

Review Paper on Assessment of Soil Bearing Capacity for Bhadbhut Barrage Upstream Flank Wall Based on Plate Load Test

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ABSTRACT

Accurate assessment of soil bearing capacity is critical in the design and construction of barrage foundation structures to ensure stability and serviceability. This paper reviews the methodology, standards, interpretation, and significance of Plate Load Tests (PLTs) conducted for determining bearing capacity at the upstream flank wall of the Bhadbhut Barrage on the Narmada River in Gujarat, India. The review synthesizes existing investigation data, analyzes typical results, and highlights implications for foundation design and performance. Practical challenges, recommendations, and areas for future research in geotechnical evaluation of large barrage projects are also discussed.

Keywords:- Soil bearing capacity, Plate Load Test, Bhadbhut Barrage, geotechnical investigation, foundation design.

1. INTRODUCTION

Bhabbhut Barrage is a major hydraulic infrastructure project under construction across the Narmada River near Bhadbhut village in Bharuch district, Gujarat, India. The project aims to provide irrigation, flood control, seawater ingress prevention, and water supply benefits.

In earth-retaining structures such as the upstream flank wall, the soil beneath these elements carries significant vertical and lateral loads. Evaluating soil bearing capacity — particularly in riverine alluvium — is therefore essential to design safe foundations that resist settlement and shear failure. Plate Load Tests are among the most reliable in-situ methods for this purpose.

2. IMPORTANCE OF SOIL BEARING CAPACITY EVALUATION

Soil bearing capacity dictates the maximum pressure the ground can support without undergoing excessive settlement or shear failure. For barrage foundations that support heavy hydraulic and structural loads, failing to accurately determine bearing capacity can lead to foundation distress, uplift, and structural damage. Field investigations including boreholes, SPT, and PLT provide the necessary data for design.

3. METHODOLOGY

The Plate Load Test (PLT) is a direct in-situ load test performed to derive the ultimate and safe bearing capacity of soil. The standard practice follows guidelines in IS 1888:2002, “Method of Load Test on Soils” for vertical loading. A rigid plate is embedded at the design level of a footing, and load increments are applied while settlement is recorded. The load–settlement curve is then interpreted to identify the yield point — representing ultimate bearing capacity — and safe bearing capacity with allowable settlement.

4. CASE REVIEW: BHADBHUT BARRAGE PLT RESULTS

At one barrage project site, tests conducted at four locations produced varying result (PLT-1). The ultimate bearing capacities ranged from approximately 37, with corresponding settlements typically within tolerable design limits.

Test ID UBC (T/m²) Settlement (mm) PLT-1 37 27.98

5. INTERPRETATION AND DESIGN IMPLICATION

Ultimate vs Safe Bearing Capacity

Ultimate Bearing Capacity is the maximum load intensity the soil can sustain before failure.

Safe Bearing Capacity is obtained by applying a factor of safety to the ultimate value, taking into account acceptable settlement criteria and design codes.

Settlement limits for barrages tend to be stringent due to the potential impact on serviceability of superstructures (gates, slabs, and retaining walls).

6. PROCEDURE CHALLENGES IN GEOTECHNICAL EVALUATION

Variability in Soil Stratigraphy

Riverine deposits often include layers of silt, sand, and clay with variable engineering properties, affecting PLT results and requiring comprehensive borehole correlation.

Influence of Water Table and Saturation

High water tables and cyclic pore pressure due to river flow may reduce effective stress, influencing measured bearing capacity and settlement.

Scale and Load Distribution

Plate size relative to actual foundation size must be carefully considered when extrapolating results to design conditions.

7. STANDARDS AND GUIDELINES

Design of foundations for barrage projects typically follows:

IS 1888:2002 — Plate load test procedures.

IS 6403 / IS 8009 — Bearing capacity criteria for shallow foundations. International and project-specific guidelines for large hydraulic structures.

8. SUMMARY AND FUTURE WORK

Plate Load Tests remain a cornerstone of geotechnical evaluation for barrage foundations. At the Bhadbhut Barrage site, PLT results indicate acceptable bearing capacities to support flank wall foundations, subject to appropriate factor-of-safety and settlement design considerations. Future work should integrate advanced numerical modelling, dynamic loading considerations, and soil improvement strategies where needed.

Further research could examine long-term consolidation behaviour of saturated soils and PLT interpretations under cyclic loading to better simulate hydraulic load effects.

Kentledge weight Calculation Sheet (Plate Load Test as per IS 1888)

- **Location :**Upstream Flank wall section 2-3

- **Design SBC:** 37t/m²

ISMB300: 5 nos. (Each 7.5mtr Length, Unit Weight 44.2 Kg/mtr) 1 ISMB300 weight = (7.5x44.2) Kg = 0.3315 MT

Total weight of ISMB300 = (0.3315x5 nos) = 1.658 MT

Size of CC Block (1.5*1.5*0.9) m = 2.025cum

1 CC Block weight = (2.025 cum x 2.4 cum) = 4.86 MT Total weight of CC Block (4.86x2 nos.) = 9.72 MT

Total Kentledge Weight: (1.658+9.72) MT = 11.378 MT Say 11.3 MT

Required Kentledge Weight as per safety factor:

Safe load x Bearing Plate Area = 37 x 2 x 0.09 = 6.66 MT (Kentledge weight is minimum of 1.25 times as per design requirement 6.66*1.25 = 8.325MT)

Where, Safe Load = 37 T/m²

Bearing Plate Area = 0.3 x 0.3 = 0.09 m² Design SBC: 37 Ton/m²

Safety Factor: 2 times of design = 37x2 = 74 Ton/m² (As per IS: 1888, Clause 4.7) Platform Size: 7.5 mtr x 1.5 mtr

Bearing Plate Size: (0.3 x 0.3) sqm. Thickness of the plate- 25mm.

Hydraulic Jack: 100 Ton Capacity Effective area of jack: 153.94 cm²

Incremental Load:

Load increment dial gauge x Ram area of jack = 5 kg/ cm² x 153.94 cm² = 769.7 kg

The Pressure intensity = Load / Bearing plate area = 769.7 kg / 900 cm² = 0.855 kg/cm² = 8.55Ton/m²

Dial Gauge: 25 mm range 4 Nos. (Least Count 0.01mm)