

Pallet

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A **pallet** (pronounced /ˈpælɪt/) (sometimes called a **skid**) is a flat transport structure that supports goods in a stable fashion while being lifted by a forklift, pallet jack, front loader or other jacking device. A pallet is the structural foundation of a unit load which allows handling and storage efficiencies. Goods or shipping containers are often placed on a pallet secured with strapping, stretch wrap or shrink wrap and shipped.

While most pallets are wooden, pallets also are made of plastic, metal, and paper. Each material has advantages and disadvantages relative to the others. (See the sections "Phytosanitary compliance" and "Materials used" below.)

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The classic wooden pallet



A plastic pallet with nine legs, which can be lifted from all four sides



A metal pallet with removable beams. These are often used by tree nurseries (to stack trees)



Automated palletizing of bread with industrial KUKA robots at a bakery in Germany

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48" x 40" galvanized steel pallet. Galvanized steel pallets are fire proof and rust resistant

Overview

Containerization for transport has spurred the use of pallets because the shipping containers have the clean, level surfaces needed for easy pallet movement. Most pallets can easily carry a load of 1,000 kg (about 2,000 lb). Today, over half a billion pallets are made each year and about two billion pallets are in use across the United States alone.

Pallets makes it easier to move heavy stacks. Loads with pallets under them can be hauled by forklift trucks of different sizes, or even by hand-pumped and hand-drawn pallet jacks. Movement is easy on a wide, strong, flat floor: concrete is excellent. A forklift truck can cost the same as a luxury automobile, but a good reconditioned hand-drawn pallet jack costs only a few hundred dollars. The greatest investment is thus in the construction of commercial or industrial buildings where the use of pallets could be economical. Passage through doors and buildings must be possible. To help this issue, some later pallet standards (the europallet and the U.S. Military 35×45.5") are designed to pass through standard doorways.

Organizations using standard pallets for loading and unloading can have much lower costs for handling and storage, with faster material movement than businesses that do not. The exceptions are establishments that move small items such as jewelry or large items such as cars. But even they can be improved. For instance, the distributors of costume jewelry normally use pallets in their warehouses and car manufacturers use pallets to move components and spare parts.

The lack of a single international standard for pallets causes substantial continuing expense in international trade. A single standard is difficult because of the wide variety of needs a standard pallet would have to satisfy: passing doorways, fitting in standard containers, and bringing low labor costs. For example, organizations already handling large pallets often see no reason to pay the higher handling cost of using smaller pallets that can fit through doors.

History

Development of commercial transport packaging

Skids and pallets were slowly introduced throughout the early 20th century; wooden boxes, crates, barrels and kegs were much more commonly used to unitize, protect, store and transport goods. The predecessor of the modern wooden pallet was a simple skid that consisted only of stringers fastened to a top deck. It first appeared in American factories in conjunction with the low lift truck. A crude low lift hand truck was invented in 1887 and a more durable, all-steel low lift truck design was introduced in 1909.



The high lift fork truck first appeared in 1915. With further modification in 1919, the truck could lift loads several feet high while other improvements included cantilever design and forks. The emergence of forks as well during the same period enabled lift trucks to handle a much greater range of materials.

Pallets stacked for loading onto barges in North London

Another development was the new capability of the mast of the fork lift to tilt both forward and back, independent of the lifting mechanism. These developments, along with the emergence of the double-faced pallet during the same time period, allowed for tiering of unit loads. As early as 1926, the essence of the modern lift truck had been developed. Now, pallets no longer were simply a means of moving materials within the plant. High lift trucks made possible vertical stacking of unit loads and a resulting dramatic improvement of warehouse and plant storage efficiencies.

Pallet Flow Rack

With Pallet Flow Rack, the pick face is always occupied since gravity rollers or tracks allow products on pallets to flow to the front of the pick face. With the lanes slightly pitched and consisting of gravity rollers or tracks, the pallet moves forward until slowed or stopped by a retarding device, physical stop or another pallet in front of it. When an operator removes pallets at the pick face with a fork lift, the remaining pallets accumulate forward. Pallet Flow Rack is the only rack system that offers a First In, First Out (FIFO) method of inventory management in warehouses and distribution centers. This is beneficial when expirations are a consideration, as well as the risk of product obsolescence.^[1]

Pallet development

The pallet was developed in stages. Spacers were used between loads to allow fork entry, progressing to the placement of boards atop stringers to make skids. Eventually boards were fastened to the bottom to create the pallet. The addition of bottom boards on the skid, which appeared by 1925, resulted in the modern form of the pallet. With the bottom deck, several problems common to the single faced skid were addressed. For example, the bottom boards provided better weight distribution and reduced product damage; they also provided better stacking strength and rigidity. Lift truck manufacturers promoted the idea of using more vertical area of a plant for stock storage.

In size, skids started narrow in order to pass through ordinary doors. As facilities were rebuilt, many organizations optimized their buildings for larger pallets in order to reduce labor costs.

The earliest referenced U.S. patent on a skid is Howard T. Hallowell's 1924 "Lift Truck Platform."^[2] (For more on Hallowell's impact on industry, see Hex key.) In 1939, Carl Clark patented a recognizably modern pallet, although with steel stringers.^[3] In World War II, palletized material handling was rapidly perfected in order to transfer Allied war materials. The patent activity picked up again after the war, as inventors claimed items they improvised for the war effort. The first four direction pallet was claimed in 1945 by Robert Braun.^[4] At the end of 1948, Sullivan Stemple claimed the basic idea of a pallet designed to be used with a fork lift; the pallet was to be stamped from steel.^[5] During World War II, to reduce the resupply time of warships, the first modern disposable four-way block pallet was developed, and patented in early 1949 by Norman Cahners, a U.S. Navy Supply Officer in the ordnance depot at Hingham, Massachusetts.^{[6][7]} The first completely modern 2-direction stringer pallet was described in 1949 by Darling Graeme.^[8]

Effect on rail transport

Pallets and forklifts also provided much quicker turnaround of rail cars and ships. In 1931, it took three days to unload a boxcar containing 13,000 cases of unpalletized canned goods. When the same amount of goods was loaded into the railway trucks on pallets or skids, the task took only four hours.

With the entry of the U.S. into World War II, the urgency for material-handling reform changed almost overnight. Palletization was regarded as an enormous opportunity to help the U.S. armed forces do more with less. Palletized loads could handle more goods with fewer people, freeing up men for military duty; it also could increase warehouse storage capacity and throughput, reducing the need for additional warehouse capacity. Pallets were used somewhat in the European theater, and were put to work extensively in the Pacific.

Standardization and regulation

Dimensions

In a pallet measurement the first number is the stringer length and the second is the deckboard length. Square or nearly-square pallets help a load resist tipping.

Two-way pallets are designed to be lifted by the deckboards. In a warehouse the deckboard side faces the corridor. For optimal cubage in a warehouse, the deckboard dimension should be the shorter. This also helps the deckboards be more rigid.

Four-way pallets, or pallets for heavy loads, or general-purpose systems that might have heavy loads are best lifted by their more rigid stringers. A warehouse has the stringer side facing the corridor. For optimal cubage in a warehouse, the stringer dimension should be the shorter.

Pallet users want pallets to easily pass through buildings, stack and fit in racks, forklifts, pallet jacks and automated warehouses. To avoid shipping air, pallets should also pack tightly inside intermodal containers and vans.

No universally accepted standards for pallet dimensions exist. Companies and organizations utilize hundreds of different pallet sizes around the globe.^[9] While no single dimensional standard governs pallet production, a few different sizes are widely used.

ISO pallets

The International Organization for Standardization (ISO) sanctions six pallet dimensions, detailed in *ISO Standard 6780: Flat pallets for intercontinental materials handling—Principal dimensions and tolerances*:^[10]

Dimensions, mm (W × L)	Dimensions, in (W × L)	Wasted floor, ISO container	Region most used in
1219 × 1016	48.00 × 40.00	3.7%	North America
1000 × 1200	39.37 × 47.24	6.7%	Europe, Asia; similar to 48x40".
1165 × 1165	44.88 × 44.88	8.1%	Australia

1067 × 1067	42.00 × 42.00	11.5%	North America, Europe, Asia
1100 × 1100	43.30 × 43.30	14%	Asia
800 × 1200	31.50 × 47.24	15.2%	Europe; fits many doorways

North American pallets

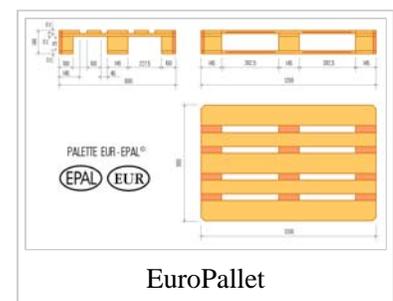
Of the top pallets used in North America, the most commonly used by far is the Grocery Manufacturers' Association (GMA) pallet, which accounts for 30% of all new wood pallets produced in the United States.^[11] The ISO also recognizes the GMA pallet footprint as one of its six standard sizes.

Dimensions, mm (W × L)	Dimensions, in (W × L)	Production Rank	Industries Using
1219 × 1016	48 × 40	1	Grocery, many others
1067 × 1067	42 × 42	2	Telecommunications, Paint
1219 × 1219	48 × 48	3	Drums
1016 × 1219	40 × 48	4	Military, ^[12] Cement
1219 × 1067	48 × 42	5	Chemical, Beverage
1016 × 1016	40 × 40	6	Dairy
1219 × 1143	48 × 45	7	Automotive
1118 × 1118	44 × 44	8	Drums, Chemical
914 × 914	36 × 36	9	Beverage
1219 × 914	48 × 36	10	Beverage, Shingles, Packaged Paper
889 × 1156	35 × 45.5	Unknown	Military 1/2 ISO container, fits 36" standard doors ^[13]
1219 × 508	48 × 20	Unknown	Retail

European pallets

In Europe, the EURO pallet, also called a CEN pallet, is widely used in many industries. It measures 800 by 1200 by 120 mm.^[14]

Manufacturers of EURO pallets must be sanctioned by the European Pallet Association (EPAL), which governs the smallest details, even which types of nails and lumber may be used. The strict standardization is based on the existence of europool pallet swap organizations - their mutual swap agreements across country boundaries does only include EURO pallets of a specific EPAL/EUR type (mostly restricted to type 1). Most freight forwarders will accept pool pallets handling the cost clearing between sender and receiver even for international transport to countries that take part in the europool system. The ongoing harmonization of freight handling within the European Economic Area has led to a decline of the europool system. The EURO pallet does not fit



efficiently within the ISO shipping container^[15] and slightly wider containers are often used for this reason.^[16]

The four common sizes of EURO pallets^[17] (alongside with ISO alternative sizes)^[18] are:

EURO pallet type	Dimensions, mm (W × L)	ISO pallet alternative
EUR, EUR 1	800 × 1200	ISO1, same size as EUR
EUR 2	1200 × 1000	ISO2
EUR 3	1000 × 1200	
EUR 6	800 × 600	ISO0, half the size of EUR
	600 × 400	quarter the size of EUR
	400 × 300	one-eighth the size of EUR

Australian Standard Pallets

Main article: Australia Standard Pallets

The Australian Standard Pallet is a pallet size commonly found in Australia but found rarely elsewhere. It is a square hardwood pallet 1165 mm by 1165 mm in size which fits perfectly in the RACE container of the Australian Railway, but is ill suited to fitting in the standard ISO containers used around the globe. However, with two Australian pallets side-by-side, there is still 22 mm "spare". If the pallets are loaded correctly (without any overhang), this means there is an average of 7 mm on between the container wall, the pallets and the opposite container wall. While this is a tight fit, it means there is less need for dunnage (stuffing) between the container walls and the pallets.

Australia also requires more stringent import standards than the globally accepted ISPM 15 wood packaging material regulations. Australia requires the wood packaging material used for international shipping to be completely bark free.^[19]

Standard-setting organizations

A number of different organizations and associations around the world work towards establishing and promulgating standards for pallets. Some strive to develop universal standards for pallet dimensions, types of material used in construction, performance standards, and testing procedures. Other organizations choose to focus on pallet standards for a specific industry (such as the groceries) or type of material (such as wood).

ISO Technical Committee 51: Pallets for unit load method of materials handling

ISO TC 51 states its scope of work entailing the "standardization of pallets in general use in the form of platforms or trays on which goods may be packed to form unit loads for handling by mechanical devices".^[20] The Technical Committee works in conjunction with other Technical Committees focused on transportation infrastructure to develop interrelated standards. TC 51 is responsible for developing *ISO Standard 6780: Flat pallets for intercontinental materials handling—Principal dimensions and tolerances* as well as sixteen other standards related to pallet construction and testing.

National Wood Pallet and Container Association

The National Wood Pallet and Container Association (NWPCA) is a trade organization based in the United States devoted to representing the interests of wood pallet and container manufacturers. The NWPCA defines its mission as helping its membership create cost-effective, environmentally-friendly solutions to customers' needs.^[21] Towards that end, the NWPCA developed a bevy of resources to assist its membership, including the Pallet Design System (PDS), which allows users to develop and analyze pallet designs.^[22]

U.S. DOD, Dept. of Navy, Naval Sea Systems Command

This organization maintains MIL-STD-1660, the standard description of palletized unit loads for the U.S. Military and some allies.^[23]

DOD Unit loads generally use 40x48" pallets, are less than 4000 lbs (1800 kg), weatherproof, and stack 16' (4.9m) high. They often use steel pallets, steel straps with notched seals, outdoor plywood, and plastic film. The standard describes tests for stacking, transport, sling, forklift and pallet jack, impact, drop tests, tip, water-retention, and disassembly.

European Committee for Standardization (Comité Européen de Normalisation)

In addition to the other standards it publishes, the European Committee for Standardization, also known as the Comité Européen de Normalisation (CEN), produces standards for pallets. While the standards are voluntary in nature, many companies and organizations involved in transportation have adopted them. The major standard for pallets produced by CEN is *ICS: 55.180.20 General purpose pallets*^[24]

Phytosanitary Compliance

Due to the International Plant Protection Convention (abbreviated IPPC), most pallets shipped across national borders must be made of materials that are incapable of being a carrier of invasive species of insects and plant diseases. The standards for these pallets is specified in ISPM 15.

Pallets made of raw, untreated wood are not compliant with ISPM 15. To be compliant the pallets (or other wood packaging material) must meet debarked standards,^[25] and must be treated by either of the following means under the supervision of an approved agency:

- **Heat treatment** The wood must be heated to achieve a minimum core temperature of 56°C for at least 30 minutes. Pallets treated via this method bear the initials **HT** near the IPPC logo.
- **Chemical fumigation** The wood must be fumigated with methyl bromide. Pallets treated via this method bear the initials **MB** near the IPPC logo.

Pallets made of non-wood materials such as steel, aluminum, plastic, or engineered wood products, such as plywood, oriented strand board, or cardboard do not need IPPC approval, and are considered to be exempt from ISPM 15 regulations.

Pallet construction

Types of pallets

Although pallets come in all manner of sizes and

configurations, all pallets fall into two very broad categories: "stringer" pallets and "block" pallets. The National Wooden Pallet & Container Association has developed a Pallet Design System PDS© to manufacture pallets. PDS© is a computer program that allows the pallet maker to generate the best suited pallet design for a specific load and generate several options for wood selections to further reduce costs. Cap3d is another program that does the same thing.

Stringer pallet

Stringer pallets use a frame of three parallel pieces of timber (called stringers). The top deckboards are then affixed to the stringers to create the pallet structure. Stringer pallets are also known as "two-way" pallets, since a pallet-jack may only lift it from two directions instead of four. Forklifts can lift a stringer pallet from all four directions, though lifting by the stringers is more secure.



Pallets being used in a warehouse in Finland.

Block pallet

Block pallets (also referred to as Manoj pallets) are typically stronger than stringer pallets. Block pallets utilize both parallel and perpendicular stringers to better facilitate efficient handling. A block pallet is also known as a "four-way" pallet, since a pallet-jack may be used from any side to move it.

Perimeter base pallet

All stringer and some block pallets have "unidirectional bases," i.e. bottom boards oriented in one direction. While automated handling equipment can be designed for this, often it can operate faster and more effectively if the bottom edges of a pallet have bottom boards oriented in both directions. For example, it may not need to turn a pallet to rack it, and operation is less sensitive to pallet orientation.

Quality improvements

The least expensive way to improve a pallet is usually to specify better nails. With non-wood pallets, a controlled coefficient of friction is often helpful to prevent the pallet from slipping from forks and racks. Stiffer pallets are more durable, and are handled more easily by automated equipment. If a pallet does not need to be lifted from all four sides, two-way pallets with unnotched stringers may be used, with the additional benefits of added rigidity and strength. Specifying tolerances on flatness and water content may help the supplier meet target requirements. Inspection of pallets, whether in person or by a third-party (such as "SPEQ" inspected pallets) offer additional assurance of quality.

Materials used

The cheapest pallets are made of softwood and are often considered expendable, to be discarded as trash along with other wrapping elements, at the end of the trip. These pallets are simple stringer pallets, and liftable from two sides.

Slightly more complex hardwood block pallets, plastic pallets and metal pallets can be lifted from all four sides. These costlier pallets usually require a deposit and are returned to the sender or resold as used. Many "four way" pallets are color coded according to the loads they can bear, and other attributes.

Wooden pallet construction specifications can depend on the pallet's intended use: general, FDA, storage, chemical, export; the expected load weight; type of wood desired: recycled, hard, soft, kiln Dried or combo (new & recycle); and even the type of fasteners desired to hold the pallet together: staples or nails.

Paper pallets are often used for light loads, but engineered paper pallets are increasingly used for loads that compare with wood. Paper pallets are also used where recycling and easy disposal is important.

Plastic pallets are often made of new HDPE or recycled PET (drink bottles). They are usually extremely durable, lasting for a hundred trips or more,^[26] and resist weathering, rot, chemicals and corrosion. They often stack. Plastic pallets are exempt by inspection for biosafety concerns, and easily sanitize for international shipping. HDPE is impervious to most acids and toxic chemicals clean from them more easily. Some plastic pallets can collapse from plastic creep if used to store heavy loads for long periods.

Plastic pallets cannot easily be repaired, and can be ten times as expensive as hardwood,^[27] so they are often used by logistics service providers who can profit from their durability and stackability. The large supply chains have increased the use of plastic pallets as many organisations seek to reduce costs through waste, transport and health & safety. Pallets and dolly combined for example the Pally^[28] eliminate pallet instability and the need for additional lifting equipment, but also create valuable space in busy operating environments and deliver significant time and cost savings by reducing supply chain handling.^[29]

Steel pallets are strong and are used for heavy loads, high-stacking loads, long term dry storage, and loads moved by abusive logistic systems. They are often used for military ammunition.^[30] Metal pallets make up less than 1% of the market. Materials include carbon steel, stainless steel, and aluminum. Of these, carbon steel offers excellent durability at the lowest cost. Stainless steel doesn't require a paint coating, and is preferred for such applications as clean room environments. Aluminum offers the durability of steel at a lighter weight. Carbon steel units are expensive compared to wood, and stainless and aluminum cost about 2-3 times that of carbon steel. Long term costs, however, can be lower than wood. General advantages of metal pallets are high strength and stiffness, excellent durability, bug free, no splinters, sanitary, and recyclable. Disadvantages include a higher initial price, significant weight, low friction, and susceptibility to rusting (carbon steel). Metal is primarily used in captive or closed loop environments where durability and product protection are key performance requirements. Metal units today are increasingly price competitive and lighter in weight. Primary industries that use metal pallets include automotive, pharmaceutical, lawn tractors, motorcycles, and tires.^[31]

Aluminum pallets are stronger than wood or plastic, lighter than steel, and resist weather, rotting, plastic creep and corrosion. They are sometimes used for air-freight, long-term outdoor or at-sea storage, or military transport.

Alternative uses

Old and discarded wooden pallets can be used in pallet crafts.

Discarded wooden pallets should not be used for fire wood or crafts unless it has been determined that the wood in these pallets has not been treated with wood preservatives, fungicides and/or pesticides.



Wooden pallet being dismantled.

Various pyrethrins and propiconazole are common treatments for wooden pallets. In addition, imported palletized goods are routinely fumigated with highly toxic pesticides such as ethylene oxide and methyl bromide. During use, harmful materials or chemicals also may spill on the pallet wood and be absorbed.

Beware of craft publications that advise readers to use pallets to build skateboarding obstacle called a manual pad, barricades during amateur paintball games, or other sport-related items. Other publications have suggested using pallet wood for small animal cages or fences. Pallet wood has been recycled for use as furniture wood by at least one company.



Stacked pallets.

Items made from pallet wood are likely to be durable and demonstrate good weather resistance due to these treatments. However, close contact with pallet wood or inhalation of dusts from sanding or sawing can be a source of exposure to pesticide and fungicide chemicals. It is likely that the January, 2010 recall of Johnson and Johnson Tylenol[™] and other drugs were due to their being stored on wooden pallets that had been treated with the fungicide/pesticide 2,4,6-tribomophenol. This chemical can be degraded by molds to produce 2,4,6-tribomoanisole whose strong, musty odor caused consumers to complain. Template:Chemical & Engineering News, January 25, 2010, p. 18 There is no acute or chronic health data on 2,4,6-tribomoanisole Template:Sigma Aldrich, MSDS, 2009, but it is believed that the contaminated drugs caused nausea and other health effects in some people.

Fire hazards

Idle pallet storage can burn intensely. Plastic pallets produce a fire far more severe than wood pallets.^[32]

See also

- 463L master pallet, a wood and aluminium air cargo pallet primarily used by the US Air Force.
- Bulk box
- Concrete block
- Crane (machine)
- Forklift truck
- ISPM 15, Regulation of wood packaging material in international trade
- International Plant Protection Convention Dictates ISPM 15 (above)
- Molded pulp pallet
- Packaging and labeling
- Pallet inverters
- Palletizer
- Slip sheet
- Stillage, a stackable pallet-like device with sides or a cage to contain the load.
- Stretch wrap
- ULD, lightweight aluminium and plastic pallet or container for aircraft.
- Unit Load

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