M 1473 MATERIALS HANDLING

LECTURE NO.1 (Fall 2025) [Mechanical Design and Production Engineering]

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LECTURE RULES

"Great things come from hard work and perseverance. No excuses."

KOBE BRYANT

COURSE SPECIFICATIONS

- Course code-title: **M 1473 - Materials Handling**
- **4th level** in Mechanical Design and Production Engineering Program
- Course duration: **One semester**
- Course type: **Compulsory**
- **6** contact hours [3 Lecture + 2 Tutorial + 1 Practical]
- Total grades: **150** [30 Semester work, 30 Practical/Oral, 90 Final exam]
- Minimum grades for success: **75** [Pass grade, percentage ≥ 50%]
- Course pre-requisite: **Nil**
- Lecture scheduled on **Wednesday** in **A2 Hall**, third floor

COURSE SPECIFICATIONS

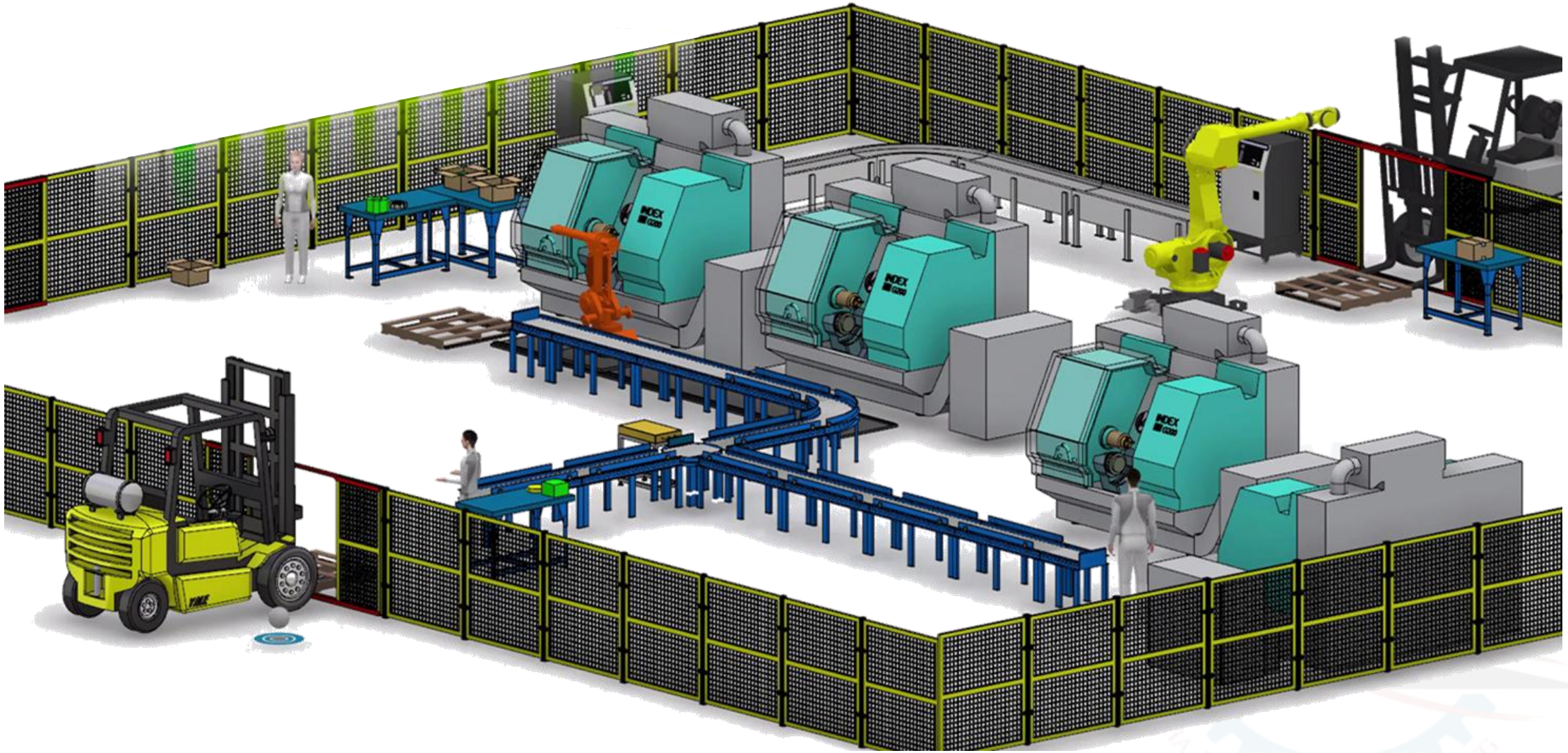
- **Course Contents:**

- Material handling (principles, equipment, and systems)
- Material handling systems design
- Plant site selection
- Material handling in warehousing
- Robots in material handling

INTRODUCTION TO FACILITY PLANNING

- ***Facilities planning*** is a multi-faceted process, influenced by numerous factors which are not always necessarily in concert and may even have contradictory impact on the decision-making process. For example, site selection.
- ***Manufacturing facilities design*** is the organization of the company's physical assets to promote the efficient use of resources such as people, material, equipment, and energy. It includes plant location, building design, plant layout, and material handling systems.
- ***Layout*** is the physical arrangement of production machines and equipment, workstations, people, location of materials of all kinds and stages, and material handling equipment. The plant layout is ***the end result*** of a manufacturing facility design project.

INTRODUCTION TO FACILITY PLANNING



INTRODUCTION TO FACILITY PLANNING

- **Cost reduction formula** is valuable when working with manufacturing facilities design and material handling. Some examples of a cost reduction formula follow:

Ask	*For Every*	*So We Can*
Why	Operation	Eliminate
Who	Transportation	Combine
What	Inspection	Change sequence
Where	Storage	Simplify
When	Delay	
How		

INTRODUCTION TO FACILITY PLANNING

- ***The five S's principles are***:

- Sifting: Keeping the minimum of what is required will save space, inventory, and money.
- Sorting: Everything has a specific place, and everything in its place.
- Sweeping: A clean plant is a result of a facility layout that has been thought to provide room for everything.
- Spick and span: A safe plant is a result of good layout planning.
- Strict: Following the procedures and standardized methods and making them a habit will keep the plant operating efficiently and safely.

INTRODUCTION TO FACILITY PLANNING

- The **five why's** will ensure that the solution to a problem is not a symptom of the problem, but rather, the base cause. The planners could have asked many whys to arrive at a final solution that will eliminate the problem from occurring again.
- For example: A machine broke down:

• The machine jammed up. Why?

• The machine was not cleaned. Why?

• The operator didn't clean it out at regular intervals. Why?

• Was it because of lack of training? Why?

• The supervisors forgot to make a written instruction to be mounted on the machine. Why?

GOALS OF MANUFACTURING FACILITIES DESIGN

- A **mission statement** communicates the primary goals and the culture of the organization to the facilities planner, and it defines the purpose for the existence of the enterprise.
- The statement should be short enough, easily remembered, timeless.
- A mission statement should be simple and should be used to keep the facilities planner on track and to help with all project decisions.
- “ACME is dedicated to the pursuit of manufacturing the safest, highest quality, and the most reliable bicycles while maintaining the lowest possible price and the strongest commitment to customer satisfaction. ACME recognizes that it is only through strong commitment to our employees that we can achieve our mission.”.

GOALS OF MANUFACTURING FACILITIES DESIGN

- Potential production goals and objectives can then be derived from the mission statement:

- Minimize unit and project costs.
- Optimize quality.
- Promote the effective use of people, equipment, and energy.
- Provide for employee convenience, safety, and comfort.
- Control project costs.
- Achieve the production start date.
- Build flexibility into the plan.
- Reduce or eliminate excessive inventory.
- Maximize the use of the building cube.

MANUFACTURING FACILITIES DESIGN PROCEDURES

- The quality of a manufacturing facility design depends on how well the planner collects and analyzes the basic data.
- The following is a systematic way of thinking about a project, in which each step will include some techniques that will not be used in every situation:

- Determine what will be produced.
- Determine how many will be made per unit of time.
- Determine what parts will be made or completely purchased.
- Determine how each part will be fabricated (process planning).
- Determine the sequence of assembly (line balancing).
- Determine the plant rate (takt time).

MANUFACTURING FACILITIES DESIGN PROCEDURES

- Determine the number of machines needed.
- Balance assembly lines or work cells.
- Study the material flow patterns to establish the best flow possible.
- Determine activity relationships.
- Layout each workstation.
- Identify needs for personal and plant services, and provide the space needed.
- Identify office needs and layout as necessary.
- Develop total space requirements from the above information.
- Select material handling equipment.
- Allocate the area according to the space needed and the activity relationships.

MANUFACTURING FACILITIES DESIGN PROCEDURES

- Develop a plot plan and the building shape.
- Construct a master plan (manufacturing facility design).
- Seek approvals, take advice, and change as needed.
- Install the layout.
- Start production.
- Adjust as needed and finalize project report and budget performance.

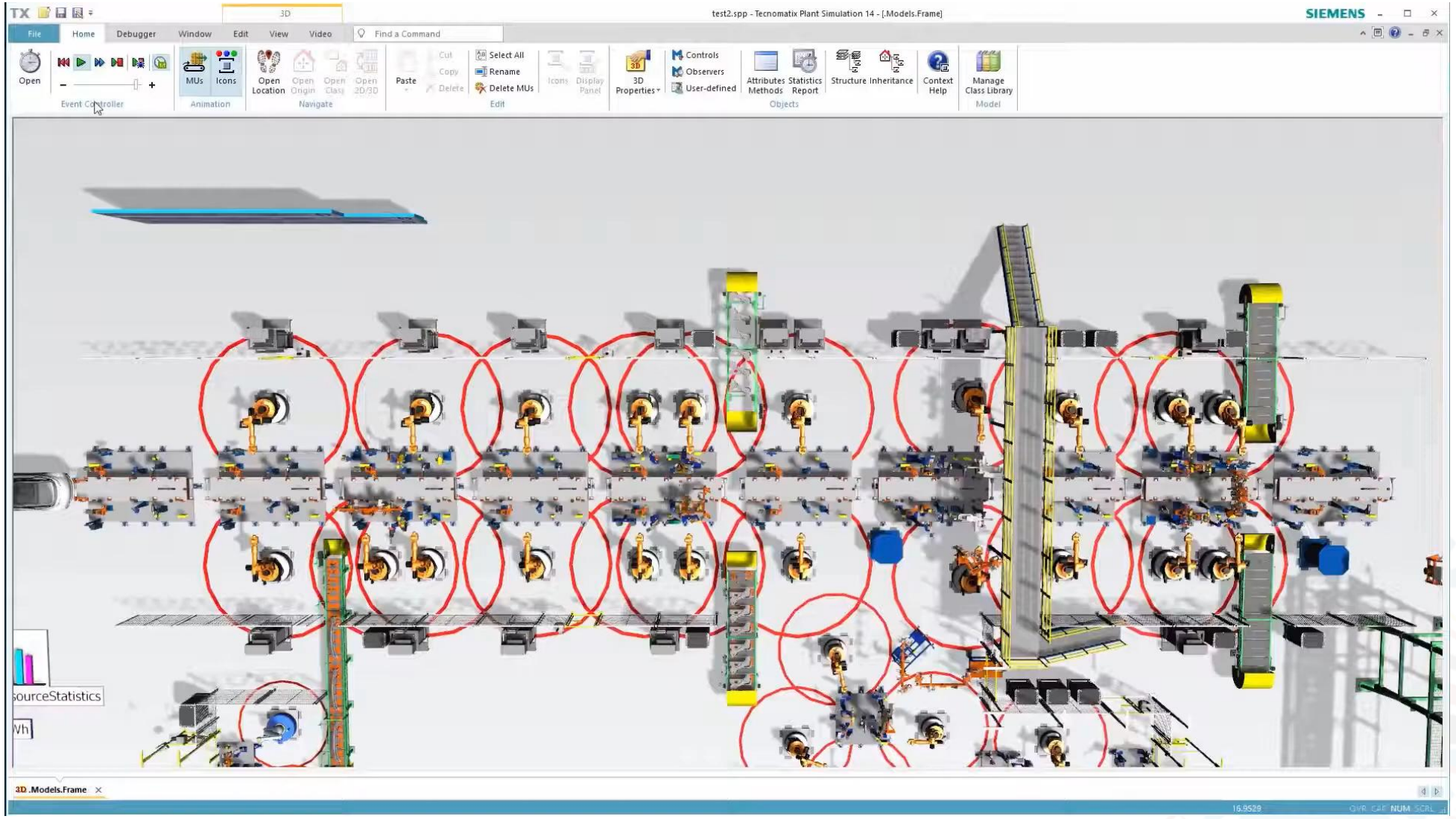
SOURCES OF FACILITIES DESIGN PROJECTS

- New facility: more fun with fewer restrictions and constraints.
- New product: incorporated into the flow where some common equipment may be shared.
- Design change (Product): always being made to improve the cost and quality.
- Cost reduction: find a better layout that will produce more products with less effort.
- Retrofit: same as for a new plant, except there are more constraints.

SIMULATION IN MANUFACTURING FACILITIES DESIGN

- Computer Simulation can be used to predict the behavior of a manufacturing or service system by tracking the movements and interaction of the system components and aiding in optimizing such systems.
- The simulation software generates reports and detailed statistics describing the behavior of the system under study.
- There are several user-friendly advanced simulation packages available that allow the user to simulate either the working of a factory, a just-in-time inventory environment, a warehousing and logistics problem, or the behavior of a group technology system.

SIMULATION IN MANUFACTURING FACILITIES DESIGN



INTRODUCTION TO MATERIAL HANDLING

- **Material handling** is the function of moving the right material to the right place, at the right time, in the right amount, in sequence, and in the right position or condition to minimize production costs.
- The **American Society of Mechanical Engineers** (ASME) defines "material handling" as the art and science involving the moving, packaging, and storing of substances in any form.
- Material handling is an integral part of plant layout.
- Reduced the drudgery of work; however, is attributed to **> 50%** of all industrial accidents.
- Material handling may be thought of as having **five distinct dimensions**: movement, quantity, time, space, and control.

COST JUSTIFICATION OF MATERIAL HANDLING

- Materials handling, **not a production process**, does not add to the value of the product.
- It costs money; therefore, it should be eliminated or at least reduced.
- However, materials handling helps production.
- If a very expensive piece of equipment reduces unit cost, it is a good purchase.
- Nonpowered equipment can be very cost efficient and should always be considered.
- Safety, quality, labor, power, and equipment costs must all be included in the unit costs.
- The long-term effect of the handling activity can cause cumulative trauma disorder (CTD).
- In USA, productivity loss due to work-related injuries, in 2018 was estimated at $60 billion.

FUNCTIONAL SCOPE OF MATERIALS HANDLING

- Bulk handling is particularly relevant in the processing, mining and construction industries.
- Unit materials handling covers handling of formed materials in the initial, intermediate and final stages of manufacture.
- Industrial packaging of in-process materials, semi-finished or finished goods, storage and transportation. **Consumer packaging is not directly related to materials handling.**
- Handling for storage/warehousing from raw materials to finished product stage.

REQUIREMENTS OF A GOOD MATERIALS HANDLING

- Efficient and safe movement of materials to the desired place.
- Timely movement of the materials when needed
- Supply of materials at the desired rate.
- Storing of materials utilizing minimum space.
- Lowest cost solution to the materials handling activities.

GOALS OF MATERIAL HANDLING

- The primary goal of material handling is to reduce unit costs of production.
- Maintain or improve product quality, reduce damage, and provide material protection.
- Promote safety and improve working conditions.
- Promote productivity through: Flow in a straight line, move as short a distance as possible, use gravity! it is free power, move more material at one time, mechanize and automate.
- Promote increased use of facilities as follows: use of the building cube, versatile equipment, standardize equipment, maximize production equipment utilization, maintain and replace as needed, integrate all material handling equipment into a system.
- Reduce tare (dead) weight.
- Control Inventory.

NEGATIVE ASPECTS OF MATERIALS HANDLING

- Additional capital costs involved in any materials handling system.
- Once implemented, flexibility for further changes gets greatly reduced.
- Failure/stoppage in equipment leads to increased downtime of the production system.
- Need maintenance, additional maintenance facilities and costs.

CHARACTERISTICS AND CLASSIFICATION OF MATERIALS

- Choice of equipment primarily depends on the type of materials to be handled.
- Different materials are classified based on specific characteristics relevant to handling.
- Basic classification based on forms: Gases, Liquids, Semi Liquids and Solids.
- Gases are generally handled tightly and where required, pressure resisting containers.
- Handling large volumes of gas using pipes/compressors (**pneumatic conveying**).
- Liquids and semi-liquids can be handled in tight or open containers which may be fitted with facilities like insulation, heating, cooling, agitating etc.
- Large quantity are also conveyed through pipes/pumps (**hydraulic conveying**).
- Solids form most materials handled in industry and classified into: **Unit load** and **Bulk load**.

CHARACTERISTICS AND CLASSIFICATION OF MATERIALS

Bulk material

Unit load

CHARACTERISTICS AND CLASSIFICATION OF MATERIALS

- Unit loads are formed solids of various sizes, shapes and weights.
- May counted by number of pieces like machine parts, molding boxes, fabricated items.
- Unit loads have been classified based on:

• Shape of unit loads: **basic geometric forms** like rectangular, cylindrical, pyramidal/conical and spherical; **typical forms** like pallets, plate, containers, bales and sacks; **irregular forms** like objects with uneven shapes and loads on rollers/wheels.

• Position of C.G. (stability) of load.

• Mass of unit load in 10 steps from 0 - 2.5 kg to more than 5000 kg.

• Volume per unit in 10 steps from 0 - 10 cm^3 to more than 10 m^3.

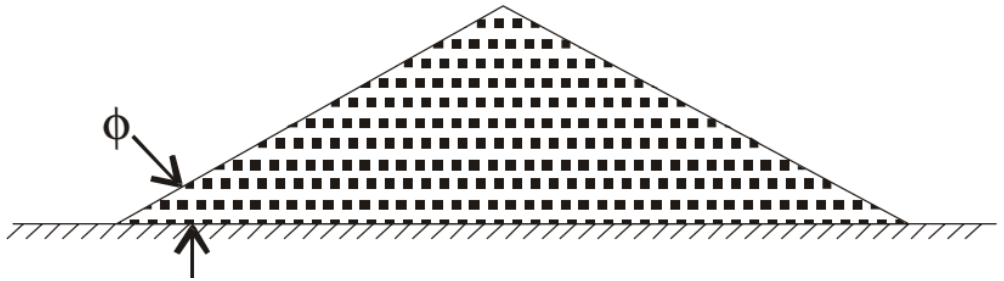
CHARACTERISTICS AND CLASSIFICATION OF MATERIALS

- Unit loads have been classified based on:
- Types of material in contact with conveying systems like metal, wood, paper/cardboard, textile, rubber /plastics, glass and other materials.
- Geometrical shape (flat, concave, convex, irregular/uneven, ribbed etc.) and physical properties (smooth, slippery, rough, hard, elastic etc) of base surface of unit load.
- Specific physical and chemical properties of unit load like abrasive, corrosive, dust emitting, damp, greasy/oily, hot, cold, fragile, having sharp edges, inflammable, explosive, hygroscopic, sticky, toxic, obnoxious, radioactive etc.
- Loads sensitive to pressure, shock, vibration, turning/tilting, acceleration/deceleration, cold, heat, light, radiation, damp etc.

CHARACTERISTICS AND CLASSIFICATION OF MATERIALS

- **Bulk materials** are powdery, granular or lumpy in nature and are stored in **heaps.**
- Examples: minerals (ores, coals etc.), earthly materials (gravel, sand, clay etc.) processed materials (cement, salt, chemicals etc.), agricultural products (grain, sugar, flour etc.) and similar other materials.
- Major characteristics of bulk materials: lump-size, bulk weight, specific weight, moisture content, flowability, angles of repose, abrasiveness, temperature, proneness to explosion, stickiness, fuming or dusty, corrosivity, hygroscopic etc.
- Classification and codification of bulk materials have been specified, as follows:

CHARACTERISTICS AND CLASSIFICATION OF MATERIALS



MATERIAL CODE =

One or more alphabets L to Z corresponding to ***miscellaneous characteristics.***

One alphabet H to K corresponding to ***Bulk Density.***

One number 6 to 9 specifying ***Abbrasiveness.***

One number1 to 5 specifying ***Flowability.***

One alphabet A to G specifying ***Lump size.***

SOLVING PROCEDURE OF MATERIAL HANDLING

- Analyze the requirements to define the problem. Be sure the move is required.
- Determine the magnitude of the problem. Cost analysis is best.
- Collect as much information as possible—why, who, what, where, when, and how.
- Search for vendors.
- Develop viable alternatives.
- Collect costs and savings data on all alternatives.
- Select the best method.
- Select a supplier.
- Prepare the cost justification.

SOLVING PROCEDURE OF MATERIAL HANDLING

- Prepare a formal report.
- Make a presentation to management.
- Obtain approvals (adjust as needed).
- Place an order.
- Receive and install equipment.
- Train employees.
- Debug (make it work) and revise as necessary.
- Place into production.
- Follow up to see that it is working as planned.
- Audit performance to see that payback was realized.

PRINCIPLES OF MATERIAL HANDLING

- Set of guidelines developed by organizations to ensure that movement, storage, control, and protection of materials is done ***safely***, ***efficiently***, and ***economically***.
- The **College Industry Council on Material Handling Education (CICMHE)** has adopted these principles of material handling such:
- Planning principle, Standardization principle, Work principle, Ergonomic principle, Unit load principle, Space utilization principle, System principle, Automation principle, Environmental principle, Life-cycle cost principle.

END OF PRESENTATION