IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES

INTEGRATED WASTE MANAGEMENT FOR A SMART CITY

FOCUSSED ON MSW, C&D AND E-WASTE MANAGEMENT

Welcome to Week-10

BRAJESH KUMAR DUBEY

DEPARTMENT OF CIVIL ENGINEERING

Construction Process

- In most cases, the construction job will be competitively "bid"
- A "bid package" is prepared
  - The construction drawings
  - The construction specifications
- The bid is advertised
- Potential bidders can pick-up or purchase copies of the bid package

- The potential bidders (construction companies) will then decide whether they want to bid on the job
- If so, they must prepare a cost proposal
- Depending on the bid package, the cost proposal may have to be very detailed
- A deadline is submitted for receipt of the construction proposal

Construction Process

- The bids will be reviewed by the engineer and the client. References may be checked.
- The "top" bidder is selected. This may or may not be the "low" bidder.
- The client/engineer and the contractor must then negotiate a contract

Construction Process

- The client normally retains an engineering firm (or perhaps uses in-house engineering staff) to oversee the construction of the project.

- In contract negotiations, a start date, a construction period, working hours, reporting and billing requirements, and meeting frequencies are established.
- The contractor has a set number of days to reach two major milestones:
  - Substantial completion
  - Final completion

Construction Process

- Substantial completion: All major components of the project have been constructed
- Final completion: Everything is complete

- Billing. The contractor bills the client throughout the process as work is completed. Only work that is completed is paid for. Some amount is always held back until project is completed.
- The contractor must submit invoices throughout the project.
- The engineer will review these invoices and make recommendations to the client as to whether they should be paid.

Construction Process

- The contractor is very specific in billing:
  - Mobilization (bringing all supplies and equipment to the site)
  - Materials
  - Completion of tasks
  - Testing
- The contractor is obliged to construct the project at the bid price

- A contingency is normally budgeted as part of the project
- If the contractor finds that the project can not be constructed as designed or if the engineer makes a change in the field, a change-order will have to be initiated.

Construction Process

- The engineer and client meet with the contractor frequently throughout the project (e.g. weekly)
- The contractor is asked to summarize work completed to date; present plans for near future; give updates on staffing, materials delivery; submit paper work; etc.
  - As part of the bid documents, the contractor is required to submit lots of paperwork prior to beginning work on specific tasks
  - For example, before the liner is placed, a liner construction plan would have to be submitted and approved by the engineers

Construction Process

- If the contractor has questions along the way, they may be able to work in out in the field with the engineers field rep, but the official process is to submit an RFI (request for information).
- For example, sometimes the drawings are not as clear as the engineer might think

Construction Process

- Testing of materials is a big part of the construction of a solid waste management system.
- The contractor is required in the bid package to have soils, pipes, geosynthetics, etc. tested in the field or by an outside lab.
- These lab reports will be submitted.
- The engineer will also take additional samples and send them off sometimes as well.

Construction Process

- Once the contractor thinks they are ready, they request a substantial completion inspection.
- At this point, the engineers come out and inspect the site. They make up a "punch list." Substantial completion may or may not be granted.
  - Once substantial completion is reached, and the items on the punch list are completed, the contractor will request a final completion inspection.
  - Once the project is finally complete, the contractor is done (with exception of warranty issues).

Construction Process

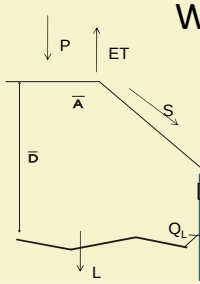
- If the contractor fails to finish the project within the contract time, they may be assessed penalties.
- If the contractor is delayed due to weather, they will request that days be added to the project.
  - One of the final deliverables of the contractor and sometime the engineer is a set of as-built construction drawings.
  - These are important, but often neglected.

Other Engineering Services

- Even after the facility is constructed, there will be other engineering services required
  - Groundwater monitoring
  - Reporting to Regulating agencies
  - Other permits
  - Technical issues
  - Closure and post closure

Predicting Leachate Generation

Water Balance

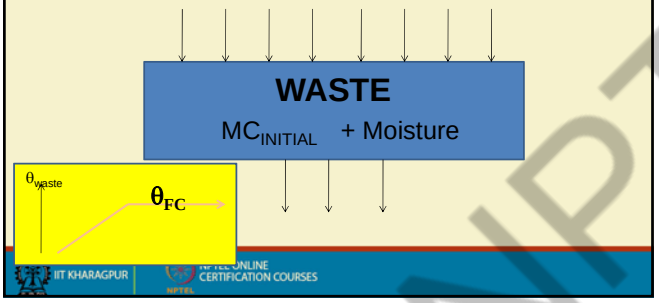


P = precipitation volume
ET = evapotranspiration
S = runoff
Q_L = leachate production
A = average surface area

[INPUTS] – [OUTPUTS] = CHANGE IN STORAGE

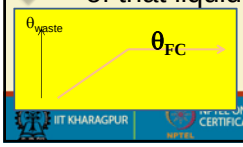
$$[P] - [ET + S + Q_L + L] = \Delta S$$

Moisture Storage



Field Capacity, θ_{FC}

Field capacity is the amount of liquid that a given mass (volume) of waste can absorb prior to downward percolation of that liquid due to gravitational forces



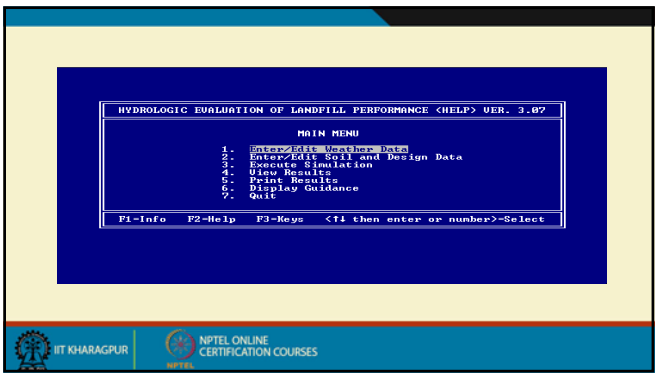
Definitions

- Evapotranspiration
  - Evaporation: the change of water from its liquid phase to its vapor phase
  - Transpiration: the evaporation occurring through plant leaves through stomal opening
- Wilting Point
  - the volumetric water content where plants can no longer draw moisture from the soil

$$\theta_{WP} < \theta_{FC} < \theta_{SAT}$$

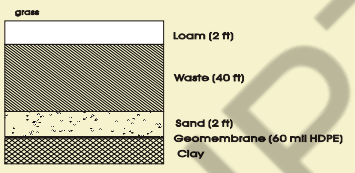
Hydraulic Evaluation of Landfill Performance (HELP)

- References
  - C:\HELP3\DOC*.pdf
- Start:
  - C:\HELP3\

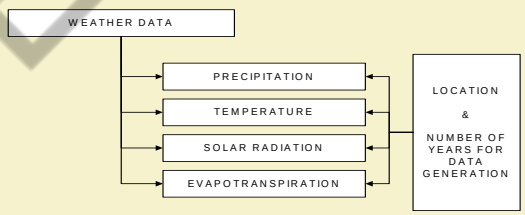


Example

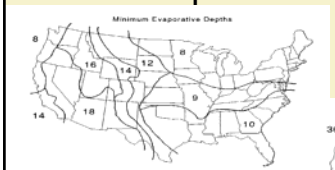
- Landfill location = Jacksonville, FL
- Number of year for data generation = 5 yr
- LF area = 5 acres
- LF layers

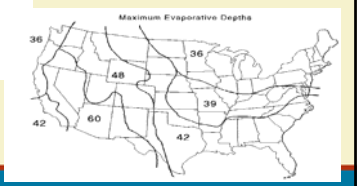


Weather Data

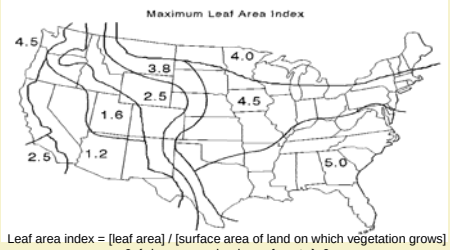


Evaporative Zone Depth





Maximum Leaf Area Index



Leaf area index = [leaf area] / [surface area of land on which vegetation grows]
0 ← bare ground ~ dense forest → 6

Layer Design

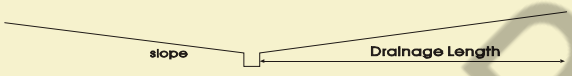
SOIL & DESIGN DATA

- LANDFILL AREA
- LAYER DESIGN
  - Thickness
  - Texture
  - Field Capacity
  - Hydraulic Conductivity
  - Drainage length & slope
  - Geomembrane & geotextile
- RUNOFF CURVE NUMBER

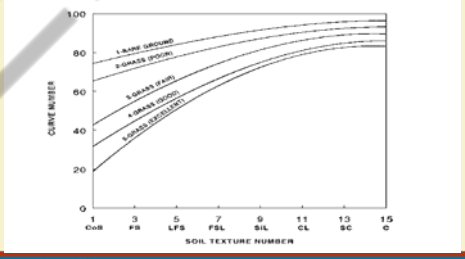
Layer Type

1. Vertical percolation
2. Lateral draining
3. Barrier soil liner
4. Geomembrane liner

Drainage Length



Curve Number



HELP	Classification USDA	Classification USCS	Total Porosity vol/vol	Field Capacity vol/vol	Wilting Point vol/vol	Saturated Hydraulic Conductivity cm/sec
1	CoS	SP	0.417	0.045	0.018	1.0×10^{-2}
2	S	SW	0.437	0.062	0.024	5.8×10^{-3}
3	FS	SW	0.457	0.083	0.033	3.1×10^{-3}
4	LS	SM	0.437	0.105	0.047	1.7×10^{-3}
5	LFS	SM	0.457	0.131	0.058	1.0×10^{-3}
6	SL	SM	0.453	0.190	0.085	7.2×10^{-4}
7	FSL	SM	0.473	0.222	0.104	5.2×10^{-4}
8	L	ML	0.463	0.232	0.116	3.7×10^{-4}
9	SiL	ML	0.501	0.284	0.135	1.9×10^{-4}
10	SCL	SC	0.398	0.244	0.136	1.2×10^{-4}
11	CL	CL	0.464	0.310	0.187	6.4×10^{-5}
12	SiCL	CL	0.471	0.342	0.210	4.2×10^{-5}
13	SC	SC	0.430	0.321	0.221	3.3×10^{-5}
14	SiC	CH	0.479	0.371	0.251	2.5×10^{-5}
15	C	CH	0.475	0.378	0.265	1.7×10^{-5}
16	Barrier Soil		0.427	0.418	0.367	1.0×10^{-7}
17	Bentonite Mat (0.6 cm)		0.750	0.747	0.400	3.0×10^{-9}
18	Municipal Waste (900 lb/yd³ or 312 kg/m³)		0.671	0.292	0.077	1.0×10^{-3}

HELP results

- Drainage collected from layer # (drainage layer) = leachate generation
- Maximum head on the liner (daily peak) < 1 ft

How could you use the HELP results?

- Leachate generation
  - Leachate storage tank & pond design
  - Pump design
  - LCS; geonet & geotextile design
- Leachate head on the liner
  - Leachate collection system design
    - Hydraulic conductivity of drainage material
    - Slope of the liner
    - The length of the drainage path
- Leachate leakage

Predicting Landfill Gas Generation Potential

Overview

- Waste Decomposition Basics
- Landfill Gas Generation Potential

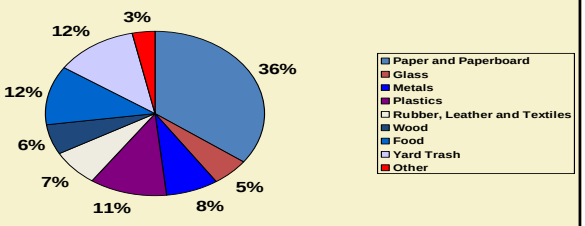
Waste Decomposition

- Anaerobic Decomposition
  - Anaerobic digestion/Composting
  - Landfill Conditions
- Aerobic Decomposition
  - Composting
  - Aerobic bioreactor landfills

What is the material that contributes most significantly to anaerobic waste decomposition in MSW Landfills?

- Readily biodegradable components
  - Paper and paperboard
  - Food waste
- Other components do break down (e.g., wood) but over a longer timeframe (half-life on the order of decades)

MSW Composition



Anaerobic Decomposition

$$C_aH_bO_cN_d - \left(\frac{4a - b - 2c + 3d}{4}\right)H_2O \rightarrow \left(\frac{4a + b - 2c - 3d}{8}\right)CH_4 + \left(\frac{4a - b + 2c + 3d}{8}\right)CO_2$$

Modeling Landfill Gas Generation

- Gas Production
- Estimating gas generation from one batch of waste
- Gas generation from multiple batches of waste
- Gas generation from Bioreactor landfills
- EPA Gas Model – LandGEM v. 3.02

Gas Production

- First order exponential decay model is commonly used

$$M(t) = M_o e^{-kt}$$

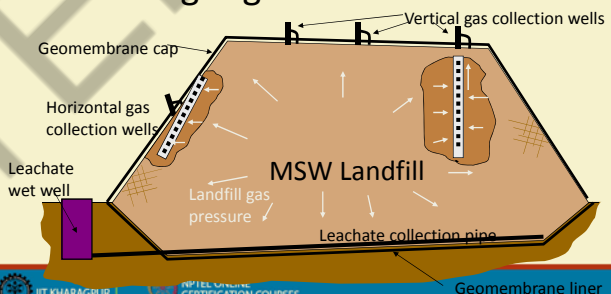
Remaining mass of a batch of waste

Decay rate

Time since the decay begun

Initial mass of waste

Landfill gas generation and flow



The total volume of gas (G_o) that can be produced by a mass of waste (M_o) is based on the landfill gas generation potential (L_o) and is defined as:

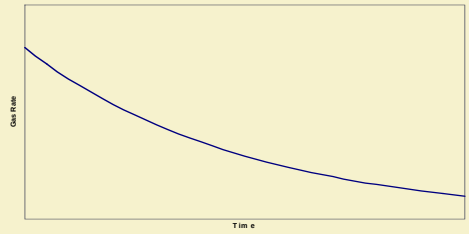
$$G_o = L_o M_o$$

The cumulative volume of gas that has been produced (G(t)) at any time (t) also depends on the rate that landfill gas is produced (k) and can be described as:

$$G(t) = M_o L_o \left(1 - e^{-kt}\right)$$

The gas flow rate at any given time can be estimated as

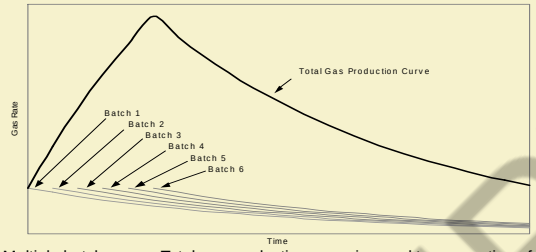
$$G_*(t) = M_o L_o k \left(e^{-kt}\right)$$



First order gas production curve corresponding to one batch of waste

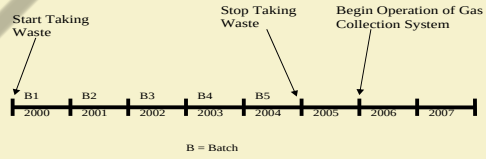
Gas Production

- Not feasible to simulate for just one batch
- Landfills accept waste for many years, so it is typical to model one batch for each year's worth of waste acceptance

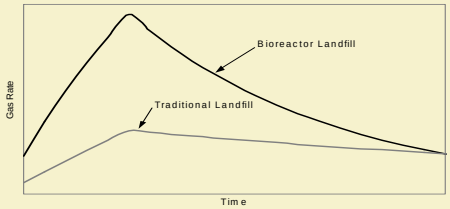


Multiple batch curve. Total gas production curve is equal to summation of each individual batch for a given year.

Several batches of waste and gas production



Modeling gas production from a bioreactor landfill



Remember: Total gas production is a function of waste mass and methane generation potential (Lo). Therefore, the area under both curves above is the same. The bioreactor landfill's goal is to increase the waste decay rate, k.

EPA LandGEM 3.02

- Uses first order decay equation
- User inputs:
  - Annual Waste Placement
  - Lo, k
  - C_{NMOC}

C&D WASTE MANAGEMENT

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Introduction

Components in Waste Management

Crushing units at Burari C&D waste recycling plant
Picture Credits: IL&FS Pvt Ltd.,

- **Recycling and reduction of C&D waste**
- Waste to Compost
- Waste to Energy and Fuel
- Wastewater to be treated

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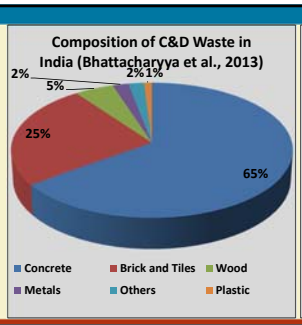
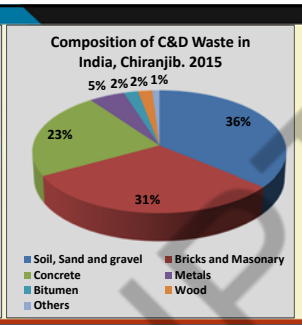
C&D Waste Compositions in India





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C&D waste processing plants (Based on field visits)

S. No	Name of the Company, Location	Capacity
1	IL&FS Ltd., Burari, North Delhi	2000 Tons
2	Amdavad Environs Projects Ltd Ahmadabad, Gujarat	300 Tons
3	Indore(Tenders were called as on 20.02.2017)	100 Tons

S. No	City	C&D Waste	Status
1	Udaipur	30 tons/day	(Tenders are being called for developing a processing facility)
2	Visakhapatnam	80 tons/day	

Crushing units at Burari C&D waste recycling plant
Picture Credits: IL&FS Pvt Ltd.,

Crushing units at Amdavad C&D waste recycling plant
Source: http://www.dnpinfra.com/wastetreatment.html

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Areas of Application

The rules shall apply to every waste resulting from construction, re-modeling, repair and demolition of any civil structure of individual or organization or authority who generates construction and demolition waste such as building materials, debris, rubble.

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Duties of waste generators

- Every waste generator shall prima-facie be responsible for collection, segregation of concrete, soil and others and storage of C&D generated.
- The generator shall ensure that other waste (such as solid waste) does not get mixed with this waste and is stored and disposed separately.
- Should keep the C&D waste within the premise or get the waste deposit at collection centre or handover it to the authorized processing facilities.
- Ensure that there is no littering or deposition of C&D waste so as to prevent obstruction to the traffic or the public or drains

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Duties of waste generators

- They should pay relevant charges for handling C&D waste as notified by the concerned authorities
- Waste generators who generate more than 20 tons or more in one day or 300 tons per project in a month should
  - Segregate the waste into four streams such as concrete, soil, steel, wood and plastics, bricks and mortar
  - Submit waste management plan and get appropriate approvals
  - Inform authorities regarding the activities at different stages of the project

Duties of service provider and their contractors

- Should develop a comprehensive waste management plan covering segregation, storage, collection, reuse, recycling, transportation and disposal of construction and demolition waste generated within their jurisdiction.
- Should remove all C&D waste and clean the area every day, if possible
- Develop a storage and collection facility depending upon the duration of the work, the quantity and type of waste generated.
- In case if service provider has no logistics support to carry out the specified work, then he should tie up with authorized agencies for management of C&D waste.

Duties of local authority

- They should issue detailed directions with regard to proper management of C&D Waste within its jurisdiction in accordance with the provisions of these rules.
- Local authority shall seek detailed plan or undertaking as applicable, from generator of construction and demolition waste
- Chalk out stages, methodology and equipment, material involved in the overall activity and final clean up after completion of the construction and demolition.
- They should seek assistance from concerned authorities for safe disposal of C&D waste contaminated with industrial hazardous or toxic material or nuclear waste if any

Duties of local authority

- They should make arrangements for collection, transport and processing of C&D waste either through own resources or by appointing private operators
- They should give appropriate incentives to generator for salvaging, processing and or recycling (preferably in-situ)
- They should examine and sanction the waste management plan of the generators within a period of one month or from the date of approval of building plan, whichever is earlier from the date of its submission

Duties of local authority

- They should keep track of the generation of C&D waste and establish a data base and update once in a year
- Measures should be taken in consultation with expert institutions for developing a sustained system of information, education and management of C&D waste generated.
- The data should be disseminated through their own website.
- Incentives should be provided for utilizing the products developed from C&D waste.

Duties of State Pollution Control Board

- They should monitor the implementation of these rules by the concerned local bodies and the competent authorities
- SPCB should grant authorization for C&D waste processing facility as specified by the rules after examining the application received.
- SPCB should prepare annual report with special emphasis on the implementation status of compliance of these rules and forward report to CPCB before the 31st July for each financial year.

Duties of State Government

- The Secretary in-charge of development in the State Government or Union territory administration shall prepare their policy document with respect to management of construction and demolition of waste in accordance with the provisions of these rules within one year from date of final notification of these rules.
- The concerned department in the State Government dealing with land shall be responsible for providing suitable sites for setting up of the storage, processing and recycling facilities for construction and demolition waste.

Duties of State Government

- The Town and Country planning Department shall incorporate the site in the approved land use plan so that there is no disturbance to the processing facility on a long term basis.
- Procurement of materials made from construction and demolition waste shall be made mandatory to a certain percentage (say 10-20%) in municipal and Government contracts subject to strict quality control.

Duties of the Central Pollution Control Board

- They should prepare operational guidelines related to environmental management of construction and demolition waste management
- Analyze and collate the data received from the SPCB to review these rules regularly.
- Coordinate with all the SPCB for any matter related to development of environmental standard
- They should forward annual compliance report to Central Government before the 30th August for each financial year based on reports given by SPCB.

Duties of Bureau of Indian Standards and Indian Roads Congress

- The are responsible for preparation of code of practices and standards for use of recycled materials and products of construction and demolition waste in respect of construction activities
- The role of Indian Road Congress shall be specific to the standards and practices pertaining to construction of roads.

Duties of the Central Government

- The Ministry of Urban Development, and the Ministry of Rural Development, Ministry of Panchayat Raj, shall be responsible for facilitating local bodies in compliance of these rule
- The Ministry of Environment, Forest and Climate Change shall be responsible for reviewing implementation of these rules as and when required.

Accident Reporting

- The Officer- in- charge of the facility shall report to the local body as per the format ***Form-V*** of C&D rules Which include
  - ***Date and time*** of accident; Sequence of events ***involved*** in accident
  - Assessment of the ***effects of the accidents*** on human health and the environment
  - ***Emergency measures*** taken; Steps taken to ***alleviate the effects*** of accidents
  - Steps taken to ***prevent the recurrence*** of such an accident
- The local body shall review and issue instructions if any, to the in- charge of the facility.

Other information in C&D rules

- Criteria for Site Selection for Storage and Processing or Recycling Facilities for construction and demolition Waste (**Schedule I**)
- Application of materials made from construction and demolition waste and its products (**Schedule II**)
- Timeframe for Planning and Implementation (**Schedule III**)

Time frame for implementation

S. No	Compliance Criteria	City with population in Millions		
		>= 1	0.5 - 1	< 0.5
1	Formulation of policy by State Government	12 months	12 months	12 months
2	Identification of sites for collection and processing facility	18 months	18 months	18 months
3	Commissioning and implementation of the facility	24 months	24 months	24 months
4	Monitoring by SPCBs	3 times a year	2 times a year	2 times a year

List of Forms

Form 1	Application for obtaining authorization
Form 2	Format for Issue of Authorization to the Operator
Form 3	Format of Annual Report to be submitted by Local Authority to the State Pollution Control Board
Form 4	Format of Annual Report to be submitted by the SPCB to CPCB
Form 5	Accident Reporting

Thank You...

What is C&D Waste?

- Solid Waste produced during the construction, renovation, or demolition of buildings, roads, bridges, and other man-made structures.

Where Does C&D Originate?

- Construction
- Demolition
- Renovation
- Land Clearing Debris
- Disaster Debris

What are the Major Components of C&D Waste?

- Concrete
- Brick
- Asphalt
  - Shingles
  - Pavement
- Drywall
- Plastic
- Cardboard
- Wood
  - Lumber
  - Engineered Wood
- Metal
- Copper
- Ferrous
- Aluminum
- Other

Example of Waste from Residential Construction

Example of Waste from Commercial Construction

Example of Waste from Commercial Demolition

Options for Managing C&D

- On-Site Management
  - Processing for reuse
  - Deconstruction
  - Separation of Recoverable Materials
- Processing and Recovery at a Central Recycling Facility
- Land Disposal

On-Site Management: Processing for Reuse

On-Site Management: Separation of Waste Materials

On-Site Management: Deconstruction

Source: http://www.philadelphiacommunitycorps.org/deconstruction/?v=c86ee0d9d7ed

Source :http://re-store.org/building-deconstruction-green-demolition-and-decon-13/

Processing and Recovery at a Central Recycling Facility

Landfill Disposal

Land Disposal as Clean (Inert) Fill

Proper Management

- Why is proper management important?
  - A regulatory requirement.
  - Improper management of C&D waste can cause harm to human health and the environment.
  - Sustainable recycling will only succeed if performed in a thought-out, safe and effective manner.

C&D Waste Recycling Approaches

- Separation at the Job Site
- Separation at a Mixed Waste Processing Facility
  - Manual Separation Only
  - Combined Manual and Mechanical Separation
  - Mechanical Separation

Markets for C&D Debris

- Portland Cement Concrete
- Asphalt Concrete
- Wood
- Drywall
- Asphalt Roofing Shingles

Definitions

Concrete = Portland Cement Concrete

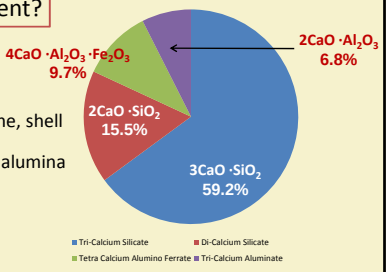
Asphalt = Asphalt Concrete

What is in Portland Cement?

1.Lime-rich materials -- limestone, shell

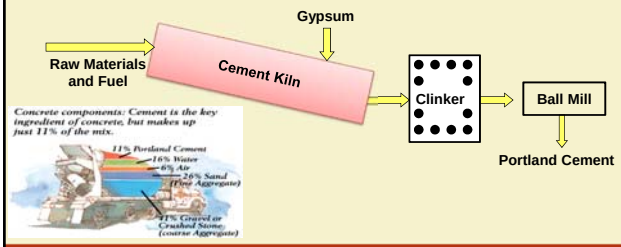
2.Clay, fly ash, sand -- silica and alumina

3.Iron containing material



What is in Portland Cement?

What is in Portland Cement?



What is Portland Cement Concrete?

What is Portland Cement Concrete?

- High Volume, Low Value Material
- Replacement for Crushed Stone as a Raw Material

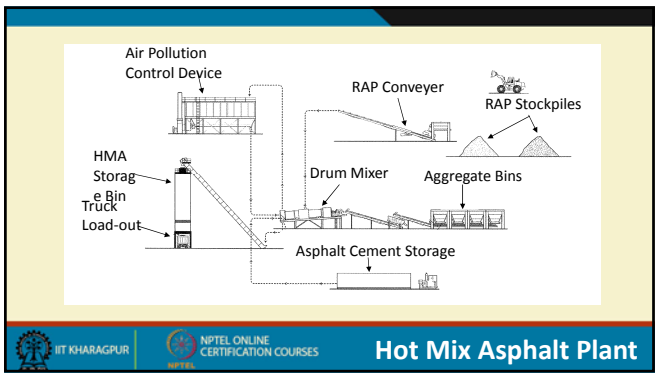
Use as Lake Fill in South Florida Common

What is Asphalt Concrete?

– Heavily Recycled in New Hot Mix Asphalt

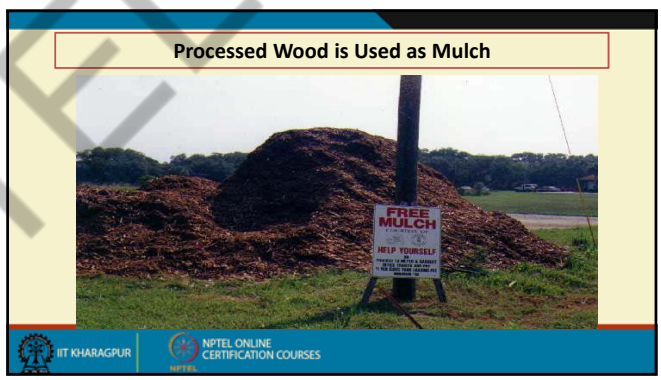
What is Asphalt?

- Asphalt Cement = Bitumen (Asphalt)
- Asphalt Concrete = Asphalt Cement + Fine and Course Aggregate
- Asphalt concrete contains approximately 6% asphalt by weight.


Air Pollution Control Device
RAP Conveyer
RAP Stockpiles
HMA Storag e Bin
Drum Mixer
Aggregate Bins
Truck Load-out
Asphalt Cement Storage
IIT KHARAGPUR
NPTEL ONLINE CERTIFICATION COURSES
Hot Mix Asphalt Plant


Wood
Primary Markets: Boiler Fuel and Mulch
IIT KHARAGPUR
NPTEL ONLINE CERTIFICATION COURSES


Processed Wood is Used as Boiler Fuel
IIT KHARAGPUR
NPTEL ONLINE CERTIFICATION COURSES


Processed Wood is Used as Mulch
FREE MULCH
HELP YOURSELF
IIT KHARAGPUR
NPTEL ONLINE CERTIFICATION COURSES


IIT KHARAGPUR
NPTEL ONLINE CERTIFICATION COURSES


NURSERY
COLOR WISE RED MULCH
2 CUBIC FEET (56L)
IIT KHARAGPUR
NPTEL ONLINE CERTIFICATION COURSES

Asphalt Shingles

- Recycled into new hot mix asphalt.
- Not currently practiced in Florida, but is successful elsewhere in US.

Consider Asphalt Shingles

Gypsum Drywall

Practiced in several states.
Under development in Florida.

Consider Gypsum Drywall

Markets

- New Drywall
- Portland Cement Production
- Agriculture
- Construction Material

Other Materials

- Soil, Land Clearing Debris
- Ceiling Tiles
- Vinyl Siding
- Cardboard

Challenges to C&D Debris Recycling

- Economics
- Inertia
- Environmental Issues

Economics

- Should evaluate prior to start of project
  - Disposal costs
  - Container costs
  - Availability of local markets
  - Availability of local recycling services

Inertia

- How do you change the *status quo*?
- Need constant education and reinforcement
- Need dedicated oversight

Environmental Issues

- May be much different if you are talking about construction versus demolition
- Examples:
  - Lead based paint
  - Asbestos
  - Treated wood

Asbestos

Hazardous Materials in Demolition Waste

- What is asbestos?
- A type of naturally mineral that has been widely used in various products, including construction materials, because of its excellent mechanical and thermal properties

Hazardous Materials in Demolition Waste

- Why is asbestos a concern?
- Respiration of asbestos fibers has been shown to result in a number serious illnesses
  - Mesothelioma
  - Lung cancer

Hazardous Materials in Demolition Waste

- Asbestos minerals
  - Chrysotile
  - Crocidolite
  - Amosite.
- How is asbestos regulated?
  - It is not a RCRA hazardous waste
  - Regulated under the CAA & TSCA

Hazardous Materials in Demolition Waste

- Several regulations govern asbestos
  - Asbestos Hazard Emergency Act
  - Asbestos Ban and Phase out Rule
  - National Emission Standards for Hazardous Air Pollutants (NESHAP)

Hazardous Materials in Demolition Waste

- Asbestos Hazard Emergency Act
- Created regulations for removing asbestos from schools

Hazardous Materials in Demolition Waste

- Asbestos Ban and Phase out Rule
- Banned certain asbestos containing products
  - Corrugated paper
  - Roll board
  - Commercial paper
  - Specialty paper
  - Flooring felt
  - New uses of asbestos
- Note: Not all asbestos products are banned

Hazardous Materials in Demolition Waste

- National Emission Standards for Hazardous Air Pollutants (NESHAP)
  - 40 CFR 61 Subpart M
  - Regulates the handling of asbestos before, during and after demolition and renovation

Hazardous Materials in Demolition Waste

- Asbestos-containing material (ACM):
  - A material containing more than 1 percent asbestos as determined using EPA-approved polarized light microscopy methods.

Hazardous Materials in Demolition Waste

- Friable ACM:
  - ACM that, when dry, crumbles, pulverizes, or reduces to powder by hand pressure

Hazardous Materials in Demolition Waste

- Categories of ACM
  - Friable ACM
  - Category 1 Non friable ACM
  - Category 2 Non friable ACM

Hazardous Materials in Demolition Waste

- Category I Non friable ACM:
  - packing's, gaskets, resilient floor covering, and asphalt roofing
- Category II Non friable ACM
  - any non-friable material not in Category I

Hazardous Materials in Demolition Waste

Regulated ACM (RACM):

1. Friable ACM
2. Nonfriable ACM that has become friable due to destructive handling
3. Category I Nonfriable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading
4. Category II Nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of demolition or renovation

Hazardous Materials in Demolition Waste

- Requirements for Asbestos Inspection
  - Inspect a building for asbestos before demolition or renovation.
  - Inform the local regulatory agency about the demolition 10 working days before the demolition, even if there is no asbestos.
  - If asbestos is present, remove asbestos in the presence of an EPA certified asbestos manager.

Hazardous Materials in Demolition Waste

- When must asbestos be removed?
- If combined amount of RACM (Regulated Asbestos Containing Material) is
  - At least 80 linear meters on pipes
  - Or at least 15 m^2 on other facility components
  - Or at least one m^3 off facility components where the length or area could not be measured

Hazardous Materials in Demolition Waste

- Asbestos Removal
  - Workers must wear OSHA approved respiratory devices and safety clothing.
  - RACM must be adequately wetted when stripped.
  - Appropriate ventilation must be provided to capture particulates.
  - Asbestos must be wetted and/or wrapped in leak tight containers for transportation to approved disposal sites.

Hazardous Materials in Demolition Waste

- Asbestos disposal
  - Emissions must be controlled during transport (sealed containers, wetting)
  - Visible emissions must be controlled upon disposal (e.g. burial with 6 inches of non asbestos material)
  - Record keeping requirements must be met

INTEGRATED WASTE MANAGEMENT FOR A SMART CITY

FOCUSSED ON MSW, C&D AND E-WASTE MANAGEMENT

End of Week-10

BRAJESH KUMAR DUBEY
DEPARTMENT OF CIVIL ENGINEERING