

THINKING BEYOND STRUCTURE: FLYOVER AND BRIDGE INTERVENTIONS ON CITY URBAN AESTHETICS

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ABSTRACT

Flyovers and bridges are vital infrastructure elements in the built environment. They are built to solve traffic and mobility problems especially in cities with high traffic density. Usually, those flyovers do not consider the architecture and city urban aesthetics. At the end of the 20th century, numerous national authorities and agencies initiated a new term "context-sensitive design", promoting the importance of bridge aesthetics. The research focuses on the flyover negative effects on urban aesthetics, with special reference to heritage urban spaces in Cairo, Egypt. The aim is to draw attention to the importance of issuing guidelines concerned with flyover aesthetic values for urban areas. This is achieved through documenting and analyzing international pilot bridge and flyover aesthetics guidelines. The paper also documents and analyzes the situation in Cairo, Egypt through visual inspection and interviews. El-Azhar area and El-Azhar flyover, Cairo, Egypt are chosen as the area for field study. The paper presents a list of flyover-negative interventions on the built environment and community together with a proposal to include the main elements in future guidelines.

KEYWORDS: Flyovers, Bridge aesthetics, Interventions, Urban qualities.

1. INTRODUCTION

Flyovers and bridges are vital infrastructure elements in the built environment. A flyover is a type of bridge that artificially eases crossing between two points. Flyovers are built mainly to solve traffic and mobility problems especially in cities with high traffic density. The bridge is a structure that provides a passage over a natural setting (river) or manmade setting (road). Also, bridges are the largest and most distinguishable manmade structures within the modern era. They are landmarks

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that articulate the whole cities acting as a reference by which everything is positioned to regulate modern city experience.

Historically, architects were in charge of bridge design and they focused on the integration of the function and aesthetics. In the industrial age, several bridges were built in Egypt with aesthetical preferences [1]. The design of the bridge then switched from architects to become the domain of engineers, where the focus changed to practicality and simplicity determined by the financial side. The design and construction of the bridge is not just a structural engineering subject, it is a multi-disciplinary subject that involves civil engineers, architects, economists, and others. Usually, flyovers and bridges do not consider the architecture and urban aesthetics. The aesthetic purpose is beyond simply creating a pleasant view; aesthetics is intertwined with the function of the facility [2]. City aesthetics are threatened by different improper interventions, Egyptian urban spaces experience harsh effects of chaos resulting from scattered sidewalks, roads, shops, signage, and others [3]. This research main concern is with those interventions that occurred by the bridges and flyovers existence. As a solution to this rising problem, multiple international authorities and agencies began in 1998 with an initiative called CSD: Context-Sensitive Design. CSD recognizes that a highway or road itself can have far-reaching impacts beyond its traffic or transportation function by integrating it within the community. A step forward, several international guidelines for the bridge aesthetics were created, each country has its own guidelines, stating the variables that must be taken into consideration while designing the new bridges.

1.1 Research Problem

Since 1970, bridge construction has been a leading issue in the Egyptian urban Agenda to solve many traffic problems. This resulted in 2972 bridge all over Egypt according to CAPMAS, 2019 [4]. Bridges and flyovers were built without considering urban aesthetics due to the lack of any Egyptian bridge aesthetics guidelines. Public spaces and buildings that exist under and beside the flyover lack natural lighting, proper ventilation, and maintenance. Also, there is no respect for the local identity and

character of the area the bridge passes through, it is an odd bulk concrete structure. The flyover formulates some unused neglected spaces within the bridge context.

The main aim of the paper is to draw attention to the importance of issuing and implementing guidelines concerned with aesthetic values of flyovers for urban areas. As well as, deduce the most important elements and aesthetic values that must be included in those guidelines. The paper will reach its goal by documenting and analyzing existing international guidelines for bridge aesthetics and focus on the negative effects of the flyovers on the aesthetics of the built environment in heritage areas, with special reference to urban spaces in Cairo, Egypt. The paper will use El Azhar flyover as the main case study. In the following section, a summary of bridge aesthetics features and qualities is presented based on the existing international guidelines.

2. BRIDGE AESTHETICS GUIDELINES

The purpose of these guidelines is to help design teams produce bridges of aesthetic value. They include the requirements, objectives, design principles and processes that guide the design of the bridge. The bridge guidelines aim to increase the level of awareness regarding visual, architectural, and aesthetic values that influence the appearance of bridges. Guidelines offer ready reference to be used during the design process and provide both general observations and specific suggestions for designing bridges. They also encourage bridge designers to include aesthetics along with science and technology in the design of bridges and highway structures. Most developing countries are unaware of the importance of bridge aesthetics guidelines, and with the consequences of the rapid bridge construction and its negative impacts on the environment. The following are examples of the international guidelines:

- Minnesota Department of Transportation (Minnesota DOT) aesthetic guidelines for bridge design [5].
- Design guideline to improve the appearance of bridges in NSW, Australia [6].
- Bridge Guidelines, Philippines [7].
- Bridge Design Practice Caltrans, California, USA [8].

- Bridge aesthetics sourcebook, TRB, USA [9].
- Bridge Design Guidelines Stantec, Canada [10].

Table 1 summarizes the elements of the international guidelines. The international guidelines titles are presented in the top row of the table, and the elements, which are presented in those guidelines are listed in the first column of the table. The shaded cells refer to the existence of the element in the guideline. Each international guidelines has different classifications for their elements and qualities. For example, elements in Minnesota DOT guideline were grouped into four key categories: aesthetic guideline fundamentals, aesthetic design process, bridge elements, and bridge related components. However, elements in NSW, Australia guideline were divided into five specific categories starting with the approach to design, the whole, the parts, and the details. These element classifications are similar but with different details depending on each guideline.

All the major and minor bridge elements from piers to details are physical features. Those are the first group in the Table 1 and they are responsible for formulating the aesthetic qualities. The perception of any mass depends on five main elements: Form, line, shape, color, and texture. In addition to those basic elements, there are other physical features based on flyover elements. In Minnesota DOT guideline, the physical features are divided into the bridge parts: super-structure and sub-structure parts, and bridge design components. In the NSW, Australia and Philippines guidelines, however, the physical features were divided into parts, finishing, and details. The parts include the bridge main elements as girder and pier. The finishing includes the elements related to surface such as color and texture. The details include barriers, joints, and signs.

Aesthetic qualities are intangible qualities, which people perceive through the perfect implementation of physical features in the surrounding environment. They provide harmony and rhythm, as well as other qualities. International guidelines consider only 11 qualities, which were repeated almost in every guideline like order, scale, and proportion. In Minnesota DOT guideline, they first mentioned qualities in terms of general aesthetics as proportion, unity, and others. Then, they formulate it

into terms of bridge design objectives as “scale and proportion”, “simplicity and continuity” and others. In NSW Australia guideline, eight qualities are introduced under the title "form as the external shape of the bridge" and are mentioned in a detailed explanation providing ratios and slopes for bridge parts. Similar details were given in the Philippines guideline but with more illustrations. The TRB, USA guideline mentioned nine qualities. For each quality, a neat description about how this quality should be achieved was provided.

The context is the main section in the guidelines, which combines the physical features and the aesthetical qualities concerning the flyover environment. The Minnesota DOT guideline generally discussed environment and aesthetic objectives. The bridges were categorized into three main levels according to their importance. The design process focuses on showing alternatives for the bridge, presenting them in 3D realistic shots within their context. The NSW Australia guideline was design oriented focusing on the creativity side of the design. In order to understand context, 11 points should be taken in consideration and were briefly discussed through the guideline. The TRB, USA guideline presents a group of questions related to context to inspire and regulate the designer thinking and intentions. In the design process it is necessary to include all concerned disciplines and community together from the very beginning. The last category is the design, which contains two main points. The first is the expressive form and the second aspect is the community consultation during the design process, which is also mentioned in the other guidelines listed above.

In summary, both Minnesota DOT and TRB, USA guidelines mentioned every element in the physical features section with a detailed illustration. Also, both NSW Australia and Philippines guidelines show almost the same aesthetic qualities, and they were distinguished from the others by the ratios and examples in each quality. The NSW Australia guideline shows the most context sensitive solution in relation to the surroundings.

Table 1. Summary of main elements of bridge aesthetics in international guidelines.

International Guidelines		Minnesota DOT, USA	NSW Australia	Philippines	California, USA	TRB, USA	Stantec, Canada	
Physical Features	Line	■		■		■		
	Type						■	
	Form	■	■	■		■		
	Texture	■		■		■		
	Shade and Shadow					■		
	Color	■	■	■		■		
	Material		■					
	Lighting	■	■	■	■	■	■	
	Ornaments (Details)		■	■		■	■	
	Shape	■					■	
	Girders	■	■	■	■	■		
	Signs	■	■	■	■	■		
	Piers	■				■		
	Pile Caps	■	■	■	■	■		
	Abutments	■	■	■	■	■		
	Parapet Railing	■	■	■	■	■		
	Safety Screens		■	■	■	■		
	Space Under the Bridge		■	■				
	Aesthetic Qualities	Proportions	■	■	■	■		
		Rhythm	■	■	■	■	■	
Order		■	■	■	■	■		
Harmony		■	■	■	■	■		
Balance		■				■		
Contrast		■	■	■	■			
Scale		■		■		■		
Unity		■	■	■	■	■		
Illusion		■				■		
Continuity		■	■	■	■	■		
Simplicity		■	■	■	■			
Symmetry			■	■				
Context	Integration	■	■	■	■	■	■	
	Character		■	■	■	■	■	
	Respect the Setting		■	■	■	■		
	Community Involvement	■	■	■		■	■	
	Context Influence		■	■	■			
Design	Expressive Form		■				■	
	Consultation with Community	■	■			■	■	

3. METHODOLOGY

The paper aims to document the main bridge aspects affecting urban aesthetics. The research adopts the qualitative method, which helps in the interpretation and better understanding of the complex reality of the bridge and its interventions on the urban environment. The research uses site visits and interviews with the designers and authorities responsible for bridge design and construction.

The interviews were conducted with the interviewees, the bridge construction designers and consultants, and the Urban Planning Authority. The following sections briefly discuss the main findings of the interviews. A site visit to El-Azhar flyover is conducted to collect data in their natural contexts through observation, maps, photos, and videos to understand the bridge context.

4. INTERVIEW FINDINGS

Interviews were held with members from the authority of planning, bridge designers and construction engineers. The officials in the Egyptian authority of urban planning include the General Director of the Authority of Urban Planning, Head of Central Administration, General Director of roads and bridges and others. The second group of interviewees were bridge designers and engineers. Questions were asked for several participants including professors, consultants, and engineers involved in bridge design projects locally in Egypt. The interview questions were divided into two main categories "context and bridge elements" and "aesthetics and surface treatments". Researchers engage with experts by neutrally posing questions, listening attentively to experts' responses, and asking follow-up questions. The aim of the paper is to document the current situation of the bridges in Egypt that could not be found in the international literature. The main interview results can be summarized into three main categories facts, interventions, and recommendations. These will be outlined below.

4.1 Facts

1. There are no rules or guidelines regarding bridge aesthetics in Egypt.
2. Engineers take in consideration solving traffic problems only.

3. Bridge type selection depends on the span length and the bridge's importance.
4. Signage and advertisement size and location is not in the authority of the engineers.
5. The architects and urban planners are rarely involved in the bridge design process.

4.2 Interventions

1. Residents and pedestrians are the most affected by the flyover existence (air and noise pollution and privacy invasion).
2. The bridge existence increases the deterioration rate of the neighboring buildings.
3. The residential apartments and the land prices along the flyover decreased after the flyover construction.
4. The flyover existence affects the activities underneath it.
5. The bridge neighboring residents are only considered by adding barriers along the bridge to protect their privacy.

4.3 Recommendations

1. Bridge signs and advertisements should be removed or regulated because they distract the driver's attention.
2. The bridge design is a multi-disciplinary project in need of different specialties of engineers and of course, the architects and urban planners must be involved.
3. It is necessary to regulate the flyover location and its relation with the surroundings.
4. A buffer zone distance should be specified in bridge construction codes and rules.
5. Aesthetic-related research or guidelines should be initiated.
6. Public involvement should occur during in the bridge design process.

5. FIELD CASE STUDY

Historic Cairo (El-Azhar) is one of seven Egyptian sites listed in 1979 as a UNESCO World Heritage Site. World Heritage is a list of places of exceptional universal value to humanity. They are listed to be protected for the benefit and enjoyment of coming generations. Cairo includes several historic districts and important monuments that show the city's architectural resources. Figure 1 shows the first UNESCO map for historic Cairo in 1979, the protected site highlighted in yellow

has expanded to include the khedival Cairo. This site is in Level A (the highest level of protection) not just as a capital of the Islamic world, but as a wonder of the human urban experience. UNESCO report [10] requests the prevention of any street cutting or widening in the area to solve any traffic problems. The report also states that the heavy vehicular traffic causes multiple negative interventions to the historical area. Despite of this constraint, El-Azhar flyover was built in the early eighties of the last century.

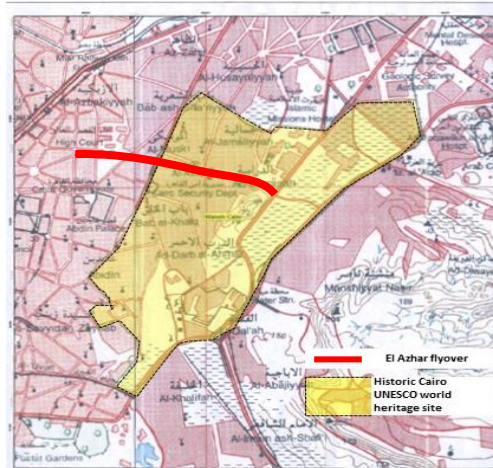


Fig. 1. UNESCO map for historic Cairo in 1979, El-Azhar Flyover highlighted in red.

5.1 El-Azhar Flyover

El-Azhar flyover was chosen because it met the selection criteria. The flyover context is rich with its historical buildings, strong identity, and character. It passes through more than one vital public space in Cairo as shown in Fig. 2. The Flyover deals with three groups of people namely residents, pedestrians, and car occupants.

El-Azhar Street passes through Fatimid Cairo, Egypt's Islamic capital around the 10th century. The area is very rich in terms of culture and historical monuments. This area is known for its historical buildings, for example (the Civil Defense and Fire Department building, the Post Office Building, Hussein mosque and Wekalet el ghouria. The presence of famous markets attracts many tourists and local visitors. Daily flow causes traffic congestion in the area. In the eighties of the last century, the government decided to build a steel flyover on El-Azhar Street to solve the traffic problem. The flyover purpose was to provide a direct connection between downtown and Salah Salem, Heliopolis and Nasr City, by bridging over those congested areas.

6. ANALYSIS OF FIELD STUDY

The following sections summarize the El-Azhar flyover aesthetic analysis. The first section addresses the physical elements of the flyover. The second section analyzes the bridge qualities addressing the whole bridge within its parts and its surroundings. The third section, "context" is concerned with the flyover integration within its surroundings and the flyover community and activities.



Fig. 2. El-Azhar and Portsaid flyover in red, yellow and blue respectively. Photos show different spaces along the flyovers.

6.1 Physical Features

In the following sub-sections, the physical features elements in El-Azhar flyover are discussed in relation to people perception.

6.1.1 Form and shape

A shape is a two-dimensional surface, it is the outline of an area or figure, but a form is a three-dimensional arrangement of elements creating the form. Form and shape were not acknowledged by the viewers. Because the flyover is adjacent to buildings, it does not provide the pedestrian's proper viewing angle to see the whole flyover. Only the flyover pier and deck could be seen by pedestrians.

6.1.2 Railing, barriers, and abutments

In El-Azhar flyover, steel railings type is chosen to visually lighten the structure as shown in Fig. 3. Barriers are added for security and privacy in some locations along the flyover. Abutments in El-Azhar flyover depends on the minimum footprint strategy shown in Fig. 4, which gave the pedestrians a better viewing angle to enjoy the setting. As compared to the entire flyover, the abutment failed to incorporate the flyover into its natural setting.



Fig. 3. Flyover barrier and railing.



Fig. 4. Flyover abutment clad with bricks.

6.1.3 Piers

Piers spacing and shape in El-Azhar flyover change along its length. They are divided into four zones as shown in Fig. 5 and Fig. 6. Zone one demonstrates the two sides of El-Azhar flyover with the same pier but on different levels. Zone two starts at Portsaid flyover which has a lower height on the right side. This created two floors and two piers for the two flyovers on the same area. Zone three of the El-Azhar flyover carried on two piers. The flyover piers at this zone are on the sidewalk just adjacent to the buildings to give room for the intersection with Portsaid flyover to pass under El-Azhar flyover. This led to a chaotic un-balanced space under the flyover as shown in Fig. 7. Zone four El-Azhar flyover deck maintains the same level until the end of the flyover.



Fig. 5. Four zones of El-Azhar flyover piers

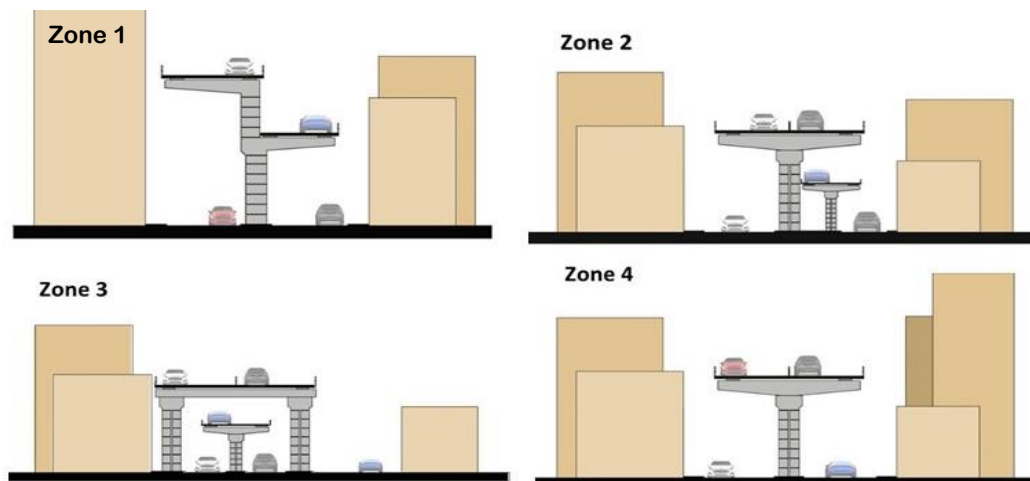


Fig. 6. The four zones of El-Azhar flyover piers and its relation with Portsaid flyover.

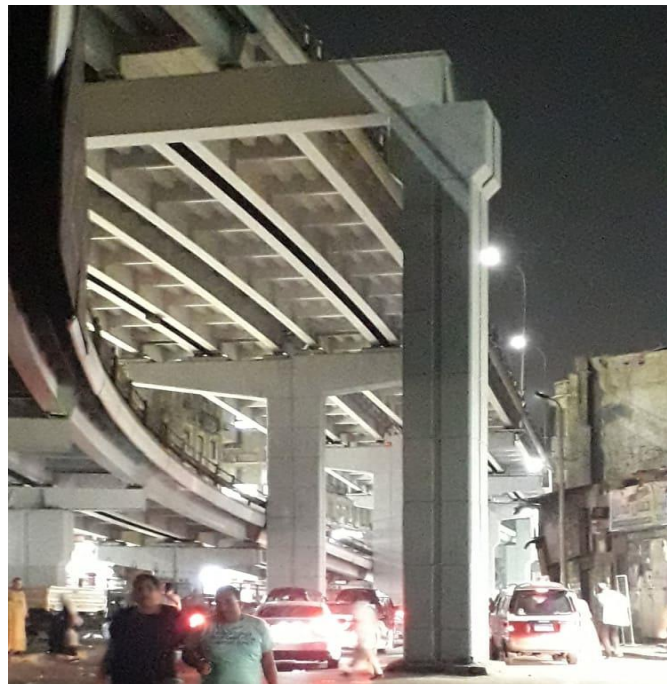


Fig. 7. The complex relation between El-Azhar flyover piers.

6.1.4 Color, texture, and materials

Color defines the visual effects of structural elements. El-Azhar flyover is grey as with other flyovers in Cairo, resembling the color of materials used (concrete and steel). A neutral color, that neither matches the surrounding nor contrast with it. The flyover texture appears as smooth concrete with horizontal groves on the piers. The abutment texture and material were simple bricks to introduce human scale, influenced by the surrounding materials.

6.1.5 Lighting and signage

The lighting in El-Azhar flyover plays its functional role, but it lacks any lighting that highlights the structure at night. Lighting posts exist in the middle pavements between both sides of the flyover. The space below the flyover is not dark, owing to its location (commercial area). On the other hand, signage does not exist on this flyover. Unfortunately, this is not the normal case of Egyptian bridges.

6.2 Aesthetic Qualities

Aesthetic qualities are derived from the arrangement of the structure physical elements. They are used to evaluate El-Azhar flyover visual composition as outlined below.

6.2.1 Order and rhythm

A sense of order is created by repeating similar elements along the flyover. Main rhythms are created by the repetition of similar pier shapes but at El-Azhar flyover the piers have different shapes and spacing along the flyover. This decreased the sense of order and rhythm as shown in Fig. 7. The appearance of barriers in some spaces and their disappearance in others creates disorder in the overall appearance.

6.2.2. Harmony

There are two levels of harmony, harmony between the flyover parts and harmony between the flyover and its surroundings. El-Azhar pier position, span, and shape along the bridge created a dis-harmonic environment. El-Azhar flyover does not reach the level of within dominance or, uniqueness.

6.2.3. Scale

Bridge design should be in relation to the context architectural scale and the human scale of users. El-Azhar flyover scale neither respects the human scale, nor does it is proportionate with surroundings. However, the different flyover elements scales in relation to each other achieves a proportionate relationship.

6.2.3. Unity

Unity is presented last because it includes the positive application of all the other qualities. However, El-Azhar flyover failed to achieve multiple qualities, so it failed to achieve the overall unity between flyover elements and its surroundings.

6.3. Context

The bridge site is the most important aspect affecting bridge aesthetic design. El-Azhar area is a rich context with its diversity. Figure 8 shows the flyover within its context, which has a strong character that should have a great impact on bridge design. The designers neglected the local valued structures, materials, and styles. For example, heritage areas can influence the form and materials adopted for a bridge.



Fig. 8. The flyover contrast within its surrounding, Google Earth.

6.3.1 Community

The community is affected by the flyover construction and therefore it should be involved within the design and construction process. There are three categories of people that are affected by the bridge as follows:

Residents: The flyover is very close to the buildings. This subjects residents to air, noise, and visual pollution. The bridge also invades their privacy and prevents daylight to enter the apartments.

Pedestrians: The pedestrian movement is subjected to multiple obstacles by the existence of flyover piers, street vendors, and car parking. The different building styles in the area could not be perceived as a total by the pedestrians. The space under the

bridge is dark in the daytime because the sunlight is partially blocked by the bridge deck.

Vehicle occupant: The car occupants could perceive more from the surrounding aesthetics. As the flyover is too close to the buildings, the vehicle occupant could barely see half of a building or a roof of another. This could be explained as an “unfinished experience”. Underneath the bridge, the flyover blocks the view of car occupants.

6.3.2 Functions and activities

The flyover established other new activities underneath it to occupy the vacant spaces. The space under the flyover was transformed into car parking lots locked for shop owners, and are not available for public use. Street vendors are found all over the street sitting in places that are supposed to be for pedestrians as shown in Fig. 9.



Fig. 9. Pedestrian flow and street vendors beneath the flyover.

7. RESEARCH MAIN FINDINGS

This section presents the main interventions of the Egyptian flyovers and proposes a list of main elements that should be included in the Egyptian guideline. Interventions are based on the interviews, site observation and analysis of El-Azhar flyover.

7.1 The Main Interventions of the Egyptian Flyovers

- Architects or urban planners are not involved in the bridge design process.

- The flyover was constructed in an UNESCO historic site, causing multiple negative effects without respect for the identity and character of the space.
- The space beneath the bridge is in need of maintenance and serves as a platform for street vendors and illegal activities.
- Flyovers cause negative visual effects on the individuals, drivers, and neighbors.
- With flyover presence, the rate of deterioration of historical buildings increases.
- Signage and advertisements add unnecessary complexity to the city's visual image.
- The selection of flyover locations does not acquire any regulations or a buffer zone (distance) from the bridge to adjacent buildings.
- Most flyovers act as grey bulk structures in the middle of the urban fabric, neither complementing nor contrasting with the surrounding environment.
- There is no community involvement during the design process and construction.
- Residents experience noise, climate, and visual pollution by flyover existence.
- There is no respect for the pedestrian's flow underneath the bridge, the flyover splits and divides the public spaces it crosses by.

7.2 Proposed Main Elements for Future Egyptian Guidelines

Figure 10 is a proposed list for the elements that should be included in Egyptian codes and guidelines concerning bridge aesthetics. The proposed classification divides elements into three main categories: physical features, aesthetic qualities, and context.

Most proposed physical elements are based on international guidelines except one new element, landscape elements. It is added to physical features, to consider the landscape treatments at the abutments and under bridge areas. The spaces around and under the flyover need to be planned and maintained to accommodate pedestrians, providing them with various activities by landscape furnishing. Nine qualities were selected, presented in the second column. Those qualities were the most repetitive qualities in accordance with international guidelines. There were three new additional elements included in context according to the interviews and site visit. First, the "Location" which should not be simply a decision of the traffic engineer, because the presence of a flyover not only affects the traffic but also has several environmental and

community impacts, which should be considered. The second element is the "buffer zone," the distance between the flyover and the buildings should be limited to a specific distance. In any potential guidelines, a minimum distance should be given. The third element is "the bridge space" that already exists in other guidelines but should address land uses and activities underneath the bridge.

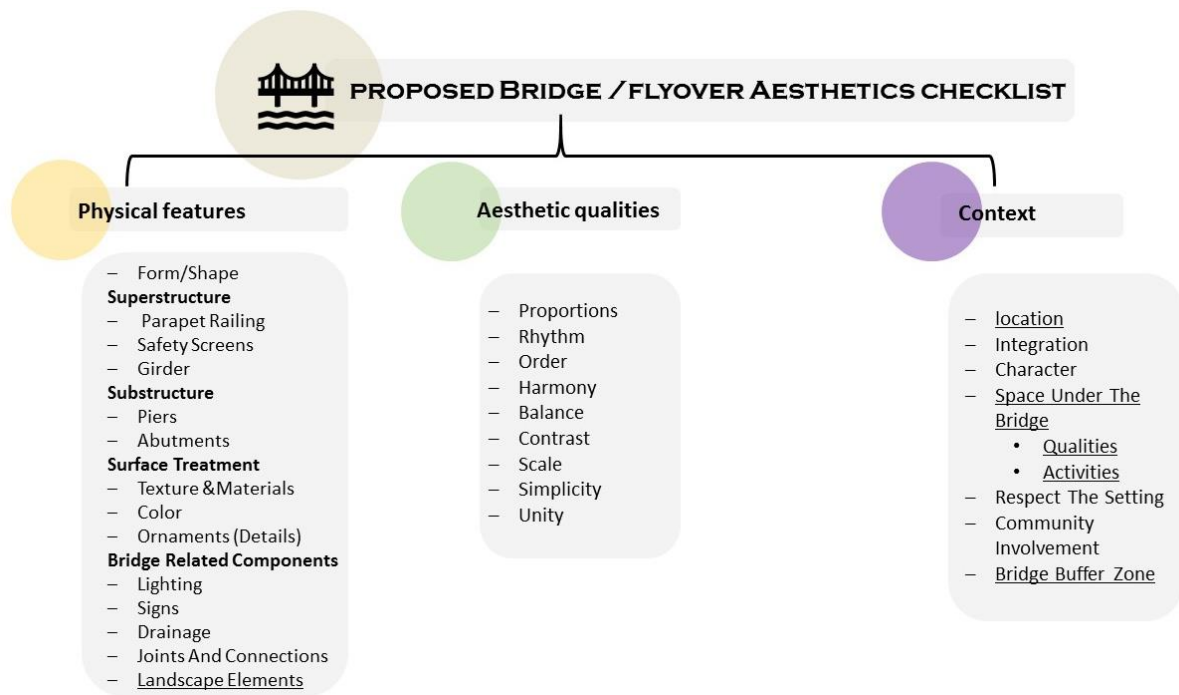


Fig. 10. A proposed list for main elements for future guidelines, the underlined elements show the added elements to be compatible with the Egyptian environment.

8. CONCLUSIONS

This research focused on the flyover effects on the urban areas and the need to issue bridge guidelines. Through documenting and analyzing the international bridge and flyover aesthetics guidelines, the paper deduced the main bridge aesthetic elements and used them to assess impact of the flyovers on the Egyptian urban aesthetics. The study depends on the interviews with a group of officials and specialists in bridge design and construction. The interview main findings were listed in the paper to have better understanding of the current design and construction of flyovers in Egypt. It was concluded that flyovers were built without consideration of

aesthetics preferences. The architects and urban planners are rarely involved in the bridge design. Community should be involved during the bridge design process.

The field study was carried out to document the flyover effects in heritage areas such as El-Azhar area. A huge flyover was built in a UNESCO heritage site, historic Cairo. Flyovers cause negative visual effects on the individuals, drivers, and neighbors. The rate of deterioration of historical buildings increases with flyover presence. The space beneath the bridge is in need of maintenance and serves as a platform for street vendors and illegal activities.

A list of the main elements that should be included in the Egyptian future guidelines is proposed based on the analysis of literature, interviews, and site visit. The proposed list includes new elements such as landscape, space underneath the flyover and buffer zone distance.

DECLARATION OF CONFLICT OF INTERESTS

The authors have declared no conflict of interests.

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التفكير خارج إطار المنشأ: تأثير الكباري العلوية للتقاطعات الحرة للطرق على الجماليات العمرانية للمدينة

يركز البحث على التأثيرات السلبية للكباري العلوية للتقاطعات الحرة للطرق على الجماليات العمرانية للمدينة وخصوصا بالمناطق ذات التراث الحضاري ويلقي البحث الضوء على اهمية اصدار ارشادات بالقيم الجمالية لتصميم هذه المنشآت ويحقق البحث أهدافه بتوثيق وتحليل الارشادات العالمية في هذ الشأن والموقف الحالي للكباري العلوية للتقاطعات الحرة للطرق بالقاهرة من خلال زيارات ميدانية واجراء حوارات مع مصممي ومنفذي هذه الكباري و دراسة لكوبرى الأزهر الذي يمر بمنطقة تاريخية ذات طابع معماري وعمراني متميز، و تقدم قائمة بأهم التأثيرات السلبية الواجب تجنبها مع مقترحات بأهم العناصر الواجب اخذها في الاعتبار في المستقبل عند وضع ارشادات القيم الجمالية للكباري العلوية للتقاطعات الحرة للطرق.