# Storage Equipments

END4650 – Material Handling Systems

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- Used for holding or buffering materials over a period of time.
- Some storage equipment may include the transport of materials
  - (e.g., the S/R machines of an AS/RS, or storage carousels).
- If materials are block stacked directly on the floor:
  - no storage equipment is required.
- Storage racks are used
  - to provide support to a load and/or
  - to make the load accessible

#### 1. Block stacking (no equipment)

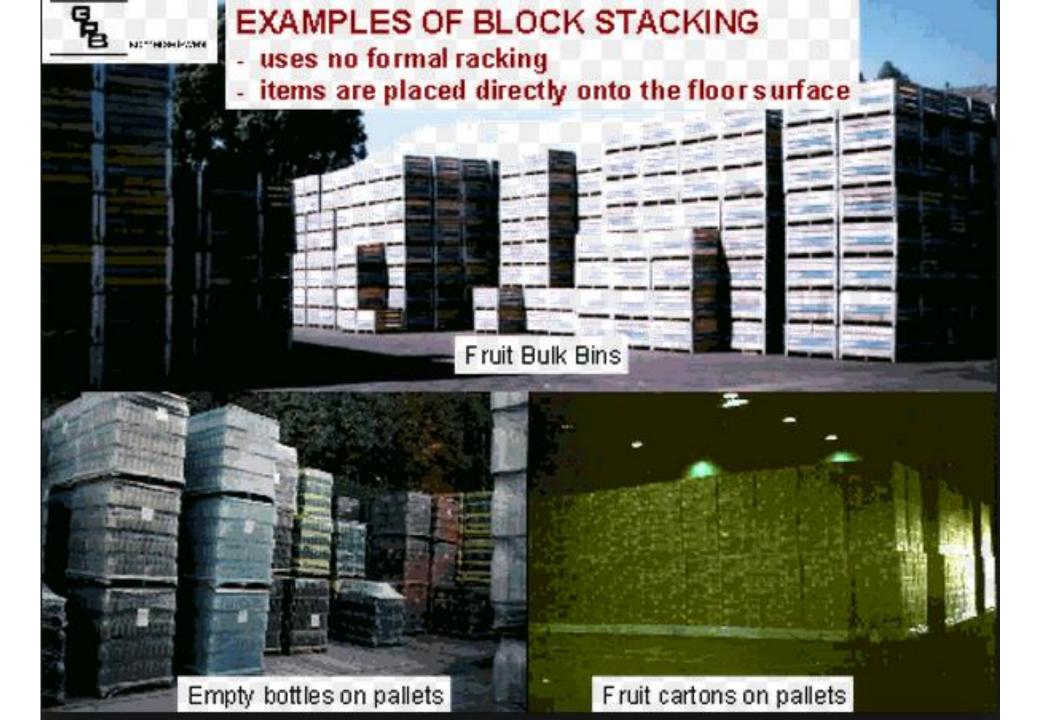
• Block stacking is the storage of loads on top of each other in stacks placed in lanes on the floor (a.k.a. *floor storage*)

#### • Adv:

- Easy to implement and very flexible.
- Low investment cost since no storage medium is required.

#### • Disadv:

- In most cases, only LIFO retrieval is possible in each lane unless there is an aisle at the back.
- Damage to loads might cause instable stacks.
- Typically two to ten rows of storage



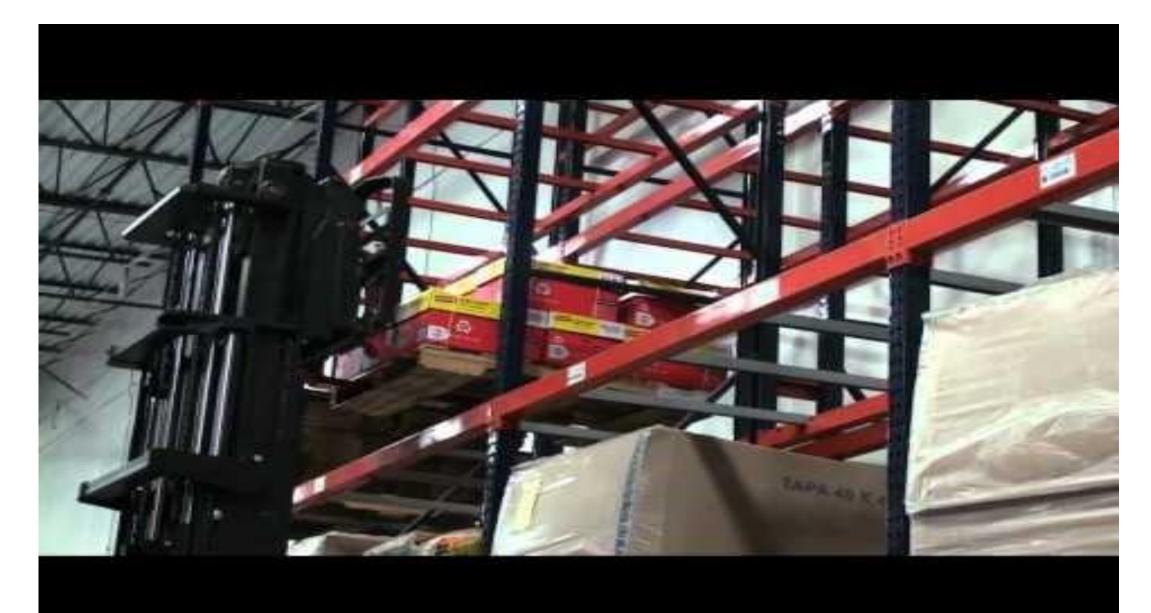
#### 2. Selective pallet rack

- Most popular type of storage rack.
- Pallets are supported between load-supporting <u>beams</u>.
- Special attachments and decking can be used:
  - to make the racks capable of supporting other types of ULs besides pallets
- Load-on-beam racks are used to provide clearance for straddles;
- Load-on-floor racks can be used when it is <u>not necessary</u> to use straddles

- 2(a) Single-deep rack
- Single slot per position
- Adv:
  - Provides complete and fast accessibility to all loads
- Disadv:
  - Can result in low cube utilization because of aisle space requirements,
  - Depends on the lift truck used
    - a turret (kule) truck would increase utilization
    - a standard CB would decrease utilization



- 2(b) Double-deep rack
- Two pallets stored per position
- Adv:
  - Provides greater cube utilization than single-deep racks
  - more loads can be accessed from the same side of the rack
- Disadv:
  - To access rear load in rack, an extended reaching mechanism is required
- Typically used when loads are stored and picked in multiples of two pallets



#### 3. Drive-in rack

- Loads are supported by rails attached to the upright beams.
- Lift trucks are driven between the uprights beams.
- Adv:
  - Provides high density pallet storage.
- Disadv:
  - Requires uniform-size loads.
  - Lengthy storage and retrieval times due to care required by driver inside of the rack.
- Closed at one end, allowing entry from one end (LIFO)
- (Start at 2.00)



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#### 4. Drive-through rack

- Similar to drive-in rack, except
  - open at both ends, hence allowing access from both ends (FIFO)

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#### 5. Push-back rack

- Loads are supported on an incline to enable
  - gravity-based movement of the loads within the rack via roller conveyor.
- Used to provide highly accessible pallet storage.
- Provides LIFO storage in each lane:
  - Loaded and unloaded at the lower end
  - closed at the higher end

- Adv:
  - Can be used to enable deep-reach storage without the need for extended reach mechanisms for loading/unloading
- Disadv:
  - Rack investment costs are greater than for double-deep racks
- Maximum depth is 5 loads
- Go to 2.40



#### 6. Flow-through rack

- Similar to push-back rack in terms of storage density,
  - except greater storage depth is possible.
- Rack is
  - loaded at higher end
  - unloaded at lower end,
  - providing <u>FIFO</u> storage in each lane.



#### 7. Sliding rack

- Location of the aisle is changed by <u>sliding</u> rows of racks along guide rails in floor
- a.k.a. *mobile rack*
- Used when
  - only single-deep storage is possible and
  - space is very limited or expensive

- Adv:
  - High cube utilization and complete accessibility to all loads
- Disadv:
  - More <u>expensive</u> compared to other storage racks.
  - Lengthy storage and retrieval times because
    - one can only pick in one lane at a time.
  - Relies on having a reliable power source available.
- Library racks...



#### 8. Cantilever rack

- Loads are supported by two or more cantilevered(destekli) "arms"
- Similar to pallet racks, except
  - the front upright and front shelf beams are eliminated
- Used when there is a need for a <u>full clear shelf</u> that can be loaded from the front without obstruction from rack support uprights
- Typically used to store long loads (e.g., bar stock, pipes, lumber)



### 9. Stacking frame

- Interlocking units that enable stacking of a load so that crushing does not occur
- Can be disassembled and stored compactly when not in use



#### 10. Bin shelving

- Alternative to racks to store small, loose, nonpalletized items.
- Pieces placed either directly on shelves, or in bins, or in cartons.
- Adv:
  - Low cost.
- Disadv:
  - Can result in excessive travel for picker.
  - Difficult to pick from top shelf depending on
    - the height of the picker
    - the weight of the unit.







#### 11. Storage drawers

- An alternative to bin shelving to store small, loose items
- Adv:
  - Can provide increased security compared to bin shelving and
  - Used when the demand for a specific item is low
  - Easy to install at point of use.
- Disadv:
  - Space is frequently underutilized
  - Cannot see inside the drawers, making labeling an important issue



#### 12. Storage carousel

 Carousel consists of a set of horizontally or vertically revolving storage baskets or bins.

#### Adv:

• Allows a large number of items to be picked at a high rate.

#### • Disadv:

Replenishment cannot occur during picking operations



#### 13. Vertical lift module

• Pieces stored on trays inside a multi-bay enclosure that are delivered to the opening of a bay for picking by a servo-driven lift carriage.

#### • Adv:

- Provides high-bay storage, and dense storage since height of trays can vary.
- All picking occurs at a user-adjustable waist height.
- Can provide even greater security compared to bin shelving when the operation of the module is often under <u>computerized control</u>, which can increase cost.

#### • Disadv:

- High cost.
- Requires reliable power source.



#### • 14. A-frame

- Units are dispensed from parallel arrays of vertical angled channels onto a belt conveyor that carries them into a container.
- Adv:
  - Very high pick rate.
- Disady:
  - Only feasible for small, rigid items of uniform shape that are not fragile.
  - Requires manual replenishment
- Enables fully automated piece picking, with manual replenishment.
- Popular within pharmaceutical distribution centers



- 15. Automatic storage/retrieval systems (AS/RS)
- Consists of integrated computer-controlled system that combines
  - storage medium,
  - transport mechanism,
  - controls with various levels of automation

for fast and accurate random storage of products and materials

- Storage/retrieval (S/R) machine in an AS/RS operates in
  - narrow aisle, serving rack slots on both sides of aisle;
  - can travel in horizontal (along the aisle) and vertical (up and down a rack) directions at same time

#### • Adv:

 Fewer material handlers, better material control (including security), and more efficient use of storage space

#### • Disadv:

• Typically, high capital and maintenance costs, and more difficult to modify



