Design of a Pedestrian-Steel Bridge Crossing Auchi-Benin Expressway

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Abstract

This research study was to design a pedestrian steel bridge at Auchi Polytechnic Hostel Gate across Auchi-Benin Expressway so as to provide a safer and easy route for the users, especially students and also to reduce accident rate. The work involved the feasibility study of the chosen sections such as soil analysis, design of the structural components of the bridge,(beams, floorplate, column and foundation) which were designed to British Standard (BS 5400, BS 5950, BS 8110). Soil allowable bearing capacity of 233KN/m 2 was established. This was used for the design of the pad footings for the steel stanchions whose dimensions were 1300 mm * 1300 mm * 450 mm and also the specification for plate was 80 mm *2 mm, staircase beam; 254 *102 * 28UB beam for bracing; 127*76*46UB, walkway beam; 356*171*57UB, landing; 254*102*28UB, column; 203*203* 46UC and foundation reinforcements were found to be 6Y20mm@300c/c (As=1050mm 2) in each direction.

Index terms— pedestrian, beams, design, foundation, structural components, column.

1 I. Introduction

he world faces today the big challenge of traffic accidents that harvest annually millions of human lives ??Muhammad, 2013). The consequences of these traffic accidents do not only affect the victims or their families, but extend to the impact the community and its progress ??Muhammad, 2013). Pedestrian bridges are structures made for allowing pedestrians to cross a street/road/highway without being exposed to the risks of car accidents. A pedestrian bridge is any structure that removes pedestrians from vehicle roadway ??Muhammad, 2013).

The first pedestrian bridge in Nigeria was a steel structure erected at Idumota cenotaph on Lagos Island (The Guardian, 2015). However, according to the Guardian newspaper, two such concrete bridges were also constructed: one in Iddo railway terminals across the road and the second was from Oyingbo to Otto near the old Leventis mainland hotel. The two bridges were planned towards the 1960 independence celebration. The construction work was carried out by Taylor Woodrow Construction Company (The Guardian, 2015). It was a major event on its own in those days especially considering the swampy terrain that the bridges were required to cross through. With the advent of the third National Development Plan ??1975) ??1976) ??1977) ??1978) ??1979) ??1980), reinforced concrete bridges on piles and prefab deck were constructed over Apapa-Oshodi expressway and the Agege Motor Way at Ikeja. A bridge is a structure that provides passage over an obstacle such as valley, rough terrain or body of water by spanning those with natural or manmade materials (Newman, 2003; ??osley and Bungey,1999;Jeswald, 2005).

According to ??ugu (2004) a footbridge or pedestrian bridge is principally designed for pedestrians and in some cases cyclists, animal traffic and horse riders rather than vehicular traffic. Recently the Lagos State Government erected a multi-functional pedestrian structure at Oshodi (The Guardian, 2015). The current governor of Lagos State, Akinwumi Ambode, has approved the construction of pedestrian bridge at Berger area of the State to give room for easy crossing by pedestrian of the ever busy Lagos-Ibadan expressway (P M News, 2015). In Benin City, Edo State of Nigeria, there was a pedestrian steel bridge constructed at close proximity to the University of Benin main gate but was dismantled because of the dualisation of the road by the Edo State Government. Types of pedestrian bridge include: simple suspension, clapper, moon, stepstone and zigzag bridge Increasing rate of accident at the hostels' gate of Auchi Polytechnic is worrisome. This involves either two or more vehicles or at times two or more motor bikes. The fatal ones always attract the attention of the Federal Road Safety Corp (FRSC) who needs to evacuate the vehicles and the injured in order to allow the free flow of traffic. The main victims of hit and run by vehicles and bike riders especially at night have been the students living on and off campus of Auchi Polytechnic, Auchi. Thus this development necessitates the design and construction of a pedestrian bridge across the Auchi-Benin highway.

2 II. Materials and Methods

3 a) Study Area

This study focuses on the design of pedestrian bridge across the Auchi-Abuja Highway in front of Auchi Polytechnic, Auchi main entrance gate. b) Design consideration, calculations and analysis i.

4 Soil Test

The following geotechnical parameters were determined as follows: (%) = ??? % ?????????????????????????????????????? [2] Coefficient of uniformity (cu) = ??30 ??60 ? x D10 [3] Coefficient of uniformity (cu) = ??60 ??10 ? [4]

ii. Specific Gravity Test (Gs) Given:Gs = (M 2 -M 1)/ (M 2 -M 1)-(M 4 -M 3)

iii. Density Test Volume of cutter (V), mass of wet soil (M), Bulk density and dry density were computed as follows:?? = ???? 2 ?? [5] M= M 2 -M 1 [6]

Global The outputs of the design analysis indicate that the chosen sections for all the structural members of the footbridge are adequate in term of ultimate and serviceability considerations. The soil analysis shows that it would be able to withstand the load from the columns and vibrations from vehicular movement. [1]

2

Figure 1: 2

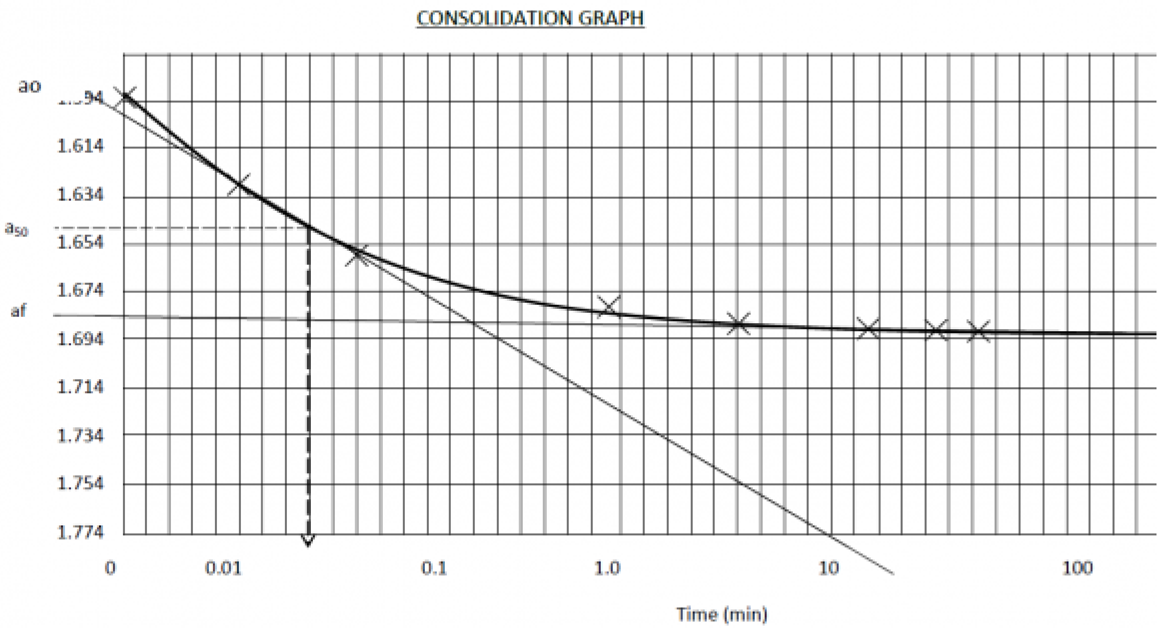

Figure 2:

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1

S/N	Observation and Calculations	Determination No	
		1	2
1	Density	4267.0	4331.0
2	Weighty of Empty Bottle (M 1) (g)	26.6	26.6
3	Weighty of Bottle +Sample (M 2) (g)	56.6	56.6
4	Weighty of Bottle + Sample H 2 O (M 3) (g)	94.0	94.1
5	Weighty of Bottle + Sample + H 2 O (M 4) (g)	77.6	76.6
6	M 2 -M 1 (g)	30.0	30.0
7	M 4 -M 3 (g)	13.6	13.5
8	Gs	2.2	2.2
Result	Density Gs = 5	2.2	2.2
			Field data, 2016

Figure 3: Table 1 :

2

S/N	Observation and Calculations	Determination No	
		1	2
1	Core Cutter No	501.0	502.0
2	Internal Diameter (cm)	10.0	10.0
3	Internal Height (cm)	13.0	13.0
4	Mass Of Empty Core Cutter (M 1)g	900.0	900.0
5	Mass Of Core Cutter With Soil (M 2)g	2900.0	2600.0
6	Mass Of Wet Soil M= M 2 -M 1	2000.0	1700.0
7	Volume Of Cutter (V) (cm 3)	1021.0	1021.0
8	Moisture Content	0.1	0.2
9	Bulk Density = Wt of Soil / Vol of Cutter (g/cm 3)	1.96	1.67
10	Dry Density (g/cm 3)	1.75	1.45
			Field data, 2016

Figure 4: Table 2 :

3

Test No.	Load	Shear Stress at Failure (KN/M2)	Normal Stress (KN/M2)
1	10	38.0	49.0
2	20	56.0	77.0
3	30	66.0	104.3
			Field data, 2016

Figure 5: Table 3 :

4

Time (Seconds)	Mass 1 10 kg	Maxx 2 20 kg	Mass 3 30 kg
5			
10			1
15			1
20			1
30			1
60			1
90	1		13
120	2	29	56
150	4	46	75
180	16	54	87
210	30	61	93
240	40	71	93
270	47	76	106
300	50	82	105
330	52	86	109
360	53	87	112
390	57	92	115
420	61	97	
450	62		
480	65		
510	65		
540	66		
570			
600			
630			
660			
690			
720			

Field data, 2016

Figure 6: Table 4 :

5

?H	?e = 0.0565 ?H	? = ? -?e
0	0.00000	0.513
0.86	0.04859	0.464
1.16	0.06554	0.448
1.43	0.08079	0.432
1.59	0.08984	0.423
1.69	0.09549	0.448

c) Design of Structural Elements
i. Live Load for Footbridge
For loaded length in excess of 30m
Live load, qk = k x 5.0KN/m 2

Where,
K= nominal HA UDL for appropriate
loaded length (in KN/m) 30 KN/m
HA value for loaded length (32.4m) = 29.1 KN/m
Therefore,
K=29.1 KN/m = 0.97
30 KN/m

But qk = k x 5.0 KNlm 2
Therefore, qk = 0.97 x 5.0 KNlm 2 = 4.85 KN/m 2
ii. Steel Plate for Treads
Assume 300mm x 2400mm size
Plate Loading
Dead load from plate
=25.55kg/m 2 x0.3mx2.4m+25.55kg/m 2 x0.147mx2.4m
=27.41kgx10=274.1Nx10 -3 =0.274KN Characteristic impose load =2.4m x0.3m
x4.85kN/m 2 =3.49KN Impose load on riser/tread=3.49x22=76.78KN
Design load, n=1.4gk+1.6qk
=1.4x0.274+1.6x76.78=123.23KN
Bending moment
BM max = WL/8
=123.23x0.3/8 =4.62KNM
For short span girder
Span/depth=12
Span/depth=15 2390mm/depth=15

Depth=2390mm/15=159mm?160mm Since d=160mm>150mm; take p y =225N/mm 2
Area of flanges, Af=M/d x p y

=4.62x106/16
4620000/3600
Width of the
[17] =0.5x160mm=
128.33/80=1.
Assume a pla
Area=80x2=1
[18] The section c
Adopt the sec
For the Web

T? 160/20=1.
Since T is a li
flanges for the
Section Classi
Flanges
T=160mm; p
But
?" =(275/225
2
T=160mm
b/T=39/160=
[19] For welded se
b/T=13x1.11
Therefore, the
Serviceability

W = 1.0gk +
[20] Where, E=20

Figure 7: Table 5 :

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