

Packaging code —

Section 4: Mechanical aids in package handling

Committees responsible for this British Standard

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- Association of Drum Manufacturers
- British Glass Manufacturers' Confederation
- British Paper and Board Industry Federation
- Department of Trade and Industry (Laboratory of the Government Chemist)
- Metal Packaging Manufacturers' Association
- Ministry of Defence
- PIRA
- Pressed Felt Manufacturers' Association
- Process Plant Association
- Timber Packaging and Pallet Confederation

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Publication(s) referred to	Inside back cover

Foreword

This Section of BS 1133 was prepared under the direction of the Packaging and Freight Containers Standards Policy Committee and supersedes BS 1133-4:1965, which is withdrawn.

BS 1133 was originally issued in December 1943, primarily to give guidance on the packaging of Service and other Government supplies. In practice, however, the standard was used not only by Government departments and contractors, but also by civilian packers and accordingly it was amended to suit commercial requirements and new Sections were added as necessary.

The packaging code now consists of the following Sections all of which are published separately with the exception of Section 1 to 3 which are published in one volume.

- *Section 1 to 3: Introduction to packaging;*
- *Section 4: Mechanical aids in package handling;*
- *Section 5: Protection against spoilage of packages and their contents by micro-organisms, insects, mites and rodents;*
- *Section 6: Protection of metal surfaces against corrosion during transport and storage;*
 - *Subsection 6.1: Cleaning and drying of metal surfaces;*
 - *Subsection 6.2: Temporary protectives and their application;*
- *Section 7: Paper and board wrappers, bags and containers;*
 - *Subsection 7.1: Wrapping papers;*
 - *Subsection 7.2: Bags and envelopes;*
 - *Subsection 7.3: Cartons and boxes;*
 - *Subsection 7.4: Fibreboard drums;*
 - *Subsection 7.5: Fibreboard cases and fitments;*
 - *Subsection 7.6: Moulded pulp packaging;*
 - *Subsection 7.7: Composite containers;*
- *Section 8: Wooden boxes, cases and crates;*
- *Section 10: Metal containers;*
 - *Subsection 10.1: Tins and cans;*
 - *Subsection 10.2: Metal drums;*
 - *Subsection 10.3: Metal collapsible tubes;*
- *Section 12: Methods of protection against shock (excluding cushioning devices);*
- *Section 13: Twines and cords for packaging;*
- *Section 14: Adhesive closing and sealing tapes;*
- *Section 15: Tensional strapping;*
- *Section 16: Adhesives for packaging;*
- *Section 18: Glass containers and closures;*
 - *Subsection 1: Terminology;*
- *Section 19: Use of desiccants in packaging;*
- *Section 21: Regenerated cellulose film, films made of plastics, aluminium foil flexible multilayer structures and metallized materials;*
- *Section 22: Packaging in plastics containers;*

Section 9 “*Textile bags, sacks and wrappings*”, Section 11 “*Packaging felt*”, Section 17 “*Wicker and veneer baskets*” and Section 20 “*Packaging for air freight excluding livestock*” were withdrawn as obsolete.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 81, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Section of BS 1133 describes the main types of handling and storage equipment involved in the movement and storage of packages in manufacturing and distribution; it also gives advice on selecting equipment and on using it to the best advantage. In addition, attention is drawn to the implications for package design of different methods of handling.

NOTE 1 Appendix A lists for information those British Standards which may be relevant.

NOTE 2 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Manual handling

2.1 Good manual handling practice

When goods are handled manually there always exists the risk of injury. Trauma injuries may result, for example, from handling sharp objects, dropping objects onto feet, by slipping or tripping, or by collision with fork lift trucks. Non-trauma injuries, which include back injuries, are receiving increasing consideration not only for their seriousness in terms of human suffering but also because of their disruptive effect in terms of absence due to sickness and the consequent cost.

The basic principle governing good materials handling practice is that which governs general occupational safety and health, i.e. "no employee shall be required to undertake work which damages his body or health". Manual handling incorporates a wide range of tasks and is influenced by many variables which can be categorized generally as task, environmental and human. Emphasis is now placed on task analysis and design, creating the right environment and on the selection and training of suitable operators for the work.

The recommended stages in establishing a system of manual handling are as follows:

a) *Carry out a task study.* This will identify critical factors in the nature of the materials handled which are likely to result in injury, e.g. the nature of the package contents, weight, horizontal handling distance (measured from mid-point of ankle to mid-point of hand grasp), vertical distance of lift, vertical travel distance, frequency of lift and task duration.

The tasks studied should include pushing, pulling and carrying tasks in addition to lifting.

b) *Analyse the data.* The objective is to identify those tasks which are acceptable as manual operations, those which are unacceptable and can be carried out only by specially selected and/or trained personnel or with handling aids, and those which can be handled only mechanically.

Upper and lower load limits are usually defined. Loads up to the action limit are usually acceptable. Above this limit and up to the maximum permissible limit it may be necessary to use handling aids, to recruit only specially selected workers or to give special training for the task. Above the maximum permissible limit handling aids have to be used.

c) *Design the task.* The objective is to design the task so that it can be within the capability of most workers. Various research reports and publications are available to assist in this task.

Generally, attention needs to be paid to ensuring that the task can be carried out safely and economically.

d) *Provide the appropriate environment and equipment.* This can be done in the following ways:

- 1) by providing handling aids where necessary;
- 2) by insisting on good housekeeping with unobstructed and clean floors to reduce tripping and slipping accidents;
- 3) by isolating truck operations from operators wherever possible and by limiting truck speeds in areas where there is accident risk.

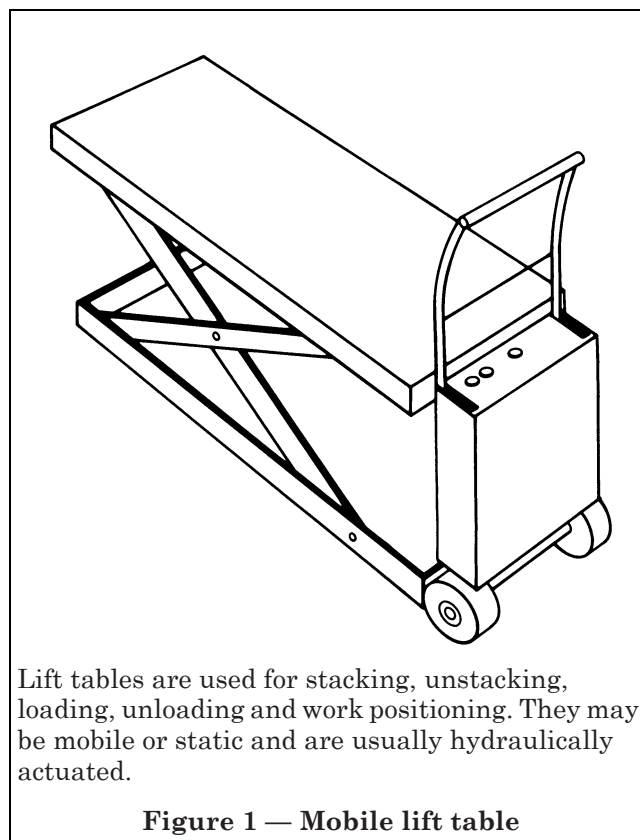
e) *Select and train the operator.* The purpose of selection procedures is to ensure that workers are suited to the work they are to carry out. Research studies suggest that pre-employment strength testing is more likely to identify those likely to suffer back or musculoskeletal injuries than medical screening. Although generally males are capable of handling a higher load level than females and the handicapped, this does not apply to individual workers and ability may reduce with age. An equal opportunities policy requires the justification of selection decisions. It also follows that a policy of task design which guarantees exclusivity to a male group would be unacceptable unless this arises from special manual handling skills based on experience of similar work.

Training for manual handling is important to demonstrate the need for correct lifting with the avoidance of unnecessary stress, to test the skills of manual handling, and to create awareness of the body's physical limits.

2.2 Packaging implications

The implications of the need for good manual handling practice on package design are as follows:

a) *Dimensions.* The further the distance between the centre of gravity of the package and the body, the potentially greater the back stress. Stress is particularly high when bending to pick up cases standing on a floor.



b) *Weight reduction.* Lowering the packed weight may bring the package into a range which will not require the use of materials handling equipment. It will, however, increase the lifting frequency.

c) *Design.* Provision should be made for good handling grasp locations including carrying handles where appropriate. Their relationship to the foot position when lifting should also be considered so as to reduce spinal stress. Sharp edges should be eliminated wherever possible.

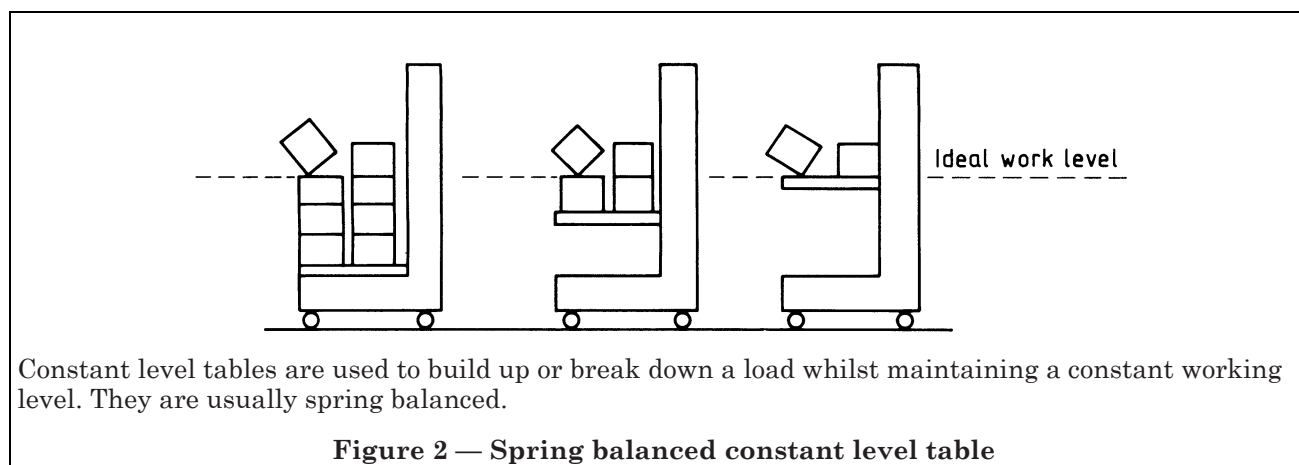
2.3 Manual handling aids

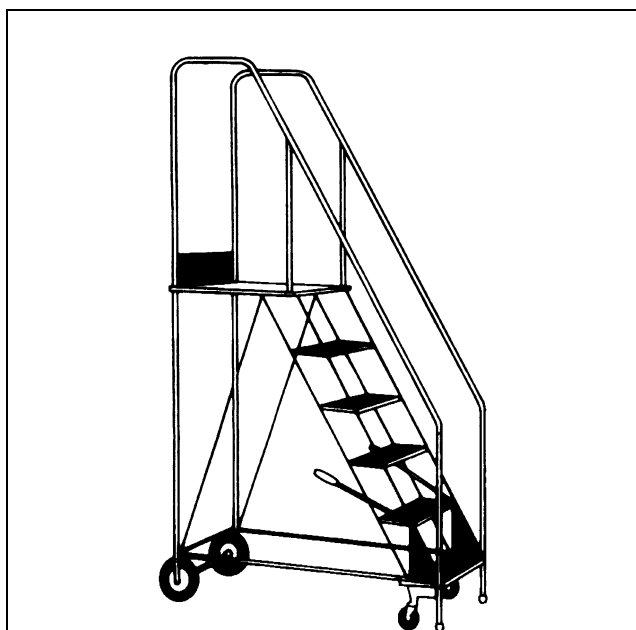
All of the movement techniques described in this standard reduce or improve manual handling. In this sense they are manual handling aids. Where manual handling cannot be reduced, typical manual handling equipment which may be provided is shown and described in Figure 1 to Figure 3.

2.4 Containers for manual handling

2.4.1 General

In general usage, the term container means anything in which material is held or carried. Containers subdivide into those which can be handled manually and those which are too large or too heavy for manual handling and can be moved only with some form of mechanical handling aid.





Mobile steps or platforms enable the operator to achieve safe access to upper locations and make better use of available space. The castor feet which permit movement may be spring loaded or activated by lever arms. A mobile powered platform may be used as an alternative.

Figure 3 — Mobile steps

As containers for manual handling, usually referred to as “tote boxes”, are meant to be handled manually, it is essential that their total weight complies with the guidelines for manually handled loads. In making this assessment their width will determine the location of the centre of gravity of the load in relation to the body and be a contributory factor in defining the maximum load. Attention should also be paid to the location of the arms in the lifting position. The handles, lips or slots used for lifting should be designed with due regard to ensuring an effective hand-hold and reducing the risk of accidents.

Since it is likely that a variety of container sizes will be required in most applications, standardization is important. This does not mean that each container needs to be identical but that their dimensions should be compatible. It is often necessary to stack containers on a pallet for storage purposes or for transport. As a consequence, a standardization policy is usually based on dimensions which are modular in relation to the pallet or unit load.

Containers may be subdivided internally to segregate different items within the one container.

They can also be designed with special component inserts which separate individual parts and prevent damage. Security can be achieved by using lids and sealing by banding with tape. Container identification can be achieved in a number of ways, either permanently by marking using identification plates or ticket holders which are an integral part of the container, or by adhesive labels.

Generally used materials are plastics, steel, wire mesh, plywood, hardboard and fibreboard.

Plastics containers can be obtained in a range of sizes to hold up to 50 kg per container. They are light in weight, which remains stable, can be differentiated by permanent identifiable colours and are generally resistant to chemical damage except from some specific chemicals. If moved by conveyor they may build up static electricity which attracts dust but this can be prevented by the choice of an appropriate plastics material.

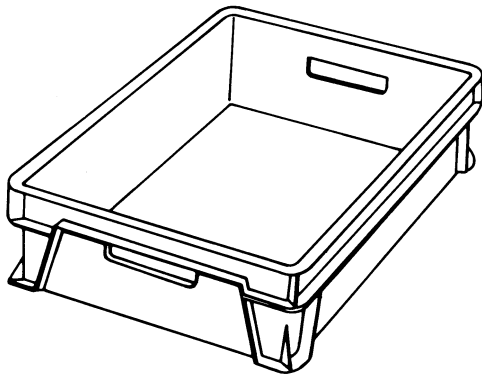
Steel containers are heavier and more durable and are widely used as tote boxes for interprocess movement and for the storage of parts in engineering component manufacture. Open-wire mesh is generally used for larger loose or boxed items and allows drainage for greasy or wet components and may be used within the process, e.g. washing of components may take place without removal from their container. Plywood is lightweight in comparison with steel and special sizes can be produced at low cost compared with plastics where the first-off cost may be high if an existing tool cannot be modified. The smooth floor base is suitable for use on conveyors. Plywood may be subject to attack by vermin and consequently may be unsuitable where hygiene is important.

Paperboard is widely used in a range of sizes up to approximately 450 mm × 300 mm, usually for loads under 11 kg. These containers are usually supplied in “knock-down” form and erected without the need for glue or fastenings. Others may be erected and stapled or glued on site. They have limited stackability which may be reduced under wet conditions. They are very light in weight, low in cost and take up minimum space when empty.

With all containers, apart from metal, there is a possible fire risk.

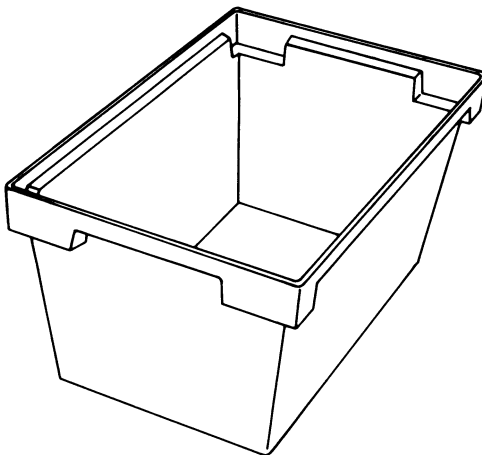
2.4.2 Typical examples of containers for manual handling

Typical containers for manual handling are shown and described in Figure 4 to Figure 7.



Stacking-only containers have relatively vertical sides which maximize the containable volume but do not allow for “nesting” to improve space utilization in transport or in store when empty. As the name implies they can be stacked on top of each other and may be modular.

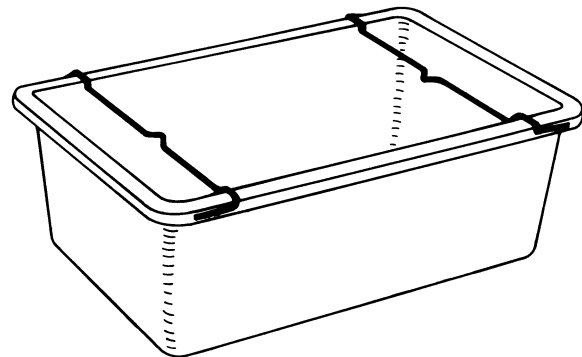
Figure 4 — Stacking-only container



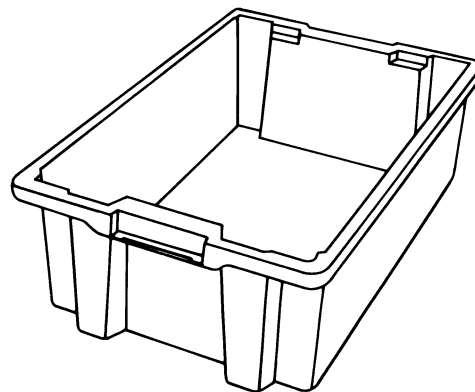
Nesting-only containers have tapered sides and can be stacked only if fitted with lids.

A nesting ratio is used to define the degree of nesting as a measure of conserved space. For example a nesting ratio of 3 : 1 means that each additional container adds up to one-third of the height of a container to the stack.

Figure 5 — Nesting-only container



(a) With bars

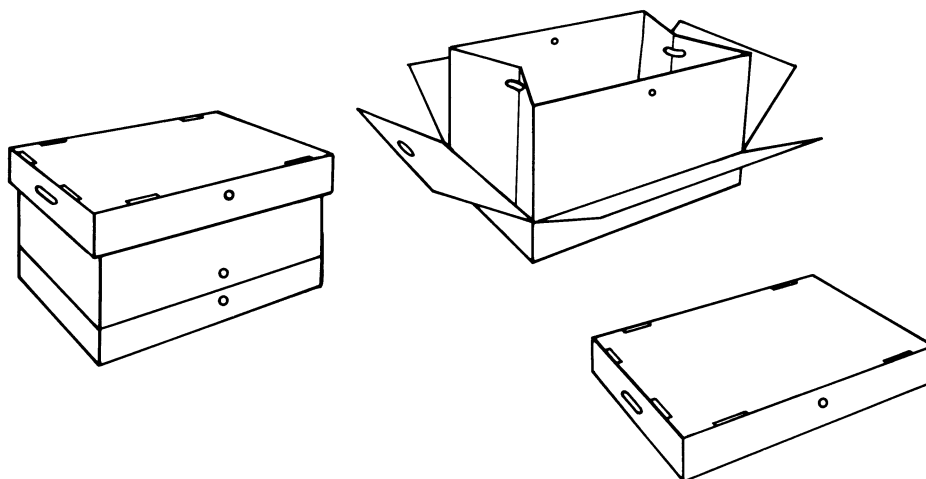


(b) Grooved

Two basic types of stack or nest containers are shown. The first type uses a pair of metal bars which can be moved into position to support the upper container.

The second type is so designed that in one position it nests with the container below but, when turned through 180° it stacks because of the physical engagement achieved by grooving or indentation.

Figure 6 — Stack or nest containers



Collapsible containers can be made from a number of materials. The most popular type is that made from die-cut corrugated fibreboard.

Figure 7 — Collapsible container

3 Unit loads

3.1 General

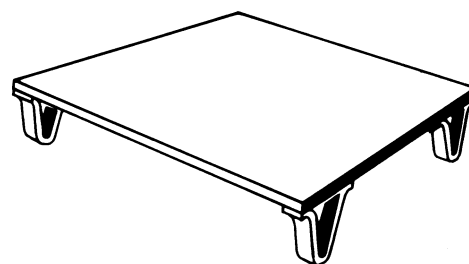
A unit load is any load which can be handled as a single object and retain its shape and form for subsequent movement. It is a principle of good materials handling practice that materials should be moved in the largest economic units having regard to safety, usually using mechanical means. Unitizing involves the assembly of items or packages and containing, stabilizing or securing them in such a manner that the entire assembly can be handled as a single unit.

3.2 Unit load equipment

3.2.1 Unitized loads

A unitized load is usually but not necessarily (see Figure 20) based on a stillage (see Figure 8) or a pallet.

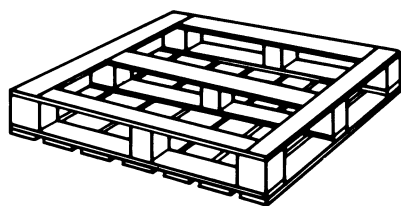
Pallets are platforms of minimum height designed for use by the insertion of forks. They may be designed to be reversible, i.e. with both upper and lower decks being usable as platforms, or non-reversible. They may also be designed so as to permit fork entry from only two sides or from all four sides.



A stillage consists of a platform supported by two side runners at a level which allows the entry of a platform lift or stillage truck. Since they are not normally handled by a fork lift truck they are not usually stacked.

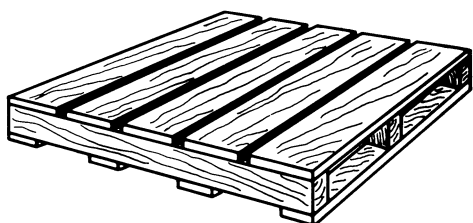
Figure 8 — Stillage

A variety of materials may be used. Wood is the most common material, providing an economic reusable pallet which is easily repaired. Plywood may be used to provide a close-boarded platform. Lighter timber sections or fibreboard may be used for expendable pallets. Plastics pallets are expensive but have specific uses where hygiene or the general avoidance of contamination by any micro-organisms is important. They can be steam cleaned and also have a stable weight since, unlike timber, they do not absorb moisture. Metal pallets are also expensive but are strong and durable and used for heavy-duty applications in engineering. They have the advantages of having constant tare weight and being oil resistant. Because of their cost, both plastics and metal pallets are best used in "captive" pallet systems, i.e. where their movement is completely controlled and recovery is guaranteed. Typical pallets and other items related to unitized loads are shown and described in Figure 9 to Figure 19.



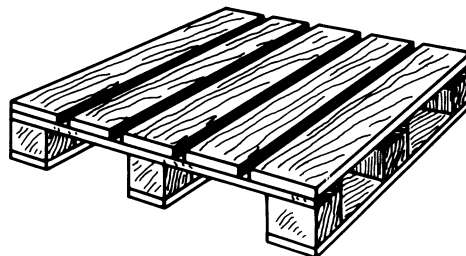
The non-reversible, four-way entry, perimeter base pallet is the most common type in use in the UK. It offers a balance between cost, the advantages of four-way entry and strength.

Figure 9 — Non-reversible, four-way entry, perimeter base pallet (shown inverted)



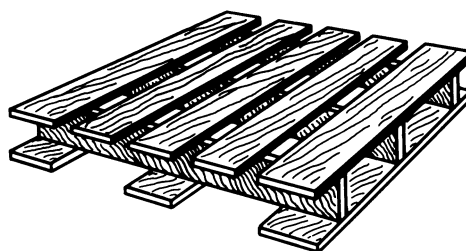
The non-reversible, two-way entry pallet is stronger than the four-way entry, perimeter base pallet; its cost is similar but it has the disadvantage of only two-way entry.

Figure 10 — Non-reversible, two-way entry pallet



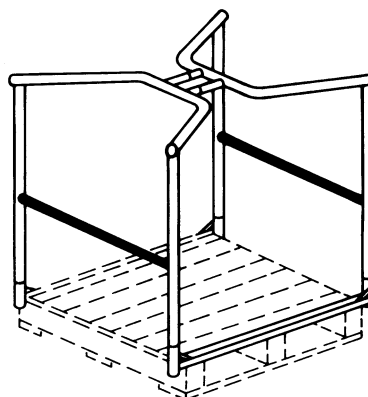
The non-reversible, four-way entry pallet is not as strong as that with a perimeter base or the two-way entry pallet but it has advantages when handled by equipment using slide-through forks.

Figure 11 — Non-reversible, four-way entry pallet



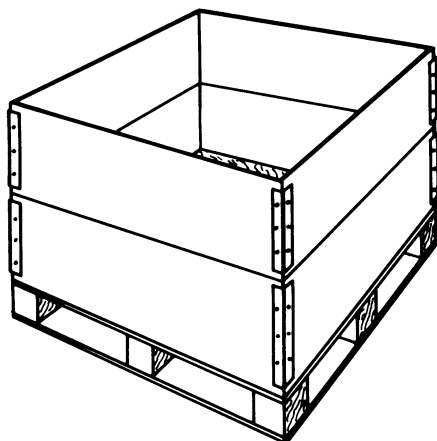
The wing pallet can be handled by cranes with bar slings as well as by fork lift trucks.

Figure 12 — Wing pallet



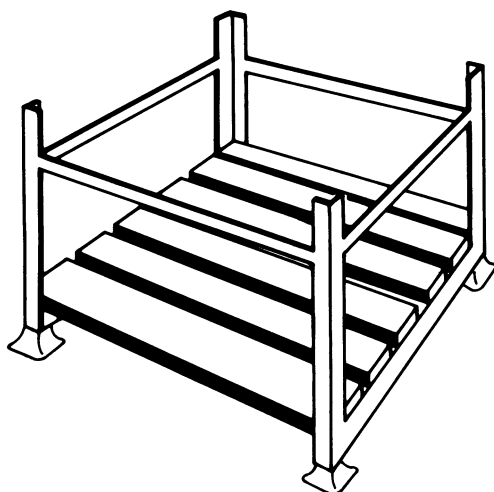
These fit over a conventional pallet to provide a superstructure suitable for block stacking to avoid excessive loading on the items on the lower pallets in a stack.

Figure 13 — Pallet converter



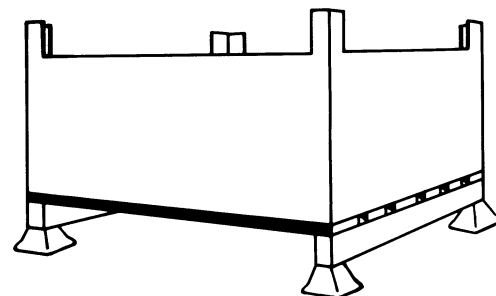
These “add-on” devices convert standard wooden pallets into box pallets. They may be hinged and thus be collapsed for the empty return journey or in store awaiting use.

Figure 14 — Pallet collar

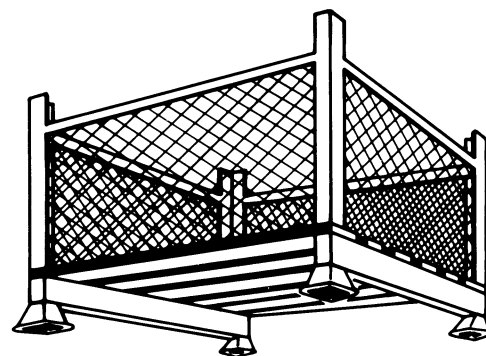


(a) Post pallet

Figure 15 — Post, box and cage pallets



(b) Box pallet

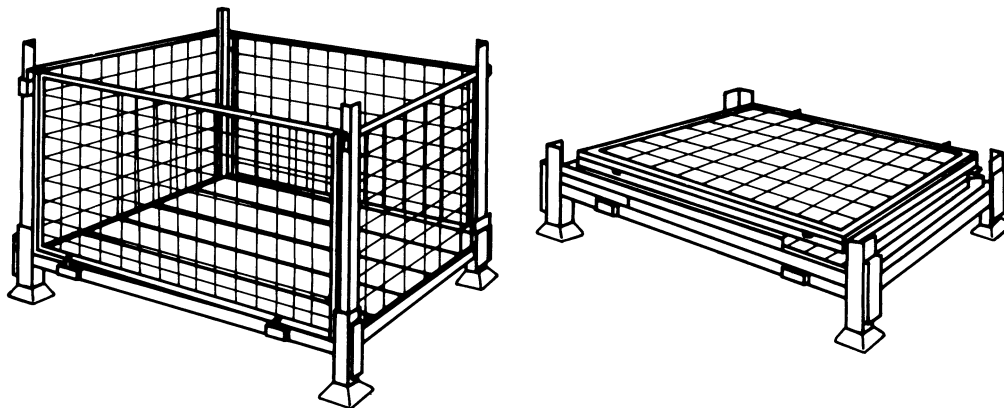


(c) Cage pallet.

Post pallets have posts to take the weight of superimposed pallets. Box pallets contain the load with sides which may be solid, slatted or of wire mesh (when they are usually described as cage pallets). They also permit stacking without damage to contents and may be fitted with a lid.

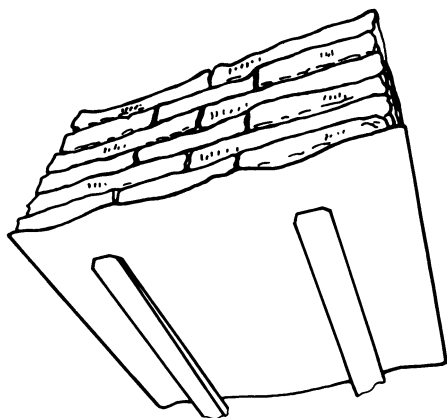
Special post pallets may be used for moving and storing materials in long lengths. Post pallets for this purpose are available in standard sizes from 1.8 m to 4.6 m long and 0.3 m to 1.2 m wide.

Figure 15 — Post, box and cage pallets
(concluded)



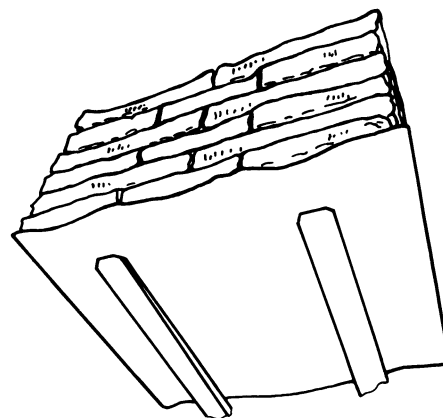
There are a number of types of collapsible box and cage pallets designed to save space when empty in store or on return transport. Typical containers will collapse to 20 % to 30 % of the full pallet height.

Figure 16 — Collapsible cage pallet



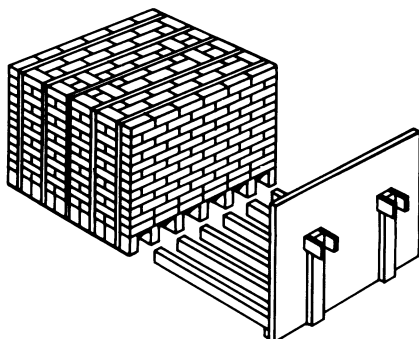
A “take it or leave it” facility may be incorporated. The whole pallet may be removed or the pallet may remain in place while the stock is removed. The stock rests on raised transverse sections which permit the entry of lift truck forks.

Figure 17 — “Take it or leave it” pallet



The slip sheet can be used to replace a pallet in certain applications more particularly when space needs to be utilized more effectively in long route container traffic. It can be made from a variety of materials and is used in conjunction with a special lift truck “push-pull” attachment (see also Figure 78).

Figure 18 — Slip sheet in use



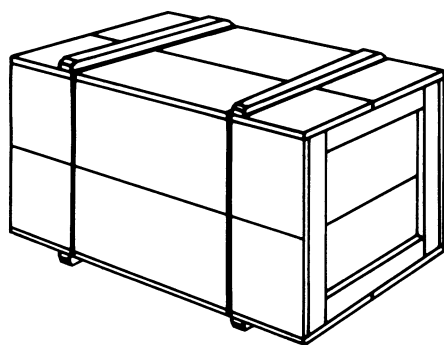
Special pallets may be designed as racks with spacers, shelves or posts to hold items so that they do not move and retain their orientation during movement. They may be provided with wheels for mobility in subsequent use.

Unit loads may be assembled without pallets or slip sheets by using special fork truck attachments such as clamps (for handling cartons and cases) or special forks, e.g. for handling bricks, as shown.

Figure 19 — Special purpose unit load

3.2.2 Single item unit loads

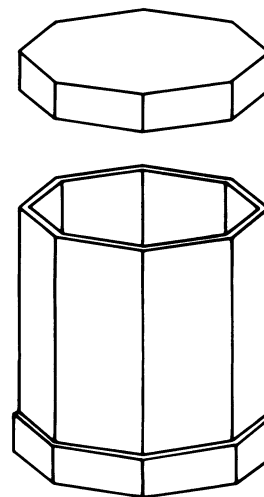
The main types of single unit load are shown and described in Figure 20 and Figure 21.



A considerable amount of goods is shipped in packing cases or crates. These should be fitted with battens to permit fork access (see BS 1133-8).

Corrugated fibreboard pallet boxes are also available in a knock-down state in order to minimize storage requirements for packing materials.

Figure 20 — Typical packing case shipment

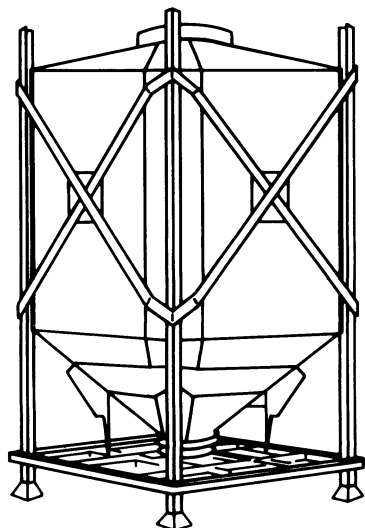


(a) Fibreboard IBC



(b) Flexible IBC fitted with slings

Figure 21 — Intermediate bulk containers (IBCs)



(c) Rigid IBC with plastic body

IBCs are specially designed for handling powders and granular materials, pastes and liquids. There are three basic types.

Specially designed fibreboard containers are designed to fit on pallets [see (a)] and some may be provided with bottom discharge features. Others may be telescopic, the container being loaded from above and compressed and strapped to reduce volume during shipment. Such fibreboard IBCs are intended for use instead of conventional packaging and may not be reusable.

The flexible intermediate bulk container, typically of woven polyolefin fabric, may be fitted with slings [see (b)] or with a lifting collar for handling by overhead crane or by lift truck.

More expensive and more suitable for use in closed distribution applications in which their return can be guaranteed are rigid metal or plastics hoppers in a post pallet framework [see (c)].

Figure 21 — Intermediate bulk containers (IBCs) (concluded)

3.3 Unit load stabilization

3.3.1 General

If the components of a unit load can move relative to each other during transit they may be difficult to unload from containers or closed vehicles and they may also have to be restacked manually on the pallet before they can be placed into the warehouse. Square packages are particularly likely to need some form of stabilization. To create a stable unit load with rectangular packages, the interlock or overlap between successive layers is recommended to be 30 % for cases weighing less than 4.5 kg, 20 % to 25 % for those of 4.5 kg to 18 kg and 15 % for those over 18 kg. In building up a pattern, any gaps between cases should be aligned parallel to the short dimension of the pallet. The friction characteristics of packing materials differ, antislip finishes are available from the manufacturers or antislip treatments can be applied during the packaging or palletizing process. Automated systems check unit loads for dimensional compatibility before accepting them into the system. Load stabilization is important and can be achieved in a number of ways.

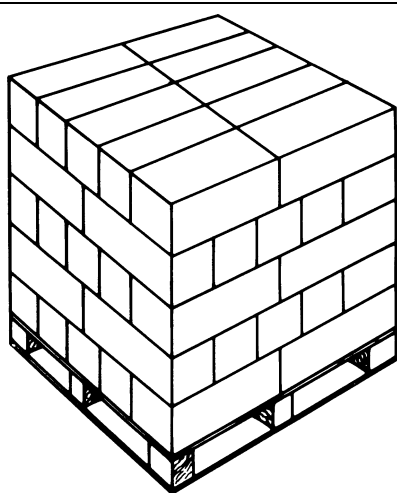
3.3.2 Stabilization techniques

3.3.2.1 General

Stabilization techniques involve either effecting a bonding between the individual units in a load or using external means such as tying, banding or strapping, or shrink/stretchwrapping to secure a stable load.

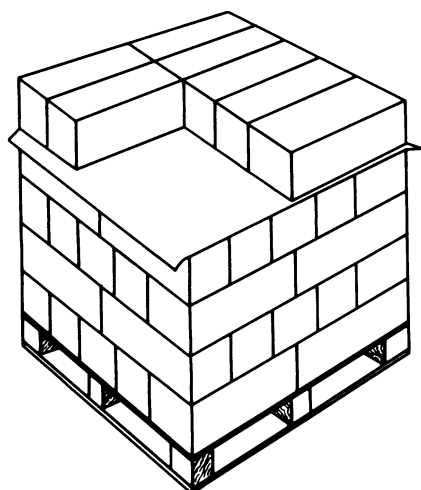
3.3.2.2 Bonding

Bonding of the individual units may be achieved by layer bonding (see Figure 22), by sheet interleaving (see Figure 23) or by adhesive bonding.



Cases are interlocked using different patterns for alternating layers. The extent of achievable interlock depends on the case dimensions. The use of square cases is undesirable since no interlocking can be achieved. Pallet patterns are specific to a case size.

Figure 22 — Layer bonding



A paperboard sheet can be inserted underneath the top layer or other layers if necessary.

Figure 23 — Sheet interleaving

Adhesive bonding is applied between layers to prevent sliding. The adhesive needs to have good shear strength but low peel strength so that items can be separated without tearing packing materials. Adhesive bonding can be useful where fine powder is present which leads to slipping. Adhesive can be brush, spray, or roll applied or, in auto-palletizers, be applied by fine jets.

3.3.2.3 Tying, banding or strapping

String, plastics, steel or film wrapping can be used as banding material. The top cases are the most susceptible to sliding and it may be sufficient to band these.

Vertical banding (see Figure 24) is often used on pallets requiring higher levels of stabilization. Where banding can cause product damage, protectors can be used. These may cover the whole of the top of the pallet or may be just corner protectors. Tensioning the bands should maintain a balance between stabilization requirements and the risk of product damage.

Tensional steel strapping (see Figure 25) is used for bundling wood, tubes, metal ingots, securing timber crates and cases, and other products which are "incompressible". It may also be used for products such as bales which are strapped under compression and expand to fit the straps when released.

Steel strapping will loosen if used on unit loads of bags, sacks and cartons, etc. which are compressible. In these conditions, non-metallic strapping is used (see Figure 26). Nylon and polypropylene possess the greatest tensile strength of non-metallic strapping materials and have elastic properties which enable them to recover by 10 % lengthwise. Strapped under tension, they will shrink with a unit load which has contracted due to overstacking, or in which the contents have settled.

Non-metallic strapping materials weigh less than tensional steel strapping and, because they are chemically inert, do not stain the unit load.

BS 1133-15 includes detailed information on tensional strapping materials, the range of sizes and the tensional strengths available.

Potential users are recommended to consult BS 1133-15 and strapping suppliers for details of the types of tools and machines available.

Belts, straps or bands which are elasticated and fitted manually are usually used in conjunction with overwrapping (see Figure 27), as an additional form of load restraint. Belts are not usually used on their own as, being relatively easily removed, they are not an adequate safeguard against pilferage.

Heavier bands and straps are produced from reinforced rubberized webbing. They are available as continuous rivetted bands, as strap bands with steel hooks fitted at each end, with or without a buckle, and as clasp and hook bands (see Figure 28).

For export shipments, polyester and polyamide straps are recommended. These can be fitted with a variety of buckles, clips, rings or hooks.

The top layer can be tied horizontally by string or restrained by a large reusable rubber band (see Figure 29). This prevents the loose layer from falling and restrains cartons in the lower layers.

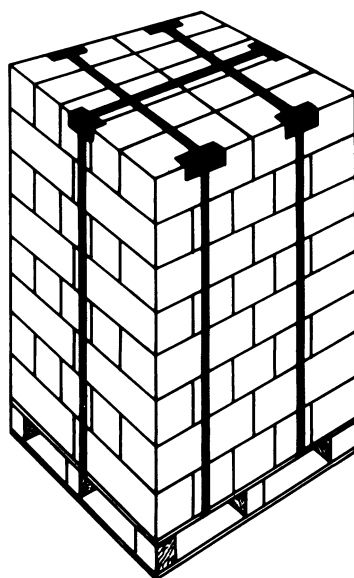


Figure 24 — Vertical banding

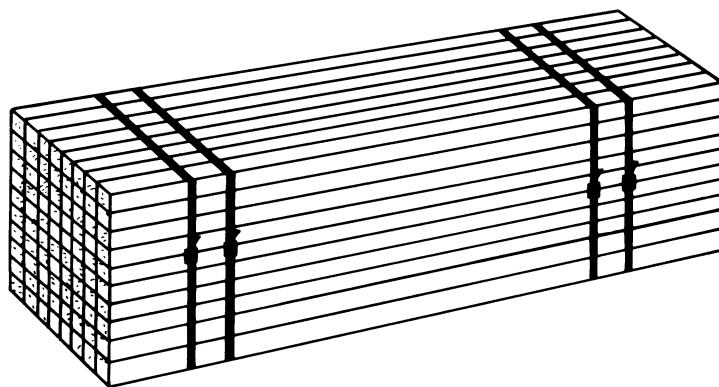


Figure 25 — Strapped bundle, tensional steel strapping

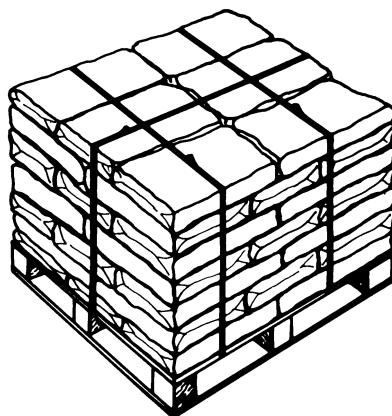


Figure 26 — Sacks strapped with non-metallic strapping

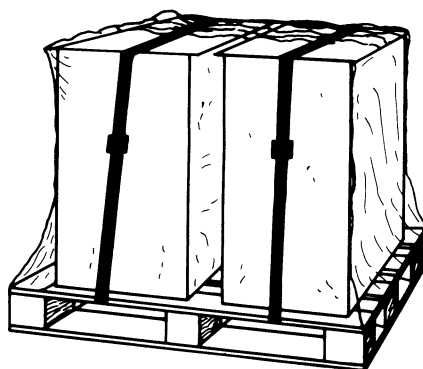


Figure 27 — Strapping with overwrapping

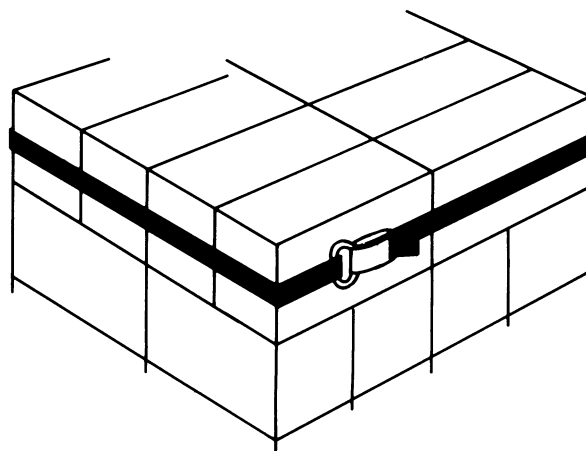


Figure 28 — Clasp and hook bands

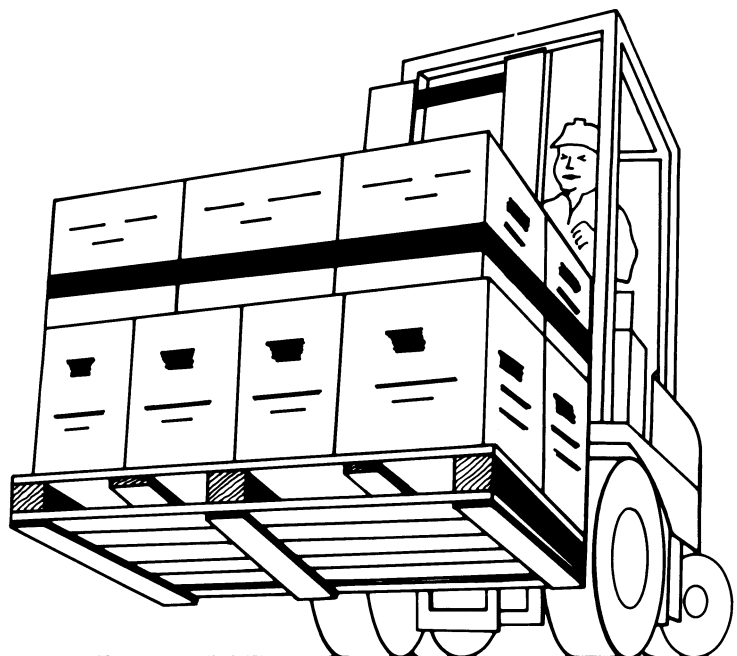


Figure 29 — Top layer banding

3.3.2.4 Shrinkwrapping and stretchwrapping

To shrinkwrap pallet loads, a plastics shroud is fitted over and heat is applied, causing the plastics film to shrink onto the load. The plastics film may be in the form of sheet or preformed bags. Heat is applied by means of a hand gun (see Figure 30), heated chamber or tunnel (see Figure 31). Care is required if the product is heat sensitive. In good practice, the rise in temperature inside a carton is usually small enough to be insignificant.

Shrinkwrap gives good protection against weather, dirt, dust and pilferage together with excellent restraint, while it is particularly useful for irregularly shaped loads.

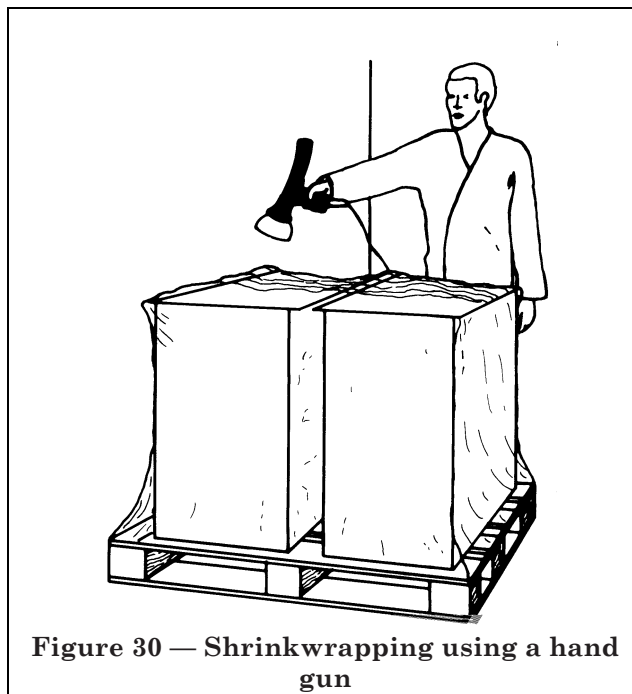


Figure 30 — Shrinkwrapping using a hand gun

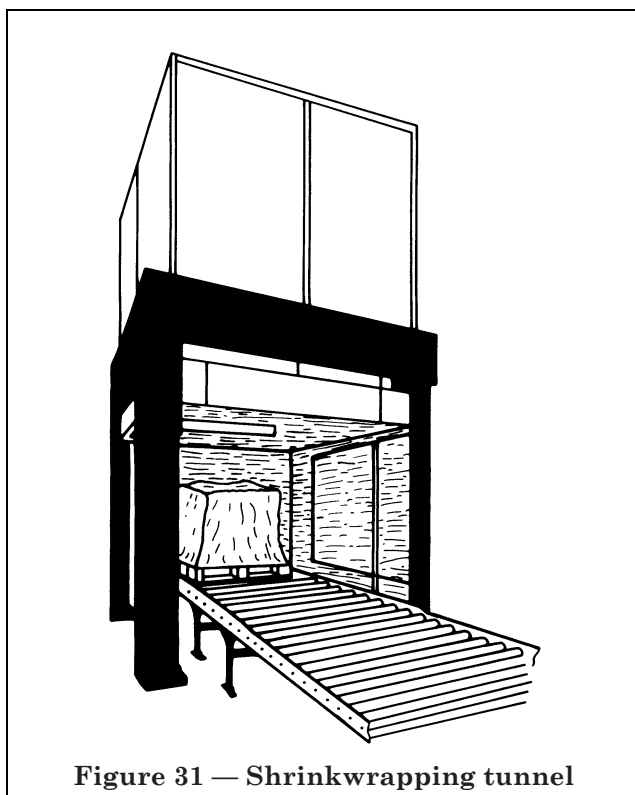


Figure 31 — Shrinkwrapping tunnel

To stretchwrap a pallet load (see Figure 32) a band of plastics material is applied to the pallet base and wrapped in a spiral either manually or mechanically to the top of the load. The tail of the spiral is then bonded to itself. This gives good load restraint but the top of the load is unprotected unless a plastics sheet is placed in position beforehand.

3.3.2.5 Unit loads without a base

With some products and types of packages it may be possible to use strapping, shrink or stretchwrapping to create a unit load without the need for a base. One specific example is that shown in Figure 19 where a unit load of bricks is strapped together for handling by a special fork attachment.

3.4 Selecting the unit load system

3.4.1 General

The steps given in 3.4.2 to 3.4.6 should be taken when considering the introduction of a unit load system.

3.4.2 Determination of the applicability of the system

Unitization involves costs which have to be justified by benefits within the system. There may be constraints which prevent the use of these techniques. In particular, there may be difficulties in the effective use of unit loads in old buildings. The following points need to be considered.

- a) What is the commodity being moved?
- b) What volumes and weights are being moved and with what frequency?
- c) What are the likely handling methods throughout the system? What are the physical constraints?
- d) What degree of control can be exercised?
- e) Can the costs of unitizing be justified by reduced costs or improved service?

3.4.3 Choice of unit load and/or pallet size

The unit load and pallet size is determined by the size of the items to be moved and by the transport mode. International standards are now accepted and in general use. The internationally recognized unit load sizes are as follows:

- 1 200 mm × 1 000 mm (the preferred unit load size)
- 1 200 mm × 800 mm
- 1 140 mm × 1 140 mm

If any “pool system” of pallet recovery is to be used then conformance to industry or “pool” practice is desirable. The most widely used pallet in the UK is the 1 200 mm × 1 000 mm size.

The 1 200 mm × 800 mm pallet is standard in the European pallet pool.

The height of the unit load may be influenced by a number of considerations which include weight constraints imposed by the available material handling equipment and physical limitations imposed by building, racking or vehicles.

3.4.4 Determination of how the unit load is to be built and constrained

Unit loads may be built manually, semi-mechanically or by automatic palletizer. If built manually, the pallet pattern has to be specified to the operator and if automatically, it has to be programmed into an automatic machine. In the semi-automatic process the operator forms the patterns for each layer but all lifting is eliminated.

The decision whether the load is to be palletless, boxed or stabilized on a pallet needs to be made at this stage and requires a knowledge of the methods to be used to handle the unit load through its life cycle.

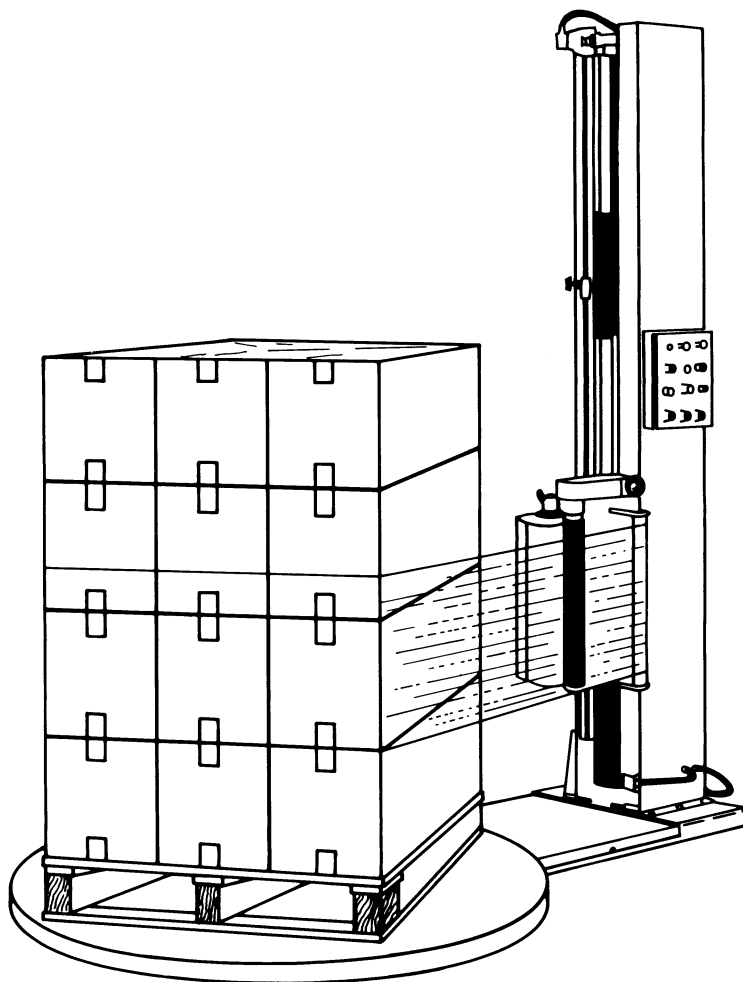


Figure 32 — Stretchwrapping

3.4.5 Deciding on the anticipated life of the pallet

Damage and loss can place a considerable limitation on the life of a pallet and on the number of work cycles achieved. In closed systems, e.g. those which do not go outside the control of the original owner, recovery may be high. In open systems, recovery may be virtually nil leading to an indication that an expendable pallet or one-trip pallet should be considered. This is an important element in the cost of unit load systems.

3.4.6 Costing the alternative systems

There are many elements of cost associated with installing and operating unit load systems as follows:

a) *the initial costs*, which include the following:

- 1) the capital cost of the purchase of unitizing equipment, e.g. palletizers, strapping machines;

- 2) the capital cost of purchasing movement and storage equipment appropriate to the new methods;

- 3) space costs associated with wider access aisles, and palletization. This may be offset by more effective use of height;

b) *the operating costs*, which include the cost of the following:

- 1) labour to assemble unit load;
- 2) labour and equipment cost for movement into and out of storage;
- 3) expendable materials, e.g. bands or straps, shrinkwrapping;
- 4) returnable materials, related to the number of movement cycles which are likely to be achieved;
- 5) depreciation of handling and storage equipment.

3.4.7 Packaging implications

3.4.7.1 Cubic efficiency

3.4.7.1.1 Unit load efficiency

A unit load can be only as efficient as the package. The cubic efficiency of a unit load is constrained by the package dimensions. Dimensional modularity is therefore important. For maximum space utilization it is important that package dimensions be modular to unit load dimensions. ISO 3676, which specifies unit load sizes, does not permit any overhang outside the pallet dimensions.

If pallet overhang occurs, the peripheral cases will not be supported by the pallet and this may cause instability if the cases are block stacked.

3.4.7.1.2 Package efficiency

The extent of the product volume contained within the outer case has an important influence on distribution costs.

3.4.7.1.3 Transport efficiency

The number of unit loads which can be fitted into the appropriate vehicle can be determined and the amount of product occupancy determined taking into account case and unit load efficiency.

3.4.7.1.4 Storage efficiency

The number of unit loads which can be stored within a given storage cube can be related to the actual product stored to give a measure for comparing unit load systems.

3.4.7.2 Unit load size and weight

For movement systems which are intercompany and intermodal, there is particular need to comply with British Standards and international standards.

The maximum allowable load should be selected taking into account the load capacity of stacking equipment which may be derated to a lower level with increasing stacking height. It may be necessary to compromise by using less than full height loads to reduce load weights for some commodities, bringing the overall system within the load range of smaller, less expensive equipment which may also operate in narrower storage aisles. Defined maximum loads (including pallet weight) should not be exceeded. Large variations in the weights of unit load cause problems in gravity conveyor systems.

The load should not substantially change its dimensions during movement and a proving test should be carried out.

3.4.7.3 System requirements

Since the unit load may have to be moved and stored on the originator's premises, on various forms of transport and on the customer's premises, regard should be paid to the possible implications as far as package and unit load design are concerned.

The pallet may be supported in a number of ways in different racking structures. It should be strong enough to withstand the loads involved, particularly with drive-in racking. Expendable or one-trip pallets may not meet all requirements.

Pallet design should be compatible with storage and movement equipment requirements. For example, perimeter based pallets may be required to give adequate bearing surface for block stacking but may be incompatible with the slide-through forks used on some types of narrow aisle trucks or stacker cranes.

If pallets are block stacked for storage or for transport, it is essential that care be taken to ensure that the packages and their contents have adequate strength to withstand the crushing load. With full deck reversible pallets, this is highest in the bottom layer on the bottom pallet. For non-reversible pallets, the worst condition occurs in the top layer of the bottom pallet. If pallets are not block stacked, the bottom packages on the pallet have to support the biggest load. Asymmetrical compression due to offset load can lead to stack collapse.

When pallets or unit loads are to be moved by conveyor, the under surface of the pallet/load should meet the requirements of the conveyor used. Where unit loads are received from a number of sources some mechanized systems provide for transfer to a slave pallet restricted to store use.

4 Storage techniques

4.1 Choice of storage technique

The choice of storage technique for a specific range of products is influenced by a number of factors which can be grouped as follows.

- a) *Product characteristics.* These include throughput and storage volumes, seasonality, order selection quantity, susceptibility to damage, extent of risk of theft, type of container, pallet or unit load employed.
- b) *Nature of the site.* This includes area and layout constraints, floor loading, stanchion modules.
- c) *Degree of control required.* This includes whether there is a requirement to rotate stock on a "first in first out" (FIFO) basis; value of product; service levels.

d) *Economic factors.* These include cost and availability of labour, equipment capital and operating cost, capital availability, required return on investment.

e) *Ergonomic factors.* A desire to create the right working environment by minimizing physical effort may be a factor in judgement.

f) *Strategic factors.* It may be necessary to plan for future expansion or for a possible change of products, storage and throughput quantities or storage site.

In any store the various products need to be accessed for storing and removal at different rates. For fast moving, frequently accessed items it is essential that this should be achieved whilst minimizing labour cost and this may be at the expense of space utilization.

Slow moving items are accessed less frequently and consequently may be stored more densely, achieving better space utilization at the expense of some small increase in labour costs.

In most stores, the “Pareto Rule” that 80 % of the throughput and/or storage applies to 20 % of the stock lines usually applies. It is this variation which implies a careful matching of product to storage technique to achieve effective store design.

4.2 Storage of non-unitized packages

Typical storage techniques are shown and described in Figure 33 to Figure 43.

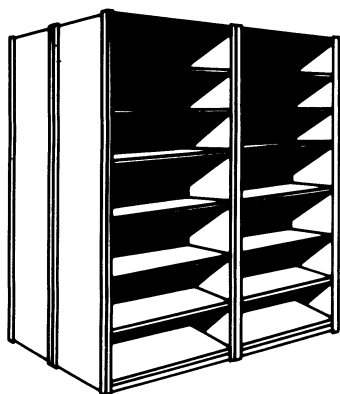
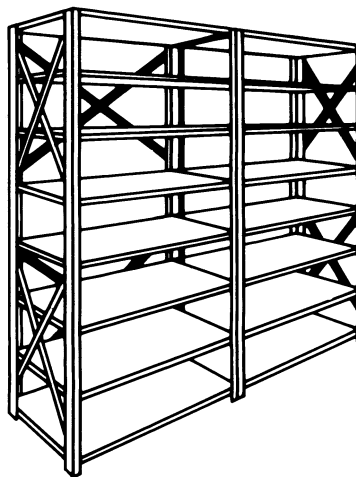


Figure 33 — Closed shelving

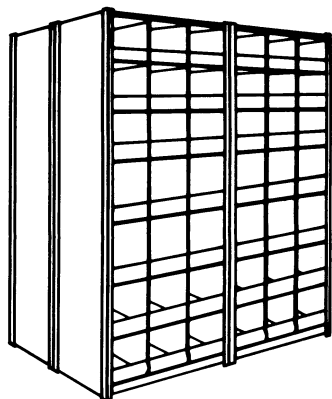


The most widely used form of shelving complies with BS 826. Other forms include rolled-edge solid sheet end-panels instead of angle upright frames, or frames constructed of slotted angle uprights. The latter can have timber, chipboard, or hardboard shelves instead of steel, at a lower cost; shelving is also available in all timber.

Some makes of both steel and timber shelving are available with quickly adjustable shelves held in position by special clips instead of bolts.

Shelving is generally used for boxed items, small containers or components which can be held without containment. It is not suitable for most loose items such as nuts and bolts or small components.

Figure 34 — Open shelving

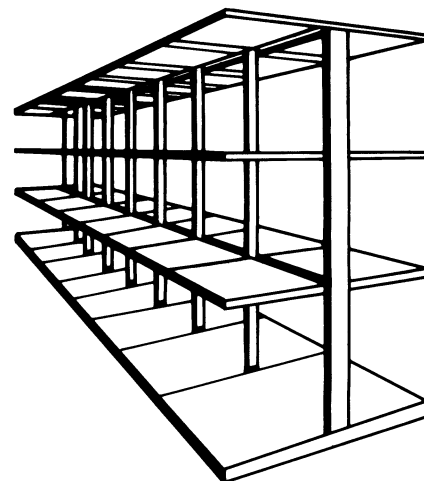


Binning systems are usually constructed from mild steel angle uprights (in heights from 975 mm to 3 075 mm) and sheet steel shelves in widths of 600 mm, 900 mm and 1 200 mm. Single-sided bay depths are typically 250, 300, 400, 500, 600 and 750 mm.

The most common system complies with BS 826 and is supplied by a number of manufacturers. This design permits the use of a wide variety of accessories, such as cladding sheets, bin fronts, bin dividers, drawers, cupboard fronts, etc. Loading capacity is 110 kg per shelf or up to 795 kg per shelf with special reinforcement.

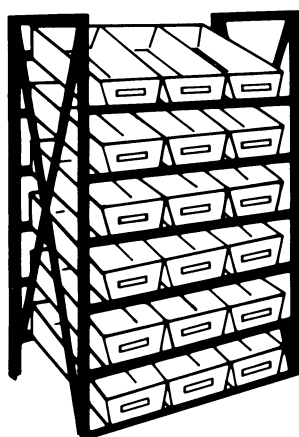
A variation of this system but with fewer accessories can be supplied in timber.

Figure 35 — Binning

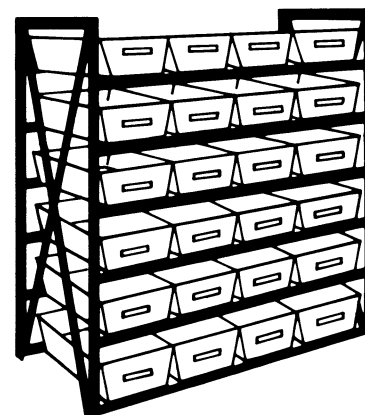


Cantilever racking systems are constructed from standard steel shelving which is bolted to pressed steel cantilever arms attached to sturdy central uprights. They eliminate space-wasting front uprights and permit unrestricted shelf space along the total length of the racking. The units are made rigid in the longitudinal plane by cross strapping and in the lateral plane by overhead ties. Shelf loadings of 250 kg/m² are normal and it is unusual to have single entry shelf depths of more than 600 mm. Unrestricted access permits better cube utilization.

Figure 36 — Cantilever shelving



(a) Tote pan racking, tilt frame



(b) Horizontal tote pan racking

Figure 37 — Tote pan racking