3 Planning of landfill -general, definition, type, site-

3.1 Introductions

Methods for the final disposal of solid wastes:

1. Dumping on land (open dumping, engineered landfill)
2. Dumping in surface waters (it is banned in many countries now)
3. Feeding to swine (animals)
4. Mixing into soil as soil conditioner
5. Reduction
6. Incineration (early incinerators were a source of noticeable air pollution; it remains waste: ash)

Engineered landfill (sanitary landfill) was developed as a relatively inexpensive alternative to incineration, e.g. communities with sufficient land area. (like, U.S.)

3.3 Engineering aspects

Sanitary landfill: (early time) landfilling with cover at the end of each day’s operation, (today) engineered facility for the disposal of MSW designed and operated to minimize the public and environmental impacts.
Development and completion of a solid waste landfill:
(b) replacement of solid waste in landfill


Landfills are often constructed in sections: staged construction. Advantages? and disadvantages?

Aerial view of area type landfill:


Concerns with landfilling of solid wastes

(1) uncontrolled release and discharge of landfill gases (\(\text{CH}_4\)):
- odor,
- explosion,
- greenhouse effect in atmosphere

(2) uncontrolled release of leachate:
- contamination of ground water and surface water

(3) breeding and harboring of disease vectors:

(4) release of the trace gases arising from the hazardous materials that were often placed in landfill in the past:
- public and environmental impact

Goal for the design and operation of a modern landfill is:
to eliminate or minimize the impacts associated with these concerns.
3.2 Classification, methods of landfills

**Classification in US:**

<table>
<thead>
<tr>
<th>Class</th>
<th>Type of waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (secured landfill)</td>
<td>Hazardous waste</td>
</tr>
<tr>
<td>II (monofills)</td>
<td>Designated waste (combustion ash, asbestos)</td>
</tr>
<tr>
<td>III (sanitary)</td>
<td>Municipal solid waste (MSW) (commingled)</td>
</tr>
</tbody>
</table>

In III, not only MSW, but also *nonhazardous industrial wastes* and sludge from water and waste water treatment plants are accepted (solid content should be greater than 51%). *Liquid waste is no longer accepted.*

**Japan:**

Three types of landfill

- Least controlled LF
- Controlled LF
- Strictly controlled LF

Waste management and public cleansing law

- Least controlled landfill
  - **five stable wastes** (安定5品目)
  - plastic tip, rubber tip, iron tip, glass and ceramics, concrete

- Controlled landfill
  - non-hazardous stable items (rubber, metal, glass, ceramic, plastic, construction waste)

- Strictly controlled landfill
  - Hazardous waste (ash, sludge, mining tail, dusts)
  - separation from the outside environment

*Leachate control*  
*Seepage control*  
*Landslide protection*  
*Subsidence protection*
Minimum liner requirements of the USEPA: Daniel (1993)

(a) for hazardous waste landfills: 
*double liner system + LCL + LDL*

- **RCRA:** Resource Conservation and Recovery Act
  - 0.9m thickness with $K < 1 \times 10^{-9} \text{m/s}$
  - detecting in 24hrs

(b) for non-hazardous waste landfills: 
*single liner system + LCL*

- 0.6m thickness with $K < 1 \times 10^{-9} \text{m/s}$

Methods of landfilling

- **Excavated Cell/Trench Method:**
- **Area Method:**
- **Canyon/Depression Method:**
- **Offshore or inshore reclamation**
  - *Tokyo Bay (Sinkamen landfill)*

Excavated Cell/Trench Method

- **cell (square about 300m in W and L)**
- **trench (60-300m in L and 5-15 m in W)**
- **depth: 1-3m**
- **excavated soil for daily cover**
- **dewatering ??**

Suitable conditions:
- adequate depth of cover material is available at the site;
- water table is not near to the ground surface.
  - but if special provisions for preventing groundwater from entering into the landfill.

Area Method

- cover soils is hauled from adjacent land or from borrow pit areas.
- compost or geomembrane can be also used for daily cover
- **Earth embankment**
- **Solid waste cells**
- **Final cover (sloped)**

Suitable Conditions:
- terrain is unstable for the excavation of trenches and cells;
- high-groundwater conditions.
Canyon/Depression Method

Factors in design and operation:

geometry of the site, quantity and quality of available cover material, hydrology and geology of the site, type of leachate and gas control facilities and access to the site.

Critical factor
control of surface drainage
in design ?? in operation ??

Offshore or on shore reclamation

main concerns:
impact to marine environment

Advantages:
scale merits especially for the communities with less available land for landfilling like mega-cities in Japan (Tokyo and Osaka)

Disadvantage:
construction const.

Site Visit: Tokyo Off landfill site
Date => 30th July p.m.

3.3 Landfill siting considerations (処分場建設地の選定)

Siting of new landfills is one of the most difficult tasks in implementing an integrated solid waste management program.

The factors considered in evaluating potential sites for the long term disposal of solid wastes:

(1) hauling distance（運搬距離）;
operational cost for transporting the waste

(2) location restrictions（現地条件）;
preventing accident, avoiding public and environmental impact preventing natural disaster

(3) available land area（有効土地面積）;
not only for landfill but also adequate buffer zone（緩衝地帯）, office, facilities, access and utility access roads and so on.

(4) site access（交通の便）;
construction of access roadway, transportation facilities
(5) soil conditions;
  daily and final cover materials, liner materials,
drainage materials

(6) climatological conditions;
(7) surface water hydrology;
(8) geologic and hydrogeological conditions;
(9) local environment conditions (周辺環境);
  residential and industrial development near the site must be
carefully considered.
(10) potential ultimate uses for the completed site (後地利用).
    As the ultimate use affects the design and operation, it should
    be considered before the layout and design is begun.
    stage planning program during and after landfilling

What is Ideal LF?

Various LFs
in
Southeast Asian countries and
Japan
Description of Payatas
Dumping Site
Quezon City
Philippines

Approximately 22 hectares – composed of two dumpsites, old and new, 35 – 40 meters high

Payatas open dumping sites for Metro Manila

Slope failure at Payatas
July 11, 2000

• garbage about 40m high
• 60,000 cubic meters of waste slid
• killed 250 people from 700 families
• up to 800 people missing

View from east taken 26/9/2000
Recovery work

26/9/2000

Geoen Eng by Dr J Takemura

CURRENT

Thai Nontaburi province dumping facility

Landfill under operation

23/07/2019 Geoen_Eng by Dr. J. Takemura

23/07/2019 Geoen_Eng by Dr. J. Takemura
Pit for construction soils

Operating Sanitary landfill in Utsunomiya, Japan

Dumping site at Phnom Penh

Solid waste management in Tokyo

Tokyo Tama Regional Recycle Association
How to make long time use of landfill
Regional Solid Waste Landfill
Futatsuduka, Hinode Town in Tokyo

- Municipal waste; incineration residue, non-hazardous and nonflammable shredded waste
- Capacity: total: 3.7Mm³ waste: 2.5Mm³ cover soil: 1.2Mm³
- Duration of fill: original design from 1998 to 2014 current to 2028
- Cost: about 50 billion yen

Proper control and operation
Staged reclamation

- Recombination of the 1st stage
- Recombination of the 2nd stage
- Recombination of the 3rd stage

Proper control and operation
Reclamation method

- Cell style is adopted, i.e., waste is firstly crushed and leveled by bulldozer and then, cover the earth over the waste as if the waste is wrapped.
- Earth cover: about 50cm thickness for each cell more than 1m for final cover

Change of annual reclaimed volume at Futazuzuka

- Introduction of Eco-cement facility
  $\Rightarrow$ 100% recycle of incinerated ashes
- Reduction of incombustible waste by 3R
- Peak of reclamation: expected lifetime: 2012 $\Rightarrow$ 2005

Record
Target

http://www.tama-junkankumiai.com/
Policy of Futatsuzuka LF

I. Facilities for safe disposal site
II. Environmental preservation
III. Proper control/operation

Facility locations

- Land area: 59.1ha
- Development area: 31.1ha
- Fill: 18.4ha
- Others: 12.6ha
- Green area: 28.1ha

Process of eco-cement production

Futatsuzuka Landfill

Eco-cement facility
Plan of facility locations

- Land area: 59.1ha
- Development area: 31.1ha
  - fill: 18.4ha
  - others: 12.6
- Green area: 28.1ha

A cross sectional view of landfill - safety facilities -

Prevention of leachate leaking

- Proper water management system; to prevent the rise of leachate level in the fill
- Proper liner system;

But no cover liner system only cover soil in Japanese standard

How to prevent rise of leachate level in the fill in case of no cover liner

- Lot bank
- Collection and drainage pipe
- Adjusting pool for adjusting and storing leachate
Three types of composite Liner

1. Bottom flat part
   - Thickness of protected soil = 100 cm
   - Thickness of nonwoven fabric = 4.0 mm
   - Thickness of geotextile = 5.0 mm
   - Specific pipe of monitoring / mat of raw water conveyance

2. Gentle slope (1:3.0)
   - Thickness of protected soil = 50 cm
   - Thickness of the upper mixed soil = 30 cm
   - Thickness of the lower mixed soil = 30 cm
   - Thickness of nonwoven fabric = 4.0 mm

3. Steep slope (1:1.5)
   - Thickness of protected soil = 50 cm
   - Thickness of ground treatment = 20 cm
   - Thickness of nonwoven fabric = 1.5 mm
   - Thickness of geotextile = 6.0 mm
   - Specific pipe of monitoring / mat of raw water conveyance

Protection of liner system from underground water

- Collection and drainage pipe of underground water
- Monitoring leachate from specific pipe in the liner
- Electric leakage detection
- Leaking leachate monitoring system

Leaking leachate monitoring system

- Detect by electricity / box cut off
- Detect by wireless / box cut off
- Detect by underground pipe / box cut off
- Detect by specific pipe of monitoring / mat of raw water conveyance

- Unusual happening!
  - Stop leakage of leachate quickly
  - Specific pipe of monitoring
  - Leaking pipe detected
  - Cemented piping
  - Mat of raw water conveyance
  - Location diagram for specific pipe of monitoring
Electric leakage detection system

Measures in planning stage
collection stage
reclamation stage
post closure stage
disclosure of monitored data in WEB

How to construct new landfill

Closed type Controlled IW LF

- Landfill area: 31,131m²
- Capacity: 422,349m³
- Total land: 118,679m²
- Daily reclamation: 60m³
- Reclamation period: 18~20 yrs
Closed type - Zero Leachate Release

Conceptual diagram of closed type landfill

Leachate treatment F

Ceiling

Sprinkling

Waste

GW collection pipe

Leachate CP

Leachate tank

Treated water

GW monitoring

Treated W tank

Various barriers against leachate leakage

Waste

Stabilized soil

Non-woven geotextile

Geomembrane

Protection soil

Bentonite mixed soil

Base compacted fill

Base layer

Leakage detection

Landfill facility observed after construction

photo taken 2015/12/9