Effect of Flood on Bridge Pier

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Abstract :This project focused on the use of computer software (MIDAS/CIVIL) for the modelling and analysis of bridge pier due to the effect of flood with University of Ilorin bridge as case study. The primary objective of the project was determining the effects of flood on bridge components. The methodology used involved the collection of data on the existing University of Ilorin Bridge, analysis of the bridge pier both manually and with computer analysis using MIDAS / Civil engineering software. The maximum stress and shear force were found to be 22.20kN/m^2 and 373.93kN at the toe of the pier, the maximum moment was found to be 1703.53kNm while the maximum deflection was 207.51mm at the top of the pier.

***Keywords**: Bridge, flood, pier, midas*

1.0 Introduction

A flood is a natural event that can have far reaching effect on people and environment. Put simply, a flood is too much water in the wrong place. Flood occurrence is a natural phenomenon which occurs as a result of heavy down pore of rain water where the excess water over topped its natural bank or hydraulic carrying capacity of the channel.

Flooding is one of the major environmental crises we have to contend with during this century. This is especially the case in most wetlands of the world. The reason for this is the general rise in sea level globally, due to global warming as well as the saturated nature of the wetlands in the Niger Delta. Periodic floods occur on many rivers, forming a surrounding region known as flood plain. Rivers overflow for reasons like excess rainfall. The good thing about river overflows is the fact that as flood waters flow into the banks, sand, silt and debris are deposited into the surrounding land. After the river water subsided and go back to its normal flow, the deposited materials will help make the land richer or more fertile. The organic materials and minerals deposited by the river water keep the soil fertile and productive (Abowei and Sikoki, 2005).

1.2 Description Of Study Area

University of Ilorin is located in the ancient city of Ilorin about 500 kilometres from Abuja, the Federal Capital Territory and about 15 kilometres from the city centre (Ilorin), the capital of Kwara state and it is situated between latitude and longitude 8^0 28’04.67’’ and 4^0 39’45.97’’ respectively. University of Ilorin Bridge is located about 8.2 kilometre from the university gate and about 2 kilometres from the senate building (Amao, 2010).

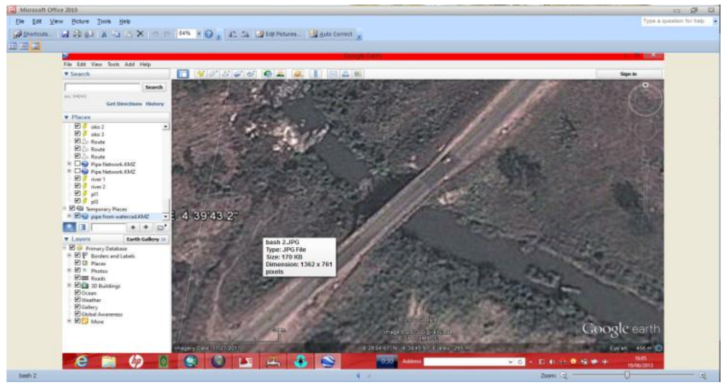

Figure 1.1 University of Ilorin Bridge

2.1 MATERIAL AND METHODOLOGY

2.1.1 Data Collection

Technical report on the annual rainfall for Ilorin metropolis was obtained. Rainfall data to monitor the increasing rainfall intensity in Ilorin was obtained at Lower Niger River Basin Development Authority; it is shown in Appendix and represented graphically below

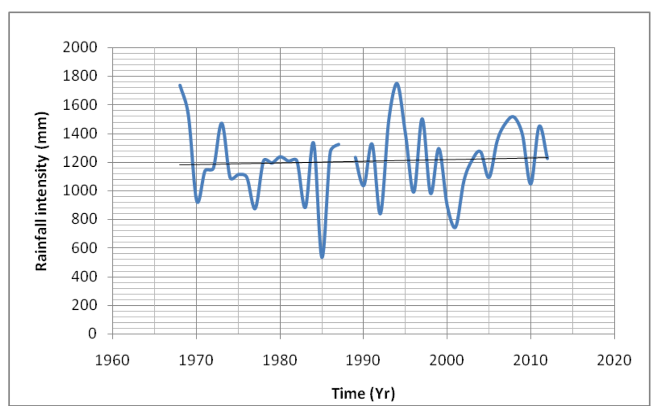

Fig 2.1 Graphical Representation of Rainfall Intensity in Ilorin (1968-2012)

2.1.2 Loading

The main objective of any structural analysis is to determine the value of the forces, stresses, moments and deformations (deflections and rotations) which are caused on each element of a structural system due to the effect of the loading experienced. Hence, the estimation of loads is of great significant in any structural analysis.

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The bridge was loaded according to the BS 5400: part 2: 1978 and modification were applied where necessary to design code specifications.

(a) Dead loads

These are the permanent load of the materials and parts of the structure that are structural elements, but excluding superimposed loads such road surfacing, rail ballast, parapets, mains, ducts etc.

(b)Superimposed dead load

These are also permanent load of all materials forming loads on the structures that are not structural elements.

(c)Live loads

These are loads due to vehicle or pedestrian traffic. Standard highway bridge loading consists of HA and HB loading. HA loading is a formula loading representing normal traffic while HB loading is an abnormal vehicle unit loading. Type HA loading consists of uniformly distributed load (UDL) and knife edge load (KEL) of a single wheel load.

HA (UDL) $W = 336(1/L)^{0.67}$ for $0 < L < 50m$

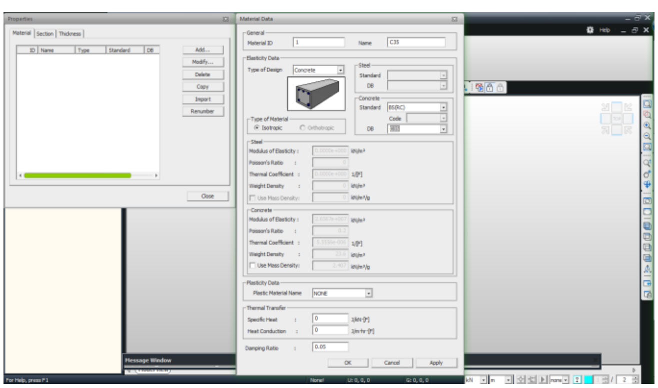
$W = 36(1/L)^{0.1}$ for $50 < L < 1600m$

2.1.3 Analysis of bridge pier

Computer Modelling of the bridge pier with Midas civil

The steps involved in the modelling and analysis of the bridge pier are as followed:

1. Setting the SI units
2. Defining materials
3. Creating groups
4. Assigning boundary condition
5. Defining and Assigning of loads
6. Setting analysis option and run the analysis
7. **Display the desired Results**



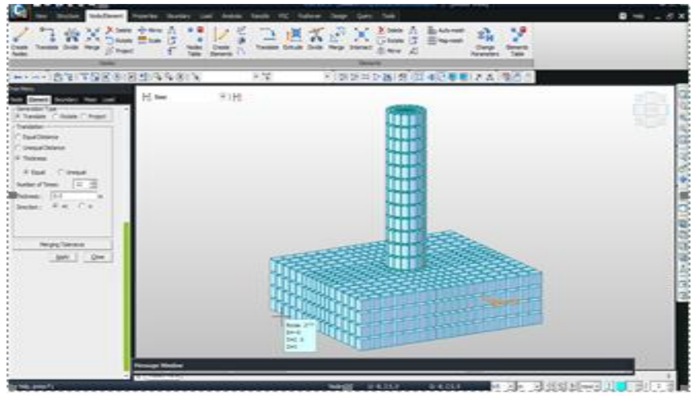
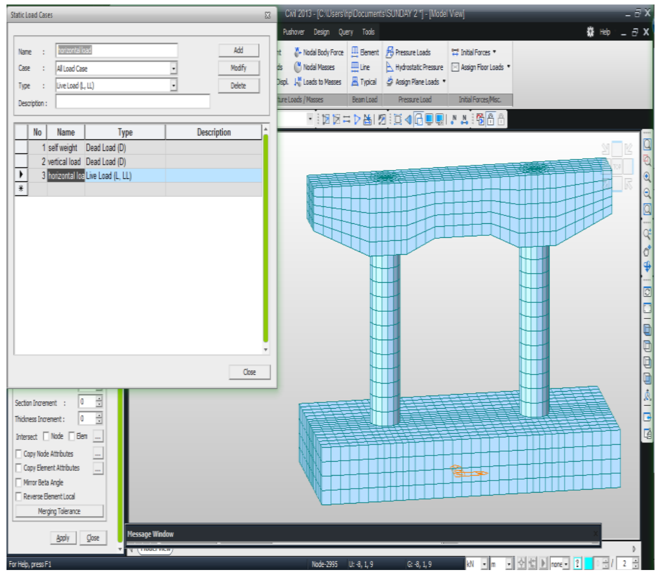


Figure 3.2 (a) project setting
Figure 3.2 (b) Extruding column



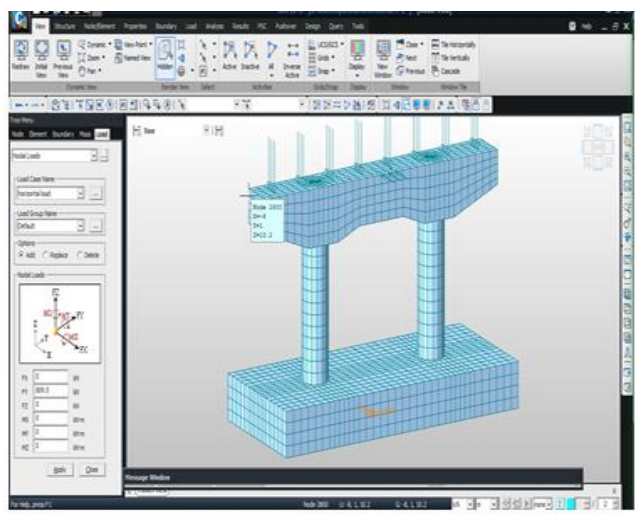


Figure 3.2 (c) structural model
Figure 3.2 (d) structural analysis

3.1 RESULTS AND DISCUSSION

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3.1.1 RESULTS FROM MANUAL AND COMPUTER APPLICATION

The Results from the application of the computer software are shown in the fig. 4.0 and 4.1

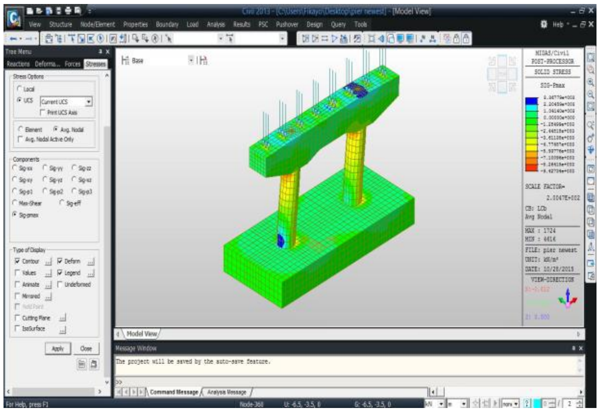

Figure 3.1 Stress Shape Result

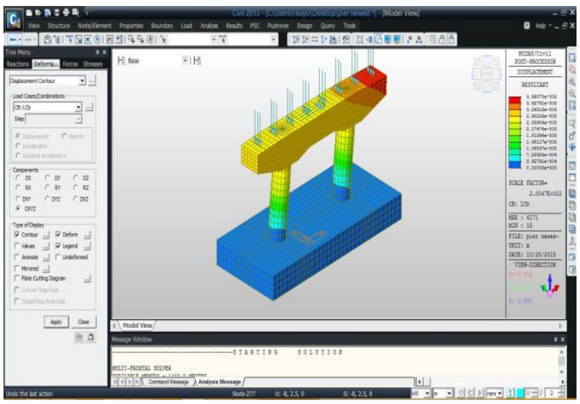

Figure 3.2 Displacement Shape Result

Table 3.0: Results from manual calculation

Nodes	SHEAR FORCE (kN)	MOMENT (kNm)	DEFLECTION (mm)
1	5.29	1097.75	207.51
2	276.18	1703.53	6.17
3	373.93	237.47	1.58

The table below shows the results from both manual calculation and computer software (MIDAS) analysis for the stresses, moment and deflection.

Table 3.1: Results for both manual and computer application analysis.

	MAXIMUM STRESS (kN/m^2)	MAXIMUM MOMENT (kNm)	MAXIMUM DEFLECTION (mm)
MANUAL CALCULATION	**22.20**	**203.22**	**207.51**
COMPUTER SOFTWARE (MIDAS)	**56.34**	**295.33**	**223.2**

3.2 DISCUSSION OF RESULTS

The Maximum stress and shear forces were found to be **22.20kN/m^2** and **373.93kN** at the toe of the pier, the Maximum Moment was found to be **1703.53kNm** and the Maximum Deflection was **207.51mm** at the top of the pier.

3.3 DEGREE OF ACCURACY

The results of the manual calculation and computer application were compared, and the percentage accuracy followed.

TABLE 3.2: Comparison between Manual and Computer Results

VARIABLES	MANUAL CALCULATION RESULTS	COMPUTER RESULTS	DIFFERENCE
MAXIMUM MOMENT (kNm)	**224**	**255.33**	**31.33**
MAXIMUM SHEAR (kN)	**373.93**	**116.14**	**11.64**
MAXIMUM STRESS (KN/m^2)	**22.20**	**56.34**	**34.14**
MAXIMUM DEFLECTION (mm)	**207**	**223.2**	**9.2**

4.1 CONCLUSION

Based on the results from both manual and computer application, it can be concluded that the bridge pier will deflect at the Maximum of 207.51mm and also the flood will erode the pier by exposing the reinforcement which can reduces the strength of the piers. The use of the finite element method of analysis was justified and the application of the MIDAS/ Civil software was found to be time saving, less fatigue and of higher accuracy compared with rigorous manual method of analysis.

REFERENCES

i. *AASHTO, 1996. Standard Specification for Highway Bridges, Sixteenth edition. American Association of State Highway and Transportation Officials.*

ii. *Abowei, J.F.N. and F.D. Sikoki, (2005). Water Pollution Management and Control Double Trust Publications Co., Port Harcourt, p: 236.*

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1 March. 2016

iii. *Adekunle, S.K. (2003), Finite Element Analysis of Bridge Deck, Final Year Project, Submitted to Civil Engineering Department, University of Ilorin.*

iv. *Adelye, A. and Rustum, R. (2011). Lagos (Nigeria) Flooding and Influence of Urban Planning. J.Urban Design and Planning (ICE), 164(3): 175-187. ISSN: 1755-0793, E- ISSN: 1755-0807.*

v. *Akin. J.E. (1994). Finite Element Analysis For Undergraduate, Harcourt Brace Jouanounch Publishers, U.S.A.*

vi. *Amao, T. K. (2010), Effect of Sedimentation Rate on the Life Span of a Reservoir (A Case Study of the Unilorin Dam), final year student project in the Department of Civil Engineering, University of Ilorin.*

vii. *Fagan, M.J. (1992), Finite Element Analysis: Theory and Practice, Pearson Limited, England.*

viii. *Karunthanakul T., 1998. Local Scour around Row Bridge Piers. Master's Thesis Department of Hydraulic Engineering, Chulalongkorn University.*

ix. *Microsoft ®Encarta ® 2009. © 1993-2008 Microsoft Corporation.*

x. *Nigel, R. N. (2003), Prestressed Concrete Bridges: Design and Construction. Thomas Telford Limited, London.*

xi. *"The Bridge Structure", May 2010.(www.wikki.bridge-structure). Accessed on 15th November, 2012.*