Chapter 2

Waste Minimization

Mixed demolition waste

Mixed construction waste

2.1. Why waste minimization?

2.1.1. What is construction and demolition (C&D) waste?

. C&D Waste defined by the Environmental Protection Department (March, 2000):

Construction waste comprises of unwanted materials generated during construction, including rejected structures and materials, materials which have been over ordered or are surplus to requirements, and materials which have been used and discarded. Waste arises from a number of different activities carried out by the Contractor during construction and maintenance and may include:

. Wood from formwork and false work.
. Equipment and vehicle maintenance parts, including machinery used in tunnel boring.
. Material and equipment wrappings.
. Waste bentonite and spoil contaminated with bentonite.
. Unusable or surplus cement/ grouting mixes.
. Damaged/surplus/contaminated construction materials.

Demolition wastes are generated as a result of site clearance and site formation works. Demolition wastes may include:

. Brick, concrete, reinforcing bars and other rubble.
. Derelict equipment, plant and furniture.
. Wood and general refuse.
. Felled trees.

Depending upon the nature of structures and activities which have been undertaken, demolition waste may be inert, mixed with putrescibles or contaminated. The uncontaminated waste should be reused if found to be suitable, otherwise this material should be delivered to landfills for disposal.

. C&D Debris defined by the Environmental Protection Agency (EPA) of United States in 1998 (Franklin) as:

C&D debris is waste material, which has arisen from processes of construction, renovation, or demolition of structures. Structures include buildings of all types (both residential and non residential) as well as roads and bridges. Components of C&D debris typically include concrete, asphalt, wood, metals, gypsum wallboard, and roofing. Land clearing debris, such as trumps, rocks and dirt, are also included in some state definitions of C&D debris.

References

Web site

- EPD, Environmental Protection Department
http://www.info.gov.hk/epd/
- EPA, Environmental Protection Agency
http://www.epa.gov
- Waste Reduction Task Force for the Construction Industry
http://www.info.gov.hk/epd/waste/cdm

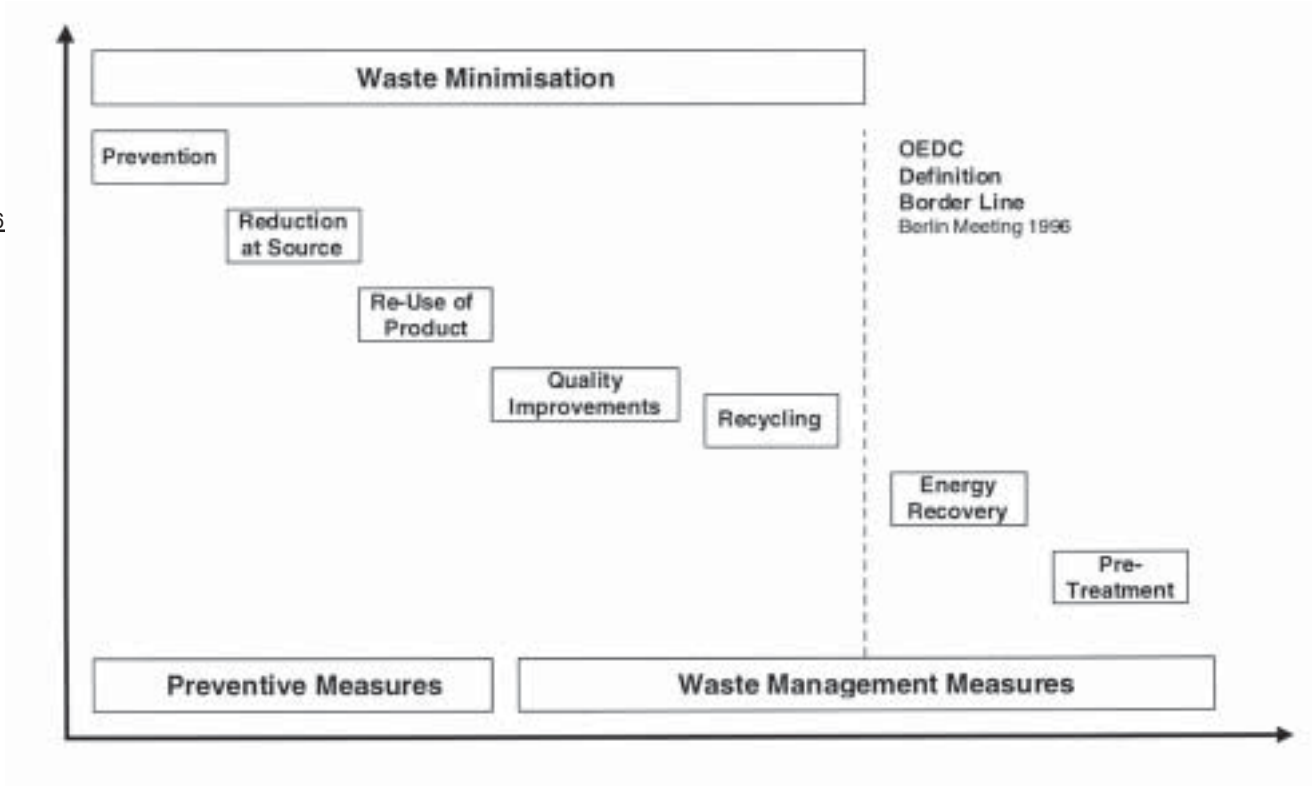


Figure 1: OECD working definition on waste minimization agreed at the Berlin workshop, 1996. (source: Information on Waste Management Practices, A Proposed Electronic Framework, EEA, Technical Report No. 24, July 1999).

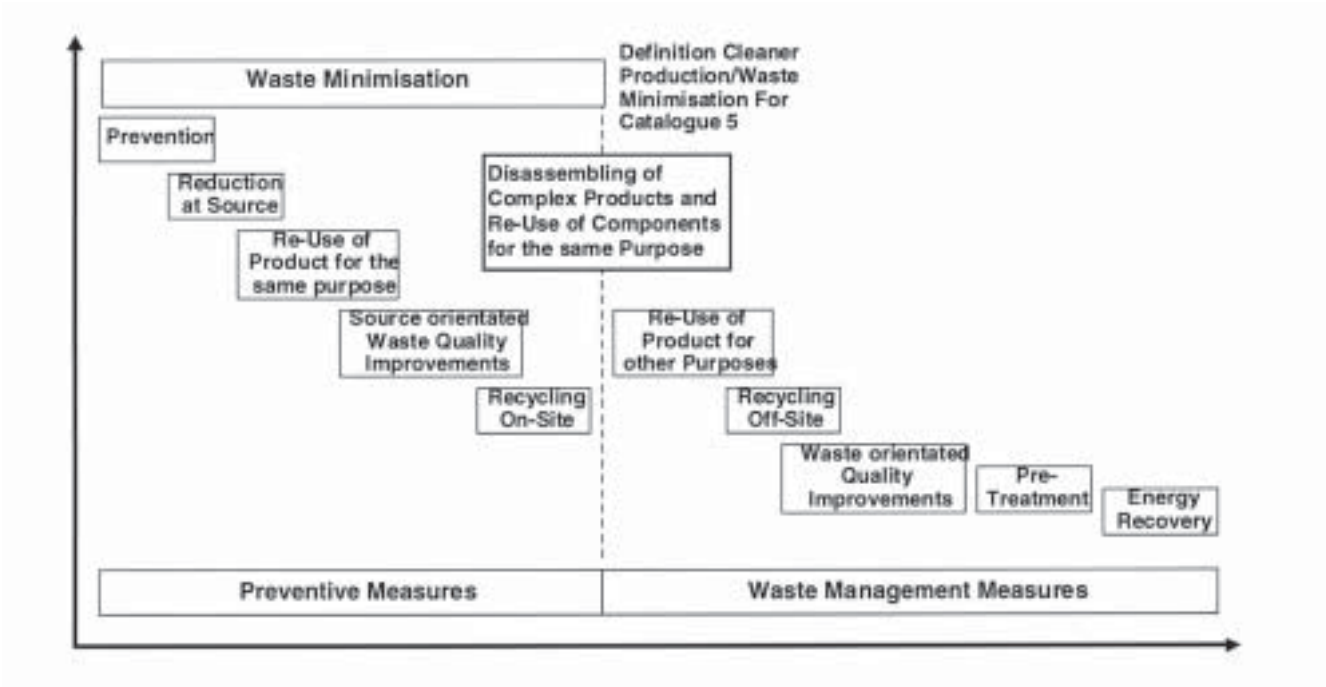


Figure 2: ETC/W Definition of cleaner production/waste minimization, agreed at the task team meeting in Stuttgart, 1998. (source: Information on Waste Management Practices, A Proposed Electronic Framework, EEA, Technical Report No. 24, July 1999).

2.1.2. What is waste minimization?

. **Waste minimization is defined by the Environmental Protection Agency (EPA) of United States as:**

Any method that reduces the volume or toxicity of a waste that requires disposal. In a practical sense, it is any method that reduces the amount of waste. Government regulations, as well as internal cost effectiveness, require that the production and therefore the disposal of all wastes, and particularly hazardous wastes, be kept to a minimum.

. **Waste minimization is defined by Crittenden and Kolaczkowski (1992) as (source CIRIA SP 134) :**

Any technique, process or activity which either avoids, eliminates or reduces waste as its source or allows reuse or recycling of the waste for benign purposes.

. **Waste minimization is defined at a workshop in Berlin organized by OECD as (source EEA technical report 24, July 1999):**

("Building the Basis for Common Understanding on Waste Minimization", OECD Workshop 1996)

A definition of waste minimization was worked out according to the following elements in order of priority:

- Preventing and/or reducing the generation of waste at the source.
- Improving the quality of waste generated, such as reducing the hazard.

Encouraging reuse, recycling and recovery.

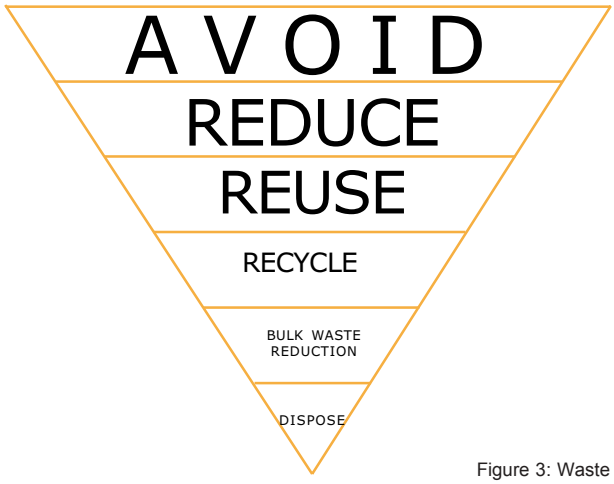


Figure 3: Waste minimization hierarchy

References

Journals

. *Information on Waste Management Practices, a Proposed Electronic Framework,* EEA Technical Report No. 24, July 1999.
. *Waste Minimization and Recycling in Construction, Design Manual,* CIRIA, Special Publication SP 134, 1999.

Web sites

. EPA, Environmental Protection Agency
http://www.epa.gov
. CIRIA, Construction Industry Research and Information Association
http://www.ciria.org.uk
. EEA, European Environment Agency
http://www.eea.eu.int
. OECD, Organization for Economic Cooperation and Development
http://www.oecd.org

	C&D Material (100%)			
	C&D Waste (16.5%)		Public Filling (83.5%)	
	Private Projects (8.7%)	Public Projects (7.8%)	Private Projects (44.6%)	Public Projects (38.8%)
Civil works	0.4%	1.5%	31.9%	26.9%
Fitting out new buildings	0.6%	0.2%	1.4%	1.5%
Renovating old buildings	2.9%	0.7%	2.1%	1.2%
Constructing new buildings	4.3%	5.1%	9.2%	9.2%
Demolishing old buildings	0.6%	0.3%		

Table 1: Summary of survey results on C&D material generation (Source: EPD, 2000)

Components	Composition of each category of C&D waste received at landfill sites (% by weight)				
	Road work material	Excavated soil	Demolition waste	Site clearance	Renovation waste
Soil/Sand*	23	73.8	21.5	33	19.4
Concrete/Mortar*	16.9	1.2	10.8	4.6	7.4
Rock/Rubble*	14.4	12.5	27.7	15	38.8
Reinforced concrete*	14.2	0.4	5.8	0.9	7
Bricks/Tiles*	0.8	0.4	12.1	1.4	9.6
Slurry & mud	1.8	9.7	1.5	1	3.1
Asphalt	24.7	0	0	0.2	0
Cement contaminated	1.7	0.4	3.2	15.6	3.3
Wood	0.6	0.9	10.5	13.3	7.1
Ferrous metals	0.5	0	0.6	1	1.3
Non-ferrous metals	0	0	0.7	0.2	0.1
Others (including bamboo, trees, glass, plastics, bulky waste/fixtures, organics & garbage)	1.4	0.7	5.6	13.8	2.9
Total	100	100	100	100	100
Percentage of total quantity of C&D waste landfilled	5.2	59.4	8.5	14.6	12.3

Note:
* Inert materials. which are considered suitable for public filling area. The above figures are estimated by visual inspection of 3060 trucks loads delivering C&D waste in 1995. They should be regarded as indicative only rather than actual composition of C&D waste during the year.

Table 2: Composition of C&D waste disposed of at landfills in 1995 (Source: EPD, 1995)

2.1.3. C&D waste generation

Construction and demolition waste in Hong Kong is a major problem due to the high population density, the scarce availability of space and the development in economics and infrastructure.

In 2000, as much as 37,690 tones per day of construction and demolition waste was generated of which 30,210 tones per day (80%) was transported to public filling areas for reclamation use, and 7,480 tones per day (20%) was disposed of at landfills.
The latest statistics on C&D waste generation can be found on the EPD web site.
The inert C&D materials (mainly sand, bricks and concrete) both suitable for land reclamation and land formation works, are disposed of at the public filling areas. The non inert portion (bamboo, plastics, glass, wood, paper, vegetation and other organic materials) ends up at municipal solid waste landfills.

References

Web sites

· EPD, Environmental Protection Department
http://www.info.gov.hk/epd/
· Waste Reduction Task Force for the Construction Industry
http://www.info.gov.hk/epd/waste/cdm

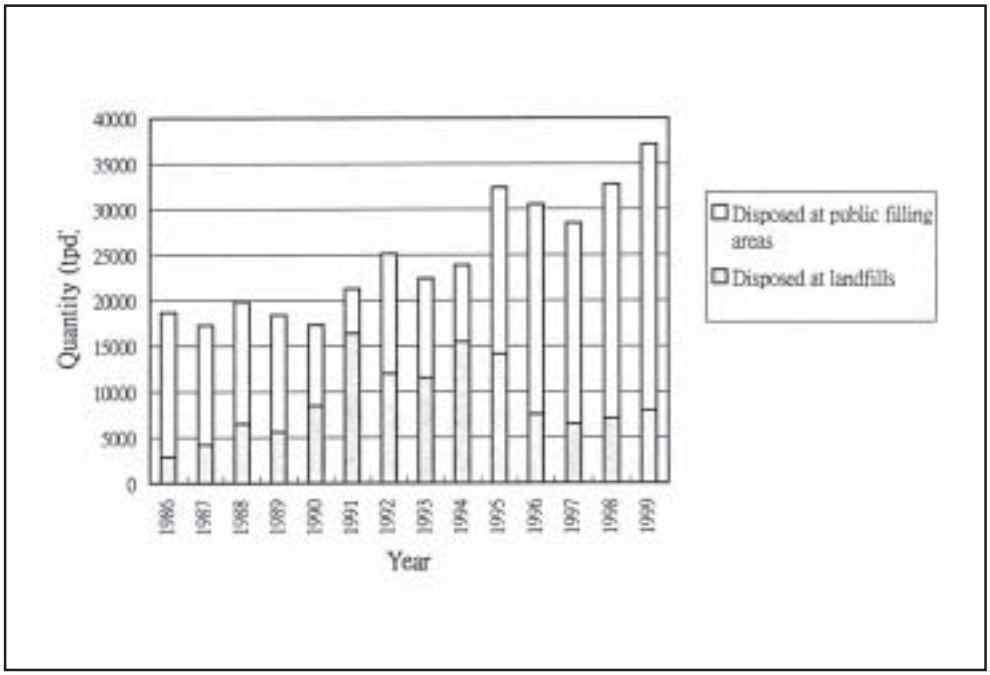
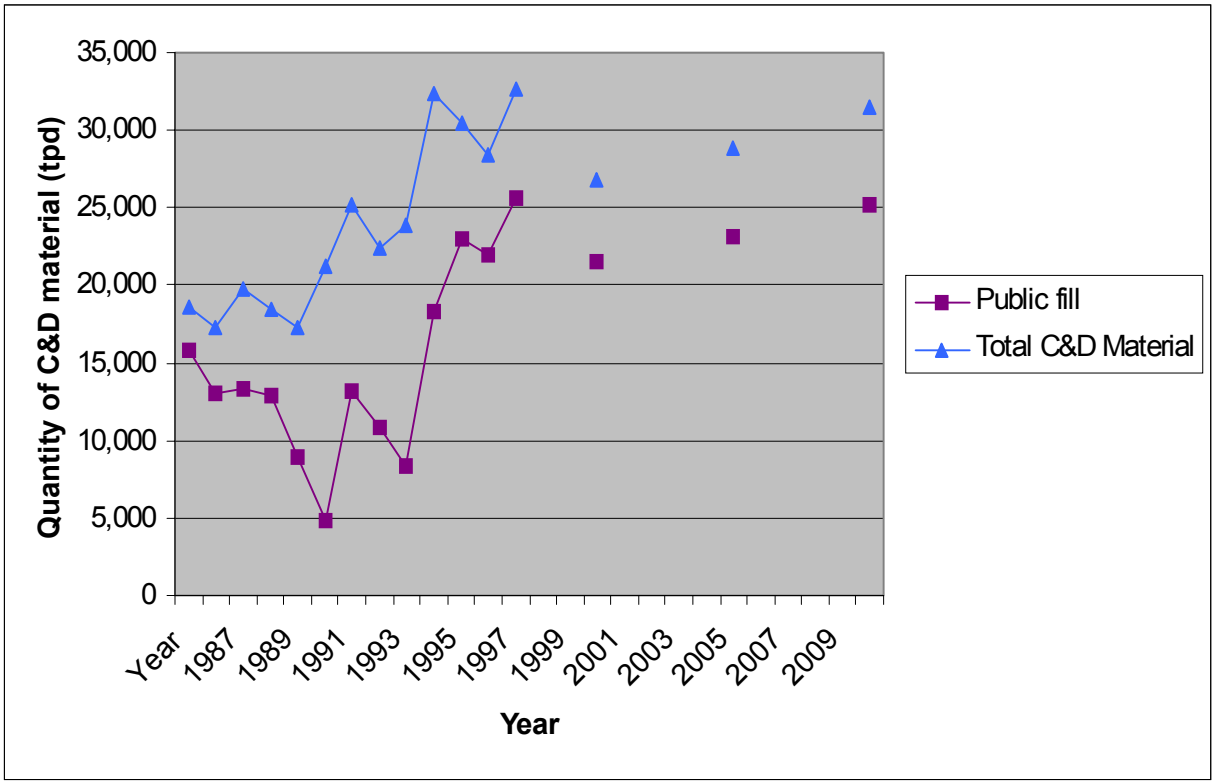


Figure 4: Quantities of C&D material generated from 1986 to 1999 (Source: Yuen, 1999 and EPD, 2000)



Top: Figure 5: Quantity of C&D waste disposed of at public filling areas and total C&D material (Source: Mouchel, 1998).
Bottom: Table 3: Quantity of C&D waste disposed of at public filling areas and landfills 1986-2011 (Source: Mouchel, 1998).

Year	*C&D material to landfills*		*Public fill to public filling areas*		*Total quantity (tpd)*
	Quantity (tpd)	*% of total C&D material*	*Quantity (tpd)*	*% of total C&D material*	
1986	2,850	15.3%	15,780	84.7%	18,630
1987	4,220	24.4%	13,070	75.6%	17,290
1988	6,520	32.9%	13,320	67.1%	19,840
1989	5,580	30.3%	12,820	69.7%	18,400
1990	8,450	48.7%	8,900	51.3%	17,350
1991	16,380	77.0%	4,880	23.0%	21,260
1992	11,960	47.6%	13,170	52.4%	25,130
1993	11,520	51.4%	10,880	48.6%	22,400
1994	15,480	64.9%	8,370	35.1%	23,850
1995	14,120	43.6%	18,280	56.4%	32,400
1996	7,520	24.6%	22,990	75.4%	30,510
1997	6,480	22.8%	21,950	77.2%	28,430
1998	7,030	21.5%	25,680	78.5%	32,710
2001	5,360	20.0%	21,460	80.0%	26,820
2006	5,770	20.0%	23,080	80.0%	28,850
2011	6,310	20.0%	25,220	80.0%	31,530

2.1.4. The problem

Hong Kong will soon be running out of both landfill spaces and public filling areas. As the majority of C&D waste (80% in 2000) is disposed of at public filling areas for reclamations, the government is examining solutions to reduce C&D waste and promote its reuse and recycle. To minimize waste, it is essential to take preventive initiatives by reducing waste before it is generated at the design stage (it is less difficult and less expensive).

The EPD web site mentioned the following:
"Hong Kong is running out of both reclamation sites and landfill spaces. Our landfills will be filled up in 10 to 15 years, and approved reclamation projects will only provide outlets for the public fills until 2004. In recent years, the mixed construction and demolition waste accounts for more than 40% of the total waste intake at the three strategic landfills. If there are insufficient public filling areas and no waste reduction measures, more public fill will be diverted to landfills and the landfill lives will be shortened."

References

Web sites

· EPD, Environmental Protection Department
http://www.info.gov.hk/epd/
· Waste Reduction Task Force for the Construction Industry
http://www.info.gov.hk/epd/waste/cdm

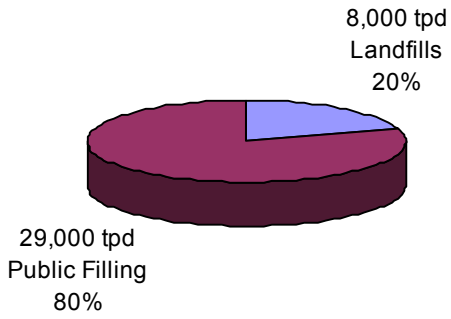


Figure 6: Quantity of C&D waste transported at public filling area and disposed at landfills in 1999 (Source: EPD, 2000)

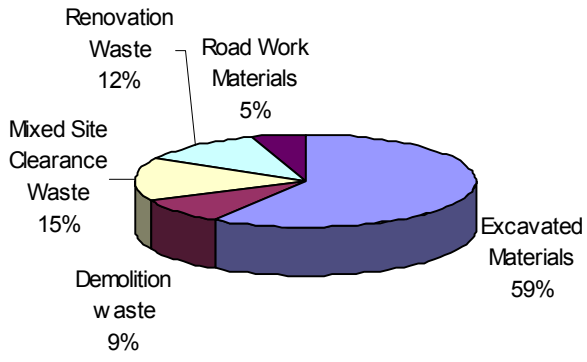
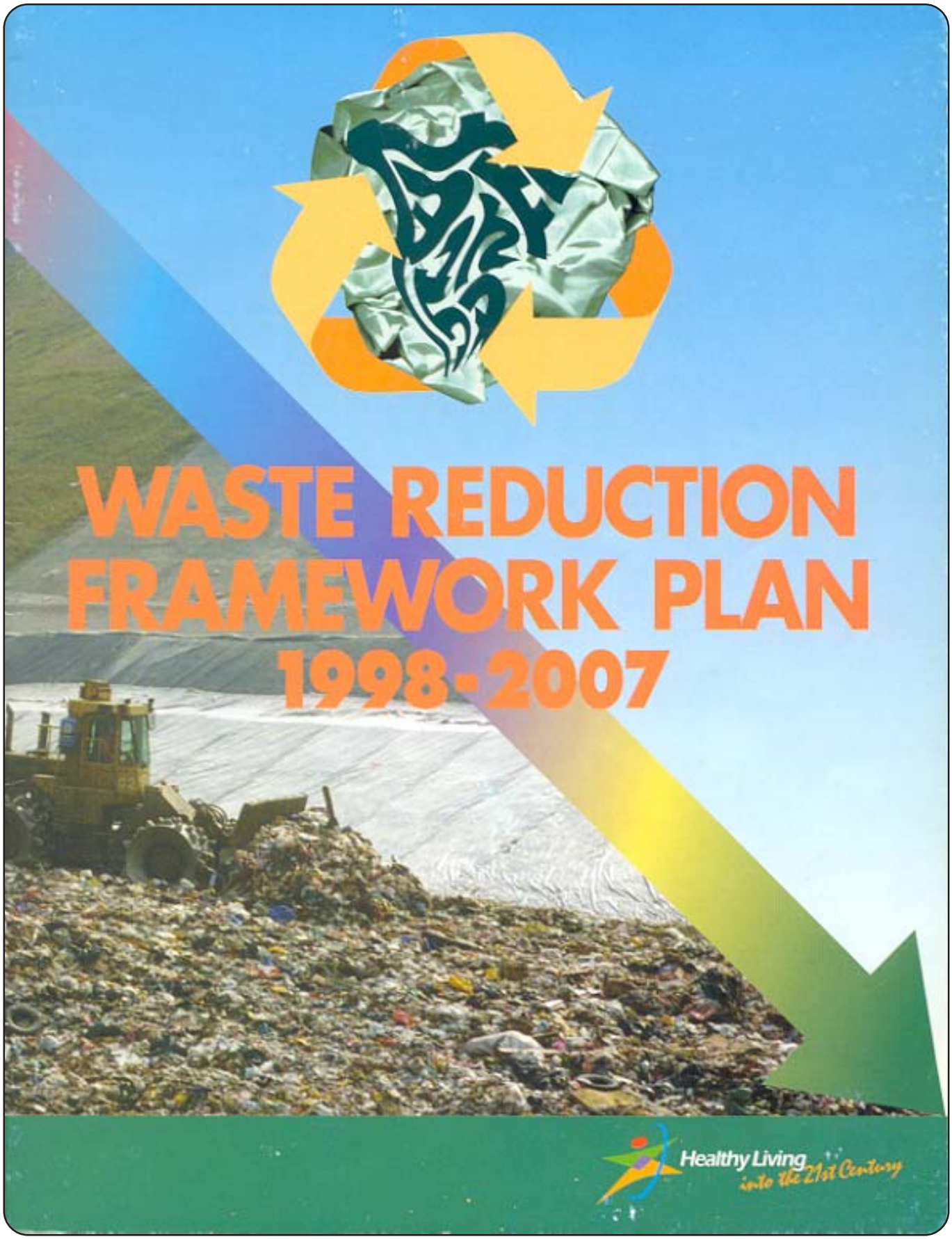


Figure 7: Analysis of source of C&D waste received at landfills (Source: EPD, 1995)


WASTE REDUCTION
FRAMEWORK PLAN
1998-2007
Healthy Living
into the 21st Century

2.1.5. The need for waste minimization action

The following issues show the need for waste minimization:

- **The consideration of environmental issues is becoming increasingly important in development and architecture, hence designers have to produce more efficient, sustainable and waste minimization designs.**

" The construction industry is under pressure to play its part in more environmentally sustainable development. This comes from a need to respond to the environmental concerns expressed in Agenda 21, the program for sustainable development in the 21st century agreed at the United Nations Conference on "The Environment and Development" in Rio de Janeiro in 1992. It also comes from economic and local environmental concerns."
(Source: CIRIA "Waste Minimization and Recycling in Construction", SP 134, 1999).

- **The existing situation of C&D waste generation and its disposal, as mentioned before, needs to be minimized.**

- **The consideration of renewable and recycled sources is also a part of waste minimization.**

"The renewable resources are those that can be renewed or harvested regularly, such as timber for construction. These resources are renewable as long as the right conditions for production are maintained…Non-renewable resources are those that cannot be renewed through harvesting, e.g. iron ore, or that renews themselves very slowly. Many of these are seriously limited – metals and oil are the most exploited, but in certain regions materials such as sand and aggregates are also becoming rare. Everyone is quite clear about the fact that many of the most important resources will be exhausted in the near future."
(Ecology of Building Materials, Bjorn Berge, 2000)

- **Also it is the government's will to reduce C&D waste generation, and to improve the current situation.**

"Alternatives are constantly being sought for construction waste, which places special burden on landfills. In 2000 the industry generated about 38 000 tones of waste per day, 7 500 tones of which ended up in landfills and the rest in reclamation sites. The Waste Reduction Task Force for the Construction Industry aims to reduce that to 6 000 tones per day by 2004. In 2000, government work contracts included a requirement for waste management plans, which would help reduce the amount of waste being created. A temporary sorting site was set up by the Civil Engineering Department at Tseung Kwan O. Studies were conducted on the use of inert construction waste in concrete, road material and drainage channels. The government also promoted the use of new technologies and on-site sorting of waste and consulted on landfill charges aimed at reducing waste loads".
(Waste Program – Highlights of 2000 – EPD)

References

Books

- **Waste Minimization and Recycling in Construction**, CIRIA SP 134, 1999.
- **Ecology of Building Materials**, Bjorn Berge, 2000.

Journals

- **Waste Program – Highlights of 2000** – EPD.

2.2. Situation in Hong Kong

2.2.1. Policies, regulations and action plan

Waste Program highlights in 1999:

- A 10 year **Waste Disposal Plan** was established in **1989**, to improve waste management.
- A **Waste reduction Framework Plan (WRFP)** was established in **1998**, to reduce the amount of waste requiring disposal over the next 10 years.
- A **Waste Reduction Committee** (WRC) was appointed in **1999**, to oversee the implementation of the plan and double the recovery or recycling of municipal waste by 2007.

The Waste Reduction Framework Plan (WRFP) 1998-2007

In November 1998, EPD (Environmental Protection Department) published a Waste Reduction Framework Plan to arouse the public's concern on the importance of waste reduction and set targets to achieve an efficient and environmentally friendly waste management plan for the next 10 years.

"To reverse the rising trend of waste growth, the Waste Reduction Framework Plan sets out dynamic and environmentally programs to extend the useful life of our strategic landfills; to minimize the amount of waste produced that requires disposal; to help on conserve the earth's non-renewable resources; to increase the waste recycling rate; to identify the true costs of collection, treatment and disposal of wastes; and improve the institutional arrangements."

It plans to reduce the annual waste management costs by about $750 million, and extend the life of landfills from 2015 to 2019.
Facing a challenge of finding land which posses a large enough area for another modern landfill, EPD delivers the message of waste reduction by introducing the principle of **"Avoid, Minimize, Reuse and Recycle".**

Waste Management Action Areas:

- **Waste avoidance**: Waste should not be produced in the first place.
- **Waste minimization**: If waste production is unavoidable, the quantities should be minimized.
- **Waste recovery, Recycling and Reuse**: Should be maximized.
- **Waste bulk reduction**: If it is not possible to recover, recycle or reuse the waste materials, the volume of residual wastes should be reduced before final disposal. This might involve incineration or composting.
- **Waste disposal**: whenever possible the residue left after bulk reduction should be used for construction purposes or reclamation in preference to being dumped at landfills.

Management of C&D Material

The strategies to stop the improper disposal of C&D material, reoccurring are to:

- Provide an adequate number of conveniently located barging points from where the public fill is taken to reclamation.
- Impose charges on C&D material taken to landfills.
- Provide on-site sorting facilities for future public demolition contracts.
- Encourage on-site sorting facilities on private construction sites.
- Provide off-site sorting facilities to separate mixed material. The inert material will then be used as public fill while the decomposable organic waste will be taken into the main waste disposal stream.
- Develop guidelines and codes of practice to reduce C&D material generation.
- Recycle as much as possible for use in less demanding construction works, for example as aggregates.
- Minimize the use of imported marine sand or other fill for reclamation projects.
- Identify new outlets for the material, such as restoring old quarries.

There are limited regulations and code of practices concerning C&D waste in Hong Kong.

PNAP: Practice Notes for Authorized Persons and Registered Structural Engineers:

- PNAP 153 – Tropical Hardwood Timber, July 1992.
- PNAP 243 – Construction and Demolition Waste, June 2000.
- PNAP 245 – Waste Minimization, Provision of Fitment and Fitting in New Buildings, July 2000.

PNRC: Practice Notes for Registered Contractors.

- PNRC 21 – Tropical Hardwood Timber, July 2000.
- PNRC 25 – Submission of Schedule of Building Materials and Products, December 1994.

Recently the government issued a Joint Practice Note on "Green and Innovative Buildings", February 2001.
Other Technical Circulars from Works Bureau:

- No.5/98: On Site Sorting of Construction Waste on Demolition Sites.
- No.5/99 & 5/99A: Trip-Ticket System for Disposal of Construction and Demolition Material.
- No.19/99: Metallic Site Hoardings and Signboards.
- No.29/00: Waste Management Plan.
- No.31/00: Specifications Allowing the Use of Recycled Inert Construction and Demolition Material.

For detailed information, refer to "Appendix" at the end of this publication.

References

Web site

- EPD, Environmental Protection Department
http://www.info.gov.hk/epd/
- BD, Buildings Department
http://www.info.gov.hk/bd
- Waste Reduction Task Force for the Construction Industry
http://www.info.gov.hk/epd/waste/cdm
- Works Bureau of the HKSAR
http://www.wb.gov.hk

2.2.2. Guidelines

There are few guidelines regarding C&D waste minimization in Hong Kong. Most of the time green guidelines only refer to material usage and specifications, and construction and demolition waste management.

HK-BEAM: Hong Kong Building Environmental Assessment Method.

It is a certification program that was initiated and funded in 1996 by the Real Estate Engineering Developers Association and researched by the Department of Building Services of the Hong Kong Polytechnic University and the School of Architecture, University of Wales, Cardiff.
This is a scheme for assessing the overall environmental performance of buildings and its focus lies on the impacts of buildings on local, global and indoor environment. It is a certification program for existing or new office buildings and new residential buildings.
Available publications:

- HK-BEAM, An Environmental Assessment for New Residential Buildings, Version 3/99.
- HK-BEAM, An Environmental Assessment for New Office Designs, Version 1/96R.
- HK-BEAM, An Environmental Assessment for Existing Office Buildings, Version 2/96R.

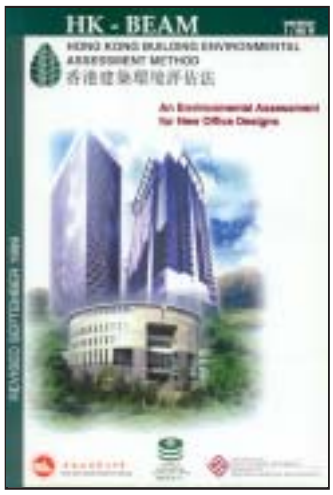
Issues relating to waste minimization:

For new residential buildings:

1. **Building design**
   - Flexible design and fitting out.
   - Waste disposal and recycling facilities.
   - Innovative and unconventional design.
2. **Materials use and specifications**
   - Construction materials
   - Use of recycled materials
   - Use of permanent timber
3. **Construction practice**
   - Environment management plan
   - Demolition waste management
   - Construction waste management plan
   - Timber for temporary works
4. **Operation and maintenance**
   - Tenants/owner's handbook

For new office buildings:

1. **Global issues and use of resources**
   - Use of timber
   - Facilities for recycling materials
2. **Building and local issues**
   - Recycled materials



For further information, the HK-BEAM publications are available from the BEC, Business Environment Council.
Other guidelines specifically on C&D waste can be found on the "Waste Reduction Task Force for the Construction Industry" web site.
For further information, consult green building guidelines published by overseas organizations

References

Books

- **High Performance Building Guidelines**, The New York City Department of Design and Construction, USA, April 1999.
- **Lessons Learned, High Performance Buildings, an Environmental Information and Resource Guide for the Commercial Real Estate Industry**, Earth Day New York, USA, July 2000.
- **Lessons Learned, Four Times Square, an Environmental Information and Resource Guide for the Commercial Real Estate Industry**, Earth Day New York, USA, January 1998.
- **LEED, Green Building Rating System, Version 2.0**, US Green Building Council.
- **LEED Resources, Reference Guide**, June 2001 Edition, US Green Building Council.
- **Sustainable Building Technical Manual, Green Building Practices for Design, Construction, and Operations**, US Green Building Council.
- **Designing In Waste Minimization,** EcoRecycle Victoria, Building Designers Association of Victoria, June 1998.
- **Green Building Design and Construction Guidelines,** R.J. Cole, K.Connery, D. Rousseau, I. Theaker, City of Santa Monica, USA, April 1999.
- **A Guide to Developing Green Builder Programs,** NAHB Research Center for US EPA's Office of Solid Waste and Office of Policy Development, April 1999.

Web sites

· Waste Reduction Task Force for the Construction Industry
http://www.info.gov.hk/epd/waste/cdm
· BEC, Business Environment Council.
http://www.bec.org.hk
· DDC, The New York City Department of Design and Construction
http://www.ci.nyc.ny.us
· USGBC, US Green Building Council
http://www.usgbc.org

2.3. Economics and waste minimization

The consideration of waste minimization can generate advantages such as financial and environmental benefits.

Financial Benefits

Waste minimization can provide financial benefits, and in some cases can even save cost and time. The financial benefits can be appreciated over a short term or long-term period. But overall, cost benefits can be appreciated throughout the whole building process by carrying out an analysis of the life cycle costs. Financial benefits include:

- Reduced transportation costs for waste materials (less transportation because of less material wasted). This includes transportation to and from the site and disposal.
- Reduced disposal costs of waste materials (as the Hong Kong government will soon be implementing new regulations for waste disposal charge)
- Reduced purchase quantity and price of raw materials by waste minimization.
- Reduced purchase price of new materials when considering reuse and recycling (depending on materials).
- Increased returns can be achieved by selling waste materials to be reused and recycled.
- Long term benefits through optimizing the building life concept, by avoiding expenses from demolition and construction of new buildings.

These benefits correspond to global considerations and variations which may appear depending on the project type, situation (whether it is a dense urban area or not), and access to the site (via boat or road). For example if materials from demolition can be stored and reused or recycled directly on site, this will reduce the transportation cost.
Some times, reuse and recycle may not always be financially viable, hence other considerations should be considered such as environmental benefits.

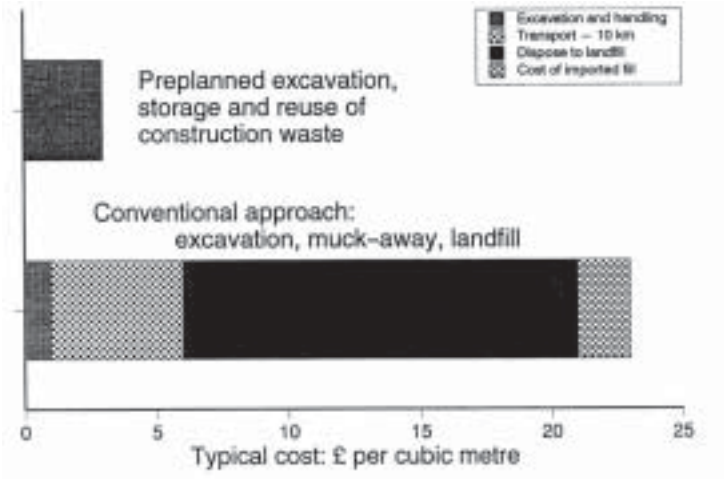


Figure 8: Managing construction waste - alternative approaches (Source: Managing and minimizing construction waste, A practical guide, J. Ferguson...)

There will soon be economic pressures on designers to consider the reduction of waste when the regulations on landfill disposal charge are implemented in Hong Kong (which already exist in many other countries). In Europe, for example, this phenomenon is increasingly stressed by the increase of disposal costs.

Environmental Benefits

Waste minimization can provide environmental benefits, which are important to be considered due to the alarming situation of waste in Hong Kong.
Environmental benefits are also essential to consider because they participate in the improvement of the planet's environment, and therefore take into consideration the next generation's environment.
The environmental benefits are:

- Reduced quantity of waste generated.
- Efficient use of waste generated.
- Minimized amounts of waste disposed of at landfills, which therefore extend the lifespan of landfills.
- Reduced environmental effects as a result of disposal, e.g. noise, pollution.
- Reduced transportation of waste to be disposed of (hence less noise, vehicle emission pollution, and energy used).

Other Benefits

- Increased site safety.
- Increased work efficiency.
- Increased image of the company (Wastewise Green Building Awards, e.g. HKBEAM certification).

The benefits could be improved if green buildings and sustainable designs are considered at the same time.
They include (Source: Green Buildings Pay):

- Direct benefits (economy on fuel bills, market advantage, lower long term exposure to environmental or health problems, greater productivity of workplace).
- Indirect benefits (healthier to use, psychological advantage, enhance company image).

Wider global benefits (global warming, ozone layer depletion, biodiversity, product miles, recycling).

References

Books

- **Managing and Minimizing Construction Waste, A Practical Guide**, J Ferguson, N Kermode, C L Nash, W A J Sketch and R P Huxford, Thomas Telford Publications, London, 1995.
- **Green Buildings Pay**, Brian Edwards *et al.,* E&FN Spon, London, 1998.
- **Waste Minimization and Recycling in Construction, Design Manual,** CIRIA Special Publication 134, 1999.