

Waste materials in construction sites



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Malaysian construction industry still faces increasing in the generation of construction waste materials and for sure they face problems in the removal of this waste. In the last two decades, huge construction building and infrastructure development projects have led to raise the production of construction waste material. The construction waste has a significant impact on the environment, and its environmental effects are in direct relation to the quality and quantity of the waste it generates. (Begum RA, Siwar C, Pereira JJ, Jaafar AH)

In Malaysia, The construction industry generates a lot of waste material that can be reused and recycled. Most of the waste materials go into landfill which is both direct cost to construction, and workers productivity and also has wider environmental implication. Moreover, Malaysia have little reliable statistic of construction and demolition that shows the rate of waste generation, type of waste, method of handling process of wastage, and the quantity of materials wastage minimized at source, reused or recycled on-site or off-site in a specific type of construction such as residential construction. (Haliza B. M 2010)

According to (Hassan et al. 1998) which shows that on average, the generation of waste can be breakdown into 36. 73% from household waste, 28. 34% from industrial and construction waste while other sources (market and commercial waste, institutional waste, landscaping waste and street sweeping waste) account for the remaining 34. 93% in the Central and Southern region of Malaysia as shown in Figure 1. 1. This figure shows that the waste generated from construction plays a significant role in contributing to the disposed in the landfills.

PROBLEM STATEMENT

The construction fields produce huge amounts of waste by consuming natural resources (Poon, 2007). Waste in the construction industry includes such delays as time, cost, lack of safety, rework, unnecessary transportation journeys, long distances, improper choice or management of programme or equipments and poor constructability.(Lee. et al., 1999)

Wastages affect not only on environment it's also bring extra project costs to the contractors and developers. Many countries especially the developed countries have started to aggressively recycle the construction materials due to its many benefits. In Malaysia, there is a huge potential' in recycling of construction waste and ' if implemented correctly; will only bring about a construction resurgence.

(Wong X. W. 2010)

It is then obvious that waste management should be implemented.

Reducing, reusing and recycling appear to be profitable alternatives that will increase the lifetime of landfills and reduce exploration of natural' resources.

(Woolley, 2000) Most importantly, our environment will not face more deterioration. In addition to the environmental benefits in reducing the demand on land for disposing the waste, the recycling of construction wastes, can also help to conserve natural materials and to reduce the cost of waste treatment prior to disposal (Poon, 2002).

Despite the efficiency and expertise of the builders in the use of the material there is an increase in the cost of disposal of demolition waste, which

requires the need to develop an effective plan for waste management options using the reduction and recycling.

Contractors, developers, architects and engineers should have knowledge about how to deal with construction waste materials by reducing, reusing and recycling. Also the governmental authority must play a role by introducing suitable legislation to implement the law and follow up on all offenders who do not follow the laws. With the expansion of urban areas, all relevant parties must make sure that waste materials are minimized and there is a full execution of recycling, waste materials to guide the construction industry in the right direction.

(Mohd. N. 2010)

OBJECTIVE OF RESEARCH

- To identify the types of waste materials in construction site
- To determine approach being use at construction site to reduce waste materials.
- To give recommendation on reduce, reuse, and recycle of construction waste materials.

SCOPE OF STUDY

The study covers area of Selangor at Malaysia.

SIGNIFICANT OF STUDY

Construction industry has an important impact on the environmental in term of unbalanced ecology, change of living environment, potential sewage, and depletion of natural resources, energy usage and production of waste. This

study will generally talk about reduction materials wastage issues in construction field.

Reduce the material wastage in construction is approved in applying reuse, recycling and reduce the building materials in construction activities. This thesis reviews the technology on construction waste recycling and their viability.

CHAPTER II

LITRATURE REVIEW

INRODUCTION

On this chapter, definition, classifications, advantages of reduce waste construction materials and reasons that lead to waste the materials.

Investigate or study the related information about this case in from literature information will be definitely implemented in the Methodology. Literature reviews is very important in the research works and consider as foundation for any study which depend on the information of previous researches that has been carried out on the related subject. It provides further knowledge about the scope of research.

DEFINITION

Construction waste material can be defined as the difference between the value of materials delivered and accepted on site and those properly used as specified and accurately measured in the work, after deducting the cost saving of substituted materials transferred elsewhere, in which unnecessary cost and time may be incurred by materials wastage.

Construction waste is any material where there holder has an intention to discard the material as no longer part of the normal commercial cycle or chain of utility.

(Ferguson, 1995).

According to The environmental protection Act 1990 (EPA 90) Section 75 defines waste as any materials which formalizes remains substances or streaming or other unnecessary surplus substance coming from the application of any process: and any material which involves to be disposed of as being damaged, run down, spoiled, or contaminated, but does not contain any material that is an explosive within the meaning of the explosives Act 1875; or Any substances that are unwanted and ignored or on other hand deal with as if the materials were waste shall be supposed to be waste unless the contrary is proved.

(PING, OMRAN, & PAKIR, 2009)

The waste building materials, packaging, and rubble resulting from construction, remodelling, repair, and demolition operations on pavements, houses, commercial buildings, and other structures.

(U. S. Environmental Protection Agency (USEPA))

Waste is defined as the by-product generated and removed from construction, renovation and demolition workplaces or sites of building and civil engineering structure.

(Cheung, 1993)

Waste is defined as any material by-product of human and industry activity has no residual value. (Serpell and Alarcon, 1998)

Construction materials wastage is unused materials (such as blocks, bricks, concrete, glass, plastics, steel, wood and soil generated by new building construction, renovation, or pulling down of existing construction.

The World Book Dictionary defines waste as “ useless or worthless material; stuff to be thrown away.

MAJOR TYPES OF WASTE MATERIALS

According to the Environment Protection Department (EPD) (Chung, 2000) .

The additional wastages require more time and extra resources for removal which might delay the building operations. The most important sources of construction material waste containing such as:

1. Concrete/cement.
2. Steel/reinforcement.
3. Brick/block.
4. Plastic/PVC
5. Glass
5. Timber/formwork.
6. Screw/bolt/nail.
7. Tile, ceramic tile

8. Non-ferrous metal aluminium

CONCRETE

Generally, the usage of concrete is mostly for substructure and superstructure of buildings wastage is largely caused from the mismatch between the amount of concrete required and that ordered from suppliers in the case of ready mix concrete supply. The service provider might not be familiar with the exact quantity due to improper management planning, leading to over-ordering. Wastage is also happened because the delays and needless waste handling processes.

STEEL REINFORCEMENT

As known steel bars are considered one of the most materials being used in construction site. Wastage of steel mainly resulted from cutting. Also wastage might be happen due to damages during storage and rusting. Pre-bending in the manufacturing works can eliminate cutting waste.

TIMBER

While timber is one of the main materials using for formwork wastage usually happen because the continuous or bad usage and as well as the over cutting. Timber usually dumped after use to do form work. Timber cannot resist termites and can easily break. So it is not suitable for long-term usage. Old timber also usually ends up in the trash and cannot be recycled.

BRICK AND BLOCK

Because the common usage of bricks and blocks in construction as walling and for partition. Wastage usually caused due to the improper cutting and careless of handling material. Improper handling might raise wastage of

brick and blocks damage because of the breakable nature of the materials. Bricks remained on site without usage will end up in the trash skip in the end.

PLASTIC/PVC

Plastic wastage normally resulted from the cutting during piping work. Also plastic wastes happen due the inappropriate storage which throws it on site without considering its bad weakness and durability. PVC or plastic will melt if it direct contact with heat. Plastic also cannot resist chemical reactions.

SCREW/BOLT/NAIL/ TILE

The usage of those items usually being as connection. For sure they are used with large quantity which easily damaged due to the carelessness of the workers. Throwing screws or nails by workers lead to increase the wastage of them. Also wastage of tiles commonly happens during cutting.

BENEFITS OF CONSTRUCTION WASTE REDUCTION

Minimizing the total costs of the project throughout avoided removal costs, averted buying new materials, and revenue profit from materials sale due to reusing of materials onsite.

Helps societies, construction companies, and construction owners comply with state and local policies, such as disposal bans and recycling goals.

- Promote general image of construction companies which minimize waste disposal. (Zhang, 2008)
- Reduce the environmental impact of the waste.
- Cleaner and safer construction site.

- Conserves space in existing landfills.
- Additional costs are avoided by diverting waste from landfills.

CAUSES OF WASTE MATERIALS GENERATION

According to Ekanayake who has discuss the causes of construction waste material he said that there are many factors lead to construction waste at site and he specified that the most important are ordered the common sources of construction waste under six categories: (1) design; (2) procurement; (3) handling of materials; (4) operation; (5) residual related; and (6) others. Furthermore those sources of waste materials probably happen during main phases of the project life cycle, (1) design, (2) operational, (3) material handling and, (4) procurement.

(Ekanayake)

- Design
- Carelessness to dimension skills of some materials
- Design changes during construction progress.
- Lack of experience of designers and project managers in scheduling works.
- Lack of attention paid to standard sizes available on the market
- Designer's familiarity with alternative products
- Complication of reading drawing's details
- Lack of information in the drawings
- Errors in contract documents
- No completed contract documents at the beginning of project
- low quality materials selection

- Procurement
- Suppliers and workers errors
- Accidents coming from carelessness of labors
- Damage to work done caused by subsequent trades
- Use of wrong materials, which need replacement
- Failure to reach the required quantity before work from quantity surveyors.
- Late passing of information to responsible person on types and sizes of materials to be used
- Equipment broken and rainy weather
- Handling materials
- Damage happens due to the transportation process
- Unsuitable storage for materials caused damages to them
- Materials supplied in loose form
- Bad construction site layout where materials close to working place
- Misunderstanding between teamwork and workers
- Theft
- Operations
- Ordering errors
- Lack of possibilities to order small quantities
- Buy materials which can not be comply with specification

CONSTRUCTION WASTE REDUCTION

Construction Waste Reduction has been defined by the UK Environment Agency (1997) as reducing construction waste by protective measures (prevent, reduce at source, and reuse of wasted materials) and waste

management measures (quality improvement, and recycling). Similarly, Envirowise (1998) defined Construction Waste Reduction as the process of systematic waste reduction at source, by preventing and reducing waste before its physical generation, and encouraging reuse, recycling and recovery. Therefore, according to (Riemer and Kristoffersen 1999) reducing waste materials is a process of avoidance, eliminate or decrease the waste on sources or allow reuse and recycling process of waste materials for such purposes in construction field.

Waste reduction hierarchy has been addressing (reduce) as one of the highest main concern for decreasing the amounts of waste. The crucial objective of the strategy of waste reduction is to avoid or eliminate it from the outset, at the beginning stage phase of the project. (Andy, Andrew and Simon)

Waste reduction is achieved through the application of a 'Waste Reduction Hierarchy' which is applied from design through to disposal, as detailed below:-

1. Reduce. Avoidance of unnecessary consumption of materials at the concept and design stage of procurement;
2. Reuse. Reuse requires the design and utilization of re-useable containers and materials without subjecting the item to a manufacturing process that changes its original configuration and composition (e. g. reusable packaging and pallets for storage);

3. Recycle. Product recycling requires the raw material to be recovered and used to manufacture another product;

4. Disposal. Disposal of waste to landfill is the least acceptable form of waste management, and is to be regarded as the option of last resort.

REDUCE

In the past, waste reduction strategies have taken many forms, but the main purpose has remained the cornerstone of most waste reduction strategies which is to find out the maximum practical benefits from waste materials and to produce the minimum amount of waste.

The understanding of what construction materials need to buy is the most first and important part in waste reduction, then monitoring materials usage, and after that find ways to avoidance, reduce, reuse, then recycle the wasted materials. A good strategy is to target the major component in the waste material stream, and put into practice the easy waste reduction steps first.

Below are some ideas to help you identify waste reduction opportunities:-

Buy pre-cut materials like foam boards and floor trusses to minimize waste.

Re-utilize wasted substances like siding, inside trim, door, and framework for wood, hardwood floors, and bath fitting.

Planning for usage 4' x 8' panels and standard timber lengths; plan to create functional usage of standard lengths of heating tube material, metal pipes, wiring, siding, and gutters.

Find out new developed methods that can decrease and make usage of materials more economically and efficiently.

Consult trade publication, construction companies, and local organizations for information on resource efficient building designs and techniques.

Choose design which allow and give opportunity to dismantling all parts of the structure as an alternative choice instead of the demolition, which might save building materials for recover them to be useful source of materials for volunteer organizations.

Work with famous designers, contractors, and suppliers those who have good characters in usage of resource-efficient design and building.

Select to expand long period of new or existing buildings. Choosing the best quality, more durable substances extend the life of the building structure and giving easier remodelling, protection, or renovation.

Usage of elegant design characteristics from architect and designers might be useful for minimization of building wastage and enhance the productivity due to the genius designation like multi-purpose rooms, encouraging smaller footprints, and choosing construction materials which friendly to environment and energy efficient.

Construction companies also might use cutting and advanced framing techniques to minimize building wastage, this method may produce few waste, and holding over surplus to the next construction site or donating by them to the volunteer organization.

REUSE

Separation of the materials is the most important thing in reuse wasted materials also separation should be separated in good condition to keep material's durability. A majority of these materials are durable and therefore, have a high potential of reuse. It would, however, be desirable to have quality standards for the recycled materials.

There are many materials might recovered from construction sites waste and they can be sold, donated, stored for later use, or reused on the current project. Some materials are convenient for reuse such as doors, cabinets, windows, carpet, brick, light fixtures, ceiling and floor tiles, wood, HVAC equipment, and decorative items (including fireplaces and stonework).

Construction waste can be used in the following manner:

Reuse on site of blocks, stone slabs, timber, piping railings etc.

Sale material that can't used again on site through design restraint or design changes.

Recycle materials such as plastics, broken glass, scrap metal etc.

Use materials like broken block or brick, plaster concrete pieces etc. in other application at the construction. For ex. levelling, cavity under coat of paths where the passage not required of heavy moving loads.

Big pieces and unused parts can be sent to lower areas to fill them.

Soft materials might be used as can be used as cover material over sanitary landfill, like sand, dust etc.

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RECYCLING

There are some materials can be directly recycled onsite into new construction or offsite at a construction and demolition processor. Typical materials recycled from construction sites contain metal, timber, asphalt, pavement, and concrete pieces, roof materials, corrugated cardboard and wallboard.

Most of the construction wastages throw out to landfill. There are many opportunities for the construction companies to reduce that in order to extend the life period of landfill sites, decrease transportation requirements and reduce the primary resource requirements.

DISPOSAL

Landfilling is the main method of disposal of all solid wastes including the construction waste materials in most of countries. Landfilling is not capital intensive and does not require skilled labour unlike composting or incineration.

MATERIALS CAN BE RECYCLING

Recycling of construction materials has been recommended from many researchers in their studies and companies work in that field but the factual administering of construction and demolition waste recycling is limited to a few types of solid wastes. According to (Mindess et al., 2003): who thought that economy, compatibility with other materials and material properties should be taken into account when considering recycle materials. He justified that recycling can be only useful when the recycled product is economical compared to the natural resource in cost and quality. He added recycled

materials will be preferable in areas where less raw materials and land filling sites exist. It investigates the technology on construction waste recycling and their viability.

In addition, (Mindess, 2003) has been mentioned to materials recycling practice had been studies such as concrete, plastic, brick, ferrous and non-ferrous metal, masonry, glass and timber.

CONCRETE

In fact, concrete is the most materials being wasted during construction and demolition. According to (Emily, 2010), manufacturers produce more than 25 billion tonnes of concrete per year. Large quantities of concrete waste during tear down/building new construction therefore concrete need to recycle. It is an easy way to recycle concrete. The most important thing is to sort concrete and remove the steel rebar then after sorting concrete go through out crush machine to grind them forming very small pieces as sand or aggregates. Crushing can be made on site to reuse at the same time.

BRICK

Bricks wastage coming from construction site might be polluted with mortar, rendering and plaster, and usually they being blinded with another materials such as wood and concrete. But there are difficulties being faced in the separation of bricks which usually need to be separated and sorting by hand. There are small percentage around 10 to 15% of bricks from damaged buildings are facing bricks, therefore they need manpower and it might be expensive to sort and clean bricks. Therefore contaminated bricks are not economical to be used because that will be more costing than natural bricks.

In 2004, Japanese building site had been burning the destroyed bricks into lime burnt ash. And, in recent year, bricks are commonly be crushed to form filling materials and hardcore in Hong Kong.

STEEL

Preferably, it is better to reuse steel wastage directly on site. If the direct usage is not possible, then it can be fuse to manufacture new steel.

According to (Coventry, 1999) there is more than 80% of the steel wastage coming from construction fields being recycled into new materials in the Netherlands, despite the fact that almost 100% may be claimed to be recyclable. Steel organization reports that roughly 100% steel reinforcement is made from recycled scrap and 25% steel sections are made from recycled scrap. Scrap steel is almost completely recycled and allowed repeated recycling. Also in Japan, they recycles construction steel such as steel reinforcement and rebar due to fabricated steel or cut to resize off-site with the cutting waste, 100% of steel waste might be recycled to keep away from wastage at construction site.

GLASS

According to (Coventry, 1999), in UK, 425, 000 tonnes of glass has been recycled. However, the recycling rate is fairly low in Hong Kong 1% comparing with countries such as USA, Japan and Germany which their rates are 20, 78 and 85%, respectively. Glass can be reused in the construction industry for a number of applications:

(i) Window: (Coventry, 1999) thought that window glass might be reusing on construction that will be depend on how they deal with glass handling, storage, transportation from/to construction site, and the quality.

(ii) Glass fibre: for material properties improvement, glass can be recycled in the manufacture of glass fibre using long easy process starting from collecting the waste to recycle pin then transported to treatment plant, the glass then should be sorted according to its colour and type and washed to clean it from any impurities after that glass crushed and melted then moulded into new product. Glass can be used in thermal and acoustic insulations, which can be mixed with strengthen cement, gypsum or resin products.

(iii) Filling material: they had practiced recycling for glass in UK as a fine material for cement replacement called ConGlassCrete that support the strength of concrete.

(iv) Tile: in US 100% replacement of recycled glass that gives good-looking reflective appearance on the exterior after burnishing.

(v) Paving block: in United State they created aggregate from recycled glass by crushing. Also in Hong Kong, they are developing this recycling technology, which can produce advantages such as promote good-looking reflective appearance on the exterior after burnishing, minimize water absorption of concrete block and provide good compressive strength.

However, the problems on instability, sharpness of aggregate and alkali-silica reaction expansion need to be resolved. By adopting pulverized fly ash

for depressant in alkali-silica reaction and reduce the impurities are necessary in improving the quality of paving block adopting recycled glass aggregate.

(vi) Asphalt in road: 15% of old glass had been recycled forming asphalt in Taiwan. Furthermore glass needed to grind to very soft materials replacing asphalt

(vii) Aggregate in road: also in US material called ‘ glassphalt’ has been made from crushed glass and used as an aggregate in bituminous concrete pavement.

(viii) Man-made soil: Japan practices adopted waste glass as ultra-fine particles at high temperature.

MASONRY

Masonry waste usually crushing as recycled to become masonry aggregate. So after grinding till become masonry aggregate will be such thermal insulating for concrete. it can also help concrete to be more strength with comfortable thermal insulation, masonry waste can be used after recycled for traditional clay bricks

(i) Crushing recycle masonry aggregate till be as ash then will be replacement for clay in brick including sand sodium silicate brick.

(ii) Using masonry aggregate in traditional clay brick in this case it prefers to avoid any contain of any element that will prevent effects on durability and strength of clay brick.

(iii) In case of single masonry in sodium silicate brick it might contain some of elements like lime but have to be under pressure of 15 bars to create sodium silicate bricks.

NON-FERROUS METAL

The major non-ferrous metal materials gathered from construction sites are aluminium, copper, lead and zinc (Coventry, 1999). Furthermore after separations and sorting of those materials, they can be sold directly to the scrap metal traders for recycling or directly to end-user by melting. In UK, the usage of aluminium is up to 95, 000 tonnes with about 70% recycled in 1997, recycling of copper is up to 119, 000 tonnes out of a national market of 262, 000 tonnes used (100% recycling rate can be achieved).

While paper and cardboard form approximately 37% of construction wastes by volume (EPD, 2002). Recycling companies usually reprocess them as paper product by purification.

PLASTIC

In fact, it is very hard to recycle plastic wastages if they are blended with other plastic or impure materials but according to (Hendriks and Pietersen, 2000) great possibility to reuse materials such as polyethylene (PE), polypropylene (PP), polystyrene (PS) and Polyvinylchloride (PVC) especially if they being gathered properly segregate and spotless.

Because of the damages in some of the characteristic of the old plastic the possibilities of high level recycle will be definitely restricted. Virgin material should include in recycling. The recycled materials are utilized for the manufacturing of new plastic includes 70% recycled material; 30% virgin

material is utilized for securing sufficient ultra violet (UV) resistance in the Netherlands. Furthermore it might be probable to develop this substitute ratio up to 80 or 90% in the coming years.

According to (Coventry, 1999) there are many major chances to address when considering the recycling of plastic such as:-

(i) Panel: in 1992 roofing panels have been started due to the recycling of diaphanous PVC. Because of the impurity and the consolidation, the recycling materials have less quality than new roofing component, so that should be applied for only the inferior face. This panel must be transformed to powder using cryogenic milling. Then powder should mingle with plasticizers and also mix up with other materials to produce new panel.

(ii) Plastic might be street furniture, roof and floor, piling, PVC window, noise barrier, cable ducting and pipe, cladding and insulation foam through recycling and redesign for usage.

(iii) there are new methods has been developed to allow construction materials to be with time infused with recycled plastic ingredient in order to increase strength, durability and impact resistance, and improve appearance.

TIMBER

The wastage of wood from building site operations is generated in huge amount all over the world. According to (Coventry, 1999) he mentioned to that the wastage of timber generated in UK is more than 2. 5 tonnes per

year. For sure, wastage of wood has possibilities to be recycled after collection for some purpose such as:

(i) Timber wastage coming from building activity might be utilized directly for reusing in any applications in construction projects but before reusing need to clean the from nails and resize the them to the proper way. Furthermore unspoiled timber should be reused as board, beams, doors, floorboard, roof beam, balcony ramparts, partitions, and pile. In Japan they already developed wood waste into new technology turning them to furniture, shoring wooden pile for relocate pine trees, wood bench and timber stair.

(ii) A special lightweight concrete might be formed from aggregate made from recycled small wooden pieces.

(iii) According to (Hendriks and Pietersen, 2000) in Japan wood waste might be recycled as energy sources, for Ex. fuel, charcoal for power generation. Also there are more than 400, 000 tonnes of wood from building activities are produced in Netherland.

(iv) wood pieces wastage throwing from building activities might be recycled and reused as new building materials as partitions, board for roof, ceiling and floor, cladding in agricultural building, advertisement panels, a packaging substitute, wall and sound barrier.

(v) Paper, In Japan, they recycled timber producing board and mulching. Besides that wastage of wood might be mixed with topsoil to improve soil texture and coated with plastic to produce material called plastic lumber.

(vi) Chipped timber is recycled by spraying them onto sloped soil surface in Japan, which is called “ geofibre”.

(vii) Timber waste can be recycled to create insulation board, kitchen tool and furniture from the chipped timber under pressure at around 180 °C for 40 min with