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## Pier Failure of Bridge and Geotechnical Investigation – A Case Study

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## PIER FAILURE OF BRIDGE AND GEOTECHNICAL INVESTIGATION A CASE STUDY

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### ABSTRACT

In this paper a case of foundation failure, due to which the complete bridge structure has collapsed, is considered. The bridge is situated in Km. 26/6 on Langi Durg Road. It was constructed in the year 1980-81. This bridge has two solid slab spans of 15.25 meters each. The substructure is of solid coarse rubble stone masonry. The base dimensions of pier foundation are 3780 mm. in traffic direction and 10080 mm. in current direction at R.L. 94.00m. The pier foundation is resting on bouldary strata. During the floods in the year 1995 the pier constructed in mid-stream failed. This brought down both the deck slabs of the bridge at the bed level. Both the deck slabs are in good condition and it is proposed to use them by lifting of slabs and reconstructing central pier after complete investigation of founding strata.

### KEYWORDS

Pier, Failure, Bridge, Collapsed, Investigations, Geotechnical, Desig Restoration.

### INTRODUCTION

Without adequate knowledge of foundation engineering it is not difficult but impossible to design a safe and durable foundation. Whether a particular type of foundation and its depth has proved to be successful over years could be known through previous experience. In addition to this geological and geotechnical investigations of the site are important factors to decide the type and the proper positioning of foundations and to give insight to the substratum through which the foundation is to be taken. These investigations could give a detailed picture of the underlying subsoil and rock and can result in considerable economy and durability.

In India about 40 years ago the practice of geotechnical investigation was limited to taking trial pit for foundation for a depth of 3 meters to 4 meters. In respect of deep foundations where hard strata is not available at shallow depth, the depth was decided by calculating scour depth by empirical formulae or on the basis of bore hole data, if rock was available in river bed no investigations were considered necessary.

Investigations of some of old bridges showed that the same are resting within 3 meters from bed level. The simply supported slab bridges has been rested on soil and these bridges have withstood for 50 years without settlement. In bouldary strata it is very difficult to decide the foundation level. As the streams in the hilly track flows with high velocity disturbs the binding soil of the boulders and the strata becomes hollow the foundations gets loosened and with passage of time due to uneven settlement such failure takes placed.

The present study deals the case of foundation failure of bridge on Langi-Durg Road.

### SALIENT FEATURES

This bridge is situated in Km. 26/6 on Langi Durg Road near Balaghat district of state of Madhya Pradesh, India. The bridge was constructed in year 1981.

Salient features of the old bridge are as follows:

1. Catchment area	:	15.63 sq miles.
2. Velocity	:	4.57 m/sec.
3. Formation Level	:	R.L. 104.05 m.
4. Foundation Level	:	R.L. 94.00 m.
5. High Flood Level (HFL)	:	R.L. 101.860 m.
6. Lowest bed level	:	R.L. 99.40 m.
7. Length of bridge	:	30.50 m (between faces of dirtwall).
8. Width of bridge	:	7.5 m. carriage way with 0.45 wide kerb.
9. Span arrangement	:	2 spans of 15.25 m.c/c.
10. Type of superstructure	:	R.C.C. solid slab.
11. Type of substructure	:	C.R. Masonry in cement mortar 1:4
12. Type of foundation	:	Open foundation in cement concrete 1:2:4

#### DETAILS OF PIER FOUNDATION & FOUNDING STRATA

This bridge has open foundation with coarse rubble stone masonry wall type pier. The top width of pier at R.L. 102.65 m. is 1200 mm. and length is 8400 mm. At R.L. 99.40 m. the dimensions of pier are 1850 mm. in traffic direction and 8400 mm. in current direction including ease and cut waters. From R.L. 99.40 m. steps have been projected by 150 mm. on all sides with height of 600mm. The base dimensions of foundation are 3780 mm. in traffic direction and 10080 mm. in current direction at R.L. 94.00m.

#### FOUNDATION STRATA

Trial pits were taken at three places and it was found that boundary strata with sandy soil is available upto 3m. depth and then soft rock is available.

#### FAILURE OF FOUNDATION

The failure of the pier and its foundation are being investigated under following two main headings:

##### i) Geotechnical Investigations

The foundation was resting on boundary strata about 5m below the lowest bed level. Position of pier is at the centre of the stream. It is hilly track, the river flows with high velocity and thus causing heavy scouring near the pier due to obstruction. The central portion of the stream got disturbed due to construction of pier at the centre with the passage of time the binding material of boulders is taken away by the floods during rainy season. This process continued and the boulders so loosened are taken away by the floods and boundary strata

below the foundation disturbed during the floods causing uneven settlement. Due to this the masonry pier collapsed as shown in photograph 1. No damage or disturbance is seen in the masonry abutment and wing walls as shown in photograph 2. During flood of 1995, the pier foundation unevenly settled causing collapse of masonry pier upto bed level. Due to this both the deck slab came at the bed level with no damage in them as shown in photograph 3.

##### ii) Design Investigations

The foundation of the pier is checked for base pressure with maximum and minimum loads and calculations shows that the foundation sizes provided are adequate. The maximum base pressure at R.L. 94.00 m is 30.68 T/m<sup>2</sup> and minimum base pressure is 8.04 T/m<sup>2</sup>. These base pressures are within maximum permissible limits and no tension on foundation base.

The pier section at R.L. 98.80 m is also checked and maximum stress about this level is 37.75 T/m<sup>2</sup> and minimum stress is 11.44 T/m<sup>2</sup> in compression. No tension is observed at this level hence sections provided are adequate.

Hence the failure of pier foundation and pier is not due to the insufficient design requirements.

#### RESTORATION OF WORK

Restoration of work has been started in January 97 and slabs have been lifted upto the top of pedestal levels as shown in photograph 4.

For lifting of deck supports were erected at two locations under the each slab using four steel columns. These column were connected by steel girder at nearer support of pier. Four jacks were placed using single pump, under the girder and decks were lifted by 30 cm at one stroke then wooden planks were placed at the support nearer to abutment to keep the slab at the lifted level as shown in photograph 5. The jack were released and lifted by wooden planks and then again jacks were placed at soffit of slab. This procedure was repeated several times bringing the slab at top of pedestal level. After lifting the slab construction of pier started.

#### CAUSES OF FAILURE

The investigation shows that heavy flood with high velocity caused removal of binding soil between the boulders. The process accelerated due to obstruction at the mid stream by construction of pier at the centre. The floating material and tree logs damaged the masonry leading to failure of pier and consequently the collapse of the complete bridge.

## REFERENCES

“Bridges in Madhya Pradesh”, Part-I [1976] and Part II [1986]

“Indian Road Congress, Code of Practice section 5”.

Kand, C.V. & Saxena, A.K. [1989], “Hydraulic Investigations and Problems of Bridges”, Paper No. 395 Vol. 50, Journal of Indian Road congress Part 3.

Kand, C.V. & Saxena, A.K. [1990], “Geotechnical Investigations and Problems of Bridges”, Vol. 51, Journal of Indian Road Congress Part 2.

Jain, J.K., Saxena, A.K. and Bhargava Rajesh, [1993], “Foundation Failure of Bridges and Geotechnical Investigations”, Third International Conference on Case Histories in Geotechnical Engineering, Vol. I.

Saxena, A.K. and Anand Selot [1988], “Geological and Geotechnical Investigations for Bridges”, Journal of Indian Highways.



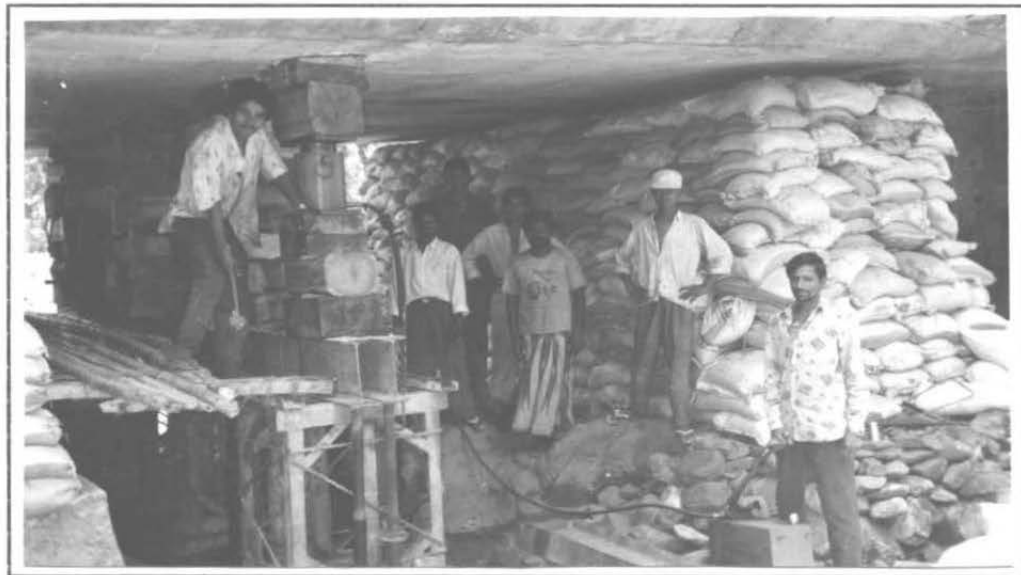
Photograph 1 View showing the collapse of pier



Photograph 2 Showing no damage signs in abutment and wings



Photograph 3 View showing deck slab resting on bed level with no damage signs



Photograph 4 View showing procedure of restoration



Photograph 5 View showing decks in partially lifted position