2 Stockholding

2.0 Introduction

Stockholding describes the process of holding materials in readiness for a subsequent activity. This process forms part of a chain of activities that eventually leads to the final incorporation of the material within a building. This chain of activity can be taken right back to the stockholding of raw materials and then forward to the stockholding of finished goods through the distribution chain form manufacturer, distributor to end user. In this section we examine the issue of stockholding on site of materials from their time of delivery.

The issue that this research explored was how effective are current arrangements for stockholding. The research explored a number of issues relating to stockholding. These include the length of time that materials are stored on site, the degree to which double handling takes place, the positioning of materials and the extent to which the right materials arrive at the right time to ensure the progression of the project. Before examining these issues we will look at the different stockholding scenarios and review the factors that need to be considered when making stockholding decisions.

2.1 Stockholding scenarios

When materials are delivered to site they are either put into stock for use at a future time or immediately incorporated into the building. The majority of materials are put into stock. This could be in a temporary holding location for a couple of hours or in a storage area where they might be held for days if not weeks. When materials are put into stock they will require additional handling before their incorporated into the building. This double handling adds costs and increases the risk of damage. However, this research highlighted the important role that stockholding plays in regulating the flow of materials and ensuring that materials are available when needed.

Fig 2.1 illustrates the range of material stockholding scenarios that can be observed on site from the point of material delivery. There are three basis stockholding options. These are i) holding materials in a secure storage area, ii) holding materials in an ancillary area and iii) taking materials directly to the area of the site operations. Each stockholding option generates its own material handling requirement as illustrated by the arrows A - E.

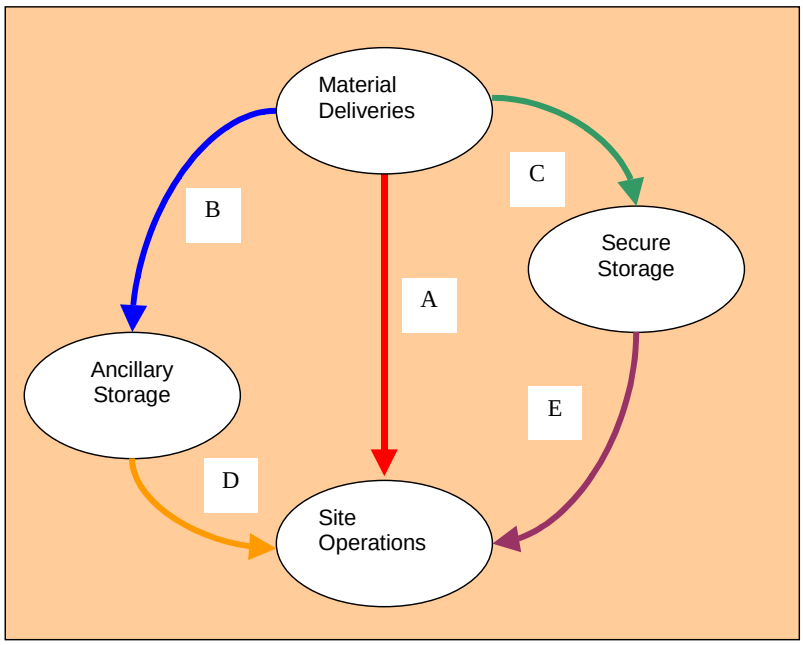

Fig 2.1

Stockholding scenarios and material flows

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2.1.1 Review of stockholding options

Ancillary Storage – this refers to storage areas that are accessible by crane or forklift. It could also include designate storage areas within the building for materials which are vulnerable to damage. Materials suitable for this form or external storage are those which when appropriately protected will not deteriorate when exposed to the weather.

Examples - Bricks, Blocks, Insulation

Secure storage – this refers to the provision of lockable storage facilities in the form of containers. These materials tend to be those of high value.

Examples - Mechanical and electrical, sanitary ware, Ironmongery, brickwork ancillaries

Site operations – this refers to materials that are positioned close to the area of in which they will be incorporated within the building. They may be in a temporary holding area for a few days or as in the case of concrete, incorporated immediately into the building.

Examples - Ready-mixed concrete, kitchen units, plasterboard

2.1.2 Factors affecting stockholding decisions

The decision on the timing of calling in materials to site has to take into account a number of factors. These include:

i) Stocks as a buffer against uncertainty – uncertainty is in terms of when materials will be delivered, the completeness of the order and when they will be needed. The timely availability of materials at the workface is clearly an essential requirement for the delivery of construction tasks. Stockholding is a means of ensuring that materials are available when required.

ii) The economics of purchasing in batches - significant discounts are offered for purchasing in full loads. This means that there is a tendency for more materials to be purchased than are needed for immediate use.

iii) Controlling vehicle movements – limiting vehicle movements favours larger and less frequent deliveries. This is an important consideration when there is limited unloading space and areas for vehicles to wait.

iv) Availability of storage space - the majority of sites have limited storage space. This situation is also dynamic with the positioning and availability of storage space changing over the course of the project.

v) Different parties being responsible for ordering materials – many of the materials on construction sites are provided on a supply and fix basis by trade contractors. This means that the main contractor does not directly control all aspects of materials management.

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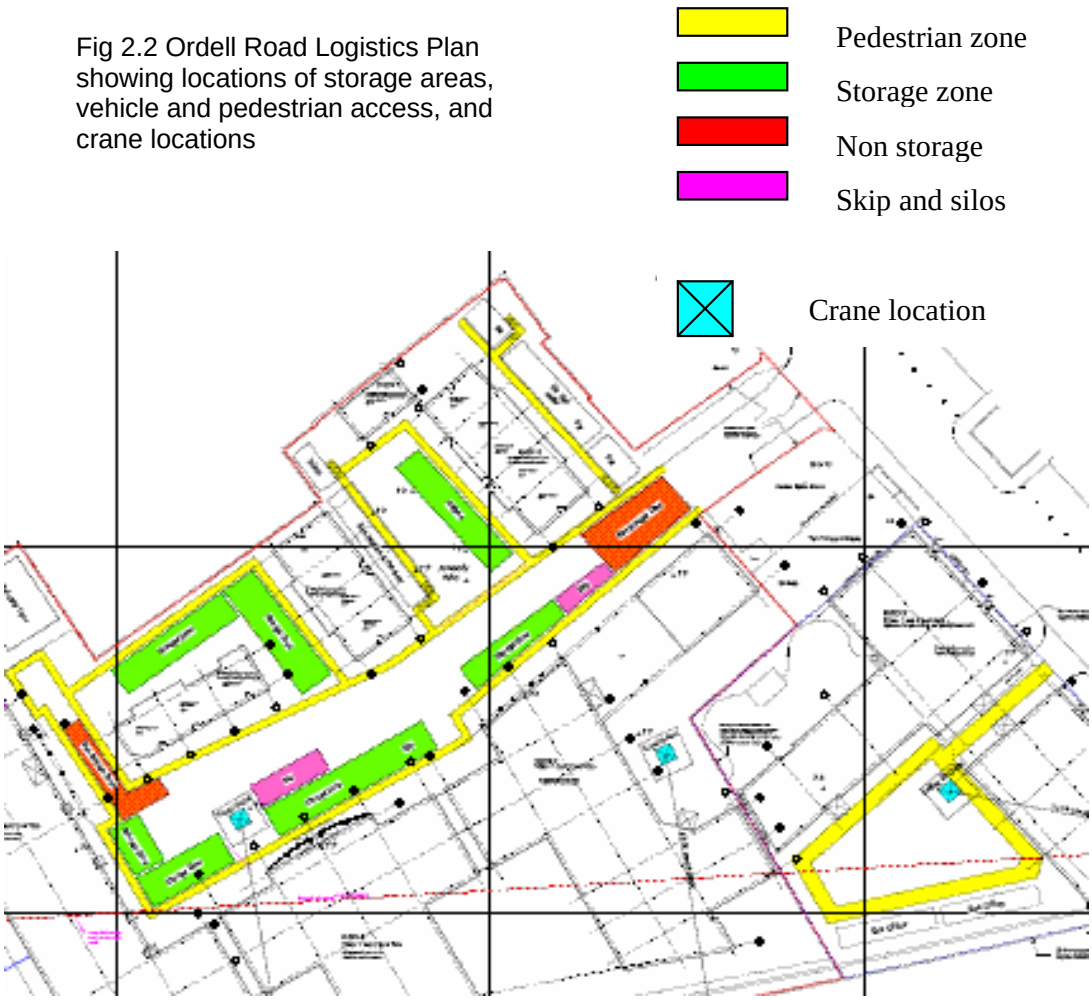
2.1 Efficiency of storing materials

2.1.1 The starting point for establishing an efficient system for storing and handling materials is the development of a logistics plan for the site. This plan takes the site layout and sets out the optimal positions for storage areas taking into account factors such as access points, offloading areas, routes for vehicle and pedestrian movements, reach of cranes and access for forklift trucks. This logistics plan provides a basis in which rational decisions can be taken as to the amount of storage to provide and the location of the storage areas.

Fig 2.2 Ordell Road Logistics Plan showing locations of storage areas, vehicle and pedestrian access, and crane locations



Out of the six storage zones indicated on the logistics plan 4 were dedicated for brick and block deliveries. These included holding areas where bricks and blocks would be moved-on within the same day and a longer-term storage area to take a full load of block types the use of which could be spread over a period of weeks. Their sizing and location took into account the planned output of the bricklaying gangs working on the three blocks. A delivery of one full load of blocks and one of bricks was scheduled for each day. Each storage area was sized to take one full load.

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2.1.2 A key factor in maintaining well managed material storage is gaining the cooperation of trade contractors. As much as 70% of materials by value on a typical construction project could be supplied directly by trade contractors. Therefore there must be an agreed plan with these trade contractors as to where they will store their materials, how they will be handled and how much material can be allowed on site at any one time.

Logistic issues will have an important impact on trade contractor costs. This is reflected in their preliminaries allowances for such matters as attendant labour for handling materials, provision of secure storage facilities and material handling equipment. Restriction on the quantity of materials to be held in storage will also affect the rates on which these materials can be procured.

There were examples of operational practices by trade contractors which resulted in poor logistics management on site. Some of these examples related to ordering full loads to take advantage of discounts when there was not sufficient storage area available. In other instances it related to lack or coordination within the trade contractor operations itself. This is where a trade contractors office will order in materials without consultation with their trade operatives on site.

Central storage area on Talwin Street accessible by forklift.

Temporary material holding areas were located at points accessible to the crane - at the front of the site and in the courtyard area at the foot of the crane.

A pavement licence allowed the creation of a holding area adjacent to the road for unloading delivery vehicles.

2.2 Length of time that materials are stored on site

The time that materials are in storage on site varies from instances where there is an immediate incorporation of the material into the building ie no storage requirement, storage in temporary holding areas for a matter of hours to occasions when materials are in store on site for weeks or even months.

The factors effecting the time on site for storage relate to the nature of the material, its handling characteristics, procurement issues and storage options.

2.2.1 On the Ordell Road site, at the time when there were three blocks of flats under construction at the same time, one load of concrete blocks (1360 No) was scheduled for delivery every day.

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Given this high volume of block deliveries it was necessary to load out the blocks at the workface on the same day to ensure that there was room to receive the following days deliveries.

Typically loading out would be two days before the blocks were laid. This meant that blocks would be on site for no more than 3 days before their incorporation into the building.

Blocks off-leaded into temporary holding areas

Blocks loaded out ready for laying

2.2.2 In the case of precast concrete floor slabs these were positioned into place directly from the lorry. Two lorries would supply sufficient slabs for one days work. During the floor positioning process slabs would be craned directly from the lorry. It would typically take 1 ½ to 2 hours for one lorry to unload if no adjustments to the floor slabs were required to take place on site. The floor laying operation for a complete floor would last approximately 3 days.

The process of installing precast floor slabs requires the coordination of three elements; the fixing gang, the crane and the slabs. Although no problems in this respect occurred on either of the site involved in the research, the site managers had experience of dealing with precast flooring suppliers who regularly failed to supply one of the elements.

Ready mixed concrete provides the best example of materials being incorporated directly into the building.

Given the nature of the material, special attention has to be given to ensure that the concrete can be positioned without delay. This is in terms of ensuring access to the site and the positioning of the concrete handling equipment.

Arial view of Ready Mixed concrete being transferred from the delivery vehicle and pumped into positioned

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2.2.3 Often, materials which are in storage for longer than would be considered necessary in relation to their availability are those that are left over from a full load. In these instances it would be judged as uneconomic to buy in part loads and the materials would be kept in storage for use at a future date. An

example includes blocks for a particular use such as for building around staircases. A full load would be ordered for use on one stair area and the remainder would be stored for use on the next floor in say 3 weeks.

2.2.4 Carpentry materials such as skirting and architraves were amongst those that are most likely to be in storage for weeks rather than days. A four week delivery cycle was typical meaning that these materials could be on site from 1 day to 4 weeks prior to incorporation into the building

Timber storage – skirting and architraves. One delivery is equivalent to one month's supply

2.2.5 Kitchen units provided an interesting comparison between the two sites in terms of their delivery and storage characteristics. At Ordell Road kitchens were delivered on the back of a rigid lorry with a full load equating to 6-7 sets. These units were then manually handled, up stairways, and positioned on the appropriate floor in a temporary holding areas located at either end of the block of flats.

The kitchen units were scheduled to arrive the week before fitting was to commence. Given that each load would take 2 carpenters 7-8 days to fit, the average time that a kitchen was in temporary storage was approximately 7 days.

One of the features of the arrangements for kitchens deliveries on the Ordell site was the policy of the kitchen supplier to quote a week commencing date for delivery and not be held to a particular day. This meant that the duration of holding stock on site tended to be longer than would have ideally been planned. However, there was no evidence that this caused any practical difficulties. What it did mean was that the site had to be geared up for dealing with a large delivery of bulky items that required a high level of manual handling.

The approach from the kitchen supplier on the Talwin street project was different. Individual kitchen sets were delivered in a transit van direct from the manufacturer. Calling off individual kitchen sets to an agreed day meant that the average time that kitchen was in temporary storage on this site was in the order of 2 days and no more than two kitchens were in storage at any one time.

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2.3 Degree of double handling

The majority of materials are handled more than once prior to their incorporation into the building. In some instances double handling can occur as a result of poor planning. This is where material has to be moved to gain access to other material or where they have been placed in an inappropriate location. This is usually a symptom of poor logistics planning and lack of coordination with the trade contractors.

However, managing materials effectively on site often involves a degree of double handling. This is because material storage plays an important role in regulating the flow of materials to the work area. Wherever there is material storage there will be some element of double handling.

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Examples of the handling process - Kitchen units

Kitchen units are essentially a joinery item and their lack of robustness tends to favour manual handling. They are generally delivered with each unit individually wrapped in plastic with protection provided to the edges.

The normal process is to unloaded the individual units from lorry by hand and place them in a temporary holding-area in order to release the delivery lorry. For sites operating with a forklift the units can be strapped onto pallets and loaded onto the appropriate floor if scaffolding access is still available. Otherwise they would need to be manually handled. Hoists are used successfully on some sites for this purpose.

The units are then stored within the appropriate dwelling in an area adjacent to the kitchen.

Examples of the handling process – Doors

Doors provide a good example of a material that because of its proneness to damage is subject to a large degree of double handing. Unlike kitchens, doors are generally delivered already palletised. This makes moving high volumes of doors to the appropriate floor relatively straightforward.

A forklift truck is generally used to unload the delivery lorry. The doors are then lifted onto the appropriate loading bay. The pallets of doors are then split by hand and manually carried to a temporary storage area on the respective floor.

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The placing of doors in a temporary centralised storage area rather than within the dwelling or the individual rooms is in order to protect them from damage. This storage strategy is based around minimising the surface area of the stored doors and avoiding creating what could act as an improvised workbench. Typically doors would be in this form of storage for 2 weeks.

Doors placed in a central storage area on the appropriate floor

Prior to fitting the doors, A set of doors will be taken from the central storage area and placed in the dwelling. However, once the doors are fitted (ironmongery incorporated and hung on hinges), they are taken off and stored in a protective box located in a location within the unit. This is to ensure that they do not get damaged during the rest of the fitting-out process.

Doors placed in a 'coffin' after having been fitted

2.4 Extent to which right materials arrive at the right time

Considerable efforts are generally made to ensure that the right materials do arrive at the right time. During the planning stage of a project a material procurement schedule is developed which lists the materials needed, the suppliers and the lead times. This provides the basis for managing the procurement process.

Neither site involved in the research project experienced any instances where any trade actually had to stop work because lack of materials. The flexible nature of the construction process means that usually there is always work available for trades to carryout even should the scheduled work not be available to start on.

In terms of delays to the project it is clear that materials deliveries can be prime factor. This is particularly true of key material items such as lifts and other items which are on long lead times. However, factors other than material availability are often more likely to delay a project as they are often outside of the control of the project team. These factors include lack of information, unavailability of labour, performance of statutory services and failure to obtain necessary permissions.

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2.4.1 Factors resulting in materials not arriving on site on time

There are four main factors that cause difficulties in relation to ensuring that the right materials are available when needed. These are:

i) Lack of information – many elements of the building are not fully designed at the start of the construction programme. This is particularly true of design & build procurement where the contractor and their trade contractors are responsible for the detailed design. This means that orders cannot be placed until this information is provided.

This is particularly true of elements that require design input by trade contractors. There is often a double "catch 22" situation. A design cannot be finalised until an order has been place - an order cannot be placed until a price has been agreed - and a price cannot be agreed until a design has been undertaken. In order to break this cycle either the trade contractor will have to work at risk or get paid for some element of the design work.

Design details of finishing items can have an important bearing on the layouts of items at the start of the building process. For example, the exact positioning of a kitchen sink will determine the location of the drainage runs. Although the kitchen will not be fitted until towards the end of the project, the installation of the drainage risers will be one of the early activities.

Example of procurement delays - front entrance doors

External doors on one of the projects was on a 12 week lead time. A delay in finalising the specification of the front doors meant that delivery to site was forced to be scheduled after the programmed start date for the installation of the doors. This had the knock on effect of delaying the plastering. However, not being on the critical path this delay did not affect the overall performance of the programme.

ii) Changes to specification or design – it is quite normal in construction for specifications to be changed mid-way through the programme. This might arise from in a client's requirement or due to design changes to take into account information that has arisen during the design development process.

iii) Incomplete orders – this refers to the situation where the correct quantity and specification of materials have been ordered, the order arrives on time but the delivery is short in terms of quantity or contains wrong items.

Incomplete orders is often be the case with ironmongery. Ironmongery is often ordered in individual packs which contain all the elements for one door. When the delivery is received on site they are normally put directly into secure storage without each pack being individually checked. They are then issued to the carpenter at the time of fitting the door. Only at this stage will any errors come to light.

iv*) Incorrect scheduling* – the process of scheduling involves itemising and measuring quantities. Detailed knowledge of individual items may be required to ensure that all ancillary items are included. Mistakes made during this scheduling process often only come to light when the material is ready to be incorporated within the building.

An example of this scheduling mistake is with joinery items where the scheduler missed a set of high level cupboard doors.

2.4.2 Impact on project of late arrival of materials

There are two issues which need to be considered in relation to the availability of materials. The first is the impact on productivity and the second is the impact on the delivery of the project.

If a task has already commenced or has been scheduled to commence shortly then non-availability of the materials will clearly cause a loss of productivity. The degree of productivity loss will depend on if and how quickly the labour and plant resources can be utilised elsewhere.

The issue is in relation to the impact on the delivery of the project will depend on the importance of that activity on the delivery of the project. A delay in starting work on an activity which is on the critical path will have an immediate impact on the progress of the project.

A delay to an activity which is non-critical will by definition not have a project impact, as long as the delay is no more than the amount of float available for that task.

This second of impact on project delivery reflects the importance of the need to focus on the procurement of certain key materials. These materials are the ones which can be characterised as having both a high risk factor in terms of availability and also high impact on the project. The appropriate procurement strategy for these materials is dealt with under *Programming the procurement process* below.

2.4.3 Material procurement strategies

The procurement strategies employed will depend on the material in question. These strategies include:

i. Maintaining buffer stocks on site of commonly used materials

Examples of these materials include insulation, wall ties, damp proof course (DPC) etc. These stocks are replenished when they fall to given level. Lead times are generally short being in terms of 1 to 2 days.

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ii. Schedule materials to match the pace of work

This method is appropriate for items such as bricks, blocks and floor planks. It means that the supplier can schedule production around an agreed delivery schedule. Notice is normally required to vary the schedule and flexibility depends on market conditions and the individual supplier.

iii. Just in Time ordering

Just in time ordering implies that there has been no buffer time allowed in placing the order. This is a symptom of lack of planning, an oversight with regard to current material stock levels on site or a change in circumstances requiring a rapid response.

Contractors' and trade contractors' procurement departments generally accept that this will be part of the normal procurement process. Expediting becomes a feature of this situation where favours have to be asked of suppliers.

Some suppliers are geared up to responding to these demands by holding a range of items in stock and accepting orders, typically upto 4.00pm, for despatch the following morning.

iv. *Just in Time delivery*

This is often held up as the ideal situation where materials arrive just in time for incorporation into the building. As we have seen within this research report there are a number of factors work against the use of this procurement strategy. These factors include buying in full loads to receive discounts and the lack of confidence in the reliability of suppliers.

v. Programming the procurement process

Some materials are subject to a lengthy procurement process involving design and manufacture prior to delivery. A procurement programme sets out milestones in which each stage of the process has to be completed including any approvals and redesign.

The delivery of materials subject to this process are the most difficult to coordinate. These are the ones that are most likely to cause disruption to the project through failing to arrive at the right time. Examples include windows, external doors, bespoke joinery, sheet roofing, roof trusses etc. A method of managing this procurement process is outlined below.

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2.4.5 Procurement programming using buffer management

This procurement management method uses a time buffer within the procurement programme to act as a shock absorber to accommodate delays to any of the process stages. It also uses the measure of the extent to which the buffer is being consumed to monitors performance. A traffic light system in the form of a “Fever chart” provides a visual tool to signal the status of the procurement programme and indicates what actions are required.

Fig 2.3 Procurement programming using buffer management

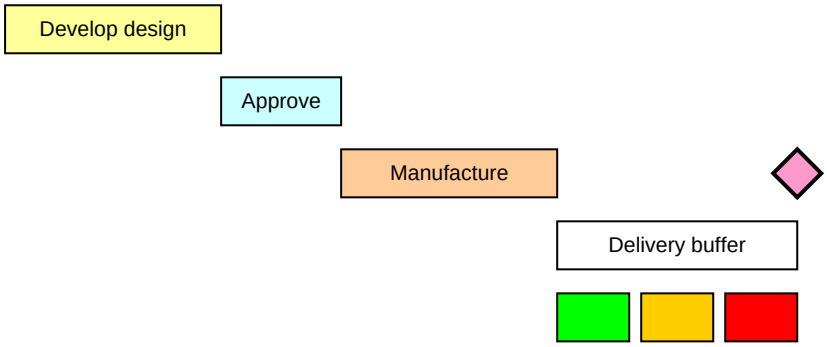

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Fig 2.4 Fever Chart showing the % of buffer consumption against time available

2.5 Positioning of materials in the most appropriate location

The optimal positioning of materials has to take into account a wide range of factors relating to storage, materials handling and security. These factors are ideally addressed as part of the site Logistics Plan. Set out below is an example of a checklist list for storage, handling and positioning together with the respective considerations with regard to internal doors.

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Fig 2.5 - Logistics check list

i. Length of time that materials are likely to be in storage for

The doors are likely to be on site for no more than 2 weeks prior to fixing.

ii. The amount of material likely to be needed to be in storage

Doors for one core at a time will be ordered equating to approximately 120 doors. This is likely to be the maximum in storage at any one time.

iii. The rate at which the material will need to be replaced

A load of 120 doors is scheduled for delivery to site every three weeks over a 4 month period.

iv. Likelihood of damage or theft

The doors are very vulnerable to damage once they have been taken off their pallets. Stacking horizontally in shoulder height piles is considered the best way of minimising damage.

v. Availability of material handling equipment and labour at the time in which the material will need to be handled

A forklift truck will be in operation during the time that doors are to be fitted. Additional labour will be needed to manually carry the doors and other joinery items.

vi. Availability of appropriate storage space

There is storage space available either within the individual units or in a central location on each floor

vii. Form of packaging in which the materials will be delivered

Doors will be delivered shrunk rapped on pallets.

viii. Handling arrangements to the storage area

Handling will be through the use of a forklift from the vehicle unloading area to the loading bay on the appropriate floor. Pallets will then be unloaded and individual doors will be manually handled to the designated storage area

ix. Handling arrangements from the storage area to the work face

The doors will be positioned within a room agreed with the carpenter where they will have their working area set up.

2.5.3 Skirting and architraves provides another interesting example of the issues in determining the positioning of materials. The key feature about timber skirting is that they are supplied in lengths of approximately 5 ½ metres. A conventional storage rack with access at one end must be positioned to allow lengths to be withdrawn. This requires in excess of 11 meters of clear space. Using storage racks means that usually the only available storage area will be in a central location in an outside area.

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2.6 Degree of Damage and material waste on site

Damage to materials and overall material wastage on site are both highly significant issues in the construction process. To understand these issues we need to look at the following factors: characteristics of the materials and the means of working, transportation, storage and handling. Bricks and blocks provide a good example of how damage and waste can occur.

2.6.1 Material and working characteristics

Bricks and blocks need to be cut in order to achieve the necessary bonding or to align with reveals. The cutting process often involves either a hammer and bolster or the side of the trowel. Often with this method bricks and blocks do not split properly and this can lead to the whole brick or block being wasted.

Some bricks are very prone to distortion during the manufacturing process. Stock bricks in particular can distort to such an extent that they have to be discarded. Distorted bricks can often be included in a pack delivered to site and could result in 10% of that pack being wasted.

2.6.2 Transportation

Damage during transportation from manufacture to site is an issue. Bricks and blocks tended to be shrink wrapped in packs which provide some level of protection. However, the packs tend to rub against each other during transportation. This can lead to chipping on the face. While some chipped bricks can be used by turning the chipped face inwards, badly damaged bricks often have to be discarded.

2.6.2 Material storage

Provision of a hard, flat, well drained storage area has a significant role in reducing damage. On sites where suitable storage is not provided it would be common to see the whole bottom row of bricks being discarded through coming into contact with mud or other pollutants.

Bricks can also be damaged while in storage through the forks on a forklift truck not being able to cleanly penetrate into the gaps provided in the packs. This situation occurs is where bricks packs are stored on uneven ground which causes the packs to distort.

2.6.3 Material handling

Measures which are commonly used to minimise waste during the handling operation included keeping the bricks in packs where possible and only splitting them when they are loaded out ready for laying.