



सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF COMMERCE & INDUSTRY
DEPARTMENT FOR PROMOTION OF INDUSTRY AND INTERNAL TRADE

PM
GatiShakti
National Master Plan for
Multi-Modal Connectivity

75
Azadi Ka
Amrit Mahotsav

e -HANDBOOK on WAREHOUSING STANDARDS

2022

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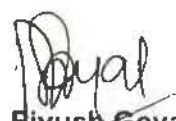
FOREWORD

The PM GatiShakti National Master Plan launched by Hon'ble Prime Minister Narendra Modi envisions to provide a boost to the economy with 7 engines of progress viz. roads, railways, airports, ports, mass transport, waterways and logistics infrastructure. This is to be achieved through synergy and coordination between centre and states at every level. The plan will help in building the NextGen infrastructure which will kickstart the virtuous cycle of private and public investment and will have a multiplier effect. Thus, a greater impetus is being given to support large-scale infrastructure development, logistics efficiency and seamless connectivity.

In the move to improve logistics performance in the country, supply chains have to be efficient and resilient. Efficient and resilient supply chains have warehousing as a critical component which cannot be achieved without standardisation. The ensuing globalization and the growing Indian economy call for compatibility of logistics with global standards. The National Logistics Policy is the next logical step which addresses standardisation of physical assets, processes, taxonomy and benchmarking of service quality standards in the logistics sector as one of the key objectives.

I am delighted that with concerted efforts of several experts from the Government agencies and the industry, "*e-Handbook on Warehousing Standards*" has been developed with a compilation of information on standards that may be referred to by the industry, logistics companies, standards development agencies and others. The handbook will serve as a guide for infrastructure improvement, achieving efficiency, cost reduction, attracting investment, adoption of newer technologies and global best practices.

I sincerely urge all the stakeholders dealing with logistics, in particular the warehousing and related physical assets to move towards standardisation and benefit themselves through improved performance, as well as contribute to the economic growth of the country. I commend all those who contributed towards developing and bringing out this valuable handbook.


Piyush Goyal



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राज्य मंत्री
वाणिज्य एवं उद्योग मंत्रालय
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Minister of State
Commerce & Industry
Government of India



MESSAGE

There are several stakeholders that have an important role in applying standards in the logistics sector. These include manufacturing industry; commerce and e-commerce agencies, traders and businesses; logistics industry, logistics service providers, developers, landlords; manufacturers of racking systems, material handling equipment, trucks, pallets, packaging systems and solutions; and standards setting agencies.

Improvement in warehousing is envisaged to be achieved through enabling adequate development of warehouses with optimal spatial planning using PM GatiShakti NMP and facilitating private investments in warehouses; increase in efficiency and productivity in warehousing through the promotion of standards, grading, digitisation, and improving quality of services at warehouses through promotion of standards, grading and promoting digitization, use of Artificial Intelligence (AI), Machine Learning (ML), warehouse automation.

I sincerely wish all those involved in the logistics sector to effectively implement the standards to achieve efficiency and reduce overall logistics cost. The "E-handbook on Warehousing Standards" is timely and I would like to congratulate all those that contributed to the development of this useful reference.

Hon'ble Minister of State for Commerce and Industry



(SOM PARKASH)
#startupindia

अनुप्रिया पटेल
ANUPRIYA PATEL



वाणिज्य एवं उद्योग राज्य मंत्री
भारत सरकार
Minister of State for Commerce & Industry
Government of India



Foreword

Infrastructure development is a critical enabler to economic growth. Logistics infrastructure is the backbone on which the nation marches ahead and a robust logistics sector can go a long way in boosting India's quest for being a manufacturing giant. The “**PM Gati Shakti National Master Plan (PMGS-NMP)**” is one such attempt to synchronise the planning and implementation stages by institutionalising inter-ministerial coordination and digitalising all planning stages. It is an extension of holistic governance.

From a largely unorganized, asset-heavy industry, warehousing sector has also undergone an evolution in India. As a significant component in supply chains worldwide, warehouse acts as a competitive asset for businesses to achieve both financial and environmental sustainability objectives in the long term.

While the National Logistics Policy is in works, there has also been an effort to address the warehousing sector through an “**e-Handbook on Warehousing Standards**” which is expected to set standards on developing world class warehouses across the country to help effectively utilise the assets. I am sure this e-handbook will serve as a valuable tool to all the stakeholders of the Industry and will go a long way in achieving Standardization and development of world class infrastructure in the country.

My best wishes to all those who contributed in development of this useful document.



(Anupriya Patel)

13.09.2022
New Delhi

अनुराग जैन, भा.प्र.से.
सचिव
ANURAG JAIN, I.A.S.
Secretary



भारत सरकार
उद्योग संवर्धन और आंतरिक व्यापार विभाग
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AND INTERNAL TRADE
MINISTRY OF COMMERCE & INDUSTRY



Foreword

Logistic efficiency plays a pivotal role in economic prosperity. To ensure cost-effective, safe and timely delivery of goods from manufacturers to consumer, robust connectivity and inventory management is crucial. This is facilitated by the warehousing sector. Government programmes and policies aimed towards establishing standards and reducing market failures have allowed private players to offer services in competitive environment.

Department for Promotion of Industry & Internal Trade (DPIIT) has been working for holistic development of the sector. DPIIT has made extensive efforts to engage with the stakeholders to identify bottlenecks and to make processes more efficient through process re-engineering and use of technology. Systemic reforms and liberalized FDI policies have seen a boost in investment from global companies. Startup initiative has seen phenomenal success. Warehousing sector has also benefited. Entrepreneurship and innovation of Indian talent is driving growth and creating large employment opportunities in the warehousing sector.

The increasing demand for warehousing has led to felt need for standardization of processes, requirement of skilled manpower, investment in technology and quality practices for warehousing. We hope that the “e-Handbook on Warehousing Standards” will be invaluable as a guide to help warehouses reduce their costs and lay the foundation to establish world class warehousing infrastructure in the country.


(Anurag Jain)



Amrit Lal Meena, IAS
Special Secretary (Logistics)



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FOREWORD

Warehouses and the related physical assets form an important element of the Logistics. It is essential to ensure standardisation of pallets, packaging, racks, goods carriers and usage of modern material handling equipment. A number of standards already exist and some more may have to be developed to achieve greater logistics efficiency.

By applying these standards in the warehousing and related physical assets, several benefits are expected. Reduced costs, efficient asset utilisation, material handling, productivity and operational efficiency, enabling inter-modal transport, reduced GHG emissions are a few to name. Our urban agglomerations and mega cities, where sizable consumers exist, could significantly benefit from the efficiencies in logistics in timely deliveries as well as reduced pollution. The “e-book on Warehousing Standards” shall be of immense use to stakeholders of warehouse.

I urge upon warehousing stakeholders to adopt those standards for bringing in logistics efficiency gain.


(Amrit Lal Meena)



Acknowledgement

Standardisation of the logistics segment and the implementation of standards creates scope for significant cost reduction in logistics, creates efficient processes and ensures seamless movement of freight across the supply chains and networks. This will go a long way in making logistics in the country cost effective, efficient, robust, agile and competent on the global scale and make India a strong contender in the world supply chain scenario.

Robust development of the sector with more infrastructure development through investment, to ensure ease of doing business to cater to the diverse requirements of retail and e-commerce is required. Diversification in warehousing sector will help attain efficiency and lowering of logistics cost in the country. Warehousing and distribution also go hand-in-hand in providing enhanced access and a more cost-effective way of delivering goods.

The Logistics Division, Ministry of Commerce and Industry, Government of India has consulted various organisations, reviewed the existing standards pertaining to warehousing and related physical assets of the logistics ecosystem and has brought out the present reference document. The handbook includes the existing standards that are issued by the standards agencies such as the Bureau of Indian Standards (BIS), the Warehousing Development and Regulatory Authority (WDRA), international standards and the global best practices which have been put together by a team of experts from industry and the Government. While this handbook is an endeavour to consolidate relevant standards as issued by concerned standard-setting agencies and to sensitize stakeholders for necessary adoption, this handbook shall not be valid for settling any legal, commercial or any other claim whatsoever. The “**e-Handbook on Warehousing Standards**” envisages to act as an enabling and guiding document for facility developers and regulatory agencies to identify and implement facility and sector specific standards. This intends to facilitate in improved performance of the logistics ecosystem in the country and pave way for global competitiveness of the Indian warehousing and logistics sector.

Logistics Division would like to acknowledge the active participation and efforts of various line Ministries and agencies of the Government of India for participating in the discussions for development of this e-handbook, including Ministry of Road Transport and Highways (MoRTH), Ministry of Railways (MoR), Ministry of Ports, Shipping and Waterways (MoPSW), Ministry of Civil Aviation (MoCA), Central Board of Indirect Taxes and Customs (CBIC), Department of Revenue, Ministry of Finance (MoF) and Warehousing Development and Regulatory Authority (WDRA).

We also appreciate the endeavour of Warehousing Association of India (WAI) for compilation of the standards in the form of an e-handbook and various industry associations that provided inputs, including Confederation of Indian Industry (CII), CII Institute of Logistics (CII-IL), Federation of Indian Chambers of Commerce and Industry (FICCI) and Indo-German Chamber of Commerce (IGCC). We would like to thank BIS for their valuable inputs and reviewing the document. We would also like to acknowledge Avalon Consulting and Rhenus Logistics India for technical inputs provided for the preparation of the e-Handbook. We would like to place our deep appreciation for the support provided by Asian Development Bank (ADB) through their technical programme and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH under the Indo-German Development Cooperation project on 'Climate- Friendly Freight Transport in India' (Green Freight) supported by the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection.

I wish all the best for the success of utility of the "e-Handbook on Warehousing Standards" to the users.



(S.K.Ahirwar)



About the publisher

The Warehousing Association of India (WAI) was formed as a section 8 Company on 8th November 2021 with the mission to promote the interest of the Warehousing Industry in India.

Key Stakeholders & Members of WAI comprise Developers/Builders of Warehouses and Logistics Parks; Users of Warehouses such as Retail/ Manufacturing/ E-Commerce Companies; Operators of warehouses such as 3PL/ Logistics/ Warehousing Companies; Associated Companies that provide such as Equipment/ Software/ Design for Warehouses. In rhythm with PM Gati Shakti NMP, the key objective of WAI is to facilitate the ease of setting up and operating world class warehouses in India.

At the outset, on behalf of the Board & Members of WAI, we are privileged to have been entrusted by Department for Promotion of Industry and Internal Trade (DPIIT) to update and publish this e- Handbook. We would especially like to thank **Shri Amrit Lal Meena, Special Secretary, Logistics** and **Dr. Surendra Ahirwar, Joint Secretary (Logistics Division)** for guiding the entire team on this endeavour. WAI also thanks **Er. S Bhardwaj, Deputy Director General (Logistics Division)** for his constant support, and **Mr. Pramod Rajendran (GIZ, India)** for coordination with all the concerned teams. This is indeed an excellent e- handbook and will benefit all the stake holders of the industry and go a long way toward standardisation and facilitate the development of world class warehousing infrastructure in India. We will continue to update this document annually and it will be our endeavour to include the latest developments, practices and technologies in the Warehousing Industry from time to time.



Manu Raj Bhalla

**President,
Warehousing Association of India**

About the e-Handbook

Warehousing and related assets are an important segment of the overall logistics sector in the country. In the warehousing value chains, “standardisation” is becoming essential for reducing costs, improving efficiency, and ensuring global compatibility as well as competitiveness.

Currently, there are numerous standards for warehousing and related assets. In view of the growing logistic sector, technology advancements and globalisation, the Logistics Division in the Department for Promotion of Industry and Internal Trade , Ministry of Commerce and Industry, Government of India took up the task of assessing the adequacy of these existing standards and to fill the gaps with additional standards and guidelines. In consultation with experts and various stakeholders, including industry, users, interest groups, standards organisation and governments, the present draft guidelines for standardisation of warehousing and related assets for seamless and efficient logistics are issued.

This e-Handbook includes the existing standards that are issued by standards agencies such as the Bureau of Indian Standards (BIS) and the Warehousing Development and Regulatory Authority (WDRA), and wherever there are gaps, practices in vogue are suggested.

The Logistics Division, Ministry of Commerce and Industry, Government of India has consulted various organisation, reviewed the existing standards pertaining to warehousing and related physical assets of the logistics ecosystem, and has brought out the present e-Handbook.

Scope of the e- Handbook

This e-Handbook includes the existing standards that are issued by the standards agencies such as the Bureau of Indian Standards (BIS) and the Warehousing Development and Regulatory Authority (WDRA), and wherever there are gaps those have been identified and suggestions are made further based on standards in use by the industry and international standards.

This e-Handbook intends to help the users to gain quick overview of the standards they should refer to. The potential users of this document include the manufacturing industry; commerce and e-commerce agencies, traders and businesses; logistics industry, logistics service providers, developers, landlords; manufacturers of racking systems, material handling equipment, trucks, pallets, packaging systems and solutions; and standards setting agencies.

Disclaimer : This document shall not be used for legal purposes. The original standards issued by the Standardization Authority shall prevail over this handbook. This e-Handbook is not a comprehensive document that covers all standards existing or required to be considered. The present e-Handbook is to be considered as an initial attempt and eventually further versions would be brought out that are more user-friendly for application of standards.

Chapter 01 - Standards for Warehousing

The present warehouse standards prescribed are primarily governing the physical infrastructure of the warehouses. Additionally, best practices are listed for ensuring reduction in warehousing costs as well as achieving improved efficiency and effectiveness covering the following areas of warehousing:

Warehousing structure standards that include design and construction standards, flooring standards, roofing standards.

Maintenance Standards including fire safety standards, security standards, occupational safety, health and sustainability standards and illumination standards. Warehouse Machinery standards and Standards for Warehouse Management Systems including regulatory compliance, labour management systems, digital management systems, and Industry 4.0

Chapter 02 - Standards for Palletisation

Palletisation plays an important role in achieving efficiencies not only in warehousing but also in the whole cycle of logistics. Standardisation of pallet sizes will allow standardisation of palletizers, racking, material handling equipment, trucks, and warehouse design. This will result in economy of space and facilitate automation, thereby eliminating manual transfer of goods and improves the overall productivity and work efficiency, as well as reduces losses and the wastage of pallets.

In addition to the existing standards, best practices are listed for standardized pallet dimensions/sizes for unitized loads for various industry segments, viz. Chemicals/ petrochemicals, food & beverages, retailers, pharma, textiles, electronics, automotive etc. The chapter includes the following:

Standards for pallet dimensions, Standards for tolerance and load capacity, Standards for pallet material specification, Packaging, Pallet stacking, Manufacturing material of pallets; and Number of entry points.

Chapter 03 - Standards for Racking

A good warehouse should provide safe and efficient storage for various products. A warehouse facility providing maximum space utilisation for storage creates higher profit margins for the operator.

Currently, there are no existing Indian Standards for racking. Application of standards for racking is essential to ensure efficient storage within warehouse premises. The practices in vogue for racking cover the following: Racking dimensions, Load factors; and Material strength factors.

Chapter 04 - Standards for Material Handling Equipment

Warehouses use various types of material handling equipment for ease of operations. The most common equipment used are forklift trucks and cranes, conveyors and other dock levelling equipment. Details of the standards for material handling equipment have been provided in detail within the chapter.

Chapter 05 - Standards for Transportation

The standards for road transportation primarily include existing guidelines for dimensions of containers and other storage and transit equipment used at various warehousing and transportation facilities. Key changes will be required in truck body standards to make trucks ready for palletized cargo to improve throughput, besides truly synchronizing with international norms. The truck body width must match the pallet sizes as also flooring of trucks should follow standards to facilitate use of mechanized material handling equipment. From environmental considerations, it is important to have optimal vehicular routing, to use electric vehicles and to and ensure efficiency and maintenance of service vehicles. The best practices cover the following areas: Dimensions, truck design and Network optimisation.

Chapter 06 - Product Specific Standards

Products stored in warehouses may be classified as agricultural and non-agricultural items. These products are required to be stored in warehouses capable of protecting the quality. The standards for agricultural products and commodities are specified by WDRA, BIS and other product specific agencies. For the non-agricultural commodities, the standards are specified by various nodal regulatory agencies such as BIS as well as international agencies. The product specific standards cover the following: Assaying/grading standards, Testing standards and Weighment standards.

Recent Trends

A) Warehouse Automation

Warehouse automation helps ensure that business-critical operations in the warehouse meet customer demand. It starts with a warehouse management system (WMS) that automates manual processes and data capture, inventory control and supports data analysis. These systems integrate with other solutions to efficiently manage and automate tasks across different business and supply chain functions.

Warehouse automation projects are expensive, but they pay back fast. The reason for impressively fast ROI is multiple new saving points provided by automation such as: reduced labour cost, higher performance, optimized handling and storage cost, minimized inventory errors, eliminated risks of mishandling and product loss. Let's look at some automation solutions in Loading/Unloading, Picking, Sortation, Movement, Storage and Retrieval within the Warehouse. The chapter covers automation systems for loading/unloading, picking, sortation, movement, storage and retrieval.

B) Artificial Intelligence in the Warehouse

In this section a broad understanding of AI with current/possible applications of AI in the Warehouse is put forward with case examples (Domestic/international). Applications of AI in storage, picking, putting away, replenishment, movement, grading, kitting, cross-docking and yard management are described briefly.

01

Standards for Warehousing

- Warehouse Structure Standards
- Maintenance Standards
- Warehouse Machinery Standards
- Standards for Warehouse Management Systems





STADARDS FOR **WAREHOUSING**



Introduction

Warehouse is an integral part of a supply chain and plays an important role in it, warehouse structures and related specifications have improved manifold over the years but this improvement has been led by industry without any guidelines or structured set of standards and specifications. The increasing demand for warehousing space has resulted in massive growth of new logistics parks and single unit warehouses led by large and medium sized developers, self-users, and manufacturers who have developed their specifications as per market or self-requirement and constructed as per their understanding.

In the past decade development of built to suit warehouses and large logistics parks has become increasingly common since the advent of domestic, multi-national companies, e-Commerce companies and the increasing flow of foreign direct investment by international developers in the warehouse infrastructure sector. This also helped improve the warehousing standards in the country since a lot of end users and developers adopted these standards when specifying their warehousing requirements to build or lease. Despite the improvement in the

standards and specifications a need was felt by the logistics and supply chain industry and developers to have a set of guidelines and standards for warehousing space development which were suitable for India and were written considering the occupiers requirements for storage and efficient operations, local conditions, economic feasibility and regulatory compliance.

This chapter outlines functional specifications, guidelines for building construction and planning of important elements like building maintenance, fire safety, building security, flooring, roofing and ventilation signage, machinery and WMS. This chapter guides the user with regards to the technical and functional standards to be followed to ensure that the warehouse building meets all best-in-class Indian standards, is compliant to regulatory requirements, is sustainable and the resultant building is functionally suitable for end-users from a large cross section of distribution channels of various industry sectors.



1. Warehouse Structure Standards

1.1 Warehouse Construction Standards

Warehouses can be classified into different types based on the physical structure, viz. conventional buildings (Brick and Mortar) or conventional structural steel buildings, Pre-Engineered Steel Buildings (PEB), Cover and Plinth (CAP) Storages, Silos, Open Yards or Depot, Storage Tanks and Underground Storages.

There are certain mandatory standards that have to be adhered to by any structure being constructed and used for warehousing purposes. These have been specified by the respective nodal regulatory agencies like the Bureau of Indian Standards (BIS), Warehousing Development and Regulatory Authority (WDRA) etc. as detailed below:

- i. National Building Code of India (NBC) provisions for Group H: Storage and Warehousing Occupancy Guidelines including its Part 6 'Structural Design' and other parts.
- ii. Construction standards based on provisions laid down under the Warehousing (Development and Regulation) Act, 2007 and subsequent rules and regulations framed thereunder by the Warehousing Development and Regulatory Authority including Warehousing (Development and Regulation) Registration of Warehouses Rules and Warehousing and Regulatory Authority (Electronic Negotiable Warehouse Receipts) Regulations, 2017.
- iii. Standards or guidelines for Warehouses design, construction and maintainance are listed in Annexure - 01.
- iv. Standards or guidelines issued by the Bureau of Indian Standards and other standardisation bodies specific to design / construction and maintenance of structures are listed in Annexure - 02

1.2 Practices in vogue

Apart from the above-mentioned mandatory standards for construction, the following national and international practices in vogue are listed for construction of warehouses:

1.2.1 National Standards

- i. Standards by the National Centre for Cold Chain Development. (NCCD.2014. guidelines & minimum system standards for implementation in Cold-chain), which lay down the minimum requirements for development of cold-chain infrastructure.
- ii. CAP Storages: BIS Guidelines for Improvement of Existing Structures Used or Intended to be Used for food grain storage (IS 609:2020), Dunnage pallet warehousing (IS 13714:1993), Guidelines issued by FCI, CWC Grain Marketing Corporation.

1.2.2 Standards for temperature-controlled storage and transportation

All types of fresh fruits and vegetables need careful storage properly in a room where there is no sunlight. The room should be dry cool & well ventilated with bins for root vegetables. Fruits and vegetables deteriorate quickly and space should therefore be available to enable easy stock rotation.

- i. IS 6028: 2002/ISO 931:1980 Green bananas Guide to storage and transport (Second Revision)
- ii. IS 6669: 2001/ISO 1212:1995 Apples – Guide to cold storage (First Revision)
- iii. IS 6670: 2018 Storage of potatoes - Guidelines (First Revision)
- iv. IS 7191: 2001/ISO 5524:1991 Tomatoes - Guide to cold storage and refrigerated transport (First Revision)
- v. IS 7192: 1974 Guide for storage of citrus fruits



- vi. IS 7252: 2013/ISO 2169: 1981 Fruits and vegetables - Physical conditions in cold stores - Definitions and measurement (First Revision)
- vii. IS 7730: 1975 Guide for storage of pears
- viii. IS 7731: 1975 Guide for storage of peaches
- ix. IS 9303: 1979 Guide for cold storage of table grapes
- x. IS 9304: 1979 Guide for storage of mangoes
- xi. IS 9311: 2001/ISO 1673:1991 Onions – Guide to storage (First Revision)
- xii. IS 11966: 1997/ISO 6663:1995 Garlic – Cold storage (First Revision)
- xiii. IS 16118: 2013/ISO 6665: 1983 Strawberries - Guide to cold storage
- xiv. IS 16119: 2013 ISO 7562: 1990 Potatoes - Guidelines for storage in artificially ventilated stores
- xv. IS 16120: 2013/ISO 5525: 1986 Potatoes -Storage in the open (In Clamps)

1.2.3 International Standards for Underground and Tank Storage:

- a. Guidelines specified for Underground Storages by the American Petroleum Institute (API), RP 1604 (Closure of Underground petroleum storage tanks), RP 1615 (Installation of Underground Petroleum storage tanks), RP 1631 (Interior lining and periodic inspection) and RP 1632 (Cathodic protection of underground tanks), Guidelines under National Leak Prevention Association Standards for Entry, Cleaning, Repair of Underground Storage Tanks (NLPA Std 631), Steel tank standards for liquid storage and underground tanks (STI R892, STI SP031, STI R942).
- b. Guidelines for Storage Tanks are as prescribed by following agency :
 - i. International Tanker Container Organisation, American Petroleum Institute (API)
 - ii. American National Standards Institute.
 - iii. ISO standards for corrosion protection (IS 16961:2015).

1.3 Warehouse Flooring Standards

Floor slabs in warehouses and distribution centres are integral to the efficient operation of the facility. They are the table-top on which a user runs his business. On the surface they appear to be one of the simplest parts of a structure to

construct. However, this simplicity often leads to an underestimation of the design and construction requirements. This section will elaborate on all the parameters such as processes related to slab on grade, approach to floor design, execution methodology, aspects and activities to consider and decision making or responsibility matrix.

A high performing, durable floor consists of engineering design, detailing, material, manpower, and workmanship. While engineering design, detailing, material are tangible parameters. Quality of manpower, experience and workmanship defines the quality of a floor. As warehouse flooring construction is a skill as well as an art, it is important to select the right designers and specialist contractors / applicators to deliver a floor which fits the purpose. This section also highlights the selection criteria for engaging the right flooring partners and a floor design consultant. It is equally important to engage with a warehouse operations and functional expert to determine the right loads and use case for designing the floor. It is recommended that the building be fully enclosed before start of floor construction.

1.3.1 Sub-base and Sub-grade

A well compacted sub-base and sub-grade should be achieved by compacting the layers to 150 mm each. Each layer should be measured by proctor density and / or a plate load test.

1.3.2 Sub-grade

Sub-grade is the first layer which forms the bulk of the earth filling. This helps in bringing the building to grade level. This layer is the cheapest to construct and the site is used as a source to construct this layer. Moreover, it is also the most important set of layers which need to be adequately compacted to avoid any settlement through the age of the building.

1.3.3 Sub-base

Basic function of sub base is to transfer the load to the sub-grade. This layer enhances the soil stiffness and holds construction traffic prior to construction of the floor. This is the most important layer, and the success of the floor largely depends on the stability of the sub-base. All precautions should be taken to ensure that this stratum is constructed with proper guidance and supervision so as to avoid settlement.

1.3.4 Slip Membrane

The slip membrane reduces the friction between the sub-base and the warehouse floor thereby allowing both sections to move independently. The slip membrane must be used to ensure that the floor is isolated from the sub-base to allow for movement. Double layer slip membrane may be used in case it is a design recommendation by a specialised floor consultant.

1.3.5 Concrete

Concrete plays a vital role in the durability of the floor. However, as a warehouse floor, also referred to as a slab on grade, is not a structural member of the building therefore workability and serviceability characteristics of concrete plays a major role as compared to the mechanical properties of the concrete. Concrete with fly ash content should be avoided.

1.3.6 Floor Design

The floor design should be derived based on two important criteria which are the loads acting on the floor and their locations. Point loads can be racking uprights, machine support & bases, mezzanine columns. Wheel loads such as material handling equipment. Locations considering center to center distance between point loads and wheel loads and Uniformly Distributed Load-UDL such as stack of loads or block storage on floor.



1.3.7 Reinforcement

A suitable steel reinforcement in the form of rebar, steel or plastic fibers should be used to reduce the cross section of concrete. The rebar or fiber reinforcement should be designed by a floor consultant or a design and build flooring contractor. (Refer Annexure 1B for specification)

1.3.8 Load Transfer / Floor Joints

Control and construction joints play a vital role in durability of the floor and ease of operations. It is mandatory to have armour joints at all the major crossings of material handling equipment and their wheel movements so as to protect the arris of the joints.

Load transfer of joints is done via use of plate / diamond dowels. A joint should be placed based on concrete supply capability and the flooring contractor's ability to complete the panel on time before the concrete hardens. A pouring plan should be prepared so as to avoid consecutive panels being poured one after the other. These control and construction joints should be opened and refilled after 12 to 18 months with modified epoxy hybrid / semi rigid epoxy. The sealant used should be manufactured by reputable manufacturers with proven results.

1.3.9 Floor Screeding Methods

Floor screeding methods such as laser operated screed machine should be used to achieve greater efficiency and speed in spreading concrete which reduces project timelines. For warehouses less than 5,000 square meters, truss screed system with proper camber arrangements can be used in case laser operated screed machine is not available. The Vacuum Dewatered Floor (VDF also termed as Tremix) method of constructing warehouse floors should be avoided where vertical storage will be installed with heavy MHE operations.

1.3.10 Sealants

Sealant is a material placed in a joint opening to prevent the ingress of debris, moisture and to support the joint arris while allowing the joint to move. It is suggested to use polyurethane sealant in control and construction joints during construction stage.

1.3.11 Floor surface regularity

Floor surface regularity is defined based on the racking height, MHE type and movement. For stringent requirements where racking height is greater than 7 meters, it is imperative that an experienced design and build flooring contractor or a flooring consultant is involved in the design, decision making and execution processes. Floor surface regularity must be measured by a certified floor survey company with equipment suitable for the required methodology for surface regularity check. Floor surface regularity should not be measured or judged by manual methods such as line dori method and water stagnation. As prescribed in PR-34 AISC, as per the selected code mentioned in Annexure 1-1B

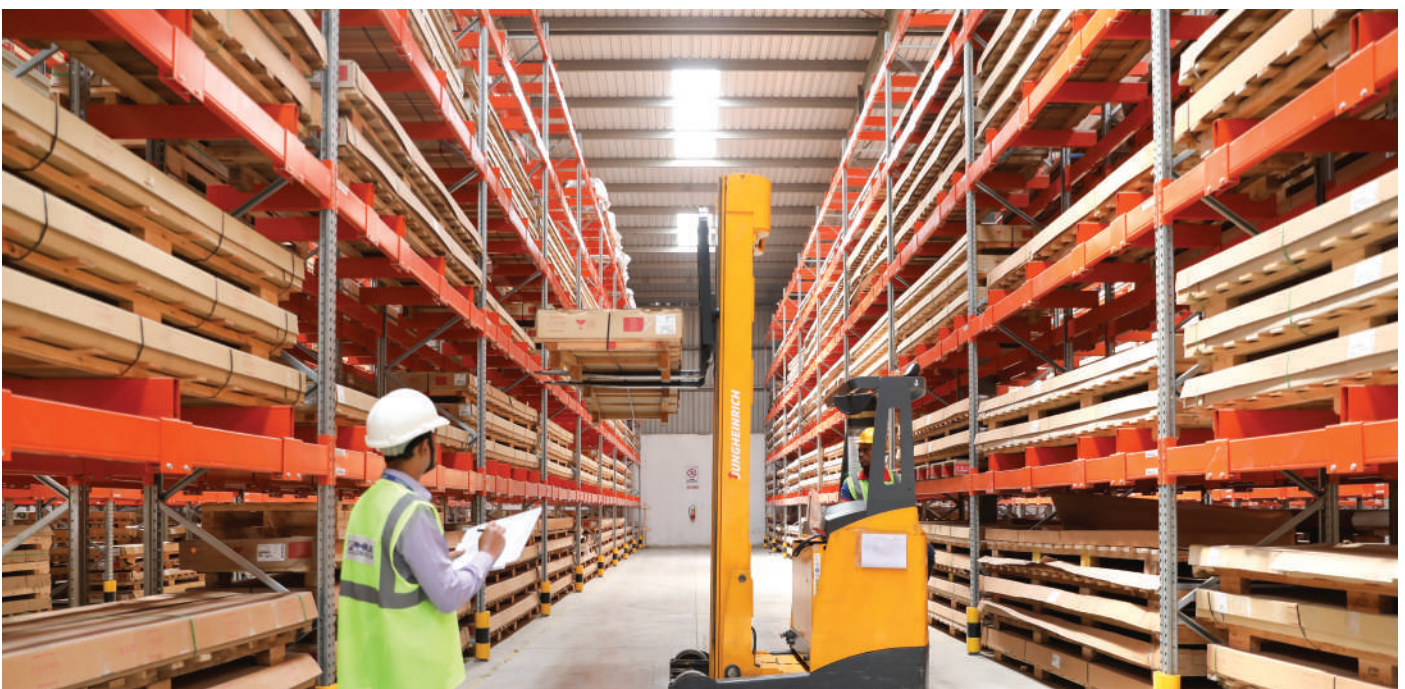
1.3.12 Floor Protection Systems

- 1. Floor Curing :** Floor curing is an extremely important process in increasing the life of floor. Proper curing is either done by providing & spraying water-based curing compound or water curing with plastic sheet. Water curing with Low Density polyethylene Sheets (LDPE) sheets method should be used for projects where a later stage floor protection system such as densification, polishing or resin coating is being planned. Curing mats may also be considered, these can be used as temporary floor protection.
- 2. Abrasion resistance – Hardeners :** Floor hardeners are cement-based products that are incorporated monolithically into a floor during the construction process. Hardeners drastically improve wear, tear and impact resistance which allows for floors which are highly abrasion resistant, easy to clean and maintain.

As mentioned in Annexures 4-10,10A.

- 3. Densification and Polishing :** Densification is a process where microscopic pores in the concrete floors are sealed which creates a dust proof floor while increasing floor hardness. Polishing helps in increasing the sheen of the floor surface and providing a clean working environment. Nano / lithium / sodium sealers can be used for floor densification and polishing. Please note that densification and polishing are used for floor protection and should not be considered as a replacement for floor hardeners.
- 4. Floor Resin Coatings:** Floor resin coatings are used as protection for floors with special requirements or where the floor will be exposed to adverse conditions such as high temperatures or thermal shock which can reduce floor life if not suitably protected. Floor resin coatings come in three forms which are epoxy, PU and cementitious form. PU can be considered as the preferred floor protection system due to its technical advantages and longevity. These coatings can be selected based on performance needs such as chemical exposure, mechanical exposure and temperature or thermal shock. The selection of coating should also address functional needs such as moisture insensitiveness, safety-slip resistance and hygiene. Usage of floor resin coatings improves the expected service life of the floor and there is no loss of operations time and cost since floor refurbishment is not required if the floor is treated during the construction stage.

Floor Design Parameters and Standards are listed in Annexure 04.



For metal deck, composite deck & structural Screed BS:8204 Should be referred and followed for surface regulations. While planning the floor structural design, layout planning and providing the floor guarantee, it is important to define a responsibility matrix which defines the decision-making process and the decision owners.

1.4 Warehouse Roofing Standards

Details of the standards and the practices in vogue for warehouse roofing are given below. The existing roofing standards are mostly aligned with the American Iron and Steel Institute (AISI) and ISO. The existing roofing standards that are used in India for warehouse roofing are:

- i. IS 875 – Part I: Dead Load
- ii. IS 875 – Part II: Imposed Loads
- iii. IS 875 – Part III: Wind Load
- iv. IS 875 – Part V: Special loads and Load Combinations
- v. IS 800 – Steel Design Code
- vi. IS 801 - Design Code for Light gauge cold rolled/formed section
- vii. American Institute of Steel Construction (AISC) Design Codes for Built up sections and Hot Rolled Sections
- viii. Metal Building Manufacturers Association (MBMA) 2012 Standards - Cold Formed Sheet Design Manual 2017

1.4.1 Practices in vogue

Apart from the above standards, the following practices may be implemented:

a. Roof Design and Construction:

- i. Use roofing material with a high solar reflective index (SRI) or apply a coating system on the roof for increasing the solar reflective index. As prescribed in Annexure – 1 C.
- ii. The heat gain in the warehouse through roof should be minimal, apart from meeting its functional requirements. For ensuring the lower heat gain, the roof assembly has to meet the Energy Conservation Building Codes (ECBC), i.e., the U value should not be more than $0.33 \text{ W / m}^2 \text{ K}$.
- iii. For reducing heat gain in the building, the roof top should be coated by high SRI paints or in case of metal roof, roof sheets with SRI values of more than 70 can be used. Make use of certified roofing sheets that meet the above requirements for roofing.
- iv. Use vegetation cover of at least 50% of the exposed area of the roof of warehouse as well as open areas including all covered parking spaces.
- iv. Roof has to be designed with screwed down roof, standing seam or screw bolt sandwich panels in a way that there is no leakage. Roof insulation and insulation in the side cladding must be present in order to create at least a 5-6 degrees centigrade lower temperature inside as compared to external temperatures. Under deck Glass wool, Earthe wool, Polyester, Rock wool, reflective foil (sandwiched air bubble), Rigid Board (EPS & XPS), Spray foam insulation material may be used.



b. Roof Ventilation:

Louver ventilation system should be used in warehouses in order to ensure that the building ventilates at least 6 air changes every hour through the roof monitor. The louvers should be provided in the wall cladding on the longer and/or the shorter side to allow for fresh air to come in as the hot air ventilates out from the roof monitor. Ridge ventilators and turbo ventilators may also be used in case they are able to provide for the required air changes. Turbo ventilators should be avoided for installation on standing seam roofs as this may lead to leakage from the joinery of the turbo ventilator and the roof sheet. In case a roof monitor is not installed for any specific reasons related to internal operations then force ventilation systems should be installed on the roof to achieve the required air changes. (As prescribed in Annexure 2, NBC 2016: Part 8/Sec 1 'Lighting and Natural Ventilation' Bureau of Indian Standards)

c. Roof Illumination:

For sufficient daylight, 50 % of the regularly occupied spaces with daylight luminance levels for a minimum of 110 Lux (and a maximum of 200 Lux) in a clear sky condition at 12 noon at working plane (through simulation or measurement approach). There should be enough skylights so as to not require additional lighting during a normal day. Indian Green Building Council (IGBC) standards prescribe at least 5% of roof area should have skylights; this can be increased as required.

1.4.2 Maintenance Standards

Details of the standards and the practices in vogue for warehouse maintenance are given below.

A. Fire Safety Standards

The following fire safety standards are prescribed by BIS and are mandatorily to be adhered to by all the warehousing structures irrespective of the type of warehousing structure or the products stored:

- i. Adherence to fire safety standards as prescribed by the National Building Code of India (Part 4).
- ii. Infrastructure to be installed following BIS Code for Practice of Fire Safety of Industrial Buildings- General Storage and Warehousing including Cold Storages (IS 3594) and Specification for Portable Fire Extinguishers (IS 15683).

B. Security Standards

A key feature of warehousing is to provide safe and secure storage for goods. The following standard is prescribed by BIS for adequate safety at warehouse premises:

- i. NBC of India 2016: Part 4 Fire and Life safety and Part 12 Asset and Facility Management.
- ii. IS 16910 Video Surveillance System for use in Security applications.

1.4.3 Practices in vogue

- i. Adhere to global security standards specified by the Transport Asset Protection Association (TAPA).
- ii. Install warehouse surveillance systems using CCTV cameras and monitors.
- iii. Deploy well defined Standard Operating Procedures (SOPS) for security personnel for dealing with events like theft, unlawful entry, damage to goods, disasters etc. Conduct mock drills regularly.
- iv. Use BIS compliant surveillance equipment.

1.4.4 Occupational Safety, Health and Sustainability

Practices in vogue for occupational safety and health are as given below :

- i. For occupational Safety and Health Administration (OSHA to ensure safe and healthful working conditions for workers by setting and enforcing standards and by providing training, outreach, education and assistance.OSHA is part of the United States Department of Labor)
- ii. IS/ISO 45001 (Occupational Health and Safety Management System)

1.4.5 Practices in vogue for sustainability

The following quality management systems, environmental management systems, energy management systems shall be considered :

- i. IS/ISO 9001: Quality Management Systems
- ii. IS/ISO 14001: Environment Management Systems
- iii. IS/ISO 50001: Energy Management System
- iv. Adherence to Standards laid down under Leadership Energy and Environmental Design (LEED)/IGBC.

1.5 Illumination Standards

Adequate illumination of warehouse premises is a significant factor in ensuring safe working conditions and risk-free handling of goods. The selection and installation of lighting equipment is essential to achieve an optimum illumination level within the warehouse premises while keeping operational and maintenance costs under control. It is advisable to use LED light fixtures since they are eco-friendly and consume less electricity.

Part 8 of National Building Code of India enlisting standards for Building services (Illumination) are the set of standards required to be implemented across all warehousing structures. (IS 3646 Part 1) of BIS.

1.5.1 Practices in vogue

The following are the practices in vogue, specified by international agencies, to achieve higher efficiency of operations:

IS 3646 (Part 1): Code for Practice for Interior Illumination.

Adequate lighting measures within premises as specified by OSHA (1915.82) (Operational Safety and Health Administration, USA) is essential to achieve optimum illumination level within the warehouse premises while keeping operational and maintenance costs under control.

1.6 Signage

Signage is an important part of warehouse assets but often ignored. Signage provides important information to the users and visitors which reduces dependence on memory and adds efficiency in day-to-day operations. Signages are used in a warehouse to provide Information, assistance or guidance and warnings.

The signage should follow a specific colour scheme based on the information a particular sign is providing.

- Mustard background with black fonts – Location / Information
- Blue background with white font – Information / guide / location tags
- Red background with white font – Warning
- Black or green background with white font – Operating area information
- Signage design guidelines are presented in Annexure 03 (source: OSHA)

1.7 Warehouse Machinery Standards

In view of the technological advancements in machinery and handling equipment such as cube containers, robotic handling equipment, drone-based equipment and warehouse machinery standards are suggested. Most modern and traditional warehouses use equipment and machinery for handling of material stored. The machinery is largely grouped into docking equipment (including dock levellers, dock seals and shelters etc.), storage equipment (pallet racks, multi-tier shelving, long span shelves, etc.), Lifting equipment (stacker, reach trucks, hand pallet trucks, articulated forklifts, cranes and forklifts etc.) and conveyors. Apart from these equipment, warehouses also use lighting equipment, safety signage and other safety equipment like rails, ramps, emergency lights etc. Standards to be considered are:

Standards for specifications, dimensions, testing and stability tests for handling equipment like forklifts, trailers and other transport handling equipment are prescribed by the following BIS standards:

IS 10517	IS 13971-2	IS 15640
IS 10312	IS 14770	IS 4357
IS 11683	IS 15487	IS 6876
IS 11757	IS 15488	IS 7309
IS 12726	IS 15611-1	IS 7525
IS 13302	IS 15611-2	IS 7570
IS 13971-1	IS 15634	IS 7617
IS 8790-2		

Table 1.1 BIS standards for Equipment handling and testing.

- IS 11592: Selection and design of belt conveyors, IS 14188: Conveyor systems – Maintenance facilities - Design parameters are some standards specified by the Bureau of Indian Standards for conveyor systems used in large warehouses.
- Illumination standards specified under IS 3646 (Part 1) Code of Practice for Interior Illumination and standards specified under international agencies like Occupational Safety and Health Administration (OSHA), are also in practice in most modern warehouses.

1.8 Standards for Warehouse Management Systems :

Due to globalisation, dynamic market and consumer behavior, the warehouse management systems (WMS) should be integrated with the external systems for accurate and timely data communication and effective business collaboration. Managing these systems integration becomes complex and tedious when the business runs on different industry verticals and on different platforms. Hence, it becomes very important and necessary for the logistics service providers to standardise the systems with integrated solutions when it comes to WMS implementation.

Different aspects of WMS are Training and deployment, Project management, Business requirements, Configuration, Integration and Testing. The WMS should be deployed after detailed evaluation of the functionalities that exists in the system and are relevant to the processes and flows adopted in a warehouse. The WMS should be able to provide all reports and performance dashboards that show the health of the operations like productivity, efficiency, work done and pending, time taken for various activities etc.

1.8.1 Warehouse Management Systems(WMS):

The warehouse management system is a transaction and process management system that helps in the operations process of the warehouse. The broad functionalities of the WMS are to:

(a) Process fresh receipt and return of goods, (b) Putting away of goods to storage (c) Sampling, inspection & grading (d) Picking, checking and packing of goods (e) Dispatch of goods (f) Integration with Transportation Management System (TMS) (g) Inventory count and reconciliation (h) Inventory management and its visibility to clients (i) Seamless integration of advance inward shipment notices, dispatch notes, outbound orders, triggering of alerts and notifications. (j) Integration with Warehouse Control Systems (WCS) between equipment like sorters, diverters, put to and pick to light systems, advance storage equipment like ASRS, pallet shuttles and robotics.

1.8.2 Regulatory Compliance:

To ensure compliance of the warehouse facility with the regulatory authorities, such as:

- i. Accreditation of warehouse with an accreditation agency
- ii. Warehouse registration
- iii. Control of documents and records
- iv. Correction / action processes
- v. Internal audit and performance review

1.8.3 Labour Management Systems:

For effective labour management, following should be ensured: Maintaining of records of manpower deployed in the warehouse. Ensuring compliance with applicable labour laws and regulations. Creating awareness amongst workers about their roles and responsibilities to protect the integrity of the products. Undertaking training and sustained skill development programs for the workers to enhance knowledge and skills with respect to good warehousing practices. Ensuring periodic assessment of workers performance, including assessing effectiveness of the training and skills development undertaken. Establishing worker safety management systems in the premises and provide necessary training as well as resources to the workers to develop and ensure safety culture.

1.8.4 Digitalisation / Digital Management Systems:

Implementation of digital management systems for facilities creates scope for ensuring robust processes and methods to ensure data collection and verification at any stage. This sort of full-chain standardisation enables seamless integration in a way that can enhance transparency in operations, centralize communication and increase collaboration potential. All in all, it leads to enhanced visibility of the full supply chain. This means that the flow of material movement can be tracked end-to-end. The application of IT Logistics Systems helps in efficient warehouse management systems and supply chain management. Due to globalisation, dynamic market and consumer behaviour, WMS has been integrated with the external systems for accurate and timely data communication and effective business collaboration.

1.8.5 The Future of Warehouse Management Systems:

Digital twins in warehousing lets companies design, simulate, and test new warehouse operations and product movements virtually, before starting up new sites or making changes within existing sites. As technology drives innovation, the warehouse of today will transform into an increasingly digital environment in future. WMS enables consistent performance at a low cost. Change will be driven with real- time transaction processing, optimised storage, and selection strategies, directed task management, and integrated labour standards. Operational and strategic teams need to be able to make accurate decisions about ongoing situations. Real-time visibility provides actionable information that can help swiftly adapt plans, improve processes, minimize threats and maximize opportunities.

These insights involve data integrated with material flow in real time. Real-time decision making is also facilitated, as access to accurate and comprehensive data can help plan for transit delays – dwell times and journey times, monitor weather and material conditions during movement, plan

for re-routing based on road and traffic conditions, rework supply during fluctuating demand, and resultantly, mitigate risks. For manufacturers, real-time visibility can give excellent insights about production volumes, manufacturing inefficiencies, and raw material sourcing or procurement. For suppliers, key information and real-time updates about order backlogs can help them strategize or tweak their inventory management processes. For logistics vendors, visibility means real-time information about cargo batches, consignments, and delivery status. This can let them manage day-to-day operations and track the movement of goods more efficiently. For the end consumer, it keeps them in the loop about the entire cycle, helping them stay updated about the dispatch and delivery status.

Industry 4.0

With the advent of Industry 4.0, technology has aided visibility and real-time decisions. From RFID tags, IoT sensors and cloud- based management systems, the real-time supply chain has enabled greater agility and flexibility via machine learning and predictive data analysis.

The advantages conferred by supply chain visibility may be individually small, but they can be applied to every movement, operation and transaction in a supply chain, thereby saving time and creating efficiencies that add up to significant savings.



02

Palletization Standards

- Pallet Standards
- Practices in Vogue





PALLETIZATION STANDARDS



Introduction

Palletisation plays an important role in achieving efficiencies not only in warehousing but also in the whole cycle of logistics. Standardisation of pallet sizes will allow standardisation of palletisers, racking systems, material handling equipment, truck load beds and containers. This will result in better space utilisation and facilitate automation, thereby eliminating manual transfer of goods and improves the overall productivity and work efficiency, as well as reduces losses and the wastage of pallets. Hence, palletisation standards are important.

A pallet is a unit load device (ULD). It is a rigid frame on which goods are placed and the pallet unit is moved using material handling equipment. Rather than choosing a pallet based solely on the lowest price, industries and logistics service providers should select a pallet that meets the need for high stiffness, proper strength and size, durability, cleanliness and low weight. In the past, a lot of efforts have been made in the field of standardisation of pallets, but a lot still remains to be done. Pallets are very common, yet they are practically invisible. Without them, global commerce would run as well as a car would without tires. Pallets are the primary interface of any unit load. They protect the product, absorb the stresses, hold the weight, encounter fork truck impacts, and safeguard goods traveling through the supply chain. Pallets have a tremendous amount of influence on the outcome of a logistics operation.

In the construction and design of any warehouse, accommodating standardised pallet dimensions is a very important factor. This allows for optimisation of workflow, and for efficient movement of inventory in and out of the plant or warehouses. Designing a warehouse to accommodate the correct pallet size represents huge financial savings for industry.

Pallet Standards

The current standards governing palletisation are specified by the BIS in India. Details of the standards for palletisation are given below which are mandatory for warehouse facilities using pallets for storage:

- i. Palletisation standards specified under TED 24 of Transport Engineering Department under the Bureau of Indian Standards (BIS).
- ii. Palletisation Standards such as IS 509 (dimensions of hand pallet trucks), IS 13609

(Guidelines for quality of timber in pallets), IS 7631 (Methods of stability testing for pallet stackers and high lift platform trucks) etc.

- iii. Crates Standards such as IS 8726 (Standards of wire bound wooden crates), IS 15532 (Standards for plastic crates for fruits and vegetables), IS 10324 (Standards for Wooden crates for bottled drinks) etc.
- iv. Export Standards for Pallets such as IS 7073 (Glossaries of terms related to air cargo Pallets & containers), IS 13823 (Guidelines for palletisation – general cargo) etc.
- v. IS 16058: Dunnage pallets made from recycled plastic wastes for warehousing application –Specification.
- vi. IS 17427: Wooden (Timber) Pallets for Packaging, Storage and Transportation - Specification.

2.1 Some ISO Standards formulated on pallets are as follows:

- i. ISO 445: Pallets for materials handling – Vocabulary
- ii. ISO 6780: Flat pallets for intercontinental materials handling -- Principal dimensions and tolerances

The Transport Engineering Department of Bureau of Indian Standards, the national standards body of India, is also actively involved in formulation of Indian Standards on Pallets and prescribes the following for design, application, material for pallets to be used for specific operations :

- iii. IS 3971: Pallets for materials handling - Vocabulary (second revision)
- iv. IS 4300: Box pallets for through transit of goods specification (first revision)
- v. IS 5325: Box pallets for through transit of goods Methods of test (first revision)
- vi. IS 6219: Methods of test for general purpose flat pallets for through transit of goods (second revision)
- vii. IS 3971: Pallets for materials handling - Vocabulary (second revision)
- viii. IS 4300: Box pallets for through transit of goods specification (first revision)
- ix. IS 5325: Box pallets for through transit of goods Methods of test (first revision)
- x. IS 6219: Methods of test for general purpose flat pallets for through transit of goods (second revision)
- xi. IS 6865: Specification for pallets for use in ISO

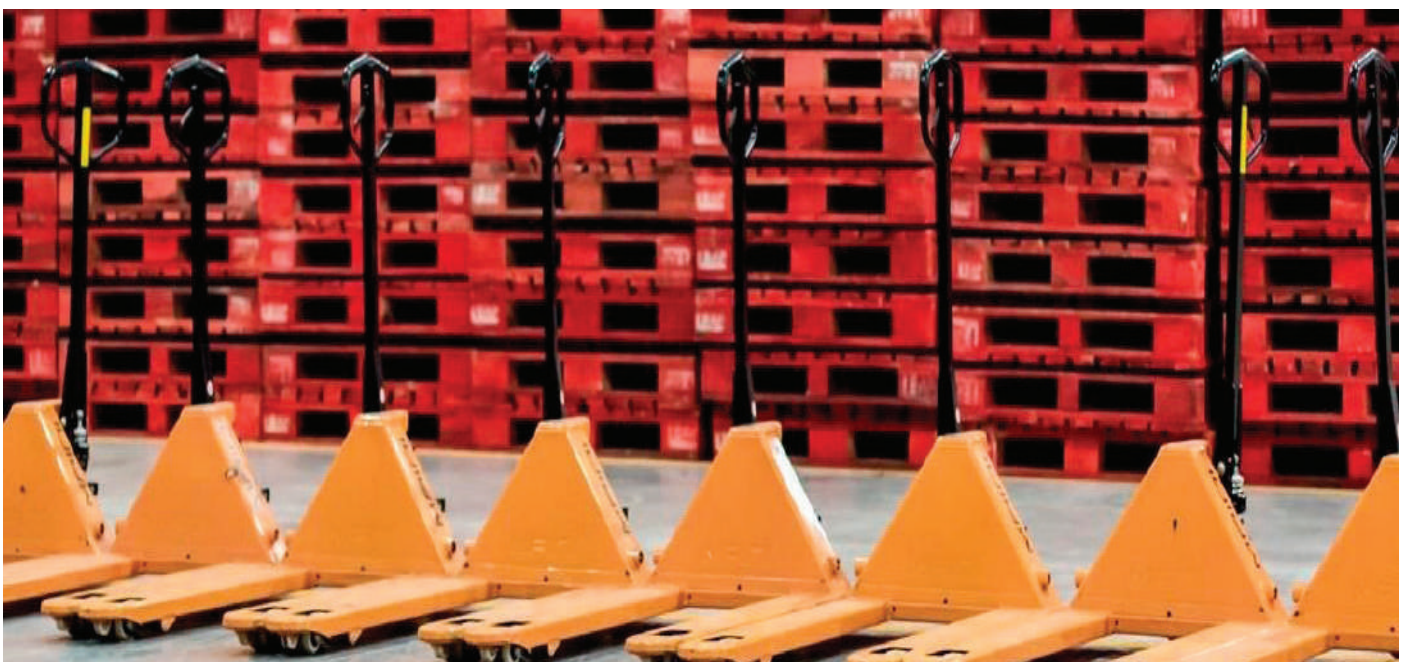
series1 freight containers.

- xii. IS 7276: Non-expendable general purpose, flat pallets for through transit of goods Specification (Second revision)
- xiii. IS 7804: Guide for palletisation of tea chests (first revision)
- xiv. IS 8005: Classification of unit loads
- xv. IS 8006: Recommendations for handling of timber pallets (first revision)
- xvi. IS 9208: Guide for palletisation of mica for export
- xvii. IS 11076: Guide for palletisation of cashew kernels for export
- xviii. IS 11982: Design rating and safe working load for general-purpose flat pallet for through transit of goods
- xix. IS 11983: Guidelines for marking of general-purpose flat pallets for through transit of goods
- xx. IS 13546: General purpose flat pallets for through transit of goods - Performance requirements.
- xxi. IS 13714: Dunnage pallets - Ware housing
- xxii. IS 13664: Polly pallets for bag storage godowns
- xxiii. IS 13664: Polly pallets for bag storage godowns
- xxiv. IS 11496: General and performance test requirements of pallet truck and stillage truck.
- xxv. IS 7631/ ISO 22915 - Industrial trucks - Pallet stackers, double stackers and order - Picking trucks with operator position elevating up to and including 1200 mm lift height – Verification of stability (Second Revision)
- xxvi. IS 6219: Methods of Test for General Purpose Flat Pallets for Through Transit of Goods
- xxvii. IS 5325: Box Pallets for Through Transit of Goods - Methods of Test

- xxviii. IS 8726: Wire bound wooden crates
- xxix. IS 7698: Returnable wooden crates for vegetables
- xxx. IS 5247: Part 2 - Converted timber (coniferous); Part 2 - Packing cases and crates.
- xxxi. IS 3071: Wooden crates
- xxxii. IS 15532: Plastics Crates for Fruits and Vegetables
- xxxiii. IS 13289: Polypropylene/impact Copolymer (PPCP) Crates for Milk Sachets
- xxxiv. IS 11584: High Density Polyethylene (HDPE) Crates for Milk Sachets

Dimensions	Applicability in Industrial Segments
1200mm x 1200mm	Chemicals/ Petrochemicals
1000mm x 1200mm	Food & Beverages, Fast Moving Consumer Goods, Fast Moving Electrical Goods, Retail, Pharma (ambient temperature), Consumer Durables, Textiles, Electronics, Hi-Tech, Industrial and Engineering, Automotive / Auto Components
800mm x 1200 mm	Automotive/Auto Components
1140mm x 1140 mm	International shipping purposes in ISO containers as prescribed by the Chemical Association

Table 2.1 Pallet standards as per various Industrial segments.



xxxv. IS 3971/ ISO 445: Pallets for materials handling – Vocabulary

xxxvi. IS 13823: Guidelines for palletisation - General cargo

2.2.Practices in vogue

2.2.1 Pallet Dimensions

Square pallets used for specific usage such as carriage of drums are e.g. 1200mm x 1200mm while full perimeter block pallet with 4-way entry is used for structural stability and ease of handling.

2.2.2 Tolerance and Load Bearing Capacity

Dimensional tolerance of $\leq 1\%$ by length and width to be maintained to ensure compatibility with Automation and the Automated Storage and Retrieval Systems where needed. For Automatic Storage and Retrieval Systems and Pallet Conveyor Lines, appropriate BIS standards for conveyors are in vogue. The maximum load capacity is 1 Ton for dynamic goods movement and 4 Tons for Storage.

2.2.3 Pallet Material Specification

Pallets to be made of certified and/or legally compliant timber source (e.g., Indian Forestry Act, 1927 for local lumber, ISPM 15 compliant for imported lumber). Pallets / Timber should not be treated with toxic chemicals especially for Food and Beverage sector, as per Indian Food and Safety Act 2008. Reduce, reuse and recycle approach should be adopted for packaging materials be it wood, composite wood, plastic, metal or paper. Apart from these, various international standards specified by International Organisation for Standards (ISO), American Society for Testing and Materials (ASTM) and National Wooden Pallet and Container Association (NWPCA) are specified:

Pallet Dimensions (mm)	Actual (mm)	Internal (mm)
300x200	297x198	243x162
400x300	396x297	346x265
600x400	594x396	544x364
800x600	800x600	752x552

Table 2.2 Pallet standards set by various International Organisations

Intermediate Bulk Container (IBC) would have an average base dimension of 1143mm x 1143mm. Drums with outer dimension of a 200-litre capacity would have the following dimensions:

Diameter		Height
Top / Bottom Rim	Chinese (ridges around drum)	243x162 mm
584 mm	597 mm	876 mm

Table 2.3 Pallet standards for drums in IBC

2.2.4 Pallet Stacking

- Rectangular stacks of dimensions of 1000 mm X 1200 mm can take 10 boxes in 2 layers or 15 boxes in 3 layers.
- Rectangular stacks of dimensions of 1200 mm X 1200 mm can take 12 boxes in 2 layers and 18 boxes in 3 layers.
- Rectangular stacks of dimensions of 800 mm X 1200 mm can take 8 boxes in 2 layers and 12 boxes in 3 layers.
- Rectangular stacks of dimensions of 1200 mm X 1200 mm can take 4 drums of standard size.

Apart from these, various international standards specified by International Organisation for Standards (ISO), American Society for testing and Materials (ASTM) and National Wooden Pallet and Container Association (NWPCA) are suggested to be referred to.

2.2.5 Manufacturing materials of Pallet

The majority of pallets are made of timber because it's strong and can be repaired. Wooden pallets having a market share of around 90% or 95%. Fumigation of wooden packing material should be carried out with methyl bromide at the dosage of 48 grams per meter cube. In this process the wooden packing crates are placed inside the fumigation covers which is kept on a smooth flooring and it is covered with gas tight sheets to make it an airtight enclosure. Plastic is durable option, often used for food and pharmaceutical products, is most cost effective in closed-loop shipping situations. Easier to clean and disinfect than wooden pallets. They are lighter because they weigh less and are even more durable than wooden ones because any knocks cause less impact to the pallet. They are also 100% recyclable. Plastic pallets have a market share of around 2%. Steel pallets are also used in pharmaceutical industry and in automated warehouses.

2.2.6 Pallets according to the number of entry points

Entry points refer to the number of sides where the forklift introduces the fork to be able to move the load for 4 entry points: the forklift or mechanical equipment to transport the pallet can access the pallet on any side along either the length or width for 2 entry points: the pallet can only be accessed on 2 sides opposite to each other. These pallets have less mobility than those with the 4 entry points because they are less accessible.

2.2.7 Pallet nomenclature according to their dimensions

The dimensions of the Industrial pallet is 1000mm x 1200 mm, also called as ISO pallet and is widely used in Asia and North America. Euro pallet is a support whose measurements are 800mm x 1200mm. Its use is most widespread in Europe.

This type of pallet is regulated by EPAL (European Pallet Association) indicating "around 500 million are currently in circulation". In addition, it is one of the types of pallets standardized by ISO (International Organisation for Standardisation). European industries and logistics companies therefore use the Euro pallet to facilitate the flow of goods and their grouping in the transport and storage process. The measurements of the euro pallet are determined by the width of the truck wagons, containers and trailers, which are usually 2400mm, which allows them to be placed in a way that takes full advantage of the load space. Flat board or square pallets for specific usage (e.g., carriage of drums) with the dimensions of 1200mm x 1200mm

2.2.8 Other consideration for pallet handling

Access areas for entry or exit to the warehouses to be well maintained with paved roads and easy manoeuvrability to load / unload shipments. For international cargo, unitised handling is suggested with Euro pallets with standard dimensions to ease handling at airport/ seaport. Manual loading/unloading to be avoided as high risks are associated to the loaders. The loaders should be trained to handle pallets with forklifts and pallet jacks. Manual loading or unloading to be avoided as high risks are associated to the loaders. The loaders should be trained to handle pallets with forklifts and pallet jacks.



03

Racking Standards

- Design Standards
- Raw Material Standards
- Standards for audit and maintenance





RACKING STANDARDS



Introduction

Racking systems are a key component of any warehouse or distribution centre, and one of the most important tools in the materials storage and handling industry. A warehouse racking system is a storage solution designed to stack materials in horizontal rows with multiple levels. The main objective of using racking systems is to improve the cube capacity utilisation of the warehouse by utilising the height of the warehouse building. The placement of the racks is based on selectivity of the pallet, storage density and speed of operations which helps in deciding the type of material handling equipment to be used for put away and retrieval of the pallet.

The other form of storage systems facilitates the storage of individual boxes or pieces of products in order to improve the picking productivity. These storage systems are commonly termed as shelving systems on single tier or multiple tiers. Basic pallet rack consists of upright steel frames connected by horizontal steel beams. Pallets rest on the beams between the upright frames.

There are various types of racking systems like, Selective Pallet racking, Double deep racking, Mobile racking, Satellite racking, Drive-In racking, Pushback racking, Pallet live racking, Narrow aisle racking, Cantilever racking, Multi-Tier Shelving System, Automatic Storage and Retrieval Systems, Pallet Shuttle Systems etc.

Standards applicable to Selective Pallet Racking Systems:

Selective pallet racking system is the most common mode of racking and used when there is a requirement for total free access to any pallet at any time. These standards cover racking dimensions and clearances, design standards, raw materials, and standards for audit and maintenance.

3.1 Dimensions and clearances:

- To match the pallet size of 1000mm width x 1200mm depth, rack beam length 2650mm to 2800mm would be ideal. (2700 mm is the most commonly used length)
- For stacking of 3 pallets of 1000mm width, 3300mm rack width is to be used.
- For square pallet, design shall be modified / adopted as per the pallet dimension.

- Pallet vertical clearance of 75mm-150mm depending upon the storage rack class and level height
- Pallet horizontal clearance of 75mm-125mm depending upon the storage rack class and level height

	Class 400 (CLEARANCE)		Class 300A (CLEARANCE)		Class 300B (CLEARANCE)	
LEVEL HEIGHT	Side	Top	Side	Top	Side	Top
(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
3000	75	75	-	-	-	-
6000	75	100	75	100	100	100
9000	75	125	75	125	100	125
12000			75	150	125	125

Table 3.1 Dimensions & clearances for racking system.

- Class 400; specifies racking for front loading forklift trucks (Stackers, Counterbalanced and Reach trucks)
- Class 300A; specifies racking for VNA man-up turret trucks.
- Class 300B; specifies racking for VNA man-down turret trucks.

3.2 Design Standards

Design of racking can be as per EN 15512 and EN 1993 for component design. Load Factors: At the limit state of strength or stability the relevant load factors as per EN 15512 are Dead load: $g_f = 1.3$, Pallet load: $g_f = 1.4$, Imposed load: $g_f = 1.5$ (other live loads), Accidental loads: $g_f = 1.0$. Material strength factors: Beam end connections at the ultimate limit state: $g_m = 1.25$, all other cases: $g_m = 1.0$, Beam deflection shall be limited to $\text{Span} / 200$ (span in mm), Deck Panels are to be decided based on a collapse criterion as well as deflection, with a limitation of deflection to $\text{span} / 200$.

Selective pallet racking systems are taller and loaded heavily. Hence it is suggested to take the users view on design of the system considering earthquake forces depending on the location of the facility. The national standard IS 1893:2016 is referenced. As per standards, guards are mandatory at intersecting aisles only and not in front of all racks. However, considering Indian operating conditions, it would be good to have guards in front of every rack to upgrade man and material safety.

3.3 Raw material standards

Steel used for critical load bearing members like Uprights, Beams, Frame bracing & Deck panels shall be "specified steels", conforming to BIS/EN/ DIN/ASTM/JIS standards (or equivalent) and shall have minimum guaranteed mechanical properties clearly specified by any of these standards.

For purpose of structural calculations, only the minimum guaranteed Yield strength specified for that particular grade of steel shall be taken and on no account, the tested Yield strength value of steel available for production shall be used. Increase in Yield strength on account of cold working (during Roll forming, etc.) shall be permitted based on the Design code being used.

In addition, the steels shall possess adequate ductility (10-20 % elongation) and a minimum gap of 10% between Yield point and ultimate strength.

3.4 Standards for audit and maintenance

A load notice has to be there in any storage system. An official SEMA Load Notice intends to give main points to workers 'on the shop floor' as they carry out their duties. It conveys key pieces of specific information and delivers reminders of the most important safety messages. All suppliers provide some safety information on load notices. What's on the display can range from just a simple list of dos and don'ts through to the full O&M manual. It's assumed that all operational personnel are suitably trained but load notices act as timely reminders of important points. Giving specifics of a particular installation is always useful.

Damage is assessed over a 1 metre section and relates to an overall bend but does not apply to dents, tears, buckles, or splits.

Conduct regular inspections to check for:

- Correct application and use
- Loads within allowable safe limits
- Accidental damage, or dislodgement of structure components

REPORT ALL DAMAGE TO THE RACKING SAFETY OFFICER

Do not alter the structure without either:

- Checking effects against manufacturers
- technical data Obtaining approval from supplier

DO NOT CLIMB PALLET RACKING

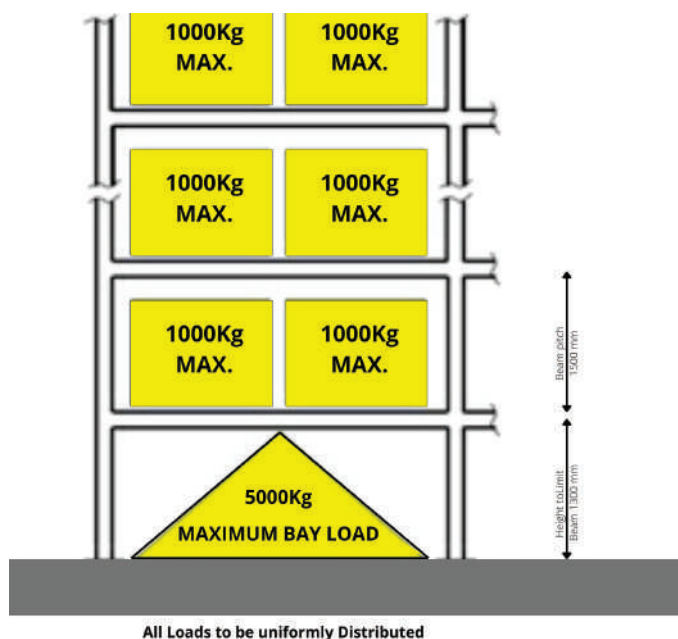
IF IN DOUBT, ALWAYS CONTACT SUPPLIER!

Localised bends should be judged on a pro rata basis. Components subject to other damage such as tears and splits must be replaced. It is a good practice to record the damage using a traffic light colour coding system in order to identify damage levels and prioritize the risk and need for action.

- i. **Green** - Minor damage within the allowable limits. No remedial action is necessary but you must continue to monitor the issue at subsequent inspections. Green risks can be useful in helping you identify patterns of damage and ascertain the cause to prevent escalation of damage.
- ii. **Amber** – Damage exceeding allowable limits requiring action or repair but not sufficiently severe to warrant immediate action. The affected location or component should be offloaded as soon as possible and not reused until repairs or rectification have been effected. Amber escalates to Red if no action is taken within one month.
- iii. **Red** - A high degree of damage is noted well beyond allowable limits requiring immediate offloading of the affected location or locations and any further action as indicated in the Red Risk notice which will be issued on site.

Risk Meter	Upright bent into the rack	Upright bent parallel to beam	Frame Bracing
Green	Upto 3 mm	Upto 5 mm	Upto 10 mm
Amber	Between 3 to 6 mm	Between 5 to 10 mm	Between 10 to 20 mm
Red	Over 6 mm	Over 10 mm	Over 20 mm

Table 3.2 Risk metering as per load notices (Source :SEMA)

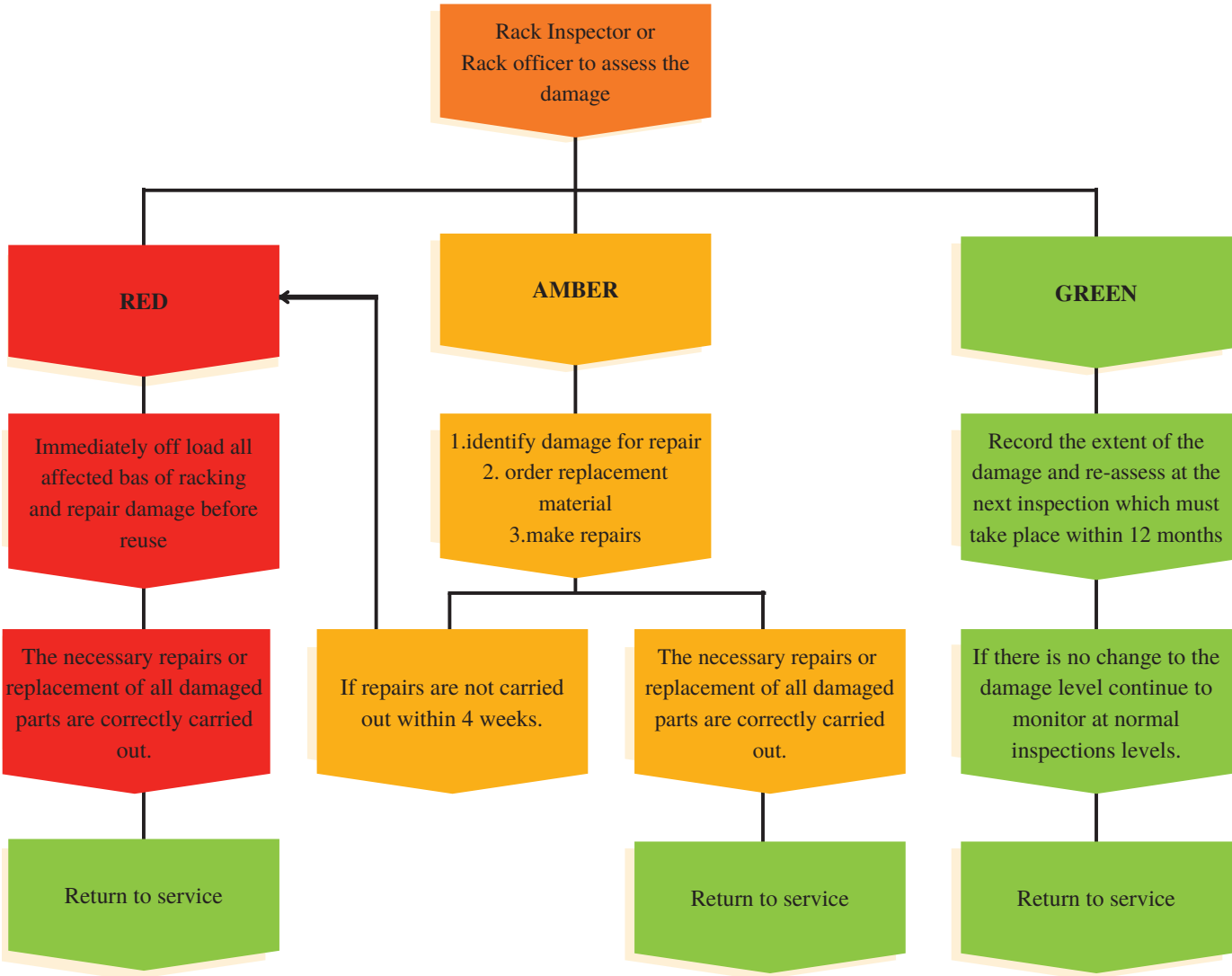


Flowchart indicating activities based on the risk identified:

Although it is true that there is no such thing as zero risk, companies can implement prevention measures in the racking systems of their warehouse to ensure effective safety conditions. Such measures can apply to the installation, the machinery, training of workers or the protection of industrial racking components.

Firstly, industries should work with a manufacturer/distributor of renowned prestige that ensures compliance with the (EN 15512, EN 15620, etc.) regulations in force on the design and

maintenance of industrial racking systems and also have appropriate documentation on installation drawings ; racking load plates with performance and characteristics that contain useful information to use the storage system ; including use and maintenance manual of the storage system installed in the warehouse.





04

Standards for Material Handling Equipment

- MHE's for different Applications
- MHE's for different Racking types





STANDARDS FOR **MATERIAL HANDLING EQUIPMENT**



Introduction

Warehouses use various types of material handling equipment for ease of operations. The most common equipment used are forklift trucks, stackers, reach trucks, articulated forklifts, man up turret trucks, hand pallet trucks, battery operated pallet trucks, cranes, robots, conveyors and other dock automation equipment. Material Handling Equipment (MHE) play a very important role in performing end to end operation of customer, starting from receipt of raw material and dispatching of finished goods as final product.

The key objective of material handling equipment is to provide for efficient handling at a safe speed while reducing human effort and fatigue. Material handling equipment are designed to integrate with material storage systems so as to effectively load the storage systems accurately, speedily and safely so that high optimum operational throughputs are achieved resulting in shorter turnaround times and improved warehouse productivity. These equipment has been historically manually operated and many have now evolved to be semi or fully automatic /automated equipment.

The standards regulating MHEs :

The standards regulating Material Handling Equipment are prescribed by BIS in India which are mandatory and are to be adhered to for use of such equipment. The standards regulating material handling equipment are:

- i. IS 10517 (Acceptance criteria for Forklift Trucks)
- ii. IS 11757 (General requirements and acceptance criteria for forklift trucks with capacity from 10000 kg to 50000 kg)
- iii. IS 4660 (Powered Industrial Trucks), etc.

A more comprehensive list of various MHE's used in warehouse is given in Annexure 05

4.1 Selection of MHE for right application.

Worldwide, the application of material handling equipment is same and that needs to be harmonized.

Right material handling equipment (MHE) for right application will help in efficient way of handling warehouses in the country. Various defined applications within warehouses are:



- i. **Throughput:** Electric Forklift and Pallet Truck can be used for this application depending on load and whether load has to be carried from floor or ramp.
- ii. **Transporting:** Depending upon distance, pallet truck should be used based on the operator's comfort as manual & battery operated. Whether it should be walk behind or seating arrangement should be dependent on distance to be covered.
- iii. **Storage/Stacking:** Material Handling Equipment like stacker, reach truck, forklift and very narrow aisle truck for storage/stacking should be decided based on number of pallets, storage type, stacking height, aisle width availability, throughputs and frequency of operation.
- iv. **Order Picking:** Order picker should be used as standard equipment for picking operations where picking from a selective pallet racking is required.
- v. **Towing:** This operation within the warehouse should be done with the help of a tow truck considering ground clearance within the warehouse.

MHE specified for different applications based on operations carried out :

Different types of material handling equipment are used to handle different kinds of cargo, such as bulk cargo or individual cartons. Bulk cargo could be solid, liquid, or gaseous. Material handling equipment is used throughout the entire chain of physical movement or storage of goods. It is used in the movement of raw materials and during the process of production.

Application	Operation	MHE	Basic Capacity	Class
Throughput	From the floor	Electric/ Diesel Forklift	1t to 10t	Class 1/4
	Over Ramp	Pallet Truck	1t to 3t	Class 3
Transporting	Short Distance	Hand/Walk Behind Pallet Truck	1t to 3t	Class 3
	Medium Distance	Walk Behind Pallet Truck	1t to 3t	Class 3
	Long Distance	Stand-on/Seat-on Pallet Truck	1t to 5t	Class 3
Storage/Stacking	Lift height up to 6200mm	Reach truck / Electric Stacker / Articulated Forklift	1t to 2t	Class 3
	Lift height up to 7500mm	Reach Truck/Man-down VNA Truck	1t to 5t	Class 1/2
	Lift height up to 13000mm	Reach Truck / Articulated Forklift / Man-up VNA Truck	1t to 2.5t	Class 2
	Lift height up to 17500mm	Man-up VNA Truck	1t to 1.6t	Class 2
Order Picking	Picking height up to 2nd level	Low Level Order Picker	0.2t to 3.6t	Class 2
	Picking height up to 14345mm	Vertical Order Picker	0.8t to 1.2t	Class 2
	Picking height up to 16530mm	Man-up VNA	1t to 1.6t	Class 2
Towing	Towing Capacity up to 28000kg	Tow Tractor	1t to 28t	Class 6

Table 4.1 Capacities & Class for MHE in various operations

Racking Types	MHE	Basic Capacity
Conventional Heavy Duty Racking	Stacker / Reach truck / Articulated forklift / VNA truck	1t to 2.5t
Double Deep Racking	Pantograph Reach truck with mechanically fixed mast	1.6t
Very Narrow Aisle Racking	Very Narrow Aisle Turret Truck	1t to 1.6t
Mobile Racking	Stacker / Reach Truck / Articulated Forklift	1t to 5t
Drive-in Racking	Stacker / Reach Truck / Articulated Forklift	1t to 5t
Shelving Racking (parts)	Order Picker	0.25t to 1.2t
Shuttle Racking	Reach Truck / Articulated Forklift	1t to 2.5t
Cantilever Racking	Multi-Directional Reach truck	2t to 2.5t

Table 4.2 Capacities of racks as per typology & their applications.

4.2 Guidelines for maintenance of MHEs :

Apart from meeting the specified BIS standards, the complete Forklift Truck should be certified by agencies such as the Automotive Research Association of India (ARAI) in order to meet the requirements of the Central Motor Vehicle Rules (CMVR) pertaining to Construction Equipment Vehicles (CEV). All Internal Combustion (IC) engine powered Forklift Trucks, whether manufactured in India or imported, as fully built or semi-knocked down or completely knocked-down condition and assembled in India, must all adhere to prevalent emission norms under BS-CEV.

All imported Forklift Trucks, whether IC engine powered or electric battery powered, must meet the existing MHE standards listed above in Existing Standards for use in India. This must apply to newly manufactured as well as to used Forklift Trucks. All Forklift Trucks used in India must be re- certified as "Fit-for-purpose" every year, either by a relevant government agency or by the OEMs themselves. ISO standards, as specified for imported forklift trucks, must be adhered to for safe and efficient material handling operations.

The key component of the material handling system in any warehouse, distribution center, factory stores or yard storage facility is the forklift truck. The forklift trucks are used to carry, lift and stack unitized loads and as such they are one of the most important components of intra logistics.

Forklifts carry heavy loads ranging from few hundred kgs up to 2 tons in a typical warehouse.

In factories and in open yards, forklift trucks can be used to carry loads as heavy as 32 tons and have to lift the load they carry up to heights of 17 meters.

All Forklift Trucks are driven by human operators and hence safety aspects play an important role. Also, the forklift trucks often handle goods



like food products, water and beverages, pharmaceuticals, all of which are directly consumed by consumers, and at times are required to handle hazardous goods like inflammable chemicals, paints etc.

4.3 Important considerations for MHE operation :

No movement of load from one place to other in lifted condition except for Very Narrow Aisle Truck. Use electric forklift for handling pallets while loading and unloading of containers instead of diesel forklift to avoid any health problem to operator due to exhaust fumes. When the warehouse length is more than 25m, use either stand-on or seat-on Material Handling Equipment to achieve operational efficiency of the operation with operator's comfort. In line with standardisation of pallet size, fix up the width of fork size of either 540mm or 670mm based on entry size of 1000mm & 1200mm for all the junior trucks. A standard aisle width can be defined for stackers, variable reach trucks and

Very Narrow Aisle operations. Overhang of pallet on racking should be restricted to 75mm for safe handling of pallets by Material Handling Equipment.

Minimum safety clearance required between load and Very Narrow Aisle truck is 100mm on each side within the guidance system. This safety clearance should not be more than 125mm for safe traverse operation for truck used in Very Narrow Aisle. Assistance equipment like a camera is advisable for reach trucks for load handling at a height of more than 7m. Travelling speed of all the Material Handling Equipment should be defined depending upon internal safety requirements. Standard clear height of the warehouse after fitment of lights and duct should be defined for MHE standardisation. Door height for Material Handling entry and exit should be standard as per Warehouse height. Stabilise power supply for charging of battery at sites. Standard Ramp specification to be defined for movement of Forklift with load. Proper lighting facility within warehouse for safe operation and proper visibility. Class 2 warehouse trucks are not meant for ramp application due to less ground clearance and traction. Chequered floor is not suitable for battery operated pallet truck as wheels get worn off.



05

Standards for Transportation

- Network Optimisation
- Vehicle Turning Radius
- Designing for Vehicles





STANDARDS FOR **TRANSPORTATION**



Introduction

The current standards governing road transportation infrastructure in the country are governed under various rules prescribed by nodal agencies. These standards are mandatory, and adherence is required by all users of any transportation infrastructure.

The objectives of this section are to suggest standard types of Vehicle dimensions and design, Network Optimisation and Turning Radius considerations, their maintenance, preventive checklists, etc., to be used in the warehousing space, to optimise the quality and efficiency of

the execution of the entire vertical. The ultimate

objective is to design specialised, quality standards that are useful as policy tools to improve the performance of freight transport and logistics service in warehousing sector.

The need for this handbook was required to achieve performance improvements by establishing in consultation with the stakeholders, a core set of generic indicators that would best serve the purpose of using standard sizes, systems and procedures to enhance the performance in freight transport logistics chains (e.g. sustainability, efficiency etc.) to encourage a switch to more efficient and cleaner forms of transport and generally improve logistics performance. The use of the following standards will ensure consistency in quality and optimisation of costs & efficiencies.

Vehicle Dimensions, design and the standard pallet loading plan:

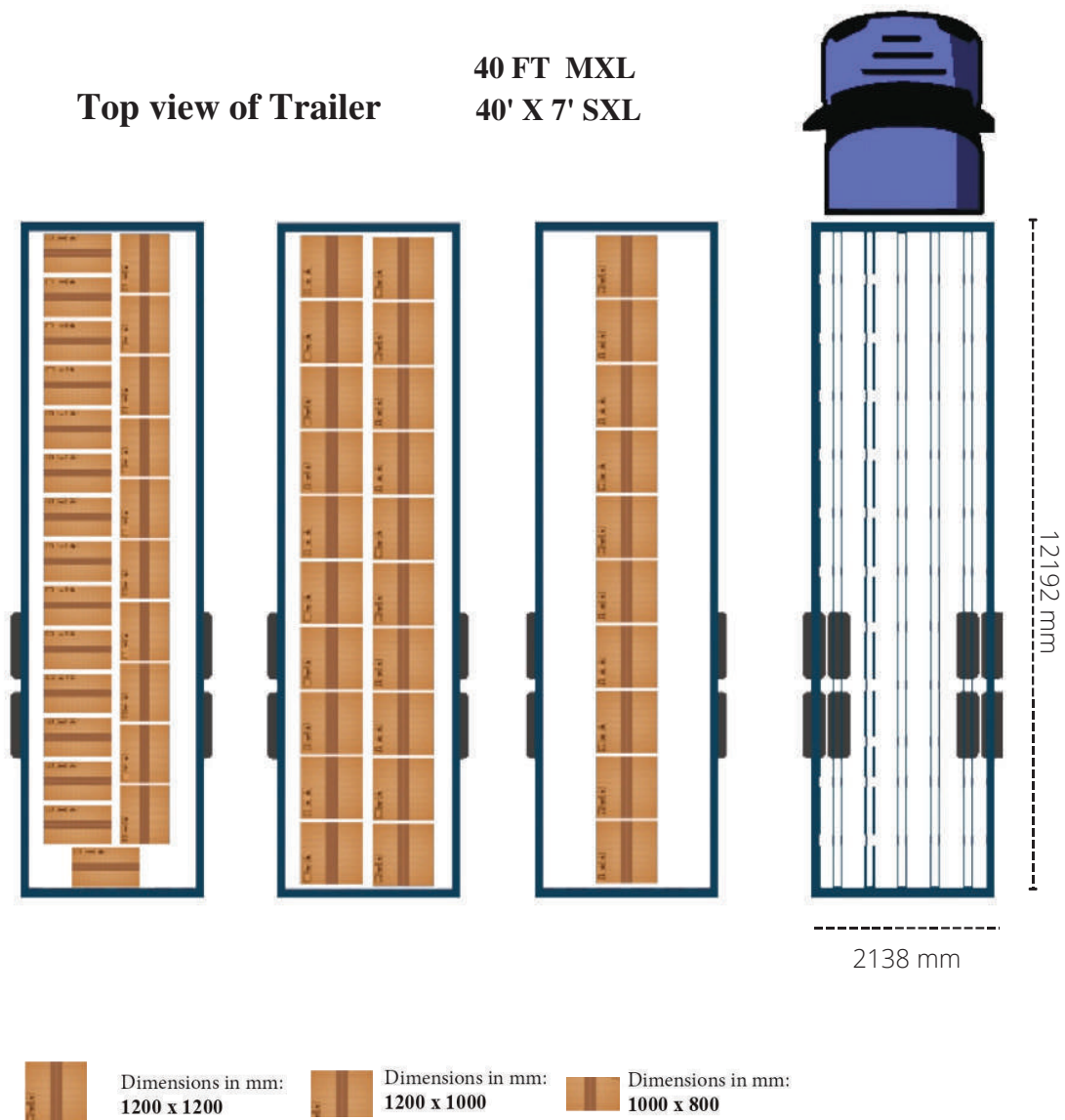
Trailer/Truck Type	Max. Wght.	Dimensions in Ft.			Dimensions in Meters				No. of Pallets		
Description	In MT	L	W	H	L	W	H	CBM	1200 x 1200	1200 x 1000	1200 x 800
Box Trailer	23.00	40.00	7.50	9.50	12.19	2.29	2.90	80.70	10	20	25
Curtain Slider Trailer	24.50	40.00	7.50	9.50	12.19	2.29	2.90	80.70	10	20	25
40' Container Trailer (Triple Axle / Double Crown)	38.00	40.00	7.50	9.50	12.19	2.29	2.90	80.70	10	20	25
40' Container Trailer Triple Axle	30.00	40.00	7.50	9.50	12.19	2.29	2.90	80.70	10	20	25
40' Container Trailer (Double Axle)	23.00	40.00	7.50	9.50	12.19	2.29	2.90	80.70	10	20	25
32' MXL Container body truck	14.00	32.00	7.50	8.00	9.75	2.29	2.44	54.37	8	17	20
32' SXL Container body truck	9.00	32.00	7.50	8.00	9.75	2.29	2.44	54.37	8	17	20
24' MXL Container body truck	14.00	24.00	7.50	8.00	7.32	2.29	2.44	40.78	6	13	15
24' SXL Container body truck	7.50	24.00	7.50	8.00	7.32	2.29	2.44	40.78	6	13	15
20' MXL Container body truck	7.00	19.50	7.00	7.50	5.94	2.13	2.29	28.99	4	8	11
Eicher 19'	7.00	18.50	7.00	7.50	5.64	2.13	2.29	27.50	4	8	11
Eicher 17'	5.00	17.00	6.00	7.00	5.18	1.83	2.13	20.22	4	5	8
Eicher 14'	4.00	14.00	6.00	6.50	4.27	1.83	1.98	15.46	3	4	6
Tata 407	2.50	9.00	5.50	5.00	2.74	1.68	1.52	7.01	2	2	4
Mahindra Bolero Pick Up	1.50	9.00	5.50	5.50	2.74	1.68	1.68	7.71	2	2	4
Tata Ace	0.85	7.00	4.80	4.80	2.13	1.46	1.46	4.57	1	2	2

Table 5.1 Vehicle Dimensions , design & standard pallet loading plans of various vehicles.

5.1 Transport specifications :

- i. Ideal truck body should have clear internal width 2286 mm for maximum efficiency considering the pallet standards of 1200 mm X 1200 mm, 1200 mm X 1000 mm and 1200 mm X 800 mm and 1140 mm x 1140 mm and taking a clearance of 50 mm on either side.
- ii. At least one side should have a collapsible flap to facilitate loading of pallets from the side, using forklifts, especially in plants having no ramp/dock-levellers. Otherwise, the forklift should be able to load / unload pallets from the back of the container trailer using a dock leveller and going inside the container.
- iii. Rules and regulations prescribed under the Central Motor Vehicles Rules (CMVR) Code of Practice for Construction and Approval of Truck Cabs, Truck Bodies and Trailers (MoRTH).
- iv. Flooring of truck / trailer should be smooth and of adequate strength to facilitate smooth movement of Battery-Operated Pallet Terminals (BOPT) and Forklifts inside the trucks for single or two high stacking of palletized loads.

5.2 Standards for arrangement patterns of pallets of in various size of vehicles



For arrangement patterns of pallets of in various trucks refer to Annexure -06

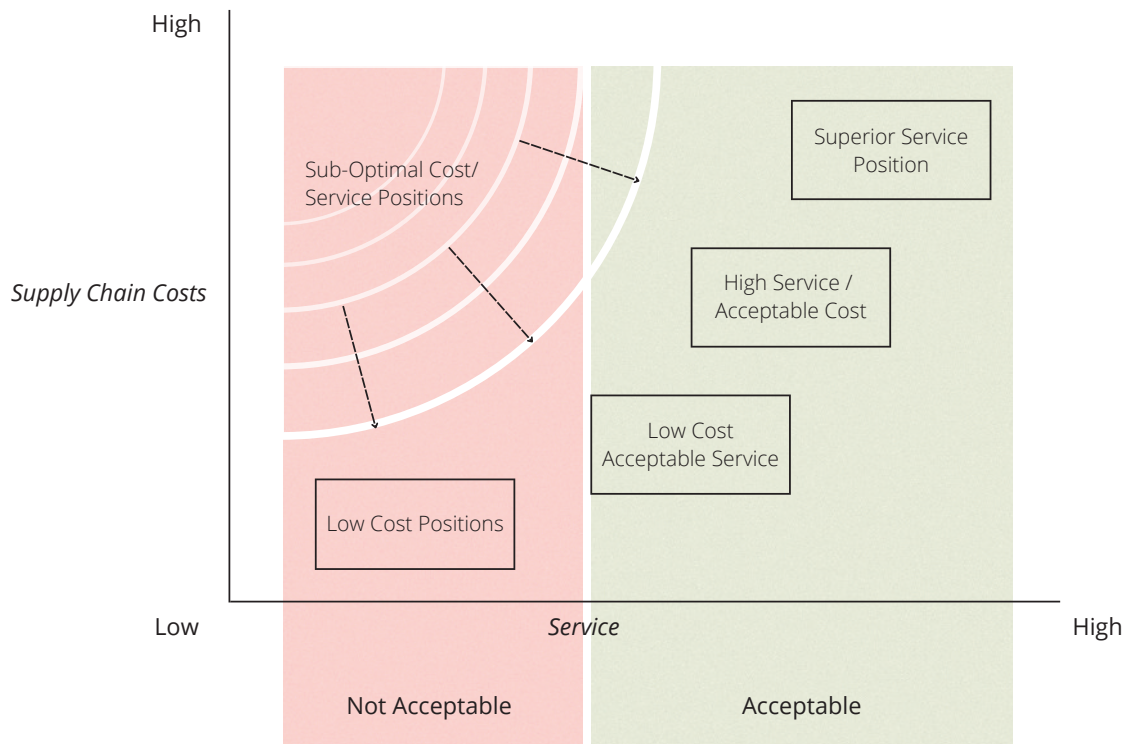


5.3 Network Optimisation

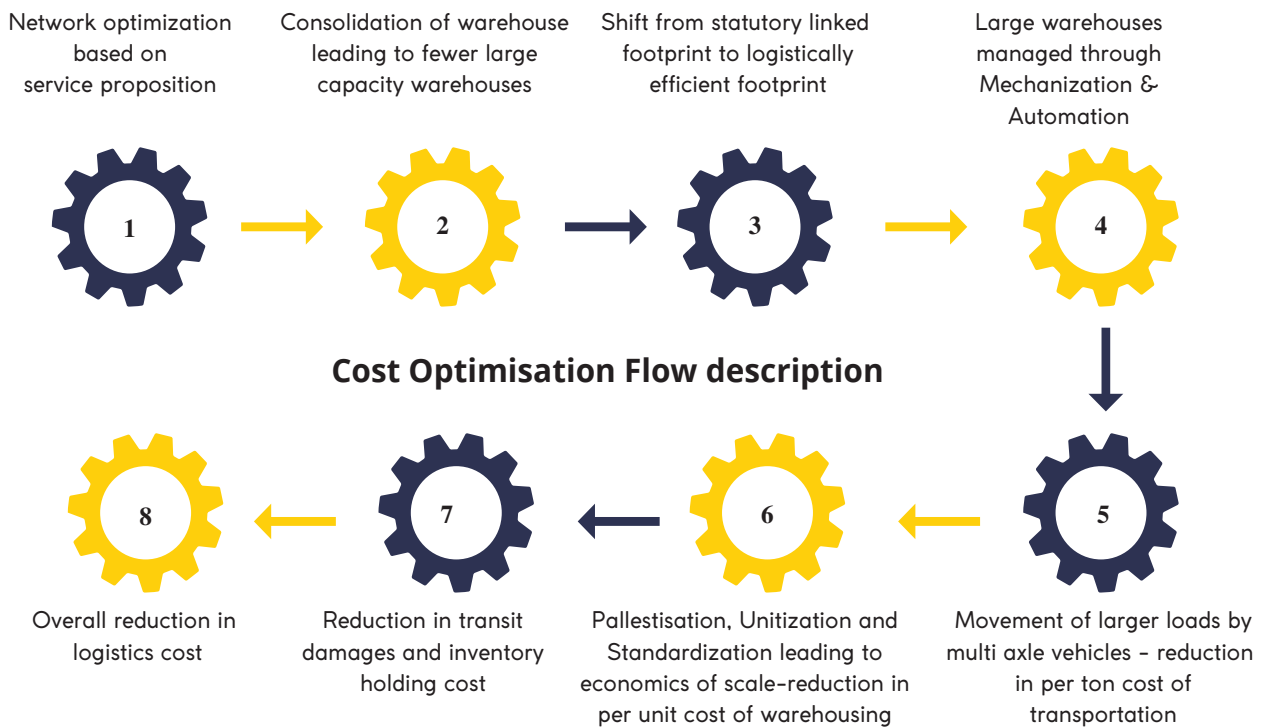
Incorporating network optimisation practices across supply chain networks can help obtain maximum cost efficiency. For warehouse network optimisation, standardisation of various aspects of the logistics industry must be undertaken. It is suggested to create and adopt appropriate network design models based on delivery lead time constraints, which may range from immediate deliveries that are unconstrained to up to 72 hours, and all variations plotted on a single graph to determine the optimum cost. Accordingly, an optimized network can be determined.

Collaborative logistics initiatives are suggested in which competitors can work together to service a common customer, or a customer can bundle competing suppliers. For example, trucking companies can bundle freight into one truck load to maximize utilisation of the truck capacity as well as to have committed return loads. This will lead to better utilisation of assets and reducing turnaround times, thereby enabling an efficient and cost-effective logistics environment.

A. Graphical representation of Service Levels Positioning



B. Graphical representation of Cost Optimisation



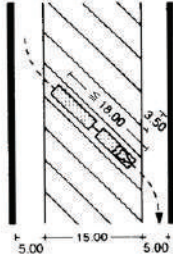
A standard daily check sheet for all vehicles coming in and going out of the warehouse does not only increase safety & security of the vehicles including the goods in them but also helps improve the efficiency and optimize maintenance costs; following is an example of checklist:

TRUCK CHECK SHEET			Dates till End Of Month				
Truck Sr . No (Assign Internal no. To ALL)			1	2	3	4	5
Check Points	Vehicle Details						
	Truck no.						
	Truck Registration date						
	Truck Kilometer (Odometer)						
	Supplier Name						
	OK		0	0	0	0	0
	NG		0	0	0	0	0
1	Coolant levels						
2	Wiper bottle						
3	Tire air pressure and Tyre condition						
4	Battery terminals check						
5	Check under/inside vehicle for any fluid leaks						
6	Cleanliness of truck inside container						
7	Mirror-Driver & Co-driver						
8	Seat belts available						
9	Stoppers available for Tyre and back door						
10	Trolley holding belt/Bar						
11	Brakes and accelerator pads						
12	Wipers						
13	Horn						
14	Reverse horn condition						
15	Head lights working						
16	Brake lights working						
17	Turn Signals working (Front/Rear)						
18	Wiring Condition of truck						
19	Door locks and handles (For safety)						
20	Fire extinguisher availability Basic Tool kit						
21	Fire extinguisher availability Basic Tool kit						
22	Vehicle fitness certificate available						
23	Any Modification in Truck Approved						
24	Hinge condition for all doors						
25	Hinge condition for all doors						
26	Availability of whistle with helper						
27	Battery Maintenance-water level & life check (frequency once in a month)	Plan					
		Actual					
	Details of any Issues						
	Countermeasure Taken						
	Implementation Date						

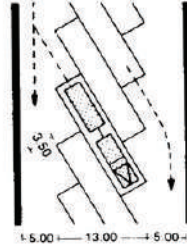
Table 5.2 Daily truck check sheet.

5.4 Vehicle Turning Radius

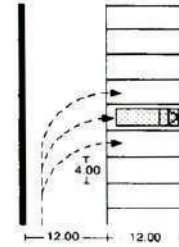
The turning radius of a truck is an important aspect of warehouse design. Warehouse access roads, main roads, entry ramps, and warehouse docking area should be designed considering the turning radii of the truck. The following diagrams can serve as a guide on how to use the turning radius calculations in your design:



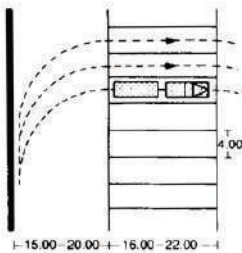
45 parking, truck with trailer



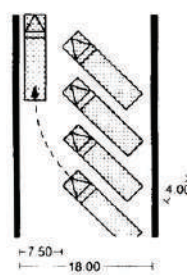
30 parking, truck with trailer



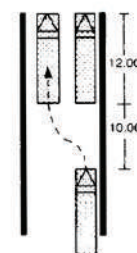
90 parking, single truck



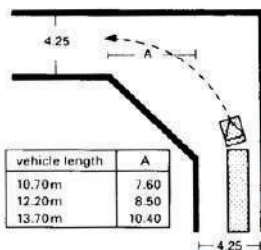
90 parking, truck with trailer



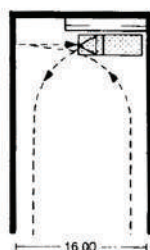
Parking at less than 45



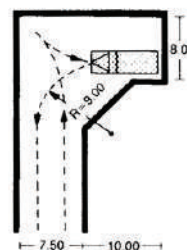
Space loss, parking parallel to kerb



Space needed at street corners



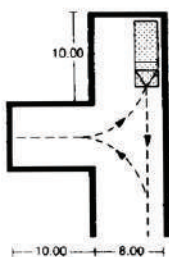
Turning in restricted areas



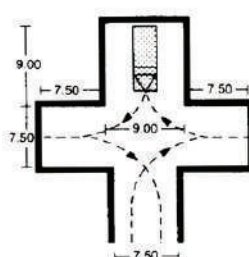
Hammerhead turn in tight space



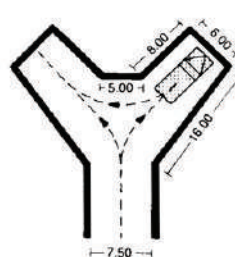
Passage width



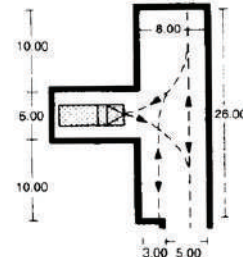
Further turning options



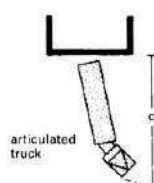
Further turning options



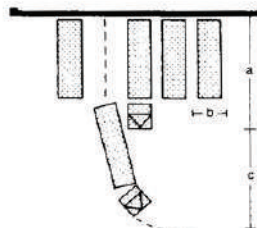
Further turning options



Further turning options



Single parking



Parking in a row

06

Product Specific Standards

- Assaying/Grading Standards
- Sampling and Testing Standards
- Weightment Standards





PRODUCT SPECIFIC STANDARDS

Introduction

Products stored in warehouses may be classified as agricultural and non-agricultural items. These products are required to be stored in warehouses capable of providing infrastructure to ensure consistent quality.

In this regard, it is essential to identify and implement standards for grading, sampling and testing and weighment of products. The guidelines for agricultural products and commodities are specified by the Warehouse Development and Regulatory Authority (WDRA)

6.1 Assaying/Grading Standards

The standards specified for grading of commodities stored within warehouses registered with the WDRA are aimed at achieving optimum quality standards for the products. The standards of grading for agricultural products are deemed mandatory and need to be implemented by all warehouses registered with the WDRA as authorized storage units for products and commodities.

6.1.1 Standards for assaying are as follows:

- i. AGMARK standards for most agricultural commodities with grades prescribed based on their intrinsic quality, cleanliness, extraneous matter, active components etc.
- ii. Commodity specific standards for specific items issued by concerned regulatory authority (Tea Board, Rubber Board etc.), BIS and other product specific agencies whereas those for non-agricultural commodities are specified by various nodal regulatory agencies like the BIS and other international agencies. The food specific standards cover the following areas; Assaying/Grading Standards, Sampling and Testing Standards, Weighment Standards, the assaying standards for non-agricultural commodities are specified by various domestic and international agencies.

6.1.2 Standards for non-agricultural commodities are:

- i. Assaying standards prescribed by BIS (for Metals like Brass, Copper, Lead etc.)
- i. Global assaying standards prescribed by international agencies like London Metal Exchange (LME), London Bullion Market Association (LBMA), Chicago Mercantile Exchange (CME).

6.2 Sampling and Testing Standards

The standards for testing are mandatory for WDRA registered warehouses, facilitating adherence to specified quality for the products.

- i. IS 2860: Sampling and testing of processed fruits and vegetables
- ii. IS 4333 has 5 parts, all these may be referred.
- iii. IS 4333: Part 1: Methods of analysis for foodgrains Part 1 Refractions (Third Revision)
- iv. IS 4333: Part 2: ISO 712: Methods of analysis for foodgrains Part 2 Determination of moisture content (Second Revision)
- v. IS 4333: Part 3: ISO 7971-3: Methods of analysis for foodgrains Part 3 determination of bulk density called mass per hectolitre (Second Revision)
- vi. IS 4333: Part 4: ISO 520: Methods of analysis for foodgrains Part 4 determination of the mass of 1000 grains (Second Revision)
- vii. IS 4333: Part 5: Methods of analysis for foodgrains Part 5 Determination of uric acid
- viii. IS 6261: Analysis of insects and rodent contamination in grains
- ix. IS 8077: 'Procedure for checking temperature of quick - Frozen foods'
- x. IS 8184: Determination of ergot in food grains
- xi. IS 10768: Test of quality characteristics of pulses
- xii. IS 11396: Test for determination of storability of food grains
- xiii. IS 12529: Methods for estimation of storage losses by insects

- xiv. IS 12700: ISO 3093: 'Wheat, rye and their flours, durum wheat and durum wheat semolina -
- xv. Determination of the falling number according to Hagberg - Perten (Second Revision)
- xvi. IS 16516: Bajra – Specification
- xvii. IS 16518: Maize – Specification
- xviii. IS 16519: Jowar – Specification
- xix. IS 16520: Barley – Specification
- xx. IS 16682: Ragi – Specification
- xxi. IS 16892: Sattu – Specification
- xxii. IS 3581: Green Coffee – Specification (Third Revision)
- xxiii. IS 3633: Black tea – Specification (Second Revision)
- xxiv. IS 15344: Green tea – Specification

6.2.1 Sampling of Agricultural commodities

- i. IS 4115: Methods of sampling of oilseeds
- ii. IS 4905: ISO 24153: Random sampling and randomisation procedures (First Revision)
- iii. IS 14818: ISO 24333: Cereal and cereal products Sampling (First Revision)
- iv. IS 5404: Methods for drawing and handling of food samples for microbiological analysis (First Revision)

6.3 Weighment Standards

While grading and testing standards primarily govern the quality of the products stored in

warehouses, the standards specified for weighment are aimed to ensure the quantity of products. The existing standards are mandatory and must be adhered to agnostic of warehouse structure.

The mandatory guidelines issued by BIS are as follows:

- i. BIS Standards for Weigh bridge specifications (IS 1436)
- ii. BIS Standards for General Requirements for Weighing Instruments (IS 1432)



Recent Trends

A

Warehouse Automation

- Loading/Unloading
- Picking
- Sortation
- Movement



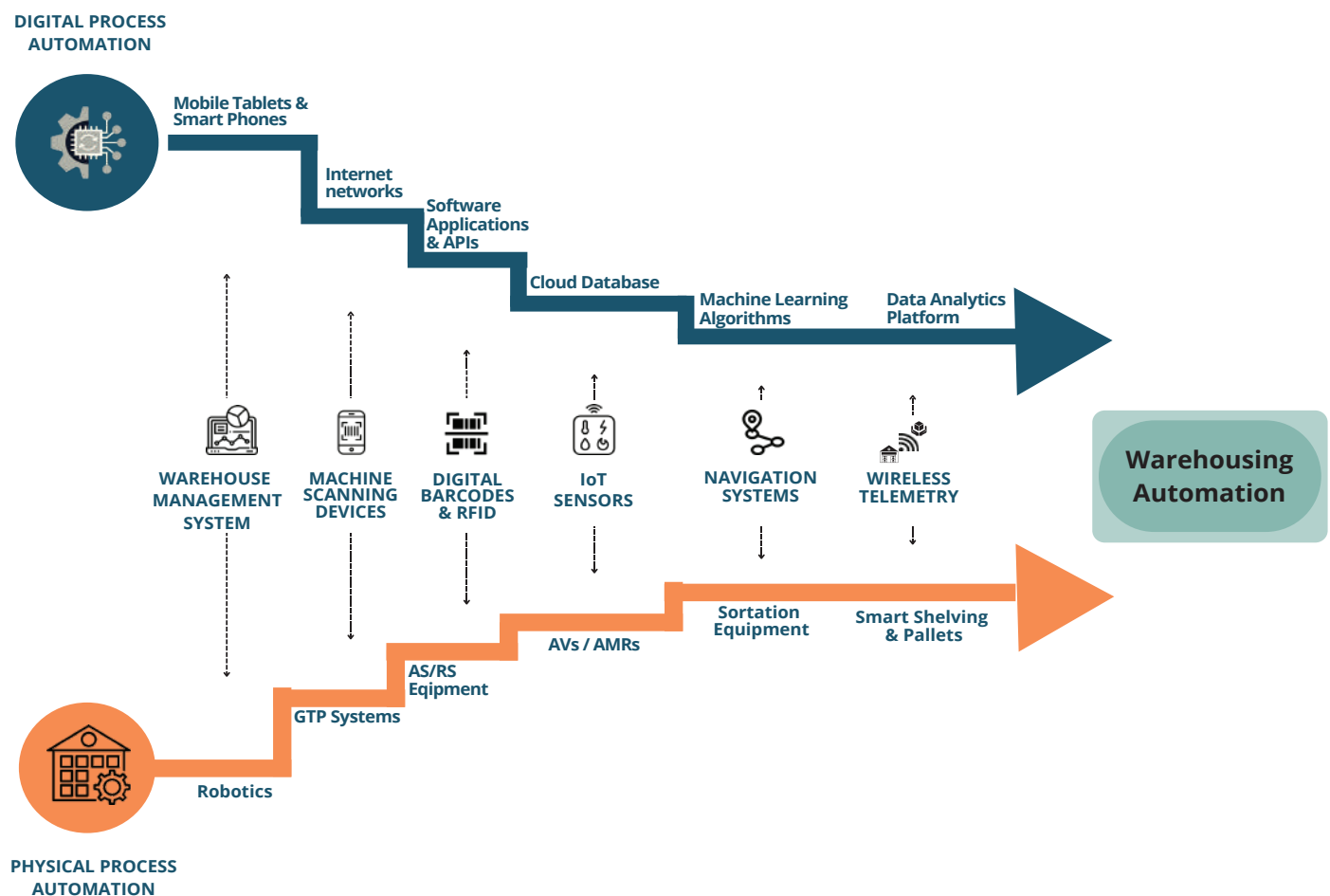
Introduction

Automation reduces time, effort and cost, while reducing errors and making the process more productive. It results in higher efficiency, better service quality and improved safety. Warehouse automation is the process of automating the movement of inventory into, within, and out of warehouses to customers with minimal human assistance. Warehouse Automation is usually the combination of digital process automation and physical process automation.

Warehouse Automation is usually the combination of digital process automation and physical process automation. Warehouse automation helps ensure that business-critical operations in the warehouse meet customer demand. It starts with a warehouse management system (WMS) that automates

manual processes and data capture, inventory control and supports data analysis. These systems integrate with other solutions to efficiently manage and automate tasks across different business and supply chain functions.

Warehouse automation projects are expensive, but they pay back fast. The reason for impressively fast ROI is multiple new saving points provided by automation such as: reduced labor cost, higher performance, optimized handling and storage cost, minimized inventory errors, eliminated risks of mishandling and product loss. Some automation solutions are mentioned further such as loading/unloading, picking, sortation, movement, storage and retrieval within the warehouse.



7. Loading/Unloading

7.1 Telescopic conveyor

When loading and unloading trucks, an extendable conveyor makes a world of difference. This solution extends all the way from the permanent conveyor to the nose of the truck trailer, making the process of getting cargo in and out faster, easier and safer.

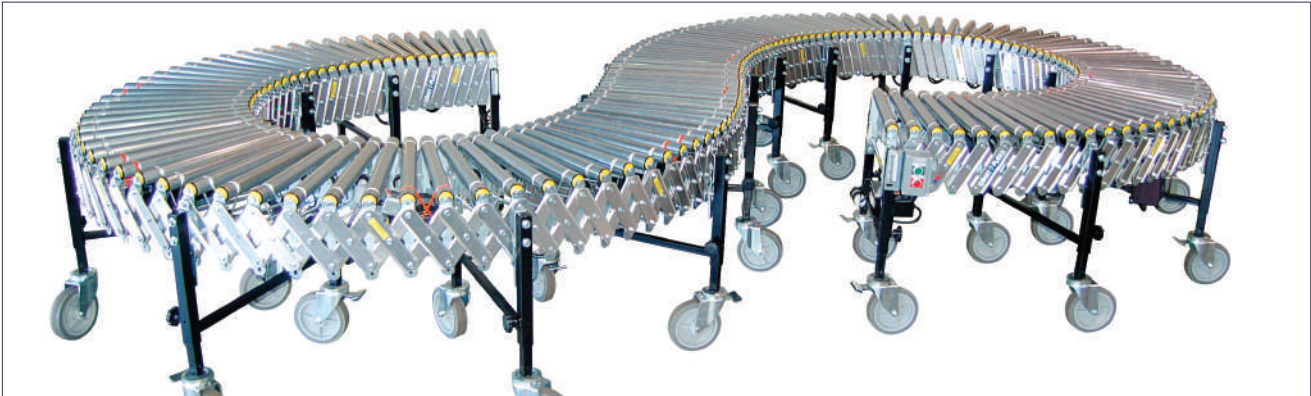
With variety of lengths, widths, accessories options, telescopic belt conveyor is capable of filling a container without the need for a operator, making it fit for top warehouse automation companies or distribution centre applications that utilize smaller packages.



7.2 Powered Flex Conveyor

The Powered Flex Conveyor has a robust design that provides optimal conveying power and can easily be moved where it is needed most.

The flexible, expandable conveyor will stretch or bend to fit your available space and is ideal for truck loading and unloading areas.



7.1 Picking

7.1.1 Put To Light

Put-to-Light systems are an effective automated sortation method to break larger quantities of product into individual customer orders, using light devices to direct operations to "put" items.

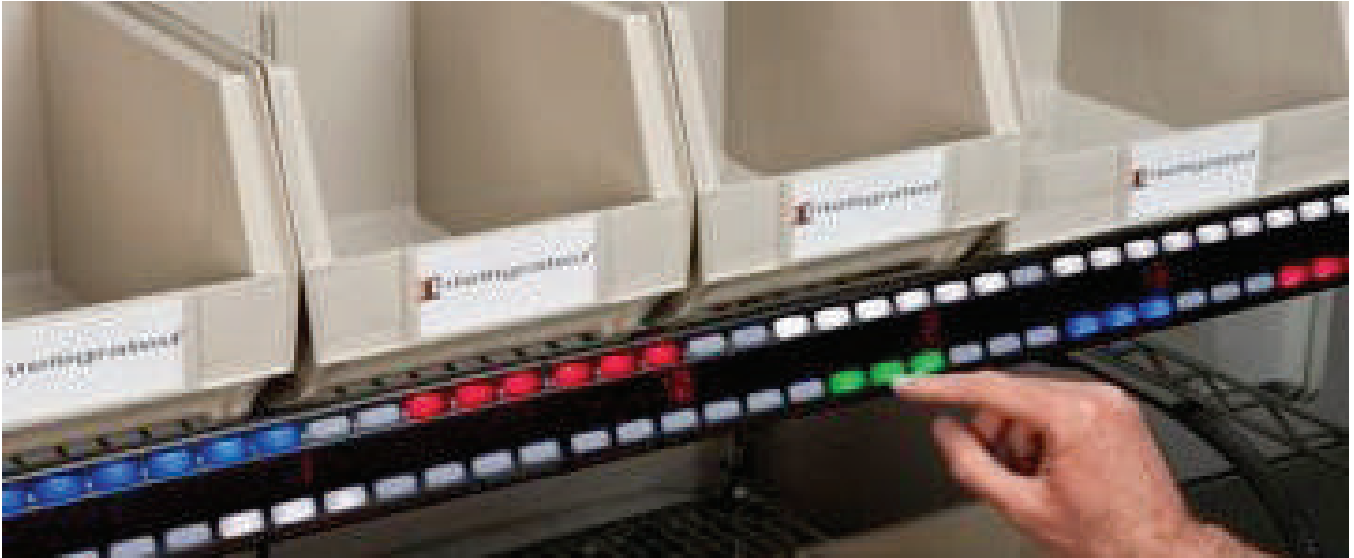
Sometimes the Put-to-Light approach is referred

to as "scan and sort". Products are typically batch picked beforehand and brought to a put station. Operators scan bar codes on individual products, then lights will light up on any individual customer orders requiring that product.

7.1.2 Pick To Light

Pick-to-Light is a light-directed order fulfillment technology that provides an accurate, simple and efficient method of paperless picking, putting, sorting and assembling products while simultaneously lowering labour costs.

A typical light-based picking system uses different coloured LED lights along with a series of letters and numbers. These tracking components allow for a faster accumulation of products while maintaining inventory accuracy.

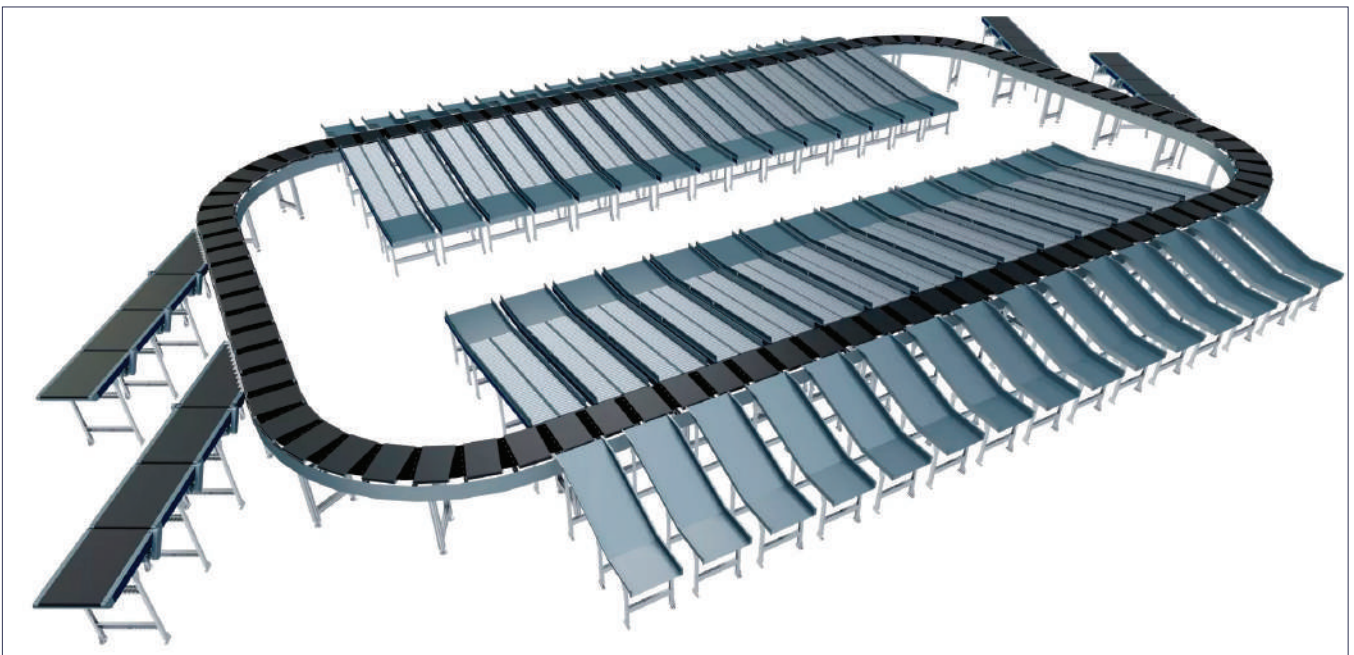


7.2 Sortation

Sortation is the process of identifying individual items on a conveyor system and diverting them to correct locations using a variety of devices controlled by task-specific software.

7.2.1 Cross belt Sorter

The Cross Belt Sorter delivers products with pinpoint accuracy using individual carriages, each with its own belt conveyor. Divert points are concentrated at close intervals making the system very space efficient.



7.2.2 Pusher or Puller Sorter

Pusher sorters are good, low to medium-throughput options for sorting irregularly shaped, difficult-to-convey items, and small items like polybags, cosmetics, or pharmaceuticals. These sorters have been in use for decades, and have a long history of reliable, accurate performance.



7.2.3 Line Sorter

Line Sorter is a semi-automatic sortation solution for small and mid-size parcels. The solution may consist of a line camera or sorter devices which are used for registering shipments and a conveyor belt with a sortation mechanics which will deliver the parcels to detachable bags according to the selected sort plan.



7.3 Material Movement

7.3.1 Automated Guided Vehicles (AGV)

AGVs are material handling systems or load carriers that travel autonomously throughout a warehouse, without an on board operator or driver, for tasks that would typically be handled by forklifts, conveyor systems or manual carts, moving large volumes of material in a repetitive manner. there are various types of AGV such as Automated Guided Carts, Forklift AGVs , Towing AGVs , Unit Load Handlers , Autonomous Mobile Robots.

Autonomous mobile robots (AMRs) are typically more technologically advanced than other types of AGVs. While many AGVs use fixed navigation systems, such as wires or magnetic tape, many AMRs are equipped with intelligent navigation capabilities such as sensors and camera systems that enable them to detect and navigate around obstacles. Thanks to more sophisticated technology, AMRs can dynamically navigate a warehouse or other facility and plan the most efficient pat

7.4 Automated Storage and Retrieval System

Automated storage and retrieval systems, known as ASRS or AS/RS, are computer-controlled systems that automatically place and retrieve loads from set storage locations in a facility with precision.

The benefits of ASRS Include Increased throughput capabilities, increased accuracy levels to 99.99%+, increased labour productivity up to 85%, Increased ergonomics by delivering items to the operator at a convenient height, eliminating time lost to walking, searching, lifting, bending and twisting activities, increased storage density, enhanced product security and real time inventory control.



7.5 Types of ASRS

7.5.1 Unit-load ASRS

They are used for large loads such as cases of items or pallets. Unit-load AS/RS is used for loads often weighing several thousand pounds. It uses fixed-aisle and movable-aisle cranes.



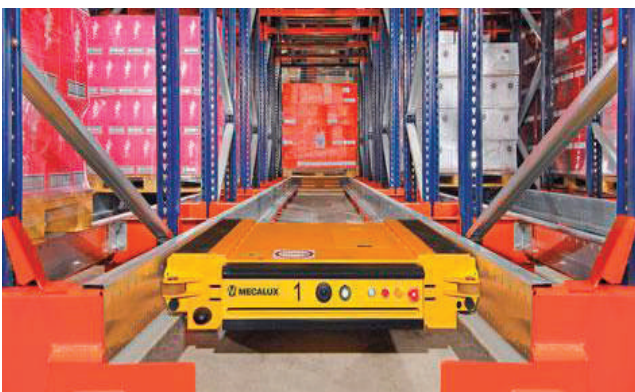
7.5.2 Mini-load ASRS

They are smaller than unit-load AS/RS solutions. They are used for handling lighter loads. Mini-load AS/RS use shuttles and cranes, which makes them suitable for warehouses with narrow aisles.



7.5.3 Pallet Shuttle Racking System

It is a high-density compact storage solution that uses powered shuttles to automatically carry loads into the rack. The pallet shuttles are remotely controlled by an operator. Hence, there is an optimum use of storage space and workplace accident rates are also reduced. This system can work either as FIFO or as LIFO.



7.5.4 Mother & Child Shuttle System

Also known as Carrier-Shuttle system is a multi-deep ASRS solution, generally employed for high density storage. The Mother carries baby along the rails perpendicular to the aisles on each floor. As per the requirement, the baby goes into the aisle to pick or place the pallet. The Mother-Baby shuttle then carries the pallet to outbound system like vertical lifts or conveyors.



Recent Trends

B

Artificial Intelligence in the Warehouse

- Storage
- Movement
- Other Tasks



Introduction

Artificial intelligence is a term applied to computers, robots, or machines that exhibit aspects of human intelligence and reasoning, such as visual perception, speech recognition, and decision-making. This is the era of Artificial Intelligence (AI) and recently broad-based application of AI have begun in the global warehousing industry. Things that were unimaginable few years ago can now be achieved, unlocking massive efficiency gains, waste elimination, and improved customer satisfaction. This section focuses on categories of Machine Vision and Internet of Things (IoT), collectively referred to as AIoT (Artificial Intelligence of Things), powered automation and augmentation a warehousing leader should explore. The AI foundation is already being laid out today by leading firms globally that will serve as a template for the rollout of "Smart Warehouses of The Future" over the next few years.

Considering the transformative power of AI and AIoT, an AI strategy is no longer optional. It is a strategic imperative for warehouse leaders of tomorrow and will play a key role as India upgrades its logistics infrastructure for increased productivity and global competitiveness.

This section defines what AI strategy should be like and what are the leading high value opportunities for warehouse automation and augmentation.

Framework for successful implementation of an AI Strategy

1. Develop consensus at the leadership level to define AI as a strategic imperative such that funding is accessible. AI initiatives can be expensive but offer massive ROI.
2. Designate a Digital Supply Chain Leader with access to proper funding to launch multiple pilot programs in parallel.
3. Define Efficiency and Accuracy as the corner stone for the organization.
4. Designate a model warehouse in a central city where AI and Robotics applications with highest ROIs can be rapidly piloted, without impacting business operations.
5. Partner with an AI first company that specializes in Logistics and Supply Chain.
6. Develop commercial deployment strategy at scale and review upfront to find and attract the best AI companies.

AI solutions with the highest ROI

Although AI is a broad category and the applications can be numerous, listed below are some of the highest value opportunities for warehouse automation and augmentation.

Intelligent Label and Barcode Scanning

Barcode, QR code, and label scans are the core foundations of a warehouse operation. If a supply chain organization cannot scan labels with accuracy, it leads to significant downstream impact in terms of claims, inventory accuracy, reverse logistics, etc. The legacy approach has been to use handheld scanners and barcode scanning cameras on conveyer belts to perform this function. But the unspoken truth of the industry is that this traditional approach comes with only a 70 to 95% accuracy range, depending on complexity of the label that needs to be scanned. This leads to automation challenges and downstream impact in supply chain.

Powered by AI and Machine Vision capabilities, legacy barcode and label scanning solution accuracy can now be improved to near 100%. This unlocks massive value for supply chain organizations across a number of functions from dispatching to receiving of goods.



Legacy barcode scanners can now be replaced by Smart Phone scanners, Machine Vision Tunnels, and Smart Glasses where AI models can be deployed to push accuracy levels to near 100% and perform rapid scans.



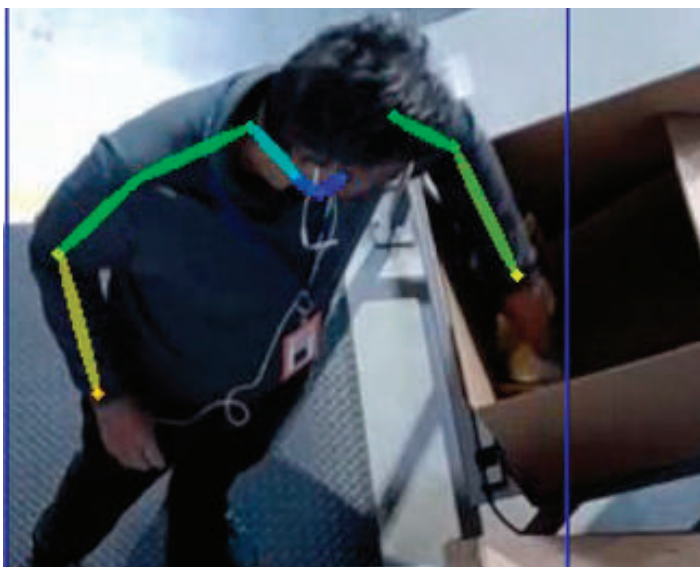
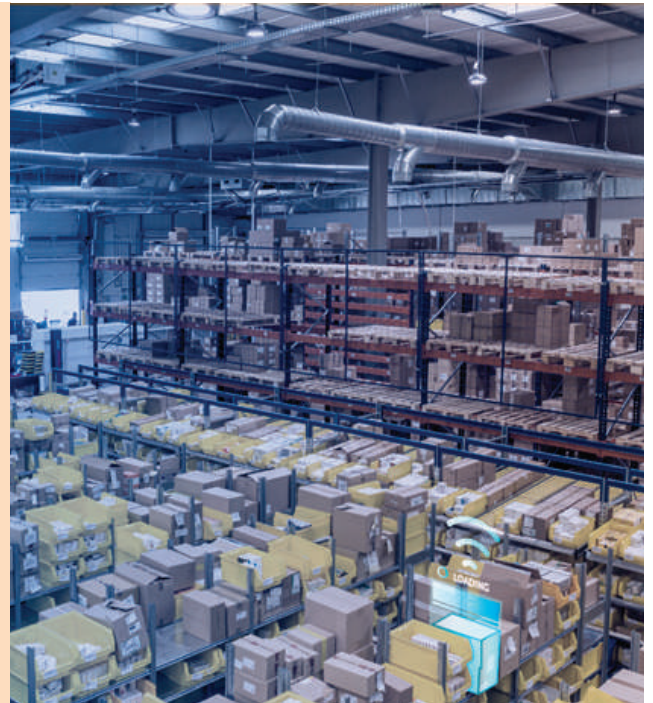
Dock Door Visibility

When goods arrive or are dispatched from the warehouse, it is critical to reconcile both quantity and quality. At the dock door, the best one can do is a visual examination of the SKUs being shipped and correlate it against the order. Warehouse leaders should consider AI and Machine Vision powered applications to automate and augment this process to build a precise audit trail, both in terms of quantity and quality.

Inventory Visibility

Once the goods are accepted into the inventory, they need to be put away for future access. The Warehouse Management Systems (WMS) that are in use in almost all Warehouses today can tell the operator where to put away the goods. It is then up to the operator to ensure it goes to that exact bin/ location in the Warehouse. The cost of putting away the goods in a wrong bin is enormous, as misplaced items lead to loss of sales, increased working capital, and operational loss due to product expiration, seasonality, and warehouse downtime for inventory cycle counting.

Machine Vision powered applications including Robotics can now be deployed to automate and augment picking, put away, and replenishment operations to build a Digital Twin of the Warehouse. This allows warehouse operations team to always know which SKU and what quantity of it is present at what location.



Human Activity Tracking

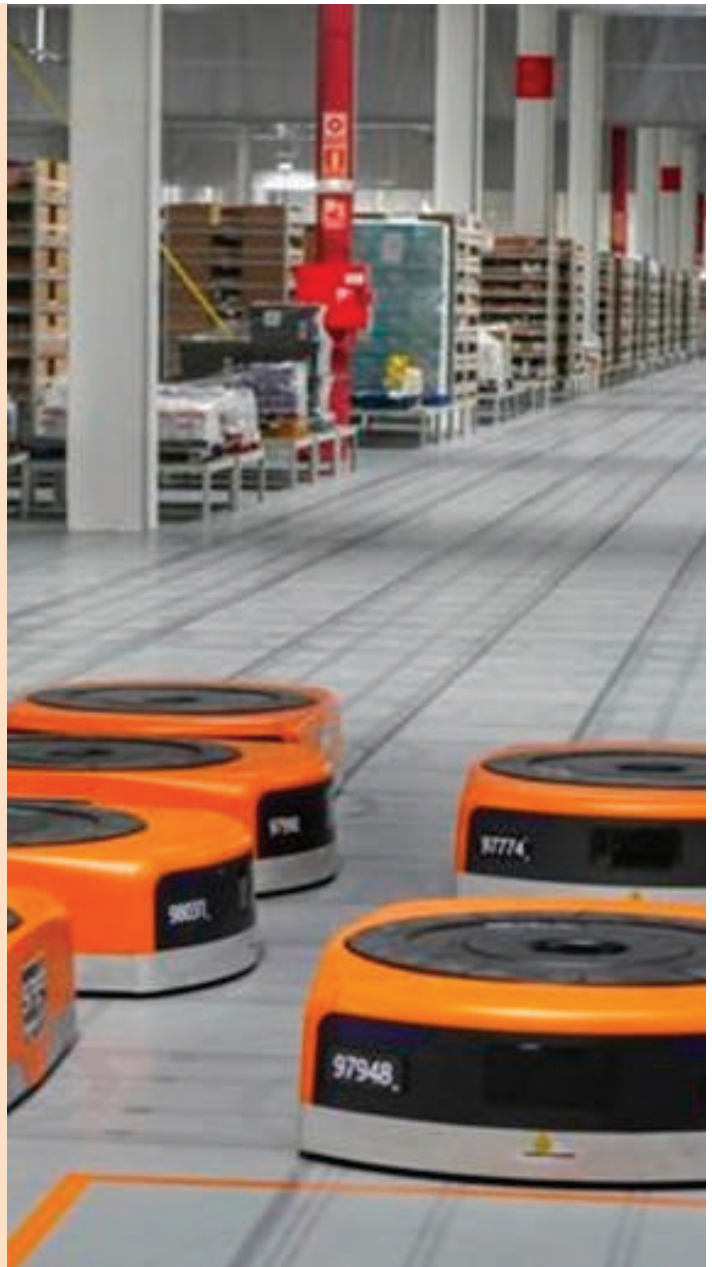
There are several manual tasks in the warehouse where billions in goods are shipped without any method of supervision and audit if the orders were packed right by a warehouse worker. Machine Vision applications can now be implemented in strategic operational locations to bring real-time audit and exception management to these activities. These applications can also be utilized to improve operational efficiency through manual task reduction such as elimination of a Pick to Light system with a Machine Vision powered application.

Robotics and Robotics as a Service (RAAS)

The arrival of AI and sensors have enabled creation of a family of Robots for a wide variety of tasks within the four walls of a warehouse. These robots range from autonomous Forklift Systems, Picking Systems, Heavy Carrier Systems, and other Machine Vision powered applications.

For example, Kitting is a mini-assembly operation. Various SKUs in pre-defined quantities are aggregated together and packed in designated packages to create a kit. A computer vision-based solution can do this crucial but repeated job without fatigue and with high accuracy. Similarly, Industrial Robotic Arms can entirely transform the process of Palletization and how goods are loaded / unloaded from Trucks as well as transferred from factories into warehouses.

Although Robots in Warehouses have already become a commodity, the price point remains a point of consideration, as Robots can be expensive. Additionally, simply implementing an autonomous Robot that lacks precise Machine Vision capabilities is not going to deliver greater ROI. Robotics as a Service and augmentation of Robots with Machine Vision capabilities are both good strategies to mitigate the impact of cost and accuracy with autonomous robotics systems.



Drones or AGVs (Autonomous Guided Vehicles)

Several companies around the world have focused on building autonomous, machine vision powered drones to enable inventory counting and stock finding in a warehouse. Drones, however, require many considerations and have some limitations. For example, SKUs that are nested on a rack are not visible to a drone, and therefore it cannot provide precision with inventory counting. Battery life of a drone for longer duration flights in a large warehouse should be another importation consideration for warehouse leaders.

Cross Docking and Smart Yards

Cross Docking and Yard Management are tasks that are not strictly within the Warehouse but are intricately connected to the success of Warehousing. Crucial to the success of these tasks is the ability to be accurate in identification of correct equipment(s) and dynamic allocation of dock doors or parking bays based on upstream and downstream processes. Machine Learning algorithms are a great way to implement a Predictive Dock Door for intelligent appointment management by combining machine vision and sensor powered real-time data points from both yard and within the warehouse.

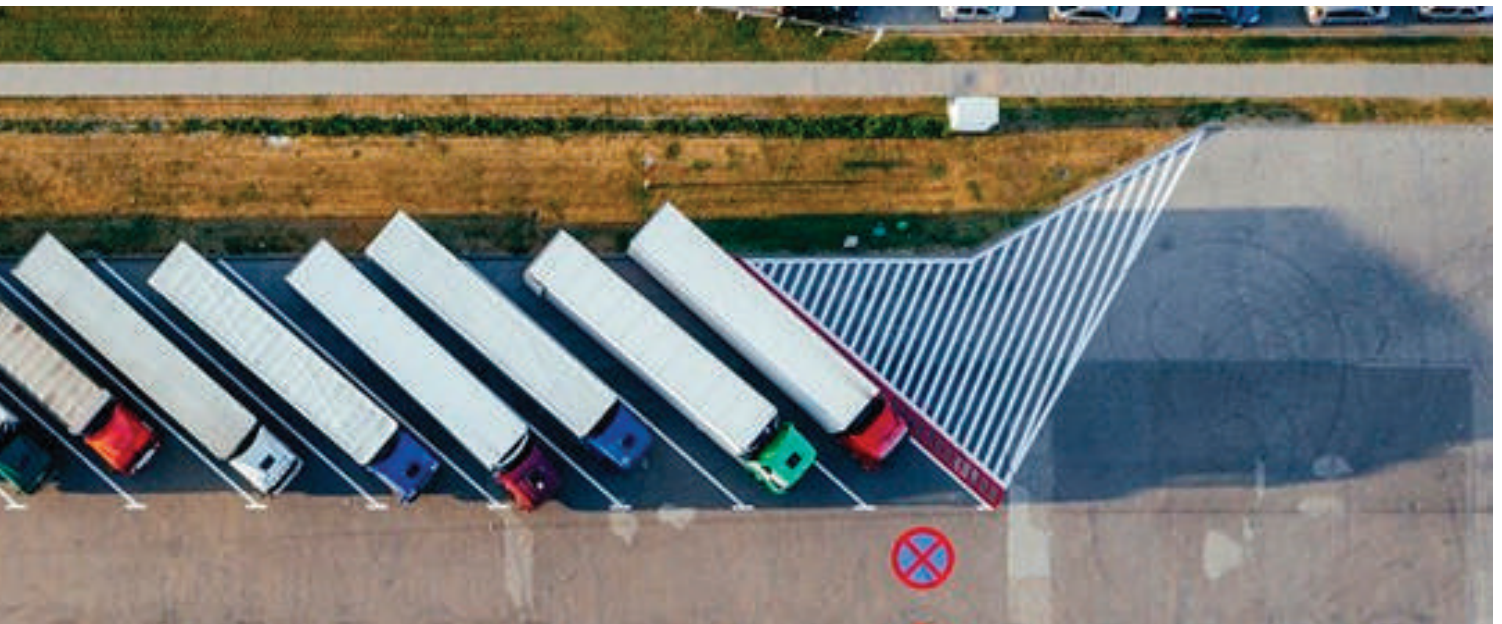


Warehouse Safety

Warehouses where operational safety compliance and enforcement is a major concern can benefit with Machine Vision powered application that can either complement or replace existing camera infrastructure. Some common use cases are safety gear (enforcing hard hats in racking areas, safety vests, etc.).

Additionally, Machine Vision and Sensors powered detection can also be implemented to avoid collision and enforce behavioral change with Forklift drivers as it relates to speed limits, sharp turns, etc.





Intelligent Sorting

Warehouses often deal with hundreds of SKUs that require precise identification for sortation, quality control, and packaging into correct bins or THUs (Transport Handling Units). Machine Vision applications can be applied to transform this critical operation with speed and accuracy.



ANNEXES

ANNEXURE - 01

Warehouse Standards

A	Civil Work	Specifications
1	Perimeter Wall	Precast Concrete panels or brick & mortar wall or autoclaved aerated concrete blocks from 3.50m to 3.90m height from finished floor level with damp proofing.
2	Plinth Height (Finished Floor Level - FFL)	FFL to be kept at +1200 mm from the Finished Road Level (FRL) at loading / unloading side of the warehouse with the assumption that dock leveler at 1200 mm will have +/- 300 mm inclination (with max 3 meter length) to cater to 12' vehicles to 40' trailers.
3	Warehouse Entrance	Façade - Glazing with ACP cladding. Entrance - With granite finish with 900mm height SS railing Ramp - 1.2 meter wide with 1:10 slope in granite finish
4	Truck Apron Area	The external docking yard or apron in front of the warehouse loading bay should be minimum of 30m in depth for perpendicular docking and 19m in case of angular docking through the full length of the warehouse building. The apron should be constructed for handling heavy vehicle traffic movement.
5	Toilets	Fully functional toilets to be provided in the warehouse building based on user layout as per NBC requirements.
6	Diesel Generator (DG) Platform	DG platform to be provided as per the user's DG dimensions and weight. The DG exhaust stack foundation should be prov
7	Anti - Termite Treatment	Anti-Termite treatment should be done in the foundations right up to the plinth beam to ensure extermination of all termites to prevent future infestation. Treatment should also be done to the sub-base of the warehouse floor.
8	Tests & Reports	The following surveys and tests should be done before commencement of construction and reports to be shared with and considered by the civil engineering team while designing: A - Topographical survey B - Soil test reports C - Hydrogeological survey D - Plate load tests on soling or on finished sub-base before start of flooring. Test quantity and target values to be specified by floor designer.

B	Warehouse Flooring	Specifications
1	Flooring Standards	TR:34 Edition IV / ICI TC 09 / ACI 302 / ACI 360
2	Floor Design Input	Floor load should be calculated on the basis of: 1 - The product attributes (such as weight & dimensions) and the unit load device on which it is placed. 2 - If placed on standard pallets of size 1000mm x 1200mm or 1200mm x 1200mm then the weight of the loaded pallet should be converted to load (Kg) per square meter. 3 - If the warehouse will store material on high rise heavy duty racking system or multi-tier shelving systems then it is necessary to calculate the load (kgs/m²) on the upright (column) of the storage system. When communicated for design the load should be stated along with the size of the base plate on which the upright is installed. 4 - The type of MHE(s) that could to be used to operate the racking system should be factored for their wheel spacing and loaded MHE(s) weight transferred on wheels for dynamic and static calculations for the purpose of floor design.
3	Floor Surface Regulations	TR:34 Edition IV / ICI TC 09 / ASTM E 1155 / FEM 9.381 / DIN 18202
4	Reinforcement	TR 34 / ICI TC 09
5	Densification / polishing on Floor	Nano/Lithium/Sodium systems should be used. The system increasing the Mohr's scale hardness should be used.
C	PEB Works	Specifications
1	Structure	Pre-engineered building,
2	Building Clear Height (at eaves)	From 9m to 16m clear or as per product stacking requirement.
3	External Bay Dimension	8.20m to 8.80m
4	Internal Bay Dimension	16.40m to 17.60m x 22m to 25m
5	Mezzanine Structure	Minimum 5% of total plinth area. Dead Load as per design, Live Load for office can be considered as 3.5 KN/Sqm and for value added services a minimum of 5.0 KN/Sqm. The deck sheet can be considered as .80mm thick 345 Mpa Galvalume sheet.
6	Dead Load - Building	0.15 KN/Sqm as per IS 875 (Part 1):1987
7	Collateral Load - For Building	Minimum 0.30 KN/Sqm
8	Collateral Load - For Mezzanine	Minimum 0.15 KN/Sqm
9	Live Load	0.57 KN / Sqm as per IS 875 (Part 2):1987
10	Wind Speed	As per IS 875:2015
11	Wind load application	As per IS 875:2015
12	Seismic code	IS 1893:2016 Part 1

C	PEB Works	Specifications
13	Design Codes	I. Loads (other than ones mentioned above) as per MBMA (2012) II. Design code as per AISC 2010 edition. III. Frame members are to be designed in accordance with AISC 2010 edition. IV. Cold Formed members are to be designed in accordance with AISI, 2012 edition. V. All welding work shall be in accordance with the AWS (American Welding Society) for the relevant procedures. VI. All Welders should be qualified for the type of welds performed. VII. Design in STAAD with 3D modelling.
14	Deflection Criteria	As per design
15	Steel specification for primary members	ASTM A572 M Grade 345 Mpa, minimum tensile strength to be 345 Mpa / AISI 2010 ASD 345 Mpa
16	Steel specification for secondary members	ASTM A 653/A 653M Grade 340 with coating as per Z275 standard and minimum yield strength of 345 Mpa / AISI 2010 345 Mpa.
17	Roof	Roof sheet of the warehouse should be made of Galvalume steel, in heat reflective color. In case of green building certification, use GreenPro Certified standing seam roof. Roof slope is determined based on rainfall data however slope ranges from 1:20 to 1:10. Minimum thickness of 0.55mm TCT, standing seam roof, in single length sheets from ridge to eaves. No breaks are allowed. 360 degree seamed roofing system with no end laps, with metal end closures at eave. Conforming to ASTM A792M, AZ150 grade 275.
18	Louvers	Louvers of appropriate size to be provided on the wall cladding with bird mesh to prevent bird ingress.
19	Building Ventilation	Minimum 6 air changes / hour through an adequately designed roof monitor and louvers in the wall cladding to support the required number of air changes.
20	Canopy	Minimum 4.50m deep for buildings with perpendicular docking and 6m deep for buildings with angular docking. The canopy to be cantilevered and back stays can be provided for additional support. Canopy to be minimum 5.20m from the finished road level (FRL).
21	Sky Lights	3% -5% of roof area, polycarbonate sheet with under deck mesh (for fall protection) with waterproofed design. Wall lights should also be provided for lighting to compensate for any reduction in sky lights.
22	Insulation	Sandwich air bubble insulation of minimum 8mm thickness with double core with minimum R value of 3.10 Sqm K/W / Rock wool insulation of 16 Kg/Cu. Mtr, density with 50mm thickness and aluminium facing on exterior side / 9mm XLPE with single side aluminium foil can be installed on roof and wall of the building.

23	Wind Bracings	There should not be any wind bracings in the warehouse area that obstructs material or MHE movement. Wind bracings to be provided above wall height or at a height that does not obstruct any movement. Bracings can be provided from the floor level on the side where there are no dock doors or any other movement.
24	Provision for fixing Solar Panels on PEB roof	20 kgs dead load to be added to the building design for providing the necessary fixing clips for the solar panels.
25	Cage ladders	The PEB building should be provided with a permanently fixed cage ladder with a door and locking mechanism on 2 sides of the warehouse building to access the roof of the warehouse.
26	Building Roof Life Line System	A lifeline system should be provided at both ends of the building to facilitate and secure people maintaining the roof and solar panels.

D	Equipment	Specifications
1	Dock Doors Numbers & Shutter Type	1 in 10,000 square feet. Minimum 2 Manual / Electrically operated MS / GI rolling shutter with a manual override option.
2	Dock Door Width x Height (meters)	For perpendicular docks - 2.4 m x 3.0 m / For angular docks - 3.0m x 3.0m
3	Dock Shelters	Dock shelters to be provided on the walls for perpendicular docks to avoid damage to the walls, ingress of dust during operations and prevent loss of temperature in air-conditioned warehouse. Dock shelter size to be as per the dock opening size.
4	MHE Dock Doors	There should be 1 door in each warehouse to enable MHE equipment to move outside the warehouse. Size of these doors should be minimum 4m (wide) x 5m (height) and should be connected to ramps suitable for the equipment being used in warehouse. This door should be electrically operated with a manual override. This door should be constructed with MS of minimum 1.2mm thickness OR a PUF infilled sectional door can be used.
5	Fire Escape Doors with Panic Bar and alarm	The numbers and locations should be provided as per NBC and local fire codes. Each fire door should have a minimum 2 hour fire rating. A Panic Bar to be provided on the Inside (warehouse side) of the door leaf.
6	Dock Guards/ Bumpers	02 numbers per dock
7	Dock Levelers	30% of dock doors to be provided with dock levelers and 100% dock doors to be provided with dock pits.
E	Electrical Works	Specifications
1	Power	Power connection up to building as per 1.00 kVA to 1.25 kVA per 1,000 sq. ft. of building space.
2	Power Back Up	The complex should have power back up facility (DG Set) to light the common roads and yard. Also to provide power to security gates, boundary wall, common structures, water pumps and fire pumps, etc.

E	Electrical Works	Specifications
3	Lightning Arrestor	Equipotential bonding of PEB / building structure & solid grounding of the same.
4	Lighting	Since lighting is the major source of energy consumption in all buildings, energy efficient LED lighting should be considered. Uniformity in indoor applications as per National Lighting Code 2010 / 2016 should be maintained. Internal Lighting Lighting is generally designed based on IS: 3646 standards. Lighting design is based on room dimensions, colours of wall / ceiling, height of ceiling, type of false ceiling and type of activity in the rooms. External Lighting External lighting should be provided by the use of LED lamps, mounted on masts, columns and building faces as required to wash the building walls and light specific areas. The luminaries should be segregated on circuits so that separate area control can be achieved. These individual areas should be provided with time clock and auto/manual/off controls with photo electronic facilities. Pathways and general pedestrian paths may be lit by means of low level bollard type luminaries if desired. External Lights should be separately controlled and should not have any connections with the warehouse light panels. Lighting levels in principal areas are generally as in following table: <u>Area Description/Considered Lux Level</u> MHE parking, charging & servicing area: 200-250 MHE parking, charging & servicing area: 200-250 Heavy Duty Racking Aisles: 150 – 200 Toilets:150 Under Canopy and Docking Yards: 100 Truck apron area: 50 The illumination levels can be measured between 0.80m to 1m from the finished floor level.
5	Emergency Lighting	Emergency lighting should be provided to permit safe evacuation of the building in case of an emergency. The systems should provide for multiple central battery systems operating at 50V DC. Local inverters should invert to 240V AC and illuminate emergency luminaries sited at strategic positions.
6	CCTV Surveillance	Server based intelligent video management CCTV system with reputed software interface or NVR based with port switches which will depend on the quantity and location demands; can be considered at park level.

F	Fire Fighting Works	Specifications
1	Sprinklers	Sprinkler of ELO or LD type of reputed make and can be integrated with fire alarm system. C Class pipes and fittings, heavy grade pipes as per IS:1293A should be used. Provision for tap off for in-rack sprinklers should be provided. The local governing norms should be checked and followed to ensure the firefighting system is compliant.
2	External Fire Hydrant System	Fire hydrant system and First Aid Hose Reel design as per IS13039:2014. All hydrant points shall be installed 2m away from the face of the building and placed 30 m apart. The pipes and hydrant points shall be strategically placed and protected wherever required to avoid any damages due to truck or vehicular movement. External fire hydrant ring should be fed from multiple connections to the Fire Hydrant Water Tank. Fire hydrant points should be provided following the Local fire norms. The external hydrant system should be approved by the concerning authority.
3	Internal Hydrant Systems	Should be designed as per local and NBC codes. All hydrant valves shall be conforming to IS:5290 and shall be of reputed brands. Rigid supporting systems for overhung pipes using galvanized support should be provided with C class pipes and fittings, (heavy grade pipes as per IS1239A.) and valves and appurtenance shall be of reputed brands and installed in accessible locations.
4	Hose Reel & Fire Extinguisher	First aid hose reel drum shall be conforming to IS:884 and the tubing shall be high quality thermoplastic, conforming to IS:12585. Hose reel drum shall have a provision to swivel 180 degrees to address the hazard swiftly and efficiently. Extinguishers shall be provided in all common areas as per IS:2190 and shall conform to IS15683.
G	Common Infrastructure	Specifications
1	Park Boundary Wall	8ft high precast / UCR wall with 2ft of concertina wire. A 'Y' shaped vertical post extension for placement of the concertina coil.
2	Internal Roads	Bitumen finish / Pavement Quality Concrete
3	Office Entrance	There should be a separate entrance for the office area, and this should not be common with the goods movement / vehicle gate entry and exit. The staircase can have granite steps with 900mm high MS railing. The pathway to the entrance and the entrance itself should be covered.
4	Truck Parking Area	A truck terminal / parking area should be provided at a common location in the logistics park. Parking lanes should be highlighted to specify parking areas. Rest rooms and washrooms should be provided near the truck parking / terminal area.

G	Common Infrastructure	Specifications
5	Visitor/Staff Parking	Visitor and staff parking to be provided as per applicable development control regulations (DCR)
6	Entrance ramp for handicap access to the buildings	1.2m wide with 1:12 slope (in feet) ramp with MS railings on both sides.
7	Storm Water Drainage	Should be designed as per NBC, the local rainfall data and local DCR norms.
8	Fresh Water supply	Provision of 20 litre per person per day as per NBC code.
9	Flushing water supply (treated STP water)	Based on 30 litre per day per person can be considered.
10	STP	Based on 45 or 30 liters per day per person as per NBC guidelines can be considered. Online monitoring should comply with local administrative guidelines.
11	Total Population	Total population accordance with standard specification ratio of 1:1000 sq. ft. building space per day including all shifts.
12	Utility Space	Well graded & levelled open space
13	Security Cabins	The warehouse will have 2 security cabins on each side of the warehouse with wash room as primary security control arrangement. These Security cabins should be at least 60 ft ² in size. The Secondary security post of the complex will be at the main entrance gate.
14	Entry and Exit Gates	At park Level and at warehouse level to ensure controlled access to individual warehouses.
15	Admin / Facility Office	May be provided on need base.
16	Rainwater Harvesting	As per statutory requirement.
17	Protection Kerbs or Kerbs Stone	Protection kerbs are to be provided on the warehouse side edges and exposed columns to prevent damage by heavy vehicles. The same should also be provided between vehicles at loading docks to ensure alignment with back stop building protection.
18	Landscaping	All landscaping, ground formations, planting and seeding is to be carried out in accordance with the local authority requirements.
19	Line Markings and External Road Information and Direction Signage	Signage on entrance, roads, warehouse main entrance, objects, items - reflective, non-reflective signage. (Post Fit out Period)
20	Utility and Scrap Area	Electrical room, scrap storage, maintenance store should be provided around the warehouse at appropriate locations.
21	EV Charging points	Should be provided for private and cargo vehicles as per local building norms.

ANNEXURE - 02

Design / Construction / Maintenance of Structures

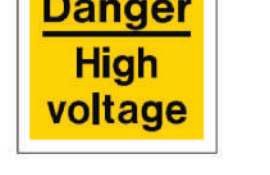
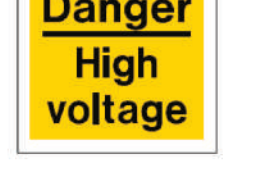
Sr. No.	Standard / Guidelines	Issuing Authority
1	Guidelines for Group H: Storage and Warehousing Occupancy Guidelines in National Building Code of India 2016 (NBC 2016) including Part 6 'Structural Design'	Bureau of Indian Standards
2	Fire safety standards as prescribed by the Bureau of Indian Standards	Bureau of Indian Standards
3	Water drainage mechanism, methods for rainwater harvesting as per Bureau of Indian Standards	Bureau of Indian Standards
4	Standards for Effluent Discharge as per NBC 2016 (Part 9)	Bureau of Indian Standards
5	Standards for Solid Waste Management	Bureau of Indian Standards
6	Fire safety of Industrial Buildings (IS 3594)	Bureau of Indian Standards
7	Code for practice for interior illumination (IS 3646 Part 1)	Bureau of Indian Standards
8	Code of Practice for Plain & Reinforced Concrete (IS 456)	Bureau of Indian Standards
9	General Construction in Steel-Code of Practice (IS 800)	Bureau of Indian Standards
10	Code of Practice for Composite Construction in Structural Steel and Concrete (IS 11384)	Bureau of Indian Standards
11	Code of Practice for use of cold-Formed light gauge steel structural members in general building construction (IS 801)	Bureau of Indian Standards
12	Code of Practice for Design Fabrication and Erection of Vertical Mild Steel Cylindrical Welded Oil Storage Tanks (IS 803)	Bureau of Indian Standards
13	Silos for grain storage (IS 5503 Part 1 and 2)	Bureau of Indian Standards
14	Criteria for design of reinforced concrete bins for the storage of granular and powdery materials (IS 4995 Part 1 and Part 2)	Bureau of Indian Standards
15	Criteria for Design of Steel Bins for Storage of Bulk Materials - Part 1 : General Requirements and Assessment of Loads ; Part 2 : Design Criteria; Part 3 : Bins Designed for Mass Flow and Funnel Flow (IS 9178 (Part 1 to 3))	Bureau of Indian Standards
16	Design, fabrication, testing and installation of underground storage/ tank storages (IS 10987)	Bureau of Indian Standards
17	Selection, Installation and Maintenance of First Aid Fire Extinguishers (IS 2190)	Bureau of Indian Standards
18	Installation of Surveillance equipment confirming to BIS 13252	Bureau of Indian Standards
19	(Information Technology Equipment-Safety)	Bureau of Indian Standards
20	Landslide control Guidelines for structures in Hilly regions (IS 14680)	Bureau of Indian Standards
21	BIS Guidelines for Improvement of existing structures used or intended to be used for food grain storage (IS 609), Dunnage pallet warehousing (IS 13714)	Bureau of Indian Standards
22	Foodgrain storage godowns – Code of Practice (IS 16144)	Bureau of Indian Standards
23	Portable Fire Extinguishers (IS 15683)	Bureau of Indian Standards
24	Guidelines for improving cyclonic resistance of low-rise houses and other structures (IS 15498)	Bureau of Indian Standards
25	Landslide control Guidelines for structures in Hilly regions (IS 14680)	Bureau of Indian Standards

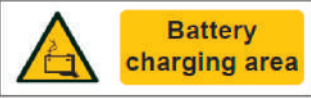
Sr. No.	Standard / Guidelines	Issuing Authority
26	Criteria for earthquake resistant design of structures [IS 1893 (Part 1) and IS 1893 (Part 4)]	Bureau of Indian Standards
27	Code of practice for design loads (Other Than Earthquake) for buildings and structures: Part 1 dead loads - Unit weights of building materials and stored materials [IS 875 (Part 1)]	Bureau of Indian Standards
28	Code of practice for design loads (Other Than Earthquake) for buildings and structures: Part 2 imposed loads [IS 875 (Part 2)]	Bureau of Indian Standards
29	Design Loads (Other than Earthquake) for Buildings and Structures	Bureau of Indian Standards
30	Code of Practice Part 3 Wind Loads [IS 875 (Part 3)]	Bureau of Indian Standards
31	Code of practice for design loads (Other Than Earthquake) for buildings and structures: Part 4 snow loads [IS 875 (Part 4)]	Bureau of Indian Standards
32	Code of practice for design loads (Other Than Earthquake) for buildings and structures: Part 5 special loads and load combinations [IS 875 (Part 5)]	Bureau of Indian Standards
33	Building Design and Erection Using Prefabricated Concrete - Code of Practice (IS 15916)	Bureau of Indian Standards
34	NBC 2016: Part 8/Sec 1 'Lighting and Natural Ventilation'	Bureau of Indian Standards
35	NBC 2016 : Part 6 'Structural design' Sec1 to 8)	Bureau of Indian Standards
36	NBC 2016 (Part 12) Asset and facility management	Bureau of Indian Standards
37	Thermal insulation of cold storage - Code of practice (IS 661)	Bureau of Indian Standards
38	The Air (Prevention and Control of Pollution) Act, 1981	Central Pollution Control Board
39	The Water (Prevention and Control of Pollution) Act, 1974	Central Pollution Control Board
40	Noise Pollution (Regulation and Control) Rules, 2000	Central Pollution Control Board
41	Standards by National Centre for Cold Chain Development	National Centre for Cold Chain Development
42	WDRA Warehouse Registration Rules, 2017 (Rule 20 for Infrastructure requirements of Warehouses)	Warehousing Development and Regulatory Authority
43	Petroleum, petrochemical and natural gas industries — Internal coating and lining of steel storage tanks (ISO 16961)	ISO
44	ISO 22311:2012 Standards for Societal Security- Video Surveillance system	ISO
45	Design Codes for Built-up section and HR sections	American Institute of Steel Construction
46	Design Codes for Cold rolled section for roofing	American Iron and Steel Institute
47	RP 1604 (Closure of Underground petroleum storage tanks)	American Petroleum Institute (API)
48	RP 1632 (Cathodic protection of underground tanks)	American Petroleum Institute (API)
49	The Environment (Protection) Act, 1986	Central Pollution Control Board
50	Guidelines issued by CWC	CWC
51	Guidelines issued by FCI	FCI
52	Guidelines under Food Safety Management System by FSSAI	FSSAI

Sr. No.	Standard / Guidelines	Issuing Authority
53	EN BS 8204-2:2002 and ASTM C779 and ASTM C944 for abrasion resistance	European Standards
54	Guidelines under International Tanker Container Organisation	International Tanker Container Organisation
55	Loading codes under MBMA	Metal Building Manufacturers Association
56	RP 1615 (Installation of Underground Petroleum storage tanks),	American Petroleum Institute (API)
57	RP 1631(Interior lining and periodic inspection)	American Petroleum Institute (API)
58	Guidelines under National Leak Prevention Association Standards for Entry, Cleaning, Repair of Underground Storage Tanks (NLPA Std 631)	National Leak Prevention Association, USA
59	Guidelines under International Tanker Container Organisation	International Tanker Container Organisation
60	Loading codes under MBMA	Metal Building Manufacturers Association`
61	Guidelines under National Leak Prevention Association Standards for Entry, Cleaning, Repair of Underground Storage Tanks (NLPA Std 631)	National Leak Prevention Association, USA
62	Construction standards based on provisions laid down under the Warehousing (Development and Regulation) Act, 2007 and subsequent rules and regulations framed there under by the Warehousing Development and Regulatory Authority including Warehousing (Development and Regulation) Registration of Warehouses Rules and Warehousing and Regulatory Authority (Electronic Negotiable Warehouse Receipts) Regulations, 2017	Warehousing Development and Regulatory Authority



Signage Guidelines

1.8 mm aluminum powdercoated panel with vinyl graphics fixing on 2" MS pipe with base plate Size : 60 cm x 70 cm  220 cm 2" MS pipe 25 cm x 25 cm base plate	vinyl graphics Only Size : 30 cm x 45 cm 	3 mm thick ACP Panel with vinyl graphics Size : 30 cm x 45 cm 	1.8 mm aluminum powdercoated panel with vinyl graphics Size : 40 cm x 60 cm 
3 mm thick ACP Panel with vinyl graphics Size : 40 cm x 60 cm 	3 mm thick ACP Panel with vinyl graphics Size : 30 cm x 45 cm 	3 mm thick ACP Panel with vinyl graphics Size : 40 cm x 30 cm 	1.8 mm aluminum powdercoated panel with vinyl graphics. Size : 60 cm x 100 cm 

3 mm thick ACP Panel with vinyl graphics Size : 50 cm x 15 cm 	3 mm thick white acrylic Panel with vinyl graphics Size : 30 cm x 10 cm 	1.8 mm aluminum powdercoated panel with vinyl graphics Size : 30 cm x 30 cm 
1.8 mm aluminum powdercoated panel with Reflective vinyl graphics Size : 45 cm x 45 cm 	1.8 mm aluminum powdercoated panel with vinyl graphics Size : 30 cm x 15 cm 	vinyl graphics Only Size : 30 cm x 15 cm 
vinyl graphics Only Size : 30 cm x 15 cm 	1.8 mm aluminum powdercoated panel with vinyl graphics Size : 40 cm x 30 cm 	3 mm thick ACP Panel with vinyl graphics Size : 40 cm x 30 cm 

Annexure - 04

Floor Parameters and Standards

Sr. No.	Floor Parameter	Standards/ Methods	Remarks
1	Sub grade / Sub base	IS 1888, IS 2914, Proctor Density, Plate Load Test	The sub-base thickness and floor topping is derived by this input. A floor cannot be laid if sub-grade value is less than 2% as it may require piling or some other support before the floor can be laid.
2	Slip Membrane	300 microns virgin LDPE	This should not be considered as a vapour barrier. It is a separation layer between the concrete and the sub-base. Double layer slip membrane may be used in case recommended by the flooring consultant based on design.
3	Concrete	IS 456/IS 10262 for mix design TR 34, ICI TC 09 for workability	Workability and finishing aspects are more important than mechanical properties of the concrete. Concrete with fly ash content to be avoided.
4	Floor Design Standards	TR 34 / ICI TC 09	TR 34: IV Edition and ICI TC 09 are both sufficient and perfect documents for floor design however other design documents like ACI 302, ACI 360 can also be consulted as per discretion of Engineer in Charge. Floor design should be done by a flooring consultant or a design and build contractor.
5	Floor Surface Regulations *	TR 34 / ICI TC 09	TR-34: IV Edition and ICI TC 09 are both sufficient and perfect documents for defining surface regulations covering all aspects of MHE. Other documents like ASTM E 1155, FEM 9.381 and DIN 18202 can also be used to satisfy MHE load requirements. However, floor surface regulations should be defined by storage system height and the MHE. The surface regularity should only be measured by authorized flooring consultant / survey company with the necessary equipment.
6	Reinforcement (Rebar / Fiber (Steel, Plastic))	TR34: IV Edition /ICI TC 09	Minimum rebar reinforcement should be 8mm x 150mm x 150mm, minimum fibre reinforcement dosage should be capable of giving 30 % RE value.

Sr. No.	Floor Parameter	Standards/ Methods	Remarks
7	Load Transfer / Floor Joints	Armour joints with studs, arris protection and plate dowels	All joints which will be in the access path of the MHE should be armoured to protect the arris and prevent breakage of edges.
8	Sealants	Polyurethane sealant during construction Stage.	Modified Epoxy /Semi Rigid Epoxy Sealant After 12-18 Months
9	Floor Screeding Methods	Laser operated screed machine	Where laser operated screeding machine is not available truss screed can be used for areas less than 5000 m ² .
10	Floor Protection Systems	Non Metallic Hardener	
10-A	Abrasion Resistance	Suggested dosage - 5 kg / M ²	BS 8204 / ICI TC 09 Min 4 KG /M ² should be used or as advised by the floor designer.
10-B	Densification and Polishing	Nano/Lithium/Sodium systems can be used. A system which increased Mohrs scale hardness can be used.	A measured performance system such as US Polishing Council guidelines is preferred but not mandatory.
11	Resin coatings	BS 8204, HACCP, USDA& CFTRI, DIN51130 & TRPL	A PU coating is preferred over epoxy coating.
12	Curing	LDPE sheets of 75 micron or curing mats, watering 3 times a day for 7 days / curing compound to be used as advised by the manufacturer.	Use of curing compound should be avoided when additional floor protection system such as densification, polishing and resin coating is planned.
13	Flooring consultant	A qualified flooring engineer with sufficient first-hand experience of floor design and execution	
13	Flooring consultant	A qualified flooring engineer with sufficient first-hand experience of floor design and execution	
14	Flooring Contractor	A flooring contractor with design and build experience of constructing floors.	

Annexure 05

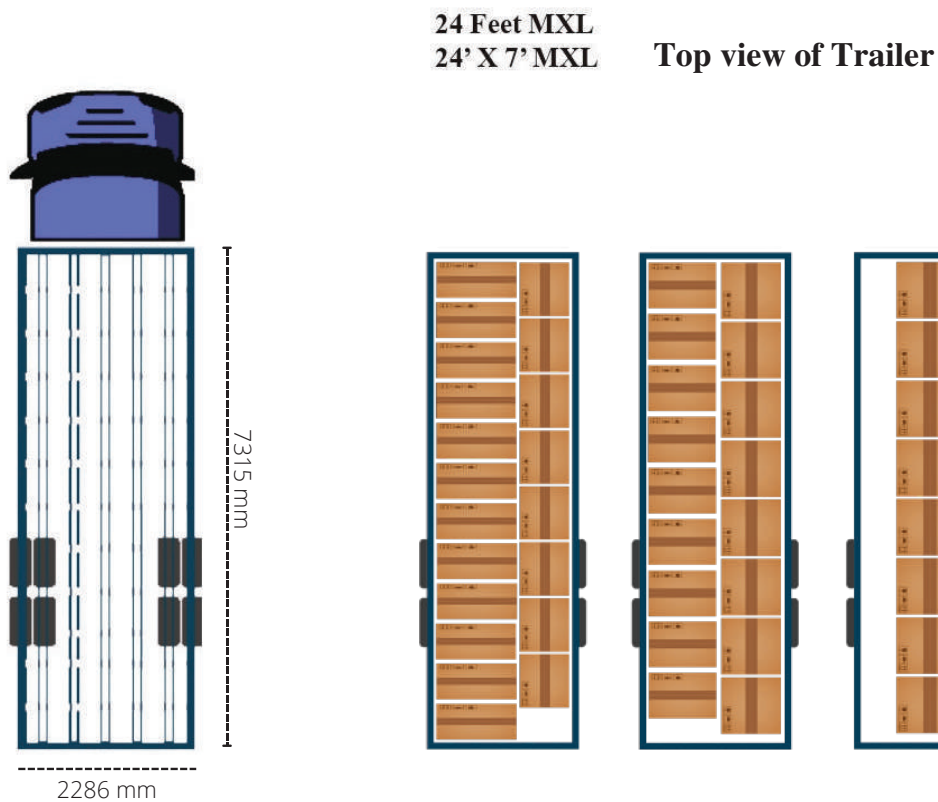
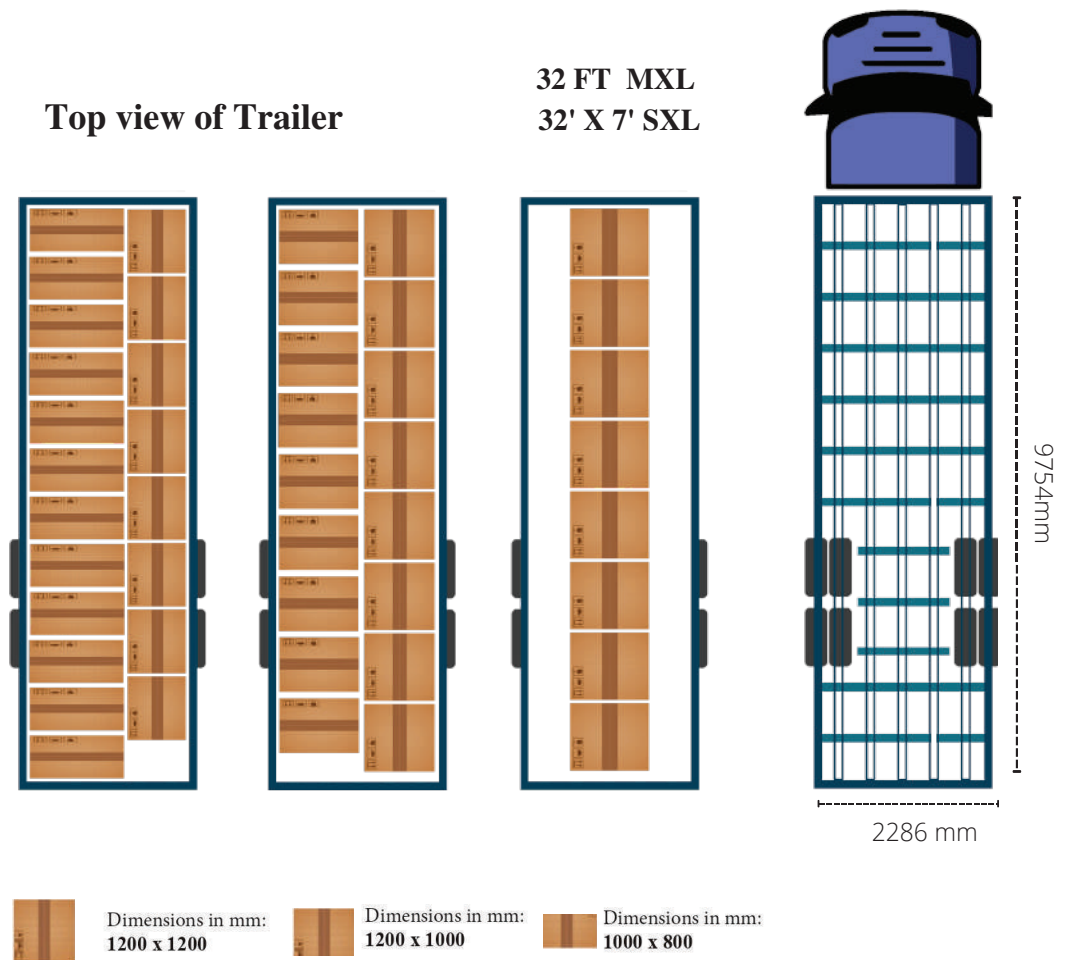
MHE Standards/Guidelines

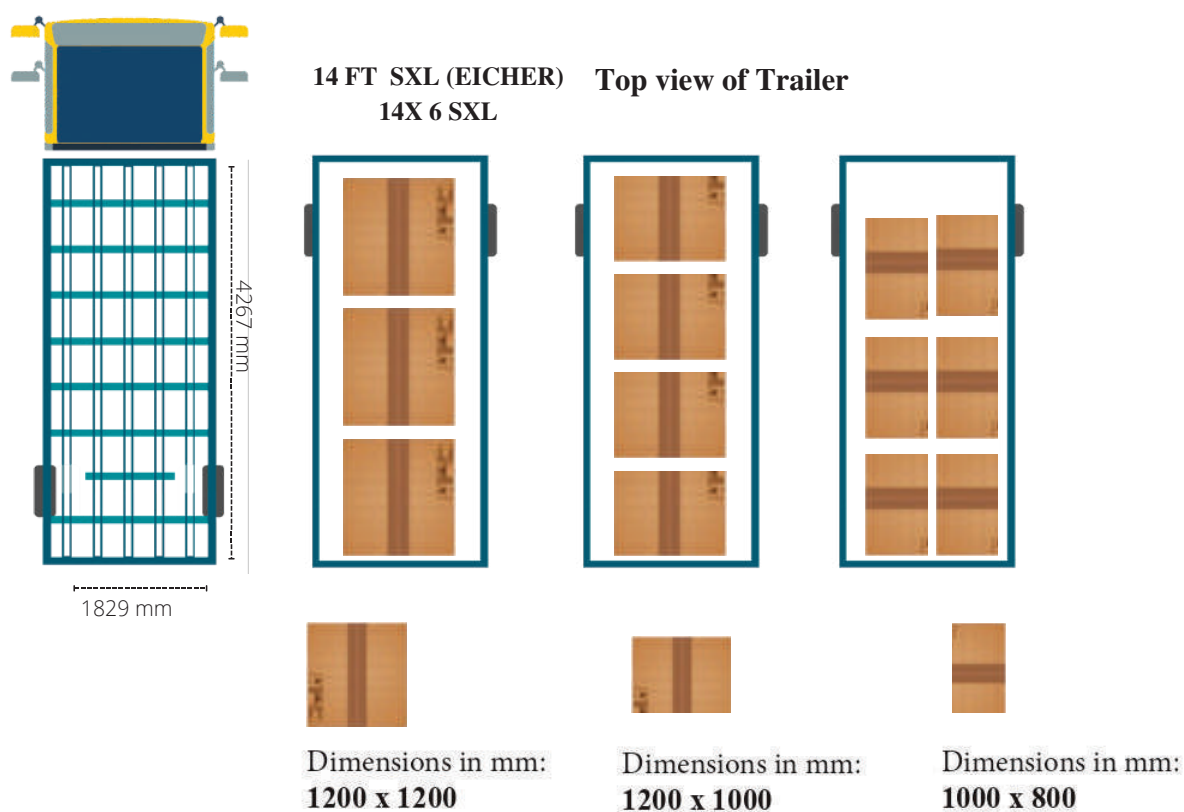
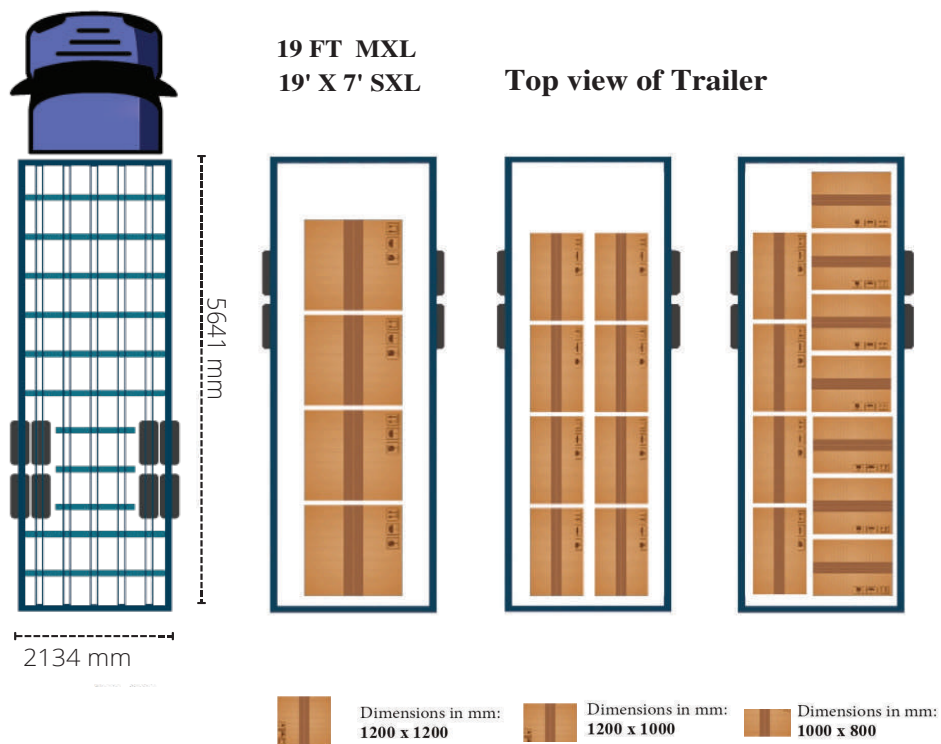
Sr. No.	Document No.	Standard / Guidelines
1	IS 10517	Acceptance Criteria for Forklift Trucks
2	IS 11757	General requirements and acceptance criteria for forklift trucks with capacity from 10000 kg to 50000 kg
3	IS 4660	Powered Industrial Trucks - Terminology
4	IS 8005	Classification of unit loads
5	IS 6765	Powered industrial trucks parameters for designation of rated capacity and capacity
6	ISO 13564-1	Powered industrial trucks - test methods for verification of visibility
7	IS 6305-1	Safety code for powered industrial trucks - Part 1 - Application, Operation and Maintenance
8	IS 6305 2	Safety Code for powered industrial trucks - Part 2
9	IS 7862	Glossary of terms relating to safety aspects concerning operating areas of industrial trucks
10	IS 7496	Direction of Travel-controls for Industrial Tractors and Powered Industrial Trucks
11	SAEJ 898	Control locations for off-road work machines
12	IS 7553	Control symbols for powered industrial trucks
13	IS/ISO 6405-1, 2	Common and specific symbols for operator controls and other displays
14	IS/ISO 9244	Compliance of machine safety labels
15	IS 15488	Powered Industrial Trucks - Safety Signs and Hazard Pictorials - General Principles
16	IS 8790-2	General requirements of powered industrial trucks working in hazardous areas, Part 2 Electric battery powered industrial trucks
17	IS 6876	Fork - Lift trucks - Fork arms - Technical characteristics and testing (Second Revision)
18	IS 7621	High lift rider trucks - overhead guards - Specification and testing
19	IS 4357	Industrial trucks - Counter balanced trucks with mast - Verification of stability
20	IS 7309	Industrial trucks - Verification of stability reach and straddle trucks
21	IS 7631	Industrial trucks - Pallet stackers, double stackers and order - Picking trucks with operator position elevating up to and including 1200 mm lift height - Verification of stability
22	IS 9075	Stability tests for side loader trucks
23	IS 14770	Industrial trucks - repairs and maintenance of fork arms in service on forklift trucks
24	IS 7570	Glossary of terms relating to fork arms and attachments of forklift trucks
25	IS 7525	Fork - Lift trucks - Hook - On type fork arms and fork arm carriages - Mounting dimensions
26	ISO 2328	Hook on type Fork Arms and Carriage
27	IS 15634	Forks-arm extensions and telescopic fork-arm - Technical characteristics and strength requirements
28	ISO 1585	Road vehicles - Engine test code - Net power
29	ISO 9249	Earthmoving machinery - Engine test code - Net power
30	ISO 8178	Exhaust emission measurement for non-road engine applications
31	DIN 72551-6	Low tension cables for off-road vehicles
32	DIN 72551	Compliance for electrical wiring
33	IS 15487	Industrial Trucks - Indicator Lights for container handling and Grapppler Arm operations
34	ISO 6055	Specification and testing standards for overhead guards
35	ISO 13849	Safety of machinery - safety related parts of control systems

Sr. No.	Document No.	Standard / Guidelines
36	ISO 20898	Electrical requirements of industrial trucks
37	ISO 3691-3	Additional requirement of trucks with elevated operator position and specifically designed to travel with elevated loads
38	IS 10311	General requirements of powered platform trucks and their acceptance criteria
39	IS 8049	Specification for platform trucks
40	IS 10312	Safety code for powered tow trucks
41	IS 6839-2	Glossary of terms relating to non-powered materials handling equipment, Part 2 Hand trucks and trolleys
42	IS 11496	General and performance test requirements of pallet truck and stillage truck
43	IS 10517	Acceptance criteria for forklift trucks
44	IS 10312	Safety code for powered tow trucks
45	IS 11757	General requirements and acceptance criteria for forklift trucks with capacity from 10000 kg to 50000 kg
46	IS 12726	Industrial trucks - Order - Picking trucks with operator position elevating above 1200 mm - Verification of stability
47	IS 14770	Industrial Trucks- Inspection and Repair of Fork-arms in Service on Forklift trucks
48	IS 15487	Industrial Trucks- Indicator Lights for container handling and Grappler Arm operations
49	IS 15488	Powered Industrial Trucks- Safety Signs and Hazard Pictorials - General Principles
50	IS 15611-1	Single side loading Forklift trucks, Part 1: Stability tests
51	IS 15611-2	Single side loading Forklift trucks, Part 2: Additional Stability tests for trucks handling freight containers of 6m length and above
52	IS 15634	Forklift Trucks- Fork arm extensions and telescopic fork arm- Technical characteristics and strength requirements
53	IS 15640	BI-Directional Multi directional forklift trucks- Stability tests
54	IS 4357	Industrial trucks - Counter balanced trucks with mast - Verification of stability
55	IS 6876	Fork - Lift trucks - Fork arms - Technical characteristics and testing
56	IS 7309	Industrial trucks - Verification of stability reach and straddle
57	IS 7525	Fork - Lift trucks - Hook - On type fork arms and fork arm carriages - Mounting dimensions
58	IS 7570	Glossary of terms relating to fork arms and attachments of forklift trucks
59	IS 8790-1	General requirements of powered industrial trucks working in hazardous areas: Part 1 internal combustion engine powered trucks
60	IS 8790-2	General requirements of powered industrial trucks working in hazardous areas, Part 2 Electric battery powered industrial trucks

Annexure 06

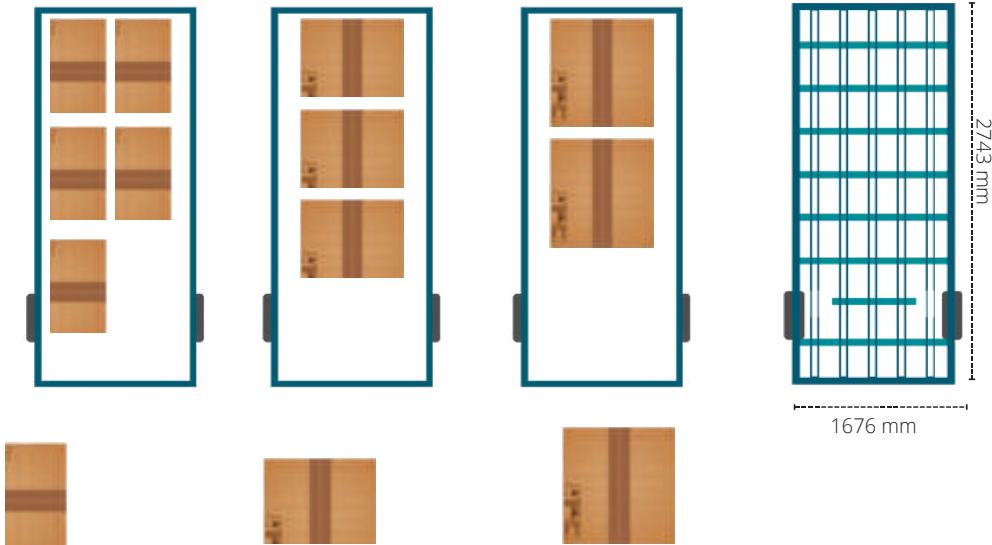
Standards for arrangement patterns of pallets of in various vehicles





Top view of Trailer

**9 FT SXL
(BOLERO PICKUP)
9 X 5.5 SXL**



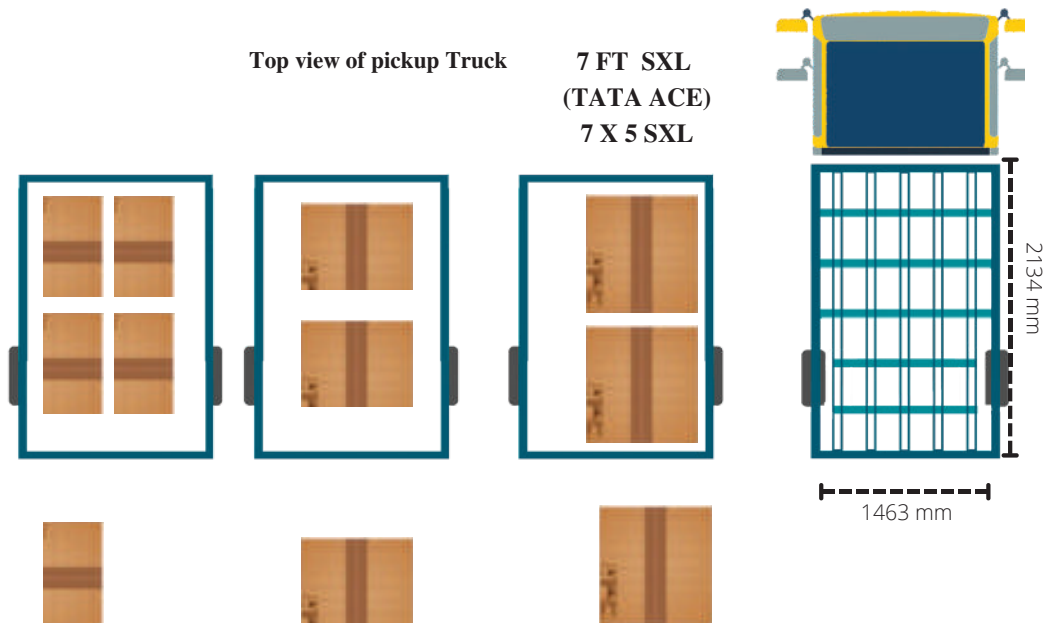
Dimensions in mm:
1000 x 800

Dimensions in mm:
1200 x 1000

Dimensions in mm:
1200 x 1200

Top view of pickup Truck

**7 FT SXL
(TATA ACE)
7 X 5 SXL**



Dimensions in mm:
1000 x 800

Dimensions in mm:
1200 x 1000

Dimensions in mm:
1200 x 1200

CONTRIBUTORS AND SPONSORS



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Freight Systems (India) Pvt. Ltd.



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Panache Green Tech Solutions Pvt Ltd.



Society of Manufacturers of Industrial Storage Systems.



Welspun One Logistics Parks Private Limited



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