TECHNICAL METHODS FOR HIGHWAYS

SAMPLING METHODS FOR ROADS CONSTRUCTION MATERIALS

PREFACE

TECHNICAL METHODS FOR HIGHWAYS (TMH) is a seriod complementing the TECHNICAL RECOMMENDATIONS FOR HIGHWAYS (TRH) series. The TRHs are intended as guides for the practicing engineer and leave room for engineering judgement to be used. The TMHs are morein the nature of manuals for engineers, prescribing methods to be used in various road design and construction procedures. It is hoped that the use of these manuals will produce uniform results throughout the country.

The TMH series is also printed and distributed by the National Institute for Transport and Road Research (NITRR) on behalf of the committee for State Road Authorities (CSRA). Any comments or queries on the document should be addressed to: The director, National Institute for Transport and Road Research, CSIR, P O Box 395, Pretoria, 0001.

ACKNOWLEDGEMENT

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SYNOPSIS

TMH5 gives detailed methods for taking samples of materials that need to be tested for road construction purposes. Methods of sampling natural materials, stockpiled material (both treated and untreated) and pavement layers are described. Instructions are also given for sample division using a riffler or by quartering. In the final chapters the background to sampling, i.e. the necessity for sampling, evaluation of test results and the reasons behind the methods used, are discussed. TMH5 is a companion volume to TMH1 in the Technical Methods for Highways series.

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CHAPTER 1

FOREWORD

This manual has a twofold purpose. Part I describes the methods prescribed for specific applications. The idea is to supplement the methods in due course so that eventually all the important material conditions will be covered in this Part.
Part II is intended as a manual which:

(a) can be used during the theoretical training of students

(b) can be used to derive a sampling plan in cases which are not covered by Part I.

As discussed in Chapter 5 sampling sizes and methods are very often limited by economic considerations. The sampling plans given in Part I do not therefore always comply with the principles stated in Part II as regards the number of samples needed.

However, it can be categorically stated that the specified plans are tried and tested and will usually be found to be realistic when the sampling costs are weighed against the value of the information obtained.

CHAPTER 2

DEFINITIONS OF TERMS USED

N.B Since these definitions form the basis of all discussions in this document, it is suggested that the reader make sure that he thoroughly understands them before he uses the rest of the manual.

1. SAMPLE

A sample is a portion or a combination of portions of a lot of a material whose degree of representation is not necessarily important and is therefore not specified. (See Definition 3.)

2. REPRESENTATIVE SAMPLE

A representative sample is a portion or a combination of portions of a lot of a material whose **degree of representation** is important and is therefore **specified.**

(It is important to understand that the representation of a sample varies between the extremes of being poorly representative and absolutely representative. This simply means that the larger the sample in proportion to the lot, the more representative it becomes, until the whole lot is tested and one may talk in terms of **absolute representation.**)

3. SAMPLE LOT

A lot of material means **a discrete specific quantity of the material** which can for all practical purposes be regarded as **a separate entity** and which does not inherently vary disproportionately in respect of the determining characteristics. (See Definition 4.)

(The size of a lot is usually determined by:
(a) The consignment or delivered quantity.
(b) The way in which it is stored when the sample is taken.
(c) The variation of the characteristics of the material.

A sample lot is therefore the specific heap, load, tank, drum or quantity of material which can be represented by a specific sample.)

4. DETERMINING CHARACTERISTICS OF A MATERIAL

These are characteristics of a material which will **determine its performance in the specific use** for which it is intended.
(The colour of gravel has no direct influence on its performance as a road foundation material. The colour of the gravel is therefore a fortuitous or **non-determining** characteristic.)

5. MINIMUM ACCEPTABLE SIZE OF A SAMPLE

This is the smallest quantity of material which can serve as a sample provided that the determining characteristics of the material can be measured with an acceptable degree of accuracy by means of such a sample.

6. MAXIMUM ACCEPTABLE SIZE OF A SAMPLE

The maximum acceptable size of a sample is the largest sample from which the desired degree of representation or accuracy can be obtained relative to the purpose for which the sample was taken.

7. PRIMARY OR FIELD SAMPLE

This is the sample originally taken from the lot at the storage site, and its size is determined by the degree of representation or accuracy can be obtained relative to the purpose for which the sample was taken.

8. SECONDARY OR LABORATORY SAMPLE

This is the sample taken from the original sample which is used to extract the test samples. A secondary sample is divided up to provide the secondary sample is usually obtained by division of the original sample on site and its size is determined by the specific tests for which it is needed.

9. **TERTIARY OR TEST SAMPLE**

This is the material used for a specific test. It is extracted from the secondary sample and its quantity depends on the quantity prescribed for the particular test which is to be done.

10. **INCREASE OF THE NUMBER OF TESTS**
When the sample size as prescribed by the test method is too small to ensure a specified degree of accuracy, the number of tests must be increased to give greater confidence about the results obtained.

11. **REPRODUCIBILITY OF A TEST**

This is the degree of variation between the results obtained by the same operator repeating a test on the same material. This factor measures therefore measures the human influence or human error in the execution of a test.

12. **REPEATABILITY OF A TEST**

This is the degree of variation between the results obtained by the same operator repeating a test on the same material. This factor therefore measures the repeatability of the same test under constant conditions, or in other words the precision of the test.

13. **SINGLE SAMPLE**

A single sample is a sample taken from a heap or a container in a random or non-random manner.

14. **COMPOUND SAMPLE**

A compound sample is composed of a number of single samples taken in a random or non-random manner. (Cf. Definition 13.)

15. **MEAN SAMPLE**

A mean sample consists of a series of single samples taken according to a predetermined fixed pattern, the size of every single sample being in proportion to the quantity of material it represents out of the whole. (See Definition 13.)

16. **APPROXIMATE MEAN SAMPLE**

A sample consisting of a series of single samples taken according to a predetermined fixed pattern, the size of every single sample being in proportion to the quantity of material it represents out of the whole. (See definitions 13 and 15.)

17. **SAMPLE WITH CONSTANT CHARACTERISTICS**

A sample whose determining characteristics are normally remain constant, unless they are artificially changed.

18. **SAMPLE WITH CHANGING CHARACTERISTICS**

A sample whose determining characteristics are normally in the process of changing, unless they are artificially kept constant.

19. **SAMPLE WITH CHANGED CHARACTERISTICS**

A sample whose determining characteristics have been changed externally.

CHAPTER 3

SPECIFIC METHODS FOR SAMPLING ROAD CONSTRUCTION MATERIALS

NATURAL MATERIALS

SAMPLING METHOD MA 1

SAMPLING OF A NATURAL ROCK MASS

1. **SCOPE**

This method describes the taking of samples from a test pit in a natural rock mass when the rock is to be crushed for use in concrete, surfacings, bases, subbases, etc.

2. **APPARATUS**

2.1 **For taking samples from test pits blasted with explosives**

2.1.1. A prospecting pick.

2.1.2. A suitable tape measure.

2.1.3. A spade.

2.1.4. A pick.

2.1.5. A sledge-hammer with a mass of approximately 5 kg.

2.1.6. A suitable crowbar.

2.1.7. Suitable canvas sheets approximately 2 x 2 m.

2.1.8. Suitable containers for rock samples such as strong canvas bags.

2.2 **For taking cores obtained with the aid of a core drill**

2.2.1 A suitable tape measure.

2.2.2 Suitable containers for the packing of cores such as a wooden box with partitions in which the cores can be firmly packed so that they cannot slide together or become mixed up during transport and handling of the box.

3. **SAMPLE SIZE**

3.1 **Samples from test pits blasted with explosives**

At lease 70kg of each rock type that is separately identified and sampled, should be obtained.

3.2 **Cores obtained with the aid of a core drill**

Where possible at alest 70 kg of each rock type that is separately identified and sampled, should be obtained. If the quantity of material that can be obtained from one borehole is insufficient, more pits must be drilled adjacent to the first hole. Alternatively, the cores can be used simply as indicators and larger test pits can be blasted with explosives and sampled at a later stage.

4. **METHOD**

4.1 **Test pits blasted with explosives which have then been opened manually**

Inspect the sides of the test pit to their full depth and record any observable changes in the rock as well as the depths between which such changes occur. Characteristicts which should be taken into account are rock type, colour, hardness, texture, etc.

Use a crowbar or pick to loosen pieces of each type of rock from each wall of the test pit and place each type in a separate container. If the pieces are too large for the containers, they may be broken up with the aid of the sledgehammer. If there is not a large variety of rock types, some of the loose material taken from the test pit can be selected outside of the pit and each type can be placed in a separate container.

Any loose earth or gravel layers on top of the rock mass or which occur in seams between the layers of rock must be sampled separately in accordance with sampling method MA2 if it is to be used for some or other purpose.

The sample containers must all be clearly and indelibly marked so that the samples can be identified when they arrive in the laboratory. (See paragraph 4 of Chapter 7.)

4.2 **Cores taken with the aid of a core drill**

Place the cores in a suitable box with partitions so that they are in order from the shallowest to the deepest part of the borehole and can be identified and measured as such when they arrive in the laboratory.

The partitions in the box must be narrow enough to ensure that the cores remain in position and do not become mixed up in the box.

5 **REPORTING**

The samples must be sent to the laboratory under cover of a properly composed report or a suitable borrow pit data form (see form TMH5-1). The report or form must contain the full particulars of every sample, for example test pit number, sample number, depths between which the samples were taken, description of the material type, what sort of containers were used to send the samples to the laboratory and how many containers there are of each sample.

A sketch of the rack mass and its environment and also of the position of each test pit must accompany the report or borrow pit data sheet. The landform of the rock mass must be determined according to the definitions in TRH2 and must be indicated on the sketch with the necessary symbols.

SAMPLING METHOD MA2

SAMPLING FROM A SAMPLING PIT IN NATURAL GRAVEL, SOIL AND SAND

1. SCOPE

This method describes the taking of samples from a test pit with vertical sides, at leas one metre square and which has been excavated in a natural deposit of gravel, soil or sand by means of a pick and shovel or any mechanical excavator or large auger. The samples may be needed for the centre line survey of the natural information or for any of the following proposed uses:
Gravel for subgrade, selected layer, subbase, basecourse, asphalt and coarse aggregate for concrete.
Soil for subgrade, selected layer, subbase and binder.
Sand for subgrade, selected layer, as a stabilizing agent for clayey materials and as fine aggregate for concrete and bituminous mixes.

2. APPARATUS

2.1 A prospecting pick.

2.2 A suitable tape measure.

2.3 A spade.

2.4 A pick.

2.5 Suitable sample containers such as strong canvas or plastic bags.

2.6 Suitable canvas sheets approximately 2 x 2m

2.7 A riffler with oenongs approximately 25mm wide, with six matching pans.

2.8 A 19 mm sieve with a recommended diameter of 450 mm.

2.9 A basin approximately 500 mm in diameter.

3 SAMPLE SIZE

The size of each sample will depend on what tests are to be done on it. A 70 kg sample will usually be sufficient but if the material is to be tested for more than one possible use, the size of each sample will have to be increased. (See paragraphs 2.1 and 2.2 of Chapter 6.) A sample may, and usually will, consist of more than one bag of material.

4 METHOD

Inspect the sides of the test pit to their full upper edge of the test pit. Now sample every distinguishable gravel, soil or sand layer by holding a spade or canvas sheet at the lower level of the layer against the side of the pit and by cutting a sheer groove to the full depth of the layer with a pick a or spade. Place the material obtained in this way in ample bags. The canvas sheet may also be spread out on the floor of the test pit. At least twice the amount of material needed for the final sample must be loosened from the layers. Once all the layers have been sampled the material from each layer must be combined on either a clean, hard, even surface or on a canvas sheet and properly mixed with a spade.

Now quarter out a representative sample of the layer as explained in methods MD1 and MD2. (See note 6.1 below and paragraph 3.2 of Test Methods A1 in TMH1.)

It is customary to fill one small sample bag which can holed about 10kg, and two or three larger bags each holding about 30 to 40 kg. When numerous test pits are made in a deposit and the materials differ very little, it is only necessary to fill large bas of each material type at every second or third test pit. Here the sampler must be guided by his discretion and experience. The sample bags (or other containers) must all be clearly and indelibly marked so that the samples can be identified in the laboratory. The identifying reference must agree with that given in the covering report or form. (See paragraph 4 of Chapter 7.)

5 REPORTING

The samples must be sent to the laboratory under cover of a properly composed report and data sheet(s) (see soil survey form TMH5-2 and borrow pit data form TMH5-1). Full particulars about every sample must be given, for example stake value, sample number of mark, depths between which the samples were taken, description of the material, type of containers used to send the samples to the laboratory, and how many containers there are of each sample.

In the case of a proposed borrow pit, a direction-orientated sketch of the environment in which the deposit occurs must accompany the report and borrow pit data sheets.

All noteworthy landmarks must be indicated on the sketch. Every test pit must be clearly shown and the distance of the proposed source from the centre line of the road must be given in kilometers, to the nearest 0,1km. The landform in which the proposed source occurs must be determined according to the definitions in TRH2 and must be indicated on the sketch with the necessary symbols.

6 NOTES

6.1 Since one is often working with rather large quantities of material in this type of sampling, the capacity of the riffling pans may often be too small to contain even half of the material obtained after the first quartering. If insufficient pans are available, another heap must be made on a clean, hard, even surface or canvas sheet. This heap must then be mixed and divided with a spade as before. (See paragraph 1 of Chapter 7 and Methods MD1 and MD2.)

6.2 **Safety precautions**

In accordance with Regulation D16 of the Factories, Machinery and Building Work Act, no excavation deeper than 1.5m may be made unless:

(a) it is properly popped and braced;

(b) the gradient of the sides is at least equal to the angle of repose;

(c) it is in firm rock.

SAMPLING METHOD MA3

SAMPLING BY AUGER

1. **SCOPE**

This method involves in-situ sampling of natural gravel, soil or sand by meand of hand or power augers. Such sampling is done for a centre line survey of the natural formation or for borrow pit surveys for subgrade, selected layer, subbase, base, or coarse or fine aggregate for concrete or asphalt.

2 **APPARATUS**

2.1 Hand augers approximately 50 to 300 mm in diameter.
2.2 Power augers approximately 600 mm in diameter.
2.3 A prospecting pick.
2.4 A suitable tape measure to measure the sampling depth in millimeters.
2.5 Shovels.
2.6 Picks.
2.7 Suitable sampling bags made of canvas or plastic.
2.8 Suitable canvas sheets approximately 2 x 2m.
2.9 A riffler with 25 mm openings and pans.
2.10 Containers approximately 500 mm in diameter.

3 **SAMPLE SIZE**

The size of the sample will depend on the tests for which it is required, but usually a sample of 70 kg is sufficient.

4 **METHOD**

4.1 The work is done by drilling into the ground with the auger to the required depth, withdrawing the auger, and then removing the soil for examination and sampling.

Reinsert the auger in the hole and repeat the process.
Where various different types of soil are horizon occurs. When sufficient material is obtained for testing, e.g. when a 50 mm auger is used, the information gathered is simply used to record the soil profile. When sufficient material is removed by drilling a laboratory sample is obtained by quartering and riffling as described in Methods MD1 and MD2.

4.2 In the case of harder rock, when the power auger may cause pulverization, it is preferable to use the following procedure.

Drill a hole, usually about 600 mm in diameter, to the full depth required. Drill a second hole approximately 0,5 to 1,0 m asay from the first hole, depending on the quantity of material needed for the sample, to the depth of the first horizon which is to be sampled. Remove all the material between the two holes up to this depth and place it on a hard, clean soil surface or on a canvas sheet. Drill the second hole to the depth of the second horizon which is to be sampled and removed all the material between the two holes as described above, placing it on a separate canvas sheet. Repeat the process to the full depth of the first hole. Alternatively, samples may be taken from a single hole by cutting a groove in the material from the side of the hole as described in Method MA2.

5 **REPORTING**

See Method MA2.

REFERENCE

ASTM-D1452.

SAMPLING METHOD MA4

SAMPLING OF WATER FOR CHEMICAL AND/OR BACTERIOLOGICAL TESTS

1 **SCOPE**

The method describes the procedure which should be followed when samples of water are taken for chemical and/or bacteriological tests. The tests and requirements are described in SABS 241-1971.

2 **APPARATUS**

2.1 **Containers for samples for chemical tests**
Clean glass bottles with a capacity of approximately 2 *l* with close-fitting clean stoppers or covers, preferably also of glass.

2.2 **Containers for samples for bacteriological tests**
Only suitable sterilized containers supplied by the test laboratory may be used.

3 **SAMPLE SIZE**

3.1 **Samples for chemical tests**
At least 10 *l* per sample.

3.2 **Samples for bacteriological tests**

3.2.1 **Volume and number of samples:** Each samples must consist of at least 250 m*l* and the minimum number of samples that may be taken at one place will depend on the number of users to be served. (No more than one sample per day may be taken.)

4 **METHOD**

4.1 **Samples for chemical tests** (see notes 6.1 and 6.2)

4.2 **Preparation of glass bottles**

Clean the bottles and their stoppers or covers thoroughly before use. If possible the bottles should be washed with a nitric acid solution and then thoroughly rinsed out with water to remove the acid. Half-fill each bottle with the water from which a sample is to be taken, shake thoroughly and then empty it. Repeat this procedure three more times before starting to take the sample.

4.1.2 **Sampling**

4.1.2.1 From a tap: Turn the tap on fully and allow the water to flow for two minutes before taking the sample. To prevent unnecessary aeration while the sample is being taken, turn the tap while the sample is being taken, turn the tap so that it is only partially open and fill the bottle to within 15 mm of the top of the neck. Close with the stopper or cover to make a tight seal and label the bottle properly with the name of the sender, the date and the time of sampling, and any special identifying mark.

4.1.2.2 From the borehole or well: If samples are being taken from a borehole or well it is preferable to take them from a pump outlet pipe through which water has been pumping continuously for at least 24 hours. Thereafter follow the method described in paragraph 4.1.2.1 above.

4.1.2.3 From a stream, lake or fountain: Remove the stopper from the sample container and completely immerse the container in the water, holding it at the base. Allow it to fill by holding it pointing upstream in running water or moving it slowly forward in standing water. Do not disturb the sediment or collect any of it in the sample. If walking in the water cannot be avoided, the sampler should keep walking upstream while taking the samples. If it is necessary to use a boat to obtain a sample at a suitable depth from a lake or dam, the boat should be propelled with as little disturbance as possible to the sampling site. The sample container can then be attached to a suitable rod and be carefully filled by immersing it in the water and moving it slowly forward as described above. As soon as the container is full, it should be closed with the stopper and must then be properly labeled as described in paragraph 4.1.2.1.

4.2 **Samples for bacteriological tests**

4.2.1 **General**
Only containers supplied by the test laboratory and which are sterile and suitable for immediate use may be used. Before each sample is taken the sampler must wash his hands thoroughly. While the sterile sample container is being handled no surface of the cover or stopper which may come into contact with the sample or with the inside surface of the cover may come into contact with the hand or any other object; under no circumstances may the covers be laid down.

4.2.2 **Sampling from a tap or pump**

Allow the water to glow for at least two minutes so that the pipe supplying the tap is thoroughly flushed out, then stop the flow and wash the mouth of the tap or pipe with a spirit burner (or other suitable type) until it is really hot. Open the tap to its fullest and allow the water to flow again until the tap has cooled down. Now fill the container with water from the running tap until it is full and close with the stopper or cover to form a tight seal. Label the sample clearly with the name of the sender, the date and time of sampling, and any special identifying mark.

4.2.3 **Sampling from a stream, reservoir or dam**

Hold the box of the container in one hand, remove the cover with the other hand and immediately immerse the container about 300 mm below the surface of the water. In running water the container must be held with its mouth pointing upstream and in standing water it must be moved so that no water which has come into contact with the hand gets into the container. Once the container has been filled, remove it from the water and seal it tightly with the stopper or cover. Label the container clearly with the name of the sender, the date nad time of sampling and any special identifying mark.

5 REPORTING

Every sample must be accompanied by a report containing the following particulars:

Name and address of the organization or person requesting the tests.

Name and number of the farmer, plot or erf and the magisterial district.

Type of test required (bacteriological or chemical or both).

Date and time at which the sample was taken.

Date and time at which the sample was dispatched.

Name of sampler.

Description of the place at which samples were taken, i.e. the storage container (reservoir, tank, etc.), well, borehole, spring or stream, as applicable.

The date on which the last rain fell and whether it was heavy or not.

Whether the water has an unpleasant smell or taste.

The approximate number of persons who receive (use) water from the source or supply.

6 NOTES

6.1 Samples must be sent to the laboratory as soon as possible, since immediate chemical analysis (or stabilization) of the samples is essential.

6.2 The water should be sampled at least four times every year at the following times:
at the beginning of the rainy season:
in the middle of the rainy season;
at the end of the rainy season;
in the middle of the dry season.

REFERENCE

SABS 241-1971

STOCKPILED MATERIAL
Untreated materials

SAMPLING METHOD MB1

SAMPLING OF STOCKPILES

1 **SCOPE**

This method describes the procedure to be followed when stockpiles are sampled (see 6.1). The stockpiles may consist of:

Natural gravel, soil or sand;
Crushed rock for base or subbase;
Screened-out crusher dust for binder, fine aggregate for concrete or fine aggregate for bituminous mixes;
Crushed single-sized aggregate for bituminous or concrete work.

2 **APPARATUS**

2.1 Shovels.
2.2 Picks.
2.3 A mechanical loader-digger (if available).
2.4 Suitable sample bags (or other containers).
2.5 Suitable canvas sheets.
2.6 A riffler with 25 mm openings and six matching pans.
2.7 A 19 mm sieve with a recommended diameter of 450 mm.
2.8 A basin with a diameter of approximately 500 mm.

3 **SAMPLE SIZE**

The sample size will depend on the proposed use of the material and the tests which have to be carried out on it. (See paragraph 2 of Chapter 6.) The following tables give an indication of the minimum secondary sample sizes for every type of material. (See note 6.3.)

Proposed use	**Mass**
Pavement and formation layers (Gravels, soils and crushed stone)	Gradings and constants: 10 kg California Bearing Ratio: 60 kg
Fine aggregate for concrete and bituminous mixes	20 kg
Single-sized coarse aggregate for concrete mixes and bituminous surfacings	25 kg

4 **METHOD**

4.1 **Sampling while stockpile is being formed by the off-loading of material**

Select one or two positions on the consolidated surface of every layer of the stockpile at random while the pile is being formed.

Make a vertical test hole through the layer (or as deep as is practically possible) with the pick and shovel. Place a canvas sheet in the bottom of the hole and cut an groove in the side of the hole from top to bottom, letting this material fall onto the canvas sheet. Gather a sufficient quantity of material by cutting successive grooves, frequently raising the canvas sheet from the h9ole and tipping its contents onto another canvas sheet on the surface. Mix the material on the canvas sheet and divide it, by means of the riffler and the quartering method (refer to paragraph 1 of Chapter 7 and Methods MD1 and MD2), into the required size so that each sample bag or container contains a representative sample of the material taken from the test hole.

4.3 **Sampling from an already completed stockpile**

Select at least twelve sampling positions in a random manner. (See 6.2) Approximately half the positions may be on top of the stockpile if its surface is fairly large. (Also see paragraph 2 of Chapter 6.)

4.2.1 **Sampling with a mechanical loader-digger**

42.1.1 **From the sides of a stockpile**

Scooping from the sides of the stockpile from the bottom towards the top, fill the bucket of the loader-digger and deposit the material on a clean hard surface – the flat steel back of a truck or a hard clean ground surface are suitable. Mix the material thoroughly with the spade and quarter it out into smaller equal parts using the quartering method (ref to Method MD 2) until a quantity approximately twice the size is obtained. (See note 6.2)

Deposit this material on a canvas sheet, mix it thoroughly again and further divide it with the aid of the riffler (see Method MD1) until the desired sample, consisting of one or more bags (or containers), each representative of the sample, has been obtained.

4.2.1.2 **From the top of the stockpile**

Use the load-digger to make a hole approximately 2 m deep. (See note 6.2) Now scoop a load of material from the side of the hole, working from the bottom to the top, and deposit it in the back of a truck. Mix and divide the sample as described in paragraph 4.2.1.1 above.

4.2.2 **Sampling with pick and shovel**

4.2.2.1 **From the sides of a stockpile**

Using shovels, dig a groove from the top to the bottom of the stockpile. (See note 6.2) Remove all the material that has collected at the bottom of the groove as a result of the digging. Place a canvas sheet of suitable size at the bottom of the groove and using picks and shovels loosen a uniform thickness of material down the full length of the groove. Throw this material onto a canvas sheet, mix it thoroughly and quarter it as described in paragraph4.2.1.1 above.

4.2.2.2 **From the top of the stockpile**

Dig a vertical test hole with a pick and shovel, preferably 2 m deep (or as deep as practically possible). (See note 6.2.) Place a canvas sheet in the bottom of the hole and cut a uniform groove into the holefrom the top to the bottom so that the material falls onto the sheet, or throw it onto the sheet. Continue with this method until you have enough material, raising the canvas sheet as often as necessary and depositing the material on another canvas sheet on the surface of the stockpile. Now mix thoroughly all the material, raising the canvas sheet as often as necessary and depositing the material on another canvas sheet on the surface of the stockpile. Now mix thoroughly all the material deposited on the canvas sheet on the surface and quarter it as described in 4.2.1.1 above.

5 REPORTING

Samples taken from stockpile are often tested in field labortaries. In such cases a proper record must be kept of the sample number, date of sampling , position in the stockpile, description of the material , depth of test hole, etc.

When samples from a stockpile are sent to a central laboratory, they must be send under cover of a properly composed report in wich full details of the stockpile and samples are given. Important particulars about the sample are the sample number, the position at which sampled, depths between which the sample was taken (oright of the side from which it was taken), description of the material of which the sample consists, number and type of bags (or containers) in which the samples is contained and the proposed use of the material. (See also Paragraph 4 of Chapter 7.)

A sketch of the stockpile showing the positions of the sampling points at which the various samples were taken must be included with the report.

6

6.1 Sampling from a stockpile should, if at All possible, be done while the stockpile is being formed. Whenever a layer has Been completed sampling points should Be taken by making test holes in the layer and taking samples from them. However, stockpiles are often scraped together in natural material with bulldozers, in which case it is better to wait until the stockpile has been completed before taking samples.

6.2 The number of samples will depend on The size of the stockpile. At least four samples must be taken from each stockpile, but if the pile is greater than 4 000 m, one sample must be taken for every 1 000 ,m, i.e.

for 0-4 000 m- 4 samples
for 5 000 m – 5 samples
for 7 000 m – 7 samples.

The primary sample should consist of at least 300 kg for coarse and 50 kg for fine material. However, since it is impractical to transport such large quantities, the material is immediately divided up into the secondary sample size as shown in paragraph 3. The tertiary sample size is determined by the test method.

NOTES

SAMPLING METHOD MB2

SAMPLING FROM A CONVEYOR BELT

1. **SCOPE**

This method describes the procedure to be followed when samples are taken from a conveyor belt for the following purposes:

crushed or natural material for the gravel layers of a road (basecourse, subbase or selected layer);

crushed and/or sieved-out single – sized aggregate for bituminous or concrete work;

fine aggregate for bituminous or concrete work. N.B. This method is not suitable if the crushers of a stone crusher first have to be emptied.

2. **APPARATUS**

2.1 A suitable spade.

2.2 A 100 mm paintbrush.

2.3 Suitable containers for samples such as strong canvas or plastic bags.

2.4 Two templates whose from corresponds to that of the conveyor belt.

2.5 Suitable metal pans such as riffling pans in which to catch the material when it is taken off the conveyor belt.

2.6 A riffler with openings of approximately 25 mm and six matching pans.

2.7 A 19 mm sieve with a recommended diameter of 450 mm.

2.8 A basin approximately 500mm in diameter.

3. SAMPLE SIZE

The size of each single sample taken from the conveyor belt will depend on what test are to be carried out and on how homogeneous the material is. The following table gives an indication of the minimum masses of the compound sample which should be aimed at

Maximum Aggregate Size (mm)	**Minimum compound secondary size (kg)**
75	**150**
63	**125**
50	**100**
37.5	**75**
25	**50**
19	**25**
13.2	**15**
9.5 and smaller	**10**

4 METHOD.

Decide during production, in a random manner, when a single sample should be taken. Where a conveyer belt is concerned it is easiest to work on a time basis, in other words to decide to take samples at say 3 hours, 5.5 hours and6.3 hours after production has started. At the designated time the conveyer belt stopped. Two templates are then placed in position on the belt such that the material between the two templates will yield a single sample which when mixed and riffled will yield a compound sample of the size specified in paragraph 3. The material between the templates is then carefully scraped off the conveyor belt into metal pans held next to the belt, and the dust and fines are brushed off the belt into pans with the 100 mm paintbrush.

The belt is started again and the above procedure repeated twice more. The material sampled is now thoroughly mixed to form the compound sample and divided according to Methods MD1 and MD2 to yield a sample of the desired size.

5 **REPORTING**

Samples from the conveyor belts are often tested in field laboratories. In such cases a proper record must be kept of the source, the sample number, the date of sampling, a description of the material, etc. A form similar to TMH5-1 may be used.

When samples are sent to a central laboratory, they must be accompanied by a properly composed report giving full details about the samples. Important particulars are the location and proposed – or approved source, a description of the material of which the sample is composed, the number and type of containers of each sample, the date and time of sampling and the number. (See also paragraph 4 of Chapter 7)

6 **NOTE**

6.1 The primary single samples must be large but never the less in a form which makes practical handling of the compound sample possible. Because of the size, the secondary compound sample as indicated in paragraph 3 must be divided up immediately to facilitate the transport thereof. The tertiary sample size is determined by test method

SAMPLING METHOD MB3

SAMPLING OF CEMENT AND LIME

1 **SCOPE**

The method describes the procedures that should be followed when samples of cement or lime are taken from:

Bulk stock or consignments;
Containers such as 50 kg bags of cement or 25 kg bags of lime

2 **APPARATUS**

2.1 Suitable, clean containers such as tins with tightly-fitting lids which can be hold 5 kg of cement or lime.

2.2 Suitable equipment for taking samples such as a grooved sampling device for taking samples from large containers, and a tube type sampling device for small containers such as bags (see drawings). The former apparatus must be about 1.7 m long with an outer diameter of about 35 mm. It must consist of two brass telescopic tubes with corresponding grooves that can be opened and closed by turning the inner tube. The outer tube must have a sharp point to facilitate penetration into the cement or lime.

3 **SAMPLE SIZE**

3.1 **Cement:** Minimum of 2.0 kg for each 12 single samples.

3.2 **Lime:** Minimum of 0.5 kg for each single samples.

4 **METHOD**

4.1 **Cement or lime in bulk containers**
If the stock of cement or lime is less than 2 m deep (see note 6.3) single samples can be obtained with slotted samplings device. Take single samples at as many different depths and well spaced points in the container as possible, and place each sample in a separate sample container. Close the sample container properly to prevent moisture or air getting to the sample.

4.2 **Cement or lime in bags**
Choose the number of bags to be sampled from the consignment or stock in a random manner. Push a sampling into the mouth of the bag. Place a thumb over the airhole of the sampling advice and withdraw the instrument. Empty the contents of the sampling device into a sample container. Repeat the procedure until the required quantity has been obtained. Close both the sample container and the hole made by the sampling device in the mouth of the bag tightly so that no air or moisture can get in.

4.3 Mark or lable each sample, showing clearly what consignment or stock it was taken from, the date of sampling, the sample number and from where in the stock the sample was taken.

5 **REPORTING**

The samples must be sent to the laboratory under cover of a full report. The report must give, amongst others, the number of each sample, particulars of the stock or consignment from which the samples were taken, and the position of each sample in the stock or consignment.

6 **NOTES**

6.1 All types of cement and lime

6.2 When the stock is deeper than 2 m, a more sophisticated apparatus such as a sampling pipe which works on an air-current should be used. Such an apparatus is capable of taking separate samples at various depths of lime and cement.

6.3 Samples must not be taken from broken bags. The number of samples taken will depend on the size of the consignment or stock, but at least 12 single samples must be taken from each consignment or stock.

References

ASTM: C 183-86 (a)
SABS 471
SABS 626
SABS 831
SABS 824

FIG 1&2 OF TUBE SAMPLER PG 17

SAMPLING METHOD MB4

SAMPLING OF BITUMINOUS BINDERS

1. SCOPE

This method describes the procedure to be followed when sampling bituminous binders from drums or tankers. Bituminous binders include:

Bitumen
Tar
Cut-back bitumen
Emulsions
Priming material

2. APPARATUS

2.1 Gas or flame for heating the drum

2.2 Sample container (5 L capacity). (Glass or plastic containers are preferred for emulsions.)

2.3 Sampling tube or thief sample.

2.4 Cleaning material.

3. SAMPLE SIZE

The sample size will depend on the purpose and type of material, as well as on the volume and method of storage. Normally the sample will be about 4 L.

4. METHOD

4.1 Sampling of all bituminous may be done using the same basic principles. However, there are a few differences which should be taken into account. (See note 6.1 –6.5)

4.2 Sampling of bituminous binder in drums

4.2.1 If the drum has to be heated, e.g in the case of tar or bitumen, this must be done slowly and uniformly after the plug has been removed toallow the gases to escape. Avoid overheating any area of the drum. (See note 6.4.)

4.2.2 Close the drum tightly and roll it from side to side and invert it until the contents are thoroughly mixed

4.2.3 Remove the plug from the drum and take a sample using the sampling tube. Let the tube down slowly into the drum so that the level of the binder in the tube stays the same as the level of the binder in the drum. Close the tube, remove it and once the binder adhering to the outside of the tube has run off, transfer it to a sample container.

4.2.4 At least 4 L of binder must be taken for each individual sample. The quantity taken from each drum will therefore depend on the number of drums to be represented by one sample. (See notes.)

4.3 Sampling of bituminous binders in tankers and distributors

4.3.1 Using a samplig valve

If the tanker or distributor is provided with a sampling valve, it is very easy to take a sample. Circulate the contents of the tanker or distributor to mix it touroughly. Draw at least 20 L of binder from the valve o clean it. Then draw at least 4 L of material into the clean sample container and seal it immediately. (See notes)

In this way samples are taken at least three levels in the tank and combined to form a total sample of a least 4 L.

4.4 If necessary, divide the samples as discussed in Chapter 7 paragraph 1.2. Mark the sample clearly and indelibly immediately after sealing. (See paragraph 4 of Chapter 7)

5 REPORTING

Compose a report in the form of a letter stating the sampling method used, the purpose of and all other essential data. (See paragraph 4 of Chapter 7)

6 **NOTES**

6.1 Emulsion are chemically very reactive and special precautions must be taken to prevent contamination. Therefore only take amples in clean new sample containers made of glass or plastic.

6.2 The characteristics of emulsions change very quickly. Test on emulsions must therefore be completed within seven days. There for always dispatch samples immediately.

6.3 Cut-back bitumens and road tars contain a fair amount of volatile material. If the volatile portions evaporate, the characteristics of the material will change. Therefore take care to seal the container with the sample as soon as possible. Ensure that cover of the container is air-tight and that it cannot become dislodge during transit.

6.4 Penetration bitumens and some tars are usually too hard to sample when they are cold. They must be heated gradually while the binder is being stirred or circulated. The sample must be extracted slowly so that the hot binder does not splash. Use gloves and wear some protection on the arms when taking samples.

6.5 The sample container may not be cleaned with solvent. If the container becomes soiled on the outside, it should be wiped down with a clean cloth.

6.6 When binder distributors or tankers possess a circulation system the contents should be circulated before a sample is taken.

SAMPLING METHOD MB5

SAMPLING OF ROAD MARKING PAINT

1 **SCOPE**

This method deals with the procedure to be followed when sampling road marking paint.

2 **APPARATUS**

2.1 Clean, dry sample containers which have an air-tight seal.

2.2 Sampling tube or thief sampler (optional).

2.3 Cleaning material

3 **SAMPLE SIZE**

A single or compound sample of at least 2L is taken.

4 **METHOD**

Use the following procedure to ensure that the sample is representive of the batch.

Examine the container to ensure that the paint has been contaminated or diluted. The container must be undamaged and sealed.

Stir the contents of the container thoroughly until a homogeneous product is obtained. Use a clean ladle to prevent contamination.

Decant a sample (or use a sampling tube or thief sampler in the case of the large containers) into the sample container. The sample must have a volume of at least 2 L. The 2 L may be a compound sample provided the paint is of the same production batch and type. Dividethe sample when necessary as explained in paragraph 1.2 of Chapter 7.

Seal the container and clean the outside of it.

Mark the container properly with the name of the paint, the colour, the name and the manafacturer, the brand name and the production batch identification.

5 **REPORTING**

Dispatch the sample with a covering letter.

6 **NOTES**

6.1 Make sure that the sample containers will not come open or leak during transit.

SAMPLING METHOD MB6

SAMPLING OF STEEL FOR CONCRETE REINFORCEMENT

1 **SCOPE**

This method describes the taking of samples of structural steel for determining the tensile strength and other characteristics as specified in SABS 920. The method can also be applied to the taking of samples for determining the strength of welded joints

2 **APPARATUS**

2.1 A hacksaw or

2.2 An oxy-acetylene cutting torch

3 **SAMPLE SIZE**

The sample size will depend on the test which are to be done on the steel. At least three rods, each about 1m long, are needed for one series of test done according to SABS 920. To ensure that there will be sufficient rods for repeating some of the tests, it is recommended that at least six rods, each approximately 1m long are sampled from each batch.

4 **METHOD**

4.1 **Definition**

A lot is applicable mass (given below) of rods of the same type, normal size, cross-section, grade and mould number, from onemanufacturer, and which are simultaneously considerd for inspection and acceptance.

Nominal size of bars, mm	Maximum batch size,kg
up to 10	2 000
12	5 000
16 to 20	10 000
25 to 32	15 000
over 32	20 000

A bundle is regarded as rods of the same type, nominal size, cross-section, grade and mould number which are bound together for delivery purposes.

4.2 **Taking of samples**

Take sufficient rods, at random, from each lot so that when they have been sawn up the desired number of samples is obtained. If more than one rod is needed, they must be taken from different bundles. Using a hacksaw or a gas flame, cut off as many one-metre-long pieces as are needed for the test from the sampled rod or rods. When welded joints are being sampled, the joint must be in the middle of the rod.

Tie the cut-off pieces from each lot together with wire and mark properly.

5 **REPORTING**

Every bundle of steel samples must be identified with a proper label and be sent to the laboratory under cover of a sample data from giving:

Type of steel

Nominal size

Cross-section

Grade and mould number

Test to be done on the samples.

REFERENCE

SABS 620

SAMPLING METHOD MB7

SAMPLING OF PREMIXED ASPHALT

1. SCOPE

This method covers the procedures to be followed when a sample of hot already-mix has to be taken for the following purposes (see note 6.1):
For manufacturing briquettes for the checking of Marshall stability, flow, air voids and bulk density (see note 6.2) and for monitoring the grading and/or binder content of the mix.
The sample can be taken at any of four **different stages,** namely :
During discharge from the mixer or from the mix is discharged into the paver; from the hopper of the paver once the mix has been discharged into it from the truck;
Immediately after it has been spread by the paver, before compaction (see note 6.2).

2. APPARATUS

2.1 Sample for making briquettes

2.1.1 A spade with built-up sides (shovel).

2.1.2 A suitable insulated sample container.

2.1.3 A suitable riffler with pans

2.1.4 A thermometer, 0-200 ^{0}C.

2.1.5 Cleaning material such as toluene, brushes, cloths, etc.

2.2 Sample for determining the grading and/or binder content

2.2.1 A spade with built-up sides(shovel).

2.2.2 A suitable sample container.

2.2.3 A riffler with pans.

2.2.4 A metal plate 300 mm square and 1mm to 3 mm thick (for sampling behind the paver).

2.2.5 Cleaning material such as toluene, brushes, cloths, etc.

3. SAMPLE SIZE

3.1 Fro making briquettes

About 3 kg per briquette.

3.2 For monitoring the grading and/or binder content

The following sample sizes serve as a guideline for various maximum sizes serve:

Maximum size of aggregate (mm)	Maximum mass of compound sample (kg)
26,50	10
19,00	8
13,20	6
9,50	4
6,70	2

4. METHOD

4.1 During unloading of the mixer or from the storage container

When unloading takes place into the back of a truck, push the spade deep into the pile on the back of the truck and throw the spadeful of the mix into a riffling pan. Take at least six spadefuls in this way from all around the pile during discharge. Use the riffler to obtain a representative sample of the desired size from all the material sampled with the spade. (See notes 6.2 and 6.3). Place the sample in a suitable, marked sample container (a heat-indulated container when briquettes are to be made) and dispatch it immediately to the laboratory.

4.2 From a truck before the mix is unloaded into a paver

Starting at the top, push the spade deep into the load and take at least six spadefuls in this way at various points, throwing each spadeful into a riffling pan.

Use a riffler to obtain a representative sample of the desired size from all the material sampled with the spade. (See notes 6.2 and 6.3) . Place the sample in a suitable, marked sample container (a heat-insulated container when briquettes are to be made) and dispatch it immediately to the laboratory.

4.3 **From the hopper of the paver**

While the paver is busy laying the mix and the hopper is full, material can be sampled from the hopper using a spade.

Push the spade deep into the mix and throw the material so obtained into a riffling pan. At least six spadefuls, three from each slide of the hopper, must be sampled in this way. Use a riffler to obtain a representative sample of the desired size from all the material sampled with the spade. (See notes 6.2 and 6.3)
Place the sample in a suitable, marked sample container (heat insulated when briquettes are to be made) and dispatch it immediately to the laboratory.

4.4 **Immdiately after the mix has been laid by the paver**

Place the 300 mm square metal plate in position in the path of the paver before laying begins. Mark he position of the plate and allow paving to be laid over the plate. Remove the plate and the material on it. Place all the material in the sample container and dispatch it immediately to the laboratory. (See notes 6.2 to 6.6.) The material may not be suitable for making briquettes because of its having cooled down.

5 **REPORTING**

The material sent to the laboratory must be accompanied by a covering letter containing full details of the sample. The most important details are the sample was taken, where the material represented by the sample was laid, date and time of manufacture and sampling, thickness of the layer, and temperature of the mix when the sample was taken.

6 **NOTES**

6.1 The method does not include the taking of samples from asphalt mixes after compaction – this is dealt with in detail in Method MC2.

6.2 When a sample is being taken for making briquettes for flow and stability tests, it is important that it should not be reheated in the laboratory. In such a case the sampler will have to decide, depending on the circumstances at what stage he will take the sample so that it does not arrive cold at the laboratory. In cold weather it may be advisable to take these samples at the mixing plant before the mix is transported to the paver.

6.3 Riffling of material intended for the making of briquettes should be done as quickly as possible and with as little heat loss as possible.

6.4 The plate method can be rearded as the most reliable method when the aim is to sample the finished product. The position of the plate can be determined in advance in a random manner. This, together with the fact that the whole sample is taken on the plate, makes it a very reliable method for controlling binder content and grading, but should be used with care for controlling stability and flow.

6.5 When a 300mm square plate is used and the specified layer thickness is 30 to 35mm, about 6 to 7 kg of the mix can be obtained.

6.6 The mix can be prevented from adhering to the plate by wiping the plate first with a cloth dampened with diesel oil. The diesel oil film must, however, be as thin as possible. Briquettes cannot be made from this material because of pollution and cooling down.

SAMPLING METHOD MB8

SAMPLING OF SLURRY MIXES

1. **SCOPE**

This method describes the procedures which should be followed when a sample of ready-mixed slurry is taken. (See note 6.1)

2. **APPARATUS**

2.1 Clean, dry sample containers capable of forming an air-tight seal.

2.2 A suitable scoop.

2.3 Cleaning material such as toluene, cloths for wiping and water.

3. **SAMPLE SIZE**

A compound sample of at least 4l each must be taken as follows:

Place a clean scoop under the machine's outlet chute and let about 5l flow into the scoop. Be sure to catch the full width of the stream of slurry. Take a 0,5l sample from these 5l and pour it into the sample container. Place the lid on the sample container.

Eight samples must be take at regular intervals, as described above, from each batch of slurry while it is being spread. The eight single samples must be placed in one container to form one compound sample of at least 4l . (See note 6.2.)

Seal the sample container properly and mark or label it with the sample number, the place at which the batch was laid and the time and date of sampling.

Dispatch the sample to the laboratory immediately so that tests can be done without delay.

5 **REPORTING**

A full report containing the details of the sample and the slurry mix (mix proportions and mix composition) must accompany the sample to the laboratory.

6 **NOTES**

6.1 Since the slurry seal is a suspension with a fairly low viscosity, it is quite easy to sample. However, the sample can only be taken at one stage and that is while the machine is engaged in spreading the mix onto the road. On no account may the modern slurry machine (which uses a continuous mixing method) be stopped so that a sample can be taken (for example to get a wheelbarrow on top of the trailer under the outlet chute.) As soon as the mixing process stops the mix changes composition. On no account may a sample of slurry be scraped off the road either, because:

The material is in intimate contact with the underlying layers and a pure and representative sample cannot be taken; and

The underlying layers usually absorb some of the binder form the slurry seal.

6.2 After each sample has been taken, the equipment must be thoroughly washed with clean water and thereafter dried with clean cloths. If the batch is discharged quickly, it may be necessary to have four sets of equipment ready to avoid the possibility of the equipment still being wet when the next single sample has to be taken.

SAMPLING METHOD MB9

SAMPLING OF FRESHLY MIXED CONCRETE

1. **SCOPE**

This method involves the sampling of freshly mixed concrete at the point of use. This concrete is then used to carry out further tests or to prepare various specimens for testing.

2. **APPARATUS**

2.1 **Scoop**

Scoops must be made of a material which will not be affected by the cement, and to make it easier to determine what volume of concrete is being taken, the capacity of the scoop should be know. Since samples have to be taken from a moving stream of concrete, the scoop should be box-shaped, have a handle long enough to make it sage and comfortable to hold with both hands, and have sides high enough to prevent excessive spilling of the concrete. When samples have to be taken from poured concrete, the scoop should be in the form of a shovel with high sides and a high back, so that it will easily penetrate the concrete.

2.2 **Containers**

Containers must be large enough to contain the required increments of concrete. They must be strong enough and made of a material which is not affected by concrete.

3 **SAMPLE SIZE**

The minimum volumes of the samples required for the various tests are given in the table below. (The volumes apply to uncompacted concrete and are intended to give a surplus of approximately 15 per cent.) Base the size of the total sample to be taken on the tests to be carried out and calculated the number, N, of single samples (i.e. scoops) to be taken at each point, from this volume and that of the scoop(s) to be used.

VOLUMES OF THE SAMPLES

Test	**Volume of the uncompacted concrete, in cubic decimeters (minimum)**
Analysis	26
Slump	25
Compaction factor	12
Vibratory consistency	8
Air content	10
Mass per volumes unit	15
Comprehensive strength: For three cubes with a nominal size of	
(a) 100 mm	5
(b) 150 mm	16
Bending strength : For three beams with a nominal size of	
(a) 100 x 100 x 500 mm	22
(b) 150 x 150 x 750 mm	76
Static elastic modulus: For three cylinders with a nominal diameter of 150 mm and a nominal height of 300 mm	24
Moisture movement: For three prisms with a nominal size of 75 x 75 x 300 mm	8

4.1 **Sampling from poured concrete**

If the samples are to be taken from concrete in open trucks, heaps or open-pan type mixers (such as those used in laboratories), the applicable procedure must be selected from the following:

(a) In the case of a production batch of concrete which, s a result of vibration or because of its consistency, has an almost smooth upper surface, the sample must be taken as follows:
Divide the batch into three approximately equal parts. Remove the upper 200 mm of material at each of three equally spaced places in each part, take N single samples (see paragraph 3) and place them in suitable containers.

(b) In the case of a batch f concrete in a heap the sample must be taken as follows:

Take N single samples (see paragraph 3) at each of six places equally spaced around the circumference of the heap at a height of approximately 0,25 H (where H is the height of the heap), and another N single samples at each of three places spaced as above at a height of approximately 0,75 H. When taking a sample, the scoop must be pushed right into the concrete. Under no circumstances may a sample be taken by scraping concrete from the surface of the heap. Place the single samples in suitable containers.

(c) In the case of a batch of concrete in a stationary pan-type mixer not provided with a discharge gate, the sample must be taken as follows:
Take N single samples (see paragraph 3) at each of six plaes equally spaced around the circumference of the pan and approximately 50 mm from the side and another N single samples at each of three places near the centre of the pan. Each sample must, if possible, include concrete from the full depth of the pan at that point. Place the single samples in suitable containers.

4.2 Sampling during the casting of concrete

If the samples are to be taken during the casting of concrete (e.g. during discharge from a mixer chute, conveyor belt or pipe), the following procedure must be used:

(a) Make sure that access to the concrete is such that the sampler is able to work without excessive physical exertion.

(b) Wherever the single samples are taken from, ensure that neither the first 10 per cent nor the last 10 per cent of the contents of the mixer are taken as a sample.

(c) Take each single sample as close as possible to the discharge point and do not allow the concrete to drop from a height of more than 500 mm before taking a single sample.

(d) Take the N single samples (see paragraph 3) at equally spaced intervals (preferably at least 9) during the discharge period and ensure that each sample is taken in one movement across the full width and thickness of the flow of concrete and immediately transferred to a suitable container.

4.3 **Preparation of the compound sample**

After the single samples have been taken, the containers must be removed to a suitably protected and convenient place without delay, the contents of the containers must be emptied onto a suitably hard and non-absorbent surface and the compound sample thoroughly mixed by hand.

5 **REPORTING**

Prepared test portions must be properly labeled and be dispatched under cover of a sample form giving the following information:

Road and contract number.
Description and source of material.
Location of material from which the sample was taken.
Date of sampling.
Group number.
Name of the sampler.

Reference

SABS Method 861.

SAMPLING METHOD MB10

SAMPLING OF TREATED PAVEMENT LAYERS TO DETERMINE CONTENT AND DISTRIBUTION OF THE STABILIZER

1 **SCOPE**

This method describes the takingof samples from a road pavement layer during the compaction of the layer after the stabilizer and water have been added and mixed, for determining the stabilizer content and distribution.

2 **APPARATUS**

2.1 A suitable tape measure approximately 3m long.

2.2 A spade with a rectangular blade.

2.3 A pick.

2.4 A suitable canvas sheet approximately 1m x 0,5m.

2.5 A hand brush or 100mm paint-brush.

2.6 A small garden spade with a sawn-off point.

2.7 Suitable sample containers such as strong plastic bags or air-tight plastic or metal containers. (See note 6.1)

3. **SAMPLE SIZES**

Each sample should weigh approximately 6kg. (See note 6.2.)

4. **METHOD**

4.1 **Preparation of the sampling hole**

During the compaction of the layer to the sampled, immediately after the first leveling cut of the road-grader, a trench is dug at the pre-determined sampling point as follows:

Dig a trench with the spade and pick, approximately 0,5m long and at least the width of the spade to the full depth of the layer. Trim one wall of the trenched layer to make it smooth and vertical. Now cover the other sides and the bottom of the trench with the canvas sheet.

4.2 **Sampling**

Using the small garden spade make a rectangular groove straight down the wall of the trench at the sampling point; the groove should be large enough to supply a sample of the desired size. Trim the sides of the groove neatly. Ensure that the full depth of the layer is sampled without getting any of the underlying material mixed into the sample.

If the layer is to be sampled to various depths to determine the vertical distribution of the stabilizer, carefully measure the depth to which sampling must be carried out and proceed as described above by making and trimming the groove to that depth.

Using the small spade, place each sample thus taken in a suitable container and carefully shake the fine material on the canvas sheet into the container. Use the hand brush or paint-brush to sweep all the fine material from the canvas sheet into the container. Cover the sample in an air-tight manner. Shake the canvas sheet well before taking the next sample.

Label each sample properly and note the sampling point and time at which hthe sample was taken, as well as the time at which the mixing of stabilizer and soil and the admixing of water commenced. (See notes 6.3 and 6.4.)

5 **REPORTING**

The samples must be sent to the laboratory under cover of a report containing the following information:

Name of the project.

Date of sampling.

Name of sampler.

Position of the sampling point.

Sample number or mark.

Description of the layer, material and stabilizer.

Time at which addition and mixing of the stabilizer and water commenced.

Method at which addition and mixing of the stabilizer and water commenced.

Method of addition and mixing used (e.g. disc harrow and grader).

Manner in which the sample was sent to the laboratory.

6 **NOTES**

6.1 The notes of canvas bags for these types of sample is not recommended as samples may become contaminated and are normally wet.

6.2 The sample size may be reduced if the material is very fine. It is preferable to reduce the size of the sample by means of further division, rather than to take smaller samples.

6.3 For some test methods the exact times at which the stabilizer and water were added and mixed need to be known, as well as when the sample was taken. The sampler must thus ascertain whether the sampling method to be used requires this information. If not, it is unnecessary to record the various times.

6.4 If the samples can only be taken after compaction has been completed, the interval between the adding and mixing of the stabilizer and water, and the taking of the sample, must be clearly brought to the attention of the laboratory if a test method which requires this information is used.

SAMPLING METHOD MC1

SAMPLING OF ROAD PAVEMENT LAYERS

1. SCOPE

1.1 This sampling procedure covers the sampling of:
Materials which has been laid but not yet compacted, and
Completed layers.

1.2 The layers from which samples can be taken are as follows:
treated and untreated bases;
treated and untreated subbases;
selected layers; and
subgrades.

2 APPARATUS

2.1 A suitable tape measure.
2.2 A shovel.
2.3 A pick.
2.4 Suitable small canvas sheets.
2.5 A hand brush.
2.6 Suitable containers for samples such as strong canvas bags or plastic bags for unstabilized layers, and suitable tins or plastic containers with air-tight lids for stabilized layers.
2.7 A riffler with 25mm openings and six matching pans.
2.8 A metal basin approximately 500mm in diameter.

3 SAMPLE SIZE

Test for which sample is intended	Mass in kg (minimum)
Indicator tests	10
Density determinations	40
California Bearing Ratio	60
Unconfined compressive strength (treated layers)	35

4 METHOD

4.1 Preparation of sampling hole

Using a pick and shovel, dig a hole in the layer which is to be sampled. The hole should be large enough to yield the required sample size. (See note 6.1.) The material should be loosened carefully so that material from the underlying layer is not accidentally loosened and mixed in with the required material. Loosen enough material to obtain the minimum quantity required.

4.2 Sampling

4.2.1 The loosened material must be placed in suitable containers. If a single container is large enough to take the full quantity, then all the material from the sampling hole should be placed in it. If necessary, a small brush may be used to sweep all the fine material together before it is added to the sample.

4.2.2 When more than one container has to be filled, for instance when one small container has to be filled for indicator tests and two to three large containers for CBR tests, all the loosened material should be removed from the sampling hole and placed on a canvas sheet or hard, even surface. It should then be quartered with the aid of a riffler and/or quartering method so that each container that is filled with material will contain a representative sample of the material taken from the layer in the sampling hole.

4.2.3 When treated material is sampled for unconfined compressive strength tests, all the loosened material should immediately be placed in a sufficiently large drum and the lid should be put on to minimize moisture loss. (See note 6.2.)

4.3 Labeling of sample containers

Every sample container must be clearly and indelibly marked so that it can be identified in the laboratory. The label or reference must concur with the reference in the covering report ofsample data form which notifies the laboratory of the arrival of the samples.

5 REPORTING

The samples must be sent to the laboratory under cover of a properly composed report and data form. (See form TMH-2 in Method MA2).

Full details of each sample must be given and must contain at least the following information:

Name of the project.

Name of the sampler.

Date of sampling.

Stake value.

Centre line offset.

Depth of the layer.

Sample number and/or mark.

Number and type of container, and the numbers with which the containers are marked.

How sampled are being sent. (If the samples are being sent by train, bus or special transport, the information about the consignment should be given in a covering letter.)

Remarks: Any important information on the layer or the material in the road, particularly how the material was processed.

6 **NOTES**

6.1 If the layer to be sampled is covered by another layer, the latter should first be cleared away from an area larger than the area required for the test hole in the underlying layer. The sides of the test hole in the underlying layer must not touch the sides of the hole in the upper layer sot that no material from the upper layer gets mixed with the material from the sampled layer when the latter is being loosened.

6.2 Samples taken for unconfined compressive strength tests must be taken to the laboratory without delay so that test samples can be compacted as soon as possible. (See also Test Method A14 in TMH1.)

All other samples of cement- or lime-treated layers should be taken immediately after the stabilizing agent and water have been mixed in, and must be taken immediately to the nearest laboratory so that the tests can be done within the prescribed time limits.

6.3 Samples that are taken for the determinations of the moisture content of a material must be placed in a water-tight container as soon as they have been loosened, for example a bottle with a wide neck and a screw-cap and sealing ring, or a plastic flask with a top which forms a tight seal. The bottle or flask must be weighed **before** the container is opened. Once the mass has been determined, the container is opened so that the sample can be dried to determine the moisture content.

SAMPLING METHOD MC2

SAMPLING OF ASPHALT AND CONCRETE FROM A COMPLETED LAYER OR STRUCTURE

1 SCOPE

This method deals with the sampling of asphalt and concrete from a completed layer or structure by drilling it out with a diamond core drill or sawing out a sample with a power saw (only for layers of 200mm or less).

2 APPARATUS

2.1 A power drill capable of drilling out cores at right angles to the surface and which can be held firmly and perpendicularly while in use, equipped with a diamond bit 150 or 100 mm in diameter, a core barrel at least 300 mm long and a water supply under pressure to cool the bit, or
A hand-held power saw equipped with a high-speed carborundum, diamond or similar blade approximately 300 mm in diameter. (Only for layers of less than 100 mm. A blade with a larger diameter must be used for thicker layers.)

2.2 Suitable containers in which to transport the cores, such as plastic bags, tins or wooden boxes.

3 SAMPLE SIZE

3.1 **Drilled out samples:** A minimum diameter of 100 mm is recommended, depending on what tests are to be done on the sample and how thick the layer is.
For thin layers, or when the grading, binder content or cement content are to be determined, a core diameter of 150 mm is recommended.
For the determination of the compressive strength of concrete, the standard length of the cores is twice the diameter, which , in turn, should be four times the maximum coarse aggregate size.

3.2 **Sawn out samples:** The sample size will depend on the tests to be done on the sample. For density determinations, binder content determinations, etc, 150 mm square blocks are adequate. Concrete beams that are sawn out for the determination of flexural strength must be 150mm wide, 150mm thick and at least 530mm long.
Blocks of asphalt that are sawn out for the determination of fatique life must be at least 150mm wide and 300mm long.

4 METHOD

4.1 Drilling out of cores

Place the drill, equipped with the required bit, in position. Support the frame of the drill so that its weight is not resting on the wheels if it is mounted on a trailer, or dig or pack the frame in so that it rests solidly on the surface if it does not have wheels. Let down the bit until it rests on the surface and then adjust it so that it is exactly perpendicular to the surface.
Turn on the water supply and start drilling. The rate at which the drill penetrates the material will depend on the hardness of the material and on the condition of the bit. The rate must be such that the drill does not lose speed but neither must it turn too fast.
The water supply must be under sufficient pressure to wash out the borings an to cool the bit.

As soon as the desired depth has been reached, the drill must be withdrawn slowly while it is still turning slowly.

If the core comes away with the barrel, it mist be carefully removed by tapping the sides of the barrel lightly, taking care that the core does not suddenly fall out of the barrel.

Should the core remain in the hole, it mist be carefully loosened by inserting a suitable lever into the drill groove and wiggling the core free. Take care that the lever does not damage the sides of the core.

To ensure that the core will come away easily, it is preferable to drill in up to a level of separation between layers, e.e. the level between an asphalt layer and a gravel layer. If, for example, a sample of an asphalt surfacing overlying an asphalt base is required, it would be better to drill through the base as well and then to separate the two asphalt layers in the laboratory using a diamond saw.

Once the core has been removed, it must be packed carefully into a tin or wooden box so that it cannot break or deform.

4.2 Sawing out of samples

Use a hand-held power saw, or when it is necessary to saw in deeper that 100mm and the larger blade size makes a hand saw impractical, a saw equipped with wheels and a high-speed cutting blade or diamond blade. If a diamond saw is used, it should be cooled by a constant stream of water.

Saw out a block of material of the required size.

If a hand-held power saw is used, take care that the cut surfaces are straight and vertical without irregularities or steps.

Once the sides have been sawn through, the block must be carefully loosened by inserting a lever in the sawn groove.

The block must then be laid flat carefully in a wooden sample box. The blocks must be quite flat in the box to prevent deformation.

5 REPORTING

The samples must be properly labeled. A form container the following information must accompany them:
Number of the road, structure or layer, and contract.
Position of the core.
Description of the core.
Date of sampling.
Name of the sampler.
Tests to be done on the samples.

SAMPLING METHOD MD1

DIVISION OF A SAMPLE USING THE RIFFLER

1 **SCOPE**

This method describes the division or reduction of a sample of granular material by means of a riffler.

2 **APPARATUS**

2.1 A riffler with suitably sized openings (see paragraph 3.1) and complete with at least three catchpans. (See Figure 3.)

3 **METHOD**

3.1 **Choice of opening width**

Choose the opening width of the riffler as follows:

Maximum size of aggregate (mm) (whether graded or single-sized)	**Opening width (mm)**
25,0 or larger	37,5
13,2 – 25,0	25,0
6,7 – 13,2	13,2
less than 6,7	6,7

3.2 **Riffling**

The sample is placed in one of the riffler's catchpans and spread evenly along the length of the pan so that when the pan is inverted over the feeder tray all the openings received an equal quantity of material in an even stream. Shake the pan lengthwise from side to side.

Replace on or both the pans in which material has been caught after riffling with an empty pan(s) and add the divided material from one of the two pans to the feeder tray again in the same manner as before.

Repeat the procedure until a sample of the requires size is obtained.

3.3 If any lumps of material remain on top of the openings, they must first be sieved through a sieve of the appropriate size and then be quartered (see method MD2) until they have been quartered the same number of times as the rest of the material. Thereafter this material may be added to the rest of the sample.

4 **NOTES**

4.1 The importance of the opening widths is discussed in Chapter 7 (paragraph 1.1.1). When graded material is being divided and it is very important that the sample be representative, the sample my be divided into the fractions indicated in paragraph 3.1 by means of sieves and then riffled through the appropriate opening widths. Ensure that the **same number** of steps is taken when dividing each fraction.

4.2 When the sample contains dust, it must be poured through carefully so that the dust is not blown away. Tap the pans against the riffler at every stage of division to make sure that any dust which adheres will fall off.

FIGURE 3
THE RIFFLER

SAMPLING METHOD MD2

DIVISION OF A SAMPLE BY QUARTERING

1 **SCOPE**

This method describes the division of a sample of granular material by quartering.

2 **APPARATUS**

2.1 A flat spade.

2.2 A small canvas sheet.

3 **METHOD**

The dmethod is illustrated in Figure 4.

In this method the material is first thoroughly mixed on a hard, clean surface and then formed into a cone in the centre of the surface.

If the material is inclined to segregate, reform the cone so that the material is thoroughly mixed. Now flatten the cone and divide it into four even quarters and separate these from each other. Remove two opposite quarters and mix the two remaining quarters together again.

Repeat this process until a sample of the required size is obtained. (See notes 4.1 and 4.2.)

4 **NOTES**

4.1 If a hard, clean surface is not available, the quartering may be done on a canvas sheet. (See Figure 5.)

Mix the material on the canvas sheet with a spade, or mix it by picking up each corner of the sheet and pulling it over towards the opposite corner. Form a cone with the material and then flatten the cone. Divide again into four quarters.

If the surface under the sheet is too uneven, a pipe or rod can be inserted under the sheet directly beneath the middle of the cone. Both ends of the rod are then lifted, leaving the sample divided into two equal parts. Leave a fold of canvas between the two halves. Now repeat the process by inserting the rod at right angles to the previous division and lifting it so that four quarters are formed. Remove two opposite quarters and mix together the two remaining ones. Repeat the process until a sample of the required size is obtained.

4.2 If the material contains a lot of dust, the surface on which the quartering is done should be such that the dust will not be lost.

FIGURE 4
QUARTERING ON EVEN HARD CLEAN SURFACE

PART III

BACKGROUND TO SAMPLING AS APPLIED TO ROAD CONSTRUCTION MATERIALS

CHAPTER 4

RANDOM SAMPLING FOR ROAD CONSTRUCTION

QUALITY CONTROL

1 **SCOPE**

Random sampling is a statistically oriented process in which samples are taken from a lot in a predetermined pattern so that each part of the lot has an equal chance of being included in the sample. For practical reasons the procedure described here can only be applied to samples taken from a completed layer of a road.

2 **CHOICE OF LOT SIZE**

By definition a lot of a material is a discrete specific quantity of the material which can for all practical purposes be regarded as a separate entity and which does not inherently vary disproportionately in respect of the determining characteristics. (See Chapter 2, Definitions 3 and 4.)

In the case of a completed pavement layer, the lot size will therefore depend on the characteristic to be tested. For density control, a section which has been processed and compacted in a single operation will count as one lot. With asphalt, for example, a day's work can count as a lot. The choice of a lot size will therefore depend on the sampler's judgement, but must comply with the requirements set out in the definition.

3 **PROCEDURE**

Once the lot size has been decidedon, determine the length and width are recorded as L^1 and W^1 respectively.

Determine the number of samples to be taken by using the specified sampling frequencies or by referring to Chapters 6 and 7. The number of samples is recorded as N. Starting with the first column of the attached table of random numbers, write down the first N pairs of figures:

Calculte $L = L^1 – 0{,}40m$

$W = W^1 – 0{,}40m$

Now multiply the length L by every number in the first column, and the width W by every number in the second coumn of the N pairs of random numbers. Now arrange the product in column 1 in numerical sequence, keeping the pairs of numbers together. These numbers give the rest points measured from a point 0,20m from the beginning of the section along its length, and the corresponding distances measured from a point 0,20m from the side of the section over the width. (See paragraph 4.)

If only the distances along the length are required for a specific sample, only one column is used at a time.

When the next section is to be sampled, the next N pairs of figures are used, and so on until the whole table has been worked through. Thereafter begin again with the first column.

The table is used from the beginning again from each sample type.

4 **EXAMPLE**

Suppose that five Mod. AASHTO samples have to be taken and that five field desities have to be measure at the same places on a section of subbase 725 metres long and 12,8 metres wide.

Now take the first five pairs of random numbers from the table:

0,397	0.040
0,420	0,366
0,631	0,507
0,290	0,081
0,210	0,414

L = 725 – 0,4 = 724,6m

W = 12,8 – 0,4 = 12,4m

Multiply the first column of figures by L and the second column by W. This gives:

287,7	0,50
304,3	4,5
457,2	6,3
210,1	1,0
152,2	5,1

The tests are now done and samples taken at:

Distance from beginning of section*	**Distance from side***
152,2m	5,1m
210,1m	1,0m
287,7m	0,5m
304,3m	4,5m
547,2m	6,3m

*Measured in both cases from 0,2m from the beginning of the side of the section.

CHAPTER 5

ASSESSMENT OF TEST RESULTS THROUGH EVALUATION AND UNDERSTANDING OF THE SAMPLE TAKEN

1 INTRODUCTION

This section is intended to give the theoretical background to sampling, and **to enable the user to determine the real value of a test result.**

2 THE DEGREE OF REPRESENTATION OF A SAMPLE

A sample of a material is usually a part of the relevant material. When a material needs to be tested, it would be ideal if all the material could be tested. However, this is impractical for most materials, and therefore only a sample is tested. (See Definition 1.)

For example, it would be possible to dig up a spadeful of soil and to declare that it is a sample of the earths surface. Of course that is true, but the degree of representation of such as sample would be negligible and unacceptable.

It is theoretically impossible to take a representative sample of the earth's surface because there are too many differences between the various types of material. However, it is possible to single out a certain portion whose characteristics do not vary so greatly and to take a representative sample of this portion (lot).

For example, it would be relatively easy to take a representative sample of desert sand from a desert because the determining characteristics of a desert sand do not differ greatly. (See Definitions 2,3 and 4.)

It should be clear from this paragraph that a sample is not automatically representative and that it is extremely important always to be aware of the degree of representation of a sample.

3 CHANGES IN A SAMPLE

A representative sample is a part of the relevant material whose characteristics one has ensured will be representative of the characteristics of the whole lot or quantity of material from which the sample is taken.

It is logical that the method of sampling should not change the determining characteristics of the material. If an auger were used to take a sample of gravel, it could break up the material to such an extent that the grading of the material would be completely changed.

At the same time, it is very important to bear in mind that not only the method of sampling but also the way in which the sample is packed and transported can affect the determining characteristics of a sample.

It is also important to realize that there are determining characteristics of a material.

(a) These may remain constant over a period of time. Such a sample is said to have **constant determining characteristics.** (See Definition 17.)

(b) These may always be **in the process of changing** despite all normal precautions. This applies, for example, to a concrete cube or other stabilized material. Such a sample is said to have **changing characteristics.** (See Definition 18.)

(c) These may normally remain constant but may have been changed artificially or by some external influence, and therefore are no longer as they were originally. (See Definition 19.) Such a sample is termed a changed sample. This applies, for example, to a sample of bitumen emulsion. Although it is a changed sample, we **accept** it if it can be tested quickly enough for the determining characteristics to have remained constant. If, however, it is kept too long, it becomes a changed sample because its determining characteristics have changed too greatly in the course of time.

It should be clear from this paragraph that

(a) *one should always consider whether any action could affect the determining characteristics of the sample;*

(b) *in the case of a changed sample it is important to establish the period within which the sample's characteristics should be determined, and also to take this fact into account when evaluating the test results.*

4 MIXING OF LOTS OF MATERIAL

The greater the inherent variation in a material's characteristics, the larger the number of single samples that need to be taken to obtain a compound sample which can be regarded as truly representative. The more continuous and homogenous the characteristics of a material, the smaller the relative size of a representative sample will be.

The more the characteristics of a lot of a material vary, the more single samples will have to be taken to cover all the variations in the characteristics. For example, a material such as steel whose characteristics vary very little will only need a simple chemical and physical analysis from which practically all its characteristics can be predicted. It is therefore easier to determine the characteristics of a homogeneous material, and a smaller sample can be accepted as being representative.

A sampler should at all times be aware of the fact that in a large quantity of material there is nearly always a mixture of materials. This fact always has to be considered when natural road construction materials are sampled. It is usually impossible to take a completely representative sample of such a mixture of materials. If every different type of material in the mass could be marked off or separated, it would be possible to take a representative sample of **every aspect or type of material.** We term this sample of every type in a large quantity of material (such as gravels from a borrow pit) **a single sample.** (See Definition 13.)

When unknown masses or quantities of different materials are mixed with each other, an **approximate mean sample** of the materials can be obtained by taking single samples according to a predetermined fixed pattern. (See Definition 16.)

Although a sampler often has not choice other than to take a mean or approximate mean sample, the value of such a sample is limited. In such circumstances the uninformed person always blames the tester or sampler for the poor degree of representation of his sample – despite the fact that the sampler often has no choice.

The monitoring of layer densities illustrates this problem quite well.

The material comes from a borrow pit which **always** consists of a series of mixed materials. The materials are loaded from one side and end up in undefined groups or lots in a road layer. If an **approximate mean sample** is taken by sampling at regular distances along the length of the layer, mixing all the samples together, and then determining the optimum density of this approximate mean sample and the densities at various points, the relative compaction indices will of necessity vary greatly. The only solution is to take single samples at every point and therefore to determine a separate optimum density for every field density.

Note from the explanations in this paragraph that sampling of mixtures of materials (and it is often difficult visually to determine whether a mass of material consists of a mixture of materials in respect of their determining characteristics is much more difficult and complicated than sampling of a homogeneous material.

If one examines the definition of a lot carefully, one may deduce that a length of gravel layer in a road cannot really be a sampling lot – because the determining characteristics often vary disproportionately from point to point along the layer. (See Definition 3.)

Therefore, when sampling lots are mixed the sampler can:

(a) *sometimes regard a point I nthe material as a lot, and sample, test and evaluate it;*

(b) *sometimes take an approximte mean sample and test and evaluate it accordingly, bearing in mind that such a method inherently yields a poor degree of representation;*

(c) *where possible, mix the total mass of material thoroughly, thus obtaining a new lot which – because of the new artificial homogeneity of characteristics – can now be sampled, tested and evaluated on a better basis.*

5 INFLUENCE OF CHARACTERISTICS AND STORAGE ON SAMPLING

The material characteristics that are important or determining for our purposes usually determine the manner in which a representative sample is taken. For example, when the moisture in a layer being compacted has to be determined, the loss of moisture through evaporation must be kept to an absolute minimum during sampling and transport of the sample.

It is quite meaningless to take a sample if the sampler does not know what characteristics of the material are to be tested or what the determining characteristics of the material are.

If drinking water was to be tested for bacteria, for example, the test would be quite useless if an unsterilized container was used for the sample. Similarly, if the moisture content of a soil core was to be determined, it would be foolish to transport the core in a core box.

The type of appearance, position or manner of storage of the material involved must necessarily affect the choice of sampling method. For example, compare the method used for sampling aggregate from a stockpile with the method used for sapling aggregate from a stockpile with the method used for sampling it from the conveyor belt of a crusher.

It is therefore important to know what tests are going to be done on the sample, and also to know in what quantity and manner the material is stored before a sampling plan can be worked out.

6 SAMPLING SIZES

The size of the sample to be taken is important and sometimes leads to insurmountable problems if it is not approached by working out a proper plan. The sampler will gain little by working out the size of the sample he intends to take by some elegant formula if the test which to be done will only use a very small quantity of that material.

It is therefore very important to find out not only the required size of the initial sample, but also the **number** tests which will need to be done to ensure that the sample is representative.

The physical characteristics of the type of material being sampled also affect the sample size. For example, a liquid can usually be adequately represented by a small sample because its components can easily be well mixed.

A plan for determining what size sample needs to be taken always includes determining the minimum and maximum sample sizes. (See Definitions 5 and 6)

The minimum sample size and the number of tests that need to be done are determined by:

(a) The variation of the determining characteristics of the material.

(b) The relative importance of the material in the construction and the costs involved.

(c) The lot size of the material.

(d) The quantity of material needed for the particular tests to be carried out.

(e) The necessary accuracy of the test results, which in turn is determined by the relative importance of the material and the costs involved.

The maximum sample size is usually limited by practical considerations, such as those below.

(a) When a sample is difficult to handle, the operator will be inclined to work less accurately.

(b) In virtually every test the quantity of material used is fixed and predetermined. Depending on the number of tests to be done, the quantity required is also more or less fixed. Usually enough material is taken for the test to be repeated, unless the sample becomes too large to be practical.

(c) It must, however, be realized that the size of the original sample taken is determined by the degree of representativeness required. Usually the initial sample is a very large quantity of material which is divided up on site into a manageable laboratory sample. (See Definitions 7,8 and 9.)

To sum up, it is clear that:

(a) the filed sample size or initial sample size is determined by the degree of representation required;

(b) the size of the secondary (laboratory) sample is determined both by the practical considerations and by the size of the test sample as well as the number of tests to be done;

(c) the size of the test sample is usually laid down by the test instructions;

(d) it is critically important to ensure representativeness when a test sample is obtained from the laboratory sample;

(e) when a test sample consists of only a small quantity of material, representativeness can be improved by testing more samples from the secondary sample;

(f) before a sample is taken, the sample size needed should be planned.

7 DESTRUCTIVE METHODS

Tests done on material may be **destructive** or **non-destructive.**

Sometimes a destructive test is not wholly but only partially destructive, with the result that the material is still usable after the test.

Non-destructive testing is ideal because the determining characteristics of the material are tested without any weakening effect. For example, the use of X-rays to test a welding joint in a pressure tank makes it possible to test the entire lot (that is all the welding joints) without in any way damaging the tank.

In non-destructive testing, the sampling process is of course also non-destructive. Any designer of sampling and test methods will always aim at implementing non-destructive methods. However, it is usually impossible to design methods which do not do any damage.

It is very important in any situation to consider whether, where destructive methods are to be applied, the amount of damage done does not outweigh the knowledge that can be gained from the tests. Repairs must be done immediately after destructive sampling to prevent further damage.

8 REPRODUCIBILITY AND REPEATABILITY

When different operators test or sample a material according to a set of instructions, the results obtained always differ to some extent because of human interpretation of human error. The more difficult and complicated the test, the greater the opportunities for errors of human judgement. This inherent deficiency in every test or sampling method is measureable and is known as the **reprocucibility of the method.** (See Definition 11.)

When the same operator repeats a method on the same material, the results obtained may also differ. Since it is statistically possible to accept that in these circumstances the human influence remains the same (this is not **always** true), it can be accepted that his gives an indication of the accuracy of that particular method. This accuracy of a method is measureable and is know as the **repeatability of the method.** (See Definition 12.)

9 SUMMARY

The benefit gained from the knowledge made available to the investigator by sampling and testing is usually not measurable, yet it is valuable. We would today be lost without sampling techniques (consider blood tests, for example).

The greater the variations in the determining characteristics of a material, however, the larger the compound sample will need to be, the more difficult it is to obtain a representative sample, the more expensive the testing process and the less accurate the deductions that can be made. Since the sample is not the cause of these vatiations in the material, he cannot be blamed for the poor repeatability of tests on road construction materials. Where this variation is known, it must be provided for in the design of, and also in the control over, the test.

However, the sampler must be aware that he is carrying a great deal of responsibility when he takes a sample.

CHAPTER 6

DETERMINATION OF SAMPLE SIZE AND SAMPLE DENSITY

1 INTRODUCTION

This part of the manual is meant to be elucidate the more general ideas involved in sampling and is mainly intended for training purposes. The ideas which will be discussed here will, however, not normally be repeated in the straightforward methods given for every test. (See Chapter 3)

2 SAMPLING FREQUENCY

Whenever samples are taken the sampling frequency must be determined beforehand.

There are statistical methods by which one can determine what sample size (number of single samples) will be needed to ensure a specific degree of accuracy. These methods are not covered in this publication.

However, it is not always possible to comply with the prescribed accuracy simply because it would be too expensive. In such cases the specified accuracy must be relaxed until the costs involved are justified in those particular circumstances.

The sampling plan therefore consists of the following steps:

(a) Decide on the degree of accuracy required.

(b) From this, decide on the sampling frequency needed.

(c) Calculate the costs involved.

(d) Adjust the specification to the degree of accuracy, and recalculate the sampling frequency if the costs are too high.

4 CHOICE OF SAMPLES AND SAMPLE UNITS

3.1 If a particular characteristic (or characteristics) of a lot or process is to be evaluated by means of samples, these samples must be taken in a random manner. Randomness, however, does not imply that samples are taken haphazardly. It is definite attempt to prevent samples from being taken according to some predetermined pattern. A random sample is usually taken according to a set of random numbers.

3.2 In order that a random sample may be taken, the lot must be divided into sample units. Drums of bitumen do not present a problem since each drum may be regarded as a sample unit.

A pavement layer of a road can be theoretically divided into blocks of 1 x 1m so that every square metre counts as a sample unit.

When aggregate is stockpiled, the problem becomes much more difficult. The easiest solution would be to divide up the pile into segments, starting from the centre – as one would cut up a round cake from the middle. However, in all cases the lot has, unavoidably, to be divided into sample units in some way, and every unit has then to be represented by a number.

3.3 The variation in characteristics determines whether a quantity of material can be represented by a mean sample. If, for example, a thankful of tar has been well circulated and then divided up into sample units, the variation between the units will be so small that it would be acceptable to throw all the samples together and then test a mean sample.

The position with stockpiled aggregate is quite different. When the pile is divided up into sample units, it will be found that the variation between the characteristics of the different units is so great that it is simply not justifiable to put together a mean sample. Since there is no way in which the pile can be mixed into a homogenous material, it is logical that every different variation needs to be evaluated separately because the aggregate will be used in the road in this condition.

This idea will be easier to understand if one bears in mind that a pile of aggregate is formed by individual loads dumped

next to one another, so that every load is still distinguishable.
Assume that every load is a sample unit. If one took a number of samples and put together a compound sample, the result of the test would tell one virtually nothing. However, if every sample unit (load) were tested separately, one would determine to what extent the aggregate complies with the specification as well as what degree of variation occurs. Then, when the loads are reloaded and used in the road one would know (at every specific point of the layer) whether the aggregate complied with the specification.

Note: Road construction materials can very seldom be represented by a compound or mean sample.

CHAPTER 7

DIVISION, MARKING AND PROPOSED FREQUENCY OF SAMPLES

1 THE REDUCTION OR DIVISION OF A SAMPLE

When a sample is too large and it has to be reduced for some purpose, this must always be done in a scientific manner.

When a large sample has to be divided into a number of smaller samples, this must also be done scientifically.

Once a sample has been divided, one may not simply "round it off" to a convenient size.

The apparatus needed and the methods to be followed for division depend on the type of material to be divided and on the size of the sample.

1.1 The division of granular material

Granular material must be as dry as possible to prevent the grains from sticking to one another.

These are two main methods for division, namely use of the riffler and the quartering method. The latter method is usually applied when a sample is larger than the quantity that can be contained in two riffler pans, otherwise it is preferred that the riffler always be used.

1.1.1 The riffler method

This is an easy method meeding little in the way of apparatus. Refer to Sampling Method MD2 for the procedure that should be followed.

1.2 The division of liquids

Liquids with high fluidity (low viscosity) usually mix very well, so that only a small error is made when the liquid is well mixed and a sample is taken immediately after mixing.

However, these liquids may also be divided as for liquids with a low fluidity.

In the case of liquids with a low fluidity, such as bituminous products, mixing is difficult and it is advisable to attempt division without mixing.

These liquids can usually be heated to a **limited extent** to increase their fluidity.

Division can be effected by placing four square containers of equal size together in a square within a larger, flat container or pan. The sample of liquid is then poured onto the centre of this square so that each container receives a more or less equal quantity of liquid. Thereafter the liquid in the two diagonally opposite continers is removed and that in the remaining two is poured together again to give a smaller sample. This process is repeated until a sample of the required size is obtained.

Notes:

(i) It is important to remember that bituminous materials oxidize more quickly under such exposed and heated conditions.

(ii) The square containers may be replaced by round ones such as glass beakers, in which case the liquid must be poured in a thin stream, using a circular motion and a steady rate of movement, so that it just touches the points of contact between the beakers.

2 SAMPLE CONTAINERS

(a) Generally sample containers must be chosen with care so that there is no risk that they will change the determining characteristics of the samples. Sample containers must always be clean. Often it is not worthwile cleaning a sample container and it is usually justifiable to use a new container for each sample.

With regard to cleanliness, the same comments apply to rifflers, hands, gloves, the covers and stoppers of containers and all other equipment used for sampling.

(b) Volatile substances, hygroscopic substances and substances affected by air or light must be protected against the particular influence that they are susceptible to during and after sampling. Use airtight containers.

(c) Sample containers must be such that a portion of the material cannot be lost from them. Tansporting a sand sample in a hessian sack, for instance, is just as senseless as trying to transport water in a sack.

(d) When a sample container is opened it **must** be closed again as soon as possible and care must be taken to see the identity marks are not destroyed or made illegible in the process.

(e) Samples that are affected by moisture must always be kept in watertight containers.

3 PRECAUTIONS TO BE OBSERVED DURING SAMPLING

3.1 When a sample is being taken, the sampler must ascertain the following:

(a) Is the material poisonous or narcotic?

(b) Is the material corrosive or does it stain?

(c) Is the material easily flammable?

(d) Is the material hot (or very cold)?

(e) Does the material give off gasses that exhibit one or more of the characteristics mentioned above?

(f) Is the material under great pressure?

3.2 It is extremely important to realise that a container may have been accidentally filled with a substance other than that stated on the label. A sampler may therefore **never** be careless.

3.3 When large quantities of liquid are sampled, or when a hazardous or hot material is sampled, two people should be present in case of a mishap.

3.4 Sampling may only be done from a position on top of a vehicle is properly braked and that it is impossible for the vehicle to begin moving of its own accord while the sample is being taken. The driver or person in charge of the vehicle must be aware that sampling is taking place so that he does not begin to operate the vehicle.

3.5 When samples are taken near moving machinery, such as a crusher or a layer that is being compacted or in a borrow pit in which material is being loosened or loaded, the sampler must make sure that the operators are aware of his presence. He must also display common sense in keeping himself and his assistants out of danger.

3.6 When a consignment appears suspect for one of the following reasons, receipt thereof must be postponed until it has been ensured that everything is in order. Examples of when samples may be suspect are:

(a) When the container is damaged or defective.

(b) When it is not certain what is in the container because of the presence of old labels, incorrect labels or no labels at all.

(c) When there are noticeably suspect non-uniformities such as great unexpected differences in colour, or a layer of water on some containers.

(d) When anything else is noticed that could indicate that something is wrong.

4 THE MARKING, LABELLING AND REFERENCE TO SAMPLES

4.1 A sample whose origin cannot be established beyond doubt is of absolutely no value. The golden rule here will be: *Rather do not take a sample at all than mark it inadequately.*

A sampler wastes both his own time and that of others if he dispatches unmarked samples. Obviously, if the label or other identifying marks are lost or otherwise destroyed in transit, this is just as frustrating and futile.

It cannot be overemphasized that the marking of a sample must be:

(a) complete and clear;

(b) neat and legible;

(c) lasting, substantial and indelible.

4.2 The sample container must be marked indelibly with a serial number, such as: An appropriate letter or form must then be sent to the receiver of the sample. It must provide all the necessary information with reference to the serial number, such as:

(a) Origin of the sample: the place, district, road or bridge and stake value.

(b) Name of the supplier, manufacturer or tenderer.
(c) Names of the dispatcher, sampler, supplier and requester of the sample.
(d) Motive for sampling: Is it routine checking? Is it suspected that the material does not comply with the specifications?
Does the material behave in a deviant or unexpected manner? Is there a dispute about the quality of the material?
(e) Instructions to the recipient: Must the sample be stored for reference? What tests must be done on it? Is the matter urgent? Is the result important? Is there a deadline for the result?
(f) Are there any special circumstances regarding the material that the recipient should know of? For example, is this the only available sample? Has some or other chance occurrence changed the properties of the material? Has it been treated with any agent or contaminated by something? Has it been overheated? Has it been standing for a long time? Is it a new product? Have some of its properties changed since delivery?
(g) Indication of storage: Was it taken from a pile, truck, drum, a road layer or a borrow pit?

5 FREQUENCY OF SAMPLING IN ROAD CONSTRUCTION

The frequency with which samples are taken are closely related to the specific purpose for which the samples are required.

5.1 Sampling frequencies for process control

Process control is the control excercised by the contractor over his manufacturing process, so that he can be sure that he will notice in time when something goes wrong with the process and this be albe to rectify the situation with as little damage as possible.
Process control therefore does not necessarily bear any relation to acceptance control (see paragraph 5.2), although it is generally the case that the result of process control can be taken into account for acceptance control.
Process control is essential because the onus is always n the contractor to ensure that the materials used in the road comply with the specifications.
It is clear that process and acceptance control should overlap s little as possible, and that only the minimum number and the most necessary tests should be done during process control is normally in the interests of the contractor, the choice as to the type and amount of control he applies should be left largely up to him.
When a statistical plan is used for process control, more tests will normally be required to make the application of statistics possible. Normally the manufacturing process in road construction is such that process control cannot be done on a statistical basis.

5.2 Sampling frequencies for acceptance control

Acceptance control is the control exercised by or on behalf of the client to ensure that the product supplied to him complies with the specifications. The product will be accepted or rejected on the strength of this control.
Acceptance control can be done on a statistical basis, particularly on large contracts where a fairly large quantity of the product is presented simultaneously for evaluation.
In the case of smaller contracts, it is often unrealistic to try to apply statistical principles.

5.3 Minimum sampling frequencies

The minimum sampling frequencies given in Table 7.1 are intended as a guide. It is impossible to make definite suggestions for every possible set of circumstances, and it will always be necessary to make some adjustments for each individual case. Note that these are minimum frequencies – normally more samples will be needed.