The pavements by precast concrete flags

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Abstract. The construction units used in pavement reinforce the functional and aesthetic effects of sidewalks and public places in the city. The pavement can be carried out from paving of different materials, which can be used according to the location and the surrounding environment. There are a number of pavers, including prefabricated concrete, asphalt, stone, etc. The study will examine the precast concrete (flag) that is used in pavement of sidewalk. Research problem: Locally, there is a weakness in integrating the engineering standards of pavement with the standards of urban design to achieve the special and distinctive urban form, which is appropriate for use. The non-use of colours in the direction of movement and the realization of privacy and the definition of use leads to lack of care for the urban environment, and its components.

Research hypothesis: The integration of engineering and construction standards of precast concrete flags used in paving sidewalks and streets must be met with urban design standards to achieve the appropriate urban shape in the urban environment, needing to use colours to guide traffic and achieve privacy and definition of use.

Keywords
Urban environment, public spaces, street, Sidewalk, pavement, precast concrete flags.

1. Introduction
Pavement units work on directing the movement. There are a number of considerations that must be taken, such as the homogeneity of used paving materials, the surface which is rough to avoid slippage, and does not affect the cleaning process.[1] Use materials of strength and durability that can endure heavy use. Select the colours and materials that do not cause the opposite of sunlight and glare [2]. The research deals with concrete paving units (Precast Concrete Flags) because they are used in local cities widely.

The research aims to know, the extent to which both the urban and architectural design criterion are met in terms of shape, colours and dimensions; the use of colours and motifs in sidewalks and their effect on the user and the urban environment; the extent of achieving street unity, identity and personality through colours, patterns, accent and edge definition and the extent of achieving easy mobility and orientation.

2. The Pavements
Pavements can include many paving materials such as concrete or asphalt used as accents or in key locations. Typical concrete paving are proven materials that meet the standard needs of pedestrians’ circulation; special paving treatments can improve public spaces in urban environment, give circulation areas a stronger sense of place, and enhance the hierarchy of public spaces. Standard
materials as well as special paving treatments, special paving can be used to both define the edges of spaces and to visually enhance spaces as the all. [3] There are several styles for tile arranging as: herring bone, parallel octal, or kerb face.

Standard Pavement: As the San Francisco Better Streets Plan 2010, Standard sidewalks should use concrete scored in 0.9 m x 0.9 m. Streets sidewalks should use concrete mix to the specifications of the Streetscape Plan.

Special Pavement: Pavers consist of sand, mortar set pavers, and permeable or porous pavers over clean drain aggregate. Special pavers include natural stone, concrete pavers, concrete permeable pavers, textured and colored concrete, and concrete with exposed or special aggregate and other finish treatments. Special aggregates, colors, and textures may also be considered. Maintenance cost of special pavers should be considered during the selection process. When non-familiar materials are used, they should extend at least a complete block for design uniformity and repair efficiency. Similarly, non-familiar scoring should extend for at least one block. Exceptions can be made where special paving is being used to highlight bus stops, parks, plazas, or other specific areas. [4]

3. Precast Concrete Flags

3.1. Terminology
This is yet another example of regional terminology in the paving industry. The name of this unit is Concrete Paving Bricks in Iraq. These units are flat, rectangular blocks of pressed concrete, referred to as 'Flags' in NW England, in other parts they are known as 'slabs'. Both terms refer to exactly the same item, and the term 'flag' will be used in the remainder of this research. These flags are manufactured to BS EN 1339. Sometimes lovingly referred to as 'Council Flags', the big, chunky boys of the paving units; the smaller, lighter patio and decorative flags are covered on the Patios page. [5]

3.2. Precast Concrete Pavement brick as IRAQ Standardization
The main materials of precast units are cement, rubble and lime. They are mixed in a homogeneous manner. Some other materials may be added, considering that they do not have a harmful effect on the concrete and they are made of one or two layers, and must take care not to cause a conflict between them.

Materials: Portland cement is used according to Specification No. (5), and lime or Nora is used as Specification No. (807), and Aggregates (soft and coarse) is used as Specification No. (45), in addition to using water as per specification (1307), at last, additive any additive that does not adversely affect concrete and pigment may be used as per specification (1712).

Classification as loading: Precast concrete pavement brick (flag) are classified in terms of durability; first: high loading that is used in large load, container garages, and the surfaces exposed to severe erosion; second: medium loading for light load vehicles, service areas; third: light loading that it used for non-vehicular roads, pedestrian roads, sidewalk, and the surfaces not exposed to corrosion.

Physical and mechanical properties: Appearance: It should have a dense structure, free of cracks, with parallel side edges, and level flawless. Dimensions: Surface area, length, thickness as in table (1). Water absorption and Compression strength: as in table (2). Abrasion resistance: it must be no more than 3 mm in thickness. Disparity of dimensions: the variation in height and width must not to be increased or decreased 2mm, at the same, the variation of thickness not be +3 or -3, except the variation in the case of the presence of a protrusion 1.5. [6]
Table 1. Concrete pavement brick (flag) classification as loading in IRAQ Standardization.

| Category as loading          | Surface area mm² | length mm | thickness mm |
|------------------------------|-------------------|-----------|--------------|
| High loading type            | 6000-5000         | 290       | 140-80       |
| Medium loading type          | 6000-5000         | 290       | 140-60       |
| Light loading type           | -                 | 290       | 140-60       |

Table 2. Water Absorption and Compressive Strength of Concrete pavement brick in IRAQ St.

| Category as loading          | Water Absorption% | Min. compressive strength of N / mm² |
|------------------------------|-------------------|-------------------------------------|
|                              | the average       | One unit                            |
| High loading type            | 6                 | 55                                  |
| Medium loading type          | 7                 | 35                                  |
| Light loading type           | 10                | 30                                  |

4. Construction

In Clause 1104 (A) - Footways and Paved Areas (Precast Concrete Flags) 2 (A), Flags must be arranged evenly on a layer of clean sharp sand or crushed rock fines complying with BS882 (Grading C or M, 25mm ± 10mm thick). Where no vehicular override of the slabs is anticipated, the bedding may be replaced with dry mortar mix not less than 10mm and not more than 40mm thick. [7] This work includes the installation of prefabricated paving units of various dimensions and colours according to the approved designs of the specified site.

4.1. Classification as Construction and shape

As Construction, they are classified into the following categories: regular concrete units and interlock concrete units.[8]

4.1.1. Regular concrete unit

This is manufactured from a 1: 3 cement mixture to sand for the bottom layer, the upper one being 1: 1 cement to the sand. The thickness of the upper part shall not be less than one quarter of the total thickness of the concrete unit. The total thickness of the paving unit shall not be less than 1/10 of the dimensions of its width. The square pieces shall be (40 cm * 40 cm) and their edges shall be bevelled by 7 mm.[9]

4.1.2. Interlocking concrete units

Interlocking concrete units called Al-Muqrnas in Iraq are used in the paving of sidewalk. Concrete paving flag is installed by interlocking or overlapping, without the use of binding materials, it is installed on the sand by depending on its interconnection between the pieces itself. There is a possibility to remove and reuse. It is a sustainable material that can be recycled. It can be used to pave floors in public spaces such as sidewalk, roads, parking, petrol stations, etc. The most important feature of this type is the large diversity of its forms, (see figure 1), which allows for a lot of creativity in the design of floors.[10]
4.2. Use of colour in Precast Concrete flag:
There is no absolute requirement for colour, but lighter colours should be used for pedestrian areas. The units should be rectangular with a distance of 200 x 100 x 65 mm according to table 10.3 of the guidelines, and 1/2 is the minimum if a part of the unit. [12]

5. Urban design criteria:
The sidewalk is part of the external urban spaces so it is presented to a large number of the negative impacts. Hence, it is required to use materials with high sustainability at the same time keeping in mind the comfort of the user of the individual walking as well as exposure to various pollution factors. So a balanced planning of the engineering aspects of construction and architecture is required to make it a comfortable area for pedestrian movement. There are scopes of architectural and urban considerations for pavement, such as type of use, ease of movement, visual character, afforestation, coordination, aesthetic elements, floor colours and facades, materials used in cladding, creating a comfortable and safe pedestrian environment. [13]

There are an enormous variety of patterns and layouts for laying flags and paver units. Some are pretty basic and are well-known to nearly everybody, while others are a little more exotic and seen less regularly. Motifs are quite common in paving layouts. There are many motifs as accent bond as accents or in key locations. See figure 2. [14].
5.1. Previous studies:

5.1.1. Study of Institute of Transportation, “Design and Safety of Pedestrian Facilities” 1998:
The design is based on the type of user, the type of space, location, organization, and that benefit is to
achieve personal characteristics, pedestrian guidance (Pedestrian - Oriented Environments, Signalization means that colours have certain meanings to achieve Positive Barriers. [15]

5.1.2. Guide to the design of sidewalks and the median strip in roads and streets 2005:
The design of sidewalks and the median strip in roads and streets shall include the following:
Create a visual character for each road and unify the coordination of the one road. Increase the width of sidewalks in selected places to achieve social interaction. Provide attractions, street furniture. Give ways to their own personality. The appropriateness and aesthetic proportions of paving materials. [16]

Study of San Francisco planning department 2010 - The Better Streets Plan:

Paving one of the Streetscape Elements, Special paving can be used to both define the edges of spaces and to visually enhance entire spaces. Special paving is a key to communicating pedestrian primacy such as within heavily traveled crosswalks or pedestrian priority spaces, and adds visual variety to the streetscape. Special paving can be a functional storm water amenity as well as an aesthetic enhancement, when designed as permeable paving. Permeable concrete pavers can provide both function and aesthetic appeal and should be used where an enhanced design treatment is desired. Permeable asphalt and concrete change the surface function but do not greatly enhance the overall aesthetics of the site. See figure 3. [17]

Unique paving treatments convey a sense of scale, detail and orientation that is welcoming to pedestrians

Acupuncture treatments can be used by accentuating the entire pavement area

Special paving can define bus stop zone, even where a shelter is absent

Special paving at intersections and on pedestrian refuges makes crossing more comfortable

Figure 3. Study vocabulary (Streetscape Elements) [18]

5.1.3. Study of Elizabeth Batchelder 2003, Pedestrian Streetscapes
The study examined the urban landscape of the street, and focused on the need to introduce historical and heritage symbols in the sidewalks and streets of the city in terms of the arrangement of sidewalks and layout as well as the use of these symbols in the street furniture.[19]
In the previous studies, as shown in table (3), the research found that the details of the tiling units used in paving the sidewalks for pedestrian were not addressed. Through these studies, the research created a set of variables as in table (4).

Table 3. Shows the basic concepts and variables of the previous studies – source (the researchers)

| Researcher | Name of study | Concepts | Variables |
|------------|---------------|----------|-----------|
| Institute of Transportation Engineers 1998 | Design and Safety of Pedestrian Facilities | Placement, Work Zone Pedestrian Users with special needs, User Type, Space type, Location of Utilities, Organization, Pedestrian Barriers | Urban Area Characteristics, Safety Factor, Pedestrian-Oriented, Signalization, Colours have meanings, Pedestrian property, Positive Barriers |
| Elizabeth Batchelder 2003 | Pedestrian Streetscapes Guide design of sidewalks and the median strip in roads and streets | Historical and heritage symbols, Personal visual, Achieving social interaction, Provide elements of attraction and diversity, Independent personal, Appropriateness and aesthetic proportions of the materials of pavement | Function marks, Various expressions, Through the common order, Through the width, Through color, Through local style colour, texture and style of units with using |
| Ministry of Municipal and Rural Affairs, Kingdom of Saudi Arabia, 2005 | Guide design of sidewalks and the median strip in roads and streets | Place, Accessibility, Installation and construction, Design and coordination, Fitness and Appropriateness with the location, Sustainability, High durability, resistance, and pressure strength | Orientation, Edges, Privacy, Pattern, Human scale, Accent, Sufficient absorption with water |
| San Francisco planning department 2010 | Better Streets Plan Streetscape Elements | | |

Table 4. Shows the variables generated by previous studies – source (the researchers)

| Main Concepts | Secondary vocabulary | Variables |
|---------------|----------------------|-----------|
| Construction Considerations | the colour, Regular geometric shape, Durability, Absorption, Sustainability (water permeability to the ground) | Compression properties, Dimensions, Durability and resistance, Compressive strength property of impregnation, permeable, Loading - Compression, Accent or dialect, Definition, Layout, colour, pattern, Positive barrier, Passive barrier, Positive barrier, Colours, Decorations, Appropriateness shape, Appropriateness use |
| Urban Design Considerations | Identity and personality | | |
6. Practical study
The Case studies are of several areas of sidewalk in Baghdad city, Al-Sinaea Street district, Al-Binouk Street, Al-Attar Street in AL-Karrada district. See figure 4

![Al-Binouk St.](image1) ![Al-Sinaea St.](image2) ![Al-Attar Street](image3)

*Figure 4.* Satellite image showing the location of the study area is sidewalk in Baghdad city

The practical study was into two parts: the first is a laboratory test of the concrete pieces used in the areas to be examined; the second was a survey of selected experts in architecture and urban design on the final form of the same sample through photographs of the pavement, and the experiment of the surveyor by passing through them.

6.1. Construction Standards Tests:
Technical specifications of roads and bridges were used in laboratory tests. [20] Multiple models of sidewalks used in the city of Baghdad were selected using samples from these areas, Samples were used only from pedestrian sidewalks, the type of use was determined, and was introduced to the laboratory test, to determine the suitability and use, the samples were as follows:

- Concrete flag from sidewalks - Al-Sinaea St. - use (Commercial + educational+ residential).
- Concrete flag from sidewalks - Al-Binouk St. - use (Commercial + residential).
- Concrete flag from sidewalks - Al-Attar St. - use (Commercial + residential). See figure 5, 6, 7, 8.
6.1.1. Compression Resistance:

The compression resistance test is one of the most important tests in the evaluation of the pieces and an indicator of their durability, according to reference manual reference - Methods of inspection concrete pavement, Directory (969) [21], Compression strength shall be at least 60 for group and 50 for each unit, See Table (5), showing the discussion of laboratory results from laboratory tests:

| Standards                  | sidewalks - Al-Binouk Street | sidewalks - Al-Sinaea Street | sidewalks - Al-Attar Street |
|---------------------------|------------------------------|-----------------------------|-----------------------------|
| Paving flag               | Compression strength = 861.7 kn | Compression strength = 1418.7 kn | Compression strength = 163.6 kn |
| Compression strength      | Surface area = 272.75 cm² | Surface area = 10 × 20 = 200 cm² | Face space = cm² |
| examination               | Compression Resistance = 8617000/27275 = 31.59 Nm / mm² | Compression resistance = 1418700/20000 = 70.93 Nm / mm² | Compression Strength = 163600 / 15437.5 = 10.59 Nm / mm² |

The results of this examination, as shown in table (6), show that the biggest resistance is the street pavement of the Al-Sinaea, which is identical to the standard compared to the Al-Binouks and Al-Attar Street (Karada), which failed in the test.
Table 6. Comparison of the results of strength and durability for the three models. Source Researchers

| Sampling areas- Sidewalk | Al-Binouk St. | Al-Sinaea St. | Al-Attar St. |
|-------------------------|---------------|---------------|--------------|
| Compression test Newton / mm | 31.593 | 70.935 | 10.59 |
| Compression resistance test Newton / mm | Failed | identical | Failed |

In tested of Colour units It was found that as in Table (7), the colours have a significant negative effect on compressive resistance and resistance. It is also shown that the dyed model of the face only has high resistance and also conforms to the specification, see table (8).

Table 7. Tests results in concrete laboratories for colour models with uniform geometric shape.

| Standards | Red colour | the yellow colour | Black Colour |
|-----------|------------|-------------------|--------------|
| Compression examination | Compression strength = 867.5 kn | Compression strength = 870.3 kn | Compression strength = 873.8 kn |
| | Surface area = 272.75 cm 2 | Surface area = 272.75 cm2 | Surface area = 272.75 cm2 |
| | Compression strength = 867500/27275 = 31.8 N / mm 2 | Compression strength = 870300/27275 = 31.9 N / mm 2 | Compression resistance = 873800/27275 = 32 N / mm2 |

Forms and their dimensions

- If the concrete unit is only coloured from the face:
  - Compression test: compressive strength = 1397.3 kilo Newton surface area = 272.75 cm 2
  - Compression resistance = 1397300/27275 = 51.23 N / mm 2

Table 8. Comparison of results - according to the colours of the different parts. Source the researchers

| Colours | red | yellow | black | Only dyed face | Without colour |
|---------|-----|--------|-------|----------------|----------------|
| Compression resistance test Newton / mm | 31.8 | 31.9 | 32 | 51.23 | 70.935 |
| The compressive strength shall not be less than 40 N / mm 2 according to the specification | Failed | Failed | Failed | identical | identical |

6.1.2. Absorption Testing:
According to the Iraqi Standards, absorption is not more than 3%. The laboratory tests have shown as tables (9) and (10) that it is the absorption rate of flags in the side walk of the Al-Sinaea street and Al-Binouks street conform to the specification while Al-Attar Street is contrary to the standard.

Table 9. Shows tests results in the concrete laboratories of the three source models of precast concrete brick (flag) from three sidewalks / source - the researchers

| Standards | sidewalks - Bank St. | sidewalks – Al-Sinaea St. | sidewalks - Al-Attar St. |
|-----------|----------------------|--------------------------|--------------------------|
| Absorption testing of Flag | Weight after flooding with water = 3.80 kg | Weight after flooding with water = 2.74 kg | Weight after flooding with water = 2.24 kg |
| | Weight after drying = 3.72 kg | Weight after drying = 2.66 kg | Weight after drying = 2.1 kg |
| | Absorption rate = (3.80 - 3.72) / 3.80 = 2.1% | Absorption rate = (2.74 - 2.66) / 2.74 = 2.9% | Absorption ratio = (2.24 - 2.1) / 2.24 = 6.25% |

Table 10. Comparison of tests results of flag samples from three sidewalks / source the researchers

| Sampling areas Pavements | Al-Binouk Street | Al-Sinaea Street | Al-Attar Street |
|--------------------------|-----------------|-----------------|-----------------|
Absorption testing

| Absorption rate must not exceed 5% according to the standard | 2.1% | 2.9% | 6.25% |
|-------------------------------------------------------------|------|------|-------|
| Identical                                                  | identical | Failed |

As shown in table (11), the colours have not been effect on the absorption ratio and the absorption test is in accordance with the specification.

**Table 11.** Tests results in the concrete laboratories of the coloured models with a unified geometric shape-source (the researchers)

| Standards | Maroon colour | Yellow colour | Black Colour |
|------------|---------------|---------------|--------------|
| Absorption testing | Weight after flooding with water = 3.84 km | Weight after flooding with water = 3.86 km | Weight after flooding with water = 3.88 km |
|              | Weight after drying = 3.74 km | Weight after drying = 3.77 km | Weight after drying = 3.79 km |
|              | Absorption rate = (3.84 - 3.74) / 3.84 = 2.6% | Absorption rate = (3.86 - 3.77) / 3.86 = 2.3% | Absorption rate = (3.88 - 3.79) / 3.88 = 2.32% |

If the face is only dyed, it will be:

Absorption test: Weight after water logging = 3.91 km ----- Weight after drying = 3.76 km

Absorption rate = (3.91 - 3.76) / 3.91 = 3.83%

Note in Table (12) that the effect of colours negatively on the absorption, but it preferred concrete units by dyed face.

**Table 12.** Comparison of results - according to the colours in different parts / the researchers.

| Colours       | red | yellow | black | dyed face | Without colour |
|---------------|-----|--------|-------|-----------|----------------|
| Absorption testing | 2.6% | 2.3% | 2.32% | 3.83% | 2.9% |
| Absorption rate | identical | identical | identical | identical | identical |
| must not exceed 5% according to the standard | | | | | |

6.2. Tests of architectural and urban Considerations

A questionnaire of selected experts in architecture and urban design, on the final form of the same sample and the effects of the presence of colours or not through photographs of the pavement and the street or through the experience of the respondent through the street, where the questionnaire was (35) architects and details in the figures 9, 10, 11 and 12:
The research vocabulary and indicators that were found from the theoretical framework of the previous studies were examined and investigated:

The identity and personality of the sidewalk: By noting the figure 13 we find that the sidewalks of the streets of the city of Baghdad that were selected failed to achieve the identity, where the lowest assessment is in accent1 - the sidewalk Al-Binouk Street where it achieved (42) points, then Accent in the Al-Sinaea street (49) Point, then Attar Street (56), the highest rating was for the colour at Al-Binouk Street (66), then Attar Street (56), finally the Al-Sinaea (53), the sidewalk colour is of great importance in promoting the street identity.

Achieve communication between the pavement and the surrounding environment: The difficulty of walking because it is a decline in the level of pavement, non-use of colours makes it difficult to determine the path, either in the pavement in the Al-Sinaea street there is a difference in levels of the ground, because excesses of the shops and stores, which leads to focus on the track while walking by looking at the ground to avoid falling. See figure 14.

Accessibility: Surfaces with a slope of more than 6%, paving materials has posed tripping hazards and caused excessive vibration for wheelchairs, Paving had not been designed, installed, and maintained to be smooth and level. Surfaces had been interrupted by steps or abrupt changes in the level. See figure 15.

Accent is a variable, Similar to language but more distinctive depends on the nature of the place does not contain certain rules; it is a dialogue method between the residents and their place.
Meanings: This item was not taken into consideration. The decorations were not used in the floors of sidewalk; they were used in Al-Attar Street and the Al-Binouks. The research found the convergence of values, as shown in figure 16.

Fitness and Appropriateness of pavement: There is an acceptance in terms of use of Attar St., and an acceptance of the form of the Al-Binouk St. see figure 17.

Unity: As figure 18, the unity was achieved in the three models, because there is not variation. In each region the same geometric pattern was used, the typical repetition was clear, and the preference of Al-Sinae St. was equal in unity the part - and the part with the whole evaluated (61) to each.

Orientation: Through the use of colours to clarify and guide the movement, we can find guidance even in AL-Attar and the Al-Sinaea, perhaps because they are commercial streets, which overlap other factors to guide the walker, see figure 19.

The human scale: Figure 20 Route guidance, figure 21 illustrates the convergence in the human scale.
7. Conclusions:

7.1. Construction:
- The best types of sidewalks are Al-Sinaea sidewalks, because they have high compression resistance and low Absorption Rate, conforming to the standard specifications.
- The colours have a significant impact on the properties of cutting it negatively affect the compressive strength of the slabs.
- The dyed parts of the face only have a higher compressive strength than the dye entering the mixture.
- Colours do not affect the significant impact on the absorption test.

7.2. Architectural and Urban:
- The pavement works to realize the identity of the street and its personal image through colour, pattern, accent bond and definition of borders and edge.
- The sidewalks of Baghdad's chosen streets have failed to achieve identity, the accent has not accentuated the region to which it belongs, and the colour of the sidewalk is of great importance in enhancing the street's identity.
- The pavement must achieve dynamic and visual communication with and adjacent to the urban environment.
- It should achieve pavement accessibility by using colours to find the path.
- The use of decorations and colours on the floors has symbolic meanings.
- A balance must be achieved between the pavement's suitability for use and the proper shape.
- The unit must be achieved in terms of part with part - and part with all.
- Guiding the user during the course of the walk, through the use of colours that can illustrate and guide the movement.
- Achieve the human scale in shape and size.
- Streets sidewalks should use flags mix as per the specifications of the Streetscape Plan.

8. Recommendations:
1. Select surface materials with low maintenance requirements and high durability, slip resistance, and compressive strength.
2. The use of colours that reduce compression and durability and have many benefits in conveying certain meanings and guiding pedestrians, as well as determining the privacy and type of use of the walkway and aesthetic, should be balanced.
3. Design pathway with suitable dimensions to meet the needs of all people and achieve human scale.
4. Prefer the use of flag dyed face only instead of coloured in areas where colours in the design.
5. To carry out studies and researches for the different types of sidewalks and to study the rest of the sidewalks of the city streets to determine their suitability.
6. Achieving the safety factor for the walk.
7. The use of precast concrete flag with good absorption of rainwater and thus, achieving improvement of ecological rules and sustainability.
8. It is preferable to use high resolution interlocking flag for reuse, and to achieve sustainability of resources.
9. Where hued finishes are required, coloured cements will be utilized. The utilization of colours at the blender will not be allowed.
10. Extraordinary consideration ought to be paid to accessibility and comfort considerations of paving materials in choosing appropriate locations for various paving types.
11. Exceptional paving can be executed as a field treatment, steady over the whole walkway, or shared space, or can characterize explicit zones inside the streetscape. Where executed as a field treatment, it ought to be composed in ordinary or sorted out aesthetic patterns.
12. Pedestrian Crossings: Paving, texture, and colour treatments are particularly important in places where it is essential to make crossings more comfortable for users.
13. Material choices must be environmentally responsible, by use with recycled content materials, regionally harvested materials and rapidly renewable materials.

9. Acknowledgment
The authors wish to thank all Iraqi professors and architects, civilians and engineers, who shared their experience in this survey and helped in the practical study of this research.

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