Chapter Two

Literature review

2.1 Introduction

All parts of the bridge above the bearing are referred as super structure while all parts below are known as substructure. Main part of bridge superstructure is known as deck or road bed which it is the roadway, or the pedestrian walkway and surface of a bridge. It is not to be confused with any deck of a ship. The deck May be of concrete, steel or wood which in turn may be covered with asphalt concrete or other pavement. The concrete deck may be an integral part of the bridge structure (T-beam structure) or it may be supported with I-beams or steel girders *(floor beams)*. The deck may also be of wood, or open steel grating. Bridge deck is frequently supported on bearings which transmit the loads to abutment at the ends or to piers or walls [2].

2.2 Types of bridge deck

There are many types of bridge decks which are classified as the following [2]:-

1- Solid Slab deck,
2- Beam deck,
3- Voided slab deck,
4- Cellular deck,
5- Discrete box deck, and
6- Beam and slab composite deck.

2.2.1 Solid slab deck

This type of bridge deck is the most cost efficient for shorter span less than 20 meters. Bridge deck can be built with or without cantilevers. Bridge deck with cantilever has less weight with less reduction on second moment of area. And deck with cantilever also gives a benefit in its aesthetic value.

Solid deck can be simply constructed from in-situ concrete and pre-cast concrete as shown in Fig (2.1) below [3].

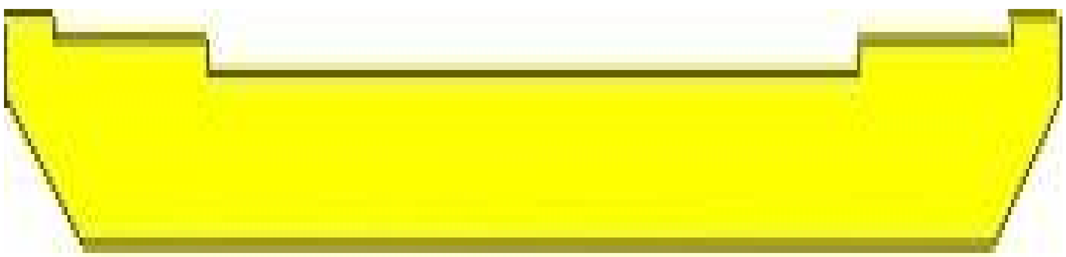

Fig. (2.1): Solid Slab Deck.

2.2.2 Beam deck

Beam deck is normally long and narrow and used as a pedestrian bridge or a flyover. Deck can be built with single span or double and usually supported with single or continues. Deck can be analyzed with manual calculation with static equilibrium equation with straight span as shown in Fig (2.2) below [3].

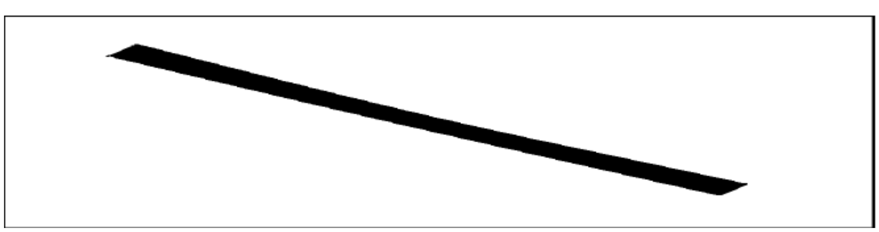

Fig. (2.2): Beam Deck.

2.2.3 Voided slab deck

Span length over than 20 meters is suitable to be built using voided rectangular slab, because it is cost –effective due to it is low in second moment of area. Deck is commonly built by reinforced concrete or post- tension beam.

Practically, voided slab is treated as same as solid slabs for the meaning of analysis. The void diameter is less than 60% of total depth ; also the void must be taken into the account when considering the design to resist transverse bending as shown in Fig (2.3) [3].

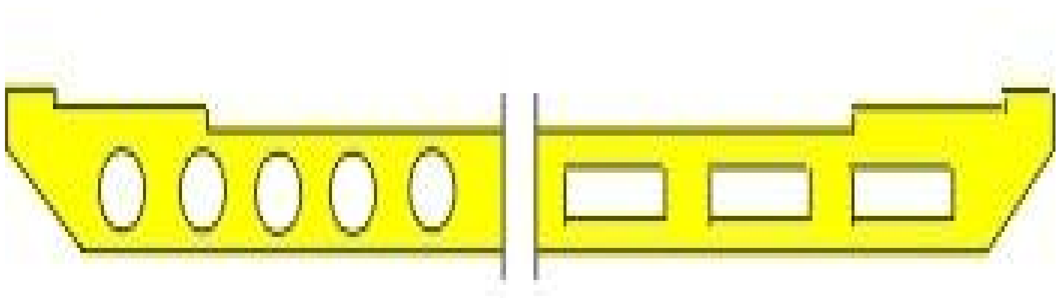

Fig. (2.3): Voided Slab Deck.

2.2.4 Cellular deck

It is more economical to use this type of deck for the span over 40 meters, because it gives higher second moment of inertia per unit weight. But it only Considered as economical at higher span when the structural depth is about 2 m it is easy for personnel to inter the void for maintenance and inspection of void as shown in Fig (2.4) below [3].

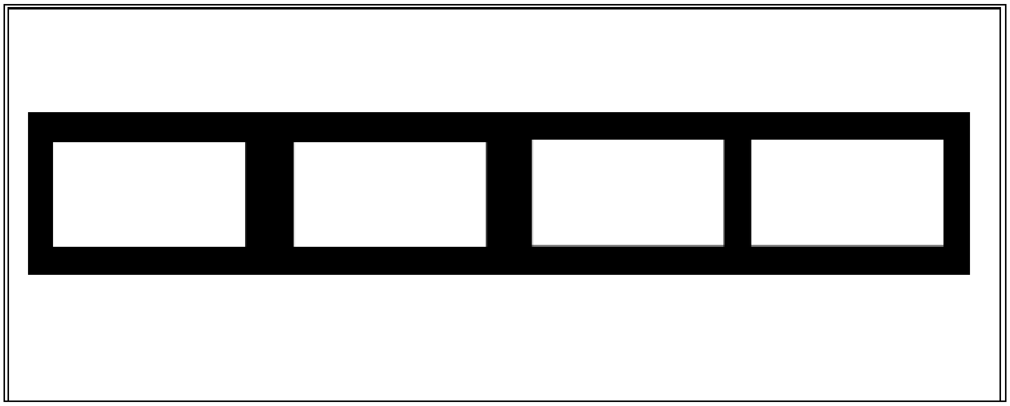

Fig. (2.4): Cellular Deck.

2.2.5 Discrete box deck

Suitable for span exceed 40 m box deck can be constructed for in-situ or pre-cast concrete , or else built compositely with a pre cast pre- tensioned U section and in-situ concrete slab as shown in Fig (2.5) below [3] .

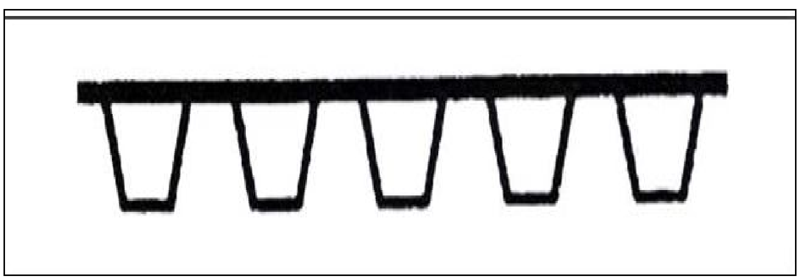

Fig. (2.5): Discrete box.

2.2.6 Beam and slab composite deck

Beam and slab deck is also known as T- section, and suitable for span in the range of 20 -40 m .The deck is very familiar to designer because it is easier to construct. The deck is less efficient than voided slab because, the structural form have more material close to natural axis of the bridge as shown in Fig (2.6) below [3].

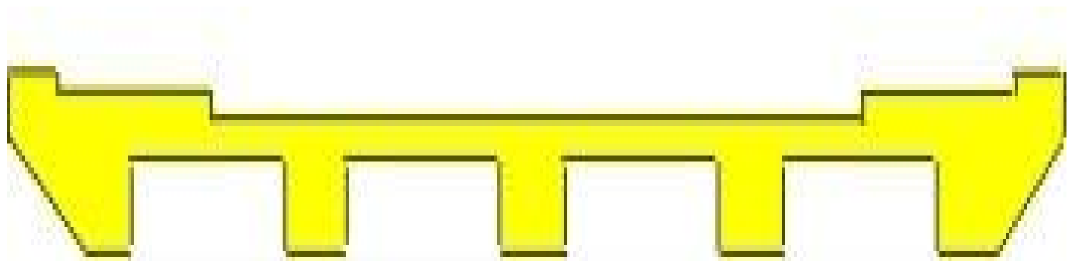

Fig. (2.6): Beam and Slab Deck.

2.3 Previous studies:-

2.3.1. Comparison of bridge decks modeling between beam and shell and 3D solid finite element models – (Mohd. A. shahruddin Bin longgo-Malaysia (2008))

Finite element analysis has been extensively in the study. Linear analysis has been done in determining the result for the analysis. Loading standard being used is BD 37/01. Analysis results are automatically obtained using LUSAS .Two models were employed in the study which was beam and shell and 3D solid model.

LUSAS software has shortened the time of analysis of bridge deck.
The critical node also can be found out to know which node has a critical value because of the sophisticated of LUSAS, it can analyze almost every

Type of structure with different geometry, data properties and different material has been investigated.

2.3.2 Finite-element analysis of bridge decks – (Mohammed. R – Abdelraouf- The Texas Highway Department, (1972))

Scoreless ' finite element method offers a good solution for bridge decks with rectangular configuration. The accuracy of this method of analysis may be slightly better than the analysis using the less-refined quadrilateral element of the present method. The two other methods of are limited to box girder type bridges.

The discrete-element method of analysis is a quick and accurate solution for slab-type bridge decks. For beam and slab-type bridges, the method still gives a good approximation if proper stiffness values are assigned to the beams. In cases of decks with narrowly spaced main beams and enough diaphragms to prevent excessive beam rotations, the common practice for selecting the composite section stiffness may be an accurate representation. In cases of widely spaced beams where considerable beam rotations exist, however, such composite section stiffness may not be a proper representation. One of the most serious limitations of the discrete-element analysis is the requirement of using a regular mesh which usually requires changes in the deck dimensions and in locations of supports and diaphragms.

In conclusion, it can be safely stated that the present method of analysis of bridge decks as shell-type structures offers a relatively good general solution with considerable flexibility. It can be used successfully to analyze a wide variety of bridges on rigid or elastic supports.

2.3.3 A finite element model for the analysis of bridge decks – (Onyia. M –E - Negeria, (2008))

The Results show that the finite element solutions of the bridge deck problem agree reasonably with the solutions obtained by the method of distribution coefficients, (less than 0.4% maximum mean difference). The proposed finite element model is there for acceptable and clearly offers more attractions than the chart-based method of distribution coefficients presently in use in many design offices. Reading the charts and interpolating between curves can be very tiresome and can easily introduce errors in the analysis. On the other hand, the finite element method, being computer-based, is incomparably faster and less prone to errors .Again; it is not limited to only simple supports as in the method of distribution coefficients. It can analyze the deck for more complex support and loading conditions. The versatility of the proposed model can be improved by including shear deformation in the formulation in order to cater for T-beam bridge decks with deep beams.