Design Of Overhead Roadway At Road Intersection

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Abstract: This project deals with the Design of overhead-roadway located at CHALLENGE junction which is a T-junction. Analysis of the existing conditions was carried out to proffers solution to the cause of the problems occurring due to the vehicle competing for space at this intersection. Before carrying out the analysis, a traffic surveys at peak hours, for morning (07:30 to 08:30 am) and afternoon (03:00 to 04:00 pm) were conducted using 15 minutes interval. From the analysis, it was found out that the peak hour factor and flow rate was 0.88 and 1656pcphpl respectively, corresponding to LOS E. This implies that the capacity of the existing road is no longer able to accommodate the traffic flow; hence, overhead roadway was introduced to improve the efficiency of the intersection. The overhead-roadway is of 140 m length with 7 spans, 20 m per span. It consists of a deck slab, longitudinal girders, cross girders, deck beam, pier, foundation and retailing wall. All structural parts for this Flyover were designed using Staad professional software package and Manual method.

Index Terms: capacity, flow rate, intersection, LOS, overhead-roadway, peak hour factor, staad-pro

1 INTRODUCTION

Transportation is one of the most fundamental systems in the world today [5] and with rapid developments in economy, society and level of urbanization, the need for mobility is correspondingly soaring. Individuals increasingly rely on the ability to travel longer distances in shorter amounts of time to achieve their personal and professional tasks. Information for public growing traffic levels and their related externalities have prompted research into methods to alleviate urban traffic congestion. To ease traffic congestion at an at-grade intersection near a big city, one method is construction a flyover bridge at the old junction in two directions on one of the main highways. The flyover-bridge intersection is an intersection that has a special bridge constructed over an at-grade intersection to allow for the free flow in two directions on one of the main road – to increase capacity of traffic flow and reduce the traffic congestion in both of these directions, but underneath of the bridge, the existing traffic signalization is still used to control traffic as the situation before [7]. Development of flyover is aimed at the realization of a national transportation system that is reliable, highly skilled and organized effectively to support and drive the dynamics of development and at the same time, supports the mobility of people, goods and services

2 AIM AND OBJECTIVES

Aim of this project is to observe whether the existing road intersection is adequate to furnish to the current traffic volumes and if found inadequate to design an overhead roadway at this intersection as a panacea to accommodate to the anticipated future traffic.

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Towards fulfilling this aim, the objective of the study would be to justify and design a solution for the safe movement of vehicular traffic at the Challenge junction by paying attention to the following:

- Identification of peak hours based on available traffic data.
- Determination of Current Level of Service and Service flow rate for Challenge juction
- Carrying out the structural design of the proposed flyover.

3 THE COMPONENT OF THE PROJECT

This project consists of main deck slab, deck beam, piers, girders, foundation and retailing wall. The bearing capacity of soil 245 kN/m². The width of road is 8m, length o deck is 40m, c/c of pier is 20m, cross beam as also being placed at 4m c/c. The dia of pier is 1.2m.

4 DESCRIPTION OF STUDY AREA

The Challenge intersection is a T-type time sharing intersection with three approaches which include, the minor (Ahmadu Bello approach) intersecting the two major approaches (namely the A-Division approach and the Post Office approach) at approximately right angle. The intersection is controlled by human traffic wardens between 7:00am and 8:00pm. It however operates as priority intersections when they are not controlled. All the legs are alienated by a median. Whereas the A-Division approach and Post Office approach have three lanes each, Ahmadu Bello approach has only two lanes. The approach slope at Challenge ranges from -4.22% for Ahmadu Bello approach to 0.12% for UBA approach while Post Office approach has a slope of -0.06% [1]. All the approaches are paved with asphalt and the surfacing are in good condition. The pavements however have no lane markings.

5 METHODOLOGY

5.1 TRAFFIC STUDY

Traffic surveys were carried out from 7:30 am to 8:30 am and 3.00pm to 4.00pm which represent morning and evening peak hours respectively using 15 minutes interval. This time was selected on the basic of the past traffic study as an average of peak hour. The following information was obtained during the survey:

- Collection of turning movement survey results.
- Obtaining the Level of Service (LOS) from the existing road section.
- Introduction of a flyover bridge to cater to the main traffic flows.
- Carrying out the traffic volume forecast for the next twenty years.

5.2 TRAFFIC LOADINGS

This project is design are for the HA loading "HIGHWAY 'A' LOADING" (a uniformly distributed loading plus knife edge load applied to each traffic lane) together with HB loading "as normal vehicle loading" for structures carrying main highways. These loadings are deemed to allow for dynamic and impact effect. One unit of HB loading is a 10kN/axle loads (2.5kN/wheel) (6.3.1 BS 5400: part two). Bridges are generally designed for HA loading and checked for the effect of a specified number of unit HB loadings [2]. Nigeria FMW (2013) specified the use of 45 units for bridges design.

5.3 STRUCTURAL DESIGN OF THE FLYOVER

- Piers were introduced to the flyover taking in to consideration the maximum span of the available beams (20m) so as to ensure minimum obstruction to the access roads to the Challenge junction.
- Pre-stressed concrete beams were designed using BS 5400.
- Piers were designed according to the guidelines given in BS 5400.
- Analysis and Design of flyover using Staad professional software and manual. 3D model of the proposed overhead roadway in Staadpro is shown in figure 1.0

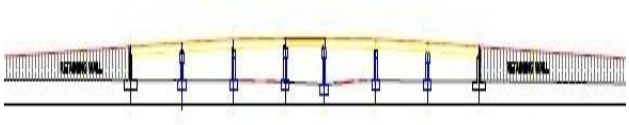

Figure 1.0: *Proposed overhead roadway*

6 RESULTS

6.1 TRAFFIC COUNT

The traffic flow along a road does not remain constant throughout a day or week but varies with both space and time. Table 1 shows the observed number of vehicles during the time periods mentioned and is also presented in Figure 1.

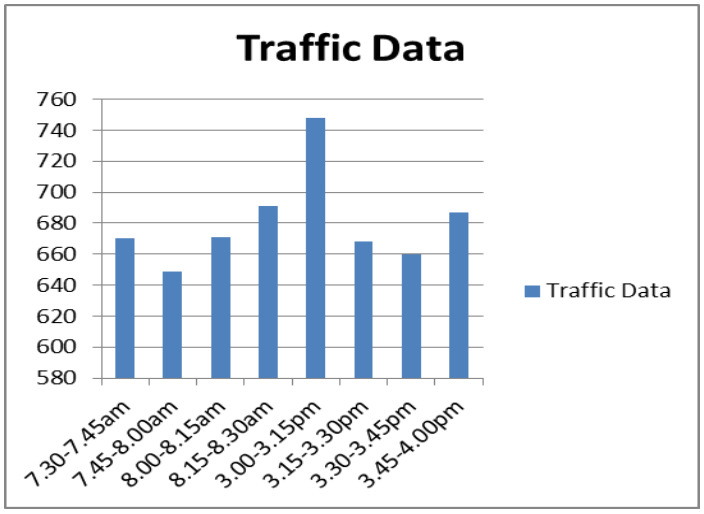

Figure 2.0: *Traffic count*

Table 1: *Traffic Census data*

Time interval	No of Vehicles	
7.30-7.45am	670	
7.45-8.00am	649	
8.00-8.15am	671	
8.15-8.30am	791	**2781**
3.00-3.15pm	748	
3.15-3.30pm	668	
3.30-3.45pm	660	
3.45-4.00pm	687	**2763**

6.2 DETERMINATION OF CURRENT LEVEL OF SERVICE AND SERVICE FLOW RATE

The level of service criteria for multilane and two lane highways are defined in terms of vehicle density and is a measure that quantifies the proximity of vehicles to each other within the traffic stream and indicates the degree of maneuverability within the traffic stream [6]. The LOS was calculated for challenge junction using the traffic volume survey data. The peak hour volume during the period from 7:30 am to 8:30 am was considered.

No of lanes = 2
Type of terrain = leveled terrain
Full hour volume, V = 2781vph
Maximum 15 min volume = 791vph
Peak hour factor =2781/ (4x791) = 0.88
Service flow rate, , $V_n = V/N \times PHF \times F_{HV}$ (1)
Calculating adjustment factor for heavy vehicles (F_{HV}),
$F_{HV} = 1/1 + P_T(E_T - 1) + P_R(E_R - 1)$ (2)
Percentage of trucks and buses = 6 / 2781, (P_T) = 0.075
Percentage of RVs, (P_R) = 0
Passenger car equivalent factor for trucks and buses, (E_T) = 1.5
Passenger car equivalent factor for recreational vehicles, (E_R) = 1.2
(Table 7.3: Highway Capacity Manual, 1985)
Therefore, F_{HV} = 0.96
And flow rate = 1646pcplph
It is seen that the current LOS for this stretch is E (Figure 7-4: Highway capacity manual, 1985) which is unsatisfactory. The

existing road stretches where LOS is lower than D need to be improved, hence the need for flyover.

6.3 Details of Deck Slab Section

Slab is supported on the four sides by the beams.
Thickness of the slab = 250 mm
Thickness of the wearing coat = 50 mm
Span in transverse direction = 2.5 m c/c
Span in longitudinal direction = 4 m c/c
Deck slab is designed for maximum moment due to deck action with the deck beam is designed as a cantilever on a pier as shown in figure 3.0.

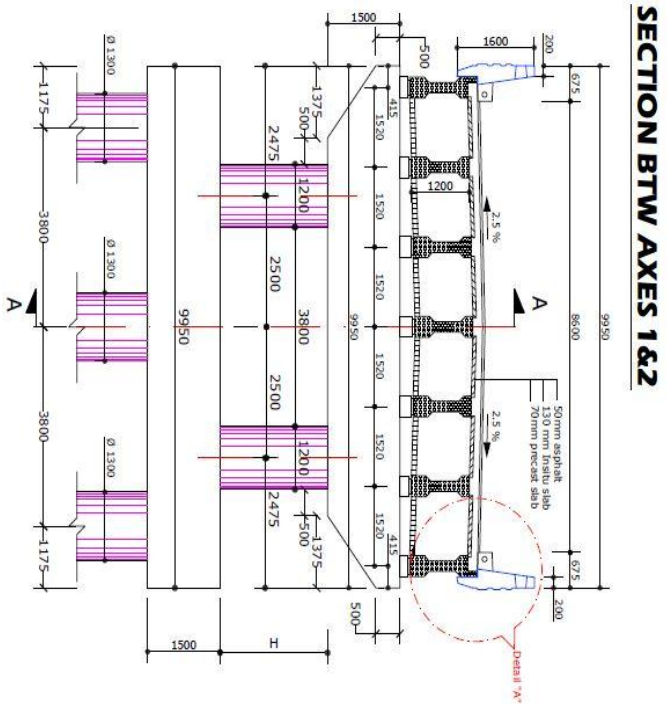

Figure3.0: *Sectional views between axes*

6.4 Details and Design of Beam Section

Pre-stressed "I" section beams were carefully chosen for the flyover. The maximum span was at the bay above the intersection. Grade 40 concrete was used for the beam and the design was done according to required dimensions using BS 5400:1978 Part 02, BS 5400:1978 Part 04 and BS8110:1997 codes.

6.5 Design of Piers

Circular reinforced concrete columns of 0.8m diameter and grade 40 concrete was selected for the piers used to support the flyover deck. Piers were designed for the axial dead load and live load from the slab, girders, deck beam using BS 5400.

6.6 DETAILS OF FOOTING

Axial load = 5000 kN
S.B.C. of Soil, q0 = 245 kN/m²
Angle of repose, φ = 30°
Weight of soil, We = 20 kN/m²
Figure 4.0 shows details of the footing

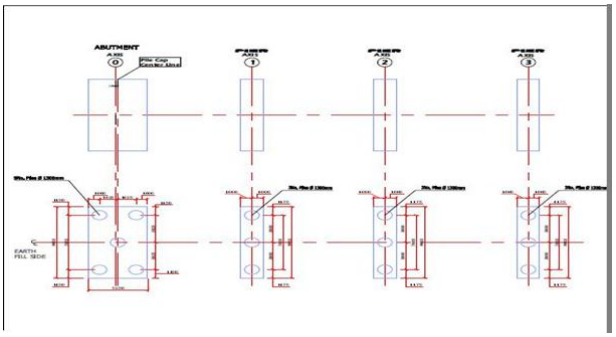

Figure 4.0: *Details of footings*

6.7 DESIGN OF RETAILING WALL

Height of embankment above ground level = 4.4m
Axial load = 5000 kN
Safe Bearng Capacity of Soil = 245 kN/m²
Angle of repose = 30°
Co-efficient of friction = 0.5
Unit Weight of soil, = 20 kN/m²

7 Conclusion

The design of the flyover was done as a panacea to ease congestion at Challenge junction. The location of the flyover was decided based on the prevailing operating conditions. Pre-stressed material was proposed for the flyover considering economic reasons with pre-stressed concrete, and in-situ reinforced concrete proposed for beams and piers respectively.

Acknowledgment

The authors wish to thank Kavnee for helping in carrying out the traffic survey used in capacity analysis of challenge junction.

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