness (mm) – Bituminous mixtures

Material type	PD 6691 reference	Compacted lift thickness (mm)		
		Minimum at any point	Nominal lift thickness	Maximum at any point
6 mm DSC	AC6 dense surf	15	20 – 30	40
10 mm CGSC	AC10 close surf	25	30 – 40	50
15/10 HRA	HRA 15/10 F surf	25	30	50
30/10 HRA	HRA 30/10 F surf	30	35	45
30/14 HRA	HRA 30/14 F surf	35	40	50
	HRA 30/14 C surf			
35/14 HRA	HRA 35/14 F surf	40	45 - 50	60
	HRA 35/14 C surf			
55/14 HRA	HRA 55/14 F surf	40	45	55
55/10 HRA	HRA 55/10 F surf	35	40	50
6 mm SMA	SMA 6 surf	15	20 - 40	45
10 mm SMA	SMA 10 surf	20	25 - 50	55
14 mm SMA	SMA 14 surf	30	35 - 50	55
10 mm PA	PA 10*	25*	30 – 35*	40*
20 mm PA	PA 20*	40*	45 – 60*	65*
50/14 HRA	HRA 50/14 F bin	30	35 - 65	85
50/20 HRA BC	HRA 50/20 bin	40	45 - 80	100
60/20 HRA BC	HRA 60/20 bin	40	45 - 80	100
14 mm SMA BC	SMA 14 bin	25	30 - 60	65
20 mm SMA BC	SMA 20 bin	40	50 - 100	110
14 mm DBC	-	35	40 - 70	80
20 mm DBC	AC20 dense bin	40	50 - 100	110

Notes:

The binder course thickness must be adjusted accordingly to the thickness of the surface course to comply with the requirements in appendices A3 to A7.

* The use of Porous Asphalt (PA) is limited in the UK except for specialist uses such as sustainable drainage systems. Where porous asphalt surfaces are encountered refer to S6.4.13 (BS EN 13108-7 contains specifications for this group of asphalts and guidance on the appropriate material should be obtained from the authority).

** 14 mm DBC is not currently included in PD 6691. It should be referenced as AC14 dense bin.

Table A2.5 shows the maximum, nominal and minimum compacted lift thickness for the bituminous materials named within it.

It must be pointed out that a structural layer (like Base layer in a Type 1 road) may contain several compacted lifts.

For example, if you wanted to lay a 250mm layer of base course material (20mm DBC) you should aim for a compacted layer between 50-100mm on each lift. The absolute minimum compacted layer is 40mm. The absolute maximum is 110mm, so therefore you will require three compacted layers (lifts) to achieve 250mm overall.



A8 - Summary

What is a compacted lift thickness?

It is a layer of correctly compacted material that may form part of a structural layer

What is a compaction pass over a material?

This is where the total area of the material has been passed over by the compaction equipment once. Therefore, six passes will mean you covered the whole area six times.

What will happen if you don't apply sufficient compaction ?

In unbound materials it is very likely you will have sinking or settlement long after you have left the job. In bituminous materials, the risk of excessive air voids is increased.

How will I know I have applied sufficient compaction?

In granular or unbound materials you should apply the requirements of Table A8.1 which provides information of the type of equipment you can use, and the compacted layer thickness you should achieve. This will also provide the recommended number of passes over the material for each compacted lift.

What do air voids in bituminous materials measure?

Essentially, compaction is expulsion of air from any material, even in unbound. However, if you don't properly compact bituminous materials at correct temperatures, and in layers, it is highly likely you will end up with excessive air voids. This is how it can be determined that compacted layers, correct temperature or correct equipment passes were not carried out correctly in the first instance.

