

Emerging Technologies in construction Industry

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COURSE LECTURES

- **Lecture 1: Emerging Technologies in construction Industry**
- **Lecture 2: Constructability of Civil Engineering Construction**
- **Lecture 3: Lean construction**

Lecture 1 - Emerging Technologies in construction Industry

Machine Learning



Drones

- Autonomous drones are being used to map out – sometimes hazardous construction sites digitally, and providing a higher level of accuracy.
- Drones collect data by flying over a site and taking high-resolution photographs.



3D printing

- The first 3D-printed building was completed in December, by Copenhagen-based 3D Printhuset.
- A gantry-type printer measuring **8x8x6 meters** – was used to create the structural walls of the “building on demand” (BOD).



Greener Asphalt

- Traditional asphalt and concrete **pavements** have a few disadvantages.
- As we've already mentioned, because these materials are ***nonporous*** (or impervious), rainwater cannot seep into them and instead runs off. As the water travels, it may also collect oil, gasoline and other pollutants as it washes into neighboring streams and rivers. ***This runoff can cause steady landscape erosion.***

- Additionally, traditional asphalt gets very hot, creating a "**heat island**" effect in urban environments.
- Permeable pavement (also known as pervious or porous concrete) is a specific type of pavement with a high porosity that allows rainwater to pass through it into the ground below.
- And plastic and rubber are **recycled** materials being mixed into asphalt

- Researchers at RMIT University in Melbourne, Australia, have shown that adding cigarette butts can improve roadway quality while safely containing heavy metals; and in Sydney, recycled printer toner is incorporated into an environmentally friendly asphalt mix.



Mortarless Masonry (Interlocking)

- Consists of compressed earth interlocking blocks or **concrete** interlocking blocks or fly-ash interlocking blocks



Light Weight Construction Technology



- Researchers have tested lightweight materials that are composed of sand, cement, and even the fiber of waste from **young coconut** and durian for strength and bulk density.

Drawback

- One of the biggest challenges engineers face when using these materials is ***fire resistance***.



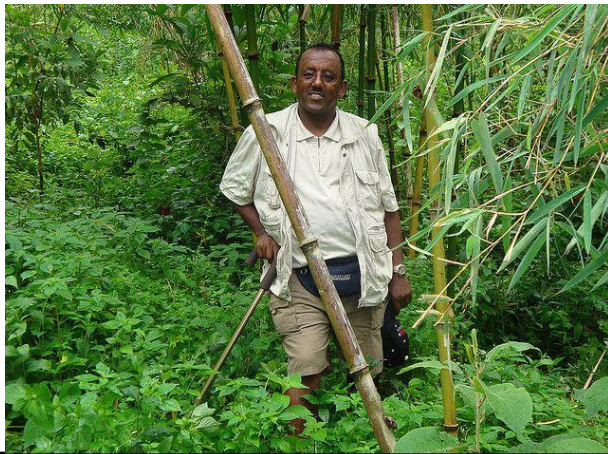
Application of agro-waste for sustainable construction materials

- The rapid urbanization is creating a shortfall of conventional building construction materials due to *limited availability of natural resources*.
- Agro-industrial and other solid waste disposal is another serious issue of concern in developing countries.
- Rice husk, coffee husk, SCG, PET plastic, glass, cow dung ,sugarcane and etc...



Bamboo Based Technologies

- Bamboo is the world's **fastest growing** woody plant. It grows three times faster than most other species and is therefore considered as **renewable material**.
- **Ethiopia** has an estimated **one million hectares of natural bamboo forest**, the largest in the African continent.
- Despite the versatile **resource** base and advanced **bamboo** utilization at a global scale, its great **potential** to enhance socio-economic and ecological development remains unrealized in **Ethiopia**.



- Bamboo fiber is a cellulosic fiber that is regenerated from bamboo plant.
- It is a great prospective green fiber with outstanding biodegradable textile material, having strength comparable to conventional glass fibers.



Bamboo applications

Traditional Bamboo Roof



Modern Bamboo Roof



Traditional Bamboo Window



Modern Bamboo Window



Traditional Wall



Modern Bamboo Wall



Construction and Structure Application

Constructability of Civil Engineering Construction

- Constructability (or buildability) is a project management technique to review construction processes from start to finish during pre-construction phase.
- The Construction Industry Institute defines constructability as the ***optimum*** use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives.
- The focus will be on the bottom line—all members of the design and construction team will be expected to find ways to complete construction faster and more efficiently. That is what constructability is all about.

- Constructability involves the process of **visualizing** the construction of the project prior to beginning the actual design, and maintaining this vision throughout the design process.
- Constructability is a **design philosophy** that begins in the conceptual design stage and links project planning to design and construction.
- Constructability is a project management technique to review construction processes from **start to finish** during **preconstruction phase**.
- It is to identify obstacles before a project is actually built to reduce or prevent errors, delays, and cost overruns.
- **BIM** is a reliable digital representation of the building available for design decision making, high-quality construction documentation, construction planning, performance predictions and cost estimates



- The following are some of the most important reviews (but not all) that should be performed during project management:

Design Stage

- Review (between contractor, client, consultants and architects/designers) whether the construction design is realistic or not; architects can sometimes get carried away, and contractors know what is feasible or not
- Review whether the design can be executed within budget
- Review whether the design will take longer to execute than time afforded to the project

- The following are some of the most important reviews (but not all) that should be performed during project management:

Planning Stage

- Review which materials will be necessary to complete the design, and which are the most cost effective while still achieving the design-vision
- Review which equipment is necessary to achieve construction, and which can be done without; eliminate luxury but non-essential construction equipment
- Perform a *cost/benefit analysis on equipment quantity* demands (i.e. will using one tractor for multiple roles which takes more time, saves more project money than investing in multiple tractors for accomplishing individual roles more quickly?)
- Review proposed site soil composition, and how it will impact building

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- The following are some of the most important reviews (but not all) that should be performed during project management:

Building Stage

- Review how quickly the contractor is performing the construction, whether it is on schedule or falling behind.
- Review whether design expectations are being met
- Review how construction waste is being managed
- Review again if there is any extraneous, non-essential equipment being used during site construction

constructability vs value engineering

TABLE 3. Comparison of Value Engineering and Constructability

Criteria (1)	Value engineering (2)	Constructability (3)
Focus	Overall reduction of life-cycle cost.	Optimize construction process in terms of construction cost, schedule, safety, and quality.
Implementation	A brainstorming session where life-cycle cost alternatives are considered for systems components while maintaining design function.	An integral part of project management and scheduling allowing construction knowledge and experience to be integrated into project planning and design.
Timing	Usually performed during design phase. In many cases, performed as a reactive process to reduce cost after design has been completed.	On-going from conceptual planning through construction and start-up.

Lean construction

- Lean construction
- **Lean construction** is a way to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value.
- **Lean Construction** is using the same principles as **lean** production to reduce waste and increase the productivity and effectiveness in **construction** work.
- “Excellent firms don’t believe in excellence – only in constant improvement and constant change.” – Tom Peters

Advanced Construction Materials

- **Application of geosynthetic**
- **Translucent Concrete**
- **High Performance Concrete.**
- **Self Compacting Concrete.**
- **Self-curing, Shrinkage-free concrete**
- **Self healing concrete**
- **Mineral** Admixtures & its Uses.
- **Fibers**
- **Others**

GEO-SYNTHETICS

- Geo-synthetics is defined as “**a planar product manufactured from polymeric material used with soil, rock, earth, or other geotechnical engineering related material**”.
- It is likely to increase in the future with stricter environmental regulations enforcement.

- Geo-synthetics are widely used in many geotechnical, environmental, and hydraulic applications related to groundwater quality and control.
- One of the most common examples is the use of geo-textile filters in trench (i.e., French) drains.
- Base and cover liner systems for modern landfills also make extensive use of geo-synthetics with the main purpose of minimizing the potential for groundwater contamination.

Geosynthetics Applications in Civil Engineering; An Introduction to value Engineering (VE) Technologies



GEO SYNTHETICS EAST AFRICA Ltd
Solutions that Last

PRODUCTS OF GEOSYNTHETICS

- Geo-textiles
- Geo-cell
- Geo-grids
- Geo-nets,
- Geo-membranes,
- Geo-composites



Geo-synthetics



- Other examples of geo-synthetics applications include the use of geotextiles as filtration elements in dams and waste containment systems,
- the use of geo-composites as erosion control elements in channels and slopes, and the use of geogrids as reinforcement elements in soil embankments, to mention just a few.



Canal lining by geo-membrane

Concrete lining of surface

geomembrane

Anchor trench



Types and Functions of Geosynthetics

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Dealing with Difficult Sites

- In the past, when dealing with difficult sites for construction purposes, the conventional practice was limited to either replacing the unsuitable soils, or bypassing them with costly deep foundations.
- ***Geo-synthetics*** have proven to be among the most versatile and cost-effective ground modification materials.
- Their use has expanded rapidly into nearly all areas of civil, **geotechnical, environmental, coastal, and hydraulic engineering.**

Standard Tests for Geo-textiles

- ASTM D4354 -Standard practice for tests
- ASTM D5101: Standard Test Method for Measuring the Filtration Compatibility of Soil-Geotextile Systems
- ASTM D5321:Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic- Geosynthetic Interfaces by Direct Shear