CHAPTER 19: CONSTRUCT WASTEWATER INFRASTRUCTURE

19.1 Introduction of the Unit of Learning

This unit covers the competencies required to construct wastewater infrastructure. It involves analysis of soil properties, construction of the wastewater infrastructure units, organization of the construction site, and preparation of construction schedule

This standard applies in the water industry.

19.2 Performance Standard

Analyse soil properties, prepare construction schedule, organized the construction site, construct the wastewater infrastructure based on available resources and the tests to be conducted, standard procedures, soil classification, and results.

19.3 Learning Outcomes

19.3.1 List of Learning Outcomes

a) Analyse soil properties
b) Prepare construction schedule
c) Organize the construction site
d) construct the wastewater infrastructure

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19.3.2 Learning Outcome No 1: Analyse Soil Properties

19.3.2.1 Learning Activities

Learning Outcome No 1: Analyse Soil Properties	
 **Learning Activities**	**Special Instructions**
1.1 Identify and gather ***soil analysis tools, supplies and materials*** 1.2 Identify engineering properties of soils 1.3 Analyse properties of soils 1.4 Prepare soil analysis report	• Use of Online videos • Power point presentation • Exercises by trainee

19.3.2.2 Information Sheet No 19/LO1: Analyse Soil Properties

Introduction to learning outcome

This learning outcome covers analysis of soil properties based on standard procedures as well as how to prepare a soil analysis report.

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Definition of key terms

Moisture Content - Moisture content is the amount of water present in a given soil mass.

PI index - Plasticity index is a measure of the range of water in which the given soil remains in plastic state

Sieve Analysis – Sieve analysis is a procedure for classifying soils using standard sieves to determine the particle size distribution.

Content/Procedures/Methods/Illustrations

1.1 Identify and gather *soil analysis tools, supplies and materials* (Sieve analysis, PI index, Moisture content, CBR, Proctor, Triaxial test, Oedometer tests, Casagrande, Cone penetrometer, Sand Replacement, California Bearing Ratio) based on available resources and the tests to be conducted

The following explains the gathered soil analysis tools, supplies and materials based on tests to be conducted:

- **CBR Test-** This refers to California Bearing Ratio which is a penetration test used for **classification of soil sub grade and base coarse materials** especially for design of flexible pavements and was developed by California State Highway Department in U.S.A.

  It shows the ratio of force per unit area needed to penetrate a given mass of soil at a rate of 1.25mm/min, to the corresponding penetration of a standard material.
- **Proctor Test-** This is a compaction test that is carried out to determine the **optimum moisture content** at which a given soil in question achieves maximum dry density through air removal.
- **Triaxial Test-** This test is done to measure the mechanical properties such as **shear strength** of soil hence it is often known as triaxial shear strength. It is performed by subjecting stress on a given soil sample in a way that the resultant stress in one direction is different in perpendicular direction.
- **Oedometer Test-** This test is done to determine **consolidation** which is an engineering property of soil. This is determined by measuring the vertical displacement of the soil being tested when it is subjected to vertical loading
- **Casagrande Test-** This is an atterberg limit test used to measure the **liquid limit** of a given soil sample. The term casagrande is used because the test apparatus was designed by Arthur Casagrande.
- **Cone penetrometer-** This is used in testing soil properties at the site because one is able to map out the soil profiles and determine properties such as **relative density of soil.**
- **Sand Replacement Test-** This test is used to determine the **dry density** of soil at the site. One needs to dig a hole first then proceeds to fill it with sand of a known density hence the term sand replacement. From this, one can determine the volume of the hole.

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1.2 Identify engineering properties of soils based on the soil classification

Engineering properties of soils are the characteristics that soils possess that make them suitable for use in the engineering field. They range from one soil to another and in that way soil has to be classified into different categories as shown below

a) AASHTO classification system

This system is based on the plastic characteristics and particle size of soil. The soil is divided into seven categories and even further when considering the group index as shown in the classification chart below:

General Classification	**Granular Materials (35% or less passing the 0.075 mm sieve)**							**Silt-Clay Materials (>35% passing the 0.075 mm sieve)**			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve Analysis, % passing											
2.00 mm (No. 10)	50 max	…	…	…	…	…	…	…	…	…	…
0.425 (No. 40)	30 max	50 max	51 min	…	…	…	…	…	…	…	…
0.075 (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)											
Liquid Limit	…		…	40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity Index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min
Usual types of significant constituent materials	stone fragments, gravel and sand		fine sand	silty or clayey gravel and sand				silty soils		clayey soils	
General rating as a subgrade	excellent to good							fair to poor			

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Note: Plasticity index of A-7-5 subgroup is equal to or less than the LL - 30. Plasticity index of A-7-6 subgroup is greater than LL - 30

In the AASHTO system:

- **gravel is material** smaller than 75 mm (3 in.) but retained on a No. 10 sieve;
- **coarse sand is material** passing a No 10 sieve but retained on a No. 40 sieve; and fine sand is material passing a No. 40 sieve but retained on a No. 200 sieve.
- Material passing the No. 200 sieve is **silt-clay** and is classified based on Atterberg limits.

Figure 184: AASHTO classification
Source: Bello, Afeez. (2013). Introductory Soil Mechanics I.

b) Unified soil classification system

This system classifies soil into three categories: Organic soils, Coarse grained and fine grained soils. This is determined depending on how much soil passes standard sieve sizes.

c) Grain size classification system

This system classifies soils based on the grain size only hence it is not very significant. The soil can be classifies as either silt, sand or clay depending on the particle size.

d) Textural classification

This is an improved system from the grain size system because it considers the grain size distribution as a percentage.

From the above classification systems, the following engineering properties can be identified as shown:

- **Shear Strength-** This refers to soil resistance to deformation when subjected to shear stress. It is important in geotechnical engineering because it helps in determining the bearing capacity of foundation.
- **Consolidation-** This according to (Terzaghi & Peck, 2013), consolidation is "any process which involves a decrease in water content of saturated **soil** without replacement of water by air".
- **Liquid Limit-** This shows the amount of moisture present when a given soil sample transitions from plastic state to liquid state such that the soil can flow. This helps classify the soil in terms of how fine it is and it is important to an engineer as they can calculate the allowable bearing capacity of foundation as well as its settlement.
- **Dry Density –** This in simple terms is the density of soil when dry and is calculated by subtracting the moisture content from the wet density. It is used to give an idea of extent of compaction of soils whereby a high dry density indicates an increased compaction.
- **Relative Density-** This property is dimensionless and shows how dense a cohesionless soil is, that is the difference between void ratios when loose and in natural state, compared to its maximum density i.e. the difference in void ratio when loose and dense state.

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1.3 Analyse properties of soils based on the standard procedures

The following standard procedures are used in analyzing engineering properties of soils:
They are divided into two main categories:

i. **In-situ Testing Procedures:** This involves field tests carried out at site of proposed location and may include but not limited to:
    a) **Standard Penetration Test**
    This test is done in accordance to **IS -2131:1963**. A bore hole is drilled to a desired depth after which a standard split spoon sampler is driven into the soil using a dropping hammer weighing 63.5kg it is dropped at a rate of 30 blows per minute over a height of 0.75m. The aim of this test is to determine the **relative density** of soil.

b) Sand Replacement Test.

This test aims at determining the **dry density** of the soil in question and it is based on **IS 2720 part 28**. The in situ compacted soil is removed and replaced with sand of known density to determine the volume of the hole after the weight of sand needed to fill the hole is determined.

ii. **Labouratory Tests:** This cannot be done at site hence the soil sample is taken to the labouratory for analysis. They include but not limited to:

a) Sieve Analysis

This test is used to determine the **particle size distribution** of soil using the standard procedure outlined in **ASTM C136 (AASHTO T-27)**. The sample soil is passed through a number of standard sieves and the retained soil in each sieve measured for analysis in determining the soil gradation.

b) Atterberg's Limits Tests

This involves a number of tests that are carried out to determine the **critical water content** in fine graded soils. The tests are carried out as outlined in **ASTM D4318** and include: liquid limit test, plastic limit test and shrinkage limit test.

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1.4 Prepare soil analysis report based on the results.

A soil analysis report is a report prepared by an engineer that shows the soil properties of the area where an infrastructure is likely to be constructed showing whether the soil conditions are suitable on not. It is important because it tells the viability of proposed project before it is started.

The following is the procedure for preparing a soil analysis report:

i. One is first required to know the client's expectations on the proposed project for instance the location where they want the project to be among others.

ii. The next step is carrying out both field and labouratory tests of the soil on the chosen location to determine its engineering properties. The tests and soil properties have been highlighted in **1.3** and **1.2** respectively.

iii. The results from the tests are the analysed to determine if the soil has suitable engineering properties thus a decision can be made whether the site is safe for engineering works.

iv. The Geotechnical engineer will then provide a detailed report of existing conditions to the client as well as give recommendations where necessary which helps in knowing if the proposed are safe and viable and what can be done incase otherwise.

Conclusion

This learning outcome covered analysis of engineering soil properties in terms of what they are, how they can be tested together with relevance in engineering field and how a soil analysis report can be prepared.

Further Reading

Research more on how soil tests are done to determine whether they possess required engineering properties by watching tutorials on You Tube.
https://www.aboutcivil.org/soil-geotechnical-investigation-report.html use this link to learn more on how to prepare a soil analysis report.

19.3.2.3 Self-Assessment

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Written Assessment

1. The following are labouratory tests in soil analysis except one:
    a) Standard Proctor Test
    b) Penetration test
    c) Triaxial Test
    d) Odometer Test
2. Soil analysis is important in engineering works. Which if the following is not an engineering property of soil:Shear Strength
    a) Plastic Limit
    b) Consolidation
    c) Water quality
3. What is an **in-situ** testing procedure? Give three examples of in-situ tests in soil analysis
4. Elabourate 4 Atterbergs Limits
5. Discuss 4 engineering properties of soil
6. Compare and contrast between density of soil and relative density of soil?
7. Proctor test is used to determine the optimum moisture content of soil. Briefly explain how the proctor test is done and its significance in the engineering field.

Case Study Assessment

Your sister was watching construction videos on you tube and came across the term **Soil Analysis Report.** She approached you to explain what a soil analysis report is and why it is crucial in the construction industry. What would you tell them?

Project Assessment

A client has approached you with the intention of consulting you on whether their preferred location for their project is suitable or they need to switch to another area. Prepare a soil analysis report that you will give them including your recommendations based on your findings. Use soil samples from the school field.

Oral Assessment

What contents are you going to include in your **Soil Analysis Report**?

19.3.2.4 Tools, Equipment, Supplies and Materials

- Computers
- Software
- Cameras
- Construction manuals
- Projectors
- Flip charts
- Calculators
- Rulers, pencils, erasers
- Charts with presentations of data
- Drawing sheets
- Internet

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19.3.2.5 References

Terzaghi, K., & Peck, R. (2013). *Soil mechanics in engineering practice*. [England]: Read Books Ltd.

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Carter, M., & Bentley, S. (2016). *Soil Properties and their Correlations*. Newark: Wiley.

Different Classification of Soils for Engineering Purpose. (2020). Retrieved 25 June 2020, from https://theconstructor.org/geotechnical/soil-classification/3358/

19.3.3 Learning Outcome No 2: Prepare Construction Schedule

19.3.3.1 Learning Activities

Learning Outcome No 2: Prepare Construction Schedule	
 **Learning Activities**	**Special Instructions**
2.1 Interpret engineering drawings 2.2 Identify ***construction activities*** 2.3 Prepare project management timelines	• Demonstration by trainer • Power point presentation • Exercises by trainee

19.3.3.2 Information Sheet No 19/ Lo 2: Prepare Construction Schedule

Introduction to learning outcome

This learning outcome applies to the Interpretation of work drawings, Construction activities (Concrete works, Steel works, Earth work, Form works, site clearance, Trenching and excavation, Backfilling) based on scope of work and Preparation of Project management timelines based on project specifications.

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Definition of key terms

Earthworks: Earthworks are operations that involves digging, transporting and compacting the surface of the earth at a particular site.

Backfilling: Backfilling is the process of placing the soil back into a trench or base after the excavation has been completed.

Trenching and **excavations**: according to Occupational Safety & Health Administration (OSHA), excavation is defined as any human-made hole, cavity, or depression in the earth's surface created by the removal of the soil, while the trench is defined as a narrow underground excavation that is narrower than the wide one and is no longer than 15 feet (4.5 meters) wide.

Content/Procedures/Methods/Illustrations

2.1 Interpret engineering drawings based on the engineering codes

Engineering drawings are a rich and detailed outline that demonstrates all the details and specifications required for the manufacture of an object or product. It's more than just drawing, it's a graphical language that communicates ideas and details. Engineering drawing provides far more detailed details and specifications, including: dimensions, geometry, tolerances, material type, finish and hardware according to www.makeuk.org.

An illustration of an engineering drawing

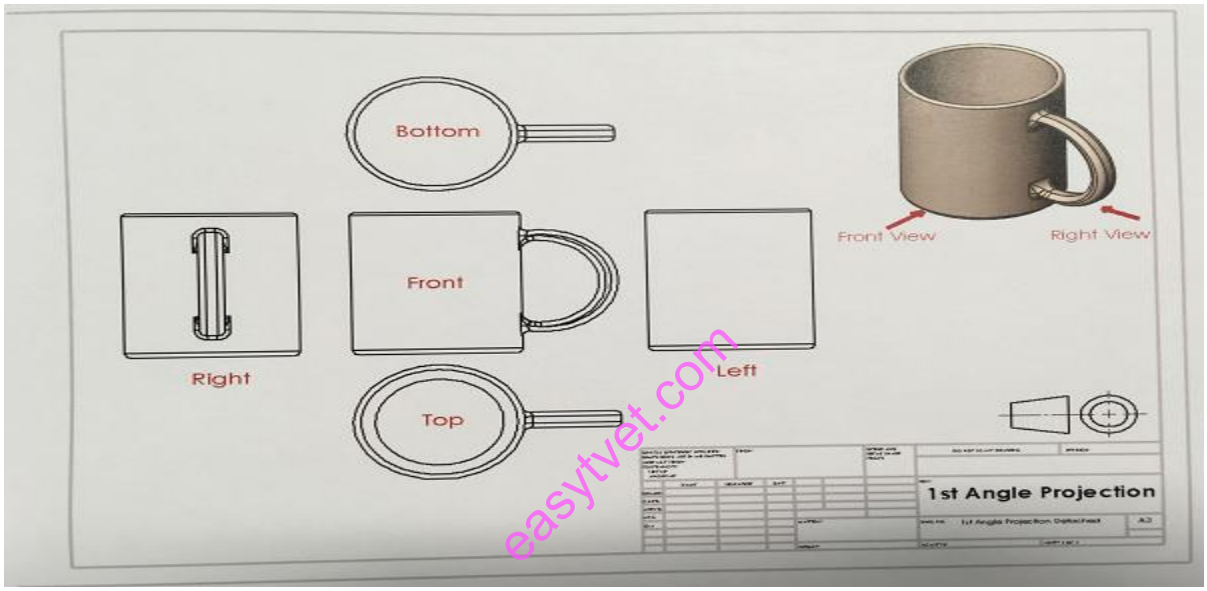

Figure 185: Illustration of an engineering drawing
Source: www.makeuk.org.

2.2 Identify *construction activities* (Concrete works, Steel works, Earth work, Form works, site clearance, Trenching and excavation, Backfilling) based on scope of work.

Construction activities shall mean any clearing, grading, excavation, grubbing, filling or other operation which results in the disturbnace of land.

Concrete works: Concrete works involves the following processes: preparation of the concrete mixture; delivery of the mixture to the construction site; feeding, distribution and compaction of the mixture in the formwork (molds); curing of the concrete while it is hardening; and quality control of the concrete work.

Steel works: Steel works is the assembly of steel components into a frame on site. This is achieved by lifting and placing components into position then connecting them together through bolting or site welding.

Earth work: Earthwork includes the loosening, removal and handling of earth amounts in the course of construction refer to a Guide to the Training of Supervisors-Trainees' Manual/Part1 (ILO, 1981,269 p.)

Form works: Formworks are temporary molds used to shape the concrete structure. Refer to the Building Construction Handbook by Roy Chudley & Roger Greeno.

Site clearance- According to Building Construction Handbook by Roy Chudley, site clearance involves removal of vegetation, surface soil, and levelling and land preparation for planned construction work.

Trenching and excavations: according to Occupational Safety & Health Administration (OSHA), excavation is defined as any human-made hole, cavity, or depression in the earth's surface created by the removal of the soil, while the trench is defined as a narrow underground excavation that is narrower than the wide one and is no longer than 15 feet (4.5 meters) wide

Backfilling: According to theconstructor.org/geotechnical, backfilling is the process of replacing or reusing the soil that is removed during construction to strengthen and support the foundation of a structure or any other structural component.

2.3 Prepare project management timelines based on project specifications

Project management timetable is where you take all the details you have about your project, including the start date, the deliverables, the end date, and how you're going to set a plan for when everything is going to be finished.

5 key steps in developing a project schedule

i. Define activities
ii. Sequence activities
iii. Estimate activity resources
iv. Estimate activity durations
v. Develop schedule

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An illustration of a construction work schedule

Table 58: Illustration of a construction work schedule

	Activity	2019	2019	2019	2020	2020	2020	2020	2020
No.	Name	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
1	Visitor center								
2	Submitted								
3	Site grading/ utilities								
4	Foundations								
5	Concrete walls								
6	Steel								
7	Envelop								
8	Interior finish								
9	Mech/Elec								
10	Commissioning/final								

Conclusion

This learning outcome has prepared the student to be able to Interpret work drawings, Construction activities. Project planning and how to prepare a project management timeline.

Further Reading

Read more on:

1. Steel works as illustrated by BS EN 1090-2:2018, Execution of steel structures and aluminum structures. Technical requirements for steel structures, BSI.
2. Watch a video on excavation and backfilling in construction

19.3.3.3 Self-Assessment

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Written Assessment

1. Which of the following is not a construction material?
    a) Tape measure
    b) Steel
    c) Cement
    d) Blocks
2. The following are construction activities. Which one is not?
    a) Concrete works
    b) Earth works
    c) CBR
    d) Form works
3. Which of the following is not a pre-tender work?
    a) Pre-tender program
    b) Cost implication
    c) Plant schedule
    d) Security
4. Which of the following is not a construction tool?
    a) Pipe wrenches
    b) Hammer
    c) Tape measure
    d) Timber

5. The following are site infrastructures. Which one is not?
    a) Site office
    b) Site store
    c) Ablution block
    d) Proctor
6. The following are considerations that should be taken by the builder when tendering. Which one is false?
    a) Access to site
    b) Labour
    c) Services
    d) Filling
7. Differentiate between trench and excavations.
8. Describe the process of backfilling.
9. Before any building work can commence, the area covered by the building must be leveled. Discuss using illustrations, the methods used.

Oral Assessment

1. Project management important? Justify
2. Are you able to differentiate the various construction activities? Differentiate

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Practical Assessment

Conduct a site visit and prepare a project schedule upon commencement of the construction.

Oral Assessment

Why is it important to prepare a project schedule?

19.3.3.4 Tools, Equipment, Supplies and Materials

- Computers
- Software
- Cameras
- Construction manuals
- Projectors
- Flip charts
- Calculators
- Rulers, pencils, erasers
- Charts with presentations of data
- Drawing sheets
- Internet
- Relevant videos

19.3.3.5 References

Chudley, R. (2015). Advanced Construction Technology, 5th edition. Trans-Atlantic Publications. ISBN-13:978-0435046835.

A, M. (2010). Project Schedule. Project Smart.

1090-2:, B. E. (2018). Execution of Steel Structures and aluminum structures. Technical requirements for steel structures.

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19.3.4 Learning Outcome No 3: Organize the Construction Site

19.3.4.1 Learning Activities

Learning Outcome No 3: Organize the Construction Site	
Learning Activities	**Special Instructions**
3.1 Clear and secure site 3.2 Identify and mobilize human resources construction plant and equipment 3.3 Put in place ***site infrastructures***	• Group discussions • Demonstration by trainer • Power point presentation

19.3.4.2 Information Sheet No 19/ Lo 3: Organize the construction site

Introduction to learning outcome

This learning outcome covers clearance of site based on the contract document, site layout and organization, resource mobilization, contract documents site infrastructures (site office, site store, ablution block, fence, signage/safety signs, hoarding) based on contract document and legal requirements and legal requirements.

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Definition of key terms

Ablution block: Ablution Block is a washroom built on site location.

Site Office: The site office is a temporary administrative center where the building project operations are carried out.

Hoarding: Hoarding are closed boarded fences or barriers erected adjacent to a highway or public footpath.

Content/Procedures/Methods/Illustrations

3.1 Clear and secure site based on the contract document.

It is advisable, during clearing and grubbing, to involve the removal of any dead branches or the trimming of low hanging branches on the trees, so as to interfere with the growth. All pruning should be carried out in compliance with appropriate nursery practices. In the case of any harm to private property, the contractor shall be responsible for the costs involved in restoring the site to its previous state. A professional arborist should be consulted to make recommendations for the restoration or replacement of vegetation.

Figure 186: Preparation of the construction site
Source: Preparation of the construction site fao.org

3.2 Identify and mobilize human resources construction plant and equipment based on the contract document

The main contractor sets out certain requirements for the selection of its subcontractors. Such requirements may include previous experience of the subcontractor, technological ability to conduct work, mobilization ability in terms of human resources and plant equipment, financial capacity, quality of work carried out in the previous, records in terms of working relationships with the main contractor, record of work safety and workers' welfare.

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3.3 Put in place *site infrastructures* (site office, site store, ablution block, fence, signage/safety signs, hoarding) based on contract document and legal requirements.

- The arrangements for office accommodation should be provided on site as it a matter of choice for each individual contractor according to the Act 1963.
- There should be site store for provision of adequate space, protection and control for building materials.
- There should be sanitary facilities such as an ablution block separate male and female if possible.
- There should be a fence with a minimum height of 1.8 m with minimum access points and lockable gate or barrier.
- The safety signs/ signage should there and positioned well
- Hoarding should be provided to prevent unauthorized persons obtaining access to the site.

Conclusion

This learning outcome has prepared the student to be able to understand clearing of the site, site infrastructures, site layout and organization, resource mobilization, contract documents and legal requirements.

Further Reading

Read more on:
Contract documents, resource mobilization and legal requirements as illustrated on the Construction Project Management Theory and Practice by Kumar Neeraj page 137.

19.3.4.3 Self-Assessment

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Written Assessment

1. The following falls under clearing of the site. Which one is does not?
    a) Demolition of existing buildings
    b) Grubbing out of bushes and trees
    c) Removal of soil with vegetable matter
    d) Builder's square
2. The following are methods used to reduce the levels in the slopping sites. Which one is not?
    a) Cut and fill
    b) Cut
    c) Fill
    d) Clear site
3. Which of the following does not fall under site work and setting out?
    a) Clearing the site
    b) Establishing a datum
    c) Setting out the building
    d) Hoarding
4. Which one of the following is not a site layout consideration?
    a) Storage
    b) Access
    c) Datum
    d) Plant

5. Which of the following is not a safety sign?
    a) Red
    b) Yellow
    c) Black
    d) green
6. Discuss three types of contract documents
7. Differentiate between fencing and hoarding.
8. Discuss the aspect to be considered when carrying out site layout considerations.
9. Describe site organization structure
10. Why do you think when a builder is tendering for a given job, he must first visit the site before filling in his unit rates in the bill of quantities?

Oral Assessment

1. Briefly explain factors to be considered when tendering?
2. Discuss the activities should be carried out in pre-tender work?

Practical Assessment

Conduct a construction site visit and prepare the site organization structure.

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Oral Assessment

Site organization structure important?Justify

19.3.4.4 Tools, Equipment, Supplies and Materials

- Computers
- Software
- Cameras
- Construction manuals
- Projectors
- Flip charts
- Calculators
- Rulers, pencils, erasers
- Charts with presentations of data
- Drawing sheets
- Internet
- Relevant videos
- Wooden pegs
- Nails
- Hammer

19.3.4.5References

Site Clearance. (2010). In L. J. Hooper, Graphic Standards Field Guide to Hardscape (p. 71). Graphic Standards Field Guide to Hardscape.

Chudley, R. (2015). Advanced Construction Technology, 5th edition. Trans-Atlantic Publications. ISBN-13:978-0435046835.

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19.3.5 Learning Outcome No 4: Construct the Wastewater Infrastructure

19.3.5.1 Learning Activities

Learning Outcome No 4: Construct the Wastewater Infrastructure	
Learning Activities	**Special Instructions**
4.1 Source and mobilize ***construction materials and tools*** 4.2 Set out infrastructure 4.3 Construct ***wastewater infrastructure units*** 4.4 Do labour payments 4.5 Prepare and submit as built drawings 4.6 Prepare payment certificate 4.7 Prepare completion certificate 4.8 Observe site personal health and safety	• Group discussions • Demonstration by trainer • Power point presentation • Exercises by trainee

19.3.5.2 Information Sheet No19/Lo 4: Construct the Wastewater Infrastructure

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Introduction to learning outcome

This learning outcome covers Constructional details of onsite sanitation facilities and Construction plant and equipment. It also equips the learner with labour payment knowledge.

Definition of key terms

Trickling filters - These are a wastewater treatment system made up of crushed rocks in a tank of a depth of about 2 metres and a diameter of about 60 metres that is used to remove organic pollutants .

Sedimentation tanks – These are part of a waste water treatment system where waste water is filled and allowed to settle for a while so as to remove suspended particles that are in the wastewater.

Grit chambers – These are tanks that are long and narrow and are used to remove inorganic solids from waste water by reducing the speed of the flowing wastewater.

Content/Procedures/Methods/Illustrations

4.1 Source and mobilize *construction materials and tools* (Cement, Aggregates (course and fine), Steel, Stones /blocks, Timber, Tape measure, Hack saws, Pipe wrenches, Levelling tools e.g. Hammer, Set of protective) gear based on the bill of quantities

A bill of quantities entails the construction materials, tools, labour and their costs. It also includes the quantities required.it is usually prepared after specifications have been set and the design of the infrastructure has been done.

It will be used as a guide to obtain the specific quantities of construction materials needed. Sourcing of construction materials involves balancing between the cost of materials and their quality.

Material sourcing for construction involves the following activities:

1. **Deciding on possible suppliers.**

   Based on the materials that are required, you can choose a supplier for example a hardware store or a wholesaler with the required materials.

2. **Checking the availability of materials.**

   You could call the viable suppliers to check whether the required materials are in stock. Also in this step you could confirm the quality of the materials in stock.

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3. **Requesting quotes from the suppliers.**

   This is done so as to find a supplier with the most economical price. The quote can be obtained via email or by going to the supplier.

   After obtaining the quotes a price comparison is done to decide the final supplier.

4.2 Set out infrastructure based on the engineering drawings.

Setting out infrastructure is a process of transferring an engineering drawing onto the site/actual ground so as to establish the necessary structural parts. It enables construction to be carried out as it has been planned.

Setting out is done by using the following methods:

a. Using the peg and rope method
b. By using a dumpy level.

The procedure for setting out is as follows:

i. The building line for the waste water infrastructure is first set out.
ii. The baseline for the infrastructure is then set out.
iii. The first right angle to the base line is set out next.
iv. The second right angle to the base line is set out.
v. The final back line is set out.

vi. The set out for the infrastructure is then checked to confirm the measurements.
vii. Profiles are then set up on corners and ranging lines attached.

4.3 Construct *wastewater infrastructure units* (Screen, Grit chamber-horizontal, aerated/spiral, Sedimentation tanks, Activated sludge chamber, Trickling filters, Ponds, Oxidation ditch, Aerated lagoons, Storm water drains, Equalization tank, Sequential Batch Reactor, Rotating biological contactors, Oil and grease trap) based on the design drawings

Waste water infrastructure units are the units that are systematically used to purify water so that it can be recycled back.

Construction of these units is done in with reference to the engineering drawings and bill of quantities on the site where they have been set out.

4.4 Do labour payments based on the progress report and attendance.

A progress report is a report that details the activities that have been carried out, those that have been completed, those that are in progress, any problems that may have been faced and how the construction project is proceeding.

The progress report facilitates labour payments, called progress payments. These are partial payments made to cover the amount of work that has been done at a particular stage or by what percentage of work that has been done.

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4.5 Prepare and submit as built drawings based on the actual construction.

As-built drawings are revised drawings that are prepared and submitted by the contractor after the project has been completed.

They usually indicate all the adjustments made while building the project.

The method of preparing is built drawings is as follows:

1. **Preparation of the as built drawings by the contractor.**
   The contractor incorporates all changes made to the original design in accordance with official notes regarding such changes. The contactor is also supposed to visit the site to ensure all the changes are reflected in the drawing.
   After preparing the drawings, they are submitted to the Engineer overseeing the construction.

2. **Approval of the as built drawing by the engineer.**
   The engineer verifies the drawings with the official notes time to time according to how much construction has been done.
   They will also go to the site and check the drawings against the constructed facilities.
   If satisfied, the engineer will accept the drawings and keep a record of them in their office.

4.6 Prepare payment certificate based on progress report.

A payment certificate in construction is a document that gives an account of the work that has been completed. It is approved by the contractor.

They are issued either on a regular basis or when a project reaches a particular milestone.

Some types of payment certificates include: certificate of non-completion, interim certificate, practical completion certificate and final certificate.

4.7 Prepare completion certificate based on the legal requirements.

A completion certificate is also called a final certificate. It is usually submitted when the project has been completed successfully at the end of the contract. The construction has to have met required specifications outlined by Building regulations stipulated by the Kenyan Government.

4.8 Observe site personal health and safety as per the OSH Act and site regulations.

OSH Act is a set of rules meant to ensure the safety and wellbeing of employees by employers by protecting them from hazards.

These regulations help in the identification, reduction and elimination of hazards that are related to construction work.

The employers and employees must adhere to the set standards of safety to avoid getting injured due to the top four construction hazards which include:

1. Falls
2. Struck-By
3. Caught-In/Between
4. Electrocutions

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Conclusion

This learning outcome covered Constructional details of onsite sanitation facilities and Construction plant and equipment.

Further Reading

Read more on the various types of payment certificates, how to come up with as-built drawings and go through the OSH Act.

19.3.5.3 Self-Assessment

Written Assessment

1. Which of the following is not a waste water infrastructure unit?
    a) Activated sludge chamber
    b) Trickling filter
    c) Pit latrine
    d) Grease trap
2. Which one is not a type of payment certificate?
    a) Final certificate
    b) Certificate of non-completion
    c) Independent certificate
    d) Interim certificate.
3. One of the following better defines an as built drawing. Which one is it?
    a) The drawing of the building before construction.
    b) The revised drawing of the building after construction.
    c) A sketch drawing
    d) None of the above.
4. A completion certificate is also called?
    a) Interim certificate
    b) b) Project certificate
    c) c) Final certificate
    d) d) None of the above
5. What does OSH Act stand for and what does it entail?
6. Define a progress report.
7. Discuss 4 wastewater infrastructure units?
8. Write a short essay outlining the basic steps that are followed in material sourcing and their significance.
9. Discuss what a payment certificate is and expound on the various types of payment certificates.

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Oral Assessment

Demonstrate various waste water infrastructure units.

Examine the steps followed while sourcing materials for construction?

Practical Assessment

Design an engineering drawing of a trickling filter and practice setting out its infrastructure.

Oral Assessment

Mention the challenges faced in the process of designing the trickling filter.

What are the major steps followed while setting out infrastructure?

19.3.5.4 Tools, Equipment, Supplies and Materials

- Computers
- Software
- Cameras
- Construction manuals
- Projectors
- Flip charts
- Calculators
- Rulers, pencils, erasers
- Charts with presentations of data
- Drawing sheets
- Internet
- Relevant videos

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19.3.5.5 References

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