ASRS STACKER CRANE

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MT-MKT-AS-02, V1.1

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INTRODUCTION

Automated Storage and Retrieval System (AS/RS) stacker cranes are advanced warehouse solutions designed for efficient storage and retrieval of palletized goods. Operating in narrow aisles and capable of reaching substantial heights, these cranes maximize vertical storage space while minimizing the need for extensive floor area. Key features include high load capacity (up to 2 tons) and precise placement and retrieval, enhancing warehouse efficiency. Integration with warehouse management systems (WMS) like ERP and SAP enables real-time data processing and monitoring. Safety features such as scanners, contour gates, and scales ensure safe operation. Automation increases productivity, optimizes storage space, enhances safety, and offers significant cost savings through improved inventory management and reduced labour costs. Muvro's AS/RS stacker cranes also provide modular construction and high adaptability, allowing optimized space utilization within any building layout, maximizing storage capacity and operational efficiency.

The stacker crane typically consists of:

Longitudinal: on a rail along an aisle

Vertical: up the column of the stacker crane.

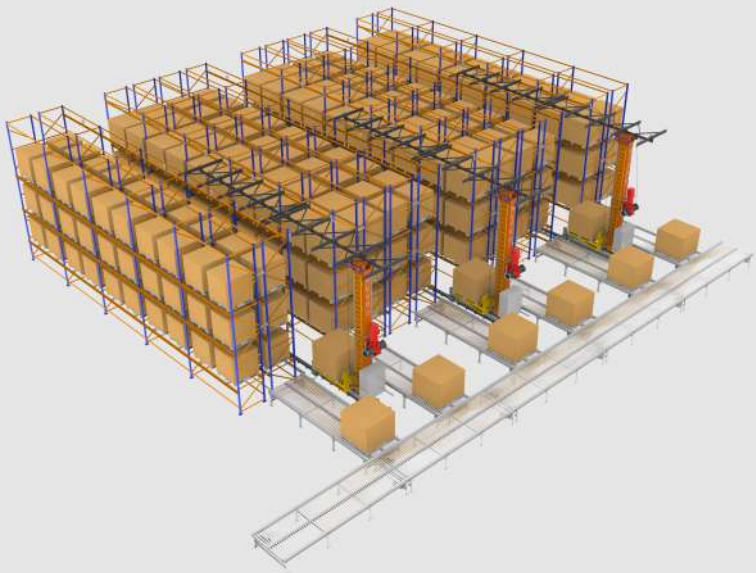
Transversal: or in depth, performed by the extraction systems fitted to the cradle of the machine in order extract or position a pallet.

Load handling device (e.g., fork, gripper, or clamp) that picks up and places items.

1. Single Mast Configuration

Structure

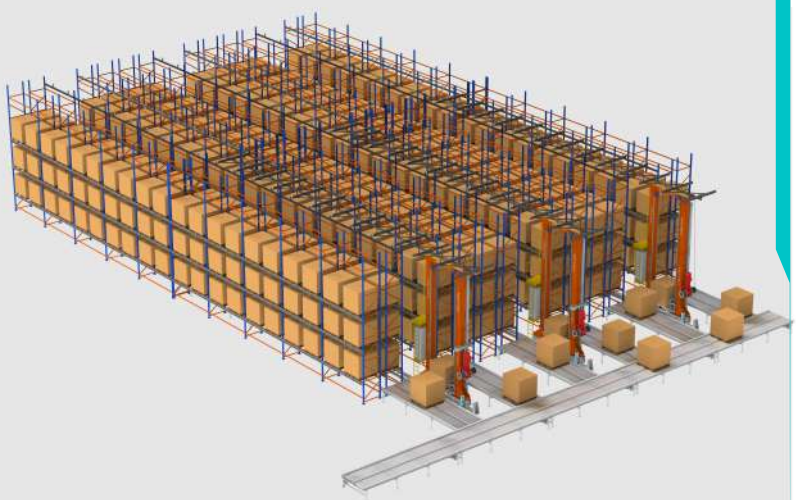
- Has one vertical mast (steel column).
- Load handling device (LHD) is attached on one side of the mast.
- Travels along a single aisle between racks.



2. Twin Mast Configuration

Structure

- Has two parallel vertical masts connected by cross braces.
- Load handling device moves between these masts for stability.
- Designed for heavy loads and tall rack systems.



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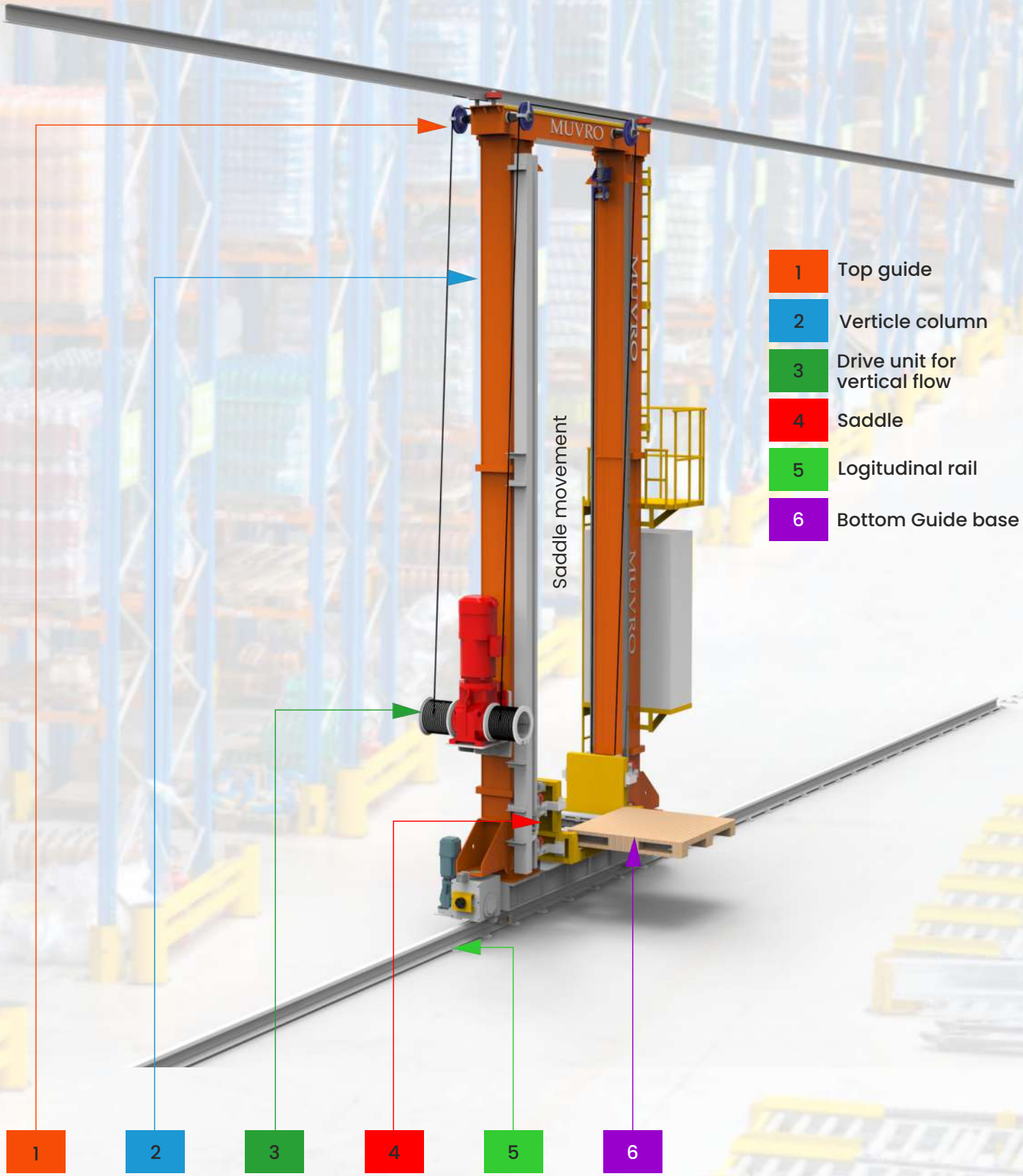
DESIGN



1. Top guide
2. Verticle column
3. Drive unit for vertical flow
4. Saddle
5. Logitudinal rail
6. Bottom Guide base

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Technical Specifications

Specification	Description / Detail	Single-Mast (MS-M1)	Twin-Mast (MS-M2)
Type	Stacker Crane Series	MS-M1 Series	MS-M2 Series
Maximum height - single deep	Maximum height of stacker crane	12m, 17m, 22m, 27m, 35m, 40m	12m, 17m, 22m, 27m, 35m, 40m
Maximum height - double deep	Maximum height of stacker crane	12m, 20m, 27m, 35m, 40m	12m, 20m, 27m, 35m, 40m
Max. Load Capacity	Maximum weight capacity for pallet handling	1,500 kg	2,000 kg
Max. Storage Height	Maximum vertical storage height	Up to 40 m	Up to 40 m
Max. Drive Speed	Maximum speed for longitudinal (aisle) movement	220 m/min	180 m/min
Max. Lifting Speed (Loaded)	Maximum speed for vertical lifting	60 m/min	60 m/min
Max. Lifting Speed (Unloaded)	Maximum speed for vertical lifting	90 m/min	90 m/min
Max. Drive Acceleration	Acceleration rate for the drive system	0.30 ~ 0.45 m/s²	0.30 ~ 0.45 m/s²
Max. Lifting Acceleration	Acceleration rate for the lifting mechanism	0.30 ~ 0.50 m/s²	0.30 ~ 0.50 m/s²
Telescopic Fork Options	Extraction system configurations for pallet handling	Single, Double, Triple Deep	Single, Double, Triple Deep
Max. Load Dimensions	Maximum pallet size	1100 × 1300 × 2400 mm	1100 × 1300 × 2400 mm
Energy Recovery System	Power saving feature (~15%)	Optional	Optional
Operating Temperature	Operating temperature range	-30°C to +40°C	-30°C to +40°C
Maintenance Cabin	Dedicated maintenance cabin	Optional	Yes
Receiving System	Compatible pallet receiving systems	Roller Conveyor, Shuttle RGV	Roller Conveyor, Shuttle RGV
Structural Components	Construction & drive system	High-strength steel; motorized wheels; gear reducers	High-strength steel; motorized wheels; gear reducers
Extraction Systems	Pallet extraction options	Single/Double/Triple-Deep Forks, Pallet Shuttle	Single/Double/Triple-Deep Forks, Pallet Shuttle
Safety Features	Integrated safety systems	Emergency stop, fall protection, laser sensors, hydraulic buffers	Emergency stop, fall protection, laser sensors, hydraulic buffers
Control & Automation	Control system	PLC-based control with onboard machine switches	PLC-based control with onboard machine switches
Operational Modes	Modes of operation	Automated, Semi-Automated, Manual	Automated, Semi-Automated, Manual
Movement Types	Primary movement directions	Longitudinal, Vertical, Transversal	Longitudinal, Vertical, Transversal
Industry Applications	Typical applications	Warehousing, E-commerce, Logistics, F&B, Pharma, Automotive, Manufacturing	Warehousing, E-commerce, Logistics, F&B, Pharma, Automotive, Manufacturing
Power Supply	Main power supply	415V ±5%, 3-Phase, 50Hz ±1%	415V ±5%, 3-Phase, 50Hz ±1%
Earthing Standard	Earthing for main panel	BS 7430:2011 + A1:2016 / IS 3043:2018	BS 7430:2011 + A1:2016 / IS 3043:2018
Power Transmission	Power feeding system	Bus Bar (4-Pole)	Bus Bar (4-Pole)
Bus Bar Position	Power feeding position	Bottom	Bottom
Certifications	Compliance & certifications	CE, ISO 9001, OSHA, UL & other standards	CE, ISO 9001, OSHA, UL & other standards

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Key Features

1

Automated Operation

Controlled by WCS/PLC; performs automatic storage, retrieval, and integrates with WMS.

2

Dual-Axis Movement

X-axis (travel) and Z-axis (lift); optional Y-axis for double-deep systems.

3

Mast Configuration

Single or twin mast designs made of high-strength steel for rigidity.

4

Load Handling Device

Fork, shuttle, or cradle type; handles pallets, totes, or bins; telescopic for deep storage.

5

High-Speed Precision

Travel: **2–3 m/s**, Lift: **0.5–1.5 m/s**, Accuracy: **±2–3 mm** with sensors.

6

Compact Aisle Design

Operates in aisles <1.5 m; maximizes storage density.

7

Safety & Control

Equipped with sensors, limit switches, and emergency stops; monitored via HMI/SCADA.

8

Power & Communication

Busbar or cable reel power; data via Wi-Fi/ Ethernet/Profibus.

9

Structural Adaptability

Suitable for indoor, outdoor, or cold storage; heights up to 40 m.

10

Maintenance & Diagnostics

Self-diagnostics, remote monitoring, and easy maintenance access.

AS/RS stacker cranes offer benefits like

Increased storage capacity and density

Improved inventory accuracy and control

Enhanced productivity and efficiency

Reduced labor costs and errors

24/7 operation capability

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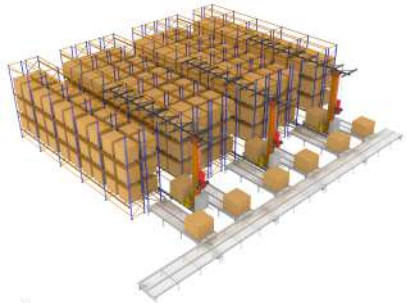
Types of stacker cranes are

Single



(for pallet load weight up to 1,500 kg).

Twin

(for pallet load weight up to 2,000 kg).

A stacker crane, also known as a stacker or automated storage and retrieval system (AS/RS), is a key component in automated warehouses and distribution centers. Its construction involves several critical elements to ensure efficient and reliable operation. Here's an overview of the main components and considerations for the construction of the column of a stacker crane:

Basic Components:

① 

Columns/Vertical frame

② 

Top guide base

③ 

Bottom Guide base

④ 

Drive and Driven wheel

⑤ 

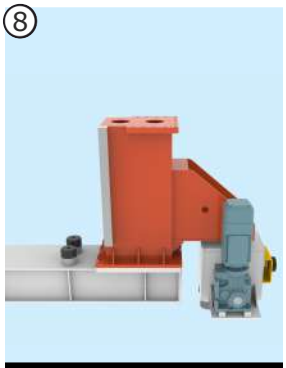
Lifting Cradle

⑥ 

Gear motor for Lifting

⑦ 

On board control panel

⑧ 

Gear motor for Travelling

⑨ 

Bottom Guide base

⑩ 

Vertical Guide

1. Column/ Vertical Frame

In Automated Storage and Retrieval Systems (AS/RS), a box girder is a type of structural element used in the column design to provide additional strength, stability, and support.
The columns can be formed by structural tubes or by box-girders. A box girder is a hollow, rectangular-shaped beam composed of four plate elements:

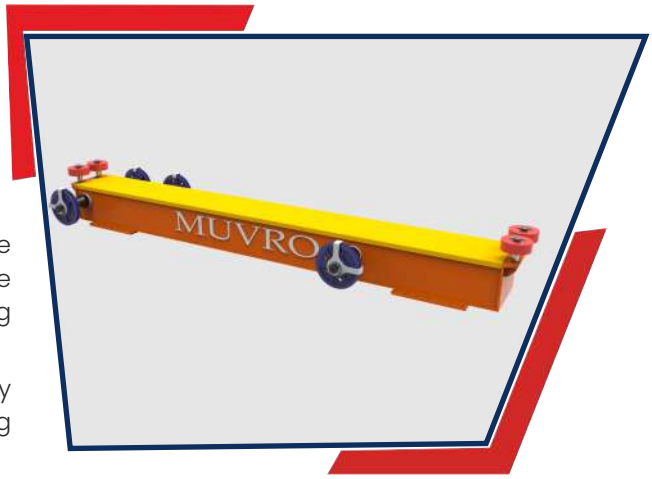
Advantages in Column AS/RS

1. **Increased strength**: Box girders offer higher load-carrying capacity and resistance to compressive forces.
2. **Improved stability:** The closed box shape provides excellent resistance to torsion and lateral forces.
3. **Reduced material usage**: Box girders can be designed to use less material while maintaining structural integrity.
4. **Enhanced durability**: The enclosed shape protects the interior from environmental factors, reducing corrosion and damage.

Design Considerations

1. **Material selection**: Choose materials that meet the required strength, durability, and corrosion resistance.
2. **Section properties**: Calculate the optimal section properties (e.g., width, height, thickness) for the box girder.
3. **Welding and connections**: Ensure proper welding techniques and connections to maintain the structural integrity.
4. **Deflection and vibration**: Consider the potential for deflection and vibration, and design accordingly.

2. Top Guide Base



In Automated Storage and Retrieval Systems (AS/RS), the top guide base is a critical component that ensures the smooth and accurate movement of the storage retrieval machine (SRM) along the vertical column.

Purpose and Function

- **Alignment:** The top guide base provides a stable and precise alignment for the stacker crane as it moves vertically along the rack structure. It helps to keep the crane on track, ensuring smooth and accurate movement.
- **Load Distribution:** It distributes the loads and stresses exerted by the stacker crane and the materials being handled, preventing excessive wear or deformation of the structure.
- **Stability:** Maintains the SRM's stability, reducing the risk of oscillations or vibrations during movement.

Design Considerations

- **Material selection:** Choose materials with high strength, stiffness, and durability, such as steel.
- **Geometry:** Design the top guide base to match the SRM's dimensions and movement requirements.
- **Tolerances:** Ensure precise tolerances to maintain accurate alignment and smooth movement.
- **Lubrication:** Consider lubrication systems to reduce friction and wear on moving parts.

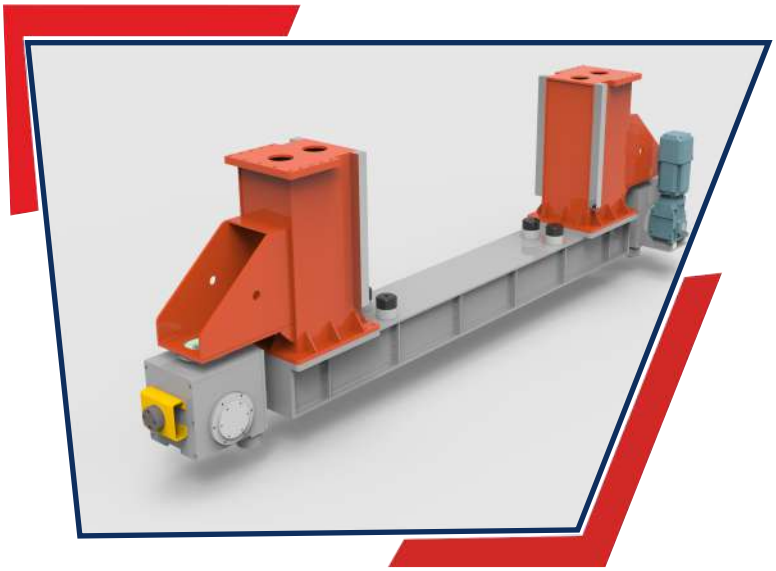
3. Bottom Guide Base

This structure in the form of a box is made up of profiles and steel sheets welded together, which are resistant to bending and torsion thanks to the reinforcement ribbing welded inside at regular intervals.

Purpose and Function

Stability: The bottom guide base provides a stable foundation for the stacker crane's movement. It helps to maintain the crane's alignment with the guide rails or tracks, reducing wobble or swaying during operation.

Load Distribution: It helps distribute the loads and stresses imposed by the stacker crane and the materials being handled, preventing damage to the rack structure and ensuring smooth operation.



Material and Design

Material: The bottom guide base is commonly made from high-strength materials like steel, chosen for their ability to handle heavy loads and resist wear over time.

Design: It must be designed to accommodate the weight and dimensions of the stacker crane and the types of materials stored. The design ensures that the guide rails remain level and properly aligned.

Installation

Precision: Accurate installation is crucial for the bottom guide base. It must be aligned perfectly with the top guide base to ensure that the stacker crane moves vertically without any misalignment or instability.

Integration: The base must be integrated with the overall rack structure and the floor of the warehouse, ensuring that it is securely anchored and supported.

Maintenance

Inspection: Regular inspections are necessary to check for any wear or damage to the guide rails and support structure. Any issues must be addressed promptly to avoid operational problems.

Lubrication: Guide rails and moving parts may require periodic lubrication to minimize friction and wear, ensuring smooth operation.

Safety Considerations:-

Safety Features: The bottom guide base should include safety features such as guard rails or covers to protect personnel and equipment from potential hazards.

Load Limits: It should be designed to handle the maximum expected loads of the stacker crane and the materials being stored, with appropriate safety margins.

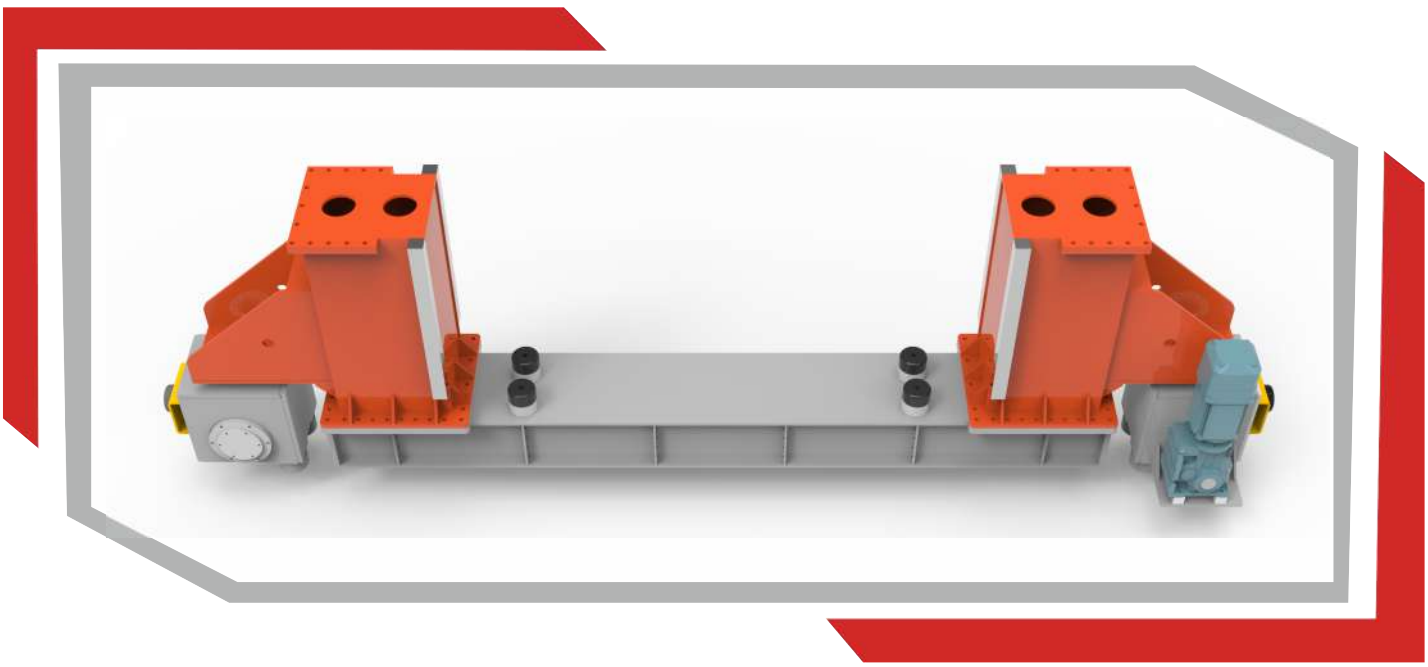
Key Points for Bottom Guide Base Construction

Robust Design: Ensure the base is robust enough to handle dynamic loads and stresses.

Alignment: Proper alignment with the top guide base is essential for smooth operation.

Load Distribution: Effective load distribution to prevent damage to the rack structure and ensure stability.

Safety and Maintenance: Include safety features and plan for regular maintenance to keep the system operating smoothly.



4. Drive and Driven wheel

In Automated Storage and Retrieval Systems (AS/RS), the drive wheel is a critical component of the stacker crane, responsible for propelling the crane along the horizontal rail.

Functions

Propulsion: Drives the crane along the rail, enabling movement and positioning.

Speed control: Regulates the crane's speed, ensuring smooth and precise movement.

Accuracy: Maintains accurate positioning, crucial for storage and retrieval operations.

Key Features

High torque: Provides sufficient torque to move the crane and its loads.

Low friction: Minimizes friction to reduce wear and ensure smooth movement.

Durability: Withstands heavy use and harsh environments.

Types of Drive Wheels

Rubber-coated: Provides traction and shock absorption.

Polyurethane-coated: Offers high wear resistance and smooth movement.

Steel wheel: Suitable for heavy-duty applications, providing high load capacity.

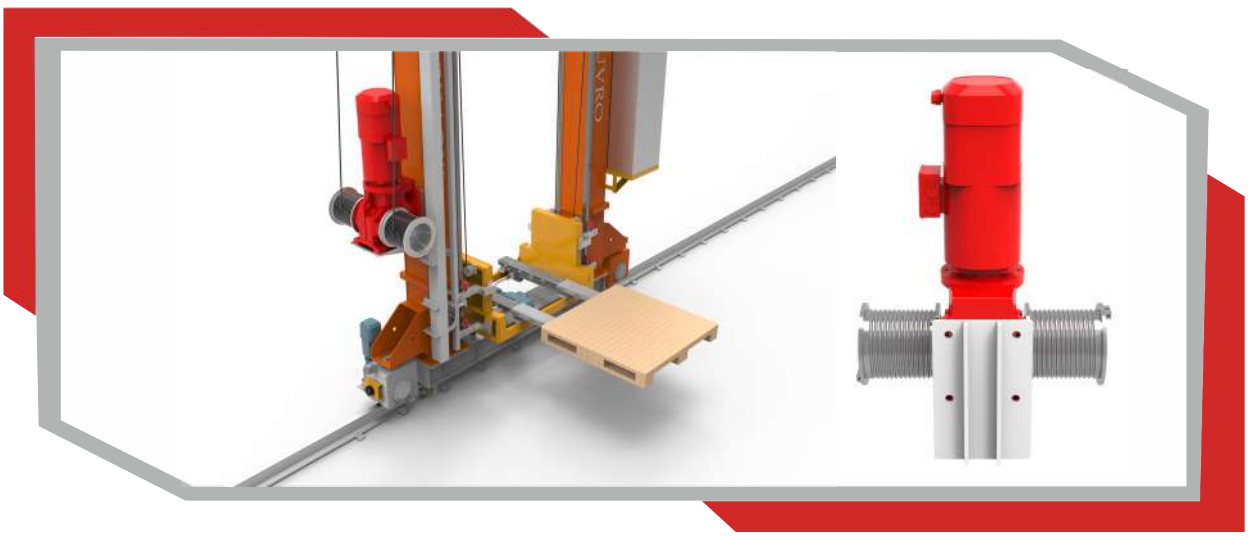
Design Considerations

Wheel diameter: Optimized for speed and torque requirements.

Wheel material: Selected for durability, traction, and resistance to environmental factors.

Bearings and seals: Ensure smooth rotation and minimize maintenance.

Integration with control systems: Seamless integration with AS/RS control systems for precise movement and positioning.



5. Lifting cradle

In an Automated Storage and Retrieval System (AS/RS), the Lifting cradle is a crucial component used to handle and transport goods within the system. It plays a vital role in the stacking and retrieval of items, especially in systems where precise lifting and placement are required. Here's a detailed overview of the lifting cradle and its functions:

Purpose and Function

Load Handling: The lifting cradle is designed to lift, support, and transport loads within the AS/RS. It ensures that items are moved safely and accurately between storage locations and retrieval points.

Stability: It provides stability to the load during lifting and transportation, reducing the risk of tipping or shifting which could damage the goods or disrupt operations.

Components and Design

Frame: The lifting cradle typically has a robust frame structure made from steel. The frame must be strong enough to support the maximum load capacity and withstand the stresses of lifting and movement.

Lifting Mechanism: This includes the system responsible for raising and lowering the cradle. Common mechanisms include:

Hydraulic Lifts: Use hydraulic cylinders to provide smooth and powerful lifting.

Electric Motors and Screws: Utilize electric motors driving screws or belts for lifting actions.

Chain or Rope Systems: Employ chains or ropes driven by motors to lift the cradle.

Platform or Pallet: The area where goods are placed. It is designed to accommodate various sizes and types of loads, and may include features like adjustable supports or clamps to secure different items.

Types of Lifting Cradles

Fixed Cradles: Have a set platform and lifting mechanism designed for specific load sizes and shapes. They are usually used for standard operations with predictable load types.

Adjustable Cradles: Feature adjustable components to handle various load sizes and types. They can be modified to fit different items and accommodate changes in inventory.

Pallet cradle: Designed for palletized loads, often with fork-like protrusions.

Integration with AS/RS

Connection to Crane or Shuttle: The lifting cradle is typically attached to a stacker crane or shuttle system that moves it to the desired location. The integration ensures that the cradle can be accurately positioned for loading and unloading.

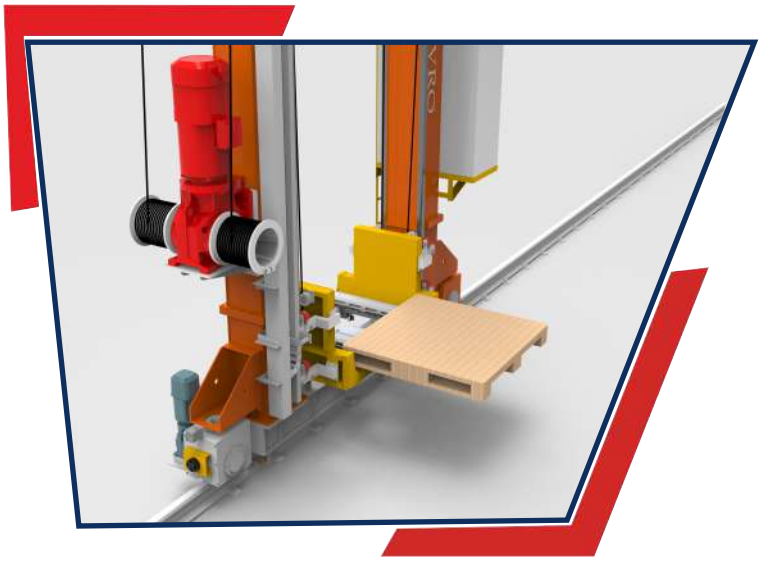
Control Systems: The lifting cradle is controlled through the AS/RS control system, which coordinates its movements with the overall storage and retrieval operations. This includes precise positioning and timing for efficient handling.

6. Hoist motor for Lifting pallet

Hoist Motor in AS/RS – Overview

Purpose:

The hoist motor enables vertical lifting and lowering of pallets in an Automated Storage and Retrieval System (AS/RS), converting electrical energy into mechanical motion to handle varying load capacities.



Key Components:

Motor: Provides driving power (usually electric).

Gearbox: Reduces speed and increases torque for lifting.

Lifting Mechanism: Chain, rope, screw, or belt system converting rotation into vertical motion.

Control System: Regulates start/stop, speed, and direction.

Types:

Electric Hoist Motors:

- **AC Motors** – Reliable and steady power.
- **DC Motors** – Precise variable speed control.

Hydraulic Hoists: High lifting power and smooth operation.

Pneumatic Hoists: Air-powered; ideal for spark-free or high-speed environments.

7. Onboard control panel

The control panel for a stacker crane in an Automated Storage and Retrieval System (AS/RS) is responsible for managing and operating the stacker crane. Here's an in-depth look at the control panel and its functions:

Purpose and Function

- Operation Control: The control panel manages all operational aspects of the stacker crane, including movement, lifting, and positioning.
- Monitoring: Provides real-time feedback on the crane's status, including position, speed, and load conditions.
- Safety Management: Ensures safe operation through built-in safety features and emergency controls.

Components

- **User Interface:**
- **Touchscreen Displays:** Modern systems often use touchscreens for intuitive control and monitoring.
- **Buttons and Switches:** Traditional panels may have physical buttons, switches, and dials for manual control.
- **Control Logic:-**
  - **Programmable Logic Controller (PLC):** Handles the logic and processing for the stacker crane's movements and operations.
  - **Microcontroller:** In some systems, a microcontroller might be used for specific control tasks.

  Indicators:-
  - **Status Indicators:** Lights or displays showing the current status of various components, such as power, error conditions, or operational modes.
  - **Alarms:** Audible or visual alarms for fault detection and safety warnings.
  - **Input/output Ports:-**
  - **Sensor Inputs:** For integrating sensors that monitor position, load, and other parameters.
  - **Actuator Outputs:** To control motors, brakes, and other actuators in the stacker crane.

Functions

- **Movement Control:**
  - **Direction Control:** Manages the direction of movement for both horizontal and vertical motions.
  - **Speed Control:** Adjusts the speed of the stacker crane's movements.
- **Lifting and Lowering:**
  - **Positioning:** Controls the precise lifting and lowering of the crane's load.
  - **Load Management:** Monitors and manages load handling to ensure stability and safety.
- **Navigation:**
  - **Routing:** Directs the stacker crane to specific storage or retrieval locations within the AS/RS.
  - **Path Planning:** Optimizes movement paths to improve efficiency and reduce travel time.
- **Data Logging and Monitoring:**
  - **Performance Data:** Logs operational data for analysis and performance monitoring.
  - **Diagnostics:** Provides diagnostic information for troubleshooting and maintenance.

Integration with AS/RS

- System Communication: The control panel interfaces with other system components, including the warehouse management system (WMS), to coordinate operations and synchronize tasks.
- Network Connectivity: Often connected to a central control network or cloud-based system for remote monitoring and management.

Design Considerations:

- Ergonomic design: Easy-to-use interface and accessible components.
- Reliability: Robust components and redundant systems ensure continuous operation.
- Scalability: Adaptable to future expansions or modifications.
- Safety standards: Compliance with relevant safety regulations and guidelines.
- Environmental factors: Protection from dust, moisture, and extreme temperatures.

8. Gear motor for Horizontal travelling

Purpose:

Drives the horizontal movement of the stacker crane or shuttle along tracks, converting electrical energy into mechanical motion with controlled torque and speed.

Key Components:

Electric Motor:

AC Motor – Reliable, steady speed.

DC Motor – Variable speed for precise control.

Gearbox: Reduces motor speed, increases torque (planetary, worm, helical, or bevel types).

Mounting Brackets: Secure the motor for proper alignment and stability.

Types:

Inline Gear Motors – Compact, aligned design.

Right-Angle Gear Motors – 90° layout for tight spaces.

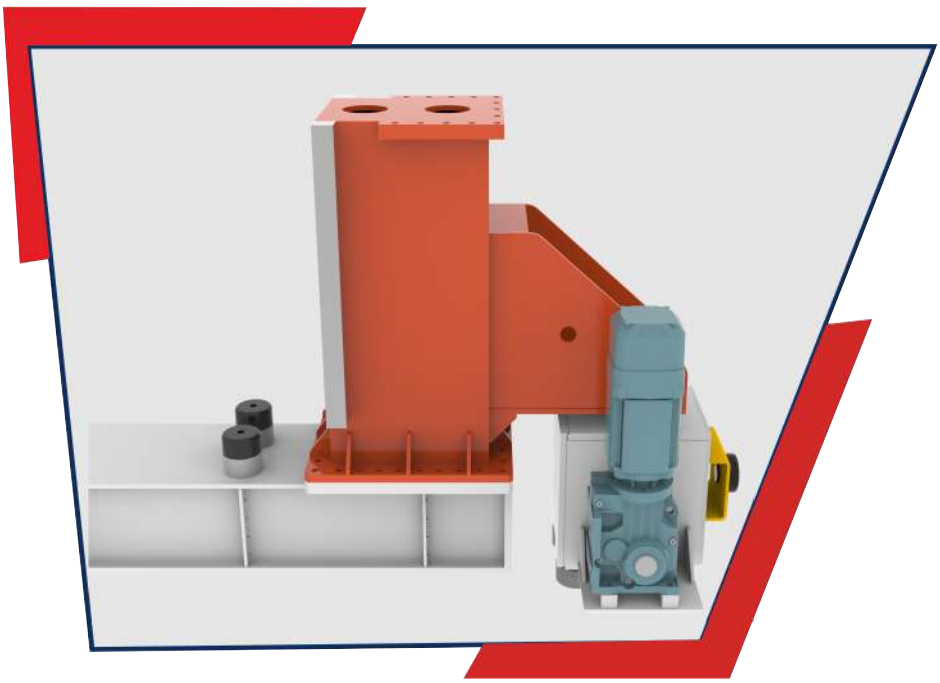
Variable Speed Gear Motors – Adjustable speed for flexibility.

Integration:

Connected to the drive system and control system of the AS/RS for direction, speed, and feedback. Equipped with sensors for position and load monitoring.

Installation:

Requires precise alignment with tracks to ensure smooth, efficient, and durable operation.

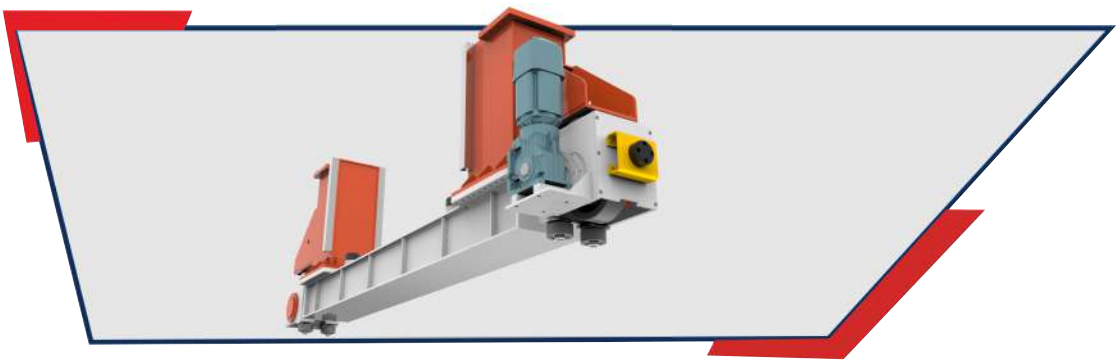


Key Points for Gear Motors in Horizontal AS/RS

Efficient Power Transmission:
Converts motor power into the controlled horizontal movement required for the AS/RS.

Torque and Speed Control:
Provides the necessary torque and speed adjustments to handle varying loads and operational conditions.

Maintenance and Safety:
Requires regular maintenance for reliable performance and safety features to protect both the system and personnel.



9. Bottom Guide track

Purpose:

Ensures precise, stable movement of the stacker crane for accurate and smooth operation.

Functions:

Guidance: Maintains fixed travel path.

Stability: Prevents sway or misalignment.

Precision: Enables accurate load handling.

Components:

Rails, supports, and guide wheels for smooth, low-friction motion.

Types:

Horizontal: Straight or curved.

Vertical: Fixed or adjustable.

Combined: For multi-directional movement.

Installation: Must be precisely aligned and securely mounted for reliable performance.

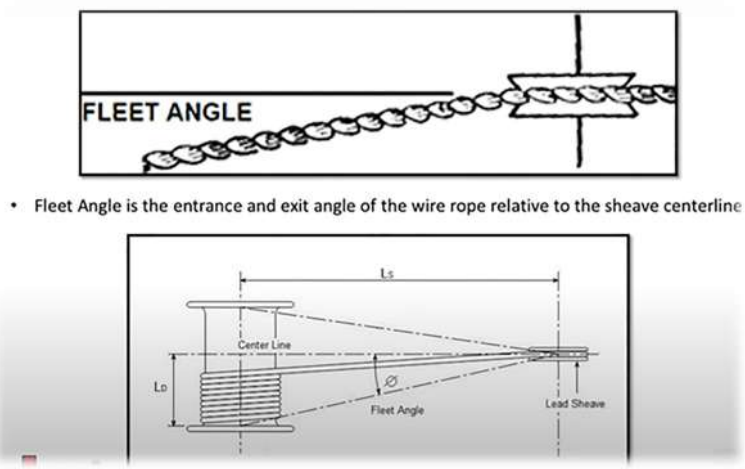
10. Fleet Angle Compensator

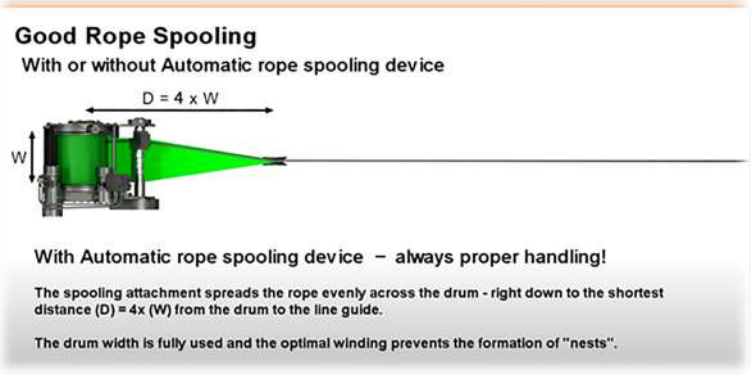
In Automated Storage and Retrieval Systems (ASRS), particularly in stacker cranes, the term "fleet angle" refers to the angle at which the lifting mechanism (such as the hoist or lift cable) approaches the load. Managing fleet angle is crucial to ensure smooth and efficient operation of the crane system.

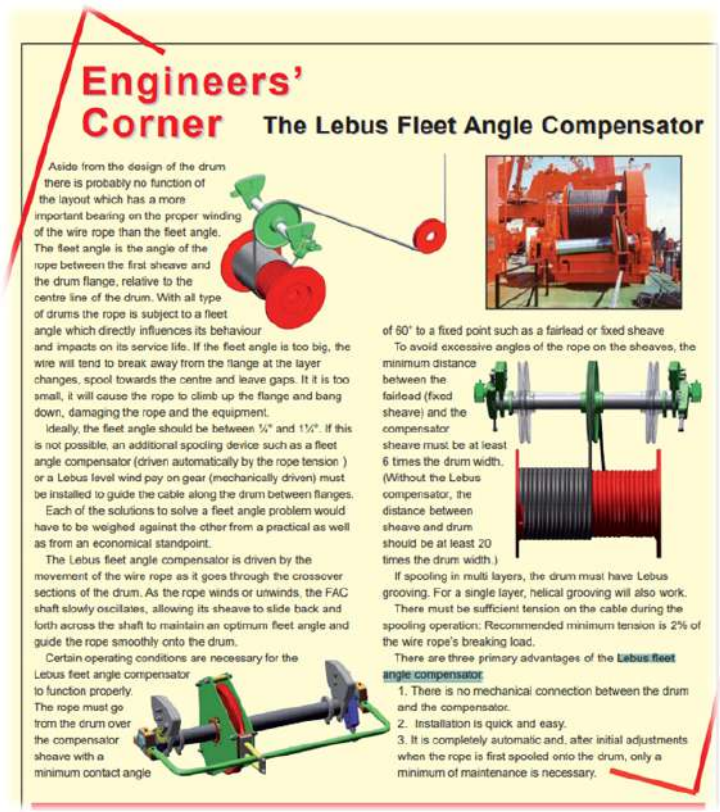
- **Function:** The compensator adjusts the alignment of the lifting cable or chain as it moves through the system. By maintaining an optimal fleet angle, it helps to reduce wear and tear on the hoist, minimize cable slippage, and ensure smooth load handling.
- **Importance:**
- **Efficiency:** Proper fleet angle management ensures that the crane operates efficiently, minimizing power consumption and reducing the strain on mechanical components.
- **Load Stability:** It helps maintain stable load positioning and movement, reducing the risk of load sway or misalignment.
- **Longevity:** Reducing the strain on cables and other components extends the lifespan of the equipment.

Types of Compensators:

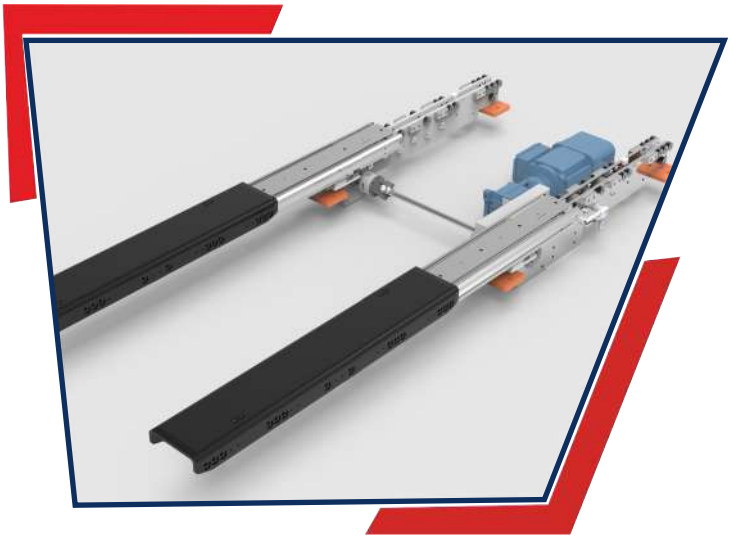
- **Mechanical Compensators:** These involve physical adjustments or mechanisms that alter the cable path to correct the fleet angle.
- **Dynamic Adjustments:** Advanced systems may use sensors and automated controls to continuously adjust the fleet angle in real-time.







11. Telescopic fork Double deep



In Automated Storage and Retrieval Systems (ASRS), a telescopic fork designed for double-deep racking is an advanced component used in stacker cranes to enhance storage density and operational efficiency. Here's a detailed look at how telescopic forks work and their advantages:

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Telescopic Fork Overview

1. Design and Functionality:

- **Telescopic Mechanism:** A telescopic fork consists of two or more sections that can extend and retract, allowing it to handle loads in different rack configurations. This telescoping action enables the fork to reach deeper storage locations than a standard single-section fork.
- **Double-Deep Racking:** Double-deep racking involves storing pallets two deep in the storage racks. This setup increases storage density but requires more complex handling since the crane needs to retrieve pallets from the second position.

2. **Operation:**

- **Extension and Retraction:** The fork extends to reach the second row of pallets and then retracts to deliver or retrieve the pallets. This functionality is crucial for accessing and handling pallets stored in deeper rows of the racking system.
- **Precision Control:** Telescopic forks are controlled with high precision to ensure that the forks extend and retract accurately, avoiding collisions and ensuring correct pallet placement.

3. **Advantages:**

- **Increased Storage Density:** By using double-deep racks, you can store more pallets within the same footprint, optimizing warehouse space.
- **Enhanced Efficiency:** The telescopic fork allows stacker cranes to access and handle double-deep storage without needing additional aisles, improving overall operational efficiency.
- **Flexibility:** The telescopic design allows for greater flexibility in handling various load types and sizes, accommodating different pallet configurations.

4. **Applications:**

- **High-Density Warehousing:** Ideal for warehouses where maximizing storage space is critical, such as in distribution centers and manufacturing facilities.
- **High-Throughput Operations:** Useful in environments where high turnover rates of pallets necessitate quick and efficient retrieval and storage.
- **Considerations:**
- **Maintenance:** Regular maintenance is essential to ensure the telescopic mechanism operates smoothly and reliably over time.
- **System Integration:** The telescopic fork must be properly integrated with the stacker crane's control systems to ensure accurate and reliable performance.

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