

S7 – Rigid and modular roads



Researched, compiled and produced by



and



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Introduction- SROH S7

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 S7 which will enable you to have a better understanding of what to look for when monitoring the reinstatement of rigid and modular roads.



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.

S7 – Rigid and modular roads

What it says in the SROH

S7.1.1 When the total thickness of any bituminous overlay is 100 mm or more, it must be reinstated as a composite road in accordance with S6.

S7.1.3 The undertaker must carry out the reinstatement in accordance with one of the following methods and should endeavour to achieve the greatest degree of immediate permanent reinstatement. Reinstatement methods are listed in Table A2.10.

What it means

If there is more than 100 mm of bituminous material laid over concrete, it is classed as a composite road and must be reinstated as such.

You will notice that only certain methods of reinstatement are available for use in rigid and concrete roads which will be further explained below.

Table A2.10 will show you what methods are available. You will see that Method A is preferred in all classes of rigid road but is only available to modular roads in Types 3 and 4.

Exactly the same applies to Method D where permanent sub-base has been applied. Method E is the only one unique to rigid roads for interim overlay.

NOTE
Binder course and base course do not generally apply to rigid and modular roads due to the type of construction.

You can see that Method E will only relate to rigid road construction as the concrete slab has already been placed and the permanent overlay has not been applied. This allows for an interim overlay to be put in place. Remember, an interim reinstatement must meet all performance requirements required within the SROH (*skid resistance, white/yellow lines, etc*).

Table A2.10 Key to reinstatement methods

Reinstatement method (at first visit)	Flexible & composite roads S6		Rigid & modular roads S7				Footways, footpaths & cycle tracks S8		
	Flexible (A3.0 - A3.4 incl.)	Composite (A4.0 - A4.3 incl.)	Rigid (A5.0 - A5.2 incl.)	Modular			Flexible and composite (A7.1 and A7.2)	Rigid (A7.3)	Modular (A7.4)
				Bituminous base (roadbase) (A6.1)	Composite base (roadbase) (A6.2)	Granular base (roadbase) (A6.3)			
All permanent	Method A (Types 0-4 incl.)	Method A (Types 0-4 incl.)	Method A (Types 0-4 incl.)	Method A (Types 3, 4 only)	Method A (Types 3, 4 only)	Method A (Types 3, 4 only)	Method A	Method A	Method A
Interim with permanent binder course	Method B (Types 0-4 incl.)	Method B (Types 0-4 incl.)	N/A	N/A	N/A	N/A	Method B	N/A	N/A
Interim with permanent base	Method C (Types 3, 4 incl.)	Method C (Types 0-4 incl.)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Interim with permanent sub-base	Method D (Types 0-4 incl.)	Method D (Types 0-4 incl.)	Method D (Types 0-4 incl.)	Method D (Types 3, 4 only)	Method D (Types 3, 4 only)	Method D (Types 3, 4 only)	Method D	Method D	Method D
Permanent incorporating interim surface overlay	N/A	N/A	Method E (Types 0-4 incl.)	N/A	N/A	N/A	N/A	N/A	N/A

This is why Method A – All permanent is the best option, as only one site visit is required



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What it says in the SROH – S7.2 Rigid road sub-base

S7.2.1 In a rigid road, the sub-base is deemed to be any layer of imported granular or HBM immediately below the base of the concrete road slab. Where such a sub-base exists, a similar or equivalent material must be laid to match the existing thickness subject to a minimum thickness of 150 mm.

S7.2.3 A CBGM base may also be used as sub-base of 150 mm thickness in small openings and narrow trenches regardless of whether the existing sub-base is cement bound.



What it means

Sub-base layer is an important part of the construction and is located immediately below the concrete layer in a rigid construction. This should be laid to the same thickness of existing sub-base, or to a minimum of 150mm of GSB Type 1 or HBM (hydraulically bound material). In small openings and narrow trenches you may use CBGM (cement bound granular material) as an alternative option.

Remember, you must ensure you apply the correct lift thickness, and number of passes to achieve suitable compaction.

This will apply to Granular materials, hydraulically bound materials and cement bound granular materials used in sub-base.

For selection of suitable equipment, number of passes and layer thickness requirements, please refer to SROH Table A8.1

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SROH – S7.3 Concrete road slab reinstatement

S7.3.2 Concrete road slabs must be reinstated with C32/40 concrete mixed in accordance with MCHW Clause 1001 and using an air entrainment admixture in the top 40 mm (at least) of the road slab. Exceptionally, where agreed, a concrete road slab may be reinstated with an alternative material to suit site conditions, e.g. a high early strength mix may be agreed to allow an earlier re-opening of a heavily trafficked road.

What it means

Where rigid (concrete) construction is found, the minimum allowable strength is C32/40. This has to be achieved as the specification says it “must” be reinstated in this way. It must match the existing concrete thickness, but should never be less than 100mm if the existing happens to be less than that. Air entrained concrete contains microscopic air bubbles that help alleviate internal pressure on the concrete by providing small pockets for water to expand into when exposed to freeze-thaw conditions. High early strength mixtures may be allowed where agreed with the local authority to open the road earlier.



Concrete core

What does the value C32/40 mean?

The 32 is the compressive requirement of **32 N/mm²** of a crushed concrete cylinder (core) after 28 days. The 40 is a compressive requirement of **40 N/mm²** for a crushed concrete cube after 28 days. If using core sample as a method of test, the compressive strength should be compared to the first number (32).

So you have to test to get the C value?

Exactly, you cannot get the value by any other means, and that is why you have cylinder (core), and cube crush testing (*in-situ performance testing, and design mix quality testing*).



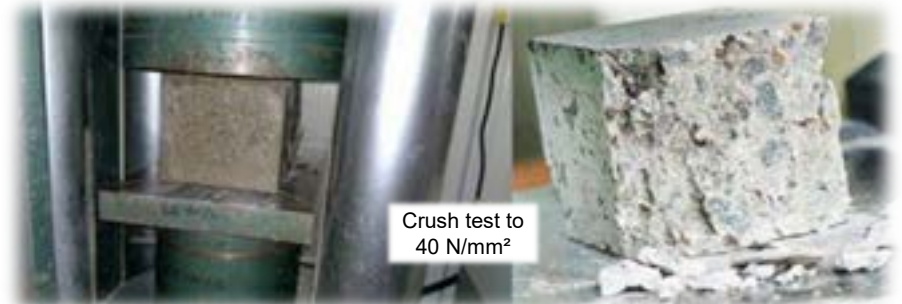
Cube moulds



Concrete cube



Crush test to 32 N/mm²



Crush test to 40 N/mm²

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SROH – S7.3 Concrete road slab reinstatement

S7.3.3 Where concrete is mixed off site, Quality Assurance certificates detailing the specifications against which the concrete has been ordered and supplied must be obtained by the undertaker for confirmation of material quality. Where possible, the concrete should be obtained from a plant that holds a Quality Assurance certificate.

In the case of small openings, a site-batched equivalent to C32/40 concrete may be used, but it must be capable of achieving these values.

If known, joint spacing and the presence of any other features near the proposed excavation should be requested from the authority by the undertaker. If this information is not made available, then inspection survey commissioned by agreement may be carried out to determine condition.



NOTE

All expansion, contraction and warping joints removed or damaged during excavation must be replaced or reconstructed to a similar design, using equivalent materials at the time of permanent reinstatement.

The same applies to any membranes (plastic or bituminous) that may be encountered during the excavation.

What it means

If you order ready mixed concrete or have concrete mixed through a mobile batching plant, you must ensure you have quality assurance certificates showing the specification of concrete ordered and provided. This will usually show a design mix specification that when properly mixed and laid, should reach the desired C values as shown on previous page at 28 days curing.



Small openings & Narrow trenches

For rigid roads, where the concrete is the running surface and is randomly grooved, a brushed surface finish to the requirements of Table S2.5 and Table S2.6 is permitted for small openings, narrow trenches and other openings less than 1 m wide.



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SROH – S7.3.10 Concrete road texture depth

S7.3.10 For small openings, narrow trenches and other openings less than 1 m wide, reference must be made to S2.6.1(2) and Table S2.5 and Table S2.6.

S7.3.11 For all other excavations the authority must be consulted and a method agreed. The finished surface must comply with **Table S2.5** and **Table S2.6**.



As mentioned on previous page, in small openings and narrow trenches reinstated in concrete a brushed finish may be applied. For all other excavations the authority must be contacted to agree a method for the surface finish. This will need to comply with the requirements of the SROH as seen from the information below where macro-texture depth for skid resistance will apply.



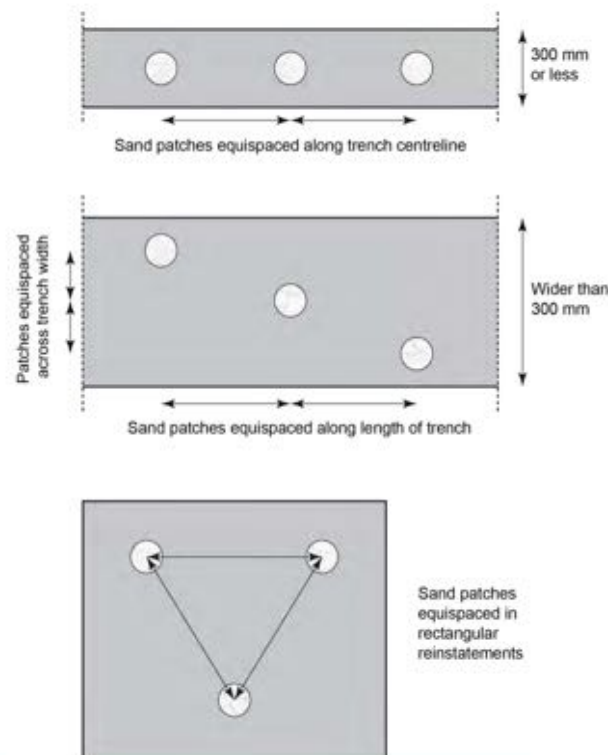
Table S2.5 Texture depth

Reinstatement location	Texture depth (mm)			Concrete carriageways
	Chipped HRA and surface dressings	SMA and TSCS	All other bituminous surfaces	
Roads where speed limit \geq 60 mph	1.5 average 1.2 minimum	1.3 average 1.0 minimum	0.6 minimum	See Table S2.6
All other roads	1.0 average 0.8 minimum	1.0 average 0.8 minimum	0.6 minimum	1.25 maximum 0.6 minimum

Table S2.6 Texture depth for concrete carriageways on roads where speed limit \geq 60 mph

Time of test	Required Texture depth (mm)		
		Specific value	Tolerance
Between 24 hours and 7 days after the construction of the slab or until the slab is first used by vehicles	An average of 10 measurements	1.00	± 0.25
Not later than 6 weeks before the road is opened to public traffic	An average of 10 measurements	1.00	+0.25 -0.35

Figure S2.7 Sand patch testing - typical locations



The cured road slab may be opened to traffic as soon as a compressive strength of 25 N/mm² has been achieved. Corner cracking, edge cracking and joint damage within the trench area must be repaired as a part of the reinstatement works.

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What it says in the SROH – S7.4 Large Diameter Cores

S7.4.1 Use of large diameter cores as an excavation and reinstatement technique is permitted in unreinforced rigid roads with the following conditions: 1) Large diameter cores cannot be taken within 300 mm of concrete slab corners or edges. This is to protect the integrity of the concrete pavement. 2) Where the technique is appropriate, it must be carried out in accordance with S6.7. To match the adjoining carriageway, between 100 mm to 150 mm of the sub-base may be removed.

Regardless of the method of excavation, care must be taken to avoid undermining adjoining structure.

If undermining occurs, re-using the core is not permitted and reinstatement must be carried out to SROH requirement.

Reinstatement by core is only permitted for single cores, two overlapping cores, or multiple cores with a minimum clear separation between core perimeters of 300 mm

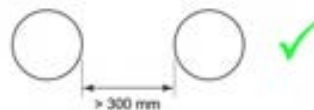
Where there are three or more overlapping cores or where the separation between multiple cores is less than 300 mm, core re-use is not permitted unless agreed to by the authority

Figure S6.2 Large diameter cores location



Core re-use is not permitted without the authority's approval when there are more than 2 interlocking large diameter cores (S6.7.4).

In such cases, reinstatement must be in accordance with S6.2, S6.3 and S6.4 or S6.5.



Individual cores are not permitted to be spaced closer than 300 mm without the authority's approval (S6.7.4).

In such cases, reinstatement must be in accordance with S6.2, S6.3 and S6.4 or S6.5.



What it means

New and innovative methods of excavation and reinstatement have been developed such as large diameter coring. The existing unreinforced concrete slab needs to be in excess of 100mm thick before it may be used to reinstate the area it was extracted from, otherwise, it must be reinstated with C32/40 concrete to minimum 100mm thickness. Where there is reinforcement found within the concrete slab, the core cannot be re-used and trimming for reinstatement of the reinforcement may be required in accordance with S7.6.

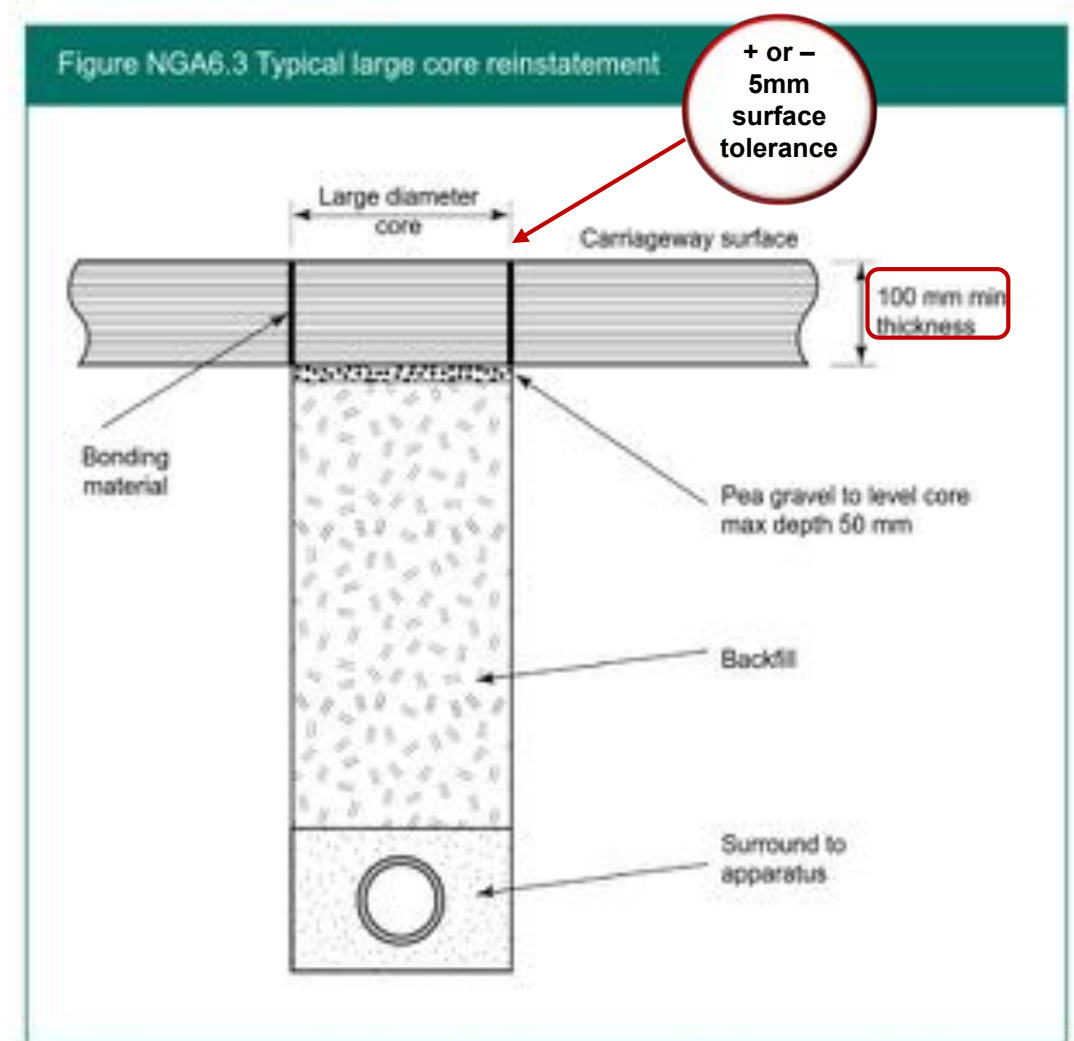
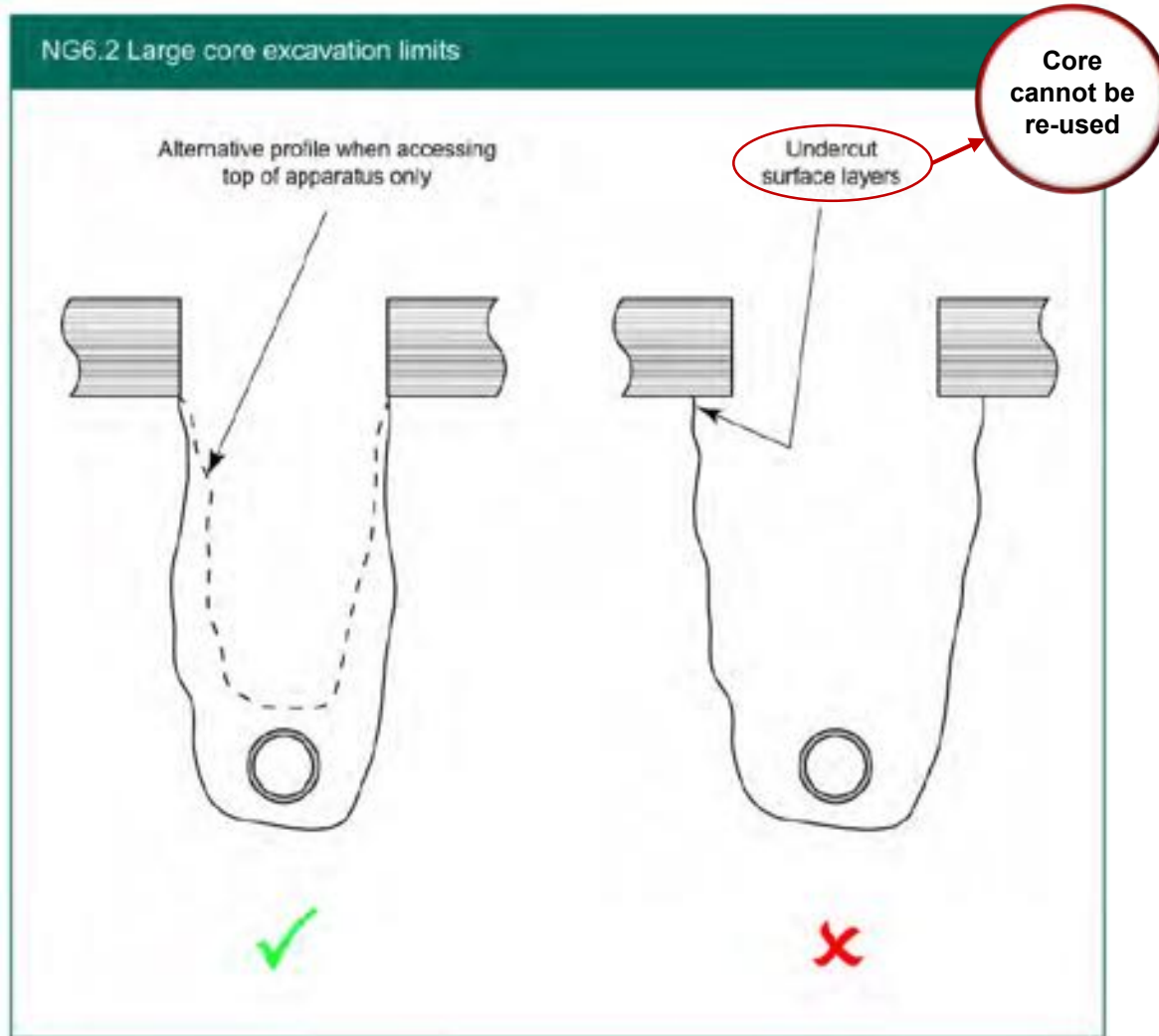
When the core is removed, it must be checked that the concrete is at least 100 mm around the total circumference. If less than 100 mm at any point, re-using the core for rigid road reinstatement is not permitted.

The core must be reinstated with a tolerance of plus or minus 5mm and this remains for the two year guarantee period. Intervention is required if this tolerance is exceeded. You will notice this is not the usual intervention requirement for edge depression (10mm) under SROH S2.2.2



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Large diameter cores – Excavation limits and reinstatement



S7 – Rigid and modular roads

What it says in the SROH

S7.5.1 The edges of all excavations in rigid roads except large diameter cores (see S7.4) must comply with:

- 1) The use of edge taper support is only permitted in road categories 3 and 4. It may be used in road category 2 by agreement with the authority. If this method is used, S7.5.2 and S7.5.3 must be followed.
- 2) For road categories 0 and 1, dowel bars must be used as per S7.5.5 to S7.5.11. For road category 2, dowels must be used unless otherwise agreed with the authority.

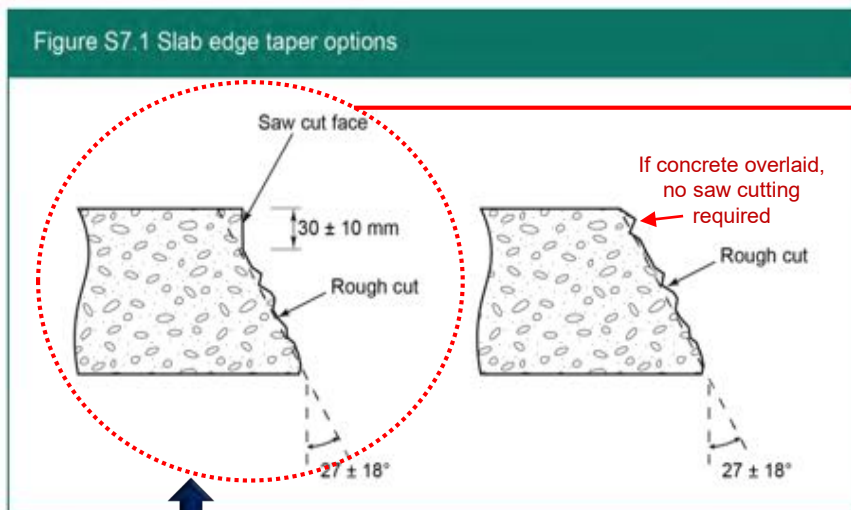


What it means

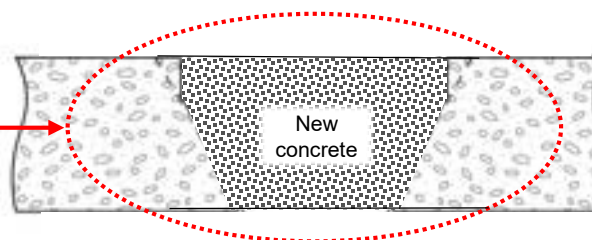
Edge taper support is where the existing concrete is tapered inwards towards the lower part of the existing slab which provides support for the new concrete. If you think of it as being similar in shape to a bath plug which tapers towards the bottom. This can only be used in Types 3 and 4 roads where dowel bars should be used in Types 2, 1 and 0 roads to provide support. The following will provide better explanation of these methods of support.



Figure S7.1 Slab edge taper options



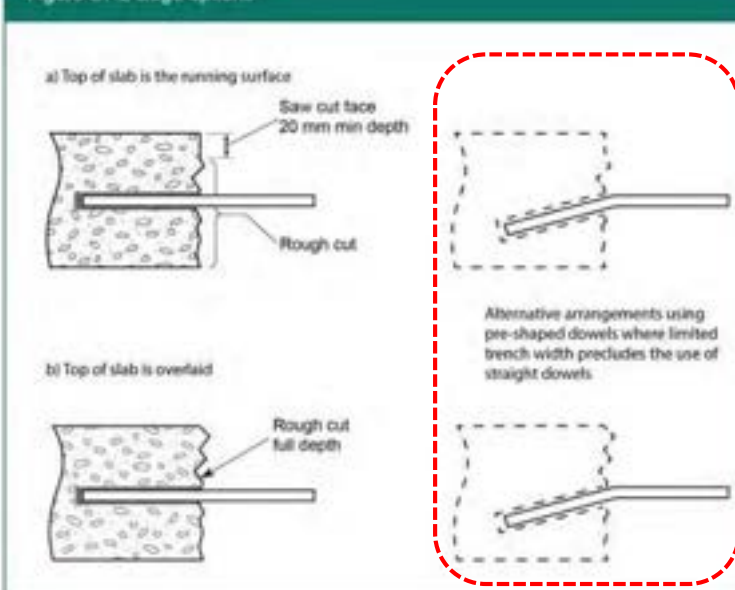
You can see above where edge taper support is applied in Type 3 and 4 roads. If surface is concrete, the top 30mm +/- 10mm should be saw cut to provide a clean edge. The remainder of the existing slab is tapered to allow the new concrete to be supported by the existing (like a bath plug).



You can see on the right where dowel bar support is applied and how the edges are vertical rather than tapered. This is because the dowel bar provides the support rather than relying on the existing concrete slab. Please refer to the SROH for dowel bar hole depths and spacing's (outlined on next page).

If the running surface is concrete where using dowel bars, it should be saw cut to minimum 20 mm depth to provide a clean edge.

Figure S7.2 Edge options



Where it may be difficult to drill dowel bar holes due to width of excavation or trench. The holes may be drilled at an angle and the dowel bars bent to run parallel with the surface as outlined above.

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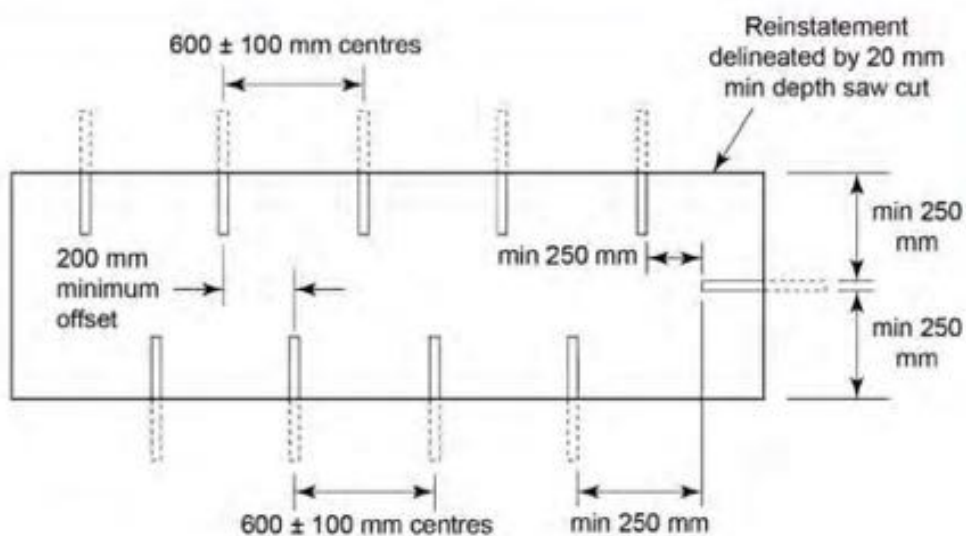
What it says in the SROH – Dowel bars

S7.5.10 Dowel bars must be located at a minimum distance of 250 mm from the edge of the excavation, see Figure S7.3.

S7.5.11 The minimum dowel bar length is equal to the width of the reinstatement less 50 mm with a maximum dowel bar length of 400 mm.



Figure S7.3 Dowel bar arrangement - plan view



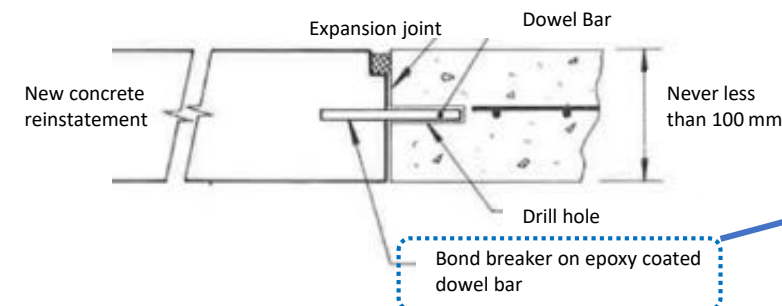
The minimum dowel bar length is equal to the width of the reinstatement less 50 mm with a maximum dowel bar length of 400 mm. The first step in installing dowel bars is to place grout (cementitious or epoxy) into the back of each hole.

What it means

The placing of dowel bars can be seen from Figure S7.3 which provides clear guidance on spacing's in relation to trench or opening size. Further information for lengths and depth of dowel bar holes can be found below.



The end of the bar that extends into the utility cut area should have a bond breaker applied to it to prevent bonding with the patch material. This bond breaker may be applied by the manufacturer or may be field-applied. Dowel bars must be clean, free of flaking rust, and epoxy-coated (or have equivalent anti-corrosion treatment) before installation.



You do not want new concrete to bond to dowel bars

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What it says in the SROH – S7.5 Edge preparation

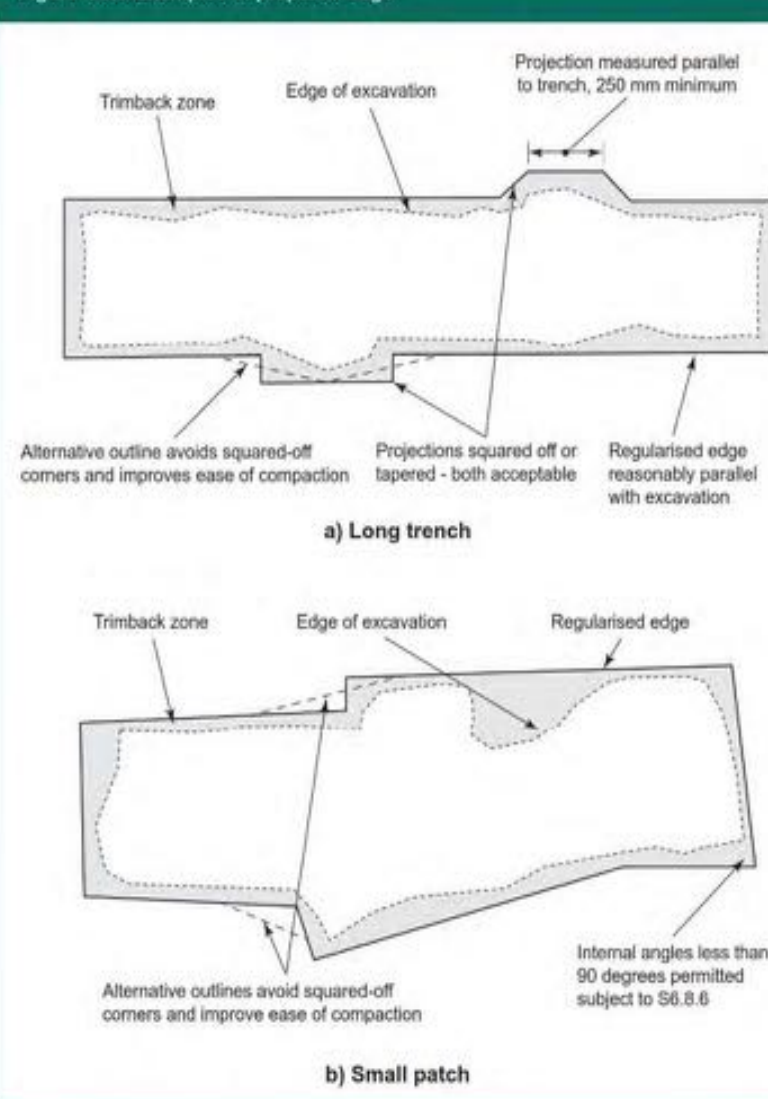
S7.5.12 Where necessary, the edges of the reinstatement must be trimmed over part or all of slab depth to comply with the following requirements:

- 1) The edge regularity must comply with the requirements of S6.8.6.
- 2) Any undercutting must comply with the requirements of S6.8.10.
- 3) Where the adjacent road slab has cracked as a result of the excavation operation, the damaged area of the slab must be removed and included within the area to be reinstated.
- 4) Where, after trimming, the excavation extends to within 300 mm of a slab edge, a joint, ironwork or another reinstatement, the relevant area of the slab must be removed and included within the area to be reinstated.
- 5) All edges must be cleaned and wetted before placing concrete.

What it means

You will notice that the above text taken from the SROH cross references with S6.8.6 of the specification. This essentially provides that the edges of the reinstatement should be treated the same as a flexible in terms of outline and trimming. Figure S6.3 will provide the necessary examples of these outlines. However, if any cracking of the adjacent slab has been caused by the works, it must be removed and included in the new concrete reinstatement. Additionally, if the trimmed excavation comes within 300 mm of any joint, reinstatement, or street furniture such as drains and covers, it must also be removed (you may recall this is 250 mm in flexible and composite roads). Finally, all edges should be clean and wetted before placing new concrete as this aids bonding and prevents new concrete from being dried out by existing slab where transfer of moisture may occur.

Figure S6.3 Examples of prepared edge



Remember
If the patch or reinstatement is within 300 mm of any joint, ironwork or other reinstatement, it must be cut out and included.

If, during the works you cause cracking of the existing slab outside the intended work area, you must cut out the cracked area and include it in the new reinstatement.

NOTE
The 300 mm cut out rule only applies to rigid roads.

Only flexible and composite roads can rely on 250 mm rule.

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What it says in the SROH – S7.6 Reinforcement

S7.6.1 If the existing concrete is unreinforced and the trench is more than 1.5 times longer than it is wide, or where the reinstatement covers more than one slab, the reinstated concrete must be reinforced to mitigate early life non-structural cracking.

S7.6.2 In this case, the reinforcement must be placed in the upper part of the slab (with a minimum cover of 60 mm).

S7.6.3 In all other cases, when the existing concrete has no reinforcement, no reinforcement is needed.

What it means

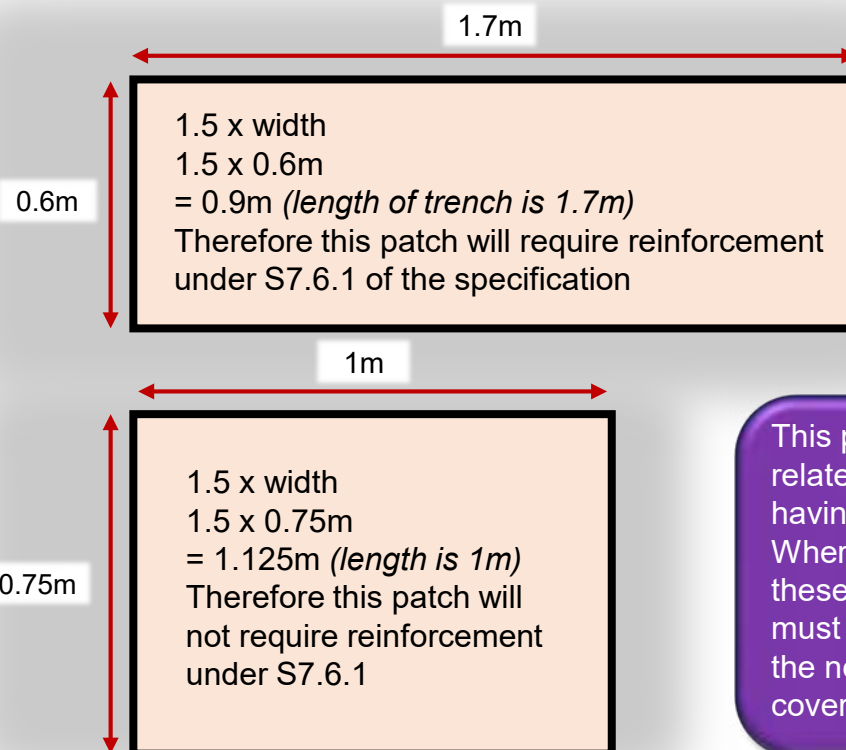
Where the existing has no reinforcement and the trench is more than 1.5 longer than its wide essentially means one and a half times longer than it's wide (3:2). Therefore a trench 0.65m x 0.5m will not need reinforcement, but a trench of 0.8m x 0.5m will require reinforcement as 0.8m is over 0.75m (*1.5 of the width, therefore $1.5 \times 0.5 = 0.75$*). Reinforcement is needed to "mitigate early life non-structural cracking" (reduces risk of cracking in new work). Where the excavation is in concrete with no reinforcement and the length is below 1.5 times the width, there is no requirement to place reinforcement.

I'm a little confused, can you explain what 1.5 longer than it is wide means?

Of course, it simply means the excavation is one and a half times longer than it is wide. If my trench is 400mm wide the longer side can not be more than 600mm otherwise you will have to use reinforcement ($400 \times 1.5 = 600$).

I have also noticed the SROH refers to the 3:2 length to width ratio, what does this mean?

Essentially, exactly the same thing. Our trench of 600mm long and 400mm wide which is a 3:2 length to width ratio and is the same as saying 1.5×1 (*length x width*).



Be advised, in this case, the purpose of reinforcement in the new reinstatement is to reduce the risk of non-structural cracking as mentioned in S7.6.1

This page only refers to S7.6.1 which relates to existing concrete slab having no reinforcement within it. Where reinforcement is required in these instances, the reinforcement must be placed in the upper part of the new reinstatement with minimum cover of 60mm (S7.6.2).

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7.7 Overlays

Where the surface of the concrete road slab or the modular surface layer is overlaid with a bituminous material or surface treatment, a matching thickness of a similar or equivalent material must be laid.

However, you must ensure the minimum layer values are achieved for surface course and binder course. If there is not enough depth to allow this, a full depth surface course material may apply.

Wherever practicable, the required surface course thickness should be maintained by adjustment of the binder course thickness. The surface course and binder course materials must not be laid to a thickness less than that required by A2 or A3 for the nominal size of each material laid.
i.e. 40mm for surface course (with -5mm tolerance) and 60mm for binder course (with -10mm tolerance)

Where the surface of the concrete road slab or modular surface has had a surface treatment including overlay, an equivalent surface treatment or overlay must be applied. This mainly relates to materials such as anti-skid coatings, coloured coatings, tar and chipping surface treatments or slurry seals.



SMA over concrete



Overlay on modular road - delaminating



Surface dressing

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What it says in the SROH – Modular roads methods

S7.8.1 Types 0, 1 and 2 modular roads are not included in this Code and reinstatement designs must be in accordance with BS 7533-3 and BS 6717.

S7.8.2 The undertaker must carry out the reinstatement of Types 3 and 4 modular roads in accordance with one of the following methods and should endeavour to achieve greatest degree of immediate permanent reinstatement.



What it means

Essentially, you will reinstate a modular road using Method A as the preferred option. It would be unusual if you completed to sub-base layer as a permanent and then an interim from there onwards. However, this is allowable should it be required to use Method D as an option.



As already covered under rigid roads, Table A2.10 will show what methods are available. You will see that Method A is preferred in modular roads Types 3 and 4 but not available in any other road types.

Exactly the same applies to Method D where permanent sub-base has been applied.

NOTE

Binder course and base course relate to bituminous materials, and therefore do not generally apply to modular roads

For information on maintaining patterns in modular road reinstatements, please refer to SROH NGA 12 which will provide helpful guidance on how surrounds to chambers and street furniture should be maintained (see next page). This will also assist with understanding of fillets and pointing sizes where relevant.

Table A2.10 Key to reinstatement methods

Reinstatement method (at first visit)	Flexible & composite roads		Rigid & modular roads				Footways, footpaths & cycle tracks		
	S6		S7				S8		
	Flexible (A3.0 - A3.4 incl.)	Composite (A4.0 - A4.3 incl.)	Rigid (A5.0 - A5.2 incl.)	Modular			Flexible and composite (A7.1 and A7.2)	Rigid (A7.3)	Modular (A7.4)
				Stumorous base (roadbase) (A6.1)	Composite base (roadbase) (A6.2)	Granular base (roadbase) (A6.3)			
All permanent	Method A (Types 0-4 incl.)	Method A (Types 0-4 incl.)	Method A (Types 0-4 incl.)	Method A (Types 3, 4 only) ✓	Method A (Types 3, 4 only) ✓	Method A (Types 3, 4 only) ✓	Method A	Method A	Method A
Interim with permanent binder course	Method B (Types 0-4 incl.)	Method B (Types 0-4 incl.)	N/A	N/A ✗	N/A ✗	N/A ✗	Method B	N/A	N/A
Interim with permanent base	Method C (Types 3, 4 incl.)	Method C (Types 0-4 incl.)	N/A	N/A ✗	N/A ✗	N/A ✗	N/A	N/A	N/A
Interim with permanent sub-base	Method D (Types 0-4 incl.)	Method D (Types 0-4 incl.)	Method D (Types 0-4 incl.)	Method D (Types 3, 4 only) ✓	Method D (Types 3, 4 only) ✓	Method D (Types 3, 4 only) ✓	Method D	Method D	Method D
Permanent incorporating interim surface overlay	N/A	N/A	Method E (Types 0-4 incl.)	N/A ✗	N/A ✗	N/A ✗	N/A	N/A	N/A

This is why Method A – All permanent is the best option, as only one site visit is required



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Figure NGA12.1 Extension of infill concrete - modules over 305 mm



Figure NGA12.2 Extension of infill concrete - modules over 305 mm

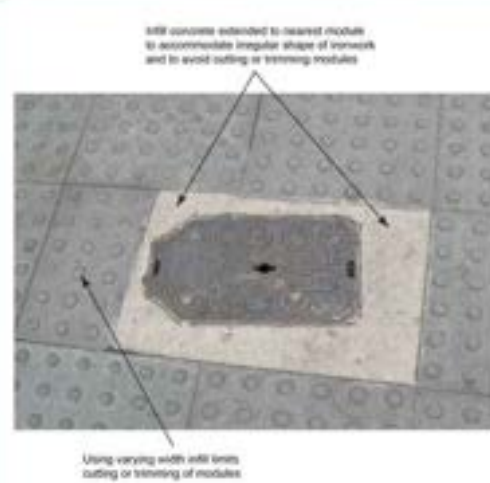


Figure NGA12.3 Extension of infill concrete - modules up to 305 mm

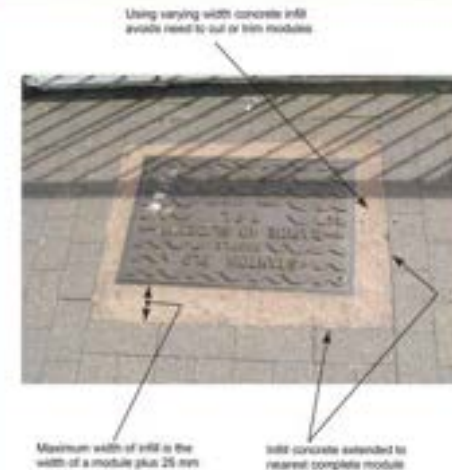


Figure NGA12.4 Acceptable loss of module pattern - modules up to 305 mm

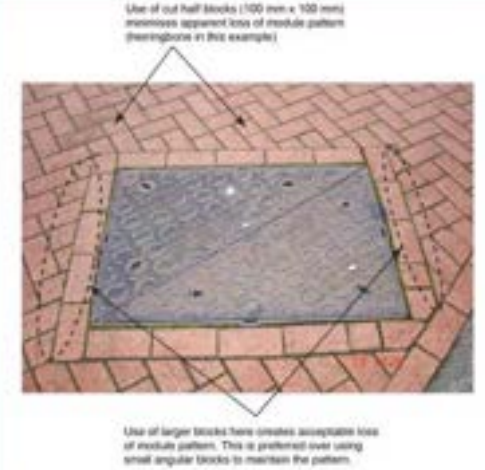
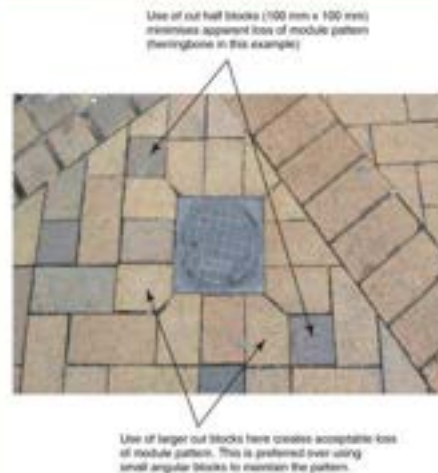


Figure NGA12.5 Acceptable loss of module pattern - modules up to 305 mm



Figure NGA12.6 Acceptable loss of module pattern - modules up to 305 mm



When placing modular paving around street furniture and chamber covers you will find helpful guidance under SROH NGA 12 where representations of cuts and fillets can be viewed for assistance. Be aware, there are maximum sizes for fillets that may exceed specified requirements.

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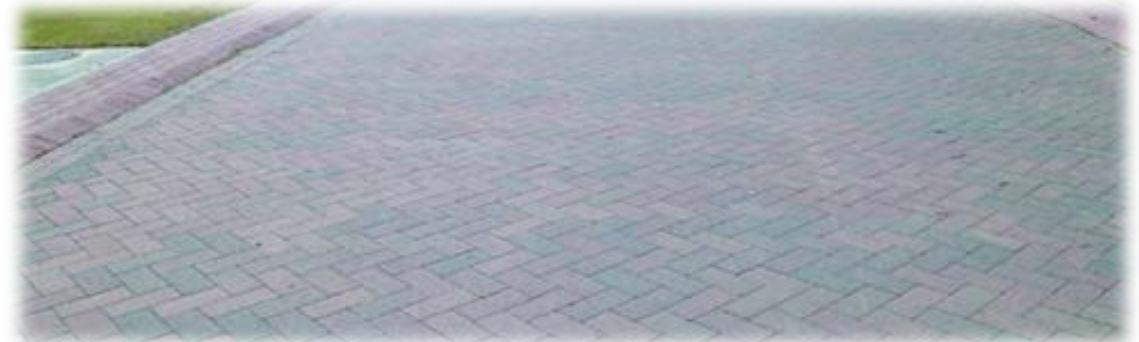
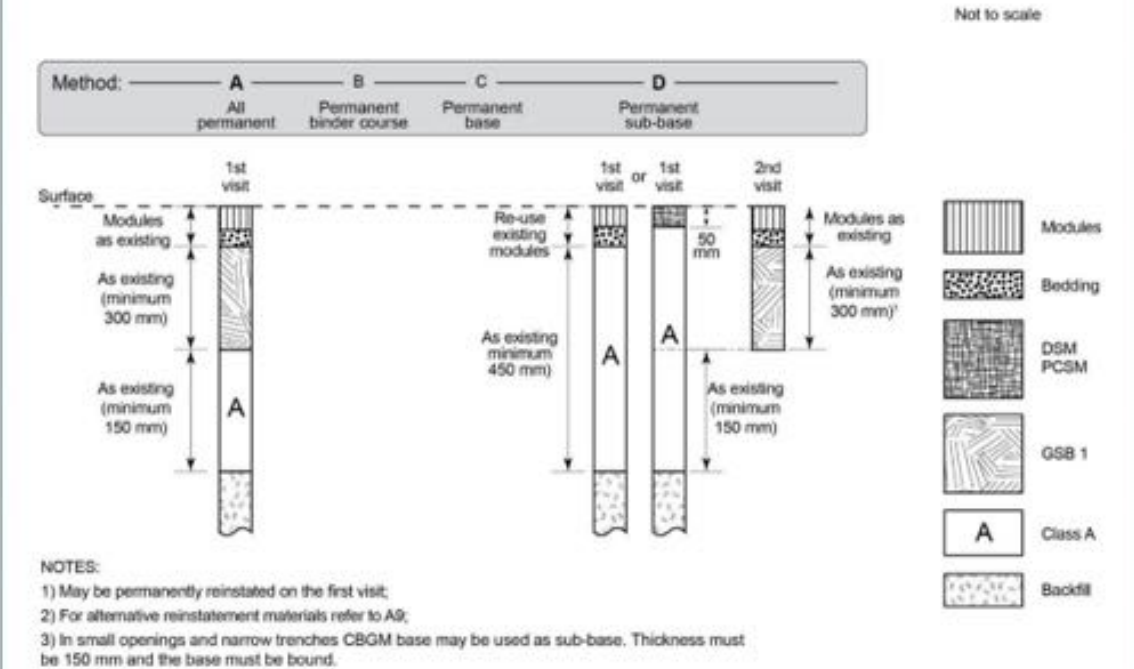
Sub base reinstatement should be completed GSB Type 1.
The existing sub-base should be matched subject to an absolute minimum of 150 mm thickness.
Granular base will be required to minimum 300 mm thickness above the sub-base layer (see Figure A6.3 on right).

Surface reinstatement

The modular surface layer must be reinstated in accordance with A6 and A12. The requirements and recommendations for replacement modules are given in A12 (see previous page).



Figure A6.3 Modular roads (granular base) types 3 and 4



S7 - Summary



What is meant by C32/40 concrete?

32N/mm² is the strength the concrete has to achieve when crushing a core sample

40N/mm² is the strength the concrete has to achieve when crushing a cube sample

What does edge taper support mean?

The cut slab is tapered to allow the new concrete to be supported by the existing.

Where does edge taper support apply?

Edge taper support only applies in road Type 3 & 4 and only by agreement in Type 2. Otherwise, dowel bars are to be used in Types 2, 1 and 0 roads.

What is trim line requirement in rigid roads?

If the reinstatement is within 300 mm of any other trench, kerb or street furniture the existing must be cut out.

What is meant by an overlay?

An overlay is where a bituminous material is laid over the concrete slab, or indeed a modular surface. If the overlay is more than 100 mm thick over concrete the reinstatement will be completed as a composite road. Whereas, if there is less than 100 mm of bituminous overlay, the reinstatement will be classed as a rigid construction as discussed in this refresher aid.

