



GOVERNMENT OF INDIA
भारत सरकार
MINISTRY OF RAILWAYS
रेल मंत्रालय

**क्षेत्रीय रेलों में भू-तकनीकी इंजीनियरी
संगठन बनाने की संदर्शिका
Guidelines For Geotechnical Engineering
Organisation in Zonal Railways**

रिपोर्ट सं. RDSO/2007/GE: G-0011

जनवरी-2008

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प्राक्कथन PREFACE

अ.अ.मा.सं. द्वारा क्षेत्रीय रेलो मे भू-तकनीकी इंजीनियरी संगठन बनाने हेतु संदर्शिका फरवरी-1987 मे पहले बनायी गई, जिसका वितरण क्षेत्रीय रेलो को किया गया । कार्यस्थल एवं प्रयोगशाला के उपकरणों में उन्नति एवं कार्यस्थल में उत्पन्न नई परेशानियों के कारण इस संदर्शिका को रुपान्तरित करने की आवश्यकता हुई । रेलवे बोर्ड ने भी उपरोक्त संदर्शिका को रुपान्तरित करने के लिए निर्देश किया । इसलिए इस संदर्शिका को रुपान्तरित किया गया है ।

भावी विकास को ध्यान मे रखते हुए इस संदर्शिका मे समय-समय पर आवश्यकता अनुसार परिवर्तन किया जा सकता है । इसमें वर्णित विचार रेल मंत्रालय (रेलवे बोर्ड), भारत सरकार के नहीं हैं ।

यह रिपोर्ट अ.अ.मा.सं. की सम्पत्ति है तथा अनिवार्यतः सरकारी कार्य हेतु ही प्रयोग की जा सकती है । इसे महानिदेशक, अ.अ.मा.सं. की अनुमति के बिना आंशिक या पूर्णतया न ही, किसी को उधार दिया जा सकता है और न ही आधिकारिक तौर पर उद्धृत किया जा सकता है ।

"Guidelines for Geotechnical Engineering Organization on Zonal Railways" was earlier issued by RDSO and circulated to Zonal Railways in February 1987. Due to the upgradation of field and laboratory equipments and newly arising problems of the fields/sites, it was felt that this guidelines need to be modified and upgraded. Railway Board also instructed to upgrade this Guidelines. Therefore this Guidelines has been modified.

The views expressed are subject to modifications from time to time in the light of future developments on the subject. The views do not represent the views of the Ministry of Railways (Railway Board), Government of India.

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(संजीव कुमार शर्मा)

संयुक्त निदेशक / भू-तकनीकी इंजीनियरी
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1.0 प्रस्तावना Introduction

Railway Board has been emphasizing that each zonal railway should establish Geotechnical Engineering (GE) Cell. The main objective of setting up GE Cell is that the railways should be able to collect field data, conduct subsurface exploration and to test the soil samples for engineering properties on their own. Though GE laboratories at present exist on some zonal railways, yet many zonal railways' construction organizations are still without GE laboratories. Based on feedback and past experiences from various zonal railways, it is gathered that establishing a full fledged GE laboratory seems to be an uphill task for the zonal railways already facing, *inter alia*, newer challenges of the present. Earlier "Guidelines for Geotechnical Engineering Organization on Zonal Railways" was issued by RDSO and circulated to Zonal Railways in February 1987. But with the recent advancements in Geotechnical Engineering and other changes with the passage of time, it has become imperative to revise this guideline. With this in view and taking a pragmatic approach to achieve the objective in true sense, an endeavour has been made to make the guidelines concise and more useful.

2.0 अध्ययन क्षेत्र Scope

In order to achieve the objective in real terms, the GE laboratories have been categorized into two Scales, i.e. Scale-1 and Scale - 2. Scale-1 laboratories are those that are set up on smaller scale, while Scale-2 laboratories are those that are full-fledged and called base laboratories having both laboratory and field equipments.

The Scale -1 laboratories will be the laboratory set up in the field at construction site where construction is going on. The number of such laboratories will depend on quantum of earthwork. The main function of these laboratories is to check the quality of earthwork and perform routine soil testing.

The Scale-2 laboratories will be set up in zonal railway head quarter. This laboratory shall have large equipments in addition to equipments for Scale-1. In this guidelines, type of tests to be conducted, manpower required for each category of the laboratories is discussed alongwith other aspects like functioning of lab, quality control and laboratory layout.

3.0 परीक्षणों के प्रकार Type of tests

The laboratories in different scales i.e. scale-1 and scale-2 shall be equipped to carry out following tests:

3.1 स्केल -1 प्रयोगशाला के लिए परीक्षण Tests for Scale - 1 laboratories

The laboratory should be equipped with minimum equipments as mentioned in the Annexure - I to facilitate the following minimum tests:

क्रम SL	परीक्षण Test
i)	स्थूल गिट्टी का अपघर्षण Abrasion Test of ballast
ii)	गिट्टी का संघातमान परीक्षण Impact Test of ballast
iii)	एटबर्ग की सीमार्ये-द्रव, सुघट्य,सकुंचन सीमार्ये एवं मुक्त स्फीति सूचकांक Atterberg's limits-Liquid, Plastic, Shrinkage limits & Free Swell Index
iv)	प्रत्यक्ष अपरूपण Direct Shear

v)	प्राकृतिक शुष्क घनत्व एवं प्राकृतिक जलांश Natural Moisture Content & Natural Dry Density
vi)	अनुकूलतम जलांश एवं अधिकतम शुष्क घनत्व Optimum Moisture Content (OMC) & Maximum Dry Density (MDD)
vii)	कण आकार वितरण (छलनी एवं हाइड्रोमीटर विश्लेषण) Particle Size Distribution (Sieve & Hydrometer Analysis)
viii)	आपेक्षिक घनत्व Relative Density
ix)	विशिष्ट गुरुत्व Specific Gravity
x)	स्थूल गिट्टी का जल अवशोषण परीक्षण Water Absorption Test of ballast

3.2 स्केल –2 प्रयोगशाला के लिए परीक्षण Tests for Scale– 2 laboratories

In addition to tests for Scale-I, following additional tests could be carried out by the GE laboratories :

क्रम SL	परीक्षण Test
i)	संघनन Consolidation
ii)	गतिक शंकु भेदन Dynamic Cone Penetration
iii)	रेजिड्यूअल अपरुपण Residual Shear
iv)	मानक भेदन Standard Penetration
v)	त्रिअक्षीय अपरुपण Tri-axial Shear
vi)	असीमित सम्पीडित सामर्थ्य Unconfined Compression

4.0 व्यक्तियों की आवश्यकता Manpower requirements

The locations and number of laboratories shall depend on scope and extent of field controls required to be executed. Decision to adequately staff the GE laboratories may be taken at PHOD level in the organization however the under mentioned man power is considered as essential. :

4.1 स्केल –1 प्रयोगशालों के लिए व्यक्तियों की आवश्यकता Manpower for Scale–1 laboratories

The laboratory will be under control of DEN/AEN and it will have suitable manpower but following manpower is considered minimum required exclusively for GE laboratories :-

क्रम SL	पद का नाम Name of post (*)	पदों की संख्या Number of post (*)
1.	Junior Engineer Gr.I/II	1
2.	Work Mistry/Bridge Mistry	1
3.	Khalasi Helper	4

(*) The number and scale of the post are tentative only and actual requirement may be assumed as per the workload of these units.

4.2 स्केल –2 प्रयोगशालों के लिए व्यक्तियों की आवश्यकता Manpower for Scale –2 laboratories

The laboratory will be under control of DEN/AEN and it will have suitable manpower but following manpower is considered minimum required exclusively for GE laboratories :-

क्रम SL	पद का नाम Name of post (*)	पदों की संख्या Number of post (*)
1.	Section Engineer	1
2.	Junior Engineer	2
3.	Supervisors	3
4.	Fitter	1
5.	Khalasi Helper	8

(*) The number and scale of the post are tentative only and actual requirement may be assumed as per the workload of these units.

5.0 जी.ई. सेल की कार्यप्रणाली Functioning of GE Cells

5.1 The team would collect field data required for the project and shall conduct soil sampling. They must have a bare minimum set of field equipments and manpower for handling and storing this equipment. They shall also conduct any field tests, if required and watch the post-construction behaviours wherever required.

5.2 The team should be able to conduct the routine soil test for classifying the soil samples and finding out other parameters as desired for designing the project. For this, soil mechanics laboratory is needed with essential equipments and staff for conducting the tests in addition to storing of samples, their handling and maintenance of laboratory equipment.

5.3 In addition to above, the GE laboratory shall be needed to perform the following :

- i) In case of field problems referred to the GE laboratories, they should be able to identify different soil tests to be carried out and perform such identified tests.
- ii) In case field problem is required to be referred to RDSO, GE laboratory will associate for experience gain and development of in-house expertise.
- iii) The GE laboratory should ensure that any consultancy rendered by RDSO is implemented in the field and quality is assured.
- iv) When implemented, the efficacy of the work would be monitored and documented.
- v) After implementation of work as per RDSO consultancy, completion report should be kept by GE laboratory and feedback comments on effectiveness of recommendations should be communicated to RDSO.
- vi) GE related items will also be monitored as per Correction Slip No. 89 to IRPW manual's para 211 (1) (v).
- vii) All the design parameters or remedial measures found out by the GE Cell should be got approved by the competent authority on the Railway, as the cost of these proposals would be considerable. A copy of these shall be sent to RDSO for the purposes of data documentation and for building up a central information storage. This is essential so that experience of one railway may be used for the benefit of others.

6.0 गुणवत्ता नियन्त्रण **Quality Control**

- 6.1** Both field and laboratory tests shall be carried out under the supervision of atleast a Junior Engineer (Gr. I/II) duly trained in Geotechnical Engineering.
- 6.2** To facilitate quality tests the laboratory is proposed to be equipped with the standard equipments as required under relevant IS Codes and listed at Annexure-I under Scale - 1 or at Annexure-II and III under Scale-2. The list of manufacturers is given in the Annexure-IV.
- 6.3** Again to ensure quality, it is suggested that the laboratory should be equipped with latest versions of IS codes (listed at Annexure-V) and Soil Mechanics reference books (listed at Annexure-VI)

7.0 प्रयोगशाला नक्शा **Laboratory layout**

For efficient functioning of the Cell typical layout plans, indicating disposition of various lab equipments etc. are placed as Annexure-VII and VIII. The layout also provides space for storage of field equipments, soil samples as also for housing lab and field staff.

अनुबद्ध—प्रथम

Annexure – I

स्केल –1 प्रयोगशाला के लिए उपकरणों की सूची
List of equipments for scale-1 laboratory
(As per alphabetical order)

क्रम SL	उपकरणों का विवरण Description of Equipment	Approximate Cost/unit (Rs.)	Quantity Recom- mended
1.	Abrasion Test (Los Angeles) apparatus Complete as per IS: 2386 Pt. 4.	78750.00	1 set
2.	Adjustable Spanner 45 cm size.	250.00	2 numbers
3.	Aluminium Dish with lid, 5 cm dia.	63.00	10 numbers
4.	Balance Physical, Capacity 1 kg. Least Count 0.01 gm, in Double Door Case; with Case and Weights 200 gms to 1 mg. With Extra Weights. of 200 gm, 20 gm, 2 gm, 200 mg, 20 mg and 2 mg.	8000.00	2 sets
5.	Beaker. 500 ml.	200.00	10 numbers
6.	Centimeter Scale 30 cm.	150.00	6 numbers
7.	Direct Shear apparatus (Electrically Operated) with Variable Rate of Strain Complete as per IS: 2720 Pt. 13. and Two Set of Mould Extra.	54400.00	1 set
8.	Dish Enamel dia 10 cm, 15 cm, 20 cm & 25 cm	200.00	10 numbers each
9.	Distillation Plant	8000.00	1 set
10.	Electric Stirrer Complete as per IS: 2720 Pt. 4, High Speed for Mechanical Determination of sedimentation Analysis Comprising of an Electric Motor Fitted to a Cast Iron Stand with Stirring Blade, Cup and Baffle Complete with One Cable and Plug. The Speed of the Stirrer as per ISI Standard.	1200.00	1 set
11.	Enameled Trays Size 30 x 25 cm	240.00	6 numbers
12.	Enameled Trays Size 45 x 30 cm	600.00	6 numbers
13.	Evaporating Dish 12 cm dia	50.00	1 dozen
14.	Evaporating Dish 10 cm dia.	35.00	1 dozen
15.	Frying Pans Size 30 x 25 cm.	150.00	3 numbers
16.	Field Density Apparatus Complete : • Sand Replacement • Core Cutter with Dolly	2100.00 2075.00	2 Sets 5 Sets
17.	Glass Cup (For SL)	150.00	2 numbers
18.	Graduated Cylinder Glass. 50 ml	180.00	10 numbers
19.	Glass Funnels dia 9 cm.	100.00	2 numbers
20.	Glass Graduated Cylinder 100 ml.	70.00	8 numbers
21.	Glass Plate 8 mm Thick, 50 x 50 cm Size.	375.00	2 numbers
22.	Glass Cylinder 1000 cc. Cap. Approx. 6 cm dia.	2400.00	6 numbers
23.	Ground Glass or Rubber Stoppers for Cylinders.	175.00	2 numbers
24.	Ground Glass Size 30 x 30 cm.	1100.00	2 numbers
25.	Hand Auger 150 mm dia with Extension Rods.	2574.00	1 Set
26.	Hand Operated Mechanical Sieve Shaker for above Sieves.	6000.00	1 number
27.	High Sensitivity Proving Ring Cap. 100 kg.	22000.00	1 number
28.	Hydrometer for Determination of Grain Size Distribution in Soil, Range 0.995 to 1.030 as per IS: 2720 Pt. 4.	2400.00	2 numbers
29.	Impact Test Apparatus Complete as per IS:2386 Pt.4	8754.00	1 Set

30.	I.S. Set of Sieves with Base & Top lid.(20mm, 10mm, 4.75 mm,2 mm,600 micron, 425 micron,212 micron, 75 micron) 20cm dia Brass Frame as per IS:460.	8450.00	2 Sets
31.	Liquid Limit Apparatus Hand Operated with Counter Grooving Tools etc. Complete.	3214.00	2 Sets
32.	Mercury	4000.00	2 kg
33.	Pallets Knives	200.00	4 numbers
34.	Pan Balance, capacity 10 Kg.	1200.00	1 number
35.	Pan Balance 1gm – 20 kg capacity	11000.00	1 number
36.	Platform Balance 200 kg. capacity	16000.00	1 number
37.	Pliers	180.00	1 number
38.	Porcelain Bowl for Liquid Limit, 15 cm dia.	75.00	3 numbers
39.	Physical Balance (250 gm/Capacity).	8000.00	1 Set
40.	Reagent Bottles.	250.00	2 numbers
41.	Riffles Divider.	6500.00	1 Set
42.	Sample Extractor to Fit 100, 75 and 50 mm dia. Tubes for Extraction of Soil Samples.	2200.00	1 number
43.	Sampler 100 mm dia with Extension Rods.	2095.00	1 Set
44.	Shrinkage Limit Apparatus Complete as per IS:2720 Pt.6	3150.00	1 Set
45.	Sodium Carbonate Chemically pure. (Capacity 1 kg)	255.00	1 number box
46.	Sodium Hexametaphosphate. (Capacity 1 kg)	395.00	5 numbers Box
47.	Specific Gravity Apparatus as per IS: 2720 Pt. III	100.00	12 numbers
48.	Spring Balance	5000.00	2 numbers
49.	Stainless Steel Spatula 20 cm x 2 cm.	800.00	2 numbers
50.	Standard Lab. Type Desiccators as per IS: 6128.	2800.00	4 numbers
51.	Standard Proctor Compaction Apparatus Complete with Mould 1000 cc capacity (as per IS: 2720 Pt.7 and IS: 2720 Pt.8.	7950.00	2 Sets
52.	Stop Watch.	1400.00	1 number
53.	Stove Janta (Kerosene Oil).	250.00	2 numbers
54.	Straight Edge of Mild Steel Nickel Polished.	445.00	2 numbers
55.	Thermometer 0° to 50°C with ½ °C accuracy.	500.00	2 numbers
56.	Thermometer 0° to 150°C with ½ °C accuracy.	800.00	2 numbers
57.	Thermostatically Controlled Hot Air Oven Complete with Adjustable Shutters, Wire and Plug to Work on 220/230V with Thermometer Size 600 mm x 600 mm. 165 liter capacity of Stainless Steel.	40920.00	1 number
58.	Tool Kits	4500.00	1 Set
59.	Tubes (Sampling), dia 100 mm, Length 450 mm.	350.00	25 numbers
60.	Vernier Calipers. Least Count 0.01mm.	6000.00	1 number
61.	Wash Bottle 1 Lit. (Plastic), 500 ml	150.00	6 numbers
62.	Wire Brush.	125.00	2 numbers
63.	Wooden Mortar and Pestle.	250.00	2 numbers

अनुबद्ध—द्वितीय

Annexure – II

स्केल –2 प्रयोगशाला के लिए अतिरिक्त प्रयोगशाला उपकरणों की सूची
List of additional laboratory equipments for scale-2 laboratory
(As per alphabetical order)

क्रम SL	अतिरिक्त उपकरणों का विवरण Description of additional equipment	Approximate Cost/Unit (Rs.)	Quantity Recommended
1.	Consolidation (Oedometer) Test Apparatus Fixed Ring Type Single Mould as per IS: 2720 Pt. 15.	21500.00	2 Sets
2.	Dial Gauges with Least Count 0.01 mm.	4268.00	20 numbers
3.	Porcelain Jars 10 liters Capacity.	300.00	5 numbers
4.	Pours Stones Diameter 55 mm to 58mm	150.00	6 numbers
5.	Membrane Stretcher	250.00	2 numbers
6.	Static Tri-axial Shear Test Equipment (Electronic)	580775.00	1 number
7.	Shear Tube 150mm x 38mm	210.00	12 numbers
8.	Thermostatically Controlled Hot Air Oven Complete with Adjustable Shutters, Wire and Plug to Work on 220/230V with Thermometer Size 600mm x 600mm. 165 lit. Capacity.	21000.00	2 numbers
9.	Rubber Membrane Thickness 0.2 to 0.3mm	44.00	50 numbers
10.	Rubber Rings	50.00	20 numbers
11.	Unconfined compressive Strength apparatus complete as per IS: 2720 Pt. 10. Motorised	45000.00	1 Set

अनुबद्ध—तृतीय

Annexure – III

स्केल –2 प्रयोगशाला के लिए फील्ड उपकरणों की सूची
List of field equipments for scale-2 laboratory
(As per alphabetical order)

क्रम SL	उपकरणों का विवरण Description of equipments	Approximate Cost/unit (Rs.)	Quantity Recommended
1.	Auger Soil 150 m dia with Extension rod to Auger up to 6 m.	2574.00	2 Sets
2.	Core Cutter Method Complete Equipment as per IS:2720 Pt.29.	1500.00	1 Set
3.	D.C.P. Equipment Complete as per IS:4968 Pt.-I with Bentonite Slurry.	272000.00	1 Set
4.	Dishes Small Enamelled.	200.00	12 numbers
5.	Plate Load Testing Equipment Complete as per IS:1888.	610000.00	1 Set
6.	Sampling Tubes 100 mm dia 450 mm Long.	750.00	50 numbers
7.	Spoon Table	50.00	3 numbers
8.	Stainless Steel Spatula 20 x 2 cm.	800.00	2 numbers
9.	Standard penetration Equipment Complete as per IS:2131.	46120.00	1 Set
10.	Stove-Janta or Kerosene.	250.00	2 numbers
11.	Wash Bottle 1 Lit. (Plastic), 500ml	150.00	1 number

अनुबद्ध-चतुर्थ

Annexure - IV

भू-तकनीकी उपकरणों के सम्भावित निर्मातों/पूर्तिकर्ताओं की सूची
List of probable manufacturers/suppliers for geotechnical equipments#
(As per alphabetical order)

क्रम SL	निर्मातों/पूर्तिकर्ताओं की विवरण Description of Manufactures/Suppliers	Phone Numbers
1.	M/s AMIL Ltd. Lucknow Office 29/9, Raj Chamber Rana Pratap Marg, Lucknow-226001.	0522-3013750
2.	M/s Associated Instrument Manufactures India Ltd., Sunlight Building, 26-27, Asaf Ali Road, New Delhi -110002	011-30810200
3.	M/s ELE INTERNATIONAL, Chartmoor Road, Chartwell Business Park,Leighton Buzzard Beds, LU74 WG.,United King Dom.	44 (0) 1525- 249200
4.	M/s Hydraulic & Engineering Instruments, A-13, Naraina Industrial Area, Phase-II, New Delhi -110023	011-25893820- 23
5.	M/s KUMAR SONS (INDIA), 11, Bhopal House LalBagh, Lucknow -226001.	0522-2625227
6.	M/s Technical and Scientific Sales, 21, Hind Rajasthan Bldg 272-273,Bhau Daji Road Extn., Sion (W), Mumbai - 400022.	022-24070480 / 24092140 / 24096732

There may be other manufactures who might be manufacturing geo-technical related machines/equipments

अनुबद्ध-पंचम

Annexure - V

बी.आई.एस. कोडस की सूची

List of B.I.S. codes

(List of codes is in increasing order of IS codes number)

क्रम SL	बी.आई.एस. कोडस की विवरण Description of B.I.S. Codes	IS : Code No.	
1.	Rounding off	IS: 2	-
2.	Sieves	IS:460	-
3.	Leading Standard For Building	IS:875	-
4.	Spread Foundation	IS:1080	-
5.	Measurement of Earthwork	IS:1200	-
6.	Classification & Identification of Soils	IS:1498	-
7.	Dry Sieving	IS:1607	-
8.	Building Lime	IS:1624	-
9.	Load Test	IS:1888	-
10.	Investigation Sub-Surface (for foundation)	IS:1892	-
11.	Design of Structures	IS:1893	-
12.	Shallow Foundation for Building	IS:1904	-
13.	Standard Penetration	IS:2131	-
14.	Thin Wall Tube Sampling	IS:2132	-
15.	Particle Size & Shape of Aggregate	IS:2386	Part 1
16.	Deleterious Materials & Organic Impurities	IS:2386	Part 2
17.	Specific Gravity, Density, Voids, Bulking	IS:2386	Part 3
18.	Mechanical Properties etc	IS:2386	Part 4
19.	Soundness	IS:2386	Part 5
20.	Preparation of Soil Samples	IS:2720	Part 1
21.	Water Content	IS:2720	Part 2
22.	Specific Gravity	IS:2720	Part 3
23.	Specific Gravity-Fine Grained	IS:2720	Part 3/Sec. 1

24.	Specific Gravity Fine Medium Coarse	IS:2720	Part 3/Sec. 2
25.	Grain Size Analysis	IS:2720	Part 4
26.	Liquid & Plastic Limits	IS:2720	Part 5
27.	Shrinkage Factors	IS:2720	Part 6
28.	Compaction - Light	IS:2720	Part 7
29.	Compaction - Heavy	IS:2720	Part 8
30.	Dry Density - Water Content Relation by Constant Weight.	IS:2720	Part 9
31.	Unconfined Compression Strength	IS:2720	Part 10
32.	Direct Shear	IS:2720	Part 13
33.	Density Index (Relative Density)	IS:2720	Part 14
34.	Consolidation Properties	IS:2720	Part 15
35.	Organic Matter	IS:2720	Part 22
36.	Sand Replacement Method (Density)	IS:2720	Part 28
37.	Core Cutter Method (Density)	IS:2720	Part 29
38.	Ring & Water Displacement (Density)	IS:2720	Part 33
39.	Rubber Balloon Method (Density)	IS:2720	Part 24
40.	Sand Equivalent Value	IS:2720	Part 37
41.	Compaction Control (Hily Method)	IS:2720	Part 38
42.	Direct Shear (Soil Having Gravel)	IS:2720	Part 39/ Sec. 1
43.	Free Swell Index	IS:2720	Part 40
44.	Swelling Pressure	IS:2720	Part 41
45.	Soil Engineering	IS:2809	-
46.	Soil Dynamics	IS:2810	-
47.	Driven Cast in Situ Concrete Piles	IS:2911	Part 1/Sec.1
48.	Bored Cast in Situ Concrete Piles	IS:2911	Part 1/Sec.2
49.	Driven Precast Concrete Piles	IS:2911	Part 1/Sec.3
50.	Timber Piles	IS:2911	Part 2
51.	Under Reamed Piles	IS:2911	Part 3
52.	Load Test on Piles	IS:2911	Part 4
53.	Raft Foundation	IS:2950	-
54.	Reciprocating Type Machine Foundation	IS:2974	Part 1
55.	Impact Type Machine (Hammer) Foundation	IS:2974	Part 2
56.	Rotary Type (Medium & High Frequency)	IS:2974	Part 3
57.	Rotary Type (Low Frequency)	IS:2974	Part 4
58.	Impact Type Machine (Other than Hammer)	IS:2974	Part 5
59.	Well Foundation	IS:3955	-
60.	Indexing & Storage of Drill Core	IS:4078	-
61.	Transmission Line Towers	IS:4091	-
62.	Construction of Building	IS:4326	-
63.	Exploration, Subsurface	IS:4453	-
64.	Investigation-Drilling Information and Core Description	IS:4464	-
65.	Sheep foot Roller	IS:4616	-
66.	DCP without Bentonite	IS:4968	Part 1
67.	DCP with Bentonite	IS:4968	Part 2
68.	Static Cone Penetration	IS:4968	Part 3
69.	Grouting of Pervious Soil	IS:4995	-
70.	Dynamic Properties of Soil	IS:5249	-
71.	Core Drilling Observation	IS:5313	-
72.	Test Sieves	IS:5421	-
73.	Vibratory Roller	IS:5500	-

अनुबद्ध-ष्टम

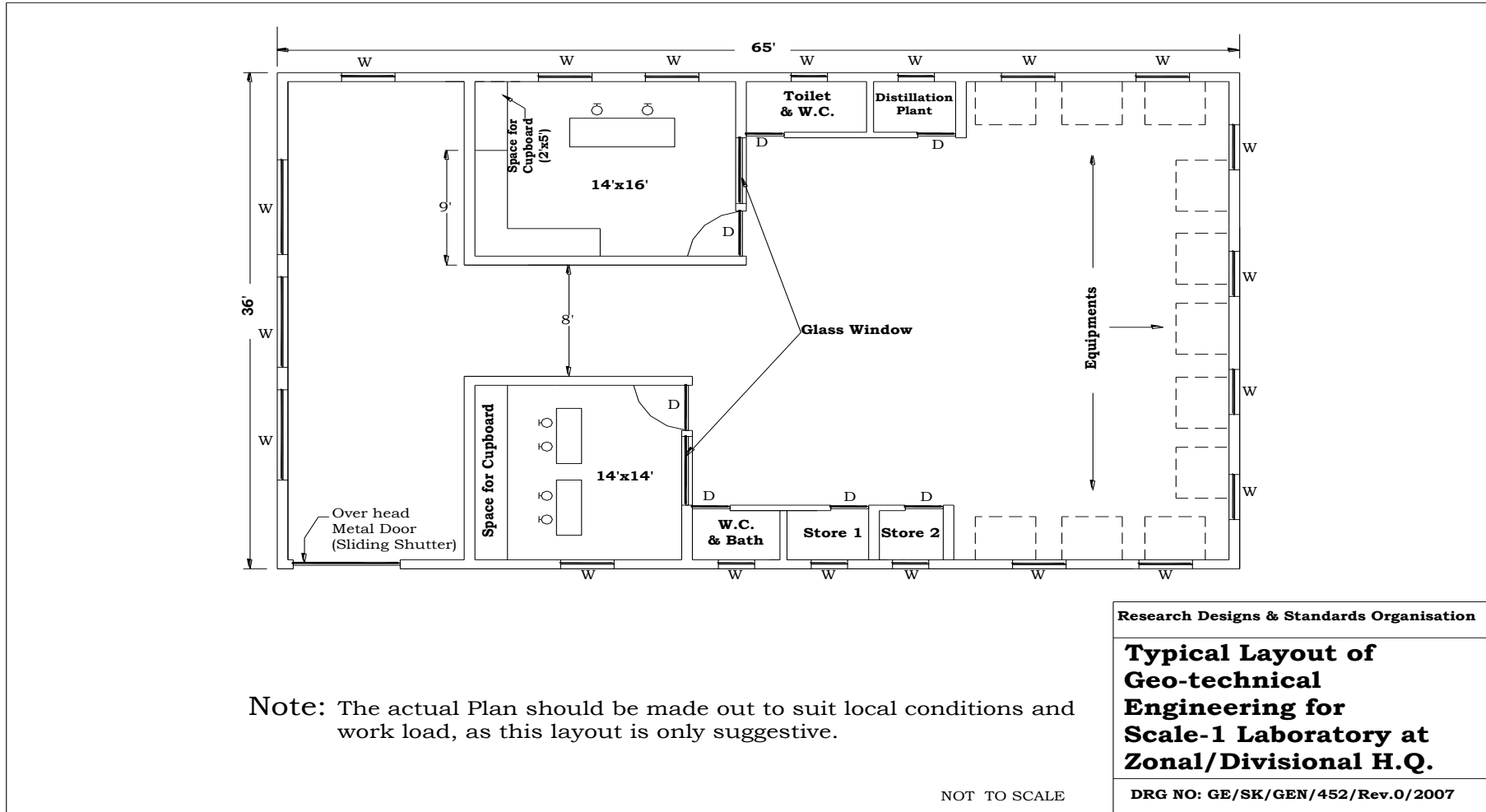
Annexure – VI

मृदा मेकैनिक्स किताबो की सूची
List of books on soil mechanics
 (As per alphabetical order)

क्रम SL	किताबों की विवरण Description of books	लेखक / कापी राइटर Author/Copy writer
1.	Basic Soil Mechanics & Foundation Engineering	Alam Singh
2.	Compendium of Indian Standards on Soil Engineering Part – I Laboratory Testing of Soil for Civil Engineering Purpose SP 36 Part : 1987	B.I.S., New Delhi
3.	Compendium of Indian Standards on Soil Engineering Part – II Field testing of soil for Civil Engineering Purpose SP 36 Part : 1988	B.I.S., New Delhi
4.	Earth Manual, (First revised edition)	United States Department of the Interior Bureau of Reclamation
5.	Foundation Engineering Hand Book	Hans F. Winterkorn & Hsai-Yang Fang
6.	Hand Book on Soil Engineering For Railway Engineers	Geo-technical Engineering Directorate/R.D.S.O.
7.	Indian Railway Track	M. M. Agarwal
8.	Pile Foundation	Robert D. Chellis
9.	Soil Mechanics & Foundation	Dr. B. C. Punmia
10.	Soil Mechanics For Road Engineers	Her Majesty Stationery Office, U. K.
11.	Soil Mechanics In Engineering Practice (3 rd edition)	Karl Terzaghi & Ralai B. Peck
12.	Special Report & State of Art Compaction of Earthwork & Sub-grade -	Indian Road Congress
13.	Technical Monograph 42	V. K. Agarwal
14.	Theoretical Soil Mechanics	Karl Terzaghi

अनुबद्ध—सप्तम

Annexure -VII



अनुबद्ध-अष्टम

Annexure VIII

