

Assessment of surface texture —

Part 2: Guidance and general information

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Foreword

This Part of BS 1134 has been prepared under the direction of the General Mechanical Engineering Standards Policy Committee and replaces BS 1134-2:1972 which is withdrawn. BS 1134 was first issued in 1950 and revised in 1961 and 1972.

BS 1134 consists of two Parts. Part 1 covers methods for the assessment of surface texture parameters including instrumentation and Part 2 provides guidance and general information.

It is hoped that Parts 1 and 2 of BS 1134 will provide a general level of understanding of the subject.

BS 6393 refers to calibration specimens for use with stylus instruments used for the measurement of surface texture and gives detailed information for practical assessment.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

0 Introduction

In practice, all manufactured surfaces depart to some extent from absolute perfection and it has long been recognized that careful finishing of components can lead to longer life, improved efficiency, functional interchangeability and other benefits. This is reflected throughout all fields of industry.

At one time the terms “rough machine”, “medium machine” and “fine machine”, or equivalent symbols were used on engineering drawings, leaving the surface to be controlled by limitations of the machining process involved and the arbitrary opinions of operator and inspector which, all too often, did not coincide. Problems resulted which became increasingly acute as the demand for a more comprehensive specification increased to keep pace with technological development.

Most of the uncertainties of specifying surface requirements have been eliminated by development of instruments for the measurement of surface texture on a numerical basis and by the issue of various national standards. However, the standards embraced much that was arbitrary and in need of wider agreement and for some years the whole question has been under study within the International Organization for Standardization (ISO). Some very important areas of international agreement have now emerged and have been incorporated in Part 1 of this standard.

1 Scope

This Part of BS 1134 gives general information and guidance on the methods of assessing surface texture given in BS 1134-1.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Geometry of surfaces

The imperfections of any surface take the form of a series of peaks and valleys which may vary both in height and spacing and result in a texture which, in feel or appearance, and in properties generally, is often characteristic of the process employed in its production. Surfaces produced by cutting tools tend to be of uniform spacing with well-defined direction of tool marks whilst those produced by grinding processes, though usually directional in character, are generally of irregular spacing. Surfaces produced by the reciprocating action of abrasives, such as honing or lapping, tend to be less directional in character.

The complete texture of any surface is, therefore, a combination of irregularities of various kinds and magnitudes arising from different causes.

It is convenient to recognize four principal orders of geometrical irregularity, resulting from the following:

- a) machine tool inaccuracies, deformation of the workpiece due to cutting forces, effect of workpiece mass, etc.;
- b) vibrations of any kind, e.g. chatter marks;
- c) the inherent action of the particular production process;
- d) rupture of the material during chip removal.

It follows that an ideally complete assessment would involve the measurement of each and every departure from the ideal surface plus an assessment of the effect of the combined texture on the functioning of the component surface.

Measuring techniques and knowledge of surfaces are constantly improving but, in state-of-the-art measuring, a simple method of approach, as given in Part 1, is realistic and likely to remain in use for some years to come.

By implementing Part 1, the complex problems of assessment which are three-dimensional in character are reduced to two-dimensional metrology. This is done by confining individual measurements to profiles of plane sections taken through the surface. On surfaces where the texture is multi-directional in character, the plane chosen for the purpose of measurement is usually immaterial, but on turned, ground and other surfaces having definite directional scratches or toolmarks forming the texture, totally different readings could be obtained from measurements made in different planes (see Figure 1). The term “lay” is applied to the directional marks constituting the topography of the surface and a further piece of simplification (see 2.1.4 of BS 1134-1:1988) is to confine measurement to a plane approximately at right angles to the predominant direction of lay. There are exceptions to this rule but they are comparatively rare.

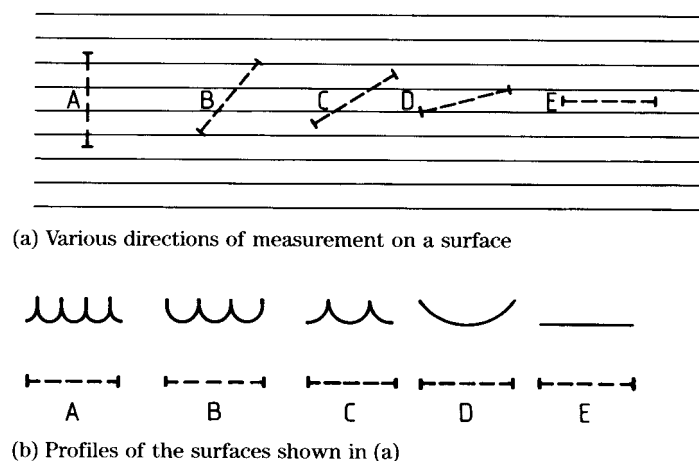


Figure 1 — Influence of direction of measurement on the effective spacing of profile crests

Having conveniently reduced the process of assessment to an analysis of the form of the profile as revealed by a plane cross section through the surface, Part 1 seeks to control the spacing of profile irregularities to be taken into account in any one assessment. The irregularities on any surface commonly represent the joint effects of roughness arising from the inherent action of the cutting process [see item c) of this clause] and waviness attributable to vibration, machine deflection and similar, phenomena [see items a) and b) of this clause]. These may be superimposed on departures from true geometrical form and thus the spacing and, hence, the sampling length chosen to make an assessment of surface texture is of vital importance. Indeed, careful study of Figure 2 shows that a misleading height value could be obtained for the profile should the length of surface (sampling length) selected for evaluation of the surface be inadequate.

Control is achieved by laying down a standard series of sampling lengths which are now internationally agreed (see clause 3 of BS 1134-1:1988). Various instruments for the measurement of surface texture have meter cut-offs which correspond with the standard sampling lengths.

When specifying a surface to be achieved, specification of the sampling length relative to numerical height value limits the maximum spacing of irregularities and indicates the meter cut-off to be used in assessment of the product specified. In effect, the meter cut-off causes the instrument to filter out and thus omit from an average reading (taken over a number of sampling lengths) errors having a spacing greater than envisaged. Thus, if the interest lies primarily in roughness, a short sampling length would be quoted with similar, attendant, instrument cut-off length but detection and measurement of any waviness present (on which roughness might be superimposed) would be revealed by selection of a greater instrument cut-off. In speaking of these features, it is not only convenient but precise to associate the term "sampling length" with the actual surface (or its representation on a drawing), leaving the term "cut-off" to apply to the instrument only.

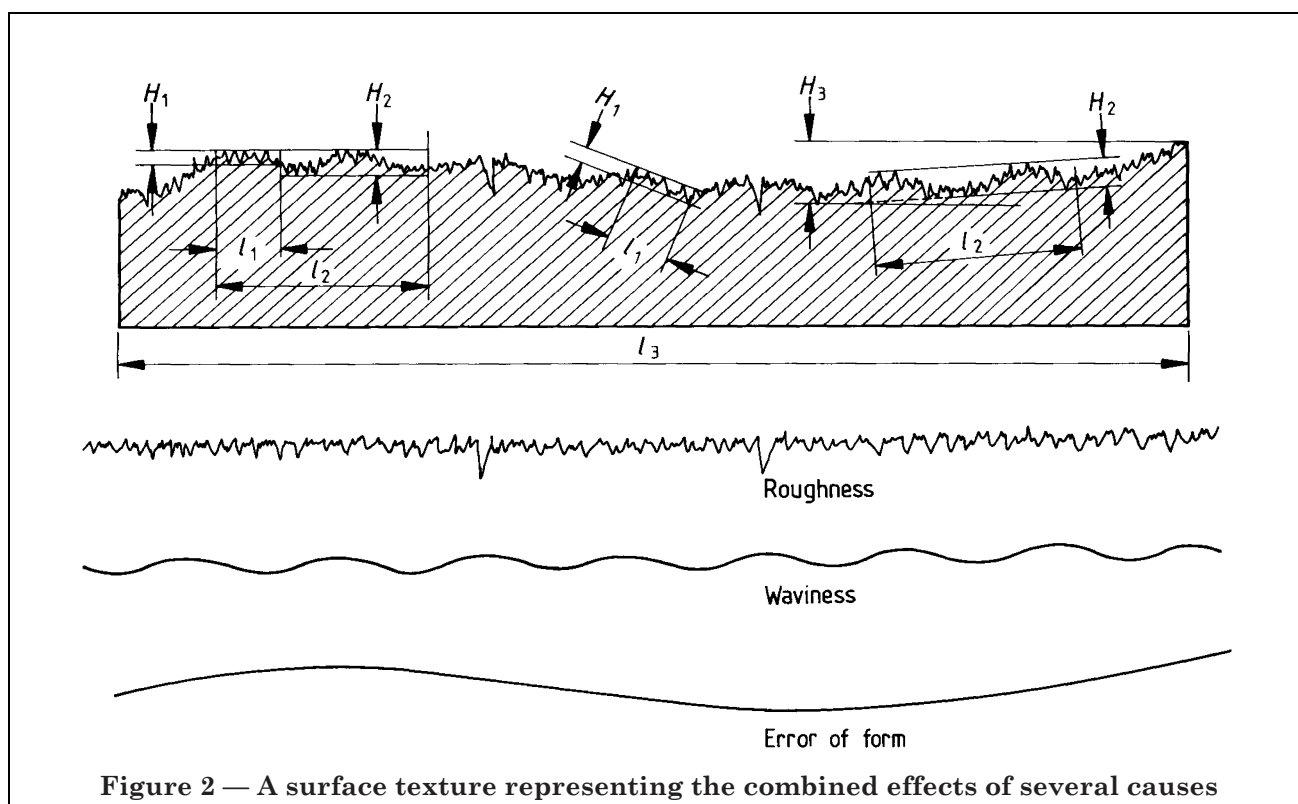


Figure 2 — A surface texture representing the combined effects of several causes

A further piece of simplification can now be effected. Experience has shown that the majority of surfaces subject to control can conveniently be assessed over a sampling length of 0.8 mm when roughness only is to be taken into account. This value is, therefore, that most popularly used as instrument cut-off for assessing the finer surfaces. It is not possible, however, to assign any particular spacing as being the demarcation between roughness and waviness because the scale of each of these features depends upon the class of work and the manufacturing processes employed.

It has thus far been established what should be revealed by an ideally complete assessment of surface characteristics and what will be revealed by the simplified approach of BS 1134-1. That Part also gives the procedures which have become internationally accepted for evaluating surface characteristics. As a basis, BS 1134-1 gives the methods of assessment from a graphical recording of the surface profile but, in practice, modern instruments provide a metered reading automatically of one or more of the parameter values relative to a defined reference line within the limitations of the selected instrument cut-off. The more sophisticated instruments provide a chart record of the surface profile in addition to a metered reading of the selected parameter. To ensure uniformity of instrument performance it is therefore necessary to state the basic requirements with which the various designs of instruments shall comply. These features are the subject of international agreement and are given in section 3 of BS 1134-1:1988.

3 Measurement

Surface textures commonly met with in practice are complete in type and often represent combined effects due to several contributing causes. For instance, see Figure 2 which shows diagrammatically a surface containing roughness, waviness and error of form. If the measurement is confined to a short sampling length of the surface, l_1 , the value obtained for the maximum height will be Ry_1 (maximum height being considered here for demonstration purposes). This is a measure of the roughness neglecting the occasional deep scratches; it is nominally the same for all parts of the surface and it neglects the irregularities of greater spacing. As the sampling length is increased, however, the height will eventually increase until, for a length l_2 , it reaches a new value Ry_2 , which takes into account the waviness, but which still ignores errors of geometrical form. Finally, for the whole surface, if such a measurement is practicable, sample length l_3 , would give a value, Ry_3 , including all irregularities and errors.

Thus, various values can be obtained for the Ry value of the surface according to the length of surface selected for measurement. It might seem that the length of surface which most fairly expresses the quality of the surface texture is the greatest, i.e. l_3 . That this may not be so is demonstrated in Figure 3 in which profile A represents, diagrammatically, a finely finished surface having a large error of form, while profile B represents a more coarsely finished surface having no error of form. The maximum heights are the same, but the surfaces are obviously far from identical in quality.

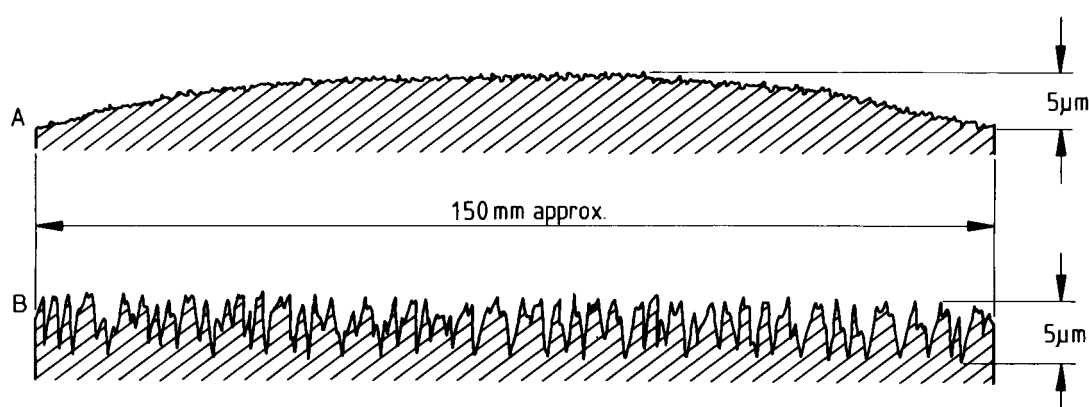


Figure 3 — Surface textures having the same maximum height but differing in geometrical profile