Ridván Garden

Conservation of the historic monuments Akko

Bahá'í World Centre
Northern Development Projects
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Final
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Report

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Ridván Garden site plan

Introduction

The Ridván Garden, located at the south-east corner of the town of Akko, south of Napoleon's Hill, is an historical property owned by the Bahá'í World Centre.

The Ridván Garden area operated as an agricultural industry, in historical times used mainly as a regional station for milling flour.

The ruins at Ridván Garden, as of today, present remnants of five buildings used, primarily, as flour mills and a system of water canals, pools and wells, all ingeniously utilized for agricultural industry.

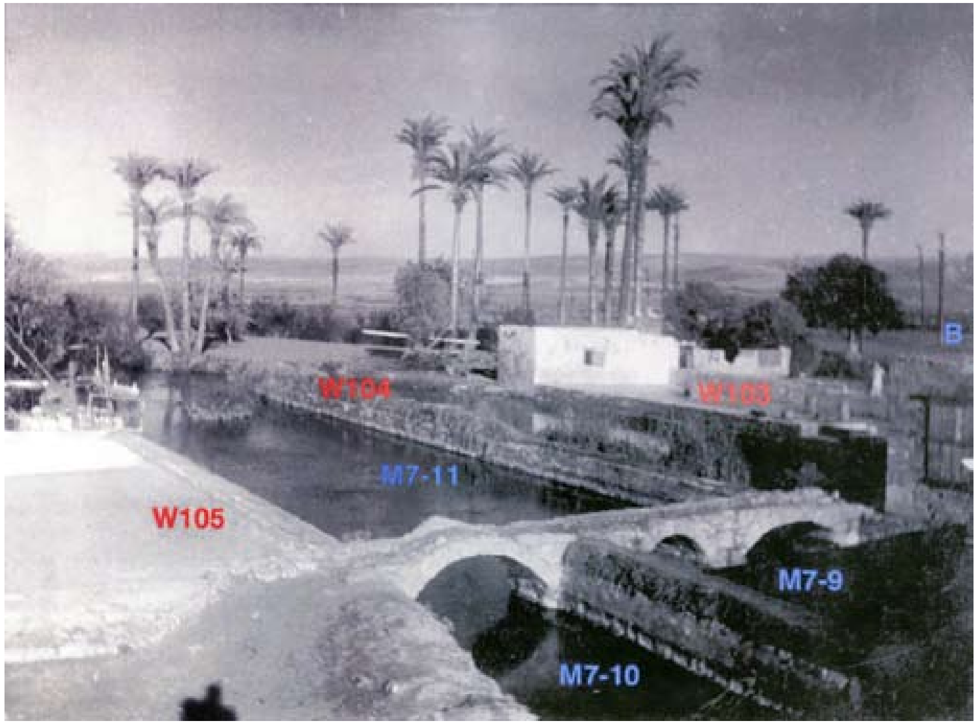
In addition to the ruins, the property boasts two conserved, historic buildings one of which sits on an island, amidst a scared Garden, surrounded by two large water canals. This house was frequently visited by the Prophet of the Bahá'í religion, Bahá'u'lláh.

The Ridván Garden is a holy site for the Bahá'í faith and is visited by the Bahá'í Pilgrims. The Bahá'í World Centre intends to open the site to the general public upon completion of the project.

The vision of the Office of the Northern Development Projects at the BWC is to reconstruct the site to an operational state according to historical pictures from the late 19th and early 20th centuries, the time of the residence of the Prophet at the site.

The implementation of this vision is a conservation, site development and site management challenge of the highest degree. With so many fixed modern limitations and considerations, together with the utmost strive to historical authenticity the challenge is even greater.

The vision and the out-coming project require a high degree of professionalism and commitment, as well as praise for the Office of the Northern Development Projects – BWC for confronting and operating such a challenging project.



The Technology of the Site

The milling technology at the Ridván Garden followed a familiar, historical system of utilizing the natural flow of a river or a stream, gravity and carefully calculated water flow management to operate the grinding mechanisms.

The system at Ridván was one step before the development of the more efficient tower mills. The flour mills were operated by using horizontal canals which narrowed as they reached a small opening from which the water pressured out, fell about one metre along a slanted slide and operated the power mechanism. The later and more efficient mills were operated using a tower through which the water fell from heights of 4 - 8 metres using the momentum of the flow to operate the power mechanism. It must be noted that the surrounding topography contributed to the mechanism chosen. Mills that were built close to hills could easily use the vertical system whereas areas close to the shore, on a flat land had to use the horizontal system.

Despite the different momentum generating system, horizontally instead of vertically, the mills at Ridván consisted of the three stages of operation: the system for supplying the water and the power; the power mechanism; the production mechanism.

The Technology of the Site

The water supply system

The ruins at Ridván show at least 15 flour mills which depended on the water flow system. The findings and report of the IAA's sample excavation point to earlier phases of operation dating back, possibly, to the Crusader's Period. Few remnants of architecture point to a more monumental phase than the existing one.

The evidence on site shows that the water supply system diverted part of the flowing water of the historical Na'aman River through a canal at the North of the property. The waters were divided at the northern edge of the Garden Island, below the North Well, into two main canals, on the east and the west. The east canal was further divided into two main canals.

The system of operation to buildings 1 and 4 were direct flow from the main canals to regulated and narrowing, lime plastered canals, under the buildings' floors.

The system of operation to buildings 2 and 3 utilized collecting pools in front of the buildings from which the water flowed through regulated, narrowing, lime plastered, sub-floor canals.

The system of operation at building 5 was not fully excavated but does show sub-floor canals similar to all the others.

All canals flowed south under the buildings and emptied into the large south pond which collected the waters and allowed flow westward, to rejoin the original Na'aman riverbed, on its way to the ocean.

It seems that the horizontal flow at Ridván, instead of the more powerful vertical flow, allowed for not all mills could be operated at once.

Grains were probably stockpiled to allow fresh grinding of flour and grinding at the winter months when the water flow had a more vigorous volume and strength.

It is generally assumed that a pressurized water flow of 50 - 80 litres per second through the narrow canal and slide operated the power and production mechanisms of the mill to yield anywhere from 20 – 50 kilograms of flour.

The Technology of the Site

The power mechanism:

As found at the base of the mills, the power mechanism consisted of a large, horizontally placed metal wheel. The wheel had a metal or a wooden hub and wooden flaps attached to the base of the wheel. The flaps were 25 cm in height and 25 cm in width slanted toward the running water. Usually there were 16 or as many as 20 such flaps on a wheel.

A metal rod, vertically placed into the centre hub of the wheel, projected upward into the hole in the vault and connected to the base of the grinding mechanism. This rod, when engaged, turned the grinding stone.

The production mechanism:

As found in buildings 3 and 4, above the vaults on the south side, the grinding mechanism consisted of two round and flat basalt stones with a hole in the middle. The diameter of the stones is ~ 150 cm. Other than the size of the stones the mechanism is similar in shape and function to the hand operated stones. The upper stone had a lip around the hole, about 15 cm. high, through which flowed the grain seeds. The friction sides of both stones were perforated or slightly channelled in order to facilitate the flow of the flour and the grinding action. Above the grinding stones on a horizontally placed log was hung a wooden funnel which contained the grains and distributed them to the stones. The slower the distribution of the seeds, the finer the flour.

Adjacent to the grinding stones there is a lime plastered flour bin into which the flour produced is automatically collected.

Construction techniques and materials:

All the ruins at the site were built from the local beach sand stone. Other than the two Monumental Gates entering the Garden, which were finely dressed, all stone used for construction on site were roughly dressed with minimum mason work.

Walls: All walls of the buildings were double faced walls with dressed stones built adjacent to each other leaving a gap of roughly 10 cm. which was filled with an earth/lime mortar laid with small rubble stones 5-8 cm. in diameter.
The average width of the walls is around 60 cm. Few walls reached up to 100 cm. thickness.
Single sided walls were finely faced toward the outside while the rough back side, facing the room, was fortified with rough lime plaster and small rubble stones and straightened with lime plaster.
Retaining walls were one sided built with very rough dressed or undressed stones. The back side of the walls was fortified with a roughly laid large rubble stones and mortar.
All walls were pointed with a lime based mortar which was set back in the gap until the core of the wall. Small stones were integrated into the pointing mortar to give it strength and support to the building stones.

Vaults: Roughly built vaults were built as support for floors allowing wide space for water flow into and out of the sub-floor canals and as space for the power mechanism of the mills. The vaults seem to have been roughly plastered with an ash lime layer than a ceramic based lime plaster.

Construction techniques and materials

Floors: All floors were made of small rubble stones driven partially into the soil and closely set together. On top were a series of lime mortar layers from rough to fine, depending on the finish desired.

The idea behind the technique of the base layer is connected to the type of soil on the site. At Ridván the soil has a high clay content and is subject to frequent wet and dry cycles, either by season or by the nature of the site.

If such earth was to be compacted, layered with earth/gravel mixture, also compacted, on top of which will be laid the base layers and final layers of the lime floor, the smallest amount of moisture would cause a failure. Moisture penetrating the compacted earth would cause the clay to expand and later shrink causing movement to all layers, instability and severe cracking.

This is not the case on a sand based soil where compaction gives stability.

The driving of the rubble stones partially into the clay-rich soil serves as a buffer zone which is free to absorb the movement of the soil without transferring the movement to the upper layers of the lime floor.

Roofs: The construction of the flat roofs was made with base logs, 15 – 20 cm. in diameter, which rested on wall tops with an average of 50 – 75 cm. between each base log. The logs seem to be from a local pine wood. On top of the base logs it is not certain what size of branches were laid perpendicular to the base logs. It can be safely assumed, as seen in similar sites from the period and the study of existing wall tops that the perpendicular placed branches were 3 – 5 cm. in diameter. On top of the small branches there were a number of layers of earth-lime mortar which were very well compressed and yearly maintained.

In rooms with space larger than three metres, a series of connecting arches were constructed, from wall to wall, in order to shorten the distances and allow the use of logs not longer than 3.00 – 3.30 metres. Examples of such arches are seen in Buildings 2, 3 and 4.

Construction techniques and materials

Canals and Pools: The walls of the water carrying canals and pools were in most cases built as double sided walls, same as the buildings' walls. The sub floor canals were covered with stone plates on which the base of the floors were laid. The canal walls were plastered with a relatively thin lime plaster system. In most cases the plaster system was not thicker than 2 cm. The base layers of plaster were composed from 1 – 2 layers of ash-lime plaster which allowed absorption and agility and gave a grey colour. The ash plaster was a weak plaster which acted as a buffer between the constructed wall and the final layers of plasters. The two final coats of plaster were made of a ceramic-lime plaster which allowed durability and water retention. These layers were stronger and less flexible and gave a reddish, pink colour. It is important to note that this type of water retention plaster system was derived from the Roman times and practiced during the Byzantine through the Ottoman eras. In Ridván, as seen in other systems, on going maintenance usually was done with any type of lime plaster, usually ash-lime, available, without attention to the original plaster system. Late repairs were made with cement plasters.

The State of Conservation

The ruins on site are divided into three complexes: the North Well; the West Well and Pool; the Mill Buildings.

The General State of Conservation:

Since the abandonment of the original intended use of the site as flour mills, the Ruins at Ridván Garden were quickly overgrown with local weeds, bushes and trees.

The site had a secondary, later phase of life primarily as living quarters and shelter for grazing livestock. Once the roofs collapsed exposing wall tops and tree roots penetrated foundations and base of walls the overall state of conservation deteriorated very rapidly. The phase where the core of the walls and the foundations are exposed to rain waters and plant growth is the time of most cumulative damage to the site. At a later phase an equilibrium is reached meaning that the collapsed portions of the ruins cover the still standing portions. This "natural" but unfortunate cover protects and supports, thus stopping further, rapid decay. When surveying the state of conservation at Ridván, this decay process is very clearly evident. The different monuments show different stages of decay but all show the same process and causes.

The State of Conservation

The North Well:

The surrounding retaining wall showed areas of wall collapse which, in turn, caused the surrounding core, infill and flooring to collapse due to water penetration. There are many missing parts of the flooring and the retaining wall of the ramp, caused by penetration of small trees and bushes. All of the pointing, deep and shallow, were missing, which caused instability to the stones and to the wall as a whole.

The well complex suffered mainly from sinking on the south and west sides which caused major, constructive cracking to the structure. Other minor decays in the pointing and surrounding plasters were noted.

The West Well and Pool:

The west pool is in a very stable condition of conservation regarding its grand size. In general there is a serious crack running length wise from south to north. This crack has come through the layers of lime plaster and the built foundation and masonry of floor and walls. The stairs on the north side have sunk and detached from the pool's wall. There are few lacunas in the plaster and most of the plaster is covered with a coat of moss. Signs of vandalism are seen on the planks of marble on some of the outer walls and on the top of the south wall. There seems to be a mild degradation in the coping although in general it is intact but a little low in height to function properly.

The west well is in an overall very bad state of conservation. The low retaining wall has survived in only a few points. The flooring around the well is non-existent. The two components which make up the well have detached from each other and each piece has sunk and tilted considerably in opposite directions. All of the well and its vicinity are overgrown with weeds and bushes.

The State of Conservation

The Mills Complex:

Building 1: The area of building 1 was completely overgrown with weeds, bushes and trees. There are no surrounding walls left standing other than the wall between building 1 and 2. This wall is severely damaged by large roots of the nearby Eucalyptus tree and is showing signs of bulging, departing of walls from core and is in immediate danger of collapse. Of the three sub floor canals, the east one is completely blocked and was not excavated. Its outlet vault on the south side was completely destroyed. The other two canals were excavated and have good amount of original plaster.
Buildings 2, 3 and 4: Although all three buildings were found in differing state of conservation, all revealed the same decay process and causes as mentioned above for building 1.

Building 2: This building comprises of two rooms. The north and west walls were in a dangerous state of conservation and very near collapse. The west room, being the smaller of the two had a major deformation of the west wall. As mentioned, this wall separated buildings 1 and 2. The cause for the bulging and deep cracking was the roots of the close by Eucalyptus tree. The main, large roots lifted the foundations upwards causing major cracking which opened the wall from both sides allowing rainwater to easily penetrate and wash out the core's earth-lime mortar. As a result of this problem over the years the wall was in great danger of collapse, similar to the east wall in building3.
The north wall hid an entrance which was found at the beginning of the conservation works and decided to be rebuilt. Both to the east and west of the new opening great voids were found in the core of the wall which managed to survive to a height of ~3 metres.
All wooden window sills/beams facing south were rotten or missing. An arch supporting the roof beams remained standing although the supporting walls from east and west were missing or leaning sharply south causing great instability to the arch. Generally most of the deep and shallow pointing was missing as well as the base layer of stone of the floor.

The State of Conservation

Building 3: : This building comprises of one large room with a general stable state of conservation besides the eastern wall. The eastern wall, which reaches a height of more than 5 metres on the outer side, suffered great damage over the years and as mentioned was in great risk of collapse. Washing out of the wall's coping allowed a small tree to grow and send its long roots into the wall's core. This caused a slow process of detachment of the outer shell of the wall from the core. Eventually the outer shell collapsed leaving the earth/lime core exposed and eroded and leaving the inner shell of the wall bare and at great risk of collapse.

A set of three arches as construction for the roof logs survived in stable condition. Wooden window beams were rotted and needed replacement. All floor bedding, pointing, plasters and coping were generally missing or in a state of decay.

Building 4: This structure survived in the best state as compared to all other structures of the flour mills. It is important to mention the west wall of the structure as being built of an outer shell and only a thick, rough, small, thin stones embedded lime plaster. Although the fragile make of the wall it showed no major constructive cracks. Although this building was constructed over 4 canals and its south wall projected over 5 metres high it showed no signs of constructive damage or problems. This structure was chosen for full reconstruction. As in the other 3 buildings also here the pointing, plasters, coping and floor bedding were missing or damaged.

Assessment of state of conservation

All conservation intervention, reconstruction and development work and strategy were based on the actual assessment of the causes and process of decay which were studied on the exposed ruins.
The need to combine actual data with the program and expectation of the Property's owner, BWC, is based on the interpretation and understanding of the causes and reasons for the decay logged on site. This understanding combined with the data of how and with what the site will be operated and maintained yield the correct model for intervention and composition of materials to be used in the conservation interventions.
The assessment of the ruins at Ridván Garden was based on:

- The vision and plan for the site by the NDP/BWC.
- The preliminary report of sample excavation by the IAA.
- Study of the original building techniques and materials employed to build the site.
- Causes of decay and of survival of architectural elements of the ruins.
- Causes of failure and of success of the original materials used in building the site.
- Climate, topography, type of soil, types of plants and vegetation on and in the vicinity of the site.

This information and data which helped us compose an understanding, working models and strategy are brought forth in all the chapters of this report. It must be stated that the work model and strategy set forth by the initial plan given by the site's original engineering firm did not match at all to the model we composed and put forth based on all the data gathered and studied. This point was crucial as many parts of the site were at great risk of loss and posed great dangers for the intervention works.

Work strategy

It must also be stated that the NDP/BWC quickly understood the logic behind the model and strategy we put forth. This allowed us to immediately stabilise all points at risk while, on the other hand, setting forth re-interpretation and the formulation of new and adapted plans as the project was set in motion.

Formulating plans when the project is underway is an undesirable system for work as it calls for far greater efforts and professional attention in order to recognise problems and causes mistakes and incorrect decisions and interventions. This process poses great risk for the conservation works, the conservation team and the Property's owner.

Again, as stated in the introduction, the vision and commitment of the staff of the NDP with the quick regrouping and appointing professional conservation architect and engineering team helped guide the works and the project to a much hoped for and needed success.

Materials used for intervention

As general, all materials chosen for intervention were as close as possible to the original materials. This principle had to take into account the required extra constructive strength and durability needed to support the ruins. Durability in the materials used for conservation and reconstruction is a needed quality as the treated state of the ruins still leaves them (with the exemption of building 4) in a state of ruin and not similar to their original, well maintained and functioning state.

After the initial clean up of the site and the study of the decay processes, the original materials, those that survived and those that failed, that were used to construct the site lay exposed and evident. This allowed us final adjustments.

Stone: All building stone for the walls were retrieved from the site itself, usually as close as possible to the area of work.

Small stones for the base layers of the floors, inside and outside, were fist size, rubble, field stones all retrieved from the site.

Small, flat stones, as a secondary layer for the stabilization of the multi-layer floor of building 4, were mostly made of beach rock and were brought from a local stone process factory in Nahariya.

Lime: After contemplation it was decided that all limes used on the project will be fresh, natural hydraulic limes. We used exclusively the limes of St. Astier of France. The preference of NHL instead of slaked lime in the project is their durability, ability to withstand reaction with salts and clays and varying strengths according to needs and uses.

St. Astier NHL 5 – used as bedding mortar in reconstruction, wall core, infill for deep pointing, voids and cracks, all flooring, coping and foundations.

St. Astier NHL 2 – used for all plasters, fine pointing, conservation and integration of plasters.

Materials used for intervention

Sands and aggregates: Three types of sands were used for the project:

Local grinded limestone sand with aggregates of up to 3 mm. Colour ranging from light beige to beige. Source: Misgav quarry.

Negev wadi sand washed from clays and salts. The sand is characterised by irregular aggregates and quartz sand grains. Colour: light brown. Source: Revivim Quarry.

Negev wadi sand composed of different size quartz grains with some impurities. Colour: dark, mustard yellow. Source: Arad Quarry.

Ceramic powder finely grinded with 2-3 mm. aggregates made from roof and floor tiles which were baked at ~1000 degrees. Used as an additive to lime plaster to achieve water retaining qualities. Source: Terra Cotta Ofakim.

Lime mortar and plaster mixes used on the project:

Rebuild of walls and wall cores: 1 part NHL5 to 4 parts limestone sand.

Deep pointing and crack filling: 1 part NHL5 to 4 parts limestone sand.

Shallow and final pointing: 1 part NHL2 to 2 parts Revivim sand + 2 parts Arad sand.

Base layer for lime/stone floor: 1part NHL5 to 2 parts limestone sand.

Upper layer of lime/stone floor: 1part NHL5 to 1 part limestone sand + 1 part Revivim sand + 1 part Arad sand + ¼ part ash.

Ash/lime plaster: 1 part NHL2 to 4 parts Revivim sand + 1 part ash.

Ceramic/lime plaster: 1 part NHL2 to 4 parts Revivim sand + ½ to 1 part ceramic powder.

Coping of canals: 1 part NHL5 to 2 parts Revivim sand + ¼ part ceramic powder. Semi liquid form.

Flooring for pools: 1 part NHL5 to 1 part Revivim sand + 1 part Arad sand + ½ part ash. Semi liquid form.

Pointing of West Pool: 1 part NHL2 to 4 parts Revivim sand + ½ part ash.

Coping of West Pool: 1.5 parts NHL2 to 3 parts Revivim sand + 1 part Arad sand + ½ part ceramic powder.

General phases of Work

Phase 1- Preparation of Site:

Camp set-up; cleaning of ruins; materials and architecture study.




General phases of Work

Phase 2 - Stabilisation of Site:

Repacking of exposed wall core; deep joint pointing; filling of wall cracks; rebuilding of dangerous missing stone and courses; supports for arches and vaults; dismantling of Garden Gate; stabilisation works at North and West Wells.

General phases of Work

Phase 3 – Reconstruction:

Rebuild of all walls; coping of wall tops; flooring; base and final coats of plaster of walls, canals, pools; rebuild of Garden Gate; roof and floor of building 4.

General phases of Work

Phase 4 – Conservation:

North and West wells; West pool; flour bins; existing plasters; fine pointing.

General phases of Work

Phase 5 – Additional works and finishing touches.

Maintenance Plan

The maintenance for the conserved and restored site should remain as simple as possible. The plan must rely on the concepts of inspection, observation and preventive action and maintenance.

As mentioned, Ridván Garden property was overgrown with wild plants, shrubs and trees for more than a century. This allowed the seeds of all these living plants to spread and germinate at every possible spot, even with the smallest quantity of soil.

The Site, as of today, has a great chance of survival simply for the fact that it will not be abandoned and will be well maintained. This is the reason we recommend a preventive measure maintenance approach.

Conservation materials in the built architecture:

We used much stronger lime concrete mixtures in the core and base of the walls and floors in order to achieve structural support.

In all flooring and foundations in contact with the clay rich soil we first utilised an inter phase layer which made direct contact between the rubble stone and earth. On top we laid the lime layers and rest of the work.

We used feeble lime mortars and plasters on the outer layers of the built architecture in order to allow maximum flexibility to minute movements and movement to surface of inner moisture and soluble salts.

We suspect that some of the feeble lime mortars and plasters, because of their nature and the intent for which we designed them, will show signs of mild decay in some areas. Most affected spots should stabilise and regain a strong weathering outer shell.

Maintenance Plan

The points to observe in preventive, on-going maintenance are new and evident cracks, disconnection and falling of mortars and plasters and plants and roots infiltration. These observations should be noted and if severe should be relayed to ACC via email or phone.

ACC will make a yearly inspection of all conservation works, as part of our commitment to the site and contract. This inspection will be at the end of each summer preferably when the water system is drained for routine maintenance.

All future changes or additions to the conserved and restored Monuments, we suggest, will be made with the same materials and proportions used by ACC. We will be available for consultations and further details regarding future interventions, additions and alterations, should these be opted or necessary.

Plants and Vegetation:

Among the parameters of on-going, preventive measures must be a programme on regular basis of weed control spray of the entire area of the conserved and restored Monuments. This action is in attempt to neutralise and stop all plant and seasonal vegetation growth. The root growth of these plants and vegetation, minute as may be, deteriorates the lime mortars and plasters and stops the materials capability to achieve a strong and durable weathering surface.

The type of weed control chemical and spray plan should be attuned with the existing experience of the Site's chief gardener.

From our experience an implemented on-going spray programme and vegetation and plant care and maintenance may be intense in the first years but later reduced as control of the site is achieved.

Every year before the first rains, an anti germination and seed growth chemical must be sprayed over all the conserved and restored Monuments.

The characteristics, quantity and dilution should be according to the product's instructions.