2013 On Site Review Report

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by Hanif Kara

Hassan II Bridge

Rabat, Morocco

Architect
Marc Mimran

Client
Agence pour l'Aménagement de la Vallée du Bouregreg

Design
2007

Completed
2011

Hassan II Bridge
Rabat, Morocco

I. Introduction

Divided into 16 regions and with a population of around 38 million, Morocco lies on the north-west corner of the African continent, boasting 2,400 scenic kilometres of Atlantic and Mediterranean shoreline. On the western side of the country the Bouregreg River creates a 6000-hectare valley more than 15 kilometres wide, stretching from the Atlantic to the boundaries of Sidi Mohamed Ben Abdella; the Hassan II Bridge is borne out of a vision to regenerate this area, close to the city of Rabat. His Majesty King Mohammed VI took a personal interest in this region by encouraging national policies and legislation to enable its large-scale redevelopment. Since His Highness the King is the highest authority in the country, his personal commitment is important, as "morally" this guarantees that the project cannot fail. One could argue that it also continues the tradition of the "king as builder", demonstrating a well-governed state.

In 2003 a special commission was formed to study the area and identify key projects and processes that would kick-start improvements in the areas of socio-economic, political, agricultural, governance and urban planning. The commission included representatives of His Majesty, the sovereign government of the region, leaders of the municipality, and experts from the fields of architecture, geography, geology, hydrology, transportation, engineering, history, archaeology, finance, agriculture and construction.

The commission published its findings in 2003 in a comprehensive report entitled "Projet d'Aménagement de la vallée du Bouregreg" (Development Project of Bouregreg Valley). Its far-reaching conclusions signalled a new stage in the history of the valley, socially, economically and urbanistically.

The Parti d'Aménagement Global (PAG) suggested a number of interventions of different scales for the improvement of Bouregreg Valley; in particular, 13 key ideas emerged:

- Embouchure et Chenal
- Port Atlantique
- Tunnel
- Promenade El Alou
- Place Souk El Ghzel
- Rive Gauche
- Pont Moulay Hassan Bridge
- Port de Plaisance
- Cité des Arts et Métiers
- Esplanade Rive Droite
- Plage de Salé
- Front de Salé
- Cimetière

The findings concluded that improved transportation should be prioritised and would be a key component of the larger urban plan, generating the specific infrastructure projects that would have the most significant and immediate impact on the populations of Rabat-Salé:

- Hassan II Bridge
- The Rabat-Salé tram line
- The tunnel of Udaya

II. Contextual Information

A. Brief historical background

The responsibility for delivering this vision and the individual projects was entrusted to the Agence pour l'Aménagement de la Vallée du Bouregreg (AAVB; Agency for the Development of the Valley of Bouregreg), a public cooperation endowed with the status of a legal entity, given financial authority and reporting directly to the sovereign state.

The AAVB, using a legal manoeuvre known as "Eminent Domain", gained control of about 6000 hectares of land covering the areas around the medinas (ancient cities) of Rabat and Salé, and took into account a number of observations made by the commission, which can be summarised as follows:

- the region is of historical and religious interest including the ancient site of Chellah, which contains the ruins of a Roman town, and has numerous historic buildings, such as the Hassan Tower and several medinas;
- the valley is home to some exceptional landscapes, including a natural estuary and the plain of Oujda;
- due to the lack of a comprehensive strategic urban-planning framework the valley is under threat from the contaminated water quality of the River Bouregreg, which suffers from tidal saltwater intrusion, mercury contaminants, and a proliferation of wasteland and slums causing pesticide and mineral contamination of the river;
- it is necessary to protect against a predicted four-metre rise in water levels inundating the banks of the river and the flood plains beyond, threatening communities and agriculture.

These points became the key driving forces for the urban plan, identifying several new projects that would not only transform the valley but also gradually change the identity of Rabat-Salé into a resilient, sustainable and modern city with a robust transportation network. Many of these projects are now underway.

B. Local architectural character, including prevalent forms and materials

The River Bouregreg has its source in the Middle Atlas mountains, is 240 kilometres in length and discharges into the ocean via a tidal estuary extending 24 kilometres upriver at a rate of around 23 m^3/s. A number of bridges for rail and cars were built during the second half of the last century to connect both sides of the river.

In developing the design of the new Hassan II Bridge, both the character of the river and its banks (including existing bridges, marinas and so on), together with the urban forms of nearby Salé and Rabat needed to be considered as the new bridge had to extend some distance beyond the immediate banks of the river. The existing bridges (Pont Moulay Youssef, Pont Al-Fida, Pont Mohammed V) over the river are a mixture of short-span steel decks with close-centred reinforced-concrete piers that obstruct the natural flow of the river and restrict navigation. Including the existing Moulay Hassan Bridge, which was to be replaced by the new structure, these are uniformly utilitarian, with little character or concern for aesthetics, and generally follow the singular traditions of engineering economy.

C. Climatic conditions

Rabat-Salé has a temperate climate and is known to be quite humid, influenced both by the Atlantic Ocean and the nearby river throughout the year.

The mean annual temperature is 17^{o}C with temperatures peaking at 30^{o}C, night-time lows of 8^{o}C and 10–14 hours of sunshine throughout the year. Annual rainfall is in the order of 550 millimetres. Snow and ice, which can have a significant impact on bridge design, are not a concern here.

D. Immediate surroundings of the site, including architectural character, access, and landscaping

As mentioned, the new bridge extends a long way into the historic cities of Rabat and Salé, located on the plateaus that flank the banks either side of the River Bouregreg; in fact, almost 95% of its 1,200-metre length is dedicated to its transition into the two cities.

These urbanised areas are situated either side of the agricultural valley of Bouregreg, with Rabat covering an area of approximately 9,528 hectares and Salé 15,075 hectares. A green belt of 1,200 hectares is prescribed in the wider plan to prevent urbanisation of the south of Rabat and separate it from Temara. North of Salé, an agricultural zone is supposed to ensure continuity between the forest of Marama and the coast.

Each bank has prestigious historical sites, which include: on the Rabat bank, the Esplanade and Hassan Tower; the Mohammed V Mausoleum; Kasbah des Oudayas; the cemetery; the ruins of Chellah; on the Salé bank, the tomb of Sidi Ben Archer; the aqueduct and Salé medina (with ruins dating back to Phoenician times and still to be excavated). The mouth of the river descends down to the Atlantic and forms a beautiful natural frontier of lowland between the cities.

E. Topography of the project site

From the banks it can be seen that both cities meet the river at different levels. On the south-western side, Rabat’s medina hangs over the cliff, while the Kasbah des Oudayas district rises up and then descends to meet the seashore at its tip. The cliff is about 60 metres above the level of the river bank, and the ribbon between the cliff and the river is used by fishermen.

To the north-east, the Salé medina is much closer to the river bank and rises to about 10 metres above the river bank level, though other districts further inland are higher.

As part of the regeneration plan, the new Bouregreg Marina at the mouth of the river on the bank of Salé has been constructed, and has been operational since March 2008. It is important at this point to consider this and the other projects planned, since they were conceived as part of the "grand vision" and formed part of the brief for the new Hassan II Bridge, tram and tunnel projects.

A mixed-use real estate project of 512,000 square metres called Bab al-Bahr, designed by the architects Foster + Partners, has also been partly constructed. This development started in 2009 and comprises a range of residential units, hotels and commercial units for "high-end" offices. In the long term, the adjacent marina will also support this massive development, which lies in the shadows of Hassan II Bridge. It will provide catering and leisure facilities as part of the area's developing cultural sector, which includes a striking 2,500-seat theatre to be built by Zaha Hadid Architects.

III. Programme

A. History of the inception of the project; how the project was initiated

The studies showed that Rabat and Salé (total population in the order of three million) had both suffered increased ghettoisation and fragmentation to varying degrees. It was also clear that unification of the two cities is essential for the purposes of future development, and that locally four key components are relevant and unite the cities:

- the new Hassan II Bridge;
- two tramway lines connecting the cities;
- a marina;
- the Bab al-Barh district redevelopment.

The city of Rabat is believed to have been formed in the 12th century and around the 17th century it served as a base for corsairs who waged war against the Christians from Spain and Portugal. During these times Rabat could hardly be evoked without mention of its ancient rival and neighbour Salé, recognised for its religious knowledge and mystics.

Under French occupation, in 1913 Rabat was declared the civic/administrative capital (reinforced after independence, 1956) of Morocco, alongside Casablanca as its economic capital. From that time until the late 20th century the growth of Rabat, as the centre of the kingdom, was evident in its new ministries, luxury hotels and residences for civil servants. Today 75% of Rabat's population is employed in government administration and support functions, and its economic activity therefore depends disproportionately on public departments. Salé, on the other hand, serves as a "dormitory" town, with the vast majority of its population commuting to Rabat and the remainder working in tourism.

The river and paucity of transport links between the two cities form physical and socio-economic boundaries. Furthermore, assessments indicated that of the 400,000 people who travel daily between

the two cities, over 50% of them were using the old Moulay Hassan Bridge, which was reaching the end of its design life, causing massive traffic jams.

The initiation of the tramway between the cities would relieve this congestion, and the most viable connection point for the tramlines would be in the location of the Moulay Hassan Bridge (and eventually its replacement the Hassan II Bridge).

B. How were the architects and specialists chosen?

The AAVB chose to organise a limited design competition for the replacement of the Moulay Hassan Bridge. The final teams that competed were:

- SETC and Marc Barani
- Marc Mimran Architecture & Engineering
- Schlaigh Bergman and Partners and Dietmar Feichtinger Architects
- Thomas Lavigne and Michel Virlogeux
- After two rounds of presentations the design team of Marc Mimram was selected.

C. General programme objectives, functional requirements and architect's brief

Though I asked for the original briefing document for the competition, to date the architects and clients have not been able to provide it. The client has, however, provided impressions of the four competition entries, and from those one can deduce that the key functional and technical objectives were:

- to design a structure that accommodates tramway ramps on both the Salé and Rabat sides, plus a two-lane tram route over the river;
- for an elevated highway to enter Salé descending approximately 9.36 metres from the bridge to Carrefour de Cardonna;
- to orientate the bridge axis to NE/SW over the waterway, parallel to the adjacent Moulay Hassan Bridge, which would remain in service during the construction of the new bridge;
- to provide a transition on plan on the Rabat side that curves (parallel to the river) and rises to Place Sidi Makhlouf by up to 20 metres;
- to cater for tidal changes of up to four metres (from -2.0 m to +2.0 m);
- to create a clear navigable channel (at the water) level of 76 metres width without intermediate supports and bridge underside approximately 11 metres clear at the centre;
- to provide a 46-metre bridge width that incorporates a tramway, three lanes of traffic, pedestrian routes and a cycleway;
- to produce a design of high architectural quality that would serve as a symbol for the modernism of the capital while rooted in the "place", respecting the historical, urbanistic, topographical and economical constraints identified above;
- for particular consideration to be given to maintaining views of the Hassan Tower, the Chellah ruins and the Mausoleum.

IV. Description

A. Bridge data: volumetry, massing, number of units, surface area in square metres

The design proposed by Marc Mimram separates the bridge into three systems: the main bridge (spanning the waterway); a viaduct on the Salé side (instead of an elevated highway); and a nautical base bridge on the Rabat side, comprising 1,200 linear metres in total.

Hassan II Bridge:

- global length: 330 m
- arch spans: 21 m – 26 m – 31 m – 36 m – 76 m* – 36 m – 31 m – 26 m – 21 m – 21 m
- width: 46 m – three decks of 14.5 m, 11 m and 14.5 m, separated with two rifts of 3 m
- about 16,000 m^2
- clearance for navigation: max 33*10, min 16*9
- material:
  10,000 m^3 superstructure concrete
  11,000 m^3 foundation concrete
  3,000 tons reinforcement
  360 tons of prestressing cables
  foundation piles up to 38 m
  76 m clear span over the water

Nautical Base Bridge:

- length: 100 m (curved on plan)
- arch spans: 35 m – 35 m
- width: variable on two 14.5 m decks up to 35 m
- material:
  4,900 m^2 surface
  2,500 m^3 superstructure concrete
  6,500 m^3 abutment and foundation concrete
  120 tons prestressing cables

Salé Viaduct:

- global length: 600 m
- arch spans: regular 21 m spans between twin columns
- width: 20 m
- material:
  0,000 m^2 (including abutments and access on each side)
  6,750 m^3 superstructure concrete
  5,500 m^3 foundation concrete
  3,300 tons reinforcement

B. Evolution of design concepts, including

1. Response to physical constraints, user requirements, spatial organisation – siting, climate

The designers commented that they were struck by the polarity of the flat plateaus, and were keen to preserve the views that celebrate the magnificence of the Hassan Tower. Accordingly, they reduced the level of the bridge by about two metres to ensure it was "a project in touch with the landscape".

Their most significant deviation from the original brief was to extend the bridge beyond the banks to reach Place Sidi Makhlouf on the Rabat side and Carrefour de Cardona in Salé; although this stretched the budget, the increase in length was deemed crucial to the success of the design.

The jury supported the designers' proposal that the space under the bridge could be used as a "new public place" for the citizens of Rabat-Salé. In order to enable this, the 600-metre-long space under the Salé Viaduct would be opened and power and water provided for future use by markets and retailers, while the underside of the 100-metre-long nautical bridge could be used to provide secure storage for yachts and market stallholders.

Marc Mimram also commented that in general terms they wanted to create a "well-detailed bridge" that would be read as "something growing out of the ground"; and that there had been no deliberate attempts to add any particular Islamic references in the proposal.

2. Landscaping

Though the landscape design falls outside the scope of Marc Mimram's work, AAVB did appoint separate consultants. Given the three dimensional complexities of the bridge, tramway and tunnel it was essential to use the landscape to define and unite the project. The regenerated riverbanks of Rabat were completed in 2007 with their frontage accessible by working boats. The water quality has improved as a result of extensive dredging, and signs of flora and fauna are returning. Under the bridge itself, hard landscaping has been completed, though it is not currently in full use. On the Salé side new hard landscaping has been completed, installed up to the entrance of the historic medina and spreading onto the Bab al-Bahr development. The exposed cliffs of Rabat highlight the influences of both man and nature on the ancient site, comprising a mixture of stone, historical walls and new flora and fauna.

C. Structure, materials, technology

1. Structural systems

The design requires three different structural systems to respond to the specifics of the site and brief: Hassan II Bridge with the longest free span, the Salé Viaduct with its repetitive span, and the nautical bridge on the Rabat bank that curves on plan while descending.

Hassan II Bridge

The central portion requires a 76-metre-clear span over the waterway and is formed by a traditional "arch" section that supports the deck. Arches work primarily in compression and historically are used for medium spans with steep sided ravines, which provide good support laterally for arch thrust. In this case, the arches begin at "column" or springing points; "half arches" span on either side of the central span, forming a total length of 330 metres for this system.

On plan, "gaps" are introduced between the carriageways and also to separate the tramway from the rest of the bridge; in section, three separate arches, each supporting its own deck, are formed. This enables an elegant cross section of hollow "T" beams with wide, thin arch sections. The half arches are not geometrically pure but asymmetric, thus inducing forces into the deck.

Nautical Bridge

On plan this portion of the structure curves significantly and the "gaps" on the deck are removed to reunite the bridge into a single-width deck. The primary structural system comprises two 40-metre-span arches that are raised to give clearance with a vertical post in the middle, while the two ends terminate in diagonal abutments that resist thrusts and uplifts.

Salé Viaduct

The 600-metre length was halved into two separate 300-metre lengths for ease of load transfer. Transverse "portal" frames were then provided to support the deck at approximately 21-metre cross centres. The portals span about 30 metres and on plan a "gap" is maintained for the full viaduct up to Carrefour de Cardona. Slipways either side of the viaduct are independent structures, as is the tramway ramp that peels away on plan to the west.

Geology

The sites of the viaduct and nautical bridge comprise made ground and alluvial deposits with a rocky layer below. As one gets closer to the river, variable strata of sandy mud overlying fine sand are found, deposited as layers of sediment over time. Bored piles were used to support the bridge throughout the whole system.

2. Materials

Reinforced concrete was chosen as the primary material for structures.

I understand that during the competition stages this decision was driven primarily by the designers' view that steelwork was likely to depend on complex procurement methods, while concrete could be manufactured and constructed locally.

It was also decided that "white" concrete would be used, as the designers wanted the changing surroundings to inform and colour the bridge's neutral materials. The strength of concrete required to

cope with the predicted forces also demanded a high-strength mix of grade C65; this combination of colour and strength had no precedent in Moroccan construction.

Technical specifications:

- white concrete C65 strength minimum
- white cement CEM II 42.5N (imported from Lafarge France)
- white Dura sand from Kenitra (Morocco)
- gravel from Oued Cherrat (Morocco)
- light grey silica fume filler (imported)
- reinforcement (5,500) prestressing cables (51,860) both imported from France
- rendering and finishes include phonic asphalt, and stainless steel mesh for barriers and handrails

3. Construction technology

The complex nature of a highway bridge requires the development of a comprehensive construction method in the initial design stages of the project. In this case, the designers felt strongly that a "precast" solution would give the desired quality of finish and deliver the fine details they wanted to achieve.

Although this decision is usually made during the procurement stages, and often contractors find alternatives to the original design later in the process, in this case the designers had undertaken sufficient analysis to secure a precast solution, combining both post-tensioned and prestressed methods. Arches were precast on the bank and manoeuvred into position by a purpose-built crane, to be tensioned into position. The Salé Viaduct (which is a simple repetitive structure with 28-metre spans of the same geometry) was procured separately and used as a pilot to test the quality of finish and precasting. The nautical bridge portion was cast in place.

4. Building services, site utilities

As this is a bridge structure, this section is covered within other parts of the report.

D. Origin of

1. Origins of materials, technology and labour

In terms of materials the project was able to use locally sourced concrete where in-situ concrete was specified, with formwork manufactured by local artisan furniture makers. The contractor SGTM also used local labour to construct the bridge, with up to 1,000 operatives active on site at its peak.

However, the decision to "prestress and post-tension" the bridge (a decision which the form geometry and design forces demanded) required the contractors to source the expertise of specialist consultants Freyssinet from Europe.

2. Origin of Professionals

Architects:	Marc Mimram Architecte, Paris, France
Engineers:	Marc Mimram Ingénierie, Paris, France
Contractors:	SGTM: Casablanca, Morocco
	SOGEA Maroc: Morrocan subsidiary of a French company (for the Salé Viaduct)
Consultants:	Egis JMI
	LPEE, CID, Casablanca, Morocco
	Corrosion Engineering, Switzerland

V. Construction Schedule and Costs

A. History of project design and implementation, with dates

International competition:	late 2005
Project's attribution:	late 2006
Project design:	2007
Building:	2008–11

B. Total costs and main sources of financing

Approximate total:	100 million EUR / 130,679,941.58 USD
Hassan II Bridge:	45 million EUR / 58,810,044.95 USD
Salé Viaduct:	30 million EUR / 39,201,418.58 USD
Nautical Base Bridge:	12 million EUR / 15,680,567.43 USD
Abutments, platform and cliff reinforcement:	13 million EUR / 16,987,281.39 USD
Financing:	Government of Morocco

C. Qualitative assessment of cost

The costs provided by the team are as above. As is often the case, one cannot be absolutely certain, but I have seen in print that the cost may have been closer to 190 million EUR (248,314,714.95 USD). My opinion is that current costs of such structures in Africa are in the order of 4,000 to 6,000 EUR (5,227.68 to 7,840.55 USD) per square metre. Finance was provided by the state.

D. Qualitative analysis of costs (per square metre, per unit, etc.)

Hassan II Bridge:	2,800 EUR/m²	(3,658.97 USD/m^2)
Salé Viaduct:	2,300 EUR/m²	(3,006.55 USD/m^2)
Nautical Base Bridge:	2,400 EUR/m²	(3137.25 USD/m^2)

E. Maintenance costs (heating, cooling, etc.)

Financing: Government of Morocco

VI. Technical Assessment

A. Functional assessment (use)

On the whole, the tramway and carriageway are functioning successfully, and the construction is of high quality in relative terms.

On two mornings between 7 am and 9 am, I did, however, observe a lot of slow-moving traffic crossing the new bridge. The client has explained that the primary cause of this is due to the success of the bridge, which is attracting too much traffic as citizens bypass other crossings. I understand that this is a temporary situation as more infrastructures, including another new bridge, are being added to the system.

The curvature and drop of the carriageway as it descends into the Rabat bank is severe; this is forcing traffic, and in particular buses, to slow down. It is likely that this unforgiving geometry was due to a last-minute change in levels in order to cut costs.

B. Climatic performance, lighting, discharge and rainwater

The design and construction were executed with great care to cope with the climatic conditions, and robust finishing that can cope with high surface temperatures together with well-detailed rainwater gutters and drainage systems have been provided.

It is also very clear that the natural light to the underside has been well considered. However, the night lighting seemed to be incomplete not only in terms of usability but also in terms of maximising the potential of the structure as a focal point.

C. Environmental response; adaptation to the natural environment; adaptation to native flora and fauna, seismic and climate change

The combination of the form and orientation of the bridge means that natural light levels change with every hour of sunlight, providing unique reflections and colours. For such a long bridge I believe this was successfully handled by the designers.

Flood levels and potential variations due to climatic change have been taken into account in the design.

For a structure of this length and shape it was essential to undertake a very detailed analysis of the potential impact of seismic activity. The dual challenges presented by the nature of this complex structure and the lack of Moroccan seismic design standards led to a specific analysis. The loads and

findings of this study were provided to the designers who undertook an independent "peer review" and accounted for seismic loads. European codes of practice were referenced in parallel with incorporating the specific study. The response to seismicity was made more complex by the asymmetry of the structure and its use of a prestressed, post-tensioned design.

The general quality of the waterway under the bridge and the immediate banks of the river appear to have improved when compared to the photographs taken prior to the construction of the bridge.

D. Durability and ageing

There is some confusion as to the design life of the bridge. I understand that at the outset a 100-year design life was prescribed, as is common for large infrastructure projects. However, this would have probably required stainless steel reinforcement and cables to support the structure, and potentially thicker structural sections. From the drawings it appears that stainless steel was not used in construction; I understand that this was a value engineering decision, but it leaves some uncertainty as to the structure's durability.

VII. Users

A. Description of those who use or benefit from the project

The citizens of Rabat and Salé generally appreciate this aspect of the project, and are more critical of the Bab al-Bahr district as this has increased property values around the bridge to the detriment of less affluent citizens. The tramway over the bridge appears to be extremely popular in achieving its objectives, and once regulated in the long term, the vehicular flow can only be of benefit.

B. Response to project by clients, users, community, etc.

It seems that the project is regarded as a success overall, as confirmed by everyone I managed to speak to, and that the initial concept of high quality has been delivered. My understanding is that the client and administration are also very satisfied with the outcome. The project has been published widely as an exemplar, both in a number of technical journals and in more general media. Comments include:

- unique, eye catching, good for Morocco and Africa;
- well blended with the surrounding landscape and medinas;
- modern, spacious, fast and efficient;
- gives Rabat-Salé a new symbol and reinforces the identity of the capital;
- some critical remarks, particularly from citizens on the Salé side, point out that traffic jams still occur.

VIII. Persons involved

A. Identification of project personnel and their roles in the project

Client:	Agence pour l'Aménagement de la Vallée du Bouregreg
	Lemghari Essakl
	Saïd Zarrou
	Nada El Kasmi
Project Manager:	Marc Mimram Ingénierie SA
	Marc Mimram
Engineers:	Jacques Durst
	Razvan Ionica
	Arnaud Delugeard
	Laurent Becker
Architects:	Nathalie Kreib
	Aldo Turchetti
	Sergio Pauletto
	Nicolas Videgrain
	Fabien Mauduit
Associate Project Manager:	CID (Conseil Ingénierie Développement)
Construction:	SGTM (main bridge, nautical base bridge, abutments, cliff reinforcement, tram access)
	Ahmed Kabbaj, Director
	Serge Bisson, Project Director
	Youssef Kriem, Project Director Assistant
Detailed design:	Hassan II Bridge: Egis JMI (Michel Duviard)
Nautical Base Bridge:	T-Ingénierie (Jean-François Klein)
	Freyssinet International (Jean Pierre Buys)
	SOGEA (Salé Viaduct and tram platform under Rabat's cliff)
	François Panafieu
	Arnaud Warcholak
Detailed design:	SECOA (Bertrand Lenoir)

B. Contact

Client:	Nada El Kasmi (elkasminada@gmail.com)
Project Manager:	Marc Mimram
	Jacques Durst (jacques.durst@mimram.com)
	Valérie Barry (valerie.barry@mimram.com)

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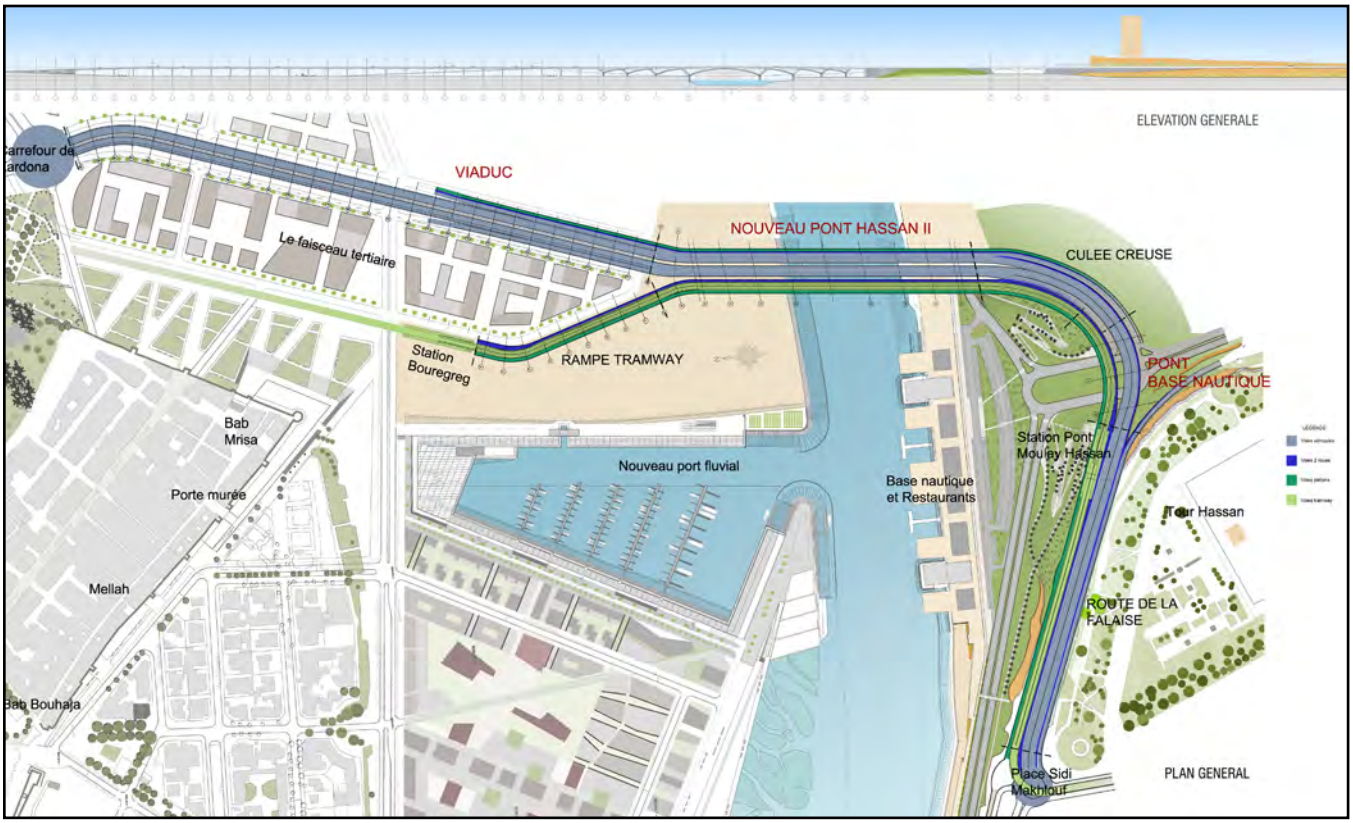
April 2013

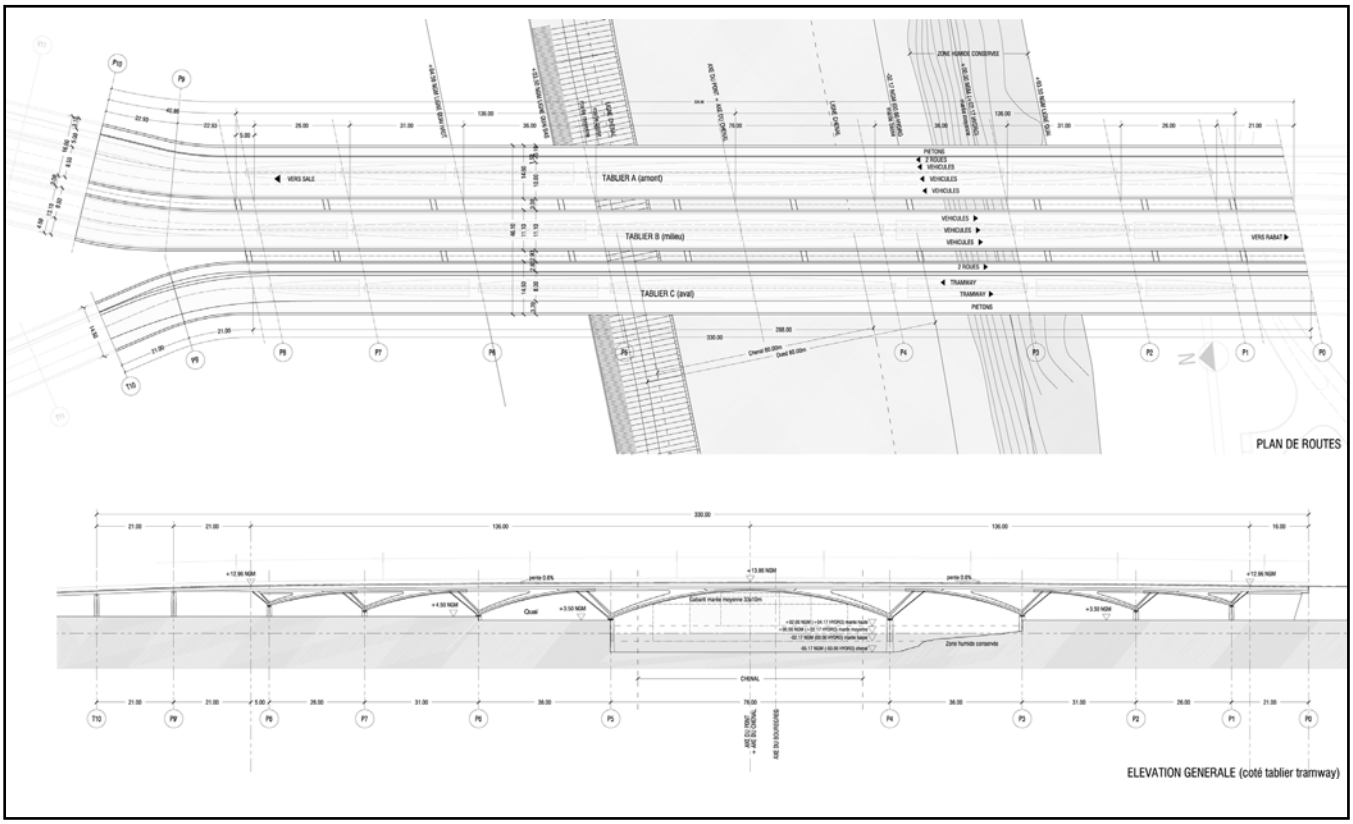

Rabat
MOROCCO
ALGERIA
MAURITANIA


LES OUDAYAS
CITE DES ARTS ET METIERS
LE FAISCEAU TERTIAIRE
VIADUC DE SALE
PORT FLUVIAL
OUED BOUREGREG
NOUVEAU PONT MOULAY HASSAN
AMENAGEMENT DE LA FALAISE
TOUR HASSAN
PLAN DE SITUATION
ECHELLE 1/10000



Site plan.

Road plan and bridge elevation



The Salé Viaduct is a simple repetitive structure with 28-metre spans of the same geometry.

Slipways either side of the viaduct are independent structures.

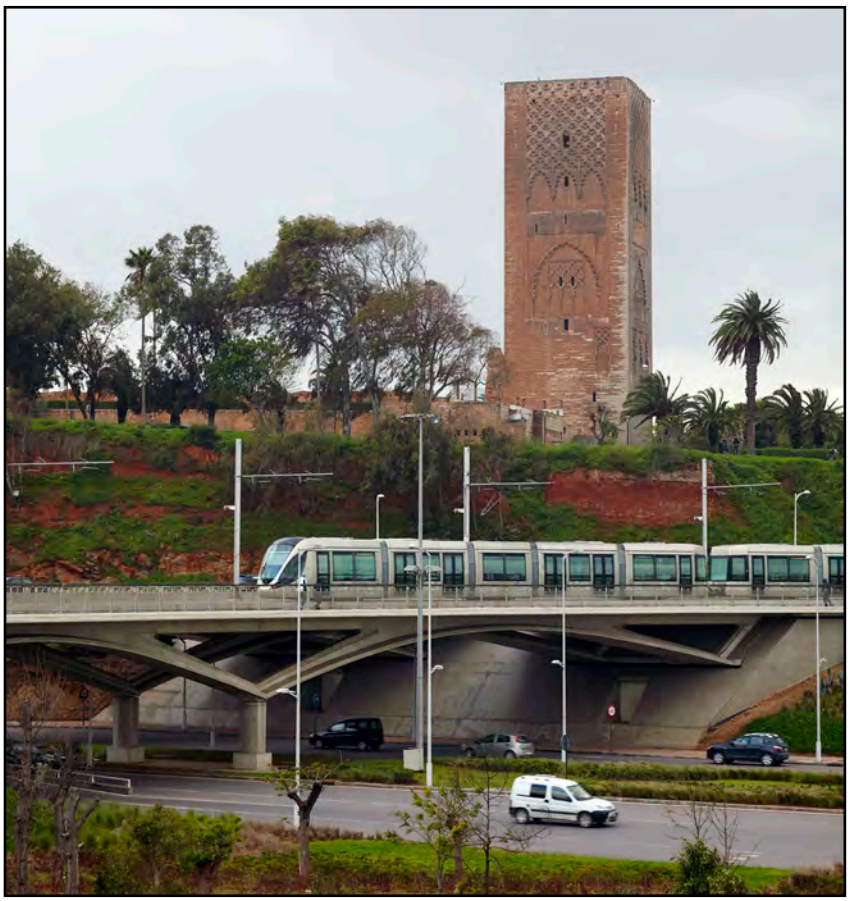
The central portion requires a 76-metre-clear span over the waterway and is formed by a traditional “arch” section that supports the deck.

Reinforced concrete was chosen as the primary material for structures.

Nautical base bridge, on the Rabat bank, curves on plan while descending.

This portion of the nautical bridge structure curves significantly and the “gaps” on the deck are removed to reunite the bridge into a single-width deck

Two tramway lines connect the cities of Rabat and Salé.



Each bank has prestigious historical sites, which include: on the Rabat bank, the Esplanade and Hassan Tower.