Appendix A1 – Backfill materials

Researched, compiled and produced by corehard and ENFIELD Council with support through TFL lane rental funding scheme

Introduction- SROH Appendix 1

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.

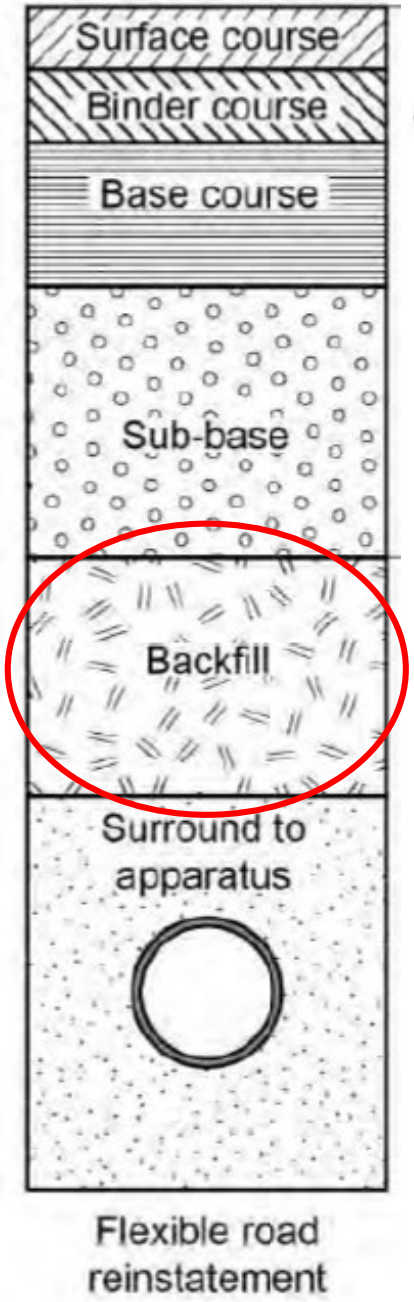
The current edition (Ed 4) of the Specification for Reinstatement of Openings in the Highway (SROH) has been updated to assist readers in understanding, and introduce new methods and developments within street-works.

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 A1 which will enable you to have a better understanding of what to look for when monitoring backfill materials classification, condition and verification, relating to reinstatement.

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 A1 – Backfill materials



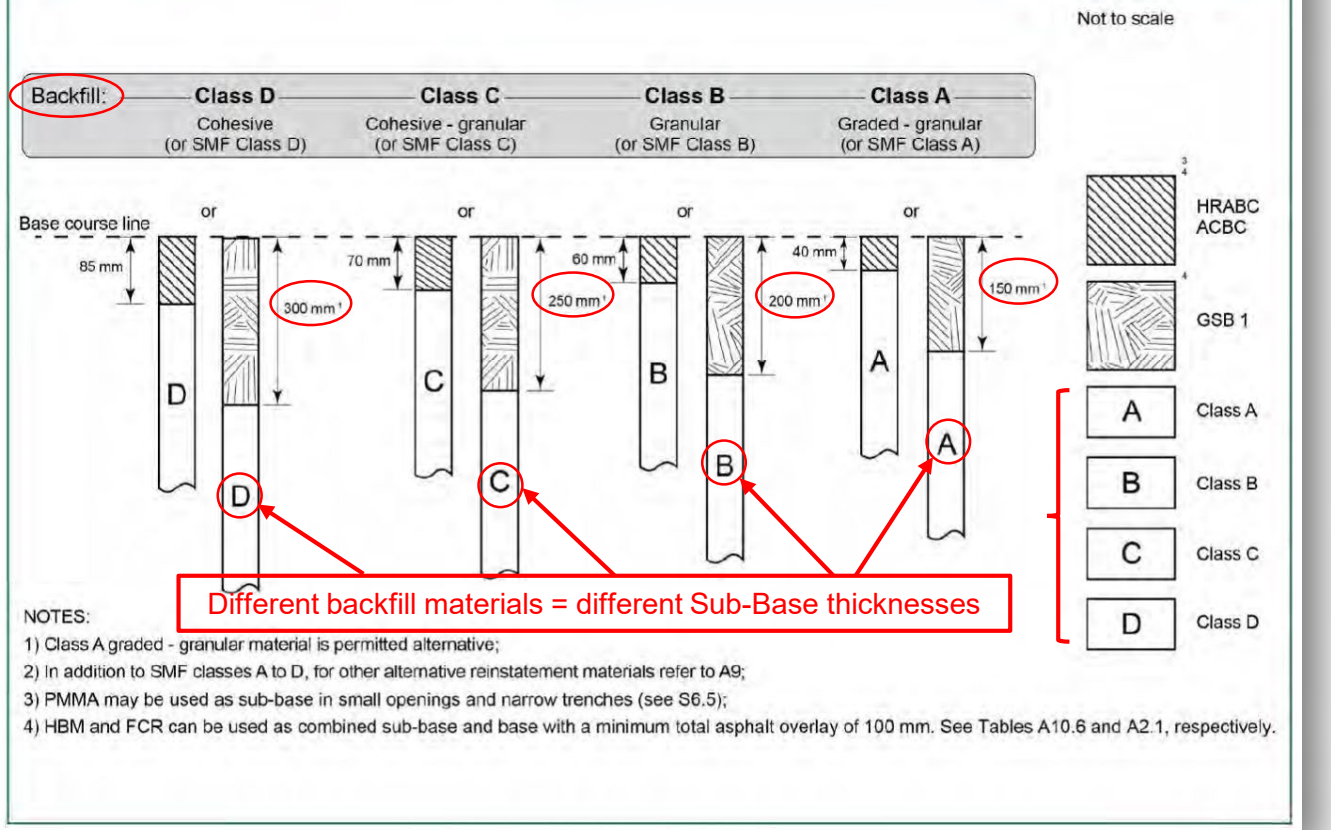
If you have already referred to the refresher aid dealing with SROH S5, the backfill layer and allowable materials will already have been described to you in terms of classification. This will also provide where certain materials can or cannot be used, along with determining the change in thickness of the sub-base layer in flexible roads.

The materials we find under SROH – S5 show how and where backfill materials are to be used. What we have to be aware of is that if you use a poorer backfill material, you are required to increase the Sub-Base layer to compensate for this (SROH – Figure A3.6)

NOTE

For each drop in backfill material class, the Sub-Base increases by 50mm

Figure A3.6 Sub-base construction for flexible roads



Appendix A1 – Backfill materials

SROH what it says – A1.1 Class A graded granular materials

A1.1.1 Materials should be well-graded granular material with a uniformity coefficient greater than 10. Material must, at the time of compaction, be at an appropriate moisture content between +1% and -2% of the optimum moisture content as determined by BS 1377-4, Vibrating Hammer Method, Method 3.7, or must be acceptable when subjected to field identification test No.3.

What it means

Essentially, we are describing a Class A material with the correct grading (uniformity coefficient) to allow interlocking under compaction. The material must have the correct moisture content to allow for successful compaction. It will be obvious how difficult it is to achieve compaction if the material is either too wet or too dry.
The field identification No 3 test will be outlined below with regards to this granular material.

What is a field identification test?

Simply, a basic test that you can carry out on site to see whether a material is suitable for use, or not.

Field Identification test No. 3.
All granular materials including Type 1 must be compacted near to their optimum moisture content. This can differ depending on the average particle size and, on the type of stone involved. Granular materials suitable for compaction by pedestrian-controlled plant *(like trench rammers)* can usually be identified by a simple visual examination. Typically, the test will identify materials within 1% to 1.5% of the field optimum moisture content depending on the aggregate type.

Test – Coarse aggregate
1) From your graded granular stockpile, dig out samples from <u>beneath the outer surface</u>, at several positions around the outside *(outer surface may be too dry)*. Examine several of the medium and larger sized particles from each sample extracted.

2) Material within the target moisture content range will show a dull sheen when viewed obliquely against the light with all fines adhering to the larger particles, and no water will be visible.
If the material is too dry, the finer particles will not be stuck to the larger ones.
If it is too wet, water droplets will be visible and fines will clump together.

Test – Fine aggregate
Take a small sample of representative sand, squeeze in one hand and release.

If the sample crumbles away and mostly fails to adhere together into a 'ball' then the sample is too dry.
A reasonable adherence is acceptable if no water is squeezed out *(too wet)*.

Appendix A1 – Backfill materials

SROH what it says –A1.1 Class A –graded granular materials

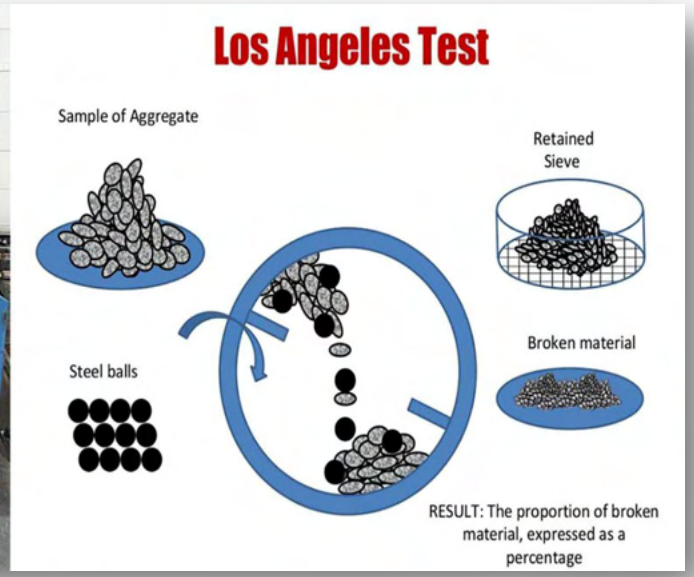
A1.1.2 Materials must show a maximum Los Angeles coefficient of LA60 when tested in accordance with BS EN 1097-2.

What it means

This relates to the strength of the aggregate. In other words, how hard it is and how resistant it is to abrasion (wearing down). There is a maximum value of LA60 which essentially means the granular graded aggregate should not be too hard.

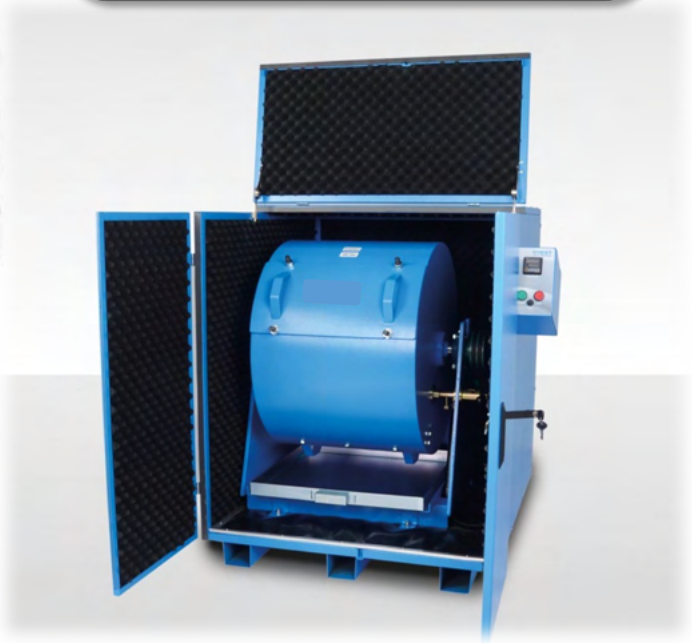
This is not something that would usually be a concern on site generally, as the materials supplied to site would normally be from a recognised supplier having the relevant certifications in place to verify or certify a Class A material.

However, if there is a doubt as to the validity of the material, samples should be taken and subjected to relevant testing to ensure they are suitable for purpose.



PLEASE NOTE

The LA abrasion test is essentially a rolling drum with steel ball bearings introduced with the aggregate. After a set period of time *(or turns of the drum)* it will be how the aggregate has been affected in terms of fragmentation and sieve passing.



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SROH what it says –A1.2 class B granular materials

A1.2.1 Material at the time of compaction must be at an appropriate moisture content, between +1% and -2% of the optimum moisture content as determined by BS 1377-4, Vibrating Hammer, Method 3.7, or must be acceptable when subjected to field identification test No.3.

What it means

As with Class A material, this material must have the correct moisture content to allow for successful compaction. Again, it will be obvious how difficult it is to achieve compaction if the material is either too wet or too dry. *The field identification No 3 test as described in previous pages relating to Class A, will also apply to class B materials.*

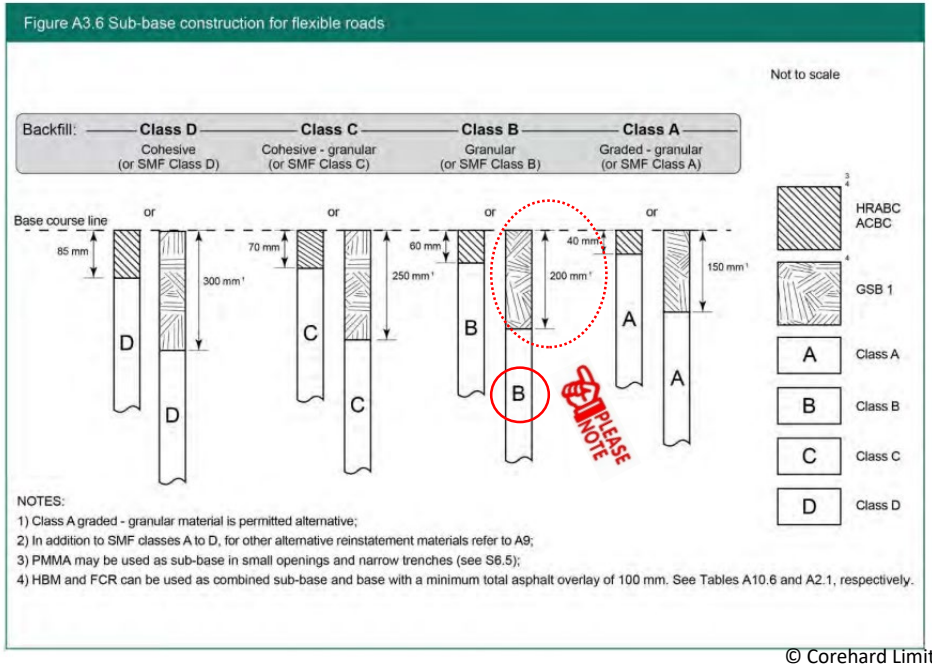
Class B
(Quarried Stone)

Class B
(recycled)

Class B granular materials will generally have a poor grading and the aggregate size will be normally of a similar size. Therefore, when compacting the interlocking and binding mechanism achieved by a Class A material will not be so available to a Class B material. When using a Class B material for backfill layer, you are required to increase the Sub-base layer thickness by 50 mm.

What is the difference between a Class A and B material?

The grading of aggregate found in a Class A assists with interlocking of the material under compaction and creating a stronger layer. This is why you increase sub-base layer for a Class B material.



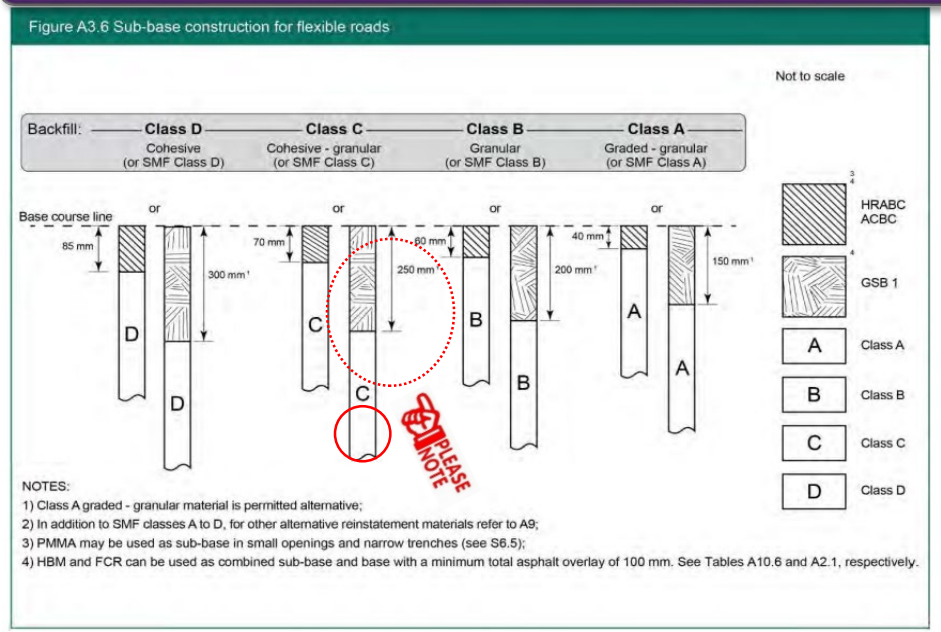
Appendix A1 – Backfill materials

SROH what it says –A1.3 Class C cohesive/granular

A1.3.1 Materials with less than 50% granular content by mass must, at the time of compaction, have a moisture content of between 0.8 and 1.2 times the plastic limit or be acceptable when subjected to field identification test No.2.

A1.3.2 Materials with a minimum of 50% granular content by mass must, at the time of compaction, have a moisture content of between +1% and -2% of the optimum moisture content as determined by BS 1377-4, Vibrating Hammer, Method 3.7, or must be acceptable when subjected to field identification test No.3.

Where the backfill material is Class C, the sub- base layer will again increase by 50 mm (100 mm more than a Class A backfill)



Note: We are only dealing with unbound granular sub-base for the purposes of this section

What it means

Essentially, we are now looking at a material that contains both cohesive *(e.g. clay)* and granular materials. What is being described is, if the granular content is less than 50%, the moisture content is based on the plastic limit of the cohesive material *(or field identification test No. 2 which will be described on next page)*.
Where the granular content is above 50% you apply the same requirements of Class A and Class B materials, or you can also use the field identification test No. 3 as described under SROH - A1.1 for Class A materials, which we have already outlined previously.

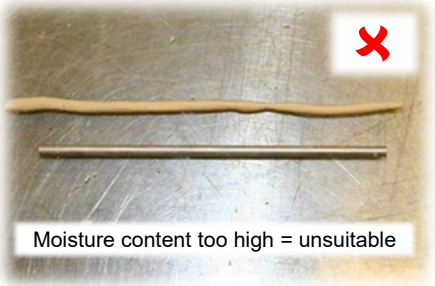
So a Class C material is a mixture of cohesive and granular?

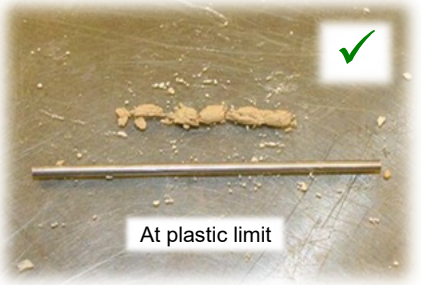
Yes, and the field identification test you apply will depend if there is more than 50% granular material or not. If there is you will apply test No. 3, if not you will apply test No. 2 which is described on next page.


Class C

What does plastic limit mean?

Basically, the plastic limit is the moisture content at which a fine-grained soil can no longer be re-molded without cracking.


Moisture content too high = unsuitable


At plastic limit

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SROH what it says – A1.4 Class D cohesive materials

A1.4.1 Cohesive materials at the time of compaction must have a moisture content of between 0.8 and 1.2 times the plastic limit or be acceptable when subjected to field identification test No. 2.

A1.4.4 High silt content materials, as defined by field identification test No. 1, must be compacted in accordance with A8 requirements for Class D Cohesive Materials.

What it means

Now we can see we are dealing with cohesive materials such as clays, soils and silts. These are the poorest of the allowable backfill materials and will be subject to two types of field tests. The SROH identifies the field identification test for silt materials as No.1 and the test for clays and soils as test No. 2. *(Both will be further explained below)*
It is apparent, is that moisture content is very important, and they should not be used either too wet or too dry, as compaction becomes virtually impossible. The sub-base layer thickness will significantly increase where these materials are used in the backfill layer.

Where it is found that clay is too dry to allow for backfill, water can be added until such time the clay becomes compliant with SROH A1.4.1 *(see above)* for moisture content.

PLEASE NOTE

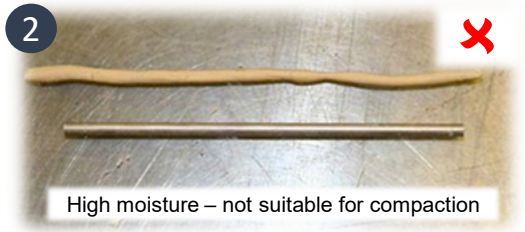
The hand below has silt remaining on the palm and fingers. Once dry this will rub off. However, the clay appears to have too high a moisture content to compact.

Below you will see result of test 2 for moisture content of clay. Image 1 shows good moisture content for compaction. Image 2 shows a moisture content which is too high for application of compaction

1

At plastic limit – suitable for compaction

2



High moisture – not suitable for compaction

Field Identification test No.1.
Silt identification.

Silt is extremely fine *(like a powder when dry)* and the test to determine presence is quite simple.
You will need to separate fine material only, and rub between the palms of your hands where it will stick.
Clap your hands to remove excess material *(clay)* and the heat of your hands will dry the remainder.
Once dry, rub your hands together vigorously and if the material essentially disappears you will have a silt content.
Otherwise, it is likely soil or clay.

Field Identification test No.2.
Clay condition.

Select a sample of fine material only, at a moisture content representative of the bulk material.
Try to roll into a ball and if it falls apart it is too dry to compact.
If not too dry, take a piece and roll on a flat surface to a cylinder shape. Where it starts breaking up is the plastic limit.
If it becomes longer and thinner than the size and length of a new pencil (175mm) without cracking, the moisture content is too high for successful compaction.
You cannot compact wet clay.

Where the backfill material is Class D, the unbound sub-base layer will again increase by 50 mm. This will provide a flexible road sub-base layer thickness of 300 mm. This only applies to unbound sub-base.

Appendix A1 – Backfill materials

SROH what it says – A1.5 Class E – Unacceptable materials

A1.5.1 The following materials, listed as unacceptable in MCHW Clause 601 paragraphs 2(ii) and 3, must not be used at any level within the permanent structure of any reinstatement:

What it means

This is quite simply, materials that are absolutely not allowed within any part of the backfill layer reinstatement.
We will outline the banned materials referred to below.

You cannot use peat or materials from swamps or marshes. These materials cannot be compacted and are likely to contain element that would rot away.

You also cannot use logs, tree stumps or any other perishable materials that could rot away such as leaves, grass cuttings, or any other organic materials.

You cannot use materials in a frozen condition. However, if such materials are suitable when unfrozen, they can then be used

Clays having a liquid limit exceeding 90, determined in accordance with BS 1377-2 Method 4, or a Plasticity Index exceeding 65, determined in accordance with BS1377-2, Method 5.4.

Essentially, these are clays that are saturated or nearly liquid.

You cannot use any materials that may be susceptible to spontaneous combustion or catching fire at any time.

Materials having hazardous chemical or physical properties requiring special measures for excavation, handling, storage, transportation, deposition and disposal.


Wet Clay


Frozen soil


Organic material


Hazardous waste


Materials susceptible to spontaneous combustion

Appendix A1 – Backfill materials

What it says– A1.6 Field test 4 granular grading

A1.6.17 All unbound granular materials must be reasonably well graded i.e. they must contain a range of particle sizes from fine to coarse, with an adequate proportion of particles of intermediate sizes. A well-graded material can be compacted to give a dense and stable structure of interlocking particles with a low proportion of air voids within the structure.

What it means

Essentially, we have a field test to determine the grading of aggregates within a granular material. This will allow for identification of materials suitable for use and can assist with sub-base layer thickness requirements.

The method from the SROH relating to Field Identification Test No. 4 will be outlined below:

1) Depending on the size of the stockpile, dig out representative samples from beneath the outer surface at several positions around the outside.

2) Spread out each sample and examine under good light. This should be done on a clean flat area where no contamination can occur.

Class A graded granular materials
Should not contain any particles greater than 75 mm nominal size and, in general, should be 50 mm or less. Smaller particles down to less than 5 mm nominal size should be present in gradually increasing numbers as the size decreases. Finer particles from sand size down to dust should be present and will usually be adhering to the larger particles. Fine particles should be visible adhering to around 30% or more of the surfaces of most of the larger particles.

Class B granular materials
Should show the same general features as described above but will usually be less well graded overall compared with Class A Graded Granular Materials.

Class C Cohesive/granular materials – will usually contain a much larger proportion of fine material. The granular content should still be less than 75 mm nominal size, down to less than 5 mm nominal size and should not be single sized.

A1 - Summary

What are backfill materials?

They are materials allowed within the backfill layer immediately below the sub-base.

I thought all loose materials were backfill materials?

Absolutely not, however the higher quality materials such as GSB Type 1 may be used in Base and Sub-base layers. Backfill materials usually refer to the backfill layer

Does the class of backfill material make any difference to the reinstatement?

Definitely, the poorer the class of backfill material will determine the road construction as the sub-base thickness has to increase to compensate *(SROH – Figure A3.6)*.

If I use clay confirmed as suitable for backfill, what thickness of sub-base will I have?

Clay is Class D material, therefore, using GSB 1 in the Sub-base, minimum thickness will be 300 mm beneath a Base layer, which is 180 mm in a Type 4 flexible road.

So that would be 480 mm of GSB 1 material in a Type 4 flexible road?

Exactly, the sub base thickness is directly affected by the backfill material, so if you use a class A material in the backfill, the sub-base is 150 mm thick beneath a Base layer of 180 mm thick. If the backfill is Class B material, the Sub-base increases to 200 mm thickness beneath the 180 mm Base layer.
If the backfill is Class C material, the Sub-base increases to 250 mm thickness.