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Internship Report

Worker Training

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Training performed on the Pan-Arab highway project executed by a joint venture between CET and A.R. Hourie companies

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Introduction

This report consits of what I saw durning my internship on the PAN-Arab Highway project being executed by a joint venture between CET and Hourie companies. the report is divided into two parts, the first one being the lab report concerning laboratory testing conducted during the first two weeks of my internship, and the second part consists of a report of the site work I saw on the roads and the viaducts during the last two weeks. The site work includes works on the Namlie and Chtaura viaducts (piles, foundation, abatements, piers, etc…) and the Chtaura – Taanayel road. The report aslo concerns the visits to the plants placed on the site camp in Chtaura.

Laboratory Tests

The following part of the report is a summary of the tests conducted in the aboratory of the site of the pan arab highway project being executed by a joint venture between CET and Hourie companies.

Basic materials

Sieve analysis:
This test is used for backfill material, natural soil, concrete or asphalt aggregate, and so on…

The test consists of analyzing the different sizes of the particles composing a certain sample.

For soil the different sizes used are:

- 3'', 2'', 1.5'', 1'', ¾'', 3/8'' and the sieve no 4 for coarse aggregates
- Sieves no 10, 40 and 200 for medium aggregates or sand
- All material that passes the sieve no 200 is considered fine aggregate (Silt and Clay)

The first step is passing the sample through sieves sized from 3'' to sieve no 4 and weighing the retained quantities in each sieve.

The second step consists of taking around 100 to 200 g of the remaining material and washing the reduced sample.

The third step consists of passing the reduced washed sample when dry through sieves no 10 to 200 and weighing the retained quantities in each sieve.

The figures obtained during the third step will be recalculated as per the weight of the material retained during the second step. Therefore these figures along with the results of the first step will give the cumulative passing weight and the cumulative passing percentage.

Proctor compaction:
The purpose of the test is to find the maximum dry density and the optimum humidity content of the backfill material.

In order to find the maximum dry density and the optimal humidity content the proctor process must be repeated at least five times at different humidity contents.

The proctor process consists of taking a sample of backfill material and adding water to it so it will reach the desired humidity content. The wet soil sample will then be filled into the standard or modified proctor mold (modified in our case) layer by layer.

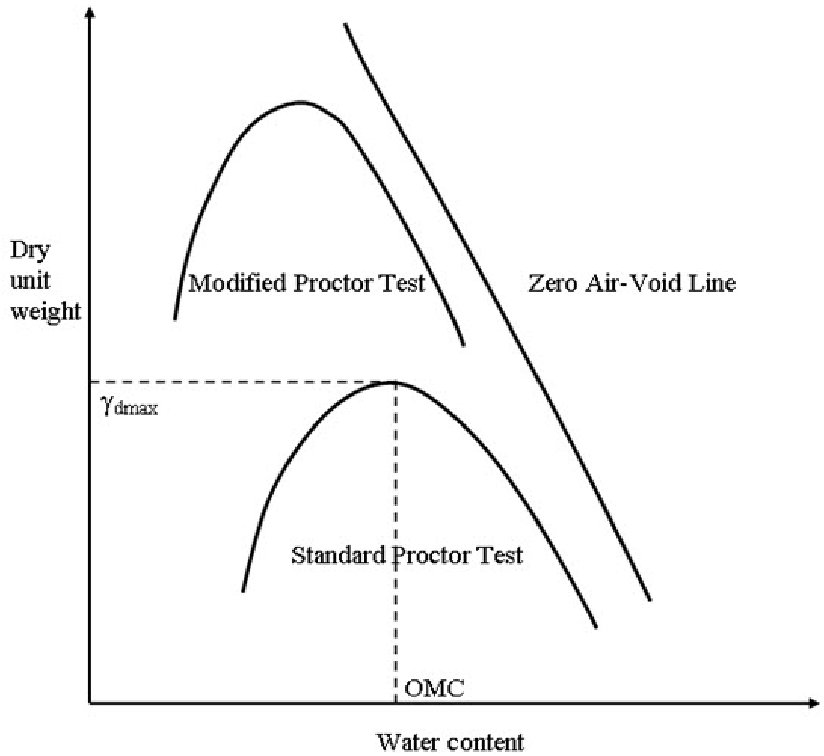
- For the standard proctor three layers of soil sieved to the no 4 seive will be added and blown 25 times each by a small proctor hammer
- For the modified proctor five layers of soil sieved to the ¾'' seive will be added and blown 56 times each by a big proctor hammer

After the compaction, all excess soil from the mold must be removed and the sample must be weighed

The weight and the known volume will determine the wet density of the sample.

The wet density and the humidity content will determine the dry density by the formula below.

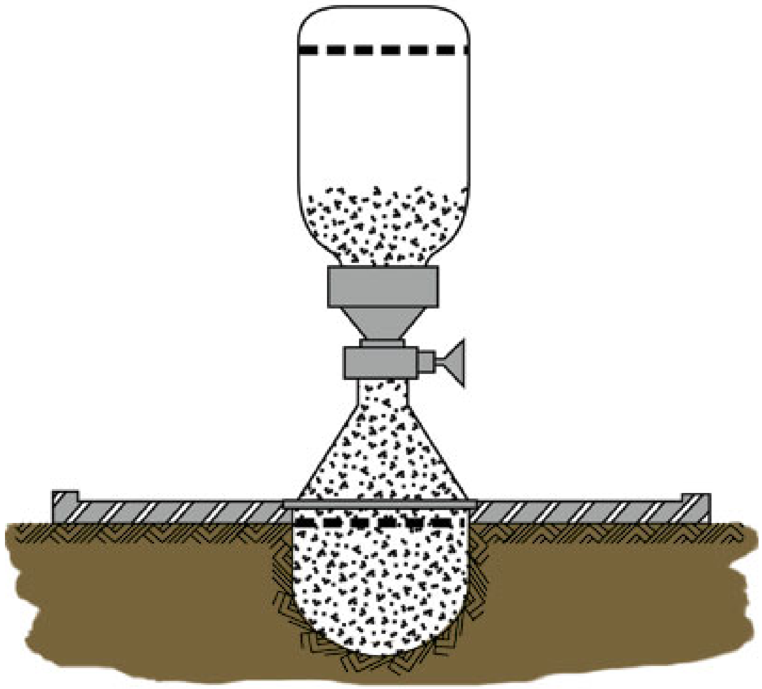
$$DryDensity = \frac{WetDensity * 100}{HumidityContent + 100}$$



In order to verify that the compaction done on site has met the requirement of specs needed to get the highest dry density, a field density test is conducted.

The field density test is a way to measure the wet density of the compacted material on site.

The method used on the pan-Arab highway is the sand cone method.



A square metal plate with a circular hole in the middle is fixed on the compacted backfill material. A cylindrical hole is dug and the retrieved material is placed in a sealed bag so it would not lose any of its humidity content and be weighed later on. A known weight of non-compactable dry sand, approximatively 6 Kg, is poured inside the container. The whole device is placed onto the plate and the valve is opened. The remaining sand in the container is retrieved to be weighed later on also.

The initial weight of the sand minus the weight of the sand that filled the cone minus the weight of the remaining sand in the container divided by the density of the sand will give us the volume of the hole dug.

The weight of the retrieved backfill material and the volume of the hole will give us the wet density of the material.

After measuring the humidity content of the material we can find, using the formula above, the dry density of the backfill material.

The compaction ratio is the percentage of the dry density measured on site compared to the maximum dry density calculated during the proctor compaction.

Atterberg Limits

The Atterberg limits are three. The plasticity index, the liquid limit and the plastic limit. The liquid limit and the plastic limits are measured by tests and the plasticity index is calculated using the plastic and liquid limits.

The plasticity index is, on the moisture content axes, the size of the part where the soil exhibits plastic properties. The plasticity index is calculated after finding the liquid limit and the plastic limit by taking the difference between them.

The liquid limit is the water content boundary between the plastic and the liquid state. It is measured using the Casagrande cup. Wet soil is put inside the Casagrand cup and it is cut by a linear groove in the middle using a special spatula. Then the cup is given blows until the grooves closes for a length of approximately one centimeter. Theoretically the liquid limit is the moisture content for witch the groove needs twenty five blows to close but it is hard to manage in the laboratory. In practice, three test in the Casagrande cup are conducted to find three moisture content for the material, one for under 20 blows, one between 20 and 30 blows and the last for over 30 blows. A graph is drawn to find the moisture content for 25 blows that equals the liquid limit.

The plastic limit is the water content boundary between the semi-solid and the plastic state. It is determined by rolling a piece of the sample into a thread. The plastic limit is the water content when the thread starts breaking at a diameter of 3.2 mm.

Classification

After doing the sieve analysis, the soil must be classified according to its composition.

There are two standards for the classification of soil:

- Unified Soil Classification System or **USCS** for natural soil
- American Association for State Highway and Transport Officials or **AASHTO** classification for road and highway material

USCS :

The USCS system uses letters to classify the soil. The classification is given in the form of pairs of letters. The letters used are the following:

G	Gravel
S	Sand
M	Silt
C	Clay
O	Organic

W	Well Graded
P	Poorly Graded
H	High Plasticity
L	Low Plasticity

The soil is given the classification using the following table.

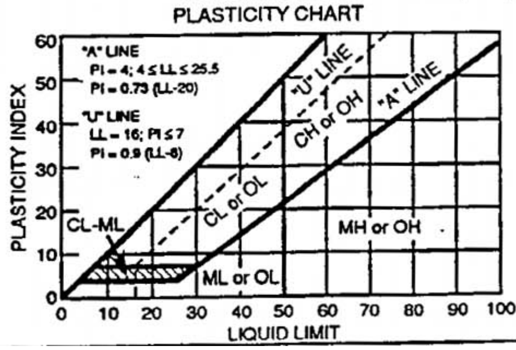
UNIFIED SOIL CLASSIFICATION SYSTEM

Soils are visually classified for engineering purposes by the Unified Soil Classification System. Grain-size analyses and Atterberg Limits tests often are performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. Graphic symbols are used on boring logs presented in this report. For a more detailed description of the system, see "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)" ASTM Designation: 2488-84 and "Standard Test Method for Classification of Soils for Engineering Purposes" ASTM Designation: 2487-85.

MAJOR DIVISIONS				GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures
					GP	Poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixtures
			Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (50% or more of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)			SW	Well graded sands, gravelly sands
					SP	Poorly graded sands, gravelly sands
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures
			Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS Limits plot below "A" line & hatched zone on plasticity chart	SILTS OF LOW PLASTICITY (Liquid Limit less than 50)			ML	Inorganic silts, clayey silts of low to medium plasticity
		SILTS OF HIGH PLASTICITY (Liquid Limit 50 or more)			MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts
	CLAYS Limits plot above "A" line & hatched zone on plasticity chart	CLAYS OF LOW PLASTICITY (Liquid Limit less than 50)			CL	Inorganic clays of low to medium plasticity, gravelly, sandy, and silty clays
		CLAYS OF HIGH PLASTICITY (Liquid Limit 50 or more)			CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity
	ORGANIC SILTS AND CLAYS	ORGANIC SILTS AND CLAYS OF LOW PLASTICITY (Liquid Limit less than 50)			OL	Organic silts and clays of low to medium plasticity, sandy organic silts and clays
		ORGANIC SILTS AND CLAYS OF HIGH PLASTICITY (Liquid Limit 50 or more)			OH	Organic silts and clays of high plasticity, sandy organic silts and clays
ORGANIC SOILS		PRIMARILY ORGANIC MATTER (dark in color and organic odor)			PT	Peat

NOTE: Coarse-grained soils with between 5% and 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone on the plasticity chart have dual classifications.

PLASTICITY CHART



DEFINITION OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Boulders	Above 12 in.
Cobbles	12 in. to 3 in.
Gravel	3 in. to No. 4 sieve
Coarse gravel	3 in. to 3/4 in.
Fine gravel	3/4 in. to No. 4 sieve
Sand	No. 4 to No. 200 sieve
Coarse sand	No. 4 to No. 10 sieve
Medium sand	No. 10 to No. 40 sieve
Fine sand	No. 40 to No. 200 sieve
Fines (silt and clay)	Less than No. 200 sieve

AASHTO

In the AASHO system, the classification is in the form of the letter A and a number between 1 and 8. The AASHTO classification is mostly used for highway backfill materials. The classification is given using the table below. It is worth noting that material with the classification A-8 are mostly organic materials.

General Classification	Granular Materials 35 percent or less of total sample passing No. 200 (75 µm)								Silt-Clay Materials More than 35 percent of total sample passing No. 200 (75 µm)						
Group Classification	A-1		A-3[1]		A-2				A-4		A-5	A-6		A-7	
	A-1-a	A-1-b	A-3	A-3a	A-2-4	A-2-5	A-2-6	A-2-7	A-4a	A-4b		A-6a	A-6b	A-7-5	A-7-6
Sieve analysis, percent passing:						*				**	*			*	
No. 10 (2 mm)	50 max														
No. 40 (425 µm)	30 max	50 max	51 min	[2]					[3]	[4]					
No. 200 (75 µm)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	35 max	36 min	50 min	36 min	36 min		36 min	
Characteristics of fraction passing No. 40															
Liquid limit	—	—	Non-	—	40 max	41 min	40 max	41 min	40 max		41 min	40 max		41 min	
Plasticity index	6 max	6 max	Plastic	6 max	10 max	10 max	11 min	11 min	10 max		10 max	11 – 15	16 min	<LL-30	>LL-30
Group Index	0						4 max		8 max		12 max	10 max	16 max	20 max	
Usual types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Sand	Silty or clayey gravel and sand				Silty soils			Clayey soils			
General rating as subgrade	Excellent to good								Good to fair						

Notes

With the test data available, the classification of a soil is found by proceeding from left to right on the chart. The first classification that the test data fits is the correct classification.

* A-2-5 is not allowed under 703.16.B. A-5 and A-7-5 is not allowed under 703.16.A. See "Natural Soil and Natural Granular Soils" (203.02.H) in this manual

** A-4b is not allowed in the top 3 feet (1.0 m) of the embankment under 203.03.A.

[1] The placing of A-3 before A-2 is necessary in the "left to right" process, and does not indicate superiority of A-3 over A-2.

[2] A-3a must contain a minimum 50 percent combined coarse and find sand sizes (passing No. 10 but retained on No. 200, between 2 mm and 75 µm).

[3] A-4a must contain less than 50 percent silt size material (between 75 µm and 5 µm).

[4] A-4b must contain 50 percent or more silt size material (between 75 µm and 5 µm).

Concrete and aggregates

Sand equivalent

The purpose of this test is to measure the percentage of impurities in sand.

The material that passed through the no 4 sieve are poured into a solution of calcium chloride, formaldehyde and glycerin. After leaving the mix to rest, the sample will divide into layers. The bottom layer will be the one with sand, and the top one will contain impurities. The bottom sand layer reading is compared the total and the percentage of sand in the mix is calculated. The result must be higher than 70% to be accepted for concrete.

Slump test

This test measures the workability of fresh concrete.

The tools needed are:

- A cone of 200 mm lower diameter, 100mm upper diameter and a height of 300mm.
- A 16mm rod of 600 mm length.

The cone is placed on a hard horizontal surface and, is filled with three separate layers of concrete tamped 25 times with the rod each.

Once the excess of concrete is removed, the cone is carefully lifted and placed near the concrete cone, the difference of height between the steel cone and the concrete cone is measured, the result being the slump value.

The lower this value is, the stiffer the concrete will be and the amount of plasticizer to be added will decided based on this value.

Compressive strength

The test measures the strength of the concrete based on cylindrical samples poured when the concrete is still fresh.

The cylinders have a diameter of 15 cm and a height of 30 cm. After checking that the cylinder is on a hard flat surface, concrete is poured in three separate layers tamped 25 times with a rod and hit with a mallet on the outside of the mold 15 times each. At the end, the excess concrete is removed and the cylinder top is leveled out.

The cylinders are left for overnight to let the concrete harden. After that, the concrete cylinders are removed from the mold and are placed is a water bath at 22°C to simulate the curing process.

Typically, for every concrete batch, at least six cylinders must be taken so that three could be tested at seven days and three at twenty eight days after pouring.

The cylinders are tested by placing them in a hydraulic press and applying compressive stress until the cylinder breaks. The press gives us the result in KN. The force applied should be divided by the area of the cylinder to get the compressive strength of the concrete.

Asphalt

Extraction

The purpose of this test is to make sure that the asphalt mix being put to use is identical to the mix design given to the plant.

As we know, asphalt is a mix of bitumen and aggregates, therefore the first step is to separate these two components. A sample of asphalt is weighed and poured into a centrifuge with gasoline. The role of the gasoline is to dissolve the bitumen and remove from the mix. When the centrifuge step is done, the remaining aggregates are oven dried and weighed. This will allow the technician performing the test to find the percentage of bitumen in the mix using the following formula.

$$BitumenPercentage = 100 - \frac{WeightOfAggregats}{TotalWeight} \times 100$$

After finding the bitumen percentage, the aggregates are washed with soapy water and dried. Then, the technician performs a sieve analysis on the aggregates that will allow him to make sure if the plant is using the right amount of coarse, medium and fine aggregates.

Marshall Test

The Marshall test is a way to measure the density, air voids, stability and flow of a bituminous paving mix. The test is conducted on compacted cylinders of asphalt samples.

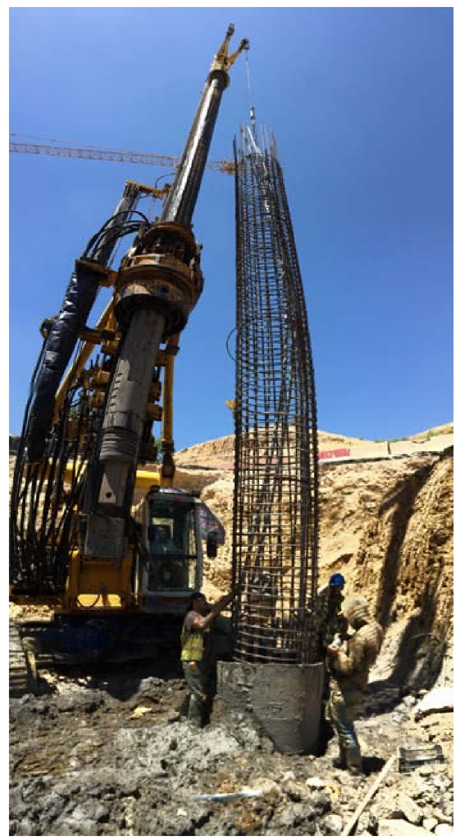
Site Work

This part of the report covers the work being done on the site of the Pam-Arab Highway project.

Piling

Piles are a kind of foundation used in construction when having week soils. The piles are cylindrical columns put in the ground under a foundation. They are made of helicoidally shaped steel placed on the radius of the pile and concrete filling the whole cylinder. The steel is made in the steel yard and moved by trucks to the site while a drill digs the cylindrical shaped hole on site. The steel is lowered in the hole using a crane and concrete is poured from the bottom up using pipes. After finishing all the piles under a certain foundation, a one or two meters deep excavation is done, blinding concrete is poured and the top of the pile is removed using a jack hammer. The steel of the pile is then tied with the steel of the foundation above the pile.

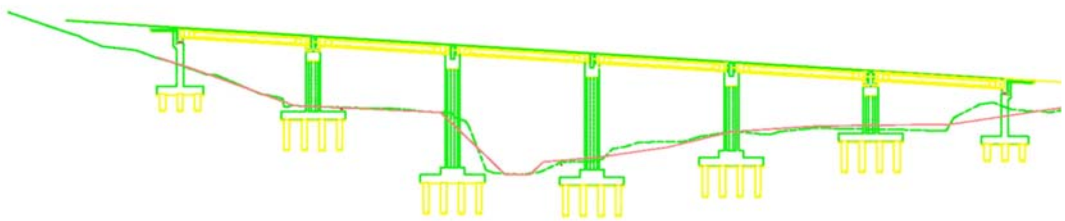
The piles could be used in one of two ways. When the week soil is on top of a strong layer of rock, the pile could work as a column holding the building on the rocky layer or, if the rocky layer is inexistent or too deep the pile could be held by the friction of the soil around it.



Viaducts

On the pan-Arab highway, three important viaducts are being constructed. The Jdita viaduct is mainly done, the Namliye viaduct and the chtaura viaduct are still under construction.

The viaducts are this project are sets of two decks each (right and left) held on piers in the middle and abatements near the ramps.

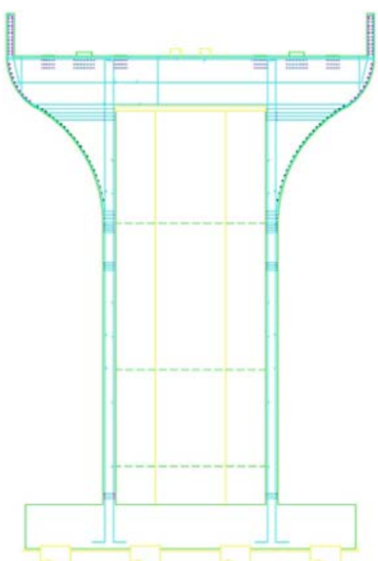


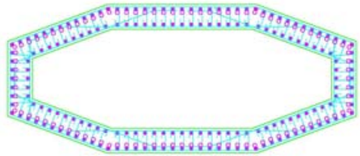
Piers and Abatements

The piers and the abatements are constructed on foundations sitting on sixteen piles each. They come in pairs, one for the right lanes and one for the left.

The abatement are used for the entrance and exit of the bridge, they are basically a wall retaining reinforced soil on one side and holding beams on the other. The reinforced soil is done by filling layers of sixty centimeters of soil between two sheets of geogrid. The sides of the reinforced soil is then covered with construction blocks.

The piers are, as seen on the pictures below, hollow reinforced concrete columns with a crown shape on top to hold beams from each side.





Deck

The deck is constructed as such:

- Pre-stressed beams are placed between the piers or abatements
- Rectangular concrete tiles are placed on the beams to make a flat surface on the deck
- A reinforced concrete slab is poured on top of the tiles
- Four or five layers of asphalt are applied on top



Roads

The road is made from thick layers of soil covered by five layers, 5 cm thick, of asphalt.

Backfill

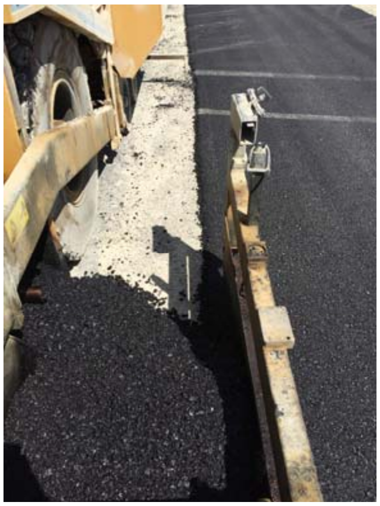
The backfill material is poured from trucks and leveled by graders then compacted by roller compactors to a certain level specified by the lab after doing the proctor compaction test. The soil poured must also have certain specifications given by the lab. It is really important that the material be well compacted so that it wouldn't fail under the weight of the traffic passing on it when the highway is done.

Asphalt

The asphalt is the wear surface of a road, it is a mix of aggregates and bitumen. The asphalt comes in trucks it is applied using a spreader in four or five layers averaging six to seven centimeters in thickness and compressed to become a five centimeters asphalt layer. Two compactors are used to compress the asphalt:

- The wheel compactor is used first to remove air voids from the mix
- The roller compactor is used later to insure cohesion of the materials

It is noteworthy that colas bitumen is poured before every layer as an adhesive.

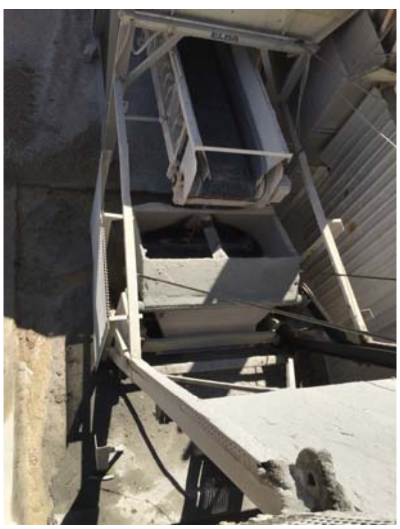


Plants

The plants on the Pan-Arab Highway Project are the beating heart of the site. The concrete and asphalt plants mix their materials and send them to the needed areas. In the steel yard, workers cut and bend steel to the required shapes and send them to the right place.

Concrete

The concrete plant's job is to mix the coarse, medium and fine aggregates with cement, water, and admixtures if needed. The mix design is set by the lab. There are different mix designs for different outputs (B20, B25, B30, C150, etc…). The cement mostly used is a Portland artificial cement but a sulfate resistant cement is available on demand.



Asphalt

The asphalt plant's job is to mix the aggregates and the bitumen to create usable asphalt for road works. In order to do that, the mixer must first hear all the aggregate to a temperature of more than 140°C without exceeding 170°C. The aggregate enter a barrel that rotates and acts as a furnace at first, and as the aggregate go deeper in the barrel, they get mixed with the bitumen. When the mix is ready, it falls onto a conveyer belt that dumps it into the truck taking the asphalt to the road to be.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ERMONT

Steel yard

The steel yard is where all the steel is prepared for the site. The steel comes in many sizes. The sizes differ by the diameter of the bar as well as the length. The steel order is given to the steel provider depending on the quantities needed. The steel comes in straight 12, 10, 9, 8, 7, 6 or 5.5 meters long.

The workers at the steel yard take the steel bars, cut them and bend them o the required shape. They do anything from helicoidal steel for pipes to small steel calipers.