1.2CLASSIFICATION OF MATERIAL TESTING

Materials testing tests the accuracy and load capacity of materials in different environmental conditions. Materials testing is not only performed at research institutes, it also helps companies to gather valuable knowledge for the improvement of existing products and the development of new ones.

The key principle of materials testing is mechanical loading of a specimen or material up to a certain deformation or to break. The material properties which come as a result of this are shown through material characteristics.

Destructive Materials Testing

In destructive materials testing, the specimens are taken from a material and tested for chemical or mechanical loads. The specimen is altered (on the surface) or destroyed. The tested component, or material specimen, can no longer be used after the test.

Destructive materials testing plays a particularly important part in aerospace engineering and the automotive industry, since in these cases material fatigue presents an extremely high risk factor. Yet, materials and components testing has also become crucial in medical engineering.

In most test techniques the specimen is destroyed:

- Impact test
- Sheet metal forming
- Drop weight test
- High-speed tensile test
- Tensile test
- Biaxial test
- Compression test/crush test
- Creep test
- Flexure test
- Fatigue test
- Puncture test
- Torsion test
- Shear test

Non-Destructive Materials Testing

The quality of a workpiece is tested without damaging it when using non-destructive materials testing. Using this approach, it can be ensured that the material quality is high enough for further processing and that it can stand up to loads reliably, for the long-term.

Liquids

One common nondestructive technique, used to locate surface cracks and flaws in metals, employs a penetrating liquid, either brightly dyed or fluorescent. After being smeared on the surface of the material and allowed to soak into any tiny cracks, the liquid is wiped off, leaving readily visible cracks and flaws. An analogous technique, applicable to nonmetals, employs an electrically charged liquid smeared on the material surface. After excess liquid is removed, a dry powder of opposite charge is sprayed on the material and attracted to the cracks. Neither of these methods, however, can detect internal flaws.

Radiation

Internal as well as external flaws can be detected by X-ray or gamma-ray techniques in which the radiation passes through the material and impinges on a suitable photographic film. Under some circumstances, it is possible to focus the X rays to a particular plane within the material, permitting a three-dimensional description of the flaw geometry as well as its location.

Sound

Ultrasonic inspection of parts involves transmission of sound waves above human hearing range through the material. In the reflection technique, a sound wave is transmitted from one side of the sample, reflected off the far side, and returned to a receiver located at the starting point. Upon impinging on a flaw or crack in the material, the signal is reflected and its traveling time altered. The actual delay becomes a measure of the flaw’s location; a map of the material can be generated to illustrate the location and geometry of the flaws. In the through-transmission method, the transmitter and receiver are located on opposite sides of the material; interruptions in the passage of sound waves are used to locate and measure flaws. Usually a water medium is employed in which transmitter, sample, and receiver are immersed.

Magnetism

As the magnetic characteristics of a material are strongly influenced by its overall structure, magnetic techniques can be used to characterize the location and relative size of voids and cracks. For magnetic testing, an apparatus is used that contains a large coil of wire through which flows a steady alternating current (primary coil). Nested inside this primary coil is a shorter coil (the secondary coil), to which is attached an electrical measuring device. The steady current in the primary coil causes current to flow in the secondary coil through the process of induction. If an iron bar is inserted into the secondary coil, sharp changes in the secondary current can indicate defects in the bar. This method only detects differences between zones along the length of a bar and cannot detect long or continuous defects very readily. An analogous technique, employing eddy currents induced by a primary coil, also can be used to detect flaws and cracks. A steady current is induced in the test material. Flaws that lie across the path of the current alter resistance of the test material; this change may be measured by suitable equipment.

Infrared

Infrared techniques also have been employed to detect material continuity in complex structural situations. In testing the quality of adhesive bonds between the sandwich core and facing sheets in a typical sandwich construction material such as plywood, for example, heat is applied to the surface of the sandwich skin material. Where bond lines are continuous, the core materials provide a heat sink for the surface material, and the local temperatures of the skin will fall evenly along these bond lines. Where the bond line is inadequate, missing, or faulty, however, temperature will not fall. Infrared photography of the surface will then indicate the location and shape of the defective adhesive. A variation of this method employs thermal coatings that change colour upon reaching a specific temperature.

Finally, nondestructive test methods also are being sought to permit a total determination of the mechanical properties of a test material. Ultrasonics and thermal methods appear most promising in this regard.

Types of Contact and non-contact method testing

Contact Methods	Non-Contact Methods
Traditional ultrasonic testing	Through transmission Ultrasonic
Eddy current testing	Radiography testing
Magnetic testing	Thermography
Electromagnetic	Infrared Testing
Penetrant testing	Holography
Liquid penetrant	Shearography
-	Visual inspection

Benefits and Limitations of DT and NDT

Destructive Testing DT		Non Destructive Testing	
Benefits	Limitation	Benefits	Limitation
Reliable and accurate data from the test specimen	Data applies only to the specimen being examined	The part is not altered and can be used after testing	It is usually quite operator dependent
Extremely useful data for design purposes	Most destructive test specimens cannot be used once the test is complete	Every item of the material can be examined with no adverse consequences	Some methods do not provide permanent records of the examination
Data achieved through DT usually quantitative	Require large, expensive equipment and a laboratory	Materials can be examined internal and externally	Orientation of discontinuities must be considered
Various service conditions are capable of being measured		Parts can be examined while in service	Evaluation of some test results are subject to dispute
Information can be used to establish standards		Portable and can be taken to the object to be examined	can be expensive *i.e.* radiography