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Textile fibres — Some methods of sampling for testing

MODIFICATION TO FOREWORD *(Inside front cover)*

The last sentence of the third paragraph is replaced by the following :

> "International Standard ISO 1130 cancels and replaces ISO Recommendation R 1130-1969 and ISO Recommendation R 220-1961."

INTERNATIONAL STANDARD ISO 1130

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Textile fibres — Some methods of sampling for testing

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

Prior to 1972, the results of the work of the Technical Committees were published as ISO Recommendations; these documents are now in the process of being transformed into International Standards. As part of this process, Technical Committee ISO/TC 38 has reviewed ISO Recommendation R 1130 and found it technically suitable for transformation. International Standard ISO 1130 therefore replaces ISO Recommendation R 1130-1969 to which it is technically identical.

ISO Recommendation R 1130 was approved by the Member Bodies of the following countries :

Australia	India	Romania
Belgium	Iran	Spain
Canada	Israel	Sweden
Colombia	Japan	Switzerland
Cuba	Korea, Rep. of	Thailand
Czechoslovakia	New Zealand	Turkey
Denmark	Norway	United Kingdom
Egypt, Arab Rep. of	Poland	U.S.A.
France	Portugal	U.S.S.R.
Hungary	South Africa, Rep. of	

The Member Bodies of the following countries expressed disapproval of the Recommendation on technical grounds :

Germany
Netherlands*

* Subsequently, this Member Body approved the Recommendation.

The Member Bodies of the following countries disapproved the transformation of ISO/R 1130 into an International Standard :

Germany
Hungary
U.S.S.R.

Textile fibres – Some methods of sampling for testing

0 INTRODUCTION

No single technique of sampling can be devised that will serve in all circumstances. Sampling from a bale of cotton, for example, presents problems quite different from those encountered in sampling from a consignment of yarn packages, while sampling from a card web is again different from either.

If the fibres in the bulk have been well mixed, so that there is no variation in composition from one part to another, i.e. the individual fibres are distributed at random, the sample can without disadvantage be taken from one place anywhere in the bulk.

If the fibres in the bulk are not known to have been well mixed, so that the composition may vary from one part to another, a sample taken from any one place would not be representative of the whole bulk.

A selection of methods is therefore presented, illustrating techniques that have been found acceptable in meeting the commoner types of problem encountered in sampling for the assessment of fibre quality. Methods peculiar to the requirements of research are not included, nor are such special techniques as have to be used, for example, in sampling of wool from the fleece, or cotton from the seed.

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies several methods for preparing laboratory samples of fibres, and presents a limited treatment of the problem of drawing specimens for testing.

The field of application of each method is given at the beginning of the clause dealing with the method.

It is not possible for the coverage of each individual procedure to be fully comprehensive; in many instances, the selection of test samples or test specimens must necessarily be covered by the appropriate method of test.

The selection of length-biased samples is not within the scope of this International Standard, nor are particular requirements relating to the determination of commercial weights.

An annex and tables are given in this International Standard for general guidance in determining the size of the test sample to be taken in order that the determined sample mean shall have given confidence limits.

2 GENERAL DEFINITIONS

For the purposes of this International Standard the following general definitions apply. Definitions particular to different types of fibres will be found in the appropriate clause.

2.1 individual : Any single fibre that might be taken for the purpose of measurement.

2.2 population : The aggregrate of individuals that it is desired to characterize in one or more particulars (for example : fibres contained in a bale of cotton; all the constituent fibres in a set of yarn cops).

2.3 zoning : When the population to be sampled is known to vary from part to part with respect to the property to be investigated, the individuals or groups of individuals in the population are taken at random from within the different parts or zones, chosen so that all variations of the property are represented in due proportion. This operation is known as zoning.

2.4 laboratory sample : A sample intended to be representative of a large bulk of material, in the state in which it is sent to the laboratory. A convenient size of sample for many types of test involving only small test specimens is about 25 to 50 g; a larger amount will be required for tests involving relatively large test specimens.

2.5 laboratory test sample : That portion of fibres taken from the laboratory sample in such a way as to ensure its representative character and to provide a quantity small enough to be easily convertible into test specimens.

2.6 test specimen : That part of the laboratory sample (yarns, fibres, etc.) which is tested at one time.

2.7 numerical sample : A sample in which all fibres in the population have an equal chance of being represented.

2.8 length-biased sample : A sample in which the chance of any fibre of the population being represented is proportional to the length of that fibre.

3 SAMPLING METHODS FOR BAST FIBRES

NOTE — Bast fibres require to be broken in the preliminary stages of processing, and consequently sampling for fibre length measurement is carried out on sliver or yarn, and not on the raw fibre.

3.1 Field of application

Raw bast fibres are usually sampled only for fibre fineness and fibre strength and the methods adopted depend on the type of bast fibre. Flax and hemp need different handling from jute and kenaf.

Method A applies to bales or other bulks of bast fibres such as flax and hemp in the raw state and to bulks of dressed line in bunches.

Method B applies to bales or bulks of jute or kenaf in the raw state.

3.2 Definitions

3.2.1 reed : The fibrous strands obtained from a jute stem after retting.

3.2.2 head : A bunch of jute reeds, given a twist and folded over before being made into a bale.

3.2.3 bunch : The aggregate of pieces of flax tied up with two or more ties preparatory to baling.

3.2.4 strick : A small bunch of flax straws, or scutched flax, or of hackled flax, of a size that can be held in the hand, or a bunch of jute similar to a head, but smaller, usually 1 to 2 kg in mass.

3.3 Sampling the bulk

Take a representative sample by abstracting small sub-samples from various parts of the bulk and reduce each of these to a convenient number of fibres by repeated halving.

3.4 Method A

Select a number of bunches (preferably not less than twenty) at random from various parts of the bale or bulk, and remove a strick of fibre from each one. Divide each strick lengthwise by gripping the centre and pulling transversely to the length of the fibres to separate the two portions. Discard one portion and retain the identity of the root and tip of the retained portion. Repeatedly halve the retained portion until the amount of fibre retained is sufficiently small. Make a composite sample for test purposes by combining the retained fibre from each strick, placing root ends together and tip ends together.

3.5 Method B

Take a number of heads of jute (preferably not less than fifty) at random from the bulk, and remove a reed from each head. Cut each of these reeds into root end, middle, and tip end, keeping the sections separate and the corresponding cut lengths from all reeds bundled together. Then tease out each of the three composite bundles by hackling on pins, or by other means, to remove cross-linked and tangled fibres.

For determinations of fibre fineness and single fibre breaking load, cut small bundles of fibres, each weighing a few milligrams and of fixed length (30 mm is suitable), from a composite bundle at a number of points and put them together to form a test sample (25 mg is often a convenient mass).

4 SAMPLING METHODS FOR COTTON FIBRES

4.1 Field of application

Clause 4 gives methods for the preparation of numerical laboratory samples.

The methods described in 4.2 to 4.6 are applicable to bulks of cotton fibres in various forms.

The methods described in 4.6.1 to 4.6.3 are applicable to all fibres spun on the cotton system.

4.2 Sampling from a small bulk of raw or blended cotton

If the bulk consists of less than 5 kg of loose raw cotton, it shall be spread out in an even layer. Unless otherwise stated, obtain the laboratory sample by selecting at random a minimum of a hundred tufts, each of 0,25 to 0,50 g.

If the bulk is greater than 5 kg, divide it into a number of equal portions, and take an equal number of tufts (of 0,25 to 0,50 g each) from each portion such that the total number from all portions exceeds a hundred.

4.3 Sampling from a bulk consisting of a bale of cotton

4.3.1 *General*

There is variation in most fibre properties between and within layers of the same bale of cotton. The values of coefficients of within- and between-layer variation and of the ratio of these coefficients of variation vary according to the fibre characteristics under consideration, and also with the type of cotton.

4.3.2 *Procedure*

If the bale is open, a suitable laboratory sample may be obtained by selecting ten tufts at random throughout each of ten equally spaced layers.

If the bale has not been opened, the above procedure cannot be followed. In this case, the following procedure may be feasible :

Extract the required number of tufts by removing cotton from one or more of the edges that are perpendicular to the layers in the bale, so that the sample includes material from many layers. In taking the tufts, reject any soiled cotton from the outside of the bale (the procedure may be facilitated by cutting one of the end bands round the bale).

NOTE — A less satisfactory sample is yielded by selecting tufts from various places over the upper and lower sides of a bale.

Although this cotton is easily accessible, any laboratory sample obtained in this manner will represent at the most two layers, one on each side of the bale.

4.4 Sampling from a bulk consisting of several bales of cotton

4.4.1 *General*

The detailed method of sampling depends on the type of test to be carried out, the number of bales, and the likely variation between the bales.

4.4.2 *Procedure*

The following procedure shall be used unless the specification states otherwise.

4.4.2.1 WHEN THE NUMBER OF BALES IS GREATER THAN 10 AND THE REAL VARIATION IN THE BULK IS NOT APPRECIABLY GREATER THAN THE PRECISION REQUIRED IN THE TEST RESULT

Make a random choice of 10 % of the bales (or ten bales if 10 % of the bulk is less than ten bales); then from the selected bales take a minimum of a hundred tufts, taking an equal number of tufts from each layer of each bale.

4.4.2.2 IN OTHER CASES

Select a minimum of a hundred tufts; take an equal number of tufts from each layer of each bale.

NOTE — For most commercial purposes, when selecting a commercial sample from a bale of cotton it is impracticable to obtain a representative sample by opening a bale and following the procedure described in 4.2 above. Samples prepared by selecting cotton from one or two layers in a bale are acceptable for many purposes of quality classification, and for some forms of testing (for example, determination of micronaire value) when past experience indicates that the feature under consideration varies appreciably more from bale to bale in a commercial lot than between layers in the same bale. Under such circumstances, it is recommended that a commercial sample be prepared in the form of two clumps of cotton, similar in surface area and mass, taken from opposite outer layers of the bale. The face of the sample should be not less than 120 mm X 150 mm and the total mass not less than 150 g. A sample consisting of a clump, of the same surface area and total mass, cut from one outer layer only, is less representative and will be deemed to fulfil the requirements of this International Standard only if mutually agreed by the parties concerned.

4.5 Preparation of laboratory test samples

In certain cases, it may be necessary to have a laboratory test sample, prepared from the laboratory sample.

These laboratory test samples should be prepared by a method which takes into consideration the test to be performed and the degree of accuracy desired.

In general, fibre blending by a mechanical blender is preferable, particularly when the test specimen is small in size, as is the case in the flat-bundle strength test. However, in some cases, samples prepared by hand are adequate.

When the laboratory sample consists of tufts taken by cutting into the bales, cut fibres shall not be included in the laboratory test sample.

4.5.1 *Mechanical blending (preferred method)*

The mechanical blender is designed to use a certain mass of fibres, for example up to 10 g.

Spread out the laboratory sample so that pinches can be taken from it at any point. Take small pinches of fibre from at least 32 different evenly spaced points in the laboratory sample.

Perform a light drafting action on the pinches before feeding them into the mechanical blender, so as to form as uniform a sheet of fibre as possible. Blend the fibres using the blender so as to produce a practically homogeneous sample, taking care not to damage the fibres.

4.5.2 *Manual methods*

Different methods have been described in national standards. They are designed for different methods of test, for example *"cut-squaring"*, making hand slivers and making small samples for successive halving and combining. In some cases, it is preferable to prepare test specimens direct from the laboratory sample.

4.6 Sampling from a bulk consisting of processed material

4.6.1 *Sliver, roving*

If the bulk consists of many cans or packages each prepared and processed in the same manner, obtain the laboratory sample sufficiently accurate for most purposes by taking equal lengths from a minimum of four cans or packages, chosen from different parts of the bulk. If the number of cans or packages is smaller than four, take equal lengths from each.

4.6.2 *Yarns*

In testing packages of yarn from a consignment, select four from different parts of the bulk; if the bulk consists of fewer than four packages, select all of them.

4.6.3 *Cloth*

Select a minimum of four threads for testing. Select warp threads at approximately equal intervals across the width; generally it will be found convenient to select about sixteen in this manner. If possible take weft threads from different places along the cloth so as to include yarn of different cops.

NOTE — A test sample or test specimen may be subsequently prepared from the selected packages or yarns by untwisting fibres from equal lengths of each, as described in 4.6.2 and 4.6.3, care being taken to exclude the fibres from cut ends of the lengths of yarn.

5 SAMPLING METHOD FOR MAN-MADE STAPLE FIBRES

5.1 Field of application

This method gives a numerical sample. It is suitable for most types of man-made fibres in bale form. Unusual consignments of staple fibre and supplies of staple produced from filament waste may require a modified sampling procedure.

5.2 Number of bales to be sampled

If the consignment comprises not more than five bales, sample all the bales. If the consignment comprises more than five but not more than twenty-five bales, take five bales at random. If there are more than twenty-five bales in the consignment, take ten bales at random.

5.3 Preparation of final sample representative of the consignment

From each bale to be sampled take four handfuls each of about 10 g, taking two of them from different places in the outside zone[1)] and two from different places in the inside zone[1)]. Keep the four handfuls separate.

From each of the handfuls, take a tuft of about 100 mg and divide it into four parts, each of about 25 mg. Lay out separately the sixteen resulting tufts, all derived from the same bale. With each of these tufts combine one of the sixteen tufts prepared in the same way from each of the other sampled bales. In this way prepare sixteen sub-samples, each of which includes about 25 mg of fibres from each bale that has been sampled. Prepare the final representative sample from these sixteen sub-samples by repeated doubling and halving as follows.

Place the first and second tufts together and thoroughly mix them by repeated drawing and doubling. Split the resulting tuft into two equal tufts; retain one tuft and discard the other. Combine and mix in the same way the other pairs of tufts (3 and 4; 5 and 6; 7 and 8, etc.), each time retaining only one half of the mixed tuft. Then combine and mix the two tufts derived from 1 and 2, 3 and 4; split the mixed tuft and retain half of it. Continue this mixing of pairs and halving until one tuft is left forming a representative sample. Take care that the drawing is done very gently so as not to stretch or break any fibres. When dividing a tuft in order to discard one half, it is essential to split it in the middle and to separate the parts laterally; do not pull them apart by their ends.

6 SAMPLING METHODS FOR WOOL FIBRES

6.1 Field of application

Clause 6 gives methods for the preparation of numerical laboratory samples, particularly for the measurement of fibre length.

The method given in 6.2 is applicable to wool fibres. The methods given in 6.3 and 6.4 are applicable to all fibres processed on the woollen or worsted systems.

6.2 Sampling method for loose fibres – Method of zoning

6.2.1 *General*

Two typical cases are described and most samples of intermediate size can be dealt with by small modifications to one of the procedures given.

6.2.2 *Sampling from a bulk consisting of a bag or bale of greasy wool*

A typical bag of wool may weigh about 350 kg and will comprise a large number of fleeces or parts of fleeces.

The total variability in fibre length may be considered in the following two parts :

a) the variability within a fleece or part fleece. This will be termed *within-zone variation*;

b) the variability between fleeces or part fleeces. This will be termed *between-zone variation*.

It cannot be assumed in general that the sackful of wool is homogeneous and it is thus necessary to sort through the whole bulk to obtain a representative sample. Consequently it may be convenient to carry out the following sampling procedure whilst transferring the wool to a hopper, bin, or lattice for the next stage of processing.

6.2.2.1 CHOICE OF NUMBER OF ZONES

The standard error, σ, of N fibres is given by

$$\sigma = \sqrt{\frac{V_r}{N} + \frac{V_z}{n}}$$

where

V_r is the residual variance within zones;

V_z is the variance between zones;

n is the number of zones;

N is the total number of fibres measured.

Then the average number of measured fibres per zone (which in general is not a whole number) is

$$\frac{N}{n}$$

In measuring mean fibre length, if the values of V_r and V_z typical of the type of wool to be tested are known, table 1 of the annex may be consulted to obtain the approximate values of n and N that will yield a mean length having a standard error of the value required for the immediate purpose. If values of V_r and V_z are not known, use the

1) A bale is considered to consist of an outside zone and an inside zone, the dimensions of the inside zone being equal to 80 % of the corresponding dimensions of the whole bale, so forming about half the total volume.

underlined values of n and N from the same table which correspond to values of V_r and V_z found to be typical of many types of wool.

In deciding N and n, it should be remembered that the time taken to measure a fibre once zoning has been completed is very much less that the time taken to sort a zone.

6.2.2.2 SELECTION OF ZONES

The procedure to be described utilizes the simplest apparatus. Mechanical handling equipment, for example conveyor belts, may possibly be used to speed it up.

When the number of zones and the total number of fibres have been decided on, obtain a box or measure that can hold about 0,5 kg of fibre. If the total mass of the bulk is Q[1] boxfuls, calculate the quotient, Q/n, to the nearest whole number. Let this number be P.

Select the required zones for sampling as follows. Fill the box repeatedly with fibres and empty it until the bulk to be sampled has been transferred, reserving the first boxful and each following boxful that is a multiple of the value of P, and keeping these boxfuls in the order in which they were drawn from the bulk. The contents of each boxful reserved constitutes a zone.

6.2.2.3 SAMPLING THE ZONES

Divide each boxful in turn into halves by hand and discard the left half. Divide the right half into two halves and discard the left of this. Continue this process of reduction until, as judged by eye, approximately the number of fibres required per zone, N/n, has been obtained. Transfer these fibres to a velvet board and cover them with a small transparent plate. Repeat this process for each selected zone or box. The final representative sample consists of the number, n, of groups of fibre on the velvet board and, to avoid bias, it is essential that all the fibres in each group be measured.

6.2.3 *Sampling from a bulk consisting of several kilograms of loose wool fibres*

The procedure is suitable for samples of wool of mass up to a few kilograms.

6.2.3.1 Lay out the locks of wool or groups of fibres constituting the sample side by side and parallel on a table so that, as far as possible, equal numbers of fibres occupy the same total length of the table. This may be effected by splitting the larger groups down to smaller units.

6.2.3.2 From table 1 of the annex, find the total number of fibres required, N, and number of zones required, n.

6.2.3.3 Take a group of fibres from each of n different points approximately equally spaced along the total length of the table.

Reduce each selected group by repeated halving, as described in 6.2.2.3, until the number of fibres required in each zone is obtained.

6.3 Sampling method for slivers — Random draw method

6.3.1 *General*

This method is suitable for fibres processed on the woollen or worsted systems, twistless sliver such as card sliver and top, and also for any sliver that can be untwisted easily prior to sampling.

This method gives a procedure for preparing the fibres by hand; automatic means of preparing the specimen, similar to the manual method, are not described.

6.3.2 *Apparatus*

A grip, suitable for taking a draw of fibres from a sliver, is required for this method. This can be made from a type of letter clip about 150 mm wide. The straight edge of the clip is, if necessary, ground to be parallel to the bent edge. A thin strip of leather is then cemented in the groove of the bent edge so that the clip so modified will hold a single wool fibre firmly at all points along its edge.

6.3.3 *Procedure*

Firmly hold the sliver to be sampled in the right hand near to a free end and then grip it at a distance of about 300 mm with the left hand. Gently part the sliver by separating both hands and discard the shorter piece. Place the remaining piece along the centres of the two velvet boards placed edge to edge with the parted end near the front of the first board, as shown in figure 1. Place a weighted glass or perspex plate on the sliver near the back edge of the second board to prevent the sliver from moving. Alternatively, use one large board.

Use the grip with leather-lined jaws to remove and discard a 2 mm fringe of fibres[2]. Repeat the procedure, removing and discarding successive 2 mm fringes for a distance about equal to that of the longest fibre in the sliver[3]. The sliver end has now been normalized and any succeeding draw of fibre ends will be a representative sample.

Choose a draw at random of ten successive draws. If required, a second draw may be chosen in the same way from the same normalized end. Then transfer the selected draw of fibres to a small velvet board and cover it with a small transparent plate and measure all the fibres according to the specified method.

1) The mass of the bulk in this case in $Q \times 0,5$ kg.

2) This distance, which is the length of fibre in the grip, may be gauged at first by marking a number of parallel lines on a paper and placing them under the parted end. After a little practice it is quite safe to estimate the distance by eye.

3) For a 22 μm top this distance is generally about 200 mm.

It is permissible to reduce the size of the last ten draws by taking them from a 1 mm fringe if only a moderate sized sample is required[1].

6.4 Sampling from a bulk consisting of yarns — Cut square method

6.4.1 *General*

This method is suitable for yarns composed of fibres processed on the woollen or worsted systems.

6.4.2 *Procedure*

From the sample under test take at random a length of yarn equal to at least three times the length of the longest constituent fibre of the yarn. Untwist the yarn by hand, lay it down centrally on a small velvet board and cover it with a small transparent plate. Then cut the yarn about 5 mm from the front edge of the plate (see figure 2).

Remove the fibres that project in front of the plate one by one, with a pair of forceps, right back to the edge of the plate. This procedure is termed *squaring.* Move the plate back a few millimetres, exposing a band of fibre ends; remove these one by one and measure them in accordance with the specified method. Continue until a total of at least fifty fibres has been taken. In all cases, however, once the plate has been moved back, take all the available fibres whose ends project. Then discard the length of yarn, take another from the sample and square it, and measure at least fifty fibres. Obtain the required number of fibres by repeating the procedure on fresh lengths of yarn, chosen at random from the bulk available.

6.5 Number of fibres in the cross-section of a sliver

It is sometimes useful in sampling to have some knowledge of the average number of fibre tips per unit length (the fibre-end density).

These quantities may be calculated from the linear density of the sliver and the average fibre length and root mean square diameter. The following approximate formulae apply to wool fibres :

Average number of fibres in cross-section is

$$972\ W \times 10^3/d^2$$

and average number of fibres (or fibre tips) per millimetre of sliver is

$$97{,}2\ W \times 10^3/d^2 L$$

where

W is the linear density of sliver, in kilotex;

d is the root mean square fibre diameter, in micrometres;

L is the average fibre length, in centimetres.

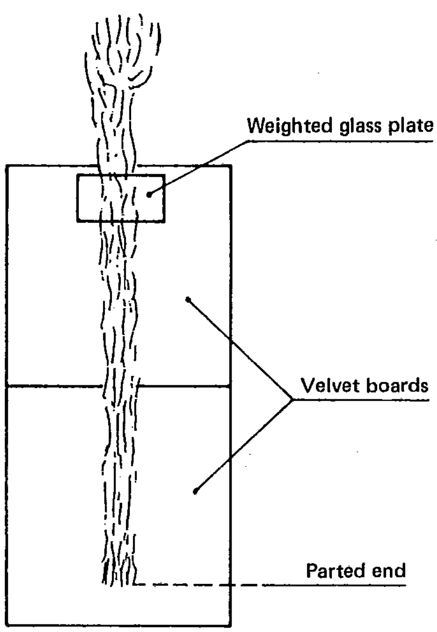

FIGURE 1

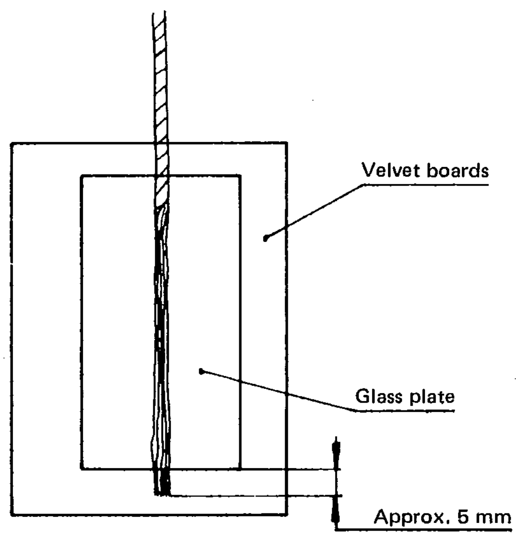

FIGURE 2

1) The number of fibres in a 1 mm draw will vary according to the fibre length and diameter, but for an average of 24 µm top it will be between 250 and 400.

ANNEX

DETERMINATION OF NUMBER OF TESTS

The number of individuals to be tested will depend on the variability of the material and the accuracy required. In random sampling the mean of the test specimens will, about nineteen times out of twenty, be within

$$\pm \frac{2C}{\sqrt{n}} \%$$

of the population mean,

where

C is the coefficient of variation per cent of the property considered;

n is the number of test specimens.

The values of $\pm 2C/\sqrt{n}$ % are the confidence limits of error.

Often the value of the coefficient of variation is known approximately and the number of fibres necessary to achieve given confidence limits of error can then be calculated. Some of these values, which are known, are given in table 2 of this annex. Table 3 can then be used to find the number of fibres required to test for any desired confidence limits of error of the mean.

EXAMPLE :

The mean strength of the fibres from a wool top is required to confidence limits of error of 10 %. From table 2 the coefficient of variation is seen to be 50 % and table 3 shows that about 100 fibres will be needed for 10 % confidence limits of error. (The top was sampled by the cut square method, which yielded 113 fibres, all of which were tested for strength.)

For a heterogeneous population, the variability of the sample mean is due partly to the between-zone variation and partly to the within-zone variation, and the above simple formula cannot then be used. If the between-zone variation is relatively large, it is best to take many zones and measure only a few fibres from each. If the converse is true, the population can, of course, be treated as homogeneous.

Whenever random sampling is specified, the use of tables of random numbers is recommended.

TABLE 1 — **Standard error of mean fibre length in centimetres**

Variance (cm^2)		$N^* = 400$			$N^* = 800$			$N^* = 1\ 600$		
		$n^{**} =$			$n^{**} =$			$n^{**} =$		
Between zones V_z	**Within zones** V_r	50	100	200	50	100	200	50	100	200
8	8	0,42	0,32	0,24	0,41	0,30	0,22	0,41	0,29	0,21
	4	0,41	0,30	0,22	0,41	0,29	0,21	0,40	0,29	0,21
	2	0,41	0,29	0,21	0,40	0,29	0,21	0,40	0,28	0,20
4	8	0,32	0,24	0,20	0,30	0,22	0,17	0,29	0,21	0,16
	4	0,30	0,22	0,17	0,29	0,21	0,16	0,29	0,21	0,15
	2	0,29	0,21	0,16	0,29	0,21	0,15	0,29	0,20	0,15
2	8	0,24	0,20	0,17	0,22	0,17	0,14	0,21	0,16	0,12
	4	0,22	0,17	0,14	0,21	0,16	0,12	0,21	0,15	0,11
	2	0,21	0,16	0,12	0,21	0,15	0,11	0,20	0,15	0,11

* N = total number of fibres

** n = number of zones

TABLE 2 — Some approximate percentage values of coefficients of variation of properties of individual fibres

(Figures are for a numerical sample unless otherwise stated and are necessarily approximate and may vary appreciably from bulk to bulk)

Source of fibres	Length %	Diameter %	Breaking load %	Breaking extension %	Linear density %
Cotton	40	25	50	35	25
Wool, sorted and scoured	50 to 60	20 to 26*	50	60	—
Wool card sliver	60	20 to 26*	50	60	—
Wool top	50	20 to 26*	50	60	—
Woollen slubbing, yarn	90	30*	—	—	—
Flax, ultimate	—	—	50	50	—
Flax line in stricks (tipples)	60	—	—	—	—
Flax line in sliver from early stages of preparing	80	—	—	—	—
Flax line in roving Tow at all stages Dry spun yarn	100	—	—	—	—
Flax in wet spun yarns	50	—	—	—	—
Flax fibre strands	—	—	75	50	50
Viscose staple fibre	—	—	15	15	10
Cellulose acetate staple fibre	—	—	15	15	15

* Denotes length-biased sample

NOTE — For wool, the coefficients of variation for breaking load and breaking extension given in this table are not a significant factor. In fact, experience between laboratories in different countries has shown that dynamic measurements on wool fibres (breaking load and breaking extension) do not always give reproducible results.

TABLE 3 — **Number of fibres* required for various confidence limits of the mean**

Coefficient of variation %	Confidence limits as percentage of the mean						
	1	2	3	5	10	20	30
2	16	4	2	1	1	1	1
5	100	25	12	4	1	1	1
10	400	100	45	16	4	1	1
15	900	225	100	36	9	3	1
20	1 600	400	178	64	16	4	2
25	2 500	625	278	100	25	7	3
30	3 600	900	400	144	36	9	4
35	4 900	1 225	545	196	49	13	6
40	6 400	1 600	712	256	64	16	8
45	8 100	2 025	900	324	81	21	9
50	10 000	2 500	1 112	400	100	25	12
55	**	3 025	1 345	484	121	31	14
60	**	3 600	1 600	576	144	36	16
65	**	4 225	1 878	676	169	43	19
70	**	4 900	2 178	784	196	49	22
75	**	5 625	2 500	900	225	57	25
80	**	6 400	2 845	1 024	256	64	29
85	**	7 225	3 212	1 156	289	73	33
90	**	8 100	3 600	1 296	324	81	36
100	**	10 000	4 443	1 600	400	100	45

* Values for number of fibres given in the body of the table are calculated from the approximate values of

$$\left(\frac{2 \times \text{percentage coefficient of variation}}{\text{percentage confidence limits}}\right)^2$$

and apply to the 95 % (19 in 20) probability level.

** Denotes more than 10 000 fibres.