SURFACE TEXTURE

***INTRODUCTION:**

Surface topography is of great importance in specifying the function of a surface. A significant proportion of component failure starts at the surface due to either an isolated manufacturing discontinuity or gradual deterioration of the surface quality. Typical of the former is the laps and folds which cause fatigue failures and of the latter is the grinding damage due to the use of a worn wheel resulting in stress corrosion and fatigue failure. The most important parameter describing surface integrity is surface roughness. In the manufacturing industry, surface must be within certain limits of roughness. Therefore, measuring surface roughness is vital to quality control of machining work piece. Below are the definition of surface roughness and its main measurement methods. . From a knowledge of the roughness amplitude and wavelength values expected from the surface, it is possible to select the appropriate instrument settings for a reliable roughness measurement.

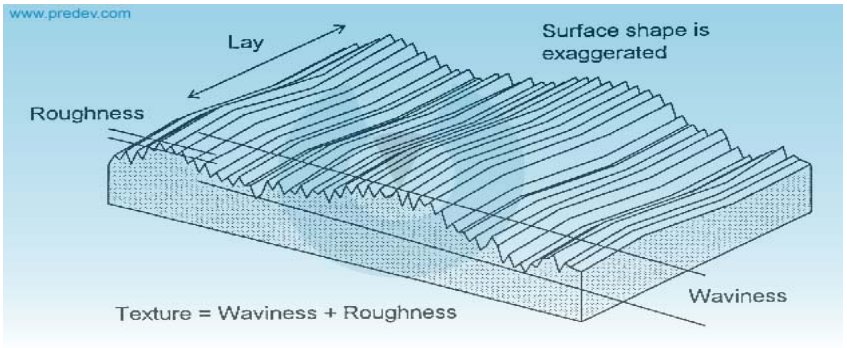

Fig.1 : Surface texture includes roughness and waviness. Many surfaces have lay: directional striations across the surface

***DEFINITIONS:**

In any discussion of this type, we need to start with a few definitions. The important ones here are:

SURFACE TEXTURE is the local deviations of a surface from its ideal shape e.g perfect flat shape, perfect cylinderical shape, sherical shape etc. The measure of the surface texture is generally determined in terms of its roughness, waviness and Form ** In surface texture there are many factors that, when combined, characterise a surface's profile. For example:

- the microstructure of the material
- the action of the cutting tool
- the instability of the cutting tool on the material
- errors in the machine tool guideways
- Mainly, what affects the surface texture could be summarized in the speed of the cutting tool, feed rate & the depth of cut.

ROUGHNESS – a quantitative measure of the process marks produced during the creation of the surface and other factors such as the structure of the material. The action of the cutting tool, chemical action, polishing, lapping, and the structure of the material all contribute to the roughness of the surface.

WAVINESS – a longer wavelength variation in surface away from its basic form (e.g. straight line or arc). . It may result from such factors as machine or work deflection, vibration, chatter, heat treatment, or warping strains

**Because both process and machine induced irregularities occur simultaneously,roughness is superimposed over waviness.

LAY refers to the predominant direction of the surface texture. Ordinarily lay is determined by the particular production method and geometry used.Turning, milling, drilling, grinding, and other cutting tool machining processes usually produce a surface that has lay

PROFILE is, mathematically, the line of intersection of a surface with a sectioning plane which is (ordinarily) perpendicular to the surface. It is a two-dimensional slice of the three-dimensional surface. Almost always profiles are measured across the surface in a direction perpendicular to the lay of the surface. Shortly saying, it's the graphical representation of the surface.

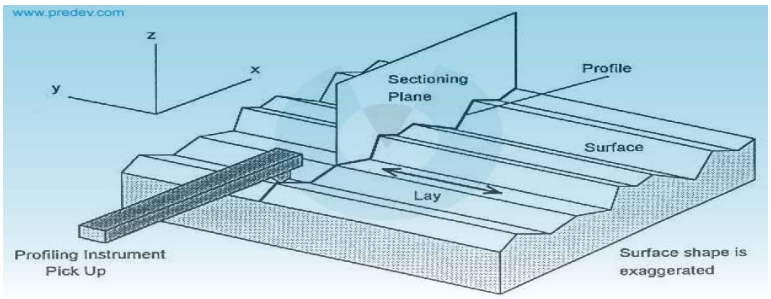

Fig.2 : A profile is a two-dimensional picture of a three dimensional surface that may be thought of as the result of a sectioning place cutting the surface. Profiles are ordinarily taken perpendicular to the lay.

CENTER LINE (Mean line) : mathematically it's poisoned in such a way that within the sampling length the sum of areas enclosed by the profile above & below the center line are equal.

FORM of a surface is the profile of the surface under consideration ignoring variations due to roughness and waviness. Deviations from the desired form result from clamping marks or sliding marks machining guide errors etc.

Ra - Average Roughness....The average roughness is the area between the roughness profile and its mean line, or the integral of the absolute value of the roughness profile height over the evaluation length Graphically, the average roughness is the area (shown below) between the roughness profile and its center line divided by the evaluation length (normally five sample lengths with each sample length equal to one evaluation length) This is the parameter that has been used universally for many years.

$$Ra = \sum A / L = \sum H / N$$

Where A = Area between the center line & the profile.
L= Sampling length.
H = Height of a point chosen from the profile with respect to the center line.
N = number of heights taken.

FILTERS are electronic or mathematical methods or algorithms which separate out different wavelengths and allow us to see only the wavelengths we are interested in.

CUT-OFF is a filter and is used as a means of separating or filtering the wavelengths of a component. Cut-offs have a numerical value that when selected will reduce or remove the unwanted wavelengths on the surface. For example, a roughness filter cut-off with a numeric value of 0.8mm will allow wavelengths below 0.8mm to be assessed with wavelengths above 0.8mm being reduced in amplitude; the greater the wavelength, the more severe the reduction. For a waviness filter cut-off with a numeric value of 0.8mm, wavelengths above 0.8mm will be assessed with wavelengths below 0.8mm being reduced in amplitude.

SAMPLE LENGTH : after the data has been filtered with a cut –off, we then sample it. Sampling is done by breaking the data into equal sample lengths. The sample lengths have the same numeric value as the cut-off. In other words, if you use a 0.8mm cut-off, then the filtered data will be broken down into 0.8mm sample lengths. These sample lengths are chosen in such a way that a good statistical analysis can be made of the surface. In most cases, five sample lengths are used for analysis.

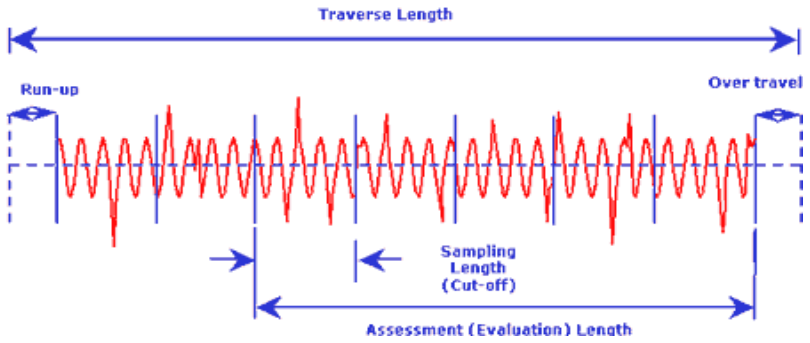

Fig.3 : Sample of surface profile

Rsk –(it's an amplitude parameter which's a measure of the vertical characteristics of the surface deviations).Rsk : is a measurement of skewness and will indicate whether the surface consists of mainly peaks, valleys or an equal combination of both. It is the measure of the symmetry of the profile about the mean line. A surface with predominant peaks will be considered as 'positive skew' and a surface with predominant valleys will be considered as 'negative skew'

RSm (it's a spacing parameter- which's a measure of the horizontal characteristics of the surface deviations) Rsm : is the mean spacing between profile peaks as they pass through the mean line (spacing is the distance between points that cross the mean line within a sample length in an upward direction).

*note - almost all parameters are defined over 1 sample length, however in practice more than 1 sample length is assessed (usually 5) and the mean calculated. This provides a better statistical estimate of the parameter's measured value

***PROCEDURE:**

1- Tactile assessment : Which's a comparison of the surface roughness with a standard surface (Rubert gauges). The comparison is done by touching the surface with your fingernail & then

comparing it with the gauges to establish the roughness value of the sample. Now, each gauge is specified for a certain process, i.e each gauge has a different color indicating a different process used in manufacturing the tested surface as milling, grinding, turning.. etc. *Using rubert gauges, the estimated value of Ra = …….. micrometer.

2- The tracer method : Which uses a stylus that's dragged across the surface. This method is the most common for obtaining quantitative results.

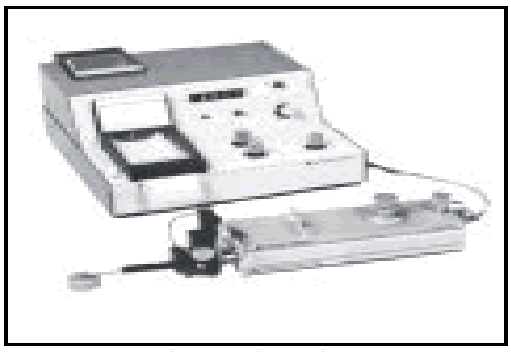

Fig.4 Talysurf 10

****Taylor-Hobson (Talysurf 10) Profilometer**

This equipment measures surface profiles by scanning a mechanical stylus across the sample. The profilometer can be used to measure etch depths, deposited film thickness and surface roughness. A modern typical surface measuring instrument will consist of a stylus with a small tip (diamond) a gauge or transducer, a traverse datum and a processor. The surface is measured by moving the stylus across the surface. As the stylus moves up and down along the surface, the transducer converts this movement into a signal which is then exported to a processor which converts this into a number and usually a visual profile. (The stylus must be moved in a straight line to give accurate readings)

*Below is a description of this process :

a- To record the profile of the specimen, switch on the instrument & adjust the coarse & fine adjustment found on the amplifier recorder to the mid position.

-The magnifications for both the vertical & horizontal are set to 1000 & 20 respectively.

- The specimen is placed in the V-block.

- Slowly bring the stylus on to the specimen until it touches the specimen. To make sure that there's a touching bring the stylus down more until the pen in the Graph Recorder comes to the mid position.

- For trial, take a trace by pressing the switch knob down.

- Now, run for a few centimeters & stop to adjust the vertical until the trace covers the graph paper.

- If you want the profile to be spread apart, switch the function knob to Vv same.

b- To find the roughness average, use the Ra meter.

- Hold the specimen on the V-block.

- Adjust the coarse & fine adjustment knobs to the mid position.

- Set the function knob Vv to the 0.8 mm cut-off length & Vv to 1000 magnification.

- Once again, slowly bring the stylus on to the specimen & check that it touches the specimen as previously.

-Press the start lever & take the reading from the Ra meter.To make use of the full range of the scale, choose the appropriate Vv & take another reading.

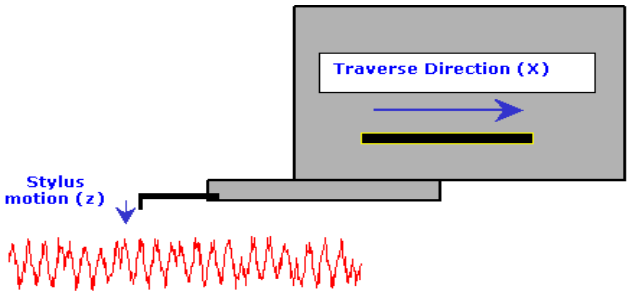

Fig.6 : Stylus operation

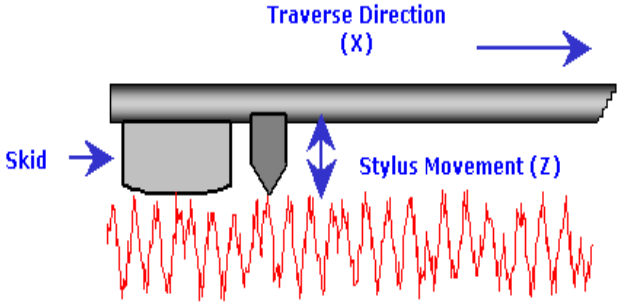

Fig.7 : Stylus and skid operation

***RESULTS:**

Turning 1

	Ra1	Ra2	Ra3	average
Rubert gauge				
Talysurf (direct)				
Talysurf (calculated)				

Turning 2

	Ra1	Ra2	Ra3	average
Rubert gauge				
Talysurf (direct)				
Talysurf (calculated)				

Milling :

	Ra1	Ra2	Ra3	average
Rubert gauge				
Talysurf (direct)				
Talysurf (calculated)				

Grinding:

	Ra1	Ra2	Ra3	average
Rubert gauge				
Talysurf (direct)				
Talysurf (calculated)				

***DISCUSSIONS:**

1- What are the advantages & disadvantages of using Rubert gauges & the stylus.
2- Why do we need the profile of the component & is it a true picture of the surface?
3- What does 1 division on Ra scale represent when Vv= 50000 magnification.
4- How do we achieve the vertical & horizontal magnifications?
5- Why is the horizontal magnification limited to only a small value in comparison with the vertical one?
6- What do you think is more accurate in finding the Ra value, ($\sum$ A / L) or ($\sum$ H / N) ?
7- What does Ra represent graphically?

***REFERENCES:**

Engineering Metrology by R K Jain.