

Road Pavement Works (Item one)

Technical Specifications of Paving Roads

Materials used in the subbase layer:

The subbase layer consists of gravel (Base Course aggregate), hard rock fragments, crushed by mechanical crushers and having the following general grading limits.

Sieve designation or sieve number	Percent by weight passing
3 inches	100
2 inches	65 - 100
No. 4	25 - 50
No. 3	3 - 10

If the material becomes disintegrated or soft and unstable, it shall be replaced by new material based on the instructions of the project manager; it is then the responsibility of the contractor to compact it, according to the specifications, using a roller weighing 10 tons at least and 15 tons at most.

Materials used in the base layer

The base layer consists of hard rock fragments (gravel) crushed by mechanical crushers and having the following general grading limits.

Sieve designation or sieve number	Percent by weight passing
2 inches	100
1 1/2 inches	90 - 100
3/4 inches	50 - 80
No. 4	25 - 45
No. 40	10 - 20
No. 200	2 - 8

- a. The sand equivalent of this material shall not be less than 40%.
- b. The general grading of materials used shall preferably be systematic, moving from the minimum percent by weight passing of a designated sieve to the maximum percent by weight passing of the following sieve, or vice versa. The amount of the fraction of material passing the No. 200 sieve shall not exceed two-thirds of the fraction passing the No. 40 sieve.
- c. The crushed stone (gravel) shall consist of hard, durable fragments of stone free from dirt, organic material, and clay. When tested for soundness using the Los Angeles AASHTO T 140 test, the disintegration percentage shall not exceed 40%.

Physical properties of various types of asphalt cement (AC)

Asphalt cement must:

- Be extracted from the processes of refining asphaltic crude/asphaltic petroleum,
- Be homogeneous and water-free,
- Not foam when heated at temperatures up to 175 degrees Celsius (347 degrees Fahrenheit),
- Be conform to the specifications and properties mentioned below:

Test	Unit	Asphalt Type					
		40/50		60/70		80/100	
		Min.	Max.	Min.	Max.	Min.	Max.
1. Penetration at 25°C, 100 grams, 5 seconds	1/10 mm	40	50	60	70	80	100
2. Ductility (elongation) at 25°C (5cm/1min)	cm	100		100		100	
3. Flash point using the Cleveland open cup tester	°C	232		232		232	
Solubility in trichloroethylene or other similar solvents	percent	99.5		99.5		99.5	
5. Weight loss upon heating at 136 degrees for 5 hours (thin film method)	percent		1		1		1
6. Penetration at original percentage even after weight loss upon heating	percent	55		52		47	
Ductility (elongation) after weight loss (using the heating test)	cm	100		100		100	
Softening point using the ring-and-ball method	°C	49	60	47	54	43	51

Chemical properties of medium curing liquid asphalt (MC)

Test	Type					
	MC-0	MC-1	MC-2	MC-3	MC-4	MC-5
1. Minimum flash point using the Cleveland open cup tester	38	38	66	66	66	66
2. Viscosity using the Saybolt Furol viscosimeter (time in seconds)						
At 25 °C	75 - 150					
At 50 °C		75 - 150				
At 60 °C			100 - 200	250 - 500		
At 82 °C					125 – 250	300 - 600
3. Water content, % by volume (maximum)	0.1	0.1	0.1	0.1	0.1	0.1
4. Distillation, % by volume up to 360 °C	50	40	33	27	22	18
5. Distillation, % by volume of total distillate up to 360 °C						
At up to 225 °C	25	25	10	5		
At up to 260 °C	40 - 70	25 - 65	15 - 55	40 - 50	30 max.	20 max.
At up to 316 °C	75 - 93	70 - 90	60 - 87	55 - 85	40 - 80	20 – 75

6. Different tests at 360°C, penetration (100 g, 5 sec, 25°C), ductility (5sec/min, 25°C), solubility in carbon tetrachloride % by weight (minimum)	120 - 300	120 - 300	120 - 300	120 - 300	120 - 300	120 - 300
	50	50	50	50	50	50
	99	99	99	99	99	99

As regards the composition of the asphalt mix:

The composition percentages of the asphalt mix made during work should not be different from those specified by the lab before starting work, as described in the table below:

Stone Materials	Percentage
Percent passing through sieve size 1 inch	7
Percent passing through sieve size 3/4 inches	7
Percent passing through sieve size No. 4	7
Percent passing through sieve size No. 10	4
Percent passing through sieve size No. 200	2
Ratio of Asphalt	0.5

That is provided that the stone materials remain within the required grading and the difference in pitch ratio does not exceed 250 grams in 1 ton of mixed pitch as one can notice.

Specifications of machinery and equipment used in pavement works:

A. Approving/using the equipment

All machinery and equipment has to be in a good and acceptable condition and must be approved by the project manager before authorizing the start of works. The contractor should maintain its

good condition all throughout the work period and should procure a sufficient number of machinery and equipment to ensure fast implementation according to the implementation timetable. The contractor must also procure a sufficient number of technical workers who can operate them efficiently.

B. Hot asphalt sprayer (Distributor)

The hot asphalt sprayer is a transport truck or trailer truck with a 1500-liter thermal-insulated tank. It has the ability to spray asphalt on the surface of the road in a systematic, uniform, using different pressure levels and spraying rates, and at different widths and at certain temperatures. In order to properly function and perform, such machines must be equipped with the following:

- A diesel or special gasoline engine to operate the heating system (burner) and asphalt pressure pump.
- A burner to raise the temperature of the asphalt to the specified operating temperature.
- Asphalt pump used to pump asphalt into the spray pipes and fill the tank with asphalt.
- Asphalt spray pipes of which the length can be changed in order to accommodate for the width of the asphalt that should be sprayed on the road. This width can vary from 2 to 7 meters. These spray pipes have connections/extensions placed at equal distances and have identical openings along them that ensure constancy and steadiness in the spraying rate.
- A speedometer placed in the driver's cabin to determine the speed of the vehicle (meter/minute).
- A device to determine the quantity released/discharged by asphalt spray pumps (liter/minute).
- A thermometer to determine the temperature of asphalt.
- A level ruler to measure the quantity of asphalt in the tank.
- A level calculator/ruler to determine the quantity of asphalt in the tank.
- The following equation can be used to adjust/regulate the spraying rate as necessary:

Quantity released/discharged by pump (liter/minute) =

Spraying width (meters) x spraying rate (liter/meter²) x car speed (meter/minute).

C. General specifications of the paver (which lays down asphalt and levels it)

This machine must be of the automatic/mechanic type which is capable of receiving the hot mix from dump trucks into a 5-ton tank or hopper; two conveyors then carry the asphalt from the hopper to the auger. The auger then lays down the asphalt on the surface of the road and the screed spreads

it over according the required width and thickness (elevation). The paver should be able to smoothen the surface through exerting pressure (through the vibrator of the screed) without causing the separation of the particles of asphalt mix.

The machine is designed in a way that enables it to lay down asphalt mix to a width varying between 2.75 meters and 3.6 meters, and to finish surfacing the road according to the required shape, form, and cross-curves, and heat the asphalt mix enough all throughout the work so that it does not stick to the lower layer of the machine and at the same time does not become heated at a temperature that exceeds that suitable mixture.

The table of costs is set according the below works:

#	Type of work	Unit
1	Cutting pavement	Meters
2	Constructing roads or widening them	Meters cubed
3	Removing old pavement	Meters squared
4	Subgrade layer	Meters cubed
5	Prime coat	Meters cubed
6	Base layer	Meters squared
7	Levelling/fixing the shape of the road	Meters squared
8	Asphalt	Meters squared

As regards paving a previously paved road:

A. Uneven/Unlevelled surfaces:

- Removing the old pavement regardless of its thickness and moving the resulting debris to the location approved by the management.
- Laying down the stone or gravel and spraying it with water while flattening it using a road roller, and that, to smoothen to road surface in places where the stones are showing under the removed pavement and to level the stones/gravel in accordance to the requirements of the road form.
- Cleaning the surface of the road using manual and automatic sweepers.
- Verifying/checking the following:
 - Percentage of air voids and voids filled with asphalt.
 - Dryness of the bitumen absorption layer
 - Cleaning the surface of the tack coat using air compressors.
 - Temperature of the asphalt mix.

- The process of mixing asphalt and the homogeneity of the mixture before laying it on the surface, and noting any surplus or shortfall in asphalt percentage.
- Periodic sampling of the mixture to conduct the extraction test in order to check the grading, asphalt percentage, flow, percent of air voids and voids filled with asphalt) and verifying that the test results are conform to specifications.
- Monitoring the process of laying down the asphalt mix and ensuring sufficient thickness by making the layer 15-20% thicker, and that, before compacting begins.
- If the asphalt is being laid/installed in more than one layer, no permission should be given to lay down the second layer until after compacting the first layer and making sure it has cooled down.
- No asphalt installation/laying down shall occur in a rainy weather.
- Monitoring the process of compacting using a road roller, checking the roller speed and that it does not exceed that mentioned in the specifications, checking all machines and equipment and their suitability, and arranging how they are introduced at each layer.
- The surveyor reviews and checks the contours and surface levelling after compaction.
- Cleanliness of the surface of the basic asphalt layer.
- Temperature of liquid asphalt material before spraying and making sure it is conform to the supervising engineer.
- Regularity of spraying according to the specified rate so that it does not exceed 0.25 liters/meters square or so that it is conform to the instructions of the supervising engineer.
- If there are places in which the spraying rate exceeds the required rate, the excess is removed before laying down/installing asphalt, and that, through putting a quantity of sand on them and flipping them to remove excess asphalt and move it away from the road.
- No spraying occurs in a rainy weather.

Sidewalk Pavement Works (Item Two)

Technical Specifications of Paving Sidewalks

- Establishing a sidewalk in the downhill area leading to Al Ain square with a curb along both sides of the sidewalk and the possibility of building small concrete walls where necessary because of the strong slope and the possibility of including stairs made of curbs and paving tiles.

These conditions shall be applied to cement tiles used for paving sidewalks and made from hard natural stone and Portland cement using an automatic tile press with vibration.

A. Specifications of the material

Tile Description

- Plain Tiles

Tiles with a face (upper layer) made of smooth particles and 40cm x 40 cm dimensions with a minimum thickness of 22 mm are used; these tiles consist of two layers tightly holding together, the upper layer called the face and the lower layer called the bottom separated by a rim parallel to the edges of the tile. The face is divided into several squares, and the color of the tile is grey.

The face is made up of hard stone/gravel, sand, rough powder, cement, and any other natural material or substance with hard particles that prevent abrasion. These composing materials are used in appropriate percentages to produce a strong and solid mix in which the quantity of Portland cement is not less than 400 kilograms per meter cubed. The quantity of water is adjusted to produce a good and coherent mix that can be used in the abovementioned tile press.

As for the bottom, it is composed of hard stones/gravel, sand, powder, and cement in a way that the Portland cement is not less than 300 kilograms per meter cubed of this mix. Therefore, the quantity of cement used for the face and bottom layers must be monitored either in the factory or by conducting chemical experiments after manufacturing or both. Additional substances can be added to color the tiles.

Manufacturing Method

These tiles are manufactured using automatic tile presses with vibration capable of pressing 250 kg/cm² after vibrating for a certain period of time depending on the need. This produces a thick and dense vacuum mix without separating water from the substances used in composing the mix. Two days after producing the tiles, they have to be sprayed with water twice a day for a week.

Conditions of Tiling

- Plain Tiles

The contractor shall prepare the base of the sidewalk to be paved; he/she sets the barriers in order to make all the necessary arrangements from leveling to digging to backfilling and then compacts the base with water to bind it together. After that, a layer of clean sand or aggregate fillings is laid down in a way that the thickness of this layer is not less than 5 centimeters, then, the tiles are set/installed with a 2% inclination towards the road taking into consideration the floor level of shops and ground floor houses/apartments situated on the side of the sidewalk as this floor level has to be higher than the level of the pavement. The tiles are set on a layer (of thickness 2 cm at least) of cement mix composed of 350 kilograms of cement for a meter cubed of clean sand. The lines between the tiles are then filled with soft mortar/grout composed of 600 kilograms of cement for each meter cubed of clean sand. The contractor also generally provides all the necessary material, tools, workers and transportation means in conformity with the instructions of the management, which includes providing and paving, when necessary, a layer of cyclopean concrete (or big stones) with a thickness of 15 cm or an up-stand (edging) from reinforced concrete to contain the tiles and removing all debris resulting from tile-setting and re-paving and transferring the debris to the public dumpsites specified by the management. It is also the contractor's responsibility to spray the tiles on the new sidewalks with water for two days and make sure no one steps on them except where there are entrances which he/she conserves throughout these two days using planks/sheets of a total width of 120 cm.

- The following tasks should also be kept in mind:

- Making sure that the tiles have a high breaking strength (resistant to breaking).
- Checking the level and degree of compaction of the sand base beneath the tiles.
- Monitoring the pouring of mass concrete beneath the tiles and making sure it is well compacted.

- Ensuring, in terms of the ingredients used in composition, the suitability of the adhesive cement mortar/grout used to bind tiles.
- Monitoring the tile-setting/installation process and checking the level of elevation, the uniformity of the joints (separating lines/rims) and their straightness, and surface leveling.
- Monitoring the grouting and joint filling process.
- Maintaining the required moisture after setting the tiles through spraying water for a period of at least 7 days or the period specified by the supervising engineer.

Method and required specifications of setting/installing interlock tiles for the town square

- A sample of the interlock tiles is presented to the consultant for approval and the sample is kept with the consultant for the purpose of using it as a reference for procuring other material needed at the site (dimensions of the interlock tiles: 20cm * 20cm).
- The site should be thoroughly cleaned from all unclean material such as rocks or construction debris and then a layer of rough sand should be laid in which the percent of stone does not exceed 10%.
- The surface/ground level should be adjusted, if needed, before beginning work.
- The up-stand/edging surrounding the interlock tiles surface or area should be constructed according to the set plan or description where the specified up-stand/edging can be made from pre-prepared concrete ready-mix powder.
- After levelling the ground according to the required level (elevation) and inclination (the ground/surface is balanced and the inclination is specified) the subgrade layer is laid with a thickness of 5-7 cm and the sand used to fill this layer has to be free of rocks. The layer is then sprayed well with water and left aside before being compacted and levelled using a hand tamper, girder-shaped rod, or aluminum rod, to obtain a levelled surface beneath the tiles.
- The subgrade layer (sand layer) should be properly laid with a suitable inclination so that water runs towards the street.
- Tile installation is performed without using cement mix, the tiles are placed directly on the subgrade layer and the cut tiles used for the edges and borders are also placed.
- Cement mortar (grout) is not to be used under the tiles in order to avoid the formation of pressure points that might lead to breaking the tile in the future.

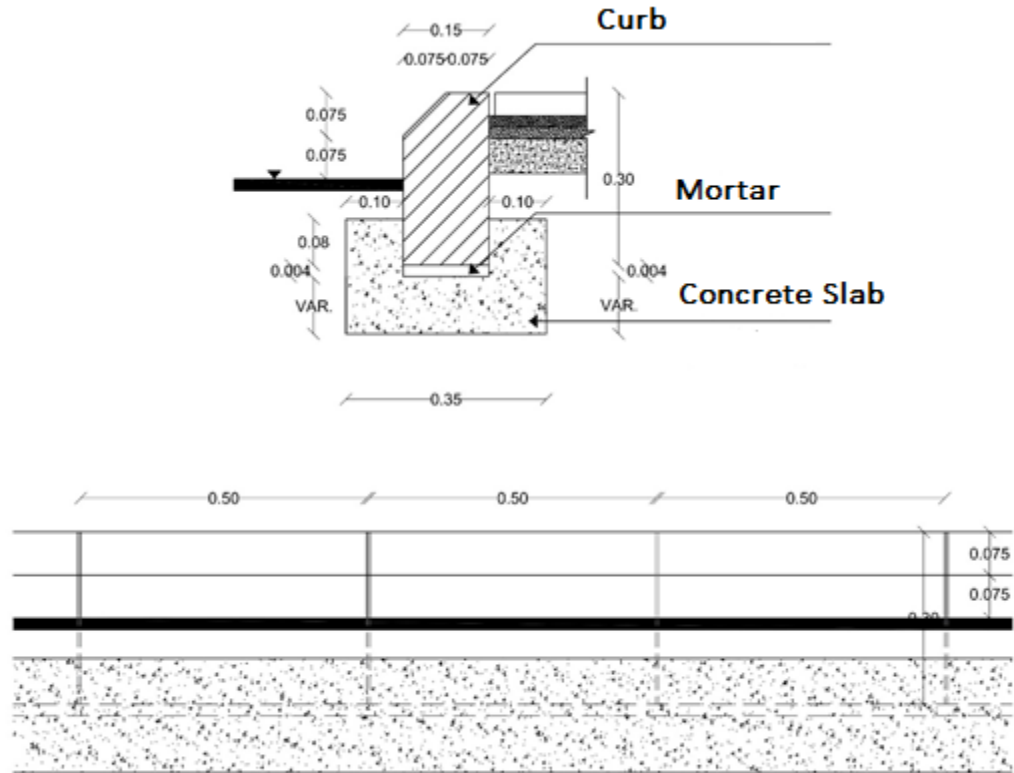
- After the installation/setting process is complete, clean smooth sand is sprinkled over the tiles to fill small gaps between the tiles, and then, it must be ensured that the required level is reached before finally cleaning the paved surface.

Conditions of laying/installing concrete (cement) curbs:

The required digging/excavation works must be conducted according to the instructions of the management in order to install curbs, all while taking into consideration the floor level of shops and ground floor houses/apartments situated alongside the sidewalk and keeping in mind the necessity to maintain drains and procure tile rings when necessary and of the required size.

Cyclopean concrete (or big stones) of height 15 cm and width 25 cm should be placed on mortar mix (mortar mix composed of 250 kilograms of cement for each meter cubed of sand) to create the base level. The curb stone is then installed on the base level using the same mortar mix in a way that the curb is eventually and generally 20 cm high (the required level is usually marked by a taught string line) though this height can be modified in some locations depending on the situation and the instructions of the management.

- The contractor should provide all the necessary material, equipment, workers, transportation means, and all other required procurements to properly complete the work from the technical side. It is also the responsibility of the contractor to remove the debris resulting from the works and transferring it to the public dumpsites specified by the management. He/she must also spray the tiles and curbs on the new sidewalks with water for two days as mentioned above.
- The dimensions of the curbs are specified using drawn schemes/maps presented to the management.
- The curb stones are procured from manufacturing companies and are transferred to the work site in a secure manner without causing any cracking in them as a result of transportation and loading.
- Minimum length curb stones are used at turns (on curves) to ensure the smooth flow of the curbs with the tiles perpendicular to them. **See Figure 1.**



- Specific curb stones with inclinations and height which do need exceed 5 cm are used at the entrances and exits of buildings and shops.
- Curb stones should be resistant to shock and breaking (high break strength).
 - o Monitoring the process of laying mass concrete beneath the curbs and verifying that proper compaction is conducted.
 - o Ensuring that the supplied curb stones match the samples approved before installation.
- The suitability of the adhesive mortar used between curb stones must be verified, in terms of the ingredients and percentages used in composition as well as the texture, to make sure it is conform to the instructions of the supervising engineer.
- The curb installation process must be monitored in order to verify the suitability of levels, surface levelling, straightness of lines, regularity of inclinations, and joints.
- The dimensions of the concrete base of the curb must be verified as well as the dimensions of the concrete edge/up-stand used behind it.

- Moisture should be preserved after installation, and that, through spraying water for a period of 7 days at least or for a period specified in the special relevant terms and conditions.
- Re-filling of the spaces/areas behind the curbs should be monitored as to ensure the use of approved material and conformity with the instructions of the supervising engineer.

Works Related to Planting Trees (Item Three)

Planting Trees

Street trees are trees planted along roads and streets in order to add beauty and an aesthetic effect as well as to cool the air and give shade in summer.

- It is preferable to use trees that grow up to two meters high approximately.
- It is preferable to plant two types of trees.
- The distance between one tree and the other should be 2.5 – 3 meters.

Steps followed to plant trees:

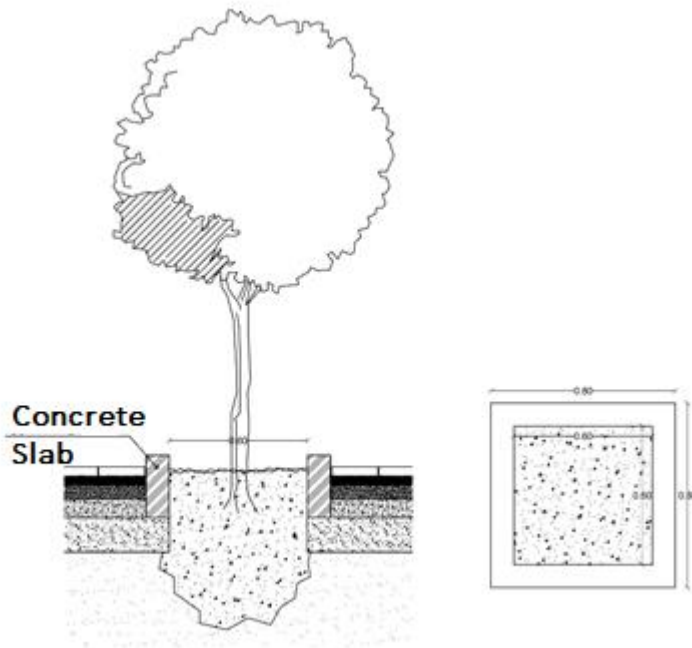
- Removing the tree from the pot/container it is planted in.
- Separating the roots one from the other if they are intertwined.
- Making sure that the soil it is planted in is held together.
- Digging a hole suitable for planting the tree.
- Making sure that the hole dug is of a depth and width twice the size (length and width) of the roots.
- Adding some soil fertilizer to revitalize the roots and stimulate growth.
- Applying dolomite to the soil if it is clay soil in order to make it suitable to receive the tree.
- Planting the tree deep in the soil.
- Staking the tree, if necessary, before refilling the hole dug, and that, in order to avoid damaging any of the roots.
- Digging a circle around the tree and pouring water in it, and if available, adding a significant quantity of sheep manure/fertilizer in the bottom of circle pit.
- Covering the tree with some hay in order to make sure that it receives the proper nutrients in summer and to prevent the growth of parasitic grass that can compete with the newly planted tree.

In addition to the abovementioned, and when necessary, concrete edges/up-stands should be procured and installed according to appropriate specifications approved by the management.

Locations of Tree Planting

A soil area is available above the basin/pond of the spring; it has an area of 50 m² approximately and should be planted with about 20 trees in order to create a sort of small forest above the spring to create a beautiful view and provide shadow from the sun.

- A row of 50 narrow and tall cypress trees is to be planted in the area around the basin/pond of the spring at the side opposing the town square (in other words at the side of the already existing trees).
- 2-meter high populus trees are to be planted at the beginning of the road leading to the internal roads of the town from the Al Ain Square.
- 50 2-meter populus trees are to be planted alongside the road linking Al Ain Square to the main road. **See Figure 2.**



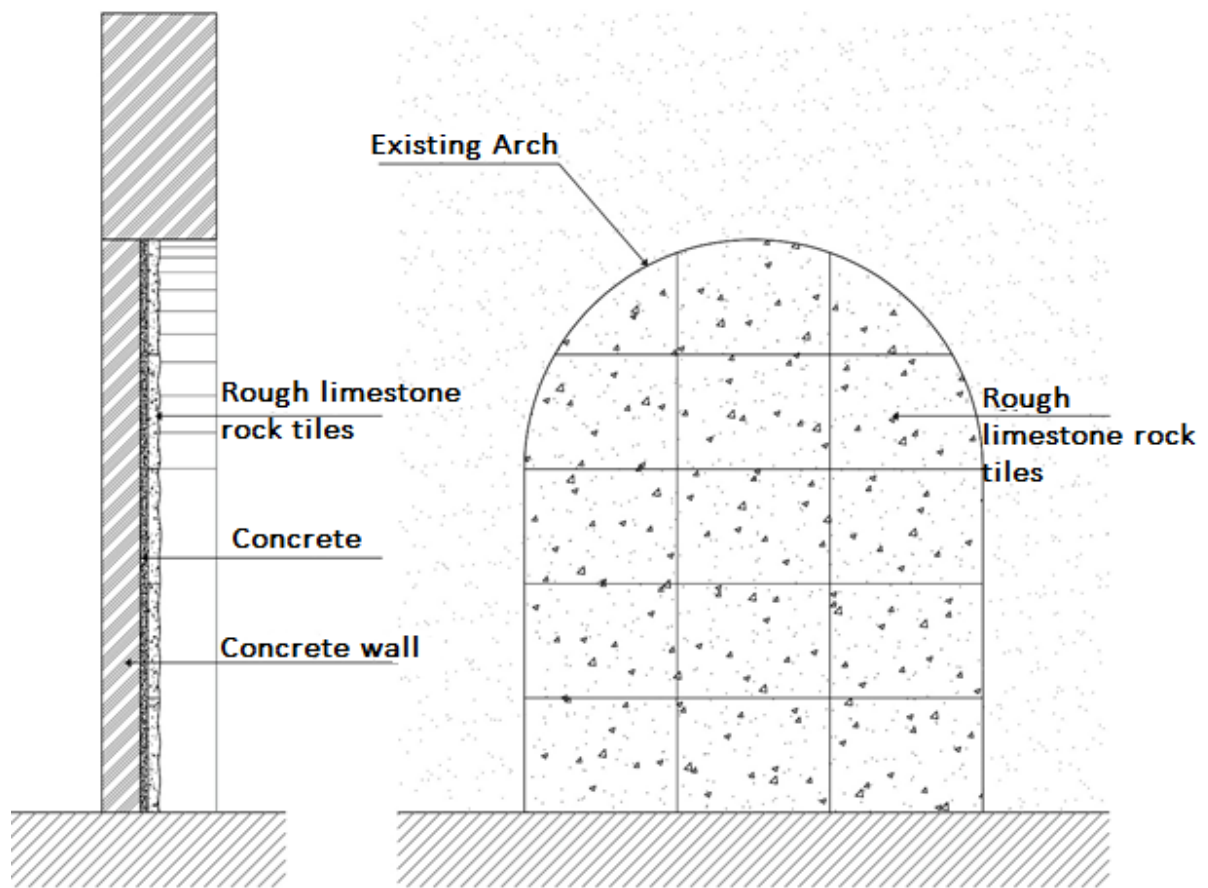
Different Works to Rehabilitate Al Ain Square (Item Four)

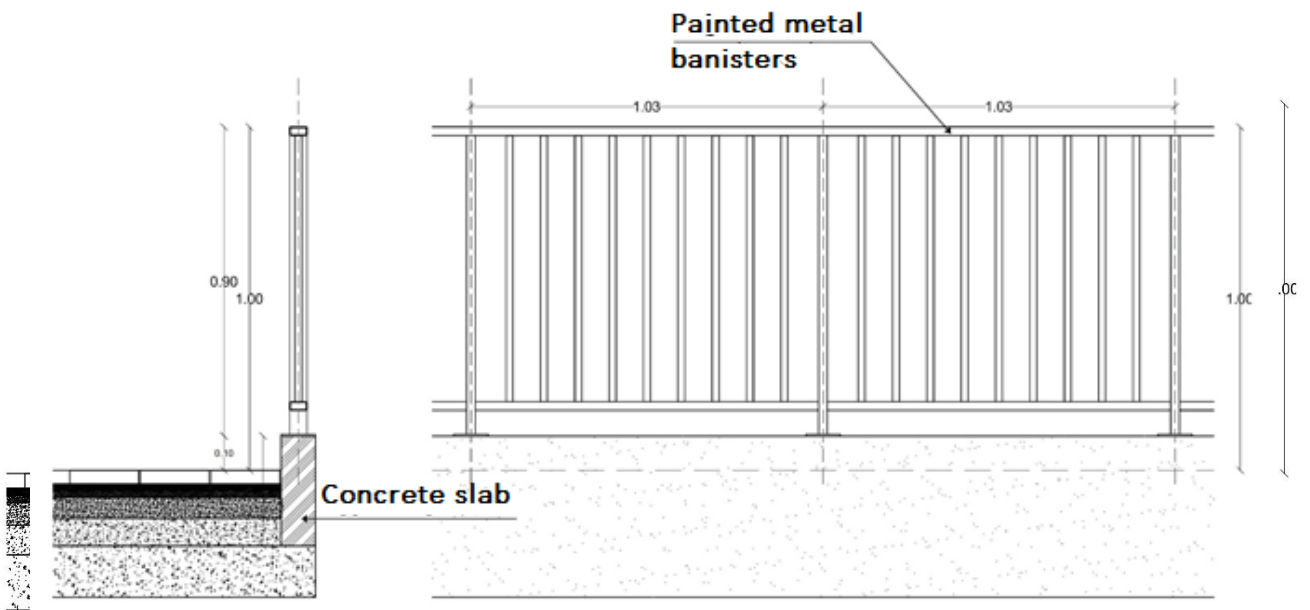
- Installing metal railing in Al Ain Square: Banisters are to be made of non-circular iron balustrades (each of an area of 2 cm x 2 cm) lined up the one next to the other and topped with a handrail (2 cm x 4 cm). The color of the banister is black. The banister is installed on a concrete bridge of width 4 cm and height 30 cm after digging a base hole for it (50 cm x 50 cm). This Beam is at a higher level (20 cm approximately) than the interlock tiles used in Al Ain Square, and that, in order to trap water. The bridge should also have openings to drain the water and should be made from smooth concrete which is not papered.
- Cleaning and beautifying Al Ain Square: constructing a rock staircase in which each step is one rock stone of width 30 cm, length 100 cm, height 3 cm, and is installed using a mortar mix of sand, cement, water. The stair risers are made of rough limestone rock and are 16 cm high with varying lengths as are the sides of the stair steps. **See attached figure.**
- Delineating and limiting the basin/pond of the spring with rocks of regular form preventing water leaking.
- Installing rough limestone rocks of height 20 cm and varying lengths on the concrete wall under the arches, and on the elevation at the bottom of the path descending to the spring, after reinforcing it with concrete and filling and then installing the rough limestone rocks on it. Moreover, the concrete rocks should be removed from under the water and replaced with regular-shaped rocks.
- Establishing rock stone gutters on the openings of water outlets.
- Removing unwanted objects (including unwanted plants) and dirt from the ground and the spring basin/pond and placing rocks flat in the bottom of the basin/pond in order to purify water and beautify the scenery.
- Installing polished stone tiles on the concrete between the stairs and the spring basin/pond beneath the spring streams.

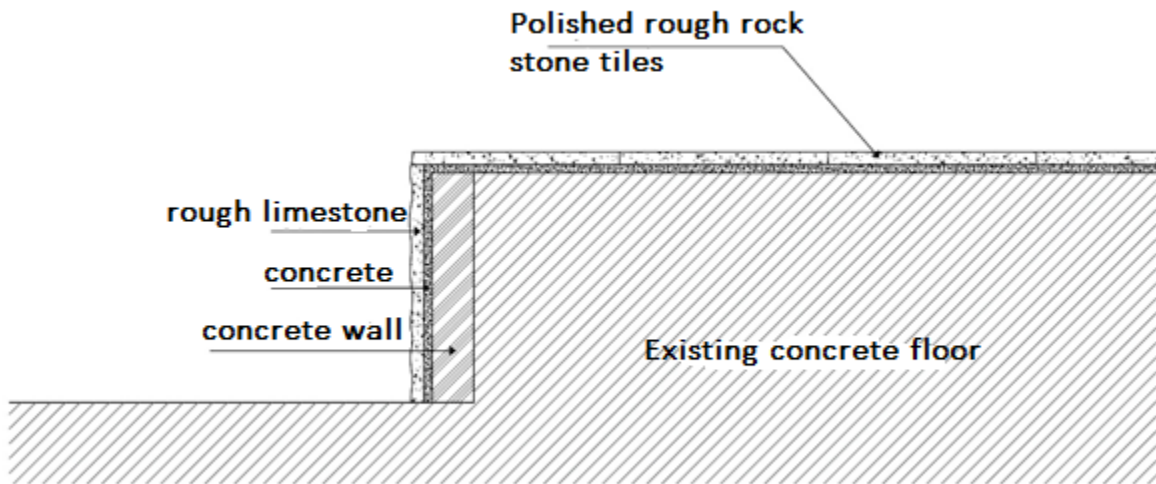
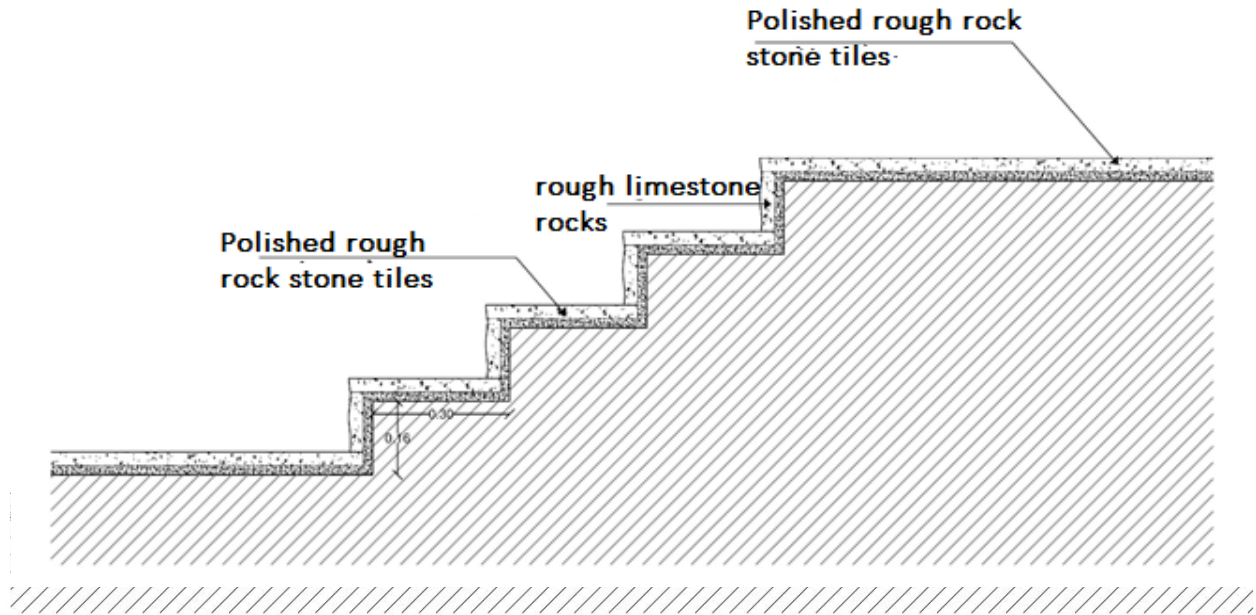
- Removing all the vines hanging on the rock stone wall above the spring basin/pond.
- Painting the banisters on the top of the 50 m rough limestone rock wall surrounding the spring.
- 30 m² of polished rock stone floor tiles.
- Setting the feather rocks on the bottom of the basin/pond without using mortar (30 m²).
- 6 rock stone stair steps.
- 2 rock stone gutters.
- Renovating existing walls (100 m²).
- Pouring a concrete barrier between the concrete floor and water pond/basin (10 m²) and installing rock stones (10 m²) in place of the concrete wall.
- Installing 4 light projector on the walls rising above the spring so that the lights hit the water of the spring.
- Installing rock stones inside the arches surrounding the spring.
- Hanging, at the beginning of the street, a sign and a road mirror with a concrete base that holds them (specifications defined throughout implementation).

Stone or concrete coating

1. Making sure that the work site is prepped and equipped according to the set schemes and plans.
2. Monitoring the supply of stones and checking them in terms of size and quality after supply in order to make sure they match the approved samples.
3. Monitoring the stone installation/setting process and making sure the appropriate mortar/grout is used and adjusting the thickness of the revetment,
4. Monitoring the process of pouring concrete revetments in order to ensure its conformity to the instructions of the supervising engineer.
5. Verifying the appropriate handling of revetments by spraying them with water every day for 7 days or for the period specified by the supervising engineer. **See figures 3-4-5-6.**







Any failure to meet the specifications or any modification or addition that might occur at a later stage in the project shall only be determined by the consultant engineer who is considered the only reference/authority responsible for project.

General Conditions

All testing is conducted at the expense of the contractor and in an officially recognized laboratory. In case the results of the tests reject the tiles, the contractor has no right to object or ask for compensation and has to remove the rejected tiles from the worksite within 24 hours or else the management will remove them at the contractor's expense and responsibility.

Additional Conditions:

No work shall be conducted if the weather is not suitable or rainy. The angle grinder or diamond cutting wheel is used to cut all tiles used for edges and borders and to cut/smoothen asphalt. Before laying down the tiles or up-stand/edging, sand, aggregate or gravel is compacted using a special roller approved by the management, and the sand should be free from voids and dirt.

Reporting:

1. Preparing the daily report:

- Main Objectives:
 - o Recording the different weather conditions
 - o Recording the number of workers and the task of each group/team of workers
 - o Recording the number of engineers, architects, technicians working with the contractor
 - o Recording the important machines and equipment which are suitable and functional.
 - o Recording the material supplied on this day and the extent of its conformity to the specifications and its safe storage.
 - o Recording the works carried out on this day.
 - o Recording any important remarks regarding the implementation of the project.
 - o Recording the contractor's days off.
 - o Predicting the weather conditions in advance in order to take some necessary precautions (hot weather, wind, rain...).
- Report copies: The supervising engineer keeps the original copy and the contractor keeps a copy.

2. Preparing the periodical report:

- Main objectives:

- A brief and very useful statement of information that gives the senior management representative a brief idea/overview of the flow of work in the project and the difficulties faced and how they were overcome.
- Centralized supervision helps in the periodical and close follow-up of work. A detailed report is usually attached to this report and is supported by pictures, graphs, and tables in order to help officials/directors in the central agency refer to one point or another or prepare a certain study or take decisions.
- The periodical report generally serves the purposes and objectives mentioned in the daily report.
 - It also serves the statistical purposes of evaluating projects and contractors.
- Report copies: The contractor and consultant each keep a copy of the report and the original copy is sent to the central agency/supervision. A copy can also be sent for data entry in the computer in order to conduct evaluations at a later stage. Reports must include photographs showing the work flow and progress.