# Measuring Surface Roughness – A Simple Method

▪ **A. Chennakesava Reddy**

## Introduction

Surface finish is one of the important factors deciding the quality of non-machined surfaces of castings. Casting surface finish is now being specified as important criteria for acceptance of castings by end users. Rough surface on castings increases tool wear, friction in fluid flow applications and needs costlier surface treatment. The as-cast surface especially from green sand modulus is irregular and random in nature. Consequently considerable developments have been made in the area of moulding system and mould and core washes which result in improvement in the surface finish of castings. Thus, when the casting manufacturers as well as purchasers have been giving importance to the finish of the castings, the development of a suitable test procedure for quantitative assessment of the surface finish of castings naturally deserves all the attention. A special experimental setup working on the stylus probe LVDT principle has been designed and developed to determine the surface roughness with a fair amount of accuracy.

Surface finish of castings represents the degree of smoothness of the as-cast surface. This is measured in terms of the surface roughness which is the mean deviation of surface at different locations from the datum surface. Jani[1] has detailed the principles of surface roughness measurement. According to Beckwith & Buck[2] either the peak to peak height or the arithmetical average or the root mean square (RMS) average may be used as a measure of the surface roughness. The American Standards Association[3] has specified the arithmetical average of deviation as the standard for expressing the surface roughness. Fairfield and Mac Conche[4] have expressed the surface roughness as the standard deviation

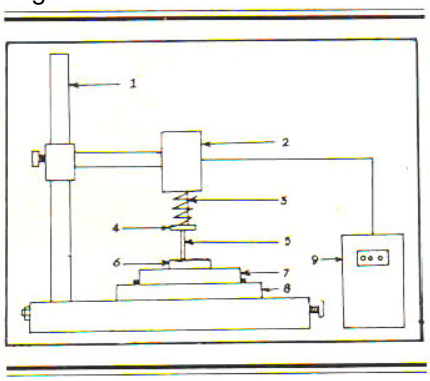


Fig. 1 Stylus Probe-LVDT method

1. Stand
2. LVDT
3. Spring
4. Core
5. Stylus probe
6. casting
7. Surface plate
8. Traversing bed and
9. Digital monitor

of hills and valleys with respect to the average level and studied the effect of sand grain distribution on the surface roughness, Nelson[5] has measured the heights of peaks and valleys at lower magnification by cutting the specimen at an angle. Swing[6] has described the Roughness Height Rating (RHR) values by a method of cross-section. In this, small cross-section are out at random locations from the casting. Photograph of samples are taken at a magnification of 200X. On the photo graph, the mean line is established by assuming a cut-off length. Measurements of deviation from the mean line are made with suitable correction for magnification and then the RHR value is computed.

## Experimental Procedure

A special experimental set-up has been designed and developed to facilitate quantitative assessment of surface roughness on the test castings by the stylus probe-LVDT method. A dial gauge method is used to compare quantitatively the readings of stylus probe-LVDT method.

## Dial Gauge Method

The test specimen is kept on the leveling table which is mounted on traversing bed. The surface of the specimen is leveled to be truly horizontal with the help of spirit level. The dial gauge is then held above the specimen and the stylus is slowly lowered till it just touches the specimen. The stylus of the dial gauge is capable of sensing minimum deviations of 0.015 mm.

## Stylus Probe-LVDT Method

The set-up shown in fig.1 consists of a stylus probe with a hardened steel ball tip with a nominal radius of 0.05mm. the stylus probe is mounted on a movable core of linear variable differential transformer (LVDT). This LVDT is connected to a digital monitor. The specimen to be tested is mounted on a surface plate which is mounted the traversing bed. The specimen is leveled to be truly horizontal using the spirit level. LVDT is then adjusted till the stylus probe touches the specimen and a zero reading is obtained on the digital monitor. When the casting is moved by the fine movement of the traversing

bed. The vertical displacement of stylus probe is picked up by LVDT whose output is led to the digital monitor. Then the readings on the monitor are noted down.

In both the methods, the deviations are measured at intervals of 1.0mm for a cut-off length of 10,0mm along one particular direction. Such measurements are made at five random locations. Then the test specimen is rotated through $90^0$. After leveling, the readings are similarly taken at random locations. The RMS average values of the readings to each cut-off length are computed and the surface roughness rating of the test plate is considered as the above RMS values.

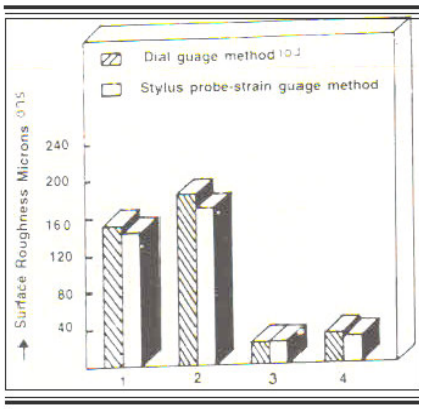


Fig.2 Surface roughness rating of castings

1. Green sand mould
2. $CO_2$-sodium silicate mould
3. Investment shell mould
4. Permanent mould

Plate castings of Al-8%Si-2%Mg alloy measuring 10cm x 10cm x 2.5cm have been cast in green sand, $CO_2$-sodium silicate, investment shell and permanent moulds. Mould washes were not employed.

## Result and Discussion

The surface roughness values of castings made in different moulds are shown in fig.2. The roughness of cast surfaces made in green sand $CO_2$ –sodium silicate moulds is random in nature. The surfaces exhibit heterogeneity with respect to roughness which varies in the different areas of the same casting. Castings made in investment shell and permanent moulds show good surface finish. It is possible to make a qualitative and quantitative assessment of surface roughness values obtained with stylus probe-LVDT method. The readings obtained by stylus probe-LVDT method are reasonably accurate.

## Conclusion

The stylus probe-LVDT method is suitable for measuring the surface roughness of castings. Surface finish of castings cast in investment shell and permanent moulds is better than that of castings made in green sand and $CO_2$-sodium silicate moulds.

## *References*


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