1.4. DEVELOPMENTOFTESTING

Materials testing, measurement of the characteristics and behavior of such substances as metals, ceramics, or plastics under various conditions by a full- or small-scale model of a proposed machine or structure may be tested. Alternatively, investigators may construct mathematical models that predict capabilities of the structure. Standard test methods have been established by such national and international bodies as the International Organization for Standardization (ISO).

a) Identify the Need& Define the Problem

The first step is to identify and define the problem. The following major problem, which needs to consider during development of material testing.

- ✓ A problem can be regarded as a difference between the actual situation and the desired situation. It involves diagnosing the situation so that the focus on there all problem.
- ✓ Development of a new manufacturing processing line or making changes to an existing one, needs an improvement of testing method sunder different conditions and in different applications.
- ✓ Improvement of Troubleshooting, to determine what is causing issues during processing.
- ✓ Scale-up of a testing technology.
- ✓ Increase fundamental understanding of materials.
- ✓ Improvement of the process/product performance relative to demands of customers.
- ✓ Reduction of existing process spread, which lead stop or capability.

(b) Research the Problem

- ✓ Some possible ways to identify potential process by using knowledgeoftheprocess,historicaldata,cause-and-effectanalysisandbrainstorming, etc.,

- ✓ The research of problem may concern of a condition to be improved, a difficulty to be eliminated, or a troubling question that exists in literature or testing techniques, specific issue, contradiction or gap between present and future testing techniques in that need of meaningful understanding and deliberate investigation.
- ✓ Ifimportantfactorsareleftoutduringdevelopmentoftestingexperiment,then the results of the experiment will not be accurate which must be take care.

(c) Develop possible testing methods

- ✓ The size of the testing is dependent on the number of factors or interactions to be studied, the number of levels of each factor, budget and resources allocated for carrying out the experiment, etc.
- ✓ The development testing plan methods is done using various techniques of graphical presentation, such as Autocad, simulation techniques methods, etc.
- ✓ During the design stage, it is quite important to consider the confounding structure and resolution of the design.
- ✓ The material testing code book gives the basics of testing develop standards, which is based on environment, material specification and analysis methods etc.

(d) Evaluate the Alternatives & Select Most Promising methods

- ✓ The various possible method is developed and stimulated in softwares ensure the theoretical acceptance.
- ✓ Pre presenting the information of testing methods are deciding criteria of effective method.
- ✓ The testing methods need to satisfy the basic criteria like cost and time
- ✓ The combination of different testing methods is also selected for the effectiveness.

(e) Initial Design

- ✓ The initial design is often made on the basis of avoiding stresses the exceed the yield strength of the material. Then the design is checked by more refined analysis, and changes are made as necessary to avoid more subtle modes of material failure, such as fatigue, brittle fracture, and creep.
- ✓ In making design decisions that involve safety and durability, the concept of a safety

factor is often used. The safety factor in stress is the ratio of the stress that causes

failure to the stress expected to occur in the actual service of the component. That is,

X 1= stress causing failure/stress in service

(f)Construct a prototype

- ✓ The materials that will be used in final testing methods may be expensive or difficult to fabricate, so prototypes may be made from different materials than the final product. In some cases, the final production materials may still be undergoing development themselves.
- ✓ A prototype, or trial model, is often made and subjected to simulated service testing to demonstrate whether it is functions properly.
- ✓ Prototypes are generally made with much closer individual inspection and the assumption that some adjustment or rework will be part of the fabrication process.
- ✓ Prototypes may also be exempted from some requirements that will apply to the final product.

(g) Test and Evaluate the Prototype

- ✓ It is important to test and evaluate your prototype along the way for functionality, usefulness, and safety. The final product may be subject to a number of quality assurance tests to verify conformance with drawings of specifications.
- ✓ These tests may involve custom inspection fixtures, statistical sampling methods, and other techniques appropriate for ongoing production of a large quantity of the final product.
- ✓ The failure of prototype leads to choosing alternatives and redesign the section.
- ✓ The early estimate of loads may have been quite uncertain. A prototype may also be subjected to simulated service testing until either a mechanical failure occurs, perhaps

by fatigue, creep, wear, or corrosion, or the design is proven to be reliable. This is called durability testing.

- ✓ For very large items, it may be impractical or uneconomical to test a prototype of the entire item. A part of the item, that is, a component, may then be tested.

(h) Communicate the Design

- ✓ Communication design is a mixed discipline between design and information-development which is concerned with such as printed, crafted, electronic media or presentations to communicate with people for overcoming some unreliable problems.

(i)Redesign

- ✓ The redesign is approached existing testing techniques is outdated for the present materials and to minimizing the calibration.

Example for development of testing

DEVELOPMENT OF MECHANICAL TESTING-Structures and machines, or their components, fail because of fracture or excessive deformation. In attempting to prevent such failure, the designer estimates how much stress (load per unit area) can be anticipated, and specifies materials that can withstand expected stresses.

* Test machine grips are designed to transfer load smoothly into the test piece without producing local stress concentrations.

DEVELOPMENT OF STATIC COMPRESSION-Tests determine a material's response to crushing, or support-type loading (such as in the beams of a house). Testing machines and extensometers for compression. Tests resemble those used for tension tests.

DEVELOPMENT OF STATICS HEAR AND BENDING TESTS- In plane shear tests indicate the deformation response of a material to forces applied tangentially Shear strength of rivets and other fasteners also can be measured.

DEVELOPMENT OF MEASURES OF DUCTILITY-Ductility is the capacity of a material to deform permanently in response to Ductility can be expressed as strain, reduction in area, or toughness Reduction in area (change in area per unit area) may be measured, for example, in the test section of a steel bar that necks when stressed.

DEVELOPMENT OF HARDNESS TESTING- Based on the idea that a material's response to a load placed at one small point is related to its ability to deform permanently (yield), the hardness test is performed by pressing a hardened steel ball (Brinell test) or a steel or diamond cone (Rockwell test) into the surface of the test piece.

DEVELOPMENT OF IMPACT TEST-Many materials, sensitive to the presence of flaws, cracks, and notches, fail suddenly under impact.

DEVELOPMEN TO FFRACTURE TOUGHNESS TESTS-The criterion for failure became sudden propagation of a crack rather than fracture. Tests have shown that cracks occur by opening, when two pieces of material part in vertical plane, one piece going up, the other down; by edge sliding, where the material splits in horizontal plane, one piece moving left, the other right; and by tearing, where the material splits with one piece moving diagonally upward to the left, the other moving diagonally downward to the right.

DEVELOPMENT OF CREEP TEST-Creep is the slow change in the dimensions of a material due to prolonged stress; most common metals exhibit creep behavior. In the creep test, loads below those necessary to cause instantaneous fracture are applied to the material, and the deformation over a period of time (creep strain) under constant load is measured, usually with an extensometer or strain gauge.

DEVELOPMENT OF FATIGUE TEST-Materials that survive a single application of stress frequently fail when stressed repeatedly. This phenomenon, known as fatigue, is measured by

mechanical tests that involve repeated application of different stresses varying in a regular cycle from maximum to minimum value.

1.3 SELECTION OF MATERIAL

One of the most challenging task of materials engineer is the proper selection of the material for a particular job, e.g., a particular component of a machine or structure. An engineer must be in a position to choose the optimum combination of properties in a material at the lowest possible cost without compromising the quality.

Factors affecting selection of materials

Performance

This characteristic refers to those properties that are required for the product to satisfy its functional requirements. Materials typically perform one or more functions in a product such as carrying loads, providing heat conduction or thermal insulation, providing electrical conduction or insulation, or containing fluids.

Mechanical properties

The material must possess a certain strength and stiffness. Selected materials are examined for strength and stiffness values, and then potential materials are further inspected for other desired properties.

Wear of materials

Wear is s problem when the materials are contacting each other in product So it must be ensured that the selected materials have wear resistance. Corrosion is an important engineering design criterion for designs open to the environment for a longer period of time. Some materials are very likely to be corroded in the service depending on the service environment Metals like iron are heavily prone to corrosion if it not prepared to recite corrosion Painting or any other surface coating method, cathodic protection, etc. are possible ways to minimize the effect and increase the service life.

Costs

Cost is a critical fact to consider when selecting materials for a certain design for most products because they are facing a severe competition in the market. The cost factor can be neglected when performance is given the top priority. When estimating costs, all the associated cost factors must be considered to get a more reasonable value. It may involve the transportation, processing costs, etc.

Reliability and Environmental Resistance

This characteristic relates to the durability of a material, which is its ability to resist deterioration in the environment in which it will be used. It includes such properties as fatigue resistance and resistance to radiation, chemical solvents, and corrosive agents.

Critical characteristics that are needed to satisfy the functional requirements and their constraints, manufacturing process, since the manufacturing process will affect the performance properties of the material. Furthermore, the selection of the manufacturing process will depend on certain properties of the materials. Material properties that can dictate the choice of a manufacturing process include ductility, toughness, form ability, and castability. In addition, one must take into account the geometric attributes of the production.

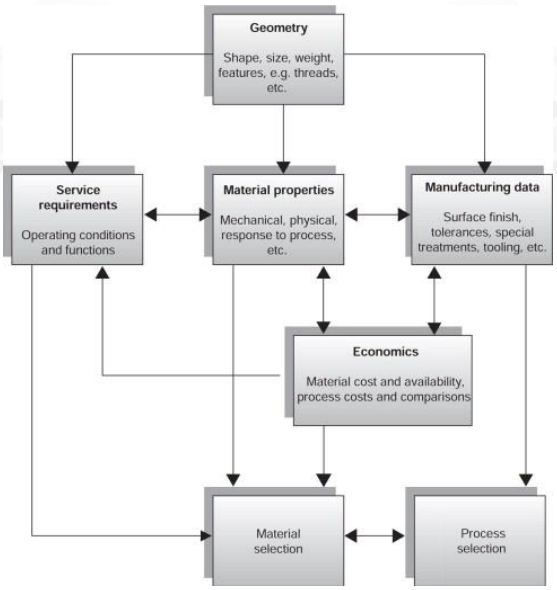
Procedure for materials selection:

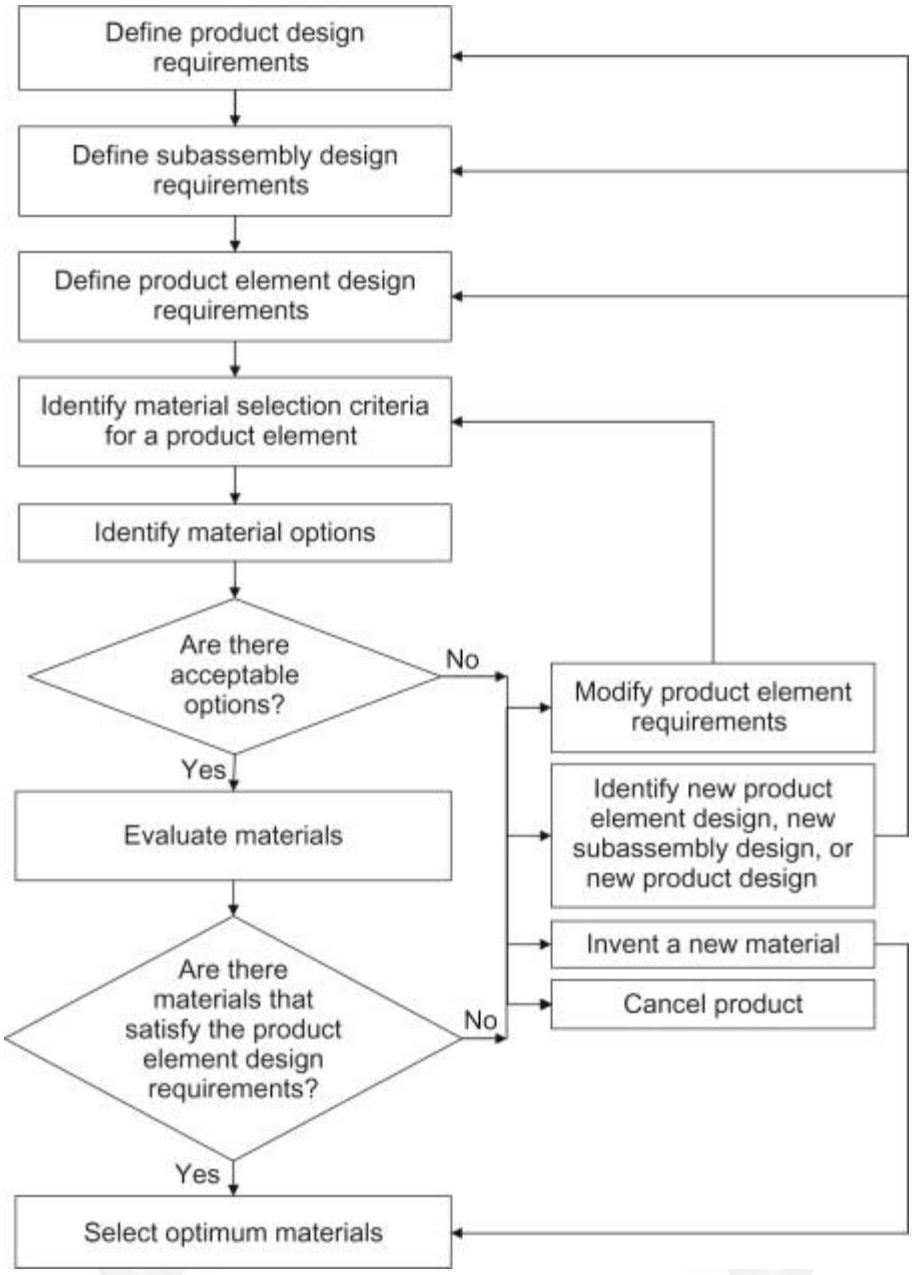
The selection of an appropriate material and its subsequent conversion into a useful product with desired shape and properties can be a rather complex process. Nearly every engineered item goes through a sequence of activities that includes:

design → material selection → process selection → production → evaluation → and possible redesign or modification

- Identify product design requirements.
- Identify product element design requirements.
- Identify potential materials.
- Evaluate materials.
- Determine whether any of the materials meet the selection criteria.

Steps to be considered for selection of materials





Step 1: Identify the design requirements.

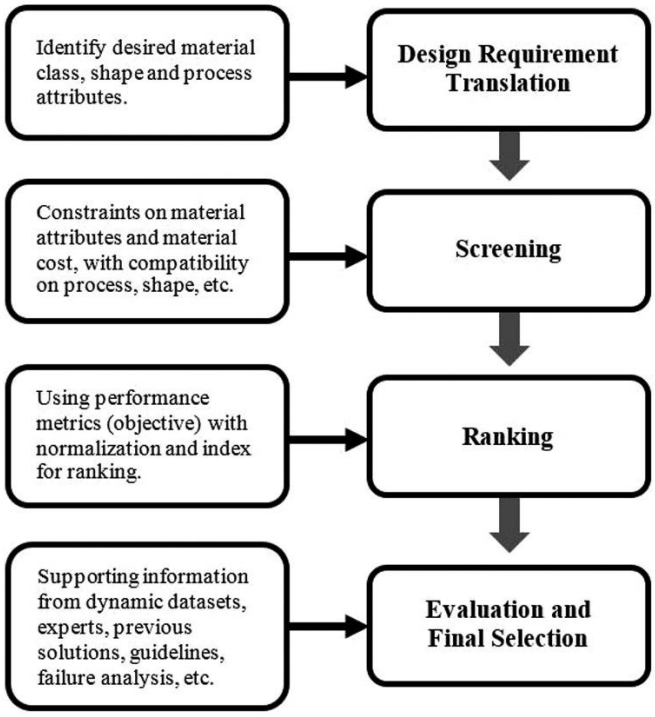
Each step involves a synthesis process in which all of the various concerns and requirements are considered together. Compromises, between conflicting requirements are usually necessary and continual effort.

The design requirements include the following items Performance requirements

- ✓ Simplicity and practicability
- ✓ Reliability requirements
- ✓ Size, shape, and mass requirements

- ✓ Cost requirements

Step 2: Identify materials selection criteria
The materials selection criteria are specific materials properties derive from the requirements identified during pervious step.
Step 3: Evaluate candidate materials
There may be candidate materials for which there insufficient date available to indicate whether the materials satisfy certain selection criteria.
Step 4: Select materials to fabricate a component or form a joint between components. they do meet the selection criteria by creating a prototype. Select the materials that satisfy all the materials selection criteria at the lowest cost. Remember, cost includes the cost of the material and the cost
Step 5: Failure Analysis
The selection of materials is finalized with help of failure analysis mode.
Step 6: Service Experience
Design changes may also be made as a result of experience with a limited production run of a new product. Purchasers of the product may also use it in a way not anticipated by the designer, resulting in failure. The design process often continues even after a product is established and widely distributed.



1.5 TESTING ORGANIZATIONS AND ITS COMMITTEE

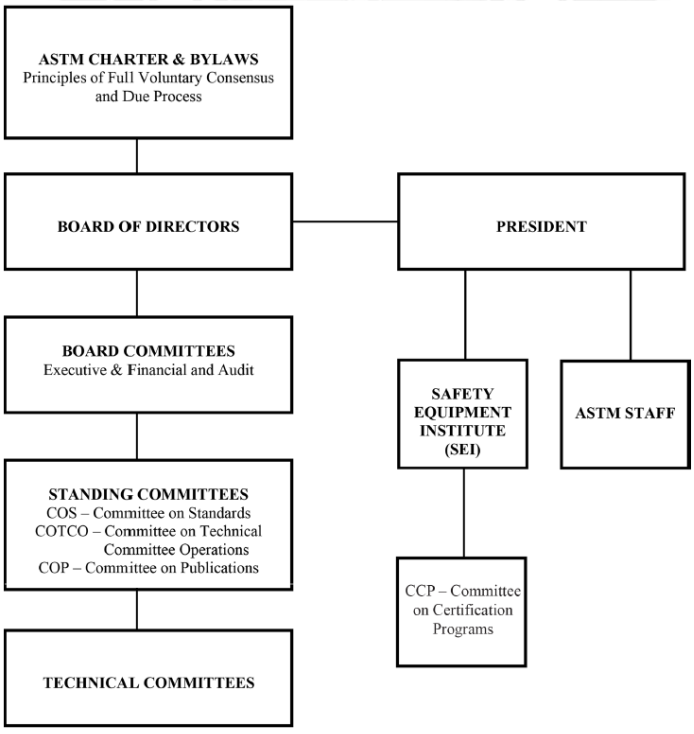
(a) INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

The International Organization for Standardization (ISO) international standard-setting body composed of representatives the various national standards organizations. ISO is a voluntary organization whose members are recognized authors on standards, each one representing onecountry.MembersmeetannuataGeneralAssemblytodiscussthestrategicobjectivesof ISO. The organization is coordinated by a central secretariat based in Geneva.

(b)ASTM INTERNATIONAL

* ASTM International, formerly known as American Society for Testing Materials, is an international standards organization that develops publishes voluntary consensus technical standards for a wide range materials, products, systems, and services.

* Organization Chart



(c) BUREAU OF INDIAN STANDARDS (BIS)

* BIS is the National Standard Body of India established under the BIS Act 2016 for the harmonious development of the activities of standardization marking and quality certification of goods and for matters connect herewith or incidental thereto.

* BIS has been providing traceability and tangibility benefits to the nation economy in a number of ways

- Providing safe reliable quality goods
- Minimizing health hazards to consumers
- Promoting exports and imports substitute
- Control over proliferation of varieties etc. Through standardization certification and testing

Organization of BIS

→The organization of BIS consists of following members,

- Governing Council Member
- Executive Committee
- Administrative Structure

Other Testing Organizations in India

- The National Metrological Institutes (NMIs) namely National Laboratory (NPL) and Bhabha Atomic Research Centre(BARC)
- The Standards Bodies namely Bureau of Indian Standards (BIS) and Standardization, Testing and Quality Certification(STQC)
- Council for Industrial and Scientific Research (CSIR), the other Boards Quality Council of India(QCI), the other organizations under nodal department of QCI i.e. Department for Promotion of Industry and Internal Trade, the other Departments / organizations under nodal Ministry i.e. Ministry of Industry and Commerce are the bodies related to NABL

Some International Standards Organizations:

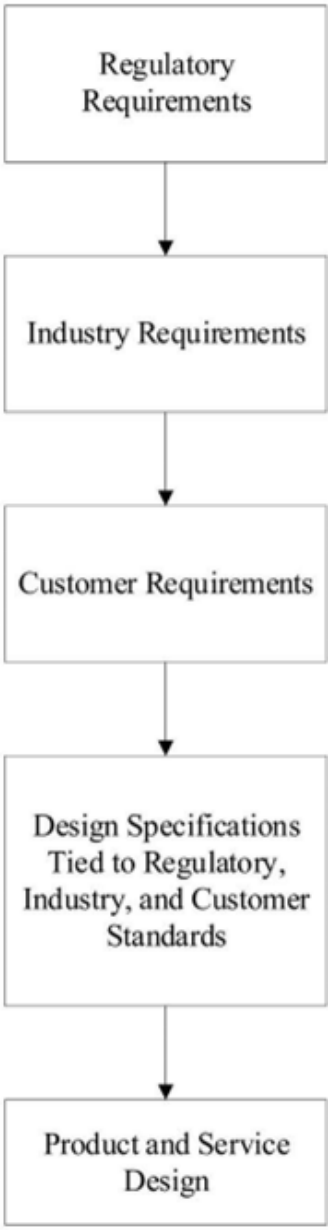
- International Organization for Standardization (ISO)
- American Society of Testing and Materials (ASTM) International World Wide Web Consortium (W3C)
- Institute for Reference Materials and Measurements (European Union)
- **Many others …...**

Some United States Standards Organizations

- American National Standards Institute (ANSI)
- National Institute of Standards and Technology (NIST)
- Society of Automotive Engineers
- American Society of Testing and Materials (ASTM)
- **Many others...**

A Partial Listing of Standards Organizations by Country

- Australia: Standards of Australia (SA)
- Canada: Standards Council of Canada (SCC)
- China: Standards Administration of China (SAC)
- India: Bureau of Indian Standards (BIS)
- Israel: The Standards Institution of Israel (SII)
- Japan: Japan Industrial Standards Committee (JISC)
- Republic of Korea: Korean Agency for Technology and Standards (KATS)
- Singapore: Standards, Productivity, and Innovation Board (SPRING SG)
- Taiwan (Republic of China): The Bureau of Standards, Metrology, and Inspection (BSMI)
- United Kingdom: British Standards Institution (BSI)
- **Many others by their country ...**



Codes for TEST procedure - Some of the testing standards codes followed in India

1. Rockwell hardness test (1S: 1586-2000)

2. Brinell and Vickers hardness tests (IS:2281-2005RA-2011)

3. Impact tests (Charpy V-Notch and Izod tests)(18:1757-1928 and 159%-1977RA-2009).

4. Tensile Test(IS:1608-2005RA-2011)

5. Compression Test (IS: 1608-2005/150 4506-1979)

6. Bend test for metal products (IS: 1599-1985RA-2011)

7. Shear Test (IS: 5242-1979RA-2006)

8. Beam or flexural bending test (IS: 16-1959)

9. Torsion test and Fatigue test (15:5074-1969RA-2001 and IS: 50751985RA-2001)

10. Indian Standard Mechanical Testing of Metals Tensile Testing (IS: 1608-1995)

11. Metallic materials-Bend test (IS1599-2012)

For all the tests described in this section, the method as specified in relevant ISO standard may also be followed as an alternate method. The final value, observed or calculated, expressing the result of a test or analysis, is rounded off in accordance with IS: 2-1960. The number of significant places retained in the rounded off that of the specified value in the code.

1.7 PRESENTATION OF RESULT

It is very important by sharing the knowledge of result or develop me with others which leads to the various development of test result by other scientist or researchers.

Thestepsto befollowedfordescriptionof testreport

- Statement of the problems
- Materials, methods and procedure used duringtesting
- Resultanalysis
- Summary, conclusion anddiscussion
- Appendicesto supportfindings

(i)Statement of the problems

Statement of the problems describes the objectives of testing which intend about problem.

(ii) Materials,methodsandprocedureusedduringtesting

* Materials, methods and procedure used during testing section includes the material to be tested, the conditions of testing specimen, important apparatus used for testing and the major procedure followed by testing which is referenced from the Indian standard code books.

(iii) Data presentation and Result analysis

The result data presented by plotting it in various methods with proper units assigned or listed in clear and meaningful manner. In every method of result presentation, the statement of result is summarized with the significance of materials.

◆The result analysis is done by various methods,

- Charts
- Graphs
- Tabulation Statement.
- Analytic Software

(a)CHARTS & GRAPHS

A chat displays schematic processes based on the outcome, v answer to a previous variable Graphs, display compare between 2 variables. For example line graphs involve an horizontally and a y-axis vertically on a grid.

(b)TABULATION

Tabulation is a systematic & logical presentation of numeric data and columns, to facilitate comparison.

Major Objectives of Tabulation

To Simplify the Complex Data

To Bring Out Essential Features of the Data

To Facilitate Comparison

To Facilitate Statistical Analysis

Saving of Space

(c) STATEMENT

Statement statistics is a form of mathematical analysis that uses quantified models, representations and synopses for a given set of experimental de or real-life studies. Statistics statement studies methodology to gather review, analyze and draw conclusions from data.

Example: The result of 28 days strength of silicon mixed cube is 29 greater than the conventional concrete.

(d) ANALYTIC SOFTWARE

Software analysis is the analytics specific to the domain of software systems taking into account source code, static and dynamic characteristic (eg, software metrics) as well as related processes of their development and evolution

Example:

BIOVIA MATERIAL S STUDIO- Materials Studio allows you to easily build, modify, visualize and simulate a wide range of materials.

LAS X MATERIALS SCIENCE MODULES- LAS X can be enhanced with a range of advanced modules and applications to form a powerful microscopy imaging environment.

MAT LAB- Computation and plotting

AUTO CAD- Designing of outline element, 20and 3Delement

STADDPRO- Designing of structures

ABACUS- Finite element analysis.

ANSYS ELECTRONICS-It is the premier solution for electromagnetic field, circuit, systems and physics simulation and analysis for electronic design.

(E)SUMMARY,CONCLUSIONANDDISCUSSION

It describes about the general findings of test or experiment and summarizes the important point. Also gives the view about the various error or difficulties occurred during testing, it gives new view and opinion about material, projected view and acceptability for use in market and environment.

(F)APPENDICES TO SUPPORT FINDINGS

It gives supporting data for testing the materials like code books, past material testing history and data for better clarity for testing.

ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY
PALKULAM, KANYAKUMARI
OBSERVE OPTIMIZE OUTSPREAD