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ENHANCING HISTORIC METALLIC BRIDGES' REHABILITATION POLICIES IN EGYPT

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ABSTRACT

International trends towards historic metallic bridges are growingly shifted towards rehabilitation policies that go beyond the maintenance of their structural stability, to include promotion of their historic and engineering significance. As a major player in world's politics during the 19th century, Egypt possesses a significant legacy of historic metallic bridges across the Nile, mostly built by internationally renowned engineers and major firms in metallic bridges constructions. Through archival research, the present work highlights the significant asset of historic metallic bridges in Egypt, and through case study analysis, the study assesses current Egyptian rehabilitation policies in light of selected western attempts. Assessment is conducted to detect current shortcomings in historic metallic bridges local rehabilitation policies in Egypt, and hence propose a framework for enhancement and implementation.

KEYWORDS: Historic metallic bridges, rehabilitation policies of historic metallic bridges, industrial heritage, 19th and 20th century bridges in Egypt.

1. INTRODUCTION

The 19th Century boom of industrialization and railway mania left behind a significant number of metallic bridges in most major cities around the world. Today, these bridges represent a physical manifestation of the great engineering achievement of the industrial period. Accordingly, international trends towards these structures are shifting towards applying rehabilitation policies instead of demolition [1-5].

During the 19th and early 20th century, Egypt witnessed a boom in the construction of metallic bridges, most of which supported the expansion of railways across the Nile [6]. Despite the significant number of historic metallic bridges built by prominent engineers and major metal bridges construction firms, current local protection mechanism is alarming on several levels. First, the strict maintenance system of historic metallic bridges in Egypt, does not put the historic or engineering

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significance of these structures into consideration; second, once one of these structures is doomed out of service, there is no guiding rule as to how to deal with it. Even in case of reuse of a metallic bridge in Egypt, no guiding rules exist for the intervention. This has led to the demolition or threatens of misuse of several significant bridges.

The present study is a qualitative research that aims, at shedding light on the status of historic metallic bridges of the Industrial Era in Egypt, and at assessing local rehabilitation policies to propose a framework for enhancement and implementation. Assessment is carried out by consulting selected western rehabilitation policies towards historic metallic bridges, and drawing rehabilitation framework parameters to be used as a benchmark for local policies assessment. The research relied on archival information to compile a preliminary list of historic metallic bridges in Egypt; then to assess current local policies, two cases of historic bridges were illustrated, analyzed, and an interview with the head of the Central Engineering Administration of Bridges in the General Authority of Egyptian Railways was conducted.

The paper is organized in four sections: the first briefly outlines the development of bridges in general and metallic bridges in particular; the second discusses selected western rehabilitation policies towards historic bridges; the third gives an overview of historic metallic bridges in Egypt; the fourth then evaluates adopted local rehabilitation policies towards historic metallic bridges in light of the analysis of the western examples, and proposes a framework for enhancement and implementation. The work is finally concluded by a brief overview of the study's propositions and findings.

2. HISTORIC DEVELOPMENT OF METALLIC BRIDGES

Bridges construction is probably the field that illustrates at the best, the progress of structural intuition in ancient times, and the structural and architectural engineering development over the centuries. Bridges can be classified by both, type and period [7]. Types of bridges include: the arch; the simple beam; the suspension; the cantilever; and the truss type. Bridges can be also classified through six periods, namely: the pre-Roman Era; the Roman; the Middle-Ages; the Renaissance; the period

between the 18th and first quarter of the 19th Century; and finally, the Modern Period, linked with the Industrial Revolution and the advent of railways construction starting 1830s. This period exhibited the utilization of all types of bridges and the perfection of the truss-type bridge [7].

During the Industrial Period, the development of the new materials, such as iron, cast-iron, wrought-iron, and steel, allowed the introduction of new building types including modern covered markets, factories, and railway terminals. They were also used in large structures such as warehouses and libraries. The Crystal Palace by Joseph Paxton provided an outstanding example of the use of cast iron and glass in Exhibition Buildings [8]. The new materials also revealed a curious debate between 19th century architectural trends and the newly offered structural possibilities [9-10]. However, their use was widely accepted for the construction of utility structures such as bridges.

Early iron bridges, made of cast-iron, were of the arch-type, imitating stone bridges. The oldest surviving cast-iron bridge is the Ironbridge at Coalbrookdale (1779), by Abraham Darby [11]. It is currently a UNESCO World Heritage Site representing an iconic feature of the Industrial Era [12]. An early example of wrought-iron bridges is a footbridge in Durham County [11]. The first steel bridge (bolted, riveted) is Forth Rail Bridge (1890), while the first steel (welded) bridge is Billingham Branch Bridge (1930) [13]. Mass production of cast-iron could only be achieved after Darby developed the use of coke to smoke iron [12]. Later on, wrought-iron could be obtained through Cort's Puddling Furnace [14]. In 1856, Bessemer developed the process to produce steel, through the Bessemer converter [15]. The development of metallic materials, coupled with the railways mania during the 1840s, led to a worldwide boom in metallic bridges construction. Several bridges examples became iconic landmarks in their cities. Famous bridges designers, including: Telford; Stephenson; Gustave Eiffel, among others.

3. SELECTED WESTERN REHABILITATION POLICIES

19th and 20th Century bridges represent a physical evidence of the leap in engineering construction of the Industrial Period. However, for many years, once one of these bridges was rendered obsolete, or its maintenance was found uneconomic,

these structures were usually regarded by local authorities as ‘old’, instead of ‘historic’ bridges. They were either demolished, abandoned or left for decay. Generally, this lasted until the preservation movements in the 1960s and 1970s in Europe and the United States, brought appreciation to the industrial heritage, including early metallic bridges.

This section focuses on rehabilitation policies towards historic metallic bridges in the US and the UK. These are selected as they were pioneers in metallic bridges construction within their territories and beyond, and because they have also developed a meticulous system for the protection of their legacy of metallic bridges in the present. The outcome here is to elicit key parameters to be used to assess the current rehabilitation endeavors of historic metallic bridges in Egypt, in the following section.

3.1. Rehabilitation Policies in the United States (US)

Concerns about historic bridges in the US followed the collapse disaster of the Silver Bridge in 1967. The tragedy was followed by the government report stating that 32,000 old bridges in the US are ‘termed unsafe’ [3], and in turn, by the government announcement of a replacement project of old bridges. Shortly after, the Historic American Engineering Record HAER was established in 1969. HAER organized a series of symposiums to highway officials and the public about the value and significance of historic bridges [3]. Attempts of HAER led that each state had documented the historic bridges in its territories, which led to listing or eligibility of listing for 8,000 bridges on the National Register of Historic Places NRHP [3]. The Historic Bridge Foundation HBF is another organization that is currently concerned with historic bridges in the US. It develops educational programs to promote awareness about the importance of these bridges; offers consultation for public officials; works on the elaboration of historic bridges databases, including the launch of a bridge finder application that enables users to locate historic bridges near their location; and offers also a step by step guide for lay people interested in saving historic bridges [16].

Historic bridges in the US are protected through scientific research programs and the solid legislative system. The National Cooperative Highway Research Program NCHRP is a research forum that addresses issues related to the State's Department of Transportation DoT. It presents practical solutions to related problems. It also provides assistance to practitioners in their assessment of historic bridges in the US. NCHRP clearly illustrates aspects of eligibility for a bridge to be registered in the National Register of Historic Places NRHP [1]. On the legal aspect, the National Historic Preservation Act, requires each State to have a long term preservation plan to historic bridges within its territory. This act also states that federal agencies have to consider the impact of their projects on listed, or eligible for listing, bridges [17]. In general, a property can be listed in the NRHP, according to its age, integrity or significance [18].

In case a historic bridge needs intervention, it is the role of the State's Department of Transportation, on behalf of the Federal Highway Administration FHWA, to seek alternatives other than demolition. Alternatives include five options. The options, in order of descending preferences, are [4]: a) Preservation of the structure, and its rehabilitation to meet the original use; b) Rehabilitation for less traffic use on site; c) Rehabilitation for a less demanding use in another area; d) Closure and stabilization of a bridge when relocation option is not available; e) Partial reconstruction.

If the federal State cannot reuse a historic bridge, the FHWA requires it to be marketed. This means, making it available for individuals, groups, public entities to own it, under the condition of demonstrating financial capability of undertaking needed rehabilitation and maintenance works. While it is relatively difficult to reuse masonry or concrete bridges, metallic bridges are potentially reusable. They can be quite easily dismantled, relocated and reconstructed. In Pennsylvania, six bridges have been successfully marketed and reused in different locations throughout the State [5]. When a marketed bridge has to be transferred outside the federal State, the recipient is obliged to maintain the bridge following the Secretary of the Interior's 'Standards for Rehabilitation and Guidelines for Rehabilitation of Historic Bridges' [5].

When a bridge owner intends to undertake rehabilitation works on a specific historic bridge in the US, the rehabilitation project plans are submitted to the State's Department of Transportation environmental and design officer, for review, approval and recommendation to the State Historic Preservation Office, which in turn reviews the recommended project and highlights points of compliance and non-compliance with the Secretary of the Interior's Standards. In case any required modifications, comments are returned to the owner/engineer, who resubmits the project after making the necessary changes. The cycle continues until the proposed project meets the standards [4]. Within this process, a dialogue between the designers and the historians, specialists or experts is essential to provide a project that respects the historic significance of the bridge [4].

3.2. Rehabilitation Policies in the United Kingdom (UK)

In the UK local and institutional awareness of the significance of historic metallic bridges have a long history. Three selected cases are highlighted: the replacement of Rennie's Waterloo Bridge in London (1930), raising several controversies; the proposal to demolish Telford Conway suspension bridge (1958), reversed due to international outcry; and the saving of Billingham Branch Bridge - linked with early railways lines, and one of the first to show welding technology - after being scheduled for demolition when the railway line became redundant [13]. In 1968, the Institution of Civil Engineers ICE established the Panel for Historic Engineering Works PHEW, which works on documentation and promotion of structures civil engineering significances [19]. The outcome was the publication of five volumes of Civil Engineering Heritage, and an annual award for conservation and repair of bridges over 30 years old [13].

In the UK, bridges can be protected by being listed for their architectural or historic value or by being scheduled as of national archaeological importance. Criteria for listed structures are less restrictive than those scheduled. In some cases, a bridge can be both listed and scheduled. In this case, the requirements for the latter take

precedents [13]. Bridges located within a conservation area are protected by conservation area legislation without necessarily being listed or scheduled.

In general, operating bridges in the UK are usually listed not scheduled. Undertaking repair works that do not alter the character of a listed bridge, can be carried out by specialised authorities, without consent for repairs, however, any works of alteration, extension or demolition, can only be implemented after applying to and getting approval of the Secretary of State [13]. In England, there exist some 525 bridges scheduled as Ancient Monuments, and some 6,325 bridges as listed structures. Moreover, Britain also has some 17 UNESCO World Heritage Sites, many of which encompass some fine bridges including the Ironbridge Gorge, Edinbrugh, and the City of Bath. Having a listed setting, helps in securing funds for conservation [13].

3.3. Rehabilitation Framework Parameters

From the previous discussion, six major parameters essential for the rehabilitation of historic metallic bridges are deduced. First raising awareness targeting both local authorities, decision makers and the public is essential to stimulate the protection of these structures. Second, legislations and listing issues are important to provide a legal support for the protection and to allow better opportunities for funds. Third, documentation and research are important to document the existing condition of bridges and prevent deterioration through interventions solutions to solve their pressing problems. Fourth, regular preventive maintenance is important to expand the life time of historic structures. Fifth, identification of intervention responsibility and procedures are important. Sixth, securing funds for the protection of historic bridges is essential for any intervention to be undertaken. It is useful to seek creative funding mechanisms that might include public or private funds, or a collaboration between both.

4. HISTORIC METALLIC BRIDGES IN EGYPT

The 19th Century marked a turning point in Egypt's modern history. It was during the first half of that century, when Egypt was transformed from Medieval to Modern country [20], and during its second half railways contract was signed between

Egypt and Great Britain [21]. Railways ran on Egyptian lands in 1854 making Egypt the 1st in Africa and the Near East, and the 25th country worldwide to operate a railway system [21]. The first proposal by R. Stephenson, the celebrated English Railway Engineer, was a direct line from Alexandria to Cairo to the west of Rosetta Branch, to be followed by another line from Cairo to Suez. However, A. Helmi, the ruler of Egypt, insisted that the line crosses through the Nile Delta to serve Egyptian cities in the Delta and improve the local economy [21]. Fig. 1 shows the first line between Cairo and Alexandria, as first proposed by Stephenson, versus the implemented line. Having the railways crossing the lowlands, and the several watercourses of the Delta, required major engineering works, among which the construction of metallic bridges across the Nile [21].

The first line was executed through the Delta, on two phases. The first line from Alexandria to Kafr ElZayat (on Rosetta Branch), inaugurated in 1853. The second line from Kafr ElZayat to Tanta in the middle of the Nile Delta region, crossed Bahr Sherbin waterway, and Damietta Branch at Banha, then headed to Cairo as shown in Fig. 1. This line was inaugurated in 1856. This trajectory enforced the construction of three bridges as a start. Two of which were considered as “the most modern and scientific constructions of the world” [22]. Today there exists a number of major masterpieces railway historic metallic truss bridges over the Nile, including: Imbaba, Banha, Kafr ElZayat, Mansoura, Zefta, Kanater, Dessouq, Edfina, ElMarazik, Nag’ Hammadi and Gerga; and also many smaller historic railway bridges built over Nile branches, canals and irrigation drainages. Fig. 2, shows Mansura, Nag’ Hammadi and Zefta Bridges as examples.

Fig. 1. First Cairo - Alex. Railway Line: the Proposed, versus the Actual Line [21].

Throughout the second half of the 19th and the first half of the 20th century, European contractors found a rich ground for work in Egypt. Nationalities of contractors included British, French, German and Belgians [21, 23]. The Khedieve Ismail Bridge (now Qassr ElNile) was built by Linant de Bellefonds with the participation of France's Five-Lilles Company (1869–1872) [24]. When the bridge became unsuitable with the advent of motor cars, retrofit works were undertaken by Cleveland Bridges & Engineering Co. (1913). The bridge continued in operation until 1931, when it was dismantled and replaced with another arch-type steel bridge by DormanLong, the company of the famous Sydney Harbor Bridge [24]. Daydé et Pillé built the Old Imbaba Bridge (1889), and the bridge between Talkha and Mansoura (1891). Levallois-Perret, another French company, built Nag' Hammadi Bridge in Upper Egypt. Nouguès, Kessler and Co. built the bridge of Dessouq in Lower Egypt [23]. Other metallic bridges of great significance include the Gustave Eiffel's suspended bridge in Giza Zoo (1875-1879) and Ellamoun Bridge (Kobri elLamoun) (1914) among others.

Fig. 2. a. Mansura, b. Nag' Hammadi, and, c. Zefta Bridges [6].

Currently, there exists no comprehensive list of historic metallic bridges in Egypt. The author compiled, from various sources, a preliminary list of historic metallic bridges constructed throughout the second half of the 19th century and the first half of the 20th century [6, 21, 25, 26] as shown in Table 1. The list aims to show the rich asset of bridges of this period, showing the construction date, location and designer, whenever available.

Table 1. List of Historic Metallic Bridges in Egypt [6, 21, 25, 26].

Bridge Name	Const. Date	Location	Designer / Company
Birket ElSab' Bridge	1853-55	Birket ElSab'	Stephenson - Wild
	1856		La Industriale Italiana

Bridge Name	Const. Date	Location	Designer / Company
Banha Bridge and New Banha Bridge	1853-55	Banha	Stephenson – Wild
	1894		La Industriale Italiana
	1931-3		
Kafr ElZayat Bridge	1859	Kafr ElZayat	Stephenson - Wild
	1897		La Industriale Italiana
Qassr ElNil Bridge	1869-72	Cairo	De Bellfonds and Fives-Lille
	1930		DormanLong Engineering
Old Imbaba	1889	Imbaba	La Maison Daydé et Pillé
Old and New Mansura Bridge	1892	Mansura	La Maison Daydé et Pillé
	1912-13		Baume et Marpent
Old and new Nag'Hammadi bridge	1896-97	Nag'Hammadi	La Maison Levallois – Perret
	1939		
Old and New Dessouq Bridge		Dessouq	Nouguès et Kessler
	1897-98		La Maison Levallois – Perret
	1926-27		DormanLong Engineering
Zefta bridge	1904-06	Zefta	La Maison Daydé et Pillé
AlQanater three bridges	1907	AlQanater	La Maison Daydé et Pillé
Abshan Bridge	1907	Kafr Sheikh	
Abbas Bridge	1908	Cairo	William Arrol & Co.
Malek ElSaleh bridge	1908	ElRoda	William Arrol & Co.
Mohamed Ali Bridge	1908	Cairo	William Arrol & Co.
Boulaq Bridge	1908-12	Boulaq	Fives-Lille and Scherzer
Zamalik bridge	1908-12	Zamalik	Fives-Lille
ElSanaei Bridge	1909	Imbaba	
Galaa bridge	1914	Cairo	Cleveland Co.
New Imbaba Bridge	1924	Imbaba	Egyptian Railways Authority
ElHamoul Bridge	1925	Kafr Sheik	
Damietta Bridge	1927-29	Damietta	Baume et Marpent
Aboul Sha'sha' Bridge	1927	Dessouq	
Gerga Bridge	1930	Gerga	
Edfina bridge	1931	Edfina	Cleveland Bridges Co.
AlFerdan Bridge	1942	Ismailia	
Marazeek Bridge	1954	Helwan	

Though the first half of the 20th century was a continuation of the construction boom of metallic bridges in Egypt, the last decades of the same century witnessed negative trends towards historic bridges. With the expansion of Egyptian cities, and lack of awareness of the significance of these structures, in many cases, local

authorities dealt with historic metallic bridges as a burden rather than an asset and valuable structures. Two selected case studies are briefly presented to outline and justify this argument.

4.1. Boulaq Bridge, Cairo (1908-1912)

Boulaq Bridge (1908 -1912), was designed by the French company Fives-Lille with the cooperation of the American Engineer, D. Scherzer, who designed the movable unit, a bascule bridge that opened vertically [6]. The 274.5 m long, and 20 m wide Bridge, served pedestrians, vehicles and the tramway [6]. A special lecture was given at the YMCA after its inauguration focusing on the rolling bascules and locking mechanism, connoting the specialty of the opening mechanism [27]. However it stopped functioning few years after inauguration due to technical problems [6].

In 1990s, authorities believed that the bridge impedes the exponentially increasing traffic flow. With the construction of the 15th of May bridge, (a 4.5 kilometers long concrete bridge), Boulaq bridge was not included in the adopted new road network and traffic management projects, and hence, the decision was to remove it in 1998 [27]. The bridge was dismantled and stored on the Nile bank, under Rod ElFarag Bridge. Currently, the parts remain dismantled, some are rusted, others damaged because of the poor and long storage, see Fig. 3. In 2008, a competition organized by the Ministry of Culture to reuse the bridge, entries refereed and winners announced. Implementation of the successful proposals was delayed, to be abandoned by the related institutions to date.

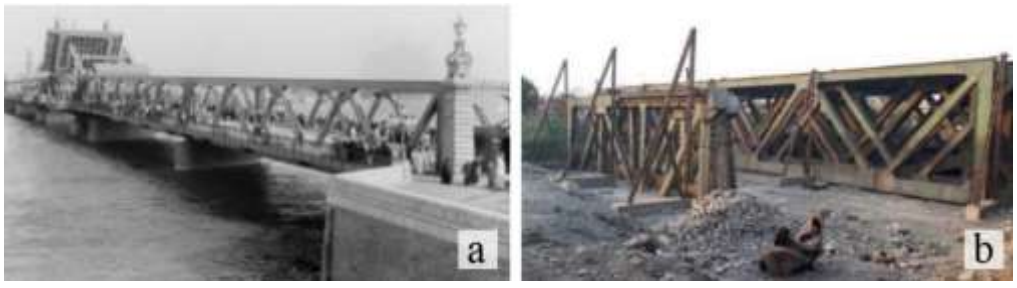


Fig. 3. a. Boulaq Bridge before Dismantling, b. Boulaq Brige after Dismantling, Author's Collection.

4.2. Damietta Bridge, Damietta - Old Imbaba Bridge, Cairo (1889)

The historic bridge in Damietta is the same originally constructed in 1889, in Imbaba, Cairo, designed by Daydé et Pillé. The original bridge in Imbaba included a

single railroad track deck of 495 m length, carrying up to 72 tons carriages and flanked with two passages for vehicles and pedestrians [28]. It provided the link between Lower and Upper Egypt trains' network. Before its construction, trains stopped to the west of Cairo, at Imbaba, and passengers crossed the river by boats to reach Cairo [28]. The bridge consisted of six fixed and one movable units. The latter was 60 m in length, rotated on a pivot, creating a 30 m cantilever from each side, an achievement at this time [28]. With the growing need for a double railroad track bridge in Cairo; in 1912, the Governorate started to build a new bridge to the north of Imbaba Bridge, to carry carriages of up to 131 tons. The then new bridge was inaugurated in 1925 [6].

Parallel to the construction of the new Imbaba Bridge, Damietta City, North East Delta, was in need for a bridge to serve vehicles and pedestrians movement from the railway station, instead of the inconvenient transportation by ferry boats. The solution was to transport to Damietta the movable and three of the fixed units from old Imbaba Bridge to be used as the needed cross link. The relocation and reinstallation of Imbaba old bridge to Damietta took place from 1927 to 1929 [6]. From this point on, the bridge was accepted as Damietta Bridge, and remained for years, a main landmark in the city.

By the beginning of the 2000s, the bridge was considered a burden for local authorities in Damietta; first, it was too narrow to take the increasing flow of cars. Second, it was blocking the river traffic, as the movable segment became dysfunctional due to poor maintenance. Thus, in 2003, Damietta Governorate announced a bid to construct a new concrete bridge to replace Damietta old bridge. The removal of the old bridge was considered a costly burden for the national treasury. Thus, local authorities approved the selling of the old bridge as scrap for a total of L.E. 200,000 [28].

When the scrap merchant started to dismantle the bridge, one of the three fixed segments collapsed and sank in the river. This incident coincided with assignment of a new governor to Damietta Governorate; an architect who recognised the value of the historic bridge. He ordered to stop the cutting and launched a reuse project for the movable segment. The segment was used as a cultural venue for arts, affiliated with a

public library located along the Nile in Damietta. As shown in Fig. 4, the 230 tons unit was transported down the river, to its new setting by carrying pontoons [28]; as for the other two fixed parts, that were not relocated, they remain closed and unused to date.

Fig. 4. a. The Movable Segment of Damietta Bridge during the Relocation [28]; b. The Remaining Fixed Parts of Damietta Bridge, photo by S. Sheweka.

The rehabilitation project of the movable unit aimed at providing an extension space to Damietta's public library; providing exhibition spaces and a flexible multi-purpose space. The design deployed appropriate materials and finishes, complementing the historic structure and reflecting the spirit of the time of the intervention. An outdoor piazza, directly connected to the river, was designed to complement the proposal. The mechanism of opening the movable part was used as part of the exhibition, so did the original drawings and other authentic documents related to the first relocation of the bridge from Cairo to Damietta [28]. Sadly, the project was vandalised and looted during the 2011 uprisings, and remained abandoned since as shown in Fig. 5.

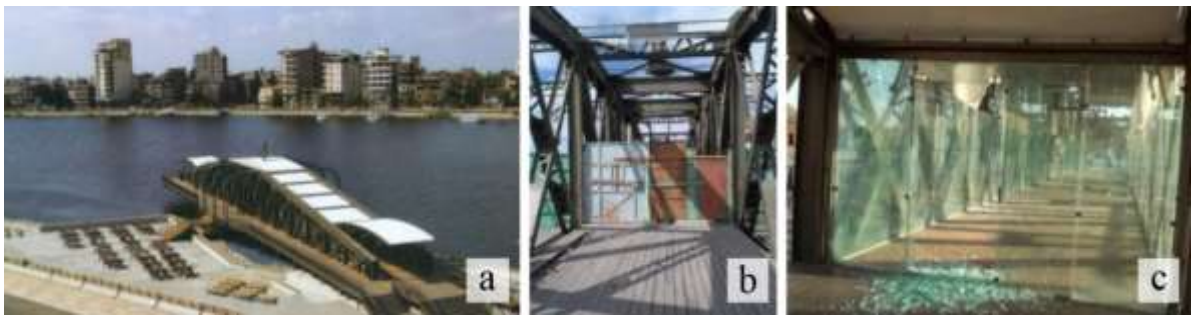


Fig. 5. a. Damietta Bridge Rehabilitation Project [28], b. and c. the project's Current Status [29].

5. LOCAL REHABILITATION POLICIES - EVALUATION AND FRAMEWORK FOR ENHANCEMENT AND IMPLEMENTATION

In this section, the paper assesses local policies towards historic metallic bridges rehabilitation in light of the discussed western rehabilitation policies. The six

parameters of rehabilitation deduced in section 3, are here used to build upon the proposed framework for enhancement and implementation.

Awareness raising programs: in Egypt, the industrial heritage in general attracts less appreciation in comparison with more ancient heritage. It is important to raise the awareness of both local authorities and the public about the importance of the protection of this heritage. Similar to the role played by HAER and the HBF in the US or ICE in the UK; it is important to create or assign a body that includes historians, architects and engineers, among other specializations to work on the promotion of the significance of protection of industrial heritage in general and this type of structures in particular.

Legislations and listing: In Egypt, buildings and structures can be listed under one of three laws. Monuments are registered according to the Antiquities Law no. 117/1983 [30]. Buildings and structures with significant architecture or linked with the national history or with prominent figures or that belong to a significant historic period, can be registered according to law no. 144/2006, regulating the Demolition of Non-Dilapidated Buildings, and the Preservation of Architectural Heritage [31]. Finally historic areas of value can be listed according to the law 119/2008 [32]. The three laws, and statutes provide a comprehensive framework for rehabilitation policies, plans and actions, but the problem mainly lies in the application of legislative procedures and related actions. Though a large number of historic metallic bridges are nationally eligible for listing, to date, only two bridges are listed according to law 114/2006. The two bridges are Qassr ElNil Bridge, Cairo and AlGalaa' Bridge, Giza and Cairo. According to law 119/2008, only six areas are designated of value in Cairo. Outside Cairo only Alexandria and Port-Fouad include designated areas of value.

Documentation and research: No documentation programs exist to document existing structures' historic and current conditions in Egypt. Supporting documentation and research towards specific types of structures is an important component to support their rehabilitation. Unlike the case of the National Cooperative Highway Research Program in the US and the Panel of Historic Engineering Works in the UK, there

exists no responsible body concerned with the documentation, research and investigation of historic metallic bridges, and all their related problems.

Regular preventive maintenance: Currently, the maintenance of metallic bridges in Egypt falls under the jurisdictions of one of three authorities: a) Railway metallic bridges are maintained by the General Authority of Egyptian Railways GAER; b) Roadway metallic bridges on highways, are maintained by the Bridges Department in the General Authority of Roadways and Bridges BD/GARB; c) Metallic bridges inside cities, are maintained by the Roadways and Bridges Section in local Governorates RB/GOV. In an interview conducted by the author in 2019, with the Head of the Central Engineering Administration of Bridges in GAER, the same maintenance program - primarily concerned with the preventive measures of bridges to secure standard performance and extend their lifetime - are carried out to historic and new metallic bridges alike. Though these measures are met, the nature of historic metallic bridges calls for special maintenance, procedures and routines. The western cases pointed out the importance of the dialogue between engineers, historians and architects in rehabilitation interventions of historic bridges; which is generally missing in current local intervention programs. Moreover, no clear guiding criteria exist to apply to those sensitive structures to guarantee the maintenance of structural stability on one hand and the historic and the protection of engineering significance on the other hand.

Intervention responsibility and procedures: though current local intervention responsibility and procedures to maintain the structural stability of bridges in service are clear, this is not the case for out of service bridges. Alternatives to demolition of historic out of service bridges are loose and undefined. Moreover, unlike the clear and strict process to be followed when a bridge owner intends to undertake rehabilitation works in the US, local procedures for adaptive reuse and rehabilitation of bridges in case of rehabilitation of a bridge for another use are not spelled out. This was behind the dismantling of Boulaq Bridge and the near demolition of Damietta Bridge, two of the oldest metallic bridges in Egypt. It can further threaten other significant historic bridges.

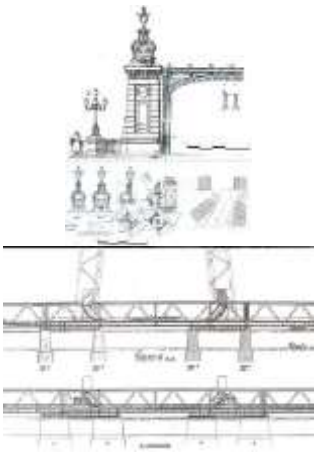
Fundraising: securing funds for heritage, monuments and settings protection is probably the hardest issue when financial resources are limited. Currently local funds are only allocated to maintain the structural stability of bridges in service, which is not the case for out of service historic (or of value) bridges; where no procedure or channels exist to finance restoration, maintenance and reuse. Thus, an old bridge becomes a burden for local authorities, especially when the cost of reconstruction of a new bridge is close to or even less than those of rehabilitation.

To overcome the above shortcomings, the study suggests the start with launching awareness programs by historians and conservation specialists affiliated to the National Organization of Urban Harmony NOUH, targeting local authorities and the public. This is to be followed by a survey of each and every historic bridge in each Governorate aiming to create a database for all historic metallic bridges in Egypt. The National Centre for Documentation of Cultural and Natural Heritage CULTNAT, under the supervision of the Ministry of Communication and Information, can be a good starting point for the launch of a national survey project. A proposed template to provide a bridge profile is presented in Table 2. The template shows the case of Boulaq Bridge as example. The same template can be used to document other historic bridges, when the urgently needed national survey project is launched. Smart systems can be employed to further enhance the data gathering and data entry processes.

Table 2. Proposed Guiding Bridge Profile, Boulaq Bridge as an Example.

	BOULAQ BRIDGE, CAIRO (1908-1912)			
Name	Boulaq Bridge			
Other names	King Fouad I Bridge, AboulEla Bridge			
Designer	Fives-Lille and Donald Scherzer			
Original location	Boulaq – Zamalik, Cairo			
Current location	Stored under Rod ElFarag Bridge, Cairo			
Setting	☑ urban ☐ natural			
Construction date	1908-1912			
Modification date	1998 (dismantling date)			
Used material	☐Cast-iron ☐wrought iron ☑steel			
Assembling technique	☑Riveted/ bolted		☐welded	
Total Length (meters)	274.5		Total width (meters)	20
Type of opening	Bascule bridge		Carrying capacity	--
Original purpose	☐railway	☑vehicles	☑tramway	☑pedestrians
Current usage	☐full	☐partial	☐closed	☑Dismantled
Comments on usage	--			
Structural condition	☐good	☐fair	☑poor	

Can be rehabilitated	☑yes ☐no			
Quality, significance	☑Historic/age ☑key events		☑prominent engineer ☑innovation	☐other
Responsible authority	☐ GAER	☐ BD/GARB	☐ RB/GOV	☑ Other

Historic drawings	Historic images	Status quo
	 	  

The database creation should be followed by listing all eligible bridges in national records. NOUH, and other national heritage preservation authorities, including the Architecture Committee at the Supreme Council of Culture SCC, and Cairo Heritage Preservation section in Cairo Governorate should issue standards guidelines for intervention. They should also elaborate alternatives for demolition, and be included in all major decisions affecting historic bridges. This must go hand in hand with proposition of creative funding mechanisms for the rehabilitation or reuse of historic bridges [33-34]. The study also suggests to create a section specialized in historic metallic bridges in each of the three responsible bodies for metallic bridges, namely: GAER, BD/GARB, and RB/GOV. The proposed sections must include both Engineers and, historians and conservation specialists, who must collaborate to apply the standards for intervention in historic bridges. Table 3 summarizes the proposed framework to enhance current policies adopted for the rehabilitation of historic metallic bridges in Egypt.

Table 3. Proposed local rehabilitation framework for historic metallic bridges.

Awareness raising programs	Targeting local authorities/ decision makers/ local community	Construction date - association with prominent builder/prominent company - innovation or rarity of design/ technology/ material/ construction process - relatedness with development of railways - association with significant events - integrity of the structure - other

		significance
Legal issues	Revisit shortcomings in laws/ statutes/ eligibility for listing/ definition of procedures	Law no. 117/1983, and statutes – Law no. 144/2006, and statutes - Law no. 119/2008 and statutes - other related legislations/ decrees/ regulations
Listing	Identify listing criteria	Local - regional – national – international listing
Jurisdiction / bodies/ authorities/	Authorities and Organisation	GAER - BD/GARB - RB/GOV - NOUH - Local Governorates – CULTNAT – SCC - others
	Ministries	Antiquities - Transportation – Culture - others
Procedures/ actions	Procedures	Documentation- Inventories - Rehabilitation guidelines- Evaluation- Conservation principles
	Actions	National survey project/ Listing/ Identifying alternatives to demolition/ Operation and maintenance/ Maintaining features and qualities
Funds	Economic viability/ selection criteria/ creative funding	Public/ private - National/ local/ international – Others

6. CONCLUSION

Historic metallic bridges enjoy growing international attention in terms of policies that promote their historic and engineering significance beside the preservation of their structural stability. Through consulting selected western rehabilitation policies of historic metallic bridges, the paper deduced six rehabilitation parameters, and used them to assess adopted rehabilitation process in Egypt. Though Egypt possesses a significant number of historic metallic bridges, mostly in operation; the study detected several shortcomings in local rehabilitation processes, collectively threatening the significance and survival of this asset. Shortcomings include; the shortage of documentation programs; the limited number of listed bridges in comparison with those eligible for listing; the lack of convenient maintenance and routines respecting historic significance; the lack of clear, spelled out alternatives for demolition for bridges that go out of service; and finally, the shortage of funds supporting rehabilitation of out of service bridges. The paper suggested a framework to enhance local rehabilitation of historic metallic Bridges and proposed a guiding tool to document bridges profile that can be elaborated and employed when a national survey project is launched.

DECLARATION OF CONFLICT OF INTERESTS

The author has declared no conflict of interests.

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دعم وتطوير سياسات إعادة تأهيل الجسور المعدنية التاريخية في مصر

يهدف البحث إلى عرض تُراث مصر الغني من الجسور المعدنية والتي تم بناء العديد منها من قِبَل مهندسين دوليين أو شركات كُبرى. وتسعى الدراسة لتقييم سياسات الحفاظ المحلية في ضوء السياسات المُتبعة عالميًا تجاه جسور فترة الثورة الصناعية وما بعدها. وذلك لتحديد أوجه القصور التي قد تُهدد حماية هذا الإرث التاريخي ومن ثم عرض لاقتراحات دعم وتطوير سياسات إعادة تأهيل الجسور المعدنية التاريخية محليًا.