## MATERIAL HANDLING

**Definition** → is the art and science involving the moving, packaging and storing of substance in any form.

**Functions of Material Handling** : Movement of material (Textile example) Raw, semi, and Ancillary, spare → Finished

- Section to section
  - With in a section
- Loading
  - unloading

**Scope of Material Handling** → Factors are product type, layout, size of organization, product value, value of activity and importance of PLH to the enterprise Material Handling problem, physical distribution activities

**Significance of Material Handling**. It includes 80% of total time in movement, waiting, finding place, 20% of TC is Material Handling Cost. Enjoys pivotal role in Production Engineering. Due to its improvement in production, today manufacture of Material Handling Equipment has itself become a major industry of its own. Today, method Study— Plant Layout—Material Handling are 3 sides of a △ .

PL and Material Handling enhance the effectiveness of each other and are co-existing. A best layout is one which ensures smooth Material Handling.

## UNIT LOAD CONCEPT

Number of items or bulk material so arranged that mass can be picked up and moved as a single object, too large for manual handling. In other words quickly move alot as a unit rather than individually.

**Principles of Material Handling :**

Following are the principles

1. Planning – Preplan for efficient operation of plant.
2. System analysis – Make all activities (Material receiving, finished good, storage production, inspection, packing and T.P) as integrated one.
3. Material flow – Design good layout with minimum flow.
4. Simplification – Handling should be simplified by reducing, combining or eliminating unnecessary movements of work.
5. Gravity – utilize wherever possible.
6. Space utilization- best utilization.
7. Unit size - Increase to possible limit.

8. Mechanization – Mechanize the operations.

9. Automation – Introduce Automation.

10. Equipment selection – While selecting pay attention to type and quantity of material to be handled / moved.

11. Standardization –

12. Adaptability –

13. Dead weight – Load carried / weight of equipment should be increased.

14. Utilization- use to best level.

15. Maintenance – plan well for pre-maintenance and replacement of spare parts.

16. Flexibility.

17. Full capacity.

18. Safety.

**Material Handling Costs**

Cost of owning + Maintenance Cost + Cost of operation

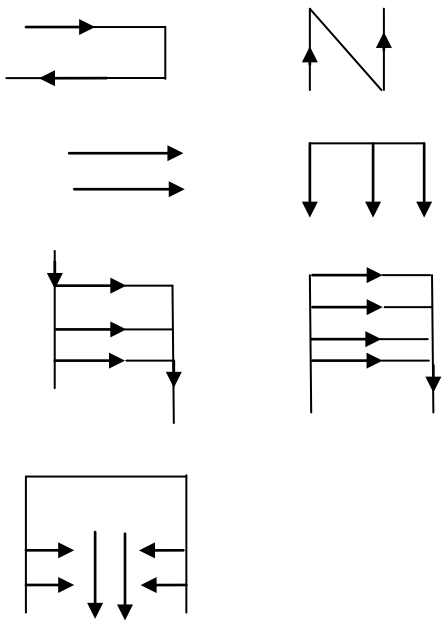
Approaches to reduce Material Handling Costs.

(i) If necessary only use Material Handling Equipment.

(ii) Mechanise, largely by conveyance Power trucks.

(iii) Making Handling more efficient.

**Flow pattern :**



**Determinants of Material Handling:**

**Approach I**: Production Process, Capacity of Material Handling equipment, Human element

**Production Process** : Volume produced, Material characteristics and type layout plan.

Eg: Heavy equipment for producing 1000 T.V. sets is different from plant producing 20 steam turbines.

**Equipment factors**

1) Load carrying and movement characteristics (Adaptability)
2) Flexibility
3) Power and Capacity
4) Speed and Space
5) Supervision and Maintenance
6) Environment and Cost

**Human factors**: Details of available man power, safety of personnel.

**Approach II:**

1. **Material / Product:** Characteristics, Volume of Production, Number of Operators, Storage requirement.
2. **Moves**: Frequency, Speed, Rate, Volume, Area, Distance, Sources, Destinations.
3. **Handling method**: Unit, Gravity
4. **Process**: Type, Sequence, Layout, Space.
5. **Building** – Size, Shape, Type, Number of Floors, Location of Door, Ceiling height.
6. **Site** – Topography, Transport Facilities, expansion possibilities.
7. **Personnel**: Number, Movement, Safety, Working Condition.

**Classification of Material Handling** :

1. Equipment oriented (Overhead system, conveyor, fork lift, Industrial truck, Underground).
2. Material oriented (Unit, liquid)
3. Method oriented ( Manual, Mechanical, Automatic)
4. Function Oriented (TP, Conveyor, Elevator, Transferring)
5. Lifting, Holding, Dropping
6. Loading, Positioning, Unloading, Moving, and Stocking.
7.

**Problems in Material Handling :**

1. Delay in handling and moving leading to stoppage of machinery, low production
2. Waste of labour skills using skilled labours for loading, unloading, moving.
3. Damages caused during Material Handling.
4. Material waiting for Material Handling and vice-versa.
5. Bad handling

6. Floor conjestion near work centers, garg ways, stores, inspection areas.

**Material Handling in Relation to Plant Layout and Safety**

**Layout:** Material Handling plays an Integral part in plant layout and influence directly. Material Handling should ensure straight line move provided machines are arranged judicially, logical sequence – location of stores tool crib - use EOT crane - in MS building elevators / lifts of proper size is required.

**Safety:** 2/3rd of accident causes are due to Material Handling. It has become a great concern for production system. Take safety precautions in relation with Material Handling.

**Economy of Material Handling:**

Maximum Justifiable Investment

$$Z = \frac{(S + T + u - E)}{A + B + C + D}$$

Yearly cost of main

y = A + B + C + D

Yearly profit = [ (S + T + U – E) X ] – Y

Rate of profit = P = (V/ I) + A

No. of years amortization of investment

H = 100 / (P + D)

**Essential of Successful Purchasing**:

It is a primary function since the first act of a manufacturing concern is to purchase materials. Proper sales cannot be affected unless proper material is purchased. Following are the ideal points for successful purchase.

1. What to purchase? 2. From where? 3. When to purchase?
4. How much? 5. At what rate? 6. Maintenance of records.

**METHODS OF PURCHASING**

Different methods of purchase are:

1. Purchasing by requirement: Purchases are strictly by need
2. Purchasing for a specific future period: standard items
3. Market purchasing: Study market trends and get right material at right place at right rate.
4. Speculative purchasing: Purchase in excess of requirement when the cost is low with the idea of selling the surplus when price rises. This has demerits like high inventory cost Deterioration

5. Contract purchasing: Give contract supply spread over a period of time at negotiated price and price concessions without holding large Q (Inventory) & blocking the capital.

6. Group purchasing: Order all items in one order only rather than small orders (Single supplier)

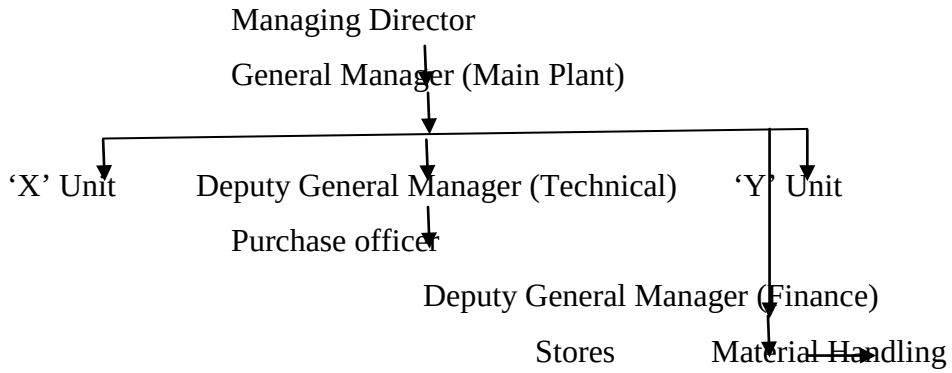
7. Scheduled purchase: Supply without much delay – Regular basis on large scale.

8. Centralised system: For entire organization only one purchase department.

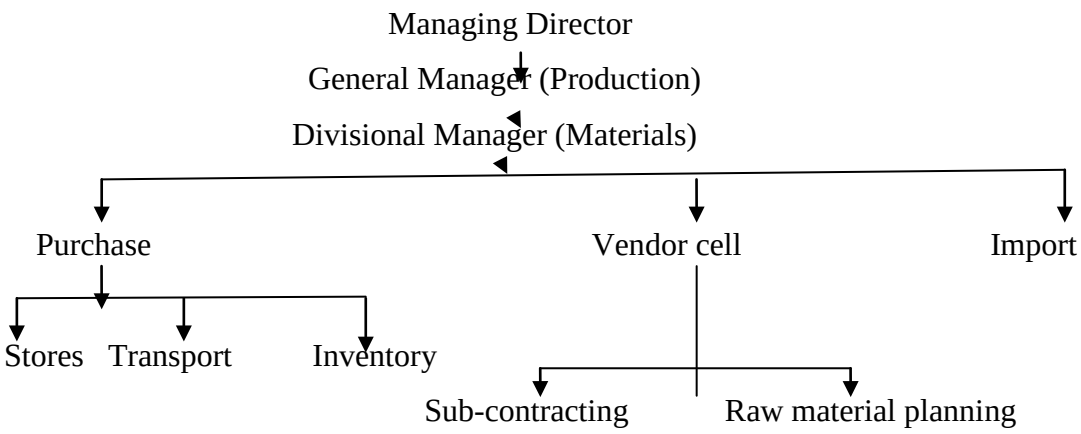
9 . Decentralisation or decentralised purchase:

If the company or organisation has more than one plant decentralised purchase is preferred. Both centralised and decentralised methods have some merits and demerits.

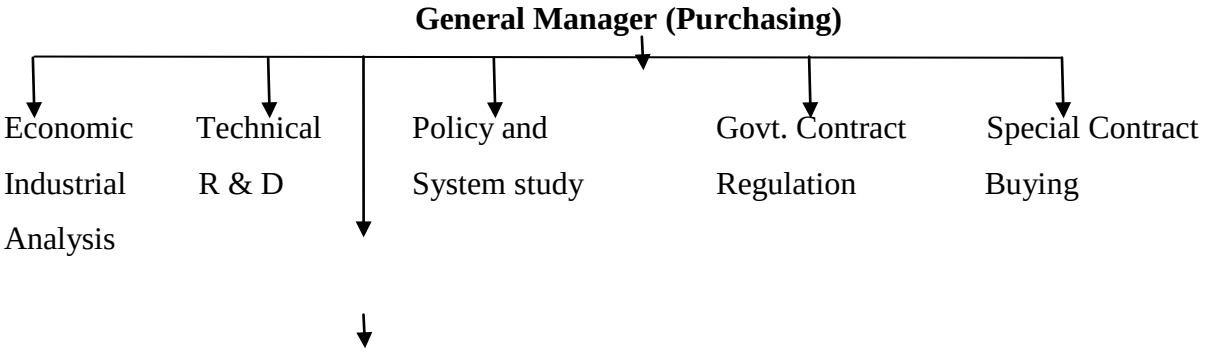
**Organisation Structure for Centralized Purchase**

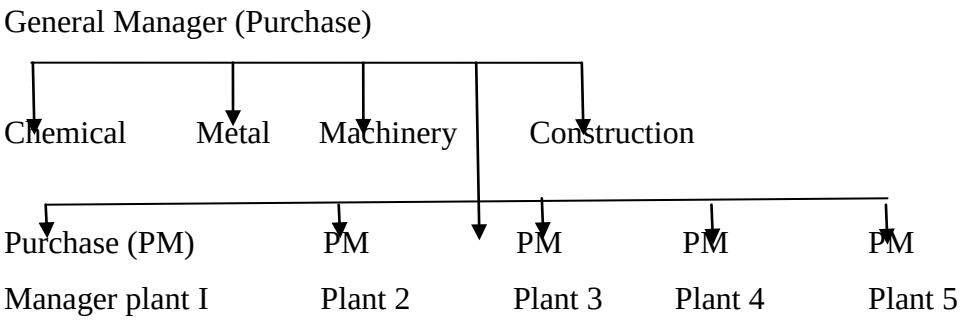



**Organisation Structure for Decentralised Purchase**

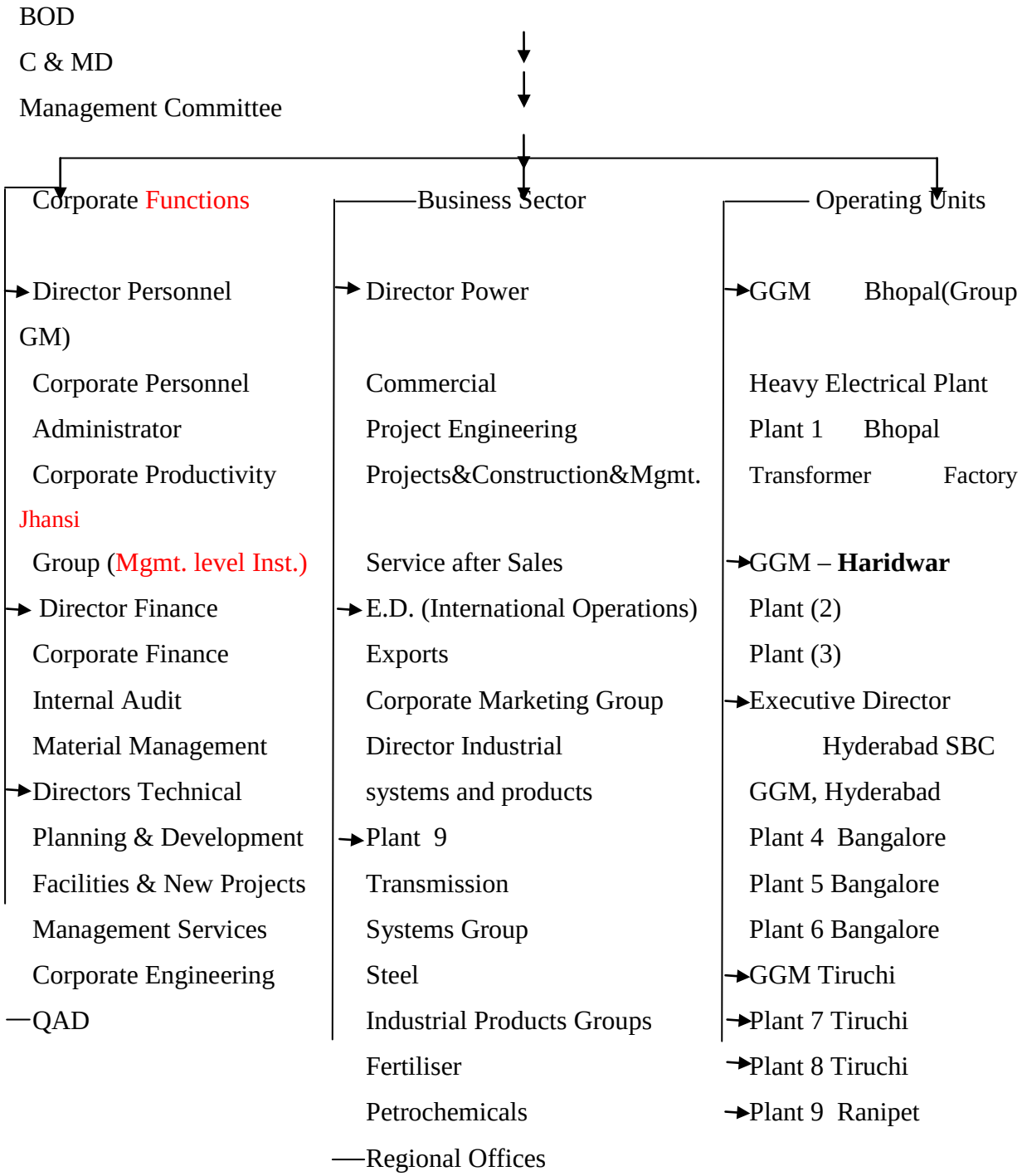



**A Combined Structure and CP & DRP**






**Example of Combined Centralized and Decentralized Purchase**



10. **Forward Buying** : It is nothing but committing an organization into the future (usually one year) Buyer commits to buy at a future date a contracted quantity at contracted price.

11. **Hedging**: Buyer tries to protect himself in the future by entering into two transactions: A purchase contract and a sales contract in two different markets, whose prices move up and down together. The profit or loss sustained in the buying transaction is compensated by the loss and profit in selling transaction. The ideal condition one can reach is zero loss by a perfect Hedge.

12. **Blanket order:** meant for 'c' class. It is an agreement to provide a required quantity over a period of time usually one year at an agreed price. Deliveries are made on the buyers need. The system relieves the buyer from routine work allowing him to concentrate on vital issues. It requires fewer purchase orders and thus reduces clerical work. It often achieves lower prices through quantity discounts by grouping the requirements. The supplier under the system maintains adequate inventory to meet the blanket orders.

**FORMAT OF BLANKET ORDER RECORD (FRONT)**

| **Blanket Order Record** | **Sheet No.** | **Commodity** |
|---|---|---|

| **Purchase of** | **Date** | **Blanket Order No.** | **Quantity** | **Price** | **Terms of Payment** | **Delivery Time Limit** | **L Low Stock point** |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

| **Requisition No.** | **Release No.** | **Date** | **Destination** | **Quantity** | **Requisi-tion No.** | **Date** | **Destination** | **Qty.** |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

| **Commodity** | **Purchased of** | **Blanket Order No.** |
|---|---|---|
| | | |

**M/s. XYZ Mills, Rate Card**

**Code No.:** **Stores :** —— **Unit:**

| **Sl. No.** | **Date** | **Supply Order No.** | **Unit Name** | **'Q' Ordered** | **Rate** | **Remarks** |
|---|---|---|---|---|---|---|
| | | | | | | |

**BLANKET ORDER RECORD (BACK)**

| **Date** | **Balance on** | **Invoice** | **Invoice** | **Total** | **Terms of** | **Gross unit** |
|---|---|---|---|---|---|---|

| | Hand | Date | No | Rs. | Payment | cost |
|---|---|---|---|---|---|---|
| | | | | | | |

| Requisition No | Release order No. | Date | Destination | Quantity |
|---|---|---|---|---|
| | | | | |

Amount Received

| Date | Amount | Remarks |
|---|---|---|
| | | |

Signature of purchase officer

General Manager
Purchasing

**13. <u>Tender buying:</u>**

To avoid favoritism, patronage and personnel preferences, tenders are preferred by public and private units. The steps involved are (i) Establish the bidders list, solicit bids, evaluate bids by comparing quotations and place the order with the lowest bidder. Usually tenders are invited when time permits and the money involved is large. Methods to obtain tenders are (1) open tender (2) Limited tender (3) Single tender (4) Oral tender.

**<u>Open tender:</u>**

Advertised in News paper when items are large and value is large. When large quantities are required, it may be desirable to place an order for a part quantity on a selected supplier to ensure continuity of supply. The lowest tenders are selected in all the cases.

**<u>Specimen Notice Inviting Tender:</u>**

**ABC Mills Ltd.**

Purchase Section

Registered Officer

Branch Office

Address:

Address:

Reference No. :

Tender for :_____

Kindly submit on or before _____ your quotation in duplicate in sealed cover addressed to Purchase Officer with purchase reference Number, due date on the quotation as well as on the cover for under described stock items subject to the terms and conditions given on overleaf.

Thanking you,

Yours faithfully,

**Purchasing officer**

Details:

1. 48” RS under pick loose Reed Semi Auto Loom
2. Drape meter
3. Hygrometer

Note: Samples / pamplates must be provided.

**Offer Form**

M/s, Modern Looms Ltd.,

Ref: No. Your Enquiry No. _____ dated: _____with due date_____

Sir,

We are here by offering the following details.

| Item No. | Description | Quantity | Rate/Unit | Amount |
|---|---|---|---|---|
| 1 | xxx | xxx | xx | xx |
| 2 | xx | xxx | xx | xx |
| 3. | xxx | xxx | xx | xx |
| | | | Total | xxxx |

+ Sales tax
+ Delivery period
+ Transportation cost
+ Erection cost
+ Facilities required at the time of installation
+ Tender validity ----- days
+ Conditions & Terms : 50% advance
  20% after delivery
  10% commissioning (Running)
  20% after satisfactory

xxxxxx

Signature of Tenderer.

M/s XYZ Mills Limited, Ahmedabad

Department : Weaving Item :_____

Comparative statement of_____

| S. No. | Detail | Party (1) | Party (2) | Party (3) | Remarks |
|---|---|---|---|---|---|
| 1 | Basic unit | | | | |
| 2. | Accessories | | | | |
| 3. | Extra yarn + Beam | | | | |
| 4. | CST | | | | |
| 5. | VAT | | | | |
| 6. | Delivery period | | | | |
| 7. | Erection + transportation | | | | |
| 8. | Terms of payment | | | | |
| 9. | Validity of Tender | | | | |

xxx

Prepared by Signature of Purchasing officer G.M.(purchase) V.P (Operations)

## PLANT LIGHTING

**Significance**: Important physical facility at work place – single factor affecting worker ŋ, satisfaction and production. Adequate light is necessary for accurate function. Minimum of 14 lumen is required. A good light is one free from Glare properly diffused, colour pleasant with steady flow (direct). Inadequately excess light accidents Legal requirement 1948 act provisions in act.

Lighting and ŋ, good light safe guards 'sight' or vision of worker operate. ŋ depends on light how best he can see accurately. A well maintained system increases ŋ increases morale decreases Fatigue increases safety.

1. **Ease of seeing** (control speed and accuracy → ŋ special care is taken for older employees suffering from eye sight problem.)
2. **Reduce Eye strain** (Bad light strains eye and fatigues)
3. **Improved quality** (Quality, workmanship depends on labor, finish, colour, dimensions – Illumination needs planning – reduce scrap or rework.
4. Increased Productivity: Increase in speed and ŋ – reduce cost of production
5. Utilisation of Cubic space : Space is costly in city location—allow uniform lighting.
6. Good Housekeeping – cleanliness
7. Fewer accidents
8. Increased morale → Industrial growth
9. Better Supervision – small objects

Sources : { Day Light
Artificial Light

**Day Light :**

1) Availability 2) Nil Maintenance Cost 3) On Power Shed Down 4) Free of Cost

**Problems with Day Light :**

1) Expensive indirectly (Win, Roof…..clean) 2) Timely availability
3) No uniform lighting 4) Can't adjust int..

**Admission of Light** : 1) Allow direct admission without barriers
2) Effective Utilisation.

**Bow Spring Type :** FIGURE

**Factors control lighting : Artificial lighting**

1) Type of source 2) Type of Illumination 3) Quality and Intensity
4) Glare and its effects 5) Colour of Surroundings 6) Maintenance Cost.

**Types of Art illuminations** :

1) General light 2) Supplementary light

3) Modification of these two (group lighting) silk way, screen examination, designing etc

**Amount of Light** : Levels vary 150 Lnn to 2000 llnn

Corridors and Passage – 70 L Stair Case: 100L ordinary work – 150 L Conference Hall -300 L, Class I : Varying simple work 250 – 500 L Class II : continuous medium fire – 500 – 1000 L, Class_III : Continuous fine work : 1000 – 2000 L Class IV : Continuous very precision = > 2000 L

**Glare:** Direct → St. from source

Reflected glare → From material & depends on nature of material, polish or finish

↓

Can overcome by shields, adjust spaces, light of lamp

Use correct lamp.

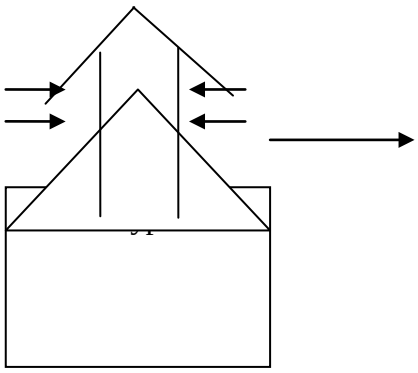
**Colour and Reflection (%)**

White 85, Cream 75, Bright Yellow – 65, Light Blue – 48 olive Green – 40, Blue 21, Deep Red 14, Brown 9, Dark Green 7.

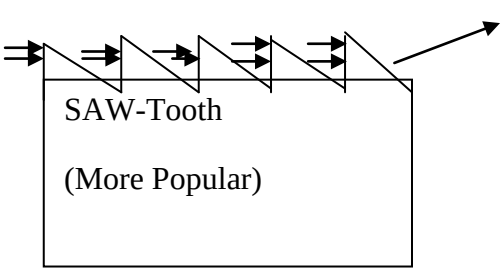
**Maintenance**: Clean frequently (Source + Surroundings) check illumination frequently,

↓

**Separate department** replace dead lamps, follow Group Replacement, Main Voltage properly, hence more spares, wash walls, ceilings frequently



Cheap glazing is North and South → admits Light indirectly

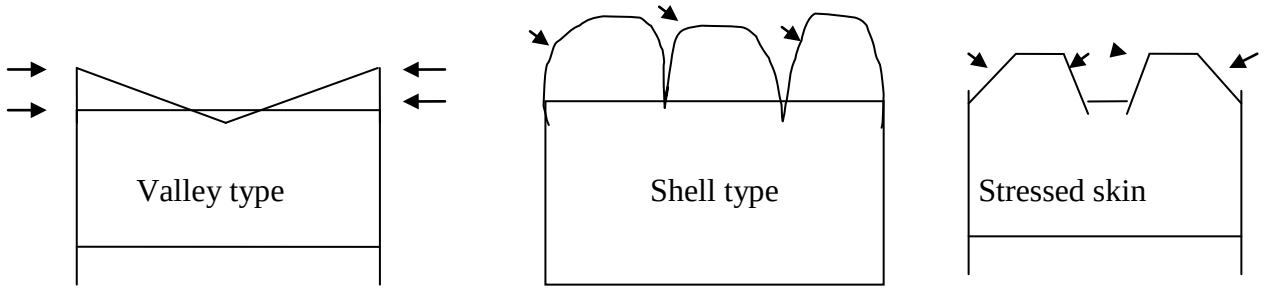


Ref / eccc

SAW-Tooth

(More Popular)

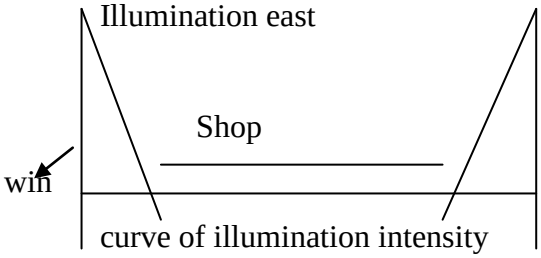
Glazing is directed Towards North




**Effective Utilization of Admitted light**

**Proper care is necessary for**

effective utilization




Problem is found in ‘MS’ building

Steps to be taken to get maximum utilisation

## COMPARISON OF DAY AND ARTIFICIAL LIGHTING

| Sl. No. | Factor / Means | Natural Light | Artificial Light |
|---|---|---|---|
| 1 | Cost | Free of cost – cost of keeping windows and maintenance is not significant. | Expensive – Fixtures are needed – Maintenance cost is high – Reliability is poor |
| 2 | Dependability | Less dependability – Changes as per season – Not available for night shift. | Dependable – Free from weather – Power costs – use of generator inevitable. |
| 3 | Maintenance | No maintenance – only for windows. | More – replacement of failed items. |
| 4 | Health | Harmless to human beings. | Produce heat – use fluorescent rather than incandescent bulbs. |
| 5 | Distribution | Equipments are required for ensuring uniform lighting. | No such problems. |
| 6 | Control of illumination. | Can't be controlled. | Controllable to suit requirement. |

**Facilities Planning: PRODUCT SELECTION**

**Product Selection Concept:**

**Product:** Input to Output with value addition – conversion process occurs at factory (internally) value is added by customers in Market (is outside). Thus the operations Manager to be conscious of consumer needs in addition to technical knowledge.

These days products includes services also – What is a Product"

**"A bundle of benefits to Customers".**

Eg. 1. *Lipstick* – combination of chemicals + adds beauty.

2. *Tonic* – mixture of vitamins which promises health.

If the product is thought in broad the benefits do follow and hence several services become part of product.

## FACTORY BUILDING:

A factory building is a factor which should receive a serious consideration on the part of the management of every industrial enterprise, new or old, big or small. Once the plant location is decided upon, the management's next important task is to raise a suitable building for the plant. A modern factory building is much more than a mere work-shed. It is required to provide protection for men, machines, materials, products, or, even the company's secrets[1]. It has to serve as a part of the production facilities and as a factor to maximize economy and efficiency in plant operations. It should be such as would offer a pleasant and comfortable working environment and project the management's image and prestige. Besides, it involves considerable investment of capital. In a way, a factory building is to the plant what skin and bones are to a living body – the structure and appearance heighten the functioning as a whole of the body corporate, or of a living body. It is for these reasons that the factory building acquires great importance.

The management of an existing factory may, on occasion, feel the need for raising a building. This may be an improvement on, or an addition to, the existing building for purpose of expansion or growth, or a new structure necessitated by product diversification or market considerations.

A factory building may be rented, if available in the place, when the management decides that way. But, generally speaking, no large factory, or even a medium-sized factory, is housed in a rented accommodation. The reasons are that, in the first place, ready built factory buildings are not available to suit particular needs, except for small plant. In the second place, a rented building does not indicate prosperity and progress – a fact which is important to a manufacturing concern in so far as its public image is concerned.

Whether a building has to be constructed, or rented, or improved, or expanded, certain factors, which are of vital importance to every plant, should be borne in mind. These considerations relate to:

i) The design of the building

ii) The types of materials for construction; and

iii) The types of buildings

Every factory management enlists the expert services of architects, engineers and contractors to ensure that these considerations find their due place in the construction of a factory building. The utility and importance of each of these considerations is examined in the following paragraphs.

**Consideration of Building Design:**

A well designed building has the following general features:

i) The design should ensure the functional smoothness of operations. All the obstructions in the way of operations should be avoided.

ii) It should be strong enough to withstand damage due to sun, storm, weather and fire, and also floods and earthquakes, if the factory is located in a place which is prone to such natural calamities; and damage resulting from particular operations.

Depending upon the span and height of the building, the soil and climate in the place of the location, and the materials used as well as the products manufactured, there are standards for structural needs; and it would suffice if these standards are suitably adapted.

The building should be so designed as to provide a number of facilities – such as lunch rooms, cafeteria, locker rooms, crèches, libraries, first-aid and ambulance rooms, materials handling facilities, heating, ventilation, air-conditioning, etc. Any negligence in, or indifference to, the designing building would cripple production. As Knowles and Thomson have observed: "A manufacturing organization, which must be adapted to the limitation of poor housing facilities, has the same competitive disadvantage as an athlete whose uniform restricts his movement."[2] A part from the general requirements of a well-designed building, the following considerations need particular mention in the designing of a factory building.

a) Flexibility: Flexibility is one of the important considerations because the building is less likely to become obsolescent and provides greater operating efficiency even when processes and technology change. Flexibility is necessary because it is not always feasible and economical to build a new plant every time a new firm is organized or the layout is changed. With minor alternations, the building should be able to accommodate different types of operations. "Former dry-cleaning plants", observe Shubin and Madeheim,

"house electroplating and machine shops. A former manufacturing plant houses a suburban departmental store, a former loft building becomes a college."[3]

Flexibility may be achieved by the use of large spans, by avoiding permanent obstructions in the manufacturing area, by placing all heating plumbing and similar items in the truss walk, by constructing wide bays, and by making ceilings high enough for overhead conveyors.

b) Product and equipment: The type of product that is to be manufactured, determines column-spacing, type of floor, ceiling, heating and air-conditioning. A product of a temporary nature may call for a les expensive building than would a product of a more permanent nature. Similarly, a heavy product demands a far more different building than a product which is light in weight.

The equipment to be used for the manufacture of a product deserves due consideration in the designing of the building. A large forge shop may demand a very high ceiling clearance and heavy reinforced concrete footing under the machine. A concern that frequently moves large machine tools must provide for inside and outside doors which are large enough to facilitate the movement.

c) Expandability: Growth and expansion are natural to any manufacturing enterprise – as natural as they as they are to a child. They are, in fact, the indicators of the prosperity of a business. A recognition of this fact in designing a building makes the letter more flexible and less subject to major alternations when expansion does take place. Expandability does not refer to the construction of a massive building in which a major portion of the space would be idle. An idle building not only locks up substantial working capital but adds to the maintenance cost. The wisdom lies in the construction of a building which is adequate enough to accommodate the present manufacturing programme and related activities, and provides for expansion as well. The following factors should be borne in mind if the future expansion of the concern is to be provided for:

i) The area of the land which is to be acquired should be large enough to provide for the future expansion needs of the firm and accommodate current needs

ii) The design of the buildings should be in a rectangular shape. Generally speaking, industrial buildings take the shape of any of the letters U,E,H,I.L,T and U. Of these, shape I is very common. Rectangular shapes facilitate expansion on any side, though northward expansion is not followed.

iii) If vertical expansion is expected, strong foundations, supporters and columns must be provided.

iv) If horizontal expansion is expected, the side walls must be made non-load-bearing to provide for easy removal.

d) Employee facilities and service area: Employee facilities must find a proper place in the building design because they profoundly affect morale, comfort and productivity. The building plan should include facilities for lunch rooms, cafeteria, water coolers, parking area etc. The provision of some of these facilities is a legal requirement*. Others make good working conditions possible. And good working conditions are good business.

Service areas, such as the tool room, the supervisor's office, the maintenance room, receiving and dispatching stations, the stock room and facilities for scrap disposal, should also be included in the building design.

e) Materials handling: Ease in materials handling assists in the reduction of manufacturing cycle time, avoids production bottlenecks and reduces materials handling cost. Cranes, conveyor belts, hoists etc. are increasingly used for an easy handling of materials. A reduction in the number of columns and the maintenance of the ceiling at a desirable height are significant to the use of materials handling equipment. It is evident that the requirements of efficient materials handling equipment affect the building design. Conversely, the characteristics of the factory building affect a concern's ability to use this equipment efficiently.[4]

f) Lighting, Ventilation and Air-conditioning: Adequate and good lighting is essential for higher employee efficiency and greater output. Lighting may be

natural or both. A building should effectively utilize both the types (for details see Chapter on "Plant Lighting").

Ventilation refers to the provision of fresh air inside the building. Fresh air may be provided through natural means or with the help of machines. Advantage should be taken of natural ventilation to avoid the cost of artificial or mechanical ventilation. The use of artificial ventilation is a significant factor in the design of a factory building (for details see Chapter on "Ventilation").

Air-conditioning promotes the comfort of the workers, and safeguards the condition of materials, products, equipment and the manufacturing process. The introduction of air-conditioning will be easy and less expensive if certain structural provisions are made in the building to that effect (for details see Chapter on "Air-conditioning").

g) Protection of Property and People: The primary function of a building is to give shelter to the employees and protect the company property from such disasters as fire, floods, earthquakes, hurricanes and tornadoes. The danger from fire is very common and almost universal. The building plan should provide for maximum fire protection and should have such items as fire alarms, sprinkler facilities, fire escape mechanisms, safety lights etc. Floods cause extensive damage to property and people. The building should be so designed as to enable the management to face such a calamity; the installation of an early warning system is one such essential item in a building. Similarly, provisions to face hurricanes should be included in the building design.

h) Security: Security arrangements are essential for the prevention of thefts. The most common method of ensuring safety in to post watchmen at the entrance and the exit. The other methods are the use of fences, guardhouses, flood lighting and closed circuit television. All these should find their place in the building design.

i) Location: The site selected for a factory building should receive due consideration in its design. If a city site is selected, firm foundations have to be laid in view of the expectation of its vertical expansion. If a village site is

selected, deep foundations are not necessary because a horizontal expansion would be possible at his site. If the terrain of the site is uneven, cellars may be constructed and used for materials storage, employees facilities, locker rooms and the like. The type of soil determines the depth of the foundation and the type of materials to be used in the construction of the factory building.

j) Service and Maintenance Charges: The service and maintenance charges of a building add to the cost of overheads and should, therefore, be avoided by providing for certain structural facilities. Junctions may be rounded off to avoid the formation of sharp corners which are inevitable dust collectors and which call for constant cleaning. The construction of single-storey buildings dispenses with the need for elevators and the expenditure incurred on them.

k) Aesthetic considerations: Efforts should be made to make the building a pleasant place for workers. Employee comfort should receive top priority because the workers spend a greater portion of their total working hours in the factory. Their stay in the factory should, therefore, becomfortable and pleasant. The building should have an elegant appearance because this adds to the pride and prestige of the managers and the managed. Any attractive, well designed plant promotes community good-will. It contributes to the elimination of factory districts, which are usually eye-sores. It also has an influence on employee morale. Such a plant suggests a progressive, successful organization and therefore stimulates pride in the company.

It is heartening to note that some managements have paid special attention to this requirement. Mention may be made of the plants of TELCO at Pimpri, Pune, and of L&T and CMTI at Bangalore to prove the point.

**Types of Building Materials:**

Many types of construction are used in today's buildings. For industrial use, however, the most popular are wood-frame, bricks, slow-burning mill, steel frame, reinforced cement concrete (RCC) and precast concrete. The considerations in the choice of a particular type are availability, strength, durability, safety and cost.

A wood-frame building may be constructed quickly and cheaply. But it is seldom used for industrial buildings because of its rapid depreciation and high insurance cost and because it is the least resistant to fire. Also known as “match-box construction”, the wood-frame is used in temporary buildings.

If good bricks are available at reasonable rates and excessive strength is not required, buildings may be constructed with bricks made of mud or cement, depending on specific requirements. Brick buildings depreciate more slowly than wood, and alternations in them can be effected with relative ease.

In a slow-burning type of construction, bricks an heavy timber are used. A fire takes a longer time to spread through the building because of the heavy timber used in it. It can be controlled before it assumes menacing proportions. Despite its reduced insurance cost, this type of construction is rarely used because it has been largely superseded by modern types of construction.

A steel-frame structure is made up of steel girders, columns and roof trusses, with spaces between columns which are filled by bricks, tiles or some other material. Alternations can be effected easily and quickly. Insurance rates for such buildings are low. Their disadvantages are high maintenance cost because of the need for frequent painting, adverse reaction in chemical industries, warping and twisting in the event of a fire, and high depreciation.

Reinforced cement concrete (RCC) is one of the most popular types of construction today, particularly for multi-storey buildings. In this type, a steel frame is encased in concrete, thereby reinforcing it. Both the floors and their supporting columns are made of concrete reinforced with steel. However, the side and interior walls are often of brick, sheet metal, or hollow tiles. These walls are merely curtain walls and give no structural support. The ceilings have concrete surfaces.

A reinforced concrete construction has many advantages. It depreciates more slowly and its insurance cost is less because of fewer fire hazards. It is durable, and cleanliness is easily maintained. Such buildings may be insulated against vibration, which can be reduced to the minimum. They are quickly constructed, and there is a saving in steel, which is scare and costly these days. Their disadvantages are: Physical strain to the workmen when they walk on plain concrete floor; too much noise made by

the transportation equipment used for the movement of materials. A provision for expansion should be made before construction starts: otherwise alternations and expansion will both be difficult and expensive.

Prestressed concrete slabs are increasingly used nowadays particularly in the construction of single-storey buildings. One type of pre-cast concrete is the tilt-up construction, in which concrete walls are poured flat on the grounds and later raised to their vertical positions. Thus, a wall is poured into a frame on the ground to fit a particular wall space. After the concrete has set, it is tilted into position by mechanical means.

Lift-slab is another type of pre-cast construction. In this case, the roof and floors are poured on the ground; after the cement sets, they are hoisted into place and fastened to supporting steel columns. The use of pre-fabricated slabs considerably reduces construction time. The only time-consuming process is to get the slabs ready.

**Types of Buildings:**

Industrial buildings may be grouped under four types:

i) Single-storey buildings
ii) High bay and monitor types
iii) Multi-storey buildings and
iv) Special types

The decision on choosing a suitable type for a particular firm depends, among other things, on the manufacturing process, the area of land, and the cost of construction. However, for a factory, more than one types of building may be constructed; for example, single storey plants housing production facilities and multi-storey structures for administrative purposes.

**Single-storey buildings:**

Most of the industrial buildings which are now designed and constructed are single-storeyed, particularly where acres of land are available at cheap rates. Extensive transport facilities have encouraged the growth of this trend because of the ease with which men and materials are transported to the plant, wherever it is located. Industrialists

now go in search of village or suburban sites where land is cheaply available in plenty – a fact which is in sharp contrast to the earlier times when they, because of the difficulty of transportation, were forced to stick to cities. The difficulty in acquiring an adequate area of land and its high cost have forced these industrialists to build multi-storey structures. It may be noted that single-storey buildings are rarely single-storeyed because of the construction of cellars where the terrain of the site is uneven and the construction of mezzanine floors.

Single-storey buildings offer several operating advantages. Some of these are:

i) There is a greater flexibility in layout and production routing;

ii) Truss construction ensures uninterrupted operating space. Spans of over 100 ft. between columns are possible;

iii) The maintenance cost resulting from the vibration of machinery is reduced considerably because of the housing of the machinery on the ground floor;

iv) There is the advantage of natural illumination when the building has a suitable roof

v) Space is not wasted on elevators, shafts, stairways and other service facilities which are essential in multi-storeyd buildings;

vi) The expenditure on the running and maintenance of elevators and stairways is eliminated

vii) Expansion is easily ensured by the removal of walls

viii) The cost of transportation of materials is reduced because of the absence of materials handling equipment between floors;

ix) All the equipment is on the same level, making for an easier and more effective layout supervision and control;

x) Greater floor load-bearing capacity for heavy equipment is ensured;

xi) The danger of fire hazards is reduced because of the lateral speed of the buildings;

xii) Single-storey buildings offer economy both in terms of the time required for their construction and the overall cost per sq. ft;

xiii) They have an elegant appearance.

Single-storey buildings suffer from some limitations. These are:

i) High cost of land, particularly in city

ii) High cost of heating, ventilating and cleaning of windows

iii) High cost of transportation for moving men and materials to the factory which is generally located far from the city

A single-storey construction is preferable when:

i) Materials handling is difficult because the product is big or heavy;

ii) Land is not a problem and its cost is not a worry;

iii) Natural lighting is desired;

iv) Heavy floor loads are required

v) The construction has to be completed within a short time; and

vi) Frequent changes in layout are anticipated.

**High bay and Monitor type:**

This is a single-storey structure with this difference, that the roof truss is surrounded by a monitor. The building is designed to give maximum overhead space for a given floor area. The overhead space may be used to operate a crane and other overhead facilities. The monitor offers good natural ventilation, and the side walls, built with glass, act as windows for natural lighting. Buildings for steel mills and foundries are often of the monitor or bar type; they enable the management to take advantage of natural ventilation and illumination coming from high roofs and center openings, which provide ample room for crane operations.

**Multi-storey buildings:**

Multi-storey buildings are gradually becoming an exception for industrial purposes because the trend now is for the construction of single-storey structures, except in Hong Kong and Singapore, which are water-locked. However, for hotels, schools colleges, shopping complexes and residences, multi-storey structures are generally popular, particularly in cities. When constructed for industrial use, multi-storey buildings offer the following advantages.

i) Maximum operating floor space per sq.ft. of land; this is best suited in areas where land is very costly;

ii) Lower cost of heating and ventilation;

iii) Reduced cost of materials handling because the advantage of the gravity flow of materials can be availed of;

iv) In case of an assembled product, the operations on the different parts can be so planned that the work moves in the same general direction to the assembly floor, with minimum movement between floors;

v) Use of overhead storage;

vi) Well-adapted to light manufacturing industries.

Against these, multi-storey buildings suffer from certain disadvantages, which make them less popular than single-storey structures. These advantages are:

i) Materials handling becomes very complicated. A lot of time is wasted in moving them between floors;

ii) A lot of floor space is wasted on elevators; stairways and fire escapes;

iii) Floor load-bearing capacity is limited, unless special construction is used, which is very expensive.

iv) Natural lighting is poor in the center of the shop, particularly when the width of the building is somewhat great;

v) Upto a certain stage, say, up to four storeys, the cost per sq.ft. of floor area may be the cheapest; but beyond that stage, the cost of construction rises rapidly;

vi) Layout changes cannot be effected easily and quickly;

vii) There is difficulty in supervision;

viii) Tall buildings may not be good-looking

Multi-storey buildings can still be justified:

i) In the manufacture of light products, using light materials;

ii) When materials can be handled by gravity feed;

iii) When the acquisition of land becomes difficult and expensive;

iv) When the floor load is less

Generally speaking, textile mills, food industries, detergent plants, and chemical industries use this type of buildings.

**Special types:**

Some manufacturing processes require a particular type of building. The aircraft industry, for example, requires buildings with wide spans, which may range from a width of 300 ft. to 400 ft. The building for a saw mill is constructed without side walls so that the flow of wind may be steady and saw dust does not accumulate inside the plant. Allowing the dust to accumulate inside the building is like welcoming a fire at the doorstep because saw dust catches fire very quickly and easily. These buildings are constructed for a specific purpose and are, therefore, inflexible. Obsolescence in this type is high because of rapid changes in technology.

**Importance of an Ideal building:**

The joint efforts of engineers, architects, contractors and managers in designing and constructing buildings should make them ideal. The ideal plant building is one which is built to house the most efficient layout that can be devised for the process involved, yet which is architecturally attractive and of such a standard shape and design as to be flexible in its use and inexpensive in its construction. An ideal buildings helps a manufacturer in the following ways:

i) It ensures a smooth operation of production activities;
ii) It gives protection to property, shelter to employees and safeguards the company's secrets;
iii) It reduces materials handling costs;
iv) It reduces work in progress inventory and manufacturing cycle time;
v) It simplifies manufacturing and employee control procedures;
vi) It reduces service and maintenance charges;
vii) It increases plant flexibility and use;
viii) It increases employee comfort and employee morale.

**Recent trends:**

Plant designs have undergone radical changes in the recent past. These changes have almost kept pace with the changes in dress fashions. These changes are really welcome because they have contributed to the elegant appearance of the buildings and their flexibility, and have spelt comfort for the employees. Some of the recent trends in building construction are:

i) There is a significant trend towards the construction of single-storey, flexible plants and their locating away from urban areas

ii) One-and-a-half storey plants are becoming increasingly popular. These are really single-storey plants, but include mezzanines or basements. The basements may be put to good use for the storage of materials, for employee facilities, locker rooms and the like.

iii) Buildings are designed to have a wider space of as many as 100 meters with fewer columns

iv) Glass blocks and hollow cement blocks, instead of bricks, are increasingly used in the construction with a view to taking advantage of natural lighting and ventilation.

v) Factors affecting employee comfort are accorded top consideration.

vi) Square or blockshaped buildings are gradually replacing the historical letter-shaped buildings. Letter-shaped buildings (I, L, E, T, U shapes) are well suited to admit natural lighting, besides easily lending themselves to expansion. The availability of inexpensive electric power, however, has reduced the dependence on daylight and has contributed to the gradual disappearance of letter-shaped buildings.

vii) Daylight construction is used in multi-storey builidings. In this construction, side walls do not carry the floor load but rather a row of columns located at a distance of about 6 ft. from the side walls. As the side walls are non-load-bearing, almost all of them may be built with glass to admit natural illumination

viii) Greater emphasis is laid on simple building designs. Such a building if flexible and has an elegant appearance.

ix) The treatment of effluents is given due consideration in view of the people's ever-increasing pre-occupation with air pollution and defacement of historical monuments.

x) Pre-cast slabs, wide windows, ample parking areas, automatic openings, rubber doors, etc., are increasingly used in modern buildings

xi) There is increased dependence on controlled environment on air-conditioning, heating, artificial ventilation etc.

xii) Larger bay sizes – 20 ft. x 40 ft. and 30 ft. x 50 ft. – preferably rectangular, are used.

xiii) There is a preponderance of concrete floors, flat and monitor roofs. Ample parking areas are provided.

xiv) Balconies are used for sub-assembly, light machining, service areas, and storage.

xv) Windowless plants are gradually becoming popular.

**Buildings for small plants:**

The details discussed thus far relate to the buildings, requirements of a large or medium sized industrial unit. Any discussion on industrial building, however, would be incomplete without a reference to the building requirements of a small industrial unit, which occupies a place of importance in our country. The building problems of a small industrialist are relatively simple because he has a number of a choices before him.

The first, the most economical, and the earliest choice is to hire a shed in an industrial estate and start manufacturing operations. A shed in an estate is very convenient for a small-scale industrialists because industrial estates are constructed by State Governments, and have all the facilities which are required for the smooth running of a factory. Besides, he can save the funds which would otherwise be locked up in building construction. But the disadvantage of renting a shed in an industrial estate is that the buildings are of standard shapes and sizes. The layout of machinery and other facilities must be adapted to the building rather than the reverse of it. Moreover, it is a problem for a small industrialist to get an allotment of a shed.

The other alternative available to a small-scale industrialist is to construct a building if he fails to get one shed allotted to him in an industrial estate. In this case, the problems faced by him are the same, though on a small scale, as those (discussed earlier in this chapter) faced by a large-scale industrialist. But all the small-scale industrialists do not venture to invest huge funds in the construction of industrial buildings. To being with, it is not uncommon for them to commence their business operations in any enclosed area – a dilapidated structure, a room or rooms on an upper floor of a residential building, a hut, a garage or a shop.