

# COMPILATION OF PLATE BEARING TEST DATA

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**Abstract**— There are different test methods to determine a bearing capacity of different types of soils. One of them is Plate Load Test. Plate load test is found to be useful in obtaining the necessary information about the soil with particular reference to design the foundation. For Plate load test three different methods are used, but Reaction Loading Method is mostly used. In this paper compilation of last 15 year's of Plate Bearing Test data is presented and discussed.

**Keywords**— Bearing Capacity; Proving Ring; Soil; Fine grained; Coarse grained; Man Sand; U.B.C.; C  $\phi$ ; Direct shear test; Settlement.

## I. INTRODUCTION

Numerous field and laboratory tests were conducted by this institute over the last 15 years for different problems relating to bearing capacity or design of foundations. It was thought that a compilation of these results would be helpful for arriving at a closer preliminary estimation of the bearing capacity wherever such estimation may suffice the purpose.

The work of compilation was taken up with a view to having a consolidated data of various types of soils and for future use as a guide line. Numerous tests in the field as well as laboratory for various foundation and design problems had been conducted in past by this institute.

The data so far collected was compiled and analyzed on the basis of i) Field test such as Plate Bearing Test and unconfined compression test, ii) Laboratory Test such as shear test and computation of bearing capacity from shear parameters, iii) The bearing capacity computations by the empirical relationship and short cut method proposed earlier in literature.

From the data compiled, range of ultimate bearing capacity for various types of soil is given. Secondly the correlation between field and laboratory values in case of fine grained and coarse grained type of soils is attempted.

To complete the compilation, recommended values of bearing capacity for different soil types/ conditions as available from various hand books, references, Indian Standards etc. are also furnished.

A few conclusions are enlisted. A suggested check list on the various items to be covered for such testing, for bearing capacity is enclosed.

## II. DETAILS EXPERIMENTAL



Materials and Procedures

### A. Plate Bearing Test –

The plate bearing test is conducted in a pit at a required depth as per field authority. The pit is fully saturated. A method to compute ultimate bearing capacity of soil from a short test has been suggested. In this method the soil is gradually loaded up to 1 kg/cm<sup>2</sup> (clayey-soils) at intervals of 0.50kg/cm<sup>2</sup> and settlement for specific load ( i.e. 1 kg/cm<sup>2</sup>) is recorded. In the case of sandy soils the specific load is re-extricated to 2 kg/cm<sup>2</sup> and settlement is measured for that material & the relation between ultimate bearing capacity and settlement for specific load has been established. For this test, there are three types –a) Gravity Loading b) Reaction Load c) Truss & Anchoring. As per experience the test procedure of first & third type is not convenient and the results are not realistic. The load settlement curve on log-log scale for the test conducted is shown in “Fig. 1,”

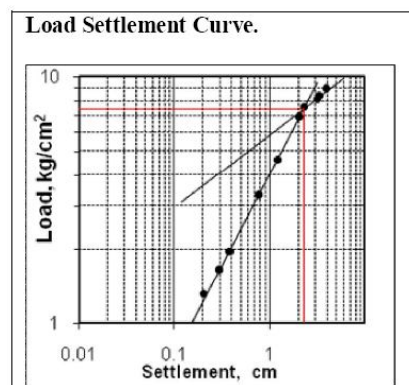


Fig. 1

From above figure it is seen the soil has failed under shear. The failure occurred at the given load intensity is in  $\text{kg/cm}^2$ . The settlement observed at ultimate bearing capacity is in cm.

### B. Laboratory Testing

The following laboratory tests also conducted on the undisturbed soil samples collected from the pit.

- a) Mechanical Analysis (Dry)
- b) Liquid Limit and Plastic Limit Test
- c) Specific Gravity
- d) Natural Moisture Content and Natural Dry Density
- e) Direct shear small box (Consolidated undrained)
- f) Permeability (Variable head)
- g) Free swell index
- h) Swelling pressure Test.

The results of laboratory testing are tabulated in accompanying Statement No.1.

### C. Work Done

At the time of compiling data on bearing capacity following data was also collected, wherever possible in order to analyze the values obtained critically.

- i) Depth at which the test was carried out.
- ii) Visual description of soil.
- iii) Atterberg's limits, Mechanical analysis, and in situ density (For classification and compaction of soil strata.)
- iv) Plate size used.
- v) Settlement at failure.
- vi) Results of shear parameters and unconfined compression strength from laboratory tests on undisturbed samples.

Thus, about 60 field tests and 40 laboratory tests were compiled. Based on the above data the results have been grouped into following groups:

- a) Fine grained soil group.
- b) Coarse grained soil group.
- c) Typical soil group viz. Marine clay, and Murum, Classification according to unified classification system is indicated.

## III. OBSERVATION OF TESTS RESULTS

### A. Fine grained soil group:

For this group total 13 PBT tests are carried out at different locations and the results are tabulated in Table 1,

- The ultimate bearing capacity obtained for fine grained soil, ranges between  $1.80 \text{ kg/cm}^2$  to  $5.70 \text{ kg/cm}^2$
- Only in two cases high values like  $6.40 \text{ kg/cm}^2$  &  $8.7 \text{ kg/cm}^2$  are obtained.
- The high bearing capacity results obtained might be due to the stiffness of clay and presence of lime/ kunkar. The group covers CH, CH-MH, and MH. CL, and NL, types of soil.

The settlement at failure in case of fine grained soil ranges between 0.5 cm. to 1.80 cm. The dry density ranged from  $1.28 \text{ g/cm}^3$  to  $1.78 \text{ g/cm}^3$ .

### B. Coarse grained soil group:

For this group total 19 PBT tests are carried out at different locations and the results are given in table -1.

- The ultimate bearing capacity values obtained in case of coarse grained type soil ranges between  $1.94 \text{ kg/cm}^2$  to  $10 \text{ kg/cm}^2$ .
- The settlement at failure of this coarse grained group of soils was between 0.34 cm. to 1.55cm.

### C. Typical Soil group:

- a) Marine sand mixed with marine clay:
  - For this group total 4 PBT were carried out at Tagore Memorial Bombay and results are displayed in Table No.1.
  - The results show that the ultimate bearing capacity ranges from  $2.65 \text{ kg/cm}^2$  to  $4.40 \text{ kg/cm}^2$ .
  - The values of C &  $\phi$  ranges from  $21.80 \text{ g/cm}^2$  to  $43.70 \text{ g/cm}^2$  and  $31^\circ$  to  $36^\circ$  respectively.
  - The values of ultimate bearing capacity computed from shear parameters ranges from  $2.65 \text{ kg/cm}^2$  to  $4.4 \text{ kg/cm}^2$ .
  - In the case of taking width of foundation equal to diameter of plate, the results worked out to be  $2.45 \text{ kg/cm}^2$  to  $3.60 \text{ kg/cm}^2$ .
  - All the above tests were carried out at Ground water Table and hence buoyancy effect had been taken into consideration.

- b) Man type soil group:

Man soil is a peculiar type of clay having high stiffness due to lime as binding material and as such has high bearing capacity.

- For this group total 8 plate bearing tests were carried out at different locations along Hatnur right bank canal. Results are shown in Table No. 1. The depth was varying from 4.00 m to 8.5m.
- The ultimate bearing capacity observed to range from  $5 \text{ kg/cm}^2$  to  $22.0 \text{ kg/cm}^2$ .
- From laboratory shear test results it is seen that the values of C &  $\phi$  range from  $50 \text{ g/cm}^2$  to  $500 \text{ g/cm}^2$  and  $27^\circ$  to  $38^\circ$  respectively.
- The value of ultimate bearing capacity computed from shear parameters range from  $4.4 \text{ kg/cm}^2$  to  $15.8 \text{ kg/cm}^2$

- c) Murum soil Group:

- About twelve plate load tests were carried out for new security Press Building and Residential Quarters at Nehru-nagar, Nashik Road and the results are shown in table No.1

All the tests had been carried out at shallow depth, of about 1 m.

- The ultimate bearing capacity from plate load test ranges from 2.25 kg/cm<sup>2</sup> to 12.00 kg/cm<sup>2</sup>. The settlement at failure ranges from 0.13 cm to 0.74 cm.
- The values of c and  $\phi$  range from 50 g/cm<sup>2</sup> to 600 g/cm<sup>2</sup> and 30° to 43° respectively.
- The values of ultimate bearing capacity computed from shear parameters range from 6.30 kg/cm<sup>2</sup> to 13.70 kg/cm<sup>2</sup>.

#### IV. CORRELATION BETWEEN UBC CONDUCTED AT FIELD AND LABORATORY

- Comparison has been done between UBC determined by Plate Load Test at the field and UBC determined by shear test at the laboratory. The results of comparative study in respect of fine grain soil (8 Locations) and coarse grain soil (9 Locations) are shown in Table no. 2 & 3 respectively.
- In the case of fine grained soils, the value of bearing capacity computed in laboratory is higher than Bearing capacity obtained by PBT method on the field.
- Same is the case for coarse grained soils.
- At some places the variation is upto 100% on higher side.
- To find UBC using shear test, it is very important to decide whether the failure occurs due to general shear or local shear

#### CONCLUSIONS

- In the case of coarse grained soils, the value of bearing capacity computed from laboratory test is found to be higher than the value obtained on the field by Plate load test.
- In computing the value of ultimate bearing capacity, from Shear parameters, it is very important to decide whether the failure would occur due to general shear or local shear.
- Water table below foundation influences the bearing capacity by reducing cohesion and density of soil. Hence, it is important to observe the water table conditions during the field test as well as obtainable any time at the foundation level in future.
- For Man soil, the high bearing capacity is observed because of the stiffness of soil which is due to, presence of lime / kunkar, and cementing material.
- For murum soils the bearing capacity is observed to be in the range of 3 kg/cm<sup>2</sup> to 9 Kg/cm<sup>2</sup> for the density range 1.38 g/cm<sup>3</sup> to 1.84 g/cm<sup>3</sup> respectively.

- Bearing capacity of CH, MH- CH and CL type soils ranges from 2 kg/cm<sup>2</sup> to 4 Kg/cm<sup>2</sup>. In the case of ML type (Yellow soil) the bearing capacity values observed are in the range of 4 kg/cm<sup>2</sup> to 5 Kg/cm<sup>2</sup>
- The UBC for fine grained soil ranges between 1.80 to 5 kg/cm<sup>2</sup>.
- The UBC for coarse grained soil ranges between 2.00 to 10 kg/cm<sup>2</sup>.

#### RECOMMENDATION

The purpose of this exercise is mainly to compile the data systematically and no detailed analysis is attempted. Nevertheless, the data will be useful for further detailed study.

#### ACKNOWLEDGMENTS

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Table No.2-. Comparison of U.B.C. conducted at the field & Laboratory for fine grained soil

Sr. No.	No. of Project	Classification U.C.S.	U.B.C. from load test kg/cm <sup>2</sup>	U.B.C. from C- $\phi$ ,
1	6	ML-2	0.70 ---5.20	1.3 --12.00
		MH-2	2.70 --5.00	2.40 ----4.50
		CH-1	3.60 ---0.00	3.40 ----0.00
		CL-1	3.10 --0.00	4.50 ----0.00

Table No.3- -. Comparison of U.B.C. conducted at the field & Laboratory for coarse grained soil

Sr. No.	No. of Project	Classification U.C.S.	U.B.C.at field kg/cm <sup>2</sup>	U.B.C. at Laboratory kg/cm <sup>2</sup>
1	18	SM-9	3.30 ---- 10.00	6.30 ---- 15.00
		SP-2	6.40 ---- 10.00	14.70 --- 16.00
		GM-2	2.25 --- 6.70	7.40 --- 10.60
		GC-1	7.00 ---- 0.00	13.70 ---- 0.00
		SC-4	2.20 --- 3.10	2.70 --- 4.40

Compilation of Plate Bearing Test Data

Table No. 1 :- LABORATORY AND FIELD TESTS RESULTS RANGE(MIN. TO MAX.) OF VARIOUS TYPE OF SOIL.

Sr. No.	Type of Soil	No of Project /Sample	Classification of U.C.S.	Specific Gravity-Range	NMC NDD	ODD g/cm <sup>3</sup> -Range	Shear test results in Range			Plate bearing test results in Range	
							C - g/cm <sup>2</sup>	$\phi$ in $0^{\circ}$	U.B.C kg/cm <sup>2</sup>	U.B.C kg/cm <sup>2</sup>	Settlement in cm
1	Fine Grained	8 / 13	CH- 3 Nos.	.....	.....	1.35-1.78	.....	.....	.....	3.95 - 8.70	0.61 -1.60
			ML-4 Nos.	.....	.....	1.47- 1.58	.....	.....	.....	4.9 0 - 6.40	0.50 - 1.06
			MH-5 Nos.	.....	.....	1.28 - 1.66	.....	.....	.....	1.80 - 5.70	0.50 -1.80
			CL-1 Nos.	.....	.....	0.0-1.40	.....	.....	.....	0.00 - 2.25	0.00 -1.50
2	Coarse Grained	9/19	SC-6 Nos.	.....	.....	0.0 - 1.88	.....	.....	.....	1.94 - 8.90	0.34 -1.55
			SM-8 Nos.	.....	.....	1.37- 2.05	.....	.....	.....	3.00 - 10.00	0.35 - 1.15
			SP-5 Nos.	.....	.....	1.72 - 1.84	.....	.....	.....	3.00 - 10.00	0.42 - 0.50
3	Marine Sand (Tagore Memorial Theaters, Bombay)	1/4	SC- 4 Nos.	.....	.....		21.8 - 43.7	31 <sup>o</sup> 0' - 36 <sup>o</sup> 54'	2.65 - 4.40	2.45 - 3.60	1.94 - 3.07
4	Man type soil( Hatnur RBC)	1/8	MH-2, Nos.	2.67 - 2.75	24.8 - 45.6 1.25 - 1.58	.....	250.00 - 500.00	27 <sup>o</sup> 10' - 38 <sup>o</sup> 80'	8.40 - 15.80	5.50 - 8.50	0.26 - 0.58
			GM-2, Nos.	2.67 - 2.72	14.90 - 28.70 1.45 - 1.67	.....	425.00 - 500.00	31 <sup>o</sup> 08' - 31 <sup>o</sup> 18'	12.40 - 13.00	13.50 - 22.00	0.04 - 0.55
			ML-3 Nos.	2.73--- 2.80	24.6 - 30.30 1.36 - 1.58	.....	200.00 - 450.00	29 <sup>o</sup> 30' - 31 <sup>o</sup> 42'	9.30 - 11.10	6.40 - 10.20	0.17 - 0.67
			SM-1 Nos.	0.0 - 2.70	0.00 - 27.00 0.00 - 1.60	.....	0.00- 50.00	00 <sup>o</sup> 00' - 32 <sup>o</sup> 41'	0.00 - 4.40	0.00 - 5.00	0.00 - 0.85
5	Murum (SM-SC)(CPWD, Nashik Road)	1/12	SM-10 Nos.	2.55- 2.80	9.50 - 27.3 1.38 - 1.84	.....	150.00 - 600.00	30 <sup>o</sup> 15 - 42 <sup>o</sup> 18'	6.30 - 12.40	3.00 12.00	0.13 - 0.74
			GM-1 Nos.	0.00- 2.73	0.00 - 11.2 0.00 - 1.62	.....	0.00 - 50.00	00 <sup>o</sup> 00' - 42 <sup>o</sup> 42'	0.00 - 7.00	0.00 - 2.25	0.00 - 0.35
			GC-1 Nos.	0.00-2.76	0.00 - 12.5 0.00 - 1.48	.....	0.00 - 425.0	00 <sup>o</sup> 00' - 37 <sup>o</sup> 14'	0.00 - 13.70'	0.00 - 7.00	0.00 - 0.44

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