Presented at NDE2002, to predict. assure. improve. www.nde2002.org
National Seminar of ISNT, the Indian Society for Non Destructive Testing
Hotel Taj Connemara and Raja Muthiah Hall, Chennai, 05. – 07. 12. 2002

Development of Ball Indentation Technique for Evaluating Mechanical Properties of Materials

Goutam Das, V. R. Ranganath, Sabita Ghosh and D. K. Bhattacharaya

National Metallurgical Laboratory, Jamshedpur

Abstract

The determinations of mechanical properties of materials by using non-conventional techniques have been an active area of research for a long time. Among the several non-destructive methods of determine mechanical properties of materials, the ball indentation technique (BIT) got tremendous importance in the recent past. Also, it is one of the most promising techniques to evaluate mechanical properties of materials, as it requires small amount of test material. Furthermore, it can be used to characterize weldments and their HAZ, avoids the need to fabricate test specimen and it is relatively rapid. It can be used in-situ on actual components.

The effectiveness of the ball indentation technique (BIT) has been established and validated with conventional test results for few materials. The design and experimental parameters of BI experimentation in the laboratory scale have been optimized. Software was developed, one for analyzing the BI test results and another for experimentation of BI test. The yield strength (YS), ultimate tensile strength (UTS), strain-hardening exponent (n), hardness (HB) and strength coefficient (K) values have been determined for all the tested materials through BIT. The conventional mechanical properties were also determined. The loading rate has been fixed at 0.05-2 mm/min and diameter of the indenting ball was kept as 1.0 - 2.0 mm. For multiple indentations at the same location, the loading has been applied through a tabletop universal mechanical testing machine. The indentation diameters were measured both through a linear variable differential transducer (LVDT) displacement and through direct optical microscope after interrupting the test at each loading. The BI test results have been verified with the conventional mechanical test results and it was found that the BI test results are very close to actual values for some materials. However, for few materials the LVDT measured indentation diameters deviated from that of direct measurement and consequently the mechanical properties also. Among all the materials studied above SA333 and HSLA steels show Lüders band. This may be correlated for the deviation of actual indentation diameter after each loading while using LVDT measured diameter. However, more work is necessary to get the details of the deviation of indentation diameter and to set a correction factors to convert the deviated indentation diameters into the actual indentation diameters.

Overall, it is found that BI technique can be used successfully to determine the mechanical properties of materials particularly where there is a constrained of test materials. It also can be used in the field on actual component to determine the degradation of particular components.