

Concrete bridges design assessments and its relationship with the surrounding space

Assist. Prof. Dr. Akram Farouk
Ain Shams University
Faculty of Engineering
Department of Architecture
Cairo, Egypt

Abstract:

The government of Arab republic of Egypt seeks to solve the traffic problems in the capital and other major cities through creating multiple solutions for the traffic, with the beginning of the twenty first century many bridges & tunnels were constructed to solve the traffic problem resulting from the population growth and the increasing number of vehicles in the streets, Cairo & Giza cities traffic problems can only be solved through the establishment of bridges at key intersections, and therefore many concrete bridges were constructed in addition to constructing extensions to some of the already existing bridges. However, bridges are constructed without the preparation of complete engineering studies related too architectural & aesthetic studies to integrate the bridges with the general character of the surrounding space, this research paper aims to assess the design of concrete bridges to employ the design to integrate with the surrounding space.

Keywords:

Concrete bridge, Egypt, 6th of October bridge, Aesthetic architectural forms, Steel Bridge.

Introduction:

Population growth problem became one of the most important priorities of responsibility in order to solve them, especially the traffic problem caused by population growth and the increasing number of cars, where the government of Egypt sought to solve this problem through constructing several concrete bridges in most of the major areas in Egypt especially in Cairo & Giza.

However, most of these bridges are constructed with the same concrete structural systems & design. They differ slightly depending on the parameters of each region in spite of the presence of many structural systems & architectural forms which through we can create bridges beautifully integrated with the surrounding space and that because of the economic aspects of the project cost.

Current concrete bridges affected negatively on most of the spaces surrounding them on all levels (economical – environmental – etc.) particularly in the general form of the surrounding space.

Reasons for building bridges:

The bridge is a way for over passing water streams and crossing perpendicular roads by providing a clear passage for vehicles with shortened duration for traffic lights in busy intersections, and to determine the need for a bridge. A detailed study must be conducted according to the following considerations. (1)

1. Feasibility study.
2. Appropriate planning and topography study of the site.
3. Main traffic (Heavy traffic & Light traffic).
4. Road quality & their hierarchy.
5. Bridge harmony with the layout from an architectural & aesthetic perspective.

Bridge design elements:

All bridge standards & provisions must be applied on all the elements of the bridge. The following should be considered: (2)

(A) Plans:

- Horizontal curved lines design.
- Number of lanes and their width design.
- Expected number of vehicles & movement direction.
- Sidewalks & passages width.

(B) Elevations / Facades:

Bridge height & clearance under the bridge must be 5m at least plus 10cm clearance in anticipation of paving in the future.

- Columns & their form.
- Railings & fences (inside & outside) and the bridge handrails.
- Bridge slabs gastropods.

Types of bridges:

Bridges can be categorized according to **usage:**

1. Vehicle & pedestrian bridges.
2. Railway bridges.
3. Pedestrians only bridges.
4. (Pipelines, water, sewage lines, .. etc) bridges.
5. Temporary bridges.

And this research paper deals with vehicles & pedestrian bridges as many bridges of this type were constructed in Egypt in the late twentieth century and in the beginning of the twenty first century, that these bridges became a real harm to the surrounding space that it lacks integration with the surrounding space. (3)

Bridges can be categorized according to **construction materials:**

1. Concrete bridges including:
 - Cast on site concrete.
 - Precast concrete.
 - Pre-stressed cast on site concrete.
 - Precast pre-stressed concrete.
2. Steel bridges including:
 - Steel truss.
 - Steel beams.
 - Suspended steel bridges.
 - Concrete & steel bridges.
3. Concrete suspended bridges.
4. Steel & wooden bridges.
5. Stone bridges.

Also bridges can be categorized according to **shape:**

- Straight dorsal bridges.
- Curved dorsal bridges.
- Straight tunnel bridges.
- Curved tunnel bridges.

In spite of all the previous types, in Egypt the cast on site concrete bridges are the most wide spread type, and rarely other types are constructed, therefore only one type in Egypt is applied in most areas which is the concrete bridge with no regard to aesthetic additions that fit with the site parameters.

Fig. no. (1) Shows different bridges column cross-sections. Fig. no. (2) Shows different bridge slab shapes.

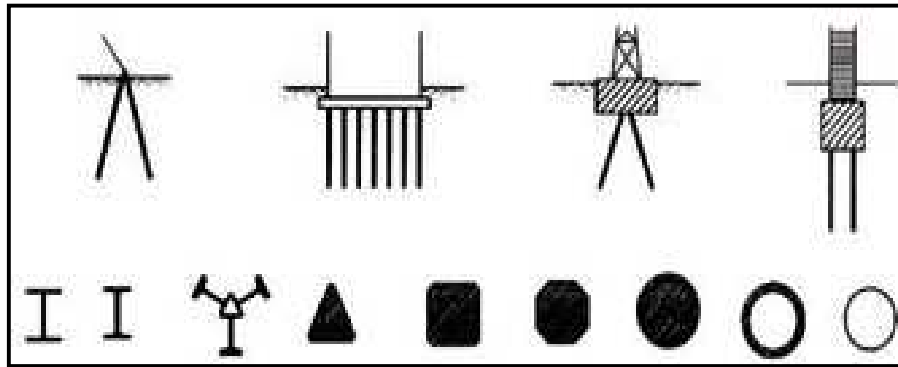


Fig.(1).shows different bridges column cross-sections.

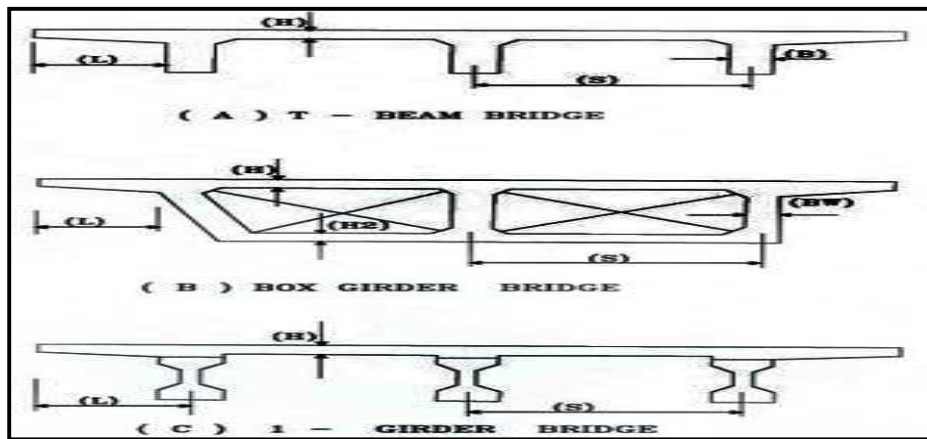


Fig. (2). shows different bridges slab shapes.

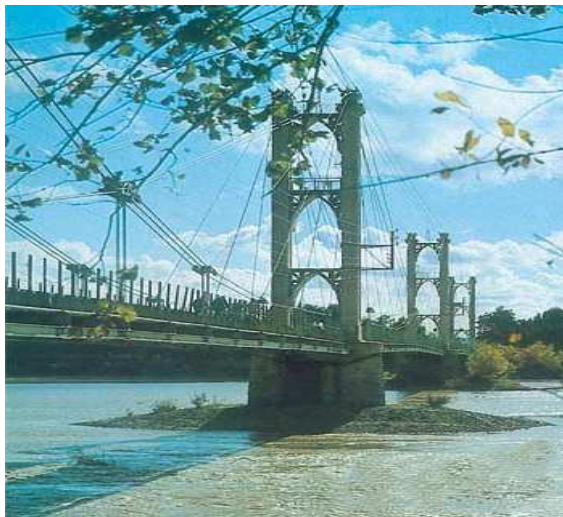
Where concrete bridges built newly in current space that already have its special architectural style and should be considered a fundamental reason to upgrade the surrounding space or vice versa.

Concrete bridges and its components (above the ground foundation – columns – concrete slabs – fences – light poles – sloping – etc.) are considered new elements in the surrounding space especially if the space has a character of its own.

Concrete bridge as a spatial element

Concrete bridge is considered an important element added to the current spatial configuration, where the bridge is designed by committees who depend on structural standards that fit the determinants of the site without studying architectural design factors that affect the surrounding space.

Concrete bridge is a spatial element that penetrates (residential, commercial, other cars roads, etc.) places, and in most cases it doesn't fit the general form with the surrounding space. Fig. no. (3) Shows some forms of bridges and



their relationship with the surrounding space and the impact of aesthetic design on the general form.

Fig. (3). show some forms of bridges and their relationship with the surrounding space and the impact of aesthetic design on the general form.

The impact of concrete bridges on the surrounding space Concrete bridges affect the surrounding space on all aspects either negatively or positively, as follows:

(A) Positive effects

- On the aspect of planning
The Concrete Bridge is considered from the basic elements of development & prosperity when constructed in some areas through the following: (4)
 - Achieving link between movement axes and divergent sides where it is considered a good development element.
 - A solution to traffic congestion problem and achieving traffic flow in crowded areas.
 - Increases activity in the surrounding area.
 - Provides opportunities for new investments.
 - Re-plans activities in the surrounding space.
- On the aspect of economics:
The bridge affects positively on economic development in some areas through the following: (5)
 - One of the best elements of economic development in some areas.
 - Achieves prosperity and financial activity in the surrounding area.
 - Causes some increase in the prices of some administrative and residential and commercial units.
 - Provides opportunities for new investments in the surrounding area.
 - Refreshes remote areas from city's movement axes.
 - Improves the surrounding area economically.
- On the environmental aspect:
The bridge affects the surrounding area positively in some cases as follows:
 - Saves many spaces which can be studied and made use of.
 - A bridge can put an aesthetic addition to the surrounding area if studied well.
 - Helps reduce air pollution caused by cars exhaust.
 - Reduces rates of noise pollution.
 - Achieves good visual composition to benefit from in the area.

(B) Negative effects

Implemented concrete bridges may also have some negative effects as follows:

- On the aspect of planning: (6)
The concrete bridge is considered a spatial element created in existing space, there are many negative effects including:
 - Failure to create a complete master plan for the relationship between the concrete bridge & the surrounding space, where the implementation of the bridge was to solve the traffic problem with no regard to the whole form.
 - Composition of unstudied spaces architecturally & on the urban scale.
 - Lack of standards that control using spaces surrounding the bridges especially spaces under the bridges that are not used architecturally.
- On the aspect of economics:
The concrete bridge represents an influential element regarding the economic aspects when constructed on all levels as follows:

- The bridge affects negatively on economic & urban project finances where some industrial or commercial project economics might be directly proportional to the concrete bridge site, where some administrative & urban project economics might be inversely proportional to the concrete bridge site, which may cause an increase in prices in some areas or a decrease in others depending on the nature of each area.
- The bridge is not considered an aesthetically pleasing element and a source of inconvenience to the surrounding space which might negatively affect the economics of some projects,
- On the environmental aspect:
Concrete bridges are considered a major cause affecting the surrounding environment especially that it's constructed to solve the traffic congestion without any regard to the side effects, which are: (7)
 - Considered a source of visual pollution, especially with the lack of planning & architectural solutions to overcome this pollution.
 - Considered a source of acoustic pollution.
 - Considered to have a negative impact on sanitation as it's a place for trash & garbage to pile up with the absence of cleaning services.
 - Lack of concrete bridges maintenance which made them source of pollution with all the accumulated dust & cars exhaust.

Examples to show the relationship between the concrete bridges & the surrounding space:

The 6th of October bridge:

It is considered one of the longest bridges in Egypt. Stretching from Dokki, in Giza governorate, to Nasr city in Cairo governorate it was implemented on 10 stages until now all from reinforced concrete with the same architectural & structural design. The design did not regard the differences between the areas it's going through. Fig. no. (4) Shows The 6th of October Bridge (Ramses st.), Fig. no. (5) Shows The 6th of October Bridge (Galaa st.).



Fig. (4). show some forms of bridges and their relationship with the surrounding space and the impact of aesthetic design on the general form.



Fig. (5). Shows The 6th of October Bridge (Ramses st.).

Where the concrete columns shape was not studied how they appear above the ground level in many areas, as well as concrete slabs gastropods making the bridge an element of visual, acoustic environmental and aesthetical pollution, because of the architectural studies for the bridge was not prepared to make the concrete bridge an integrated object with the surrounding environment. Some of its stages have been implemented two levels higher than the streets level in some areas.

The height of 6th of October Bridge is 6m high & 12m wide (over Galaa st.), the bridge is raised on 2 columns with repetitive span of 20m long, added to them a third steel column in the midpoint of the span carries a cantilever beam of 120cm of depth, in addition to the depth of longitudinal beams making the total depth to more than 2m, (column dimensions are 3.80m X 1.20m to the eastern side of the street).

Other parts of the bridge vary in width & height according to the available space, and parts of the bridge were designed 2 levels higher in Ghamra district, some parts of the bridge were attached using steel structures forming columns & slabs and using cantilever parts with the lack of consistency between the steel and the concrete parts, this bridge must be dealt with as a very effective element in greater Cairo and Giza, a specialized committee must be recruited to employ the bridge spaces and to change its features to cope with the new century.

Al-Azhar Bridge:

Al-Azhar Bridge was constructed to solve the problem of traffic jams in Al-Azhar area. It has been implemented on two levels; it was that most important bridge that made a traffic breakthrough in Al-Azhar area and (al-qahira al fatimia) but it had many negative impacts on the historical area which contains priceless historical buildings, also it affected the commercial movement in the area, Fig. no. (6) Shows the connection between the steel part & the concrete part of the bridge.



Fig.(6). Shows The 6th of October Bridge (Galaa st.).

Al-Azhar Bridge did not take into account many elements regarding the bridge levels and its relation with the surrounding buildings. The shape of the bridge & its columns don't fit with the surrounding space. Fig. no. (7) Shows the relationship between the bridge & the surrounding buildings. Fig. no. (8) Shows the relationship between the bridge & the surrounding bridge and the uses, the height of the other buildings.



Fig.(7). Shows the connection between the steel part & the concrete part of the bridge.



Fig. (8). Shows the relationship between the bridge & the surrounding buildings.



Fig. (9). Shows the relationship between the bridge & the surrounding uses.

Some environmental solutions to the concrete bridges:

There are many architectural solutions to the bridge elements. Some of these solutions can be applied through:
(8)

1. Selection of architecturally aesthetic solutions for the bridge slabs gastropods to add an aesthetic spirit to the space which depends on the structural system.
2. Column design to satisfy the structural aspects and use of architectural elements to match the style of each area and to make use of them in advertising materials, also to make the newly created spaces & surrounding elements look better.
3. Bridge side fences through using architectural forms that fit with the use & differs according to the givens of each region in addition to using other architectural solutions when needed to suit each surrounding space to add an aesthetic spirit to the space.
4. Study of the lighting systems under bridges, so as not to become a source of pollution and a place for garbage to pile up, and a place for squatters under the bridge.
5. The need to study the bridge levels and their relationships with the surrounding buildings & the vehicles using the bridge.
6. Using aesthetic architectural forms for the bridge in coordination with the structural aspects, some examples will be demonstrated for bridges with superior aesthetic & architectural form, also the structural system to give the aesthetic spirit to the surrounding space.

There are many architectural solutions that can be studied to make the concrete bridge with its elements a spatial object that makes it a good addition to the space. Fig. no. (9) Shows some of the aesthetic solutions to the concrete bridge elements.



Fig. (10). Shows some of the aesthetic solutions to the concrete bridge elements.

Study of the concrete bridge to serve the general form in space: (9)

1. Using the bridge sides to create ornamental shapes and artistic forms to give a new spirit in some areas and to re-study the shape of current bridges sides.
2. The need to add green areas on both sides of the bridge not to isolate users from the ground while adding an aesthetic form.
3. Bridge columns design with good aesthetic architectural forms that fit each of the areas the bridge goes through and it can be used as an advertising element.
4. Lighting design beneath the bridge carefully so as not to be a place for dumping garbage and waste collection.
5. Using the area beneath the bridge to provide services that fits the bridge shape and the surrounding space.
6. Studying the space between the bridge & the surrounding buildings to follow standards & theoretical rules to ensure high aesthetic quality in spatial configuration design.
7. Taking into account the privacy of the residential buildings where the bridge passes by using aesthetic elements to ensure privacy.

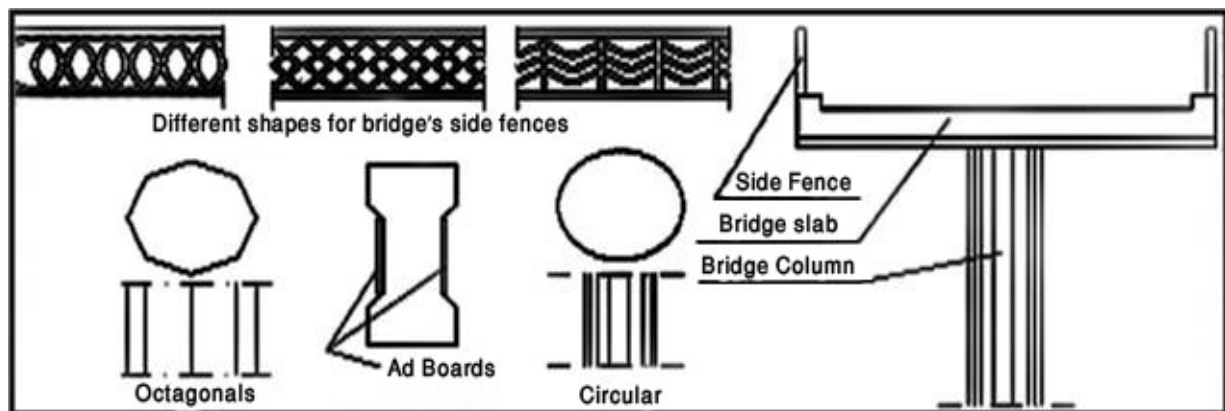


Fig. (11). Shows some architectural design to some of the bridge elements.

Conclusion & recommendation

Through the reviewed in this research paper, the concluded results & recommendations are as follows:

Recommendations regarding planning & architectural aspects:

- Forming an engineering specialized committee to review and to approve the bridge design.
- Setting provisions & engineering standards to control the ratios of the space that the bridge goes through.
- Case study for the area the bridge goes through to study the general form of space to fit the bridge with.
- The need to redirect the designers' ideas into constructing tunnels to suit the current urban congestion.
- Forming a specialized committee to study the attempt to create visual schematics for the areas around & under the bridges through specialized visual studies to solve the visual problems through a set of targets & policies that suit each region.

- Preserving the remnants of the distinctive features of the character & the architecture of important areas especially the established activities without introducing any new activities to the urban context of these areas.
- Setting standards & principles to ensure keeping a suitable passage for pedestrian traffic, and removing the parking places for cars.
- Re-configuration of the space under the bridge to suit the uses of each area, in attempt to provide the needed services & aesthetic elements, pedestrian passages , and benefiting from bridge slabs as roofs for the spaces underneath it to be seating areas or flower shops in a specific form & system.
- Creating future management schematics for the targeted future bridges.
- Studying various commercial activities which the constructed bridges will pass by and the expected effect.
- The attempt to assert the role of streets in the process of guidance especially in night periods through lighting & methods of light distribution.
- Taking into consideration areas & buildings of historical value and keeping away from them. Or to be taken into account when constructing these bridges while attempting to inflect the least possible degree of visual pollution and deal strictly with them.

Recommendations for administrative & regulatory aspects:

- Setting standards and principles for the required maintenance and the necessary development to upgrade the bridges.
- Forming specialized committees to maintain the overall condition of the bridge and its spaces to fit the nature of each bridge, and the development of spaces around the bridge.

Acknowledgment

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors

References:

1. Prof. Dr. Ahmed Khaled Allam, Regional planning, Al-Nahda Al-Arabia press, Cairo 1992
2. Ali Raafat, Structural creativity within architecture, Al-Ahram press 1998
3. Scientific research academy, General research authority for building, housing & urban planning research
4. American Association of State Highway and Transportation Officials, Load Resistance Factor Design, AASHTO, Washington, D.C., 1996.
5. Dr. Jachen Kar Fmacher , Economical Aspects of Urban Upgrading – 1997 .
6. American Association of State Highway and Transportation Officials, Standard Specifications for Highway Bridges, 16th ed., AASHTO, Washington, D.C., 1996.
7. American Association of State Highway and Transportation Officials, Guide Specification and Commentary for Vessel Collision Design of Highway Bridges, Vol. I: Final Report, AASHTO, Wash-ington, D.C., February 1991.
8. Bridge Engineering Hand book – Wai-Fah Chen Lian Duan – Boca Raton : CRC Press, 2007.
9. Borhan Mahmoud Shafiq, Elements design standards and how to benefit from it in light steel structures, Applied arts PhD, 2000