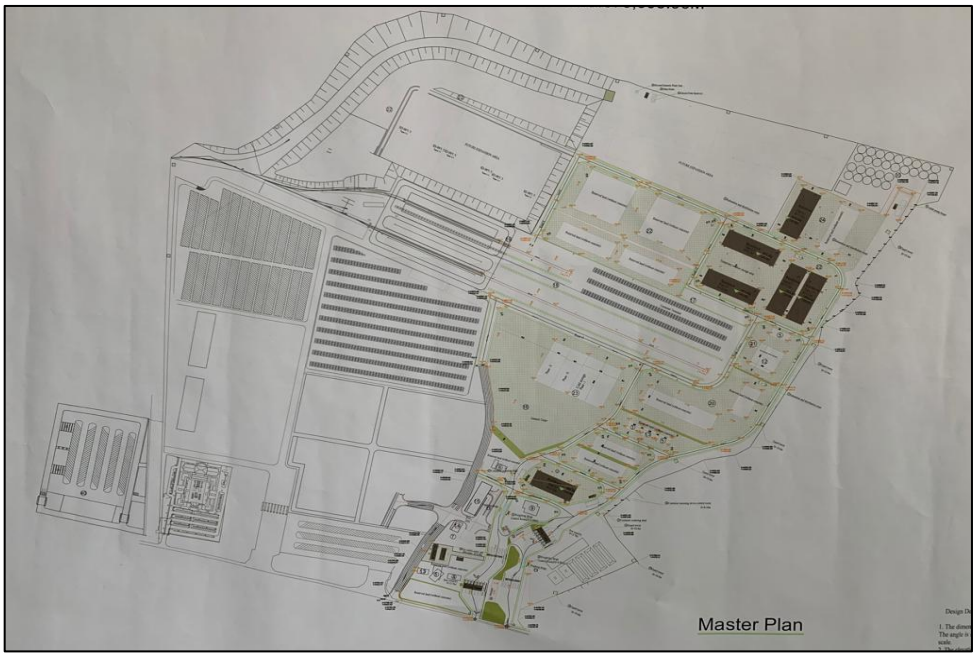
INTERNSHIP REPORT

MODJO DRY PORT EXPANSION



Submitted to

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An internship report submitted as part of 2 weeks of training

Taken at Modjo Dry Port, Modjo, Ethiopia

ABSTRACT

This internship report presents a concise and comprehensive summary of my 2-week long study and learnings from the Modjo Dry Port Expansion and Upgradation project. The report mainly consists of my understanding of the expansion Master Plan, summarizing the IT requirements, supervision of on-site Construction works and testing, and analyzing materials used for the construction at the site laboratories. In order to understand the feasibility of a material, a detailed method of testing has been discussed in the report.

The report contains comprehensive details of different departments that work as part of the expansion project and their roles. It also gives an overview of the Modjo Dry Port expansion project and what I have learned and understood during the 2 weeks period of my internship.

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Acknowledgment

First, I would like to thank Eptisa, Ethiopia branch for giving me such a great opportunity to work and learn during my internship. The internship provided me with a holistic overview of a consultancy project of such a high level, I could understand the importance and work of each individual that goes into making a large-scale project successful

The whole team at Eptisa, Ethiopia had helped me at every stage and pushed me to work with seniors of various fields during this period.

I would also greatly thank **Mr. Nebyi,Gebremariam Branch head and contracts manager Eptisa, Ethiopia** for constantly supporting me, helping me throughout this period, and always being available to solve any issues be it meetings, arrangements, or logistics for traveling to Modjo.

I am also grateful to **Mr. Fadhili Mosa**, **Resident Engineer** at the Modjo Dry Port expansion project who despite his busy schedule made sure I had enough resources to complete my work.

I was also supported by **Mr. Asmama**, the **Assitant Resident Engineer** of the project , and **Mr. Lemma**, the **Material Engineer** of the project who made arrangements for me to work in the site laboratory with Mr. Samuel, The Material Inspector of the project.

Mr. Brajnandan Kumar, the **IT expert engineer** for the project, and, **Mr. Jon**, **Sanitary Engineer** for the project also helped me understand the project through IT and Sanitary aspects.

Not to forget the help and support of **Mr. Mici** and **Mr. Tess** who were there every time I needed some help for any kind of issue during my internship period.

INTRODUCTION

Dry ports and their uses:

A dry port is an inland intermodal terminal located far from the sea but connected to a seaport by a direct land link, such as a railway or highway.

The benefits of having dry ports are

i. ability to relieve the issues of storage and customs space that frequently plague seaports.
ii. Sea Ports have a limited amount of space, which is far less than is sometimes necessary to handle the large quantities of goods coming in.
iii. They help reduce the competition of companies trying to get their goods stored temporarily before they embark onward to their destinations.
iv. Dry ports act as central distribution hubs for a massive amount of goods
v. Dry ports also speed up the movement of cargo between ships and inland transportation systems that distribute the goods and improve import & export of countries.

Africa and its Need for Dry Ports-

Africa has 16 landlocked countries that have no access to waterways import and export through Sea Ports. Africa's dry port network is rapidly advancing, as part of a continental effort to increase freight movement between sea and land and tackle logistics constraints; particularly for landlocked nations.

The African Continental Free Trade Agreement (AfCFTA), which is intended to significantly increase trade between African nations has significantly boosted the development of dry ports in Africa.

Trade corridors (Major Dry Port areas) in Africa

Many landlocked developing countries regularly face physical isolation, supply chain-related barriers from the sea, and high trade costs with the rest of the world.

Botswana, for example, operates the Botswana Dry Port in the Namibian port of Walvis Bay. **Ethiopia's** 8th dry port **Dire Dawa Port** was built to facilitate trade with Sudan.

Export value 2006 – 2011: World, Africa & East African LLDCs (USD millions)

Exporter	2006	2007	2008	2009	2010	2011	
World	12134707	14015751	16137233	12518117	15257877	18211356	100%
Africa	373284	438914	561559	394888	508201	590766	3.24%
Ethiopia	1043	1277	1602	1618	2330	2615	0.01%
Uganda	1188	2000	2712	2995	3107	2409	0.01%
Burundi	58	62	54	62	100	122	0.00%
Rwanda	147	177	268	193	297	417	0.00%

Growth 200 - 285%

Source: UNCTADSTAT

The impact of Dry ports on African LLDCs

Nigeria plans to build six more dry ports across its territory. The Dosso dry port in Niger, is located on the Dori (Burkina Faso) – Cotonou (Benin) corridor**. Benin, Nigeria, Kenya, South Africa,** and **Senegal** are also countries that have developed dry ports to facilitate marine trade and the flow of goods from sea to land and facilitate trade for landlocked nations.

Ethiopia and its Need for Dry Ports

Ethiopia has the most promise of becoming a middle-income country in the near future because it has had one of the highest average annual GDP growth rates in SSA(Sub-Saharan Africa) (around 10%) over the past decade. Ethiopia, a north-eastern African

country is classified as a LLDC (Landlocked Developing Country) with a GDP of $126.78 billion which is almost 6 times compared to its GDP of $27.07 billion way back in 2008.

Ethiopia's exports were worth $1447.9 million USD and imports were worth $7726.6 million USD in fiscal year 2008/09. On comparing with the latest fiscal year 2021/22 their exports were worth $10460 million USD while the import stood at $23809.3 million USD. Obviously, the trade volume as indicated has risen significantly over these years.

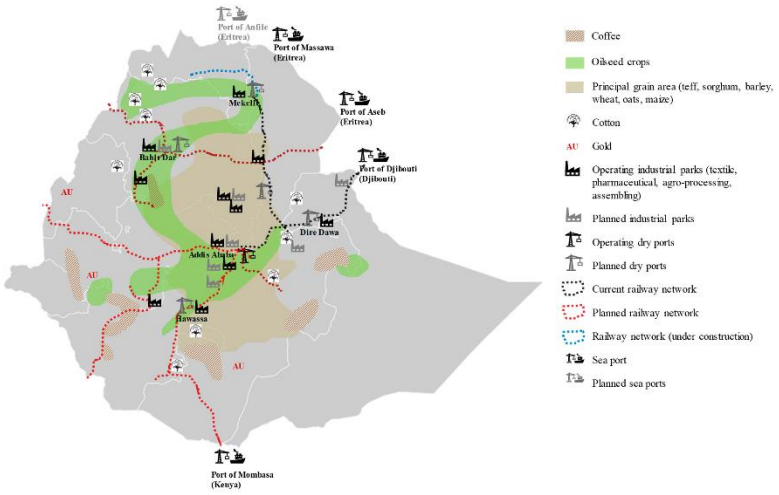
Coffee and Gold, major exported goods of Ethiopia have increased their trade volume since the first Dry port became operational.

Dry Ports in Ethiopia are a major economic booster

Ethiopia is a landlocked country; therefore, exports are dependent on foreign seaports, mainly the Port of Djibouti, which handles about 95% of the exports of Ethiopia

Why did the Ethiopian Govt. want to invest more in intermodal goods export/import?

i. To strengthen the connection between industrial parks and the Port of Djibouti
ii. reduce domestic transportation times
iii. Being an LLDC, dry ports would improve international trade



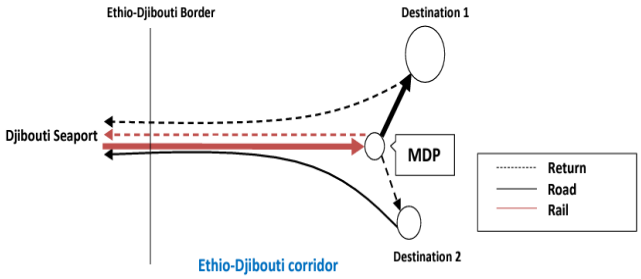
Overview of the main export goods, industrial parks, and intermodal transport network of Ethiopia

Drawbacks of road transport of goods from Djibouti to Ethiopia?

If an operator is serving the main import–export route from Djibouti to Addis Ababa (Modjo Dry Port), one truck is only able to serve this track with 2.5 trips per month, meaning that the transportation times are extremely high. Due to these circumstances, truck utilization in Ethiopia is extremely low compared with utilization in other countries

Modjo Dry Port and its Expansion and Upgradation

Modjo Dry Port is the leading dry port in the country, 75 kilometers from Addis Ababa, Ethiopia built on 158 hectares. It handles 80 % of the country's import-export market along the Ethiopia-Djibouti trade corridor.



MDP link with Djibouti Port, by Road and Rail

Based on the **Ethiopian National Logistics Strategy (ENLS)** document, it takes on average four months to import cargo into Ethiopia under the current logistics system while the average global standard is one month.

A picture of my site visit to Modjo dry port container terminal on 5th July 2023

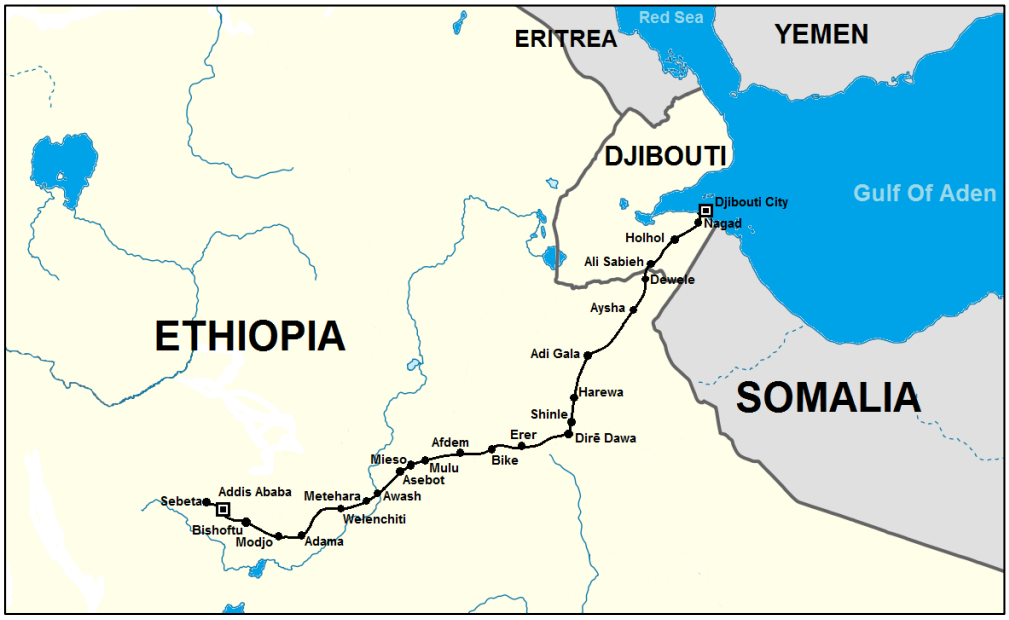
Why is there a need for the expansion and upgradation of Modjo Dry Port?

i. The **Port Dwell Time** of containerized cargo at Modjo Dry Port is **10 times higher** than the average **global standard** of **3 days**.

ii. **Shortage of transporters** which led to failures in picking up shipments quickly enough. The delay in picking up containers severely hampers the effectiveness of the dry ports.

iii. The dry port has **insufficient cargo handling equipment**, and it **lacks facilities to store**, **load**, or **unload** import and export containers.

iv. Missing management systems, such as a proper terminal operation system (**TOS**), lead to delays in locating containers and other inefficient operations



Pictorial representation of Railway track from Djibouti port to Modjo dry port, Ethiopia

What will the new upgradation and expansion project add to Modjo Dry Port?

The are currently **4 operational warehouses** of **5400m^2** and **2 small warehouses** of **1600m^2** in Modjo dry port and 2 warehouses of 5400m^2 are under construction.

In the **expansion of Modjo dry port**, there will be:

i. **6 refrigerated warehouses of 5400m^2**

ii. More **reserved land without concrete left for future upgradation** as per requirement.

iii. There will be **more access roads**,

iv. The entrance and exit gates will be equipped with IR Sensors, NPR cameras

v. In addition to these, the Modjo Dry Port expansion project will fill what the Modjo Dry Port lacks, "3S" aspects of **Safety**, **Security,** and **Sanitation.** Lack of fire-fighting management at the old dry port is a big concern, the 4 warehouses do not have proper water supply and fire-fighting services (fire alarms & fire extinguishers).

SANITARY- a major backdrop of Modjo Dry Port

On my visit to the Modjo dry port on talking with the administration I got to know that the sanitary aspect of the Modjo dry port is a big drawback in the efficiency of the port. The expanded dry port will have

i. a good water supply, fire-fighting pipes below the pavement, and

ii. sewage pipes for proper drainage in the port.

In our meeting with the head engineer of ICT of Modjo Dry Port, he informed us about various IT features at the port.

The IT system of Modjo dry port is not integrated fully. The upgraded & expanded Modjo port will tackle these issues. The new technology and upgradation on Information Technology infrastructure building will be explained in detail later in the report.

My visits at the Eptisa project site and Modjo Dry Port

Before my visit to the site, **Mr. Nebyi** explained to me the flow of work that I had to complete as per scheduled dates. My first visit to Eptisa site office at Modjo was on 30th June 2023. Had a small meeting with **Mr. Fadhili Mosha**, **Resident Engineer** of the Modjo Dry Port expansion and upgradation project, who briefed me about my role in the internship project.

The flow of work assigned to me in the internship period were-

- Understanding the AutoCad drawing of Modjo Dry Port Master Plan- Mrs. Seble(Design Expert)
- Going on-site at the Dry Port to understand the IT aspects of the old port and the new proposed Modjo Dry Port- Mr. B.Kumar (IT expert)
- Work for a few days in the Eptisa office in Addis Ababa, Ethiopia
  Visiting the Eptisa Modjo Dry Port project site for 3 days:
    i. Visiting the site Laboratories with Mr. Lemma (Material Engineer) and Mr. Sameul for understanding soil tests and material feasibility.
    ii. Meeting Mr. Asmama, ARE (Assistant Resident Engineer) for understanding the construction requirements, supervising the contractor CCECC (China Civil Engineering Construction Corporation Ltd), understanding the surveying instruments and its workings

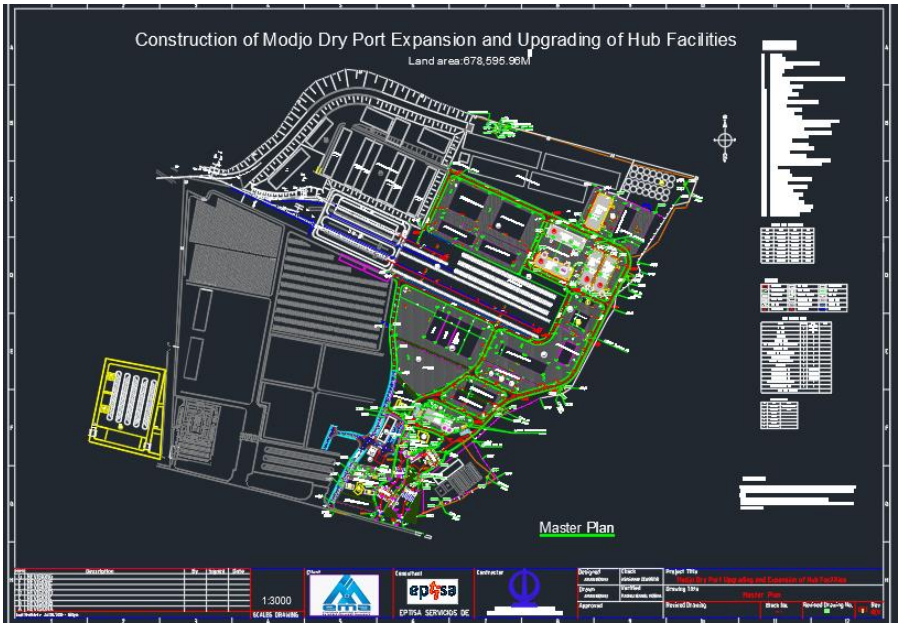
iii. Meeting Mr.Jon, a Sanitary expert on the project to learn the sanitation & fire-fighting related work of the expansion.

iv. Working with the Resident Engineer, Mr Mousha to understand his role.

- Meeting with Mr. Nebyi, to understand his role as the contractor supervisor and branch head of Eptisa, Ethiopia.
- Submitting a report on the internship period to Mr. Nebyi.

MODJO DRY PORT EXPANSION MASTER PLAN- AUTOCAD

Modjo Dry Port Existing Design and Expansion Design- What I learned



Mrs. Seble, the Design engineer, and I discussed the Autocad drawing, she explained the overall plan. My learnings are shared below in detail.

The Autocad layout designed for the purpose of upgradation and expansion of the Modjo Dry Port is divided into majorly 4 parts:

i. Entrance & exit for distribution of cargo

ii. Warehouses & Silos

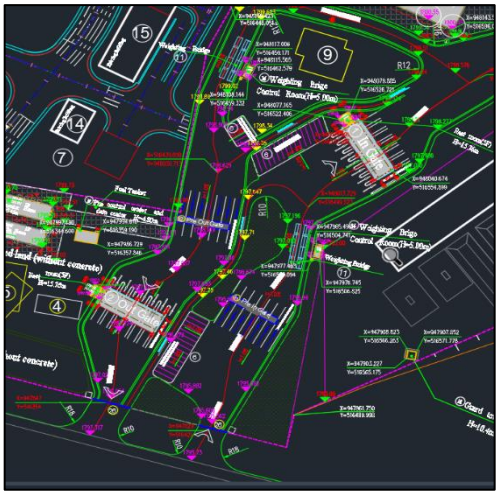
iii. Security/Sanitary & Fire safety aspects

iv. Railway Terminal

The Master Plan is drawn considering international standards. The dimension and distances of the master plan are in meters (m) and other units are in millimeters (mm). Angles given are in degrees.

The plan also **follows Ethiopia National Elevation System** for showing the elevation of roads. The radius of the turning point unless specified is 12m in the plan.

Entrance & exit of trucks



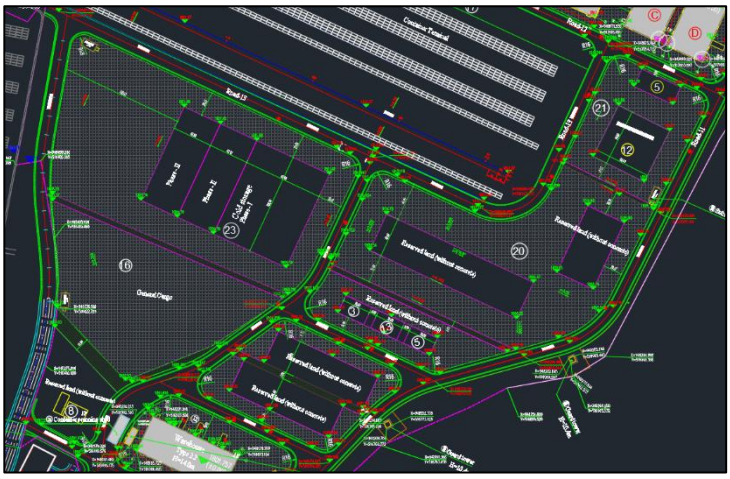
The entrance and exit gate are divided into a **Pre-In Gate** & **Pre-Out gate** and **an In Gate** & **Out Gate**.

The pre-gates have a separate **lane for oversized trucks** and a **Weighing Bridge**.

The Entrance and exit gates will be connected with:

- CCTV Optical Fiber Cables from the Data Center
- Electricity supply lines
- Control Rooms for monitoring the logistics
- Sewage supply line connecting the Modjo Dry Port to the city's main sewage line

STORAGE OF CARGO CONTAINERS

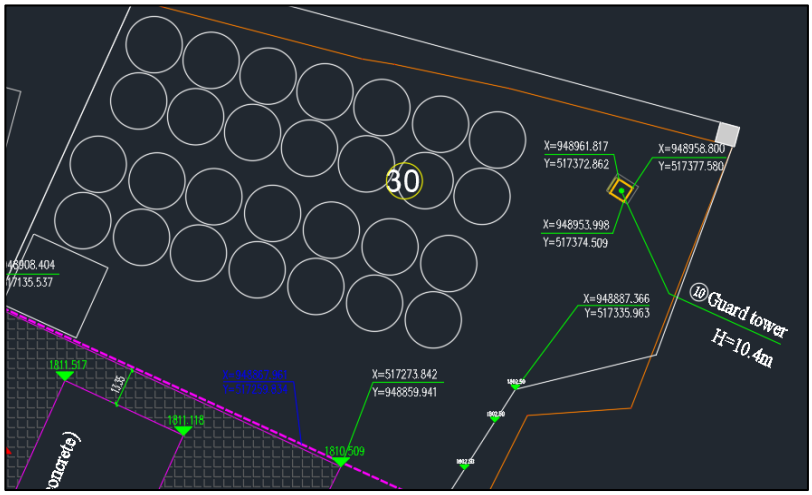


The **cargo delivered by the Ethiopian Railways from Djibouti will be stored on various Concrete pavements**. The concrete pavements have warehouses (of different types for storing different kinds of cargo) and reserved lands.

Each concrete land is made for storing different kinds of container cargo. The Storage land is divided into a total of **8 concrete lands** with also reserved lands within it with no concrete for future upgradation.

The plan divides the concrete lands into a total of **5 Storage facilities**:

I. **Dry Bulk Storage** for Grains
II. **Cold Storage** for storing goods at low temperature
III. **General Cargo Storage** for goods that are individually transported in drums, boxes, or barrels.
IV. **Import Deconsolidation Zone** for unbundling individual orders into smaller packages.
V. **Export Consolidation Zone** for bundling orders into a container



Silos for storage at the dry port

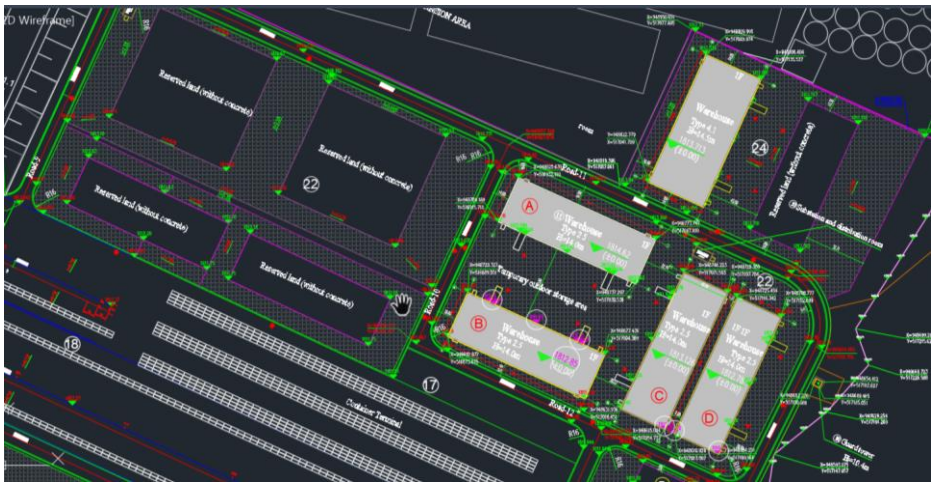
At the far end (marked by 30) of storage areas are the **Silos to store grain, powders, and fermented feed**) and animal slurry.

The plan for the Dry port expansion shows **6 warehouses**, **1 warehouse** of **Type 2.2** at the entrance & exit Road-11 & Road 17.

Type 2.2 warehouse at the entrance used in case of On-demand storage.

The other **5 warehouses** are along the roads-**Road 10, Road 11,** and **Road 12**. The 4 warehouses in the Import Deconsolidation concrete storage land are of **Type 2.5**. And the other one is a **Type 4.1 warehouse** used for **Dry Bulk storage** such as grains.

Loading, Unloading, and Logistics Zone

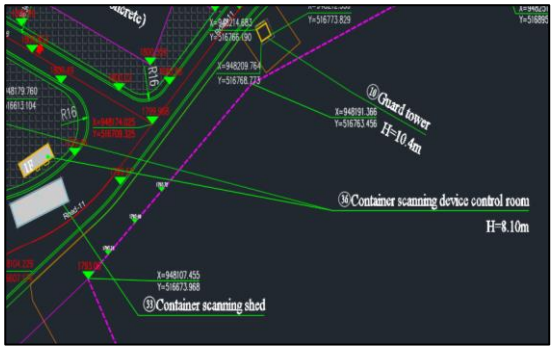


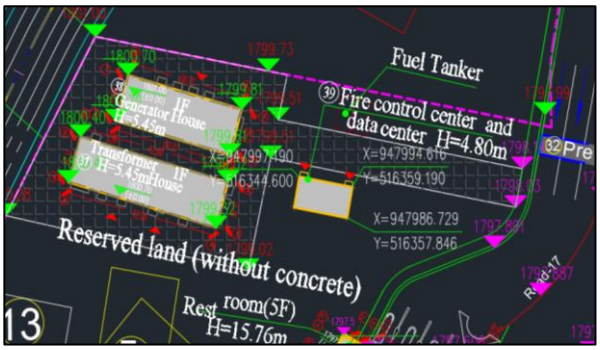
The container goods brought through the railway line from Djibouti will be also unloaded, ie. **Import Deconsolidation** at the marked zone no. **22**. The individual in barrels or boxes or bulk goods will be unloaded in the zone.

The area marked as **20** near the main **4 warehouses** of sizes **5,400m^2** is for **export consolidation** that will be used for loading the goods to trucks for delivery in different parts of Ethiopia.

The main logistics aspect of the Modjo Dry Port will be covered within these areas of unloading and loading of goods from containers.

Security, Safety & Utility Aspects of Expanded Modjo Dry port

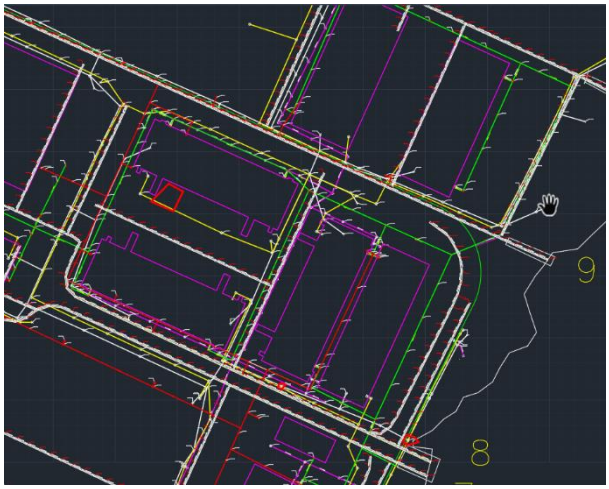




The dry port has **Container Scanning devices** at the Entrance & Exit gates also **CCTVs** and **guard towers** at Road-11.

For Safety purposes there are **firefighting water pipelines 2.5m below** the **pavement level** along all the roads in the dry port and the Fire control center near the exit gate of the Dry Port.

SANITARY & WATER SUPPLY ASPECT



The water is divided into domestic supply and sewage supply. **Sewage drain pipelines** (represented in purple) are **buried 1.5m below the pavement level** and surround every warehouse and facility building in the Dry Port.

INFORMATION & COMMUNICATIONS TECHNOLOGY

OF EXISTING & PROPOSED MODJO DRY PORT

On my visit to the Modjo Dry Port with Mr. Braj Kumar, ICT Head Engineer & Mr. Jon, Sanitary Engineer the expansion project site in Modjo, I learned about the current IT system in the port and the IT infrastructure to be developed in the expansion and upgradation Project.

Eptisa, as a consultant company, the contract requires IT experts to work on the IT Infrastructure of the expansion & upgradation of the Modjo Dry Port. The WMS & TOS will be provided by the client (Ethiopia Maritime Agency).

The Modjo Dry Port existing IT framework:

i. The Dry Port has a total of **140-150 CCTV cameras** of which around **104 are Bullet & Dome** cameras and around **20 high mast PTZ cameras** around all 6 warehouses. A total of 12 TV of 49 inches screens were in the CCTV room for monitoring the Port activities.

ii. The Modjo Dry Port has its **Datacenter in the ICT room** in the admin building.

iii. The Dry port has an **internal Wi-Fi connection** with **20 Mbps** speed.

iv. Different parts of the port such as customs, entrance-exit gate -warehouse also use Local Administrative Network,

v. The dry port uses **Cisco's service** for **external Wi-Fi**,

vi. Modjo Dry Port currently uses **Oracle's cloud-based services** for its **ERP system**. **Oracle's Warehouse Management System** is also used with some modifications by the Ethiopian Maritime Agency's employees to make it a Terminal Operating System

vii. **WASS**-a local company from Addis Ababa **set up a CCTV OFC network** in the Dry Port.

viii. There are 2 networks concerning ICT, the Optical Fiber Cables network and the other network line connecting the Systems at:

(i) The warehouse
(ii) The In-Out Gates
(iii) The container terminal areas

to the Datacenter at the administrative building.

ix. At the In-Out Gate of the Modjo Dry Port, the IT infrastructures involved are:

ANPR & Bullet camera and Sensors at each lane

Image to Text converter bullet camera

i) **An ANPR camera** in each lane for number plate recognition at each lane along with a bullet camera,

ii) **2 sensors for Vehicle detection** at each lane

iii) **2 Image-Text converter cameras** at each side of each lane for detecting the number code of containers carried by trucks. (The converted text is then used in WMS at the gates for cross-checking correct shipments as assigned to the truck)

iv) **1 IR sensor camera** for detecting if the truck is empty or occupied with a container or goods. (The camera sends rays to check the dimensions of the truck and matches it with the size of the container assigned to check for the right container and shipment)

v) The CCTV camera system and the Data Centre for the warehouse and terminal operating system are not integrated.

vi) Separate servers for CCTV and Data centers are made.

As mentioned above, Eptisa has a contract of working on the IT infrastructure so the WMS, TOS ANPR, and Wi-Fi system are not under the scope of work

IT work proposed by Eptisa under expansion & upgradation of Modjo Dry Port

Eptisa's work on IT infrastructure development & upgradation in the project has 3 objectives:

i. **IT infrastructure upgradation and set up for CCTV and other utilities**:

- OFC connection for CCTV cameras from the ICT control room and setting up cable connection for OFC and electric supply either by forming a duct or separate lines for each water, electricity, sewage, or CCTV line. **WASS,** a local company**,** would be contacted for setting up the network.

ii. Building a SCADA system for integration and monitoring/supervision of all systems at the Dry Port.

- For monitoring all the departments like electric, sanitary, water supply, and warehouse management system of the dry port a SCADA system would be set up.
- SCADA system at Dry Port benefits:

Electricity Supply Aspect:

(1) Ethiopia faces a lot of unusual power shortages and blackouts which causes a huge economical loss to the country

(2) The introduction of the automated SCADA system, advanced measurement, and smart communication technologies provide a better way to detect rapid disturbances and protect the overall grid at Dry Ports from the propagation of fast-cascading outages to avert a blackout in real time.

Scada uses in all aspects of CCTV, Wi-Fi connections, Fire-Fighting, and Water supply at the dry port:

- SCADA encompasses the collecting of information via a RTU, transferring it back to the central site (The control rooms at the In-Out

gates or the Administration Room), carrying out any necessary analysis and control, and then displaying that information on a number of operator screens or displays.

- A SCADA system gathers data from sensors and instruments located on remote sides. Then, it transmits data to a central site for the controller monitoring process**.**

iii. **Setting up a Fire-Fighting related SCADA monitoring system**

(Coordination work between IT expert Mr.Brajnandan Kumar and Sanitary Expert Mr. Jon).

- Under the project, an integrated fire alarm & sensor system will be set up in each warehouse along with fire-fighting resources.
- Fire-fighting equipment accessibility at each warehouse, In-Out gates, and container storage zones will be increased

Water Supply and management in Modjo Dry Port expansion and upgradation project

In my discussion with Mr. Jon, the Sanitary Engineer of Modjo Dry Port expansion I understood the role of the SCADA system for Water supply in the upgradation of Modjo System at the dry port.

SCADA(Supervisory Control And Data Acquisition) system for Water Supply:

Water supply and quick availability at the Dry ports or any facility are vital for the facilities' functioning. Water supply management is also crucial to know the information regarding consumption, resources, and production.

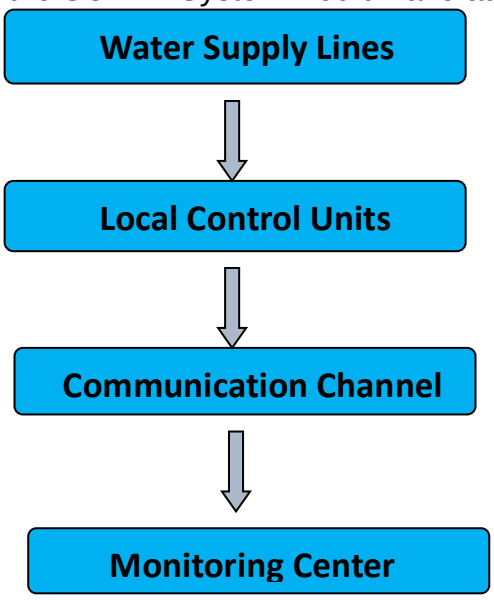
SCADA system for water supply management and monitoring is mainly used for continuous status checks for finding optimal working parameters and to solve any issues that might arise in real time.

SCADA for water supply would consist of:

i. A supervision and control system for real-time installation,
ii. programmable logic controllers with basic functions (communication, adjusting, measuring, etc.) libraries,
iii. communication systems,
iv. standard interfaces or dedicated ones with sensors, measuring devices, etc.
v. A data center for monitoring purposes.

The Architecture of the SCADA system would be a network of Local Control Units at different parts connected either wirelessly or through the wire to the **Supervision Center**

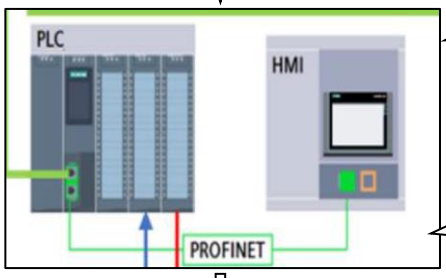
The units of Layer that the SCADA System would have at the Dry Port are:



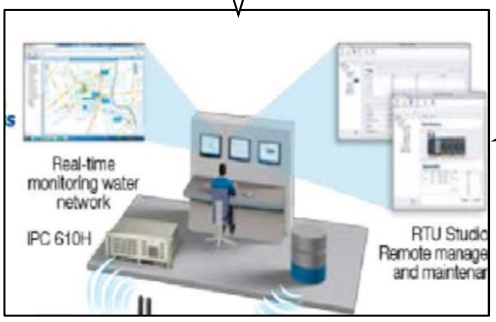
For Water supply, at each layer, the systems involved are:

Actuators and Sensors in the water supply

PLC for collecting data from Sensors and processing



HMI for operators to analyze the data



Server and SCADA Monitoring Control center

TESTING MATERIALS OF CONSTRUCTION SITES

Mr. Lemma (Material Engineer) and Mr. Sami (Material Inspector)

On 10th July 2023 on my visit to Modjo Dry Port expansion project & construction site, the material testings' done by me were:

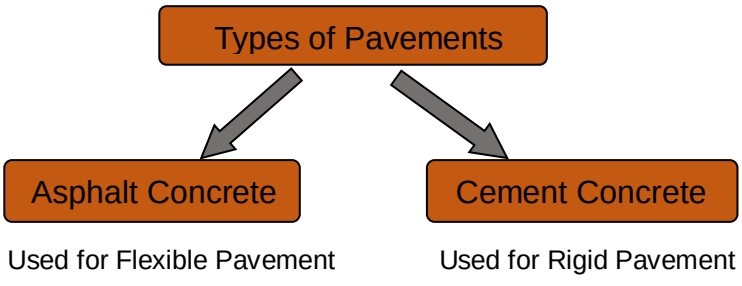
i) To practically understand and learn about the material testing of soils for cement concrete and making pavement,

ii) To test the Flexure strength and bending stresses of steels used for the construction work.

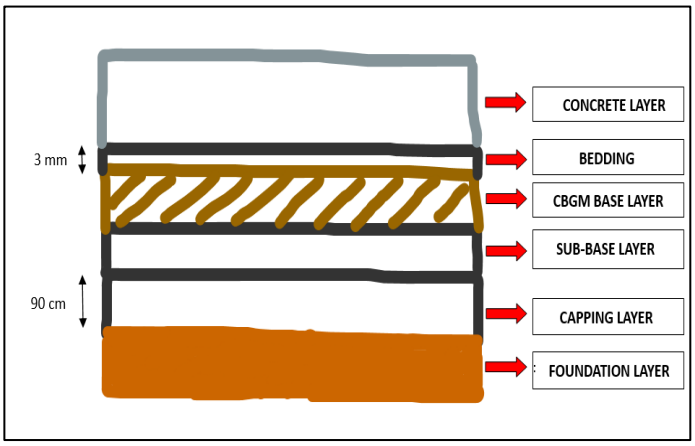
For the Modjo Dry Port expansion, pavements must be made in the warehouse and the roads.

Aims of Material Engineers in Modjo Dry Port expansion project

i. Deciding the type of pavements to construct and
ii. the type of soil for sub-base, bedding, CBGM (Cement Bound Granular Mixture), and Cement Concrete type to use.
iii. Choosing a suitable steel type for the project.
iv. Classification of Soil & Cement to use for construction
v. Choosing a suitable Aggregate material for the cement.
vi. Approving the Cement Concrete's strength



Mr. Sami explained me the structure of the cement concrete pavement:



A pictorial representation of the Pavement layer at Modjo site as explained by Mr. Sami

The pavement type chosen for the Modjo Dry Port expansion & upgradation project was **Cement Concrete Pavement** because of high strength and durability to heavy-load vehicles at the port

The layers in the cement concrete pavement are:

i. The lowest layer is the Foundation Layer which is the fine sand of the area
ii. The Capping layer of 90cm improves the foundation stability, the 90cm is further divided into a 40cm Rock layer which is compacted then 2 layers of 15cm each compacted after putting over the previous layer.
iii. The next layer is the Sub-Base Layer to reduce the pressure in the lower layers and improves the permeability of the pavement to let the water soak.
iv. The CBGM (Cement Bound Granular Mixture) Layer is a base layer for pavement for withstanding heavy loads at the port.
v. A 3mm of bedding above the CBGM Layer
vi. A cement concrete layer made up of several concrete blocks at the top.

Some material testing machines that are not available in the Site Laboratory are tested in Addis Ababa University.

The boulders at the sites are supplied to the crusher machine which separates the boulders of sand into:

i. Coarse Sand
ii. Crushed Coarse Sand
iii. Crushed Sand

The material testing laboratory at Eptisa project sites had 3 types:

i. **Mechanics Lab**:
   - Cement mixing
   - Bending & Flexure Testing Machine
   - Compaction Testing Machine

ii. **Soil Lab**:
   - Soil Index Test
   - California Bearing Ratio Testing Machine
   - Soil Gradation Test using Sieve Analysis
   - Proctor Compaction Test Machine
   - Plasticity Index (PI) Testing Machine

- Oven for heating soil material for Moisture vs Density test (Proctor Test)

iii. **Concrete Lab**:

- Los Angeles Abrasion Testing Machine (LAAT)
- Concrete blocks Soaking Bath Tanks

Tests conducted at Eptisa's site laboratory were:

Tests on aggregates for use in the Dry Port:

i. Aggregate Crushing Value Test (ACV):

ACV test provides the strength of resistance of the aggregate against crushing under gradually increasing compressive load.

Aim- To find out the Average aggregate crushing value.

Weighing the aggregate post-compaction

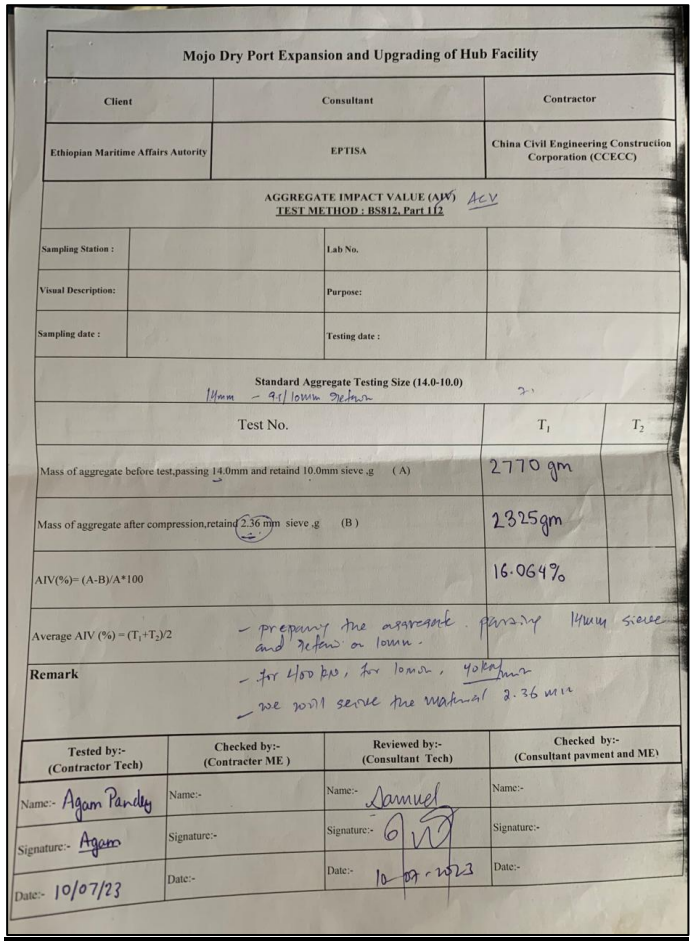
Aggregate in a beaker under compressive load

Method:

- We collect and dry the aggregate of any moisture that might be present
- The initial mass is taken of the aggregate that passes through the 14.00mm sieve but is retained by the 10.00mm sieve. (w1)
- After noting down the initial mass, the aggregate is put in a 15cm diameter steel cylindrical beaker with a plunger and a base plate.
- The beaker is then adjusted between the pistons of the Compaction Machine

- A total compressive of 400kN is applied for 10mins with a constant rate of 40kN/min
- After the load has been applied some aggregates break on compaction
- We now pass the aggregate through a sieve of,2.36mm
- Measure the weight of the aggregate now. (W2)
- Aggregate Crushing value = (W2-W1)/W1*100
- The aggregate crushing value must be less than the maximum permissible percentage of 50Z%, in the case of Modjo Dry Port.

Observation & Result:



Mojo Dry Port Expansion and Upgrading of Hub Facility

Client	Consultant	Contractor
Ethiopian Maritime Affairs Autority	EPTISA	China Civil Engineering Construction Corporation (CCECC)

AGGREGATE IMPACT VALUE (AIV) ACV
TEST METHOD : BS812, Part 112

Sampling Station :		Lab No.	
Visual Description:		Purpose:	
Sampling date :		Testing date :	

Standard Aggregate Testing Size (14.0-10.0)
14mm - 9.5/10mm Retain

Test No.	T_1	T_2
Mass of aggregate before test,passing 14.0mm and retaind 10.0mm sieve ,g (A)	2770 gm	
Mass of aggregate after compression,retaind 2.36 mm sieve ,g (B)	2325gm	
AIV(%)= (A-B)/A*100	16.064%	
Average AIV (%) = $(T_1+T_2)/2$	- preparing the aggregate passing 14mm sieve and retain on 10mm.	
Remark	- for 1/00 bar, for 10min, 40kg/min - we will serve the material 2.36 mm	

Tested by:- (Contractor Tech)	Checked by:- (Contracter ME)	Reviewed by:- (Consultant Tech)	Checked by:- (Consultant payment and ME)
Name:- Agam Pandey	Name:-	Name:- Samuel	Name:-
Signature:- Agam	Signature:-	Signature:-	Signature:-
Date:- 10/07/23	Date:-	Date:- 10-07-2023	Date:-

- The initial mass of the aggregate before the test, passing through the 14mm sieve but retained by 2.36mm sieve=**2770gm**
- The mass of aggregate after compression, retained by 2.36gm sieve= **2325gm**
- ACV %= (W1-W2)/W1*100= (2770-2325)/2770 *100= **16.064%**

Since the Aggregate Crushing value is low and lower than the project requirement of 25% max that means the material aggregate material is good for the dry port and for every 100gm of the aggregate only 16.064gm will be crushed under heavy compressive load (in such case, trucks)

ii. Los Angeles Aberration Test (LAA Test):

Los Angeles abrasion test on aggregates is the measure of aggregate toughness and abrasion resistance such as crushing, degradation, and disintegration. When vehicles move on the road, the soil particles present between the pneumatic tyres and road surface cause an abrasion of road aggregates. The steel rimmed wheels of animal driven vehicles also cause considerable abrasion of the road surface. Therefore, the road aggregates should be hard enough to resist abrasion.

Aim: To find the percentage of aberration of the aggregate. Los Angeles Aberration Value calculation

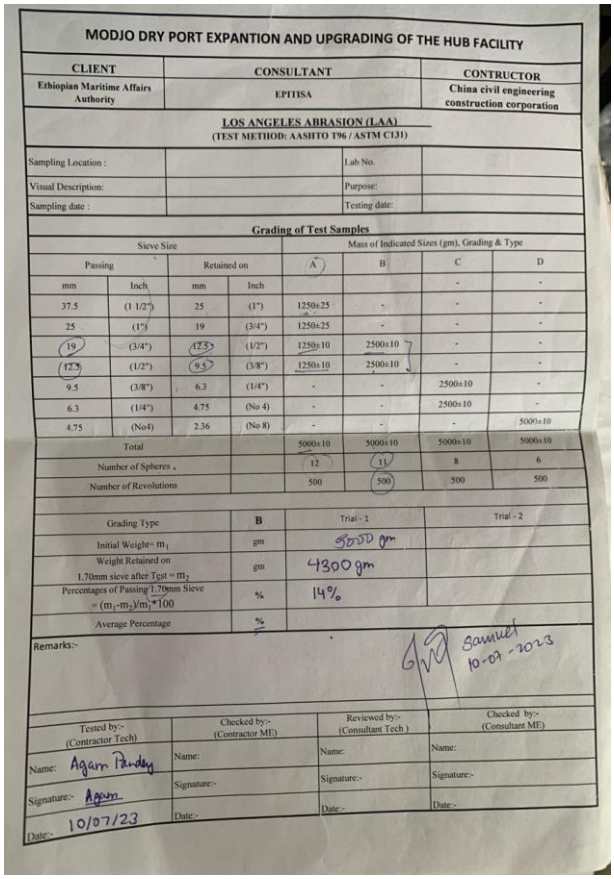
Apparatus used:

i. Los Angeles Machine
ii. Abrasive charge: Cast iron or steel balls, approximately 48mm in diameter and each weighing between 390 to 445 g; six to twelve balls are required.
iii. Sieve: 1.70, 2.36, 4.75, 6.3, 10, 12.5, 20, 25, 40, 50, 63, 80 mm IS Sieves.
iv. Weighing Machine
v. Drying oven
vi. Miscellaneous like tray

Method:

- Select gradings of the aggregate either Grade A, Grade B, Grade C or Grade D type
- For this test, we took 2 Grade B aggregate:
    i) One that passes through a sieve size of 19mm and retained by a sieve size of 12.5mm
    ii) Other aggregate, that passes through a sieve size of 12.5mm and is retained by a sieve size of 9.5mm
- We took 2500gm with +- 10gm error of each Grade B aggregate
- According to ASTM standards we took 11 cast iron spherical balls of 48mm diameter each.
- Then, after putting the spheres and a total of 5000gm aggregate into the Los Angeles Machine we set the machine's revolution to 500 to test its resistance to crushing and degradation.
- After the rotation stops, we pass the Grade B aggregate mix through a 1.70mm Sieve size.
- Weight of the retained aggregates mix (W2) of two types are noted and then Los Angeles Aberration value is calculated.
- LAA Value = (W1-W2)/W1*100
- The more the LAA value the less strength the aggregate will have against resisting aberration by vehicle's tyres.

Observations and Result:



MODJO DRY PORT EXPANTION AND UPGRADING OF THE HUB FACILITY

CLIENT	CONSULTANT	CONTRUCTOR
Ethiopian Maritime Affairs Authority	EPTISA	China civil engineering construction corporation

LOS ANGELES ABRASION (LAA)
(TEST METHOD: AASHTO T96 / ASTM C131)

Sampling Location :		Lab No.	
Visual Description:		Purpose:	
Sampling date :		Testing date:	

Grading of Test Samples

Sieve Size				Mass of Indicated Sizes (gm), Grading & Type			
Passing		Retained on		A	B	C	D
mm	Inch	mm	Inch				
37.5	(1 1/2")	25	(1")	1250±25	-	-	-
25	(1")	19	(3/4")	1250±25	-	-	-
19	(3/4")	12.5	(1/2")	1250±10	2500±10	-	-
12.5	(1/2")	9.5	(3/8")	1250±10	2500±10	-	-
9.5	(3/8")	6.3	(1/4")	-	-	2500±10	-
6.3	(1/4")	4.75	(No 4)	-	-	2500±10	-
4.75	(No4)	2.36	(No 8)	-	-	-	5000±10
Total				5000±10	5000±10	5000±10	5000±10
Number of Spheres				12	11	8	6
Number of Revolutions				500	500	500	500

Grading Type	B	Trial - 1	Trial - 2
Initial Weight= m_1	gm	5000 gm	
Weight Retained on 1.70mm sieve after Tgst = m_2	gm	4300 gm	
Percentages of Passing 1.70mm Sieve = $(m_1-m_2)/m_1*100$	%	14%	
Average Percentage	%		

Remarks:-

Samuel 10-07-2023

Tested by:- (Contractor Tech)	Checked by:- (Contractor ME)	Reviewed by:- (Consultant Tech)	Checked by:- (Consultant ME)
Name: Agam Pandey	Name:	Name:	Name:
Signature:- Agam	Signature:-	Signature:-	Signature:-
Date:- 10/07/23	Date:-	Date:-	Date:-

- Initial weight W1 of the 2 types of Grade B aggregate= **5000gm**
- Final weight W2 retained on passing the aggregate mix through a 1.70mm sieve size= **4300gm**
- Percentage of passing 1.70mm sieve size=(W1-W2)/W1*100 **=(5000gm-4300gm)/5000gm*100= 14%**

The Los Angeles Abrasion value =14% which is less than the maximum permissible value of 50%. Thus, the aggregate is suitable to use for the dry port.

Test of Steel rods for Yield strength:

Aim: To determine the maximum tensile strength that a steel rod would bear and its elongation using Bending & Flexure Testing Machine

Method:

- Two steel rods, one of diameter 25mm other of 8mm were taken
- To check the maximum tensile strength, it could bear the rods were put in the machine
- Elongation was calculated by measuring the final and initial length of each rods
- The machine printed the test results

Observation and Results:

Rod 1: (Diameter 25mm and initial L=20cm) had a/an:

i) yield tensile strength of 271.12kN
ii) Maximum Tensile strength of 316.59kN (before breaking)
iii) Elongation=3.3cm
iv) % elongation= 3.3/20*!00=16.5%

Rod 2: (Diameter 8mm and initial L=20cm) had a/an:

i) yield tensile strength of 27.11kN
ii) Maximum Tensile strength of 31.08kN (before breaking)
iii) Elongation=2.9cm
iv) % elongation= 2.9/20*100=14.5%

Test for Moisture – Density Relation of soils using Modified Proctor Test (4.54kg) Rammer

The moisture-density relation Proctor test is done to find out the moisture content for which the soil will have the maximum dry density (MDD). The Proctor Compaction Test establishes the maximum unit weight that a particular type of soil can be compacted to using a controlled compaction force at an optimum water content.

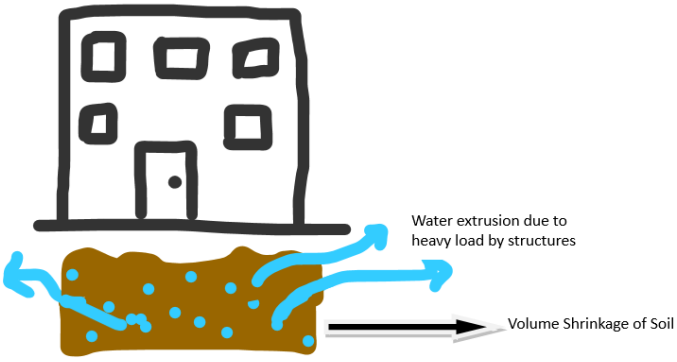
Why do we need to find out the MDD?

Mr. Samuel explained to me the importance of perfect moisture content in the soil at the time of setting up the foundation layer for buildings or pavements.

There are two phenomena:

- Soil Consolidation:
  Shrinkage in the soil's volume due to the removal of excess water from the voids of the soil
- Soil Compaction:
  Shrinkage in the soil's volume due to the removal of air from the voids.

The case of "Sinking" of soil happened in Joshimath, Uttrakhand, India where due to soil compaction the buildings started to "sink".



Pictorial representation of Soil Consolidation

To prevent such dangerous conditions using laboratory tests, we determine the moisture content for the soil used at the project site to get the Maximum Dry Density.

A **modified Proctor Compactor Machine** which has a **Rammer of 4.54kg** and a **457mm Drop** is used for such test for better accuracy.

Aim: To find out the Dry Density (g/cm^3) vs % Moisture content we followed the AASHTO T 180-95 Method-D.

Method:

i) Firstly, a sample of soil is taken from the construction site
ii) To remove the sample of any moisture we heat it in an oven at 60degree Celsius for 24hrs
iii) After the heating, the sample is evenly spread and divided into 4 parts of 5000gm each for trials and other samples are taken for PI and CBR tests.

Dividing the soil taken from site for various tests

iv) Now, the weight of the mold is noted
v) The 4 soil samples are taken and progressively 7%, 10%, 13% and 4% of moisture content is added by mixing it with water of different volumes

Adding water to the soil sample

Compactor Machine with 56 blows

vi) For 7% moisture soil the soil is mixed and then 5 layers are added to the mold

vii) After adding each layer, the Proctor compactor drops for 56 blows

viii)The compacted wet soil is extracted from the mold using extruder machine

Extruding the compacted sample using an extruder machine

ix) The wet soil's weight is then taken in a container and kept in the oven for heating at 110 degrees Celsius for 16-18hrs.

x) After 16hrs, we measure the weight of the dry soil and thus calculate the Dry density at each %moisture content.

xi) Plotting of graph at the end will result in a parabolic graph that reaches a maximum at a certain moisture content level.

Observations and Results:

After drying the soil sample and weighing it and further calculations we get the graph relation between Moisture Density and %Water Content.

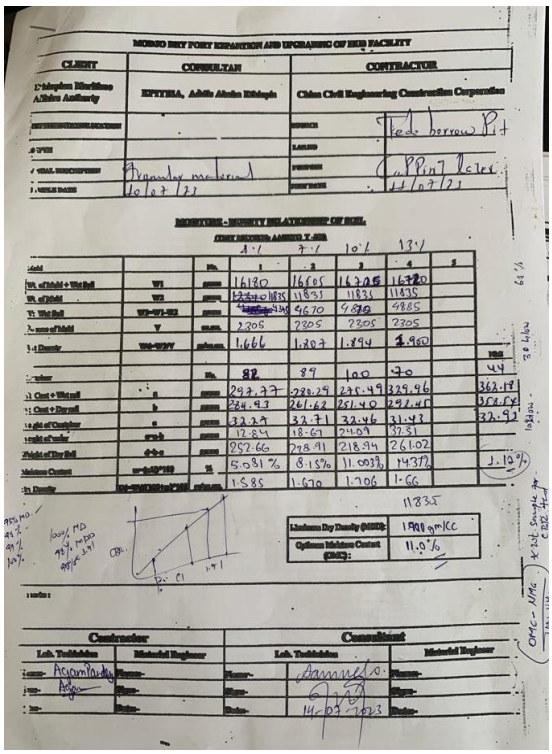
Sample Calculations:

For a 4% moisture-soil on 56 Blows with a modified Proctor Compaction machinen
Wt. of Mold+Wt. of Soil= 16180gm
Wt. of Mold=11835gm
Wt. of Wet Soil=4345gm
Volume of Mold=2305gm
Wet Density of Soil=1.885 gm/cc

Now, weighing the extruded wet soil before keeping it in oven for 16-18hrs
For a container No. 82,

Wt. of Container=32.27gm
Wt. of Cont+Wet soil=297.77gm
Wt. of Cont+Dry soil=284.93gm
Wt. of water= Wt.Wet soil-Wt.Dry soil=12.84gm
Wt.of Dry Soil=Wt. Cont+Dry soil- Wt.Cont=252.66gm
Moisture Content= (Wt.water/Wt.dry soil) x100=5.0819%

Dry Density= Wet Density/(100+m) *100=1.885/ (100+5.0819) *100=1.79gm/cm^3

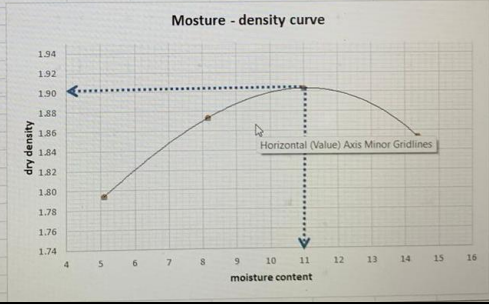


Readings for the Moisture-Density relation test

Similarly on plotting the Dry densities for 7%,10% and 13% moisture content we will get a Parabolic Graph with a Maximum Dry Density (MDD) at an Optimal Moisture Content (OMC)

Weight of Container	c		grams	32.27	32.71	32.46	31.43		32.93
Weight of water	e=a-b		grams	12.84	18.67	24.09	37.51		3.64
Weight of Dry Soil	d=b-c		grams	252.66	228.91	218.94	261.02		325.61
Moisture Content	m=(e/d)*100		%	5.08	8.16	11.00	14.37		1.12
Dry Density	Dd=Wd/(100+m)*100		gr/cu.cm.	1.79	1.87	1.90	1.85		

Maximum Dry Density (MDD):	1.900	gm/cc
Optimum Moisture Content (OMC)	11.0	%



Graph plotted between Dry Density vs Moisture Content using the readings

MDD=1.900gm/cm^3

OMC=11.0%

California Bearing Ratio Test (CBR)- After the moisture and density relationship test

The CBR test is conducted in laboratories at the construction site for evaluating the strength of soil samples for layers made for pavement. CBR value found during the test gives us the base thickness and selecting pavements for construction sites.

CBR value gives us the soil's Resistance to penetration.

Aim: To find a graphical relation between CBR Value and Dry density of soil

Method:

i. The prerequisites of CBR testing for soil require Moisture content and Dry density relation testing to find out the Maximum Dry Density (MDD) of the soil sample

ii. The Optimal Moisture Content corresponding to the MDD and Normal Moisture Content of soil are also needed for CBR testing.

iii. After drying the soil sample in an oven for 24hrs at 60 degrees, we take a 6000gm of soil sample.

iv. The amount of water to be added for moisture is calculated by

Moisture needed= (OMC-NMC)/(100+NMC) *weight of soil sample (ml)

v. After adding the water, the CBR test requires 3 samples at 65 blows, 30 blows and 10 blows by the Modified Proctor Compaction machine.

vi. After compaction, the soil is not extruded from the mold, and its weight is measured.

vii. The mold and soil is then kept for 96hrs in the CBR Soaking Bath with surcharge weights to simulate the weight of the pavement.

Compacted Soil sample kept in Soaking Bath for 96hrs

viii. The volume expansion of the soil is measured through an expansion measuring apparatus and swell plates

ix. After 96hrs, the soil sample and the mold are taken out and tested for its resistance to penetration

x. Now, the penetration at the CBR Penetration machine starts at a rate of 12.7mm per minute

xi. As the penetration is increased the soil's load is recorded at 11 depths in the soil.

xii. The readings of the Dial, Load(kN) are noted to calculate the CBR

xiii. We plot a graph for Penetration(mm) vs Load(kN). The CBR value is the stress on the soil at 2.54mm penetration depth.

Observation and Results:

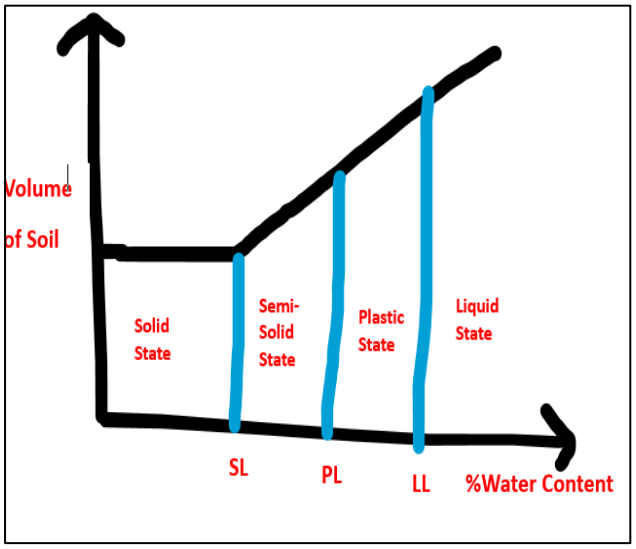
Plastic Index Test – Calculating Plastic Limit and Leaky Limit of soil

Atterberg's system proposed four stages of soil states:

1) Liquid
2) Plastic
3) Semi-Solid
4) Solid

Mr. Samuel explained to me about the limits of each stage:

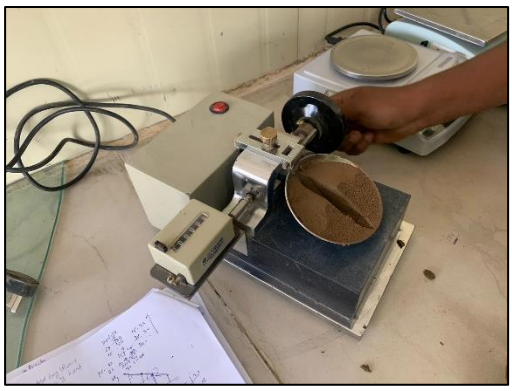
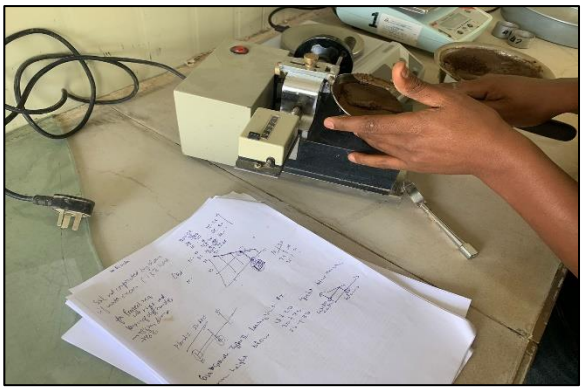
- **Shrinkage Limit**-SL is the water content at which the soil ceases to shrink is denoted as the Shrinkage Limit
- **Plastic Limit**- PL is the minimum water content at which a soil will begin to crumble when rolled into a thread approximately 3 mm diameter on a glazed plane glass plate.
- **Liquid Limit**-The moisture content when a soil ceases to behave like a liquid and begins to exhibit the behavior of a plastic deformation



Aim: To calculate the Plastic Index of soil

Method:

i. A soil sample of mass about 100g from evenly mixed soil which passes through the 0.425mm sieve is taken and dried of Natural moisture content for 24hrs in an oven
ii. After drying the sample is taken and throroughly mixed with 15-20ml of demineralized water.
iii. As moisture content of soil increases the number of blows required also increases.
iv. Either add more water or dry the soil to take reading of the blows required to 'close the gap'
v. Take a small portion of the soil paste with spatula and spread it evenly on the Casa Grande's device that must be adjusted for 10mm blows

The soil pastes on Casa Grande Device with a groove

vi. Cut a vertical groove on the paste with a grooving tool
vii. Now, give blows to the paste by rotating crank at a rate of 2 rotations per second and note the blows.
viii. Rotate the device till there is no gap between the cut parts of the paste
ix. Note down the number of blows
x. Collect and weigh the sample of paste and note down the readings.
xi. After each reading of blows increase water content by 1-3ml to the soil

Observations and Result: