

 IIT PALAKKAD	भारतीय प्रौद्योगिकी संस्थान पालक्काड Indian Institute of Technology Palakkad अहलिया एकीकृत कैम्पस, कोझिपारा Ahalia Integrated Campus, Kozhipara पालक्काड- 678557 Palakkad – 678 557	दूरभाषसंख्या/ Phone no: 04923 – 226300/590/586 ईमेल/ Email : purchase@iitpkd.ac.in
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Prof. Job Kurian
Registrar i/c

Ref : Geotechnical Engineering Lab/IIT Palakkad
Date: 13.11.2017

Open Tender No: IITPKD/CIE/TKSU/057/2017

Due Date: 04.12.2017 at 3.00 PM

Dear Sir/Madam,

On behalf of the **Indian Institute of Technology, Temporary campus, Palakkad**, Quotations are invited for the supply, installation, testing and commissioning of the following “**Geotechnical Engineering Laboratory Equipment**” conforming to the specifications given in the Annexure II.

Item	Equipment	Quantity
1	Automated Static Triaxial System	1
2	Automated Oedometer System	1
3	Automated Direct Shear System	1
4	Fully Computerized Dynamic / Cyclic Triaxial Test System	1
5	Fully Automated Flexible Wall Permeameter	1
6	Fully Automated Soil-Geosynthetic Interface Shear Resistance Testing System	1

Pre-bid meeting – The Pre-bid meeting is scheduled to be held on **21.11.2017 at 3.00 PM in Conference Room, Academic Block, IIT Palakkad.**

Technical Bid Opening: The technical bid will be opened on **08.12.2017 at 3.00 PM in Conference Room, Academic Block, IIT Palakkad.**

Instructions to the Bidder

- (i) **Preparation of Bids:** - The tenders should be submitted **under two-bid system (i.e.) Technical bid and Financial bid in separate envelopes.** The technical bid should consist of all technical details. No prices should be included in technical bid. Financial Bid should indicate item – wise prices for the items mentioned in the technical bid. The technical and the financial bids should be put in separate cover and sealed. Both sealed covers should be put into a bigger cover. **Technical bids must either be spiral bound / stapled together. No loose sheets will be accepted. All pages must be numbered.**
- (ii) **The Quotations duly sealed and superscribed on the envelope with the reference No. and due date, should be addressed to the undersigned so as to reach him on or before the due date stipulated above.**

- (iii) **The bidder may quote for one or more items (Item 1, Item 2, etc.) above. However within any item, the quotation should be made for all the components together and no further splitting would be allowed. For each item mentioned above, the purchase order for that item will be given to the successful bidder for the respective item.**
- (iv) **Delivery of the tender:** - The tender shall be sent to the below-mentioned address either by post or by courier so as to reach this office before the due date and time specified in the Schedule. The offer/bid can also be dropped in the tender box on or before the due date and time specified in the schedule. **The tender box is kept in the office of the “Academic Block, IIT Palakkad, Ahalia Integrated Campus, Kozhipara, Palakkad-678 557.**
- (v) **Opening of the tender:** - The offer/Bids will be opened by a committee duly constituted for this purpose. The technical bids will be opened first and it will be scrutinized by a technical committee, which will decide the suitability of the bid as per our specifications and requirements. The bidders will be invited for opening of Technical bids. **The person who is attending the tender opening should bring an authorization letter from their principals duly authorizing him to attend the tender opening. Without the authorization letter, nobody will be allowed to attend the tender opening.** In respect of opening of financial bid, those bidders who are technically qualified only will be called.
- (vi) **Prices:** - The price should be quoted in net per unit (after breakup) and must include all packing and delivery charges indicated separately for each item. **The price indicated should be CIF/CIP Kochi.** The offer/bid should be exclusive of taxes and duties, which will be paid by the purchaser as applicable. However the percentage of tax & duties should be clearly indicated. The price should be quoted without custom duty, **the custom duty will be paid at concessional rate against duty exemption certificate.**
- (v) **Agency Commission:** - Agency commission, if any, will be paid to the Indian agents in Rupees on receipt of the equipment and after satisfactory installation and smooth functioning. Agency Commission will not be paid in foreign currency under any circumstances. The details should be explicitly shown in Tender even in the case of ‘Nil’ commission. The tenderer should indicate the percentage of agency commission to be paid to the Indian agent. The foreign Principal should indicate about the percentage of payment and it should be included in the originally quoted basic price, if any.
- (vi) **Terms of Delivery:** - The item should be supplied to our Institute as per Purchase order. In case of **import supply**, the item should be delivered at the cost of supplier to our institution. The installation and commissioning should be completed as specified **by us in the attached schedule** .
- (vii) **Acceptance & Rejection:** IIT Palakkad reserves the full right to accept / reject any tender at **any** stage without assigning any reason.

Yours sincerely

Registrar, IIT Palakkad

SCHEDULE

Important Conditions:

1. The due date for the submission of the tender is **04.12.2017 at 3.00 PM**
2. The offers / bids should be submitted in two bids systems (i.e.) Technical bid and financial bid. The Technical bid should consist of all technical details / specifications only. The Financial bid should indicate item/equipment-wise price and it should contain all Commercial Terms and Conditions including Taxes, transportation, packing & forwarding, installation, guarantee, payment terms, pricing terms etc. The Technical bid and financial bid should be put in separate covers **superscribed clearly as “Technical Bid” and “Financial bid”** and sealed. Both the sealed covers should be put in a bigger cover. The Open Tender for **“Geotechnical Engineering Laboratory”** should be written on the left side of the Outer bigger cover and sealed.
3. **EMD: -EMD should be at 2% (two percent) of the tender value quoted by the bidder.** The EMD should be enclosed with the financial bid which will not be opened for Technical evaluation. Enclosing the EMD in the Technical bid will automatically disqualify the bidder. EMD should be in the form of DD in favour of **“Indian Institute of Technology Palakkad” and payable at Palakkad**”. The tender without EMD would be considered as UNSOLICITED and will be REJECTED. Photo/FAX copies of the Demand Draft/Banker’s pay orders will not be accepted. No interest will be paid for the EMD and the EMD (Bid Security) will be refunded to the successful bidder on receipt of Performance Security.
4. **Performance Security:-** The successful bidder will be asked to submit Performance Security for an amount of 5% of the value of the contract/supply. The Performance Security may be furnished in the form of an Account Payee DD or FD Receipt from the commercial bank or Bank Guarantee from any nationalized bank of India. Only after submission of Performance Security, Purchase Order/Work Order will be released / L.C will be opened.
5. **Performance Security in the form of Bank Guarantee:-** In case the successful bidder is a foreign company and wishes to submit Performance Security in the form of Bank Guarantee, the Bank Guarantee should be routed through the Beneficiary Bank to the end user bank. Otherwise, the Indian Agent of the foreign vendor has to submit a Bank Guarantee from a Nationalized Bank of India

The Bank Guarantee should remain valid for a period of sixty days beyond the date of completion of all contractual obligations of the supplier including the warranty obligations.
If an Indian agent is involved, the following documents must be enclosed:
Foreign principal’s proforma invoice indicating the commission payable to the Indian Agent and nature of after-sales service to be rendered by the Indian Agent.
 - ✓ Copy of the agency agreement with the foreign principal and the precise relationship between them and their mutual interest in the business.
6. The offer/bids should be sent only for **a system or equipment** that is available in the market and supplied to a number of customers. A list of customers in India and abroad with details must accompany the quotations. Quotations for a prototype machine will not be accepted .

7. Original catalogue (not any photocopy) of the quoted model duly signed by the principals must accompany the quotation in the Technical bid. No prices should ever be included in the Technical bid.
8. Compliance or Confirmation report with reference to the specifications and other terms & conditions should also be obtained from the principal.
9. **Validity:** Validity of Quotation not less than 90 days from the due date of tender.
10. **Risk Purchase Clause:-** In the event of failure of supply of the item/equipment within the stipulated delivery schedule, the purchaser has all the right to purchase the item/equipment from other sources on the total risk of the supplier under risk purchase clause.
11. **Payment:-** No Advance payment will be made for Indigenous purchase. 100% Payment after supply and successful installation and commissioning and certification by the end user. In case of import supplies the payment will be made only through 100% Letter of Credit i.e. (50% payment will be released against shipping documents and 50% after successful installation and meeting acceptance criteria wherever the installation is being done). Advance payment may be considered on submission of Bank Guarantee equal to the amount of advance payment.
12. **On-site Installation:** - The equipment or machinery has to be installed or commissioned by the successful bidder within 15 to 20 days from the date of receipt of the item at site of IIT Palakkad.
13. **Warranty/Guarantee:** - The offer should clearly specify the warranty or guarantee period for the machinery/equipment. Any extended warranty offered for the same has to be mentioned separately. (For more details please refer our Technical Specifications).
14. **Late offer:** - The offers received after the due date and time will not be considered. The Institute shall not be responsible for the late receipt of Tender on account of Postal, Courier or any other delay.
15. **Acceptance and Rejection:** - IIT Palakkad has the right to accept the whole or any part of the Tender or portion of the quantity offered or rejects it in full without assigning any reason.
16. **Do not quote the optional items or additional items unless otherwise mentioned in the Tender documents / Specifications.**
17. **Disputes and Jurisdiction:** - Any legal disputes arising out of any breach of contract pertaining to this tender shall be settled in the court of competent jurisdiction located within the city of Palakkad in Kerala.
18. All Amendments, time extension, clarifications etc., will be uploaded on IIT Palakkad website only and will not be published in newspapers. Bidders should regularly visit the above website to keep themselves updated. No extension in the bid due date/ time shall be considered on account of delay in receipt of any document by mail.
19. **Loading & unloading: Loading and unloading charges will be borne by the successful bidder.**

Acknowledgement:- It is hereby acknowledged that the tenderer has gone through all the conditions mentioned above and agrees to abide by them.

**SIGNATURE OF TENDERER
ALONG WITH SEAL OF THE
COMPANY WITH DATE**

QUALIFICATION REQUIREMENT

1. Bidder qualifications

The Bidder must be an Original Equipment Manufacturer (OEM) of all the quoted equipment or his Authorized Dealer/Authorized Distributor/ Authorized Stockist/ Channel Partner having a Direct Purchase and Support agreement with the OEM. If the Bidder is a Dealer/Distributor, the bidder should provide a copy of valid LETTER OF AUTHORIZATION from the Original Equipment Manufacturer for Dealership.

2. Performance Certification

- a) The bidder should have supplied and installed atleast 50% of the quoted equipment (fully, not in parts) to organizations such as IITs, IISc, NITs, DRDO, CSIR labs or foreign reputed universities. The copies of the purchase orders and other documents of proof have to be attached with the technical bid. Vendor should also enclose the reference with contact details and the performance certificate along with the technical bid.
- b) The bidder must produce certificates of satisfactory performance and service support from the end-users.
- c) The list of end-users specifically for the quoted item or similar equipment along with the complete name, address and contact numbers of the user organizations/persons should be submitted with the quotation.
- d) IIT Palakkad, may gather feedback from the users about the particular model specified in the quote, or similar equipment, and about the general service and maintenance provided by the vendor. The feedback may also be sought from users, who are not listed by the vendor.

3. Specifications

- a) It should be ensured that the bids must be strictly as per IIT Palakkad's specifications mentioned in Annexure II. At the same time, it must be kept in mind that merely copying IIT Palakkad's specifications in the quotation shall not make the parties eligible for consideration of the quotation. **A quotation has to be supported with a printed copy of published technical catalogue and photographs showing all the components of each item included in the quotation. Quotations without proper technical documents and catalogues will be summarily rejected without providing any opportunity for clarifications/negotiations by the vendor.** The model quoted should be highlighted in the leaflet/literature enclosed with the quotation. Non-compliance of the above shall be treated as incomplete/ambiguous, and the offer can be ignored without giving an opportunity for clarification/negotiation, etc., to the quoting party. Lack of clarity in any information will treated as lack of information.
- b) The technical bid shall be evaluated for acceptability by the technical committee duly constituted for this purpose. Before issuing the purchase order, the eligible vendor should be prepared to make a technical presentation if required. If the manufacturer is using a component manufactured by another manufacturer, the vendor should clearly specify the make, brand, and name of the manufacturer.

4. Demonstration

- a) Upon request from IIT Palakkad, if required, the vendor should arrange demonstration of the equipment offered, free of charge on a mutually agreeable place and date prior to opening of financial bid to ascertain their conformity with tendered specifications. Unsatisfactory demonstration may lead to disqualification of the vendor. A letter to the registrar which clearly states the details of the equipment for demonstration and the organization having the equipment should be attached with the technical specifications. The required approval from the organization must be obtained by the vendor.

5. Compliance statements

- a) Vendors must furnish a Compliance Statement of each and every required specification of IIT Palakkad's tender in the format as shown in Annexure I. The deviations, if any, from the tendered specifications should be clearly brought out in the statement.

6. Infrastructure requirements

The bidder should clearly give in writing, the requirements that have to be arranged by the institute for proper functioning of the equipment within two weeks after the release of purchase order.

7. Delivery schedule

- a) All the tendered equipment should be supplied within 18 weeks of order and installation, testing and commissioning should be done in another 4 weeks, in consultation with IIT Palakkad. **In case there is any deviation in the delivery schedule, liquidated damages clause will be enforced or penalty for the delayed supply period will be levied.**

8. Installation and commissioning

The vendor should take full responsibility for the supply, installation, testing and commissioning of all the tendered equipment. Installation and commissioning should be carried out at IIT Palakkad by trained and experienced service engineers. The installation, testing and commissioning should be completed within 4 weeks from the date of delivery. The performance of the system should be demonstrated to the satisfaction of the faculty/staff of IIT Palakkad.

9. Acceptance test

Acceptance tests will be carried out to check the performance of all the equipment as per technical specifications of IIT Palakkad. The selected vendor should demonstrate the basic and advanced tests. The list of acceptance tests along with the details should be submitted, and will be verified by faculty of IIT Palakkad. Any modifications suggested by the faculty/staff of IIT Palakkad should be incorporated by the vendor. All test kits and specimens for the test should be brought by the vendor at their cost.

10. Maintenance and service support

The vendor should have competent and reliable service network in India for performing quick and necessary repair and maintenance of all the components of the tendered equipment. Details of the nature of service support and which vendor can provide it, should be given along with the technical bid. The vendor should commit to provide maintenance

service and supply necessary spares for the equipment for at least 10 years after successful installation and commissioning of the equipment. The service provider should have a history of providing such services for the past 5 years, and should be supported with corroborating documents. The details provided by the vendor in this regard should be convincing to IIT Palakkad.

11. Warranty

The Successful bidder shall provide standard warranty along with extended warranty put together three years of warranty after the completion of installation and final acceptance including on-site. The quote should clearly mention that the extended warranty support includes free replacement of spares wherever necessary with no cost to IIT Palakkad. The warranty should include at least one scheduled visit per annum of bidder's service engineer for inspection and maintenance of equipment. This should be in addition to any number of visits that may be required for attending warranty related issues.

12. Operation and maintenance manuals

a) Two sets of operation and maintenance manuals along with all necessary drawings should be supplied with each equipment. Backup CD/DVD for total firmware, background software and the application software packages should be supplied.

13. Operation and Maintenance Training

The vendor should arrange for operational and maintenance training of all the tendered equipment for the faculty/staff of IIT Palakkad. The trainer should be technically sound, and be able to answer/demonstrate all queries that the faculty/staff of IIT Palakkad may have. The trainer should be thoroughly familiar with the equipment and its various components. The trainer should be a permanent employee of the company with a minimum of 3 years' experience in demonstrating such equipment for conducting soil tests. The details about the training programs and a brief bio-data of the trainer should be submitted along with the technical bid. IIT Palakkad may decide to record (audio and/or video) training/demonstration of the use of equipment for internal use. Training material by the manufacturer shall also be provided. All costs related to the training shall be borne by the vendor.

14. Transport

The vendor is responsible for all cost related to freight and transport of the equipment to IIT Palakkad's facility. The custom duty will be paid at concessional rate against duty exemption certificate.

15. Payment

The complete payment will be done after commissioning and satisfactory performance of the equipment.

ANNEXURE I: COMPLIANCE STATEMENT OF SPECIFICATIONS

Instructions for filling the Compliance Statement of Specification

1. The vendor should prepare, sign and submit the Compliance Statement of Specification **in the given format in A3 size sheets** along with the technical bid.
2. Submit separate Compliance Statement of Specification sheets for each item/ equipment.
3. Ensure that the component number and heading in the Technical Specifications is clearly mentioned in the document. If there are any deviations from the specifications mentioned by IIT Palakkad, the vendor should clearly indicate the deviations and give reasons for the deviation with proper justification.
4. Technical leaflet/literature/catalogue or any relevant document for all the quoted equipment should be provided to IIT Palakkad. The information provided in the compliance statement without supporting documents will not be considered for the evaluation of the technical bid.
5. If the supporting documents are not available for any information provided in the compliance sheet, it will be treated as non-compliance and may lead to the disqualification of the technical bid.
6. The vendor should clearly respond to every requirement given in the technical specification. Lack of clarity will be considered as lack of information and may subsequently lead to disqualification of the technical bid.
 7. Every component should have manufacturer's logo/name engraved/pasted on it. Photograph to be provided as proof.

Item No.	IIT Palakkad's technical specification of components / parts as given in Annexure II	Specifications of model quoted by the vendor	Vendor's specification complies with IIT Palakkad's technical specification? (YES/ NO)	Deviation, if any, to be indicated in unambiguous terms	Page no. of relevant specification for the quoted model in the technical manual/leaflet

ANNEXURE II: TECHNICAL SPECIFICATIONS

Item No	Name of Experiments	Name of Equipment	Quantity	List of Components
1	Conventional Static Triaxial Compression Tests (UU, CU, CD) and Stress Path Tests	Automated Static Triaxial System	1	A. Load Frame; B. Triaxial Stress Path Cell; C. Automated Pressure Control and Volume Change System; D. Sensors; E. Installation kit; F. Specimen Preparation Accessories; G. System Control and Data Acquisition Software; H. Software Modules for UU, CU and CD Tests; I. PC Desktop

Specification:

Fully automated static triaxial setup for conducting conventional triaxial tests such as UU, CU and CD and stress path tests. The equipment should have fully computerized control system for the application of cell and back pressures, and deviator stress, and measurements of volume change, pore pressure; stress/strain paths, etc., so that no operator intervention is required. The system should include the following minimum components:

A. Load Frame: 50 kN capacity or higher electro-mechanical, two column digital loading frame, capable of automatic control through a networked computer as well as by a built-in waterproof graphical touch screen display for standalone application.

- Speed range: 0 - 50 mm/min. or greater.
- 50 kN or higher load capacity.
- Integrated data logger with a minimum sampling rate $\geq 40/\text{sec}$.
- 4 channel 24 Bit A/D converter.
- Data storage: 1000 tests or more.
- Voltage: 110-240V, 50/60 Hz, 5 amps.
- Vertical clearance: minimum 900 mm.
- Horizontal clearance: minimum 300 mm.
- Platen diameter: In the range of > 250 mm.
- Platen travel should not be less than 60mm.

- Port for PC control, data acquisition and systems upgrade.

B. Triaxial Stress Path Cell: Should be suitable for soil specimens up to 75mm diameter and capable for handling a minimum working confining pressure of 1000 kPa. It should include a transparent acrylic chamber, a hardened stainless steel piston and interchangeable pedestals and top caps for specimens of sizes 38mm, 50mm and 75mm. The cell should have five zero-volume-change-valves with de-airing block for pore-pressure transducer. The valve fittings should be made of brass and the cell top and base made with precision machined anodised aluminium.

C. Automated Pressure Control and Volume Change System: It should consist of the following:

- Fully automated Pneumatic Pressure Controller: It should be able to handle a pressure of 1000 kPa or greater and a volume up to 100 cc very accurately. This should provide computer control and monitoring of cell pressure, back pressure, pore water measurement and volume change. Data acquisition 4 channels 24 Bit A/D conversion, electronic regulators, and a waterproof graphical touch-screen display for standalone control and monitoring of testing.
- Pressure Distribution Panel: With all necessary connections for distributing compressed air, water, de-aired water and vacuum and for computer controlled, automatic sample saturation when used in conjunction with automated pressure controller. Air/Water pressure cylinders, extra bladders (3 minimum) should also be provided.
 - Max input pressure: ≥ 1000 kPa,
 - Pressure resolution 1kPa.
- De-Airing System: To de-air water without the use of heat using combined mechanical agitation and vacuum to ensure complete de-airing of at least 7.5 L batch in 5 minutes or less is required.
- Silent Compressor:
 - Noise level: < 45 db/A,
 - Output: > 100 L/min,
 - Maximum pressure: > 1000 kPa
- Vacuum Pump:
 - Free air displacement: 85L/min,
 - Maximum vacuum: 76 cm

D. Sensors:

- i. Load Cell: 10 kN capacity, non-linearity/accuracy: 0.05% or better of Full Range Output

- ii. Displacement Transducer and bracket: 50 mm travel, non-linearity/accuracy : 0.1% or better of Full Range Output
- iii. Displacement Transducer and bracket: 25mm travel, non-linearity/accuracy : 0.1% or better of Full Range Output
- iv. Pore Pressure Transducers: Capacity > 1000 kPa, non-linearity/accuracy: 0.1% or better with adequate overload protection, for cell and pore pressures each.

E. Installation Kit: All fittings, quick connects, ferrules, tubings, hex wrenches, thread tape, reducer couplers, regulator elbow, couplers and other tools required to complete the Triaxial Equipment setup.

F. Specimen Preparation Accessories Kit for 38, 50 and 75mm specimens:

- i. Latex Membranes: 0.012” thickness, 1 dozen each size
- ii. Porous Stones: 4 for each size
- iii. O-Rings: 2 dozen for each size
- iv. Filter Paper: 100 nos. for each size
- v. Membrane stretchers, O-ring placement tool, Split mould – 1 for each size, Vacuum split Former, Sample trimmer with knife, Acrylic discs – 2 for each size.
- vi. Any other part/ tool or accessory required for the purpose of installation.

G. System Control and Data Acquisition Software: Software module for the complete control of the operation of test machines, and real time data acquisition of test data through a networked computer should be provided.

- Should provide real-time graphical and numerical display.
- Should have ability to configure testing machines and the testing process
- Should have ability to calibrate channels to load cell and transducers.
- Option for exporting reports to Excel or a CSV format.

H. Software Modules for UU, CU and CD Tests: Test-specific software modules for running various types of triaxial tests (UU, CU and CD) should also be supplied. The software should allow real-time monitoring of test, provide the tabulated test results, relevant graphs and calculations in real-time, and generate reports. It should also be possible to create and save test-specific templates for the fast setting of similar tests in future. The software should have an auto-recovery option to prevent the data loss in case of power interruption. All tests, reporting and parameters in accordance with ASTM/BS/ BIS standards.

I. PC Desktop: A desktop computer for test control, data acquisition and monitoring should also be provided. Following are the minimum PC requirements:

- Processor : 64 bit (i-5 Processor)
- RAM: 8 GB DD4
- Hard Drive: 1T
- Monitor: 23" flat, expanded key board & mouse
- UPS
- Operating system: Original MS Professional 64 bit version Windows compatible with equipment and software modules supplied.

Item No	Name of Experiments	Name of Equipment	Quantity	List of Components
2	One-dimensional Consolidation and Swell Tests	Automated Oedometer System	1	A. Electro-mechanical Load Frame; B. Touch-screen Display and Controller; C. Oedometer Cell with Fixed Ring; D. Sensors; E. Data Logger and Software Modules; F. Installation Kit; G. PC Desktop

Specification:

Fully-computerised oedometer apparatus for performing consolidation and swell tests. The system should have an integrated stepper motor driven unit for automatic incremental loading, which eliminates the hanging dead weight arrangement used in traditional consolidation apparatus. Once the test conditions has been set at the beginning by the user, the system must perform the complete test including the application of successive stress increments without the intervention of operator. The system can be operated either in stand-alone mode using a touch-screen graphical display and embedded data acquisition system or in a desktop controlled mode. The system should include but not limited to the following vital components:

A. Electro-mechanical Load Frame: 10 kN capacity or higher, two column digital loading frame with a stepper-motor drive system for applying stress increments.

- Maximum Load: $\geq 10\text{kN}$
- Nominal Stroke / Piston Travel: $\geq 12.5\text{ mm (0.5")}$
- Vertical clearance: $> 150\text{ mm}$
- Horizontal clearance: $> 180\text{ mm}$
- Power Supply: 110 -240V, 50/60 Hz.

B. Touch-screen Display and Controller: The setup should have a high resolution waterproof touch-screen display and an integrated two-channel 24 Bit A/D data logger for control and monitoring in a stand-alone configuration. The operation can be controlled and viewed through a networked desktop as well if needed. The apparatus should have sufficient number of USB or LAN ports or RS232 interface for connecting to a computer or other external devices (eg., USB).

- Data storage of 1000 tests or more.
- Capable for running test automatically including the successive application of stress increments when necessary
- Sampling rate: $> 40\text{ readings per second}$.

- Calibration of channels to load cell and transducers.
- Smart Test Function: automatically start from the point where it left off if the test was not completed due to an unexpected event (eg., power failure) and prevents data loss.
- Free upgrade to the latest version of software should be possible

C. Oedometer Cell with Fixed Ring: Complete sets for two sample sizes: 50 and 75 mm, made of stainless steel.

- Cell base
- O-ring
- Upper and lower porous stones
- Self-trimming cutter ring
- Clamping ring
- Loading pad
- Stainless steel ball for load application
- Lifting knob
- Locking nut
- Outer cylinder
- Air filter and water trap: for clean and dry air supply

D. Sensors:

- Load cell and adaptor: 10 kN or higher capacity, accuracy/non-linearity : 0.05 % or better of Full Range Output
- Linear displacement transducer and bracket: ≥ 10 mm travel, accuracy/non-linearity : 0.1% or better of Full Range Output

E. Data Logger and Software Modules: Multi-channel data acquisition system and software for test control and real-time monitoring through a PC should be supplied. The software should allow the user to create new test-specific setup, store for future use, monitor ongoing test and generate graphs and report.

- Data storage of 1000 tests or more.
- Capable for running test automatically including the successive application of stress increments when necessary
- Sampling rate: > 40 readings per second.
- Calibration of channels to load cell and transducer.

- Option for exporting reports to Excel or a CSV format.
- Free upgrade to the latest version of software should be possible
- Auto-recovery and smart test option: automatically start from the point where it left off if the test was not completed due to an unexpected event (eg., power failure) and prevents data loss.

F. Installation Kit: All fittings, fasteners, tubings and other tools required to complete the installation of consolidation equipment setup.

G. PC Desktop: A desktop computer and LAN cables for test control, data acquisition and monitoring should also be provided. Following are the minimum PC requirements:

- Processor : 64 bit (i-5 Processor)
- RAM: 8 GB DD4
- Hard Drive: 1T
- Monitor: 23" flat, expanded key board & mouse
- UPS
- Operating system: Original MS Professional 64 bit version Windows compatible with equipment and software modules supplied.

Item No	Name of Experiments	Name of Equipment	Quantity	List of Components
3	Direct Shear Test to Determine the Shear Strength Parameters of Soil	Automated Direct Shear System	1	A. Pneumatic normal and shear loading mechanism; B. Touch-screen display and controller; C. Sensors; D. Shear box assembly; E. Data logger and Software modules; F. Installation kit; G. PC Desktop

Specification:

The system should be capable of performing direct / residual shear test under fully computerised control utilizing a pneumatic loading approach for applying normal loads to a sample, which eliminates the need for several loading weights required in a conventional dead weight-lever arm system. The system should incorporate a microprocessor based stepper-motor to apply horizontal loads to the specimen. The apparatus should also be equipped with a touch-screen graphical display and built-in data acquisition system for control and monitoring of test in a stand-alone configuration as well as in a computer-controlled configuration. Following are the essential components and features of the required system:

A. Pneumatic Normal and Shear Loading Mechanism:

- Horizontal shear force: ≥ 10 kN
- Normal load: ≥ 10 kN
- Horizontal movement: ≥ 50 mm
- Power Supply: 110-240 Vac, 50/60 Hz.
- Speed range: 0.00003 to 10 mm/min or higher

B. Touch-screen Display and Controller: A high resolution waterproof touch-screen display for control and monitoring of test and for viewing the real-time test data in both graphical and tabular forms. It should also be featured for control through a networked computer if necessary. In case of stand-alone configuration, downloading of data to an external device through a USB or LAN ports or RS232 interface should also be possible at a later stage.

- Data storage of 1000 tests or more.
- Capable to be programmed to run shearing cycles automatically
- Sampling rate: > 40 readings per second.
- Calibration of channels to load cell and transducers.
- Free upgrade to the latest version of software should be possible

C. Sensors:

- 2 load cells and adaptors: 10 kN capacity, accuracy/non-linearity : 0.05 % or better of Full Range Output
- Vertical displacement transducer and bracket: ≥ 10 mm travel, accuracy/non-linearity : 0.1% or better of Full Range Output
- Horizontal displacement transducer and bracket: ≥ 25 mm travel, accuracy/non-linearity : 0.1% or better of Full Range Output

D. Shear Box Assembly: For 100 mm square soil specimen. The assembly should include the following:

- Shear box housing
- Sample box
- Base plate
- 2 Porous stones
- Upper loading pad
- Grid and perforated plates
- Holding pins
- Counter balance device
- Shear box cutter
- Dolly/tamper
- Calibration disc
- Air filter and water trap: for clean and dry air supply

E. Data Logger and Software Modules: Multi-channel data acquisition system and software for test control and real-time monitoring through a PC should be supplied. The software should allow the user to create new test-specific setup, store for future use, monitor ongoing test and generate graphs and report.

- Data storage of 1000 tests or more.
- Capable to be programmed to complete shearing cycles automatically
- Data acquisition 4 channel, 24 Bit A/D conversion
- Sampling rate: > 40 readings per second.
- Calibration of channels to load cell and transducer.
- Option for exporting reports to Excel or a CSV format.
- Free upgrade to the latest version of software should be possible
- Auto-recovery option to prevent the data loss in case of power interruption.

F. Installation Kit: All fittings, fasteners, tubings and other tools required to complete the direct shear equipment setup.

G. PC Desktop: A desktop computer for test control, data acquisition and monitoring should also be provided. Following are the minimum PC requirements:

- Processor : 64 bit (i-5 Processor)
- RAM: 8 GB DD4
- Hard Drive: 1T
- Monitor: 23" flat, expanded key board & mouse
- UPS
- Operating system: Original MS Professional 64 bit version Windows compatible with equipment and software modules supplied.

Item No	Name of Experiments	Name of Equipment	Quantity	List of Components
4	Dynamic / Cyclic Triaxial Test	Fully Computerized Cyclic Triaxial Test System	1	A. Load Frame; B. Digital Servo Controller And Data Acquisition System; C. Automatic Pressure Controllers; D. Pressure Control Panel & Volume Change Arrangement; E. Triaxial Cell; F. Test Specimen Accessories; G. Air Compressor H. De-airing system I. Installation Kit; J. Software; K. Computer.

Specification:

Fully automated cyclic triaxial testing system with digital servo-control of axial loading, cell pressure and back pressure application. The system should be capable of performing isotropic and anisotropic consolidation; Ko-consolidation; cyclic triaxial tests with different drainage conditions (CD, CU, and UU) to obtain dynamic shear strength and deformation, liquefaction potential, shear modulus, damping ratio, etc. The system should include the following vital components:

- A. Load Frame:** With pneumatic servo control actuator capable of providing a dynamic loading capacity of 10 kN or higher, at frequencies up to 10 Hz or greater.
- 50-mm (2 inch) or higher stroke/travel.
 - +/- 10 kN or greater static and dynamic actuator load capacity.
 - At least 7.5 -mm peak-to-peak amplitude @ 5 Hz frequency.
 - Deformation transducer: 50 mm or greater range with 0.1% or better accuracy/non-linearity.
 - Load cell: +/-10 kN range with 0.05% or better accuracy/non-linearity.

- Vertical clearance: > 700 mm
- Horizontal clearance: > 300 mm.

B. Digital Servo Controller and Data Acquisition System: The system should include a microprocessor based digital servo controller and a high speed data acquisition system for automatic loading and data measurements. At least 16 channel data acquisition and 4 outputs for proportional servo control. 24 Bit A/D conversion, automatic sensor recognition of sensors, 800MHz microprocessor with 256MB RAM and 2 GB solid state internal memory. Wireless control if available shall be preferred. The control unit should allow the user to create their own wave forms including using digitized earthquake records.

C. Automatic Pressure Controllers: For cell pressure and back pressure control. This should allow the complete automation of triaxial test stages such as specimen saturation, consolidation, and cyclic shear loading without the intervention of operator.

- Maximum pressure: ≥ 1000 kPa (150 psi).

D. Pressure Control Panel & Volume Change Arrangement: Pressure control panel and volume change device for optional manual control should also be provided. The panel should include the following:

- 2 (for cell & back pressure) pressure transducer: ≥ 1000 kPa range with 0.25% linearity.
- 1 volume change differential pressure transducer: 500 mm H₂O range or higher with 0.25% linearity.
- Pore pressure differential pressure Transducer: ≥ 1000 kPa range
- 3 regulators for optional manual control of cell, top, and bottom back pressures.
- Precision pressure gage with 2.5 kPa or higher resolution and selector valve.
- Graded water level sight tubes for electronic and manual readings.
- Built-in venturi vacuum pump
- Regulated air supply to servo valves
- Other necessary valves

E. Triaxial Cell: A precision made 1000 kPa or higher cell pressure capacity triaxial cell with external acrylic plastic wall should be provided. It should include a low-friction loading piston, graphite seal, ball bushing guide and drainage lines at top and bottom. The cell should be capable to accommodate cylindrical soil samples having a diameter up to 75 mm.

F. Test Specimen Accessories for 70-mm Diameter Specimens: Set of test specimen accessories should be supplied. This includes but not limited to,

- Top and bottom platens with pore water pressure ports
- Spherical seat loading set
- Rigid loading connection
- Porous stones (top/bottom)
- O-rings for sealing membranes to platens,
- Latex membranes.

G. Air Compressor: A silent air compressor to provide free dry air should also be supplied.

- Noise level: < 45 db/A,
- Output: > 100 L/min,
- Maximum pressure: > 1000 kPa

H. De-Airing System: To de-air water without the use of heat using combined mechanical agitation and vacuum to ensure complete de-airing of at least 7.5 L batch in 5 minutes or less is required.

I. Installation Kit: All fittings, quick connects, ferrules, tubings, hex wrenches, thread tape, reducer couplers, regulator elbow, couplers and other tools required to complete the cyclic triaxial setup.

J. Software: A software for advanced digital servo control and data acquisition should be provided. There should be option to program customized cyclic triaxial test procedures to perform simple cyclic test such as liquefaction, modulus measurement, cyclic strength, etc. It should also include procedures for automatic back pressure saturation and consolidation. The waveform library of the software must include sinusoidal, Haversine, triangular, square and rectangular waveforms. The software should allow real-time monitoring of test, provide the tabulated test results, relevant graphs and calculations in real-time, and generate reports. It should also be possible to create and save test-specific templates for the fast setting of similar tests in future. The software should have an auto-recovery option to prevent the data loss in case of power interruption.

- Should provide real-time graphical and numerical display.
- Should have ability to configure testing machines and the testing process
- Should have ability to calibrate channels to load cell and transducers.
- Option for exporting reports to Excel or a CSV format.

K. PC Desktop: Suitable computer to control and execute the test automatically should also be provided. Following are the minimum PC requirements:

- Processor : 64 bit (i-5 Processor)
- RAM: 8 GB DD4

- Hard Drive: 1T
- Monitor: 23" flat, expanded key board & mouse
- UPS
- Operating system: Original MS Professional 64 bit version Windows compatible with equipment and software modules supplied.

Item No.	Name of Equipment	Name of Experiments	Quantity	List of Components
5	Fully Automated Flexible wall Permeameter	Constant gradient test, Constant flow test, Isotropic consolidation test, Hydraulic conductivity ratio test.	1	<ul style="list-style-type: none"> A. Fully automated Control system to regulate the pressure and volume B. Permeability test software for controlling and reporting C. PC based data acquisition and control system D. PC Desktop E. Permeability cell F. Top cap and base Pedestal G. Load frame H. Specimen preparation accessories for 50 mm and 100 mm dia samples I. Automatic de-airing water system J. Toxic interface units K. Tool kit

Specification:

Fully Automated Flexible wall Permeameter for conducting hydraulic conductivity tests such as constant gradient test, constant flow test and isotropic/anisotropic consolidation test and hydraulic conductivity ratio tests. The unit should meet the requirements of ASTM D5084, BS 1377 Part 6 1990, ASTM D5567. **The equipment should have automatic, computerized control for the application of cell pressure and back pressures and measurements of cell and sample volume change, pore pressure, flow volume and flow rate so that no operator intervention is required during all testing stages.** System should be complete in all respect to perform all tests as per relevant ASTM/ BS/ BIS standards. System should include the following minimum components:

A. Fully automated Control system to regulate the pressure and volume in the test cell and specimen:

- i. Fully automated pressure control system capable of maintaining a desired pressure within 0.50 kPa along with pore pressure transducers and sensors
- ii. System should be capable of providing constant pressure and constant rate of pressure change
- iii. System should have minimum pressure capacity of 1000 kPa
- iv. System should have minimum volume capacity of 200 cc
- v. Fully automated closed loop computer control system for providing constant volume, constant rate of volume change and monitoring volume changes within 0.001 cc
- vi. It should work and controlled remotely through computer and software
- vii. System should be fitted with computer controlled valves for fill and drain water
- viii. All component in touch with water should be made from anti-corrosive material
- ix. Resolution of 0.05 kPa pressure and accuracy within $\pm 0.5\%$.
- x. Fitted with safety limit switch for over load, travel and over temperature
- xi. The apparatus should have sufficient number of USB or LAN ports or RS232 interface for connecting to a computer or other external devices (eg., USB)

B. Permeability test software for controlling and reporting:

- i. Windows based software to use feedback from the pressure transducers and other sensors to provide real-time control of pressure and volume change. The software should be capable of performing the test including back pressure saturation, isotropic/anisotropic consolidation, constant head or constant flow permeability with all stages of the tests automatically.
- ii. Test reports should be generated differently for all stages including saturation, consolidation and permeability stages so that variation of B-Value with time, variation of volume change with respect to time during consolidation, t_{100} , coefficient of volume compressibility, coefficient permeability with respect to time can be obtained.
- iii. Report should be generated in graphical and tabular format

- iv. It should have the facility to export all test data in to Excel
- v. It should have the facility to calibrate the sensors by the user as and when required
- vi. Free upgrade to the latest version of software should be possible
- vii. Test should automatically start from the point where it was left off if the test was not completed due to an unexpected event such as power failure and should have auto recovery option to prevent data loss

C. PC based data acquisition and control system:

- i. On-line data acquisition and real-time graphical and numerical display of readings
- ii. 8-channel data acquisition with minimum 24-bit resolution
- iii. Minimum Data Storage of 1000 tests
- iv. Minimum Effective sampling rate of 50 readings per second

D. PC Desktop:

A desktop computer for test control, data acquisition and monitoring should also be provided. Following are the minimum PC requirements:

- i. Processor : 64 bit (i-5 Processor)
- ii. RAM: 8 GB DD4
- iii. Hard Drive: 1T
- iv. Monitor: 23" flat, expanded key board & mouse
- v. UPS
- vi. Operating system: Original MS Professional 64 bit version Windows compatible with equipment and software modules supplied.

E. Permeability cell:

- i. Acrylic Cell which can accept 50 mm to 100 mm diameter samples with double height
- ii. Capable of withstanding minimum pressure of 1000 Kpa with high quality stainless steel valves and fittings and Teflon tubings. All valves, fittings and tubings should be resistant to corrosive and toxic permeants.
- iii. The cell should have five zero-volume-change-valves for cell, back pressure and pore pressure lines with de-airing block for pore-pressure transducer.

F. Top cap and base Pedestal:

Top cap (resistant to corrosive and toxic permeants) with two drain ports and groove for sealing membrane and Removable base pedestal (resistant to corrosive and toxic permeants) which accommodates various sample diameters (50 mm to 100 mm diameter samples).

G. Load frame:

- i. It should work in Load and Displacement control mode
- ii. It should work and controlled remotely through computer and software
- iii. Fully independent operation by keypad & LCD screen for standalone applications to apply / measure load and displacement
- iv. Fitted with safety limit switch for over load, travel and over temperature
- v. All components in touch with water should be made from anti-corrosive material
- vi. Minimum loading capacity 50 kN and minimum piston displacement 60 mm
- vii. Load Cell: 10 kN capacity, non-linearity/accuracy: 0.05% or better of Full Range Output
- viii. It should maintain and regulate load within 0.01 kN and displacement within 0.01 mm
- ix. Displacement speed should be capable of varying from atleast 10^{-4} mm/min to 15 mm/min
- x. It should have the space to accommodate the test cell to test 150mm (Diameter) x 300mm (Height) samples; and horizontal clearance should be minimum 300 mm and vertical clearance, minimum 900 mm
- xi. Voltage: 110-240V, 50/60 Hz, 5 amps

H. Specimen preparation accessories for 50 mm and 100 mm dia samples:

- i. Latex Membranes of 0.3 mm (0.012") thick: 20 Nos.
- ii. Split mold (3 part) for disturbed and undisturbed sample diameters 50 mm, 100 mm with arrangement to apply vacuum for sand samples: 1 No. each
- iii. Membrane stretcher and membrane placing tool for sample diameters 50 mm, 100 mm: 1 No. each
- iv. Membrane tester: 1 No.
- v. O-Rings : 1 dozen each size
- vi. O-Ring placing tool: 1 No.
- vii. Porous Disc for sample diameters 50 mm, 100 mm: 4 Nos. each size
- viii. Acrylic disc for sample diameters 50 mm, 100 mm: 4 Nos. each size
- ix. Sample trimmer with knife: 1 No.
- x. High vacuum grease
- xi. Whatman filter papers (100 Nos. for each size)

I. Automatic de-airing water system:

- i. It should consist of minimum 10 litre water tank, tank holding stand, water distribution panel, vacuum pump and pipe etc. control and **automation package**
- ii. Silent Compressor:
 - a. Noise level: < 45 db/A,
 - b. Output: > 100 L/min,
 - c. Maximum pressure: > 1000 kPa
- iii. Vacuum Pump:
 - a. Free air displacement: 85L/min,
 - b. Maximum vacuum: 76 cm

J. Toxic Interface Units: 2 Nos.

For permeability tests of corrosive or toxic permeants. It should act as a fluid separator to prevent permeant from entering the control unit and prevent the contact with air.

K. Tool kit:

All fittings, quick connects, ferrules, tubings, hex wrenches, thread tape, reducer couplers, regulator elbow, couplers and other tools required to complete the test setup.

Any other tools or accessories required for the purpose of installation and running the test

Item No.	Name of Equipment	Name of Experiments	Quantity	List of Components
6	Fully Automated Soil-Geosynthetic Interface Shear Resistance testing system	Interface shear resistance testing for - Geomembrane with soil - Geotextile with soil - Geocomposites with soil - GCL with soil - Geogrid with soil - Internal friction of GCLs	1	A. Interface shear box assembly and specimen preparation accessories B. Loading unit / Load frame C. Displacement transducers D. Test software for controlling and reporting E. PC based data acquisition and control system F. PC Desktop G. Tool kit

Specification:

The unit should meet the requirements of ASTM D5321, D6243, D3080 and BS 1377 standards. The unit should have automatic computer control to determine the interface shear resistance of Geosynthetic materials such as geomembrane, geotextile, geocomposites, GCL, geogrid, etc. with the soil, shear strength parameters of soil by direct shear test on soil, Internal and Interface shear resistance of Geosynthetic

clayliner (GCL) etc.. Should be suitable for testing minimum 300mm x 300mm x 200mm sample containing soil and geosynthetic to evaluate soil to geosynthetic friction characteristics. The unit should be capable of providing variable rate of strain for interface shear test. System should be complete in all respect to perform all tests as per relevant ASTM/ BS/ BIS standards. The system should include the following minimum components:

A. Interface shear box assembly and specimen preparation accessories:

- i. Interface Shear box assembly with dimension of minimum 300mm x 300mm x 200mm in two halves and all sample preparation and testing accessories as per ASTM D5321, D6243, D3080 and BS 1377 standards
- ii. End clamps and grip plates for geosynthetics and GCL
- iii. Linear bearings for minimum horizontal friction
- iv. Unit should be capable of applying a constant rate of strain or stress at any displacement rate up to minimum 10 mm per minute
- v. The assembly should also include minimum : Base plates, 4 Porous stones, Upper loading pad, Grid and perforated plates, Holding pins, Grip plates and end clamps, Counter balance device, Shear box cutter, Dolly/tamper etc.

B. Loading unit / Load frame:

- i. Loading unit should be capable of applying the horizontal and vertical loads up to minimum 50 kN
- ii. It should work in Load and Displacement control mode
- iii. Fully independent operation by keypad & LCD screen for sample setup
- iv. Stepper motor with built-in controls for applying vertical load and horizontal load
- v. Vertical Travel and Horizontal Travel : Minimum 100 mm with a resolution of 0.002 mm
- vi. It should maintain and regulate load within 0.01kN and displacement within 0.01mm

- vii. Load cells with adapters: Strain gauge type load cells 2 numbers; +/-50 kN range , accuracy/non-linearity : 0.05 % or better of Full Range Output
- viii. It should have space to accommodate the sample of 300mm x 300mm x 200mm
- ix. Power: 110-240 V, 50/60 Hz, AC- 1 phase
- x. Fitted with safety limit switch for over load, travel and over temperature
- xi. The apparatus should have sufficient number of USB or LAN ports or RS232 interface for connecting to a computer or other external devices (eg., USB)

C. Displacement transducers: 2 No.s (For Horizontal and Vertical displacement measurement)

- i. Range- 100mm
- ii. Resolution- minimum 0.002 mm
- iii. Accurate displacement rate control : minimum 10^{-4} mm/min to 15 mm/min
- iv. Accuracy/non-linearity : 0.1% or better of Full Range Output

D. Test software for controlling and reporting

- i. Windows based software to use feedback from the sensors to provide real-time control of load and displacement
- ii. The software should be capable of controlling the test without user intervention to perform incremental consolidation, interface shear displacement control, shear load control, residual shear load and displacement control, constant volume swell, constant stress swell etc. with all stage of tests automatically.
- iii. Report should be generated in graphical and tabular format differently for all stages of the test

- iv. It should have facility to export all test data to Excel
- v. It should have facility to calibrate the sensors by the user as and when required
- vi. Free upgrade to the latest version of software should be possible
- vii. Test should automatically start from the point where it was left off if the test was not completed due to an unexpected event such as power failure and should have auto recovery option to prevent data loss

E. PC based data acquisition and control system:

- i. On-line data acquisition and real-time graphical and numerical display of readings
- ii. 4-channel data acquisition with minimum 16-bit resolution
- iii. Minimum Data Storage of 1000 tests
- iv. Minimum Effective sampling rate of 50 readings per second

F. PC Desktop:

A desktop computer for test control, data acquisition and monitoring should also be provided. Following are the minimum PC requirements:

- i. Processor : 64 bit (i-5 Processor)
- ii. RAM: 8 GB DD4
- iii. Hard Drive: 1T
- iv. Monitor: 23" flat, expanded key board & mouse
- v. UPS
- vi. Operating system: Original MS Professional 64 bit version Windows compatible with equipment and software modules supplied.

G. Tool kit:

All fittings, fasteners, tubings and other tools required to complete the test setup.

Any other tools or accessories required for the purpose of installation and running the test