1.3 Sampling

It is not possible or desirable to test all the raw material or all the final output from a production process because of time and cost constraints. Also many tests are destructive so that there would not be any material left after it had been tested. Because of this, representative samples of the material are tested. The amount of material that is actually tested can represent a very small proportion of the total output. It is therefore important that this small sample should be truly representative of the whole of the material. For instance if the test for cotton fibre length is considered, this requires a 20 mg sample which may have been taken from a bale weighing 250 kg. The sample represents only about one eleven-millionth of the bulk but the quality of the whole bale is judged on the results from it.

The aim of sampling is to produce an unbiased sample in which the proportions of, for instance, the different fibre lengths in the sample are the same as those in the bulk. Or to put it another way, each fibre in the bale should have an equal chance of being chosen for the sample [1].

1.3.1 Terms used in sampling

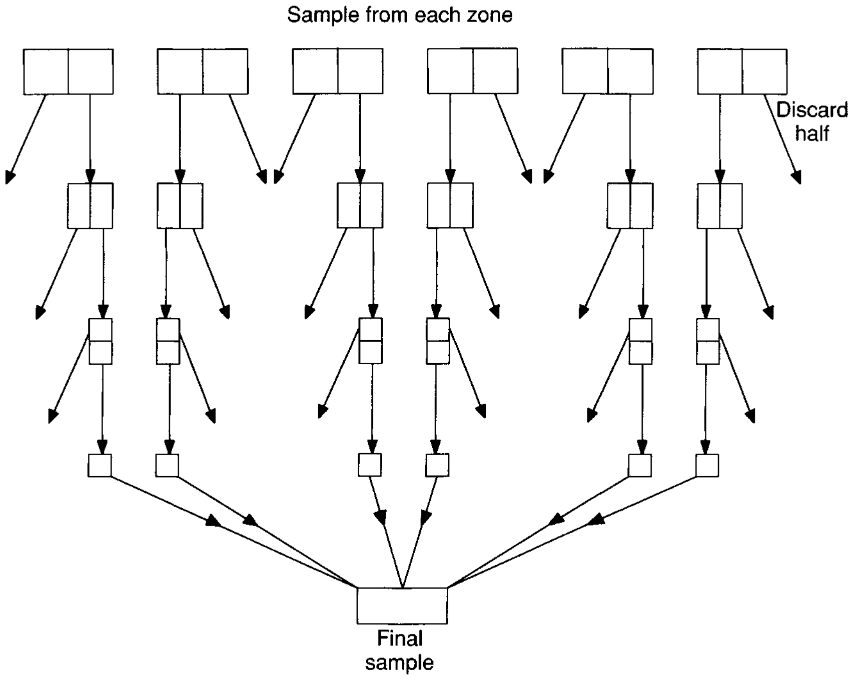
Several of the terms used in sampling have different meanings depending on whether wool or cotton, yarn or fibre is being sampled. This is due to the different representative organisations which have historically grown around each industry. The appropriate standard should always be consulted [1–4]:

- **Consignment**: this is the quantity of material delivered at the same time. Each consignment may consist of one or several lots.
- **Test lot or batch**: this consists of all the containers of a textile material of one defined type and quality, delivered to one customer according to one dispatch note. The material is presumed to be uniform so that this is the whole of the material whose properties are to be characterised by one set of tests. It can be considered to be equivalent to the statistical population.
- **Laboratory sample**: this is the material that will be used as a basis for carrying out the measurement in the laboratory. This is derived by appropriate random sampling methods from the test lot.
- **Test specimen**: this is the one that is actually used for the individual measurement and is derived from the laboratory sample. Normally, measurements are made from several test specimens.
- **Package**: elementary units (which can be unwound) within each container in the consignment. They might be bump top, hanks, skeins, bobbins, cones or other support on to which have been wound tow, top, sliver, roving or yarn.
- **Container or case**: a shipping unit identified on the dispatch note, usually a carton, box, bale or other container which may or may not contain packages.

1.3.2 Fibre sampling from bulk

Zoning

Zoning is a method that is used for selecting samples from raw cotton or wool or other loose fibre where the properties may vary considerably from place to place. A handful of fibres is taken at random from each of at least 40 widely spaced places (zones) throughout the bulk of the consignment and is treated as follows. Each handful is divided into two parts and one half of it is discarded at random; the retained half is again divided into two and half of that discarded. This process is repeated until about n/x fibres remain in the handful (where n is the total number of fibres required in the sample and x is the number of original handfuls). Each handful is treated in a similar manner and the fibres that remain are placed together to give a correctly sized test sample containing n fibres. The method is shown diagrammatically in Fig. 1.1. It is important that the whole of the final sample is tested.



1.1 Sampling by zoning.

Core sampling

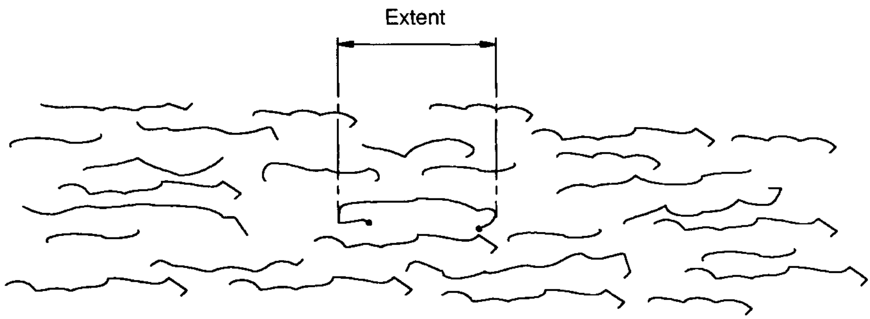
Core sampling is a technique that is used for assessing the proportion of grease, vegetable matter and moisture in samples taken from unopened bales of raw wool. A tube with a sharpened tip is forced into the bale and a core of wool is withdrawn. The technique was first developed as core boring in which the tube was rotated by a portable electric drill. The method was then developed further [5] to enable the cores to be cut by pressing the tube into the bale manually. This enables samples to be taken in areas remote from sources of power.

The tubes for manual coring are 600 mm long so that they can penetrate halfway into the bale, the whole bale being sampled by coring from both ends. A detachable cutting tip is used whose internal diameter is slightly smaller than that of the tube so that the cores will slide easily up the inside of the tube. The difference in diameter also helps retain the cores in the tube as it is withdrawn. To collect the sample the tube is entered in the direction of compression of the bale so that it is perpendicular to the layers of fleeces. A number of different sizes of nominal tube diameter are in use, 14, 15 and 18 mm being the most common the weight of core extracted varying accordingly. The number of cores extracted is determined according to a sampling schedule [6] and the cores are combined to give the required weight of sample. As the cores are removed they are placed immediately in an air-tight container to prevent any loss of moisture from them. The weight of the bale at the time of coring is recorded in order to calculate its total moisture content.

The method has been further developed to allow hydraulic coring by machine in warehouses where large numbers of bales are dealt with. Such machines compress the bale to 60% of its original length so as to allow the use of a tube which is long enough to core the full length of the bale.

1.3.3 Fibre sampling from combed slivers, rovings and yarn

One of the main difficulties in sampling fibres is that of obtaining a sample that is not biased. This is because unless special precautions are taken, the longer fibres in the material being sampled are more likely to be selected by the sampling procedures, leading to a length-biased sample. This is particularly likely to happen in sampling material such as sliver or yarn where the fibres are approximately parallel. Strictly speaking, it is the fibre extent as defined in Fig. 1.2 rather than the fibre length as such which determines the likelihood of selection. The obvious area where length bias must be avoided is in the measurement of fibre length, but any bias can also have effects when other properties such as fineness and strength are being mea-



1.2 The meaning of extent.

sured since these properties often vary with the fibre length. There are two ways of dealing with this problem:

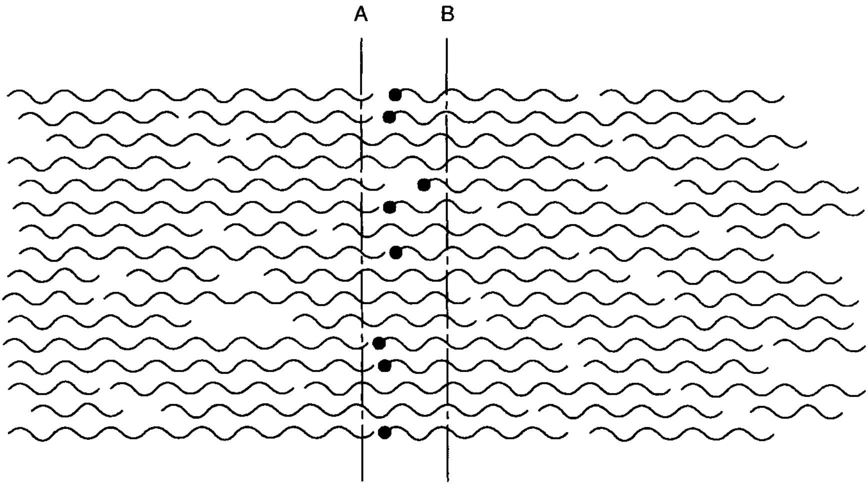
1 Prepare a numerical sample (unbiased sample).
2 Prepare a length-biased sample in such a way that the bias can be allowed for in any calculation.

Numerical sample

In a numerical sample the percentage by number of fibres in each length group should be the same in the sample as it is in the bulk. In Fig. 1.3, A and B represent two planes separated by a short distance in a sample consisting of parallel fibres. If all the fibres whose left-hand ends (shown as solid circles) lay between A and B were selected by some means they would constitute a numerical sample. The truth of this can be seen from the fact that if all the fibres that start to the left of A were removed then it would not alter the marked fibres. Similarly another pair of planes could be imagined to the right of B whose composition would be unaffected by the removal of the fibres starting between A and B. Therefore the whole length of the sample could be divided into such short lengths and there would be no means of distinguishing one length from another, provided the fibres are uniformly distributed along the sliver. If the removal of one sample does not affect the composition of the remaining samples, then it can be considered to be a numerical sample and each segment is representative of the whole.

Length-biased sample

In a length-biased sample the percentage of fibres in any length group is proportional to the product of the length and the percentage of fibres of

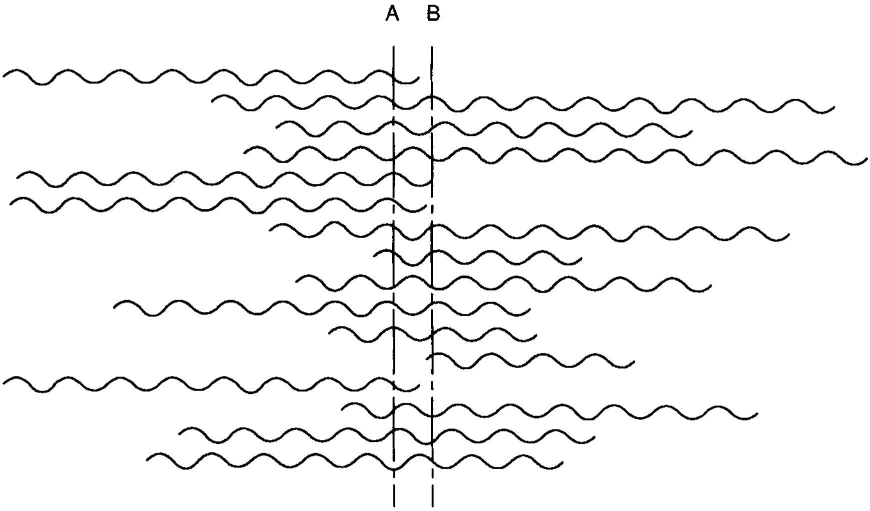


1.3 Selection of a numerical sample.

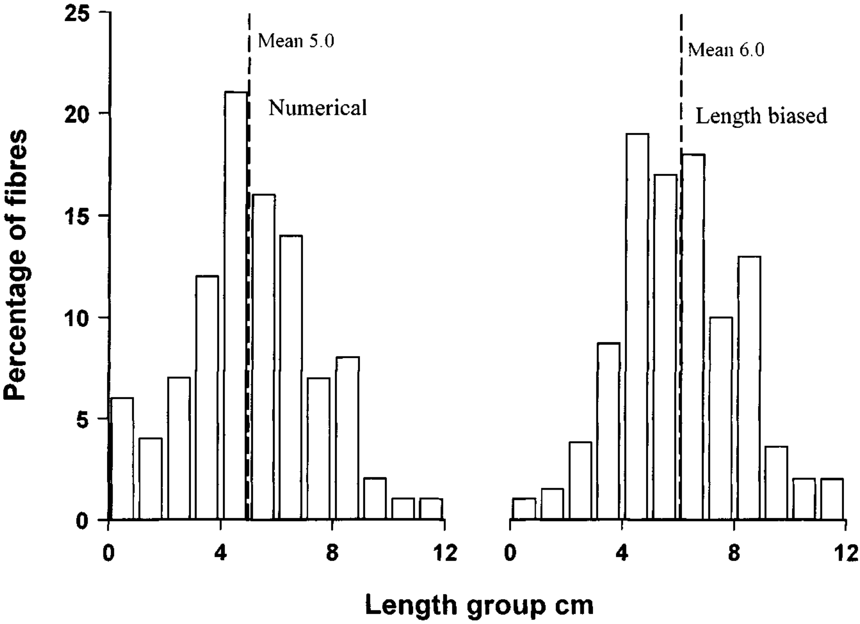
that length in the bulk. The removal of a length-biased sample changes the composition of the remaining material as a higher proportion of the longer fibres are removed from it.

If the lines A and B in Fig. 1.3 represent planes through the sliver then the chance of a fibre crossing these lines is proportional to its length. If, therefore, the fibres crossing this area are selected in some way then the longer fibres will be preferentially selected. This can be achieved by gripping the sample along a narrow line of contact and then combing away any loose fibres from either side of the grips, so leaving a sample as depicted in Fig. 1.4 which is length-biased. This type of sample is also known as a tuft sample and a similar method is used to prepare cotton fibres for length measurement by the fibrograph. Figure 1.5 shows the fibre length histogram and mean fibre length from both a numerical sample and a length-biased sample prepared from the same material [7].

By a similar line of reasoning if the sample is cut at the planes A and B the section between the planes will contain more pieces of the longer fibres because they are more likely to cross that section. If there are equal numbers of fibres in each length group, the total length of the group with the longest fibres will be greater than that of the other groups so that there will be a greater number of those fibres in the sample. Samples for the measurement of fibre diameter using the projection microscope are prepared in this manner by sectioning a bundle of fibres, thus giving a length-biased sample. The use of a length-biased sample is deliberate in this case so that the measured mean fibre diameter is then that of the total fibre length of the whole sample. If all the fibres in the sample are considered as being



1.4 Selection of a tuft sample.



1.5 Histograms of length-biased and numerical samples.

joined end to end the mean fibre diameter is then the average thickness of that fibre.

Random draw method

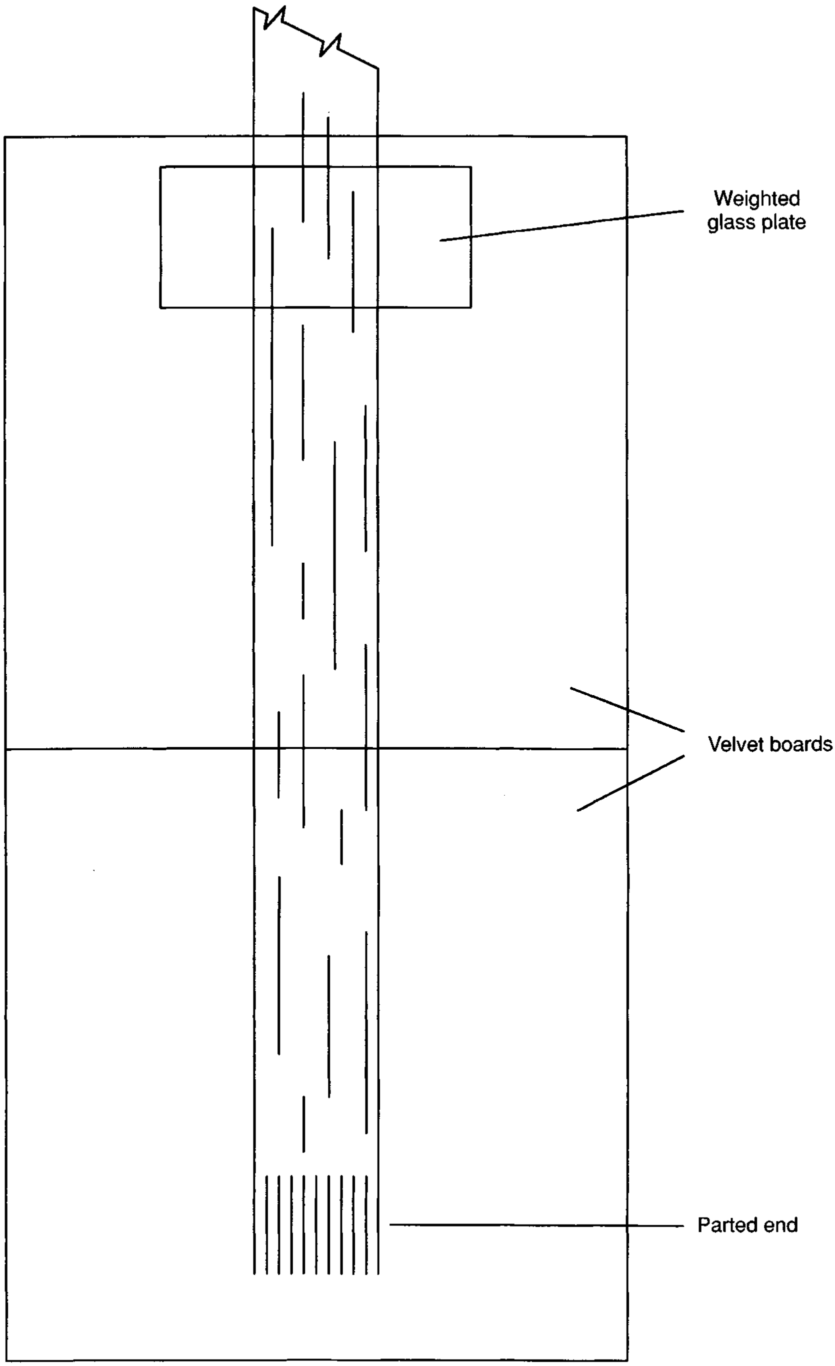
This method is used for sampling card sliver, ball sliver and top. The sliver to be sampled is parted carefully by hand so that the end to be used has no broken or cut fibres. The sliver is placed over two velvet boards with the parted end near the front of the first board. The opposite end of the sliver is weighed down with a glass plate to stop it moving as shown in Fig. 1.6. A wide grip which is capable of holding individual fibres is then used to remove and discard a 2mm fringe of fibres from the parted end. This procedure is repeated, removing and discarding 2mm draws of fibre until a distance equal to that of the longest fibre in the sliver has been removed. The sliver end has now been 'normalised' and any of the succeeding draws can be used to make up a sample as they will be representative of all fibre lengths. This is because they represent a numerical sample as described above where all the fibres with ends between two lines are taken as the sample. When any measurements are made on such a sample all the fibres must be measured.

Cut square method

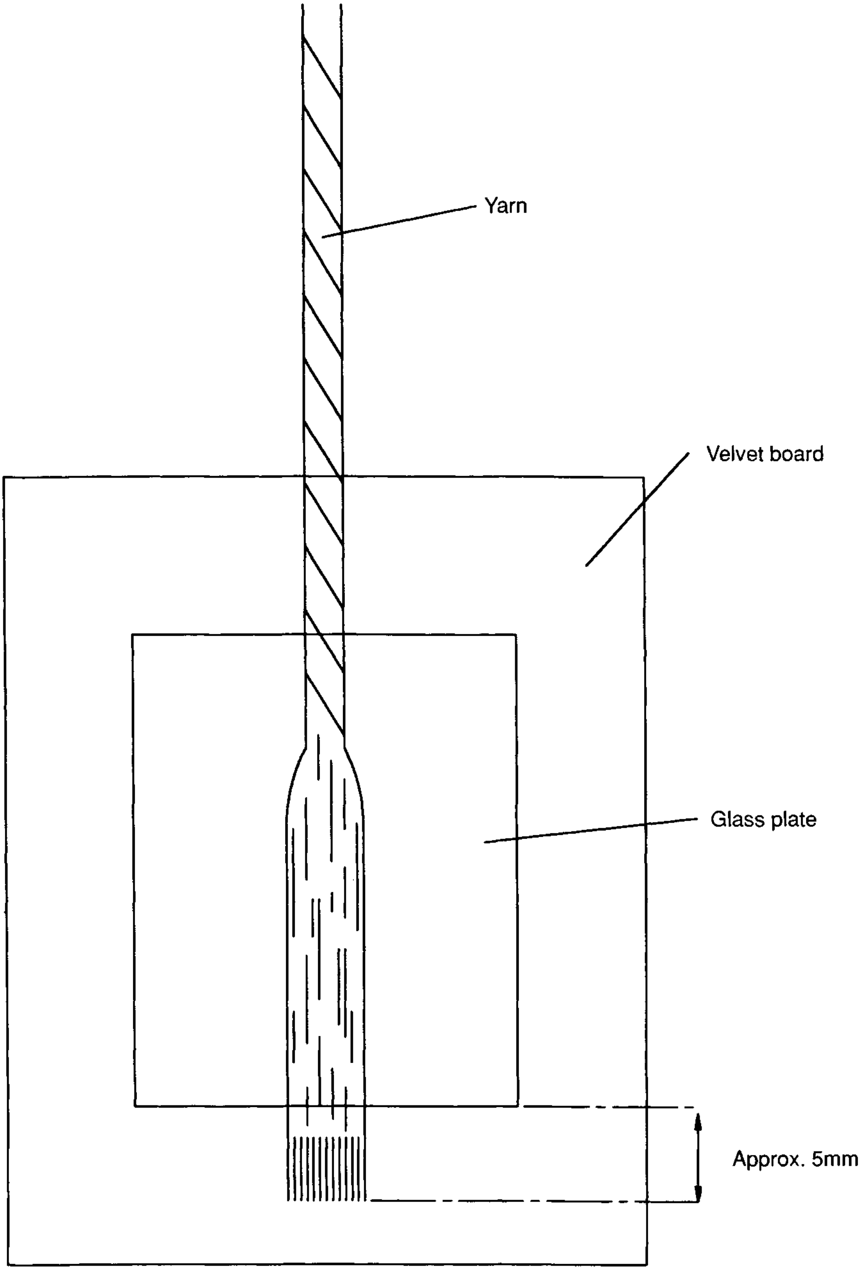
This method is used for sampling the fibres in a yarn. A length of the yarn being tested is cut off and the end untwisted by hand. The end is laid on a small velvet board and covered with a glass plate. The untwisted end of the yarn is then cut about 5mm from the edge of the plate as shown in Fig. 1.7. All the fibres that project in front of the glass plate are removed one by one with a pair of forceps and discarded. By doing this all the cut fibres are removed, leaving only fibres with their natural length. The glass plate is then moved back a few millimetres, exposing more fibre ends. These are then removed one by one and measured. When these have all been measured the plate is moved back again until a total of 50 fibres have been measured. In each case once the plate has been moved all projecting fibre ends must be removed and measured. The whole process is then repeated on fresh lengths of yarn chosen at random from the bulk, until sufficient fibres have been measured.

1.3.4 Yarn sampling

When selecting yarn for testing it is suggested [8] that ten packages are selected at random from the consignment. If the consignment contains more than five cases, five cases are selected at random from it. The test



1.6 The random draw method.

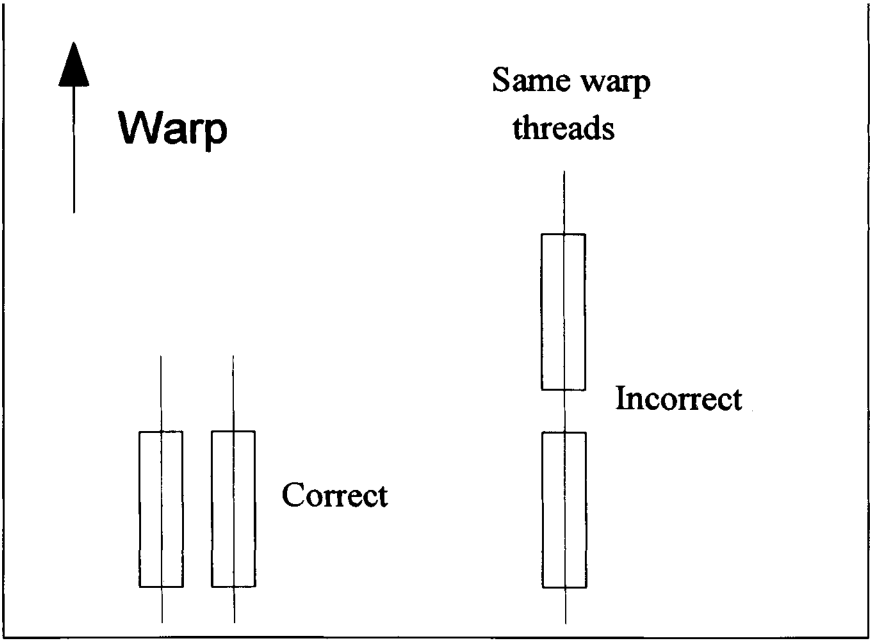


1.7 The cut square method.

sample then consists of two packages selected at random from each case. If the consignment contains less than five cases, ten packages are selected at random from all the cases with approximately equal numbers from each case. The appropriate number of tests are then carried out on each package.

1.3.5 Fabric sampling

When taking fabric samples from a roll of fabric certain rules must be observed. Fabric samples are always taken from the warp and weft separately as the properties in each direction generally differ. The warp direction should be marked on each sample before it is cut out. No two specimens should contain the same set of warp or weft threads. This is shown diagrammatically in Fig. 1.8 where the incorrect layout shows two warp samples which contain the same set of warp threads so that their properties will be very similar. In the correct layout each sample contains a different set of warp threads so that their properties are potentially different depending on the degree of uniformity of the fabric. As it is the warp direction in this case that is being tested the use of the same weft threads is not



1.8 Fabric sampling.

important. Samples should not be taken from within 50 mm of the selvedge as the fabric properties can change at the edge and they are no longer representative of the bulk.